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A DICTIONARY

OF

HYGIENE AND PUBLIC HEALTH.

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789

A DICTIONARY

OF

HYGIÈNE AND PUBLIC HEALTH,

COMPRISING

SANITARY CHEMISTRY,
ENGINEERING, AND LEGISLATION,
THE DIETETIC VALUE OF FOODS,
AND THE DETECTION OF ADULTERATIONS,

ON THE PLAN OF

THE "DICTIONNAIRE D'HYGIÈNE PUBLIQUE" OF
PROFESSOR AMBROISE TARDIEU.

BY

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LONDON:
CHARLES GRIFFIN AND COMPANY,
STATIONERS' HALL COURT.
MDCCCLXXVI.

TO

THE RIGHT HONOURABLE EARL FORTESCUE,

AS A TRIBUTE OF ESTEEM

FOR HIS DISINTERESTED AND WELL-DIRECTED EFFORTS

IN THE CAUSE OF SANITARY SCIENCE,

This Work

(WITH HIS KIND PERMISSION)

IS RESPECTFULLY INSCRIBED

BY

THE AUTHOR.

PREFACE.

THE work now offered to the public aims at filling a vacant place in English sanitary literature, namely, that of a book of reference which, in one volume of convenient size, shall contain the information on sanitary topics at present only to be gathered from the perusal of many separate and distinct treatises.

It is not intended solely and entirely for any particular class. Sanitation is imperial—it concerns every living unit of the State, and is of equal value to all. Therefore, although the special wants of the practical hygienist—the medical officer of health and public analyst—have naturally claimed the first place, and received the attention which their importance demands, the Author has throughout endeavoured to render intelligible to non-professional readers also, every subject susceptible of such treatment.

At the outset, the task he proposed to himself was simply an adaptation for English readers of the well-known "Dictionnaire d'Hygiène Publique" of Professor Ambroise Tardieu; and the kind permission of the veteran hygienist had been obtained to translate such portions of his great work as should be deemed suitable for the purpose. But this plan was soon and of necessity abandoned, both on account of the exclusively *French* character of the work, and of the rapid strides made by sanitary science since the publication of its last edition. None the less, however, does the Author feel it incumbent on him to acknowledge the dictionary of Professor Tardieu as the basis of his own, and as a great assistance to him in the execution of the work.

Other valuable works to which the author is indebted are—

The works of Glen, Lumley, and Chambers on Sanitary Legislation.

The works of Bailey Denton, Eassie, Latham, and Rankine on Sanitary Engineering.

The works of Parkes and Gordon on Military Hygiène.

The works of Acton, Aitken, Allen, Atcherley, William Budd, Chevallier, Cooley, Corfield, Guy, Hassall, Sir William Jenner, Letheby, Liebig, Macnamara, Miller, Murchison, Normandy, Pereira, Parkes, Pavy, Pettenkofer, De Pietra-Santa, Rumsey, Angus Smith, Edward Smith, Léon Soubeiran, Taylor, Sir Henry Thompson, Ure, Wanklyn, and Wilson, on various subjects connected with Hygiène.

The Author's thanks are especially due to Dr. Angus Smith, the late Dr. Edward Smith, Mr. Atcherley, Mr. Bailey Denton, Messrs. Sutherland and Galton, Mr. James Lewis, and Mr. Edward Stanford, for permission to use extracts or diagrams, and to Dr. Slade King of Ilfracombe for preparing a list of errata.

A special feature of the present work is that it contains, in a form admitting of easy and rapid reference, the whole of the Public Health Act, 1875, as well as sections and portions of other sanitary statutes, without alteration or abridgement, save in a few unimportant instances.

Those who have to consult the Sanitary Acts, and know how difficult it frequently is to find any particular section, will, it is hoped, appreciate this arrangement.

The value of an undertaking of this kind must always be in exact proportion to its accuracy and completeness; and bearing these conditions in mind, the Author has spared no pains to fulfil both of them to the best of his ability. He ventures to hope that, whatever may be the shortcomings of his work in other respects, it will at least prove a useful one, and as such find a place on the library shelves of those interested in sanitary progress.

BARNSTAPLE,
February 1876.

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Map of the Geographical Distribution of Health and Disease (by permission, from Keith Johnston's Physical Atlas) . . . *To face page* 186

Diagram of the Intermittent Downward Filtration Sewage System, as in operation at Merthyr Tydfil (by permission of Mr Bailey Denton) *To face page* 524

ERRATA.

Page 4, col. 1, line 2, *for* "receives" *read* "receive."

,, 4, col. 2, the formula for caffeic acid should be $C_{14}H_{16}O_7$.

,, 11, col. 2, *for* "hence 1110·8 must be added" *read* "hence 110·8 c.c. must be added."

,, 50, col. 2, *for* "amygdala oleum" *read* "amygdalæ oleum."

,, 76, col. 1, 3d line from the bottom of the page, *for* "at figure 6" *read* "at figure 9."

,, 120, col. 1, the formula for caramel should be $C_{12}H_{18}O_9$.

,, 210, in the table, 1st column, 3d line, *for* "100" *read* "120."

,, 218, col. 3, near the bottom, *for* "offa" *read* "offal."

,, 256, article "Glucose," *for* "effluvia" *read* "effluvium."

,, 293, article "Hygiène," after the word "labourer" *insert* "and."

,, 323, article "Lactin," *for* "or $C_{12}H_{22}O_{11}H_{20}$" *read* "or $C_{12}H_{22}O_{11}H_2O$."

,, 334, article "Lice," *for* "especially the pubis" *read* "especially the pubes."

" 397, the formula of sinapine in article "Mustard" should be $C_{16}H_{23}NO_5$, and that of "myronate of potash" $K_2C_{20}H_{38}N_2S_4O_{19}$.

,, 400, last line in article "Mutual Aid Societies," *for* "and 1860" *read* "1860 and 1875."

,, 425, in article "Paraffine," *for* "a mat or garment" *read* "sand, earth, ashes, or a mat or garment."

,, 475, col. 2, line 28, *for* "1844" *read* "1814."

A

DICTIONARY OF HYGIÈNE.

Abattoir—Abattoirs are public slaughter-houses established in Continental and other towns. The subject is fully considered under SLAUGHTER-HOUSES.

Ablution—Personal cleanliness is one of the most important habits to inculcate on a people. It cannot be, however, lost sight of, that in order to introduce among the poorer classes habits of cleanliness, a plentiful water-supply and cheap baths are requisite. The *amount* as well as the *nature* of the water-supply should be inquired into by every medical officer of health. The body should be washed all over every morning with either cold or lukewarm water and soap. This custom is more necessary for workmen employed in laborious and dirty occupations than for men of sedentary lives; but all people perspire, and from every drop of perspiration the water evaporates away, and leaves a trace of solid matter on and around the sweat-pores. If this solid matter is not washed off, it accumulates, and may derange the health. It is then well to remember that dirt on the skin does not always come directly from without, but also from within. Cold ablution, that has been so indiscriminately recommended, is not half so efficacious or so safe as lukewarm. The German aurists, struck with the prevalence of deafness in England, ascribe it to our habit of washing the head and ears each morning with cold water.

Absinthium—Wormwood—The flowering herb of *Artemisia Absinthium;* nat. order *Compositæ;* indigenous, growing in thickets and mountainous places. It occurs in bundles of the dried herbs, having a silky touch, disagreeable odour, and intensely bitter taste. The plant yields its bitterness to water and spirit, and contains a volatile oil, green in colour, with the odour of the plant; also a bitter extract yielding *absinthine* ($C_{16}H_{22}O_5$) and absinic acid. The absinthine is the bitter principle. It is omitted now from the British Pharmacopœia, and its place occupied by the active principle santonine.

Absinthe is the name given to an intoxicating drink used largely by all classes of society on the Continent. An analysis recently made at the *Conservatoire des Arts* shows that absinthe now contains a large quantity of antimony, a poison which cannot fail to add largely to the irritant effects necessarily produced on the alimentary canal and liver by constant doses of a concentrated alcoholic liquid. And we have recently received the results of some experiments made by M. Magnau of Paris. By means of successive distillations he has been able to isolate various products—(1) a blue oil; (2) a yellowish oil; (3) an oxygenated product. There was besides a yellowish residue left in the glass. These various substances were tried on animals; ten grammes of the yellow sediment given to a small dog produced no effect; thirty centigrammes (about five grains) of the blue oil produced from eight to ten epileptiform attacks. The oxygenated product proved, however, the most powerful toxic agent. Fifteen centigrammes of it, injected into the veins of a large dog, caused the most violent epileptic attacks, which followed in rapid succession, and ended in death. There was an extraordinary rise of temperature, from 39° Centigrade to 42°, and the *post mortem* showed various apoplectic centres. Dr. Decaisne regards the terrible evil of this almost universal absinthe-drinking as the greatest national calamity that has ever befallen France, and has made an eloquent appeal to the Government to strike at once a decisive blow at the trade in this liqueur. Originally the only important ingredient in its composition besides alcohol was the essential oil of absinthium, or wormwood; and though this without doubt added something to the mischievous effects of the liquor, it would be impossible to trace to it, or to the other comparatively trivial ingredients, the more serious of the special results which are now observed to occur to victims of absinthe, though the habitual drinking even in small doses of *good* absinthe, is believed by Dr. Decaisne sooner or later to produce disorders in the human economy. Now, various deleterious substances are added, the most important of these being antimony. As at present constituted, therefore, and especially when drunk in the disastrous excess now common in Paris, and taken, as it frequently is, on an empty stomach, absinthe forms a chronic poison of almost unequalled virulence, both as an irritant to the stomach and bowels, and also as a destroyer of the nervous system. The effect of absinthe is to produce a superabundant activity of the brain, a cerebral excitement which at first is agreeable; intoxication comes on rapidly; the head swims, and the effect produced is nearly the same as that of poisoning by a narcotic, which certainly does not occur with an equal dose of brandy. With the absinthe-drinker, as with the opium-eater, the excitement the spirit produces diminishes daily in intensity. Each day he is obliged to augment the dose in order to bring himself up to the right pitch. The diseases brought on by the excessive drinking of ardent spirits are produced with greater rapidity by the use of absinthe.

The amount of absinthe consumed in London has during the last few years been enormously on the increase.

Acarus Farinæ, or Flour-Mite—This insect is found only in damaged flour, and is more frequently met with in the flour of the *Leguminosæ* than that of *Gramineæ*. A single acarus may occasionally be found in good flour; but even one should be looked on with suspicion, and the flour should be afterwards frequently examined to see if they are increasing. It differs considerably in structure from the *Acarus sacchari*.

Acarus Sacchari, or Sugar-Mite—Found in nearly all the brown sugars of commerce, and is in size so considerable that it is plainly visible to the unaided sight. It may always be detected by the following proceeding: Two or three drachms or teaspoonfuls of sugar should be dissolved in a large wine-glass of tepid water, and the solution allowed to remain at rest for an hour or so; at the end of that time the acari will be found, some on the surface of the liquid, some adhering to the sides of the glass, and others at the bottom, mixed up with the copious and dark sediment formed of fragments of cane, woody fibre, grit, dirt, and starch granules, which usually subside on the solution of even a small quantity of sugar in hot water. The *Acarus sacchari*, when first hatched, is scarcely visible, and first appears as a rounded body or egg. This becomes elongated and cylindrical, until it is about twice as long as broad. After a time the legs and proboscis begin to protrude. The body is partially covered by setæ, and the feet terminate in hooks. In its perfect state its structure is as follows: The body is oval, or rather somewhat ovate, being broader behind than before. From its posterior part four long and stiff bristles proceed, two together on each side, and some eight or ten smaller ones are arranged nearly at equal distances around the circumference of the body. From the anterior part a proboscis of complex organisation proceeds, and from its inferior surface eight legs, jointed and furnished with spines or hairs at each articulation. The spine which issues from the last joint but one of each leg is very long, and extends much beyond the termination of the leg itself. In most samples of sugar the acari may be seen of all sizes, that is, in all stages of their growth, and in every condition. In sixty-nine out of seventy-two samples of sugar examined by Dr. Hassall sugar acari were found.

Acarus Siro—Acarus Domesticus, or Cheese-Mite—A very small insect, scarcely perceptible without the aid of the microscope, found in decayed cheese; in fact, the dry and powdery parts of cheese consist almost entirely of these acari and their eggs, in different stages of development. The eggs of this insect are hatched in about eight days. The *Acarus siro* is furnished with a peculiar elongation of the snout, forming strong-cutting, dart-shaped mandibles, which it has the power of advancing separately or together. They appear to be able to retain life for a lengthened period though deprived of food. Leewenhoek informs us that one lived for eleven weeks gummed on its back to the point of a needle. When kept without food, it is no uncommon sight to see them killing and devouring each other. Cheese is rapidly destroyed by them; they crumble it into minute pieces, and emit a liquid substance which causes the decayed parts to spread speedily. Exposure to a strong heat quickly kills them, or plunging the cheese in whisky will have the same effect.

Acetic Acid—*See* Acid, Acetic.

Acid—The popular everyday signification of this word means anything which is sour to the taste. Scientifically speaking, acids are definite chemical compounds, which unite with alkalies, form bases, and redden vegetable blues. They are now generally considered salts of hydrogen; thus, sulphuric acid (H_2SO_4), hydrochloric acid (HCl), nitric acid (HNO_3), are called respectively the sulphate, the chloride, and the nitrate of hydrogen. In a public-health sense they are chiefly interesting as being emanated in the process of various manufactures, and then acting injuriously both on vegetation and man. Besides this, most of the more common ones are to a degree disinfectants, and many of them have been, by accident or design, used as poisons.

The gases evolved from manufactures of alkali used to contain so large a proportion of hydrochloric acid, that it had a most injurious effect on the vegetation of the surrounding district; so much so, that an Act was passed for the more effectual condensation of such gas in alkali-works (26 & 27 Vict. c. 124). This Act, in the first instance, was continued to the 1st of July 1868; but by 31 & 32 Vict. c. 36, s. 1, it has been continued without limitation to time. A section of the Act provides for the appointment of an inspector of such works by the Board of Trade. (*See* ALKALI ACT.) Now this acid is so effectually condensed that the air emitted from the flues hardly makes a solution of nitrate of silver turbid. The fumes from hydrochloric, sulphuric, sulphurous, nitric, and nitrous acids are quite irrespirable if attempts are made to inhale them in an undiluted form. Diluted well with air, as in some processes for making steel, they appear to irritate the lungs greatly, and have been said to cause pneumonia, bronchitis, and phthisical ulcerations of the tissue of the lungs. Amongst bleachers, and various workers in wool, bronchitis prevails, and the men look sallow and anæmic. This effect has been ascribed to the sulphurous acid disengaged.

The effect of acids on vegetation is a subject of practical importance, especially in relation to the question as to whether a manufactory is properly condensing its gases, or whether it is not injuring the surrounding country. The distance at which an acid-emitting manufactory has been found to injure vegetation is about 2187 yards; prevailing winds may, however, carry the vapours farther than this in particular directions; slight undulations in the ground, hedges, walls, belts of trees, and similar obstacles, modify and obviate the action in such a manner as to lead to the conclusion that the gas does not mix uniformly with the air, but is absorbed in small globules of water, which are thrown forward by currents of wind or air, and are driven over any wall or interruption to a distance in a curve from the top.—(ANGUS SMITH.) Rain washes acid gases down to the earth quickly; so that, though the local action is more severe, it is less extended.

The effect of acids on the vegetation is to be judged of by the general appearance of the plants, shrubs, and trees in the vicinity. The sources of error in this investigation are numerous, and are more especially due to the fact that dry cold winds, fungi, and insects, produce many spots and changes in leaves and plants similar to those from corrosive vapours. Acids shrivel and curl up the leaves, but do not, like winds, break the stalks, and render them ragged. The coloured spots on the leaves may be tested with litmus paper; but care must be exercised and careful comparisons instituted between the same leaves from healthy plants. Dr. A. Smith says, indeed, that many plants contain chlorides, even on the surfaces of the leaves, at a great distance from alkali-works. Mr. Rothwell affirms that in fields exposed to acid vapours, handfuls of dead grass may be pulled up in the spring, smelling strongly of the vapour, and that trees, under similar influences, become bark-bound. Dr. A. Smith gives, in his work on "Air and Rain," the following list of trees, in the order in which they are affected, on Mr. Rothwell's authority:—

Forest Trees.

1. Larch.
2. Spruce fir.
3. Scotch fir.
4. Black Italian poplar.
5. Lombardy poplar.
6. Ash.
7. Oak.
8. Elm.
9. Birch.
10. Alder.
11. Sycamore.

Fruit Trees.

1. Damson.
2. Greengage.
3. Halewood plum.
4. Jacob plum.
5. Pears.
6. Apples.
7. Cherries.

Shrubs, Evergreens, and Wild Plants.

1. British laurels.
2. Portugal laurels.
3. *Aucuba Japonica.*
4. Barberry evergreen.
5. Hazel.
6. Guelder rose.
7. Sloe thorn.
8. Hawthorn.
9. Raspberries.
10. Gooseberries.
11. Blackberries.
12. Gorse.
13. Hollies.

Farm Crops.

1. Potatoes.
2. Mangel.
3. White clover and rhubarb.
4. Red clover.
5. Trefoil.
6. Rye-grass.
7. Wheat.
8. Oats.
9. Barley.
10. Common turnips.
11. Swedes.

As well as a

Second list of plants affected by noxious vapours. mixing the classes according to the effects produced on each:—

I.

Fern, only in the summer.
Scotch firs, spruce, and larches, a little in winter.
Clover, wh. & red, receives damage in winter to roots.
Trefoil, " " "
Rye-grass, " " "
Poplars, " " "
Hawthorn, " " "
Potatoes, " " "

II.

Wheat receives some damage in winter.
Oats in May; when in the grass state soon receives damage.
Barley. Mangels. Common turnips. Rhubarb.

III.

Laurels, British and Portugal, Aucubas, Yews, Holly, Gorse — These plants receive damage in winter, but more in summer.

Old grass meadows and pastures receive much damage in the winter.

IV.

Ashes, oaks, hazels. Horse-chestnuts. Walnuts. Spanish chestnuts. Sloe thorn.

V.

Swedish turnip and cabbages. Damson. Other fruit trees. Beech. Elm. Birch. Alder. Sycamores.

As Disinfectants.—All the mineral acids are powerful if poured upon putrid matter, because they destroy it; but they are hardly suitable for common use, on account of their irritating nature to man. In 1773 Guyton Morveau wrote a large volume recommending muriatic acid as a disinfectant, and Dr. Carmichael Smith used nitrous acid at Winchester in 1780. Sulphurous acid is of real value, and has been used from the most ancient times as a disinfectant and fumigator. (*See* SULPHUR.) Of the organic acids, vinegar, or impure acetic acid, still deservedly retains some repute as a disinfectant; yet it is only a weak agent, at all events a poor protection against the germs of disease, for in vinegar itself infusoria and vegetable organisms develop. Most stinks are in all probability compound ammonias, at all events the odorous gases of this nature usually have an alkaline reaction; therefore vinegar or other acid fumes probably neutralise them. The most valuable of the acid disinfectants are, however, carbolic and tar acids.

The acids that have been used accidentally or designedly as poisons are sulphuric, hydrochloric, nitric, arsenic, and phosphoric among the mineral; oxalic, meconic, prussic, and a few others, among the organic acids. The most important of these will be considered under their respective heads.

The antidotes for poisoning by the mineral acids are chalk, magnesia, white of egg, oil, &c.

Acid, Acetic—($HC_2H_3O_2$)—Sp. gr. 1·063.—This acid derives its name from *acetum*, vinegar. It exists naturally in the sap of the oak, and in other plants. It is usually obtained from the destructive distillation of wood, or from the oxidation of alcohol. (*See* VINEGAR.) The acid is often adulterated with water, sometimes sulphuric acid and lead—the latter to such an extent as sometimes to be poisonous. The amount of acetic acid may be estimated by *acidimetry*, and the lead detected by passing a stream of sulphuretted hydrogen through it.

The acid in its concentrated form is a poison, but cases of this kind of poisoning are rare; the treatment would be the same as for the acids generally. (*See* ACIDS.) It is a valuable antiseptic, and is used in pickling and preserving animal and vegetable substances and anatomical preparations; it is also much employed in the arts, manufactures, and for medicinal and other purposes.

Acid, Benzoic—($HC_7H_5O_2$)—This acid is usually obtained by subliming it from gum benzoin; occasionally by dissolving it out from the gum by means of an alkaline liquid. Its principal adulterations are—hippuric acid, detected by its diminished solubility in water (1 part of pure benzoic acid is soluble in 300 of water), by its exhaling the odour first of the tonquin bean, and then of prussic acid; succinic acid, recognised by the solubility being increased; sugar, detected by the odour of caramel, and the black and carbonaceous residue—while pure benzoic acid sublimes. Camphor and spermaceti are also used, and may be detected by the odour, and other well-known properties.

Acid, Caffeic—According to Vlaanderen and Mulder, the formula for this acid is $C_{14}H_6O_7$. It is an astringent principle obtained from coffee. The dry berry contains about 5 per cent. of it.

Acid, Camphoric—($H_2C_{10}H_{14}O_4$)—Obtained from the oxidation of camphor by nitric acid. *See* CAMPHOR.

Acid, Carbolic (Phenic Acid), (Phenylic Acid)—($HC_6H_5O.$)—Sp. gr. of liquid, 1·065; fusing-point about 95° F. (35° C.); boiling-point, 369° (187° C.) This substance, when pure, is in crystals in the form of long, colourless needles. It is obtained from coal-tar. The commercial acid is, roughly speaking, of two kinds: one a cheap liquid, varying from a light-brown to a very dark, almost black, liquid; and Calvert's carbolic acid, which is in beautiful white crystals, and is used for medicinal and other purposes.

Properties.—The crystals, when pure, are white; but in keeping frequently become pink, rose, or crimson. It has a powerful tarry odour, and a very small quantity of water serves for its liquefaction. The crystals are very sparingly dissolved in water, but they are freely soluble in alcohol, acetic acid, and ether. With bases the acid forms phenates or carbolates — *e.g.*, carbolates of lime, potash, &c.

A slip of deal moistened with carbolic acid, and then dipped into hydrochloric or nitric acid, turns in drying to a blue colour.

A drop of the acid leaves a greasy stain on paper, which is, however, transient. Solutions of the acid do not redden litmus paper.

The most important properties of carbolic acid are its disinfectant and antiseptic powers. Of late years it has taken its position in popular estimation as the best practical deodoriser and disinfectant for drains, putrefying matter, &c. &c. ; and as a preventive of disease it has been placed in nearly all the urinals and water-closets of railway stations, in the hospitals, barracks, and other public places in the kingdom. It is invariably used in all kinds of contagious diseases to disinfect the excreta, and in a diluted form is frequently applied direct to the bodies of persons suffering from smallpox, scarlet fever, &c.

Nor has its use been confined to this country. In France, M. Devergie has warmly supported it, and declared it to be the best disinfectant known. He has employed it successfully in purifying the Morgue. This is done by a continuous stream of carbolised water, containing 1 of the acid to 4000 parts of water.

That it is extremely valuable for these several purposes it is impossible to doubt ; that it is superior to every other disinfectant, as some have asserted, may well be questioned. One of the gravest objections is its poisonous character. It is obvious that it is unsafe to drench and saturate all sorts of places with such an active poison as carbolic acid.

It certainly does not destroy when in a dilute form every form of contagion. Dr. H. J. Von Ankum, in the "Morandschrift voor Natuurwetenschappen," states that atmospheric air, to which the vapour of carbolic acid has been added, does not hinder the development of lower organisms in water with hay in milk or urine. Experiments have also been made with air saturated with carbolic acid on vaccine lymph, which has, after exposure to this agent for some time, still preserved its activity. This agrees with Pettenkofer's observation,* that carbolic acid preserves inert ferment cells, but they resume their activity upon withdrawal from its influence. In fact, its real action appears to be very similar to that of great cold, the substances are preserved as if frozen. On this account it must be looked upon with suspicion as a disinfectant when any contagious germs are to be dealt with ; it may fix them for a time, but does it destroy them? On the other hand, as an antiseptic it is of inestimable value. Mr. Crookes investigated it with great industry, and found that a solution of 1 per cent. preserved meat, skin, gut, and other substances if steeped in the solution and then dried ; it also stopped fermentation, and destroyed gnats, beetles, caterpillars, mites, fish, and infusoria.

* Allgemeine Zeitung, Feb. 4, 1866.

Angus Smith has recommended it for the disinfection of sewers. M'Dougall has used a mixture of tar oil and lime for this purpose in Carlisle ; and in Leipzig a mixture of chloride of magnesium, lime, and tar has been tried, and found of some practical value. The two principal carbolic acid powders in use here for various purposes are M'Dougall's and Calvert's.

M'Dougall's powder is composed of—

Carbolate of lime,	33
Sulphite of magnesia,	59
Water,	8
	100

Calvert's powder consists of carbolic acid (20 to 30 per cent.), alumina, and silica.

These powders may be sprinkled about a room, added to sewage, or diffused in water, and applied in solution.

In disinfecting cholera or typhoid stools, very strong solutions should be used. *See* DISINFECTANTS.

One part dissolved in 100 of olive oil or glycerine is a good application to make to the bodies of patients suffering from smallpox, scarlet fever, or other disease in which cells or germs are supposed to be thrown off.

It is used as a medicine both topically and internally—topically, as an application to the skin in the strong form as an escharotic ; and diluted, as a lotion to all kinds of foul sores, skin diseases, &c.

Internally it closely resembles creosote in its action, allays vomiting, and is said to be useful in diabetes.

During the prevalence of the cattle plague it was extensively used.

The appendix to the Royal Commissioners Report on the Cattle Plague contains the following:—

According to the principles laid down, the air must be treated, and where there is no disease there is only a secondary use in treating anything besides the air. Several cowhouses have been treated with carbolic acid with very excellent results. The mode has been, first, to remove from the floor the mass of manure which too often adheres to it; secondly, to sprinkle the floor with strong carbolic or cresylic acid; next, to wash the walls, beams, and rafters, and all that is visible in the cowhouse, with lime, in which is put some carbolic acid, 1 to 50 of the water used, or with strong carbolic acid alone. Next, to make a solution, containing 1 of carbolic or cresylic acid to 100 of water, or perhaps still better, 60 of water, and to water the yard and fold until the who place smells strongly of the acid. Only a few farms have been treated in this way, so far as I know, but in each it has been successful. It may be well to give the cattle a little of the weak solution of carbolic acid, but this has not been so fully tried as the external use. The washing of the mouth and entire animal with the weak solution may be attended with good results, especially in the early stage of disease; but I know nothing of cure, and speak only hopefully of prevention. The animals seem to have an instinct for disinfection, and lick substances touched with this acid. They must not be allowed to drink it, as when strong, as already said, it blisters the skin, and especially the mouth and tongue.

Mr. Crookes gives the results of his experiences as follows:—

It appeared evident that if harm were to follow the injection of carbolic acid, the mischievous effect would be immediate; but that if the fluid could pass through the heart without exerting its paralysing action on that organ, and could get into the circulation, no present ill effects need be anticipated. I therefore determined to push these experiments as far as possible, increasing the quantity of carbolic acid until it produced a fatal result. The next operation was on cow No. 11, in which 3 ounces of solution (containing 52½ grains of pure carbolic acid) were very slowly injected: no bad effect followed. Increasing the dose, cow No. 12 had injected into her vein 4½ ounces of solution (equal to 78¾ grains of carbolic acid); this also was followed by no immediate ill effect. Cow No. 13 was then treated with 6 ounces of solution (containing 105 grains of pure carbolic acid), in two portions of 3 ounces each, five minutes' interval elapsing between each injection. The first 3 ounces produced a slight trembling, but not so severe as in the case of cow No. 10, as she seemed better in a few minutes. The second dose of 3 ounces was injected. This proved too much, or was pumped in too hurriedly; for almost before I had finished, the animal trembled violently, its eyes projected, its breathing became laborious, it fell down and expired. The result could scarcely be attributed to the accidental injection of air into the vein, for the distress began with the injection of the first syringeful, and was only increased by the second; nor is it likely that this accident would happen twice consecutively. I was particularly careful on this point, and the construction of the instrument rendered such an occurrence scarcely possible with ordinary precaution. It is probable that the injection was performed too rapidly, or that the vital powers were lower than usual. In the case of the remaining animal, No. 14, I decided to inject as large a dose as it would bear, stopping the operation at the first sign of trembling, and delivering the liquid very gradually. The first syringeful caused no bad symptoms, and I had just finished injecting the second dose when trembling commenced. It was rather violent for a short time, but soon went off, and in five minutes the animal appeared as well as before. This cow, therefore, bore without inconvenience the injection of 6 ounces of a 4 per cent. solution, containing 105 grains of pure carbolic acid. Careful observations with the thermometer were taken before each operation. There were no more diseased beasts on the farm, or I should have carried my experiments still further. On visiting the farm the next day, I was told that all the animals seemed better; and on testing them with the thermometer that statement was confirmed. I gave directions that each animal was to be drenched with half a wine-glassful (1 ounce) of carbolic acid in a quart of warm water every morning, but in other respects they might be treated as Mr. Tomlinson, a skilful cow-doctor, should direct. Business now calling me to London, I was unable to watch the further progress of these cases. This is to be regretted, as a series of daily thermometric observations would have been of great value in suggesting further experiments. I had, however, frequent accounts sent me. Cow No. 14 continued to improve slowly until convalescent; she is now quite well. Nos. 10, 11, and 12 remained in apparently the same state for four days; they then changed for the worse, and died. It is not improbable that, had I been able to inject a further quantity of carbolic acid during the four days in which they were thus hovering between recovery and relapse, it would have turned the scale, and some of them, at all events, would be now alive and well.

The following table gives the thermometric observations:—

TABLE showing Results of Injecting Carbolic Acid into the Blood of Animals suffering from the Cattle Plague.

No.	Grains of Carbolic Acid injected.	Temperature before Injection.	Second Day.	Third Day.	
		F.	F.		
10	26¼	105·4	103·8	Better.	Died on 6th day.
11	52½	103·8	102·8	Better.	Died on 6th day.
12	78¾	104·8	104·4	Better.	Died on 6th day.
14	105	103·7	103·1	Better.	*Recovered.*

If future experiments prove that injection of carbolic acid or other antiseptic will do good, it is an operation very easily performed. I have injected five animals and taken thermometric observations within an hour. Sulphite or bisulphite of soda apparently occasions some pain, as the animals struggle very much; with carbolic acid I found them tolerably quiet. I have calculated the proportion which the carbolic acid bore to the whole quantity of blood in these operations. Taking the whole amount of blood in the animal at 150 pounds, there were injected into—

No. 10, one part carbolic acid, in 40,000 of blood.
,, 11, ,, ,, 20,000 ,,
,, 12, ,, ,, 13,300 ,,
,, 14, ,, ,, 10,000 ,,

It is worth mentioning incidentally, that in the case of cow No. 14 (which recovered) the proportion of carbolic acid injected into the blood would have been enough to keep from decomposition the whole quantity of that liquid for a considerable time. In Nos. 10, 11, and 12 the proportion of carbolic acid would probably not have been sufficient for that purpose. I am informed by Dr. Calvert that cresylic acid has much less coagulating power on albumen than carbolic acid, and my own experiments entirely confirm this statement.

We find in the "Gardeners' Chronicle," November 9, 1867, a description given by the Hon. W. Hope of experiments made on diseased cattle at his farm near Barking. He says:—

I thought that while there was life there was hope, and I determined to do more than anybody had done before; where one man had used a hundredweight of lime I determined to use a ton, and where one man had used a pint of carbolic acid I determined to use a gallon. The dry substance I had at hand to deal with in large quantities was lime. This I slaked in small pyramids in the centre of the sheds; I also laid trains of it outside the sheds underneath the ventilators, and then slaked it. I also smothered the roads and paths at different points in layers of quicklime, three or four inches deep, so that every man and animal would be compelled to pass it. After scouring out the sheds, every cow's tail was dipped into a bucket of carbolic acid and water. Their heads and noses were dabbed over with it, also their sides and flanks. All the manure and litter from the cow's stall, as well as from the adjoining ones, was taken out at once, and the floor thoroughly cleansed and saturated with carbolic acid; and on the suggestion of Professor Brown I had four days previously commenced the use of sawdust saturated with carbolic acid, one or two shovelfuls of which were placed every day underneath the cow's head. This operation was also repeated in each stall, and the cows were then drenched with gruel and sulphite of soda.

He then adds—

Of the fifty-eight cows in shed F. and fifty-three in shed E. that I took the entire charge of, and treated as described, I did not lose one. Two that had been condemned to death were "smuggled" out, and exchanged for two others of less value. These two condemned had been in actual contact with diseased animals in every stage of the disease, in no less than three infected, and highly-infected, sheds, and were even placed beside a diseased animal in a shed which had been emptied of diseased animals suffering from the most virulent type of the disease for a couple of days, and had only been disinfected for thirty-six hours.

Poisoning by Carbolic Acid.—There have been numerous cases of poisoning by this acid; in most cases it has been taken in mistake for medicine. The symptoms are, in the recorded cases, great prostration, inability to swallow, pain in the stomach and throat, black stools and dark urine, speechlessness, coma, weak pulse, and death.

Death usually takes place quickly. A young married woman, after taking about 7 oz., died without a struggle almost immediately. A child æt. 7, after taking ½ an ounce, died* comatose in 1 hour and 15 minutes. Another case died† in three-quarters of an hour after taking an ounce. But sometimes death takes place a considerable time afterwards. A young man, of 18 years of age, died in two days from the effects of a tablespoonful of acid. The pathological changes are usually limited to the tongue, pharynx, gullet, stomach, and intestines. In most cases these parts are covered by a white coating, which has been described as similar to whitelead. In one case, curiously enough, the action of the acid was limited to three feet of the small intestine, the whole of the canal, from the lips to the first two inches of the duodenum, escaping unhurt. In some cases, Dr. Moxon has witnessed a kind of tanning of the stomach; and in a case that Dr. Way brought before the Pathological Society, the mucous membrane of the stomach and the intestine for fifty inches was thickened and altered, and of a bluish-white colour. In all cases the odour of the acid has been distinctly perceived in the stomach, sometimes in the brain, and often in the urine.

Treatment.—The best treatment appears to be the prompt administration of bland oils, such as castor or sweet oil, in cases of poisoning; but unfortunately the action appears so rapid that, before assistance arrives, the case has gone too far. Besides, in most cases the power of swallowing is gone, and the stomach-pump is more likely to do harm than good. In the recorded cases, oil, gruel, brandy, and emetics appear to have been given with but little effect. Brandy should be avoided. There is generally great depression of temperature, which should be kept up by artificial means. If the dose of acid is large, under any known treatment the patient will probably die.

Tests.—The tests for carbolic acid have often failed, even when it has been smelt strongly in the animal fluids.

The odour is, therefore, in cases of poisoning, the most reliable. The following are some other tests: A slip of deal, as already mentioned, dipped in carbolic acid, then moistened with nitric or hydrochloric acid and dried, becomes of a bright blue colour.

Perchloride of iron added to carbolic acid gives a beautiful mauve or purple colour.

A small quantity of the acid put in a test-tube, a little saliva added, and then a few drops of tincture of guaiacum, allowed to stand exposed to the air, then shaken, becomes of a bottle-green colour.

A weak solution of carbolic acid, to which a little chlorinated lime has been added, and then liquor ammonia, shows a bright blue colour.

Carbolic acid may be distinguished from creosote by its solubility in glycerine. Creosote is insoluble in glycerine. *See* DISINFECTION, &c.

* Lancet, June 21, 1873. † Ibid., Feb. 18, 1873.

Acid, Carbonic—This acid is considered partly in the article Air, in which it is always present in minute quantity. Indeed its presence is essential to vegetation. Besides the sources of respiration and combustion, it issues in a comparatively pure state from the earth in various places, *e.g.*, the Grotto del Cane, in Italy, and the Valley of Poison, in Java. It is also to be found in all springs, and it gives to them their sparkling character. In a solid state it is combined with various constituents of the earth's crust, as limestone, magnesia, &c.

Its properties are well known. It is a colourless, uninflammable, irrespirable gas, haviug a slight pungent odour and feebly acid taste. Its chemical formula is CO_2; its equivalent is 44; its relative weight, 22; and specific gravity, 1·5203. It may be liquefied by pressure aud cold, or, in a simpler manner, by generating it in closed stroug vessels. It then forms a liquid as transparent as water, requiring a pressure of 38·5 atmospheres to retain it in the fluid state; aud when allowed to escape into the air, freezes, from the rapid evaporatiou, into a snow-white solid. Its most marked properties are its weight and power of extinguishing both flame and life. 100 cubic inches of it weigh, at 60° F. and 30° Bar., 47·303 grains. It may therefore be poured from one vessel to another like water, and it collects at the bottom of vessels, vats, mines, or other places where it is developed or introduced. An atmosphere containing one part of carbonic acid in 2500 acts upon the system like a narcotic poisou.

The tests and estimation of carbonic acid in air are described under that article. For carbonic acid in spring water, see Water, Analysis of.

When combined with bases in the numerous carbonates, the following method is generally employed: Two flasks (the size and weight of which must be regulated by the capacity of the operator's balance) are connected as in the diagram. The weighed substance put into *a*, the other one, *b*, is half filled with concentrated sulphuric acid. The tube *e* is closed by a little bit of indiarubber tubing drawn over it, and a small, accurately-fitting bit of glass rod inserted iu the open end. When all is ready, the apparatus is accurately weighed, the glass rod removed, and by sucking at *c*, successive portions of acid are made to pass over from *b*. The carbonic anhydride escapes perfectly dried through *d*. At the end of the operation the stopper is removed out of *a*, and air sucked through *d*; the stopper replaced, and the apparatus allowed to stand some hours, and then weighed again: the loss

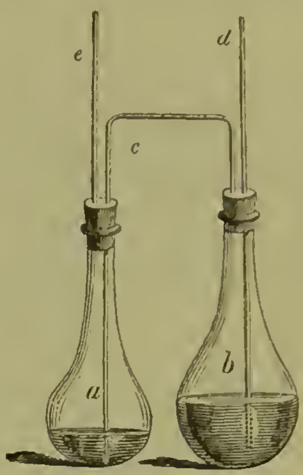

Fig. 1.

iudicates the carbonic acid. This process is not so suitable for bases which form insoluble salts with sulphuric acid, and in that case is modified by having a bulb on *a*, containing dilute nitric acid, which is allowed to escape from time to time on to the substauce in *a*. There are various other contrivances based upon the apparatus as above described; but the principle is the same, and it would be out of place here to go into more detail. Another very convenient method of estimatiug carbonic acid is by fusion of the previously dried and weighed carbouate with vitrified borax, also previously weighed. The loss of weight indicates very accurately the carbonic acid.

In cases of poisoning by this gas, the treatment of the drowned will be required, viz., artificial respiration, ammonia to the nostrils, free exposure to air, and galvanism.

Acid, Citric—*See* Citric Acid.

Acidimetry—This is the name of chemical processes by which the amount of free acid in any liquid is determined. It is of great use in the arts, as well as to the food analyst, who by it determines the amount of acid in beer, wine, &c. If the liquid contains a free acid, and is not mixed with anything else but water, the specific gravity may be taken in the ordinary way, or determined by a hydrometer; the percentage of acid will then be found by the aid of the following tables:—

TABLE showing the PERCENTAGES OF ANHYDROUS ACID corresponding to various specific gravities of Aqueous Nitric Acid, by URE. Temperature 15° C.

Specific Gravity.	Percentage of Anhydrous Acid.	Specific Gravity.	Percentage of Anhydrous Acid.	Specific Gravity.	Percentage of Anhydrous Acid.	Specific Gravity.	Percentage of Anhydrous Acid.
1·500	79·7	1·419	59·8	1·295	39·8	1·140	19·9
1·498	78·9	1·415	59·0	1·289	39·0	1·134	19·1
1·496	78·1	1·411	58·2	1·283	38·3	1·129	18·3
1·494	77·3	1·406	57·4	1·276	37·5	1·123	17·5
1·491	76·5	1·402	56·6	1·270	36·7	1·117	16·7
1·488	75·7	1·398	55·8	1·264	35·9	1·111	15·9
1·485	74·9	1·394	55·0	1·258	35·1	1·105	15·1
1·482	74·1	1·388	54·2	1·252	34·3	1·099	14·3
1·479	73·3	1·383	53·4	1·246	33·5	1·093	13·5
1·476	72·5	1·378	52·6	1·240	32·7	1·088	12·7
1·473	71·7	1·373	51·8	1·234	31·9	1·082	11·9
1·470	70·9	1·368	51·1	1·228	31·1	1·076	11·2
1·467	70·1	1·363	50·2	1·221	30·3	1·071	10·4
1·464	69·3	1·358	49·4	1·215	29·5	1·065	9·6
1·460	68·5	1·353	48·6	1·208	28·7	1·059	8·8
1·457	67·7	1·348	47·9	1·202	27·9	1·054	8·0
1·453	66·9	1·343	47·0	1·196	27·1	1·048	7·2
1·450	66·1	1·338	46·2	1·189	26·3	1·043	6·4
1·446	65·3	1·332	45·4	1·183	25·5	1·037	5·6
1·442	64·5	1·327	44·6	1·177	24·7	1·032	4·8
1·439	63·8	1·322	43·8	1·171	23·9	1·027	4 0
1·435	63 0	1·316	43·0	1·165	23·1	1·021	3·2
1·431	62·2	1·311	42·2	1·159	22·3	1·016	2·4
1·427	61·4	1·306	41·4	1·153	21·5	1·011	1·6
1·422	60·6	1·300	40·4	1·146	20·7	1·005	0·8

TABLE showing the PERCENTAGES OF HYDRATED ACID corresponding to various specific gravities of Aqueous Acetic Acid, by MOHR.

Specific Gravity.	Percentage of Hydrated Acid.	Specific Gravity.	Percentage of Hydrated Acid.	Specific Gravity.	Percentage of Hydrated Acid.	Specific Gravity.	Percentage of Hydrated Acid.	Specific Gravity.	Percentage of Hydrated Acid.
1·0635	100	1·0735	80	1·067	60	1·051	40	1·027	20
1·0655	99	1·0735	79	1·066	59	1·050	39	1·026	19
1·0670	98	1·0732	78	1·066	58	1·049	38	1·025	18
1·0680	97	1·0732	77	1·065	57	1·048	37	1·024	17
1·0690	96	1·0730	76	1·064	56	1·047	36	1·023	16
1 0700	95	1·0720	75	1·064	55	1·046	35	1·022	15
1·0706	94	1·0720	74	1·063	54	1·045	34	1·020	14
1·0708	93	1·0720	73	1·063	53	1·044	33	1·018	13
1·0716	92	1·0710	72	1·062	52	1·042	32	1·017	12
1·0721	91	1·0710	71	1·061	51	1·041	31	1·016	11
1·0730	90	1·0700	70	1·060	50	1·040	30	1·015	10
1·0730	89	1·0700	69	1·059	49	1·039	29	1·013	9
1·0730	88	1·0700	68	1·058	48	1·038	28	1·012	8
1·0730	87	1·0690	67	1·056	47	1·036	27	1·010	7
1·0730	86	1·0690	66	1·055	46	1·035	26	1·008	6
1·0730	85	1·0680	65	1·055	45	1·034	25	1·007	5
1·0730	84	1·0680	64	1·054	44	1·033	24	1·005	4
1·0730	83	1·0680	63	1·053	43	1·032	23	1·004	3
1·0730	82	1·0670	62	1·052	42	1·031	22	1·002	2
1·0732	81	1·0670	61	1·051	41	1·029	21	1·001	1

TABLE showing the Percentages of Anhydrous Acid corresponding to various specific gravities of Aqueous Hydrochloric Acid, by URE. Temperature 15° C.

Specific Gravity.	Percentage of Hydrochloric Acid	Specific Gravity.	Percentage of Hydrochloric Acid.	Specific Gravity.	Percentage of Hydrochloric Acid.	Specific Gravity.	Percentage of Hydrochloric Acid.
1·2000	40·777	1·1515	30 582	1·1000	20·388	1·0497	10·194
1·1982	40·369	1·1494	30·174	1·0980	19·980	1·0477	9·786
1·1964	39·961	1·1473	29·767	1·0960	19·572	1·0457	9·379
1·1946	39·554	1·1452	29·359	1·0939	19·165	1·0437	8·971
1·1928	39·146	1·1431	28·951	1·0919	18·757	1·0417	8·563
1·1910	38·738	1·1410	28·544	1·0899	18 349	1·0397	8·155
1·1893	38·330	1·1389	28·136	1·0879	17·941	1·0377	7·747
1·1875	37·923	1·1369	27·728	1·0859	17·534	1·0357	7·340
1·1857	37·516	1·1349	27·321	1·0838	17·126	1·0337	6·932
1·1846	37·108	1·1328	26·913	1·0818	16·718	1·0318	6·524
1·1822	36·700	1·1308	26·505	1·0798	16 310	1·0298	6·116
1·1802	36·292	1·1287	26·098	1·0778	15·902	1·0279	5·709
1·1782	35·884	1·1267	25·690	1·0758	15·494	1·0259	5 301
1·1762	35·476	1·1247	25 282	1·0738	15·087	1·0239	4·893
1·1741	35·068	1·1226	24·874	1·0718	14·679	1·0220	4·486
1·1721	34·660	1.1206	24·466	1·0697	14·271	1·0200	4·078
1·1701	34·252	1·1185	24·058	1·0677	13·863	1·0180	3·670
1·1681	33·845	1·1164	23·650	1·0657	13·456	1·0160	3·262
1·1661	33·437	1·1143	23·242	1·0637	13·049	1·0140	2·854
1·1641	33·029	1·1123	22·834	1·0617	12·641	1·0120	2·447
1·1620	32·621	1·1102	22·426	1·0597	12·233	1·0106	2·039
1·1599	32·213	1·1082	22·019	1·0577	11·825	1·0080	1·631
1·1578	31·805	1·1061	21·611	1·0557	11·418	1·0060	1·124
1·1557	31·398	1·1041	21·203	1·0537	11·010	1·0040	0·816
1·1537	30·990	1·1020	20·796	1·0517	10 602	1·0020	0·408

TABLE showing the Percentages of Hydrated and Anhydrous Acids corresponding to various specific gravities of Aqueous Sulphuric Acid, by BINEAU; calculated for 15° C., by OTTO.

Specific Gravity.	Percentage of Hydrated Acid.	Percentage of Anhydrous Acid.	Specific Gravity.	Percentage of Hydrated Acid.	Percentage of Anhydrous Acid.	Specific Gravity.	Percentage of Hydrated Acid.	Percentage of Anhydrous Acid.	Specific Gravity.	Percentage of Hydrated Acid.	Percentage of Anhydrous Acid.
1·8426	100	81·63	1·675	75	61·22	1·398	50	40·81	1·182	25	20·40
1·842	99	80·81	1·663	74	60·40	1·3886	49	40·00	1·174	24	19·58
1·8406	98	80·00	1·651	73	59·59	1·379	48	39·18	1·167	23	18·77
1·840	97	79·18	1·639	72	58 77	1·370	47	38·36	1·159	22	17·95
1·8384	96	78·36	1·627	71	57·95	1·361	46	37·55	1·1516	21	17·14
1·8376	95	77·55	1·615	70	57·14	1·351	45	36·73	1·144	20	16·32
1·8356	94	76·73	1·604	69	56·32	1·342	44	35·82	1·136	19	15·51
1·834	93	75·91	1·592	68	55·59	1·333	43	35·10	1·129	18	14·69
1·831	92	75·10	1·580	67	54·69	1·324	42	34·28	1·121	17	13·87
1·827	91	74·28	1·568	66	53·87	1·315	41	33·47	1·1136	16	13·06
1·822	90	73·47	1·557	65	53·05	1·306	40	32·65	1·106	15	12·24
1·816	89	72 65	1·545	64	52·24	1·2976	39	31·83	1·098	14	11·42
1·809	88	71·83	1·534	63	51·42	1·289	38	31·02	1·091	13	10·61
1·802	87	71·02	1·523	62	50·61	1·281	37	30·20	1·083	12	9·79
1·794	86	70·10	1·512	61	49·79	1·272	36	29·38	1·0756	11	8·98
1·786	85	69·38	1·501	60	48·98	1·264	35	28·57	1·068	10	8·16
1·777	84	68·57	1·490	59	48·16	1·256	34	27·75	1 061	9	7·34
1·767	83	67·75	1·480	58	47·34	1·2476	33	26·94	1·0536	8	6·53
1·756	82	66·94	1·469	57	46·53	1·239	32	26·12	1·0464	7	5·71
1·745	81	66·12	1·4586	56	45·71	1·231	31	25·30	1·039	6	4·89
1·734	80	65·30	1·448	55	44·89	1·223	30	24·49	1·032	5	4·08
1·722	79	64·48	1·438	54	44·07	1·215	29	23·67	1·0256	4	3·26
1·710	78	63·67	1·428	53	43·26	1·2066	28	22·85	1·019	3	2·445
1 698	77	62·85	1·418	52	42·45	1·198	27	22 03	1·013	2	1·63
1·686	76	62·04	1·408	51	41·63	1·190	26	21·22	1·0064	1	0·816

TABLE showing the Percentages of Crystallised Acid corresponding to various specific gravities of Aqueous Tartaric Acid, by OSANN.

Specific Gravity.	Percentage of Crystallised Acid.
1·274	51·42
1·208	40·00
1·174	34·24
1·155	30·76
1·122	25·00
1·109	22·27
1·068	14·28
1·023	5·00
1·008	1·63

The more generally useful method is, however, to prepare an alkaline fluid of known strength, and neutralise the acid. In order to do this, the operator requires burettes, tincture of litmus, or litmus paper, a dilute acid of known strength, and a dilute alkaline fluid also of known strength. The acid solution must in all cases be diluted so as to contain an exact equivalent number in grammes or grains of the acid in 1000 c. c. or parts. For instance, 40 grammes of sulphuric, 36·46 of hydrochloric, 63 of oxalic to the litre. These solutions are called normal acids.

The normal alkaline solution is made so that one volume of it exactly neutralises one volume of the acid solution. Soda is nearly always used. In order to prepare it, a solution of soda is made, and diluted until about the specific gravity 1·05, which corresponds to 3·6 per cent. of soda. A portion of it is then run from a burette, until it exactly neutralises 30 c. c. of a normal acid solution. The exact point of neutrality is determined by litmus. Suppose 27 c. c. of soda neutralises 30 of the acid, then it is too strong; to every 27 c. c. 3 c. c. of water must be added—*i.e.*, 111·1 to the litre.

The solutions of normal acid must be prepared with great care; the acids used must be absolutely pure. A solution of oxalic acid Fresenius does not think so good for acidimetry as hydrochloric acid, on account of the difficulties in drying the former. (*See* ACID, OXALIC.) The normal hydrochloric acid is thus prepared:—900 c. c. of water are mixed with 180 c. c. of ordinary pure hydrochloric acid of 1·12 specific gravity. Fill a burette with the mixture, measure off two quantities of 20 c. c. each, precipitate the acid with nitrate of silver, carefully filter, dry, ignite, and weigh the resulting precipitate: the two precipitates should agree very closely. Take the mean of them, and calculate from them how much water must be added to 1000 c. c. *E.g.*, suppose 20 c. c. contained ·810 grammes of hydrochloric acid, therefore 1000 c. c. contains 40·5 grammes, consequently we have—

$$36{\cdot}46 \; : \; 1000 \; :: \; 40{\cdot}5 \; : \; x = 1110{\cdot}8$$

Hence 1110·8 must be added to the litre of water. Normal sulphuric acid is prepared on a similar plan, only it is precipitated by chloride of barium. (The resulting sulphate, if multiplied by ·34335, gives the sulphuric acid.) The actual analysis is performed by taking a determinate quantity, say 100 c. c., of the liquid to be examined, and dropping from a burette the alkaline liquid until exact neutrality, as determined by litmus paper or tincture of litmus, and the number of centimetres used will indicate the amount of free acid.

The following table will be found useful:—

WEIGHT of the RESPECTIVE ACIDS equivalent to the given weight of the principal bases, Hydrogen being taken as unity.

17 grains of pure ammonia
31 ,, anhydrous soda
40 ,, hydrate of soda
53 ,, dry carbonate of soda
143 ,, crystallised carbonate of soda
84 ,, crystallised bicarbonate of soda
47 ,, anhydrous potassa
56 ,, hydrate of potassa
69 ,, dry carbonate of potassa
100 ,, crystallised bicarbonate of potassa
50 ,, pure chalk / ,, marble
28 ,, fine caustic lime
37 ,, hydrate of lime (fresh)
44 ,, dry carbonic acid (when the bicarbonate of soda or potash is used for testing in the process of Fresenius and Will)
22 ,, dry carbonic acid (when a dry carbonate is used)

Are exactly neutralised by

51 acetic acid (anhydrous).
60 ,, ,, (crystallised or glacial).
99 arsenious acid (dry).
35 boracic acid (dry).
67 citric acid (crystallised).
85 gallic acid (dried at 212°).
94 ,, ,, (crystallised).
127½ hydriodic acid (dry or gaseous).
27 hydrocyanic acid (anhydrous).
36½ hydrochloric acid (dry or gaseous).
109 ,, ,, (liquid, sp. gr. 1·162).
166½ iodic acid.
54 nitric acid (anhydrous).
63 ,, ,, (liquid, monohydrated, sp. gr. 1·517 to 1·521).
67½ ,, ,, (liquid, sesquihydrated, sp. gr. 1·5033 to 1·504).
72 ,, ,, (liquid, binhydrated, sp. gr. 1·486).
90 ,, ,, (liquid, sp. gr. 1·42).
36 oxalic acid (anhydrous).
63 ,, ,, (crystallised).
72 phosphoric acid (anhydrous).
81 ,, ,, (glacial).
50 succinic acid (dry or anhydrous crystals).
59 ,, ,, (ordinary crystals).
40 sulphuric acid (anhydrous).
49 ,, ,, (liquid, monohydrated, sp. gr. 1·8485).
75 tartaric acid (crystallised).
212 tannic acid (dried)

Acid, Lactic ($H_2C_6H_{10}O_6$) — A transparent, inodorous, syrupy liquid with a sharp taste; sp. gr. 2·215. It was first obtained by Scheele from whey. It is an important constituent of the gastric juice. It is found in muscular tissue, in small quantities in the urine and sweat, and has, in cases of diabetes, been met with in the saliva. It also exists in some plants, *e.g.*, *Nux vomica*. When milk is said to turn sour, this sourness is due to a special fermentation. The caseine acts like diastase or other ferments. Peculiar cells, like those of yeast, but smaller, make their appearance, and lactic acid appears in the liquid; but as caseine is coagulated by acid, directly this change has taken place, the ferment caseine is coagulated, and the action stops, to be again renewed, however, if chalk, &c., is added to neutralise the acid. Besides milk, many other organic liquids will undergo this fermentation. It is, indeed, a frequent result of the acetification of vegetable substances. The most effective way of preparing the acid is that of Wackenroder. Digest together 25 parts of sugar of lead, 20 of powdered chalk, 100 of skimmed milk, 200 of water, at 75° F. In six weeks the chalk will be dissolved. The whole is then heated, but not to boiling; the cheese is separated, pressed, and the liquid decanted, clarified by albumen, and evaporated; the lactate of calcium crystallises. It may then be decomposed by sulphuric or oxalic acids.

Acid, Meconic (*μήκων*, a poppy)—This acid is contained in opium. Its formula is $H_3C_7HO_7,3H_2O$. It strikes a blood-red colour with chloride of iron, and this fact forms the basis for a valuable test in suspected cases of opium poisoning. *See* OPIUM.

Acid, Oxalic (Dihydric Oxalate) ($H_2C_2O_42H_2O=90+36$) — This substance is made on a very large scale by heating a mixture of hydrate of potash and sawdust. It may also be obtained by heating tartaric, citric, or malic acid with potassic hydrate, and by boiling starch or sugar with nitric acid. The process above mentioned of obtaining oxalic acid from sawdust (Robert Dale & Co.'s patent) has so cheapened this acid, that whereas in 1851 it cost 16d. a pound, it now costs about half that. It occurs naturally in the wood-sorrel (*Oxalis acetosella*), in the *Rumex acetosa*, and in the leaf-stalks of the common rhubarb.

It is of importance to obtain this acid perfectly pure. The purification of the oxalic acid of commerce is very easy. The process is carried out as follows:—The impure acid is put into a flask, and treated with lukewarm distilled water, in such proportions as will leave a large amount of the acid undissolved, and shaken. Filter, crystallise, and let the crystals drain dry at the ordinary temperature in blotting-paper. Another process is to decompose oxalate of lead by dilute sulphuric acid. If the acid is prepared in this way, it has the formula $H_2C_2O_42H_2O$, and its equivalent is accordingly 63.

It is used by the analyst in various methods of analyses, especially in alkalimetry, acidimetry, and in standardising various volumetric solutions.

In order to detect the acid in the contents of the stomach (which in such a case would be strongly acid), the contents are boiled with distilled water, filtered, then treated with a solution of acetate of lead. If oxalic acid is present, it will be precipitated as an oxalate of lead. This precipitate must be well washed, and then suspended in water, through which pass a stream of sulphuretted hydrogen, filter off the black sulphide of lead, evaporate to dryness, weigh and test the residue. Another way is by treating the oxalate of lead by sulphide of ammonium, and obtaining thus the oxalate of ammonia.

Having obtained by either method a substance supposed to be oxalic acid or oxalate of ammonia, the following tests may be applied. Lime water gives a precipitate in solutions of oxalic acid of oxalate of lime, a white powder, insoluble in acetic acid, but soluble in strong mineral acids. If a little solid oxalic acid is treated with strong sulphuric acid in a test tube, it is decomposed, froths up, emitting carbonic acid and carbonic oxide, the latter burning with a blue flame. A solution of oxalic acid reduces the salts of gold. The former tests agreeing, with its physical properties, will easily identify the acid if present.

Acid, Phenic—*See* ACID, CARBOLIC.

Acid, Prussic (syn. **Acid Hydrocyanic**) — (HCy = 27) — Observed specific gravity of vapour 0·9476, of liquid 0·7058 at 44·6° (7° C.); melting-point, 5° F. (−15° C.); boiling-point, 80° F. (26·5° C.); rel. weight 13·5. This substance is a most deadly poison. In its concentrated state, it kills with a lightning-like rapidity; but in the dilute commercial form, even after a large dose, a few simple acts, such as walking to a bedroom door, putting a cork in a bottle, getting into bed, &c., have been performed. The symptoms are paleness, syncope, gasping for breath, convulsions, contracted pupils, nausea, insensibility, and death.

The most appropriate remedy is ammonia,

both internally and applied to the nostrils. A little weak liquor ammonia may, if time permit, be injected under the skin or into the veins. Chlorine water has also done good, and cold douches to the head.

To detect the acid in the contents of the stomach, or in any fluid, if the smell, either of bitter almonds or of the acid itself, be perceptible, and the liquid have an acid reaction, simple distillation into a receiver, containing a little distilled water, will separate it in a tolerably pure state. If the reaction is alkaline, the liquid may contain cyanide of potassium—a very common salt. In such a case, a little sulphuric acid added to it, and then distilled as before, will separate it in the form of dilute hydrocyanic acid.

The dilute prussic acid obtained by either of the above processes may be tested as follows:—Add a little liquor potassa, a few drops of a solution of sulphate of iron, and then a little perchloride of iron: the result is Prussian blue—the blue turned to brown by alkalies. This is very reliable evidence of prussic acid.

Add nitrate of silver, a white precipitate, curdy, insoluble in cold dilute nitric acid, soluble in ammonia and cyanide of potash, denotes cyanide of silver, and is also a very reliable test.

A very accurate and convenient method is to take two accurately-fitting watch-glasses, moisten the one with a little sulphuric acid, add a few drops of the liquid for examination, invert the other one over it, which must contain a little sulphide of ammonium. (Or the two watch-glasses may be placed the one above the other, in the ordinary way, under a glass shade.) After a little time the upper one is removed, dried, and perchloride of iron is added. If prussic acid is present, a blood-red colour is produced, which is discharged by bichloride of mercury, thus distinguishing it from the similar colour afforded by meconic acid.

The chief forms in which prussic acid is ordinarily met with are—

1. The dilute medicinal acid = 2 per cent. anhydrous acid.
2. Scheele's acid = 2 per cent. anhydrous acid.
3. Cyanide of potassium, 2½ grains = 50 drops of medicinal acid.
4. Oil of bitter almonds = 13 per cent. anhydrous acid.

Acid, Pyroligneous — Impure acetic acid, obtained from the destructive distillation of wood. Owing to its impurities, which are of a tarry nature, it is a little more antiseptic than pure acetic acid. *See* ACID, ACETIC.

Acid, Pyrogallic ($C_6H_6O_3$)—This substance has no acid reaction. It forms brilliant plates, freely soluble in water, alcohol, and ether. It is prepared by subliming gallic acid, which may be mixed with pumice-stone, and put in a retort, through which carbonic acid gas is passed.

It is used in photography, and in the analysis of air and other gases, where it is of great value, from the fact that an alkaline solution of pyrogallic acid absorbs oxygen rapidly, and will completely remove it from air or other mixture of gases.

Acid, Sulphurous (Sulphurous Anhydride)—Properly speaking, the latter is the proper name, as its chemical composition is represented by the symbols SO_2; and it is composed of 1 volume of sulphur united with 2 of oxygen, the three volumes, at the time of combination, being condensed into two. The theoretic specific gravity of the gas is 2·2112; observed specific gravity, 2·247; of the liquid, 1·38 at 60°(15° C.); melting-point, −105° F. (−76° C.); boiling-point, 14° F. (10° C.) This substance is ordinarily in the form of a gas, but may be liquefied by intense cold.

It is prepared for commercial purposes by deoxidising charcoal or sawdust by sulphuric acid, and distilling. It is accompanied in this case by half its volume of carbonic anhydride.

In a pure state for the laboratory, 90 grammes of concentrated sulphuric acid are boiled with 15 grammes of copper clippings; the result is sulphate of copper, water, and pure sulphurous anhydride. It is also prepared by heating sulphur and oxide of manganese; and whenever sulphur is burned in air, this gas is formed.

Properties and Uses.—The gas has a pungent, suffocating odour, and if a person inhales it slightly or entirely undiluted, it rapidly causes death. In a dilute form it acts simply as an irritant, and causes running at the eyes and nose, sneezing, &c. It quickly extinguishes flame, and is not inflammable. By passing it through a tube, cooled by a freezing mixture, it may be condensed to a colourless transparent liquid, which dissolves bitumen. Water takes up 68·8 of its bulk of this gas at 32° F., 43·5 at 59° F. (15° C.), and 32 at 75° F. (24° C.) Thus it is extremely soluble. When passed into water it combines with it, and is then converted into the real acid—sulphurous acid (H_2SO_3)—but this compound has never been isolated. Sulphurous acid combines with bases, forming sulphites, bisulphites, and hyposulphites.

This gas is extensively used by the bleachers of straw, wool, silken goods, isinglass, sponge, and other goods. It is a most excellent antiseptic. It is used in this country to keep casks sweet before putting cider, &c., in them; and in Italy, also, a little sulphur is burnt in the casks to purify them. Meat, sealed up in canisters, filled with sulphurous acid, and with the addition of nitrogen, or a little nitric oxide, keeps fresh for years.

Another way which Mr. Gamgee has introduced, is to kill the animal with carbonic oxide, and then the meat is preserved in canisters filled with carbonic oxide and sulphurous acid gas. A piece of meat, about an inch broad and thick, and about three inches long, was sealed up by Dr. Angus Smith in a bottle, and was good at the end of twenty-eight days, but its colour had changed to pink. As a disinfectant, either as a fumigating agent, or in solution, it deservedly takes a high place. As a fumigator, it has been used from the earliest times, and is mentioned by Ulysses in Homer (Odyssey, Bk. xxii. l. 492). It is used to fumigate sick-rooms, destroy odours, and has been lately employed in rather a large scale to sewers. (*See* SEWERS.) It does not appear to remove all odours, but certainly the greater number of them. It acts chemically as a deoxidiser, and then it appears to oxidise afterwards by parting with its own oxygen. Sometimes, also, when mixed with vegetable matter, it is entirely decomposed, and sulphuretted hydrogen is given off. Its exact action on the low forms of animal life is hardly known. Certain it is, that, even much diluted, it stops the amœboid movements of living cells, destroys or kills vibrios, and acts deleteriously on vegetation. It has been suggested that, as the acid is always present in towns, it is the cause of the decay of the teeth, principally from the fact that, in works where this gas is emanated, the workmen lose their teeth.

It is a most valuable agent as a parasiticide —especially the vegetable parasites—and as such is used in cutaneous affections with the most beneficial effect, whether the disease exists in man or animals. It has also been used in the Cattle Plague by Dr. Dewar and others, and they have spoken very highly of its effects in this disease. By the chemist, among other uses, it is employed to reduce peroxide of iron to protoxide.

The sulphites have a very similar action as disinfectants, and are sometimes more convenient. In order to disinfect clothes, letters, and other articles, the articles may be suspended over pieces of lighted brown paper, previously coated with sulphur, or over a shovel, or dish of red-hot coals, upon which sulphur is sprinkled, or in which a crucible is immersed containing a lump of sulphur. To thoroughly disinfect a room, it should be almost hermetically sealed, and a very large quantity of sulphur burnt. In such a case, if this agent is used, there may be some destruction of property, for it discharges vegetable colours, attacks iron, and is absorbed by cloth, leather, &c. Indeed, in cases of contagious fevers, it can rarely be used in sufficient quantity to be really efficient. *See* DISINFECTANTS.

Aconite — Aconite Root — Aconiti radix—Natural order, *Ranunculaceæ.*—The root, dried, of *Aconitum Napellus*, imported from Germany, or cultivated in Britain, and collected in winter or early spring before the leaves have appeared. Numerous cases of poisoning have occurred from this root being mistaken for horse-radish; but there are striking differences, horse-radish root being of a *long cylindrical* shape, of the same size and thickness for many inches, and whitish-yellow outside, having a powerful pungent odour when scraped, whilst aconite root is SHORT and CONICAL, *tapering rapidly to a point.* Externally its colour is of an earthy brown, but white inside, having a strong earthy odour.

Aconitia—Aconitina—An alkaloid obtained from aconite. The plant is about five feet in height. The leaves are deep green on the upper surface, lighter beneath, smooth, palmate, five partite, the segments wedge-shaped and pinnately cut. The root is fusiform, like a carrot, from one to three inches long, not thicker than the finger at the crown, with fleshy fibres, dark brown on the surface, whitish within. The *flowers* are purple, helmet-shaped, numerous, and in dense racemes. All parts of the plant are bitter and acrid, causing a tingling of the lips and skin, followed by numbness. They contain the alkaloid *aconitia* ($C_{30}H_{47}NO_7$), united with *aconitic* acid ($C_6H_6O_6$). Another base is also present, which has been named *Aconella*, resembling narcotine in its composition and properties, capable of crystallisation, but not possessing the active properties of aconitia. Aconitia is a white, uncrystallisable solid, soluble in 150 parts of cold and 50 parts of hot water, and much more soluble in alcohol and ether; alkaline, neutralising acids, and precipitated from them by the caustic alkalies. It is a very active poison, entirely soluble in pure ether, and leaves no residue when burned with free excess of air.

The separation of this poison in a *post-mortem* examination seems at present almost an impossibility, owing to the changes which it undergoes in the organism, as well as by its decomposition during the process of evaporation and exposure to the air, by which it becomes converted into *ammonia.* Nor are there any peculiar chemical reactions by which it can be readily identified. Its physiological—that is, its benumbing and paralysing—effects are the only prominent ones. The following are the principal tests. *Cold nitric* or *sulphuric acid* applied to the solid produces *no reaction;* but if heated with the latter acid, it produces a brown colour.

The *caustic alkalies* produce with its solutions a *white precipitate*, which is redissolved on the addition of more water, by which it is distinguished from *atropia.*

Chloride of gold produces an abundant *yellow amorphous precipitate.*

Chloride of platinum produces NO PRECIPITATE with this alkaloid, which is characteristic. In cases of poisoning, an emetic should at once be given, and the patient placed in the recumbent position, applying friction over the heart, and chafing the limbs. If the patient can swallow, a stimulant should be given.

Aconitia is often very impure: sometimes it is mixed with *delphinia*, and sometimes it contains *aconella*, the other principle contained in the root, and precipitated with the aconitia. Pure aconitia in $\frac{1}{50}$ gr. dose will destroy a dog; but 1 gr. of the spurious alkaloid can often be given without much effect.

Act Adulteration (35 & 36 Vict. c. 74)—This Act is now repealed, and the Sale of Food and Drugs Act substituted in its stead. *See* ADULTERATION.

Act, Alkali—*See* ALKALI ACT.

Act, Artisans and Labourers Dwellings, 1868 (31 & 32 Vict. c. 130), **Artisans Dwellings, 1875**—*See* HABITATIONS.

Act, Bakehouse (26 & 27 Vict. c. 40)—*See* BAKEHOUSE.

Act, Bakehouse Regulation (26 & 27 Vict. c. 40)—Both rural and urban authorities have to carry out, and are subject to the provisions of, this Act. *See* BAKEHOUSE.

Acts, Baths and Washhouses—These are "An Act to Encourage the Establishment of Public Baths and Washhouses" (9 & 10 Vict. c. 74), and an Act amending the same (10 & 11 Vict. c. 61). These Acts may or may not be adopted by an urban authority. *See* BATHS.

Act, Coal Mines Regulation, 1872 (35 & 36 Vict. c. 7)—*See* MINES, SANITARY LEGISLATION, &c.

Acts, Common Lodging-House, 1851 (14 & 15 Vict. c. 28), **1853** (16 & 17 Vict. c. 41)—Both these Acts are repealed, and included in the Public Health Act, 1875, except those portions which relate to the Metropolitan Police District.

Acts, Contagious Diseases—*See* CONTAGIOUS DISEASES ACT, VENEREAL DISEASES, PROSTITUTION, &c.

Act, Diseases Prevention—The whole of this Act, except so far as relates to the Metropolis, has been repealed, and is included in the Public Health Act, 1875. *See* DISEASES, PREVENTION OF.

Acts, Factory—*See* FACTORY; TRADES, INJURIOUS.

Acts, Labouring Classes Lodging-Houses.—Under this general appellation are included the Labouring Classes Dwelling-Houses Act, 1851 (14 & 15 Vict. c. 34), the Labouring Classes Dwelling-Houses Act, 1866 (29 & 30 Vict. c. 28), Labouring Classes Dwelling-Houses Act, 1867 (30 & 31 Vict. c. 28). The whole of these Acts apply only to urban districts, and may or may not be adopted; but where they are in force, the provisions must be duly carried out by the urban authority.

Acts, Land Clauses, Consolidation of—*See* LANDS, PURCHASE OF.

Acts, Local—There are various local Acts still in force in different places. The Local Government Board has now the power by provisional order to wholly or partially repeal, alter, or amend any Local Act (with the exception of a Local River Conservancy Act). Any such provisional order may provide for the extension of the provisions of the Local Act referred to therein beyond the district within the limits of such Act, or for the exclusion of the whole or a portion of any such district from the application of such Act; and may provide what local authority shall have jurisdiction for the purposes of the Public Health Act in any area which is by such order included in or excluded from such district (P. H., s. 303).

All Acts whatever done by authorities by virtue of the powers conferred upon them by a Local Act are valid, notwithstanding the passing of the Public Health Acts, 1872 and 1875 (P. H. 338).

Where a local sanitary Act is in force within the district of a local authority, proceedings may be instituted at discretion, either under the Local Act or under the General Act (*i.e.*, P. H.); but no person may be punished for the same offence both under a Local Act and under the Public Health Act, nor is the local authority, by reason of the existence of a Local Act in their district, exempted from the performance of any duty or obligation to which they are subject under the Public Health Act, 1875 (P. H. 340).

Acts, Local Government, 1858 (21 &

22 Vict.), **1861** (24 & 25 Vict. c. 61), and **1863** (26 & 27 Vict. c. 17)—These Acts have been repealed, and are included in the Public Health Act, 1875. *See* LOCAL BOARDS, URBAN SANITARY AUTHORITY, &c.

Act, Markets and Fair Clauses, 1847 (10 & 11 Vict. c. 14)—*See* MARKETS.

Acts, Nuisance Removal, 1855 (18 & 19 Vict. c. 121), **1860** (23 & 24 Vict. c. 77), **1863** (26 & 27 Vict. c. 117), **1866** (29 & 30 Vict. c. 4), are all repealed, except so far as relates to the Metropolis, and included in the Public Health Act, 1875.

Act, Petroleum, 1871 (34 & 35 Vict. c. 105)—*See* PETROLEUM.

Act, Pharmacy, 1868 (31 & 32 Vict. c. 53)—*See* POISONS.

Acts, Public Health, 1848 (11 & 12 Vict. c. 63), **1872** (35 & 36 Vict. c. 79), and its Amendment Act of 1874, are included in the Public Health Act of 1875, and are altogether repealed with a few exceptions relating to the Metropolis. *See* DISTRICTS, SANITARY; MEDICAL OFFICER OF HEALTH; INSPECTOR OF NUISANCES, &c. &c.

Act, Public Health, 1875 (38 & 39 Vict. c. 55)—This important Act became law on the 11th of August 1875. It repeals and embodies the Public Health Acts, the Local Government Act, the Nuisance Removal Acts, the Sanitary Acts, the Sewage Utilisation Acts, and the Diseases Prevention Act, either entirely or partially, as set forth in detail in the first and second parts of the fifth schedule of the Act, as follows :—

SCHEDULE V.

PART I.

ENACTMENTS which have been already repealed are in a few instances included in this repeal, in order to avoid the necessity of reference to previous statutes.

SESSION AND CHAPTER.	TITLE OR SHORT TITLE.	EXTENT OF REPEAL.
11 & 12 Vict. c. 63. ...	The Public Health Act, 1848. ...	The whole Act.
14 & 15 Vict. c. 28. ...	The Common Lodging-Houses Act, 1851.	The whole Act, except so far as relates to the Metropolitan Police District.
16 & 17 Vict. c. 41. ...	The Common Lodging-Houses Act, 1853.	The whole Act, except so far as relates to the Metropolitan Police District
18 & 19 Vict. c. 116. ...	The Diseases Prevention Act, 1855.	The whole Act. except so far as relates to the Metropolis.
18 & 19 Vict. c. 121. ...	The Nuisances Removal Act for England, 1855	The whole Act, except so far as relates to the Metropolis.
21 & 22 Vict. c. 98. ...	The Local Government Act, 1858.	The whole Act.
23 & 24 Vict. c. 77. ...	An Act to amend the Acts for the Removal of Nuisances and the Prevention of Diseases.	The whole Act, except so far as relates to the Metropolis.
24 & 25 Vict. c. 61. ...	The Local Government Act (1858) Amendment Act, 1861.	The whole Act.
26 & 27 Vict. c. 17. ...	The Local Government Act Amendment Act, 1863.	The whole Act.
26 & 27 Vict. c. 117. ...	The Nuisances Removal Act for England (Amendment) Act, 1863.	The whole Act, except so far as relates to the Metropolis.
28 & 29 Vict. c. 75. ...	The Sewage Utilisation Act, 1865.	The whole Act, except so far as relates to Scotland and Ireland.
29 & 30 Vict. c. 41. ...	The Nuisances Removal (No. 1) Act, 1866.	The whole Act, except so far as relates to the Metropolis.
29 & 30 Vict. c. 90. ...	The Sanitary Act, 1866.	Parts I., II., and III., except so far as relates to the Metropolis or to Scotland or Ireland.
30 & 31 Vict. c. 113. ...	The Sewage Utilisation Act, 1867.	The whole Act, except so far as relates to Scotland or Ireland.
31 & 32 Vict. c. 115. ...	The Sanitary Act, 1868.	The whole Act. except so far as relates to the Metropolis.
32 & 33 Vict. c. 100. ...	The Sanitary Loans Act, 1869. ...	The whole Act. except so far as relates to the Metropolis
33 & 34 Vict. c. 53. ...	The Sanitary Act, 1870	The whole Act, except so far as relates to the Metropolis.
35 & 36 Vict. c. 79. ...	The Public Health Act, 1872. ...	The whole Act, except so far as relates to the Metropolis.
37 & 38 Vict. c. 89. ...	The Sanitary Law Amendment Act, 1874.	The whole Act, except so far as relates to the Metropolitan Police District.

Of the above Acts, the following (namely), "The Public Health Act, 1848," and "The Local Government Act, 1858," and "The Local Government Act (1858) Amendment Act, 1861," and "The Local Government Act Amendment Act, 1863," are in this Act referred to as "The Local Government Acts."

PART II.

Session and Chapter.	Title or Short Title.	Extent of Repeal.
12 & 13 Vict. c. 94. ...	The Public Health Supplemental Act, 1849.	The whole Act, except— Section 1 (confirmation of certain provisional orders of the General Board of Health), and section 12 (short title of Act), and the schedule
13 & 14 Vict. c. 90. ...	The Public Health Supplemental Act, 1850 (No. 2).	The whole Act, except— Section 1 certain provisional orders of General Board of Health confirmed), and section 7 (short title of Act), and the schedule.
15 & 16 Vict. c. 42. ...	The first Public Health Supplemental Act, 1852.	Sections 6 to 12, both inclusive (first election or first selection and election of certain local boards), and section 13 (11 & 12 Vict. c. 63, ss. 68, 69, as to repair of highways), and section 14 (interpretation of year), and section 15 (Act incorporated with Public Health Act).

The Act does not extend to Scotland or Ireland, nor to the Metropolis, except where expressly stated.

It contains 343 sections or clauses, and is divided into eleven parts, as follows:—

I. *Preliminary.*—This part is almost entirely composed of definitions of various words and titles used.

II. *Authorities for Execution of the Act.*—This part provides for the division of the whole of England into rural and urban sanitary districts, describes the authorities, and lays down their powers.

III. *Sewerage and Drainage.*—This division provides authorities with the necessary powers for constructing sewers and dealing with sewage, and, generally speaking, confers on local authorities power to enforce drainage where necessary.

It enacts penalties for building houses without privy accommodation, and gives power to enforce closets or privies where necessary.

It provides for the scavenging and cleansing of streets, the purification of houses, and, generally, the removal of filth.

It contains important sections relative to the supply, storing, and protection of water; it regulates lodging-houses, defines nuisances, forbids the unauthorised establishment of offensive trades in urban districts, gives powers with regard to unhealthy or unsound foods, contains provisions as to the establishment of hospitals, the prevention of infectious and epidemic disease, and the establishment of mortuaries.

IV. *Local Government Provisions.* — This portion of the Act relates entirely to urban districts, and regulates certain matters relative to highways, streets and buildings, markets, public pleasure-grounds, and police.

V. *General Provisions.*—The general provisions of the Act are those relative to contracts, the purchase of lands, arbitration, bylaws, the conduct of business, the appointment and the duties of the officers of local authorities.

VI. *Rating and Borrowing Powers.*—This division defines the expenses of the different authorities, makes provision for meeting those expenses by rates, gives power to borrow for certain sanitary purposes, and provides for the efficient audit of the accounts.

VII. *Legal Proceedings.*—This portion of the Act contains sections setting forth in detail the legal procedure for the prosecution of offences, and the recovery of penalties; providing an appeal in certain cases to Quarter Sessions, in others to the Local Government Board; it also lays down the exact manner in which notices are to be served.

VIII. *Alteration of Areas and Union of Districts.*—This portion gives very large powers to the Local Government Board in regard to the alteration of areas and the union of districts, not alone for sewerage and general purposes, but also for the purpose of appointing a medical officer of health; it also provides for the constitution, expenses, &c., of port sanitary authorities.

IX. *Local Government Board.*—This part of the Act is exclusively devoted to sections relating to the powers, orders, and proceedings of the Local Government Board.

X. *Miscellaneous and Temporary Provisions.*—The miscellaneous provisions are those relative to entry on lands, penalty for obstructing the execution of the Act, compensation in certain cases, hop-pickers, &c. The temporary provisions relate to the clerk and treasurer of certain authorities, to special district rates, to main sewerage, district and joint sewerage boards, and a few other matters.

XI. *Saving Clauses and Repeal of Acts.*—This division, as its title implies, contains various saving clauses, and is followed by the schedules.

The various sections of the Public Health Act and its schedules will be found, either in detail or in substance, throughout this work; and in quoting the Act the abbreviation P. H. will be employed.

Act Regulating Sale of Intoxicating Liquors (35 & 36 Vict. c. 94)—*See* ALCOHOLIC BEVERAGES.

Act, Sanitary, 1866 (29 & 30 Vict. c. 90)—The first, second, and third parts of this Act are repealed, except so far as relates to the Metropolis, or to Scotland or Ireland; the whole of the Sanitary Act, 1868 (31 & 32 Vict. c. 115), and the whole of the Sanitary Act, 1870, except so far as relates to the Metropolis, is repealed, and the main provisions of the whole three Acts are included in the Public Health Act, 1875.

Act, Sanitary Loans, 1869 (32 & 33 Vict. c. 100)—The whole of this Act, except so far as relates to the Metropolis, is repealed; its main provisions are embodied in the Public Health Act, 1875. *See* EXPENSES, WATER-SUPPLY, &c.

Acts, Sewage Utilisation (28 & 29 Vict. c. 75, and 30 & 31 Vict. c. 113)—The whole of these Acts are repealed, except so far as relates to Scotland or Ireland.

Act, Towns Improvement Clauses, 1847 (10 & 11 Vict. c. 34)—The following provisions of this Act are incorporated in the Public Health Act, 1875, and refer exclusively to urban districts:—

1. With respect to naming the streets and numbering the houses.
2. With respect to improving the line of the streets and removing obstructions.
3. With respect to ruinous or dangerous buildings.
4. With respect to precautions during the construction and repair of the sewers, streets, and houses.
5. With respect to the regulation of slaughter-houses.

Notices for alterations under the 69th, 70th, and 71st sections, directions under the 73d section, and orders under the 74th section of the said Towns Improvement Clauses Act, may, at the option of the urban authority, be served on owners instead of occupiers, or on owners as well as occupiers, and the cost of works done under any of these sections may, when notices have been so served on owners, be recovered from owners instead of occupiers; and when such cost is recovered from occupiers, so much thereof may be deducted from the rent of the premises where the work is done as is allowed in the case of private improvement rates under the Act. (P. H., 160.)

Act, Towns Police Clauses, 1847 (10 & 11 Vict. c. 89)—The following provisions of this Act are incorporated with the Public Health Act, 1875:—

1. With respect to obstructions and nuisances in the streets.
2. With respect to fires.
3. With respect to places of public resort.
4. With respect to hackney carriages.
5. With respect to bathing.

The Act applies to *urban* districts only (P. H., 171).

Act, Watching and Lighting (3 & 4 Will. IV. c. 90) is now superseded by the Public Health Act (38 & 39 Vict. c. 55, s. 163). *See* GAS.

Act, Water-Works Clauses, 1863—This Act is incorporated with the Public Health Act (38 & 39 Vict. c. 55, s. 57), and also certain clauses of the Water-Works Act, 1847. *See* WATER.

Adipocere—*See* SAPONIFICATION.

Adulteration—This term is only properly applied to the adding of substances to articles of commerce, food, or drink, for the purposes of deception or gain; but the term by magistrates and analysts is often practically applied to accidental impurity, or even in some cases to actual substitution.*

The Society of Public Analysts have unanimously adopted the following definition of an adulterated article.

An article shall be deemed to be adulterated—

A. In the case of food or drink—

1. If it contain any ingredient which may render such article injurious to the health of a consumer.
2. If it contain any substance that sensibly increases its weight, bulk, or strength, or gives it a fictitious value, unless the amount of such substance present be due to circumstances necessarily appertaining to its collection or manufacture, or be necessary for its preservation, or unless the presence thereof be acknowledged at the time of sale.
3. If any important constituent has been wholly or in part abstracted or omitted, unless acknowledgment of such abstraction or omission be made at the time of sale.

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* *E.g.*, a person was fined under the Adulteration Act for selling as citrate of magnesia a substance which did not contain a particle of that salt, and a hawker for selling cigars in which there was no tobacco at all.

4. If it be an imitation of, or be sold under the name of, another article.

B. In the case of drugs—

1. If when retailed for medicinal purposes under a name recognised in the British Pharmacopœia it be not equal in strength and purity to the standard laid down in that work.

2. If when sold under a name not recognised in the British Pharmacopœia it differ materially from the standard laid down in approved works on Materia Medica, or the professed standard under which it is sold.

Limits.—The following shall be deemed limits for the respective articles referred to:—

Milk shall contain not less than 9·0 per cent., by weight, of milk solids not fat, and not less than 2·5 per cent. of butter-fat.

Skim Milk shall contain not less than 9·0 per cent. by weight of milk solids not fat.

Butter shall contain not less than 80·0 per cent. of butter-fat.

Tea shall not contain more than 8·0 per cent. of mineral matter, calculated on the tea dried at 100° C., of which at least 3·0 per cent. shall be soluble in water, and the tea *as sold* shall yield at least 30·0 per cent. of extract.

Cocoa shall contain at least 20 per cent. of cocoa-fat.

Vinegar shall contain not less than 3·0 per cent. of acetic acid.

The practice of fraudulent adulteration has existed for ages. In our own country an enactment to prohibit adulteration was in force as early as 1267, and punishments for it were provided in 1581, 1604, 1836, 1851, &c. &c. Public attention was drawn to it in 1822 by Accum's "Death in the Pot;" and in 1855 Dr. Hassall, an excellent microscopist, published his "Food and its Adulterations." Later, a variety of works by Letheby, Pavy, Hassall, Parkes, and others, on food, &c., have appeared, which, with the aid of the evidence brought before the Commissioners of the House of Commons, and the "Lancet" Sanitary Commission, have enabled the public to better appreciate the nutritive value of pure food, and the nature of some of the adulterations practised, and finally led to the important Adulteration Acts.

The sophistications may be divided into several distinct classes:—

1. To give weight or volume, such as water added to butter; plaster-of-Paris to flour, &c.; red earths to annatto; sand to tea leaves, &c.; water to milk, &c.: all these, therefore, are substitutious of worthless or very cheap articles which take the place of the real.

2. To give a colour which either makes a good article more pleasing to the eye, or else disguises an inferior one—*e.g.*, Prussian blue, black-lead, &c., to green teas; annatto to cheese, &c.; arsenite of copper to sweetmeats, &c.

3. Substitutions of a cheaper form of the article, or the same substance from which the strength has been extracted put in the place of the real—*e.g.*, tea mixed with spent leaves, &c.

4. A very small class, where the adulteration is really added with no fraudulent intent, but to enhance the quality of the goods sold—*e.g.*, alum to bread, when added in small quantities. *See* BREAD.

The following is a list of the principal adulterations practised:—

Name.	Nature of Adulteration.
Aconitia	With other alkaloids—*e.g.*, delphinia, aconella, &c.
Ale	Common salt, *Cocculus Indicus*, grains of paradise, quassia, and other bitters, sulphate of iron, alum, &c.
Allspice	Mustard husks.
Anchovies	Other fish and colouring-matters—*e.g.*, Armenian bole, Venetian red, &c.
Annatto	All sorts of starch, soap, red ferruginous earths, carbonate and sulphate of lime, salts, &c.
Arrowroot	Various other fecula, such as sago, tapioca, potato, and others.
Balsam of copaibæ	Turpentine and fixed oils.
Beef (potted)	Armenian bole.
Bismuth	Carbonate of lead, sometimes arsenic.
Bloaters (potted)	Armenian bole.
Brandy	Water, burnt sugar, &c.
Bread	Potatoes (mashed), alum, inferior flour, &c. &c.
Butter	Water, salt, colouring-matter, lard, tallow, and other fats.
Cajuput oil	Copper, camphor dissolved in oil of rosemary, and coloured with copper (as a substitute).
Calamine	Coloured sulphate of baryta.
Calomel	Sulphate of baryta, chalk, white precipitate, white-lead, pipe-clay, &c. &c.
Calumba	Tinged bryony root, root of *Frasera Walteri*, and others.
Cambogе	Starch, &c.
Camphor	A substitution of Borneo camphor has been made.
Cantharides	Golden beetle, artificially-coloured glass, &c.
Carbonate of lead	Sulphate of baryta, sulphate of lead, chalk, &c. &c.
Carmine (cochineal)	Sulphate of baryta, boneblack, &c.
Cassia (senna)	Leaves of *Solenostemma argel*, and other foreign leaves.
Castor oil	Other oils, often small quantities of croton oil.
Cayenne	Ground rice, vermilion, Venetian red, turmeric.
Champagne	Gooseberry and other wines as a substitute, different colouring-matters, &c.
Cheese	Annatto, bole (Armenian), and other colouring-matters.
Chicory	Colouring-matters, such as ferruginous earths and burnt sugar, Venetian red, &c.; and different flours, such as wheat, rye, beans, &c.; and sometimes sawdust.
Cider	Lead (as an impurity, not intentional).
Cigars	Substitutions of hay and other rubbish, inferior tobaccoes, &c.
Cinnamon	Cassia, clove stalks, and different flours.
Claret	Brandy, and substitution of inferior wines.
Cloves	Clove stalks.
Cocoa and chocolate	Cheaper kinds of arrowroot, such as *Tous-les-mois*, Maranta, and East Indian, animal matter, corn, sago, tapioca, &c.

Name.	Nature of Adulteration.
Coffee	Chicory, roasted wheat, rye flours, and colouring-matters, such as burnt sugar, &c.
Cod-liver oil	Other oils mixed with it.
Colocynth (extract comp.)	The extract is not unfrequently made with the pulp and seeds
Confectionery	Injurious colouring-matters, such as arsenite of copper, chromate of lead, &c.
Confection, aromatic	Expensive ingredients omitted, turmeric substituted for saffron, &c. &c.
Copal	Gum dammar, resin, &c.
Curry powder	Red-lead, ground rice, salt.
Cusparia bark	The bark of *Strychnos nux vomica* has been substituted.
Custard and egg powder	Turmeric, chrome yellow, and different flours.
Elaterium	Starch, flour, chalk, &c.
Epsom salts	Chloride of magnesium, chalk, &c.
Ether	Alcohol.
Flour	Other and inferior flours, as the flour from rice, bean, Indian corn, potato, &c., sulphate of lime, alum.
Gelatine	Salt and sugar.
Gin	Water, sugar, flavouring-matters of different kinds, turpentine, alum, tartar.
Ginger	Turmeric and husks of mustard, flour from wheat, sago, &c.
Guaiacum resin	Other resins.
Honey	Flour, cane-sugar.
Hops	*Cocculus Indicus*, grains of paradise, &c. &c.
Iodide of potash	Water, carbonate of potash, chlorides of soda and potash, iodate of potash, iodine, &c.
Iodine	Water, plumbago, charcoal, black oxide of manganese, &c.
Ipecacuanha	Other roots, extraneous woody fibre; also in powder, chalk, flour, &c., have been added.
Isinglass	Gelatine.
Jalap	Raspings of guaiacum, false jalap root, &c.
Lard	Carbonate of soda, salt, potato, flour, lime.
Lemon juice	A mixture of sugar-and-water, acidulated with sulphuric acid, has been substituted.
Liquorice	Rice, chalk, gelatine, and different flours.
Magnesia (oxide) sulphate	Lime, carbonate of magnesia.
Magnesia carb	Lime, sulphate, &c. &c.
Marmalade	Apple or turnip pulp.
Mercury	Lead, tin, zinc, bismuth, &c.
,, green iodide of.	Red iodide of mercury.
,, oxide of	Brick-dust, red-lead, &c.
,, white precipitate of	Chalk, carbonate of lead, plaster-of-Paris, &c. &c.
Milk	Water.
Mustard	Turmeric, wheat flour.
Myrrh	Gum bdellium, and other gum resins.
Oatmeal	Barley flour, rubble.
Opium	Stones, sand, clay, vegetable extracts, sugar, treacle, water, &c.
Pareira root	Different roots substituted
Pepper	Linseed-meal, different flours, mustard husks, &c.
Pickles	Salts of copper, acetate of copper, &c.
Porter and stout	Sugar, treacle, water, and salt.
Potash	Carbonate, sulphate, and chloride of potash, lime, iron, and alumina.
,, acetate of	Sulphates and chlorides of potash.
,, carbonate of	Sulphates and chlorides of potash.
Potash, bicarbonate of	Carbonate of potash.
,, citrate	Sulphates of potash.
,, chlorate of	Chloride of potassium.
,, tartrate of	Tartrate of lime.
,, nitrate of	Sulphate or chloride of potash.
Preserves	Salts of copper.
Quinine	Sulphate of lime, chalk, magnesia, cane-sugar, sulphate of cinchonine, &c. &c.
Rhubarb	Turmeric, and inferior varieties substituted for Turkey.
Rum	Water, cayenne, burnt sugar.
Sago	Potato flour.
Sauce	Treacle, salt, cochineal, Armenian bole, and other colouring-matters.
Scammony	Chalk, starch, guaiacum, jalap, dextrin, &c.
Senega	Ginseng, gillenia.
Senna	Leaves of *Cyanchum argel*.
Sherry	Sulphates of potash, soda, brandy, burnt sugar, &c.
Snuff	Carbonate of ammonia, glass, sand, colouring-matters, &c.
Soda, bicarbonate of	Carbonate and sulphate of soda.
Soda, carbonate of	Sulphate of soda.
,, phosphate of	Phosphate of lime.
Spices	Colouring materials, substitutions, and different flours.
Squills	Wheat flour.
Sugar	Sand, flour, &c.
Sulphur	Sulphurous acid (as an impurity).
Sulphuric acid	Lead, water, arsenic, hydrochloric acid.
Tapioca	Mixing inferior starches with the true tapioca.
Tea	Sand, iron filings,* exhausted tea leaves, foreign leaves; and in green teas, black-lead, Prussian blue, China clay.
Tobacco	Sometimes inferior tobacco mixed with good, water; other adulterations rare.
Turmeric	Yellow ochre, carbonate of soda or potash.
Uvæ ursi (bearberry leaves)	Leaves of red whortleberry and others.
Vinegar	Sulphuric acid, and metallic impurities.
Wines	Water, jerupiga, bitartrate of potash, substitution of inferior wines, brandy, spirits, and various other matters.
Zinc, oxide of	Chalk, carbonate of magnesia.

The Sale of Food and Drugs Act has now taken the place of several Acts passed during the present century to prevent adulteration. There yet remains an Act prohibiting the mixture of injurious ingredients with intoxicating liquors, and one or two statutes regulating trade frauds, as, for example, the Adulteration of Seeds Act, 1869. These Acts have not been incorporated in the Sale of Food and Drugs Act.

SALE OF FOOD AND DRUGS (38 & 39 Vict. c. 63).

An Act to repeal the Adulteration of Food Acts, and to make better provision for the Sale of Food and Drugs in a pure state. (11*th August* 1875).

Whereas it is desirable that the Acts now in force relating to the adulteration of food should be re-

* By "iron filings" is meant an earth strongly impregnated with iron; it is without doubt a Chinese adulteration. *See* TEA.

pealed, and that the law regarding the sale of food and drugs in a pure and genuine condition should be amended :

Be it therefore enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows :

1. From the commencement of this Act the statutes of the twenty-third and twenty-fourth of Victoria, chapter eighty-four, of the thirty-first and thirty-second of Victoria, chapter one hundred and twenty-one, section twenty-four of the thirty-third and thirty-fourth of Victoria, chapter twenty-six, section three, and of the thirty-fifth and thirty-sixth of Victoria, chapter seventy-four, shall be repealed, except in regard to any appointment made under them and not then determined, and in regard to any offence committed against them or any prosecution or other act commenced and not concluded or completed, and any payment of money then due in respect of any provision thereof.

2. The term "food" shall include every article used for food or drink by man, other than drugs or water :

The term "drug" shall include medicine for internal or external use :

The term "county" shall include every county, riding, and division, as well as every county of a city or town not being a borough :

The term "justices" shall include any police and stipendiary magistrate invested with the powers of a justice of the peace in England and any divisional justices in Ireland.

Description of Offences.

3. No person shall mix, colour, stain, or powder, or order or permit any other person to mix, colour, stain, or powder, any article of food with any ingredient or material so as to render the article injurious to health, with intent that the same may be sold in that state, and no person shall sell any such article so mixed, coloured, stained, or powdered, under a penalty in each case not exceeding fifty pounds for the first offence ; every offence, after a conviction for a first offence, shall be a misdemeanour, for which the person, on conviction, shall be imprisoned for a period not exceeding six months with hard labour.

4. No person shall, except for the purpose of compounding as hereinafter described, mix, colour, stain, or powder, or order or permit any other person to mix, colour, stain, or powder, any drug with any ingredient or material so as to affect injuriously the quality or potency of such drug, with intent that the same may be sold in that state, and no person shall sell any such drug so mixed, coloured, stained, or powdered, under the same penalty in each case respectively as in the preceding section for a first and subsequent offence.

5. Provided that no person shall be liable to be convicted under either of the two last foregoing sections of this Act in respect of the sale of any article of food, or of any drug, if he shows to the satisfaction of the justice or court before whom he is charged that he did not know of the article of food or drug sold by him being so mixed, coloured, stained, or powdered as in either of those sections mentioned, and that he could not with reasonable diligence have obtained that knowledge.

6. No person shall sell to the prejudice of the purchaser any article of food or any drug which is not of the nature, substance, and quality of the article demanded by such purchaser, under a penalty not exceeding twenty pounds ; provided that an offence shall not be deemed to be committed under this section in the following cases ; that is to say—

(1.) Where any matter or ingredient not injurious to health has been added to the food or drug because the same is required for the production or preparation thereof as an article of commerce, in a state fit for carriage or consumption, and not fraudulently to increase the bulk, weight, or measure of the food or drug, or conceal the inferior quality thereof ;

(2.) Where the drug or food is a proprietary medicine, or is the subject of a patent in force, and is supplied in the state required by the specification of the patent ;

(3.) Where the food or drug is compounded as in this Act mentioned ;

(4.) Where the food or drug is unavoidably mixed with some extraneous matter in the process of collection or preparation.

7. No person shall sell any compound article of food or compounded drug which is not composed of ingredients in accordance with the demand of the purchaser, under a penalty not exceeding twenty pounds.

8. Provided that no person shall be guilty of any such offence as aforesaid in respect of the sale of an article of food or a drug mixed with any matter or ingredient not injurious to health, and not intended fraudulently to increase its bulk, weight, or measure, or conceal its inferior quality, if at the time of delivering such article or drug he shall supply to the person receiving the same a notice, by a label distinctly and legibly written or printed on or with the article or drug, to the effect that the same is mixed.

9. No person shall, with the intent that the same may be sold in its altered state without notice, abstract from an article of food any part of it so as to affect injuriously its quality, substance, or nature, and no person shall sell any article so altered without making disclosure of the alteration, under a penalty in each case not exceeding twenty pounds.

Appointment and Duties of Analysts, and Proceedings to obtain Analysis.

10. In the city of London and the liberties thereof the Commissioners of Sewers of the city of London and the liberties thereof, and in all other parts of the metropolis the vestries and district boards acting in execution of the Act for the better local management of the metropolis, the court of quarter sessions of every county, and the town council of every borough having a separate court of quarter sessions, or having under any general or local Act of Parliament or otherwise a separate police establishment, may, as soon as convenient after the passing of this Act, where no appointment has been hitherto made, and in all cases as and when vacancies in the office occur, or when required so to do by the Local Government Board, shall, for their respective city, districts, counties, or boroughs, appoint one or more persons possessing competent knowledge, skill, and experience, as analysts of all articles of food and drugs sold within the said city, metropolitan districts, counties, or boroughs, and shall pay to such analysts

such remuneration as shall be mutually agreed upon, and may remove him or them as they shall deem proper; but such appointments and removals shall at all times be subject to the approval of the Local Government Board, who may require satisfactory proof of competency to be supplied to them, and may give their approval absolutely or with modifications as to the period of the appointment and removal, or otherwise: Provided that no person shall hereafter be appointed an analyst for any place under this section who shall be engaged directly or indirectly in any trade or business connected with the sale of food or drugs in such place.

In Scotland the like powers shall be conferred and the like duties shall be imposed upon the commissioners of supply at their ordinary meetings for counties, and the commissioners or boards of police, or where there are no such commissioners or boards, upon the town councils for boroughs within their several jurisdictions; provided that one of Her Majesty's Principal Secretaries of State in Scotland shall be substituted for the Local Government Board of England.

In Ireland the like powers and duties shall be conferred and imposed respectively upon the grand jury of every county and town council of every borough; provided that the Local Government Board of Ireland sha'l be substituted for the Local Government Board of England.

11. The town council of any borough may agree that the analyst appointed by any neighbouring borough or for the county in which the borough is situated, shall act for their borough during such time as the said council shall think proper, and shall make due provision for the payment of his remuneration, and if such analyst shall consent, he shall during such time be the analyst for such borough for the purposes of this Act.

12. Any purchaser of an article of food or of a drug in any place being a district, county, city, or borough where there is any analyst appointed under this or any Act hereby repealed shall be entitled, on payment to such analyst of a sum not exceeding ten shillings and sixpence, or if there be no such analyst then acting for such place, to the analyst of another place, of such sum as may be agreed upon between such person and the analyst, to have such article analysed by such analyst, and to receive from him a certificate of the result of his analysis.

13. Any medical officer of health, inspector of nuisances, or inspector of weights and measures, or any inspector of a market, or any police constable under the direction and at the cost of the local authority appointing such officer, inspector, or constable, or charged with the execution of this Act, may procure any sample of food or drugs, and if he suspect the same to have been sold to him contrary to any provision of this Act, shall submit the same to be analysed by the analyst of the district or place for which he acts, or if there be no such analyst then acting for such place to the analyst of another place, and such analyst shall, upon receiving payment as is provided in the last section, with all convenient speed analyse the same, and give a certificate to such officer, wherein he shall specify the result of the analysis.

14. The person purchasing any article with the intention of submitting the same to analysis shall, after the purchase shall have been completed, forthwith notify to the seller or his agent selling the article his intention to have the same analysed by the public analyst, and shall offer to divide the article into three parts to be then and there separated, and each part to be marked and sealed or fastened up in such manner as its nature will permit, and shall, if required to do so, proceed accordingly, and shall deliver one of the parts to the seller or his agent.

He shall afterwards retain one of the said parts for future comparison, and submit the third part, if he deems it right to have the article analysed, to the analyst.

15. If the seller or his agent do not accept the offer of the purchaser to divide the article purchased in his presence, the analyst receiving the article for analysis shall divide the same into two parts, and shall seal or fasten up one of those parts, and shall cause it to be delivered, either upon receipt of the sample or when he supplies his certificate to the purchaser, who shall retain the same for production in case proceedings shall afterwards be taken in the matter.

16. If the analyst do not reside within two miles of the residence of the person requiring the article to be analysed, such article may be forwarded to the analyst through the post office as a registered letter, subject to any regulations which the Postmaster-General may make in reference to the carrying and delivery of such article, and the charge for the postage of such article shall be deemed one of the charges of this Act or of the prosecution, as the case may be.*

17. If any such officer, inspector, or constable, as above described, shall apply to purchase any article of food or any drug exposed to sale, or on sale by retail on any premises or in any shop or stores, and shall tender the price for the quantity which he shall require for the purpose of analysis, not being more than shall be reasonably requisite, and the person exposing the same for sale shall refuse to sell the same to such officer, inspector, or constable, such person shall be liable to a penalty not exceeding ten pounds.

18. The certificate of the analysis shall be in the form set forth in the schedule hereto, or to the like effect.

19. Every analyst appointed under any Act hereby

* The following regulations have been laid down by the Postmaster-General in regard to the conveyance and delivery of such articles as are permitted by the Act to be forwarded to duly-appointed analysts as registered letters through the post: Each packet must be addressed according to the official designation of the analyst, as "Public Analyst," or otherwise, and the nature of its contents must be stated on the front of the packet. Any postmaster at whose office a packet for a public analyst shall be tendered for registration may refuse to accept it for this purpose unless it be packed in so secure a manner as to render it at least unlikely that its contents will escape and injure the correspondence. Liquids for analysis shall be contained in stout bottles or bladders, which shall be enclosed in strong wooden boxes with rounded edges—the boxes being covered by stout wrappers of paper or cloth; and no such package shall exceed 8 inches in length, 4 inches in width, or 3 inches in depth. No packet whatever addressed to a public analyst shall exceed the dimensions of 18 inches in length, 9 inches in width, or 6 inches in depth. The postage and registration fee on each packet must be prepaid.

repealed or this Act shall report quarterly to the authority appointing him the number of articles analysed by him under this Act during the foregoing quarter, and shall specify the result of each analysis and the sum paid to him in respect thereof, and such report shall be presented at the next meeting of the authority appointing such analyst, and every such authority shall annually transmit to the Local Government Board, at such time and in such form as the Board shall direct, a certified copy of such quarterly report.

Proceedings against Offenders.

20. When the analyst having analysed any article shall have given his certificate of the result, from which it may appear that an offence against some one of the provisions of this Act has been committed, the person causing the analysis to be made may take proceedings for the recovery of the penalty herein imposed for such offence, before any justices in petty sessions assembled having jurisdiction in the place where the article or drug sold was actually delivered to the purchaser, in a summary manner.

Every penalty imposed by this Act shall be recovered in England in the manner prescribed by the eleventh and twelfth of Victoria, chapter forty-three. In Ireland such penalties and proceedings shall be recoverable, and may be taken with respect to the police district of Dublin metropolis, subject and according to the provisions of any Act regulating the powers and duties of justices of the peace for such district, or of the police of such district; and with respect to other parts of Ireland, before a justice or justices of the peace sitting in petty sessions, subject and according to the provisions of "The Petty Sessions (Ireland) Act, 1851," and any Act amending the same.

Every penalty herein imposed may be reduced or mitigated according to the judgment of the justices.

21. At the hearing of the information in such proceeding the production of the certificate of the analyst shall be sufficient evidence of the facts therein stated, unless the defendant shall require that the analyst shall be called as a witness, and the parts of the articles retained by the person who purchased the article shall be produced, and the defendant may, if he think fit, tender himself and his wife to be examined on his behalf, and he or she shall, if he so desire, be examined accordingly.

22. The justices before whom any complaint may be made, or the court before whom any appeal may be heard, under this Act may, upon the request of either party, in their discretion cause any article of food or drug to be sent to the Commissioners of Inland Revenue, who shall thereupon direct the chemical officers of their department at Somerset House to make the analysis, and give a certificate to such justices of the result of the analysis; and the expense of such analysis shall be paid by the complainant or the defendant as the justices may by order direct.

23. Any person who has been convicted of any offence punishable by any Act hereby repealed or by this Act by any justices may appeal in England to the next general or quarter sessions of the peace which shall be held for the city, county, town, or place wherein such conviction shall have been made, provided that such person enter into a recognisance within three days next after such conviction, with two sufficient sureties, conditioned to try such appeal, and to be forthcoming to abide the judgment and determination of the court at such general or quarter sessions, and to pay such costs as shall be by such court awarded; and the justices before whom such conviction shall be had are hereby empowered and required to take such recognisance; and the court at such general or quarter sessions are hereby required to hear and determine the matter of such appeal, and may award such costs to the party appealing or appealed against as they or he shall think proper.

In Ireland any person who has been convicted of any offence punishable by this Act may appeal to the next court of quarter sessions to be held in the same division of the county where the conviction shall be made by any justice or justices in any petty sessions district, or to the recorder at his next sessions where the conviction shall be made by the divisional justices in the police district of Dublin metropolis, or to the recorder of any corporate or borough town when the conviction shall be made by any justice or justices in such corporate or borough town (unless when any such sessions shall commence within ten days from the date of any such conviction, in which case, if the appellant sees fit, the appeal may be made to the next succeeding sessions to be held for such division or town), and it shall be lawful for such court of quarter sessions or recorder (as the case may be) to decide such appeal, if made in such form and manner and with such notices as are required by the said Petty Sessions Acts respectively hereinbefore mentioned as to appeals against orders made by justices at petty sessions, and all the provisions of the said Petty Sessions Acts respectively as to making appeals and as to executing the orders made on appeal, or the original orders where the appeals shall not be duly prosecuted, shall also apply to any appeal made under this Act.

24. In any prosecution under this Act, where the fact of an article having been sold in a mixed state has been proved, if the defendant shall desire to rely upon any exception or provision contained in this Act, it shall be incumbent upon him to prove the same.

25. If the defendant in any prosecution under this Act prove to the satisfaction of the justices or court that he had purchased the article in question as the same in nature, substance, and quality as that demanded of him by the prosecutor, and with a written warranty to that effect, that he had no reason to believe at the time when he sold it that the article was otherwise, and that he sold it in the same state as when he purchased it, he shall be discharged from the prosecution, but shall be liable to pay the costs incurred by the prosecutor, unless he shall have given due notice to him that he will rely on the above defence.

26. Every penalty imposed and recovered under this Act shall be paid in the case of a prosecution by any officer, inspector, or constable of the authority who shall have appointed an analyst or agreed to the acting of an analyst within their district, to such officer, inspector, or constable, and shall be by him paid to the authority for whom he acts, and be applied towards the expenses of executing this Act, any statute to the contrary notwithstanding; but in the case of any other prosecution the same shall be paid and applied in England according to the law regu-

lating the application of penalties for offences punishable in a summary manner, and in Ireland in the manner directed by the Fines Act, Ireland, 1851, and the Acts amending the same.

27. Any person who shall forge, or shall utter, knowing it to be forged for the purposes of this Act, any certificate or any writing purporting to contain a warranty, shall be guilty of a misdemeanour, and be punishable on conviction by imprisonment for a term of not exceeding two years with hard labour;

Every person who shall wilfully apply to an article of food, or a drug, in any proceedings under this Act, a certificate or warranty given in relation to any other article or drug, shall be guilty of an offence under this Act, and be liable to a penalty not exceeding twenty pounds;

Every person who shall give a false warranty in writing to any purchaser in respect of an article of food or a drug sold by him as principal or agent, shall be guilty of an offence under this Act, and be liable to a penalty not exceeding twenty pounds;

And every person who shall wilfully give a label with any article sold by him which shall falsely describe the article sold, shall be guilty of an offence under this Act, and be liable to a penalty not exceeding twenty pounds.

28. Nothing in this Act contained shall affect the power of proceeding by indictment, or take away any other remedy against any offender under this Act, or in any way interfere with contracts and bargains between individuals, and the rights and remedies belonging thereto.

Provided that in any action brought by any person for a breach of contract on the sale of any article of food or of any drug, such person may recover alone or in addition to any other damages recoverable by him the amount of any penalty in which he may have been convicted under this Act, together with the costs paid by him upon such conviction and those incurred by him in and about his defence thereto, if he prove that the article or drug the subject of such conviction was sold to him as and for an article or drug of the same nature, substance, and quality as that which was demanded of him, and that he purchased it not knowing it to be otherwise, and afterwards sold it in the same state in which he purchased it; the defendant in such action being nevertheless at liberty to prove that the conviction was wrongful, or that the amount of costs awarded or claimed was unreasonable.

Expenses of Executing the Act.

29. The expenses of executing this Act shall be borne, in the city of London and the liberties thereof, by the consolidated rates raised by the Commissioners of Sewers of the city of London and the liberties thereof, and in the rest of the metropolis by any rates or funds applicable to the purposes of the Act for the better local management of the metropolis, and otherwise as regards England, in counties by the county rate, and in boroughs by the borough fund or rate;

And as regards Ireland, in counties by the grand jury cess, and in boroughs by the borough fund or rate; all such expenses payable in any county out of grand jury cess shall be paid by the treasurer of such county; and

The grand jury of any such county shall, at any assizes at which it is proved that any such expenses have been incurred or paid without previous application to presentment sessions, present to be raised off and paid by such county the moneys required to defray the same.

Special Provision as to Tea.

30. From and after the first day of January one thousand eight hundred and seventy-six all tea imported as merchandise into and landed at any port in Great Britain or Ireland shall be subject to examination by persons to be appointed by the Commissioners of Customs, subject to the approval of the Treasury, for the inspection and analysis thereof, for which purpose samples may, when deemed necessary by such inspectors, be taken and with all convenient speed be examined by the analysts to be so appointed; and if upon such analysis the same shall be found to be mixed with other substances or exhausted tea, the same shall not be delivered unless with the sanction of the said commissioners, and on such terms and conditions as they shall see fit to direct, either for home consumption or for use as ship's stores or for exportation; but if on such inspection and analysis it shall appear that such tea is in the opinion of the analyst unfit for human food, the same shall be forfeited and destroyed or otherwise disposed of in such manner as the said commissioners may direct.

31. Tea to which the term "exhausted" is applied in this Act shall mean and include any tea which has been deprived of its proper quality, strength, or virtue by steeping, infusion, decoction, or other means.

32. For the purposes of this Act every liberty of a cinque port not comprised within the jurisdiction of a borough shall be part of the county in which it is situated, and subject to the jurisdiction of the justices of such county.

33. In the application of this Act to Scotland the following provisions shall have effect—

(1.) The term "misdemeanour" shall mean "a crime or offence:"

(2.) The term "defendant" shall mean "defender" and include "respondent:"

(3.) The term "information" shall include "complaint:"

(4.) This Act shall be read and construed as if for the term "justices," wherever it occurs therein, the term "sheriff" were substituted:

(5.) The term "sheriff" shall include "sheriff-substitute:"

(6.) The term "borough" shall mean any royal burgh and any burgh returning or contributing to return a member to Parliament;

(7.) The expenses of executing this Act shall be borne in Scotland, in counties, by the county general assessment, and in burghs, by the police assessment:

(8.) This Act shall be read and construed as if for the expression "the Local Government Board," wherever it occurs therein, the expression "one of Her Majesty's Principal Secretaries of State" were substituted:

(9.) All penalties provided by this Act to be recovered in a summary manner shall be recovered before the sheriff of the county in the sheriff court, or at the option of the person seeking to recover the same in the police court, in any place where a sheriff officiates as a police magistrate under the provisions of "The Summary Procedure Act, 1864," or of the Police Act in force for the time in any place in which a sheriff officiates as aforesaid, and all the jurisdiction, powers, and authorities necessary for this purpose are hereby conferred on sheriffs :

Every such penalty may be recovered at the instance of the procurator fiscal of the jurisdiction, or of the person who caused the analysis to be made from which it appeared that an offence had been committed against some one of the provisions of this Act :

Every penalty imposed and recovered under this Act shall be paid to the clerk of court, and by him shall be accounted for and paid to the treasurer of the county general assessment, or the police assessment of the burgh, as the sheriff shall direct :

(10.) Every penalty imposed by this Act may be reduced or mitigated according to the judgment of the sheriff :

(11.) It shall be competent to any person aggrieved by any conviction by a sheriff in any summary proceeding under this Act to appeal against the same to the next circuit court, or where there are no circuit courts to the High Court of Justiciary at Edinburgh, in the manner prescribed by such of the provisions of the Act of the twentieth year of the reign of King George the Second, chapter forty-three, and any Acts amending the same, as relate to appeals in matters criminal, and by and under the rules, limitations, conditions, and restrictions contained in the said provisions.

34. In the application of this Act to Ireland—

The term "borough" shall mean any borough subject to the Act of the session of the third and fourth years of the reign of Her present Majesty, chapter one hundred and eight, intituled "An Act for the Regulation of Municipal Corporations in Ireland :"

The term "county" shall include a county of a city and a county of a town not being a borough :

The term "assizes" shall, with respect to the county of Dublin, mean "presenting term:"

The term "treasurer of the county" shall include any person or persons or bank in any county performing duties analogous to those of the treasurer of the county in counties, and, with respect to the county of Dublin, it shall mean the finance committee :

The term "police constable" shall mean, with respect to the police district of Dublin metropolis, constable of the Dublin Metropolitan Police, and with respect to any other part of Ireland, constable of the Royal Irish Constabulary.

35. This Act shall commence on the first day of October one thousand eight hundred and seventy-five.

36. This Act may be cited as "The Sale of Food and Drugs Act, 1875."

SCHEDULE.

Form of Certificate.

To *

I, the undersigned, public analyst for the , do hereby certify that I received on the day of 18 , from † , a sample of for analysis (which then weighed *), and have analysed the same, and declare the result of my analysis to be as follows :—

I am of opinion that the same is a sample of genuine or .

I am of opinion that the said sample contained the parts as under, or the percentages of foreign ingredients as under.

Observations.†

As witness my hand this day of .
A.B., at .

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* Here insert the name of the person submitting the article for analysis.

† Here insert the name of the person delivering the sample.

Ague may be thus defined : Febrile phenomena, occurring in paroxysms, and observing a certain regular succession, characterised by unnatural coolness, unnatural heat, and unnatural cutaneous discharge, which prove a temporary crisis, and usher in a remission. These phenomena are developed in an uninterrupted series or succession more or less regular, which pass into each other by insensible steps. It is a paludal fever, which has always been observed to be the disease of marshy, moist districts, and to be most prevalent in low, swampy, and humid countries, where seasons of considerable heat occur. The neighbourhood of marshes, or of a district which has been at some recent time under water; the banks of great lakes, and the shores of rivers and seas where the water flows sluggishly, and in some places stagnates ; shallow rivers ; extensive flat tracts of wood, where moisture is constantly present, and the surface constantly exhaling humidity, —these are the terrestrial physical conditions in which paludal and littoral fevers are found to abound. It must be admitted though, that these diseases do not prevail in *all* marshy districts. The poison generated in these districts is absorbed, and affects the blood as cholera, typhus, and other miasmatic poisons do. No exact knowledge of the nature and source of this poison—which, in the absence of any better name, is known as *malaria*—has

* When the article cannot be conveniently weighed, this passage may be erased, or the blank may be left unfilled.

† Here the analyst may insert at his discretion his opinion as to whether the mixture (if any) was for the purpose of rendering the article portable or palatable, or of preserving it, or of improving the appearance, or was unavoidable, and may state whether in excess of what is ordinary, or otherwise, and whether the ingredients or materials mixed are or are not injurious to health.

In the case of a certificate regarding milk, butter, or any article liable to decomposition, the analyst shall specially report whether any change had taken place in the constitution of the article that would interfere with the analysis.

yet been obtained; indeed, it has yet to be proved that *malaria* has a substantial existence. No poisonous principle has yet been chemically demonstrated in the air of malarious regions; but the general impression is that *malaria* exists in the form of a gaseous fluid in the atmosphere of certain regions. The fever may exist without any alteration of structure being set up; but in the milder forms of this disease a greater number of organs and tissues are morbidly altered than perhaps in any other disease, as the liver, spleen, lungs, heart, brain, and the serous and mucous membranes of the body generally. The specific action of the malarial poison, within certain limits, may be said to be in the inverse ratio of the intensity of the fever which attends its action. The affections of the liver and spleen also vary greatly according to the country, for in some parts of India the spleen is the organ chiefly attacked, while in other districts it is the liver. Patients in this country generally recover under medical treatment without any manifest derangement either of structure or of function of any organ or tissue. When, however, long neglected, the liver may suffer. Notwithstanding the opinion of Finke and Professor Colin, there appears to be considerable ground for the supposition that ague may be caused by the drinking of marsh and surface water. Mr. Bettington of the Madras Civil Service, in an interesting essay ("Indian Annals," 1856, p. 526), says, "It is notorious that the water produces fever and affections of the spleen." Indeed, in that publication we find some remarkably strong evidence on this point. He refers to villages placed under the same conditions as to marsh-air, but in some of which fevers are prevalent, in others not, the only difference being that the latter are supplied with pure water, the former with marsh or mullah water, full of vegetable *débris*. In one village there are two sources of supply—a spring and a tank, fed by surface and marsh water. Those only who drink the tank-water are attacked by fever. And again, in Tulliwaree no one used to escape the fever. Mr. Bettington dug a well; the fever disappeared, and during the last fourteen years has not reappeared. Similar facts have been noticed in this country. Mr. Blower of Bedford, twenty years ago, called attention to a case in which the ague of a village had been much lessened by digging wells; and he refers to one instance in which, in the parish of Houghton, almost the only family which escaped ague at one time was that of a farmer who used well-water, while all the other persons drank ditch-water.

At Versailles, a sudden attack of ague in a regiment of cavalry was traced to the use of surface-water taken from a marshy district.

In the "Indian Annals," 1867, Dr. Moore gives his opinion that malarious disease may be thus produced; and M. Commaille has quite recently stated (Rec. de Mém. de Méd. Mil., Nov. 1868, p. 427) that in Marseilles paroxysmal fevers, formerly unknown, have made their appearance since the supply to the city has been taken from the canal of Marseilles. Dr. Townsend, the Sanitary Commissioner for the Central Provinces of India, tells us, in his able report for 1870, that the natives have a current opinion that the use of river and tank water during rainy seasons (when the water always contains much vegetable matter) will almost certainly produce fever (*i.e.*, ague). Boudin (Traité de Géographie et de Statistiques Médicales, 1857, t. i. p. 142) records an extremely strong and extraordinary case. 800 soldiers in good health embarked in three vessels to pass from Bona, in Algiers, to Marseilles, in the year 1834. They all arrived at Marseilles the same day. In two vessels there were 680 men, without a single sick man. In the third vessel, the Argo, there had been 120 men (soldiers); 13 died during the short passage, and of the 107 survivors no less than 98 were disembarked with all forms of paludal fevers. Boudin himself saw the men, so the diagnosis was doubtless correct. The crew of the Argo had not a single sick man. The crew and soldiers of all the boats were exposed to the same atmospheric conditions—the influence of air must therefore be excluded. There is no mention of food; but it has never been suggested that food has ever been concerned in the production of malarious fever. The water was, however, very different: in two of the ships it was good, while the Argo had been supplied with marsh-water, which was both offensive to the smell and disagreeable to the taste. This was supplied to the soldiers, while the crew drank pure water. The evidence here appears particularly strong. Notwithstanding this, Professor Colin, well known for his researches on intermittent fever (De l'Ingestion des Eaux Marécageuses comme Cause de la Dysenterie et des Fièvres Intermittentes, par L. Colin, Paris, 1872) questions the production of paroxysmal fevers by marsh-water. He particularly calls attention to numerous cases in Algiers and Italy, where impure marsh-water gives rise to indigestion, diarrhœa, and dysentery, but in no case to intermittent fever, and in all his observations he has never met with an instance of such an origin of ague. He denies this power, and without contesting the celebrated case of the Argo, he views it with considerable suspicion, and questions whether Boudin has given the exact details. Finke (Oesterlen's Handb. der Hygiene, 2d edit., 1857) also states that in Hungary and Holland marsh-water is daily taken without injury.—(PARKES.)

The inhalation of the fumes of oxide of zinc appears to produce a variety of ague, termed by Thackrah "brass ague," and by Dr. Greenhow "brassfounders' ague," to which workers in this metal are subject. The symptoms are tightness and oppression of the chest, with indefinite nervous sensations, followed by shivering, an indistinct hot stage, and profuse sweating. These attacks are not periodical.

It may be doubted whether the malarious poison is in the form of a gas, for the observations of microscopical observers show the extreme minuteness of the germs of disease: they are probably not more than $\frac{1}{10000}$ of an inch in size, and it is highly probable that the real cause of ague is the entry into the blood of some low forms of spores of fungi, or of some minute animalcules. Ague is always to be found where fungi grow, and is always associated with great impurity of what Pettenkofer calls "the ground-air"—that is, the air contained in the interstices of the soil, no inconsiderable volume of which is drawn into every house which has a fire on the floor which rests on the earth. That animalcules, &c., may exist in the blood is proved by the wonderful discovery by Dr. Lewis (*see* FILARIA) of hair-like worms in the circulation; and in considering this point, we should bear in mind that the remedial agents employed to check ague—quinine, arsenic, &c.—are drugs capable of destroying animal life, and it is possible that they exercise a beneficial effect by destroying these spores or animalcules.

Thorough and efficient drainage—and it must be remembered that drainage purifies both the ground-air and the ground-water—and good water, free from vegetable contamination, are the most satisfactory means employed to drive malarial fevers from a district; and that these means may be employed with certainty of success is proved by the fact that during the last two hundred years cases of ague have in this country been greatly on the decrease, as good drainage has become more general and perfect, and as—speaking generally—the supply of water to the houses has greatly improved, both in quality and quantity, so the number of patients suffering from paludal poisoning has steadily diminished.

We are reminded of the prevalence of intermittent fevers two centuries ago by the well-known words of Oliver Cromwell—himself a victim to ague—"Matrem pietissimam, fratres, sorores, servos, ancillas, nutrices, conductitias, quotquot erant intra eosdem nobiscum parietes, ac fere omnes ejusdem ac vicinorum pagorum incolas, hoc veneno infectos et decumbentes vidi." And when we remember that the country surrounding London in Cromwell's time was as marshy as the fens of Lincolnshire, we cannot feel surprise at the extraordinary mortality from ague. *See* MARSHES, FEVERS, MALARIAS, &c.

Air—It was long thought that air was an element, a kind of ether, but we now know that it is just as material as a bit of iron or lead; and the time may yet come when, by the aid of immense pressure and intense cold, the air may be condensed into a liquid. As yet it has, however, never been made visible, like carbonic acid gas, nitrous oxide, and some other gases. It is transparent, inodorous, and without colour. A cubic foot, at 60° F. and 30° Bar., weighs 536·96 grains; a litre, at the same temperature and pressure, weighs 1·299100 grammes. Its average composition in England is as follows:—

	Oxygen . . .	20·61
	Nitrogen . . .	77·95
	Carbonic anhydride .	·04
	Aqueous vapour . .	1·40
	Nitric acid . . .	traces.
	Ammonia . . .	traces.
	Carburetted hydrogen .	traces.
In towns.	Sulphuretted hydrogen	traces.
In towns.	Sulphurous anhydride	traces.

Before entering upon a description of each of these constituents, it will be well to consider a few of the properties of air, one of the most important of which is its power of penetration, and its universality. Air is indeed present everywhere; there is scarcely a solid, however compact it may appear to be, which does not contain pores, and these pores filled with air. The soil contains no small quantity; indeed, if it were not so, the numberless insects, worms, &c., which burrow in its interstices would cease to exist. The most compact mortar and walls are penetrated with it, and water of natural origin contains a large quantity of air in solution. The atmosphere is supposed to extend to a very great height, from 200 to 300 miles; it used to be considered only five miles high, but observations on shooting-stars, &c., show that this opinion is erroneous. Owing to the force of gravity, the air is much denser near the earth, and gets more attenuated, layer by layer, as you ascend. If, then, the atmosphere were possessed of colour, it would be very dark just round the globe, and the tint would gradually fade into space. The air is by no means wholly gaseous; it contains, indeed, an immense amount of life, and small particles derived from the whole creation. In the air may be found animalcules, spores, seeds, pollen, cells of all kinds, vibriones, elements of contagia, eggs of insects, &c., and a few fungi, besides formless dust, sandy and other particles of local origin; for example, no one can ride in a railway carriage without being accompanied with dust, a great portion of which is attracted by a magnet, and is, indeed, minute particles of iron derived from the rails. The purest air has some dust in it. There probably never fell a beam of light from the sun since the world was made which did not show, were there eyes to see it, myriads of motes; these, however, generally speaking, are quite innocuous to man (*see* DUST)—some, indeed, may possibly be beneficial. Another most important property of air is its mobility; on the calmest day, and in the quietest room, there are constant currents of air which rapidly dilute any noxious odours or gases.

Oxygen.—The uniformity of the actual amount of oxygen in the air of different places is remarkable. Normal air contains 20·96 of oxygen in 100 parts, and any differences that may exist in various ocalities are almost always, when analysed by accurate chemists, to be found in the second decimal place. For example, Regnault analysed the following specimens:—

100	from	Paris	from 20·913	to 20·999
9	,,	Lyons and around	,, 20·918	,, 20·966
30	,,	Berlin	,, 20·908	,, 20·998
10	,,	Madrid	,, 20·916	,, 20·982
23	,,	Geneva and Switzerland	,, 20·909	,, 20·993
15	,,	Toulon and Mediterranean	,, 20·912	,, 20·982
5	,,	Atlantic Ocean	,, 20·918	,, 20·965
1	,,	Ecuador	,,	,, 20·960
2	,,	Pichincha	,, 20·949	,, 20·981
Mean of all foregoing			20·949	20·988
,, of the Paris specimens			20·96	

Nitrogen.—This gas is one of the most indifferent of the elements; while oxygen, to which it is united, is one of the most energetic. It is generally considered to be a mere dilutant of the oxygen, and to serve the purpose of moderating its action both on combustion and life. The average amount of nitrogen is 79·00 per 100 in normal air.

Carbonic Acid (*see* ACID, CARBONIC).—This gas, theoretically speaking, is not a constituent of normal air, but the actual fact is that it nearly always exists in minute proportions even in the best air; and if we think of the sources of this gas, the reason of its presence is obvious. The processes of respiration, combustion, and decay of vegetable and other organic matter, besides other less obvious and less constant sources, are continually, though silently, evolving it. The following examples of carbonic acid gas in pure air are compiled from Dr. Angus Smith's classical work on "Air and Rain:"—

	Per cent.
Mean of 18 analyses, by Saussure, on the Lake of Geneva	·0439
Mean of 18 analyses, by Saussure, at Chambeisoy	·0460

It appears from De Saussure's analyses that there is more carbonic acid on the mountains than in the plains.

NAME OF MOUNTAIN.	Height of Mountain in Metres.	Carbonic Acid in Air of the Mountain.	Carbonic Acid in Air of Plain.
La Dolè	1267	·0461	·0474
Grand Saleve-sur-Crevin	877	·0557	·0482
Hermitage (Petit Saleve)	331	·0544	·0482
La Dolè	1267	·0491	·0446
Vasserode sous-la-Dolè	908	·0481	·0446
Grand Saleve-sur-Grange, Tournier	945	·0413	·0367 / ·0359
Col de la Faucille	963	·0443	·0414
,,	,,	·0454	·0415
,,	,,	·0369	·0387
,,	,,	·0360	·0322
,,	,,	·0422	·0355
,,	,,	·0395	·0315

In towns the carbonic acid varies, but is generally higher than in open places.

	Per cent.
Air of Madrid outside the walls. Mean of 12 analyses, by Luna	·045
Mean of 12 analyses within the walls of Madrid, by Luna	·051
The mean of 14 analyses, by Angus Smith, in Manchester (suburbs)	·0369
In Manchester streets—	
Usual weather	·0403
During fogs	·0679
About middens, of which there are thousands (Manchester)	·0774
Mean of carbonic acid in London streets (Angus Smith)	·0380

In close places in London, the mean of 18 experiments by Dr. Angus Smith give ·1288 per cent. His highest number is ·320; his lowest, ·040.

In Leicester—

	Per cent.
Case of overcrowding, with three gaslights (Weaver)	·528
Crowded girls' schoolroom (Pettenkofer)	·723
In a stable, École Militaire	·7

Carbonic acid is of great interest in a sanitary point of view, as it is quickly and readily estimated, and is an indirect measure of the purity of the air. The reason for which is pretty obvious, since the carbonic acid which the sanitary officer tests for is almost invariably derived from respiration, and therefore accompanied with organic matters derived from the lungs and skin. In fact, a considerable quantity of carbonic acid gas is breathed by workers in certain manufactories, *e.g.*, soda-water, &c., without injury, although in large quantities, and undiluted, it is rapidly fatal; while comparatively speaking small quantities in theatres, assembly-rooms, and other places, where human beings are crowded together, have a very depressing effect, because there are other impurities in the air.

Ozone.—This is generally considered to be an allotropic form of oxygen. Three atoms of oxygen are condensed into one molecule, as is represented by the formula O_3. It exists in variable quantity in the air, and probably is of some importance. For full details and tests, *see* OZONE.

The Air of Towns has generally traces of sulphuric, hydrochloric, sulphuretted, and other acids, derived from combustion and different manufactories, besides a considerable quantity of suspended particles of carbon-dust, derived from traffic and emanations from human beings. The air, even of small towns, has more organic matter than country-places (*see* RAIN-WATER, ANALYSIS OF), which is easily shown by estimating the ammonia and albuminoid ammonia in air. The carbonic acid is of course increased. The oxygen is decreased, but only to a small amount. For example, the mean of the 22 analyses by Dr. A. Smith of the worst places in Perth gave 20·938; while on the seashore and the heath the mean of several analyses gave 20·999. Odorous particles of all kinds are more common in towns.

The Air of the Country and Open Places varies a little, according to elevation, vegetation, whether populated or not, &c. But the general result is that the oxygen is greater, and the carbonic acid less, than in towns, while the air is free from the acid emanations and carbon so copiously poured out from towns. Of all places, heaths and mountains, as would be expected, possess the best and purest air. Dr. Angus Smith's analysis of mountainous districts in Scotland gave a mean of 20·94 oxygen, while the carbonic acid of the same mountains, taken, however, at a different time, gave ·0331. Dr. Pietra-Santa observes that the air of hills or mountains, at the height of 2300 feet, is lighter than common air, contains in equal volume a smaller proportion of oxygen, and is impregnated with a more considerable amount of aqueous vapour; it also contains a good deal of ozone. He considers such a climate peculiarly soothing to persons suffering from certain maladies, such as chest diseases, &c.

The Air of Mines.—The greatest variety of atmosphere occurs in mines, the quality of the air ranging from that of fair purity to that of excessive contamination by gases, dust, and smoke. Dr. Angus Smith made 339 analyses of the air of mines. Of these, 38 had the normal amount of oxygen. The mean of the 38 normal specimens was 20·94 oxygen. The mean of 31 normal specimens in which the carbonic acid was estimated was ·083. The mean of the whole 393 specimens was 20·26 per cent. oxygen; carbonic acid, ·785. The highest oxygen found was 21·04 per cent.; the lowest was 18·27 per cent. The least carbonic acid found was ·02 per cent.; the greatest number for carbonic acid was 2·73 per cent. The analyses were divided into three groups—those that showed the air normal, or nearly so; those that were decidedly impure; and those that were exceedingly impure:—

	Per cent.
The first class, or normal, gave the carbonic acid	10·67
The second class	24·69
The third ,,	64 63

Thus it may be seen that the air of mines varies from comparative purity to intense pollution; for besides the impurities from respiration, the combustion of lamps, &c., in most mines there are nearly always blasting operations, which, when gunpowder is used, disengage clouds of dust from the rock, besides its own solids and gases. For example, 12 ounces (340 grammes) of gunpowder exploded will give as gases—

	Litres.
Carbonic acid	34·5799
Nitrogen	26·9969
Carbonic oxide	2·5473
Hydrogen	·7944
Sulphuretted hydrogen	·3939
Oxygen	·3414
	65 6538

As solids—

	Litres.
Sulphate of potash	144·710
Carbonate of potash	43·311
Hyposulphite of potash	11·189
Sulphide of potassium	7·296
Sulphocyanide of potassium	1·[illegible]49
Nitrate of potassium	12·751
Carbon charcoal	2·494
Sulphur	·466
Carbonate of ammonia	9·790
	233·056

These gases and matters are all at times breathed by the miners, besides the dust of arsenic and other metals. *See* MINES.

The Effects of Impure Air.—The amount of air inhaled and exhaled by an adult in the twenty-four hours averages 360 cubic feet, or 2000 gallons. This forms in amount a great contrast to what we take in the shape of liquid or solid, which does not amount to more than 5½ pints, which is equal to $\frac{1}{3000}$ of the volume of air passing through the lungs. It will be readily understood, after these figures, the importance of pure air, and how minute differences in composition are really of great importance, since the lungs act, as it were, as immense strainers or filters, and catch the floating particles, while they rapidly absorb deleterious gases. The amount of air required by each person in a room is no less than 2100 feet per hour. When the ventilation does not allow of this constant change, it smells stuffy, the furniture becomes coated with a film of organic matter unless constantly cleaned, and the carbonic acid becomes increased to more than its normal amount.

The effect of constantly breathing impure air necessarily varies as to its state of pollution and other circumstances. When the impurity is moderate, the first effect is headache, lassitude, and a general paleness of the face and skin, owing to a diminution of the red globules of the blood. If the food is insufficient, other evils, such as scrofula and consumption, are very common. For instance, Dr. Guy showed the great mortality from consumption in those trades in which workmen pursued their calling in hot, close, gas-lit rooms, in comparison to those who passed most of their time in the open air.

If the air is vitiated to a large extent, it is quickly fatal, not alone probably from the carbonic acid exhaled, but from the exhalation from the skin and lungs. In the Black Hole of Calcutta, as well as in the case of the Austrian prison after the battle of Austerlitz,

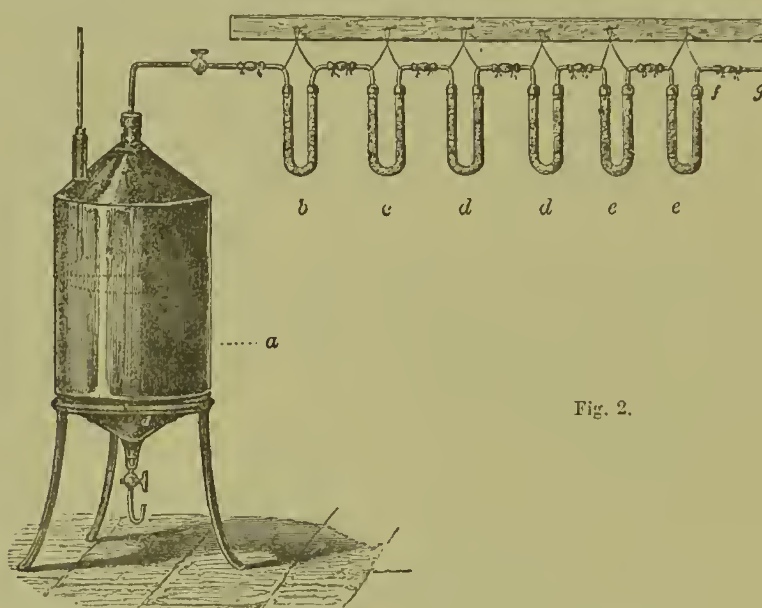


Fig. 2.

where 260 out of 300 prisoners died rapidly, the symptoms were rather those of blood-poisoning than anything else. There was great fever, restlessness, and eruptions and boils appeared among the survivors. The effect of impure air is not alone seen on man, but also on animals. Cows, horses, and sheep, if penned up in close stables or outhouses, show a great mortality from phthisis and other diseases.

The effect of dust in air, affecting the workmen employed in various arts, will be considered under DUST.

Analysis of the Air.—For health purposes much information may be obtained on the composition of the air from chemical examination of the rainfall of the different parts of a district, for the rain washes down the impurities in the air to the ground as it descends. *See* RAIN.

The ordinary analysis of air embraces the estimation of the following constituents: oxygen, nitrogen, carbonic acid, aqueous vapour, and ammonia.

Aqueous Vapour, Determination of.—To determine the water, an aspirator must be used. They are easily made, and not expensive. The above is a diagram of the arrangement generally adopted (fig. 2). *a* is an aspirator made of galvanised iron or sheet zinc. It holds from 50 to 100 litres. A known volume of air by this means is drawn through the tubes marked *b*, *c*, *d*, *e*, which may be filled with pumice-stone, moistened with strong sulphuric acid; but if the carbonic acid is to be estimated as well, *b* and *c* are filled with moist hydrate of lime (potash used to be employed, but hydrate of lime is to be preferred, as the potash absorbs oxygen as well), and *d* and *c* as above. Each of the tubes is accurately weighed previous to connecting them with the apparatus. It is obvious that each of the tubes must be connected by perfectly air-tight joints. They are usually coated with sealing-wax. The gain of weight in *d*, *c* gives the water, in *b* and *c*, the carbonic acid.

Carbonic Acid.—For the exact determination of the carbonic acid the following method, known as Pettenkofer's, is better. It may be shortly defined as follows: Baryta-water of definite strength is prepared and accurately standardised by a standard solution of oxalic acid. A portion of this baryta-water is then made to act upon a definite quantity of air. It will absorb the whole of the carbonic acid in that air. In consequence, the alkalinity of the liquid will be diminished; it will take less of the oxalic acid solution than before, which shows so much less caustic baryta, and from which the carbonic acid absorbed may be easily calculated.

The Actual Analysis.—Two kinds of baryta-water may be used, the one containing 7 grm. to the litre, the other three times that strength. 1 c.c. of the stronger = 3 mgrms. of carbonic acid, 1 c.c. of the weaker, 1 mgrm. The baryta-water is best kept in the bottle represented in fig. 3.

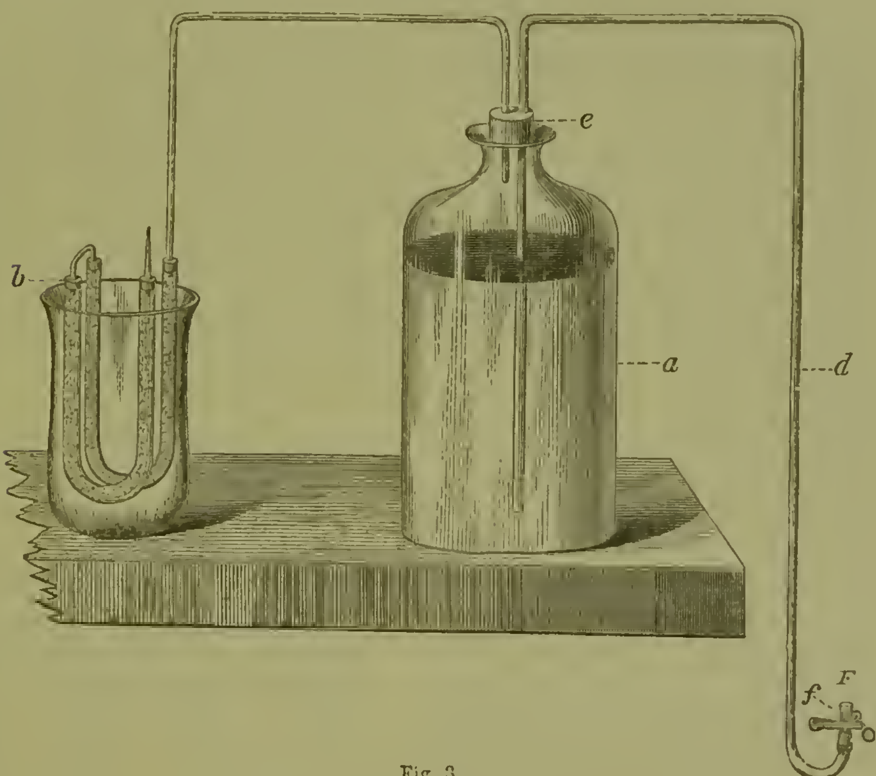


Fig. 3.

The bottle *a* contains the baryta-water. It has an accurately-fitting double-perforated caoutchouc stopper. The left-hand tube is connected with tube *b*, containing pumice-stone, moistened with potash, while the right-hand one is a siphon. When required for use, the stopcock *f* is opened, and suction applied by a glass tube to *F*. The siphon is thus filled, and the stopcock closed. If a pipette is required to be filled, its nozzle is inserted at *F*, the stopcock compressed, and the fluid immediately rises into the pipette. The air entering the bottle as the fluid decreases in *a* is of course thoroughly deprived of its carbonic acid by the tubes at *b*.

The first thing to be done is to standardise the baryta solution by a solution of oxalic acid, containing 2·8636 grammes of crystallised oxalic acid to the litre. (*See* Acid, Oxalic.) Thirty c.c. of baryta solution are run into a small flask, and the oxalic acid run in from a Mohr's burette with float, the vanishing-point of the alkaline reaction being ascertained by delicate turmeric paper. As soon as a drop placed on turmeric paper does not give a brown ring the end is attained.

The actual analysis is performed by filling a bottle of known capacity, with the aid of a pair of bellows, with the air to be analysed, then distributing over its sides 45 c.c. of the baryta-water, it is left for half an hour. The turbid water is poured into a cylinder, closed securely, and allowed to deposit; then take out 30 c.c., by a pipette, of the clear fluid, run in the solution of oxalic acid, multiply the volume used by 1·5, and deduct the produce from the c.c. of oxalic acid used for 45 c.c. of the fresh baryta-water. A different method to this has been suggested by Dr. Angus Smith—viz., to measure the carbonic anhydride by the turbidities of the baryta-water; in fact, a colorimetric test, as it were. Lastly, Mr. Wanklyn has suggested the following method, which is probably the simplest of all:—

A solution of carbonate of soda is first made as follows: 4·47 grammes of gently-ignited carbonate of soda are dissolved in one litre of water, giving a solution of such a strength that one cubic centimetre contains exactly one cubic centimetre of carbonic acid (= 1·97 milligrammes of CO_2), a large quantity baryta-water (strength about 0·1 per cent.) is prepared.

If now 100 cubic centimetres of clear baryta-water be treated with one cubic centimetre of carbonate of soda just described, a certain degree of turbidity is produced. If two cubic centimetres of the solution be taken, another degree of turbidity is produced, and so on. If then a bottle capable of holding 2000 cubic centimetres of air, together with 100 cubic centimetres of baryta-water, be filled with the sample of air to be tested, there will be a certain depth of turbidity produced in shaking up.

Having got the air to expand itself on 100 cubic centimetres of baryta-water, the degree is to be found by comparison with another 100 cubic centimetres of baryta-water in which a like turbidity has been induced by means of the standard solution of carbonate. Every cubic centimetre of soda solution counts for a cubic centimetre of carbonic acid in two litres of air. A consumption of one cubic centimetre will correspond to 0 05 volumes of carbonic acid per cent. Good air should accordingly not take more than one cubic centimetre of the soda solution: air which takes two cubic centimetres being already bad.

In order practically to execute this determination of carbonic acid, the following apparatus is required: Several bottles capable of holding 2·210 cubic centimetres, and well stoppered (failing bottles of exactly the right capacity, Winchester quart bottles will answer); a small pair of bellows; several colourless glass cylinders marked at 100 cubic centimetres capacity. The nesslerising cylinders will answer for this purpose. A graduated pipette or burette to deliver tenths of a cubic centimetre of solution; the standard solution of carbonate of soda and the baryta-water, which may be of moderate strength.

The testing is managed thus: Winchester quart bottles having been marked clean, are rinsed with distilled water, and allowed to drain a little. They are then closed with their stoppers, and are ready for use. The operator having provided himself with two or three of these bottles, and a small pair of bellows, enters the room, the air of which is to be tested. The stopper is then removed from one of the bottles, and some air of the room blown through with the bellows, and then the stopper is replaced, and the bottle carried away to be tested.

The testing is done by pouring into the bottle 100 cubic centimetres of clear baryta-water, shaking up for two or three minutes, and then pouring out into a cylinder of colourless glass, and observing the depth of turbidity in various lights, and against various backgrounds. The turbidity is to be exactly imitated by means of the standard solution of carbonate of soda. In order to imitate the turbidity produced by a Winchester quart full of good air, only one cubic centimetre of this solution of carbonate of soda is required.

If two cubic centimetres, or more than two are required, the air is bad, and the ventilation is defective. In place of the first cubic centimetre of solution of carbonate of soda, the carbonic acid naturally present in a Winchester quart of good average air may be used, and a little practice and intelligence will suggest the necessary precautions.

For rough everyday work the process of Angus Smith is extremely useful. It depends upon the fact that the amount of carbonic acid in a given quantity of air will not produce a precipitate in a certain given quantity of lime or baryta water, unless the carbonic acid is in excess. The following is one of his tables. Columns 1 and 2 give the rates of carbonic acid in the quantity of air which will produce no precipitate in half an ounce of lime-water. Column 3 is the same as column 2; but 14·16 c.c. (half an ounce) is added to give the corresponding size of bottle, and column 4 gives the size of the bottle in ounces:—

To be used when the point of observation is "No precipitate." Half an ounce of baryta-water, containing about ·08 gramme baryta.

Air at 0° C., and 760 millims. Bar.

Carbonic Acid in the Air per cent.	Volume of Air in Cubic Centimetres.	Size of Bottle in Cubic Centimetres.	Size of Bottle in Ounces Avoirdupois.
·03	185	199	7·06
·04	139	154	5·42
·05	111	125	4·44
·06	93	107	3·78
·07	79	93	3·31
·08	70	84	2·96
·09	62	76	2·69
·10	56	70	2·46
·11	51	65	2·29
·12	46	60	2·14
·13	43	57	2·01
·14	40	54	1·90
·15	37	51	1·81
·20	28	42	1·48
·25	22	36	1·29
·30	19	33	1·16
·40	14	28	1·04
·50	11	25	·89
·60	9	23	·83
·70	8	22	·78
·80	7	21	·75
·90	6	20	·72
1·00	5·5	19·7	·70

Oxygen.—The method employed by Angus Smith, in his numerous analyses of the air, was that of explosion. Bunsen's eudiometers were used, five or six of them at once, and exploded by a large battery and Ruhmkoff's coil; he preferred it to Liebig's method given below, as more expeditious, and perhaps more accurate. The following are the principles of the former method (Miller's Chemistry, vol. ii. p. 53): "By means of the eudiometer various gaseous mixtures may be analysed with great exactness. Many different forms of this instrument are in use. One of the most convenient is Hoffmann's. It consists of a stout siphon tube (fig. 4). Into the sides of the tube, near the sealed end, two platinum wires, *a*, *b*, are fixed for the purpose of transmitting an electric spark through the cavity of the tube. The sealed limb is accurately graduated to tenths of a cubic centimetre, or other

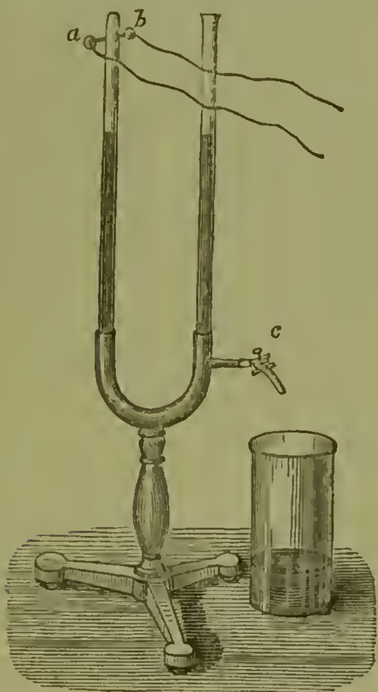


Fig. 4.

suitable divisions. Suppose it is desired to ascertain the proportion of oxygen in atmospheric air: The instrument is first filled with mercury, after which a small quantity of air is introduced; the bulk of this air is accurately measured, taking care that the liquid metal stands at the same level in both tubes, which is easily effected by adding mercury, or by drawing off the mercury, if needed, through the caoutchouc tube which is fixed upon the small inlet tube, just above the bend, and which is closed by means of a screw tap *c*. A quantity of pure hydrogen, about equal in bulk to the air, is next introduced, and the bulk of the mixture is again accurately measured. The open extremity of the tube is now closed with a cork, below which a column of atmospheric air is safely included. This portion of air acts as a spring which gradually checks the explosive force, when the combination is effected by passing a spark across the tube by means of the platinum wires. The mixture is then exploded by the electric spark. The remaining gas now occupies a smaller volume, owing to the condensation of the steam which has been formed. Mercury is, therefore, again poured into the open limb, until it stands at the same level in both tubes, and the volume of the gas is measured a third time. One-third of the reduction of bulk experienced by the gas will represent the entire volume of oxygen which the mixture contained."

Liebig's method is as follows. It is based upon the fact that an alkaline solution of pyrogallic acid absorbs oxygen:—

1. A strong measuring tube holding 30 c.c., and divided into $\frac{1}{2}$ or $\frac{1}{10}$ c.c. is filled to $\frac{5}{8}$ with the air intended for analysis. The remaining part of the tube is filled with mercury, and the tube is inverted over that fluid in a tall cylinder widened at the top.

2. The volume of air confined is measured—a quantity of solution of potassa of 1·4 sp. gr. (1 part of dry hydrate of potassa to two parts of water), amounting to from $\frac{1}{30}$ to $\frac{1}{50}$ of the volume of the air, is then introduced into the measuring tube by means of a pipette with the point bent upwards (fig. 5), and spread over the entire inner surface of the tube by shaking the latter. When no further diminution of volume takes place, the decrease is read off. The carbonic acid is thus removed.


Fig. 5.

3. A solution of pyrogallic acid, containing 1 gramme of the acid in 5 or 6 c.c. of water, is introduced into the same measuring tube by means of another pipette similar to the above. The mixed fluid (the pyrogallic acid and solution of potassa) is spread over the inner surface of the tube by shaking the latter, and, when no further diminution of volume is observed, the residuary nitrogen is measured.

4. The solution of pyrogallic acid, mixing with the solution of potassa, of course dilutes it, causing thus an error from the diminution of its tension; but this error is so trifling that it has no appreciable influence upon the results. It may, besides, be readily corrected by introducing into the tube, after the absorption of the oxygen, a small piece of hydrate of potassa, corresponding to the amount of water in the solution of the pyrogallic acid.

5. There is another slight error on account of a portion of the fluid adhering to the inner surface of the tube, so that the volume of the gas is never read off with absolute accuracy.

It is unnecessary to add that the usual corrections for temperature, pressure, &c., must be made.

Nitrogen.—The nitrogen is usually determined by subtracting the aqueous vapours, oxygen and carbonic acid, from the volume of air examined, and if the foregoing principles have been accurately determined, the sources of error are immaterial.

The Ammonia and Organic Matter are best determined by drawing a known volume of air through absolutely pure water, water, *i.e.*, free from organic matter and ammonia. To obtain this, it is best to redistil distilled water, rejecting the first portions, then adding an alkaline solution of permanganate, and rejecting any portions of the distillate which give the least trace of colour to the Nessler test; the water through which the air is drawn should be kept cool, and afterwards submitted to the process described under WATER ANALYSIS. Solid bodies, such as vibriones, germs, fungi, dust, &c., may be obtained by using an aspirator, and drawing the air either through a drop of glycerine or water. Organic matter may also be obtained by suspending glass vessels filled with iced water over or in the places to be investigated and submitted to the microscope. High powers, such as immersion lenses, are requisite for the investigation of germs, &c. *See also* CLIMATE, &c.

Albumen — This word literally means white of egg, which is its most convenient source. It is a nitrogenous substance of highly complex chemical composition, existing in large quantity in all animal bodies, in eggs, in certain vegetables, especially carrots, turnips, cabbages, green stems of peas, and oleaginous seeds. There are slight but marked differences in most of the albumens found naturally. The albumen of the egg, the albumen in the blood, the albumen found in the urine of persons suffering from disease, and vegetable albumen, all exhibit a slight difference in their reactions; probably they are all united with bases, and are albuminates. Pure albumen, as obtained by precipitating white of egg with hydrochloric acid, dissolving the precipitate in water, then again precipitated by chloride of ammonium, and when freed from fat by alcohol and ether, has a slight acid reaction in solution, is tasteless and colourless, and exerts a left-handed rotatory power on polarised light. Its composition, according to Lieberkuhn, is as follows :—

Carbon	53·3
Hydrogen	7·1
Nitrogen	15·7
Oxygen	22·1
Sulphur	1·8
	100·0

There is considerable difficulty in dissolving absolutely pure albumen in water, but with an addition of a very minute portion of caustic soda or potash, it readily dissolves. It is also soluble in a strong solution of nitrate of potash.

When submitted to distillation, first with hydrate of potash, and then with an alkaline solution of permanganate of potash, the albumen of hen's egg gives in every 100 c.c.—

Ammonia to Hydrate of Potash.	Ammonia by Permanganate of Potash.
0·32 gramme.	1·30 gramme.

A hundred parts of dry albumen give about ten parts of NH_3.

One of the most remarkable properties of albumen is its coagulation by heat; this takes place at a temperature varying from 145° to 165° F. It is then white and opaque, and when dried, horny and brittle. Albumen in solution gives precipitates with most acids (except acetic and phosphoric), with corrosive sublimate, and many other metallic salts, and alcohol.

Uses.—It is of great value as an article of diet; it is employed in photography as a varnish, and has various other uses, such as a clarifier for wines, syrups, &c.; and for fixing the colours in calico-printing, in the preparation of gloves, &c.

Preparation.—In France it is prepared on some considerable scale at the abattoirs, by separating it from the blood of slaughtered animals, and spreading it in thin layers to dry. *See* FOOD.

Albuminates in Food—*See* FOOD.

Albuminose — The pepsin of the gastric juice, acting in presence of an acid, turns nearly every description of animal and fibrinous matter into a liquid called *albuminose* by Mialbe, but by Lehmann *peptone*. It differs from albumen in the following important particulars: it is not coagulable by heat, and the slight precipitate which falls upon the first addition of an acid is dissolved in an excess of acid; it does not easily decompose, and is capable of dialysis, *i.e.*, transudation through animal membrane. *See* FOOD.

Albuminous Matters of Food — *See* FOOD.

Albuminuria, after Bathing — *See* BATH.

Alcohol—The term alcohol, in its ordinary acceptation, means the volatile, inflammable spirituous liquid which is the intoxicating principle of wines, beers, and spirits; but in a chemical sense it is applied to all neutral compounds of oxygen, carbon, and hydrogen, which by the action of acids form ethers.

TABLE exhibiting the PROPERTIES of the PRINCIPAL ALCOHOLS.

Alcohols.	Formula.	Specific Gravity.		Vapour. Rel. Wt. H = 1.	Boiling-Point.	
		Liquid.	Vapour.		Fahr.	Cent.
1. Wood spirit, or methylic alcohol	CH_4O	0·798	1·12	16	149·9	65·5
2. Spirit of wine, or ethylic alcohol	C_2H_6O	0.7938	1·6133	23	173·	78·3
3. Tritrylic or propylic	C_3H_8O	0·817	2·02	30	206·	96·7
4. Tetrylic or butylic	$C_4H_{10}O$	0·8032	2·589	37	233·	111·7
5. Fusel oil, or amylic	$C_5H_{12}O$	0·8184	3·147	44	269·6	132·0
6. Hexylic or caproic	$C_6H_{14}O$	0·833	3·53	51	299·309	148·154
7. Heptylic	$C_7H_{16}O$	0·819	...	58	351·	176·7
8. Octylic or caprylic	$C_8H_{18}O$	0·823	4·5	65	356·	180·0
10. Laurylic	$C_{12}H_{26}O$					
16. Ethal or cetylic	$C_{16}H_{34}O$					
27. Cerotin or cerylic	$C_{27}H_{56}O$					
30. Melissin or mellisylic	$C_{30}H_{62}O$					

Each term of the series becomes denser, so that at one end we have a light volatile fluid, and at the other a waxy-looking solid.

Ordinary vinous alcohol (the second in the table) is the most important. It is formed during the fermentation of the saccharine principles contained in the fruits, stalks, or roots of certain plants, especially the raisin, the sugar-cane, the red-beet, the cereals, the potatoes, and other amylaceous substances. It is most usually obtained from malt. When perfectly pure, and unmixed with water, it is called absolute alcohol; when mixed with 16 per cent. of water, it is called rectified spirit; when with 51 per cent. of water, proof-spirit.

Absolute Alcohol is a most powerful solvent of alkaloids, volatile oils, iodine, and its specific gravity should be 0·795. Its purity is easily ascertained. A small portion of the liquid should be digested on common salt, which should be insoluble in it. If any dissolves, there is water with the alcohol. It should not become cloudy on the addition of water; it should be entirely volatilised with heat, leaving no stain behind, and should not give a blue colour with anhydrous sulphate of copper. If all these tests are satisfactory, the liquid is free from oily matters and other impurities.

Rectified Spirit should be of the specific gravity 0·838. If of any other specific gravity, the amount of water present can be seen by the table. On applying a light to a small portion, when pure, it burns with a pale-blue flame, without smoke; it does not give a red colour with sulphuric acid. Four fluid ounces, to which half a grain of crystallised nitrate of silver in solution has been added, on exposure for twenty-four hours to a bright light, and then decanted from the black powder which forms, undergoes no further change.

The proportion of alcohol to water, in any mixture of pure spirit and water, may easily be ascertained by taking the specific gravity, and referring to the following table:—

PROPORTION of ABSOLUTE ALCOHOL by WEIGHT in 100 parts of Spirit of different specific gravities at 60° F. (15·5 C.)

Alcohol per cent.	Specific Gravity.	Alcohol per cent.	Specific Gravity.	Alcohol per cent.	Specific Gravity.	Alcohol per cent.	Specific Gravity.
0	1·0000	9	·9855	19	·9728	29	·9593
0·5	·9991	10	·9841	20	·9716	30	·9578
1	·9981	11	·9828	21	·9704	31	·9560
2	·9965	12	·9815	22	·9691	32	·9544
3	·9947	13	·9802	23	·9678	33	·9528
4	·9930	14	·9789	24	·9665	34	·9511
5	·9914	15	·9778	25	·9652	35	·9490
6	·9898	16	·9766	26	·9638	36	·9470
7	·9884	17	·9753	27	·9623	37	·9452
8	·9869	18	·9741	28	·9609	38	·9434

PROPORTION of ABSOLUTE ALCOHOL by WEIGHT in 100 parts of Spirit of different specific gravities at 60° F. (15·5 C.)—*continued.*

Alcohol per cent.	Specific Gravity.	Alcohol per cent.	Specific Gravity.	Alcohol per cent.	Specific Gravity.	Alcohol per cent.	Specific Gravity.
39	·9416	55	·9069	71	·8696	86	·8331
40	·9396	56	·9047	72	·8672	87	·8305
41	·9376	57	·9025	73	·8649	88	·8279
42	·9356	58	·9001	74	·8625	89	·8254
43	·9335	59	·8979	75	·8603	90	·8228
44	·9314	60	·8956	76	·8581	91	·8109
45	·9292	61	·8932	77	·8557	92	·8172
46	·9270	62	·8908	78	·8533	93	·8145
47	·9249	63	·8886	79	·8508	94	·8118
48	·9228	64	·8863	80	·8483	95	·8089
49	·9206	65	·8840	81	·8459	96	·8061
50	·9184	66	·8816	82	·8434	97	·8051
51	·9160	67	·8793	83	·8408	98	·8001
52	·9135	68	·8769	84	·8382	99	·7969
53	·9113	69	·8745	85	·8357	100	·7938
54	·9090	70	·8721				

See ALCOHOLISM, ALCOHOLOMETRY, ALCOHOLIC BEVERAGES.

Alcohol, Effects of; Alcoholism—1. *Effects of Alcohol in Health.* — The amount of absolute alcohol taken by temperate people, in the twenty-four hours, in the different forms of beer, wine, and spirits, varies generally from one to two ounces. More than this, at all events in the great majority of people, causes slight alcoholic symptoms. If the excess of this quantity is small, the symptoms will be in no way evident to others, but may be appreciated by the individual himself, and consist in firstly a slight excitement of the faculties of the brain, a feeling of warmth and pleasure, followed by a general feeling of torpor and transient drowsiness, with a slight blunting of the sensibilities. The couple of pints of beer, four or five glasses of wine, or two ounces of brandy, that men and women engaged in the ordinary business of life take daily, have not been proved to exercise the slightest injury—in most people, indeed, digestion is aided, and more work done, by theso moderate doses. On the other hand, the slightest habitual excess, that excess which we have spoken of, the symptoms of which are not perceptiblo to others, all evidence—historical, pathological, and physiological—shows to be injurious. The experiments of Anstie, Parkes, and Count Wollowicz, appear to show that any quantity of alcohol exceeding an ounce and a half taken by an adult, showed itself in the urine, which these writers consider a sign that tho system has taken more alcohol than can be used in the body itself. Tho action in slight doses is, that it has a sedative effect upon the nerves, and reddens slightly tho lining membrane of the stomach, stimulates the secretion of the gastric juice, and thus may in small doses, and no doubt does, promote the appetite. In excess, all these effects are turned to evil, an inflammatory condition of the stomach supervenes, compression of the gland-ducts, from thickening of the tissuo around it, excessive mucous secretion, and great loss of appetite. When carried into the circulation, it greatly increases the force of the heart's action, and at the same time paralyses, as it were, tho inhibitory nervous supply to the arteries and small vessels, so that they no longer oppose themselves to the blood-current, but dilate. This action, to a small degree, occurring in persons of a weak and languid circulation, is no doubt beneficial; on the other hand, when in excess, it is the most dangerous, and is a cause of a greater portion of the diseases of the heart and great vessels.

There appears to be a slight fall of temperature with moderate doses of alcohol, a very decided fall with excessive doses; the muscular and nervous system are transitorily stimulated, and may do more work when small doses are given in cases of fatigue, but in other cases there is a marked torpor of the nervous, and a want of co-ordination of the muscular system.

The pathological changes havo been well studied by Dickinson and others. Dickinson, in a paper "On the Morbid Effects of Alcohol in Persons who trade in Liquor," gave the results of an examination of 149 traders in liquor, as compared with 149 persons of various trades. The general results were, diseases of the liver, mostly cirrhosis, more common in the alcoholic. In the lungs, tubercle affected sixty-one persons of the alcoholic, forty-four of the non-alcoholic. Tubercle in the brain, liver, kidneys, spleen, bowels, mesenteric glands, and peritoneum was twice as common in the alcoholic as in the non-alcoholic. The conclusion is therefore inevitable, that alcohol engenders tubercle in the brain, inflammations, atrophy, hæmorrhages; in the heart and vessels, atheroma, hypertrophy, and other affections, were all more common in the alcoholic than in the non-alcoholic series. The evidence in kidney disease was not so conclusive, but some forms of kidney disease appear to be increased. The author sums up thus:—

Alcohol causes fatty infiltration and fibroid encroachment; it engenders tubercle, encourages suppuration, and retards healing; it produces untimely atheroma, invites hæmorrhage, and anticipates age. The most constant fatty change, replacement by oil of the material of epithelial cells and muscular fibres, though probably nearly universal, is most noticeable in the liver, the heart, and the kidney.

There would appear also to be special diseases produced by alcohol besides the more common and generally-known ones of delirium tremens, alcoholism, &c. &c., *e.g.*—

M. Galezowski has described a peculiar affection of the eyes, which he calls "alcoholic amblyopia," especially prevalent during the siege of Paris. In the five months of the siege fifty patients presented themselves, while during the twelve months preceding the siege only nineteen were met with. The disease was ascribed to the habit of taking alcoholic drinks in the morning, fasting.

Handfield Jones and Wilks have also described cases of alcoholic paraplegia.

It would also appear tolerably well established that alcohol either causes or increases insanity, though there may be another explanation of the fact that many mad people have been great drinkers. A large proportion of those subject to insanity are driven by their morbid minds to drink, so that it may be "insanity causes drink," not "drink causes insanity." The following table is given by Dr. Joseph Williams :—

	Total Admission.	Proportion caused by Intemperance.
Charenton . .	855	134
Bicetre and Salpetriere	2012	414
Bordeaux . .	156	20
Turin, 1830–31 .	158	17
,, 1831–36 .	390	76
Gard . . .	209	4
United States . .	551	146
Palermo . . .	189	9
Caen . . .	60	16
Dundee . . .	14	4
M. Parchappe .	167	46
M. Batteu . .	288	54
	5049	940

The effects of alcoholism are in a pre-eminent degree to cause disease, to shorten life, and to prematurely age. Nothing can prove this better than the following statistics :—

A Temperate Person's chance of Living is,	An Intemperate Person's chance of Living is.
At 20 = 44·2 years.	At 20 = 15·6 years.
,, 30 = 36·5 ,,	,, 30 = 13·8 ,,
,, 40 = 28·8 ,,	,, 40 = 11·6 ,,
,, 50 = 21·25 ,,	,, 50 = 10·8 ,,
,, 60 = 14·285 ,,	,, 60 = 8·9 ,,

The average duration of life after the commencement of habits of intemperance is—

Among mechanics, working and labouring men, ...	18 years.
,, traders, dealers, and merchants,	17 ,,
,, professional men and gentlemen,	15 ,,
,, females, ...	14 ,,

NELSON'S *Statistics.*

The Effects of Alcohol in Disease.—This subject has not been scientifically investigated. Dr. Wilks has prescribed it, however, in the form of rectified spirit, but the cases as yet are too few to form a correct estimate. The truth really is that it has been prescribed, even by the most eminent men, under the forms of beer, wine, and spirits, the strength, adulterations, and composition of which are seldom in any given sample known, in the most opposite affections, and as a result, it has been on the one hand extravagantly given, and lauded to a most unwarrantable degree, while on the other hand, by another class of observers it has been entirely withheld. These facts, no doubt, prompted the following document, which was published in 1871, and signed by a long list of some of the most eminent members in the profession; others, however, equally eminent, refused, and withheld their signature on various grounds :—

As it is believed that the inconsiderate prescription of large quantities of alcoholic liquids by medical men for their patients has given rise, in many instances, to the formation of intemperate habits, the undersigned, while unable to abandon the use of alcohol in the treatment of certain cases of disease, are yet of opinion that no medical practitioner should prescribe it without a sense of grave responsibility. They believe that alcohol, in whatever form, should be prescribed with as much care as any powerful drug, and that the directions for its use should be so framed as not to be interpreted as a sanction for excess, or necessarily for the continuance of its use when the occasion is past.

They are also of opinion that many people immensely exaggerate the value of alcohol as an article of diet; and since no class of men see so much of its ill effects, and possess such power to restrain its abuse, as members of their own profession, they hold that every medical practitioner is bound to exert his utmost influence to inculcate habits of great moderation in the use of alcoholic liquids.

Being also firmly convinced that the great amount of drinking of alcoholic liquors among the working classes of this country is one of the greatest evils of the day, destroying more than anything else the health, happiness, and welfare of those classes, and neutralising to a large extent the great industrial prosperity which Providence has placed within the reach of this nation, the undersigned would gladly support any wise legislation which would tend to restrict within proper limits the use of alcoholic beverages, and gradually introduce habits of temperance.

It is still a matter of dispute as to how alcohol is eliminated from the body, and whether any of it is destroyed, notwithstanding the researches of Percy, Strauch, Masing, Lallemand, Duroy, Parkes, Dupré, Anstie, Thudichum, and others. Among the most recent are those of Subbotur on rabbits. The general result is contradictory. Some affirm that it is eliminated as aldehyd, others as carbonic acid; but the former supposition is almost disproved, and the experiments of Dr. E. Smith show that the carbonic acid is decreased by brandy and gin, and increased by rum. The only probable supposition which facts support tends to show that the alcohol is turned into acetic acid in the body, some of which unites with potash and other bases and some is destroyed. All pretty well agree that in the form of spirits alcohol is of no value whatever as a food; but in the form of beer and wine it has slight dietetic powers, naturally varying with the amount and nature of the different substances held in solution in these beverages. *See* ALCOHOLIC BEVERAGES.

Drunkenness and the consumption of spirits would appear to be on the increase by the different returns in our own country and abroad. The imports of spirits in the seven years from 1850 to 1857 amounted to 70,740,980 galls., whilst the imports in the seven years following—viz., from 1857 to 1864—amounted to 78,016,071 galls., showing an increase of 7,305,091 galls. The population has, however, increased in the time, and a deduction on that account, and a correction in one or two other heads, are required; still, that there is increase is indisputable.

In France, the following figures by M. Hussou show a remarkable increase:—

The Mean Consumption of Spirits for each Inhabitant.

	Litres.		Litres.	
From 1825 to 1830	8·96	yearly	·024	daily.
,, 1831 ,, 1835	8·74	,,	·023	,,
,, 1836 ,, 1840	10·15	,,	·027	,,
,, 1841 ,, 1845	11·14	,,	·031	,,
,, 1846 ,, 1850	11·03	,,	·030	,,
,, 1851 ,, 1854	14·25	,,	·039	,,

In the United States, the consumption during the period from 1807–1828 averaged 27 litres for every inhabitant, which is even greater than the highest of the above figures. The demoralisation also of the French army in the late Franco-Prussian war is almost unanimously ascribed to the excessive use of spirituous liquors.

Drunkenness, as modified by Race.—The Massachusetts Board of Health in 1870 undertook an elaborate inquiry into drunkenness as it existed in different parts of the world, and issued a report on it which has been analysed and summarised by Dr. Druitt (Medical Times and Gazette, April 15, 1872). The answers they obtained as to the effects of drink from the 164 physicians in Massachusetts were extremely conflicting, but the information gained as to the comparative sobriety was instructive. Dr. Druitt thus summarises the evidence:—

We may arrange the various populations, concerning whom the correspondents of the Massachusetts Board sent reports under four categories in descending scale, beginning with (1) those who abstain; (2) those who drink, but in such moderation that drunkenness forms no feature of the place or people; (3) populations amongst whom drunkenness is pretty common, but of an innocent, jolly, and not criminal character; and (4) populations disgraced by drunkenness, accompanied with brutality and crime.

1. Under the total abstinence head we may arrange the Mussulman populations of Constantinople, Alexandria, Zanzibar, and the people of Hayti.

2. The population is shown to drink, but without any features of excess, by the answers received from Ancona and Florence, Athens, Cadiz, Teneriffe, Funchal, Fayal, Malta, Beerut, Geneva, Vienna, Bremen, Leipsic, Nicaragua, Pernambuco, St Juan, Pare, Trinidad, Lima, and Honolulu.

3. People are shown to drink too freely, but innocently and without violence, by the answers from Trieste, Basel, Berne, Zurich, Frankfort, Copenhagen, Elsinore, Yokohama, Hiojo, and Santa Cruz.

4. In the lowest category rank the answers from Liverpool, Manchester, Dublin, Edinburgh, Rotterdam, Utrecht, Odessa, Toronto, Cologne, Colombo.

So that highest in the scale of temperance come the Turks and Arabs; next the Iberians, Levantines, Greeks, and Latin races; lower down, the Japanese, Scandinavians, Belgians, and the Irish Celt; lowest of all, the so-called Anglo-Saxon of either continent.

It would seem from this that a great deal depends upon the nature of the liquid imbibed, whether wine, beer, or spirits. *See* ALCOHOLIC BEVERAGES.

It therefore appears unhappily too true that there is really an increase in the consumption of spirituous liquors in most countries, and as a natural, though not inevitable, sequence, an increase of drunkenness. Professor Levi gives the following statistics on this subject in regard to England: In 1860, the committals for drunkenness in England and Wales were 88,000; and in 1870, 134,000, an increase of 50 per cent. In Manchester the increase from 1860 to 1870 was 375 per cent., or, computed according to the increase of population, 35·3 per cent. In London, drunkenness is in the proportion of 5·43 per 1000; in Leeds, 7·40; in Manchester, 31·13; and in Liverpool, 42·82. It must be remembered, however, that these figures are based upon mere committals, which greatly depend on the activity of the police, and the noisy or quiet character of the drunkard.

Whether Alcohol is necessary or not.—All experience, both at home and abroad, shows, by facts that cannot be disputed, that a person can do quite as hard work without alcohol as with it; and probably, as the limits between moderation and excess are easily passed, and as the generality of mankind, even without intending it, err on the latter side, the result is that a comparison between total abstainers and even temperate men generally terminates in favour of the former. It would appear that total abstainers live longer, are better citizens, and can do more work than the rest of mankind. The figures of the United Kingdom Temperance and General Provident Institution go far to prove the above.

This insurance society is divided into two sections. One section consists of abstainers, the other of persons selected as not known to be intemperate. The claims for five years anticipated in the temperance section were £100,446, but the actual claims were only £72,676. In the general section the anticipated claims were £196,352; the actual claims no less than £230,297. In war, the march of 2000 miles in the War of Independence by Cornwallis and his troops (1783), the Maroon War of Jamaica, the 400 miles' march of an English army across the desert from Komer, on the Red Sea, a march of 1000 miles in the Kaffir War, experience at sieges, in action, in hot, temperate, and cold climates, where abstinence was either forced through circumstances, or followed, shows to every unprejudiced mind that soldiers endure more fatigue, are healthier, and fight better without stimulants than with them, and this fact is endorsed by every commander of the present day. The excess and abuse of spirits, as before remarked, lost the French their military *prestige* in the late war.

In very hot and very cold climates the Indian observers and the Arctic explorers all unite in condemning its use in the slightest excess, or even in moderate doses. It does not warm the body in cold climates, and the reaction that follows the exciting of the circulation is followed by a dangerous depression; whilst in hot, it combines with the climate, and quickly produces disease.

In this country and others, various attempts have been made to repress the growing evil of drunkenness. Mr. Dalrymple introduced a bill in 1871, which, if it had passed, would have committed the poorer class of habitual drunkards to a reformatory, while, practically, it would have allowed the opulent drunkard to go free, unless he was convicted of drunkenness. The American law makes no invidious distinction in this way, but treats all alike. The following is an American statute on the subject:—

Revised Statutes of New York.—Title II. of the custody and disposition of the estates of idiots, lunatics, persons of unsound mind, and drunkards.

Section II.—Whenever the overseers of the poor of any city or town in this State discover any person resident therein to be an habitual drunkard, having property to the amount of 250 dollars, which may be endangered by means of such drunkenness, it shall be their duty to make application to the Court of Chancery for the exercise of its powers and jurisdictions.

Section III.—If such drunkard have property to an amount less than 250 dollars, the overseers may make such application to the Court of Common Pleas of the county, which is hereby vested with the same powers in relation to the person and real and personal estate of such drunkard as are by this title conferred in the Court of Chancery, and shall in all respects proceed in like manner, subject to an appeal to the Court of Chancery.

In England the Total Abstinence Society have made great efforts to inculcate their doctrines. Unfortunately, however, zeal so often leads their votaries beyond the bounds of discretion, that it brings them into ridicule, although they certainly have reason and experience on their side.

At Versailles, the mayor in 1850 established temperance prizes, varying from 2000 francs to 50. These were conferred upon the most honest, frugal, and temperate workmen in Versailles.

Alcoholometry — This word signifies the determination of the amount of alcohol in any given liquid. This may be done in a great variety of ways.

1. By using instruments called hydrometers, which, by sinking to a certain depth, indicate the specific gravity. The Revenue use Sykes' hydrometer, but there are others made of glass which are in use, and are much cheaper.

2. By distilling the alcohol in a more or less pure state from the liquid supposed to contain it, and then taking its specific gravity.

3. Gröning's method — from the temperature of the vapour.

4. From the boiling-point.

5. From the expansion of the liquid when heated.

6. From the tension of the vapour. (Geissler's alcoholometer.)

TABLE showing the DENSITIES and VALUES OF SPIRITS at 60° F. corresponding to every indication of Sykes' Hydrometer.

Sykes' Hydrometer indication.	Strength per cent.	Specific Gravity.	Per cent. of Absolute Alcohol.		Sykes' Hydrometer indication.	Strength per cent.	Specific Gravity.	Per cent. of Absolute Alcohol.	
			By Measure.	By Weight.				By Measure.	By Weight.
	O.P.					O.P.			
0	67·0	·81520	95·28	92·78	51	11·4	·90551	63·54	55·70
1	66·1	·81715	94·78	92·08	52	10·0	·90732	62·74	54·89
2	65·3	·81889	94·31	91·42	53	8·6	·90913	61·94	54·09
3	64·5	·82061	93·84	90·78	54	7·1	·91107	61·09	53·23
4	63·6	·82251	93·33	90·07	55	5·6	·91299	60·24	52·38
5	62·7	·82441	92·80	89·36	56	4·2	·91479	59·43	51·57
6	61·8	·82622	92·29	88·67	57	2·7	·91666	58·58	50·73
7	60·9	·82800	91·77	87·99	58	1·3	·91839	57·78	49·94
8	60·0	·82978	91·25	87·30		U.P.			
9	59·1	·83151	90·74	86·63	59	0·3	·92037	56·86	49·04
10	58·2	·83323	90·23	85·96	60	1·9	·92228	55·96	48·17
11	57·3	·83494	89·72	85·30	61	3·4	·92408	55·10	47·33
12	56·4	·83661	89·21	84·65	62	5·0	·92597	54·19	46·46
13	55·5	·83827	88·70	84·00	63	6·7	·92798	53·22	45·53
14	54·6	·83993	88·17	83·33	64	8·3	·92984	52·30	44·65
15	53·7	·84153	87·67	82·70	65	10·0	·93176	51·36	43·76
16	52·7	·84331	87·10	81·99	66	11·7	·93367	50·39	42·84
17	51·7	·84509	86·51	81·26	67	13·5	·93586	49·34	41·86
18	50·7	·84680	85·95	80·58	68	15·3	·93758	48·31	40·90
19	49·7	·84851	85·39	79·89	69	17·1	·93949	47·29	39·96
20	48·7	·85022	84·81	79·19	70	18·9	·94135	46·29	39·04
21	47·6	·85205	84·19	78·44	71	20·8	·94327	45·20	38·04
22	46·6	·85372	83·61	77·74	72	22·7	·94518	44·09	37·03
23	45·6	·85537	83·04	77·07	73	24·7	·94709	42·96	36·01
24	44·6	·85700	82·47	76·39	74	26·7	·94899	41·82	34·98
25	43·5	·85878	81·85	75·66	75	28·8	·95092	40·63	33·92
26	42·4	·86055	81·21	74·92	76	31·0	·95288	39·40	32·82
27	41·3	·86229	80·59	74·19	77	33·2	·95484	38·10	31·68
28	40·2	·86402	79·97	73·47	78	35·6	·95677	36·76	30·50
29	39·1	·86574	79·34	72·75	79	38·1	·95877	35·32	29·24
30	38·0	·86745	78·71	72·03	80	40·6	·96068	33·90	28·01
31	36·9	·86915	78·08	71·32	81	43·3	·96259	32·41	26·73
32	35·7	·87099	77·40	70·54	82	46·1	·96457	30·77	25·32
33	34·5	·87282	76·71	69·77	83	49·1	·96651	29·08	23·88
34	33·4	·87450	76·08	69·06	84	52·2	·96846	27·31	22·38
35	32·2	·87627	75·41	68·32	85	55·5	·97049	25·39	20·77
36	31·0	·87809	74·72	67·55	86	59·0	·97254	23·41	19·11
37	29·8	·87988	74·03	66·79	87	62·5	·97458	21·39	17·42
38	28·5	·88179	73·29	65·98	88	66·0	·97660	19·41	15·78
39	27·3	·88355	72·60	65·23	89	69·4	·97857	17·46	14·16
40	26·0	·88544	71·86	64·43	90	72·8	·98057	15·51	12·56
41	24·8	·88716	71·17	63·68	91	76·1	·98261	13·58	10·97
42	23·5	·88901	70·43	62·89	92	79·2	·98452	11·85	9·56
43	22·2	·89086	69·69	62·10	93	82·3	·98657	10·04	8·08
44	20·9	·89268	68·95	61·32	94	85·2	·98866	8·28	6·65
45	19·6	·89451	68·21	60·53	95	88·0	·99047	6·83	5·48
46	18·3	·89629	67·47	59·76	96	90·7	·99251	5·25	4·20
47	16·9	·89822	66·67	58·92	97	93·3	·99448	3·80	3·03
48	15·6	·89997	65·93	58·15	98	95·9	·99658	2·31	1·84
49	14·2	·90182	65·14	57·34	99	98·2	·99851	·997	·793
50	12·8	·90367	64·31	56·52	100	...	1·00000	...	...

7. From the difference between the specific gravity before and after ebullition.

8. Brande's method.

9. Organic analysis.

1. Sykes' hydrometer is a useful instrument, and is employed by the Revenue. There are tables always sold with the instrument, and full directions for use. The one on the preceding page may, however, be useful. It is taken from Loftus's "Inland Revenue Officers' Manual."

2. The second method, for medical officers of health and analysts, is the best, as it is especially applicable to beer, wine, sweetened spirits, &c. &c. 300 parts of the liquid to be examined is accurately measured and distilled in a retort, until exactly a third has passed over. Sometimes salt is added to the liquid, in order to raise its boiling-point. The specific gravity of the distillate is now taken, and the percentage found from the foregoing table. In practice it is, however, generally convenient to operate on smaller quantities than the foregoing. Take 100 centimetres; distil over about a third; dilute it with water until it weighs 50 grammes; bring up the temperature to 16·5° C. (or 60° F.); then fill a 50-gramme-specific-gravity bottle, and weigh and calculate by the aid of the table as before, or the following short one may be used:—

Percentage by Weight.	Specific Gravity.	Percentage by Weight.	Specific Gravity.
0·5	·9991	11	·9828
1	·9981	12	·9815
2	·9965	13	·9802
3	·9947	14	·9789
4	·9930	15	·9778
5	·9914	16	·9766
6	·9898	17	·9753
7	·9884	18	·9741
8	·9869	19	·9728
9	·9855	20	·9716
10	·9841		

It is unnecessary to add that, as the distillate weighed 50 grammes, the strength of the distillate must be halved to arrive at the strength of the original liquid. For instance, if the specific gravity of a distillate of 50 grammes is ·9884, the strength of the beer or other liquid is not 7 per cent., but 3·5.

3. *Gröning's method* is based on the fact that the temperature of the vapour is an exact measure of the strength of the alcohol, but it is more valuable to the distiller and rectifier than to the analyst or health officer. The bulb of a thermometer is put (on the small scale) into a flask with a bilateral tube, and the temperature of the vapour carefully noted. The following table may be used:—

TABLE showing the ALCOHOLIC CONTENT BY VOLUME OF BOILING SPIRITS AND OF THEIR VAPOUR. From the temperature of the latter, as observed by a thermometer. By GRÖNING.

Temp. of the Vapour (F.)	Alcoholic Content of the Distillate per cent.	Alcoholic Content of the Boiling Liquid per cent.	Temp of the Vapour (F.)	Alcoholic Content of the Distillate per cent.	Alcoholic Content of the Boiling Liquid per cent.
170·0	93	92	189·8	71	20
171·8	92	90	192·0	68	18
172·0	91	85	194 0	66	15
172·8	90½	80	196·4	61	12
174·0	90	75	198·6	55	10
174·6	89	70	201·0	50	7
176·0	87	65	203·0	42	5
178·3	85	50	205·4	36	3
180·8	82	40	207·7	28	2
183 0	80	35	210·0	13	1
185·0	78	30	212·0	0	0
187·4	76	25			

4. *The Boiling-Point.*—Within certain limits the boiling-point of alcoholic liquids is not materially altered by admixture with saline and organic matter. A thermometer with a movable scale is employed. Before using it the thermometer is immersed in boiling distilled water, and the 212° of the scale accurately adjusted to the level of the mercury; it is then ready for several hours' operation, or even an entire day, if no considerable variations of atmospheric pressure are experienced.

The other methods—viz., the expansion of the liquid and the tension of the vapour—require special instruments, such as *Silbermann's dilatatometer*, and Geissler's alcoholometer, and though in their way excellent, are not likely to be used by medical officers of health.

The following tables will be found useful:—

TABLE exhibiting the BOILING-POINTS OF MIXTURES OF ALCOHOL AND WATER of the given strengths. By GRÖNING.

Boiling-Point (F.)	Alcohol per cent. per Volume.	Boiling-Point (F.)	Alcohol per cent. per Volume.
205 34	5	179 96	55
199·22	10	179·42	60
195 8	15	178·7	65
192·38	20	177 62	70
189·50	25	176·54	75
187·16	30	175·46	80
185·	35	174·92	85
183·38	40	174·2	90
182·12	45	173·14	95
181 58	50	172·	100

TABLE showing the Boiling-Points of Under-Proof Spirit.—(Ure.)

Boiling-Point (F.)	Percentage strength.	Corresponding Specific Gravity.
178·5	Proof.	·9200
179·75	10 u.p.	·9321
180·4	20 ,,	·9420
182·1	30 ,,	·9516
183·4	40 ,,	·9600
185·6	50 ,,	·9665
189·	60 ,,	·9720
191·8	70 ,,	·9786
196·4	80 ,,	·9850
202·	90 ,,	·9920

Brande's method has no claim to accuracy, but it is extremely expeditious, and therefore often convenient. The liquid is put into a graduated glass tube, decolourised by a strong solution of subacetate of lead and powdered litharge, and then saturated with carbonate of potash. After remaining at rest a little time the alcohol floats to the surface iu a well-marked stratum, the volume of which is then read off.

In certain cases a very small quantity of alcohol may have to be operated on. There would then appear no other way of determining it than by actual organic analysis, and calculation of it as carbonic anhydride and water.

Alcoholic Beverages, Effects of—The more commonly used spirits—brandy, whisky, gin, and rum—have an action similar to alcohol. But the flavouring-matters, essential oils, and adulterations that they contaiu modify their action considerably. The alcohol also often contains minute traces of ether, aud is mixed with small quantities of butyl, propyl, and amyl alcohols. They are the worst form of alcoholic beverages, as they are frequently taken undiluted; and the evidence appears clear that intemperance from spirits shortens life more than intemperance from other intoxicating driuks. The different species of beer, porter, &c., when pure and unadulterated, appear to act to a very slight degree as a food. Liebig observed that less bread was eateu iu families where beer was drunk. The starchy and extractive matters in the beer act like sugar, &c., and tend to raise fat; indeed, those who drink freely of this liquid, it is well known, generally become corpulent. The bitter also is stomachic and tonic. The action of the free acids is not knowu. Certain it is, however, that some people cannot driuk a glass of beer without experiencing rheumatic pains in the joints, which has been ascribed to the acidity. The heavy, low-priced beer occasions drunkenness of a peculiarly brutal character.

Wines are so various that little can be said of them in a general way. The clarets and subacid wines are highly antiscorbutic, and the light wines are to be recommended in preference to the stronger. Port, sherry, beer, stout, &c., appear to predispose to gout sooner than claret, light German, and other wines. There may be a little nourishment in the albumiuous principle of the wine, but this is not proved. It is probable that the vegetable salts, the ethers and sugar, play the most important part in the system. Red subacid wines have been proposed to be introduced as a drink in the navy on account of their antiscorbutic powers. Some of the Indian alcoholic drinks appear to cause a temporary madness.

For the effects of robur, absinthe, &c., *see* Absinthe, Robur.

The following is Mr. Brande's table, correeted by Dr. Henderson, and will show the strength of wines and spirits in use in this country and elsewhere.

PROPORTION of Alcohol, sp. gr. 0·825, iu 100 parts by measure of the following Wines and Malt and Spirituous Liquors:

1. Lissa . .	26·47
,, . .	24·35
Average	25·41
H.	15·90
2. Raisin wine .	26·40
,, .	25·77
,, .	23·20
Average	25·12
3. Marsala .	26·03
,, .	25·05
Average	25·09
H.	18·40
4. Port, average of six kinds .	23·48
Highest	25·83
Lowest .	21·40
5. Madeira .	24·42
,, .	23·93
,, (Sercial)	21·45
,, .	19·24
Average	22·27
6. Currant wine	20·55
7. Sherry . .	19·81
,, . .	19·83
,, . .	18·79
,, . .	18·25
Average	19·17
8. Teneriffe .	19·79
9. Colares . .	19·75
10. Lacryma Christi	19·70
11. Constantia (wh.)	19·75
,, (red)	18·92
H.	14·50
12. Lisbon . .	18·49
13. Malaga .	18·94
14. Bucellas .	18·49
15. Red Madeira	22·30
,,	18·40
Average	20·35
16. Cape Muscat .	18·25
17. Cape Madeira	22·94
,,	20·50
,,	18·11
Average	20·51
18. Grape wiue .	18·11
19. Calcavella .	19·20
,, .	18·10
Average	18·65
20. Vidonia . .	19·25
21. Alba Flora .	17·26
22. Malaga .	17·26
23. White Hermitage . .	17·43
24. Roussillon .	19·00
,, .	17·29
Average	18·13
25. Claret . .	17·11
,, . .	16·32
,, . .	14·08
,, . .	12·91
Average	15·10
H.	12·91
26. Malmsey Madeira . .	16·40
27. Lunet . .	15·52
28. Scheraaz .	15·52
29. Syracuse .	15·28
30. Sauterne .	14·22
31. Burgundy .	16·60
,, .	15·22
,, .	14·52
,, .	11·95
Average	14·57
32. Hock . .	14·37
,, . .	13·00
,, (old, in cask)	8·88
Average	12·08
Rüdesheimer—	
1811, H.	10·72
1800, H.	12·22
Average, H.	11·47
Johannisberger, H. . .	8·71
33. Nice . .	14·63
34. Bardac . .	13·86
35. Teut . .	13·30
36. Champagne (still)	13·80
,, (sparkling)	12·80
,, (red)	12·56
,, .	11·30
Average	12·61
37. Red Hermitage	12·32
38. Viu de Grave	13·94
,,	12·80
Average	13·37
39. Frontignac .	12·79

40. Côte Rôtie	12·32	48. Mead	7·32
41. Gooseberry wine	11·84	49. Ale, Burton	8·88
42. Orange wine, average of six samples made by London manufacturer	11·26	,, Edinburgh	6·20
43. Tokay	9·88	,, Dorchester	5·56
44. Elder wine	9·87	Average	6·87
45. Rhenish wine, H.	8·71	50. Brown stout	6·80
46. Cider, highest average	9·87	51. London porter, average	4·20
Lowest	5·21	London small-beer, average	1·28
47. Perry, average of four samples	7·26	52. Brandy	53·39
		53. Rum	53·68
		54. Gin	51·60
		55. Scotch whisky	54·32
		56. Irish whisky	53·90

35 & 36 VICT. c. 94.

An Act for Regulating the Sale of Intoxicating Liquors.—(10*th August* 1872.)

. . . .

Adulteration.

Sect. 19.—(1.) Every person who mixes or causes to be mixed with any intoxicating liquor sold or exposed for sale by him any deleterious ingredient, that is to say, any of the ingredients specified in the first schedule to this Act, or added to such schedule by any Order in Council made under this Act, or any ingredient deleterious to health; and

(2.) Every person who knowingly sells, or keeps, or exposes for sale any intoxicating liquor mixed with any deleterious ingredients (in this Act referred to as adulterated liquor), shall be liable for the first offence to a penalty not exceeding twenty pounds, or to imprisonment for a term not exceeding one month, with or without hard labour; and for the second and any subsequent offence to a penalty not exceeding one hundred pounds, or to imprisonment for a term not exceeding three months, with or without hard labour, and to be declared to be a disqualified person for a period of not less than two years nor exceeding ten years, and shall also in the case of the first as well as any subsequent offence forfeit all adulterated liquor in his possession with the vessels containing the same. Where the person so convicted is a licensed person, he shall further, in the case of a second or any subsequent offence, be liable to forfeit his license, and the premises in respect of which such license is granted shall be liable to be declared to be disqualified premises for a period of not less than two years nor exceeding five years.

In the case of a first offence and any subsequent offence until the license is forfeited, the conviction shall be recorded on the license of the person convicted.

Where a licensed person is convicted of any offence under this section, and his license is not forfeited for such offence, the police authority of the district shall cause a placard stating such conviction to be affixed to the premises. Such placard shall be of such size and form, and shall be printed with such letters, and shall contain such particulars, and shall be affixed to such parts of the licensed premises the police authority may think fit, and such licensed person shall keep the same affixed during two weeks after the same is first affixed; and if he fails to comply with the provisions of this section with respect to keeping affixed such placard, or defaces or allows such placard to be defaced, or if the same is defaced, and he fails forthwith to renew the same, he shall be liable to a penalty not exceeding forty shillings for every day on which the same is not so undefaced, and any constable may affix or reaffix such placard during the said two weeks, or such further time as may be directed by a court of summary jurisdiction.

20. Every licensed person who has in his possession or in any part of his premises any adulterated liquor, knowing it to be adulterated, or any deleterious ingredient specified in the first schedule hereto, or added to such schedule by Order of Her Majesty in Council, for the possession of which he is unable to account to the satisfaction of the court, shall be deemed knowingly to have exposed for sale adulterated liquor on such premises.

. . . .

22. Any of the following officers, that is to say, any superintendent of police, or other constable authorised in writing by the police authority so to do, and any officer of Inland Revenue, may procure samples of any intoxicating liquor from any person selling or keeping or exposing the same for sale (in this section referred to as the vendor); he may procure such samples either by purchasing the same, or by requiring the vendor to show him and allow him to inspect all or any of the vessels in which any intoxicating liquor in the possession of the vendor is stored, and the place of the storage thereof, and to give him samples of such intoxicating liquor on payment or tender of the value of such samples.

If the vendor, or his agent or servant, when required in pursuance of this section, refuses or fails to admit the officer, or refuses or wilfully omits to show all or any of the vessels in which intoxicating liquor is stored, or the place of the storage thereof, or to permit the officer to inspect the same, or to give any samples thereof, or to furnish the officer with such light or assistance as he may require, he shall be liable to the same penalty, forfeiture, and disqualifications as if he knowingly sold or exposed for sale adulterated liquor.

When the officer has by either of the means aforesaid procured samples of intoxicating liquor, he shall cause the same to be analysed, at such convenient place and time, and by such person, as the Commissioners of Inland Revenue may appoint; provided always that a reasonable notice shall have been given by such officer to the vendor by whom such sample was furnished, to enable such vendor, if he think fit, to attend at the time when such sample is open for analysis; and if it appear to the person so analysing that the said samples of intoxicating liquor are adulterated liquor within the meaning of this Act, he shall certify such fact, and the certificate so given shall be receivable as evidence in any proceedings that may be taken against any person in pursuance of this Act, subject to the right of any person against whom proceedings are taken to require the attendance of the person making the analysis for the purpose of cross-examination.

The vendor may require the officer, in his presence, to annex to every vessel containing any samples for analyses the name and address of the vendor, and to secure with a seal or seals belonging to the vendor the vessel containing such samples, and the name and address annexed thereto, in such manner that the vessel cannot be opened, or the name and address taken off, without breaking such seals; and a corresponding sample, sealed by such officer with his own seal, shall, if required, be left with the vendor for reference in case of disputes as to the correctness of the analysis or otherwise; and the certificate of the person who analyses such samples shall state the name and address of the vendor, and that the vessels were not open, and that the seals securing to the vessels the name and address of the vendor were not broken, until such time as he opened the vessels for the purpose of making his analysis; and in such case as aforesaid no certificate shall be receivable in evidence unless there is contained therein such statement as above, or to the like effect.

Any expenses incurred in analysing any intoxicating liquor of a vendor in pursuance of this section shall, if such vendor be convicted of selling or keeping, or exposing for sale, or having in his possession adulterated liquor, in contravention of this Act, be deemed to be a portion of the costs of the proceedings against him, and shall be paid by him accordingly. In any other event such expenses shall be paid as part of the expenses of the officer who procured the sample.

. . . .

First Schedule.

Deleterious Ingredients.

Cocculus Indicus, chloride of sodium, otherwise common salt, copperas, opium, Indian hemp, strychnine, tobacco, daruel seed, extract of logwood, salts of zinc or lead, alum, and any extract or compound of any of the above ingredients.

Aldehyd—A name given by chemists to a class of bodies intermediate between the alcohols and the acids. Each of the alcohols may be made to furnish its aldehyd. (*See* Alcohol.) Thus we have acetic, propionic, butyric, and valeric aldehyd. They are less oxidised than the acids, and the general principle in preparing them is by gradual oxidation. Thus, if the vapour of alcohol is transmitted, mixed with air, through a porcelain tube, heated to low redness, or if it is acted upon by chromic or nitric acid, aldehyd is formed. The most usual way, however, is that of Liebig, who distilled alcohol with sulphuric acid and black oxide of manganese.

Aldehyd, thus prepared, is a volatile liquid, inflammable, neutral to test-paper, forming a crystalline substance with ammonia, and a brown resinous mass with liq. potassæ. It reduces the salts of silver, and with chlorine forms chloral.

It is a test for alcohol, which may, by any of the above processes, be converted into aldehyd.

Ale—*See* Beer.

Algæ—A tribe of subaqueous plants, including sea-weeds (*Fucus*), and the lavers (*Ulva*) growing in salt water, and the fresh-water confervas. Those sea-weeds which are of commercial value belong to the great division of the *jointless algæ*, of which 160 species are known as natives of the British Islands. In the manufacture of kelp all the varieties of this division may be used. The edible sorts (*see* Algæ, Marine) belong to the same group, as do also those which the agriculturists employ for manure. The following table, giving the results of several analyses of different kinds of algæ, will show the remarkably large quantity of nitrogen contained in these plants:—

Kinds of Algæ.	Water.	Dry Matter.	Percent. Nitrogen in Dry Matter.	Protein contained in Dry Matter.
Chondrus crispus, bleached, from Bewly Evans	17·92	82·08	1·534	9·587
Chondrus crispus, unbleached, Ballycastle	21·47	78 53	2·142	13·387
Gigartina mamillosa, Ballycastle	21·55	78·45	2·198	13 737
Chondrus crispus, bleached, 2d experiment	19 79	80·21	1·485	9·281
Chondrus crispus, unbleached, 2d experiment	19·96	80·04	2·510	15·687
Laminaria digitata, or dulse tangle	21·38	78·62	1 588	9·925
Rhodomenia palmata	16·56	83·44	3·465	21 656
Porphyra laciniata	17 41	82·59	4·650	29·062
Iridæa edulis	19·61	80·39	3·088	19·300
Alaria esculenta	17·91	82·09	2·424	15·150

It would then appear from these gratifying results that sea-weeds are among the most nutritious of vegetable substances—richer in nitrogenous matter than oatmeal or Indian corn. The varieties at present used are the following: *Porphyra laciniata* and *vulgaris*, called *laver* in England, *stoke* in Ireland, and *slouk* in Scotland. *Chondrus crispus*, called *carrageen* or *Irish moss*, and also *pearl-moss* and *sea-moss*. *Laminaria digitata*, known as the *sea-girdle* in England, *tangle* in Scotland, and *red-ware* in the Orkneys; and *Laminaria saccharina*, *Alaria esculenta*, or *bladder-lock*, called also *hen-ware*, and *honey-ware* by the Scotch. *Ulva latissima* or *green laver*—*Rhodomenia palmata*, or *dulse* of Scotland.

These are the principal varieties which are eaten by the coast inhabitants of this country and the Continent; indeed in parts of Scotland and Ireland they form a considerable portion of the diet of the poor. The lavers, under the name of "marine sauce," were once esteemed a luxury in London. The first thing to be done in preparing them for food is to steep them in water, to remove the saline matter, and in some cases a little carbonate of soda added to the water will remove the bitterness. They should then be stewed in water or milk until they become tender and mucilaginous. Pepper and vinegar are the best condiments to flavour them with.

Algæ in Water.—In nearly all waters algæ are present, and they cannot be held to indicate any great impurity; to condemn water because of their presence would be really to condemn all waters, even rain, in which minute algoid vesicles (*protococci*) are often found.

Aliments—*See* FOOD.

Alkali — The term alkali is of Arabic origin; it was given in the first instance to carbonate of soda, or sodic carbonate, which was then obtained from the ashes of seaweeds; but it is now extended to a class of substances possessing many qualities exactly the reverse of those of acids. An alkali is soluble in water, and produces a liquid, soapy to the touch, and of a peculiar nauseous taste; it restores the blue colour to vegetable infusions which have been reddened by an acid. It turns many of these blue colours into green, as in the cases of a solution of red cabbage and of syrup of violets; and it gives a brown colour to vegetable yellows, such as those of turmeric and rhubarb. For the regulations applicable to alkali-works, *see* ALKALI ACTS.

Alkali Acts—The principal Alkali Act is the 26 & 27 Vict. c. 24, amended by 37 & 38 Vict. c. 43, the amended Act coming into operation in 1875.

Every alkali-work must be carried on so as to ensure the condensation of not less than 95 per cent. of muriatic acid evolved therein; and it must be so condensed that in each cubic foot of air, smoke, or chimney gases escaping from the works into the atmosphere there is not contained more than one-fifth part of a grain of muriatic acid. Penalty for first conviction, £50; for second and other offences, £100, or less (26 & 27 Vict. c. 124, s. 4; 37 & 38 Vict. c. 43, s. 4).

The owner of every alkali-work is also bound to "use the best practicable means of preventing the discharge into the atmosphere of all other noxious gases arising from such work, or of rendering such gases harmless when discharged." The noxious gases are defined to be sulphuric acid, sulphurous acid (except that arising from the combustion of coals), nitric acid, or other noxious oxides of nitrogen, sulphuretted hydrogen, and chlorine (37 & 38 Vict. c. 43, s. 5 and 8).

The owner is liable for any offence against the Alkali Acts, unless he prove that the offence was committed by some agent, servant, or workman, and without his knowledge, in which case the agent, &c., is liable (26 & 27 Vict. c. 124, s. 5).

Every alkali-work must be registered: penalty for neglect, £5 per day (ibid. s. 6).

Powers are given to owners to make special rules for the guidance of their workmen (ibid. s. 13).

Alkalimetry—This is the reverse of acidimetry, and signifies the chemical determination of alkali in any given sample or solution.

This may be determined by several methods.

If the alkali is dissolved in pure water, the specific gravity may be taken, and, by the aid of the following tables the percentage composition ascertained.

If the alkali is in the form of carbonate, the carbonic acid may be expelled by an acid, and from the loss the amount of alkali ascertained.—(FRESENIUS and WILL.) In the case of ammonia, the colorimetric method described under WATER ANALYSIS may be used.

The more usual method, however, is based upon the capacity of the base to saturate acids. (For the method of Fresenius and Will, *see* ACID, CARBONIC.) This method only requires one fluid of known strength, *e.g.*, a standard sulphuric acid.

(*a*) In order to prepare this, 5 grammes of carbonate of soda are ignited gently in a platinum crucible, and then accurately weighed, next dissolved in about 200 c.c. of water, and lastly coloured blue with tincture of litmus.

(*b*) 60 grammes of concentrated sulphuric acid are mixed with 500 c.c. of distilled water, and cooled.

The acid is now added from a burette to the point of saturation to the 5-grammes solution of soda. If the carbonate was not exactly 5 grammes, a rule-of-three sum will easily calculate it into 5 grammes. Having obtained thus the number of centimetres of the acid which saturates 5 grammes of carbonate of soda, the acid must be diluted, so as to give a fluid 50 c.c. of which exactly saturates 5 grammes of carbonate of soda. For example, if 40 c.c. of the acid does this, 10 c.c. of water must be added to each 40 of acid, when the acid is thus prepared:—

	Grms.	
50 c.c. of the stand. acid saturate	5·000	carb. of soda.
" " "	2·925	soda
" " "	6·519	carb. of potassa.
" " "	4·443	potassa.

In the actual analysis it is convenient to stain the acid with litmus, and to add drop by drop from a burette to the point of saturation. If this is done twice, and the mean taken, the results are fairly accurate. (Tables I., II., III.)

TABLE I.

Percentages of Anhydrous Potassa corresponding to different specific gravities of Solution of Potassa.

Dalton.		Tünnermann (at 15°).			
Specific Gravity.	Percentage of Anhydrous Potassa.	Specific Gravity.	Percentage of Anhydrous Potassa.	Specific Gravity.	Percentage of Anhydrous Potassa.
1·60	46·7	1·3300	28·290	1·1437	14·145
1·52	42·9	1·3131	27·158	1·1308	13·013
1·47	39·6	1·2966	26·027	1·1182	11·882
1·44	36·8	1·2803	24·895	1·1059	10·750
1·42	34·4	1·2648	23·764	1·0938	9·619
1·39	32·4	1·2493	22·632	1·0819	8·487
1·36	29·4	1·2342	21·500	1·0703	7·355
1·33	26·3	1·2268	20·935	1·0589	6·224
1·28	23·4	1·2122	19·803	1·0478	5·002
1·23	19·5	1·1979	18·671	1·0369	3·961
1·19	16·2	1·1839	17·540	1·0260	2·829
1·15	13·0	1·1702	16·408	1·0153	1·697
1·11	9·5	1·1568	15·277	1·0050	0·5658
1·06	4·7				

TABLE II.

Percentages of Anhydrous Soda corresponding to different specific gravities of Solution of Soda.

Dalton.		Tünnermann (at 15°).					
Specific Gravity.	Percentage of Anhydrous Soda.	Specific Gravity.	Percentage of Anhydrous Soda.	Specific Gravity.	Percentage of Anhydrous Soda.	Specific Gravity.	Percentage of Anhydrous Soda.
1·56	41·2	1·4285	30·220	1·2982	20·550	1·1528	10·275
1·50	36·8	1·4193	29·616	1·2912	19·945	1·1428	9·670
1·47	34·0	1·4101	29·011	1·2843	19·341	1·1330	9·066
1·44	31·0	1·4011	28·407	1·2775	18·730	1·1233	8·462
1·40	29·0	1·3923	27·802	1·2708	18·132	1·1137	7·857
1·36	26·0	1·3836	27·200	1·2642	17·528	1·1042	7·253
1·32	23·0	1·3751	26·594	1·2578	16·923	1·0948	6·648
1·29	19·0	1·3668	25·989	1·2515	16·319	1·0855	6·044
1·23	16·0	1·3586	25·385	1·2453	15·714	1·0764	5·440
1·18	13·0	1·3505	24·780	1·2392	15·110	1·0675	4·835
1·12	9·0	1·3426	24·176	1·2280	14·506	1·0587	4·231
1·06	4·7	1·3349	23·572	1·2178	13·901	1·0500	3·626
		1·3273	22·967	1·2058	13·297	1·0414	3·022
		1·3198	22·363	1·1948	12·692	1·0330	2·418
		1·3143	21·894	1·1841	12·088	1·0246	1·813
		1·3125	21·758	1·1734	11·484	1·0163	1·209
		1·3053	21·154	1·1630	10·879	1·0081	0·604

TABLE III.

Percentages of Ammonia (NH_3) corresponding to different specific gravities of Solution of Ammonia at 16°.—(J. Otto.)

Specific Gravity.	Percentage of Ammonia.	Specific Gravity.	Percentage of Ammonia.	Specific Gravity.	Percentage of Ammonia.
0·9517	12·000	0·9607	9·625	0·9697	7·250
0·9521	11·875	0·9612	9·500	0·9702	7·125
0·9526	11·750	0·9616	9·375	0·9707	7·000
0·9531	11·625	0·9621	9·250	0·9711	6·875
0·9536	11·500	0·9626	9·125	0·9716	6·750
0·9540	11·375	0·9631	9·000	0·9721	6·625
0·9545	11·250	0·9636	8·875	0·9726	6·500
0·9550	11·125	0·9641	8·750	0·9730	6·375
0·9555	11·000	0·9645	8·625	0·9735	6·250
0·9556	10·950	0·9650	8·500	0·9740	6·125
0·9559	10·875	0·9654	8·375	0·9745	6·000
0·9564	10·750	0·9659	8·250	0·9749	5·875
0·9569	10·625	0·9664	8·125	0·9754	5·750
0·9574	10·500	0·9669	8·000	0·9759	5·625
0·9578	10·375	0·9673	7·875	0·9764	5·500
0·9583	10·250	0·9678	7·750	0·9768	5·375
0·9588	10·125	0·9683	7·625	0·9773	5·250
0·9593	10·000	0·9688	7·500	0·9778	5·125
0·9597	9·875	0·9692	7·375	0·9783	5·000
0·9602	9·750				

Alkaloids — The *volatile* alkaloids may be extracted by simply digesting the plant containing them in a weak solution of potash or soda, and distilling them in a suitable retort with condenser. The distillate is then neutralised with sulphuric acid, evaporated, and then the residue digested with alcohol, which dissolves out the sulphate of the organic base required. The sulphate of the alkaloid may then be decomposed by agitating it with a strong solution of caustic potash and ether, and obtained in a state of purity from the ether which rises to the top.

Non-volatile alkaloids are obtained by powdering or rasping the vegetable, and digesting it in dilute acids. Ammonia, magnesia, or carbonate of soda is added to the filtered liquid; the resulting precipitate is filtered off, and treated with boiling alcohol; the alkaloid crystallises out on cooling, and may be purified by animal charcoal. The above are general modes of extracting alkaloids, which must be varied for particular purposes.

In the search for an organic base in cases of suspected poisoning by these substances, Stas recommends tho adoption of the following method: To tho contents of the stomach add twice their weight of concentrated alcohol, then from 10 to 30 grains of tartaric acid, and heat the mixture in a flask to 160° or 170°; allow it to cool completely, and wash the residue with strong alcohol. Evaporate the filtrate *in vacuo*, or in a current of air, at a temperature not exceeding 90°, filtering tho solution if any fat separates; treat the dry residue with cold absolute alcohol. Evaporate *in vacuo*. Dissolve the acid residue in a few drops of water, adding hydropotassic or hydrosodic carbonate (bicarbonate), till it ceases to produce effervescence; then agitate with four or five times its bulk of fine ether. When clear, allow a portion of this ethereal solution to evaporate spontaneously in a very dry place. In this way the base is obtained in a state of purity sufficient to allow of its examination by its characteristic reagents. If sulphuric acid be added to the ethereal solution, the sulphates of the following volatile bases may be separated in a crystalline form: Ammonia, tetrylia, nicotylia, aniline, quinoline, and picoline. Conylia sulphate is slightly soluble in ether. Stas states that he has thus successfully isolated morphia, codeia, strychnia, brucia, veratria, emetia, atropia, hyoscyama, aconitina, and colchicine, all of which, when uncombined with acid, are sufficiently soluble in ether to admit of extraction by the foregoing method. Many organic bases aro also dissolved by chloroform, which may often bo advantageously substituted for ether in Stas's process.

The liquid is filtered, if necessary, and agitated with about one-thirtieth of its bulk of chloroform. The chloroform speedily separates in tho form of a heavy oily layer, which can be decanted; it will be found to contain nearly the whole of the base, which may afterwards be purified by the usual methods. The following bases are especially soluble in chloroform: Veratria, quinia, brucia, narcotine, atropia, and strychnia; cinchonia is but sparingly soluble, and morphia still less so.

The following is a summary of the best known routine process of identification of an alkaloid:—

The presence of the alkaloids and their salts, in clear solutions, may be thus determined:—

I. (FRESENIUS.)—1. The solution is rendered very slightly alkaline with dilute solution of potassa or soda, added drop by drop.

(*a*) No precipitate is formed; total absence of the alkaloids. (*See* 4, below.)

(*b*) A precipitate is formed; solution of potassa or soda is added, drop by drop, until the liquid exhibits a strong alkaline reaction.

(*A*) The precipitate redissolves; absence of *brucia, cinchonia, narcotina, quina, strychnia*, and *veratria;* probably presence of MORPHIA.

(*B*) Precipitate does *not* redissolve, or not completely; probably the presence of one or more of the first six of the above-named alkaloids. The fluid is filtered from the precipitate, mixed with either bicarbonate of soda or of potassa, gently boiled nearly to dryness, and treated with water. If it dissolves completely, absence of *morphia;* an insoluble residue indicates MORPHIA.

2. The precipitate (1 *b*, *B*) is washed with cold distilled water, dissolved in a slight excess of dilute sulphuric acid, neutralised with a saturated solution of bicarbonate of soda, and allowed to repose a few hours.*

(*a*) No precipitate; absence of *cinchonia, narcotina*, and *quina*. The solution is gently evaporated nearly to dryness, and treated with cold water. If it dissolves completely, pass on to 4; if there is an insoluble residue, it may contain *brucia, strychnia*, or *veratria*. (*See* 3.)

(*b*) A precipitate; the filtered fluid is treated as directed at 2 *a*; the precipitate is washed with cold distilled water, dissolved in a little hydrochloric acid. Ammonia is added in excess, and subsequently a sufficient quantity of ether, agitation being had recourse to.

(*A*) The precipitate formed by the ammonia redissolves completely in the ether, and the clear liquid separates into two layers; absence of CINCHONIA; probable presence of QUINA or NARCOTINA.

(*B*) The precipitate produced by the ammonia does not redissolve in the ether, or not completely. Probable presence of CINCHONIA, and perhaps also of *quina* or *narcotina*. The filtered liquid may be tested for these alkaloids as at *a*.

3. The insoluble residuum after the evaporation of the solution 2 *a*, or of the filtrate 2 *b*, is now dried in a water-bath, and digested with absolute alcohol.

(*a*) It dissolves completely; absence of *strychnia;* probable presence of BRUCIA, QUINA (?) or VERATRIA. The alcoholic solution is evaporated to dryness, and if quina has been already detected, the residue is divided into two portions, one of which is tested for *brucia*, the other for *veratria*.

(*b*) It does not dissolve, or not completely. Probable presence of STRYCHNIA, and perhaps also of *brucia* and *veratria*. The filtered fluid is divided into two portions, and tested separately as at *a*.

4. The original liquid (1 *a*) may contain *salicine*, a proximate vegetable principle, closely allied to the alkaloids; a portion is boiled with hydrochloric acid for some time; the formation of a precipitate shows the presence of SALICINE. (*See* 2, below.)*

II. (LAROCQUE and THIBIERGE).—Terchloride of gold is recommended by writers as a more decisive test for the alkaloids than the "double chloride of gold and sodium," commonly employed for this purpose. The following are the colours of the precipitates which it produces with the aqueous solution of their salts: BRUCIA, milk-brown, passing into coffee-brown, and lastly chocolate-brown; CINCHONIA, sulphur-yellow; MORPHIA, yellow, then bluish, and lastly violet. In this last state the gold is reduced, and the precipitate is insoluble in water, alcohol, the caustic alkalies, and sulphuric, nitric, and hydrochloric acids. It forms with aqua regia, a solution which is precipitated by protosulphate of iron. QUINA, buff-coloured; STRYCHNIA, canary-yellow; VERATRIA, pale greenish-yellow. All these precipitates, with the exception mentioned, are very soluble in alcohol, insoluble in ether, and only slightly soluble in water. Those with *morphia* and *brucia* are sufficiently marked to prevent these alkaloids from being mistaken for each other, and those with *brucia* and *strychnia* are, in a like manner, easily distinguishable.

The best methods of discriminating the poisonous alkaloids in the solid state are—(1) Their behaviour with nitric and sulphuric acid; (2) the amount of ammonia they evolve when distilled with an alkaline solution of permanganate of potash; (3) the temperature at which they sublime.

These three methods should always be combined, and they cannot fail to identify the alkaloid.

I. The behaviour of the principal alkaloids with sulphuric and nitric acid may be seen by a glance at the following table (GUY):—

	Sulphuric Acid.			Nitric Acid.
	Cold.	Warm.	Hot.	
Cantharidine.	0	0	0	0
Strychnine....	0	0	yellow[1] †	pink
Brucine.........	0	0	yellow[2]	red[3]
Morphine......	0	0	brown	orange[3]
Atropine.......	0	0	brown[1]	0
Aconitine......	0	brown	black	0
Picrotoxine ...	0	yellow	brown	0
Veratrine......	orange[3]	scarlet	claret	0
Digitaline...	red-brown[1]	red-brown[2]	red-brown[3]	0
Solanine........	yellow[3]	brown[2]	brown[3]	6

* Before setting the glass aside the liquor should be well mixed, and the glass-stirrer vigorously rubbed against the sides of the vessel.

* For further information on this subject, see the admirable System of Qual. Chem. Anal., by Dr C. R. Fresenius (J. and A. Churchill).

† The small figures 1, 2, 3, show degrees of intenseness.

II. An entirely different, extremely delicate, and valid method of discriminating the different alkaloids, is the estimation of the ammonia they evolve on distillation with a strongly alkaline solution of permanganate of potash. This method is the natural result of Wanklyn's observation that organic substances in general, when they do not contain the nitrogen in the nitro state or urea, evolve it as ammonia, some giving up all their nitrogen, others only a part.

The mode of procedure is of the simplest nature. A small flask, with a bilateral tube (see fig. 6, p. 53), is charged with about 25 c.c. of the solution of permanganate of potash, described under Water-Analysis, and connected with a small Liebig's condenser. A minute quantity of the alkaloid, carefully and accurately weighed, is now introduced, and the mixture slowly distilled. The best results are obtained by treating from 1 to 5 milligrammes in this way; but quantities so small as $\frac{1}{10}$th of a milligramme will, in skilled hands, give accurate results. The ammonia is found in the distillate, is nesslerised and estimated colorimetrically as described under Ammonia, Water-Analysis, &c.

The poisonous alkaloids may be for practical purposes divided into four classes:—

(*a*) Those which yield from − 5 to 2 per cent. of ammonia.

(*b*) Those which yield from 2 to 3 per cent. of ammonia.

(*c*) Those which yield from 3 to 5 per cent. of ammonia.

(*d*) Those which yield a larger quantity than 5 per cent., *e.g.*—

	NH_3 per cent.
I.	
Solanine yields half its nitrogen as ammonia	0·98
II.	
Morphia yields half its nitrogen as ammonia	2·98
Codeine do. do.	2·87
Papaverine do. do.	2·50
Veratria do. do.	2·87
III.	
Atropia yields all its nitrogen as ammonia	5·73
Narcotine do. do.	4·11
Strychnine yields half its nitrogen as ammonia	5·09
Brucine do. do.	4·32
Aconite do. do.	3·5
Coneine do. do.	4·6
IV.	
Nicotine yields half its nitrogen as ammonia	10·49

III. The exact heat at which the poisonous alkaloids melt and sublime has been very carefully worked out by various observers, especially Dr. Guy. A very minute speck of the substance may be placed on a porcelain plate or copper disc, and a square or circle of microscope covering-glass placed over it, supported by a thin ring of glass, or any other convenient substance. Heat is applied, and the temperature, as observed by a thermometer, at which any change takes place, carefully recorded.

	Fahr.	Cent.
Cantharidine sublimes as a white vapour, without change of form or colour	212°	100°

		Sublime. Fahr.	Sublime. Cent.	Melt. Fahr.	Melt. Cent.
Morphine	Sublime, melt, and yield carbonaceous residue.	330°	165°	340°	171°
Strychnine		345°	174°	430°	224°

		Melt. Fahr.	Melt. Cent.	Sublime. Fahr.	Sublime. Cent.
Aconitine	Melt, change colour, sublime, and deposit carbon.	140°	60°	400°	204°
Atropine		150°	66°	280°	135°
Veratrine		200°	93°	360°	182°
Brucine		240°	116°	400°	204°
Digitaline		310°	154°	310°	154°
Picrotoxine		320°	160°	320°	160°
Solanine		420°	215°	420°	216°

In all cases the solubility of the alkaloids will materially assist the diagnosis. The following is a summary of the relative solubility of the more important, the figures giving the number of parts of the liquid required for solution:—

Absolute Alcohol.—Strychnine insoluble; brucine soluble.

Amylic Alcohol.—Solanine (1061); digitaline sparingly soluble; *morphine* (133); strychnine (122); veratrine, brucine, atropine, aconitine, and picrotoxine freely soluble.

Benzole.—All the poisonous alkaloids except solanine are soluble in benzole.

Chloroform.—Solanine (50,000); morphine (6550); strychnine (8); the rest freely soluble.

Ether.—Solanine (9000); morphine (7725); strychnine (1400); aconitine (777); brucine (440); veratrine (108); atropine, picrotoxine, and digitaline very soluble.

Water (cold).—Strychnine (8333); veratrine (7860); morphine (4166); aconitine (1783); solanine (1750); brucine (900); atropine (414); picrotoxine (150); digitaline very soluble.

Allspice, Pimento, or Jamaica Pepper—The berry or fruit of the *Eugenia Pimento*, one of the *Myrtaceæ*. This beautiful tree is planted in Jamaica in regular walks, which are called *Pimento walks*. The fruit, which is gathered while still green, but not until it has attained full size, is usually sun-dried, but sometimes kiln-dried on sheets. During this process the colour of the fruits changes from green to reddish brown. The thoroughly-ripe berry is glutinous, and becomes dark purple in colour, and hence in that state it is unfit for preservation.

The essential oil of pimento is a mixture of two oils—a light and a heavy oil.

The pimento berry is divisible into husk and seed, or seeds proper. The following are the characteristics of the husk: It is thick, and when dry, soft and brittle; it sends off from its inner surface a prolongation which forms a septum, and divides the interior into two parts or cells.

Viewed under the microscope, a vertical section of the husk presents the following structures: On the outer part of the section are seen several large cells or receptacles for the essential oil. These are often two or three deep. More internally, numerous stellate cells, attached to and imbedded in cellular tissue, occur. Next to these may be seen bundles of woody fibre and delicate spiral vessels, while the deepest or innermost part of the section consists of cellular tissue only. The two cells formed by the husks are each occupied by a small flattish seed of a dark brown or chocolate colour. If we macerate this, we may succeed, after some little difficulty, in separating two membranes from the surface of the seed. The external of these, very thin and delicate, consists of a single layer of elongated and angular cells. The internal tunic—to which the dark colour of the surface is due—is composed of several layers of large, corrugated, coloured cells. When viewed under the microscope they exhibit the characteristic port-wine tint.

If we divide the *seed* proper in vertical sections, the following structures are displayed: Running round the outer part of the section is a single layer of large receptacles, the remaining thickness being made up of angular and transparent cells, the cavities of which are filled with numerous well-defined starch granules.

The various structures here mentioned, when the pimento berries are reduced to powder, become disunited, broken up, and intermixed. The port-wine-coloured cells are particularly conspicuous, and afford a character by which the nature of the powder may be at once determined.—(HASSALL.)

As this spice is remarkably cheap, it is not much adulterated, though we occasionally find it sophisticated with *mustard husk*. This adulteration can be detected by means of the microscope. The structural peculiarities of mustard will be found in the article on that condiment.

ANALYSIS of the COMPOSITION OF THE PIMENTO BERRY. Published in Journ. de Chim. Méd., i. 210, by M. BONASTRO.

	Husks	Kernels.
Volatile oil	10 0	5·0
Green oil	8 4	2·5
Solid fat oil	0 9	1·2
Astringent extract	11·4	39·8
Gummy extract	3 0	7·2
Colouring-matter	4 0	...
Resinous matter	1·2	...
Uncrystallisable sugar	3 0	8 0
Malic or gallic acid	0 6	1·6
Lignin	50 0	...
Saline ashes	2 8	1·9
Water	3 5	3·0
Loss	1·6	1·8
Red matter insoluble in water	...	8·8
Pellicular residue	...	16·0
Brown flocculi	...	3·2
Total	100 0	100·0

Almonds—There are several varieties of almonds. The principal are the seed of the bitter almond tree, *Amygdalus communis*, var. *amara*, brought chiefly from Mogadore; *Amygdala dulcis*, sweet almond, Jordan almonds; the seed of *Amygdala communis* (the sweet variety), the sweet almond tree, growing in Syria, Persia, also in Northern Africa and in Southern Europe from trees cultivated about Malaga.

From the seeds of *Amygdala communis* an oil is expressed, *Amygdala oleum.*

The almond seed is above an inch in length, lanceolate acute, with a clear cinnamon-brown seed-coat, and a sweetish nutty-flavoured kernel; the bitter almond is the smaller of the two. The oil is of a very pale yellow colour, made by expression, and whether obtained from the sweet or bitter variety is the same in properties and composition, being nearly inodorous, or having a nutty odour with an oleaginous taste.

Both varieties of almonds contain about 50 per cent. of the *fixed* oil, chiefly oleine, an albuminous principle, soluble in water, called *emulsine*, with sugar, gum, and woody fibre; the bitter variety, in addition to these, possesses a peculiar white crystalline principle, *amygdaline* ($C_{20}H_{27}NO_{11}+3H_2O$), soluble in water and alcohol, the solutions having a slightly bitter taste. It is to the presence of this body that the peculiar properties of the bitter almond are due, for when *amygdaline* is acted upon by the *emulsine*, as occurs on moistening the almond, a species of fermentation ensues, and *hydrocyanic acid* (HCN) and *volatile oil of bitter almonds*, or hydride of benzoyl (C_7H_5OH), are formed, with a little glucose and formic acid, and hence poisonous effects may result from such a decomposition, which may be thus represented—

$$C_{20}H_{27}NO_{11}+2H_2O=CNH+C_7H_6O+2C_6H_{12}O_6$$

The volatile oil, when deprived of prussic acid, is not poisonous, and resembles in appearance other volatile oils; it is chiefly composed of hydride of benzoyl (C_7H_5OH): on exposure it absorbs oxygen, and is converted into benzoic acid ($C_7H_6O_2$). It is procured by distilling the marc left after the expression of the fixed oil from bitter almonds with water; that sold in shops is intensely poisonous from the large amount (from 4 to 8 per cent.) of prussic acid contained in it.

100 drops of oil of almonds are equal to 13 grains of anhydrous acid, or 11 drachms (nearly 1½ ounce) of ordinary acid. 100 grains of *bitter almond pulp* are equal to 2 of the oil, or ¼ grain of anhydrous acid, or 12½ drops of medicinal acid. From 15 to 30 drops of oil of bitter almonds have proved fatal.

Alum—Sulphate of alumina and ammonia crystallised. Its chemical composition may be thus represented—$NH_4Al(SO_4)_2 12H_2O$. A number of other salts may be procured which have the same crystalline form as ammonium alum, forming a remarkable series of isomorphous compounds, a few of which we here enumerate:—

Potassium alum,	$KAl2SO_412H_2O$
Sodium alum,	$NaAl2SO_412H_2O$
Iron alum,	$KFe2SO_412H_2O$

This salt is occasionally found native in volcanic districts in the form of a white efflorescence produced by the action of the sulphuric acid of the volcano upon the compounds of aluminum and potassium contained in the lava and trachytic rocks; for commercial purposes, however, it is generally manufactured artificially.

It forms transparent, white, regular octahedral crystals, having an acid, sweet, astringent taste; it is slightly efflorescent in air, from the loss of some of its water by crystallisation. It is precipitated by chloride of barium, and by the addition of alkalies and their carbonates, but redissolved by excess of the former.

Alum is used extensively in dyeing, and for the adulteration of several kinds of food. This drug appears to be of especial use to the publican. Alum, in conjunction with other substances, quickly clears gin which has become turbid from the addition of water; to porter it gives the creamy "head" so much prized by lovers of that beverage; and to beer generally a "smack" of age. Nor is it confined to these more humble drinks, but is extensively used to give to port wine the brilliancy looked upon with such favour by the connoisseur. We also find it in American lard, and its frequent presence in bread is a matter of the greatest notoriety. The adulterations of these several articles will be found fully considered under their respective headings.

It is also in some degree a disinfectant, and is used to purify water. The sulphate of alumina has been in this way applied to filters, especially in India. It exercises a peculiar influence on animal bodies, such as cells, animalculæ, &c., which may be compared to a kind of tanning: it thus renders them innocuous and inert.

The general method of detecting alum in articles of diet is, if they are solid—*e.g.*, bread—to burn them down, and look for alumina in the ash; if liquid, to evaporate to dryness, burn the residue, and proceed, as will be described under the different headings of BREAD, BEER, &c. &c.

Aluminum has recently been successfully used for the estimation of nitric acid in water; a complete description of the process will be found in the article on WATER.

Amabele—Amabele consists of crushed millets. *See* MILLETS.

Amasi—The natives of Central Africa never make use of new milk until they have first caused it to become sour, by putting it into vessels charged with the remains of former operations; this drink is considered by them far more wholesome than fresh milk. They have given it the name of *Amasi*.

Ambulance—An ambulance is an hospital in miniature, attached to an army and following its movements. It is a term originally used by the French, but has now taken a place in our own tongue.

The French ambulance is composed of a surgeon-in-chief, an apothecary, a controlling officer, a certain number of assistant-surgeons, assistants, and nurses. It is well provided with surgical instruments and appliances. Every wounded or sick person is received first by the ambulance. After his wounds have been attended to, he is either restored to his corps, or, if the case is serious, transferred to the nearest hospital.

On the battle-field the ambulance is divided into *ambulance volante*, and *dépôt d'ambulance*.

The flying ambulance consists of two surgeons, a controlling officer, and of two nurses. Its duties are to promptly aid and convey the sick from the field. A light covered waggon is attached to the ambulance, in which the wounded are placed. The stationary ambulance is established in a shady place, close, if possible, to drinking-water; its site is marked by a red flag, and the wounded are conveyed to the cover of its tent as quickly as possible by the staff and assistants of the flying ambulance.

The *dépôt d'ambulance* has 1 principal medical officer, 4 medical officers, 1 purveyor, 2 ward-masters, 10 orderlies, 1 ambulance-waggon complete, 30 mattresses, 30 stretchers, 60 coverlets, 10 sets of furniture, 10 litters, 12 spring carriages.

Ammonia (NH_3) = 17.—This substance derives its name from sal-ammoniac, so called from the circumstance of its having been obtained first in Libya, near the temple of Jupiter Ammon. It is also familiarly termed volatile alkali, spirit of hartshorn, &c. Its observed specific gravity is 0·59; boiling-point, −37° F. (−38° C.); melting-point, −103° F. (−75° C.) At the ordinary pressure and temperature ammonia is a gas, but it may be liquefied by exposure to intense cold, or by the pressure of its own atmosphere. It derives its importance, in a sanitary point of view, from its presence and amount in air and water giving a very fair estimate of the purity of these two essentials of life. Whenever moist nitrogenous matters decompose, ammonia is one of the products. It is found in clayey and peaty soils, and in minute quantity in good air and water. There are many chemical bodies formed on the type of ammonia, and it is probable that most of the disgusting odours from sewers, drains, &c., are really stinking ammonias.

In analysis two kinds of ammonia are recognised, both identical in composition, but differing in their mode of origin. They are usually distinguished as AMMONIA and ALBUMINOID AMMONIA. The first is obtained by boiling or evaporating down an organic fluid, and keeping for some time at a temperature of 150° C., with excess of hydrate of potash. The second, on further boiling it with a strong solution of potash and permanganate of potash. There are certain animal fluids—in which the quantity of ammonia yielded by each method bears a certain ratio to the other, which is characteristic as well as the actual amount evolved. We are mainly indebted for these facts in their practical application to Professor Wanklyn. In all probability they will in future be found of great utility in the analysis of most animal fluids, *e.g.*, there is no quicker way of estimating the caseine of milk than by turning it into ammonia (*see* MILK), and there is no easier way of finding minute traces of albumen in urine than by following out the same process.*

* The same process may be used to discriminate the different alkaloids. *See* ALKALOIDS.

The following table was drawn up by Mr. Wanklyn.

100 cubic centimetres gives of

	Ammonia by Potash at 150° C.	Ammonia by Permanganate of Potash.
Urine, human . .	0·90 gram.	0·05
Milk of cow . .	0·13 ,,	0·28
Blood of sheep .	0·46 ,,	2·29
Liquid white of egg (hen)	0·32 ,,	1·30
Dry solid gelatine .	...	10·09

"Of all the animal fluids," says Mr. Wanklyn, "I know of only one which yields a large proportion of ammonia to caustic potash, and that fluid is urine. On the other hand, urine is distinguished by the smallness of the yield to ammonia by permanganate of potash." Gelatine gives no ammonia, or only the least trace, to potash; a good quantity to permanganate.

The method employed is similar to the ammonia process of water-analysis; but very minute quantities are taken. 5 c.c. of the animal fluid are diluted with 500 c.c. of water, and 5 c.c. of this liquid are put into a flask with a strong solution of hydrate of potash, evaporated down to dryness, and kept at 150° C. for some time, then some solution of alkaline permanganate is added, and the different portions of the distillate are estimated by the Nessler test. (*See* WATER, ANALYSIS OF.) The following apparatus is convenient (fig. 6): *a* is a small flask with a lateral tube, which is fitted to *b*, the tube of a Liebig's condenser *g*, by means of a cork; it is heated by means of a spermaceti bath *x*, the temperature being regulated by a thermometer *h*, and the distillate is received in a flask *i*. This apparatus, by the use of a little larger flask, is also the most convenient for the distillation of beer and wine, as well as for the contents of the stomach in the case of the volatile poisons, *e.g.*, prussic acid.

Ammonia exists in air in minute quantity (*see* AIR), as well as in every kind of natural water. *See* WATER.

The tests for ammonia are as follow: Free ammonia in a liquid is expelled by boiling, and, if the vapour is condensed, it will give a coloration if in small quantity; if in large, a precipitate with the Nessler test. (*See* NESSLER.) Free ammonia in a solution of iodine in iodide of potash forms, if in some quantity, the explosive black iodide of nitrogen. If a saturated solution of arsenious acid is mixed with a solution of nitrate of silver (strength 2 per cent.), a trace of ammonia causes the formation of a yellow triargentic arsenite. Free alkalies and alkaline earths do the same, so they must be known to be absent before applying the test. Ammonia salts give off free ammonia on boiling with caustic potash. Ammonia is estimated by the colorimetric test, described under WATER-ANALYSIS, or gravimetrically by precipitating it with platinic chloride; a yellow insoluble double salt falls, containing in 100 parts 7·62 of ammonia; its chemical composition is ($2H_4NClPtCl_4$). It may be also estimated indirectly by distilling the substance with caustic potash and permanganate, and then determining the alkalinity of the resulting liquid in the usual way. Most of the salts of ammonia in commerce are now obtained from the refuse liquid at the gas-works.

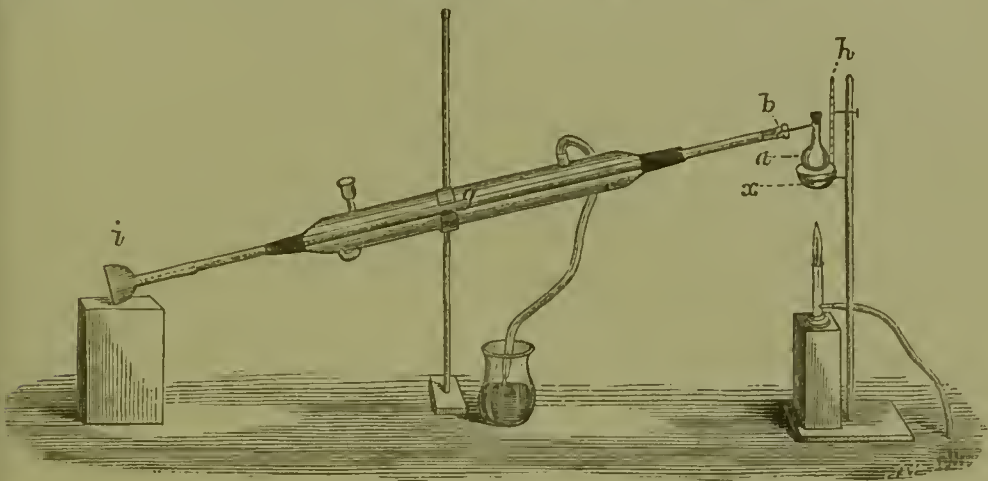


Fig. 6.

Amygdaline—*See* ALMONDS.

Analysis—This term, used in a general sense, means the resolution of anything, whether an object of the senses or of the intellect, into its component parts; in chemistry, the resolution of a compound body into its constituent parts or elements. Analysis is divided by chemists into two great classes — qualitative and quantitative analysis. By qualitative analysis, merely the nature of a compound is known; thus, for instance, that chlorate of potash contains chloric acid and potassium: by quantitative analysis, not alone the quality, but also the quantity, of the component parts is known; for instance, the exact amount by weight of caseine, water, sugar, ash, and fat that make up 100 parts of milk is an example of quantitative analysis.

For success in analysis, knowledge of the theory and a considerable amount of practice of chemistry is required. Most chemical operations, especially those of a quantitative nature, require, besides great patience and skill, often no small leisure. The essential instruments of the laboratory are—(1) a balance to weigh to a milligramme; (2) weights of the most accurate kind (a somewhat indifferent balance may be made to answer, provided good weights are employed); (3) good measuring instruments, such as graduated burettes, flasks, &c.; (4) beakers, evaporating dishes, retorts, &c.; (5) a supply of gas and water; (6) one or two platinum dishes. With such a supply, and provided with stands, holders, flasks, and so on, nearly any ordinary analysis may be performed. Full information on the principal analytical operations that are required by health officers and analysts will be found under the different headings. *See* especially MILK, WATER, BREAD, &c.

Analyst, Appointment of—*See* ADULTERATION.

Anchovies—Various kinds of fish are substituted for the true or Gorgona anchovy, but before we consider the numerous adulterations to which this favourite delicacy is subjected, we give a description of this fish.

Generic Characters. — Distinguished from the herring, in having the head pointed; the upper jaw the longer, the mouth deeply divided; the opening extended backwards behind the line of the eyes; the gape branchial apertures very large; the ventral fins in advance of the line of the commencement of the dorsal; abdomen smooth; branchiostegous rays, twelve.

I have followed Dr. Fleming in preserving to the anchovy the old name by which it was formerly known. It was called *Lycostomus*, from the form of its mouth; and *Engraulis encrasicolus*, because from its bitterness it was supposed to carry its gall in its head. For this reason the head as well as the entrails are removed when the fish is pickled.

The anchovy is immediately recognised among the species of the family to which it belongs by its sharp-pointed head, with the upper jaw considerably the longer. The length of the head compared with the length of the body alone, is as one to three; the depth of the body about two-thirds the length of the head, and compared to the length of the whole fish is as one to seven; the first ray of the dorsal fin arises half-way between the point of the nose and the end of the fleshy portion of the tail; the third ray of the dorsal fin, which is the longest, is of the same length as the base of the fin; the pectoral fin small; the ventral fins arise in a vertical line in advance of the commencement of the dorsal fin, which is over the space between the ventral and anal fins; the base of the anal fin is as long as the distance from its commencement to the origin of the ventral fins; the rays short; the tail deeply forked.

The fin-rays in number are—D. 14; P. 15; V. 7; A. 18; C. 19.

The breadth of the eye is one-fifth of the length of the whole head; the peculiarity in the comparative length of the jaws has been previously noticed; the gill-covers are elongated; the scales of the body large and deciduous; the colour of the top of the head and back blue, with a tinge of green; irides, gill-covers, sides, and belly, silvery white; the fins delicate in structure, and greenish white; the membranes connecting the rays almost transparent.

From four to five inches is the ordinary size, but many as large as seven inches and a half have been taken in the Cornish seas.—(YARRELL'S British Fishes.)

The adulterations practised are principally the substitution of inferior fish for the true anchovy, and the addition of colouring-matters to the brine or liquor in which they are preserved. True anchovies come over here in barrels, preserved in strong brine, and then they are bottled by the wholesale pickle merchants. In the preserving liquor Armenian bole and Venetian red have been found.

Dutch, French, Sicilian fish, sardines, and even sprats have beeu substituted for the true anchovy; it is only by a perfect acquaintance with the characters of the fish that these frauds can be detected. It must be remembered that the process of preserving will considerably modify the appearance of the anchovy, for the head, intestines, scales, and pectoral fins will have been removed; the principal points of guidance are then the colour of the flesh, the size of the fish, and the number of dorsal, caudal, and anal rays. And with regard to the latter, Dr. Hassall declares, when preserved, that as many as sixteen dorsal, nineteen anal, and twenty-six caudal rays may be counted.

Anemometer (*anemos*, the wind, and *metron*, a measure) — An instrument for measuring the force of the wind. There are different sorts, some measuring the velocity, others the pressure, and some again of a very delicate construction, used for estimating the ventilation of public buildings. For measuring the velocity of the wind a *hemispherical cup anemometer*, invented by Mr. Robinson, is generally considered the simplest and the best. Two horizontal rods of iron cross each other at right angles, and are supported on a vertical axis, which turns freely; to the ends of these two horizontal rods four cups or hemispheres are screwed. These cups, when placed in the wind, revolve, and the arms are of such a length that when a mile of wind has passed the anemometer, 500 revolutions are registered by the instrument.

Should any doubt be entertained regarding the accuracy of the machine, it may be tested by rapidly conveying it through the air on a perfectly calm day, for the distance of a mile and back again, and noting the number of revolutions registered.

An endless screw, on an upright axis, sets in motion a system of index-wheels, by which the number of revolutions made in a given time is shown and read in the same way as a gas-meter. To find the number of miles travelled during a day, hour, or any specified time, it is only necessary to multiply the revolutions registered during that time by 2, aud divide by 1000. To ascertain the rate of the wind per hour, observe the revolutions made, say in two minutes, multiply by 60, aud divide by 1000; *e.g.*, suppose 800 revolutions were made in two minutes, the velocity of the wind would be at the rate of 48 miles per hour.

To learn the force or pressure which the wind exerts, it is necessary to use an Ostler's anemometer, or a Lind's wind-gauge. Ostler's instrument is of simple construction. It consists of a plate a foot square, acting on a spiral spring, to which an index showing the degree of pressure is attached. Tho plate is kept perpendicular to the wind by a vane. The pressure given in pounds avoirdupois on the square inch is registered by means of clockwork on a piece of paper, fitted on a turning drum.

Lind's wind-gauge consists of a tube about half an inch in diameter, in the form of a siphon, oue end of it being bent so as to face the wiud. It turns freely on a vertical axis, and a vane keeps the mouth of it directed to the wind. It is half-filled with water, and when the wind blows into the mouth of the instrument it drives the water up the other leg, to which a scale showing the pressure is attached. The zero of the scale is the level at which the water stands when the air is calm. It may also be made to measure maximum gusts of wind by filling iuto the tube a chemical solution, which colours bits of prepared paper, placed at different levels on the scale limb of the instrument.

For ascertaining the ventilation of public buildings, &c., Combe's instrument should be used.

Combe's anemometer is also one of the best to ascertain the velocity of currents of air. It is made of metal, with four small mica sails, like the sails of a little windmill, which turn on an axis, furnished with an endless screw, and supported on two copper uprights. This, again, turns various toothed wheels, two of which have plates showing the number of revolutions performed by each; and thero are two small needles, which travel round circles, properly divided. From zero, upwards, these needles register the observations. Two threads, held by the experimenter, engage or disengage the wheels, so that it can be stopped or set going at pleasure. In order to make an anemetrical observation, the two needles are placed at zero; and, to make the operation quicker, the anemometer can be disengaged, so that the wheels can be stopped at zero instantly. To make the observations exact, it is necessary to place the anemometer in a well of a certain depth, and perfectly regular, when the swiftness of the currents can be measured. Without these precautions tho current of air is subject to contractions and irregularities, which are opposed to all certain results. When there is a difficulty in finding a position to make successful experiments, an iron tunnel, of which the section is known, is mado, which is placed upon the banks of a canal, when care must be taken that the outside air does not pass into the anemometer without passing *through* it. To effect this, there is placed exactly in the centro of the tunnel a platinum plate, which acts as a wall, where it is fastened by a screw. The two threads ought always to be on the outside, and be perfectly free in their movements. If the observer takes one of these threads in each hand, the mill stops. An assistant holds a watch in his hands; if it does not mark the minutes, he must observe the exact moment the needle passes one of the divisions, and he then gives the signal to disengage the mill, by pulling one of the threads. As the needle marks tho wished-for number of minutes, he again gives the signal, by pulling the other

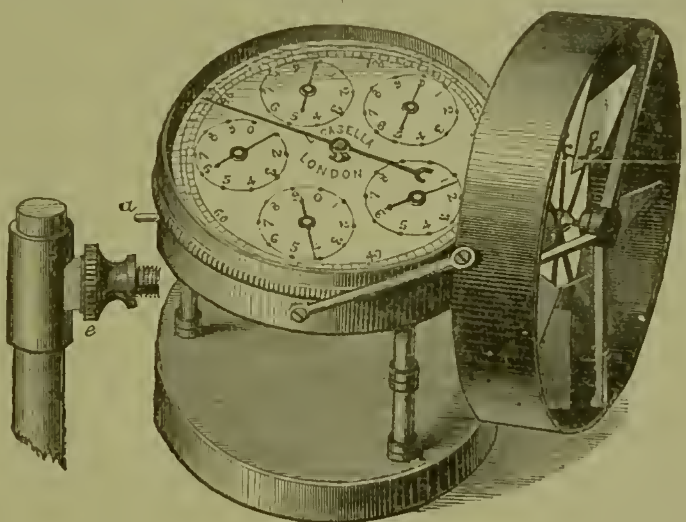


Fig. 7.

thread, and the mill stops. The anemometer is then taken from the tunnel, and tho result is easily read on the dial, counting from zero. If the second wheel has advanced three teeth, and the first from the twelfth division, the anemometer shows 312 turns. Where two observations are made, the experiments should be made again. If it is shown that there is a variation—that is to say, when the needle is stopped by a spring, the observer puts this needle upon 12, and, at the moment when it stops, he orders the anemometer to be disengaged, and at the end of two or three minutes he stops it. To deduct the real velocity of the currents of air from the number of turns observed, a special instrument is employed, on the outside of which is a very simple form —n representing the number of turns observed, and v the velocity of the air.

General Morin has made numerous observations with an anemometer, which he has constructed on the principle of M. Combe's; but he has added two enamelled dials, two needles joined to cups, a third minute-wheel, and an indicator, by which 500,000 turns may be observed, and the number of turns of the mill determined in the interval. This arrangement also gives prolonged observations, and includes fractions, at equal intervals, making errors almost impossible.

A modification of this instrument was suggested by Dr. Parkes, the result being a very handy air-meter, known as "Casella's" (fig. 7). The manufacturer's description of it is as follows:—

"The object of this little instrument is to give correct means of measuring the velocity of currents of air passing through coal and other mines, and the ventilating spaces of hospitals and other public buildings.

"It was first constructed for Dr. Parkes, F.R.S., of the Royal Victoria Hospital, Netley, for measuring the state of ventilation in that large military establishment.

"The graduations for each instrument are obtained by actual experiment by means of machinery made for the purpose, so that the indications of all are as comparable with each other as the weight or measure of ordinary substances.

"The indications are shown by means of the large dial and hand, and five smaller ones, as shown in the annexed plate. The whole circumference of the large dial is divided into 100 parts, and represents the number of feet up to 100 traversed by the current of air. The five smaller dials are each divided into ten parts only, one revolution of each being equal to ten of the preceding dial, and representing 1000, 10,000, 100,000, 1,000,000, and 10,000,000 respectively. By means of the large dial, the low velocity of fifty feet per minute may be measured, and by the smaller ones continuous registration is extended up to 10,000,000 feet, or equal to 1893 miles, being practically beyond what the most extended observations can require, whilst jewelling in the most sensitive parts ensures the utmost delicacy of action.

"By moving the small catch *a* backwards or forwards, the work is put in or out of gear, without affecting the action of the fans; this prevents the injurious effect of stopping them suddenly, and enables the observer to begin or end his observations to a second. A small handle with universal joint accompanies the instrument, and may be screwed in at the base; by putting a stick through this, it may be raised or lowered to any required height, and used in any position.

"A simple table accompanies each air-meter, by means of which (in strict observations) allowance may be made for the difference caused by inertia at high and low velocities."

Aniline (Kyanol, Phenylamine, Phenylia, Crystalline, or Benzidam), (C_6H_5,H_2N), or ($C_{12}H_7N = 93$)—Sp. gr. of liquid, 1·020, of vapour, 3·210. This base may be prepared from several sources, and by a variety of reactions, and it is contained in small quantity among the product of destructive distillation of coal in the process of gas-making.

Aniline is a nearly colourless limpid liquid, of an agreeable vinous odour, and an aromatic burning taste. It is very acrid and poisonous. When exposed to the air it rapidly absorbs oxygen. Most of the salts of aniline readily crystallise. With chromic acid, the salts of aniline strike a green, blue, or black colour, according to the degree of concentration of the solutions. Aniline produces a white precipitate in a solution of corrosive sublimate, and a green crystalline precipitate in one of cupric chloride.

Nitrobenzol is converted into aniline by sulphide of ammonium, sulphuretted hydrogen being decomposed whilst sulphur is deposited. The poisonous properties of nitrobenzol depend on aniline, which it is capable of being converted into by the animal organism. Dr. Letheby was the first to call attention to this substance as a poison, from several cases which had come under his observation, and it is to that gentleman that the method of its elimination and identification is due. He considers nitrobenzol to be a powerful narcotic poison, attended, when taken internally, or even inhaled, with drowsiness, convulsions, and coma. Several days may sometimes elapse before its fatal termination. When death is rapid, the smell of nitrobenzol is perceptible in every tissue of the body; but in lingering cases, no smell is observable, it having been converted into aniline, the colouring effects of which are sometimes recognised in the skin, gums, lips, and nails. To extract the poison, Dr. Letheby directs the matters to be bruised in a mortar, with a little distilled water, acidulated with *sulphuric acid*, and then distilled from a retort, *nitrobenzol* passes over into the receiver unchanged, and can be detected by the *bitter almond-like smell;* the residue in the retort is treated with strong alcohol to extract the sulphate of aniline; the alcoholic solution is treated with *acetate of lead* to precipitate organic matter, and the excess of lead separated by *sulphate of soda;* the filtered solution is next treated with *caustic potash*, and distilled to dryness in an oil bath. The distillate contains the aniline, which is detected by the nascent oxygen of a galvanic battery thus: A drop or so of the solution of aniline in 1000 of dilute sulphuric acid (1 to 7 of water) is placed on a clean piece of platinum foil and touched with the negative pole of a galvanic battery (a single Grove's cell), whilst the positive pole is in contact with the platinum plate. The liquid instantly acquires a *bluish* tint, then a violet, changing to pink—the colour being more intense when the aniline solution is stronger. Men employed in works where aniline is extensively used are sometimes subject to symptoms of poisoning, such as neuralgia, giddiness, and insensibility, from inhaling it; and the contact of aniline colours with the skin is said occasionally to produce a peculiar eruption.

Annatto—This article, although not used as food, is yet added to several articles of consumption. It is the colouring-matter obtained from the seeds of a plant named *Bixa Orellana*, and which forms the type of the small natural order *Bixineæ*. Annatto is chiefly prepared in Brazil and Cayenne. The colouring-matter is situated on the outside of the seeds, which are enclosed in pods, and is of two kinds—an orange-coloured, strongly tinctorial resin called bixin ($C_{16}H_{12}O_2$), associated with a yellow one called orellin. Bixin is freely soluble in alcohol, ether, the fixed oils, and the alkalies; when in solution by an alkali, on addition of an acid, it falls as an orange precipitate. Upon this fact is based the method of purifying it. The commercial annatto is dissolved in an alkaline liquid, *e.g.*, a solution of pearl-ash; dilute sulphuric acid is added to neutralisation, and the resulting precipitate collected. Genuine commercial annatto consists of 28 per cent. of resinous colouring-matter, and 20 per cent. of extractive matter.

Characters, Microscopical and Chemical.—When annatto is examined by the microscope, the outer red portion presents an almost homogeneous appearance, and the surface of the seed proper consists of narrow or elongated cells or fibres vertically disposed, while the inner white portion consists of cells filled with starch corpuscles, well defined, of medium size, and resembling in the elongated and stellate hilum the starch granules of the pea and bean.

When the annatto is manufactured, and an unadulterated sample is examined, but little structure is met with. Portions of the outer cells may be seen; and in those specimens, which in the course of their preparation have not been subjected to the action of boiling water, a few starch granules may be noticed.

Dyers, soapmakers, and painters use annatto. The two former frequently purchase it in the state in which it is imported, adding the alkali as a solvent when they use it. In these cases it does not pass through the so-called English manufacturer's hands at all.

Since annatto, when manufactured, presents so few evidences of structure, by means of the microscope we can easily detect the presence of most foreign vegetable substances, such as turmeric powder, the starch of wheat, rye, barley, and sago flours. The salt and alkali present in the annatto generally greatly alter the appearance of the turmeric. Most of the colouring-matter of the cells is discharged, so that the starch corpuscles contained within them become visible. Loose starch granules of turmeric may also be frequently seen, and in consequence of the action of the alkali much enlarged. The microscopic characters of turmeric powder, wheat, rye, barley, and sago starch will be found fully described under their respective names.

Annatto is used also to colour milk, butter, and cheese.

Dr. John found the pulp surrounding the fresh seed to consist of 28 parts of colouring resinous matter, 26·5 of vegetable gluten, 20 of ligneous fibre, 20 of colouring extractive matter, 4 formed of matters analogous to vegetable extractive, and a trace of spicy and acid matters. The colouring-matter is soluble in alkalies and alcohol, less so in water.

Annatto is adulterated to an extraordinary extent, and this adulteration is of the grossest possible description. In fact, there is scarcely an article we are acquainted with that is so largely and so generally tampered with. The substances are numerous, some organic, others inorganic.

The *organic* substances used are *turmeric*, *rye*, *barley*, and *wheat* flours. The *inorganic* ones are *sulphate of lime*, *carbonate of lime*, *salt*, *alkali*, *an oily substance* (probably soap), red ferruginous earths, mostly *Venetian red*, *red-lead*, and *copper*.

When large quantities of flour and lime are used, the colour of the annatto is so reduced that it becomes necessary to use salt, alkalies, and the red earths to restore it to its original standard. Salt heightens the intensity of vegetable reds, hence its use. Lead is probably introduced into the annatto through the Venetian red used. Copper is added to prevent the annatto becoming attacked by fungi.

The extent to which annatto is adulterated will be shown by the following fact. On examination of thirty-four samples of annatto of various kinds, *as imported* and obtained from *English manufacturers*, and as purchased from *dealers*, two only were found genuine. As annatto is used to colour different articles of diet, when adulterated its use may often prove detrimental to health. Accum, Mitchell, Bernays, Normandy, and Hassall appear to have detected in cheese, adulterated with annatto, sufficient red-lead to cause injurious effects to ensue from eating it; but from recent investigations, it would seem extremely doubtful whether red-lead is now employed to the extent they state. Annatto, after being kept some time, becomes attacked by maggots.

In order to estimate the commercial value, and detect adulteration in a sample, the quickest and best way is the following: Weigh accurately a gramme in a small platinum dish; dry in the water-bath for a couple of hours, then weigh: the loss is the water. Finely powder and digest it for some hours in alcohol; then boil, filter, and treat with successive portions of alcohol, until all the colouring-matter is dissolved; filter, evaporate the filtrate down, and weigh: the result is tho resin. The insoluble portion will, in a good commercial specimen, consist of woody matter, extractive, gluten, &c. For the ash, weigh another gramme in a platinum dish; dry for a short time over the water-bath; then powder and burn until it ceases to lose weight. It is prudent to fuse a little on charcoal, with carbonate of soda, before the blow-pipe, before burning it in a platinum vessel, as there may be lead in the annatto. The ash should then be submitted to the various reagents in order to detect lime, iron, alumina, &c. &c. If the ash is not excessive, and the resin about 28 per cent., it is a fair specimen. A correct determination of ash and resin is all that is required to definitely pronounce on the purity or impurity of the sample.

The following is an analysis of a fair commercial sample by the author.

No. 1. The sample was in the form of a paste, colour deep red, odour peculiar but not disagreeable:—

Water	24·2
Resinous colouring-matter	28·8
Ash	22·5
Starch and extractive matter	24·5
	100·0

The following is an analysis of an adulterated specimen. The sample was in a hard cake of a brown colour, with the maker's name stamped upon it, and marked patent; texture hard and leathery, odour disagreeable:—

Water	13·4
Resin	11·0
Ash—consisting of iron, chalk, salt, alumina, silica	48·3
Extractive matter	27·3
	100·0

Thus, in the one the resin was 28 per cent., the ash 22; in the other the resin was only 11 per cent., the ash no less than 48.

Antidote—In medicine, toxicology, &c., a substance administered to counteract or lessen the effects of poison.

The principal poisons, with their antidotes, are noticed under their respective heads. Antidotes may be divided into direct and indirect antidotes: the former neutralising or destroying the injurious action of the poison on meeting it in the system; the latter counteracting the injurious physiological effects of the drug. The following list gives the most important antidotes to the chief poisons:—

Direct Antidotes.

Poisons.	Antidotes.
Acids	Magnesia, chalk, and dilute solutions of alkaline carbonates.
Alkalies and alkaline earths	Vinegar-and-water, and oil.
Alkaloids	Finely-divided animal charcoal.
Antimony	Preparations containing tannin in solution, as decoction of cinchona.
Arsenic	None. Charcoal may be given, or magnesia, or hydrated peroxide of iron.
Baryta salts	Soluble sulphates.
Chlorine	Ammonia, magnesia.
Cyanides and hydrocyanic acid	Solution of chlorine, mixed oxides of iron.
Iodine	Starch.
Lead salts	Sulphate of soda, or magnesia.
Mercurial salts	White of egg.
Opium	Animal charcoal absorbs morphia, &c.
Phosphorus	Oil of turpentine.
Silver, nitrate of	Chlorides of alkalies.
Zinc, sulphate of	Dilute solution of carbonate of soda.
Belladonna, Henbane, Stramonium	Liq. potassæ.
Strychnine	Perhaps monobromated camphor.

Antiseptic—An epithet applied to anything which impedes or arrests putrefaction, *e.g.*, cold, heat, chlorine, iodine, sulphur, carbolic acid, tar, alum, salt, nitre, alcohol, vinegar, &c. *See* DISINFECTANTS.

Antozone—*See* OZONE.

Appeals—The power of appeal is amply provided for by the Sanitary Acts.

Any person on whom an order of prohibition, or an order requiring the execution of structural works, is made, may appeal to Quarter Sessions, pending which decision there is no liability to penalty, nor shall the work or proceedings be gone on with (P. H., s. 99).

Any person feeling himself aggrieved by any rate made under the provisions of the Public Health Act, or by any order, conviction, judgment, or determination of any matter done by any court of summary jurisdiction, in cases in which the sum or penalty adjudged exceeds twenty shillings, may appeal to Quarter Sessions.

In all the above cases the following conditions must be observed:—

The appeal must be made to the next Quarter Sessions, holden not less than twenty-one days after the decision of the authority or court from which the appeal is made. The appellant must give notice to the other party and to the court or authority from which he appeals, within fourteen days after the cause of appeal has arisen, stating his intention to appeal, and the grounds thereof.

The appellant shall, immediately after such notice, enter into a recognisance before a justice of the peace, with two sufficient sureties, conditioned personally to try such appeal, to abide the judgment of the court thereon, and to pay such costs as may be awarded by the court, or give such other security by deposit of money or otherwise as the justice may allow.

If the appellant is in custody, the justice may, if he think fit, release him on giving similar security.

In appeals against rates, the court has the same power of amending or quashing a rate of assessment, and of awarding costs, as a court of Quarter Sessions has in appeals against poor-rates, and the costs may be recovered in the same manner: provided that, notwithstanding the quashing of any rate appealed against, all moneys charged by such rate shall, if the court of appeal think fit so to order, be levied as if no appeal had been made, and such moneys, when paid, shall be taken as payment on account of the next effective rate for the purposes in respect of which the quashed rate was made.

In the case of other appeals the court of appeal may adjourn the appeal, and on the hearing thereof may confirm, reverse, or modify the decision of the court of summary jurisdiction, or remit the matter to the court of summary jurisdiction with the opinion of the court of appeal thereon, or make such other order in the matter as the court thinks just. The court of appeal may also make such order as to costs to be paid by either party as the court thinks just.

The decision of the court of appeal shall be binding on all parties: provided that the court of appeal may, if such court thinks fit, in the case of an appeal against the decision of a court of summary jurisdiction under the provisions of P. H. relating to nuisances, state the facts specially for the determination of the Court of Queen's Bench, in which case it shall be lawful to remove the proceedings by writ of *certiorari* or otherwise into the Court of Queen's Bench (P. H., s. 269).

If any person feel himself aggrieved by the decision of a local authority in respect to the summary recovery of expenses or in the declaring of expenses as private improvement expenses, he may, on giving notice, memorialise the Local Government Board, and the order the Board makes is binding (P. H., s. 268).

An owner or ratepayer disputing the validity of a vote of owners and ratepayers, declaring that it is expedient a district should be made a local government district, may appeal within six weeks from the declaration of the decision of the meeting to the Local Government Board, who may make, after local inquiry, such order as is necessary (P. H., s. 274).

Apples—Natural order *Pomaceæ*.

Apples are of small nutritive value, containing not more than 13 per cent. of solid matter, and this is of no more value than so much rice; but they have an agreeable flavour, and are useful for their antiscorbutic properties.

Composition of Apples (Fresenius).

Soluble Matter—	
Sugar	7·58
Free acid (reduced to equivalent in malic acid)	1·04
Albuminous substance	0·22
Pectous substances, &c.	2·72
Ash	0·44
Insoluble Matter—	
Seeds	0·38
Skins	1·44
Pectose	1·16
[*Ash from insoluble matter included in weights given*]	[0·13]
Water	85·14
	100·00

Appointment of Inspectors of Nuisances—*See* Inspectors of Nuisances.

Appointment of Medical Officers of Health—*See* Medical Officers of Health.

Apricot (*Prunus Armeniaca*)—This fruit is a native of Armenia, and was introduced into England in the time of Henry the Eighth. From the bitter kernels of the apricot, *eau de noyaux* is distilled.

Composition of Apricots (Fresenius).

	Fine—rather large.	Small.
Soluble Matter—		
Sugar	1·140	2·736
Free acid (reduced to equivalent of malic acid)	0·898	1·603
Albuminous substances	0·832	0·411
Pectous substances	5·929	5·562
Ash	0·820	0·723
Insoluble Matter—		
Seeds	4·300	3·415
Skins, &c.	0·967	1·248
Pectose	0·148	0·750
[*Ash from insoluble matter included in weights given*]	[0·071]	[0·060]
Water	84·966	83·552

Arbitration—The matters directed by the Public Health Act, 1875, to be settled by arbitration are—

1. Disputes between persons and the local authority in regard to amount of compensation in case of damage done by the local authority by reason of the exercise of any of the powers of the Act.

2. Terms upon which water companies ought to furnish a proper and sufficient supply of water for all reasonable purposes for which it is required.

3. Whether the water which any company is able and willing to supply is proper and sufficient for the purposes for which it is required.

4. Whether the purposes for which it is required are reasonable.

5. Disputes between local authorities as to the supply of water, in the case of an authority supplying water to a neighbouring district.

6. Disputes as to the amount of compensation to be paid by an urban authority, to the owner or other person interested, in the case

of houses or buildings which have been put backward or forward in order to regulate the line of buildings in the street.

7. Disputes as to whether matters or things proposed to be done, injure or interfere with canals, rivers, &c. *See* CANALS.

8. Differences of opinion with respect to the efficiency of substituted sewers, and with regard to the consequences resulting from interferences with water rights.

9. Terms on which sewers may be used by persons outside the district.

10. Disputes between the Universities of Oxford and Cambridge, and the urban authority of those places respectively, as to the proportion and manner in which they shall contribute towards any expenses under the Act.

11. By the 34 & 35 Vict. c. 41, s. 27, differences relating to the supply of gas may be settled by arbitration. Amounts under £20 may be settled in a court of summary jurisdiction. The court may invoke the advice of a competent surveyor (not being the surveyor of the sanitary authority), and make what order it thinks fit as to costs.

All questions referred to arbitration under the Public Health Act, when the amount in dispute is less than £20, may at the option of either party be determined before a court of summary jurisdiction, which court may, if it thinks fit, require the aid and report of a competent surveyor on works, &c., in dispute, and the court may determine the amount of costs incurred in that behalf, and by whom they are to be paid (P. H., s. 181).

Arbitrators—The word "arbitrators," under the Public Health Act, 1875, includes a single arbitrator; and the words "arbitrators" and "arbitrator" include an umpire. The appointment of an arbitrator must be made under the common seal on behalf of the local authority, and on behalf of any other party under his hand, or if such party be a corporation, under their common seal.

There are certain provisions in case of the death of an arbitrator.

The time for making an award must not exceed three months.

When there is more than one arbitrator, they must appoint by writing under their hands an umpire. If the umpire dies pending the arbitration, another must be appointed in his stead. If the arbitrators neglect or refuse to appoint an umpire within seven days when requested to do so, the Quarter Sessions may on application appoint one.

Before any arbitrator or umpire can enter upon any reference, he must make and subscribe the following declaration before a justice of the peace :—

I, A. B., do solemnly and sincerely declare that I will faithfully and honestly, and to the best of my skill and ability, hear and determine the matters referred to me under the Public Health Act, 1875.

This declaration is to be annexed to the award when made, and any arbitrator or umpire wilfully acting contrary to it is guilty of a misdemeanour. The arbitrators must be unbiassed, and have no direct personal interest in the matter, however remote. The decision of the arbitrator is binding (P. H., s. 179-181).

Areas, Sanitary—*See* SANITARY DISTRICTS.

Areometer—An instrument to take the specific gravity of liquids. It is, however, seldom exactly accurate, and there are other methods which give better results. In this country, the word is principally applied to the areometers of Baumé, which are in general use on the Continent, and are fairly accurate.

AREOMETER FOR LIQUIDS HEAVIER THAN WATER, *Pèse-acide* or *Pèse-sirop*.

Degrees.	Specific Gravity.	Degrees.	Specific Gravity.	Degrees.	Specific Gravity.	Degrees.	Specific Gravity.	Degrees.	Specific Gravity.
0	1·0000	16	1·1176	32	1·2667	47	1·4476	62	1·6889
1	1·0066	17	1·1259	33	1·2773	48	1·4615	63	1·7079
2	1·0133	18	1·1343	34	1·2881	49	1·4758	64	1·7273
3	1·0201	19	1·1428	35	1·2992	50	1·4902	65	1·7471
4	1·0270	20	1·1515	36	1·3103	51	1·5051	66	1·7674
5	1·0340	21	1·1603	37	1·3217	52	1·5200	67	1·7882
6	1·0411	22	1·1692	38	1·3333	53	1·5353	68	1·8095
7	1·0483	23	1·1783	39	1·3451	54	1·5510	69	1·8313
8	1·0556	24	1·1875	40	1·3571	55	1·5671	70	1·8537
9	1·0630	25	1·1968	41	1·3694	56	1·5833	71	1·8765
10	1·0704	26	1·2063	42	1·3818	57	1·6000	72	1·9000
11	1·0780	27	1·2160	43	1·3945	58	1·6170	73	1·9241
12	1·0857	28	1·2258	44	1·4074	59	1·6344	74	1·9487
13	1·0935	29	1·2358	45	1·4206	60	1·6522	75	1·9740
14	1·1014	30	1·2459	46	1·4339	61	1·6705	76	2·0000
15	1·1095	31	1·2562						

CORRESPONDING SPECIFIC GRAVITIES AND DEGREES OF BAUMÉ'S AREOMETER FOR HEAVY LIQUIDS.
From the Batavian Pharmacopœia.

Degrees.	Specific Gravity.	Degrees.	Specific Gravity.	Degrees.	Specific Gravity.	Degrees.	Specific Gravity.	Degrees.	Specific Gravity.
0	1000	16	1125	32	1286	47	1485	62	1758
1	1007	17	1134	33	1298	48	1501	63	1779
2	1014	18	1143	34	1309	49	1561	64	1801
3	1022	19	1152	35	1321	50	1532	65	1823
4	1029	20	1161	36	1334	51	1549	66	1847
5	1036	21	1171	37	1346	52	1566	67	1872
6	1044	22	1180	38	1359	53	1583	68	1897
7	1052	23	1190	39	1372	54	1601	69	1921
8	1060	24	1199	40	1384	55	1618	70	1946
9	1067	25	1210	41	1398	56	1637	71	1974
10	1075	26	1221	42	1412	57	1656	72	2000
11	1083	27	1231	43	1426	58	1676	73	2031
12	1091	28	1242	44	1440	59	1695	74	2059
13	1100	29	1252	45	1454	60	1715	75	2087
14	1108	30	1261	46	1470	61	1736	76	2116
15	1116	31	1275						

CORRESPONDING DEGREES OF BAUMÉ'S AREOMETERS AND REAL SPECIFIC GRAVITIES.
Areometer for Liquids lighter than Water or *Pèse-esprit.**

Degrees.	Specific Gravity.	Degrees.	Specific Gravity.	Degrees.	Specific Gravity.	Degrees.	Specific Gravity.	Degrees.	Specific Gravity.
10	1·0000	21	0·9300	32	0·8690	42	0·8202	52	0·7766
11	0·9932	22	0·9241	33	0·8639	43	0·8156	53	0·7725
12	0·9865	23	0·9183	34	0·8588	44	0·8111	54	0·7684
13	0·9799	24	0·9125	35	0·8538	45	0·8066	55	0·7643
14	0·9733	25	0·9068	36	0·8488	46	0·8022	56	0·7604
15	0·9669	26	0·9012	37	0·8439	47	0·7978	57	0·7556
16	0·9605	27	0·8957	38	0·8391	48	0·7935	58	0·7526
17	0·9542	28	0·8902	39	0·8343	49	0·7892	59	0·7487
18	0·9480	29	0·8848	40	0·8295	50	0·7849	60	0·7449
19	0·9420	30	0·8795	41	0·8249	51	0·7807	61	0·7411
20	0·9359	31	0·8742						

* These instruments are in France adjusted at 15° Cent., or 59° Fahr. ; those in England at 60° Fahr.

Armenian Bole—*See* BOLE.

Army, Hygiène of—*See* HYGIÈNE, MILITARY.

Arrack—The ordinary arrack is a spirit distilled from fermented rice, but the finer qualities are distilled from the fermented juice (toddy-palm wine) of the cocoanut-tree, palmyra-tree, and other palms. Batavian, Madras, and China arrack are the three varieties most esteemed. The *pariah arrack* is generally narcotic, very intoxicating, and unwholesome. It is often prepared from coarse jaggery, spoilt toddy, refuse rice, &c., and rendered more intoxicating by the addition of *hemp leaves, poppy heads, juice of stramonium,* and other substances. The Hindoos, Malays, &c., take arrack largely. Arrack, like other spirits, is colourless, or nearly so, but when kept long in wood it gradually acquires a slight tinge similar to that of old hollands. The inferior qualities are more heating and apt to disagree with the stomach than the other commercial spirits. It is used in this country chiefly to make punch. *See* ALCOHOL and ALCOHOLIC BEVERAGES.

Arrowroot—*See* STARCH.

Arsenic, or **Arsenicum,** was known in various stages of combination to mankind before the Christian era. This element presents many analogies with phosphorus and with nitrogen, and several French writers consider it as belonging to the non-metallic elements, notwithstanding that it conducts electricity with facility, and possesses a high metallic lustre. It generally presents itself as an alloy with some other metal, especially with iron, or with cobalt, nickel, copper, or tin. Occasionally it is found in its native state, and it sometimes occurs united with oxygen and certain metals, constituting arseniates such as those of iron, copper, and lead. More rarely it is found united with sulphur, either as the red sulphide (As_2S_2) realgar, or as the yellow sesquisulphide (As_2S_3) known as orpiment. The arsenic of commerce is usually prepared from mispickel (FeAsS), an arsenical sulphide of iron furnished abundantly by Silesian mines; and from the arsenides of nickel and cobalt, which yield arsenious sesquioxide as a secondary product in the ordinary process of working these ores.

Arsenic, Effects of.—Arsenical vapour or dust diffused, in certain arts, through the atmosphere, seldom fails to exercise an injurious influence on the health. Recent accidents observed to follow the employment of arsenical greens in the manufacture of leaves and artificial flowers, and of certain fabrics, may now be added to facts formerly ascertained amongst workmen in painted paper.

Dr. Blandet, in a memoir on "Poisoning" by Schweinfurt green, showed that the workmen employed in printing, brushing, and glazing the paper are subject to a kind of arsenical poisoning, which causes an œdema of the scrotum, preceded by swelling of the face and a papulose or pustulous eruption on the skin. Similar symptoms have been noticed from the use of an arsenical paste in the manufacture of jewellery.

These observations have been questioned by MM. Guérard and Chevallier. They conclude that the manufacturers are not agreed upon the influence of Schweinfurt green on the workmen, that some have observed the symptoms, and others have only heard of them; that according to some, the injurious consequences are to be attributed to faulty manufacture of the green; according to others, to differences in the constitution of the workmen, and that the effects of the green have been exaggerated. These objections have, however, now been disproved by a number of independent observers who corroborate Dr. Blandet, *e.g.*, MM. Beaugraud, Vernois, and Pietra-Santa, more especially in the case of artificial flower-workers.

In France, all manufacturers who, even involuntarily, are the cause of such accidents, are severely corrected by the law. Why it is considered of so much importance in France may be readily understood, if the number of workpeople employed at Paris in the manufacture of artificial flowers be considered: they amount to more than 15,000, a quarter at least of whom are employed in fabrics in which Schweinfurt green is used, and a great number of them work in small, ill-furnished and ill-ventilated rooms.

The details of the operations are thus given by Dr. Vernois:—

These greens are formed either from arsenite of copper alone, or mixed in variable proportions with acetate of copper (English green). Arsenical greens are employed to colour different herbs, to tint the fabric destined to prepare the leaves of artificial flowers, or they are painted directly on the leaves or petals of flowers worked on cloths of various texture. For these various uses they buy the Schweinfurt or the English green (*vert Anglais*), either in powder or in aqueous solution, and add to it, according to the effect desired, a certain quantity of Flanders glue, starch, gum, honey, or turpentine. Sometimes it is applied in the dry state, in order to sprinkle it over the things already coloured by the arsenical green. They frequently also, in order to modify the colour, mix with it a certain quantity of chromate of lead or picric acid.

The preparation of herbs is carried on as follows: The workman plunges into a shallow vessel, containing a sufficiently liquid solution of Schweinfurt green, one or several stalks of natural plants, perfectly dried, and agitates them quickly, seizing them by their roots by a pair of forceps. This is the steeping. This operation stains the fingers, the arms, the person, and the clothes of the workman, and the surrounding objects are covered with traces of this kind of paint. The plants thus prepared are hung on a line, and there allowed to dry for thirty-four or forty-eight hours. At the end of that, all the stalks are gathered and formed into bundles, which are used finally for bouquets. Often enough, to satisfy some freak of fashion, they are sprinkled with powdered arsenite of copper. This is the powdering. The bouquet-work constitutes one of the principal dangers; for the colouring-matter not having been fixed by any mordant, detaches itself in the form of a fine dust, which penetrates the skin of the hands, and which the workman breathes constantly. This danger is still more increased when he handles the bouquets covered with arsenical powder. At other times, however, in the manufacture of the plants, the Schweinfurt green is diluted with a sufficient quantity of turpentine. In this way the colour takes a smooth appearance, not altered by contact with water, and does not escape immediately in the form of powder by gentle handling; but when it is thoroughly dry it falls to the ground in little flakes, and may again rise in the air with ordinary dust. Thus the danger is modified, a little retarded, but always exists. There are then in this specialty of the florist the operations of steeping, drying, powdering, and arranging the flowers for bouquets, which, in their detail, place the workman or the purchaser under the more or less direct, and more or less active, influence of arsenical salt. This particular industry is exercised under conditions which render it still more injurious; for it is freely practised by a number of poor workpeople, by households living in one or two rooms, ill-ventilated, ill-lighted, and which they never sweep, and of which the floor, like the furniture, and like the clothing of the workpeople, is continually impregnated by pigment, and covered with arsenical dust. The preparers of the cloth destined for the manufacture of the artificial leaves by the aid of arsenical greens, comprehend the portion of the work most exposed to deleterious action. They use arsenite of copper alone, mixed principally with starch, and in rare instances associated with acetate of copper in variable proportions. Some use *enblée*, a mixture of picric acid and of greenish indigo, in which they steep their stuffs. Other manufacturers use fabrics prepared with hot solutions by ordinary dyers. According to the hue which the Schweinfurt dyer wishes to obtain, the workman commences by giving the stuff a yellow shade, by plunging it into a solution of picric acid and pure alcohol. He squeezes it between his fingers, in order to completely impregnate it, and dries it. It is this preliminary operation which stains the workman's fingers yellow. Frequently the latter mixes the picric acid by grinding it with the Schweinfurt green, and applies this paste immediately to the fabric. The paste is prepared by kneading the Schweinfurt green, already treated with water, with a solution of starch, thick enough, yet sufficiently liquid to be easily spread on the cloth. During this working up the paste, the fingers, arms, and hands of the workman are covered with arsenical solution. This being ready, the workman lays out his stuff, distributes the paste over it, then beats it between his hands, in order to make the colouring-matter thoroughly penetrate the cloth. The longer it is beaten, the better is the quality of the article. During this operation the skin of the hands and arms is completely impregnated with the solution. Sometimes the cloth, having been touched here and there with arsenical paste, is attached to a hook in the wall, and twisted different ways—wrung, as it were. In this way a very uniform colouring is obtained. This process is as bad to the workman as the former. Lastly, a process, which is generally practised, consists in placing the fabric, stained or not with picric acid, on a wooden table, and distributing on both sides the arsenical preparation with a brush, and then beating the stuff with a thick rubber. In this way the hands and arms of the workman are much less exposed to the paste than in the preceding processes. After the brushing and beating of the fabric, comes the drying, and this is the operation to which I wish to call attention. Once impregnated with the green colour by whatever process, the pieces, in squares of about 1 metre 50 cent., are hung on wooden frames furnished with teeth, on which the borders of the cloth are transfixed. During this simple operation, the workmen stain themselves much. When the stuffs are detached from the squares, they are folded; and from every crease falls a fine dust, which may then be carried into the mucous membranes. These workmen, then, are liable to all the accidents of the manufacturers of flowers, especially in the operations of kneading the paste, or during the beating, brushing, drying, and folding of the cloths. From the hands of the fabricator the fabrics are very often immediately consigned to the manufacturers of artificial flowers, who press them, figure them (that is to say, make the nerves), and arm them with a wire, and mount them with flowers. It may be at once understood how much all the manipulations I have just mentioned are liable to develop the arsenical dust. The paste has not been fixed on the stuffs by any mordant; the starch with which it is mixed has given it a very brittle consistence, and has predisposed it to be easily detached from the cloth. The stamping is effected by putting a certain number of folded pieces one above the other, and submitting them to the pressure of a stamping instrument. Repeated blows of this instrument detach the paste in scales, and cover with dust the fingers and person of the workman. A series of small packets are taken from the stamping-press, which contain, strongly pressed together, from twelve to twenty-four leaves. They are passed on to another workman who is charged with the folding. This operation is performed by holding the little bundle of leaves between the thumb and index-finger of the left hand. The thumb of the right hand presses the edges quickly and sharply so as to separate leaves one from another, as you separate the leaves of a book recently bound. During this process still more dust escapes. Then comes the figuring, which, by reason of successive blows applied to each leaf, covers the body of the operator with the same pulverulent material. Fixing a wire to the leaves at their lowest part by the aid of gum follows that operation. Then the leaves are arranged together in dozens, and passed to the bouquet manufacturers, who mount them. From thence they go to the milliners, who adapt them to different articles of dress, and sell them to the public. Through all this series of transformations there is the same manipulations, the same production of dust, the same action on the skin and mucous membranes, only in a decreasing degree, from the first preparer to the milliner. There is, however, a process of preparing the cloth which diminishes notably the severity and frequency of the evils of the Schweinfurt green. It is that which immediately after the drying of the stuffs submits them at once to the "Calendrage." This operation causes the arsenical paste to penetrate mechanically into the fibres of the stuff, and gives it a smooth and glazed aspect which only permits imperfectly the production of the arsenical dust. This process renders the successive workings of this cloth less injurious, but it would be an error to consider it as inoffensive. During the action of the press, and especially during the separating and figuring of the flowers, a notable quantity of the toxic dust is still produced. However well prepared the fabric may be, you have only to tear it to detach the coating under the form of a palpable powder. It is only necessary to add that the waxing of the leaves, after they have been separated and figured, and before putting them into bouquets, constitutes a protecting envelope against the effects of the powdered coating for workmen who then handle them, as well as for women who wear them; but this film of wax is only applied, comparatively speaking, to a small number of leaves, for it alters the green and vivacity of its colour.

The poisonous symptoms of arsenic produced by these different trades, &c., are loss of appetite, pain in the præcordia, disturbance of the bowels, constant headache, and a distressing oppression. The muscular force, especially of the extremities, is much weakened. This is a very constant and characteristic sign. Actual paralysis may indeed occur, and persist long after the individual has ceased to be exposed to the arsenical poisoning. The eyelids are red and irritable, and vesicular and pustular eruptions appear in several parts of the body. It is especially on the face, forehead, scrotum, chest, arms and hands, where the dust penetrates either directly or indirectly, that pustules occur, which a superficial examination might confound with syphilitic eruptions.

In the preparing of the stuffs, in the process of drying, Dr. Vernois says :—

A new condition, and serious results appear. The multiplicity of sharp points fixed in the wooden squares inevitably pricks and scratches the skin of the workmen. An inoculation of the arsenical salt immediately takes place, as if it had been practised experimentally. The skin irritates and inflames, a vesicle first, then a large pustule covers the orifice of the prick, and undergoes all the stages of inflammation, which produces suppuration and often gangrene, below which a deep and painful ulceration is developed—all the more tedious to heal, as the inoculation is renewed from day to day. The action of picric acid, mixed with the paste, can only augment and aggravate the irritation of the wounds. If the ulcerations are numerous, the workman may absorb the arsenious acid, and be liable to serious results. I have seen a certain number of workmen with glandular enlargements under the armpits, and the hands in such a state that they were obliged to come to the hospital, where they were only cured after one or several months of treatment. The aspect of the hand was then characteristic; to the greenish-yellow tint of all the skin, and especially of the palmar aspect of the hands, to the greenish crust under the nails, was nearly always added a yellow colour of the nails, produced by the repeated contact with picric acid. When we add a generally diffused erythema, then a series of black points, or of inflamed pustules, and sometimes a whitlow, we shall have a faithful representation of the evils which most frequently present themselves in the preparers of stuffs for artificial flowers tinted with Schweinfurt green.

Among the endeavours made to make this branch of industry more healthy, should be noticed, on the one hand, the satin-making machine of M. Ebert; on the other, the attempt to substitute chrome for Schweinfurt green, and the ingenious process of directly incorporating the arsenical colouring-matter with a special collodion invented by M. Bérard-Zenzelin.

The following cases will well illustrate the foregoing remarks : In the month of December 1872, Dr. Isambert had under his charge, at *St. Antoine*, a patient suffering from arsenical intoxication, through external absorption. The man had been handling cakes of Schweinfurt green, and reducing them to powder. Four days after, an eruption broke out on the face and scrotum. In this latter situation the eruption was followed by an eschar. Two months later, intense pain (nocturnal especially) supervened along the limbs and in the joints. At the same time disorders of mobility and sensibility appeared in the limbs, especially the lower ones, which now presented veritable paralysis. Dr. Isambert states that these symptoms are due to the local penetrating action of arsenic—symptoms due to its exit or elimination being especially marked on the mucous membrane.

In these cases of poisoning, through external absorption, symptoms of internal poisoning are exceedingly rare.

A case is recorded by Dr. Wintrebert of Lille, in the "Bulletin Médical du Nord," of arsenical ulcerations of the arms. The lesions were brought on by the local use of a green paper (intended for bills), and which had been dyed with arsenite of copper. They disappeared on the patient ceasing to use the paper.

Notwithstanding that so much has been said against green papers, they are far from uncommon; and, strange to say, the most dangerous of these—those covered with a thick, unvarnished, loosely coherent layer of Scheele's green—are most frequently met with in our nurseries. The beds, too, are frequently placed next the wall, and the attrition of the bedclothes easily removes portions of the poisonous colouring-matter. The fine cupro-arsenical dust, which thus becomes diffused through the air, occasionally produces in children symptoms resembling those of violent catarrh. Some of the paper described has been found to contain nearly 18 grains of arsenious acid in a square foot.

Some little time since, Mr. T. Bolas of the Charing Cross Hospital examined a sample of wall-paper containing 27·53 grains of arsenious acid in the square foot, and in this case the poison was so loosely fixed that very slight friction sufficed to detach a portion and diffuse it through the air. In Prussia the use of arsenical pigments is interdicted unless the colouring-matter is properly fixed or protected from accidental removal, and it most certainly appears desirable that some such regulation should come into force here. It is not generally known that arsenic is also occasionally found in the white or cream-coloured enamel papers so frequently used in drawing-rooms, and in drab papers tinted with native ochre.

A curious case, illustrating the effect of arsenical wall-papers, is related by Dr. D. B. Dalzell of Malvern. He was attending a lady who was attacked by scarlet fever; during her illness her husband occupied a small bedroom. The very first night, while sleeping in it, he experienced much discomfort, his sleep being unrefreshing, and disturbed by frightful dreams ; and he rose in the morning languid and weak, with much nausea and dull headache. Towards the evening the symptoms considerably abated. The second night, and day following, there was a repetition of the same symptoms. He now changed his room, and from that hour his symptoms steadily and gradually disappeared. A servant next occupied the chamber, and immediately became affected in the same way as her master. On examination being made by Dr. Dalzell, he found that the wall-paper contained a large quantity of arsenic, which was, no doubt, the cause of the mysterious visitation on the sleepers.

It has recently been shown by Professor Fleck (Zeitsch. für Biologie, bd. viii. p. 445, 1872) that the arsenious acid in the Schweinfurt green, when in contact with moist organic substances, and especially starch sizing, forms arseniuretted hydrogen, which diffuses in the room, and is, no doubt, the cause of some of the cases of arsenical poisoning from green papers.* Arsenic is also used to give that bright green often seen in coloured sweets. During the Christmas of 1873, a large cake, in which was imbedded a green card labelled, "For the bairnies," was seized in a baker's shop at Greenock. *The card was coated with sugar*, and on being submitted to analysis, was found to contain 7·04 grains of arsenious acid! We find arsenic in green wax candles and green tapers. Mr. T. Bolas of Charing Cross Hospital having noticed the arsenical odour which was present during the burning of green wax tapers, Christmas candles, and similar articles, was induced to examine several samples, with the following results: Of thirteen samples, one only contained arsenic, the majority being coloured with verdigris, and two samples were tinted with ultramarine green. The arsenical tapers were of the kind usually employed in houses for lighting gas; and one taper, weighing 17·69 grains, was found to contain 0·276 grains of arsenious acid. When we consider how extremely sensitive some people are to the action of this poison, especially when it enters the system through the respiratory organs, it will be sufficiently apparent that it is highly reprehensible to use a volatile poison like arsenic, even though the amount employed may be small, for colouring tapers or other similar articles intended for burning in houses. A Christmas tree brilliantly illuminated with arsenical candles may be taken as an extreme instance of the danger likely to arise from this source. Vinegar not unfrequently presents traces of arsenic, this being introduced through the sulphuric acid used largely in the sophistication of the vinegar. Mr. Scanlan, in his evidence before the Parliamentary committee, says: "You get arsenic in oil of vitriol to a great extent. This arises from the employment of pyrites instead of sulphur. Oil of vitriol is made in large quantities by alkali-makers, and when the price of sulphur is high, they use pyrites instead; and pyrites almost invariably contains arsenic. Irish pyrites contains a good deal; but I have understood that Cornish pyrites contains still more. Some few years ago, I found an enormous quantity in sulphuric acid here in London. It finds its way into muriatic acid made from that sulphuric acid, or in the manufacture of which that sulphuric acid is employed; and hence it may be very mischievous. A mixture of muriatic acid and soda has been used in bread, and I have seen muriatic acid containing a very fearful quantity of arsenic."

For the washing of sheep an arsenical composition is employed. At Lincoln, in April 1872, a piece of this fell upon the floor, and was eaten by a child, who shortly afterwards died.

Arsenic is adulterated with gypsum and chalk; these can readily be detected by not subliming with heat.

Tests for Purity.—It is entirely volatilised by a heat of 400°. Four grains dissolved in boiling water with eight grains of bicarbonate of soda, discharge the colour of 808 grain-measures of a volumetric solution of iodine, containing 12·7 grains of iodine in a 1000 grain-measures. This decolorisation is effected by the conversion of the iodine into hydriodic acid. The change may be represented by the formula: $As_2O_3 + 2H_2O + 4I = As_2O_5 + 4HI$, four equivalents of iodine corresponding to one equivalent of arsenious acid. The hydrated peroxide of iron is the antidote generally used in an overdose of arsenic.

The following are the principal tests for arsenic: A few drops of a neutral solution of ammonia nitrate of silver added to a solution of *arsenical sublimate* above mentioned, produce a lemon-yellow precipitate of arsenite of silver, which is soluble in *aq. ammoniæ*.

Ammonia sulphate of copper produces an apple-green precipitate of arsenite of copper, known as Scheele's green, so extensively used for making green-coloured paper, sugar ornaments, &c. To test the presence of arsenic in green wall-papers, immerse a piece in a dish containing a little ammonia-water; after standing some few minutes, pour off the blue

* That arsenic is actually present in the *air* of rooms papered with arsenical papers has been lately demonstrated by experiment:—

"Hamberg drew by means of aspirators the air of a room, the walls of which were papered with a very old dry green paper, through various tubes containing cotton wool and silver nitrate. On examination scarcely any solid particles could be discovered. The cotton wool was fused with sodium nitrate and carbonate, and gave a little ferric-oxide and a trace of arsenic, but the solution of nitrate of silver gave decided evidences of arsenic as well as of sulphide of silver."—(Pharm. J., Trans. [3], iv. 81–83.)

liquid into a test-glass, and throw in a crystal of *nitrate of silver*, when a *yellow* precipitate of *arsenite of silver* forms at the bottom. The quantity of arsenite of copper contained in a *given size* of the paper may easily be ascertained by digestion in weak *ammonia-water*, and evaporation to dryness over a water bath, the resulting green powder being equal to 50 per cent. of arsenic. Or it may be detected by Reinsch's method. A strip of clean copper foil, $\frac{1}{16}$ in. wide, and $\frac{3}{4}$ in. long, is boiled in a test-tube with about one drachm of diluted hydrochloric acid, and if at the end of three minutes the copper retains its colour, the acid may be considered free from arsenic. About a square inch of the paper is now introduced, and the boiling is continued for about five minutes. If arsenic is present, the copper loses its lustre, and becomes covered with a dark crust of arsenic ; but the darkening of the metal must not be considered as a conclusive proof of the presence of arsenic, as papers frequently contain ultramarine blue or green; and this, when treated with an acid, yields sulphuretted hydrogen, which acting on the copper produces a dark film of copper sulphide on its surface. After having been washed, and dried with blotting-paper, the darkened slip of copper is heated to low redness in a narrow glass tube about three inches long. If the dark colour was produced by arsenic, a sublimate, consisting of minute shining octahedrons, will deposit itself in the cold part of the tube. A lens is often necessary to render the crystals visible. In testing for arsenic in the stomach, should sulphide of arsenic be present, Reinsch's test (that of boiling copper foil or wire with acid in the suspected liquid)—since the sulphide is insoluble in hydrochloric acid—would fail to detect the insoluble portion.

White arsenic is more commonly the poison used, but there have been cases known in which the sulphurets of arsenic (such as the yellow or orpiment, and the red or realgar) have been taken, for they are extensively used in some workshops for fireworks. Then again, where a corpse has been long buried, and is disinterred for examination, the white arsenic taken by the deceased has become, by the putrefaction of the body, changed into yellow sulphuret. In all these cases the use of hydrochloric acid as a solvent, and Reinsch's process as the precipitant, cannot apply, as the arsenic is liable to be overlooked, for the yellow sulphide is insoluble in hydrochloric acid, but dissolves readily in fuming nitric acid or in nitro-muriatic acid. It is found that the *post mortem* change into orpiment is never quite complete, so that for the detection of arsenic in solid organic substances, such as the tissues of the body, the best general method is most decidedly to convert the arsenic, if present, into the *volatile* chloride; and, according to Dr. Taylor, there is always sufficient arsenic (if present at all) unchanged into sulphide to ensure success. The only necessary caution is that the substance be thoroughly dried, and that the reagents be pure. After drying, it is placed in a retort with fuming hydrochloric acid, and slowly distilled by the heat of a sand bath. The distillate contains chloride of arsenic, if arsenic was present, and may be submitted to further tests. Part of it may be deposited on copper, and part tested in a Marsh's apparatus.

Marsh's test is as follows :—

Place in a suitable apparatus a few pieces of granulated zinc free from arsenic, and pour over it some diluted sulphuric acid with the solution to be tested. The hydrogen, as it is evolved, carries with it any arsenic present, and on being burnt deposits metallic spots on a cold piece of porcelain held in the flame; but if the same are produced with zinc and acid only, the articles are impure. Arsenic spots are of a nutty-brown colour. The spots of *antimony* are of a smoky-black. These spots are readily distinguished by the application of a drop or so of a solution of hypochloride of soda, which readily dissolves *arsenic* but not *antimony spots*.

The best reducing agent of the sulphide of arsenic, or arsenite of copper, is a mixture of cyanide of potassium, with either carbonate of soda or potash, as this gives off *all* the arsenic. The prussiate of potash answers every purpose.

Ammonia nitrate of silver shows $\frac{1}{12000}$ of a grain of arsenic acid. Ammonia sulphate of copper shows $\frac{1}{60000}$ of a grain of arsenious acid. Ten grains of arsenite of silver equal ·99, or 3 grains arsenious acid. Ten grains of arsenite of copper equal 5·26, or better than 50 per cent. arsenious acid. *Sulphuretted hydrogen*, as well as *yellow sulphide of ammonium*, produce in ACID aqueous solutions of the *arsenical sublimate*, a golden-yellow precipitate, which is increased on boiling.—(HORSLEY.)

The employment of arsenic in the arts is regulated in France by an ordinance of the "Conseil d'Hygiène."

By the 14th of Vict. c. 12, every person selling arsenic is bound to keep a written record of every particular relative to each transaction, such as the name, abode, and calling of the purchaser, the purpose for which the poison is required, and the quantity sold, &c. These particulars are to be signed also by the purchaser. No person (sec. 2) is allowed to sell arsenic to any one unknown to the seller, unless in the presence of a witness whom the seller is acquainted with. The arsenic sold (sec. 3) is to be mixed with soot or indigo in the proportion of half an ounce of indigo to a pound of arsenic. Penalty on conviction, £20, or less. The Act applies to all the colourless preparations of arsenic; but it is not to affect chemists in making up prescriptions for medical men, or in supplying medical men; nor is it to affect the wholesale dealers in supplying arsenic to retail shops, &c.

Arsenites—Arsenious acid combines with various alkaline, earthy, and metallic elements, forming arsenites, all of which are poisonous, and give rise to symptoms and effects similar to those described under ARSENIC.

The only metallic arsenites met with in commerce are those of copper, and these, under various names—such as Scheele's green, mineral green, emerald green, Brunswick, Schweinfurt, or Vienna green—are the basis of a great variety of pigments, and, as a consequence, find their way into cakes of water-colours, into wafers, candles, wall-papers, and even into confectionery and other articles of food. Bread has been impregnated with arsenic from the loaves having been placed on shelves freshly painted with green paint (Medical Times and Gazette, April 1854, p. 326); and there are many cases on record of this poison finding its way into eatables through curious and unsuspected channels.

The only other common arsenites are those of potash and soda. Fowler's solution, or liquor arsenicalis, is a solution of arsenite of potash coloured with tincture of lavender. Arsenite of potash, tar, and soap is a common wash for sheep; and fatal cases have occurred both amongst the animals to which it has been applied and the men applying it; and the various "fly-waters" are solution of arsenites of soda and potash sweetened with sugar. *See* ARSENIC.

Arseniuretted Hydrogen — *See* HYDROGEN, ARSENIC, &c.

Artichoke — The *Cynara Scolymus*, a thistle-like perennial plant of the natural order *Compositæ*, a native of Southern Europe, but extensively cultivated in our gardens for its "bottom," or the sweet fleshy receptacle of its flowers, which is eaten as a pot-herb. It has much the same nutritive value as carrots, onions, cauliflower, cabbages, &c. This must not be confounded with the Jerusalem artichoke, which is altogether a different plant.

Artichoke, Jerusalem—Derived from the *Helianthus tuberosus*. A native of Mexico, and said to have been introduced into England in 1617. The term "Jerusalem" is supposed to be a corruption of the Italian word *girasole*, meaning *sunflower*, a tribe to which the *Helianthus tuberosus* belongs. It contains no starch, but a large quantity of sugar, as will be seen from the following analysis of Payen, Poinsot, and Fevry :—

Composition of the Jerusalem Artichoke.

Nitrogenous matter	3·1
Sugar	14·7
Inuline	1·9
Pectic acid	0·9
Pectine	0·4
Cellulose	1·5
Fatty matter	0·2
Mineral matter	1·3
Water	76·0
	100·0

This vegetable is but little eaten in England.

Artisans' and Labourers' Dwellings —*See* HABITATIONS.

Ascaris lumbricoides—Round worm. This is the most common human parasite. It is from eighty-four to sixteen inches long, round and elastic, tapering towards each end. Of a greyish-red colour, and somewhat transparent. Children are very frequently attacked with them. The worms generally inhabit the small intestines and stomach, from whence they have been known to pass up into the gall-ducts, frontal sinuses, nostrils, mouth, &c. The writer has known an infant at the breast throw up, in the course of one day, more than twenty round worms of various sizes. They are, however, most frequently in pairs, often solitary.

It is probable that the ova gain admittance into the human body through drinking-water, and perhaps through uncooked vegetable food. Dr. Paterson of Leith observed that certain families drawing water from a well supplied from a dirty pool, which contained numerous vermiform animalculæ, were very subject to the Ascaris lumbricoides, while others in the same street drinking a different supply were unaffected.

Ascaris mystax—A round worm, infesting the cat. It has been found in the human subject. *See* WORMS, ROUND.

Ash—In commerce the word ash is applied to the ashes of the vegetable substances from which the alkalies are obtained, as *kelp*, *barilla*, &c. It is the popular name of the vegetable alkali, potash, in an impure state, as procured from the ashes of plants by lixiviation and evaporation. The plants which yield the greatest quantity of potash are wormwood and fumitory. The ashes of all species of woods and weeds are found to contain some alkali, hence it is that the residuary matter after the combustion of any vegetable matter is found to act as a stimulant to vegetable

	Peas.	Beans.	Red Clover.	Sainfoin.	Wheat Grain.	Straw.	Barley.	Oats.	Turnip Root.	Turnip Leaves.	Beetroot.	Carrot Root.	Potatoes.*	Lettuce Leaves and Stalk.†	Olive-Tree Wood.‡	Hops.§	Hay.‖	Sprouts. Clupea Sprotus.¶
Potassa	42·43	36·72	18·44	31·90	29·76	10·51	20·07	17·70	23·70	11·56	21·68	37·55	25·41	22·37	20·60	24·88	11·93	17·23
Soda	3·27	0·14	2·79	...	5·26	1·03	4·56	3·84	14·75	12·43	3·13	12·63	...	18·50	...	...	1·07	1·19
Lime	5·73	12·06	35·02	24·30	2·88	5·91	1·48	3·54	11·82	28·49	1·90	9·76	2·34	10·43	63·02	21·59	14·76	23·57
Magnesia	5·92	6·00	11 91	5·03	11·06	1·25	7·45	7·33	3·28	2·62	1·79	3·78	4·17	5·68	2·31	4·69	5·30	3·01
Sesquioxide iron	0·44	0·65	0·98	0·61	0·23	0·07	0·51	0·49	0·47	3·02	0·52	6·74	0·50	2·82	...	1·75	2·75	0·28
Sulphuric acid	6·23	4·28	3·91	3·28	0·11	2·14	0·79	1·10	16·13	10·36	3·14	6·34	4·71	3·85	3·09	7·27	0·20	...
Silica	1·74	1·52	4·03	3·22	2·23	73·57	32·73	38·48	2·69	8·04	1·40	0·76	3·64	11·86	3·82	19·71	53·43	...
Carbonic acid	4·38	1·63	12·92	15·20	0·22	...	...	...	10·47	6·18	15·23	15·15	...	...	...	2·17	...	...
Phosphoric acid	29·92	33·74	5·82	9·35	48·21	5·51	31·69	26·46	9·31	4·85	1·65	8·37	10·38	9·38	4·77	14·47	6·34	43·52
Chloride potassium ...	...	...	...	6·21	...	...	...	0·92	...	...	...	...	12·40	...	1·09	...	...	...
Chloride sodium	...	3·26	4·13	0·78	...	...	...	...	7·05	12·41	49·51	4·91	trace	15·09	...	3·42	2·27	11·19
Total amount ...	99·96	100·00	99·95	99·96	99·96	99·99	99·98	99·96	99.93	99·96	99·96	99·99	100·00	99·99	100·00	99·95	100·00	100·00
Percentage of ash in dry substance	2·60	2·90	7·87	6·37	2·05	...	2·50	2·50	6·00	16·40	11·32	5·12	4·86	...	0·58	5·95	6·97	...
Percentage of ash in the fresh substance	2·24	2·54	6·77	5·65	1.81	...	2·25	2·27	0·75	1·97	1·02	0·77	...	...	...	...	6·15	...

* Griepenkerl. † Griepenkerl. ‡ A. Möller. § Way. ‖ Hubert. ¶ Way.

growth. A careful determination of the ash of different substances is of great use to the analyst in detecting adulterations; for example, almost every plant has a very constant amount of ash, and not alone the quantity is constant, but the different proportions of the various components are also within certain limits fairly constant. Many plants have the power of selecting from the soil or medium in which they are placed rare elements; for example, the ash of tobacco contains *lithium*; tea, *manganese*; and seaweed, *iodine*: indeed, it is even possible that by careful chemical and spectroscopic observations of the ash new elements may be discovered.

The percentage of ash of the different foods will be found in their respective articles. We, however, give here a short list of the average percentage of ash of a few important substances:—

	Total Ash.
Cayenne pepper,	from 5 to 6 per cent.
Chicory,	„ 5 „
Cocoa,	„ 3 to 4 „
Coffee,	„ 4 „
Flour,	„ ·7 to 1·5 „
Mustard,	„ 3 to 4·5 „
Pepper,	„ 4·3 to 5 „
Rice,	„ 5 „
Tea,	„ 5·6 „
Turmeric,	„ 5 to 6 „

The chemical composition of the ashes of a few common plants may be gathered from the table on preceding page.

Ashes are used in agriculture in certain instances, according to the nature and proportions of earthy matters and different salts which they contain. According to M. Soulange Bodin, they hold the middle place between stable-dung and pasture-manure. They act mechanically in dividing too compact soils hygroscopically by absorbing moisture, and they appear to have a similar action to lime in accelerating the decomposition of the mould; they also probably act as a stimulant to the earth. In low-lying lands they are most suitable on very damp argillaceous soils.

In Picardy, turf-ashes are used; in England, the Low Countries, and the north of France, coal-ashes. Coal-ashes, mixed with excrement, besides disinfecting the latter, make an excellent manure.

For the powers of sanitary authorities with regard to the due removal of ashes, *see* REFUSE, DISPOSAL OF.

Ashpits—*See* REFUSE, DISPOSAL OF.

Asparagin ($C_4H_8N_2O_3H_2O$)—This crystalline body is extracted from the young shoots of asparagus and of the climbing vetch, from the roots of the marsh-mallow, and from several other plants. It may generally be procured in crystals by simply evaporating the expressed juice of one of these plants. The brown crystals thus obtained may be purified by treatment with charcoal and recrystallisation. Asparagin is chiefly remarkable for the facility with which it is decomposed into aspartic acid and ammonia. Piria found that if the expressed juice of the vetch was allowed to putrefy, the asparagin contained was gradually converted into ammonium succinate by the assimilation of 2 atoms of hydrogen. *See* ASPARAGUS.

Asparagus (natural order *Liliaceæ*, subclass *Asparageæ*)—Asparagus owes its remarkable qualities to the presence of a peculiar principle called asparagin, which is said to be more abundant in *Asparagus acutifolius* than in the species commonly cultivated. When young and well boiled it is wholesome and digestible, but far less nutritious than the potato; in fact, it does not contain more than from 9 to 17 per cent. of solid matter, and of this only about 1–2 is nitrogenous. It gives the urine a peculiar odour.

Asparagus, and indeed all succulent vegetables, are endowed with antiscorbutic powers, but in a less degree than the potato.

Assamar — A substance described by Reichenbach as being contained in the crust of bread, and possessing the faculty of retarding tissue metamorphosis. *See* BREAD.

Atmometer (*atmos*, vapour, and *metron*, measure) — An instrument to measure the quantity of water evaporated in a given time under ordinary atmospheric conditions. It is of very simple construction, and possesses some practical value. It consists of a long glass tube graduated into inches, having attached to the bottom a hollow ball of porous earthenware, similar to that used in water-bottles. In using it, water is poured in at the top till it rises to the zero-point of the scale. The outside of the porous ball being always covered with dew, the more rapid the evaporation the more quickly will the water fall in the tube.

Atropia ($C_{17}H_{23}NO_3$)—A crystalline alkaloid, discovered by Brander in *Atropa Belladonna*, or deadly nightshade.

When pure it is obtained in colourless transparent silky prisms, if crystallised from hot concentrated solutions, or needles, from dilute alcoholic solutions. The alkaloid has an acrid, bitter, somewhat metallic taste. It is freely soluble in amylic alcohol, benzole, and chloroform. It dissolves in 200 parts of cold and about 50 of boiling water, in $1\frac{1}{2}$ parts of cold alcohol, in 25 parts of cold and 6 parts of boiling ether.

It is extremely poisonous, $\frac{1}{12}$ of a grain has even caused serious symptoms in the human subject. When the symptoms of poisoning are fully developed, they mainly consist of dilatation of the pupil, insensibility, or delirium and convulsions, terminated by coma.

From the contents of the stomach the poison may be separated by the method of Stas, and developed by its action on the pupil, and by the tests described under art. ALKALOIDS.

In solution, atropia yields a precipitate to chloroiodide of potassium, chloride of gold, carbazotic acid, chloride of platinum, and tannic acid. It is not affected by either chromate or sulphocyanide of potash.

Audit—The Public Health Act, 1875 (s. 245–250), very fully provides for the audit of accounts.

The accounts of every local authority are to be made up in the form and to the day in every year appointed by the Local Government Board. (P. H., 245.)

In the case of an urban sanitary authority, when it is a town council, the accounts are to be audited and examined by the borough auditors, under the same regulations as those under which the municipal accounts are audited.

An urban authority not being a town council, has to get its accounts audited by the poor-law auditor of the district; but if he should be a member of the board, the accounts are to be audited by such auditor of any adjoining union as may from time to time be appointed by the Local Government Board. (P. H., 247.)

Not less than two guineas a day and travelling expenses are to be paid as fees to the auditor for each audit.

The auditor fixes the day or days on which he will conduct his audit, and the authority is to give at least fourteen days' public notice of the time and place of the audit in one or more of the local newspapers, and also notice when and where the accounts will be open for the inspection of the ratepayers.

Seven clear days before the audit, a copy of the accounts duly made up and balanced, "together with all rate-books, account-books, deeds, contracts, accounts, vouchers, and receipts," are to be deposited in the office of the authority, and remain open for inspection, during office hours, to all persons interested, who are at liberty to take copies or extracts from them without fee or reward. Any officer obstructing the inspection or tampering with the accounts is liable to a penalty of £2. (Ibid., 247.)

The duties of the auditor are, to require the production of every document relating to the audit, and he may also require the attendance of persons; failure in either case involves penalties. He is to examine the accounts minutely, and to disallow any which he considers illegal. Of those unlawful items which have actually been paid, he is to surcharge the amount upon the person who made or authorised the same. This sum the person will have to pay within fourteen days; but if he think himself aggrieved, he may compel the auditor to state in writing his reasons for making the surcharge, and may apply for redress to the Local Government Board, or he may apply to the Court of Queen's Bench for a writ of *certiorari* to remove the disallowance into the said court, "as if it were a disallowance by a poor-law auditor." (Ibid.)

The auditor is to enforce by legal proceedings his surcharges, as in the case of poor-law accounts, the sanitary authority reimbursing expenses not recovered. (Ibid.)

Ratepayers or owners of property may be present at the audit, and may make objections to the accounts before the auditor, and they have the same right of appeal against allowances as they have against disallowances.

Fourteen days after the completion of the audit, the auditor is to deliver his report on the accounts audited to the clerk; this is to be deposited at the sanitary authority's office, and an abstract published in the local newspapers.

Rural sanitary authorities are to prepare by their clerk their accounts at the close of each half-year (General Order of Accounts, Art. 30); these accounts, as well as the accounts of overseers collecting or paying any money for the purposes of the Public Health Act, 1875, are to be audited by the poor-law auditors; the powers and obligations of the auditor and the right of appeal are exactly similar to those prevailing in the case of poor-law audits. (P. H., 248.)

Accounts of local authorities not audited at the time of passing of the Public Health Act, 1875, are to be deemed accounts under the said Public Health Act for the purpose of audit. (P. H., 324.)

Autopsy—This word really signifies self-examination, but is now in general use as meaning a *post mortem* investigation. It is performed in England, to ascertain the cause of death in medico-legal investigations, or in the interests of science and pathology. It is also a preliminary to embalmment in this and other countries, and is sometimes used simply as a means of preserving the child when a woman dies in full pregnancy. In France no *post mortem* can be undertaken under twenty-four hours after death, for fear that the body operated upon may yet be alive.

In England, a *post mortem* cannot be instituted (without the consent of the friends) unless by a coroner's order. In public institutions, however, *post mortem* inquiries are frequently undertaken without formal consent, and whenever a prisoner dies an inquest and *post mortem* is required by an old custom, for there does not appear to be any definite law on the subject. In the interests of the public health autopsies should be conducted in a decorous, cleanly manner, and should be discouraged when a person has died of any infectious disease, such as smallpox, typhus, &c.; but if the autopsy be necessary, during and after the operation disinfectants should be freely used, and other precautions taken. *See* MORTUARIES, &c.

Autumnal Fever—A term used chiefly by American writers to designate typhoid fever, on account of its prevalence in the autumn. *See* FEVER, TYPHOID.

B.

Bacon—Bacon differs from fresh meat in the relatively large amount of fat and small proportion of water; it is more digestible than cured meats usually are, and the loss in cooking should not exceed 10 or 15 per cent. Its composition is shown in the following table:—

COMPOSITION OF BACON.

Dried Bacon.		*Green Bacon.*	
Nitrogenous matter	8·8	Nitrogenous matter	7·1
Fat . . .	73·3	Fat . . .	66·8
Saline matter .	2·9	Saline matter .	2·1
Water . . .	15·0	Water . . .	24·0
	100·0		100·0

See FOOD, MEAT, &c.

Bacteria, Vibriones, or **Microzymes**—Bacteria are the smallest and least organised of living beings; in shape they may be either globular, rod-shaped, egg-shaped, or filamentous, but the most common of these forms is that of jointed rods moving with rapidity, in size about one-third of the width of a blood corpuscle (*i.e.*, about $\frac{1}{8000}$ of an inch).

The material of which they are composed is protoplasm, surrounded by an envelope of cellulose, and they are nourished by ammonia, carbonic acid, and certain salts. Thus in their structure they are like low vegetable forms, and also like plants in their food, for they derive the nitrogen by the aid of which they build up albuminous compounds from ammonia, and not from previously-existing albuminous compounds. For them to appear or exist in any liquid, three things are requisite—1. An organic carbonaceous substance (they will derive their carbon from almost any substance containing carbon, except carbonic acid, by dissociation of its elements). 2. A nitrogenous substance, which need not be organic (*e.g.*, a nitrate will nourish bacteria, and be reduced by their growth to a nitrite). 3. A phosphate. Guided by these facts, liquids of definite composition may be employed in experimenting upon these bodies. The best cultivation fluid is perhaps the following: "Potassii phosphate, half a percentage; magnesic sulphate, half a percentage: dissolve in water having a trace of calcic phosphate in suspension, and then adding a percentage of tartrate of ammonia, and boiling the mixture."—(BURDON SANDERSON.) This liquid, if properly boiled, is free from bacteria; but the contact of almost any organic substance—*e.g.*, a drop of water, a pinch of hay, a morsel of meal, &c.—will cause their appearance.

Bacteria multiply by bisection, and, under favourable circumstances, the rate of multiplication is enormous. From measurement of the longest time a single bacterium remains without dividing (about an hour), it may be computed that every single bacterium must produce 16,777,220 individuals in twenty-four hours. Putting it otherwise, the progeny of a mass of bacteria would at the end of a day weigh a pound.

Drs. Ferrier and Burdon Sanderson made some experiments with a view to discover the circumstances which determine the existence of bacteria in the liquids and tissues of the body. They showed that the occurrence of organisms in these liquids was in proportion to the degree of external contamination, and that all water except freshly distilled teemed with invisible germs of bacteria.

Different varieties of water possess the zymotic power, as they term it, in different degrees. The water supplied by the different London water companies was examined, and different degrees of bacteria impurity were found to exist. They further showed that the animal fluids and tissues do not normally contain the germs of bacteria, and that the occurrence of these, and consequent putrefaction, was due to contact with surfaces of ordinary water.

It was found that beef, milk, wine, &c., do not putrefy if kept from contamination with water, or any surface which has not been superheated or rendered innocuous by some antizymotic which is fatal to the life of bacteria. The experiments further showed that there is no developmental connection between bacteria and torula. They also found that—(1.) Thoroughly-boiled liquids preserved in tubes, first prepared and sealed, remain perfectly free from organic forms. (2.) The germinal matter from which microzymes spring does *not exist in ordinary air*, whilst the activity of the development of the penicillium is in proportion to the degree of exposure to such air. (3.) The germinal particles of microzymes are rendered inactive by thorough drying, without even the application of heat; and the contamination of water by apparently dry surfaces happens only in those cases in which desiccation is incomplete. (4.) Disinfectants—such as ozone, peroxide of hydrogen, chlorine, permanganate of potassium, carbolic acid, quinine, and the application of heat—may be so applied as to prevent the development of bacteria without stopping the germination of the penicillium. (5.) Filtration exercises no perceptible influence on the zymotic property of water.

Muscle, cellular tissue, blood, urine, saliva, and probably milk, do not possess the zymotic property, and they contain no microzymes, either potentially or actually. The liquid products of inflammation (pus) are occasionally zymotic, but not always so.

From the deportment of microzymes with reagents it is assumed that the particles are albuminous.

The tendency of these experiments is to prove that fungi are not developed from microzymes, and that their apparent association is one of mere juxtaposition. The grounds of this conclusion are thus concisely stated: (1.) The prompt appearance of torula-cells in Pasteur's solution whenever it is exposed to the air, and the rapid development and luxuriant fructification of the higher form (penicillium), show that, so far as the chemical composition of the liquid is concerned, there exists in it all the conditions favourable to the process. (2.) When precautions are taken to prevent contamination by impure surfaces or liquids, the development which ends in penicillium goes on from first to last without the appearance of microzymes. (3.) Whenever it is possible to impregnate the test-liquid with microzymes, without at the same time introducing torula cells or germs, the development of the former begins, and continues by itself without any transformation into the latter. Thus fungi are not developed, *notwithstanding the presence of microzymes* in the same liquid in which, *microzymes being absent*, but air having access, they appear with the greatest readiness. In air the germs of bacteria exist in large numbers.

On the other hand, the experiments of Hiller of Berlin rather negative the doctrine taught by Burdon Sanderson and Ferrier, and tend to show that bacteria have little influence on putrefaction, that putrefaction can exist independently of bacteria, that bacteria can develop in liquids such as urine without exciting its decomposition, and that the degree of development and rate of multiplication depend upon the amount of assimilable material.—(Centrallblat, Nos. 53 and 54, November 1874.)

By dialysis of a putrid decoction of flesh, it is possible to obtain a liquid containing bacteria only. The effect of reagents in these bodies is as follows:—

Strong sulphuric acid, strong hydrochloric acid, alcohol, ether, and chloride of ammonium, dissolve them. Creosote makes them clearer, and the vacuole is then well seen. Iodine colours them brown, carmine red.—(Oscar Grimm, Archiv für Mikroscop. Anatomie.)

Bacteroid: Origin of Disease—Many *savants*, both at home and abroad, contend that infectious diseases depend upon bacteria in the blood.

In cholera, Drs. Lewis and Cunningham found no fungi or bacteria in the fresh blood.

Professors Core and Feltz of Strasbourg (Recherches sur les Maladies Infectiennes, 1872) found a linked bacterium in septicæmia, typhoid, and puerperal fevers, which they have named *bacterium catenula*.

In variolous blood, both human and in that of the sheep, Keber, Hallier, and Zurn describe bacteria, according to Cohn, belonging to the globular or sphere bacteria.

Core and Feltz have also found bacteria in the blood of scarlet fever. This blood injected into the circulation of rabbits induced a fatal feverish disease. In the rabbits the bacteria greatly increased in size.

In measles bacteria were also found; and in the splenic apoplexy of sheep and cattle.

Winge and Heiberg of Christiania describe growths on the valves of the heart, which were called by the former *mycosis endocardii.* Virchow, who examined a sample, considered the granules found on these growths as not fungoid, but vibrional.

In diptheritical exudation in the kidney and womb, and in rheumatic fever, bacteria have been discovered. There cannot be the slightest doubt, then, that bacteria are found in the blood in many feverish disorders. That they have any significance is open to the gravest doubt.

Bakehouse—For the purposes of the Bakehouse Regulation Act, the word is defined to mean "any place in which are baked bread, biscuits, or confectionery, from the baking or selling of which a profit is derived."

The Bakehouse Regulation Act of 1863 (26 & 27 Vict. c. 40) limits the hours of labour of young persons employed in bakehouses, and makes regulations with respect to cleanliness.

No person under the age of eighteen is to be employed between nine P.M. and five A.M. Penalty on conviction, for first offence, £2, or less; for second offence, £5, or less; for third and subsequent offences, £1 a day for each continuance of the offence, up to £10.

In places containing over five thousand inhabitants, the Act enacts certain regulations with regard to painting or lime-washing the inside walls; but a bakehouse, *wherever* situated, must be kept in a cleanly state, efficiently ventilated, and free from effluvia arising from drains, privies, and other nuisances. Penalty for neglect, £5, or less (26 & 27 Vict. c. 40, s. 4).

Section 5 enacts, that in places over five thousand, no place forming part of the bakehouse building, and in the same level as the bakehouse, shall be occupied as a sleeping-place, unless (*a*) it is effectually partitioned off from the bakehouse by a partition from floor to ceiling, and (*b*) is provided with an external glazed window of at least *nine* superficial feet, the half of which, at least, can be opened. Penalty for letting, occupying, or knowingly suffering to be occupied, any place in contravention to the Act, £1, or less, and for each subsequent offence £5, or less.

By section 6, any officer of the sanitary authority may enter and inspect a bakehouse during the hours of baking. Penalty for obstruction, £20, or less.

Baking Powders are for the most part mixtures of tartaric acid and carbonate of soda, with a little farinaceous matter, the common proportions being 1 part of tartaric acid, 1½ of carbonate of soda, and 4 of potato flour or other dry starch, with a little turmeric powder to impart a rich yellow tint. When these are mixed with flour and wetted, they effervesce as in the case of the common seidlitz powder, and so diffuse carbonic acid through the dough. Mr. M'Dougall has recently proposed the use of phosphoric acid as being a more natural constituent of the food than the preceding, and this with an alkaline carbonate forms the mixture known as phosphatic yeast. Other preparations for the same purpose consist of bisulphate of potash, or alum and carbonate of soda. *See* BREAD.

Banana (natural order *Musaceæ*)—The banana contains about 27 per cent. of solid matter, and has nearly the same nutritive value as rice. It is largely used in the tropics, and 6½ lbs. of the fresh fruit, or 2 lbs. of the dry meal, with a quarter of a pound of salt meat or fish, is a common allowance for a labourer.

Composition of the Pulp of Ripe Bananas (CORENIDINDER).

Nitrogenous matter	4·820
Sugar, pectose, organic acid, and traces of starch	19·657
Fatty matter	0·632
Cellulose	0·200
Saline matter	0·791
Water	73·900
	100·000

Bannocks—Thick cakes made from the coarser kinds of OATMEAL, which see.

Barley—Barley belongs to the class *Endogens* or *Monocotyledons;* Glumel alliance of Lindley; natural order *Graminaceæ.* There are four sorts of barley cultivated in this country:—

(1.) *Hordeum hexastichon*—Six-rowed barley.

(2.) *Hordeum vulgare*—The Scotch bere or bigg; the four-rowed barley.

(3.) *Hordeum zeocriton*—Putney, fan, sprat, or battledore barley.

(4.) *Hordeum distichon*—Two-rowed or long-eared barley.

Barley and oats are the cereals which are cultivated farthest north in Europe.

From an examination instituted by the Royal Agricultural Society of England, and carried out under the directions of Messrs. Way and Ogston, the following results have been arrived at:—

Kind of Barley employed.	Moisture in 100 parts of Grain.	Specific Gravity of Grain.	Ash in 100 parts of Dried Grain.
Unknown	12·00	...	2·43
Chevalier barley	10·00	1·260	2·50
Ditto	16·00	1·234	2·82
Ditto from Moldavia	11·00	1·268	2·38
Ditto, ditto	16·00	...	2·75
Grains of Chevalier barley	15·00	...	14·23

The analysis of several varieties gave as the composition of the ashes of the grains of barley:—

	Unknown.	Chevalier Barley.	From Moldavia.	Chevalier Barley.
Potash	21·14	20·77	37·55	7·70
Soda	...	4·59	1·06	0·36
Lime	1·65	1·48	1·21	10·36
Magnesia	7·26	7·45	10·17	1·26
Sesquioxide iron	2·13	0·51	1·02	1·46
Sulphuric acid	1·91	0·79	0·27	2·99
Silica	30·68	32·73	24·56	70·77
Phosphoric acid	28·53	31·69	38·64	1·99
Chloride sodium	1·10	...	1·47	1·10

As an article of diet it is said by Percira to be rather laxative, and Dr. Parkes has noticed its unsuitability in dysenteric cases. It has the same advantages and disadvantages as WHEAT (which see); it contains rather more protein bodies than wheat, and these consist of gluten-casein, gluten-fibrin, mucedin, and albumen; therefore we cannot doubt that it is very nutritious. The Greeks trained their athletes on it; according to M'Culloch it was the usual food of the common sort of people at the time of Charles I. (1626), and even as late as the last century, in the northern counties of England, scarcely any wheat was used. The grain is generally ground whole, and the farina greatly resembles wheaten flour, but the amount of gluten is very different; in fact, the nitrogenous matter, which amounts to about 6 per cent., is chiefly in the form of albumen; hence the bread is heavy and compact, for albumen will not vesiculate or sponge like gluten. It may, to make it into bread, be mixed with an equal proportion of wheaten flour; sometimes it is used by mixing it with oatmeal and ryemeal, and baked into cakes. It can also be made in the form of a thick gruel or "stirabout" by stirring the meal into boiling water, this latter is the best method of preparing it for food.

Pearl-barley and Scotch barley are the grains deprived of their husks and rounded by attrition; the former is more carefully prepared than the latter, but both are used to give consistence to broth.

The following tables show the composition of barley and barley-meal. Its nutritive value is less than that of wheat, but since it is cheaper it is more economical to use it:—

Composition of Dried Barley (PAYEN).

Nitrogenous matter	12·96
Starch	66·43
Dextrine	10·00
Fatty matter	2·76
Cellulose	4·75
Mineral matter	3.10
	100·00

Composition of Barley-Meal (LETHEBY).

Nitrogenous matter	6·3
Carbohydrates	74·3
Fatty matter	2·4
Saline matter	2·0
Water	15·0
	100·0

In examining barley-grains, the same points are to be attended to as in the examination of wheat.

Barley is not greatly adulterated, and the best tests of its purity are its physical signs, colour, freedom from dust, grit, and insects, and *cooking*. The powdered barley should be examined with the microscope, to see if any kind of cheaper grain has been mixed with it. The diseases which arise from the altered quality of barley resemble those of wheat—viz., indigestion, flatulence, and diarrhœa.

Barley is said to be extensively used for the purpose of adulterating wheat, annatto, and roll liquorice.

BARLEY

[illegible]th INCH

Fig. 5.

Barometer (*baros*, weight; *metron*, measure)—The barometer is a scientific instrument which was first invented by Torricelli in 1643, and is used for indicating and measuring variations of pressure of the atmosphere. The barometers, which are constructed of tubes containing mercury or some other liquid, are usually divided into two classes—siphon and cistern barometers. The principle of both these is identical, and may be illustrated by Torricelli's experiment. A glass tube about 33 inches in length, open at one end, is filled with mercury, and then the open end (temporarily closed by the finger) plunged into a bowl containing mercury. The mercury does not all run out of the tube, as an uninstructed person might suppose, but the column falls to about 30 inches above the level of the mercury. The reason of this is, that the air presses upon the mercury in the bowl and supports it. There are, indeed, two columns in equilibrium, the one the visible mercury, the other the invisible air, and any variation in the weight of the column of air is expressed by the rising or falling of the mercurial column. In the aneroid barometer, the weight of the atmosphere is indicated by exhausting a metallic chamber of its air; then the incurving or expanding of the delicate walls, under the varying weight of the atmosphere, is indicated by an index-hand moved by a series of levers.

As the heights of the columns of two fluids in equilibrium are inversely as their specific gravities, it follows that the lighter the liquid filling the barometer tube, the longer that tube must be; and the longer the tube, the more visible will be minute variations. If we use water, as water is 14 times lighter than mercury, we get a column of 35 feet, and it will indicate very minute changes; but there are so many serious objections to all liquids except mercury, that mercury is the only one at all generally employed, mercury requiring a barometer tube of no great length, and the space above it being the most perfect vacuum hitherto obtained; whereas when water or similar fluids are used, an appreciable amount of vapour is contained above the fluid, and presses upon it with a force varying with the temperature—*e.g.*, if the fluid used be water at a temperature of 32° Fahr., the depression of the column would be half an inch, and if raised to 75°, a foot; still, of course, corrections for this depression may be employed.

Great care is required in the construction of mercurial barometers. The purest mercury alone must be employed, and the liquid metal freed from air and moisture by prolonged boiling in the tube itself. Of the two classes of mercurial barometers, siphon and cistern, the latter is certainly the best: its simplest form is the mercury-filled tube, inverted in a reservoir, as already described; but in such a simple form there are two sorts of error, the one arising from capillarity, the other the error from capacity. As mercury is a fluid which does not *wet* the surface of glass, the effect of capillarity is to depress the column, and the smaller the diameter of the tube the greater the depression. If the diameter be $\frac{1}{2}$ of an inch, the capillary error will be only ·003 inch; but if the diameter be $\frac{1}{8}$ inch, the error is ·070 inch: hence, as is remarked farther on, cistern barometers require an *addition* to be made to the observed height. The other error arises in this way:—

The height of the barometer is the distance between the surface of the mercury in the cistern and the upper surface of the mercury in the tube. If the barometer falls from 30 to 29 inches, an inch of mercury must flow *out of the tube and pass into the cistern*, thus raising the level of the cistern. If, on the other hand, it rises from 29 inches to 30 inches, mercury must flow from the cistern into the tube, thus lowering the level of the cistern. Hence, then, owing to the incessant changes in the level of the cistern, the readings on the fixed scale are sometimes too high and sometimes too low. The simplest way of compensating for this error is to ascertain (1) the *neutral point* of the instrument—that is, the height at which it stands when the zero of the scale is on a level with the surface of the mercury in the cistern, or when it agrees with a standard barometer; and (2) the rate of the error as the column rises or falls above this point, and apply a correction proportioned to this rate. This method, however, is both clumsy, and gives rise to frequent mistakes. The error is less the more the area of the surface of the cistern exceeds that of the column in the tube, because the mercury which flows into and out of the cistern is spread over a larger surface. For this reason the cisterns of barometers should be made as large as possible.—(BUCHAN.)

There are many varieties of mercurial barometers; but the best is the one invented by Fortin, or one based upon similar principles. In this barometer the cistern is contained in a brass box, has its walls of boxwood and its bottom of leather. A brass screw presses against the leather, and by its aid the level of the mercury may be raised or depressed, to adjust it, so that the level of the mercury in the cistern may be at the zero-point, from which the scale of the instrument is graduated. A float, resting in the mercury, moves between two ivory supports, and there is a horizontal line on the float and the supports. When an observation is to be taken, the brass screw is turned one way or the other until the line on the float is in the same straight line with that in the supports, in this way "the error of capacity" is got rid of.

The mercury tube itself is enclosed in one of brass having two opposite slits and a sliding vernier.

The siphon barometer is made of a tube bent in the form of a siphon, and having a graduated scale along the whole length of the tube. An observation is taken by carefully noting the difference in length of the two columns.

The wheel barometer is a modification of the siphon; it is not suitable for scientific purposes.

The Fitzroy barometer is a very cheap instrument; it is on the siphon principle, but the lower limit is blown into a bulb, and thus forms a cistern.

The aneroid barometer, already explained, when of the *very best* construction, gives very reliable indications, and is specially useful to the health officer if he desire to measure heights.

Management of the Barometer.—The instrument should be hung perfectly perpendicular by means of a plummet-line; it should be in a good light, but protected from direct sunlight or rain; the mercury must then be lowered by means of the screw, *before unfastening the float*, for carelessness in this respect may lead to some spirting and loss of mercury. If air by accident should get in a common cistern barometer, it may be got rid of by first fixing the ivory piston, so as to prevent the escape of the mercury, then by means of the screw raising the mercurial column nearly to the top of the tube, by slowly inverting the instrument and tapping the cistern gently, the air may be induced to ascend to the cistern, and thence escape. In transporting a barometer from place to place it is safest to carry it by hand; and, if packed, it is almost unnecessary to remark that the float must be firmly fixed and the mercurial column raised by means of the screw, so as to prevent any escape of the liquid.

How to read the Barometer.—First, the mercury in the cistern must be brought by means of the screw to the zero-point, and then the vernier screwed up, so that its horizontal edge forms *a tangent to the mercurial curve.* The *vernier* (named after its inventor) is an instrument used for reading off the graduated scale of the barometer true to the 100th or $\frac{1}{500}$th of an inch.

It consists (figs. 9 and 10) of a piece similar to the scale of the barometer along which it slides. It will be observed from fig. 9 that ten divisions of the vernier are exactly equal to eleven divisions of the scale—that is, to eleven-tenths of an inch. Hence each division of the vernier is equal to a tenth of an inch, together with a tenth of a tenth or a hundredth, or to ten-hundredths and one-hundredth—that is, to eleven-hundredths of an inch. Similarly two divisions of the vernier are equal to twenty-two hundredths of an inch, which expressed as a decimal fraction is 0·22 inch; three divisions of the vernier is 0·33 inch, &c. Suppose the vernier set as previously described—that is, having the zero line of the vernier a tangent to the convex curve of the mercury in the column. If the vernier and scale occupy the relative positions as in fig. 9, then the height of the barometer is 30·00 inches; but if they stand as in fig. 10, we set about reading it in this way: (1.) The zero of the vernier being between 29 and 30, the reading is more than 29 inches but less than 30 inches, and we obtain the first figure, 29 inches. (2.) Counting the tenths of an inch from 29 upward, we find that the vernier indicates more than 7-tenths and less than 8-tenths, giving the second figure, 7-tenths, or 0·7 inch. (3.) Casting the eye down the scale to see the point at which a division of the scale and a division of the vernier lie in one and the same straight line, we observe this to take place at figure 6 of the vernier, this gives the last figure, 9-hundredths, or 0·09 inch. And placing all these figures in one line, we find that the height of the barometer is 29·79 inches. This sort of vernier gives readings true to the hundredth of an inch. If the inch be divided into half-tenths or twentieths, and 25 divisions of the vernier

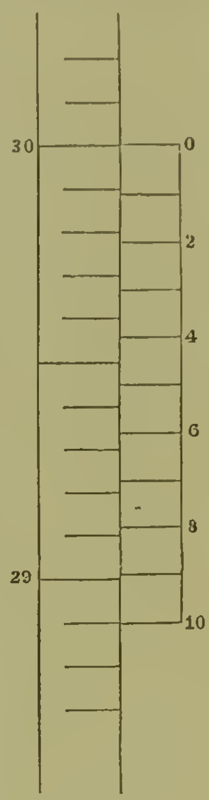


Fig. 9.

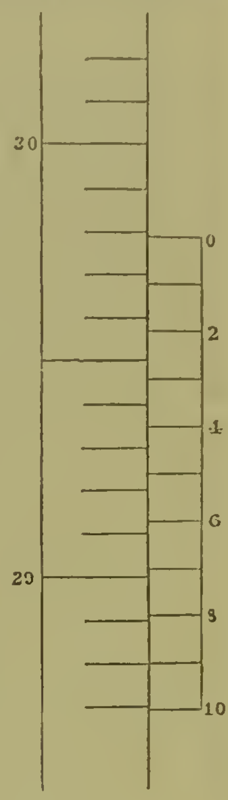


Fig. 10.

equal 24 divisions of the scale, it follows that the difference of these divisions is two-thousandths of an inch.

A still more divided vernier is always used with the best barometers, and, though a little troublesome to read at first, yet if the method of reading the simpler one just described be understood, the difficulty will be easily overcome.—(BUCHAN.)

Corrections for Temperature, Capillarity, &c.—There are two constant corrections for all barometers—viz., capillary and index error. The index error is given by the maker, who obtains it by comparison with standard instruments. The capillarity of the instrument is also notified by the maker; the latter is always additive, and depends upon the diameter of the tube and whether the mercury has been boiled or not.

Diameter of Tube.	Numbers to be added for Capillarity if the Mercury has been boiled.
0·1 inch.	·070 inches.
0·2 ,,	·029 ,,
0·3 ,,	·014 ,,
0·4 ,,	·007 ,,
0·5 ,,	·003 ,,
0·6 ,,	·002 ,,

Correction for Temperature.—The barometer is always registered as if the temperature of the mercury were 32° Fahr. If the temperature of the mercury be above this, the metal expands, and reads higher than it would do at 32°. The amount of expansion of mercury is ·0001001 of its bulk for each degree; but the linear expansion of the brass scale must also be considered. Schumacher's formula is used for the correction, viz.—

h=observed height of barometer in inches.
t=temperature of attached thermometer (Fahr.)
m=expansion of mercury per degree, viz., ·0001001.
l=linear expansion of scale, viz., ·000104344; normal temperature being 62°.

$$h + \frac{m\,(t-32°) - l\,(t-62°)}{1+m\,(t-32)}$$

Sir H. James' work, which is distributed to army medical officers, contains tables which greatly facilitate the correction for temperature. The one which we give here will doubtless be found of use.

Correction for Sea-Level.—As the mercury falls about $\frac{1}{1000}$ (·001 inch) for every foot of ascent, this amount multiplied by the number of feet must be added to the height, if the place be above sea-level. The temperature of the air has also to be taken into account if great accuracy is required.

TABLE I.—For Reduction of Barometer to Freezing-Point.

The number opposite the temperature of attached thermometer is to be deducted.

Fahr. Deg.	Correction for Barometer at			
	27 Inches.	28 Inches.	29 Inches.	30 Inches.
32	·0086	·0088	·0091	·0094
34	·0134	·0138	·0143	·0148
36	·0183	·0188	·0194	·0201
38	·0231	·0238	·0246	·0255
40	·0279	·0288	·0298	·0309
42	·0327	·0338	·0350	·0362
44	·0375	·0388	·0402	·0416
46	·0423	·0438	·0454	·0470
48	·0471	·0488	·0506	·0523
50	·0519	·0538	·0558	·0577
52	·0568	·0588	·0609	·0630
54	·0616	·0638	·0661	·0684
56	·0664	·0688	·0713	·0738
58	·0712	·0738	·0765	·0791
60	·0760	·0788	·0817	·0845
62	·0809	·0838	·0868	·0898
64	·0857	·0888	·0920	·0951
66	·0906	·0938	·0971	·1005
68	·0954	·0988	·1023	·1058
70	·1000	·1037	·1075	·1112
72	·1049	·1087	·1126	·1165
74	·1097	·1137	·1178	·1218
76	·1146	·1187	·1229	·1272
78	·1194	·1237	·1281	·1325
80	·1241	·1286	·1332	·1378
82	·1289	·1336	·1384	·1432
84	·1338	·1386	·1435	·1485
86	·1385	·1435	·1486	·1538
88	·1433	·1485	·1538	·1591
90	·1482	·1535	·1589	·1644

Measurement of Heights.—When heights are ascended a certain amount of air is left below, so the barometer falls. The diminution is not uniform, for the higher the ascent the less weighty the air; and a greater and greater height must be ascended to depress the barometer one inch. This is illustrated by the following table (the height can be readily taken from this table by calculating the number of feet which must have been ascended to cause the observed fall, and then making a correction for temperature by multiplying the number obtained from the table, which may be called A, by the formula—t is the temperature of the lower and t' of the upper station)—

$$1 + \frac{t + t' - 64}{900} + A$$

To lower from	31	in. to	30= 857	ft. must be ascended.
,,	30	,,	29= 886	,,
,,	29	,,	28= 918	,,
,,	28	,,	27= 951	,,
,,	27	,,	26= 986	,,
,,	26	,,	25=1025	,,
,,	25	,,	24=1068	,,
,,	24	,,	23=1113	,,
,,	23	,,	22=1161	,,
,,	22	,,	21=1216	,,
,,	21	,,	20=1276	,,
,,	20	,,	19=1341	,,
,,	19	,,	18=1413	,,

The measurements of heights in this way is of great uso to medical officers ; the aneroid barometer can be used as high as 5000 feet, and a delicate instrument will measure as little as 4 feet. A great many plans aro in use for calculating heights ; it can easily be done by logarithms, but it is not always that it is convenient to obtain a table of logarithms.* Tho simplest rule of all is one derived from Laplace's formula. In the Proceedings of the Royal Society, 1865, No. 75, p. 283, Mr. Ellis has lately stated this formula as follows : Multiply the difference of the barometric readings by 52,400, and divide by the sum of the barometric readings. If the result be 1000, 2000, 3000, 4000, or 5000, add 0, 0, 2, 6, 14 respectively. Subtract $2\frac{1}{3}$ times tho difference of the temperature of the mercury. Multiply the remainder by a number obtained by adding 836 to the sum of the temperatures of the air, and dividing by 900. A correction must also be given for latitude, which can be done by Table IV., p. 80.

Messrs. Negretti and Zambra, in their "Treatise on Meteorological Instruments" (1864), give tables for estimating the approximate height due to barometric pressure, and these are the easiest formula we know of. We give them here. (Tables II., III., IV., and V.) A good mercurial barometer with an attached thermometer, or an aneroid compensated for temperature, and a thermometer to ascertain the temperature of the air, are required. Two barometers and two thermometers, which can be observed at the same moment at the upper and lower stations, are desirable. Supposing, however, there is but one barometer, take the height at tho lower station and correct for temperature to 32°, according to the table for reduction of barometer to freezing-point, p. 77. Take the temperature of the air. Ascend as rapidly as possible to the upper station, and take the height of the barometer (correcting it to 32°) and the temperature of the air ; then use Tables II., III., IV., and V.

* There is, however, a convenient little book by Sang of logarithms to five places, which will go in the waistcoat-pocket.

If the height is less than 300 feet, Tables III., IV., V., need not be used.

TABLE II. is calculated from the formula, height in feet = 60,200 (log. 29·922 − log. B) + 952 ; where 29·922 is the mean atmospheric pressure at 32° Fahr. and the mean sea-level in latitude 45°, and B is any other barometric pressure, the 952 being added to avoid minus signs in the table.

TABLE III. contains the correction necessary for tho mean temperaturo of the stratum of air between the stations of observation, and is computed from Regnault's coefficient for the expansion of air, which is ·002036 of its volume at 32° for each degree above that temperature.

TABLE IV. is the correction due to the difference of gravitation in any other latitude, and is found from the formula $x = 1 + {\cdot}00265$ cos. 2 lat.

TABLE V. is to correct for the diminution of gravity in ascending from the sea-level.

Negretti and Zambra say : "To use these tables, the barometer readings at the upper and lower stations having been corrected and reduced to temperature 32° Fahr., take out from Table I. the numbers opposite the corrected readings of the two barometers, and subtract the lower from the upper. Multiply this difference successively by the factors found in Tables III. and IV. The factor from Table IV. may be neglected unless precision is desired. Finally, add the correction taken from Table V."

In the table the barometer is only read to 10ths, but it should be read to 100ths (·01) and 1000ths (·001), and the number of feet corresponding to these amounts calculated from the tables.*

* *Example.*—On the 21st October 1852, when Mr. Welsh ascended in a balloon at 3h. 30m. P.M., the barometer, corrected and reduced, was 18·85, the air temperature 27° ; while at Greenwich, 159 feet above the sea, the barometer at the same time was 29·97 inches, air temperature 49°, the balloon not being more than five miles S.W. from over Greenwich ; required its elevation.

	Feet.
Barometer in balloon, 18·85, Table II. .	13,007
,, at Greenwich, 29·97, ,, .	883
	12,124
Mean temperature, 38°—Table III. Factor .	1,012
	12,269
Latitude, 51½°—Factor from Table IV. .	99,941
	12,262
Correction from Table V.	38
	12,300
Elevation of Greenwich	159
,, balloon	12,459

TABLE II.—APPROXIMATE HEIGHT DUE TO BAROMETRIC PRESSURE.

Inches of Barometer.	Feet.	Inches of Barometer.	Feet.	Inches of Barometer.	Feet.
31·0	0	27·3	3,323	23·6	7,131
30·9	84	27·2	3,419	23·5	7,242
30·8	169	27·1	3,515	23·4	7,353
30·7	254	27·0	3,612	23·3	7,465
30·6	339	26·9	3,709	23·2	7,577
30·5	425	26·8	3,806	23·1	7,690
30·4	511	26·7	3,904	23·0	7,803
30·3	597	26·6	4,002	22·9	7,917
30·2	683	26·5	4,100	22·8	8,032
30·1	770	26·4	4,199	22·7	8,147
30·0	857	26·3	4,298	22·6	8,262
29·9	944	26·2	4,398	22·5	8,378
29·8	1,032	26·1	4,498	22·4	8,495
29·7	1,120	26·0	4,588	22·3	8,612
29·6	1,208	25·9	4,699	22·2	8,729
29·5	1,296	25·8	4,800	22·1	8,847
29·4	1,385	25·7	4,902	22·0	8,966
29·3	1,474	25·6	5,004	21·9	9,085
29·2	1,563	25·5	5,106	21·8	9,205
29·1	1,653	25·4	5,209	21·7	9,325
29·0	1,743	25·3	5,312	21·6	9,446
28·9	1,833	25·2	5,415	21·5	9,567
28·8	1,924	25·1	5,519	21·4	9,689
28·7	2,015	25·0	5,623	21·3	9,811
28·6	2,106	24·9	5,728	21·2	9,934
28·5	2,198	24·8	5,833	21·1	10,058
28·4	2,290	24·7	5,939	21·0	10,182
28·3	2,382	24·6	6,045	20·9	10,307
28·2	2,475	24·5	6,152	20·8	10,432
28·1	2,568	24·4	6,259	20·7	10,558
28·0	2,661	24·3	6,366	20·6	10,684
27·9	2,754	24·2	6,474	20·5	10,812
27·8	2,848	24·1	6,582	20·4	10,940
27·7	2,942	24·0	6,691	20·3	11,069
27·6	3,037	23·9	6,800	20·2	11,198
27·5	3,132	23·8	6,910	20·1	11,328
27·4	3,227	23·7	7,020	20·0	11,458

TABLE III.—Correction due to Mean Temperature of Air:

The temperature of the upper and lower station being added and divided by 2.

Mean Temperature.	Factor.	Mean Temperature.	Factor.	Mean Temperature.	Factor.
10	0·955	35	1·006	60	1·057
11	0·957	36	1·008	61	1·059
12	0·959	37	1·010	62	1·061
13	0·961	38	1·012	63	1·063
14	0·963	39	1·014	64	1·065
15	0·965	40	1·016	65	1·067
16	0·967	41	1·018	66	1·069
17	0·969	42	1·020	67	1·071
18	0·971	43	1·022	68	1·073
19	0·974	44	1·024	69	1·075
20	0·976	45	1·026	70	1·077
21	0·978	46	1·028	71	1·079
22	0·980	47	1·031	72	1·081
23	0·982	48	1·033	73	1·083
24	0·984	49	1·035	74	1·086
25	0·986	50	1·037	75	1·088
26	0·988	51	1·039	76	1·090
27	0·990	52	1·041	77	1·092
28	0·992	53	1·043	78	1·094
29	0·994	54	1·045	79	1·096
30	0·996	55	1·047	80	1·098
31	0·998	56	1·049	81	1·100
32	1·000	57	1·051	82	1·102
33	1·002	58	1·053	83	1·104
34	1·004	59	1·055	84	1·106

TABLE IV.—Correction due to Difference of Gravitation in Different Latitudes.

Latitude.	Factor.	Latitude.	Factor.	Latitude.	Factor.
80	0·99751	50	0·99954	20	1·00203
75	0·99770	45	1·00000	15	1·00230
70	0·99797	40	1·00046	10	1·00249
65	0·99830	35	1·00090	5	1·00261
60	0·99868	30	1·00265	0	1·00265
55	0·99910	25	1·00170		

TABLE V.

Height in 1000 Feet.	Corrective Additive.	Height in 1000 Feet.	Corrective Additive.	Height in 1000 Feet.	Corrective Additive.
1	3	6	17	11	33
2	5	7	20	12	37
3	8	8	23	13	41
4	11	9	26	14	44
5	14	10	30	15	48

TABLE VI.—SHOWING THE WEIGHT IN GRAINS OF A CUBIC FOOT OF DRY AIR under pressure of 30 inches of Mercury for every degree from 0 to 100.

Temp. Fahr.	Weight of Cubic Foot of Dry Air.	Temp. Fahr.	Weight of Cubic Foot of Dry Air.	Temp. Fahr.	Weight of Cubic Foot of Dry Air.	Temp. Fahr.	Weight of Cubic Foot of Dry Air.
	Grains.		Grains.		Grains.		Grains.
0	606·37	26	573·87	51	545·74	76	520·25
1	605·05	27	572·69	52	544·67	77	519·28
2	603·74	28	571·51	53	543·61	78	518·31
3	602·43	29	570·34	54	542·55	79	517·35
4	601·13	30	569·17	55	541·50	80	516·39
5	599·83	31	568·01	56	540·45	81	515·43
6	598·54	32	566·85	57	539·40	82	514·48
7	597·26	33	565·70	58	538·36	83	513·53
8	595·98	34	564·56	59	537·32	84	512·59
9	594·71	35	563·42	60	536·28	85	511·65
10	593·44	36	562·28	61	535·25	86	510·71
11	592·18	37	561·15	62	534·22	87	509·77
12	590·92	38	560·02	63	533·20	88	508·84
13	589·67	39	558·89	64	532·18	89	507·91
14	588·42	40	557·77	65	531·17	90	506·99
15	587·18	41	556·66	66	530·16	91	506·07
16	585·95	42	555·55	67	529·15	92	505·15
17	584·72	43	554·44	68	528·14	93	504·23
18	583·49	44	553·34	69	527·14	94	503·32
19	582·27	45	552·24	70	526·15	95	502·41
20	581·05	46	551·15	71	525·16	96	501·50
21	579·84	47	550·06	72	524·17	97	500·60
22	578·64	48	548·97	73	523·18	98	499·70
23	577·44	49	547·89	74	522·20	99	498·81
24	576·24	50	546·82	75	521·22	100	497·93
25	575·05						

When flying levels are taken across a country, the following formula is sufficiently correct :—

Let the quantities observed be denoted as follows :—

	At the Lower Station.	At the Higher Station.
Height of the mercurial column in the barometer	H	h
Temperature of mercury in degrees Fahr., as shown by attached thermometer	T	t
Temperature of air in degrees of Fahr., as shown by the detached thermometer	T'	t'

Then the height of the higher station above the lower in feet

$$= 60360 \left\{\log. H - \log. h - \cdot000044\,(T - t\right\} - \left(1 + \frac{T' + t' - 64}{986}\right)$$

For rapid calculation, the following, though less exact, is convenient :—

$$\text{Height in feet} = 56300\,(\log. H - \log. h).\left(1 + \frac{T' + t'}{900}\right) \text{ nearly.}$$

In the absence of logarithms, the following formula may be used for heights not exceeding about 3000 feet. Correct the barometric reading at the higher station as follows :—

$$h' = h\left(1 + \frac{T - t}{10000}\right) : \text{ then}$$

$$\text{Height in feet} = 52428\,\frac{H - h'}{H + h'}\left(1 \times \frac{T' + t' - 64}{950}\right)$$ nearly.

Barracks—The parts of a barrack consist of—1. The barrack-room, and non-commissioned officers' (sergeants, &c.) room screened off; 2. quarters of the married privates; 3. quarters of the staff-sergeant and sergeants' mess; 4. quarters of the officers; 5. kitchens; 6. ablution rooms; 7. latrines and urinals; 8. orderly room and guard-room; 9. cells; 10. tailors' shop and armoury commissariat stores, canteen; 11. reading-room (in many barracks), schools, magazine.

The hygiène of barracks is evidently subject to the same principles as habitations (*see* HABITATIONS), yet there are some special points which require notice.

About fifteen years ago the barracks of this country were so ill-constructed, so confined as to cubic space, and therefore so impure as to air, that the mortality from destructive lung diseases and fevers, especially typhoid, was greater than that of almost any civil population of equal age, and excited the attention of the War Office. A committee was therefore appointed in 1855, to report upon the state of the barracks at that date; this led to the organisation of the Barrack Improvement Commission, which in 1861 published a blue book, entering into great detail on the construction, ventilation, and sewerage of new barracks.

These two reports are now bearing fruit. Of late years, both in England and India, no expense has been spared to render the barracks healthier. The Commission found that no regular plan or principle had been followed in the older edifices; they especially condemned building the barracks so as to enclose a square, which certainly very effectively prevents ventilation. They recommended that the barracks should consist of numerous detached buildings arranged in lines — the lines, when possible, running north and south, so that each side has the benefit of the sun. The barrack unit, that is, the barrack-room, is recommended to be narrow, with opposite windows, to have only two rows of beds, and 100 feet of cubic space to each bed.

Many of these recommendations are carried out. In recently-built barracks there is an excellent system of warming and ventilation, an ample water supply, and there are great facilities for personal cleanliness and cooking purposes. The soldier, however, still sleeps and lives in the same room, although in some barracks there are reading-rooms, which take the place of a day-room. Seven per cent. of the soldiers are permitted to marry. They inhabit separate quarters; but to each family one room alone is allotted, which is decidedly contrary to sanitary principles.

The latrines are Jenning's or Macfarlane's patents, placed at some little distance from the barracks, connected with them by a covered way. These latrines are troughs made of metal or earthenware about one-third full of water. Twice a day the trap is lifted and the soil flushed into a tank; the seats and floor are kept scrupulously clean.

In barracks in hot climates the same principles are applicable, namely, narrow buildings with cross ventilation—they are generally recommended to be raised from off the ground, to face the prevailing winds, to be painted either white or a light yellow; and there are frequently required special arrangements for ventilation, such as *Punkahs*, *Thermanditotes*, &c., and sprays of water to cool the air. The importance of frequent ablution in hot climates also necessitates the construction of numerous baths. *See* HABITATIONS, OVERCROWDING, &c.

Baryta, Hydrate of—Hydrate of baryta is prepared by digesting caustic baryta or barium oxide with a little water. It can be obtained crystallised as follows:—

1. From a concentrated solution of either nitrate or chloride of barium, precipitated with a rather strong solution of pure potassa, or of pure soda, perfectly free from carbonic acid.

2. A strong solution of sulphide of barium is boiled with successive portions of black oxide of copper, until it ceases to give a black precipitate with a salt of lead; the liquid after filtration yields crystals of the hydrate on cooling.

Its principal use to the medical officer of health is in the estimation of carbonic acid in air, as it is one of the most sensitive tests for that substance, the least trace of carbonic acid being absorbed by it, and forming the white insoluble carbonate of baryta. Two kinds of baryta-water are generally used in Pettenkofer's process: one containing 21 grms. the other 7 to the litre. 1 c.c. of the weaker one corresponds to one milligramme of carbonic acid. 1 c.c. of the stronger = 3 mgrm. of carbonic acid. *See* AIR, ANALYSIS OF.

Baryta-Water—Baryta-water is a solution of hydrate of baryta in water.

Bastards—A product of the manufacture of loaf-sugar. *See* SUGAR.

Batata (*Convolvulus batatas*), or **Sweet Potato**—The batata was introduced here by Sir Francis Drake and Sir John Hawkins, and a good crop was grown at Formby in Lancashire. Batatas are used largely in Central America, but they do not bear the cold of our winter; and hence to successfully cultivate them in England appears impossible. The tubers contain about 32 per cent of solid matter; 16 of which is starch, 10 sugar, 1·5 albumen, 1·1 gum, ·3 fat, 2·9 mineral matter. *See* POTATO.

Baths, Bathing—The beneficial effects of the bath, both moral and physical, are too obvious to be enlarged upon. Gibbon says that for centuries Rome needed no physician but the bath; and there is no doubt that the bath is a preventive as well as a remedial agent.

The skin is continually subjected to abrasion, and the processes of reproduction and decay; hence the cuticle is being constantly thrown off as effete and useless matter in the shape of very minute scales or dust, and this becoming mixed with the oily and saline matters of the skin, is sufficiently adhesive to attach itself to the surface of the body and clothing, and to attract waste particles of the dress, and dust and soot floating in the atmosphere. Unless the skin, therefore, be frequently washed, the channels of perspiration become choked, and the clothing unfit to be worn. The result of the pores of the skin being thus obstructed is impeded transpiration, by which its functions as a respiratory organ are suspended. This adhering pellicle of refuse matter forms a favourable medium for the absorption and transmutation into the body of effluvia, miasmata, poisonous gases, and the infectious and contagious matters of disease.

Should the skin long continue dirty, the blood is deprived of one of its sources of oxygen, and one of its outlets of carbon, and matters which should be thrown out by the skin are retained in the system, and serious effects may ensue; besides this, bathing promotes personal comfort and personal beauty.

The ranges of the temperature of water appropriate to the respective baths, according to the common nomenclature, are shown in the following table :—

	Temp. Fahr.		
Cold bath . . .	33°	to	75°
Temperate bath . .	75°	,,	82°
Tepid bath . . .	82°	,,	90°
Warm bath . . .	90°	,,	98°
Hot bath . . .	98°	,,	112°

Cold-bathing in this country is only suited to the healthy and vigorous, and can only be safely practised in the warmer months of the year, and in a mass of water sufficient to permit of the heat of the body being maintained by swimming or other active exercise. The cold bath, medically considered, is tonic, stimulant, and restorative when judiciously taken, and when not too long continued or too often repeated. When beneficial, the patient feels a pleasant glow on the surface of the body immediately following it: if a sensation of coldness or shivering ensues, it acts injuriously and should not be repeated. If the bather remains too long in the water, it has a sedative effect. The sedative effect of sea and mineral waters is much less than that of pure water, or of spring or river water. Dr. George Johnson, in a paper read before the Clinical Society of London in November 1873, drew attention to the curious fact that many persons after remaining in the water from fifteen to thirty minutes are subject to temporary attacks of albuminuria. It is the opinion of this gentleman that the presence of albuminuria in these cases was directly due to suppressed action of the skin.

The water should be soft and pure, and good soap sparingly but regularly employed whenever the skin requires it.

Workers in particular trades find the frequent use of the bath absolutely essential to health. The following workmen especially are compelled frequently to bathe—workers in lead, hatters, starchers, makers of blankets, tanners, leather dressers, dyers, and quicksilverers.

Paris appears to be much better off for bathing accommodation than London, for we find that in 1852 there were 5958 bathing places in that city. M. Chevallier has proposed that the steam escaping from engines in large manufactories, should be utilised for warming the water of baths; by adopting this process a considerable saving would be effected in fuel, &c. That this idea is not impracticable is proved by the fact that this course has been adopted at more than one manufactory in France for the use of the men engaged, and with the most successful and beneficial results.

It has been often observed, and with truth, that one particular in which the therapeutic machinery of our English hospitals falls lamentably short of that of Continental hospitals, is in the matter of baths. The first step to remedy this was taken by the University College Hospital in 1873, the authorities of which erected, at a cost of £1800, baths available for a variety of not only skin complaints, but other diseases, such as rheumatism, paralysis, neuralgia, syphilis, sciatica, and many others.

Baths, Mud (*illutation*), were common among the ancients, the mud on the seashore and the slime of rivers being especially prized for this purpose. The Tartars and Egyptians still use them in certain diseases, and they are largely taken at Driburg, Memberg, Eilson, Neundorf, Pyrmont, and Spa. The chief varieties of mud-baths appear to be—

1. Mud or slime deposited from mineral waters, used either for complete immersion or for poultices, as at Acqui and St. Amand.
2. Simple peat earth or other earths.
3. Peat earth impregnated with mineral water.

Mud-baths appear to act as a strong stimulant to the skin, partly from their heat and partly from the increased pressure and friction. After being used a few times they sometimes bring out rashes, and are believed to excite anew old inflammations. They not unfrequently induce a feeling of weariness, and distaste for food. In general torpor and atony of the system, in paralysis, neuralgia, and in old affections of the joints, they are said to have been useful.

Baths, Salt (*Salz Bäder*)—Sea-bathing is extremely popular in England, but neither the strong salt-baths of Droitwich nor the weaker ones of Woodhall Spa, Ashby-de-la-Zouch, and a few others, are as well known as they deserve to be. There can be little doubt of the stimulating action of saline solutions on the skin and whole system. Sea-bathing is rarely pursued systematically except in the summer months, and artificial salt-baths may be said to be unknown amongst the poorer classes. Physicians, moreover, when ordering salt-baths, seldom specify the strength.

The Atlantic Ocean contains from three to four per cent. of saline matters, hence the ordinary quantity of two to six pounds of salt for an adult bath, containing perhaps sixty gallons, is absurd. Artificial baths, to be of any use whatever, will require to be made the strength of sea-water, twice its strength, or three times its strength, according to circumstances. In Germany the Stassfurt salt has been lately much commended; its average composition is as follows:—

	Per cent.
Chloride of potassium	16·8
,, magnesium	26·5
,, sodium	13·6
Sulphate of magnesium	11·6
Water, &c.	31·6
	100·00

Its great advantage is its cheapness—one pound in Germany only costs two pfennings (one-fifth of a penny). If sea-water is desired to be imitated, a mixture of salts, such as Tidman's sea-salt, is easily purchased, which, if added in proper quantity to water, really makes a bath possessing most of the properties of sea-water. By a careful study of the composition of various natural saline baths given in article WATER, these waters may be more or less successfully imitated and used.

There are a variety of medicated baths, a description of which belongs more properly to a treatise on medicine.

The first bath opened in England for the purpose of hot-bathing is said to have been in Bagnio Court, now Bath Street, Newgate Street; this was established in 1679. Peerless Pool (Perilous Pool), mentioned by Stow (1600), was enclosed as a bathing-place in 1743. The first public baths and wash-houses opened in London were established by Mr Bowrie in the neighbourhood of the London Docks in 1844; and in the same year, through the instrumentality of Catherine Wilkinson, who in 1832 began to lend her room and appliances for poor people for washing, public baths and wash-houses were founded in Liverpool. An Act was passed in 1846 to encourage the establishment of public baths and wash-houses "for the health, comfort, and welfare of the inhabitants of populous towns and districts in England and Ireland." Since then, public baths and wash-houses have been established in every district in London, and in most of our large towns.

Any local authority may, if they think fit, supply water from any waterworks, purchased or conducted by them, to any public baths or wash-houses, on terms to be agreed upon by the local authority and the persons desirous of being supplied. A local authority may also construct works for the gratuitous supply of any public baths established otherwise than for private profit, or supported out of any poor or borough rate.—(P. H., s. 65.)

The Baths and Wash-houses Acts (9 & 10 Vict. c. 74, 10 & 11 Vict. c. 61) may be adopted by *urban* sanitary authorities; they encourage and give facilities for the establishment of baths and wash-houses. An *urban* sanitary authority, having any seashore or river strand within its district, may make bylaws with regard to the use of bathing-machines, the establishment of bathing-places, indecent exposure, the distances at which boats let to hire shall be kept from persons bathing, &c., &c.—(P. H., s. 171; 10 & 11 Vict. c. 89, s. 69.)

It is unlawful for men to bathe near a public footway frequented by women, unless the men are hidden from view by a screen or covering; and if they expose themselves in this manner, they are liable to an indictment for indecency, notwithstanding that at that particular place people have long been accustomed to bathe. It is also indictable for a man to undress himself on the sea-beach and bathe in the sea, in a place where he can be distinctly seen from inhabited houses, although such houses may have been recently erected, and although it may have been customary for men to bathe there (Glen). Bathing is prohibited in streams, reservoirs, conduits, aqueducts, or other waterworks belonging to or under the control of a sanitary authority. Penalty £5 or less.

Beans—The different species of edible beans, speaking generally, are characterised by containing a considerable amount of nitrogenous substances, hence their dietetic value. The nitrogenous substance in ordinary beans is called legumin or vegetable casein. It exists in combination with sulphur and phosphorus. Beans contain more salts than the cerealia, especially those of potash and lime.

The following table shows the Composition of the Kidney and the Broad Bean :—

	Phaseolus Vulgaris—Kidney-Bean.	Vicia Faba—Common or Broad Bean.
Water	16·	12·8
Legumin, albumen, and gluten - like substances	22 5	22·
Cellulose	4 4	5·
Starch, dextrine, and sugar	49 9	52 6
Fat	2·0	1·6
Chlorophyll	—	—
Salts	2 4	2·5
Potash	·48	·62
Soda	·24	·34
Lime	·23	·15
Magnesia	·18	·2
Iron	·001	·03
Phosphoric acid	·64	·9
Sulphuric acid	·07	·08
Chloride of potash	—	—
,, sodium	—	—
Chlorine	·025	·06

The results of an Analysis of Indian Beans is thus given by Forbes Watson :—

	Soja Hispida (a bean)—Bhoot of India.	Dolichos (a bean)—Wall or Ghot Wall, or Cooltree, of India.	Ervum Lens, a lentil, called Dholl, like the Cajanus or Mussoor, in Hindustani.*
Water	10·25	12 03	11·84
Nitrogenous substances	38·83	23·27	25·15
Fat	10 51	2·20	1 26
Starch	26·65	59 38	59·85
Mineral matters	4·14	3·19	1·92

Beans are not very digestible, about 6·5 per cent. passing away unaltered ; and on an examination of the fæces, starch cells, giving a blue reaction with iodine, may be found ; besides this, a great deal of flatulence is said to be produced by the sulphuretted hydrogen formed from the legumin. In preparing beans for the table, they should be boiled slowly, and for a long time. Old beans, no matter how long boiled, will not soften ; in fact, on prolonged boiling, they become hard. Both men and animals can be nourished upon beans alone for somo time. Added to rice, they form the staple food of large populations. The Hindoo mixes lentils with ghee and rice ; the Arabs eat Egyptian horse-beans, and *frijoles* (a species of black bean) are extensively consumed in Yucatan and Central America.

Bean-flour has been used for the adulteration of wheaten flour ; it can be detected by its microscopic characters. The meshes of cellulose are very much larger than those of the fourth coat of wheat, with which it has sometimes been confounded, and the starch grains are also quite different (fig. 11) ; they aro oval or reniform, or with one end slightly larger ; they have no clear hilum or rings, but many havo a deep central longitudinal cleft running in the longer axio, and occupying two-thirds or three-fourths of the length, but never reaching completely to the end : this cleft is sometimes a line, sometimes a chasm, and occasionally secondary clefts abut upon it at parts of its course ; sometimes instead of a cleft there is an irregular-shaped depression. If a little liquor potassæ be added, the cellulose is seen more clearly. If tho flour be added to a little boiling water, the smell of bean becomes apparent. *See* Flour.

Fig. 11.

Bedding, Purification of—Bedding cannot be properly disinfected unless taken to pieces and subjected to dry heat, which can only be done in large ovens or disinfecting chambers.

Any local authority may provide a proper place and necessary appliances for the disinfection of bedding.—(P. H., s. 122.)

Any local authority may direct the detention of bedding, clothing, &c., which have been exposed to infection, and *may* givo compensation for the same.—(Ib., s. 121.)

Any person giving, lending, selling, transmitting, or exposing bedding, clothing, rags, &c., which have been exposed to infection, is liablo to a penalty not exceeding £5.

Bedrooms—*See* Disinfectants, Habitations, Ventilation, &c.

Beef—*See* Food, Meat, Training.

Beer—Beer is an artificial compound, the chief constituents being a fermented saccharine solution plus a wholesome bitter. It is

* This is not liked much by the Hindoos, on account of its blood-red colour.

usually defined as a fermented infusion of malt flavoured with hops, but this is quite erroneous, sugar largely taking the place of malt, other vegetable bitters the place of hops.

Before the introduction of hops from the Netherlands, beer was always bittered by camomile, horehound, &c., and directly the hop was imported, there was so loud an outcry against its use, that its employment in beer was forbidden by Act of Parliament. A few years afterwards, however, the hop was not alone recognised, but its use was legalised to the exclusion of all other bitters. This step must be regarded as a fiscal one, rendering the collection of the duty easier. In 1862 the hop-duty was repealed, the consequence being a return on the part of the trade to bitters, which are cheaper than the hop.

The bitters actually used, either in substitution of hops, or more frequently as an addition, are camomile, calumba, chirata, gentian, horehound, wormwood, quassia, and simaruba; now all these are recognised tonics, and there can be no valid objection against their use. We cannot see that hop is superior to any of them. The bittering of beer, indeed, is entirely a question between the brewer and the palate of his customers; always so long as nothing injurious or poisonous is introduced.

Besides malt, sugar, hops, and bitters, the brewers use various chemicals, which assist in the preservation of beer; such as, for example, Bean's brewing material, patented; bisulphate of lime; finings, &c.

There are many varieties of ales and beer; the following are a few of the most important:—

Pale ale.—Manufactured from the finest and lightest dried malt and the choicest hops, the latter in excess.

Mild ale differs from pale ale in being sweeter, stronger, and almost free from the flavour of the hop.

Bitter ale or *bitter beer* has, as a rule, less body than pale ale, and is more highly bittered.

Table beer is a weak liquor, commonly containing three or four times the proportion of water usually present in ordinary beer and ale.

Porter.—The beer or porter of the metropolitan brewers is essentially a weak mild ale, coloured and flavoured with roasted malt. Its richness in sugar and alcohol, on which its stimulating and nutritive properties depend, is hence less than that of an uncoloured mild ale brewed from a like original quantity of malt. In point of strength, it would seem to stand about midway between light and strong ales, although frequently brewed of a strength very slightly above that of table ale.

Stout is a richer and stronger description of porter, and may be said to have nearly the same relation to the higher qualities of mild ale that porter holds with regard to pale ale or bitter beer.

The average specific gravity of English beers and porters is from 1010 to 1014. The percentage of malt extract (dextrine, cellulose, sugar) is least in bitter and highest in the sweet ales; it varies from 4 to 15 per cent. in ale, and 4 to 9 per cent. in porter. The hop extract (lupulin and resin) is in much smaller amount. The alcohol varies from 1 to 10 per cent. in volume. The free acidity which arises from lactic, acetic, gallic, and malic acids ranges (if reckoned as dry acetic acid) from 15 to 40 grains per pint. The sugar has a great tendency to form glucinic acid ($C_8H_6O_6$). The albuminous matter in most beers does not average more than ·5 per cent. The salts, which consist of alkaline chlorides and phosphates, and some earthy phosphates, average ·1 to ·2 per cent. Ammoniacal salt is found in small quantities. Caramel and assamar are found in the dark beers or porters. Carbonic acid is always more or less present, the average is ·1 to ·2 parts by weight per cent., or about 1¾ cubic inch per ounce. Volatile and essential oils are also present.

Adopting mean numbers, 1 pint (20 ounces) of beer will contain—

Alcohol . .	1 ounce.
Extractives, dextrine, sugar . .	1·2 „ (534 grains).
Free acid . .	25 grains.
Salts . . .	13 grains.

(PARKES.)

Bass's bottled bitter ale contains in 100 cubic centimetres—

5·3 grms. of alcohol.
5·52 grms. of organic residue.
0·36 grms. of ash.

A sample of draught ale, costing 2d. per pint in London, contained in 100 cubic centimetres—

4·7 grms. of alcohol.
5·8 grms. of organic residue.
0·32 grms. of ash.

A sample of London porter, in 100 cubic centimetres—

3·3 grms. of alcohol.
4·45 grms. of organic residue.
0·30 grms. of ash.

(WANKLYN.)

Nutritive Value.—Although beer has a higher nutritive value than similar alcoholic drinks, yet its power as a food must be extremely small. Its effects are those of alcohol (*see* ALCOHOLISM) modified by the associated saccharine, extractive, and saline matters. It would seem that it exercises a continual, though slight, interference with elimination, the urea and pulmonary carbonic acid are both decreased, which explains its effects on the gouty and rheumatic, as well as its tendency to fatten. Hogarth, in his illustrations of the drunkards of "Beer Alley" and "Gin Lane," has made a striking difference between the plump condition of the one and the emaciated aspect of the other.

Ranke (Phys. des Menschen, 1868, p. 139) has ascribed the peculiar exhausting or depressing action of beer taken in excess to the large amount of potash salts, but probably the other constituents (especially the hop), are also concerned. Some members of the faculty conceive that porter is better suited to persons with delicate stomachs and digestion than ale.

The characteristics of good beer are transparency, a fine colour, an agreeable semi-vinous flavour, and the property of remaining for several hours exposed in a glass or cup without becoming flat or insipid.

Adulterations.—In the Licensing Act (1872), clause 19 contains penalties for using any deleterious substance for mixing with liquors sold by persons having licenses under the Act; and in the first schedule to the Act is a list of deleterious ingredients—viz., "cocculus indicus, chloride of sodium, copperas, opium, Indian hemp, strychnine, tobacco, darnel seed, extract of logwood, salts of zinc or lead, alum, and any other extract or compound of any of the above ingredients." A vast variety of substances are said to be common adulterants of beer. Foots, finings, salt, copperas, alum, grains of paradise, picric acid, &c.; but many of these have been rarely found by analysis. The only common adulterants actually demonstrated being salt, alum, and copperas.*

Analysis of Beer.—The following is the best process to detect the adulterations, and to estimate the quality of ale:—

Determine the acidity by alkalimetry, calculating it as acetic acid.

Take 100 c.c. of beer, put it in a flask with a lateral neck, and connect it with a Liebig's condenser; distil at least a third over, then make it up with distilled water to its original volume, and take its specific gravity at 60° F. (15·6 C.), or weigh the distillate and make up its weight to 50 grammes, and then take its specific gravity; by reference to the tables under ALCOHOLIMETRY, the alcoholic strength will be found, but as the tables give the percentage when the latter process—viz., *taking 50 grammes by weight*—is adopted, it is obvious the strength must be divided by 2; thus if the specific gravity of the 50 grammes of distillate be ·9815, the percentage of alcohol in the beer is 6, not 12.

The addition of salt to raise the boiling point is unnecessary.

To obtain the solid residue, 25 c.c. can be evaporated down in a platinum dish to dryness, and then weighed; the weight of the dish, subtracted from the weight obtained, gives the solid residue. This may now be ignited, and the resulting ash weighed; the latter subtracted from the total residue gives what is usually entered as the *malt extract.*

* The addition of vegetable bitters, unless noxious, cannot now be considered illegal.

The alcohol, ash, malt extract, and free acid are now expressed in percentage, and a very fair idea of the quality of the ale may be formed by comparing the quantities obtained with those usually found in the same class of beer. The following table gives the amount of alcohol and extract in most common beers:—

	Alcohol per cent.	Malt extract per cent.
London ale for export .	6 to 8	7 to 5
,, ordinary .	4 to 5	5 to 4
London porter for export	5 to 6	7 to 6
,, ordinary	3 to 4	5 to 4
Brussels Lambik .	4·5 to 6	5·5 to 3·5
,, Faro . .	2·5 to 4	5 to 3
Bière forte de Strasbourg	4 to 4·5	4 to 3 5
Bière blanche de Paris	3·5 to 4	8 to 5
Bavarian beer . .	3 to 4·5	6 5 to 4
White beer of Berlin .	1 8 to 2	6·2 to 5·7

But if further examination is desirable, it will be necessary to, in the first place, estimate quantitatively some of the constituents of the ash. For this purpose the ash must be dissolved in hot water, and the chlorine estimated volumetrically, as described under WATER ANALYSIS. It is to be noticed, that alkaline phosphates somewhat obscure the reaction, and may, if necessary, be removed; but this is not of much practical importance, the error being in favour of the brewer—143·5 parts of chloride of silver = 58·5 parts of salt (chloride of sodium). Prosecutions under the Adulteration Act have been successfully instituted in respect of quantities of salt, varying from 38 to over 117 grains per gallon.

The iron of the ash may be either precipitated as peroxide of iron by means of acetate of ammonia (160 parts of peroxide = 308 parts of ferrous sulphate), or it may be estimated volumetrically or colorimetrically. *See* IRON, ESTIMATION OF.

Alum should also be looked for, and estimated, if present, by the process described in *Art.* BREAD.

Any other mineral adulterant than salt, alum, and sulphate of iron is improbable; but if other exist, a careful examination of the ash can hardly fail to detect it.

The detection of the kind of bitter used, and of the organic adulterations in beer, is by no means easy; but most of them can be separated, if the analyst operates upon sufficient quantities and spends sufficient time in the analysis.

Wiltsten (Archiv. der Pharmacie) recommends the following general process:—One litre of the beer is evaporated to a syrupy consistence, it is then poured into a tared glass cylinder of sufficient size, and weighed, and next digested in the same vessel with five times its weight of 93° to 95° alcohol, with frequent stirring for twenty-four hours, the solution is decanted and the residue again heated with fresh alcohol; lastly, the two products are mixed, filtered, and the alcohol driven off by a gentle heat; the residue will contain, if present, picric acid, brucine, strychnine, colchicine, colocynthine, picrotoxine, aloine, gentipicrin, menyanthin, quassiin, and, of course, the hop bitter; whilst gum, dextrine, sulphates, chlorides, &c., will remain in the first residue, these bodies being almost insoluble in strong alcohol.

A small portion of the alcoholic extract is diluted with three times its quantity of water, and a strip of white woollen material is steeped in it for one hour and then washed; a permanent yellow colour indicates *picric acid.*

The remaining portion of the alcoholic extract is exhausted with pure benzole, and evaporated down; three several portions of this extract (*a*, *b*, and *c*) are placed in separate porcelain capsules and tested—

(*a*) With nitric acid—a red colour denotes brucine; a violet, colchicine.

(*b*) With sulphuric acid—a red colour denotes colocynthine.

(*c*) With sulphuric acid and bichromate of potash—a purple violet denotes strychnine.

The remaining portion of the alcoholic extract is treated with amylic alcohol. Now this alcohol does not take up the hop bitter nor the bitter principles—absinthin, gentipicrin, menyanthin, and quassiin; but it dissolves aloes and it dissolves picrotoxine, both of which it leaves on evaporation, the latter in fine white crystals, the former in a dark amorphorus powder, recognisable by its taste and saffron-like odour.

The yet remaining portion of the syrupy extract, which is insoluble in amylic alcohol, is freed from the latter substance by blotting-paper and treated with anhydrous ether, which takes up the hop bitter and absinthin (if present), the latter is recognised on evaporation by its wormwood-like aroma, and the production of a reddish-yellow colour, with concentrated sulphuric acid changing to an indigo-blue.

There still remains an insoluble portion of the alcoholic extract; if this is decidedly bitter, it would indicate gentipicrin, menyanthin, or quassiin. To test for these, the extract is dissolved in water, and a portion is treated with strong ammoniacal solution of silver; if it remain clear, quassiin is present; if the silver be reduced, gentipicrin or menyanthin is probably present. Another portion evaporated to dryness in a porcelain dish is treated with concentrated sulphuric acid, and heated gently; gentipicrin would give a carmine red, menyanthin a yellowish-brown colour changing to violet.

Picrotoxine may also be specially tested for by some one of the following processes:—

Herapath's process.—Mix the beer with acetate of lead in excess; filter, and transmit sulphuretted hydrogen through the filtrate. Filter again, concentrate the filtrate, treat it with animal charcoal, which has the property of absorbing the picrotoxine. Wash the animal charcoal, dry at 212° F., boil with alcohol; this dissolves out the picrotoxine, from which it may be obtained in tufts of crystals.

Depaire's process.—Mix with one litre of beer finely powdered rock-salt, which throws down the resinous and extractive matters; shake the liquid with ether, an impure picrotoxine crystallines on separating the ether and evaporating it: or the beer may be simply acidulated with hydrochloric acid and agitated with ether, the ether separated and evaporated as before. The crystals may be identified according to the tests under PICROTOXINE.

Schmidt's process.—1. Evaporate the beer in a water-bath to a syrupy consistence, mix it with tepid water till it is perfectly liquid, so as to bring the volume to a third of the liquid used; heat and shake with animal charcoal. Stand several hours, filter, and heat slightly, precipitate by basic acetate of lead, and again filter. The liquid should now be of a yellow wine-colour; if not, re-filter through animal charcoal. Add from five to ten cubic centimetres of amylic alcohol, and shake briskly several times at intervals; after 24 hours the amylic alcohol collects on the surface containing the greater part of the picrotoxine. The remainder is subsequently eliminated by fresh treatment with amylic alcohol. Collect limpid layers of this alcohol, and leave the rest to evaporate spontaneously. On the sides of the capsule a yellowish ring forms, and this contains the picrotoxine mixed with resinous substances.

2. *Isolation of the Picrotoxine.*—First dissolve the resinous product in weak alcohol, evaporate to dryness, recover by a little boiling water containing a small quantity of H_2SO_4, boil to expel any volatile matter, add a little animal black to eliminate all extractive and resinous matter, and lastly filter. Evaporate inodorous liquid, and when a fresh bitter taste is developed, shake up with ether; this redissolves the picrotoxine and collects into a distinct layer on the surface of the liquid.

Treat again with ether, and the whole of the picrotoxine is eliminated; finally, the ethereal liquids are mixed, a little alcohol is added, and the whole is evaporated. The white or yellowish ring formed consists of picrotoxine, which then has only to be dissolved in alcohol to furnish the immediate principle in the form of well-defined crystals.

N.B.—These crystals will not be obtained unless the solution be quite free from resinous substances; if not free, and if, for instance, the ethereal solution is of a yellow colour, it must be recovered with water and treated by charcoal as above described.

Schmidt was able to detect by this process 0·04 of picrotoxine in a bottle of beer which had been adulterated with eight grains of Indian berry.—(M. SCHMIDT, Chem. News, March 12, 1864, p. 122.)

Atcherley has proposed the following special test for picric acid:—

Distil the extract in a tubulated retort, with a solution of chloride of lime (bleaching powder);

chloropicrine, a compound of an extremely penetrating odour, will be found in the distillate, should picric acid be present in the beer, and may be distinctly recognised by its smell.

Strychnine is never present in beer, except by accident, or for the purposo of poisoning. *See* STRYCHNINE.

Tobacco is best indicated by the odour of tho alcoholic extract of beer heated gently over a lamp.

Beetroot—For composition of the ash of beetroot, *see* ASH. For beetroot-sugar, *see* SUGAR.

Belladonna—*See* ATROPIA.

Benzoic Acid—*See* ACID, BENZOIC.

Benzole, Nitrate of—*See* NITRO-BENZOLE.

Bilharzia Hæmatobia A fluke-like parasite. It is bisexual. The body of the male is thread-shaped, round, white, and flattened anteriorly. The genital pore lies between the abdominal sucker and the commencement of the canalis gynæcophoris; the latter is a peculiar and distinctivo canal for tho reception of the female. The female is thin and delicate, having the genital pore and abdominal sucker in contact, and not being provided with a canal. In both sexes the oral sucker is triangular, the abdominal circular.

This parasite was first discovered by Bilharz of Cairo, in the portal vein and in the bladder. It is especially prevalent on the banks of the Nile and at the Cape of Good Hope, inducing very serious symptoms, and even death.

The main symptoms are usually referred to the urinary system, but the parasite is a great, if not the chief cause, of the dysentery prevalent in Egypt, the eggs of the distoma being found deposited in rows within the intestinal vessels, or beneath the exudations of the swollen mucous membrane. Dr. Harley has found the ova in the urine of persons at the Cape of Good Hope suffering from hæmaturia; and it is probable that the latter disease, so prevalent at the Cape, is there, in some degree, due to the distoma. Tho appearances after death from this parasite are various—in the bowels, congestion, deposits upon the mucous membrane, and extensive ulcerations; degeneration and atropy of the kidneys, dependent upon an infiltrated state of the ureters, and blocking of the portal vein from myriads of these parasites, aro some of tho most important pathological changes.

Bioplasm—*See* GERMS.

Births, Deaths, and Sickness Returns—By section 15 of the Order of the Local Government Board (Nov. 11, 1872), it is the duty of the medical officer of health to transmit quarterly, in forms provided by the Local Government Board, returns of sickness and death. The Board has lately addressed a circular to the different sanitary authorities, pointing out that the death returns may be obtained from the registrars, and suggesting that tho sanitary authorities should remunerate them for their troublo.

Returns in towns should be sent weekly, or even more frequently, to tho medical officer of health. In rural districts, returns each month are found to answer every purpose, except there be a death from any infectious disease; it is *then* the duty of the registrar to transmit information at once.

In most districts the registrars are paid on vaccination terms; that is, 2d. an entry. In a great many no returns can bo obtained at all, from the apathy of the authorities.

It is obvious that neither the sanitary authority nor the health officer is in a position to improve the health of his district, or to prevent the spread of contagious disease, without being kept constantly informed of the causes of death, and of the amount and nature of sickness. Thero can be little doubt that in the future it will be found convenient in certain places to make the nuisance inspector the registrar of births and deaths, the health officer the superintendent registrar. This course would, in somo towns, be economical and advantageous.

There is considerable difficulty in obtaining sickness returns. The sources appear to be tho poor-law returns of medical relief, public medical institutions, benefit societies, sick clubs, and schools. Of all these, the only one that is in practical use is the poor-law returns, supplemented by information from other medical men concerning their private patients. Returns once obtained should be classified and calculated out in death rates per 1000 or 10,000, or sickness per 1000, &c. (*See* STATISTICS.) At the present time, however, death returns are made so loosely, especially in rural districts, that caution must be exercised in using them for scientific purposes. On carefully examining death returns, it will often be found that one street in a town or one parish in a district shows a persistently high death rate, and this local information is perhaps the most valuable of all to a hygienist, as it indicates the dark spots calling for amendment.

All sickness and death returns should be calculated quarterly, from the first day of the month to the last, and not to tho quarter days. Likewise the yearly statistics should be made out, *not* from Christmas to Christmas, but from the 1st of January to the 31st of December.

A very good form has been arranged by Dr. David Page of Westmoreland, by which the deaths occurring annually in a district may be summarised under their proper heads.

A useful register of deaths and diseases has also been settled by Dr. Ogle, in which the returns can be *posted* up month by month.

It is of great importance, in all combined districts, that the different registrars should use the same printed form. Many of these have been suggested. Dr. Thursfield's is as follows, and is as good as any. It is entitled—

"District Registrar's Form of Return of Deaths to Medical Officers of Health;" and the information given is arranged under the following heads:—Return of Deaths from the District, from the day of to the day of , 1875: (1) No. of Entry in Register; (2) Name; (3) Age; (4) Sex; (5) Condition of Life;* (6) Date; (7) Locality; † (8) Cause of Death.‡

The instructions given to the district registrars upon the covers of the books of forms are as follows:—"Under ordinary circumstances, one of these forms should be filled up, and sent in to the medical officer of health for the district, at the end of each month. On the occasion of any *first* death in a locality from any of the diseases enumerated below (the principal zymotic diseases), an immediate return should be sent in, and also on the occurrence of any subsequent *group* of deaths in the same locality from the same cause. During epidemics, special directions will be given by the medical officer of health for sending in returns."

Biscuits (derived from two French words, meaning twice cooked)—Of biscuits there are a great variety, and made of various substances, such as meat, arrowroot, charcoal, &c. The simplest biscuits consist merely of flour and water. Biscuits contain but little water, hence, bulk for bulk, they are more nutritious than bread. Three-fourths of a pound are usually taken to equal one pound of bread; and from the smallness of their bulk they are easily transported. The continuous use of them is attended with many disadvantages; they become difficult of digestion, and it has been found that men do not thrive if kept to this diet for any length of time.

Biscuits are deficient in fat, and should therefore, when eaten, be combined with some fatty substance. The composition of the simple biscuit is as follows:—

Water	8 to 12
Nitrogenous substances	15
Dextrine	3·8
Sugar	1·9
Fat	1·3
Starch	72 to 75

The following is an analysis of Huntley & Palmer's lunch-biscuit, which contains, as will be observed, a considerable quantity of fat:—

	Grammes.
Starch, dextrine, and sugar	83·284
Water	7·95
Fat	7·000
Nitrogen	1·066
Ash	·7
	100·000

The biscuits averaged 20 grammes each in weight, therefore the above would be contained in about five biscuits.

Good ship-biscuits should be well baked, of a good colour, and steeped in water, should thoroughly soften down. They should also be free from weevils.

Liebig's extract of meat, mixed with baked flour, forms a valuable and pleasant biscuit.

A biscuit, made by Mr. Gail Borden of Galveston, Texas, contains equal parts of meat extract and dried flour (made in Papin's digester). A biscuit like this was largely used during the American war.

The inventor represents that 10 lbs. will last a man for fourteen days, or at the rate of 11·2 ounces a day; but this statement, like most of the statements made by the sanguine introducers of such preparations, is clearly an exaggeration. The biscuit, after being powdered, is soaked in cold water for a few minutes, then boiled for twenty or thirty minutes, and after being flavoured, makes a good soup.

A biscuit of charcoal has been prepared by Mr. Bragg of London, well known as "Bragg's charcoal-biscuit." This has been found a very valuable preparation for patients suffering from flatulence, indigestion, foulness of breath, &c.

The consumption of biscuits in this country is doubtless very large, though probably not so great as in France. A few years since, the manufacture of a favourite biscuit called "Rheims" amounted to more than 18,000 dozen a day, and the yearly consumption in Paris alone was 2,555,000 dozen.

Adulterations.—Carbonate of ammonia has been added to biscuits to increase the bulk of the paste; carbonate of lead has occasionally been recognised (but only in small quantities), and chloride of ammonia has been detected.

The analysis of biscuits, in order to detect adulteration, may be conducted as follows:—

* Deaths of illegitimate children under twelve months of age should be entered as such.

† This entry should in all cases include the name of the parish, in addition to the exact locality.

‡ This should be a complete copy of the same entry on the medical attendant's certificate of death, or if uncertified, should be entered as such.

Burn in a little platinum dish 1 gramme of the biscuit until the ash is white; the ash should be very minute in quantity: 1 gramme of a Huntley & Palmer's lunch-biscuit only left ·007 grammes of ash. If the ash is excessive, it may be tested in the usual way for mineral matters which may have been added to increase the weight.

The fat may be estimated by treating 1 gramme with dry ether, then evaporating the ether down in a platinum dish by floating the dish first in warm water, then drying on the water-bath.

The nitrogen is best estimated by combustion with oxide of copper; but as the nitrogenous matter in biscuit is mostly soluble, it may also be determined by the ammonia process. *See* AMMONIA.

For estimation of the sugar, *see* SUGAR.

The water is easily determined by putting 1 gramme of the powdered substance in a platinum dish and evaporating over the water-bath for three hours or more—in fact, until it ceases to lose weight; the difference in the weight before and after drying is the water.

The starch and dextrine may be determined by the loss or by conversion into grape-sugar. *See* STARCH.

Bixeine—The red-colouring principle of annatto. *See* ANNATTO.

Black Assizes—There are no less than six assizes on record in which an infectious fever was conveyed from the prisoners to the judges and jurymen and other people in the court, and hence from the fatality that attended them called *black.*

The first was at Cambridge Lent assizes, in the reign of Henry VIII., 1522. It "broke out at the assize of Cambridge, when held in the castle there, in the time of Lent, 13 Henry VIII., 1521–22. For the justices there, and all the gentlemen, bailives, and others resorting thither, took such an infection that many of them died, and almost all that were present fell desperately sick, and narrowly escaped with their lives."—(WOOD's History and Antiquities of Oxford.)

Tho second was the notorious black assize at Oxford, 1577. It was held at Oxford Castle on July 4th and two following days, for the trial of ono Rowland Jenkes, arraigned and condemned "for his seditious TOONG." He was a bookbinder and a Roman Catholic, and though there were other prisoners, yet the account states that after judgment had been pronounced against him, "there arose amidst the people such a *dampe* that almost all were smouldered, very few escaping that were not taken at that instant."—(HOLINSHED.) Among those who were thus so suddenly affected were Sir Robert Bell, Chief Baron of the Exchequer, Sir Nicholas Barham, sergeant-at-law, two sheriffs, one knight, five justices of the peace, and most of the jury: "above 600 sickened in ono night, and the day after, the infectious air being carried into the next village, sickened there an hundred more." In July and August no less than 510 persons perished, who either had been present at the trial, or who had caught it from those who had attended the court.

Tho third black assize occurred at Exeter in 1586. "Certaine poore Portingals," about 38 in number, had been captured at sea by Barnard Drake, and "cast into the deepe pit and stinking dungeon." They had, it seems, suffered great privations at sea, and in the prison had no change of raiment, but were left to lie on the bare ground. The appearance of the prisoners, emaciated by hunger and weakened by disease, was distressing in the extreme, some had to be led, others conveyed by hand-barrows. They were rested and exposed to the air for a little time; on being brought into court, they infected those present. The judge died, and the disease spread over the whole county, and was not extinguished until 1586. Out of one jury of twelve there died eleven, hence the disease must have been very fatal.

In 1730 the fourth black assize was held at Tauntou in Lent. "At the Lent assizes in Taunton in 1730, some prisoners who were brought thither from Ivilchester gaol infected the court, and Lord Chief Baron Pengelly, Sir James Sheppard, serjeant, John Pigot, Esq., sheriff, and some hundreds besides, died of the gaol distemper."—(HOWARD.)

A fifth black assize occurred at Launceston, and is described by Huxham in his "Observations on the Air and Epidemic Diseases, 1742." The symptoms were evidently those of typhus.

The sixth black assize was in 1750, at the Old Bailey. The sessions began on the 11th of May, and there happened to be more criminals and a greater crowd of people than usual. A hundred prisoners were put into two rooms, measuring 14 feet by 11 feet, and 7 feet high. Some others were put in the bail-dock. The court itself was very confined and narrow; an open window at the farther end of the court carried the infection from the reeking bodies of the prisoners to the bench and the body of the court. Sir Samuel Pennant, the Lord Mayor, Sir Thomas Abney, and Baron Clarke, judges, and Sir Daniel Lambert, alderman, two or three counsel, and many others in the court were affected; and over forty, it is said, succumbed to the gaol-fever caught in this manner.

The disease of the six black assizes is generally considered to have been typhus. Dr. Guy, however, thinks the Oxford outbreak may have been a malignant dysentery. *See* FEVER, TYPHUS.

Black Death—A name given to a frightful pestilence which ravaged the whole of Europe and Asia in the 14th century. It appears, however, to have existed previous to that date under various names. The symptoms were analogous to those of plague, and by many physicians it is considered to be nothing more nor less than a variety of oriental plague.

A careful study of the symptoms of the two diseases renders this, to say the least, doubtful. We are of Anglada's opinion, that it was a distinct species, and that now it no longer exists, having been rendered extinct by the general improvement of the habitations, the food, and the customs of the people.

Black Jack—Burnt sugar, used to impart colour and bitterness to beverages, and specially used for adulterating coffee. It is sometimes called "coffee refined," and is generally sold in tin canisters. It is also used for colouring vinegar, brandy, and rum. We shall have occasion again to refer to this article when treating of the adulterations of these various liquids.

"Black Jack" is also the name given by miners to blende, or the sulphide (sulphuret) of zinc.

"Black Jack" is a name given to butter with which water has been largely incorporated.

Black Pudding—Made of the blood of the pig, mixed with groats and fat. It contains about 11 per cent. of nitrogenous matter.

Blindness and Deaf Mutism—It is computed that there are 30,000 blind persons in this country, or 1 in every 1800, and that from various causes 1000 people become blind yearly. Of this number 13 per cent. are under 20 years of age, 17 per cent. under 40, and 23 per cent. under 60. In other words, blindness increases, as might be expected, with age. Thus—

1 in every 3300 is blind over 20 years of age.
1 ,, 770 ,, 40 ,,
1 ,, 200 ,, 60 ,,
1 ,, 50 ,, 80 ,,

A very large proportion of the blindness in this and in other countries is due to preventable diseases—*e.g.*, out of 6347 blind persons in Ireland, 690 lost their sight from zymotic and other fevers. Thus—

526 from smallpox.
31 ,, measles.
34 ,, scarlet fever.
99 ,, fever.

690, or about $\frac{1}{10}$ of the 6347.

According to M. Dufau, there are in France 3766 blind, or 1 in every 950; in Belgium there are 4117, or 1 in every 1000. In Denmark the proportion is 1 in 790, and in Norway 1 in every 500.

	Groups.	Number of Blind.	Number of Deaf Mutes.	Proportion to Population. Blind.	Proportion to Population. Deaf Mutes.
1	Picardie	3675	2890	1 to 920 inhabitants	1 to 1168 inhabitants
2	Normandie	3352	2041	,, 838 ,,	,, 1328 ,,
3	Bretagne	2964	2051	,, 957 ,,	,, 1384 ,,
4	Anjou	1614	1267	,, 1202 ,,	,, 1531 ,,
5	Ile de France	3016	1601	,, 953 ,,	,, 1796 ,,
6	Champagne	1908	1264	,, 821 ,,	,, 1255 ,,
7	Bourgogne	1978	1360	,, 879 ,,	,, 879 ,,
8	Lorraine	2420	2933	,, 999 ,,	,, 825 ,,
9	Poitou	1641	1427	,, 1145 ,,	,, 1306 ,,
10	Guienne	2285	1537	,, 937 ,,	,, 1400 ,,
11	Gascogne	1620	1588	,, 954 ,,	,, 973 ,,
12	Languedoc	1901	1291	,, 833 ,,	,, 1226 ,,
13	,,	2218	1514	,, 763 ,,	,, 1118 ,,
14	Auvergne	1574	1716	,, 1129 ,,	,, 1036 ,,
15	Berry	1400	1394	,, 1298 ,,	,, 1303 ,,
16	Lyonnais	1931	2181	,, 1217 ,,	,, 1078 ,,
17	Provence	1730	1113	,, 772 ,,	,, 800 ,,
	Corse	435	344	,, 513 ,,	,, 686 ,,

There are some curious facts worked out by M. Dufau with regard to the connection of blindness and deaf mutism, more especially as regards France. Thus he calculates that there is 1 blind to every 950 inhabitants, and 1 deaf mute to every 1212 inhabitants, or nearly one-fourth more blind than deaf mutes, whilst in other countries the numbers are about equal; for instance, in Prussia, a few years since, there was 1 blind in every 1378 inhabitants, and 1 deaf mute in every 1269 inhabitants. Blindness increases as you go to the north—the numbers already given show this—while deaf mutism increases as the country is more or less elevated above the snow-line; therefore, mountainous regions present more examples than plains.

With regard to the influence of age, deaf mutism is congenital, while blindness is frequently an accident occurring at any age, hence there are more youthful mutes than youthful blind people. It has been calculated in Prussia, that in 100 deaf mutes 70 are aged from 1 year to 30 years, and 30 above that age; whilst among 100 blind, the ages of 24 vary from 1 to 30 years, and 76 above that age.

The preceding table was drawn up by M. Dufau.

If we divide these 17 groups into 3 zones, thus—

(1) Northern region,	1, 2, 3, 5, 6, 8	groups.
(2) Central region,	4, 7, 15, 16, 14	,,
(3) Southern ,,	10, 11, 12, 13, 17	,,

we obtain the following facts:—

Northern region,	1 person blind in every		965
Central ,,	1	,,	145
Southern ,,	1	,,	852

From this we gather the significant fact that blindness is distributed in France as in the northern hemisphere—*i.e.*, in the central part we find the least number of blind people, and in the northern the greatest. We find also that in those French provinces which are considered as the least advanced, such as Poitou, Berry, Auvergne, &c., where the industrial movement has made but slow advances—where the industrial population is, in fact, placed under the most unfavourable conditions—the number of blind is still less than in the north; whilst in the principal centre of the industrial movement in France, from causes sufficiently evident, a large amount of blindness is to be met with.

The large number of people who are blind in the southern region, confirms the principle we have previously enunciated. In considering the number of the deaf, Dufau divides these 17 groups into two divisions, an eastern, which consists of groups 6, 8, 11, 12, 13, 14, 16, 17, and a western region, comprising groups 1, 2, 3, 4, 5, 9, 10, 15.

In the eastern region we find 1 in every 1081 of the inhabitants deaf mutes, while in the western division the amount is 1 in 1402. Thus we find that in all the mountainous regions of France the number of deaf mutes is nearly a third higher than in the flat country. We find also that there are more blind than deaf mutes in seven groups (viz., 2, 3, 5, 6, 10, 12, 13), more deaf mutes than blind in five groups (viz., 8, 11, 14, 15, 16), and that the proportion is nearly the same in the five remaining groups.

With regard to sex, it is well established that the masculine sex affected by either of these infirmities is greatly in excess of the female. Thus in Prussia there are 100 blind men to 87 blind women, and 100 deaf men to 76 female deaf mutes.

Institutions for Educating the Blind.—There are twenty-seven institutions in England established for the purpose of educating the blind, two only giving attention to the higher branches of education, the others being mostly confined to the teaching of some manual trade and reading raised type. One of the two higher-class institutions is "The College for Blind Sons of Gentlemen, Worcester," founded in 1866, its object being to provide such an education as shall enable a blind man of good means to enter a university, and prepare himself for the professions open to him, or one of slender fortune to compete for a maintenance as a teacher of music and languages, or a translator. The Royal Normal College, founded in 1868, for talented children of the lower classes, is almost wholly eleemosynary, and gives a more liberal education than any other institution of the same class, while it pays the greatest attention to music and tuning as a means of gaining a livelihood.

In France there is a large institution, in the charge of the State. At Würtemberg and Zurich, the institute for the blind has been combined with that for the reception of deaf mutes, who are found useful, as they act as guides to the blind. In short, in Europe and in America there are many valuable establishments created for the training and education of the blind.

Blood—A corpusculated animal fluid, contained in a system of vessels called the circulatory system. In animals low down in the scale the blood is a colourless fluid, but in the vertebratæ it is coloured (with one or two exceptions). The arterial blood is of a bright red, the venous of a dull purple colour. It is the most important of the animal fluids. Under the microscope, it is seen not to be homogeneous, but to consist of corpuscles in the form of a multitude of little flattened disks floating in fluid. These little disks are tolerably uniform in the same animal, both in shape and size, but differing in different species. In man they are round and concave, in birds and reptiles oval.

Human blood has two kinds of corpuscles, the red averaging $\frac{1}{3200}$ of an inch in diameter, the white a little larger. The white corpuscles are as much alive as monads, for in the body, or when put on a glass slide and kept at the temperature of the body, they exhibit movements, which can be seen by high powers.

The chemical composition of human blood is as follows :—

The Average Composition of Human Blood (A. Becquerel and Rodier).

	Male.	Female.
Specific gravity of defibrinated blood	1·0600	1·0575
Of serum	1·0280	1·0274
Water	779·00	791·10
Fibrine	2·20	2·20
Fatty matters	1·60	1·62
Serolin	0·02	0·02
Phosphorised fat	0·49	0·46
Cholesterin	0·09	0·09
Saponified fat	1·00	1·05
Albumin	69·40	70·50
Blood corpuscles	141·10	127·20
Extractive matters	6·80	7·40
	1000·10	1000·02
Salts: Sodic chloride	3·10	3·90
Salts: Other soluble salts	2·50	2·90
Salts: Earthy phosphates	0·33	0·35
Metallic iron	0·57	0·54
	6·50	7·69

The blood also contains in solution oxygen, nitrogen, and carbonic acid, as well as a free alkaline carbonate.

The Coagulation of the Blood and its Physiology is not within the scope of this work.

The Blood in Disease.—The contagious particles of fever and other contagious diseases exist, without doubt, mostly in the blood. The blood of scarlet fever and typhoid has been injected into rabbits, and produced in them a fatal feverish disease ; in the one case with a redness of the skin, in the other Peyer's patches were involved.

The blood from a person suffering from measles has also been injected, but without result (Core and Feltz). In relapsing fever, smallpox, rheumatism, septicæmia, puerperal ever, and typhoid, bacteria have been discovered (*See* Bacteria) ; and Dr. Lewis, in 1871, made the remarkable discovery of animalculæ, or an entozoon in the blood, existing in countless numbers. *See* Filaria sanguinis hominis.

A theory has also sprung up, that vertebrate blood in a peculiar state of decomposition causes and generates scarlet fever ; hence, whether true or not, it is well to see that no slaughter-house is established near a public or private school. *See* Fever, Scarlet.

In a medico-legal point of view, the distinguishing of human blood from that of other animals, from iron-mould, and from other stains, is of the greatest importance. A microscopical examination will generally suffice to show whether the fluid or stain is blood or not, and whether it is the blood of a mammal. The red vegetable colouring matters, such as cochineal, logwood, &c., in solution give with ammonia a deep crimson tint ; others, such as the red colouring from flowers and fruits, change into a blue or green. The iron-moulds and red paints containing iron will at once respond to the usual tests for iron.

A commission composed of MM. Mialhe, Mayel, Lefort, and Cornil have reported lately (1873) on the best methods of examining blood stains ; the following are their results (Chemical News, Dec. 5, 1873) :—

1st, When the stain is of recent date, or supposed to be so, the red corpuscles should be particularly examined, and every care taken to preserve them without change. The stains must not be washed with water, so that the hæmatin may not be altered. After insisting on the microscopic characters of the blood stains, isolated or compared with those of various animals, the Commission enumerate with care the fluids which are destructive or preservative of blood corpuscles. Among the first, water, and particularly hot water, acetic, gallic, hydrochloric, and sulphuric acids ; and of alkalies, potash and soda, even in weak solution, and ether and chloroform, and many other re-agents, so alter the blood corpuscles as to cause them to entirely disappear. Alcohol, chromic and picric acids, and bichromate of potash, preserve the corpuscles, though they alter their form. The preservative fluids are those whose composition approach nearest to serum, such as the iodised serum of Schultze, an excellent preparation made with amniotic fluid, to which are added a few drops of the tincture of iodine, so as to give it the colour of white wine ; or better, a fluid composed thus—white of egg, 30 grammes ; distilled water, 270 grammes ; and chloride of sodium, 40 grammes ; or even a fluid containing 0·5 per cent of chloride of sodium, or 5 or 6 per cent of sulphate of soda. If the stains be wetted and softened by these fluids, and then examined, white and red corpuscles and fibroid particles will be observed.

2nd, In more difficult cases, when the microscope, owing to the alterations which time has effected in the hæmatin, can give but vague information, examination by the spectroscope and chemical analysis enables us to arrive at precise results. The use of these means, being less known and also more delicate, requires special study.

(1) *Spectrum Analysis*—Colouring matters have the power of absorbing certain coloured rays of white light—the same always for the same substance. This is the principle on which spectroscopic examination is based. If into an analysing tube filled with water a few drops of a solution of hæmoglobin be introduced, till it has the colour of peach-blossoms, the luminous rays of the spectrum passing through this fluid present two bands of absorption, in the lines D and E of Frauenhofer, in the yellow and the green. The same fact would be observed if a few drops of blood were substituted for hæmoglobin in the analysis. In a case of doubt, the hæmoglobin of the blood could be reduced by adding to this latter a reducing body. Destroyed hæmoglobin has a different spectrum from oxygenated hæmoglobin;

a single absorption band, as large as the two former bands united, and a little to the left of Frauenhofer's line D.

(2) In blood in a state of decomposition, or which has been treated by acids or caustic alkalies, hæmoglobin is changed into a new substance; hæmatin is formed, which, combined with hydrochloric acid, gives characteristic crystals. In order to obtain them we must proceed thus:—A small fragment of dried blood is placed on a glass slide, it is dissolved in a drop of water, and a minute portion of sea-salt is added. It is covered with a thin slide, and pure acetic acid is made to pass between the two slides, and it is heated over a spirit-lamp to boiling point; acetic acid is again added, and it is heated afresh, and this is repeated till the crystals are obtained. They are rhomboidal, of a dirty brown colour, quite characteristic, and require to be seen with a magnifying power of three hundred or four hundred diameters. With the smallest quantity of blood these two reactions can always be produced—the spectrum examination and the crystals of hydrochlorate of hæmatin; and they are so certain, that the existence of one alone enables one to affirm the presence of blood.

(3) The third process, though not so exact as the preceding, ought nevertheless not to be neglected. If to a very small quantity of blood dissolved in a little water be added a few drops of tincture of guiacum and of binoxide of hydrogen, a persistent blue colour is immediately produced; but this very sensitive reaction can be obtained with other organic matter —nasal mucus, saliva, &c.; it therefore only gives a probability. We must proceed in the following manner:—A tincture of guiacum is prepared with alcohol at 83 degrees, and guiacum resin; a mixture of sulphuric ether and binoxide of hydrogen is also made, and enclosed in a stoppered bottle, and kept under water in the dark. This preparation is less liable to change than pure oxygenated water. The object stained with blood, if it be white, is put into a little cup, then moistened with water to dissolve out the blood stain, and washed in distilled water; this water is then submitted to the action of these reagents. If the thing stained be coloured, and the stain little or not at all visible, it must be moistened, and then pressed between two or three sheets of white blotting-paper, and tried first with the guiacum. If the stain be of blood, a reddish or brown spot will form on the paper. One of the sheets should be treated with ammonia, and the stain will become crimson or green. A second sheet, treated with tincture of guiacum and ozonised ether, will give a blue colour more or less intense, according to the quantity of the blood.

To recapitulate—(1) If the stains or scales of blood appear recent, the corpuscles may, after the necessary precautions, be examined under the microscope, and their presence, diameter, &c., observed, which will enable one to diagnose the origin of the blood, whether human or animal. (2) If the stains be old and the blood changed, the reaction with the tincture of guiacum would make the presence of blood probable; but its actual presence cannot be affirmed without spectrum examination, or the production of crystals of hydrochlorate of hæmatin; one of the two is sufficient. It is unnecessary to add, that these reactions do not show whether the blood is human or animal.

Dr. Richardson has succeeded, by the use of very high powers and careful measurements, in proving that it is possible, in skilled hands, to distinguish between human and animal corpuscles.

Blood-Boiler—The boiling of blood or offal gives rise to very offensive organic vapours; if established near dwelling-houses, the urban authority should see that the offal is boiled in closed coppers, and that the fumes are carried off into the furnace-fire, so as to be consumed.

The trade of a blood-boiler comes under the category of an offensive trade, and as such cannot be established without the consent of an *urban* authority.—(P. H., s. 112.)

The *urban* authority may make bylaws respecting blood-boiling.—(P. H., s. 113.)

On complaint by the medical officer of health, or by any two legally qualified practitioners, or by any ten inhabitants in the district of an *urban sanitary authority*, that any building or place for boiling offal or blood is a nuisance, or causes any effluvia injurious to the health of the inhabitants of the neighbourhood, proceedings may be taken by the authority as described under TRADES, OFFENSIVE, &c.—(P. H., s. 114.)

Board, General, of Health—The General Board of Health has ceased to exist; its powers were transferred by 21 & 22 Vict. c. 77, s. 1, to the Local Government Board. *See* LOCAL GOVERNMENT BOARD.

Board, Joint—*See* DISTRICT, UNITED.

Boat-Racing—*See* HEART DISEASE.

Boats—An *urban* authority may license the proprietors of pleasure-boats and vessels, and the boatmen or other persons in charge, and may make bylaws for regulating the numbering and naming of such boats and vessels, and the number of persons to be carried therein, and the mooring places for the same, and for fixing rates of hire, and the qualification of such boatmen or other persons in charge, and for securing their good and orderly conduct while in charge.—(P. H., s. 172.)

Body-Searcher—A body-searcher was one who formerly examined the bodies of the dead in order to report on the cause of death. It was an important office at the time of the plague, and was performed by the chirurgeons, who were paid twelve pence out of the goods of the party searched. At one time it was, however, intrusted to two old women, much to the damage of the bills of mortality.

In France there are *vérificateurs de décès*, their office being almost identical with that of the old body-searcher; they inspect each dead person, and give a certificate, for which they get a fixed sum.

Boil (*Furunculus*)—A circumscribed round hard swelling, depending on inflammation of one spot of the true skin, and of the deposit therein of unhealthy lymph; usually attended with the acutest pain and tenderness, and ending in suppuration, with the discharge of pus, flakes of softened lymph and small sloughy shreds of areolar tissue, which form what is called the core. It may be caused by blood disorder, from unwholesome food, or from unknown epidemic, atmospheric causes, or from depressing influences generally.

Living for some time in an impure atmosphere has, without doubt, frequently caused an eruption of boils; and drinking unwholesome water may have produced the same result. In 1848 a remarkable and curious endemic occurred in the vicinity of Frankfort. Dr. Clemens (HENTE'S Zeitschrift für Nat. Med. 1849, vol. viii. p. 215) made an exhaustive inquiry into the cause of this outbreak, and came to the conclusion that the complaint was caused by drinking water containing sulphuretted hydrogen gas, which was set free in some large chemical works, and was washed down by the rains into the brooks from which the drinking-water was derived; but as sulphides, and the Harrogate waters, which contain sulphuretted hydrogen, are now known to be the best remedy for boils, it admits of grave doubt whether Dr. Clemens' conclusions are correct.

Probably the unhealthy boils or ulcers so common in India, especially in the north-west, and along the frontier, are connected with bad water. Since the waters of the Jumna were used, instead of the impure well-water, the "Delhi" boil has much decreased in frequency; yet, on the other hand, from Fleming's observations, there appears to be a doubt whether the water was really to blame. Dr. Alcock, apparently a disciple of Dr. Clemens, would have us believe that the frontier ulcers in India are caused by the evolution of sulphuretted hydrogen; but the evidence he has produced to support his theory is hardly of a satisfactory or convincing kind.

Bole—A kind of clay, often highly coloured by iron. It usually consists of silica, alumina, iron, lime, and magnesia. It is not a well-defined mineral, and consequently many substances are described by mineralogists under this name.

Armenian Bole is of a bright red colour. It is often employed as a dentifrice, and in some cases is administered medicinally. It is used for the adulteration of cocoa, anchovies, potted meats, fish, and sauces.

Bole of Bois is of a yellow colour. It contains carbonate of lime, and effervesces with acids.

Bohemian Bole—Yellowish red.

French Bole—Pale red, with frequent streaks of yellow.

Lemnian Bole and *Silesian Bole* are in most respects similar to the above-named varieties.

The following analyses are by C. Von Haule:—

	Capo di Bove.	New Holland.
Silica . . .	45·64	38·22
Alumina . . .	29·33	31·00
Peroxide of iron .	8·88	11·00
Lime . . .	0·60	trace
Magnesia . . .	trace	trace
Water . . .	14·27	18·8
Waste . . .	1·28	·97

Bone-Boiler—The trade of a bone-boiler comes under the character of offensive trades (P. H., s. 112-114), and an *urban* sanitary authority can regulate and control or oppose its establishment in their district. *See* BLOOD-BOILER; BONES; TRADES, OFFENSIVE, &c.

Bones—Bones are used very extensively both in this country and abroad. For the purposes of the sugar-refiner alone, an immense quantity is annually employed; besides which, they are utilised in the extraction of gelatine, in the manufacture of soap and candles, and in other branches of industry besides those in which the bone itself is cut or turned into various shapes.

The mean composition of bones, taken from a heap about to be used for manufacturing purposes—*i.e.*, covered with the periosteum and imperfectly cleansed from flesh—appears to be as follows:—

Fibrous tissue . .	32	Organic matter = 50.
Water	8	
Fat	9	
Albumen vessels, &c. .	1	
Phosphate of lime . .	38	Mineral matter = 50.
,, magnesia .	2	
Carbonate of lime . .	8	
Other salts, as— Chloride soda . ,, potash . Sulphates, &c. .	2	

Bones in the dry state contain about 33·3 per cent. of animal, and 66·7 per cent of mineral matter, and on an average they yield about 19 per cent. of their weight of gelatine and fat. It is impossible to make a nutritious soup out of bones alone.

The late Mr. E. Smith was certainly in error in saying that 6 lbs. of bones. broken small and boiled in water from 9 to 10 hours, will yield a soup that contains the nutritive elements of 2 lbs. of meat as far as carbon is concerned, and of 1 lb. of meat in respect of nitrogen; for although this may be so as regards the actual weights of carbonaceous and nitrogenous matters, yet it is far otherwise with their nutritive powers. In the well-known experiments of the French gelatine commission, it was found that the soup or jelly from boiled bones would not support the life of dogs, although raw bones in like proportion would; from which it is evident that there is a great difference in the nutritive power of the gelatinous tissue and its cooked products. Gelatine, in fact, has never been discovered in the blood of animals, nor is it a constituent of eggs or milk, which are the two primary foods from which the tissues of the young are formed. It would appear, then, that gelatine is not an essential article of diet, although it is probable that gelatinous tissue undergoes digestion by being converted into peptones.

The following is the process recommended by Proust for making the best of bones in hospitals, gaols, and similar establishments. The bones, crushed small, are to be boiled for fifteen minutes in a kettle of water, and the fat (which is fit for all common purposes) skimmed off as soon as cold. The bones are then to be ground, and boiled in eight or ten times their weight of water (of which that already used must form a part) until half of it is wasted, when a very firm jelly will be obtained. Iron vessels should alone be used for this purpose, as jelly and soup act upon copper, brass, and other common metals.

For the manufacture of gelatine, the bones of the skull or the small bones of the feet of animals are generally used. The bones are boiled when *fresh*, since they do not when dry so readily give up their fat by boiling; they still contain fat, but it appears by the process of drying to become infiltrated into the bony tissue.

In all manufacturing operations on bones, foul odours and complaints are likely to arise, (*a*) from the heaps of bones having shreds of flesh in a state of putrefaction; (*b*) from the multitude of rats nearly always frequenting the heaps; (*c*) from the offensive organic vapours in the various manufacturing operations. The vapours should always be led by a special flue into the furnace-fire, and there consumed.

Borax ($Na_2O2B_2O_3,10H_2O$)—Borax, chemically speaking, is an acid borate of sodium, its composition in 100 parts being, *anhydrous*, Na_2O, 30·7; B_2O_3, 69·3; H_2O, 47·12. Its specific gravity (cryst) is 1·73, and its form is that of prismatic crystals. It is found in an impure state in the lakes of Thibet, and in many other parts of the world. A large quantity of the borax of commerce is manufactured from the boracic acid found in the lagoons of Tuscany.

The crystals are slightly efflorescent; they are soluble in half their weight of boiling and twelve parts of cold water. When heated strongly, borax swells up, becomes anhydrous, and melts below redness into a clear transparent glass, which has the property of dissolving many of the metallic oxides.

Borax is used in the arts as a flux in the making of enamels, in the fixing of colours on porcelain, and by the refiner in the melting of gold and silver.

M. Schnetzler (Comptes Rendus, vol. lxxx. p. 473) has made several experiments, which show that solutions of borax have considerable power in arresting the growth of vegetable cells and the putrefaction of animal substances.

Experiments made by submitting the leaves of *Elodea Canadensis* and *Vaucheria clavata*, the spores of the grape fungus *Oidium Tuckeri*, and the cells of *yeast*, *moulds*, &c., to the action of concentrated solutions of borax, showed in each case coagulation and death of the protoplasm.

In like manner, solutions of borax were found to be fatal to the *Infusoria*, *Rotifera*, *Entromostraca*, and to the larvæ of frogs.

Ripe grapes and currants, after being kept two years in a concentrated solution of borax, showed no sign of mouldiness or fermentation; they were not, however, edible.

Meat placed in tins containing a concentrated solution of borax, acquires, after some weeks, a peculiar and disagreeable odour, but does not putrefy. A pound of beef thus kept a year and a half was of a yellowish colour, but as soft and tender as fresh meat. Meat placed in a similar solution, in *hermetically-sealed* tins, was perfectly preserved.

These experiments are worthy of extension and repetition.

Boroughs—The word "borough," for the purposes of the Public Health Act, 1875, means any place subject, for the time being, to the 5 & 6 Will. IV. c. 75. The sanitary authority of a borough, whether a local board or a town council, is now designated an *urban* sanitary authority.

Borrowing Powers—*See* LOANS.

Bosh Butter—A very inferior kind of butter, made up in Hamburg, and sent over here to adulterate other butters with. *See* BUTTER.

Bothriocephalus Cordatus—A parasitic worm affecting the human intestines, first described by Leuckart. It is common in dogs, but rare in man. The following diagram (fig. 12) shows— *b*, head, back view, magnified five diameters; *b′*, upper part of body and head, magnified two diameters. *a* is a portion of the worm, natural size. *See also* BOTHRIOCEPHALUS LATUS.

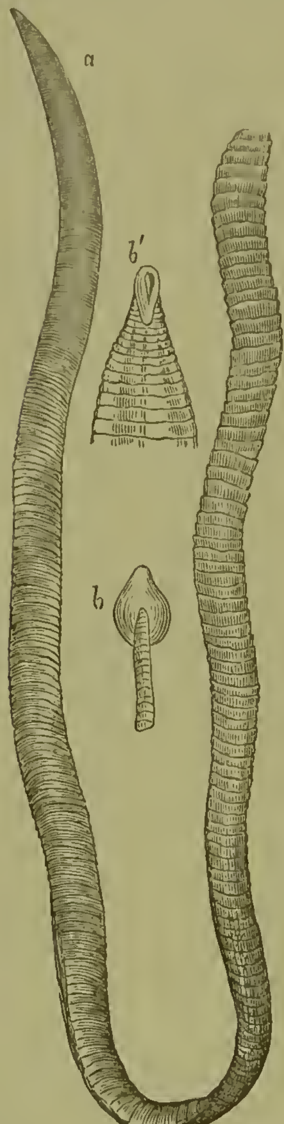


Fig. 12.

Bothriocephalus Latus—A parasitic worm found in the intestines of man. Although classed with tape-worms, it differs essentially from tænia. The head is of an elongated form (fig. 13), compressed, with an

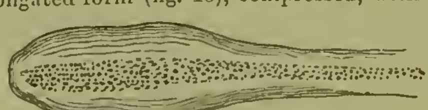


Fig. 13.

anterior obtuse prominence into which the mouth opens. The animal has the power of elongating and contracting the neck, so that it appears sometimes short, sometimes long. The joints or segments commence about three inches from the head; the anterior ones are nearly square, but the remainder are much elongated transversely. Each segment contains on its flat surface two orifices, the anterior connected with a male, the posterior with a female organ of generation. The whole parasite is of a brown colour, and from six to twenty feet in length. Persons affected with this worm never pass the single segments or proglottides from the bowels, but pass them in chains of many links. The ova are also generally to be discovered in the fæces; they are of an ovoid shape; the capsule is perfectly translucent, and the yolk can be distinguished. The yolk undergoes segmentation,

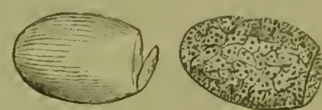


Fig. 14.

and ultimately develops an embryo, with six hooks at the anterior extremity, cased in a mantle studded with vibratory cilia; the lid of the capsule then opens up (fig. 14), and the embryo escapes. If they do not obtain access to the intestines of an animal within a week, they lose their ciliated mantle and perish. Facts appear to show that drinking-water is the chief, perhaps the only medium, through which the worm is propagated among man. It would appear to be unknown in England, except when imported; but it is common in Russia, Sweden, Norway, Lapland, Finland, Poland, and Switzerland.

Brain Fever—*See* FEVER, TYPHUS.

Bran—Bran is the inner husk or proper coat of the cereal grains sifted from the flour. Its average composition is—

Albuminoid bodies	13·80
Oil	5·56
Starch, fibre, &c.	61·67
Ash	6·11
Water	12·86
	100·00

Poggiale gives a somewhat different analysis.

Composition of Bran (POGGIALE).

Water	12·66
Non-azotised soluble matter . .	7·70
Sugar	1·99
Fat	2·87
Soluble nitrogen available . .	3·86
Soluble nitrogen non-available .	3·51
Starch	21·69
Woody fibre	34·57
Salts	5·54

Bran, then, contains a considerable portion of fatty and nitrogenous matters, but it is nevertheless excessively indigestible; the sharp particles appear to act on the intestines as an irritant, and the greatest portion ingested escapes unchanged. Tardieu fed dogs on bran alone, but they soon became excessively weak, and eventually died.

Bran has been found as an adulterant of oatmeal, pepper, and tobacco.

The bran of wheat is used by the calico-printer as a mordant; it is a useful manure, containing phosphates of ammonia and magnesia; it is popularly believed to be a useful remedy for coughs and colds when taken in the form of tea, and bread has been made of it by the poorer classes.

Brandy—An alcoholic beverage obtained from the distillation of wine. When first distilled it is colourless, but it becomes of a pale amber colour upon being stored in oaken casks. The darker brandies are coloured by caramel.

The constituents of pure brandy are alcohol, water, acetic acid, acetic ether, œnanthic ether, small quantities of volatile oil, colouring-matter, and tannin. The amount of alcohol varies from 45 to 55 per cent.

As redistillations injure the flavour of brandies, they are but slightly rectified; and the strength of the very best brandies seldom exceeds proof; besides, the strength decreases by keeping.

The kinds of brandy esteemed in England are Cognac and Armagnac; those of Rochelle and Bordeaux come next in quality; while inferior brandies are obtained from Portugal, Spain, and Italy.

In France there are a great many kinds of brandy in use, known by names descriptive of their qualities, source, and strengths.

Eau de vie supérieure.—This is the finest variety of *Cognac brandy*, both "white" and "pale," of the English drinker, being seldom artificially coloured. It is made from pale white wines by skilful distillation.

Eau de vie ordinaire.—This is the ordinary brandy of the taverns and hotels, and is prepared from inferior or spoilt white or red wine, the average specific gravity being ·9476 (from 22 to 27 under proof).

Eau de vie de marc.—Used chiefly to mix with other brandy; distilled from the lees of sour, damaged, and inferior red wines, the marc or cake of grape, &c.

Eau de vie seconde.—Very weak and inferior.

Eau de vie à preuve de Hollande.—Sp. gr. ·941 to ·942 (18 to 20 under proof).

Eau de vie à preuve d'huile.—Sp. gr. ·9185. Pure olive oil just sinks in it; it is the strongest brandy kept for retail sale in France.

Eau de vie forte.—Distilled from common brandy at a low temperature. It answers to our spirits of wine. Sp. gr. ·839.

Esprit de vin is brandy or spirit carefully rectified to ·861.

The brandies we obtain here are often very different from those we see drunk at the best tables on the Continent; this is accounted for by the fact that French brandies are generally "made up" for the English market.

The action of brandy on the system does not exhibit any peculiarity, and the consideration of this point comes more naturally under the head of ALCOHOL and ALCOHOLIC BEVERAGES.

Adulterations.—Water, burnt sugar, Cayenne pepper, grains of paradise, horse-radish, acetic ether, fusel oil. Some of the cheaper brandies are mere imitations, manufactured from corn-spirit and flavouring and colouring matters.

The following are examples of receipts used by the trade:—

To ten puncheons of brandy .	1081	galls.
Add flavouring raisin-spirit .	118	,,
Tincture of grains of paradise .	4	,,
Cherry-laurel water . . .	2	,,
Spirit of almond-cake . .	2	,,
	1207	,,

Add also ten handfuls of oak sawdust, and give it complexion with burnt sugar.

The following formulæ for "reducing" brandy are those of two large wholesale dealers:—

1. Cognac brandy (10 under proof), 20 galls.; British brandy (17 under proof), 5 galls.; water, 4½ galls. Strength of mixture, 25 under proof.

2. To 72 galls. of full-flavoured French brandy (5 under proof) are added 10 galls. of spirit of wine (58 over proof), 25 galls. of water, and 1 pint of good colouring. The whole is then well "rummaged up," and allowed to stand for two days, when it is fit for use. Strength of mixture, 22 under proof.

A liqueur sold in London under the name of "brandy improver," or "brandy essence," consists of a thin sugar syrup, flavoured with acetic ether and essence of cayenne, and coloured with burnt sugar. It is said to heighten the true Cognac flavour and restore lost alcoholic strength. In the trade, the addition of water "liquor" to spirit is technically called "*reducing*," whilst absolute adulteration is known under the name "*improving*."

Detection of Adulterations.—The first thing to be done is to determine its alcoholic strength. To do this, put 100 c.c. in a flask with lateral tube or small retort, and distil to dryness, or nearly so, condensing the products by means of a suitable receiver, &c., and estimate the alcohol by means of the processes detailed under ALCOHOLOMETRY. The residue in the retort may be tested with litmus paper: if acid, sulphates or sulphuric acid may be present; if the latter, the paper will char on drying. In either case, the residue may be further tested with chloride of barium, and the exact amount of sulphates estimated. The brandy may be roughly tested for fusel oil by burning a little of it in a dish, and depressing over the flame a saucer or other cold piece of porcelain. If there is a black stain, some of the lower alcohols are very probably present, and should be looked for by distilling half a pint of the spirit and examining the later or heavier products. The vinic alcohol being the most volatile, comes over first; the heavier, fusel oil, remaining until the later stages.

For a more accurate process for the detection of amylic alcohol, *see* art. FUSEL OIL.

Cocculus Indicus may be detected exactly as in the process detailed under BEER.

Copper.—(*a*) Agitate a little of the brandy with a little pure olive oil; if copper be present, the oil will acquire a green colour.

(*b*) A clean knife immersed in the acidulated liquid becomes coated with a film of metallic copper, if that metal is present.

Lead.—Sulphuretted hydrogen throws down a black precipitate if in large quantity, or gives a dark coloration if the lead is in minute quantity.

Capsicum and peppers may be detected in the extract by the taste; if acid, it must be previously neutralised with soda.

Methylated spirit is detected by rubbing a little on the hands, and then drawing a long breath with the hands over the mouth, the peculiar odour of the methylated spirit is then evident; but this requires practice. *See* ALCOHOLISM, ALCOHOLIC BEVERAGES, &c.

Braxy of Sheep—*See* MEAT.

Bread—The principal varieties of bread at present in use in this country are *bricks*, *Coburg*, *cottage*, *batch*, *French rolls*, and *rye-bread*. These are all made of the same dough, the only difference is in the shape given to them, their various flavours depending on the way in which they are affected by the heat of the oven in baking. The "cottage" loaves and the French rolls are frequently made of a superior flour to that employed in manufacturing the "batch," or household loaf.

Rye-bread consists generally of ordinary wheat-flour mixed with bran.

Bread is made of the flour of different cereal grains, but only those that contain gluten admit of conversion into light and spongy bread. In this respect wheaten flour is superior to all others. In times of scarcity and famine, however, various substances besides the flour of the cereals have been made into bread, or have been mixed with it. For this purpose almost every amylaceous vegetable at once plentiful and cheap has in its turn been eagerly appropriated. Acorns, the leguminous seeds, numerous starchy bulbous roots, and similar substances have been employed, either in the form of meal, or made into an emulsion or jelly, which has been used instead of water to form ordinary flour into dough. At such times bran, a nutritious and valuable portion of the grain, generally rejected, has been retained in the flour, and indeed occasionally added in excess. Birkenmayer, a brewer of Constance, during a period of scarcity, succeeded in manufacturing bread from the farinaceous residue of beer (brewer's grains). Ten lbs. of this substance, rubbed to a paste, with ½ lb. of yeast, 5 lbs. of ordinary meal, and a handful of salt, produce 14 lbs. of BLACK BREAD, which is said to be both "savoury and nourishing."

Iceland, carrageen, and other mosses, either alone or mixed with flour or meal, have also been used. Cowitch-grass and beet have before now been substituted for flour, or mixed with it as in Egypt.

In Poland a sort of gruel is prepared from this cowitch-grass.

Rye-bread is brown, and rather heavy, but possessing a savoury smell. It has the quality of keeping seven to eight days without getting dry, but it is very liable to become mouldy.

Cassava-bread is made from the root of the manihot, by first expressing the juice, then grinding it into a coarse meal, and baking it in the form of cakes upon thin iron plates. When steeped in oil, and flavoured with cayenne, and lightly broiled upon a gridiron, it is not unpalatable.

Composition of Bread-Stuffs.—The most common and also the most ancient method of vesiculating bread is by fermentation, and the processes now in use are not very different from those employed in the earliest times. Yeast (as brewer's or patent yeast, prepared from an infusion of hops and malt; German yeast, the solid residue of the yeast produced by the fermentation of rye in making hollands; baker's yeast, made from potatoes and flour; or leaven, which is old dough in a state of fermentation) is mixed with the flour or dough, and this soon begins to ferment by the action of the yeast fungus (*Micoderma cerevisiæ*) on the sugar of flour, whereby carbonic acid is produced, which being diffused through the substance of the dough, vesiculates it, and causes it to swell.

The chemical process of baking cannot be rightly understood without a knowledge of the ordinary composition of the principal varieties of flour employed in the preparation of bread.

When corn is ground in a mill, the grain is reduced to powder, which may be separated by sifting into two principal portions, flour and bran. The bran is composed of the brownish-coloured outer covering of the grain, which is tougher and harder than the internal portions, and consequently is not reduced by grinding to so fine a state of division; the flour is produced by the pulverisation of the inner portion of the grain.

The most important constituents of the varieties of corn used as food are—

(1) Starch; (2) gluten, a peculiar azotised substance allied to albumen, which confers the tenacity and toughness upon dough; (3) a small portion of sugar, or of dextrine; (4) a little oily matter; (5) a small quantity of saline matter; (6) a skeleton of ligneous tissue, which is the only portion of the seed not susceptible of digestion in the stomach. The proportions in which these ingredients are present in some of the principal varieties of grain used as food may be seen from the subjoined table. They vary, however, considerably in the same grain when grown in different climates. The proportion of gluten contained in wheat grown in the southern parts of Europe and in the north of Africa is considerably higher than in the best English-grown wheat; and the hard, thin-skinned wheats furnish a larger proportion of gluten than the softer varieties of the grain.

Components.	Whole Wheat-Meal.			Maize.	Decorticated Rice.	Rye.	Peas.
	Polish.	Hardy White.	Algerian.				
	Péligot.			Boussingault.			
Water	15·2	13·6	13·6	17·1	7·3	14·7	8·6
Starch	61·3	60·8	59·8	59·0	83·0	65·1	56·9
Dextrine and sugar	6·3	10·5	6·4	1·5	...	...	...
Azotised matter: Soluble	1·6	2·0	1·6	12·8	7·5	12·5	25·0
Azotised matter: Insoluble	12·7	10·5	14·4	7·0	0·7	2·0	2·2
Oily matter	1·5	1·1	1·1	1·5	1·0	3·3	4·4
Fibre	...	1·5	1·4	1·1	0·5	2 4	3·1
Salts	1·4	...	1·7	...	...	...	...
	100·0	100·0	100·0	100·0	100·0	100·0	100·2

Components.	Bran of Soft French Wheat.	Barley (Fresenius).
Water	13·9	13·00
Starch, Dextrine, Sugar	51·0	48·06
		3·87
		3·75
Gluten or equivalent	14·9	13·18
Oily matter	3·6	0·34
Fibre	9·7	13·34
Salts	5·7	3·56
	98·8	100·00

The principal portion of the woody fibre is accumulated in the bran; but this substance likewise contains a large proportion of nutritive matter, for both gluten and oily matter are deposited in its cells more abundantly than in any other part of the grain, as may be seen by the result of its analysis given in the preceding table. Other grains are sometimes mixed with flour, such as rye, buckwheat, *melampyrum*, sainfoin, &c. Bad flour frequently causes the bread to have an acid taste, arising from an excess of lactic acid, and perhaps acetic acid. Bad yeast will also cause acidity. Great cleanliness should be enforced on the part of the men who make up the dough.

In India, bread becomes sour from bad cleaning of the flour, and if too much water be present it rapidly becomes mouldy. Rice is used as an addition, on account of its cheapness. Rice-bread is heavier, of closer texture, and less filled with cavities than wheaten bread. The rice retains water. For acid flour lime-water is used instead of pure water, lime-water having this advantage, that while it does not check the fermentation of yeast, it hinders the action of diastase on starch. The lime-water should be made from *caustic lime*, and not be a mixture of chalk-and-water, which is not unfrequently the case.

The operation of kneading, as usually performed, has many disadvantages; it is laborious, and it certainly is uncleanly. Many kneading-machines have been invented, but the hand-machine of Mr. Stevens is the one generally used. It is in use at the Holborn Union, where about 5632 lbs. of bread are turned out every week by one man and two boys; and they contrive to make ninety-six 4-lb. loaves out of every sack of flour (280 lbs.); the materials used on the average of a whole year being as follows:—

Flour	4129 lbs.	which produce 5632 lbs. of bread, or 1408 4-lb. quartern loaves.
Cones	140 ,,	
Potatoes	168 ,,	
Salt	68 ,,	
Malt	13 ,,	
Hops	1½ ,,	

Many writers have recommended the use of unfermented bread, but few care to eat it, and it certainly is not so easily digested as bread made in the ordinary way. The best sample of unfermented bread is that known as *aërated*, made by Dr Dauglish's process. His method has this advantage, that during the whole of the operation neither the flour nor the dough comes in contact with the flesh of the workmen.

This bread is found to agree better with some persons than bread made with yeast. The great objection brought against it is that it has a tendency to become disagreeably dry. It is easily digested and assimilated, and may even be eaten quite new by the dyspeptic without his feeling any of the discomfort which new leavened bread generally produces. It is certainly better for infants than ordinary bread.

When taken from the oven the bread begins to lose weight. The 4-lb. loaf loses—

In the first 24 hours	1¼ ounce.
In 48 hours	5 ounces
,, 60 ,,	7 ,,
,, 70 ,,	8¾ ,,

But this, of course, is merely an average, and is subject to many variations.

The weight of the loaves is generally taken when they are hot. The Austrian army authorities permit a loss of 2·9 per cent. in four days.

In the French army different kinds of bread are used—ordinary bread, biscuited bread, bread half-biscuited, bread one-quarter biscuited, and hospital. The "pain biscuité" is used only on service. It is firmer than ordinary bread.

	Summer.	Winter.
Pain de munition ordinaire keeps	5 days.	8 days.
,, au quart biscuité	,, 10 ,,	15 ,,
,, demi ,,	,, 20 ,,	30 ,,
,, biscuité	,, 40 ,,	50 ,,

The French munition loaf weighs 1·5 kilogrammes (3·3 lbs. avoirdupois), and contains two rations of 760 grammes (each 1·65 lb.) The ration of biscuit is 550 grammes (1·2 lb.)—(Code des Officiers de Santé, 1863.)

Nutritive Value of Bread.—The nitrogenous substance contained in bread is to the carboniferous as 1 to 6·3. It therefore requires more nitrogen for a perfect food. It is more digestible than flour. No satiety attends its use, although it may be always prepared in the same way. This is probably owing to the great variety of its components. A certain proportion of bread should form an addition to every meal. It should not be taken new. Fatal accidents have occurred from the distension of the stomach by an excessive meal of newly-baked bread. Young infants should not be fed upon bread—in various forms a practice common enough, but reprehensible in the last degree. Bread given to infants always occasions disorder, griping, and flatulence. The following tables illustrate the nutritive values of the ordinary English bread, and the bread of the French and Austrian commissariat:—

ENGLISH BAKER'S BREAD.

Water	37	Nitrogenous } Total p. ct.	8·1
Albumen	8·1	Carbonaceous starch } Total p. ct.	55·00
Starch	47·4	Carbonaceous to 1 nitrogen	6·8
Sugar	3·6	Nitrogen } Total p. ct.	1·25
Fat	1·6	Available carbon } Total p. ct.	28·21
Salts	2·3		

	Water.	Nitrogenous Substances.	Fat.	Starches.
French Commissariat—				
Old formula	41	7·2	1·5	47
New formula	35	7·9	1·5	52·6
Austrian Commissariat	45·50	6·2	1·4	46

M. Poggiale analysed samples of bread supplied to ten different European armies, the results we append:—

	Nitrogen obtained.	Nitrogen calculated.
Paris	2·26	14·69
Grand Duchy of Baden	2·24	14·56
Piedmont	2·19	14·23
Belgium	2·08	14·52
Holland	2·07	13·45
Stuttgart	2·06	13·39
Austria	1·58	10·27
Spain	1·57	10·20
Frankfort	1·44	9·36
Bavaria	1·32	8·73
Prussia	1·12	7·28

In the usual English military-hospital bread the nitrogen contained is from ·9 to 1·12 per cent. of the undried bread, or 1·7 per cent. of dried bread.

Bread is poor in fat, hence the common practice of using fat with it in the shape of butter, dripping, or fat bacon.

Bread badly prepared gives rise to dyspepsia, flatulence, and unpleasant sensations, such as heartburn, &c.; this is said to be caused by using bad yeast. The fermentative changes, when inferior yeast is in the bread, go on in the stomach, when much carbonic acid is disengaged, and the distressing symptoms we have enumerated are the results.

A substance called by Reichenbach *assamar* is said to be contained in the crust of bread, and its particular action is described as that of retarding tissue metamorphosis. We have not, however, yet received confirmation of the presence of this waste-preventing substance.

The next table shows the composition of the ash of the different cereal grains which have been used for the purpose of bread-making.

	Wheat.	Barley with Husk.	Oats.	Rye.	Indian-corn.	Rice.
Potash	23·72	13·64	} 26·18	22·08	} 32·48	18·48
Soda	9·05	8·14		11·67		10·67
Lime	2·81	2·62	5·95	4·93	1·44	1·27
Magnesia	12·03	7·46	9·95	10·35	16·22	11·69
Oxide of iron	0·67	1·48	0·40	1·36	0·30	0·45
Phosphoric acid	49·81	38·96	43·84	49·55	44·87	53·36
Sulphuric acid	0·24	0·10	10·45	0·98	2·77	...
Chlorine	...	0·04	0·26	...	0·18	0·27
Silica	1·17	27·10	2·67	0·43	1·14	3·35
Alumina	...	0·21	0·06	...	...	...
	99·50	99·75	99·76	101·35	99·40	99·54
Percentage of ash	about 2·0	2·84	2·18	2·425	about 1·5	1·00

New and Stale Bread.—Bread, as we have previously remarked, is more digestible the day after it is baked, for new bread is gummy in its nature, and is difficult of mastication. It is very generally supposed that the change which takes place in the properties of bread which has been kept for a few days is owing to the loss of water by keeping. This, however, is not the case. The crumb of newly-baked bread when cold contains about 45 per cent. of water, and that of stale bread contains almost exactly the same proportion. The difference in properties between the two depends simply upon difference in molecular arrangement. Boussingault found that a loaf which had been kept for six days, though it had become very stale, had not lost more than 1 per cent. of its weight when new. This same loaf was then placed in the oven for an hour, and at the end of that time it had acquired all the properties and appearance of new bread, although during the second baking it lost 3½ per cent. of water. In another experiment, a portion of bread was enclosed in a tight case to prevent loss of water by evaporation, and allowed to become stale; it was then heated, and was thus restored to the condition of new bread. These effects were produced alternately, many times in succession, upon the same piece of bread. A heat of about 131° (55° C.) was found to be sufficient to reconvert stale into new bread.

The amount of bread daily consumed in Paris by each inhabitant has been calculated not to exceed 508 grammes (the gramme equals 15·432348 grains), and the mean quantity taken by each Londoner to be 350 grammes.

Fungi.—When bread has been kept a few days and has become stale, certain species of fungi are apt to become developed, such as *Penicillium glaucum*, which forms the green mould of cheese; the *Fermentum cerevisiæ*, or yeast fungus; the *Oidium aurantiacum*, an orange-red mould; the *Puccinia graminis*, and others.

Diseases connected with the Quality of Flour and Bread.—The flour may be *ergotised* or *grown*, and fermenting with fungi forming.

The continuous use of ergotised bread causes the poisonous symptoms of ergot, which in its most intense form gives rise to dry gangrene; in its less severe forms, to violent intestinal symptoms. Ergot is more common in rye-flour, but is also met with in wheat. Fermenting bread gives rise to indigestion, and acid bread to diarrhœa. Fungi, more especially the *Oidium aurantiacum*, also give rise to diarrhœa.—(BONDIN and FOSTER, Archives Gen. de Med., 1848, p. 244.)

Oats attacked by the *aspergillus* (mouldiness) have given rise to paralytic symptoms in horses, so that these fungi should be looked upon with considerable suspicion.

It is not known that the acarus, so common in flour, has any bad effects when eaten. *See* also articles ACARI and FLOUR.

Adulterations.—The following substances have been discovered in bread with more or less frequency:—

Ammonia (sesquicarbonate).	*Potash* (carbonate and bicarbonate).
Beans.	*Potatoes.*
Bone-dust.	*Rice.*
Dari (an Egyptian grain).	*Soda* (carbonate and sesquicarbonate).
Chalk.	*Starch* (potato).
Clay.	*Water* in excess.
Copper (sulphate).	*Zinc* (sulphate).
Lime (sulphate, from the soda-water makers).	*Alum.*
Magnesia (carbonate).	*Barley.*
Kessaree dholl (India).	*Panicum italicum* (Indian millet).
Plaster-of-Paris.	

In addition to the above, foreign observers have found *borax*, *alabaster in powder*, *salep*, and *orris-root*.

Ammonia carbonate and *magnesia carbonate* are employed to realise the important consideration of producing light and porous bread from spoiled, or, as it is technically termed, sour flour. If carbonate of magnesia be used in large quantities, it may prove injurious to health; for during fermentation lactic acid is developed, and the carbonate of magnesia becomes converted into a lactate, which has a purgative action.

Carbonate and *bicarbonate of potash.*—Both these salts are used for the same purposes as ammonia and magnesia.

Marine salt has the effect of making the bread more compact, and hence heavier. In 1848 it was discovered that the bakers of Nantes had been in the habit of using salt which had been previously employed for the purpose of salting sardines, cod, &c. Heads of sardines and scales of the cod were even found in the bread.

Borax has been discovered by M. Duville in second-quality bread; this adulteration was probably accidental.

Chalk, *clay*, *alabaster*, and similar substances have been used with the object of increasing the weight.

Barley, *beans*, *peas*, and *dari* are frequently mixed with flour. According to the evidence before the Adulteration Committee, wheat-flour is frequently mixed with as much as 25 per cent. of barley. Bean-flour is added not so much for the sake of profit, as with the object of rendering certain descriptions of flour more tenacious when made into dough, and is especially used as an addition to damaged flour; the proportions are from 1 in 40 to 1 in 60, or even more. *Dari* is an Egyptian grain, at one time imported for the purpose of mixing with wheaten flour.

White peas improve the appearance of flour, but not the quality, and are put in to cheapen it.

Water in excess.—The natural quantity of water has been estimated at 66 parts in 150; many practices are, however, resorted to to increase this amount. One of the principal means employed to attain this end is the addition of rice-flour, which, swelling up, absorbs more water than wheat-flour. Potatoes added in large quantities have probably the same effect. The addition of rice is highly reprehensible, as the amount of gluten contained in it is, when compared with wheat, excessively small, and potatoes are equally deficient in gluten.

Another method employed to increase the quantity of water in bread is, after having incorporated with the dough as much water as possible, to put the loaf in a very hot oven; this causes the crust to form speedily, and thus the escape of water is prevented. The same object is to a certain extent effected by throwing sacks over the loaves when removed from the oven.

Sulphate of copper.—Some few years since, the inhabitants of the Continent and this country were considerably startled by the discovery that many of the Belgian bakers were in the habit of mixing sulphate of copper with their bread, for the purpose of improving its appearance and making it lighter.

This practice has also been resorted to in Holland and in some parts of France. In 1844 a whole Belgian family were poisoned from bread adulterated with sulphate of copper: before that date, in 1841 and 1843, several bakers were punished with great severity for this offence. The quantities used ordinarily to adulterate bread with this substance are, according to M. Kuhlmann, extremely small, viz., ·47 grains to 200 loaves, each weighing 2·2 lbs. avoirdupois; there is, however, the danger of unequal admixture.

Sulphate of copper added to bread, even in such a small quantity as $\frac{1}{70000}$ part to 1 part of dough, has a very apparent effect on its rising. This amount (*i.e.*, $\frac{1}{70000}$ part) would be equal to *one* part of metallic copper in 300,000 parts of bread, or ·05 of the sulphate of copper in 3·75 kilogrammes. The proportion which gives the greatest degree of lightness is from $\frac{1}{300000}$ to $\frac{1}{150000}$ part to 1 part of dough. Should a larger quantity than this be used, the bread is too moist, it becomes very white, and acquires a disagreeable odour, similar to the smell of yeast.

The largest quantity which can be employed without damaging the bread is $\frac{1}{3000}$ part to 1 part of dough. If the quantity used be larger than this, the bread is very watery, and presents large cavities; on the addition of $\frac{1}{1800}$ part of sulphate of copper, the paste does not rise, fermentation is stopped, and the bread assumes a green colour.

M. Malapert of Poitiers has discovered in the wafer-bread (*pains à cacheter*) of that town large quantities of *vert métis* (arsenite of copper). Each of these wafers, weighing about ·20 grammes, contained about 30 to 35 per cent. of the poison.

Tardieu informs us that specimens of the *pains de gélatine* have been found so highly coloured as, in point of fact, to consist only of a mixture of sulphate of copper and iron.

In India, a vetch, *Lathyrus sativus*—Kessaree-dholl—is occasionally used with wheat and barley. Dr. Irvine in the "Indian Annals" has described a peculiar form of paralysis of the legs which this vetch, when it exceeds $\frac{1}{12}$ part of the flour, gives rise to. The *L. Cicera* has the same effect.

Lime-water has been recommended by Liebig for the purpose of whitening bread made from musty or damaged flour.

Microscopic Characters of Bread.—Under the microscope, starch-cells broken up into angular masses, or greatly enlarged, and stringy masses of gluten, are usually seen; besides this, high powers frequently discover bacteria in the shape of rods, the source of which is probably the yeast. Great care must be taken lest the serious mistake should be made of mistaking the many curious forms the broken-up wheat-starch presents for adulteration. By practice and the constant examination of the characters of unadulterated bread, and a practical knowledge of the appearance different starch-grains assume after being more or less changed in shape by cooking, it is possible to detect by the microscope rice-flour, bean-flour, and Indian millet; but barley-flour and potatoes both present great difficulties. There is very little difference in the shape of the barley starch-granule and that of the wheat, and in the process of bread-making the potato-granules are so changed as to confuse all their distinctive characters. Bone-dust and a few other mineral adulterations may also be detected by the microscope.

Alum.—The custom of mixing alum with bread is a remarkably old one, at any rate in this country, and appears to have been practised from the earliest times. It is used to prevent an excess of fermentation when the altering gluten or cerealin acts too much on the starch, and it also whitens the bread; it does not increase the amount of water, as generally supposed, and it enables wholesome bread to be made from flour which otherwise could not be used.

The dangers which are said to arise from this practice have probably been much exaggerated. The amount of alum added is really small; indeed, as Mr. Wanklyn has observed, the addition of large quantities of alum would render the bread unsaleable.

Alum, Detection and Estimation of.—The detection of the presence of alum in bread is easily effected by Mr. Horsley's method. An alcoholic solution of logwood containing an excess of carbonate of ammonia colours alumed bread blue. To use the test, the bread-crumb is simply soaked in the liquid for six or seven minutes, and then squeezed. This will show the presence of alum in so small a quantity as 7 grains in the 4-lb. loaf. With such minute quantities the colour is of a light blue, and there are gradations of colour up to 30 grains, by which a practised observer can estimate the quantity of alum present. At about 30 grains the colour becomes so dark that the gradations are lost, and no approximation to the quantity of alum can be made by the eye. The obvious objection to the test is that carbonate of magnesia and some other substances also produce a blue coloration. Still the analyst, if the logwood test responds, knows that there is something wrong, and will submit the bread to a closer examination; while, if the test fails, it is certain the bread does not contain any appreciable amount of alum.

Determination of Alum.—Of the numerous methods, good, bad, and indifferent, which have been proposed for the estimation of alum in bread, that worked out by Dupré (slightly modified by Wanklyn) is the one now generally practised. Its principle is this: the ash of bread consists of silica, common salt, phosphates of lime and magnesia, a trace of phosphate of iron, and, if alum be present, phosphate of alumina. Phosphates of lime and magnesia are soluble in acetic acid, phosphates of alumina and iron insoluble. The whole of the phosphates are therefore precipitated, the phosphates of alumina and iron separated by dissolving the others out, the alum and iron weighed, the amount of iron determined volumetrically, and the difference is the alum.

The actual operation is performed by taking

100 or 200 grammes of bread, and burning it down to an ash, either in a muffle or a large platinum dish. The ash obtained is moistened with from 5 to 10 c.c. of strong hydrochloric acid, and then 30 or 40 c.c. of distilled water is added, the whole filtered, boiled, and the precipitate well washed with boiling water. The precipitate may be removed from the filter, burnt, and weighed. It consists entirely of silica. The phosphates are in the filtrate; the filtrate is accordingly treated with 5 or 10 c.c. of liquor ammonia, which precipitates the phosphates. Then the liquid is rendered powerfully acid by acetic acid, boiled and filtered. Phosphate of alumina, contaminated by a little phosphate of iron, remains in the filter. The amount of the latter substance is determined by a volumetric process (best by the ferrocyanide of potash test) calculated into phosphate of iron, and subtracted from the weight of the phosphate of alumina.

Other Mineral Adulterations.—If any other mineral adulterant besides alum has been used, it cannot fail to be detected by a careful examination of the ash. The ash of bread varies from 1·3 to 2 per cent. Any weight beyond 4 per cent. most certainly must be looked upon with suspicion, and if no alum is found, may be examined for magnesia, &c.

Bread-Fruit (*Artocarpus incisa*), nat. order *Grammaceæ.* Found in Central America, the South Sea Islands, and the islands of the Indian Archipelago. Its composition is principally starch, sugar, and water, the latter in the large proportion of 80 per cent. It is gathered when the starch is in a mealy condition, peeled, wrapped in leaves, and baked between hot stones. Its taste is then very similar to sweet bread. The natives of the above places also have a method of preserving it, by allowing the nitrogenous parts to putrefy in water-tight pits. They ultimately obtain a mass of the consistence of soft cheese, which, when required for use, is baked in the same way as the fresh fruit.

Bricks and Brick-Fields.—Brick-fields exhale a very peculiar unwholesome odour, the exact cause of which still remains obscure. The gases which are evolved from the kilns are carbonic anhydride, carbonic oxide, and sulphuretted hydrogen, mixed with sulphurous and muriatic acid fumes. Hence it is very quickly fatal if breathed in a concentrated form.

In the burning of bricks household breeze is used as a fuel; in other words, refuse household ashes, and these nearly always contain salt. The alkali combining with the clay, and forming a fusible glass, sets the muriatic acid free, which escapes in the form of gas. The remedy for this is easy. The brickmaker need not use household breeze at all, but coke instead; or if he use household breeze, he can purify it from the salt by exposing it to the action of the weather for some time. It is mainly the acid fumes, which are certainly preventable, that destroy the vegetation around brick-fields to such a large extent.

So loud have been the complaints in some parts of France of the effects of brick-making on the surrounding herbage, that in the north of France it is enacted—(1.) That bricks shall not be burnt within 50 mètres (54½ yards) of the public road. (2.) That the ovens shall be covered with cloth and straw matting to protect the neighbourhood from the disagreeable effects of the smoke. (3.) Brick-fields are not allowed to be established near nurseries; and (4.) the ovens are only permitted to be lighted at night.

Persons whose property has been injured by the fumes arising from the brick-furnaces, can in France recover an indemnity from the owners of the brick-fields for the loss sustained. In England, in almost all the actions brought against brick-manufacturers, nothing more than a nuisance has been established.

Workers at this particular industry are subject to many complaints. Those obtaining the clay, which necessitates their remaining for hours at a time on damp and humid earth, are frequently attacked with obstinate and weakening fevers. Those whose duty it is to knead the clay suffer from the same effects, and are subject to diseases which are likely to attack those whose lives are passed on damp soils.

The workers who attend more particularly to the baking, suffer not unfrequently from disease of the eye.

The grinders are subject to inflammation of the synovial sheaths and articulations of the hands. This particular state is termed by French writers *craquement des ligaments.*—(RAMAZZINI, TURNER, THACKRAH, HALFORD.)

Public attention, in the year 1873, was particularly directed to the state of the children employed in our brick-fields by Mr. George Smith, who eloquently pointed out the degradation of their mental and physical nature, directly induced by the conditions under which they obtained a laborious livelihood. Mr. Smith at length succeeded in getting the Legislature to extend the principle of the Factory Act to the brick-fields.

For the purposes of hygiène, hollow and waterproof bricks are the best—the first for ventilation and lightness, the last for preserving the dryness and integrity of our homes under all the vicissitudes of climate, season, and weather, either on damp soils or dry ones.

To preserve buildings from the blackening influence of the smoke of large towns, Dr. Angus Smith has recommended the use of smooth bricks. "Polished or glazed bricks," he says, "would render the rain capable of washing the carbon off, but certainly it will be much better not to allow it ever to arrive there. The importance of preserving the beauty of the original materials is daily increasing."

Formerly a peculiar kind of brick (*fornacea testæ*, or tiles) was bruised in vinegar, and the liquid used as a specific in cutaneous affections. It entered into a cerate used for herpetic and other eruptions, &c. To the *terra fornacum*, or brick-earth, the same virtues were assigned. Hot bricks are sometimes used to apply heat to a part, as to the abdomen in colic, or after the operation for popliteal aneurism; or reduced to a very fine powder and mixed with fat, as an application to herpetic and psoric affections.

Charcoal, coal, and some bituminous substance have been amalgamated together in the shape of bricks, and have been found a clean and economical fuel. They are retailed under the title of firebricks.

Whether brick-making or brick-burning is a nuisance or not depends upon circumstances, nor is there any general rule as to distance from occupied houses laid down. An injunction was, however, granted in the case of Roberts *v.* Clarke (118 L. T., 49), in which the burning took place at 240 *yards* from habitations; and it is clearly established that the fumes from a brick-kiln reaching dwelling-houses are a nuisance (Evans *v.* Smith, Trinity Term, 1867). The principal cases, besides the two quoted, bearing upon brick-burning up to the present time, are Beardmore *v.* Tredwell, injury to trees from brick-burning, injunction granted (31 L. J., Ch. 892; 7 L. T., 207); Cavey *v.* Leadbetter, allegation of convenience of place no answer to an action (32 L. J., C. P., 104; 13 C. B. (N. S.), 470; 3 F. and F., 14); Luscombe *v.* Steer, the brick-burning must be a material injury to property or personal comfort (17 L. T., 219; 15 W. R., 1191).

Bridges—Any urban authority may agree with the proprietors of any canal, railway, or tramway to adopt and maintain any existing or projected bridge, viaduct, or arch within their district, over or under any such canal, railway, or tramway, and the approaches thereto, and may accordingly adopt and maintain the same as parts of public streets or roads maintainable and repairable at the expense of such urban authority; or such authority may themselves agree to construct any such bridge, viaduct, or arch at the expense of such proprietors; they may also, with the consent of two-thirds of their number, agree to pay, and may accordingly pay, any portion of the expenses of the construction or alteration of any such bridge, viaduct, or arch, or of the purchase of any adjoining lands required for the foundation and support thereof, or for the approaches thereto.

Bromine — so named from βρωμος, a stench—was discovered by Balard in 1826, in bittern. It is a dark-red volatile liquid, its properties resembling chlorine and iodine. Relative weight, 80; theoretic sp. gr. of vapour, 5·528; observed, 5·54; sp. gr. of liquid at 32° F. (0° C.), 3·187. It is a disinfectant, and was used largely in the late American war for this purpose; but it has not found much favour in this country, as chlorine is more active, cheaper, and less irritating to the lungs. If required to be used, a solution of bromine in bromide of potassium is placed in saucers and exposed to the air.

Bronzing—*See* TRADES, INJURIOUS, &c.

Brose—Oatmeal stirred with boiling water until it has the consistence of hasty-pudding. This, more diluted and boiled for a short time, makes *porridge*. *See* OATMEAL.

Broth—A very nutritious broth, containing the albumen of the meat as well as the soluble extract, is obtained by infusing a third of a pound of minced meat in 14 ounces of cold soft water, to which a few drops (4 or 5) of muriatic acid and a little salt (from 10 to 18 grains) have been added. After digesting for an hour or so, it should be strained through a sieve, and the residue washed with 5 ounces of water, and pressed. The mixed liquids thus obtained will furnish about a pint of *cold extract of meat*, containing the whole of the soluble constituents of the meat; and it may be drunk cold or slightly warmed, the temperature not being raised above 100° F., for fear of coagulating the albumen.—(LETHEBY.) In broth we find the following substances: Albumen, gelatine, creatine, fatty matter, inosic acid, combined with baryta and potash; several complex extractive matters; lactates, phosphates, and chlorides, united with potash and soda, and sometimes traces of lime and free soda.

Brucia (Brucine) $C_{23}H_{26}N_2O_4 2H_2O$—This alkaloid was discovered by Pelletier and Caventon in the bark of *Bruceæ antidysenterica*. It is also associated with strychnine in *Nux vomica*.

Brucia crystallises in colourless transparent oblique rhombic prisms. When thrown down by ammonia from a solution of the acetate, it presents itself in long curved needles or in tufts.—(GUY.)

Brucia dissolves in about 900 parts of water, 440 of ether, but is freely soluble in benzole, amylic alcohol, chloroform, and absolute alcohol.

Brucia is distinguished from strychnine by the intense red colour it strikes with nitric acid. The further addition of protochloride of tin produces a violet shade. If this test is applied to a rather considerable quantity of brucine, a colourless gas is developed, with an odour of *pommes de reinette*, inflammable, burning with a greenish flame, and depositing crystalline orange - red flakes, insoluble in water, and even in boiling alcohol.—(TARDIEU, Sur l'Empoisonnement.)

Brucia is a violent poison. Its effects are very similar to those of strychnine. *See* STRYCHNIA.

Brushmakers—Workers at this particular industry are subject, from the inhalation of dust, to phthisis. *See* PHTHISIS; TRADES, INJURIOUS, &c.

Buckwheat — The seed of *Fagopyrum esculentum*, cultivated in this country as food for pheasants, but largely used in North America for making "buckwheat cakes," eaten at breakfast, &c. The following table gives its composition:—

Composition of Fagopyrum in 100 *parts* (PARKES).

Water	12·754
Nitrogenous matter	2·645
Dextrine	2·850
Sugar	0·914
Fat	0·943
Starch	79·894

The ash is about 1·09 per cent., and contains chiefly potash, magnesia, and phosphoric acid.

Buffalo Extract—An extract made principally in the Dutch East Indian possessions from the flesh of the buffalo, and sometimes exported to Holland. A sample of buffalo extract examined by Dr. Pott contained 20·9 per cent. water, 62·7 extractive, and 16·4 ash or mineral matter.

Buildings—An *urban* sanitary authority has considerable power over buildings, especially the erection of new buildings. Some of these powers they possess under statutes, and others they can obtain by bylaws. *See* BY-LAWS.

The re-erection of a building pulled down to the ground-floor, or of any frame building of which only the framework is left down to the ground-floor, or the conversion into a dwelling-house of any building not originally constructed as such, or the conversion into more than one dwelling-house of a building originally constructed as one dwelling-house only, are, for the purposes of the Public Health Act, 1875, to be considered "the erection of a new building."—(P. H., s. 159.)

No house or building may be brought forward beyond the fronts of the houses in an urban district without the written consent of the urban authority, under a penalty of 40s. per day whilst the offence continues after written notice.—(P. H., s. 156.)

The line of buildings is sometimes a matter of great dispute. The general line of buildings in a proceeding under the Metropolis Local Management Act, s. 7, was ultimately ruled by the Court of Queen's Bench "to be the general line as fixed by the superintending architect of the Metropolitan Board of Works."

When a house or building situated in a street in an urban district has been taken down, the urban authority may prescribe the line in which the front of any building erected in its stead is to be built.—(P. H., s. 155.)

An urban sanitary authority may make bylaws—

(1.) With respect to the structure of walls, foundations, roofs, and chimneys of new buildings, for securing stability, the prevention of fires, and for purposes of health.

(2.) With respect to the sufficiency of space about buildings to secure a free circulation of air, and with respect to ventilation.

(3.) With respect to the drainage of buildings, the provision of water-closets, privies, ashpits, &c., and the closing of buildings or parts of buildings unfit for human habitation, and the prohibition of their use for such habitation.

Bylaws made by urban authorities with regard to buildings under the 157th section of the Public Health Act are not to affect any building erected "in any place (which at the time of the passing of the Public Health Act was included in an urban sanitary district) before the Local Government Acts came into force in such place, or any building erected in any place (which at the time of the passing of this Act is not included in an urban sanitary district) before such place becomes constituted or included in an urban district, or by virtue of any order of the Local Government Board subject to this enactment."—(P. H., s. 157.)

An urban sanitary authority has power to cause their surveyor to examine buildings and walls, and if they are in a dangerous and ruinous state, to give notice to the owner or occupier to take down, repair, or secure the building. On non-compliance, action is taken before two justices, who can make an order for the owner or occupier to do what is necessary; and on non-compliance, the sanitary authority has power to take down, repair, rebuild, or secure, and recover the expenses from the owner; and if he does not pay on demand, a justice may issue a warrant and levy by distress; and if the owner cannot be found, or sufficient distresses on his goods and chattels cannot be made, the authority, on giving twenty-eight days' notice, may sell or otherwise dispose of such building or land, and deduct the expense out of the compensation provided to the owner by the Lands Clauses Consolidation Act, 1845.

No building may be erected over a sewer without the written consent of the authority. —(P. H., s. 26.)

Any sanitary authority may provide buildngs for the disposal of sewerage. *See* BY-LAWS, &c.

Bunt (*Uredo caries*, DEC.; *Uredo fœtides*, BAYER)—A fungus found in wheat. It has an extremely repulsive odour. The spores, highly magnified, are easily recognised, for they are large and reticulated.

Burgundy—*See* WINE.

Burnett's Disinfecting Fluid—A concentrated solution of chloride of zinc. *See* DISINFECTANTS.

Business, Conduct of — Every urban authority is to maintain and provide from time to time offices for the conduct of business.

Every urban authority, not being the council of a borough, is to hold an annual meeting, and a meeting for the transaction of business at least once a month.—(P. H., s. 199.)

Every local authority is to make an annual report, in such form and at such time as the Local Government Board may from time to time direct, of all works executed by them during the preceding year, and of all sums received and disbursements made under and for the purposes of the Public Health Act, and must publish the same in some newspaper circulating in the district, and send a copy to the Local Government Board.—(P. H., s. 206.)

For further information as to the conduct of business, *see* SANITARY AUTHORITIES, DISTRICTS, LOCAL BOARDS, &c.

Butter—Butter principally consists of the fatty portions of cow's milk. By violently agitating cream, the oil globules of the cream break up, coalesce, and form a fatty mass, which is washed, pressed, worked up by the hand, and mixed with a small quantity of salt. Butter made in this way consists of fat, caseine, water, and salt.

1. *The fat* of butter consists of a mixture of the glycerides of the fatty acids, palmitic, stearic, and oleic, as well as butyric, caproic, caprylic, and capric acids.

Palmitic acid is derived from palmitine, a white solid fusing at 36° C. (96·8° F.)

Stearic acid is derived from stearine, which is also a white solid, having a higher fusing-point, viz., 63° C. (145·4° F.)

Oleine is at ordinary temperatures an oily liquid, solidifying at 5° C. (41·0° F.)

Butyric acid ($C_4H_8O_2$) occurs in no other fat except butter. It is a volatile liquid. Sp. gr., 0·98; relative weight, 44; boiling-point, 157° C. (314·6° F.) This acid is monobasic, and forms crystalline salts called butyrates.

Caproic, capric, and caprylic acids are also volatile. Bromeis estimated the volatile acids in butter fat at 2 per cent., but Messrs. Angell and Hehner assert that butter fat contains nearly 10 per cent. of volatile acids. —(Butter, its Analysis and Adulterations, by ARTHUR ANGELL and OTTO HEHNER.)

2. *Water.*—The amount of water in normal butter may vary from 5 to 18 per cent. If under 5 per cent., there is a suspicion of the butter having been adulterated with foreign fats containing no water; if above 18 per cent., water has probably been added, or the proper degree of pressure has not been applied to press the milk, &c., out.

3. *Caseine.*—The caseine in butter varies from 2 to 5 per cent. An undue amount of caseine acts as a ferment, and induces decomposition.

4. *Salt.*—The salt in butter averages 2·5 per cent.; in very salt butter it may be as high as 28·6 per cent.; it should never exceed 8 per cent.—(*Op. cit.*, p. 8.)

Fresh butter is of an equal colour throughout, and has an agreeable odour. Streaks indicate lard, and a sour smell imperfect washing. A knife thrust into rancid butter acquires an unpleasant smell; the rancidity is due in great measure to changes in the caseine. Such butter has been known to produce diarrhœa and indigestion.

Methods for the Preservation of Butter.— The Tartars and the French have been long in the habit of preserving butter by melting it with a moderate heat, whereby are coagulated the albuminous and curdy matters remaining in it, which are very putrescible. This fusion should be made by the heat of a warm bath about 176° F., continued for some time, to effect the more complete purification of the butter. If in this settled liquefied state it be carefully decanted, strained through a tammy-cloth, and slightly salted, it may be kept from six to nine months perfectly fresh. Dr. Anderson's plan for the preservation of butter is as follows: Take of saltpetre and white sugar, of each, 1 oz.; best Spanish great salt (or Cheshire large-grained salt) 2 oz., all in very fine powder; mix thoroughly, and add

1 oz. of this mixture to every pound of butter, and thoroughly incorporate them together. The butter thus prepared is then to be pressed into clean glazed earthenware vessels, or well-seasoned casks, so as to leave no vacuities. Butter thus prepared, says Dr. Anderson, will keep in a cool place for years, and will bear a voyage to the East Indies if it be packed so that it does not melt. At the end of the first three or four weeks it acquires a rich marrow-like flavour, which no other butter ever possesses. M. Breon recommends that water acidulated slightly (3 grammes to 1 litre) with acetic or tartaric acid should be added to the butter, and the whole placed in a close-fitting vessel. This plan appears to answer its purpose remarkably well.

The common proportions of the best salt butter of the shops are—fresh butter, 21 lbs. ; salt, 1 lb. ; saltpetre, 1 oz. : or, fresh butter, 18 lbs. ; salt, 1 lb. ; saltpetre, 1½ oz. ; honey or fine brown sugar, 2 oz. ; this latter is the best.

Rancid butter may be restored, or in all cases greatly improved, by melting it in a water-bath with some fresh-burnt and coarsely-powdered animal charcoal (which has been thoroughly freed from dust by sifting), and straining it through clean flannel.

The nutritive value of butter differs but little from that of other fats, with the exception that, being fat in one of its most pleasant forms, more can be taken into the system than in the case of other edible fats, as beef, pork, &c. The nutritive value of butter, &c., may be gathered from the following table:—

	Water.	Fat.	Salt.	Carbonaceous Starch.	Available Carbon.
Butter and fats......	15	83·0	2·0	207·50	92·22

Adulterations of Butter.—The most common adulteration is the incorporation of large quantities of water with the butter. Professor Calvert, in his evidence before the Parliamentary Committee, remarks, "The quantity of water and salt that such an article as butter ought to contain is 2½ per cent. of salt and 10 per cent. of water." Mr. Wanklyn, however, gives the amount in fresh Devonshire butter as 16·2 of water and 1·1 of salt; and in Normandy butter the quantity of water is 16·1, and that of salt 1·8, in 100 parts. Mr. Wanklyn examined a great many butters supplied to the London workhouses; the amount varied from 8·6 to 23·7 parts of water in a 100 parts of butter, the samples containing the lowest and highest quantity being described as "wretched." Hassall has found as much as 35 per cent. of water in butter, and Messrs. Angell and Hehner 42·35 per cent. A method said to be adopted by the trade to adulterate butter is as follows: The butter is brought to the melting-point, water and salt are then stirred in until the mixture becomes cold. The inferior kind of butter known as "bosh" (*see* BOSH BUTTER) is occasionally mixed with *starch*, generally potato-flour. The adulteration is only practised at a certain time, and depends on the wholesale price of butter. Sir John Gordon, Mayor of Cork, in his evidence before the Parliamentary Committee, mentions curds as an adulteration to which butter is sometimes subjected. Animal fats are also occasionally used, such as lard, beef, mutton, veal, and horse fat. A process has lately been devised by Mege Mouries (Pharmaceutical Journal, October 1872) for mixing beef suet with butter.

The beef suet is melted in warm water, with carbonate of potash and portions of fresh sheep's stomachs. The fat, thus separated from the cellular tissue, is cooled and subjected to hydraulic pressure, when the oleo-margarine is separated from the more solid stearine (which is used for candle-making) and mixed with milk, with a little of the soluble matter obtained by soaking cows' udders in milk, and with aunatto, and is then churned. This process, it is obvious, could only be practised on a large scale.

Scraped carrots and annatto are the common substances used to colour butter. There is a practice very prevalent of making from salt butter a so-called fresh butter. Irish salted butter of a very inferior quality is used for this purpose. This is repeatedly washed with water, in order to free it from the salt. This being accomplished, the next process is to wash it frequently with milk, and the manufacture is completed by the addition of a small quantity of sugar.

Wheat-flour, oatmeal, pea-flour, &c., are also said to be used for the sophistication of butter, but such adulterations are extremely rare.

M. Chevallier gives the following as a list of the adulterations found in French butters: Chalk, potato-starch, cooked potatoes, wheat-flour, good butter mixed with butter of an inferior quality, carbonate or acetate of lead. saffron, juice of carrot, alkanette, flowers of marigold, aspergrallus berries, the fruit of the winter cherry, and the juice of celandine to give it a yellow colour.

We now proceed to give the most recent methods of analysing butter.

Analysis of Butter.—For a quantitative analysis of butter, the best process is most decidedly the one devised by Mr. Wanklyn, and described under MILK ANALYSIS. The processes are really identical, thus—

Water.—Carefully weigh 1 gramme of butter, and evaporate it in one of the milk-analysis platinum dishes (fig. 15) from four to

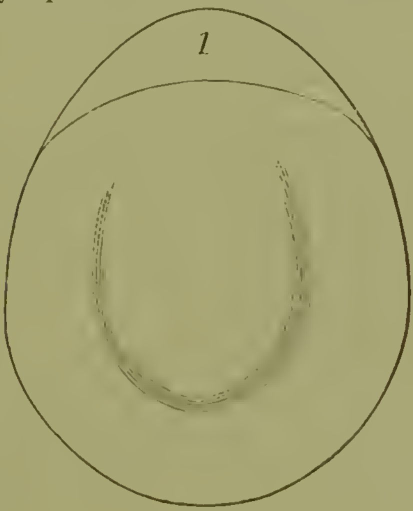


Fig. 15.

six hours, or even more—in fact, until it ceases to lose weight. The loss of weight is the water, and should be calculated and expressed in percentages.

Fat.—The dried butter is now to be heated with ether (the ether should be made to boil by floating the dish in hot water). Several successive portions should be taken, the whole passed through a filter, the filter well washed with ether, and the filtrate evaporated to dryness and weighed.

Caseine and Ash.—The residue from which the fat and the water have been extracted is now to be taken, carefully weighed, then burned down at a low red heat; the residue remaining is the ash, the loss the caseine.

The amount of ash, practically speaking, is the salt; but if there is any doubt as to its composition, the chlorine may be estimated by a volumetric solution of nitrate of silver, and further examined. The following table shows the composition of a few genuine and other butters examined according to the same, or at least a similar process to the one described:—

	Fat.	Ash—principally Salt.	Water.	Caseine.	Quality.	
Fresh Devonshire butter	82·7	1·1	16·2		Good	Wanklyn.
Normandy butter	82·1	1·8	16·1		,,	,,
Jersey butter	78·491	8·528	10·445	2·536	,,	Angell and Hehner.
Normandy butter	82·643	2·915	9·305	5·137	,,	,,
Butter from Ventnor	86·280	6·600	3·831	3·289	Found to be adulterated with foreign fat.	,,
Butter from London	87·580	1·559	23·981	6·880	Adulterated with water.	,,
,, ,,	47·119	2·689	42·358	7·834	Adulterated with water, and contains an excess of curd.	,,

Detection of Foreign Fats.—A really good process for the accurate detection of foreign fats has been long a desideratum. We believe that this a little time ago was impossible, but now the observations of Dr. Campbell Brown, and the processes of Angell and Hehner, will enable any admixture of foreign fats to be determined. Dr. C. Brown proposed placing a weighed portion of butter in a test-tube $\frac{7}{8}$ of an inch in diameter, placing the tube in hot water, and inserting in the tube a thermometer with a pear-shaped bulb; the butter is melted, then allowed to cool, and the exact point observed, both when the stem is obscured and when it is invisible (*vide* table).

Angell and Hehner have proposed a rather more practical plan than this. A bulb is blown the size and shape shown in fig. 16; a little mercury is put into it, until it weighs 3·4 grammes; and if made properly, it displaces 1 c.c. of water. 20 or 30 grammes of the butter to be tested is melted, and then poured into a test-tube and allowed to cool. The test-tube or tubes are immersed in a capacious beaker of water, the little bulb dropped on to the surface of the fat, a thermometer placed in the water, and heat applied. At the exact moment at which

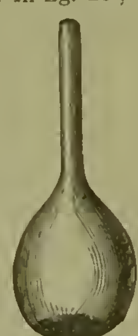


Fig. 16.

the bulb sinks, the thermometer is read. The arrangement is shown in fig. 17.

Fig. 17.

Dr. Hassall has modified this process by employing a float, having a weight of ·18 grammes and a volume of about ·5 c.c., which is placed in the bottom of the test-tube, and fixed there by a little of the melted fat. The bulb of the thermometer he immerses in the fat itself, instead of in the water. He solidifies the fats before remelting by immersion in water of 50° F., and uses tubes of $\frac{1}{3}$-inch diameter. The exact temperature at which the float rises is carefully noted.

The average sinking-point, as determined from twenty-four genuine butters, was 35·5° C. (95·9° F.), the highest and lowest in the twenty-four being 36·3° C. (97·34° F.) and 34·3° C. (93·74° F.) respectively.

The sinking-points of fats other than butter they give as follows:—

	Degrees Centigrade.
Tallow	53·3
Butterine (patented)	31·3
Ox fat, from	48·3 to 53·0
Mutton fat, from	50·1 to 51·6
Lard, from	42·1 to 45·3
Dripping, from	42·7
,, from beef	43·8
,, from veal	47·7
,, mixed	42·6
Cocoa butter	34·9
Palm oil	39·2
Stearine	62·8

They also give the following formula for calculating the sinking-point of a mixture of known composition. Multiply the percentage of the constituents by their respective sinking-points, divide the sum of the products by the sum of the percentage of the constitnents.

e.g., F being fat, and S sinking-point,

$$\frac{F_1.S_1 + F_2.S_2}{F_1 + F_2} = \text{sinking-point.}$$

There is yet another plan, to which most chemists, perhaps, will give preference, and that is taking the melting-point of a fat in a capillary tube. A glass tube about ·2 of an inch bore is drawn out at the end until almost capillary. This fine portion should be about three inches long. The melted fat is drawn up to the height of about an inch, and allowed to cool. Mr. Heisch recommends the employment of two beakers, the one inside the other, the inner beaker containing a thermometer and the tube, with a little water at the bottom of the beaker, the space between the beakers containing water. Heat is applied very gradually, about the rate of 1° F. per minute, and the exact temperatnre at which the fat *rises* carefnlly noted. There are, of course, many modifications of this method, but the principle is good, and admits of wide application. *See* paper on the melting-point of fat in Proceedings of the Society of Analysts, 1875, by Heisch, Tripe, Angell, &c.

Microscopical Examination of Butter.—A thin film of butter placed upon a glass slide and examined by transmitted light shows globules, granular masses, and crystals of salt. There are no crystals of stearine unless the butter has been fused. Other bodies, such as starch, &c., may be detected if present. Something also may be gathered by examining butter by polarised light. Dr. C. Brown's table will illustrate these remarks.

Besides determining the sinking-point, Messrs. Angell and Hehner have worked out a new process for estimating the volatile acids in butter; their process is shortly as follows, and depends upon their assertion that butter *fat* (not butter) contains nearly 10 per cent. of volatile acids; they therefore free the butter from the curd, water, and salt, either by washing with hot water, or more quickly by fusion. A weighed portion of this purified butter fat is taken and saponified. This saponification was at first effected by treatment of the fat with a concentrated solution of caustic potash in a porcelain dish, but the process has been much simplified lately by Mr. G. Turner of Portsmouth, by the use of alcohol. "Three to four grains of fat are weighed into a porcelain dish, capacity about 100 to 150 c.c., melted over the water-bath, and treated with from 20 to 30 c.c. of alcohol or methylated spirit; three-quarters of a stick of potash is added, which is then gradually dissolved by a little water. By adding the water carefully at intervals until this point is reached, no turbidity, or only a transient one, is produced, and afterwards it may be used freely. The soap must now be quite freed from alcohol by boiling. When this point is reached, it remains perfectly clear, has no spirituous smell, and usually a soapy pellicle forms on the surface."

The soap is decomposed by dilute acid, the fatty acids are fused, collected in a weighed filter, and thoroughly washed with boiling water. As the volatile acids are soluble in water, and palmitic, stearic, and oleic are insoluble, the latter remain on the filter, and are dried at 212° F. and weighed.

	When Heated.		On Cooling.				
	Softens at Fahr.	Melts at Fahr.	Obscures Reading.	Stearine indistinct.	Stearine invisible.	Solid at Fahr.	Examined by a Microscope with a ¼-inch Object-Glass with Polarised Light and Selenite Plate.
	°	°	°	°	°	°	
Newly-made butter from town-fed cows	69	76	83	76	73	62	Nothing is seen except globules and curd.
The same salted	69	75	83	75	74	62	Globules, particles of curd, cubical crystals of salt.
Irish butter	75	89	73	71	69	62	Globules, curd, and salt. Does not polarise after being kept for nine months; does not exhibit any crystals which polarise light.
Irish butter, best quality	69	80	78	74	71	66	Globules, curd, and salt. After being kept for eight months exposed to sun is white, but contains no crystals which polarise light, nor after being melted.
Irish butter, low quality	76	89	82	77	74	69	... ...
Cornish butter	72	80	80	78	72	58	... ...
Canadian butter	74	90	71	69	68	66	Globules, curd, large crystals of salt very numerous. The only things visible which polarise light are a few hairs and fibres. After being kept a year exposed to changes of temperature and light, exhibits the same characters.
Canadian butter	73	89	72	70	68	66	Globules, curd, large and numerous crystals of salt; magnesium salts, a few fibres. After eight months is decomposing, but contains no fat crystals which polarise light.
Kiel butter	75	90	74	72	71	70	Globules, curd, and small crystals of salt. Is highly coloured. After eight months presents the same characters. Does not polarise light after being melted and cooled.
Suspected butter	81	96	106	84	76	73	Globules, curd, cubical crystals of salt; stars and other crystals of fat which polarise light.
Lard	84	96	...	...	96	85	Stellar and fusiform crystals which polarise light.
Lard	79	87	80	79	76	68	Full of crystals which polarise light.
Lard	87	96	80	79	78	74	Stellar masses which polarise light.
Palm oil	81	92	...	88	80	69	Corpuscles and radiating masses of crystals which polarise light.
Stearine from palmitine (is really palmitine)	83	88	95	93	88	79	Crystals which polarise light.
Stearine from tallow	105	118	95	94	93	92	Stars and radiating masses of crystals which polarise light.
Butter with 20 per cent. lard	82	96	86	82	76	71	Globules and salt, broken stars which polarise light.
Butter with 20 per cent. tallow. Stearine free from taste	88	99	79	77	76	73	Globules, curds, salt, and minute stars which polarise light.
Butter with 30 per cent. dripping	82	93	92	81	71	71	Globules, curd, salt, colouring-matter; stars and other crystalline particles which polarise light.

The average of twelve analyses gave 85·85 per cent. of fixed acids, and they show that the difference between the quantity of fatty acids in butter and other fats averages 9·65 per cent. An adulteration of 100 per cent. of foreign fat gives a difference of 9·65 per cent.; 10 per cent., ·965, &c. It is probable that the process in skilled hands is of value.

The Society of Analysts have proposed to consider butter adulterated which does not contain 80 per cent. of butter fat. *See* ADULTERATION, &c.

Butterine—A substitute for butter, introduced into this country from New York.

"In general appearance, taste, and consistence it is very similar to ordinary butter; but notwithstanding that its solidifying point is lower than that of some butters, it retains much of the peculiar crumbly texture and fracture of dripping.

"It softens at 78° F., and melts at 86°. When heated and slowly cooled, it obscures the thermometer at 62° and solidifies at 60°. It contains—

Water	11·25 to	8·5
Salt	1·03 to	5·5
Curd,	·57 to	0·6
Fat,	87·15 to	85·4
Colouring-matter,	...	...
	100·00	100·0

"The fat consists of oleine, palmitine, margarine (?), a trace of stearine, and about 5 or 6 per cent. of butter. When dissolved in about four times its weight of ether, and allowed to evaporate spontaneously, it does not deposit any fat until more than half of the ether has passed off, and if the temperature is not below 60°, the deposit is not solid.

"The first deposit, when dried, fuses at 108°; the second deposit fuses at 88°, and solidifies at 64°.

"Under the microscope butterine does not appear to consist of acicular crystals of fat, but of irregular masses, containing a few butter-globules, particles of curd, and crystals of salt. With polarised light, the irregular crystalline structure is beautifully seen, and is clearly distinguishable from butter which has been melted and recongealed. When old and rancid, it acquires the odour and taste of dripping, but it keeps longer undecomposed than butter. When fresh, it is a wholesome substitute for real butter, and if not brought into the market as butter, no one can reasonably take exception to its sale.

"Butterine may be detected by the following characters :—

"1. Its crumbly fracture.

"2. Its loss of colour when kept melted for a short time at 212°.

"3. The behaviour of its ethereal solution.

"4. Its action on polarised light."—(Dr. CAMPBELL BROWN.)

Butyric Ether ($C_2H_5C_4H_7O_2$)—This substance has been found useful as a disinfectant. *See* DISINFECTANTS.

Bylaws, by the summary powers they give, greatly increase the power of sanitary authorities. Urban sanitary authorities are enabled to avail themselves of bylaws to a very considerable extent, whereas rural sanitary authorities can only make bylaws in a few matters. There can be little doubt that it would be a beneficial reform to allow rural sanitary authorities the same powers with respect to this matter as urban, and to have a proper, authorised, official code of bylaws.

All bylaws made by a local authority must be under their common seal, and any bylaw may be altered or repealed by a subsequent bylaw; but no bylaw is of effect if repugnant to the laws of England.—(P. H., s. 182.)

Local authorities may impose penalties by bylaws not exceeding £5; and in the case of a continuing offence a further penalty, not exceeding 40s. per day, after written notice; and they are to be so framed as to permit the recovery of a lesser sum.

Bylaws are of no effect until confirmed by the Local Government Board.

A copy of the proposed bylaws are to be kept at the office of the local authority for one month, and any ratepayer may inspect the proposed bylaws without the payment of any fee or reward; and the clerk of any local authority, on application, is bound to furnish any ratepayer with a copy of such proposed bylaws, or any part thereof, on payment of 6d. for every hundred words contained in such copy.

Notice of intention to apply for confirmation of the proposed bylaws must be given in one or more local newspapers one month before applying. These conditions having been fulfilled, the Local Government Board may confirm them or not; but if confirmed, the confirmation of no other authority is necessary.—(P. H., s. 184.)

All bylaws made for sanitary purposes and duly confirmed are to be printed and hung up in the office of the local authority. A copy is to be delivered on application to any ratepayer of the district to which the bylaws refer; and in the case of a rural authority, a copy of the bylaws must be transmitted to the overseers of every parish to which the bylaws relate, to be deposited with the public documents of the parish, and to be open to the inspection of every ratepayer of the parish at all reasonable hours.—(P. H., s. 185.)

A copy of any bylaws made by a local authority other than a town council, signed and certified by the clerk to be a true copy, and to have been duly confirmed, is to be received as evidence in courts of law.—(P. H., s. 186.)

The provisions of the Public Health Act also apply to bylaws of a council of a borough made under 5 & 6 Will. IV. c. 76.

The following matters may be regulated by bylaws:—

Urban sanitary authorities may make bylaws or obtain power to do so with respect to—

Animals kept so as to be injurious to health.
Ashes, disposal of.
Ashpits, cleansing of, regulation of, &c.
Bathing.
Baths and *wash-houses.*
Boats let for hire.
Buildings, closing of, when unfit for habitation, drainage of, ventilation of, walls of new buildings, to secure stability and prevent fire, roofs, foundations, and spouts of buildings.
Burial-grounds, management of.
Business, meetings and general arrangements for.
Cesspools.
Dust, nuisance from.
Fairs.
Filth, nuisance from.
Footways, cleaning of.
Hackney carriages (including drivers), and horses, ponies, mules, and asses let for hire.
Hop-pickers, lodging of, &c.
Libraries, public, management of.
Lodging-houses, labouring classes'.
Lodging-houses (common), number of persons to occupy, registration of, inspection of, cleansing of, &c.
Markets, management of.
Mortuaries, management of.
Museums, public, management of.
Officers and *servants*, duties and conduct of.
Privies, cleansing of, &c.
Refuse, rubbish, &c., removal and prevention of.
Slaughter-houses and *knackers' yards*, regulation of.
Snow, nuisance, &c., arising from.
Streets, level, width, construction, and sewage of new streets.
Trades, offensive, newly established.
Tramways.

Rural sanitary authorities have power to make bylaws with respect to—

The cleansing of footways and pavements adjoining any premises.
The removal of house-refuse from any premises.
The cleansing of earth-closets, privies, ashpits, and cesspools belonging to any premises.
The lodging of hop-pickers, &c.
Regulations as to the number of persons to occupy lodging-houses.
Registration of, inspection of, and enforcing cleanliness in lodging-houses.

Bywash is a term used in relation to waterworks; it means a channel by the side of the reservoir to convey away the flood-discharge of the streams supplying the reservoir.

C.

Cabbage — Cabbages are useful for their antiscorbutic properties and the salts they contain. They hold a large quantity of water in their tissues—no less, indeed, than 90 per cent.—and contain a nitrogenous principle and sulphur; hence the disagreeable odour of water in which cabbages have been boiled, and the copious development of sulphuretted hydrogen. The chemical composition of cabbage is very similar to that of the carrot. *See* CARROT, DIETARIES, &c.

Caffeic Acid—*See* ACID, CAFFEIC.

Caffeine ($C_8H_{10}N_4O_2$), syn. *Theine*—This is a crystalline alkaloid discovered by Robiquet in coffee. It is found in tea, Paraguay tea, and Guarana cocoa, according to Dr. Stenhouse, the average amount in the different substances being—

	Theine or Caffeine, per cent.
Guarana or Brazilian cocoa	5·07
Good black tea	2·13
Black tea	1·97
Dried coffee-leaves	1·26
Maté or Paraguay tea	1·20
Various samples of coffee-beans	0·8 to 1·00

Liebig found the proportion of caffeine to the pound of coffee in six samples to be as follows:—

Martinique	32 grains, or	0·45 per cent.
Alexandrian	22 ,,	0·31 ,,
Java	22 ,,	0·31 ,,
Mocha	20 ,,	0·27 ,,
Cayenne	19 ,,	0·27 ,,
St. Dominique	16 ,,	0·22 ,,

Caffeine is soluble in 100 parts of cold water, freely soluble in hot water. It form crystallisable salts with bichloride of platinum, terchloride of gold, sulphuric and hydrochloric acids.

Caffeine may be prepared by boiling raw or unroasted coffee in water, and adding subacetate of lead to the filtered decoction to throw down the retractive and colouring-matter. The excess of lead is next precipitated with sulphuretted hydrogen, and the liquid filtered and evaporated by a gentle heat. The residuum is then dissolved in boiling water, the solution agitated with freshly-burnt animal charcoal, filtered, evaporated, and crystallised. By redissolving the product in hot alcohol, it may be obtained in white shining silky filaments as the solution cools. Or it may be obtained by Vogel's process. An extract of powdered coffee is made with commercial benzole; this being distilled off, leaves an oil and caffeine behind. The oil is then removed by a little ether, or by hot water, from which latter liquid the alkaloid crystallises on cooling.

From a hot infusion of tea-leaves it may be obtained by the process first mentioned. Liebig states that theine is related to kreatinine, and to glycocol, which we may suppose to exist in gelatine coupled with another compound. According to this observer there are no drinks which, in their complexity and in the nature of certain constituents, have more resemblance to soup than tea and coffee.

The physiological effects of theine are not yet completely investigated. Mr. Cooley took 20 grains daily for above a month without any very decided symptoms.

Demberts, however, shows that in large doses it is fatal to animals, inducing tetanic stiffness of the muscles, an increase in the frequency of the heart's action, and increased reflex action. Hence it has been proposed as an antidote in cases of opium-poisoning.

Cagliari Paste—*See* MACCARONI.

Calcium, Chloride of ($CaCl_2$)—Chloride of calcium is largely used as a disinfectant. (*See* CHLORINE and DISINFECTANTS.) When dissolved in water, the crystals produce great cold, and hence are frequently employed as an ingredient in freezing powders. In the laboratory, chloride of calcium is used for the purpose of drying gases and absorbing the water from ethereal and oily liquids in organic analysis. It is used also for the rectification of alcohol, and as a chemical reagent in detecting certain organic acids. It is found in water, and if it exists in any considerable quantity it renders it hard. *See* CHLORINE and LIME.

Calculi—Calculus, or stone in the bladder, is to some extent due to drinking hard water. The evidence is perhaps not quite so satisfactory as might be desired, still, when the prevalence of stone in Norwich and Norfolk, where they certainly use hard water, is compared with that of districts where soft water is used, and when animals, such as sheep, are known to be affected in the limestone districts, and escape in other localities, the inference naturally drawn from the circumstances is that the water, which is the only essential point in which these various localities differ, is the cause; but accurate analyses and inquiries on a large scale are yet wanting.

Calorigen—This is a stove figured and described under art. WARMING.

Camp Fever—*See* FEVER, TYPHUS.

Camphor ($C_{10}H_{16}O$)—A crystalline substance, only obtained in large quantities from two plants, viz., *Camphora officinarum* and *Dryobalanops aromatica*. It is found in small quantities in other plants. Camphor is a weak antiseptic, but is of no value whatever as a disinfectant. It does not prevent the growth of mould, nor will it destroy low vegetable growths unless in considerable quantity. As a medicine its action is directly on the nervous system; an overdose produces giddiness, delirium, coma, and even death. Three children poisoned by camphorated oil suffered from convulsions, purging, vomiting, and coma; and one, an infant eighteen months old, died in seven hours. The dose in each of these cases was about 30 grains.—(Journal de Chimie Medicale.) The smallest dose on record which has caused serious symptoms is 20 grains. Monobromated camphor has been recently proposed as an antidote for strychnia. *See* CAMPHOR, MONOBROMATED; STRYCHNIA.

Camphor, Monobromated ($C_{10}H_{15}BrO$)—This compound is prepared by gradually adding 2 parts of bromine to 1 of pulverised camphor in a large flask. The mixture is distilled in a water-bath, and the vapours, consisting of hydrobromic acid gas, bromine, and camphor, conducted into an alkaline solution. The impure monobromated camphor remaining in the flask is purified by treatment with boiling distilled water, and ultimately dissolved in boiling alcohol and filtered through animal charcoal.

Monobromated camphor crystallises in colourless prismatic needles. It is insoluble in water, but soluble in alcohol, fixed and volatile oils, ether, carbonic disulphide, chloroform, &c. It has been proposed as an antidote to poisoning by strychnine. *See* STRYCHNIA.

Camphoric Acid—*See* ACID, CAMPHORIC.

Camps, Encampments—Encampments are divided into—

1. Incidental or flying camps.
2. Stationary camps.

The site of flying camps in actual warfare, however important, seldom admits of much selection. With stationary camps the case is different. The principal things to be considered are dryness of site, proximity to water-supply, elevation, and aspect. Special care should be taken in temperate climates not to encamp in a narrow valley. The cold night air being heavy, sinks into the valleys, and there night frosts are keenest. A moderate elevation, sheltering the men from the cold winds, and on a gentle slope, so that there will be plenty of fall for surface-drains, is best. The tents should be a little distance from each other, and not crammed together, for the sake of pleasing the eye. They should be well ventilated, and the ground, as a rule, should not be excavated within. A trench should be excavated round each tent 4 inches deep, and carried into a surface-drain running in front of the tents. In camps of position the floor of the tents is often boarded, and the tents themselves raised on a wall of stones or earth; but in other cases the floor may be covered with canvas, waterproof sheeting, or straw. In any case, filth and refuse are liable to collect beneath the covering; hence the boards, &c., should be frequently removed for the sake of cleanliness. *Latrines* are generally placed at the rear of camps in the form of long deep trenches, and earth is thrown in them daily; when near the surface, another trench is dug, and so on. A urinal is also generally constructed near the trench with a sloping channel running into it; and men should not be allowed to urinate around the tents. All refuse, animal or vegetable, should be burnt. A camp of position should be changed from time to time. No old camping-ground should be reoccupied.

Canada Balsam—A thick viscid oleoresin obtained from the *Abies balsamea*, a tree of common growth in Canada and the State of Maine. It is largely employed as a medium for mounting microscopic objects. Canada balsam is especially used for mounting transparent objects; the pure balsam, however, is too thick for use, and requires to be diluted with spirit of turpentine, chloroform, &c., to render it sufficiently fluid to permeate the structure to be exhibited. Mr. William Henry Heys, in the "Microscopical Journal," describes a plan of mounting objects in a mixture of balsam and chloroform. Take a quantity of the oldest balsam procurable, and place it in an open glass cup, and mix with it as much chloroform as will make the whole quite fluid, so that a very small quantity will drop from the lip of the contained vessel. Then put this prepared balsam into long thin half-ounce vials, and cork and set them aside for at least a month. The advantage of having it ready made is that there is no waste, and none of the usual and troublesome preparation required for putting up objects in Canada balsam; and if it has stood for some time, it loses the yellow tinge which is observable in most samples when first mixed, and, moreover, air-bubbles escape more readily. Professor Rutherford of King's College, London, prepares the Canada balsam in the following manner: (1.) Take pure Canada balsam and place it in a saucer or other shallow vessel. (2.) Cover the vessel with bibulous paper to exclude dust. (3.) Dry it in an oven at a temperature not above 150° F., until when it cools *it becomes as hard as ice*. (4.) Dissolve this crystalline balsam in chloroform or oil of turpentine. A solution in the former medium dries most rapidly, but a solution in turpentine is generally preferable for mounting sections of tissues. Canada balsam is suitable for mounting unsoftened bone, tooth, hair, and most tissues which have been hardened in alcohol or chromic acid. Canada balsam is now being replaced by Dammar, which see.

Canals—The waters of a canal are generally impure, for they are contaminated by vegetable, organic, and other refuse matter being thrown into them. The mud found at the bottom is generally black and fœtid, giving forth various odours, that of sulphuretted hydrogen predominating. The neighbourhood of a canal will be more or less unhealthy as its waters differ in foulness. In this respect a canal has the same effect upon the locality through which it runs as any other course of water. Canals may be said to be intermediate between running streams and stagnant waters.

Nothing in the Public Health Act, 1875, is to affect injuriously the navigation or use of canals, or to interfere with the towing-path. Nothing in the Act is also to affect the supply of water to the canal, or to interfere with any of its bridges.—(P. H., s. 327.)

Nothing in the Public Health Act, 1875, authorises a local authority to interfere with the waters of a canal or its feeders so as to injuriously affect the supply, fall, or quality of the water.—(P. H., s. 332.)

Any person or persons authorised by Act of Parliament to navigate on any canal, or demand tolls or dues in respect of such navigation, may at their own expense take up or alter sewers, drains, pipes, or culverts passing under or interfering with the canal, or its towing-path, providing they substitute others equally effectual.—(P. H., s. 331.)

Any difference of opinion with regard to whether the pipes, &c., substituted are equally efficient with the former ones, is to be settled by arbitration.—(P. H., s. 333.) *See* ARBITRATION.

Cancer—This word (literally, a crab) is now the general name given to a malignant growth mainly composed of cells. Its characteristic feature is recurrence, and the leading and most striking principle distinguishing it from other growths is its malignant nature, by which it infiltrates itself into surrounding tissues, instead of being limited by a capsule or other investing membrane. In a sanitary point of view, the cause and prevention of cancer are of more importance than either the classification or symptoms of the disease.

There are many remarkable facts on record showing that the old notion of the contagiousness of cancer has been too hastily thrust aside. The author has made some investigations of the causes of cancer, which are at present far from complete. The principal conclusions the inquiry at present appears to lead to, however, as to its relation to consumption, and as to its contagious qualities, are as follows :—

1. There is no connection between consumption and cancer, as asserted; they are each independent diseases.

2. Cancer in certain cases is contagious.*

3. Cancer is analogous in its course to a fever. A cancer germ is introduced from without. There is a period of incubation and a period of manifestation.

4. The period of incubation is for the most part excessive—not days, nor months, but years; hence many die of other diseases who would have died of cancer; hence, also, it is the old who principally die of cancer.

That cancer is contagious is rendered in the highest degree probable by—

(1.) Its remarkable increase in certain districts, *e.g.*—

In the union of Dulverton, from 1837 to 1873, a period of thirty-seven years—in other words, a period of so small a magnitude as to scarcely allow hereditary predisposition to come into play—the deaths were as follows :—

The first seven years 9 died of cancer.
The next ten years 11 ,,
,, ,, 30 ,,
,, ,, 40 ,,

The population during the decades did not undergo any remarkable increase.

(2.) Various isolated facts which, if carefully collected and examined, may probably be sufficiently numerous to put on one side the general explanation of curious coincidences; *e.g.*, a gentleman who suffered from cancer of the lip allowed a favourite dog to occasionally lick it; the dog died of cancer of the tongue. Again, there is a house in the writer's district in which three successive tenants, unconnected in any way, all died of cancer.

(3.) Its unequal prevalence in different districts; *e.g.*, the following table gives the actual deaths from cancer, and its comparative fatality, in five unions in one year :—

	Actual Deaths from Cancer.	Proportion of Deaths from Cancer per 1000 Deaths from all causes.
South Molton.....	16	60
Bideford............	4	29
Torrington.........	5	25
Okehampton......	5	17
Dulverton	2	14

This inequality is exactly similar to that which a zymotic disease would show.

The author is aware that all information on the question is as yet very crude, but this short article is only inserted in the hope that other members of the medical profession will take up the subject, and turn their attention to the causes of a horrible disease, which is certainly on the increase, and against which, if contagious, *no means of prevention are at present taken.* It is to the medical officer of health of *rural districts*, and to the medical men serving in our army and navy, that we must look for accurate statistics and researches on this point. In all matters involving the question of contagion or non-contagion, the researches of physicians practising in large towns must be accepted with great caution, the liability to error being increased with the density of the population. In this state of doubt and uncertainty, is it not better to supply disinfectants to every case of open cancer?

Canna Arrowroot—*See* STARCH.

Cannabis Indica—*See* INDIAN HEMP.

Cantharides—The Spanish fly, an insect of the order *Coleoptera.* It abounds in the

* "The prevalence of phthisis in the armies of Europe is probably due in part to the inhalation of expectorated tubercular matter, dried, broken up into dust, and floating in the air of close barracks. To test this may be difficult, but the origin and propagation of the most fatal of all human diseases deserves full investigation. The inquiry should also extend to cancer and the other constitutional diseases, among which should perhaps now be included diabetes, &c."—(FARR, 28th Report, Registrar-General, 1865.)

"This cancerous matter does not seem to acquire its malignant or contagious quality till the cancer becomes an open ulcer, and the matter secreted in it is thus exposed to the air; then it evidently becomes contagious, because," &c.—(DARWIN's Zoonomia, ii. 287.)

south of France, Spain, and Italy, and has spread into Germany and the south of Russia. Those from Russia which come by way of St. Petersburg are the largest and most esteemed. They are from eight to ten lines long, furnished with two wing-covers of a shining metallic green colour, under which are two membranous transparent wings. Odour strong and disagreeable; powder greyish-brown, containing shining green particles. Free from mites. The powder is frequently adulterated. It is said to have been the plan of the wholesale druggists to sort out the most worthless flies for powdering, and to compensate for their deficiency of vesicating power by adding 1 lb. of euphorbium to every 12 or 13 lbs. of flies. When a superior article is required, liquorice powder is added (4 or 5 lbs. to every 14 lbs.), along with about 1 lb. of euphorbium, and sufficient blue, black, or charcoal to turn the yellow of the liquorice to a greenish colour. The best mode of detecting this adulteration is by the microscope.

Cases of poisoning by cantharides are not very common, still they occasionally occur.

Dr. Pallé, in the July (1872) number of the "Journal de Phar. et de Chimie," instances some interesting cases of poisoning by Spanish fly. Some soldiers, we learn from this gentleman, had in mistake drunk large quantities of tincture of cantharides; and although the physical agony and suffering were very great, yet under the treatment pursued, which was the ordinarily-received one—emetics, warm baths, camphor, and opium, with oleaginous drinks and injections — they all recovered. In fatal cases of poisoning by cantharides, very minute particles may be discovered in the stomach and intestines on a *post-mortem* examination. Orfila thus found particles of cantharides in a body that had been interred nine months.

The poison mainly determines to the kidneys, and small repeated doses may induce kidney disease, while a large single dose causes inflammation of the bowels and kidneys, and exerts an irritant action on the whole urinary apparatus.

Poisoning by cantharides is more frequent in France than in our own country, occupying, according to Tardieu, the tenth place in the criminal statistics of poisoning, which, of course, do not include accidental and suicidal deaths from this cause.

Capers—The flower-buds of the various species of *Capparis*, particularly of *C. spinosa*, preserved in vinegar, chiefly imported from Spain, Italy, and south of France. The lively green colour so much admired arises generally from the presence of copper derived from the sieves used in sorting them. Copper coins are often put in with them to effect this purpose. *See* COPPER.

Capsicum—A genus of plants belonging to the natural order *Solanaceæ*. The particular kind usually employed for Cayenne pepper, *Capsicum annum*, is a native of America, but it is also cultivated in the West and East Indies, and to a slight extent in the greenhouses of England and other European countries. The Cayenne pepper consists of the pods or seed-vessels ground to powder. The dried berries are sold as *chillies*. The two following analyses, one made by Bucholz in 1816, and the other by Bracannot in 1817, show the composition of capsicum berries:—

Bucholz's Analysis.

Acrid soft resin (capsicum)	4·0
Wax	7·6
Bitter aromatic extractive	8·6
Extractive with some gum	21·0
Gum	9·2
Albuminous matter	3·2
Woody fibre	28·0
Water	12·0
Loss	6·4
Fruit of *Capsicum annum*, without seeds,	100·0

Bracannot's Analysis.

Acrid oil	1·9
Wax and red colouring-matter	0·9
Brownish starchy matter	9·0
Peculiar gum	6·0
Animalised matter	5·0
Woody fibre	67·8
Salts: extract of potash, 6·0; phosphate of potash and chloride of potassium, 3.4	9·4
Fruit of *Capsicum annum*,	100·0

The hygroscopic moisture ranges in different samples from 10 to 13 per cent. The author analysed several samples of genuine cayenne, and the mean of several analyses was as follows:—

Aqueous extract of dried cayenne	32·1 per cent.
Alcoholic extract	25·79 ,,
[Benzole extract	20·00] ,,
[Ethereal extract	10·43] ,,
Ash . 5·693 (soluble, 3·32)	,,
Total nitrogen in 100 grammes,	2·04 ,,

Hence the ash of cayenne should not exceed 6 per cent.; it should yield at least ¼ of its weight to alcohol, and from 9 to 10 per cent. to ether. Mineral adulterations are the most probable, which are easily detected in the ash.

In small doses Cayenne pepper is a useful condiment, and no doubt increases the digestive powers of the stomach; in larger doses it is an irritant, and even when applied to the skin will blister it. It owes its irritant property to a very acrid resin, *capsicine*. A minute quantity of this substance burnt in a room will cause great irritation of the throat and larynx of every person present. Cayenne pepper, if administered in a large dose—*e.g.*, a teaspoonful—would probably cause death. It appears in one case (Reg. *v.* Stevens), in which it was administered by a quack to a boy suffering from hip-joint disease, to have at least accelerated death. The stomach of the deceased was much congested.

Caramel—A dark-brown product obtained by heating sugar. It is formed during the roasting of all materials containing sugar, such as coffee and malt. It is much used for colouring soups, wines, beers, spirits, coffee, &c., and it is known in the trade as "Black Jack." Its chemical composition is $C_{18}H_{18}O_9$. It is soluble in water, and precipitated by baryta, subacetate of lead, or alcohol.

Caraway Seeds—The fruit of the *Carum carui* (Linn.), an umbelliferous plant, common in England and other parts of Europe. The caraway seeds (mericarps) are slightly curved, with fine filiform ridges, and contain a single vitta in each channel; the longitudinal ridges are of a lighter colour than the intervening interstices. Colour brownish, with an aromatic odour and warm taste.

An infusion of caraway seeds has been used for the adulteration of porter.

Carbo-Hydrates are a group of substances in which hydrogen and oxygen are united in the exact proportion to form water with carbon. The type of these bodies is starch, sugar, &c. For example, starch may be represented, $C_6 5(H_2O)$; cane-sugar, $C_{12}11 (H_2O)$.

The carbo-hydrates, or hydrates of carbon, are very numerous. All the starches and sugars—glycogen, gum, cellulin, erythrite, dulcite, pectine, and many other bodies—belong to this class. All of them, with the exception of sorbine and inosine, are convertible into some of the forms of grape-sugar by prolonged boiling with dilute sulphuric acid. *See* STARCH, SUGAR, DIETARIES, FOOD, &c.

Carbolic Acid—*See* ACID, CARBOLIC.

Carbolic Acid Powders—*See* ACID, CARBOLIC.

Carbon—An elementary or simple non-metallic solid body very widely diffused through nature. Its purest form is that of the diamond.

Carbon is an essential constituent of organic matter, and hence has been termed the "organic element."

Carbon is an important article in diet, and a certain quantity must be daily taken to preserve the body in health.

Dr. Lyon Playfair concludes, from a large series of observations, that the following may be regarded as the average quantity of carbon contained in the daily dietary of an adult man under different circumstances of existence:—

	Carbonaceous Matter calculated as Starch.
Subsistence only	13·3 oz.
Quietude	14·5 ,,
Moderate exercise	23·2 ,,
Active labour	26·3 ,,
Hard work	26·3 ,,

Pettenkofer and Voit say that an adult requires daily 22·38 of carbonaceous matter calculated as starch.

The amount of carbon in any diet may be calculated in two ways—

(1.) Calculate out the dry albuminates, fat, and carbo-hydrates in ounces, then use the following table:—

Carbon in Grains.			Carbon.
1 oz. of water-free albuminate			233
1	,,	fat	345·6
1	,,	carbo-hydrate, except lactine	194·2

These numbers are thus obtained: The various dry albuminates contain about 53·3 per cent. of carbon; fat contains 79 per cent.; starch and sugar 44·4 per cent.; and lactine 40 per cent. No account of any hydrogen in excess of that forming water with the oxygen of the food is taken.—(PARKES.)

Or Dr. Parkes' table may be used, in which the amount of carbon per ounce has been calculated, the substance being supposed to be in its natural state.

	One Ounce (= 437·5 Grains) contains in its natural state in Grains
Uncooked meat (beef)	64
Uncooked fat meat (beef)	98·3
Cooked meat	117·7
Bread	119
Wheat-flour	168
Biscuit	183
Rice	176
Oatmeal	172
Maize	176
Peas	161
Potatoes	49
Carrots	18
Butter	315
Egg	71·5
Cheese	162
Milk	30·8
Sugar	187

See FOOD.

Carbonic Acid—*See* ACID, CARBONIC; AIR; MEAT.

Carbonic Oxide in Air—*See* AIR.

Carbonisation of Sewage—*See* SEWAGE.

Carbuncle—A carbuncle is an inflammation of an isolated portion of the subcutaneous cellular tissue rapidly running on to suppuration. Carbuncles have been observed more frequently since the pleuro-pneumonia of cattle has appeared, and there may be a connection between them. (*See* PUSTULE, MALIG-

NANT.) Carbuncles occur not unfrequently in old people, and cause death. Carbuncular swellings are constantly seen in cases of plague, and occasionally in typhus fever. *See* PUSTULE, MALIGNANT; PLAGUE; FEVER, TYPHUS, &c.

Carburetted Hydrogen—*See* HYDROGEN.

Cardamom Seeds, or **Grains of Paradise**—The dried seeds of the Malabar cardamom. They are met with in curry-powder, and are used to adulterate beer, &c.

Carmine—Pure carmine is a very light lustrous scarlet powder, entirely soluble in ammonia, a test by which its purity is readily determined. It is prepared from the cochineal insect (*which see*), the pure colouring principle of which is, according to Mr. Warren de la Rue, carminic acid. Carmine is largely used by microscopists, for it possesses the property of staining the bioplasm of animal tissues. The staining or colouring fluid employed by Dr. Beale is made as follows: Carmine, 10 grains; strong liquid ammonia, ½ drachm; Price's glycerine, 2 ounces; distilled water, 2 ounces; alcohol, ½ ounce. The carmine is to be placed in a test-tube, and the ammonia added to it. Upon applying the gentle heat of a spirit-lamp it is dissolved. Boil it up for a few seconds, and allow it to cool before adding the glycerine and the rest of the ingredients. Lastly, pass it through a filter, or allow it to stand for some little time, and decant off the clear solution. The solution should neither be too alkaline nor perfectly neutral: if the former, the colouring becomes too intense, and thus much of the soft or imperfectly-formed tissue is destroyed; and if the latter, the uniform staining of tissue and germinal matter equally mars the result.

The permeating power of the solution may be increased by the addition of a little more water and alcohol.—(BEALE, "How to work with the Microscope.") Cooks frequently colour the sauces prepared by them for the table with carmine. As carmine is frequently adulterated with vermilion, such a practice should be discouraged.

Carrageen Moss—*See* ALGÆ.

Carriages for conveyance of infected persons—*See* CONVEYANCES.

Carrots—The carrot, as an article of diet, is less nutritious than the potato, but, like other succulent vegetables, it is an antiscorbutic.

The following table shows its average composition:—

Composition of the Carrot.

Water	83·0	Nitrogenous } Total p. ct.	1·3
Albumen	1·3	Carbonaceous as starch } Total p. ct.	15·0
Starch	8·4		
Sugar	6·1	Carbonaceous to one nitrogenous	11·5
Fat	0·2		
Salts	1·0		
		Nitrogen } Total per ct.	0·20
		Available carbon } Total per ct.	7·28

Drs. Frankland, Playfair, Parkes, and others say that 1 gramme of carrot will equal 220 kilogrammes of energy, and that 1 ounce will equal 20-foot tons of energy, or, in other words, would raise 20 tons 1 foot high.

Carrot-seed is carminative and diuretic. The expressed juice of the root is said to be anthelmintic.

Carrots are used as a colouring agent to butter and cheese, and they have been met with as an adulterant of coffee.

Caseine—A nitrogenous principle met with in milk.

It is very probable that under the name of caseine several nitrogenous substances are confused together; however this may be, caseine proper in milk is always associated with albumen, and it is inseparably united with phosphate of lime. It has, therefore, never been obtained in a pure state. Its composition is identical with that of albumen and fibrine:—

Carbon	53·7
Hydrogen	7·1
Nitrogen	15·7
Oxygen	23·5
	100·0

There is also a small quantity of sulphur, said to be about 1 per cent.

Caseine was formerly supposed to be a compound of albumen and potash, but as milk-ash contains no alkali, this view is no longer held. It differs from albumen in not being coagulated by heat, and in being thrown down by the organic acids. It agrees with albumen in composition, as before said, and also in the fact of its capability of existing in a soluble and insoluble state. This change is at present unexplained, and supposed to be molecular. It differs from fibrine in not undergoing spontaneous coagulation. Caseine forms insoluble salts with the acids, and various metallic salts, such as sulphate of copper and bichloride of mercury.

The average amount of caseine in the milk of different animals is as follows:—

Ass's milk	1·82 per cent.
Woman's milk	1·52 ,,
Cow's ,,	4·5 ,,
Goat's ,,	4·02 ,,
Ewe's ,,	4·50 ,,

Cheese consists almost entirely of caseine. *See* MILK, CHEESE, &c.

Catarrh, Epidemic—*See* INFLUENZA.

Catchpit—*See* CESSPOOLS.

Catechu—There are many plants which yield an astringent extract similar if not identical with catechu. Commercial catechu is found in two forms—(1) the *black catechu*, which is an extract from the heart-wood of *Acacia Catechu;* and (2) the *pale catechu*, which is also an extract, but derived from the leaves and young shoots of *Uncaria Gambir*, a cinchonaceous shrub growing in the islands of the Eastern Archipelago.

Both species of catechu are very similar in chemical composition; both contain astringent principles, called *catechu-tannic acid* and *catechin*, besides mucilage and extractive matters.

The average percentage of these substances is as follows :—

	Catechu-tannic Acid and Catechin.	Extractive.	Mucilage.	Insoluble Matter.
Pale catechu	48·5	36·5	8·0	7·0
Dark ,, .	54·5	34·0	6·5	5·0

Catechin is insoluble in cold water, but soluble in boiling water, alcohol, and ether. It is converted by alkalies and their carbonates into japonic and rubinic acids. A decoction of catechu should not be rendered blue by iodine.

Catechu has been found as an adulterant of exhausted tea-leaves and other substances.

Cayenne Pepper—*See* CAPSICUM.

Cauliflower—*See* CABBAGE, &c.

Cellars—The word "vault" or "underground room" is for the purposes of the Public Health Act included in the term "cellar."

It is not lawful to let or occupy, or suffer to be occupied, separately as a dwelling, any cellar built or rebuilt after the passing of the Public Health Act, or which is not lawfully so let or occupied at the time of the passing of the Public Health Act.—(P. H., s. 71.)

It is not lawful to let or occupy, or suffer to be occupied, separately as a dwelling, any cellar whatsoever, unless the following requisitions are complied with ; (that is to say,)

Unless the cellar is in every part thereof at least 7 feet in height, measured from the floor to the ceiling thereof, and is at least 3 feet of its height above the surface of the street or ground adjoining or nearest to the same ; and

Unless there is outside of and adjoining the cellar, and extending along the entire frontage thereof, and upwards from 6 inches below the level of the floor thereof up to the surface of the said street or ground, an open area of at least 2 feet 6 inches wide in every part ; and

Unless the cellar is effectually drained by means of a drain, the uppermost part of which is 1 foot at least below the level of the floor thereof ; and

Unless there is appurtenant to the cellar the use of a water-closet, earth-closet, or privy, and an ashpit, furnished with proper doors and coverings, according to the provisions of the Public Health Act ; and

Unless the cellar has a fireplace with a proper chimney or flue, and an external window of at least 9 superficial feet in area clear of the sash frame, and made to open in a manner approved by the surveyor (except in the case of an inner or back cellar let or occupied along with a front cellar as part of the same letting or occupation, in which case the external window may be of any dimensions not being less than 4 superficial feet in area clear of the sash frame).

Provided that in any area adjoining a cellar there may be steps necessary for access to such cellar, if the same be so placed as not to be over, across, or opposite to the said external window, and so as to allow between every part of such steps and the external wall of such cellar a clear space of 6 inches at the least ; and that over or across any such area there may be steps necessary for access to any building above the cellar to which such area adjoins, if the same be so placed as not to be over, across, or opposite to any such external window.—(P. H., s. 72.)

Any person who lets, occupies, or knowingly suffers to be occupied for hire or rent, any vault, cellar, or underground room contrary to the provisions of the Act, is liable for every such offence to a penalty not exceeding 20s. for every day during which the same continues to be so let or occupied after notice in writing from the local authority in this behalf. —(P. H., s. 73.)

Any cellar in which any person passes the night shall be deemed to be occupied as a dwelling within the meaning of the Act. —(P. H., s. 74.)

Where two convictions for occupying a cellar against the provisions of the Act have taken place within three months (whether the persons so convicted were or were not the same), a court of summary jurisdiction may direct the closing of the premises so occupied for such time as it may deem necessary, or may empower the local authority permanently to close the same, and to defray any expenses incurred by them in the execution of the 75th section of the Act.—(P. H., s. 75.)

Any person in an *urban* district who causes any vault, arch, or cellar to be newly built or constructed under the carriage-way of any street without the written consent of the authority, is liable to forfeit the sum of £5 to the *urban* authority, and a further sum of 40s. per day during continuation of offence after the written notice of the authority; and power is given to the authority to cause the structure to be pulled down or otherwise dealt with, and the expenses of such action may be recovered summarily.—(P. H., s. 26.)

Any person in an *urban* district suffering waste or stagnant water to remain in a cellar twenty-four hours after the authority's written notice, is liable to a penalty not exceeding 40s. for each offence, and a further penalty of 5s. a day during continuance of offence after notice.—(P. H., s. 47.)

Cellulose, syn. *Lignin* ($C_{18}H_{30}O_{15}$)—Ligneous fibre or true woody matter consists mainly of cellulose. It is presented in a pure condition in finely-carded cotton, in the best white filtering-paper, and in linen. It occurs nearly pure in cotton, in the pith of the elder, and in that of the *Aralia papyrifera*, from which rice-paper is made.

Pure cellulose is white, tasteless, innutritious, insoluble in water, alcohol, ether, and oils. Dilute acid solutions and dilute alkaline solutions scarcely affect it. Strong hydrochloric and strong sulphuric acid both dissolve cellulose, the latter converting it first into dextrine and then into grape-sugar.

An ammoniacal solution of the oxide or the carbonate of copper dissolves cellulose, from which it may be precipitated unaltered on acidulating the liquid.

Cemeteries—*See* DEAD, DISPOSAL OF; CHURCHYARDS, &c.

Cerasine (Sugar-Cane Wax)—A peculiar kind of wax found coating the sugar-cane. *See* SUGAR.

Cerealin—Mr. Morson has extracted from the inner layer of bran a nitrogenous digestive principle called *cerealin*, of the nature of diastase, and consolidated it with sugar in a preparation which he has named *saccharated wheat phosphate*. This, as an aid to the digestion of farinaceous matters, and when properly applied, is useful in the treatment of infants' food. *See* WHEAT.

Cesspools (Catchpits, Cesspits)—These are pits or reservoirs for the reception of excreta. In country places where earth-closets are not used, and where there is no system of sewage, they may be a necessity. A cesspit properly constructed and frequently emptied is not injurious to health. It should be at as great a distance from the house as possible. If there is a pump near the building, it will be well to lead an efficiently-trapped drain from the pump to those drains that empty in the cesspit, for the purpose of flushing. The cesspit should be of a square form, the walls built of brick, set in a puddle of clay, and lined with cement. It should have a brick roof, arched, and provided with a manhole; the bottom should also be arched, and be deeper at one end. A galvanised-iron wire diaphragm or grating should be placed across the tank, and thus divide it into two parts—one containing the solids, the other the liquids. A pump should be placed at one end, or an overflow-pipe, in order to utilise the sewage on the land. A ventilating-pipe, containing some trays of charcoal (*see* SEWERS, VENTILATION OF), should be attached to the tank, and it should be emptied frequently.

Ill-kept, ill-constructed, and foul cesspits are the most prominent and frequent nuisances in villages and elsewhere that have to be dealt with. Such a cesspit as mentioned above, although adapted for several houses, is too expensive and elaborate for little cottages, often owned by the poor widow or labourer. In such cases they should, if possible, be done away with, and the dry-earth system introduced; in other cases, a cesspit, away from drinking-water, communicating with the privy, lined with clay, and having a removable cover, may, if frequently emptied, and with the daily use of ashes, not be offensive or injurious. The great fear is always leakage into drinking-water, and in cases of fever, infectious emanations.

It is expressly cast upon every local authority to see that the cesspits within their district are so kept and constructed as not to be a nuisance, nor injurious to health.—(P. H., s. 40.) The inspection of cesspits is naturally one of the duties of the nuisance or sanitary inspector, but any officer appointed by the authority is to be deemed "a surveyor," and can serve notices with certain powers of entry. A local authority may undertake or contract for the cleansing of cesspools, or they may make bylaws imposing on occupiers of premises the duty of doing so.—(P. H., s. 42, 44.)

If a local authority have undertaken or contracted for the cleansing of cesspits, and after notice from an occupier, fail to do their duty, they are liable to pay to the occupier a penalty not exceeding 5s. a day during default.—(P. H., s. 43.)

Any person in an *urban* district allowing the contents of a cesspool to overflow or soak therefrom is liable to a penalty of 40s. for each offence, and a further penalty of 5s. per day during continuance of offence after notice.

—(P. H., s. 47.) *See* BYLAWS; NUISANCE; REFUSE, DISPOSAL OF.

Champagne—*See* WINE.

Charbon—*See* PUSTULE, MALIGNANT.

Charcoal—Carbon in a more or less pure state. There are two kinds in commerce—viz., *animal*, derived from calcining bones, &c., and *vegetable* or *wood* charcoal.

Dumas gives the following as the composition of animal charcoal prepared by calcining the bones of the ox, sheep, and horse:—

Phosphate of lime } Carbonate of lime }	88·0
Charcoal	10·0
Carburet of iron	2.0
Sulphide of calcium or iron	traces
Common bone-black	100·0

The most powerful charcoal is prepared by calcining blood and well washing the residue. This is the method recommended in the last "London Pharmacopœia."

As a decolouriser and deodoriser, animal charcoal is greatly superior to vegetable charcoal. Charcoal possesses the remarkable property of abstracting certain substances (*e.g.*, sulphuretted hydrogen, organic colouring principles, various odorous matters, &c.) from liquids in which they are dissolved, or through which they are diffused. Besides this, it will condense within its pores a certain quantity of any gas with which it may be placed in contact. The quantity absorbed of the different gases by an equal bulk of charcoal is almost exactly in the ratio of their solubility in water. Thus De Saussure found that freshly-burnt wood charcoal absorbed different gases in the following proportions, the bulk of the charcoal being taken as—

Ammonia	90
Hydrochloric acid	85
Sulphurous anhydride	65
Sulphuretted hydrogen	55
Nitrous oxide	40
Carbonic anhydride	35
Olefiant gas	35
Carbonic oxide	9·4
Oxygen	9·2
Nitrogen	7·5
Marsh gas	5·0
Hydrogen	1·7

The more compact the charcoal, the greater is its absorbent power. Thus Dr. Stenhouse found, that taking ·5 grammes of wood, peat, and animal charcoal, the number of centimètres of the different gases absorbed was as follows:—

Gas used.	Wood Charcoal.	Peat Charcoal.	Animal Charcoal.
Ammonia	98·5	96·0	43·5
Hydrochloric acid	45·0	60·0	...
Sulphuretted hydrogen	30·0	28·5	...
Sulphurous anhydride	32·5	27·5	...
Carbonic anhydride	14·0	10·0	5·0
Oxygen	0·8	0·6	0·5

After exposure for some little time charcoal becomes absolutely inert, hence the necessity of having it freshly prepared. Charcoal will abstract lime and certain saline matters from syrups and other aqueous solutions, especially organic ones, at the same time that it decolourises them. Freshly-burnt charcoal restores tainted meat and purifies putrid water. Dr. Garrod has proposed purified animal charcoal as a general antidote in cases of poisoning; but Taylor, Pereira, and others find that though it is capable of acting mechanically, and of thereby impeding the action of poisons, it yet possesses no special antidotal power. Charcoal has been proposed and used for filtering sewer air. The gases are passed through a charcoal-tray, and enter the air free from odour and danger. The results of the experiments of Dr. Stenhouse, Dr. Letheby, and Mr. Hayward on this point were most satisfactory, and clearly showed the value of this filtration. Vapour extricated during the combustion of charcoal operates fatally when breathed, in consequence of the carbonic acid and the carbonic oxide contained in it. Low or imperfect combustion is more favourable to the production of carbonic oxide than when the charcoal is vividly consumed.

Charcoal vapour may be regarded as a mixture of carbonic acid, carbonic oxide, aqueous vapour, and air partially deodorised, and at a low temperature we get associated with it a small quantity of carburetted hydrogen. Cases of poisoning by charcoal vapour frequently occur, especially in France, where the use of charcoal is more general; in fact, on the Continent it may be said to be a favourite mode of committing suicide.

Dr. Eatwell, in his report on Indian opium, mentions powdered charcoal as being frequently found as an adulterant of opium; this can be readily detected by breaking up the drug in cold water. *See* OPIUM.

Charcoal-Filters—*See* FILTERS.

Charlock (*Sinapis arvensis*)—The seeds of charlock closely resemble those of black mustard. A microscopical examination, however, shows sufficient difference in the minute structure to enable them to be identified. The cells of the outer mucilaginous coat are smaller and more delicate than those of white mustard. "They are, however, perforated like them, but in addition they each seem to be made up of numerous angular, very delicate, and minute cells; these are characteristic of the seeds of charlock."—(HASSALL.) The seeds of charlock are used as an adulterant of mustard.

Cheese—Cheese is an article of diet made from the milk of the cow, and sometimes from that of the sheep. The varieties of cheese met with in commerce are numerous, and differ greatly in quality—*e.g.*, Cheddar, Cheshire, Cream, Dutch, Gloucester, Green or Sage, Derbyshire, Gruyère, Neufchâtel, Parmesan, Stilton, Roquefort, Suffolk, York, Wiltshire, Swiss, Slipcoat or Soft, Westphalian, and others.

Tardieu divides cheeses into three classes, viz.—

1. Recent unsalted cheeses, commonly called *fromages Mous*, having no other properties than those of cream or caseine.

2. Recent salted cheeses, having the same properties as the preceding, but easier of digestion on account of the salt.

3. Fermented and alkaline cheeses. These comprise all the old cheeses which have undergone a kind of putrefaction, in which ammoniacal salts have been developed, fatty acids, and a peculiar acrid oil.

The chemical composition of cheese may be gathered from the following table:—

	Nitrogenous Matter.	Fatty Matter.	Saline.	Water.	Non-nitrogenous Matter, Loss, &c.	Authority.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
Roquefort	26·52	30·14	5·07	34·55	3·72	Payen.
Gruyère	31·5	24·00	3·00	40·00	1·5	,,
Dutch	29·43	27·54	...	36·10	6·93	,,
Neufchâtel (fresh) . .	8·00	40·71	0·51	36·58	15·80	,,
,, (matured) . .	13·03	41·91	3·63	34·47	6·96	,,
Camembert	18·90	21·05	4·71	51·94	4·40	,,
Brie	18·48	25·73	5·61	45·25	4·93	,,
Chester	25·99	26·34	4·16	35·92	7·59	,,
Parmesan	44·08	15·95	5·72	27·56	6·69	,,
Cheddar	28·40	31·10	4·5	36·00	...	Letheby.
Skim cheese	44·80	6·30	4·9	44·00	...	,,
Cheese	33·50	24·30	5·4	36·80	...	Parkes.

Great light has been thrown upon the chemistry of cheese, and the change which it undergoes under the influence of "mould," by the researches of M. Ch. Blondeau (Annales de Chimie et de Physique, 4ième Ser. t. i. 1864) on the celebrated Roquefort cheese (*fromage de Roquefort*). A portion of a typical cheese was taken by this observer and divided into four parts, the first of which was at once submitted to analysis; the three others were replaced in the cellars, and analysed after one month, two months, and a year's respective sojourn.

No. 1. The fresh or new Roquefort had the following composition:—

Caseine	85·43
Fat	1·85
Lactic acid	0·88
Water	11·84
	100·00

No. 2. The piece which had remained in the cellars a month had all the appearance of a fatty body; its odour had changed, and its taste was sweet and agreeable. The analysis shows that a large portion of the caseine had undergone fatty change.

Caseine	61·33
Fat	16·12
Chloride of sodium	4·40
Water	18·15
	100·00

No. 3. The piece which had remained in the cellar two months was exactly in the condition most prized. Analysis showed that there was a still further change of caseine into fat, and also that small portions of butyric acid were formed.

Caseine		43·28
Fat {Margarine . . .	18·30}	= 32·30
{Oleine . . .	14·00}	
Butyric acid		0·67
Chloride of sodium		4·45
Water		19·30
		100·00

No. 4. The fourth portion was kept a year. By the end of that time it had acquired a brown colour, a strong odour, and a pungent taste. Analysis showed some further fatty changes of the caseine, and also that a great portion of the oleine had disappeared, and in its place were found various products resulting from its oxidation, hence it is probable that the rancidity of butter also is due principally to the formation of oxidation products derived from the oleine.

Caseine	40·28
Margarine	16·85
Oleine	1·48
Butyrate of ammonia	5·62
Caproate of ammonia	7·31
Caprylate of ammonia	4·18
Caprate of ammonia	4·21
Chloride of sodium	4·45
Water	15·62
	100·00

All these changes are produced by the agency of minute mycoderms. It may be supposed that as they require, for the purposes of life, ammonia, water, and carbon, they borrow these different principles from the caseine, which thus losing a portion of its elements, forms a fatty matter.

Cheese is a highly nourishing article of diet, and in conjunction with bread often forms the staple food of the labourer. Some cheeses are extremely easy of digestion, but the poorer and closer kinds are the reverse.

Cheese is subject to the attacks of a fly (*Piophila casei*), the larvæ of which are the well-known small maggots or jumpers.

It is also liable to mould. The blue is generally the *Aspergillus glaucus*, the red the *Sporendonema casei*. A peculiar kind of decayed cheese has been said to cause symptoms of poisoning.

Adulterations.—Cheese may be said not to be commonly or seriously adulterated. It is certainly generally coloured with annatto, carrots, saffron, &c.; but the colouring, unless excessive, or unless injurious ingredients are used, cannot be called an adulteration. Potatoes and starch have been detected in cheese, more especially on the Continent; and indeed in Thüringen (Saxony) there is a species of cheese manufactured, almost entirely made of potatoes. A wash or preparation containing arsenic has been used to the rind of cheese, as a preservative against the attacks of the fly. This practice does not prevail in England, and it is certainly most dangerous. In the process of manufacture some cheeses owe their flavour to the practice of infusing certain leaves—*e.g.*, sage, parsley, &c.—in the cheese itself; hence fragments of leaves may be detected in certain kinds. The famous *fromage de Brie* of France is said to owe its peculiar flavour to its admixture with urine —a disgusting suggestion, almost incredible.

Detection of Adulterations.—If arsenical preparations to the rind are suspected, the same process may be employed for its detection as is described under ARSENIC.

If it is required to know the exact amount of caseine, fat, salt, ash, and water, the analysis should be conducted on the same principles as described under MILK-ANALYSIS; that is, the amount of water should be estimated by evaporating a known weight in a porcelain or platinum dish, the fat by extraction with ether, the ash by burning down a known quantity, and the remainder calculated as caseine. The salt may be estimated by the volumetric solution of nitrate of silver (*see* WATER-ANALYSIS) and chromate of potash (every 100 parts of salt containing 60·68 of chlorine). An ash as high as 7 per cent. is no proof of mineral adulteration, so that in this instance the analyst must be very careful not to draw conclusions until the ash has been qualitatively examined for lead by sulphuretted hydrogen, and for other mineral matters evidently of foreign origin, always remembering that the ash of genuine cheese consists of very little else but salt and phosphate of lime.

The microscope is of no very great utility in detecting foreign substances in cheese. Starch, however, may be seen in very soft cheeses. It will be found convenient to freeze a portion, and then cut a very fine section. In such a case the polariscope may also be used, and tests, such as iodine, &c., may be applied to a minute fragment in the field.

Cherry—The fruit of different species of the genus *Cerasus*. They are regarded as wholesome, cooling, laxative, nutritive, and antiscorbutic; but, like plums, they require to be eaten in moderation. Inflammation of the alimentary canal has been occasioned by swallowing the stones. The following is the composition of cherries as given by Fresenius:—

Composition of Cherries (FRESENIUS).

	Sweet light red Heart.	Very light Heart.	Sweet Black.
Soluble Matter—			
Sugar	13·110	8·568	10·700
Free acid (reduced to equivalent in malic acid) . . .	0·351	0·961	0·560
Albuminous substances	0·903	3·529 (both)	1·010
Pectose substances .	2·286		0·670
Ash	0·600	0·835	0·600
Insoluble Matter—			
Seeds	5·480	3·244	5·700
Skins	0·450	0·464	0·366
Pectose . . .	1·450	0·401	0·664
[Ash from insoluble matter included in weights given] .	[0·090]	[0·070]	[0·078]
Water . . .	73·370	81·998	79·700

Cherry-Laurel Water—An infusion of the leaves of the *Cerasus Lauro-cerasus*. Very common in England, and often confounded with the true laurel or sweetbay, which has no deleterious properties. The effects of cherry-laurel water are similar to those produced by hydrocyanic acid.

It is used for the adulteration of GIN, *which see*.

Chestnuts—Ground chestnuts, both the horse-chestnut (*Æsculus Hippocastanum*) and the edible chestnut, have been used as adulterants in chicory, coffee, &c. See fig. 18 (after Atcherley).

Chicory—Prepared from the root of *Cichorium Intybus*, a plant of the natural order *Compositæ*.

It is prepared by slicing the root, roasting it, mixed with a small quantity of lard, and subsequently drying it. It is used mainly as an addition to coffee, and as an adulteration of that article. In some parts of the world it is used as a beverage alone, especially in Flanders. The fresh root is medicinal, acting as a tonic and slight aperient. The roasted and ground article would appear to possess scarcely any decided properties whatever.

Fig. 18.

Structure of the Root.—The structure of the root is of importance, in order to detect its admixture in coffee. The chief part of the root is made of cells, rounded or flattened. A thin section, examined by the microscope, shows these cells, as well as dotted vessels and branching laticiferous ducts, which in the fresh root carry a milky sap (fig. 19).

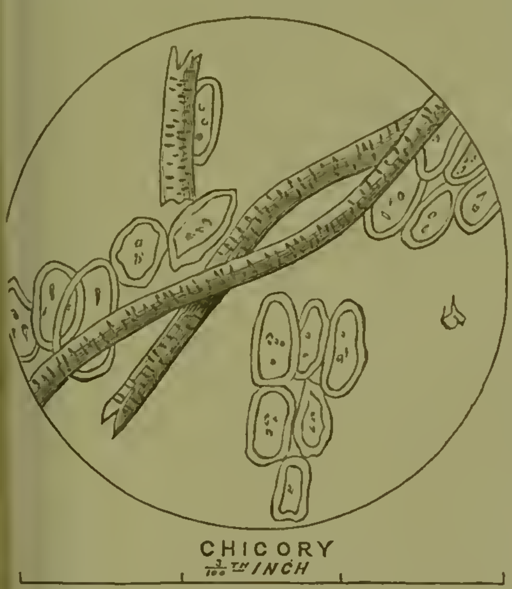


Fig. 19.

The chemical composition of chicory is as follows (LETHEBY):—

	Raw Root.	Kiln-dried.
Hygroscopic moisture	77·0	15·0
Gummy matter (like pectine)	7·5	20·8
Glucose or grape-sugar	1·1	10·5
Bitter extractive	4·0	19·3
Fatty matters	0·6	1·9
Cellulose, inuline, and woody matter	9·0	29·5
Ash	0·8	3·0
	100·0	100·0

Composition of the Roasted Root (LETHEBY).

	First Specimen.	Second Specimen.
Hygroscopic moisture	14·5	12·8
Gummy matter	9·5	14·9
Glucose	12·2	10·4
Matter like burnt sugar	29·1	24·4
Fatty matter	2·0	2·2
Brown or burnt woody matter	28·4	28·5
Ash	4·3	6·8
	100·0	100·0

The ash of these had the following composition:—

	First Specimen.	Second Specimen.
Chloride of potassium	0·22	0·45
Sulphate of potash	0·97	0·98
Phosphate of potash	1·41	1·37
,, magnesia	0.30	0·53
,, lime	0.40	0·81
Carbonate of lime	0·10	0·26
Alumina and oxide of iron	0·20	0·20
Sand	0·70	2·20
	4.30	6·80

The adulterations of chicory are numerous. The following have been either found or suspected: Venetian red, reddle, red clay, roasted acorns, beans, carrots, damaged dog-biscuits, damaged bread, damaged wheat, horse-chestnuts, mangel-wurzel, parsnips, peas, rye, and sugar; coffee flights (the husks of coffee), coffina (roasted lupines), Hamburg powder (roasted peas coloured with reddle), and the marc of coffee; bark from tanyards, logwood-dust, mahogany-dust, &c., &c.

Detection of Adulterations.—A familiarity with the microscopical structure of chicory is soon obtained, and then any admixture with foreign substance may be with comparative ease detected. Besides the microscope, the following tests may be employed:—

Chicory thrown into water rapidly sinks and colours the liquid reddish brown. A cold decoction tested with litmus or solution of iodine gives a brown colour. There is no starch in chicory, so if it produces a blue or black colour, it indicates the presence of roasted peas, beans, rye, &c. It should not turn black on the addition of perchloride or persulphate of iron; if it does, it shows an admixture of a vegetable substance containing tannin, such as acorns.

A weighed quantity should be burnt in a platinum dish, and the ash carefully examined. It should not exceed 5 per cent., and be of a grey colour, not red. *See* Coffee.

Childbed—*See* Puerperal Diseases.

Children, Employment of—*See* Brick-Fields; Trades, Injurious, &c.

Children, Mortality of—*See* Infant Mortality.

Chillies—Used for the adulteration of pepper and vinegar. *See* Capsicum, Pepper, &c.

Chimneys—Chimneys were not introduced into England until the reign of Queen Elizabeth. They were first used in the better-class mansions and in towns, but were a long time before they were adopted in country places; for example, they were certainly not introduced into the farmhouses of Cheshire until the middle of the seventeenth century. The chimney is not alone a mere tube to convey away the products of combustion, but also a ventilator. The principle by which a chimney exerts a draught is as follows: The chimney is a tube containing a column of air; if the room and the chimney be at the same temperature, the chimney column of air is exactly balanced by a column of air without the chimney; but if, as is usually the case, the room is warmer than the outside air, the warm air, being lighter, floats up the chimney, creating a slight but continual current. If a fire be lit in the grate, it warms the whole column of air, which expands, is rendered lighter, and therefore ascends, its place being continually taken by the colder and heavier air. Therefore when a fire is burned it must be supplied copiously with air. If it obtains an insufficient quantity from the room, by reason of the excellent workmanship of the doors and windows, or from want of due ventilation, it will obtain the air from above; in other words, a down current, carrying with it the smoke, will be established, and this is one of the principal causes of smoky chimneys, another of them being insufficient contraction of the throat of the chimney. By contracting the chimney-throat, and by closing partially the open space in front of a fire, almost any amount of draught may be obtained, the reason being that the immense volume of air continually drawn up the chimney is thus all made to pass through the fire instead of over it, as $\frac{9}{10}$ of the air does in open fireplaces. Another cause of smoky chimneys is the flues being too straight or too large, the consequence being that every gust of wind blows the smoke into the room; the more tortuous a flue, the less the risk of smoke.

The best general cure for smoky chimneys, according to Mr. Eassie, is a peculiar cone of terra-cotta fixed to the top of the chimney. This cone contracts considerably the top of the flue, is not unsightly, and the wind blowing against its external slope, quickly extracts the smoke. These cones are also provided with partitions of terra-cotta, so as to be isolated from each other. The cone failing, he uses an iron injector, which is a circular apparatus of iron fixed to the top of the chimney. It is provided with a series of outside mouths, which receiving the wind, pass it down narrow tubes, at the foot of which, when well compressed, it is caught by an angular valve, which compels it to escape with great force into the smoke-flue, and thence into the atmosphere. *See* Smoke.

Chimney-Sweepers (Sweeps)—The general hygienic condition of sweeps has always ranked low. They were formerly employed as nightmen, and their usual sleeping-place was a heap of soot. Naturally of a low class, of dirty habits, following a filthy and dusty occupation, there cannot be a doubt that their general health was not good, and that their lives were short, especially when most of them had in extreme youth to serve an apprenticeship of ill-usage, and were forced to climb the narrow flues before their limbs were developed. We have no statistics of the mean duration of sweeps' lives at the present day, nor has their present hygienic condition been investigated on a large scale. That they are more subject to cancer, and especially cancer of the scrotum, than other men, is a general idea, which at present is neither proved nor disproved. Dr. Walshe states that in 649 cases of cancer three were sweeps; in other words, 4·5 per 1000 cases. Whether this is a large number or not, can only be known by a return of the number of sweeps living in the places from whence the 649 cases were derived.

Chinese Botanical Powder—Used for the purpose of adulterating tea. It consists of catechu and wheat-flour. The directions for its use are as follows: Take half a teaspoonful of the powder to two teaspoonfuls of tea, and it will produce (so run the directions for its use) a strength equal to four teaspoonfuls of tea. This powder is very astringent, and therefore its frequent use is highly objectionable. *See* Tea.

Chloralum—This substance, which is an impure aqueous solution of chloride of aluminum, sp. gr. 1·15, was introduced in 1870 by Professor Gamgee as an antiseptic and disinfectant, for which purpose the article should be diluted with four times its bulk of water. This is a powerful disinfectant, and possesses the advantages of being non-poisonous, inodorous, and very cheap. Chloralum is thought by Professor Gamgee to be a much more useful antiseptic and disinfectant than carbolic acid, for it was found in experiments made by Professor Haughton that it destroys offensively odorous matter and secretions which are simply masked by carbolic acid. "For removing fœtor and effluvia," says Professor Wanklyn, "it is better and more available than any agent with which I am acquainted." In this respect it is incomparably superior to chloride of lime. Dr. Dougall found that it arrests putrefactive change, and prevents the appearance of animalculæ to a greater extent than any of the commonly employed disinfectants. It is not volatile, hence it cannot be regarded as an aerial disinfectant; but it is useful in washing infected clothing, or as a scouring material for cleansing rooms. It may be used with advantage as a dressing for surgical wounds, but as a deodorant for sewage, it is certainly in no way superior to chloride of lime and other old disinfectants. Experiments carried out in the laboratory at Dresden were not, indeed, very favourable to this new agent, for, according to Dr. Eulenberg, the following was the result of the investigations :—

	Per cent. of Putrefying Matters.
Chloride of lime disinfects	100·0
Quicklime ,,	84·6
Alum ,,	80·4
Sulphate of iron ,,	76 7
Chloralum ,,	74·0

—(Vierteljahrsschrift, j. Ger. Med. u. Off. San., nouv. série, t. xx. No. 2.)

It thus appears to be rather inferior to sulphate of iron, but notwithstanding this, the substance has qualities of a very useful nature, and equals the other disinfectants named, providing a proportionately larger quantity is used.

The Board of Trade requires all British ships to be furnished with a supply of chloralum for disinfecting purposes, in case a disinfectant should be needed.

Chlorine—Chlorine is an elementary substance discovered by Scheele in 1774. It was at first supposed to be a compound, but was proved by Sir H. Davy to be a simple substance, as Gay-Lussac and Thenard had suggested.

Properties, &c.—Chlorine is a gas of a greenish-yellow colour; its relative weight is 33·5, and its observed specific gravity 2·47. It is soluble in about half its bulk of cold water, but is much less soluble when collected over warm water. It is heavier than air, 100 c.c. weighing between 77 and 78 grains at 60° F. and 30 inches bar. pressure. It may be condensed into a yellow limpid liquid by a pressure of 4 atmospheres at 60° F., and it forms a definite hydrate with water.

Copper, arsenic, antimony, and phosphorus combine so energetically with chlorine, that when introduced in a finely-divided state into the gas they take fire spontaneously.

Chlorine has a great affinity for hydrogen, combining with it and forming hydrochloric acid; it is in this way that it acts on organic substances, and transforms bodies of an undefined nature into more or less definite compounds.

Preparation.—It may be made in many ways. In bleaching-works it is produced on an enormous scale by the action of hydrochloric acid on oxide of manganese. A very constant, regular supply of chlorine is evolved by dropping a crystal of chlorate of potash from time to time into muriatic acid ; and a third economical way is the addition of some acid to chloride of lime (the same purpose may also be effected by 1½ parts of alum-cake mixed with 1 of chloride of lime). For disinfecting purposes, chlorine may be obtained by taking two tablespoonfuls of common salt, two teaspoonfuls of red-lead, half a wine-glassful of sulphuric acid, and a quart of water ; mix the lead and salt with the water, stir well, and add the sulphuric acid gradually. Chlorine is evolved, and is absorbed by the water, from which it is slowly driven out. It may be kept in a jar or stoppered bottle, left open as occasion may require.

Uses, &c.—As obtained by any or all of these methods, chlorine is one of the most powerful deodorants and disinfectants known. It is destructive to all animal matter, and fatal when breathed by living beings in a concentrated form. The foulest smells cannot exist long in an atmosphere containing free chlorine, so that it is an excellent disinfectant for urinals and similar places, as a very small quantity continuously given off keeps them free from objectionable odour. As a gaseous disinfectant it is perhaps the best we possess, and is invaluable for the purpose of fumigating a room after infectious disease ; but its destructive and bleaching powers on the paper, coloured cloth, &c., must be remembered, and the precautions taken described under DISINFECTION, &c.

Chlorine, when continuously breathed by healthy people, acts as an irritant to the lungs —its frequent use, indeed, in the Paris hospitals is said to have caused phthisis; it is not, therefore, adapted as a disinfectant for ordinary household purposes. *See* DISINFECTANTS, DISINFECTION, &c.

Chocolate—*See* COCOA.

Cholera, Asiatic—*History.*—The first description of cholera is given by Garcia del Huerto, a physician of Goa, about 1560. It appeared in India in 1774, and succeeding years, and finally established its home in the Sunderbunds of Bengal, from whence it has issued at different times, and has appeared in almost every inhabited country on the globe. It prevailed in Russia in 1830, and has so frequently infected Eastern Europe, that, according to Dr. Pelikan, it is now endemic or naturalised there. It appears to have first been carried into Germany in 1829 and 1830, slaying more than 900,000 persons in the year. In France, successive and fatal epidemics appeared in 1831, 1849, and 1854. In England and Wales, in 1848–49, no less than 53,293 persons died of cholera; and in 1854, 20,097. In the recent outbreak of cholera in Europe, it appears to have come westwards from Russia, where it had lurked from at least 1866; and it appeared in 1871, 1872, and 1873 at the ports in the Baltic. Previous to this, however, it had attacked (1869) Victoria Nyanza, and in 1870 spread with great virulence in Africa. In 1873 it was in Italy, Hungary, Germany, Holland, and even made its way to the United States. In the same year there were several importations into the English ports; but owing to the exertions of the sanitary authorities (notably in one case at the Port of London), and probably to other favourable climacteric conditions, the disease did not spread; and now (1875) we may be said for the present to be cholera free. The following is the modern chronology of the disease to 1871:

Cholera appeared in Sunderland on the 26th of October 1831.

It was first observed at Edinburgh, 6th Feb. 1832. At Rotherhithe, Limehouse, and London, 13th Feb.; in Dublin, 13th March.

In the same year cholera attacked the Continent, and between March and August 18,000 people died of the disease in Paris.

Cholera epidemic in Rome, the two Sicilies, Geneva, Berlin, &c., July and August 1837.

Another visitation of cholera in England took place in 1849. The number of deaths in London for the week ending 15th September was 3183; the ordinary average 1008; and the number of deaths by cholera from 17th June to 2d October in London alone 13,161. The mortality lessened, and the distemper disappeared about 13th October 1849.

Newcastle-upon-Tyne, Hexham, Tynemouth, and other northern towns, suffered much from cholera, September 1853.

It raged in Italy and Sicily, 1854. Above 10,000 are said to have died at Naples. It was also very fatal to the allied troops at Varna, autumn, 1854.

Cholera was very severe for a short time in the southern parts of London, and in Soho and St. James's, Westminster, August and September 1854.

Raged in Alexandria, June; abated, July, 1865.

Prevailed in Ancona (843 deaths), August; subsided, September, 1865.

Very severe in Constantinople (nearly 50,000 deaths), August; subsided after the great fire, 6th September 1865.

Cases at Marseilles, Toulon, and Southampton, end of September 1865.

Cholera prevalent at Marseilles, Paris, Madrid, and Naples, July to October 1865.

An international meeting at Constantinople to consider preventive measures, proposed October 1865, met 18th February 1866. At the last sitting, the conclusions adopted were, that cholera may be propagated, and from great distances; and a number of preventive measures were recommended, 26th September 1866.

Cholera appeared at Bristol, 24th April; at Liverpool, 13th May; at Northampton, July 1866.

Cholera severe in the east of London; 346 deaths in week ending 21st July 1866.

House - to - house visitation; Metropolitan Relief Association formed; large subscriptions received (Queen's, £500), July and August 1866.

Cholera subsided, September 1866.

Very severe at Naples, September 1866.

Cholera Relief Committee closed, 31st October 1866.

Cholera declared to be extinct in London, 1st December 1866.

Cholera in Rome, Naples, and Sicily, August to September; in Switzerland, October, 1867.

Alarm of approaching cholera, July; said to be severe in Königsberg, in Prussia, August, 1871.

The Nature of Cholera.—Cholera is an infectious disease, the principal contagion residing in the excreta. It has a period of incubation, of accession, and decline.

The period of incubation is generally considered to average from three days to a week, but it has sometimes been much longer, even as much as twelve and fourteen days.

The accession is sometimes with a lightning-like rapidity, but in a great many cases a painless diarrhœa sets in for some days previously (varying from twelve hours to a week, or even more). If the disease does not end in death, in many cases the recovery of the patient is as rapid as the attack.

The following is a typical case of cholera: A man, either in perfect health or after a few days of painless diarrhœa, is suddenly seized with a most unaccountable sickness and purging. He becomes cold; his countenance has the paleness, his eyes the leaden hue of death; his voice sinks to a feeble whisper. Every single secretion is drained into one channel. His blood thickens and curdles in his veins, while enormous quantities of liquid run from his bowels. The urine, the bile, the skin, all cease to act; while the most frightful cramps of the muscles, of the legs and bowels, rack the sufferer every moment with an insupportable agony. The evacuations from the bowels are like no other fluid; they appear to be composed of a thin watery fluid, with flocculent white shreds floating in it. These shreds look something like rice, hence the evacuations are called "rice-water discharges." These discharges are seldom, if ever, absent. In those cases of sudden choleraic death, they have nearly always been found in the intestine by a post-mortem examination, death having in such cases been so rapid that no external discharge showed itself.

The three things, then, that are pathognomic in cholera are—

1. The rice-water evacuations.
2. The extreme collapse.
3. The suppression of all secretion except that of the bowel. (The milk of suckling women is, however, still secreted.)

Mode of Propagation.—There ought to be little doubt that the views of Dr. W. Budd of Bristol, with regard to the mode of propagation of cholera, are correct, supported as they are not alone by his own cogent reasoning, but by, we might almost say, actual experiment. He believes that the poison is cast off by the intestine of the cholera patient in the characteristic rice-water discharges, and that it is and may be transmitted to uninfected persons in the following principal ways:—

1. By the soiled hands of attendants on the sick, a mode of communication probably very common in cases nursed at home.
2. By means of bed and body linen, and other articles tainted with the rice-water discharges.
3. Through the medium of the soil. The discharges being liquid, the great bulk of them find their way to the ground, from which the poison may be propagated in three ways—(*a*) by rising into the air as a product of evaporation; (*b*) by percolating into the drinking-water; (*c*) by atmospheric dispersion in the form of impalpable dust after it has passed into the dried state.

There are cases recorded which put beyond a doubt that if cholera evacuations get into the water, the disease may be communicated in that way; *e.g.*, the case of the Broad Street pump in 1854 (Report on Cholera Outbreak at St James's, Westminster, 1854), the outbreak at Newcastle-on-Tyne in 1865, traced to contaminated water from the Tyne, with several others in England, together with remarkable cases recorded by Macnamara as occurring in India. The latter observer appears to show that the stools are most infectious when swarming with vibriones; but when ciliated infusoria appear, the danger is over. This very important observation tends to show that there is a contagious principle (a nitrogenised body?) on which the one class of animalcules feed; this being exhausted, they must die, and a new generation supplants them. Evidence of a different kind, but quite as good as if it were an actual experiment, is the outbreak of cholera which appeared at the Devon County Lunatic Asylum. It was introduced from Exeter into the men's side of the institution, and there were in all no fewer than forty cases, *all men*, no single case occurring among the females. It was considered a great mystery, until Dr. C. Budd of North Tawton, who was consulted by the authorities, pointed out that the disease was communicated through the medium of the *latrines* from man to man, the men's closets being, of course, distinct and entirely separate from the women's. In fact, there is a vast collection of positive evidence on the contagiousness of the rice-water discharges, but it cannot be here inserted; the facts are to be found in its history, and speak for themselves.

Propagation of Cholera by Food.—There have been a few marked instances of this in India; *e.g.*, in a case recorded by Dr. Fairweather (Report of the Sanitary Administration of the Punjab for 1871: Lahore, 1872), a man died of cholera, infecting freely the floor of the room in which he died. Six days afterwards a burial-feast was given in this room, and about 350 attended. The food—rice, lentils, ghee, sugar, and spices—was cooked in the room, and spread out on an open mat laid on the earthen floor. Some of the guests carried home part of the feast to their wives and daughters. There had been no cases of cholera previously in the district, but at the end of three days after the feast there were seventy-three cases and forty-six deaths, the cases being confined to the men and their wives who had eaten this food, so that it is highly probable the rice was infected by contagion lurking in the floor.

Certain geological conditions of soil appear greatly to influence the spread of cholera. Pettenkofer of Munich, indeed, maintains that a certain condition of soil is actually necessary for the development of epidemic cholera.

It must be pervious to water and air, and possess a particular degree of humectation, depending upon the position of the subsoil-water to the surface, and must be charged with excrementitious matter. He supposes that when a soil in this condition receives the cholera poison, it undergoes multiplication in the interstices of the soil.

The influence of season and other meteorological conditions in the propagation of cholera is very evident from its history. The visitations of 1832, 1848, and 1854 were all characterised by great atmospheric pressure, and in two out of the three years by a high temperature. In 1866 a very peculiar blue mist prevailed at the same time as cholera. The only certain fact, however, at present known is, that a high temperature and a stagnant air are both extremely favourable conditions in promoting the spread of cholera.

Precursory and Concomitant Phenomena.—It is a notable fact that many outbreaks of cholera have been preceded by severe epidemics of influenza; sometimes also intermittent fevers have prevailed, and in India, Russia, and Poland epizootics of a most fatal character amongst sheep, dogs, oxen, and domestic fowls have been the precursors of cholera. In the last Russian epidemic (1870), horses are said to have been attacked by cholera. Diseases of all kinds have also coexisted with cholera. In 1832, at Constantinople, it raged in company with the plague, and in France it co-existed with the sweating sickness. It has also accompanied scarlatina, typhoid, and other fevers.

The *causes* predisposing are insanitation, overcrowding, drinking water liable to pollution, and general uncleanliness.

Prevention of Cholera.—"No greater mistake can be made than to assert of Asiatic cholera, as is done with a kind of Oriental fatalism by some popular writers, that cholera is under no kind of control. Now it is, I believe, more completely under medical control than any other known epidemic disease. In the first place, its propagating fluid is tangible, and can be destroyed; and, in the second place, the disease almost invariably begins as diarrhœa, which can in the great majority of cases be stopped by simple remedies. The disease here never decimates cities, except when its poison is diffused through their potable waters. To the practical applications of these well-ascertained scientific facts it is due that Asiatic cholera, which in 1849 destroyed 53,273 lives, in 1854 was only fatal to 20,097; in 1866 to 14,378 lives in England and Wales. The deaths from common cholera of this climate were 702 in 1869, and 1065 in the present year (1870)."—(Dr. FARR, Registrar-General's Report.)

As Asiatic cholera is invariably imported, the first problem is to watch narrowly every vessel coming from an infected, or indeed a non-infected port, and not to permit the landing of any person until a certain period has passed. When cholera has been or is raging in a ship, the ship should be moored as far from the shore as possible, and, if it can be done, in such a position that the town is to the windward of the prevailing or prevalent winds. To carry this out, however, in rough weather and small harbours, would be simply impossible; in such a case the best means at hand should be taken. In all cases the discharges of those suffering should either go direct from the patient's body into the sea, or be received in a bucket of salt water and immediately thrown overboard. If he should die, his body should almost at once be consigned, properly loaded, to the deep, and all bedding and clothes with the slightest soil or discharge upon them burnt. No one should land or communicate with the shore until seven days have elapsed since the last case. We append the Orders of the Council given in 1871. Their great defect is that they allow a person to leave a cholera-stricken ship provided he is apparently in health; it is evident that he may have the seeds of the poison in the system, and there is not a spot in the United Kingdom to which in these days of quick communication he might not carry them.

When cholera has once obtained a footing on land, however, the medical officer of health should repair to the place without delay. He should have the discharges of his patient or patients received in a vessel containing sawdust and paraffine, and *at once burnt.* If this is not available, let him use the best disinfectant that he has carried with him, or that is to be had, for no time is to be lost; and while paraffine and sawdust are being sent for, the evacuations may in the meantime be received in carbolic acid, solution of green copperas, or in common salt (which is almost sure to be at hand even in the most out-of-the-way houses), and buried in the ground deeply. There can, however, be no doubt that burning the evacuations is better, where it can be practised, than allowing them, even when thoroughly disinfected, to enter the ground. Wells or supplies of water, if suspected on the slightest evidence of being contaminated, had better be shut up. All soiled clothing should be thoroughly disinfected or burnt. The use of carbolic acid to the ground and floor of an infected place is to be commended. If a case should end fatally, the body must be quickly put into a coffin and covered with chloride of lime and sawdust, and buried as speedily as possible. If, despite all these measures, fresh cases occur, a house-to-house visitation should be made, and inquiries at each house as to whether any inmate has diarrhœa or not instituted. In the last cholera epidemic a house-to-house visitation was adopted, and found to work admirably, for thus the first symptoms of the malady were checked with appropriate remedies.

In epidemics of cholera, the Diseases Prevention Act may be put in force in the metropolis; but elsewhere any extraordinary action will have to be taken under the directions of the Local Government Board.

"The Local Government Board may from time to time make, alter, and revoke such regulations as to the said Board may seem fit, with a view to the treatment of persons affected with cholera, and epidemic, endemic, and infectious disease, and preventing the spread of cholera and such other diseases, as well on the seas, rivers, and waters of the United Kingdom, and on the high seas within three miles of the coasts thereof, as on land; and may declare by what authority or authorities such regulations shall be enforced and executed. Regulations so made shall be published in the 'London Gazette,' and such publication shall be for all purposes conclusive evidence of such regulations.

"Any person wilfully neglecting or refusing to obey or carry out or obstructing the execution of any regulation made under this section shall be liable to a penalty not exceeding £50."—(P. H., s. 130.)

Orders in Council as to the Cholera in Ships.

By an Order in Council, dated the 29th day of July 1871, and published in a supplement to the "London Gazette" of Friday the 2d of July, after a recital of the 6 Geo. IV. c. 78, s. 6, and the sect. 52 of the Sanitary Act, 1866, and further that "cholera is now prevailing in certain parts of Continental Europe with which this country has communication, and that it is requisite to take precaution, as far as is practicable, against the introduction of that disease into this country," it is ordered as follows:—

1. In this Order the term "ship" includes vessel or boat; the term "master" includes the officer or person for the time being in charge or command of a ship; the term "cholera" includes choleraic diarrhœa; the term "nuisance authority" has the same meaning as in "The Sanitary Act, 1866."

2. It shall be lawful for any nuisance authority, having reason to believe that any ship arriving in its district comes from a place infected with cholera, to visit and examine such ship before it enters any port, or lands any person or thing in the district, for the purpose of ascertaining whether such ship comes within the operation of this Order.

3. The master of every ship within the district of a nuisance authority having on board any person affected with cholera, or the body of any person dead of cholera, or anything infected with or that has been exposed to the infection of cholera, shall, as long as the ship is within such district, moor, anchor, or place her in such position as from time to time the nuisance authority directs.

4. No person shall land from any such ship until the examination hereinafter mentioned has been made.

5. The nuisance authority shall, immediately on the arrival of such a ship, cause all persons on board of the same to be examined by a legally-qualified medical practitioner, and shall permit the persons who shall not be certified by him to be suffering from cholera to land immediately.

6. All persons certified by the examiner to be suffering from cholera shall be dealt with under any rules that may have been made by the nuisance authority under the 29th section of the Sanitary Act, 1866; or where no such rules shall have been made, shall be removed, if their condition admits of it, to some hospital, or place to be designated for such purpose by the nuisance authority, and no person so removed shall quit such hospital or place until some physician or surgeon shall have certified that such person is free from the said disease.

7. In the event of any death from cholera taking place on board such vessel, the body shall be taken out to sea, and committed to the deep, properly loaded, to prevent its rising.

8. The clothing and bedding of all persons who shall have died, or had an attack of cholera, on board such vessel, shall be disinfected, or (if necessary) destroyed, under the direction of the nuisance authority.

9. The ship, and any articles therein which may be infected with cholera, shall be disinfected by the nuisance authority.

10. Every person obstructing the nuisance authority in carrying this Order into effect, or otherwise offending against this Order, shall be liable, on summary conviction, to a penalty not exceeding £20.

Another Order in Council, bearing date the 3d day of August 1871, empowers any customhouse officer, or other person having authority from the Commissioners or Board of Customs, at any time before the nuisance authority shall visit and examine the ship, to detain the ship, and requires the master to moor the ship where such officer shall order.

No person shall, after such detention, land from the ship, and the officers shall forthwith give notice of the detention, and of the cause thereof, to the proper nuisance authority, and the detention shall cease as soon as the nuisance authority shall visit and examine the ship, or at the expiration of twelve hours after notice shall have been given to such nuisance authority.

And by another Order in Council, bearing date the 5th day of August 1871, it was ordered that—

1. No master of any ship in which, during the voyage and before the arrival thereof at any port of the United Kingdom, any person has been attacked with or died of cholera, shall bring his ship into any such port until he has destroyed the clothing and bedding of all persons who shall so have died, or had an attack of cholera, on board such vessel during such voyage.

2. The terms "ship," "master," and "cholera" are defined as in the former Order.

3. The terms "clothing and bedding" mean and include all clothing and bedding in actual use and worn or used by the person attacked as aforesaid at the time of and during such attack.

Cholera, English—This is merely an exaggerated diarrhœa. It may, however, put on the symptoms of Asiatic cholera, as shown by cramps, deadly pallor, coldness, &c., and may terminate in death; but the characteristic rice-water evacuations, suppression of bile, urine, and other secretions, will be absent, and serve to distinguish it from the foreign enemy. It will be well to remember that in all probability the English disease is contagious, and to disinfect with a solution of sulphate of iron the excreta, or to burn them, as recommended under CHOLERA, ASIATIC. *See also* DIARRHŒA.

Churchyards—The reports of the General Board of Health, first on the burial-grounds of the metropolis, and then on those of country towns, drew the serious attention of the Legislature to the fearful state of the churchyards, and resulted in the prohibition of intramural interment in large towns. The regulation of burial-grounds yet requires extension. The evils complained of formerly yet exist in a moderate degree. *See* DEAD, DISPOSAL OF.

Cider, or **Cyder** — A fermented beverage obtained from the juice of the apple. Cider was known to the ancients, for Pliny speaks of it as the "wine of apples." Fruit that is not fit for eating on account of its acid, bitter, or rough taste, may be made use of for the manufacture of cider; but, as a general rule, those varieties should be chosen that yield a juice rich in sugar, and contain no undue amount of acid, and which, after the period of active fermentation is past, furnish a liquid which clarifies itself, and keeps well. This quality of the juice can generally be determined from its specific gravity. The heaviest and the clearest is the best, other points being equal. The specific gravity of the juice of apples varies from 1·060 to 1·100. The very best cider is most decidedly that made from sweet apples; but as it requires some skill in its manufacture, and as the mode of operation generally followed is of a rude character, farmers usually prefer to make it of sour and *rough*-tasted apples, which, as they contain a large quantity of malic acid, impede the conversion of the alcohol of the cider into vinegar.

The amount of alcohol in cider varies, the highest average in the ciders analysed by Brande was 9·87 and the lowest 5·21 per cent. of alcohol *by measure*. The following may be taken as the type of an ordinary average sample of cider, such as is consumed by farm-labourers in the field. Its appearance was that of a bright light-yellow sparkling liquid, its taste sweetish, not very acidulous, and its odour agreeable.

Devonshire Cider (specific gravity, 1·001).

	Grammes per Litre (Parts by Weight per 1000).
Water	938·36
Alcohol	40·00
Sugar	10·00
Ash	3·00
Volatile acid (calculated as acetic acid)	1·55
Fixed acid (calculated as malic acid)	3·35
Extractive matters	3·74
	1000·00

Cider, when pure, is one of the most wholesome of alcoholic drinks. Attacks of colic are frequent in cider districts, but the majority of them are certainly due to the accidental contamination of the cider with lead, as Sir George Baker ably proved, as long ago as 1767, in the case of Devonshire colic. (*See* COLIC.) The different ways by which lead enters the cider are various. The presses used to be lined and repaired with lead, leaden pipes conveyed the liquid from one cask to another, leaden weights used to be put into the casks to prevent acidity, and salts of lead added to correct acidity when already present. Lead in any shape or form should not be used in the manufacture or subsequent treatment of cider.

Cider is said to be used for the adulteration of port wine or claret. Some claret, indeed, has been found to be nothing but coloured and flavoured cider.

Adulteration.—The main adulteration is lead. It is easily detected by evaporating the cider to dryness, incinerating in a porcelain vessel, and then dissolving the ash in dilute nitric acid. If lead be present, the liquid will give a black precipitate with sulphuretted hydrogen, a white precipitate with dilute sulphuric acid, the latter recognised as sulphate of lead by its solubility in acetate of ammonia, and by its reduction to the metallic state when mixed with cyanide of potassium and submitted to the flame of the blow-pipe.

Cinnamon—The inner bark of shoots from the truncated stock of *Cinnamomum Zeylanicum*, imported from Ceylon, natural order *Lauraceæ*.

Cinnamon bark is imported in closely-rolled quills. The bark is brown in colour, aromatic in odour, and in taste astringent. The thickness of the bark averages one-fifth of a line in diameter, and it breaks with a splintering fracture. The constituents of cinnamon are a peculiar oil, mainly consisting of hydride of cinnamyl (C_9H_7OH) mixed with small quantities of a hydrocarbon ($C_{10}H_{16}$), cinnamic acid (C_9H_7OHO), an oleo resin, tannin, lignin, starch, &c.

The structure of the bark is complicated and peculiar. A longitudinal section shows—1. Numerous sharp-pointed woody fibres provided with a central canal. 2. A thick layer of large oval or quadrangular cells, with a central cavity, and rays or channels leading from the centre to the circumference. These cells have little structural connection one with the other, and are readily isolated. 3. A more connected layer of thin-walled cells, generally containing a few starch-corpuscles. 4. Starch-corpuscles, usually united in twos or fours. 5. Deep granular masses of a yellowish colour.

Adulteration of Cinnamon.—Cinnamon is extensively adulterated with cassia (*Cinnamomum cassia*). With a little practice, the detection of this adulteration is easy; without a practical knowledge of the appearance of cinnamon and cassia, it is very difficult. Cassia bark is much thicker and rougher than cinnamon, and is of a different taste. The microscope shows a similar structure to cinnamon, but the rayed cells and woody fibre are less abundant, the starch-cells more numerous and larger. Cinnamon infusion, although it contains a minute quantity of starch, does not give a perceptible blue with iodine; cassia, on the contrary, does.

Other adulterations have been detected, such as baked wheat-flour and sago, and the oil has been extracted.

Cisterns—*See* TANKS.

Citron—The fruit of the citron-tree (*Citrus medica*) is larger and less succulent than the lemon, and of a strongly acid taste. The peel is very thick, and the surface warty and furrowed. Its juice, mixed with water and sweetened, forms an excellent refrigerant and antiscorbutic drink. Mixed with cordials, it is used as an antidote to the manchineel poison. Its peel is often candied in the same way as that of the lemon and orange, and candied citron-peel has frequently been found to be contaminated with copper. For tests, &c., *see* COPPER.

Claret—*See* WINE, ALCOHOL, &c.

Clay—The various sorts of clay, which are very numerous, are chemical compounds consisting of silicates of alumina, either alone or combined with silicates of potash, soda, lime, magnesia, iron, and manganese. The complex clays approximate in their composition to felspar.

Clay and sand mechanically mixed together constitute *loam*; clay and carbonate of lime mixed form *marl*. The following table shows at once the principal varieties, and their composition :—

	Washed Kaolin.			Stourbridge Fire-Clay.	Pipe-Clay.	Sandy Clay.	Blue Clay.	Brick-Clay.
	Chinese.	St. Yrieix.	Cornish.					
Silica . .	50·5	48·37	46·32	64·10	53·66	66·68	46·38	49·44
Alumina .	33·7	34·95	39·71	23·15	32·00	26·08	38·04	34·26
Oxide of iron .	1·8	1·26	0·27	1·85	1·35	1·26	1·04	7·74
Lime . .	...	...	0·36	...	0·40	0.84	1·20	1·48
Magnesia .	0·8	trace	0·44	0 95	trace	trace	trace	5·14
Potash and soda	1·9	2·40 }	12·67	...	...	...	...	...
Water . .	11·2	12·62 }		10·00	12·08	5·14	13·57	1·94
	99·9	99·60	99·80	100·05	99·49	100·00	100·23	100·00

China or kaolin is a very pure clay, consisting almost entirely of silicate of aluminum. It is found in China, Cornwall, and some parts of France.

Clay absorbs ammonia freely, and possesses some purifying properties. It is utilised as a deodoriser of sewage in the A B C and other processes. *See* SEWAGE.

Clay is used for adulterating several different articles of food. It has been found in condiments, confectionery, and tea.

Cleansing—*See* REFUSE, DISPOSAL OF; SCAVENGING.

Clerk of Local Authority—*See* OFFICERS, APPOINTMENT OF.

Climate—The name *climate* is given to the sum of the physical conditions resulting from the various situations on the earth of different regions which are of a nature to exercise a special influence on organised beings.—(TARDIEU, SAUSSURE, ZIMMERMAN, CLARKE.)

Classification of Climates.—Climates may be divided variously, but if temperature alone be considered, Humboldt's classification is perhaps the best. He distinguished seven climates, bounded by isothermal lines, viz.—

	Mean Temperature. Centigrade.	Fahrenheit.
1. Hot . . .	27 to 25	80·6 to 77
2. Warm . . .	25 to 20	77 to 68
3. Mild . . .	20 to 15	68 to 59
4. Temperate . .	15 to 10	59 to 50
5. Cold . . .	10 to 5	50 to 41
6. Very cold . .	5 to 0	41 to 32
7. Glacial .	Below zero	Below 32

Climates may also be classed as moist and dry, insular and continental, and in many other obvious ways, but for health purposes —*i.e.*, the study of climate as it relates to the health of man—a modification of Humboldt's system is most convenient, by which the earth is simply divided into tropical, temperate, and polar zones; the torrid or tropical zone being bounded north and south by the isotherm of 77° F., the temperate zone bounded on the one hand by the isotherm of 77° F., and on the other by that of 41°, and the polar zone north and south comprising the coldest parts of the earth.

The great majority of diseases are common to all regions, but many of the zymotic class, with others, are so dependent upon climate and soil that they are either truly endemic, or have a well-defined and circumscribed range. *See* map illustrating article DISEASE, GEOGRAPHICAL DISTRIBUTION OF.

The dominant element in the constitution of climates is *temperature*. The mean temperature of any place could be predicated from its latitude, longitude, and the position of the sun, were it not for a variety of complex causes, which so modify temperature that a real knowledge of its distribution is only to be obtained by observation.

TABLE 1.—Range of the MEAN TEMPERATURE in the UNITED STATES for the Extreme Months, Seasons, and Year (Army Meteorological Register, 1855).

Stations.	Years.	Latitude.	January.	July.	Spring.	Summer.	Autumn.	Winter.	Year.
		° ′	°	°	°	°	°	°	°
Hancock Barracks, Maine . .	17	46 07	16·0	8·7	6·4	6·8	7·2	7·1	5·8
Fort Sullivan, Maine . . .	25	44 54	14·0	9·9	7·7	6·8	4·7	7·8	3·7
Fort Constitution, New Hampshire	25	43 04	14·0	9·0	7·0	7·4	5·7	11·9	6·7
Fort Independence, Massachusetts	17	42 20	9·9	8·6	7·8	4·9	6·9	11·0	4·7
Fort Columbus, New York . .	33	40 42	12·6	11·8	7·8	7·1	9·9	10·3	7·3
Watervliet, New York . . .	31	42 43	15·3	10·5	8·8	4·7	9·2	12·8	7·4
Alleghany Arsenal, Pennsylvania .	22	40 32	18·9	14·5	12·9	7·8	12·0	11·2	7·8
Fort M'Henry, Baltimore, Indiana	24	39 17	14·2	6·8	8·9	6·0	7·2	11·2	4·9
Fort Monroe, Virginia (Norfolk) .	30	37 00	16·9	7·4	10·1	5·9	7·6	16·0	9·0
Fort Moultrie, S.C. (Charleston) .	28	32 45	18·3	6·1	7·1	7·3	9·5	16·7	6·9
Ft. Marion, St. Augustine, Florida	20	29 48	16·1	8·6	11·3	6·7	7·1	15·4	6·7
Key West, Florida . . .	14	24 32	12·6	5·9	3·5	3·2	4·2	8·2	3·5
Fort Brooke, Florida . . .	25	28 00	17·7	6·8	6·8	5·4	4·8	11·9	4·0
Fort Barrancas, Pensacola, Florida	17	30 18	18·2	5·3	7·1	3·2	4·5	9·7	3·0
Mount Vernon Arsenal, Mobile, Al.	14	31 12	14·2	6·1	4·7	4·3	5·6	6·8	3·5
Fort Pike, Louisiana . . .	14	30 10	10·7	4·2	6·2	3·0	7·0	13·3	4·8
New Orleans, Louisiana . .	20	29 57	18·0	6·8	7·4	5·2	5·5	8·9	4·7
Baton Rouge, Louisiana . .	24	30 26	15·4	7·1	9·3	4·8	6·9	11·1	4·2
Fort Jessup, Louisiana . .	23	31 33	17·5	7·8	9·0	4·6	7·6	10·6	6·6
Fort Gibson, Indian Territory .	27	34 47	19·5	7·8	9·2	8·6	11·3	14·4	6·9
Jefferson Barracks, Missouri .	26	38 28	17·6	12·0	15·0	9·1	10·2	19·2	7·0
St. Louis, Missouri . . .	12	38 40	14·0	7·2	7·2	4·7	7·4	7·3	3·7
Fort Gratios, Michigan . .	17	42 55	13·6	11·8	11·8	8·2	8·9	10·7	6·1
Fort Mackinac, Michigan . .	24	45 51	12·3	10·3	8·1	5·8	7·9	9·9	6·1
Fort Brady, Michigan . . .	31	46 30	13·0	13·3	13·0	8·5	9·8	9·0	7·1
Fort Howard, Wisconsin . .	21	44 30	14·5	11·8	9·2	7·6	9·9	16·6	5·1
Fort Crawford, Wisconsin . .	19	43 05	19·6	10·4	17·7	8·1	9·2	16·4	8·9
Fort Armstrong, Illinois . .	11	41 30	18·5	10·3	6·8	8·3	6·2	17·4	7·5
Fort Swelling, Minnesota . .	35	44 53	27·9	14·6	17·3	11·0	10·4	16·0	8·6
Fort Leavenworth, Kansas . .	24	39 21	24·7	10·0	17·8	8·0	9·4	13·3	8·0
Fort Rearney, Nebraska . .	6	40 38	19·9	5·2	5·8	4·1	7·0	13·0	5·3
Fort Laramie, Nebraska . .	6	42 12	13·2	4·5	6·4	2·6	10·8	4·8	5·8
Fort Brown, Texas . . .	7	25 54	10·0	2·9	2·5	2·2	3·1	4·2	1·6
Fort M'Incosh, Texas . . .	6	27 31	10·2	3·7	4·8	5·5	3·1	3·6	1·9
Santa Fé, New Mexico . . .	5	35 41	4·3	6·9	2·3	1·8	5·0	3·7	0·8
San Diego, California . . .	5	32 42	3·7	6·9	14·7	2·7	3·6	2·6	2·3
Benicia, California . . .	6	38 03	6·9	4·9	4·6	2·9	3·4	3 2	3·2
Fort Vancouver, Oregon . .	6	45 40	10·1	3·4	4·0	2·5	2·2	2·3	1·4
Fort Steilacoom, Washington Terr.	6	47 50	12·6	3 8	2·3	1·8	2·8	4·0	2·0

TABLE II.—AMERICA.

Places.	Latitude.	MeanTemperature of several Years.	Mean Temperature of different Seasons.				Mean Temperature of	
			Winter.	Spring.	Summer.	Autumn.	Warmest Month.	Coldest Month.
	° ′	°	°	°	°	°	°	°
Nain	57 08	26·42	0·60	23·60	48·38	33·44	51·80	11·20
Fort Brady, Michigan	46 39	41·37	14·09	37·89	61·83	43·94	62·87	12·65
Quebec, Lower Canada	46 47	41·74	14·18	38·04	68·00	46·04	73·40	13·81
Eastport, Maine	44 54	42·44	23·44	38·58	60·54	45·43	63·52	20·91
Fort Howard, Michigan	44 40	44·50	20·82	41·40	68·70	45·18	73·67	17·95
Fort Crawford, Mississippi	43 03	45·52	23·76	43·09	69·78	46·74	71·34	20·14
Cambridge, Massachusetts	42 21	50·36	33·98	47·66	70·70	49·82	72·86	29·84
Council Bluffs, Mobile	41 25	50·82	27·38	46·38	72·84	48·60	75·92	27·19
Newport, Rhode Island	41 30	51·02	33·82	46·87	68·70	53·83	71·46	32·14
Philadelphia	39 56	53·40	32·18	51·44	73·94	56·48	77·00	32·72
New York	40 40	53·78	29·84	51·26	79·16	54·50	80·78	25·34
Cincinnati	39 06	53·78	32·90	54·14	72·86	54·86	74·30	30·20
Monticello, Virginia	37 58	55·40	37·67	54·67	73·33	56·50	75·00	36·00
Washington, Dist. of Columbia	38 53	55·56	36·80	53·83	75·90	56·59	79·13	34·66
Smithfield, North Carolina	34 00	58·88	53·44	64·76	80·46	68·15	82·93	50·69
Charleston, South Carolina	32 47	60·18	51·09	66·73	80·89	67·55	82·81	49·43
Natchez, Mississippi	31 34	64·76	48·56	65·48	79·16	66·02	79·70	46·94
Pensacola, Florida	30 28	68·77	55·13	69·67	82·57	69·05	83·55	53·80
St Augustine, Florida	29 48	72·23	59·29	71·47	82·73	75·15	83·94	56·60
Tampa Bay, Florida	27 57	72·37	61·24	72·93	80·14	75·28	80·72	58·70
Vera Cruz	19 11	77·72	71·96	77·90	81·50	78·62	81·86	71·06
Havana	23 10	78·08	71·24	78·98	83·30	78·98	83·84	69·98
Bahamas	26 40 to 27 5	78·3*	71·00	77·00	83·00	80·00	90·00	64·00
Barbadoes	13 10	79·3	76·7	19·00	81·00	80·00	...	...
Cumana	10 27	81·86	80·24	83·66	82·04	80·24	84·38	79·16

* St Louis, Missouri, lat 38° 46′; mean temperature, 55·86°. New Harmony, lat. 38° 11′; mean temperature, 56·74°. New Orleans, lat. 30°; mean temperature, 69·01°. Baton Rouge, lat. 30° 26′; mean temperature, 68·07°. Jamaica coast, mean temperature, 80·6°.

TABLE III.—Europe, Africa, &c.

Places.	Latitude.	Mean Temperature of several Years.	Mean Temperature of different Seasons.				Mean Temperature of	
			Winter.	Spring.	Summer.	Autumn.	Warmest Month.	Coldest Month.
	° ′	°	°	°	°	°	°	°
Geneva	48 12	49·28	34·70	47·66	64·94	50·00	66·56	34·16
Gosport	48 1	50·24	40·44	47·63	62·00	50·08	...	...
Newport, Isle of Wight	50 40	51·00	40·31	49·00	63·09	57·63	...	...
Sidmouth	...	52·10	40·43	50·60	63·83	53·50	...	...
Penzauce	52 11	51·80	44·03	49·63	60·70	53·36	...	...
Undercliff	...	51·11	42·14	29·26	60·28	52·76	...	...
Hastings	50 52	57·00	40·11	45·77	60·45	51·00	...	...
Bute	55 42	48·25	39·62	46·66	58·02	48·59	...	...
Cove of Cork	51 54	51·58	34·90	49·43	61·26	51·73	...	...
Jersey	49 13	53·06	36·82	50·97	62·84	44·63	...	...
Paris	48 50	51·08	38·66	49·28	64·58	51·44	...	...
Pau	43 7	54·95	41·79	54·96	67·41	55·64	65·30	36·14
Sienna	43 24	55·60	40·50	54·10	70·80	57·10	...	...
Nantes	47 13	55·62	42·23	53·10	70·73	56·41	...	...
Bordeaux	44 50	56·48	42·08	56·46	70·88	56·30	70·52	39·02
Montpellier	43 36	57·60	44·20	53·33	71·30	61·30	73·04	41·00
Avignon	...	58·20	42·60	57·13	74·66	59·00	...	...
Florence	43 46	59·00	44·30	56·00	74·00	60·70	...	...
Nice	43 42	59·48	47·82	56·23	72·26	61·63	...	...
Marseilles	43 17	59·50	45·50	57·56	72·50	60·08	...	...
Toulon	43 07	59·90	43·30	53·70	74·30	59·00	...	...
Leghorn	43 33	60·00	46·30	57·60	74·10	62·00	...	...
Genoa	44 25	60·37	44·57	58·60	74·03	62·94	...	...
Pisa	43 43	60·60	46·03	57·20	75·15	62·80	...	...
Rome	41 53	60·40	44·86	57·74	75·20	62·78	77·00	42·26
Naples	40 44	61·40	48·50	58·50	70·83	64·50	...	...
St. Michaels, Azores	37 47	62·40	47·83	61·17	86·33	62·33	...	...
Cadiz	36 32	62·88	52·90	59·53	70·43	65·35	...	...
Madeira, Funchal	32 37	64·56	59·50	62·20	69·33	67·23	...	...
Algiers	36 48	69·98	61·52	65·66	80·24	72·50	82·76	60·08
Canaries, Santa Cruz	28 28	70·94	64·65	68·87	76·68	74·14	...	...
Cairo	30 02	72·32	58·46	73·58	85·10	71·42	85·88	56·12

London, lat. 51° 30′; mean temperature, 56·36°. Environs of London, mean temperature, 48·81°. Perpignan, mean temperature, 59·51°. Lyons, mean temperature, 55·76°. Nismes, mean temperature, 60·26°.

TABLE IV.—MEAN TEMPERATURE.

Places.	December.	January.	February.	March.	April.
	°	°	°	°	°
Sidmouth.............	43·00	36·30	42·00	45·00	51·00
Penzance..............	46·50	43·00	44·50	46·50	48·50
Pau	41·53	38·89	44·96	46·80	55·79
Montpellier	46·00	42·00	45·00	47·00	53·00
Nice......................	48·60	45·85	49·00	51·45	57·00
Rome.....................	49·62	47·65	49·45	52·05	56·40
Naples..................	50·50	46·50	48·50	52·00	57·00
Madeira	60·50	59·50	58·50	61·06	62·50

TABLE V.—DAILY RANGE OF TEMPERATURE.

Places.	December.		January.		February.		March.		April.	
	Mean Daily Range.	Greatest Daily Range.	Mean Daily Range.	Greatest Daily Range.	Mean Daily Range.	Greatest Daily Range.	Mean Daily Range.	Greatest Daily Range.	Mean Daily Range.	Greatest Daily Range.
	°	°	°	°	°	°	°	°	°	°
Sidmouth..............	...	13	...	13	...	12	...	12	...	13
Penzance..............	3	...	4	...	6	...	8	...	9	...
Pau.......................	7	13	7	16	9	16	9	17	8	18
Montpellier	9	...	8	...	9	...	14	...	14	...
Nice......................	6	14	8	16	9	18	9	17	11	18
Rome.....................	9	15	11	16	10	18	12	19	13	20
Naples..................	9	13	9	14	11	19	11	18	14	20
Madeira.........	11	14	11	17	9	13	10	14	9	13

TABLE VI.—MAXIMUM, MINIMUM, AND RANGE OF TEMPERATURE.

Places.	December.			January.			February.			March.			April.		
	Max.	Min.	Range.	Max.	Min.	Range.	Max.	Min.	Range.	Max.	Min.	Range.	Max.	Min.	Range.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Sidmouth	54	25	29	47	21	26	52	27	25	56	26	30	60	31	29
Penzance	56	34	22	54	28	26	55	33	22	59	34	25	62	36	26
Pau......................	56	25	31	56	21	35	60	35	25	65	35	30	71	43	28
Montpellier..........	57	32	25	53	27	26	55	30	25	58	35	23	64	41	23
Nice.....................	59	40	19	58	27	31	58	37	21	65	41	24	69	46	23
Rome....................	60	31	29	58	29	29	60	33	27	65	37	28	74	44	30
Naples..................	61	34	27	58	29	29	60	31	29	69	38	31	78	43	35
Madeira................	68	52	16	69	50	19	68	51	17	69	51	18	72	55	17

The temperature of each day presents a maximum and a minimum: the minimum is between 3 A.M. and 7 A.M.; the time of the maximum scarcely varies according to climate, and answers to 2 or 3 o'clock in the afternoon. The temperature taken by means of the thermometer at 9 A.M., at 12 P.M., 3 P.M., and 9 P.M., gives a mean equivalent to the mean of twenty-four hours. This mean is found about 7 o'clock in the morning in July, and 10 A.M. in January. The mean temperature of the summer and the mean temperature of the winter gives the mean temperature of the year.

The preceding tables give the mean temperature of a number of places.

Climates, with respect to temperature, are either constant, variable, or extreme. Extreme climates are those in which there are great differences between the summer and winter temperatures, and this abrupt transition from a glacial coldness to a tropical warmth is most injurious to the inhabitants. "At Yakutsk, in Siberia, the temperature in July is 13·3°, and in January 41·4°; whereas at Christiansand, Norway, nearly the same latitude, these are respectively 54·4° and 34·3°. Thus the difference between the temperature in the summer and winter at Yakutsk is 100·7°, while at Christiansand it is only 20·1°. The temperature of Sitka, in the west of North America, is 55·6° in July, and 32·0° in January; whereas at York Factory, on Hudson Bay, in the same latitude, the July temperature is 56·0°, and the January 12·0°; thus giving a difference of only 23·6° between the summer and winter temperature on the coast of the Pacific, but of 68·8° in the interior of the continent."—(BUCHAN.)

The chief causes of variation in temperature (and hence in climate) are winds, the presence of sheets of salt or fresh water, mountains, vegetation, humidity, &c.

Winds convey for a long distance the temperature of the places whence they arise. The S.W. gale brings to our own shores the humidity of the Atlantic, the N. and N.E. winds carry with them the dryness and coldness of the Arctic and Siberian regions, while the S. wind gives us the climate of Spain. The cause of all winds may be shown to arise from a difference of *barometric pressure* in different countries, a current of air setting *in from the region of high pressure to the region of low pressure.*

In the winter months, and during cold weather, extended observations have shown that the pressure in Siberia, and generally in the polar zone, is high, and the barometer marks over 30 inches, while in the British Isles the pressure may be as low as 29·2°. The wind then blows from the regions of the high pressure, and hence the prevalence of N. and N.E. winds. In summer and warm weather, again, the pressure is distributed in an entirely different manner, the mean atmospheric pressure being higher over the Atlantic than in Europe, hence southerly and S.W. winds prevail.

Waters.—The ocean, with its currents, has an enormous influence on climate. This is due to the fact that water has the greatest specific heat of all known substances (the specific heat being the units of heat required to raise the temperature of one pound one degree). If the specific heat of the water of the ocean be compared to that of the rocks and shores which it leaves, the proportion will be in about the ratio of 4 to 1. It follows from this that the surface of the sea cannot be raised to the same degree of heat as the land, and with a falling temperature it cools much more slowly.

It is on account of this specific heat of water that insular climates are more equable than continental, the summers cooler and the winters warmer.

The influence of salt water is especially seen in the oceanic currents. If it were not for a powerful current causing a general flow of the Atlantic north-eastward into the Arctic Ocean, the mean temperature of the British Islands would be 20° lower than at present. The peculiar distribution of the winter temperature of the British Isles comes from the same cause. The entire eastern coast of England and Scotland has a lower temperature than the western side, while the whole of the latter is warmer, but presents little difference in temperature, however far north or south observations may be taken. The practical bearings of this on the treatment of disease are obvious. A consumptive patient on the east coast will do well to go westward, but it will make, generally speaking, very little difference whether he go north or south. This difference between the two coasts is mainly dependent upon the Gulf Stream impinging on our western shores, and bringing with it the temperature of the warmer latitudes. The general effect of oceanic currents may be summarised thus: They raise the temperature of the west of Europe, the east of South America, the east of Africa, and the south of Asia; while the temperature by their agency is depressed on the east and west coasts of North America, the west coast of South America, the west coast of Africa, the east coast of Asia, and the south coast of Australia.

Inland sheets of water also influence climate greatly. As an instance we may take Loch Ness, which, owing to its great depth, never freezes, its temperature, therefore, being always higher than that of the surrounding country. The climate of its shores is mild and insular. Shallow lakes, on the other hand, rapidly becoming frozen, increase the rigour of the winter, while they cool the summer seasons, as may be seen on a large scale in the lakes of North America.

Mountains modify the climate of a country in many ways, a narrow range often separating two very different climates; *e.g.*, the island of Ceylon is divided into two halves by a high range of mountains. The seasons on either side are entirely different, and the effect of the periodical monsoons, which set in from opposite sides of them, is completely terminated by their agency.

The chief effect of mountain ranges is to deprive the winds passing over them of their moisture. The leeward will thus have colder winters and hotter summers, for the screen of vapour which would otherwise protect them from excessive radiation or excessive heat is removed.

Norway and Sweden may be taken as an example of this. The difference between the summer and winter temperatures of Hernosänd, on the Gulf of Bothnia, is 42·5°, while on the other side of the mountains, in the same latitude, at Alesund, the difference is only 18·5°.

The greater rainfall of our own western, and the greater dryness of our eastern, shores is due to a similar agency.

On mountains themselves, especially in the tropics, every variety of climate may be experienced, the influence of altitude, generally speaking, being analogous to that of latitude, in the same way that from the base to the summit of a mountain meteorological phenomena present variations similar to those observed on a vast scale from the equator to the poles, so that the earth may be considered as formed of two mountains joined at their bases by the equator. The actual rate of decrease of the mean temperature with altitude has not been satisfactorily determined. "It varies with the latitude, the situation, the dampness and dryness of the air, calm or windy weather, and conspicuously with the season of the year and the hour of the day." The general calculation is, however, 1° F. decrease for every 300 feet of elevation. Hence it happens frequently that the mean temperature of different places in different latitudes may on account of elevation be identical; for example, the mean temperature of St. Petersburg, 59° 50′ latitude, at the sea-level is the same as that of the Antisana, 1° of latitude, 4000 mètres above the level of the sea.

Humboldt and Boussingault have made many observations on this point; and zoological and botanical researches have confirmed in a striking manner the strict analogy between altitude and latitude.

The following are actual temperatures observed in ascending the Cordilleras:—

Cordilleras (5° latitude).

	Height (Feet).	Mean Temp. Degrees.
Cumana . . .	0	80·58
Ansuma . . .	3,444	74·66
Latacunga . . .	9,384	59·9
Antisana . . .	13,350	38·12
Perpetual snow-line .	14,760	34·88
Glacier, St. Antisana .	17,712	29·48

There now remain to be considered the climacteric influences of *vegetation*, *soil*, and *rain*. A ground destitute of herbage rapidly heats and as rapidly cools. A sandy soil attains a higher temperature than loam or clay, whilst rocks, being good conductors, are cooler. The sandy deserts of Africa and Arabia frequently mark a surface temperature of 120°, 140°, or even 200°; but if they were covered with vegetation, part of the heat would be expended in vapourising the sap, and but little would reach the soil itself. The heat in a country clothed with vegetation is therefore more evenly distributed throughout the twenty-four hours, and less intense in the warmest periods of the day. Large tracts of forests confer on the climate of a country an insular character. They make the days cooler and the nights warmer, and may therefore be considered as reservoirs in which the heat of the day is stored up against the cold of the night. Evaporation under trees goes on slowly, and the emanations from the soil and the decaying leaves collect under the thick canopy of the interwoven branches. In tropical countries forests are therefore generally unhealthy, and the haunt of malarious fevers. Forests also generally increase the rainfall of a district. A remarkable proof of this fact is afforded by Lake Tacarigua, which had for thirty years showed a gradual drying up; when, owing to the War of Independence, the land was left uncultivated for twenty-two years, forests sprang up around it, and the waters rose so much as to cover land formerly under cultivation.

The *rainfall* of a country depends more on its topography than its latitude. The entire absence of rain is a very remarkable feature on the coast of Peru, the valleys of the rivers Columbia and Colorado, the Sahara in Africa, and the desert of Gobi in Asia; while, on the other hand, it rains daily at Chiloe, Patagonia, the region of calms on each side of the equator, and at a few other places. The greatest annual rainfall on the globe, as far as is known, occurs at the Khasia Hills, facing the Bay of Bengal. Here the astonishing quantity of 600 inches falls annually.

In our own country, Stye, in the Lake District, is the wettest of all known localities. In 1865, 38·9 inches, and in 1866, 224·5 inches fell. We obtain nearly all our rain from the Atlantic, the greater part of which is condensed on the hills of the west coast. *See* RAIN, RAINFALL, &c.

Effects of Climate, Acclimatisation.—The human body *accommodates* itself to climate in a remarkable manner, and experience shows that this resisting or accommodating power is greatest in the inhabitants of temperate climates, who penetrate alike the glacial regions of the pole and the burning heat of the tropics with impunity, while the natives of tropical regions suffer greatly if transferred to the colder zones. It is extremely probable that Europeans would, generally speaking, enjoy fair health in the hot parts of India, if temperature were the only thing to be contended with; but until of late years bad sanitary conditions, coupled with zymotic diseases, so increased the death-rate as to make it appear that a tropical climate was extremely inimical to the European constitution; but it must ever be remembered that zymotic diseases are a something superadded to climate, not climate itself.

The elementary facts relative to the action of heat, cold, altitude, &c., on the human body are shortly as follows :—

Heat has a very depressing influence on the nervous system. The nervous current by excessive heat is retarded, and may be destroyed, hence the languor and depression in hot weather, and occasionally death from sunstroke. The human body in temperate climates, in health, has a constant temperature, when taken in the armpit, of 98·5°; any deviation of more than 2° from this generally shows disease; and if the temperature of a person rises in fever or from some other cause to 107° or 108°, and continues there for some hours, the danger to life is great. According to physiologists, at such high temperatures myosin coagulates, and the white corpuscles lose their amœboid movements. The heat of the sun seldom raises the temperature of the body to such a degree as to be incompatible with life; when it does so, generally speaking, perspiration has been checked; for so long as a person perspires freely, the external heat is carried away, and the temperature rises but little above the normal condition. It is a noticeable fact that sunstroke is hardly ever met with at sea; the reason of this is doubtless the free circulation of air, and the cooling influence of the surrounding ocean. The climate of a ship is eminently an insular one.

According to Dr. Becher's careful observations on himself, in travelling from temperate climates to the tropics, the temperature of the body rises in the proportion of ·05 F. for every increase of 1° F. in the air. This increase is, of course, modified by perspiration. The general effect on Europeans of transit from a cold or temperate to a hot clime is seen in some slight loss of flesh, impaired appetite and digestion, the lungs act less and the skin more than usual, the urine is lessened, the urea increased, the pulse is slower than usual, and the nervous system is somewhat depressed, the most exhausting effects being felt where the heat is continuous and the air rarefied; then, indeed, there is less oxygen than usual in a given cubic space. Sometimes Europeans become feverish, solely from the heat of the tropics. This form of fever is called *thermic fever*.

The influence of *great cold* is at first stimulating and then depressing. The small vessels of the skin contract and drive the blood into the warmer parts of the body, the nervous system becomes languid, and torpor, coma, and death may supervene.

The cold winds and frosts of our English winters are ever marked by an augmented death-rate, the increase being specially marked in diseases of the respiratory organs.

The degree of humidity cannot but have some influence on health, though little is known on this point. Lehmann has shown that pigeons exhale more carbonic acid in a moist than a dry atmosphere, and in some chronic lung diseases a saturated air allays cough, and is felt particularly comfortable.

The most agreeable amount of humidity would appear to be 70 or 80 per cent. In inquiries relative to humidity, it is the relative, not the absolute, amount of moisture which must be taken into account; for what is required to be known is the *evaporating* power of the air, the main effect of moist or dry air being on the evaporation of the skin and lungs; hence the oppression and *malaise* of man and beast on the approach of the moist, hot sirocco, which, being already saturated with water, heats the body to an insufferable degree. Damp weather, either hot or cold, but especially the former, would appear to be extremely favourably to the propagation of zymotic diseases; *e.g.*, plague and smallpox do not spread in a very dry air, but, *cæteris paribus*, rapidly in a moist air.

The influence of *altitude* remains to be considered, and is best studied in the effect of balloon ascents, as the conditions are uncomplicated by physical exertion. Birt and Gay-Lussac, at 9000 feet, found an increase of eighteen to thirty beats of the pulse; Glaisher, at 17,000 feet, found an increase of ten to twenty-four beats of the pulse, and at 24,000 an increase of twenty-four to thirty-one. The urine is diminished, and the evaporation from the skin and lungs augmented. At great heights, swelling of the cutaneous veins, with bleeding from the nose, often occurs, and the limbs feel heavy and strange.

In ascending mountains the effects are similar, but mingled with those induced by exertion and fatigue. The natives of mountain regions have generally large barrel-shaped chests, which has given rise to the notion that their vital capacity is large. Such, however, is not the case, this form of the chest usually being caused by emphysema, the result of repeated attacks of bronchitis. Phthisis, anæmia, and scrofula are often benefited by a mountain air, the scrofula existing in the Alps being nearly always due to the sedentary occupations and the miserable insanitary state of the dwellings of the poor. To sum up, man, by strict attention to diet, clothing, and habitation, can generally establish himself in any climate where the conditions are such as to ensure a sufficient supply of food for subsistence. *See* CLOUDS, METEOROLOGY, RAIN, THERMOMETER, &c.

Clocks, Public—Any urban authority may from time to time provide such clocks as they consider necessary, and cause them to be fixed on or against any public building, or, with the consent of the owner or occupier, on or against any private building, the situation of which may be convenient for that purpose, and may cause the dials thereof to be lighted at night, and may from time to time alter and remove any such clocks to such other like situation as they may consider expedient.—(P. H., s. 165.)

Closets—The word "closet," as in general use, is applied only to water and earth closets; the inferior closets and middens are usually called *privies*. *See* PRIVIES.

Closets, Earth. — The best is that originally proposed by the Rev. Mr. Moule. The closet consists of a wooden box, and a receptacle below for the excreta. There is a mechanical arrangement, so that when the plug is pulled up, dried earth falls upon the fæces. It requires about $1\frac{1}{2}$ lb. per head daily of dried earth, so that no inconsiderable quantity of this material should be stored in a convenient place. The slop-water should not be allowed to be thrown in. With proper attention, the earth system for small villages and isolated houses is absolutely perfect; but unless the people give it that attention, it fails signally. The collection is removed from time to time, and is a valuable manure. There is no smell nor nuisance, and the dried earth is an excellent disinfectant. For large towns it cannot be recommended. The best earth is clay marl and vegetable mould; chalk and sand do not appear to answer.

Dr. Buchanan summarises the advantages of the earth-closet as follows:—

1. The earth-closet, intelligently managed, furnishes a means of disposing of excrement without nuisance, and apparently without detriment to health.

2. In communities, the earth-closet system requires to be managed by the authority of the place, and will pay at least the expenses of its management.

3. In the poorer classes of houses, where supervision of any closet arrangements is indispensable, the adoption of the earth system offers special advantages.

4. The earth system of excrement removal does not supersede the necessity for an independent means of removing slops, rain-water, and soil-water.

5. The limits of application of the earth system in the future cannot be stated. In existing towns favourably arranged for access to the closets, the system might be at once applied to populations of 10,000 persons.

6. As compared with the water-closet, the earth system has these advantages: it is cheaper in the original cost, it requires less repair, it is not injured by frost, it is not damaged by improper substances driven down it, and it very greatly reduces the quantity of water required by each household.

Closets, Pneumatic.—*See* SEWAGE, DISPOSAL OF (Captain Liernur's system).

Closet, Taylor's Dry. — The principle of this closet is to separate the solids from the liquids, this is effected by the following mechanical arrangement: A revolving disc is connected by a lever to the closet seat; when the lid is lifted, the disc moves slightly round, and when it is closed, ashes, either alone or mixed with disinfectant powder, is thrown by a hopper on the soil. The solids remain in the disc until a complete revolution is made, they are then scraped off with a knife. The whole is self-acting.

Closets, Water.—These alone are suitable to large towns, although they involve an enormous waste of water; and unless properly constructed, lead to serious evils. The usual construction is to place (if there are more than one closet) them one above the other, and a cistern at the top, or at some more elevated spot. The seat is usually wood, the pan of some smooth substance—sometimes metallic, but generally of ware—and furnished with a siphon-pipe of discharge connected with a drain leading into the sewer. The seat, the pan, the closet itself, are generally, and should be always, ventilated. The ventilation of the soil-pipe is to be specially insisted upon, not alone on account of the danger arising from sewer-gas escaping into the house, but because, if pent up, the gas attacks the lead of the pipe and corrodes it.

If the soil-pipe is ventilated, and also a shaft carried up to the top of the house from the drain, there can be no danger either of corrosion of the pipes or of the siphon being forced.

There is a very good form of water-closet which is so arranged that, every time the handle is pulled, a jet of disinfectant fluid is squirted into the pan, in addition to the ordinary flushing. In default of this arrangement, it is well to have the supply-cistern constantly provided with a soluble disinfectant. One of the best for the purpose is sulplate of iron. A pound of this could be put into the cistern, and then the pan would be always flushed with a disinfectant. Nothing would arrest and prevent typhoid spreading in towns so much as a simple plan, universally followed, of this kind.

The forms of water-closets, the mechanical arrangements for flushing, &c., are so various that it is impossible here to enumerate them.

The great bulk of people have to accept the details of a house already built, but those who design or build should not allow the water-closet to be put in any out-of-the-way corner. The best position, as approved by the most eminent architects of the day, is that of a special block for a large house, built tower-fashion and abutting against the outer wall, with an anteroom or passage between each closet and the house, so that it may be thoroughly ventilated, and both provided with doors. In smaller houses the closet may be simply projected from the building; but in both cases care should be taken to have them well lighted by windows that will open freely, or permanently by air-bricks.

Water-closets are calculated to use about 6 gallons per head daily; even the best constructed frequently require a very large supply to keep them wholesome.

Every sanitary authority is to see that the water-closets in its district do not become a nuisance or injurious to health.

No new house is to be built or old house rebuilt without a sufficient water-closet or privy, the word "house" including factories, &c., and any building in which more than one person is employed at one time. Penalty, £20 or less. A sanitary authority may compel the owner or occupier of any house deficient in this respect to provide sufficient convenience, but there is no enactment pointing out or enforcing the particular style, plan, or pattern of the closet to be built.

The public schools under the Education Act must have separate closets for different sexes, a regulation which also applies to factories.

A sanitary authority may erect public closets at the cost of the general district rate.

Any enactment in force within the district of any local authority requiring the construction of a water-closet, shall be deemed to be satisfied by the construction of an earth-closet, or other place for the reception and deodorisation of fæcal matter, to the satisfaction of the local authority.

The local authority may, as respects any houses in which such earth-closets or other places as aforesaid are in use with their approval, dispense with the supply of water required by any contract or enactment to be furnished to the water-closets on such terms as may be agreed upon.

The local authority may themselves undertake, or contract with any person to undertake a supply of dry earth, or other deodorising substance, to any house or houses within their district for the purpose of any earth-closet.

An urban sanitary authority may provide and maintain in suitable places public earth-closets.

The enactments relative to closets are more fully given in article PRIVIES.

Clothing—The hygienic importance of clothing is beginning to be studied with the zeal the subject demands. The changes brought about by clothing are principally relative to heat. The known three methods by which all bodies tend to equilibrium of temperature are disturbed; the surface of the body is prevented from radiating heat directly to colder objects; the heat must first be conducted to the clothes, and then the clothes will radiate it. Thus the clothes prevent rapid radiation; they keep the heat longer near the body, and on this account in some degree the thinnest covering will keep us warm. The colour of the material, radiation alone being considered, has very little influence. When, however, heat is received—*e.g.*, from the sun—colour makes a very great difference, although material in this case makes very little. For instance—

	Deg. Fahr.
When white cotton received, . .	100
,, linen ,, . .	98
,, flannel ,, . .	102
,, silk ,, . .	108

But with shirtings of different colours the following were the figures:—

	Deg. Fahr.
White	100
Pale straw colour	102
Dark yellow	140
Light green	155
Dark green	168
Turkish red	165
Light blue	198
Black	208

This result harmonises with practical experience. Every one feels hotter in the sun with a black coat than a light one.

Clothing differs much in its power of radiation. It is evident that clothing which radiates least will keep us warmer than clothing which admits of rapid cooling. It is found, by direct experiment, that there are very inconsiderable variations according to the nature, colour, texture, &c., of the cloth. Krieger covered cylinders of tin with different fabrics, and filled them with warm water. He found no very great differences. The decrease of temperature was noted in pounds.

He used layers composed of different materials, but it did not make much difference what the outer layer was composed of. Silk and cotton, however, allowed of more radiation than wool.

Krieger also experimented on the conduction of different substances, by surrounding his cylinders tightly with single or double layers.

The following numbers represent the proportions of loss by heat through double tight-fitting coverings in comparison to single ones, the losses through the single ones being taken as 100. They were through—

Double thin silk	97
Gutta-percha	96
Shirtings	95
Fine linen	95
Stout silk	94
Thick home-spun linen	91
Chamois leather	88 to 90
Flannel	86
Summer buckskin	88
Winter ,,	74 to 84
Double stuff	69 to 76

These experiments show that what the substance is, and what its weight is, does not make so much difference as its texture and volume. This is well shown by covering the tin cylinders, previously filled with warm water, by common wadding, and observing the fall of the thermometer. On compressing the wadding, the temperature falls rapidly; whereas, uncompressed, the loss of temperature is slow. This proves that a tight-fitting garment, other things being equal, is not so warm as a loose one. The following experiments also bear upon this: A light layer was placed over the warm cylinders, and a free space of $\frac{1}{3}$ to $\frac{1}{2}$ an inch left between it and a second layer—both analogous, say, to a light shirt next the skin and an easy garment covering it. The amount due for conduction being subtracted, the impediment by the second layer was—

For linen	32 per cent.
,, shirting	34 ,,
,, silk	32 ,,
,, flannel	29 ,,
,, wash leather	30 ,,
,, gutta-percha sheeting	36 ,,

Thus there is not much difference between the different materials, but a second layer does cause a great impediment to the cooling of bodies.

Pettenkofer examined different materials for their permeability to air. Taking flannel as 100, he found that—

Linen allowed	58
Silk ,,	40
Buckskin ,,	58
Kid ,,	1
Chamois ,,	51

parts of air to pass through them. Permeability to air is necessary for our health and comfort. Few people feel comfortable in a mackintosh on this account.

The use of furs, &c., dates from time immemorial. The warming properties of these furs and skins depend, as might be expected, mainly upon the hair. Animals, such as rabbits, when shorn of their fur and their skin varnished, quickly die from cold; they freeze to death from excessive radiation of heat. Krieger sheared a rabbit, and wrapped the living body round with a wet cloth. The temperature of the room was 66°. The temperature of the rabbit was at first 102°, and respirations 100; but after five hours its interior temperature had fallen to 76°, and its respirations to 50 per minute. The same thing was shown by the tin cylinders. Taking the entire fur as 100°, when the fur was shorn, the loss of heat rose to 190°; when the porosity of the skin was altered by coating with linseed-oil varnish, the loss of heat rose to 258°, and when a solution of gum-arabic was used instead, it rose to 296°.

The Hygroscopic Power of different Fabrics.—The facility with which articles of clothing take up water in their interstices causes great difference in their warming properties. Pettenkofer has made some excellent observations on this point. He took two equal pieces of flannel and linen, and dried them at 212°, and then put them into well-closed boxes of known weight and weighed them together. "They were then exposed to the air in places of different temperatures, and from time to time put back into the tin boxes and the weights taken again."

The relative quantities of water absorbed by the linen and flannel are given in the table on the following page.

On this table Pettenkofer says, "What most strikes one is the invariably greater hygroscopic power of wool than of linen; the maxima and minima of flannel and linen being respectively 175 and 111, 75 and 41.

"Obs. 5–8 show that linen changes the quantity of its hygroscopic water at a proportionately quicker rate than flannel. The two pieces were for twelve hours in the cellar, when linen absorbed 111, flannel 175; immediately after, for four hours, in a cold place, where linen lost 18 per 1000 of its absolutely smaller amount of water, while the flannel lost only 15 per 1000; but during the next three hours linen lost only 2, but flannel 12 per 1000. When, obs. 9–15, the pieces had come from the cold lecture-room into a warmer room, linen again ceased giving off water at a much greater rate than flannel. The accelerated rate, only in an opposite direction, took place again. Obs. 15–18. When the temperature in

Observation.	Locality.	Temperature, Degrees F.	Time.	Hygroscopic Water in	
				Linen.	Flannel.
1	Cellar . . .	37·58	12 hours . .	77	157
2	Lecture-room	34·16	12 ,, . .	74	143
3	Room . . .	64·25	12 ,, . .	41	75
4	Laboratory .	53·96	12 ,, . .	69	105
5	Cellar . . .	39·92	12 ,, . .	111	175
6	Lecture-room	40·1	4 ,, . .	93	160
7	,,	40·1	3 ,, . .	91	148
8	,,	41·9	15 ,, . .	85	146
9	Room . . .	69·8	10 minutes .	73	113
10	,, . . .	69·8	10 ,, . .	52	96
11	,, . . .	70·7	10 ,, . .	45	87
12	,, . . .	70·7	10 ,, . .	43	82
13	,, . . .	68·9	15 ,, . .	42	78
14	,, . . .	68	15 ,, . .	42	77
15	,, . . .	64·25	30 ,, . .	41	75
16	,, . . .	62·6	1 hour . .	48	76
17	,, . . .	61·7	2 hours . .	45	77
18	,, . . .	59·9	...	46	78

the room sunk from 65° to 59°, all bodies became more hygroscopic with a sinking tempeture, but the absorption of water and increase of weight, as well as the contrary process, take place proportionately quicker with linen than with flannel. The more the air in any material is dispersed by water, the less it keeps us warm, the quicker it conducts the heat; hence the frequent injury from wet clothes, and the striking discomfort produced by a damp cold. All know how comfortable we can feel in a walk when the air is cold and dry, and how differently we feel when it is damp, although not colder; then our clothes also get much damper, and conduct more heat away. This is not to be underrated. We have seen in the table that 1000 parts of flannel took up in the cellar 157 parts of water. Take the weight of a whole woollen garment as 10 lbs., it is then evident that it may absorb 1½ lb. of hygroscopic water, which requires about 1680 caloric units from one body to be evaporated. Linen and flannel bear the same relation towards water they are wetted with as towards their hygroscopic water. Linen is quickly wetted and soaked, wool more slowly, but linen cannot take up the same quantity. Spilled water has certainly taught us this many times when we desired to take it up. It is the same in evaporation, which is also much quicker from linen.

"Two equal pieces of linen and flannel, weighing each 1000 grammes, put into water and wrung out till they no longer yield a drop of water, keep back respectively 740 and 913 per 1000; but a much greater difference exists between the intensity of evaporation from wet linen and from wet flannel during equal periods in a heated room.

Observation.	Temperature, Deg. F.	Minutes	Water to 1000 Grammes of	
			Linen.	Flannel.
1	70	...	740	913
2	68	15	521	701
3	68	30	380	603
4	67	30	229	457
5	66	30	99	309
6	66	30	55	194

"It is easy to see from this table how much more quickly linen works than wool in all directions. During the first 75 minutes there evaporated from 1000 parts of linen 511, from 1000 parts of flannel 456 water. Afterwards the reverse took place. In the following 30 minutes 130 evaporated from linen, 148 from flannel; and in the last 30 minutes only 44 per 1000 from linen, but 115 from flannel. It is also evident how much more evenly the drying proceeds in wool. In the first 15 of the whole 135 minutes, 219 evaporated from linen, in the last 15 minutes 28 per 1000: while with wool it was respectively 212 and 97 per 1000. It must not be forgotten that all these experiments were made with pieces of nearly equal size and shape."—(PETTENKOFER.)

It hence is evident that for tropical climates, where much heat is received, white is the best *colour*. The same remark also applies to the clothing of men engaged in manufactures or employments in which they are exposed to intense heat and glare from furnace-fires or melted metal.

Then as to material, one layer of thin flannel is practically as cool a substance as we can have, and its great hygroscopic power causes it to *absorb* perspiration, instead of, as in the case of linen, allowing the fluid to rapidly evaporate, and thus cool us quickly and dangerously. In other words, a person after violent exertion may sit down on a cool bank, if dressed in a flannel shirt, with less danger than if his dress were linen.

For cold climates a multiplication of layers tends to warmth. Two shirts, one over the other, are warmer than a shirt of thickness equal to the two. Garments of loose thick texture, and dark in colour, are preferable to those of thin and close texture. The cavities of the chest and abdomen are the most important parts to be thoroughly protected from chill. The feet should be kept dry and warm, but the head, especially in children, should not be heated by too closely-fitting coverings.

In temperate climates like our own, the great danger lies in the abrupt transitions from wet to dry, from cold to hot. These transitions especially occur in autumn and spring, and in those seasons the weakly should pay especial attention to their clothing, and dress according to temperature.

Days occur in the summer in which the heat equals occasionally that of the tropics, and chiefly owing to improper clothing, especially about the head, deaths from sunstroke are common. Large, light straw-hats should always be worn in the hot days of summer by all classes of society.

Clothing has frequently been the agent through which infectious disease has been propagated. Judging from Stark's observations on the power of absorbing odours, the probability is that contagion is absorbed after the same manner. Stark found that the absorption of odours was in proportion to the hygroscopic absorption, and that it depended in a great measure upon colour—black absorbing most, then blue, red, green, yellow, and lastly white; hence, theoretically, a black or dark-coloured woollen garment is the worst possible dress for a nurse attending cases of fever, a light-coloured cotton dress the best.

Dr. Guy, in his lectures on public health, tells us that the plague which ravaged London in 1665 was carried to Eyam, a small hamlet among the hills of the Peak of Derbyshire, by clothes. "Quite early," writes Dr. Guy, "in the month of September, when the plague was at its worst in London, there was sent from London to one George Vicars, a tailor, a box of clothes. He opened the box and hung the clothes to the fire, and while he watched them was suddenly seized with violent sickness and other alarming symptoms. . . On the third day the plague-spot was on his breast, and he died on the following night, the 6th of September."

The jail distemper has frequently, beyond doubt, been carried to the outside population by means of clothes. One of the most remarkable examples of typhus communicated by clothes was the "Black Assize" at the Old Bailey in 1750. Here the prisoners had not the disease which with such fatal effect they communicated to the court that tried them.—(PRINGLE.) From Foderé we get a remarkable instance in which typhus was communicated to the inhabitants of fifteen towns and villages by the soldiers of the French army, where, retreating from Italy in 1799, they halted on their route.

Parry relates two remarkable instances in which relapsing fever was transported to a distance by infected clothes; and Bretonneau and Geudron believed that the poison of enteric fever could adhere to the clothes and bedding of the sick, and that the disease might be thus propagated, and Murchison cites the following case as illustrative of this idea:—

The wife of a butcher residing on the Cornish moors travelled to Cardiff, in Wales, to see a sister who was ill, and soon after died, of "typhoid fever." She brought back her sister's bedding. A fortnight after her return another sister was employed in hanging out these clothes, and soon after was taken ill with typhoid fever, which spread from her as from a centre. The woman who had been to Cardiff never took the fever herself. There had been no cases in the village previous to her return, neither were there any cases in the neighbouring villages either before or after.

The writer of this article has seen diphtheria unmistakably propagated by clothes being sent from a diphtheritic house to be mangled, and similar instances may be found in medical literature.

Clothing and bedding are best disinfected by exposure to a dry heat of about 240° or 250° F.

Dr. Ransome has proposed to disinfect clothing by placing it in layers in a box, at the bottom of which is sand sprinkled with carbolic acid. See DISINFECTION, &c.

Clouds—To the meteorologist clouds are extremely important, their form and aspect never failing to assist his predictions as to the prospect of fine, wet, or stormy weather. The classification and nomenclature now adopted is that published by Luke Howard in 1803. Mr. Howard divided clouds into seven kinds.

Simple Forms.

1. *Cirrus* (Lat. *cirrus*, a curl).—This cloud consists of parallel wavy diverging filaments

which by association form a brush, or woolly hair, or slender network. It has the least density of all clouds, the greatest elevation, and the greatest variety of extent and direction, or figure. It has even been questioned whether it is composed of water; if so, it must be frozen. It is the cloud first seen after serene weather, and in this climate it generally comes from the south-west. (BUCHAN.)

2. *Cumulus.*—Convex or conical heaps of clouds, increasing upwards from a horizontal base. Very dense, formed in the lower regions of the atmosphere, and carried along in the current next the earth. Cumuli are often compared to balls of cotton wool.

3. *Stratus.*—A widely-extended continuous horizontal sheet, called the *cloud of night*, since it generally forms about sunset.

Modifications.

4. *Cirro-cumulus.* — Small, rounded, well-defined masses in close horizontal arrangement. It is formed by the breaking up of the fibres of the cirrus-cloud. When the sky is covered with such clouds it is said to be fleecy.

5. *Cirro-stratus.* — This cloud partakes partly of the characteristics of the cirrus and stratus, and consists of horizontal masses or strata more compact than the cirri. At the zenith they seem composed of a number of thin clouds; at the horizon they look like a long narrow band. This cloud is markedly a precursor of storms.

6. *Cumulo-stratus.* — Cirro-stratus blended with the cumulus.

7. *Cumulo-cirro-stratus, or Nimbus.*—This is the well-known rain-cloud, consisting of a horizontal sheet, above which the cirrus spreads, while the cumulus enters it laterally or from below.

Estimation of Amount of Cloud.—To do this the scale generally adopted in this country is 0 to 10. 0 expresses a cloudless sky, and 10 a perfectly clouded sky; the intermediate numbers, various degrees of cloudiness. To get these numbers, look midway between the horizon and zenith, and then turn slowly round, and judge as well as possible of the relative amount of clear and clouded sky.

Height of Clouds.—The height of clouds varies from 1300 feet to 10 miles. Of all clouds the cirrus is the lightest, and found at the greatest elevations.

Cloves — The unexpanded flower-bud, dried, of *Caryophyllus aromaticus*, a clove-tree growing in the East Indian Islands, Penang, Bencoolen, and Amboyna.

Cloves contain, according to Trommsdorf—

Volatile oil	18
Resin	6
Tannin	13
Extractive	4
Gum	13
Woody fibre	28
Water	18
	100

The volatile oil is the important ingredient. It consists of a hydrocarbon ($C_{10}H_{16}$) and of eugenic acid ($C_{10}H_{12}O_2$). It also contains a crystallisable body, caryophylline ($C_{10}H_{16}O$), which is isomeric with camphor, and eugenine, a body probably isomeric with eugenic acid.

Cloves are aromatic and stimulant. The oil of cloves is used for microscopical purposes, to render tissues transparent. It does not mix with water; the latter must therefore be removed from the tissue before the oil is applied.

The chief adulteration of cloves is the exhaustion of the oil. They are then dried, brightened up with sweet oil, and exposed for sale. The only certain way of detecting this fraud is to distil the oil and estimate it. Cloves should yield at least 17 per cent. of volatile oil.

Cocculus Indicus — The fruit of the *Anamirta paniculata*, a shrub growing in Malabar and several islands in the Indian Ocean. As met with in commerce, it is an extremely bitter, dark, tough, wrinkled berry about the size of an ordinary cherry. The outside or husk is hard, enclosing a soft fatty substance. The shell is an emetic, but the seed is a very active poison, containing a glucoside called picrotoxine ($C_5H_6O_2$). This substance crystallises in colourless needles, or well-marked prismatic crystals, or fine silky filaments, or transparent plates, or granular crystals. The crystals have an intensely bitter taste. They melt at 320° Fahr., and give a sublimate; heated on a porcelain plate, they darken, effervesce, give off vapour, and leave an abundant carbonaceous residue. In common with other glucosides, when boiled with an alkaline solution of sulphate of copper, they reduce the copper to the state of suboxide. Picrotoxine is soluble in 150 parts of cold, in 25 parts of boiling water, in one-third of its weight of alcohol, and in less than half its weight of ether. It is not changed in colour by strong nitric acid, but gives an orange-yellow colour with sulphuric acid, changed into green by the contact of a crystal of bichromate of potash.

Cocculus Indicus is used for poisoning fish and other animals. It is said to be the active principle of "Barber's poisoned wheat," and has been used, and possibly continues to be employed, for the purpose of adulterating beer.

Dr. Taylor, in reference to the symptoms, &c., produced by *Cocculus Indicus*, says: "Porter, ale, and beer owe their intoxicating properties in some instances to a decoction or extract of these berries. The fraud is perpetrated by a low class of publicans. They reduce the strength of the beer by water and salt, and then give to it an intoxicating property by means of this poisonous extract. A medical man consulted me some years since in reference to the similarity of cerebral symptoms suffered by several of his patients in a district in London. It was ascertained that they were supplied with porter by retail from the same house. The effects produced by this drug are remarkable. There is a strong disposition to sleep, and at the same time wakefulness. There is a heavy lethargic stupor, with a consciousness of passing events, but a complete loss of voluntary power. It is a kind of nightmare feeling, altogether different from healthy sleep. *Cocculus Indicus* is sometimes used by robbers to intoxicate their victims, and to this form of intoxication the term 'hocussing' is applied."—(TAYLOR'S Medical Jurisprudence, vol. i. p. 395.)

No antidote is known. Acetic acid has in some cases given relief.

For processes for the detection of picrotoxine in organic mixtures, *see* BEER.

Cocoa and **Chocolate**—Cocoa is the roasted seeds of the *Theobroma Cacao*, natural order *Byttneriaceæ*.

Chocolate is manufactured from cocoa by mixing it with sugar and other substances.

There are numerous varieties of cocoa—such as Trinidad, Grenada, Caracas, Dominican, &c.—the seeds differing a little in size and in quality, but very little in the proportions of the different chemical constituents. The average composition of cocoa seeds is as follows:—

Average Composition of Cocoa Seeds (WANKLYN).

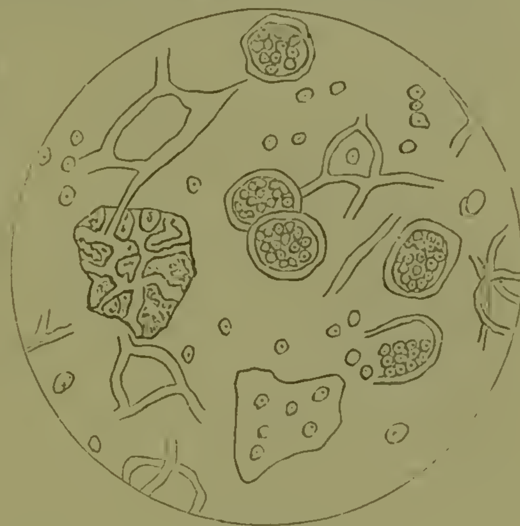
	Per cent.
Fat (cocoa butter)	50·00
Albumen, fibrine, and gluten	18·00
Starch	10 00
Gum	8·00
Colouring matter	2 60
Water	6 00
Theobromine	1·50
Ash	3·60
Loss, &c.	0·30
	100·00

Structure of the Cocoa Seed.—The seed is composed of husk and seed proper.

The *husk* has on its surface a number of tubular fibres containing granular matter and minute corpuscles.

It is composed of three membranes: the first consisting of a single layer of elongated cells; the second (forming the chief portion of the husk), of angular cells, enclosing mucilage, and also containing a few spiral vessels and woody fibres. The third membrane is very thin and delicate; it consists of small angular cells containing minute globules of fat.

The *seed* is composed of minute cells containing starch. The starch-corpuscles are very small, with a trace of inuline (fig. 20).



COCOA
1/100 TH INCH

Fig. 20.

Ash of Cocoa.—The amount of ash in cocoa seeds is of practical importance. The following percentages have been worked out by Mr. Wanklyn:—

	Percentage of Ash.
Common Trinidad	3 37
Very fine Trinidad	3·62
Fair, good, fine Trinidad	3·64
Fine Grenada	3·06
Caracas	4·58
Bahia (Brazil)	3·31
Fine Surinam (small	3·06
Mexican	4 27
Dominican	2·82
African	2 68
Mean of the twelve being	3·39

Thus the lowest determination is 3·06, the highest 4·58 per cent.

The nibs show a lower ash than the shell. The nibs of the Caracas gave 3·95 per cent. of ash, 2·00 being soluble and 1·95 insoluble in water.

The nibs of Mexican seeds gave 2·59 per cent. of ash, ·89 parts being soluble and 1·70 insoluble in water. The ash of the shell is rich in carbonates; the nib is almost devoid of carbonates.

According to Mr. William Bettell the composition of the ash of cocoa seeds is as follows:—

Potash	29·81
Chloride of sodium	0·10
Peroxide of iron	1·00
Alumina	2·40
Lime	7·72
Magnesia	7·90
Phosphoric acid	24·28
Sulphuric acid	1·92
Carbonic acid	0·98
Silica	5·00
Sand	12·15
	99·86

Nutritive Value.—A pint of cocoa made with an ounce of ground nibs will contain the following proportions of nutritious matters.—(LETHEBY.)

Nitrogenous matters	96·2 grains.
Fatty matter	218·8 ,,
Gum, sugar, and extractive	65·6 ,,
Mineral matter	17·5 ,,
Total extracted	398·1 ,,

Adulterations.—Sugar, reddle, Venetian red, amber, chicory, cocoa husk, cereal grains, arrowroot, sago, or potato starches, sugar. According to Normandy, brick-dust and peroxide of iron are met with to increase the weight. Chocolate, according to M. Chevallier, is adulterated with the following matters, besides those already mentioned as being mixed with cocoa: Copper, lime, lentils, maize, beans, olive oil, almonds, yolk of egg, veal or mutton fat, storax, balsam of Peru, benzoin, rasped almonds, Arabic and tragacanth gum, cinnabar, red earths, red-lead, red oxide of mercury, &c. Many of these are obviously very improbable adulterants.

Detection of Adulterations.—The microscope will detect most of these. If any mineral substance has been added, an examination of the ash cannot fail to detect it. The ash is apparently never more than 5 per cent.; indeed, in soluble cocoa it is very small. Thus Mr. Wanklyn gives—

Soluble cocoa (by mixing with starch and sugar)	1·45
Dunn & Hewett's commercial cocoa	1·71
Chocolate	1·11

An infusion in cold water of good cocoa nibs yields the following percentages:—

Organic matter	6·76
Mineral matter	2·16

A convenient quantity of cocoa for this purpose is 10 grammes in 220 c.c. of water.

Wanklyn has suggested the determination of phosphoric acid in the ash as a means of detecting the adulteration of cocoa. It is obvious that the addition of starchy and saccharine matters must dilute the phosphates of the seed. The sample must be burnt down at a low red heat, the ash dissolved, and the phosphoric acid precipitated by a mixture of solution of ammonia, sulphate of magnesia, and phosphate of soda. After standing several hours, the resulting precipitate is washed first by decantation, then filtered, and again washed; lastly, dried, ignited, and weighed. Pyrophosphate of magnesia × by ·06396 = phosphoric acid. The ash of the entire seeds contains 24 per cent. of its weight of phosphoric acid.

The Society of Public Analysts consider that cocoa should be called adulterated in which the cocoa butter is reduced below 20 per cent. The fat can of course be estimated by extraction with ether.

Cod-Fish—As an article of diet, cod is inferior to mackerel, eels, salmon, and trout, for these contain a much larger amount of fat.

The flesh of the cod contains but little fat (2·9 per cent.), it being largely accumulated in the liver. The following table will show the nutritive value of this fish:—

Composition of Cod.

Nitrogenous matter	18·1
Fat	2·9
Saline matter	1·0
Water	78·0
	100·0

Cod-Liver Oil (*Oleum Morrhuæ*)—The oil extracted from the fresh liver of the cod (*Gradus Morrhua*, Linn.) by the application of a heat not exceeding 180°. Other species besides the *Gradus Morrhua* also yield this oil, such as *G. callarius*, *G. carbonarius*, *G. molva*.

There are three chief varieties of cod-liver oil in commerce, distinguished by their colour—the light, the pale brown, and the dark brown. The two former are usually the purest.

Cod-liver oil contains oleine, margarine, certain colouring matters of the bile, phosphoric acid (·09 per cent.), sulphuric acid, salts of lime, magnesia, and iron, free phosphorus (·02 per cent.), iodine, and bromine; but the proportion of all the different substances is not accurately known.

Cod-liver oil gives, in common with all oils of hepatic origin, a lake or crimson colour when heated with sulphuric acid. Cod-liver oil is said to be extensively adulterated. If mixed with an oil not of hepatic origin, it may be tested with sulphuric acid in the manner detailed under OILS; but, practically speaking, the adulterations of cod-liver oil are difficult to detect. *See* OILS.

Coffee—The seeds or berries of the *Caffea Arabica*, or coffee plant. This plant belongs to the natural order *Cinchonaceæ*, and to the sub-order *Caffea*. It is said to be a wild plant in Abyssinia and in the low mountainous districts of Arabia Felix; but it is cultivated on a very large scale in various parts of the earth.

and it has been computed that no less than 600,000,000 lbs. of coffee are annually consumed by the whole world. Of this large quantity England uses only 40,000,000, which is in a great measure supplied by our own plantations in the West Indies; the finest Mocha, however, comes from Aden.

The leaves possess in some degree the qualities of the plant, and have been used in a similar way to the leaves of tea, but it is the seed or berry that is principally employed in all countries.

Preparation.—The seeds are roasted to a chocolate brown, and are then ground to powder in a mill, and used in the form of infusion or decoction.

Chemical Composition.—The properties of coffee depend upon an aromatic oil and an alkaloid called caffeine. The following is the composition of coffee, both before and after roasting. The analyses are by Schrader :—

	Raw Coffee.	Roasted.
Peculiar caffeic principle	17·58	12·50
Gum and mucilage	3·64	10·42
Extractive	0·62	4·80
Oil and resin	0·93	2·08
Solid residue	66·66	68·75
Loss (water)	10·57	1·45
	100·00	100·00

Payen's analysis is somewhat different, and it is generally considered as accurate :—

Cellulose	34·000
Water (hygroscopic)	12·000
Fatty substances	10 to 13·000
Glucose, dextrine, and undetermined vegetable acid	15·500
Legumine, caseine (gluten)	10·000
Caffeate of potash and caffeine	3·5 to 5·000
Nitrogenous substance	3·000
Free caffeine	0·800
Concrete essential oil	0·001
Aromatic fluid essential oil	0·002
Mineral substances	6·697

The amount of caffeine in coffee has been very variously stated; it is probably about ·80 per cent. Graham, Stenhouse, and Campbell give ·87 per cent.; Aubert found it between ·709 and ·849 per cent.; while Boutron and Robiquet put it as low as ·238 per cent., and Payen as high as 1·736 per cent. See Caffeine.

The effects of roasting on coffee are to swell the berry (this is from the extraction of various gases, but principally carbonic acid), to drive off a large quantity of water, and to change the sugar into caramel. For instance, Graham and Stenhouse found the following difference in the amount of sugar between raw and roasted coffee :—

Sugar per cent.

	Raw.	Roasted.
Highest amount	7·78	1·14
Lowest amount	5·70	...
Average of twelve specimens grown in different places	6·97	0·26

The roasting does not destroy the caffeine, and it is in a large degree free and soluble. Aubert found in a cup of coffee made with 16·66 grammes, from ·1 to ·12 grammes (1·5 to 1·9 grains) of caffeine.

Microscopical Structure of the Coffee Seed.—The berries consist of a hard and tough tissue that resists even long soaking. The testa covering the berry is made up of lengthened cells with oblique markings, resting on a thin membrane almost structureless (fig. 21). The

Fig. 21.

oblique markings of the cells are so characteristic that they may be distinguished from every other tissue. The substance of the berry is made up of angular cells closely adherent to each other, and each containing droplets of oil. The process of roasting dissipates in some measure this oil, but leaves the structure, where it is not charred, unimpaired.

Physiological Action of Coffee, and its Value as an Article of Diet.—The action of caffeine by itself, and the action of coffee, is widely different, and the two must not be confused, as they have been by some authors. Yet, who would undertake to deduce the properties of opium from its alkaloid morphia? Coffee appears to act decidedly on the nervous system; it is essentially a nervous stimulant. It causes wakefulness, increased brain power, and, in large doses, tremors. According to Edward Smith, it lessens the action of the skin and promotes that of the bowels. Lehmann asserted that coffee and tea lessened the waste of the system, decreasing the urea and phosphoric acid; but this has lately been doubted: if true, coffee would be an indirect food. According to the present state of knowledge, it can only be called a true nervous stimulant. *See also* CAFFEINE.

Adulterations of Coffee.—The adulterations of coffee are numerous—chicory, roasted wheat, rye, and potato flours, roasted beans, mangel-wurzel, acorns, burnt sugar, or black jack; and when mixed with adulterated chicory, it may also contain any of the sophistications mentioned under CHICORY. The adulterations are generally to be found in the ground coffee, but the berries are sometimes mixed with chicory compressed into shapes resembling coffee berries. In 1850, Messrs. Duckworth of Liverpool actually took out a patent for this purpose.

The adulteration of coffee was at one time a regular organised industry; and there existed, ten years ago, two manufactories in France—one at Lyons and the other at Havre—expressly established for the purpose of mixing coffee with burnt cereals and the scorched outer covering of cocoa.

Detection of Adulterations.—Chicory is the principal adulteration, and its microscopical character, its sophistications, &c., should be carefully studied. *See* CHICORY.

The process of ascertaining an admixture of any foreign substance with coffee is tolerably certain.

1. *Preliminary Examination.*—Strew a little of the powder on the surface of cold water. Genuine coffee floats, and does not colour the water; chicory and burnt sugar rapidly sink to the bottom, and impart a brown colour to the liquid. If any sediment occurs, it will be well to remove it with a pipette for microscopical examination.

2. *Microscopical Examination.*—This will reveal most of the adulterations of coffee. It is well to obtain an accurate knowledge of the structure of pure coffee and pure chicory first. (*See* CHICORY.) If a sample of coffee be moistened with water, and small black shining particles be seen in the field, surrounded by a dark coloration, burnt sugar is present.

3. By making standard infusions of pure coffee and chicory, and then taking the same weight of the suspected coffee, and comparing the colour, it is possible to obtain a very accurate idea of the quantity of chicory added.

Leebody recommends this to be done as follows: Take 1 gramme of the unknown mixture, and 1 gramme of a standard mixture of equal parts of chicory and coffee; remove all the colouring matter from each sample, and make the extract of each up to the same bulk. Put 50 c.c. of the filtered extract from the *unknown mixture* in a Nessler cylinder, and determine by trial how many c.c. of the extract from the *standard mixture*, together with sufficient distilled water to make up the 50 c.c., will give the same colour. In calculating the percentage of chicory present, closely accurate results are obtained in practice by assuming the tinctorial power of chicory to be three times that of coffee.—(J. R. LEEBODY, Chemical News, xxx. 243.)

4. Messrs. Graham, Stenhouse, and Campbell proposed to take the density of different infusions of coffee, &c., as a guide to its adulteration; and it is found in practice to work tolerably well, and to give approximative results. The following solutions were made by them by first treating the powder of the roasted substance with ten times its weight of cold water, boiling, and filtering, and determining the density at 60° F.:—

Spent tan	1002·14
Lupine seed	1005·70
Acorns	1007·30
Peas	1007·30
Mocha coffee	1008·00
Beans	1008·40
Neilgherry coffee	1008·40
Plantation Ceylon coffee	1008·70
Java coffee	1008·70
Jamaica coffee	1008·70
Costa Rica coffee	1009·00
" "	1009·05
Native Ceylon coffee	1009·00
Brown malt	1010·90
Parsnips	1014·30
Carrots	1017·10
Bouka	1018·50
Yorkshire chicory	1019·10
Black malt	1021·20
Turnips	1021·40
Rye-meal	1021·60
English chicory	1021·70
Dandelion root	1021·90
Red-beet	1022·10
Foreign chicory	1022·60
Guernsey chicory	1023·20
Mangel-wurzel	1023·50
Maize	1025·30
Bread raspings	1026·30

Allen (Chemical News, March 27, 1874) gives, as the result of his estimations of the density of pure coffee, 1008·7, and proposes the following formula, by which, when prepared as above, the proportion of chicory to coffee may be calculated. C represents the percentage of coffee, D the density of the solution:—

$$C = \frac{(1020{\cdot}6 +) \, 100}{12}$$

5. Decolourise an infusion of the sample either by animal charcoal or by permanganate of potash, and test for starch by tincture of iodine. This test, when negative, excludes many adulterations, but does not exclude chicory. Neither chicory nor coffee possesses starch.

6. Put 1 gramme of coffee, well ground, in a platinum dish, and ignite until the ash is constant, then cool and weigh. The ash of genuine coffee should not exceed more than

4·5 per cent., and it should be nearly all soluble in boiling hydrochloric acid. If only 1 per cent. remains undissolved, it is a proof of adulteration, as coffee ash contains no silica.

7. Ignite 5 grammes of coffee, and carefully examine the chemical constitution of the ash. The following are the principal differences between the ash of coffee and of chicory :—

	Coffee Ash.	Chicory Ash.
Silica and sand .	...	10·69 to 35·85
Carbonic acid .	14·92	1·78 to 3·19
Sesquioxide of iron	0·44 to 0·98	3·13 to 5·32
Chlorine . .	0·26 to 1·11	3·28 to 4·93

It results from this, that coffee adulterated with chicory will give an ash containing silica, with less carbonic acid than normal, more iron and more chlorine, all of which can be easily determined.

8. The proportion between the soluble and insoluble constituents of the ash in water appears constant. On this account, Mr. Allen proposes it in union with other tests as a valuable indication. He says—

"I ignited three samples of genuine coffee of different kinds and three of chicory, taking 5 grammes for each experiment. After weighing, the ash was boiled in water, the liquid filtered, the clear solution evaporated to dryness, and the residue heated to full redness and weighed. The following were the proportions in 100 of the sample :—

	Total Ash.	Soluble Ash.		Per cent. of total Ash.
1. Coffee . .	3·86	2·95	=	76
2. ,, . .	3·95	3·40	=	86
3. ,, . .	4·20	3·38	=	80
Average of coffees	4·00	3·24	=	81
1. Chicory, foreign	5·36	1·20	=	22
2. ,, ,,	5·05	1·83	=	36
3. ,, English	4·90	2·18	=	44
Average of chicories	5·06	1·74	=	34

"The proportion the soluble ash of the chicories bears to the total varies considerably, owing to the different quantities of silica present in the samples, and the percentage of soluble ash is not so constant as in the case of coffee.

"Assuming 3·24 per cent. as the average soluble ash of coffee, and 1·74 as that of chicory, the percentage of coffee in a mixture would be represented by the following equation, where C is the percentage of coffee and S the percentage of soluble ash.

$$C = \frac{(100\,S - 174)\,2}{3}."$$

—(Chemical News, March 27, 1874.) *See* CAFFEINE, CHICORY.

Colchicine—An alkaloid extracted from the seeds of the meadow saffron (*Colchicum autumnale*). It was formerly supposed to be identical with veratria. It differs from veratria in being more soluble in water, and not exciting sneezing. It is extremely poisonous.

Sulphuric acid turns it of a yellowish brown. Nitric acid turns it violet, passing into indigo blue, green, and yellow.

Collector of Rates — *See* OFFICERS, APPOINTMENT OF.

Colostrum, or **"Beastings"**—The first milk yielded by the cow after parturition. It is of a somewhat viscid or stringy consistence, with a turbid and yellowish appearance, and a strongly alkaline reaction. For the first ten days after the cow has calved, it is totally unfit for use. It contains more albumen than caseine, and hence undergoes coagulation on boiling. Under the microscope a number of large irregular bodies are seen, which consist of conglomerations of small fat globules, held together by an amorphous, somewhat granular substance. These are called *colostrum corpuscles.*

Colostrum has a somewhat sickly odour and a purgative action.

Colouring Matters—The following list gives the names of the principal substances used for colouring food, drugs, &c.:—

Alum.
Annatto.
Antwerp blue.
Artificial ultramarine.
Baked horse's liver.
Beetroot dregs.
Bichromate of potash.
Bilberries.
Bisulphuret of mercury.
Black-jack (burnt sugar).
Black-lead.
Blood, burnt.
Bole, Armenian.
Brazil wood.
Brick-dust
Brunswick green
Carbonate of lime and magnesia.
Catechu.
Chalk.
China clay.
Chinese yellow.
Chromates of potash.
Chrome, yellow.
Cobalt.
Cochineal.
Copper, salts of.
Dutch pink.
Elderberry juice.
Emerald green.
Ferruginous earths (various).
Gamboge.
Gum.
Indigo.
Lard.
Liquorice.
Litmus.
Logwood.
Madder root.
Milk of almonds.
Naples yellow.
Opium.
Oxalic acid.
Plaster-of-Paris.
Potash.
Prussian blue.
Red dyes.
Red-lead.
Red ochre.
Rose pink.
Sap-green.
Smalt.
Sugar.
Treacle.
Turmeric.
Ultramarine.
Venetian red.
Vermilion.
Yellow ochre.

Combustion, Products of—It is found that *coal* of average quality gives off in combustion—

1. *Carbon.*—About 1 per cent. of the coal is given off as fine carbon, and tarry particles.
2. *Carbonic Acid.*
3. *Carbonic Oxide.*—When there is abundance of air given to fuel at the proper time

and place, the result of the combustion of carbon is carbonic acid; but if there be more carbon than air, the result is carbonic oxide.

4. *Sulphur, and Sulphurous and Sulphuric Acid.*—The amount of sulphur in coal varies from ½ to 6 or 7 per cent.

5. *Sulphuret of Carbon.*

6. *Ammonium, Sulphide, or Carbonate.*

7. *Sulphuretted Hydrogen.*—Sometimes.

8. *Water.*

Regarding the sulphuric acid found in coal smoke, it may be observed that when coal is burnt, every pound consumes the oxygen of 150 cubic feet of air. When there is 1 per cent. of sulphur in the coal, this will be equal to ·46 grains in a cubic foot of the smoke, or ·92 of sulphurous acid—nearly one grain of sulphurous acid in a cubic foot of smoke. But twice, and sometimes even four times, this amount of air is supplied.

Burning coal with 1 per cent. of volatile sulphur gives out a smoke, a cubic foot of which at the ordinary temperature contains the following grains of sulphurous acid:—

	Grains.
Using 150 cubic feet of air to 1 lb. of coal	1
,, 300 ,, ,,	5
,, 600 ,, ,,	25

and burning coal with 2 per cent. of volatile sulphur, double the amount is given out.

Dr. Angus Smith, in his well-known work, "Air and Rain," gives the following table, showing the sources of the different gases found in coal smoke:—

Source of Gas.	Carbonic Acid.	Carbonic Oxide.	Oxygen.	Nitrogen.
Gas from chimney 4 feet above the fireplace	0·35 1·65	... 0·38	19·63 19·29	80·02 78·68
Gas from the middle of a good fire	19·46 20·90	0·09 0·10	... ...	80·45 79·00
A great mass of coal over the fire, the gas taken from below the glowing mass	17·50 17·44	....	2·46 0·39	80·04 82·17
A heap of glowing coal gas taken close to the spot where carbonic oxide was burning	15·43 18·17	3·49 2·48	0·96 ...	80·12 79·35
Gas from clear fire below	16·10	...	4·95	78·95
Gas from same fire at the upper part 1 inch below the surface	17·21 20·80	... 0·99	4·25 ...	78·54 78·21

In four analyses of the smoke issuing from the large chimneys of sugar-works, the same observer obtained the following results:—

Gases.	I.	II.	III.	IV.
Carbonic acid ...	7·67	7·47	7·31	7·13
Carbonic oxide..	none	none	none	0·52
Oxygen	12·61	8·11	10·59	12·93
Olefiant gas.......	none	none	none	none
Nitrogen	79·62	84·42	82·10	79·42
	99·90	100·00	100·00	100·00

And in an examination of the deposit taken from the top of a blast-furnace (which may be considered as condensed smoke), the following substances were found in it:—

Arsenic	0·08
Oxide of lead	0·24
Peroxide of iron *	23·35
Alumina	14·37
Silica	26·63
Sulphate of lime	12·76
Carbonate	2·50
Lime, probably with silica	2·12
Sulphate of potash	6·66
Chloride of sodium	4·89
Sulphate of soda	1·72
Magnesia	1·63
Carbon	1·95
Lithium	trace
Vanadium	trace

* 16·03 soluble, 7·32 nearly insoluble.

The composition of coal ash is thus given in Watt's "Dictionary of Chemistry:"—

Analysis of the Ashes of Coal.

	Newcastle Coal, after deducting Sulphuric Acid.	Average of Five Welsh Coals.	Average of Five Scotch Coals.
Silica	62·44	42·67	49·63
Alumina	31·22	...	...
Sesquioxide of iron and alumina	...	43·56	38·24
Sesquioxide of iron	2·26	...	...
Lime	0·75	6·65	3·18
Magnesia	0·85	1·08	1·31
Potash	2·48	...	...
Soda	...	...	...
Sulphuric acid	...	4·46	6·26
Phosphoric acid	...	0·66	1·03
Percentage of ash	1·36	8·15	...

For complete combustion 1 lb. of coal demands about 240 cubic feet of air. The products of the combustion of coal pass into the atmosphere, and usually are at once largely diluted; but it is not so with the tarry matters and suspended carbon. Particles of carbon are not found higher than 600 feet. The air of London is so loaded with carbon, that even when there is no fog, particles can be collected on Pouchet's aeroscope, when only a very small quantity of air is drawn through. It would appear that it is chiefly from combustion that the air of towns contains so much acid as to make the rain-water acid.

Angus Smith found in Manchester, in 1868, the rain to contain from 5·6 grains to 1·4 grain of sulphuric acid (free and combined), and from 1·277 to ·0278 grains of hydrochloric acid, per gallon. The sulphuric acid is always larger in amount than the hydrochloric.

Coal gas has the following composition :—

Hydrogen	40	to	45·58
Marsh gas (light carburetted hydrogen)	35	to	40
Carbonic oxide . . .	3	to	6 6
Olefiant gas	3	to	4
Acetylene	2	to	3
Sulphuretted hydrogen .	0·29	to	1
Nitrogen	2	to	2·5
Carbonic acid . . .	3	to	3·75
Sulphurous acid . . .	0.5	to	1
Ammonia or ammonium sulphide	in the best cannel-coal gas only traces.		
Carbon bisulphide . .			

As much as 11 per cent. of carbonic oxide, 56 per cent. of the light carburetted hydrogen, and 60 grains of sulphur have been found. The Parliamentary maximum of sulphur is 20 grains in 100 cubic feet.

When the gas is partly burnt, the hydrogen and light and heavy carburetted hydrogens are almost destroyed, nitrogen (67 per cent.), water (16 per cent.), carbonic acid (7 per cent.), and carbonic oxide (5 to 6 per cent.) being the principal resultants which escape generally into the air of rooms. If the combustion were perfect, there would be little carbonic oxide.

One cubic foot of gas will destroy the entire oxygen of about 8 cubic feet of air, and it will raise the temperature of 31·290 cubic feet of air 1° F. Weaver found as much as 5·32 volumes of carbonic acid per 1000 in the room of a framework-knitter in Leicester, with fourteen gaslights burning. In other workrooms the amounts were 5·28, 4·6, down to 2·11 volumes per 1000. Such large amounts are undoubtedly very injurious.

Wood produces carbonic acid, acetic acid, and water, but few compounds of sulphur. 1 lb. of dried wood demands about 120 cubic feet of air for complete combustion.

Candles.—The products of the combustion of a candle are carbonic anhydride and aqueous vapour. A candle of six to the pound will in an hour burn about 170 grains.

Oil.—A lamp with a moderately good wick will burn about 154 grains of oil per hour, and will consume the oxygen of about 3·2 cubic feet of air, and produce about ½ a cubic foot of carbonic acid. 1 lb. of oil demands from 140 to 150 cubic feet of air for complete combustion. Dr. Zock says that oil, for an equal illuminating power, gives off less carbonic acid than gas. Dr. Olding found that candles, for an equal illuminating power, contaminated the air more than gas; the latter, though, gives out more water.

Tobacco smoke contains particles of nicotine* or its salts, and probably of picoline bases. There are also much carbonic acid, butyric acid, and ammonia.

Committees—A committee for sanitary purposes is often a better body for the despatch of business than a larger board.

Boards of guardians for unions of any size have generally so much business to transact at their ordinary meetings, that when they form a sanitary authority, it is generally at a late hour, and the sanitary business necessarily gets hurried through or slurred over, so that it is well for those thus situated to delegate all their powers to a committee, who should meet on some other day than a board-day.

In those districts which are formed of several unions which have united in order to secure the services of one health officer, a central committee, composed of delegates from each of the local authorities, if not absolutely essential, would be found of great utility. Such a committee could meet at least once a year. *See* DISTRICTS, UNITED.

"A *rural* authority may, at any meeting specially convened for the purpose, delegate for the current year of their office all their powers to a committee consisting wholly of their own members; provided that one-third at least of such committee shall consist of *ex-officio* guardians, but in case an adequate number of such *ex-officio* guardians does not exist, then the number deficient shall be made up of elected guardians; and any such committee shall have the powers by this Act vested in the rural authority by which it was formed, and shall be deemed to be during such year of office as aforesaid the rural authority of the district."—(P. H., s. 201.)

"*Every* urban authority may from time to time appoint out of their own number so many persons as they may think fit, for any purposes of the Public Health Act, which in the opinion of such authority would be better regulated and managed by means of a committee: provided that any committee so appointed shall in no case be authorised to borrow any money, to make any rate, or to enter into any contract, and shall be subject to any regulations and restrictions which may be imposed by the authority that formed it."—(P. H., s. 200.)

* This is denied. *See* TOBACCO.

Committees, Parochial.—Parochial committees, according to their constitution, are either an assistance or an obstruction to sanitary work.

The best men to be on a parochial committee, speaking generally, are—(1) the guardians of the parish; (2) the *ex-officio* guardians; (3) the clergyman of the parish; (4) one or two of the principal owners of property in the parish.

"A rural authority (including any committee so formed as aforesaid) may, at any meeting specially convened for the purpose, form for any contributory place within their district a parochial committee consisting wholly of members of such authority or committee, or partly of such members and partly of such other persons liable to contribute to the rate levied for the relief of the poor in such contributory place, and qualified in such other manner (if any) as the authority forming such parochial committee may determine.

"A rural authority (including any committee so formed as aforesaid) may from time to time add to or diminish the number of the members, or otherwise alter the constitution of any parochial committee formed by it, or dissolve any parochial committee.

"A parochial committee shall be subject to any regulations and restrictions which may be imposed by the authority which formed it: provided that no jurisdiction shall be given to a parochial committee beyond the limits of the contributory place for which it is formed, and that no powers shall be delegated to a parochial committee except powers which the rural authority could exercise within such contributory place.

"A parochial committee shall be deemed to be the agents of the authority which formed it, and the appointment of such committee shall not relieve that authority from any obligation imposed on it by Act of Parliament or otherwise.

"A parochial committee may be empowered by the authority which formed it to incur expenses to an amount not exceeding such amount as may be prescribed by such authority; it shall report its expenditure to such authority as and when directed by such authority, and the amount so reported, if legally incurred, shall be discharged by such authority."—(P. H., s. 202.)

"Any casual vacancy occurring by death, resignation, disqualification, or otherwise, in any committee, may be filled up within one month, by the authority which formed such committee, out of qualified persons."—(P. H., s. 203.)

The following duties may, in the opinion of the Local Government Board, be assigned to parochial committees:—

1. To inspect their district from time to time, with a view of ascertaining whether any works of construction are required, or any nuisances exist which should be abated.

2. To superintend the execution and maintenance of any works which may be required, or have been provided for the special use of the district; and to give directions for any repairs or other matters requiring immediate attention in relation to such works, which fall within the reasonable scope of the authority which they possess as agents of the sanitary authority.

3. To consider complaints of any nuisances, and the action of the medical officer of health or inspector of nuisances thereon; and to inform these officers of any nuisances requiring their attention, and to give such directions for abatement of the same, in cases of urgency, as the circumstances may seem to require.

4. To examine and certify all accounts relating to expenditure chargeable as special expenses within their district.

5. To report to the sanitary authority from time to time the several matters requiring their attention, and the manner in which their officers and servants have discharged their duties.

The proceedings of a committee are to be conducted in strict accordance with the rules given in the first schedule of the Public Health Act, 1875, as follows:—

Rules applicable to Committees of Local Authorities, other than Councils of Boroughs, and to Joint Boards.

1. A committee or joint board may meet and adjourn as it thinks proper.

2. The quorum of a committee or joint board shall consist of such number of members as may be prescribed by the authority that appointed the committee or joint board, or, if no number is prescribed, of three members.

3. A committee or joint board may appoint a chairman of its meetings.

4. If no chairman is elected, or if the chairman elected is not present at the time appointed for holding any meeting, the members present shall choose one of their number to be chairman of such meeting.

5. Every question at a meeting shall be determined by a majority of votes of the members present and voting on that question.

6. In case of an equal division of votes, the chairman shall have a second or casting vote.

7. The proceedings of a committee or joint board shall not be invalidated by reason of any vacancy or vacancies amongst their members, or any defect in the mode of appointment of such committee or joint board, or of any member thereof.

8. Any minute made of proceedings at a meeting, and copies of any orders made or resolutions passed at a meeting, purporting to be signed by the chairman of the meeting at which such proceedings took

place or such orders were made or resolutions passed, or by the chairman of the next ensuing meeting, shall be received as evidence in all legal proceedings; and, until the contrary is proved, every meeting where minutes of the proceedings have been so made shall be deemed to have been duly convened and held, and all the proceedings thereat to have been duly had.

Compensation—Full compensation must be made to any person sustaining damage by reason of the exercise of any of the powers of the Public Health Act, 1875, in relation to any matter as to which he is not himself in default. Disputes as to the amount, &c., are to be settled by arbitration. *See* ARBITRATION.

Compensation in certain cases is provided for officers deprived of their posts. *See* OFFICERS.

Condy's Disinfecting Fluid—This consists of a solution of permanganate of potash. It oxidises organic matter, but does not destroy living organisms. As it has no odour, is of a beautiful colour, and easily applied, it is much used as a disinfectant. Condy's fluid is, however, untrustworthy if used to disinfect matters exposed to the contagion of fever. *See* DISINFECTANTS.

Confectionery, Colouring Matter of, and Adulterations—The colouring and flavouring matters of confectionery are extremely various. Many substances—such as chromate of lead, essence of almonds, and aniline contaminated with arsenic—are very poisonous; but it must be remembered that, ordinarily speaking, the analyst finds these substances in such minute quantities, that no injurious effect upon the health could result, except a person consume a pound or so at once. Still, as undoubted cases of wholesale poisoning have occurred, it is evidently the duty of the local authorities from time to time to have the gaudy and attractive wares of the confectioner tested.

The manufacturer can put anything he pleases in the sweetmeat, providing it is not injurious to health, and therefore the chemical examination is solely to discover if there be any poisonous salt in sufficient quantity to be injurious. The poisons that sweetmeats are made of generally reside in the colouring matters. It must be remembered that all shades of brown, up to black, may be produced by the sugar being partly or wholly changed into caramel, and that the brighter reds, greens, and yellows are the most suspicious. If the analyst determines (*a*) the nature and amount of colouring matter, (*b*) the amount of sugar, (*c*) the amount of ash, he will then generally be in a position to state whether the substance is injurious or not.

Examination of the Colouring Matters.

(*a*) *Red.* — 1. Powder 1 gramme of the sweetmeat, previously dried, and digest it with alcohol. It dissolves; it is probably an aniline dye: pass on to 4. It does not dissolve: pass on to 2.

2. Place a drop of a solution of bleaching-powder on the colour. The colour fades and disappears; it is in all probability a vegetable colour. The colour does not fade: pass on to 3.

3. Burn a weighed portion of the sweetmeat in a porcelain dish, estimate the ash, and then dissolve it in weakly acidulated water. Test for lead by sulphuretted hydrogen, mercury by iodide of potash, iron by hydrosulphate of ammonia, confirming it by ferrocyanide of potassium. The sulphuretted hydrogen precipitates lead, black; the iodide of potash precipitates mercury, light yellow, changing to scarlet; ferrocyanide of potash gives a blue precipitate with iron.

4. Put the substance in a Marsh's apparatus and test for arsenic. *See* ARSENIC.

(*b*) *Yellow.*—The probable colouring matters will be chromate of lead, gamboge, chromate of barium, antimony, arsenic, and oxide of lead.

1. Dissolve the sweetmeat in distilled water. The insoluble residue is filtered off; a portion of it is fused with carbonate of soda on a bit of charcoal. Minute beads, with yellow colouration of the surrounding carbonate, and the beads very soft, flattening under pressure, denote lead.

2. The rest of the residue may be boiled in a solution of carbonate of potassium and filtered. Neutralise with dilute nitric acid, add a few drops of nitrate of silver. A purple or scarlet precipitate or colouration taking place is evidence of chromium.

3. If lead has been already discovered, and chromium, then it is probably chromate of lead; if chromium has been found, but no lead, add dilute sulphuric acid to the residue in solution. A dense heavy precipitate indicates sulphate of baryta, and therefore the colouring matter was probably chromate of barium.

4. Arsenic and antimony, if present, will volatilise completely when heated on charcoal, or the residue may be dissolved in a dilute acid, and either tested with hydro-sulphuric acid (a canary-yellow precipitate denotes arsenic, an orange, antimony) or, better still, put in a Marsh's apparatus. *See* ARSENIC.

5. If none of the former substances are found, the colouring matter is probably gamboge. To detect it, dissolve the sweetmeat

in alcohol, filter, and add distilled water in excess. The resin will then fall as a precipitate, and when moistened with ammonia a deep red colour is produced.

(c) *Green.*—The probable colouring matters are copper, chromium, arsenic, zinc, Rinman's green (zinc and cobalt). The chromium and arsenic would be detected as above; if none of these are present—

1. Dissolve the sweetmeat in acetic acid, and saturate with ammonia. A blue colour indicates copper.

2. If copper be not present, again acidulate the same solution, and pass a stream of sulphuretted hydrogen, which, if zinc be present, will precipitate it as the whole sulphide. This may be identified by redissolving in hydrochloric acid, boiling, saturating with ammonia, and precipitating with sulphide of ammonium.

3. Cobalt should be tested for by moistening a bead of borax with the solution, and holding it in the blow-pipe flame. A fine blue colour in both flames is produced, if that metal be present. If cobalt be present, arsenic is frequently associated with it.

The sugar of the sweetmeat may be estimated by taking a weighed quantity and proceeding as in the process described under SUGAR, ESTIMATION OF.

A weighed portion of the sweetmeat should also be carefully burnt down, and the ash examined and weighed. This will generally give a clue as to whether there is any mineral matter or not. A special portion should also be tested for prussic acid, so often in the essence of almonds used as a flavouring matter. A little of the sweetmeat is put into a watch-glass, and slightly acidified with dilute sulphuric acid. Another watch-glass, the concave side of which is moistened with a solution of yellow sulphide of ammonium, is inverted over it, and they are put on one side for some time. The upper one is then taken off, and dried in a water-oven. The residue is then moistened with a weak solution of perchloride of iron. A blood-red colour is evidence of prussic acid, due to the formation of sulphocyanide of iron.

The following is a list of colouring matters which are actually used or have been found:—

Yellows.—Saffron, turmeric, yellow lakes, Persian berries, fustic woods, gamboge, chromate of lead, massicot, iodide of lead, yellow ochre, sulphide of antimony, aniline.

Reds.—Cochineal, various red lakes, carmine, Brazil wood, red-lead, vermilion, red earths, bisulphate of arsenic, aniline, &c.

Browns.—Caramel, Vandyke brown, amber.

Purples.—Madder purple, logwood, indigo; any of the lakes with indigo or litmus.

Blues.—Indigo, litmus, Prussian blue, Antwerp blue, cobalt, smalt blue, verditer, ultramarine, German ultramarine.

Greens.—Sap-green, yellow lake; any of the vegetable colours or lakes, with indigo, and including Persian berries and indigo; false Brunswick greens, mineral green, verdigris, emerald green, true Brunswick green, false verditer.

Bronze Powders.—gold, silver, and copper bronzes, white or carbonate of lead.

Conia ($C_8H_{15}N$)—A liquid volatile alkaloid, contained in all parts of the hemlock plant, but found more plentifully in the fruit than in the leaves. It is an oily-looking transparent volatile liquid, its specific gravity being ·878 (BLYTH). It has a strong peculiar odour, resembling somewhat a combination of the odours of tobacco and mice. Its taste is acrid, and its vapour produces a flow of tears. Conia, when exposed to the air, is resolved into ammonia, and a bitter extractive matter possessed of no poisonous properties. Conia is soluble in alcohol, ether, or chloroform, leaving the oil behind on evaporation. It is not, like nicotine, soluble in water. Its solutions are not precipitated by alkalies. Conia is remarkably poisonous; one drop placed in the eye of a rabbit killed it in nine minutes. For the discovery of the presence of this poison, *see* ALKALOIDS.

No chemical antidote is known for conia, although Pereira thinks that an infusion of galls might be serviceable. The first object should be to evacuate this poison from the stomach. Subsequent treatment will depend on the symptoms. Blood-letting may be necessary, and in extreme cases artificial respiration should not be omitted. *See* ALKALOIDS.

Consumption—*See* PHTHISIS.

Contagion—The word "contagion" is commonly used to express the communication of disease from one body to another, whether by means of actual contact or through a medium such as the air, &c. By some, however, *contagion* is used only to express a communication by direct contact, in contradistinction to *infection*, which operates at a distance.

The Nature of Contagia.—It appears certain that in some, and probable that in all diseases, the contagious particles are not liquid nor gaseous, but of a solid nature: that they are excessively minute; that they possess an independent life; that under certain conditions they increase and multiply at a prodigious rate; and that probably their chemical composition is of a nitrogenous nature.

In lymph from the vaccine vesicle, and from the variolous pustule, the particles have actually been seen; and Beale, in the serum of cattle-plague blood, discovered particles of bioplasm not present in normal blood, some of them being not more than $\frac{1}{20000}$ of an inch in diameter.

That contagion consists of particles is shown by Chauveau's experiments, in which the poison of smallpox, glanders, vaccine, and sheep-pox was placed at the bottom of a small test-tube standing upright. Water was then allowed to flow over the surface of the liquid until it formed a layer a few lines in thickness. The tube was then allowed to stand some time. Diffusion took place according to the ordinary laws—*i.e.*, the soluble salts and albumen passed into the water, but that which was solid remained below, the upper part of the liquid being inert, the lower active.

Contagion mainly Resides in the Excreta.—In scarlet fever, for example, it is principally conveyed by the epithelial cells of the skin, and all discharges, whether from the nose, bowel, throat, or elsewhere. The same may be said of smallpox.

In typhoid fever there is probably some contagion in the emanations from the skin, but it resides mainly in the bowel excreta. In typhus, again, more especially, the skin is affected. Below is a list of the principal contagious and infectious diseases, most of which obey the following laws:—

1. That they invariably arise from a pre-existing disease of exactly the same essential nature.

2. That they run, within certain limits, a definite course.

3. That they have a period of incubation, a period of development, a period of height and decline.

These diseases may be divided into two classes of practical utility, viz.:—

1. Those transmitted only by direct inoculation or immediate contact (contagious).

2. Those transmitted through the medium of the air or other carrier (infectious).

1. *Contagious Diseases.*

Name.	Period of Incubation.
Syphilis	From six weeks to six months, sometimes more.
Gonorrhœa	No true period of incubation; a local disease.
Various skin diseases, often depending on fungoid growth or animal parasites; *e.g.*, pityriasis, scabies or itch, tinea, mycetoma, &c.	Local diseases; no period of incubation.
Hydrophobia	From four to sixteen weeks, or sometimes longer.
Farcy	From two to eight days.
Malignant pustule (charbon)	No true period of incubation.

2. *Infectious Diseases.*

Name.	Period of Incubation.
Smallpox	About fourteen days.
Scarlet fever (scarlatina)	From a few hours to ten days.
Measles	From ten to sixteen days.
Rubeola, rötheln	Not exactly known.
Hospital erysipelas	Not exactly known.
Cholera	From three days to a week, sometimes no true incubation; premonitory diarrhœa frequent, and varying from a few days to one or two weeks.
Diphtheria	No true or a very short latent period; premonitory symptoms show themselves rapidly, although actual development is at first slow.
Hooping-cough	Five to six days or more.
Dysentery	Uncertain; in some cases attack very sudden.
Typhus	About twelve days, sometimes twenty-one, and in some cases five days; occasionally no latent period.
Typhoid	Probably from eighteen to twenty-one days.
Relapsing fever	From four to nine days; occasionally no latent period.

The contagious diseases, or first class, are scarcely transmitted unless from direct contact or inoculation, and this mostly from man to man; but some, like hydrophobia, arise from actual inoculation from animals to man; while others—charbon, for example—are not unfrequently carried by insects.

The predisposing influence to both classes of disease is, without doubt, filth. That they ever arise spontaneously is improbable, and has never yet been satisfactorily proved; but that insanitary conditions not alone assist in their propagation, but add to their malignancy and fatality, is fairly established.

There are certain atmospheric and geological conditions which appear to greatly modify the propagation of some kinds of contagion. *See* CHOLERA, ASIATIC; SMALLPOX; FEVER, TYPHOID, &c.

Contagious Diseases Act—An Act passed for the purpose of regulating and controlling prostitution in certain military and naval stations, in order to prevent the spread of venereal diseases.

History.—The first Act was passed in 1864 (27 & 28 Vict. c. 85), but it was a temporary measure. The first permanent Act was issued (29 & 30 Vict. c. 35) in 1866, and amended Acts were passed in 1868 (31 & 32 Vict. c. 80, and 32 & 33 Vict. c. 96). These Acts are applied only to certain military and naval stations. The Admiralty and Secretary of

State for War have powers to appoint visiting surgeons and inspectors. They do not directly come under the cognisance of medical officers of health.

The working of the Acts may be judged of by the following extract from the Army Medical Report, 1871:—

The question of the results of the operation of the Contagious Diseases Act has excited considerable public interest. With a view to show these numerically the following tables have been compiled. The first table shows the prevalence of primary venereal sores and of gonorrhœa at the twenty-eight largest garrisons in the United Kingdom in 1864 (the year in which the first Contagious Diseases Act was passed, but before it came into operation), and in 1871 at the same stations, subdivided into those at which the Act was and those at which it was not in operation:—

Year.	Act in Operation. Ratio per 1000 admitted for		Act not in Operation. Ratio per 1000 admitted for	
	Primary Venereal Sores.	Gonorrhœa.	Primary Venereal Sores.	Gonorrhœa.
1864	...	...	108·6	112·5
1871	52·0	115·6	93·4	107·4

Comparing, therefore, the results at stations where the Act was in operation with those of the year previous to the first Act being applied, the decrease in primary venereal sores has been 56·6 per 1000, or contrasted with the results in 1871 at stations not under the Act, it has been 41·4 per 1000. But as objection may be taken to deductions drawn from so limited a period of time as one year, the following table has been framed to show the average results of seven years at the stations under the Act, contrasted with the average of the same years at those not under the Act:—

Average of Seven Years' Period, 1865-71.	Average Annual Strength.	Average Annual Admissions for Primary Venereal Sores.	Average Annual Admissions for Gonorrhœa.	Ratio per 1000 of Mean Strength admitted for Primary Venereal Sores.	Ratio per 1000 of Mean Strength admitted for Gonorrhœa.
Stations under the Act........	28,202	1841	3318	65·8	117·7
Stations not under the Act	34,325	3481	3858	101·4	112·4

This table shows that the admissions for primary venereal sores, or that form of disease which is likely to produce constitutional deterioration, were on the average of the seven years 36·1 per 1000 of mean strength less annually at the stations under than at those not under the Act. Perhaps the fairest estimate of the benefit derived by the army from the Acts is to be found in the difference between the admissions at the stations under the Act in 1871, and the average of them during the seven years at the stations not under the Act, amounting to 49·4 per 1000 of the strength.

The following are the more important provisions of the Act:—

Sect. 15. Where an information on oath is laid before a justice by a superintendent of police, charging to the effect that the informant has good cause to believe that a woman therein named is a common prostitute, and either is resident within the limits of any place to which this Act applies, or, being resident within five miles of those limits, has, within fourteen days before the laying of the information, been within those limits for the purpose of prostitution, the justice may, if he thinks fit, issue a notice thereof addressed to such woman, which notice the superintendent of police shall cause to be served on her: provided that nothing in this Act contained shall apply or extend, in the case of Woolwich, to any woman who is not resident within one of the parishes of Woolwich, Plumstead, or Charlton.

Sect. 16. In either of the following cases, namely:—

If the woman on whom such a notice is served appears herself, or by some person on her behalf, at the time and place appointed in the notice, or at some other time and place appointed by adjournment:

If she does not so appear, and it is shown (on oath) to the justice present that the notice was served on her a reasonable time before the time appointed for her appearance, or that reasonable notice of such adjournment was given to her (as the case may be):

The justice present, on oath being made before him substantiating the matter of the information to his satisfaction, may, if he thinks fit, order that the woman be subject to a periodical medical examination by the visiting surgeon for any period not exceeding one year, for the purpose of ascertaining at the time of each such examination whether she is affected with a contagious disease; and thereupon she shall be subject to such a periodical medical examination, and the order shall be a sufficient warrant for the visiting surgeon to conduct such examination accordingly. The order shall specify the time and place at which the woman shall attend for the first examination.

The superintendent of police shall cause a copy of the order to be served on the woman.

Sect. 17. Any woman, in any place to which this Act applies, may voluntarily, by a submission in writing, signed by her in the presence of and attested by the superintendent of police, subject herself to a periodical medical examination under this Act for any period not exceeding one year.

Sect. 18. For each of the places to which this Act applies, either the Admiralty or the Secretary of State for War (but not both for any one place) may from time to time make regulations respecting the times and places of medical examinations under this Act at that place, and generally respecting the arrangements for the conduct there of those examinations; and a copy of all such regulations from time to time in force for each place shall be sent by the Admiralty or the Secretary of State for War (as the case may be) to the clerk of the peace, town clerk (if any), clerk of the justices, visiting surgeon, and superintendent of police.

Sect. 19. The visiting surgeon, having regard to the regulations aforesaid, and to the circumstances of each case, shall at the first examination of each woman examined by him, and afterwards from time to time as occasion requires, prescribe the times and places at which she is required to attend again for examination; and he shall from time to time give or cause to be given to each such woman notice in writing of the times and places so prescribed.

Sect. 20. If on any such examination the woman examined is found to be affected with a contagious disease, she shall thereupon be liable to be detained in a certified hospital, subject and according to the provisions of this Act ; and the visiting surgeon shall sign a certificate to the effect that she is affected with a contagious disease, naming the certified hospital in which she is to be placed ; and he shall sign that certificate in triplicate, and shall cause one of the originals to be delivered to the woman, and the others to the superintendent of police.

Sect. 21. Any woman to whom any such certificate of the visiting surgeon relates may, if she thinks fit, proceed to the certified hospital named in that certificate, and place herself there for medical treatment ; but if after the certificate is delivered to her she neglects or refuses to do so, the superintendent of police, or a constable acting under his orders, shall apprehend her, and convey her with all practicable speed to that hospital, and place her there for medical treatment ; and the certificate of the visiting surgeon shall be a sufficient authority to him for so doing. The reception of a woman in a certified hospital by the managers or persons having the control or management thereof shall be deemed to be an undertaking by them to provide for her care and treatment, lodging, clothing, and food, during her detention in the hospital.

Sect. 22. Where a woman certified by the visiting surgeon to be affected with a contagious disease places herself, or is placed as aforesaid, in a certified hospital for medical treatment, she shall be detained there for that purpose by the chief medical officer of the hospital until discharged by him by writing under his hand. The certificate of the visiting surgeon, one of the three originals whereof shall be delivered by the superintendent of police to the chief medical officer, shall, when so delivered, be sufficient authority for such detention.

Sect. 23. The inspector of certified hospitals may, if in any case it seems to him expedient, by order in writing signed by him, direct the transfer of any woman detained in a certified hospital for medical treatment from that certified hospital to another named in the order.

Every such order shall be made in triplicate, and one of the originals shall be delivered to the woman and the others to the superintendent of police. Every such order shall be sufficient authority for the superintendent of police, or any person acting under his orders, to transfer the woman to whom it relates from the one hospital to the other, and to place her there for medical treatment ; and she shall be detained there for that purpose by the chief medical officer of the hospital until discharged by him by writing under his hand.

The order of the inspector of certified hospitals, one of the originals whereof shall be delivered by the superintendent of police to the chief medical officer of the hospital to which the transfer is made, shall, when so delivered, be sufficient authority for such detention.

Sect. 24. Provided always that any woman shall not be detained under any one certificate for a longer time than three months, unless the chief medical officer of the hospital in which she is detained, and the inspector of certified hospitals, or the visiting surgeon for the place whence she came or was brought, conjointly certify that her further detention for medical treatment is requisite (which certificate shall be in duplicate, and one of the originals thereof shall be delivered to the woman) ; and in that case she may be further detained in the hospital in which she is at the expiration of the said period of three months by the chief medical officer until discharged by him by writing under his hand ; but so that any woman be not detained under any one certificate for a longer time in the whole than six months.

Sect. 25. If any woman detained in any hospital considers herself entitled to be discharged therefrom, and the chief medical officer of the hospital refuses to discharge her, such woman shall on her request be conveyed before a justice, who, if he is satisfied upon reasonable evidence that she is free from a contagious disease, shall discharge her from such hospital, and such order of discharge shall have the same effect as the discharge of the chief medical officer.

Sect. 26. Every woman conveyed or transferred under this Act to a certified hospital, shall, while being so conveyed or transferred thither, and also while detained there, be deemed to be legally in the custody of the person conveying, transferring, or detaining her, notwithstanding that she is for that purpose removed out of one into or through another jurisdiction, or is detained in a jurisdiction other than that in which the certificate of the visiting surgeon was made.

Sect. 28. In the following cases, namely :—

If any woman subjected by order of a justice under this Act to periodical medical examination at any time temporarily absents herself in order to avoid submitting herself to such examination on any occasion on which she ought so to submit herself, or refuses or wilfully neglects to submit herself to such examination on any such occasion ;

If any woman authorised by this Act to be detained in a certified hospital for medical treatment quits the hospital without being discharged therefrom by the chief medical officer thereof by writing under his hand (the proof whereof shall lie on the accused) ;

If any woman authorised by this Act to be detained in a certified hospital for medical treatment, or any woman being in a certified hospital under medical treatment for a contagious disease, refuses or wilfully neglects, while in the hospital, to conform to the regulations thereof approved under this Act ;

Then, and in every such case, such woman shall be guilty of an offence against this Act, and on summary conviction shall be liable to imprisonment, with or without hard labour, in the case of a first offence, for any term not exceeding one month ; and in the case of a second, or any subsequent offence, for any term not exceeding three months ; and in the case of the offence of quitting the hospital without being discharged as aforesaid, the woman may be taken into custody without warrant by any constable.

Sect. 29. If any woman is convicted of and imprisoned for the offence of absenting herself, or of refusing or neglecting to submit herself to examination as aforesaid, the order subjecting her to periodical medical examination shall be in force after and notwithstanding her imprisonment, unless the surgeon or other medical officer of the prison, or a visiting surgeon appointed under this Act, at the time of her discharge from imprisonment, certifies in writing to the effect that she is then free from a contagious disease (the proof of which certificate shall lie on her), and in that case the order subjecting her to periodical examination shall, on her discharge from imprisonment, cease to operate.

Sect. 30. If any woman is convicted of and imprisoned for the offence of quitting a hospital without being discharged, or of refusing or neglecting, while in a hospital, to conform to the regulations thereof as aforesaid, the certificate of the visiting surgeon under which she was detained in the hospital shall continue in force, and on the expiration of her term of imprisonment she shall be sent back from the prison to that certified hospital, and shall (notwithstanding anything in this Act) be detained there under that certificate as if it were given on the day of the expiration of her term of imprisonment, unless the surgeon or other medical officer of the prison, or a visiting surgeon appointed under this Act, at the time of her discharge from imprisonment, certifies in writing to the effect that she is now free from a contagious disease (the proof of which certificate shall lie on her); and in that case the certificate under which she was detained, and the order subjecting her to periodical medical examination, shall on her discharge from imprisonment cease to operate.

Sect. 31. If on any woman leaving a certified hospital a notice in writing is given to her by the chief medical officer of the hospital to the effect that she is still affected with a contagious disease, and she is afterwards in any place for the purpose of prostitution without having previously received from a visiting surgeon appointed under this Act a certificate in writing endorsed on the notice, or on a copy thereof certified by the chief medical officer of the hospital (proof of which certificate shall lie on her) to the effect that she is then free from a contagious disease, she shall he guilty of an offence against this Act, and on summary conviction before two justices shall be liable to be imprisoned with or without hard labour, in the case of a first offence, for any term not exceeding one month, and in the case of a second, or any subsequent offence, for any term not exceeding three months.

Sect. 32. Every order under this Act subjecting a woman to periodical medical examination shall be in operation and enforceable, in manner in this Act provided, as long as and whenever from time to time the woman to whom it relates is resident within the limits of the place to which this Act applies wherein the order was made, or within five miles [now ten miles] of those limits, but not in any case for a longer period than one year; and where the chief medical officer of a certified hospital, on the discharge by him of any woman from the hospital certifies that she is free from a contagious disease (proof of which certificate shall lie on her), the order subjecting her to periodical medical examination shall thereupon cease to operate.

Sect. 33. If any woman subjected to a periodical medical examination under this Act (either on her own submission or under the order of a justice), desiring to be relieved therefrom, and not being under detention in a certified hospital, makes application in writing in that behalf to a justice, the justice shall appoint by notice in writing a time and place for the hearing of the application, and shall cause the notice to be delivered to the applicant, and a copy of the application and of the notice to be delivered to the superintendent of police.

Sect. 34. If on the hearing of the application it is shown to the satisfaction of a justice that the applicant has ceased to be a common prostitute, or if the applicant, with the approval of the justice, enters into a recognisance, with or without sureties, as to the justice seems meet, for her good behaviour during three months thereafter, the justice shall order that she be relieved from periodical medical examination.

Sect. 35. Every such recognisance shall be deemed to be forfeited if at any time during the term for which it is entered into the woman to whom it relates is (within the limits of any place to which it applies) in any public thoroughfare, street, or place for the purpose of prostitution, or otherwise (within those limits) conducts herself as a common prostitute.

Sect. 36. If any person, being the owner or occupier of any house, room, or place within the limits of any place to which this applies, or being a manager or assistant in the management thereof, having reasonable cause to believe any woman to he a common prostitute, and to be affected with a contagious disease, induces or suffers her to resort to or be in that house, room, or place for the purpose of prostitution, he shall be guilty of an offence against this Act, and on summary conviction thereof before two justices shall be liable to a penalty not exceeding £20, or, at the discretion of the justices, to be imprisoned for any term not exceeding six months, with or without hard labour: Provided that a conviction under this enactment shall not exempt the offender from any penal or other consequences to which he may be liable for keeping or being concerned in keeping a bawdy-house or disorderly house, or for the nuisance thereby occasioned.

Sect. 37. All proceedings under this Act before and by justices shall be had in England according to the provisions of the Act of the session of the 11th and 12th years of her Majesty (chapter 43), "to facilitate the performance of the duties of justices of the peace out of sessions within England and Wales with respect to summary convictions and orders," and in Ireland according to the provisions of the Petty Sessions (Ireland) Act, 1851, as far as those provisions respectively are not consistent with any provisions of this Act, and save that the room or place in which a justice sits to inquire into the truth of the statements contained in any information or application under this Act against or by a woman shall not, unless the woman so desires, be deemed an open court for that purpose; and unless the woman otherwise desires, the justice may, in his discretion, order that no person have access to or be or remain in that room without his consent or permission.

The Contagious Diseases Act, 1869
(32 & 33 Vict. c. 96).

Sect. 3. Any woman who, on attending for examination or being examined by the visiting surgeon, is found by him to be in such condition that he cannot properly examine her, shall, if such surgeon has reasonable grounds for believing that she is affected with a contagious disease, be liable to be detained in a certified hospital, subject and according to the provisions of the Contagious Diseases Acts, 1866 to 1869, until the visiting surgeon can properly examine her, so that she be not so detained for a period exceeding five days. The visiting surgeon shall sign a certificate to the effect that she was in such a condition that he could not properly examine her, and that he has reasonable grounds to believe that she is affected with a contagious disease, and shall name therein the certified hospital in which she is to be placed; and such certificate shall be signed and otherwise dealt with in the same manner, and have the same effect, except as regards duration, as a certificate under the principal Act. If the reason that the visiting surgeon cannot examine the woman is that she is drunk, she may be detained upon an order of the visiting surgeon for a period not exceeding twenty-four hours in any place named in the order where persons accused of being drunk and disorderly or of offences punishable summarily are usually detained, and the gaoler or the keeper of such place shall upon the receipt of such order receive and detain the woman accordingly.

Sect. 4. Where an information on oath is laid before a justice by a superintendent of police, charging to the effect that the informant has good cause to believe that a woman therein named is a common prostitute, and either is resident within the limits of any place to which this Act applies, or being resident within ten miles of those limits, or having no settled place of abode, has, within fourteen days before the laying of the information, either been within those limits for the purpose of prostitution, or been outside of those limits for the purposes of prostitution in the company of men resident within those limits, the justice may, if he thinks fit, issue a notice thereof addressed to such woman, which notice the superintendent of police shall cause to be served on her: Provided that nothing in the Contagious Diseases Acts, 1866 to 1869, shall extend, in the case of Woolwich, to any woman who is not resident within the limits specified in the first schedule to this Act. Section 15 of the principal Act is hereby repealed, and the foregoing enactment in this section is substituted for it; provided that all proceedings taken and acts done under the section hereby repealed shall notwithstanding remain of full effect, and shall, if necessary, be continued as if they had been taken and done under this section.

Sect. 5. Any order for subjecting a woman to periodical medical examination shall be in operation and enforceable as long as and whenever such woman is resident within ten miles of the limits of the place where the order was made, instead of within five miles, as prescribed by section 32 of the principal Act.

Sect. 6. When any woman in pursuance of the principal Act voluntarily subjects herself by submission in writing to a periodical medical examination under that Act, such submission shall, for all the purposes of the Contagious Diseases Acts, 1866 to 1869, have the same effect as an order of a justice subjecting the woman to examination; and all the provisions of the principal Act respecting the attendance of the woman for examination, and her absenting herself to avoid examination, and her refusing or wilfully neglecting to submit herself for examination, and the force of the order subjecting her to examination after imprisonment for such absence, refusal, or neglect, shall apply and be construed accordingly.

Sect. 7. A woman may be detained for a further period not exceeding three months, in addition to the six months allowed under section 24 of the principal Act, if such certificate as is required by that section (to the effect that her farther detention for medical treatment is requisite) is given at the expiration of such six months; so, nevertheless, that any woman be not detained under one certificate for a longer time in the whole than nine months.

Sect. 8. Where an order is made discharging a woman from any hospital, or where a certificate is given, under section 30 of the principal Act, that a woman is free from a contagious disease, such order and certificate shall be delivered to the superintendent of police, and retained by him.

Sect. 9. Any woman subjected, either on her own submission or under the order of a justice, to a periodical medical examination under the principal Act, who desires to be relieved therefrom, and is not under detention in a certified hospital, may make application in writing in that behalf to the visiting surgeon. The visiting surgeon shall cause a copy of such application to be delivered to the superintendent of police, and if after a report from such superintendent he is satisfied by such report or other evidence that the applicant has ceased to be a common prostitute, may, by order under his hand, direct that she be relieved from periodical medical examination. Such order shall be in triplicate; one copy shall be delivered to the woman, and two copies shall be delivered to the superintendent of police, who shall communicate one copy to the justice (if any) who made the order subjecting the woman to a periodical medical examination, or to his successor in office. The provisions of this section shall be in addition to and not in substitution for the provisions of the principal Act for relieving a woman from examination.

Contagious Diseases, Prevention of —*See* EPIDEMIC.

Contracts — Any local authority may enter into any contracts necessary for the due execution of the Public Health Act, 1875.—(P. H., s. 173.)

With respect to urban contracts the following regulations are to be observed :—

"1. Every contract made by an urban authority whereof the value or amount exceeds *fifty pounds* shall be in writing and sealed with the common seal of such authority:

"2. Every such contract shall specify the work, materials, matters, or things to be furnished, had, or done, the price to be paid, and the time or times within which the contract is to be performed, and shall specify some pecuniary penalty to be paid in case the terms of the contract are not duly performed :

"3. Before contracting for the execution of any works under the provisions of this Act, an urban authority shall obtain from their surveyor an estimate in writing, as well of the probable expense of executing the work in a substantial manner as of the annual expense of repairing the same; also a report as to the most advantageous mode of contracting, that is to say, whether by contracting only for the execution of the work, or for executing and also maintaining the same in repair during a term of years or otherwise:

"4. Before any contract of the value or amount of one hundred pounds or upwards is entered into by an urban authority, ten days' public notice at the least shall be given, expressing the nature and purpose thereof and inviting tenders for the execution of the same; and such authority shall require and take sufficient security for the due performance of the same:

"5. Every contract entered into by an urban authority in conformity with the provisions of this section, and duly executed by the other parties thereto, shall be binding on the authority by whom the same is executed, and their successors, and on all other parties thereto, and their executors, administrators, successors, or assigns, to all intents and purposes: Provided that an urban authority may compound with any contractor or other person in respect of any penalty incurred by reason of the non-performance of any contract entered into as aforesaid, whether such penalty is mentioned in any such contract, or in any bond or otherwise, for such sums of money or other recompense as to such authority may seem proper."—(P. H., s. 175.)

Convalescents — Convalescents from scarlet fever, smallpox, typhus, and measles, &c., are often more liable to spread disease than those actually ill. The reason is that (1.) the skin is desquamating, or other organs are throwing off the poison in large quantities. (2.) Instead of being confined to a sick-chamber, they may be walking about, and may even go into crowded assemblies, and there one case may give a fearful disease, like typhus, to numbers. (3.) Even when the convalescent is not contagious himself, he may wear the clothes that have been infected by him, or those from which he originally caught the disease.

There is no adequate provision against convalescents from infectious diseases exposing themselves. They might, perhaps, be proceeded against under P. H., s. 126, if they wore clothing which had been exposed to infection. *See* Exposure, Infection, &c.

Conveyances—Conveyances for the purpose of transporting persons suffering under contagious or infectious diseases may be provided by any sanitary authority, and it is lawful for the latter to pay the expense of conveying any such person to an hospital or place for the reception of the sick or other place of destination.—(P. H., s. 123.)

Any one entering a public conveyance suffering from a contagious disease without previously notifying to the owner or driver that he was so suffering, shall on conviction be liable to a penalty not exceeding £5, and shall also be ordered by such justice to pay such owner and driver all the losses and expenses they may suffer in carrying out the provisions of the Public Health Act, 1875, which provides that the owner or driver of a public conveyance must immediately disinfect the vehicle after it has conveyed a person so affected. Penalty for neglect, £5 or less.—(P. H., s. 126, 127.)

No owner or driver of any public conveyance shall be required to convey a person suffering from a contagious disease until they shall have been first paid a sum sufficient to cover all such expenses.—(P. H., s. 127.)

Urban sanitary authorities have the power of licensing conveyances which ply for hire, and of regulating such matters by bylaws.—(P. H., s. 171.) *See* Hackney Carriages, Bylaws.

Cooking—Much depends on the method in which our food is prepared, not only as to its digestibility, but also as to the amount eaten, well and properly cooked meat tempting the appetite, while the stomach turns against food which is revolting to the sight and badly prepared. All nations have discovered the advantages attendant upon cooking, and it is only amongst savages who have no fuel (*e.g.*, the Esquimaux and Samoeides) that flesh is eaten in a raw state. Besides improving the flavour of meat, rendering it more easy of mastication, and pleasing to the sight, cooking possesses other advantages; it kills any parasites which may exist in the tissues of the meat, and it secures a certain temperature, and by this means conveys warmth to the system.

Cooking has the effect of solidifying the fibrine, gelatinising the tendinous, fibrous, and connective tissues, and of coagulating the albumen and colouring-matter. Thus the whole substance becomes more tender and less coherent, and hence more digestible. Meat cooked before the *rigor mortis* has set in is more easy of digestion than if cooked after that state has passed off. Bruising also before cooking has the effect of loosening the texture of the meat and rendering it more tender.

The principal modes of cooking commonly employed in this country are boiling, roasting, broiling, baking, frying, stewing. It is highly essential that meat should not be overdone, for Dr. Beaumont has satisfactorily shown that meat when overdone is rendered more and more indigestible in proportion to the prolonged action of heat. In boiling meat, the piece should be large, and it should be plunged suddenly into the water when it is in a state of brisk ebullition. The boiling should be kept up for some few minutes. When the meat is treated in this manner, the albuminous matter upon the surface is coagulated, and leads to the formation of a more or less unpermeable layer, through which the juices of the meat cannot escape. The boiling should not be continued, but a temperature of between 160° and 170° F. maintained until the cooking process is completed will be quite sufficient. Meat cooked in this way presents a far finer appearance than either that which has been subjected to a greater heat than 170°, or that which at first has been placed in water below the boiling-point; for in the former case the meat will be found to be shrunken, hard, and indigestible, and in the latter the meat will present a raw and undressed appearance, consequent upon the albuminous and colouring matters not being properly coagulated. If the object be to extract the nutritive qualities of the meat, an exactly opposite course should be pursued. The meat should be chopped in small pieces, and be allowed to remain soaking in *cold* water for some little time, and the temperature gradually raised. For broths boiling is not necessary, but for soups, when we desire to fully extract the gelatine, prolonged boiling is requisite.

Boiling is the most economical method of preparing meat, and it also renders it most digestible; but the flavours developed are not so savoury as those obtained from roasted meat.

Some descriptions of meat are altogether unsuited for boiling purposes, such as the flesh of young animals, which contain a large proportion of gelatine and albumen, substances which freely dissolve in water, and will therefore to a great extent boil away.

American pork loses 50 per cent. of its weight in boiling, whereas the pork of Denmark, Holstein, England, and Ireland only loses from 25 to 30 per cent.

The average loss in weight sustained by mutton and beef during the process is, according to Dr. Pereira, only about 17½ per cent.

Letheby gives the ordinary loss of weight in cooking in the following table:—

	Boiling.	Baking.	Roasting.
	Per cent.	Per cent.	Per cent.
Beef generally	20	29	31
Mutton generally	20	31	35
Legs of mutton	20	32	33
Shoulders of mutton	24	32	34
Loins of mutton	30	33	36
Necks of mutton	25	32	34
Average of all	23	31	34

In *roasting* meat, as in boiling, the heat should be strongest at first, and may then be much reduced. Liebig recommends that in all cooking operations of meat the heat should be limited to 170° F.; but it is doubtful whether that heat is strong enough to kill the parasites which infest meat, and therefore Letheby advises that the temperature should be as nearly as possible that of boiling water. Roasted meats are not generally so digestible as meats which have been boiled; and many stomachs which can tolerate poultry, meat, fish, and puddings boiled, find that roasted meat, &c., and baked puddings, cause great discomfort. This may be explained by the fact that during the process of roasting much of the superficial fat, from prolonged exposure to heat, undergoes decomposition, attended with the production of fatty acids, and an acid volatile product known as acroleine, which may seriously disturb sensitive stomachs.

These remarks apply also to *broiling, frying*, and *baking*, and more especially to the latter, for the operation being carried on in a confined space, the volatile fatty acids generated are prevented from escaping, and thus permeate the cooked articles.

Stewing and Hashing.—By either of these processes the meat is placed in a highly favourable state for digestion. Much of the nutritive matter passes into the surrounding liquid, which is consumed with the solid material. The best way to stew meat is to place it in a vessel over the top of which a cloth is tied. The vessel is then immersed in water contained in a saucepan. The water in this saucepan is made to gently simmer or slightly boil, and in this manner the meat is stewed in its own vapour, and forms a most suitable food for the convalescent invalid. Captain Warren's cooking-pot depends on this principle.

A contrivance, called the "Norwegian nest," sold by Messrs. Silver & Co., may be worth describing here. It consists of a box constructed like a refrigerator, the only difference being that it keeps the heat *in* instead of out. It is padded inside with a non-conducting material, with a space in the centre for receiving the vessel in which the process of cooking is carried on. If the vessel be filled with water, and this by the aid of heat kept at the boiling-point for a few minutes, and then placed in the box and shut in by the closure of the lid, the process of cooking goes on away from the fire, no matter in what situation the box may be placed. On the score of economy this box recommends itself to every household.

On account of its economy, the Norwegian pot was introduced into the French navy in 1869, and the results have been very satisfactory.—(Annales d'Hygiène, 1874.)

In boiling *fish*, it is well to remember that fish boiled in hard water is much firmer than if it be prepared in soft water; hence fish boiled in sea-water, or water to which salt has been added, is finer flavoured and much firmer than it would have been had it been cooked in ordinary water. Speaking generally, although there are some very important exceptions, fish are always better *fried*.

Vegetables boiled in water to which salt has been added, are not so tender as they would be if no salt were added. The salt is generally put in to preserve the colour.

Copper — Metallic copper is found in various parts of the globe, but its most abundant source is that of various copper ores. It is principally obtained from the pyrites of Cornwall, Devonshire, and Cuba, and from the carbonates of copper imported from Australia.

It has a specific gravity of 8·86 to 8·894. It is combustible and readily oxidised. It communicates a green tinge to flame. Acid, alkaline, saline, and fatty bodies, when placed in contact with it in air, promote its union with oxygen, and by dissolving a portion of the newly-formed oxide acquire poisonous properties.

Characteristics of the Salts of Copper.—Copper dissolves in dilute nitric acid. The solution possesses the following properties: In colour it is blue or greenish-blue. With potash or soda it yields a blue precipitate (*hydrate of copper*); a small quantity of ammonia produces with it a similar bluish-white precipitate, but an excess redissolves it, forming a deep blue liquid; ferrocyanide of potassium occasions in it a reddish-brown precipitate (*ferrocyanide of copper*); sulphuretted hydrogen and the hydrosulphides throw down a black precipitate (*sulphide of copper*); and lastly, a polished iron plate plunged into the liquid becomes coated with metallic copper ($Cu2NO_3 + Fe = Cu + Fe2NO_3$).

One of the most important salts which copper forms is sulphate of copper. It is met with in the form of oblique rhombic azure-blue crystals, with a styptic metallic taste, slightly efflorescing in dry air, soluble in water, and reddening litmus paper. It acts as an emetic, as a stimulant and astringent, and externally as an escharotic. The fatal dose of this salt is variable; as much as 5 drachms have been taken without proving fatal. Smaller doses are often more fatal than larger ones, owing to the emetic action induced by the latter.

Detection of Copper.—Whether copper be searched for, in cases of poisoning, in the contents of the stomach or in foods, the same process is applicable. If searched for in an organic liquid, it will be better to evaporate to dryness, add nitric acid, and boil to destroy organic matter, dilute and filter. A clean knife-blade or a needle inserted in the liquid will give evidence of copper, if present.

Another excellent way, applicable to any organic solid, is to burn down to an ash in a platinum dish, treat the ash with a little dilute acid, and then insert a slip of zinc; if copper be present, it is deposited on the platinum dish. Copper thus obtained may be confirmed by other tests; thus prussiate of potash added to a solution of copper gives a *chocolate precipitate*, ammonia a *blue colour*, &c.

Adulterations.—Sulphate of iron and sulphate of zinc are sometimes fraudulently added. The iron is detected by ammonia not redissolving the oxide; zinc, by first precipitating the copper with sulphuretted hydrogen, then, on the addition of ammonia, some of the above gas being in solution, a whitish sulphuret of zinc is thrown down.

Copper-founders, and others working in this metal, are very subject to affections of the chest.

When copper vessels are used for culinary or pharmaceutical purposes, great care should be exercised in their employment. Copper vessels should never be employed for any fluids that are the least acidulous, or that may have to remain long in them. Acid syrups, vegetable juices, aqueous extracts, soups, stews, &c., prepared in copper sauce-pans or boilers receive a metallic contamination proportional to the length of time they are exposed to the action of the metal; and it is important to remember that when copper vessels are allowed to get wet or dirty, or more especially greasy, a poisonous green rust forms upon the surface somewhat similar to verdigris. If articles are prepared in them in this state, serious consequences may ensue. Cases of poisoning from this cause are frequently met with, therefore it is necessary to be very careful that copper vessels should be thoroughly cleaned out immediately previous to their being used.

Such copper vessels are occasionally lined by a thin film of tin; but this necessarily, from constant use, becomes imperfect, and affords but little protection, therefore great caution must be used in employing *tinned copper boilers.* Mr. W. Thompson in one case found no less than 3·575 grains of copper in a gallon of water drawn from a kitchen-boiler of this description. The copper existed in this case in the form of a soluble sulphate. After a careful examination of the cause, Mr. Thompson could only suggest, that as in the process of galvanising the copper it is first pickled in sulphuric acid, some of the acid must have been retained in the crevices of the rivets and then dialysed out, carrying with it the copper.—(*See* Chemical News, vol. xxxi. No. 801, 1875.)

Indeed copper in minute quantities is continually finding its way into the human body through the use of copper vessels, copper coins, intentional and accidental contamination of food, &c. This fact is conclusively established by Bergeron and L. L. Hote, who examined specially the kidneys and livers of fourteen human bodies for copper, the result being that the metal was found in every case.

In *two* of the cases, aged seventeen years, its presence could only be proved qualitatively. In eleven, aged from twenty-six to fifty-eight years, the quantities of copper found ranged from ·7 to 1 milligramme. And in one individual, aged seventy-eight years, the copper found amounted to 1·5 milligrammes.—(Comp. Rend., lxxx. 268.)

Water, and hence food, has occasionally become contaminated with copper through strange channels. For example, in France, at Roubaix, many of the rain-water tanks were found to contain considerable quantities of sulphate of copper. Most of the stoves there had been supplied with copper flues, the sulphur compounds from the coal had formed a sulphide of copper, which the action of the air changed into sulphate; this being deposited on the roofs, the rains washed down and dissolved into the cisterns.

The various compounds of copper are largely used for the adulteration and colouring of different articles used as foods.

Carbonate and arsenite of copper have been used for the purpose of colouring tea leaves. *See* TEA.

Sulphate of copper has been employed chiefly in Belgium for the purpose of whitening bread. *See* BREAD.

Sulphate and acetate of copper are constantly added to pickles for the purpose of giving them a bright green colour. *See* PICKLES.

Preserves and jellies are often adulterated with copper. In sauces, also, this metal has frequently been discovered. It has been detected in annatto, in confectionery, in wine, and in the absinthe so much used in France.

The emanations from copper-works where pyrites are burnt are large quantities of sulphurous acid, arsenic, and a little copper.

Copperas—A generic name for the *crude metallic sulphates.* When used without a qualifying adjective, it generally means sulphate of iron. *See* IRON.

Coriander Seeds—The dried ripe fruit of the *Coriandrum sativum*, natural order *Umbelliferæ.* Grows wild about Ipswich and some parts of Essex, although not really indigenous, but a native of the south of Europe. The coriander seed is used for mixing with curry powders. It is about the size of white pepper, globular, finely ribbed, and of a yellowish-brown colour. It consists of two hemispherical mericarps, adherent by their concave surfaces. Each mericarp is without evident primary ridges, but the four secondary ridges are more prominent and keeled. The channels are without vittæ, but the commissure has two. It has a peculiar, agreeable, aromatic odour. The mature seed does not contain starch. *See* CURRY.

Corn-Flour—*See* FLOUR, &c.

Cosmetics—It is convenient to understand by the term "cosmetics" all substances applied to the skin, hair, beard, nails, and teeth to improve their appearance. There are many instances on record of poisoning from the use of cosmetics of a deleterious nature; for example, Horace Walpole relates, "That pretty young woman, Lady Fortrose, Lady Harrington's eldest daughter, is at the point of death, killed, like Coventry and others, by white-lead, of which nothing could break her."—(HORACE WALPOLE, Letters, vol. iii. p. 200.)

The same substance is to this day used by the London actresses. Dr. George Johnson has recently called attention to several cases, treated at King's College Hospital, of lead-poisoning, caused by the use of *flake-white*, "amongst the ballet dancers and others."

Cosmetics are generally prepared from the vegetable and mineral kingdom; some few from the animal world, such as *spermaceti*, *civet*, and most *pomades*.

Cosmetics, speaking generally, are not adulterated with dangerous substances, but usually mixed with similar articles of an inferior quality.

On the other hand, some few consist almost entirely of metallic substances.

Arsenic is generally present in large quantities in depilatory powders.

Subnitrate of bismuth is used as a preparation for imparting clearness to the complexion (*blanc de perle*).

Carbonate of lead is often used to adulterate this substance, and enters largely into the composition of two substances known as *blanc de Kréms* and *blanc de vinaigre*.

Lead is also frequently present in preparations used to stain the hair black; and in one or two instances poisoning has occurred, for example—

Mr. John C. Hunter relates the case of a gentleman in Glasgow who had used a "hair-restorer" to dye his grey locks, and soon exhibited symptoms of lead-poisoning. The strength of the wash appears to have been 2·75 grains of lead to the fluid ounce, the lead existing in the form of acetate.—(Pharmaceutical Journal, February 27, 1875.)

Dr. Taylor also states, that he has met with an instance in which paralysis of the muscles on one side of the neck arose from the imprudent use of a hair-dye containing litharge.—(TAYLOR'S Principles of Medical Jurisprudence, vol. i. p. 299.)

Nitrate of silver as a dye is also much used, and *mercury* finds its place in various washes and ointments largely dispensed by chemists for the purpose of destroying parasites, &c.

Cottages—*See* HABITATIONS.

Cotton—The cotton of which textile fabrics are made consists of hairs covering the seeds of certain plants belonging to the natural order *Malvaceæ*, or the Mallow family. The commercial cotton is derived from four distinct species—*Gossypium arboreum*, an Indian species; *Gossypium Barbadense*, the Barbadoes cotton plant; *Gossypium herbaceum*, the common cotton plant of India; *Gossypium Peruvianum* or *acuminatum*, a species supposed to be indigenous to America. It is a diaphanous substance, which forms fibres about $\frac{1}{1000}$ of an inch in diameter, ribbon-like, and flattened in shape. The fibres are twisted at intervals, and the borders are a little thickened. The interior canal is very frequently obliterated, or if it is not, it may contain some extractive matters.

Fresh cotton fibre is a cylindrical hair with thin walls, which collapses and twists as it becomes dry. Iodine stains it brown; iodine and sulphuric acid (in very small quantities) give a blue or violet blue; nitric acid unrolls the twists, but does not destroy them.

Cotton wears well; it is very non-absorbent, does not shrink in washing, and conducts heat less rapidly than linen, but much more rapidly than wool. Smoothness, evenness of texture, and equality of spinning are the chief points to be attended to in choosing cotton fabrics.

Cotton alone is used in cotton shirting and calico. In merino and other fabrics, it is used with wool in the proportion of 20 to 50 per cent. of wool, the threads being twisted together to form the yarn. *See* CLOTHING.

Court Leet—*See* LEET, COURT OF.

Courts—The hygienic condition of our courts of law in past times was defective in the extreme, and led to serious results. For example, the Black Assizes at the Old Bailey, Taunton, Launceston, Exeter, &c., were directly due to contagion from the prisoners, and this contagion would probably not have been so fatal if the courts had been built larger and not so crowded. At the present date many of our courts are the same as those of the Black Assizes. Their great fault is their small size, which permits overcrowding to a great and insufferable extent. Besides, it is not ordinary overcrowding, but a collection of people very frequently from the lowest and most unhealthy parts of our towns. The sanitary officials of every place should carefully examine the drains, water-closets, ventilation, &c., of every courthouse, and notices should be posted warning people recovering from any infectious disease from entering into the court. *See* BLACK ASSIZES, VENTILATION, DISINFECTION.

Cream is that portion of the milk which rises to the surface on standing. It is really milk rich in fat.

The following table shows the composition of six samples of genuine cream analysed by Mr. Wanklyn:—

	1.	2.	3.	4.	5.	6.
Water . .	72·20	71·2	66·36	60·17	53·62	50·00
Fat . .	19·00	14·1	18·87	33·02	38·17	43·90
Milk, sugar, caseine, and ash	8·80	14·7	14·77	6·81	8·21	6·10

Cream is rich in butter, a quart of good cream generally yielding from 13 oz. to 15 oz. of commercial butter. In good seasons, when the cows are fed on rich pasture-land, a quart of cream will often yield about 16 oz. of butter; and if they are fed on oilcake, as much as from 22 oz. to 24 oz. are obtained. The so-called clotted cream of Devonshire is thus prepared. The milk is allowed to stand for a day to allow the cream to rise; it is then strongly heated, but not allowed to boil; the heat coagulates some of the caseine, and the cream is involved in the coagulum.

The analysis of cream is conducted on exactly the same principle as that of milk; but it must be weighed, not measured, and smaller quantities may be evaporated to dryness in order to estimate the water, if the ratio of the water to the solids, not fat, is such that adulteration may be suspected; for this ratio, although occasionally disturbed by some of the caseine rising with the fat, is practically the same as in milk.

Mineral adulterations, such as carbonate of magnesia, will be detected, if present, in the ash. *See* MILK.

Crèches (infant asylums)—These are charitable institutions where children of both sexes, up to the age of six, are admitted during the day, and receive proper care and education, whilst their mothers are at work. They appear to have been first originated by Oberlin, the well-known Protestant pastor of the Vosges. They were definitely established in France about the year 1826. In 1837 there were in France 261 *asiles*, admitting daily 29,244 children; in 1840 they had increased to 555; and in 1860 they had again increased to 3000, utilised by 300,000 children. *Crèches* have been introduced into England. There are several in London, which are found very useful, and a benefit to the poorer classes.

Crenothrix Polyspora—A plant or fungus belonging to a new genus, and to which the above name was given by Dr. Cohn, who discovered it in well-water at Breslau, in a part noted for the prevalence of typhus.

Creosote, or **Kreosote** ($C_{12}H_{16}O_2$, or $C_8H_{10}O_2$), sp. gr. 1·057 — This is a peculiar substance discovered by Reichenbach, and so named from its antiseptic properties (κρεας, flesh; σωτηρ, preserver). The true composition of creosote is not definitely settled.

Müller considers it as methyloxykresylic acid ($HC_7(CH_3)H_6O_2$).

It is obtained amongst the products of the distillation of wood tar, and its purification is difficult and tedious.

Long before its discovery by Reichenbach, it was a component of *Aqua Binelli*, the composition of which was kept secret in Italy for years.

Creosote, when pure, is a colourless oily liquid of great refractive power. Its taste is pungent and caustic, and the vapour is extremely irritating to the eyes. It boils at 400° F., and is still fluid at 16·6° F. It is soluble in all proportions in acetic acid, alcohol, ether, benzole, naphtha, bisulphide of carbon, the essential and fatty oils, ammonia, and potash; but it is sparingly soluble in water (about 1 in 80). Gmelin states that water containing so small a quantity as 1 in 10,000 smells of smoke.

Creosote is decomposed by the strong acids. It reduces the nitrate and acetate of silver, is resinified by chlorine, and is a solvent for phosphorus, iodine, sulphur, the resins, the alkaloids, indigo blue, the acetates and chloride of calcium and tin, and several other salts.

Creosote precipitates albumen, although the aqueous solution is neutral.

Creosote is inflammable. It burns with difficulty, with a smoky flame. A slip of deal immersed in creosote, and then dipped in hydrochloric acid and allowed to dry in the air, acquires a greenish-blue colour. It turns a ray of polarised light to the right, which easily distinguishes it from carbolic acid, which turns a ray of polarised light to the left.

Few substances are more adulterated and impure than commercial creosote. Much of it is nothing but carbolic acid flavoured with creosote. In other cases it is a mixture of creosote, picamar, and light oil of tar. The purity of creosote may be known by the following tests: 1. It should be perfectly soluble in acetic acid. 2. Mixed with water, not more than $\frac{1}{80}$ should disappear; if more than $\frac{1}{80}$ disappear, it has probably been adulterated with water. 3. Its aqueous solution is perfectly neutral, and there is no residue floating on the surface.

Creosote is a powerful antiseptic. It preserves all animal substances. Smoked hams, &c., are really preserved in great measure by the creosote which the smoke contains. In the preservation of meat it acts in two ways—by arresting putrefaction, and by preventing the access of insects, for it is a true insecticide, and a saucer containing a few drops of creosote will keep a pantry very free from flies. Its disinfectant properties are, it may be surmised, high, but it has never been used on a large scale, its place having been taken to a great extent by carbolic acid.

Creosote is used in the arts as a preservative of all kinds of organic substances. It is employed in medicine both externally and internally, and it has been used as an adulterant to give a smoky flavour to a made-up whisky, &c.

Crétinism—*See* GOÎTRE.

Croton Oil—*See* OILS.

Croup—The croup of English writers, as Dr. G. Johnson has ably shown, confuses together two distinct affections: one, a spasm of the larynx (*Laryngismus stridulus*), not a fatal disease, although death occasionally results; the other, true diphtheria, with the characteristic exudation in the larynx. *See* DIPHTHERIA.

Cubic Space—To maintain the purity of the air in rooms, public buildings, &c., the cubic space should be large enough to permit the passage of 3000 cubic feet of air per head without producing any perceptible draughts. Professor Pettenkofer found that by means of artificial ventilation, and with the aid of the best mechanical contrivances, the air in a chamber of 424 cubic feet can be renewed six times per hour without creating any appreciable air currents.

According to the army regulations—

	Cubic Feet Space.
In permanent barracks a man is allowed	600
In wooden huts ,,	400
In hospital wards at home ,,	1200
In hospital wards in the tropics ,,	1500
In wooden hospitals at home ,,	600

In the common lodging-houses, 30 superficial and 240 cubic feet are allowed. In the section houses of the metropolitan police, 50 feet superficial and 450 cubic feet are given. The Poor Law Board allows 300 cubic feet for every healthy person in dormitories, and from 850 cubic feet and upwards, according to circumstances, as far as 1200 feet, for every sick person. In Dublin an allowance of 300 cubic feet is required in the registered lodging-houses. In the Prussian army the allowance is 495 cubic feet, the superficial space being 42-45 square feet. In the old Hanoverian army the cubic space was 700 to 800 cubic feet (Prussian).

The London School Board have given in a general schoolroom 10 square feet per scholar, and in graded schools 9 square feet—the height was ordered to be 13 feet—making 130 and 117 cubic feet respectively.

To measure cubic space, simply multiply the three dimensions—length, breadth, and height. Should the room be of irregular form, semicircular, containing many angles, &c., then the ordinary rules for the measurement of the area of circles, segments, triangles, &c., must be applied. Recesses containing air should also be measured and added to the amount of cubic space. Solid masses of furniture, projections, cupboards, &c., should also be measured and their cubic contents deducted from that already taken. Bedding occupies a certain amount of space, and the fact that the bodies of persons living in the room take the place of a certain quantity of air should not be forgotten. A soldier's hospital mattress, pillow, three blankets, one coverlet, and two sheets will occupy almost 10 cubic feet.—(PARKES.) And a man of average size displaces about 2½ to 4 cubic feet of air. *See* VENTILATION.

Cumin Seeds—The cumin plant (*Cuminum Cyminum*), belonging to the natural order *Umbelliferæ*, is a native of Upper Egypt, but is extensively cultivated in Sicily and Malta. The seeds are much used in the making of curry powders; they are larger than anise, and of a light brown or greyish-yellow colour —something like, but larger than, a caraway seed. Each mericarp has five primary ridges, which are filiform and furnished with very fine prickles. The four secondary ridges are prominent and prickly, and under each there is one vitta. These seeds have a peculiar medicinal taste and smell. The seeds do not contain starch. *See* CURRY POWDER.

Cupralum—A form of disinfectant designed by Dr. Bond, Medical Officer of Health to the Gloucestershire Combined Sanitary Districts, composed of a combination of the sulphates of aluminum and copper with potassic dichromate and terebene. Dr. Bond claims for this combination the following advantages: (*a*) the highest power of coagulating albumen practically available; (*b*) a similarly high antiseptic power; (*c*) great activity as a deodorant, due partly to the action of the metallic salts upon sulphuretted hydrogen, ammonia, &c., partly to the action of terebene as an ozoniser, and partly to the mechanical effect which the latter body has in preventing dissemination of gases from liquid surfaces by forming over them an impermeable film.

Curcuma Arrowroot—*See* STARCH.

Curd—Curd constitutes the basis of cheese. It is coagulated caseine which has involved and carried with it the suspended milk globules. Curd, therefore, consists of the nitrogenous portion of milk mixed with the chief part of its fatty element. *See* CHEESE, MILK, &c.

Currants—The so-called currants which are used in cakes and puddings constitute the dried fruit of a vine which grows in the Ionian Islands, and yields a very small berry. The word "currant," as there employed, is a corruption of Corinth, where the fruit was formerly produced. The currants of our gardens are varieties of the *Ribes rubrum* and *Ribes nigrum* (Linn.) The first includes red currants, and the second white currants. The fruit of both these varieties is gently acidulous, cooling, and wholesome. The fruit of the black currant is slightly aperient.

Composition of Currants (FRESENIUS).

	Middle-sized Red.		Very large Red.
Soluble Matter—			
Sugar	4·78	6·44	5·647
Free acid (reduced to equivalent in malic acid)	2·31	1·84	1·695
Albuminous substances	0·45	0·49	0·356
Pectous substances	0·28	0·19	0·007
Ash	0·54	0·57	0·620
Insoluble Matter—			
Seeds	4· 5 }	4·48	3·940
Skins, &c.	0·66 }		
Pectose	0·69	0·72	2·580
[Ash from insoluble matter included in weights given]	[0·11]	[0·23]	[0·185]
Water	85·84	85·27	85·355
	100·00	100·00	100·00

		Middle-sized White.	
Soluble Matter—			
Sugar	6·61	7·692	7·12
Free acid (reduced to equivalent in malic acid) . . .	2·26	2·258	2·53
Albuminous substances	0·77	0·300	0·68
Pectous substances .	0 18		0·19
Ash	0·54	0·560	0·70
Insoluble Matter—			
Seeds / Skins . . .	4·94	4·144	4·85
Pectose . . .	0·53	0·240	0·51
[Ash from insoluble matter included in weights given] .	[0·12]	...	[0·14]
Water . . .	84 17	84·806	83·42
	100·00	100·00	100·00

Curry Powder—Curry powders are useful for giving a relish to the otherwise insipid rice so largely taken in the East, and for the same reason we use them with the almost flavourless mixtures of rice and chicken, rabbit, or fish. The composition of the Ceylon curry powder, which is usually allowed to be the finest, is, according to Dr. Balfour, as follows: A piece of green ginger, two fragments of garlic, a few coriander and cumin seeds, six small onions, one dry chilli, eight peppercorns, a small piece of turmeric, half a desert-spoonful of butter, half a cocoa-nut, and half a lime; but it is necessary, to have it in perfection, that it be made the same day on which it is to be cooked.

Good unadulterated curry powder, as met with in this country, generally consists of turmeric, black pepper, coriander seeds, cayenne, fenugreek, cardamoms, cumin, ginger, allspice, and cloves: the three latter substances are frequently omitted. A description of these different ingredients will be found in the articles under their several headings.

The curry powder of commerce is seldom pure. The adulterations that have been detected are *ground rice*, *potato starch*, *red-lead*, and *salt*.

Cyanide of Potassium—*See* POTASSIUM.

Cyanide of Silver—*See* SILVER.

Cychorium Intybus—*See* CHICORY.

Cyclops Quadricornis, or **Water-Flea**—Generally very common in the spring, and only found within 1 or 2 feet of the surface. They occur in so many good waters, that they cannot be considered as indicating any dangerous impurity. The *Cyclops quadricornis*, when first born, is totally unlike its parents, being of an ovoid shape, having only two short antennæ and two pairs of feet. In three moults the animal reaches its perfect form, with its two pairs of antennæ, five pairs of feet, and body divided into several distinct rings or segments. *See* WATER.

Cysticerci are forms of embryo tænia or tapeworms which infest the bodies of animals, and these, when taken into the system of an appropriate subject, by eating the infested flesh or otherwise, become developed into tapeworms; they are, therefore, although separate parasites, extremely unlike tapeworms—in point of fact, only a stage of development in the life-history of the tapeworm, just as the chrysalis, in the insect world, is an intermediate stage between the maggot or caterpillar, and the fully-developed, winged, mature insect.

The following are the more important cysticerci:—

1. *Cysticercus telæ cellulosæ*—the cysticercus of the *Tæni asolium* found in man, in the pig, ox, horse, camel, sheep, and roe-deer.

2. The cysticercus of the *Tænia mediocanellata* found in the muscles and internal organs of cattle.

3. The cysticercus of the *Tænia marginata* found in cattle, sheep, horses, the reindeer, squirrels, in various monkeys, and occasionally in man.

The *Cysticercus cellulosæ* is a parasite very frequently met with, more especially in pork, which when attacked by it is generally known as "measly." According to Professor Gamgee's communication in the "Fifth Report of the Medical Officer to the Privy Council," 1865, at least 3 per cent., and probably 5 per cent., of the pigs in Ireland are thus affected.

The *Cysticercus cellulosæ* is in the shape of a little white glistening conical vesicle, varying in size from the $\frac{4}{100}$ of an inch long and $\frac{3}{100}$ broad to a size of $\frac{1}{3}$ of an inch, or even

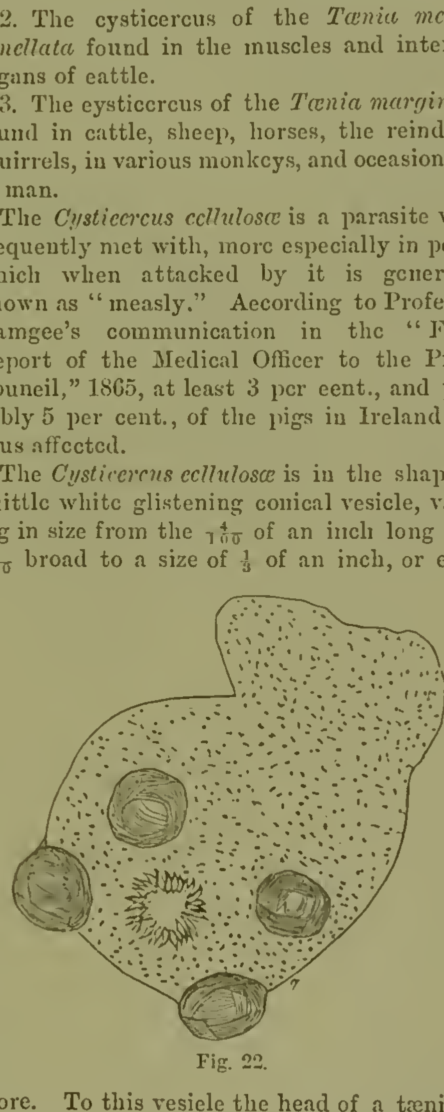


Fig. 22.

more. To this vesicle the head of a tænia is attached by a narrow transversely-marked pedicle or neck. The head is furnished with the characteristic hooklets described in article

Tænia, and it can be retracted within or protruded from the vesicle. In muscle, or in firm tissues, a cyst is developed around the parasite at the expense of the tissue; in free cavities, such as in the ventricles of the brain and in the eye, this external cyst is absent, and the parasite may develop to a very large size.

Fig. 22 shows the head of the embryo *Cysticercus cellulosæ* from measly pork.

The symptoms of measles in the pig are obscure; the animal is dull and off its food, there is tenderness in the groin and swelling in the shoulder; but these symptoms may all be absent. It may be, however, found, during life, in the tongue, especially underneath it, in the sublingual glands; it may also be discovered on the conjunctiva, and in the folds of mucous membrane near the anus.

From the experiments of Professor Leuckart of Giessen, it appears certain that man may become infested with the *Tænia mediocanellata* by eating imperfectly-cooked veal or beef affected with cysticerci.

This cysticercus is very similar in appearance, in size, &c., to the one previously described; it may be diagnosed by its hooklets.

Fig. 23 is a representation of the head of the parasite from ration beef.

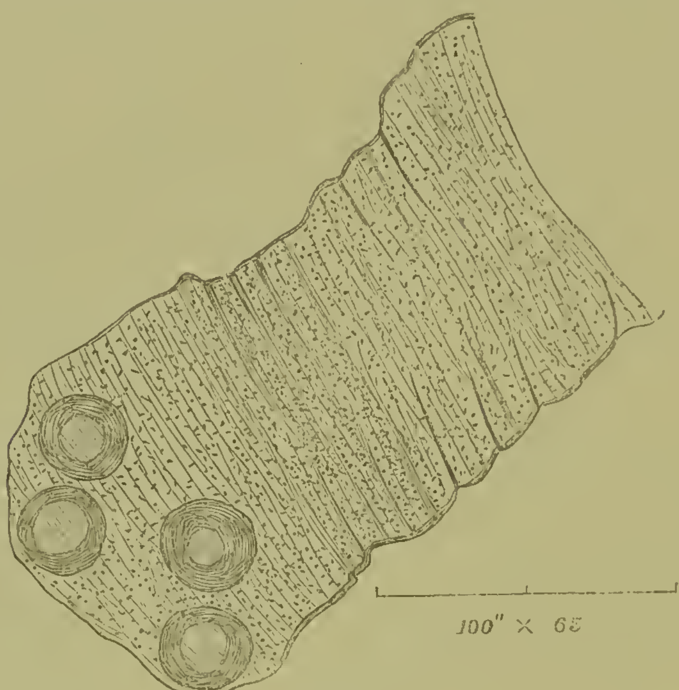


Fig. 23.

D.

Dammar—This substance is now largely used by microscopists for mounting unsoftened bone, teeth, hair, and most tissues which have been hardened in alcohol or chromic acid. Dr. Klein gives the following receipt for preparing this fluid :—

(*a.*) Gum dammar, ½ oz.; oil of turpentine, 1 oz.: dissolve and filter.

(*b.*) Gum mastic, ½ oz.; chloroform, 2 oz.: dissolve and filter. Add solution *a* to solution *b*.

Dammar, if rendered thick by drying, may be used as a luting.

Dampness, whether of foundations of houses, of floors, or of clothing, is a recognised cause of a great variety of diseases.

Attempts have been recently made to estimate the dampness of walls quantitatively.

J. Glässgen (Zeitschrift für Biologie, x. 247–262) obtained good results by taking a piece of mortar from the wall and passing dry air free from carbonic acid over it, the weight of the mortar before and after the operation being carefully taken, and the difference expressed as the *mechanically*-combined water. Lastly, the *chemically*-combined water was estimated by passing carbonic anhydride over the mortar and again weighing it.

Experiments of this kind carried out at Munich showed the gradual drying of the walls with age, and the retardation of the drying process in buildings in confined situations, where the air having but little movement becomes saturated with moisture, so that the water can no longer evaporate from the walls.

The absolute amount of moisture allowable in any given locality depends on the material of which the house is built, the season of the year, and local conditions. J. Glässgen considers that the moisture on the walls of houses at Munich should not exceed 1 per cent. of the mortar; but no experiments of the kind appear to have been undertaken in England.

Damp-proof Courses—This is a name given by builders and architects to an arrangement in the walls of houses to prevent the damp, arising from the foundation by capillary attraction, from going upwards all over a house. Various kinds are in use. The most simple one is a double course of slates, in cement, laid along the top of the walls just as they emerge above the ground-line. The best damp course is said to be a vitrified stoneware tile, perforated with holes, about 1½ inch thick. This ventilates the floor, prevents dry-rot in the timbers, and acts as an efficient damp-proof course.

Daphnia Pulex (Water-Flea)—This animal is found in so many good waters, that its presence can scarcely be considered an indication of dangerous impurity. *See* WATER.

Darnel (*Lolium temulentum*)—This poisonous grass frequently becomes mixed either with the flour of wheat or some other cereal farina. The effects of these seeds on man are described by Pereira as being headache, giddiness, languor, ringing in the ears, confusion of sight, dilated pupil, delirium, heaviness, somnolency, trembling convulsions, paralysis, and great gastro-intestinal irritation. Seeger says that one of the most certain signs of poisoning by them is trembling of the whole body.

All the inmates of the poorhouse at Sheffield, to the number of eighty, were attacked with analogous symptoms after a meal of oatmeal porridge, and it was supposed that these ill-effects arose from the presence of darnel in the meal. On the authority of Dr. Kingsley of Roscrea, Dr. Taylor states that in the month of January 1854 about thirty people suffered severely from the effects of bread containing the flour of darnel seeds ; and in a prison at Cologne sixty persons suffered from the use of a bread-meal containing a drachm and a half of *Lolium temulentum* in 6 ounces of bread.

Monsieur C. Baillet and Filhall made some valuable experiments a few years ago on the action of the watery extract and the oil of darnel in animals.

The oil extracted from 3 kilogrammes of darnel acts in a most violent manner upon horses, causing increased frequency of the heart's action and of the respiration, followed by tremors of the whole body, passing into convulsions, death taking place in a somnolent state ; or if the dose be small, a sleepy, stupid aspect invariably preceding recovery. The *post mortem* appearances showed congestion of the brain and spinal cord, congestion of the intestines, redness of the stomach, and engorgement of the liver.

The watery extract, when given by the mouth in very large doses, causes but very slight symptoms in horses, but given to dogs, cats, &c. (*Carnivora*), is rapidly fatal ; but when a large dose of the extract (that from 4 kilogrammes of the plant) was injected into the veins of an old horse, the animal died after three days of great suffering, the symptoms being very similar to those produced by the oil. But in addition, there was a profuse salivation; the urine was scanty, thick, dark, and offensive; and a large œdematous swelling of the chest appeared. After death, engorgement of the kidneys and liver, redness of the peritoneum and stomach, and congestion of the intestines, were the principal lesions observed.

The chemical tests for darnel, when mixed with flour, are of a very unsatisfactory character. Viewed beneath the microscope, the flour of the darnel seed presents, according to Dr. Hassall, the following appearance: The starch corpuscles are polygonal, and resemble in this respect those of rice. They are, however, much smaller, and frequently united into compound grains of various sizes, the larger grains consisting of some fifty or sixty starch corpuscles.

The structure of the testa is very different from that of either rice or oat, or indeed any of the other cereal grains. It is formed of three coats or membranes. The cells of the outer coat form but a single layer, and, contrary to the arrangement which exists in the oat, their long axes are disposed transversely, in which respect they resemble rice. The fibres of the husk of rice and the cells of the testa of lolium are, however, very distinct in other respects. In the former the cells are long and narrow, forming fibres, while in the latter they are but between two and three times as long as broad. The cells of the second coat, which are ranged in two layers, follow a vertical disposition, an arrangement which is contrary to that which obtains in all the other cereal grains, with the exception of rice. The cells of the *third* coat form but a single layer, and resemble those of other grains.

Dates—The date is derived from the *Phœnix dactylifera*, or palm-tree of Scripture, a native of Africa and parts of Asia. The fruit is of a drupaceous nature, and according to Reinsch, the fleshy part contains 58 per cent. of sugar, accompanied by pectine, gum, &c. Dates, and more especially dried dates, are very nutritious.

Daturia—An alkaloid obtained from the seeds of the thorn-apple (*Datura Stramonium*). The seeds themselves, or preparations from them, are employed to a considerable extent in India by the Thugs to render their victims insensible. The alkaloid was considered by Dr. Planta and others to be identical with atropia, but the physiological properties are different. (*See* BONCHARDET, Ann. de Thérapeutique, 1864, p. 24.) Daturia, if heated in a tube, evolves ammonia. It is soluble in water, with an alkaline reaction. It is precipitated by tannic acid and chloriodide of potassium. Nitric and hydrochloric acid dissolve it without change of colour. It is precipitated from its solutions by alkalies in the form of a white powder. Daturia crystallises in colourless quadrangular prisms. It is highly poisonous; one-eighth of a grain killed a sparrow in three hours.

The principal symptoms of daturia-poisoning are insensibility and dilated pupils. *See* ALKALOIDS, &c.

Dead, Disposal of—The ancient methods of disposal of the dead were various.

The ancient Greeks burnt their dead from a very early period; so also did the Romans for a time, but afterwards they adopted burial.

Cremation was also used by the Thracians, Celts, Germans, Danes, Swedes, Norwegians, and Sarmatians.

The Egyptians embalmed their dead, and preserved them in immense stone edifices.

The Ichthyophagi, or fish-eating nations around Egypt, cast their dead into the sea.

The Hebrews sometimes made use of cremation, but mostly buried.

The Scythians exposed their dead to the air.

The Chinese neither used interment nor cremation, but planted trees and burnt wood by the grave.

The Hindoos in part burnt their dead, but some threw them into sacred rivers, or, more curious still, exposed them to be eaten by vultures.

In modern times many of these customs have descended.

The Hindoos still endeavour to follow the ancient usages; bodies yet float in the Ganges, and the *silent towers* are standing.

The New Zealanders have a curious custom of burying their chiefs for a time, and then unearthing them in order to recover the ornaments. Some tribes place the body in a kind of cage until the flesh falls through. The bones are then cleansed, and preserved with reverence in a little house elevated on a pole.

The disposal of the dead varies in some parts on account of some peculiarity of the locality. At Iquique the corpses are placed in a large cave, the sides of which are naturally saturated with nitre. Here they are preserved indefinitely, but when the cave is full there is a general delivery, and putrefaction in the exposed corpses is rapid even in that dry air. In like manner, the Cordeliers at Toulouse had a church in which the soil dried the dead, "a property not belonging to any other part of the convent or its grounds. Old bodies are taken out to make room for new-comers, put in the tower to sweeten, and then arranged along the walls of the *charnier*, which is under the choir." "L'on y a vu pendant longtemps celui de la Belle Paule, que fut la plus belle femme de Toulouse."—(BEISCHING.)

The disposal of the dead has at times varied, simply from fear of desecration of the grave. In the time of the resurrectionists many bodies were buried in quicklime, and a resident of Dundee was so fearful lest the coffin of his child should be disturbed, that he arranged an explosive apparatus, which was buried with the coffin.—(SOUTHEY'S Commonplace-Book, iii. 783.)

The methods in modern use are, however, as every one knows—1. Burial; 2. Cremation; 3. Embalmment. The latter method is treated of elsewhere. (*See* EMBALMING.) The two remaining ones will now be considered.

Burial of the Dead.—This is the method of disposal which is adopted by all civilised races. It is a question whether it is the best or not. In a purely sanitary point of view, certainly not; but there are other considerations—such as popular prejudice, the detection of crime, old-established custom, &c.—which ought to have weight. Other methods of putting the dead out of our sight have been proposed, and have met with more favour than might have been anticipated—*e.g.*, cremation (see *Cremation*) and deep-sea burial. The latter is certainly impracticable for inland places, nor is it in harmony with the feelings of the present day.

Mr. Seymour Haden would abolish coffins altogether, and substitute wickerwork filled with flowers. The proposal is new, and has been recommended with great force, but we fear the result might be something like that described in the following extract:—

"In the course of walking round this city we had occasion to pass through one of the cemeteries, but the horrible effluvia from the graves obliged us to alter our course. *The Turks do not make use of coffins.* Having dressed the dead, they place over the body a few thin pieces of wood, and then cover it with earth. Heavy rain has often the effect of opening passages down to the putrefying mass, occasioning that pernicious and terrible smell which we experienced, and to which may in some degree be attributed the frequency of pestilential diseases in Turkey."—(JOHN GALT, Voyages and Travels, &c., p. 236.)

The present method of burial may be modified so as to remove many of the objections raised by those who advocate cremation. We draw out a scheme of disposal of the dead guided by the following principles: 1. Quick burial, in such a manner that the body is preserved for a certain limited time. 2. That there shall be no nuisance nor danger of infection to the living. 3. That there shall be no danger of a cemetery becoming injurious to health.

Every body directly after death should be covered with sawdust, to which should be added either tan, carbolic acid, or chloride of lime—charcoal would be a good application, if it were not for its colour, which to some people would be most objectionable; the sawdust not only absorbs obnoxious gases, but also prevents the escape from a badly-joined coffin of putrescent fluids. We cannot but think that it is safest to treat all corpses as if they were infectious, and to have a very speedy burial; the time we would fix would be at the end of three days, but in time of virulent epidemics as quickly as it can possibly be done, certainly within forty-eight hours.

The material that the coffin is made of is, in a sanitary point of view, of great importance; the grand and essential point is that it should be impervious to air, and sufficiently strong to bear for a considerable time a good weight of earth.

One of the best and cheapest coffins is that described by Mr. Baker in his evidence before the Sanitary Commission. The body is first of all placed in a common shell, and then the shell in a coffin; the interval between the two is filled with boiling pitch, and then the outside coffin is coated over with pitch, so that it is as perfectly air-tight as a leaden shell. If required, a glass can be put over the face in both shell and coffin, so that a jury, for example, could inspect the body.

In the Exhibition of 1856, at Paris, an American artisan exhibited a coffin of glass. This material can only be looked upon as a curiosity. Leaden coffins, though excellent and durable, are too expensive for general use. It is not so, however, with a patent American metallic coffin, which is cheap, strong, and air-tight. With infectious corpses it is certain that no ordinary wooden coffin (unless pitched) should be used.

The time of burial is an important matter. Why should we not convey our friends to the last resting-place at night? The advantages of this alteration are real and solid, at all events, in large towns. There is no one who knows London well, but must have been struck by the numerous processions of funerals pouring along the roads leading to the great cemeteries, and obstructing the traffic. Surely we are reminded sufficiently of death without requiring the visual perception of those hideous mummeries against which the late Charles Dickens lifted his voice! Burial at night would also have the real advantage, in times of epidemic, of lessening the probability of spreading the disease, as fewer people would be about; and it would strike a blow to that foolish and often repulsive pomp of woe which some people love to indulge in, even to the detriment of the living.

We would strongly advocate an excessive depth for the grave, that only one body should be buried in it, and that there should be sufficient space between grave and grave.

The depth of the grave varies in different countries. In Austria the depth adopted is 6 ft. 2 in.; in Hesse Darmstadt, from 5 ft. 7 in. to 6 ft. 6 in.; Munich, 6 ft. 7 in.; Stuttgard, 6 ft. 6 in.; Russia, from 6 ft. to 10 ft. In our own country the practice is generally to make the depth about 6 ft., but then coffins may be placed one on the other, so that, as an actual fact, they often very closely approach the surface. The regulations followed at Stuttgard are much to be commended. In the cemeteries there, the space allotted for each grave is an oblong piece of land 10 ft. in length and 5 ft. broad. In France the graves vary in depth from 1½ metres (4·921 ft.) to 2 metres (6·561 ft.) They are 8 decimeters (2·264 ft.) in breadth, and distant the one from the other from 3 to 4 decimeters (11·911 in. to 1·132 ft.)

There is some practical difficulty in laying down a universal law for the depth of graves, on account of difference of soil, height of the subsoil water, &c. Still we would strongly recommend, where possible, a minimum depth of 8 ft., and that in the selection of cemeteries it should be made essential that neither rock nor water should be found within 10 or 12 ft. of the surface; or if the soil is damp, that it should be deeply drained. The lower part of the grave should in most cases be well lined with clay. It should never be lost sight of that, in the interests of justice, we should strive to keep every body from decay for at least a month or so, and it is pretty certain that the looser the soil the more air it will contain, and that, all other things being equal, the quicker decomposition will set in. We would, therefore, have a supply of clay in every churchyard and cemetery where the soil is not clayey, and the coffin should rest on and be covered with it. The length and breadth of each burial allotment for adults should be 8 ft. by 4 ft.; for children, proportionately less. There should only be one body buried in the same grave for many years, even in the most preservative soils. The size, then, of a new burial-ground or cemetery for a town or district should be large enough to contain the bodies (calculated from the average death-rate) of those that may be expected to die in many years to come; it should then be divided into two halves, and one half should be used until full before the other half is utilised.

In order to utilise cemeteries, it must be presumed, first of all, that no brick graves nor family vaults should be allowed; that the bodies themselves should be at the depth already stated; that they should not be utilised until seventy or eighty years after the *last burial;* and that two or three years' notice of the reversion of the cemetery to secular uses should be given, and permission accorded to any relatives to remove the dust of their ancestors, if they desire it.

Popular prejudices are at present against any utilisation of cemeteries, on account of desecration—a very proper feeling when the death is recent; but it is idle to talk of desecrating human dust centuries old—a mere matter of sentiment, followed so little in practice that hardly a king of England has been allowed to rest in peace. Every time a church is repaired, or an old graveyard opened, this desecration is committed far more wantonly, and in a more repulsive manner, than could ever occur in the method suggested.

Cremation (the burning of the dead).—This very ancient method of disposing of the dead has, in modern times, been to a certain extent revived. In England a society has been formed to introduce the practice, and in Germany cremation has also made some progress. Different experiments prove very conclusively, that a body may be burnt without odour and at a comparatively small cost. Sir Henry Thompson consumed a body, weighing 227 lbs., in a furnace invented by Dr. W. Siemens, in fifty-five minutes: the ashes weighed about 5 lbs. The essential feature of this furnace is that it contains a cylindrical vessel 7 ft. long by 6 ft. in diameter. This is heated white hot (2000° F.), and then the body is introduced, the gases emitted going over a large surface of strongly-heated firebricks. Sir H. Thompson suggests the following sketch of cremation, if universally adopted: "When death occurs, and the necessary certificate has been given,* the body is placed in a light wood shell, then in a suitable outside receptacle preparatory to removal for religious rites or otherwise. After a proper time has elapsed, it is conveyed to the spot where cre-

* Sir H. Thompson very properly suggests that officers be appointed to examine and certify into all cases of death. They would hold a position similar to the *médecin vérificateur* of France.

mation is to be performed. There nothing need be seen by the last attendant or attendants than the placing of a shell within a small compartment, and the closing of the door upon it. It slides down into the heated chamber, and is left there an hour until the necessary changes have taken place. The ashes are then placed at the disposal of the attendants."—(Sir H. THOMPSON, Cremation, 1874.)

The serious, and almost insuperable objection, is the facility with which cremation would conceal certain crimes, such as poison, and render identity in other cases impossible. This difficulty is not got over by keeping (as has been proposed) the stomach in a jar, properly preserved, for a certain time, since it is well known that many alkaloids cannot be found in that organ, but must be discovered in the tissues.

Burial of the dead and *burial-grounds* are regulated by various statutes which local authorities have nothing to do with directly, with the exception that in a local government district, when the vestry resolves to appoint a burial board, the vestry may declare the local board to be the burial board of such parish; and the expenses of such burial board are to be defrayed out of a rate levied on such parish in the same manner as a general district rate.

If such parish has been declared a ward for the election of members of the local board, such members are to form the burial board for the parish.—(21 & 22 Vict. c. 90, s. 49.)

A sanitary authority may provide a proper place for the reception of dead bodies, as well as for those which are to undergo a *post mortem* examination. A sanitary authority may make arrangements for interment. An urban sanitary authority has the useful power of regulating these matters by bylaws. A sanitary authority, once constituted a burial board, has to carry out the Burial Acts, to repair the fence of a disused burial-ground, and generally to preserve and regulate all burial-grounds within its jurisdiction.—(24 & 25 Vict. c. 61, s. 21.)

When a burial-ground is dangerous to the health of persons living in its neighbourhood, or to the health of those frequenting the church, it may be closed, and a place of interment provided elsewhere. It may be useful in this place to note, that the common law casts upon the person under whose roof a death takes place, the obligation of providing burial. He may neither cast the body forth, nor carry it uncovered to the grave, but must give the corpse decent burial. This obligation not alone extends to private persons, but to public bodies also.

Justices may, on a certificate signed by a legally-qualified medical practitioner, order removal of a corpse to a mortuary in certain cases. *See* MORTUARY.

Interment within the walls or underneath any church, or other place of public worship, built in any *urban* district, since August 31, 1848, is forbidden under a penalty of £50.—(11 & 12 Vict. c. 63, s. 83.) *See* INFECTIOUS DISEASES, MORTUARIES.

Deadly Nightshade — *See* ATROPIA, HEMLOCK, &c.

Deaf Mutes—*See* BLINDNESS AND DEAF MUTISM.

Death, Registration of—*See* BIRTHS, DEATHS, AND SICKNESS RETURNS, &c.

Death, Returns of — *See* BIRTHS, DEATHS, AND SICKNESS RETURNS.

Deaths, Verification of—In Paris and large French towns there is a complete system of medical inspectors called *médecins vérificateurs*, whose business it is to visit each house where a death occurs, and ascertain that the person is really dead, and that there are no suspicious circumstances whatever connected with his or her decease. More than eighty qualified medical men are employed for this purpose in Paris.

In the rural districts of France this system is not in force. Two witnesses making a declaration to the civil officer that a death has taken place, is considered sufficient. The burial is not allowed to take place until at least twenty-four hours after this declaration. The *maire* is also supposed to assure himself, by actual inspection, that the person is dead, and that there are no suspicious circumstances about the death; but this is not always followed out in practice.

Decomposition, Animal—*See* PUTREFACTION.

Dengue—A peculiar febrile disease, the chief symptoms of which would almost agree with those of a mixture of scarlet fever and rheumatism. There is an eruption about the third or fourth day, and the course of disease is marked by pains in the limbs, glandular swellings, and frequent remissions.

It appears to be infectious, but it is not known as an epidemic disease in England, although a few isolated cases have occurred. It prevails from time to time in India, the West Indies, and was epidemic in America in 1826–28, and then disappeared for some time—at all events, until 1847. An epidemic in Virginia occurred in 1861.

For prevention, &c., *see* FEVER, SCARLET.

Dew-Point—*See* HYGROMETER.

M

Dextrine ($C_6H_{10}O_5$)—This is a soluble substance something like gum, formed by the action of dilute acids at the boiling temperature, and by infusion of malt at about 160° Fahr., on starch. It is also obtained by exposing potato starch and some of the other farinas to a heat of about 400°.

Dextrine is used in the adulteration of *sugar* and of *scammony*. *See* BREAD, SUGAR, &c.

Dhurra, Dhoora, or **Sorgho Grass** (*Sorghum*)—Although commonly called Indian millet, it belongs to a different tribe of grasses from the true millets. Like rice, it is largely cultivated in India, Algeria, the interior of Africa, and Egypt. The seeds here are mostly used for feeding birds, but in India they are ground small and made into cakes. This bread is said to have been issued to the English troops in the last Chinese expedition. It is described by Johnston as being equal in nutritive value to the average of our English wheats, but Letheby says that dhurra is little more nutritious than rice, for it contains on an average about 9 per cent. of nitrogenous matter, with 74 of starch, sugar, 2·6 fat, and 2·3 of mineral matter.

Dialysis — In practical chemistry, the method of separating substances by diffusion through a septum of gelatinous matter. Professor Graham adopted this process with advantage for the separation of poisons from organic matters. The method, however, is tedious, and only adapted for qualitative purposes. The metallic or vegetable alkaloidal poison is separated, for the most part, freer from contamination by animal matter than in the ordinary way. A circular band of gutta-percha, over which a piece of wetted parchment, paper, or bladder is strained, and this kept *in situ* by another ring (one of 4-inch diameter will suffice), completes the apparatus required. The contents of the stomach or the sliced organic matter being placed on the diaphragm, is covered with water acidulated with hydrochloric or acetic acid, and the vessel floated over a body of distilled water contained in an outer glass dish or pan, and left for twenty-four or forty-eight hours. It will then be necessary to evaporate the mixed diffusates to dryness, and examine the residue in the usual way for poison. If metallic, by digestion in hydrochloric acid; and if alkaloidal, by precipitation by an alkali; and then resolution by means of ether, chloroform, &c. It will be necessary, in the case of insoluble metallic compounds with albuminoid matter, to boil the organic matter in dilute hydrochloric acid, and let it cool before proceeding to dialyse. Aqueous or acid solutions only should be dialysed.

Diarrhœa is a great cause of infant mortality. The ordinary summer and autumnal diarrhœa appears to consist essentially of a catarrh of the intestines; so that just as in winter colds affecting the nose and bronchial tubes are frequent, so in summer the action is changed to the intestinal canal. The deaths from diarrhœa are, taking the average of several years, least in December, January, February, April, and May; greatest in July and August. Many diseases—such as cholera, dysentery, typhoid, &c.—begin with diarrhœa, and all epidemics of cholera have coincided with epidemics of diarrhœa.

The causes of non-specific diarrhœa appear to be extreme heat of weather, excessive use of fruit, foul and impure water, whether from organic impurities or fœtid gases, or from fæcal matter. Many diarrhœas from the latter are, however, probably specific—that is, dependent upon contagion. Diarrhœa among troops has arisen before now from drinking water strongly impregnated with purgative salts. In all cases of continued diarrhœa it is well to examine the drinking-water.

Prevention.—Disinfection of the dejecta, care in the selection of food, seeing that each person has a supply of uncontaminated water, and protection from the heat of the sun. *See* CHOLERA, DYSENTERY, TYPHOID FEVER.

Diastase—A peculiar azotised ferment termed *diastase* exists in all germinating seeds during the act of growth. It is probably merely albumen or gluten in a particular stage of decomposition. Malted barley is said to contain $\frac{1}{500}$ part of this substance, yet this small portion is quite sufficient to convert the starch of the malt into sugar during the operations of brewing.

Diastase may be prepared by the following method: A cold infusion of malt is heated to 153° F. (to coagulate in albumen); it is then allowed to cool, and alcohol added to the filtered liquid, when diastase is precipitated in the form of a tasteless white powder, which is freely soluble in water. Diastase has never been obtained in a state of purity, hence little is known concerning it.

Mialhe has named the nitrogenous substance ptyaline *animal diastase*, since it is a ferment which converts starch first into dextrine, and then into grape sugar, and is a substance somewhat of the nature of diastase.

Diatoms, Diatomaceæ, Brittleworts, are microscopic organisms found in water. Each diatom is composed of two symmetrical plates or valves. The typical form is rectangular or prismatic. The valves are marked variously with fine lines, dots, or striæ, and are of great microscopical interest. Each diatom is enclosed in a soft organic sarcode envelope. The diatoms are generally allowed to belong to the animal kingdom. They inhabit every kind of water—fresh, salt, and brackish—and their presence is not necessarily a mark of impurity.

Dietaries—It would appear from Dr. Letheby that a barely sustaining diet should contain about 3888 grains of carbon and 181 grains of nitrogen. Dr. Edward Smith has proposed the following averages as representing the daily diet of an adult man and woman during periods of idleness :—

	Carbon. grs.	Nitrogen. grs.
Adult man . . .	4300	200
Adult woman . . .	3900	180
Average adult . .	4100	190

Dr. Letheby, taking the mean of all the researches which have been made by eminent physiologists, gives the following as representing the amounts required daily by an adult man for idleness, for ordinary labour, and for active labour :—

Daily diets for,—	Nitrogenous. oz.	Carbonaceous. oz.		Carbon. grs.	Nitrogen. grs.
Idleness	2·67	19·61	=	3816	180
Ordinary labour	4·56	29·24	=	5688	307
Active labour	5·81	34·97	=	6823	391

The amount of carbon and nitrogen actually excreted by adult men under different conditions of diet and exercise has been accurately determined by numerous experiments, and the results, summarised by Dr. Letheby in the following table, correspond very closely with those just given :—

During idleness, as determined—	Nitrogenous. oz.	Carbonaceous. oz.		Carbon.	Nitrogen grs.
By dietaries	2·67	19·61	=	3816	180
By excretions	2·78	21·60	=	4199	187
Average	2·73	20·60	=	4005	184
Routine work, as determined—					
By dietaries	4·56	29·24	=	5688	307
By excretions	4·39	23·63	=	4694	296
Average	4·48	26·44	=	5191	302

The following table, also taken from Letheby, shows the daily proportion of carbon and nitrogen in the food at different ages per poundweight of the body :—

	Carbon. grs.	Nitrogen. grs.
In infancy	69	6·78
At ten years of age . .	48	2·81
At sixteen years of age .	30	2·16
At adult life . . .	23	1·04
In middle age . . .	25	1·13

Moleschott gives the following table as showing the alimentary substances required daily for the support of an ordinary working man of average height and weight :—

Dry Food.	In oz. Avoir.	In Grains.	In Grammes.
Albuminous matter .	4·587	2006	130
Fatty matter . .	2·904	1296	84
Carbo-hydrates . .	14·250	6234	404
Salts	1·058	462	30
Total . . .	22·859	9998	648

PLAYFAIR'S DIETARIES.

Sustenance Diet.—The mean of certain prison dietaries, the diet of needlewomen in London, the common dietary for convalescents in the Edinburgh Infirmary, and the average diet during the cotton famine in Lancashire in 1862, gives a daily allowance of—

	oz.
Nitrogenous matter	2·33
Fat	0·84
Carbo-hydrates	11·69
Dynamic value,* 2453 foot-tons.	

Diet of Adult in full Health with moderate Exercise.—The mean of the dietaries of the English, French, Prussian, and Austrian soldiers during peace stands as follows :—

	oz
Nitrogenous matter	4·215
Fat	1·397
Carbo-hydrates	18·690
Mineral matter	0·714
Dynamic value, 4021 foot-tons.	

The dietaries of the Royal Engineers during peace are referred to by Dr. Playfair, as affording a representation of the quantity of food required by labouring men performing a fair day's work.

Dr. Playfair for twelve consecutive days carefully ascertained the amount of food consumed by 495 men belonging to different companies, and reduced it to its dietetic value. The mean of all the returns came out as follows :—

	oz.
Nitrogenous matter	5·08
Fat	2·19
Carbo-hydrates	22·22
Mineral matter	0·93
Dynamic value, 5232 foot-tons.	

Diet of active Labourers.—To represent this class Dr. Playfair has placed together the dietaries of soldiers engaged in the arduous duties of war—viz., those of the English during the Crimean and Kaffir wars, the French during the Crimean war, the Prussians during the Schleswig war, the Austrians during the Italian war, the Russians during the Crimean war, the Dutch during the Belgian war, and those of the Federal and Confederate armies

* *See* DYNAMIC VALUE OF FOOD.

in the American war of 1865. The mean of the above gives the following quantities :—

	oz.
Nitrogenous matter	5·41
Fat	2·41
Carbo-hydrates	17·92
Mineral matter	0·68
Dynamic value, 4418 foot-tons.	

We shall now give some hospital, prison, lunatic asylum, &c., dietaries.

Hospital Dietaries.

Guy's Hospital.

Full or Extra Diet.—14 oz. of bread; 1 pint of porter for males, ½ pint of porter for females; 6 oz. dressed meat, roasted and boiled alternately, with 8 oz. of potatoes; ½ lb. rice-pudding three times a week; ½ pint of mutton-broth in addition on days when boiled meat is given (four times weekly); or occasionally 1 pint of strong vegetable-soup, with meat and rice-pudding twice a week; 1 oz. of butter each day; porridge, gruel, and barley-water as required.

Middle or Ordinary Diet.—12 oz. of bread; ½ pint of porter; 4 oz. of dressed meat, roasted and boiled alternately, with 8 oz. of potatoes; ½ lb. rice-pudding three times a week; ½ pint mutton-broth in addition on days when boiled meat is given; or occasionally 1 pint of strong vegetable-soup, with meat and rice-pudding twice a week; with the full-diet allowance of bread; 1 oz. of butter each day; porridge, gruel, and barley-water as required.

Milk or Pudding Diet.—12 oz. of bread; 2 pints of milk, or 1 pint of milk with rice, sago, or arrowroot boiled or made into light pudding; ½ pint of beef-tea when ordered; 1 oz. of butter; gruel and barley-water as required.

Low Diet.—10 oz. of bread; ½ pint of beef-tea; mutton-broth, rice, arrowroot, or sago, when specially ordered; ¾ oz. of butter; gruel and barley-water as required.

Tea, ¼ oz.; sugar, ¾ oz.; and milk, 2½ oz. daily, with all diets. Fish, chops, steaks, chicken, chicken-soup, eggs, and other extras are to be specially ordered by the medical attendant, and will be given with the low diet. Wines and spirits, if continued, must be mentioned each time the physician or surgeon attends.

King's College Hospital.

Meat Diet (Men).—Bread, 12 oz.; milk, ¾ pint; meat, 4 oz., cooked; potatoes, ½ lb.; porter or ale, 1 pint; rice or other pudding, ½ lb.

Meat Diet (Women).—Bread, 8 oz.; milk, ¾ pint; meat, 4 oz., cooked; potatoes, ½ lb.; porter or ale, ½ pint; rice or other pudding, ½ lb.

Milk Diet (Men).—Bread, 8 oz.; milk, 1½ pint; eggs, 2; rice or other pudding.

Milk Diet (Women).—Bread, 6 oz.; milk, 1½ pint; eggs, 2; rice or other pudding, ½ lb.

Children under ten years of age same as milk diet for women.

Beef-tea (on milk diet only), wine, and spirits may be ordered by the resident medical officers. Fish or mince may be added to milk diet, such addition to be authorised by the signature of the visiting physician or surgeon, to be renewed once in a week at least.

Dietary of Colney Hatch Lunatic Asylum.

Males.

Breakfast.—6 oz. bread; ½ oz. butter; 1 pint of cocoa.

Dinner.—Monday—9 oz. of pie, containing 4 oz. of meat; 9 oz. of vegetables; ½ pint of beer. Tuesday, Thursday, Friday, and Sunday—5 oz. of cooked meat; 9 oz. of vegetables; 4 oz. of bread; ½ pint of beer. Wednesday—1 pint of stew and 6 oz. of bread, as on Saturday; or 8 oz. of fish, 9 oz. of vegetables, and 4 oz. of bread; ½ pint of beer with either dinner. Saturday—1 pint of Irish stew, made with 3 oz. of meat and the liquor from meat of previous day; 12 oz. of potatoes and other vegetables, and 1 oz. of dumpling; 6 oz. of bread; ½ pint of beer.

Tea or Supper.—6 oz. of bread; 2 oz. of cheese, or ½ oz. of butter; ½ pint of beer, or 1 pint of tea.

Females.

Breakfast.—5 oz. of bread and ½ oz. of butter; 1 pint of tea.

Dinner.—Monday—9 oz. of pie, containing 4 oz. of meat; 8 oz. of vegetables; ½ pint of beer. Tuesday, Thursday, Friday, and Sunday—4 oz. of cooked meat; 8 oz. of vegetables; 4 oz. of bread; ½ pint of beer. Wednesday—1 pint of soup, made with 4 oz. of meat and the liquor from meat of the previous day, peas, rice, Scotch barley, herbs; and 5 oz. of bread; or 8 oz. of fish, 8 oz. of vegetables, and 4 oz. of bread; or 12 oz. of currant-dumpling; ½ pint of beer with either dinner. Saturday—1 pint of Irish stew, made with 3 oz. of meat and the liquor from meat of previous day; 12 oz. of potatoes and other vegetables, and 1 oz. of dumpling; 5 oz. of bread; ½ pint of beer.

Tea.—5 oz. of bread; ½ oz. of butter; 1 pint of tea.

DIETARIES OF ENGLISH CONVICT ESTABLISHMENTS.

TABLE I.—Hard-Labour Diet.

Daily period of labour—Summer, 10 hours 40 minutes; Winter, 8 hours 55 minutes.

Weekly Allowance.		Nitrogenous Matter.	Carbo-Hydrates.	Fat.	Mineral Matter.	Total Solid Matter.
	oz.	oz.	oz.	oz.	oz.	oz.
Cocoa . . .	3·500	0·560	1·540	1·295	0·105	3·500
Oatmeal . . .	14·000	1·764	8·932	0·784	0·420	11·900
Milk	14·000	0·574	0·728	0·546	0·112	1·960
Molasses . . .	7·000	...	5·390	...	...	5·390
Salt	3·500	...	...	...	3·500	3·500
Barley . . .	2·000	0·126	1·486	0·048	0·040	1·700
Bread . . .	168·000	13·608	85·680	2·688	3·864	105·840
Cheese . . .	4·000	1·340	...	0·972	0·216	2·528
Flour . . .	8·625	0·931	6·081	0·172	0·147	7·331
Meat (cooked, no bone) . .	15·000	4·140	...	2·318	0·442	6·900
Shins (made into soup)	16·000	3·376	...	0·640	4·144	8·160
Suet	1·500	...	...	1·244	0·030	1·274
Carrots . . .	2·000	0·026	0·290	0·004	0·020	0·340
Onions . . .	3·500	0·042	0·252	...	0·021	0·315
Turnips . . .	2·000	0·024	0·144	...	0·012	0·180
Potatoes . . .	96·000	2·016	21·120	0·192	0·672	24·000
Total weekly allowance .		28·527	131·643	10·903	13·745	184·818

TABLE II.—Light-Labour Diet. Labour consists of Oakum-picking, &c.

Weekly Allowance.		Nitrogenous Matter.	Carbo-Hydrates.	Fat.	Mineral Matter.	Total Solid Matter.
	oz.	oz.	oz.	oz.	oz.	oz.
Cocoa . . .	3·500	0·560	1·540	1·295	0·105	3·500
Oatmeal . . .	14·000	1·764	8·932	0·784	0·420	11·900
Milk	14·000	0·574	0·728	0·546	0·112	1·960
Molasses . . .	7·000	...	5·390	...	...	5·390
Salt	3·500	...	...	...	3·500	3·500
Barley . . .	2·000	0·126	1·486	0·048	0·040	1·700
Bread . . .	145·000	11·745	73·950	2·320	3·335	91·350
Cheese . . .	4·000	1·340	...	0·972	0·216	2·528
Flour . . .	4·625	0·499	3·261	0·092	0·079	3·931
Meat (cooked, no bone or gravy)	12·000	3·312	...	1·854	0·354	5·520
Shins (made into soup)	12·000	2·532	...	0·480	3·108	6·120
Suet	0·750	...	...	0·622	0·015	0·637
Carrots . . .	2·000	0·026	0·290	0·004	0·020	0·340
Onions . . .	3·500	0·042	0·252	...	0·021	0·315
Turnips . . .	2·000	0·024	0·144	...	0·012	0·180
Potatoes . . .	96·000	2·016	21·120	0·192	0·672	24·000
Total weekly allowance .		24·560	117.093	9·209	12·009	162·871

TABLE III.—INDUSTRIAL-EMPLOYMENT DIET.

Employment as Tailors, Shoemakers, Weavers, &c.

Weekly Allowance.		Nitro-genous Matter.	Carbo-Hydrates.	Fat.	Mineral Matter.	Total Solid Matter.
	oz.	oz.	oz.	oz.	oz.	oz.
Cocoa	3·500	0·560	1·540	1·295	0·105	3·500
Oatmeal	14·000	1·764	8·932	0·784	0·420	11·900
Milk	28·000	1·148	1·456	1·092	0·224	3·920
Molasses	7·000	...	5·390	...	...	5·390
Salt	3·500	...	...	...	3·500	3·500
Barley	1·000	0·063	0·743	0·024	0·020	0·850
Bread	148·000	11·988	75·480	2·368	3·404	93·240
Cheese	4·000	1·340	...	0·972	0·216	2·528
Flour	8·625	0·931	6·081	0·172	0·147	7·331
Meat (cooked, no bone or gravy)	16·000	4·416	...	2·472	0·472	7·360
Shins (made into soup)	8·000	1·688	...	0·320	2·072	4·080
Suet	1·500	...	...	1·244	0·030	1·274
Carrots	1·000	0·013	0·145	0·002	0·010	0·170
Onions	3·000	0·036	0·216	...	0·018	0·270
Turnips	1·000	0·012	0·072	...	0·006	0·090
Potatoes	96·000	2·016	21·120	0·192	0·672	24·000
Total weekly allowance .		25·975	121·175	10·937	11·316	169·403

TABLE IV.—PENAL DIET.—For offenders against the prison laws, may be continued for three months. Also used every fourth day in the place of punishment diet, where punishment diet is ordered for more than three days:—

Daily Allowance.		Nitro-genous Matter.	Carbo-Hydrates.	Fat.	Mineral Matter.	Total Solid Matter.
	oz.	oz.	oz.	oz.	oz.	oz.
Bread	20·000	1·620	10·200	0·320	0·460	12·600
Oatmeal	8·000	1·008	5·104	0·448	0·240	6·800
Milk	20·000	0·820	1·040	0·780	0·160	2·800
Potatoes	16·000	0·336	3·520	0·032	0·112	4·000
Total daily allowance .		3·784	19·864	1·580	0·972	26·200

TABLE V.—PUNISHMENT DIET.—Bread-and-Water Diet.

Daily Allowance.		Nitro-genous Matter.	Carbo-Hydrates.	Fat.	Mineral Matter.	Total Solid Matter.
	oz.	oz.	oz.	oz.	oz.	oz.
Bread	16·000	1·296	8·160	0·256	0·368	10·080

Or representing the nutritive value of these diets in the same manner as adopted by Playfair, they come out as follows :—

Hard-Labour Diet per Diem.

	Ounces.
Nitrogenous matter	4·075
Fat	1·557
Carbo-hydrates	18·806
Mineral matter	1·963

Dynamic value, 4072 foot-tons.

Light-Labour Diet per Diem.

	Ounces.
Nitrogenous matter	3·508
Fat	1·315
Carbo-hydrates	16·727
Mineral matter	1·715

Dynamic value, 3577 foot-tons.

Industrial-Employment Diet per Diem.

	Ounces.
Nitrogenous matter	3·710
Fat	1·562
Carbo-hydrates	17·310
Mineral matter	1·616

Dynamic value, 3787 foot-tons.

Penal Diet per Diem.

	Ounces.
Nitrogenous matter	3·784
Fat	1·580
Carbo-hydrates	19·864
Mineral matter	0·972

Dynamic value, 4193 foot-tons.

Punishment Diet per Diem.

	Ounces.
Nitrogenous matter	1·296
Fat	0·256
Carbo-hydrates	8·160
Mineral matter	0·368

Dynamic value, 1541 foot-tons.

It will be seen that the hard-labour diet very closely conforms with the representative diet for full health and moderate exercise as given by Dr. Playfair, and it is considerably under that, especially in nitrogenous matter, of active labourers. The punishment diet would not long support life.

Dr. J. B. Thompson, resident surgeon to the General Prison for Scotland, writing in the "Medical Times and Gazette," vol. i., 1868, after ten years' observation, speaks strongly in favour of a diet into which meat enters very sparingly, and which contained instead a moderate amount of milk. The dietary in the General Prison for Scotland, for all adult male prisoners under sentence of nine and not exceeding twenty-four months, consists of bread, oatmeal, barley, 1 oz. of meat per diem made into soup with succulent vegetables, and 20 oz. of skimmed or butter milk. Fish once a week is substituted for the soup. The health of the prisoners had been uniformly good, and 88 per cent. had been found to have gained or maintained their weight.

Soldiers' Diet.—Dr. Parkes represents the nutritive value of the English soldier's food when on home service to be as follows :—

	Ounces.
Nitrogenous matter . . .	3·86
Fat	1·30
Carbo-hydrates	17·35
Mineral matter	0·808

Dynamic value, 3726 foot-tons.

Dr. Playfair calculates the nutritive value of the English soldier's diet as being somewhat higher than this :—

	Ounces.
Nitrogenous matter . . .	4·250
Fat	1·635
Carbo-hydrates	18·541
Mineral matter	0·789

Dynamic value, 4099 foot-tons.

According to the same authority, the nutritive value of the English sailor's fresh-meat diet stands as follows :—

	Ounces.
Nitrogenous matter . . .	5·00
Fat	2·57
Carbo-hydrates	14·39

Dynamic value, 3911 foot-tons.

Dr. de Chaumont complains that the dietary of the soldier during war is insufficient for his wants, it being, he says, deficient in albuminates, very deficient in fats, rather deficient in salts, and containing starches in excess.

He proposes that, instead of the scale at present used, the following should be substituted :—

	Ounces.
Meat, 1 lb., less bone . . .	12·8
Bread	20·0
Potatoes	16·0
Vegetables, as carrots, &c. . .	4·0
Peas or beans	3·0
Cheese	2·0
Bacon, fat, oil, or butter . . .	2·0
Sugar	2·0
Salt	0·5
Vinegar	2·0
Condiments, as required.	
Tea	0·5
Or coffee or cocoa	2·0
Beer	20·0
Or wine, red	10·0

This would give—

	Grains.
Nitrogen	375 to 390
Carbon, exclusive of alcohol .	5300 to 5930
Salts	780

The two following tables—one from Dr. Edward Smith's work, and the other taken from Dr. Playfair—showing the amount eaten by people in different employments, will prove of interest :—

DR. E. SMITH'S TABLE OF WEEKLY DIETARIES OF LOW-FED OPERATIVES—Calculated as Adults.

Class of Labourer.	Bread-Stuff.	Potatoes.	Sugars.	Fats.	Meat.	Milk.	Cheese	Tea.	Containing	
									Carbon.	Nitrogen.
	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	grs.	grs.
Needlewomen, London .	124·0	40·0	7·3	4·5	16·3	7·0	0·5	1·3	22,900	950
Silk-weavers, Coventry .	166·5	33·7	8·5	3·6	5·3	11·6	1·0	0·3	27,028	1104
Silk-weavers, London .	158·4	43·8	8·8	5·5	11·9	4·3	0·3	0·6	48,288	1165
Silk-weavers, Macclesfield	138·8	26·6	6·3	3·4	3·2	41·9	0·9	0·3	27,346	1177
Kid-glovers, Yeovil . .	140·0	84·0	4·3	7·1	18·2	18·3	10·0	0·9	28,623	1213
Cotton-spinners, Lancash.	161·8	22·6	14·0	3·1	5·0	11·8	0·7	0·7	29,214	1295
Hose-weavers, Derbyshire	190·4	64·0	11·0	3·9	11·9	25·0	2·2	0·4	33,537	1316
Shoemakers, Coventry .	179·8	56·0	10·0	5·8	15·8	18·0	3·3	0·8	31,700	1332
Farm-labourer, England .	196·0	96·0	7·4	5·5	16·0	32·0	5·5	0·5	40,673	1594
Farm-labourer, Wales .	224·0	138·7	7·5	5·9	10·0	85·0	9·8	0·5	48,354	2031
Farm-labourer, Scotland.	204·0	204·0	5·8	4·0	10·3	124·8	2·5	0·7	48,980	2348
Farm-labourer, Ireland .	326·4	92·0	4·8	1·3	4·5	135·0	...	0·3	43,366	2434
Mean of all . .	184·2	78·1	8·0	4·5	10·7	42·9	3·1	0·6	34,167	1500
Average per day .	26·3	11·1	1·1	0·6	1·5	6·1	0·4	0·1	4,881	214

DAILY DIETARIES OF WELL-FED OPERATIVES (DR. PLAYFAIR).

Class of Labourer.	Flesh-Former.	Fats.	Starch and Sugar.	Containing		Containing	
				Carbonaceous.	Nitrogenous.	Carbon.	Nitrogen.
						grs.	grs.
Fully-fed tailors . . .	4·61	1·37	18·47	21 64	4·61	5136	325
Soldiers (in peace) . .	4·22	1·85	18·69	22·06	4·22	5246	297
Royal Engineers (work) .	5·08	2·91	22·22	29·38	5·08	6494	358
Soldiers (in war) . . .	5·41	2·41	17·92	23·48	5·41	5561	381
English sailor . . .	5·00	2·57	14·39	20·40	5·00	4834	252
French sailor . . .	5·74	1·32	23·60	26·70	5·74	6379	405
Hard-worked weavers . .	5·33	1·53	21·89	25·42	5·33	6020	375
English navvy (Crimea) .	5·73	3·27	13·21	21·06	5·73	5014	404
English navvy (railway) .	6·84	3·82	27·81	37·08	6·84	8295	482
Blacksmith	6·20	2·50	23·50	29·50	6·20	6864	437
Prize-fighter (training) . .	9·80	3·10	3·27	10·70	9·80	4366	690
	5·81	2·42	18·63	24·31	5·81	...	400
	3·04	0·64	21·18	22·78	3·04	...	214

The following is the diet taken with so much success by Mr. Banting. In twelve months he lost about 3½ stone, decreasing from a weight of 202 lbs. to 150 lbs.

Breakfast—5 or 6 oz. of either beef, mutton, kidneys, broiled fish, or cold meat of any kind except pork or veal; a large cup of tea or coffee, without milk or sugar; a little biscuit, or 1 oz. of dry toast: making together 6 oz. of solid and 9 oz. of liquid.

Dinner (2 P.M.)—5 or 6 oz. of any fish except salmon, herrings, or eels; any meat except pork and veal; any vegetable except potato, parsnip, beetroot, turnip, or carrot; 1 oz. of dry toast; fruit out of a pudding, not sweetened; any kind of poultry or game; and two or three glasses of good claret, sherry, or madeira—champagne, port, and beer are forbidden: making together 10 to 12 oz. solid and 10 liquid.

Tea (6 P.M.)—2 or 3 oz. cooked fruit, a rusk or two, and a cup of tea (no milk or sugar): making together 2 to 4 oz. solid and 9 liquid.

Supper (9 P.M.)—3 or 4 oz. of meat or fish similar to dinner, with a glass or two of claret or sherry-and-water: making together 4 oz. solid and 7 liquid.

Gin, whisky, brandy, may be taken, without sugar, as a nightcap, if required. *See* FOOD, DINNER, DYNAMIC VALUE, &c.

Digestibility of Animal Substances—The following table shows the times given by Dr. Beaumont for the chymification of different animal foods:—

Articles of Diet.	How Cooked.	Time of Chymification.	
		Hours.	Minutes.
Pig's feet, soused	Boiled	1	0
Tripe, soused .	...	1	0
Eggs, whipped .	Raw	1	30
Salmon-trout . .	Boiled	1	30
Venison-steak .	Broiled	1	30
Brains . . .	Boiled	1	45
Ox-liver . . .	Broiled	2	0
Cod-fish, cured .	Boiled	2	0
Eggs . . .	Roasted	2	15
Turkey . . .	Boiled	2	25
Gelatine . .	Boiled	2	30
Goose . . .	Roasted	2	30
Pig, sucking .	Roasted	2	30
Lamb . . .	Broiled	2	30
Chicken . .	Fricasseed	2	45
Beef . . .	Boiled	2	45
Beef . . .	Roasted	3	0
Mutton . . .	Boiled	3	0
Mutton . . .	Roasted	3	15
Oysters . . .	Stewed	3	30
Cheese . . .	Raw	3	30
Eggs . . .	H. boiled	3	30
Eggs . . .	Fried	3	30
Beef . . .	Fried	4	0
Fowls . . .	Boiled	4	0
Fowls . . .	Roasted	4	0
Ducks . . .	Roasted	4	0
Cartilage . .	Boiled	4	15
Pork . . .	Roasted	4	15
Tendon . . .	Boiled	5	30

Relative Digestibility of Vegetable Substances.

Articles of Diet.	How Cooked.	Time of Chymification.	
		Hours.	Minutes.
Rice . . .	...	1	0
Apples, sweet .	...	1	30
Sago . . .	...	1	45
Tapioca . . .	...	2	0
Barley . . .	...	2	0
Apples, sour . .	...	2	0
Cabbage with vinegar	...	2	0
Beans . . .	...	2	30
Sponge-cake . .	...	2	30
Parsnips . .	...	2	30
Potatoes . .	...	2	30
Potatoes . .	...	2	33
Apple-dumpling .	...	3	0
Indian-corn cake .	...	3	0
Indian-corn bread	...	3	15
Carrot . . .	...	3	15
Wheaten bread .	...	3	30
Potatoes . .	...	3	30
Turnips . . .	...	3	30
Beets . . .	...	3	45
Cabbage . .	...	4	0

Digitaline—Commercial digitaline is in the form of a white powder, which may be defined as a mixture of several of the active principles of the *Digitalis purpurea* or foxglove.

Schmiedeberg (Archiv. iii., Experiment. Pathol. und Pharmakol., 1874, iii. 16) has recently prepared a new well-defined crystallisable principle, *digitoxine*, from the leaves of *Digitalis purpurea*. Digitoxine, when pure, is in the form of colourless scales or needle-shaped crystals; its chemical formula is $C_{21}H_{33}O_7$. It is insoluble in water, benzole, and bisulphide of carbon; sparingly soluble in ether, more abundantly so in chloroform, and completely in alcohol. Digitoxine is a very powerful poison, acting on the heart and muscles of frogs.

From ordinary commercial digitaline, according to Schmiedeberg, no less than three principles may be obtained—viz., 1. Digitonine; 2. Digitaline; 3. Digitalein. Digitonine ($C_{31}H_{52}O_{17}$) is an amorphous body allied to saponine, and affords by decomposition various derivatives. Digitaline ($C_5H_8O_2$) is in the form of colourless soft grains. It may be obtained from commercial digitaline by digesting the latter in a mixture of one volume of ether and three of alcohol. Digitaline dissolves in cold sulphuric acid without change of colour, but on warming shows a yellowish tint, changing into a beautiful red if bromide of potassium be added. Digitalein can only be distinguished from digitaline by its solubility in water and absolute alcohol.

Diphtheria—An acute disease depending upon the infection of a specific poison. It usually runs its course in from eight to fourteen days. Dr. Jenner divides it into the following varieties:—

1. The mild form of diphtheria.
2. The inflammatory form.
3. The insidious form.
4. The nasal form.
5. The primary laryngeal form.
6. The asthenic form.

The essence and typical mark of the disease is a spreading inflammation of a mucous membrane, generally that of the pharynx and larynx, with the exudation of a peculiar whitish membrane, composed of lymph. It sometimes appears in the conjunctiva, and sometimes in a wound.

When the disease affects the larynx, it has been called croup by most English writers, who appear to have confounded under the same name spasmodic croup (a disease, in a great measure, dependent on spasm of the glottis) and diphtheria attacking the larynx.

The exudation of lymph in the throat, trachea, &c., it must be remembered, is not the disease itself, but only a *symptom*, hence local remedies are of little avail. It is a blood disease, and the whole system is profoundly affected.

Diphtheria is probably not confined to man. There are several cases, described under various names, recorded in veterinary works, which present great analogy to diphtheria. Thus, a contagious malady in horses is described by a Mr. J. Cooper, in the "Veterinarian," 1865, under the name of "Severe Attacks of Influenza." The horses showed, on a *post mortem* examination, great congestion of the pharynx, larynx, and bronchial tubes; and in the one horse there was observed a discharge of bloody serum from the nose, "accompanied with large flakes of fibrinous matter, which almost blocked up the nostrils."

Causes and History.—Infection may by analogy, and the evidence of its spread when fit subjects are submitted to the action of its contagion, be presumed to play the greatest, if not the only part in its propagation; but it does happen from time to time in places so isolated, and under such circumstances as to render the idea of infection difficult to hold. But so little is known of the exact nature of the contagion, that at present it is more a matter for inquiry than assertion.

Diphtheria seldom attacks large bodies of people in the present day, being often confined to one household or one street, and attacking children rather than adults. In past times, however, it prevailed very extensively.

Diphtheria was among the fatal epidemics of the sixteenth century. It broke out in Holland in 1517, and spread from thence into Switzerland, where in eight months it killed no less than 2000 people. It broke out again at Alkanet in October, 1557, and "destroyed 200 people in a few weeks, and laid more than 1000 people on their backs in a single day."—(GUY.) Its last appearance in England as an epidemic was in 1859, although sporadic cases and partial epidemics are not unfrequent.

In one of these epidemics, which broke out at Ilfracombe in 1873 and 1874, the health officer, Dr. Slade King, noticed the following facts:—

1. That the epidemic arose from a single case, in which no information was given to the sanitary officers, and no precautions taken.

2. That the disease in its earlier stages was confined to children, but later on it attacked adults, and cases of sore throat put on a diphtheritic character.

3. That nine-tenths of the cases were confined to the higher parts of the town, the lower escaping almost entirely.

4. That isolation, the removal of delicate children to a distance, and disinfection on a large scale, were the only means which arrested the spread of disease.

5. That it was propagated mainly through the private and public elementary schools.

The same epidemic extended into the author's district, and the fact of its preference for high, open, and airy situations was extremely marked; the places of selection being isolated houses on lofty hills, supplied with polluted water and surrounded with nuisances. It was, however, propagated also into houses where there were certainly no insanitary conditions whatever.

In Ilfracombe several marked cases of propagation by infected clothes were noticed. It was also observed by Dr. Slade King that contagion resided for a considerable time in the walls, &c., of a house. In one case three weeks elapsed before a room which had been cleansed but not disinfected was occupied, but notwithstanding this interval, the tenant's child became immediately affected.

Prevention of Spread.—Strict isolation of all suffering from the disease is the first thing to be done. If it should break out in a large school, the sick should be removed to some house or hospital at a *distance*. All expectorated matters and excreta should be thoroughly disinfected with carbolic acid, sulphate of iron, or some other powerful agent. If the sanitary authority possess, as they should possess, an hospital, the cases should be promptly removed there. During the epidemic, or when the disease is in the neighbourhood, a sanitary authority should be particularly active, and inquire strictly into the quality of the water-supply, and should watch the schools, for it is essentially a disease of childhood. Its accession is in some cases very rapid, and through inadvertence, a diphtheritic child, or a healthy child from an infected house, may propagate the disease in one single afternoon to all the school-children it comes in contact with.

On the termination of the disease, the walls of the patient's house, &c., should be thoroughly disinfected. If a case should end fatally, it must be remembered that the corpse is infectious, and due precautions taken. *See* DISINFECTION, &c.

Disease, Geographical Distribution of—The map illustrating this article gives a good general idea of the geographical distribution of disease. The main factor causing diversity of ailments in different countries would appear to be *temperature;* but soil, humidity, prevalent winds, habits, and race also exert some influence. The map is divided into three zones—viz., the torrid, the sub-torrid and temperate, and the sub-temperate and Arctic zone—of disease.

In the torrid zone, yellow fever, dysentery, diarrhœa, malignant cholera, hepatic affections, and malarious fevers are found.

The sub-torrid and temperate zone is characterised by great diversity of diseases, and as in summer and winter the temperate

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zones embrace the extremes of temperature of the torrid and frigid zone, it has, especially towards its northern and southern limits, representatives of the types of disease prevailing in both those realms. The mixed classes of disease are, however, especially prevalent. Of fevers, typhus and typhoid fever are found between the parallels of 44° and 60° in Western Europe, and smallpox prevails where vaccination is neglected. Over the whole of this zone rheumatism and consumption are unequally distributed, both diseases being influenced in a marked degree by wetness or dryness of subsoil.

The northern zone is especially characterised by influenza, scurvy, erysipelas, diseases of the skin, constitutional and catarrhal affections. *See* MALARIA, CLIMATE, METEOROLOGY, &c.

Disinfectants are those substances which are employed under the belief that they purify the air from noxious matters, or disinfect the ground, the water, or other substances from odours or hurtful organic substances. All antiseptics are to a certain extent disinfectant as well. The burning of bedding, clothes, bodies, &c., may also fairly come under the above head. When the object is to destroy contagion, it is a disinfection, a purifying by fire.

Disinfectants may be, for the purpose of convenience, divided into—

1. *Volatile, in the Form of Gas or Vapour.*

1. Substances which, like the halogens, appear to form substitution compounds, *e.g.*—

Chlorine.
Bromine.
Iodine.

2. Substances which probably combine chemically, and thus destroy contagion:—

Sulphurous acid.
Nitrous acid.
Fumes of other acids.

3. Oxidising substances, such as—

Pure air.
Oxygen.
Ozone.

4. The volatile oils, &c. Feeble disinfectants, supposed, however, to oxidise:—

Camphor.
Oil of hops.
,, rue.
,, rosemary.
,, chamomile.

2. *Solid or Liquid Disinfectants.*

1. The chlorides of different metals, earths, and bases:—

Chlorides of the alkalies.
,, iron.
,, copper.
,, manganese.
,, zinc.
,, aluminium.
,, lime.
,, mercury.

And, in fact, all chlorides which are soluble.

2. All soluble sulphates, especially sulphates of iron and aluminum.

3. All soluble sulphites.

4. Some acetates, as acetate of iron.

5. Some nitrates, such as the nitrates of potash and soda.

6. Certain agents which appear to arrest putrefaction or condense certain gases, &c., without either destruction or oxidation:—

Carbolic acid.
Tar acids.
Charcoal.
Great cold.
Heat sufficient to dry organic substances, but not to char them.

7. Preservative liquids and solutions. Many of these act by coagulating the albumen of organised bodies. Antiseptics—

Alcohol.
Solutions of corrosive sublimate.
,, common salt.
,, saltpetre.

8. Destructive agents. Not true disinfectants; they act not by disinfection, but by destruction:—

A dry heat of 200° to 400° F.
The strong undiluted acids and alkalies.

9. Agents which act in many ways—partly by condensing gases, partly by absorbing moisture, and partly by a peculiar action on organic matter analogous to tanning:—

Dry earths.
Clays.
The natural and artificial compounds of aluminum.

See DISINFECTION.

Disinfection—The air, the walls of a room, sewers, &c., are said to be infected when from their odour, or from the circumstance of contagious disease having existed in a certain place, it may be fairly inferred that injurious emanations or noxious matters remain there. The different operations to destroy or change these matters come under the heading disinfection.

Some of the principles which require disinfection are definite chemical products, such as sulphuretted hydrogen; others are ill-defined compound bodies. Many of the bad odours from drains, &c., are probably compound stinking ammonias; others are nitrogenised bodies, dead, but in a state of change; and others, again, are living, growing cells: some, like the contagion of smallpox, little bits of pus, dry and hard without, soft within; and others are probably soft, easily destructible bodies. Some contagions are supposed to be gaseous and volatile; others are heavy, and creep along the ground; so that it is evident there never will be any one disinfectant that will be useful, like a quack pill, for every kind of contagion. We have many influences acting in various ways to contend against, which must be met by defences as various. The matters presented for disinfection are—

The air.

Habitations, walls, floors, and ceilings.

Streets, courts, and other open-air places.

Sheds.

The earth itself.

Collections of stagnant water.

Cesspools.

Sewers, drains, water-closets, and wherever there is human excreta.

The excreta of man and animals.

Clothes.

The bodies, living or dead, of man and animals.

Let us first premise that cleanliness is the greatest and most essential disinfectant; that it would be a retrograde sanitary step to allow filth to collect in streets, houses, or elsewhere, on the plea that they can be disinfected. Prompt daily removal of all refuse matters to places where they will serve for the purposes of manure or other uses; frequent cleansing with water of the habitations of men, and the sheds and buildings of domestic animals; the establishment of baths, and the daily use of water and soap to the entire body of man;—these will always be the first sanitary requirements, to which disinfection may be added as an auxiliary of subordinate importance—except in cases of contagious disease, when it is of almost equal value with cleanliness, as from a neglect of disinfection, even with scrupulously clean people, disease will spread.

The Air, Disinfection of.—Some writers imagine that it is impossible to deal with the air, and that it would be about as sensible to attempt to disinfect the sea as to cause the destruction of germs or deleterious vapours in the ocean of air (so to speak), at the bottom of which we live. But to be consistent, they would have to deny that the air can be infected; and as there is no doubt about this, theory would also argue that it could be purified—and indeed the experience of the acid fumigations of Guyton Morveau, first brought out in 1773, and the chlorine fumigations, employed by Fourcroy in 1791, have proved in various epidemics that the air *can* be successfully purified. It is obvious that a disinfectant, to act upon the air, must be volatile to be universally efficacious, as it is seldom possible to draw the air of a room or apartment over a dry non-volatile substance like charcoal, or through a liquid.

The chief gases to be attacked by air-purifiers are no doubt ammonium sulphide and sulphuretted hydrogen, and these are easily destroyed by chlorine or sulphurous acids; but both sulphuretted hydrogen and sulphide of ammonium, if in small quantity, are not extremely deleterious. Many a chemist in his laboratory constantly breathes more or less of these gases without any very evident result. Whether the germs of disease are analogous to these bodies, or whether they may not resist agents more obstinately, is a question that as yet is not settled. Judging from analogy, it is computed that the same substances which will destroy odours having a definite chemical composition will also destroy those whose composition is unknown.

In all cases of air-disinfection, if the air of a house is to be purified, and if it is possible to remove all persons out of it, all windows and doors should be hermetically sealed up by list, rags, &c., in the cracks, and nitrous acid, chlorine, or other disinfectant, copiously disengaged in each room; and after many hours a thorough ventilation of the whole will be necessary.

What disinfectant is most valuable when smallpox is in the air, and what when typhus, or scarlet fever, or diphtheria? This question cannot be answered at present. Chlorine and nitrous acid fumes are perhaps to be looked upon with most favour; carbolic acid fumes are untrustworthy. For example, Dr. Parkes says: "It" (*i.e.*, carbolic acid) "rapidly arrests the growth of fungi, though it will not completely destroy them; for example, I put some fresh fæcal matter, free from urine, in a bottle, and drew air washed in strong sulphuric acid over it; fungi appeared rapidly on the fæcal matter. I then passed air impregnated with carbolic acid over the fungi; they became discoloured, brownish, and apparently died; but on again substituting washed air, they revived. The rapid destruction, and the as rapid recovery and regrowth, could be repeated many times, and showed that the carbolic acid air had withered without actually killing the fungi."—(PARKES, Manual of Practical Hygiène.) (*See* ACID, CARBOLIC.) So that whether clothes are wetted, or Dr. Langstaff's ingenious trough is used for saturating the air with this acid, it is yet a question whether it does not act temporarily, by preventing change—by freezing, as it were, the living cells, which are again thawed into life on the withdrawal of this agent. In all practical operations of disinfection it stands to reason, that chemical gases will act better in the presence of moisture than in the dry state. On this account Dr. W. Budd has proposed that when a room is to be disinfected, a little time before the actual disinfection, a tub of boiling water should be placed in it, so that the steam may wet the walls and the air, as he thinks there is a danger of gaseous disinfectants not destroying the germs if they are in a dry state. There is every reason to believe that this is just, sound, and practical, and it is to be strongly recommended.

Occasionally, as in the air supplied to the Houses of Parliament, the air is purified by passing through a fine spray of water, which is supposed to, and no doubt does, wash down with it and arrest organic matter and dust.

The disinfectants for infected air that are most likely to hold their ground are bromine, iodine, sulphur, nitrous and other acid fumes, and ozone.

Chlorine is a great destroyer of animal life, and also of odours. It appears to act on odours (which are, a great many of them, alkaline bodies analogous to ammonia, consisting of carbon, hydrogen, and nitrogen somewhat loosely connected together) by subtracting the hydrogen and replacing it by chlorine—that is, forming true substitution compounds. The vapour of iodine is also extremely valuable, and sulphur has been used from time immemorial.

Chlorine (or the two other halogens, bromine and iodine) may be used in the manner described under their respective headings. *See* CHLORINE, BROMINE, IODINE.

Acid fumes, such as nitrous acid (easily obtained by putting a bit of copper in nitric acid), are without doubt most powerful oxidising agents, and have been used with success in typhus fever and plague.

Acetic acid fumes, ammonia, volatile oils, camphor, assafœtida, musk, &c., are of very doubtful efficacy. Probably some act feebly as true disinfectants and oxidisers, but most substances of this kind merely disguise odours by substituting a more pleasant and powerful smell for an unpleasant one.

Disinfection of Walls, Houses, Streets, &c.—The walls and ceilings of a house are best dealt with by whitewashing with lime, and the floors by a thorough scrubbing. In some instances it will be necessary (as in cases where the floor consists of boards a few feet from the earth) to take the floor up, and to thoroughly cleanse the earth beneath.

Streets and courts, &c., should be swept frequently, the rubbish removed, and watered, as recommended by Cooper, with a solution of the waste chlorides of commerce.

Disinfection of the Earth.—Although earth is in itself a disinfectant, yet there are some grounds for believing that typhoid fever, cholera, and possibly some few other diseases, infect the soil itself, and even gain new force there. Under such circumstances, lime, tar, soot, &c., would be, according to theory, the best substances to mix with the earth, and it would be necessary to obtain the water-supply elsewhere.

Sewers, Drains, &c.—On the large scale, where the question of the cost of a disinfectant has to be considered, the waste chlorides of commerce answer every indication. But beside these, sulphate of iron, carbolic acid, chloralum, lime, clay, &c., are useful. All drains and sewers should be periodically disinfected with some cheap substance.

Collections of Stagnant Water and Cesspools must be treated on the same principle as the above, providing they cannot be done away with altogether.

The Excreta of Man and Animals, when used for the purposes of manure, should be mixed with earth, ashes, and lime. This will not injure the value of the sewage.

The Living Bodies of Men and Animals.—*See* FEVER, SCARLET, &c.

The Dead Bodies of Men and Animals.—When necessary to disinfect large quantities of animal matter, common salt, carbolic or cresylic acid, and chloride of lime are the best agents.

Disinfection of Clothes, Beds, &c.—These perhaps are the most important of all materials requiring disinfection; for although in nine cases out of ten destruction by fire is better than disinfection, still it is not always either possible or desirable to proceed in this way. All garments of linen, wool, &c., that will wash should be plunged at once into boiling water, and boiled for several hours with soda. There are probably few contagions which will bear a heat of 212° F. in the presence of soda. They should then be washed in the ordinary way. Other clothing should be baked in hot-chambers, the ticking removed from beds, mattresses, &c., and the feathers, wool, horse-hair, &c., baked in ovens or in hot-chambers. *See* DISINFECTING-CHAMBERS.

In all cases the quantity of disinfectant must be proportioned to the matter requiring disinfection. As a rule, a liquid disinfectant is better than a solid, and a solid than a gaseous, as applied to substances.

It is the duty of any local authority, on the receipt of the certificate of their medical officer of health, or of any other legally-qualified practitioner, to the effect that it would check or prevent infectious disease, if a house, or any articles likely to retain infection in the house, were cleansed and disinfected, to give the necessary notice in writing to the owner or occupier. If he fail to comply, he is liable to a penalty of not less than 1s. nor more than 10s. per day. The authority can perform the necessary cleansing and disinfecting, and recover the expense in a summary manner; but in case of poverty or other cause preventing the owner or occupier from properly carrying out the disinfection, the sanitary authority has power to do so, and may defray the expenses incurred. Any local authority may direct the destruction of infected bedding, clothing, or other articles, and may give compensation for the same. Any local authority may provide a proper place, with all necessary apparatus and attendance, for the disinfection of infected woollen articles, clothing, bedding, or other articles, and may cause any articles brought there to be disinfected free of charge.—(P. H., s. 120–122.)

Disinfecting-Chambers—Chambers for the express purpose of disinfection, so constructed as to be heated either directly by fire or by hot air or steam.

A baker's oven is a disinfecting-chamber on a small scale, and may be used as such.

On a large scale, the chambers at Liverpool may be taken as a model. They are arched, built of solid brickwork, with doors of wrought iron accurately fitting into cast-iron frames; the floor has double iron sliding gratings, and beneath it a hot-air passage. The dimensions are 5 feet wide, 7 feet from front to back, and 6½ high. The arch is also furnished with a valve, through which the air escapes into an exhaust-shaft. Two cast-iron smoke-flues pass from a cast-iron cockle along the hot-air passages into a chimney placed at the farther end. There are also arrangements for regulating the temperature; if necessary, a heat higher than 280° F. may be maintained. The clothes are suspended in the chamber at a temperature of 240° to 250° F.

Few fabrics will bear a dry temperature of more than 250° F. without injury, but it is necessary to reach that or nearly that degree.

The Berlin disinfecting-chambers are also of excellent construction. They are made of iron, and are heated by steam: one for mattresses, with a spiral steam-pipe in the centre of an iron case, which heats with steam compressed to two atmospheres; the other for general purposes, in the form of two iron cylinders, one within the other, the internal cylinder carrying the clothes, while the steam works under pressure between the two cylinders. Both were invented by Dr. Esse.

Dr. Ransom has devised a gas-stove, which answers well, and can be regulated.

Fraser's patent disinfecting apparatus is also found very efficient, it consists of—1. A brick oven or chamber, occupying a space of about 8 square feet, with doors in front. In the lower portion of this is a covered furnace, with flues capable of raising the air inside to the required temperature. 2. A closed truck or carriage, provided with shelves, racks, dampers, and doors. The clothes and bedding are collected in this carriage from the infected houses and conveyed to the chamber. The doors of the chamber are opened, and the carriage placed inside. The process of disinfection then takes place, sulphur or other fumes being used. When the process is completed, the carriage is taken back to the house, and the articles removed. The chief points are—The whole of the vapours given off during disinfection are, by a peculiar arrangement of flues, made to pass through the furnace, and thus consumed. The clothing is not removed from the carriage till returned to the owner. The carriage which conveys the clothing to the house, and returns the same, is disinfected on each occasion with the clothes, &c.

This apparatus will produce a temperature of 220° F. in the interior of a flock bed. It was much used by the Holborn District Board in the epidemic of smallpox of 1871.

There are many other forms, such as iron stoves, the floors of which are covered with sand, various arrangements of brick furnaces, &c.; but the principle in each is the same. No town of any size should be without a chamber for disinfection. The average cost of an efficient apparatus is £100.

Any local authority, as stated in article DISINFECTION, may provide disinfecting-chambers, &c. *See* DISINFECTION, DISINFECTANTS.

Disinfecting and Deodorising Compounds:—

Bayard's Disinfectant.—A powder of sulphate of iron, clay, lime, and coal-tar.

Bond's (Dr. Francis) Cupralum and Ferralum. *See* CUPRALUM, FERRALUM.

Burnett's (Sir William) Disinfecting Liquid consists of zinc dissolved in hydrochloric acid to saturation.

Collins' Disinfecting Powder.—Two parts of dry chloride of lime are mixed with one of burnt alum. To be used dry in saucers about a room, or moistened with water.

Condy's Disinfectant Fluid.—A solution of the alkaline manganates and permanganates.

Corne, M., took out a patent in 1858 for a mixture of lime and mineral tar.

Ellerman's Deodorising Fluid.—This consists chiefly of perchlorides and chlorides of iron and manganese.

Labarraque's Disinfecting Solution (*Liquor Sodæ chlormatæ*).—A solution of chlorinated soda.

Larnande's Antimephitic Liquor.—A solution of the sulphates of zinc and copper.

Ledoyen's Disinfecting Fluid.—A solution of nitrate of lead, 1 part in about 8 parts of water, or of litharge, 13½ oz., in nitric acid (sp. gr. 1·38), 12 oz., previously diluted with water, 6 pints (sp. gr. 1·40).

Sirel's Disinfecting Compounds.—1. A mixture of sulphate of lime, 53 lbs.; sulphate of iron, 40 lbs.; sulphate of zinc, 7 lbs.; and peat charcoal, 2 lbs.: made into balls. 2. Sulphate of iron, 20 parts; sulphate of zinc, 10 parts; tan or waste oak bark (in powder), 4 parts; tar and oil, of each 1 part, as before.

Precipitating and other deodorising processes, more especially applied to sewage, will be considered under SEWAGE.

Many of the compounds used above are extremely valuable. There is no one which will meet all requirements, but each has some special value for certain cases.

M. Labarraque brought his valuable liquid out in 1822, and obtained the prize of the "French Society for Encouraging National Industry" for its introduction; and in 1844 the same society awarded a prize to Henri Bayard.

Sirel's mixtures are powerful disinfectants of which it is impossible to speak too highly, and they have the advantage of cheapness.

Dr. Bond's disinfectants are as yet too new and too little known to speak definitively as to their value, but they promise well.

Distomata (fluke-like parasites)—The distomata are oviparous parasites of the higher vertebrata. The history of these hematode parasites is remarkable and instructive. Tracing the animal from the egg to maturity, the changes are briefly as follows: The egg is $\frac{1}{280}$ of an inch long, and $\frac{1}{210}$ of an inch wide (fig.

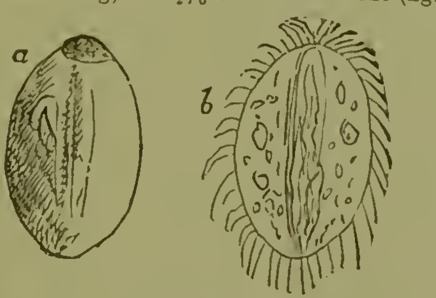


Fig. 24.

24). This egg opens by springing off a sort of hood, and gives vent to a ciliated embryo, which has, until comparatively recently, been considered one of the *infusoriæ*, and has been called opalina, but which is now recognised as the earliest embryonic form of a distoma. These opalinæ are not unfrequently found in sewage-water; in fact, impure water is necessary for the life of the opalina. When distoma eggs are hatched in pure water, the opalina soon dies. The opalina is not converted directly into a distoma, but has a progeny gradually formed from germ-cells within it, and consisting sometimes of one, but more frequently of a number of bodies, which, when they arrive at maturity, present each one an external form and internal structure, and locomotive powers entitling them to be considered as independent animals. These, again, are not yet distomata. A new progeny is formed within them, differing completely from the ultimate form; but now each individual of this series produces in its interior germ-cells, which develop into minute worms, having tails, and are extremely lively in water, exhibiting the structure of a true hematode. These cercariæ now either become enclosed, like a chrysalis in a pupa state, or they penetrate into the bodies of soft animals, become encysted and parasitic. It appears probable that the distomata enter the human intestinal canal as cercariæ, and then pass into the biliary passages. At Zurich two distomata were found in a woman's foot, and Frerichs remarks that it was probably whilst bathing that the cercariæ entered the sole. The eating of uncooked fish, whelks, shellfish, &c., is probably the most usual means by which man and animals become affected with "flukes."

The symptoms of distomata vary according to the seat of the parasite. In man they often occasion hæmaturia and dysentery. In the sheep the disease is known as "the rot," and as such kills thousands annually. The number of species affecting man are usually enumerated as nine—viz., the *Fasciola hepatica*, *Distoma crassum*, *D. lanceolatum*, *D. ophthalmobium*, *D. heterophyes*, *Bilharsia hæmatobia*, *Tetrastoma renale*, *Hexathrydium renarum*, and *H. pinguicola*.

District Fund Account—Every *urban* authority has to keep a separate account, called the "District Fund Account," for the purpose of defraying general and other expenses.—(P. H., s. 209.) *See* EXPENSES, RATES.

Districts, Sanitary—*See* SANITARY DISTRICTS.

Districts, United—*See* SANITARY DISTRICTS.

Ditches—An offensive ditch may be cleansed or filled up by the local authority, or notice may be given to abate the nuisance in the usual way.

If an offensive ditch lie near to or form the boundary of two or more districts, one of the local authorities may make application to a justice of the peace, who has power to summon the parties to appear before a court of summary jurisdiction; and the court, after hearing the parties, or *ex parte* if they should fail to appear, may make an order as to which authority shall execute the works, what persons shall execute it, the amount and proportion of the costs, by whom to be paid, and the time and mode of payment.—(P. H., s. 48.)

Dochmius Duodenalis (*Strongylus duodenalis*, *Sclerostoma duodenale*)—An entozoon, belonging to the class *Cœlelmintha*. Its habitat is the human duodenum, jejunum, and ileum. It is from $\frac{1}{3}$ to $\frac{1}{2}$ an inch in length, and its width about $\frac{1}{60}$ of an inch. Its head has a round apex, and it is provided with hooklets. It is common in Northern Italy and Egypt. From frequent and repeated hæmorrhages, caused by thousands of these parasites nestling in the mucous membrane of the intestines, anæmia and chlorosis are produced.

Drain—The distinction between drains and sewers is thus laid down in the Public Health Act, 1875:—

"'Drain' means any drain of and used for the drainage of one building only, or premises within the same curtilage, and made merely for the purpose of communicating therefrom with a cesspool or other like receptacle for drainage, or with a sewer into which the drainage of two or more buildings or premises occupied by different persons is conveyed.

"'Sewer' includes sewers and drains of every description, except drains to which the word 'drain' interpreted as aforesaid applies."

Drains and sewers are so closely connected together, that it will be more convenient to treat of both in one article. The reader is therefore referred to SEWERS.

Dripping—*See* FAT.

Dung—*See* MANURE.

Dust—The air of the plain, the mountain, the heath, the forest, the road, the city, the village, the house, the workshop, contains solid particles. These are mostly invisible except under certain circumstances, such as a sunbeam streaming into a room, or the ray of an electric light; then the air looks thick and impure, myriads of little particles vibrate, ascend and descend, and float hither and thither. A great portion of ordinary dust—the dust of a room, for instance—is organic. Tyndall has shown that the dust in the beam of an electric light may be consumed by fire, with the result first of a light blue smoke, and then almost perfect blackness; the beam has been purified. The exact nature of ordinary dust may be studied by examining that which settles on furniture. It is then seen to consist mainly of débris, bits of wood, hairs, fibres, crumbs of bread, formless matter, portions of insects, &c. Besides this, there can be no doubt that an incredible number of spores of fungi exist in air, for few moist organic substances can be left even in the still air of cupboards without in a few days mould or mildew making its appearance, and some of the spores have actually been seen. Pasteur's experiments long ago showed that air first submitted to a high temperature, and then admitted to organic fluids (recently boiled), is deprived of its germs, for the fluids remain fresh. Or again, if the air be not allowed to get at them except through cotton wool or other efficient filtering substance, moulds and the other putrefactive changes do not take place. These facts are strongly in favour of the view that the spores of the lower moulds must exist everywhere. The rain, too, shows that there is a large amount of organic matter floating in the air. Washed by a shower to earth, it may there be caught and estimated by the chemist in the form of ammonia and albuminoid ammonia.

How to obtain Dust, &c., for Examination.—The most simple way to obtain the emanations from a sick-room, for microscopical observation, is to suspend a common water-bottle from the ceiling filled with iced water. The moisture of the air condenses and brings with it organic matters. Or the moisture may be gathered which adheres to panes of glass in cold weather; or a bottle may be taken, containing some distilled water absolutely free from impurities of any kind, and filled several times with the air of the place. The water may then be submitted to microscopical and chemical examination.

Metallic dust, such as iron, may be attracted by a magnet. The most usual and successful way is, however, by *aspiration*, either by an aspirator expressly made for the purpose (*see* AIR) or by means of an ordinary cask, by which a considerable volume of air is drawn through a small quantity of distilled water, glycerine, or other liquid.

The indirect way for the organic matter, &c., mentioned above—viz., analysis of the rain-water—and the obvious way of collecting dust by carefully sweeping it off shelves, &c., may be also enumerated.

Examination of Dust.—The dust obtained by any or all of these methods should now be examined microscopically and chemically.

Low powers should be used at first, and then (if looking for germs) the highest that can be obtained. If the dust is in any quantity, it can be submitted to chemical examination; but a knowledge of what class it belongs to —animal, mineral, or vegetable—is sufficient for most purposes.

Mr. Titchborne found that dust was a ferment even when taken from buildings of a considerable height, and he has proposed a fermentation test, so as to compare the fermenting powers of various kinds of dust in various places. This is new, and promises well.

Dust, as obtained by all or any of these processes, is found to be, as might be expected, a most heterogeneous and miscellaneous substance. There is not a thing that is material that may not rise by the force of evaporation, by strong currents of air, by the expulsive force of volcanic or other explosions, by attrition, by heat, and various other ways. Evaporation takes up minute animalcules from the waters of ponds and ditches, and mineral matters, such as chlorides and sulphates, from the sea. From the soil we get earthy matters of all kinds, silicate of aluminum, carbonate and phosphate of limo, peroxide of iron, &c. From the animal world, hair, epithelium, wings of insects, eggs, and other débris. From the vegetable world, multitudes of spores, cells, pollen (causing asthma), hairs, fibres, &c.

From man, his workshops, and his domestic animals, the débris of the cutaneous and respiratory systems, various products of industry, and too often the germs of contagious disease.

Sand-showers carried by the winds from large deserts, showers of ashes and other matters from volcanoes, and sometimes even showers of meteoric dust, are known to have occurred.

These showers from deserts, &c., frequently contain living animalcules. Silvester, in 1872, found in Sicily, from a sand-shower, four species of diatoms and living infusoria. Ehrenberg examined microscopically seventy showers, and has described more than two hundred distinct organic forms.

Miners, steel-grinders, flat-pressers, button-makers, brassfounders, Portland-cement makers, glassmakers, &c., all inhale mineral and earthy dust. Minute particles of metals rise with ease into the air. Angus Smith collected the dust in a train, and found it to consist of iron. If merely a train running on the smooth rails rubs off appreciable iron dust, it may readily be understood how in these trades where there is great friction—*e.g.*, in grinding steel—particles will be continually detached. *See* TRADES, INJURIOUS.

The dust or smoke of gunpowder is mainly sulphate of potash.

Mr. Titchborne analysed the dust from tho roof of the Theatre Royal, Dublin. He found 21 per cent. of oxide of iron. He ascribed this to the combustion from the gas-burners.

The dust of the streets naturally consists of fine particles of the road, horse-droppings, fibres and hairs from the clothing of persons, &c. Mr. Titchborne analysed the street dust of Dublin. He found variable quantities of organic matter, according to the height from the ground—29·7 per cent. at the top of a pillar 134 feet high, while on the street it was 45·2 per cent. It was a ferment consisting principally of stable manure in fine powder. Its deoxidising power was great: it reduced potassic nitrate into nitrite.

In dust many organised bodies have been found.

In hospitals, houses, and other inhabited places, spores, mycelium, and bacteria from a cholera ward, sporules of achorion and tricophyton from a skin-disease ward, minuto particles of pus from a smallpox ward, various cells in stables and sheds where animals were suffering from pleuro-pneumonia, cattlo plague, &c., have all been observed by independent and trustworthy observers—such as Beale, Brittan, and Swayne, Bakewell, Dundas Thompson, and others—and prove almost to demonstration that we are occasionally exposed to breathe contagious germs and cells.

Action of Dust.—In the article on TRADES, INJURIOUS, a list will be given of the dust-producing trades. Here it may be stated that mineral dust—such as that produced in mines, consisting (as Angus Smith has shown) of particles of the rock they are working, combined with carbon, in a finely divided form, and when gunpowder is used for blasting, sulphato of potassium with various gases—or tho dust from steel or iron, is the most injurious. The organic dust of small hairs and fibres from clothes, flax, wool, &c., is also extremely irritating, and excites cough, affections of the larynx, &c. When we inhale dust in moderate quantity, part of it gets filtered at the mouth, especially if a man has a beard and moustache. All miners should therefore grow hair, when they can, well over the mouth. Part is arrested in the nasal cavities, and in the mouth and fauces. A small portion gets into the bronchial tubes, and a still smaller portion may get into the lungs themselves. That which is in tho nasal and buccal cavities is soon expectorated forth; that which is on the bronchial tubes is also, but more slowly, brought up by the following process: The whole of the bronchial tube is lined with living cells, each of which has a bunch of hair-like filaments, called cilia, growing from its upper surface. These cilia have a continual lashing movement, and fluids upon the surface of the cilia continually move upwards. The action of one ciliated epithelial cell would be insignificant; but when it is considered that there are millions all acting in the same direction, there is no difficulty in understanding how this action becomes powerful enough to raise minute bodies against the force of gravity. Some substances of an organic nature may also be decomposed. When the dust is excessive or continuous, the cilia, acting slowly, are not sufficiently powerful to bring the dust up so as to keep the chest clear; and the miner says quite truly that he is clogged up—in fact, there is a true deposition of carbon, bits of steel, &c., in his lungs.

But with comparatively soft substances, without hard-pointed and jagged ends, such as the fibres of fabrics mentioned, there is much mortality and sickness, from the irritation of the lungs, produced by constant inhalation of impure thick air; and affections of the larynx and chest are common.

Tyndall showed how air filtered through cotton wool was deprived of its dust; and various respirators have been invented. Men in mines and workshops are, however, chary of wearing anything over their mouths, so that the main thing to be insisted upon in mines is free ventilation and the cultivation of beard and moustache. In the streets it is important for our comfort that the dust should be laid. Mr. Cooper has proposed a plan which possesses the merit of disinfecting, laying, and keeping the dust moist—viz., by watering the streets with a solution of the waste chlorides of commerce, chlorides of magnesium, calcium, &c. This should invariably be recommended to the notice of urban authorities.

Any urban authority may provide receptacles for the temporary deposit of dust, ashes, and rubbish. They may also provide fit buildings or places for the deposit of any matters collected by them, in pursuance of the Public Health Act, 1875.—(P. H., s. 45.)

Urban authorities may make bylaws for the prevention of nuisances arising from dust, among other things. *See* BYLAWS; REFUSE, DISPOSAL OF, &c.

Dust-Bins—Temporary receptacles for the deposit of dust should (1) not be too large; (2) have a proper cover; (3) be in a proper situation; and (4) be frequently emptied.

The contents must be kept dry, for household refuse—such as ashes, &c.—emits little smell so long as the contents are kept from getting moist. The principal odour, indeed, from dust-bins arises from decomposing animal and vegetable matter. In towns this should never be cast into the bins. Such substances as potato-parings, heads of fish, &c., should be thrown on the back of the kitchen fire, and there allowed to smoulder. *See* ASH, DUST, &c.

Dwellings—*See* HABITATIONS.

Dynamic Value of Food—For calculating this the experimental determinations of Frankland are used. These were obtained by ascertaining with the calorimeter how much heat is evolved during the oxidation of a given quantity of a substance subjected to examination. The measured heat is then transformed into its equivalent of working power, and represented in kilogrammes or force required to raise a kilogramme 1 metre high. The following figures are given for the undermentioned alimentary substances. They represent the three groups of organic elementary principles:—

Force produced by the oxidation of 1 *gramme* (15·432 *grains*) *as consumed within the body.*

	Kilogrammetres.
Albumen (purified)	1865
Fat (beef fat)	3841
Starch (arrowroot)	1657

Kilogrammetres are convertible into foot-tons (tons lifted 1 foot high) by multiplying by ·0032285.

Force produced by the oxidation of 1 *oz.* (437·5 *grains*) *as consumed within the body.*

	Foot-Tons.
Albumen (purified)	165·20
Fat (beef fat)	351·56
Starch (arrowroot)	131·66

See DIETARIES, FOOD, &c.

Dysentery—A specific disease depending upon the contagion or infection of a specific poison, which when taken into the system causes an eruption on the mucous membrane of the large intestine, and which eruption is quickly replaced by ulcers.

The essential nature of the disease, then, is that it is specific, and every case must have had a progenitor from which it is descended in the direct lineal line.

The eruption on the intestine is in the form of whitish round elevations, in size varying from a millet seed to an extreme minuteness, perfectly analogous (but not identical) with the intestinal eruption of typhoid fever. (*See* FEVER, TYPHOID.) When pricked, a white secretion is emitted. It is probable that this is an infectious matter strictly similar to the matter of smallpox. These are quickly replaced by ulcers, which may extend into the small intestine beyond the ileo-cæcal valve. The eruption occurs about the eighteenth or twentieth day. The mucous membrane of the affected intestine is inflamed, swollen, and injected in all stages of the disease. These views are not yet generally accepted by the profession, although so logically enforced by Dr. W. Budd and a few others. Many observers see in dysentery a mere local disease, sometimes contagious and infectious, sometimes not, and they talk of it as arising *de novo* from sewage contamination, impure water, &c.; and it no doubt often does apparently rise from these causes, but never, as we believe, without the specific germ, or whatever it may be, of dysentery being present in the sewage, water, &c. There are two forms of dysentery, the acute and chronic. In the acute form the disease is often masked and insidious. Men walk about with diarrhœa, often with very little suffering, and omit to make application to hospitals or medical men until the disease has made considerable progress. Death in such cases frequently takes place in ten or twelve days. Recovery seldom takes place under three or four weeks. The liver and other organs suffer.

The chronic form may last for years; it is a sequela of the acute, and is generally very hopeless, reducing the victim to extreme emaciation before death.

The symptoms in both forms are diarrhœa, first like ordinary diarrhœa, and then purging of bloody stools, with shreds of mucous membrane, &c., with generally great pain, and in the latter stages the stools are extremely offensive.

Dysentery is frequently a complication of other fevers in warm climates, and its association with scurvy is well known.

History.—Dysentery has been known from the earliest times, it is a disease essentially of tropical climates, from whence it has spread all over the world; and modern observation has shown that in whatever climate, and however varied the type and character of the epidemic, it yet has always retained its peculiar and distinctive features. Dysentery has been the scourge of armies for more than two centuries. The history of the British army in Holland in 1748, that of the French, Prussian, and Austrian in 1792, the Walcheren expedition in 1809, the Peninsular war and the Crimean, show how fatal and disastrous dysentery is when it attacks large bodies of men. In England dysentery used to be an extremely fatal disease. It has been decreasing as a cause of death since 1852, and now is rarely to be seen, except in cases imported from India or other foreign stations. The following tables are extracted from Aitken's "Science and Practice of Medicine:"—

PREVALENCE and MORTALITY of Dysentery in various Countries, by the late Sir ALEXANDER TULLOCH, K.C.B.

Stations.	Period of Observation.	Aggregate Strength.	Dysentery.		
			Attacked.	Died.	Proportion of Deaths to Admissions.
	Years.				Per cent.
Windward and Leeward Command	20	86,661	17,843	1367	7·7
Jamaica	20	51,567	4,909	184	3·7
Gibraltar	19	60,269	2,653	64	2·4
Malta	20	40,826	1,401	94	6·6
Ionian Islands	20	70,293	3,768	184	4·8
Bermudas	20	11,721	1,751	36	2·0
Nova Scotia and New Brunswick	20	46,442	244	18	7·4
Canada	20	64,280	735	36	4·8
Western Africa	18	1,843	370	55	14·2
Cape of Good Hope	19	227,111	1,425	44	3·0
St. Helena	9	8,973	751	69	9·0
Mauritius	19	30,515	5,420	285	5·2
Ceylon	20	42,978	9,069	993	11·1
Tenasserim Provinces	10	6,818	1,460	137	9·3
Madras	5	31,627	6,639	559	8·3
Bengal	5	38,136	5,152	411	8·0
Bombay	5	17,612	1,879	151	8·0

AVERAGE RATES of Sickness and Mortality from Dysentery and Diarrhœa among European Troops in India, compiled from Data contained in Tables xxvi. and xxvii. of "Vital Statistics of European and Native Armies in India," by Dr. JOSEPH EWART of Calcutta Medical College.

Presidency.	Periods.	Strength.	Admissions.	Deaths.	Percentage of Admissions to Strength.	Percentage of Deaths to Strength.	Percentage of Deaths to Admissions.
1. From Dysentery alone.							
Bengal . .	1812 to 1853–54	543,768	100,542	8873	18·48	1·64	8·82
Bombay . .	1803–4 to 1853–54	306,978	51,010	4705	16·61	1·53	9·22
Madras . .	1829 to 1851–52*	213,587	30,593	2304	14·32	1·07	7·53
2. From Diarrhœa.							
Bengal . .	1812 to 1853–54	543,768	64,823	2141	11·92	·39	3·30
Bombay . .	1803–4 to 1853–54	306,978	32,290	551	10·51	·17	1·77
Madras . .	1829 to 1851–52*	213,587	19,458	353	9·11	·16	1·81
3. From Dysentery and Diarrhœa as a Class.							
Bengal . .	1812 to 1853–54	543,768	165,365	11,013	30·41	2·02	6·65
Bombay . .	1803–4 to 1853–54	306,978	83,300	5,256	27·13	1·71	6·30
Madras . .	1829 to 1851–52*	213,587	50,051	2,657	23·43	1·24	5·30

Propagation and Predisposing Causes.—There can only be one cause, if the view of its essential nature, as detailed above, is correct—viz., contagion; and in this respect it obeys the same laws as typhoid fever—viz., that the excreta from the bowels mainly carry the poison; but that in all probability other excreta, whether from the skin, the sputa, or the breath, may also carry infection. It is, then, an infector of—

The soil.
The drinking-water.
The clothes.
The air.

Of all these, the drinking-water and the actual emanations from the dejecta are by far the most common. Dr. Parkes, in his "Manual of Hygiène," records a number of instances where the disease was ascribed to water; those cases where men using a certain water were affected with dysentery, while others using a different supply were unaffected, are in the nature of positive proofs. For example, Davis mentions as a curious fact that ships' crews in the West Indies ordered to Tortola "were invariably seized with fluxes," which were caused by the water; but the inhabitants, who used tank-water, were free. Cheyne also relates the following: "Several years ago dysentery raged violently in the old barracks at Cork. At the period in question, the troops were supplied with water from the river Lee, which, in passing through the city, is rendered unfit for drinking by the influx of the contents of the sewers from the houses, and likewise is brackish from the tide. Mr. Bell, surgeon, of Cork, suspecting that the water might have caused the disease, had a number of water-carts engaged to bring water for the troops from a spring called the Lady's Well, and at the same time prohibited the use of water from the river. By this simple but judicious arrangement the dysentery very shortly disappeared from the troops."—(CHEYNE, On Dysentery, 1821.)

That actual emanations from dysenteric stools—whether spread on the ground in ordinary sewage irrigation, or in the close stools of hospital wards, or in the latrines of barracks—will cause the disease, is amply proved by numerous instances that have occurred both in this country and abroad.

As predisposing causes, deficient food, great heat, exhaustive marches, and especially absence of a vegetable diet, may be mentioned.

"The effects of *salt* diet in the production of dysentery being less known than the other predisposing causes, it may be as well to state that, by an experience of twenty years in the West Indies, it has been determined that in the Windward and Leeward Command, when the rations issued to the troops consisted of salt provisions five days in the week, the mortality from diseases of the stomach and bowels among the officers was as 2 to 4 per cent., whilo that among the soldiers was as 20·7, or a tenfold ratio. On the contrary, in Jamaica, when salt provisions were issued to the troops

* Exclusive of 1839, 1840, and 1841.

only two days in the week, the mortality from the same diseases approximated so nearly between these two ranks as to be almost an equality. And corresponding facts to these have been observed in Gibraltar, on the coast of Africa, and at St. Helena.

"The Sierra Leone Commissioners on the western coast of Africa, who investigated this subject on the spot, were of opinion that the large proportion of salt rations mainly contributed to the sickness and mortality from diseases of the stomach and bowels in the form of dysentery and diarrhœa; and the following statement, given by the late Sir Alexander Tulloch in his Statistical Reports (p. 11) on the sanitary condition of the troops in the West Command, shows the marked reduction which took place in the deaths from this class of diseases subsequent to the introduction of fresh-meat diet, the mortality being reduced to a tenth part of its former ratio:—

Previous to Alterations in Rations.						Subsequent to Alterations in Rations.					
Year.	Mean Strength.	Dysentery and Diarrhœa chiefly.		Ratio per 1000 of Mean Strength.		Year.	Mean Strength.	Dysentery and Diarrhœa chiefly.		Ratio per 1000 of Mean Strength.	
		Admitted.	Died.	Admitted.	Died.			Admitted.	Died.	Admitted.	Died.
1825	571	235	32	411	56	1828	232	139	1	600	
1826	471	256	26	543	56	1829	114	50	...	439	$5\frac{1}{10}$
1827	345	209	13	606	38	1830 to 1836	42	22	1	524	
Total	1337	700	71	505	51	Total	388	211	2	543	$5\frac{1}{10}$
				Average.						Average.	

"In the navy the same effects of ill-regulated diet have been observed, and the good results of a change. 'In 1797,' says Dr. Wilson, 'the victualling [of the navy] was changed, greatly improved, and, consequently, immediate to the change the health of the seamen improved strikingly. Scurvy, typhoid fever, dysentery, and ulcer, which up to the period of the change had produced great havoc, became comparatively rare in occurrence, and light in impression;' and, it may now be added, are hardly known except by name. An insufficient diet was the main predisposing cause of the dysentery which prevailed in London at the Penitentiary, Millbank, shortly after its completion. This prison is built on a marsh below the level of the Thames at high water, the river being banked out by a narrow causeway. As long as the prisoners were allowed a full and ample diet, they appear to have resisted the action of the paludal poison, and to have enjoyed good health. No sooner, however, was the quantity and quality of their dietary lowered than dysentery of a very fatal character broke out, and made it necessary to clear that establishment for a time of all its inmates."—(Aitken.)

Prevention.—The prevention is in all respects similar to that of typhoid fever; that is, thorough disinfection of all excreta, isolation as far as possible, to which may be added great attention to the diet. In military stations, on the appearance of dysentery, it may be necessary to watch the latrines, and to report every man who goes there twice a day.

Dysenteric contagion would appear more volatile than typhoid. It certainly infects the air, therefore it will be essential to use some volatile disinfectant, such as chlorine, as well as to burn or disinfect the stools. That chlorine will destroy this contagion is extremely likely. It was used by Mojon in 1807. He says: "Dysentery became contagious in the hospital at Genoa. Almost all the sick of my division, nearly 200, were attacked; and as we know that this disease, when contagious, is communicated ordinarily from one person to another, by the abuse which exists in all hospitals of making the same latrines serve for all the sick of a ward, I wished to see if fumigations of chlorine had the power of destroying these contagious exhalations. I therefore caused fumigations to be used twice daily in the latrines, and in a few days I was able to destroy that terrible scourge, which already had made some victims." *See* Disinfection; Fever, Typhoid, &c.

E.

Echinococcus Hominus—This is the larva of the *Tænia Echinococcus.* It is an extremely common parasite of the human body, and has been found in the kidneys, lungs, liver, brain, heart, spleen, ovaries, breasts, tissue of the throat, and the bones. It is especially prevalent in Iceland, about a sixth of the whole population being affected. It induces a long and painful illness, is irremediable, and is frequently terminated by death.

The liver is one of the most frequent seats of the disease, and may have either one or more hydatid tumours developed in its substance. The tumour is white, slightly tinged with yellow. The capsule is very adherent to the surrounding tissue. Within it is to be found—

"1. A gelatinous, translucent, grey bladder or bladders, composed of numerous concentric hyaline layers, giving a laminated appearance to a section. It is finely granulated in some parts (degeneration?), and highly elastic.

"2. A very thin and delicate membrane is spread over the interior of this elastic hyaline bladder, as the innermost layer of the hydated 'tumour.' This membrane is the mother sac of the echinococcus embryo (Huxley), and corresponds with the germinal membrane of Professor Goodsir. It is studded with innumerable transparent cells, varying as extremes of measurement from $\frac{1}{100000}$ to $\frac{1}{3000}$ of an inch. It is the seat of development of innumerable echinococci, and to this membrane, in a fresh hydatid tumour, they are found connected by a delicate membrane, either singly, or more commonly in clusters, the number of individuals on the cluster varying from ten to a hundred or more, as shown in the annexed woodcut," fig. 25. —(AITKEN.)

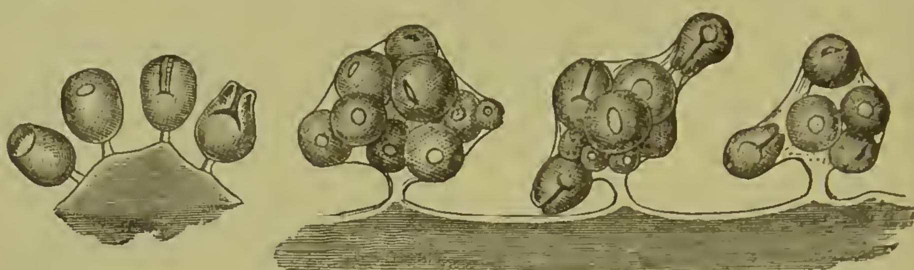


Fig. 25.

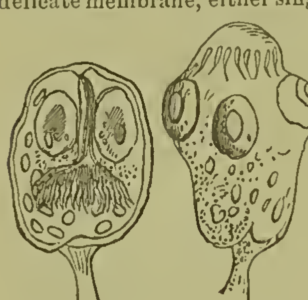


Fig. 26.

The embryo itself varies in size, according as to whether it is contracted or elongated, being from $\frac{1}{18}$ to $\frac{1}{20}$ of a line in the former, from $\frac{1}{10}$ to $\frac{1}{18}$ of a line in the latter case.

Fig. 26 represents two echinococci, the one with the head retracted within the vesicle, the other with the head extruded.

Fig. 27.

Fig. 27 and fig. 28 show, *A*, an echinococcus viewed transversely. *s*, *s*, are suctorial discs; the hooklets may be seen encircling a membranous disc. *B* shows the circlet of hooklets, thirty-four in number, seventeen long and seventeen short. *C* gives various views of separate hooklets. *b* is the base, *c* the central extremity, *e* the hooklets viewed upon their concave or inferior border. The dotted line connecting *f*, *g*, *k*, represents the outer surface of the neck, and runs through the fixed point of the three hooks, which move upon the central fixed process as on a pivot. See PARASITES, TÆNIA, &c.

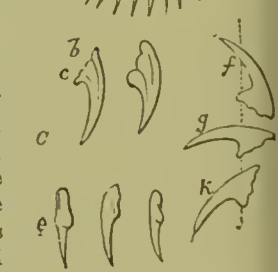


Fig. 28.

Eel—The eel is characterised by the presence of fatty matter incorporated with the flesh. The following, according to Letheby, shows the composition of this fish :—

Nitrogenous matter	9·9
Fat	13·8
Saline matter	1·3
Water	75·0
	100·0

Payen's analysis gives a considerably larger quantity of fat.

Composition of Eels deprived of non-edible Portions (Payen).

Nitrogenous matter	13·00
Fatty matter	23·86
Mineral matter	0·77
Non-nitrogenous matter and loss	0·30
Water	62·07
	100·00

It has been considered that taking eels as a regular article of diet has a tendency to produce scrofula; this belief derives some slight support from the fact that this is the prevailing disease of the Maori, who eat the eel immoderately.

Eggs—The egg of the common domestic fowl is very nutritious and easy of digestion. It necessarily contains all that is required for the construction of the body, as the young fowl is developed from it, but the shell should be taken into account as well as the contents. Hard-boiled eggs are more difficult of digestion than lightly-boiled ones, and have a constipating action on the bowels.

The larger end of a new-laid egg feels cold when placed against the tongue; it is semi-transparent when placed between the eye and a strong light. New-laid eggs are more transparent in the centre, old ones at the top.

Good eggs sink in a solution composed of 1 oz. of salt in 10 oz. of water; indifferent, float; and bad ones will swim even in pure water.

There are several methods for preserving eggs: one is to pack them with the small end downwards in clean dry salt in barrels or tubs, and to keep them in a cool and dry situation; or they may be placed in vessels containing milk of lime or strong brine. If they be covered with a solution of bees-wax in warm olive oil—one-third bees-wax, two-thirds of olive oil—they will keep, speaking generally, for two years.—(Chemical News, August 1865). All these different processes act by the exclusion of the air.

Several interesting researches on the decomposition of eggs have been instituted by the late Dr. Grace Calvert and Mr. William Thompson, F.C.S. According to their experiments, it appears that eggs can only be decomposed by one, two, or all of three different agencies. The first is the *putrid cell*. This is generated from the yolk, and takes place no matter how well the shell is protected; in fact, it is an action from *within*. The granules or cells of the yolk assume a morbid vitality, the yolk and white become mixed, and putrefaction takes place. The growth of the putrid cell is retarded by carbonic dioxide and coal gas, facilitated by oxygen.

The second is due to *vibrios*. "This decomposition is from a worm, which always appears quite straight, sometimes swimming about, and sometimes moving to and fro." They in all cases penetrate the shell from without. Eggs remaining dry are never attacked by this agent; but if the outside of the shell becomes wet or moist, the vibrios, always present in the atmosphere, fall on it, develop in the moisture, and penetrate the shell. The vibrios consume oxygen, evolving carbonic acid. They cannot live nor develop in an atmosphere of coal gas or one of carbonic acid.

The third decomposing agent is a fungus—the *Penicillium glaucum*. This fungus attacks a certain percentage of eggs, whether the shells be dry or moist. The whole egg may be full of filaments, and of the consistence of cheese. "In some cases of decomposition by this means we have found the egg to appear as if it had been completely coagulated by cooking; the white appeared to be quite as solid, but more transparent." The growth of the fungus is entirely prevented in an atmosphere of carbonic dioxide. The fungus grows rapidly in oxygen, forming carbonic dioxide; it also appears to liberate nitrogen from the albumen.—(William Thompson, F.C.S., Chemical News, vol. xxx. No. 775, p. 159.)

Composition of the entire Contents of the Egg.

Nitrogenous matter	14·0
Fatty matter	10·5
Saline matter	1·5
Water	74·0
	100·0

Composition of the White of Egg.

Nitrogenous matter	20·4
Fatty matter	...
Saline matter	1·6
Water	78·0
	100·0

Composition of the Yolk.

Nitrogenous matter	16·0
Fatty matter	30·7
Saline matter	1·3
Water	52·0
	100·0

Reckoning the weight of an egg at 2 oz., and that one-tenth of this consists of shell, the contents will furnish the following amounts of dry constituents, the percentage composition given above being taken as a basis of calculation :—

Dry Constituents of the Contents of an Egg.

	Grains.
Nitrogenous matter	110
Fatty matter	82
Saline matter	11
Total solid matter	203

The quality of the egg will vary with the food which the fowl may be fed upon. Prout gives the following as being the composition of the shell of a hen's egg:—

Animal matter	2·0
Calcic phosphate	1·0
Calcic carbonate	97·0

Elder (*Sambucus niger*)—A large shrub or small tree, belonging to the natural order *Caprifoliaceæ*. A native of the North of Asia and of Europe. The flowers yield on distillation a volatile oil. The leaves and the inner bark are purgative and emetic, and have been used in the treatment of dropsies, &c. The juice from the fresh berries is fermented and made into elder wine, which often figures largely as an adulterant of port wine. *See* WINE.

Embalming—This term is employed to denote a method which has for its object the preservation of the dead from decomposition. The operation dates from a very high antiquity, for it was practised by the ancient Egyptians, who believed that their souls after many thousand years would reinhabit their bodies if preserved entire. Some of these enbalmed Egyptian bodies, called mummies, although buried 3000 years ago, are still perfect.

The Egyptian method of embalming was in essence a process of eviscerating. They drew the brain through the nostrils with crooked instruments, and extracted the other viscera through a small opening in the side made with an Ethiopian stone. They then employed aromatic preservatives and common salt, together with bitumen and oil of cedar; and in a few of the more expensive processes, the face was gilded.

The Ethiops dried the bodies of their dead, painted them to represent life, and enshrined them in columns of transparent solid substance, so that they could be seen by the living.

The Peruvians preserve their dead principally by desiccation.

Lewis de Bils, in 1750, embalmed without evisceration. Clauderus, in 1769, immersed the whole body in a preservative solution. In the same century, a cerecloth coated with wax, oil, and aromatic preservatives came into operation, and was used among others by Benjamin Gooch, who has minutely described the operation. Hunter greatly improved the art by injections into the veins, and two bodies are at the present time in the Museum of the Royal College of Surgeons in an excellent state of preservation. One of these John Hunter preserved by injecting camphorated spirits of wine. Doctor Tranchina of Naples used as an injection 2 lbs. of arsenic, coloured with minium or cinnabar, in 20 pints of water or spirit. M. Gaunal also first used a solution of arsenic; but in 1846, the use of arsenic, for obvious reasons, was forbidden to be used for the purpose of embalming the dead in France.

A commission, in 1847, of the Académie de Médecine examined the processes of M. Gaunal and Dr. Souquet. M. Gaunal's liquid was a solution of sulphate and chloride of aluminum in water. On putting it into a Marsh's apparatus, the commission also discovered arsenic. He was therefore obliged to omit the arsenic. Souquet's liquid was a solution of chloride of zinc without arsenic. Two bodies were embalmed in the presence of the commission—one by Souquet, the other by Gaunal—and buried. They were then exhumed at the end of a year and two months. Gaunal's process had failed, Souquet's body was completely preserved, and on exposure to the air it dried without putrefaction, and became as hard as wood or stone.

These two processes were much used in France. In the two years 1849 and 1850 there were 134 embalmments—63 by the Gaunal process, 67 by the Souquet, 4 by other methods.

Modern embalmment has been studied in England scientifically by Dr. W. B. Richardson.—(Medical Times and Gazette, January 16, 1875.)

He uses three solutions—(1) A saturated solution of chloride of zinc; (2) Zinc colloid; (3) A saturated solution of silicate of soda.

No. 1 is injected slowly and carefully into either the tracheal or femoral artery. This takes about two hours, and is repeated at the end of about six hours, if necessary. The artery is not tied, but plugged up by injecting a few ounces of silicate of soda. The abdomen is emptied of air by a fine puncture, and the styptic colloid thrown in.

The brain is reached through the nose, and the cranial cavity treated with styptic colloid. The nose is stuffed with cotton wool, and the eyelids and lips sewn up. If a *post-mortem* has taken place, the process is very similar; but it entails tying most of the divided vessels, and the injection is necessarily more in detail.

Emigrant Ships—*See* HYGIÈNE, NAVAL.

Encampments—*See* CAMPS, TENTS, &c.

Endemic—A disease is said to be endemic when it arises from some more or less continuous local cause. It is a word which is often used loosely, in the place of epidemic, &c.

Energy, Amount of, produced by Food, or the actual force evolved by complete oxidation of any food-stuff, measured by means of the calorimeter. The possible amount of thermotic power which can be manifested in the body will depend on two conditions—(1) the actual amount of potential energy in the food, expressed either in units of heat or of motion; and (2) the extent to which the processes in the body can liberate and apply this energy. Helmholtz has calculated that the animal system is capable of turning one-fifth of the actual energy developed by the oxidation of the food to account as external work.

It should be remembered that the mere expression of potential energy does not fix dietetic value, it only gives a certain broad indication of the value of the substance.

The following table is based on Frankland's experimental results.

Name of Substance.	Per cent. of Water.	1 Gramme will equal Kilogram-metres of Energy.	1 oz. will equal Foot-Tons of Energy, or, in other words, would raise the under-given Number of Tons 1 Foot high.
Beef, lean	70·5	604	55
Veal, lean	70·9	496	45·3
Ham, lean, boiled	54·4	711	64·9
Bread-crumb	44	910	83
Flour	...	1627	148 5
Ground rice	...	1591	145·3
Oatmeal	...	1665	152
Peameal	...	1598	146 1
Potatoes	73	422	88·5
Carrots	86	220	20
Cabbage	88·5	178	16 2
Butter	...	3 77	280 9
Egg, white of	86·3	244	22·3
Egg, yolk	47·0	1400	127
Cheshire cheese	24	1846	168·5
Arrowroot	...	1557	151·3
Milk	87	266	24·3
Sugar, lump	...	1418	129·5
Ale, Bass's	88·4	328	30
Porter, Guinness's	88·4	455	41·5

See FOOD, FOOT-TONS.

Enteric Fever—*See* FEVER, TYPHOID.

Entozoa—Entozoa are parasites affecting the internal parts of man and animals. A full list of those which have been found in the human frame is given in article PARASITES.

The following are supposed to be introduced through drinking-water:—

Bothriocephalus latus (*Tænia lata*).
Distoma hepaticum (*Fasciola hepatica*).
Ascaris lumbricoides.
Dochmius duodenalis (*Strongylus duodenalis*).
Anchylostomum seu Sclerostoma duodenale.
Filaria sanguinis hominis.
Filaria dracunculus (Guinea worm).
Bilharzia hæmatobia.

Entry, Powers of—The general powers of entry of the local authority are very clearly laid down in the Public Health Act.

"The local authority, or their officer, shall be admitted into any premises for the purpose of examining as to the existence of a nuisance thereon, or of enforcing the provisions of any Act in force within the district requiring fire-places and furnaces to consume their own smoke, at any time between the hours of nine in the forenoon and six in the afternoon, or in the case of a nuisance arising in respect of any business, then at any hour when such business is in progress or is usually carried on.

"Where under the Public Health Act a nuisance has been ascertained to exist, or an order of abatement or prohibition has been made, the local authority or their officer shall be admitted from time to time into the premises between the hours aforesaid, until the nuisance is abated, or the works ordered to be done are completed, as the case may be.

"Where an order of abatement or prohibition has not been complied with, or has been infringed, the local authority, or their officer, shall be admitted from time to time at all reasonable hours, or at all hours during which business is in progress or is usually carried on, into the premises where the nuisance exists, in order to abate or remove the same.

"If admission to premises for any of the purposes of this section is refused, any justice on complaint thereof on oath by any officer of the local authority (made after reasonable notice in writing of the intention to make the same has been given to the person having custody of the premises), may, by order under his hand, require the person having custody of the premises to admit the local authority, or their officer, into the premises during the hours aforesaid; and if no person having custody of the premises can be found, the justice shall, on oath made before him of that fact, by order under his hand, authorise the local authority or their officer to enter such premises during the hours aforesaid.

"Any order made by a justice for admission of the local authority or their officer on premises shall continue in force until the nuisance has been abated, or the work for which the entry was necessary has been done."—(P. H., s. 102.)

Any person refusing to obey a justice's order for admission of the local authority or their officers is liable to a penalty not exceeding £5.—(P. H., s. 103.)

FORM F.

Order of Justice for Admission of Officer of Local Authority.

WHEREAS [*describe the local authority*] have by their officer [*naming him*] made application to me *A. B.*, one of Her Majesty's justices of the peace having jurisdiction in and for [*describe the place*], and the said officer has made oath to me that demand has been made pursuant to the provisions of the Public Health Act, 1875, for admission to [*describe situation of premises so as to identify them*], for the purpose of [*describe the purpose, as the case may be*], and that such demand has been refused.

Now, therefore, I the said *A. B.*, do hereby require you [*name the person having custody of the premises*], to admit the said [*name the local authority*], [*or* the officer of the said *local authority*], to the said premises, for the purpose aforesaid.

Dated this day of 18 .

A. B.

Power of entry at *reasonable times* is given to the medical officer of health and inspector of nuisances to inspect food, &c. Penalty for obstruction, £5 and under. *See* FOOD, INSPECTION OF.

Ephestia Eletella, or **Chocolate Moth**—The larva of this moth feeds on cocoa, and causes great ravages in flour and in biscuits. It has happened several times, that when cocoa and biscuits have been stored in the same place, much damage has been done by this insect. The female moths fly by night in swarms, and lay their eggs on the biscuits or in the casks. On being hatched, the larvæ, which are never more than half an inch long, find their way through the cracks of the puncheons and consume the biscuit, a large quantity of which is also damaged by their webs.

Mr. Huxley, who examined the ravages of the moth at Gibraltar, made the following suggestions :—

1. Have no cocoa stored in any place in which biscuits are manufactured.

2. Lead up all biscuit-puncheons as soon as they are full of the freshly-baked biscuit.

3. Coat puncheons with tar after they are leaded up, or at least work lime-wash well into the joints and crevices.

4. Line the bread-rooms of ships with tin, so that if the ephestia has got into a puncheon, it may not infest the rest of the ship.

5. If other means fail, expose the woodwork of puncheons to a heat of 200° F. for two hours. Or they might be destroyed by driving into the puncheon a stream of carbonic oxide, and afterwards exposing it well to the air. Weevils in biscuit have frequently been exterminated by this method, and there appears to be no reason why this treatment should not be equally efficacious for getting rid of the larvæ of the *Ephestia eletella*.

Epidemic—An epidemic is a disease that prevails exceptionably—that is, is absent for a longer or shorter period of time, and then prevails extensively, and attacks a great number of people; *e.g.*, measles, scarlet fever, hooping-cough, influenza, are our common epidemics. Some epidemics, such as influenza, arise suddenly, and disappear as soon. When diphtheria was epidemic, it also followed the same rapid course. (*See* DIPHTHERIA.) Others arise slowly and insidiously, commencing by isolated cases, increasing little by little, then enormously, until finally a maximum is reached and the disease declines; *e.g.*, the Plague followed this course.

The real cause of all true epidemics is contagion, and contagion is propagated in each instance, we believe, by extremely minute particles of living matter, of bioplasm, capable of growth, individual life, and excessive multiplication, when circumstances are favourable. Just as in some years there is an extraordinary cloud of insects, or an immense increase of some one kind of fish, bird, or wild animal; so at particular times, from the absence of some destroying cause, a particular epidemic will attain fatal proportions. Like all living entities, each germ is struggling for existence, and in the absence of certain destructive agencies, will increase indefinitely. Probably one of the controlling checks is deficiency of food. An epidemic makes its appearance, it attacks all those susceptible of it, reaches its height, the soil is exhausted, the germs wither and die for want of nutriment. The laws and nature even of other destructive agencies are extremely obscure. We know a few of them—that heat and dryness of the atmosphere, if not destructive, are at least unfavourable to smallpox; dilution with air to typhus; and probably disinfectants and strong chemical agents to all.

Epidemics may be divided into two kinds—indigenous and exotic or imported. The indigenous epidemics are such as scarlet fever, measles, typhoid. The exotic are such as Asiatic cholera, plague, &c.

There is no year without an epidemic of some kind or other, and they are found to obey the following laws :—

1. Indigenous epidemics, the seeds of which may be said to exist constantly, are always more or less active, but they from time to time become endemic, attain a maximum, and then decline—*e.g.*, scarlatina, measles, &c.

2. Exotic epidemics are almost or entirely absent from us for long periods of time: they are not indigenous, but when they appear they then obey the first law.

3. Each epidemic, even of the same disease, has its own peculiar feature: one is mild,

another is fatal; a certain complication is noted in one, a peculiar colour of an eruption in another; in a third the sequelæ, or after-effects, are different from what had been observed before.

4. The cause of each epidemic is contagion or infection, either travelling through the air or by actual contact.

5. Two or more distinct epidemics may prevail at the same time; no epidemic is known to neutralise another.

6. Providing fresh importations of living and susceptible people were continually brought within the area of infection, there is no known limit to the number who would be affected by an epidemic; in other words, the contagion is by fresh cases indefinitely multiplied, and therefore cannot be exhausted.

The following *special* regulations with regard to epidemic diseases are now in force:—

Prevention of Epidemic Diseases.

"Whenever any part of England appears to be threatened with or is affected by any formidable epidemic, endemic, or infectious disease, the Local Government Board may make and from time to time alter and revoke regulations for all or any of the following purposes; (namely,)

(1.) For the speedy interment of tho dead; and

(2.) For house-to-house visitation; and

(3.) For the provision of medical aid and accommodation, for the promotion of cleansing, ventilation, and disinfection, and for guarding against the spread of disease;

and may by order declare all or any of the regulations so made to be in forco within the whole or any part or parts of the district of any local authority, and to apply to any vessels as well as arms or parts of the sea within the jurisdiction of the Lord High Admiral of the United Kingdom, or the Commissioners for executing the office of the Lord High Admiral for the time being, for the period in such order mentioned, and may by any subsequent order abridge or extend such period." —(P. H., s. 134.)

All such regulations, &c., made by the Local Government Board are to be published in the "London Gazette," and such publication is to be held as conclusive evidence.—(P. H., s. 135.)

"The local authority of any district within which or part of which regulations so issued by the Local Government Board are declared to be in force, shall superintend and see to the execution thereof, and shall appoint and pay such medical or other officers or persons, and do and provide all such acts, matters, and things as may be necessary for mitigating any such disease, or for superintending or aiding in the execution of such regulations, or for executing the same, as the case may require. Moreover, the local authority may from time to time direct any prosecution or legal proceedings for or in respect of the wilful violation or neglect of any such regulation."—(P. H., s. 136.)

"The local authority and their officers shall have power of entry on any premises or vessel for the purpose of executing or superintending the execution of any regulations so issued by the Local Government Board as aforesaid."—(P. H., s. 137.)

"Whenever, in compliance with any regulation so issued by the Local Government Board as aforesaid, any poor-law medical officer performs any medical service on board any vessel, he shall be entitled to charge extra for such service, at the general rate of his allowance for services for the union or place for which he is appointed; and such charges shall be payable by the captain of such vessel on behalf of the owners thereof, together with any reasonable expenses for the treatment of the sick.

"Where such services are rendered by any medical practitioner who is not a poor-law medical officer, he shall be entitled to charges for any service rendered on board, with extra remuneration on account of distance, at the same rate as those which he is in the habit of receiving from private patients of the class of those attended and treated on shipboard, to be paid as aforesaid. In case of dispute in respect of such charges, such dispute may, where the charges do not exceed *twenty pounds*, be determined by a court of summary jurisdiction; and such court shall determine summarily the amount which is reasonable, according to the accustomed rate of charge within the place where the dispute arises for attendance on patients of the like class as those in respect of whom the charge is made." —(P. H., s. 138.)

"The Local Government Board may, if they think fit, by order authorise or require any two or more local authorities to act together for the purposes of the provisions of this Act relating to prevention of epidemic diseases, and may prescribe the mode of such joint action and of defraying the costs thereof."—(P. H., s. 139.)

"Any person who—

(1.) Wilfully violates any regulation so issued by the Local Government Board as aforesaid; or,

(2.) Wilfully obstructs any person acting under the authority or in the execution of any such regulation, shall be liable to a penalty not exceeding *five pounds*."—(P. H., s. 140.) *See* Infectious Diseases; Fever, Scarlet, Typhoid, Typhus; Plague; Smallpox, &c.

Epizootics—Epizootics are diseases which prevail among animals in a similar manner to epidemics among the human race. In a public-health point of view, independently of whether they are communicable to man or not, they are intimately connected with sanitation.

The different species of domestic animals have nearly always presented, in certain localities, at different epochs, special epizootics. Cattle, sheep, pigs, horses, dogs and cats, tame or wild birds, fish, silkworms, and bees have furnished instances of unaccustomed and sudden mortality due to similar affections. For example, the rinderpest or cattle plague; the typhus charbonneux, which attacks cattle, horses, cats, and birds; the smallpox of sheep; the charbon of pigs; the diphtheritic malady affecting oxen, sheep, goats, and pigs; catarrhal affections, glanders, and farcy; the pleuro-pneumonia of ruminants; the blood disease and rot of sheep,—diseases, the causes, nature, or treatment of which are far from being equally known.

Our insular position protected us from many of these plagues, until the principles of free trade and the increase of population caused a great importation of cattle. Until then, *clavelée*, the smallpox of sheep, was unknown, nor had the rinderpest or cattle plague prevailed in so terrible a manner. Even now we are more fortunate than are, generally speaking, our Continental neighbours. Of all the European states, Russia suffers most from epizootics. Year after year plagues sweep over the country from their home in the steppes of the south-east. The average annual loss of horned cattle from epizootic disease in Russia is 400,000, equal to a sum of 12,000,000 roubles. *See* Smallpox, Glanders, &c.

Ergot—Ergot is the sclerotium of *Claviceps purpurea*, produced within the paleæ of the common rye.

In the ergotised grain the seed coat and gluten cells are replaced by a layer of dark cells, the large cells of the albumen by the small cells of the ergot, and the starch grains of the albumen cells by drops of oil.

Ergot occurs in grains from ⅓ to ½ an inch in length, triangular in form, furrowed at the sides, of a purple or brown colour, and covered more or less with a bloom; the fracture is short, exhibiting a white or pinkish interior, and the odour is very peculiar.

Various views of the nature of ergot have been entertained. Some have considered it a degeneration of the true cells of the rye; others, that it is a fungus growing in place of the ovary. Its fungoid character is now generally admitted.

The ergot of rye is fed on by a little acarus, in size about one-fourth of the cheese-mite. This animal destroys the interior of the ergot, leaves the grain as a mere shell, and produces much powdery excrementitious matter. In four months 7½ oz. of this fæcal matter of the acari were formed in 7 lbs. of ergot. It is advisable always to use fresh ergot.

Ergot contains a fixed viscid oil (sp. gr. 0·924), of an acrid taste and an aromatic flavour. This oil consists chiefly of palmitic acid, oleic acid, and glycerine. Associated with the oil is an alkaloid, to which the name of *ecboline* has been given. The grain also contains a reddish-brown, bitter substance, called *ergotine*. The activity of the drug is mainly dependent upon ecboline. The oil is inert, and ergotine has but slight action.

Ergot is extremely interesting in a hygienic point of view, for although the fungus is most frequent in the rye, it has also been observed in other cereals used as food; and whenever ergotised flour is eaten, a very peculiar disease, called *ergotism*, has never failed to make its appearance. The leading symptoms of ergotism are convulsions, gangrene of the extremities, and general ill-health.

The disease has never appeared on an extensive scale in England, but on the Continent several serious attacks have occurred. It prevailed in 1694 at Cologne and at Orleans, and since that date several successive epidemics are on record there, in Switzerland, and other places.

Some of the cases observed in these different epidemics showed the disease in its utmost intensity. The upper and lower limbs "grew as dry as touchwood, and as emaciated as Egyptian mummies." Most, but not all, of the instances of mortification were of the dry kind. Some patients suffered very great agony, others but little. In many there were fever and delirium. The mortification usually began in the toes, and spread gradually upwards to the thigh. Here the limb separated either of its own accord or through the assistance of the surgeon.

Ergotism is not confined to man, it also attacks animals fed with the diseased grain.

Ergot is used in medicine to arrest hæmorrhage, and to stimulate the uterus to contraction when labour has commenced and proceeds but slowly from insufficiency of uterine action. This determination of the poison to the uterus *occasionally* takes place, if a large dose of the poison be administered to a pregnant person; hence it has been used as an abortive, especially in America. It has never been used, as far as is known, for its direct poisonous effects, and but little is known of the dose required to destroy life. Repeated small doses will certainly act fatally. In 1864 a woman in Brighton took a teaspoonful of the tincture three times a day for eleven weeks, in order to procure abortion, but she died without this taking place. Patches of inflammation were found in the stomach after death.

A single full dose in man gives rise to irritation of the intestinal canal, flushing of the face, headache, and lowering of the pulse; but as yet there is no instance on record of a case of acute poisoning.

There are no satisfactory tests for detecting ergot or ecboline in the tissues; the only possible way by which ergot could at present be detected is its odour, and the physical and chemical characters of any fragments which might be found in the stomach or intestines.

Ervalenta—*See* REVALENTA.

Ervil—The meal of the bastard lentil (*Errum ervilia*). It is used for the purpose of adulterating scammony. *See* LENTIL, SCAMMONY, &c.

Erysipelas—A febrile disease of a specific and infectious nature, attended with a peculiar rash or inflammation of the skin.

Essential Nature of the Disease. — This disease is essentially contagious, dependent for its propagation upon a specific poison. It is considered that because erysipelas makes its appearance so frequently in wounds in hospitals, that the first of such cases is a good example of a contagion arising *de novo;* but the observations of Dr. William Budd, who saw the eruption of smallpox first appear over a bruise on the nates, and of Sir William Paget, who has seen measles first appear at the wound where he had cut a boy for stone, sufficiently show that the local determination of erysipelas and other allied diseases is no proof of their local origin or local nature. Erysipelas is, indeed, whether it appear at the seat of a wound or in the unbroken skin, essentially a blood disease; and it has a period of latency, a period of accession, and various terminations. What the nature of the contagion is, is at present unknown. Living matter of some kind it must be—perhaps pus—for Dr. Day of Geelong has shown that pus from cases of erysipelas is more active than ordinary pus. "In 1868," he observes, "I had the good fortune to discover a very delicate test for pus, and have since been in the almost daily habit of applying it. . . . I have found that healthy pus when dried becomes chemically inactive, although when moistened with water it again resumes its chemical activity. I have found that strumous pus possesses much less chemical activity than pus derived from healthy persons, and that the pus from persons suffering from diseases allied to erysipelas possesses unusual activity, which it is capable of retaining for years." — (Medical Times and Gazette, 1871, vol. i. p. 287.) *See* PUS.

Dr. Willan has also inoculated the fluid from the vesicles of erysipelas, and produced an inflammation analogous to erysipelas.

History and Predisposing Causes.—It has prevailed from the earliest times, and has been the scourge of our hospitals and the terror of surgeons; for of all the predisposing causes, that of a wound holds the first place. In 1760 it spread so extensively through the wards of St. Thomas's Hospital that it was believed the plague was there, and there are few, if any, large hospitals that have not since had disastrous experience of its effects. Mr. Erichsen says: "A remarkable proof of the contagious nature of erysipelas occurred in the winter of 1857 in one of my wards at University College Hospital. The hospital had been free from any cases of the kind for a considerable time, when on the 15th January, at about noon, a man was admitted under my care, with gangrenous erysipelas of the legs, and placed in Brundrett ward. I ordered him to be removed to a separate room, and directed the chlorides to be freely used in the ward from which he had been taken. Notwithstanding these precautions, however, two days after this, a patient, from whom a necrosed portion of ilium had been removed a few weeks previously, and who was lying in the adjoining bed to that in which the patient had been temporarily placed, was seized with erysipelas, of which he speedily died. The disease then spread to almost every case in the ward, and proved fatal to several patients who had recently been operated upon. In several instances patients were affected with the constitutional without any appearance of local inflammatory action."—(ERICHSEN'S System of Surgery.)

The predisposing causes are wounds, overcrowding, a low depressed state of the system, whether from deficient food or other causes, age, moisture, and season of the year.

Prevention of Spread.—Erysipelas hangs longer to the walls of a room, clothes, &c., than any other disease. The old "Dreadnought" Hospital was so impregnated with erysipelas that she had to be broken up and a new vessel substituted. Therefore, the first thing is to see that wounded men, whether wounded by the surgeon's knife or in war, should not be treated in any ward that has had erysipelas in it, unless the ward has been excessively disinfected; and on the other hand, should a case of erysipelas occur, it should be strictly isolated, and the erysipelatous rash covered with carbolic acid well diluted with oil.

The main principles of preventing the spread of erysipelas, then, are, with regard to the individual, isolation, smearing the affected part over with some unctuous disinfecting substance, and of course the disinfection of all excreta, and thorough baking of the clothes.

With regard to disinfecting the ward or sick-room, it had better not at first be washed, but scraped, walls and all, then fumigated with chlorine and nitrous acid fumes; then thoroughly washed and limed, again fumigated by chlorine and nitrous acid, with the windows and doors sealed; lastly, everything opened, and the wind allowed to blow through, with a good fire burning in the grate for two or three days.

Erysipelas seldom appears in tents and tent hospitals. These are, in warm climates, and in our own hot summers, strongly to be recommended. *See* DISINFECTION, &c.

Essential Oils—*See* OILS.

Ether (*Æther sulphureus*, $C_4H_{10}O$)—This is a volatile liquid, said to have been known in the thirteenth century, prepared from alcohol, and containing not less than 92 per cent. per volume of pure ether. It is an inflammable liquid, emitting a strong and characteristic odour, and boiling below 105°. Specific gravity, 0·735. Fifty measures agitated with an equal volume of water are reduced to 45 by an absorption of 10 per cent. It evaporates without residue. There are no particular tests for it beyond its peculiar penetrating odour, and its property of floating on water. It is recommended by M. Stas as the best solvent for the separation of the alkaloids—morphia, strychnia, &c.—in medico-legal analysis. The effects produced by a large dose of ether are similar to those occasioned by alcohol. It has a hot burning taste, and produces during swallowing a sense of heat and constriction in the throat. We have no case on record of poisoning by ether taken in its liquid form ; but in several instances, when the vapour has been breathed, it has caused death. It would appear that the practice of taking sulphuric ether as a beverage is far from uncommon in Ireland, for we learn from the "Chloralum Review" (December 1874) "that the drinking of sulphuric ether is on the increase in the North of Ireland, and that one extensive Dublin manufacturer of ether sends the greater part of his production into the far northern counties, particularly Antrim."

When it has been taken in a liquid form, it can be distilled from the contents of the stomach by the process given for ALCOHOL (*which see*). It may be recognised by its odour and inflammability.

Ether has been used as a disinfectant, and Angus Smith found from some experiments made by him, that a piece of meat kept in a bottle containing ether vapour remained unchanged for twenty-eight days.

A mixture of ether vapour and air is highly explosive, and accidents have resulted from carelessness and a want of knowledge of this fact.

Euchlorine—Produced by gently heating chlorate of potassa with hydrochloric acid. It is probably a mixture of chlorous acid and free chlorine. Professor Stone of Manchester strongly recommends euchlorine as an air-purifier. It is easy of development, and has a far pleasanter smell than chlorine, which it greatly resembles in its action.

Euglenæ (DUJARDIN)—These are infusorial animalcules, all free and furnished with hair-like appendages. Their colour varies, their movements are remarkable for their rapidity, and many changes of the form appear to take place. They are sometimes developed in extraordinary quantities in a very short time, and will then impart to the water which contains them a blood-red colour. Ehrenberg conjectures that the miracle in Egypt, recorded by Moses, of turning the water into blood, might have been effected by the agency of these creatures. Different species, such as *E. viridis*, *E. pyrum*, &c., are found in most pond and tank waters. It is not known that they are positively hurtful in themselves, but an abundance of these bodies proves that the water contains food for them, and this must be either vegetable or animal organic matter. *See* WATER.

Evaporation—Evaporation may be defined as the conversion of a fluid into vapour by means of heat, diminished atmospheric pressure, or exposure to a dry atmosphere. Faraday proved that there is a temperature below which evaporation ceases, and that this temperature is different for different substances: for mercury the limit is about 4° C., but for sulphuric acid it is much higher. It is not necessary for the evaporation of a body that it should be in the liquid form. Solid camphor emits a vapour; and ice, if introduced into the vacuum of a barometer, immediately causes a depression of the mercurial column.

Patches of snow and ice, owing to this evaporation, gradually disappear, even during the continuance of a severe frost. In the process of evaporation the vapour is supplied only from the superficial layer of the liquid, hence the practice of using very shallow vessels for evaporating dishes. Evaporation goes on most rapidly when a current of hot dry air is made to pass over the liquid; for by this means the vapour is prevented from resting on the liquid, and so impeding the process by its pressure. Dr. Ure says, that if the pan used be corrugated it will evaporate exactly double the quantity of water given off by a smooth pan. It is found that, under ordinary circumstances, 10 square feet of heated surface will evaporate fully 1 lb. of water per minute. The amount and nature of the pressure upon the surface of the liquid will influence the rate of evaporation. A series of experiments on this subject was made by Daniell with the following results:—

Pressure in Inches of Mercury.	Grains evaporated.	Pressure in Inches of Mercury.	Grains evaporated.
30·4	1·24	1·9	15·92
15·2	2·97	0·95	29·33
7·6	5·68	0·47	50·74
3·8	9·12	0·07	112·22

These experiments were made with water. For the purpose of measuring the amount of evaporation from a given moist surface, instruments known as atmometers have been invented. Leslie's, which was the first, consisted of a ball of porous earthenware fixed to a glass tube with divisions, each corresponding to an amount of water which would cover the surface of the ball with a film equal to the thickness of $\frac{1}{1000}$ part of an inch. The evaporation from the surface of the ball is then read off.

Evaporation—the amount of which is influenced by temperature, wind, humidity of the air, rarefaction of the air, degree of exposure or shading, and by the nature of the moist surface—is continually going on over the entire surface of the earth, and consequently the atmosphere is always charged with moisture; but it is generally below the proportion which experiment gives as the maximum density for aqueous vapour due to the observed temperature. Thus it is owing to this fact that evaporation is continually going on. The vapour thus raised may float about in masses of cloud, or become invisible; in the former case, the clouds travel onwards until attracted by some mountains, hills, or elevated ridges of earth, when they become condensed, and descend as rain, and supply stores of water, which burst from the earth as springs or serve to furnish constant supplies to the rivers. The frequency of such showers and other meteorological phenomena—and, indeed, many of the great peculiarities of climate—are influenced by the variations in the quantity of moisture which is contained in the atmosphere; and for the physician the amount of evaporation is a very important point, not only as showing the moisture of the air abstractly, but also as influencing the evaporation from the skin and lungs.

The evaporating power of the air is inversely to its relative humidity in a still air; but temperature, movement, and density of air will also greatly affect the evaporation. An atmosphere containing 75 per cent. of saturation has a very different evaporating power at a temperature of 40° than it has at one of 80°. The evaporative power increases faster than the temperature rises, and evaporation is greater from moist soil than from water. It would appear from the experiments of Lehmann on pigeons and rabbits, that in a moist atmosphere more carbonic acid is exhaled from the lungs than when the atmosphere is dry. Persons affected with chronic lung disease prefer a very moist air, as it allays the cough. Most healthy persons prefer the humidity to be about 70 or 80 per cent.

What rate of evaporation is most conducive to health remains an open question, but it is well known that warmth and great humidity are borne, on the whole, more easily than cold and great humidity. It has been calculated that each square inch of water in this country gives off a vapour varying in amount from 20 to 24 inches annually. In the tropical seas the quantity has been stated to be from 80 to 130, or even more inches. In the Indian Ocean it has been stated that as much as an inch in twenty-four hours passes off as vapour, or 365 in a year. *See* CLIMATE.

Exanthematous Diseases—*See* FEVERS, ERUPTIVE; FEVER, SCARLET; SMALL-POX, MEASLES, DENGUE, &c.

Excreta—By the term "excreta" is meant, in a narrow sense, the urine and fæces of man and animals; in a broader sense, the whole of the effete matters which are thrown off by the body, whether by the skin, the lungs, the kidneys, or the bowels.

It is incontestably proved that in some, and probably that in all infectious diseases, the outlet of the contagion—of the seeds—is the excreta; so that the study of means of the proper disposal of healthy, and of disinfection of diseased excreta, becomes one of the most important problems of hygiène.

The excreted matters discharged by the kidneys and bowels of a male adult daily vary according to food and climate. The Hindoo, living on rice and farinaceous food, passes a far more considerable quantity of effete material than the European.

The excreta from the bowels mainly consist of the insoluble salts of the food, biliary matter, the débris of vegetable and animal substances taken, and water. Perfectly dry fæces contain from 12 to 20 per cent. of nitrogen and 40 to 50 per cent. of carbon. Dr. Marcet obtained from healthy fæces a crystalline principle, which he terms excretine, and to which he assigns the formula $C_{78}H_{156}SO_2$; it is soluble in ether, but insoluble in water or in potash solution. He also obtained a fusible olive-coloured fatty body, to which he gave the name of *excretolic acid*. The composition of the urine of man is given in article URINE. It is a highly nitrogenised amplex fluid, varying in composition in different animals, but fairly constant in the same animal.

Both the urine and fæces decompose when exposed to the air. The urine first becomes acid and then alkaline, from the transformation of the urea into carbonate of ammonia. If urine is mixed with fæces, the decomposition is more rapid than it would be if they were separate. The gases given off by decomposing fæces are light carburetted hydrogen, nitrogen, carbonic acid, sulphuretted hydrogen, and offensive ammoniacal compounds. Small collections of *healthy* fæces cannot be proved to be injurious to health. Large quantities of fæces, or moderate collections in a small space, such as a courtyard or in a house, are decidedly injurious to health, the gases themselves being poisonous. The *smallest* quantity of excretal matter from a person ill of some infectious disease is without doubt liable to propagate disease.

There appears little danger in utilising human excreta as manure, providing it is applied to the ground in moderate quantities *intermittently*, as recommended in article SEWAGE, DISPOSAL OF.

Money Value of Excreta.—Mr. Lawes has made numerous analyses respecting the average amount and composition of excretal matter discharged by a male adult daily.

	Fresh Excrements.	Dry Substances.	Mineral Matter.	Carbon.	Nitrogen.	Phosphates.
	oz.	oz.	oz.	oz.	oz.	oz.
Fæces......	4·17	1·041	0·116	0·443	0·053	0·068
Urine	46·01	1·735	0·527	0·539	0·478	0·189
Total ...	50·18	2·776	0·643	0·982	0·531	0·257

It will be observed that the urine voided in the twenty-four hours greatly exceeds in manurial value the fæces passed in the same time. Numerous analysts have determined the relative value as being 6 to 1. Messrs. Lawes & Gilbert estimate the value of both urine and fæces in sewage at 6s. 8d. per individual per annum, supposing that 10 lbs. of ammonia is a fair estimate of the amount voided in that time.

Dr. Parkes estimates that in a mixed population the actual amounts per individual will be 2½ oz. fæcal matter, and 40 oz. urine daily, an estimate which gives 25 tons solid fæces for every thousand inhabitants annually, and 91,250 gallons of urine.

Letheby gives the mean amount per head as 2·784 oz. of fæces, and 31·851 oz. of urine; and he has calculated that in a mixed population of 1000 persons of different sexes and ages, the daily discharge of the whole town will be 2266 lb. avoirdupois of urine, and 177·5 lb. of fæces. *See* SEWAGE, &c.

Exercise—A due proportion both of mental and bodily exercise is absolutely necessary for the enjoyment of health. In all towns it is the duty of the authorities, and indeed of the Government, to see that parks, open spaces, gymnasia, &c., be made, and every facility given for the people to have outdoor amusements, games, and exercise.

The ordinary daily work of a great variety of trades, as well as the routine followed by soldiers and sailors, is probably quite sufficient exercise in itself (*see* Table I.); but those engaged in sedentary pursuits, and those shut up in crowded workshops, should always have a certain daily amount of exercise. Among work-people, the much shorter hours of labour in the present day must certainly facilitate this.

TABLE I.—Actual Daily Work in Pounds raised 1 Foot high (LETHEBY).

Kind of Labour.	Amount of Work in Foot-Pounds.	Authority.
Bricklayer's labourer carrying bricks . .	1,627,200	Mayhew.
Coal-whipping . . .	1,774,221	Mayhew.
Ascending Faulhorn .	933,746	Fick.
Ascending Faulhorn .	1,074,913	Wislicenus.
Treadmill . . .	1,008,000	Mayhew.
Treadmill . . .	865,166	Edw. Smith.
Turning a winch . .	837,766	Coulomb.
Pedestrians (20 miles a day)	792,000	Haughton.
Paving and pile-driving .	788,480	Coulomb.
Porters carrying loads .	732,480	Coulomb.
Shot-drill punishment .	694,400	Haughton.
Average . . .	1,011,670	

External work or actual labour .	1,011,670
Work of circulation, 75 beats a minute	500,040
Work of respiration, 15 beats a minute	98,496
Total ascertainable work per day	1,610,206

The physiological effects of exercise have been of late carefully studied. It has been shown that the appetite, especially for meat and fats, is increased, but not so much for farinaceous foods; and that those exercises are the best which bring all the muscles of the body into play—*e.g.*, walking, riding, rowing, &c.—whereas those that bring a particular group of muscles into action may, if carried to excess, cause actual injury. The muscles, with regular exercise, alternating with periods of rest, become larger, more enduring, and harder; they appropriate nitrogen, and grow. Most people imagine that when they run they are really hotter than when sitting still, but, providing the skin is in a healthy condition, there is in reality very little difference in temperature. It is a *feeling* of heat, not heat itself. If it were not, indeed, for perspiration, the heat of the body would be great. It would appear that *during* exertion there is no danger of catching cold, even by drinking cold water or bathing; but if the body is just beginning to cool, then none of these things is good, and great caution is necessary. In violent exercise there is often excessive thirst, the body craves for water, which should be indulged in by a little at a time, at frequent intervals.

The greatest stress in exercise of a severe character falls on the lungs, the heart, and great vessels. The respirations are greatly increased, more carbonic acid is expired than at rest, and the blood circulates rapidly through the lungs.

Dr. Edward Smith has worked out many of the facts relative to the work done by the lungs. He found, taking the lying position as unity, the quantity of air inspired as follows:—

Lying position	1·0
Sitting	1·18
Standing	1·33
Singing	1·26
Walking 1 mile per hour	1·9
Walking 2 miles per hour	2·76
Walking 3 miles per hour	3·22
Walking, and carrying 34 lbs.	3·5
Walking, and carrying 62 lbs.	3·84
Walking, and carrying 118 lbs.	4·75
Walking 4 miles per hour	5·0
Walking 6 miles per hour	7·0
Riding and trotting	4·05
Swimming	4·33
Treadmill	5·5

The amount of carbonic acid was also investigated by Dr. E. Smith in the following manner. A mask was closely fitted to his face, and a tube passing off from it conducted the air to a suitable absorption apparatus. The results were as follows:—

	Carbonic Acid exhaled per Minute in Grains.
During sleep	4·99
Lying down, and almost asleep (average of three observations)	5·91
Walking at the rate of 2 miles an hour	18·10
Walking at the rate of 3 miles an hour	25·83
Working at the treadmill, ascending at the rate of 28·65 feet per minute (average of three observations)	44·97

The result, then, is that carbonic acid is increased in proportion to the amount of work done.

Still more accurate experiments have been performed by Pettenkofer and Voit, by means of an air-tight chamber, sufficiently large to enable a man to live, move about, and sleep in. An apparatus was attached to provide renewal of air, while that which escaped could pass through one or more absorption apparatuses. On July 31, 1866, a watchmaker remained there for twenty-four hours, at rest, taking his meals and sleep regularly. Three days later the same man again entered the chamber, and passed a day of work, the work consisting of turning a wheel with a weight attached to it. The results were as follows:—

Day of Rest.

	Carbonic Acid.	Urea.
6 A.M. to 6 P.M.	532·9 grammes.	21·7 grammes.
6 P.M. to 6 A.M.	378·6 ,,	15·5 ,,
Total	911·5 ,,	37·2 ,,

Day of Work.

	Carbonic Acid.	Urea.
6 A.M. to 6 P.M.	884·6 grammes.	20·1 grammes.
6 P.M. to 6 A.M.	399·6 ,,	16·9 ,,
Total	1284·2 ,,	37·0 ,,

The same observers have also shown that during the work-day 3804 grains of oxygen were absorbed in excess of the rest-day, and that a large amount of water is eliminated during exercise. The increase of carbonic acid comes mainly from the muscles.

If exercise is very great, congestion of the lungs may ensue. This is generally the cause of death of horses in the hunting-field which have been taxed beyond their powers.

In running and great exertions, the heart's work is enormous, being estimated, on an average, as from 122 to 277 tons lifted a foot.

The pulse on any great and unwonted exertion frequently becomes intermittent; but it appears that disease of the heart and great vessels is more common among men who occasionally make great efforts, than those who work regularly and continuously.

The effects of excessive exercise not alone affect the heart and lungs, but also the whole nervous system and digestive organs. For example, Mr. Weston, the American pedestrian, attempted to walk 400 miles in five consecutive days, and actually did walk 317½ miles during four days. There was progressive decrease in the weight of the body; the temperature was lowered and the pulse; there was loss of appetite, and but little sleep. On the third day great drowsiness was noticed; on the fourth Mr. Weston became dizzy; he staggered, and failed to see the track sufficiently to turn round the corners. The fourth night sleep was obtained, and there was a slight gain in weight. The physiological results were very carefully examined by Dr. Flint and a staff of associates, especially in relation to the nitrogen eliminated. The results are given in the following table. From these results Dr. Flint asserts that excessive and prolonged muscular exertion increases enormously the excretion of nitrogen, and that the excess of nitrogen discharged is due to an increased disassimilation of the muscular substance.

Dr. FLINT'S Observations on the Effects of the Five-Day Pedestrian Feat performed by Mr. WESTON.

	Weight of Body (nude).	Temperature.	Pulse.	Miles walked.	Nitrogen in Injecta.	Nitrogen in Ejecta.	Excess or Deficiency in Nitrogen ejected.
Before the walk—	lbs.				Grains.	Grains.	Grains.
First day . .	120·5	99·7	75	15	361·22	323·26	− 37·96
Second ,, . .	121·25	98·4	73	5	288·35	301·18	+ 12·83
Third ,, . .	100	98·0	71	5	272·27	330·36	− 58·09
Fourth ,, . .	118·5	99·1	78	15	335·01	300·57	− 34·44
Fifth ,, . .	119·2	99·5	93	1	440·43	320·06	+120·37
During the walk—							
First day . .	116·5	95·3	98	80	151·55	357·10	+205·55
Second ,, . .	116·25	94·8	93	48	265·92	370·64	+104·72
Third ,, . .	115	96·6	109	92	228·61	397·58	+168·97
Fourth ,, . .	114	96·6	68	57	144·70	348·53	+203·83
Fifth ,, . .	115·75	97·9	80	40·5	383·04	332·77	− 50·27
After the walk—							
First day . .	118	98·6	76	2	385·65	295·70	− 89·95
Second ,, . .	120·25	98·4	73	2	499·10	358·81	−140·29
Third ,, . .	120·25	99·3	70	2	394·83	409·87	+ 15·04
Fourth ,, . .	123·5	98·8	78	2	641·71	382·89	−258·82
Fifth ,, . .	120·75	97·5	76	3	283·35	418·49	+135·14

However interesting the table is in other respects, it is obvious it cannot be looked upon as trustworthy evidence of the increase of the elimination of nitrogen, as the man's health suffered, and he was therefore in an abnormal state. The reverse is really the case, as proved by several independent experimenters, and especially by the careful working out of the problem by Dr. Parkes, who has repeated the experiments of Voit and others, and thus summarises the results :—

"1. When a period of exercise is compared after an interval with one of rest (the diet being without nitrogen or with uniform nitrogen), the elimination of nitrogen by the kidneys is decidedly not increased in the exercise period. The experiments on this point are now so numerous that it may be stated without doubt. It is possible that the elimination may even be less during the exercise than during the work period. This would appear in part from some of Panke's and Fick and Wislicenus's experiments; from Noyes, as far as regards the urea; and from Meissner's, as far as the creatine (or creatinine) is concerned; while I found a decrease both in the total nitrogen and in the urea. The decrease in my experiments was not inconsiderable. Additional observations are, however, much wanted on this point.

"2. When a day of rest is compared with a day of work (*i.e.*, a day with some hours of work and some hours of rest), the amount of nitrogen is almost or quite the same on the two days; if anything, there is a slight increase in the nitrogen on the rest-day. In a day of part exercise and part rest, it is quite possible that there may be compensatory action—one part balancing the other—so as to leave the total excretion little changed.

"3. When a period of great exercise is immediately followed by an equal period of rest, the nitrogenous elimination is increased in the latter. Meissner's observations show that this is in part owing to increased discharge of creatine and creatinine; my observations also show an increase of non-ureal nitrogen. But the urea is also slightly increased during this period.

"4. When two days of complete rest are

immediately followed by days of common exercise, the nitrogenous elimination diminishes during the first day of exercise.

"On the whole, if I have stated the facts correctly, the effect of exercise is certainly to influence the elimination of nitrogen by the kidneys, but within narrow limits, and the time of increase is in the period of rest succeeding the exercise; while during the exercise period, the evidence, though not certain, points rather to a lessening of the elimination of nitrogen."—(PARKES' Hygiène.)

Measure of the Work done by Exercise.—The Rev. Professor Haughton has shown that walking on a level surface is equivalent to raising a twentieth part of the weight of the body through the distance walked.

When ascending a height, a man raises his whole weight through the distance ascended. The formula for calculation is $\frac{(W + W') \times D}{20 \times 2240.}$ W is the weight of the person; W′ the weight carried, if any; D the distance walked in feet; 20 the coefficient of traction; and 2240 the number of pounds in a ton. The result is the number of tons raised 1 foot. To get the distance in feet, 5280 must be multiplied by the number of miles walked.

An average-sized man, with his clothes, we may assume, weighs 150 lbs. From this data we get the following table:—

Kind of Exercise.	Work done in Tons lifted 1 Foot.
Walking 1 mile	17·67
,, 2 miles	35·34
,, 3 ,,	53·03
,, 4 ,,	70·71
,, 5 ,,	88 60
,, 6 ,,	106·29
,, 7 ,,	123·74
,, 8 ,,	143 68
,, 9 ,,	147·89
,, 10 ,,	176 7
,, 20 ,,	353·4

Weights, of course, much increase the work done:—

Kind of Exercise.	Work done in Tons lifted 1 Foot.
Walking 1 mile, carrying 60 lbs.	24·75
,, 2 miles, ,,	49·5
,, 10 ,, ,,	247·5
,, 20 ,, ,,	495

60 lbs. is the usual weight a soldier carries when in marching order; and as 400 tons lifted 1 foot is a hard day's work, it is evident that 20 miles is a severe march. Most of the long marches have, however, been without the 60 lbs.

Exhumation—Circumstances from time to time occur in which it is necessary to exhume one, or sometimes a number of bodies. The dangers of exhumation have been much exaggerated. The exhumations of the Church and Cemetery of St Innocents in Paris were made in 1785-86, and lasted six months. More than a thousand corpses in all stages of decomposition and decay were exhumed, yet no evil effect followed either to the workmen or to those in the vicinity. Parent du Chatelet remarks that every year at the Cemetery of the Père la Chaise, two hundred exhumations are made, to transfer bodies which have been provisionally deposited in graves to suitable tombs. These exhumations are made at all periods of the year, two or three months after death. No evil effects follow to the grave-diggers. The latter themselves believe that danger only exists during the first few days after burial, when decomposition is very active.

In all large exhumations, that are simply for removal of the dead, each body, directly it is identified, should be covered with tan, or saw-dust, and carbolic acid, and placed in a proper coffin. The exhumation should, if possible, take place in cold weather, or at all events at the coolest part of the day.

Exhumations on a large scale took place during the late Franco-Prussian war, but owing to the precautions followed, no bad effect ensued; *e.g.*, Dr Gordon, in his "Lessons on Hygiène and Surgery from the Franco-Prussian War," says:—

An important question presented itself in connection with the burial of the dead on the field, not only after the battles fought immediately around Paris, but after others that had taken place during the war. In the hurry of interment, the bodies of the killed in action at Champigny, Montretout, Bry, Chevilly, &c., had no more than 50 centimetres, or 19½ inches of earth over them. The rains in some instances washed away much of this covering, exposing more or less of the decaying body, and the question presented itself, how far evil consequences to persons living in the near vicinity were to be averted when the rains and high temperature of the spring should exert their normal effects. So early as February 1871 public attention was drawn to these circumstances. On some of the fields limbs were found projecting from the ground, and partially devoured by animals. The Central Commission of Hygiène took steps to have all the battle-fields explored; to have the bodies interred at sufficient depths, a layer of tar being placed over each, the ground where numbers were buried together sown with seeds of plants, the roots of which penetrated deep, and thus were likely to absorb the fluids of decay.

In exhumations for legal purposes, and especially in cases of suspected poisoning, the viscera often require removing. In this case excessive care should be taken that the viscera be deposited in clean jars, and that copious minute notes of all the circumstances of the exhumation be taken; and occasionally it is even necessary to carry away some of the earth around the coffin, so as, in case arsenic be discovered in the body, to be able definitely to ascertain the presence or absence of that substance in the soil. If vaults are entered, it will be well to leave them open a little time before descending, and then to use some disinfectant.

Expenses of Sanitary Authorities—The expenses of sanitary authorities are defrayed by rates. *See* RATES.

A Joint Board, Expenses of.—Any expenses incurred by a joint board in pursuance of the Public Health Act, unless otherwise determined by the provisional order, are to be defrayed out of a common fund, to be contributed by the component districts or contributory places in proportion to the rateable value of the property in each district or contributory place, such value to be ascertained according to the valuation list in force for the time being.

For the purpose of obtaining payment from component districts of the sums to be contributed by them, the joint board are to issue their precept to the local authority of each component district, stating the sum to be contributed by such authority, and requiring such authority, within a time limited by the precept, to pay the sums therein mentioned to the joint board, or to such person as the joint board may direct.

Any sum mentioned in a precept addressed by a joint board to a local authority is to be a debt due from that authority, and may be recovered accordingly, such contribution in the case of a rural authority being deemed to be general expenses.

If any local authority makes default in complying with the precept addressed to it, the joint board may, instead of instituting proceedings for the recovery of a debt, or in addition to such proceedings as to any part of a debt which may for the time being be unpaid, proceed in the same summary manner as detailed under "Expenses of Port Sanitary Authority."

For the purpose of obtaining payment from contributory places of the sums to be contributed by them, the joint board shall have the same powers of issuing precepts and of recovering the amounts named therein as if such contributory places formed a rural district, and the joint board were the authority thereof.—(P. H., s. 283, 284.)

Port Sanitary Authority, Expenses of.—Any expenses incurred by a port sanitary authority constituted temporarily in carrying into effect any purposes of the Public Health Act are to be defrayed out of a common fund to be contributed by the riparian authorities in such proportions as the Local Government Board thinks just. But the mayor, aldermen, and commons of the city of London, being the port sanitary authority of that city, are to pay the port sanitary expenses out of their corporate funds.—(P. H., s. 291.)

The port sanitary authority, if itself a local authority independently of its character of a port sanitary authority, is to raise the proportion of expenses due in respect of its own district in the same manner as if such expenses had been incurred by it in the ordinary manner for the purposes of the Public Health Act.

For the purpose of obtaining payment from the contributory riparian authorities of the sums contributed by them, the port sanitary authority is to issue their precept to each authority, requiring payment within a time limited by the precept.

Any contribution payable by a riparian authority to such port sanitary authority shall be a debt due from them, and may be recovered accordingly, such contribution in the case of a rural authority being deemed general expenses of that authority. If any riparian authority makes default in complying with the precept addressed to it by a port sanitary authority, such port sanitary authority may, instead of instituting proceedings for the recovery of the debt, or in addition to such proceedings, as to any part of the debt which may for the time being be unpaid, proceed in the summary manner in the Act provided to raise within the district of the defaulting authority such sum as may be sufficient to pay the debt due.

Where several riparian authorities are combined in the district of one port sanitary authority the Local Government Board may declare that some one or more of such authorities shall be exempt from contributing to the expenses incurred by such authorities.—(P. H., s. 290.)

Where any port sanitary authority, joint board, or other authority, are authorised, in pursuance of the Public Health Act, to proceed in a summary manner to raise within the district of a defaulting authority such sum as may be sufficient to pay any debt due to them, the authority so authorised has in relation to such sum the same powers as if they were the defaulting authority, and have therefore power to levy a rate upon individual ratepayers in the defaulting authority's district by any officer appointed by them; and the officer so appointed has the same powers, and the rate is to be levied in the same manner, and is to be subject to the same incidents, in all respects as if it were being levied by the officer of the defaulting authority for the payment of the expenses of that authority; and where the defaulting authority have power to raise moneys due for their expenses by issuing precepts, &c., the authority so authorised as aforesaid has the same power as the defaulting authority would have of issuing precepts, &c.

Any precepts issued by the said authority for raising the sum due to them may be enforced in the same manner in all respects as if they had been issued by the defaulting authority.

The said authority may, in making an estimate of the sum to be raised for the purpose of paying the debt due to them, add such sums as they think sufficient, not exceeding 10 per cent. on the debt due, and may defray thereout all costs, charges, and expenses (including compensation to any persons they may employ) to be incurred by such authority by reason of the default of the defaulting authority; and the said authority so authorised are to apply all moneys raised by them in payment of the debt due to them, and such costs, charges, and expenses as aforesaid, and shall render the balance, if any, remaining in their hands after such application to the defaulting authority. —(P. H., s. 292.)

Private Improvement Expenses.—Such expenses as the construction of necessary house-drains, of a sufficient water-closet (or privy or earth-closet), and of an ashpit, the repairing of existing water-closets and ashpits, the cleansing of offensive ditches, &c., removal of offensive accumulations so far as the expenses are not covered by the sale thereof, and the like, are defrayed by private improvement rates, a rate which both urban and rural authorities have power to make for such purposes.—(P. H., s. 213, 232.) *See* RATE, PRIVATE IMPROVEMENT.

Recovery of Private Improvement Expenses from Owner. — Where any local authority have incurred expenses for the repayment whereof the owner of the premises for or in respect of which the same are incurred is made liable under the Public Health Act, such expenses may be recovered, together with interest at a rate not exceeding five pounds per centum per annum, from the date of service of a demand for the same till payment thereof, from any person who is the owner of such premises, when the works are completed for which such expenses have been incurred. In all summary proceedings by a local authority for the recovery of expenses incurred by them in works of private improvement, the time within which such proceedings may be taken shall be reckoned from the date of the service of notice of demand.

Where such expenses have been settled and apportioned by the surveyor of the local authority as payable by such owner, such apportionment shall be binding and conclusive on such owner, unless within three months from service of notice on him by the local authority or their surveyor of the amount settled by the surveyor to be due from such owner, he shall by written notice dispute the same.

The local authority may, by order, declare any such expenses to be payable by annual instalments within a period not exceeding thirty years, with interest at the rate of five pounds per centum per annum, until the whole amount is paid; and any such instalments and interest, or any part thereof, may be recovered in a summary manner from the owner or occupier for the time being of such premises, and may be deducted from the rent of such premises, in the same proportions as are allowed in the case of private improvement rates under this Act.—(P. H., s. 257.)

Power of Individuals to Appeal against Private Improvement Expenses, &c.—Where any person deems himself aggrieved by the decision of the local authority in any case in which the local authority are empowered to recover in a summary manner any expenses incurred by them, or to declare such expenses to be private improvement expenses, he may, within *twenty-one* days after notice of such decision, address a memorial to the Local Government Board, stating the grounds of his complaint, and shall deliver a copy thereof to the local authority; the Local Government Board may make such order in the matter as to the said Board may seem equitable, and the order so made shall be binding and conclusive on all parties.

Any proceedings that may have been commenced for the recovery of such expenses by the local authority shall, on the delivery to them of such copy as aforesaid, be stayed; and the Local Government Board may, if it thinks fit, by its order, direct the local authority to pay to the person so proceeded against such sum as the said Board may consider to be a just compensation for the loss, damage, or grievance thereby sustained by him.—(P. H., s. 268.)

Rural Authority, Expenses of. — The expenses incurred by a rural authority in the execution of the Public Health Act are divided into general expenses and special expenses.

General expenses are payable out of a common fund to be raised out of the poor-rate of the parishes in the district according to the rateable value of each contributory place.

Special expenses are a separate charge on each contributory place.

General expenses (other than those chargeable on owners and occupiers under the Act) are the expenses of the *establishment and officers* of the rural authority, the expenses in relation to *disinfection*, the *providing conveyance* for infected persons, and all other expenses not determined by the Act or by order of the Local Government Board to be special expenses.

Special expenses are the expenses of the *construction, maintenance, and cleansing of sewers* in any contributory place within the district, the *providing a supply of water* to any such place, and maintaining any *necessary works* for that purpose, the *charges and expenses arising out of or incidental to the possession of property* transferred to the rural authority in trust for any contributory place, and all other expenses incurred or payable by the rural authority in or in respect of any contributory place within the district, and determined by order of the Local Government Board to be special expenses.

Where the rural authority make any *sewers* or provide any *water-supply* or execute any other work under this Act for the common benefit of any two or more contributory places within their district, they may apportion the expense of constructing any such work, and of maintaining the same, in such proportions as they think just, between such contributory places, and any expense so apportioned to any such contributory place shall be deemed to be *special expenses* legally incurred in respect of such contributory place.

The overseers of any contributory place, if aggrieved by any such apportionment, may, within twenty-one days after notice has been given to them of the apportionment, send or deliver a memorial to the Local Government Board stating their grounds of complaint, and the said Board may make such order in the matter as to it may seem equitable, and the order so made shall be binding and conclusive on all parties concerned.

The following areas situated in a rural district shall be contributory places for the purposes of the Public Health Act; that is to say,

(1.) Every parish not having any part of its area within the limits of a special drainage district or of an urban district; and

(2.) Every special drainage district; and

(3.) In the case of a parish wholly situated in a rural district, and part of which forms or is part of a special drainage district, such portion of that parish as is not comprised within such special drainage district; and

in the case of a parish a part of which is situated within an urban district, such portion of that parish as is not comprised within such urban district, or within any such special drainage district as aforesaid.—(P. H., s. 229.)

Urban Authority, Expenses of.—The expenses of an *urban* authority in the execution of the Public Health Act, 1875, are defrayed out of the district fund and general district rate (*see* RATES), subject to the following exceptions:—

"That if in any district the expenses incurred by an urban authority (being the council of a borough) in the execution of the Sanitary Acts were at the time of the passing of the Public Health Act payable out of the borough fund or borough rate, then the expenses incurred by that authority in the execution of the Act shall be charged on and defrayed out of the borough fund or borough rate; and

"That if in any district the expenses incurred by an urban authority (being improvement commissioners) in the execution of the Sanitary Acts were at the time of the passing of the Public Health Act payable out of any rate in the nature of a general district rate leviable by them as such commissioners throughout the whole of their district, then the expenses incurred by that authority in the execution of this Act shall be charged on and defrayed out of such rate; and for the purposes of this section the council of the borough of Folkestone shall be deemed to be Improvement Commissioners; and

"That where at the time of the passing of the Public Health Act the expenses incurred by an urban authority in the execution of certain purposes of the Sanitary Acts were payable out of the borough fund and borough rate, and the expenses incurred by such authority in the execution of the other purposes of the said Acts were payable out of a rate or rates leviable by that authority throughout the whole of their district for paving, sewering, or other sanitary purposes, then the expenses incurred by that authority in the execution of the same or similar purposes respectively under this Act shall respectively be charged on and defrayed out of the borough fund and borough rate, or out of the rate or rates leviable as aforesaid."—(P. H., s. 207.)

And in certain cases, where at the time of the passing of the Public Health Act, the expenses of an urban authority were defrayed otherwise, the Local Government Board, on application, may alter the mode of payment, and declare that the expenses shall be defrayed out of the district fund and general district rate.—(P. H., s. 208.)

The following expenses are paid out of the district fund and general district rate, viz.:—

Expenses under Artisans' and Labourers' Dwellings Acts.

Expense of the auditor's fees, where the sanitary authority is not a town council.
Compensation for damages.
Election expenses.
Filth, removal of, from ditches.
Expenses connected with gas and water-supply.
Expenses connected with the repair of highways where the whole district is not rated for paving, &c.
Legal expenses connected with the clerk.
The lighting of streets.
Maps and plans.
Public baths and wash-houses.
Public conveyances.
Provisional order, costs of.
Salaries of officers.
Salary of stipendiary magistrates.
Surveys.
Tramways, expenses of.
General expenses, and expenses not otherwise provided for. *See* LOANS, RATES, &c.

Extract of Meat—*See* MEAT, EXTRACT OF.

Eye, Diseases of—*See* BLINDNESS, OPHTHALMIA, SCHOOL HYGIÈNE.

F.

Factories, Factory Acts—The *Factory Acts* are a series of statutes, extending from 1833 to 1874—viz., The Factory Act, 1833; the Factory Act, 1844; the Factory Act, 1856; the Factory Act, 1871; and Factory Act, 1874—to regulate the hours of employment, the age, the prevention of injury to health, and other matters relating to persons employed in factories.

The Factory Acts enter into considerable detail, so that they cannot be inserted here; but the principal sanitary provisions will be given.

The factories are under special inspectors, but the sanitary officers of a sanitary authority have the same right of entry, &c., as they have in respect to other buildings.

The word "factory" is defined by 27 & 28 Vict. c. 48, as follows:—

"In the manufacture of earthenware, except as aforesaid, any place in which persons work for hire in making, or assisting in making, finishing, or assisting in finishing, earthenware of any description.

"In the manufacture of lucifer matches, any place in which persons work for hire in making lucifer matches, or in mixing the chemical materials for making them, or in any process incidental to making lucifer matches, except the cutting of the wood.

"In the manufacture of percussion-caps, any place in which persons work for hire in making percussion-caps, or in mixing or storing the chemical materials for making them, or in any process incidental to making percussion-caps.

"In the manufacture of cartridges, any place in which persons work for hire in making cartridges, or in any process incidental to making cartridges, except the manufacture of the paper or other material that is used in making the cases of the cartridges.

"In the employment of paper-staining, any place in which persons work for hire in printing a pattern in colours upon sheets of paper, either by blocks applied by hand or by rollers worked by steam, water, or other mechanical power.

"In the employment of fustian-cutting, any place in which persons work for hire in fustian-cutting.

"For the purposes of this Act an apprentice shall be deemed to be a person working for hire.

"No building or premises used solely for the purpose of a dwelling-house shall be deemed to be a factory."

The 30 & 31 Vict. c. 103, enacts that the word "factory" shall mean as follows:—

1. Any blast-furnace or other furnace, or premises in or on which the process of smelting, or otherwise obtaining any metal from the ores, is carried on (which furnace or premises are hereinafter referred to as a blast-furnace).

2. Any copper-mill.

3. Any mill, forge, or other premises in of on which any process is carried on for converting iron into malleable iron, steel, or tin-plate, or for otherwise making or converting steel (which mills, forges, and other premises are hereinafter referred to as iron-mills).

4. Iron-foundries, copper-foundries, brass-foundries, and other premises or places in which the process of founding or casting any metal is carried on.

5. Any premises in which steam, water, of other mechanical power is used for moving machinery employed—

(*a*.) In the manufacture of machinery.

(*b.*) In the manufacture of any article of metal not being machinery.

(*c.*) In the manufacture of indiarubber or gutta-percha, or articles made wholly or partly of indiarubber or gutta-percha.

6. Any premises in which any of the following manufactures or processes are carried on, namely—

(*a.*) Paper manufacture.
(*b.*) Glass manufacture.
(*c.*) Tobacco manufacture.
(*d.*) Letterpress printing.
(*e.*) Bookbinding.

7. Any premises, whether adjoining or separate, in the same occupation, situated in the same city, town, parish, or place, and constituting one trade establishment, in, on, or within the precincts of which fifty or more persons are employed in any manufacturing process. And every part of a factory shall be deemed to be a factory, except such part, if any, as is used exclusively as a dwelling.

"Manufacturing process" shall mean any manual labour exercised by way of trade or for purposes of gain in or incidental to the making any article or part of an article, or in or incidental to the altering, repairing, ornamenting, finishing, or otherwise adapting for sale any article.

Age.—In future, no child may be employed under the age of nine (1875), and after 1875 under the age of ten.—(37 & 38 Vict. c. 44, s. 12.)

Cleanliness and Ventilation of Factories.—A factory is to be kept in a cleanly state and properly ventilated, so as to render harmless, as far as practicable, gases, dust, and other impurities generated during manufacture. Penalty for neglect, £10 or less, but not less than £3 (27 & 28 Vict. c. 38, s. 4). The court may, however, instead of inflicting a penalty, order certain works to be done.

It is lawful for the occupier to make special rules for compelling the observance, amongst his workmen, of the conditions necessary to ensure the required degree of cleanliness and ventilation, and to annex to any breach of such rules a penalty not exceeding £1. They must be approved of by one of her Majesty's Principal Secretaries of State, and printed copies hung up in the factory.—(27 & 28 Vict. c. 38, s. 5.)

There are also useful enactments in force with regard to lime-washing the walls, ceilings, &c., of a factory.—(7 & 8 Vict. c. 15, s. 18, &c.)

In every factory where grinding, glazing, or polishing on a wheel, or any other process, is carried on by which dust is generated and inhaled by the workmen to an injurious extent, if it appears to any inspector of factories that such inhalation could be to a great extent prevented by the use of a fan or other mechanical means, it shall be lawful for the inspector to order a fan or other mechanical means, of such construction as may from time to time be approved by one of her Majesty's Principal Secretaries of State.—(30 & 31 Vict. c. 103, s. 9.)

Hours.—The period of employment in factories is restricted, with a few unimportant exceptions, to ten hours a day—*i.e.*, twelve working hours, with two hour's intervals for meals. No child, young person, or woman may be employed for any purpose whatever after two o'clock on Saturday afternoon. No child, young person, or woman may be employed on Sunday in or about any factory.

Meals, Food, &c.—There are useful regulations for preventing the injury to health arising from the operatives eating their meals in the same room in which they work.

In the manufacture of lucifer matches, no child, young person, or woman shall be allowed to take his or her meals in any part of the factory where any manufacturing process is going on, except cutting the wood.—(27 & 28 Vict. c. 48, s. 6.)

In the manufacture of glass, no child, &c., is allowed to take meals in any part of the factory where the materials are mixed, or in the manufacture of flint-glass, where the work of grinding, cutting, and polishing is carried on.—(27 & 28 Vict. c. 48, s. 6.)

All children, young persons, and women in the factory shall have the time allowed them for meals at the same hours of the day, unless some alteration for special causes be allowed in writing by an inspector.—(37 & 38 Vict. c. 44, s. 7.)

No child, young person, or woman is allowed during meal-time to be employed in the factory, or to remain in any room in which any manufacturing process is carried on.—(37 & 38 Vict. c. 44, s. 8.)

Two hours are to be allowed for meals in factories in which the hours are from 7 A.M. to 7 P.M., or from 6 A.M. to 6 P.M. One of the two hours, at least, must be before 3 o'clock P.M. No child, young person, or woman may be employed for more than four and a half hours without an interval of at least half an hour for a meal.—(37 & 38 Vict. c. 44, s. 5.)

Overcrowding.—No factory shall be so overcrowded while work is carried on, as to be dangerous or prejudicial to the health of those employed therein.—(30 & 31 Vict. c. 103.)

Privies, &c.—Where it appears to any local authority by the report of their surveyor that any house is used or intended to be used as a factory or building in which persons of both sexes are employed or intended to be employed, at one time in any manufacture, trade, or business, the local authority may, if they think fit, by written notice require the owner or occupier of such house, within the time therein specified, to construct a sufficient number of water-closets, earth-closets, or privies and ashpits for the separate use of each sex.

Any person who neglects or refuses to comply with any such notice shall be liable for each default to a penalty not exceeding *twenty pounds*, and to a further penalty not exceeding *forty shillings* for every day during which the default is continued.—(P. H., s. 38.)

The most recent return (1871) showed that 1,258,000 women, children, and young persons were under Government protection as far as regarded the Factory and Workshop Acts; but the principle of these Acts has been still farther extended by recent legislation to textile manufactories, so that the numbers given are much below the true figures. The whole of the Factory Acts should without doubt be consolidated, and their principles still farther extended.

Factories, Air of—Suspended in the air of factories will be found minute portions of the substance or fabrics manufactured in them, epithelium, and other organic impurities; hence the necessity for thorough and complete ventilation. *See* AIR; FACTORIES; TRADES, INJURIOUS; VENTILATION, &c.

Fæcal Matter—*See* EXCRETA.

Fairs—An *urban* authority has power to regulate the holding and the protection of fairs under the provisions of the Markets and Fairs Clauses Acts, 1847.—(10 & 11 Vict. c. 14.)

Famine—There is no subject that is of greater interest, as a cause of disease, than famine. It has always been associated with pestilence in ancient times, under which name we must suppose plague and typhus fever to have existed. The more modern epochs of distress have been associated with famine fever, typhus, typhoid, erysipelas, diphtheria, and other diseases. To trace the causes of the different famines of our own country is so large a subject that it is impossible to treat of it here. The dates of the chief English famines are as follows:—

	A.D.
Famine in Britain; people ate the bark of trees	272
Famine in Scotland; thousands died	306
Famine in England; 40,000 perished	310
Famine in England, Wales, and Scotland	739
Famine in England, Wales, and Scotland; thousands died from it	823
Famine in England, Wales, and Scotland; lasted four years	954
Famine in England, 21 William I.	1087
Famine in England and France, combined with a fatal pestilential fever, and lasted from	1193 to 1195
Famine in England	1251
Famine in England. The people devoured the flesh of horses, dogs, cats, and vermin, so great was the distress	1315
Famine in England, occasioned by heavy and long-continued rains	1335
A famine in England, so severe that, according to Stow, bread was made from fern roots	1438
A famine in Great Britain	1565
A famine in England	1795
The Irish famines, caused by the failure of the potato crop, 1814, 1816, 1822, 1831, 1846	

Famine Fever—*See* FEVER, RELAPSING.

Farcy—*See* GLANDERS.

Farms, Sewage—*See* SEWAGE, UTILISATION OF, &c.

Fat—Fat, chemically considered, consists of mixtures, in various proportions, of several closely-allied bodies, the principal of which are four—viz., stearine, margarine, palmitine, and oleine. The last mentioned is liquid, the three former solid, at ordinary temperatures. Each of these bodies consists of a certain number of atoms of carbon, hydrogen, and oxygen, and are ordinarily described as a combination of a fatty acid with glycerine: thus stearine is stearic acid and glycerine; palmitine, palmitic acid and glycerine, and so on; but Berthelot has shown that they ought to be considered as tribasic ethers of the triatomic alcohol glycerine.

The fat of animals is a concrete oil contained in the cellular membrane of their bodies, more especially round some of the viscera. The vegetable fats are generally most abundant in the seeds, although found in other parts of the plant. Fats are soluble in ether, benzole, and turpentine, and they may be mixed with each other in any proportion.

Stearine ($C_{57}H_{110}O_6$) is a white crystalline fat. According to Duffy (Q. J. Chem. Soc., v. 210), it exists in three modifications, each having a different density and a different fusing-point:—

α.	Fuses at 125·6° F. (52° C.);	density,	0·986
β.	,, 147·4° F. (64·1° C.);	,,	1·010
γ.	,, 157° F. (69·5° C.);	,,	1·017

Stearine occurs only in animal fats; it has not hitherto been found in vegetable fats. It yields about 95·73 per cent. of stearic acid. It is soluble in seven times its weight of boiling alcohol, and freely in hot ether, but separates on the cooling of the liquid.

Stearine is easily obtained from mutton fat, which contains a very large quantity of it. It can also be made by heating together stearic acid and glycerine under pressure.

Margarine ($C_{54}H_{104}O_6$) is probably not a simple substance. It is the solid ingredient of human fat, of goose grease, and is contained in all vegetable fats. Its fusing-point is 116° F. (47° C.)

Palmitine ($C_{51}H_{98}O_6$) is a white solid, crystallising in laminæ. It has three different modifications—(*a*) fusing at 114·8° F. (46° C.); (*b*) at 143° F. (62·7° C.); and (*c*) at 145° F. (62·8° C.) On decomposition it yields 95·28 per cent. of palmitic acid.

Oleine ($C_{57}H_{104}O_6$).—This is a colourless oily liquid, solidifying at 41° F. (5° C.)

Vegetable fats are richer in oleine than animal. On decomposition it yields 95·7 per cent. of oleic acid.

Liebig considered that the carbo-hydrates—that is, starch, sugar, and similar bodies—formed fat by a process of oxidation. Thus, looked at in a purely chemical sense, glucose would form stearine, carbonic acid, and oxygen according to the following equation:—

$$\underset{\text{Sugar.}}{20C_6H_{12}O_6} = \underset{\text{Stearine.}}{2C_{57}H_{110}O_6} + 6CO_2 + 10H_2O + 43O_2$$

And this opinion as to the formation of animal fat was supported by the experiments of Gundlach, who fed bees on pure sugar, and found that they secreted wax in abundance; and by the researches of Huber, Dumas, Milne Edwards, Boussingault, Lehmann, Gronwen, Lawes and Gilbert, and Pasteur. This view, however, does not appear to be altogether true; and recent researches, especially those of Voit and Pettenkofer, which include experiments extended over a series of years, rather prove that the function of the carbo-hydrates is to protect fat from decomposition, and that the fat itself is really formed *from* albuminous and other nitrogenous substances. There is no relation apparent between the amount of carbo-hydrates taken in and the amount of fat deposited, but the amount of fat bears a most unmistakable relation to the amount of meat decomposed. According to these observers, every amount of albumen requires a certain quantity of carbo-hydrates, in order that the fat formed from the albumen may be entirely deposited. These experiments were made upon a dog; but it is highly probable that the process of fat-formation in the carnivora differs in no essential degree from the herbivora or other classes of animals; besides which, the conclusions are strengthened by other facts and observations, such as the formation of adipocere entirely from nitrogenous tissues; the experiments of Blondeau, Hoppe, Kemmerich, and Fleischer, according to which fat was formed at the expense of caseine; and the researches of J. Bauer, on the slow poisoning of dogs with phosphorus, all of which point in the same direction, and disprove the older views.

The functions of fat in the body, besides the important mechanical functions of filling up interstices, diminishing friction, and retaining animal heat, through its bad conducting power, are various. It is generally held to be one of the great heat-producing or respiratory agents, a view supported by the craving of inhabitants of cold climates for a fatty diet. Experiments have also shown that it is a digestive agent of considerable power, for Lehmann proved that albuminous substances, deprived of fat, remain longer in the stomach than the same substances impregnated with fat. It is also, with good reasons, supposed to aid greatly in cell-growth, the nutrition of nerve tissue, and in the genesis of blood.

The calorific or motive powers of fat are generally believed to be twice and a half as great as those of the other hydrocarbons.

	Pounds of Water raised 10° F.	Pounds lifted 1 Foot high.
Butter . . .	18·61	14,421
Beef fat . . .	20·91	16,142

How much fat is really required by the system is difficult to determine. Moleschott gives the amount of fat daily required for a male European adult of average height as 2·964 oz., while Pettenkofer and Voit give 3·63 oz. as the quantity required. For a soldier on service in the field, Parkes allows 3·5 to 4·5 oz. daily. Playfair says that a prize-fighter in training takes 3·1 oz. daily. For a man at rest, 1 oz. daily is the amount calculated as being sufficient. If we look at the proportion of fat in milk, which we may regard as a model food, the amount required by the system would seem to be at least 28 per cent. of the dry solid matter of food. Animal fats appear easier of digestion and absorption than vegetable. Berthé found that, in addition to the fat in his ordinary diet, he could absorb 30 grammes, or 1·059 oz., of cod-liver oil, butter, or other animal food. In some instances 1¾ oz. were absorbed, but only 20 grammes or 0·7 oz. of vegetable oils. When he took 40 grammes, 31·5 were absorbed, 8·5 passed by the bowels; when 60 grammes were taken, 48 were absorbed and 12 passed.

The proportions of fat contained in the offal and carcasses of different animals are shown in the following table:—

	Carcass.	Offal.
Store oxen	16·0	...
Half-fat oxen	22·6	15·7
Fat oxen	34·8	26·3
Fat calves	16·6	14·6
Store sheep	23·8	16·1
Half-fat sheep	31·3	18·5
Fat sheep	45·4	26·4
Very fat sheep . . .	55·1	34·5
Fat lambs	36·9	20·1
Store pigs	28·1	15·0
Fat pigs	49·5	22·8
Mean of all . .	34·4	21·0

Fellmonger—The business of a fellmonger comes under the denomination of an offensive trade, and as such can be regulated by bylaws in an *urban* district. The penalty for establishing a fellmonger's business without the consent of the urban authority is £50 or less, and 40s. a day during continuance of offence. —(P. H., s. 112, 113.)

Fermentation—A vital process, the result of cell-growth, by which various organic bodies are decomposed into two or more substances of simpler composition. Thus the sugars are broken up into carbonic anhydride and alcohol, with or without the separation of the elements of water and starch, sorbin and glycerine. All, under the influence of fermentation, produce alcohol, and undergo strictly analogous changes. Fermentation is in all cases preceded, caused, and accompanied by minute microscopic cells, which increase and multiply, feeding on the nitrogenous substances in a liquid, and assimilating and changing the saccharine bodies. These fungi have received various names, according to the kind of fermentation they produce. Thus the *Torula cerevisiæ* and *Penicillium glaucum* cause the vinous fermentation, and the *Torula aceti* the acetous fermentation.

Mitscherlich proved by a very simple experiment that fermentation only takes place in contact with the cells. He tied a piece of filtering paper over one end of a tube open at both ends, and having placed on it a little yeast, immersed the tube in a jar of syrup. Fermentation only took place in the tube, although free communication for liquid particles existed between the syrup in the tube and the syrup in the jar.

Pasteur has lately shown that the presence of free oxygen is not necessary for fermentation, and that there are two kinds of ferments —the one, *aérobies*, requiring air; the other, *anérobies*, which can live without air.

The conditions necessary for fermentation are—1. The presence of water; 2. A temperature ranging between 41° and 113° F. (5° and 45° C.); 3. The living cells; 4. The body which is to undergo fermentation.

A nitrogenous substance in the liquid greatly assists fermentation, but is not necessary, providing a sufficient quantity of yeast, for example, is added. The yeast cells themselves contain nitrogen, and by the decomposition of some the remainder increase and multiply.

All things which destroy the life of cells are inimical to fermentation; *e.g.*, the presence of 20 per cent. or upwards of alcohol, small quantities of nitrate of silver, chloride of sodium, sulphate of copper, strychnine, quinia, creosote, oil of turpentine, and most disinfectants stop the process. On the other hand, curiously enough, fermentation is not influenced by either arsenious acid, acetate of lead, or tartar-emetic.

The knowledge that without the presence of living cells fermentation cannot take place, and that therefore the air must be rigorously excluded from a liquid or body which by heat or otherwise is free from latent life, is a knowledge replete with practical applications in the preservation of food; as, for example, the hermetically-sealed tins of meat and of milk manufactured on a large scale, and the carefully-protected jars of preserves made by every housewife on a small scale.

Fermentation may be considered as one of the many subtile processes in nature for destroying and removing effete matters. "It is the grand power that cleanses the Augean stable of nature, at the same time that it provides some of the most esteemed articles of utility and luxury for the wellbeing and enjoyment of man."

Fermented Liquors—*See* ALCOHOLIC BEVERAGES.

Fermentum Cerevisiæ—This is the yeast fungus. It is occasionally developed in *bread*. *See* YEAST.

Ferralum—A form of disinfectant designed by Dr. Bond, Medical Officer of Health to the Gloucestershire Combined Sanitary District, for use in cases where a disinfectant is required to be used in considerable quantities—*e.g.*, in flushing sewers, deodorising cesspools, urinals, &c. It consists of a combination of the ferrous and aluminic sulphates with a mixture of terebene and carbolic acid. Dr. Bond claims for it the advantages, that whilst very little dearer than the cheapest of the ordinary forms of disinfectants, it is, unlike most of them, largely soluble in water, is much less disagreeable in odour, and much more effective in its permanent results.

Fever—The definition of fever generally accepted in the present day is that of Virchow: "Fever consists essentially in elevation of temperature, which must arise in an increased tissue change, and have its immediate cause in alterations of the nervous system." The first cause of most fevers is, however, contagion; "there are, in fact, as many poisons as there are fevers."—(TODD.) This specific contagion once absorbed, after a longer or shorter period, according to the kind of fever, a peculiar train of actions is set up. The symptom that is common to all fevers, whether in man or animals, is heat—"Essentia vero febrium est præter naturam caliditas." Accompanying this heat there is increase in the oxidation of the carbonaceous and nitrogenous constituents; the lungs exhale more carbonic acid, and more nitrogen is excreted; for example, the normal amount of urea excreted on fever diet is about 250 grains in one day. Mr Murchison found in a case of typhus fever 1012 grains, and Vogel, in a case of typhoid, 1065 grains. It is obvious that this bears no relation to the food taken, and this continual excretion fully accounts for the progressive loss of flesh. Both the muscular system and the natural fat of the body wastes. The very bones, according to Virchow, become lighter, while the glandular organs, the liver, spleen, kidney, &c., may increase in size.

The various kinds of fever, their causes, mode of propagation, and the means to prevent their spread, are treated under their respective headings. *See* FEVER, TYPHUS; FEVER, TYPHOID; FEVER, SCARLET, &c. &c.

For the fifty years, 1814-65, the deaths from fever averaged 20,000 yearly.

For the eight years, 1865-71, they averaged over 18,000.

In 1872 the deaths from fever were only 13,507.

Fever, Bilious Remittent—A fever analogous to *relapsing*, but not identical with it. It prevails in Egypt and the Levant. Deficient hygienic conditions are generally assigned as the cause.

Fever, Brain—*See* FEVER, TYPHUS.

Fevers, Continued—Several distinct forms of fever, under the name of *continued*, used to be confused together. The investigations of Henderson, Gerhard, Stewart, Jenner, W. Budd, Parkes, and others have separated them, and now at least four distinct fevers, under the class of *continued*, are recognised, viz.—

1. Simple fever.
2. Typhoid.
3. Typhus.
4. Relapsing.

Murchison asserts that these fevers have destroyed during the last thirty years (prior to 1873) 530,000 of the population of England and Wales, and 71,335 of London alone. "The actual number attacked, represented by this mortality, has probably amounted to between five and six millions in England and Wales, and to about 750,000 in London."—(MURCHISON.)

The following tables give the deaths from typhus, typhoid, and simple continued fever for a number of years:—

TABLE I.—DEATHS in ENGLAND from FEVER, at several Groups of Ages in the Twenty-four Years, 1848-71.

Ages.	Deaths in the Twenty-four Years, 1848-71.		Average Annual Deaths, 1848-71.		Deaths in 1871.	
	Males.	Females.	Males.	Females.	Males.	Females.
All ages	212,764	220,518	8865	9188	7817	7973
Under 5 years . .	41,792	42,597	1741	1775	1447	1544
At 5 ,, . .	25,502	28,617	1063	1192	935	995
,, 10 ,, . .	16,833	21,096	701	879	682	783
,, 15 ,, . .	36,896	40,149	1537	1673	1439	1472
,, 25 ,, . .	23,834	24,062	993	1003	978	868
,, 35 ,, . .	19,724	19,049	822	794	687	716
,, 45 ,, . .	17,304	15,736	721	356	616	624
,, 55 ,, . .	14,982	13,715	624	571	522	473
,, 65 ,, . .	11,296	10,573	471	440	400	360
,, 75 years and upwards	4,601	4,924	192	205	117	138

TABLE II.—DEATHS from FEVER—Typhus, Typhia, and Typhinia—in England to 10,000 Persons living, and Proportional Number to 1000 Deaths, in the Twenty-two Years, 1850–71.

Years.	Number of Deaths registered.	Deaths to 10,000 Persons living.*	Proportional Number to 1000 Deaths.
1850	15,374	8·66	43
1851	17,930	10·15	46
1852	18,641	10·41	47
1853	18,554	10·25	45
1854	18,893	10·28	44
1855	16,470	8·89	39
1856	16,182	8·60	42
1857	19,016	9·97	46
1858	17,883	9·28	40
1859	15,877	8·14	36
1860	13,012	6·63	31
1861	15,440	7·76	36
1862	18,721	9·31	43
1863	18,017	8·86	38
1864	20,106	9·77	41
1865	23,034	11·09	47
1866	21,104	10·05	43
1867	16,862	7·95	36
1868	19,701	9·17	41
1869	18,389	8·46	37
1870	17,910	8·04	35
1871	15,790	6·99	31
Mean .	17,859	9·08	40

Fevers, Eruptive—Many of the continued fevers—typhus, typhoid, &c.—are accompanied by an eruption, but under the term "Eruptive Fevers" are classed more especially smallpox, chickenpox, scarlet fever, measles, dengue, erysipelas — *See* ZYMOTIC DISEASES.

Fever, Littoral—*See* FEVERS, MALARIOUS.

Fevers, Malarious—These are fevers which arise from malaria. There are at least three well-defined kinds—

1. Ague. *See* AGUE.
2. Remittent fever.
3. Malarious yellow fever.

The malignant local fevers of tropical climates are usually remittents, paroxysmals, or malarious yellow fevers. They all depend upon the absorption of some organic poison into the blood, and are generally found in low-lying tropical districts.

Malarious yellow fever exists in the West Indian Islands, the west coast of Africa, the equinoctial portion of America, and several parts of Spain. Europeans landing at Vera Cruz or Havanna in May, June, October, or November, are almost invariably attacked with malarious yellow fever. "While ague is the offspring of the marsh or its margins, and remittent is the effect of a more concentrated form of the same exhalation from some moist surface in the process of solar desiccation, the malarious form of yellow fever appears to be the product of that state of the atmosphere which takes place after a long continuance of solar heat, with little or no wind, in those points chiefly where the atmosphere of the sea and that of the land are in constant communication and interchange. It is indeed a remarkable fact that the intense form of remittent fever, which has been distinguished as 'bilious remittent of malignant type,' is rather rare in the interior of countries, and is seldom found in towns situated on rivers higher than the influx of the tide. The fevers which appear in these situations are more of the usual remittent' character; and in the interior of the American continent there is little doubt that the *lake fever* represents the malarious *yellow fever* of the coasts. Even in Europe, while the towns on the sea-coast and on rivers were labouring under the malarious yellow fever, the sickliness in the interior approached more to that of the remittent or remittent-continuous type."—(CRAIGIE.)

* The mortality from fever here given includes a proportion of the mortality from causes not specified.

The preventive means are general sanitary measures, removal to a higher post, sleeping on an upper floor rather than a ground-floor, raising houses or huts on piles of wood, good food, warm clothing, and a pure supply of water. *See* MARSHES, AGUE, &c.

Fever, Malarious Yellow—*See* AGUE; FEVERS, MALARIOUS; MARSHES, &c.

Fever, Paludal—*See* AGUE; FEVERS, MALARIOUS; MARSHES, &c.

Fevers, Paroxysmal — *See* FEVERS, MALARIOUS.

Fever, Petechial—*See* FEVER, TYPHUS.

Fever, Puerperal — *See* PUERPERAL DISEASES, PYÆMIA, &c.

Fever, Relapsing (*Famine Fever*, *Miliary Fever*, *Typhus recurrens*)—A contagious fever of a specific nature, depending upon the absorption of a poison into the blood, prevailing especially in times of scarcity and famine.

The symptoms are "a very abrupt invasion, marked by rigors or chilliness; quick, full, and often bounding pulse; white moist tongue, rarely becoming dry and brownish; tenderness at the epigastrium, vomiting, and often jaundice; enlarged liver and spleen; constipation; skin very hot and dry; no characteristic eruption; high-coloured urine; severe headache, and pains in the back and limbs; restlessness, and occasionally acute delirium; an abrupt cessation of all these symptoms, with free perspiration, about the fifth or seventh day; after a complete apyretic interval (during which the patient may get up and walk about), an abrupt relapse on or about the fourteenth day from the first commencement, running a similar course to the first attack, and terminating on or about the third day of the relapse; sometimes a second, or even a third relapse; mortality small, but occasionally death from sudden syncope, or from suppression of urine and coma; after death, no specific lesion, but usually enlargement of liver and spleen."—(MURCHISON.)

The very curious discovery has been made by Dr. Obermeir of Berlin, that in persons suffering from relapsing fever, there are fine filaments in the blood, that have undulatory movements and spiral contractions. They are about the diameter of 1½ to 6 blood corpuscles. They are only found in the paroxysms, and are absent during the intermissions, and are supposed to be bacteria.

History.—It is not at all improbable that the sweating sickness of the fifteenth century was a variety of relapsing fever, although at that period it attacked almost exclusively those who were well fed and well housed; but, on the other hand, in our own last epidemic, relapsing fever was by no means confined to the poor and destitute. *See* SWEATING SICKNESS.

The earliest reliable account of the disease is in Rutty's "Chronological History of the Diseases of Dublin." He there describes a fever breaking out at the end of summer and prevailing through the autumn of 1739, which is evidently relapsing fever; and he also states that it was present in 1741, 1745, and 1748. The next notice recorded is that by Dr. John Clark of Newcastle in 1777. Barker and Cheyne noticed it in 1800; and it prevailed in Ireland, more or less, until the great epidemic of 1817–19, which commenced in Ireland and spread to Britain. The precursors of this epidemic were as follows: The winters of four previous years had been of great severity, and in 1815–16 there was a complete failure of the harvest and potato crop; and in the following year, 1817, ensued a cold wet autumn, again destroying both potato and corn harvests. The turf or peat also was so sodden with wet that the Irish could not use it for fuel. Thousands were thrown out of work; the greatest destitution prevailed; many died of hunger, after wandering about the country eating nettles, wild mustard, and other weeds; and thousands died of diseases brought on by exposure to wet, cold, and deficiency of food. Relapsing fever began in 1817 in Ulster, Munster, and Connaught, and spread all over Ireland. An eighth of the population was stricken with it; in Dublin alone there were 70,000 cases. The total number of deaths was estimated, from this fever in Ireland (1817–19), as 44,000; there were, however, many cases of typhus included.

The epidemic declined and died out after the plentiful harvest of 1819. England and Scotland also suffered, but not to the same extent as Ireland. In this, as in most epidemics of famine fever, it became more fatal towards the close, from a greater preponderance of typhus cases. Between 1819 and 1826 no mention is made of relapsing fever—it was probably absent entirely; but in the latter year it broke out, and for the first time a distinction was drawn between typhus and relapsing fevers. It declined and disappeared in 1828; and then, again, there is a blank of several years, during which it was either latent or absent altogether.

In 1842–43, relapsing fever, instead of, as usual, originating in Ireland, seemed to have its birth in Scotland. It appeared first on the east coast of Fife, and prevailed all over Scotland, and in many of the principal towns in England. The mortality was low, about 2½ per cent. It prevailed at a period of great distress, and was restricted to the poorest and most wretched of the population; and was, as usual, mixed with typhus, but not to a great extent. It declined in 1843, but isolated cases continually occurred up to 1847, a year marked by great scarcity, not only in this country but in various parts of the Continent, especially Upper Silesia. In that year, accompanying the famine, a very widespread epidemic occurred of relapsing fever; but it rapidly gave place to typhus, and subsided in 1848, reappearing partially in 1851 and 1853, and did not occur in this country again until 1868, when it would seem to have been imported from abroad; for in 1865 it was at St. Petersburg, and spread to Germany and elsewhere. This epidemic of 1869 was diligently studied at the different hospitals in this country, and its symptoms and course accurately marked. The first case occurred on 4th July 1868, and was followed by two others; all three were admitted into the London Fever Hospital. In October 1868, a severe epidemic occurred in Tredegar, but it did not become prevalent in London until the autumn of 1869, at which time it also attacked Liverpool and Manchester, and in 1870 had invaded Scotland.

Many of the cases could be distinctly traced to contagion. The epidemic was peculiar, for it followed typhus, instead of preceding it. It was not a time of famine; its victims were by no means exclusively those in destitute circumstances, and a very small proportion of the patients were Irish.

With regard to its geographical range, it has prevailed extensively in Russia, Poland, Germany, and Great Britain. Most of our own epidemics have begun in Ireland. One—viz., 1843—was imported from Scotland; and the last, 1869, probably from Germany. It has also been imported to Philadelphia and New York, and occurs in India and tropical countries.

Predisposing Causes.—It is a diseaso little influenced by climate, sex, or occupation. The great predisposing cause is famine, and as destitution usually coexists with overcrowding, tho latter is favourable to its propagation. A great number of cases wero tramps, vagrants, hawkers, &c., but it must be remembered that in such a class the poorest people are found.

The greatest proportion of cases occurred between the ages of fifteen and twenty-five.

Prevention of Propagation.—Tho last epidemic showed the contagious nature of the disease without a doubt; and it is acknowledged that it is especially tho cutaneous excretion which contains the poison. The present writer,* indeed, advanced at that time (1870) the view that the cause of the relapse is the breathing by tho patient of the large quantity of sour-smelling fluid thrown off by the skin at the time of the crisis. This being taken into the system, again infects it. The apyretic period being really the time of incubation, ho attempted to prevent the relapse in three cases by watching for the crisis, and bathing off and disinfecting tho perspiration. The relapse, however, appeared, though not at the usual time, and the second attack was somewhat shortened. Tho experiment is worth trying again, should opportunity offer.

The chief poison, then, is thrown off by the skin, and infects the air, the clothes, and perhaps the walls of the room, &c.

The excreta from the bowels, &c., may also be contagious.

Therefore the means to be used are evidently to keep the skin anointed with carbolic acid oil (which, indeed, will be a great comfort to the patient, and may prevent the relapse), and also to fumigate tho room, disinfect the bowel excreta, bake or destroy tho clothes, &c., as described under DISINFECTION, DISINFECTING-CHAMBERS.

Fever, Scarlet (synonym, *Scarlatina*)—A fever produced by a specific poison. Tho symptoms of the fever are that on the second day of tho illness a scarlot efflorescence appears on the face and neck, fauces and pharynx, accompanied with sore throat. It ordinarily terminates with desquamation both of the epithelium that covers the body, and also of the epithelium lining the tubes in the kidney. From the fifth to the sixth day the kidneys are nearly always affected, and the throat often very severely. Dropsy, deafness, and abscess frequently follow the fever.

The following table gives the deaths in England from scarlet fever for a number of years:

* A. W. BLYTH, Medical Times and Gazette, 1870, i. 22.

DEATHS in ENGLAND from SCARLET FEVER (exclusive of Deaths by Diphtheria and Cynancho Maligna), at different Ages, in each of the Seventeen Years, 1855–71.

Years.	All Ages.	Under 1 Year.	1.	2.	3.	4.	Under 5 Years.	5.	10.	15.	25.	35.	45.	55.	65	75	85	95 and upwards.
1855	16,929	1,131	2,306	2,700	2,537	1.957	10,631	4,523	1,078	438	128	71	36	15	8	1	...	...
1856	13,557	983	1,930	2,161	2,085	1,669	8,830	3,419	800	332	88	55	20	10	3	...	...	...
1857	12,646	855	1,790	2,032	1,988	1,462	8,127	3,252	766	321	104	40	23	7	3	3	...	...
1858	23,711	1,444	3,468	3,980	3,638	2,860	15,390	6,160	1,325	557	159	69	33	10	6	2	...	...
1859	19,310	1,294	2,824	3,062	2,992	2,379	12,551	4,937	1,050	469	174	80	26	12	7	4	...	...
1860	9,305	636	1,378	1,499	1,409	1,146	6,068	2,329	477	287	77	37	19	7	4	...	...	...
1861	9,077	572	1,288	1,490	1,423	1,119	5,892	2,317	447	264	91	31	21	10	...	4	...	...
1862	14,334	903	2,158	2,454	2,268	1,786	9,569	3,893	818	364	117	42	16	9	2	3	1	...
1863	30,475	1,761	4,050	4,886	4,683	3,842	19,222	8,191	1,820	805	267	113	34	15	5	2	...	...
1864	29,700	1,778	3,915	4,682	4,571	3,763	18,709	8,027	1,711	796	280	102	44	20	7	4	...	...
1865	17,700	1,118	2,497	2,914	2,613	2,140	11,282	4,759	953	448	158	56	23	14	7	...	...	...
1866	11,685	690	1,741	2,038	1,835	1,415	7,719	2,964	571	267	109	30	19	5	1	...	...	...
1867	12,300	805	1,806	2,064	1,961	1,457	8,093	3,269	551	251	97	26	9	1	2	1	...	...
1868	21,912	1,390	3,209	3,533	3,368	2,695	14,195	5,939	1,099	408	179	66	18	6	2	...	...	...
1869	27,641	1,792	4,073	4,698	4,110	3,405	18,078	7,194	1,419	538	266	91	40	9	5	1	...	...
1870	32,543	2,164	4,667	5,212	4,809	3,853	20,705	8,540	1,959	789	348	134	34	21	10	3	...	...
1871	18,567	1,206	2,753	3,054	2,695	2,161	11,869	4,706	1,101	556	214	68	39	11	2	1	...	...
Total	321,892	20,524	45,853	52,459	48,985	39,109	206,930	84,420	17,945	7890	2856	1111	454	182	74	29	1	...

In the time of Sydenham it used to be regarded as a mild disease, but the epidemics of our day have been extremely fatal and severe.* For example, the last epidemic of 1870 swept over the whole country, destroying 32,513 people.

Nature of the Disease.—Scarlet fever is a blood disease. The contagion, whether it be bacteroid (*see* BACTERIA), or, more probably, analogous to the variola poison, multiplies with rapidity and infects the whole body. It is principally thrown off, however, in myriads of those little cells which cover the skin of the body, the mouth, the intestinal canal, and even the delicate tubes of the kidney, and which are extensively distributed over the system, called epithelium. The poison principally attacks the epithelial cell, and the epithelial cell is the great, but not the only, carrier of the poison.

It may then infect the breath, and therefore the air of the room.

The clothes.

The excreta (both urine and fæces), and consequently the hands of attendants.

The room, walls, curtains, bedding, &c.

From the excreta it may be carried into sewers, or it may infect the privy or water-closet, and from thence may percolate into the drinking-water, although the latter mode of origin has not been as yet finally established.

The clothes of attendants may distribute it wherever the attendants themselves go.

These various media, and others that will readily suggest themselves, are probably sufficient to account for the propagation of the disease; yet that there are peculiar conditions, whether of the soil or climate, in addition, must be allowed; *e.g.*—

Dr. Ballot, in an interesting paper,† gives the following statistics for Holland, which show that, owing to some cause imperfectly understood, scarlet fever is in the same country much more prevalent in some places than others—that is to say, there is a local, an endemic, as well as an epidemic character.

	Average Population.	Deaths from Scarlatina.					One Death in Inhabitants.
		1866.	1867.	1868.	Total.	Per Year.	
North Holland . . .	570,742	91	430	87	790	192	2,900
Amsterdam . . .	266,681	86	410	2	587	146	1,900
South Holland . . .	679,950	12	36	8	67	16	42,374
Rotterdam . . .	116,650	7	13	1	24	8	14,511
The kingdom . . .	3,576,382	393	565	283	1566	391	9,146

Attempts have been made to account for the origin of the disease by other means than that of contagion. For example—

Dr. Druitt, in his address to the Association of Medical Officers of Health, said (1870): "I am one of those who believe scarlet fever to be emphatically a product of sewer gases. Whether those gases be, according to the very able and consistent theory some years since advocated by Dr. Budd, merely the vehicles of germs cast into the sewers, or whether they generate disease *de novo*, is not my purpose to inquire. Suffice it to say that, in my own experience, sore throats and sewer gases go together, and that in cases where scarlet fever has spread in houses, spite of well-devised and sufficient means of isolating and disinfecting the first patient, I believe I have sometimes found the common source of contamination to be in the breathing of sewer air or drinking of sewer water. One example I bring before you in the drawing of a rain-water pipe, with an open funnel top, close to the window of a bed-room in which child after child was seized with scarlet fever."

But as all sewers are the channels by which the excreta gases conveying infectious particles are diffused and conveyed from one point to the other, the most probable explanation of such cases is, that it is a contagion, the gas being simply the vehicle.

A novel theory has been propounded by Dr. Carpenter. He summarises his ideas as follows:—

"1. That scarlatina is a highly infectious disease, capable of propagation by contact, but which can also arise *de novo* without being necessarily preceded by another case of the same kind.

"2. That when it arises *de novo*, it results

* "Ceux qui ont vu comme moi la scarlatine exerçant ses ravages pendant trente-sept ans, sur toutes les classes de la société et dans divers pays, soit à l'état sporadique, soit épidémiquement, ne nieront pas qu'elle constitue le plus terrible fléau qui existe actuellement en Europe."—(J. FRANK, Pathol. Int., t. ii. p. 98; Encycl. des Sc. Méd.)

† Medical Times and Gazette, May 6, 1871.

from germs of organic matter which have been given off from vertebrate blood in a particular state of decomposition. (Whether healthy blood will set free such germs is a point upon which hitherto I have not been ablo to get satisfactory evidence.)

"3. That those germs are particles of albuminoid matter in a state of retrocedent change, which by some vital or catalytic actiou are able to reproduce themselves when they find admission to any part of the respiratory tract of the human body, provided that body has not been already submitted to a similar influence and actiou on a preceding occasion.

"4. That these germs cannot set up the disease if the ordinary excreta, the natural result of the act of living, are properly and within a proper time evacuated from the system through the various excretory organs provided for the purpose.

"5. It follows, therefore, that scarlatina can only be entirely prevented by the removal of all thoso causes which tend to reproduce it, and that with isolation and disinfection it may be 'stamped out.'

"6. That scarlatina is as amenable as typhus to sanitary regulations, and if perchance it be introduced into a district, it need not spread at all if proper measures are used to prevent it, of which ventilation is the most important, because the germs which reproduce it are deprived of their power and their virulence if the retrocedent decomposition upon which that power depends is arrested and oxidisation promoted.

"7. That if by accident it should spread among comparatively healthy children, it will be shorn of its terrors if these children have not taken in any insanitary matters which can act as pabulum for the scarlatina germs to feed upon and grow in.

"8. That the virulence of the disease will depend upon the quantity of such matter in the blood of the recipient. If the quantity is small, the disease will be slight, and *vice versâ;* if it is great, it may lead to such changes in the blood as are incompatible with the continuance of life.

"9. That the matters which promote the spread of scarlatina most easily are the products of decomposing carnivorous animal excreta, but that it is only at certain times and in certain seasons that the disease is epidemic.

"10. It follows that a district may be comparatively free from scarlatina in which the decomposition of blood is prevented, and in which carnivorous animal excreta are carefully removed from the neighbourhood of our towns and villages, and are not allowed to contaminate our food and water supply."

Prevention of Spread of the Disease.—The principal points are—

1. If possible to isolate the patient.
2. To attack the throat and skin as the main channels of infection.
3. To disinfect all excreta.
4. To take care that all clothes be thoroughly washed and disinfected, and all soiled rags burnt.
5. To take care that no convalescent be allowed to go into public until desquamation has ceased, which should be aided with medicated baths, alternating with free oiling. A complete change of clothes is also necessary.

What in practice is most needed, and most neglected, is oiling the skin with olive oil mixed with a little carbolic acid. This prevents the skin epithelium from being carried about by every curreut of air. It also does the disease itself good, and disinfects when it is most needed. The throat should be mopped out with a weak solution of Condy's fluid.

Medical men in practice too often neglect the prophylactic measures to prevent the spread of scarlet fever.

It will be seldom necessary to burn bedding, &c.—at all events, in towns which possess a proper disinfecting-chamber. (*See* DISINFECTING-CHAMBERS.) Indeed, with all linen things, a thorough boiling and washing confer sufficient safety. Dr. Carpenter's theory should be borne in mind. Subsequent observation must either confirm or modify his views. In the meantime no new school should be near a slaughterhouse, and all collections or manufactories where blood is used should be watched. It must be remembered that among much error there may be a germ of truth in the idea that we obtain our scarlet fever from animals, for there is no more common disease in young horses than "strangles," which certainly must be considered the scarlet fever of solipedes; but whether this is communicable to man or not is yet unknown.

Fever, Simple Continued (*Febricula, Ardent Fever*, &c.)—This is a non-contagious fever, and therefore does not come within the scope of this work. Its causes are various, such as exposure to the sun, surfeit, &c. It is rarely fatal in England.

Fever, Spotted—This term was used by Shother, 1729, to denote typhus. *See* FEVER, TYPHUS.

Fever, Typhoid (synonyms: English—*Gastric Fever*, *Enteric or Intestinal Fever*, *Low Fever*, *Common Continued Fever*, *Infantile Remittent*, *Endemic Fever*, *Pythogenic Fever*. German—*Darm-Fieber*, *Darm-Typhus*.

Latin—*Ileo Typhus, Typhus Abdominalis.* French—*La Fièvre typhoïde, La Dothinenterie, Fièvre entero-mésentérique*) — A contagious fever, produced by the absorption of a specific poison, always derived from a previous pre-existing case.

There is scarcely a part of the world exempt from this fever. It has been observed in the British Isles, France, Germany, Spain, Russia, Italy, Turkey, Norway, Sweden, Ireland, Africa, East and West Indies, North and South America, Australia, New Zealand, and Van Diemen's Land.

Essential Nature of the Disease.—The essential nature of the disease is that it is a contagious eruptive fever, the eruption occurring on the mucous membrane of the intestines, and therefore removed from view. This is not a novel statement of the case. Petit and Serres in 1813 described the morbid appearances in the intestine, and considered that it was of an eruptive nature, like the poison of variola. Cruveilhier, Lerminier, Andral, and Bretonneau of Tours all spoke of the disease as of an internal exanthem. And Dr. W. Budd, the latest writer, in his beautiful and classical monograph says (referring to some illustrations of the small intestine at an early stage): "I do not know what impression these illustrations may make on others, but to me it seems impossible to look at them without the idea of an eruption at once arising in the mind. When we remember that this affection —to repeat the essential points once more—is characteristic of this fever; that it stands in the same relation to it as a diagnostic mark, at least, as a peculiar pustular eruption does to smallpox; that it is an affection which, proceeding from within, breaks out on the surface; that it results in the elimination of the morbid product; and lastly, that the product itself is the one known specific product of a contagious fever, the evidence becomes irresistible, that we have here the essence of an eruptive process, whatever the name by which we may choose to call it." —(Dr. W. BUDD, Typhoid Fever, 1873.)

The principal pathology is as follows: There is a period of incubation, the time of which is not exactly fixed. Dr. W. Budd considers from ten to fourteen days; Murchison thinks that it is often less than two weeks, and may not exceed one or two days. After this period the symptoms of fever commence. A few cases of death in the first week of the fever have occurred; and the examination of the body showed the following: In the small intestine a certain number of Peyer's patches, or of the solitary follicles, are found thickened and raised above the internal surface of the gut; this thickening is from the infiltration of a yellowish-white cheesy matter. The small circular follicles stand out in this early stage, and in fact the bowel looks covered with the pustules. At a later stage, the pustules *ulcerate*, and form the well-known *ulcerations* so frequently seen. These *ulcerations*, of course, take the place of, and destroy, as it were, the foregoing features, which are very rarely noticed, simply because death takes place usually at an advanced stage. Both the ulcerations and the pustules, in all probability, contain by far the greatest portion of the poison.

History.—It appears to have prevailed from the earliest times, and is described by Hippocrates, Galen, and Spigelius, although under different names. Panarolus in 1694 described a fever at Rome, with an intestinal lesion as if they were burnt. Willis, Sydenham, Lancisi, Hoffman, Manningham, and others, all have left descriptions of fever under various names, the symptoms of which were undoubtedly typhoid. The French pathologists, Petit and Serres, Cruveilhier, Andral, and especially Bretonneau, and after him Louis, were the first to study and point out the morbid appearances in the intestine as an important and distinguishing mark, but they still confused typhus and typhoid. In the meantime English observers had been gradually leading up towards the actual separation of typhus and typhoid, so long confounded. In 1836 Dr. Perry published his paper, in which he laid down the distinctions between the two diseases; and Dr. Lombard, who had come over from Geneva, stated that there were "two distinct and separate fevers in Great Britain." Other observations and treatises followed in succeeding years, both for and against the new doctrine. Dr. A. P. Stewart, in 1838, after studying fever in the Glasgow Fever Hospital, gave a masterly description of the essential differences between the two diseases; and the proofs rapidly accumulated, up to Sir W. Jenner, whose careful researches, published between 1849 and 1851, leave no doubt upon the subject, even if his conclusions were not ratified, as they have been, by such men as Peacock, Wilks, Tweedie, Gairdner, W. Budd, and many others.

On account of the confusion of the continued fevers, the real history of the disease, its prevalence among armies and nations, is obscure. The great fact is, that it appears to have extensively prevailed, from the earliest-recorded cases, in all places.

Predisposing Causes.—There are certain predisposing causes that render one person more liable than another to the contagion. One of the most important of these is age; for instance, in 100 cases of typhoid, the percentage at each period of life would be somewhat near the following:—

Years of Age.	Per cent.
Under 5	0·98
From 5 to 9	9·44
,, 10 to 14	18·16
,, 15 to 19	26·86
,, 20 to 24	19·69
,, 25 to 29	10·15
,, 30 to 34	5·36
,, 35 to 39	3·40
,, 40 to 44	2·09
,, 45 to 49	1·08
,, 50 to 54	0·60
,, 55 to 59	0·33
,, 60 to 64	0·33
,, 65 to 69	0·08
,, 70 to 79	1·33

It is, then, mainly a disease of youth and adolescence; at and beyond fifty it is not so common. The practical application of this is evident—viz., that those who nurse cases of typhoid should not be young men or women. "Persons under thirty are more than four times as liable to enteric fever as persons over thirty."—(MURCHISON.)

Season of the year exercises a most undoubted influence. In this country, in France, in America, and most others, autumn is the most favourable season for its development, as shown by statistical evidence; winter and spring the least so. After dry summers it is far more prevalent than after wet. In France this fever was unusually prevalent in the autumn of 1846, and it was attributed to the excessive heat.

The Spread and Communication of the Disease.—The contagion of the disease is principally cast off by the intestines, but there is reason to believe that it may also be in the cutaneous or other excretions.

The typhoid excreta may then infect the soil, the drinking-water, the hands of the sick, the bed-clothes, linen or garments of the attendants, and it may also infect the air.

The fresh discharges from the bowel do not appear to be at all times greatly contagious. Seeing this, Murchison argued that it was only when they decomposed; but this fact is susceptible of another explanation. For example, Dr. W. Budd, speaking of the contagion, says:

Much of it, even when first voided, is no doubt already in a state of fine division, but much also is present in the form of clots or pellets of yellow matter, which are to the contagious germs which float impalpable in air or water, much as the block of granite is to the dust into which it may be ground. The application of these considerations to the case before us must be obvious to every one. If they be true, it necessarily follows that before the poison contained in the typhoid stool can exert to its full extent the contagious power inherent in it, and take its full part in the work of typhoid propagation, it must be liberated, by drying, fermentation, or some other mode of disintegration, from the clots, pellets, or other organic husk or entanglement in which it is embedded, and resolved into particles, which, suspended in the media that surround us, represent the condition under which it can alone convey widespread infection. The case may be likened to that of the poppy, or many another plant.

Poppies, like contagious fevers, propagate themselves. When the seed capsule is ripe it drops off, but the capsule itself has to be broken up—often travelling long distances the while—before the numberless seeds it encloses are cast out upon the soil to spring up as fresh poppies. And so in a measure with the fever seed also.—(Dr. W. BUDD, Typhoid Fever, 1873, p. 94.)

That the vehicle is frequently drinking-water, whether from a tainted well or from a polluted stream, or even from a small quantity of typhoid-polluted water, has been proved to demonstration. Infection by water would also seem to be, as a rule, more rapid and fatal than infection in any other way. It also may be generally very clearly traced—witness Dr. W. Budd's account of the fever at Cowbridge in 1853, at Kingswood in 1866; Dr. Ballard on the outbreak of typhoid communicated by milk, &c.

In all cases where the writer of this article has examined wells from a belief that he could actually trace typhoid to the water, the latter has been found impure.

For instance, a well at Astley, near Stourport, where the sewage from typhoid excreta leaked into the well, gave—

	Grains per Gallon.
Solid residue	59·5
Chlorine	2·8
	In 1 Litre. Milligrammes
Free ammonia	0·15
Albuminoid ammonia	0·30

A well near Dolton, Devon, into which typhoid excreta leaked, and which caused several severe and fatal cases of fever, gave on analysis the following:—

	Grains per Gallon.
Solid residue	44·8
Chlorine	8·85
	Parts per Litre. Milligrammes.
Free ammonia	0·16
Albuminoid ammonia	0·12

On the other hand, to show that water defiled extremely with sewage and organic matter, but lacking the specific element, will not give typhoid, *see* WATER, where there are several analyses of highly impure water which had been drunk for a long time without causing typhoid fever.

The Soil.—The writer of this article cannot but state his belief that discharges of typhoid, when undisinfected and thrown upon the earth, infect the soil itself, and that the contagion, indeed, may gain new force there; and in certain soils, such as Pettenkofer mentions—for instance, a porous soil, saturated at its lower part with water—it may remain active for indefinite periods. In such a case, the emanations would be greatly influenced by the *ground-water*, and its changes in height, and would bear out the observations of Pettenkofer, although the latter puts a different interpretation on the facts.*

Prevention of its Propagation.—This cannot be put in simpler or plainer language than the rules drawn up for popular use by Dr. W. Budd.

"The means by which typhoid fever may be prevented from spreading are very simple, very sure, and their cost next to nothing.

"They are founded on the discovery that the poison by which this fever spreads is almost entirely contained in the discharges from the bowels.

"These discharges infect (1) the air of the sick-room; (2) the bed and body linen of the patient; (3) privy and the cesspool, or the drains proceeding from them" (to which the writer of this article also thinks should be added the soil).

"From the privy or drain the poison often soaks into the well, and infects the drinking-water. This last, when it happens, is of all forms of fever-poisoning the most deadly.

"In these various ways the infection proceeding from the bowel-discharges often spreads the fever far and wide. The one great thing to aim at, therefore, is to disinfect these discharges on their very escape from the body, and before they are carried from the sick-room. This may be perfectly done by the use of disinfectants. One of the best is made of green copperas.

"This substance, which is used by all shoemakers, is very cheap, and may be had everywhere. A pound and a half of green copperas to a gallon of water is the proper strength. A teacupful of this liquid put into the night-pan every time before it is used by the patient renders the bowel discharge perfectly harmless. One part of Calvert's liquid carbolic acid in fifty parts of water is equally efficacious.

"To disinfect the bed and body linen, and bedding generally, chloride of lime, or Macdougall's or Calvert's powder, is more convenient. These powders should be sprinkled by means of a common dredger on soiled spots on the linen, and about the room to purify the air.

"All articles of bed and body linen should be plunged, immediately on their removal from the bed, into a bucket of water containing a tablespoonful of chloride of lime, or Macdougall's or Calvert's powder, and should be boiled before being washed. A yard of thin wide gutta-percha placed beneath the blanket under the breech of the patient, by effectually preventing the discharges from soaking into the bed, is a great additional safeguard. The privy or closet, and all drains communicating with it, should be flushed twice daily with the green copperas liquid, or with carbolic acid diluted with water.

"In towns and villages where the fever is already prevalent, the last rule should be put in force for all houses, whether there be fever in them or not, and for all public drains.

"In the event of death, the body should be placed as soon as possible in a coffin sprinkled with disinfectants. Early burial is on all accounts desirable.

"As the hands of those attending on the sick often become unavoidably soiled by the discharges from the bowel, they should be frequently washed.

"The sick-room should be kept well ventilated day and night.

"The greatest possible care should be taken with regard to the drinking-water. Where there is the slightest risk of its having become tainted with fever-poison, water should be got from a pure source, or should at least be boiled before being drunk.

"Immediately after the illness is over, whether ending in death or recovery, the dresses worn by the nurses should be washed or destroyed, and the bed and room occupied by the sick should be thoroughly disinfected. These are golden rules. Where they are neglected, the fever may become a deadly scourge; where they are strictly carried out, it seldom spreads beyond the person first attacked."

The present writer considers that it is even better, if possible, to burn the discharges with sawdust and paraffine, and in case of a typhoid soil, to lime it well and cover it with soot. *See* DISINFECTION, DISINFECTANTS, &c.

Fever, Typhus (synonyms: *Parish Infection*, *Pestilential Fever*, *Brain Fever*, *Spotted Fever*, *Typho-rubeoloid*, *Adynamic Fever*, *Malignant Fever*, *Camp Fever*, *Military Fever*, *Jail Distemper*, *Jail Fever*, *Ship Fever*, *Ochlotic Fever*, *Irish Ague*, &c.)—A contagious fever, the symptoms of which are "more or less sudden invasion, marked by rigors or chilliness; frequent, compressible pulse; tongue furred, and ultimately dry and brown; bowels in most cases constipated; skin warm and dry; a rubeoloid rash appearing between the fourth and seventh days, the spots never appearing in successive crops, at first slightly elevated and disappearing on pressure, but after the second day persistent, and

* The curious fact, that when the subsoil water sinks, and therefore when the wells are low, typhoid fever is most active and fatal, and that when the reverse of this takes place, typhoid fever is least active and virulent, may, as Liebermeister suggests, be explained by the fact that in the one case any leakage into a well containing but little water would necessarily contaminate it intensely, in the other case it would be much diluted. This theory is far more simple and probable than that of Pettenkofer.

often becoming converted into true petechiæ; great and early prostration; heavy flushed countenance; injected conjunctivæ; wakefulness and obtuseness of the mental faculties, followed, at the end of the first week, by delirium, which is sometimes acute and noisy, but oftener low and wandering; tendency to stupor and coma, tremors, subsultus, and involuntary evacuations, with contracted pupils. Duration of the fever from ten to twenty-one days, usually fourteen. In the dead body no specific lesion; but hyperæmia of all the internal organs, softening and disintegration of the heart, and voluntary muscles, hypostatic congestion of the lungs, atrophy of the brain, and œdema of the pia-mater are common."—(MURCHISON.)

History.—It is probable that the disease has existed from the earliest ages, and formed one of the pestilences of the Scriptures as well as of the plagues of Greece and Rome; but as the symptoms of the ancient scourges have seldom been delineated with any precision, although there are the strongest presumptions, there is no decided proof of this.

The history of typhus shows that it has decimated insanitary armies and navies, that it has invaded prisons, and that its greatest ravages have been where overcrowding and famine have prevailed; *e.g.*—

In the army of Ferdinand (1487) 17,000 troops perished from the prevalence of a spotted fever. Charles V. (1552) lost a very large number of men from a similar disease while besieging Metz; and fourteen years later, the same epidemic, under the name of the *Morbus Hungaricus*, appeared in the army of Maximilian II., and spread over the whole of Europe.

The period from 1619 to 1648 was the epoch of the Thirty Years' War, during which Central Europe was devastated both by famine and fever. Some idea of its fatality may be gained from the fact that the Bavarian army in Bohemia lost 20,000 men from these causes; hence the name *Bohemian Disease.*

The army of the Earl of Essex at the siege of Reading (1643) was much overcrowded, and fever broke out in the camps of both the besieged and the besiegers. Typhus fever also prevailed to a disastrous extent in the wars of Louis XIV., Frederick the Great, Napoleon I., and lastly, in the Crimean war. It has earned its name of *Ship Fever* from its frequent occurrence in crowded vessels, whether these were employed for the purpose of transporting troops, or as hulks for the seclusion of convicts, like the convict hulks of Toulon, in which no less than six epidemics of typhus are recorded—viz., in 1820, 1829, 1833, 1845, 1855, and 1856.

For a similar reason—viz., its prevalence in prisons—the fever was called the *Jail Fever* or *Distemper*, and it is supposed to have been the disease communicated from the prisoners at the six Black Assizes. (*See* BLACK ASSIZES.) It has prevailed greatly in prisons both at home and abroad even during the early part and middle of the present century—*e.g.*, in the Dublin prisons, 1815, at Rheims, 1839, and Strasburg in 1854. If it has ravaged armies navies, prisons, and hospitals, it has been also fatal to the civil population. In many cases the soldiers, sailors, or prisoners have evidently imported the disease; in others, if it has not arisen *de novo*, the mode of origin has been more obscure and difficult to trace. In Tuscany, 1550–54, a season of great scarcity, it destroyed 100,000 persons, and history shows that it has raged in various parts of the world like a plague. Ireland has had so many epidemics that typhus may be looked upon as thoroughly naturalised in that country. The principal Irish typhus years are 1708, 1718, 1729, 1735, 1740, 1770, 1797, 1803, 1817, 1826, and 1846. Most of the Irish epidemics have been imported into England. The chief dates marking severe outbreaks of typhus in this country are as follows: 1721, 1740, 1817, 1827, 1843, 1846–48, 1856, and 1862–69. There are only three of these outbreaks which were not connected with Ireland—viz., the epidemic of 1843, which began and raged most violently in Scotland; that of 1856, which was owing to a temporary distress connected with the Crimean war; and that of 1862–69, principally confined to London. One of the most violent of the Irish epidemics occurred in 1740. It is computed to have destroyed, together with famine, 80,000 people. But the epidemic of 1846 was of still greater magnitude, and indeed attained unprecedented proportions. It raged over the whole British Islands, and lasted two years. There are computed to have been 300,000 cases in England, 19,254 in Scotland, and a million cases in Ireland in 1847. The Irish flocked to England in thousands, bringing the pestilence with them. It therefore was extremely prevalent in Liverpool, no less than 10,000 persons dying of typhus in that city.

The last epidemic of typhus, 1862–69, in England was of a partial character; its principal seat was London. "There was no failure of crops in England, but for some time before there had been great and increasing distress among the poor of London, consequent on the organised system of strikes, the effects of which had only temporarily been averted by the relief from the societies for promoting the short-hour movement. As in 1826, 1836, and 1856, an *artificial* scarcity was the result."

—(MURCHISON.) This epidemic, also, cannot be said to have been imported from Ireland, since nearly 14,000 cases in 1862-69 were admitted into the London Fever Hospital, of which but a small proportion were Irish.

Dr. Murchison considers that the history of typhus leads to the following conclusions:—

"1. Typhus prevails for the most part in great and widespread epidemics.

"2. These epidemics appear during seasons of general scarcity or want, or amidst hardships and privations arising from local causes, such as warfare, commercial failures, and strikes among the labouring population. The statement that they always last for three years, and then subside, is erroneous.

"3. During the intervals of epidemics sporadic cases of typhus occur, particularly in Ireland, and in the large manufacturing towns of Scotland and England.

"4. Although some of the great epidemics of this country have commenced in Ireland, and spread thence to Britain, appearing first in those towns on the west coast of Britain where there was the freest intercourse with Ireland, it is wrong to imagine that all epidemics have commenced in Ireland, or that typhus is a disease essentially Irish. The disease appears wherever circumstances favourable to its development are present.

"5. In many epidemics typhus has been associated with relapsing fever, and the relative proportion of the two fevers has varied greatly.

"6. From the earliest times typhus has been regarded as a disease of debility, forbidding depletion, and demanding support and stimulation.

"7. The chief exception to the last statement originated in the erroneous doctrines taught in the early part of this century, according to which the disease was looked upon as symptomatic of inflammation or congestion of internal organs.

"8. The success believed at one time to follow the practice of venesection was only apparent. It was due to the practice having for the most part been resorted to in cases of relapsing fever and acute inflammations, and to the results having been compared with those of the treatment by stimulation of the much more mortal typhus.

"9. Although typhus fever varies in its severity and duration at different times, and under different circumstances, there is no evidence of any change in its type or essential characters. The typhus of modern times is the same as that described by Fracastorius and Cordanus. The period during which epidemic fever was said to present an inflammatory type was that in which relapsing fever was most prevalent, and the times in which the type has been described as adynamic have been those in which relapsing fever has been scarce or absent."—(MURCHISON.)

Geographical Range. All countries in Europe, the United States, North America, and probably India. Australia and New Zealand appear free from typhus, nor has it been observed in Africa.

Independent Origin.—A great number of facts have been brought forward attempting to prove the actual generation of typhus from the combined influence of overcrowding and destitution, but it has not been by any means established, and it can confidently be asserted that in no recorded first case of typhus is the idea of contagion absolutely excluded.

Dr. Parkes, speaking of the siege of Metz, says (Report on Hygiène, 1872): "With reference to the particular kind of fever in Metz, it may be noticed that an important argument against the production of exanthematic typhus from simple overcrowding has been drawn from the experience both of Metz and Paris. In both places during the sieges there was overcrowding, wretchedness, and famine, particularly at Metz; yet, as pointed out by Professor Chauffard to the Académie de Médecine, there was scarcely any or no typhus, as there had been in the wars of the first Napoleon. There was typhus in the German besieging force, but so strict was the blockade that it was not imported into Metz, and was not generated there."

Three cases, related by Murchison, occurred in London, and although there were no *known* typhus cases in the city at that time, yet there are all the chances that it was lurking about somewhere, and possibly not diagnosed. The celebrated case of the Scheah Gehaad is still more unsatisfactory, as it is now known that the Arabs from Alexandria were ill of *some disease* when they embarked. It is still an open question.

Predisposing Causes.—These have been already sufficiently indicated.

Prevention of Spread.—The first and cardinal point is free ventilation. It would appear that even without disinfectants free dilution destroys the poison, and renders it inert. If possible, a typhus patient should be put in the highest room in a house or hospital, as there is ample evidence to show that the poison is volatile and ascends. The breath and cutaneous exhalation of the patient are probably the principal, although not the only, vehicles of infection. The skin can be sponged frequently with some disinfecting fluid, such as Condy's, or permanently coated with olive oil mixed with a little carbolic acid. The room should be fumigated with chlorine or nitrous acid fumes. The latter is shown by experience to have most effect. The bedding should be burnt after the termination of the case, or thoroughly baked and washed, and the excreta disinfected with a solution of sulphate of iron.

In hot weather typhus patients will do better in tents or sheds than in hospitals. In any case they should never be crowded together, but have as much cubic space as possible. "It has been often shown that even exposure to weather, bad diet, and insufficient attendance are less dangerous to the patients than the aggregation of cases of typhus."—(PARKES.) *See* DISINFECTION ; FEVER, TYPHOID, &c.

Fever, Yellow — A specific fever of a continuous and malignant type, occurring only once in the same individual. There are no remissions. The symptoms are various. In most cases, after a period of incubation of from two to eight days, intense fever supervenes, attended by yellowness of the conjunctivæ and skin, delirium, hæmorrhages from the stomach, mouth, nares, and rectum (this has been called black-vomit, black-stools, &c.), intense headache, a slow and sometimes intermittent pulse.

Nature of the Disease.—Nearly all authorities who have *seen* the disease concur in agreeing that yellow fever is of a continuous type, and has nothing in common with marsh fever or malarious intermittents. "Yellow fever is an essentially continual and non-marshy fever. . . . It is not a marsh fever, nor a bilious remittent, nor a bilious hæmaturic."—(SULLIVAN, Yellow Fever at Havana, Medical Times and Gazette, 1871.)

It depends upon the absorption of a specific poison into the blood, which increases like other analogous diseases. Aitken thus summarises the facts as borne out by the history : (1.) That there is a specific yellow fever, propagated by a contagious virus or poison, which multiplies itself by its passage through the human system, and which reproduces the same specific true yellow fever. The type of this fever is continuous. Pyrexia, delirium, suppression of urine, black-vomit, are the leading symptoms of this fever—the hæmogastric pestilence, as it has been also called. (2.) That there are other fevers, and especially severe marsh fevers, in certain geographical limits, which have a close resemblance in symptoms to the contagious and specific yellow fever.

Geographical Range.—This is limited. It has never been known to propagate itself beyond 48° north latitude, and is principally observed in the islands and coasts of Central America. "The yellow fever zone appears to be chiefly, in Central America, confined to the volcanic range of the west of the country. West of the Lake of Nicaragua, the volcanic hills, which belong to a later geological period than the granitic slopes between the lake and the Atlantic, and throw a light tufaceous ash over the whole soil, include the chief yellow fever districts, like Realejo, Granada, Marsaya, or Rivas."—(Medical Times and Gazette, 1871, vol. i. p. 399.)

It is also observed on the western coast of Africa, and has been imported into Europe —*e.g.*, Lisbon (1859), Barcelona, Genoa, and has even appeared in France, at Brest (1857), Havre (1860), St. Nazaire (1861); but its true habitat is low-lying tropical coasts, the poison appearing to require a heat of at least 72° for its full development.

It also rarely occurs above an elevation of 2500 feet above the sea. Whether this is because of the more frequent cool winds and temperate or even cold climate of such heights is not clear. Yet it has prevailed at the Jamaica Newcastle, which is 4000 feet high.

Method of Propagation.—It is eminently an infectious disease. So many remarkable instances have been recorded of this property that the fact is put beyond a doubt. For example, the importation into St. Nazaire of yellow fever took place as follows : The 13th of June the Anne Maria left Havana for France with a cargo of sugar. At this port yellow fever was then raging. There was no sickness for seventeen days, but on the 1st of July two sailors were seized with yellow fever and died ; others were attacked on following days ; and when, on the 25th of July, she reached St. Nazaire, seven men were still sick. On arriving, the sailors left the ship, and dispersed yellow fever throughout the land. The fresh men employed to unload the ship were also attacked, and the fever was communicated besides to the crews of two out of eight vessels which lay near the Anne Maria. One of these, Le Chastan, lost all her crew, consisting of five men, although they had only been on the Anne Maria for a quarter of an hour. Other instances occurring in ships—such as the cases of La Plata, the Eclair, the Bann, the Imaun, and the Icarus—show that the period of incubation is sometimes more than seventeen days, and that a ship may carry infection to any port in Europe, especially if the weather is hot.

The predisposing causes and fatal character of the disease may be seen in the course of the yellow fever which raged like a plague at Buenos Ayres in January, February, March, April, and May 1871. During nine days, from April 3d to the 12th, 3985 are said to have died, and the Board of Health ordered all who could do so to leave the city. The mortality was greatest among males, and the total number of deaths of all ages and both sexes in the five months was estimated at about 20,000, and this out of a population of 180,000.

"The influence of meteorological conditions was remarkable. Cold greatly increased the number of deaths, but seemed to be followed by a smaller number of new cases. Heat augmented the number of new cases, and rain, combined with heat, appeared to favour most the progress of the epidemic. An arrest seemed to be put to the disease by several days of extreme cold, followed by very heavy rains, even although the temperature which followed was again higher, though not so high as previous to the week of climatic crisis."—(HIRON, On Yellow Fever, Medical Times and Gazette, 1871, ii. p. 125.)

"Statements about diminution of ozone in the atmosphere, and of electrical aberrations, were made, but they were entirely unsupported by acceptable evidence. It was the opinion of the professor of chemistry in the university (who unfortunately himself succumbed to the disease), from some partial experiments he made, that the amount of ozone was not diminished."—(*Op. cit.*)

That the fever finds a ready vehicle in putrid emanations, and propagates most readily in stinking, crowded, and insanitary places, appears very evident from the history of this and other epidemics—*e.g.*, "the greatest sufferers by the plague have been the Italians, who are the poorest part of the population, and live in the worst hygienic conditions."—(*Op. cit.*)

The picture of the town itself is also instructive.

"Buenos Ayres is a city without drainage, in which the population occupies a small area in proportion to its number. The streets are narrow, and, rents being very high, it is usual for many people to live in one house. The most complete disregard for all hygienic rule exists, and the débris from the slaughter of the cattle has been hitherto discharged into an almost stagnant inlet of the river, in most unpleasant proximity to the city. The odour from this source has been with a favourable wind almost insupportable, even in the centre of the city. The method of making streets has been to fill up with offal before macadamising. Such filthy water-closets I have never met with anywhere, although one gets to a certain extent prepared by what one encounters on the continent in Europe."—(HIRON, On Yellow Fever in the Plate, 71.)

All the widespread epidemics tell the same tale of disgraceful filth. For instance, the city of Shreveport was recently visited by a frightful epidemic of yellow fever.

"Owing to political causes there had been no regular municipal government at Shreveport, and the city became in a very filthy condition, added to which a Texan boat with cattle sank in the Red River, and the bodies of the dead animals were allowed to putrefy on the shore."—(Lancet, Nov. 15, 1873.)

Prevention of the Spread of the Disease.—"La fièvre jaune," says Tardieu, "avec la peste se place au premier rang des maladies pour lesquelles les mesures sanitaires sont reconnues indispensables."

The great principle is, then, isolation of actual cases; a strict quarantine for at least twenty days of vessels coming from infected ports, or men from infected localities; removal of an army or a camp from a low-lying district to a higher station, if possible; disinfection of all excreta, and the free use of nitrous fumes. The dead must be speedily buried, and the house or camp where they died razed to the ground, burnt, or, if that is impracticable, thoroughly cleansed, fumigated, and disinfected.

Yellow fever is best treated in the open air, or in temporary sheds, if weather permits.

The general sanitary measures alluded to include the prompt removal of refuse from the streets of a town, good drainage, healthy habitations, and a pure water-supply.

The history of the disease would show that the greater portion of the poison is in the vomit and dejecta.

T. G. Wilson has described and figured some small circular cells in the vomit, which were not blood corpuscles, and which gave signs of activity by dividing under the microscopic field. These were observed in an epidemic at Bermuda, 1864.—(Lancet, November 1, 1873.) What these cells mean is at present unknown. The perspiration, and probably all excreta, is contagious.

Fibrine—*See* SYNTONINE.

Figs—The figs of commerce are the dried fruit of *Ficus Carica*, the common fig-tree. It is a native of Asia and Barbary, and has been naturalised in Greece, Italy, Spain, and the South of France. The best figs are brought from Smyrna, and are known as Turkey figs. They are a very rich and luscious fruit, contain a large quantity of sugar, and when dried are very nutritious. They are demulcent, emollient, laxative, and pectoral.

Filaria Dracunculus (*Medinensis*), or **Guinea Worm**—The Guinea worm is essentially a tropical parasite. It exists as a female in the connective tissue of man and of some animals, and it resembles a long piece of uniformly thick white whipcord. The female contains enormous quantities of young. As many as fifty worms have been discovered in

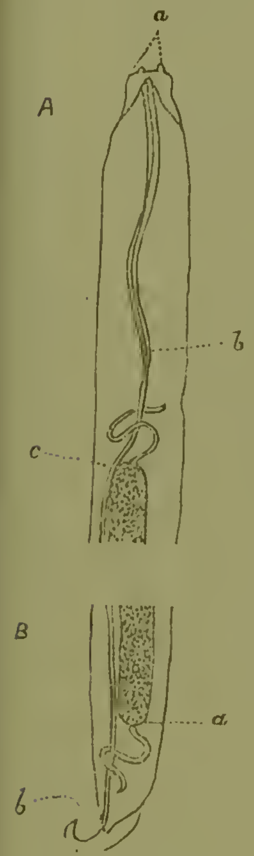


Fig. 29.

Fig. 30.

one individual, but such a number is extremely rare; in the majority of cases only one is present. 98·95 per cent. of this parasite make their exit at the lower extremities; but occasionally the worm appears in the socket of the eye, the mouth, the cheeks, or below the tongue. The average length of the Guinea worm is 25·5 inches (EWART), the shortest being 12¾ inches, and the longest 40 inches. Its structure may be gathered from the following diagrams. *A*, fig. 29, is the anterior extremity of the worm slit open and magnified, showing, *a*, upper and lower cephalic papillæ in profile; *b*, junction of œsophagus with intestine, and constriction of peritoneal sheath. *c* is the anterior termination of the uterus, with short ovarian tube; the whole extent of this uterine sac is crowded with innumerable young. *B* is the posterior extremity of the worm, showing, *a*, the posterior termination of the uterus and ovarian tube, and *b*, the termination of intestine. The mature animal protrudes the extremity of this proliferous capsule through one of the small papillæ (*see* fig. 30), representing the anterior extremity of the worm, with *a*, the dilated and protruded ovisac; and *b*, the funnel-shaped sheath surrounding it. The anterior end of the worm has a punctum in its centre $\frac{1}{2000}$ of an inch in diameter, surrounded by rugæ in circles. Above and below are two papillæ opposite each other, with a transparent area in the centre of each. Two lateral tubercles, small and indistinct, also exist. — (BASTIAN.) The relative position of these structures is shown in fig. 31. There are great varieties in the shape of the lower end of the worm (*see* fig. 32). A transverse section of the worm shows—*a*. *a*, *a*, *a*, sections of four longitudinal muscles; *b*, the flattened intestine; *c*, the walls of the uterine sac (*see A*, fig. 33).

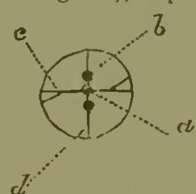


Fig. 31.

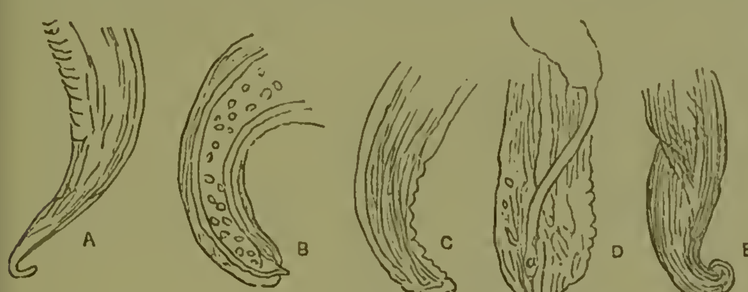
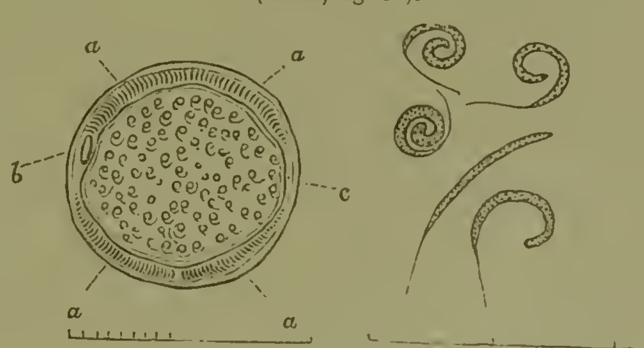


Fig. 32.

The young of the Guinea worm are represented in fig. 33, *B*.

It is generally believed that this parasite is introduced by means of water, and it has been a disputed point whether it is taken into the stomach in drinking or penetrates the skin during bathing or wading. Dr. Lorimer says, "Many people belonging to the bazaars in the vicinity of the lines, affected with the parasite, came for the express purpose of extracting the



A Fig. 33. *B*

worm to the same tank where the men of the regiment bathe. The people so infested swim about in the water with the worm hanging loose, drawing the limb quickly backwards and forwards through the water, and from side to side, until expulsion is effected." The female, in these cases, would die in the stream, and so give freedom to her immense brood of young. If placed in pure water, the latter die in four, five, or six days; but in impure water they will live twenty-one days. This parasite is induced to leave the human body more quickly by means of water than by anything else, and is usually to be discovered beneath organic débris in tanks, wells, and other reservoirs. That the parasite enters the body of man when bathing, or lying on moist places where the tank-worm abounds, is extremely probable, and this view is supported by pretty strong evidence.

Filaria Sanguinis Hominis — This hæmatozoon was discovered in the blood and urine of certain patients who had come under the notice of Mr. T. R. Lewis, M.B., in India, during the year 1872. It is about $\frac{1}{75}$ of an inch in length, and with a transverse diameter of $\frac{1}{3500}$ of an inch.

On being first removed from the blood it moves about incessantly, coiling and uncoiling itself unceasingly, lashing the blood corpuscles about in all directions, and insinuating itself between them. At first the worms look translucent; the larger specimens, however, frequently present an aggregation of granules towards the junction of the lower and middle half. Occasionally a bright spot is seen at the thicker extremity, suggestive of a mouth. They continue active from six to thirty hours. The hæmatozoon is enveloped in an extremely delicate tube, closed at both ends, within which it is capable of elongating or shortening itself. Mr. Lewis concludes from this fact that its home is the blood, and that it has no means of perforating the tissues.

"They are persistently so ubiquitous," says the discoverer, "as to be obtained day after day by simply pricking any portion of the body, even to the tips of the fingers and toes of both hands and both feet of one and the same person, with a finely-pointed needle. On one occasion six excellent specimens were obtained in a single drop of blood by merely pricking the lobule of the ear."

Dr. Lewis calculates, from the number found in one drop of blood, that more than 140,000 were present in one patient; and it would appear that chylous urine, a disease common in the East, is dependent on the presence of these creatures in the blood. It is probable that this worm may be introduced by the water used for drinking purposes.

Filters—Filtration is usually resorted to for the purpose of freeing liquids from feculence, dirt, and other foreign matter; but frequently it has for its object the collection of the suspended substances as precipitates, &c.; for laboratory filtration, filtering papers are prepared.

Before speaking of the larger and more elaborate filters it may be as well to repeat here the following suggestion (which we take from the Proceedings of the British Association) for making a small portable filter. Take any common vessel perforated below, such as a flower-pot, fill the lower portion with coarse pebbles, over which place a layer of finer ones, and on these a layer of clean coarse sand. On the top of this a piece of burnt clay, perforated with small holes, should be put, and on this again a stratum, 3 or 4 inches thick, of well-burnt pounded animal charcoal. A filter thus formed will last a considerable time, and will be found to be particularly useful in removing noxious and putrescent substances held in solution by the water.

Water is purified on an extensive scale by being received into large filter-beds previous to its distribution. A filter-bed is a kind of tank or reservoir many feet in depth, with paved bottom, on which are laid a series of open-jointed or perforated tubular drains leading into a central culvert increasing in coarseness.

The effect of this filter is shown in the following table:—

It lessened the—	Grains.
Total solids by	7·063
Mineral solids by	4·703
Volatile solids by	2·360
Total amount of oxygen required for oxidation by nearly one-half	0·1546
Hardness by	4·61
Chlorine by	0·6
Free ammonia by	0·0042
Albuminoid by	0·0126

After a certain time the sand becomes useless and requires washing. The fine white sand is the best, and should be carefully chosen.

These drains are covered with a layer of gravel about 3 feet deep, over which is spread a layer of sand about 2 feet deep. The gravel is coarse at the bottom, becoming gradually finer towards its upper surface, and the sand is arranged in a similar manner. The water is delivered uniformly and slowly; and in order that the filtering process may not be carried on too hurriedly the pressure is always kept low, the depth of water being seldom above 2 feet, and in some cases only 1 foot.

Dr. Parkes made some experiments on a sand filter of 1 square foot surface, and made in imitation of a London water company's filter—viz., 15 inches of fine well-washed white sand, and 20½ inches of gravel gradually.

A filter which possesses the advantages of being easily and cheaply cleaned when dirty, and which frees water from mechanical impurities with great rapidity, may be formed by placing a stratum of sponge between two perforated metallic plates, united by a central screw, and arranged in such a manner as to permit of the sponge being compressed to any required degree. Water under gentle pressure flows with great rapidity through a compressed sponge; but this, of course, has no chemical action on the liquid, and does not remove organic matters dissolved in the water.

Pure, well-compressed animal charcoal, deprived of calcium, phosphate, and carbonate by washing with hydrochloric acid, is certainly the best filtering substance. Filters made of the magnetic carbide of iron are also very useful; and those composed of charcoal, or of the latter substance, are capable of removing all the suspended matters, and at least 40 per cent. of dissolved organic impurities, together with a considerable amount of salts, such as calcium, carbonate, and sodium chloride. The filtering material of the magnetic carbide filter is prepared by heating hæmatite with sawdust. It gives a slight taste of iron to the water. The silicated carbon filter will render river-water, containing a considerable amount of free and albuminoid ammonia, as pure as deep spring-water.—(Wanklyn.) The same authority says that slow filtration, through a layer 4 inches thick of animal charcoal in coarse powder, removes all organic matter from water; but after it has been in use some little time, the charcoal fouls and requires to be cleaned, either by being treated with permanganate of potash and potash, by which means we get off ammonia from it in large quantities, or by letting it stand for some hours in the air, and thus the organic matter will be oxidised and disappear.

Waters may also be purified by precipitation. This is known as Dr. Clark's process, and is useful for such waters as contain carbonate of lime retained in solution by excess of carbonic acid. To such water lime is added, and is, as well as that contained in the water, precipitated. *See* Water.

Parkes gives the following method for cleaning filters: "Instead of taking the filter to pieces when it is clogged, every two or three months (according to the kind of water) air should be blown through; and if the charcoal be in a block form, it should be brushed. Then 4 to 6 oz. of the pharmacopœial solution of potassium permanganate, or 20 to 30 grains of the solid permanganate in a quart of distilled water, and 10 drops of strong sulphuric acid should be poured through, and subsequently a ¼ to ½ oz. of pure hydrochloric acid in 2 to 4 gallons of distilled water. This both aids the action of the permanganate and assists in dissolving manganic oxide and calcium carbonate. Three gallons of distilled or good rain water should be poured through, and the filter is then fit for use." Charcoal may be purified in the manner previously mentioned, or it may be baked in an oven.

A charcoal filter has recently been introduced by Captain Crease of the Royal Marine Artillery, for the use especially of ships, and is now largely employed in the navy; but it is also found to be of great value in large buildings, such as asylums, workhouses, &c. The tank is made of iron lined with cement, and is divided into three chambers. The two filtering-boxes which it contains are filled with pieces of animal charcoal, or one may be filled with charcoal and the other with sand and gravel. The upper perforated plates of the boxes are movable, so that by means of screws working on rods attached to the fixed under plates, which are also perforated, the filtering media may be lessened or compressed to any extent, according to the degree of impurity of the water. The water descends through one box into a small chamber at the bottom of the tank, which retains any deposit, and then rises through the second box into the reservoir, which contains the filtered water. The whole can readily be taken to pieces and cleaned when necessary, the joints being made water-tight by means of indiarubber bands. On the same principle smaller filters have been patented by Captain Crease.

Filters are now made of all shapes, sizes, and materials; but, as already remarked, those in which the filtering material consists of charcoal, magnetic carbide of iron, or silicated carbon, are the best. *See* Water, Disinfectants, Charcoal, &c.

Filtration of Sewage—*See* Sewage.

Fireplaces—*See* Warming.

Fires—As recommended by the Select Committee of the House of Commons on Fire Protection (1867), there should be in all towns and places of any size in the kingdom a general building Act, which should contain provisions for protection against fire arising from faulty construction.—(Report, No. 471, Session 1867.)

One of the most interesting questions relative to hygiène is that of spontaneous fires. One of the most common causes of these is friction, which, taking place between two combustible bodies, often develops sufficient heat to kindle one or both of them; or if it take place between non-combustible bodies, the heat produced may nevertheless set on fire adjacent substances. The continual to-and-fro movement of a ship's mast has frequently ignited the cargo, and fires have arisen in railway carriages and manufactories by the friction of the wheels or other machinery.

The sun's rays may by accident be condensed on inflammable matter; for instance, a piece of a broken bottle has remained in such a position as to act like a burning-glass, and concentrate the solar rays on a heap of straw, which has ignited and set fire to a building. In July 1840 an explosion took place at Grenoble, which could only be explained by the sun's rays being condensed by a pane of glass with certain flaws in it, and the destruction of the palace of the Duchess of Abrantes is cited as due to a similar cause.

Quicklime has given rise to spontaneous combustion—*e.g.*, a heap of quicklime was in a farmyard near a stable, the urine from the horses having moistened the lime, enough heat was developed to set fire to some dried leaves, from which it spread elsewhere.—(TARDIEU.) Heaps of charcoal, iron pyrites and other metallic sulphides, scrap-iron, and the like, have all, whether by oxidation or chemical action, caused fires.

But the most dangerous collections are, without doubt, heaps of greasy rags, wool, bits of cotton, &c. Many fires occurring in factories arise from carelessness in heaping together shreds of stuff which have been used for wiping machinery, and are therefore impregnated with carbonaceous matter and oil. Experiments have long ago shown that a mixture of soot, oil, and rags is more liable to spontaneous combustion than any substance *commonly* met with. All humid vegetable or animal heaps, whether they be straw, hay, oats, flour, manure, leaves, or similar matters, do occasionally take fire spontaneously, simply from the heat developed by oxidation. According to M. Chevallier, the different matters most liable to ignite spontaneously are—

1. Heaps of damp wheat.
2. Ground coffee.
3. Malt.
4. Scorched chicory.
5. Scorched rye.
6. Heaps of peat ashes.
7. Large compact heaps of newly-ironed linen put up hot.
8. Heaps of burnt cocoa.
9. Bones covered over with animal black.
10. Wet sawdust.
11. Flour from grain or from leguminous seeds.
12. Heaps of old cordage.
13. Linseed-oil cakes.
14. Mixtures of vegetables which have been boiled with greasy substances, and retain them.
15. Heaps of tobacco.
16. Rotten wood.
17. Sulphuric and nitric acids in contact with combustible matters, such as straw, wool, essential oils, &c.
18. Phosphoric *briquets* made with phosphorus and magnesia.
19. Different species of pyrophores.

Every householder should see that, in case of emergency, he has access to plenty of water, and should remember that if a fire breaks out in a room, the first thing to be done is to shut doors and windows fast, so as to rob the fire of the air which feeds it. On the same principle a chimney on fire is easily put out by stopping up the chimney or fireplace beneath. A little sulphur thrown on the coals will also extinguish a chimney on fire. Sal ammoniac, or kitchen salt, may also be used for this purpose; dissolved in water, the extinguishing power is much greater.

In escaping from a burning apartment, as smoke and most gases ascend, although it is impossible to breathe standing up, the air may be tolerably pure close to the boards. Experience has proved this, so that the person should crawl along with the head low down and a damp handkerchief over the face.

In 1871 the returns show that 167 males and 307 females died from their clothes taking fire. This accident should never happen, especially to females, as there are numerous methods of rendering even muslin uninflammable: the best is a solution of a salt called tungstate of soda. "Muslin steeped in a solution containing 20 per cent. of this salt is perfectly non-inflammable when dry, and the saline film left on the surface is smooth and of a fatty appearance, like talc, and therefore does not interfere with the process of ironing, but allows the hot iron to pass smoothly over the surface. The non-fulfilment of this latter condition completely prevents the use of many other salts, such as sulphate or phosphate of ammonia, which are otherwise efficacious in destroying inflammability for all fabrics which have to be washed and ironed."—(WATTS.)

Urban sanitary authorities may provide fire-engines and all necessary appliances, and fire-escapes. They may also purchase and keep on hire horses for drawing the engines, provide enginehouses, and employ persons to act as firemen, paying them whatever salaries or rewards they may think fit. These engines and firemen may be employed in cases of fire beyond the limits of the district. The owners of the buildings on fire are to pay for the service rendered.

By 11 and 12 Vict. c. 63, s. 124, urban sanitary authorities are to cause fire-plugs, and all necessary works, machinery, and assistance, to be provided and maintained, in order to have an efficient supply of water in cases of fire. For this purpose they may enter into agreement with any water company or other person. The situation of the fire-plugs is to be indicated by marks on the neighbouring houses or walls.—(P. H., s. 66.)

Urban authorities may make bylaws relative to the structure of walls, roofs, buildings, &c., in order to prevent fires.—(P. H., s. 157.)

By the 28 and 29 Vict. c. 90, s. 30, the Metropolitan Board of Works, when necessary, may permit any part of the fire brigade establishment of the metropolis to proceed with their engines, escapes, &c., beyond the limits of the metropolis.

Persons wilfully setting a chimney on fire are liable to a penalty not exceeding £5. Notwithstanding the fine, the person is not exempted from liability to be indicted for felony. The chimney of a house catching fire from any omission (such as not being swept), neglect, or carelessness, the occupier is liable to a penalty not exceeding 10s.

Under the Metropolitan Building Act, 18 and 19 Vict. c. 122, s. 1, there is a very useful prohibition against building the walls of houses in the metropolis of wood or other combustible material.

Fish—The composition of the most common edible fish will be found under their respective headings. *See* Eel, Salmon, &c.

Flounder—This fish contains about 22 per cent. only of solid matter, and 18 per cent. of this is nitrogenous. It requires fat, therefore, to render it of any great nutritive value.

Composition of Flounder.

Nitrogenous matter	18·1
Fat	2·9
Saline matter	1·0
Water	78·0
	100·0

Flour—The meal of wheat and of the seeds of some of the leguminosæ finely ground and "dressed." The wheat which is cultivated in this country is a kind known as *Triticum vulgare*; of this there are two varieties, *T. æstivum* and *T. hybernum*, the former the summer wheat, the latter the winter wheat. The article known specifically as "flour" in this country is obtained from the summer variety (*T. æstivum*). Flour of the best quality is almost always freed from bran, and since the latter contains as much as 15 per cent. of nitrogen, some fat, and a good proportion of salts, it becomes a question whether this separation is desirable. (*See* Bran.) Should the whole of the wheat be used, it is important that it should be ground very fine, since the harder envelopes are excessively irritating. Flour is one of the most useful alimentary materials we possess. In the form of bread it constitutes the staple food of this and many other countries; made into cakes, puddings, and biscuits, it is largely taken; and from the hard, highly-glutinous wheat of Sicily, Russia, Sardinia, Algeria, and Egypt certain granular powders and dried pastes, possessing great nutritive properties, are manufactured. The more important of these are semola, semolina, soujee, mannacroup, maccaroni, vermicelli, and Cagliari paste.

For the full consideration of flour as an alimentary substance we would refer the reader to the article on Bread; but we may mention here that wheaten flour contains a greater amount of proteine or nitrogenised compounds —that is, of blood and flesh-making principles —than any other description of farina.

The amount of flour obtained from one quarter or 504 lbs. of wheat is given by Mr. Hard of Dartford as being 392 lbs., the rest of the products consisting of "biscuit or fine middlings," "toppings or specks," "best pollard," "fine pollard," "bran," and "coarse pollard," &c.

Good wheaten flour should be sweet and free from acidity. It should not lose more than from 6 to 12 per cent. by being carefully baked in a stove; should exhibit no trace of bran even when pressed smooth with a polished surface; and its cohesiveness should be so great that on being squeezed in the hand the lump should be some time before losing its shape. The colour of good flour is white, or with a very slight tinge of yellow. There should be no lumps in it, or if any exist they should at once break down on slight pressure. When the flour is made into a paste with water, its quality may be judged of by the tenacity of the dough, the length to which it may be drawn into a thread, or the extent to which it may be spread out into a thin sheet. The nutritive value of flour, as far as gluten is concerned, may be determined by the following method: About 500 grains of flour are made into a stiff dough, and by tender manipulation carefully washed under a stream of water. The gluten remains, and when it is baked it expands into a clean-looking ball, which should weigh, when dried thoroughly, 54 grains. Bad flour makes a thin ropy gluten, which is very difficult to deal with, and has when baked a dirty brown colour.

The practical test for determining the quality of flour is to make a loaf with it, see if it be acid when fresh (best flour, although not acid to the taste, gives an acid reaction with the test-paper), and how soon it becomes so, if the colour be good, and the rising satisfactory. Old and changed flour does not rise well. It gives a yellowish colour to the bread, and speedily becomes acid.

Adulterations of Flour.—The flour of wheat is adulterated with the flour from cheaper substances, such as beans, peas, maize, oats, rye, barley, and potato, and in some countries with rice, buckwheat, millet, linseed, &c. The mineral adulterants which have been found are alum, sulphate of lime, bone-dust, calcium, and magnesium carbonates, and a few others.

The inferior flours may be detected by a microscopic examination combined with careful measurements by a micrometer. The granules of wheat starch (fig. 34) are 0·36 millimetres in diameter (or ·0015 inch), and are thus intermediate in size between potato and rice starch. *See* WHEAT, RICE, &c.

Fig. 34.

Potato starch, if present, may be readily separated for microscopical examination by the following process: Mix the flour with 40 per cent. of its weight of water and knead it into a homogeneous paste, separate the gluten by a stream of water, reserving the washings containing the starch cells for examination. The washings are then shaken briskly, filtered through a linen filter, and decanted into a conical glass. The potato granules being the heaviest, settle first, so that as soon as a deposit shows itself, before the liquid clears completely, the supernatant fluid is decanted off, the deposit taken and suspended in water, and the same process repeated four or five times, the products being examined by the microscope. This process, it is said, will detect one part of potato starch in a hundred of wheat-flour. (Journ. de Pharmac., 3d Series, xv. 241.)

Chemical Examination of Flour.—The following table gives the composition of flour. It will be observed that the different authorities fairly agree of fat, water, and sugar, but the ash in Peligot's, Letheby's, and Payen's analysis is much too high.

Analyses of Flour.

	PELIGOT. Mean of 14 Analyses.	LETHEBY.	PAYEN.	WANKLYN Fine Wheaten Flour
	per cent.	per cent.	per cent.	per cent.
Water	14·0	15·0	14·22	16·5
Fat	1·2	2·0	1·25	1·2
Nitrogenous matters, gluten, &c.	12·8	10·8	14·45	12·0
Do. soluble in water	1·8	...	...	...
Non-nitrogenised substances, dextrine, sugar, &c.	7·2	70·5 (with starch and cellulose)	68·48	69·6
Starch	59·7			
Cellulose	1·7			
Salts (ash)	1·6	1·7	1·6	0·74

The water may be estimated by drying up a gramme in a platinum dish, in the usual way upon a water-bath. The water naturally present in flour would appear to vary from 14 to 17 per cent. The same sample burnt up, should not yield more than 0·7 per cent. of ash. If it yields as little as even 1 per cent., adulteration should be suspected. Hence the detection of mineral substances is satisfactory and easy. A determination of the fat in flour may be made by treatment with ether. If mixed with oats or maize, the fat would be *above* the normal amount; if mixed with rice, it would be *under*.

A hundred grammes of flour, according to Mr. Wanklyn, yields an extract to cold water weighing 4·69 grammes. Its composition is as follows:—

	Grammes.
Sugar, gum, and dextrine	3·33
Vegetable albumen	0·92
Phosphate of potash	0·44
	4·69

Mr. Wanklyn recommends the determination of gluten by his well-known ammonia process. For this purpose 20 milligrammes of flour are put into a retort and distilled with alkaline permanganate (*see* AMMONIA, WATER ANALYSIS, &c.), and the distillates nesslerised. Twenty milligrammes of flour give 0·24 milligrammes of ammonia; *i.e.*, 100 parts of flour yield 1·2 parts of ammonia.—(WANKLYN.)

For the detection of *alum* in flour, *see* BREAD.

Flukes (*Trematoda*)—A parasite which infests the livers of men and herbivorous animals. The most common is the *Distoma hepaticum*, or liver-fluke. *See* DISTOMATA.

Flummery, Sowans, or **Seeds**—This is a very popular article of diet in Scotland and Wales. The husks of oats, with the starchy particles adhering to them, are separated from the rest of the grain and steeped in water for one or two days until the mass ferments and becomes sourish. It is then skimmed, and the liquid boiled down to the consistence of gruel. The husk contains between 6 and 7 per cent. of saline matter. *See also* OATMEAL.

Flux, Bloody—The bloody flux was the old and vulgar name for dysentery, and indeed for any discharge from the bowels accompanied with blood. *See* DYSENTERY.

Fly-Poison—Many of the common fly-papers contain arsenic, the ordinary ingredients being either a strong solution of white arsenic sweetened, or a mixture of saccharine matters and orpiment. There is also a fly-powder made of the suboxide of arsenic mixed with sweets. All the above are poisonous, and have accidentally caused fatal effects both in man and animals. Nor is there any reason that such deadly substances should be employed as fly-killers, for the following compounds are equally efficacious, but, as far as man is concerned, harmless in ordinary doses:—

1. Quassia chips, ¼ oz.; water, 1 pint. Sweeten with treacle.

2. Black pepper, 1 teaspoonful; brown sugar, 2 teaspoonfuls; cream, 4 teaspoonfuls.

Saucers of either of the above exposed in fit places rapidly decrease the number of flies in a room.

Fogs—That fogs, especially if dense and prolonged, are very injurious to public health there can be no question, and the following returns fully illustrate the truth of this statement:—

From the 8th of December until the 12th of the same month, 1873, London was visited with a thick dense fog, and the Registrar-General's return shows the effect this visitation had upon the mortality of the metropolis. The death-rate in London, for the week ending December 6, was 23 per 1000; in the following week, when the fog was prevailing, the rate rose to 27; and in the week afterwards, the full effect of the fog is shown by the remarkable death-rate of 38 per 1000. The deaths returned from phthisis and diseases of the respiratory organs in the same weeks were 520, 764, 1112 respectively. That this altered death-rate was not occasioned by the cold which accompanied the fog, is shown by the fact that in large provincial towns where the weather was equally cold, but where there was no fog, the increase in the mortality was slight compared with that which occurred in London. The mean of the deaths registered in London, in the two weeks ending December 20, showed an increase of 41 per cent. upon the number returned in the first week of the month. The corresponding increase in the seventeen other large English towns was only 8 per cent. The cattle-show was held during this week, and it is said that the animals suffered severely, several dying in consequence of the thickness of the atmosphere.

Dr. Angus Smith found 20·82 per cent. of oxygen in a dense fog, "such as has rarely visited Manchester." (The amount contained in a favourable specimen of air he gives as being 20·96.) *See* AIR.

Foie Gras—*See* LIVER.

Fomites—The general meaning of this vague term is clothes, rags, bedding, or any other substance carrying with it the contagion of fever. Thus when we say typhus is communicated by *fomites*, we mean that it may be conveyed from place to place in clothes, linen, boxes, &c., and from these substances the specific germ communicated to a healthy person.

Food—Food may be defined as a substance containing a certain amount of latent or potential energy, which may become converted into dynamic or actual energy, and which manifests itself in the body as constructive power, heat, nervo-muscular action, mechanical action, &c.; or it may consist of inorganic substances, which, although themselves not capable of oxidation, are necessary to the metamorphosis of organic matter which takes place in the animal economy. Food, to properly deserve that title, must consist of these two classes, the organic and the inorganic; for neither of these alone is capable of the manifestation of energy.

Irrespective of experiment, there are two great sources of knowledge from whence we may with considerable accuracy predicate the necessary elements of the food of man or animals; that is, first, the composition of the body itself; secondly, the composition of the simple aliment it receives in early life; for the components of the body must be built up from the outer world, and the food the body receives whilst growing must contain all the elements necessary to form the tissues. But as nothing in nature is pure, neither the invisible air nor the transparent water, still less more complex substances, it is probable that the traces of certain substances found in very small quantities in human and animal bodies are purely accidental, and not essential.

The human body contains the following substances, which may be deemed essential: Carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, chlorine, sodium, potassium, calcium, magnesium, iron, fluorine, and smaller quantities of silicon, manganese, aluminum, and copper, which are possibly merely accidental impurities.

The first nutritive fluid the young of the higher animals receive is *milk*, and from this fluid bone and muscle, nerve elements, and other tissues are capable of being formed, a fact which every one can verify.

Now, milk contains the types of the two chief classes of organic substances which, according to the great generalisation of Liebig, are the essentials of food—viz., *nitrogenous substances*, represented by caseine and other albuminoid components; and saccharine and hydrocarbonaceous bodies, represented by sugar and fat, all being associated with water and salts; the latter are especially combinations of calcium, magnesium, sodium, potassium, and iron, with chlorine, phosphoric acid, and in smaller quantities with sulphuric acid.

It then appears a just method, one supported by reason and known facts, in classifying foods, to take as a leading principle the constitution of milk, but without losing sight of other considerations. Thus—

1. Inorganic Matters, comprising water and salts.

2. Organic Matters. (1.) *Non-nitrogenous.* (*a.*) *Hydrocarbons or Fats.*—Substances containing carbon and hydrogen in combination with only a small amount of oxygen. (*b.*) *Carbo-Hydrates.*—Substances in which carbon exists with oxygen and hydrogen, these latter always being in the proportion to form water. (2.) *Nitrogenous Matters.*

Inorganic Constituents of Food.

Water.—Water itself is not a force-producing agent, but as the body contains no less than 15½ lbs. of water, and twice this amount daily ebbs and flows, its importance is manifest. Water, indeed, is concerned in almost every physiological action, and is an absolute necessity of life. It lubricates the tissues, conveys and distributes the food throughout the system, removes effete matter, and by its evaporation maintains the body at a constant temperature.

Mineral Matters of Food.—The following table from Liebig will give a good idea of the relative importance of the saline matters of the blood.

Percentage Composition of the Mineral Matters of Blood.

	Man.	Pig.	Dog.	Fowl.	Sheep.	Ox.
Phosphoric acid . . .	31·79	36·50	36·82	47·26	14·80	14·04
Alkalies	55·66	49·80	55·24	48·41	55·79	60·00
Alkaline earths	3·33	3·80	2·07	2·22	4·87	3·64
Mineral acids and oxide of iron	9·22	9·90	5·87	2·11	24·54	22·32
Total	100·00	100·00	100·00	100·00	100·00	100·00

Lime, usually in the form of phosphate, forms almost entirely the ash of milk. It is not only present in the hard structures of the body, as the bones and teeth, but it also enters into the composition of the flesh; and indeed there is no tissue in which it is entirely absent. And there is good reason for believing that no cell-growth can take place without it. In the lowest forms of infusorial life we find earthy phosphates.

Chlorine acts on the albuminates, iron is required for the red-blood corpuscles, and there are no secretions which do not contain the alkalies in the form of chlorides or carbonates, or both; in short, it may be inferred that at least the alkalies, phosphoric acid, chlorine, the salts of lime and magnesia, and small quantities of iron are necessary for the purposes of healthy nutrition.

Organic Matters of Food.

(1.) *Non-nitrogenous.* (*a.*) *Hydrocarbons or Fats.*—Fats, chemically considered, consist of a fatty acid, in combination with a radical, and the following may be given as the percentage composition of the chief fatty principles:—

Carbon	79
Hydrogen	11
Oxygen	10
	100

The formula answering to the above consists of $C_{10}H_{18}O$.

The main function of fat is most decidedly to keep up the heat of the body; it has, moreover, certain mechanical offices to perform. (*See* FAT.) Some considerable doubt exists as to whether fat and starch are nutritively convertible. The most recent experiments of Pettenkofer and Voit (Zeitschrift für Biologie, ix. 435–540) answer the question decidedly in the negative, so far as the dog (*Carnivora*) is concerned. They assert that in no instance is fat formed from a carbo-hydrate, but entirely from albuminous matters, and there is no relation between the starch ingested and the fat deposited. Thus some of the results of their experiments are exhibited in the following tables:—

Dry Starch taken in.	Meat decomposed.	Fat deposited from the Starch or Albumen.
379	24	24
608	193	22

which shows that, although twice as much starch is ingested, the same quantity, or even less, of fat is deposited.

The following table is still more striking. It shows that with equal quantities of starch, but increasing quantities of meat, the amount of fat regularly rises in exact proportion to the amount of meat decomposed, which certainly is in the nature of a positive proof of the origin of fat from albumen:—

	Dry Starch taken in.	Meat decomposed.	Fat deposited from Starch or Albumen.	Deposit of Fat calculated from (1).
(1.)	379	211	24	...
(2.)	(344)	(344)	(39)	39
(3.)	379	608	55	67
(4.)	379	1469	112	132

Voit agrees with Henneberg, that 100 parts of fresh meat give 11·2 of fat.

As regards the manifestation of energy, it may be assumed from these experiments that 175 parts of starch are equivalent to 100 of fat.

(*b.*) *Carbo-Hydrates.*—The oxygen and hydrogen contained in these substances are united with the carbon in the proportion to form water, hence their name, carbo-hydrates. Comprised under this head are such substances as starch, grape-sugar, sugar of milk, inosite, gum, dextrine, cellulose, &c.

The carbo-hydrates are mainly decomposed in the system into carbonic acid and water. The fat is not formed from the carbo-hydrates, but the ingestion of starchy matters protects the fat from decomposition: in other words, if no starch matters be given, the matters required for respiration, &c., will be derived from the fat; but if starch be present, the fat will be spared; so that though they are not mutually replaceable, yet there is a very intimate connection between them. Besides being excreted in the form of carbonic acid and water, it is probable that we obtain from them, entirely or almost so, lactic acid, which without doubt plays an important part in the human body.

The calorific power of the carbo-hydrates is, as previously stated, considerably less than that of fat. This point is illustrated by Tables I. and II.

(2.) *Nitrogenous Constituents of Food.*—The body requires to be freely supplied with *organic* nitrogenous matter, for it is not from the nitrogen of the atmosphere that we obtain our supply, as formerly imagined. The nitrogenous compounds contained in food are usually divided into two classes—(1) The albuminous or proteine group; and (2) the gelatinous principles.

The former, when subjected to the action of an alkali and heat, yield *proteine*—a substance discovered by Mulder, and containing the four elements, carbon, hydrogen, oxygen, and nitrogen. Whilst from the latter no proteine can be similarly procured. The proteine compounds comprise albumen, fibrine, caseine, vitelline, globuline, syntonine, vegetable albumen, vegetable fibrine, vegetable caseine.

The *gelatinous principles* are *gelatine* and *chondrine*. These substances contain no phosphorus, and their aqueous solutions possess the property of gelatinising upon cooling.

It has already been shown that a portion of the nitrogenous constituents of food are converted into fat; and it is allowed that the main source of muscular energy is the oxidation of non-nitrogenous substances. But, as Dr. Parkes remarks, the "proposition is not impeached, that the presence of nitrogen in an organised structure, and its participation in the action going on there, is a necessary condition for the manifestation of any force or any chemical change." Various experiments of great accuracy have shown that the nitrogenous tissues determine the absorption of oxygen, and "without the participation of nitrogenous bodies no oxidation and no manifestation of force is possible."

TABLE I.—CALORIFIC and MOTIVE POWERS of 10 Grains of the Substance in its natural state (LETHEBY).

	Lbs. of Water raised 1° F.	Lbs. lifted 1 Foot high.
Grape-sugar	8·42	6,500
Lump-sugar	8·61	6,647
Arrowroot	10·06	7,766
Butter	18·60	14,421
Beef fat	20 91	16,142

TABLE II.—THERMOTIC POWER and MECHANICAL ENERGY of 10 Grains of the Material in its natural condition, when completely burnt in Oxygen, and when oxidised into Carbonic Acid, Water, and Urea in the Animal Body (FRANKLAND).

Name of Food.	Pounds of Water raised 1° Fahr.		Pounds lifted 1 Foot high.		Per cent. of Water in Material.
	When burnt in Oxygen.	When oxidised in the Body.	When burnt in Oxygen.	When oxidised in the Body.	
Butter	18·68	18·68	14·421	14·421	15
Cheshire cheese	11·95	11·20	9·225	8·649	24
Oatmeal	10·30	10·10	7·952	7·800	15
Wheat-flour	10·12	9·87	7·813	7·623	15
Peameal	10·12	9·57	7·813	7·487	15
Arrowroot	10·06	10·06	7·766	7·766	18
Ground rice	9·80	9·52	7·566	7·454	13
Yolk of egg	8·82	8·50	6·809	6·559	47
Lump-sugar	8·61	8·61	6·649	6·649	19
Grape-sugar	8·42	8·42	6·510	6·510	20
Entire egg (boiled)	6·13	5·86	4·732	4·526	62
Bread-crumb	5·74	5·52	4·431	4·263	44
Ham (boiled)	5·09	4·30	3·929	3·321	54
Mackerel	4·60	4·14	3·551	3·200	71
Lean beef	3·03	3·66	3·111	2·829	71
Lean veal	3·38	3·01	2·609	2·324	71
Guinness's stout	2·77	2·77	2·138	2·188	88
Potatoes	2·60	2·56	2·007	1·987	73
Whiting	2·32	2·03	1·791	1·569	80
Bass's ale	1·99	1·99	1·536	1·536	88
White of egg	1·72	1·48	1·328	1·143	86
Milk	1·70	1·64	1·312	1·246	87
Carrots	1·36	1·33	1·050	1·031	86
Cabbage	1·12	1·08	0·864	0·834	89

The main elimination of nitrogenous substances takes place as urea, and it was thought that the amount of urea evolved was a measure of the destruction of the organised or nitrogenous part of the muscular tissue; but various experiments, especially those of Dr. Parkes, have conclusively proved that the amount of urea eliminated depends upon the nitrogenous substances ingested, and not upon the amount of work. The muscle, instead of oxidising, and therefore losing its substance during labour, actually appropriates nitrogen and grows.

The true food, then, of man consists of water, salts, nitrogenous matters, carbo-hydrates, and fats. Man can live for a short time on a diet without carbo-hydrates, but to keep in health, he must be supplied with a proper proportion of the whole of the principles mentioned; besides which, experience proves, his diet must be varied from time to time, either by substitution of different aliments, or by different modes of preparation of the same aliment.

It is concluded that an average adult, performing moderate labour, requires daily 4 oz. of dry nitrogenous matter (exclusive of gelatine), and combined with at least four or five times its weight of carbonaceous principles, of which one-tenth consists of fat (it is better, however, if this latter proportion be doubled). Vegetables containing salts of potash must form an integral part of the diet. Three hundred grains of mineral matter must be carried with the food; and the total amount of water daily cousnmed (including that contained in what is usually considered dry food) should not be less than three pints.

For the practical application of these principles, *see* DIETARIES, EXERCISE, &c.

Food, Inspection of—Considerable powers are given to sanitary officers with regard to the inspection and seizure of unwholesome foods, though it does not appear clear how such foods as flour and milk can be known to be unwholesome without analysis.

"Any medical officer of health or inspector of nuisances may at *all reasonable times* inspect and examine any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, or milk exposed for sale, or deposited in any place for the purpose of sale, or of preparation for sale, and intended for the food of man, the proof that the same was not exposed or deposited for any such purpose, or was not intended for the food of man, resting with the party charged; and if any such animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, or milk appears to such medical officer or inspector to be diseased, or unsound, or unwholesome, or unfit for the food of man, he may seize and carry away the same himself or by an assistant, in order to have the same dealt with by a justice."—(P. H., s. 116.)

"If it appears to the justice that any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, or milk so seized is diseased, or unsound, or unwholesome, or unfit for the food of man, he shall condemn the same, and order it to be destroyed, or so disposed of as to prevent it from being exposed for sale or used for such food; and the person to whom the same belongs or did belong at the time of sale, or of exposure for sale, or in whose possession, or on whose premises the same was found, shall be liable to a penalty not exceeding £20 for every animal, carcase, or fish, or piece of meat, flesh, or fish, or any poultry or game, or for the parcel of fruit, vegetables, corn, bread, or flour, or for the milk so condemned, or, at the discretion of the justice, without the infliction of a fine, to imprisonment for a term of not more than *three months.*

"The justice who, under this section, is empowered to convict the offender may be either the justice who may have ordered the article to be disposed of or destroyed, or any other justice having jurisdiction in the place."—(P. H., s. 117.)

"Any person who in any manner prevents any medical officer of health or inspector of nuisances from entering any premises and inspecting any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, or milk exposed or deposited for the purpose of sale, or of preparation for sale, and intended for the food of man, or who obstructs or impedes any such officer or inspector, or his assistant, when carrying into execution the provisions of this Act, shall be liable to a penalty not exceeding £5."*—(P. H., s. 118.)

"On complaint made on oath by a medical officer of health, or by an inspector, or other officer of a local authority, any justice may grant a warrant to any such officer to enter any building or part of a building in which such officer has reason for believing that there is kept or concealed any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, or milk which is intended for sale for the food of man, and is diseased, unsound, or unwholesome, or unfit for the food of man; and to search for, seize, and carry away any such animal or other article, in order to have the same dealt with by a justice under the provisions of this Act.

"Any person who obstructs any such officer in the performance of his duty under such warrant shall, in addition to any other punishment to which he may be subject, be liable to a penalty not exceeding £20."—(P. H., s. 119.)

With regard to the inspection of slaughter-houses, &c., *see* SLAUGHTERHOUSES.

Foot-Pounds, Foot-Tons—*See* EXERCISE, ENERGY, &c.

Footsoreness — Soldiers on the march and pedestrians often become footsore, which arises from undue pressure, chafing, riding of the toes, from faulty boots, or bad socks or stockings. Many plans have been adopted to prevent this. One is to bathe the feet before starting in hot water, to which a little salt and alum have been added, or just before the march dip the feet in hot water, wipe them dry, and then rub with soft soap until the foot is in a lather; then put on the stocking. In the late war the Germans found an ointment composed of 1 part of tannin and 20 parts of zinc-ointment exceedingly useful. Should the feet be sore at the end of the day, they should be wiped with a wet cloth, and then rubbed with tallow and spirits mixed in the palm of the hand. For soldiers, Parkes advises that the stockings should be frequently washed, and then greased.

Form of Rent-Charge — *See* RENT-CHARGE.

Form of Voting Paper—*See* VOTES, VOTING.

Forms of Notice for the Abatement of Nuisances—*See* NUISANCES.

Foundlings are children of unknown parentage, who have been found in the streets or elsewhere, or have been deposited at the gates of foundling hospitals. Children also abandoned by their parents under certain conditions come in France under the denomination of foundlings. Foundling hospitals are of very ancient date. A species of foundling hospital was erected at Milan in 787, and in the middle ages most of the Continental cities possessed one. A foundling hospital was projected in London by Thomas Coram, a sea-captain, and opened in 1756. It suc-

* The provision of a £20 penalty for the *possession* of unsound food, and only one-fourth of that sum for obstructing an inspecting officer, effectually makes the law inoperative—there is actually a premium on resistance!!

cours annually about 500 children. A foundling hospital was also established in Dublin, 1704; but owing to the great mortality among the inmates, and from moral considerations, the internal department was closed by order of Government in 1835. In Moscow there is an institution of this kind, which was founded by Catherine II., and receives about 12,000 children annually. Foundling hospitals are carried to excess in France. In 1790 foundlings were declared to be the children of the State, and previous to that date, and since, hospitals—some with turning-boxes (*tours*), and some without—have been established all over France. In 1784 there were 40,000 succoured; 1819, 99,346; 1825, 118,305; 1830, 118,073; and 1833, 129,699. This great and progressive increase alarmed the Government, who accordingly suppressed in the course of five years 165 depositing-places, with the effect of reducing the figures to 95,624. Since then, the number of infants found in the turning-boxes or in the streets has been almost stationary. In 1845 the number of births was 973,465, and the admitted foundlings were 25,239, or 1 in 39. Madame de Watteville has ascertained the important fact, that a tenth of the French foundlings are legitimate. Three to four thousand children are re-claimed by their parents every year. On entering these French institutions, the newly-born children are immediately put to nurse. Some are brought up by hand, but where possible they are given to a wet-nurse, who is carefully examined by a medical man to see that she is in good health and has a fit supply of milk. For fear of substitution, each child has a little silver buckle put through the ear, and a seal with certain characters on it, which is worn until fourteen years old or more. At fourteen years of age they are apprenticed to some trade. The mortality of foundlings is considerable. In 1838 it was 14·02 per cent.; ten years later it had, however, decreased to 11·30 per cent.

Freezing Mixtures — The following table, drawn up from actual experiments performed by Mr. Walker, exhibits a few of the most useful freezing mixtures (COOLEY):—

Ingredients.	Parts.	Thermometer sinks—
Snow or pounded ice	2	From any temperature to − 5°
Chloride of sodium	1	
Snow or pounded ice	5	,, to − 12°
Chloride of sodium	2	
Sal ammoniac	1	
Snow or pounded ice	12	,, to − 25°
Chloride of sodium	5	
Nitrate of ammonia	5	
Snow	8	From + 32° to − 27°
Hydrochloric acid (concentrated)	5	
Snow	2	,, + 32° to − 50°
Crystallised chloride of calcium	3	
Sal ammoniac	5	,, + 50° to + 10°
Nitrate of potassa	5	
Water	16	
Nitrate of ammonia	1	,, + 50° to + 4°
Water	1	
Nitrate of ammonia	1	,, + 50° to + 7°
Carbonate of soda	1	
Water	1	
Phosphate of soda	9	,, + 50° to − 21°
Nitrate of ammonia	6	
Diluted nitrous acid	4	
Sulphate of soda	8	,, + 50° to − 0°
Hydrochloric acid	5	
Snow	3	,, + 0° to − 46°
Diluted nitrous acid	2	
Snow	2	,, − 20° to − 60°
Sulphuric acid	1	
Water	1	
Snow	1	,, 0° to − 66°
Crystallised chloride of calcium	2	
Snow	1	,, − 40° to − 73°
Crystallised chloride of calcium	3	
Snow	8	,, − 68° to − 91°
Sulphuric acid	5	
Water	5	

Frijoles—A name given in Central America to black beans, which, well boiled in water, and taken with pepper, salt, and fat pork, are extensively used. *See* BEANS.

Frogs are eaten in many countries. The esculent variety in Europe is the common green or gibbous frog, the *Rana esculenta* of Linnæus, and this is highly prized in France for its hind-legs. The bull-frog (*Rana taurina*), a native of North America, is greatly esteemed by the Americans, and thought to equal turtle. The Société d'Acclimatisation have recently introduced this large edible frog into France. The South Africans eat a large frog, which when cooked looks like a chicken; this variety is called *Matlamétlo*. The Chinese and the natives of Australia are also large consumers of frogs, the flesh of which is said to be "delicate and full of gelatinous matter."

Fruits—The strict botanical signification of the term "fruit" is the mature ovary, containing the ripened ovules or seeds; hence, grains of wheat, oats, &c., and such substances as peas and beans, are, botanically speaking, fruits. Here, however, the term is used in its everyday and popular signification.

Ordinary fruits, when ripe—such as apples, pears, peaches, oranges, &c. — are of little nutritive value, few of them containing more than 13 per cent. of solid matter. Their great bulk, chemically considered, is simply made up of water; yet, apart from their direct nutritive value, it is questionable whether they are not occasionally, at all events, necessary for the health of man, their chief value lying in their antiscorbutic powers, derived from the vegetable acids, salts, and carbohydrates they contain.

Fruit has the effect of diminishing the acidity of the urine; this is accomplished by the vegetable salts contained in the fruit becoming decomposed in the system, and converted into the carbonate of the alkali, which passes off with the urine.

Fruit is largely preserved in bottles, and is generally more or less noxious, on account of the matter used to heighten the colour, &c. Copper is the principal substance thus employed, and that the admixture is not accidental, is proved by the fact that this metal has not been discovered with the preserved *red* fruits. The colour of preserved limes, gooseberries, rhubarb, greengages, and olives is nearly always intensified by copper.

It is generally the sulphate of copper or bluestone which is employed, and Dr. Hassall has the authority of a manufacturer for stating that the quantity of this powerful substance used is often fully as much as 60 grains to 1 gross of bottles of the fruits, making nearly half a grain—the full medicinal dose—per bottle. The colour of some of the green fruits is also apparently heightened by employing bottles of an intense green colour. Decoction of logwood or infusion of beetroot is not unfrequently used to improve the colour of inferior or damaged red fruits.

The presence of copper can be identified in the ash by the tests mentioned in article COPPER. *See also* APPLES, CHERRY, CITRON, COPPER, LEMON, LIME, MEDLAR, ORANGE, PEACH, PEAR, PLUM, &c.; FOOD, INSPECTION OF.

Fumigation — Fumigation with strong chemical agents — such as chlorine, iodine, and nitrous fumes—is without doubt of real efficacy in the prevention of contagion; but it is doubtful whether the burning of scented papers, pastilles, &c., is of any actual utility. It has, however, been observed that strong-smelling aromatic substances prevent mouldiness. *See* DISINFECTION.

Fungi—There is a mass of evidence as to the undoubted influence of fungi upon health, and their causing a great variety of diseases in man and animals. That there are some fungi which will grow on animal tissues may be verified by any one who chooses to examine house-flies in autumn. Many of these die from a fungous growth. The *Muscardine*, a fungus, kills the silkworm, and is a national calamity from time to time in silk-producing countries; and instances are recorded of moulds, &c., in the internal cavities of larger animals — *e.g.*, M. Deslongchamps found mouldiness in the lungs of an eider duck whilst alive.—(Ann. Nat. History, viii. 230.) Colonel Montague also noticed the same thing in the scarp duck.—(Ib., ix. 131.) Dr. Bennett has observed a mould growing from tubercle in the lungs of man, and mould on the skin of the living goldfish. These instances all establish the grand fact that fungi will attack living bodies. But much confusion has been thrown over the causation of disease by fungi, by observers recording their experience without being sufficiently acquainted with the botanical nature of fungi generally. No superficial knowledge is of any service, for fungi appear under protean aspects. "That it must be a matter of extreme difficulty to form any precise opinion concerning fungi, without long experience, will be apparent from the observations of Fries upon the genus *Thelephora*. He asserts that out of mere degenerations or imperfect states of *Thelephora sulphurea*, the following genera, all of which he has identified by means of unquestionable evidence, have been constructed—viz., *Athelia* of Persoon, *Ozonium* of Persoon, *Himantia* of Persoon, *Sporotrichum* of Kunze, *Alytosporium* of Link, *Xylostroma*, *Racodium* of Persoon, *Ceratonema* of Persoon, and some others. Nees von Esenbeck also assures us that the same fungoid matter which produces *Sclerotium mycetospora* in the winter develops *Agaricus volvaceous* in the summer. It would thus seem that the opinions of those who have asserted that the species or genus of a fungus depends not upon the seed from which it springs, but upon the matrix by which it is nourished, are at least specious, especially if we take the above fact in connection with the experiments of Dutrochet, who obtained different genera of mouldiness at will by employing different infusions. He says that certain acid fluids constantly yield monilias, and that certain alkaline mixtures equally produce botrytis."—(Lind. Veg. King.)

The vegetable parasitic diseases of man are many of them communicable to animals, and *vice versâ*. For example, the *Tinea circinatus*, or ringworm, is contracted frequently from grooming horses affected with the *T. tonsurans*. And "Dr. Fox mentions an instance of a white cat, a great pet with the children of a family of nine, which contracted the mange, and *T. tarsi* from *T. tonsurans* affecting five of the children. The fungus of the mange in the cat is the same fungus as that of *Tinea* in man—namely, the *Tricophyton*."—(AITKEN.)

It is very probable that the smuts and blights of plants have an influence on the health of man—at all events, the grass-smut (*Ustilago hypodytes*), which causes disease in grasses in France, produces injurious effects on the French haymakers. Hallier has made some observations on peculiar fungoid bodies found in cholera stools; and Sanderson and Buchanan have cultivated fungi from vaccine lymph. Berkeley, our great mycologist, has shown that yeast may be cultivated in a globule of water surrounded with air, and placed in a closed cell; it then fructifies. He therefore thinks that it is a mistake to give to mycelial and imperfect states of fungi special names, like those given below, before the fungus itself has been identified by careful similar cultivation.

The principal vegetable parasites associated in man with special morbid states have been enumerated as follows:—

1. *Tricophyton tonsurans vel Achorion Lebertii* (ROBIN), which is present in the three varieties of *Tinea tondeus*—namely, *T. circinatus* (ringworm of the body); *T. tonsurans* (ringworm of the scalp); and *T. sycosis menti* (ringworm of the beard).

2. The *Tricophyton sporuloides* (VON WALTHER), together with the above, which are present in the disease known as *Plica vel Tinea Polonica*.

3. The *Achorion Schönleinii* (REMAK), and the *Puccinia favi* (ARDSTEN), which are present in *Tinea favosa* (the honeycomb ringworm).

4. The *Microsporon mentagrophytes* (GRUBY), which is present in sycosis or mentagra.

5. The *Microsporon furfur* (EICHSTADT), which occurs in *Pityriasis vel Tinea versicolor*.

6. The *Microsporon Audouini* (GRUBY), which is present in *Porrigo vel Tinea decalvans* (*Alopecia areata*).

7. The *Mycetoma vel Chionyphe Carteri* (H. V. CARTER, BERKELEY), which gives rise to the disease known as "the fungus foot of India," a cotton fungus occurring in the deep tissues and bones of the hands and feet. *See* MADURA FOOT.

8. *Oidium albicans*, or "thrush fungus" of diphtheritis and aphtha.

9. *Cryptococcus Cervisiæ* (KUTRING), *Torula Cerevisiæ* (TURPIN), yeast plant, in bladder, stomach, &c.

10. *Sarcina ventriculi*, or *Merismopœdia ventriculi* (ROBIN), in the stomach.

Fungi round a house should be destroyed if they are not edible, as they not only may be eaten by children, but they also vitiate the atmosphere by robbing it of its oxygen, and exhaling carbonic acid.* *See* MUSHROOMS, &c.

Fusel Oil, Fousel Oil, Potato Spirit, Grain Spirit Oil, or **Amylic Alcohol** ($C_{10}H_{12}O_2$). (*See* ALCOHOL)—This substance constitutes the fifth term of the alcoholic series. An offensive strong-smelling oil, produced along with alcohol during the fermentation of grain, potatoes, &c., on a large scale, and which gives the peculiar flavour and odour to raw whisky. It essentially consists of hydrated oxide of amyl, but trifling and variable quantities of other organic compounds are usually mixed with it. It is a nearly colourless volatile liquid, with an acrid burning taste, a high boiling-point, and a durable, penetrating, offensive smell. When swallowed it occasions nausea, vomiting, delirium, and in any great quantity is a narcotic poison.

Public attention has recently been drawn to this alcohol by a communication made by Dr. Edgar Sheppard to the "Times" (October 1873), wherein he calls attention to the fact that common alcohol, sold in the shops in the form of gin, rum, brandy, wine, &c., is often mixed with a heavier alcohol, particularly with amylic alcohol (fusel oil), and that great injury is produced on alcoholic drinkers by

* For a description of the fungus causing potato disease, *see* POTATO.

this admixture. Dr. Richardson, in 1864 and in 1869, in his special report on the physiological action of the heavier alcohols to the British Association for the Advancement of Science, showed the difference of action of the alcohols as they ascend in the series, and as the carbon increases. He observed, as a singular fact evidenced in all his experiments, that common ethylic alcohol, while it produces stupor, does not, unless it be long continued, induce tremors or convulsions, while butylic and amylic alcohols directly produce these effects. The tremors caused by amylic alcohol are most persistent; they are called forth by the smallest excitement, and complete recovery from them, as indicated by the return of the natural temperature, is not attained, even when the alcohol has been withdrawn, in a shorter interval than three days. He remarks, in his report in 1869, that, considering how much of the heavier alcohols is distributed for consumption, it is possible that they (the heavier alcohols) may be the cause of delirium tremens in the human subject, as they are frequently the cause of that continued coldness, lassitude, and depression which follow the well-known dinner with "bad wine." This question is one of great and practical importance, for how is it possible for us to come to correct conclusions respecting the action of the different alcohols, when we are ignorant of what particular one we may be administering?

Fusel oil may be separated from spirits by fractional distillation. A rough test for its presence is to ignite a small portion of the suspected alcohol, and to place a cold body—*e.g.*, a saucer—in the flame. If fusel oil be present, there will be a dark deposit of carbon on the saucer.

G.

Galactometer—*See* LACTOMETER.

Gamboge—The gum resin obtained from *Garcinia Morella*, var. *pedicellata.* It is an odourless substance, with slight taste at first, afterwards acrid, easily powdered. It consists of about 70 per cent. of a resin which has marked acid properties, gambogic acid ($C_{30}H_{35}O_6$), and is soluble in alcohol, ether, and precipitated from these solutions by water, with gum, &c. Gamboge is often adulterated with starch. An emulsion made with boiling water should not become green when iodine is added. Gamboge is largely used for colouring sweetmeats, &c. (*See* CONFECTIONERY.) Taken frequently, and in large quantities, it is liable to excite severe vomiting, purging, and other symptoms of irritation, as it is a powerful poison. Sixty grains have caused death.

Gaol Fever—*See* FEVER, TYPHUS.

Gas—There are many gases, but it is to coal or illuminating gas that our remarks in this article will refer.

In 1785 a French engineer, called Lebon, established the first complete works for lighting with gas, the principle of which was long before this known, but not applied. Lebon used wood. Other early attempts at illuminations by means of gas were those made by Mr. Murdoch in 1792, and afterwards carried out very successfully in illuminating the large factory of Boulton & Watts, Soho Square, at the celebration of the Peace of Amiens, 1802. The Chartered Gas Company, ten years afterwards, was the first to undertake the experiment of lighting by coal gas on a large scale, and from that time to the present it has become, we may say, a necessity to have towns lit by gas.

Coal gas consists of an important mixture of hydrocarbons produced by the destructive distillation of pit coal, and contains the following bodies: Marsh gas, olefiant gas, hydrogen, carbonic oxide, nitrogen, vapours of liquid hydrocarbons, and vapour of bisulphide of carbon. The yield and illuminating power of gas vary greatly with the different kinds of coal employed. The average yield may be roughly estimated at 10,000 cubic feet of gas per ton.

On the first establishment of gasworks much nuisance was caused by mismanagement, want of skill, and, above all, by a want of knowing how to turn the waste products to account. The refuse of some of the London gas companies used to flow into the Thames; and at Paris, fifty years ago, an enormous basin of gas liquor burst and ran into the river, causing an insufferable odour and poisoning an immense quantity of fish. But at the present time there is ample power to prevent nuisances from gasworks, and ample means to properly condense offensive products.

The manner in which gas is ordinarily made, and the sources of nuisances, are as follows:

The pit coal is heated or distilled in hollow flattened retorts. These cylinders are set in stacks of three or five, arranged in a brick furnace; the lids are movable, and luted on with clay. Each retort has a tube at its upper part, which forms the first of a series of tubes, &c., commencing at the retort and terminating in the gasometer or reservoir of gas—viz., first, the hydraulic main, in which the retort tube terminates. The hydraulic main is usually half full of tar and moisture, and also contains carbonate and hydrosulphate of ammonia. There are wells or tanks connected with the hydraulic main into which the tar flows over. Secondly, the hydraulic main is connected with a series of serpentine or contorted tubes, called refrigerators or condensers, generally kept cool by water flowing over them. Here more tar and moisture is deposited. From the condenser the gases pass to certain *purifiers*, which usually consist of cast-iron vessels carrying numerous perforated shelves. On these shelves layers of dry slaked lime used to be placed, but at the present time a mixture of sawdust and hydrated ferric oxide is generally preferred. In the purifier the carbonic acid, sulphuretted hydrogen, sulphocyanogen, cyanogen, and traces of naphthaline are arrested. The oxide of iron is mostly converted into sulphide, which is used as a source of sulphur ($2Fe_2S_3xH_2O + 3O_2 = 2Fe_2O_3xH_2O + 3S_2$), and the oxide of iron is used over again. Lastly, the gas either bubbles through dilute sulphuric acid, or it passes through a scrubber consisting of a tower filled with small coke resting on perforated shelves, in either case losing its ammonia. It then passes into the gasometer for distribution.

The great danger of nuisance occurs, without doubt, when the scrubbers, purifiers, &c., are cleaned out. Then there is a very powerful odour, which is extremely penetrating, and may spread to a great distance. But, besides the ordinary distillation of gas, at many works they find it profitable and convenient to manufacture sulphate of ammonia somewhat after the following process: The ammonia of gas liquor is evaporated or distilled either in a Coffey's still or in a closed boiler; in each case the heating agent is steam. The volatile products, consisting of ammonia, carbonic acid, and sulphuretted hydrogen, are conveyed into a closed chamber or saturator, which is generally made of lead, and contains a charge of dilute sulphuric acid; this absorbs the ammonia, and the carbonic acid and sulphuretted hydrogen are passed into the furnace fire through a 4-inch pipe, having been first deprived of moisture by passing through pipes in coils, or by other means. When the acid in the condenser is saturated by ammonia, as shown by test-paper, steam alone is blown through it in order to purify it completely from sulphuretted hydrogen. The alkaline liquor is lastly drawn off into open pans, and evaporated by means of steam at high pressure passing through a closed coil of piping. The precautions to be taken are—

"1. The transference and storage of the gas liquor in air-tight tanks guarded with boxes of hydrated oxide of iron.

"2. The distillation of the liquor in a steady and continuous manner in air-tight stills by means of high-pressure steam.

"3. The saturation of the ammonia in close vessels, and the complete expulsion of sulphuretted hydrogen from the saturated solution before it is drawn off for evaporation.

"4. The condensation of moisture from the sulphuretted hydrogen evolved from the saturator, and the conveyance of the cold dry gas to the furnace fire, where it is to be completely burnt.

"5. The treatment of the exhausted liquor from the still with cream of lime, so as to recover the residual ammonia by a second distillation; or, if the process be in operation at a gaswork, the use of the residual ammonia as an absorbent in the purification of gas.

"6. The observance of the greatest care as regards the tightness of all parts of the apparatus."—(LETHEBY.)

Wherever a gas-burner is fixed, a tube to convey these products of combustion into the foul-air shaft, or to the outer air, should be provided. The most simple means of ventilation for gasaliers is to fix a zinc tube, running into the chimney or open air, behind the centre flower of a room or over the burners.

Not only is it essential to guard against the inhalation of the products of gas-combustion, but it is also necessary to be careful that no gas escapes unburnt; for, besides the danger of an explosion which may take place from such a cause, many cases of poisoning have resulted from an escape of gas. M. Ziegler relates the following instance: An escape of gas occurred through a carious piece of pipe in the main, and the gas was conducted along an old foundation-wall to some distance, the end of which wall was immediately under the bedroom of a gentleman, who was in consequence seized during the night with the oppression and other symptoms of gas-poisoning, although it was noticed that but little odour of the gas was discernible.

In September 1873, a young lad lost his life at a school in this country from an escape of gas in his bedroom. He was found dead in his bed in the morning, and it was evident from the appearance and posture of the body that no effort had been made to escape the impending fate; for the unfortunate victim was discovered in an attitude of calm repose, and his countenance retained all the placidity of slumber.

The most noxious ingredient of coal gas is carbonic oxide, of which most samples of gas contain from 7 to 8 per cent. by volume. An atmosphere containing one-fifteenth of its volume of pure carbonic oxide will kill a rabbit in twenty-three minutes, and half this amount produces death in thirty-seven minutes.—(M. TOURDES.)

Claude Bernard states that death is produced by a paralysis of the red corpuscles, which brings to a standstill their power of absorbing and carrying oxygen.

The escape of this gas generally, according to Professor Christison, by its powerful odour soon wakes those who are exposed to its influence: indeed, were this not the case, deaths from this cause would probably be more frequent than they are; for from the careless manner in which gasfitters usually perform their work, escapes of gas are excessively common. Great care is taken in America to guard against this danger. Before the gasfitter asks the company to make the connection with their main he proves the pipes. All the outlets which have been left for brackets and pendants, &c., are, with one exception, stopped up either with plugs or screwed caps. A force-pump containing a few drops of sulphuric ether is then attached to the outlet which has been left, and the pump is set to work until a high pressure has been registered. A high pressure is necessary, for the iron pipes may have many latent weaknesses—pinholes filled with grease, seams just ready to burst, &c.; these, when a high pressure is employed, at once become apparent. When the gauge indicates a certain figure the pumping ceases, and if the mercury falls it is evident that there is one or more palpable leaks, which are at once sought for and remedied: the sulphuric ether will aid in their detection.

Before the connection with the main is made, an inspector in the employ of the gas company carefully and closely scrutinises all the pipes, bends, joints, plugs, &c., where brackets and chandeliers are intended to be fixed; and should he in any of these discover the slightest weakness or departure from the rules, he insists upon all being made right. The pump is set in action before him, and if the pipes are now air-tight, he has simply to cast an eye upon the gauge, the column of which will no longer sink; and if all is satisfactory, he signs the requisite order.

Little trouble is taken in this country either by the gasfitter or the gas company to ascertain whether the pipes are free from leakage, or the joints properly made.

We would here call attention to a danger arising from covering our streets with asphalte—a danger which has hitherto been overlooked. It follows that if the surface of the ground is rendered practically air-tight, gases, either those escaping from the company's pipes or other subterranean vapours, will find vent in our houses, where no such resistance is encountered, and our habitations will thus serve as upcast shafts for the whole district. This difficulty may be met by underlaying every house with a thick layer of the same substance, so that the resistance indoors may be as great or greater than that without.

Lighting Streets, &c.—Any *urban* authority may contract with any person for the supply of gas, or other means of lighting the streets, markets, and public buildings in their district, and may provide such lamps, lamp-posts, and other materials and apparatus as they may think necessary for lighting the same.

Where there is not any company or person authorised by or in pursuance of Act of Parliament, or any order confirmed by Parliament, to supply gas for public and private purposes, supplying gas within any part of the district of any urban authority, such authority may themselves undertake to supply gas for such purposes or any of them throughout the whole or any part of their district; and if there is any such company or person so supplying gas, but the limits of supply of such company or person do not coincide with the boundaries of the district, then the urban company may themselves undertake to supply gas throughout any part of the district not included within such limits of supply.

Where an urban authority may under the Public Health Act themselves undertake to supply gas for the whole or any part of their district, a provisional order authorising a gas undertaking may be obtained by such authority under the provisions of The Gas and Water Works Facilities Act, 1870; and in the construction of the said Act the term "the undertakers" shall be deemed to include any such urban authority: provided that for the purposes of the Public Health Act the Local Government Board is throughout the said Act to be deemed to be substituted for the Board of Trade.—(P. H., s. 161.)

For the purpose of supplying gas within their district, any urban authority, with the sanction of the Local Government Board, may buy, and the directors of any gas company, in pursuance, in the case of a company registered under the Companies Act, 1862, of a special resolution of the members passed in manner provided by that Act, and in the case of any other company, of a resolution passed by a majority of three-fourths in number and value of the members present, either personally or by proxy, at a meeting specially convened, with notice of the business to be transacted, may sell and transfer to such authority, on such terms as may be agreed on between such authority and the company, all the rights, powers, and privileges, and all or any of the lands, premises, works, and other property of the company, but subject to all liabilities attached to the same at the time of such purchase.—(P. H., s. 162.)

The Watching and Lighting Act of William IV. is superseded by the Public Health Act, and all the lamps, gas-pipes, &c., vested in the inspectors for the time being under that Act are now vested in the urban sanitary authority.—(P. H., s. 163.)

Alteration of Gas-Mains, &c.—Where for any purpose of the Public Health Act any urban authority deem it necessary to raise, sink, or otherwise alter the situation of any water or gas pipes, mains, plugs, or other waterworks or gasworks laid in or under any street, they may by notice in writing require the owner of the pipes, mains, plugs, or works to raise, sink, or otherwise alter the situation of the same, in such manner and within such reasonable time as is specified in the notice. The expenses of or connected with any such alteration shall be paid by the urban authority ; and if such notice is not complied with, the urban authority may themselves make the alteration required :

Provided—

That no such alteration shall be required or made which will permanently injure any such pipes, mains, plugs, or works, or prevent the water or gas from flowing as freely and conveniently as usual ; and

That where under any local Act of Parliament the expenses of or connected with the raising, sinking, or otherwise altering the situation of any water or gas pipes, mains, plugs, or other waterworks or gasworks, are directed to be borne by the owner of such pipes or works, his liability in that respect shall continue in the same manner and under the same conditions in all respects as if the Public Health Act had not been passed.—(P. H., s. 153.)

Water Pollution from Gas-Washings, &c.—Any person engaged in the manufacture of gas who—

(1.) Causes or suffers to be brought or to flow into any stream, reservoir, aqueduct, pond or place for water, or into any drain communicating therewith, any washing or other substance produced in making or supplying gas ; or,

(2.) Wilfully does any act connected with the making or supplying of gas whereby the water in any such stream, reservoir, aqueduct, pond or place for water is fouled,

shall forfeit for every such offence the sum of *two hundred pounds*, and where the water belongs to or is under the control of the local authority, after the expiration of twenty-four hours' notice from them in that behalf, a further sum of *twenty pounds* for every day during which the offence is continued or during the continuance of the act whereby the water is fouled.

Every such penalty may be recovered, with full costs of suit, in any of the superior courts ; in the case of water belonging to or under the control of the local authority by the local authority, and in any other case by the person into whose water such washing or other substance is conveyed or flows, or whose water is fouled by any such act as aforesaid, or in default of proceedings by such person, after notice to him from the local authority of their intention to proceed for such penalty, by the local authority ; but such penalty shall not be recoverable unless it be sued for during the continuance of the offence, or within six months after it has ceased.—(P. H., s. 68.)

The *Gaswork Clauses Act*, which is to be construed with the 10 & 11 Vict. c. 15, contains several important provisions with regard to gas and gasworks. The principal sections are as follows :—

The provisions of the Act apply to every gas undertaking authorised by any special Act hereafter passed, or by any provisional order made under the authority of the Gas and Water Works Facilities Act, 1870, save where the said provisions are expressly varied or excepted by any such special Act or provisional order ; and every such special Act and provisional order is in the Act included in the term "the special Act."—(Sect. 3.)

The undertakers are not to manufacture gas, or any residual products, except upon lands described in the special Act, and they are not to store gas, except upon those lands, without the previous consent in writing of the owner, lessee, and occupier of every dwelling-house situate within three hundred yards of the limits of the site where such gas is intended to be stored.—(Sect. 5.)

The quality of the gas supplied by the undertakers is to, with respect to its illuminating power, be such as to produce at the testing-place provided in conformity with the Act, a light equal in intensity to that produced by the prescribed number of sperm candles of six in the pound, and such gas shall as to its purity not exhibit any trace of sulphuretted hydrogen when tested in accordance with the rules prescribed in that behalf in Part II. of the Schedule A to the Act annexed.—(Sect. 12.)

The undertakers must provide, at the place prescribed and within the prescribed time, a testing-place, with apparatus therein, for the purposes following, or such of them as may be prescribed by the special Act; that is to say:—

1. For testing the illuminating power of the gas supplied;
2. For testing the presence of sulphuretted hydrogen in the gas supplied.

The apparatus must be in accordance with the regulations prescribed in Part I. of the Schedule A to the Act, or according to such rules as may from time to time be substituted in lieu thereof by any special Act, and shall be so situated and arranged as to be used for the purpose of testing the illuminating power and purity of the gas supplied by the undertakers, and the undertakers are at all times thereafter to keep and maintain such testing-place and apparatus in good repair and working order.—(Sect. 28.)

The local authority of any district within the limits of the special Act, where the gas is not supplied by such local authority, may after the passing of the special Act from time to time appoint, or may appoint and keep appointed, a *competent and impartial person to be a gas examiner to test the gas at the testing-place provided in conformity with the provisions of the Act; and such gas examiner may there test the illuminating power and purity of the gas supplied by the undertakers, on any or every day between the hours of five o'clock and ten o'clock in the afternoon from the* 1*st day of October to the* 31*st day of March, both inclusive, and on any or every day between the hours of eight o'clock and eleven o'clock in the afternoon from the* 1*st day of April to the* 30*th day of September, both inclusive.*—(Sect. 29.)

Where no such gas examiner is appointed, or where the testing of the gas is imperfectly attended to by the local authority, two justices, on the application of consumers of the gas of the undertakers, not being less than five, by order in writing may appoint some competent and impartial person to be gas examiner, and such person may at any time within the hours aforesaid, on producing the said order, enter on the premises of the undertakers, and there test the illuminating power and purity of the gas supplied by them. —(Sect. 30.)

The undertakers may, if they think fit on each occasion of the testing of the gas by the gas examiner, be represented by some officer, but such officer must not interfere in the testing.—(Sect. 31.)

Any tests taken in pursuance of the Act are to be taken in accordance with the rules prescribed in Part II. of Schedule A.—(Sect. 32.)

The gas examiner shall, on the day immediately following that on which the testing of the illuminating power or purity of the gas has been conducted, make and deliver a report of the results of his testing to the local authority or justices by whom he was appointed, and to the undertakers, and such report shall be receivable in evidence.—(Sect. 33.)

The undertakers must give to the gas examiner and to his assistants, and to every local authority within the limits of the special Act, and their agents, access to the testing-place, and must afford all facilities for the proper execution of the Act; and in case the undertakers make default in complying with any of the provisions of this section, they are liable to a penalty of five pounds or less to the local authority or to the persons making the application.—(Sect. 34.)

SCHEDULE A.

Part I.

Regulations in respect of Testing Apparatus.

1. The Apparatus for Testing the Illuminating Power of the Gas *shall consist of the improved form of Bunsen's photometer, known as Letheby's open* 60-*inch photometer, or Evans' enclosed* 100-*inch photometer, together with a proper meter, minute clock, governor, pressure gauge, and balance.*

The Burner *to be used for testing the gas shall be such as shall be prescribed.*

The Candles *used for testing the gas shall be sperm candles of six to the pound, and two candles shall be used together.*

2. The Apparatus—

(*a.*) For Testing the Presence in the Gas of Sulphuretted Hydrogen.—*A glass vessel containing a strip of bibulous paper moistened with a solution of acetate of lead, containing sixty grains of crystallised acetate of lead dissolved in one fluid ounce of water.*

Part II.

Rules as to Mode of Testing Gas.

1. Mode of Testing for Illuminating Power.

The gas in the photometer is to be lighted at least fifteen minutes before the testings begin, and is to be kept continuously burning from the beginning to the end of the tests.

Each testing shall include ten observations of the photometer made at intervals of a minute.

The consumption of the gas is to be carefully adjusted to five cubic feet per hour.

The candles are to be lighted at least ten minutes before beginning each testing, so as to arrive at their normal rate of burning, which is shown when the wick is slightly bent and the tip glowing. The standard rate of consumption for the candles shall be 120 *grains each per hour. Before and after making each set of ten observations of the photometer, the gas examiner shall weigh the candles, and if the combustion shall have been more or less per candle than 120 grains per hour, he shall make and record the calculations requisite to neutralise the effects of this difference.*

The average of each set of ten observations is to be taken as representing the illuminating power of that testing.

2. Mode of Testing.

(*a.*) For Sulphuretted Hydrogen.—*The gas shall be passed through the glass vessel containing the strip of bibulous paper moistened with the solution of acetate of lead for a period of three minutes, or such longer period as may be prescribed; and if any discoloration of the test-paper is found to have taken place, this is to be held conclusive as to the presence of sulphuretted hydrogen in the gas.*

Gelatine—A nitrogenous substance obtained from white fibrous tissue, cellular tissue, the skin, the serous membranes, and the organic constituents of bone. Glue and size are coarse varieties of gelatine prepared from hoofs, hides, skins, &c. ; and isinglass is a purer kind obtained from the air-bladders and other membranes of fish. Gelatine does not exist in the vegetable kingdom. It does not appear to exist in a free state, but is developed by the action of boiling water upon the tissues above mentioned. Its solution, when evaporated to dryness, leaves a brownish-yellow transparent mass. Gelatine consists of carbon, hydrogen, oxygen, nitrogen, and a small quantity of sulphur. Concerning the nutritive power of gelatine there has been much discussion, inasmuch as it has never been discovered in the blood of animals; nor is it a constituent of eggs and milk, the two primary foods from which the tissues of the young are formed. Letheby believes that it undergoes digestion by being converted into peptones, which have a low nutritive power, but there is no satisfactory proof that cooked gelatine is of the same nutritive value. Liebig believes that gelatine associated with meat economises the albumen, and that it has considerable nutritive power. Pavy found that when gelatine is introduced directly into the circulation, it passes off with the urine. The researches of the Paris Gelatine Commission—the object of which was to ascertain *whether it was possible economically to extract from bones an aliment which alone or mixed with other substances would take the place of meat*—first threw considerable light on the value of the substance. The conclusions they arrived at are of interest, and not wanting in importance, and are as follows:—

"1. It is not possible, by any known process, to extract from bones an aliment which either alone or mixed with other substances can take the place of meat.

"2. Gelatine, albumen, and fibrine taken separately nourish animals but for a very limited period, and only in a very incomplete manner. In general, they soon excite an insurmountable disgust, so that the animals rather die than partake of them.

"3. These same alimentary principles, artificially reunited and rendered agreeably sapid by seasoning, are taken more readily and for a longer period than when in a separate state, but they have no better ultimate influence on nutrition; for the experiment of feeding animals on them in considerable quantities resulted in death, accompanied by all the signs of complete inanition.

"4. Muscular flesh in which gelatine, albumen, and fibrine are united according to the laws of organic nature, and associated with other matters, as fat, salts, &c., suffices, even in a very small quantity, for complete and prolonged nutrition.

"5. Raw bones may have the same effect, but the quantity consumed in the twenty-four hours must be very much larger than in the case of meat.

"6. Every kind of preparation—such as decoction with water, the action of hydrochloric acid, and particularly the transformation into gelatine—diminishes, and seems even in certain cases almost completely to destroy, the nutritive quality of bones.

"7. The Commission, however, is unwilling at present to express an opinion upon the employment of gelatine associated with other aliments in the nourishment of man. It believes that direct experiment can alone throw light upon this subject in a definite manner."

Germs, Germinal Matter (*Bioplasm*)—All living matter, whether vegetable or animal, consists, according to Dr. Beale, of two materials—a living substance, called bioplasm or germinal matter; and a dead, called formed material. This bioplasm exists, generally speaking, in the form of glistening, somewhat viscid, soft masses, sometimes of extreme minuteness (in all cases requiring microscopic aid), in the substance of tissues or in cells, or free in organic fluids. To make this plainer, one of the properties of germinal matter is that it may be stained red by either carmine or magenta, while the formed material is left intact. Now, if a tissue of a young animal—say, the tendon of a kitten—be taken and steeped in an alkaline solution of carmine, a thin section of it, when examined microscopically, will show a number of red masses dispersed throughout the tissue. The red or carmine masses are the masses of bioplasm, the tissue between them is the formed material. There is a current of nutriment or pabulum attracted to each mass, which is as much alive as a monad, and can in some instances be actually seen to push out little processes. This pabulum feeds the little mass of bioplasm, which excretes, as it were, formed material. The masses of bioplasm possess the power of multiplication by division. From these facts it theoretically follows that in a given space an old tissue will present fewer masses of bioplasm than a young one, and this is actually found to be the case. The masses of germinal matter will be found to be separated widely from each other in the old tissue, in contradistinction to the young, which will have them closer together. The white corpuscles of the blood are masses of living bioplasm; the corpuscles in saliva, the nuclei of vegetable and animal cells, are the same. The one cardinal point is that one kind of bioplasm is always distinct from another. The bioplasm of tendon will produce tendon, and tendon only; the bioplasm of cartilage will produce cartilage only, and so on. No difference can be seen by the eye in the germs of vaccine lymph, which are extremely minute, and other germs, although their effects are different; therefore we can only study the properties of bioplasm through its effects. The germ theory of disease takes its birth in the above facts. It is supposed (and we have strong evidence to support the supposition) that in zymotic and contagious diseases there is great multiplication of a particular species of germinal matter or bioplasm—*e.g.*, an inconceivably minute speck of the matter from a smallpox pustule, containing, however, in that speck millions of minute atoms of living matter of a particular species, is introduced into a healthy man's body; these atoms of bioplasm, being in a suitable soil, subdivide, multiply, and feed upon the tissues best adapted to them to an almost incredible extent, and throw off into the air, on to the clothes, &c., little germs like themselves, which, being taken into the blood of other healthy people, are capable of multiplying in the same wonderful manner, and causing the like malady. Such is the germ theory of disease.

Ghee—There are two substances of this name—one, a butter used by the natives of India; and the other an impure sort of treacle, used frequently for the adulteration of opium.

Gin — This spirit possesses considerable interest for the public hygienist; large quantities are annually consumed, and it is very generally sophisticated.

Gin, originally a soft rich spirit, flavoured chiefly with juniper berries, was for some time wholly obtained from Holland. The gin now met with in commerce is a very different article to that formerly imported. In Holland it is made solely from unmalted rye and barley malt, rectified with juniper berries. In Britain, gin is for the most part obtained from a mixture of malt and barley, molasses and corn being sometimes employed, particularly when there is a scarcity of grain; and it is not only flavoured with juniper berries, but with oil of turpentine, creosote, fusel oil, various aromatic substances, liquorice powder, orange-peel, and several other matters.

The great object in the manufacture of gin is to obtain a perfectly pure and neutral spirit as a basis for the addition of the flavouring agents. During fermentation there is developed, besides the ordinary alcohol, a small amount of amylic alcohol or fusel oil (*which see*). As we have stated in the article on fusel oil, this is an extremely powerful and deleterious substance, producing tremors and convulsions with a considerably greater rapidity than the ordinary and lighter alcohol does. The generality of writers on this subject state that in the distillery means are taken to get rid of this contaminating spirit. So far from this being the fact, it is found that practically fusel oil is often *added* to the rectified gin; and it appears to be pretty generally allowed by those in the trade that good "sterling" gin cannot be made without it. The following receipts for the making of good creamy gin we take from Mr. Cooley's Dictionary:—

1. Clean corn spirit, at proof, 80 gallons; newly-rectified oil of turpentine, 1¼ pint; mix well with violent agitation; add culinary salts, 14 lbs., dissolved in water, 40 gallons; again well agitate, and distil over 100 gallons, or until the "faints" begin to rise (faints = fusel oil).

Product.—A hundred gallons of gin 22 under proof, besides 2 gallons contained in the faints. If 100 gallons at 17 under proof are required, 85 gallons of proof spirit or its equivalent must be employed.

2. Proof spirit (as above), 8 gallons; oil of turpentine, 1 fluid oz.; salt, 1½ lb., dissolved in water, 4 gallons; draw over 10 gallons, as before, 22 under proof.

3. Clean corn spirit, 80 gallons; oil of turpentine, 1 pint; pure oil of juniper, 3 fluid oz.; salt, 21 lbs.; water, 35 gallons; draw over 100 gallons, as before, 22 under proof.

4. To the last, before distillation, add of oil of caraway, ½ fluid oz.; oil of sweet fennel, ½ fluid oz.; cardamoms, 8 oz.

5. To No. 3 add of essential oil of almonds, 1 drachm; essence of lemon, 4 drachms.

6. To No. 1, before distillation, add of creosote, 3 fluid drachms.

7. To No. 3 add of creosote, 2 drachms.

8. Proof spirit, 80 gallons; oil of turpentine, ¼ pint: creosote, 2 drachms; oranges and lemons sliced, of each 9 in number; macerate for a week and distil 100 gallons 22 under proof.

9. To No. 1 add rectified fusel oil, ½ pint.

10. To No. 1 add of oil of juniper, ½ pint.

Effects.—For the general effects of spirits, *see* ALCOHOLIC BEVERAGES. Gin differs but little from other spirits. In consequence of the turpentine or juniper berry contained in it, its diuretic properties are greater, and it is more likely, if taken for any length of time, to produce cirrhosis of the liver.

The specific gravity of gin is ·930 to ·944. It contains from 49 to 60 per cent. of alcohol; ·2 per cent. of solids; ash, 1; acidity per ounce, reckoned as tartaric acid, 0·2; and sugar per cent., 1.

Adulterations of Gin.—The great and first adulteration is that of mixing *water* with it. This renders the liquid milky or turbid, and hence it has to be fined, and for this purpose alum, subcarbonate of potash, and occasionally acetate of lead and sulphuric acid are employed. *Sugar* is then added to sweeten, and *cayenne*, in the form of tincture of capsicum or grains of paradise, and *caustic potassa*, to give it pungency and apparent strength. Sliced horse-radish and sulphate of zinc are often mixed with the spirit to give it "piquancy" and "mellowness."

Cassia buds and orris are also frequently added.

Detection of Adulterations in Gin.—The analyst will have to estimate (1) the alcohol; (2) the sugar; (3) the free acid; (4) the extract; (5) the ash. For the first three methods, *see* articles ALCOHOLOMETRY; SUGAR, ESTIMATION OF; ACIDIMETRY. For the *extract*, 200 c.c. are evaporated down in a platinum dish to dryness, and the weight carefully taken. This extract burnt up will give the *ash*. Fusel oil should be detected by fractional distillation, capsicum by the fiery taste of the extract and its irritating properties. Lead, alum, sulphuric acid, &c., must be looked for in the ash. Methylated spirit may be detected with a little practice by the peculiar odour gin adulterated with it possesses. This odour is best brought out by taking a few drops on the warm hand. It may be also with more accuracy detected by the process given under METHYLATED ALCOHOL.

Ginger—The scraped and dried rhizome of *Zingiber officinale* (B. P.) It is cultivated in Asia, America, and Sierra Leone. The following analyses—one made by Buchholz in 1817, and the other by Morin in 1823—will show its composition:—

Buchholz's Analysis.

Pale yellow oil (volatile)	1·56
Aromatic acrid soft resin	3·60
Extractive soluble in alcohol	0·65
Acidulous and acrid extractive insoluble in alcohol	10·50
Gum	12·05
Starch, analogous to bassorine	19·75
Apotheine, extracted by potash (ulmine)	26·00
Bassorine	8·30
Woody fibre	8·00
Water	11·90
	102·31

Morin's Analysis.

Volatile oil.
Acrid soft resin.
Resin, insoluble in ether aud oil.
Gum.
Starch.
Woody fibre.
Vegeto-animal matter.
Osmazoma.
Acetic acid, acetate of potash, sulphur.

The ashes contained carbonate, sulphate of potash, chloride of potassium, phosphate of lime, alumina, silver, and oxides of iron, and manganese.

The structure of ginger, as shown by the microscope, is as follows:—

1. The epidermis consists of a membrane composed of large angular, transparent, inseparable cells. The under surface contains a few yellow cells, exactly like those of turmeric, as well as globules of oil. Beneath the epidermis a great number of crystals are generally found.

2. The substance of the rhizome mainly consists of large five-sided cells, most of them containing a great number of starch cells of a lengthened oval form, with a very obscure hilum. These bodies somewhat resemble in size and shape the starch corpuscles of East Indian arrowroot. A few other of the large cells contain the yellow turmeric-like bodies before mentioned. Bundles of woody fibre and dotted ducts are also met with. In *ground ginger* the starch corpuscles, a few of the turmeric cells, with occasional portions of woody fibre, &c., are seen, but the starch corpuscles greatly predominate.

Ginger is adulterated to a considerable extent. Convictions have been recently obtained in several cases in which the analyst found samples adulterated with plaster-of-Paris, wheat-flour, ground rice, white pepper, damaged arrowroot, maize, wheat and barley starch. An examination by the microscope, assisted by the weight of the ash, cannot fail to detect such adulteration.

Glanders and Farcy—A disease affecting the horse, the ass, and the mule (*Soli-*

pedes), and capable of being communicated to man. The word "glanders" has reference to the implication of the glands in the disease; the word "farcy" is of Latin origin, and alludes to the stuffed condition of the animal's limbs.

Glanders and farcy are two names denoting really *one* disease, dependent upon the same specific poison; but the designation *glanders* is employed when it affects the air-passages, and *farcy* when it affects the skin, areolar tissue, lymphatics, and glands.

Symptoms in the Horse.—*Farcy* shows itself in the horse by an enlargement of the lymphatic vessels and glands, an obliteration of the superficial veins, and an eruption of subcutaneous or superficial *buttons*, discrete or confluent, which ulcerate, and are covered with crusts or fungus vegetations. The limbs are swollen (puffed), and the general symptoms little marked.

Glanders in its chronic form consists of engorgement and induration of the glands of the groin, running from the nose, ulcerated or non-ulcerated pimples on the pituitary membrane, thickening and swelling of the mucous membrane and of the osseous tissue, pimples, recent or cicatrised ulcerations in the larynx, trachea, and bronchial tubes; lastly, peculiar changes in the lungs, consisting of miliary granulations in red, yellow, or white masses, more or less indurated and disseminated on the surface or interior of the lungs. A general and gradual failing of the vital powers accompany these lesions, and the disease terminates in death, or more frequently merges into *acute glanders*. The latter is distinguished by its rapid course and the violence of its symptoms. The most striking of the latter are the bloody, purulent, and very abundant discharge; the eruption of little cutaneous (rarely subcutaneous), lenticular, painful *buttons*, scattered more particularly on the nostrils, neck, and shoulders; an extremely acute inflammation of the pituitary membrane, with redness, swelling, and pain of the nostrils, and deep ulceration. Death is the constant termination of acute glanders.

The lungs are always riddled with spots of ecchymosis and purulent deposits. Sometimes these are centres of hepatisation. Pus is also found in the muscles, joints, and other parts.

The period of incubation in the horse is variously given. It is probably, generally speaking, not more than three days.

The principal circumstances favouring the propagation and reception of the glandered poison among horses are damp, ill-ventilated, narrow, and ill-built stables, insufficient or unwholesome food, and excessive fatigue, &c.

Method of Propagation.—It appears both contagious and infectious. The discharge from the nostrils is the principal vehicle. This, snorted into the air, may travel some distance. Healthy horses have caught it from drinking out of the pail which had been used for a glandered horse, by eating infected hay accidentally blown into the stable, and by inoculation of matter both under the skin and mucous membrane. It has also been produced by giving to a horse farcied matter, made up into balls, by the stomach.

Symptoms of Glanders in the Human Subject.—The question of communication from the horse to the man, and then even from man to man, is put beyond a doubt, and therefore need not be discussed. In all cases recorded it has been almost an inoculation rather than a contagion.

Mr. Gay, President of the Medical Society of London, January 1871, recounted an interesting case of glanders in the human subject. He had been called to him for the purpose of performing tracheotomy, "but there was no dyspnœa, though otherwise the man was very ill. He was an omnibus conductor, and caught glanders from a horse which sneezed in his face. Coryza, pain in the neck, difficulty in swallowing, exalted temperature, rigors, &c., were present. The skin looked dusky, and a remarkable stench pervaded the room. The nostrils and fauces were implicated, and sanious pus was discharged from the bowels. There was an eruption on the skin, and the only gland implicated was the submaxillary. The patient died. No examination of the body was procurable."—(Medical Times and Gazette, 1871, i. p. 116.)

In the human subject, as in the horse, there appear to be two distinct forms—*acute glanders* and *chronic* or *farcy*.

The *acute glanders* begins with fever, and generally rigors, followed by rheumatic-like pains in the limbs; abscesses supervene at the seats of pain, discharging pus and bloody matter, and ultimately becoming gangrenous. In almost every case there is a discharge from the nostrils of bloody and purulent matter, the eyelids are tumefied, and the submaxillary glands enlarged. About the twelfth day there is an eruption on the face, trunk, limbs, and genital organs. This eruption is something like that of smallpox. Sometimes black bullæ are observed on the nose, forehead, below the ears, on the fingers, toes, and genital organs, and these have been followed by gangrene more or less deep.

In most cases death occurs about the seventeenth day.

Chronic glanders or *farcy* runs a slower course. There is first the local lesion, then the general infection. It usually comes from a wound, as may happen in cutting up a glandered horse. The lymphatics from the wounded part inflame, the glands in the arm-pit enlarge, inflammation and abscesses of the whole limb may follow, and if they are multiplied over the whole body with the characteristic eruption, the result is generally fatal; but there are milder cases, which recover.

Prevention. — Provision is made by the English law against offering for sale or working a glandered horse. In Germany the law directs that any horse which has been in contact with a glandered animal shall immediately be killed.

There can be little doubt that the most stringent enactments are required in order to stamp out such a dangerous and almost uniformly fatal disease. *Every horse affected with glanders should be destroyed as soon as the disease is recognised, and neglect of this should be visited by a heavy penalty.* When the horse is killed, it should be buried deeply in plenty of lime. In cases occurring in man, great cleanliness in the persons of attendants, disinfection of the discharges and room, and if death occurs, speedy burial, are the chief points to be noted.

Glucose ($C_6H_{12}O_6H_2O$) (*grape - sugar*)— This is now manufactured on a large scale from various starches, and is principally used in the brewing of beer. There is a good deal of offensive effluvia during the preparation of glucose, so that unless the organic vapours are properly conducted into the chimney or into the furnace-fire, the manufacture may give rise to considerable nuisance. At the present time it is commonly made from rice. The rice is crushed between rollers, and the gluten dissolved out of it by maceration in an alkaline solution, aided by constant stirring. Upon the starch settling, the supernatant fluid is run off, and the starch transferred to a vat containing water acidulated with sulphuric acid. Here it is again stirred, and it emits the odour of butyric and lactic acids. From this vat it is transferred to a strong digester, and steam at 20 lbs. pressure is blown into it for about half an hour. This last process converts it into glucose.

The solution is now drawn off into a vat, and the acid neutralised by chalk. During this operation, which takes a little time, there is again an offensive odour, principally consisting of that caused by the presence of butyric and lactic acids. The remainder of the operation is the separation of the sulphate of lime by filtration, and the evaporation of the sugar *in vacuo*, first to a thin syrup, in which state it is filtered through charcoal, and then to the consistence of honey; lastly, it is allowed to solidify in moulds.

Rice yields about 85 per cent. of grape-sugar.

Commercial glucose should contain about 80 per cent. of grape-sugar, with a small quantity of gum and a minute quantity of ash.

Glucose exists naturally in most fruits. It is contained in honey, and in the urine of persons suffering from diabetes. It may be formed artificially by acting on any starchy matter by dilute sulphuric acid.

Grape-sugar crystallises with difficulty in warty concretions. It is less soluble in water than cane-sugar, but more soluble in alcohol, requiring its own weight of water. Whilst 100 parts of alcohol at 68° F. (20° C.) dissolve 2 parts, the same quantity at the boiling-point dissolves 21 parts. Grape-sugar forms a crystallisable compound with common salt ($NaCl,H_2O2C_6H_{12}O_6$). It is dissolved without blackening by sulphuric acid. It yields a precipitate with ammoniacal acetate of lead. When boiled with an alkaline solution of potassio - cupric tartrate, or with solutions of the salts of mercury, silver, and gold, it gives a precipitate of the respective metals or their oxides by reduction. It becomes brown when treated by alkalies. It yields saccharic and oxalic acids when treated with nitric acid, and produces right-handed rotation of a ray of polarised light = 57·4°.

The test for the presence of glucose in cane-sugar, &c., is to boil a solution of the substance with an alkaline solution of potassio-cupric tartrate. If glucose be present, the red suboxide of copper is thrown down. In testing for grape-sugar, it is important to take care to neutralise any free acid in the liquid under investigation. The amount of glucose can be determined by the method described under SUGAR, ESTIMATION OF. In order to ascertain the quality and purity of glucose, the amount of sugar is estimated. A little of the sugar is burnt down to an ash, which is weighed, and it is, if necessary, examined by the microscope. Glucose should certainly, as before said, contain at least 80 per cent. of sugar.

Gluten — This is a peculiar substance found in the grain of wheat and other cereals. It is prepared by washing paste, made of the flour of wheat or rye, in successive waters until all starchy matter is removed. Gluten obtained from wheat and from rye possesses a peculiar tenacity, which is not observed in anything like the same extent in that obtained from other cereals; and it is this tenacity of the gluten which especially fits the flour of wheat and rye for conversion into bread. Gluten cannot be regarded as a single definite body. It consists of at least two distinct substances, one of which is soluble in hot alcohol, whilst the other remains undissolved when treated with this menstruum. This insoluble portion is regarded by Liebig and by Dumas as vegetable fibrine. The alcoholic solution on cooling deposits flocculi, which have the composition and characters of caseine. A third substance yet remains in the alcoholic liquid, and gives to this solution a syrupy or gelatinous consistence. On the addition of water a white substance resembling albumen is precipitated. Dumas and Cahours have termed it *glutin.* On its being treated with ether a small quantity of fat is extracted, and the *glutin* is left in a state of purity. Strong hydrochloric acid dissolves it, and communicates to it a violet tint. Raw gluten contains, therefore, several azotised principles, which differ considerably in chemical properties, though they are closely allied in ultimate composition, as may be seen by the following table:—

Constituents.	Dumas and Cahours.			Bence Jones.
	Gluten Fibrine.	Gluten Caseine.	Gluten.	Crude Gluten.
Carbon	53·23	53·46	53·27	52·22
Hydrogen	7·01	7·13	7·17	7·42
Nitrogen	16·41	16·04	15 94	15·98
Oxygen, sulphur	23·35	23·37	23·62	21·38
	100·00	100·00	100·00	97·00

The following shows the average percentage of gluten contained in different specimens of wheaten flour:—

Genesse	9·8
New York	9·8
Canada	9·8
Ohio	11·5
Maryland	11·5
Richmond	11·5
George Town	13·4 to 13·7
New Orleans	13·4 to 13·7
Dantzig	8·9 to 13·3
Hamburg	8·9 to 13·3
Spain	10·0 to 15·0
Portugal	10·0 to 15·0
Black Sea	10·0 to 15·0
English	10·4 to 10·8

It would appear, in examining flour, that the quantity of gluten as represented by nitrogen increases with the coarseness of the flour, and so also does the amount of mineral matter, of which phosphoric acid is the chief constituent.

Dried tea-leaves contain gluten to the extent of one-fourth of their weight; and coffee contains from 13 to 25 per cent. of this substance.

Gluten certainly possesses great nutritive value, and the French Gelatine Commission, of which we have spoken in our article on Gelatine, found that gluten extracted from wheaten flour or maize-flour by itself is both satisfying and nutritious. It is probable, though, that the gluten used in the experiments made by the above Commission contained some non-nitrogenous principle, and it is also probable that mineral matter was present. *See* Bread, Flour, Wheat, &c.

Glycerine ($C_3H_8O_3$)—A liquid formed during the saponification of oils and fats. It is colourless, odourless, uncrystallisable, sweet to the taste, of a syrupy consistence, and mixes with water in all proportions.

Glycerine is largely employed for various purposes, but it is chiefly of interest to us as an agent for mounting microscopic objects. It is useful for this purpose from its transparency and antiseptic properties.

Liver, lung, alimentary canal, skin, algæ, fungi, urinary deposits, &c., show better in glycerine than in balsam or dammar. For specimens containing carmine or Prussian blue add 2 drops of hydrochloric acid to 1 oz. of glycerine. Glycerine should not be used for mounting things hardened in osmic acid. Glycerine jelly may be used for mounting the following, first steeping them in weak spirit: Connective tissue, softened bone and tooth, cartilage, blood-vessels, lung, &c.

For similar purposes pure glycerine or the following mixture may be used: Pure glycerine, 4 fluid oz.; distilled water, 2 oz.; gelatine, 1 oz. by weight: dissolve the gelatine in the water made hot, then add the glycerine and size.

Glycerine Jelly—This is a good medium for mounting vegetable tissues for microscopic purposes. An excellent kind is made by Mr. Rimmington of Bradford, and Mr. White of Letcham, Norwich. Mr. Lawrence's recipe (Quarterly Journal of Microscopical Science, 1859) is as follows:—

Take any quantity of Nelson's gelatine and let it soak for two or three hours in cold water, pour off the superfluous water and heat the soaked gelatine until melted. To each fluid ounce of the gelatine add 1 drachm of alcohol, and mix well; then add a fluid drachm of the white of an egg. Mix well while the gelatine is fluid but cool. Now boil until the albumen coagulates and the gelatine is quite clear. Filter through flannel, and to each fluid ounce of the clarified gelatine add 6 fluid drachms of Price's pure glycerine, and mix well.

Mr. Poclington uses for wood sections an ounce of the gelatine, soaked as in the previous formula, and adds an equal portion of strong glycerine in which a few grains of arsenic have been dissolved; for arsenic, chloride of barium may be substituted.—(Pharmaceutical Journal, November 21, 1874.)

Goître and Crétinism—Among epidemic diseases which attack entire populations, there are none which exercise a more profound action on the physical and moral constitution of man than goître and crétinism. The deterioration of entire generations is the consequence of this affection, and being due to local and still obscure causes, merits in a high degree the attention of the sanitary authorities. We have no hesitation in uniting goître and crétinism in one article; because, although they must not be confounded, it appears impossible not to consider them as different forms of the same endemic cause.

M. Grange affirms that crétinism is never met with in a population where goître is not endemic, and that generally crétinism does not begin to appear until goître has attacked a fifth or a tenth of the population.

Goître consists of a swelling of the thyroid gland—a gland situated in the neck, over and on each side of the windpipe or trachea. At first, though the gland is enlarged, it is soft; but it gradually acquires a firm and even cartilagiuous consistence. It may, indeed, be iufiltrated with calcareous matter, or become ossified. The appearance of these tumours is repulsive, and they cause frequeutly extreme difficulty in breathing. Not mau alone is affected with goître in the goîtrous districts, but also dogs and cats.

Crétinism is a form of idiocy; it has been thus defined:—

"A condition of imperfect development and deformity of the whole body, especially of the head. It is endemic in the valleys of certain mountainous districts, and is attended by feebleness or absence of the mental faculties and special senses, and is often associated with goître."—(AITKEN.)

The stature of the crétin is diminutive, his features are dull and heavy, with thick lips and a big tongue; the legs are weak, short, and bowed; the belly is either tumefied and large, or sunk and pendulous; the head is of great size, but flattened at the top and spread out laterally. This condition has been shown by Virchow to be due to an early ossification of the ceutral bones of the base of the skull—*i.e.*, the sphenoid and basilar process of the occipital—probably owing to the same cause as goître—*i.e.*, lime and magnesia in the driuking-water.

Geographical Range of Goître and Crétinism.—These diseases are endemic in a large number of the provinces of Germany, Wurtemberg, Saxony, Silesia, Tyrol, Carynthia, Galicia, Austria, and Switzerland. In England goître is endemic principally on the magnesian limestone extending from Nottingham to the Tyne, and in some degree in Derbyshire, Norfolk, Cambridge, and Somersetshire, where a few sporadic cases of crétinism are met with. Goître also prevails in France to a greater extent than is generally known. In Asia it is found in Chinese Tartary, Thibet, and Ceylon; and in India in the valleys of the Himalayas, and in some of the vast plains at the foot of these mountains. In Africa there are also several important localities afflicted with this disease. In North America it is found in the vast plains of the river Edmonstone; in South America, on the plateaus of New Granada, where, according to Humboldt, it exists under essentially opposite conditions—in the deepest and most humid valleys, as well as on the most arid plains and the least covered with vegetation.

Cause of Goître.—The cause of goître is in all probability the drinking of water impregnated with salts of lime and magnesia.

"The water from snow or from glaciers," says Dr. Grange, "does not give goître, for this affection is unknown in the most elevated mountain valleys to the sources of the Rhone, and in the high Valais to the source of the Aar, and in Oberland, between Meiringen and Grimsel, in the upper valley of the Rhine. All these valleys, covered with snow during the greater part of the year, and in which they drink water coming from the depths of the snow and glaciers, present uo case of goître. This malady is unknown in Norway and Sweden, and unknown in the glacial plains of the North, where the people live in huts dug in the ground and only drink snow-water. On the other hand, goître is met with in Africa and the island of Sumatra, where snow never falls. As to conditions of ventilation, in Maurienne, Tarentaise, and Valais there are continual breezes, an upward current from 10 A.M. to 5 P.M., and during the night a current of air in the contrary direction powerful enough to bend the trees. No one can have the least knowledge of the circulation of fluids to admit that in the most narrow and shady valleys there is no ventilation. At St. Jean de Maurienne, the statue of Fodéré, the great propagator of this opinion, is surrounded with poplars, which daily, bowed to the earth by the ascending breeze, give a formal lie to the theories written in the book he has left to posterity. The Swiss plain, that of Turin and Lombardy, terminated on the horizon by the white outline of the Alps, present too great a number of instances of the ravages of endemic diseases to attribute them to meteorological causes. I will say nothing of the differences and variations of temperature, and the action of marsh miasma, for the cantons in France most severely attacked by marsh fevers are exempt from this affection.

"Poverty and uncleanliness aggravate all diseases, but they are not the cause of that which now occupies our attention. What land is so blessed as to be exempt from the presence of these two companions of suffering humanity? If frequent pregnancies and hereditary influence predispose to the goîtrous development, it is certain that these circumstances have only a very secondary influence. To consider goître and crétinism as an exaggeration of scrofula is to be in direct opposition to facts. In the Pyrenees, where scrofula is rare, the affection of which we treat is extremely common; and in the Niévre, where the scrofulous diathesis makes great ravages, goître is scarcely known. These different diseases sometimes occur together, and then their intensity is necessarily increased by their double influence.

"Does drinking-water produce goître through not being sufficiently aerated? The learned author of this theory, which he founded on facts relating to the elevated *plateaux* of Southern America, has himself renounced it, when he saw in our continent goître on moderate heights and on plains under circumstances where water dissolves the maximum of air.

"The opinion which attributes the development of these affections to the air of certain waters is supported by numerous proofs of the deleterious action ascribed to them. In each valley of the goîtrous countries one or two springs are cited which have the property of developing this disease in a short time."

In the Tarantaise and Maurienne M. Grange has seen these springs, which they call *tuffeuses*, and he knows men who, preferring to carry a deformity rather than wear a military coat, have produced in a few months a goître large enough to ensure rejection.

"Goître and crétinism are met with at all heights, from 50 metres above the sea-level to the utmost elevations on which man can exist. They are met with in countries the most diverse, whether as regards geographical position, climate, manners, or food. They occur where the temperature varies annually only 4° or 5°, and where there is a variation of more than 60°; in short, everywhere except on the sea-coast.

"One circumstance alone is common to every goîtrous country; its soil is formed of magnesian rocks, which contain magnesian salts, dolomite, sulphate of lime, and magnesia, &c.—a fact ascertained by M. Chatin and several other observers."

M. Grange is not alone in his opinion concerning the influence of the salt of lime and magnesia. Baillarger states that horses and mules become affected by drinking the water of the Isère, which latter river certainly contains much calcareous salts.

Johnston (Edinburgh Monthly Journal, May 1855) asserts that a water which had 77 grains of solid residue, consisting principally of lime and magnesia salts, affected the thyroid glands of certain *prisoners* under his observation. By using a purer water the malady disappeared.

Dr. M'Clellan, in his "Medical Topography of Bengal," gives the following interesting table:—

Goître and Crétinism in Kumaon (Oude).

	Percentage of Population affected— With Goitre.	With Cretinism.
Water derived from—		
Granite and gneiss .	0·2	0
Mica, slate, and hornblende	0	0
Clay-slate . . .	0·54	0
Green sandstone . .	0	0
Limestone rocks . .	33	3·1

These observations are, however, not entirely accepted. M. St. Lager denies the connection between lime and magnesian waters with goître, and shows that goître is endemic in metalliferous districts. He argues that the constituent of the water is iron pyrites, or some other metallic sulphide.

The whole subject requires further investigation. That it is the water, or soil, or both, is certain. A dozen really trustworthy analyses of water and soil in each goîtrous district compared with non-goîtrous districts should settle the matter.

Gooseberry—The fruit or berry of the *Ribes grossularia.* It is a native of many parts of Europe and North of Asia, and grows wild in thickets and rocky situations. Malic and citric acids and sugar give it its chief characteristic. The unripe fruit is cold and acidulous, while the ripe fruit is wholesome and slightly laxative. The seeds and skins should not be eaten, as they are very indigestible. Factitious champagne is often manufactured from them. (*See* WINE.) The seeds, washed and roasted, were formerly used as a substitute for coffee.

Composition of Gooseberries (FRESENIUS).

	Large Red.	Small Red.	
Soluble Matter—			
Sugar	8·063	6·030	8·239
Free acid (reduced to equivalent of malic acid) . . .	1·358	1·573	1·589
Albuminous . .	0·441	0·445	0·358
Pectous . . .	0·969	0·513	0·522
Ash	0·317	0·452	0·504
Insoluble Matter—			
Seeds . . .	2·481	2·442	2·529
Skins . . .	0·512		
Pectose . . .	0·294	0·515	1·423
Ash from insoluble matter included in weights given .	[0·146]	[0·069]	[0·247]
Water . . .	85·565	88·030	84·831
	100·000	100·000	100·000

	Middle-sized Yellow		
Soluble Matter—			
Sugar	6·383	7·507	6·483
Free acid (reduced to equivalent in malic acid) . . .	1·078	1·334	1·664
Albuminous . .	0·578	0·369	0·306
Pectous . . .	2·112	2·113	0·843
Ash	0·200	0·277	0·553
Insoluble Matter—			
Seeds . . .	3·380 }	2·081	2·803
Skins . . .	0·442 }		
Pectose . . .	0·308	0·955	0·390
Ash from insoluble matter included in weights given .	[0·100]	[0·170]	[0·133]
Water . . .	85·519	85·364	86·958
	100·000	100·000	100·000

Gorgona Anchovy—*See* Anchovy.

Grains—The principal grains will be found fully described under their respective headings.

Grapes—The fruit of the *Vitis vinifera*, or common grape vine, indigenous in the East, but introduced at a very early period to the South of Europe.

The grape is an extremely useful and valuable fruit. Ripe grapes are cooling and antiseptic, and in large quantities diuretic and laxative. Dried, they are used as currants and raisins, and besides this, they furnish the choicest wines and spirits. The skin and seed, which should be rejected, are indigestible.

"Grapes, if taken without the husks, are the safest and most nutritive of summer fruits."—(Cullen.)

The amount of sugar contained in different varieties of grapes varies. Fresenius found that in very ripe *Oppenheim* grapes it amounted to 13·52 per cent.; over-ripe *Oppenheim*, 15·14 per cent.; red very ripe *Asmannshäuser*, 17·28 per cent.; and *Johannisberg*, 19·24 per cent.

The skins of grapes are found to yield to boiling alcohol a considerable quantity of white wax, and this material may be looked upon as designed to impede both the penetration of water from without and the escape of moisture from within. The fleshy part of the grape consists of a mass of delicate vesicles holding the chief portion of the juice. The latter contains no tannic acid or other astringent matter, but this is found in abundance in the stones.

The stalks also contain tannic acid, and when they are placed in the fermenting fats, as they frequently are, they help to give astringency to a wine prepared with their employment.

The following table shows the composition of grapes:—

Composition of Grapes (Fresenius).

	White Austrian, quite ripe.	Kleinberger, quite ripe.
Soluble Matter—		
Sugar	13·780	10·596
Free acid reduced to equivalent in malic acid .	1·020	0·890
Albuminous substances .	0·832	0·622
Pectous substances, &c. .	0·498	0·229
Ash	0·360	0·577
Insoluble Matter—		
Seeds . . . . }	2·592	1·779
Skins . . . . }		
Pectose	0·941	0·750
Ash from insoluble matter included in weights given	[0·117]	[0·077]
Water	79·997	84·570
	100·020	100·019

Grasses, Poisonous—The most important poisonous grass which may get mixed with wheat is darnel (*Lolium temulentum*). *See* Darnel.

Grates—*See* Warming.

Graves—*See* Churchyards; Dead, Disposal of; Putrefaction; Saponification, &c.

Graveyards—*See* Churchyards; Dead, Disposal of; Putrefaction; Saponification.

Greengages—*See* Plum.

Groats—Oats deprived of their *paleæ* are called "groats" or "grits;" when crushed they constitute "Emden groats."

Ground-Air—*See* Air; Ague; Water, Ground, &c.

Ground-Water—*See* Water, Soils, &c.

Gruel—Prepared from groats and boiling water. It is a soothing and nutritive food.

Guaiacum Resin—The resin prepared from the wood of *Guaiacum officinale*. The resin is a dark brown, transparent, brittle substance. A solution of it in rectified spirit strikes a clear blue colour when applied to the inner surface of a paring of raw potato, due to the action of guaiacic acid on the gluten. The resin contains two acids—viz., about 10 per cent. of guaiaretic acid, which is crystalline ($C_{20}H_{26}O_4$), and 70 per cent. of guaiaconic acid ($C_{19}H_{22}O_5$).

Guaiacum is a valuable medicine, possessing diaphoretic, alterative, and stimulant properties; it is used in skin-diseases, chronic rheumatism, and other affections. In large doses it causes heat in the throat and irritation of the intestinal canal.

Guaiacum is employed in testing for the presence of blood. A solution of the red colouring matter of blood in water produces with freshly-made tincture of guaiacum a reddish-white precipitate of the resin. On adding to this an ethereal solution of *peroxide of hydrogen* a beautiful blue colour appears. *See* BLOOD.

Guaiacum is frequently adulterated with other resins. A simple tincture of guaiacum, when thrown into water, becomes milky from the precipitation of the resin : if a solution of potash is now carefully added, it is cleared, and remains so after excess of the alkali, provided guaiacum only be present, but not if other resins are contained in the tincture. Guaiacum is used for the purpose of adulterating scammony, jalap, &c.

Guinea Worm—*See* FILARIA DRACUNCULUS.

Gum ($C_{12}H_{22}O_{11}$)—This important substance extensively pervades the vegetable kingdom. It occurs in its purest form as an exudation upon the bark of certain trees, but is met with in the juices of nearly all plants. Gums are insoluble in alcohol, ether, and oils; with water they produce a tasteless, ropy mucilaginous liquid, possessing strongly adhesive properties, which render it extremely useful for a variety of purposes. Seventy per cent. of gum consists of gummic acid in combination with lime, magnesia, and potash. There are small quantities of acid malate of calcium, chlorides of calcium, and potassium, with traces of iron, silica, and phosphate of calcium, and 17 per cent. of water. By boiling with dilute sulphuric acid it is convertible into sugar. There are several varieties of gum, the principal being gum acacia or Arabic.

Some difference of opinion exists with regard to the alimentary value of gum, but from the experiments of Magendie on dogs, and Tiedemann and Gmelin on geese, it is conclusively proved that it is insufficient to support life. Lehmann declares that gum remains altogether unabsorbed, but it is probable that under some form or other it does to a slight extent reach the circulation. Dr. Pavy, from experiments on dogs and rabbits, has shown that gum does not undergo conversion in the alimentary canal into sugar.

Gum is largely used for the purpose of adulterating tea, and also, it is said, with potted meat, fish, &c., mustard, pepper, confectionery, port wine.

The general principles of its estimation are as follows: A decoction of the substance (*e.g.*, tea) is evaporated almost to an extract, and then treated with methylated spirit in successive portions. The liquid is then filtered, the gum remaining on the filter. It is then washed off by hot water, and the solution of gum thus obtained dried and weighed, and finally burnt up. The ash is now weighed, then the weight of the ash deducted from the weight of the gum before ignition gives the weight of the gum. This process has, however, to be frequently modified to meet special cases.

Gunpowder—An exact knowledge of the smoke which the explosion of gunpowder produces is interesting to the hygienist, as some occupations, such as that of the soldier and the miner, entail the breathing from time to time of air deteriorated by the products of explosion.

Taking the composition of gunpowder to be as follows :—

Nitre	101
Sulphur	16
Carbon	18
	135

Dr. Angus Smith found that after explosion the weight remained the same, and that the powder had become converted into—

Carbonic acid	66
Nitrogen	14
Sulphide of potash	55
	135

The reason that gunpowder smoke differs from ordinary wood or coal smoke, which is always heavier than the material consumed, is that powder burns without air. It supplies its own air in the nitre employed. When gunpowder is used for blasting purposes, a certain amount of sulphide of potassium, or an equivalent in sulphate of potash, remains floating in the atmosphere a portion of the time.

In mines this substance exists after the explosion in such excess that sight and breathing become difficult; and if during eight hours there are used 12 oz. of gunpowder for above three half hours out of the eight, sight and breathing will through the diffusion of this sulphide of potash become almost impossible.

About one-third of the powder is fired off at a time. Seven hundred and thirteen grains of sulphide of potassium, or its equivalent in sulphate of potash, are sent into the air at once, leaving ·59 grains in a cubic foot. This amount, small as it seems, is intolerable, and the men can neither work nor live in it. They wait till it diminishes.

After leaving a mine, the mouth and nostrils are found to be extremely black; the reason being that the current of air which enters by these channels is purified by the mouth, moustache, &c., to a great extent, and strained of the charcoal from the powder.

The charcoal is not wholly burnt during the explosion of the powder, the sulphur is not wholly consumed as a sulphide of potassium, and the nitre is not wholly robbed of its oxygen.—(A. SMITH.) *See* MINES.

An explosion of gunpowder has the effect also of adding a certain quantity of carbonic acid to the air, and hence rendering it extremely unhealthy.

Karolyi succeeded in analysing the gases of gunpowder which had been fired in conditions closely resembling those which occur in artillery practice. A charge of powder was enclosed in an iron cylinder of such strength that it just burst when the powder was fired by means of the electric spark. This charged cylinder was suspended in a hollow spherical bomb, from which the air was exhausted before firing. After the explosion had been produced, the gases and the solid residue of the powder were submitted to analysis. The following table exhibits the results obtained :—

TABLE I.

1. *Composition of the Powder used.*

		Ordnance Powder.		Small-Arms Powder.	
	Nitre	73·78		77·15	
	Sulphur	12·80		8·63	
Charcoal	Carbon	10·88	13·39	11·78	14·27
	Hydrogen	0·38		0·42	
	Oxygen	1·82		1·79	
	Sulphur	0·31		0·28	
		99·97		100·05	

2. *Products of Combustion by Weight.*

		Ordnance Powder.		Small-Arms Powder.	
Gaseous	Nitrogen	9·77	30·58	10·06	34·18
	Carbonic anhydride	17·39		21·79	
	Carbonic oxide	2·64		1·47	
	Hydrogen	0·11		0·14	
	Sulphuretted hydrogen	0·27		0·23	
	Marsh gas	0·40		0·49	
Solid	Ammonic sesquicarbon	2·68	69·25	2·66	65·14
	Potassic sulphate	36·95		36·17	
	Potassic carbonate	19·40		20·78	
	Potassic hyposulphite	2·85		1·77	
	Potassic sulphide	0·11		0·00	
	Charcoal	2·57		2·60	
	Sulphur	4·69		1·16	
	Loss	0·17		0·68	
		100·00		100·00	

3. *Products of Combustion by Volume in* 100 *of Gas.*

	Ordnance Powder.		Small-Arms Powder.	
Nitrogen	37·58	100·00	35·33	100·00
Carbonic anhydride	42·74		48·90	
Carbonic oxide	10·19		5·18	
Hydrogen	5·93		6·90	
Sulphuretted hydrogen	0·86		0·67	
Marsh gas	2·70		3·02	

The effect produced on the surrounding atmosphere by the explosion of gunpowder, as measured by the combustion of candles, is well shown by Dr. Angus Smith's experiment in his now celebrated lead-chamber.

TABLE II.—Showing the Results obtained by burning Gunpowder in a close Lead-Chamber, 6 Feet long, nearly 4 Feet unequally broad, and 8 Feet high, the Cubic Contents about 170 Feet. Experiment made by Dr. A. Smith, February 17, 1864.

12 hours 56 min.	22 in.	1 candle	41°F.
After 14 minutes	20 ,,	·826 ,,	51·5°

After 45 grains of gunpowder had been burnt in the chamber there was no immediate diminution of light, but in a few minutes the candle changed suddenly as the smoke fell down upon it.

After 24 min.	18 in.	·669 candle	51·5° F.

Fifteen grains then burnt 60 in all.

After 27 min.	18 in.	·669 candle	52° F.
After 29 ,,	16 ,,	·529 ,,	52·5°

Very unpleasant breathing, as if every little crystal was felt sharply; caused coughing and discomfort.

After 39 min. 14·5 in. ·434 candle 53° F.

Distinct taste of salt, as it came from the throat after collecting there, and causing much phlegm. Depressing. Breathing worse than after three and a half hours in the chamber without saltpetre.

After 47 minutes fired another 15 grains.

After 51 min. 13 in. ·349 candle 53·5° F.

Decided weakening of the flame, as seen by its indistinct edges. It becomes shorter; the flame at the bottom becomes whitish; it is usually blue. Thirty grains fired.

After 64 min. 11·5 in. ·273 candle 54·5° F.

Weight of *outside* candle on entering. 27·04 grammes; at end of experiment, 12 11 grammes.

Weight of *inside* candle on entering, 21·87 grammes; at end of experiment, 12·11 grammes.

Outside candle burnt 14·93 grammes.

Inside candle burnt 13·37 grammes.

Gutter—*See* NUISANCES.

Gymnasium—In the eighteenth century there was a revival of gymnastic institutions, so much encouraged by the ancients. Salsman founded an institution in Saxony, and several states of Europe followed the example. At Stockholm a central institute was formed under the direction of Professor Ling. In England and Switzerland similar institutions were erected, and multiplied under the impulsion of M. Clias, &c. In France, Rollin and Bartholemy supported the erecting of gymnastic institutions; and, in short, from that time to the present their utility has been recognised more or less by all Europe. Large gymnastic societies at the present time exist; it is studied as an art, and possesses an extensive literature.

Gymnastic exercises are of the greatest importance in training recruits. Gymnasia are now erected at all the large military stations, and a code of instructions used, which has been drawn up by MacLaren of Oxford. This is published by authority and strictly followed. The system consists of progressive exercises, foot walking and running, then leaping, bar and vaulting, horse exercise, &c., up to escalading.

The guiding principle of the above code is evidently gradually to train the heart and the voluntary muscles to great efforts, and there is no doubt that such a system does no harm whatever, but develops the bodily powers to a remarkable degree. Injudicious gymnastics (as, for example, the allowing youths or young recruits to commence laborious and difficult exercises at the outset) throw a great strain on the heart and lungs, and may produce permanent injury.

H.

Habitations—The house has been called the sanitary unit; its sanitation is therefore of the first importance. The crowded dwellings of the poor in all times have been a source of disease, and their state in every country has been more or less unsatisfactory.

In England, as late as the time of Henry VIII. the better class of houses was extremely filthy, as evidenced by the celebrated letter of Erasmus to Cardinal Wolsey's physician, in which he comments upon the continual plagues, and notably the sweating sickness, so constantly affecting England, and considers it caused by the insanitary, unventilated state of the houses, the floors of which at that time were made of loam strewed with rushes, constantly renewed without the removal of the previous layer, and remaining for a number of years, necessarily concealing fish-bones, broken victuals, and other filth, "and impregnated with the urine of dogs and men." The habits of our ancestors were indeed disgusting in this matter.—(*See* Critical and Miscellaneous Essays, by Thomas Carlyle, people's edition, vol. vi. p. 229.)

The poorer dwellings in Continental towns were, however, quite equal in this respect to those in England; and even at the present time, parts of Mulhouse, Dornach, Amiens, Lyons, Rouen, Lille, Paris, &c., are a disgrace to any civilised community. The cellars of Lille (*caves de Lille*) have especially achieved an unenviable notoriety.

"The principal quarter of the Lille poor is that of St. Sauveur, where all the combinations which produce disease are concentrated. It is composed of a series of islets separated by narrow gloomy alleys abutting on little yards, known under the name of *courettes*, which serve at once as sewers and as a depôt for refuse, in which there is a constant humidity all the year through. The windows of the houses and doors of the cellars open on the infected passages, and the houses are built around these plague-centres. As soon as you penetrate into the *courettes*, a strange population of sickly, lame, deformed, and pallid children besiege you, demanding alms. But the latter, at least, breathe open air. It is only in the depths of the cellars that the misery of those who on account of their age or the rigour of the season cannot go out, can be judged. The father of the family is seldom home in these sad dwellings; he hastens from them at break of day, and only returns late at night. The tender vigilance alone of the mother braves the horror of such a life for the sake of supporting her children."—(BLANQUI.)

In 1828 no less than 3687 people lived in these cellars.

But leaving our Continental neighbours, we will endeavour to sketch briefly the present state of our own habitations—(*a*) In the town; (*b*) in the country.

(*a*.) *In the Town.*

The houses in towns of the richer and middle classes are, if not all that can be desired, yet, speaking generally, built well, lighted sufficiently, and fairly healthy. But when we go lower down in the scale, we find houses, especially in the metropolis, which may be divided into three classes:—

1. Ancient houses built more than a century ago, crowded from garret to ground-floor, and even to cellar when the latter fact can be concealed from the authorities.

2. Good houses in what was once a fashionable quarter, but has gone down, also crammed with lodgers.

3. Mushroom new houses of an inferior class, run up by a speculator or a contractor.

There is, again, a fourth class of houses, of excellent construction—*e.g.*, the Shaftesbury estate, &c.—inhabited strictly by the working class, and having every sanitary requirement fulfilled.

Another class might be made of the small cottage property, but the state of these cottages is obvious, and they are therefore really better looked after by the sanitary authorities than the first three classes mentioned above—most of which show a fair respectable frontage, so that it is only upon entering them that the real facts of the case are seen.

Each room of the first two classes is a separate tenement, and the house as full as a factory, with deficient privy accommodation, water-supply, places to put refuse, &c.

It has been noticed, especially in the large Scotch cities where similar overcrowding exists, that the common staircase acts as an *upcast shaft*, carrying the emanations of the lower inmates to the denizens of the garrets, so that the higher stories show a far greater death-rate than the lower ones.

The third class of houses, in spite of the Building Act of 1858, as Dr. Liddle, the medical officer of health for Whitechapel, has pointed out, is frequently built upon foundations of dry rubbish, without either damp-courses, drainage, water-closets, or ventilation.

Another source of evil arises from the practice of placing houses too close together. When buildings intended as dwellings are crammed within a small area, each jostling and encroaching upon its neighbour, and taking up space, air, and light, it is a case of gregarious overcrowding,* and generally co-exists, as at Liverpool, with overcrowding in the house-unit itself, and deficient sanitary arrangements.

The obvious method to cure the latter evil is to open up, in a gradual manner, wide and straight streets into the poorer quarters, as recommended by Parkes and Sanderson in their report on Liverpool.

In large towns, like the metropolis, Liverpool, Manchester, &c., there are great difficulties in ascertaining the exact number of people who sleep in a house. A house-to-house inspection (*see* HOUSE-TO-HOUSE INSPECTION) every year or two in the worst localities is likely to afford valuable information, for it is evident that a house built for one family, and accommodating ten, can never possess the proper sanitary arrangements.

There are also some houses, and even whole streets, as Mr. Cross justly remarked in his speech (February 8, 1875), so engrained with disease that no expenditure of money will make them healthy. Family after family go into them, and are successively struck down with fever. In such cases the only remedy is to pull them down, a power now given to the sanitary authorities of the metropolis and those of the larger towns by the Artisans' Dwellings Act, 1875, the details of which are to be found at the end of this article.

(*b*.) *Houses in the Rural Districts.*

Here we have—

1. The isolated country gentleman's house, often with a stagnant sheet of water before it,

* "Then it is not simply that houses are overcrowded, but districts are overcrowded, and the air is vitiated. I know of one place in St. Giles where there are seventy streets close together without one single thoroughfare through which the residents can get a breath of pure air."—(Speech of Mr. Cross, in moving for leave to introduce "The Working Class Dwelling Act," February 8, 1875.)

called a lake, imperfect and rat-riddled drains, and polluted water-supply. All surgeons in country practice know that the country seats are the frequent haunts of typhoid fever and other sicknesses. The spread of sanitary science has, however, in this direction borne fruit, and these defects are being appreciated and remedied.

2. The labourer's cottage.

3. The village.

The agricultural labourer's cottage is, in some few instances, well built, but in most it is hardly fit for human habitation. The Agricultural Commissioners in their report say, "It is lamentably evident that though much has been done towards remedying the omission of past generations in this respect, a large portion of the agricultural labourers throughout the country are still housed in dwellings in which they cannot fail to be subjected to great and serious discomforts, and in which the decencies of life are almost impossible." Dr. Bond also, who has paid considerable attention to this subject, says, "I do not think that I exaggerate when I express my belief that in the southern and western parts of the country, with which I am best acquainted, at least 20 per cent. of the labourers' cottages are, either from defective construction or dilapidation, not really habitable." The present writer can bear this out. The cottages in Devon are for the most part built of cob, a kind of clay mixed with straw, which rests on a foundation of stone or brick, and they are thatched with straw. So long as the thatch is kept repaired, the cob stands the weather, and is very comfortable and warm; but if through defect of thatch it gets wet, it rapidly goes to ruin. The floors are seldom boarded, being mostly the earth itself paved with pebbles. Two-thirds have no back premises, and few any privy accommodation. They throw their slops and dirty water outside their doors, and for the requirements of nature go behind the nearest hedge. Overcrowding in some places prevails to a great extent, and these evils are being remedied but slowly.

With regard to Scotland the facts are very similar. "One-third of the population live in tenements comprising one room only; another third live in houses containing two rooms; one-eighth only possess dwellings with three rooms. . . . If a minimum of one-third of the agricultural houses of Great Britain require to be rebuilt, you have something like a measure of our great necessity on the rural side. It is a matter of building 700,000 cottages at a cost of £70,000,000 sterling."—(LORD NAPIER.)

The villages in the rural districts present every variety of cleanliness and filth. Some have drains to carry off the refuse-water, others have nothing of the kind, and all the filth stagnates in open gutters. The houses are, however, often of a better class than isolated cottages, but there is the same utter want of sanitary arrangements. In many villages the houses have no water-supply nearer than two or three hundred yards. Damp foundations, cesspools leaking into the drinking-water, no ventilation, imperfect windows, &c., are everywhere common.

It is the urgent and pressing duty of every one to aid in attempting to alter this state of things. Much in the metropolis has been done by means of two distinct classes of societies, the one founded upon a charitable, the other upon a commercial basis.

"The most important of the charitable agencies is the Peabody Trust. The amount of the trust fund was in November last £600,000, and of this £220,000 had been spent in the purchase of sites and the erection of buildings. The large balance of unexpended capital will be used as soon as sites can be obtained, but so many obstacles exist to the sale of land in London that great difficulties are experienced in obtaining convenient areas."

This paragraph needs no comment, and it shows, with a force to which no words could add, the necessity of giving increased powers to building societies for the acquisition of land.

Of the societies founded on a commercial basis, the best known is that with which the name of Sir Sydney Waterlow is associated, the "Improved Industrial Dwellings Company (Limited)." This society has spent £250,000 in the erection of buildings, and 5 per cent. on the outlay has been uniformly realised and paid to the shareholders. This society accommodates 1268 families, comprising 6340 persons. The tenements are of three kinds—(*a*) those having three rooms each, and for which sums varying from 3s. 9d. to 6s. are paid weekly; (*b*) tenements of four rooms each, for which 4s. 9d. to 8s. are paid weekly; and (*c*) tenements of five rooms, for which a maximum sum of 11s. is charged. There is a scullery, closet, and water-supply to each tenement. The success of this undertaking shows that there ought to be no difficulty in providing any amount of house accommodation for the poor, provided the obstacles in the form of the acquisition of land, &c., were removed.—(Report of the Lancet Sanitary Commission, 1874.)

These evils are not permanent; the progress of society tends itself to gradually improve the dwellings of the working classes. In the great population centres the great and increasing cheapness of transit encourages the artisan to live in the suburbs, at a distance from his work, and thus relieves the denser neighbourhoods. The attention that all matters relating to sanitation is now receiving from the public, supplemented by the useful powers under the Artisans' Dwelling and other Acts, will, there is little doubt, in a few years effect great improvements, at all events, in the larger towns.

The improvement under Mr. Cross's measure must take place slowly, for the inhabitants, compelled to vacate unhealthy and overcrowded tenements, must find accommodation elsewhere. Much good in Liverpool, Edinburgh, and Glasgow has already been effected under local Acts. Houses were destroyed and new streets opened up, the result being not alone an improvement in health, but also a diminution of crime, the most criminal quarters always coinciding with the most insanitary and the most overcrowded.*

It will probably be found necessary to supplement the present Acts by others, or to extend the application of those already existing to rural districts. What the latter especially require is power to supervise the construction of new houses. It is a question whether all houses intended for habitation should not be registered by each sanitary authority, and the exact number, as a maximum, the house should be allowed to contain as permanent residents definitely fixed.

Dr. Bond of Gloucester has insisted with great force on the necessity of giving *all* sanitary authorities power to include the erection of cottages among the sanitary works that they may carry out. In this opinion he is, I have reason to believe, generally supported by the medical health officers throughout the country.

The principal Sanitary Acts relating to habitations are—

1. The Public Health Act, 1875, embodying the Lodging-Houses Acts, except so far as relates to the metropolis.

2. The Artisans' and Labourers' Dwellings Act, 1868, otherwise known as the M'Cullagh Torrens Act.

3. The Artisans' and Labourers' Dwellings Improvement Act, 1875.

4. The Labouring Classes' Lodging-Houses Act, 1851.

5. The Labouring Classes' Lodging-Houses Act of 1866.

In the metropolis there is also the Common Lodging-Houses Acts of 1851 and 1853 still in force, and the Metropolitan Building Act of 1855. The latter prescribes the conditions of future construction with reference to every description of building agency within the metropolitan limits.

The Public Health Act, and Artisans' Dwellings Act of 1875, embody regulations concerning the sanitary condition of houses generally, with powers in extreme cases of closing and demolition.

If, on the certificate of the medical officer of health, or of any two medical practitioners, it appear to any local authority that any house or part thereof is in such a filthy or unwholesome condition that the health of any person is affected or endangered thereby, or that the whitewashing, cleansing, or purifying of any house or part thereof would tend to prevent or check infectious or contagious disease, the local authority shall give notice in writing to the owner or occupier of such house or part thereof to whitewash, cleanse, or purify the same, as the case may require.

If the person to whom notice is so given fails to comply therewith within the time therein specified, he shall be liable to a penalty not exceeding *ten shillings* for every day during which he continues to make default; and the local authority may, if they think fit, cause such house or part thereof to be whitewashed, cleansed, or purified, and may recover in a summary manner the expenses incurred by them in so doing from the person in default.—(P. H., s. 46.)

If a nuisance exist in a house or building of such a nature that in the opinion of a court of summary jurisdiction the house is unfit for human habitation, the court may prohibit the use of it until it is rendered fit for that purpose; and on being satisfied that this has been done, they may determine their order by another declaring the house, &c., habitable.—(P. H., s. 97.)

The health officer is to report to an *urban* sanitary authority any premises dangerous to health, so as to be unfit for human habitation. This report is to be referred to a surveyor or engineer, who must give a report in writing on the cause and remedy of the evil, or whether the premises ought to be demolished. A copy of both reports are to be given to the owner, with notice of the time and place appointed by the sanitary authority for the consideration of them, and the owner may attend and state his objections. The urban sanitary authority may make an order in writing, and, if requisite, have a plan, specification, and estimate prepared. The owner is to be informed that the plan, &c., have been prepared. He may see it and take a copy; and if he objects to it, he may within three weeks state his objection in writing, and support such objection by a personal interview. The urban sanitary autho-

* "Many nests of crime have been broken down in Edinburgh, and the police report a falling off in the number of serious offences from 670 to 570 in the year."—(Mr. Cross's speech on introducing the Artisans' Dwellings Bill.)

rity shall thereupon make such order as it may think fit. An appeal to Quarter Sessions is provided.

If the owners make default, the sanitary authority must order the premises to be shut up or demolished, or may itself do the necessary works. The expenses, on application to Quarter Sessions, may be charged on the premises, with interest at the rate of 4 per cent. per annum. The urban sanitary authority is to be deemed a mortgagee.—(13 & 14 Vict. c. 145, Part II.)

When premises are ordered to be *demolished*, if the owner does not comply within three months, the sanitary authority must demolish it, selling the materials; and after paying expenses, if there should be a balance, paying the same to the owner.—(Ib. 20.)

If the urban sanitary authority order the *improvement* of any premises, and the owner, instead of improving, demolishes them, it is held to be a compliance with the order.—(Ib. 23.)

If four or more householders in or near any street represent to the medical officer of health that any premises in their locality are in a state dangerous to health, he must at once inspect the premises and report on them; and if the sanitary authority neglects for three mouths to take proceedings, the householders may apply to the Local Government Board.

Most of the matters connected with houses are under the operation of bylaws, which in this matter give very extensive powers to *urban* sanitary authorities. The power of making bylaws in regard to the walls of buildings is now extended to the roofs, foundations, and spouts on the outside thereof, and for purposes of health, as well as for the purposes of stability and protection against fire.—(P. H., s. 157.)

The Artisans' and Labourers' Dwellings Improvement Act, 1875, applies to the city of London, the metropolis, to urban sanitary districts in England and Ireland of 25,000 population and above, and is carried out by the respective local authorities.

Upon an official representation "to the local authority that any houses, courts, or alleys within a certain area under the jurisdiction of the local authority are unfit for human habitation, or that diseases indicating a generally low condition of health amongst the population have been from time to time prevalent in a certain area within the jurisdiction of the local authority, and that such prevalence may reasonably be attributed to the closeness, narrowness, and bad arrangement or the bad condition of the streets and houses or groups of houses within such area, or to the want of light, air, ventilation, or proper conveniences, or to any other sanitary defects, or to one or more of such causes, and that the evils connected with such houses, courts, or alleys and the sanitary defects in such area, cannot be effectually remedied otherwise than by an improvement scheme for the re-arrangement and re-construction of the streets and houses within such area, or of some of such streets or houses, the local authority SHALL take such representation into their consideration, and if satisfied of the truth thereof, and of the sufficiency of their resources, shall pass a resolution to the effect that such area is an unhealthy area, and that an improvement scheme ought to be made in respect of such area, and after passing such resolution they SHALL forthwith proceed to make a scheme for the improvement of such area."

Provision is also made to prohibit interested persons voting on the scheme under a penalty of £20.

The *official representation* is defined to mean a representation by the medical officer of health.

The medical officer of health is either the ordinary medical officer of health, or, in case of illness, &c., his substitute.

In the metropolis there is also power to appoint one or more duly-qualified medical men for the special purpose of carrying out the Act, and there the term "medical officer of health" will include these auxiliary officers.

The action of the medical officer of health is either spontaneous, or from representations made to him by two justices of the peace acting within his district, or by twelve or more ratepayers.

In certain cases, such as failure of the health officer to inspect an area after he has received the complaint from twelve or more ratepayers, or has made a favourable report, the ratepayers may appeal to the confirming authority, who may make a local inquiry, and decide whether the area is or is not an unhealthy area. If they agree with the health officer, they may order the costs of the inquiry to be borne by the appellants; if otherwise, by the health officer's local authority.

The improvement scheme is to be accompanied with maps, particulars, and estimates.

Lands may be taken compulsorily under the existing powers, and moneys borrowed on the rates, &c.

The scheme must provide for the accommodation of at least as many persons as have been displaced in the area with respect to which the scheme is proposed.

Upon the completion of the scheme, the local authority has to serve proper notices on the owners and occupiers of the houses and the owners and occupiers of the lands, and ample provision is made for full publicity both previous to tho confirmation of tho scheme and previous to its execution.

Ultimately a petition is to be transmitted, in tho case of tho metropolis to a Secretary of State, and in tho case of other urban authority to tho Local Government Board, praying for an order to confirm tho scheme.

The confirming authority may then, if satisfied that tho scheme is necessary, and that all the forms, &c., have been observed, make a provisional order; which provisional order will go before Parliament in tho usual way, and may, upon petition of parties opposing, be referred to a committee of either House, and the committee shall take into consideration whether the opposition was justifiable or not, and award costs accordingly.

In cases in which the local authority will not act, the confirming authority may hold a local inquiry.

When tho confirming Act has been passed, it shall be the duty of the authority to carry out the scheme. They may sell any part of the area to any person or persons, &c., on the condition that the purchasers will carry the scheme into execution; but the local authority are not at liberty themselves to undertake the building of houses, &c., unless with the express sanction of the confirming authority; and even in that case, unless the confirming authority otherwise determine, they must sell and dispose of all such dwellings within ten years from the time of completion thereof.

In any grant or lease of any part of the area for the erection of dwellings for the working classes, the local authority shall impose suitable conditions and restrictions as to the elevation, size, and design of the houses, and the extent of the accommodation to be afforded thereby; and shall make duo provision for the maintenance of proper sanitary arrangements. After failure of the local authority to complete a scheme within five years by reason of no buyer, &c., the confirming authority may order the land to be sold by auction, with the condition that the buyer is to erect dwellings for the working classes.

There are various other details, for which the reader must consult the Act itself.

Tho Labouring Classes' Dwellings Acts of 1851 and 1866 enable local authorities to construct dwellings and to borrow money from the Loan Commissioners. *See* Loans.

For regulations with regard to the erection of houses in urban districts without proper drainage (P. H., s. 25), *see* Sewers; and with regard to tho erection of houses over sewers (P. H., s. 35), *see* Buildings, Sewers. With regard to the supply of water to houses and sanitary conveniences, *see* Privies and Water.

Habitations, Construction of—The construction of houses deals with—

(*a.*) Tho site.
(*b.*) The material.
(*c.*) The design.
(*d.*) Tho sanitary arrangements, such as ventilating, lighting, heating, draining, &c.

Ono of tho first things is the site. This should preferably be on a slight elevation. If the house be in a valley enclosed with high ground, the winter frosts are apt to be severe; the cold, and therefore heavy night air, flows down the sides of the hills and settles in the valley. No ground ought to rise abruptly at the back of a house, as in the country is so frequently seen; it not alone takes away air and light, but the ground behind really drains into the house, which is liable to be damp. Tho soil cannot always be selected, but when it can, a dry porous soil, other things being equal, is better than an impervious and somewhat stiff soil. In a malarious country, the house should be raised off tho ground by pillars or piles. No one should build over ground where there has been cholera or typhoid fever, they are diseases which infect the earth itself; but if such ground must be built over, it should be well excavated, a layer of charcoal put down, and over this concrete or asphalte.

We must remember that the earth breathes: when the ground-water falls, she inspires; when it rises, expiration is performed, an expiration carrying with it whatever is deleterious. An impervious covering prevents this interchange of ground-air, which otherwise is drawn into the house by the kitchen and other fires.

Houses havo been before now built on rubbish—that is, on waste ground which had been filled with the débris of towns. Common sense and practical experience alike condemn such a practice.

The vegetable soil and its contained roots and seeds should always be removed from the site of a house, and the ground drained. This is the more necessary in the case of clays.

No house should havo its floor resting on the ground, but should bo provided with a double floor, with free ventilation between the ground and flooring, both to prevent dry-rot and for the purposes of health.

Aspect.—Tho aspect of a house cannot always be chosen; when it can, however, a glance at the aspect compass of Professor Kerr (to whom tho writer is indebted for permission to insert the accompanying diagram, fig. 35) will be of service.

In the centre of the compass is the plan of a window facing south—the first ray of the sun entering at 7·30 A.M., the last ray at 4·30 P.M.

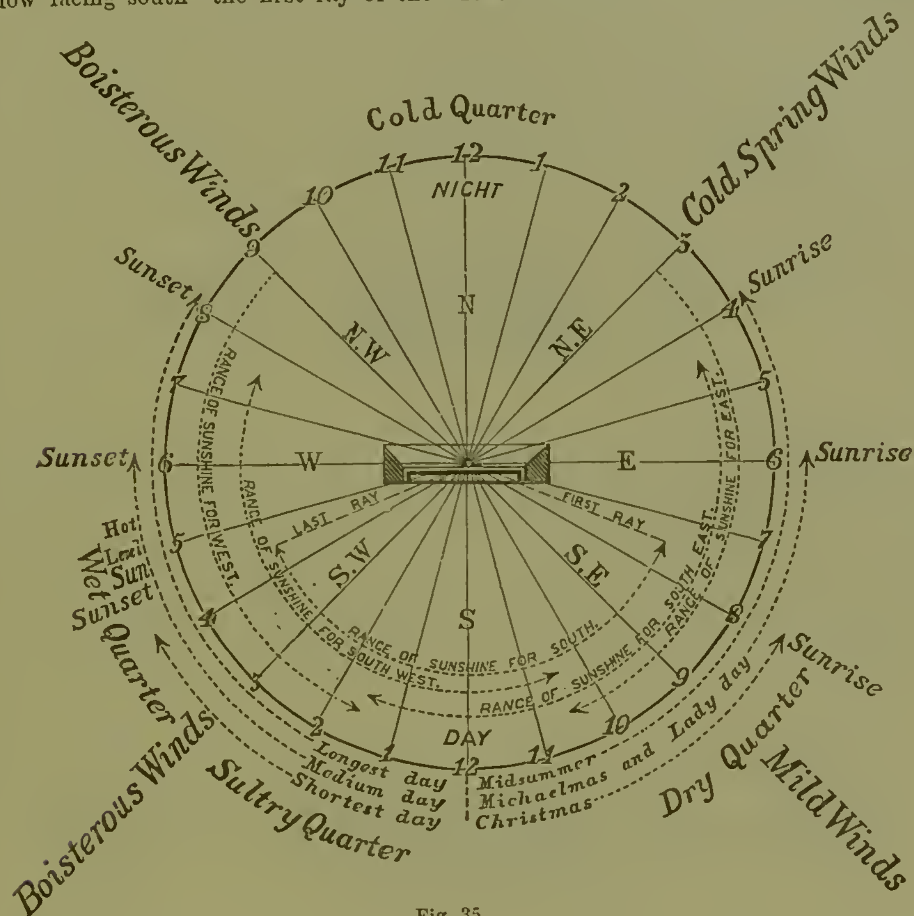


Fig. 35.

Mr. Eassie has given a table founded on this compass, showing the length of time that the sun would shine in at any window.

Window.	Sun enters at—	Is full in front at—	Is lost at—
East . . .	3 A.M.	6 A.M.	10 30 A.M.
South-east.	4·30 A.M.*	9 A.M.	1·30 P.M.
South . .	7·50 A.M.	10 A.M.(noon)	4·30 P.M.
South-west.	10·30 A.M.	3 P.M.	7·30 P.M.†
West . .	1·30 P.M.	6 P.M.	At setting only.

By the aid of this table and a study of the compass, the principal points with regard to aspect will be seen. The south-east, generally speaking, is the best aspect for the front of the house ; or, at all events, for that part of the house in which the most used or best rooms are.

For the larder, the staircases, and dairy, a northern aspect is to be preferred.

A south-west aspect for sitting-rooms is the worst one possible.

* Or at dawn, if later. † Or at sunset, if earlier.

The material of houses is various. One thing is certain, that it must be dry and porous—all the best building-stone and bricks are so. This may be easily proved by Pettenkofer's experiment.

"I have," says the Professor in his well-known lecture, "here a cylindrical piece of mortar—half lime, half sand—5 inches by 1⅔. The cylinder has been covered all over with melted wax, which is impermeable to air, with the exception of its two circular ends. You see this glass funnel with a tube (fig. 36). I fix it on one circular end, where the mortar lies free, and make an air-tight connection by wax, with the waxen coat of the cylinder. If I blow through the tube, the air must appear on the free mortar end, provided the mortar is permeable to air. It has as yet no effect on the flame of this candle, because its velocity is not great enough. But if I fix a funnel on the other end of the cylinder, the air, which has passed through the mortar, can only escape through its narrow end, and there you see the flame sensibly deviating (fig. 37). You may even succeed in extinguishing it altogether. The velocity of the air in going through the tube must increase in proportion as the transverse section of the tube is smaller than the mortar surface, out of which the air escapes, exactly as with the water of the pond and its in and out flow. Now, when I dip the end of one tube into water, you see and hear the air, which has passed through the mortar, escape from the water. If you make a similar arrangement with a piece of wood, or a brick, you will see the same result. Most kinds, also, of sandstone are so porous that water and air easily pass through them. Solid or quarried limestones are scarcely permeable to air; but as they are mostly of irregular shapes they require more mortar, and that is the reason why such walls are, after all, not so much more air-tight than walls made of regular bricks and thin layers of mortar.

Fig. 36.

"Observations have been taken of the average quantity of mortar used with different building-stones. We may suppose that, taking the wall as a whole, it is one-third with quarried lime, one-fourth with tufaceous lime, one-fifth to one-sixth with bricks, one-sixth to one-eighth with cubes of sandstone. In practice, then, the quantity of the mortar rises with the decrease of porosity in the building-stones, and assists in keeping the walls pervious to air to a certain degree. It is self-evident that the quantity of air which passes through building materials of a certain thickness must increase in proportion to the surface; 2 square feet must give passage to twice as much air as 1 square foot.

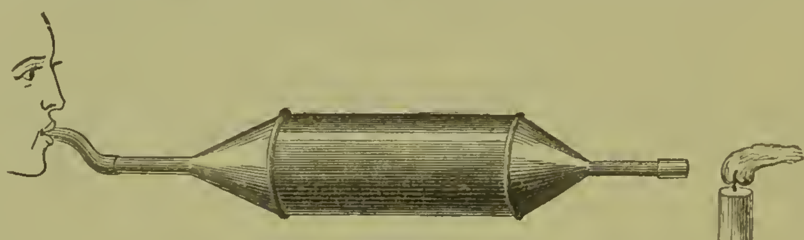


Fig. 37.

"The effect of wetting porous materials is quite surprising. In proportion as the pores fill with water they become impervious to air. The adhesion of water to stone and mortar is greater than that of air. It is not difficult to blow great volumes of air through dry mortar and dry bricks, but it requires a great exertion to drive a few drops of water through the same materials. You know this cylinder of mortar (*see* above)—instead of blowing air through it into water, I will suck the air off it. You see now the water rise in the tube and wet the surface of the mortar. Now, I will try to blow again air through the mortar. I cannot with all my exertions, because the pores of the mortar are filled with water. This simple experiment lays bare the great hygienic disadvantages of wet walls. They are air-tight, not to speak of other injurious effects."

In some parts of England the cottage-houses are built of wood, others have a frame of wood only. In the west, as mentioned in a previous article, a great many of the labourers' cottages are constructed of "cob," a kind of clay mixed with straw. The cob stands on a stone or brick foundation, and is thatched; and this substance makes a good, healthy, and substantial wall, provided it is kept dry. Thatched and wood houses are objectionable on account of fire.

Mr. Howard of Bedford has had built six cottages of concrete. The walls are a foot thick. There can be no doubt that concrete will make a dry and serviceable wall. It has also the merit of cheapness. Each of the cottages has three bedrooms and an earth-closet. The cost of the whole, exclusive of the earth-closets, was £660.—(Sanitary Record, vol. i. No. 19, p. 323.)

The design of the house may be well left to the taste of the builder in the middle-class and better houses, but with regard to cottage tenements, the best plan would certainly be to build them long and narrow, and, where ground is cheap, one story high.

For the sanitary arrangements of a house, *see* Closets, Drain, Ventilation, &c.; *also see* House-to-House Inspection.

Hackney Carriages—*See* Conveyances.

Haddock—This fish is closely allied to the whiting, but it is inferior to it in flavour and digestibility. It contains 18·1 per cent. nitrogenous matter, 2·9 per cent. fat, 1·0 per cent. saline matter, and 78·0 per cent. of water.

Ham—*See* PORK.

Hamburg Powder—Roasted and ground peas, &c., coloured with Venetian red, constitute this article, which is used for the purpose of adulterating chicory. *See* CHICORY.

Harbours — *See* SANITARY AUTHORITY, PORT.

Health, General Board of—*See* BOARD, GENERAL, OF HEALTH.

Heart, Disease of—The causes and distribution of heart diseases possess the highest int rest for sanitarians, as it is now evident that many of the causes are preventible. Speaking roughly, 10,000 people die annually in England from disease of the heart. Considering what the heart is, and what it does, it is almost a matter of surprise that it is not even more prevalent. "The heart is a small muscle, weighing only a few ounces, beating perpetually day and night, morning and evening, summer and winter; and yet often an old man's heart, nearly a hundred years of age, is as perfect and complete as when he was a young man of twenty."—(HAUGHTON'S Principles of Least Action in Nature; Medical Times and Gazette, i. 71, p. 653.)

According to the same eminent authority, 20 lbs. are lifted by an ounce-weight of the heart every minute through a foot.

DEATHS and DEATH-RATE from Heart Disease in the Four Quinquennial Periods between 1851 and 1870, and also in the year 1871.

MALES.

Quinquennial Periods.	Deaths at different Ages.					Annual Rate per 1000 Living.				
	All Ages.	0–20.	20–45.	45–65.	65 and upwards.	All Ages.	0–20.	20–45.	45–65.	65 and upwards.
1851–55	32,617	4416	6,454	11,873	9,874	0·725	0·177	0·553	1·829	5·065
1856–60	39,678	3433	8,723	14,629	12,893	0·836	0·156	0·529	2·137	6·268
1861–65	49,738	3942	11,128	18,662	16,006	0·993	0·169	0·605	2·583	7·381
1866–70	57,687	4296	13,089	21,132	19,170	1·085	0·174	0·709	2·757	8·329
1871	12,911	925	2,981	4,773	4,232	1·164	0·178	0·788	2·968	8·603

FEMALES.

Quinquennial Periods.	Deaths at different Ages.					Annual Rate per 1000 Living.				
	All Ages.	0–20.	20–45.	45–65.	65 and upwards.	All Ages.	0–20.	20–45.	45–65.	65 and upwards.
1851–55	33,497	4784	6,719	12,165	9,829	0·713	0·171	0·530	1·780	4·232
1856–60	41,095	3610	9,349	14,930	13,206	0·825	0·164	0·516	2·061	5·361
1861–65	51,243	4153	11,025	18,897	17,168	0·970	0·178	0·573	2·454	6·568
1866–70	60,003	4632	12,711	21,588	21,072	1·067	0·187	0·621	2·632	7·574
1871	13,308	982	2,716	4,906	4,704	1·138	0·189	0·653	2·818	8·025

There has been an increase in disease of the heart within the last twenty years. 11,356 deaths were referred to heart disease in 1850; 18,758 in 1860; and 26,219 in 1871. "The increase was progressive and rapid in the twenty years. Looking further back, to the five years when registration first began, these affections of the heart were recognised to a still smaller extent—they ranged from 3562 to 4925 a year. The deaths ascribed to aneurism amounted to 119 in 1838, to 286 in 1850, to 368 in 1860, and to 627 in 1870. This is a well-defined affection of the great arteries, but it was not formerly detected with so much certainty as it is now. Simultaneously with the increase of death by heart disease there was a decrease of death ascribed to dropsy, and the fact to bear in mind is that dropsy is one of the striking obvious symptoms of heart disease. The early mortality tables, previous to the inspection of the organs after death, when the knowledge of pathology was in its infancy, recognised no such thing as aneurism, pericarditis, hypertrophy, or any of the other forms of disease of the circulating system. Dropsy, on the other hand, was one of the earliest diseases named. The circulation of the blood is so essential to the life of every organ—the brain, for example—that its derangement may give rise to diseases of those organs, such as apoplexy, much more obvious to the eye than the heart-sounds are to the ear. It is fair, then, to assume that a part of the increase of heart disease in England is only apparent, and is due to improved nomenclature, to advancing diagnosis—what was called dropsy is called hypertrophy of the heart, and so in other cases. Nevertheless, after making due allowance for this element, Dr. Quain, who has recently delivered the Lumleian Lectures at the Royal College of Physicians, holds that there has been, within the last twenty years, an actual increase of heart disease in England. The table on preceding page was framed at the instance of Dr. Quain, and should be carefully considered by every student."—(Dr. FARRE's Letter to the Registrar-General on the Causes of Death in England, 1870.)

Diseases of the circulation, according to Dr. Parkes, rank second as causes of death in the home army.

"The ratio per 1000 of strength for the last five years (1867–71), for all diseases of the organs of circulation, is 1·462; and in these years, out of every 100 deaths, no less than 16·7 were from disease of the heart and great vessels. In addition, there is a large amount of invaliding from this cause.

"If the fatal diseases of the circulatory system of these five years are divided into two classes—those referred to some disease of the heart itself (chiefly chronic), and those referred to aneurism (including an occasional rare return headed *degeneratio aortæ*)—it is found that the deaths are, from—

	Per 1000 of Strength.	In 100 Deaths.
Cardiac disease .	0·727	8·31
Aneurism . .	0·735	8·4
	1·462	16·71

These numbers are higher than those of the nine years (1859-67), when the mortality from circulatory disease was only ·908 per 1000 of strength, and the percentage on the total deaths was 9."—(PARKES' Hygiène.)

Myers shows that disease of the heart is greater among the Foot Guards than amongst metropolitan policemen, and greater among soldiers than sailors.—(Diseases of the Heart among Soldiers, by MYERS.)

Dr. Parkes has also calculated out the causes of invaliding, and has shown that the production of these diseases begin early in the soldier's career.

Out of 6856 invalided, 1014 of whom were under two years' service, he found the percentage of heart and vessel disease as a cause was 7·7 in the whole number, and 14·23 per cent. among the men under two years' service.

There would appear to be a great excess of heart disease in certain arms of the service; for example, the deaths from heart disease in the Artillery per 1000 is 1·2, the Cavalry of the Guard only ·18. The Artillery head the list both as to aneurism and disease of the heart. Such an unequal distribution points to an appreciable and therefore removable cause.

Geographical Distribution of Heart Disease in England and Wales.—This has been worked out in a very careful manner in "The Geographical Distribution of Heart Disease and Dropsy in England and Wales," by ALFRED HAVILAND, M.R.C.S.

1. As respects the eleven registration divisions, he finds that the two midland divisions have a mortality from heart disease and dropsy above the average, and that two-thirds of the *coastal* divisions have a low rate of mortality. Then, comparing the character of the coast-line, which forms the boundaries or the divisions having a high with those having a low mortality, he finds, coincident with a *high* mortality, a precipitous rock-bound coast, having few inlets, and those at right angles to the prevailing winds and the current of the tidal wave; and, on the other hand, coincident with a *low* mortality, low or shelving coasts, valleys, and rivers having a direction in their course favourable to the free access of the prevailing sea-winds and tidal currents, and numerous sea-inlets, opening into wide vales, which freely admit a thorough afflux and efflux of powerful winds from any quarter.

2. As regards the fifty-three registration counties which make up the registration divisions, Mr. Haviland finds, first, that the coastal counties with a low mortality from heart disease and dropsy are more numerous than those with a high mortality: that those most exposed to the prevailing winds, or most free from obstruction to their operation, have the *least* mortality; while those which are most protected by their physical surroundings, and are most inland, have the *greatest* mortality. As regards the inland counties, on the other hand, out of twenty-six, only six have a mortality below the average. Dividing the counties into coastal, inland, and midland or central counties, the death-rate from these diseases was as follows: Coastal, 11·9; inland, 12·5; and central, 15·1 per 10,000 persons living. Thus, coincident with the lowest amount of exposure to the sea-air, as in the midland counties, is the highest amount of mortality in those counties; on the other hand, coincident with the highest amount of

exposure is the lowest amount of mortality; and finally, the counties which lie intermediately between these extremes have also an intermediate death-rate.

3. As respects the 623 union districts, the coastal registration districts, as a rule, have a low mortality from heart disease and dropsy. There are three coast-lines around England and Wales—the east, the south, and the west. "Coincident with the great number of sea-inlets and low coast-line on the eastern side of England, we find a *low* mortality in twenty-nine out of forty-one districts. Coincident with the rocky and precipitous coast of the south, an absence of important sea-inlets, and the courses of the rivers being at right angles with the prevailing winds, we find that of the forty districts twenty-eight have a *high* mortality. And lastly, coincident with the physical facilities afforded on the western side for a full purging from the Atlantic of the valleys from air-sewage, it will be seen that out of fifty-two districts, from Redruth to Wigton inclusive, forty-two are below the average, and only ten above it."

With regard to the inland, midland, and insular or peninsular districts, Mr. Haviland finds that, on the whole, the *inland* districts have a higher mortality than the coastal, but that the low-mortality inland districts are found contiguous to those which border the great sea-inlets and the coast, as well as where there is elevated ground admitting of free ventilation on all sides; that the *midland* group of districts, which are not intersected by the great sea-inlets, but are protected by high ranges of hills on all sides, have the highest mortality; and lastly, that the *insular* and *peninsular* districts, the most exposed to the sea-winds of all districts, have a low mortality from heart disease and dropsy.

Causes of Heart Disease.—Apart from hereditary influence and disease of obscure developmental origin, there are tangible causes of heart disease which will partly account for their present increase, and merit in a strong degree the attention of the hygienist.

The first of these is the influence of impure air, which on a large scale may be seen in the above geographical sketch.

Dr. Black, in treating of the causes of heart disease, says:—

"I showed the effect of impure air in promoting the degenerative tendency in the structures of the heart, and especially in those of the right side of the heart, after the ages of forty. I was thus led to a passing consideration of the baneful influence produced upon the heart by badly-ventilated houses, schools, manufactories, pits, theatres, underground railways, and all places of a similar character."—(Lancet, 1872, i. p. 329.) Dr. Black showed that the effect of diminishing oxygen and increasing carbonic acid could be observed on the heart of the trout. He hatched some thousands of this fish, and submitted them to daily microscopic investigation. As the oxygen in the water was exhausted, and as the carbonic acid increased, the sensibility and contractility of the heart was diminished, and at length entirely destroyed. He considers that the same effect is produced upon the human heart by an accumulation of carbonic acid in the air respired, and that deficient ventilation is a great source of degeneration of the heart.

"The impure atmosphere of the bedrooms of the poor, and indeed of many of the middle class, proves a sharp spur to the degenerative tendency manifested by the heart, and especially by the right side of the heart, after the age of forty.

"I hold that the breathing of impure air is a fruitful source of disease of the right heart, occurring after middle age. How many people ignorantly favour its occurrence by confining themselves to closely-shut, non-ventilated, hot, stifling rooms, in which the carbonic acid has accumulated to 2 or 3 per cent. of the air they respire! And many are thus destroyed by being compelled, through the exigencies of life, to pass the greater part of their time in pits and manufactories where ventilation is defective, or in which the air respired is poisoned by noxious fumes and offensive emanations from the materials undergoing the process of manufacture. How many are falling victims to the poisonous influence on the heart of the atmosphere of an underground railway! What do these facts suggest? How are these evil results to be prevented? The simple answer is, Let the rooms in which you live be effectually ventilated by an incoming current of air, filtered from all adventitious impurities, and so divided that no draught shall be felt; and by an outgoing current, which shall remove from the apartments the carbonic acid, carbonic oxide, sulphurous acid gas, sulphuretted hydrogen, and other noxious compounds as rapidly as they are generated. Apply the same principle to public buildings, theatres, schools, manufactories, pits, and to all places in which people are accustomed to congregate."—(Dr. Cornelius Black, *loc. cit.*, p. 254.)

Overstraining of the Heart.—The increase of heart affections in modern times is probably in some degree due to this cause. Men leading sedentary lives suddenly make great efforts—*e.g.*, catching a train, lifting heavy weights, violent athletics, &c. In these and similar ways the valves and walls of the heart, unaccustomed to the strain, may be irretrievably damaged. The immense exertion in efforts such as the Oxford boat-race may be appreciated from the estimates of the Rev. Samuel Haughton, who says: "I obtained from Mr. Main of Oxford, and Mr. Maclaren, the trainer, the cross-sections of the Oxford eight and other particulars. The time in which this race has been done is on an average 23 minutes, 3½ seconds, and the length of the course 4·31 miles. From these data, and plans and sections of the boats, I was able to determine the amount of work done by the muscles of these young men. I found that during the 23 minutes that the race lasts, every ounce of muscle in the arms and legs is working at the rate of 20·124 lbs. If any of you have seen the exhausted condition of these young men when lifted out of the boats, you will agree with me that human beings could not endure such exertion for 40 minutes."

Again, Dr. Black justly says, speaking of severe rowing: "At every effort made with the hands and feet, the muscles are strained to their utmost; the chest is violently fixed; no air is admitted into the lungs; blood is thrown by the goaded heart with great force into the pulmonary vessels; they become distended; they at length cannot find space for more blood; the onward current is now driven back upon the right heart; its cavities and the blood-vessels of its walls become in like manner distended; the foundation of disease is laid."

Most modern physicians recognise the great frequency of heart affections in those accustomed to make violent efforts. Strikers in foundries, bargemen, heavy porters, runners, wrestlers, boxers, &c., are the classes where this influence is most apparent; nor must we exclude the soldier, who, heavily weighted and accoutred, often has to make extraordinary efforts.

Alcoholism is a too frequent cause of fatty disease of the heart, as well as of slow degenerations of its tissue. The daily ingestion of alcohol not alone irritates the heart, but often causes a slow inflammation of the lining membranes of the great vessels leading from it. It thus induces heart disease in two ways—1. By increasing its action. 2. By acting as an irritant. Besides this, if alcohol take the place of nutriment, the impoverished blood will not nourish or feed the heart like healthy blood.

Rheumatism, gout, and syphilis are fruitful and evident causes of heart disease, to which may be added kidney diseases; and, probably, of *all diseases* this class predisposes more than any other to cardiac affections.

Mechanical causes such as the tight uniform of the soldier, the constant holding of a tool against the chest, constrained postures, &c.—should also be enumerated.

Heating of Public Buildings — *See* WARMING.

Heights, Measurement of—*See* BAROMETER, &c.

Hellebore—There are three commercial kinds of hellebore — the white (*Veratrum album*), the green (*V. viride*), and the black. The latter roots are imported in bags or barrels from Hamburg, and, according to Professor Bentley, are frequently adulterated with those of the baneberry (*Actæa spicata*). All varieties are poisonous. The white hellebore owes its properties to veratria (*see* VERATRIA). Half a drachm of the aqueous extract of black hellebore killed a man, aged fifty, in eight hours (MORGAGNI, quoted by TAYLOR); and, according to Hertwig, "quantities of from 2 to 3 drachms produce in horses, colic, enteritis, and death in from forty to fifty hours, and from 1 to 3 drachms produce similar effects among sheep and goats."

Pereira says: "Given by the mouth to the carnivora (as dogs), it causes vomiting, frequently purging and griping. In excessive doses it produces gastro-enteritis. If the œsophagus be tied to prevent the ejection of the root from the stomach, it causes staggering, weakness, or paralysis of the hind extremities, insensibility, and death. Similar effects result from the application to a wound."

Two cows died from accidental poisoning from this substance, and their cases are detailed in the "Veterinarian" of 1855. The cows had been fed on dry food for some time previously, and some portion of the plant, which the animals ate ravenously, had been thoughtlessly thrown in the yard. The symptoms were "purging, rumen distended with gas, saliva dribbling from the mouth, animal constantly lying down and getting up, and when made to move uttering a low groan." This cow died about twenty-four hours after eating the plant, the other one had died previously.

Hellebore, in the form of powder or decoction of the root, is a frequent quack medicine.

Hemlock—The ripe dried fruit of the *Conium maculatum*, also the leaves carefully separated and dried. All parts contain a liquid volatile alkaloid, *Conia* ($C_8H_{15}N$) (*which see*). Hemlock acts as a direct sedative, especially on the spinal cord, and in very large doses causes paralysis. In some cases it induces stupor, coma, and slight convulsions. For tests, antidotes, &c., *see* CONIA.

Henbane—The fresh and dried stalk-leaf of the biennial herb *Hyoscyamus niger*. Henbane is anodyne, antispasmodic, and sedative; it is not a stimulant, and does not confine the bowels. In large doses it is poisonous. It owes its properties to the presence of an alkaloid, HYOSCYAMIA.

Herring—This fish contains, incorporated with its flesh, more fatty matter than the generality of fish. In composition it resembles the eel. *See* EEL.

Highways — The proper repair of our roads is of the greatest interest in a sanitary point of view. It is true it may not be of any great consequence to the public health if they should be full of deep ruts and holes in places far from villages or towns, but directly the road approaches a block of houses or a village, it becomes subject to greater wear, it is liable to be made a place on which all sorts of refuse are deposited; and if the surface is uneven or improperly made, or repaired so that the surface-pollutions stand in puddles, instead of running into their proper channels, the effect is insanitary to a high degree. All refuse-drains running into the road—slops being thrown upon it where there is no proper channel, &c., may be dealt with effectually under the Public Health Act. The surveyor of roads may also deal with such cases very effectually under 5 & 6 William IV. c. 50, s. 72, which enacts that if any person "shall lay any timber, stone, hay, straw, dung, manure, lime soil, ashes, rubbish, or other matter or thing whatsoever upon such highway, to the injury of such highway, or to the injury, interruption, or personal danger of any person travelling thereon, or shall suffer any filth, dirt, lime, or other offensive matter or thing whatsoever to run on or flow into or upon any highway from any house, building, erection, lands, or premises adjacent thereto, . . . every person so offending shall for each and every such offence forfeit and pay any sum not exceeding forty shillings, over and above the damages occasioned thereby."

By section 73 it is also enacted that any timber, stone, hay, straw, dung, manure, lime, soil, ashes, rubbish, or other matter or thing whatsoever, so as to be a nuisance, are to be removed on notice; and if the notice is not complied with, the surveyor, by order in writing from any one justice, is to remove and to dispose of the same, and the offending person has to reimburse the surveyor if the proceeds of the sale be not enough to cover the expense.

The term "public highway" imports a road for carriages, as well as for other purposes; but it has been held that it might mean a public bridleway only.—(Reg. *v.* Aldborough, J. P., 648; GLEN'S Public Health.)

Every *urban* authority shall within their district, exclusively of any other person, execute the office of and be surveyor of highways, and shall have, exercise, and be subject to all the powers, authorities, duties, and liabilities of surveyors of highways under the law for the time being in force, save so far as such powers, duties, or authorities are or may be inconsistent with the provisions of the Public Health Act; every urban authority shall also have, exercise, and be subject to all the powers, authorities, duties, and liabilities which by the Highway Act, 1835, or any Act amending the same, are vested in and given to the inhabitants in vestry assembled of any parish within their district.

All ministerial acts required by any Act of Parliament to be done by the surveyor of highways may be done by the surveyor of the urban authority, or by such other person as they may appoint.—(P. H., s. 144.)

The inhabitants within any urban district shall not in respect of any property situated therein be liable to the payment of highway rate or other payment, not being a toll, in respect of making or repairing roads or highways without such district: provided, that any person who in any place after the passing of the Public Health Act ceases under or by virtue of any provision of the said Act, or of any order made thereunder, to be surveyor of highways within such place, may recover any highway rate made in respect of such place, and remaining unpaid at the time of his so ceasing to be such surveyor, as if he had not ceased to be such surveyor; and the money so recovered shall be applied, in the first place, in reimbursing himself any expenses incurred by him as such surveyor, and in discharging any debts legally owing by him on account of the highways within his jurisdiction; and the surplus (if any) shall be paid by him to the treasurer of the urban authority, and carried to the fund or rate applicable to the repair of highways within their district. —(P. H., s. 145.)

Any urban authority may agree with any person for the making of roads for the public use through the lands and at the expense of such person, and may agree that such roads shall become, and the same shall accordingly become on completion, highways maintainable and repairable by the inhabitants at large within their district; they may also, with the consent of two-thirds of their number, agree with such person to pay, and may accordingly pay, any portion of the expenses of making such roads.—(P. H., s. 146.)

Any urban authority has power to enter into an agreement with the trustees, &c., of any road, to repair, maintain, cleanse, &c., the same.—(P. H., s. 148.)

The powers of a Highway Board as a sanitary authority are abolished.

Where a local government district is surrounded or adjoined by a highway district under the Highway Acts, the local government district is to be deemed within such highway district.—(P. H., App. Part III.; 26 & 27 Vict. c. 17, s. 6.)

Highway Rate.—In any urban district where the expenses under the Public Health Act of the urban authority are charged on and defrayed out of the district fund and general district rates, and no other mode of providing for repair of highways is directed by any local Act, the cost of repair of highways is to be defrayed as follows; (that is to say,)

(1.) Where the whole of the district is rated for works of paving, water-supply, and sewerage, or for works for such of these purposes as are provided for in the district, the cost of repair of highways is to be defrayed out of the general district rate:

(2.) Where parts of the district are not rated for works of paving, water-supply, and sewerage, or for such of these purposes as are provided for in the district, the cost of repair of highways in those parts is to be defrayed out of a highway rate to be separately assessed and levied in those parts by the urban authority as surveyor of highways, and the cost of such repair in the residue of the district shall be defrayed out of the general district rate:

(3.) Where no public works of paving, water-supply, and sewerage are established in the district, the cost of repair of highways in the district is to be defrayed out of a highway rate, to be levied throughout the whole district by the urban authority as surveyor of highways:

Provided that where part of a parish is included within an urban district, and the excluded part was, before the constitution of such district, liable to contribute to the highway rates for such parish, such excluded part shall, unless in the case of an urban district constituted such before the passing of the Public Health Act, 1875, which has passed a resolution deciding that such excluded part should be formed into a separate highway district, in pursuance of the Local Government Act, 1858, Amendment Act, 1861, or unless such excluded part has been included in a highway district under the Highway Acts for all purposes connected with the repairs and the rates of highways, be considered and treated as forming part of such district.

In the case of an urban district constituted after the passing of the Public Health Act, a meeting of owners and ratepayers convened, &c., according to Schedule III. of the Public Health Act (*see* RESOLUTIONS), may decide that such excluded part shall be a highway parish, and thereupon the excluded part shall for *all purposes* connected with highways, surveyors of highways, and highway rates, be considered and treated as a parish maintaining its own highways; but the requisition for holding any such meeting is to be made within six months after the constitution of the urban district.

The Court of Quarter Sessions may by order direct that for any such excluded part a way-warden or way-wardens shall be elected, and may invest any way-warden elected in pursuance of such order with all or any of the powers of way-warden under the Highway Acts.—(P. H., s. 216.)

It shall not be necessary for the urban authority, in the case of any highway rate made by them—

To lay such rate before any justices, or obtain their allowance;

To annex thereto the signature of such urban authority;

To lay the same before the parishioners assembled in vestry;

To verify before any justices any accounts kept by them of such highway rates;

and all such accounts shall be audited in all respects in the same way as the other accounts of the urban authority.—(P. H., s. 217.)

The powers and duties of the Secretary of State under the Highway and Turnpike Acts are transferred to the Local Government Board.—(35 & 36 Vict. c. 79, s. 36, and P. H., Schedule V. Part III.)

Hock or **Hocheimer**—The German wines produced on the banks of the Rhine generally pass in this country under the name of Hock. They are of light alcoholic strength, acidulous, and have a peculiar aroma or fragrance. They are useful beverages at the commencement of dinner, acting as an excitant of the appetite. A want of brightness is the characteristic of the lighter German wines, hence the custom of drinking them in coloured wine-glasses. *See* WINE, ALCOHOLIC BEVERAGES, &c.

Hollands—*See* GIN.

Hominy—*See* INDIAN-CORN, FLOUR, &c.

Honey is a sweet substance obtained by the bee from the nectariferous glands of flowers, and is elaborated in the body of the bee, and ultimately deposited in the honeycomb.

Honey contains grape-sugar, manna, gum-mucilage, extractive, wax in small quantities, pollen, and odoriferous substances.

The sugar in honey consists partly of grape-sugar, which crystallises, and partly of an uncrystallisable sugar. The crystals may be separated by filtration through linen.

The different varieties of honey are known as—

Virgin honey, or that which spontaneously flows from the honeycomb of young bees which have never swarmed.

Ordinary honey, obtained by heat and pressure.

English honey, produced by bees which have principally fed on furze and broom flowers.

Narbonne honey, produced by bees feeding on rosemary and other labiate flowers.

The microscopic appearances of honey are thin transparent brittle crystals, in the form of six-sided prisms, intermixed with grains of pollen. Honey is used in medicine as a very mild laxative.

In dietetic value it is similar to sugar. It was of more importance to the ancients than to ourselves, as the former were not acquainted with cane-sugar.

Honey is sometimes poisonous. Trebizonde honey from the Black Sea has proved fatal, its poisonous effects being due to the fact that the bees have collected it from the *Azalea Pontica*. The honey gathered by the bees from the savannas of New Jersey intoxicates in small quantities, and in larger produces poisonous symptoms, the calmia and azalea being there the principal flowering shrubs.

Adulterations.—Honey has been found to be adulterated with treacle, potato-sugar, syrup, potato-starch, common starch, and wheat-flour.

To judge of the quality of honey, and to detect its adulterations, an analysis will be necessary. The sugar should be estimated as described under SUGAR, ESTIMATION OF, the water by evaporation in the water-bath, the ash by burning a weighed quantity down. Starch can be detected by the blue colour produced on addition of a solution of iodine, gelatine by its giving a precipitate with tannic acid. The ash from pure honey is small in quantity, and the addition of chalk, &c., is therefore very easy of detection.

Hooping-Cough — *See* WHOOPING-COUGH, &c.

Hops—"The catkins of the female plant of the *Humulus Lupulus*, or common hop." The strobiles (or catkins, as they are called), and which in commerce are termed "hops," consist of scales (bracts), nuts (achenes), and lupulinic glands or grains.

The lupulinic glands, according to Payen, contain 2 per cent. of volatile oil, 10 30 of bitter principle, and 50 to 55 per cent. of resin. The scales contain tannic acid. Volatile oil of hops resides in the lupulinic glands. The bitter principle of hops is LUPULITE (*which see*).

The odorous emanation of hops possesses narcotic properties. The lupulinic glands are aromatic and tonic.

The sedative, anodyne, and narcotic properties of hops are very uncertain. *See* BEER, PORTER, &c.

Hop-Picking, Hop-Pickers—Recent legislation has given local authorities power to regulate "hop-picking" by bylaws.

About the close of the first week of September the hops are ready to be gathered in the fields of Kent, Worcester, and a few other counties; and there is an influx of hop-pickers from London and the large towns into the hop-fields. Cheap trains are run for their accommodation by the companies, and they arrive in dense swarms. The returns of the South-Eastern Railway Company, showing the number of hop-pickers conveyed to Kent alone, will give some idea of the magnitude and sanitary importance of hop-picking:—

	Hop-Pickers from London by Special Train.	Returned by Ditto.
1865 . . .	11,000	12,000
1866 . . .	11,000	13,000
1867 . . .	8,777	10,694
1868 . . .	14,476	17,288

It therefore follows that the sanitary authorities of Kent have suddenly the responsibility of looking after the health of a mass of people equalling in number an army; but with this essential difference, that an army has an ample supply of tents and necessaries, is under discipline and control, and is not accompanied by women and children, whilst the hop-pickers carry as little luggage as they possibly can, are accompanied by women and children, and are often very disorderly. A little time ago the hop-pickers were mainly composed of the very scum of the population of large towns, but by the laudable exertions of various societies, especially of the Maidstone Hop-Pickers' Society, a great improvement in the respectability of the pickers is manifest. The great feature of hop-picking in a sanitary aspect is overcrowding. They go to the fields, whether by rail or road, they work, they eat, and they sleep in dense crowds. But the evils of this overcrowding are to a great extent neutralised by the open-air occupation, the regular and healthy work, and the ample food which they are able to obtain.

Most of the pickers are derived from the most unhealthy and crowded parts of large towns, and hence are liable to import contagious diseases; and as no conditions could possibly be more favourable to the propagation of zymotic diseases than those under which hop-pickers live, it is the urgent duty of each sanitary authority not alone to have special arrangements for obtaining early information of any case of fever or infectious disease, but also to have a temporary or permanent hospital, to which the patient may be instantly removed. It will be the duty of the sanitary officers to see that the drinking-water supplied to the pickers is sufficient, of fair purity, and not liable to be contaminated; and that the employers provide latrines of simple construction. Perhaps the best latrine in such cases is the military one, consisting of a deep trench, into which earth is thrown every day, and as one is filled another is dug in front of it, the whole being properly screened from observation by bushes, canvas, or boards.

Bylaws for Hop-Pickers.—"Any local authority may, if they think fit, make bylaws for securing the decent lodging and accommodation of persons engaged in hop-picking."—(P. H., s. 314.)

The bylaws should be based upon the following principles:—

1. The lodgings, whatever the materials, must be weatherproof.

2. A minimum space of 16 square feet must be allowed for each adult, two children counting as one person.

3. Proper facilities must be given for the separation of the sexes, and such screens and divisions provided as are necessary to protect occupants from indecent exposure.

4. Every employer must provide (*a*) a sufficient supply of good water; (*b*) proper latrines; (*c*) a sufficient number of cooking-houses.

5. Every employer must give immediate notice of *any case of serious illness, whether infectious or not*, to the sanitary officers.

Horse-Radish—The root of the *Cochlearia Armoracia.* It is a pungent acrid stimulant and rubefacient. Taken as a condiment, it provokes the appetite and assists digestion. Aconite root has sometimes, and with fatal results, been mistaken for horse-radish. The two roots, however, present striking differences. The taste of the horse-radish is warm and pungent, approaching that of mustard, while aconite has a bitter taste and a disagreeable earthy odour, and after a few minutes' contact with the mouth, tongue, and fauces, produces a feeling of numbness and tingling. Aconite root is short and conical, tapering rapidly to a point, while horse-radish is long and cylindrical, and of the same thickness for many inches, and has a powerful pungent odour when scraped. It is in the spring and autumn that this mistake has generally occurred. *See* Aconite.

Horses, &c.—An *urban* authority may license the proprietors, &c., of horses, ponies, asses, and mules standing for hire within their district, and may regulate such matters by bylaws. *See* Bylaws, Conveyances.

Hospitals are a necessity, and in some degree the care which a nation bestows upon its sick is in direct proportion to its civilisation. If the political, moral, and religious state of the ancients be examined, it is easy to be convinced that they had not, nor could they have, hospitals; for to found and maintain them a virtue was necessary which paganism was destitute of, namely, Charity; and it is to this virtue, wholly Christian, that we owe these buildings which, begun in the first days of Christianity, have continued to our time.

The founding of hospitals may be traced to the commencement of the Church. The bishops were charged with the poor and sick of their diocese. These establishments were known under the name of "Lazar," "Leper-houses," &c., and to their maintenance the Church consecrated a fourth part of its revenues.

Gregory of Tours relates that to the fifth century there existed in churches a special place for the sick. Later on, the piety of princes, led by a wise policy, no longer left to individuals the honour of founding these establishments. In France, Childebert and Queen Brunchault erected the first hospitals—the Hôtel Dieu, Lyons; that of Paris, Autun, &c.

Besides, the monasteries assisted the poor, aided travellers, and very often had the care of the sick, a duty which was frequently enjoined by their rules. Charlemagne founded several hospitals and hospices. During the Crusades these establishments multiplied, for another cause besides the promptings of charity increased them.

Leprosy, which had ravaged Europe during the middle ages, covered France with leper-houses. In the thirteenth century there were in existence 2000 of them, an almost incredible number, considering the population of that time. The fact is however proved by the will of Louis VIII., who left them 2000 livres. St. Louis perhaps did more for hospitals than all his predecessors. In 1254 he founded the Quinze-Vingts, not, as is generally believed, for his companions in arms who returned to their native land suffering from blindness, but simply for 300 blind Paris poor. He established hospices, and endowed them, at Vernon and Pontoise. At a later period he enlarged the Hôtel Dieu of Paris, and endowed it independently of separate gifts which he regularly transmitted. Lastly, he erected and inaugurated with great solemnity the Compiègne Hospital. Henry IV. founded in France the first military hospital. In 1604 he laid the first stone of the Hôpital St. Louis, one of the most beautiful in Europe. This prince added to the Hôtel Dieu two rooms, still existing. Some years before, Marie de Medici had brought some Frères de St. Jean de Dieu to cure the sick at the Hôpital de la Charité, which she had founded. Under Louis XIII. the Incurables, La Pitie, La Salpetrière, were founded. The Bicêtre was destined for invalid soldiers. It was also under this king that St. Vincent de Paul commenced his efforts in favour of foundlings. Louis XIV. created the Hôpital des Enfants trouvés, the Invalides, and the General Hospital.

The eighteenth century witnessed the erection of several hospitals whose names will be ever honoured, such as Beaujon, Cochin, Necker, &c.

In England the oldest hospital is Bethlehem Hospital, a royal foundation for lunatics incorporated by Henry VIII., 1547. The chief hospitals of the metropolis and the dates of their erection are as follows:—

	Founded.
Bethlehem (oldest lunatic asylum in Europe, except one at Granada)	1547
Cancer, Brompton	1851
Charing Cross (New hospital built, 1831)	1818
Consumption, Brompton	1841
Dental	1858
Dreadnought ship (seamen's)	1821
Eveline (Baron Rothschild's)	1869
Fever	1802
Free Royal, Gray's Inn Lane	1828
German, Dalston	1845
Great Northern	1856
Guy's	1721
Hahnemann (homœopathic)	1850
Idiots'	1847
Incurables'	1850
Jews'	1747
King's College	1839
Lock	1746
London	1740
Lying-in, British	1749
Lying-in, City of London	1750
Lying-in, General, Lambeth	1765
Lying-in, Queen Charlotte's	1752
Lying-in, Queen Adelaide's	1824
London Ophthalmic, Finsbury	1804
London Ophthalmic, Gray's Inn Road	1843
Middlesex	1745
Orthopedic	1838
Samaritan, free (for women and children)	1847
Sick Children	1851
Smallpox	1746
St. Bartholomew's	1546
St. George's	1733
St. Luke's (lunatics)	1751
St Marylebone	1871
St. Mary's, Paddington	1843
St. Thomas's (removed 1862 and 1871)	1553
University College	1833
Westminster	1719
Women's, Soho Square	1843

That the crowding together of a number of sick in one building has its evils there can be little doubt, and in former times it has been attended with great fatality, partly from faulty construction, and in a great measure from neglect of the most common-sense rules of hygiène. For example, in a French book published in 1777, we read:—

"Imagine a long suite of rooms close together, in which are assembled diseases of every description, and in which are crowded often three, four, and six patients in one bed, the living by the side of the moribund and dead, the air infected by exhalations from this heap of unhealthy bodies, carrying from one to the other the pestilential germs of disease, and on every side sorrow and suffering—such is the Hôtel Dieu."

This account is corroborated by Lenon, who, writing in 1788, says: "At the Hôtel Dieu the number of beds is 1219, of which 733, called large beds, 52 inches wide, accommodate four or even six men, who have thus only either 8½ or 13 inches at their disposal; and 486, called small beds, 3 feet wide, in which the sick lie singly. We have seen wards so crowded that the number of the sick amounted from 558 to 818. It has been proved that in no hospital is there so little air to breathe as in the Hôtel Dieu; elsewhere they give them 7 cubic toises (a toise is 6·39459 ft.), whilst in the Hôtel Dieu they scarcely have in some wards more than 2½ toises, in others 1 toise. There are even wards whêre the cubic space is below that." Such a state of things is impossible at the present day, although in hastily-constructed hospitals, in times of epidemic stress, great errors in our own times have been committed in administration; witness, for example, the notorious Hampstead Smallpox Hospital. There are differences now in the rate of mortality in different London hospitals, especially with regard to surgical cases, evidently due to defective sanitary conditions. It has long since been decided, that although there must be general hospitals for accidents and the legion of ordinary diseases, and although there may be special hospitals for the furtherance of distinct branches and specialities,—such, for example, as the eye, the ear, &c.—there must be in every populous district or town a proper and fit place for the treatment of infectious fevers. The definite establishment of fever hospitals was the direct outcome of the fatal typhus epidemic which committed such ravages at the close of the eighteenth century, and the first was opened at Chester. Liverpool, Manchester, Norwich, Hull, Dublin, London, and other towns soon followed; and at the same time the necessity of establishing fever wards in the old hospitals was acknowledged, and in a great many cases acted upon. There are yet, however, numerous institutions with no means of isolating infectious cases. It is scarcely two years ago when smallpox broke out in a provincial infirmary; the authorities turned out all those who were able to leave, with the effect of introducing the disease into the neighbouring villages!!

The separation of fever from general cases would appear one of those first principles of an obvious character that are at once accepted by the human mind; yet even to the present time there are many who oppose the plan, the chief objection in their opinion being that the poison of the fever being more concentrated, there is a greater mortality among the patients themselves, and the nurses and attendants are likely to catch the disease. The first of these objections is purely theoretical, and is disproved by facts; for instance, Murchison shows that one person took typhus (in 1862) for every five typhus patients admitted into the general hospitals, but only one for every sixty-seven admitted into the London Fever Hospital; and that one person died out of every fourteen admitted into the former, but only one for every 326 admitted into the latter.

In large towns it is seldom difficult to obtain a staff of nurses whose age is such that it does not predispose them to fever, or who have previously had an attack. Statistics show that persons of forty years of age are not very liable to typhoid, while persons under thirty pass through typhus better than those over that age. It is therefore well in a typhoid ward to employ elderly or middle-aged people, in a typhus, younger persons. Typhoid is, however, treated daily in general hospitals without evidence of injury, the principal contagion residing in the dejecta. The exhalations from the breath and skin do not appear to travel far or have great virulence, and the dejecta can be easily disinfected. Cases of fever should, however, never be mixed up with the other patients, but have separate wards. Typhus in a general hospital is one of the most dangerous diseases, and is so likely to spread, that it should never, where possible, be admitted. It is not easy to prevent the importation of one or two cases in epidemics, as the diagnosis, until the fever is developed, is not always easy; still reasonable care can always be exerted.

Hospital Construction generally.—We have learned much in hospital construction since the "Report of the Commission on the Sanitary State of the Army in 1857," which embodied the general principles of improved hospital construction. The theory of erection of a good sanitary building is perfect, but the practice in carrying out the details leaves yet much to be desired. The brain can often conceive what the hand has not the skill to accomplish.

As they are charitable institutions, suggested, built, and endowed by charity, the first axiom is, economy of construction. All unnecessary embellishments, architectural adornments, corridors, passages, rooms, are to be avoided. A hospital should contain nothing more than wards for sick, and rooms for attendants and ward requirements. The foundation of a hospital plan is the ward, all else is merely subsidiary. And this subsidiary accommodation should be no longer in superficial area than is absolutely wanted; more than this is unnecessary expenditure, and adds an element of mischief to the building.

For obvious reasons, the out-patients' department should have no connection with the hospital so called. The same remark applies to kitchens, stores, boiler-rooms, cellars, dust-bins, and the like, also to physicians' and surgeons' rooms, and dispensary. It is quite possible in practice to keep the buildings required for patients and their attendants just as much by themselves as if they were miles away from the subsidiary accommodation, and yet to place the whole of this latter in perfectly convenient localities.

It is a grave error and no saving of cost to place them altogether within the hospital. The whole structure is complicated by this arrangement, and the sanitary condition of the building is endangered. Small country hospitals may to some extent form an exception to this rule, but even in them there should be no communicating atmosphere between the wards and the subsidiary accommodation.—("Principles of Hospital Construction," by SUTHERLAND and GALTON, Lancet, 1874.)

One of the first things is to ensure a healthy site. There may be some difficulty in towns to obtain an unexceptionable one, since hospitals are most useful in an unhealthy, over-crowded locality; but this, of all sites, is the worst, and instead of putting the hospital in such a population centre, it is best to establish it where there is most facility of communication. The soil should be, if possible, a self-draining, gravelly soil; but if a damp, clayey, impermeable soil must be built upon, then it should be prepared thoroughly by draining.

A gentle elevation, *cæteris paribus*, is best, but no hospital or habitation of any kind should be built with the ground rising directly in front or behind. This obstructs ventilation, and the high ground drains directly into the low. The surroundings of a hospital are of the first importance. If narrow courts, filthy alleys and passages, cluster on all sides, every wind must bring deteriorated air. If there are smoky manufactories, or other insanitary conditions, in the vicinity, the patients must suffer.

Where possible, an open space in the suburbs of a town should be selected. If sufficient ground can be had for the exercise of patients, so much the better. The French hospitals in this respect have a manifest advantage over ours. For instance, the St. Antoine, St. Louis, and the Necker are surrounded by large and beautifully laid-out gardens, a pleasant resort for convalescents.

"The requirements as to site are thus dryness, healthiness of surroundings, and facility of external movement of the atmosphere."—(*Op. cit.*)

The next consideration is the form of the building. The time when large hospitals were constructed of one huge block or great rambling continuous building, like the Hôtel Dieu of Paris, is probably for ever at an end.

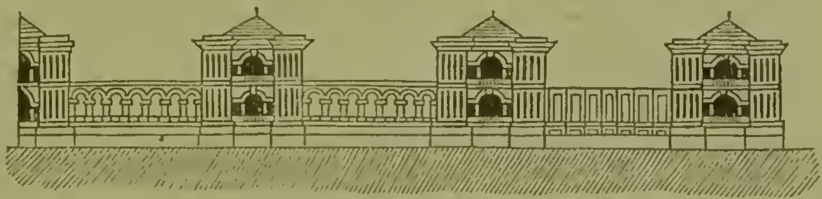


Fig. 38.

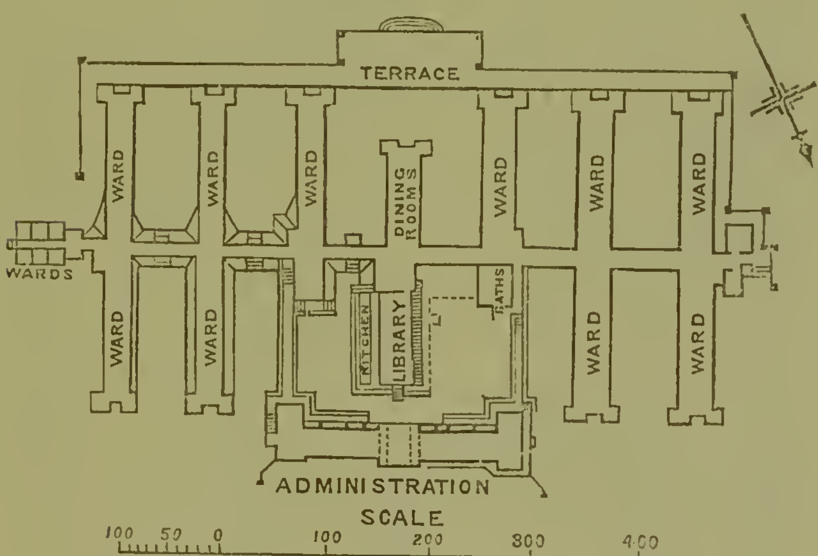


Fig. 39.

The grand principle that appears to be definitely settled is isolated blocks, so arranged that the atmosphere of each block is also isolated. This is the true pavilion principle, and is effected in perfection in the Herbert Hospital; but certainly not in the new St. Thomas's, where there is a *nominal*, not a *real* isolation. In order to carry the principle out, it is necessary that there should be two distinct divisions in the plan, one entirely for the sick, the other for administrative purposes. "This latter division might be so designed as to contain the dispensary and the out-patient department; but it would be far better, where funds admit of it, to separate the out patient department entirely from the hospital and its administration. The design should, of course, provide for easy means of communication between the different blocks, but this can be, and ought to be, effected (as in the Herbert Hospital, figs. 38 and 39) in such a manner that the air-isolation of the different blocks shall be complete. The hospital proper in its turn should be divided into the required number of blocks, so that not more than a certain number of sick are placed under one roof; and these blocks or pavilions should be connected with each other in such a way that each pavilion should be as isolated from its neighbour as if it stood by itself. The hospital should, in short, consist of a certain number of perfectly distinct hospitals connected together merely for facility of access. Such a hospital, therefore, must consist of a number of pavilions." – (*Op. cit.*)

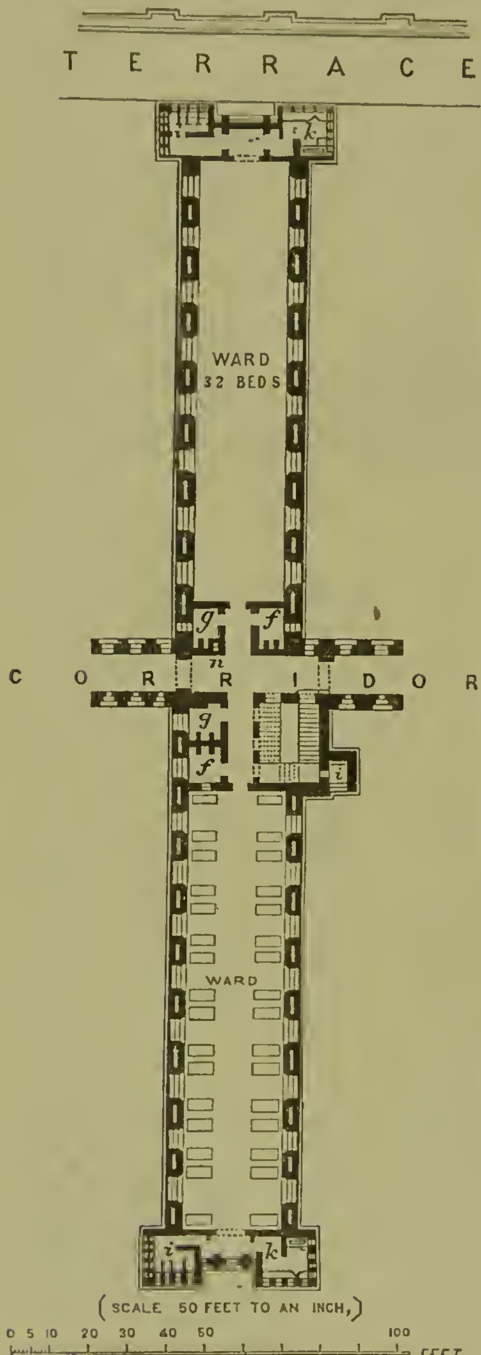


Fig. 40.

In small hospitals in the provinces, the block system is probably as good as any other, and the pavilion plan unnecessary (figs. 38 and 39).

The general axis of hospitals should run north and south, or, at all events, the axis of the wards; thus each side obtains the influence of the sun, which aids ventilation and prevents damp.

The next thing to be considered is the ward, the hospital unit. It should be of sufficient size to give 2000 cubic feet of air to each bed, which, with good ventilation, ought to keep the air sweet.

The ward is best made long and narrow (narrow, *i.e.*, in proportion to its length), with opposite windows, to admit of cross-ventilation (fig. 40). The height should be about 14 feet; the wall-space, per bed, 7 feet 4 inches; the width of the ward certainly not less than 24 feet. The length must depend upon the number of beds.

The great and essential point is the superficial space per bed. This at the Lariboisière is 104 square feet, at the Vincennes it is 90 square feet, at the Herbert 96 square feet; so that it may be put down that it varies in the best-constructed hospitals from 90 to a 100 square feet. In this respect we have not only to consider the amount for sanitary requirements, but also in the London schools a number of students are taught around each bed, and therefore such hospitals require additional area.

The following is a sketch of a ward, or rather double pavilion, each half of which represents a ward unit; it embodies the following principles (fig. 40):—

"The number of beds is divisible by four, by which the whole wall-space is utilised. Wherever it is not intended to introduce fireplaces in the outer walls, the same numerical relations should be observed; but of course such a proportion in the bed-spaces necessitates the introduction of artificial warming and ventilating arrangements; or, as in the case of the Herbert Hospital, the use of firegrates, of which there are two placed in the centre line of each ward. The wards have windows along opposite sides, with a bed in each corner, and two beds between every two windows along the wall. Each ward has likewise an end window to the open air, and it will be seen that the beds are protected by projections from direct currents entering by these end windows, which currents are thrown down the centre space between the beds.

"The water-closets, ward sinks, baths, lavatory basins, and urinals are placed in two projections at the outer or free ends of the wards, having special ventilating arrangements for assuring that, from whatever direction the wind blows, no effluvia can enter the wards (fig. 41).

"For each ward is provided a small nurses' room, with an inspection-window into the ward, and a small scullery for washing up tea things and providing warm water, or warm food or drink for special cases.

"The relative dimensions of all these parts, shown in the plan, have been found in practice sufficient in the Herbert Hospital, in planning which they were considered in connection with the entire arrangements. In the double

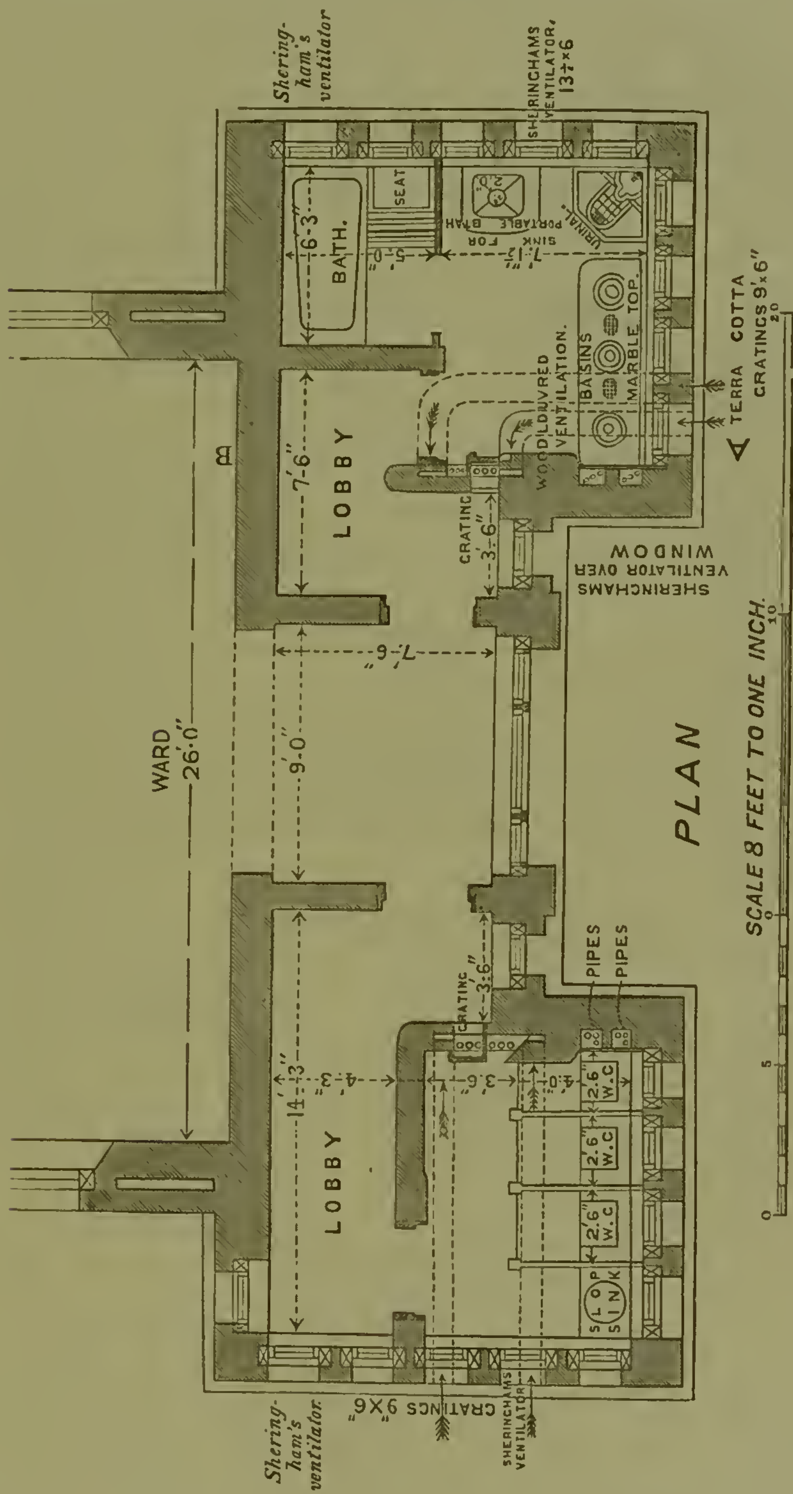


Fig. 41.

wards shown in fig. 40 the two wards are effectually cut off from each other by a 12-feet-wide corridor and a central hall carried up to the roof of the building, where it is lighted and ventilated by several large lofty windows. But the wards admit of other methods of arrangement. They may be placed singly or alternately, or in line.

"One advantage, indeed, of the pavilion structure is the facility with which it accommodates itself to the shape of the site."—(*Op. cit.*)

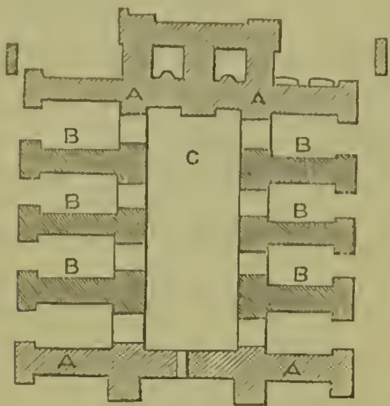


Fig. 42.

The accessories of the ward remain to be considered. It must be light, have floors and walls into which contagious fluids or particles do not easily soak. The windows in some hospitals are at the rate of one to each bed. Perhaps this is more than enough. As no window fits tight, they even, when closed, are natural ventilators. Too much glass is objectionable. In winter, it cools the air; in summer, a room with many windows may become like a conservatory in temperature. Plate-glass is the best material, and the window should swing open top and bottom. The walls are recommended to be coated with as dense and as impervious a cement as can be obtained. One of this kind, capable of being polished, has been tried in the Herbert Hospital. It admits of being washed with soap and water. The floor is best constructed of oak, with close joints, polished with bees-wax. Such a floor is, however, very slippery, and weak patients may have many a fall. The best position for water-closets is a separate square block at the end corners, with a passage and lobby leading to them, both having cross-ventilation by opposite windows. All the pipes from the drains should be trapped, and where necessary fitted with charcoal deodorisers.

Single wards are undoubtedly best. When

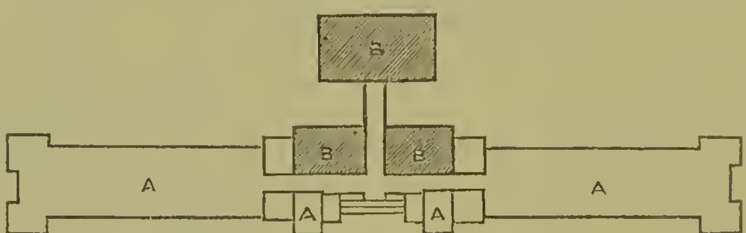


Fig. 43.

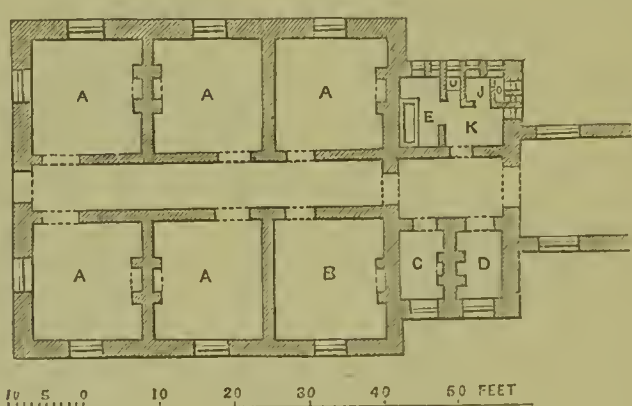


Fig. 44.

superimposed one upon the other, there is danger of foul air rising from one to the other. The unhealthiness of top wards has often been shown. For example, Hunter remarked that in two wards of exactly the same dimensions, but the one over the other, and containing exactly the same number of sick under similar circumstances, the mortality was greatest in the upper one. The Marquis de Pastoret, in his Report on the Hospitals (France) from 1804 to 1814, showed that there was always the greatest mortality in the upper wards of the Hôtel Dieu, where they were superimposed, but elsewhere equal. He truly remarked that attendance on the sick was more difficult in the high wards than in the lower floors, that the convalescents could not walk out with the same facility, and that in case of fire there would be great difficulty in saving life.

Esquirol had previously called public attention to the incontestable advantage in buildings of the kind, of ground-floors in the chest affections of old men. Still, ground is so dear in large towns that a two-storied building is in many cases a necessity, nor with proper arrangements should it have any ill-effect. More than two stories high, although practically often difficult to avoid, is to be looked upon with disfavour, but mechanical arrangements—such as lifts, &c.—partially obviate the objections.

The arrangement of the different units, the separate pavilions, is a matter which may be dealt with in various ways, and greatly depends upon the particular site. They may be placed parallel to each other, or end to end. Figs. 42, 43, and 44 will show the different systems employed in the best hospitals.

There are one or two points that are applicable to all—viz., that the pavilions should have no structure between them, and they should be connected simply by a low corridor. It is best open—mere open arches supported by pillars. The administration should be entirely separate from the pavilions, and there should be a separate building for the nurses to sleep in. It is a great stroke of policy for the managers of a hospital to keep the nurses in the best possible health; by so doing they ensure efficiency.

A very original plan of hospital construction has been proposed by Mr. Greenway of Plymouth. There is a double row of glass compartments along the centre of the ward, and separated from the side walls by a corridor. The glass compartment is so ventilated that the vitiated air is effectually removed. Experience will show whether thus putting our sickly plants under glass shades will answer better than the usual plan. The cost per bed is £150.

To the general and daily management of a hospital is often due its good or its bad results. Careful sanitary supervision will make a badly-constructed hospital healthy. Carelessness and ignorance will falsify the results of the best architects and physicians.

The immediate disinfection of all contagious excreta, the hourly watching of ventilation, excessive cleanliness, the prompt removal of the dead, order, discipline, sobriety, and intelligent quiet management,—these are the things that render a hospital efficient.

The general hospitals having been considered, there remain those special structures peculiar to warfare—viz., military and naval hospitals—as well as cottage hospitals, and hospitals for sanitary authorities.

Military Hospitals.—A stationary military hospital is constructed on the same principles as the civil, but the exigencies of warfare require either camps or light buildings, which can rapidly be put up in the rear of an army, and as rapidly removed. The late war has enforced the lessons taught long ago—viz., that all buildings, churches, hotels, &c., are to be avoided as hospitals. The sick and wounded do far better in tents, wooden huts, and other light buildings constructed at the time.

During the siege of Paris we learn that almost every kind of building was utilised as a hospital, and as a consequence pyæmia and gangrene prevailed to a frightful extent.

Our own war hospitals are divided into—

1. Regimental, which are small hospitals for the purpose of treating men when first reported sick, and slight cases.

2. Division Hospitals. These are in charge of a staff surgeon, and are for the wounded.

3. The Field General Hospital, where all the wounded that can be transported from the front to the rear are placed.

In rear of these, again, there is some more permanent building, sometimes constructed of iron at home, and then sent out in pieces, so as to be quickly put up.

The Germans follow a similar plan. Their war hospitals are in three classes, called respectively Feld, Kriegs, and Reserve Latharin, and the wounded are successively transferred from the one to the other, and then when well enough transported into the interior. The great established principle in war hospitals is that they should be either tents or wooden huts, with ridge ventilation, and that as soon as possible the wounded, if able to bear the journey, should be transported far away from the seat of operations.

Dr. Parkes, summing up the hygiène of field hospitals, considers that they should consist of tents of good size, well ventilated, and with flaps, by which they can, if desired, be converted into awnings; the tent floor to be covered with clean, and, if possible, dried earth or charcoal, and to be then covered with a waterproof cloth or boarded. The boards should be removed frequently and the earth cleaned, in order to prevent the accumulation of offensive rubbish. In the war of the American Secession, as well as in the Franco-Prussian war, the American tent-ambulance, constructed of field tents, 14 feet long, 15 feet broad, and 15 feet high to the ridge-pole, was much used, and appeared to answer well. "Three such tents joined end to end formed one long pavilion capable of accommodating eighteen wounded men without crowding (figs. 45 and 46). The flooring consisted of planks placed upon cross-supports, and raised about 3 inches from the soil. In each division or separate small tent were six camp iron beds — the very ones that had been employed in the American war—and free ventilation was ensured by means of an opening in the roof alternately on opposite sides of the united tents. The cloth itself was, moreover, permeable to air, although not to wet; and it deserves to be stated that the whole expenses of installation, including heating apparatus and flooring, were under 130 francs per bed.

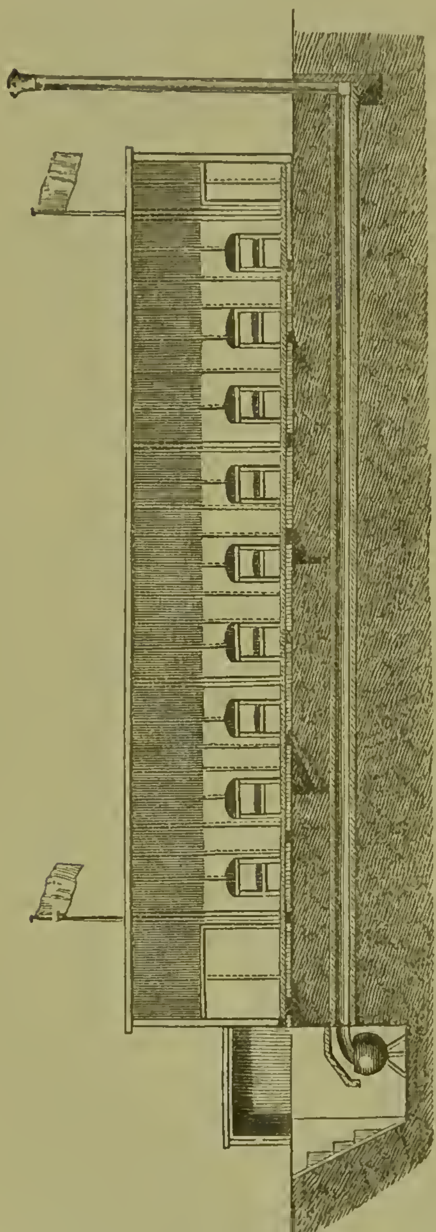


Fig. 45.

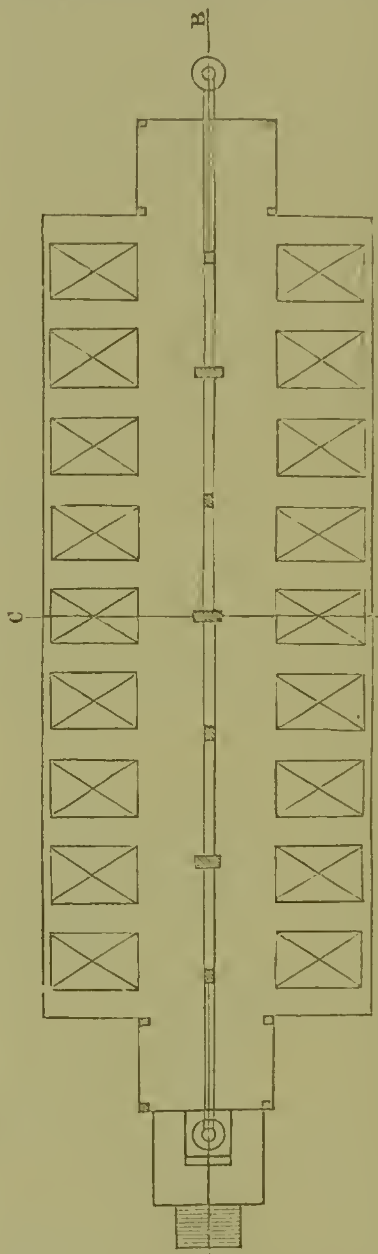


Fig. 46.

"The system of warming was efficient, simple, and economical. A trench of about 40 centimetres broad and deep was made in the ground, extending from one end to the other of the tent; a pit of about 1 millimetre 50 centimetres in dimensions excavated at one end. An ordinary stove was built into the latter, the flue of which extended along the trench under the floor, and rose at the farther end in the form of a chimney. Along its course it was carefully built in by brick and mortar, a grated opening being left in the flooring at short intervals, so as more readily to admit the heat. The pit for the stove was covered over by a pent roof, a few steps leading down to the fireplace. A movable valve in the flue provided a ready means of regulating the temperature, and even of diverting the heat from one tent to the one adjoining, for which purpose branch flues were arranged from some of them.

"Among the many advantages of this mode of heating was the circumstance that after a time the soil under the tent became heated as well as the interior itself; a steady and constant movement of air in the interior was, moreover, kept up; and even in the depth of winter, with an external temperature of 25° F., that of the interior could be retained easily at 55° F. if necessary."—(Lessons on Hygiène and Surgery from the Franco-Prussian War, by C. A. Gordon.)

In the American war some of the hospitals contained from 2000 to 2800 beds—in fact, they were much too large. The numbers under the same roof should be as small as possible. Hammond states that in his experience the best size for a ward or tent was that which would accommodate fifty men: length of ward, 175 feet; width, 25 feet; height, 14 feet; superficial area per man, 87 feet; cubic space per man, 1200 feet; ridge ventilation by an opening 10 inches wide running the whole length of the roof.

In the Austrian campaign of 1859, the method of distribution over a large tract of country, and in many small hospitals frequently entirely removed from military control, notwithstanding the disadvantage of badly-arranged transport and want of care *en route*, was attended by most satisfactory results, not only as regards the health of the sick but the behaviour of the soldiers.

The distribution spread no epidemic among the civil population, but, on the contrary, epidemics among the soldiers were arrested by it.

Hospital Ships.—Ships have the one great advantage of isolation, but they are difficult to ventilate, the space is cramped, and there are other disadvantages. They are, however, extremely useful in certain cases, especially in warfare. One of the best hospital ships ever constructed was the Victor Emmanuel, sent out to the Ashantee war. A short account of this vessel will give an actual example of what a hospital ship ought to be.

"H.M.S. Victor Emmanuel is a wooden screw steamship of the old class, of 5157 tons, and carried originally seventy-nine guns. She was launched at Pembroke dockyard in September 1855, under the name of the Repulse; but having been, shortly after the close of the Crimean war, visited and admired by the Emperor Victor Emmanuel, she was ordered henceforth to bear the name of that monarch." She was converted into a hospital ship in 1873. As now constituted, she is a flushed-deck ship with poop added, and has below what may be called a service deck, a main, gun (or lower), and orlop deck. The water-supply is stored in large tanks amidship. Three of these reservoirs contain salt water for flushing closets; three fresh water, for washing and bathing purposes; and two are fitted with Crease's filters, for drinking and cooking purposes only. From these tanks, by an elaborate system of pipes, all parts of the ship are supplied, so that anywhere, at any moment, salt, fresh, or filtered water may be obtained. The hospital deck is 230 feet long; width, 52 feet; height from deck to beam 6 feet 2 inches, and from deck to deck nearly 7 feet. Ventilation and light are ensured by sixty-six ports, fitted with sashes and jalousies. The hatchways and two large stern ports also assist ventilation; while six cowled tubes, projecting higher than the bulwarks, and trimmed head to wind, act as downcasts. The upcast ventilation is provided for by long slits in the deck, covered with wooden hoods (resembling in some respects the ridge ventilation in hospital tents). These hoods are arranged so that they may be raised or depressed to any extent. There are numerous orifices leading into goose-neck pipes along the top-sides of the deck above, which also assist. The engine-room hatchway is completely separated by glazed bulkheads, so that no heat or smell can find its way from that source into the hospital deck. There are cabins on each side of the stern for the use of sick officers. The latrines are on the upper deck, opening towards the bows just abreast of the smoke-funnel. There are also closets fitted with patent disinfecting apparatuses in different parts of the ship. They are arranged in three sets—viz., two sets aft, two at the bows, and two opposite the engine hatchway. The hospital accommodates 140 patients, occupying cots arranged in three rows fore and aft, and made so as to "rock" and "lock." The cots are also provided with mosquito-curtains rendered uninflammable by tungstate of soda, and light canvas screens are provided. There is a large outside platform, protected by wire fencing, on each side of the hospital deck, on which the patients can have the benefit of fresh air either in beds or chairs. There are excellent arrangements in the lavatories, numerous baths, and a laundry fitted with Bradford's washing apparatus, an arrangement by which the foul linen can be hoisted up from below. The ship has a spacious cooking-galley, ice-making machines, dispensary, lifts, pumps, &c., and the whole painted white, in order to show any dirt. The arrangements were so admirable that it was expected to be a great success, and it fully realised all anticipations, except a few minor defects easily remedied.

Here, then, we have a model of a hospital ship — effectual arrangements for plenty of water, for cooking food, the disinfection of excreta, the ventilation of the ship throughout, the comfort and amusement of the sick, and as much cubic space as can well be obtained in a vessel.—(For further details, *see* Report on H.M.S. Victor Emmanuel, Lancet, 1873, and Lancet, April 18, 1874.)

Dr. Parkes considers it would be a good plan in large expeditions to have a small ship converted entirely into a laundry, a proposal that deserves consideration ; and he insists on the facilities for bathing and sea-drenching, with regular fumigation and disinfection.

Cottage Hospitals.—The same principle that has already been laid down as applied to separate tents in military field hospitals, to separate pavilions in large hospitals, is seen in cottage hospitals. These have now been established in nearly every county in England, and the results of treatment are so good that they are on the increase.

The cottage-hospital system was originated by Mr. Napper of Cranleigh ; it is especially applicable to rural districts. Its advantages are—

1. Skilled nursing.
2. Special appliances—such as water beds, fracture apparatus, &c. (in fact, all the mechanical appliances necessary).
3. Isolation.
4. Home comforts.
5. Any medical man practising in the district may have the use of them for a deserving patient.

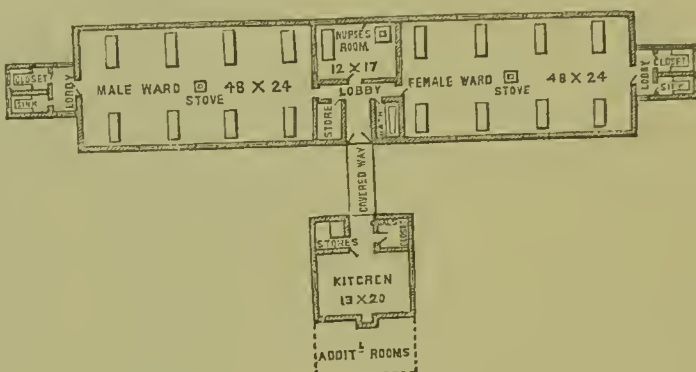


Fig. 47.

The patients themselves pay a certain sum weekly, according to their means, so that the cottage hospital is to some extent self-supporting, although voluntary contributions are also necessary. Each subscriber, no matter what the amount of his subscription, should have equal privileges in recommending cases. Those of emergency and accident are at once admitted, in other cases a recommendation from a subscriber is necessary. All infectious cases as well as incurable diseases are excluded.

There will be little difficulty either in construction or in selecting a proper site. "In most instances a couple of huts or cottages for each sex, with two or three rooms each for subdivision, nurses' rooms alongside the wards, and detached kitchens, all connected by open verandahs, will answer every purpose."—(Galton and Sutherland's Hospital Construction.)

With regard to the size of a cottage hospital, it should be at the rate of one bed for every 1000 of population. Three cottage hospitals, of six beds each, will serve effectually a rural population of 18,000. The cost is about £90 per bed.

Hospitals for Infectious Diseases.—It is important that every sanitary authority should act upon the 131st section of the Public Health Act, and provide a proper place for the treatment of infectious diseases. Every board of guardians should also have a detached contagious ward.

"Every village ought to have the means of accommodating instantly, or at a few hours' notice, say, four cases of infectious disease, in, at least, two separate rooms, without requiring their removal to a distance. A decent four-room or six-room cottage at the disposal of the authority would answer the purpose. Or permanent arrangement might be made beforehand with trustworthy cottage-holders, not having children, to receive and nurse, in case of need, patients requiring such accommodation. Two small adjacent villages (if under the same sanitary authority) might often be regarded as one."—(Memorandum of Privy Council.) The same Memorandum insists, very properly, that when required, an extension of accommodation could be provided in summer and autumn by tents and wooden huts. It is a question, indeed, whether huts or marquees with ridge ventilation are not the best for sanitary authorities to erect in cases of epidemic disease, as they could be quickly put up, and when not required stowed away. In all cases not less than 144 square feet of floor and 2000 cubic feet should be given to each patient.

Fig. 47 is a diagram taken from the Memorandum referred to. It shows the ground-plan of a hospital hut for eight persons of each sex; and where there is plenty of ground, can be extended, as shown in fig. 48.

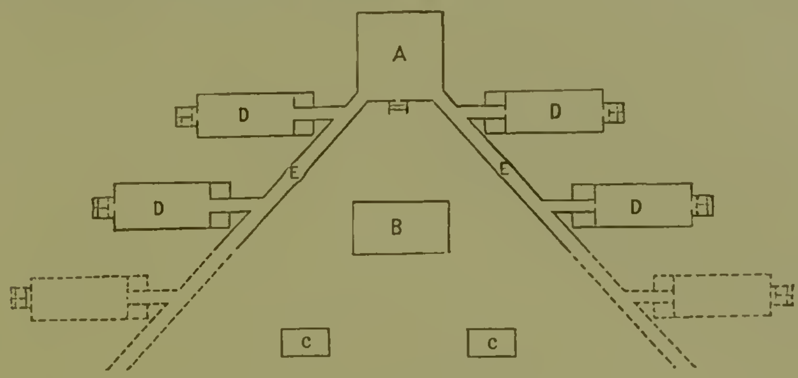


Fig. 48.

A, administrative buildings (kitchen, stoves, offices, nurses' bedrooms, &c.); B, laundry, &c.; C, disinfection, dead-house, &c.; D, huts for ten patients each, with scullery and bathroom at end, and closet and sink at other end of each; E, open corridors. The dotted lines show direction for farther extension.

The London vestries have generally erected temporary hospitals of corrugated iron lined with match-wood. In the Hampstead Small-pox Hospital there was an interval between the wood and iron which was filled with felt.

Any local authority may provide for the use of the inhabitants of their district hospitals, or temporary places for the reception of the sick, and for that purpose may—

Themselves build such hospitals or places of reception; or

Contract for the use of any such hospital or part of a hospital or place of reception; or

Enter into any agreement with any person having the management of any hospital, for the reception of the sick inhabitants of their district, on payment of such annual or other sum as may be agreed on.

Two or more local authorities, having respectively power to provide separate hospitals, may combine in providing a common hospital. —(P. H., s. 131.)

Any costs incurred by a local authority in maintaining in a hospital, or in a temporary place for the reception of the sick (whether or not belonging to such authority), a patient who is not a pauper, shall be deemed to be a debt due from such patient to the local authority, and may be recovered from him at any time within six months after his discharge from such hospital or place of reception, or from his estate in the event of his dying in such hospital or place.—(P. H., s. 132.)

Where any suitable hospital or place for the reception of the sick is provided within the district of a local authority, or within a convenient distance of such district, any person who is suffering from any dangerous infectious disorder, and is without proper lodging or accommodation, or lodged in a room occupied by more than one family, or is on board any ship or vessel, may, on a certificate signed by a legally-qualified medical practitioner, and with the consent of the superintending body of such hospital or place, be removed, by order of any justice, to such hospital or place at the cost of the local authority; and any person so suffering, who is lodged in any common lodging-house, may, with the like consent and on a like certificate, be so removed by order of the local authority.

An order under this section shall be addressed to such constable or officer of the local authority as the justice or local authority making the same may think expedient; and any person who wilfully disobeys or obstructs the execution of such order shall be liable to a penalty not exceeding *ten pounds*.—(P. H., s. 124.)

Any local authority may make regulations (to be approved of by the Local Government Board) for removing to any hospital to which such authority are entitled to remove patients, and for keeping in such hospital so long as may be necessary, any persons brought within their district by any ship or boat who are infected with a dangerous infectious disorder, and such regulations may impose on offenders against the same reasonable penalties, not exceeding 40s. for each offence.—(P. H., s. 125.)

The Admiralty, with the consent of the Treasury, lend old ships to port sanitary authorities for the purpose of conversion into floating hospitals. *See* VENTILATION; HYGIÈNE, NAVAL, &c.

Houses—*See* HABITATIONS.

House-to-House Inspection—Medical officers of health, where they possibly can do so, should have a minute inspection of all the houses in their district made once, at least, in every five years. The agents or inspectors who are selected for this office should inquire into all the sanitary arrangements and surroundings of the building, health of the inmates, number, sex, age, &c. Such an inspection, if uniformly carried out by every district once, at least, every two years, would be a complete census, and afford valuable statistical aid to the politician and to the hygienist. Such inquiries for health purposes have been made in several districts, but as the permission and the carrying out of such a scheme rest with sanitary authorities, unfortunately it has not been in any degree uniform; and though the officer of health may *recommend*, he cannot *enforce* it, being in this respect at the mercy of the authorities. "Such an inquiry was made in Merthyr in the autumn of 1866. Nearly 10,000 houses were examined and reported on by four intelligent persons. Five weeks were occupied in the examination and report, the cost to the local board being £25. This inquiry embraced the following: The name of the street, number of each house, names of occupier and owner, number of family and lodgers; the ventilation, how it was secured, whether by back-doors or by windows the upper sashes of which could be fully let down; the number of privies or of water-closets, and the condition of these; the water-supply, whence derived; and the state of any back premises, noticing particularly whether any animals or poultry were kept. When these returns were completed, they were tabulated by the medical officer for each street in each district, and the results summed up. The usefulness of these returns has been continuous. They now afford standpoints of reference whence to mark the improvements made, and to note the dark spots that call for amendment by referring to this 'Dictionary of Habitations.' The state of each house is at once apparent, and upon the occurrence therein of any case of disease—such as, *e.g.*, enteric fever or phthisis—the exciting cause, whether excrementitious exhalations or dampness of foundations, may be found."—(British Medical Journal, November 16, 1872.)

This course has also been adopted amongst the rural sanitary authorities in the county of Gloucester. Dr. Bond in his annual report says: "I therefore felt it my duty to advise each authority that the first object to which it was advisable that its attention should be directed was to obtain a complete and detailed sanitary survey of the district under its jurisdiction, and that its subsequent action should be founded upon the facts which the survey might disclose. This course has been adopted by all the authorities with whom I am connected, with two exceptions, in one of which nothing has been done in consequence of delay in the appointment of an inspector. . . . The inspectors in various parts of the district have, up to the 31st of December, investigated the condition of the whole or part of 72 parishes, embracing a total of 8546 separate premises."—(Annual Report of Medical Officer of Health to Gloucester Combined Sanitary Authorities, 1874.)

Hydatids—*See* ECHINOCOCCUS.

Hydrometer—An instrument used for the purpose of ascertaining the density of water. It is a glass vessel loaded with mercury or shot, and furnished with a scale. The zero point is found by floating it in distilled water at a temperature of 60°, and marking the point on the scale just where it meets the surface of the water.

Hydrophobia, Rabies, Canine Madness (LA RAGE)—Hydrophobia or rabies is a disease resulting in man from the transmission of the rabies of animals, especially of the genus *Canis*, characterised by general illness and a profound affection of the nervous functions, great exaltation of sensibility, severe constrictions of the throat, spasmodic action of the diaphragm, and often tetanic spasms—all aggravated by attempts to drink fluid, by the sound of running water, the least breath of air, the contact of cold things, and other external impressions. It is uniformly fatal.

The deaths from hydrophobia in this country are on the increase. In the four years from 1868-71 they were as follows: 7, 18, 32, and 56.

In Prussia it is still more fatal than in our country, for in ten years 1666 deaths were attributed to it.

In France about twenty-three deaths occur annually from hydrophobia.

The animals in whom hydrophobia is supposed to originate are the dog, the wolf, the fox, and perhaps the cat. The causes predisposing are somewhat vaguely enumerated as extreme heat, alternations of temperature, bad food, deficient water, forced continence, &c. It is highly probable that it never arises *de novo*, but is always propagated by contagion. In this way it may be produced in almost any animal, and even in birds; they in their turn can communicate it to others, and so on.

With respect to the species of animal whence the disease was communicated to man in 228 cases in France, the following figures are interesting:—

The Number of Cases of Hydrophobia in France from 1850 *to* 1859, *with their Origin.*

188	from the	bite of the	dog.
26	,,	,,	wolf.
13	,,	,,	cat.
1	,,	,,	fox.
228			

The seat of the wound through which the poison was introduced is a striking index of the facility with which the contagion acts. The seat was noticed in 145 cases.

Superior extremities, and chiefly in the hands	79
Face	37
Inferior extremities	29
	145

Like many other zymotic diseases, there is a period of incubation before the effects of the poison are manifested.

The French Commission appointed to investigate hydrophobia have recorded the period of incubation in 147 cases in which it could be accurately fixed, as follows:—

1 month in	26 cases.
1–3 months in	93 ,,
3–6 ,,	19 ,,
6–12 ,,	9 ,,
	147 ,,

Thus the important fact is established, that the effects of rabies are usually seen in from a few weeks to three months after the contagion, and that longer periods are more rare. There are, however, a few instances on record in which the incubative period would appear excessive—*e.g.*, a case recorded by Mr Hall Thompson, in the "Lancet," of a lad aged eighteen, who had been twenty-five months in prison, during which period he had certainly not been bitten by any animal; but it was found that seven years previously he had been severely bitten by a dog on the hip, the scar still remained, and death occurred after a three days' illness.

The symptoms in the dog, and, generally speaking, in other animals, are as follows: He first appears depressed and restless, and refuses food and drink. To this succeeds a state of agitation, the animal is deaf to the voice of its master, wanders without any apparent object, the eyes inflamed and threatening, the ears and tail down, with the mouth foaming and the voice hoarse or almost extinct. Sometimes he howls dismally. In his course—at times rapid, at others slow and uncertain—he attacks, either spontaneously or because irritated, animals and men whom he may meet. Many dogs avoid water, but some show no dread whatever of that fluid, and will lap it during the disease. These acute symptoms do not last long. After four, five, or six days the strength becomes exhausted, and paralysis of the hind-legs supervenes, or frequently-recurring convulsions end in death. But the symptoms are not always the same. Certain mad dogs are to the last attached to their master, and do not refuse drink from his hand. The desire to bite is confined to those animals which use the teeth as a weapon of defence. This tendency is in some cases neutralised by paralysis of the lower jaw, which hangs uselessly (*rage mue*).

There is no characteristic morbid change if the affection has been of short duration, but in cases of any length, the principal lesions are found in those parts supplied by the eighth pair of nerves—*i.e.*, the tongue, fauces, salivary glands, &c.—which are swollen and inflamed. Vesicles underneath the tongue were said to exist, but this is erroneous; they may be present in a few cases, but have no connection with the disease.

Symptoms in Man.—The invasion of the disease is marked by a feeling of general lassitude, accompanied with headache, agitation, sleeplessness, an unaccustomed exaltation of the intellectual faculties, or, on the contrary, an unwonted sadness, a seeking for solitude, gloomy presentiments, and sometimes spasmodic movements, rigors, nausea, and vomiting. In a few cases there are dull or lancinating pains in the wound. The cicatrix which has formed as usual over the seat of injury may become the seat of a more or less considerable swelling, which, taking a livid tint, may even burst, and give exit to a reddish serosity. This period of invasion may last from two to three, or four to six days. It is soon followed by more serious events; the agitation is increased, and is accompanied with a pitiable feeling of distress. The senses are greatly exaggerated, the least noise or light is insupportable, and the sight of bright objects, especially water, determines violent convulsions. This hydrophobia is carried in the greatest number of cases to such a degree that the patients repel all kinds of drink, falling into convulsions if they feel the contact of a drop of liquid, or if an attempt is made to give them a bath. The latter symptom is not, however, constant; some patients are able to drink during the course of the disease, when even a loud voice or bright light will throw them into the most horrible convulsions. These paroxysms, which recur under the influence of the slightest cause, present themselves with a truly fearful intensity; the whole body becomes rigid for some seconds, and then ensues a succession of violent jerks and spasms strong enough to break almost any controlling bonds, and the head and limbs are bruised against the walls. In the intervals a continual spitting is observed, which may be equally due to the spasm preventing the saliva from being swallowed, and the augmentation and alteration of the salivary secretion, which may become a true lather (*bave*). The pupils are dilated, the eye sunk and brilliant, sleep incessantly disturbed or wanting. Some cases are troubled with a very marked venereal excitement. It is extremely rare to see that anxiety to bite which renders the approach to such cases so formidable in the eyes of the vulgar. Some cases are gloomy and restless, only speaking briefly at rare intervals, and, giving themselves up to continual terrors, show a true panophobia; in others the sentiments of affection persist and are augmented. As the disease makes progress the attacks of spasm repeat themselves with increasing violence, the more cruel because intelligence often remains intact to the last. The continuity of the paroxysms does not fail to exhaust the strength, the ideas become confused, the anxiety increases; in some cases the eyelids retract and the eyes protrude, the body is suffused with perspiration, and if death does not take place suddenly in the midst of a convulsion at an early stage, it does so towards the third or fourth day. Death is the constant termination of hydrophobia.

The duration of the disease in 161 cases in which it could be exactly ascertained was as follows:—

2 days in	34 cases.
4 ,, ...	98 ,,
6 ,, ...	24 ,,
7 ,, ...	2 ,,
8 ,, ...	2 ,,
9 ,, ...	1 ,,
	161 ,,

The pathological changes must be looked for primarily in the spinal cord, the other effects—such as inflammation of the pharyngeal mucous membrane, &c.—are only secondary. The poison, instead of, as in smallpox, going to the skin, or, as in typhoid fever, to the intestine, affects the most vital centre of life, the *medulla oblongata*, and upper part of the spinal cord, where the slightest alteration appears to be incompatible with life.

Several microscopical sections of the morbid changes in these centres were shown at the Pathological Society, London, in 1872, by Dr. Clifford Allbutt.

"The specimens were taken from the cerebral convolutions, from the central ganglia, the medulla oblongata, and the cord. Throughout all these centres were found the same morbid conditions, but in different degrees, and these were as follows: 1. Evidences of great vascular congestion, with transudation into the surrounding tissues. In all the grey centres the vessels were seen in various degrees of distension, their walls in many cases being obviously thickened, and here and there were seen patches of nuclear proliferation. There was a diminished consistence of some of the parts, particularly of the medulla. This seemed to be due to serous infiltration and soddening. 2. Hæmorrhages of various size, and in many places a refracting material visible outside the vessels, due apparently to coagulate fibrinous exudation. 3. Little gaps, caused by the disappearance of nerve-strands, which had passed through the granular disintegration of Clarke. In addition to these appearances in the nervous centres, an enlarged spleen had been found in both cases. The parts seemed to be affected in the following order as regards severity: (1) medulla, (2) the cord, (3) the cerebral convolutions, and (4) central ganglia. This was in accordance with the symptoms during life—viz., (1) reflex irritability in the region of the medulla, with no tetanic spasms; (2) increasing irritability throughout the cord, with semi-tetanus; (3) delirium."—(Lancet, 1872, vol. i. p. 82.)

Hydrophobia in man is always the result of contagion, operating only by one direct and immediate way—the inoculation of the rabid virus by domestic or wild animals—and the only vehicle is the *bave* or saliva which they deposit in the wound.

It has been proved that neither the flesh nor the milk of a mad animal exercises any contagious action. Although hydrophobia may be transmitted from carnivorous animals to the herbivorous, and from the latter to others of the same species, it does not appear that the last have the power to communicate it to man. After several successive transmissions, the faculty of contagion appears to be exhausted even in the dog.

Hydrophobia is said to be not communicable from man to man. The cohabitation of a man affected with rabies with a woman does not communicate it. There are recorded one or two instances in which inoculation of animals with the saliva of a hydrophobic patient had given the disease.

The virus only acts on denuded surfaces. It is not certain whether it can be absorbed by mucous membranes, but it may be presumed possible. All persons are not equally liable to be affected, "for only ninety-four persons are known to have died out of one hundred and fifty-three bitten, making the chances of escape as three to one nearly."—(AITKEN.)

There would appear to be a few predisposing influences, such as all circumstances which depress the mind or body.

The season of the year has also evidently an influence; in 181 cases occurring in France—

66 were in June, July, and August.
44 ,, March, April, and May.
40 ,, December, January, and February.
31 ,, September, October, and November.

Or, dividing the year into two parts, there were 110 cases in the hot seasons, and only 71 in the cold seasons.

Prevention. — The only method of prevention known is the removal of all causes likely to dispose dogs to receive the disease. They should be frequently washed, have good food, opportunities for exercising their natural appetites, and a strict watch kept by the police on vagrant dogs. The raids made from time to time in London are required all over the country. All unowned dogs should be destroyed, and every case of canine madness reported to the medical officers of health in the district, who would then have an opportunity, through the sanitary authority, of taking the necessary measures. In cases of actual bite, the person attacked should if possible immediately suck the wound, and if assistance is at hand, have it cauterised. No one should wait for the arrival of a medical man, but if the wound is small, either cut it out or apply a red-hot iron at once, or use both cauterisation and excision, if, as in some cases, there is no doubt of the madness of the dog. Let no foolish feeling of ill-directed mercy influence the bystanders. Many a poor wretch who has died one of the most awful of deaths would have been saved by a little *instant* decision. In many cases, however, the person is bit on the highroad, or in places where assistance cannot be had. If the part bitten is one of the extremities, after sucking well, a tight string placed above the injury would appear to be likely to prevent absorption, at all events, until the sufferer could reach some place of help; but if in the face or buttock, trust must be placed, under such untoward circumstances, in encouraging the blood to flow, and washing the wound in the nearest rivulet or puddle. It is greatly to be feared that unless cauterisation is effected immediately, or very soon after the injury, it is useless.

In 115 fatal cases the methods of prevention were noted—*i.e.*, whether the wound was cauterised sufficiently or not.

Years.	Deaths from Hydrophobia.	Not Cauterised.	Cauterisation delayed.	Cauterisation insufficient.
1852–1854	44	26	18	0
1855	21	41	5	5
1856	20	11	6	3
1857	13	10	3	0
1858	17	6	5	6
	115	64	37	14

The influence of taxation on decreasing hydrophobia does not, according to either our own or the French returns, appear to have any influence. It is pretty well known that under the new regulations in England few dogs now escape taxation, and yet hydrophobia is not decreased. All muzzles, the wholesale destruction of healthy, well-cared-for dogs, &c., are injudicious measures which should be condemned.

Hygiène—Hygiène is the art of preserving health, of prolonging life, and of showing how the human species may be perpetuated and developed in the greatest perfection. It is naturally divided into private and public —private, when it relates to the individual; public, when it deals with masses of men.

Public Hygiène.—The comprehensive aim and scope of public hygiène cannot be better expressed than in the words of Dr. Guy: "It has to do with persons of every rank, of both sexes, of every age. It takes cognisance of the places and houses in which they live; of their occupation and modes of life; of the food they eat, the water they drink, the air they breathe. It follows the child to school; the labourer artisan into the field, the mine, the factory, the workshop; the sick man into the hospital; the pauper into the workhouse; the lunatic to the asylum; the thief to the prison. It is with the sailor in his ship, the soldier in his barrack, and it accompanies the emigrant to his new home beyond the seas. To all these it makes application of a knowledge remarkable for its amount, and the great variety of sources whence it is derived. To physiology and medicine it is indebted for what it knows of health and disease; it levies large contributions on chemistry, geology, and meteorology; it co-operates with the architect and engineer; its work commends itself to the moralist and divine."—(Dr. GUY, Public Health, 1874.)

There have been treatises on hygiène from the very earliest times, which Hippocrates is supposed to have embodied in his works; but as a science it cannot be said to have existed until a comparatively modern epoch, for it is a science that is based on the researches and discoveries of physiologists, and actual statistics. It would be impossible for the legislator to make efficient laws, or the sanitary engineer to carry out his designs effectually, without its aid.

In England the science may be said to have begun with the rude measures of prevention in the time of the plagues and murderous epidemics of past times; to have shown its power when Howard purified the jails, when Jenner conquered smallpox, and Sir George Baker discovered the cause of Devonshire colic; and to have definitely taken its position as a branch of study recognised by the State, when the first great and comprehensive measure, the groundwork of sanitary legislation, was passed —viz., the Public Health Act of 1848. Its study and practical application have done, and are doing, great things in our armies, navies, factories, and workshops. The Legislature is at last thoroughly alive to its importance, and its future may be looked to as of the brightest character. It is to be confidently expected that the present Public Health Act of 1875 will be greatly amended, its faults and deficiencies corrected, that the prevention of disease will not be a theory but an accomplished fact, and that the twin goddesses of Health and Knowledge will at last bestow their untold blessings on the land.

Private Hygiène.—There are certain general principles which are applicable to all men—that they should have sufficient pure air and water; that they should live in healthy houses, follow occupations which are not injurious, be cleanly in habits, be moderate and abstemious in all things, wear suitable clothing, and eat a sufficiently plentiful and nourishing diet. And, again, there are certain principles applicable to the individual only which no universal rule can embrace. One man had better abstain entirely from alcoholic liquors; another requires a slight stimulant. A certain food is so much poison to one, while others eat it with impunity. Thus, "Know thyself" should be written on every door; and a knowledge of that self is to be obtained, not by a nervous and apprehensive curiosity regarding all that goes on within the body of the individual, but by an intelligent and sensible observation of the causes, whether internal or external, physical or emotional, which have injuriously affected him, and a knowledge of the past medical history of his ancestors. If every man handed down to his children a chronicle of his ailments, with their causes, as corrected and revised by his physician, although in many cases, it is to be feared, it would be a humiliating and painful record, yet it would be of the greatest use to the individual who has inherited the same features, passions, and predispositions. It is, however, impossible here to enlarge upon the subject of hygiène generally, since every article in this book bears upon and is included in the subject.

Hygiène, Military - This subject is too large to be fully treated here. The reader is referred to Dr. Parkes' "Hygiène" as the best book in our language, and to the "Handbuch der Militär-Gesundheitspflege," by Dr. W. Roth and Dr. R. Lex. Berlin, 1872.

Military hygiène deals with all that bears upon the health of the soldier—his food, his clothing, his dwelling, his occupations, &c.

All army surgeons and writers on military hygiène unite in stating, as the result of their experience, that the age of the recruit as at present fixed is too low, and propose twenty years of age as the minimum. Indeed, the events of the late war have strengthened the opinion which a former study of physiology and the laws of growth naturally led to—viz., that the recruit of eighteen is decidedly immature.

The Army of the Loire, composed of very young men, melted away before the trained German soldier. Men of twenty-seven and thirty can stand fatigue, insufficient food, and all the changes of climate far better than young lads. Military service is, and always will be, even in peace, somewhat arduous to the recruit.

Michel Levy, in "Traité d'Hygiène Publique," writing ten years ago, says: "In time of peace, for drilling exercise, the soldier is called early in the summer mornings, and undergoes the fatigue of monotonous attitudes, too long exposed to the sun, wind, and dust. These exercises often become laborious, as they are more frequent and prolonged at the approach of reviews and general inspections. Then come marches, parades, evolutions, sham combats, gymnastic exercises, keeping guard, sentry duty, picquets, and patrols, which expose the soldier to the night air (according to Marshal Soult (1842), the mean of the guard-nights for the French soldier is from two to five); and all this without mentioning a number of other labours —the frequent migrations of the garrison at short intervals for troops of the line, adding the dangers of change of climate to the fatigue of a march. In time of war the soldier accomplishes great distances, passes into distant climates, embarks for voyages more or less long in ships nearly always crowded, executes forced marches, fights by day, bivouacs by night, camps beneath tents or in barracks which imperfectly shelter him against the rain, cold, and heat, endures hunger and thirst, and undergoes in ambulances and temporary hospitals the deleterious influences of overcrowding. What is the result of the sum of these influences? Disregarding the exceptional mortality of battle, the deaths in the army in men from twenty to thirty years are, according to M. Benoiston de Chateauneuf, 22·5 per 1000, but according to official documents still higher—*e.g.*, in 1825 it was 27·2—while among the civil population the deaths in men of the same age are 12·5 per 1000. These figures are the more disproportionate, because they are furnished by men chosen in the flower of their age; they are not explained by an increase of mortality resulting from duels, suicide, nostalgia, syphilis, and celibacy, which are only secondary influences. There are two principal causes of the mortality of the army — the sudden changes of climate, and the fatigue of the daily exercises —*i.e.*, of the manœuvres, parades, frequent watches, &c.; that is to say, an expenditure of force goes on which exceeds the powers of the constitution and that of the alimentary reparation. Thus we see the powerful action of the degree of labour—the mortality is less for the sub-officer than for the soldier, and less for the officer than for the sub-officer. In England the mortality of the whole army is estimated at 17 per 1000, and at 12 per 1000 for officers. In France it is 19 for the army, 10·8 for officers, and 22·3 for soldiers only. The passing into different climates and war augments the mortality. Thus the French troops in the Antilles lost 75 per 1000, in Algeria 70, and in Egypt 69. In the Spanish war, disease alone carried off officers at the rate of 37, and soldiers at the rate of 119 per 1000."

Since that time there has been, however, a general improvement in the health of the soldier. For example, the last army report (1871) gives the following instructive table:—

	Loss per 1000 by—			
	Death.	Invaliding.	Death and Invaliding. 1871.	1870.
Household Cavalry	2·49	4 98	7·47	14·07
Cavalry of line	1·72	2·10	3·82	7·03
Royal Artillery	2 64	5 20	7·84	8·26
Foot Guards	1·77	4 34	6·11	13·21
Infantry regiments	2 30	4·47	6·77	9·14
Depôt Brigade, Royal Artillery	2·19	5 70	7·89	9·60

Dr. Parkes, also speaking of the excessive mortality in all countries of the soldier in the years 1846–53, as compared with the civil population, gives the following statistics:—

	Army Loss per 1000
French (1823)	28 3
French (Paixham, 1846) .	19·9
French, mean of 7 years (1862–68)	10·0
French (1869)	9·55
French in Algeria (1846) . .	64·0
French in Algeria (1862–66) . .	14·98
Prussian (1846–63), excluding officers	9 49
Prussian (1867)	6·54
Russian, series of years . .	39·0
Russian (1857–61)	18 7
Austrian	28·0
Piedmontese (1859) . . .	16·0
United States, before the war .	18·8
Portuguese (1851–53) . . .	16·5
Danish	9·5

and compares the decrease of the mortality of all arms, as shown by the following figures:—

	Mortality per 1000 per Annum— From all Causes.	From Disease alone, *i.e.*, excluding violent Deaths.
Mean of 10 years (1861–70)	9·45	8·534
Mean of 10 years (1871) .	8·62	7·8

Dr. Parkes ascribes the improvement to the great reforms in the army with which the name of Lord Herbert is associated, and observes, as a curious fact, that the mortality of the French and English armies is now almost the same—viz., about 9 5 per 1000 with the colours—slightly lower, however, in the English army. The causes of mortality may be gathered from the following table, calculated out by Dr. Parkes, from Appendix I. in Dr. Balfour's Report on the Army Medical Department Blue-Books (1859-71):—

Causes of Mortality.

	Mortality per Annum per 1000 of Strength (1867-71), 5 Years.	Deaths in 100 Deaths (1867-71), 5 Years.	Deaths in 100 Deaths.
Phthisis and tubercular hæmoptysis	2 648	30 26	33·806
Diseases of heart and vessels	1·462	16·71	9 008
Pneumonia	0 777	8·88	6·540
Violent deaths	0 598	6 84	6·325
Diseases of nervous system	0·576	6·58	6·596
Continued fevers, chiefly enteric	0·405	4·63	5·685
Suicides	0·288	3 30	3 030
Bronchitis	0 167	1 91	5·467
Delirium tremens	0·069	0·80	0·900
All other causes	1·756	20·07	22·553

Such a result is in the highest degree satisfactory, and tends to produce a confidence in sanitary measures. We will now shortly consider the food, clothing, and habitations of the soldier.

The Food of the Soldier.—One of the great difficulties in war is to provide proper food, and in peace as well as in war to keep men from taking too much alcohol. One of the first principles in the diet of the soldier is that he should have in actual field-work very little alcohol. General Grant prohibited absolutely the use of spirits in camp by his soldiers and officers, and the result was a most marked improvement in the health of both classes. In the details given under ALCOHOL it will be seen that there is ample proof of its inutility as a diet, as a heat-giver, and as a supporter of muscular exertion. That it may be required to give a temporary fillip in cases of emergency, is quite possible—the pedestrian who walks a hundred miles in a hundred consecutive hours, towards the end of the course urges on his flagging heart by a few mouthfuls of champagne.

For the general diets of soldiers, *see* RATIONS. In time of war, the great thing is to so vary the food of the soldier as to keep off the ravages of the scurvy. The use of fresh vegetables, fruits, &c., is essential, but not always to be obtained in sufficient or regular supply. Condensed foods, meat extracts, biscuits, and the German pea-sausage are required for quick movements; but despite the inventive ingenuity of preservers of meat, &c., no really good portable and compact food has yet been brought forward suitable for the soldier in such cases.

The clothing of the soldier has excited much attention; it is evident that it ought to vary according to the climate in which he is employed. It would be, indeed, well to copy to a certain extent the costume of the nation against which he is engaged—to wear the sandal on the hot Eastern plains, to wrap himself up in sheepskins in Siberian snows, and, generally speaking, to adapt his costume to what the experience of the natives has shown to be the best. We still load some of our soldiers with heavy, hot helmets, cramp their necks with stiff stocks, and injure their chests with tight garments.

"The clothing of the soldier should be selected sufficiently loose to permit the neck and chest to be at ease; the trousers should not press too tightly over the stomach." On entering upon active service, the clothing should be new, or nearly so, the shoes well fitting, and the soldier should have two flannel binders. The cavalry should, moreover, use a *suspensor*, a precaution the advantage of which is apparent. Up till now the use of waterproof material has not been authorised, although during the late war such officers and men of the various contingents as were able to provide themselves with it did so, and in the regular army officers are *recommended* to provide themselves with two flannel shirts and a waterproof cloak. The greatcoat used by the men is of sufficiently good material to be to some extent proof against the admission of wet. A few of the general regulations on the subject of clothing may, in conclusion, be given. Thus, "It should, above all, have the preservation of health as the first object; all intended for parade, and which adds useless weight to either officers or men, should be suppressed; that only should be retained in which he can at any time march against the enemy."—(Lessons on Hygiène and Surgery from the Franco-Prussian War, by C. A. GORDON, M.D., C.B.)

Next in importance to clothing and diet comes the *habitation of the soldier*—in times of peace lodged in barracks (*see* BARRACKS), in times of war in tents, huts, or wherever he can be located.

"In the densely-peopled towns or villages which soldiers are so often constrained to occupy, the soil beneath the houses and around them is often reeking with corruption, sodden with the damp products of decay; and these not only become parents of fever and nurses of all sorts of pestilential maladies by polluting the air, but also, as we know, by poisoning the waters of wells or streams with the seeds of dysentery, cholera, and typhoid fever, and probably of every form of contagious malady." —(Dr. W. A. GUY, Public Health.)

Overcrowding in war always prevails more or less. It is not alone too many in one tent, or too many tents on a given spot of ground, but there is a novel form of overcrowding introduced—namely, an *overcrowding on the march*. Men are occasionally pressed and condensed together, breathing the breath, perspiration, and dust unavoidably raised from the bodies of their comrades and the roads they traverse; hence it is well, when circumstances permit, to march in as open order as possible. *See* BARRACKS, CAMPS, GYMNASIUM, HOSPITALS, RATIONS, TENTS.

Hygiène, Naval—The total force serving in her Majesty's ships amounts to about 47,640 men. The merchant navy is manned with about 327,000 hands, and we may reckon (according to the returns of the Emigration Commissioners, 1872) that about 300,000 persons annually leave the shores of the United Kingdom. Add to these figures men employed on coasting vessels, barges, and other craft, and it will be seen that sanitary science afloat cannot deal with less than half a million men, hence its importance.

The Navy.—The ravages that all kinds of diseases, and especially scurvy, formerly made in our navy is a matter of history.

Sanitary progress in this department has been slow—*e.g.*, lemon-juice was supplied to merchant ships as early as 1617, but was actually not introduced into the navy until nineteen years afterwards. In 1781 the first slop-ships (a kind of floating baths and wash-houses) were established. The separation of the sick, proper cleansing and disinfection, the use of distilled water, and many other practical sanitary measures now carried out, have met with much stolid opposition in their day, and it was only at the beginning of the present century that our navy was really brought into its present state of sanitary excellence. We were taught *naval hygiène* by terrible experience. For example—

"In 1779, 70,000 men were voted for the service of the navy; of these, 28,592 were sent sick to hospital, and 1658 died. In 1813, out of just twice the number (140,000), 13,071 were sent to hospital, and 977 died. In 1779, therefore, the sick were more than 2 in every 5, and the deaths 1 in every 42; while in 1813 the sick were about 2 in 21, and the deaths 1 in 143—the sickness reduced to a fourth, the deaths to little more than a third!

"I will give you one other numerical statement. I extract from one of Sir Gilbert Blane's tables all those years in which the number of seamen and marines voted by Parliament was the same—namely, 120,000—and I give you the sick for those years. They form, as you see, a descending series—20,544 in 1797; 15,713 in 1798; 14,608 in 1799; 8083 in 1805; 7662 in 1806. Or take a similar comparison, where the numbers voted were in each year 100,000. The years 1782, 1795, and 1804, the figures for the sick are 22,909, 20,579, 7650. These figures speak for themselves. They are very eloquent."—(Dr. Guy, Public Health.)

What sanitary measures and general management can effect is seen in the returns of the health of our navy for 1871. The total force then amounted to 47,460, and the death-rate from disease was only 6·3 per 1000.

From the same report we also learn that out of the whole force of 47,460 men, there were only four cases of scurvy in the year, a triumph of sanitation.

There are, however, still reforms and improvements required in the dietaries and medical service of the navy, as well as in the ventilation of the vessels. The following is a brief account of the dietaries of the different navies, with practical suggestions with respect to our own, taken from an excellent paper by Dr. John Hunter (Observations on the Dietaries of British and Foreign Navies):—

TABLE I.—Weekly Rations of the British Navy in 1720 (in Ounces).

	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Total.	Nitrogenous.	Carbonaceous.
Biscuit . . .	16	16	16	16	16	16	16	112	17·47	86·85
Salt beef . .	...	...	32	...	...	...	32	64	4·93	2·39
Salt pork . .	16	...	...	...	16	...	...	32	2·50	31·29
Peas . . .	8	8	...	8	8	...	...	32	7·30	20·04
Dried fish . .	...	2	...	2	...	2	...	6	1·00	00·43
Butter . . .	...	2	...	2	...	2	...	6	0·00	12·47
Cheese . . .	...	4	...	4	...	4	...	12	3·40	9·20
Total dry food	40	32	48	32	40	24	48	264	36·60	162·77
Beer . . .	160	160	160	160	160	160	160	1120	0·56	48·72
Total									37·16	211·49
Deduct one-eighth for purser's allowance									4·64	26·43
Net Total . .									32·52	185·06

A note to the foregoing table says that when there is no dried fish (fired or sized fish) oatmeal is given, which was usually made into "burgoo."

It will be observed, that on certain days no meat was issued. These were the "banian" or "bauyan" days, and are referred to by Smollett in his "Roderick Random." Six pounds of meat were issued weekly, being a pound for every day but Friday, which was a day of limited supply.

The great deficiencies of this scale are obvious, and are quite sufficient to explain the terrible mortality from scurvy that occurred during protracted voyages about this period. The Centurion, the celebrated flag-ship of Admiral Anson, lost about two hundred men, out of a complement of between four and five hundred, during the months of April, May, and June 1741; and on arriving at Juan Fernandez on June 9th, there were only ten foremast men in a watch, all the others being helpless, or dying from scurvy. About eighty died during the last ten days, and the condition of the survivors was most horrible.

It is interesting to trace the gradual changes that have taken place in the scale of diet of the British Navy since the year 1720 up to the present time, which Dr. Hunter has been able to do by the aid of the admirable library at Haslar Hospital.

The table-beer allowed by the scale of 1720 was never carried in sufficient quantity to last above six or seven weeks (LIND), and half a pint of spirits was issued in its place. In 1740, the time of the disastrous Carthagena expedition, Admiral Vernon ordered the spirit to be mixed with water when served out, and through him the mixture received the name of "grog," said to be so named from the "grogram" breeches which the admiral usually wore.

In 1761, Dr. Lind, R.N., discovered that fresh water could be distilled from sea water, but little practical use was made of this important discovery till very many years afterwards, when it was applied to the cooking galleys of troop and emigrant ships, and to the boilers of steam-vessels.

In 1795, owing to the representations of Drs. Lind, Trotter, and other naval medical officers, lemon-juice was regularly issued to the crews of sea going men-of-war.

At this time the usual breakfast of the men was oatmeal boiled in water, and sweetened with molasses, when procurable.

Cocoa was now used by vessels on the West India station, and soon afterwards came into general use for breakfast throughout the navy, in place of the much disliked "burgoo."

In 1824 a great change took place in the scale of diet. Banyan days were abolished, and the following scale introduced:—

Daily—Biscuit, one pound.
,, Beer, one gallon.
,, Cocoa, one ounce.
,, Sugar, one and half ounce.
,, Fresh meat, one pound.
,, Vegetables, half a pound.
,, Tea, quarter of an ounce.
Weekly—Oatmeal, half pint.
,, Vinegar, half-pint.

"When fresh meat and vegetables are not procurable, there shall be allowed in lieu thereof, salt beef, three-quarters of a pound; and flour, three-quarters of a pound: or, salt pork, three-quarters of a pound; and peas, half a pint." Raisins and suet were allowed for an equal weight of flour, in a certain proportion. This was the first issue of tea; and the ration of spirits substituted for the gallon of beer was reduced from half a pint to one gill; and from two shillings and sixpence to three shillings and sixpence a month was added to the pay of the men.

It is curious to note, that though, according to the circulars, "banyan days were abolished," yet the amount of salt meat a week was reduced by three-quarters of a pound.

In 1850 the following scale was introduced, in which the spirit ration was again reduced one-half, and the salt-meat ration raised to one pound daily:

Biscuit, one pound; spirits, half a gill; fresh meat one pound; vegetables, one pound; sugar, one and three-quarter ounces; chocolate, one ounce; tea, quarter of an ounce, daily.

Oatmeal, quarter pint; mustard, half an ounce; pepper, quarter ounce; vinegar, quarter pint, weekly.

"When fresh meat cannot be procured, there shall be substituted, salt pork, one pound; peas, half-pint every alternate day; and salt beef, one pound, with flour three-quarters of a pound; or preserved meat, three-quarters of a pound; and preserved potatoes or rice, quarter of a pound on every alternate non-salt-pork day." Suet and raisins as before. The preserved meat was so often found to be either offal or putrid, that it was soon discontinued.

In 1856 split peas were issued instead of whole peas.

In April 1859 the ration of biscuit was increased to one and a quarter pounds, and sugar to two ounces.

Leave was also given to occasionally issue an extra ration of beef, an ounce of cocoa, and half an ounce of sugar. In 1865 a superior kind of preserved meat was issued, and is still in regular use.

It would be more esteemed in the tropics if it were sometimes eaten cold, instead of being warmed first.

Table No. II. is the scale of diet of the present time, 1871.

TABLE II.—WEEKLY RATIONS of the BRITISH NAVY for 1871 (in Ounces).

	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Total.	Nitrogenous.	Carbonaceous.
Biscuit	20	20	20	20	20	20	20	140	21·84	108 57
Preserved beef	12	...	...	...	12	...	...	24	3·55	17·88
Salt beef	...	...	16	...	...	...	16	32	2·48	2·32
Salt pork	...	16	...	16	...	16	...	48	3·76	46·94
Peas	...	5·2	...	5·2	...	5·2	...	15·6	3·58	9·77
Flour	...	...	9	...	...	...	9	18	2·62	12·88
Suet	...	...	0·75	...	...	...	0·75	1·5	0·00	3.11
Raisins	...	...	1·5	...	...	...	1·5	3	0·00	2·85
Preserved potatoes	4	...	...	...	...	...	...	4	0·25	2·70
Rice	...	...	...	...	4	...	...	4	0·25	3·25
Sugar	2	2	2	2	2	2	2	14	0·00	13·30
Cocoa	1	1	1	1	1	1	1	7	0·25	6·65
Tea	0·25	0·25	0·25	0·25	0·25	0·25	0·25	1·75	?	?
Rum	2·5	2·5	2·5	2·5	2·5	2·5	2·5	17·5	...	...
Vinegar	...	5	...	...	...	...	...	5	...	...
Pepper, &c.	...	...	...	...	...	...	...	...	...	...
Total (excluding liquids)	39·25	44·45	50·50	44·45	39·25	44·45	50·50	312·85	38·58	230·22

One ounce of sugar and ·5 of lime-juice daily, after fourteen days at sea.

TABLE III.—PROPOSED SCALE of WEEKLY RATIONS for the BRITISH NAVY, 1871 (in Ounces).

	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Total.	Nitrogenous.	Carbonaceous.
Biscuit	20	20	20	20	20	20	20	140	21·84	108·57
Preserved beef	12	...	...	...	12	...	...	24	3·55	17·88
Salt beef	...	...	16	...	...	...	16	32	2·48	2·32
Salt pork	...	16	...	16	...	16	...	48	3·76	46·94
Peas	...	5·2	...	5·2	...	5·2	...	15·6	3·58	9·77
Flour	...	...	9	...	...	...	9	18	2·62	12·88
Suet	...	...	0·75	...	...	...	0·75	1·5	0·00	3·11
Raisins	...	...	1·5	...	...	...	1·5	3	0·00	2·85
Preserved potatoes	4	...	4	...	4	...	...	12	0·75	8·10
Pearl barley	...	...	...	...	...	...	2	2	0·28	1·52
Compressed vegetables	...	...	...	...	...	...	2	2	0·25	0·50
Pickles	...	1	1	1	...	1	1	5	0·25	0·40
Sugar	2	2	2	2	2	2	2	14	0·00	13·30
Cocoa	1	1	1	1	1	1	1	7	0·25	6·65
Tea	0·25	0·25	0·25	0·25	0·25	0·25	0·25	1·75	?	?
Rum	2·5	2·5	2·5	2·5	2·5	2·5	2·5	17·5	?	?
Vinegar	...	5	...	...	...	...	...	5	...	...
Pepper, &c.	...	...	...	. .	...	...	...	...	...	...
Total (excluding liquids)	39·25	45·45	55·50	45·45	39·25	45·45	55·50	325·85	39·61	234·79

One ounce of sugar and half an ounce of lime-juice, after seven days at sea.

These three tables refer to the diet of the men when at sea, as in harbour one pound of fresh meat and one pound of vegetables are issued daily in place of the salt or preserved meat. The officers provide their own food, and usually carry a sufficiency of live stock and preserved provisions, though they are entitled to draw the whole or a portion of the daily rations if they choose.

Table III. is slightly deficient in nitrogenous food, and the excess of carbonaceous is derived chiefly from the biscuit and salt pork, to get the full value from which requires excellent teeth and great capability of digesting fat. The result of a great number of observations that Dr. Hunter has made is, that seamen are generally deficient in the number of their teeth, many having lost four molar teeth before arriving at thirty years of age.

Table II. is also deficient in antiscorbutic food, the ill-effects of whose absence is only partially obviated by the use of lime-juice.

In Table III., which Dr. Hunter has drawn up as a proposed improvement upon the present scale, an endeavour has been made to better the diet, while as few changes as possible have been introduced.

Preserved meat is still restricted to twice a week, because the heat to which it is exposed during the process of preserving (226°) develops a kind of flavour akin to that of baked meat, which flavour quickly palls on the palates of most persons, and causes a positive dislike to arise if the meat is frequently used.

If by any process, such as boiling *in vacuo*, or at a great height, where the boiling-point is low, the meat could be preserved as simple boiled meat, and not overcooked as it is at present, then it could be substituted for the salt beef with very great advantage, for pickling renders the fibrine of beef indigestible.

Pork, from containing so much fat, does not lose so much by salting as beef does, therefore it is issued thrice a week, and beef only twice.

Four ounces of preserved potatoes are added to the rations on one salt beef day, and a soup of two ounces of compressed vegetables and two ounces of pearl barley on the other. One ounce of pickles is issued on every salt meat day, as besides their antiscorbutic value, they aid the digestion of salt meat, and thus enable the system to extract more nutriment from it. The best and cheapest pickles are red cabbage and onions.

This table could be still further improved by substituting one quart of porter for the half-gill of rum, but the difficulty of stowage is the great objection to this; by making water an article of the ration, the minimum in the tropics being fixed at one gallon a day for each person, for there can be no doubt that it is simply cruel, as well as hurtful, to limit to the inadequate quantity of half a gallon each person, the amount of water supplied to men who are living on salted meat and going through active exercise in the heats of the tropics. The allowance in the Prussian Navy is 3½ quarts daily to each person.

The men take dinner at noon, and about half-past four they have tea, which is called supper. There can be no doubt that it is much too long, particularly for men who work during the night, to go without any food, except biscuit and milkless tea, from noon till breakfast next morning at seven, a period of nineteen hours. Any one who doubts this may easily satisfy his mind, though not his body, by making the experiment. Tea is believed to have the power of retarding the waste of tissue, but the black-boiled milkless decoction that the men drink is chiefly a solution of tannin, and cannot have much other effect than causing constipation. The lime which the captains of the hold will insist upon throwing into the tanks "to keep the water sweet," will also, as well as the boiling, prevent the tea from being what it should be. It would be an improvement for the men to take their mess-kettles to the galley to be filled with boiling water, upon which the tea should be thrown. This is the Australian mode of tea-making.

Sometimes the men are able to save a portion of their dinner for supper, and with certain improvements in the quality or kinds of the meat, this might be oftener done, but seamen are frequently met with who never touch their salt beef at all, but dine on biscuit and their allowance of grog. In some vessels an allowance of chocolate is issued to the middle and morning watches, with very beneficial effects.

The change required in a tropical climate is sufficiently made by the addition of fruit, which the men purchase for themselves from the boats that come alongside with fruit and vegetables for sale.

Tables IV., V., VI., and VII. are those of foreign navies.

The French and Dutch Navies appear to rely principally on peas, and bring their scale up to the proper standard as regards amount.

Sameness of diet, a great evil, appears to be the chief objection to their systems.

The United States Navy relies on pickles and preserved vegetables as antiscorbutics, and boasts that it does not require lime-juice; indeed, "lime-juicer" is an uncomplimentary epithet applied by American to British merchant-seamen.

TABLE IV.—Weekly Rations of the United States Navy, 1871 (in Ounces).

	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Total.	Nitrogenous.	Carbonaceous.
Biscuit	14	14	14	14	14	14	14	98	15·28	83·55
Coffee	1	1	1	1	1	1	1	7	?	?
Tea	0·25	0·25	0·25	0 25	0·25	0·25	0·25	1·75	?	?
Sugar	4	4	4	4	4	4	4	28	0·00	13·60
Molasses	...	10	...	...	...	...	...	10	0·00	7·70
Preserved beef	12	...	...	...	12	...	...	24	3·55	17·88
Salt beef	...	...	16	...	...	16	...	32	2·47	2·30
Salt pork	...	16	...	16	...	...	16	48	3·76	46·94
Rice	8	...	...	...	8	...	...	16	1·00	13·00
Beans	...	8	...	8	...	...	8	24	5·52	15·30
Dried fruit	...	...	2	...	...	2	...	4	0·00	3·80
Pickles	...	...	...	4	...	...	4	8	0·40	0·64
Preserved tomatoes	4	...	...	...	4	...	...	8	0·40	0·64
Butter	2	...	...	...	2	...	...	4	0·00	8·30
Flour	...	...	8	...	...	8	...	16	1·72	12·80
Total	45·25	58·25	45·25	47·25	45·25	45·25	47·25	328·75	34·10	226·48

The allowance of biscuit is not sufficient; but as the men purchase soft bread for themselves when in harbour (which they are well able to do, an A.B.'s pay being £4, 10s. per month), and allow the biscuit to accumulate till they go to sea again, the allowance is practically unlimited, and is much nearer twenty ounces than fourteen. On some stations, two ounces of preserved potatoes are issued in place of the four ounces of preserved tomatoes. These preserved potatoes are little used, as the men of the United States Navy appear to be unacquainted with the fact, that long-continued cooking removes all the disagreeable earthy flavour, and that frying in the fat of the preserved beef makes them really delicious.

TABLE V.—Weekly Rations of the French Navy at Sea, 1871 (in Ounces).

	Total.	Nitrogenous.	Carbonaceous.
Biscuit, 19·4 × 7	135·8	21·18	105·31
Brandy, 2·1 × 7	(14·7)	?	?
Vin de Campagne, 16·1 × 7	(112·7)	?	?
Coffee, ·7 × 7	4·9	?	?
Sugar, ·85 × 7	5·95	0·00	5·65
Preserved beef, 7·0 × 3	21·0	3·10	15·64
Salt pork, 7·85 × 3	23·55	1·84	23·03
Dried peas, 2·1 × 6	12·6	2·89	7·89
Cheese on Fridays	3·5	0·99	2·71
Dried peas for supper, 7 7 × 7; sometimes rice is substituted	53·9	12·39	33·76
Sourcroute, ·7 × 7	4·9	0·25	0·40
Butter, ·5 × 7	3·5	0·00	7·26
Olive oil, ·28 × 7; also vinegar and salt	1·96	0·00	4·06
Total	271·56	42·64	205·71

Lime-juice and sugar are also issued.

TABLE VI.—Weekly Rations of the Dutch Navy in Europe, 1871 (in Ounces).

	Total.	Nitrogenous.	Carbonaceous.
Biscuit	70·04	10·98	54·59
Barley for breakfast, 10·5 × 7	73·50	4·63	59·09
Salt beef	21·00	1·59	1·43
Smoked pork	33·50	3·28	40·95
Cheese	8·80	2·49	6·84
Peas	95·54	21·97	59·85
Butter	8·80	0·00	18·26
Coffee	4·90	?	?
Sugar	3·70	0·00	3·51
Pickles	7·00	0·31	0·56
Gin	(12·32)	?	?
Vinegar	(9·80)	...	...
Total	326·78	45·25	245·08

Lime-juice and sugar are also issued.

TABLE VII.—Weekly Rations of the Dutch Navy in the East Indies, 1871 (in Ounces).

	Total.	Nitrogenous.	Carbonaceous
Biscuit	70·04	10·98	54·59
Rice for breakfast	112·70	7·10	91·76
Salt beef	49·40	3·81	3·55
Smoked pork	26·40	1·87	23·27
Butter	8·80	0·00	18·26
Peas, 42·0; calavanches, 52·9 : 94·9 (by measure)	80·76	18·55	50·53
Onions	4·00	0·40	0·64
Coffee	7·40	?	?
Sugar	17·60	0·00	16·72
Tea	0·98	?	?
Vinegar	10·60	?	?
Chillies	0·35	...	...
Pepper, salt	{0·50 / 5·00}	...	...
Gin	12·32	...	...
Total	378·34	42·71	259·32

Ventilation of Ships.—The ship is a *habitation* of a special character. In ordinary dwellings, a continual interchange of air takes place, not only through fissures and cracks in doors, windows, chimneys, or through special openings made for the purpose of ventilation, but also from the ground beneath, and through the walls themselves, which are by no means impervious to air. In a vessel, however, the ground-air is replaced by what I would call the *bilge-air*. The wooden or iron walls, as the case may be, are not at all permeable, and special means have to be used both for bringing fresh air into the ship and getting rid of it when impure, especially in rough weather, or when, as in action, the hatchways and ports are closed. On the other hand, advantage may be taken of the fact that a vessel at sea is in constant motion, and therefore there are continual currents of air around the sides, about the deck, &c. This continual motion of the vessel is utilised in *Thiers' ship ventilator*, which has been fitted up with satisfactory results in her Majesty's ships Vigilant, Thetis, and Osborne. The invention is extremely ingenious. Two tanks (*see* fig. 50), A and B, are placed opposite each other on each side of the vessel, four in all. Each pair is connected by a transverse pipe—one pipe, E, containing water, the other, F, mercury; therefore the two opposite tanks, A A, may be called the water-tanks, B B the mercury-tanks. A A have each a long pipe, C, leading into the hold, or wherever ventilation is required. The tanks B B have also a tube furnished with valves opening inwards, G G, and leading down to the neighbourhood of the keelson. The pipes D D communicate with the open air, and have valves opening outwards. It is perfectly automatic; the least roll of the vessel causes a vacuum in either the front or starboard tanks, and the water from the bilge rushes up one of the G pipes, the air up one of the C pipes into the respective tanks, the next roll forcing this water and air out of the pipes D.

Many vessels have spaces open on the shelf-pieces, the consequence being that a direct communication with the bilge-air is ensured, which of course is fundamentally wrong. Others trust entirely to hatchways, ports, scuttles, and windsails, most of which cannot be used at all in rough weather.

It will probably be found that Thiers' automatic ventilator is the best to fit up a new

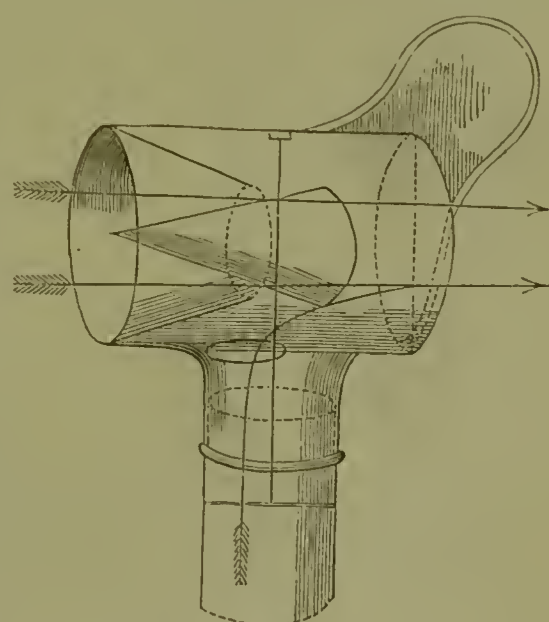


Fig. 49.

vessel with, but there are also several simple means of ventilation which may be adapted to any class of ship. Tubes may be led from the spar deck to the lower deck with cowled

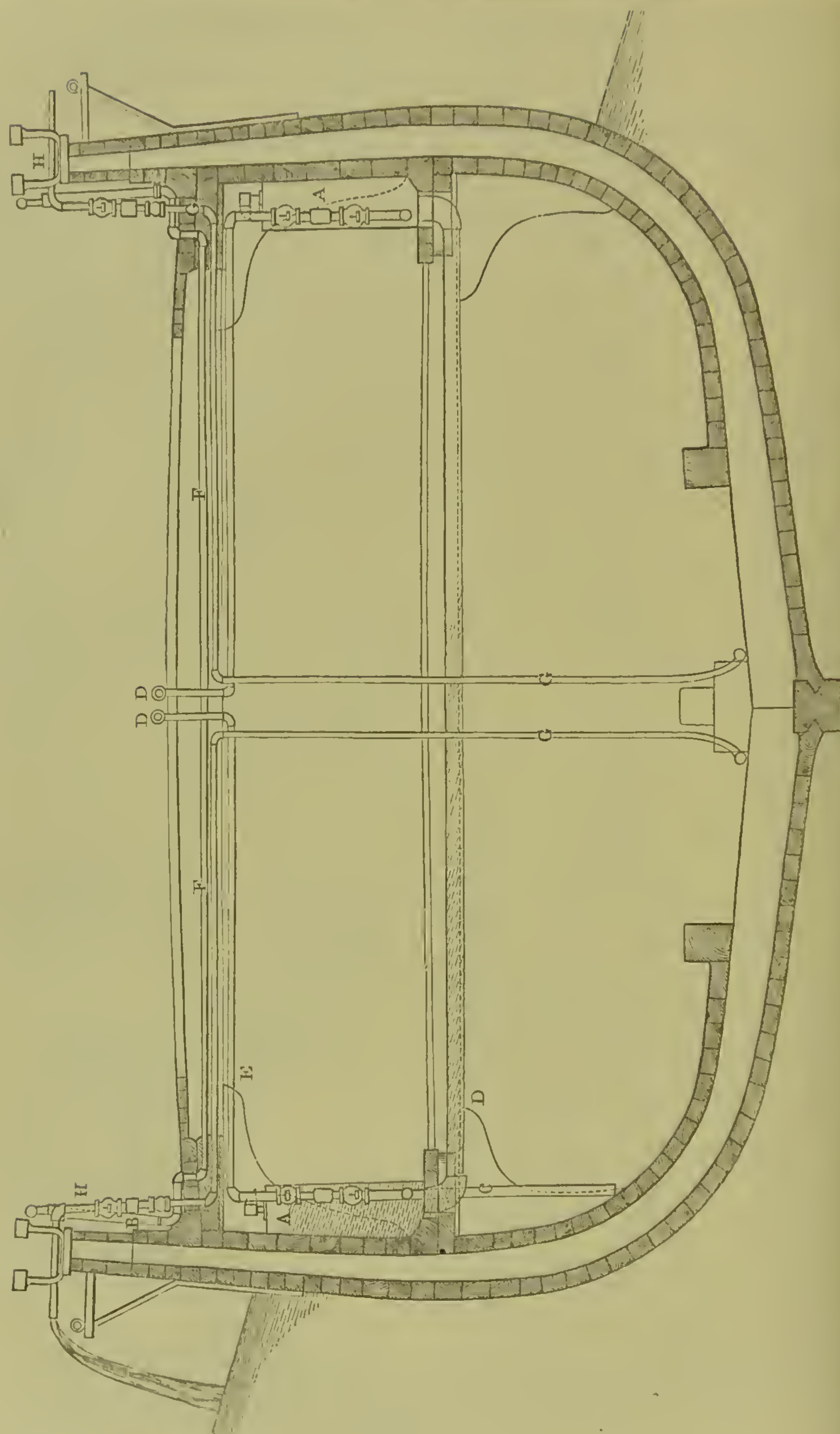


Fig. 59.

heads trimmed to wind. In the Indian transports there are deck air-channels communicating with main ventilators, both up-cast and down-cast, on Dr. Edmond's principle (*see* fig. 49). The aspirating force of these ventilators is sometimes increased by steam jets introduced into the up-casts. In some ships the hollow iron masts are utilised either as up-casts or down-casts—*e.g.*, her Majesty's ship Monarch, and the steamers of the Peninsular and Oriental Company—the latter, however, aided by windsails, trellised bulkheads, and side ports. In the ventilation of iron-clads of the Monitor class it is necessary to provide for a supply of air when all hatches are closed and light excluded. Both the Glatton and Devastation are ventilated by fans driven by steam-power; indeed, under such circumstances, mechanical agencies are indispensable, and of these the fan system appears practically to have been of most service. There is hardly a craft afloat, from a canal-boat to the finest clipper ship, that could not take advantage of the heat of the stove of either the galley or cabin in steamships. Again, the value and applicability of this method is evident; properly-arranged shafts connected with a jacket surrounding a boiler would draw air from all parts of a vessel. It is impossible to recommend any one system of ventilation, since each case must be judged of by its merits, but it is certain that any ventilation that does not get rid of the bilge-air is worthless in a sanitary point of view. (For further information the reader is referred to an excellent article, "Sanitary Science Afloat," in "Naval Science" for April 1872.)

Merchant Service.—The vessels comprising the merchant service may be most conveniently divided into three chief classes — 1. Ocean-going ships; 2. Coasters; 3. Barges and River Craft. The very unsatisfactory condition of this service has been forcibly exposed from time to time by Dr. Harry Leach, the Medical Officer of Health for the Port of London, in various able papers—*e.g.*, "Report on the Hygienic Condition of the Mercantile Marine, London, 1867," and "Report on Hygienic Condition of the Mercantile Marine in the Port of London, 1871," with others. With Dr. Leach's permission we make considerable use of the papers referred to.

1. *Ocean-going Ships.*—These vessels vary in size from 250 to 2500 tons, and the number of their crews (all told) from ten to sixty men; and just as there is no law on land to proportion the number of persons living in a cottage to the size of the cottage, so in these vessels there is no definite law to proportion the number of men to the size of the ship, therefore, practically speaking, a large amount of over-crowding on the one hand, or undermanning on the other, may exist.

By the rules of the Government Emigration Service, however, four men are required to every 100 tons up to 500, three men to every additional 100 tons up to 1000, and two men for every 100 tons above this amount; so that, for example, a vessel of 1500 should carry forty-five hands, all told. Some few owners adopt this scale in tolerable entirety; but our readers will see, from the following tabulated statement of vessels that have arrived in the Thames during 1865 and 1866, to what extent this arrangement is carried out:—

Name of Ship.	Registered Tonnage.	No. of Hands Home (all told).
Galloway	1329	29
French Empire	1324	27
Eaglet	392	14
Thorndean	1207	35
Royal Alice	1244	32
Geelong	456	14
Prince Oscar	1292	32
Tamerlane	764	21
Marlborough	899	23
Saint Andrew's Castle	639	19
Hoang-Ho	566	21
Stirling Castle	1165	32
Blanche Moore	1858	35
Merrie England	1045	29
Hermine	538	17

When, too, we know that thirty years ago, the regular complement for every 100 tons was five men and one apprentice it is evident that, on this head, a decadence has taken place, though some allowance must be made on account of recent improvements (such as patent reefing topsails), which naturally and reasonably tend to curtail the number of hands required. The able and ordinary seamen are berthed in a deck-house built between the fore and main masts, or, more usually, in what is technically called a top-gallant forecastle, and in some cases in a lower forecastle. The first plan is, however, gaining ground as to large ocean going ships; and Mr Green's Highflyer is a good example of many new vessels built on the deck-house principle. It is ordered by the Merchant Shipping Act that nine superficial feet shall be allotted to every one of the crew, if sleeping in hammocks; or twelve superficial feet under any other arrangement; that every such place shall be free from stores or goods, and shall be properly caulked and ventilated—a failure as to the rule to result in a penalty. These regulations are, however, practically a dead letter; for as no inspection of seamen's quarters takes place previous to sailing, as no law exists as to the number of seamen carried, and as, moreover, all space allotted to the crew is deducted from the tonnage of the ship when registered, the terms of the Act are frequently evaded in a very great degree. We may fairly, too, take exception to the terms of an Act which indicates nine superficial feet as sufficient for the healthy lodgment of a sailor.

The following list, however, contains the measurement of seamen's quarters in several of the finest vessels now in the East India Docks:—

Registered Tonnage.	Name of Ship.	No. of Bunks.	Dimensions of Upper or Top-gallant Forecastle: Length. Feet.	Breadth. Feet.	Height. Feet.
833	Hindostan	14	22	24	7
963	Duke of Athole	22	30	24	7
793	Blackwall	...	32	27	6

			Dimensions of Lower Forecastle.		
819	Gala .	...	20	22	7
			Dimensions of Deck-house.		
1012	Highflyer .	20	30	14	6½
468	Anzi . .	8	10	12	5¾

Examples are here given of the three different modes of housing ships' crews. No deductions are made in this table for the space occupied by chain-cable and bowsprit, and the measurements are in all cases taken at the widest parts.

In all the forecastles, where the bunks are mostly arranged round the bows of the ship, the space abaft (or the widest end) is completely open from the break of the forecastle to the deck below when in port; and at the other, or forward end, of this very airy apartment, two large hawse-holes are constantly open for the passage of the cables These latter, of course, run completely through the quarters of the crew; and by consequence, unless the weather be fine and the water smooth, these quarters are constantly wet. Here the men eat, drink, and sleep, in the immediate vicinity of the galley, and often in very close proximity to any live stock that may be carried for the use of officers or passengers during the voyage. It may, therefore, without nautical knowledge, be inferred that any comparative amount of decency or cleanliness (not to speak of comfort) is utterly impossible when the cables are bent. When at sea, the hawse-pipes are closed; the open space is sometimes partially, sometimes wholly, filled up in a rough-and-ready style, egress and ingress being afforded to the sailors by means of a hatch opening on to the forecastle, which, from its normal dimensions, may be called a man-hole.

Thus much for healthy accommodation and ventilation of quarters. It should be remarked that, as to iron ships, the consequences of these latter deficiencies are, in warm latitudes, necessarily much exaggerated.

We come next to rations. The scale of provisions accorded to the crews of sea-going ships is not prescribed by Act of Parliament, and so this important matter is also left entirely to the discretion of owner and captain. As facts should always precede opinions, we append in this place some scales of provisions taken from agreements of certain ships engaged in the foreign trade.

London to East Indies.

	Bread.	Beef.	Pork.	Flour.	Peas.	Tea.	Coffee.	Sugar.	Water.	Rice.
	lb.	lb.	lb.	lb.	pt.	oz.	oz.	oz.	qts.	lb.
Sunday.....	1	1½	...	½	...	⅛	½	12 weekly	3	...
Monday....	1	...	1¼	...	¼	⅛	½		3	...
Tuesday....	1	1½	...	½	...	⅛	½		3	...
Wednesday	1	...	1¼	...	¼	⅛	½		3	...
Thursday..	1	1½	...	½	..	⅛	½		3	...
Friday	1	...	1¼	...	¼		½		3	...
Saturday...	1	1½	...	...	...	⅛	½		3	½

Liverpool to East Indies.

	Bread.	Beef.	Pork.	Flour	Peas.	Tea.	Coffee.	Sugar.	Water.
	lb.	lb.	lb.	lb.	pt.	oz.	oz.	oz.	qts.
Sunday	1	1½	...	½	...	⅛	½	2	3
Monday	1	...	1¼	...	⅓	⅛	½	2	3
Tuesday..........	1	1½	...	½	...	⅛	½	2	3
Wednesday	1	...	1¼	...	⅓	⅛	½	2	3
Thursday	1	1½	...	½	...	⅛	½	2	3
Friday	1	...	1¼	...	⅓	⅛	½	2	3
Saturday	1	1½	...	...	...	⅛	½	2	3

Sunderland to East Indies, &c.

	Bread.	Beef.	Pork.	Flour.	Peas.	Rice.	Tea.	Coffee.	Sugar.	Water.
	lb	lb.	lb.	lb.	pt	lb.	oz	oz.	oz.	qts.
Sunday....	1	1½	...	½	...	...	⅛	½	2	3
Monday..........	1	...	1¼	...	⅓	...	⅛	½	2	3
Tuesday	1	1½	...	½	...	...	⅛	½	2	3
Wednesday.....	1	...	1¼	...	⅓	...	⅛	½	2	3
Thursday........	1	1½	...	½	...	...	⅛	½	2	3
Friday............	1	...	1¼	...	⅓	...	⅛	½	2	3
Saturday.........	1	1½	...	...	...	½	⅛	½	2	3

These scales represent fairly enough those used by most ships of the present day; and, notwithstanding the vast amount of improvement in variety of portable prandial material during the last twenty years, we may safely assert that, beyond the introduction once a week of a certain small amount of preserved mixture called soup and *bouilli*, no change has taken place in the mode of provisioning vessels for the last half-century. (It cannot be denied, however, that in good-class ships the *quality* of diet has greatly improved.) When a vessel is in port, the Act commands that fresh provisions of good quality shall be served out to the crew day by day; and there is no doubt that, on smart lines, the men, when at harbour service, fare well. But it is well known that masters of ships frequently put into St. Helena, or stand "off and on" while a boat goes on shore, without providing fresh rations or even fresh vegetables for their men, though watercresses grow in profusion about the island. It is, too, within our cognisance, that vessels arriving at Gravesend from abroad, and remaining there at least twenty-four hours, have taken in no fresh provisions whatever until they have come up the river and hauled into dock, though the homeward passage may have extended over 120 days. During the ship-to-ship visitation so admirably conducted by the Seaman's Hospital Society in the Thames last year, under the auspices of Dr. Rooke, Mr. W. Johnson Smith, chief of the visiting staff, found the crew of a vessel (which had just arrived from the West Indies) busily engaged in cooking a mass of animal matter, which nasal demonstration quickly discovered to be in a semi-putrid state. He was told by the seamen that the master and mate had gone ashore (probably to dinner), and that this was the last remnant of their sea-fare, off which, *nolentes volentes*, they were then about to dine. It is not, however, to these points alone, which, it may be hoped, are somewhat exceptional, that we would draw special attention; but chiefly to the miserable want of variety in the above scales of diet, however good and however abundant such diet may be. By way of contrast, we may refer to the following scale of provisions adopted in the French mercantile marine, a perusal of which will show how very materially and usefully it differs from those above quoted :—

Synopsis of Diet Scale adopted in the French Mercantile Marine.

Breakfast.—Coffee, bread or biscuit, brandy or rum.

Dinner.—Preserved beef or salt pork, vegetables or desiccated vegetable mixture, and wine.

Supper.—Haricot beans dressed in two ways, potatoes baked in the cinders, and wine.

Seasonings, &c.—Sourcrout or pickles, preserved sorrel, olive oil, mustard, vinegar, and lemon juice, at the rate of *one ounce* per man daily, with one ounce of sugar, and one pint and three-quarters of water.

The most noticeable articles in this scale of diet are the variety of vegetables given, and the ration of wine or brandy. Very few sailors are now supplied with any grog at all at sea; but to this, among other additions and changes, we shall presently refer Arrangements for the supply of good water are lamentably neglected, in spite of the simplicity of a distilling apparatus, and the patent fact that the river-water at Calcutta and some other ports is notoriously provocative of dysentery and maladies akin thereto.

With the view of protecting the seamen in the matter of provisions, it is ordered by the Merchant Shipping Act that, upon a complaint made by three or more of the crew of any ship to a naval, consular, or customs officer, or shipping master, in any port, as to quality of water or provisions, an examination may be made, and a penalty exacted; that the seamen shall receive, by way of compensation for any reduction or bad quality of provisions, at a certain rate per day. It is also enacted that proper weights and measures shall be carried, for the correct weighing out of the rations. It is scarcely necessary to point out the extreme difficulty to sailors of taking action under the first section of the Act above mentioned, or of the inutility of so doing when they return home, unless, indeed, money be to them of more value than health; and, as no control of weights and measures exists before or during the voyage, this latter section can be of no practical benefit whatever to the persons meant to be protected by it.

Thus much as to provisions. It is, in the next place, our province to mention the existing prophylactic measures that are by British law employed for the preservation of health to seamen afloat. The following measures refer particularly to diseases, and specially to that least excusable, because preventable malady, called scurvy. By the terms of the Act it is enjoined that every foreign-going ship (except those bound to ports in Europe or the coasts of the Mediterranean, or those north of the 35th degree of north latitude) shall be provided with a sufficient quantity of lime or lemon juice, which shall be served out with a stated proportion of sugar (to the crew) daily, at the rate of half an ounce per man. A penalty is enjoined on this head for bad quality, or a deficient quantity of the article; and the same penalty applies also, under the same conditions, with respect to all drugs and medical stores, a list of which is issued by the Board of Trade. As to this clause, it is to be observed that, unlike the section on provisions, no seaman can recover any compensation, how much soever his health may have suffered from a breach thereof, as all penalties under that clause go to the Crown; so that even the poor satisfaction of a financial *quid pro quo* is here denied him. It is ordered, indeed, that any Local Marine Board *may*, on being required by the Board of Trade to do so, appoint an inspector to examine lime-juice and medical stores. But the insertion of the above italicised word makes the clause practically useless, and so neither sailor nor shipowner has any guarantee as to the quality of lime-juice and medical stores supplied. Nor has the former any means of redress on account of deteriorated health at the end of the voyage.

This state of things would be, to a certain extent, better in the present day if the Merchant Shipping Act of 1867 was effectively carried out; for it provides for a fit and proper supply of lime and lemon juice, a tolerably liberal space for the berths of the crew, a proper supply of medicine and medical stores, an authorised "Ship's Medical Guide," and a permissive clause as to the medical inspection of seamen before signing articles. It enjoins that every place used for the accommodation of seamen shall be "securely constructed, properly lighted and ventilated, properly protected from weather and sea, and, as far as practicable, properly shut off and protected from effluvium which may be caused by cargo or bilge-water." And it also enjoins that there "shall be one or more properly-constructed privy or privies for the use of the crew," and that every place for the accommodation of the crew "shall be kept free from stores or goods of any kind, not being the personal property of the crew in use during the voyage."

That this Act has not been properly enforced may be inferred from Dr. Leach's evidence, who says (Report on Hygienic Condition of the Mercantile Marine, London, 1871): "I inspected four vessels, none of which had any provision for light or ventilation, except by means of the hatchway. Another forecastle, divided longitudinally for the accommodation of crew and firemen, had no outlet from above; and great complaints were made as to the hawse-pipe, which in this case, as always, causes a chronic state of wet bunks whenever the cables are bent. The men employed on board this ship begged me to have this source of discomfort remedied. They averred that the sea sometimes washed through the port hawse-pipe with so much force that the flooring of the lower bunks was started, and the bunks themselves rendered, of course, quite uninhabitable."

2. *Coasting Vessels.*—Over 150,000 of these vessels are annually cleared from the ports of the United Kingdom. Coal, stone, and bones form a large proportion of their cargo, the size of the vessels varying from 80 to 300 tons. Without doubt they represent a large number of hands. Coasting is trying work for the sailor, involving exposure to severe weather, much waiting for changes in the tide, and more continuous anxious labour than falls to the lot of the ocean-going sailor. They are, however, better fed, but there is a great want of accommodation, and a great necessity for sanitary supervision. The number of hands each vessel carries varies from three to seven, always including one or two boys. The master and mate sleep in the cabin, the rest in the fore-

castle. The dimensions of various forecastles of coasting vessels, measured by Dr. Leach in the ports of London, Lynn, and Newcastle-on-Tyne, are as follows :—

Name of Vessel.	Register. Tonnage.	Crew Fore-castle.	Dimensions of Forecastle.			Dimensions of Hatchway.	
			Height. ft. in.	Length. ft in.	Width. ft. in.	Length. ft. in.	Width. ft. in.
Dispatch, sloop . .	48	2 or 3	5 0¼	12 1	13 0	...	...
Richard Ellwood, billyboy	58	2	6 1½	6 1	16 10	2 0	2 0
Prosperity, billyboy . .	57	2	5 3½	5 10	16 0	1 4	2 0
Alderman, brig . .	197	4	5 5	15 10	22 3	1 10	2 0
Jane Owens, schooner .	97	3	6 2	9 10	14 6	1 10	2 0
Ocean Maid, schooner .	107	4	5 10	9 11	17 2	1 10	2 0
Mitton Hill, sloop* . .	45	1	...	...	...	...	...
Thames, brig . . .	131	3	4 0	8 0	16 0	...	...
Perseverance, brig . .	94	3	4 6	7 4	20 0	1 0	1 0
Europe, brig . . .	169	5	5 8	14 0	16 6	...	...
Iris, schooner . . .	72	2	5 6	8 0	...	...	...
Remembrance . . .	252	7					
Malta	207	8	†5 6	16 0	24 0	2 6	2 6
Nautilus	268	7					
Sisters	234	7					

* The forecastle of the Mitten Hill was a merc hole filled with cordage.
† Average measurement.

There is thus much uniformity with regard to room and cubic space, but as the forecastles in nearly every case contained rope, cordage, and other articles, the measurements in the table are much in excess of the real space possessed by the men. The only aperture for the purpose of light or ventilation is the hatchway. Most of these forecastles were found filthy and offensive. In rough weather they are nearly always wet, and in case of sickness the condition of the sailor is something truly miserable.

3. *Barges, &c.*—Under this head may be classed canal-boats, ballast-barges, steam-lighters, tugs, monkey-barges, &c. According to Dr. Leach, no less tban 7000 barges are employed in the Port of London alone, representing a population of from 14,000 to 15,000 souls. The bargemen do not appear an unhealthy class of men, although the sanitary arrangements are in no degree satisfactory.

Dr. Cameron estimated the amount of carbonic acid in four canal-boats; the results are as follows :—

1. Cabin, 183¼ cubic feet; three occupants, each having 61¼ cubic feet; no windows or ventilators, except, for the latter, a hatch, 4 square feet; height of cabin, 3 feet 9 inches; close iron stove, burning peat. Amount of carbonic acid (8 A.M.), ·34 per cent.

2. Cabin, 4 feet 3 inches high, 400 cubic feet; a close iron stove, burning peat; three occupants, but two absent the night before examination. Amount of carbonic acid, ·098.

3. Cabin, 3½ feet high, 350 cubic feet; no opening save hatch of 4 square feet; occupants two men and a boy. Air at 7·30 A.M. felt very close. Amount of CO_2, ·305 per cent.

4. Cabin, 4 feet 10 inches in height, 360 cubic feet; no ventilator save hatch of 3 square feet; iron stove, burning peat; three men sleep in one bed, a boy in anotber, and two dogs on the floor. Air (8 A.M.) felt oppressive. Amount of carbonic acid, ·95.—(Amount of Carbonic Acid in the Air of Canal-Boats. By CHARLES CAMERON, M.D., Chemical News, vol. xxx. No. 776, p. 169.)

The above-quoted analyses show the extreme impurity of the air of canal-boats, and the urgent necessity of sanitary supervision.

Name of Barge.	Dimensions of Cabin.			Dimensions of Hatchway.		Dimensions of Skylight.	
	Height. ft. in.	Length. ft. in.	Width. ft. in.	Length. ft. in.	Width. ft. in.	Length. ft. in.	Width. ft. in.
Jane and Sarah, of Grays...	5 9½	10 0	14 9	2 3	2 0	1 3	1 0
Denton, of Rochester........	5 10	10 2	13 7	2 2	1 10	1 1	0 9
Willing Trader, of Maldon	5 3	9 2	14 2	2 3	2 3	1 3	0 11¼
Susanna & Mary, of London	1	10 6	12 10½	2 0	1 10	0 9¾	0 6

Dr. Leach has given some measurements, &c., of the class of boats known as the Rochester barge, the cabins of which are usually very clean; still the above table clearly shows how extremely deficient these vessels are in cubic space, air, and light.

Summary.—What is required, then, is firstly systematic inspection of every vessel, whether an ocean-going vessel, an emigrant ship, a coaster, or even a canal-boat, by competent medical inspectors, whose duty would be to see that all legislative enactments relative to the health, comfort, safety, or convenience of the crew were carried out. It is obviously absurd to enact laws, and provide no adequate machinery for the purpose of seeing that they are carried out. It is true that the medical officer of health is responsible for the port to which he is appointed (*see* SANITARY AUTHORITIES, PORT), but in large ports there ought to be a systematic ship survey. The duty of such inspectors would be to see that a sufficient, and sufficiently varied, supply of food was provided; that the passengers or sailors were in good health; that, in the case of ocean-going vessels, there was a supply of lime-juice or vegetables on board; that there was ample provision for water-supply; that emigrants, passengers, or men had the cubic space as laid down by the Duke of Richmond's Act; and special attention should be directed to the forecastle in ships where there is no deck-house, and to the arrangements for cooking and ventilation. Under-manning or overcrowding could, under such a system, hardly fail to be observed and prevented. All vessels carrying passengers, and of any size, should carry a surgeon, whilst the drugs supplied to ships should be examined by the analyst under the Adulteration Act previous to final shipment. If measures such as these were carefully carried out, there is great reason to hope that much preventable waste of life would be decreased; but at the same time it must be confessed that many of the lower class of sailors are addicted to filthy habits, and require sanitation in their own persons as much as the vessels themselves. *See* HOSPITAL SHIPS; VENTILATION; SHIPS; SANITARY AUTHORITIES, PORT; SCURVY, &c.

Hygrometer—An instrument used for the purpose of determining the amount of aqueous vapour in the air.

The most accurate hygrometers are those constructed, like Daniell's and Regnault's, on the principles of condensation and evaporation.

Daniell's hygrometer consists of a glass tube bent at right angles at two points, with a bulb at each extremity. The one bulb is half-filled with ether, in which the bulb of a delicate thermometer is immersed; the other is covered with muslin.

An observation is taken as follows: The muslin is wetted with ether, the evaporation of which quickly cools the bulb and condenses the vapour of ether with which it is filled. As a consequence, evaporation goes on rapidly from the liquid ether in the other bulb, and its temperature falls. The outside of the bulb is narrowly watched, and directly a ring of dew is deposited, at that instant the thermometer is read. The great objection to this hygrometer is that every observation entails a trifling expense. It has generally given place to—

The Dry and Wet Bulb Thermometers.—Now this is simply a special arrangement of two ordinary thermometers, and any two will do, providing they are both constructed of exactly similar materials, and, as a matter of convenience, are adjusted to the same scale. The one thermometer is simply hung on a board near the other, whilst the second has its bulb covered with thin muslin (which must be clean and free from starch). A few threads of the muslin are led into a vessel containing distilled water. The bulbs of both thermometers project below the scales. The necessary precautions in the use of these thermometers are, to see that the muslin is wet—*the muslin must be either wet, or, in case of temperatures below freezing-point, frozen*—and if the temperature should rise above freezing-point, the muslin still remaining frozen, it *must be thawed* before an observation is taken.

The extreme importance of observations of the difference of temperature between the two thermometers may be gathered from the fact that by their aid the following facts can be ascertained:—

1. The dew-point.
2. The elastic force of vapour, or the amount of barometric pressure due to the vapour present in the atmosphere.
3. The quantity of vapour in a cubic foot of air.
4. The additional vapour required to saturate a cubic foot of air.
5. The relative humidity.
6. The weight of a cubic foot of air at the time of the observation.

The dew-point and elastic force of vapour are both determined by Dr. Apjohn's formula, and by the aid of Table I.

Let F be the elastic force of saturated vapour at the dew-point, f the temperature of the wet bulb—in other words, the elastic force at the temperature of evaporation—d the difference between the dry and wet bulbs, and h the barometric pressure, then, when the wet-bulb reading is above 32° F.

$$F = f - \frac{d}{88} \times \frac{h}{30}$$

and when below 32° F.—

$$F = f - \frac{d}{96} \times \frac{h}{30}$$

d and h are, of course, obtained by observation, f is found in Table I., and F is then the only unknown quantity, and is quickly found by calculation, and from F, by Table II., the dew-point is obtained thus:—

If the dry bulb read 50°, the wet 45°, and the thermometer stands at 29 inches, what is the elastic force of saturated vapour at the dew-point, and what is the dew-point?

By Table I. the numbers opposite the wet-bulb temperature is ·299; then f = ·299, d = 50° − 45° = 5°, and h = 29 inches.

$$F = \cdot 299 - \frac{5}{88} \times \frac{29}{30} = \cdot 244$$

which is the elastic force of saturated vapour at the dew-point; and on referring to Table I., the temperature opposite ·244 is 39·7, which is the dew-point itself.

TABLE I.—Showing the ELASTIC FORCE of AQUEOUS VAPOUR in Inches of Mercury from 0° to 80°, calculated from the Experiments of REGNAULT. From Mr. GLAISHER'S Hygrometric Tables. The intermediate Tenths of Degrees may be easily interpolated.

Temp.	Force of Vapour.	Temp.	Force of Vapour.	Temp.	Force of Vapour	Temp.	Force of Vapour.	Temp.	Force of Vapour.
Deg.	Inch.	Deg.	Inch.	Deg.	Inch.	Deg.	Inch.	Deg.	Inch.
0	·044	29·5	·163	39·7	·244	47·3	·327	54·7	·428
1	·046	30·0	·167	40·0	·247	47·5	·329	55·0	·433
2	·048	30·5	·170	40·3	·250	47·7	·331	55·5	·441
3	·050	31·0	·174	40·5	·252	48·0	·335	56·0	·449
4	·052	31·5	·177	40·7	·254	48·3	·339	56·5	·457
5	·054	32·0	·181	41·0	·257	48·5	·342	57·0	·465
6	·057	32·5	·184	41·3	·260	48·7	·344	57·5	·473
7	·060	33·0	·188	41·5	·262	49·0	·348	58·0	·482
8	·062	33·5	·192	41·7	·264	49·3	·352	59·0	·500
9	·065	34·0	·196	42·0	·267	49·5	·355	60·0	·518
10	·068	34·5	·199	42·3	·270	49·7	·357	61·0	·537
11	·071	35·0	·204	42·5	·272	50·0	·361	62·0	·556
12	·074	35·3	·206	42·7	·274	50·3	·365	63·0	·576
13	·078	35·5	·208	43·0	·277	50·5	·367	64·0	·596
14	·082	35·7	·209	43·3	·280	50·7	·370	65·0	·617
15	·086	36·0	·212	43·5	·283	51·0	·374	66·0	·639
16	·090	36·3	·214	43·7	·285	51·3	·378	67·0	·661
17	·094	36·5	·216	44·0	·288	51·5	·381	68·0	·684
18	·098	36·7	·218	44·3	·292	51·7	·384	69·0	·708
19	·103	37·0	·220	44·5	·294	52·0	·388	70·0	·733
20	·108	37·3	·223	44·7	·296	52·3	·393	71·0	·759
21	·113	37·5	·225	45·0	·299	52·5	·396	72·0	·785
22	·118	37·7	·226	45·3	·303	52·7	·399	73·0	·812
23	·123	38·0	·229	45·5	·305	53·0	·403	74·0	·840
24	·129	38·3	·231	45·7	·307	53·3	·407	75·0	·868
25	·135	38·5	·233	46·0	·311	53·5	·410	76·0	·897
26	·141	38·7	·235	46·3	·315	53·7	·413	77·0	·927
27	·147	39·0	·238	46·5	·317	54·0	·418	78·0	·958
28	·153	39·3	·240	46·7	·319	54·3	·422	79·0	·990
29	·160	39·5	·242	47·0	·323	54·5	·425	80·0	1·023

The use of Table II. is to obviate the foregoing calculations. In order to determine the dew-point of the foregoing example by Table II., it is merely necessary to take the factor opposite the temperature of the dry bulb—viz., 2·06—and multiply it by the difference of temperature of the two bulbs, thus:—

$$2 \cdot 06 \times 5 = 10 \cdot 3$$

Now subtract this from the dry-bulb temperature and the product is the dew-point 50 − 10·3 = 39·7, as before.

TABLE II.—FACTORS for Multiplying the Excess of the Dry-Bulb Thermometer over that of the Wet Bulb, to find the Excess of the Temperature of the Air above that of the Dew-Point. From Mr. GLAISHER'S Hygrometric Tables.

Dry-Bulb Ther.	Factor.	Dry-Bulb Ther.	Factor.	Dry-Bulb Ther.	Factor.	Dry-Bulb Ther.	Factor.	Dry-Bulb Ther.	Factor.
°		°		°		°		°	
10	8·78	29	4·63	47	2·12	65	1·82	83	1·67
11	8·78	30	4·15	48	2·10	66	1·81	84	1·66
12	8·78	31	3·70	49	2·08	67	1·80	85	1·65
13	8·77	32	3·32	50	2·06	68	1·79	86	1·65
14	8·76	33	3·01	51	2·04	69	1·78	87	1·64
15	8·75	34	2·77	52	2·02	70	1·77	88	1·64
16	8·70	35	2·60	53	2·00	71	1·76	89	1·63
17	8·62	36	2·50	54	1·98	72	1·75	90	1·63
18	8·50	37	2·42	55	1·96	73	1·74	91	1·62
19	8·34	38	2·36	56	1·94	74	1·73	92	1·62
20	8·14	39	2·32	57	1·92	75	1·72	93	1·61
21	7·88	40	2·29	58	1·90	76	1·71	94	1·60
22	7·60	41	2·26	59	1·89	77	1·70	95	1·60
23	7·28	42	2·23	60	1·88	78	1·69	96	1·59
24	6·92	43	2·20	61	1·87	79	1·69	97	1·59
25	6·53	44	2·18	62	1·86	80	1·68	98	1·58
26	6·08	45	2·16	63	1·85	81	1·68	99	1·58
27	5·61	46	2·14	64	1·83	82	1·67	100	1·57
28	5·12								

The relative humidity, &c., are best determined by the aid of Mr. Glaisher's tables, which every practical meteorologist should possess. The determination of the dew-point is, however, of the most importance—one of its most evident applications being the prediction of frost. If the dew-point in the evening be well above freezing-point, no matter how clear and frosty-looking the sky may look, the absence of frost may be with some confidence predicted; if, on the other hand, the dew-point be 29·4°—that is, below freezing-point—there will certainly be frost. *See* AIR, BAROMETER, WIND, &c.

Hyoscyamia—The active principle of the *Hyoscyamus niger*, also found in the thorn-apple, *Datura Stramonium*. It may be obtained in silky crystals; very soluble in alcohol and ether. It is difficult to recognise by chemical tests. Sulphuric acid turns it brown. *See* DATURIA, &c.

I.

Ice—Water at a temperature below 32° F. (0° C.) freezes and becomes ice. At the moment of congelation it increases in bulk about one-twelfth, and expands so forcibly as to burst the vessel in which it is contained. The most compact ice has a specific gravity of ·923. 1000 parts of water at 0° C. become dilated on freezing to about 1083. Water in freezing becomes much purer, losing a large portion, sometimes the whole, of its saline contents, and the air is expelled; hence ice-water may be considered tolerably pure. The ice from a good fresh-water spring is perhaps the purest water in nature.

Ice is used in medicine for the purpose of allaying sickness, inflammation, hæmorrhage, and lately it has been recommended as a remedy in the treatment of diphtheria. It is also used in hot weather for the preservation of fish, game, meat, butter, &c. Most large establishments are now furnished with an ice room or chamber, and ocean-going steamers also contain this necessary appliance.

Ice is preserved during the summer months by confectioners, &c., in a drained well or excavation, somewhat of the form of an inverted sugar-loaf, contained in a small shed or building called an icehouse. This building should always be situated on a dry sandy soil, and if possible on an eminence, with the door on the north side, and the roof conical and thickly thatched with straw. There are now many machines for the manufacture of ice, and the cost of making it ranges from 2s. 6d. to 10s. per ton. Sufficient cold is obtained in some of the machines by the quick evaporation of liquid ammonia from compressed ammoniacal gas, and in others it is produced by the expansion of compressed air.

The custom of eating ices after a hearty and varied meal cannot be too strongly condemned, since the sudden cold stops the flow of gastric juice. Thus digestion is interfered with, and if the practice is persisted in, dyspepsia is inevitable. *See* FREEZING MIXTURES, &c.

Iceland Moss—*See* LICHEN.

Improvement Act, Improvement Act Districts—An "Improvement Act" means an Act for regulating and managing the police of, and for draining, cleansing, paving, lighting, watching, and improving, a place; or it may be an Act for any one of those purposes.

"Improvement Act District" means any area for the time being subject to the jurisdiction of any commissioners, trustees, or other persons invested by any local Act with powers of town government and rating, and empowered under the Local Government Acts to adopt those Acts, or any parts thereof.

Every Improvement Act district is now an urban sanitary authority.

Provision is made by P. H., s. 310, in case of an Improvement Act district or local government district becoming a borough, that all rights, duties, liabilities, &c., of the Improvement Act district, or local board, as the case may be, shall pass to, and be vested in, the council of the borough. *See* SANITARY DISTRICTS.

Indian-Corn—Common maize or Indian-corn (*Zea Mays*) is a native of tropical America, and is now extensively cultivated in the United States, Africa, Southern Europe, Germany, and Ireland. The grains usually met with are of a yellow colour.

Letheby gives the following, as showing the composition of *Indian-corn meal*:—

Nitrogenous matter	11·1
Carbo-hydrates	65·1
Fatty matter	8·1
Saline matter	1·7
Water	14·0
	100·0

A recent examination of the average Indian-corn flour of the shops, made by Mr. H. C. Bartlett, gave the following results:—

	Oz.	Grs.	Percentage.
Water	2	140	14·5
Albuminoid, nitrogenous, or flesh-forming matters	1	332	11·0
Starch	9	402	62·0
Sugar, gum, &c.	0	28	0·4
Fat	1	100	7·7
Cellulose	0	210	3·0
Mineral matter	0	98	1·4
	16	000	100·0

Composition of Dried Maize (PAYEN).

Nitrogenous matter	12·50
Starch	67·55
Dextrine	4·60
Fatty matter	8·80
Cellulose	5·90
Mineral matter	1·25
	100·00

By the aid of the microscope it may be seen that the testa of Indian-corn is composed of two membranes, the outer of which is made up of several layers of oblong cells, the inner of only a single layer of cells. The cells of the cellulose make up the remainder of the seed. They form a cellulated network, each space holding a starch corpuscle. The starch corpuscles show under the polariscope a black cross. They are disc-shaped, with a central concavity, and generally show a divided and radiate hilum (*see* fig. 51).

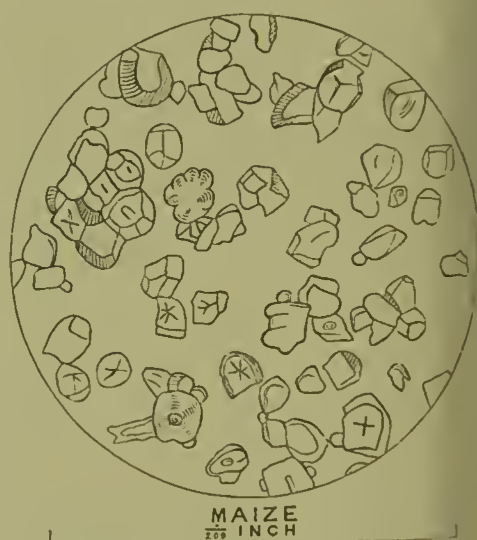


Fig. 51.

Indian-corn is largely eaten all over the world, but more especially in tropical countries.

The ration for a Kafir servant is 3 pints of Indian-corn meal per day, and on this scanty allowance—for he gets little else—he manages to keep in good health. Indian-corn has since 1846—the potato-famine year—been largely used in Ireland. It is stirred into boiling water or boiling milk, and formed into a sort of hasty-pudding, or thick porridge, and thus eaten.

Throughout Mexico it forms the staple food, and is cooked by baking into cakes.

Indian-corn, being deficient in gluten, does not make good bread. Its flavour is harsh and peculiar. A weak solution of caustic potash removes this unpleasantness; but it also deprives it of much of its nitrogenous matter, and so renders it less nutritious than before. This is the foundation of the process for preparing the articles extensively sold under the names of Oswego, Maizena, and Corn-flour.

As a mere adjuvant, or auxiliary, prepared Indian-corn may be of value, but mothers and nurses should be earnestly cautioned against injudiciously giving it to infants. *See* INFANTS, DIET OF.

Indian Hemp—The dried flowering tops of the female plants of *Cannabis sativa*, Linn. (natural order *Urticaceæ*.) For medicinal use that which is grown in India, and from which the resin has not been removed, is alone to be employed.

The parts employed in Asia for the purposes of intoxication are the herb or leaves, and the resin. Indian hemp contains a resin (cannabine) soluble in alcohol and ether, but precipitated by water; to this resin the plant owes its active properties. The other principles which have been separated are gum, extractive, and an ethereal oil.

Indian hemp produces a peculiar kind of intoxication, with hallucinations of a pleasing kind. It is said to act as an aphrodisiac, and to augment the appetite for food. It is much used in the East, and preparations of it are sold under the name of "Hashish Bhang," "Gunjab," &c. "Gunjab-smoking," says Dr. Chevers, "is ascertained to be the cause of a very large proportion of the cases of acute mania admitted to the native lunatic asylum of Bengal."

As an intoxicant it is certainly not used to any extent in England, and as a medicine it has much disappointed practitioners. Dr. Froumuller suggests that the drug contains some ethereal ingredient which is dissipated in the voyage from India; for he has seen in that country marked effects from half a grain of the extract or even less, so that he had been accustomed to consider a grain and a half a large dose; while in England he had found it necessary to give ten, twelve, or more grains to produce the desired effect.

The present writer has seen it produce in England, when taken in large doses for the purpose of experiment, a sleepy, stupid state of drunkenness. There was certainly little or no exhilaration, and rather absence of thought, and utter indifference to external things, than excitement or hallucinations.

Infants, Diet of—Carefully-collected statistics, allied to general observation and particular experiments, have conclusively proved that, as a food for young infants, nothing has yet been found which can take the place of milk.

Dr. West, in his valuable "Lectures on the Diseases of Infancy and Childhood," says: "The infant whose mother refuses to perform towards it a mother's part, or who by accident, disease, or death is deprived of the food that nature destined for it, too often languishes and dies. Such children you may see with no fat to give plumpness to their limbs, no red particles in their blood to impart a healthy hue to their skin, their face wearing in infancy the lineaments of age, their voice a constant wail, their whole aspect an embodiment of woe. But give to such children the food that nature destined for them, and if the remedy do not come too late to save them, the mournful cry will cease, the face will assume a look of content, by degrees the features of infancy will disclose themselves, the limbs will grow round, the skin pure red and white, and when at length we hear the merry laugh of babyhood, it seems almost as if the little sufferer of some weeks before must have been a changeling, and this the real child brought back from fairyland."

Those who have visited the wretched homes of women employed at factories, or of the pernicious baby-farmers, will be able to endorse fully Dr. West's words.

Milk—and it is the mother's milk to which we now particularly refer—contains the principles required for the growth and nourishment of the child, and contains them in such a form as to be easily assimilated. For the first few months but little saliva is secreted; the teeth do not appear for some time; and the digestive organs of the child are so extremely susceptible of derangement that it is necessary even for the mother to exercise the greatest caution over what she herself eats. All this tends to show that the digestive capacity is extremely feeble—nay, often, until after the eighth month, absolutely incapable of assimilating anything but milk.

When from an unnatural objection on the part of the mother, from disease, from death, or any other cause, the child does not receive the aliment prepared and elaborated by nature for its sustenance, then, undoubtedly, the nearest approach to the actual food given in the milk of the parent is the milk furnished by another woman.

It scarcely comes within our province to give advice on the selection of a wet nurse. Indeed, the directions usually offered on this point are of the most obvious and apparent description—viz., that she should be young, recently confined, and in perfect health. It is said that a brunette makes a better nurse than a blonde, and L'Héritier even affirms that the milk of the former is richer in solid constituents than that of the latter.

Should, however, a wet nurse be impracticable, recourse must be had to the milk of the cow, which approaches in composition nearer to the milk of woman than any other. Ass's milk has been recommended as a food for infants, but it is deficient in nitrogenous matter and fat, although rich in sugar and soluble salts. It will be seen from the following tables that cow's milk is richer in solid constituent principles than woman's, but by slight dilution with water and the addition of sugar it may be made to approximate more closely to the composition of the infant's natural food. In the following tabulated form, Payen gives the constituents of different milks :—

	Woman.	Cow.	Goat.	Sheep.	Ass.	Mare.
Nitrogenous matter and insoluble salts......	3·35	4·55	4·50	8·00	1·70	1·62
Butter ...	3·34	3·70	4·10	6·50	1·40	0·20
Lactine and soluble salts.	3·77	5·35	5·80	4·50	6·40	8·75
Water....	89·54	86·40	86·60	82·00	90·50	89·33

Letheby gives the following table as illustrating the composition of woman's and cow's milk :—

	Woman's Milk.			Cow's Milk.
	Max.	Min.	Average.	Average.
Caseine...........	4·36	2·97	3·52	3·64
Butter.............	5·18	4·45	4·02	3·55
Sugar of milk....	4·43	3·29	4·27	4·70
Various salts....	0·26	0·38	0·28	0·81
Total solids	14·20	11·69	12·69	12·70
Water.............	85·80	88·91	87·91	87·30
	100·00	100·00	100·00	100·00

It is stated by Sourdat that the milk of the right breast is generally much richer in butter and caseine than that of the left. With reference to the caseine of woman's milk, Lehmann states that in general it is somewhat gelatinous, and not so dense or solid as that of cow's, and therefore more easily digested by the child's stomach.

It will hardly be necessary to insist upon the milk's being derived from a healthy animal, and one that is surrounded by wholesome conditions; but another point of great importance—viz., the desirability of always obtaining the supply from the same cow, instead of indiscriminately from any animal—is not so apparent, and more likely to be overlooked. It cannot, therefore, be too frequently enforced.

M. Guillot, by weighing the child immediately before and after suckling, found that the increase in weight varied from 2 to 5 oz. in infants under a month old, and that $2\frac{1}{2}$ lbs. avoirdupois has been concluded to form the smallest quantity that will suffice for the daily nourishment of a healthy infant during the first month of its existence.

Much discussion has taken place with regard to the value of condensed milk as a food for infants (for composition of the different varieties, *see* MILK), and the question is scarcely yet satisfactorily settled, though it would appear that while condensed milk may prove of value if occasionally given, its habitual use is not calculated to add to the strength of the child.

Many attempts have been made to produce by artificial means a milk which would prove valuable as a food for infants.

Dr. C. A. Condereau recommends a mixture of eight eggs with 2 oz. of sugar, and enough water to make a pint and a half of liquid, to which he adds a little lime-water and a small quantity of sulphate of potash and chloride of sodium.

Dufrunfant states that a good substitute for milk may be made by emulsifying about 900 grains of olive oil or other comestible fatty matter with from 600 to 870 grains of sugar (milk-sugar, cane-sugar, or glucose), from 300 to 460 grains of dried albumen (the dried white of egg, as met with in Paris), and from 15 to 30 grains of crystals of carbonate of soda dissolved in a pint of water. This liquid has the appearance of cream, and requires to be mixed with twice its volume of water before it produces a liquid resembling milk. These substances, though occasionally useful for adults, must be given to children with extreme caution, if at all.

Liebig's food for infants is a food devised upon chemical principles to form an appropriate substitute for woman's milk. The following is the method of its preparation: "Take $\frac{1}{2}$ oz. of wheat-flour, $\frac{1}{2}$ oz. of malt-flour, and $7\frac{1}{4}$ grains of crystallised bicarbonate of potash, and after well mixing them, add 1 oz. of water, and lastly 5 oz. of cow's milk. Warm the mixture, continually stirring over a slow fire until it becomes thick. Then remove the vessel from the fire, stir again for five minutes, put it back on the fire, take it off as soon as it gets thick, and finally let it boil well. It is necessary that the food should form a thin and sweet liquid previous to its final boiling. Before use it should be strained through a muslin or fine hair sieve, to separate fragments of husk that may be present. The bicarbonate of potash is added to neutralise the acid reaction of the two kinds of flour, and also to raise the amount of alkali in the food to the equivalent of that in woman's milk. The ferment contained in the malt leads, during the exposure to the warmth employed in the process of preparation, to the conversion of the starch of both the flours into dextrine and sugar, the latter of which gives the required sweet taste. The newly-formed products also being soluble accounts for the mixture becoming thin, and it is a point contended for by Liebig that principles in this state tax the digestive and assimilative powers of the infant much less than starch."

The composition of the food, according to Liebig, is as follows :—

	Plastic Matter. oz.	Carbonaceous Matter. oz.
10 oz. milk . . .	0·40	1·00
1 oz. wheat-flour .	0·14	0·74
1 oz. malt-flour . .	0·07	0·58
	0·61	2·32

This food has been extensively used in Germany, and is widely known in England, but it is probable that it owes its reputation more to the name of its popular introducer than to any intrinsic merits it may possess.

All articles of a farinaceous nature—such as bread, biscuit-powder, baked flour, rusks, and more particularly the so-termed *food for infants*—must be looked upon as foreign to the diet of infants of tender age. They should be firmly and energetically excluded, and habitually discountenanced. All these articles contain a large percentage of starch, a substance which is entirely wanting in the mother's milk, a substance which has to undergo a special and elaborate digestive process before it can be assimilated, and a substance for the transformation of which at an early stage of infantile life there is no provision. No greater fallacy is possible than to imagine that because many articles containing it form a light and useful diet for older children, they are also valuable as a diet for infants. A great portion of such food passes unacted upon into the lower part of the bowel, there to decompose, giving rise to fœtid evacuations, diarrhœa, vomiting, spasms, emaciation, loss of appetite, and if this diet be persisted in, death may supervene. No class of aliments causes so much infantile disease as farinaceous foods, and the one food whose deadly influence we have most frequently to combat is *corn-flour*, since this is in some parts of the country universally used.

Until the teeth are formed an infant's diet cannot be too simple, and up to seven or eight months should consist exclusively of milk. After this age other solid substances may be administered, much depending on the constitution of the child itself. Without recommending their use at too early an age, it is well to remember that a child can digest albumen and meat far more easily than it can starch.

The daily proportion of carbon and nitrogen required in the food at different ages is calculated by Dr. Edward Smith to be about as follows :—

	Carbon.	Nitrogen.
In infancy	69	6·78
At ten years of age . .	48	2·81
At sixteen years of age .	30	2·16
At adult life . . .	23	1·04
In middle age . . .	25	1·13

See Food, Dietaries, Flour, &c.

Infant Mortality—A very large number of young children die in infancy. 800,000 are born yearly, and of these 119,594 die in the first year.

The causes of mortality may be stated approximatively thus :—

The causes of death in 10,000 infants would be as follows :—

5000, or about ½, are returned from atrophy, debility, convulsions, diarrhœa, &c., most of which are certainly caused by the use of a too exclusively farinaceous diet, such as bread soaked in water, arrowroot, sago, corn-flour, and other imperfect substitutes for milk. About 150, or ⅓, would die from diseases of various kinds, especially pneumonia and bronchitis ; 80, or about $\frac{1}{12}$, are born prematurely. About $\frac{1}{18}$ die violent deaths, mostly accidental. Of all the violent deaths, "overlaying" is the most common. The frequency of this accident on Saturday nights raises the question as to whether a large proportion of such deaths are not due to the drunkenness of the mothers, who retire to rest in a state of alcoholic stupor. A smaller proportion is directly ascribed to infanticide, want of breast-milk, and other causes.

Among other influences unfavourable to infant life is the attendance of unskilled midwives on women in their confinements. It would appear that both in rural districts and in towns an immense number of confinements, varying from 30 to 90 per cent., are attended by midwives, many of whom are not alone unskilled, but grossly ignorant ; and it is to be feared that some few may be criminal.

In London, Glasgow, and Sheffield there are, however, a few midwives of a superior class.

In the manufacturing districts the administration of cordials, spirits, and narcotics prevails to an alarming extent. It is probable that many deaths returned as convulsions are really cases of poisoning. Indeed, the causes of convulsions amongst children are often so obscure that mistakes in diagnosis must occasionally occur.

Baby-farming, although prevalent in London, does not appear to be common elsewhere.* According to Mr. Curquiver, 80 per cent. of the illegitimate children put out to nurse in London die. Neglect, ill-usage, and deficient food, either from poverty or from a criminal design, is without doubt common, and in all probability infanticide is more frequent than is generally supposed. Looking at other countries, the infant mortality in Norway is lowest, in Italy highest, and England occupies an intermediate station.

On the authority of Dr. Willard Parker, speaking in 1871, among the 35,000 annual births in New York, 2500 are illegitimate, and about 3000 children are annually got rid of in any way whereby the individual can be secure from the penalty of the law. In 1869, 27·4 per cent., and in 1870, 31 per cent., of all the deaths were of infants under one year. In the foundling asylum at Montreal out of 4059 infants received, 3769 died, or only 7 per cent. lived one year. On Randall's Island 10 per cent. of infants only are saved when reared by hand, but 27½ when suckled by nurses. When nursed by the mother 70 per cent. are reared, while in rural towns 88 per cent. survive.

In this country the Infant Life Protection Act is now in force. Its leading clause enacts that "from and after the commencement of this Act it shall not be lawful for any person to retain or receive for hire or reward in that behalf more than one infant, and in case of twins more than two infants, under the age of one year, for the purpose of nursing or maintaining such infants apart from their parents for a longer period than twenty-four hours, except in a house which has been registered as hereinafter provided." This regulation is put in the hands of the petty justices of each division of the county, and in the town councils of boroughs, each of which bodies is to keep a proper register. In the absence of any regular system of inspection, such an Act remains to a great extent a dead letter. *See* INFANTS, DIET OF, &c.

* It is to be feared that it may secretly exist in many places, owing to the apathy of the authorities and the cunning concealment of the baby-farming householder. Witness the case of Betsy Binmore, sentenced at the Devon Lent Assizes (1875) to twelve years' penal servitude. She had taken a house in Newton Abbott, and regularly nursed and received children for a year, during the whole of which period the authorities were ignorant of her occupation, and the house was not registered.

Infection—This term is now used as synonymous with *contagion*. Some would, however, restrict the latter term to the communication of disease by actual contact, and use the word "infection" when disease is generated by contagium acting at a distance or wafted through the air. The distinction is, however, merely one of words. In each case there is contact of the poison; but in the one it is either volatile, or capable of being wafted in a dry state, in another it is fixed. For example, syphilis would be a strictly contagious disease, while typhus would be both contagious and infectious. *See* CONTAGION.

Infectious Diseases—There are in force various regulations with regard to the prevention of infectious diseases, some of which are enumerated under CONVEYANCES, CHOLERA, EPIDEMIC DISEASES, HOSPITALS, LODGING-HOUSE.

It is noticeable that no definition of the term "infectious disease" is attempted in the Sanitary Acts, and as, unfortunately, it will for some time to come be a matter of opinion whether certain diseases are or are not infectious, some difficulty may arise upon this point.

The Local Government Board may from time to time make such regulations as they may think fit with regard to epidemic and infectious diseases. Penalty for obstruction or neglect of such orders, &c., £50 or less.—(P. H., s. 130.)

Local authorities have power to provide carriages for the conveyance of persons suffering from infectious disorders.—(P. H., s. 123.) *See* CONVEYANCES.

In certain cases persons so suffering may be compulsorily removed to a hospital.—(P. H., s. 124, 125.) *See* HOSPITALS.

Ships or vessels having on board any person affected with a *dangerous* or infectious disorder are to be deemed within the provisions of 6 Geo. IV. c. 78.—(29 & 30 Vict. c. 90, s. 52, and Sched. V. Part III., P. H.)

Any person who—

1. While suffering from any dangerous infectious disorder wilfully exposes himself without proper precautions against spreading the said disorder in any street, public place, or public conveyance, or enters any public conveyance without previously notifying to the owner, conductor, or driver thereof that he is so suffering; or
2. Being in charge of any person so suffering, so exposes such sufferer; or
3. Gives, lends, sells, transmits, or exposes, without previous disinfection, any bedding, clothing, rags, or other things

which have been exposed to infection from any such disorder,

shall be liable to a penalty not exceeding *five pounds;* and a person who, while suffering from any such disorder, enters any public conveyance without previously notifying to the owner or driver that he is so suffering, shall in addition be ordered by the court to pay such owner and driver the amount of any loss and expense they may incur in carrying into effect the provisions of this Act with respect to disinfection of the conveyance.

Provided that no proceedings under this section shall be taken against persons transmitting with proper precautions any bedding, clothing, rags, or other things for the purpose of having the same disinfected.

The words in the Act "*while suffering*" do not appear to include "convalescents," and the convalescent period in many diseases is, as is well known, the most infectious period. It may, however, be perhaps argued legally that the convalescent period is part and portion of the illness.—(P. H., s. 126.)

The owner or driver must disinfect and cleanse the conveyance after conveying a person suffering from an infectious disorder. Penalty for neglect, £5 or less.

The following sections are very stringent and important:—

Any person who knowingly lets for hire any house, room, or part of a house, in which any person has been suffering from any dangerous infectious disorder, without having such house, room, or part of a house, and all articles therein liable to retain infection, disinfected to the satisfaction of a legally-qualified medical practitioner, as testified by a certificate signed by him, shall be liable to a penalty not exceeding *twenty pounds.*

For the purposes of this section, the keeper of an inn shall be deemed to let for hire part of a house to any person admitted as a guest into such inn.

Any person letting for hire, or *showing for the purpose of letting for hire*, any house or part of a house, who, on being questioned by any person negotiating for the hire of such house or part of a house as to the fact of there being, or within six weeks previously having been therein, any person suffering from any dangerous infectious disorder, knowingly makes a false answer to such question, shall be liable, at the discretion of the court, to a penalty not exceeding *twenty pounds*, or to imprisonment, with or without hard labour, for a period not exceeding *one month.*—(P. H. s. 129.)

Where the body of one who has died of any infectious disease is retained in a room in which persons live or sleep, or any dead body which is in such a state as to endanger the health of the inmates of the same house or room, any justice may, on the certificate of a qualified medical man, order the body to be removed, at the cost of the local authority, to any mortuary provided by such authority, and direct the same to be buried within a time to be limited in such order; and unless the friends or relations of the deceased undertake to bury the body within the time so limited, and do bury the same, it shall be the duty of the *relieving officer* to bury such body at the expense of the poor-rate, but the expense so incurred may be recovered by the relieving officer in a summary manner from any person legally liable to pay the expense of such burial. Penalty for obstruction of order, £5 or less.—(P. H., s. 142.)

Influenza—The disease was first given this name by the Italians, "thus recognising an inscrutable *influence* which affects numberless persons at the same time."—(HECKER.) It is essentially an infectious specific disease, dependent upon the absorption of a morbid poison into the blood; its chief symptoms are those of an intense catarrh, with cough, running at the eyes and nose, frontal headache, fever, disorders of the digestive organs, and often rheumatic pains. Its average duration is five days.

In various epidemics there are different complications, the most common and most fatal of which are bronchitis and pneumonia.

One of the noteworthy and distinctive features of influenza is the short sojourn it makes in places attacked by it, as well as its almost simultaneous appearance over a large area.

Its great interest to the hygienist consists not only in its fatality during certain years, but also in the fact that it has several times preceded cholera, and has been the forerunner as well as the follower of extensive epidemics. It appears to attack animals as well as men; at all events, extensive epizootics accompanied by similar symptoms have prevailed during various epidemics. In the present obscurity as to the mode of propagation of the disease, no means of prevention can be pointed out; the discharges from the nostril and sputa are probably the vehicle of the poison, but this is not conclusively proved. It only remains, therefore, to give a short historical account of the disease.

No very distinct notices of influenza are to be found before 1411. "In the year 1411," says Pasquier, "there was another kind of disease which affected an infinity of people, by which they lost the desire to drink, eat, or sleep; it was accompanied with fever. What the sick ate became bitter and putrid; there was shivering, and the limbs were so weak and tender that they could not bear them to be touched. The disease was accompanied with a violent cough, which tormented them day and night, and lasted three whole weeks, yet without proving fatal; although it is true that, by reason of the vehemence of the cough, many men were ruptured and women aborted. When they were about recovering, there was an effusion of blood from the nose, mouth, and bowels. No physician could imagine from whence the disease came, unless from a general infection of the air, the cause of which was obscure. This disease was called the *Tac*."—(Pasquier, livre iv. chap. xxviii. pp. 375, 376.)

The *tac* of 1411, which appeared in France, was followed by the *coqueluche* of 1414. This word signifies "a monk's hood," and this nickname was given to the disease on account of the sufferers necessarily covering and wrapping up their heads. The *coqueluche* was succeeded by the *ladendo* of 1427. All these are probably one and the same disease—viz., influenza. The *coqueluche* of 1414 more especially attacked the larynx, so that many colleges in Paris were shut up on account of the hoarseness of the professors; the *ladendo* of 1427 more especially seized the loins. In the sixteenth century there were five epidemics of influenza; the dates of the outbreaks are 1510, 1551, 1557, 1564, and 1580. Indeed, from 1510 to 1837 there are recorded, in Dr. T. Thompson's "Annals of Influenza," no less than twenty epidemics; of these, that which occurred in the winter of 1732–33 was the most noteworthy. Dr. Short characterises it as "the most sudden and universally epidemic catarrh that has been in this age, sparing neither ranks, sexes, ages, old or young, weak or strong," and killing off "many hectic and phthisical people."

From 1838 to 1847 the average deaths from influenza were a little over 1000 yearly; but in 1847 and 1848 there was a very widespread epidemic, and the returns showed the large numbers (considering the general non-fatal character of the disease) of respectively 4881 and 7963. From 1849 to 1860 about 1600 died annually; since then not more, according to the returns, than a yearly average of 600; so that, practically speaking, we are at the present time comparatively free from influenza. The history of all these epidemics shows that it is most fatal in the lowest, dirtiest, and overcrowded portions of towns. Season, weather, and latitude influence it greatly. It is hardly known out of northern latitudes, and generally occurs in a severe form in the winter, being somewhat rare in warm weather.

Inhumation—*See* Dead, Disposal of.

Inspector of Nuisances, Sanitary Inspector—The name of inspector of nuisances should be discarded, and the wider term of sanitary inspector substituted; this not alone on account of the somewhat unsavoury appellation, but because under the new *régime* the sanitary inspector has various duties besides that of detecting nuisances. The appointment of a sanitary inspector is obligatory both for urban and rural authorities. (*See* Officers, Appointment of.) An inspector thus appointed, if the authority pay him the whole of his salary without aid from Government, may be under the entire control of the sanitary authority, and be removable at their pleasure. This mode of holding office is neither to the interest of the authority nor to that of the officer. The authority, by accepting Government assistance, merely lose the right of dismissing their officer without the sanction of the Local Government Board, which is more than counterbalanced by the solid pecuniary gain of half the salary.

If, on the other hand, any portion of his salary be paid by Government, the appointment cannot be made without the consent of the Local Government Board, nor can the officer whose appointment is thus sanctioned be dismissed within the period for which he is appointed without the consent of the Local Government Board. The sanitary authorities in either case control the duties and salaries of their officers.

The duties and conduct of the inspector of nuisances are to be regulated in the case of urban sanitary authorities by bylaws.

It may be laid down as a general and important principle, that an inspector of nuisances should not have any private calling whatever; but as under the present system it appears impossible, or at least not usual, to give good salaries, any public office, not incompatible, might be held by inspectors in certain cases. In large towns and populous districts a sufficient salary should be given, and the officer's whole time devoted to the work. In some cases it will be advisable for adjoining sanitary authorities to have a common inspector—power is given under P. H., s. 191.

The Local Government Board does not think it desirable that the offices of relieving officer and inspector of nuisances should be held by one and the same person; nor may the superintendents of police be inspectors of nuisances. Such public posts as surveyor (P. H., s. 192), vaccination officer, inspector of weights and measures. inspector of markets, &c., may be united with advantage in certain small towns or districts with that of nuisance or sanitary inspector. In electing such an inspector there are certain physical and mental endowments particularly essential. An inspector should be in good health, and not labour under any physical defect—such as imperfect sight, smell, &c.—which would impair his efficiency; he should not be timid or irresolute; while, on the other hand, a man passionate, reckless, prying, and unpopular should be avoided. He should certainly know how to read and write, and be able to make calculations with regard to cubic space, length of drains, &c. Other things being equal, a person brought up to one of the constructive trades is likely to make a better inspector than a farmer or shopkeeper, or a person of no special occupation. Hence we find sanitary authorities generally preferring masons, carpenters, surveyors, and builders to other candidates, who, with the exception of technical knowledge, may be quite equal to their competitors.

The inspector of nuisances should at all times be ready to assist the medical officer of health, and should accompany him throughout the district, pointing out the principal places requiring amendment, and in all difficult cases asking his advice. He should be careful to send notices of overcrowding and infectious disease to the medical officer of health immediately he hears of their occurrence. He should be very careful to keep a record of all his visits, and ought to send quarterly to the medical officer of health a statement of the amount of work done by him, arranged under—(1) Number of houses visited; (2) number of nuisances reported; (3) nuisances still unabated; (4) the state of the slaughter-houses, lodging-houses, and schools in the district; (5) action taken under the Adulteration Acts, &c.

The following are the regulations of the Local Government Board relative to the appointment, tenure of office, and duties of an inspector of nuisances:—

SECTION I.—*Appointment.*

Art. 1. A statement shall be submitted to the Local Government Board, showing the population and extent of the district for which the sanitary authority propose to appoint the inspector of nuisances, and the salary or remuneration intended to be assigned to him; and where the circumstances render desirable the appointment of one inspector of nuisances for two or more sanitary districts, statements shall, in like manner, be submitted to the Local Government Board, showing the names of the districts to be combined for that purpose, the population and extent of each district, the mode in which it is intended that the appointment shall be made, whether jointly or severally by the sanitary authorities of those districts, and the amount of salary or remuneration proposed to be assigned to the officer appointed.

Art. 2. When the approval of the Local Government Board has been given to the proposals submitted to them, the sanitary authority or authorities shall proceed to the appointment of an inspector of nuisances accordingly.

Art. 3. No appointment of an inspector of nuisances shall be made under this order, unless an advertisement giving notice of the day when such appointment will be made, shall have appeared in some public newspaper circulating in the district or districts, at least seven days before the day on which such appointment is made: Provided that no such notice or advertisement shall be necessary for the appointment of a temporary substitute.

Art. 4. Every such appointment hereafter made shall, within seven days after it is made, be reported to the Local Government Board by the clerk to the sanitary authority, or, in the case of a joint appointment, by the clerk to one of the sanitary authorities by whom the appointment is made.

Art. 5. Upon the occurrence of a vacancy in such office, the sanitary authority or authorities shall proceed to make a fresh appointment, which shall be reported to the Local Government Board as required by sect. i. art. 4, of this order; but if the sanitary authority or authorities desire to make any fresh arrangement with respect to the district or the terms of the appointment, they shall, before filling up the vacancy, supply the particulars of the arrangement to the Local Government Board, in the manner prescribed by sect. i. art. 1, in regard to the first appointment; and if the approval of the Local Government Board be given, absolutely or with modifications, the sanitary authority or authorities shall then proceed to fill up the vacancy according to the terms of the approval so given.

Art. 6. If any officer appointed under this order be at any time prevented by sickness or accident, or other sufficient reason, from performing his duties, the sanitary authority or authorities, as the case may be, may appoint a fit person to act as his temporary substitute, and may pay him a reasonable compensation for his services; and every such appointment shall be reported to the Local Government Board as soon as the same shall have been made.

SECTION II.—*Tenure of Office.*

Art. 1. Every officer appointed under this order shall continue to hold office for such period as the sanitary authority or authorities appointing him may, with the approval of the Local Government Board, determine, or until he die, or resign, or be removed, by such authority or authorities, with the assent of the Local Government Board, or by the Local Government Board.

Provided that the appointments first made under this order shall not be for a period exceeding five years.

Art. 2. Where any such officer shall have been appointed after the passing of the Public Health Act, 1872, for one or more sanitary districts, and any change in the extent of the district or districts, or in the duties, salary, or remuneration, shall be deemed necessary, and he shall decline to acquiesce therein, the sanitary authority or authorities by whom he was so appointed may, with the consent of the Local Government Board, but not otherwise, and after six months' notice in writing, signed by their clerk or clerks, given to such officer, determine his office.

Art. 3. No person shall be appointed who does not agree to give one month's notice previous to resigning the office, or to forfeit such sum as may be agreed upon as liquidated damages.

SECTION III.—*Duties*.

The following shall be the duties of the inspector of nuisances in respect of the district for which he is appointed, or if he shall be appointed for more than one district, then in respect of each of such districts :—

(1.) He shall perform, either under the special directions of the sanitary authority or (so far as authorised by the sanitary authority) under the directions of the medical officer of health, or in cases where no such directions are required, without such directions, all the duties specially imposed upon an inspector of nuisances by the Sanitary Acts, or by the orders of the Local Government Board.

(2.) He shall attend all meetings of the sanitary authority when so required.

(3.) He shall by inspection of the district, both systematically at certain periods, and at intervals as occasion may require, keep himself informed in respect of the nuisances existing therein that require abatement under the Sanitary Acts.

(4.) On receiving notice of the existence of any nuisance within the district, or of the breach of any bylaws or regulations made by the sanitary authority for the suppression of nuisances, he shall, as early as practicable, visit the spot, and inquire into such alleged nuisance or breach of bylaws or regulations.

(5.) He shall report to the sanitary authority any noxious or offensive businesses, trades, or manufactories established within the district, and the breach or non-observance of any bylaws or regulations made in respect of the same.

(6.) He shall report to the sanitary authority any damage done to any works of water-supply, or other works belonging to them, and also any case of wilful or negligent waste of water supplied by them, or any fouling by gas, filth, or otherwise, of water used for domestic purposes.

(7.) He shall from time to time, and forthwith upon complaint, visit and inspect the shops and places kept or used for the sale of butcher's meat, poultry, fish, fruit, vegetables, corn, bread, or flour, or as a slaughter-house, and examine any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, or flour which may be therein ; and in case any such article appear to him to be intended for the food of man, and to be unfit for such food, he shall cause the same to be seized, and take such other proceedings as may be necessary in order to have the same dealt with by a justice : provided, that in any case of doubt arising under this clause, he shall report the matter to the medical officer of health, with the view of obtaining his advice thereon.

(8.) He shall, when and as directed by the sanitary authority, procure and submit samples of food or drink, and drugs suspected to be adulterated, to be analysed by the analyst appointed under the Sale of Food and Drugs Act, 1875, and upon receiving a certificate stating that the articles of food or drink, or drugs, are adulterated, cause a complaint to be made, and take the other proceedings prescribed by that Act.

(9.) He shall give immediate notice to the medical officer of health of the occurrence within his district of any contagious, infectious, or epidemic disease of a dangerous character ; and whenever it appears to him that the intervention of such officer is necessary in consequence of the existence of any nuisance injurious to health, or of any overcrowding in a house, he shall forthwith inform the medical officer thereof.

(10.) He shall, subject in all respects to the directions of the sanitary authority, attend to the instructions of the medical officer of health with respect to any measures which can be lawfully taken by him under the Sanitary Acts for preventing the spread of any contagious, infectious, or epidemic disease of a dangerous character.

(11.) He shall enter from day to day, in a book to be provided by the sanitary authority, particulars of his inspections and of the action taken by him in the execution of his duties. He shall also keep a book or books, to be provided by the sanitary authority, so arranged as to form, as far as possible, a continuous record of the sanitary condition of each of the premises in respect of which any action has been taken under the Sanitary Acts, and shall keep any other systematic records that the sanitary authority may require.

(12.) He shall at all reasonable times when applied to by the medical officer of health, produce to him his books, or any of them, and render to him such information as he may be able to furnish with respect to any matter to which the duties of inspector of nuisances relate.

(13.) He shall, if directed by the sanitary authority to do so, superintend and see to the due execution of all works which may be undertaken under their direction for the suppression or removal of nuisances within the district.

(14.) In matters not specifically provided for in this order, he shall observe and execute all the lawful orders and directions of the sanitary authority, and the orders which the Local Government Board may hereafter issue applicable to his office.

SECTION IV.—*Remuneration*.

Art. 1. The sanitary authority or authorities, as the case may be, shall pay to any officer appointed under this order such salary or remuneration as may be approved by the Local Government Board ; and where such officer is appointed for two or more districts, the salary shall be apportioned amongst the districts in such manner as the said board shall approve.

Provided that the sanitary authority or authorities, with the approval of the Local Government Board, may pay to any such officer a reasonable compensation on account of extraordinary services, or other unforeseen circumstances connected with his duties or the necessities of the district or districts for which he is appointed.

Art. 2. The salary or remuneration of every such officer shall be payable up to the day on which he ceases to hold the office, and no longer, subject to any deduction which the sanitary authority or authorities may be entitled to make in respect of sect. ii. art. 3; and in case he shall die whilst holding such office, the proportion of salary (if any) remaining unpaid at his death shall be paid to his personal representatives.

Art. 3. The salary or remuneration assigned to such officer shall be payable quarterly, according to the usual feast-days in the year—namely, Lady Day, Midsummer Day, Michaelmas Day, and Christmas Day; but the sanitary authority or authorities may pay to him at the expiration of every calendar month such proportion as they may think fit on account of the salary or remuneration to which he may become entitled at the termination of the quarter. *See* OFFICERS, APPOINTMENT OF.

Inspectors, Local Government Board—The inspectors of the Local Government Board have, in respect of any inquiry directed by the board, similar powers to those of poor-law inspectors relative to the examination of witnesses, the production of papers, &c.—(P. H., s. 296.)

They are also empowered to attend any meetings of rural or of an urban authority (being a local board), when and as directed by the Local Government Board.—(P. H., s. 205.)

Intemperance—*See* ALCOHOLISM.

Iodine (I.=127)—Iodine is an element obtained from kelp, the vitrified ashes of seaweed, which being dissolved, a liquor is ultimately obtained, containing the iodides of sodium, potassium, magnesium, &c.

These iodides are decomposed by the addition first of sulphuric acid, and then of peroxide of manganese, and the iodine sublimed and collected in suitable receivers.

Iodine is usually met with in the form of black scales or laminar crystals, with a metallic lustre, specific gravity 4·95, with an odour similar to chlorine. It melts when heated, and then sublimes in a violet vapour, without leaving any residue. It is soluble in rectified spirits and ether; slightly so in pure water; but to a much greater extent in a watery solution of iodide of potassium and chloride of sodium. The aqueous solutions precipitate starch of a dark blue colour. In free alkaline solutions iodine dissolves, and forms iodides and iodates. This important therapeutic agent was accidentally discovered in 1812 by De Courtois, a saltpetre manufacturer of Paris; but the merit of its introduction into pharmacy is due to Dr. Coindet, a physician of Geneva.

With its numerous pharmaceutical uses we have nothing to do; it is chiefly of interest to the hygienist as a strong disinfectant, in which capacity it may be compared to chlorine. Its smell, unlike that of bromine, is not unpleasant.

A piece of meat, about 1 inch broad and thick, and about 3 inches long, suspended in iodine vapour by Dr. A. Smith, remained perfectly good. It became white inside, but acquired no smell of iodine.

It is not, perhaps, so useful as chlorine, since it condenses easily, and does not diffuse everywhere, as does the latter. Dr. Richardson proposes to saturate a solution of peroxide of hydrogen with iodine, and to add 2½ per cent. of sea-salt. By "atomising" or "pulverising" the fluid by the little instrument used for this purpose, the air can be charged with iodine and sea-salt spray very readily.

Iodine decomposes sulphuretted hydrogen, and will therefore destroy much odour.

Another method employed for the purpose of diffusing it through the air of a room is that of placing the iodine on a hot plate.

Adulteration.—Water, iodide of cyanogen, fixed impurities, as plumbago, black oxide of manganese, charcoal, iron, &c. The first two are volatile. Water can be detected by finding whether bibulous paper is moistened by iodine. Iodide of cyanogen may be detected by distilling the iodine at a very low temperature, when this salt sublimes in white crystalline needles before the iodine comes over. The fixed impurities are left after sublimation.

Ipecacuanha—The dried root of the *Cephaëlis Ipecacuanha*, imported from Brazil. It occurs in pieces 3 or 4 inches long, and somewhat about the size of a small writing quill, more or less contorted, and either simple or branched. In consequence of a number of deep circular fissures, it has a knotty appearance. The fissures are about a line in depth, and extend inwardly through the cortical portion to a central white ligneous cord, so as to produce the appearance of a number of rings strung upon a thread. Ipecacuanha has an acrid and somewhat bitter, nauseous taste, and a slightly nauseous but peculiar odour. Three varieties are known in commerce—viz., the brown, the red, and the grey annulated ipecacuanha.

Ipecacuanha contains a feeble alkaloid, *emetina*, separable as a whitish or yellowish amorphous powder, of a bitter taste, soluble in alcohol, sparingly so in water and ether, and precipitated by tannin; also a peculiar acid, *cephaëlic* or *ipecacuanhic* acid, allied to catechin, formerly thought to be gallic acid, and striking green with the persalt of iron. The following are the tabulated results of two analyses, one by Pelletier, and the other by Bucholz:—

	Cortex.	Medullium.	Red do. Cortex.
Emetina	16	1·15	14
Odorous fatty matter	2	traces	2
Gum	10	5·00	16
Wax	6	...	...
Starch	42	20·00	18
Ligneous matter	20	66·60	48
Non-emetic extractive	...	2·45	...
Loss	4	4·80	2
	100	100	100

Bucholz's *Analysis*.

Emetic extractive (emetina)	4·13
Soft resin	2·43
Wax	0·75
Gum	25·17
Starch	9·00
Woody fibre	10·80
Bitter extractive	10·12
Sugar	2·00
Extractive, gum and starch extracted by potash	34·80
Loss	0·80
	100·00

Emetina, when first discovered in 1817, was obtained in a very impure state. Pure emetina is white, pulverulent, and inodorous, with a slightly bitter taste; fusible at 122° F.; slightly soluble in cold, but much more so in hot water. The following composition has been assigned to it: $C_{35}H_{25}O_9N$.

The best ipecacuanha yields about 1 per cent. of pure emetina. The microscopical appearances of ipecacuanha are well marked and characteristic.

The root consists of an outer cortical portion and an inner woody part.

1. *Cortical portion.*—The cortical portion mainly consists of colourless cells filled with starch corpuscles. It is clothed with an epidermis composed of deep brown cells.

2. The *medullary portion* possesses a remarkable structure, mainly consisting of woody fibres containing starch corpuscles. The extreme rarity of starch corpuscles in woody fibre renders this a very characteristic feature.

Adulterations.—Other sorts, such as those of striated ipecacuanha, have been substituted for the true root. Starch, chalk, tartar-emetic, and other substances have been mixed with the powdered substance.

Irish Ague—The old Irish designation for typhus fever. *See* Fever, Typhus.

Iron—Iron exists native, in the form of oxide, carbonate, sulphide, &c., in various ores; it is also found in the blood, and is one of the constituents of several natural waters. The oxide of iron purifies water to a considerable extent, and is used in various filtering processes. *See* Filters.

Many of the salts of iron possess antiseptic and disinfectant properties of the highest value, and being cheap, are adapted for use on a large scale.

Dr. Voelcker declares spongy iron to be a deodorising material of greater power than animal charcoal. Sewage-water passed through a filter of this substance is said to be completely purified; and this filtered water, after being kept for six months, protected from air, has been found to be perfectly sweet and free from any fungoid growth. The spongy iron is obtained by calcining a finely-divided iron ore with charcoal.

Of all the different salts of iron which might be used for disinfecting purposes, the sulphate possesses at present the most favour; but the chloride and acetate appear of equal power, and have the advantage of not evolving sulphuretted hydrogen, which the sulphate in contact with organic matter occasionally does. Sulphate of iron, either in solution or in substance, was the favourite disinfectaut of Dr. W. Budd, who recommended its use in typhoid fever. (*See* Fever, Typhoid.) Experience has shown that it really possesses some considerable value in the destruction of contagious matter. *See* Disinfectants.

The different salts of iron have been administered as poisons and as abortives; for the latter purpose, the sulphate is used in France, the muriate or perchloride in England.

Iron moulds have been mistaken for spots of blood; they can generally be distinguished by their brown colour, and by the absence of all stiffening of the fibre in the stained spot. They are quite insoluble in water, and the ferrocyanide of potassium test will at once show their true nature.

Various preparations of iron have been found in the following substances, the admixture having for its object either coloration or increase of weight: Tea, coffee, chicory, annatto, porter, tobacco, snuff, cayenne, red sauces, potted meats and fish, bottled anchovies. In some of the above small quantities of iron exist naturally.

The soluble salts of iron respond to the following tests: Both the ferrous and ferric salts are not precipitated from acid solutions by *sulphuretted hydrogen*, and *ammoniac hydrosulphate* throws down a black precipitate of hydrated sulphide. The ferrous salts give a grey or green precipitate of hydrated protoxide with the *alkalies;* the ferric, similarly treated, a reddish-brown precipitate of sesquioxide.

Potassic ferrocyanide gives a pale blue precipitate with the ferrous salts, a bright blue with the ferric; but the best way to distinguish between the ferrous and ferric salts is by means of the ferridcyanide of potash: this salt gives a bright blue precipitate with the former, and no precipitate with the latter salts.

Methods of estimating the amount of iron in water, the ash of food, &c., are given under WATER, VOLUMETRIC SOLUTIONS, &c.

Irrigation Sewage—*See* SEWAGE, UTILISATION OF.

Isinglass—The finest kinds of isinglass are obtained from the inner membrane of the floating bladder of the genus *Acipenser*, or sturgeon. The bladder is opened, folded, and twisted, and this is the only preparation the isinglass receives. Good isinglass should be almost entirely soluble in boiling water, and the solution should form, when cold, a nearly white, scentless, semi-transparent, solid jelly. It is soluble in weak acids, and this solution is precipitated by alkalies. The aqueous solution is not precipitated by spirit of the common strength. One part of good isinglass dissolved in twenty-five parts of hot water forms a rich tremulous jelly.

Isinglass may be distinguished from gelatine by the following methods:—

A particle of isinglass put into cold water remains opaque, like a piece of white thread, and does not swell out; whereas gelatine becomes transparent, and enlarges a good deal in bulk. Jelly made from good isinglass remains neutral to test papers, and has a slightly fishy smell; jelly made from gelatine, on the other hand, has a distinct odour of glue and an acid reaction. If a few grains of isinglass be burnt in a metal spoon until the ash alone remains, the ash will be very small in quantity and of a reddish colour; while that of gelatine will be much larger in amount and white in appearance. Isinglass agrees with a delicate stomach much better than gelatine. *See* GELATINE.

Isolation—In practice this important and *theoretically* simple plan to prevent the spread of diseases is most difficult to carry out. In the first place, epidemics naturally attack with the greatest virulence the poorest parts of a town, where there is most dirt and overcrowding; secondly, a medical man is often not called in until the disease has already spread; and thirdly, he has formidable obstacles to contend against in the ignorance and prejudice existing in all classes of society with regard to sanitary precautions. All medical men in practice know, indeed, that it is absolutely impossible to isolate their patients, with the exception of those who have roomy houses, and those who can be induced or compelled to go to special institutions, such as fever hospitals, &c. At some future time this state of things may be altered, viz.—

1. When contagious hospitals are established in every place, in number and size proportioned to the population.

2. When every individual, not having facilities in his own home for isolation, shall be compelled by law to repair, when possible, to such institution.

3. When in such cases large powers are given to medical officers of health and sanitary authorities.

Under very favourable conditions, isolation of a fairly perfect character is of course possible, and in practice the following principles should guide us:—

1. The patient must be placed in an airy ward, room, or tent.

2. The windows may be opened, but when they are, should be protected by fine muslin or gauze, as it is amply proved that flies and other insects often convey infection.

3. There must be one or more nurses in attendance, and these not permitted to go out without a previous change of dress and a complete bath.

4. All the measures described under Disinfection, Contagion, &c., must be carried out to the letter.

5. The ventilation and warming must be of the most perfect description, and so arranged as not to send streams of infected air into the house, or into adjoining dwellings.

6. The nurses, medical attendant, clergymen, and *absolutely necessary visitors*, should, on entrance into the house, be given a long loose cotton robe, well buttoned up round the throat, and tight round the wrists. This garment should be put on before seeing the patient, and afterwards well heated in an oven. On leaving, the visitor should take care to wash the face and hands with a little dilute Condy's fluid. It is indeed greatly to be feared that medical men and other visitors occasionally convey infection; and as it is impossible for them to carry a change of dress with them, it should be provided by the patient.

J.

Jail (Jayl) Fever—*See* FEVER, TYPHUS.

Jalapa—The dried tubercules of *Exogonium Purga*, or true jalap plant. It grows in the woods of Mexico, near Chicanquiaco, at an altitude of nearly 6000 feet above the level of the sea. The only market for it is Xalapa, from which town it takes its name. True jalapa is known commercially as Vera Cruz jalap, but another kind has lately been introduced, *Tampico jalap*.

Gerber's Analysis.

Hard resin	7·8
Soft resin	3·2
Slightly acrid extractive	17·9
Gummy extractive	14·4
Colouring matter	8·2
Uncrystallisable sugar	1·9
Gum with some salts	15·6
Bassorine	3·2
Vegetable albumen	3·9
Starch	6·0
Water	4·8
Malic acid and malates of potash and lime	2·4
Chlorides of calcium and potassium	1·4
Phosphates of magnesia and lime	1·7
Carbonate of lime	3·0
Loss	4·6
Jalap	100·0

Guibourt's Analysis.

	Officinal Jalap.	False Rose-scented Jalap.
Resin	17·65	3·23
Liquid sugar by alcohol	19·00	16·47
Brown saccharine extract, obtained by water	9·05	5·92
Gum	10·12	3·88
Starch	18·78	22·69
Woody fibre	21·60	46·00
Loss	3·80	1·81
Jalap	100·00	100·00

The jalap tuber owes its activity as a purgative to the resin contained in it. This resin ($C_{31}H_{50}O_{16}$) is insoluble in oil of turpentine, soluble in alcohol, but only partially so in ether, and insoluble in water. It becomes crimson from oil of vitriol.

Jalap resin from the true jalap plant contains convolutin (rhodeoretin), a strongly purgative substance, homologous with jalapine from the fusiform root.

It is colourless and transparent. It is insoluble in ether, thus differing from jalapine.

Jalapine ($C_{34}H_{56}O_{16}$) is the chief constituent of spurious or fusiform jalap. It is soluble in alcohol and ether, and but little soluble in water. By acting on jalapine with alkaline solutions, salts of jalapic acid are produced.

The so-termed jalapine of the shops is the resin of jalap, extracted by spirit from the tuber, and afterwards precipitated by means of water.

Adulterations.—Jalap is frequently adulterated with stalks, spurious jalap, Pareira's rose-scented jalap, and other inferior sorts.

Juniper-Berries—The fruit of the *Juniperus communis*, or common juniper-tree.

These berries are about the size of a pea, of a blackish-purple colour, and covered by a glaucous bloom. They are marked superiorly with a triradiate groove, indicating the adhesion of the succulent scales; and inferiorly with the bracteal scales, which assume a stellate form. They contain three seeds. *Juniper-tops* have a bitter terebinthinate flavour and a balsamic odour. Juniper-wood is obtained either from the stem or root. Juniper-berries principally contain *volatile oil*, *resin*, *sugar*, *gum*, and *water*. They operate on the urinary organs, promote sweat, relieve flatulence, and provoke the catamenia. In large doses they occasion irritation to the bladder and heat in the urinary passages.

Oil of juniper is distilled in Britain from the unripe fruit of *Juniperus communis*. It is either of a pale, greenish-yellow colour, or else perfectly colourless. It is lighter than water, and causes the left-handed rotation of polarised light, agreeing in this respect with French oil of turpentine. Alcohol dissolves it with difficulty. It is a carburet of hydrogen ($C_{10}H_{16}$), and isomeric with oil of turpentine. Hollands gin owes its flavour and diuretic properties to oil of juniper. *See* GIN.

Jute—Jute is obtained from Russia and India, and comes from the *Corchorus capsularis*. It may be used for the purpose of mixing with linen or cotton. The fibres are of considerable length, hollow, and thickened, and with narrowings and constrictions in the tubular portions. *See* CLOTHING.

K.

Kangaroo—The aborigines of Australia eat these animals, and their flesh is considered excellent. Kangaroo soup, which is far superior to ox-tail, has recently been introduced into England. It is imported in quart tins, and to those who have no knowledge of its virtues we would recommend a trial. The flavour is full and "gamey," and it is not deficient in nutritive qualities.

Kennels—Kennels where a number of dogs are kept for hunting or sporting purposes should always be located at some distance from houses or public roads. The most injurious feature as regards health is the putrid emanation from the horse-flesh necessarily hung or stored in the vicinity of the hounds. Besides this, few horses will easily pass a kennel without shying or rearing, and serious accidents have arisen from this cause. It is evident, then, that a kennel kept near houses or by the side of a public road is a nuisance, and can be dealt with as such by the sanitary officers. *See* NUISANCES, PUTREFACTION, &c.

Kidney—If lightly cooked, the kidney is soft, juicy, and agreeably sapid, and forms a useful relish, though an article of difficult digestibility. The substance of the kidney is of a close fleshy nature, and when exposed for any time to a high temperature it suffers considerable contraction, and becomes hard, dry, and comparatively tasteless. The following analysis shows its composition:—

Composition of Sheep's Kidney (PAYEN).

Nitrogenous matter	17·250
Fatty matter	2·125
Saline matter	1·100
Non-azotised organic matter and loss	1·325
Water	78·200
	100·000

Koumiss—A sort of milk wine made by fermentation from mare's milk, and an important article of nourishment among the people of Tartary. It has recently been manufactured in England for the use of those whose digestion is impaired, and is said to impart immunity from phthisis. The following shows the results of an analysis made by Mr. Wanklyn of "full koumiss" forty-eight hours old:—

In 100 Parts by Weight.

Water	87·32
Alcohol	1·00
Carbonic acid	0·90
Solids	10·78
	100·00

The 10·78 parts of solids contained—

Caseine	2·84
Lactose	6·60
Fat	0·68
Ash	0·66
	10·78

At 67° F. it had a specific gravity of 1·032.

This may be compared with the analysis of mare's milk made by Dr. C. A. Cameron (Chemical News, xxi. 54):—

Average of Fourteen Samples.

Water	90·310
Fats	1·055
Albuminoids	1·953
Sugar	6·285
Mineral matters	0·397
	100·000

The solids in the fourteen samples varied from 8·5 to 11·5 per cent., the fats from ·6 to 2·12 per cent., the caseine from 1·46 to 2·4 per cent., the sugar from 5·67 to 6·87 per cent., and the ash from ·33 to ·44 per cent. The specific gravity was about 10·31. *See* MILK.

L.

Lactin, or **Lactose** (*Sugar of Milk*) ($C_{12}H_{24}O_{12}$, or $C_{12}H_{22}O_{11}H_{20}$)—This variety of sugar is found solely in the milk of the mammalia.

Lactose crystallises in hard four-sided prisms. It is soluble in about six parts of cold and two of boiling water, hence it is much less soluble than grape-sugar. It is not directly susceptible of the alcoholic fermentation, except under the action of dilute acids, which convert it into grape-sugar. When oxidised by nitric acid it yields mucic and oxalic acids. It reduces the salts of copper, silver, and mercury. It produces right-handed rotation (= 56·4°) when submitted to the action of polarised light.

It is obtained by gently evaporating clarified whey. The sugar crystallises, and the crystals are purified by digestion with animal charcoal and repeated crystallisations.

Sugar of milk is chiefly imported from Switzerland. Its principal commercial use is to disguise the taste of medicine. The proportion in which it exists in different milks, &c., will be found in article MILK, *which see*.

Lacto - Butyrometer—Instruments to determine the amount of butter in milk. The lacto-butyrometer of Marchand consists of a glass tube, closed at one end, of a diameter of from 0,010 to 0,012 centimetres. It is divided into three equal divisions (decimetres), and each of these divisions is divided into ten parts, the upper part being again divided into hundreds. A decimetre of milk is placed in the tube, and a little potash added to hold the caseine in solution ; an equal bulk of ether is then added, and the whole agitated ; next a decimetre of alcohol is poured in, and the tube is submitted to the gentle heat of a water-bath. The butter rises in a well-defined layer to the top of the liquid, and the number of divisions can be read off, and the amount of butter per litre or per pint ascertained by calculation or by the use of tables. This method of Marchand's, it may be remarked, is exactly on the same principle as Mr Horsley's. *See* MILK.

Lactoscope—An instrument invented by M. Donné of Paris for estimating the amount of butter in milk. The lactoscope is constructed in such a way that the milk may be examined by means of it in layers of every thickness—from almost perfect transparency to complete opacity. It gives at once the richness of milk, in indicating the degree of opacity to which the proportion of cream stands in relation. It consists of a kind of eyeglass composed of two tubes, sliding one within the other, and furnished with two parallel glasses, which approach each other up to contact, and separate more or less the one from the other at will, by means of a very fine screw. A little funnel, destined to receive the milk, is placed at the upper part ; on the opposite side is fixed a handle, which serves to hold the instrument. The tube which screws within the other forms the anterior or ocular part, that to which the eye is applied ; it is marked with divisions to the number of fifty, and figures which indicate the richness of the milk. A few drops (taken from the mass of the liquid) of the milk to be examined are poured into the funnel, and this being full, the ocular tube is turned from right to left until the liquid has penetrated between the plates of glass and collected at the bottom. The ocular tube is then turned in the contrary direction, from left to right, and the observer looks through it until the flame of a candle or taper can be distinguished ; he then manipulates the glass until the light is lost to view, ceasing to disturb the glasses immediately on the disappearance of the light. There now only remains to read the figure of the division to which the arrow marked on the immovable tube corresponds. The following table shows to what degree of richness, or to what proportion of cream, the figure corresponds :—

TABLE of comparative Richness of different kinds of Milk, as indicated by the Degree which they show on the Lactoscope.

Animal.	Amount of Cream.	Number shown on Lactoscope.
Cow . .	5 per cent. . .	40 to 35
,, . .	5 to 10 per cent.	35 to 30
,, . .	10 to 15 ,,	30 to 25
,, . .	15 to 20 ,,	25 to 20
,, . .	Excessively rich	20 to 15
,, . .	Very weak . .	150 to 3
Ass . . .	Good quality .	50 to 80
,, . . .	Very weak .	150 to 20, or 4 on lactoscope.
Goat . .	Rich	10 to 15
Woman .	Rich	20 to 25
,, . .	Medium . . .	30 to 35
,, . .	Weak	40 to 45

Lamprey, Great Lamprey, Seal (the *Petromyzon marinus* of Linnæus)—This fish was formerly considered a great delicacy, but is now rarely eaten in this country. Between October and March large numbers are taken in the Thames and Severn, and are sent over to Holland as a bait for cod and turbot. The flesh of the lamprey is soft and gelatinous, but extremely difficult of digestion. Potted lampreys are too highly seasoned to be wholesome articles of food.

Lands, Letting and Purchase of—Any local authority may for the purposes of the Public Health Act purchase or take on lease, sell or exchange any lands, or any rights in, over, or on lands, whether situated within or without their district ; they may also buy up any water-mill, dam, or weir which interferes with the proper drainage of or the supply of water to their district.

Any lands purchased by a local authority, and not required for the purpose for which they were purchased, shall (unless they are let to any person in pursuance of the powers in the Act contained) be resold at the best price that can be gotten for the same, and the proceeds of such resale shall be carried to the account of the fund or rate applicable by the local authority for the general purposes of the said Act.—(P. H., s. 175.)

With respect to the purchase of land by a local authority for the purposes of the Act, the following regulations shall be observed; (that is to say)—

(1.) The Lands Clauses Consolidation Acts, 1845, 1860, and 1869, shall be incorporated with the Public Health Act, except the provisions relating to access to the special Act.

(2.) The local authority, before putting in force any of the powers of the Lands Clauses Consolidation Act with respect to the purchase and taking of land otherwise than by agreement, shall

Publish once at the least in each of three consecutive weeks in the month of November, in some newspaper circulated in their district, an advertisement describing shortly the nature of the undertaking in respect of which the land is proposed to be taken, naming a place where a plan of the proposed undertaking may be seen at all reasonable hours, and stating the quantity of land that they require; and shall further

Serve a notice in the month of December on every owner or reputed owner, lessee or reputed lessee, and occupier of such land, defining in each case the particular land intended to be taken, and requiring an answer stating whether the person so served assents, dissents, or is neuter in respect of taking such land.

(3.) On compliance with the provisions of this section with respect to advertisements and notices, the local authority may, if they think fit, present a petition under their seal to the Local Government Board. The petition shall state the land intended to be taken, and the purposes for which it is required, and the names of the owners, lessees, and occupiers of land who have assented, dissented, or are neuter in respect of the taking such land, or who have returned no answer to the notice; it shall pray that the local authority may, with reference to such land, be allowed to put in force the powers of the Lands Clauses Consolidation Acts with respect to the purchase and taking of land otherwise than by agreement, and such prayer shall be supported by such evidence as the Local Government Board requires.

(4.) On the receipt of such petition, and on due proof of the proper advertisements having been published and notices served, the Local Government Board shall take such petition into consideration, and may either dismiss the same, or direct a local inquiry as to the propriety of assenting to the prayer of such petition; but until such inquiry has been made no provisional order shall be made affecting any land without the consent of the owners, lessees, and occupiers thereof.

(5.) After the completion of such inquiry the Local Government Board may, by provisional order, empower the local authority to put in force, with reference to the land referred to in such order, the powers of the Lands Clauses Consolidation Acts with respect to the purchase and taking of land otherwise than by agreement, or any of them, and either absolutely or with such conditions and modifications as the Board may think fit, and it shall be the duty of the local authority to serve a copy of any order so made in the manner and on the person in which and on whom notices in respect of such land are required to be served:

Provided that the notices by this section required to be given in the months of November and December may be given in the months of September and October, or of October and November, but in either of such last-mentioned cases an inquiry preliminary to the provisional order to which such notices refer, shall not be held until the expiration of one month from the last day of the second of the two months in which the notices are given; and any notices or orders by this section required to be served on a number of persons having any right in, over, or on lands in common may be served on any three or more of such persons on behalf of all such persons. —(P. H., s. 176.)

Any local authority may, with the consent of the Local Government Board, let for any term any land which they may possess, as and when they can conveniently spare the same. —(P. H., s. 177.)

The Public Health Act also contains a special provision empowering the Chancellor and Council of the Duchy of Lancaster, if they think fit, to contract with any local authority for the sale of lands belonging to the Duchy of Lancaster.—(P. H., s. 178.)

For the powers of entry on lands, *see* SEWERS, &c.

Lard—The fat of the pig melted by a gentle heat and strained through flannel or a hair sieve. The fat about the loins yields the whitest and hardest lard. According to Braconnet its composition is as follows:—

	Per cent.
Stearine, Margarine	38
Elaine	62
	100

Lard is frequently adulterated with water, tallow, starch, alum, caustic lime, carbonate of soda, carbonate of potash, and salt.

These adulterations are easily detected. A gramme put in a platinum dish and evaporated for six hours over the water-bath, and then weighed, will give the amount of water in lard. The fat can be estimated as in butter, as well as the salt. By boiling the lard in water, the starch will be dissolved; and in testing with iodine, if starch be present a blue colour will be seen. If turmeric paper is put into lard, and an alkali has been added, the turmeric will of course at once become brown. Alkalies are often added for the purpose of taking up water. Pure unsalted lard, on being burnt up, scarcely leaves any residue; thus all saline substances commonly added to it may be estimated in the ash—*e.g.*, alum, carbonate of potash, common salt, &c.

The detection of tallow is somewhat difficult, but the following tests will assist in determining its presence: Pure lard always fuses below 100° F. (38° C.), but if mixed with tallow, at a much higher degree; and hogs-lard when pure is perfectly white, when mixed with tallow, not so. The specific gravity of hogs-lard at 15° C. is ·930, of tallow about ·913. Pure lard is entirely soluble in ether. In melting a mixture of lard and tallow, the fat sputters. The odour of tallow can often be distinguished. Lastly, the "sinking-point," taken as described under Butter, will be found of great value. Tallow has a sinking-point of 53·3° C., lard one from 42·1° to 45·3° C. *See* BUTTER.

Latrines—*See* SEWAGE, REMOVAL OF; CLOSETS; URINALS, &c.

Laudanum—*See* OPIUM.

Lavender—*See* OILS.

Laver—*See* ALGÆ.

Lead (*Plumbum* = 207; specific gravity of commercial, 11·35 to 11·361; specific gravity of pure lead, 11·45; fusing-point, 617° F. = 325° C.)—The main source of lead is the native sulphide (galena); the native carbonate and phosphate are met with, but are unimportant sources.

Galena is found in this country in veins traversing the primitive rocks, particularly in the clayslate of Cornwall and the mountain limestone of Cumberland. It is generally mixed with quartz, blende, pyrites, baric sulphate, fluorspar, and argentic sulphide. The lead ore is first submitted to mechanical operations, and then smelted in a reverberatory furnace. Large quantities of deleterious fumes, consisting principally of sulphurous anhydride, are given off. The lead is subsequently submitted to "Pattinson's process" to extract the silver.

The lead of commerce contains from 96 to 99 per cent. of the pure metal, mixed with iron, tin, copper, and other metals. It is hardly ever perfectly pure, but may be obtained so by reducing the oxide left by igniting the pure nitrate or carbonate of the metal.

The general properties of lead are too well known to require description; but the action of air, water, and other solvents upon it is of great importance in a hygienic point of view.

Pure recently-boiled water has no action on lead, providing air be excluded.

The carbonates, the phosphates, and the sulphates all exert a protective agency on lead, by forming an insoluble film on its surface. Carbonate of calcium, held in solution by carbonic acid, has especially a great protective influence, the film of insoluble carbonate being deposited, and preventing any farther action. The phosphate of sodium and the iodide of potassium have also powers equal to the calcic carbonate. And lastly, some kinds of vegetable matter form insoluble compounds with lead.

On the other hand, pure water, well aërated and exposed to the atmosphere, quickly corrodes lead. The lead is first oxidised and then dissolved, the oxide absorbing carbonic acid from the air, and being deposited as the hydrated basic carbonate.

Nitrites and nitrates in solution act powerfully on lead, especially the former.

Ammonia, the carbonic acid evolved from decaying vegetable matter, and acetates, all dissolve lead.

Hence it follows that as most natural waters contain carbonate of lime, only minute portions of lead are dissolved; but, on the other hand, rain-water—water polluted with sewage—water kept in tanks made of lead, with iron or zinc fastenings, whereby galvanic action being set up, the salts lose their protective influence—water from tanks having at the bottom a rich vegetable mud, may all become dangerously contaminated with lead.

All the salts of lead are poisonous. They are unintentionally at the bottom of an immense amount of chronic poisoning; but none of them are very violent, acute poisons—not nearly so active as people imagine. The acetate, a very soluble common salt, has been given in so large a quantity as 18 grains for a week or ten days without producing any serious symptoms; but when the dose has been excessive — *e.g.*, 1 or 2 ounces — dangerous symptoms have occurred.

The acute symptoms of poisoning by lead are briefly violent pains in the stomach, colic, cramps of the limbs and paralysis, obstinate constipation and scanty urine, sickness and slow, feeble pulse, an anxious countenance, and usually a blue line round the gums.

The chronic symptoms are constipation, colic, and paralysis, which usually commences at the wrist, a blue line round the gums, and albuminuria, constant or intermittent.

Chronic poisoning by lead is by far the most important to the hygienist, both on account of its frequency and with a view to its prevention.

From the author's observations, lead appears to be eliminated very slowly from the kidneys, causing slow interstitial changes in these organs, which cannot in any way be distinguished in the later stages from the chronic desquamative nephritis of Dr. Johnson. In cattle poisoned by lead, the author has found casts in the urine, and blindness from the retinitis and extravasations in the retina, met with in Bright's disease. The coma and convulsions are also rather the effect of the induced uræmia than the primary action of the poison. This interference of the functions of the kidney by lead without doubt causes the great prevalence of gout among plumbers. Uric acid and other excretory products collect in the blood, for elimination is interfered with.

The most common source of lead-poisoning is from drinking water contaminated with lead; possibly a very infinitesimal quantity is drunk daily, but then when this quantity is imbibed day after day and year after year, a point comes at last, when, on account of the very slow way by which lead is excreted, sufficient lead is accumulated to give rise to symptoms.

The least quantity of lead required to produce these symptoms is not definitely known; it can only be at present inferred that some people are extremely susceptible of the poison, whilst others resist it, more or less perfectly. Sir George Baker found that Devonshire colic had been produced from cider containing $4\frac{1}{2}$ grains of lead in eighteen bottles.

Some persons are peculiarly liable to be affected by very small quantities of lead. Dr. Taylor relates the case of a military officer who was attacked with paralysis by painting in oil. As his servant always ground his colours, cleaned his brushes, &c., the poison must have been inhaled. Dr. Taylor has himself suffered from a severe attack of colic, which he attributed to sitting in a room for a few hours a day in which a large surface of canvas for an oil painting had been covered with whitelead and drying oil. — (TAYLOR'S Principles of Jurisprudence, vol. i. p. 296.)

The family of Louis Philippe, when at Claremont, suffered severely from drinking water containing 1 grain of lead to the imperial gallon. Adams states that as little as $\frac{1}{100}$ of a grain has proved injurious, and Angus Smith showed that a like quantity had produced paralysis.

Water containing $\frac{1}{10}$ of a grain of lead to a gallon should be condemned as being unfit for use; and it is well not to forget the words of Dr. Richardson: "Contamination of water, both hard and soft, impure and pure, by lead, is in all parts of the kingdom, and under every variety of circumstance, the cause or source of various obscure diseases of man (and also, doubtless, of the lower animals), of the nature specially of dyspepsia and colic. This proposition was abundantly proved by cases of minor diseases induced by lead-contamination of various of the hard or impure waters of London." From the researches of Dr. Roque, published in the "Mouvement Médical" (Dec. 1872), it would appear that slow saturnine poisoning in the father or mother not only brings on miscarriage, and causes great mortality among infants, especially during the first weeks of life, but may also determine in children convulsions, idiocy, imbecility, and epilepsy.

In the soft lake-waters of Scotland, the presence of a little vegetable matter acts as a preserving agent, by combining with a portion of oxide of lead, and forming an insoluble and closely-adhering natural pigment which lines the pipes and cisterns. Few waters kept in lead cisterns can be met with which do not yield some trace of lead.

Lead in the arts gives rise to much disease.

Artisans employed in the manufacture of whitelead frequently suffer severely. In French manufactures, where the powder was ground dry, horses, dogs, and even rats have died from the effects of lead. For this reason the carbonate is now almost universally ground under water.

Plumbers, besides being liable to gout, as already stated, are affected with nausea and tightness of the chest, followed by colic and palsy, consequent on inhaling volatilised oxide of lead, which rises during the process of casting.

A new and recent source of chronic lead-poisoning has been pointed out by Dr. G. Johnson—viz., in the manufacture of *American overland cloth*. This fabric receives a coating of chalk and carbonate of lead, and in handling it a fine dust is given off, which has caused several cases of poisoning amongst the workmen.

Animals and men are occasionally affected by lead through curious and unexpected channels—*e.g.*, potmen in cleaning pewter pots (Medical Gazette, vol. xlviii. p. 1047); a trunkmaker from handling vulcanised rubber (Pharmaceutical Journal, 1870, p. 426); a tea-dealer placing pieces of tealead in his mouth (Taylor, Principles of Jurisprudence, vol. i. p. 299); cattle swallowing the lead-splashes left on the grass as the result of volunteers firing at the butts;* infants eating farinaceous food which has been wrapped up in leadfoil (*op. cit.*) *See also* Cosmetics.

Lead may also gain access into the system from being used as an adulterant to articles of food—*e.g.*, chromate of lead has been employed for the purpose of colouring various articles of food, especially mustard, confectionery, and snuff.

Redlead has been detected in annatto, while the acetate or sugar of lead is often used for the adulteration of gin, rum, port wine, and sherry. (*See* the respective articles.)

Wine has been known to prove poisonous from contact with bottles which had been cleaned with leaden shot, and earthenware glazed with litharge imparts oxide of lead to fat in dripping and to acid liquids. A spurious tinfoil, consisting chiefly of lead faced with tin, is much used for covering articles of food. When exposed to damp it undergoes chemical changes, whereby carbonate of lead is produced.

Recently, Professor Church of the Royal Agricultural College at Cirencester has pointed to a danger resulting from the use of gazogènes for preparing aërated waters. He says: "I have examined a large number of different waters—English and foreign, old and new—and I find one defect universal. The upper part of the long glass tube (through which the aërated liquor is forced from the lower vessel) is fitted into a tube of pewter. The aërated water standing in this dissolves some of its lead, and the first wineglassful of water drawn each time that the apparatus has been left to itself turns brown when tested with hydrosulphuric acid. Why should not the new tin-lined lead tubes be used for the metal fitting in which the little spring piston of these machines works?"—(Food Journal.)

It has also been detected in lemonade, probably from the employment of citric acid impregnated with lead.

Tests.—A liquid containing lead, on being acidulated and then treated with a solution of sulphuretted hydrogen, either throws down a black precipitate or exhibits a brown discoloration; by this discoloration a very minute trace of lead can be estimated by a colormetric method described under Water-Analysis.

A solution of chromate of potash added to a liquid containing lead throws down the yellow chromate of lead (1 gramme of chromate of lead = ·683 of oxide). Horsley says that this test will detect $\frac{1}{100000}$ part of a grain of lead.

Iodide of potassium produces in solutions of lead a yellow precipitate of iodide of lead, soluble in *boiling water*, and deposited in very brilliant scales on cooling (1 gramme of iodide of lead = ·452 of lead).

A deposit of metallic lead may be obtained by placing a little of the solid nitrate or carbonate on a sovereign, drenching it with *hydrochloric acid*, and then touching it with a piece of zinc. Lead may often be extracted thus from the evaporated residues of water without the use of *sulphide of hydrogen*.

Sulphuric acid, or either of the *alkaline sulphates*, when added to a solution of lead, produces a dense white precipitate of *sulphate of lead*, insoluble in water, and turns black or brownish black, according to the quantity, with a weak solution of *sulphide of ammonia*, by which it is distinguished from the corresponding white precipitates of *sulphate of baryta* and *strontia*. Ten grains of sulphide of lead are equal to 8·637 grains of lead, and equal to about 16 grains of acetate of lead (or 1 gramme of sulphide = ·8637 of lead).

Lead may be separated from organic fluids by evaporating the liquid to dryness, destroying the organic matter by carbonising it, and then heating the residue with nitric acid; or sulphuric acid may be used to carbonise, and then the resulting sulphate of lead dissolved out by carbonate of soda or acetate of ammonia, and the usual tests applied.

Lead in organic solids may be separated by a process conducted exactly on the same principles. All these operations are best performed in porcelain dishes, as lead attacks platinum.

* The author was recently consulted in a case in which several cattle died from eating lumps of paint which had been placed on a field to manure it. The cattle died from uræmic poisoning. The urine was extremely albuminous, and contained numerous epithelial casts. Lead was detected in liver, kidneys, and brain.

Lead Pipes—The use of lead pipes in the conveyance of water, and the danger arising from that source, have been already commented upon in article LEAD. The water is not alone contaminated more or less, but rats have been known to gnaw through the pipes. Many devices are at present in use to obviate this contamination of the water by lead. Dr. Parkes summarises them thus :—

1. Lining with tin ; but Calvert's experiments show that both extra-tinned and ordinary-tinned lead piping gave up lead to the pure water now used in Manchester.

2. A much better plan is by having a good block-tin pipe enclosed in a lead pipe, as in Haines' patent. If the tin is good, it is little acted on, and the strength of the pipe is increased, while bends and junctions can be made without destroying the continuity of the tin.

3. Fusible metal, viz. lead, bismuth, and tin.

4. Bituminous coating (M'Dougall's patent).

5. Various gums, resins, gutta-percha, and indiarubber. These would probably be efficacious.

6. Coating interior of pipes with lead sulphide, by boiling the pipes in sodium sulphide for fifteen minutes. The sodium sulphide may be made by boiling sulphur in liquor sodæ (Schwartz's patent).

7. Resin and grease with whitelead (!) has been proposed, also resin and arsenic !! Both are most objectionable.

8. Varnish of coal tar.

Leather — Leather is well adapted for clothing in countries where cold north winds are prevalent, since no wind blows through it. Coats of sheepskin or buffalo-hide are used by sentries in Canada, and jackets made of a similar material are in common use in Turkey, Tartary, Persia, and the Danubian provinces. Leather should be well tanned, and without any marks of corrosion or attacks of insects. The thin kind should be perfectly supple. *See* CLOTHING.

Leather-Dressers — In the process of preparing leather, lime and yellow orpiment (sulphide of arsenic) are employed, and these substances cause the workers considerable inconvenience. In some cases ecchymoses invades the skin of the hand, and it presents a tumefied appearance, more especially near the extremities of the fingers ; and in others, the lime, &c., occasion an ulceration of the skin which is excessively painful. This ulceration readily disappears if the men leave off work for a time, but it is very liable to return. The affection would seem to be quite a local one, for the general health appears unaffected.

The wearing of oilskin gloves has been recommended as a preventative, but the men evince but little inclination to act upon this hint.

Leek (the *Allium porrum*, Linn.)—The juice of this vegetable contains an acrid volatile oil, which possesses strongly irritant and excitant properties, and is said to be capable of dissolving phosphatic calculi. The general properties of the leek are intermediate between those of the onion and garlic. In nutritive value it is far inferior to the potato.

Leet, Court of—The court leet, or view of frankpledge, is a court of record held once in the year, and not oftener, within a particular hundred, lordship, or manor, before the steward of the leet, being the king's court, granted by Charles to the lords of those hundreds or manors.

A custom in a court leet for a jury to examine weights, &c., and to destroy the light ones, is good. Wilcock *v.* Windsor, 3 B. and Adol., 43.—(Present State of Common and Statute Law, PETERSDORFF, iii. p. 440.)

Legal Proceedings—Any local authority may appear before any court, or in any legal proceeding, by their clerk, or by any officer or member authorised generally or in respect of any special proceeding by resolution of such authority, and such person being so authorised is at liberty to institute and carry on any proceeding which the local authority is authorised to institute and carry on under the Public Health Act.—(P. H., s. 259.)

But although it is perfectly legal for an inspector of nuisances or a medical officer of health to prosecute and conduct a case when authorised so to do by a local authority, all such matters, unless under very exceptional circumstances, should devolve upon the clerk.

In proceeding by or against a local authority, the name of the authority need not be proved.—(P. H., s. 260.)

Demands below £50 may be recovered in the county courts.—(P. H., s. 261.)

No rate, order, proceeding, matter, or thing made or done or relating to the execution of the Public Health Act, shall be vacated, quashed, or set aside for want of form, or (unless otherwise expressly provided by the Act) be removed or removable by certiorari or any other writ or process whatsoever into any of the superior courts.

Provided that nothing is to prevent the removal of any case stated for the opinion of a superior court, or of any rate, order, conviction, or thing to which such special case relates.—(P. H., s. 262.)

No justice of the peace is to be deemed incapable of acting, although he be a member of the local authority, or liable to contribute. —(P. H., s. 258.)

Any false evidence on oath under the Public Health Act is punishable as perjury.—(P. H., s. 263.)

All offences under the Public Health Act, and all penalties, forfeitures, costs, and expenses under the said Act directed to be recovered in a summary manner, or the recovery of which is not otherwise provided for, may be prosecuted and recovered in manner directed by the Summary Jurisdiction Acts before a court of summary jurisdiction. The court of summary jurisdiction, when hearing and determining an information or complaint under the Act, shall be constituted of two or more justices of the peace in petty sessions, sitting at a place appointed for holding petty sessions, or of some magistrate or officer for the time being empowered by law to do alone any act authorised to be done by more than one justice of the peace sitting at some court or other place appointed for the administration of justice.—(P. H., s. 251.)

Any complaint or information made or laid in pursuance of the said Act shall be made or laid within *three* months from the time when the matter of such complaint or information respectively arose.

The description of any offence under the said Act in the words of the Act shall be sufficient in law.

Any exception, exemption, proviso, excuse, or qualification, whether it does or not accompany the description of the offence, may be proved by the defendant, but need not be specified or negatived in the information; and, if so specified or negatived, no proof in relation to the matters so specified or negatived shall be required on the part of the informant.—(P. H., s. 252.)

The local authority may if they think fit cause legal proceedings with regard to *nuisances* to be taken in any superior court of law or equity, if in their opinion summary proceeding would afford an inadequate remedy. —(P. H., s. 107.)

In case of an action against the local authority, due notice, &c., must be given as follows :—

A writ or process shall not be sued out against or served on any local authority, or any member thereof, or any officer of a local authority, or person acting in his aid, for anything done or intended to be done under the provisions of the Public Health Act, until the expiration of *one month* after notice in writing has been served on such local authority, member, officer, or person, clearly stating the cause of action, and the name and place of abode of the intended plaintiff, and of his attorney or agent in the cause; and on the trial of any such action, the plaintiff shall not be permitted to go into evidence of any cause of action which is not stated in the notice so served; and unless such notice is proved, the jury shall find for the defendant.

Every such action shall be commenced within six months next after the accruing of the cause of action, and not afterwards, and shall be tried in the county or place where the cause of action occurred, and not elsewhere.

Any person to whom any such notice of action is given as aforesaid may tender amends to the plaintiff, his attorney or agent, at any time within one month after service of such notice, and, in case the same be not accepted, may plead such tender in bar; and in case amends have not been tendered as aforesaid, or in case the amends tendered be insufficient, the defendant may, by leave of the court, at any time before trial, pay into court under plea such sum of money as he may think proper; and if upon issue joined, or upon any plea pleaded for the whole action, the jury find generally for the defendant, or if the plaintiff be nonsuited or judgment be given for the defendant, then the defendant shall be entitled to full costs of suit, and have judgment accordingly.—(P. H., s. 264.)

The local authority and their officers are protected from personal liability.

No matter or thing done, and no contract entered into by any local authority or joint board or port sanitary authority, and no matter or thing done by any member of any such authority, or by any officer of such authority or other person whomsoever acting under the direction of such authority, shall, if the matter or thing were done or the contract were entered into *bonâ fide* for the purpose of executing the Public Health Act, subject them or any of them personally to any action, liability, claim, or demand whatsoever; and any expense incurred by any such authority, member, officer, or other person acting as last aforesaid shall be borne and repaid out of the fund or rate applicable by such authority to the general purposes of the said Act.

Provided that nothing in this section shall exempt any member of any such authority from liability to be surcharged with the amount of any payment which may be disallowed by the auditor in the accounts of such authority, and which such member authorised or joined in authorising.—(P. H., s. 265.)

For legal proceedings for the abatement of nuisances, for the recovery of penalties and rates, *see* NUISANCES, PENALTIES, RATES.

Legumine, or Vegetable Caseine—Thus named by its discoverer, Bracannot. It forms the nitrogenous matter of the pulses. It may be extracted from peas or from almonds by digesting the pulp of the crushed seeds in warm water for two or three hours. The undissolved portion is strained off by means of linen, and the turbid liquid is allowed to deposit the starch which it holds in suspension. It is next filtered and mixed with dilute acetic acid. A white flocculent precipitate is thus formed, which must be collected on a filter and wasbed. It is then dried, powdered, and digested, first in alcohol, and afterwards in ether.

Legumine is associated in the seed with considerable quantities of potassic, calcic, and magnesic phosphates. It may be coagulated by rennet, like the caseine of milk; hence the Chinese make a kind of cheese from peas and beans. It is very prone to decay, and this causes the sourness and irritating effect of pea-soup after it has been kept a little time. It is insoluble in boiling water, cold alcohol, and ether, but cold water dissolves it in considerable quantity. It is precipitated from its concentrated solutions by the addition of acetic acid.

Dried peas contain about one-fourth of their weight of legumine.

Lemon—The fruit of the *Citrus Limonum* or lemon-tree, a native of Asia, cultivated in the South of Europe. There are two varieties: in the one the juice is sweet, while in the other it is remarkable for its acid properties.

Lemon-juice possesses valuable antiscorbutic properties, and made into lemonade, constitutes a refreshing beverage. The rind contains a volatile oil and bitter principle, which render it useful as an aromatic and stomachic. *See* LEMON AND LIME JUICE; OILS, &c.

Lemon and Lime Juice—Since these juices are so nearly identical in their composition and uses, it will be convenient to consider them together.

Lime or lemon juice, as met with in commerce, is chiefly prepared in Sicily or the West Indies. It is mixed with brandy or whisky in the proportion of about 1 oz. of spirit to 10 of juice, and olive oil is poured on the top. Occasionally the juice is simply boiled without admixture, but that to which brandy has been added is less liable to spoil. Sugar in the proportion of half its weight is also added to improve its taste. Good lemon-juice should keep for at least three years, but bad juice soon becomes turbid, then stringy and mucilaginous, and the citric and malic acids decompose, glucose and carbonic acid being formed.

According to Proust, lemon-juice consists of citric acid, 1·77; malic acid, gum, bitter extractive, ·72; and water, 97·51. Its specific gravity, as ordered by the British Pharmacopœia, is 1·039, and the amount of citric acid in one fluid ounce on an average should be 32·5 grains. "Mr. Stoddart points out that the specific gravity is too high for the quantity of acid stated. There may, however, be other ingredients. He gives himself the specific gravity as 1·040 to 1·045, and the citric acid as 39 to 46 grains per ounce (citric acid, $C_6H_8O_7$)."—(PARKES.)

Harkness examined the juice expressed from two varieties of lemons—viz., Palermo and Messina—with the following results:—

	Palermo.	Messina.
Ounces of juice yielded by 100 lemons . .	108	96
Specific gravity of juice	1044.85	1038·56
Percentage of citric acid	8·12	7·04
Percentage of ash . .	0·289	0·301

A hundred parts of the ash of the juice of Palermo lemons gave—

Sulphuric acid	10·59
Carbonic acid	16·33
Chlorine	0·81
Phosphoric acid	6·74
Ferric phosphate	1·32
Lime	8·89
Magnesia	3·02
Potash	47·84
Soda	3·32
Silica	0·72
Loss	0·42
	100·00

The juice of the lime contains a larger quantity of citric acid, but less gum. The following shows the results obtained by Mr. Cooley from an examination of three different samples of limes:—

	W. Indies.	Jamaica.	S. Africa.
Sp. gr. of juice .	1041·30	1044·18	1044·90
P. cent. citric acid	7·96	8·66	8·50
P. cent. ash . .	0·321	0·401	0·364

Mr. Stoddart states that the standard for lemon-juice of the Board of Trade is a specific gravity of 10·30 without spirit, and 30 grains of citric acid per ounce.

Dr. Parkes examined two samples of lemon-juice, with the following results:—

After separation of the oil and carefully evaporating down, a brownish fragrant extract was obtained, the amount of which was 7·186 and 7·1828 per cent. On being incinerated, an alkaline whitish-grey ash was left; and if the alkalinity was neutralised by a standard acid, it corresponded to ·15 grains of citric acid per cent. The ash was ·52 and ·53 per cent. respectively, and of this ·38 were soluble salts; the potash was ·12 per cent. (½ grain an ounce), and the phosphoric acid was ·008 per cent., or ·035 grains per ounce. The total acidity (= citric acid, $C_6H_8O_7$) was 4·61 and 5·36 per cent., or on an average nearly 22 grains of citric acid ($C_6H_8O_7$) per ounce.

In evaporating lemon-juice down, should the operation be carried too far, the extract is decomposed; and according to Mr. Stoddart, acetone, carbonic acid, and carbonic oxide and pyrocitric acid are formed.

Lemon or lime juice is refrigerant, antiscorbutic, and furnishes a very agreeable and refreshing beverage. It is useful for allaying sickness, and is adapted for lithic acid deposits. In poisoning by the alkalies and their carbonates, the vegetable acids are the antidotes. Lemon-juice may with advantage be administered in cases of poisoning by narcotic substances—such as opium, &c.—after the poison has been removed from the stomach to counteract the effects.

It is ordered by the Merchant Shipping Act (1867), that after the ship has been at sea ten days, 1 oz. of lime or lemon juice, mixed with 1 oz. of sugar and ½ pint of water, be served out to the crew between the hours of twelve and one in the day. Since this Act came into operation, scurvy in the merchant ships of this country has diminished more than 70 per cent. (*see* Statistics of the Seamen's Hospital). The juice is in the first instance examined in the laboratory of the Inland Revenue as to specific gravity, amount of citric acid, and absence of sulphuric or other cheap acids, &c. It is then, under direction of the customs' officers, mixed in bond with 10 per cent. of rum, brandy, gin, whisky, or hollands, and kept in bond until required for shipment.

Factitious Lemon-Juice.—1. Citric acid, 1¼ oz.; carbonate of potassa, 45 grs.; white sugar, 2½ oz.; cold water, 1 pint: dissolve, add the yellow peel of a lemon, and in twenty-four hours strain through a hair sieve or piece of muslin.

2. Same as last, but using 15 or 16 drops of oil of lemon to flavour, instead of the lemon-peel.

Many substitutes for lime-juice are used. Citric acid or citrate of potash are the best. Nitrate of potash stands the lowest in value.

Adulterations.—Much of the lemon and lime juice commonly sold is adulterated with tartaric, sulphuric, hydrochloric, and nitric acids, and afterwards flavoured with oil of lemons.

Tartaric Acid.—Dilute the sample, and if the juice be turbid filter it. Add a solution of acetate of potassium, and stir briskly without touching the sides of the vessel with the stirrer, and leave for twenty-four hours; when, if tartaric acid be present, precipitation of acid tartrate of potassium will take place.

Sulphuric Acid.—Dilute the filtered juice with a few drops of hydrochloric acid, and a solution of chloride of barium is added. Sulphate of barium in the form of a white precipitate will be thrown down if sulphuric acid be present.

Hydrochloric Acid.—Test with nitrate of silver and a few drops of dilute nitric acid. A white insoluble precipitate indicates a chloride.

Nitric acid is a very rare adulteration. Its presence may be determined by any one of the methods given under Water.

The citric acid may be determined by means of a standard solution of caustic soda. *See* ACIDIMETRY, &c.

Lemon, Oil of—*See* OILS.

Lentils—The seed of the *Ervum Lens*, natural order *Leguminosæ*.

They are grown and eaten in all parts of the world, and when they can be digested, are considered highly nutritious. They are considerably smaller than an ordinary pea, and are shaped like a double convex lens (*see* fig. 52).

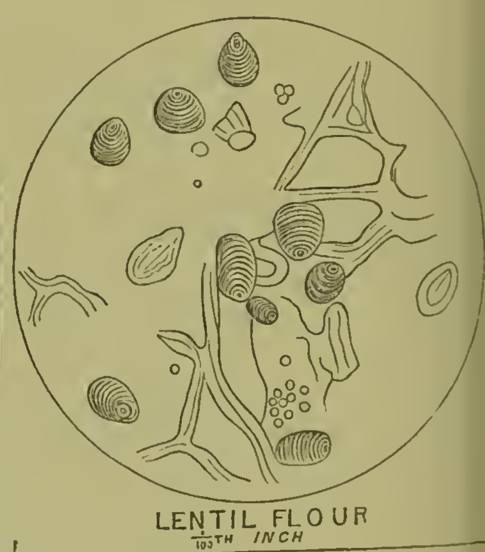


Fig. 52.

The following shows their composition:—

Composition of Lentils (PAYEN).

Nitrogenous matter	25·2
Starch, &c.	56·0
Cellulose	2·4
Fatty matter	2·6
Mineral matter	2·3
Water	11·5
	100·0

Lentils are largely employed in the preparations known as *revalenta* and *ervalenta*. The nitrogenous matter of the pulses is called legumine. *See* LEGUMINE, PEAS, &c.

Lettuce (*Lactuca sativa*) — Supposed to be a native of the East Indies, but largely cultivated in Europe. The lettuce forms a wholesome, digestible, cooling, and agreeable salad, and is occasionally boiled. It contains a milky juice which possesses mild soporific properties, and is known as *lactucarium* or *lettuce opium*.

Levelling — Levelling is that branch of surveying which determines the inequalities of the earth's surface, and ascertains the relative heights of places above a certain line, called the datum line, equidistant from the centre of the earth. Levelling is determined by the aid of an instrument called the spirit-level. This in its simplest form is "a glass tube sealed at both ends, containing some very limpid liquid—such as alcohol, chloroform, or sulphuret of carbon—and a bubble of air. The tube itself having a slight curvature, convex upwards, the air-bubble places itself at the highest point in the tube, and a tangent to the upper internal surface of the tube at that point is horizontal." When the centre of the bubble, then, is in the middle of the tube, the instrument is properly adjusted.

The use of levelling to the sanitary engineer is obvious. It enables him to lay down sewers with the proper declivity, gives him the heights of the hills, determines the watershed of the district, and has a variety of applications with regard to water-supply and other matters. For laying down drains, and taking, generally speaking, short levels, the ordinary spirit-level, mounted in a frame having two slits at right angles to each other at either end, will be found to answer very fairly. To use the instrument, the bubble is adjusted at the centre by elevating or depressing one of the extremities, the tube is then level, and by looking through the slits, the level line may be extended any distance.

For more extended surveys, the Dumpy level of Mr. Gravatt, or a similar instrument, is required (*see* fig. 53).

"A is a spirit-level attached by screws at *a a* to the telescope B C; by means of these screws it can be adjusted, in order to place a tangent to its middle point parallel to the line of collimation of the telescope. A small circle near the object-end B of the telescope, indicates a small transverse level used to show whether the horizontal cross-wire is truly horizontal. The diaphragm of the telescope contains one horizontal and two parallel vertical cross-wires" (*see* fig. 54). "B is the object-end of the telescope; C, the eye-piece; *b*,

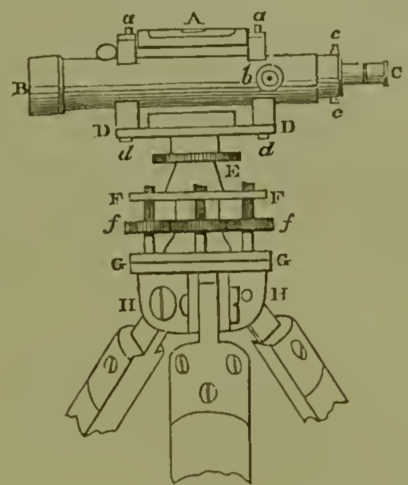


Fig. 53.

the milled head of the pinion by which the inner tube is drawn in and out; *c c*, screws for adjusting the diaphragm, so as to bring the horizontal cross-wire exactly to the line of collimation or axis of the telescope. D D is an oblong plate or flat bar fixed on the top of the vertical axis E; to this plate the telescope is connected by adjusting screws at *d d*, by means of which the line of collimation is placed perpendicular to the vertical axis. The vertical axis is hollow, and turns upon a spindle fixed to the upper parallel plate F; that spindle is continued downwards, and attached to the lower parallel plate G by a ball-and-socket joint. The vertical axis is set truly vertical by means of the plate screws *f f*. A compass is generally carried in D D." —(Professor RANKINE.)

Fig. 54.

There are various other forms of levels, such as Troughton's, the Y level, &c.

The actual operation of levelling is performed by aid of the spirit-level and of the *levelling-staff*. The old levelling-staff was provided with a vane, which was slid up and down the staff by the staffman, according to the directions of the leveller. But the staff usually used now is a "rectangular wooden rod, having a face 2 or $2\frac{1}{2}$ inches broad, on which is painted in a bold conspicuous manner a scale of feet divided into tenths and hundreds, commencing at the lower end of the staff." The staff when in use must be held exactly vertical, and is read either through the telescope or the sights of the level. The readings of the staff are called "sights."

When two sights only are taken from one station—one with the staff upon a point whose level has been ascertained, and the other with the staff upon a point whose level is yet to be ascertained—the former is called the "back-sight," and the latter the "foresight." If the back-sight is the greater, the ground rises, and if the foresight is the greater, it falls from the former point to the latter.

When the levels of a series of points are taken with the level at one station, in order to make a continuous section, the first and the last observations are the principal back and fore sights respectively. Of intermediate sights, each is a foresight relatively to the preceding sight, and a back-sight relatively to the following one. For example (fig. 55)—

"A is a station where the level is set up, and the horizontal line *b* A *c* is *the line of sight*, or straight line in prolongation of the line of collimation. The *first back-sight* is taken with the staff on B, and it gives the reading on the staff, B *b*. The *last foresight* is taken with the staff on C; it gives as the reading of the staff, C *c*. The first intermediate sight

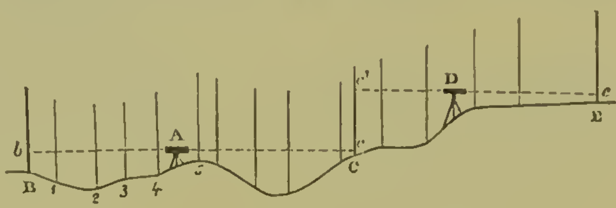


Fig. 55.

at the point marked 1 is a foresight relatively to that at B, and a back-sight relatively to that at the point 2, and so on."

"When the leveller has to carry his level on to a new station, such as D, the staffman holds his staff steadily at C, only making it face about. The leveller advances to D, sets up and adjusts his level, takes the first back-sight C *c*′, and proceeds as before. E *e* represents the position of the staff when the last foresight is taken from D. The staff is held there until the leveller has moved on and planted his level at a third station, and so on."

The section is measured by the chain in the usual way. In crossing streams, the existing level of the surface of the water is taken, and the levels of the bottom are taken by sounding.

The figures are entered in the field-book, which is most conveniently divided into seven columns headed as follows: Rise, back-sight, foresight, fall, reduced level, distance, description of object.

As an example of a simple calculation of levels, a well was distant from a village 300 feet, the length of the foresight was 20 feet, the back-sight 5. The total descent, then, from the well was $20-5$, or 15 feet, and as this descent takes place for 300 feet, the descent for a foot was $\frac{1}{300}$ of 15 feet—*i.e.*, 05 feet, or 5 in every 100 feet.

Libraries—By the Libraries Amendment Act, 1871 (34 & 35 Vict. c. 71, s. 1), urban sanitary authorities are empowered to execute the general Acts relating to libraries and museums.

Lice—Five forms of lice infest the skin of man. These are the *Pediculus capitis*, met with in the hair of the head; the *Pediculus pubis*, found in the other hairy parts of the body, but especially the pubis; the *Pediculus corporis*, living on the general trunk of the body; a fourth is the *Pediculus palpebrarum*; and a fifth, the *Pediculus tabes-centium*. The first four species limit themselves to the regions named.

The Body Louse (fig. 56).—This is the most common, and consequently the most important, variety. It varies in length from ½ line to 2 lines. It is of a whitish colour, the body being elongated, the abdominal portion broad, and its margins lobulated and covered with little hairs. The thoracic portion, which is very narrow, carries three legs on each side. The legs are jointed, hairy, and terminate in claws. The

Fig. 56.

louse in feeding causes great itchiness of the skin. It is usually found amongst the folds of the clothing, where it also deposits its eggs, which are crystalline, shining, yellowish, and opaque bodies.

The Head Louse (fig. 57).—These parasites multiply with astonishing rapidity. They are much smaller than the body louse, the legs are larger in proportion to the size of the body, and the abdomen is distinctly divided into seven segments, separated from each other at the margins by deep notches. They produce

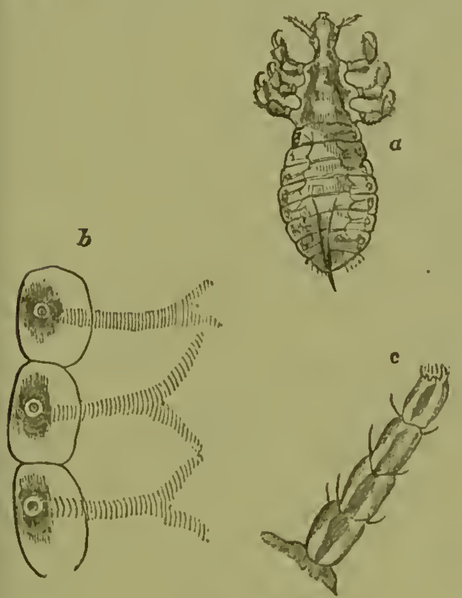


Fig. 57.

an *eczema* from which fluid abundantly exudes, the hairs become glued together, and crusts, involving the cuticular débris or exuviæ of the lice, and the remains of epidermis are formed.

Tho *Crab Louse* (fig. 58) has in proportion to its size a much broader body than either of the other two forms of lice. It is "shield"-shaped, and there does not appear to be any distinct separation between its thorax and abdomen. It is found in the hair of the pubis, armpits, scrotum, perinæum, anus, and, in extreme cases, in the eyebrows; it is, however, never discovered in the hair of the head. It grasps the stems of the hairs with its forelegs, and adheres so firmly that it is difficult to remove it without extracting the hair.—(AITKEN.)

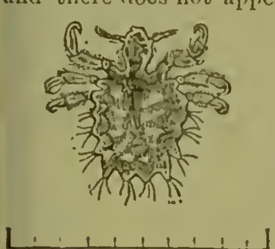


Fig. 58.

The presence of pediculi is, as a general rule, an indication of dirty habits, but occasionally they are found on cleanly people, who catch them, in the first place, from sleeping in strange beds, using dirty water-closets, or unclean combs and brushes, and in many other obvious ways. With ordinary care, clean people, if they should happen to be unfortunate enough to become affected, rapidly get rid of them.

Persons whose skins are liable to constitutional skin-diseases in which watery or secreting eruptions prevail, are much more subject to the attacks of lice than others. Children attending schools where there is an insufficiency of spaco often become attacked from close contact with children so diseased. This is one of the many dangers which arise from overcrowding,—an additional argument for plenty of space being allowed in schools for each individual.

Lichens—Several lichens are eaten in Arctic regions, where during the greater part of the year no other food is procurable. Iceland moss (*Cetraria Icelandica*) and reindeer moss (*Cladonia rangiferina*) are examples of these. The former contains as much as from 27 to 31 per cent. of starchy matter, and the latter about 5 per cent. Two species of lichen—the *Gyrophora proboscidea* and *G. erosa*—furnished the *tripe de Roche* of our Arctic navigators, which was their chief food in time of scarcity.—(LETHEBY.)

Franklin's party, however, who subsisted for some time on this diet, became miserably thin, and at last the weed was thoroughly nauseous to all, and produced diarrhœa amongst several.

If the lichens be deprived of their bitter principles by soaking first in an alkaline lye, and then in cold water, they may be made to yield a palatable food. The *Roccella tinctoria*, the *Variolaria orcina*, the *Lecanora tartarea*, &c., when ground into paste with water mixed with putrid urine or solution of carbonate of ammonia, and left for some time freely exposed to the air, furnish the archil litmus and cudbear of commerce—very similar substances, differing chiefly in the details of their preparation.

Liebig's Extract of Meat—*See* MEAT, EXTRACT OF.

Light—This principle is a necessary element in the development of organised beings. and in its absence all the higher classes of plants and animals languish and etiolate; for where there is deficient light in dwellings, other unfavourable conditions, such as deficient cubic space and impure air, are generally present as well, so that there is a combination of unhealthy influences. That any artificial light should take the place of the solar rays, or exert the same influence, is in the highest degree improbable, since the direct rays of the sun are great remedial and preventive agents in certain diseases, such as scrofula, phthisis, rickets, &c.

In dwellings it must be remembered that every opening which lets in light is also a ventilator; thus the wretchedly small windows of many cottages are to be condemned. Light is more essential to the period of growth than to that of maturity; hence all nurseries, schools, or places where children are congregated should be supplied with large windows, and the best aspect chosen for the house—viz., the south-easterly—so that the sun may strike on both sides.

The sun and all artificial lights are, so to speak, ventilators; for no sooner is a lamp lit, or a sunbeam allowed free access to a room, than currents of air are established.

The sun, again, is a disinfector, not only producing ozone under certain circumstances, but also drying up fœtid matters.

Artificial lights—such as gas, candles, and lamps fed with oils, &c.—used in well-ventilated rooms, cannot be proved to be injurious; but used to a great extent in badly-constructed workshops, where there is not sufficient ventilation, they rapidly deteriorate the air, heat the room, and injure the health of the workmen. An artificial light should be steady, toned down by tinted or ground glass globes, and bright enough to read by with ease. Lights that flicker and are insufficient strain the eyes and injure the sight; but, as before said, it is by no means established that properly-arranged artificial lights cause any injury. Public buildings are preferably lighted from the ceiling, and each burner, when connected with an up-cast ventilating shaft, aids in purifying the air. *See* SUNSTROKE, VENTILATION, &c.

Lights—Pig's lights are eaten as a fry with the animal's liver. A food is prepared, called "faggots," from bullock's and sheep's lights mixed with bullock's liver.

Lignin—*See* CELLULOSE.

Lime (*Calx*, CaO)—Lime, or quicklime, is made from chalk (carbonate of lime) by strongly heating it, so as to drive off the carbonic acid. For use in the arts a kind of wind-furnace called a kiln is employed. It is quite white when pure. A solution of it has an alkaline reaction, and yields a white precipitate with oxalate of ammonia, and it soon absorbs carbonic acid if exposed to the air. Lime, if previously slaked, dissolves in dilute hydrochloric acid without effervescence; and if this solution be evaporated to dryness, and the residue redissolved in water, only a very scanty precipitate forms on the addition of saccharated solution of lime, showing the presence of traces of alumina and magnesia. Lime reacts powerfully on vegetable colours as an alkali. It is slightly soluble in water. According to Mr. Phillips—

1 pint of water at 32° dissolves 13·25 grains.
,, ,, 60° ,, 11·6 ,,
,, ,, 212° ,, 6·7 ,,

In the burning of lime, carbonic acid is given off abundantly; but owing to the nature of the fuel used, carbonic oxide and sulphurous acid are mixed with it. Tramps, &c., who have thoughtlessly slept in the neighbourhood of a burning limekiln during a cold night, have been suffocated by the respiration of these vapours.

Lime has been recommended for the purpose of absorbing carbonic acid from the air, and Liebig has advised that some be constantly kept in the sleeping apartments. Dr. Angus Smith, however, experimented on the purifying of vitiated air by this means, and it was found that the room in which the plan was tried was rendered too uncomfortable for daily life.

Navier speaks of lime-water and milk as an antidote in poisoning by arsenous acid, and in the absence of more appropriate antidotes, lime-water may be administered in poisoning by the common mineral and oxalic acids.

Lime added to water, sewage, &c., is a great purifying agent. *See* WATER, SEWAGE.

Lime is largely used for the purpose of purifying coal-gas. During the passage of the gas through the lime-purifiers, coal-gas loses its sulphuretted hydrogen, carbonic acid, sulphocyanogen, and cyanogen and naphthaline.

Lime is also of great value as a manure.

Lime may contain carbonic acid and metallic impurities, which can be detected by the tests given above.

Lime, Carbonate of (CaCO). — This forms a considerable portion of the known crust of the earth. In the crystalline form it constitutes *calcareous spar* and *aragonite*. *Statuary marble* is the more primitive and esteemed limestone. *Chalk*, found extensively in the South of England, constitutes the newest of secondary rocks. There are various other forms of carbonate of lime, called by mineralogists *stalactitic carbonate of lime*, *oolite*, *pisolite*, *marl*, and *tufa*. The following are the tests for chalk:—

It effervesces with acids, and dissolves, with only a slight residue, in diluted hydrochloric acid. This solution, when supersaturated with solution of ammonia, gives, on the addition of oxalate of ammonia, a copious white precipitate. The salt formed by dissolving the prepared chalk in hydrochloric acid, if rendered neutral by evaporation to dryness, and redissolved in water, gives only a scanty precipitate on the addition of saccharated solution of lime, showing its freedom from any considerable quantity of silica, alumina, oxide of iron, magnesia, or phosphate of lime.

Lime, Chloride of, or *Chlorinated Lime.*—The commercial chloride of lime is not calcic chloride, which may be readily made by neutralising hydrochloric acid with carbonate of lime, but a compound of hydrochloride, chloride. and hydrate of lime.

On the large scale, chlorine gas is conducted through a leaden tube into a chamber made of siliceous sandstone, in which dry, fresh-slaked lime is arranged on trays. The lime is continually agitated by means of iron rakes, the handles of which pass through boxes of lime placed in the walls of the chamber.

Tests, &c.—Partially soluble in water. On the addition of oxalic acid, chlorine is copiously evolved and oxalate of lime deposited. Exposed to the air, it attracts carbonic acid, evolves hypochlorous acid, and is thereby converted into a mixture of carbonate of lime and chloride of calcium, the latter of which deliquesces. When heated, it evolves oxygen gas, sometimes also chlorine gas, and becomes converted into a mixture of chloride of calcium and chlorate of lime, which has no bleaching properties. Good samples of commercial chloride of lime should contain on an average 36 per cent. of available chlorine.

This substance is extensively used for its bleaching and disinfecting properties.

It is very valuable for destroying putrid odours and checking putrefaction. Its action on sulphuretted hydrogen, ammonia, and hydrosulphuret of ammonia (substances evolved by decomposing animal matters) can be readily demonstrated. Applied to foul ulcers or secretions, or employed to prevent the putrefaction of corpses previously to interment, to destroy the odour in privies, sewers, drains, dissecting-rooms, stables, &c., chlorinated lime will be found extremely useful. For further remarks on its disinfecting properties the reader is referred to the article on CHLORINE, and also to that on DISINFECTANTS.

Solution of chlorinated lime or soda is the best antidote for poisoning by *sulphuretted hydrogen*, *sulphide of ammonia*, *sulphide of potassium*, and *hydrocyanic acid.*

A handkerchief moistened with a solution of chloride of lime applied to the mouth and nose will effectually preserve any one from the effects of sulphuretted hydrogen.

In cases of poisoning by chlorinated lime, administer albuminous liquids, milk, flour-and-water, oil, or mucilaginous drinks, and excite vomiting. Carefully avoid the use of acids.

Lime, Sulphate of (native) ($CaSO_4 2H_2O$).—Plaster-of-Paris consists of the above deprived of its water by heat. It is used to adulterate various articles of food, and as a test for determining the presence of oxalic acid in tartaric acid.

Limes—The fruit of the *Citrus Limetta.* Smaller and smoother than the lemon. The rind is very thin, and the juice extremely acid. It is largely used in the preparation of citric acid. Lime-juice is extensively used on board ship for its antiscorbutic properties. *See* LIME AND LEMON JUICE, &c.

Linen*—A textile fabric made of the liber fibres of the *Linum usitatissimum*, or common flax. It conducts heat, and absorbs water slightly better than cotton; is remarkable for the smoothness and softness of its texture, and is hence highly esteemed in temperate climates as an agreeable article of clothing for use next the skin.

Starch is often used to give glossiness. This may be readily detected by iodine, and removed by the first washing.

Linen is often sophisticated with cotton.

Cooley gives the following methods for detecting this admixture :—

"1. A small strip (a square inch, for instance) of the suspected cloth is immersed for two or three minutes in a boiling mixture of about equal parts of hydrate of potassium and water, contained in a vessel of silver, porcelain, or hard glass; after which it is taken out and pressed between the folds of white blotting-paper or porous calico. By separating eight or ten threads in each direction their colour may be readily seen. The deep yellow threads are *linen*, the white or pale yellow ones are *cotton.*

"2. A small strip of the cloth, after having been repeatedly washed with rain-water, boiled in the water, and dried, is immersed for one or two minutes in sulphuric acid. It is then withdrawn, carefully pressed under water with the fingers, washed, immersed for a few seconds in ammonia, solution of carbonate of potassium, or solution of carbonate of sodium, again washed with water, and dried between filtering-paper. By this treatment the cotton fibres are dissolved, while the linen fibres are merely rendered thinner and more translucent, according to the duration of the experiment. After a short immersion the cotton fibres appear transparent, while the linen fibres remain white and opaque."

The fibres of flax, as seen beneath the micro-

* Philostratus would wear no garment made of the skin of an animal that died of any disease—he, in fact, after a time rejected all animal clothing, using linen alone.

"I clothe my-elf with this fleece of the earth, not shorn from the sheep's back, but springing up purely from the pure, being a gift of water and earth, even made of linen."—(PHILOSTRATUS's Appolonius Tyaneus, Blount's translation.)

scope, are round, straight, and jointed. *See* CLOTHING, COTTON, &c.

Linseed—The seeds of *Linum usitatissimum* (LINN.) Cultivated in Britain.

The seed is small, oval, oblong, flattened and pointed at one end, dark brown and shining on the surface, and white within. The flour or meal of linseed consists of the seeds ground and deprived of their oil by expression, and the cake reduced to powder.

The seeds contain about 20 per cent. of a fixed oil and mucilage, together with the ordinary constituents of the seeds. The oil is found in the kernel, the mucilage in the envelope or testa of the seed. The fixed oil has a specific gravity ·93. It rapidly absorbs oxygen from the air, and forms a varnish, called, on this account, a *drying oil.*

It contains palmitine, perhaps stearine, with a glyceride of linoleic acid ($C_{16}H_{28}O_2$)—the latter in a much greater quantity.

The cake left after expressing the oil (linseed-cake) is now largely used for feeding cattle (*see* OIL, LINSEED).

Linseed-meal is often adulterated with *bran*, *clay*, and *sawdust*. These admixtures may readily be detected by means of the microscope. The microscopical characters of linseed are as follows :—

The seed is covered by four coats or tunics. The outer coat contains the mucilage. It is composed of a single layer of very large hexagonal cells. The second coat consists of round thick-walled cells, enclosing granular matter, and also in a single layer. The third membrane is made up of longitudinal and transverse fibre. The fourth, of squarish cells, enclosing masses of a resinous colouring matter. The substance of the seed itself is made of cells enclosing starch and oil globules.

Boiling water extracts from 24 to 25 per cent. of ground linseed seeds, alcohol from 38 to 39 per cent.

Linseed-meal leaves from 4 to 5·25 per cent. of ash.

Liqueur—It will not be necessary for us to devote much space here to the consideration of this class of stimulants, since the principal ones are fully described in separate articles, and few have any special action of their own. A liqueur may be defined as being "a stimulating beverage composed of weak spirit aromatised and sweetened."

Noyeau is flavoured with the kernels of the peach, apricot, cherry, or with bitter almonds.

Maraschino derives its flavour from cherries.

Kirschwasser is also prepared from cherries. The cherries are bruised and allowed to ferment, the stones and kernels being used as well.

Anisette is flavoured with aniseed and coriander.

Kümmel consists of sweetened spirit flavoured with cumin and caraway seeds.

Parfait amour contains a number of aromatics—*e.g.*, lemon-peel, cinnamon, rosemary, cloves, mace, cardamoms, and orange flower-water. *See* ABSINTHIUM.

Liquorice—The underground stem or rhizome, fresh and dried, of a plant, *Glycyrrhiza glabra*, a native of the south of Europe, cultivated in this country at Mitcham in Surrey and other places. Liquorice is met with in the form of a powder, pharmacopœial extract, foreign extract, pipe-liquorice, and Pontefract lozenges. The powder is the root ground and pulverised ; the foreign extract is extensively imported from Spain, Italy, France, &c., under the name of *liquorice-juice*, or, according to the countries from whence it is brought, Spanish or Italian juice. Solazzi juice is most esteemed. The Spanish extract is prepared in Catalonia from *G. glabra*, while the Italian is obtained in Calabria from *G. echinata*. It is usually imported in the form of cylindrical rolls or sticks enveloped in bay leaves. When pure it is black and dry, with a glossy fracture and a sweetish taste, and is completely soluble in water. Hassall gives the composition of a hundred parts of the fresh root, a hundred parts of the undecorticated powder, and a hundred parts of the decorticated powder as follows :—

The Fresh Root.

Glycyrrhizine	8·60
Gum	26·60
Matter soluble in alcohol, chiefly resin	6·75
Albumen	0·97
Starch	22·91
Woody fibre	13·36
Moisture	26·81
Ash 3·07 per cent	...
Total	100·00

The Undecorticated Powder.

Glycyrrhizine	10·40
Gum	43·30
Matter soluble in alcohol, chiefly resin	1·09
Albumen	1·51
Starch	24·41
Woody fibre	15·20
Moisture	4·10
Total	100·00

The Decorticated Powder

Glycyrrhizine	13·0
Gum	37·1
Resin	0·8
Albumen	1·80
Starch	29·52
Woody fibre	16·58
Moisture	1·02
Total	99·82

The fresh root yields 35·2 per cent. of extract, the dry, 55 per cent.; 19·3 per cent. of the extract consists of liquorice-sugar.

Glycyrrhizine (liquorice-sugar) is an uncrystallisable sugar not susceptible of viuous fermentation.

The elements composing the root are shown by the microscope to consist of woody fibro, dotted ducts, and cellular tissue. Most of the cells of the cellular tissue are filled with small oval starch corpuscles.

The yellow colour appears to reside in the woody fibre and dotted ducts.

Adulterations.—Sago, rice, turmeric, wheat-flour, arrowroot, potato starch, Indian-corn, rye-flour, gelatine, cane-sugar, chalk, and in some cases copper. A chemical examination of the extract, a determination of the ash, and a microscopical examination cannot fail to discover these matters.

Litmus—Prepared by the united influence of air, water, ammonia, and either potassa or soda, from *Rocella tinctoria*, *Lecanora tartarca*, or any of the other *tinctorial lichens* capable of yielding archil, by a process similar to that used for archil, except that chalk or plaster-of-Paris is generally used to form the paste, which is moulded into cakes and dried. (*See* LICHENS.) Soluble in both water and alcohol. Its blue colour is reddened by acids, and is restored by the addition of alkalies.

Litmus paper is extensively used in the laboratory as a test for acids.

Litmus is sometimes used for colouring sugar confectionery.

Liver—Liver, as a food, is a highly nitrogenous substance, apt to disagree with those who have delicate stomachs. Its composition is as follows :—

Composition of the Calf's Liver (PAYEN).

Nitrogenous matter	20·10
Fat	3·58
Carbo-hydrates (amyloid matter)	0·45
Saline matter	1·54
Water	72·33
	98·03

The celebrated *foie gras*, so greatly esteemed as a luxury, is obtained by subjecting the goose to a special process of feeding in a dark place, whereby the liver becomes enormously enlarged and loaded with fat.

Composition of Foie gras (PAYEN).

Nitrogenous matter	13·75
Fat	54·57
Carbo hydrates (amyloid matter)	6·40
Saline matter	2·58
Water	22·70
	100·00

Loans, Borrowing Powers of Local Authorities—Urban and rural authorities, as well as joint boards and port sanitary authorities, under the Public Health Act, 1875, and the local board of health of any main sewerage district, and any joint sewerage board constituted under any of the Sanitary Acts existing when the said Public Health Act was passed, have power to borrow and reborrow on the credit of any fund or rate applicable by them to the purposes of the Act, or on the credit of sewage-land and plant; but the latter method of borrowing is to be deemed distinct from and in addition to the general borrowing powers of a local authority.—(P. H., s. 233, 235, 244.)

The borrowing powers are subject to the following regulations :—

1. Money shall not be borrowed except for permanent works (including under this expression any works of which the cost ought in the opinion of the Local Government Board to be spread over a term of years).

2. The sum borrowed shall not at any time exceed, with the balances of all the outstanding loans contracted by the local authority under the Sanitary Acts and this Act, in the whole the assessable value for two years of the premises assessable within the district in respect of which such money may be borrowed.

3. Where the sum proposed to be borrowed with such balances (if any) would exceed the assessable value for one year of such premises, the Local Government Board shall not give their sanction to such loan until one of their inspectors has held a local inquiry and reported to the said board.

4. The money may be borrowed for such time, not exceeding sixty years, as the local authority, with the sanction of the Local Government Board, determine in each case; and, subject as aforesaid, the local authority shall either pay off the moneys so borrowed by equal annual instalments of principal or of principal and interest, or they shall in every year set apart as a sinking fund, and accumulate in the way of compound interest by investing the same in the purchase of exchequer bills or other Government securities, such sum as will be sufficient to pay off the moneys so borrowed, or a part thereof, at such times within the period sanctioned as the local authority may determine.

5. A local authority may at any time apply the whole or any part of a sinking fund set apart under this Act, in or towards the discharge of the moneys for the repayment of which the fund has been established: provided that they pay into the fund in each year, and accumulate until the whole of the moneys borrowed are discharged, a sum equivalent to the interest which would have been produced by the sinking fund or the part of the sinking fund so applied.

6. Where money is borrowed for the purpose of discharging a previous loan, the time for repayment of the money so borrowed shall not extend beyond the unexpired portion of the period for which the original loan was sanctioned, unless with the sanction of the Local Government Board, and shall in no case be extended beyond the period of sixty years from the date of the original loan.

Where any urban authority borrow any money for the purpose of defraying private improvement expenses, or expenses in respect of which they have determined a part only of the district to be liable, it shall be the duty of such authority, as between the ratepayers of the district, to make good, as far as they can, the money so borrowed, as occasion requires, either out of private improvement rates, or out of a rate levied in such part of the district as aforesaid.—(P. H., s. 234.)

The funds, rates, sewage-land, &c., may for the purposes of borrowing be mortgaged. *See* MORTGAGE, RENT-CHARGE.

The Public Works Loan Commissioners have power to make any loan to a local authority for the purposes of the Public Health Act on the security of the rates, &c.—(P. H., s. 242.)

"And on the recommendation of the Local Government Board they may make any loan to a local authority, whether for works already executed or yet to be executed, on the security of any fund or rate applicable to any of the purposes of the Public Health Act, and without requiring any further or other security, such loan to be repaid within a period not exceeding fifty years, and to bear interest at the rate of three and a half per centum per annum, or such other rate as may, in the judgment of the Commissioners of the Treasury, be necessary, in order to enable the loan to be made without loss to the Exchequer:

Provided—

1. That in determining the time when a loan under this section shall be repayable, the Local Government Board shall have regard to the probable duration and continual utility of the works in respect of which the same is required.
2. That this section shall not extend to any loan required for the purpose of defraying expenses incurred by the Local Government Board in the performance of the duty of a defaulting local authority after the passing of the Public Health Act, 1872.

"In the case of a loan made before the passing of the Public Health Act, 1872, to any local authority in pursuance of any powers conferred by the Sanitary Acts, the Public Works Loan Commissioners may reduce the interest payable thereon to the rate of not less than three and a half per centum per annum."—(P. H., s. 243.)

The sanitary works for which the Commissioners may lend money are defined in the first schedule of the Public Works Loans Act (38 & 39 Vict. c. 89) as follows:—

Baths and wash-houses provided by local authorities.

Burial-grounds provided by burial boards, or (in Scotland) by burial boards or parochial boards.

Conservation or improvement of rivers or main drainage.

Improvement of towns.

Labourers' dwellings.

Waterworks established or carried on by a sanitary or other local authority.

Any work for which a sanitary authority are authorised to borrow under the Public Health Act, 1875.

Any work for which a local authority are authorised to borrow under the Public Health (Scotland) Act, 1867, or any Act amending the same.

Besides the powers under the Public Health Act, local authorities may have recourse to the Local Authorities Loans Act (38 & 39 Vict. c. 83), which became law in August 1875, and of which the following is a summary:—

The Act comes into force January 1, 1876. It does not extend to Scotland or Ireland.

Any local authority having power to levy a rate for public local purposes, leviable on the basis of an assessment in respect of property, may have recourse to the Act.

A local authority shall be deemed to borrow under the Act when it raises a loan by the issue of debentures or debenture stock, or annuity certificates, or partly in one way and partly in another; but where a particular mode is prescribed, that and no other is to be adopted.—(Sect. 4.)

A debenture as well as an annuity certificate is to take effect as a deed charging the local rate or property specified therein with payment, as in the debenture mentioned, of the principal sum and interest therein specified, or in the case of certificates, of the annual sum therein specified.

Where a debenture or an annuity certificate charges property other than the local rate, and it is intended, in default of payment of the principal and interest, that the property is to be sold, this is to be stated. The principal sum may be made payable to the bearer of the debenture or annuity certificate, or to a person named therein, his executors, administrators, or assigns.

A debenture or certificate in which the principal sum is made payable to the bearer is to be transferable by delivery; but where made payable to a person named therein, his executors, &c., a debenture is to be termed a nominal debenture, a certificate a nominal annuity certificate, and they are to be transferable by deed.

A debenture is not to be issued for a less sum than the prescribed sum, or where no sum is prescribed, than £20; and there is a similar restriction with regard to annual certificates, but in this case the least sum is £3.

There may be attached to a debenture under the Act, or be thereafter issued in respect thereof, or partly in one way and partly in the other, coupons making the interest as therein mentioned payable to the bearer, or to the person named, or to his order; or the interest may be made payable to the owner of the debenture, or otherwise, as mentioned therein.—(Sect. 5, 7.)

On certain conditions set forth in detail in the 6th section of the Act, a local authority, duly empowered to do so, may create and issue debenture stock.

All sums due or authorised to be raised on or in respect of the same loans are to be paid without any preference. When issued in respect of several loans, they are to take priority according to the dates of the loan. Moneys borrowed under the Act may, unless otherwise prescribed, be raised as one or several loans, as most convenient to the borrowers, providing the aggregate amount authorised to be borrowed is not exceeded. The date of the commencement of each loan is to be fixed by the local authority, and may be so fixed irrespectively of the dates of the particular securities issued in respect of the loans, so, however, that the period within which the loan required to be discharged be not exceeded.—(Sect. 8.)

In cases of non-payment by a local authority of moneys due on securities under the Act, a remedy may be had by *mandamus* or by the appointment of a receiver.

But a receiver cannot be appointed unless the aggregate amount, whether in one sum or separate sums, amounts to at least £500.—(Sect. 11, 12.)

Every loan is to be discharged within the prescribed period; where no period is prescribed, the period is to be twenty years. The discharge of the loan is to be secured by one or more of the following methods:—

1. By the issue of annuity certificates limited to expire within the prescribed period.

2. By the issue of debentures in such manner as to make it obligatory on the local authorities to pay off an equal sum in each year to the prescribed period, or to some lesser period.

3. By the annual appropriation of a fixed sum to the discharge of a certain portion of such loan.

4. By the creation of a sinking fund where such is prescribed, but not otherwise.—(Sect. 13.)

Various regulations with regard to sinking funds, including an annual return to the Local Government Board of the amount invested and applied for the purpose of a sinking fund, are set forth in detail in the 15th and 16th sections.

Any trustee or other persons authorised or directed to invest any moneys in the debentures or debenture stock of any railway or other company, may, unless the contrary is provided by the instrument authorising or directing such investment, invest such moneys in nominal debentures or nominal debenture stock.—(Sect. 27.)

The Act also contains provisions as to coupons. The principal are as follows: Coupons, in respect of any debenture or stock certificate to bearer, may be issued comprising the interest payable during the whole term of the debenture, or during any less period. At the expiration of any such less period, fresh coupons may be issued, or such debenture, &c., may be exchanged for another, with coupons for a further period.—(Sect. 17, 18, 19.)

Stock certificates to bearer may under certain regulations be converted into nominal debenture stock. A trustee of debenture stock is not to hold a stock certificate to bearer unless authorised to do so by his trust. —(Sect. 20, 21.)

Any local authority about to raise a loan under the Act may apply to the Local Government Board to authorise the issue of securities under official sanction. Before granting such sanction the Local Government Board is to require the local authority to produce particulars of its financial condition, and the sanction of the Local Government Board is not to be given unless that board is satisfied with the results of the inquiries made. Securities under official sanction are to be authenticated by official stamp, as the Local Government Board may direct. The sanction of the Local Government Board is to be conclusive evidence that the securities to which it relates are in conformity with the Act. The owner of any security issued under official sanction is to be furnished, in the case of a security on a rate, with a statement of the rateable value of the property subject to the rate; and in case of a security charged on property, with a statement of the estimated value of such property, also to the relative priority of the loan in respect of which such security is issued, and of the other loans, if any, of the local authority.—(Sect. 26.)

The Public Works Loans Commissioners may, under conditions, accept securities under the Act.—(Sect. 28.)

Local authorities may reborrow in manner provided by the Act for the purpose of discharging their loans, provided that the time for repayment of any money so borrowed shall not be extended beyond the unexpired portion of the term for which the original loan was contracted unless with the sanction of the Local Government Board, and in no case shall be extended beyond the prescribed period.—(Sect. 31.)

The foregoing are the principal and important sections of the Local Loans Act, and for further information the Act itself must be consulted. *See also* MORTGAGE, RENT-CHARGE.

Lobster—The lobster is of difficult digestibility, and therefore should be carefully avoided by the invalid, the dyspeptic, and the aged. The flesh is white and firm, and it is regarded as a choice article of food by most people. With some, however, it produces a cutaneous eruption, and other urgent symptoms for which it is difficult to account. The female or hen lobster is in special request for making sauce, and for the sake of the spawn or eggs belonging to it. These pounded and mixed with the sauce give it the desired red colour. The part commonly called the "coral," which becomes of a bright red colour on boiling, consists of the ovary, and is used for garnishing.

Composition of the Edible Portions of the Lobster (PAYEN).

	Flesh.	Soft internal Substance.	Spawn.
Nitrogenous	19·170	12·140	21·892
Fatty	1·170	1·444	8·234
Mineral	1·823	1·749	1·998
Non-nitrogenous and loss	1·219	0·354	4·893
Water	76·618	84·313	62·983
	100·000	100·000	100·000

Potted lobster is frequently coloured with Armenian bole.

Local Authorities—"Local Authority" means urban sanitary authority, and rural sanitary authority.—(P. H., s. 4.) *See* SANITARY AUTHORITIES.

Local Boards—*Local Government District.*—A "Local Government District" means any area subject to the jurisdiction of a local board constituted in pursuance of the Local Government Acts before the passing of the Public Health Act, or in pursuance of the last-mentioned Act, and "Local Board" means any board so constituted. The rules as to the meetings of local boards are contained in the first schedule of the Public Health Act, 1875, and are as follows:—

Rules applicable to Local Boards.

1. Every local board shall from time to time make regulations with respect to the summoning, notice, place, management, and adjournment of their meetings, and generally with respect to the transaction and management of their business under this Act.

2. No business shall be transacted at any such meeting unless at least one third of the full number of members be present thereat, subject to this qualification, that in no case shall a larger quorum than seven members be required.

3. Every local board shall from time to time at their annual meeting appoint one of their number to be chairman for one year at all meetings at which he is present.

4. If the chairman so appointed dies, resigns, or becomes incapable of acting, another member shall be appointed to be chairman for the period during which the person so dying, resigning, or becoming incapable would have been entitled to continue in office, and no longer.

5. If the chairman is absent from any meeting at the time appointed for holding the same, the members present shall appoint one of their number to act as chairman thereat.

6. The names of the members present, as well as of those voting on each question, shall be recorded, so as to show whether each vote given was for or against the question.

7. Every question at a meeting shall be decided by a majority of votes of the members present, and voting on that question.

8. In case of an equal division of votes the chairman shall have a second or casting vote.

9. The proceedings of a local board shall not be invalidated by any vacancy or vacancies among their members, or by any defect in the election of such board, or in the election or selection or qualification of any members thereof.

10. Any minute made of proceedings at a meeting, and copies of any orders made or resolutions passed at a meeting, if purporting to be signed by the chairman of the meeting at which such proceedings took place or such orders were made or resolutions passed, or by the chairman of the next ensuing meeting shall be received as evidence in all legal proceedings; and until the contrary is proved, every meeting where minutes of the proceedings have been so made shall be deemed to have been duly convened and held, and all the proceedings thereat to have been duly had.

11. The annual meeting of a local board shall be held as soon as may be convenient after the annual election of members; and the first meeting of a local board for a district constituted after the passing of this Act shall be held at such place and on such day (not being more than ten days after the completion of the election) as the returning officer may by written notice to each member of the board appoint; and the members shall appoint one of their number to be chairman at such meeting, and shall also appoint one of their number to be chairman for one year at all meetings at which he is present.

12. Nothing in these rules contained with respect to the appointment of chairman shall apply to the Oxford district, and in such district a chairman shall be appointed as heretofore.

Formation of Local Government District.—A rural sanitary authority may by application to the Local Government Board manage their affairs by a local board, and make their district a local government district. If the district has no known boundary, the Local Government Board may settle a boundary by order.—(P. H., s. 272.)

The procedure of the first formation of a local government district is as follows: First, a meeting must be called of ratepayers and owners, as detailed under article RESOLUTIONS. The resolution having passed, if not less than one-twentieth of the owners or ratepayers, or the owners and ratepayers in respect of one-twentieth of the rateable property in the place, are desirous that the district be not constituted a local government district, they may petition the Local Government Board against it. Any owner or ratepayer may also, within six weeks after the decision, dispute the validity of the vote, on giving fourteen days' notice to the parties interested. In both these cases the Local Government Board makes local inquiry and gives such order as may appear necessary.

The Local Government Board having, however, determined that the resolution is valid, the next step is the election, the rules for which are set forth in great detail in the second schedule to the Public Health Act, 1875, and are substantially as follows:—

The number and qualification of members are determined by the order forming the district, and may be decreased or diminished from time to time by order of the Local Government Board.

A person is not qualified to be a member of a local board unless at the time of his election, and so long as he continues in office by virtue of such election, he is resident within the district for which or for part of which he is elected, or within seven miles thereof, and is seised or possessed of real or personal estate, or both, to the value of not less than five hundred pounds in districts containing less than twenty thousand inhabitants, or to the value of not less than one thousand pounds in districts containing twenty thousand or more inhabitants; or is rated to the relief of the poor of such district, or of some parish within the same, on an annual value of not less than fifteen pounds in districts containing less than twenty thousand inhabitants, or on an annual value of not less than thirty pounds in districts containing twenty thousand or more inhabitants.

Where two or more persons are jointly seised or possessed of real or personal estate, or both, of such value or amount as would, if equally divided between them, qualify each to be elected, or if two or more persons are jointly rated in respect of any property which if equally divided between them would qualify each to be elected, each of the persons so jointly seised, possessed, or rated may be elected, but the same property shall not at the same time qualify the owner and the occupier thereof.

A person who is a bankrupt or whose affairs are under liquidation by arrangement, or who has entered into any composition with his creditors, shall be incapable, so long as any proceedings in relation to such bankruptcy, liquidation, or composition are pending, of being elected member of a local board.

If the district has been divided into wards by provisional order (*see* WARDS), and any member is elected in more than one ward, the local board at their meeting shall decide which ward he shall represent, and a vacancy be declared in the other ward or wards.

Those who are qualified to vote do so according to the following scale:—

If the property in respect of which the person is entitled to vote is rated to the poor-rate on a rateable value of less than fifty pounds, he shall have one vote; if such rateable value amounts to fifty pounds and is less than one hundred pounds, he shall have two votes; if it amounts to one hundred pounds and is less than one hundred and fifty pounds, he shall have three votes; if it amounts to one hundred and fifty pounds and is less than two hundred pounds, he shall have four votes; if it amounts to two hundred pounds and is less than two hundred and fifty pounds, he shall have five votes; and if it amounts to or exceeds two hundred and fifty pounds, he shall have six votes.

An owner and occupier of the same property is entitled to vote in respect of both ownership and occupation.

In the case of property belonging to a body of persons, such body is deemed to be one owner for the purpose of voting, and no member of such body is entitled to vote individually.

The local board shall cause a register to be made and kept, and from time to time revised, in which shall be entered the names, addresses, and qualifications of the owners making claims, and the names or descriptions, addresses, and qualifications of the bodies appointing the proxies, and the names and addresses of such proxies; and such register shall be open to the inspection of candidates and other persons interested at any election or in any question at which any such owner or proxy claims to vote, subject to such regulations as the local board may prescribe for the prevention of loss, injury, or disorder.

An owner or proxy is not entitled to vote unless his name is on the register, or unless at least fourteen days previously to the last day appointed for the delivery of the voting papers, he delivers to the proper person a claim in writing, &c.

The *returning officer* for the purposes of the election of a local board shall be the chairman of the board, or in the case of the first election, if the district is constituted by provisional order, such person as may be appointed by order of the Local Government Board; and if the district is constituted in pursuance of a resolution of owners and ratepayers, the summoning officer of the meeting of owners and ratepayers; and all powers and duties by the Act vested in or imposed on the returning officer, and all other duties requisite to be performed by him in relation to such election, shall be exercised and performed by the chairman or such person as aforesaid.

If the office of chairman be vacant, or if the chairman be absent from illness or other sufficient cause, in the case of the first election, the Local Government Board appoints a chairman; in any other case, the local board.

The returning officer may appoint a deputy, the local board may also appoint persons to assist him in his duties.

At least twenty-one days before the last day appointed for delivery of nomination papers the returning officer shall publish a notice, signed by him, and specifying—

- The number and qualification of the persons to be elected;
- The place where the nomination papers hereinafter mentioned are to be delivered or sent to him;
- The last day on which they are to be delivered or sent in;
- The mode of voting in case of a contest;
- The day or days on which the voting papers will be delivered, and the day on which they will be collected; and
- The place for the examination and for the casting up of the votes;

and shall also cause copies of such notice to be affixed at the places where parochial notices are usually affixed.

The returning officer may, if he thinks fit, cause to be made an alphabetical list of the persons entitled to vote at the election.

The clerk of the board of guardians of any union, and the overseers or other officers of every parish wholly or in part within the parts for which the election is held, and having the custody of any books or papers relating to the election of guardians of the poor, or of the poor-rate books relating to any such parish, shall permit the same to be inspected and copies or extracts to be taken therefrom by the returning officer. Any person having the custody of any such books or papers who refuses to permit the same to be inspected, or copies or extracts to be taken therefrom, shall be liable to penalty not exceeding five pounds.

Any person entitled to vote may nominate for the office of member of the local board himself (if qualified to be elected), or any other person or persons so qualified (not exceeding the number of persons to be elected).

Every such nomination shall be in writing, and shall state the names and residence and calling or quality of the person or persons nominated, and shall be signed by the person nominating, and be delivered or sent to the returning officer.

Any person nominated may withdraw from his candidature by giving notice to that effect, signed by him, to the returning officer.

If the number of persons nominated and not withdrawn is the same as or less than the number of persons to be elected, such persons (if duly qualified) shall be deemed and shall be certified by the returning officer under his hand to be elected.

If the number nominated and not withdrawn exceeds the number to be elected, the returning officer shall cause voting papers, in the form L. (*see* VOTING), to be prepared and filled up, and shall insert therein the names and residence and the calling or quality of each of the persons nominated, in the alphabetical order of the surnames of such persons, but it shall not be necessary to insert more than once the name of any person nominated.

The returning officer shall, three days at least before the day of collection of the voting papers, cause one of such voting papers to be delivered, by persons appointed by him for that purpose, at the address stated in the register or claim of each owner and proxy, and at the residence within the district of each ratepayer entitled to vote therein.

Each voter shall write his initials in the voting paper delivered to him against the name or names of the person or persons (not exceeding the number of persons to be elected) for whom he intends to vote, and shall sign such voting paper.

Any person voting as a proxy shall in like manner write his own initials and sign his own name, and state also in writing the name of the body of persons for whom he is proxy.

Any voter unable to write shall affix his mark at the foot of the voting paper in the presence of a witness, who shall attest and write the name of the voter against the mark, as well as the initials of such voter against the name of every candidate for whom the voter intends to vote.

The returning officer shall cause the voting papers to be collected on the day of collection by such persons as he may appoint.

No voting paper shall be received or admitted unless the same has been delivered at the address or residence as aforesaid of the voter, nor unless the same is collected by the persons appointed for that purpose: Provided—

a. That if any person qualified to vote has not received a voting paper as aforesaid, he shall, on personal application before the day of collection to the returning officer, be entitled to receive a voting paper from him, and to fill up the same in his presence, and then and there to deliver the same to him :

b. That if any voting paper duly delivered has not been collected, through the default of the returning officer or the persons appointed to collect the same, the voter in person may deliver the same to the returning officer before twelve o'clock at noon on the day, or on the first day (as the case may be) appointed for the examination and casting up of the votes.

If any person nominated, or any person on his behalf, gives at least one clear day's notice in writing to the returning officer, before the delivery or collection of the voting papers, of an intention to send some agent to accompany the deliverer or collector of the papers, the returning officer shall make his arrangements so as to enable the person appointed by him to be so accompanied, but no such agent shall interfere in any respect in the delivery or collection of the voting papers.

The returning officer shall on the day immediately following the day of collection of the voting papers, and on as many days immediately succeeding as may be necessary, attend at the place appointed for the examination and casting up of the votes, and ascertain the validity of the votes, by an examination of the rate-books and such other books and documents as he may think necessary, and by examining such persons as he may see fit; he shall cast up such of the votes as he finds to be valid, and to have been duly given, collected, or received, and shall ascertain the number of such votes for each candidate.

Any candidate may himself attend or may appoint any agent to attend the examination and casting up of the votes; any candidate or agent so attending who obstructs or in any way interferes with the examination and casting up of the votes may, by order of the returning officer, be forthwith removed from the place appointed for that purpose, and if so removed shall not be permitted to return.

The candidates to the number to be elected who, being duly qualified, have obtained the greatest number of votes, shall be deemed and shall be certified by the returning officer under his hand to be elected, and to each person so elected the returning officer shall forthwith send or deliver notice of his election.

The returning officer shall also cause to be made a list containing the names of the candidates, together with (in case of a contest) the number of votes given for each, and the names of the persons elected, and shall sign and certify such list, and shall deliver the same, together with the nomination and voting papers which he has received, to the local board at their first or next meeting (as the case may be), who shall cause the same to be deposited in their office.

Such list shall during office hours be open to public inspection, together with all other documents relating to the election, for six months after the election, without fee or reward; and the returning officer shall, as soon as may be after the completion of the election, cause such list to be printed, and copies thereof to be affixed at the usual places for affixing parochial notices within the parts for which the election has taken place.

The returning officer shall make all his arrangements for the conduct of the election so as to ensure its completion and the ascertainment of the result, on or before the fifteenth of April in each year; and on that day such candidates shall come into office, and until that day the members in whose room they are elected shall continue to hold office.

Provided that the first election of a local board for a district constituted after the passing of the Act may be held at any time mentioned in the order constituting the district, and the members shall come into office on the day appointed for their first meeting, but shall for the purposes of retirement be deemed to have been elected on the fifteenth of April next following the commencement of the order.

A person shall not act as a member of a local board (except in administering the following declaration) until he has made and signed before two or more other members of such board a declaration in writing to the effect following; (that is to say,)

I, *A. B.*, do solemnly declare that I am seised or possessed of real or personal [*or* real and personal] estate to the value or amount of [*or* that I am rated to the relief of the poor of on the annual value of .]

(Signed) *A. B.*

Made before us, *C. D.* and *E. F.*, members of the Local Board for the District of , this day of .

Such declaration shall be signed by the person making the same, and shall be filed and kept by the clerk of the local board; and any person who falsely or corruptly makes and subscribes such declaration, knowing the same to be untrue in any material particular, shall be deemed guilty of a misdemeanour.

Any person who neglects to make and subscribe the declaration required by the Act for the space of three months next after he has become a member of the local board shall be deemed to have refused to act, and shall cease to be a member of such local board, and his office as such shall thereupon become vacant.

One-third of the number of members elected for the whole or any part or parts of a district respectively shall go out of office on the fifteenth of April in each year.

The order in which the persons elected at the first election of a local board for a district constituted after the passing of the Act shall go out of office shall be regulated by the local board; and if the number of persons to be elected is not divisible by three, the proportion to go out of office in each year shall be regulated by the local board, so that as nearly as may be one-third shall go out of office in each year.

No person elected shall in any case continuously remain in office for more than three years: provided that if the number of persons to be elected for any part of a district is less than three, the persons elected shall go out of office on the fifteenth of April in such year or years as the local board may, with the sanction of the Local Government Board, determine.

Before the fifteenth of April in each year a number of persons shall be elected equal to the number of retiring members, and so many others as may be necessary to complete the full number of the local board in respect of which the election is held.

Any person who has ceased to be a member is re-eligible (if qualified).

Any member who ceases to hold his qualification, or becomes bankrupt, or submits his affairs to liquidation by arrangement, or compounds with his creditors, or is absent from meetings of the local board for more than six months consecutively (unless in case of illness), or accepts or holds any office or place of profit under the local board of which he is member, or in any manner is concerned in any bargain or contract entered into by such board, or participates in the profit thereof, or of any work done under the authority of the Act in or for the district, shall, except in the cases next hereinafter provided, cease to be such member, and his office as such shall thereupon become vacant:

Provided that no member shall vacate his office—

By reason of his being interested in the sale or lease of any lands, or in any loan of money to the local board; or

By reason of his being interested in any contract with the local board as a shareholder in any joint-stock company, but he shall not vote at any meeting of the local board on any question in which such company are interested, save that in the case of a water company, or other company established for the carrying on of works of a like public nature, this prohibition may be dispensed with by the Local Government Board.

Casual Vacancies.—Any casual vacancy occurring by death, resignation, disqualification, or otherwise in a local board may be filled up within six weeks by the local board out of qualified persons; but the member so chosen shall retain his office so long only as the vacating member would have retained the same if no vacancy had occurred.

In the event of a casual vacancy, or of an ordinary vacancy which ought to have been filled up at a previous election, being filled up at an annual election, if there is a poll, the member who has been elected by the fewest votes shall be deemed elected to fill such vacancy; if there is no poll, the member to be deemed to be elected to fill such vacancy shall be determined by lot.

Whenever the day appointed for the performance of any act in relation to any election is a Sunday, Christmas Day, or Good Friday, a Bank holiday, or any day appointed for public fast or thanksgiving, such act shall be performed on the day next following, unless it is one of the days excluded as aforesaid.

The necessary expenses attendant on any election, and such reasonable remuneration to the returning officer and other persons for services performed or expenses incurred by them in relation thereto as may be allowed by the local board, shall be paid out of the general district rates levied under the Act.

If the returning officer refuses or neglects to comply with any of the provisions of this schedule relating to elections, he shall be liable to a penalty not exceeding fifty pounds; and any person employed for the purposes of any such election by or under the returning officer who is guilty of any such neglect or refusal shall be liable to a penalty not exceeding five pounds.

Any person who—

Fabricates in whole or in part, alters, defaces, destroys, abstracts, or purloins any voting paper, or

Personates any person entitled to vote at any election, or

Falsely assumes to act in the name or on the behalf of any person so entitled to vote, or

Interferes with the delivery or collection of any voting papers, or

Delivers the same under a false pretence of being lawfully authorised so to do,

shall be liable to a penalty not exceeding twenty pounds, or, in the discretion of the court, to imprisonment with or without hard labour for any period not exceeding three months.

Any person who, not being duly qualified to act as member of the local board, or not having made and subscribed the declaration required of him by the Act, or being disabled from acting by any provision of the Act, acts as such member, shall be liable to a penalty of fifty pounds, which may be recovered by any person, with full costs of suit, by action of debt; in such action it shall be sufficient for the plaintiff to prove in the first instance that the defendant at the time when the offence is alleged to have been committed acted as such member; and the burden of proving qualification, and the making and subscription of the declaration, or of negativing disqualification by reason of non-residence, or not being seised or possessed of the requisite real or personal estate, or both, shall be on the defendant.

But all acts and proceedings of any person disqualified, disabled, or not duly qualified, or who has not made and subscribed the declaration required by the Act, shall, if done previously to the recovery of the penalty mentioned in the Act, be valid and effectual to all intents and purposes.

Where the district of a local board established under the Public Health Act, 1848, before the passing of the Local Government Act, 1858, comprises the whole or any part of a borough or boroughs, and also parts not within the boundaries of any such borough, the following provisions shall have effect (namely)—

a. Each person selected by the council of any such borough out of their own number shall be a member of the local board with which he is selected to act, so long as he continues without re-election to be member of the council from whom he was selected, and no longer; and a declaration shall not be required to be made by any person so selected.

b. Each person selected by any such council otherwise than out of their own number shall be a member of the local board with which he is selected to act, for one year from the date of his selection, and no longer.

c. In case of any vacancy in the number selected, some other qualified person shall be selected by the council by whom the person causing the vacancy was selected, within one month after the occurrence of the vacancy.

d. The meeting of any council at which any selection as aforesaid is made in pursuance of the Act shall to all intents and purposes be deemed to be a meeting held in pursuance of an Act passed in the sixth year of the reign of King William the Fourth, intituled "An Act for the Regulation of Municipal Corporations in England and Wales," and any Act amending the same.

e. If any person is both selected and elected to be a member of any such local board, he shall, within three days after notice thereof from the clerk, choose, or, in default of such choice, the local board of which he is so selected and elected to be member shall determine, the title in respect of which he shall serve; and immediately on such choice or determination the person so selected and elected shall be deemed to be member only in respect of the title so chosen or determined, and his office as member in respect of any other title shall thereupon become vacant.

Elective members of any local board established under the Public Health Act, 1848, before the passing of the Local Government Act, 1858, shall be elected by such owners of property and ratepayers and in such manner as in this schedule mentioned; and the provisions of this schedule (with the exception of the provisions relating to the number and qualification of members) shall apply accordingly.

All members of local boards existing at the time of the passing of the Public Health Act shall, notwithstanding any provision of any Act or order confirmed by Parliament, continue to hold office till the fifteenth day of April one thousand eight hundred and seventy-six; and the next election of members of such local boards shall be held in accordance with the provisions of this schedule.

The provisions of section twenty-six of the Sanitary Law Amendment Act, 1874, shall be deemed not to have been compulsory in the case of the first election of members of any local board elected after the passing of that Act, and before the passing of this Act; but all elections held or purporting to have been held in accordance with such provisions before the passing of the Act shall be deemed to have been duly held, and to be valid for all purposes.

Nothing in the rules of the schedules applies to the local government district of Oxford.

Proceedings in Case of Lapse of Local Board.—Where any local board lapses through its members ceasing to hold office, and failure to elect new members in manner by the Act provided, any mortgagee or other person entitled to any principal or interest on any mortgage of rates made by such local board may, without prejudice to any other mode of recovery, apply for the appointment of a receiver to a court of summary jurisdiction. The said court may, by writing under their hands, appoint a person to make, levy, and collect the whole or a competent part of the rates liable to the payment of the principal and interest in respect of which the application is made, and to recover all arrears of such rates until such principal and interest, together with the costs of the application and of collection, are paid; and on such appointment being made, all such rates, competent part thereof, and arrears, shall be paid to the receiver so appointed, and shall be rateably apportioned by him among the mortgagees or other persons entitled to the same.

In the case of any lapse of a local board, the owners and ratepayers of the district may, by resolution passed in manner provided by Schedule III. to the Act, determine to elect, and may accordingly proceed to the election of a new local board in manner provided by this schedule, and the result of such election shall be signified to the Local Government Board by the returning officer; and all the powers, rights, duties, property, and liabilities of the lapsed board shall attach to the new board as if there had been no lapse before the election thereof, and from the date of the completion of such election all powers of any receiver to make rates under this schedule shall determine.

If no election takes place in pursuance of this provision within three months from the date of the lapse of the board, the Local Government Board may by order dissolve the district, and declare it to be a rural district, or to be included in any adjoining rural district; and from and after a day named in such order all the powers, rights, duties, property, and liabilities of the lapsed board shall attach to the rural authority named in the order, and such property shall be held by the rural authority for the benefit of the dissolved district.

The Local Government Board may by order determine any question as to the fact of a local board having lapsed, or as to the date of the lapse of any local board.

In cases where an Improvement Act district or a local government district becomes a borough, all the powers, rights, liabilities, &c., of the local government district are transferred to the council of the borough.—(P. H., s. 310.)

Any local board may with the sanction of the Local Government Board change their name.—(P. H., s. 311.)

Local Board or **Local Government District of Oxford**—The following is a special enactment relative to Oxford:—

The local government district of Oxford shall be subject to the jurisdiction of a local board consisting of the vice-chancellor of the university of Oxford and the mayor of Oxford for the time being, and of forty-five other members, fifteen to be elected by the university of Oxford, sixteen by the town council of Oxford, and fourteen by the ratepayers of the parishes situated within the area formerly within the jurisdiction of the commissioners for amending certain mileways leading to Oxford, and making improvements in the university and city of Oxford, the suburbs thereof, and the adjoining parish of St Clement, and of the member or members for any parish or parts of parishes which may have been or may hereafter be added to the Oxford district.

After the passing of this Act a district formed out of the rural sanitary districts of the city of Oxford and the Abingdon union, to be termed the "Grandpont district," shall be defined by an order of the Local Government Board, and on a day to be mentioned in such order, the said district shall form part of the said local government district of Oxford.

The election of members of the said local board by the town council and by the ratepayers of the parishes and parts of parishes respectively shall be conducted at the same time, in the same way, and subject to the same regulations in and subject to which such election is conducted at the time of the passing of this Act.

As regards the district of Cowley now comprised in the said local government district of Oxford, and the district of Grandpont when added to the same district, the chairman of the said local board, or in his absence the clerk to the local board, shall summon a meeting of the several persons rated to the relief of the poor in respect of hereditaments situated in the said Cowley and Grandpont districts respectively, by public notices under his hand, to be affixed three clear days previously to the principal doors of every church and chapel in the districts; such meeting to be held on the day when the members for the parishes are elected, and at a place in each such district to be fixed by the chairman or clerk; and the appointment of a chairman, and all other the business of such meetings, shall be conducted as if the meetings respectively were the meetings of a vestry in a parish.

An election of the member for the Grandpont district shall take place as soon as convenient after that district has been added to the Oxford local government district as aforesaid, and he shall continue in office until the next annual election of the said local board.

The fifteen members to be elected by the university shall be elected as follows; namely, four members shall be elected by the university in convocation, and eleven members shall be elected by the heads and senior resident bursars of the several colleges, entitled by any statute of the university or otherwise to matriculate students, and by the heads of the several halls; any member of the university, being of the degree of Master of Arts, Bachelor of Civil Law, or Bachelor in Medicine, or any superior degree of the university, shall be qualified to be elected; and the elections shall be conducted by the said university, and by the colleges and halls respectively, at the same time, and in the same way, and subject to the same regulations, in and subject to which guardians of the poor for the university and for the colleges and halls are now or may hereafter be chosen by them respectively, save that in the election of members the heads and bursars of all the colleges and the heads of all the halls shall be summoned by the vice-chancellor for that purpose, and shall be entitled to vote.

Except as above provided, nothing in this Act shall affect the provisions of any order confirmed by Parliament relating to the local government district of Oxford, and in force at the time of the passing of this Act.—(P. H., s. 342.)

Local Government Board—This board is the supreme authority in all matters relating to public health. It has also, by an Act passed in 1871, all the powers and duties of the Poor-Law Board, which has been transferred into it, or, more properly speaking, absorbed. Its constitution is as follows: A President appointed by her Majesty. All her Majesty's Principal Secretaries of State for the time being. The Lord Privy Seal. The Chancellor of the Exchequer. A Parliamentary Secretary. A permanent Secretary.

It has also a medical officer, various inspectors (scientific, legal, and others), and a large staff of clerks and officials.

The powers and duties of the board are great and various. They are as follows:—

The powers and duties of the Poor-Law Board as far as it concerns England.

All the matters referring to public health hitherto devolving upon the Secretary of State or the Privy Council.

It has a general power over the acts of all local authorities.

It has all the powers and duties that the Board of Trade hitherto had under the Alkali Act, 1863. *See* ALKALI ACTS.

All the powers of the Board of Trade with respect to the supervision of the metropolitan water-supply.

All the powers and duties, &c., of the Home Secretary in relation to turnpike roads, highways, paths, and hedges in England and Wales are now transferred to the Local Government Board.

All the powers and duties relating to the registration of births, deaths, and marriages; drainage and all sanitary matters; baths and wash-houses; public monuments; town improvements; artisans' and labourers' dwellings.

The powers and duties of the Privy Council as to prevention of disease and vaccination.

And lastly, local taxation as far as the Home Secretary is concerned.

The Sanitary Acts formerly conducted by either the Secretary of State or the Privy Council may be conveniently summarised as follows:—

Secretary of State.

6 & 7 Will. IV. c. 86.	24 & 25 Vict. c. 61.
1 Vict. c. 22.	26 & 27 Vict. c. 17.
9 & 10 Vict. c. 74.	28 & 29 Vict. c. 75.
10 & 11 Vict. c. 84.	29 & 30 Vict. c. 96.
10 & 11 Vict. c. 61.	30 & 31 Vict. c. 113.
11 & 12 Vict. c. 63.	31 & 32 Vict. c. 115.
21 & 22 Vict. c. 98.	31 & 32 Vict. c. 130.
23 & 24 Vict. c. 36.	32 & 33 Vict. c. 100.

Privy Council.

11 & 12 Vict. c. 63.	23 & 24 Vict. c. 77.
18 & 19 Vict. c. 116.	29 & 30 Vict. c. 90.
21 & 22 Vict. c. 97.	30 & 31 Vict. c. 84.
22 & 23 Vict. c. 8.	31 & 32 Vict. c. 115.

The transfer power also applies to amended Acts; it therefore includes the recent Public Health Act, which consolidates a great many of these Acts, and also still farther enlarges the powers of the Local Government Board, especially as to the compulsory union of districts, &c.

The Local Government Board, when any portion of the salaries of officers is paid out of Government, has the power to confirm or reject their appointment, to lay down the duties, and to determine the salaries. Even when the salary of medical officer of health is paid entirely by the local authority, the Local Government Board may by order prescribe his qualification and duties.—(P. H., s. 191.)

The Local Government Board act often through provisional orders (*see* ORDERS, PROVISIONAL) and through "orders."

The general routine business of sanitary authorities—such as the regulation of salaries, the duties of their officers, and even certain compulsory matters, such as the union of districts for the joint appointment of a medical officer of health—may be dealt with by the "orders" of the Local Government Board without having recourse to a provisional order (except in the case of opposition). These orders are to be binding and conclusive as to the matters to which they refer.—(P. H., s. 295.)

The Local Government Board may from time to time make inquiries under the Public Health Act, the costs of such inquiries being settled by a Local Government "order;" and every such order may be made a rule of in one of the superior courts of law, on the application of any person named therein.—(P. H., s. 293, 294.)

The settlement of differences arising out of the transfer of powers or property to local authority is a matter which the Local Government Board has also power to settle by order.

The most important powers of the Local Government Board are (1) The compulsory union of districts (*see* SANITARY DISTRICTS); and (2) the power to enforce performance of duty by defaulting local authority, as follows:—

Where complaint is made to the Local Government Board that a local authority has made default in providing their district with sufficient sewers, or in the maintenance of existing sewers, or in providing their district with a supply of water, in cases where danger arises to the health of the inhabitants from the insufficiency or unwholesomeness of the existing supply of water, and a proper supply can be got at a reasonable cost, or that a local authority has made default in enforcing any provisions of this Act which it is their duty to enforce, the Local Goverument Board, if satisfied, after due inquiry, that the authority has been guilty of the alleged default, shall make au order limiting a time for the performauce of their duty in the matter of such complaint. If such duty is uot performed by the time limited in the order, such order may be enforced by writ of mandamus, or the Local Government Board may appoint some person to perform such duty, and shall by order direct that the expenses of performiug the same, together with a reasonable remuneration to the person appointed for superintending such performance, and amounting to a sum specified iu the order, together with the costs of the proceedings, shall be paid by the authority in default; and any order made for the paymeut of such expenses and costs may be removed into the Court of Queen's Bench, and be enforced in the same manner as if the same were an order of such court.

Any person appointed uuder this section to perform the duty of a defaulting local authority shall, in the performance and for the purposes of such duty, be invested with all the powers of such authority other than (save as hereinafter provided) the powers of levying rates; and the Local Government Board may from time to time by order change any person so appointed.—(P. H., s. 299.)

Any sum specified in an order of the Local Government Board for payment of the expenses of performing the duty of a defaulting local authority, together with the costs of the proceedings, shall be deemed to be expenses properly incurred by such authority, and to be a debt due from such authority, and payable out of any moneys in the hands of such authority or of their officers, or out of any rate applicable to the payment of any expenses properly incurred by such authority, which rate is in this part of this Act referred to as "the local rate." If the defaulting authority refuses to pay any such sum, with costs, as aforesaid, for a period of fourteen days after demand, the Local Government Board may by order empower any person to levy, by and out of the local rate, such sum (the amount to be specified in the order) as may, in the opinion of the Local Government Board, be sufficient to defray the debt so due from the defaulting authority, and all expenses incurred in consequence of the nonpayment of such debt.

Any person or persons so empowered shall have the same powers of levying the local rate, and requiring all officers of the defaulting authority to pay over any moneys iu their hands, as the defaulting authority would have in the case of expenses legally payable out of a local rate to be raised by such authority; and the said person or persons, after repaying all sums of money so due iu respect of the order, shall pay the surplus, if any (the amount to be ascertained by the Local Government Board), to or to the order of the defaulting authority.—(P. H., s. 300.)

The Local Goverument Board may from time to time certify the amouut of expenses that have been incurred, or an estimate of the expenses about to be iucurred, by auy person appointed by the said board under this Act to perform the duty of a defaulting local authority; also, the amount of any loan required to be raised for the purpose of defraying any expeuses that have been so incurred, or are estimated as about to be incurred; and the certificate of the said board shall be conclusive as to all matters to which it relates.

Whenever the Local Government Board so certifies a loan to be required, the Public Works Loan Commissioners may advance to the Local Government Board, or to any person appointed as aforesaid, the amount of the loan so certified to be required on the security of the local rate, without requiring any other security; aud the Local Government Board, or the person so appointed, may, by any instrument duly executed, charge the local rate with the repayment of the principal and interest due in respect of such loan, and every such charge shall have the same effect as if the defaulting local authority were empowered to raise such loan on the security of the local rate, and had duly executed an instrument charging the saue ou the local rate.—(P. H., s. 301.)

Any principal money or interest for the time being due in respect of any loan under this Act made for payment of the expenses incurred or to be incurred in the performance of the duty of a defaulting local authority shall be taken to be a debt due from such authority, and, in addition to any other remedies, may be recovered in the manner in which a debt due from a defaulting authority may be recovered in pursuance of the provisions of this Act.

The surplus (if any) of any such loan, after payment of the expenses aforesaid, shall, on the amount thereof being certified by the Local Government Board, be paid to or to the order of the defaulting authority.

"Expenses," for the purposes of the provisions of this part of this Act relating to defaulting local authorities, shall include all sums payable under those provisions by or by the order of the Local Government Board, or the person appointed by that board.—(P. H., s. 302.) *See* INSPECTORS, LOCAL GOVERNMENT; SANITARY AUTHORITIES, &c.

Lodging - Houses — *Common Lodging-Houses.*—The regulations as to lodging-houses are contained in the following sections of the Public Health Act, 1875:—

Every local authority shall keep a register in which shall be entered the names and residences of the keepers of all common lodging-houses within the district of such authority, and the situation of every such house, and the number of lodgers authorised according to this Act to be received therein.

A copy of any entry in such register, certified by the person having charge of the register to be a true copy, shall be received in all courts and on all occasions as evidence, and shall be sufficient proof of the matter registered, without production of the register, or of any document or thing on which the entry is founded; and a certified copy of any such entry shall be supplied gratis by the person having charge of the register to any person applying at a reasonable time for the same. —(P. H., s. 76.)

A person shall not keep a common lodging-house or receive a lodger therein until the house has been registered in accordance with the provisions of this Act; nor until his name as the keeper thereof has been entered in the register kept under this Act: provided that when the person so registered dies, his widow or any member of his family may keep the house as a common lodging-house for not more than four weeks after his death without being registered as the keeper thereof.—(P. H., s. 77.)

A house shall not be registered as a common lodging-house until it has been inspected and approved for the purpose by *some officer* of the local authority; and the local authority may refuse to register as the keeper of a common lodging-house a person who does not produce to the local authority a certificate of character, in such form as the local authority direct, signed by three inhabitant householders of the parish respectively rated to the relief of the poor of the parish within which the lodging-house is situated for property of the yearly rateable value of *six pounds* or upwards.—(P. H., s. 78.)

The keeper of every common lodging-house shall, if required in writing by the local authority so to do, affix and keep undefaced and legible a notice with the words "Registered Common Lodging-House," in some conspicuous place on the outside of such house.

The keeper of any such house who, after requisition in writing from the local authority, refuses or neglects to affix or renew such notice, shall be liable to a penalty not exceeding *five pounds*, and to a further penalty of *ten shillings* for every day that such refusal or neglect continues after conviction.—(P. H., s. 79.)

Every local authority shall from time to time make bylaws—

1. For fixing and from time to time varying the number of lodgers who may be received into a common lodging-house, and for the separation of the sexes therein; and,
2. For promoting cleanliness and ventilation in such houses; and,
3. For the giving of notices and the taking precautions in the case of any infectious disease; and,
4. Generally for the well-ordering of such houses.—(P. H., s. 80.)

Where it appears to any local authority that a common lodging-house is without a proper supply of water for the use of the lodgers, and that such a supply can be furnished thereto at a reasonable rate, the local authority may by notice in writing require the owner or keeper of such house, within a time specified therein, to obtain such supply, and to do all works necessary for that purpose; and if the notice be not complied with accordingly, the local authority may remove such house from the register until it is complied with.—(P. H., s. 81.)

The keeper of a common lodging-house shall, to the satisfaction of the local authority, limewash the walls and ceilings thereof in the first week of each of the months of April and October in every year. Penalty for neglect, *forty shillings* or less.—(P. H., s. 82.)

The keeper of a common lodging-house in which beggars or vagrants are received to lodge, shall from time to time, if required in writing by the local authority so to do, report to the local authority, or to such person as the local authority direct, every person who resorted to such house during the preceding day or night, and for that purpose schedules shall be furnished by the local authority to the person so ordered to report, which schedules he shall fill up with the information required, and transmit to the local authority.—(P. H., s. 83.)

The keeper of a common lodging-house shall, when a person in such house is ill of fever or any infectious disease, give immediate notice thereof to the medical officer of health of the local authority, and also to the poor-law relieving officer of the union or parish in which the common lodging-house is situated. —(P. H., s. 84.)

The keeper of a common lodging-house, and every other person having or acting in the care or management thereof, shall, at all times when required by any officer of the local authority, give him free access to such house or any part thereof. Penalty for refusing access, *five pounds* or less.—(P. H., s. 85.)

Any keeper of a common lodging-house, or other person having or acting in the care or management thereof, who—

1. Receives any lodger in such house without the same being registered under this Act; or
2. Fails to make a report, after he has been furnished by the local authority with schedules for the purpose in pursuance of this Act, of the persons resorting to such house; or
3. Fails to give the notices required by this Act where any person has been confined to his bed in such house by fever or other infectious disease,

shall be liable to a penalty not exceeding *five pounds*, and in the case of a continuing offence to a further penalty not exceeding *forty shillings* for every day during which the offence continues.—(P. H., s. 86.)

In any proceedings under the provisions of this Act relating to common lodging-houses, if the inmates of any house or part of a house allege that they are members of the same family, the burden of proving such allegation shall lie on the persons making it.—(P. H., s. 87.)

Where the keeper of a common lodging-house is convicted of a third offence against the provisions of this Act relating to common lodging-houses, the court before whom the conviction for such third offence takes place may, if it thinks fit, adjudge that he shall not at any time within five years after the conviction, or within such shorter period after the conviction as the court thinks fit, keep or have or act in the care or management of a common lodging-house without the previous licence in writing of the local authority, which licence the local authority may withhold or grant on such terms and conditions as they think fit.—(P. H., s. 88.)

For the purposes of this Act the expression "common lodging-house" includes, in any case in which only part of a house is used as a common lodging-house, the part so used of such house.—(P. H., s. 89.)

Bylaws as to Houses let in Lodgings.—The Local Government Board may, if they think fit, by notice published in the "London Gazette," declare the following enactment to be in force within the district or any part of the district of any local authority, and from and after the publication of such notice such authority shall be empowered to make bylaws for the following matters; (that is to say,)

1. For fixing the number, and from time to time varying the number of persons who may occupy a house or part of a house which is let in lodgings or occupied by members of more than one family, and for the separation of the sexes in a house so let or occupied:
2. For the registration of houses so let or occupied:
3. For the inspection of such houses:
4. For enforcing drainage and the provision of privy accommodation for such houses, and for promoting cleanliness and ventilation in such houses:
5. For the cleansing and limewashing at stated times of the premises, and for the paving of the courts and courtyards thereof:
6. For the giving of notices and the taking of precautions in case of any infectious disease.

This section shall not apply to common lodging-houses within the provisions of this Act relating to such houses.—(P. H., s. 90.)

Logwood—Logwood is the produce of the heartwood of the *Hæmatoxylon Campechianum.* It contains a crystalline matter termed *hæmatoxylin* ($C_{16}H_{14}O_6 \cdot H_2O$, and $3H_2O$. Gerhardt), which in its pure state is not red, but straw-yellow or honey-yellow. Logwood is extensively used in dyeing, for the production of reds, violets, purples, blacks, drabs, &c. It readily yields its colour both to spirits and boiling water. A solution of logwood is turned yellow by acids, and deepened in colour—which is a fine red turning on purple or violet—by alkalies. Logwood is used to colour tea, chicory, bottled red fruits, port wine, claret, &c.

Lupulite (syn. *Humulin*)—The bitter principle of hops may be procured by treating the aqueous extract of the lupulinic glands united with a little lime with alcohol. The alcoholic tincture is to be evaporated to dryness, the residue treated with water, and the solution evaporated. The residue when washed with ether is lupulite. It is neutral, uncrystallisable, yellowish white, very bitter, soluble in twenty parts of water, very soluble in alcohol, and slightly so in ether. Lupulite contains no nitrogen. *See* Hops.

M.

Maccaroni—This substance is manufactured from Italian wheat, which is remarkably rich in gluten. It is highly nutritious, but somewhat indigestible.

Weight for weight, maccaroni contains from two to three times as much flesh-forming material as good wheaten bread. This is the opinion of eminent analytical chemists at home and abroad, while Dr. Hassall claims for it far more nutrient power than any of the cereals employed as food in this country.

Mace—The tough, membranous, lacerated covering (*ariliode*) of the nutmeg. There are two varieties—the cultivated, and the wild or false mace; the latter is of a dark-red colour, and is deficient in flavour and aroma. In its general properties it resembles the nutmeg, but possesses a more agreeable odour. The following is, according to N. E. Henry, the composition of mace:—

Composition.

Volatile oil.
Red fat oil, soluble in alcohol.
Yellow fat oil, insoluble in alcohol.
Alcoholic extractive.
Amiden.
Ligneous fibre with lime.

Adulteration by the admixture of the wild mace is easily detected, on account of its dark red colour and its want of flavour and aroma.

Mackerel (the *Scomber scombrus*, Linn.)—A well-known, spiny-finned sea-fish, much esteemed at certain seasons for the table. It is characterised by the presence of about 7 per cent. of fatty matter incorporated with the flesh, and consequently is less suited for a delicate stomach than the white fish. Occasionally it induces symptoms resembling those of poisoning.

Madeira—*See* Wine.

Madura Foot (syn. *Mycetoma*)—This is a disease of the foot described (1860) by Dr. H. V. Carter of Bombay, and recognised about twenty years previously. It occurs in many parts of India, and the north-eastern shores of the Persian Gulf. It is due to a fungus which eats away and burrows into the bones of the foot. Mr. Berkeley, our eminent fungologist, succeeded in developing a peculiar mould, the perfect condition of the species, from portions of mycelium which were sent him by Dr. Carter.

There appear to be three distinct forms.

Fig. 59.

The first form is that in which the bones of the foot and the lower end of the leg bones are perforated in every direction with canals and cavities, the cavities being filled up with the fungus, which is in the form of black masses: these masses are of a dark red colour internally. The whole of the surrounding softer parts are embedded in a semi-opaque glairy substance. There is a fœtid purulent discharge, and the whole foot is enlarged and has somewhat the appearance of the swelling seen in bad cases of scrofula (*see* fig. 59).

There are also to be seen in the skin ovate groups of minute orange-coloured particles, and occasionally layer cells. Fig. 60, from the "Intellectual Observer," shows the larger cells.

Fig. 60.

They present the character of a true *oidium*, such as *O. fulvum*. Short, beaded, tawny threads arise from a common base, consisting of cylindrical articulated filaments, bearing on their tips spore-like cells. The fungus of the foot closely resembles the genus *mucor*, but there is no *columella* in the sporangium —a character which accords with *chionyphe* rather than with *mucor*, therefore the species has been named by Mr Berkeley *Chionyphe Carteri.*

In the second form the black fungus masses are wanting, and there are white granules instead; the disease, however, is the same.

The third form occurs in *madura*, hence the ame madura foot. In this form, also, there are no black masses, but small particles looking like grains of red pepper.

This disease of the foot is confined to the natives of India who go about with naked feet. The fungus germ is very probably introduced through some scratch or abrasion of the skin. The only remedy is amputation. It is evidently a preventible disease, and the means are obvious—viz., cleanliness and the efficient protection of the feet.

Magnesia (oxide of magnesium, MgO)—Magnesium, the metallic base of the magnesian salts, does not exist native. When obtained artificially it is a brilliant grey-coloured metal, specific gravity 1·7, not readily oxidised except when heated in air; it then forms the earth magnesia. This is a white powder with scarcely any taste, almost insoluble in water, but when moistened gives a slight alkaline reaction to turmeric paper, turning it brown. It dissolves without effervescence in hydrochloric acid, and the solution, when neutralised by a mixed solution of ammonia and chloride of ammonia, gives a copious crystalline deposit when phosphate of soda is added (the ammonio-magnesian phosphate). Dissolved in nitric acid, and neutralised with a mixture of ammonia and chloride of ammonium, it does not give any precipitate with oxalate of ammonia or chloride of barium, showing the absence of any sulphate of lime or carbonate of magnesia and lime—the most frequent adulterations.

Magnesia is used for the purpose of adulterating tea, tobacco, and other substances, and it is found in the ash of coffee and chicory.

Maize—*See* FLOUR, INDIAN-CORN, &c.

Maizina — This substance is prepared from Indian-corn meal. *See* INDIAN-CORN.

Malaria—*See* MARSHES.

Malignant Pustule — *See* PUSTULE, MALIGNANT.

Malt—A name given to different kinds of grain which have become sweet from the conversion of some of their starch (or cellulose?) into sugar, in consequence of incipient germination artificially produced. The principal cereals so treated are barley, oats, rye, maize, &c.; but barley is the grain usually employed.

Pale malt is that produced when the barley is dried at a temperature ranging between 90° and 120° F. This forms the basis of all malt liquors.

Yellow or *pale amber malt* is formed when the heat is raised to from 125° to 135°.

Amber malt is produced when the temperature ranges between 140° and 160°; and if heated to 160° or 180°, the product is known as amber-brown or pale brown malt. The latter is much used for colouring and flavouring stout and porter.

According to the experiments of Lawes, 100 parts of dry barley yield 90·22 of malt, 93·99 of malt and kiln dust.

Barley loses as much as 13·5 per cent. of the total quantity of nitrogen contained in 100 parts of the dry grain in being converted into malt. Lawes found the nitrogen in the barley to amount to 1·78 per cent. of the weight of the dry grain; that contained in dry malt being 1·70 per cent.

Barley yields about 80 per cent. of malt after drying and sifting from the radicles. Thompson says that 12 per cent. of this loss is due to water, only 8 per cent. being wasted in the form of carbonic anhydride and trimmings. The amount of diastase yielded does not exceed $\frac{1}{200}$ of the weight of the grain; and it is found that other grains do not give even so much as this.

In order to determine the quality of malt, three things are required to be known—viz., (*a*) the amount of moisture; (*b*) the amount of soluble matter; (*c*) the amount of sugar. The first may be obtained by evaporating in the water-bath about 1 gramme of the carefully weighed and powdered substance until it ceases to lose weight. Malt generally contains 7 or 8 per cent. of water.

The soluble matter and extract may be obtained in an exactly similar manner to that described under Tea. Good malt gives 66 per cent. of extract.

For the estimation of the sugar, *see* SUGAR, ESTIMATION OF. *See also* BEER, &c.

Manganese, Chloride of ($MnCl_2$)—This substance is useful for preventing decay of animal matter. *See* DISINFECTANTS.

Manures—The food of vegetables, in so far as their organic structure is concerned, consists entirely of inorganic compounds, which are carbonic acid, water, and ammonia—the final products of putrefaction; but unless to these be added small quantities of certain mineral substances, the vegetable does not obtain sufficient nutriment. The mineral matters found in the ashes of plants—silica, potassa, and phosphate of lime, magnesia, soda, sulphates, and oxide of iron, and other matters—appear to be essential to the existence of the vegetable tissue, so that plants will not grow in soils destitute of them. The carbon contained in plants is derived from the carbonic acid, the hydrogen and oxygen are chiefly derived from the water, and the nitrogen from the ammonia which is supplied to them in rain and in manures, and which remains in the soil until absorbed by the roots.

Differing from Baron Liebig in his "mineral theory" of manuring, Messrs. Lawes and Gilbert have, from extensive experiments, come to the conclusion that it is impossible to obtain good crops by using mineral manure alone, and that nitrogenous manures (farmyard manure, guano, ammoniacal salts, &c.) are fertilising agents of the highest order. The following are some of the numerous substances which come under the designation of manures: Dejecta and débris of animals; refuse from slaughter-houses (blood, &c.), stables, cesspools, and certain manufactories; fish (in many parts of the country); the ordinary stable-dung, which contains all the elements necessary for producing vegetation; and Guano (*which see*), a powerful source of ammonia, containing much oxalate and urate of ammonia with some phosphates. Nightsoil and urine (especially the latter) are also most valuable for the ammonia they yield, as well as for phosphates and potassa; but they are very much neglected in this country, although their importance is fully appreciated in Belgium, France, and China. Messrs. Lawes and Gilbert have estimated the actual value of both urine and fæces at 6s. 8d. per individual per annum. Nitrate of soda is valued as a source of nitrogen. All organic substances may be employed as manures, those which contain nitrogen, however, most readily decay when mixed with the soil.

The mud of towns has been successfully used as a manure. After collection it requires to be left to the action of the air for six months, and as during this time it gives off very unpleasant emanations, it should be stored at some distance from houses, &c. It has been stated that the ashes from lead and zinc manufactories, when used as an earth-fertiliser, have produced in animals eating the herbage poisonous symptoms. Tardieu instances the case of a cow which died from the effects of eating clover that had been manured with ashes containing lead. It is possible, however, that the ashes themselves were eaten, and that they had not been absorbed by the earth. *See* LEAD.

That manures have frequently been the source of fever, &c., few care to deny; but it is probable that when ill-effects have arisen, the manure has contained poisonous human excreta. We have no evidence to show that the ordinary stableyard dunghill is injurious, unless (as happens in some parts of the country) human fæcal matter is mixed with it. In China, where animal dejecta is so largely employed in agriculture that the air is filled with a very pungent effluvia, no bad effect is produced, owing probably to the great deodorising and absorbing powers of the earth. Parkes states that he has been unable to find any satisfactory evidence of disease being produced by manuring the ground. The ordinary dung-heap may prove inconvenient by displacing oxygen, but certainly it exhales no specific poison of its own. The men employed in the English manure manufactories enjoy excellent health, and people residing in the neighbourhood do not appear to suffer any annoyance.

Tardieu, speaking of the men engaged in making *poudrette*, says, "The action of the exhalations from the manure manufactories on man is certainly not injurious. The workmen show actually no trace of sickness or disease which can be referred to the influence of these exhalations." In this opinion Parent-Duchâtelet and Patissier concur. M. Patissier states that he has not observed workers in urates and powdered manures attacked with any peculiar illness. The two inconveniences which they suffer from are *cuts*, which heal with difficulty, sometimes taking as long as three months; and a slight ophthalmia, caused by the irritation of the ammoniacal vapours—this, however, by the application of some simple lotion, readily disappears.

When the *poudrette* is decomposing, and large quantities are brought into a small space, serious consequences may ensue. Parent-Duchâtelet mentions the case of a vessel carrying manure to Guadaloupe in which half the crew died, and the rest were in a wretched state of health on arrival, caused by the exhalations of the fermented *poudrette;* and the same effects have been noticed in the boats which travel with manure between Rochelle and Nantes. In one of these cases all the crew were attacked, the disease appearing in the form of "an adynamic fever." There was intense pain of the head and of all the limbs, vomiting, great prostration, and in two cases severe diarrhœa.

The internal temperature of the boat was 44° C. (111·2° F.) — the port-holes being open—while the external temperature was only 18° C. (64·4° F.) Much vapour was given off by this manure, and an odour resembling sulphuretted hydrogen and ammonia was also apparent. Parent-Duchâtelet advised that the manures should be mixed with plaster and conveyed in air-tight cavities.

Manure in this country has caused typhoid fever; but in these cases, as already explained, there was in all probability human typhoid excrement present.

The following are the chief regulations in force for the proper keeping of dung, &c.:—

Where in any *urban* district it appears to the inspector of nuisances that any accumulation of manure, dung, soil, or filth, or other offensive or noxious matter, ought to be removed, he shall give notice to the person to whom the same belongs, or to the occupier of the premises whereon it exists, to remove the same; and if at the expiration of twenty-four hours after such notice the same is not complied with, the manure, dung, soil, or filth, or matter referred to, shall be vested in and be sold or disposed of by the urban authority, and the proceeds thereof shall be carried to the account of the fund or rate applicable by them for the general purposes of this Act.

The expenses of removal by the urban authority of any such accumulation, so far as they are not covered by the sale thereof, may be recovered by the urban authority in a summary manner from the person to whom the accumulation belongs, or from the occupier of the premises, or (where there is no occupier) from the owner, or they may by order of the urban authority be declared to be private improvement expenses.—(P. H., s. 49.)

Although the section quoted is confined to an urban district, as in P. H., s. 101, it is expressly provided that any matter or thing removed by the local authority in abating a nuisance may be sold by public auction, it is evident that after failure to comply with notice, a *rural* authority has very similar powers to urban with regard to the sale of manure.

Notice may be given by any *urban* authority (by public announcement in the district or otherwise) for the periodical removal of manure or other refuse matter from mews, stables, or other premises; and where any such notice has been given any person to whom the manure or other refuse matter belongs who fails so to remove the same, or permits a further accumulation, and does not continue such periodical removal at such intervals as the urban authority direct, shall be liable without further notice to a penalty of *twenty shillings* for each day during which such manure or other refuse matter is permitted to accumulate.—(P. H., s. 50.)

In Smith *v.* Waghorn, 27 J. P., 744, Lord Chief-Justice Cockburn said, "A dunghill may or may not be a nuisance, according to the way in which it is kept. If the dung is kept so long that a stench arises, and annoyance to the neighbouring inhabitants, then I think the case comes within the enactment, and the party may be convicted."

Marches—*See* Exercise; Hygiène, Military; Training, &c.

Mare's Milk—An analysis of mare's milk is given in article Koumiss, and the composition of the ash is to be found in the tables in article Milk.

Markets—In non-corporate *urban* districts, with consent of the owners and ratepayers, as expressed by resolution at a public meeting (*see* Resolutions), and in corporate districts, with the consent of two-thirds of all the members of the authority, an urban sanitary authority may provide within its district a market-place, and construct a market-house with all conveniences, such as houses and places for weighing, carts, proper approaches, &c. But in establishing a market, and thus acquiring exclusive rights, existing exclusive rights must not be prejudiced; so that if such rights exist, the sanitary authority cannot set up a market of its own without the consent of the parties whose rights will be affected.—(P. H., s. 166.)

For the purpose of giving urban authorities facilities for establishing and regulating markets, the provisions of the Markets and Fairs Clauses Act, 1847, are incorporated with the Public Health Act, 1875, so far as relates to the holding of the market or fair and the protection thereof, to the weighing goods and carts, and to bylaws.

All market tolls must be approved of by the Local Government Board.

There also exist powers by which an urban authority can buy the undertaking of a market company.—(P. H., s. 166-168.)

Marriage—It would appear, from the inquiries of M. Bertillon, that the influence of the conjugal association, whether on the health or the morality of both sexes, is considerable.

It is only, however, in France, Belgium, and Holland that official documents allow of an appreciation of the differences of the conditions which prevail with respect to celibates, the married, and the widowed, according to age, sex, and nationality.

As to the *men*, it is found that from twenty-five to thirty years the married furnish 6 deaths, celibates 10, and widowers 22 deaths per 1000; from thirty to thirty-five years the deaths are respectively 7, 11, and 19 per 1000; and from thirty-five to forty years, 7½, 13, and 17½ per 1000; and so on for all other ages. The married man continues to have greater powers of vitality and dies less easily than the celibate.

This cannot be explained by the fact that the class of married men comprises, as a rule, those who are better off in regard to worldly fortune, who are more prudent, or who lead a more regular life than others; for how on this assumption can we explain the (comparatively) great mortality which prevails among the widowers of all ages and of all countries? From a careful examination of the French, Belgian, and Dutch returns during ten years, it is found that *very early marriages* do not follow this rule; for of 8000 men who marry before twenty in France, and whose mortality before marriage was hardly 7 per 1000, the mortality rises after marriage to 50 per 1000, young married men from eighteen to twenty years dying at the same rate as aged men of from sixty-five to seventy.

In *women* the advantage derived from marriage does not show itself until after twenty-five, and is scarcely remarked until thirty. From thirty to thirty-five the deaths amongst spinsters are 11, and only 9 per 1000 amongst wives; the difference increases until fifty-five, beyond which age the advantage diminishes somewhat. From fifty to fifty-five, wives exhibit but 15 or 16 deaths per 1000, while spinsters or widows furnish 26 or 27. Prior to twenty-five years for France, and twenty years for Paris, marriage is injurious to the vitality of women, the mortality of spinsters from fifteen to twenty being 7·53, and of wives 11·86 per 1000; and of spinsters from twenty to twenty-five, 8·22, of wives 9·92 per 1000.

The effect of widowhood on the mortality of women is singular, more particularly in Paris. From the age of twenty-five to thirty it is mischievous; for while but 9 deaths per 1000 were furnished by maids and wives of these ages, in widows the figures rose to 17 per 1000. But in France, and especially in Paris, this mortality soon diminishes, and after forty-five it is not greater than in maids of that age. At this age it is the mothers who are most spared by death. "The calculation of probabilities," says M. Bertillon, shows us that the man who marries between twenty to twenty-five has yet a mean of forty years to live in place of thirty-five years, and that the girl who marries at the same age has forty years of life to hope for in place of thirty-six, which she would have lived unmarried—the one adding five years to his existence, and the other four years to hers."

The influence that marriage exerts in relation to criminality is also singular. For 100 criminal celibates there are but 49 married as regards crimes against the person, and only 45 in crimes against property; and not only does this enormous disparity exist, but in the gradual diminution of criminality which has taken place since 1840 the married have borne the largest part. The criminality of widowers, and especially of widows, is generally somewhat in excess of that of the married.

The number of suicides among celibates and the widowhood is about double that which takes place among the married. Insanity also appears to affect the married in a still less proportion.

Marshes—To define accurately what a marsh is, is not easy; but marshes must not be confounded with peat-bogs, for the latter never produce marsh fevers and agues, although the cold and wet may induce rheumatism. We shall in this article give the term "marsh" a wider significance than is generally accorded to it, and consider under it all places from which miasmas are exhaled — ponds, lakes, mouths and banks of rivers, canals, ditches, reservoirs, rivulets, and some parts of the sea-coast. It is during the months of July, August, and September that the vapours rising from marshes are most pernicious, and they are found to be excessively active when both summer and autumn are remarkable for heat and humidity. A saturated soil gives off a larger quantity of effluvia than one that is either completely submerged or very dry. When a deep layer of water covers the marsh, the miasmatic vapours almost cease to form; and when the ground is hard and dry, the marsh miasm is in some places succeeded by a subtle brilliant dust, which with the slightest breeze rises in a choking cloud, like the sandy particles of the Great Desert driven before the hurricane. In such cases a true mirage is not unfrequent.

Dr. Ancelon took some curious and instructive observations in the vicinity of the Lake of Luidre (La Meurthe). He found that when the lake was filling, intermittent fever was prevalent in the neighbourhood, that typhoid raged when it contained its ordinary amount of water, and that in the dry state fever was usually met with in a malignant form.

In the marshes of Normandy much the same effects have been observed.

Malaria, raised by the solar rays, diffuses itself during the day, and at night, as the dew condenses, it falls; and it is at this time that its effects on man and animals are most marked and deleterious.

The vapours arising from marshy soils are carried by the winds; and Dr. Le Fèvre affirms that the miasma proceeding from the marshes of Brouage is carried as far as Rochefort, a distance of 7 or 8 kilometres (a kilometre = 1093·633 yards).

Marennes, a town which is surrounded by marshes, is alternately preserved or attacked, according to the direction of the wind.—(MÉLIER.)

In a calm air, Levy has supposed that the malaria will spread until it occupies a cube of 1400 to 2000 feet, which is equivalent to saying that it will spread 700 to 1000 feet horizontally from the central point of the marsh. But currents of air take it great distances, though the best observations show that these distances are less than were supposed, and seldom exceed 1 or 2 miles, unless the air-currents are rapid and strong. The precise limits are unknown, but it is very doubtful if the belief in transference of malaria by air-currents for 10, 20, or even 100 miles is correct.—(PARKES.)

Salt water will stop the spread of the miasma better than fresh. In the Channel 3000 feet stopped it, in China $\frac{3}{4}$ of a mile, and in the West Indies 1 mile.

M. Pluvis, in his excellent treatise on this subject, states that if ponds occupy $\frac{1}{200}$ part of the soil of a district, the action of the miasma is felt on a $\frac{1}{13}$ of it.

The following gases are usually found in the air of marshes: Carbonic acid, ·6 to ·8 per 1000 volumes. Watery vapour in large quantity. Sulphuretted hydrogen; if the water of the marsh contains sulphates, which in presence of organic matter are converted into sulphurets, from which SH_2 is derived by the action of vegetable acids. Carburetted hydrogen. Free hydrogen. Ammonia. Phosphoretted hydrogen.

Vanguelin (1810), De Lisle, Moscati (1818), Boussingault (1829–39), Gigot (1859), Becchi (1861), have all described organic matter as being present in considerable quantity in the air of marshes. This organic matter, when collected in sufficient quantity for examination, is flocculent, has a powerful marshy odour, contains nitrogen, and reduces nitrate of silver. It is not destroyed by ozone. It is said to have the property of decomposing quinine.

The air also contains innumerable insects, infusoria, &c. It would appear well established that in the air of the marshes near Rome, the spores and sporangia of an algoid plant are found in quantity; and Balestra attributes marsh fever to this cause, but proof is yet wanting.

Ozone is not absent from marsh air, as was once supposed; indeed, stagnant waters are often highly oxygenated, the dissolved air containing 61 per cent. of oxygen.

A slight degree of elevation will frequently

—although the spot may be surrounded by marshes—give some immunity from malaria, but complete security is only obtained at greater heights.

The elevation of perfect security in different parts of the world appears to be, according to Carrière—

	Feet.
Italy	400 to 500
America (Appalachia)	3000
California	1000
India	2000 to 2500
West Indies	1400 to 1800, up to 2200

Humboldt said that in Mexico the fever did not trouble those who were 900 metres above the marshes (metre = 3·280899 feet). The effect of marshes on the population in their neighbourhood is most marked. "Wherever," says Siminot, "the marsh miasm exists, man is put into the dilemma either to remove the cause or to be annihilated." Those whose constitution is remarkable for vigour may for some time resist the insidious influences of the miasmic vapours, but all authorities are agreed that acclimatisation is absolutely impossible. Animals suffer equally with man, and large cattle quickly disappear from marshy countries. Wherever these malarious vapours exist, the mean length of life is notably reduced. Hausset and Price state that it does not exceed twenty-six years. Condorcet places it at only eighteen years. Indeed, we know from actual statistics that from 1790 to 1799 the mean duration of life at Rochefort, which is surrounded by a marshy country, was only nineteen years. Bequerel has also strikingly illustrated the unfortunate truthfulness of these calculations. And lastly, Mélier, in his "Rapport sur les Marais salants," states that in certain communes of the department Charente-Inférieure the mortality from malaria is 1 in 13. The mortality is highest in infants and children, and that the great number of these deaths are caused by miasmatic vapours is supported by the fact, that the mortality is greater in those months when the poison is most active. In marshy districts the deaths exceed the births; and notwithstanding that immigration takes place, the population of Rochefort has been diminished annually by 360. Even in singularly healthy seasons 1 man in 3 of our British troops in India is attacked by malarious fevers, and it is an historical fact that every officer and man of Sir C. Napier's army of 17,000 suffered more or less acutely from the same affections. Dr. Fayrer of Calcutta relates a case in which a young, muscular, temperate Englishman died in a few hours from the effects of malarious poisoning.

Much has been said concerning the preservative effects of warm clothing, nourishing food, tobacco, and the cinchona principles but although these may somewhat mitigate the danger, the only satisfactory way to strike at the root of the evil is to thoroughly inundate or dry up the malarial soil. In Sologne they have recovered the marshes by canal irrigation, lining the earth with chalk, and planting woods in the vicinity. Large tracts of marshy ground have by means of drainage, worked by steam or windmills, been rendered safe, valuable, and productive. Mantegazza recommends that such plants as cherry-laurel, clove, lavender, narcissus, hyacinth, and mignonette be cultivated near marshes. These plants develop in the direct rays of the sun ozone, and he is sanguine that this ozone would prove beneficial in counteracting miasmatic vapours.

Miasma.—Pettenkofer defines miasma to be "an infectious matter arising *outside* the body," in contradistinction to contagion, which he declares to be a "specific infectious matter arising *within* the body of the person."

The question of the real nature of miasma has given rise to much discussion, voluminous treatises, and numberless theories; and at the present time considerable controversy exists on this subject, many denying altogether the existence of any specific miasmatic poison.

It was noticed by the ancients that the air at certain times and under certain circumstances possessed the power of disarranging greatly the animal economy, and Varro, in his book "De Re Rustica," attributes the cause to insects which are produced spontaneously where the waters become marshes, and penetrate into the organs. Such was for a long time the general opinion.

"I have said that the smell of the marshes was considered by the ancients as the cause of fever, and one reason is that those who are attacked are always those who have been exposed at night to the influence of the air, but more particularly at the approach of night or the first twilight of morning—properly speaking, at the time of the formation of the dew; and this is the time when the smell is most intense."—(Il Miasma Palustre; Lezioni di Chimica Igienica, date nell' Istituto provinciale de Mantova, a Antonio Selmi. Padova, 1870.)

Sir James Pringle, who accompanied the British army in the Netherlands (1743–48), and who saw much of intermittent and remittent fevers, concluded that they were due to "the heat and moisture of the air."

Lind, who had many opportunities of observing remittent fever in Bengal in 1762, while regarding malaria as due to vegetable decomposition, adds that "violent heat is a powerful exciting cause of this fever;" and he further adds that "sudden cold in hot marshy countries is to be reckoned, next to the marsh miasmata, as the strongest exciting cause of this disorder; and many are of opinion that cold alone, providing the body be sufficiently predisposed, is sufficient to generate a disorder perfectly like that which is produced by the marsh miasmata."

Ferguson, Morehead, and other authorities imagine that the result of prolonged action of the sun's rays on a marshy surface is the production of malaria, the poison being most intense when the drying of the ground begins.

Parkes, while laying great stress on the internal predisposition, says that the external cause of malarious fevers is presumed to be decomposing vegetable matter derived from a moist and putrescent soil; and he also believes that they may be caused by the water used for drinking. For malaria to exist, there is little doubt that there must be some organic impurity in the soil; the soil itself must be porous, damp, and of a certain temperature. The malarious agent, whatever its nature, may be presumed to be contained in the "ground-air." If such be the case, the malaria would be most intense in times of heavy rain, with, of course, rise in the ground-water; least in dry weather, and a sinking or aspirating ground-water. This view is generally borne out by facts.

There are many theories with regard to the actual nature of the marsh poison, and the question is still unsettled.

Dr. Salisbury, an American physician, writing in 1866, considered the cause of malarious fevers to reside in the spores of *gemiasma*, a form of algoid vegetation resembling palmellæ. These vegetations, he said, he found abundant in marshy places; and he likewise affirmed that he had detected them in the sputa and urine of patients suffering from the disease. They cause a dry, feverish, constricted feeling in the mouth, fauces, and throat, which soon become parched and hot. He also found that the cryptogamic spores rise and are suspended in the cold damp exhalations from the soil after the sun has set, and that they fall again to the earth when the sun has risen; and that the day air of malarial districts is quite free from these spores, and never gives rise to intermittent fevers.

Professor Niemeyer has "no hesitation in saying decidedly that marsh miasma—malaria—must consist of low vegetable organisms whose development is chiefly due to the putrefaction of vegetable substances."

Antonio Selmi, whose work, published at Padua, 1870, we have previously referred to, reasons that the cause of malarious fevers cannot be a gas. "Having," he says, "in one night, at a temperature of 10° C. (50° F.), collected 670 cubic centimetres of liquid, I concluded that as every cubic centimetre had a specific gravity of 1·004, the liquid had been taken from 137 cubic metres of air (a cubic metre of air, according to Pouillet, containing 4·91 grammes of vapour of water). The water was examined. After allowing it to stand, it was found by the microscope to contain a deposit; this was formed of a multitude of seeds of algæ, and myriads of microscopic infusoriæ swimming. This, my first observation, was confirmed at the same time by Dr. Pietro Balestra at Rome. . . . He uses these words, 'In the microscope the condensed dew exhibits only a surprising quantity of spores and sporanges.'"

Mr. C. F. Oldham, M.R.C.P.E., Assistant-Surgeon H.M. Indian Forces, has recently published a work entitled "What is Malaria?" He affirms *that malaria, as a specific poison, does not exist, but that the cause of the disease attributed to it is chill, or in other words, the sudden abstraction of animal heat*, and he supports this theory with some force. He fully endorses the late Dr. Livingstone's view, that "the best preventives against fever are plenty of interesting work to do, abundance of wholesome food to eat, and the being well housed and well clothed."

The Italian physician Minzi, in his treatise "Sopra la Genese delle Febbri Intermittenti," Rome, 1844, takes a precisely similar view of malarious fevers. He contends that fluctuations between intense midday heat and evening damp chills rob the body of the power of resisting cold, and that the ague fit is a reaction from chill. Fires are the preventive; but how, he asks, can a fire neutralise poisonous air?—(Medical Times and Gazette, March 1871.) *See* AGUE; FEVERS, MALARIOUS, &c.

Matches—*See* PHOSPHORUS.

Maté (Paraguay tea)—Maté, or Paraguay tea, is derived from the dried leaves of the *Ilex Paraguayensis*, or Brazilian holly, a plant belonging to the same tribe as the holly of this country. Maté resembles somewhat Chinese tea, but it is a mistake to imagine that it is a substitute for that article. The leaves of the Brazilian holly, as imported, resemble in appearance those of senna, as met with in the druggist's shop. An infusion has a yellowish-brown appearance, and the taste is not unpleasant. It is a curious and interesting fact that it contains an active principle, formerly called *paraguaine*, which is identical with theine and caffeine. Authorities differ as to the proportion of theine contained in this tea; some observers putting it at 1·20 per cent., while others say that it is as little as from ·13 to ·44 per cent. An aqueous extract contains other nitrogenous matter besides theine, 10 grammes of the tea yielding to water a solution from which ·005 grammes of ammonia is obtainable on boiling with alkaline permanganate. (For process, *see* TEA.)

The following is Mr. Wanklyn's analysis of this substance:—

Moisture	6·72
Ash	5·86
Soluble organic matter	25·10
Insoluble organic matter	62·32
	100·00

Measles—An eruptive fever. The eruption appears in crops of a crimson rash, consisting of slightly elevated minute dots disposed in a somewhat crescentic form. The duration of the disease is from nine to twelve days. In mild uncomplicated measles the disease begins like a common cold, with running at the eyes and nose, and cough. The temperature at the fifth day may attain, but seldom exceeds, 109° F., and defervescence is completed by the tenth.

There are two distinct varieties of measles —viz., the mild kind, *Morbilli mitiores*, and the severe, *Morbilli graviores*. The latter form is characterised by its great fatality; it is of a malignant type, and the eruption is frequently black. It is not often seen now, but was common in the middle ages.

Essential Nature of the Disease.—A living animal germ is absorbed into the blood and there multiplies, just as in smallpox and the other exanthemata.

Propagation.—It is essentially contagious and infectious, and never arises *de novo.* A striking exemplification of this occurred in the year 1824. Prior to that year, the measle germ, considered for the sake of illustration as a minute animal, was to all intents and purposes as extinct in the island of Malta as the mammoth; but some children of the 95th Regiment imported it into the island, and it spread so extensively that many of the natives died.

The poison hangs to clothing, to the walls of rooms, and infects the air, so that by that medium alone it has travelled some distance. No age appears exempt, but it is more frequent in children than in adults.

So common is measles in this country that it is regarded by many mothers, who by their education ought to know better, as a natural and inevitable disease of childhood; and at a favourable time of year healthy children are frequently and deliberately placed with those affected, in order that they may take the disease.

The great complication to be feared in measles is catarrhal pneumonia and other affections of the chest: it is to the absence or presence of this complication that the variations in mortality in different years are due.

In 1851 the proportion of deaths from measles in every 1000 deaths was 24·107; in 1852, 14·599; in 1853, 11·818; and in 1854, 21·463. Or if we take the actual numbers for ten years—*e.g.*, 1862–71—the same variation is seen—1862, 9800; 1863, 11,349; 1864, 8323; 1865, 8562; 1866, 10,940; 1867, 6588; 1868, 11,630; 1869, 10,309; 1870, 7543; 1871, 9293 —the average number of deaths for the whole ten years being 9413 deaths.

Particular institutions show the same thing. Watson says that in one year at the Foundling Hospital 1 in 10 died, and another 1 in 3.

It would appear, speaking generally, to be more fatal in towns than in the country.

Predisposing Causes and Prevention.—All overcrowding, insanitary conditions, and cold weather predispose to the disease. The poison is probably contained for the most part in the profuse discharges from the nose and eyes, in the expectoration from the chest, and in emanations from the skin. The means, therefore, to be taken to prevent the propagation of the disorder are—

1. Isolation as far as practicable.
2. The use of rags to wipe away and receive discharges from nose, &c., which rags when used must at once be burnt.
3. Smearing over the whole body with oil, to which a little carbolic acid has been added.
4. Disinfection of all excreta.
5. Thorough disinfection of all things used by the sick upon convalescence or death, a complete change of clothes, &c.
6. In case of death, early and quick burial.
7. Prevention, by a careful watch, of the pernicious and illegal practice of placing a healthy child with one suffering from measles.

See DISINFECTION, &c.

Meat—In this article we shall consider generally, beef, mutton, veal, lamb, pork, bacon, and venison. In London, the indoor operatives eat it to the extent of 14·8 oz. per adult weekly; 70 per cent. of English farm-labourers consume it to the extent of 16 oz. per man weekly. 60 per cent. of the Scotch, 30 of the Welsh, and 20 of the Irish also eat it.—(LETHEBY.)

Dr. Wynter has computed that in London as much as 30¾ oz. per head weekly, or about 4½ oz. per day for every man, woman, and child, is consumed.

Boudin states that the amount consumed in France is 50 grammes daily per head (gramme = 15·432348 grains).

Meat differs very much in its nutritive value, according to the quantity of fat and lean. The lean of all meat has much the same nutritive value.

Meat supplies the body with nitrogen, with fat, with iron, and with salts, such as the chlorides, phosphates, and carbonates of the alkalies, besides which, probably certain organic acids, which on incineration appear in the ash as carbonates.

Oxen, according to M. Bizet, yield of *best-quality* beef 57 per cent. meat, and 43 per cent. waste. The waste includes the internal viscera, &c. *Second-quality* beef, 54 per cent. meat, and 46 per cent. waste; *third-quality* beef, 51 per cent. meat, and 49 per cent. waste. In *milking cows*, 46 per cent. meat, and 54 per cent. waste. *Calves* yield 60 per cent. meat, and 40 per cent. loss; and *sheep* yield 50 per cent. meat, and 50 per cent. loss.

The following table, compiled from Letheby, Ranke, &c., shows the compositions of the various kinds of meat:—

	Cooked Meat, roast, no Dripping lost. Boiled assumed to be the same (Ranke).	Lean Beef.	Fat Beef.	Lean Mutton.	Fat Mutton.	Veal.	Fat Pork.	Dried Bacon.	Green Bacon.
Nitrogenous matter	27·6	19·3	14·8	18·3	12·4	16·3	9·8	8·8	7·1
Fat	15·45	3·6	29·8	4·9	31·1	15·8	48·9	73·3	66·8
Saline matter	2·95	5·1	4·4	4·8	3·5	4·7	2·3	2·9	2·1
Water	54·00	72·0	51·0	72·0	53·0	63·0	39·0	15·0	24·0

Parkes gives the following as the composition of fresh beef (Moleschott, mean of all the Continental analyses), remarking that the proportion of fat given is certainly too small:—

Water	73·4
Soluble albumen and hæmatin	2·25
Insoluble albuminous substances	15·2
Gelatinous substances	3·3
Fat	2·87
Extractive matters	1·38
Creatine	0·068
Ash	1·6

The amount of bone in meat varies from about 8 to 10 per cent., but in the shin and leg of beef it amounts to one-third or even one-half the total weight.

The ordinary loss in cooking meat is from 20 to 30 per cent., but occasionally it is as much as 40 per cent. *See* Cooking.

The flesh of young animals is more tender than that of old, but it is not so easily digested. Animals of middle age afford the most easily assimilated beef. The flesh of the largest breeds of oxen is in greatest perfection at about seven years old, that of the smaller breeds a year or two earlier. Cow beef can hardly be too young. Wether mutton is best at four or five years old, ewe mutton at about two years old.

The flesh of the female animal is generally more tender than that of the male, but the latter is greatly improved by castration. In the process of slaughtering, the animal is drained as far as possible of its blood. The Jews are particularly strict on this point; their regulations are such as to secure to the fullest extent the removal of the blood, and they will not partake of any animal food which has not been killed by a slaughterer of their own persuasion. Pig's, and occasionally bullock's blood, is used for making black puddings.

It will not be necessary to treat separately each description of meat, their characteristics being so generally known. In the article Digestibility, &c., the case or difficulty with which each is assimilated will be seen; and we have also devoted articles to the consideration of Bacon, Liver, Kidney, &c., to which we refer the reader.

Meat, considered generally, may be divided into *fresh* and *salt*. Salting alters the composition of meat, much impairing its nutritive value, but not to so great an extent as was formerly imagined.

The following tables show the results of several analyses of fresh and salted meat:—

Composition of Uncooked Meat, Fresh and Dried.

	Beef.		Salted Beef.	
	Fresh.	Dried.	Fresh.	Dried.
Water	75·90	...	49·11	...
Fibrine and cellular tissue	15·70	63·14	24·82	48·78
Fat..................	1·01	4·19	0·18	0·35
Albumen..........	2·25	9·34	0·70	1·38
Extractives	2·06	8·55	3·28	6·44
Soluble salts.....	2·95	12·24	21·07	41·39
Loss..................	0·13	0·54	0·84	1·66
	100·00	100·00	100·00	100·00
Phosphoric acid, per 100 parts .	0·222	0·925	0·618	2·216
Nitrogen, do.....	3·000	12·578	4·62	9·101
Salt, do...........	0·489	2·03	11·516	22·63

The results of these several analyses may be thus expressed :—

	Fresh Meat.	Salt Beef.
Water	75·90	49·11
Solid matters . .	24·10	50·89
	100·00	100·00
Nitrogen	3·031	4·631
Phosphoric acid . .	0·229	0·618

Composition of Fresh and Dried Meat cooked with Vegetables.

	Superfluous Liquor drained off.	Dried at 212° F.	Superfluous Liquor drained off.	Dried at 212° F.
Water . .	6·90	...	6·80	...
Salt . . .	2·20	2·363	4·40	4·721
Organic matters	90·20	97·657	88·80	95·279
	100·00	100·000	100·00	100·000
Phosphoric acid, per 100 parts . .	0·269	0·289	0·802	0·86
Nitrogen, do .	10·67	11·460	11·818	12·680
Salt, do. .	0·479	0·515	1·775	1·90

Composition of the "Soup" resulting from the boiling of Fresh and American Salted Beef.

	Fresh Beef.		Salted Beef.	
	With Salt, dried at 212° F	Without Salt, dried at 212° F	With Salt, dried at 212° F.	Without Salt, dried at 212° F.
Water . .	...	...	...	...
Salt . .	43·083	12·13	42·122	16·454
Organic matters	56·917	87·87	57·878	83·546
	100·000	100·00	100·000	100·000
Phosphoric acid, per 100 parts . .	1·003	1·52	1·65	2·21
Nitrogen, do.	3·511	2·868	3·151	3·08
Salt, do.	38·352	1·333	35·15	5·6027

The following is the composition of the brine in which the American salted beef is brought over :—

Composition of 1 Litre of Brine.

Water	622·250
Albumen	12·300
Other organic matters . .	34·050
Phosphoric acid	4·812
Marine salt	290·071
Other saline matters . . .	36·577
	1000·000
Nitrogen, per cent. of dry extract	2·669

Brine has occasionally proved poisonous in instances where it has been employed several times. Animal matters which have passed into it appear to decompose, but no special poisonous agent has been separated.

Salted beef is remarkable for the large amount of nitrogen and phosphoric acid, and the small quantity of fat, it contains. It is also deficient in albumen. In examining results obtained from analyses, it is important to remember that the amount of nutritious substances which the chemist may succeed in extracting from a given food is not always a measure of that which the stomach can utilise. The amount of energy developed by 1 gramme of fresh meat equals 604 kilogrammes, or 1 oz. would raise 55 tons 1 foot high. *See* ENERGY.

Diseases of Meat.—The diseases are almost as numerous and as varied as those of man. The principal ones which render the flesh unwholesome are as follows :—

1. Parasitic—*e.g.*, *phthisis*, produced in sheep by the ova of the *Strongylus filaria ;* the *fluke disease* of the same animal, caused by the *Distoma hepaticum ;* the *Cysticercus cellulosæ* of the pig ; and *trichinæ*, affecting many domestic animals.

2. *Specific fevers*—as the smallpox of sheep, the plague of cattle, the foot-and-mouth disease, &c.

3. *Other affections*—such as epidemic pleuro-pneumonia, carbunculous affections, abscesses, &c.

Animals affected with any of the above disorders can hardly be considered suitable for consumption.

Effects of Diseased, Putrid, and Mouldy Meat.—Diseased meat is frequently eaten—considering the large number of unhealthy animals yearly sent to the market—without injurious effects ; but, on the other hand, the most alarming symptoms are often induced by such meat being used, and occasionally by eating flesh which to all appearance is perfectly healthy. The Scotch herdsman, first cutting away the darker portions of the flesh and salting the remainder, readily eats the meat of sheep which have died from braxy ; and notwithstanding that this meat has been pronounced by high authorities to be excessively injurious, he will tell you that it is quite wholesome. Labourers in this country frequently eat the flesh of sheep affected with staggers, and of animals dying of acute inflammatory diseases. Tardieu relates that three hundred army horses affected with glanders (*morve*) were led to St Germain, near Paris, and killed. For several days they served to feed the poor of the town without causing any injury to health. The same thing happened some years afterwards in the Bois de Vincennes, when the professors of L'École d'Alfort killed a number of horses attacked with glanders and farcy. The inhabitants of the neighbouring villages freely partook of the flesh of these horses, and no case of illness followed. During the siege of Paris glandered horses were eaten without injurious effects following. M. Coze tells us that the entire population of Strasburg in 1815 ate of the meat of oxen attacked with a malady which he designates typhus (*i.e.*, rinderpest), without any apparent inconvenience resulting. Dr. Brücke, Professor of Physiology at Vienna, tells us that when the steppe-murrain was prevalent in Bohemia, the poor people dug up the bodies of those animals which had died from this disease, and which had by order of the Government been buried, and ate the flesh without experiencing any ill-effects. Many people eat, and indeed prefer, the liver of sheep full of flukes. During the cattle plague in this country, there can be no doubt that a very large number of animals affected with the rinderpest were eaten; and Professor Gamgee assures us that at least one-fifth of the meat which is sold in the public markets is diseased. It is evident from this that the human stomach has marvellous protective power, and it is highly probable that the operation of cooking renders most bad meat harmless.

There is no danger in eating the flesh of animals whose death has resulted from accident.

Liebig notices a case in which a family of five persons were made seriously ill by the flesh of a roebuck that had been caught in a snare, and had struggled violently before death. The flesh of animals that have been excited before death by overdriving or by torture has frequently proved unwholesome, and Professor Gamgee states that the flesh of overdriven animals often contains a poison which produces eczema on the skin of those who handle it.

The flesh of animals in the *early stage of acute inflammatory disease.*—The meat is apparently not altered, and if the blood be all taken from the body, it is wholesome.

In chronic wasting diseases—*phthisis*, *dropsy*, &c.—the flesh is said to give rise to sickness and diarrhœa, and if decomposed, severe gastro-intestinal derangement.

What effect *epidemic pleuro-pneumonia* of cattle may have upon the meat is uncertain. Parkes has been informed on good authority that the Kaffirs ate their cattle, when destroyed by the epidemic lung disease which prevailed at the Cape some years ago, without injury. Dr. Livingstone, however, says that when eaten in South Africa, by either natives or Europeans, it invariably produces malignant carbuncle; and he says that the virus is neither destroyed by boiling nor by roasting.

"Now, it is a remarkable circumstance that ever since the importation of this disease (pleuro-pneumonia) into England from Holland in 1842, the annual number of deaths from carbuncle, phlegmon, and boils has been gradually increasing. In the five years preceding that time, the mortality in England from carbuncle was scarcely 1 in 10,000 of deaths; from 1842 to 1846 there is no record of disease, but in the next five years, from 1846 to 1851, the mortality rose to 2·6 per 10,000 of the deaths, and in the next five years it amounted to 6·2 per 10,000, and in the succeeding five years to 5·4 per 10,000. In the case of phlegmons, the increase in the mortality is still more remarkable; for it rose from an average of 2·5 per 10,000 of the deaths in the five years preceding the importation of the disease, to 81 per 10,000 in the ten years from 1847 to 1856."—(LETHEBY.)

Anthrax and *malignant pustule.*—Ramaz, Lancisi, Chaussier, Menschel, Parent-Duchâtelet, and the Belgian Academy of Medicine, have all spoken of the bad effects which have followed the eating of the flesh of animals so attacked.

The evidence concerning the effects of the meat of braxy sheep is of a most contradictory nature, and the only point on which writers on this subject appear to agree is that, as before said, many of the shepherds in the Highlands of Scotland eat it with impunity.

Smallpox meat of sheep is said to produce sickness and diarrhœa, but we have no very satisfactory evidence on this point.

Foot-and-mouth disease.—The flesh of animals so suffering has been eaten without ill-effects following. The evidence on the other side is of a very vague and uncertain nature.

Cattle plague (*rinderpest, typhus contagiosus*).—We have already referred to the fact that at Strasburg and in Bohemia this flesh has been eaten, without bad results following. Renault, the director of the veterinary school at Alfort, asserts that there is no danger from the cooked flesh of cattle, pigs, or sheep dead of any contagious disease.—(PARKES.)

Pork-pies and sausages become poisonous from the formation in them of some unknown substance. In Wurtemberg as many as 150 persons have died during the last fifty years from eating such sausages. M. Vanden Corput, who has examined this subject, attributes the poisonous effects to the presence of a fungus which becomes developed in the sausage, and which he calls *Sarcina botulina.*

Whatever may be the opinion of the effects likely to be produced by eating diseased meat, there can be no doubt that taking meat infected with parasitic disease is attended with great danger.

Putrid meat is frequently eaten without causing inconvenience, but it may give rise to gastro-intestinal disorder — vomiting, diarrhœa, and great depression.*

But frequently after eating meat, and especially pork, which is free from putrescence, and in which no disease can be detected, people have been attacked with this same gastro-intestinal disorder. Letheby mentions that in Crzaut's "History of Greenland" there is an account of the death of thirty-two persons at a missionary station called Kangek, from a repast on the putrid brains of a walrus.

Accidents occasionally happen from animals eating poisoned grain. It is a common practice to steep grain in solution of arsenic previous to sowing; and the flesh of birds which have eaten of this often proves highly deleterious. Animals which have during life been treated with antimony, when eaten often produce injurious effects.

Inspection of Meat and Animals.—An ox should weigh not less than 600 lbs., and will range from this to 1200 lbs.; a heifer from 350 to 400 lbs.; a full-grown sheep from 60 to 90 lbs.; and (but this varies in different breeds) a full-grown pig from 100 to 188 lbs., or more.

The common method employed in this country for taking the weight of oxen, &c., is to obtain the dimensions of the animal in cubic feet, by measuring the length along a line commencing just in front of the scapula, and the circumference taken just behind the scapula. Each cubic foot is supposed to weigh 42 lbs. avoirdupois. The formula is $(C \times \cdot 08) \times L \times 42$.

The fat of the animal is best felt on the false ribs and tuberosities of the ischium, and the line of the belly from the sternum. The skin should be supple, and the flesh firm and elastic. The nasal mucous membrane red, moist, and healthy-looking; the eye bright; the coat in good condition; the respiration regular, and not possessing a fœtid odour; and the excreta natural in appearance.

Meat should be inspected not later than twenty-four hours after it has been killed. 20 per cent. may be allowed for bone. The fat should not be excessive in quantity, and should be firm and healthy-looking. The lungs and liver should be examined; and to detect the cattle plague, the mouth, stomach, or intestines must be seen.

For discovering parasites in meat a microscope will usually be necessary. A low power will bring into view, should they be present, either cysticerci or trichinæ. To detect the latter, take a thin slice of flesh of the pig, put it into liquor potassæ (1 part to 8 of water), and let it stand for a few minutes, until the muscle becomes clear. The white specks are now easily seen, and the worm will be discovered coiled up.—(PARKES.)

In salting beef only common salt should be employed, and no saltpetre, &c., used. Partially putrefied meat will always remain soft, notwithstanding any amount of salting, and there may be putrefactive odour and a greenish colour. Bad-smelling sausages should always be condemned.

Good meat has the following characters (LETHEBY):—

1. It is neither of a pale pink colour nor of a deep purple tint; for the former is a sign of disease, and the latter indicates that the animal has not been slaughtered, but has dried with the blood in it, or has suffered from acute fever.

2. It has a marbled appearance, from the ramifications of little veins of fat among the muscles.

3. It should be firm and elastic to the touch, and should scarcely moisten the fingers, and the juice should be distinctly acid; bad meat being wet and sodden and flabby, with the fat looking like jelly or wet parchment.

4. It should have little or no odour, and what is perceptible should not be disagreeable; for diseased meat has a sickly cadaverous smell, and sometimes a smell of physic. This is very discoverable when the meat is chopped up and drenched with warm water.

5. It should not run to water or become very wet on standing for a day or so, but should, on the contrary, dry upon the surface.

6. When dried at a temperature of 212° or thereabout, it should not lose more than from 70 to 74 per cent. of its weight, whereas bad meat will often lose as much as 80 per cent.

7. It should not shrink or waste much in cooking.

To assist in judging of the freshness of meat, a clean knife may be passed into it and applied to the nose on withdrawal. In this

* It is possible that the effects of putrid animal substances are due to the development of some poisonous alkaloid; for F. Selmi (Deut. Chem. Ges. Ber., vi. 142), Rörsch and Fassbender (ibid., vii. 1064), and W. Schwanery have all extracted from putrid livers, spleens, &c., a liquid alkaloid, the properties of which have not yet been fully investigated.

way the condition of the centre may be ascertained. Butchers not unfrequently rub bad and diseased meat over with fat to give it the appearance of healthy flesh. If the meat is at all suspicious, the muscular fibre should be examined under the microscope. The fibre of bad meat is found to be sodden and ill-defined.

For legislative measures relative to the seizing and inspecting of unwholesome meat, *see* FOOD, INSPECTION OF; INSPECTOR OF NUISANCES, DUTIES OF; MEDICAL OFFICER OF HEALTH, DUTIES OF; SLAUGHTER-HOUSES, &c.

Meat, Australian—Meat imported from Australia in air-tight tins hermetically sealed. There are two serious objections to this meat —the one is that it is invariably *overcooked*, from the desire to ensure the complete exclusion of atmospheric air; and the second, that the tins often crack from the constant pressure of the atmosphere, there being a vacuum within them. But this difficulty has been by some companies obviated by the introduction of inert gases, as carbonic acid, nitrogen, &c.

Mr. Ogilvie has recently made some analyses of Australian and home mutton; the results we append. — (Chemical News, April 24, 1874.)

Water.

No.	Per cent.	
1	59·26	Australian.
2	61·48	Australian.
3	61·57	Australian.
	52·59	Home mutton.

Fat.

No.	Per cent.	
1	19·62	Australian.
2	14·62	Australian.
3	15·79	Australian.
	28·88	Home mutton.

Extractive Matters.

No.	Alcoholic Extract.	Watery Extract.	Total.	
1	2·47	4·47	6·94	Australian.
2	2·87	4·05	6·92	Australian.
3	3·12	3·82	6·95	Australian.
	2·28	1·85	4·13	Home mutton.

Albumen and Fibrine.

The albumen in preserved mutton being rendered insoluble by boiling, it cannot be separated from the fibrine.

No.	Per cent.	
1	14·6	Australian.
2	16·92	Australian.
3	16·39	Australian.
	14·40	Home mutton.

Mineral Matters.

No.	Soluble	Insoluble.	Total.	
1	0·654	0·444	1·098	Australian.
2	1·019	0·543	1·562	Australian.
3	0·705	0·160	0·865	Australian.
	0·303	0·150	0·453	Home mutton.

Meat, Extract of—Liebig's *extractum carnis* must not be considered as an article of nutrition, but being very rich in flavouring matter, it is useful for imparting additional flavour to soup, &c. It possesses some stimulant and restorative properties which render it useful in exhausted states of the system; but it contains no albumen, gelatine, or fat, and may be said to comprise the salines of the meat with various extractive principles, a considerable portion of which probably consists of products in a state of retrograde metamorphosis, and of no use as nutritive agents. The fact that 34 lbs. of meat only yield 1 lb. of extract shows its poverty in those substances which render meat valuable as a dietetic agent.

The following table gives the composition of a few of the extracts of meat of commerce:—

	Liebig's Company.		Tooth, Sydney.	French Company, South America.	Whitehead.	Twentyman.
Water	18·56	16·00	17·06	16·50	24·49	20·81
Extractive, soluble in alcohol	45·43	53·00	51·28	28·00	22·08	13·37
Extractive, insoluble	13·93	13·00	10·57	46·00	44·47	59·10
Mineral matter	22·08	18·00	21·09	9·50	8·96	6·72
	100·00	100·00	100·00	100·00	100·00	100·00

Meat, Fluid—This preparation is used as an enemata, and originated with Dr. Pavy, who says concerning it: "A preparation that has been made at my suggestion by Messrs. Darby & Gosden of London, and called 'Fluid Meat.' It constitutes meat that has been reduced to a fluid state by artificial digestion; and representing, as it does, a product of digestion, it furnishes a material in identically the same favourable state for absorption as that which naturally passes on from the stomach. It may be mixed with sugar and thickened with mucilage of starch or arrowroot, or if necessary, a little brandy may be added." This is an excellent preparation.

Meats, Preserved—There is a considerable number of patents for making the well-known varieties of preserved meats, but nearly all of them are based on the same principle—viz., the exclusion of air, either by hermetically sealing in tins, or by placing the substance in oil or viscid liquids, or in caoutchouc, or by covering with impervious coatings.

Plowden (1807) preserved meat in rich gravy; Granholm (1817), in hot fat; Wothley, in oil. Dr. Redwood proposes to first cover the meat with coatings of paraffine, by successive dippings in baths of that fat, beginning at a temperature of 250°; then using colder baths; lastly, covering the meat with a coating of gelatine.

Mr. Gamgee has introduced a novel method —viz., making an animal breathe carbonic oxide gas; killing it whilst insensible; hanging it up in a chamber filled with carbonic oxide, and containing boxes of charcoal charged with sulphurous acid.

"The Belgian 'Musée de l'Industrie' notes the following methods of preserving meats as the most deserving of attention amongst those communicated to the French Academy of Sciences, and published in the 'Comptes Rendus:'—

"1. M. Bandet's method, by which the meat is kept in water acidulated with carbolic acid in the proportion of 1 to 5 parts of acid per 1000 of water. A series of experiments proved that all kinds of meat could thus be kept fresh for lengthened periods without acquiring any ill taste or odour. The meat may be placed in barrels or air-tight tin cases filled with acidulated water of the above strength, and then headed up, or the pieces may be packed in barrels or cases in alternate layers of charcoal pounded small, and saturated with water containing $\frac{5}{1000}$ of carbolic acid.

"2. In the case of South American meat, M. Bandet proposes the use of large sacks of caoutchouc. The meat should be packed in them, with alternate layers of charcoal as above described, and each sack when filled should be hermetically closed by drawing another empty caoutchouc sack capwise over it. The caoutchouc is supposed—its high price notwithstanding—to cover expense of packing and freight, and so permit the meat to be sold in Europe at a very small advance on cost price. If intended for use a second time, the empty bags should be steeped in boiling water for a few minutes to remove any organic impurities adhering to them.

"3. M. Gorge's method, which is in use in La Plata, consists in washing and drying the meat, and afterwards steeping in successive waters containing hydrochloric acid and sulphite of soda, and then packing it in air-tight cases holding 1, 5, or 10 kilogrammes each. Meat thus treated requires to be soaked in warm water for about half an hour before use.

"4. M. Léon Soubeiran has recommended braying and drying in the fashion adopted by the Chinese and Mongols, as described by M. Simon, French Consul in China, in a communication made by him to the Société d'Acclimatation. The *pemmican* of our Arctic voyagers and the *charqui* of South America are familiar examples of meat preserved by analogous processes. The late M. Payen, a distinguished member of the Academy, insisted upon the great perfection to which this system might be carried by the aid of hot-air stoves and suitable apparatus."

One of the most recent methods of preserving meat is that known as *Zellier's process*. It essentially consists in manufacturing methyl ether on a large scale, the production of ice by the evaporation of the ether, and admission of the air that has passed over the ice or the ether-pipes into chambers which contain the meat. Meat was kept for eight months in this way, and was at the end of that time perfectly edible.—(Ann. Chim. Phys., [5,] iii. 502.)

Meconic Acid ($H_3C_7HO_7 3H_2O$) — An organic acid found only in the Poppy tribe.

This acid was discovered by Sertürner in 1804. Its main interest lies in the fact, that being invariably present in opium, and answering in a very characteristic manner to tests, its detection in any organic substance or liquid is almost equivalent to the detection of opium.

The acid when pure crystallises in pearly scales. It has an acid astringent taste, and forms well-defined salts called meconates. It is unchanged by cold sulphuric, nitric, and hydrochloric acids. When heated to 300° F., it is resolved into carbonic acid gas, and a new bibasic acid named *comenic;* and at a somewhat higher temperature, comenic acid in its turn is resolved into carbonic acid gas, and a monobasic acid called *pyromeconic*.

Sesquichloride of iron and persulphate of iron strike a deep red colour with meconic acid. This colour cannot be distinguished by the eye from a similar reaction with the sulphocyanides; but the latter colour is quickly discharged by a solution of corrosive sublimate, whilst the meconic acid colouring remains unchanged.

Strong hydrochloric acid produces a crystalline precipitate, ferrocyanide of potassium, hairlike crystals; chloride of calcium, groups of colourless transparent crystals; and nitrate of silver, sulphate of copper, and acetate of lead also produce precipitates.

Meconic acid may be separated from the contents of the stomach, &c., by treating the organic liquid with acetic acid, digesting for some time at a gentle heat, straining through muslin, evaporating down to a small bulk, and then precipitating with acetate of lead. The meconate of lead is thrown down with other matters, and meconic acid may be separated by collecting the contents of the filter, suspending them in water, and transmitting sulphuretted hydrogen gas through the liquid. The sulphide of lead is filtered off, and the filtrate concentrated to a small bulk.

Medical Officer of Health—The appointment of a medical man, whose office it is to watch over the public health, is now the compulsory duty of each sanitary authority. A similar office has existed many years under the Towns Improvement Clauses Act, 1847; the Public Health Act, 1848; the Metropolis Local Management Act, 1855; and the Artisans' and Labourers' Dwellings Act, 1868; but the Public Health Act of 1872 (now consolidated and embodied in the Public Health Act of 1875) was the first enactment which made the appointment of such an officer compulsory. *See* OFFICERS, APPOINTMENT OF.

Appointment.—A person shall not be appointed medical officer of health under the Act unless he is a legally-qualified medical practitioner; and the Local Government Board shall have the same powers as it has in the case of a district medical officer of a union with regard to the qualification, appointment, duties, salary, and tenure of office of a medical officer of health or other officer of a local authority, any portion of whose salary is paid out of moneys voted by Parliament, and may by order prescribe the qualification and duties of other medical officers of health appointed under the Act.

The same person may, with the sanction of the Local Government Board, be appointed medical officer of health or inspector of nuisances for two or more districts, by the local authorities of such districts; and the Local Government Board shall by order prescribe the mode of such appointment, and the proportions in which the expenses of such appointment and the salary and charges of such officer shall be borne by such authorities.

Any district medical officer of a union may, with the sanction of the Local Government Board, and subject to such conditions as the said board may prescribe, be appointed a medical officer of health; and a medical officer of health may exercise any of the powers with which an inspector of nuisances is invested by the Act.

In case of illness or incapacity of the medical officer of health, a local authority may appoint and pay a deputy medical officer, subject to the approval of the Local Government Board.—(P. H., s. 191.)

Appointment to a United District.—Where it appears to the Local Government Board, on any application made to it, that the appointment of a medical officer of health for two or more districts situated wholly or partially in the same county would diminish expense, or otherwise be for the advantage of such districts, the Local Government Board may by order unite such districts for the purpose of appointing a medical officer of health, and may make regulations as to the mode of his appointment and removal by representatives of the authorities of the constituent districts, and the proportion in which the expenses of the appointment and of the salary and expenses of such officer are to be borne by such authorities, and as to any other matters (including the necessary expenses of such representatives) which, in the opinion of the said board, require regulation for the purposes of this section; and no other medical officer of health shall be appointed for any constituent district, except as an assistant to the officer appointed for the united districts:

Provided that no urban district containing a population of twenty-five thousand and upwards, or in the case of a borough having a separate court of quarter sessions, shall be included in any union of districts formed under this section without the consent of the council of such district or borough.

Not less than twenty-eight days' notice that it is proposed to make an order under this section shall be given by the Local Government Board to the local authority of any district proposed to be included in the union; and if, within twenty-one days after such notice has been given to any such authority, they give notice to the Local Government Board that they object to the proposal, the Local Government Board may include their district in the union by a *provisional order*, but not otherwise.

There may be assigned by the Local Government Board to the district medical officer of any union comprising or coincident with any constituent district such duties in rendering local assistance to the medical officer of health appointed for such constituent districts as the said board may think fit; and such district medical officer shall receive, in respect of any duties so assigned to him, such additional remuneration as the local authority may, with the approval of the Local Government Board, determine.—(P. H., s. 286.)

Medical Officer of Health, Appointment of, Duties of, &c.—The appointment, duties, &c., of a medical officer of health are laid down in the following minutes as to duties, &c.,

of medical officers of health, issued by the Local Government Board, 1872-73 :—

SECTION I.—*Qualification.*

Art. 1. No person shall be qualified to be appointed to the office of medical officer of health under this order, unless he shall be registered under "The Medical Act of 1858," and shall be qualified by law to practise both medicine and surgery in England and Wales, such qualification being established by the production to the sanitary authority of a diploma, certificate of a degree, licence, or other instrument granted or issued by competent legal authority in Great Britain or Ireland, testifying to the medical or surgical, or medical and surgical qualification or qualifications of the candidate for such office.

Provided that the Local Government Board may, upon the application of the sanitary authority, dispense with so much of this regulation as requires that the medical officer of health shall be qualified to practise both medicine and surgery, if he is duly registered under the said Act to practise either medicine or surgery.

SECTION II.—*Appointment.*

Art. 1. A statement shall be submitted to the Local Government Board showing the population and extent of the district for which the sanitary authority propose to appoint the medical officer or medical officers of health, and the salary or remuneration intended to be assigned; and where the circumstances render desirable the appointment of one medical officer of health for two or more sanitary districts, statements shall in like manner be submitted to the Local Government Board showing the names of the districts to be combined for that purpose, the population and extent of each district, the mode in which it is intended that the appointment shall be made, whether jointly or severally by the sanitary authorities of those districts, and the amount of salary or remuneration proposed to be assigned to the officer appointed.

Art. 2. When the approval of the Local Government Board has been given to the proposals submitted to them, the sanitary authority or authorities shall proceed to the appointment of a medical officer of health accordingly.

Art. 3. No appointment of a medical officer of health shall be made unless an advertisement giving notice of the day when such appointment will be made shall have appeared in some public newspaper circulating in the district or districts, at least seven days before the day on which such appointment is made; Provided that no such advertisement shall be necessary for the appointment of a temporary substitute.

Art. 4. Every such appointment hereafter made shall, within seven days after it is made, be reported to the Local Government Board by the clerk to the sanitary authority, or, in the case of a joint appointment, by the clerk to one of the sanitary authorities by whom the appointment is made.

Art. 5. Upon the occurrence of a vacancy in such office, the sanitary authority or authorities shall proceed to make a fresh appointment, which shall be reported to the Local Government Board, as required by sect. ii. art. 4, of this order; but if the sanitary authority or authorities desire to make any fresh arrangements with respect to the district, or the terms of the appointment, they shall, before filling up the vacancy, supply the particulars of the arrangement to the Local Government Board in the manner prescribed by sect. ii. art. 1, in regard to the first appointment, and if the approval of the Local Government Board be given, absolutely or with modifications, the sanitary authority or authorities shall then proceed to fill up the vacancy according to the terms of the approval so given.

Art. 6. If any officer appointed under this order be at any time prevented by sickness or accident, or other sufficient reason, from performing his duties, the sanitary authority or authorities, as the case may be, may appoint a person qualified as aforesaid to act as his temporary substitute, and may pay him a reasonable compensation for his services; and every such appointment shall be reported to the Local Government Board as soon as the same shall have been made.

SECTION III.—*Tenure of Office.*

Art. 1. Every officer appointed under this order shall continue to hold office for such period as the sanitary authority or authorities appointing him may, with the approval of the Local Government Board, determine, or until he die, or resign, or be removed by such authority or authorities with the assent of the Local Government Board, or by the Local Government Board.

Provided that the appointments first made under this order shall not be for a period exceeding five years.

Art. 2. When any such officer shall have been appointed after the passing of the Public Health Act, 1872, for one or more sanitary districts, and any change in the extent of the district or districts, or in the duties, salary, or remuneration, may be deemed necessary, and he shall decline to acquiesce therein, the sanitary authority or authorities by whom he was so appointed, may, with the consent of the Local Government Board, but not otherwise, and after six months' notice in writing, signed by their clerk or clerks, given to such officer, determine his office.

Art. 3. No person shall be appointed who does not agree to give one month's notice previous to resigning the office, or to forfeit such sum as may be agreed upon as liquidated damages.

SECTION IV.—*Duties.*

The following shall be the duties of the medical officer of health in respect of the district for which he is appointed; or if he shall be appointed for more than one district, then in respect of each of such districts :—

1. He shall inform himself, as far as practicable, respecting all influences affecting or threatening to affect injuriously the public health within the district.

2. He shall inquire into and ascertain by such means as are at his disposal the causes, origin, and distribution of diseases within the district, and ascertain to what extent the same have depended on conditions capable of removal or mitigation.

3. He shall by inspection of the district, both systematically at certain periods and at intervals as occasion may require, keep himself informed of the conditions injurious to health existing therein.

4. He shall be prepared to advise the sanitary authority on all matters affecting the health of the district, and on all sanitary points involved in the

action of the sanitary authority or authorities; and in cases requiring it, he shall certify, for the guidance of the sanitary authorities, or of the justices, as to any matter in respect of which the certificate of a medical officer of health or a medical practitioner is required as the basis or in aid of sanitary action.

5. He shall advise the sanitary authority on any question relating to health involved in the framing and subsequent working of such bylaws and regulations as they may have power to make.

6. On receiving information of the outbreak of any contagious, infectious, or epidemic disease of a dangerous character within the district, he shall visit the spot without delay, and inquire into the causes and circumstances of such outbreak, and advise the persons competent to act as to the measures which may appear to him to be required to prevent the extension of the disease, and so far as he may be lawfully authorised, assist in the execution of the same.

7. On receiving information from the inspector of nuisances that his intervention is required in consequence of the existence of any nuisance injurious to health, or of any overcrowding in a house, he shall, as early as practicable, take such steps authorised by the statutes in that behalf as the circumstances of the case may justify and require.

8. In any case in which it may appear to him to be necessary or advisable, or in which he shall be so directed by the sanitary authority, he shall himself inspect and examine any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, or flour exposed for sale, or deposited for the purpose of sale or of preparation for sale, and intended for the food of man, which is deemed to be diseased, or unsound, or unwholesome, or unfit for the food of man; aud if he finds that such animal or article is diseased, or unsound, or unwholesome, or unfit for the food of man, he shall give such directions as may be necessary for causing the same to be seized, taken, and carried away, in order to be dealt with by a justice according to the provisions of the statutes applicable to the case.

9. He shall perform all the duties imposed upon him by any bylaws and regulations of the sanitary authority, duly confirmed, in respect of any matter affecting the public health, and touching which they are authorised to frame bylaws and regulations.

10. He shall inquire into any offensive process of trade carried on within the district, and report on the appropriate means for the prevention of any nuisance or injury to health therefrom.

11. He shall attend at the office of the sanitary authority, or at some other appointed place, at such stated times as they may direct.

12. He shall from time to time report, in writing, to the sanitary authority his proceedings, and the measures which may require to be adopted for the improvement or protection of the public health in the district. He shall in like manner report with respect to the sickness and mortality within the district, so far as he has been enabled to ascertain the same.

13. He shall keep a book or books, to be provided by the sanitary authority, in which he shall make an entry of his visits, and notes of his observations and instructions thereon, and also the date and nature of applications made to him, the date and result of the action taken thereon, and of any action taken on previous reports, and shall produce such book or books, whenever required, to the sanitary authority.

14. He shall also prepare an annual report, to be made at the end of December in each year, comprising tabular statements of the sickness and mortality within the district, classified according to diseases, ages, and localities, and a summary of the action taken during the year for preventing the spread of disease. The report shall also contain an account of the proceedings in which he has taken part or advised under the Sanitary Acts, so far as such proceedings relate to conditions dangerous or injurious to health; and also an account of the supervision exercised by him, or on his advice, for sanitary purposes, over places and houses that the sanitary authority has power to regulate, with the nature and results of any proceedings which may have been so required and taken in respect of the same during the year. It shall also record the action taken by him, or on his advice, during the year, in regard to offensive trades, bakehouses, and workshops.

15. He shall give immediate information to the Local Government Board of any outbreak of dangerous epidemic disease within the district, and shall transmit to the board, on forms to be provided by them, a quarterly return of the sickness and deaths within the district, and also a copy of each annual and of any special report.

16. In matters not specifically provided for in this order he shall observe and execute the instructions of the Local Government Board on the duties of medical officers of health, and all the lawful orders and directions of the sanitary authority applicable to his office.

17. Whenever the Diseases Prevention Act of 1855 is in force within the district, he shall observe the directions and regulations issued under that Act by the Local Government Board, so far as the same relate to or concern his office.

SECTION V.—*Remuneration.*

Art. 1. The sanitary authority or authorities, as the case may be, shall pay to any officer appointed under this order such salary or remuneration as may be approved by the Local Government Board; and where such officer is appointed for two or more districts, the salary shall be apportioned amongst the districts in such manner as the said board shall approve.

Provided that the sanitary authority or authorities, with the approval of the Local Government Board, may pay to any such officer a reasonable compensation on account of extraordinary services, or other unforeseen circumstances connected with his duties or the necessities of the district or districts for which he is appointed.

Art. 2. The salary or remuneration assigned to such officer shall be payable quarterly, according to the usual feast-days in the year—namely, Lady Day, Midsummer Day, Michaelmas Day, and Christmas Day; but the sanitary authority or authorities may pay to him at the expiration of every calendar month such proportion as they may think fit on account of the salary or remuneration to which he may become entitled at the termination of the quarter.

Given under our seal of office, this eleventh day of November, in the year one thousand eight hundred and seventy-two.

JAMES STANSFELD, *President.*
JOHN LAMBERT, *Secretary.*

The actual working of the Public Health Act of 1872 is that there are three classes of medical officers of health appointed—1. Medical officers of health to combined sanitary districts, such as Kent, Shrewsbury, Gloucester, North Devon, &c.; these devote their whole time to the office, although some few hold other appointments—such as analyst, coroner, &c.—which do not interfere with their duties. 2. Medical officers of health who are not restricted in any way, but are given either a fair salary or an annual sum, which though perhaps inadequate, is yet indirectly sufficiently remunerative. 3. Union medical officers and the like, to whom is given a paltry annual fee, or, as in some places, a stated sum for each report, a report not to be sent in unless required by the sanitary authority. (!)

What are, or rather should be, the qualifications of a medical officer of health? First, he must be a medical man—that is legally essential; then he must be a man of capacity, of good education, and of sound common sense, riding no dangerous hobby-horse to death. A knowledge of the mode of propagation of all contagious diseases, with their pathology, and an acquaintance with practical chemistry, microscopy, and the chief sanitary statutes are essential. These things may be easily acquired by any man of average abilities, and no one can possibly be an efficient officer without a sound knowledge of them all. In addition to the foregoing, it is desirable, although not essential, that a knowledge of the following branches of science should be acquired: geology, engineering (especially the practical parts relating to sewers and drains, the taking of levels, the measurement of heights, and the best methods of conveying and storing water), meteorology, and the kindred sciences.

There is nothing more instructive and useful to medical officers of health than an acquaintance with the history of the different epidemics of ancient times, and of the middle ages, as compared with our own. It is, however, possible that the man best qualified as to knowledge, may by infirmities, either of body or of temper, make a very indifferent officer, since it is a post requiring a knowledge of the world, a robust body, and sound judgment, as well as the special acquirements mentioned above. Previous experience was only obtained in a few instances in the first appointments under the Public Health Act, 1872; but, of all things, *experience* would be a necessary qualification for future high-class appointments. And here, again, sanitary authorities may be misled by the specious testimonials of medical officers belonging to the third, the *roi-fainéant* class, who most assuredly will be tempted to play upon the name of medical officer of health, which they may have borne for many years without at the same time having had any practical experience whatever in its duties.

A health officer cannot well take any other post, or engage in private practice, if his district is very large or populous; on the other hand, if he has leisure, and is duly qualified, there are certain offices, such as analyst and coroner, which are of a kindred nature, and which would harmonise with his duties. Much has been said against medical officers of health as public analysts. It must depend upon individual qualifications and amount of time whether such a union is desirable or not. The adulteration of food has always been taught at the same time and in the same manuals as sanitary science, and the Adulteration Act is carried out by sanitary authorities and sanitary officials; so that it has evidently been considered a part and portion of hygiène.

Routine Work of Medical Officer of Health.—It has been well said, one of the first things that should be done is a house-to-house inspection by the subordinates, as described under HOUSE-TO-HOUSE INSPECTION. Such a course equally applies to rural and urban districts; and the medical officer should also accompany from time to time his inspector, and gain a knowledge personally of the district. In strictly urban districts, the work will often be somewhat of a special character; there will be manufactories, lodging-houses, butcheries, dairies, and other places which will require the continual care of the sanitary authorities. Public buildings should be narrowly watched. There are many things that are neglected by sanitary officials because they have never been thought of; for instance, the dressing-rooms, &c., of theatres (*see* THEATRES) and other places. The water-supply of every large town should be analysed by the ammonia process at least once a month, and for such analysis the health officer should be paid. He should have an office in some convenient part of the town, where the inspectors can confer with him, and to which official correspondence can be addressed. His attendance at this office would be probably regulated by a bylaw, but whether that be so or not, for his own convenience it should be regular.

Every month, by analysing the rain falling in different parts of the town, he can estimate the sulphuric acid in the air, which will give the measure approximatively of impurity through smoke of the atmosphere. *See* RAIN.

In case there should be an outbreak of fever, it will be his duty to personally isolate every case which cannot be removed to hospital; and at such times he may require assistance, which should be given to him. A record of each death and of each contagious case of sickness should be transmitted to the office daily. (*See* BIRTHS, DEATHS, AND SICKNESS RETURNS.) The returns of death are easily obtained; the returns of sickness will be by no means perfect, but an officer must make the best of his resources.

In large rural combined districts a central office can only in some cases be established. Each union is so distinct in itself that one office is seldom of any practical value; a room in the workhouse is generally easy to get, and may be used when required. The routine is very much the same as in urban authorities. The medical officer meets the inspector at different places, obtains returns of deaths and sickness about once a fortnight, receives the notices the inspector sends him of contagious disease, overcrowding, &c., and attends the sanitary meetings in all combined rural sanitary authorities. It is most convenient that each rural sanitary authority should have a special *monthly meeting;* then, if well arranged, the health officer can generally attend each in turn. Parochial committees (from their local knowledge) are also sometimes of use in meeting the health officer. On inspecting a parish, the officer of health should place himself in communication with the clergyman, guardians, and medical men, if there be any, and inquire (*a*) into the water-supply; (*b*) into the drainage; (*c*) into the health of the inhabitants and past sanitary history of the place; and (*d*) into overcrowded and unhealthy houses.

If there should be any disease—such as goître—that would appear to spring from some endemic cause, no one has so good an opportunity of investigating it as the health officer. If possible, he should construct a map of his district, the spots where this endemic disease appears being appropriately marked. On this head he will find the maps of the distribution of heart and other diseases by Haviland help him much.

It is the medical officers of health of *rural* districts to whom the profession will look to solve the problems of the causes of contagious disease, as to whether they do or do not arise *de novo*—the disturbing conditions of towns are too many to elucidate them satisfactorily. Had Dr. W. Budd lived all his life in Bristol, he would have hardly been able to trace so satisfactorily the sequence of events in his book on typhoid fever.

All reports to the sanitary authority should be made with the greatest care, and a copy kept; for these reports may be used for any purpose by the sanitary authority, being the property of that authority.

Melting-House, Melting-Place.—(P. H., s. 114.) *See* TRADES, OFFENSIVE.

Mercury (Hg = 200)—The Arabian physicians Avicenna and Rhazes first employed this metal medicinally, but they only ventured to use it externally against cutaneous diseases and vermin. The Hindoos were probably the first to prescribe it internally. It is obtained chiefly from its sulphide, native cinnabar, by distillation with iron. Sometimes it is met with in its metallic state, sometimes combined with chlorine. The mercury of commerce is purified by redistillation and washing with dilute hydrochloric acid. The principal mines are those of Idria in Carniola, Almaden in Spain, and New Almaden in California.

The purity of this metal is shown by its brilliancy. Mere mechanical impurities—such as dust, dirt, &c.—may be readily removed by squeezing the metal through chamois leather or flannel; and it may be further cleaned by shaking well with a little strong nitric acid, washing with distilled water and drying by blotting-paper, or filtering through warm chamois leather. When pure, mercury is a brilliant white metallic liquid, becoming solid at − 39° F.; specific gravity, 13·5; entirely vapourised by a heat below that of visible redness; and when small globules of it are rolled slowly upon a sheet of paper, not the least particle adheres. Above 40° F. a slight vapour arises from it. It forms two classes of salts—proto and per salts. It dissolves many metals, as tin, bismuth, zinc, silver, and gold, and forms amalgams with them. One of the most important salts of mercury is the *perchloride of mercury* ($HgCl_2$), or *corrosive sublimate*, which is obtained by heating together certain quantities of sulphate of mercury, chloride of sodium, and black oxide of manganese. A double decomposition takes place, resulting in the formation of chloride of mercury and sulphate of soda. This substance appears in the form of white crystalline masses of prismatic crystals, soluble in 20 parts of water, in alcohol, and in ether. It gives a white precipitate with ammonia, and curdy white precipitate with nitrate of silver; and it precipitates albumen. When heated it should sublime without decomposition, leaving no residue. There are many other compounds of mercury, which in a work of this description it will not be necessary to discuss. All mercurial compounds, when heated with carbonate of soda, give a sublimate consisting of globules of metallic mercury. Solutions containing mercury give a silvery stain to copper when that metal is boiled in them. When acidified and mixed with excess of protochloride of tin, they give a greyish-black precipitate of metallic mercury. Solutions of the protosalts give with caustic potash or soda a black precipitate (Hg_2O); the persalts give with the same a yellow precipitate (HgO), and with the iodide of potassium a scarlet one (HgI_2), easily soluble in excess.

Some doubt appears to exist as to whether the liquid mercury is innocuous or not; but the generally-received opinion, notwithstanding that several fatal cases have occurred of poisoning from metallic mercury, is that it is perfectly harmless. It is well known that it has been repeatedly taken in doses of a pound or more in cases of obstruction of the bowels without proving noxious; while, on the other hand, may be instanced a case which recently occurred to Sir D. Gibb. For the purpose of causing abortion a girl swallowed 4½ oz. by weight of mercury. It had no effect on the uterus, but in a few days the girl suffered from a trembling and shaking of the body (mercurial tremors) and loss of muscular power. These symptoms continued for two months, but there was no salivation, and no blue mark on the gums.

Pereira is of opinion that in the few instances in which it has acted injuriously, it has been retained in the bowels for a considerable time, and has become oxidised.

Mercury breathed or swallowed in a state of *vapour*, or absorbed in a finely divided condition, in which form it appears to be highly susceptible of oxidation, may prove deleterious. As shown by numerous recorded cases, death has occurred from excessive doses of blue-pill, and also from inunction by strong mercurial ointment. The latter ointment contains half its weight of mercury, and has been used as a dressing to sheep and cattle in place of arsenic. Mr. Gamgee informed Dr. Taylor that 25 tons alone of this ointment had been sold in one year by a druggist in Boston, chiefly to farmers; and that sheep poisoned with mercury have been sent for sale to the dead-meat markets in London, and have realised more money than sound mutton sold in the county of Lincoln. —(TAYLOR.) This, then, may be a serious danger; hence, in any case of suspected illness from meat, although the meat may look sound and good, it is well to have it analysed for metallic poison.

Water-gilders, looking-glass silverers, barometer-makers, men employed in quicksilver mines, and others exposed to mercurial emanations, become subject to a form of paralysis and salivation called *mercurialismus*. Some constitutions appear to be capable of resisting the effects which the inhalation of mercurial vapours induces for a considerable period, while others yield after a few months' exposure to their insidious influence. At a meeting of the Medical Society in April 1872, Mr. Spencer Watson showed a patient suffering from mercurial tremors. He was a barometer-maker, and had been in the trade for fifteen years. For seven years he had resisted the influence of the fumes of mercury. He had never been salivated, but his gums were sore, and marked with a blue line; and his teeth were most of them loose, and some much decayed. Ever since the first attack he had been unable to sign his name from the unsteadiness of his hand. Dr. Crisp at the same meeting instanced the case of a family of five who were all sufferers from mercurial tremors. They were water-gilders. This gentleman was of the opinion that efficient ventilation was all that was required in buildings where mercury was largely employed.

A well-known instance of the effect of mercurial vapour is afforded by the Triumph man-of-war and Phipps schooner, which received a large quantity of quicksilver on board, saved from a wreck. The bags in which the mercury was stored became rotten and allowed the mercury to escape. In the space of three weeks 200 men were salivated, two died, and all the animals were destroyed.

Dr. Meyer has obtained excellent results in preventing all symptoms of mercurial poisoning in the looking-glass manufactory of St. Gobain, by sprinkling the floor with ammonia. He states that during the five years that it has been employed at St. Gobain, not one case of poisoning has been observed among the workmen, whilst there is a marked amendment in the symptoms of those who were previously affected. About half a litre of common liquid ammonia is simply to be sprinkled on the floor of the workshop every evening after the day's work. This preservative effect of ammonia was discovered accidentally, and Dr. Meyer cannot explain its action.—(Lancet, 1873, i. 601.)

In slow or chronic poisoning by mercury, the constitutional effects are indicated by irritability or looseness of the bowels, difficulty of breathing, spitting of blood, cough, general trembling or convulsive movements of the limbs, and palsy, with fever and emaciation, under which the patient sinks. The most marked effect of *slow* poisoning by mercurial compounds is *salivation* or ptyalism, indicated by an increased flow of saliva.

The elimination of mercury takes place by all the fluid secretions, but chiefly by the urine and intestinal liquids.

Antidotes.—The only efficacious antidotal treatment consists in the administration of albuminous substances. Peschier states that one egg is required for every 4 grains of mercury; but although albumen retards, it does not prevent the absorption of the poison. There can, however, be little doubt that, among these preventive measures, workmen exposed to mercurial fumes should swallow the whites (raw) of one or more eggs daily.

The *tests* for mercury have been already indicated.

Bisulphuret of mercury has been used as colouring agent in articles of food, and frequently has been discovered in Cayenne pepper. *See* CAPSICUM.

Mercurial salts were used by Ryan as disinfectants and antiseptics, but they are of too poisonous a nature to be commonly employed. Ryan used them for preserving timber.

Meteorological Influences.—The influence of temperature and the seasons plays a most important part on, and is intimately connected with, public health. Full information on the different branches of meteorology itself will be found under the articles BAROMETER, THERMOMETER, CLIMATE, CLOUDS, &c. It only remains to point out the connection between seasonal influences and disease. The late Dr. Edward Smith has worked this out in a truly philosophical manner, and we therefore borrow the following from his work, "Health and Disease: Periodical Changes in the Human System:"—

"*Statements of the Ancients.*—It is almost impossible to turn over the pages of the medical fathers without finding how much importance was attached to season in the production and cure of disease, or without admitting that the information which they have handed down to us is true and applicable to our own era. We do not purpose to enter at any length into the history of this department of knowledge; but we think that it will be instructive to notice with what extent and accuracy the influence of season was known to Hippocrates, as is shown in the twenty-four Aphorisms which he has transmitted, and which have been so ably edited for us by Sprengel,* Adams, and Clifton.

The division of the seasons has varied with different nations and eras, and has been arbitrary, except in so far as it was associated with the occurrence of certain natural phenomena more or less general or peculiar to the locality. We find that in the most ancient periods the Egyptians † divided the year into three seasons—viz., the 'Season of Vegetation,' the 'Season of Manifestation,' and the 'Season of the Waters,' or the 'Inundation;' and at the present time the first is called 'Winter,' the second 'Summer,' and the third 'Inundation,' or literally 'The Nile.' This division was associated with terrestrial changes; but in ancient Greece it was determined by astronomical phenomena, as it is with us at the present day.

Dr. Adams informs us that with the ancients *Winter* began at the setting of the Pleiades—viz., the period when they set with the sun, and continued to the vernal equinox. *Spring* commenced at the last-mentioned period (the vernal equinox), and ended at the rising of the Pleiades—viz., the rising with the sun. *Summer* began at the rising of the Pleiades, and continued to the rising of Arcturus; and *Autumn* extended from the rising of Arcturus to the setting of the Pleiades. Thus the division of the seasons was purely astronomical, and the constellations of the Pleiades and Orion were the dividing objects; the rising of the Pleiades with the sun separating the first from the second half of the year, and the setting of the same constellation with the sun terminating the year.

Having thus defined the several seasons, we will now, in a few words, give a condensed account of their influence as gathered from the opinions of Hippocrates, expressed in the Aphorisms above mentioned.

Change of seasons, and the alternations of cold and heat in those seasons, are most effectual causes of diseases. Some natures are well or ill affected in summer, and some in winter. Some diseases and some ages are well or ill affected at different times of the year, &c.

Autumnal diseases may be reasonably expected when on the same day it is sometimes hot and sometimes cold. The south wind dulls the senses of hearing and sight, causes headache, heaviness, and faintness. When it prevails, these incidents occur to the weak and sickly. The north wind affects the chest and throat, and causes constipation, dysuria, and muscular pains. The south wind relaxes and the north wind contracts the tissues of the body. When the summer is like the spring (viz., cool and wet), we must expect much sweating in fevers. Dry seasons are the cause of sharp fevers.

Constant and seasonable times of the year are accompanied by diseases which are regular and mild, but in inconstant and unseasonable times the diseases are uncertain and difficult of cure.

In autumn diseases are most acute and pernicious, and that season is hurtful to those in consumption. Spring is most healthy and free from fatal disease. If the spring be rainy with southerly winds, and have followed a dry and

* Aphorisms of Hippocrates, by Dr. Sprengel. London, 1708.

† Horæ Egyptiacæ, 1851.

cold winter, there will be in the following summer acute fevers, catarrhs, and bloody discharges. With a dry and northerly spring, following a rainy and warm winter, there will be bloody discharges, ophthalmia, rheumatism, and catarrhs, fatal to old people. Abortions easily arise under theso conditions, and children thus born near the spring are weak and diseased, and either grow up so or die quickly. A rainy and warm (southerly) autumn, following a dry and cold (northerly) summer, will produce in the winter pains in the head, cough, catarrhs, and consumption. A dry and cool (northerly) autumn is good for those of a moist temperament, but to others it produces ophthalmia, acute and lingering fevers, and melancholy.

Great droughts are more wholesome and less destructive than continual rains and frequent showers. Continual rains cause most diseases, as lingering fevers, diarrhœa, diseased humours, falling sickness, and apoplexy. Great droughts occasion consumption, inflammation of the eyes, rheumatism, incontinence of the urine, and bloody discharges.

Continued northerly weather braces and strengthens the body, makes it agile, fresh-coloured, and quick of hearing. It restrains the bowels, increases chest-pains, and offends the eyes. Southerly seasons relax and moisten the body, dull the senses of hearing and sight, cause heaviness, vertigo, laziness, and diarrhœa.

Children and very young people have good health in the spring and the beginning of summer; old people in summer and some part of autumn; people of middle age in autumn and winter.

All diseases appear at all seasons, but some are caused and exasperated rather in one than another. In the spring, affections of the brain, falling sickness, discharges of blood, affections of the throat and chest, diseases of the skin, and rheumatism. In summer, some of the above; also burning fevers, agues, disorders of the stomach and bowels, violent sweatings, and affections of the eyes, ears, and mouth. In autumn, many summer diseases, also fevers, enlargement of the spleen, dropsies, consumption, asthma, diarrhœa, and dysentery; iliac passion, falling sickness, and brain diseases.

Present Liability to Disease.—The existence of seasonal disease is well established, for from the era of Hippocrates to our day the experience of mankind has borne testimony to the variations in the prevalence of disease at various seasons of the year, and to the fact that the same kind of disease assumes a different aspect at various seasons; or, to speak more generally, in various years. We need only refer to the occurrence of the plague in London in 1593, 1603, 1625, 1636, and 1665,* all of which received their vast development in the hot season, and to the general manifestation of cholera in our day at the same periods. The occurrence of yellow fever at the end of summer in southern climes, the prevalence of special eruptive maladies at different seasons, and the occurrence of inflammatory diseases in the cold season, are familiar illustrations of universal belief upon this subject; but as we shall hereafter give details upon this question, we shall not now discuss it further.

The foundation of seasonal disease is the varying degree of vital action proceeding within the body at the different seasons of the year.

We must admit that disease is in its principal forms an exaggeration of a natural tendency then existing in the human body—a tendency which only becomes disease when carried beyond a certain limit. Thus we find that a person of feeble habit is especially liable to disease in which exhaustion is a prominent feature, and one of plethoric habit is unusually exposed to congestive and inflammatory diseases.

We have already shown that the human system varies in its amount of vital action in a very definitive manner, the maximum being in the spring, the decline and the minimum in the summer, the minimum and the increase in the autumn, and a stationary elevation in the winter. Just in the like order is it exposed to an exaggeration of these tendencies. Thus, as a rule, the diseases of the end of summer are those of exhaustion, whilst those of winter and spring are known as inflammations, and those of autumn and the end of spring are marked by such conditions as result from rapid variation in the animal economy in its relation to the influence of external agents. There is also a variation in the type of disease according to the advancing tendency of the system, so that in the later part of spring, when there is the commencement of a downward tendency of the vital actions, the progressive attacks of the diseases will progressively show an asthenic type, until they at length terminate in the diseases of exhaustion infesting the summer season; whilst, on the other hand, diseases occurring at the end of summer and the early autumn progressively change their aspect from the asthenic form until they merge into the sthenic conditions of winter.

Hence there are both settled sthenic and asthenic conditions, and conditions varying in a definite direction between them, and as they are due to the amount of vital action existing (which results from the influence o

* Report on Cholera (Dr. Farr), p. 173.

the agencies which constitute the season), so will the sthenic or asthenic character be manifested at their respective seasons. With this key, therefore, we may not only foretell the character of disease at a given period of the year, but may also be acquainted with the variations in the type of the same disease, as manifestations of it may from time to time occur with the progression of the seasons. Thus, for example, an attack of scarlatina occurring at the end of a hot summer, and with a warm and moist autumn, must manifest a distinctly adynamic type; whilst if it occur after the cold weather has set in, or during a cold summer, it will be more and more inflammatory, until the system is no longer very liable to that form of disease.

There are diseases which result from an arrest or lessening of the natural tendencies of the system.

Such is the character of disease which is induced by an excess of seasonal influences or in a system unusually sensitive to the ordinary degrees of seasonal influence—viz., one of exaggeration of the natural tendencies of the system; but there are other diseases arising from a contrary condition. Thus, if when the temperature is increasing, and the skin is required to be unusually active, so as to produce great dispersion of heat, some condition occurs which leads to the arrest of, or a serious diminution in, the action of the skin, the natural tendency of the system is thwarted, and the only condition compatible with health being for the time set aside, a state of disease immediately ensues. This is familiarly illustrated by a cold, the ordinary effect of undue exposure of a part of the body to a lower temperature, and also by the indulgence in such articles of food as tend to lessen the action of the skin. Or again, if during winter, when the action of the skin and the sensibility of the surface should be much reduced so as to prevent an undue waste of heat, and to pass unheeded the influence of cold, a condition be imparted which tends to maintain the skin in the normal activity of summer—as, for example, the occupation of highly-heated apartments, or the constant use of the Turkish bath—the body will be liable to the effects of too great dispersion of heat, and will certainly be more sensitive to the influence of external cold. Or finally, if with the necessity for high vital action in the winter and spring there should be deficient nutriment supplied, there will be an arrest of that condition which is natural to the body at that period of the year.

All this latter class of causes may be regarded as adventitious or accidental, and they act by arresting the natural order of the phenomena within the system; whilst the former are, so to speak, natural—for the most part flowing from natural causes—and act by adding force to the natural order of phenomena. Both are connected with season, but the latter alone can be truly regarded as seasonal, and subject to the law of cyclical change, which we are now discussing.

The constitutional peculiarities of individuals modify the effects of season.

The relation of these internal changes has already been demonstrated, but it may be well to show yet more clearly that there is a constant antagonism proceeding between those external influences and the vital actions of the system; and although the influence of the external agents will in the end draw the vital changes of the body in their train, there is not a uniform readiness to submit to their controlling power. This is commonly referred to the constitution of the individual, so that it is said that such a one "suffers much from hot weather," or he "bears hot or cold weather well," according to the peculiar tendencies of his system to aid or resist the influence of external agencies. The former illustration has been abundantly exemplified in two investigations which have been already referred to. In that conducted at the Brompton Hospital on fifteen cases of phthisis, during the increasing temperature of the month of June, there was found to be great variation in the effects of the season in the different cases, and it was ascertained beyond a doubt that those who knew from experience that they bore heat badly had an excess of all the seasonal effects. So, in like manner, when determining the amount of carbonic acid evolved daily during the year, Mr. Moul, who suffers much from heat, showed a much greater diminution in the amount of carbonic acid evolved under the influence of temperature than we evinced who bear heat well—his diminution being, as already stated, 27 per cent. at the middle of June, whilst ours was but little more than that amount at the end of August.

In this, no doubt, lies the explanation of the selection of a few victims when many persons are exposed to the same morbid conditions, for it is well known that although there may be an epidemic of influenza or an outbreak of cholera which may extend over a great city, only a small proportion of the population thus exposed will be seized by it. It has always been difficult to explain this fact, and hence many theories have arisen referring to the accumulation and the transmission of the morbid influence, each of which may have some weight, but no one has been shown to exert so general a power as to be regarded as an adequate cause of this diversity. Now, however, it having been proved that morbid influences arise under certain external conditions which, whilst they lead to variations in the vital powers of the system, have greater influence upon certain individuals than upon others, we have a ready and general explanation of the selection of such persons as the earliest victims. But, with this truth admitted, we may still need increased information as to the origin and transmission of the morbid influence, as well as to the mode by which those external agencies act which both engender these morbid agents and prepare the system for the reception of their influence.

The dangers to be apprehended in the progress of disease vary with the season.

In the maximum and minimum conditions of the system we find that causes have been long acting, and have gained power by continuance, and hence *the dangers will increase as the season progresses.* This we shall show to be the case in a remarkable degree in the summer season, as manifested by the progress of cholera, and in the winter season by the progress of bronchitis.

In the season of change the danger lies in the difficulty of adapting the body with its numerous functions to a new order of external phenomena, and hence *the danger will be the greatest at the commencement of the period of change*, and this may be well illustrated by the early severity and special cause of death from eruptive diseases at the two periods of change.

The frequency of certain diseases has a relation to the season and to the nature of the disease.

We have affirmed that the diseases of hot weather show an adynamic and those of the cold weather a dynamic type, whilst the characteristic of the spring and autumn months is that of change; and we now purpose to show that such is the actual nature of the diseases which prevail at those periods.

For this purpose we have analysed the London returns of the Registrar-General for the five non-epidemic years of 1850 to 1854, both inclusive, and have ascertained the amount of mortality which occurred from each disease in each quarter of the several years. When these results are compared with the mortality which would have occurred had the deaths been uniformly distributed over the year, we at once perceive the periods of excess or defect, and it is upon that principle that the following table has been compiled:—

TABLE showing the EXCESS or DEFECT in the PREVALENCE of certain DISEASES at each Season of the Year from the Amount which would have occurred had the Mortality been equally distributed through the Year.

Disease.	Vital Changes. 1st Quarter. Maximum.	2d Quarter. Maximum and Decreasing.	3d Quarter. Decreasing and Minimum	4th Quarter. Minimum and Increasing.
Diarrhœa .	— 15·2	— 14·5	+ 36·4	— 6·9
Enteritis .	— 1·7	+ 2·9	+ 4·0	+ 0·2
Gastritis .	— 2·4	+ 1·4	+ 4·4	— 4·6
Nephritis .	+ 2·3	— 0·5	+ 3·4	— 0·8
Peritonitis .	+ 0·7	+ 4·6	— 4·1	— 1·4
Pleuritis .	+ 5·0	+ 5·0	— 6·2	— 0·3
Bronchitis .	+ 12·9	— 1·9	— 14·0	+ 2·8
Pneumonia .	+ 4·8	+ 1·1	— 10·7	+ 6·7
Pericarditis .	+ 4·5	+ 0·3	— 6·4	+ 1·5
Cephalitis .	+ 1·6	+ 0·5	...	— 2·3
Convulsion .	+ 2·7	— 0·6	— 2·1	— 0·2
Apoplexy .	+ 2·6	— 1·7	— 2·1	+ 1·2
Epilepsy .	+ 2·4	— 3·7	— 2·3	+ 3·0
Smallpox .	+ 1·0	+ 1·4	— 4·0	+ 1·3
Measles .	— 1·1	+ 6·4	— 5·8	— 0·1
Scarlatina .	— 8·3	— 4·6	— 0·2	+ 12·5
Typhus .	— 2·1	— 2·0	+ 0·5	+ 4·2

It is manifest that there are inconveniences in the construction of this table, for as we have shown that certain months exhibit changes of far greater magnitude than others which are comprehended in the same quarter, the full effect cannot be shown when all are added together. This is particularly the case in the second quarter, for whilst April and May are maximum months, June is a month of marked decline. Such diseases, therefore, as depend upon a diminution in the vital powers will scarcely exhibit this characteristic when compared with the conditions of the previous maximum periods. Hence it would have been better for our purpose if the mortality from each disease could have been recorded in each month separately, but the publications of the Registrar-General do not give the required data.

Again, the mortality is not sufficient evidence of the prevalence of a disease, for whilst it embraces the question of frequency, as well as that of intensity, the former is necessarily subordinate to the latter; but here also published data fail us, and we are compelled to be content with a knowledge of the mortality alone.

All these circumstances militate against the full development of the results which we seek; and whilst the latter are very decided in the foregoing table, it may be inferred that their value is greater than the treble power.

Diseases of the alimentary canal have their maximum intensity and frequency at the period of minimum vitality.

Diarrhœa is the most marked illustration of this fact, for whilst there is a defect in each of the three other quarters, there is an excess of no less than 36 per cent. in the quarter of minimum vitality, and the extremes are so great as a defect of 15 per cent. in the maximum, and an excess of 36 per cent. in the minimum quarter. These numbers are so decided that for all practical purposes diarrhœa may be regarded as a disease solely of the minimum period of vitality; and when it occurs at other periods, we may readily believe that it is due to fortuitous circumstances, or occurs in a state of system which in an unusual degree evinces the characters of the human system in general at the minimum period of vitality. Cholera, in its various outbreaks in England, has followed a similar progression, and has proved itself to be essentially a disease of the minimum period of vitality.

The following table shows this fact in a striking manner, in the two outbreaks of 1832 and 1849, by the percentage of deaths which occurred in England in the months of May, June, July, August, September, October, and November:—

TABLE showing the MONTHLY PROPORTION per Cent. of all the DEATHS from CHOLERA in 1832 and 1849.

	1832. Per Cent.	1849. Per Cent.
May	2·41	0·60
June	4·40	3·76
July	13·57	13·91
August	18·69	29·17
September	17·71	37·46
October	13·19	8·55
November	2·59	1·55

There was thus a progressive increase in the mortality from cholera through June and July to the maximum mortality in August in 1832, and through June, July, and August to the maximum in September 1849, and thenceforward in both years there was a rapid decline. These facts show a great preponderance of mortality in the two months when the vital actions were at the minimum.

It is interesting to notice that the month of maximum mortality from cholera was earlier in Paris than in this country—viz., in June in 1849, and even in April in 1832; but there is so great a want of uniformity in the progression of the monthly returns from that city that we are tempted to doubt if the records have been well kept, or if the features of this disease were the same in Paris as in London. It is, however, highly probable that a disease which is so closely connected with the degree of vital power of the body will exhibit different manifestations in different countries and climates, for the human constitution certainly differs in its power in various parts of the world, and hence will vary in its capability to resist morbid agencies.

Enteritis and gastritis produce their maximum of mortality in the second and third, or decreasing and minimum, quarters, whilst there was a defect on the average in both diseases in the maximum period of vitality, and in gastritis the defect was continued even into the increasing period.

The greatest mortality from the plague in England occurred at the minimum period of vitality.

The various attacks of the disease known as the Plague, which occurred in London in the sixteenth and seventeenth centuries, exhibited the same features as the cholera of our day in reference to the question now under discussion, and show a remarkable similarity in the essential nature of the two diseases, as the following extracts from a table copied into the same report from Mr. Marshall's work on the Mortality of the Metropolis very clearly show:—

TABLE showing the WEEKLY NUMBER of DEATHS from the PLAGUE in LONDON in the various Epidemics, contrasted with the usual Mortality in other Years.

Week.	Average of 7 Years, 1640-46.	Periods of Plague. 1593.	1603.	1625.	1665.
27	211	850	267	640	684
28	214	1440	445	942	1006
29	210	1510	612	1222	1268
30	235	1491	1186	1741	1761
31	259	1507	1728	2850	2785
32	278	1503	2256	3583	3014
33	282	1550	2077	4517	4030
34	333	1532	3054	4855	5319
35	353	1508	2853	5205	5568
36	379	1490	3 85	4841	7496
37	395	1210	3078	3897	8252
38	372	621	3129	3157	7690
39	373	629	2456	2148	8297
40	385	450	1961	1994	6460
41	364	...	1831	1236	5720
42	365	...	1312	838	5068
43	338	...	766	815	3219
44	320	...	425	661	1806
45	301	...	...	375	1388
46	284	...	...	...	1789
47	247	...	...	...	1359
48	247	...	...	...	405

In each of these outbreaks it will be seen that the great development of the attack occurred in July, and reached its maximum point in the minimum months of vitality—viz., in August and September, whilst in November the disease had nearly disappeared.

The greatest mortality in chest diseases is found in the periods of increasing and maximum vital action, and the least mortality at those of minimum vital action.

This is shown by the deaths from bronchitis, pneumonia, and pleuritis, and especially in bronchitis, in which the extreme difference was so great as a defect of nearly 11 per cent. in the minimum and an excess of nearly 13 per cent. in the maximum period. There is no exception to be found in the returns in these two directions; but in reference to the second quarter of the year, in which there is a mixture of influences, we find that whilst the deaths from bronchitis were then in defect, those from pneumonia and pleuritis were still in excess—a fact doubtless owing to the admixture of the returns in April and May with those in June.

Pericarditis followed precisely the order of pneumonia, and had its maximum at the period of maximum vital action, and *vice versâ*, and the defect in the summer season was so much as 6½ per cent.

Brain diseases prevail in the cold season.

Apoplexy and epilepsy exhibited an excess of deaths in the increasing and maximum periods of vitality, and convulsions were in excess at the latter period only, whilst in all these diseases there was the least mortality at the periods of decreasing and minimum action.

Eruptive diseases for the most part prevail at the seasons of change.

This is a part of the subject worthy of the most profound study, and one which is necessarily most complicated in its details, for at the same period we find the confluence of two sets of causes which are antagonistic to each other, and which have to be reconciled by the system exposed to their influence. In the end of the struggle the conditions of the advancing season gain the mastery, but in the earlier period we are subjected to the evils of the soft, sensitive, perspiring skin of the end of summer being exposed to the rude equinoctial blasts, the enfeebled powers of assimilation struggling more or less feebly to supply the increased vital transformation which the cooler weather demands, and the active pulsation of the heart opposed by the lessened action of the skin, which, being accompanied by contraction of the capillaries, offers an unusual obstacle to the current of the blood at the surface, and causes it to accumulate in the internal parts. These and other antagonistic influences are doubtless the cause of much autumnal disease, just as in the contrary conditions of spring we find spring diseases, all of which are due to the antagonistic influence of a new order of external phenomena upon a system which may not be able to adapt itself quickly enough to those novel influences.

We do not purpose to enter at length into this interesting question, but will only point out one or two of the most remarkable agreements or diversities to be met with in these seasonal diseases.

Scarlatina and typhus show a remarkable correspondence under this head, since both were most fatal in the increasing periods of vitality, and the least so in the next quarter, when the vital powers were the highest. Measles and scarlatina offer as remarkable a contrast, for the greatest mortality from the former occurred at the period of decreasing and the latter at that of increasing vital changes. Smallpox offered less diversity than might perhaps have been expected (the cases of death are happily now few), but the least mortality was found with low vital action.

In seeking to connect epidemics and eruptive diseases with certain states of vitality of the system, we must especially bear in mind the caution already given, that the nature of the season will exert a great effect not only upon the type of that attack of the disease, but upon the month in which the maximum or minimum mortality will occur. Hence we are prepared to find that there was a retrocession in time in the epidemic of scarlatina in 1844 and 1848, and it is probable that measles will scarcely be more fatal in the second than in any other quarter if the spring and summer be cold. But these do not materially affect the general rule, that measles will be more fatal at the beginning of summer and scarlatina at the beginning of winter.

The type of a disease has also reference to the conditions of the system which preceded its occurrence.

This consideration is especially applicable to autumnal diseases, which occur with an increasing, but immediately follow the period of minimum, state of the vital powers. It has been often stated in the preceding pages that there is a progressive decline of the vital actions during two or three months at the middle and end of summer; but the minimum period is not an extended one — not so extended as the maximum period in the spring—and hence the upward tendency, which occurs at the middle of September, induces a somewhat sudden change in the vital actions, and during this period of change eruptive diseases, as scarlatina, are very apt to occur. It is therefore easy to understand that the type of a disease, commencing immediately on the occurrence of this change, will have more reference to the period of low vital power, which has just passed over, than that of the same disease appearing when the upward tendency has become well developed. The former would exhibit adynamic and the latter dynamic conditions.

Hence, not only must we look forward to the advancing season in order to judge of the type of any epidemic which may be existing, but we must have regard to the season which is just passing—or has very recently passed—in order to estimate rightly the type of the existing attack; and as this is particularly applicable to the seasons which we have called seasons of change, we may very well take scarlatina in the autumn and measles in the spring as illustrative of these two conditions. The early cases of scarlatina will be marked especially by exhaustion, and the latter by inflammatory complications, whilst the early cases of measles will be marked by inflammation, and the latter by prostration. The table under consideration shows that there is a decided difference in those two diseases as to the condition of system in which they commonly arise; but, as has already been intimated, should the conditions be transposed to other months, these diseases may assume each other's special characters.

An excess of seasonal conditions, whatever they may be, will induce an excess of seasonal disease; whilst any marked defect of the former may cause the importation of diseases which are commonly restricted to other seasons.

Viability of Infants.—There is reason to believe that the viability of children is in a degree dependent upon the season of their birth. I worked out this inquiry in the office of the Registrar-General with the following results:—

On careful analysis and the exclusion of doubtful cases, 3050 cases were found in which the children had died within one year of birth, and in which the month of age at death was recorded. Of these it was found that the percentage of those born in the different months varied from less than 7 per cent. in February and 7 per cent. in September to nearly 11 per cent. in June, with a great progressive increase in May and June, and then a decrease in July, August, and September. During the months of October, November, and December the proportion was tolerably stationary, and somewhat under a uniform average of the whole year—viz., 8 per cent.; whilst in January it had risen to the uniform average, and in February it fell 1½ per cent., and rose in equal amount in March, in which month and in April the percentage was that found in January.

The greatest viability occurred in those born in the winter months, and the least in those born in the summer months. The months of May, June, July, and August were those in which the greatest percentage of those born in them died during the first year of age. Hence it appears that this lessened viability is rather associated with the lessening powers of the human system at the season of birth than with the period of conception, and it may be inferred that in man, in common with so many animals, his offspring born in the cold season has a higher probability of life than when born in the hot season."

Miasma—*See* MARSHES.

Microphytes—Balestra attributes marsh fever to the presence of the *Microphyte granule*, found in marsh air. *See* MARSHES.

Microscope—The details of construction of a microscope or its theory hardly come within the scope of this work. The best for the medical officer of health or analyst to procure is undisputably a Hartnack, as will be evident from the following extract:—

"The microscope which, in my opinion, is by far the best, both for the student and any one who wants really to work, is that made by Hartnack. It is so easy to work with it. The stage is just high enough to permit of the hand moving the slide without the arm being raised from the table. That expensive and time-wasting apparatus, the movable stage, is absent. The coarse adjustment is effected by sliding the tube up or down without the use of a rack or pinion—another expensive and useless addition. Some persons say that without the rack and pinion the student will bring the lens down on the convex glass and break the preparation, or it may be the lens. After having given twenty-six courses of histology, and after having taught some five hundred students, I am glad to say that I never had a lens injured, and I have only had two covering glasses of preparations broken in this way. The student only requires to be carefully instructed on this point when he begins to work with the microscope. Hartnack's lenses, too, are so excellent that the student can see things clearly and not in a mist, as is the case with most English cheap lenses, and with the majority of Grundlach's one-eighths which found their way to this country."—(RUTHERFORD'S Notes on Practical Histology.)

The chief use of the microscope to analysts and hygienists is in the examination of water, of vegetable tissues, of crystals, and sublimates.

The examination of water is simple. Sometimes it is necessary to filter a large quantity through a small pellet of cotton wool, which will arrest a great many organisms and vegetable débris; the wool may then be soaked in glycerine-and-water, and examined.

The analytical microscopist will require needles mounted in handles, thin covering glass, scissors, forceps, scalpels, razor, mounting clips, and about twelve 1-oz. bottles, with wide mouths fitted with clean corks, in which are fixed glass rods filled with the following reagents: (1) Distilled water; (2) solution of chloride of sodium, ·75 per cent.; (3) absolute alcohol; (4) oil of cloves; (5) oil of turpentine; (6) glycerine; (7) acetic acid; (8) weak solution of iodine; (9) solution of chloride of zinc; (10) solution of dammar (*see* DAMMAR); (11) a thick solution of dammar resin in benzole; (12) weak spirit—one part of methylated spirit, three parts distilled water.

Different vegetable tissues require different treatment, which experience will teach—*e.g.*, chicory is best seen when the fragments are teased out by needles in glycerine-and-water; pepper shows best in Canada or dammar balsam. Few things that the analyst meets with can be seen satisfactorily in a dry state, they often require considerable preparation.

Sublimates and crystals of alkaloids are examined best by a binocular microscope—they may be mounted in the mother liquor. For sublimates Dr. Guy invented a short test tube set in a plate of glass; another slide is placed upon this, and the substance being heated, will, if it sublimes at all, condense on the slide.

Starches may be distinguished not alone by their size, but also by examination by polarised light, which is also useful for crystals.

Analysts should make careful sections of all vegetables used for the purpose of adulteration, and these should be always at hand for comparison.

Microzymes—*See* BACTERIA.

Microzyme, Test for Water—Germs of bacteria in water which cannot be detected by the highest microscopic powers, or even by Tyndall's test of the electric beam, may be distinguished by the following method: Take some recently-prepared Pasteur's fluid—composed of 10 grammes of crystallised sugar, ·5 grammes of ammonium tartrate, ·1 of well-burnt yeast ash, and 100 cubic centimetres of distilled water—boil it, and into a test tube previously heated to 356° F., put 1 or 2 cubic centimetres; add three or four drops of the water to be examined, and close the orifice of the tube with cotton wool. In a few days the liquid becomes milky if microzymes or their germs are present. *See*, BACTERIA, WATER, &c.

Miliary Fever—*See* FEVER, RELAPSING.

Military Fever—*See* FEVER, TYPHUS.

Military Service—*See* HYGIÈNE, MILITARY.

Milk—Milk containing, as it does, all the elements that are required for the growth and maintenance of the body, is rightly regarded as the type of an alimentary substance. Wherever it can be easily obtained it is largely used. It is the chief diet of the peasantry in Switzerland, and in England is used by 76 per cent. of the labouring classes.

In Wales the average consumption is 4½ pints per adult weekly, in Scotland it amounts to 6½ pints per head weekly, and in Ireland it reaches 6¾ pints.

It is the poor indoor operatives of London who use the least; the weavers of Spitalfields taking only about 7·6 oz. per head weekly, while those of Bethnal Green have only a fraction above 1½ oz. per head.

The amount of milk annually consumed in Paris amounts to 103·76 litres (litre = 1·763 pint), while in London the proportion is only 38 litres per head. This calculation is based on returns published ten years since, but there is no reason to believe that the proportion has since altered.

It would be commonplace here to enlarge on the value of milk as a dietetic agent. When we say that it contains all the necessary aliments for the support of life, and that they are in the best form for assimilation—viz., nitrogenous matters, fat, sugar, water, and salts—we sufficiently indicate the high place milk occupies amongst foods.

Cow's milk is the kind usually employed in this country; but in Sweden and Denmark sheep's milk, in Switzerland goat's milk, in Lapland reindeer's milk, and in Tartary mare's milk is used. Goat's and ass's milk is occasionally used here, but in this article, when not otherwise stated, it will be understood that our remarks especially apply to cow's milk.

Composition of Milk.—Good milk is a white homogeneous fluid secreted by the mammary glands of animals. It is an aqueous solution of caseine, milk-sugar, and saline matters, and holds in suspension fat in a finely-divided state. The specific gravity of genuine milk varies within the limits of 1026 and 1031.

Caseine.—The nitrogenous matter of the milk consists principally of an albuminous substance called *caseine*, which is not coagulable by heat, but is by acetic acid, by the products of its spontaneous decomposition, and by a neutral organic substance obtainable from the stomach (pepsine). It is caseine which constitutes the basis of cheese. A little *albumen* is present, and a third nitrogenous principle, called *lacto-proteine.*

The Fatty Matter.—This exists in the milk under the form of microscopic globules suspended in the fluid. These appear to be surrounded by an envelope of caseine or albuminoid matter, which during the process of churning becomes broken up.

Lactine.—This is a variety of sugar, and is described in article LACTOSE.

Inorganic Constituents of Ash of Milk.—The ash of cow's milk is very constant in quantity, its weight being from 7 to 8 grammes in 1000 cubic centimetres of milk. It may be said to mainly consist of phosphate of lime and chlorides of the alkalies. We possess very extensive analyses of the ash of different milks by Bunge (Zeitschr. f. Biologie, x. 295–335). The method he employed to determine the alkalies was by evaporation of 100 to 200 cubic centimetres to dryness, gentle ignition, exhaustion with water; then a second ignition of the residue; and lastly, making a solution of the ash in hydrochloric acid, and precipitating with barium hydrate; then the analysis was conducted in the usual manner. For the estimation of the chlorine, 100 to 200 cubic centimetres were evaporated down with a solution of a little pure carbonate of soda, and the ignition was as gentle as possible.

The results are contained in the following tables, and show some very curious relations in regard to the composition of the ash, the kind of food, and the inorganic components of the bodies of young animals. Thus in feeding the herbivora with substances rich in potash—*e.g.*, clover—the ratio of the equivalent of potash to soda may be raised to 5·6 to 1; and if the ash of milk of dogs be compared with the ash of the whole bodies of puppies and kittens, the constituents are found in almost exactly the same ratios. The quantities of potash, soda, and chlorine in milk vary with the food and other conditions. In woman's milk the ratio of the equivalent of potash to that of soda varies from 1·3 to 4·3 — equal K_2O to 1, equal Na_2O.

Another result brought out by the study of these tables is the great similarity of the composition of the ash of all milks. In all, the phosphate of lime holds the first place as to quantity, next comes potash and soda, then magnesia and iron; and in all is found a large quantity of chlorine, but no sulphuric acid, ready formed, is contained in the milk of woman, the cow, or the mare.

TABLE I.—ANALYSES of MILKS and of the ASH of YOUNG ANIMALS.

	MILK.							Whole Bodies of Sucking Animals.		
	1. Dog's Milk.	2. Dog's Milk.	3. Cow's Milk.	4. Cow's Milk.	5. Mare's Milk.	6. Woman's Milk.	7. Woman's Milk.	8. Cat.	9. Dog.	10. Rabbit.
Solid matter	270·08	281·95	105·84	...	96·04	134·89	132·58	...	...	...
Albuminoids	95·88	99·24	40·38	...	18·41	15·52	14·64	...	...	...
K_2O	1·413	1·683	1·766	1·071	1·045	0·7799	0·7029	2·79	2·677	2·967
Na_2O	0·806	0·696	1·110	0·636	0·139	0·2315	0·2570	2·285	2·589	1·630
CaO	4·530	4·281	1·599	1·864	1·236	0·3281	0·3427	9·412	11·295	9·586
MgO	0·196	0·215	0·210	0·299	0·125	0·0636	0·0654	0·420	0·508	0·591
Fe_2O_3	0·019	0·013	0·0035	0·127	0·015	0·0039	0·0058	0·067	0·107	0·063
P_2O_5	4·932	4·677	1·974	2·102	1·309	0·4726	0·4685	11·102	12·549	11·478
Cl	1·626	1·803	1·697	0·751	0·308	0·4377	0·4450	1·965	2·314	1·351
	13·522	13·368	8·3595	6·850	4·177	2·3173	2·2873	28·041	32·039	27·674
O = Cl	0·367	0·407	0·383	0·176	0·069	0·0987	0·1004	0·443	0·522	0·305
Ash	13·155	12·961	7·9765	6·674	4·108	2·2186	2·1869	27·598	31·517	27·369

TABLE II.

	Potash, Soda, and Chlorine in 1000 Parts.			One eq. Soda to	
	Na_2O.	K_2O.	Cl.	Eq. K_2O.	Eq. Cl.
1. Bitch's milk	0·806	1·413	1·626	1·15	1·76
2. ,, (1)	0·677	1·57	1·203	1·523	1·554
,, (2)	0·644	1·92	...	1·96	...
,, (3)	0·614	1·96	...	2·10	...
,, (4)	0·696	1·683	1·803	1·59	2·27
12. Cat's milk	1·010	1·221	...	0·796	...
13. Sheep's milk	1·090	1·267	1·217	0·765	0·976
14. ,,	0·4204	1·773	...	2·78	...
15. Cow's milk	0·636	1·071	...	1·11	...
16. ,,	0·5934	2·057	1·190	2·81	1·753
17. ,,	1·230	1·713	1·709	0·9165	1 214
18. ,, (1)	1·31	1·56	...	0·783	...
,, (2)	0·968	1·73	...	1·18	...
,, (3)	0·902	1·84	...	1·34	...
,, (4)	1·04	1·74	...	1·11	...
,, (5)	1·110	1·766	1·697	1·05	...
19. ,,	0·678	1·748	...	1·696	...
20. ,,	0·373	2·137	...	3·77	...
5. Mare's milk (1)	0·139	1·045	0·308	4·961	1·940
,, (2)	0·103	0·8725	0·2483	5 58	2·11
21. ,,	0·1464	0·6599	...	2·97	...
22. Woman's milk	0·1077	0·7075	0·4308	4·32	3·50
23. ,,	0·3838	1·217	...	2·086	...
24. ,, (1)	0·371	0·747	0·624	1·33	1·47
,, (2)	0·207	0·828	0·450	2·63	1·90
,, (3)	0·220	0·785	0·436	2·35	1·73
,, (4)	0·232	0·780	0·438	2·22	1·65
,, (5)	0·290	0·732	0·470	1·66	1·42
,, (6)	0·287	0·722	0·479	1·65	1·46
,, (7)	0·257	0·703	0·445	1·80	1·51
25. ,,	0·2183	0·5694	...	1·716	...
26. Camel's milk	1·235	1·334	...	3·74	...
Mouse, whole body	1·70	3·28	1·49	1·27	0·77
Cat, 19 days old	2·285	2·72	1·965	0·8034	0·7519
27. Cat, 1 day old	2·666	2·691	...	0·6643	...
28. Cat, 29 days old	2·292	2·684	...	0·7706	...
9. Dog, 4 days old	2·589	2·677	2·314	0·6805	0·7815
10. Rabbit, 2 weeks old	1·630	2·967	1 351	1·197	0·7245
29. Rabbit, embryos	2·183	2·605	2·082	0·786	0·834
Pupæ, Pontia brassicæ	0·2403	3·134	0·743	11·25	2·70
Pupæ, Pygoera bucephala	0·0716	5·513	...	50·69	...
Pupæ, Pygoera bucephala, dry	0·247	19·03	...	...	...
Ox-flesh, muscle	0·7698	4·654	0·6716	3·776	0·7627
Ox-flesh, with fat, &c.	0·81	4·16	0·71	3·38	0·77
Rice, dry	0·028	1·044	0·2699	24·27	8·34
Phaseolus vulgaris, dry	0·128	21·41	...	109·8	...
Clover, dry	0·167	22·64	2·866	69·26	15·02
Meadow hay, dry	0·327	17·22	4 52	34·61	12·07
Apples, dry	0·070	10·64	0·132	100·11	1 646
Strawberries, dry	0·201	21·74	1·422	71·14	6·18
Beetroots, fresh	1·28	4·28	...	2·20	...
Potatoes	0·32 to 0·58	20 to 28	...	31 to 42	...

Notes to the Tables.

1. Milk from a pointer bitch fed on ox-flesh and bones, collected for twelve days during the fourth and fifth weeks of lactation.

2. From a setter, on fourteenth and fifteenth days of special feeding. *Vide infra*, 11.

3. After fifteen days' feeding with clover without salt.

4. Analysis of the mixed ash of 300 samples (Ann. Chem. Phys., [4,] viii. 320) contained in addition ·323 SO_3, ·277 CO_2, and ·006 SiO_2. Total ash = 7·23.

5. (1.) Milk of specific gravity, 1032·42, taken four

and a half months after birth of foal. Food, clover; no salt. (2.) Solid matter and albuminoids from milk; specific gravity, 1029·03. From another mare; three and a half months' lactation, same food.

6. Woman at twenty-eight; fifteen days after bearing, and after four days' mixed diet, with 30 grammes of salt daily. *Vide* 21.

7. Same woman, three days subsequently, with same diet without salt. *Vide* 24.

8. Kitten, nineteen days old; removed from mother twenty-four hours before killing by means of ether. This plan was adopted with all the suckling animals, so that little milk was left undigested in them.

9. Puppy, four days old.

10. Rabbit, two weeks old.

11. Same bitch as No. 2; during fourth and fifth weeks of lactation. (1.) On the fourth and fifth days, feeding on a mixed diet, poor in potash and rich in soda. (2 and 3.) On the fourth and fifth subsequent days, the food during the five days being rich in potash and poor in soda. (4.) On the fourth and fifth days, of same diet as (1).

12. From two cats fed on ox-flesh and blood.

13. Specific gravity, 10·24. From three sheep in pasture; no salt.

14. Sheep on clover-hay; no salt.

15. Marchand's analysis. *Vide* 4.

16. From two cows in a herd receiving salt equal to 19 grammes daily per head.

17. Cow from same herd, after three months' stall-feeding and fourteen days without salt.

18. From the same cow (after seventeen), at intervals of three days' fed on clover-hay; no salt. It is noticeable that the highest contents in potash correspond with the lowest in soda, and *vice versâ*. During the clover-feeding the yield fell from 7—8 litres to 5—6 litres daily.

19 and 20 are from the fourteen days' yield of two cows, giving respectively the least and most milk of nine cows of approximatively the same age, weight, and period of lactation, and receiving the same food, including 12 grammes of salt daily. 19 gave 63·27 litres,' and 20 gave 214·7 litres in the same time. They show that the greater the secretion of milk, the less soda and the more potash is contained in it. The intermediate numbers are only approximately in this order.

21. Specific gravity, 1028·42. Mare fed on clover and oats.

22. Specific gravity, 1026·28; solid matter, 118·34; albuminoids, 12·027. Woman at thirty-five, after suckling a foster-child eleven months.

23. Specific gravity, 1032·42; ten to twelve days after bearing.

24. *Vide* 6. The milk collected on seven consecutive days from the eleventh after confinement. The first four days on a mixed diet with 30 grammes of salt daily, the last three days on same diet without salt. Specific gravity, 1029·79 to 1027·26, decreasing gradually during the last four days.

25. From same woman eleven months after bearing. Specific gravity, 1027·28; solid matter, 99·27; albuminoids, 9·016.

26. Dragendorff (Pharm. Zeits. f. Russ., iv. 171).

27. Kitten removed from mother one hour after birth.

The general composition of milk—that is, the amount of water, milk-solids, caseine, fat, and ash—has received of late much attention; on this account we reproduce here some old analyses made in France by MM. Chevallier and Henry, Hailden, Lecanu, Simon, Doyère, and Poggiale.

COMPOSITION in 100 PARTS.

	Water.	Milk-Solids.	Milk-Solids not Fat.	Caseine.	Fat.	Milk-Sugar.	Ash.
Mean	86·67	13·33	9·88	4·88	3·45	4·44	0·66
Maximum . . .	84·80	14·30	9·92	7·20	4·38	9·95	0·75
Minimum . . .	87·60	12·40	9·65	3·00	2·75	2·80	0·60

MM. Bussy and Boudet obtained the following from an examination of eight samples of milk collected in the environs of Montes:—

COMPOSITION in 100 PARTS.

	Water.	Milk-Solids.	Milk-Solids not Fat.	Fat.
Mean	86·93	13·07	9·30	3·77
Maximum . . .	84·17	15·83	10·01	5·82
Minimum . . .	88·50	11·50	8·65	2·85

EXAMINATION of Nine Samples of MILK received from a PARIS DAIRY.

COMPOSITION in 100 PARTS.

	Water.	Milk-Solids.	Caseine and Ash.	Solids not Fat.	Fat.	Milk-Sugar.
Mean . . .	87·22	12·78	3·47	8·91	3·87	5·43
Maximum . .	86·62	13·38	4·50	8·86	4·52	5·84
Minimum . .	88·03	11·02	2·22	7·90	3·12	5·10

THIRTY-FIVE SAMPLES of MILK collected from Seventeen different Shops in PARIS (1856). COMPOSITION in 100 PARTS.

	Water.	Milk-Solids.	Solids not Fat.	Caseine and Ash.	Fat.	Milk-Sugar.
Mean . . .	86·42	13·58	9·58	4·14	4·000	5 043
Maximum . .	83·88	16·12	11·05	0·05	5·068	6·010
Minimum . .	88·24	11·76	9·10	1·14	2·658	4·525

The following statement shows the general results obtained by *all* these analyses :—

Mean of 100 *Parts of Milk.*

No.	Water.	Milk-Solids.	Solids not Fat.	Caseine and	Fat.	Milk-Sugar.
1	86·67	13·33	9·88	5·54	3·45	4·44
2	86·93	13·07	9·30	5·57	3·77	4·44
3	87·22	12·78	8·9	3·47	3 87	5·43
4	86·42	13·58	9·58	4·14	4·00	5·43

Maximum of 100 *Parts of Milk.*

No.	Water.	Milk-Solids.	Solids not Fat.	Caseine and Ash.	Fat.	Milk-Sugar.
1	87·60	14·30	10·26	7·95	4·038	5·95
2	88·50	15·83	10·44	7·95	5·082	5·95
3	88·08	13·38	9·32	4·50	4·052	5·84
4	88·24	16·12	10·43	8·05	5·687	6·10

Minimum of 100 *Parts of Milk.*

.	Water.	Milk-Solids.	Solids not Fat.	Caseine and Ash.	Fat.	Milk-Sugar.
1	84 80	12·40	9·32	3·00	2·075	2·80
2	84·17	11·50	9·41	3·00	2·085	2·80
3	86·62	11·92	8·9	2·22	3·012	5·10
4	83·88	11·76	9·1	1·14	2·658	4·52

These analyses are extremely interesting, for at the time they were made the methods of analyses were faulty in the extreme. In particular, it was the custom to evaporate large quantities of milk—from 50 to 100 cubic centimetres—to dryness, necessitating a prolonged drying in the water-bath, and inevitable decomposition and loss ; yet, notwithstanding, in only three cases do the solids not fat fall below the standard of 9 per cent.; and as there is no evidence of the method employed, nor of the genuineness of the samples, such a result only confirms the more modern researches.

The following is the mean of several analyses of average-quality country milk, after Wanklyn :—

Composition in 100 *Parts by Weight.*

Water	87·45
Fat	3·08
Caseine	4·14
Milk-sugar	4·62
Ash	0·71
	100·00

Milk of Alderney Cow. Composition per 100 *Parts by Weight.* (After WANKLYN.)

Water	87·34
Fat	3·22
Caseine	4·61
Milk-sugar	4·13
Ash	0·70
	100·00

Mr. F. N. Macnamara of Calcutta published a short time since an interesting analysis of the milk of the little Bengali cow.—(Chemical News, May 30, 1873.) His results show how constant the composition of milk is, whether obtained from the much-prized and well-fed Alderney, or the poor, ill-nourished Bengali cow. "The following," says Mr. Macnamara, "is the ordinary food of a Bengali cow ; but the animal in the Bengali's hut plays very much the part of the Irishman's pig, and, with its master, has occasionally to manage as best it can : About 12 lbs. of rice-straw, 2½ lbs. of oilcake, 1 lb. of husks of rice, sometimes a little very poor grazing, the water in which the family rice has been boiled, and about 35 lbs. of water."

No.	Age of Calf, in Months.	Weight of Milk given per Day by Cow.	Solids of Milk.	Caseine.	Sugar.	Fat.	Salts.
		lbs.	P. cent	P. cent.	P. cent.	P. cent.	P. cent.
1	1	6½	15·12	5·50	3·98	4·98	0·76
2	2	5	12·82	4·30	4·40	3·60	0·70
3	2½	5	15·28	5·76	4 10	4·10	0·84
4	5	4	11·90	4·30	4·37	2·52	0·78
5	6	10	12·84	4·30	4·10	3·20	0·70
6	7	5	11·65	5·40	3·86	1·90	0·82
7	10	4	11·92	4·20	4·37	3·00	0·68
8*	...	...	15·90	7·76	3·40	4·10	0·90

The great and cardinal point brought out by hundreds of analyses, both at home and abroad, is that the *solids not fat* vary in milk only to a small amount, and are indeed a fairly constant quantity. On the other hand, the cream or fat is extremely variable, but seldom below a certain standard.

Husson found that milk from cows suffering from the cattle plague contained less lactine but more nitrogenous matter; blood and aggregated granules were also present. In the foot-and-mouth disease, pus-cells and blood

* This cow is two months in-calf, and is milked only about once in two or three days.

are often seen, and the specific gravity is altered.*

Milk from diseased animals decomposes very rapidly.

The following statement shows the composition of the milk of woman and different animals:—

Composition in 100 *Parts* (PAYEN).

	Woman.†	Goat.	Sheep.	Ass.	Mare.
Nitrogenous and insoluble salts	3·35	4·50	8·00	1·70	1·62
Butter . .	3·34	4·10	6·50	1·40	0·20
Lactine and soluble salts .	3·77	5·80	4·50	6·40	8·75
Water . .	89·54	85·60	81·00	90·50	89·33
	100·00	100·00	100·00	100·00	100·00

Mare's milk in Tartary is made to ferment, and drunk, under the name of Koumiss, as a sort of milk wine. For some recent analyses of this substance the reader is referred to the article KOUMISS.

From a considerable number of experiments, Messrs. Deyeux and Parmenter class the six kinds of milk which they have examined in the following order as regards the relative quantity of materials they contain:—

Caseine.	Butter.	Sugar of Milk.	Serum.
Goat.	Sheep.	Woman.	Ass.
Sheep.	Cow.	Ass.	Woman.
Cow.	Goat.	Mare.	Mare.
Ass.	Woman.	Cow.	Cow.
Woman.	Ass.	Goat.	Goat.
Mare.	Mare.	Sheep.	Sheep.

Effects of bad Milk.—It is important that cows giving milk should not be driven or harassed, for strong excitement may often have an unfavourable influence on the secretion of the mammary gland. Payen quotes a case in which the milk of a woman, the subject of nervous attacks, became in less than two hours after each paroxysm mucilaginous like the white of egg. Poisonous herbs fed on by the cow contaminate its milk; and that the food does influence its flavour, &c., is apparent from the fact that its colour may be modified by mixing saffron or madder with the food, that its odour is affected by eating plants of the cabbage and onion tribes, and that its taste may be altered by the cow feeding on wormwood, turnips, or the decaying autumnal leaves.

Quite recently, indeed, very decided evidence that milk may become poisonous under certain circumstances has been furnished, for throughout the month of June 1875 the inhabitants of the Riono Borgo in Rome suffered from an epidemic of gastro-intestinal irritation. This epidemic was conclusively proved to arise from the use of goats' milk, the goats having browsed on the *Colchicum autumnale*. Professor Ralti succeeded in isolating colchicine from the milk.

A fungus, either the *Oidium Lactis* or *Penicillium*, first noticed by Fuchs (1861), sometimes appears in milk, and from such milk poisonous symptoms have, according to *Nessler*, occurred. Other moulds in milk have apparently caused attacks of diarrhœa, some of which were of a serious character.

Whether the milk obtained from animals suffering from the foot-and-mouth disease gives rise in man to any disorders is still a disputed point; it would appear, however, that it frequently has been taken without any ill effects being induced. Milk contaminated with pus, &c., has caused aphthæ on the mucous membrane of the lips and gums.

It has been recently proved that milk may be the means of conveying the poisons of enteric and of scarlet fever. An outbreak of typhoid fever which occurred in London, 1870, was distinctly traced to the milk consumed. (*See* Medical Times and Gazette, November 1870.) It appears that the milk acquired its noxious properties by being mixed with polluted water before distribution to the consumer. The scarlet-fever poison has also been conveyed into the milk from the throat discharges or cuticle of persons affected with scarlet fever, who were employed in the dairy when ill or convalescent. *See* FEVER, SCARLET; FEVER, TYPHUS, &c.

Milk should not be kept in lead or zinc vessels, as it speedily dissolves a portion of these metals, and becomes poisonous.

Adulterations.—The adulterations usually enumerated are water, starch, dextrine or gum, annatto, chalk, and emulsion of seeds. Of these the first is the only one commonly met with. It is, practically speaking, a thing of extreme rarity to find milk adulterated with any foreign substance except water. There are, of course, other frauds practised, which, though not strictly speaking adulterations,* can be dealt with under the Act, such as skimming the milk, or first skimming and then watering.

* The author has recently investigated the milk of cattle suffering from foot-and-mouth disease.—(Chem. News, vol. xxxii. No. 834.) Some of the samples, when taken within the first three days of the malady, exhibited a very large number of flattened, highly refractive bodies, measuring from $\frac{1}{800}$ to $\frac{1}{1000}$ of an inch in length. Such milk was fatal to kittens, producing intestinal inflammation and death.

† A recent analysis of woman's milk, by Bruner (Jour. de Pharmacie et de Chimie, Avril 1875), gives the following figures:—

Water	90·00
Fat	1·73
Caseine	0·63
Sugar	6·23
Soluble salts	1·41
	100·00

* Borax is not unfrequently added in small quantities to milk for the purpose of preserving it.

The detection of the adulterations in milk is extremely easy to any one possessing the requisite knowledge and apparatus. The best method is to make a complete analysis of the milk. Such an analysis cannot fail to show any deviation from the normal composition, whether this has been effected by the addition of water, the removal of fat, or the practice of the rarer adulterations.

To Mr Wanklyn belongs the credit of perfecting milk-analysis, of rendering it a simple, accurate, and speedy process, instead of, as heretofore, a tedious, uncertain, and cumbersome one, hardly to be intrusted to the hands of any one not well versed in chemical manipulation.

A correct estimation can be now made of the *water*, *caseine*, *milk-sugar*, *fat*, and *ash* of a great number of milks by Mr. Wanklyn's process, or its numerous modifications, in the course of a single morning's work.

For milk-analysis the apparatus required is as follows:—

1. An accurate balance, which should be capable of weighing at least 50 grammes, and sufficiently delicate to indicate half a milligramme.

2. Platinum, glass, or porcelain dishes. Mr. Wanklyn uses platinum of the size and shape shown in fig. 61. The advantage of

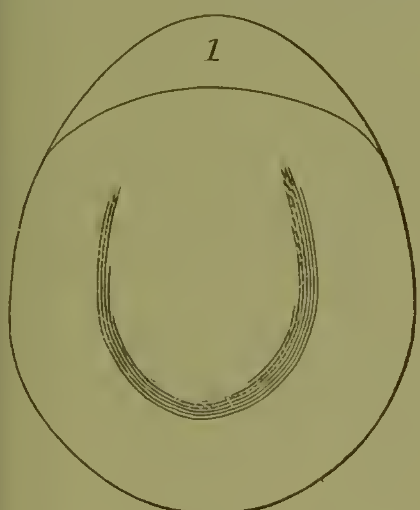


Fig. 61.

platinum is that it cools very quickly, and therefore there is no loss of time in waiting for the dish to cool before weighing. The disadvantages are the expense and want of constancy in weight. A platinum milk-dish requires to be reweighed after every half-dozen operations.

Dr. Redwood employs small porcelain dishes of 1½ oz. (42·53 grammes) capacity. The weight of each dish is carefully marked by means of a writing diamond on the outer rim, and each is furnished with a little glass stirrer.

Mr. Rimmington prefers hemispherical glass evaporating dishes of 3 oz. (85·06 grammes) capacity.

The advantages of porcelain dishes are cheapness and constancy in weight. The disadvantages of glass dishes are that the ash cannot be determined in them, and hence another set of vessels, either platinum or porcelain, is required.

3. A *water-bath* with holes of a proper size to carry the dishes. Mr. Wanklyn uses a square one; Dr. Redwood prefers an enamelled cast-iron bowl of a diameter of 9 inches and depth of 4 inches, provided with a copper cover turned over at the rim, but not otherwise fastened. This bath is supported on a cylinder of sheet iron, with holes round the upper and lower edges of it for the admission of air and escape of products of combustion. In this furnace the ring-burner is placed, and the heat can be regulated to a nicety.

4. A pipette discharging 5 cubic centimetres, or if grain measures be preferred, a pipette discharging 100 to 300 grain measures. If, however, the milk is weighed, which perhaps after all is best, no pipette will be required.

5. The apparatus described under WATER-ANALYSIS; this last is not absolutely necessary, but only convenient.

The actual analysis* consists in first weighing or measuring a certain quantity of milk into one of the little dishes (whether porcelain, glass, or platinum), and the most convenient quantity to take in grammes is 5 grammes, in grains is 100 grains. The dish or dishes are placed in the water-bath and evaporated at 100° C. (212° F.) for three hours, at the end of which time they are weighed. The weight of the empty, clean dish, minus the weight with the dried milk, gives the milk-solids, and a simple calculation gives the percentage. During this drying it is well to break the pellet from time to time with either a glass or a platinum stirrer. If Mr Wanklyn's process is now accurately copied, the little dish is put upon a triangle of wire covered over with tobacco-pipe, and ignited, the resulting dish containing the *ash* weighed, and calculated out as before. This necessitates a separate evaporation of about 10 or 15 cubic centimetres in a separate dish in order to extract the fat. Many analysts, however, simply take the fat, water, and milk-solids,

* A good plan adopted by many analysts is to first take the specific gravity of the milk; for this purpose a Westphall's balance is very convenient. *See* SPECIFIC GRAVITY.

and neglect the determination of ash, which is mostly unnecessary.

In order to determine the fat, it is extracted with ether. Mr. Wanklyn evaporates down for about an hour 10 cubic centimetres of milk, moistens with alcohol, then pours upon this milk methylated ether, boils it very carefully over warm water, and pours it through a filter, which operation is repeated at least three times, and the little rim of fat left in the filter is dissolved by cutting that portion of the paper off, digesting it in ether, and adding it to the filtrate. The ethereal solution of fat is then evaporated to dryness, and the fat weighed. The majority of analysts operate in a somewhat different way —viz., by treating the dry residue with successive portions of ether, which is carefully poured from the dish into a beaker, and then when the milk is exhausted, they weigh the milk-solids and estimate the fat by the loss. By this process filtering is unnecessary, and the ether may be recovered; for after each operation the impure ether may be put in a bottle, and then when sufficient is collected, may be purified by distillation. It is not easy to thoroughly exhaust the milk of its fat, and hence some employ sand and powdered glass so as to break the caseous envelopes and divide the milk. Others extract under pressure, by placing the milk and ether in a tube, and regulating the pressure by the aid of the thumb, partially or entirely closing the orifice. Ether may thus be prevented from boiling at its usual low temperature. In such a case as this, it is not necessary to feel anxious about obtaining the very last percentage of fat: it is better to employ the process most used, especially as, should an analysis be disputed, the milk may be transmitted elsewhere; and it is certain, if every one followed to the minutest detail a given process, there would be no discrepancy in analyses.

From the milk-solids exhausted by ether, the milk-sugar may be extracted by first treating it with strong alcohol, and then adding to it a little boiling water. The weak alcoholic solution is to be evaported to dryness, weighed, ignited *gently*, and the residue on ignition subtracted from the total weight before ignition. The difference is the milk-sugar. It may also be estimated in the ordinary way by copper solution. *See* SUGAR, ESTIMATION OF.

The caseine may be washed off the filter-paper, dried in a little platinum dish, and weighed; then burnt up, and the ash weighed. The ash, minus ash and caseine, gives the caseine; or the caseine may be more quickly estimated by putting 5 cubic centimetres of milk into a half-litre flask, diluting up to the mark with distilled water, and submitting 5 cubic centimetres of this to distillation by the ammonia process, as described under WATER-ANALYSIS. The yield of albuminoid ammonia from 100 cubic centimetres of genuine milk is ·26 grammes. Every one part of caseine gives ·065 of ammonia.

Calculation of Results.—The following is from Mr Wanklyn's treatise on "Milk-Analysis:"—

"*Problem* 1.—Given the percentage of 'solids not fat' (= a) in a specimen of sophisticated milk (*i.e.*, milk either watered or skimmed, or both); required the number of grammes of genuine milk which was employed to form 100 grammes of it.

"*Answer.*—Multiply the percentage of 'solids not fat' by 100, and divide by 9·3, or

$$\frac{100}{9\cdot3}a.$$

"*Problem* 2.—Given the percentage of 'solids not fat' (= a), also the percentage of fat (= b), in a specimen of sophisticated milk; required the number of grammes of fat which have been removed by skimming from the genuine milk which was employed to from 100 grammes of it.

Answer.— $$\frac{3\cdot2}{9\cdot3}a - b.$$

"In translating fat into cream, the rule is that a removal of ·2 gramme of fat equals a removal of 1 gramme of cream. This rule is directly founded on experiment. I do not, however, claim a high degree of accuracy for the measurement of the cream.

"Finally, a slight refinement may be noticed. If a specimen of sophisticated milk has been produced by both skimming and watering, it will be obvious, on consideration, that the extraneous water employed in manufacturing 100 grammes of it is equal to the difference between 100 and the quantity of genuine milk employed to make 100 grammes of sophisticated milk, together with a quantity of water equal to the fat removed by skimming.

$$\left.\begin{matrix}\text{Extraneous}\\\text{water}\end{matrix}\right\} = 100 - \frac{100}{9\cdot3}a + \frac{3\cdot2}{9\cdot3}a - b.$$

$$= 100\,\frac{100 \;+\; 3\cdot2}{9\cdot3}a - b."$$

It is then evident that a definite opinion as to the genuineness or not of the milk can generally be given without estimation of caseine or milk-sugar. For practical purposes, drying the milk up, extracting the fat, and estimation of the ash, will be sufficient; for the analyst will then have—*total solids*, *solids not fat*, *fat*, and *ash*.

An extremely useful method of estimating the fat in milk is one originally proposed by M. Marchand and subsequently modified by

Horsley and others. The process is neither accurate enough for scientific investigation nor for the purposes of a prosecution, but it enables an analyst to rapidly come to a conclusion whether a more elaborate analysis is necessary or not, especially if he has taken the specific gravity of the milk.

The method essentially consists in shaking up a known weight or volume of the milk with ether, precipitating the fat from the ether by the addition of alcohol, gently warming, allowing it to stand a little time in a graduated tube, and reading off the number of divisions or *lines* of fat.

Milk, when it has undergone some amount of decomposition, is sometimes transmitted for analysis. The first and ordinary change when milk is kept is *lactic fermentation*, the elementary constituents of the milk-sugar rearranging themselves to form lactic acid. The lactic acid deprives the caseine of its alkali, and therefore renders it insoluble. At the same time a small quantity of ethylic alcohol is formed, which in ordinary analysis would be lost. If a milk in which there is much lactic acid be evaporated down, the results may be far from accurate, as this acid chars the milk-solids, and hence the estimate of the latter is generally too low. In taking the ash, there is also found to be loss of hydrochloric acid. All these difficulties are however obviated, either by determining the acidity of the milk by titration, and then adding the proper amount of soda to neutralise the acid, or by neutralising the milk with a weighed portion of freshly-ignited sodic carbonate; of course corrections must be made for the loss of hydrogen on neutralising the acid ($C_6H_6O_3+NaHO = C_3H_5NaO_3+H_2O$; or, $2C_3H_6O_3+Na_2CO_3 = 2C_3H_5NaO_3+H_2O+CO_2$), and secondly, for the sodium carbonate introduced into the milk-ash. When the milk has undergone further decomposition, there is a development of butyric acid, butylic alcohol, and other bodies, and it is so changed that it is impossible to pretend to state by analysis its original composition.

Milk, Condensed—Milk, by evaporation in a suitable manner, and hermetically sealing in tins, can both be preserved and condensed. "The English Condensed Milk Company" have been especially successful in preparing a really good condensed milk. The following is an analysis of one of their tins:—

Water	25·10
Fat	11·73
Caseine	15·17
Milk-sugar	16·24
Cane-sugar	29·46
Ash	2·30
	100·00

The cane-sugar is an addition, and is said to be white and of good quality, the amount introduced being limited to the minimum compatible with the preservation of the product for an indefinite time.

Letheby gives the following:—

Composition of various Samples of Condensed Milk per 100 Parts.

	Anglo-Swiss.	Vivis, Swiss.	Sassin, Prussia	Kempton, Bavaria.
Caseine	18·10	15·96	14·24	14·90
Butter	12·76	12·03	12·63	13·65
Sugar	44·25	46·92	51·83	50·21
Salts	2·41	2·67	2·48	2·43
Total solids	72·02	77·58	81·18	81·19
Water	22·98	22·42	18·82	18·81
	100·00	100·00	100·00	100·00

The following is Wanklyn's analysis:—

Composition of Condensed Milk per 100 Parts by Weight.*

Water	51·12
Fat	12·11
Caseine	13·64
Milk-sugar	20·36
Ash	2·77
	100·00

Analysis of Anglo-Swiss Company's milk, from "Food, Air, and Water," Oct. 1872:—

Composition per 100 Parts.

Caseine	18·52
Fatty matter	10·80
Sugar of milk	16·50
Cane-sugar	27·11
Ash	2·12
Phosphoric acid	0·649
Water	24·30
	99·999

Condensed milk may be analysed by the process described in our article on MILK. The estimation of the fat will, however, require great care.

Condensed milk has been largely employed as a food for infants, who take it readily on account of the large quantity of sugar it contains.

Milk, Preserving—Many methods are at present employed for the purpose of preserving milk, but it will not be necessary for us to describe them here. The "concentrated milk" is prepared by evaporating the water of the milk in open pans, and the "condensed milk" by evaporation in closed vacuum pans. *See* MILK, CONDENSED.

Milk may be preserved in stout bottles, well corked and wired down, by heating them in this state to the boiling-point in a water-bath, by which means the oxygen of the small quan-

* Of the English Condensed Milk Company.

tity of enclosed air becomes absorbed. It must be afterwards stored in a cool situation. Milk thus treated will retain its properties for years. Under Bethel's patent the milk or cream is scalded, and, when cold, strongly charged with carbonic acid gas by means of a soda-water machine, and the corks are wired down in the usual manner. The bottle should be kept inverted in a cool place. An addition to every pint of milk of 10 or 12 grains of carbonate or bicarbonate of soda will preserve milk for eight or ten days in temperate weather. According to D'Arcet, $\frac{1}{2000}$ part of the bicarbonate is sufficient for the process.

Millet (*Panicum miliaceum*)—A native of the East Indies, but extensively cultivated in other parts of the world. There are many varieties of millet, and in some parts they constitute the principal food of the inhabitants.

The nutritive power is generally considered to be about equal to that of rice.

The following table shows the composition of three varieties of millet-meal freed from bran:—

	Panicum miliaceum, Common Millet.	*Penicillaria spicata*, a kind of Millet much used in India under the name of Bajia.	*Sorghum vulgare*, Dhurra of the Arabs, Joar of India.
Water	12·22	11·8	11·95
Nitrogenous substances	9·27	10·13	8·64
Dextrine	9·13	...	3·82
Sugar	1·80	...	1·46
Fat	7·43	4·62	3·9
Starch	59·04	71·75	70·23 *
Silica	0·11	...	...

The leaves of the plant dried at 100°, yield 10·186 per cent. of ash, the stem 2·510, and the grains 3·273. The stem contains 3·38 of nitrogen, and the grain 1·41.

The composition of the ash is as follows (A. PAVESI and E. ROTONDI, Gaz. Chim. Italiana, iv. 192–195):—

	Stalk.	Leaves.	Grain.
Potash	39·163	8·344	10·436
Soda	1·803	1·802	1·065
Lime	6·312	10·079	6·372
Magnesia	6·489	2·220	8·471
Phosphoric acid	5·238	1·616	20·838

Dr. James Watson records the result of an experiment made with millet (which is so extensively used by the Chinese as an article of diet), to show its effect on European constitutions. A sailor who had been guilty of several serious offences was sentenced to solitary confinement for forty-nine days in the consulate jail. Permission was obtained by Dr. Watson to feed him solely on millet and water, on his promising to change the food at once if the man lost weight, or seemed in any way to suffer from his restricted diet. He entered prison on the 3d of April, when he weighed 146 lb. 8 oz., and he left it on the 22d May, weighing 147 lb. 14 oz. Throughout the confinement he never weighed so little as on the day it commenced, and this in spite of the depressing effects of solitude and the monotony of his food. He ate about 3½ lbs. of millet daily, and when he left prison he looked, as he said he felt, perfectly well. The experiment shows that the grain which has been chosen by the people as their principal food is capable of maintaining for a considerable length of time perfect health under very depressing circumstances.—(Lancet, November 9, 1872.) *See* DHURRA.

* With husks.

Mineral Waters—The tables on pp. 391, 392, give the composition of the principal mineral waters.

Mines—The condition of those who laboured in mines was until recently extremely unsatisfactory. Very young children were employed, women of all ages worked in some of them—often in a state of nudity, and mixed without any distinction with men—ventilation was faulty, and the safety-lamp had not been invented. Successive commissions and inquiries led to the Mines Regulation Act in 1860, and another Act was passed—viz., the Metalliferous Mines Regulation Act—in 1872. These Acts, by preventing the employment of very young children, and by otherwise measures, have done much to ameliorate the condition of mines and those who work in them.

Mines are, without doubt, unhealthy. The chief causes of this unhealthiness are first and foremost the impure air, then the excessive toil, the danger of explosions and accidents, the dampness of the ground and atmosphere in many cases, the constrained postures that the men are obliged to work in, and the poisonous copper, arsenical, or other metallic dust in certain mines.

It is pretty certain that the rate of mortality amongst miners is closely connected with the quality of the ventilation. Mr. Simon states that, with the exception of the well-ventilated mines of Durham and Northumberland, the 300,000 miners in England break down prematurely from bronchitis and pneumonia, caused by the atmosphere in which they live. This atmosphere is not alone deteriorated by the emanations of the miners, but by the combustion of the lamps, dust, and by blasting operations.

TABLE I.—Exhibiting the COMPOSITION of several of the Celebrated MINERAL WATERS. Sixteen Fluid Ounces contain the following Ingredients :—

WATERS.	Nitrogen in Cubic Inches.	Carbonic Anhydride in Cubic Inches.	Sulphuretted Hydrogen in Cubic Inches.	Carbonate of Sodium in Grains.	Carbonate of Magnesium in Grains.	Carbonate of Calcium in Grains.	Sulphate of Sodium in Grains.	Sulphate of Magnesium in Grains.	Sulphate of Calcium in Grains.	Chloride of Sodium in Grains.	Chloride of Magnesium in Grains.	Chloride of Calcium in Grains.	Ferric Oxide.	Silica.	Temperature.	Total of Saline Contents.
Carbonated.																
Seltzer	...	17·0	...	4·0	5·0	3·0	...	...	...	17·0	...	...	...	...	cold	29·0
Pyrmont	...	26·0	...	...	10·0	4·5	...	5·5	8·5	1·5	...	...	0·6	...	,,	30·6
Spa	...	13·0	...	1·5	4·5	1·5	...	...	...	0·2	...	...	0·6	...	,,	8·3
Carlsbad	...	5·0	...	5·0	...	1·5	8·5	...	...	4·5	...	...	a trace	0·3	165°	19·8
Pouges	...	30·0	...	10·0	1·2	12·0	...	...	...	2·2	...	...	2·5	0·5	cold	28·4
Saint Parize	...	32·0	...	...	0·5	11·0	...	...	13·0	...	...	...	...	...	,,	25·0
Chalybeate.																
Tunbridge	0·59	1·0	{ trace of oxygen }	...	...	0·03	...	...	0·17	0·30	0·03	0·05	0·28	...	cold	0·86
Cheltenham	...	2·5	...	0·5	...	...	22·7	6·0	2·5	41·3	...	...	0·8	...	,,	73·8
Brighton	...	2·2	...	...	...	...	...	...	4·0	3·0	0·75	...	1·4	0·14	,,	9·29
Saline.																
Seidlitz	...	...	...	...	2·5	0·8	...	180·0	5·0	...	4·5	...	...	...	cold	192·8
Cheltenham Pure Spring	...	...	...	...	...	...	15·0	11·0	4·5	50·0	...	...	...	...	,,	80·5
Bristol	...	3·5	...	...	...	1·5	1·5	...	1·5	0·5	1·0	...	...	...	74°	6·0
Buxton	0·2	...	...	...	...	1·3	...	...	0·3	0·2	...	...	0·03	...	82°	1·83
Bath	...	1·2	...	...	...	0·8	1·5	...	9·0	3·3	...	...	a trace	0·2	116°	14·8
Scarborough	...	...	...	...	...	a trace	20·0	...	9·0	...	...	...	,,	...	cold	29·0
Barèges	...	...	uncertain	2·5	...	,,	...	...	a trace	0·5	...	...	...	...	120°	3·0
Plombières	...	...	...	2·2	...	0·3	2·3	...	...	1·5	...	...	...	0·3	?	6·6
Kilburn	...	3·5	8·54?	...	0·5	1·0	12·0	37·0	5·5	2·5	5·5	0·2	a trace	...	cold	64·2
Leamington New Bath .	0·4	a trace	a trace	...	...	...	19·0	...	14·0	53·0	1·5	...	0·8	...	,,	88·3
Leamington Old Bath .	0·3	...	,,	...	...	...	7·5	7·0	18·0	41·0	...	...	...	...	,,	73·5
Sulphurous.																
Harrogate	0·8	1·0	2·3	...	0·7	2·5	...	1·3	...	77·0	11·0	1·5	...	...	cold	94·0
Moffat	0·5	0·6	1·2	...	...	...	...	...	...	4·5	...	...	...	...	,,	4·5
Aix-la-Chapelle . .	...	...	5·5	12·0	...	4·2	...	...	...	5·0	...	...	...	...	143°	21·2
Cheltenham Sulphur Spring	...	...	1·5	...	...	...	23·5	5·0	1·2	35·0	...	...	0·3	...	cold	65·0

TABLE II.—Exhibiting the COMPOSITION of the principal MINERAL WATERS of GERMANY, and of the SARATOGA CONGRESS SPRING of AMERICA (after COOLEY).

Grains of Anhydrous Ingredients in 1 lb. Troy.	Adelheids-Quelle.	Auschowitz, Ferdinands-Brunnen.	Carlsbad.	Eger, Franzens-Brunnen.	Ems.	Fachingen.	Kissingen, Ragozi.	Kreuznach, Elizen-Brunnen.	Marienbad, Kreuzberg.	Püllna.	Pyrmont.	Saratoga Congress Spring.	Schlesischer, Obersalz-Brunnen.	Seidschutz.	Selters.	Spa Pouhon.
Carb. soda	5·2443	4·5976	7·2712	3·8914	8·0625	12·3328	...	...	5·3499	...	...	0·8261	7·6211	...	4·6162	0·5531
,, lithia	0·0902	0·0507	0·0150	0·0282	0·0405	...	...	...	0·0858	...	...	...	...	...	...	...
,, baryta	0·0024	...	...	...	0·0022	...	...	...	...	...	...	...	...	...	0·0014	...
,, strontia	0·0387	0·0040	0·0055	0·0023	0·0080	...	0·0592	...	0·0028	...	...	0·0672	0·0170	...	0·0144	...
,, lime	0·4703	3·0085	1·7775	1·3501	0·8555	1·8667	4·8180	0·2058	2·9509	0·5775	4·7781	5·8531	1·5464	5·1045	1·4004	0·7387
,, magnesia	0·2980	2·2867	1·0275	0·5040	0·5915	1·2983	1·3185	1·1812	2·0390	4·8045	...	4·1155	1·5496	0·8235	1·5000	0·8421
,, (proto) manganese	0·0012	0·0692	0·0048	0·0322	0·0028	...	0·0121	0·0072	2·0288	...	0·0364	0·0202	0·0026	0·0032	...	0·0389
,, (,,) iron	0·0121	0·2995	0·0208	0·1762	0·0120	...	0·1397	0·1495	0·1319	...	0·3213	0·0173	0·0356	0·0095	...	0·2813
Sub. phos. lime	...	...	0·0012	0·0172	...	0·0061	...	...	...	0·0026	...	...	...	0·0117	0·0007	0·0102
,, alumina	...	0·0040	0·0019	0·0092	0·0014	...	...	...	...	...	0·0110	...	...	0·0088	0·0020	0·0064
Sulph. potassa	0·0066	...	...	...	0·4050	...	1·2540	...	...	3·6000	0·0314	0·1379	0·3160	3·6705	6·2978	0·0593
,, soda	...	16·9022	14·9019	18·3785	...	0·1267	...	...	28·5868	92·8500	1·6092	...	2·5106	17·6220	...	0·0281
,, lithia	...	...	...	...	...	...	...	...	...	...	0·0067	...	...	...	...	...
,, lime	...	...	...	...	...	...	5·5485	...	...	1·9500	5·0265	...	...	1·1287	...	...
,, strontia	...	...	...	...	...	...	...	...	...	...	0·0154	...	...	0·0347	...	...
,, magnesia	...	...	...	...	...	...	...	...	...	C9·8145	2·3684	...	...	62·3535	...	...
Nitr. of magnesia	...	...	...	...	...	...	...	...	...	...	...	0·1004	...	5·9302	...	...
Chlor. ammonium	...	...	...	...	...	...	0·0364	...	...	...	...	0·0326	0·0164	...	...	...
,, potassium	0·1845	...	...	...	0·0338	...	...	0·7287	...	...	...	1·6256	...	...	0·2685	...
,, sodium	28·4608	6·7472	5·9820	6·9229	5·7255	3·2337	39·3733	54·6917	10·1727	...	...	19·6653	0·8682	...	12·9690	0·3371
,, lithium	...	...	...	...	...	...	...	0·0562	...	...	...	...	...	...	...	...
,, calcium	...	...	...	...	...	...	...	9·7358	...	...	...	...	...	...	...	...
,, magnesium	...	...	...	...	...	...	3·6599	...	...	14·7459	0·8450	...	...	1·2223	...	...
,, barium	...	...	...	...	...	...	...	0·2366	...	...	...	...	...	...	...	...
,, strontium	...	...	...	...	...	...	...	0·5494	...	...	...	...	...	...	...	...
Bromide sodium	0·3060	...	...	...	...	...	0·3331	0·2304	...	...	...	0·1613	0·0051	...	...	...
Iodide sodium	0·1500	...	...	...	...	...	...	0·0024	...	...	...	0·0046	...	...	...	...
Fluoride calcium	...	...	0·0184	...	0·0014	...	...	...	...	...	...	...	...	...	0·0013	...
Alumina	0·0166	...	...	...	...	...	...	0·0086	0·0023	...	...	0·0069	...	...	...	...
Silica	0·1922	0·5023	0·4329	0·3548	0·3104	0·0657	0·1609	0·2355	0·2908	0·1320	0·3727	0·1112	0·2423	0·0900	0·2265	0·3739
Total saline contents	35·4739	34·4719	31·4606	31·6670	16·0525	18·9300	56·7136	68·0190	51·6417	188·4806	15·4221	32·7452	14·7309	98·0133	21·2982	3·2691
Carbonic acid gas in 100 cubic inches	10	154	58	154	51	135	96	12	105	7	160	114	98	20	126	136
Temperature	58°	40°	Spru. 165°, Neub. 138°, Mühl 128°, Ther. 122°	54°	Kess. 117, Kran. 84	50°	53°	47°	53°	58°	56°	50°	58°	58°	58°	58°
Authorities	Struve	Steinmann	Berzelius	Berzelius	Struve	Bischoff	Struve	Struve	Berzelius	Struve	Struve	Schweitzer	Struve	Struve	Struve	Struve

The effects on the air of the mine by blasting may be judged by the following extract:—

"If we put together all the substances thrown into the air of the 1200 cubic feet space, we have, as air and impurities together—

	Grammes.
Oxygen	9048·957
Nitrogen	33726·7
Carbonic acid . . .	1200·44
Carbonic oxide . . .	3·188
Hydrogen	0·07186
Sulphuretted hydrogen . .	0·59869
Sulphate of potash . . .	144·760
Carbonate of potash . .	43·311
Hyposulphite of potash .	11·189
Sulphide of potassium . .	7·296
Sulphocyanide of potassium .	1·049
Nitrate of potassium . .	12·751
Carbon	2·494
Sulphur	0·466
3/2 carbonate of ammonia .	9·790
Organic matter . . .	...
Sand	...
Sulphurous acid, or sulphite of ammonia . . .	...
Arsenious acid . . .	...

"All these substances actually are breathed by the miners; all except carbonic oxide, hydrogen, sulphocyanide, and arsenic have been actually found in the air. These four have been proved to enter it, and would be found if sought. We know assuredly that they exist, and search is therefore voluntary. Every gas, with the exception of the first two, is injurious."—(ANGUS SMITH "On Air and Rain.")

The same observer has described and figured the particles of dust found in mines. It appears to consist of various minute bits of coal or metal, at times of crystals of saltpetre, sulphate of potash, &c. &c. This dust actually gets down into the lungs and induces pulmonary affections, in many of which the lung is found after death thoroughly infiltrated with carbonaceous or metallic dust.

The following table gives the average annual deaths per 1000 from pulmonary disease during the years 1860-62:—

Between the Age of	Metal-Miners in Cornwall.	Metal-Miners in Yorkshire	Metal-Miners in Wales.	Males, exclusive of Miners, in Yorkshire.
15 and 25	3·77	3·40	3·02	3·97
25 and 35	4·15	6·40	4·19	5·15
35 and 45	7·89	11·76	10·62	3·52
45 and 55	19·75	23·18	14·71	5·21
55 and 65	43·29	41·47	35·31	7·22
65 and 75	45·04	53·69	48·31	17·44

The number of accidents in mines does not appear to have shown any increase, at all events, in the years 1871 and 1872.

In 1870, out of 12,339 violent deaths in the whole of England, 1108, and in 1871, out of 12,678 violent deaths, 1030, were connected with mines. The details are as follows:—

ACCIDENTS in COAL and METAL MINES during the Years 1870–71.

	Coal Mines.		Copper, Tin, Iron, &c., Mines.	
	1870.	1871.	1870	1871.
Fall of coal, stone, wood, &c.	437	430	54	40
Crushed . . .	19	49	19	12
Fall in pit or shaft, &c.	76	84	16	31
Broken rope . .	4	...	...	...
Explosion of fire-damp	196	149	...	...
Choke-damp . .	15	19	...	...
Machinery in mines .	18	13	3	3
Explosion of steam-boiler	3	...	2	...
Killed by waggon, tramway, &c. . .	78	89	5	8
Killed by tub . .	57	56	...	...
Blasting . . .	41	15	9	13
Drowned . . .	9	15	...	2
Manner not stated, or otherwise than the above causes . .	6	2	1	...
	990	921	109	109

Nothing in the Public Health Act is to be construed to extend to mines, so as to interfere or obstruct their efficient working; nor to the smelting of ores and minerals, nor to the calcining, puddling, and rolling of iron and other metals, nor to the conversion of pig-iron into wrought iron, so as to obstruct or interfere with any of such processes respectively.—(P. H., s. 334.)

Mites, Cheese—*See* ACARUS SIRO.

Molasses—A dark-coloured viscid liquid which drains off during the preparation of raw sugar. The beetroot-sugar molasses has a very disagreeable taste, and is therefore not used as cane-sugar molasses is. *See* SUGAR, TREACLE, &c.

Monkshood, Wolfsbane, or **Blue Rocket**—The roots, seeds, and leaves are highly poisonous, owing to the presence of the alkaloid *aconitina*. *See* ACONITE, &c.

Morphia, Morphine ($C_{17}H_{19}NO_3$)—An important alkaloid, discovered by Sertürner in 1804, existing, chiefly in combination with meconic acid and partly with sulphuric acid, in all varieties of opium.

The following method is an excellent one to separate the alkaloid in a crude state from opium, for the purpose of estimation or otherwise: 15 parts of opium are treated with 25 parts of boiling water until complete disaggregation has taken place; 60 parts of boiling alcohol are then added, and the whole digested for a little time; the liquid is then filtered through linen, and the residue treated with 10 parts of water and 60 parts of alcohol, after which it is extracted with 50 parts of boiling absolute alcohol. The united liquids are cooled, filtered, concentrated to one-third, and again filtered. The morphine is now precipitated by 10 parts of ammonia, and the mixture evaporated over sulphuric acid.—(M. ROUSSILE.)

Morphine, when pure, is in the form of short, rectangular, prismatic crystals. 1 part of morphia is soluble in 4166 parts of water, in 7725 of ether, in 6650 of chloroform, and in 133 of amylic alcohol. Benzole is the best solvent of morphia—in this menstruum it is freely soluble: it also dissolves in the fixed alkalies and alkaline earths, but is sparingly soluble in ammonia. An alcoholic solution of morphia turns a ray of polarised light to the left. With acid, morphia yields salts, which are well-defined compounds, and of which the acetate and the hydrochlorate are largely used in medicine.

Morphia is the chief active ingredient in opium, and the symptoms referable to poisoning by opium and morphia are not clinically distinguishable. The best method to separate it from the contents of the stomach or the tissues is a modification of Stas's process, in which benzole is substituted for ether.

Tests.—For the important tests of *sublimation*, amount of *ammonia* evolved, and changes of colour with nitric acid, *see* article ALKALOIDS. The following are three additional very characteristic and conclusive tests :—

1. A small portion of the solid substance strikes a rich indigo blue when touched with a neutral solution of permuriate of iron.

2. When morphia, in small quantity, is added to a solution of iodic acid in cold starch, iodine is immediately set free, as shown by the production of a blue colour.

3. If a crystal of morphia be touched with a drop of sulphuric acid, there is no change; but the addition of a drop of a solution of bichromate of potash produces first a rich brown, rapidly passing into green. *See* ALKALOIDS, OPIUM, &c.

Mortgage—All local sanitary authorities have power to mortgage any fund, rate, or rates applicable to the purposes of the Public Health Act, 1875, in order to raise money for sanitary purposes. They have also similar powers with regard to the mortgage of sewage land and plant.—(P. H., s. 233, 235.)

Every mortgage under the Public Health Act is to be by deed, sealed with the seal of the authority, &c., and according to the following forms, or one to the like effect.—(P. H., s. 236.)

FORM II.

Form of Mortgage of Rates.

By virtue of the Public Health Act, 1875, we, the , being the local authority under that Act for the district of , in consideration of the sum of paid to the treasurer of the said district by *A. B* of for the purposes of the said Act, do grant and assign unto the said *A. B*, his executors, administrators, and assigns, such proportion of the rates arising or accruing by virtue of the said Act from [*the rates mortgaged*] as the said sum of doth or shall bear to the whole sum which is or shall be borrowed on the credit of the said rates, to hold to the said *A. B.*, his executors, administrators, and assigns, from the day of the date hereof until the said sum of with interest at the rate of per centum per annum for the same, shall be fully paid and satisfied: And it is hereby declared, that the said principal sum shall be repaid on the day of at [*place of payment*]. Dated this day of one thousand eight hundred and .

[*To be sealed with the common seal of the local authority.*]

A mortgagee may transfer his mortgage, and such transfers are to be made according to the following form, or to the like effect :—

FORM I.

Form of Transfer of Mortgage.

I, *A. B.* of , in consideration of the sum of paid to me by *C. D.* of , do hereby transfer to the said *C. D.*, his executors, administrators, and assigns, a certain mortgage, bearing date the day of and made by the local authority under the Public Health Act, 1875, for the district of for securing the sum of and interest thereon at per centum per annum [*or if such transfer be by endorsement on the mortgage, insert, instead of the words immediately following the word "assigns,"* the within security], and all my right, estate, and interest in and to the money thereby secured, and in and to the rates thereby assigned. In witness whereof I have hereunto set my hand and seal this day of one thousand eight hundred and .

A. B. (L.S.)

All mortgages are to be registered at the office of the local authority within fourteen days after the date of the mortgage. The register shall contain the number and date of the mortgage, and the names and descriptions of the parties thereto. This register is to be open to public inspection, without fee. The refusal to allow this inspection by the custodian entails liability to a penalty of £5 or less.

The transfer of mortgages must also be registered within thirty days of such transfer, if executed within the United Kingdom, or if executed elsewhere, within thirty days after its arrival in the United Kingdom. The registration fee is 5s., payable to the clerk. The local authority is not responsible to the transferee until the registration has taken place. For neglect or refusal to register a transfer the clerk is liable to a penalty of £20 or less. —(P. H., s. 238.)

In cases where the principal or interest on a mortgage is six months overdue, and after demand in writing, an application may be made (providing the sums due to the applicant, or to two or more persons making joint application, amount at least to £1000) to a court of summary jurisdiction for the appointment of a receiver; and the court may appoint in writing a receiver, who will collect and receive the whole or a competent part of the rates liable to the payment of principal or interest in respect of which the application is made, until the sums due, with the costs of the application and collection, are fully paid.—(P. H., s. 239.) *See* LOANS, RATES, RENT-CHARGE.

Mortuary, Public—Every town should be provided with a building of this description, for the reception of bodies waiting either identification or judicial inquiry. Every facility should be given for the ingress and egress of the public, and in cases where the body is unknown, all the clothes worn by the deceased should be exposed. So many difficulties are at present put in the way should any one desire to view the body of a person whose name and condition may be unknown, that few care to do it; and hence it is we yearly consign to the grave so many persons whose family we are ignorant of, and whose station in life we can only guess. Crime goes unpunished, and mysterious disappearances take place to which no clue can be discovered. These remarks will not appear forced when we inform the reader that the bodies of from 350 to 400 murdered persons are received annually by the Morgue in Paris, and that half the identifications are due to *chance;* and since the new Morgue has been opened—which is provided with greater conveniences for the public—the identifications have increased from scarcely three in every four bodies to eight in every nine. This building has greatly assisted the police in the detection of crime. Many of the identifications were made through the clothes of the deceased being *conspicuously exposed*, and the importance of preserving any articles of attire worn by an unrecognised body cannot be too strongly insisted upon. The necessity of having the mortuary in the most public parts of the town, cannot fail, from the foregoing remarks, to strike the reader; and the nearer it is to the police station—for obvious reasons—the better. In erecting mortuaries, the three grand requisites are—space, thorough ventilation, and a good supply of water.

In the building of the new Morgue in Paris, the following points were ordered to be attended to by the Council of Public Health (1857): The exposing-room was to be placed in the centre of the building, and provided with twelve marble tables; above these tables, taps, with constant water-supply, were to be arranged, and an opening at the lowest part of the table to allow the water to run off. The room itself was to be square, and the roof to be either sloping or to consist of a dome with an outlet at top for foul air, and a little gas lighted to facilitate its expulsion. The public not to enter the room, but to gaze upon the bodies through a sheet of glass over which a movable curtain is suspended.

The room for the public to contain two doors, one of entrance and one of exit; the doors to be large enough to admit a vehicle. On each side of the exposing-room a dead-room was to be built, containing ten tables for the bodies when they first arrive and for those recognised. A large trough for washing clothes was to be fitted up, sufficient space to wash bodies on the ground allowed. A supply of hot and cold water, a drying-chamber, and a room to contain the clothes of the unrecognised dead for from six to eight months, were also ordered. And behind the exposure-room, an autopsy-room, with every convenience for performing *post-mortem* examinations, was to be erected. These were the principal points contained in the Council of Health's plan for a new mortuary; many matters of detail we have necessarily omitted.

It is satisfactory to notice that many of the more energetic of the London vestries are on the point of erecting mortuaries, which are to be fitted up with the different appliances requisite for the performance of a *post-mortem* examination, and are to contain air-tight coffins having glass lids for the convenience of viewing the bodies.

The following are the regulations at present existing with regard to mortuary-houses:—

Any local authority may, and if required by the Local Government Board shall, provide and fit up a proper place for the reception of dead bodies before interment (in the Act called a mortuary), and may make bylaws with respect to the management and charges for use of the same; they may also provide for the decent and economical interment, at charges to be fixed by such bylaws, of any dead body which may be received into a mortuary.—(P. H., s. 141.)

Any local authority may provide and maintain a proper place (otherwise than at a workhouse or at a mortuary) for the reception of dead bodies during the time required to conduct any *post-mortem* examination ordered by the coroner or other constituted authority, and may make regulations with respect to the management of such place; and where any such place has been provided, any coroner or other constituted authority may order the removal of the body to and from such place for carrying out such *post-mortem* examination, such costs of removal to be paid in the same manner and out of the same fund as the costs and fees for *post-mortem* examinations when ordered by the coroner.—(P. H., s. 143.)

With regard to the removal of dead bodies to mortuaries under the order of a justice of the peace, *see* INFECTIOUS DISEASES.

Moselle—*See* WINES.

Moss, Iceland—*See* LICHENS.

Museums—*See* LIBRARIES.

Mushrooms—Edible fungi. The following are the species usually eaten in England: The *Agaricus campestris*, common field or garden mushroom, used to make ketchup, and eaten either raw, stewed, or broiled; the *Morchella esculenta*, or morelle, used to flavour soups or gravies; and the *Tuber cibarium*, or common truffle.

The *Agaricus campestris* is a native of most of the temperate regions of both hemispheres, and springs up spontaneously in our pastures during the months of September and October, and it is cultivated in beds, from which it can be obtained all the year round. Mushrooms are somewhat difficult of digestion, and consequently scarcely suitable for the invalid; and in some persons the harmless varieties produce all the poisonous symptoms which noxious mushrooms induce. Dr. Taylor instances a case of a woman dying in twenty-four hours from eating ordinary mushrooms; but usually they only produce in those who are extremely susceptible to their action vomiting, purging, and colic.

The *Morchella esculenta*—common morelle—is kept, as a rule, in a dry state and sold at Italian warehouses; it is imported from the Continent.

The *Tuber cibarium*, or common truffle, is a subterraneous fungus found in light dry soils, and especially in the downs of Wiltshire, Hampshire, and Kent. The larger varieties come from France. Since they do not appear above the surface, there is nothing to indicate their presence; but their odour enables them to be scented out by dogs trained for the purpose in England, and by pigs in France. They are very firm and tough, and more indigestible than the ordinary mushroom.

From the ordinary mushroom ketchup is prepared; it consists of the juice flavoured with salt and aromatics.

The analyses of Payen of the three varieties mentioned give the following results:—

Composition of Edible Fungi (PAYEN).

	Mushrooms.	Morelle.	White Truffles.	Black Truffles.
Nitrogenous matter and traces of sulphur . . .	4·680	4·40	9·958	8·775
Fatty matter .	0·396	0·56	0·442	0·560
Cellulose, dextrine, saccharine matter, mannite, and other non-nitrogenous principles .	3·456	3·63	15·158	16·595
Salts (phosphates and chlorides of the alkalies, lime and magnesia), silica . . .	0·458	1·36	2·102	2·070
Water . . .	91·010	90·00	73·340	72·000
	100·000	100·00	100·000	100·000

Serious consequences frequently arise from people eating by mistake poisonous mushrooms. The effects produced by these are very uncertain. Sometimes they act as a narcotic, at other times as an irritant, and the symptoms may occur immediately or not before the lapse of some hours after the meal. It has been noticed that usually when the effect produced is narcotic—drowsiness, giddiness, dimness of sight, and debility—the symptoms appear shortly after eating the poisonous fungi; but when irritation of the bowels is induced, the vomiting, purging, &c., which ensues is delayed for some time. The same fungi has been found to act upon the members of the same family in one case as a narcotic and in another as an irritant. In most instances recovery takes place, especially if there be early vomiting, but fatal cases are not unfrequent.

Antidotes.—Vomiting should be immediately induced by the administration of an emetic, and tickling the fauces with the finger or a feather, after which a strong cathartic should be given, with ½ to 1 fluid drachm of ether in a glassful of water or weak brandy.

M. Chansarl strongly recommends as an antidote a solution of ½ drachm of tannin in 1½ pint of water, or a decoction of ½ oz. of powdered galls or of 1 oz. of powdered cinchona bark in a like quantity of water.

The following general characters given by Professor Bentley may enable us to distinguish the edible species:—

Edible Mushrooms.

1. Grow in dry, airy places.
2. Generally white or brownish.
3. Have a compact, brittle flesh.

4. Do not change colour by the action of the air when cut.
5. Juice watery.
6. Odour agreeable.
7. Taste neither bitter, acrid, nor astringent.

Poisonous Mushrooms.

1. Grow in clusters in woods and dark damp places.
2. Usually with bright colours.
3. Flesh tough, soft, and watery.
4. Acquire a brown, green, or blue tint when cut and exposed to the air.
5. Juice often milky.
6. Odour commonly powerful and disagreeable.
7. Have an acrid, astringent, acid, salt, or bitter taste.

Writing on this subject, an experienced mycologist (the Rev. J. Berkeley) says: "No general rule can be given for the determination of the question whether fungi are or are not poisonous. Colour is quite indecisive, and some of the most dangerous fungi, and amongst them the *Agaricus Phalloides*, are void of any unpleasant smell when fresh, though the most wholesome may be extremely offensive when old. Experience is the only safe test, and no one should try species incautiously with whose character he is not thoroughly acquainted."

The late Professor L. C. Richards, the eminent botanist, although no one was better acquainted with the distinctions of fungi than himself, would never eat any mushroom that had not been raised in gardens or beds.

Mussel (*Mytilus edulis*)—Many fatal cases of poisoning have occurred through eating mussels, and often in people who had been accustomed to take this shellfish habitually. Dr. Christison refers to an instance which occurred at Leith in 1827, in which no fewer than thirty people were severely affected and two died after partaking of a dish of mussels.

As is the case with other kinds of shellfish, some people appear more sensitive to the deleterious action of this fish than others, and it has not yet been ascertained to what the poisonous effects are to be attributed.

Composition of Mussel (PAYEN).

Nitrogenous matter	11·72
Fatty matter	2·42
Saline matter	2·73
Non-nitrogenous matter and loss	7·39
Water	75·74

Mustard—The flour or finely-powdered seeds of the *Sinapis nigra*, or black mustard; or the seeds similarly treated of the *Sinapis alba*, or white mustard; or the flour of both these varieties mixed.

White mustard seeds are of a yellow colour, elliptical, smooth, a little larger than those of black mustard, and of a sharp biting taste. The seeds of black mustard are dark brown in colour, very small, inodorous, and sometimes covered with a whitish coating.

White mustard seeds contain a fixed oil from about 36 per cent., a non-volatile acrid substance, and sulphosinapisin, which is an organic sulphur compound capable of crystallisation, and supposed to be the sulphocyanate of a peculiar alkaloid called sinapine ($C_{16}H_{23}NO_8$).

Black mustard seeds contain myronate of potash ($C_{10}H_{18}KNS_2O_{10}$) ·2 per cent., and a substance, called myrosine, of an albuminous nature. Both these are absent in white mustard seeds.

Black mustard yields a volatile oil on being moistened with water. It does not contain it ready formed, but it is produced by the action of the myrosine on the myronate of potash, which latter substance breaks up in the presence of water into the oil of mustard, glucose, and sulphuric acid, with some free sulphur and an insoluble organic substance derived from the myrosine. The volatile oil thus obtained has a specific gravity of 1015; it has the properties and composition of sulphocyanide of allyl (C_3H_5CNS), is freely soluble in alcohol and ether, sparingly so in water, and blisters the skin when applied to it.

The fixed oil contained in both species of mustard contains erucic acid ($C_{22}H_{42}O_2$).

Neither black nor white mustard contains starch.

Manufacture.—The seeds are first crushed between rollers, then pounded in large mortars. The resulting powder is then passed through sieves. The portion in the first sieve is called the *dressings*, that which passes through is the *impure flour of mustard.* The impure flour, on being passed through a second sieve, yields the pure flour of mustard and a second quantity of dressings.

The dressings are submitted to pressure for the sake of the fixed oil they contain, which is utilised with rape and other oils.

Structure of the Seed.—The white mustard seed is made up of the husk and the seed proper.

The *husk* consists of three membranes:—

1. The outer membrane is composed of two kinds of large transparent cells, which Dr. Hassall thus describes: "Those of the first kind are of an hexagonal figure, and united by their edges so as to form a distinct membrane, the centre of each cell being perforated; the cells of the second kind occupy the apertures which exist in the previously-described cells, and they are themselves traversed by a somewhat funnel-shaped tube which appears to terminate on the surface of the seed. Immersed in water, these cells swell up to several times their original volume, occasion the rupture of the hexagonal cells, and become themselves much wrinkled or corrugated, the

extremity of the tubes in some cases being seen protruding from the proximate termination of the cells. It is possible, however, that what are here described as two different kinds of cells really form distinct parts of the same cells." It is from these cells the thick mucilage obtained by digesting mustard seeds in water is derived.

2. The second layer, or *middle tissue*, consists of very minute, angular, coloured cells.

3. The inner or third layer of the husk consists of a single layer of angular cells.

The seed proper consists entirely of very minute oil-bearing cells.

The black mustard in its structural composition only differs from the white in not containing the large perforated cells of the husk, the outer membranes consisting of two or three layers of large, transparent, hexagonal cells, the other structures being similar to those already described.

Adulterations.—Mustard is largely adulterated. The following substances are generally enumerated as having been fraudulently mixed with mustard: Wheat-flour, turmeric, *Sinapis Arvensis*, Cayenne pepper, ginger, gamboge, potato-starch, pea-flour, radish and rape seed, linseed-meal, yellow ochre, chromate of lead, plaster-of-Paris, and clay.

Of these, certainly the most common are wheat-starch and turmeric.

The organic adulterations may all be detected by the microscope, but valuable information will also be afforded by a chemical examination.

The analyst should in all cases estimate (1) the total sulphur; (2) the amount of fat or oil; (3) the ash; (4) the soluble ash; (5) test for starch; (6) for turmeric; (7) test for gamboge.

The microscopical examination should precede all other methods. The mustard must be examined both by ordinary and polarised light, and tested whilst under the field of the microscope by appropriate reagents, such as iodine, &c.

1. *The Total Sulphur.* — By weighing out about a gramme of the dried mustard, and treating for some time with fuming nitric acid, aided at first by a gentle heat, the organic sulphur compounds are oxidised. The resulting liquid filters with ease, especially if heated, and the sulphates are precipitated in the usual manner with a solution of chloride of barium, the precipitate thoroughly washed, dried, and weighed. Sulphate of baryta, multiplied by ·13734, = sulphur. Next, a sufficient quantity of the seeds must be burned at a low temperature, the ash dissolved in hydrochloric acid, and the sulphates of the ash precipitated by chloride of barium, and the difference between the sulphates of the ash and the total sulphates estimated—a necessary precaution, since very frequently mineral sulphates are fraudulently added to mustard.

The author found that white mustard seeds, ground by himself, gave as the mean of sixteen experiments 1·8631 per cent. of total sulphur—the lowest determination being 1·2 per cent., the highest 2·5 per cent. The mean quantity of sulphur in the ash being ·3483 per cent.

Black mustard, oxidised in a similar manner, gave 1 per cent. of total sulphur, while the ash gave ·22 per cent. Thus black mustard contains less sulphur than white mustard.

Many of the adulterants of mustard contain little or no sulphur—*e.g.*, rice—while, on the other hand, the seeds of most of the *Cruciferæ* contain it in considerable quantity; in other words, a deficiency or great excess of sulphur is indicative of adulteration, but a normal quantity is no certain sign of purity.

2. *The Amount of Fat.*—This is particularly useful when wheat-starch is the adulterating agent. Mustard exhausted by benzole or ether gives up a quantity ranging from 33·9 to 36·7 of oil, whilst wheat-flour does not contain more than 1·2 to 2·1 per cent. of oil; hence a large admixture of wheat-flour necessarily produces deficiency of ethereal extract.

The best method to take the oil is to place a small quantity, carefully weighed—*e.g.*, a gramme—in a tube closed at one end, and treat it with about 50 cubic centimetres of ether, corking the tube, and allowing to stand over night. The ether in the morning is poured off and fresh ether added, boiling it up with successive portions several times by immersing the tube in hot water, whilst the boiling-point is raised by causing a certain safe amount of pressure with the thumb adapted to the open part of the tube. In this way the whole of the oil may be extracted from mustard, the ether evaporated, and the residue dried and weighed.

Some analysts use the following formula in order to determine the amount of mustard in an admixture which the microscope has shown to mainly or entirely consist of wheat-flour and mustard:—

x = amount of mustard, y = of oil found.

$$\frac{33{\cdot}9\,x}{100} + \frac{1{\cdot}2\,(100 - x)}{100} = y.$$

$$\frac{36{\cdot}7}{100} + \frac{2\,(100 - x)}{100} = y.$$

Such calculations are rough guides, but should not be implicitly relied upon.

3 and 4. *The Ash.*—The ash is best taken by weighing 1 or 2 grammes into a platinum

dish and burning at a low temperature. The total ash of dried mustard averages 5 per cent.; the highest number the author has obtained is 5·3 per cent., the lowest 5·088 per cent. The ash of mustard in its natural state is from 4 to 4·5 per cent. Of this ash 1·2 at least is soluble in water; in other words, the ash of mustard consists of 30 parts per cent. soluble, 70 parts insoluble in water.

The value of taking the percentage of ash is great; for if it be above 5·5 per cent., mineral matter is certainly present; if below 4 per cent., it indicates some organic adulterant, such as wheat-flour, which possesses a very small amount of saline matter. The great fallacy in the determination of ashes is incomplete ignition. A true ash does not lose weight when reignited, nor does it contain any appreciable quantity of carbon.

5. *Starch.*—Mustard, if pure, contains no starch; hence if treated with iodine, and no blue coloration is produced, this negative result excludes a great variety of adulterations. By the use of a volumetric solution of starch a very good idea of the amount of admixture may be formed. The method to be employed is very similar to *nesslerising*. Two glass cylinders are taken, one containing a known quantity of the mustard to be examined, diffused through water; to this is added a little iodine, and the blue colour which is produced exactly imitated by the addition of the same quantity of iodine to an equal column of water in the other cylinder, and running in the standard starch solution from a burette until the same or a similar tint is produced.

6. *Turmeric.*—Turmeric may be readily recognised by the microscope, but there are also some very good special chemical tests. One of these is based upon the fact that the seeds of the black and white mustard yield a yellow colouring matter, soluble in spirits of wine, devoid of fluorescence; while, on the contrary, turmeric is strongly fluorescent: hence an alcoholic solution of mustard, if fluorescent, is certain to be adulterated.

The alcoholic solution may be placed in a test-tube and held vertically in water contained in a glass blackened internally. If the observer now slightly inclines the top from the window and looks from above, *outside* the test-tube, the least bit of green fluorescence will be readily observed.—(STOKES.)

A still easier method is that of passing a little castor oil through adulterated mustard on a filter. The oil, if turmeric be present, shows a very distinct green colour. The above test will detect a mere trace of turmeric.

Another excellent method is to mix a little mustard with two or three times its volume of methylic alcohol, to filter the liquid, and evaporate to dryness in a porcelain capsule containing a small piece of filtering-paper about the size of a sixpence. When the evaporation is completed, the paper is moistened with a strong solution of boric acid and dried. If turmeric be present, the paper takes a reddish colour; if it then be treated with a solution of potash or soda, there is a play of colours, among which green and purple predominate. A still further confirmation may be obtained by adding a drop of hydrochloric acid, which produces a red orange-green colour, turned by excess of an alkali to green and blue.—(ALLEN.)

7. *Gamboge.*—The same process as the last will detect gamboge. The little bit of filter-paper treated with caustic soda turns a bright red; with hydrochloric acid, a yellow colour is produced.

All mineral adulterations will be found in the ash.

The *oil* or *essence of mustard* is not unfrequently adulterated. If pure, it should be of the specific gravity already mentioned, and its boiling-point be 298° F. (112° C.) One part of oil of mustard mixed with four parts of water and sixteen of alcohol gives a clear solution.

The pure essence takes a very light yellow when mixed with fifteen to twenty times its volume of concentrated sulphuric acid; but if the essence is mixed with others, a red colour is formed, more or less strong, according to the extent of adulteration.

The adulterations which have been actually discovered in the essence appear to be alcohol, sulphide of carbon, petroleum oil, castor oil, and essence of cloves.

Mutton—*See* MEAT.

Mutual Aid Societies (syn. *Friendly Societies*)—The largest of these societies are the "Manchester Unity of Oddfellows" and the "Ancient Order of Foresters;" but there are many others established for the same purpose—viz., of supporting their members when sick, and providing medical attendance. Of late years, in large towns, numerous clubs have amalgamated together, forming large societies, united for no other purpose than that of employing one medical man, who devotes his whole time to the care of the members and their families.

All clubs, amalgamated societies, &c., which keep a record of their sick may be utilised by sanitary authorities in giving notice of epidemic disease, &c., among their members; this they would do the more readily, as it is the interest of the clubs to keep their members healthy. Friendly societies were subjected to slight control in 1793, and other Acts were passed in 1855, 1858, and 1860.

Mycosis Endocardii—A fungoid disease of the valves of the heart, described by Winge of Christiania, 1869. *See* BACTERIA; BACTEROID, ORIGIN OF DISEASE.

N.

Nessler Test.—The most delicate test for ammonia or its salts known. It is an aqueous solution of iodide of potassium, saturated with biniodide of mercury, and rendered powerfully alkaline with potash. It is prepared as follows: 35 grammes of iodide of potassium are dissolved in a small quantity of distilled water; a saturated solution of bichloride of mercury is now added, little by little; a red precipitate appears, which almost immediately is dissolved. In continuing to add, a point is at last reached, when the precipitate commences to be insoluble. Sufficient corrosive sublimate has then been added. The liquid is now filtered, and to the filtrate 120 grammes of caustic soda (or 160 grammes of potash) are added in strong aqueous solution. The liquid is then diluted so as to measure a litre. Lastly, 5 cubic centimetres of a saturated solution of bichloride of mercury are added. This makes the Nessler solution clear rapidly, and also imparts to it sensitiveness of reaction. The liquid now deposits a sediment if allowed to stand, and the clear liquid should be decanted off into a stock-bottle well corked and of large size. From this stock-bottle a little can be put in a smaller one for immediate use, as frequent opening spoils it by rendering it turbid.

If the Nessler reagent be added to a liquid containing a very minute quantity of ammonia, a light yellow, a dark yellow, or a brown coloration is produced, according to the quantity of ammonia present. If there is a larger quantity of ammonia, there is a precipitate formed. This precipitate has the composition of Hg_2NIH_2O. It is hydrargo-ammonium iodide, or ammonium in which four atoms of hydrogen are displaced by two of mercury. By multiplying the weight of the precipitate by ·03041—viz., $\frac{17}{559}$—the weight of the ammonia is obtained. It is, however, by the colorimetric method that ammonia is usually measured for health purposes. (*See* WATER.) By this method "the Nessler test is capable of indicating less than $\frac{1}{200}$ milligramme of ammonia dissolved in 100 cubic centimetres of distilled water—being one part of ammonia in 20,000,000 parts of water. And ammonia admits of concentration. $\frac{1}{100}$ milligramme of ammonia dissolved in two litres of water would for the most part pass into the first 100 cubic centimetres of distillate, if the two litres of water were distilled.

"In this way, therefore, ammonia may be detected when the quantity is $\frac{1}{100}$ milligramme in two litres of water, or 1 part of ammonia in 200,000,000 parts of water. And even this statement, surprising though it may seem, is an under-statement of the delicacy of the test."—(Water-Analysis, by Wanklyn and Chapman.)

Nicotina, Nicotine ($C_{10}H_{14}N_2$) (syn. *Nicotia*) — A volatile base discovered by Reimau and Posselt, and found in the leaves, root, and seeds of the tobacco plant. It is a colourless, volatile, liquid alkaloid, with an acrid odour and an acrid burning taste. The vapour has the odour of tobacco, and is extremely irritating. It restores the blue colour of reddened litmus, and renders turmeric brown. It boils and undergoes decomposition at 482° F., but does not solidify at 14° F.

The peculiarity of this alkaloid is that it is soluble in water and ether. In many of its reactions it resembles ammonia. It is an energetic poison, almost equalling in activity hydrocyanic acid, for a single drop will kill a large-sized dog. Two cases of poisoning by nicotine are alone on record. Count Bocarmé especially prepared it for the purpose of poisoning his wife's brother, Gustave Fougnies; and it was also used for a suicidal purpose by an English chemist, and proved fatal in less than five minutes.

Good Virginia and Kentucky tobacco dried at 212° F. contains from 6 to 7 per cent. of nicotina, Havana tobacco (cigars) less than 2 per cent.—(SCHLOESING.)

"Nicotine is present in some cigars in the proportion of about 4 per cent., but the smoke derived from them contains none. Small quantities of sulphide and cyanide of ammonium were found in the smoke. Snuff yielded from ·04 to ·06 per cent. of nicotina."—(Ann. d'Hyg., 1873, i. p. 436. Quoted by TAYLOR.)

Dr. Emil Heubel of Kiew, a noted university in Russian Poland, after some exhaustive researches into this subject, arrives at the following conclusions (Centralblatt, October 5, 1872): *—

1. Nicotine is certainly contained in tobacco smoke.

2. It exists in the smoke, for the most part, as a salt of the alkaloid.

3. In the working of tobacco smoke, both upon the human and brute organisms, an essential share in the effect is taken by the nicotine ingredient of the smoke.

Tests.—A solution of nicotina in hydrochloric acid affords with *chloride of gold* a reddish-yellow, curdy precipitate; with *chloride of platinum*, a crystalline yellow precipitate; and if heated with *hydrochloric acid*, a violet colour is produced. But the most characteristic precipitate is that which nicotine produces with corrosive sublimate. Even so small a portion as $\frac{1}{2500}$ grains of nicotine will yield white crystals, if treated with an aqueous solution of corrosive sublimate. The only other alkaloid with which this reagent produces a *crystalline* precipitate is strychnine, but the forms of the crystals are entirely different. The amount of ammonia evolved, &c., as described in article ALKALOIDS, will also distinguish nicotine from other substances of similar appearance. *See* ALKALOIDS, TOBACCO.

Nitre (*Nitrate of Potassa*)—*See* POTASSA.

Nitro-Benzole (*Essence of Merbane*) ($C_6H_5NO_2$)—This substance is prepared by treating benzole with strong fuming nitric acid with heat. After the violence of the reaction is over, the liquid is diluted with water, and the heavy oily fluid which separates is collected, washed, and dried.

It is of a yellowish colour; smells of bitter almonds; is insoluble in water, and is little affected by reagents. It boils at 415° F.; specific gravity, 1·209.

Nitro-benzole has some antiseptic properties; a piece of lean meat suspended in its vapour was preserved perfectly fresh for over eight days.

This substance is largely employed as a substitute for the essential oil of bitter almonds in perfumery and confectionery, and has now taken its place among narcotic poisons. *See* CASPER, Vierteljahrsschrift, b. xvi. p. 1; Guy's Hospital Reports, October 1864, p. 192; and Ann. d'Hyg., 1873, i. p. 444.

According to Letheby, its poisonous properties depend on *aniline*, which it is capable of being converted into by the animal organism. For tests, &c., *see* ANILINE.

Nitrogen—An elementary gaseous substance discovered by Rutherford in 1722, and found to be a constituent of the atmosphere by Lavoisier, 1755. Its relative weight is 14, and its observed specific gravity is ·9713. It forms four-fifths of the bulk of the atmosphere; is an essential component of animal substances, of gluten, of the alkaloids, of ammonia, and of various vegetable and commercial products.

Nitrogen is a colourless, tasteless, inodorous gas, which as yet has resisted all efforts to liquefy it. It is neither a supporter of combustion nor a combustible body itself. In fact, alone and uncombined, it appears a very inert substance, yet in combination it plays an extremely important and active part in the universe.

Nitrogen in food, in some form or other, is absolutely necessary to life, the quantity required by man being, according to Dr. Parkes, 316 grains daily. The functions of nitrogenous matters are to construct and repair tissue, but it is probable that they have other duties to perform of an assimilative, respiratory, and force-producing quality.

Nitrogen, Estimation of.—The estimation of nitrogen is frequently required by the hygienist or analyst. The nitrogen in a great variety of organic liquids—such as tea, milk, beer, wine, urine, sewage, &c.—may be readily estimated by the processes given under AMMONIA, WATER-ANALYSIS, &c.

For solids the best process is most decidedly that of Dumas. A combustion-tube about 70 centimetres long, and sealed at one end, is taken. First, a layer of bicarbonate of soda 12·15 centimetres long is introduced, then a layer of oxide of copper 4 centimetres long; this is followed by an intimate mixture of an accurately-weighed portion of the substance (·3 to ·6 grammes) with oxide of copper, then a layer of pure oxide, and lastly a layer of copper turnings about 15 centimetres long. A delivery-tube is attached to this, and the end is inserted in an inverted graduated cylinder filled two-thirds with mercury, one-third with strong solution of potash. The operation is conducted as follows: First, all air is expelled by heating the posterior end of the tube containing the bicarbonate. When it is found all bubbles are absorbed by a solution of potash, the

* Drs. Vohl and Eulenberg (Vierteljahrsschrift für Gerichtl. Med., 1871, xiv. p. 249) have arrived at different conclusions. The results of their investigations are given in article on TOBACCO.

cylinder filled, as before described, is placed over the delivery-tube, and the actual operation commenced by heating the anterior end of the tube first, and then going gradually backward until the whole tube is red-hot. The nitrogen in the cylinder after the operation is finished is ultimately measured over water, with corrections for temperature, pressure, and tension of aqueous vapour. There are many other processes; the above are the most convenient.

Nitrous Oxide (*Protoxide of Nitrogen, Laughing-Gas, Nitrogenii protoxydum*) ($N_2O = 44$)—Theoretic specific gravity, 1·5238; observed specific gravity, 1·527.

Nitrous oxide is a transparent colourless gas with a faint sweetish smell. 100 volumes of water at 32° dissolve 130 of the gas; at 59°, 77 volumes; and at 75° only 60 volumes. It boils at about −126°, and may be frozen into a transparent solid at about −150°. It supports the combustion of many bodies with a brilliancy resembling that which they exhibit when burning in oxygen, and may be distinguished from this gas by its considerable solubility in water. Its most remarkable property is its action on the system when inspired. Soon after its discovery, Sir Humphrey Davy proved that when mixed with air it might be breathed without danger to life. A few deep inspirations were usually succeeded by a pleasing state of excitement, attended often with an irresistible propensity to uncontrollable laughter, which soon subsided, without being followed by depression or languor.

Sir H. Davy, in one of his early experiments, inhaled with safety 5 gallons; and it is said that from 4 to 12 gallons might be breathed without danger. Like chloroform or ether, it produces temporary insensibility to pain, and is now extensively employed as an anæsthetic in dental surgery. When affections of the heart, lungs, or brain are present, it should never be employed. For such operations as the drawing of teeth, &c., nitrous oxide is a useful and a comparatively safe anæsthetic; but experience has shown that the keeping of an individual under its influence for any time is attended with danger, hence it is seldom employed for producing insensibility during the more important hospital operations.

Considering how extensively it is used, the deaths resulting from its employment are comparatively few. The first case that attracted any particular attention was that of a lady at Exeter, who inhaled about 6 gallons of nitrous oxide in order to annul pain during the extraction of a molar tooth. Shortly after, insensibility came on, the face became livid, the features began to swell, the tongue protruded, and in spite of every effort to restore her, she breathed two or three times, and then the pulse stopped.

Dr. Johnson has pointed out that the convulsions produced by this gas are analogous, if not identical, with those of epilepsy; and according to the recent experiments of MM. Joylet and Blanch (Archives de Physiologie, Juillet 1873), this gas when breathed operates fatally by producing pure asphyxia. The insensibility which is a result of breathing the gas, is, in their view, owing to the non-oxygenation of the blood. It is dissolved in the blood, and circulated with it, the blood not having the power to separate the combined oxygen from it. According to these physiologists, the anæsthetic state produced by this gas is owing to temporary asphyxia, which, in proportion to its duration and the time for which air is cut off, may end in recovery or death. There is not only a circulation of unaërated blood, but this liquid containing the nitrous oxide in solution may produce some direct effect on the nerve-centres.—(Taylor.)

In the second report of the joint committee of the Odontological Society on the action of nitrous gas (October 1872) it is stated: "As to the mode of death, it is certain that the respiration stops in fatal cases in dogs before the heart ceases to beat. The gas acts upon the nervous centres, controlling the respiratory act; hence the value of artificial respiration and electricity, should death be impending."

Notices—The Public Health Act contains very full and explicit directions as to the serving and delivery of *notices*.

Notices, orders, and other such documents under the Public Health Act may be in writing or print, or partly in writing and partly in print; and if the same require authentication by the local authority, the signature thereof by the clerk to the local authority or their surveyor or inspector of nuisances shall be sufficient authentication.—(P. H., s. 266.)

Notices, orders, and any other documents required or authorised to be served under the said Act may be served by delivering the same to or at the residence of the person to whom they are respectively addressed, or where addressed to the owner or occupier of premises, by delivering the same or a true copy thereof to some person on the premises, or if there is no person on the premises who can be so served, by fixing the same on some conspicuous part of the premises; they may also be served by post by a prepaid letter, and if served by post, shall be deemed to have been served at the time when the letter containing the same would be delivered in the ordinary course of post, and in proving such service it shall be sufficient to prove that the notice, order, or other document was properly addressed and put into the post.

Any notice required to be given to the owner or occupier of any premises may be addressed by the description of the "owner" or "occupier" of the premises (naming them) in respect of which the notice is given, without further name or description.—(P. H., s. 267.)

There has hitherto been some practical inconvenience in the absence of precise directions as to whom the notice should be served on in the matter of ordinary nuisances. The following is a summary of the action which may be taken by the local authority or their officers in this matter :—

Enforcing the Drainage of Houses.—Notice is to be given to the owner or occupier, but in case of the failure of either to comply, and the authority having to do the work, the expense falls on the *owner*.—(P. H., s. 23.)

Insufficient Privy Accommodation. — The same procedure as under the 23d section.—(P. H., s. 36, 37.)

The Cleansing and Whitewashing of Houses.—Notice to the owner or occupier. The person on whom the notice is served is liable to a penalty if it is not complied with.—(P. H., s. 46.)

The Removal of Manure or Filth, &c., in an Urban District.—Notice to be served on the person to whom the manure belongs, or to the occupier of the premises whereon it exists. If the urban authority have to remove it themselves, the expense of removal falls upon the owner of the manure, &c., or the occupier of the premises, or where there is no occupier, the owner of the premises.—(P. H., s. 49.)

In the case of nuisances, notice is to be served upon the person *causing* or permitting the nuisance to remain, or if he cannot be found, on the owner or occupier of the premises on which the nuisance arises ; but if the nuisance arises from the want or defective construction of any structural convenience, or where there is no occupier, notice is to be served on the owner.—(P. H., s. 94.)

In the case of houses, &c., requiring disinfection, notice is to be given to the owner or occupier ; and in case of non-compliance, the person on whom the notice is served is liable to penalties, and the expenses of the authority doing the necessary works fall upon that person (with certain exceptions in case of poverty).—(P. H., s. 120.) *See* Disinfection.

Section 160 of the Public Health Act enacts that alterations under the 69th, 70th, and 71st sections, directions under the 73d section, and orders under the 74th section, of the Towns Improvement Clauses Act, may at the option of the urban authority be served on owners instead of occupiers, or on owners as well as occupiers.

For forms of notices for the abatement of nuisances and for the construction of sewers, *see* Nuisances, Sewers ; *see also* Orders.

Noxious Trades — *See* Nuisances ; Trades, Injurious ; Trades, Offensive, &c.

Nuisance Inspector—*See* Inspector of Nuisances.

Nuisances—The following are the definitions of nuisances by eminent legal authorities. Blackstone says : "Nuisance, nocumentum, or annoyance, signifies anything which worketh] hurt, inconvenience, or damage. And nuisances are of two kinds—*public* or *common* nuisances, which affect the public, and are an annoyance to all the king's subjects—for which reason we must refer them to the class of public wrongs or crimes and misdemeanours ; and *private* nuisances, which are the objects of our present consideration, and may be defined, anything done to the hurt or annoyance of the lands, tenements, or hereditaments of another." "Common nuisances are a species of offences against the public order and economical regimen of the State ; being either the doing of a thing to the annoyance of all the king's subjects, or the neglecting to do a thing which the common good requires. Common nuisances are all those kinds of nuisances (such as offensive trades and manufactures) which, when injurious to a private man, are actionable, and when detrimental to the public, punishable by public prosecution, and subject to fine according to the quantity of the misdemeanour ; and particularly the keeping of hogs in any city or market-town is indictable as a public nuisance"—(Blackstone.)

According to Lord Mansfield, to constitute a nuisance it is enough that the matter complained of renders the enjoyment of life and property uncomfortable.

There is, however, a difference between a nuisance at common law and a nuisance under the Sanitary Acts, for a nuisance under the Sanitary Acts *must be one which is injurious to health.* *See* Great Western Railway Company *v.* Bishop, 41 L. J. M. C., 120 ; L. R., 7.

It is, of course, obvious that this interpretation renders action extremely difficult under the Sanitary Acts, as in a great majority of nuisances what is or is not injurious to health is a mere matter of opinion.

There are, however, certain things distinctly specified as nuisances in the Public Health Act, such as accumulations of filth, foul ditches, dirty premises, &c.

The following are the chief provisions of the Public Health Act relative to nuisances:—

Definition of Nuisances.—1. Any premises in such a state as to be a nuisance or injurious to health:

2. Any pool, ditch, gutter, watercourse, privy, urinal, cesspool, drain, or ashpit so foul as to be a nuisance or injurious to health:

3. Any animal so kept as to be a nuisance or injurious to health:

4. Any accumulation or deposit which is a nuisance or injurious to health:

5. Any house or part of a house so overcrowded as to be dangerous or injurious to the health of the inmates, whether or not members of the same family:

6. Any factory, workshop, or workplace (not already under the operation of any general Act for the regulation of factories or bakehouses) not kept in a cleanly state, or not ventilated in such a manner as to render harmless as far as practicable any gases, vapours, dust, or other impurities generated in the course of the work carried on therein that are a nuisance or injurious to health, or so overcrowded while work is carried on as to be dangerous or injurious to the health of those employed therein:

7. Any fireplace or furuace which does not as far as practicable consume the smoke arising from the combustible used iu such fireplace or furnace, and is used for working engiues by steam, or in any mill, factory, dyehouse, brewery, bakehouse, or gaswork, or in any manufacturing or trade process whatsoever; and

Any chimney (not being the chimney of a private dwelling-house) sending forth black smoke in such quantity as to be a nuisance,

shall be deemed to be nuisances liable to be dealt with summarily under the Public Health Act: Provided—

First. That a penalty shall not be imposed on any person in respect of any accumulation or deposit necessary for the effectual carrying on any business or manufacture if it be proved to the satisfaction of the court that the accumulation or deposit has not been kept longer than is necessary for the purposes of the business or manufacture, and that the best available means have been taken for preventing injury thereby to the public health:

Secondly. That where a person is summoned before any court in respect of a nuisance arising from a fireplace or furnace which does not consume the smoke arising from the combustible used in such fireplace o furnace, the court may hold that no nuisance is created within the meaning of this Act, and dismiss the complaint, if it is satisfied that such fireplace or furnace is constructed in such manner as to consume as far as practicable, having regard to the nature of the manufacture or trade, all smoke arising therefrom, and that such fireplace or furnace has been carefully attended to by the person having the charge thereof.—(P. H., s. 91.)

The Duty of the Local Authority to inspect, &c.—It shall be the duty of every local authority to cause to be made from time to time inspection of their district, with a view to ascertain what nuisances exist calling for abatement under the powers of the Public Health Act, and to enforce the provisions of the said Act in order to abate the same; also to enforce the provisions of any Act in force within their district requiring fireplaces and furnaces to cousume their own smoke.—(P. H., s. 92.)

Information of Nuisances.—Information of any nuisance under the said Act in the district of any local authority may be given to such local authority by any person aggrieved thereby, or by any two inhabitant householders of such district, or by any officer of such authority, or by the relieving officer, or by any constable or officer of the police force of such district.—(P. H., s. 93.)

On the receipt of any information respecting the existence of a nuisauce, the local authority shall, if satisfied of the existence of a nuisance, serve a notice on the person by whose act, default, or sufferauce the nuisance arises or contiuues, or, if such person cannot be fouud, ou the owner or occupier of the premises on which the nuisance arises, requiring him to abate the same within a time to be specified in the notice, and to execute such works and do such things as may be necessary for that purpose: Provided—

First. That where the nuisance arises from the want or defective constructiou of any structural convenience, or where there is no occupier of the premises, notice under this section shall be served on the owner:

Secondly. That where the person causing the nuisance cannot be found, and it is clear that the nuisance does not arise or continue by the act, default, or sufferance of the owner or occupier of the premises, the local authority may themselves abate the same without further order.—(P. H., s. 94.)

Procedure on Failure to comply with Notice.—If the person on whom a notice to abate a nuisance has beeu served makes default in complying with any of the requisitions thereof within the time specified, or if the nuisance, although abated since the service of the notice is, in the opinion of the local authority, likely to recur on the same premises, the local authority shall cause a complaint relating to such nuisance to be made before a justice, and such justice shall thereupon issue a summons requiring the person on whom the notice was served to appear before a court of summary jurisdiction.—(P. H., s. 95.)

Power of the Court to make an Order dealing with the Nuisance.—If the court is satisfied that the alleged nuisance exists, or that although abated it is likely to recur on the same premises, the court shall make an order on such person requiring him to comply with all or any of the requisitions of the notice, or otherwise to abate the nuisance within a time specified in the order, and to do any works necessary for that purpose; or an order prohibiting the recurrence of the nuisance and directing the execution of any works necessary to prevent the recurrence.

The court may by their order impose a penalty of £5 or less on the person on whom the order is made, and shall also give directions as to the payment of all costs incurred up to the time of the hearing or making the order for abatement or prohibition of the nuisance.—(P. H., s. 96.)

Penalty for not obeying Order.—Any person not obeying an order to comply with the requisitions of the local authority or otherwise to abate the nuisance, shall, if he fails to satisfy the court that he has used all due diligence to carry out such order, be liable to a penalty not exceeding *ten shillings* per day during his default; and any person knowingly and wilfully acting contrary to an order of prohibition shall be liable to a penalty not exceeding *twenty shillings* per day during such contrary action; moreover, the local authority may enter the premises to which any order relates, and abate the nuisance, and do whatever may be necessary in execution of such order, and recover in a summary manner the expenses incurred by them from the person on whom the order is made.—(P. H., s. 98).

Appeal against Orders.—Any person may appeal against an order.—(P. H., s. 99.) *See* APPEALS.

Order may be addressed to the Local Authority in certain Cases.—Whenever it appears to the satisfaction of the court of summary jurisdiction that the person by whose act or default the nuisance arises, or the owner or occupier of the premises is not known or cannot be found, then such order may be addressed to and executed by the local authority.—(P. H., s. 100.)

There are large powers with regard to the entry of premises in which nuisances either exist or are supposed to exist. *See* ENTRY, POWERS OF.

Power of Complaint by Private Individuals.—Complaint may be made to a justice of the existence of a nuisance under this Act on any premises within the district of any local authority by any person aggrieved thereby, or by any inhabitant of such district, or by any owner of premises within such district, and thereupon the like proceedings shall be had with the like incidents and consequences as to making of orders, penalties for disobedience of orders, appeal, and otherwise, as in the case of a complaint relating to a nuisance made to a justice by the local authority:

Provided that the court may, if it thinks fit, adjourn the hearing or further hearing of the summons for an examination of the premises where the nuisance is alleged to exist, and may authorise the entry into such premises of any constable or other person for the purposes of such examination:

Provided also, that the court may authorise any constable or other person to do all necessary acts for executing an order made under this section, and to recover the expenses from the person on whom the order is made in a summary manner.

Any constable or other person authorised under this section shall have the like powers and be subject to the like restrictions as if he were an officer of the local authority authorised under this Act, to enter any premises and do any acts thereon.—(P. H., s. 105.)

Power of Police to proceed in certain Cases.—Where it is proved to the satisfaction of the Local Government Board that a local authority have made default in doing their duty in relation to the abatement of nuisances under this Act, the Local Government Board may authorise any officer of police acting within the district of the defaulting authority to institute any proceeding which the defaulting authority might institute with respect to the abatement of nuisances, and such officer may recover any expenses incurred by him, and not paid by the person proceeded against, from the defaulting authority:

But such officer of police shall not be at liberty to enter any house or part of a house used as the dwelling of any person without such person's consent, or without the warrant of a justice, for the purpose of carrying into effect this enactment.—(P. H., s. 106.)

Costs and Expenses of executing the Provisions relating to Nuisances.—All reasonable costs and expenses incurred in making a complaint, or giving notice, or in obtaining any order of the court or any justice in relation to a nuisance under the Public Health Act, or in carrying the same into effect, shall be deemed to be money paid for the use and at the request of the person on whom the order is made; or if the order be made on the local authority, or if no order is made, but the nuisance is proved to have existed when the complaint was made or the notice given, then of the person by whose act or default the nuisance was caused; and in case of nuisances caused by the act or default of the owner of premises, such costs and expenses may be recovered from any person who is for the time being owner of such premises: Provided that such costs and expenses shall not exceed in the whole one year's rackrent of the premises.

Such costs and expenses, and any penalties incurred in relation to any such nuisance, may be recovered in a summary manner or in any county or superior court; and the court shall have power to divide costs, expenses, and penalties between the persons by whose act or default the nuisance arises as to it may seem just.

Any costs and expenses recoverable under this section by a local authority from an owner of premises may be recovered from the occupier for the time being of such premises; and the owner shall allow such occupier to deduct any moneys which he pays under this enactment out of the rent from time to time becoming due in respect of the said premises, as if the same had been actually paid to such owner as part of such rent:

Provided, that no such occupier shall be required to pay any further sum than the amount of rent for the time being due from him, or which, after demand of such costs or expenses from such occupier, and after notice not to pay his landlord any rent without first deducting the amount of such costs or expenses, becomes payable by such occupier, unless he refuses, on application to him by the local authority, truly to disclose the amount of his rent and the name and address of the person to whom such rent is payable, but the burden of proof that the sum demanded from any such occupier is greater than the rent due by him at the time of such notice, or which has since accrued, shall lie on such occupier:

Provided also, that nothing herein contained shall affect any contract between any owner or occupier of any house, building, or other property whereby it is or may be agreed that the occupier shall pay or discharge all rates, dues, and sums of money payable in respect of such house, building, or other property, or to affect any contract whatsoever between landlord and tenant.—(P. H., s. 104.)

For the closing of houses unfit for habitation on account of a nuisance, *see* HABITATIONS.

Power of Sale of Manure, &c.—Any matter or thing removed by the local authority in abating a nuisance may be sold by public auction.—(P. H., s. 101.)

Nuisance caused by Drains, Privies, &c.—All drains, water-closets, earth-closets, privies, ashpits, and cesspools are to be supervised by the local authority, whose duty it is to provide that they are to be so constructed and kept as not to be a *nuisance* or *injurious to health.*—(P. H., s. 40.) On the written application of any person to a local authority stating that any one of the structures mentioned is a nuisance or injurious to health (but not otherwise), the local authority may by writing empower their surveyor or inspector of nuisances, after twenty-four hours' written notice to the occupier, or *in case of emergency without notice*, to enter such premises, with or without assistants, and cause the ground to be opened, and examine any of the said structures. If all is found in good condition, the ground is to be closed, the damage made as good as can be, and the expenses of the works defrayed by the local authority. But if any of the said structures appear to be in a bad condition, or to require alteration or amendment, notice must be given by the local authority to the owner or occupier to do within a reasonable specified time the necessary works. Penalty for neglect, 10s. a day during default. The local authority may execute the works, and may recover the expenses from the owner in a summary manner, or declare them "private improvement expenses."—(P. H., s. 41.)

Nuisances without the District.—Where a nuisance under the Public Health Act within the district of a local authority appears to be wholly or partially caused by some act or default committed or taking place without their district, the local authority may take or cause to be taken against any person in respect of such act or default any proceedings by this Act authorised as if such act or default were committed or took place wholly within their district, so, however, that summary proceedings shall in no case be taken otherwise than before a court having jurisdiction in the district where the act or default is alleged to be committed or take place. This section extends to the metropolis.—(P. H., s. 108.)

Proceedings in certain Cases against Nuisances.—Where any nuisance under the Public Health Act appears to be wholly or partially caused by the acts or defaults of two or more persons, it shall be lawful for the local authority or other complainant to institute proceedings against any one of such persons, or to include all or any two or more of such persons in one proceeding; and any one or more of such persons may be ordered to abate such nuisance, so far as the same appears to the court having cognisance of the case to be caused by his or their acts or defaults, or may be prohibited from continuing any acts or defaults which, in the opinion of such court, contributes to such nuisance, or may be fined or otherwise punished, notwithstanding that the acts or defaults of any one of such persons would not separately have caused a nuisance, and the costs may be distributed as to such court may appear fair and reasonable.

Proceedings against several persons included in one complaint shall not abate by reason of the death of any among the persons so included, but all such proceedings may be carried on as if the deceased person had not been originally so included.

Whenever in any proceeding under the provisions of the Public Health Act relating to nuisances, whether written or otherwise, it becomes necessary to mention or refer to the owner or occupier of any premises, it shall be sufficient to designate him as the "owner" or "occupier" of such premises, without name or further description.

Nothing in this section shall prevent persons proceeded against from recovering contribution in any case in which they would now be entitled to contribution by law.

Nuisances in Ships, &c.—For the purpose of the provisions of this Act relating to nuisances, any ship or vessel lying in any river, harbour, or other water within the district of a local authority shall be subject to the jurisdiction of that authority in the same manner as if it were a house within such district; and any ship or vessel lying in any river, harbour, or other water not within the district of a local authority shall be deemed to be within the district of such local authority as may be prescribed by the Local Government Board, and where no local authority has been prescribed, then of the local authority whose district nearest adjoins the place where such ship or vessel is lying.

The master or other officer in charge of any such ship or vessel shall be deemed for the purpose of the said provisions to be the occupier of such ship or vessel.

This section shall not apply to any ship or vessel belonging to her Majesty or to any foreign government.—(P. H., s. 110.)

The Provisions of the Public Health Act do not affect other Remedies.—The provisions of this Act relating to nuisances shall be deemed to be in addition to and not to abridge or affect any right, remedy, or proceeding under any other provisions of this Act or under any other Act, or at common law:

Provided that no person shall be punished for the same offence both under the provisions of this Act relating to nuisances, and under any other law or enactment. — (P. H., s. 111.)

The following are the proper forms of notices, orders, &c., relative to the abatement or prohibition of nuisances :—

SCHEDULE IV.

FORM A.

Form of Notice requiring Abatement of Nuisance.

To [*person causing the nuisance*, or *owner* or *occupier of the premises whereon the nuisance exists, as the case may be*].

Take notice that under the provisions of the Public Health Act, 1875, the [*describe the local authority*], being satisfied of the existence of a nuisance at [*describe premises* or *place where the nuisance exists*], arising from [*describe the cause of nuisance, for instance*, want of a privy or drain; or *for further instance*, a ditch or drain so foul as to be a nuisance or injurious to health; or *for further instance*, swine kept so as to be a nuisance or injurious to health], do hereby require you within from the service of this notice to abate the same, and for that purpose to [*state any things required to be done or work to be executed*].

If you make default in complying with the requisitions of this notice, or if the said nuisance, though abated, is likely to recur, a summons will be issued requiring your attendance to answer a complaint which will be made to a court of summary jurisdiction for enforcing the abatement of the nuisance, and prohibiting a recurrence thereof, and for recovering the costs and penalties that may be incurred thereby.

Dated this day of 18 .

Signature of officer of local authority

FORM B.

Form of Summons.

Summons.

To the owner *or* occupier of [*describe premises*], situated at [*insert such a description as may be sufficient to identify the premises*], or to *A. B.* of

County of , [*or* borough of , &c., *or* district of *or as the case may be*] to wit. } You are required to appear before [*describe the court of summary jurisdiction*], at the petty sessions [or court] holden at on the day of next, at the hour of in the noon, to answer the complaint this day made to me by that in or on the premises above mentioned [*or* in or on certain premises situated at No. in the street in the parish of , or *such other description* or *reference as may be sufficient to identify the premises*], in the district, under the Public Health Act, 1875, of [*describe the local authority*], the following nuisance exists [*describing it, as the case may be*], and that the said nuisance is caused by the act or default of the occupier [*or* owner] of the said premises, *or* by you, *A. B.* [*or in case the nuisance be discontinued, but likely to be repeated, say*, there existed recently, to wit, on or about the day of , on the premises, the following nuisance [*describe the nuisance*], and that the said nuisance was caused [*&c.*], and although the same has since the said last-mentioned day been abated or discontinued, there is reasonable ground to consider that the same or the like nuisance is likely to recur on the said premises].

Given under my hand and seal this
day of 18 .

J. S. (L.S.)

FORM C.

Form of Order for Abatement or Prohibition of Nuisance.

To the owner [*or* occupier] of [*describe the premises*] situated [*give such description as may be sufficient to identify the premises*], *or* to *A. B.* of .

County of , [*or* borough, *&c.*, of , *or* district of , *or as the case may be.*] WHEREAS on the day of complaint was made before , Esquire, one of her Majesty's justices of the peace acting in and for the county [*or other jurisdiction*] stated in the margin, [*or as the case may be,*] by , that in or on certain premises situated at , in the district under the Public Health Act, 1875, of [*describe the local authority*] the following nuisance then existed [*describing it*]; and that the said nuisance was caused by the act or default of the owner [*or* occupier] of the said premises [*or* was caused by *A. B.*] [*If the nuisance have been removed, say,* the following nuisance existed on or about [*the day the nuisance was ascertained to exist*], and that the said nuisance was caused, [*&c.*,] and although the same is now removed, the same or the like nuisance is likely to recur on the same premises.]

And whereas , the owner [*or* occupier] within the meaning of the said Public Health Act, 1875, [*or* the said *A. B.*,] hath this day appeared before us [(*or* me) *describing the court*], to answer the matter of the said complaint [*or in case the party charged do not appear, say,* and whereas it hath been this day proved to our (*or* my) satisfaction that a true copy of a summons requiring the owner [*or* occupier] of the said premises [*or* the said *A. B.*] to appear this day before us [*or* me] hath been duly served according to the said Act.]

Now on proof here had before us [*or* me] that the nuisance so complained of doth exist on the said premises, and that the same is caused by the act or default of the owner [*or* occupier] of the said premises [*or* by the said *A. B.*], we [*or* I], in pursuance of the said Act, do order the said owner [*or* occupier, *or A. B.*] within [*specify the time*] from the service of this order or a true copy thereof according to the said Act [*here specify the works to be done, as, for instance,* to cleanse, whitewash, purify, and disinfect the said dwelling-house; *or, for further instance,* to construct a privy *or* drain, *&c.; or, for further instance,* to cleanse *or* to cover *or* to fill up the said cesspool, *&c.*], so that the same shall no longer be a nuisance or injurious to health as aforesaid.

[*And if it appear to the court that the nuisance is likely to recur on the premises, say,* [And we] [*or* I] being satisfied that, notwithstanding the said cause or causes of nuisances may be removed under this order, the same is or are likely to recur, do therefore prohibit the said owner [*or* occupier, *or A. B.*] from [*here insert the matter of the prohibition, as, for instance,*] from using the said house or building for human habitation until the same, in our [*or* my] judgment, is rendered fit for that purpose.]

In case the nuisance were removed before complaint, say, Now, on proof here had before us that at or recently before the time of making the said complaint, to wit, on as aforesaid, the cause of nuisance complained of did exist on the said premises, but that the same hath since been removed, yet, notwithstanding such removal, we [*or* I] being satisfied that it is likely that the same or the like nuisance will recur on the same premises, do hereby prohibit [*order of prohibition*]; and if this order of Prohibition be infringed, then we [*or* I] [*order on local authority to do works*].

Given under the hands and seals of us, [*or* the hand and seal of me, *describing the court*].
This day of 18 .

FORM D.

Form of Order for Abatement of Nuisance by Local Authority.

To the town council, *&c., as the case may be.*

County, *&c.*, to wit. WHEREAS [*recite complaint of nuisance as in last form*].

And whereas it hath been now proved to our [*or* my] satisfaction that such nuisance exists, but that no owner or occupier of the premises, or person causing the nuisance, is known *or* can be found [*as the case may be*]; Now we [*or* I], in pursuance of the said Act, do order the said [*local authority, naming it,*] forthwith to [*here specify the works to be done*].

Given, *&c.*

See also LEGAL PROCEEDINGS.

Nutmeg—The kernel of the seed of *Myristica officinalis*, Linn. Cultivated extensively in the Banda Islands of the Malayan Archipelago.

It is roundish or elliptical, like the French olive. The colour of the unlimed or brown nutmeg is ashy brown; that of limed nutmegs is brown on the projecting parts, and white (from the presence of lime) in the depressions. It is marked externally with reticulated furrows, and internally it is greyish red, with dark brown veins.

There are three varieties known in the London market—viz., *Penang nutmegs;* these are unlimed or brown nutmegs, and fetch the highest price. *Dutch* or *Batavian nutmegs;* these are limed nutmegs. *Singapore nutmegs;* these are a rougher, unlimed, narrow sort, of somewhat less value than the Dutch kind. Besides these, a long inferior nutmeg—the produce of *Myristica fatua*—is met with in commerce under three conditions: in the shelled or clean state (*long or wild nutmegs*): contained within the shell (*long or wild nutmegs in the shell*); and with the mace dried round the shell (*long or wild nutmegs covered with mace*).

The following is Bonastre's analysis of nutmegs:—

Composition in 100 *Parts per Weight.*

Volatile oil	6·0
Liquid fat	7·6
Solid fat	24·0
Acid	0·8
Starch	2·4
Gum	1·2
Ligneous fibre	54·0
Loss	4·0
	100·0

Nutmegs are often attacked by the nutmeg-insect, but since they are never sold in the powdered state, they are rarely adulterated. Chevallier, however, speaking of nutmegs, says, "The workmen of Marseilles have even made them of bran, clay, and the refuse of nutmegs. These nutmegs, placed in contact with water, soften down in that liquid. The worm-eaten nuts are equally insipid, and almost inodorous; sometimes they have a mouldy odour." They are occasionally mixed with the long variety just described. *See* MACE.

Nux Vomica—The seeds of *Strychnos Nux vomica*, Linn., imported from the East Indies. The seeds are circular, slightly convex on the dorsal, and concave on the ventral surface. In the centre of the ventral surface is the rounded hilum or umbilicus. The seeds are usually surrounded by filiform annular striae. Nux vomica has no perceptible odour; its powder has a yellowish-grey colour. The seeds contain the alkaloids STRYCHNIA and BRUCIA, *which see.*

O.

Oats, Oatmeal—The common oat is derived from the *Avena sativa.* As met with in commerce, oats consist of the seeds enclosed in their paleæ or husk. Oats deprived of these integuments go by the name of groats or grits.

Oats consist of from 24 to 28 per cent. of husk, 74 to 78 per cent. of grain. M. Payen gives the following as being the composition of oats:—

	Per cent.
Starch	60·59
Nitrogenous matter	14·39
Saccharine and gummy matter	9·25
Fatty matter	5·50
Cellulose	7·60
Silica and saline matter	3·25

Professor Johnson gives the ash as being 2·18 per cent., and consisting of potassa and soda, 26·18; lime, 5·95; magnesia, 9·95; oxide of iron, ·40; phosphoric acid, 43·84; sulphuric acid, 10·45; chlorine, ·26; silica, 2·67; alumina, ·06 per cent.

Norton says that the husk contains 6 to 7 per cent. of saline matter. The nitrogenous matter of the oat consists chiefly of a principle resembling caseine, called *avenine.* It may be thus obtained: "Let oatmeal be washed on a sieve, and the milky liquid which runs through be allowed to repose, to deposit the suspended starch-granules. The supernatant liquid, on being heated to 200° F., throws down albumen, and then on the addition of acetic acid, a white precipitate falls, which constitutes *avenine.*"

Viewed by the microscope, the oat is found to consist of two or three envelopes—the outer, or glumes, corresponding to a calyx; the inner envelope, or paleæ, occupying the position of a corolla, within which is the seed covered with hairs. The envelopes consist of long-shaped cells lying parallel with each other, and the sides of these cells have a regular serrated appearance. The starch-cells of the seed are small, many-sided, and cohere into composite round bodies. The oat-starch does not polarise light (*see* fig. 62).

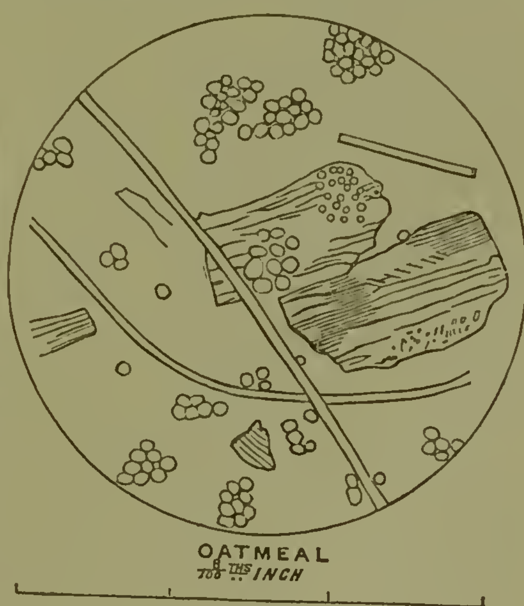


Fig. 62.

The hairs of the oat are tubular, pointed at the end, and have a central cavity.

The farina, or meal of the oat, is called oatmeal; its composition is as follows:—

Composition of Oatmeal in 100 Parts (Letheby).

Nitrogenous matter	12·6
Carbo-hydrates	63·8
Fatty matter	5·6
Saline matter	3·0
Water	15·0
	100·0

Oatmeal is remarkably rich in oily or fatty matter, and the proportion of protein compounds it contains is very great. As a flesh-and-blood-forming principle it holds a high rank, but its use is not always unattended with inconvenience. Some years ago the frequency of intestinal concretions in Scotland was remarked. These concretions were principally composed of phosphate of lime and fibrous matter. The origin of the latter was a subject of great mystery, until Dr. Wollaston pointed out that the fibrous network was simply the hairs of the oat, mixed with portions of the husk, derived from the oatmeal. Of late years, however, from improved processes in preparing oatmeal, intestinal concretions have not been so frequent.

Oatmeal has been found to be adulterated with different starches, such as barley-flour, rice, and maize, all of which may be detected by the aid of the microscope, whilst mineral adulteration may be detected in the ash, which should not exceed 2·36 per cent.

Obstruction of Local Authority—There are various penalties provided in different sections of the Public Health Act for the offence of obstructing officers, &c., representing the local authority, in carrying out the Act, which will be found alluded to throughout this work. The following is a section which deals with the subject generally :—

" Any person who wilfully obstructs any member of the local authority, or any person duly employed in the execution of this Act, or who destroys, pulls down, injures, or defaces any board on which any bylaw, notice, or other matter is inscribed, shall, if the same was put up by authority of the Local Government Board or of the local authority, be liable for every such offence to a penalty not exceeding *five pounds*.

"Where the occupier of any premises prevents the owner thereof from obeying or carrying into effect any provisions of this Act, any justice to whom application is made in this behalf shall, by order in writing, require such occupier to permit the execution of any works required to be executed, provided that the same appear to such justice to be necessary for the purpose of obeying or carrying nto effect the provisions of this Act ; and if within twenty-four hours after the making of the order such occupier fails to comply therewith, he shall be liable to a penalty not exceeding *five pounds* for every day during the continuance of such non-compliance.

"If the occupier of any premises, when requested by or on behalf of the local authority to state the name of the owner of the premises occupied by him, refuses or wilfully omits to disclose or wilfully misstates the same, he shall (unless he shows cause to the satisfaction of the court for his refusal) be liable to a penalty not exceeding *five pounds*." —(P. H., s. 306.)

Occupier—*See* Notices, Nuisances, Obstruction, Owner, &c.

Offal—*See* Trades, Offensive.

Officers, Appointment of, and Regulations concerning—1. *Appointment.*—It is compulsory for every *urban* authority from time to time to appoint fit and proper persons to be medical officer of health, surveyor, inspector of nuisances, clerk, and treasurer : Provided that if any such authority is required by any other Act in force within their district to appoint any such officer, this enactment shall be deemed to be satisfied by the employment under this Act of the officer so appointed, with such additional remuneration as they think fit, and no second appointment shall be made under this Act. Every urban authority shall also appoint or employ such assistants, collectors, and other officers and servants as may be necessary and proper for the efficient execution of this Act, and may make regulations with respect to the duties and conduct of the officers and servants so appointed or employed.

Subject, in the case of officers any portion of whose salary is paid out of moneys voted by Parliament, to the powers of the Local Government Board under the Public Health Act, the urban authority may pay to the officers and servants so appointed or employed such reasonable salaries, wages, or allowances as the urban authority may think proper ; and, subject as aforesaid, every such officer and servant appointed under this Act shall be removable by the urban authority at their pleasure.—(P. H., s. 189.)

It is also compulsory for every rural authority from time to time to appoint fit and proper persons to be medical officer or officers of health, and inspector or inspectors of nuisances; they shall also appoint such assistants and other officers and servants as may be necessary and proper for the efficient execution of this Act.

The rural authority may award the clerk and treasurer of the guardians such remuneration in respect of additional duties under the Public Health Act as they may with the consent of the Local Government Board determine. If the clerk is unable or unwilling to undertake the duties, the assistant clerk is to be appointed.—(P. H., s. 190.)

2. *What Offices are compatible.*—The same person may be both surveyor and inspector of nuisances, but neither the person holding the office of treasurer, nor his partner, nor any person in the service or employ of them or either of them, shall be eligible to hold or shall in any manner assist or officiate in the office of clerk; and neither the person holding the office of clerk, nor his partner, nor any person in the service or employ of them or either of them, shall be eligible to hold or shall in any manner assist or officiate in the office of treasurer.

Penalty for offence against this enactment, £100, recoverable by any person, with full costs of suit, by action of debt.—(P. H., s. 192).

3. *Officers and Servants must not contract with the Local Authority.*—Officers or servants appointed or employed under the Public Health Act by the local authority shall not in anywise be concerned or interested in any bargain or contract made with such authority for any of the purposes of the said Act.

If any such officer or servant is so concerned or interested, or, under colour of his office or employment, exacts or accepts any fee or reward whatsoever, other than his proper salary, wages, and allowances, he shall be incapable of afterwards holding or continuing in any office or employment under this Act, and is also liable to a penalty of £50, recoverable as in the section last quoted.—(P. H., s. 193.)

4. *Officers and servants, before being intrusted with the custody or control of money, must give proper security to the local authority.*—(P. H., s. 194.)

5. *Officers have to account for all Money, &c., intrusted to their Charge.*—Every officer and servant appointed or employed under the Public Health Act by a local authority shall, when and in such manner as may be required by such authority, make out and deliver to them a true and perfect account in writing of all moneys received by him for the purposes of the said Act, stating how, and to whom, and for what purpose such moneys have been disposed of, and shall, together with such account, deliver the vouchers or receipts for all payments made by him, and pay over to the treasurer all moneys owing by him on the balance of accounts.

And every such officer or servant employed in the collection of any rate made under the said Act shall, within seven days after he has received any moneys on account of any such rate, pay over the same to the treasurer, and shall, as and when the local authority may direct, deliver a list, signed by him, containing the names of all persons who have neglected or refused to pay any such rate, and the sums respectively due from them.—(P. H., s. 195.)

6. *The Local Authority may take Summary Proceedings against defaulting Officers.*—If any officer or servant appointed or employed under this Act by a local authority—

- Fails to render accounts, or to produce and deliver up vouchers and receipts, or to pay over any moneys, as and when required by this Act, or
- Fails within five days after written notice in that behalf from the local authority to deliver up to the local authority all books, papers, writings, property, and things in his possession or power, relating to the execution of the Public Health Act, or belonging to such authority,

the local authority may complain to any justice, and such justice shall thereupon summon the party charged to appear before a court of summary jurisdiction.

On the appearance of the party charged, or on proof that the summons was personally served on him, or left at his last known place of abode or business, if it appears to the court that he has failed to render any such accounts, or to produce and deliver up any such vouchers or receipts, books, papers, writings, property, or things as aforesaid in accordance with the provisions of the said Act, and that he still fails or refuses so to do, the court may commit the offender to gaol, there to remain, without bail, until he has rendered such accounts, and produced and delivered up all such vouchers, receipts, books, papers, writings, property, and things in respect of which the charge was made: provided that a person shall not be imprisoned under this section for a period exceeding six months.

No proceeding under this section shall be construed to relieve or discharge any surety of the offender from any liability whatever.—(P. H., s. 196.)

Compensation is provided for officers under certain circumstances, thus: If any officer of any trustees, commissioners, or other body of persons intrusted with the execution of any Local Act, whether acting exclusively under the Local Act or partly under the Local Act and partly under the Local Government Acts, or any officer of any sanitary authority under the Sanitary Acts by the Public Health Act repealed, or of any local authority under the Public Health Act, is, by or in pursuance of the Public Health Act, 1872, or of the Public Health Act, 1875, or any provisional order made in pursuance of either of those Acts, removed from his office, or deprived of the whole or part of the emoluments of his office, and does not afterwards receive remuneration to an equal amount in respect of some office or employment under or by the authority of any district under the Public Health Act, the Local Government Board may by order award to such officer such compensation as the said board may think just; and such compensation may be by way of annuity or otherwise, and shall be paid by the local authority of the district in which such officer held his office out of any rates applicable to the general purposes of the said Act within that district.—*See* INSPECTOR OF NUISANCES, MEDICAL OFFICER OF HEALTH, &c.

Oils—Oils are variously divided into fixed, volatile, animal, vegetable, and others, by chemists. Only a few oils are treated of in this work, and therefore for a full description technical works of a different character must be consulted.

Oils of all kinds are much adulterated, and it is a matter of extreme difficulty in most cases to detect the exact adulterant, although comparatively easy to tell when a sample is pure.

One of the best general methods of testing oils is their peculiar reactions in the "cohesion figures." A drop of oil placed upon water has a particular pattern which is peculiar to itself. Hardly any two oils give the same pattern. A pure oil mixed with another will not give the usual pattern. Tomlins and Moffatt have recently studied this test. They recommend two perfectly clean soup-plates to be filled with cold water; a sample of the pure oil is now taken, and a drop of it from a pipette allowed to fall on the surface of the water in one of the plates. An exactly similar quantity of the sample suspected to be adulterated is dropped upon the water in the other plate, and the patterns compared. This test is easily done, and is useful, but everything employed must be scrupulously clean. The plates should be first rinsed with oil of vitriol, and then cleansed, without wiping, by a stream of water.

In dropping the oil, the surface of the water must be perfectly calm; the slightest vibration may disturb the results.

There are special tests used to distinguish impurities in the more important oils, some of which are of value; for example, sulphuric acid added to cod-liver oil spread in a thin layer on a plate gives a beautiful lake colour. This reaction is peculiar to liver oils. If cod oil be adulterated with whale, seal, olive, or other oils not containing biliary principles, either the lake colour is not produced, or else is immediately obscured by a dark-brown tint from the charring of the oil.

The adulteration of olive oil with poppy is indicated by a froth when it is agitated, and M. Pontel has given the following *qualitative* test, which is said to be reliable:—

A solution of mercury is made by dissolving 6 parts of it in 7½ parts of nitric acid; specific gravity, 1·36 in the cold. When 1 part of this freshly-prepared solution is added to 10 parts of pure olive oil, the mixture becomes solid in a few hours. The admixture of foreign oils prevents this.

The purity of oils is also indicated by their smell, and by their specific gravity.

Mr. J. J. Coleman has recently investigated the subject with the special object of determining the commercial value of vegetable and animal oils, and has extended the observations of Schubler and Ure on the viscosity of the fatty oils. Mr. Coleman uses two glass cylinders, one within the other. The inner one is filled with the oil to be examined, and is furnished with a stopcock, the aperture of which is of such dimensions that German refined rape at 120° F. will run through it in thirty seconds; the outer cylinder is filled with steam (*see* fig. 63).

The oil being placed in the inner cylinder, steam is generated until the oil shows a temperature of 120° F.; the stopcock is then opened, and the time that the oil takes in running out accurately registered.

The results obtained by Mr. Coleman were as follows (Chemical News, March 1874):—

	Min.	Sec.
French refined colza rape	11	0
German refined rape	8	30
Neat's foot oil	8	30
Olive	8	15
East Indian ground-nut	8	0
Tallow oil	7	30
Southern whale	7	40
Lard oil	7	0
Cotton-seed oil	7	0
Seal oil	6	30
Lisbon seed oil	6	35
Sperm oil	5	0

Fehling distinguishes between the different oils by mixing 1 part of sulphuric acid with 3 parts of oil, and noting the temperature. There is great variation in the amount of heat produced; for example, rape oil gains a 100°, and olive oil 68°.

Mr. Gellatly has proposed as a test the relative liability of fatty oils to ignite spontaneously when in contact with cotton or other waste. The cotton waste is dipped in the oil to be examined, taken out, and placed rather loosely in a paper box enclosed in a hot-air bath kept at a temperature of from 130° to 200° F. After a certain length of time, characteristic of each oil, the mass enters into active combustion, *e.g.*—

	Hours.	Min.
Boiled linseed	1	15
Seal oil	1	40
Raw linseed	4	0
Lard oil	4	0
Gallipoli olive	5	0
Refined rape, about . . .	9	0

The volatile or essential oils are frequently adulterated with the fatty oils, resin, spermaceti, alcohol, or with other essential oils of a cheaper kind or lower grade. If adulterated with any of the first three, a drop of the oil on paper, when exposed to heat, instead of evaporating entirely, leaves a greasy stain. And on submitting the oil to the action of three times its weight of rectified spirit, the essential oil is dissolved, but the other ingredients remain unacted upon.

"The presence of alcohol may be detected by agitating the oil with a few small pieces of dried chloride of calcium. These remain unaltered in a pure essential oil, but dissolve in one containing alcohol, and the resulting solution separates, forming a distinct stratum at the bottom of the vessel. When only a very little alcohol is present, the pieces merely change their form, and exhibit the action of the solvent on their angles or edges, which become more or less obtuse or rounded."

M. Beral's test for alcohol is very delicate, and is as follows: "Twelve drops of the oil are placed on a perfectly dry watch glass, and a piece of potassium, about the size of a pin's head, set in the middle of it. If the small fragment of metal retains its integrity for twelve or fifteen minutes, no alcohol is present; but if it disappears after the lapse of five minutes, the oil contains at least 4 per cent. of alcohol; and if it disappears in less than one minute, it contains not less than 25 per cent. of alcohol."

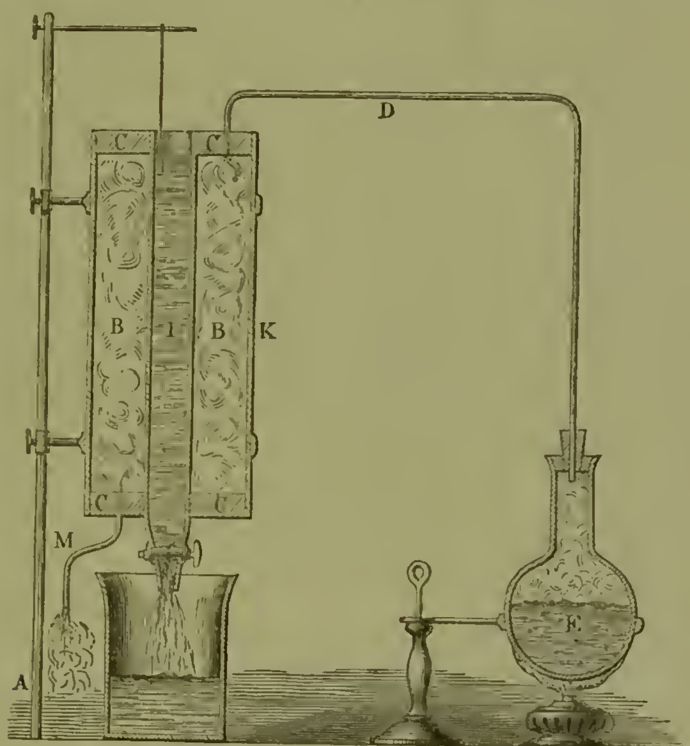


Fig. 63.

The mixture of an inferior oil with one more costly may often be detected by pouring a drop or two on a piece of porous paper or cloth, and shaking it in the air; the difference of odour at the beginning and the end of evaporation will often show the adulteration.

The index of refraction in a single drop of oil is also useful, as suggested by Dr. Wollaston.

A mixture of a heavy oil with a light oil may be detected by agitating the subjected oil with water, when the two will separate and form distinct strata.

The table on p. 414 is from Mr. Cooley's "Cyclopædia;" it may be of use in distinguishing various oils.

Olive (*Oleo Europæa*)—A native of the south of Europe. The fruit in the ripe state is black, and furnishes the oil. Those imported into this country have been gathered green and soaked first in strong lye, and then in fresh water, to remove their rough bitter taste before being preserved in a solution of salt. The olive is remarkable for yielding a fixed oil from the pericarp instead of from the seed.

TABLE giving the REACTIONS of various OILS with SULPHURIC ACID, and with a SATURATED SOLUTION of BICHROMATE of POTASSA in SULPHURIC ACID (COOLEY).

, *The result indicated is obtained in each case by the action of one drop of the reagent on twenty drops of oil.*

NAME OF OIL.	REAGENTS. Sulphuric Acid. Not Stirred.	REAGENTS. Sulphuric Acid. Stirred.	REAGENTS. Saturated Solution of Bichromate of Potassa in Sulphuric Acid. Stirred.
Almond oil	Green-finch yellow, with orange spots	Dirty green	Yellowish small lumps.
Castor oil	Yellow, with slight spots	Littlo reaction	Slightly green.
Cod-liver oil (fine sample of pale oil)	Deep purple in the centre, rapidly turning brown, whilst violet or purple clouds or streaks spread out towards the circumference, the colour of which remains unaltered for some minutes after the central portion has turned nearly black	Deep purple, passing into purple brown, reddish brown, and gradually deepening to an intense brown, approaching black	Reddish-brown clots, changing to a clear bright greeu.
Hemp-seed oil	Small brown lumps or clots on a yellow ground	Greenish brown	Small yellow lumps or clots on a green ground.
Linseed oil (Upper Rhine)	Dark reddish brown	Brown small lumps on a grey ground	Brown small lumps on an almost colourless ground.
Do. (Paris)	Reddish brown, less dark coloured	Brown clots on a green ground	Brown small lumps on a green ground.
Do. (English)	Chestnut brown	Browu clots ou a greenish-grey ground	Brown lumps on a greenish-grey ground.
Liver train oil	Dark red	Dark red	Dark red.
Madia sativa oil	Slightly reddish brown underneath a thin greyish film	Olive green	Light brown small lumps on an olive-coloured ground.
Black mustard oil	Bluish green	Olive green	Olive brown.
Neat's foot oil	Yellow, slight spots	Dirty brown	Brown spots on a brownish ground.
Nut oil (recent)	Yellowish brown	Clotted, dark brown	Small brown lumps or clots.
Do. (one year old)	Yellow	Dirty brown, less dark coloured	Small brown lumps.
Do. (still older)	Orange yellow	Dirty brown	Small brownish lumps.
Oleine, oleic acid, lard, or tallow oil	Reddish spots with reddish circles	Reddish brown	Bright chestnut colour.
Olive oil	Yellow	Dirty brown	Olive brown.
Do. (another sample)	Orange yellow	Brownish grey	Brown.
Do. (from fermented olives)	Do.	Do.	Do.
Poppy oil (recent cold-drawn)	Yellow spots	Olive brown	Small yellow lumps on a white ground.
Do. (recent, expressed with slight heat	Greenish-yellow spots	Olivo brown, turning more on the green	Small yellow lumps on a greenish-grey ground.
Do. (one year old, expressed with heat)	Greenish spots	Olive green	Small yellow lumps on a green ground.
Rapo or colza oil (trade)	Yellowish-brown streaks surrounded by a bluish-green ring	Brownish, turning on the olive green	Yellow small lumps on a green ground.
Do. (recent)	Green	Bluish green	Do. do. do.
Do. (one year old)	Do.	Do.	Yellow small lumps on a brighter green ground.
Do. (one year old)	... ...	... ...	Small yellow lumps, more numerous on an olive-green ground.
Do. (rough hot-pressed)	Do.	Olive green	
Whale train oil	Small reddish lumps on a brownish ground	Resembles wino lees	Small bright chestnut-coloured lumps on a brown ground.

Onion (*Allium Cepa*)—Though differing so much from the asparagus, the onion, like it, belongs to the lily tribe of plants. It contains an acrid volatile oil, which possesses irritant and excitant properties. The onion is diuretic, expectorant, rubefacient, and stimulant.

Dr. Cullen says onions are acrid and stimulating, and possess little nutrient power. In bilious constitutions they generally produce flatulence, thirst, headache, and febrile symptoms; but where the temperament is phlegmatic, they are of infinite service, by stimulating the system and promoting the excretions, particularly expectoration and urine.

Ophthalmia, Purulent (syn. *Contagious*, *Military*, *Egyptian*, &c.) — This may be shortly defined as a contagious inflammation of the conjunctivæ of the eyes, attended with purulent discharge, and extremely dangerous to sight. This disease of the eyes has been the scourge of soldiers in unhealthy camps and crowded barracks; of children in workhouses and pauper schools; and of people living in dirty, badly-lit, and impure dwellings.

Parkes, treating of it in a military point of view, says: "The disease, as we now see it, is one of the legacies which Napoleon left to the world. His system of making war with little intermission, rapid movements, abandonment of the good old custom of winter quarters, and intermixture of regiments from several nations, seems to have given a great spread to the disease; and though the subsequent years of peace have greatly lessened it, it has prevailed more or less ever since in the French, Prussian, Austrian, Bavarian, Hanoverian, Italian, Spanish, Belgian, Swedish, and Russian armies, as well as in our own. It has also been evidently propagated among the civil population by the armies, and is one more heritage with which glorious war has cursed the nations."

The terrible effects of ophthalmia cannot be better exemplified than in the history of the cruise of the slave-ship Le Roideur.

In the year 1819 the French ship Le Roideur sailed with a *cargo* of 160 negroes from Beuny, on the coast of Africa, to Guadaloupe. Her crew consisted of twenty-two men, so that the whole number of human beings on board, including the officers, was about 188. No epidemic had been perceived among the natives, and at the time of sailing the crew enjoyed perfect health, nor was there any sign of disease among the wretched prisoners.

The slaves were crammed down into the hold, and the air soon became very foul. Water, too, was scarce; they were at first allowed 8 oz. a day, which about the thirteenth or fourteenth day was reduced to half a wine-glass. The ophthalmia began in the eyes of the poor negroes. The lids became red and inflamed, and therefore the surgeon advised that they should breathe in succession the purer air of the deck; accordingly they were brought up alternately, but were soon confined again to the hold on account of many of them committing suicide by jumping into the sea. The disease was of a most virulent kind. It spread rapidly among the Africans, and from thence to the crew. A notable fact, showing that ophthalmia is propagated by material particles, is that the first man of the crew attacked was a sailor who kept near the hatch communicating with the hold. The next day a landsman was taken ill, and in three days more the captain and almost all the rest of the crew were infected. The number of victims daily increased; and at last only *one of their number* remained free, and was thus able to steer the ship, so that they were in the greatest alarm lest he too should be seized with blindness and that they should be left to the mercy of the waves, like the Spanish ship Leon, the crew of which, to a man, lost their eyesight and were never heard of. They, however, reached Guadaloupe on the 21st of June. Thirty-nine of the negroes had entirely lost their sight (thirty-six of whom had been thrown into the sea because they were unsaleable), twelve had lost an eye, and fourteen were blinded to a greater or less degree. Twelve of the crew, including the surgeon, were totally blind, five were blind of one eye, and four were partially injured. The steerer of the vessel caught ophthalmia three days after the vessel arrived in port.

Of late years considerable attention has been directed to this subject on account of its extensive prevalence in certain of the metropolitan workhouses and pauper schools.

One of the most important facts to grasp is that purulent ophthalmia does not readily spread among a community of healthy persons, there is nearly always a preliminary condition of the lining membrane of the lids.

"This antecedent condition is not one of mere ill-health or debility either inherited or acquired, but it is something definite, manifested by the development in the lining membrane of the eyelids of certain little bodies which are not unlike grains of boiled sago, and which are commonly called after this resemblance."—(Brudenell Carter.)

The existence of the "sago grains" remained unknown until 1848, when they were first discovered by Dr. Loffler, a Prussian surgeon. In Dr. Loffler's regiment many men were attacked by ophthalmia and disabled. Dr. Loffler, in order to treat the disease from the commencement, caused the whole regiment to be paraded daily for inspection, and he examined the inside of the eyelids of every man. In a large proportion of the apparently healthy men he found these sago grains, and at first did not know what they signified; he soon, however, recognised their importance, in finding that the men with granular lids were sooner or later attacked with ophthalmia, while those with healthy lids remained exempt.

The inquiry thus begun was taken up by other surgeons, especially Drs. Frank Marston and Welch, who confirmed Dr. Loffler's conclusions, that the sago grains are a necessary antecedent of an epidemic of contagious ophthalmia; and they also established the fact, that when a large number of persons are crowded together and breathe impure air, and live, generally speaking, amongst insanitary conditions, they become the subjects of these sago grains; "so that the presence or absence of sago grains affords a delicate test of the sanitary state of a school, regiment, or any similar community."

Stromeyer (Maximen der Kriegsheilkunst, p. 49) has also met with this condition of the eye amongst many of the domestic animals, more especially pigs, and has shown that they exist in proportion to the dirty condition in which these animals are kept. "In a regiment the proneness to the development of sago grains is found to decrease as life advances—that is, to be much greater in young soldiers than in old ones, and, by a parity of reasoning, it is assumed to be greater in a community of children than in a community of adults. In any individual, and therefore in any community, the sago grains may disappear without producing mischief. But, as a matter of fact, sources of irritation to the eyes abound in the world, and when these sources of irritation act upon eyelids in which sago grains are already present, they often excite the contagious form of ophthalmia."—(BRUDENELL CARTER.) The exact nature of these vesicles has been of late years carefully investigated, and it is now generally considered that they are really the enlarged closed follicles of Krause; these follicles are situated directly beneath the epithelium, and are not apparent in a normal state of the conjunctiva, but become swollen and enlarged when this membrane is in an irritable condition. They are, therefore, analogous to the enlarged glands met with in scrofulous and feeble children.

The mode of propagation of this disease is without doubt through the discharge, and so completely is this proved that ophthalmic surgeons, on one eye of the patient being affected, hermetically seal up the other, which, if properly done, will then escape the infection. "The secretion passes along the tear-passages into the nostrils, and is driven out with the expired air at every breath. Besides the chances of direct contact that must exist when a child with ophthalmia is perpetually sending into the atmosphere what I may describe as a spray of contagious particles."—(BRUDENELL CARTER.)

The period of contagion also appears extremely protracted. Until the eyes of a child are perfectly well, "they remain in a state in which any chance irritation—the entrance of a particle of dust, or of an insect, or even some temporary disturbance of the health—may reproduce a secretion of the most active character."—(BRUDENELL CARTER.)

Again, according to Warlomont, a man once affected has no safety; so that any one who has once had the disease may have a relapse from the most trivial causes, and is therefore a source of danger, and should be watched.

Prevention of the Disease.—The disease is always due to deficient hygienic arrangements.

Whenever it appears, whether in an army, a school, or any place where control is possible, every person's eyes should be inspected daily; and if the sago-grain appearance be detected, the individual should be at once separated from the healthy. An insufficient supply of water and towels is often the cause of the disease spreading among a community; hence in all cases lavatories should be large, and be supplied with plenty of basins and towels. In an epidemic of ophthalmia, each affected person, and indeed every healthy person, should be furnished with a separate towel, and any towel used by an affected person should be plunged into a disinfectant fluid. In certain schools visited by ophthalmia the infected towels were actually hung on the rail of the bed, a practice to be condemned. The eyes will require frequent bathing, and for this purpose a supply of clean, white, soft rags should be provided, to be burnt directly after use. In pauper schools a liberal supply of meat has been often found to diminish greatly the number of cases. In metropolitan schools, or in large towns, while proper sanitary remedial measures are taken for the healthy, the diseased may be at once placed in an eye-hospital, which of course thoroughly separates them from the ophthalmia centre.

In some cases the pillow-case has been a medium of infection. The patients should have a fresh pillow-case daily, and the bed-clothes should be changed frequently.

The attendants, in bathing the eyes of patients, should be provided with shades to protect their own eyes from contagion.

Stromeyer greatly reduced the disease in the Hanoverian army simply by ventilation. The contagious particles, instead of lodging on the furniture, clothes, eyelids, beard, &c., of the men, are swept away and diluted by the currents of air.

In this disease, disinfection of the air by chemicals must be avoided, as by irritating the eyes it is likely to do more harm than good.

The effects of the different varieties of contagious ophthalmia are thickening and distortion of the eyelids, impairment of efficiency or entire disablement, and too often complete loss of sight.

Opium—The juice inspissated by spontaneous evaporation, obtained by incision from the unripe capsules of the poppy (*Papaver somniferum*, Linn.), grown in Asia Minor.

Opium appears in the form of irregular lumps, weighing from 4 oz. to 2 lbs., enveloped in the remains of poppy seeds, and generally covered with the chaffy fruits of a species of rumex. When fresh, plastic; tearing with an irregular, slightly moist, chestnut-brown surface; shining when rubbed smooth with the finger; having a most peculiar odour and a nauseous bitter taste.

Opium contains a peculiar acid, *meconic acid* ($C_7H_4O_7$), and the following alkaloids: *Morphia* ($C_{17}H_{19}NO_3$), *codeia* ($C_{18}H_{21}NO_3+H_2O$), *papaverina* ($C_{20}H_{21}NO_4$), *thebaia* or *paramorphia* ($C_{19}H_{21}NO_3$), *narcotine* ($C_{22}H_{23}NO_7$), *narceia* ($C_{23}H_{29}NO_9$), *meconine* or *opianyl* ($C_{10}H_{10}O_4$), *opianine* and *porphyroxine*. The following are the constituents of 100 parts of ordinary Smyrna opium (MULDER):—

Composition of 100 *Parts of Weight.*

Morphia	10·842
Codeia	0·678
Narcotine	6·808
Narceia	6·662
Meconia	0·804
Meconic acid	5·154
Resin	3·582
Gummy matter	26·242
Mucus	19·086
Fatty matter	2·166
Caoutchouc	6·012
Water	9·846
Matter undetermined, and loss	2·118
	100·000

Opium is perhaps more extensively used than any other drug; and indeed so highly is it valued as a medicine, that it has been called the "gift of God to man." It is, however, somewhat uncertain in its action, some people being able to take enormous quantities without apparent injury. The smallest fatal dose of the crude opium on record is that related by Dr. Sharkey, in which a man aged thirty-two died shortly after taking 4 grains of crude opium; and as small a quantity as 2 drachms of the tincture has been known to destroy life. On the other hand, Dr. Garrod mentions the case of a young man who took 60 grains of Smyrna opium night and morning, and frequently, in addition to this, 1 to 1½ fluid ounces of laudanum during the day. In 1866 he also had a man about thirty-five years of age under his care who positively asserted that he had taken 72 grains of acetate of morphia in one day, and also that he had swallowed as much as a pint of laudanum.

Opium, excessively useful as a medicinal agent when discreetly used, and often a valuable stimulant to the mental faculties, becomes most dangerous when habitually employed; the digestive organs become impaired, the energy of the mind is lessened, memory is destroyed, a state of fatuity and abject misery is induced.

Opium-eating, unfortunately, appears to be on the increase in all parts of the world, more being now consumed in China than ever. In many of the Western States of America the practice has become so notoriously common, that in 1872 the Legislature of Kentucky passed a bill by which any person who through the excessive use of opium is incapacitated from managing himself or his affairs, may upon the affidavit of two citizens be confined in an asylum, and subjected to the same restraint as lunatics and habitual drunkards. We hear on all sides that of late years opium-eating and laudanum-taking have been greatly on the increase in this country, and the employment of this drug as a soporific for infants and young children has become so general amongst the poor and dissipated as to call for the interference of the Legislature. Recent customhouse returns show that 250,000 lbs. in weight of opium are annually imported into this country, and it is computed that not more than one-third at most of the drug is used for medicinal purposes.

Dr. Chevers states that opium eating and smoking are very prevalent in many parts of India, and that it is extensively employed for the destruction of female children. To this end it is either introduced into the infant's mouth, or the mother's nipples are anointed with it. Drugging older children to keep them quiet is also common enough.

Adulterations.—Opium is mixed with many impurities, such as leaves, bullets, stones, fruits, &c. These can generally be detected by making a decoction of the suspected drug, and then straining. The amount of water present may be estimated by drying at 212° F., and observing the loss. A decoction of opium, when cold, should not give a blue precipitate on the addition of tincture of iodine.

The following substances are occasionally added: Extract of lettuce, lactucarium, mucilage of gum tragacanth, dried leaves, starch, water, clay, sand, gravel, and other bodies, in order to increase the weight.

The quality of opium is best determined by a simple assay of the amount of morphia contained in it; this should amount to at least 6 or 8 parts per 100. The assay is made as follows: Opium, 4 parts, quicklime, 1 part, made into a milk with water *q.s.*, are boiled together, and the solution filtered whilst hot. Dilute hydrochloric acid then added, to saturation, and the morphia precipitated by the addition of ammonia, any excess of the latter being expelled by heat. The precipitate is then collected, dried, and weighed. If 100 grains have been operated on, the given weight will represent the percentage richness of the sample in morphia.

The tests, &c., for discovering opium have been fully described under MORPHIA.

Antidotes.—Evacuants should at once be employed, and strong coffee administered. If the patient is unable to swallow, and a stomach-pump is at hand, the stomach should be emptied, and coffee can then be injected by the same instrument. Every effort should be made to rouse the patient, and as a last resource artificial respiration and galvanism should be used. *See* MORPHIA, MECONIC ACID, &c.

Orange—The common sweet orange is the fruit of the *Citrus Aurantium.* The Seville or bitter orange is produced by *Citrus vulgaris* or *Bigaradia.*

The orange is an agreeable and refreshing fruit, and probably one of the most useful of all the sub-acid fruits. Orange-juice differs from that of lemons chiefly in containing less citric acid and more sugar. In their general properties the two are nearly identical. *See* LEMON-JUICE, &c.

Orders—The general powers of the Local Government Board with regard to local government orders have been condensed in article LOCAL GOVERNMENT BOARD. In this article provisional orders will be alone treated of. *Provisional orders* are orders of the Local Government Board, which are of no force until confirmed by Parliament; so that they are virtually Acts of Parliament, and if passed through both Houses, a provisional order is part and portion of the law of the land. The matters dealt with by provisional orders are changes in or actual repeal of Local Improvement Acts, alterations of area, the union of districts for the appointment of a health officer in case of opposition to such a course, the amalgamating of two or more districts for certain purposes, and other matters considered in this work under their respective headings.

The following enactments are in force with regard to provisional orders:—

1. The Local Government Board shall not make any provisional order under the Public Health Act unless public notice of the purport of the proposed order has been previously given by advertisement in two successive weeks in some local newspaper circulating in the district to which such provisional order relates.
2. Before making any such provisional order, the Local Government Board shall consider any objections which may be made thereto by any persons affected thereby, and in cases where the subject-matter is one to which a local inquiry is applicable, shall cause to be made a local inquiry, of which public notice shall be given in manner aforesaid, and at which all persons interested shall be permitted to attend and make objections.
3. The Local Government Board may submit to Parliament for confirmation any provisional order made by it in pursuance of the Public Health Act, but any such order shall be of no force whatever unless and until it is confirmed by Parliament.
4. If, while the Bill confirming any such order is pending in either House of Parliament, a petition is presented against any order comprised therein, the Bill, so far as it relates to such order, may be referred to a select committee, and the petitioner shall be allowed to appear and oppose as in the case of private bills.
5. Any Act confirming any provisional order made in pursuance of any of the Sanitary Acts, or of the Public Health Act, and any Order in Council made in pursuance of any of the Sanitary Acts, may be repealed, altered, or amended by any provisional order made by the Local Government Board, and duly confirmed by Parliament.
6. The Local Government Board may revoke, either wholly or partially, any provisional order made by them before the same is confirmed by Parliament, but such revocation shall not be made whilst the Bill confirming the order is pending in either House of Parliament.
7. The making of a provisional order shall be *primâ facie* evidence that all the requirements of the Public Health Act in respect of proceedings required to be taken previously to the making of such provisional order have been complied with.
8. Every Act confirming any such pro-

visional order shall be deemed to be a public general Act.—(P. H., s. 297.)

The reasonable costs of any local authority in respect of provisional orders made in pursuance of the Public Health Act, and of the inquiry preliminary thereto, as sanctioned by the Local Government Board, whether in promoting or opposing the same, shall be deemed to be expenses properly incurred for purposes of the said Act by the local authority interested in or affected by such provisional orders, and such costs shall be paid accordingly; and if thought expedient by the Local Government Board, the local authority may contract a loan for the purpose of defraying such costs.—(P. H., s. 298.)

For the consideration of orders of justices, and the "forms" referring to nuisances, *see* NUISANCES.

For the form of the justice's order for the admission of the officers of the local authority, *see* ENTRY, POWERS OF.

For the form of justice's order for the execution of works, *see* SEWERS.

Orders, Provisional—*See* ORDERS.

Orpiment, Yellow—Native sulphide of arsenic. *See* ARSENIC.

Orris (*Orris-Root*)—The dried rhizome of *Iris Florentina pallida* and *Germanica*. It is used to impart a violet odour to oils, tooth-powder, snuffs, spirits, &c. It has also been used in the adulteration of jellies, jams, &c.

Osmazome — The flavouring matter of meat. It may be obtained in the following manner: Mince and digest lean meat in water, with occasional pressure. The filtered infusion is generally evaporated nearly to dryness, and then treated with alcohol; the alcoholic tincture is lastly evaporated. The product has a brownish-yellow colour, is soluble in water, and its aqueous solution is precipitated by infusion of galls and the mineral astringent salts. Liebig's extract is rich in osmazome.

Overcrowding— Overcrowding is at least of two kinds—too many people living and sleeping in one habitation, and too many dwellings in a given area. "Now, overcrowding may present itself in more than one aspect—as too many houses, huts, or tents, too many streets, or lanes, or courts, on a given area; as too many persons in one house; as too many people serving in a shop or warehouse, or toiling in a workroom or manufactory; as too many sleepers in one dormitory; as too many prisoners thrust in one place of detention; as too many sick persons in one hospital, or ward of a hospital,—and in all these cases health and life are sacrificed. These cases of overcrowding may be arranged in three distinct categories. First of all, we may group together, as forming one class, the cases of the shop, warehouse, workroom, factory, or dormitory, in which men are assembled in undue numbers, but, as a rule, exposed to no other unwholesome influences than those that emanate from their own bodies (the case of the dormitory), or from these in conjunction with the heat, dust and chemical effluvia which are given out in the course of certain processes of manufacture. Then we have the case of the overcrowded dwelling, of which the inmates are exposed not only to the poisonous products of respiration in sitting-rooms and bedrooms, but also to such noxious effluvia as may arise out of a damp soil or defective drainage. And lastly, we have the case of the hospital, in which infectious forms of disease originate and spread among the subjects of accidental injuries or of operations."—(Dr GUY, Public Health, Part 1.)

All forms of overcrowding influence the rate of mortality. Overcrowding, by vitiating the air, facilitating the spread of contagious diseases and the transference from one body to another of germs and parasites, is in the highest degree unfavourable to the health of man, and indeed also to animals.

The death-rate in towns is directly in relation to the density of population. For example, Dr. Gairdner gives the following table (Public Health in Relation to Food and Water):—

Population to 1 Square Mile in Districts taken in England.	Deaths per 1000 per Annum.
56	15
106	16
144	17
149	18
182	19
202	20
220	21
324	22
485	23
1216	24
1262	25
2864	26
2900	27 and upwards.

Overcrowding exists more or less in all districts, both urban and rural. It is, of course, greatest in large manufacturing cities, where not alone each house may accommodate six or seven times the number of people its construction and cubic space should allow, but the houses themselves are also built closely together. The extent of overcrowding in some parts of the metropolis may be gathered from the following table, taken from "the Report of the Lancet Sanitary Commission on the Dwellings of the Poor. No. II. Soho.—Lancet, May 16, 1874:"—

Name of Locality.	Population in 1871.	No. of Inhabited Houses.	Area in Acres.	No. of Inhabitants per Acre (roughly).	No. of Inhabitants in each House (roughly).
The entire metropolis . .	3,254,260	411,767	75,362	43	8
Westminster district . .	51,181	4,554	216	237	11
St. James's Square sub-district	10,472	1,384	84	125	8
Golden Square ,,	12,860	1,111	54	238	11
St. Anne's, Soho, ,,	17,562	1,337	54	325	13
Berwick Street ,,	10,287	722	24	428	14
St. Giles's, South, ,,	19,109	1,214	64	298	15
Spitalfields ,,	15,848	1,431	52	304	11

In rural districts it is generally individual houses, and more especially the houses of the agricultural and mining labourer, which are overcrowded. The writer of this article in his own district has frequently had to deal with cases in which the solitary bedroom of a cottage was shared by a large family, with the addition of lodgers. Instances of a family—husband, wife, grandmother, and ten children from nineteen years to two or three years of age—having only one sleeping-room are not uncommon. The remedy for this state of things is often worse than the disease. The offenders may be turned out into the road, and find nowhere to go to except the workhouse, for, as a fact, in many places houses are scarce and difficult to get. The only real cure would appear to be increased facilities for the building of cottages. Mr. Liddle, medical officer of health for Whitechapel, expresses his opinion that the best plan for remedying overcrowding in densely-populated localities is for the Metropolitan Board of Works to obtain powers for the compulsory purchase of lands and houses which are unfit for habitation, and sell the ground either to private individuals or public companies, for the purpose of erecting suitable houses for the use of the working classes. And Dr. Bond, medical officer of health to the county of Gloucester, proposes that sanitary authorities should be given the power to build cottages for the poor.

The diseases produced from overcrowding are consumption, continued fevers, general impairment of the health, a putrid condition of the body followed by death, mania, boils, erysipelas, pyæmia, malignant ulcer, hospital gangrene, an augmented liability to the spread and reception of infectious diseases—*e.g.*, typhus and ophthalmia—as well as of skin and parasitic affections.

Of these, consumption is the disease more particularly produced by men breathing vitiated air for a long period of time in their workshops and houses.

Dr. Guy questioned 320 men working in rooms of different sizes, and instituted comparisons between men occupying narrower and wider spaces, or working on different floors more or less freely communicating with one another. "All the comparisons led to the same result—the establishment of the same vital truth—that consumption (inferred from the existence of the leading symptom, hæmoptysis) and colds (doubtless comprising attacks of consumption) were uniformly rife wherever the cubic space was smallest, or the air most close, hot, and foul. I will content myself with two instructive comparisons. Forty men worked in five rooms with 303 cubic feet of air per man; other forty in other five rooms with 789. Of the forty in the smaller rooms, five had had hæmoptysis, and six were subject to severe colds. Of the forty in the larger rooms, not one had spat blood, and one only was subject to severe colds.

"My second comparison throws the 320 men into three groups of nearly equal size, all comprising more than a hundred. The first group worked in rooms affording to each man less than 500 cubic feet of air, the second had from 500 to 600, the third more than 600. Reducing all these groups to the standard of 10,000, I found that of the first group 1250 would have spat blood; of the second, 435; of the third, 396; while 1250 of the first group, 348 of the second, and 198 of the third respectively would have been subject to severe colds."—(Dr. W. A. Guy, Public Health, Part I.)

The deficient cubic space of the accommodation provided for the Foot Guards, in comparison with that of the Household Cavalry, was so disastrous to the health of the men, that in the interval from 1830 to 1836, while the rate of mortality was 145 per 10,000 for the Household Cavalry, it was 216 per 10,000 for the Foot Guards, and of this large mortality in the Foot Guards 204 per 10,000 was due to consumption.

The same writer, Dr. Guy, says: "I have

at hand notes of cubic spaces rising by easy stages, from the 8 of St. Martin's Round House and the 40 of the Black Hole, through the 30 to 60 of Marlborough House, Peckham, formerly the Union Workhouse, and busy fever-factory of the city of London; the 52 cubic feet of the most crowded rooms in Church Lane, St. Giles's, the scene of a great mortality from fever and cholera; the 84 cubic feet of a village hovel in Dorsetshire, where a very fatal fever prevailed; the 100 cubic feet of the Parish House, near Launceston, a haunt of cholera; the 136 cubic feet of the Drouet establishment for pauper children at Tooting, where in the epidemic of 1849 the cholera slew 170 children in three weeks; the 150 cubic feet of the Wood Street Compter, another notorious haunt of jail fever; the 170 cubic feet of the Cambridge Town Bridewell, smitten with jail fever in 1774; up to the 202 cubic feet of a London printing-office, where I found the deaths from consumption following as fast on each other as deaths from some contagious fever might do; and the 228 of certain sick-wards of Christchurch Workhouse, where in 1848 gangrene of the mouth prevailed."

In all overcrowded localities every observer must be struck with the pallid anæmic look of the population generally, showing that, irrespective of any particular disease, it produces a general want of vigour and tone.

With regard to acute cases of overcrowding in emigrant-ships, prisons, camps, &c., instances in history are sufficiently numerous—*e.g.*, the Black Hole of Calcutta and the state of our prisons two centuries ago.

In 1847, at the time of the Irish famine fever, there were an immense number of emigrants from Ireland to the United States, and fearful overcrowding of the ships. In ten vessels arriving at Montreal, July 1847, there were 4427 Irish passengers, of whom 804 died on the passage and 847 arrived sick. The Emigration Commissioners now require 15 superficial feet and a height of 6 feet for each emigrant, so that although this space is very inadequate, yet it is not likely such cases will arise now, at least in England. The most recent case of a fatally-overcrowded ship is that of the Leibnitz, which left Hamburg with German emigrants for New York. The ship had a cargo of wool and hides, and carried 544 passengers. They experienced every horror that can arise from insufficient space and light, bad food and ill-treatment, and 108 died out of the whole number.

In the year 1782, from "An Account of a singular Disease which prevailed among some Poor Children maintained by the Parish of St. James's, in Westminster," it would appear that intense pollution of the air from overcrowding produces occasionally a kind of mania, accompanied with colic, convulsions, and pains in the limbs.

The Action of the Medical Officer of Health in Cases of Overcrowding.—The medical officer of health will usually act from information either from the inspector of nuisances or other person. It is then his duty to go down and inspect the premises, and examine the rooms, cubic space, and ventilation. He is then to take such steps as are authorised by the statutes, and "as the circumstances of the case may justify and require." So it is, practically speaking, left to him to use his judgment; and in cases where there is only one family, and this consisting of little children, apparently healthy, it may not be advisable to move in the matter—in fact, every case must be dealt with on its merits.

The 91st section of the Public Health Act, 1875, defines "any house or part of a house so overcrowded as to be dangerous or injurious to the health of the inmates, whether *or not members of the same family*, to be a nuisance."

This being the case, the procedure for the abatement of overcrowding is exactly the same as in ordinary nuisances. *See* NUISANCES.

Where two convictions against the provisions of any Act relating to the overcrowding of a house have taken place within three months (whether the persons convicted were or were not the same), a court of summary jurisdiction may, on the application of the local authority of the district in which the house is situated, direct the closing of the house for such period as the court may deem necessary.—(P. H., s. 109.)

Owner—The term "owner" is thus defined for the purposes of the Public Health Act, 1875: "'Owner' means the person for the time being receiving the rackrent of the lands or premises in connection with which the word is used, whether on his own account or as agent or trustee for any other person, or who would so receive the same if such lands or premises were let at a rackrent."

The proper person to serve notice on, whether owner or occupier, in cases of nuisance, and the proper person to levy a rate on, will be found fully considered in articles NOTICES, NUISANCES, RATES.

For obstruction of owner by occupier, in the case of the former carrying into effect any of the provisions of the Public Health Act, *see* OBSTRUCTION.

Oxalic Acid—*See* ACID, OXALIC.

Oxford and Cambridge, Rating of—*See* RATES.

Oxford, Local Board of—*See* LOCAL BOARD OF OXFORD.

Oxyuris Vermicularis—*See* WORMS, ROUND.

Oysters (*Ostrea edulis*, Linn.)—Oysters are nutritious and easy of digestion, especially when eaten raw, the process of cooking coagulating and hardening them. The following shows their composition :—

Composition of Oysters (PAYEN).

	Mean of Two Analyses.
Nitrogenous matter	14·010
Fatty matter	1·515
Saline matter	2·695
Non-nitrogenous matter and loss	1·395
Water	80·385
	100·000

Ozone and Antozone—Ozone (from *ozo*, I smell) is a peculiar variety of oxygen, distinguished from ordinary oxygen by its greater weight, its peculiar and somewhat chlorous smell, its intensely active oxidising powers, and the ease with which it passes into common oxygen. It is indeed a condensed form of the latter gas, containing three atoms of oxygen instead of two, the formula for ordinary oxygen being O_2, for ozone O_3. It then necessarily follows that ozone is half as heavy again as oxygen; its atomic weight is therefore 24, that of oxygen being 16. The history of ozone is as follows : In 1785, Van Marum observed the production of a peculiar smell when electric sparks were passed through oxygen, and considering electricity a material substance, he called this odour "the smell of electricity." In 1840, Schonbein of Basle, in decomposing water by the Voltaic pile, discovered the new agent, which he called "ozone." He pointed out several ways of producing it, invented a test for its presence, and investigated its properties. He, however, up to the time of his death never held a correct theory in regard to its nature. In 1856 the first book wholly devoted to ozone was written by M. Scoutetten of Metz; and researches by Marignac, Dedalline, Becquerel, Fremy, Andrews and Tait, Loret, Brodie, C. Fox, and others, in still more recent times, have elucidated its true nature.

Dr. Cornelius Fox, in his work on ozone and antozone, has collected very completely all that is known respecting these two bodies, and has himself added many new facts.

Antozone is nothing more nor less than peroxide of hydrogen.

The sources of ozone, according to Dr. Fox, are—"The oxidation of metals, the decomposition of rocks, the germination of seeds, the growth of plants; the falling of dew, rain, hail, and snow; the collision between air-currents of different degrees of humidity, proceeding from opposite quarters, with one another, or with the earth; the evaporation which is continually proceeding from saline fluids, such as oceans, seas, and lakes; the dashing and splashing, the smashing and crashing, of the restless waves on the rocky coast,—are all concerned in the simultaneous development of electricity and ozone."

The chemist is able to generate it in many ways—

1. By mixing very gradually 3 parts of strong sulphuric acid and 2 of permanganate of potash. (Instead of this, Dr. Lender (Deut che Klinik, Nov. 19, 1873) employs a mixture of peroxide of manganese, permanganate of potash, and oxalic acid. This mixture in contact with water disengages abundance of ozone.)

2. By the induction-tube of Siemens. This consists of two tubes, one inside the other. The inner side of the inner and the outer side of the outer tube are coated with tinfoil, and these coatings are connected with the terminals of an induction-coil. Dry air or oxygen streams between the tubes, and passes out ozonised.

3. It may be generated by half immersing a stick of phosphorus in tepid water in a wide-mouthed bottle.

4. It is liberated in the electrolysis of water, the burning of hydrogen at a jet, and in other analogous reaction.

5. By moistening barium dioxide with sulphuric acid, ozone is disengaged, and the evolution proceeds for a considerable time.

Ozone has never been isolated. By the use of Siemens' induction-tube, oxygen containing 20 volumes per cent. of ozone has been obtained; but though such a mixture can be produced, it has hitherto been found impossible to separate the ozone from the oxygen. Ozone is entirely converted into oxygen at 276° F. It is one of the most powerful oxidising agents known, oxidising silver, mercury, iodine, and many other substances immediately. It is therefore considered with reason to be a powerful disinfectant. In certain cases ozone acts as a reducing agent—*e.g.*, peroxide of hydrogen and ozone reduce one another, producing water and oxygen. It is also a powerful bleaching agent.

Ozone is frequently present in the atmosphere. It varies in amount according to height, locality, temperature, electricity, &c. "It is more abundant on the sea-coast than inland, in the west than in the east of Great Britain, in elevated than in low situations, with south-west than with north-east winds, in the country than in towns, and on the windward than on the leeward sides of towns. From the observations made by the observers of the Scottish Meteorological Society, ozone is most abundant from February to June, when the average amount is 6, and least from July to January, when the average is 5·7. The maximum, 6·2, is reached in May, and the minimum, 5·3, in November. Thus the maximum period occurs when evaporation is greatest, and the minimum when the condensation of aqueous vapour is greatest—a result in accordance with the conclusions arrived at by Dr. Berigny and M. Houzeau. It thus appears it is most abundant where electricity is produced, and least so, or entirely wanting, where electricity is in least quantity, and where there is much decaying vegetable and animal matter."—(BUCHAN'S Meteorology.)

Speaking generally, an ozonised air is a healthy and stimulating air, likely to destroy mephitic vapours, bad odours, and low germs.

"As the most powerful known disinfectant, it most readily unites with the gases which arise from decaying vegetable and animal matter, and by depriving them of their noxious qualities is a great purifier of the air."

It has been proposed by Dr. Fox to use it on a large scale for this purpose. For example, he says—

"Ozone should be diffused through fever-wards, sick-rooms, the crowded localities of the poor, or wherever the active power of the air is reduced and poisons are generated. Its employment is especially demanded in our hospitals, situated as they mostly are in densely-populated districts, where the atmosphere is nearly always polluted by rebreathed air, decomposing substances and their products, and where no mere ventilation can be fully effective. If practicable, it would be highly advantageous to direct streams of sea-air, or air artificially ozonised, into the fever and cholera nests of our towns. Ozone may be easily disseminated through public buildings, theatres, and other confined atmospheres, where numbers of people are accustomed to assemble, in order to maintain the purity of the air."

Lender also (GOSCHEN'S Deutsche Klinik, 1872-73) has lately come forward as an ardent champion of the medical application and efficacy of ozone, which he recommends both as ozonised air and water in tuberculosis, rheumatism, asthma, &c.; but it is argued by the opponents of the ozone treatment, that it is impossible to convey into the blood a body of such unstable composition, and that inhaling ozone would result in breathing oxygen only. It would, however, appear from the observations of Lehone (Berl. Chem. Ges., 1873, 1226) and Houzeau (Ann. Chim. Phys., [4,] xxvii. 16), that it is more stable than generally believed, for after working with ozone, its peculiar odour adhered to their hands and garments for some time.

Lender is putting his belief to a practical test, for he has established an ozone manufactory, and he sells ozone inhalations at 7½d. per cubic foot, or £1 per cubic metre.

Oxygen containing about 10 per cent. of ozone kills small animals very rapidly. Small birds will die in such a mixture in less than two minutes. Respiration is rendered slower, the pulse gets weaker, and the blood is rendered venous. This latter is a remarkable phenomenon, the very reverse of what theoretically might have been expected. This is considered by Dewar and M'Kendrick to be caused by the high specific gravity of ozone, which exceeds that of carbonic acid, and therefore retards the diffusion of the latter out of the blood.

Ozone also produces a very powerful irritant action on mucous membranes.—(DEWAR and M'KENDRICK, R. Soc. Ed. Proc., Session 1873, 1874.)

The exact influence ozone exerts on health and disease is still unknown. Some observers are inclined to ascribe the greatest importance to this agent, others even doubt its very existence. Schonbein observed at Berlin, during an epidemic of influenza, a considerable quantity of ozone; and Dr. Pietra-Santa has also shown that when influenza prevails, the ozone-papers show lively reactions.

Billard Wolf, Bœckel, and Strambis agree that the cholera in Strasbourg, Berlin, and Milan coincided with the absence of ozone, and that it reappeared on the decline of the disease. Others have attempted to trace a connection between fevers, chest diseases, and other maladies, and the presence or absence of ozone.

These facts have, however, been disputed, and the whole question requires many thousands of accurate observations before it can be settled definitely.

The observation of ozone is usually made by the aid of iodised litmus and papers coated over with a composition of iodide of potassium and starch.

Schonbein's proportions are 1 part of *pure* iodide of potassium, 10 parts of starch, and 200 of water. Lowe's is 1 part of iodide to 5 of starch. Moffat's is 1 to 2½. The best arrowroot should be used for starch. It should be dissolved in cold water and filtered, so that a clear solution is obtained. The iodide is dissolved in another portion of water, and gradually added. The paper, cut in slips and previously soaked in distilled water, is placed in the mixed iodide and starch for several hours; and lastly, slowly dried in a cool dark place, the slips being hung horizontally. Schonbein's papers require moistening with water after exposure before the trial is taken. The following sources of error in the old experiments must be avoided :—

"*Errors associated with the old Ozonometric Method.*

1. Impurity of chemicals, } Employed in the manufacture of the tests.
2. Impurity of paper, }

3. Formation of the iodate of potash.

4. Non-union with the starch of the whole of the liberated iodine.

5. Changes in the force of the wind.

6. Bleaching and fading of coloured tests from—

a. Formation of the iodate of potash.

b. Excess of moisture in the air.

c. A high temperature of the air.

d. A great velocity of the air.

e. A long exposure to the air.

f. Sulphurous acid in the air.

g. *True* antozone in the air.

7. Light.

8. Ozonometers faulty in construction.

9. Differences of aspect and elevation."—(Fox, Ozone and Antozone.)

The iodised litmus papers are to be used when ozone is to be estimated to the exclusion of *all* other bodies. A great variety of information on this subject, and directions of a most explicit character as to the observing of ozone, are given in Dr. Fox's work. *See* AIR, OZONOMETER, &c.

Ozonometer—This word is derived from the Greek *ozo*, I smell, and *metron*, a measure. The papers referred to in *ozone* (*see* OZONE) are ozonometers. The word is more generally applied to a box the bottom of which is out, and in which are hung properly - prepared papers. There are various modifications of this apparatus—the above is the simplest.

P.

Pancreas, or **Sweetbread**—A compound sacculated gland which secretes a fluid called the pancreatic juice. This secretion contains three ferments — one converts starch into sugar, another changes albuminoids into albuminose or peptones, and a third breaks up the large granules, crystals, and globules of oil and fat into myriads of minute particles of from $\frac{1}{3000}$ to $\frac{1}{15000}$ of an inch in diameter ; and so the fat is emulsified and converted into a milky liquid, which mixes freely with water and passes through the tissues of the intestines into the lacteals.

The secretion, even though it be rendered acid, still acts upon fat. During twenty-four hours about 1 lb. is secreted.—(RUTHERFORD.) The secretion commences when food is introduced into the stomach. The flow is at first very slow ; it gradually becomes faster, and attains its maximum in about four hours after food has been introduced into the stomach ; by about the seventh hour it has entirely disappeared. The following, according to Bidder and Schmidt, is the composition of the pancreatic fluid :—

Water	900·76
Organic matter (pancreatine)	90·38
Chloride sodium	7·36
Free soda	0·32
Phosphate of soda	0·45
Sulphate of soda	0·10
Sulphate of potassa	0·02
Combinations of Lime	0·54
Combinations of Magnesia	0·05
Combinations of Oxide of iron	0·02
	1000·00

Pancreatine is a nitrogenous organic substance of the nature of ptyalin or diastase. It is coagulable by heat and nitric acid, and by sulphate of magnesia in excess. Unlike albumen, it can be redissolved. For consideration of this organ as an article of diet, *see* SWEETBREAD.

Paper-Hangings, Wall-Papers, &c. —The more common colours used for wall-papers are as follows :—

Blacks.—Frankfort ivory and blue black.

Blues.—Prussian blue, verditer, and factitious ultramarine.

Browns.—Umber (raw and burnt) and mixtures.

Greys.—Prussian blue and blue black, with Spanish white.

Greens.—Brunswick green, Scheele's green, Schweinfurt green, and green verditer; also mixtures of blues and yellows.

Reds.—Decoctions of Brazil wood (chiefly), brightened with alum or solution of tin, the red ochres, and sometimes red lake.

Violets.—Decoction of logwood and alum, also blues tempered with bright red.

Yellows. — Chrome - yellow decoction of French berries or of weld, terra di Siena, and the ochres.

Whites.—Whitelead, sulphate of baryta, plaster-of-Paris, and whiting, and mixtures of them.

Of all the above, the greens are the only colours liable to injure health. *See* ARSENIC.

Messrs. Wilkinson & Son of London have recently introduced some patent washable paper-hangings, which may be cleansed when soiled by washing, and which have the advantage of becoming as hard as stone when hung. Medically, these papers are of interest, inasmuch as they are said not to absorb the contagion of infectious disorders; so that a sick-room may be thoroughly cleansed by the simple application of soap-and-water, without the necessity of stripping the paper off the walls.—(Lancet, vol. ii. 1872.)

Paradise, Grains of—*See* CARDAMOM.

Paraffine—A substance discovered by Reichenbach in coal tar. It is obtained from wood tar, coal, Rangoon petroleum, and peat. It is a white, hard, translucent body, melting at about 110° F. Chlorine, sulphuric acid, and nitric acid below 212° F., exert no influence on it; hence its name, *par affiné*, from its want of affinity. It is used for making candles, and is useful to the microscopist in embedding tissues, in order to cut fine sections.

Paraffine oil is a mineral oil obtained from the distillation of cannel coal, Boghead coal, &c., at a temperature considerably lower than that employed in the manufacture of gas. It is of a light amber colour; specific gravity, ·823. Point of temporary ignition, 150° F.; odour slight. This oil and others similar are now largely employed for illuminating purposes. The great objection to their use is the frequent accidents resulting from the fracture of the lamp. Many railway carriages are lit by paraffine oil. In the event of a collision, the reservoir above may be fractured, and the lighted oil run down on the passengers. Water will not extinguish it, and the only way to proceed in case of accident, is to throw over the lighted oil a mat or garment to exclude the air.

Parasites—Human parasites are both animal and vegetable: the former include *Entozoa*—animals living in the interior of the human body; and *Ectozoa*—those which infest the exterior. The vegetable parasites are the *Entophyta* and *Epiphyta*—the former existing in the interior, and the latter on the exterior, of the body. The following arrangement shows the principal parasites. It is slightly altered from a table given in Aitken's "Science and Practice of Medicine." The more important parasites which infest food are described under their respective headings.

TABLE OF HUMAN PARASITES.

I. *Entozoa.*

Acephalocystis endogena, *liver.*
,, multifida, *brain.*
Anchylostomum seu Sclerostoma duodenale, *intestines.*
Anthomyia canicularis, *intestines*
Ascaris alata, ,,
,, lumbricoïdes, ,,
,, mystax, ,,
Bilharzia seu Distoma hæmatobia, *portal and venous system.*
Bothriocephalus cordatus, *intestines.*
,, latus, ,,
Cysticercus cellulosæ seu telæ cellulosæ (C. of Tænia solium), *muscles.*
,, of Tænia marginata (C. tennicollis), *intestines.*
Dactylius aculeatus, *urinary bladder.*
Diplosoma crenatus, ,,
Distoma seu Distomum crassum, *duodenum.*
,, hepaticum seu Fasciola hepatica, *gall-bladder.*
,, heterophyes, *intestines.*
,, lanceolatum, *hepatic duct.*
,, oculi humani seu ophthalmobium, *capsule of crystalline.*
Ditrachyceras rudus, *intestines.*
Echinococcus hominis (hydatid of Tænia Echinococcus), *liver, spleen, and omentum.*
Filaria bronchialis seu trachealis, *bronchial glands.*
,, seu dracunculus Medinensis, *skin and areolar tissue.*
,, sanguinis hominis, *blood.*
,, oculi seu Lentis, *eye.*
Hexathrydium pinguicola, *ovary.*
,, venarum, *venous system.*
Monostoma Lentis, *crystalline.*
Œstrus hominis, *intestines.*
Oxyuris vermicularis, ,,
Pentastoma constrictum, *intestines and liver.*
,, denticulatum, *intestines.*
Polystoma pinguicola, *ovary.*
,, sanguicola seu venarum, *venous system.*
Spiroptera hominis, *urinary bladder.*
Strongylus seu Eustrongylus bronchialis, *bronchial tubes.*
,, seu Eustrongylus gigas (Ascaris renalis), *kidney and intestines.*
Tænia acanthotrias, *intestines.*
,, elliptica, ,,
,, flavopuncta, ,,
,, lophosoma, ,,
,, mediocanellata ,,
,, nana, *intestines and liver.*
,, solium, *intestines.*
Tetrastoma renale, *kidney.*
Trichina spiralis, *muscles.*
Trichocephalus dispar, *intestines.*

II. *Ectozoa.*

Demodex seu Acarus folliculorum, *sebaceous substance of cutaneous follicles.*
Pediculus capitis (head louse).
,, corporis seu vestimenti (body louse).
,, palpebrarum (brow louse).
,, pubis, Phthirius inguinalis (crab louse).
,, tabescentium, *phtheiriasis* (*lousy disease*).
Pulex penetrans (chigoë), *skin, cellular tissue.*
Sarcoptes seu Acarus scabiei (itch insect), *scabies.*

III. *Entophyta and Epiphyta.*

Achorion Lebertii (Tricophyton tonsurans), *Tinea tonsurans.*
,, Schönleinii, *Tinea favosa.*

Chionyphe Carteri (fungus of mycetoma), *deep tissues, bones of hands and feet.*
Leptothrix buccalis (alga of the mouth).
Microsporon Audonini, *Tinea decalvans.*
,, furfur, *Tinea versicolor.*
,, mentagrophytes, *follicles of hair in sycosis or mentagra.*
Oidium albicans (thrush fungus), *mouth, mucous and cutaneous surfaces.*
Puccinia favi, *Tinea favosa.*
Sarcina ventriculi, *stomach.*
Torula cerevisiæ (Cryptococcus cerevisiæ, yeast plant), *stomach, bladder, &c.*
Trichophyton sporuloïdes, *Tinea Polonica.*

Parish Infection—The "parish infection" of the English Bills of Mortality, now known to have been typhus fever. *See* FEVER, TYPHUS.

Paroxysmal Fever—*See* FEVERS, MALARIOUS.

Parsnip—The root of *Pastinaca sativa*, used as a table vegetable. It is a native of Britain, but is also found in many parts of Europe and the north of Asia.

Composition of Parsnip (LETHEBY).

Nitrogenous matter	1·1
Starch	9·6
Sugar	5·8
Fat	0·5
Salts	1·0
Water	82·0
	100·0

Pasteur's Fluid—Pasteur's fluid is composed of 10 grammes of crystallised sugar, ·5 grammes of ammonium tartrate, ·1 of well-burnt yeast ash, and 100 cubic centimetres of distilled water. It should be quite clear.

Pauperism is a subject closely allied to public health. To trace its causes, to diminish its increase, must be the urgent endeavour of all sanitarians. The following tables show its extent in the United Kingdom up to 1873:—

TABLE I.—NUMBER of REGISTERED PAUPERS and their DEPENDENTS (exclusive of Casual Poor) in RECEIPT of RELIEF in PARISHES in SCOTLAND, on the 14th of May in each Year.

(On 14th May.) Years	Number of Parishes.	Paupers.	Dependents.	Total.
1858	883	79,199	(Cannot be specified.)	
1859	883	78,501		
1860	883	77,306	36,903	114,209
1861	883	78,433	38,680	117,11[illegible]
1862	884	78,724	40,204	118,9[illegible]8
1863	884	78,717	41,567	120,284
1864	884	78,682	42,023	120,705
1865	884	77,895	43,499	121,394
1866	885	76,229	43,379	119,608
1867	885	76,737	44,432	121,169
1868	887	80,032	48,944	128,976
1869	887	80,334	48,005	128,339
1870	887	79,290	46,897	126,187
1871	887	77,759	45,811	123,570
1872	887	74,752	42,859	117,611

TABLE II.—NUMBER OF PAUPERS in RECEIPT of RELIEF in UNIONS in IRELAND at the Close of the First Week of January in each Year.

Years (First Week of January).	Indoor.			Outdoor.	In Blind and Deaf and Dumb Asylums and Extern Hospitals.	Total.
	Adult Able-bodied.*	All other Paupers.	Total.			
1858	11,198	38,110	49,308	1,274	(Not specified.)	50,582
1859	9,167	34,432	43,599	1,267		44,866
1860	8,975	34,243	43,218	1,711		44,929
1861	10,422	36,930	47,352	3,331		50,683
1862	12,680	42,488	55,168	4,373		59,541
1863	13,674	46,364	60,038	5,809	381	66,228
1864	12,559	47,308	59,867	7,752	516	68,135
1865	11,387	48,111	59,498	9,182	537	69,217
1866	9,795	44,640	54,435	10,163	459	65,057
1867	10,243	44,687	54,930	13,291	429	68,650
1868	9,997	46,666	56,663	15,830	432	72,925
1869	9,994	46,940	56,934	17,320	491	74,745
1870	9,004	44,683	53,687	19,729	505	73,921
1871	8,073	42,742	50,815	23,382	495	74,692
1872	7,462	41,276	48,738	26,056	549	75,343
1873	7,778	42,078	49,856	29,232	561	79,649

* Exclusive of any who are temporarily disabled by sickness.

TABLE III.—NUMBER of PAUPERS (exclusive of Vagrants) in RECEIPT of RELIEF in the several Unions and Parishes under Boards of Guardians, in ENGLAND and WALES, on the 1st of January in each Year.

1st January in each year.	Number of Unions and Parishes.	Adult Able-bodied.			All other Paupers (exclusive of Vagrants).			Total.		
		Indoor.	Outdoor.	Total.	Indoor.	Outdoor.	Total.	Indoor.	Outdoor.	Total.
1858	629*	23,281	143,323	166,604	103,200	638,382	741,582	126,481	781,705	908,186
1859	642*	20.098	117,320	137,418	103,207	619,845	723,052	123,305	737,165	860,470
1860	646*	18,882	117,879	136,761	100,144	614,115	714,259	119,026	731,994	851,020
1861	646†	23,402	127,124	150,526	107,559	632,338	739,897	130,961	759,462	890,423
1862	649†	26,578	141,068	167,646	116,613	661,907	778,520	143,191	802,975	946,166
1863	653†	26,501	226,998	253,499	119,686	769,429	889,125	146,197	996,427	1,142,624
1864	655†	23,663	163.087	186,750	114,144	708,395	822,539	137,807	871,482	1,009,289
1865	655†	23,400	146,736	170,136	114,719	686,578	801,297	138,119	833,314	971,433
1866	655†	22,290	127,030	149,320	115,696	655,328	771,024	137,986	782,358	920,344
1867	655†	23,399	134,909	158,308	121,230	679,286	800,516	144,629	814,195	958,824
1868	655†	28,646	156,984	185,630	130,077	719,116	849,193	158,723	876,100	1,034,823
1869	655†	29,826	153,336	183,162	133,245	723,142	856,387	163,071	876,478	1,039,549
1870	649‡	30,389	163,700	194,089	134,935	750,367	885,302	165,324	914,067	1,079,391
1871	648	29,320	160,519	189,839	135,969	756,118	892,087	165,289	916,637	1,081,926
1872	647§	25,035	128,718	153,753	129,198	724,713	853,911	154,233	853,431	1,007,664
1873	647	22,053	105,644	127,697	132,118	630,557	762,675	154,171	736,201	890,372

* Population in 1851 of 629 unions and parishes, ... 16,628,399
,, ,, 642 ,, ,, ... 17,463,827
,, ,, 646 ,, ,, ... 17,670,935
† ,, 1861 649 ,, ,, ... 19,814,000
,, ,, 653 ,, ,, ... 19,875,000
,, ,, 655 ,, ,, ... 19,886,000
‡ ,, ,, 649 ,, ,, ... 20,053,000
§ ,, 1871 647 ,, ,, ... 22,701,137

Paving—The advantages attendant upon the paving of towns, &c., are so obvious that it is scarcely necessary to enlarge upon them. Paving prevents the soil becoming impregnated with organic detritus. In the wet seasons it carries the rain, &c., away from our houses, preventing the formation of puddles and the accumulation of mud; and in the hot summer months it lessens the quantity of irritating, injurious dust in the air, and prevents, especially when laid down in the basements, &c., of our houses, the rise of the ground-air and damp. Its disadvantages are that it prevents the rain from permeating the earth and so washing it, and the consequence is that in old towns we find the well-water undrinkable; and in such pavings as asphalte, &c., the surface of the ground in the streets is rendered practically air-tight, and hence all subterranean gases and vapours find vent in our houses, where no such resistance is encountered.

In paving basements, &c., the whole floor superficies should be covered first with proper concrete 6 inches in depth, and then the flags (stones) bedded on a layer of cement upon this concrete. It is important to say that the subsoil should be drained as much as possible, and the surrounding walls guarded by external areas, or the water may find its way through them and cover the concrete.

Mr. Eassie says that he has seen cellars which have been duly protected by areas from the wetness of the environing soil, and yet, from the absence of ground drains, the piers which supported the flags were found surrounded with water. The only cure for damp flags is to take them up, excavate underneath, put in a bed of concrete, and lay them in cement upon that, or upon piers or sleeper walls.

For regulations as to the paving of streets, &c., see STREETS.

Peach (*Amygdalus Persica*)—A native of Persia and the north of India, but now cultivated in all temperate climes with great success, especially in the United States. The following table shows the very small quantity of saccharine matter it contains in comparison with other kinds of edible fruits:—

Composition of Peaches (Fresenius).

	Large Dutch.	Similar Variety.
Soluble Matter—		
Sugar	1·580	1·565
Free acid (reduced to equivalent in malic acid)	0·612	0·734
Albuminous substances	0·463 }	11·058
Pectous substances	6·313 }	
Ash	0·422	0·913
Insoluble Matter—		
Seeds	4·629	0·764
Skins }	0·991	2·420
Pectose }		
[*Ash from insoluble matter included in weights given*]	[0·042]	[0·163]
Water	84·990	76·546
	100·000	100·000

Pear (*Pyrus communis*)—This fruit, like the apple, is indigenous to this country, but the wild pear is a very insignificant fruit. Its composition is as follows:—

Composition of Pear (Fresenius).

	No. 1.	No. 2.
Soluble Matter—		
Sugar	7·000	7·940
Free acid (reduced to equivalent in malic acid)	0·074	trace
Albuminous substances	0·26)	0·237
Pectous substances, &c.	3·281	4·409
Ash	0·285	0·284
Insoluble Matter—		
Seeds	0·390 }	3·518
Skins	3·420 }	
Pectose	1·340	0·605
[*Ash from insoluble matter included in weights given*]	[0·050]	[0·049]
Water	83·950	83·007
	100·000	100·000

Peas—The garden-pea is derived from the *Pisum sativum*, a native of the south of Europe, but long known in England. The field-pea grown by the farmer to feed cattle with is from the *Pisum arvense*. Peas require a good deal of boiling to render them digestible; but when old, no amount of boiling will soften them—indeed, they only become harder.

There is a kind of pea called the *sugar-pea*, the pods of which are gathered young, and cooked and eaten with the seeds in them in the same way as French beans.

The following is, according to Parkes, the composition of peas (*Pisum sativum*):—

Water	14·500
Legumine, albumen, and gluten like substances	22·300
Cellulose	4·000
Starch, dextrine, and sugar	52·600
Fat	2·090
Chlorophyll	1·200
Salts	2·400
Potash	0·860
Soda	0·160
Lime	0·100
Magnesia	0·180
Iron	0·023
Phosphoric acid	0·850
Sulphuric acid	0·077
Chloride of potassium	0·067
Chloride of sodium	0·044
Chlorine	0·000
	101·261

Composition of Dried Peas (Payen).

Nitrogenous matter	23·8
Starch	58·7
Cellulose	3·5
Fatty matter	2·1
Mineral matter	2·1
Water	8·3

Pea-flour resembles very closely bean-flour; the chief difference consists in the size of the starch corpuscles, which are much smaller in pea than in bean flour (*see* fig. 64).

PEA FLOUR, DRY.
1/100 TH INCH

Fig. 64.

Pea-flour is employed as an adulterant with a variety of substances, notably pepper, flour, &c.

The following shows the composition of some of the Indian peas:—

	Pisum sativum, Indian Pea.	*Cajanus Indicus*, a Pea called Dholl in India.
Water	11·79	10·63
Nitrogenous substances	27·96	22·18
Fat	1·47	1·95
Starch	56·36	62·13
Mineral matters	2·48	3·11

Penalties — All penalties, forfeitures, costs, and expenses directed to be recovered in a summary manner, or not otherwise provided for, may be prosecuted and recovered under the "Summary Jurisdiction Acts" before a court of summary jurisdiction (P. H., s. 251); but proceedings for the recovery of penalties are only to be taken by the person aggrieved, or by the local authority of the district, except the consent in writing of the Attorney-General be obtained. But this restriction does not apply to the proceedings of a local authority with regard to nuisances, offensive trades, houses, &c., without their district, in cases in which the local authority are authorised to take proceedings with respect to any act or default.—(P. H., s. 253.)

Unless otherwise provided for, the penalty is thus applied: One-half goes to the informer, and the remainder to the local authority of the district in which the offence was committed; but if the local authority be the informer, they are entitled to the whole of the penalty recovered. All penalties and sums recovered by a local authority are paid to the treasurer, and carried to the account of the fund applicable to the general purposes of the Public Health Act.

(The justices or court have power to reduce penalties imposed by 6 Geo. IV. c. 78.—P. H., Part III.)

The following is a list of various penalties which may be imposed under the Public Health Act, 1875:—

Building or re-erecting a house in an urban district without proper drains, &c., £50 or less.—(P. H., s. 25.) For building or re-erecting a house in any district without proper sanitary conveniences (privies, &c.), £20 or less.—(P. H., s. 35.)

Unauthorised building over sewers and under streets in an urban district, £5 penalty, and 40s. per day during continuance of offence.—(P. H., s. 26.)

Burial.—For obstructing a justice's order with regard to the burial of a person who has died from an infectious disease, &c., £5 or less. —(P. H., s. 142.)

Bylaws. —Penalties may be imposed by local authorities for the contravention of bylaws—such penalties are not to exceed £5; and for continuing offences further penalties of sums not exceeding 40s. a day.—(P. H., s. 183.) Penalty for injury or defacement of any board, &c., on which a notice or bylaw of a local authority is inscribed by the authority of the Local Government Board, or of the local authority, £5 or less.—(P. H., s. 306.)

Cellars.—Unauthorised occupation of, 20s. per day.—(P. H., s. 73.)

Cleansing and Whitewashing, &c.—Failure to comply with notice to cleanse and whitewash a house, 10s. per day.—(P. H., s. 46.)

Contracts.—All contracts are to specify some pecuniary penalty.—(P. H., s. 174.) Officers or servants being concerned or interested in contracts, accepting fees, are liable to a penalty of £50, recoverable with full costs of suit.

Disinfection.—Failure to comply with notice to disinfect and cleanse articles and premises, not less than 1s., and not more than 10s. per day. Expenses of local authority doing the work may also be recovered.—(P. H., s. 120.) Failure to disinfect public conveyances after conveying infected persons, £5 or less.—(P. H., s. 127.) For letting infected houses without proper disinfection, £20 or less.—(P. H., s. 128.)

Drains, &c.—Unauthorised connection of a drain with a sewer, £20 or less.—(P. H., s. 21.) For neglecting to comply with notice for the construction of privies, &c., for factories, £20 or less, and 40s. per day.—(P. H., s. 38.) For non-compliance with notice for the construction of drains, privies, &c., 10s. per day.—(P. H., s. 41.)

Epidemic Diseases.—For violation or obstruction of the regulations of the Local Government Board with regard to epidemic diseases, £5 or less.—(P. H., s. 140.)

Exposure of infected persons or things, £5 or less.—(P. H., s. 126.)

Houses or Rooms.—Making false statements with regard to infectious diseases for the purposes of letting, £20 or less, or imprisonment for one month, with or without hard labour.—(P. H., s. 129.)

Lodging-Houses.—Receiving lodgers in unregistered houses; failure to make a report; failure to give notice of infectious disease, £5 or less, and 40s. per day during continuance of offence. Refusal or neglect to affix or renew notice of regulation in common lodging-house, £5 or less, and 10s. a day during continuance of offence after conviction.—(P. H., s. 79.) For neglecting the limewashing and cleansing of lodging-houses according to the Act, 40s. or less.—(P. H., s. 82.)

Manure.—Failure to comply with a notice of urban authority to periodically remove manure, &c., 20s. a day.—(P. H., s. 50.)

Meat.—For exposing for sale or having in possession unsound meat and other articles of food specified in the Act, £20 or less for each carcase, or piece of meat, or fish, &c., or three months' imprisonment, with or without the option of a fine.—(P. H., s. 117.) For obstruction of officer inspecting the food, £5 or less. —(P. H., s. 118.)

Mortgage of Rate.—Refusal of custodian of register to permit inspection, £5 or less. Neglect or refusal of clerk to register transfer of mortgage, £20 or less.

Nuisance.—The court may impose a penalty of £5 or less with regard to nuisances generally. —(P. H., s. 98.) For want of diligence in carrying out the order to abate nuisances, 10s. per day; for contravention of order, if wilful, 20s. per day during such contrary action, besides the expenses of the local authority in abating the nuisance.—(P. H., s. 98.)

For nuisances from pigs, pigsties, and the contents of cesspools, &c., overflowing, 40s. or less, and 5s. per day during continuance of offence.—(P. H., s. 47.)

Obstruction. — For wilful obstruction of member of, or person authorised by, local authority, £5 or less.—(P. H., s. 306.)

Obstruction of owner by occupier in carrying out any of the provisions of the Act, £5 per day, commencing twenty-four hours after non-compliance with the justice's order.—(P. H., s. 306.)

Offices.—Certain offices are not to be held by the same person. Penalty for offence, £100, recoverable with full costs of suit. —(P. H., s. 192.)

Order of Justices.—Refusal to obey order for admission of local authority, £5 or less—(P. H., s. 103.)

Rates.—Refusal of officer in custody of rate-books, valuation lists for the relief of the poor, &c., to permit inspection, £5 or less.—(P. H., s. 212.)

Refusal of person to permit inspection of rate, £5 or less.—(P. H., s. 219.)

Scavenging.—Obstructing the contractor or local authority in scavenging the streets, or in the removal of refuse, £5 or less.—(P. H., s. 42.)

Neglect of local authority to scavenge after undertaking to do so, 5s. per day.—(P. H., s. 43.)

Streets.—Wilful unauthorised displacement or injury of pavement stones, injury to fences, &c., of streets vested in *urban* authority, £5 or less, and a further penalty of 5s. or less for every square foot of pavement injured, &c. Compensation may also be awarded by the court for injury to trees.—(P. H., s. 149.)

For building or bringing forward buildings beyond the general line of the houses in the street in an *urban* district, 40s. per day after written notice.—(P. H., s. 156.)

Trade, Offensive.—Unauthorised establishment of, in an *urban* district, £50, and 40s. per day during continuance of offence.—(P. H., s. 112.) Nuisance arising from offensive trade is punishable by a penalty—for first offence, not less than 40s., and not exceeding £5; for second or any subsequent offence, double the amount of the last penalty which has been imposed, but in no case to exceed £200 (P. H., s. 114.)

Water.—Pollution of by gas, £200; and when offence is continued at the end of twenty-four hours' notice, £20 per day.—(P. H., s. 68.)

For injuring water-meters, 40s. or less, and the damage sustained may also be recovered. —(P. H., s. 60.)

Works.—For wilful damage of works or property belonging to a local authority, in cases where no other penalty is provided, £5 or less. —(P. H., s. 307.)

Pentagraph—This is an instrument for taking exact copies of plans, maps, designs, &c., which it will reduce, enlarge, or copy same size, no matter how crooked or complex the outlines may be. Pentagraphs range in price from £3, 3s. to £10, 10s., and the importance of getting a really good instrument cannot be too strongly insisted upon. To medical officers of health, inspectors of nuisances, &c., a pentagraph is invaluable; for by its aid the plan of a parish or village may be readily copied from the Ordnance maps.

Pentastomata—Pentastomata are parasites which have been found in the liver of man. The *Pentastoma denticulatum* has been shown by Leuckart to be the larvæ of the *Pentastoma tænoïdes*, and has been found in the liver and small intestines. The *Pentastoma constrictum* has been found in one or two instances. The accompanying diagrams (from Aitken) illustrate the appearance of the parasite.

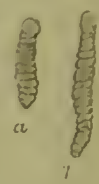


Fig. 65.

a and *b* (fig. 65) are of the natural size. Fig. 66 represents the same specimens somewhat magnified.

Fig. 66.

Fig. 67 represents the anterior aspect of the flattened head-end of the parasite. "The dotted lines from *a* and *b* point to two pairs of hooks or claws, one pair on each side of a pit or mouth *c*. The points of the claws indicated by *a* are seen nearly in profile; those at *b* are directed more towards the observer. These claws appear to be implanted in socket-like hollows or depressions, surrounded by much loose integument. These socket-like hollows appear to be elevated on the summit of the mass of tissues which lies underneath the folds of integuments surrounding the base of the hooks. These parts are regarded as the feet of the parasite, and the hooks are the foot-claws. The pit or mouth (indicated by the dotted line to *c*) is of an oval shape, the long axis of the oval lying in the direction of the length of the worm. The less or outer margin of the pit is marked by a well-defined thin line. There

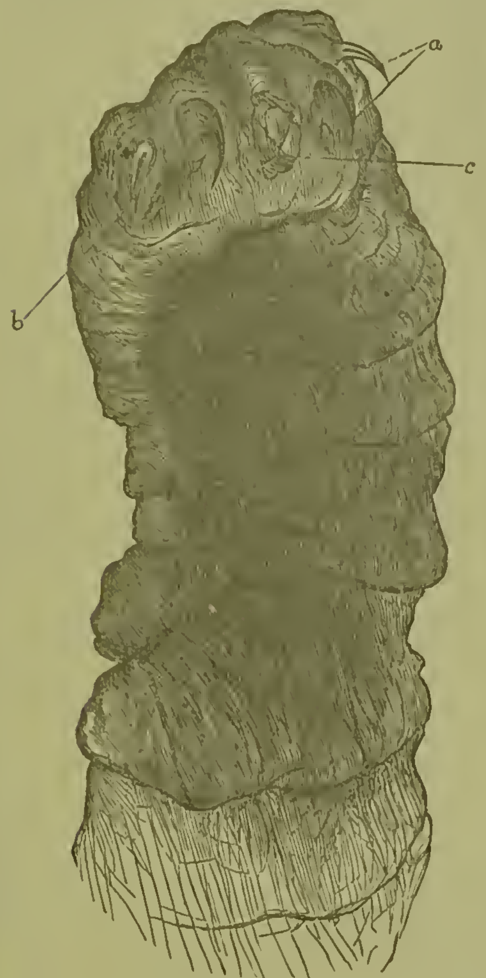


Fig. 67.

are no spines nor hooks on the integument of the elongated body."—(Aitken.)

The *Pentastoma constrictum* is unknown in this country. In the recorded cases it appears to have caused death by inducing peritonitis.

Pepper—Black pepper is the dried *immature* fruit of *Piper nigrum*, one of the *Piperaceæ*, or Pepperworts.

White pepper is the same berry decorticated, or deprived of its outer and black husk or covering.

The Pepperworts are a well-defined natural order, confined to the hottest parts of the world, and delighting in low places, valleys, and the banks of rivers. Although neither the number of its genera nor of its species is great, yet the whole order is remarkable for a variety of active and useful plants—*e.g.*, the aromatic black and long peppers, the astringent matico, the intoxicating *Macropiper methysticum*, the different varieties of cubebs useful in the treatment of inflamed mucous membranes, and several other plants possessing medicinal properties,* belong to the natural order of *Piperaceæ*.

Black pepper itself is a climbing plant, attaining the height of from 8 to 12 feet; the berries—or, botanically speaking, "drupes" —are at first green, then red, and, if left still longer ungathered, turn to black; but before this latter change takes place the berries are gathered by hand and dried in the sun—the result being an entire change of appearance; instead of a red, smooth berry—a black or reddish-black peppercorn, with the cortex contracted and shrivelled in such a manner as to form a veined network, is obtained. The plant is cultivated in various portions of the equatorial regions of the earth, the zone of cultivation being confined to the isotherms of 82°. It would not, however, be strictly correct to say that this high mean annual temperature is essential, or even necessary; for the fact is that it is produced principally in the cooler valleys, where the mean annual temperature does not perhaps exceed 70° F.

The black pepper imported into this country principally comes from the islands of Malacca, Java, Borneo, and Sumatra. The commercial varieties are at least five—viz., Malabar, Penang, Sumatra, Trang, and Tellicherry, names indicating the localities from whence they are derived. The differences which these varieties of pepper present *to the eye* are evident enough when the several samples are at hand for comparison, but it takes a very practised observer to identify a solitary sample; and if samples of each of the kinds named were mixed together, it is doubtful whether an adept even could separate the berries again, identifying each sort with any correctness. The merchant indeed relies more upon the weight than the appearance; he takes a handful of peppercorns, and by long practice can tell in a moment whether it is a light or a heavy sample. Chevallier has determined the weight of what is technically called heavy, half-heavy, and light pepper. A litre of the first weighed 530 grammes; of the second, 512 grammes; of the third, 470 grammes. That there is considerable difference in weight in the different berries is certain,

* The *Artanthe eucalyptifolia*, used in Brazil in case of colic; *Piper parthenium*, used in menstrual disturbances; *Chavica Betle* and *Siriboa* cause salivation and decrease the function of the skin. Beside these, *Acrocarpidium hispidulum*, *Coccobryon capense*, *Artanthe adunca*, *Chavica adunca*, and others possess active and useful properties.

for the author carefully weighed 100 berries of each kind, with the following result:—

		Grammes.
100 peppercorns of Penang weighed		6·2493
100 ,,	Malabar ,,	0·0536
100 ,,	Sumatra ,,	5·1476
100 ,,	Trang ,,	4·5736
100 ,,	Tellicherry ,,	4·5076

If, then, quality is to be judged of by weight, Penang and Malabar may be bracketed together as standing first, Sumatra holding the second place, and Trang and Tellicherry bracketed together in the third. The general opinion of the trade is that Malabar is really the heaviest, and possibly the samples of Penang which the author possesses are unusually fine. The whole of the ground peppers of commerce are mixtures of different kinds of pepper; there is no such thing to be found in the shops as a pure ground Malabar or a pure ground Penang. The principal varieties mixed for household purposes and retailed are Malabar, Penang, and Sumatra: the first of these is the dearest.

The usual mixture, according to Chevallier,* is—

33 per cent. of Malabar to give weight,
33 per cent. of Penang to give strength, and
33 per cent. of Sumatra to give colour.

The pepper thus mixed is either ground by the aid of large millstones, or in an apparatus perfectly analogous to a coffee-mill. The latter mode is far preferable to the former, as the friction of the stones develops considerable heat, and dissipates some of the aromatic principles. Pepper thus damaged by the heat of the mechanical operations is technically known as "burnt."

The chemistry of black pepper is still in a very imperfect state. Pelletier has recognised and separated piperine ($C_{17}H_{19}NO_3$), a volatile oil ($C_{10}H_{16}$), gum, bassorine, starch, an acrid resin, malic and tartaric acids, salts, extractive, and woody fibre; but there is no quantitative analysis of the whole of the known constituents.

The following is a quantitative analysis of *white* pepper by Lucä:—

White Pepper (Lucä).

Acrid resin	16·69
Volatile oil	1·61
Extractive gum and salt	12·50
Starch	18·50
Albumen	2·50
Woody fibre	29·00
Water and loss	19·29
	100·00

In the last analysis the piperine is included in the resin (?).

* Du Poivre, par A. Chevallier (Annales d'Hygiène Publique, July 1875).

The *resin* is soluble in alcohol and ether, and is very acrid.

The specific gravity of the *volatile oil* is ·9932. It has the odour and taste of pepper.

Piperine ($C_{17}H_{19}NO_3$, STRECKER). — This substance is isomeric with morphia, and possesses feeble basic properties. White pepper easily yields it when treated with alcohol, which extracts a resinous matter with the piperine, from which the latter may be freed by digestion in a solution of potash. The piperine that remains undissolved is recrystallised from alcohol, and furnishes colourless prisms, which are fusible at 212° F., good pepper yielding about 1·5 per cent. of the alkaloid. It is soluble (slightly) in cold water, and has an acrid taste. Sulphuric acid dissolves it. The hydrochlorate is its most stable salt. Nitric acid acts powerfully on piperine, developing an odour of bitter almonds, whilst a brown resin rises to the surface. On evaporating the solution to dryness, a brown residue is left, which, when treated with potash, yields a magnificent blood-red liquid, and on distilling this mixture, it furnishes piperidine ($C_5H_{11}N$), which is a powerfully alkaline base.

The writer has made some observations* on (1) the hygroscopic moisture; (2) the ash, its percentage and composition; (3) the nitrates in pepper; (4) the alcoholic; and (5) the aqueous extract.

1. *The Hygroscopic Moisture.*—This was determined by weighing about 1 gramme of the very finely powdered substance and drying in a water-bath in the usual way. Without doubt pepper dried at this heat retains a considerable quantity of water, but the very strong odour which all aromatic substances evolve at 100° C. sufficiently shows that volatile principles are, during the whole evaporation, given off; it therefore is very questionable whether it is advisable to dry at a higher heat than 100° C.

The percentage of moisture is as follows:—

Penang	9·531
Tellicherry	12·908
Sumatra	10·163
Malabar	10·548
Trang	11·664

The highest percentage, then, is 12·9, the lowest 9·5, the mean of the whole 10·95.

2. *The Ash.*—In the determination of the ash, about 2 grammes were placed in a large platinum dish and burnt down at a low red heat, until it was of an equally grey colour and ceased to lose weight; it was then weighed

* Chemical News, October 1874.
Etude Chimique sur les Poivres du Commerce, par le Dr. A. Wynter Blyth (Annales d'Hygiène Publique, July 1875).

as quickly as possible, the result expressed as total ash; the ash was then dissolved in boiling water, the solution filtered, evaporated down, gently ignited, and the result expressed as soluble ash.

	Pepper dried at 100° C. Soluble Ash. Per cent.	Total Ash. Per cent.	Pepper as sold. Total Ash. Per cent.
Penang	2·212	4·189	3·843
Tellicherry	3·380	5·770	5·346
Sumatra	2·626	4·316	3·334
Malabar	3·453	5·195	4·674
Trang	2·538	4·775	4·211
Long pepper	4·472	8·308	7·154
White pepper	0·558	1·120	0·788

In all inquiries of this kind the extreme numbers are those which have the most value—the least amount of ash, the greatest amount of ash ever found in genuine samples. Now the smallest percentage of ash derived from a ground black pepper taken in its undried state that the author can give is 3·3 per cent.; the greatest amount is 5·3 per cent., and invariably a little more than half of this ash is soluble. It is useful to compare with these numbers those obtained by Dr. Hassall, and published in "Food, Water, and Air."

Whole Black Pepper (Hassall).

Sample 8	Ash 4·03 per cent.
,, 9	,, 4·33 ,,
,, 10	,, 3·90 ,,
,, 11	,, 4·61 ,,
,, 12	,, 4·01 ,,
,, 13	,, 3·67 ,,

Thus the greatest percentage of ash given by Dr. Hassall is 4·33 per cent., the lowest 3·9, the mean of the eleven numbers derived from the two sets of independent observations gives us the ash of a genuine black pepper, 4·17 per cent., and the conclusion is inevitable that in no case should a ground black pepper, *as sold*, give an ash of 5½ per cent. That the ground black peppers of commerce do give very high percentages of ash, and are therefore much adulterated, is evident from the fact, that in sixteen samples of ground black pepper examined by Dr. Hassall, only one was under 5 per cent., the percentages of the other fifteen being distributed as follows:—

One	gave between	5 and 6 per cent. of ash.
Three	,,	6 and 7 ,,
Three	,,	7 and 8 ,,
Seven	,,	9 and 10 ,,
One	,,	11 and 12 ,,

Now, if these peppers were properly burnt, as without doubt they were, fifteen out of the sixteen were adulterated.

With regard to the composition of the ash of black pepper, the following is an analysis of the ash of Tellicherry pepper:—

	100 Grammes of Ash.
Potash	24·380
Soda	3·226
Magnesia	13·000
Lime	11·600
Iron	0·300
Phosphoric acid	8·470
Sulphuric acid	9·613
Chlorine	7·570
Carbonic acid	14·000
Sand	6·530

Of all of these constituents the sand is the most variable. The highest determination of sand which the writer has as yet met with occurred in a sample of Penang pepper, which gave 9 parts of sand in every 100 of ash; but if we allow that a pepper ash may contain 10 parts in every 100 of sand, how, on any theory except wilful adulteration, can we account for the fact of the ground pepper of commerce yielding to the analyst an ash one-third or one-half of which is very commonly found to consist of sand? The iron, part of which is magnetic, the alkaline earths, the chlorine, the alkalies, all vary somewhat; but there is one constituent which is extremely constant, and may be of technical utility, and that is the phosphoric acid. The phosphoric acid the writer finds to average 8·5 per cent. of the ash, and does not believe that it varies more than half a percentage either way; its determination is therefore of some value.

With regard to the arrangement and combination of the different elements found upon incineration there is much to be learned. That the carbonic acid has no relation whatever, nor is any guide, to a knowledge of the amount of carbonates existing as such in the plant, is well known, and may be proved. Thus, numerous analyses of pepper ash have given from 12 to nearly 15 per cent. of carbonic acid calculated upon the ash; but pepper itself has very minute quantities of carbonate; for the author has finely powdered Malabar pepper, treated it with acid, and placed it in an absorption apparatus connected with an aspirator, and drawn through the solution perfectly dried carbonic acid free air, and found that 100 grammes yielded only ·657 milligramme of CO_2, or about ·143 per cent. of the ash; hence the 10 or 11 per cent. must be produced from the organic salts, &c.

Nitrates and Nitrites in Pepper.—Comparatively few observations of the amount of nitrates and nitrites in organic substances are on record: it is a subject of some scientific interest, especially since it has been observed that nitrates and nitrites are decomposed in the presence of free oxalic acid. Whether the determination of nitric acid will be of service to the food analyst or not, is unknown: it certainly may be so, if it be found that a substance rich in nitrates is fraudulently mixed with one poor in nitrates.

			Calculated as Nitric Acid. Grammes.
100 grms. undried	Penang	pepper yield	0·04470
,, ,,	Malabar	,,	0·03858
,, ,,	Tellicherry	,,	0·08860
,, ,,	Sumatra	,,	0·06560
,, ,,	Trang	,,	0·11870

The alcoholic extract, obtained by exhausting a weighed sample of the dried substance by repeated quantities of boiling alcohol in a flask attached to an inverted condenser, is a fair index of the quality of a pepper, for the extract so obtained consists almost entirely of piperine and resin, the two constituents on which the qualities of pepper almost exclusively depend; nor do we believe that the advantage of separating these constituents sufficiently compensates for the extra trouble and time.

100 *Grammes of the Substance dried at* 100° *C.*

	Grammes.
Penang	7·650
Malabar	6·375
Sumatra	6·450
Tellicherry	7·896
Trang	6·300
Long pepper	2·600
White pepper	7·650

The extract, then, varies from 6·3 to 7·8 per cent.

The aqueous extract, containing extractive and colouring matter, soluble salts, gum, starch, and small quantities of piperine and resin, was determined by thoroughly exhausting a *small* weighed portion of pepper by a *large* quantity of boiling distilled water, and found to vary from 18 to 20 per cent.

100 *Grammes of the dried Substance taken.*

	Aqueous Extract. Grammes.
Penang	18·335
Malabar	20·375
Sumatra	17·500
Tellicherry	16 500
Trang	18·175
Long pepper	16·825

The amount of starch in the five samples is very nearly the same—a fact easily proved by making a decoction of each, of exactly similar strength, decolourising by charcoal, then placing in Nessler cylinders, and adding an equal quantity of iodine to each; the gradations of colour are so faint that there can be hardly the difference of a percentage in the whole five. It is, however, shown in this way that Sumatra has most starch; next in order comes Penang, then Malabar, Tellicherry, and Trang, the last three containing identical quantities of starch.

Structure of Pepper.—A thin section of the pepper-berry shows, from without inwards—(1) a layer of elongated cells, large and distinct, having a central cavity, from which numerous lines radiate towards the circumference; (2) a layer of small, angular, dark-coloured cells; (3) a thin stratum of woody fibre and spiral vessels; (4) a layer of large round cells; (5) a tissue divisible into two layers, the outer consisting of coloured cells, the inner colourless, and really constituting a membrane.

The first five structures described form the cortex of the pepper. The central part of the berry is composed of large cells, most of which are coffin-shaped. Their general arrangement is radiate. In the outer portion of the seed they are hard and adherent, in the inner portion pulverulent and readily separable. In ground black pepper all these structures may be seen; in ground white pepper only the cells of the inner part of the seed, and some of the red cells of the fourth layer, together with those of the fifth layer, are found.

Adulterations of Pepper.—Pepper has been adulterated for at least two centuries and a half, for Pierre Pomet,* writing in 1614, says, "As the greatest part of pepper, white as well as black, is sold '*battu*' (that is to say, powdered), it should only be bought of honest merchants, because all the pepper the retailers sell is no other thing, for the white, than '*des épices d'Auvergne blanches*,'† or rather black pepper whitened with ground rice; the black is only the dust either of the crust of bread, grey Auvergne spices, or manignette."

The list of the adulterations enumerated by authors is an extraordinary one. Linseed-meal, rice, pepper leaves, mustard, wheat-flour, sago, woody fibre, chillies, rapeseed, potato, spices, capsicum, manignette (otherwise known as Guinea pepper), chicory, rye, powdered leaves of the laurel, which have been previously used to wrap round extract of liquorice, the stones from olives, bone-dust, marine salt, and various mineral adulterations, are all said to have been selected.

However various may be the adulterations in France (where Chevallier tells us in Paris alone he is acquainted with a manufactory producing 1200 to 1500 kilogrammes annually of a mixture sold solely for the purpose of adulterating pepper), the only common adulterations of this country are what are known in the trade as P.D., H.P.D., and W.P.D., abbreviations for pepper-dust, hot pepper-dust, and white pepper-dust: the first, or P.D., used to be principally composed of the faded leaves of autumn, but linseed-meal is now preferred; H.P.D. is chiefly the husks of mustard; and W.P.D. is ground rice. To all these we must add sand, which is most certainly added; whether derived from the sweepings of the shops, or added as sand, is not at all clear.

Besides the formidable list of adulterations just given as found in powdered pepper, the

* Pomet, Histoire Générale des Drogues, 1735.

† "Depuis un temps immémorial le poivre en poudre sous le nom d'epices d'Auvergne, est composé de pain de chenevis et de tourteaux de faine et souvent aussi avec de la terre pourrie."—(Soubeiran, Dictionnaire des Falsifications, Paris, 1874.)

berry itself is not free from manipulation, for as the merchant judges by the weight of the sample, means are taken to render the lighter sorts equal in weight to the heavy Malabar and Penang, and in order to do this they are macerated in tubs of brine for twenty-four hours, and thus impregnated with salt and water, find their way into the market as Malabar; but such samples are quickly recognised by the astute merchant, and the high chlorides, the high ash, the great amount of humidity, could hardly fail to reveal their nature to the analyst.

As coffee has been cleverly imitated by chicory pressed into the shape of the coffee-berry, so by pressing various pastes into the shape of the pepper-berry has pepper been imitated. Of this adulteration there is the most undoubted evidence. Accum noticed artificial peppercorns made of oilcake, common clay, and Cayenne pepper, and Chevallier in a recent paper states that in 1843 he was requested to examine a sample taken from forty bales, in which he found from 15 to 20 per cent. of artificial pepper, composed of pepper-dust, bran, and other matters.

Pepper, Cayenne—*See* CAPSICUM.

Peppermint, Oil of—This substance has been employed as an antiseptic. A piece of meat suspended in its vapour remained good for nearly twelve days. *See* DISINFECTANTS.

Pepsin—Pepsin is a peculiar organic compound found in the gastric juice, and capable, in conjunction with hydrochloric acid, of digesting albumen and some other portions of food, and of dissolving, as Tuson has recently shown (Lancet, August 1870), calomel and certain mineral substances. Pepsin is an albuminoid body, soluble in water, but insoluble in alcohol. Its aqueous solutions are precipitated by corrosive sublimate, salts of lead, and by solutions of tannic acid. Boiling destroys the digestive property of pepsin.

Pepsin can be artificially made, and when carefully prepared it is a valuable remedial agent, but many of the samples met with in commerce are almost worthless. Tuson recently made an examination of the chief kinds of pepsin in the market, with a view to the determination of their real value. Ten different samples prepared by six different makers were examined, and the results tabulated. The experiments (all of which were performed in duplicate) were divided into two series. In one, white of egg, in the other, finely-minced lean of rump steak, was employed. In every experiment 5 grammes (77 grains) of the albumen or fibrine were mixed with either 25 or 50 cubic centimetres (424 or 848 minims) of 1 per cent. hydrochloric acid. Quantities of pepsin, which varied from ·05 to 5·0 grammes (·72 to 72 grains), were added, and the whole digested at 100° F. for four hours. The pepsin prepared by four out of the six makers was found to have *no digestive power whatever*. Of the remaining two kinds, one was almost exactly ten times as good as the other.

A series of experiments, having the same object in view, were published in the "Practitioner" (June and August 1872). All the samples tested were pronounced to be nearly worthless.

Professor Beale (Medical Times and Gazette, February 10, 1872, p. 152) gives the following as being the best method that can be employed for the preparation of pepsin: "The mucous membrane of a perfectly fresh pig's stomach is carefully dissected from the muscular coat and placed on a flat board. It is then lightly cleansed with a sponge and a little water, and much of the mucous remains of food, &c., carefully removed. With the back of a knife, or with an ivory paper-knife, the surface is scraped very hard, in order that the glands may be squeezed and their contents pressed out. The viscid mucus thus obtained contains the pure gastric juice, with much epithelium from the glands and surface of the mucous membrane. It is to be spread out upon a piece of glass so as to form a very thin layer, which is to be dried at a temperature of 100° over hot water, or *in vacuo*, over sulphuric acid. Care must be taken that the temperature does not rise much above 100° F., because the action of the solvent would be completely destroyed. When dry, the mucus is scraped from the glass, powdered in a mortar, and transferred to a well-stoppered bottle. With this powder a good digestive fluid may be made as follows:—

Of the powder	5 grains.
Strong hydrochloric acid . .	18 drops.
Water	6 ounces.

"Macerate it at a temperature of 100° F. for an hour. The mixture may be filtered easily, and forms a perfectly clear solution very convenient for experiment. . . .

"*Test.*—Eight grains of this pepsin, with 10 drops dilute hydrochloric acid, and an ounce of distilled water, dissolves 100 grains of hard-boiled white of egg in from twelve to twenty-four hours. In the body, probably twice this quantity of white of egg, or even more, would be dissolved in a comparatively short space of time. The digestive powder prepared from the pig's stomach retains its activity for any length of time if kept dry. I had some which had been kept in a bottle for upwards of five years, and still retained its active power unimpaired. The solution made with this pepsin and hydrochloric acid was nearly tasteless and inodorous. One pig's stomach, which costs 6d., will yield about 45 grains of the powder prepared as above described."

From the experiments of Mr. Scheffer, it seems that the activity of pepsin is destroyed by alcohol, even when diluted by an equal volume of water, and is materially diminished by smaller quantities of alcohol. If this be true, pepsin wine would of course be valueless. He also finds that true pepsin and bismuth cannot exist in the same solution, and that the solutions sold under the joint names are therefore worthless, so far as the pepsin is concerned; and he further makes the important observation, that pepsin may be precipitated from its slightly acid solution by the addition of an equal volume of a saturated solution of common salt.

Peptone—*See* Food.

Perfumes — Perfumes have from the earliest times been used for the purpose of either masking or destroying offensive odours, but are of doubtful value.

Permanganate of Potash—*See* Potassium.

Perry—Perry is a fermented liquor made from pears in the same way as cider from apples. It forms a pleasant, refreshing, and wholesome drink.

The following represents the percentage of spirit in some samples which were examined by Brande:—

	Alcohol. Specific Gravity ·825, at 60° F. Per cent. by Measure.
Perry, average of four samples .	7·26

The best perry contains about 9 per cent. of absolute alcohol, ordinary perry from 5 to 7 per cent. *See* Pear, Cider, Alcoholic Beverages, &c.

Petroleum (syn. *Rock Oil*)—Petroleum is an oil principally obtained in Pennsylvania and other parts of the United States, and in Canada. Where it exists plentifully, the soil is saturated with it, and the oil oozes out of the ground or is obtained by sinking wells.

Chemically speaking, it is a highly complex mixture of volatile oils; and when submitted to distillation yields gases homologous with carburetted hydrogen, liquids of similar constitution, and solid paraffine-like bodies.

The crude petroleum is distilled for commercial purposes, yielding petroleum spirit or mineral naphtha. The uses of this latter product are various. It is employed for illuminating purposes, for lubricating machinery, and as a substitute for turpentine.

The value of a sample of rock oil is determined by distilling a weighed quantity in a small glass retort and weighing the products. The petroleum, or middle product, must be of such a character as to have a specific gravity not higher than 810 or 820, and to contain so little petroleum spirit that it only evolves inflammable vapour when heated to 100° F. in the manner prescribed in the Petroleum Act, 1871, the principal provisions of which are as follows:—

The Petroleum Act, 21*st August* 1871.
34 & 35 *Vict. cap.* 105.

Sect. 2 defines borough, &c.

Sect 3. For the purpose of this Act the term "petroleum" includes any rock oil, Rangoon oil, Burmah oil, oil made from petroleum, coal, schist, shale, peat, or other bituminous substance, and any products of petroleum or any of the above-mentioned oils; and the terms "petroleum to which this Act applies," means such of the petroleum so defined as when tested in manner set forth in Schedule I. to this Act, gives off an inflammable vapour at a temperature of less than one hundred degrees of Fahrenheit's thermometer.

. . . .

Sect. 7. Save as hereinafter mentioned, after the passing of this Act, petroleum to which this Act applies shall not be kept except in pursuance of a licence given by such local authority as is in this Act mentioned. All petroleum kept in contravention of this section shall, together with the vessel containing the same, be forfeited; and in addition thereto the occupier of the place in which such petroleum is so kept shall be liable to a penalty not exceeding twenty pounds a day for each day during which such petroleum is so kept. This section shall not apply to any petroleum kept either for private use or for sale, provided the following conditions are complied with:—

(1.) That it is kept in separate glass, earthenware, or metal vessels, each of which contains not more than a pint and is securely stoppered.

(2.) That the aggregate amount kept, supposing the whole contents of the vessels to be in bulk, does not exceed three gallons.

Sect. 8 defines the local authority to grant licences, &c.

Sect. 9. Licences in pursuance of this Act shall be valid if signed by two or more of the persons constituting the local authority, or executed in any other way in which other licences, if any, granted by such authority are executed. Licences may be granted for a limited time, and may be subject to renewal or not, in such manner as the local authority think necessary. There may be annexed to any such licence such conditions as to the mode of storage, the nature and situations of the premises in which, and the nature of the goods with which petroleum to which this Act applies is to be stored, the facilities for the testing of such petroleum from time to time, the mode of carrying such petroleum, within the district of the licensing authority, and generally as to the safe keeping of such petroleum, as may seem expedient to the local authority. Any licensee violating any of the conditions of his licence shall be deemed to be an unlicensed person. There may be charged in respect of each licence granted in pursuance of this Act such sum, not exceeding five shillings, as the local authority may think fit to charge.

Sect. 10 provides, that should the local authority refuse to grant a licence, the person applying for the same may petition the Secretary of State to grant such licence, forwarding him at the same time the reasons in writing why the said local board refused to grant the said licence.

Sect. 11. Any officer authorised by the local authority may purchase any petroleum from any dealer in it, or may, on producing a copy of his appointment purporting to be certified by the clerk or some member of the local authority, or producing some other sufficient authority, require the dealer to show him every or any place, and all or any of the vessels in which any petroleum in his possession is kept, and to give him samples of such petroleum on payment of the value of such samples. When the officer has by either of the means aforesaid taken samples of petroleum, he may declare in writing to the dealer that he is about to test the same, or cause the same to be tested, in manner set forth in Schedule I. to this Act; and it shall be lawful for him to test the same, or cause the same to be tested, at any convenient place at such reasonable time as he may appoint, and the dealer or any person appointed by him may be present at the testing; and if it appear to the officer or other person so testing, that the petroleum from which such samples have been taken is petroleum to which this Act applies, such officer or other person may certify such fact, and the certificate so given shall be receivable as evidence in any proceedings that may be taken against a dealer in petroleum in pursuance of this Act. But it shall be lawful for the dealer proceeded against to give evidence in proof that such certificate is incorrect, and thereupon the court before which any such proceedings may be taken, may, if such court think fit, appoint some person skilled in testing petroleum to examine the samples to which such certificate relates, and to declare whether such certificate is correct or incorrect.

Any expense incurred in testing any petroleum of such dealer in pursuance of this section shall, if such dealer be convicted of keeping, sending, conveying, selling, or exposing for sale petroleum in contravention of this Act, be deemed to be a portion of the cost of the proceedings against him, and shall be paid by him accordingly. In any other event, such expenses shall be paid by the local authority out of any funds for the time being in their hands.

Sect. 12 imposes a penalty on any dealer who refuses information, or wilfully obstructs the local authority or any officer of the local authority in the execution of the Act.

Sect. 13 authorises a search for petroleum.

Sect. 14 empowers her Majesty by Order in Council to apply the Act to other substances.

. . . . . .

SCHEDULE I.

Directions for testing petroleum to ascertain the temperature at which it gives off inflammable vapour.

The vessel which is to hold the oil shall be of thin sheet-iron; it shall be two inches deep and two inches wide at the opening, tapering slightly towards the bottom; it shall have a flat rim, with a raised edge one quarter of an inch high round the top; it shall be supported by this rim in a tin vessel four inches and a half deep, and four inches and a half in diameter; it shall also have a thin wire stretched across the opening, which wire shall be so fixed to the edge of the vessel that it shall be a quarter of an inch above the surface of the flat rim. The thermometer to be used shall have a round bulb about half an inch in diameter, and is to be graduated upon the scale of Fahrenheit, every ten degrees occupying not less than half an inch upon the scale.

The inner vessel shall be filled with the petroleum to be tested, but care must be taken that the liquid does not cover the flat rim. The outer vessel shall be filled with cold or nearly cold water. A small flame shall be applied to the body of the other vessel, and the thermometer shall be inserted into the oil so that the bulb shall be immersed about one and a half inches beneath the surface. A screen of pasteboard or wood shall be placed round the apparatus, and shall be of such dimensions as to surround it about two-thirds, and to reach several inches above the level of the vessels.

When heat has been applied to the water until the thermometer has risen to about 90° F., a very small flame shall be passed across the surface of the oil on a level with the wire. If no pale blue flicker or flash is produced, the application of the flame is to be repeated for every rise of two or three degrees in the thermometer. When the flashing-point has been noted, the test shall be repeated with a fresh sample of oil, using cold or nearly cold water as before, withdrawing the source of heat from the outer vessel. When the temperature approaches that noted in the first experiment, and applying the flame, test at every rise of two degrees in the thermometer.

Pharmacy Act (31 & 32 Vict. c. 121)—The following are the more important provisions of this Act:—

Sect. 1. From and after the 31st day of December 1868 it shall be unlawful for any person to sell or keep open shop for retailing, dispensing, or compounding poisons, or to assume or use the title "chemist and druggist," or chemist or druggist, or pharmacist, or dispensing chemist or druggist, in any part of Great Britain, unless such person shall be a pharmaceutical chemist, or a chemist and druggist within the meaning of this Act, and be registered under this Act, and conform to such regulations as to the keeping, dispensing, and selling of such poisons as may from time to time be prescribed by the Pharmaceutical Society with the consent of the Privy Council.

Sect. 2 The several articles named or described in the Schedule (A) shall be deemed to be poisons within the meaning of this Act, and the council of the Pharmaceutical Society of Great Britain (hereinafter referred to as the Pharmaceutical Society) may from time to time by resolution declare that any article in such resolution named ought to be deemed a poison within the meaning of this Act; and thereupon the said society shall submit the same for the approval of the Privy Council, and if such approval shall be given, then such resolution and approval shall be advertised in the "London Gazette," and on the expiration of one month from such advertisement the article named in such resolution shall be deemed to be a poison within the meaning of this Act.

. . . .

Sect. 17. It shall be unlawful to sell any poison, either by wholesale or retail, unless the box, bottle, vessel, wrapper, or cover in which such poison is contained be distinctly labelled with the name of the article, and the word "poison," with the name and address of the seller of the poison. And it shall be unlawful to sell any poison of those which are in the first part of Schedule (A) to this Act, or may hereafter be added thereto under section 2 of this Act, to any person unknown to the seller, unless introduced by some person known to the seller; and on every sale of any such article, the seller shall, before delivery, make, or cause to be made, an entry in a book to be kept for that purpose, stating in the form set forth in Schedule (F) to this Act, the date of the sale, the name and address of the purchaser, the name and quantity of the article sold, and the purpose for which it is stated by the purchaser to be required, to which entry the signature of the purchaser and of the person, if any, who introduced him, shall be affixed. And any person selling poison otherwise than is herein provided shall, upon a summary conviction before two justices of the peace in England, or the sheriff in Scotland, be liable to a penalty not exceeding five pounds for the first offence, and to a penalty not exceeding ten pounds for the second or any subsequent offence; and for the purposes of this section, the seller on whose behalf any sale is made by any apprentice or servant, shall be deemed to be the seller; but the provisions of this section, which are solely applicable to poisons in the first part of the Schedule (A) to this Act, or which require that the label shall contain the name and address of the seller, shall not apply to articles to be exported from Great Britain by wholesale dealers, nor to sales by wholesale to retail dealers in the ordinary course of wholesale dealing, nor shall any of the provisions of this section apply to any medicine supplied by a legally-qualified apothecary to his patient, nor apply to any article when forming part of the ingredients of any medicine dispensed by a person registered under this Act: provided such medicine be labelled in the manner aforesaid, with the name and address of the seller, and the ingredients thereof be entered with the name of the person to whom it is sold or delivered in a book to be kept by the seller for that purpose; and nothing in this Act contained shall repeal or affect any of the provisions of an Act of the session holden in the fourteenth and fifteenth years in the reign of her present Majesty, intituled, "An Act to Regulate the Sale of Arsenic." *See* ARSENIC.

SCHEDULE A.

Part I.

Arsenic and its preparations.
Prussic acid.
Cyanides of potassium and all metallic cyanides.
Strychnine, and all poisonous vegetable alkaloids and their salts.
Aconite and its preparations.
Emetic tartar.
Corrosive sublimate.
Cantharides.
Savin and its oil.
Ergot of rye and its preparations.

Part II.

Oxalic acid.
Chloroform.
Belladonna and its preparations.
Essential oil of almonds, unless deprived of its prussic acid.
Opium, and all preparations of opium or of poppies.

Phenylia—*See* ANILINE, NITRO-BENZOLE, &c.

Phosphates in Food—*See* FOOD.

Phosphoretted Hydrogen—Hydride of phosphorus (PH_3). *See* PHOSPHORUS.

Phosphorus ($P = 31$)—A non-metallic element discovered by Brandt in 1669. Relative weight, 62; theoretic specific gravity of vapour, 4·284; observed specific gravity, 4·42; fusing-point, 111·5° F. (44·2° C.); boiling-point, about 550° F. (288° C.)

Phosphorus is prepared on a large scale by the distillation of superphosphate of lime with charcoal. The superphosphate is changed by the process into tribasic calcic phosphate and phosphoric acid, and this free acid is deoxidised by the charcoal—carbonic oxide, hydrogen, and free phosphorus being the ultimate products. The two stages may be thus represented:—

Stage 1. $3(H_4Ca2PO_4) = Ca_32PO_4 + 4H_3PO_4$.
Stage 2. $4H_3PO_4 + 16C = P_4 + 6H_2 + 16CO$.

Phosphorus may be obtained in several allotropic forms. There is a transparent, a white and opaque, a vitreous, a viscous, a black, and a red form of phosphorus. The only two common forms of phosphorus are, however, the common or transparent, and the red or amorphous variety of phosphorus.

The difference between these two forms is great, and may be exhibited as follows:—

Ordinary Phosphorus.	*Red or Amorphous Phosphorus.*
Colourless.	Bright red.
Crystallisable.	Amorphous.
Specific gravity, 1·83.	Specific gravity, 2·14.
Soluble in bisulphide of carbon.	Insoluble in bisulphide of carbon.
Oxidisable and phosphorescent on exposure to air.	Unalterable and not phosphorescent on exposure to air.
Inflammable at 158° F. (70° C.)	Inflammable at 500° F. (260° C.)
Attached energetically by nitric acid.	Action of nitric acid on it but slight.
Combines with chlorine with production of flame.	Combines with chlorine without production of flame.
Very poisonous.	Not poisonous.

Common phosphorus is a violent poison, and its fumes produce on individuals exposed to them for any lengthened period a peculiar disease, known as necrosis of the jaw. This complaint is not so common since the amorphous description of phosphorus has been employed in match manufactories. The amorphous form of phosphorus, indeed, appears to be wholly inert. It has been given in very large quantities to animals, and taken by man in considerable doses, without any apparent effect.—(Annuairo de Thérapeutique, 1855, p. 103.)

Poisoning by phosphorus, accidental, criminal, and suicidal, is not so common here as in France, in which country it appears to be on the increase, and at present occupies the first place in the criminal statistics—*e.g.*, from 1851 to 1872, in 793 cases of poisoning, 287 or 36·2 per cent. were duo to arsenic, and 267 or 31·1 per cent. to phosphorus; whilst in the years 1872 and 1874, in 141 criminal poisonings by arsenic and phosphorus, only 74 were due to arsenic.

This increase may be ascribed in a great measure to the ease with which common phosphorus may bo obtained by the purchase of some kinds of matches, as also the various phosphorous pastes used for the destruction of vermin. Besides this, the taste and odour of phosphorus in a free state is not difficult to conceal, nor is it very repulsive, for Tardieu remarks that he has made dogs swallow the different phosphorous pastes without the animals evincing any repugnance. It is to be hoped that it will be made compulsory in all countries to manufacture matches with the amorphous phosphorus only, both for the sake of the health of the workmen, and also in order to decrease cases of poisoning by this substance.

Symptoms of Poisoning by Phosphorus.—The symptoms, although various, may bo referred to three distinct forms—viz., a common form, a nervous form, and a hæmorrhagic form.—(TARDIEU, Étude Medico-legale sur l'Empoisonnement.) Each of these forms may succeed each other, and only constitute periods in the same case; but it cannot be doubted that each may show itself alone, unaccompanied by the rest, during the whole course of tho malady produced by the poison.

The most common symptoms, and therefore referable to the first form, are that five, six, or even twelve hours after having drunk or eaten something which usually has been referred to as having a disagreeable taste, and may have been followed by alliaceous and phosphorescent eructations, there is pain in the throat and swelling of the tongue. Nausea follows, ending in vomiting, but the latter is not a constant symptom. Vomiting is often followed by colic and diarrhœa; the stomach and bowels are rather tender; the brain is not affected. After twenty-four or thirty-six hours, apparent recovery takes place; the patient walks about, complaining only of wandering pains about the loins and legs. He may go on like this for two or three days, and then die suddenly, without the manifestation of any other symptom.

More commonly, however, about the second or fourth day jaundice appears, accompanied with albuminuria, and death takes place by coma.

The symptoms among infants do not follow this course; they mainly consist of vomiting, somnolence, and convulsions.

In tho second or nervous form the symptoms are mainly referable to the nervous system. There is extremo prostration, painful cramp, delirium about the fifth or sixth day, and death by coma, often preceded by convulsions.

In the hæmorrhagic form the whole course of the disease is slower. Death may not take place for ono or two weeks, or even for a month. Vomiting of blood, stools of blood, ecchymoses of the skin, and frequent hæmorrhages from all or any of the mucous surfaces, with great and progressive weakness and increase in the size of the liver, are the most prominent and marked symptoms.

In all the above forms the vomited or expectorated matters may be luminous in the dark.

In cases where the patient has recovered, a persistent weakness and partial paralysis has been observed.

The most constant *post-mortem* appearances are marks of irritation and inflammation of the stomach and bowels. Sometimes the stomach is perforated. The viscera have frequently presented a luminous appearance, and have emitted white fumes. Fatty degeneration of tho liver and other soft organs is also a very constant change.

Detection.—If there is the peculiar smell of phosphorus in the contents of the stomach or elsewhere, combined with luminosity, there can be little doubt of the presence of phosphorus; so also lumps of phosphorus in a free state may be met with.

In any other case the only certain and reliable method for the detection of free phosphorus is that of Mitscherlich. The tissuo to be examined is cut up into small pieces and placed in a flask with a little water, or if a liquid is under investigation, the liquid may be placed in the flask without water; in any case, a littlo sulphuric acid is added, sufficient to neutralise any ammonia which otherwise all organic matters give off in considerable quantity when distilled (this addition is absolutely necessary, as phosphorus is not luminous in the presence of ammonia). The flask may now be adapted to a small Liebig's condenser, and distilled by the heat of a sand-bath in *perfect darkness.* If free phosphorus be present, the tube will be more or less luminous, according to the quantity of phosphorus present. The distillate, which should be received in a small bottle, will be acid, and will, on being shaken, exhibit a luminosity. The distillate may be treated with a little pure nitric acid, evaporated to a small bulk, and tested qualitatively for phosphoric acid by the usual tests. It may also be estimated by precipitation with ammonia and sulphate of magnesia, the resulting precipitate washed, dried, ignited, and weighed, and the amount of phosphorus calculated out from the pyrophosphate of magnesia.

Free phosphorus often cannot be found even when known to have been taken; the reason of this is that it has undergone oxidation, and appears under the form of phosphoric acid.

In cases where no free phosphorus is found, it has been recommended by some chemists to estimate the phosphoric acid found in the stomach, or even in the tissues. Such a process must inevitably lead to disastrous errors. Phosphates exist in all parts of the body, and even crystals of the ammonia-magnesian phosphate may be found in people who have not taken any free phosphorus, especially when the organs are in a state of decomposition; nor is the phosphoric acid naturally present in the body, fixed and invariable. Jules Lefort found ·179 per cent. of phosphoric acid in the muscles of a man who died from disease at La Pitie, and in the muscles of another corpse, that of a man who died from accident, ·333 per cent. was found. The liver, the stomach, the lungs, &c., of different subjects, yielded variable quantities of phosphoric acid. It must also be remembered that the different varieties of food found in the stomach nearly all contain phosphoric acid, *e.g.*—

	Phosphates. Per cent. of the Substance calculated as Phosphoric Acid. Grammes.
Bread (crust and crumb)	0·049
Beef (fillet)	0·395
Beef (round)	0·398
Veal (fillet)	0·361
Pork (leg)	0·458
Rabbit (leg)	0·387
Carp (muscles of back)	0·345
Pike do.	0·465
Skate do.	0·514
Mackerel do.	0·532
Brain of ox (white and grey substance)	0·503
Brain of sheep	0·760
Tripe	0·067

—(Recherche Toxicologique du Phosphore, Annales d'Hygiène, 1874, ii. p. 405.)

Antidote.—The evidence appears pretty complete that oil of turpentine is a true antidote to phosphorus. The dose should be about a teaspoonful every four hours.—(*See* Arsenic, Phosphore, et Antimonie, par M. le Docteur CH. ROUCHER, Annales d'Hygiène, 1874, t. ii. p. 406.)

Phthisis, Consumption, Tuberculosis, &c.—Although there are differences between phthisis, consumption, and tuberculosis, they are only such as have been pointed out of late years by a more accurate and extended pathology; hence it will be convenient for the study of consumption statistics to define, for the purpose of this article, the term "phthisis" as a disease of the lungs attended by wasting, and returned in the Bills of Mortality as tissie, in the Registrar-General's as phthisis, or tubercular disease, and signified by other writers as consumption, dry-rot, &c.; and it must be premised that a percentage of many other diseases—such as chronic bronchitis, emphysema, fibroid changes of the lung—have been for many years returned as phthisis. It is, however, probable that the figures representing the mortality are fairly accurate, as the errors are to a certain extent compensating; and indeed tubercles are often found even in the diseases above mentioned.

The pathology of phthisis may be shortly stated thus, that there is a production in the lungs and other organs of a morbid product called tubercle, either in the shape of little, grey, almost structureless masses, or a yellow cheesy-like substance, which is either scattered more or less uniformly through the tissue, or is collected into larger or smaller masses. The tissue around each little mass generally inflames and ulcerates, the ulceration and suppuration being an effort of nature to get rid of the foreign substance. Thus, by successive ulceration a large portion of the lung may be destroyed, or by inflammation of such a tissue as the peritoneum, or the meninges of the brain, a fatal result be rapidly attained. Recent researches would appear to show that tubercle begins in the lymphatics, the first changes being in the epithelial cells (endothelium) lining those vessels. It will be convenient to first prove the importance of the study of consumption to hygienists by referring to the mortality from this disease.

Table I., on p. 441, shows the number of deaths from consumption within the London Bills of Mortality from 1629, with several breaks, down to 1832, and is taken from the "Insurance Cyclopædia," art. Consumption.

Consumption occupies the first place in the causes of death. For instance, in the Registrar-General's returns for 1871, phthisis comes first, with the proportional number of 2364 to 1,000,000 deaths from all causes. Then bronchitis, with the proportional number of 2112 to 1,000,000 deaths from all causes.

TABLE 1.—Showing the Number of DEATHS from CONSUMPTION within the LONDON BILL OF MORTALITY from 1629 (with several breaks) down to 1832.

Year.	Number of Deaths.	Year.	Number of Deaths.	Year.	Number of Deaths.	Year.	Number of Deaths.
1629	1827	1685	3502	1741	4981	1787	4579
1630	1910	1686	3569	1742	4716	1788	5086
1631	1713	1687	3473	1743	4353	1789	5172
1632	1797	1688	3867	1744	3865	1790	4852
1633	1754	1689	3981	1745	4015	1791	5090
1634	1955	...	...	1746	4887	1792	5255
1635	2080	1701	2678	1747	4560	1793	5474
1636	2477	1702	2730	1748	4487	1794	4781
...	...	1703	2831	1749	4623	1795	5733
1647	2423	1704	3013	1750	4543	1796	4265
1648	2200	1705	2784	1751	4182	1797	4767
1649	2388	1706	2716	1752	3558	1798	4533
1650	1988	1707	3049	1753	3915	1799	4843
1651	2350	1708	2796	1754	4241	1800	5721
1652	2410	1709	3040	1755	4322	1801	4695
1653	2286	1710	2706	1756	4459	1802	4078
1654	2868	1711	2520	1757	3973	1803	4076
1655	2606	1712	2551	1758	3411	1804	3447
1656	3184	1713	2745	1759	3569	1805	3432
1657	2757	1714	3029	1760	3776	1806	3996
1658	3610	1715	2842	1761	4110	1807	4964
1659	2982	1716	3189	1762	5139	1808	5220
1660	3414	1717	2764	1763	4892	1809	4570
1661	3788	1718	3106	1764	4435	1810	5427
1662	3485	1719	3206	1765	4176	1811	4754
1663	3260	1720	3054	1766	4685	1812	4942
1664	3645	1721	3188	1767	4383	1813	4736
1665	4808	1722	3107	1768	4379	1814	4829
1666	2592	1723	3352	1769	4249	1815	4210
1667	3087	1724	3371	1770	4594	1816	4272
1668	2856	1725	3240	1771	4809	1817	4200
1669	3162	1726	3764	1772	5179	1818	4242
1670	3272	1727	3340	1773	4825	1819	3839
1671	2710	1728	3491	1774	4242	1820	3959
1672	3165	1729	3544	1775	4452	1821	3639
1673	3320	1730	3728	1776	4508	1822	3608
1674	3785	1731	3425	1777	4906	1823	5012
1675	3148	1732	3719	1778	4426	1824	4980
1676	3223	1733	4601	1779	4477	1825	5062
1677	3272	1734	4139	1780	4889	1826	5290
1678	3448	1735	4064	1781	4516	1827	5372
1679	3675	1736	4554	1782	4861	1828	5213
1680	3427	1737	4441	1783	4575	1829	5251
1681	3784	1738	4326	1784	4540	1830	4704
1682	3464	1739	4429	1785	4569	1831	4807
1683	3241	1740	4919	1786	4987	1832	4499
1684	3862						

Dr. Young, writing in 1815, considered that consumption carried off in Great Britain a fourth, in Paris a fifth, and in Vienna a sixth of the inhabitants.

Dr. Clarke, writing in 1835, estimated at one-half the total mortality, and gave the following table of the proportions of deaths from consumption for the 121 years ending 1821:—

TABLE II.

For the year 1700	the deaths from consumption were to all the deaths of the year	145
,, 1700–1750	,,	214
,, 1750–1801	,,	263
,, 1801–1811	,,	288
,, 1811–1821	,,	316

General average for the 121 years, 245, or 1 in 4.

In Dr Farr's letter for 1841 the following extract and table occur, both of which are instructive :—

"Diseases of the respiratory organs were fatal to 92,183 persons in 1841. The mortality which they occasioned was nearly 6 to 1000 [of the living] ; it was 5911 in a million, or 132 less than 1840, when 6645 in a million died of pulmonary affections. Of the decrease of 132 to a million, 55 was in pneumonia, and 75 in phthisis. The mortality by these two diseases remained, nevertheless, excessively high."

TABLE III.

—— :	1838.	1839.	1840.	1841.
Pneumonia—				
Total deaths........	17,019	18,151	18,582	17,997
Deaths to a million living.....	1,219	1,200	1,209	1,154
Phthisis—				
Total deaths........	59,025	59,559	59,923	59,592
Deaths to a million living.....	3,996	5,939	3,897	3,822
Other diseases of respiratory organs—				
Total deaths........	13,799	12,855	14,402	14,594
Deaths to a million living.....	934	850	937	935

Contagion of Consumption. — It has long been firmly believed in Italy that consumption is contagious, but that, generally speaking, it is not so, is sufficiently proved, as Dr. Guy remarks, by the small fluctuations of the annual mortality from this cause. The lowest number of deaths from consumption, for a million of inhabitants of London, for any one of the fifteen years from 1840 to 1854 inclusive, was 2645, and the fluctuation is very slight. The figures in three consecutive years were as follows: 1849, 2777 ; 1850, 2645; 1851, 2970. "If then," Dr. Guy says, "any one were to assert that this disease is contagious, which is tantamount to saying that it may be epidemic, the figures I have quoted would in themselves furnish an answer in the negative. They are suggestive of a domestic disease, influenced as is bronchitis by the seasons and the weather."

The same small fluctuation is shown, if the twenty years from 1850 to 1869 are taken. In the whole twenty the mean annual rate of the deaths from consumption was 3449·1. In the first ten of these years, 1850–59, it was 3551·4 ; in the second ten, 3346·8 : or dividing the whole period into four equal parts of five years each, for the first quarter we have 3665 as the mean annual rate, for the second 3148, for the third 3367, for the fourth 3326—the lowest number being 3326, the highest 3665.

There are, however, instances in which phthisis would appear to be contagious, especially in crowded ships, barracks, and rooms. Dr. Guy indeed mentions a certain printing-house where the workmen died from consumption as fast as if it was contagious. And Dr. Farr in 1815 said, "The prevalence of phthisis in the armies of Europe is probably due in part to the inhalation of expectorated tubercular matter, dried, broken up into dust, and floating in the air of close barracks."

But it must be remembered that in all crowded localities there is direct vitiation of air, and it is difficult to say whether the foul air or actual contagious particles have most to do with the propagation of the malady. In short, consumption under ordinary conditions is certainly not contagious ; but under special insanitary influences, certain forms of consumption may be contagious, although it is still a matter not proven.

Causes.—These may be divided into two great classes : the one comprising all those predispositions which from a variety of causes exist in the constitution of the individual himself, such as hereditary influence, sex and age, &c. ; the other class comprising influences external to the body, such as impure air, occupation, clothing, peculiarities of the soil, climate, &c. Although these causes will be dealt with *seriatim*, those of the second might be reduced to (1) exposure to cold and wet ; (2) impure air, whether from deficient cubic space or the following of an unhealthy occupation ; and (3) dampness of soil.

Hereditary Influences.—We have not the slightest doubt that this influence has been much exaggerated ; it must be remembered that it is one of those influences so mixed up with other surroundings that it is often impossible to estimate it apart.

For example, the father and mother of a family die of consumption, and the children show signs of it; but it will generally be found that these children have been subjected to the same soil, to the same air, and to the same house which developed the phthisis of their parents, yet the cause would probably be put down to hereditary influence! It is this identity of external conditions and occupations amongst many families that swells the figures of so-called hereditary transmission. There are, without doubt, instances pure and simple of this transmission, especially in those cases of general tuberculosis, that every physician must meet with, in which a young person, of a marked strumous appearance, born of diseased parents, yet with every favourable external condition, dies of consumption. There is an accidental consumption, and there is a constitutional consumption. There is a consumption that arises from a common cold, in which the inflammatory action, first in the bronchial tubes, insidiously extends itself to the air-cells of the lungs, and thus being accidental, can hardly be transmitted, at all events to children begotten before the disease was contracted; and there is a consumption the seeds of which are constitutional or latent, the germs of which are born with the individual, and ready to light up on the least exciting cause. This latter may be, and frequently is, transmitted. Medical men to insurance companies should not alone study the bare figures, which give an exaggerated idea of hereditary influence, but inquire as to the conditions under which the consumptive progenitor existed.

Dr. Brinton found that among hospital consumptive patients, about 90 per cent. had lost some of their nearer relatives by what appeared to be the same disorder; "and that instead of $1\frac{1}{2}$ out of 10 (the average mortality), about $3\frac{1}{2}$ had thus died."

In relation to this he says further: "There is an impression (which is favoured by some well-known facts in the physiology of generation) that the tendency to phthisis is more likely to be transmitted by a mother than by a father thus diseased. Other things being equal, it may be so; but such preponderance is often outweighed by a strong and predominant likeness of the offspring to either of their parents. For such an external likeness may well be supposed associated with an equal similarity of constitution, especially where it involves the framework of the thoracic cavity, in which the disease chiefly shows itself. Hence, though the father of one subject may have died of decline, still if he himself takes strongly after his mother, this resemblance to the healthier branch of his ancestry goes far to nullify the injurious suspicions which his father's death might otherwise have excited."—(On the Medical Selection of Lives for Assurance, by Dr. Brinton.)

According to the medical officers of the Brompton Hospital, as to the proportion of cases on the books in which hereditary taint could be traced, out of 1010 cases, comprising 669 males and 341 females, 122 males and 124 females (forming 18 and 36 per cent. respectively of the whole, or 24·5 per cent. of males and females combined) were born of phthisical parents; or, in other words, 1 in every 4 of the 1010 patients was descended from consumptive parents.

As hinted at before, all these figures, as they do not distinguish between accidental and constitutional consumption, are to be looked upon with suspicion.

Sex and Age.—The influence of sex and age is indisputable. Women are more liable to consumption than men, old people less liable than young and middle-aged. Women are more exposed to the bad hygienic condition of an insanitary dwelling; and old men, from the very fact of their being old, are, so to speak, *selected lives.* Sir James Clark showed that in seven cities in Europe and America there is a pretty uniform decline in the ratio of deaths from phthisis from twenty years to extreme age.

In Edinburgh the ratio was found to decline from ·285 at twenty years, to ·052 above sixty years; at Nottingham, from ·416 to ·017 in the same period of time; at Chester, from ·245 to ·054; at Carlisle, from ·290 to ·097; and in Paris, according to Louis, from ·325 to ·042: while the general average decline was from ·285, or 28·5 per cent., at twenty to thirty, to ·078, or 7·80 per cent., above sixty.

Dr. Guy prepared the following table, showing the deaths from consumption in 1000 males and 1000 females of the population of England and Wales, and of London respectively, living in 1851, at decennial ages:—

TABLE IV.

Ages.	Males.		Females.	
	England.	London.	England.	London.
15 to 25 . . .	3·18	2·96	3·85	2·46
25 ,, 35 . . .	4·03	4·81	4·55	3·58
35 ,, 45 . . .	4·(8	6·34	4·14	4·45
45 ,, 55 . . .	3·95	6·47	3·18	3·29
55 ,, 65 . . .	3·55	5·07	2·68	2·64
65 and upwards	2·2)	3·62	1·51	2·45

Dr. John Clendinning's table, which appeared in the "Statistical Journal," shows the same thing—viz., that consumption declines after puberty.

Of 1044 deaths occurring in the workhouse and infirmary of Marylebone between May 1821 and December 1835, the distribution according to age was as follows:—

TABLE V.

	No. of Deaths from Phthisis.	Percentage Proportion of each Year
Under 5 years	70 }	8·33
From 5 to 10 ,,	17 }	
,, 10 ,, 20 ,,	52	5·08
,, 20 ,, 30 ,,	247	23·66
,, 30 ,, 40 ,,	223	21·36
,, 40 ,, 50 ,,	164	15·71
,, 50 ,, 60 ,,	121	11·59
,, 60 ,, 70 ,,	97	9·29
,, 70 ,, 80 ,,	45	4·31
,, 80 ,, 90 ,,	7	0·67
Totals . . .	1043	100·00

Impure Air, Density of Population, Overcrowding, &c.—The three headings of this section may be, practically speaking, reduced to one—viz., impure air; for although it is true that together with impure air there are often other coexisting influences (such as dusty employments, insufficient food, &c.), yet that impure air alone will produce consumption, the excessive mortality of soldiers in certain barracks, alluded to in our article on Hygiène (Military), sufficiently proves. *See also* article OVERCROWDING.

The following table shows the relation between density of population and phthisis :—

TABLE VI.

	Density of Persons to a Square Mile.	Proximity or Nearness of Person to Person.	Average Annual Mortality to 100,000 Living.					
			Phthisis.			Other Diseases of the Respiratory Organs.		
		Yards.	15 to 25.	25 to 35.	35 to 45.	15 to 25.	25 to 35.	35 to 45
Healthy districts .	135	163	336	398	330	34	45	67
London . . .	19,470	14	264	395	493	45	69	148
Lancashire . . .	1,008	60	419	475	484	46	86	195
England and Wales .	308	108	362	438	407	38	61	113

Occupation.—In the consideration of *occupation* as influencing the disease, the differences we meet with are striking and remarkable, especially as regards outdoor and indoor employments, and residence in town or country. With respect to the latter, the death-rate from consumption and other diseases of the respiratory organs was stated by Dr. Farr in 1843 to be 782 in towns, against 5·22 in country districts, to each 100,000 living; but the actual rate is much higher than this, for the country returns are exaggerated by many artisans and others, who, born in the country, contract their chest affection in the town and return home to die. The influence of indoor against outdoor occupation is shown in the following table :—

TABLE VII.—DEATHS from TUBERCULAR DISEASE at the VICTORIA PARK HOSPITAL, showing the influence of Occupation.

Cause of Deaths.	Ages under 20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	Not stated.	Totals.
Female lives . . .	45	41	25	15	12	3	1	1	...	...	...	143
Indoor occupation . .	32	31	30	24	15	9	5	...	...	...	4	150
Males { Mixed . . .	10	7	7	5	4	3	4	...	...	...	1	41
Males { Outdoor . .	9	21	21	13	12	11	8	2	1	...	2	100
	96	100	83	57	43	26	18	3	1	...	7	434
The same reduced to a percentage.												
Female lives . . .	32	28	18	10	8	2	1	1	...	...	...	100
Indoor occupation . .	21	21	20	16	10	7	3	...	...	...	2	100
Males { Mixed . . .	24	17	17	12	10	7	10	...	...	...	3	100
Males { Outdoor . .	9	21	21	13	12	11	8	2	1	...	2	100
	86	87	76	51	40	27	22	3	1	...	7	400

If we examine more in detail the influence of occupation, we shall find, generally speaking, that those pursued in the largest houses, with the best diet and the warmest clothing, are the least subject to consumption; thus Dr. Guy, in a valuable contribution to the Journal of the Statistical Society, gives Table VIII.

"The ratio of deaths from consumption follows the same order as the average age at death, being lowest where the average age is highest, and the reverse. Thus the average age at death of the class of gentlemen is 58·61, and the ratio of deaths from consumption 1 to 2·60; while in the class of artisans the average age is 48·06, and the proportion of deaths from consumption 1 to 2·29.

TABLE VIII.

Condition.	15 to 20.	20 to 30.	30 to 40.	40 to 50.	50 to 60.	60 to 70.	70 to 80.	Under 30.	Under 40.	Average Age at Death.	Ratio.	No. of Deaths. Consump-tion.	Other Diseases.
Gentlemen, &c.	10·84	18·67	27·11	19·27	15·06	6·03	3·01	29·51	56·62	39	1 to 5·00	166	835
Tradesmen... ..	8·46	24·34	26·98	20·11	12·70	6·35	1·06	32·80	59·78	38	1 to 2·60	189	491
Artisans.........	7·25	23·69	26·24	22·79	13·34	6·26	0·43	30·94	57·18	38½	1 to 2·29	2318	5308

"Again, the class of gentry presents a smaller proportional number of deaths under thirty and forty than either of the other classes. It is also well worthy of observation that the percentage proportion of deaths from consumption under thirty and forty is higher in the class of tradesmen than in that of the artisan and labourer, although the ratio of cases of consumption is greater in the latter class. This is doubtless accounted for by the fact already established, that the strong exertion which a considerable portion of the labouring class employed within doors use in their occupations, and the large number employed out of doors, has the effect of retarding the attack of pulmonary consumption. The tradesman, it will be seen, occupies the intermediate place between the indoor and outdoor labourer, between the artisan using little exertion and the artisan using much exertion. . . . Another point attracts attention—viz., the great proportion of deaths from consumption occurring in the class of gentry from fifteen to twenty years of age. Does not this show that the liability to the disease is greater in this class than in the two others, and does it not tend to strengthen the position that the excess of the deaths from consumption in the other classes is due to the unfavourable circumstances in which they are placed?

"The ratio of deaths from consumption in the class of gentry, low as it is, would have been still lower if the medical men, who are included in it, were omitted. The number of cases of pulmonary consumption occurring in members of that profession is very remarkable, and it is a subject of regret with the author that they were not made a separate class."—(*Op. cit.*)

An interesting paper was read at the Statistical Society in 1841, by Major Tulloch, in which the diseases of the lungs amongst naval and military men were compared. It appears that the chest attacks were twice as numerous in the naval as in the military force, but the mortality only half as great. This peculiarity would appear to arise from the naval affections being less deadly, and indeed, on reference to the table, it will be seen there is more consumption in the army than in the navy, and what was true then is almost equally true now:—

TABLE IX.

	Naval Force. Out of an Aggregate Strength of 55,709. Attacked.	Died.	Military Force. Out of an Aggregate Strength of 62,300. Attacked.	Died.
Inflammation of lungs and pleurisy	1,742	54	1667	71
Spitting of blood	147	3	171	7
Consumption.........	285	165	417	272
Catarrhs	11,237	12	6586	52
Asthma and difficulty of breathing	103	3	112	3
	13,514	177	8953	405
Annual ratio per 1000 of mean strength	243	3·2	144	6·5

In the sixth report of the medical officer of the Privy Council it is stated, "*In proportion as the people of a district are attracted to any collective indoor occupation, in such proportion, other things being equal, the district death-rate by lung diseases will be increased.*" For the bad ventilation, which as a rule belongs to the place of employment, tends to develop among the workpeople a large excess of phthisis, and probably some excess of other fatal lung diseases; and probably in all England there is no exception to the rule, that in every district which has a large indoor industry the increased mortality of the workpeople is such as to colour the death return of the whole district with a marked excess of lung disease. The mortuary statistics recently laid before Parliament place this matter in a singularly striking light. In those returns, for instance, it may be seen that while about

100 deaths by phthisis and other lung diseases are occurring in various agricultural districts of England among men aged from fifteen to fifty-five, there occur in similar masses of population in Coventry 163 such deaths; in Blackburn and Skipton, 167; in Congleton and Bradford, 168; in Leicester, 171; in Leek, 182; in Macclesfield, 184; in Bolton, 190; in Nottingham, 192; in Rochdale, 193; in Derby, 198; in Salford and Ashton-under-Lyne, 203; in Leeds, 218; in Preston, 220; and in Manchester, 263. The same sort of evidence comes out even more strongly when (as in the annexed table) the statistics are limited to the decennial of adolescence, and are so given that, with regard to districts where only one sex pursues indoor industry, the death-rates of the sexes may be compared. There, for instance, it is seen (and no one who knows the circumstances under which girls are employed in lace-making and straw-plaiting can wonder at the fact) that among the adolescent population of Berkhampstead, Newport Pagnell, Towcester, and Leighton Buzzard, the female victims of lung disease are more than twice as numerous as the male. And there, again, in the death-rates of Leek, Congleton, and Macclesfield, the same sort of sad testimony is borne (but not exclusively by the female population) as to the atrocious sanitary circumstances under which much of our silk industry is conducted.

TABLE X.

District.	Nature of principal Industry in the District.	Death-Rate by Phthisis and other Lung Diseases at between 15 and 25 Years of Age, per 100,000 of each Class referred to. Male.	Female.
Berkhampstead	Extensive female employment in straw-plaiting	219	578
Leighton Buzzard		319	554
Newport Pagnell	Extensive female employment in lace-making	301	617
Towcester		239	577
Yeovil	Extensive female, with some male, employment in glove-making	280	409
Leek	Extensive employment — more female than male—in silk-work	437	856
Congleton		566	790
Macclesfield		593	890
Standard Northern District	Agriculture	531	333

With regard to dusty occupations, &c., H. C. Lombard (Recherches Anatomiques sur l'Emphysème Pulmonaire) showed that in 1000 deaths from consumption the following causes contributed in the relative proportions named in the following enumeration:—

Occupations with vegetable and mineral emanations	176
Occupations with various dusts	145
Sedentary life	140
Workshop life	138
Hot and dry air	127
Stooping posture	122
Sudden movements of the arms	116
Muscular exercise and active life	89
Exercise of the voice	75
Living in the open air	73
Animal emanations	60
Occupations with watery vapour	53

The order of the respective fatality of "dusts" he found to be as follows: (1) mineral; (2) animal; (3) vegetable.

Influence of Season, Climate, &c.—In this branch of inquiry it is difficult to obtain accurate data as to which particular season produces the largest number of cases of consumption. Probably it is the coldest and dampest time of the year, when colds and coughs are frequent, which does the mischief. With regard to the actual mortality, the evidence renders it certain that the spring is the most fatal. Mr. Haviland, in his "Climate, Weather, and Disease," 1855, says: "In England we learn from the statistical returns that the *spring* is the most fatal to consumptive patients, whether male or female; but with regard to the other seasons there is considerable variability. For instance, suppose we take the seasons of 1838 in the order of their fatality to males, they would stand thus—spring, 1137; winter, 1048; summer, 968; autumn, 904. To females—spring, 972; summer, 937; winter, 896; autumn, 825. Then again, although the spring invariably takes the lead, the other seasons change places with each other from year to year; and what is remarkable, this inconsistency does not seem to be dependent upon the temperature, as we shall presently see. In the returns for 1853 the following statistics in deaths from consumption appear: winter, 1872; spring, 1971; summer, 1745; autumn, 1914. The order of fatality in the years above quoted would therefore be:—

1838.—*Males.*
1. Spring. 2. Winter. 3. Summer. 4. Autumn.

1838.—*Females.*
1. Spring. 2. Summer. 3. Winter. 4. Autumn.

1840.—*Total.*
1. Spring. 2. Winter. 3. Summer. 4. Autumn.

1853.—*Total.*
1. Spring. 2. Autumn. 3. Winter. 4. Summer."

So far, therefore, as seasons are concerned, the above table proves that *spring*—*i.e.*, April, May, June—is the most inimical quarter to phthisical patients, and probably *autumn*—October, November, December—the least so. In London at least, if not throughout England generally, the spring is undoubtedly the most obnoxious to consumptive cases; and this statement is in accordance with the experience of those physicians who have opportunities of seeing the rise, progress, and end of many hundreds of phthisical patients during the year. Dr. Richard Quain observes "that the cold easterly wind of spring completes the work which the winter had left undone."

Influence of Soil, Locality, &c.—Drs. Bowditch and Buchanan, working independently, have successfully established the fact that there is a decided relation of cause and effect between dampness of soil and consumption; and Mr. Simon and others have shown how draining has actually diminished the disease in several localities. These researches will no doubt lead to good results, and explain the immunity from consumption that many districts of the world, with the most varied climates, enjoy. A knowledge of the geographical distribution of the disease will probably be extremely valuable to the hygienist. In our own country this has been successfully traced by Mr. Haviland and others, and in the United States by Dr. Andrews of the Chicago Medical College. According to the latter observer, consumption is most abundant near the sea, and diminishes as we recede from it. At equal distances from the sea it prevails at the north and diminishes towards the south. For example, beginning at Massachusetts and going westward, the proportion of deaths from consumption to deaths from all causes regularly diminishes as we recede from the Atlantic. Thus deaths from Massachusetts, 25 per cent.; New York, 20 per cent.; Ohio, 16 per cent.; Indiana, 14 per cent.; Illinois, 11 per cent.; Missouri, 9 per cent.; Kansas, 8 per cent.; Colorado, 8 per cent.; Utah, 6 per cent.; and then in California it increases again to 14 per cent., on account of the proximity of the Pacific Ocean. A similar decrease is observed in going from north to south—viz., Michigan, 16 per cent.; Indiana, 14 per cent.; Kentucky, 14 per cent.; Tennessee, 12 per cent.; Alabama, 6 per cent.

It has been observed, speaking generally, that the mortality from consumption appears to follow the moisture and temperature of localities. Massachusetts is ten times as fatal to consumptives as Georgia; and Minnesota, notwithstanding all that has been said in its favour, is twice as fatal as Georgia. A damp soil, a damp atmosphere, and variable weather, are great producers of consumption.

Prevention.—It will be gathered from the enumeration of the chief causes productive of consumption that such influences as cold winds, seasons, constitutional weakness, &c., are beyond the control of man. There probably will always be deaths from this malady; but, on the other hand, the consumption arising from damp soil, unhealthy trades, tight clothing, &c., can certainly be remedied by the hygienist. Dr. Guy remarked, in his inquiry into the health of letterpress-printers, that out of 36,000 deaths annually in England and Wales, which he attributed to true pulmonary consumption, 5000 might be saved by increased space and improved ventilation in ships, workshops, and factories. And there is in certain localities a diminution of consumption solely by draining the damp soil. So that we may confidently hope for good results when the public shall have been fully awakened to the necessity of diminishing overcrowding, of making provision for thorough ventilation, and attending to hygienic precautious generally.

Pickles—Various adulterations have been met with in pickles. The most common frauds are substitutions, such as shrivelled cucumbers pickled instead of gherkins, or white cabbage, coloured red, sold for red cabbage. The beautiful green colour given to many preserved vegetable substances has several times been found to be due to salts of copper; and as pepper, salt, vinegar, and other substances are used as pickling agents, all these may be adulterated. *See* respective articles on these substances.

Picrotoxine—The active principle of *Cocculus Indicus*. *See* COCCULUS INDICUS.

Pigs and Pigsties—Pigs and pigsties are in rural districts the most frequent nuisances a sanitary inspector has to deal with.

No pigsty should be interfered with simply because it is a pigsty, and no action taken unless it is evidently a nuisance. It must be remembered that the pig is so much food to the poor man, and that many cottagers would be on the parish were it not for their pig, and that it is the peculiar office of hygiène not to increase but to diminish the poor-rates. But, on the other hand, every pigsty should be properly drained; and where no effective drain or sewer is near the sty, the owner of the pig should be compelled to make a proper, covered, ventilated, and water-tight tank, in which the fluid matters may be drained and collected.

Urban authorities have ample powers with regard to pigsties under P. H., s. 46, which enacts that any swine or pigsty kept by any person in a dwelling-house, or so as to be a nuisance to any person, is liable to a penalty of 40s. or less, and to a further penalty (if offence is continued) of 5s. a day. The authority can also, if they choose, abate the nuisance themselves, and recover the expenses of such action from the *occupier* of the premises in a summary manner.

In the case of *rural* authority, action, where necessary, may be taken with regard to pigsties under P. H., s. 91, 3. *See* NUISANCES.

Pimento—*See* ALLSPICE.

Pine - Apple — (*Ananassa sativa*)—This fruit, although possessing but little nutritive value—containing not more than 13 per cent. of solid matter—has an agreeable flavour, and is often useful as an antiscorbutic. Besides being eaten in the fresh state, it is made into a preserve with sugar, and is also used for the purpose of flavouring rum.

Piperidine—*See* PEPPER.

Piperine—*See* PEPPER.

Plague—A contagious and specific fever, attended with an eruption of carbuncles and swelling of the inguinal and other glands. It has been known under different names at different times, such as the Black Death, the Grand Mortality, the Great Plague, the Oriental Plague—all these are one and the same disease.

According to Papon, the origin of the plague is lost in remote ages.—(De la Peste; ou, Époques Mémorables de ce Fléau, et les Moyens de s'en preserver, t. ii. Paris, An. VIII. de la Rép. 8.) The remotest period to which we can distinctly trace it is in 544, when it broke out as the plague of Constantinople, Justinian being emperor. Before that date, and since, there are notices in authentic history of a great many pestilences, some of which were the true plague, others probably malignant fevers. Hecker traces the plague in China in the year 1333, and ascribes the outbreak of the black death of the fourteenth century, amongst other causes, to contagion from the East. The great historical outbreaks of plague are—(1) the black death of the fourteenth century; (2) the plague of the fifteenth and sixteenth centuries; (3) the great plague of the seventeenth century.

Anglada (Étude sur les Maladies Étcintes) traces the black death from China into Europe by three distinct routes — "the northern route, by Bokhara and Tartary, the Black Sea and Constantinople, having brought it by the Bosphorus and the Mediterranean, and so into Europe."

Some writers, especially Hecker, have been at great pains to chronicle the disastrous commotions of the earth and atmosphere, the famines, the fearful earthquakes, which occurred simultaneously with the plague—how mountains like Tsinchcon fell in, leaving a hideous chasm—how meteors appeared, and plagues of locusts came with the wind, and dying, polluted the air; but it is doubtful whether all or any of these phenomena, apart from the distress and mental depression they would occasion, had any share whatever in even acting as predisposing causes. It spread by contagion, and contagion only; its origin is as mystic as the origin of all created things. Of the active nature of this contagion the following passages from Hecker will give a striking idea:—

> Every spot which the sick had touched, their breath, their clothes, spread the contagion; and as in all other places, the attendants and friends, who were either blind to their danger or heroically despised it, fell a sacrifice to their sympathy. Even the eyes of the patient were considered as sources of contagion which had the power of acting at a distance, either on account of their unwonted lustre or the distortion which they always suffer in plague, or in conformity with an ancient notion, according to which the sight was considered as the bearer of a demoniacal excitement.
>
> The pestilential breath of the sick who expectorated blood caused a terrible contagion far and near; for even the vicinity of those who had fallen ill of plague was certain death, so that parents abandoned their infected children, and all the ties of kindred were dissolved.*

The mortality of the black death was, without doubt, dreadful; it desolated Asia, Europe, and Africa, and the people yet preserve the remembrance of it in gloomy traditions. It began in Europe in January 1348, and visited Greece, Italy, Germany, France, &c., and reached England in August of the same year, appearing first in Dorset,

* "Et fuit tantæ contagiositatis specialita quæ fuit cum sputo sanguinis quod non solum morando, sed etiam inspiciendo unus recipiebat ab alio; intantum quod gentes moriebantur sine servitoribus, et sepeliebantur sine sacerdotibus, pater non visitabat filium, nec filius patrem, charitas erat mortua, spes prostrata."

spreading through Devon and Somerset, and throughout the whole country. At that era there were no bills of mortality nor trustworthy records of population anywhere, so that its ravages can only be estimated approximatively. Hecker assumes that Europe lost no less than 25,000,000 of its inhabitants. He gives the following estimate of the mortality in different cities:—

In Florence there died of the black plague	60,000
In Venice	100,000
In Marseilles, in one month	16,000
In Siena	70,000
In Paris	50,000
In St. Denis	14,000
In Avignon	60,000
In Strasbourg	16,000
In Lübeck	9,000
In Basle	14,000
In Erfurt, at least	16,000
In Weimar,	5,000
In Limburg	2,500
In London, at least	100,000
In Norwich	51,000

To which may be added—

Franciscan Friars in Germany	124,434
Minorites in Italy	30,000

It is a noticeable fact, that in all attacks of the plague, a disease among domestic animals of a similar nature has appeared; it is probable that it is communicable to animals. "Boccaccio himself saw two hogs on the rags of a person who had died of plague, after staggering about for a short time, fall down dead, as if they had taken poison. In other places multitudes of dogs, cats, fowls, and other animals, fell victims to the contagion; and it is to be presumed that other epizootics among animals likewise took place, although the ignorant writers of the fourteenth century are silent on this point." —(HECKER.)

The moral effects of the black death were extraordinary and characteristic at once of the manners, barbarity, and ignorance of the age. The panic was universal. Merchants poured their riches into the monasteries to the horror of the monks, who feared contagion with the money-bags; the Flagellants revived and marched in long processions through the towns of Europe until they attained political significance, and were crushed by the rulers and persecuted by the people; the fears of instant death banished all the social and kindly relations, and curdled the milk of human kindness.

The contagion of the plague appears to have frequently been conveyed by drinking water from the very inefficiently-protected wells; hence there arose a cry that the wells were poisoned, and suspicion fell upon the Jews, who were almost everywhere racked and tortured, burnt and massacred.

In the plagues of the sixteenth and seventeenth centuries more accurate statistics as to the mortality can be obtained. London had then its weekly bills of mortality, which although imperfect, yet have considerable value. Mr. Marshall has compiled from these and other sources tables which give a good idea of the fatality of the disease. From them we glean the important fact that besides the recognised plague years, the plague, as a disease, appears at that period to have been seldom absent from the country; and in many years not alluded to by historians as seasons of pestilence, there are entries varying from less than 1000 to more than 4000 deaths from plague in the year. It appears to have been most prevalent in the warm weather and autumn, less in the spring, and least of all in the winter; in fact, it was an exotic plant, requiring warmth, and really foreign to our clime. The epidemics always reached their climax in summer, and decreased when the cold weather set in. There was from 1593 to 1665 about one outbreak in every fifteen years —*i.e.*, five serious epidemics of pestilence.

In London, according to Sir William Petty, the plague usually killed one-fifth of the inhabitants. The figures for the five great plague years are as follows: 1593, 11,503; 1603, 36,269; 1625, 35,417; 1636, 10,400; 1665, 68,596. This last figure belongs to the year of what is commonly called *The* Plague of London—The Great Plague. In this last, and indeed in most of the others, there were no phenomena of earthquakes, meteors, famines, &c.; it was indeed so much a season of great prosperity, that foreign writers were in the habit of ascribing the pestilence to the gluttonous habits of the English people. The first two cases began in 1664 in a family at Westminster, whence the disease was carried into London; but the December frosts delayed its spreading. On the break up of winter, however, it gained ground; the authorities became alarmed, and infected houses were shut up and marked with a red cross (X) inscribed with "The Lord have mercy upon us;" but the plague still increased.

"Nor will this surprise us if we imagine the frantic and successful efforts that must have been made by the non-infected to escape, and the temptation to servants and nurses to appropriate and remove the property of the dying and dead. Indeed, Dr. Hodges accuses the nurses of strangling their patients, and secretly conveying the pestilential taint from sores of the infected to those who were well; and he justifies his accusations 'of these abandoned miscreants'—the Gamps and Prigs of the seventeenth century—by two instances: the one, of a nurse who, 'as she was leaving the house of a family, all dead, loaded with her robberies, fell down dead under her burden in the streets;' the other, of a 'worthy citizen,' who being considered dying by his nurse, was beforehand stripped by her, but recovering again, he came a second time into the world naked."—(Dr. GUY, Public Health, Part I. p. 90.)

In August and September the disease attained its maximum. Three, four, and five thousand died weekly, and one week in the middle of September the death-roll reached the astonishing figure of 8000. The moral influence in London showed itself by a thousand extravagances; and the near expectation of death gave rise to acts of atrocity, cowardice, madness, and heroism. The aspect of the streets at the time of the plague is described by various writers as something terrible. "Some of the infected ran about staggering like drunken men, and fell down dead in the streets, or they lay there comatose and half dead; some lay vomiting, as if they had drunk poison; and others fell dead in the market in the act of buying provisions." The plague spared "no order, age, or sex." The divine was taken in the very exercise of his priestly office, and the physician while administering his own antidote; and though the soldiers retreated and encamped out of the city, the contagion followed and vanquished them. Many in their old age, others in their prime, most women and still more children, perished; "and it was not uncommon to see an inheritance pass successively to three or four heirs in as many days." There were not sextons enough to bury the dead, the bells ceased tolling, the burying-places were full, so that the dead were thrown into large pits dug in waste ground in heaps, thirty or forty together; and those who attended the funerals of their friends one evening were often carried the next to their own long home.

It rapidly declined after September, and in December the city again filled; and the whole malignity ceasing, the city returned to itself —as after the great fire, "a new city suddenly arose out of the ashes of the old, much better able to stand the like flames another time." But it was by no means confined to London, for the continual exodus of infected people, merchandise, clothing, &c., conveyed the infection into the country, and even into remote hamlets.

The plague has not been seen in England for two centuries, but it prevails occasionally in Egypt and the East. It broke out at Copenhagen in 1712, at Marseilles in 1720, at Moscow in 1771. It has appeared in the present century at the Russian ports in the Black Sea. In 1813 it broke out in Malta and Gozo, killing between 4000 and 5000 people. Later still it invaded in 1816, Noja (Calabria); in 1818, Corfu; in 1819, Silesia; and lastly, in 1828–29, it devastated the Russian army in Bulgaria; whilst there is reason to believe there have been yet more recently at Odessa cases of true Oriental plague. In many of these places the disease was new to the oldest physician living. It had not been seen in Moscow for 150 years, nor in Malta for 137, so that we dare not say that England is perfectly safe from future infection. Given a tropical summer, a cargo of plague-stricken passengers, and an unhealthy badly-managed port, the plague may yet be revived.

The symptoms of the Oriental plague, as seen in modern times, are identical in all essential points with those of the black death and the plague of the seventeenth century. It has been well described by Dr. Russel. In the most destructive forms the vital forces appear to be suddenly annihilated by a most intense and malignant blood-poisoning, and death is remarkably rapid, without external eruption, of buboes, carbuncles, or spots. In such cases the body has no time to show the "tokens" before death. In the great majority of cases the disease is preceded by lassitude, loss of strength, anxiety, and afterwards by vomiting. The characteristic swellings in the armpit and groin follow, petechiæ and carbuncles appear, delirium succeeds, and too frequently death. The carbuncle is not of constant occurrence; Dr. Russel found it in 490 cases out of 2700. The body is generally covered with them, the only parts exempt being the scalp, the palms of the hands, and the soles of the feet. The disease has most resemblance in its course to typhus fever.

Pathology shows rather the effects of the poison on the tissues and organs, as shown by enlargement and congestion of the spleen, kidneys, &c., than anything especially characteristic. There are numerous hæmorrhagic effusions, and dissection shows that buboes always result from enlargement and suppuration of the lymphatic glands. It is probable that all the fluids and secretions of the plague-stricken body are contagious.

In case plague be reported as existing in any port with which we have commercial relations, it will be the duty of the port sanitary authorities to use every effort, by a strict inspection of vessels, to prevent the introduction of this disease. The prevention of its propagation would be similar to that recommended in our articles on typhus, cholera, &c., consisting of quarantine of infected vessels, strict isolation in proper hospitals, disinfection of the clothing, excreta, pus from the buboes, &c., speedy burial, and general sanitary measures. *See* CHOLERA; DISINFECTION; FEVER, TYPHUS, &c.

Plaice (*Platessa vulgaris*)—A fish common on the English and Dutch coasts. It is comparatively easy of digestion, but is very watery, containing only 22 per cent. of solid matter, 18 of which is nitrogenous, hence it requires fat to increase its nutritive value.

Plantations—M. Chevreul, in his work on the hygiène of cities, considers that the judicious distribution of trees and plantations around a town is of some importance in sanitation, by purifying the air and getting rid of organic matters.

It has, however, long been the custom to plant belts of trees so situated as to break the force of the cold winds, and thus shelter exposed houses, which indirectly preserves health by rendering habitations warmer.

Trees planted along public walks, although they entail more expense in the repair of roads, are doubtless useful, and of sanitary importance, by the facility they afford for shelter in wet or shade in hot weather. They thus diminish the danger of sunstroke and some other diseases. In an urban district a court of summary jurisdiction may award compensation to be paid to the local authority by a person injuring trees.

Playthings—The bright green, yellow, and red colours coating playthings are often composed of such virulent poisons as ceruse, vermilion, arsenical greens, orpiment, salts of copper, &c. Several cases of poisoning from children sucking such toys are recorded by Chevallier (Annal. d'Hygiène, tom. xli., 2d series, 1874) and other observers. As harmless colours could be substituted for those in use, this should certainly be done. It is possible that sucking the paint off toys may be the cause of a considerable amount of sickness amongst children which has hitherto escaped detection in this country.

Plum—A name applied to several varieties of the *Prunus domesticus* (Linn.) or wild plum. This is supposed to be a native of Asia Minor, but it has long been naturalised in England. Among the cultivated varieties those best known are the damson, greengage, French plum, magnum bonum or mogul, Mirabelle, Orleans, and prune. The following table shows the composition of many of these kinds :—

	Mirabelle Common Yellow.	Greengage.		Black-blue Middle-sized Plums.	Dark Black-red Plums.	Mussel Plums.	
		Yellow Green, Middle Size.	Large Green, very Sweet.			Common.	Italian, very Sweet.
Soluble matter—							
Sugar . . .	3·584	2·960	3·405	1·996	2·252	5·793	6·730
Free acid (reduced to equivalent in malic acid) . . .	0·582	0·960	0·870	1·270	1·331	0·952	0·841
Albuminous substances	0·197	0·477	0·401	0·400	0·426	0·785	0·832
Pectous substances, &c.	5·772	10·475	11·074	2·313	5·851	3·646	4·105
Ash	0·570	0·318	0·398	0·496	0·553	0·734	0·590
Insoluble matter—							
Seeds	5·780	3·250	2·852	4·190	3·329	3·540	3·124
Skins, &c. . . .	0·179	0·680	1·035	} 0·509	1·020	1·990	0·972
Pectose . . .	1·080	0·010	0·245			0·630	1·534
[*Ash from insoluble matter included in weights given*] . .	[0·082]	[0·039]	[0·037]	[0·041]	[0·063]	[0·094]	[0·066]
Water . . .	82·256	80·841	79·720	88·751	85·238	81·930	81·272
	100·000	99·971	100·000	99·925	100·000	100·000	100·000

Pneumonia — Pneumonia is an inflammation of the lungs, and when the pleura is affected as well, it is then called pleuro-pneumonia.

The disease is usually divided into (1) acute or croupous pneumonia; (2) catarrhal pneumonia; and (3) chronic or interstitial pneumonia, to which a fourth form may be added—viz., that kind of pneumonia so often seen as a complication of zymotic diseases.

Inflammation of the lungs may be produced by a variety of causes. The catarrhal kind appears first to be a bronchitis, and then by extension to invade the lung tissue; it is in its essence a secondary form. The chronic or interstitial form is that produced by external irritants, such as the breathing of dust, and is elsewhere described as fibroid phthisis (*see* PHTHISIS); whilst the fourth kind of pneumonia appears to arise from the blood being loaded with effete products. This kind has been noticed in scarlatina, in typhus, typhoid, and rheumatic fevers, in glanders, in farcy, in septicæmia, in erysipelas, and is not uncommon in diseases of the kidney.

Acute or croupous pneumonia is entirely different from any of these. Instead of being a secondary form, it would appear well established by its definite course, by the rapid defervescence when the exudation is poured into the lung, by the occurrence of albumen in the urine, and by the fact that the mother has communicated pneumonia to the fœtus (F. WEBER, Path. Anat. des Neugeb. und Säuglinge), that it is a blood disease, that some poison is taken into the blood, and that it culminates in the pulmonary tissues, the pulmonary air-cells being in this case the seat of election, just as in typhoid fever the bowel, in hydrophobia the spinal cord, and in smallpox the skin, are the organs to which in some mysterious way the poison determines and fructifies in.

It is computed that 3 per cent. of all diseases are pneumonic. In Continental and our own cities about 8 per cent. of the deaths are due to pneumonia. Ziemssen gives the deaths in European population as 1·5 per 1000, including all ages and both sexes.

The admissions in the hospitals and deaths annually per 1000 strength in the army, for thirteen years, 1859-71, are given by Professor Parkes as follows:—

	Admissions.	Deaths.
Average	5·25	641
Highest in thirteen years	7·13	741
Lowest „	3·49	423

The ratio of deaths from pneumonia in England, according to the Registrar-General's returns for the eighteen years, 1854-71, to 1,000,000 persons living is as follows: 1854, 1280; 1855, 1406; 1856, 1204; 1857, 1230; 1858, 1374; 1859, 1257; 1860, 1287; 1861, 1152; 1862, 1179; 1863, 1189; 1864, 1189; 1865, 1083; 1866, 1198; 1867, 995; 1868, 927; 1869, 1163; 1870, 1065; 1871, 1008.

Symptoms.—The symptoms of an ordinary case of croupous pneumonia are as follows: The patient experiences for two or three days a general feeling of *malaise*, during which no physical signs can be detected. Marked rigors supervene; the respiration is difficult and hurried, from 30 to 50 in a minute; the pulse frequent, from 100 to 120 per minute. The countenance becomes dusky from the interference with the respiration, and there is a peculiar short ringing cough, with expectoration of viscid sputa, in which may often be found fibrinous casts of the minute bronchi. The temperature of the skin is high, oscillating between 103° and 104° F. for five or six days, and then, towards the end of the sixth, seventh, or eighth days, suddenly falling to the normal temperature, the mean duration of cases of pneumonia being a little over nine days.

The *morbid anatomy* of croupous pneumonia shows that there are at least four stages in the first of which the lung is drier than usual, and intensely injected; in the second, the lung is gorged with venous blood, pits on pressure, and is heavier than the normal lung; in the third (*red softening*), serum has been poured out into the gorged lung tissue; in the fourth, there is a new product, an active growth of new cells, and the air-cavities are filled with these cells, as well as by small firm plugs of coagulable fibrine. In this stage the lung is firm, heavy, rigid, friable, and condensed, hence it has been termed *hepatised*. The whole of these stages may be detected during life by auscultation and attention to the symptoms.

Infectious Pneumonia.—Whether all cases of acute or croupous pneumonia (with or without pleurisy) are infectious, admits of doubt, but that there is an infectious pneumonia the writer is convinced.

Laennec in 1814 noticed a pneumonia occurring among the conscripts, and he remarked that it was probably due to deleterious miasms suspended in the air, which entered the circulation and operated particularly on the lungs.—(De l'Auscultation Méd.)

Dr. Parkes also remarks, "Considering that the pleuro-pneumonia of cattle is propagated through the pus and epithelium-cells of the sputa passing into the air-cells of other cattle, that *even in man there is evidence of a pneumonia or phthisical disease being contagious*, the floating of these cells in the air is worthy of all attention."

Greissinger also has observed that in malarious districts pneumonia is apt to assume an *epidemic* form.—(Infections Krankheiten.)

Dr. Aitken remarks that it is a disease of general and universal prevalence, and *sometimes appears as if it were epidemic.*—(Practice of Medicine.)

It is also a noticeable fact that Grisolle asserted a discoverable cause (that is, in the nature of a chill) could only be affirmed in one-fourth of his cases, Ziemssen in one-tenth of his, and Dr. Wilson Fox could only trace any connection between exposure to cold and the disease in ten out of fifty-three cases.

Nor is it a disease predominating in winter, but as severe or nearly so in spring and autumn.—(Pythogenic Pneumonia, by Drs. GRIMSHAW and MOORE, Dublin Journal of Medical Science, May 1875.)

It may be well to add to these scattered notices from different medical writers brief notes of cases in which the infectious character of pneumonia was fully shown, and on which the author's opinion of its infectious nature rests.

Two outbreaks of pneumonia occurred in

the Akerhus Prison, Christiania—one in 1847, another in 1866. In the last epidemic no less than sixty-two cases occurred in six months amongst 360 prisoners. Professor W. Boeck attributed the outbreak chiefly to overcrowding.—(Norsk. Mag. for Laegevidenskaben, vol. xxii. p. 345.)

Thoresen of Eidsvold records an epidemic of croupous pneumonia almost confined to a single row of cottages. The epidemic lasted a month.—(*Op. cit.*, 3d series, vol. i. p. 65, 1871.)

An epidemic of pleuro-pneumonia broke out in 1860 in the Mediterranean fleet. Its infectious character was very evident, and Dr. Bryson, who has recorded it, pointed out several characters common to it and the pleuro-pneumonia of cattle.—(Lancet, January 9, 1862.)

Five cases of pneumonia almost simultaneously occurred in March 1874 at a school at East Sheen, Mortlake. The time of attack coincided with a large escape of sewer gas into the school, and the boy first attacked slept in one of the rooms most exposed to the effluvium.—(Sewer-Gas Pneumonia, Irish Hosp. Gaz., November 1, 1874.)

Mr Alfred Mayo, Mildenhall, Suffolk, in a private letter to the author, gives a series of cases in which the infectious character of the malady was well marked. The first case was a bricklayer about thirty-five years of age, who was taken ill with pleuro-pneumonia. His mother, who nursed him, very shortly afterwards took the same disease and died. A neighbour, a healthy young woman over thirty, who came in to nurse the last patient, was also taken similarly ill, and died with all the physical and other signs and symptoms well developed; and lastly, her child contracted the disease, but eventually recovered. There were other cases in the neighbourhood at the same time, and all of them were remarkable for their fatality.

Dr. Christian Budd of North Tawton has for more than twenty years believed in the infectious nature of acute or croupous pneumonia, and among many remarkable instances which he related to the author, the following two are selected.

A farmer at Bow was affected with acute pneumonia, and was nursed by his niece. She in her turn contracted the disease, and going home, carried it to her husband.

An old man suffering from pneumonia leant his head during a great portion of his fatal illness on the shoulder of a relative. The latter was very shortly afterwards affected with the same ailment.*

Mr. Mitchell of Dolton gave to the author a list of cases which occurred in his own practice during a most severe epidemic of pneumonia which swept over the south-western counties during the *autumn* and *winter* of 1874, and the *spring* of 1875.

A farmer became ill on April 16th. Mr. Mitchell was sent for on the 18th, but the patient died about midnight. The servant-woman contracted the same disease a week afterwards, and gave it to her married sister with whom she was staying.

Another man became ill of pneumonia in April, and died after ten days' illness. His wife contracted the disease, her first symptoms appearing immediately after his death.

About the same date, a farmer's daughter, a mile from the house of the former patient, became ill of pneumonia, and five other cases followed, all in the same parish (pop. 470), consisting of a small village and a few scattered houses.

The cases already quoted are fair evidence of its infectious nature, and it is, we believe, the duty of the health authorities of the country to recognise acute or croupous pneumonia as an infectious disease, and to take the proper precautions, by isolating patients thus affected, and by insisting upon disinfection of the sputa and excreta.

Poison—"A poison is a substance which when absorbed into the blood is capable of seriously affecting health or destroying life." To the consideration of the principal poisons we have devoted separate articles, and for the laws regulating their sale the reader is referred to PHARMACY ACT.

Police—The powers of the police in certain cases to deal with nuisances are detailed in article NUISANCES.

Pollen—The pollen of grasses, more particularly *Anthoxantum odorata* and some others, produces in many persons summer catarrh or hay fever. Mr Blackley has performed several experiments on himself with various kinds of pollen, experiments the more valuable because the operator was himself a sufferer from hay fever.

"The pollen of a number of the grasses

* Dr. Richard Budd of Barnstaple has communicated to the author the following remarkable cases: 1. A clergyman, after attending a public meeting, became affected with acute pneumonia. 2. The nurse in attendance became ill of the same disease about a week afterwards. 3. The clergyman's sister, taking the place of the nurse, was in her turn also seized with pneumonia. 4. A brother of the clergyman, who now undertook the duty of nurse, was in a very short time laid up with the same malady. The nurse and sister died, the two brothers recovered. Dr. Budd concludes his communication as follows: "Since that time I have witnessed innumerable instances of the occurrence of this disorder in several members of the same family in succession, and I am thoroughly convinced that it spreads by infection, as the facts I have observed admit of no other explanation."

was first tried, and in every one of these trials this gave distinct and unmistakable evidence of its power to disturb the healthy action of the respiratory mucous membrane. When a small portion of pollen, just sufficient to tinge the tip of the finger yellow, was applied to the mucous membrane of the nose, some of the symptoms of hay fever were invariably developed, the severity and continuance of which were dependent upon the quantity and upon the number of times it was used. In an experiment made with the pollen of *Lolium Italicum*, the first sensation produced was that of a very slight degree of anæsthesia of the spot to which this had been applied. This was followed by a feeling of heat, which gradually diffused itself over the whole cavity of the nostril, and was accompanied by a slight itching of the part. After some three or four minutes a discharge of serum came on, and continued at intervals for a couple of hours. The mucous membrane appeared to swell, and eventually became so tumid that the passage of air through the nostril was very much impeded."—(Experimental Researches on the Causes and Nature of Catarrhus Æstivus (Hay Fever or Hay Asthma), by C. H. Blackley, M.R.C.S. London, 1873.)

The pollen of *Secale cereale* is shown by the same author to produce very severe local and even constitutional symptoms. One drop of 1-per-cent. decoction of the pollen of gladiolus applied to the eye produced a catarrhal ophthalmia. Inoculation by the skin of the pollen of *Lolium Italicum* produced pain and swelling.

Mr. Blackley has also estimated the amount of pollen in the air by exposing slips of glass moistened with a mixture of proof-spirit, water, and glycerine, to which a minute quantity of carbolic acid was added. He also determined the amount of pollen at different altitudes by flying kites to which prepared slips of glass were attached, and by these means has discovered the interesting fact that there is more pollen in the upper than in the lower regions of the air. In one experiment, a breeze had been blowing for twelve hours from the sea, and a kite with a glass attached to it was elevated to the height of 1000 feet, a similar glass was also exposed at the margin of the water. After three hours' exposure, the kite-glass showed 80 pollen grains, the one near the water none whatever. Mr Blackley considers the action of pollen as partly mechanical and partly chemical. The most severe symptoms seem to follow only upon the bursting of the external coat of the pollen grain and the escape of the granular contents. Between May and August in 1866 and 1867, according to Mr. Blackley's tables, the maximum of pollen in the air was reached on June 28th, when a rural slip of glass exhibited 880 grains; an urban, 105 grains of pollen. The severity of Mr Blackley's symptoms invariably coincided with the maximum of the pollen-dust.

In Scinde the pollen of the elephant's grass (*Typha elephantina*), in New Zealand that of the *Typha angustifolia*, is employed to make a species of bread. It is a singular circumstance that countries so far apart as Scinde and New Zealand should have adopted the same unusual kind of diet.

Poppy (*Papaver somniferum*)—*See* Opium, Morphia, &c.

Population—The finally-revised results of the eighth decennial census show that the population of England and Wales has increased at the rate of 13·19 per cent. since the census of 1861; the total population of England and Wales being in that year 20,066,224, while in 1871 it had increased to 22,712,266 persons. This is the largest decennial increase, relatively as well as actually, that has taken place since 1831–41. Regard being had to disturbing elements, it is apparent, as a broad general deduction from the facts, that the population of England and Wales at the census of 1871 was greater by 590,186 persons than it would have been had the increase between 1861 and 1871 been dependent solely upon the balance between the natural growth or excess of births over deaths and the recorded emigration. During the ten years the births exceeded the deaths by 2,705,598, from which deducting 649,742 persons of English origin reported to the Emigration Commissioners as having sailed from this country within the decennium, there is a residue of 2,055,856, which would have approximately represented the difference between the enumerated population in 1861 and 1871, supposing there had been no emigration. On an average of the ten years the annual excess of births was 270,560, the annual number of emigrants 64,974; and to account for the actual population discovered in 1871, it is obvious that the influx of Scotchmen, Irishmen, or foreigners, or of Englishmen returned to their native land, must have averaged about 59,019 per annum.

Population of the United Kingdom.

United Kingdom . . .	31,628,338
England	21,495,131
Wales	1,217,135
Scotland	3,360,018
Ireland	5,411,416
Isle of Man and Channel Islands	144,638

A provisional return shows the number of the army, navy, and merchant seamen absent from the kingdom in April 1871 to have been about 229,000.

The enumerated population of the United Kingdom, like that of its capital city, is variously defined for fiscal, statistical, and other purposes, and may therefore be required to represent either of the following :—

	Population, 1871.
United Kingdom: *including* islands in British seas, and army, navy, and merchant seamen abroad	31,857,338
United Kingdom: *including* islands in British seas, but *excluding* army, navy, and merchant seamen abroad	31,628,338
United Kingdom: *excluding* islands in British seas, and army, navy, and merchant seamen abroad	31,483,700

The present population of the kingdom (*exclusive* of the army, navy, and merchant seamen abroad) represents an increase since 1861 of 2,557,406 persons, which is equivalent to a rate of 8·8 per cent. in the ten years, and to a daily addition of 700 to the population.

During the last decade England has added 2,646,042, or 13 per cent., to her population, and Scotland 297,724, or 9·7 per cent.; while Ireland counts 387,551, or 6·7 per cent., fewer inhabitants than she had in 1861.

Population of England and Wales.—As the first census was taken in 1801, no exact account of the population in the earlier periods can be obtained; but various estimates of the population were framed in those times by contemporary writers; and series of returns of baptisms and burials have been preserved in many parishes since 1571. After collating the various sources of information, the following estimates have been framed, founded on data which justify the belief that they represent approximately the population of England and Wales in the middle of each of three centuries:—

Middle of the Years.	Estimated Population of England and Wales.	Increase of Population.
1651	5,466,572	...
1751	6,335,840	869,268
1851	18,109,410	11,773,570

Thus, according to the estimates, the people of England and Wales amounted to more than *six* millions in 1751, and to more than *eighteen* millions in 1851; they having increased nearly *twelve millions* in the hundred years; while the increase of the numbers in the preceding century (1651–1751) was less than *one million*: and the numbers can scarcely be wrong either way more than half a million.*

A comparison of the excess of baptisms over burials in 1801–10 shows that the excess of baptisms over burials must be raised nearly *one-third part* for the births of children who are not baptized to make it equal to the increase of population.

* *See* Davenant's Works, vol. ii. p. 175–185, ed. 1771; and the Tables of Baptisms, Burials, and Marriages in the Census Reports, 1811–41.

The population of England and Wales enumerated on April 3, 1871, was 22,712,266 persons. Starting with the first census, in 1801, our numbers have gone on increasing in the following manner:†—

Years.	Population.	Increase between each Census.	Decennial Rate of Increase per Cent.	Decenniads.
1801	8,892,536	...	...	...
1811	10,164,256	1,271,720	14 30	1801–11
1821	12,000,236	1,835,980	18 06	1811–21
1831	13,896,797	1,896,561	15·80	1821–31
1841	15,914,148	2,017,351	14·52	1831–41
1851	17,927,609	2,013,461	12·65	1841–51
1861	20,066,224	2,138,615	11·93	1851–61
1871	22,712,266	2,646,042	13·19	1861–71

The annual rate of increase in the seventy years of this century was 1·35 per cent., the actual aggregate increase being 13,819,730, or 155 per cent. The population of 1801 doubled its numbers in 1851; at the rate of increase prevailing in the last ten years, the population would double itself in fifty-six years, while the period of doubling deduced from the annual rates reigning during this century is fifty-two years.

Males and Females.—The boys born in England are in the proportion of 104,811 to 100,000 girls; but they experience a higher rate of mortality, and, according to the new English Life Table, the rates are so finely adjusted that the numbers are reduced in the end very nearly to an equilibrium, the men and women living, of all ages, being in the proportion of 100,029 to 100,000. Such would be the state of things if there were no emigration, or if the men and women emigrated in pairs. That has not hitherto been the case; and at the census, 11,653,332 females, and 11,058,934 males were enumerated. There was an excess of 594,398 women at home; the men of the corresponding ages being on the Continent, in the colonies, or in foreign lands, unless their numbers have been reduced by higher rates of mortality than prevail in England.

† The Registrar-General estimates the population of the United Kingdom in the middle of this year (1874) at 32,412,010. The population of Ireland (5,300,485) is only 84,000 more than in 1801; that of Scotland (3,462,916) is 212,000 more than double; and that of England and Wales (23 648,609) is about 5½ millions more than double the population than in 1801. The following is the present estimated population of our largest towns: London, 3,400,701; Liverpool, 510,640; Glasgow, 508,109; Manchester, 355,339, and Salford, 133,068; Birmingham, 360,892; Dublin, 314,666; Leeds, 278,798; Sheffield, 261,029; Edinburgh, 211,691; Bristol, 192,889; Bradford, 123,056; Newcastle-upon-Tyne, 135,437; Hull, 130,996; Portsmouth, 120,436; Brighton (with suburbs), 109,319; Leicester, 106,2[illegible]2; Sunderland, 104,378.

To 100,000 women, of all ages, in England, there are 94,900 men, of all ages, at home; the proportion of men to women at home is less than it was at any previous census since 1811, owing probably to the increase of the army abroad. The disparity in the numbers of the two sexes at home was greatest in 1801 and 1811, during the war; this was due to the men abroad in the several services.

To complete this view of the proportions of the two sexes living at home, their ages must be taken into account. There is an excess of boys over girls living under the ages of fifteen; and by the Life Table an excess of men is provided all through the middle period of life; but that surplus is overdrawn by emigration, so that the women exceed the men in number to a considerable extent in the early and middle, and still more in the advanced ages, when their longevity comes into play.

The excess of the emigration of males over females accounts for the present difference in the proportion of the sexes.

Families.—The number of families was 5,049,016 in 1871, as compared with 4,491,524 in 1861; and the proportion of persons to a family was 4·50 and 4·47 in the two periods. The proportion of persons to a family varied from 4·69 in 1801 to 4·83 in 1851, the year of the Great Exhibition. If the inmates of public institutions, the persons on board ships, boats, and barges, and those without houses, are excluded from the calculation, the proportion of persons to a family in 1871 will be reduced to 4·41, as compared with 4·38 in 1861.

	1851.	1861.	1871.	Decennial Rate of Increase per Cent.	
				1851–61.	1861–71.
London	2,362,236	2,803,989	3,254,260	18·7	16·1
Portsmouth	72,096	94,799	113,569	31·5	19·8
Norwich	68,713	74,891	80,386	9·0	7·3
Bristol	137,328	154,093	182,552	12·2	18·5
Wolverhampton	49,985	60,860	68,291	21·8	12·2
Birmingham	232,841	296,076	343,787	27·2	16·1
Leicester	60,584	68,056	95,220	12·3	40·0
Nottingham	57,407	74,693	86,621	30·1	16·0
Liverpool	375,955	443,938	493,405	18·1	11·1
Manchester	303,382	338,722	351,189	11·6	3·7
Salford	85,108	102,449	124.801	20·4	21·8
Oldham	52,820	72,333	82,629	36·9	14·2
Bradford	103,778	106,218	145,830	2·4	37·3
Leeds	172,270	207,165	259,212	20·3	25·1
Sheffield	135,310	185,172	239,946	36·9	29·6
Hull	84,690	97,661	121,892	15·3	24·8
Sunderland *	63,897	78,211	98,242	26·1	25·6
Newcastle-on-Tyne	87,784	109,108	128,443	24·3	17·7
Total of 18 towns	4,506,184	5,368,434	6,270,275	19·1	16·8

Urban and Rural Populations. — Now, adopting a broad principle of classification based on the registration districts and sub-districts, the Registrar-General throws the population into two groups, one inhabiting the districts and sub-districts which include the chief towns, the other occupying the remainder of the country, and dwelling therefore in the small towns and country parishes. Taking the first of these groups as representing the bulk of the urban population, it comprises in round numbers nine millions in 1851, eleven millions in 1861, and thirteen millions in 1871; the rate of increase in this group between 1851 and 1861 was 19 per cent., and 18 per cent. between 1861 and 1871. In the rest of the country, assumed to be for the most part rural, the population increased 4 per cent. between 1851 and 1861, and 7 per cent. between 1861 and 1871. The urban districts have in the last ten years grown more than twice as fast as the country districts; in the previous decade the growth of the towns was more than four times as fast as that of the rural population—a result probably accounted for by some of the rural districts having gradually assumed the character of towns. In point of fact, a correct estimate of the extent to which the large towns have drawn upon the

* The boundaries of this municipal borough have been extended since 1861.

population of the rural districts, cannot be arrived at without taking into account the growth of suburban neighbourhoods consequent upon the increasing value of property in town centres for purely business purposes, the gradual displacement of the people from the denser parts as a result of improved sanitation, and the development of railways, which every year adds to the number of those who resort to suburban or to country homes after their day's business in towns is over.

Certain cities and towns, either from their magnitude or their importance on other grounds, have been selected by the Registrar-General for the publication of weekly rates of mortality in comparison with those of the metropolis and of other British and foreign cities. Those cities and towns, eighteen in number, with London at their head, comprise a total population of 6,270,275—less than a third, but more than a fourth, part of the entire English population. Within their municipal limits, the population enumerated at the three last censuses, with the intervening rates of increase, will be found stated in the table on p. 456.

As regards most of the above tabulated large towns in which a diminished rate of growth is evidenced, it would be found that the surrounding neighbourhoods have received the overflow from the municipal areas, and exhibit in many cases a complete transformation from suburban, or even rural, to purely urban localities. This view of the matter receives support from what is observable in relation to the following group of towns, secondary in magnitude or importance to the eighteen above referred to.

	Population.	
	1861.	1871.
Croydon, Surrey	30,240	55,652
Rochester & Chatham, Kent	40,798	44,536
Brighton, Sussex	77,693	90,011
Southampton, Hants	46,960	53,741
Reading, Berks	25,045	32,324
Oxford, Oxon	27,560	31,404
Northampton, Northampton	32,813	41,168
Cambridge, Camb.	26,361	30,078
West Ham, Essex	38,331	62,919
Ipswich, Suffolk	37,950	42,947
Yarmouth, Norfolk	34,810	41,819
Exeter, Devon	33,738	34,650
Plymouth, Devon	62,599	68,758
Devonport and East Stonehouse, Devon	64,783	64,034
Bath, Somerset	52,528	52,557
Cheltenham, Glo'ster	39,693	41,923
West Bromwich, Staff.	41,795	47,918
Walsall, Stafford	37,760	46,447
Hanley, Stafford	31,953	39,976
Dudley, Worcester	44,951	43,782
Worcester, Worc.	31,227	33,226
Aston Manor, Warw.	16,337	33,948
Coventry, Warwick	40,936	37,670
Derby, Derby	43,091	49,810
Stockport, Cheshire	54,681	53,014
Macclesfield, Cheshire	36,101	35,450
Chester, Cheshire	31,110	35,257
Birkenhead, Cheshire	37,796	45,418
Burnley,* Lancashire	28,700	40,858
Bolton, Lancashire	70,395	82,853
Bury, Lancashire	37,563	38,596
Wigan, Lancashire	37,658	39,110
Warrington, Lanc.	26,431	32,144
Ashton-under-Lyne, Lancashire	34,886	31,984
Rochdale, Lancashire	38,114	44,559
Blackburn, Lancashire	63,126	76,339
Preston, Lancashire	82,985	85,427
St. Helen's, Lancashire	18,396	45,134
Huddersfield, York	60,944	70,253
Halifax,* York	37,014	65,510
Middlesborough,* York	18,992	39,563
York, York	40,433	43,796
South Shields, Durh.	35,239	45,336
Gateshead, Durham	33,587	48,627
Tynemouth, Northumberland	34,021	38,941
Carlisle, Cumberland	29,417	31,049
Cardiff, Glamorgan	32,954	39,536
Merthyr Tydfil, Glam.	49,794	51,949
Swansea, Glamorgan	40,802	51,702
Total	1,971,091	2,333,703

Houseless Population.—On the morning of the 3d April 1871 there were found throughout the country 1921 males and 437 females who had slept the preceding night in barns and sheds, and 4325 males and 3700 females whose sleeping-places were caravans and tents, or under the open canopy of heaven. The numbers living out of houses vary with the seasons. In winter they shrink into such dwellings as

* The boundaries of these municipal boroughs have been extended since 1861.

are available to them, and in summer they swarm out into the lanes, commons, and fields. The ascertained houseless class amounted to 20,318 persons in 1841, in 1851 to 15,764, in 1861 to 11,441, and in 1871 to 10,383. The census in 1841 was taken in June; on the three subsequent occasions it was taken in March and April. The class appears, therefore, to be undergoing a gradual reduction.

Maritime Population.—66,187 persons were enumerated on board 10,726 sea-going vessels lying in harbours, creeks, and rivers, in the last census, and have been included with the population of the several parishes contiguous to which the vessels were lying. These vessels include 96 of her Majesty's ships, with 13,454 persons on board; 9193 British sea-going vessels, with 40,188 persons; and 1437 foreign and colonial vessels, with 12,545 persons on board.

There were also 10,976 persons enumerated in barges and boats on inland waters, as compared with 11,915 persons so enumerated in 1861, and 12,562 in 1851.—(Digest of English Census. JAMES LEWIS. London, 1873.)

European Statistics.—The following tables, extracted from the Registrar-General's report for 1871, show the population of the more important European countries:—

ITALY (inclusive of VENETIA).—POPULATION, NUMBERS, and PROPORTIONS per 1000 of MARRIAGES, BIRTHS, and DEATHS, in the Years 1863 to 1871.

YEARS.	NUMBERS.					PROPORTIONS PER 1000 TO POPULATION.			
	Estimated Population, 31st Dec.	Marriages.	Persons Married.	Births. (Exclusive of Still-born.)	Deaths. (Exclusive of Still-born.)	Marriages.	Persons Married.	Births.	Deaths.
1863	24,680,974	201,225	402,450	964,137	760,164	8·17	16·34	39·06	30·78
1864	24,882,633	189,759	379,518	938,795	737,136	8·02	16·04	37·73	29·62
1865	25,097,182	226,458	452,916	961,234	746,685	9·23	18·46	38·30	29·75
1866	25,344,192	142,024*	284,048	980,200	733,190	5·37	10·74	38·67	28·93
1867	25,404,723	170,456	340,912	927,396	866,865	6·72	13·44	36·51	34·12
1868	25,527,915	182,743	365,486	900,416	777,223	7·16	14·32	35·27	30·45
1869	25,766,217	205,287	410,574	952,134	713,832	7·97	15·94	36·95	27·70
1870†	25,944,543	188,986	377,972	951,495	773,169	7·28	14·57	36·67	29·80
1871	...	...	...	...	...	...	...	...	...

* The decrease of marriages in 1866 may be attributed to the law which then came into operation, removing the civil registration from the parochial authorities to the communes; there had been a marked increase in the previous year, resulting from a wish to evade the law about to come into operation. Doubtless many of the marriages solemnised in the churches during 1866 escaped registration.

† The figures of 1870 were supplied by Signor L. Bodio, chief of the Statistical Department in Italy.

SPAIN.—POPULATION, NUMBERS, and PROPORTIONS per 1000 of MARRIAGES, BIRTHS, and DEATHS in the Eleven Years 1861 to 1871.

YEARS.	NUMBERS.					PROPORTIONS PER 1000 TO POPULATION.			
	Estimated Population.	Marriages.	Persons Married.	Births.	Deaths.	Marriages.	Persons Married.	Births.	Deaths.
1861	15,879,868	130,731	261,462	624,096	417,764	8·23	16·46	39·30	26·31
1862	16,065,124	128,696	257,392	615,919	430,663	8·01	16·02	38·33	26·81
1863	16,210,263	124,176	248,352	606,800	461,661	7·66	15·32	37·43	28·48
1864	16,340,323	126,303	252,606	629,546	499,486	7·73	15·46	38·53	30·57
1865	16,423,793	128,917	257,834	622,050	538,580	7·85	15·70	37·87	32·79
1866	16,579,090	131,981	263,962	618,981	463,684	7·96	15·92	37·34	27·97
1867	16,716,151	118,409	236,818	624,212	487,151	7·08	14·16	37·34	29·14
1868	16,853,212	111,684	223,368	579,464	548,690	6·63	13·26	34·38	32·56
1869	16,883,986	137,120	274,240	602,287	550,6[illegible]0	8·12	16·24	35·67	32·61
1870	16,935,613	105,543	211,086	599,786	509,669	6·23	12·46	35·42	30·09
1871	...	...	...	...	...	...	...	...	...

NOTE.—The population enumerated at the census of 1860 was 15,673,536. The estimated population for the years subsequent to 1861 has been deduced from the excess of births over deaths in each year. This method of estimating the population is sanctioned by the Junta General de Estadistica at Madrid. The decline of registered marriages in 1870 is believed to be due to the introduction of civil registration, which occurred during that year.

Estimated Population of England, France, Austria, and of Prussia, in the middle of each of the Nineteen Years 1853 to 1871.

Years.	England and Wales.	France.	Austria.	Prussia.
1853	18,404,368	36,225,000	31,328,874	17,065,143
1854	18,616,310	35,910,496	31,493,583	17,183,544
1855	18,829,000	35,974,930	31,200,576	17,202,831
1856	19,042,412	36,039,364	31,425,385	17,318,539
1857	19,256,516	36,154,398	32,053,235	17,479,512
1858	19,471,291	36,236,322	32,361,605	17,739,913
1859	19,686,701	36,331,642	32,750,697	17,983,484
1860	19,902,713	36,522,404	33,108,529	18,105,757
1861	20,119,314	37,386,313	33,399,945	18,491,220
1862	20,371,013	37,521,486	33,719,823	18,711,806
1863	20,625,855	37,657,134	23,078,057	18,950,278
1864	20,883,889	37,793,278	23,317,544	19,254,649
1865	21,145,151	37,929,918	20,876,643	19,465,146
1866	21,409,684	38,067,064	20,835,908	19,543,540
1867	21,677,525	38,204,696	20,986,536	23,971,337
1868	21,948,713	38,342,818	21,185,021	24,148,516
1869	22,223,299	36,855,478	20,217,531	24,380,505
1870	22,501,316	36,985,212	20,385,498	24,635,893
1871	22,782,812	...	...	24,643,874

Pork—*See* Meat.

Porridge—*See* Oats, &c.

Porter—*See* Alcoholic Beverages, Beer, Hops, Malt, &c.

Port Sanitary Authority—*Ports.*—The Local Government Board may by provisional order permanently constitute any local authority whose district or part of whose district forms part of or abuts on any part of a port in England, or the waters of such port, or any conservators, commissioners, or other persons having authority in or over such port or any part thereof (which local authority, conservators, commissioners, or other persons are in the Public Health Act referred to as a "riparian authority"), the port sanitary authority of the whole of such port or of any part thereof.

The Local Government Board may also by provisional order permanently constitute a port sanitary authority for the whole or any part of a port, by combining any two or more riparian authorities having jurisdiction within such port, or any part thereof, and may prescribe the mode of their joint action; or by forming a joint board consisting of representative members of any two or more riparian authorities, in the same manner as is by the said Act provided with respect to the formation of a united district.

The Local Government Board may also by provisional order permanently constitute a port sanitary authority for any two or more ports, by forming a joint board consisting of members of all or any of the riparian authorities having jurisdiction within such ports, or any part thereof.

The Local Government Board may, if it thinks fit, temporarily constitute by order any such authority, until a provisional order for its permanent constitution is confirmed by Parliament, and may from time to time renew any such last-mentioned order, and may by any such order make any such provisions as it is empowered to make by provisional order.

Any order constituting a port sanitary authority may assign to such authority any powers, rights, duties, capacities, liabilities, and obligations under the Public Health Act, and direct the mode in which the expenses of such authority are to be paid; and where such order constitutes a joint board the port sanitary authority, it may contain regulations with respect to any matters for which regulations may be made by a provisional order forming a united district under the said Act.—(P. H., s. 287.)

The order of the Local Government Board constituting a port sanitary authority gives jurisdiction over all waters within the limits of such port, and also over the whole or such portions of the district of any riparian authority specified in the order.—(P. H., s. 288.)

A port sanitary authority may, with the sanction of the Local Government Board, delegate the exercise of their powers to any riparian authority within or bordering on their district.—(P. H., s. 289.)

The mayor, aldermen, and commons of the city of London are the port sanitary authority of the port of London.—(P. H., s. 291.) For the provisions with regard to the expenses of port sanitary authorities, *see* Expenses.

A great many port sanitary authorities have now been constituted in England, but sufficient time has not yet elapsed to pronounce any judgment as to the amount or the efficiency of the work done. The whole of the Irish coast has also been divided into districts, and placed under the control of port nuisance authorities.—(Second Annual Report of Local Government Board for Ireland, 1873–74.)

A very serious responsibility rests upon every port in the kingdom. Each vessel arriving from abroad requires to be most narrowly examined, for the history of the past shows that cholera and other diseases have again and again been imported; and from want of effective regulations, persons actually and evidently labouring under disease have been allowed to land and infect a whole nation. The duty of every medical officer of health connected with a port is to insist upon a proper hospital being erected or adapted, as the case may be, so that on the arrival of an infected vessel the sick may immediately be isolated. In large ports he should be provided with a sufficient staff to enable a thorough inspection of every vessel coming to our shores to be efficiently carried out, and he should therefore have a small steamer or other means of locomotion at his disposal. It well admits of argument whether the appointment of medical officers of health to ports ought not to be taken out of the hands of local authorities, as the importation of cholera is a national calamity, and therefore the necessary precaution should not be left to the unequal and sometimes unintelligent action of local authorities.

Port Wine—*See* WINE.

Post-Mortem Examinations — Any local authority may provide and maintain a proper place (otherwise than at a workhouse or at a mortuary) for the reception of dead bodies, for the purpose of undergoing authorised *post-mortem* examinations.—(P. H., s. 143.) *See* MORTUARY.

Potassium (K = 39·1)—A metallic element discovered by Sir H. Davy in 1807. Specific gravity, ·865; fusing-point, 144·5° F. (62·5 C.) This remarkable substance is a bluish-white metal, which at the common temperature of the air is so soft that it can easily be cut by a knife, but at 32° F. it is crystalline and brittle. It has a most powerful affinity for oxygen, rapidly tarnishing in air, and decomposing water, with the production of flame, when thrown upon it.

The salts of potassium are very numerous. They are all soluble in water, and most of them are colourless. They may be recognised in a pure state by the violet hue they impart to the blowpipe flame when heated in platinum wire, by giving no precipitate either with sulphuretted hydrogen or with sulphide of ammonium, and by giving a yellow crystalline precipitate with bichloride of platinum, and a white crystalline precipitate with tartaric acid, when the latter is added in excess to moderately strong neutral or alkaline solutions. We can only here notice a few of the salts of potassium.

Potassium, Arseniate of (KH_2AsO_4), is prepared with arsenious acid and nitrate of potash. It forms large crystals, which are soluble in about 4½ parts of water, and insoluble in alcohol. It is employed medicinally, and also to form a resist paste in calico-printing and in the manufacture of cobalt blue. *See* ARSENIC.

Potassium, Carbonate of (K_2CO_3), often contains an undue quantity of water, as well as silicic acid, sulphates, and chlorides. The water may be detected by the loss of weight the salt suffers when heated; the silica, by adding to it hydrochloric acid in excess, evaporating to dryness, and igniting the residuum by which the contamination is rendered insoluble. The sulphates and chlorides may be detected by adding nitric acid in excess, and testing the liquid with nitrate of silver and chloride of barium. If the former produces a white precipitate, a chloride is present; and if the latter does the same, the contamination is a sulphate.

Potassium, Chromate of (K_2CrO_4), prepared from chrome ore, a natural octahedral chromate of iron found in various parts of Europe and America, and the *bichromate of potassium* ($K_2Cr_2O_7$), prepared from the above, have been extolled by Dr. Angus Smith as being powerful antiseptics, but their price is too great to allow of their being largely employed.

Potassium, Cyanide of (KCN or KCy), is a highly poisonous salt, extensively used in photography and gilding. Accidents from its employment are not uncommon. It has a local chemical action upon the skin, and if this be abraded or wounded, it may be absorbed, and produce serious effects. The symptoms produced by the salt are the same as those produced by prussic acid—2½ grains being equal to 50 drops of medicinal prussic acid. It has been found as an impurity in reduced iron. It may be detected by the tests previously given for potassium, and it gives a *white* precipitate with nitrate of silver, which, when dried and heated, possesses all the properties of cyanide of silver. If a solution of proto-sulphate of iron is added to a solution of the cyanide of potassium, and after agitation the mixture is treated with diluted sulphuric acid, Prussian blue will be produced.

Potassium, Nitrate of.—Saltpetre (KNO_3). Specific gravity, 1·925 to 1·975.

The salt occurs as an efflorescence on the soil in the East Indies and elsewhere; it is also produced artificially on the Continent by exposing nitrogenous matters mixed with a calcareous earth to the atmosphere. A nitrate of calcium is slowly formed, lixiviated out and decomposed by wood ashes, the main result being that carbonate of lime is precipitated, and nitrate of potash remains in solution, from which it is recovered by evaporation and crystallisation.

Nitrate of potash is a dimorphous salt, its usual form being that of six-sided striated prisms, but also occurring in microscopic rhombohedra. It is soluble in about three and a half times its weight of cold water, and a third of its weight of boiling water; it is insoluble in alcohol. It fuses without decomposition at 642·2° F. (339° C.), and may be cast into moulds (*sal prunelle*). If heated to redness, part of the oxygen is expelled, and a deliquescent mass of potassic nitrite is formed; by a yet stronger heat, nitrogen mixed with oxygen escapes, potash and peroxide of potash remaining.

Commercial nitre generally contains chlorides, sulphates, or calcareous salts; the first may be detected by its solution giving a cloudy white precipitate with nitrate of silver, the second by chlorides of barium or calcium giving a white precipitate, and the third by oxalate of ammonium giving a white precipitate.

In a hygienic point of view saltpetre is most valuable for its disinfectant and antiseptic properties; but it is employed in the arts for a variety of purposes, such as manufacture of fireworks, gunpowder, and nitric acid. This salt has on several occasions destroyed life, but only when taken in large doses. An ounce has proved fatal.

Potash, Permanganate of ($KMnO_4$), is made by mixing together certain quantities of chlorate of potash, peroxide of manganese, caustic potash, and a small quantity of water, and afterwards evaporating, &c. This is a valuable disinfectant, but it possesses no antiseptic properties. Put into the foulest waters, it destroys almost instantaneously all disagreeable smell, and will quickly deodorise the most offensive substance. In sick-rooms, &c., where impurities cannot be removed with sufficient speed, permanganate of potash is invaluable. *See* DISINFECTANTS.

Other important salts of potassium are bromide of potassium (KB) (*see* BROMINE), iodide of potassium (KI) (*see* IODINE), and the ferro and ferri cyanides of potassium. These latter are important tests for IRON, &c., *which see.*

Potato—The potato consists of the tuber—which forms an exuberant growth of a portion of the underground stem of—the *Solanum tuberosum*, a plant belonging to the order *Solanaceæ*, an order which furnishes some of the most poisonous narcotic products encountered, such as the belladonna, stramonium, henbane, and tobacco plants.

Composition of the Potato (PAYEN).

Nitrogenous matter	2·50
Starch	20·00
Cellulose	1·04
Sugar and gummy matter	1·09
Fatty matter	0·11
Pectates, citrates, phosphates, and silicates of lime, magnesia, potash, and soda	1·26
Water	74·00
	100·00

Boussingault gives the average composition of the tubers of the potato as follows:—

	Moist.	Dry.
Water	75·9	...
Albumen	2·3	9·6
Oily matter	0·2	0·8
Fibre	0·4	1·7
Starch	20·2	83·8
Salts	1·0	4·1
	100·0	100·0

Mineral Constituents in 100 *Parts of Ash of Potato.*

	Way.	Fromberg.
Potash	46·60	50·23
Soda	...	3·7
Magnesia	8·70	4·4
Lime	4·54	0·83
Phosphoric acid	13·20	10·10
Sulphuric	4·66	14·67
Chloride of potassium	...	11·76
Chloride of sodium	3·43	...
Carbonic acid from the incineration of organic acids, such as citrate, malate, tartrate, &c.	13·30	...
Oxide of iron	...	...
Silicate of alumina	1·95	...

The composition of the ash is remarkable for the great disproportion which exists between the potash and soda salts. The amount of potash is indeed very large, and this disproportion perhaps affords an explanation of the fact that all who use the potato instinctively add salt to it.

Potatoes are deficient in fat, and they do not contain more than 2½ per cent. of nitrogenous matter, so that, dietetically speaking, the potato is a carbo-hydrate or starch food, and requires the addition of meat and fat to render it a perfect article of food.

The potato has great antiscorbutic properties, so much so that the addition of potatoes to the diet has been found sufficient to arrest the prevalence of scurvy in prisons where it had before existed.

Potatoes may be preserved for a considerable time by thoroughly desiccating them in an oven or by steam heat. For this purpose the roots, either raw or three parts dressed, are generally first cut into dice of above ¾ inch square to facilitate the operation. Under a patent granted to Mr. Downes Edwards, August 1840, the boiled potatoes are mashed and granulated by forcing them through a perforated plate before drying them. The granulated product, beaten up with a little hot milk or hot water, forms an excellent extemporaneous dish of mashed potatoes.—(COOLEY.) Parkes recommends that slices of potato be packed in sugar, and also gives the following methods for determining the amount of solids, starch, and the quality:—

"The *solids* can be determined by taking the specific gravity and multiplying it by a factor taken from the subjoined table, the result is the percentage of solids.

Specific Gravity between	Factor
1061–1068	16
1069–1074	18
1075–1082	20
1083–1104	22
1105–1109	24
1110–1114	26
1115–1119	27
1120–1129	28

"If the starch alone is to be determined, deduct seven from the factor and multiply the specific gravity by the number thus obtained; the result is the percentage of starch.

"If the specific gravity of the potato is below 1068, the quality is very bad; between 1068–1082, the quality is very inferior; between 1082–1105, the quality is rather poor; above 1105, the quality is very good; above 1110, the quality is best."

A poisonous principle, termed *solanine*, is said to become developed in the buds and shoots of potatoes that are allowed to grow out on keeping; but no case is recorded, notwithstanding the universal consumption, of poisonous effects arising from the use of such potatoes.

With regard to the cooking of potatoes, the best general method is, without doubt, either to bake or steam them in their skins. Dr. Letheby asserts that when potatoes are peeled and then boiled, the loss in cooking is 14 per cent.; but if cooked without peeling, it is only 3 per cent.

The Potato Disease.—In the United States in 1843 a disastrous disease appeared among the potato crops; in 1844 it had reached Canada, and before the end of 1855 it had shown itself in most European countries. Since that date this disease appears to have been on the increase, and it resists all efforts to eradicate it. It usually appears in July, August, September, and October, but a few crops have been attacked in May. A mild and moist atmosphere appears to favour the spread of this malady, and no soil is exempt from its attacks, though sloping well-drained soils are always the least affected. An abundance of manure, especially if directly applied, often corresponds with the maximum intensity of the plague; and again, the potatoes only lightly covered by the soil have frequently been those most violently attacked. No variety has been able to resist this disease, though one or two have in a measure succeeded in escaping its influence. It commences in the leaves of the plant, and thence extends from the stem to the tubers. On the surface of the latter brown spots make their appearance, penetrate the substance, and eventually lead to decay.

The disease is caused by a minute fungus called *Peronospora infestans.* The life-history, a large portion of which has long been known by the researches of Montague, Berkeley, De Bary, and others, has recently been completed by the discoveries and investigations of Worthington G. Smith. Fig. 68, reduced from a cut in the "Gardeners' Chronicle" (July 17, 1875) to one of Mr. Smith's original papers, will give an idea of the nature and method of reproduction of the fungus. It represents a very fine and successful section of the leaf of a diseased potato highly magnified. A A are the minute hairs always present; B B are the individual cells of the leaf. The former are structures belonging entirely to the healthy plant, whilst the threads and bodies shown at C, D, E, F, and G belong to the fungus, the parasite which preys upon the plant. The fine thread at C is a continuation of the spawn or mycelium living inside, and at the expense of the assimilated material of the leaf. Emerging into the air, the thread ramifies at the tips of the branches and bears fruit, D D. These fruits are termed simple spores, or conidia, because of their dust-like appearance. The conidia are capable of germinating and reproducing the species just in the same way as a seed. A second method of reproduction of the peronospora is shown in the "swarm-spores" E F. These, when moistened artificially, or in nature by dew or rain, set free fifteen or sixteen bodies known as "zoospores," so named because they exhibit every phenomenon of animal and spermatozoa-like life. They are furnished with two lash-like tails, and move about for half an hour with great rapidity. The zoospores falling upon any portion of the plant, have an extraordinary power of instantly corroding and boring through the cellular epidermis. When movement ceases, the tails (cilia) disappear, the zoospores burst at one end, and protrude a tube which develops into mycelium, producing, as before, the perfect plant. These two asexual methods of reproduction have long been known, but as in both of them the structures are far too delicate to withstand the frosts of winter, it was difficult to account for its winter life until Mr. Smith showed that the third mode of reproduction, already made out in similar species of peronospora, was also to be found in the potato plant. The third form is a true sexual method, perfectly analogous to the reproduction of the higher flowering plants. This third method is the production of egg-shaped bodies, about $\frac{1}{1000}$ of an inch in diameter, known as "oospores." The oospores are produced by the conjugation of two bodies — the one, the male, known as the antheridium (*see* H, fig. 68), and analogous to the anther of a flower; and the other the oogonium (J), the female, analogous to the ovary of a flower. The antheridium and oogonium have been seen in contact, and a fertilising tube from the former has been observed entering the oogonium. After fertilisation the oogonium develops into the oospore analogous to the matured seed. This third method only appears to take place in the rotten and decayed parts of the plant. The oospores are not transparent and unenduring, but dense in substance, of a dark brown colour, and covered externally with reticulations or warts. "They are produced from the mycelium by the contact of the antheridium and the oogonium in the substance of tho decaying plant. They are washed into the earth, and there they rest till a certain set of conditions makes them germinate in

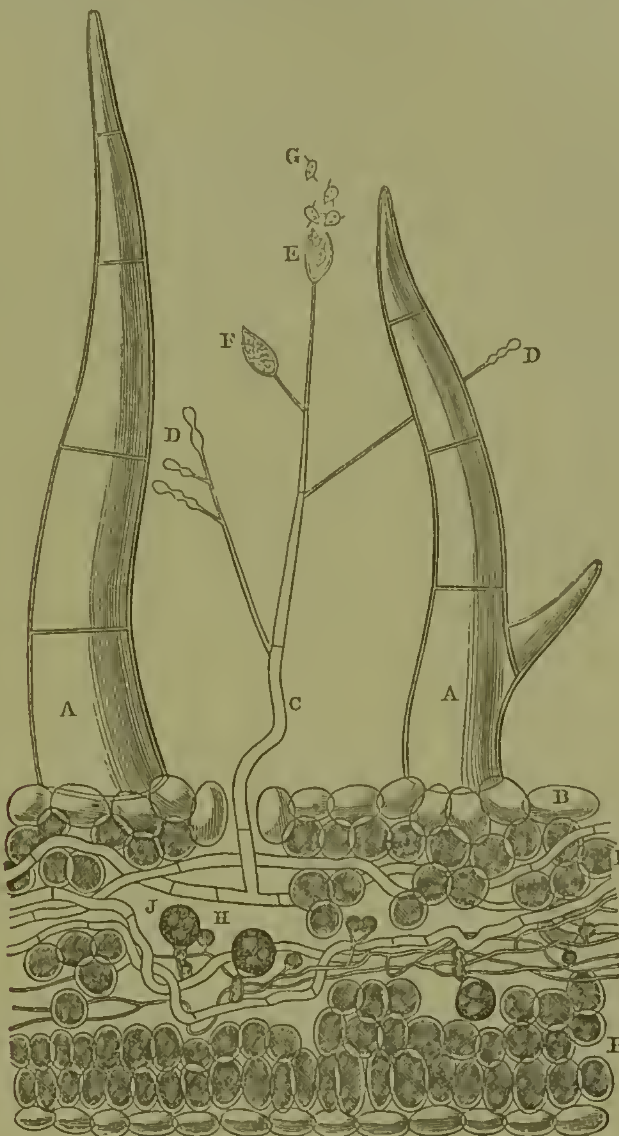


Fig. 68.

the year following their production, just as a seed falls and rests in the autumn, and starts again into life during the following spring."—(W. G. Smith.)

Although we now possess the last link in the chain, and know probably the entire history of the fungus, the remedy is not so clear; for the parasite in the *living* plant can hardly be reached by any destructivo agencies without destroying the potato, since the life of the fungus is passed within the very tissues itself. There is one thing, however, evident—viz., that destruction by fire of all diseased haulms would without doubt check the disease very effectually; that it would extinguish it altogether is doubtful, for it is certain that the potato plant is not the only one affected with the peronospora, and if therefore the whole of the diseased potato plants in the world were destroyed, in the next season the fungus might again invade the crops from other solanaceous plants.

Potato, Sweet—*See* Batata.

Poultry—Poultry usually contains too much nitrogenous matter and too little fat to be very nourishing. The duck and the goose, which possess more fat, contain certain flavouring matters which are not easy of digestion. No bird nor bird's egg is known to be poisonous, but some birds are rendered poisonous by the food which they have eaten. The pheasant, for instance, which feeds on the buds of the *Calmia latifolia*, in North America, is deemed poisonous during the winter and spring; and birds in this country which have fed on poisoned grain have produced serious symptoms in those who have eaten them.

A medical officer of health, &c., may inspect, and if necessary seize, poultry. *See* Food, Inspection of.

Poverty—*See* Pauperism.

Powers of Sanitary Authorities—*See* Sanitary Authorities.

Preserves—Preserved fruits—jams, jellies, &c.—frequently contain copper, and in some cases this metal has been found to be present in large quantities. It is derived either from the copper vessels in which the preserves are often prepared, or has been added to improve the colour of the article. *See* Copper.

Prevention of Disease—*See* Epidemic, &c.

Prices—The prices of the principal provisions have greatly increased since 1852. The following table clearly shows this:—

The Average Prices of Consols, of Wheat, of Meat, and of Potatoes in each of the Twenty Years 1852-1871.

Years.	Average Price of Consols (for Money).	Average Price of Wheat per Quarter in England and Wales.	Average Prices of: Meat per lb. at the Metropolitan Meat-Market (by the Carcase). Beef. Range of Prices.	Beef. Mean.	Mutton. Range of Prices.	Mutton. Mean.	Best Potatoes per Ton at Waterside Market, Southwark. Range of Prices.	Mean.
	£	s. d.	d.	d.	d.	d.	s.	s. d.
1852 . . .	99⅜	40 10	3¼–5	4⅛	4 –5¾	4⅞	79-103	91 0
1853 . . .	97⅝	52 11	4 –5¾	4⅞	4¾–7	5⅞	116-145	130 6
1854 . . .	91⅞	72 5	4½–6½	5½	4¾–7	5⅞	107-131	119 0
1855 . . .	90⅜	74 8	4⅝–6⅝	5⅝	4¾–6¾	5¾	94-107	100 6
1856 . . .	93	69 2	4¼–6½	5⅜	4¾–6¾	5¾	78- 93	85 6
1857 . . .	91⅞	56 5	4¼–6½	5⅜	4¾–7	5⅞	108-134	120 8
1858 . . .	97	44 3	4¼–6¼	5¼	4½–6¾	5½	104-136	120 0
1859 . . .	95	43 10	4½–6½	5½	4¾–7	5⅞	79-109	94 0
1860 . . .	94	53 3	4 –6⅝	5⅜	5 –7⅛	6	120-145	132 6
1861 . . .	92	55 4	4 –6½	5¼	5 –7¼	6⅛	114-134	124 0
1862 . . .	93⅘	55 5	4 –6¼	5⅕	5 –6¾	5⅞	125-149	137 0
1863 . . .	92⅞	44 8	4¼–6¼	5¼	4¾–7	5⅞	90-111	100 6
1864 . . .	90⅜	40 2	4½–6½	5½	5¼–7	6¼	64- 86	75 0
1865 . . .	89⅝	41 9	4½–7	5¾	5¾–8¼	7	75-101	88 0
1866 . . .	87⅞	49 11	4¾–7	5¾	5½–8	6¾	69-109	89 0
1867 . . .	93⅛	64 5	4¾–6¾	5¾	5 –7	6	115-161	138 0
1868 . . .	94	63 9	4½–6¾	5⅝	4½–6¾	5⅝	111-164	137 6
1869 . . .	93⅛	48 2	4¾–7½	6⅛	5 –7½	6¼	75-124	99 6
1870 . . .	92⅝	46 10	4¾–7¼	6	5¼–7¾	6½	90-119	104 6
1871 . . .	93	56 10	5¼–7¾	6½	5½–8⅜	7	65- 89	77 0

Prison Diets—*See* Dietaries.

Privies—It would be well for sanitary authorities to select, in every case, properly-designed plans of privies, and to enforce by-laws ordering that no privy be erected which is constructed imperfectly or built in an improper place. A very useful plan and specification, which may be modified to suit particular circumstances, are given on pp. 465, 466.

There is no privy yet constructed that will give satisfactory results with dirty and careless people; but when an owner provides his houses with fit accommodation, there is an obligation then on the tenant to keep it properly attended to. The ordinary privy, with an open cesspit at the back of it, should in all cases be superseded by either earth-closets, or if a cesspit is preferred, it *must be* properly

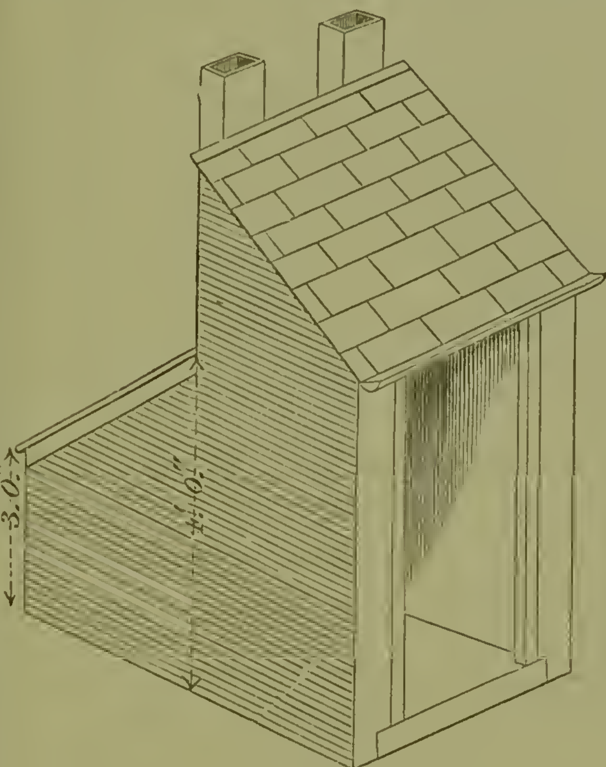


Fig. 69.

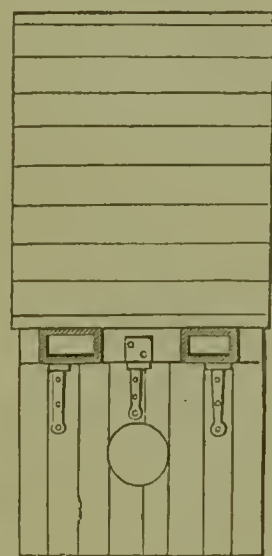


Fig. 71.

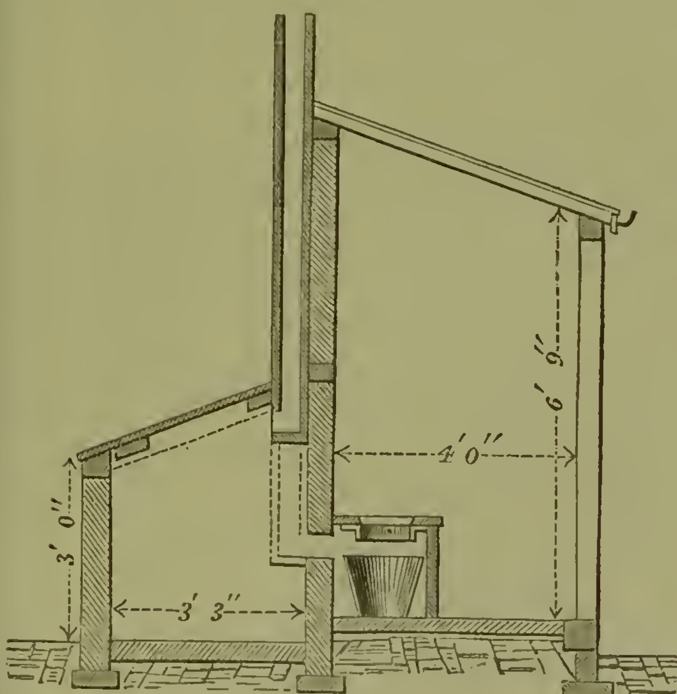


Fig. 70.

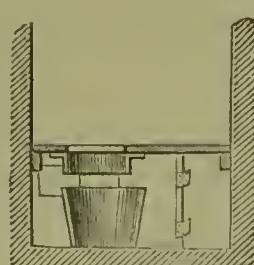


Fig. 72

ventilated, and have walls perfectly water-tight. The forms of privies are innumerable: the simplest is perhaps a galvanised zinc pan, either furnished with handles or on wheels, and put *close up* to an ordinary seat: this is emptied when necessary.

Specification.—The privy and dust-bin to be built of 4½-in. brickwork, in well-ground mortar, of approved quality.

Two rows of 4½ and 3 in. bond timber to be built in at back of privy for securing ventilating-shafts.

The ventilating-shafts to be 7 by 4½ in., inside measurement, of best red deal boards 1 in. thick, closely put together, with strong white-lead paint, and well nailed and carefully seamed to the 4½ and 3 in. bond timber.

These shafts to have coats of boiled tar both inside and out.

The lid of refuse-bin to be of best 1-in. red deal boards, with two strong ledges or battens across them ; to be hung with three strong band hinges to the sides of the ventilating-shafts, and the making-up piece between the same. A circular orifice to be made in centre of lid, between the battens, 10 in. wide. The lid to have two coats of boiled tar both inside and out.

A 4½ and 3 in. frame, of red deal, to be securely fixed on top of the dust-bin as a seat for the lid.

A lid over the privy seat to be hinged on at the back, with a child's seat over centre of large one. The larger seat to be provided with an earthenware circular rim beneath.

The earth compartment to be without lid, and provided with a pint scope for each occupant to throw in a pint of the stored dry earth or dry ashes through the seat into the galvanised iron pail, the contents of which must be scattered over the garden, or put in the dust-bin, before the pail becomes full. A loose foot-block may be furnished where there are young children.

The dust-bin may be placed at side of the privy if required. The floor of dust-bin to be at the ground-level, slightly inclined outwards, and paved with brick.* (Figs. 69-72.)

The chief provisions as to privies and closets are as follows :—

It is not lawful newly to erect any house, or to rebuild any house pulled down to or below the ground-floor, without a sufficient water-closet, earth-closet, or privy, and an ashpit, furnished with proper doors and coverings. Penalty for contravention, £20 or less.—(P. H., s. 35.)

If a house within the district of a local authority appears to such authority by the report of their surveyor or inspector of nuisances to be without a sufficient water-closet, earth-closet, or privy, and an ashpit, furnished with proper doors and coverings, the local authority shall, by written notice, require the owner or occupier of the house, within a reasonable time therein specified, to provide a sufficient water-closet, earth-closet, or privy, and an ashpit, furnished as aforesaid, or either of them, as the case may require.

If such notice is not complied with, the local authority may, at the expiration of the time specified in the notice, do the work required, and may recover in a summary manner from the owner the expenses incurred by them in so doing, or may by order declare the same to be private improvement expenses: provided that where a water-closet, earth-closet, or privy has been and is used in common by the inmates of two or more houses, or if in the opinion of the local authority a water-closet, earth-closet, or privy, may be so used, they need not require the same to be provided for each house.—(P. H., s. 36.)

Any enactment in force within the district of any local authority requiring the construction of a water-closet shall be deemed to be satisfied by the construction, with the approval of the local authority, of an earth-closet.

Any local authority may, as respects any house in which any earth-closet is in use with their approval, dispense with the supply of water required by any contract or enactment to be furnished to any water-closet in such house, on such terms as may be agreed on between such authority and the person providing or required to provide such supply of water.

Any local authority may themselves undertake or contract with any person to undertake a supply of dry earth or other deodorising substance to any house within their district for the purpose of any earth-closet.

The term "earth-closet" is to include any place for the reception and deodorisation of fæcal matter constructed to the satisfaction of the local authority—(P. H., s. 37.) *See also* CLOSETS, FACTORIES, NUISANCES, PUBLIC NECESSARIES, SCAVENGING.

Prostitution—The prevention of this terrible evil has baffled the united efforts of the legislator, the philanthropist, and the hygienist. Prostitutes have existed from the most ancient times down to our own, and so long as human nature is the same as it is now will continue to exist. The only practical means of in any way controlling this vice within bounds is to render clandestine prostitution impossible, to register public. and to give prostitutes every facility of reforming their manner of life, as well as by periodical inspection to be able to isolate and cure those who are affected by venereal disease, and thus prevent its propagation.

It is difficult to know the number of prostitutes, except in those few places where the Contagious Diseases Acts are in force. In London, for example, only the more notorious and open prostitutes are known to the police; and it is evident that clandestine prostitution, which is known to exist to a considerable amount, will always render official returns inaccurate. The following table, however, gives some idea of London prostitution :—

* The above forms can be obtained of Knight & Co., 90 Fleet Street, London.

TABLE I.—METROPOLITAN POLICE. Abstract Return of the Number of BROTHELS and PROSTITUTES in each Division.—(From ACTON'S work on "Prostitution.")

	POLICE DISTRICTS.	NUMBER OF BROTHELS AND PLACES				TOTAL.	NUMBER OF PROSTITUTES			TOTAL.
		Where Prostitutes are kept.	Where Prostitutes lodge.	Where Prostitutes resort.	Coffee-houses and other places known to the Police as Brothels or places of accommodation of Prostitutes.		Well dressed, living in Brothels.	Well dressed, living in Private Lodgings.	In Low Neighbourhoods.	
A	Whitehall	...	...	...	...	...	...	...	...	...
B	Westminster...	...	141	2	18	161	...	167	310	477
C	St. James's.....	...	106	1	21	128	...	227	10	237
D	Marylebone.....	...	7	3	15	25	...	128	162	290
E	Holborn	1	171	8	11	191	10	371	136	517
F	Covent Garden	1	...	1	21	23	1	2	427	430
G	Finsbury........	...	86	35	13	134	...	29	235	264
H	Whitechapel ...	...	126	2	11	139	...	...	623	623
K	Stepney..........	...	350	9	16	375	...	133	799	932
L	Lambeth	...	149	34	21	204	...	144	228	372
M	Southwark......	...	19	23	19	61	...	14	314	328
N	Islington	...	127	...	15	142	...	247	186	433
P	Camberwell	...	43	1	4	48	...	...	65	65
R	Greenwich......	...	125	6	12	143	...	144	415	559
S	Hampstead.....	...	...	...	5	5	...	128	45	173
T	Kensington.....	...	193	1	4	198	...	236	110	346
V	Wandsworth...	...	12	...	...	12	...	33	85	118
W	Clapham	...	27	...	1	28	...	23	53	76
X	Paddington	...	23	1	6	30	...	61	50	111
Y	Highgate........	...	51	5	16	72	...	68	96	164
	Total..........	2	1756	132	229	2119	11	2155	4349	6515

An attempt was made as early as 1352 to regulate prostitution in London. "Adam Francis, mercer, and Lord Mayor of London, 1352, procured an Act of Parliament that no known whore should wear any hood or attire on her head except raised or striped cloth of divers colours" (FULLER'S Pisgah Sight, p. 253; Stow quoted, p. 553); but the "Contagious Diseases Acts" is the only earnest attempt ever made by our Legislature to control the evil (*see* CONTAGIOUS DISEASES ACT), thus partially following the example set for some time on the Continent, where prostitution is recognised and regulated by the State.

In France the prostitutes are divided into several distinct classes: (1) Prostitutes who are shut up in *les maisons de tolérance*, and under the direction of a woman to whom they are subject; and (2) those who are free, and who give an account of their conduct to the administrative sanitary authorities.

As to the girls of the second category, a special card is given, having on it the sanitary visits to which they are subjected. These girls are called *filles-en-carte*, in opposition to the others, who are only classed by the number of the house in which they live, and who are called *filles à numero.*

The *carte* with which the former are furnished we append.

185 { Here are entered her name, age, general appearance, residence, &c.

18 .	First Fortnight.	Signature of Medical Officer.	Second Fortnight.	Signature of Medical Officer.
Jan.				
Feb.				
Mar.				
April				
May				
June				
July				
Aug.				
Sept.				
Oct.				
Nov.				
Dec.				

On the reverse of this *carte* are printed the following—

Obligations and Restrictions imposed on Public Women.

Public women, *en carte*, are called upon to present themselves at the dispensary for examination, once at least every fifteen days.

They are called upon to exhibit this card on every request of police officers and agents.

They are forbidden to practise the calling during daylight, or to walk in the thoroughfares until at least half an hour after the public lamps are lighted, or at any season of the year before seven o'clock, or after eleven P.M.

They must be simply and decently clad, so as not to attract attention by the richness, striking colours, or extravagant fashion of their dress.

They must wear some kind of cap or bonnet, and not present themselves bareheaded.

They are strictly forbidden to address men accompanied by females or children, or to address loud or anxious solicitations to any person.

They may not under any pretence whatever exhibit themselves at their windows, which must be kept constantly closed and provided with curtains.

They are strictly forbidden to take up a station on the foot-pavement, to form, or walk together in groups, or to and fro in a narrow space, or to allow themselves to be attended or followed by men.

The neighbourhood of churches and chapels, within a radius of twenty-five yards, the arcades, and approaches of the Palais Royal, the Tuileries, the Luxemberg, and the Jardin des Plantes are interdicted.

The Champs Elysées, the Terrace of the Invalides, the exterior of the Boulevards, the quays, the bridges, and the more unfrequented and obscure localities, are alike forbidden.

They are especially forbidden to frequent public establishments or private houses where clandestine prostitution might be facilitated; or to attend *tables d'hôte*, reside in boarding-houses, or exercise the calling beyond the quarter of the town they reside in.

They are likewise strictly prohibited from sharing lodgings with a kept woman or other girl, or to reside in furnished lodgings at all without a permit.

Public women must abstain when at home from anything which can give ground for complaints by their neighbours or the passers-by.

Those who may infringe the above regulations, resist the agents of authority, or give false names or addresses, will incur penalties proportioned to the gravity of the case.

Les maisons de tolérance are licensed by the police. The women in charge of them are obliged to register within twenty-four hours every prostitute that presents herself there as a candidate for admission. Likewise when a prostitute quits such a house, the mistress of the house is obliged to make a declaration to the authorities within twenty-four hours after her departure. These regulations are rigorously enforced. The brothel-keepers have a book, divided into two parts; the one destined for the registration of the prostitutes under her care, the other for the registration of occasional visitors who only go to the house at certain hours. Each page of the first division is divided into four columns; the first contains the name and age of the woman, the second the date of her entry into the house, the third indicates the day on which the sanitary visit is made, and the last is reserved to enter the day of her departure.

Belgian Regulations.—The Belgian regulations greatly resemble those in force in France, but there are some peculiarities which we now proceed to notice. All prostitutes in this country are divided into (1) *filles de maisons tolerées*, called *numérotées*; and (2) *filles éparses*, corresponding to the French *fille-en-carte*. They are not allowed to promenade the streets after sunset. Women under twenty-one may not be inscribed; and the medical visitation *au speculum* takes place twice a week by the divisional surgeons, and by the superintending officer whenever he pleases. All the *éparses* and third-class *filles de maisons* are seen at the dispensary, and the first and second classes of the latter order at their domiciles. The *éparses* may secure this privilege by payment of an extra franc per visit.

The tariff of duties payable by houses and women is as follows :—

Every 1st-class	*maison de passe*,			£1	per month.
,, 2d	,,	,,		10s.	,,
,, 3d	,,	,,		4s.	,,

Every first-class *maison de débauche* pays £2, 8s. to £3 monthly, according to the number of its authorised occupants—from six to ten—and 2s. extra for each additional person.

Every such second-class house pays 16s. to £1, 6s., for from three to seven women, and 1s. extra for each additional female.

Every such third-class house pays 6s. to 13s. for from two to seven women, and 1s. extra for each additional inmate.

Every 1st-class	*fille éparse*	pays	on each inspection	4d.
,, 2d	,,	,,	,,	3d.
,, 3d	,,	,,	,,	1½d.

Upon punctuality for four successive visits these payments are returned; for inexactitude they are doubled.

All women who on examination are discovered to be diseased, or to present any suspicious appearance, are sent to hospital, and medical men are strictly enjoined to treat diseased prostitutes at their own houses. The consequence of these regulations is that syphilis has almost disappeared from the Brussels hospitals.

The following regulations, which are also in force, may be of interest :—

" Every girl or woman who shall be pointed out as giving herself up clandestinely to a life of prostitution shall be summoned to the police office, to make her statement and produce any justification of her conduct she may wish. The accusation and report, with her justification, shall be brought before the council, and her registration as a public prostitute will take place, if approved of by the council. In this case the decision shall be announced to the girl within twenty-four hours, through the officer of police charged with this duty.

"Every girl not registered who shall be detected furtively practising prostitution shall be immediately arrested and brought before the police officer, then to be interrogated. From thence she is to be sent to the dispensary to be examined by the surgeon. The next step is for the police to draw up a report on the circumstances giving rise to the arrest, which report comes before the council.

"Each room, according to the police instructions, is to contain a bottle holding a solution of caustic soda, say 1 oz. of liquor sodæ to 1 pint of distilled water; also a bottle containing sweet oil: both bottles to be legibly labelled."

The following table, showing the number of prostitutes in Brussels in 1868, we take from Mr. Acton's work:—

TABLE II.—Movement of Prostitution in the City of Brussels from January 1 to December 1, 1868 (Acton).

Registered Prostitutes present, 1st December 1868.			Women sent to Hospital as Venereal since the 1st January.		Approximative Number of Clandestine Prostitutes.			Number of Beds given up for Treatment.		Observations.
In Houses.	Isolated.	Total.	Registered.	Clandestine.	Residing in Cafés and Public-Houses reputed to harbour Prostitutes.	Residing in Lodgings.	Arrested as Prostitutes since the 1st of January.	Registered Women.	Clandestine Prostitutes.	
83	192	275	149	226*	100	150	170	43	37	
18	...	18	3	...	40	...	...	...	...	Schaerbeek.†
23	...	23	1	2	40	...	...	...	...	St Fosse-ten Roode.†
124	192	316	153	228	180	150	170	43	37	

Prussian Regulations.—In Berlin it has been found necessary to revive the *maisons de tolérance*, which were formerly suppressed. These are governed by very stringent regulations, similar to those in force in France and Belgium. In 1869‡ there were in Berlin 13,538 females strongly suspected of prostitution, and who were therefore under the censorship of the police. In 1868 the number of registered prostitutes subjected to regular sanitary control was 1639. Of these an average of 225 present themselves daily for medical examination, and the reports prove that $2\frac{1}{2}$ per cent. of these are found to be infected with syphilis.

The subjoined police form shows the method of dealing with women who, though not actually enrolled in the police lists of prostitutes, behave in such a manner as to subject themselves to grave suspicion:—

Berlin, 18*th August* 1868.

This day appeared, known by nobody, from , age , residing at .

She was informed that she was strongly suspected of an immoral way of living. She was forbidden—

1. To entice male persons to her lodgings through words, winks, signs, or any other announcement (for instance, showing a lamp or light) either from the window or from the door.

2. To make herself conspicuous, or to entice men through words, speech, or signs in public places, in the street, in squares, or in the theatre, or any other public buildings.

3. To enter the lodgings of people suspected of being procurers, or who have been already punished for this misdemeanour.

4. To go about in the neighbourhood of barracks, military buildings, the Park of Invalids, and any other places much frequented by soldiers.

5. To take lodgings in the neighbourhood of churches, schools, and royal buildings, as well as to enter ground-floor habitations.

* Makes 54 per cent. in eleven months.
† These are suburbs of Brussels.
‡ Population of Berlin, 1867, was 702,000.

6. To go into the boxes of the first range in any theatre except the pit of the Royal Theatre and the "Krollsche Local."

This ordinance will be enforced by a punishment of up to four weeks' police imprisonment, pronounced according to the Instructions of Government, dated 23d October 1807, and the ordinance of the 26th December 1808.

Public women in Berlin are medically examined once a week.

In Austria public women are not licensed, but the police have the power of entering their dwellings, accompanied by one of the police physicians, and if they are diseased, compelling them to go into hospital. Mr. Wilde says, speaking of prostitution in Vienna, "the lowest calculation allows the number of public females in the capital to be 15,000."

In Stockholm there are no regulations whatever, and according to Bayard Taylor, it is the most licentious city in Europe.

At Copenhagen they have established registration, but there are no regular licences. They have only attempted to take care promptly of those affected with syphilis, and there are no special houses. Infected women are to present themselves at the police office within fifteen days after contracting the disease. They are recompensed for this compliance by being cured secretly and without cost. If they do not attend when affected, the law is put vigorously in force. They have even gone farther than this, and have forced men, when affected, to be taken care of in a hospital, unless they give some guarantee that they will keep to their own houses, and not propagate the disease.

Spain, which was the first to legislate on prostitution, has abandoned it for two centuries, since Philip IV. suppressed all the *maisons de tolérance*, and imprisoned the prostitutes. Therefore at the present day the police do not interfere, unless the bad women in the public promenades become excessive or the hospitals contain too large a number of venereal cases. It is not a matter of astonishment in such a state of things to see outrages on decency multiply; and in a single year (1843), 843 were noticed, a figure which is far from representing the actual number. These indecencies were punished in a very light manner, so that there is very little chance of seeing them diminish.

In Holland, since 1856, the municipal authority has strictly enforced the regulations to which prostitutes are liable, and the police surveillance is very severe. The following rules from the Hamburg regulations are peculiar:—

"Places other than authorised brothels, where meetings between men and women take place for purposes of cohabitation (so-called *absteigequartière*), will not in future be tolerated if—

"1. The keepers, male or female, have not been duly registered.

"2. At least one registered girl does not live there.

"3. Any but registered girls are omitted, no keeper, either of this or another sort, to allow other girls or women to meet men at his house, under penalty of heavy punishment or withdrawal of concession (licence). It is ordered that the girls may claim (calculate) for one visit in an extra room, which visit does not last over half an hour—

"1st class, no more than $1 = 4s. 7d.; and for every hour further, also $1 per hour.

"2d class, one-half.

"No consideration is hereby taken of any further claims in consequence of demands (requests) made to them by their visitors.

"Girls are strictly forbidden to undress in the guest-room.

"This tariff to be posted in all rooms, also where girls live, and is to be shown at the request of each guest.

"A public girl who gives herself (abandons herself) in an unnatural manner to men, will be punished with the heaviest (severest) punishments promulgated in these regulations."

Dance music is forbidden in brothels, and cards are not allowed. The girls are medically examined twice a week, and are taxed at 8, 6, or 4 marks* each per month, according to the class of the keeper or girls. To girls who have to suckle children, this tax may be remitted, according to circumstances. The prices to be charged for refreshments at brothels in Hamburg are regulated by the police. The keeper of a licensed house must defray the cost of curing any person whose contamination by venereal disease in his house can be established. The population of Hamburg in 1867 was 225,074 souls, including 1311 military; and the number of registered prostitutes is 1076, of whom about 120 are usually in hospital. There is nothing else in the Hamburg regulations which calls for special remark.

Regarding Naples, Acton says, "The stews or *bordelle* of the capital are fully recognised, if not licensed, by the police, and undergo inspection at intervals by underpaid Government officials, who derive additions to their income from the contributions of the class whom it is their supposed duty to supervise. There are also in Naples great numbers of quasi-clandestine prostitutes, chiefly Sicilians, who are supported through the activity of the

* 12s. 3d., 9s. 2d., and 6s. 1d.

ruffani, or pimps, who operate in the frequented quarters of the town, and pester Englishmen especially with their offers of service. The low prostitution of the town, ministering for the most part to the desires of the military and marine, is gathered together in the suburb outside the Porta Capuana."

It has been impossible for us here to enter into any discussion as to the merits of the regulations we have briefly cited, and those who desire to pursue the subject we would refer to the writings of Acton, Parent-Duchâtelet, Fait, Von Lippert, Duchesne, &c. *See* CONTAGIOUS DISEASES ACT, VENEREAL DISEASES.

Prussian Blue—Employed as a colouring matter in tea, confectionery, &c. *See* TEA, CONFECTIONERY, &c.

Prussic Acid—*See* ACID, PRUSSIC.

Psorospermia—Small, transparent, oval or kidney-shaped little bodies, found in the flesh of oxen, sheep, and pigs. They lie within the sarcolemma, and appear often not to irritate the muscle. No injurious effects have been produced on man by eating these bodies, but in sheep and pigs they produce decided illness. *See* MEAT.

Ptyalin—A peculiar organic principle found in the secretions of the submaxillary and sublingual glands. It is very prone to putrefaction, and somewhat resembles sodic albuminate. It is characterised by its power of converting starch into dextrine and into sugar. Mialhe has termed this substance *animal diastase*, and according to him 1 part of ptyalin is capable of converting 8000 parts of insoluble starch into sugar. It has been computed that 116 grains of ptyalin are on an average daily secreted by an adult. *See* SALIVA.

Public Institutions—Excluding barracks and her Majesty's ships, which can hardly be classed as "public institutions" in the ordinary acceptation of the term, the following is a comparison of the returns for 1871 with those of 1861:—

	Number of Institutions		Total number of Occupants, including Officers, &c.	
	1861.	1871.	1861.	1871.
Workhouses	721	730	131,440	154,967
Hospitals...........	167	407	13,200	26,565
Lunatic asylums..	144	166	29,198	45,731
Prisons..............	179	149	29,959	32,174
Reformatory and industrial schools	?	118	?	11,748
Other institutions	282	559	27,157	38,535

The following tables exhibit the number of persons who have died at public institutions in England (*see* HOSPITALS, &c.):—

DEATHS registered in the principal PUBLIC INSTITUTIONS of ENGLAND in the Year 1871.

Divisions and Registration Counties.	Total Number of Institutions.	Total Deaths in all Institutions.	Workhouses.				Hospitals.				Lunatic Asylums.			
			Number of Institutions.	Deaths.			Number of Institutions.	Deaths.			Number of Institutions.	Deaths.		
				Persons.	Males.	Females.		Persons.	Males.	Females.		Persons.	Males.	Females.
England .	1135	46,556	707	28,753	16,622	12,131	346	13,706	8902	4804	82	4097	2314	1783

LONDON.—DEATHS in PUBLIC INSTITUTIONS in the 52 or 53 Weeks of the 13 Years 1859–71.

	1859.	1860.	1861	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.
					(53 weeks)					(53 weeks)			
Total deaths in public institutions . .	9633	9550	10,276	11,313	11,112	12,731	12,116	13,054	12,002	12,326	12,298	12,300	14,665
In workhouses . .	5228	5161	5757	6401	6187	7055	6715	7088	6829	6789	7068	6833	6675
In prisons . . .	40	41	46	53	64	125	99	95	90	75	83	78	76
In military and naval asylums . . .	307	272	251	307	289	315	278	195	147	176	165	86	81
In general hospitals .	2927	3039	3234	3167	3169	3558	3354	3813	3291	3714	3480	3614	3796
In hospitals for special diseases . .	431	413	335	690	827	982	1002	1167	929	933	849	981	3320
In lying-in hospitals—													
Women . .	35	34	38	35	11	24	26	22	31	15	13	31	16
Children . .	51	57	58	40	37	48	42	50	51	46	41	40	37
In military and naval hospitals. . .	187	173	223	236	203	215	176	146	177	163	170	200	218
In hospitals and asylums for foreigners .	46	47	58	74	61	82	71	96	100	79	93	102	99
In lunatic asylums .	381	313	276	310	264	327	353	382	357	336	336	335	347

Public Necessaries—Any *urban* authority may, if they think fit, provide and maintain, in proper and convenient situations, urinals, water-closets, earth-closets, privies, and ashpits, and other similar conveniences for public accommodation.

Public Pleasure-Grounds—Any *urban* authority may purchase or take on lease, lay out, plant, improve, and maintain, lands for the purpose of being used as public walks or pleasure-grounds, and may support or contribute to the support of public walks or pleasure-grounds provided by any person whomsoever.

They may also make bylaws for the regulation of any such public walk or pleasure-ground, and may by such bylaws provide for the removal from such public walk or pleasure-ground of any person infringing any such bylaw by any officer of the urban authority or constable.—(P. H., s. 164.)

Public Works Loans Commissioners—*See* LOANS.

Puerperal Diseases—The disease entered in the Registrar-General's returns as puerperal fever, really includes almost any fatal disease at the time of childbirth; for it is the custom of medical men to return cases of uræmic poisoning, puerperal convulsions, inflammation of the womb, and peritoneum, &c., as puerperal fever. Indeed it is a great question whether most cases of this fever are not really malignant forms of other zymotic diseases, such as smallpox, scarlet fever, typhoid, diphtheria, and others. All epidemics—whether of cholera, typhus, and smallpox in our times, or of plague, sweating sickness, and other pestilences of the past—have been attended with deaths from childbirth and abortions; and it will be found on reference to the Registrar's returns, that, generally speaking, years of most fatality from fevers of the zymotic class are always most fatal to lying-in women. The puerperal state would appear to be peculiarly susceptible of contagion, and too often the system at once sinks under the annihilating influence of the poison. In such cases the patient exhibits no character by which the disease can be identified—there is neither eruption, nor can a characteristic line of temperature be traced by the physician on the chart; convulsions and insensibility are alone present, symptoms belonging to many diseases.

The following are the proportions to 100,000 births of cases of puerperal fever during the ten years 1862–71: 1862, 132; 1863, 159; 1864, 200; 1865, 178; 1866, 162; 1867, 139; 1868, 152; 1869, 152; 1870, 188; 1871, 183. The mean annual number of the actual deaths from puerperal fever from 1854–71 is 1145, but during the last ten years about 1200 have annually died from this cause.

To these the deaths from childbirth should be added. This heading of course includes many causes of death, such as exhaustion, rupture of the uterus, hæmorrhage, inflammation, and also puerperal fever, for there can be no doubt a few cases of the latter are returned as deaths from childbirth. The connection between zymotic diseases and deaths in the puerperal state will be seen in the following table:—

	20 years, 1850–69.	10 years, 1850–59.	10 years, 1860–69.	5 years, 1850–54.	5 years, 1855–59.	5 years, 1860–64.	5 years, 1865–69.
Zymotic diseases	5086·2	5136·7	5035·6	5234·1	5039·5	4899·3	5171·8
Puerperal fever	54·9	54·6	55·2	54·0	55·2	54·2	56·2
Childbirth	112·8	113·8	111·9	122·6	105·0	113·4	110·4

Whatever the infection of puerperal fever may be, there can be no doubt of its great malignancy. No medical man, midwife, nurse, or other person who has had aught to do with a woman ill of real puerperal fever, should approach, even for a moment, a lying-in woman until several weeks have elapsed since the infection, and their clothes and bodies have been completely and thoroughly disinfected. If any one wilfully or thoughtlessly neglects proper precautions, such a one, in the writer's opinion, is morally and legally guilty of a very great crime; and it would be the duty of a health officer, in such a case, to advise his sanitary authority to prosecute the offender.

Puerperal Fever—*See* PUERPERAL DISEASES.

Pulses—A group of farinaceous seeds, including beans, peas, and lentils, characterised by containing a large proportion of nitrogeuous matter. All the important constituents of this group have been treated of under their respective headings.

Pumps—All existing pumps used for the *gratuitous* supply of water are vested in the local authority, by whom they are to be kept in order and plentifully supplied with pure and wholesome water. *See* WATER.

Pustule, Malignant (*Charbon*)—Dr.

William Budd first called the attention of English medical men to this disease, with which physicians on the Continent had for some time heen familiar. He showed that it had long been preseut in this country as an epizootic, and yearly had heen fatal to our live stock. The various names by which the disease is known are the "joint murraiu," the "black quarter," the "quarter evil," and the "blood." In Franco it is called "charhon," "quartier," and "sang;" aud in Germany the "milzbrand."

The disease is at first local. It hegins in cattle, as in man, at the point where the contagion is first implanted with a vesicle, and if this vesicle is early destroyed the beast is saved; hut this is seldom done, for the vesicle escapes noticc until too late.

The disease is commuuicable to man in the following ways:—

1. By inoculation, as in the case of butchers, farmers, skinners, &c.

2. By means of the skin or hair of diseased beasts. Trousseau, for examplo, relates that in two factories for working up horse-hair imported from Bucuos Ayres, in which only six or eight hands were employed, no less than twenty persons died of oharbou in ten years. Dr. Budd, by this and mauy other cases, shows that the virns when dried may retain its powers for a considorablo period of time.

3. Instances have occurred hy which it would appear to have been caused by eating the flesh of the diseased animals, and also by using the milk or even butter of affected cows.

4. Jusects which have heen in contact with the bodies or carcases of diseased cattlo may communicate the infection to man; and it would appear from puhlished cases that this may be effected not alone by insects with piercing prohosces, hut hy other flies implanting the poison ou the skin by their soiled wings or feet—*e.g.*, thero is au iuteresting case related hy Dr. J. Rogers in the "Lancet" of July 12, 1873, in which a lady died in seven days from charbon communicated to her hy a large blue-hottlo fly which settled on her chin.

The *symptoms* of this diseaso in man are shortly as follows: Thero is generally a history of infection either from the sting of au infected insect, tho scratch of an infected kuife, or otherwise. Some littlo irritation at the seat of inoculatiou is succeeded hy a red spot; this in from twelve to fifteen hours becomes a vesicle, which, at first small, grows larger, then bursts. In about twenty-four hours from tho oommencement, a small, hard, circumscribed, lentil-shaped nueleus may be seen at the seat of the vesicle, in the centre of an inflamed areola, on which form a number of vesicles similar to the first one. At first isolated, then confluent, they contain lymph of a most virulent and contagious uature; the part affected swells considerahly, and rapidly hecomes hard, black, and gaugreuous.*. "The death of the tissue is so cutire that tho part creaks when cut with a knife; no pain attends the incisions. Crops of secondary vesicles form round an erysipelatous-liko areola, chains of lymphatics become inflamed, the hreath fetid, and death follows amid all the indications of septic poisoning."—(BUDD.)

There are, however, non-fatal eases, iu which the dead parts aro separated from tho liviug by suppuration.

To prevent tho propagation of the disease, every animal affected with it, which is uot seen iu tho very earliest stage, should be destroyed, and at once buried in lime.

The only way to cure tho disease in man or animals is to rocogniso it when an insignificant pimple, and destroy it with canstic, such as potassa fusa, nitric aeid, or chloride of antimony.

There would appear to be a kind of carbuncle analogous to malignaut pustule (possibly identical with it) produced by eating the flesh of animals affected with pleuro-pneumonia. The late Dr. Livingstoue notieed that iu South Africa eating such meat invariably produced tho disease, and the virus was neither dostroyed by boiling nor by roasting. It is also certain that the mortality from tho disease returned as carbuncle in the death returns has somo connection with the lung disease of cattlo. Pleuro-pneumonia was imported into this country from Holland in 1842, and in the five years preceding that time the mortality in England from carbuucle was scarcely 1 in 10,000 of tho deaths. From 1842 to 1846 there is no record of the disease; bnt iu the five years from 1846 to 1851 the mortality rose to 2·6 per 10,000 of tho deaths, and in the next five years it amounted to 6·2 per 10,000, and in the sueceeding five years to 5·4. This poiut is certainly worthy of farther investigation.

Putrefaction—This term comprehends certain chemical changes which spontaneously take place in dead animal matter, during which offensive gases are evolved. Organic bodies are for the most part made up of highly com-

* On the 14th of April 1864, Dr. Raimbert was called to a carter who had contracted charbon from cattle suffering from splenic fever. The pustule was removed and microscopically examined; it was discovered to be a perfect felt of bacteria, and rabbits fed with it contracted splenic fever and communicated charbon to other animals.—(Revue des Deux Mondes, November 15, 1864.)

plex combinations of the following elements: oxygen, hydrogen, carbon, nitrogen, sulphur, phosphorus, &c. Immediately life ceases, a general metamorphosis and decomposition of these combinations take place, and they are successively reduced to definite and simple compounds. This process is in principle identical with fermentation; in detail, however, it is slightly different. For the complete decomposition of an animal substance the presence of warmth, air, and moisture is requisite; and this change can only be prevented by reduction of temperature, exclusion of atmospheric air, and the abstraction of moisture. Thus on the acrid, dry, sandy deserts of Egypt bodies of dead animals are reduced to a fine powder and buried; and deep in the frozen snows of Siberia antediluvian elephants have been discovered in an edible condition.

Putrefaction is said to be rapid at 10° C. (50° F.) under water, but in the air the same rapidity is not attained till 25° C. (77° F.)

Animal matters much more readily putrefy than vegetable matters.

The products of the decomposition of these two substances are shown in the following statement taken from M. Girardin's "Leçons de Chimie," tome ii.:—

Products of the Decomposition of Animal Matters.

Carbonic acid.
Carburetted hydrogen.
Nitrogen in large quantity.
Sulphuretted hydrogen.
Phosphoretted hydrogen.
Ammonia.
Water.
Acetic acid.
Earthy residue considerable, containing carbon, salts of ammonia, &c.

Products of the Decomposition of Vegetable Matters.

Carbonic acid.
Nitrogen, traces.
Water.
Acetic acid.
Oily substances.
Black residue, in which carbon predominates.

This process does not begin to manifest itself in the dead body until after the cessation of cadaveric rigidity, and generally about the third day. The abdomen and chest, face, neck, and legs, are the parts of the body which first show signs of decomposition having begun, the arms being attacked last. Putrefaction takes place with variable rapidity, and bodies have been found in an advanced state of decomposition in the short period of *sixteen hours* after death, while in other cases the process has been greatly protracted.

Schröder (Liebig's Annal., cix. 35, and cxvii. 273) has shown that any organic liquid may be prevented from fermenting or putrefying if it be heated under pressure to about 266° F. (130° C.), then transferred to a flask and boiled, the mouth of the flask being plugged whilst boiling with a pellet of cotton wool. In this way he preserved, during a hot summer, various liquids, including freshly-boiled wort, blood, white of egg, whey, urine, broth, and milk; but when afterwards the plug of cotton was withdrawn, the liquids began to undergo decomposition. He supposes that the spores of some organism must find access to the substance in order to set up the process of decomposition. By a temperature of 260° any such spores which the liquid itself might contain are effectually destroyed, and as the air is filtered through the cotton before it reaches the interior of the flasks, none of these organic germs can afterwards obtain access to the body under experiment.

Putrid emanations have from the earliest times been believed to be capable of producing injurious effects on the human system. In the Bible we read of the great care taken to disinfect or clean vessels in which any putrid matter may have been, and in Rome measures were adopted for the efficient cleansing of the sewers and streets of that city. "The prætor took care that all sewers should be cleansed and repaired for the health of the citizens, because uncleansed or unrepaired sewers threaten a pestilential atmosphere, and are dangerous."—(Digesta Just., lib. 43, tit. 23.) It was also forbidden to throw refuse on the roads.—(Ib., tit. 9.) Galen believed that dead bodies left on battle-fields, &c., occasioned pestilential fevers; and St. Augustine relates that a quantity of drowned locusts which had been cast upon the shore by the sea, and which there putrefied, occasioned a cruel and disastrous plague. In more modern times Forestus was eyewitness to a plague caused by the accumulation of dead bodies; and he also speaks of a malignant fever which appeared at Egmont in Northern Holland, and which arose from the putrefaction of the body of a large whale left on the bank. A similar case is recorded by Ambrose Paré, which occurred on the Tuscan shores, and a pestilential fever which ravaged Venice in the time of the former authority is ascribed by him to have been produced by the putrefaction on that part of the Adriatic of a small species of fish; an observation repeated by Jean Wolf in his relation of the malignant epidemic fever which happened at Cork Island in 1731, where they slew annually more than 120,000 beasts for the use of the fleet. Rogers does not hesitate to class among the most active causes of infection the emanations from large slaughter-houses, and those arising from refuse matter left to putrefy in the streets; while the eminently practical observations of the sagacious Pringle clearly indicate at every step the pernicious effects which are produced by the putrefaction of animal substances. The works of Ambrose Paré offer facts not less conclusive on the danger of putrescent exhalations. We read there that in Agenois there prevailed in 1562 a pestilential fever which ravaged a circle of ten leagues, and which was caused by putrid animal vapour arising from a pit in the Château de Pem, into which had been thrown, many months before, several dead bodies. In excavating beneath the Paris church of St. Eustache, it was found necessary to place a number of the bodies in a sort of cellar which was situated under the church, and which for some time had not been opened. Some children attending the church were attacked by an illness, and tho same symptoms presented themselves in many adults—viz., laboured respiration, the mind confused, palpitation of the heart, and in some cases convulsive movements of the arms and legs. Tho Abbé Rosier relates that in the year 1760 some persons living at Marseilles opened, in a place where in 1720 a large number of bodies had been buried, trenches for the purpose of planting trees. Scarcely had they taken out more than a few spadefuls of earth, when three of the workmen were immediately suffocated, and could not be revived! Both Ramazzeni and Haguenot relate cases in which persons descending into vaults, &c., have lost their lives. These fatal effects they ascribe to putrid emanations, but they were probably due to the presence of carbonic acid gas in the air. Many instances in which gravediggers have been attacked by serious symptoms after exhuming a body are on record, and there can be no doubt that putrid emanations occasionally have caused death.

Putrid vapours, although dissolved in water, are none the less hurtful; and we know of more than one instance of the general sickness of a family being traced to the presence of the body of a rat or bird in a state of decomposition in the cistern. In one case a man fell into a cesspool, and although he only remained in it for a few moments, death ensued in less than twenty-four hours. Indeed, there can be no reasonable doubt of the extreme danger of putrid substances, when confined in small places, such as dissecting-rooms, cesspools, &c. When putrid matters are introduced into the circulatory system, fatal effects immediately follow.—(Gaspard.) The blood becomes very thin, due, according to Audral Gavarret, to diminution of fibrine and increase of free alkali. Rïecke imagines that putrid vapours act by making a strong impression on the organs of sense; but it is probable that they are absorbed, for it has often been noticed that for some days after attending a *post-mortem* examination, all the secretions of the operator are charged with the characteristic odour.

From the foregoing remarks it will be apparent that a medical officer of health would be justified in condemning as a nuisance putrescent carcases exposed near the public highway. For instance, bodies of horses hung up near kennels as food for the dogs, &c.

Many authorities have contended that putrid emanations are harmless, and in support of this view Parent-Duchâtelet draws attention to the fact that the rate of mortality amongst knackers, nightmen, gravediggers, sewer-men, &c., is not above the average. Thackrah states that sewer-men are not subject to any particular complaint, and are not short-lived. From an inquiry recently instituted, it would appear that the London sewer-men are not as a class unhealthy, and that those employed in Liverpool also enjoy good health.

From Parent-Duchâtelet's observations we learn that there are some men so affected by the air of sewers that they can never work in them, but those who remain suffer at first only from a little ophthalmia and lumbago, which usually soon pass off. Tho air of sewers has, however, been found to greatly aggravate venereal diseases; and those who persist in working with the disease on them inevitably perish. Labourers employed in removing putrid fish to be used as manure suffer no inconvenience, and emanations from the ordinary stable-manure heaps act, Parent-Duchâtelet is persuaded, as air-purifiers.

Another fact cited to support the view that vapours arising from decaying animal matters, &c., are inoffensive, is that in 1844 4000 dead horses were left for twelve days exposed to excessive heat on the battle-field of Paris without any injurious effects following, either to the inhabitants of the surrounding district or to the rag-dealers, knackers, &c., who prowled about the ground; and it is worthy of note that when the odour given off by the river Thames was highly offensive, the death-rate of London was remarkably low.

Regarding the general effect of putrid emanations nothing very definite can be declared, all depending on the mode of putrefaction, nature of emanation, degree of concentration, and the amount of resistance the individual organism is capable of offering to their attacks. Evidence is certainly adverse to the belief that putrefying organic matter is capable of originating epidemics, and in the words of a recent writer we may say, "without attempting to examine this matter carefully, the result here would seem to be, that whilst the decomposition of organised beings after death produces gases and vapours that are opposed to health, these gases or vapours are incapable of originating, although they may be capable of feeding, some of those diseases, such as cholera or plague, which have been observed at all times to come from a warmer climate. There must, however, be some first origin of these diseases, and we cannot prove that the first origin might not take place in our climate, although it seems probable that it requires a warmer sun and a richer vegetation than is to be found in the north. This, however, is sufficiently made out, that when these diseases do come amongst us, they take root with most effect in those places where decomposing animal matter is found. If we were to suppose a seed of disease planted in a rich fertile soil of decomposing matter, we should give a pretty fair description of the fostering effect of impurity on disease. It would, in fact, appear as if the putrid matter itself took the disease and transferred it to the living."

Putrid Emanations — *See* PUTREFACTION.

Putrid Malignant Fever (HUXHAM, 1739)—*See* FEVER, TYPHUS.

Q.

Quarantine—This name is derived from the period of forty days, which was the ancient quarantine. It probably, as Hecker remarks, had a medical origin, "for the fortieth day, according to the most ancient notions, has always been regarded as the last of ardent diseases, and the limit of separation between these and those which are chronic. It was the custom to subject lying-in women for forty days to a more exact superintendence. There was a good deal also said in medical works of forty days' epochs in the formation of the fœtus, not to mention that the alchymists expected more durable revolutions in forty days, which period they called the philosophical month. This period being generally held to prevail in natural processes, it appeared reasonable to assume, and legally to establish it, as that required for the development of latent principles of contagion, since public regulations cannot dispense with decisions of this kind, even though they should not be wholly justified by the nature of the case. Great stress has also been laid on theological and legal grounds, which were certainly of greater weight in the fifteenth century than in modern times, such as the forty days' duration of the Flood; the forty days' sojourn of Moses on Mount Sinai; our Saviour's fast for the same length of time in the wilderness; lastly, what is called the Saxon term, which lasts for forty days," &c. — (HECKER, The Black Death.)

It would be tedious to enumerate the various regulations and restrictions, all more or less vexatious, which the Governments of Spain, Portugal, Greece, and Turkey still enforce in the matter of quarantine.

It is felt both at home and abroad that some restrictions are absolutely necessary to prevent contagion being imported from one country to another, but the great difficulty is to obtain this protection so as scarcely to impede trade, and only really to interfere with individual liberty. The anxiety of the European Governments to obtain some really good regulations is evinced from the fact that since 1866 no less than four International Sanitary Conferences have been held; the last one was in 1873 at Vienna, at which a resolution was carried by a large majority, in favour of abolishing quarantine regulations in Europe on rivers, but it was decided to continue the system by sea.

In England we enforce a kind of quarantine only in cases of ships coming from infected ports; in such a case a port sanitary authority has considerable power.

The systematic inspection of vessels—allowing those among the crew and passengers who are well to go on shore, but enforcing the removal of the sick to a special hospital—is perhaps the only really practical measure that can be enforced in ordinary cases. If, however, there should be a serious outbreak among the crew or passengers, then removal of the whole to a proper place of detention while the ship is fumigated, disinfected, and unloaded, submitting the passengers to a strict isolation and surveillance for a number of days, based upon known periods of incubation, would be, if carried out, good measures. Every case should be judged by a port sanitary authority according to its merits.

The following are some of the regulations which may be put in force:—

By an order in Council, July 29, 1871, it is lawful for a sanitary authority, having reason to believe that any ship arriving in its district comes from a place infected with cholera, to visit and examine the ship before it enters the port.

Art. 3 provides that the master of a cholera-infected ship, or one that has even been exposed to the infection of cholera, is to moor, anchor, or place her in such position as from time to time the sanitary authority shall direct.

Art. 4 provides that no person shall land from any such ship until after the examination.

Art. 5 provides for the proper examination of all persons on board by a legally-qualified medical practitioner, and permits those not suffering from cholera to land immediately.

Another order in Council, August 3, 1874, empowers any customhouse officer, or other person having authority from the Commissioners or Board of Customs, at any time before the nuisance authority shall visit and examine the ship, to *detain* the ship.

"No person shall, after such detention, land from the ship, and the officer shall forthwith give notice of the detention, and of the cause thereof, to the proper nuisance (local) authority; and the detention shall cease as soon as the nuisance authority shall visit and examine the ship, or at the expiration of twelve hours after notice shall have been given to such nuisance authority."

By another order in Council, August 5, 1871, a master of a vessel in which cholera has existed is not allowed to bring his vessel into port until he has destroyed the infected clothes and bedding.

The Local Government Board have now very extensive powers with regard to regulations respecting vessels when any part of England is threatened with any infectious disease, and therefore they may, if they think fit, enforce quarantine where necessary. The main Act, however, regulating quarantine is the 6th of Geo. IV. c. 78, and vessels having on board any person affected with a dangerous or infectious disorder are to be deemed within its provisions.—(P. H., Schedule V. Part III.) There is also power under the Public Health Act for the justices to mitigate, if they think right, the penalties imposed under 6 Geo. IV. c. 78. *See* CHOLERA, INFECTIOUS DISEASES, &c.

Quinine ($C_{20}H_{24}N_2O_2$)—Found principally in the bark of *Cinchona officinalis*, and in good *Calisaya* bark, more especially in that from Bolivia.

In this article the tests for the purity of quinine, and the effects produced upon the workmen employed in its manufacture, can alone be considered, its medicinal properties not falling within the scope of this work.

The assay of cinchona barks for the purpose of ascertaining the percentage of quinine present may be thus conducted: "One hundred grains of the bark are reduced to powder, and thoroughly exhausted by maceration and percolation, with water acidulated with hydrochloric acid. To this solution subacetate of lead is added until all the colouring matter is removed, care being taken to keep the fluid acid. The precipitate is removed by filtration, and to the filtrate caustic potash, enough to redissolve the precipitate which is at first formed, is added, and the solution then well shaken with successive quantities of ether, until a drop of the ether evaporated to dryness yields no perceptible residue. The ethereal solutions are then evaporated to dryness, and the residue, which consists of nearly pure quinine, and should be readily soluble in dilute sulphuric acid, is weighed, and in this case should not be less than two grains." For pale and red barks chloroform should be substituted for ether in the process.

Sulphate of quinine is often found adulterated with sulphates of cinchonine, quinidine, and cinchonidine, salicine, sugar of milk, cane-sugar, mannite, starch, and stearic acid; and with the following *inorganic* substances: sulphate of lime, chalk, magnesia, and boracic acid. These latter, except boracic acid, may be easily detected by their not dissolving in alcohol, by heating the suspected salt on a piece of platinum foil, where it leaves an ash, the nature of which can be ascertained by the ordinary tests. Cinchonine, cinchonidine, and quinine can be separated by their different solubilities in water, alcohol, and ether. Salicine may be detected by the blood-red colour produced by sulphuric acid; the sugars, by the solution of the salt after the precipitation of the alkaloids by means of an alkali being sweet, and by Trömmer's test; starch, by its striking blue with iodine; and boracic acid, if present, by its giving to its alcoholic solution the property of imparting a green tinge to flame.

The British Pharmacopœia gives the following quantitative test: 10 grains with 10 minims of diluted sulphuric acid and half a fluid ounce of water form a perfect solution, from which ammonia throws down a perfect precipitate. This redissolves on agitation of the whole with half a fluid ounce of pure ether, without the production of any crystalline matter floating on the lower of the two strata into which the agitated fluid separates on rest. Crystals, if present, consist of quinidine, which is very slightly soluble in ether. The upper stratum of fluid, if entirely removed by a pipette and evaporated, leaves a white residue, which when dried in the air without heat weighs 8·5 grains.

Solutions of *quinine* or its salts in acidulated water exhibit the following reactions:—

Ammonia, potassa and the alkaline carbonates give white pulverulent precipitates, soluble in ammonia in excess. If recently-prepared chlorine be added to it, and then ammonia, an emerald-green colour is developed. If a concentrated solution of ferrocyanide of potassium be added after the chlorine instead of ammonia, a dark red colour is produced. If caustic potassa be used instead of ammonia, the solution acquires a sulphur-yellow colour.

"The best test, however, for quinine is the formation of its iodosulphate, the so-called herapathite. For this purpose the quinine is dissolved in ten parts of proof-spirit acidulated with one-twentieth part of sulphuric acid, and to this solution an alcoholic solution of iodine is carefully added, and the liquid in the meanwhile stirred with a glass rod. There appears either immediately or after some minutes a black precipitate of iodosulphate of quinine, which if redissolved in boiling proof-spirit forms in cooling the beautiful crystals of herapathite. A hundred parts of this herapathite, if dried on a water-bath, represent 56·5 parts of pure quinine."

Quinine is distinguished from both cinchonine and quinidine by its comparatively free solubility in ether; the last of those being very sparingly soluble, and the other wholly insoluble in that menstruum.

According to Chevallier, the workmen employed in the manufacture of sulphate of quinine are subject to a skin disease, and no means for preventing this has yet been discovered. It appears to attack not only the workmen actually engaged in the preparation, but also those employed in or near the factory, and the sober are as liable to it as the intemperate.

M. Zimmer, a quinine manufacturer of Frankfort, has observed that the men employed in the powdering of the cinchona bark are subject to a particular kind of fever, which he terms *cinchona fever*. Both statements, however, that men working at this industry are subject to a fever and to a skin disease, have been denied by several writers.

Quinine destroys vibrionic life, and is a weak disinfectant.

Quinoa (*Chenopodium Quinoa*). — This plant belongs to the order *Chenopodiaceæ*, and although scarcely known in this country, it forms the principal food of the inhabitants of Chili and Peru, on the high tablelands of which countries it grows at an elevation of 13,000 feet above the level of the sea.

Mr. Johnson has described two varieties, the sweet and bitter, both of which are very nutritious, approaching, as will be seen by the following analysis, oatmeal in chemical composition. The starch grains are said to be the smallest known, and the meal can only be made into cakes.

Analysis of Quinoa (VOELCKER.)

	Quinoa Seeds, dried at 212° F.	Quinoa Flour.
Nitrogenous matter	22·86	19
Starch	56·80	60
Fatty matter	5·74	5
Vegetable fibre	9·53	...
Ash	5·05	...
Water	...	16

Quorum—A quorum of an urban sanitary authority is one-third of the full number of members, but in no case is a larger quorum than seven members required. No act of a rural sanitary authority is valid unless three members are present and agree. If three members are present, and they do not concur on any particular question, the question is not settled.—(Consol. Order, 1847, article 38.)

The quorum of a committee or joint board consists of such number of members as is prescribed by the authority appointing such committee or joint board, but if no number is prescribed it consists of three members.

R.

Rabbit—The *Lepus cuniculus* (Linn.) of the Cuvian order *Rodentia*. The rabbit when young is a light and wholesome article of food; it is easily digested, but its nutritive value is impaired by its containing a large quantity of water and too little fat. In March 1873, at the suggestion of the "Lancet," Mr. H. C. Bartlett undertook an analysis of the flesh of the rabbit. He purchased for 3s. 6d. three Ostend rabbits, weighing 1 lb. 7 oz. 139 grains, 1 lb. 9 oz. 349 grains, and 1 lb. 12 oz. 266 grains (avoirdupois) respectively.

The ends of the tibiæ and metatarsal bones were snipped off as containing no practical amount of flesh, and the eyes being but seldom eaten were also extracted. "These portions of bone, fur, skin, and eyes are therefore," says Mr. Bartlett, "a complete loss, and weigh, as will be seen, more than three-quarters of an ounce per rabbit. The flesh was then carefully dissected from the bones and cartilages, and comprised muscular flesh, including a small quantity of adipose tissue, liver, and heart, the kidneys and surrounding fat being removed previous to shipment."

The following shows the result of the analysis (Lancet, March 29, 1873) :—

Composition of Rabbit's Flesh (Bartlett).

	Rabbit No. 1. Grains.	Rabbit No. 2. Grains.	Rabbit No. 3. Grains.	Average Grains.	Percentage. Grains.
Water	5,982	6,623	7,315	6,640	73·17
Fibrine and syntonine	1,143	1,247	1,393	1,261	13·90
Gelatine	302	335	350	329	3·63
Fat	240	272	345	286	3·15
Albumen	276	305	340	307	3·38
Alcoholic extract, including salts	106	119	135	120	1·32
Watery extract, ,,	102	108	125	112	1·23
Calcium phosphates	16	19	25	20	0·22
Edible portion	8,167	9,028	10,029	9,075	100·00
Additional gelatine from stewing bones	215	232	251	233	2·06
Bones, &c., dissected out and stewed	1,501	1,674	1,854	2,027	17·88 waste
Shank-bones, fur, and eyes thrown away	318	352	382		
	10,201	11,286	12,516	11,335	...

The meat of rabbit resembles veal more than any other butcher's meat (*see* Veal), and the extracts are identical with the ordinary "Extractum carnis Liebig."

English rabbits, especially those fed for the market, contain a larger quantity of fat than do the Ostend; but since bacon, &c., can usually be purchased at about the same price as rabbits, the paucity of fat is not a matter of much importance.

Rackrent—"Rackrent" means rent which is not less than two-thirds of the full net annual value of the property out of which the rent arises; and the full net annual value is taken to be the rent at which the property might reasonably be expected to let from year to year, free from all usual tenant's rates and taxes, and tithe commutation rentcharge (if any), and deducting therefrom the probable average annual cost of the repairs, insurance, and other expenses (if any) necessary to maintain the same in a state to command such rent.—(P. H., s. 4.)

Radish (*Raphanus sativus*)—The radish is a native of China, but it has for many years been cultivated in this country. Eaten, as it generally is, raw, it is very indigestible, and should be avoided by the delicate. In composition it resembles the carrot.

Railway Stations, Railways—The hygienic and general arrangements of railway stations should earnestly engage the attention of all sanitary bodies. It must be remembered that it is here that the first importation of disease may take place; hence the necessity, when serious epidemics are expected—*e.g.*, cholera—to obtain early information from the railway officials of any persons taken ill in the train.

Many, nay, most of the waiting-rooms at the smaller stations — especially those for ladies—are nothing more nor less than centres for the propagation of typhoid fever. At one end there is a door directly leading to a water-closet, without the intervention of a lobby; and there is generally a most unpleasant effluvia, owing to the trap being neither ventilated nor the pan disinfected. The water-closets attached to waiting-rooms should be a separate building, connected with the station by a covered way; with either cross ventilation, or the roof of the covered way simply supported by pillars.

Every station should be visited at least once a quarter by the sanitary officials.

Besides the deficiencies in the waiting-room closets, there are the urinals, which, through negligence of the company's servants, are frequently foul; although it must be said that the male lavatories are, generally speaking, better placed than, and not so objectionable as, the others.

Railway stations are also fertile producers of colds and coughs. The rooms are frequently insufficiently warmed in the winter months; and the system of ventilation being one of open doors and windows, cold draughts are unavoidable; and such draughts cause the more injury, since the very persons who have to wait the longest are those who have used the utmost personal exertion to catch a train, and just missing, sit down reeking with perspiration.

The companies are liberal in their expenditure in the larger stations, but it has been in most cases an expenditure without the requisite knowledge of sanitary construction, the convenience of the officials and the general architecture having been thought of before health, which—so long as the public do not die on the platform—little concerns the railway companies.

With regard to railways, accidents appear to increase; and it is only by a sound and careful legislation—enforcing a useful, practical, and uniform system of signalling, pushing on of traffic, and management on every line throughout the United Kingdom—that the bulk of accidents will be prevented.

In 1870 the deaths connected with railways were 861; in 1871, 1042.

Whilst it is to be remembered that a part of this increase is due to the annual extension of railways, the fact is also not to be lost sight of, that at least 90 per cent. of the deaths are preventable by common care on the part of individuals, and better regulations on the part of companies.

The details of these accidents were as follows:—

	1870.	1871.
Run over on the line	539	700
Fall from carriage or engine	40	40
Collision	24	24
Carriage off rail, &c.	5	11
Explosion of boiler, &c.	1	1
Machinery of locomotive engine	...	1
Crushed	131	175
Fall of heavy substances on	20	12
Fall of earth	2	...
Fall from railway bridge	1	...
Other deaths, manner not stated, or otherwise than the above causes	98	78
	861	1042

Rain—In the different manuals relating to public health, it appears to have been overlooked that an indirect but valuable knowledge of the sanitary condition of a place may be obtained by analysing the rain falling there. The cold rain falling from the distant cloud condenses the emanations from man and animals, the acid emitted from manufactories, and the various impurities from other sources, and washes them down to earth. An analysis of the air is tedious, requires special practice and much time. It is, then, our opinion, that for health purposes, indirect methods of ascertaining the purity of air are best; it is indeed a question whether if an analysis of the rain, combined with estimation of the carbonic acid of a place, is not superior in a hygienic point of view to a correct determination of oxygen and nitrogen. Health officers who wish to follow out this can readily get the assistance of observers of the rainfall, a great number of whom are in every county in England and Wales; their addresses can be obtained by consulting Symons' "British Rainfall." The rain should be collected in a clean glass bottle, furnished with a large glass funnel. The quantity collected should at least be a gallon; something can, however, be done by taking great care with 1500 or 2000 cubic centimetres ($1\frac{1}{2}$ or 2 litres).

The analysis of the rain-water is conducted on precisely the same principles as WATER-ANALYSIS, *which see.*

The main differences between rain and common water are, generally speaking, the very small residue, the high ammonia, the small amount of chlorides and sulphates, contained in the former. The most important of all these are the free and albuminoid ammonia and the sulphuric acid; the amount of the latter Angus Smith calls "a measure of the sewage of the air." In his valuable work on Air and Rain many useful tables will be found, from which the following are extracted:—

TABLE I.—Ammonia.

Rain obtained from—	Ammonia. Parts per Million.
Valentia, Ireland	0·180
Scotland, sea-coast country places (west)	0·484
,, inland	0·532
,, sea-coast, average	0·738
,, sea-coast (east)	0·992
England, inland	1·070
,, sea-coast (west)	1·900
German specimens	1·910
London, 1869	3·450
Scotland, towns (Glasgow not included)	3·820
St. Helens	4·560
Runcorn	4·630
England, towns	5·160
Liverpool	5·380
Manchester, 1869	6·360
,, 1869-70, average	6·469
,, 1870	6·578
Glasgow	9·100

TABLE II.—Averages. Albuminoid Ammonia.

Rain obtained from—	Albuminoid Ammonia. Parts per Million.
Ireland, Valentia	0·034
Scotland, inland country places	0·039
,, sea-coast country (west)	0·105
,, ,, ,, average	0·105
,, ,, ,, (east)	0·106
England, inland	0·109
German specimens	0·122

TABLE II.—*Continued.*

Rain obtained from—	Albuminoid Ammonia. Parts per Million.
Liverpool	0·159
Runcorn	0·190
London, 1869	0·205
Scotland, towns (Glasgow not included)	0·212
England	0·214
Manchester, 1869 and 1870, average	0·251
,, 1870	0·285
Glasgow	0·300
England, sea-coast country place (west)	0·400

TABLE III.—Averages. Sulphuric Acid (Sulphates).

Rain obtained from—	Sulphuric Acid (Sulphates). Grains per Gallon.	Sulphuric Acid (Sulphates). Parts per Million.
Scotland, inland country places	0·1444	2·06
Ireland, Valentia	0·1911	2·73
Scotland, sea-coast country places (west)	0·2529	3·61
England, inland country places	0·3865	5·52
Scotland, sea-coast country, average of east and west	0·3947	5·64
England, sea-coast (west) country	0·4116	5·88
Scotland, sea coast country places (east)	0·5366	7·66
Waterloo, Liverpool	0·8004	11·43
German specimens	1·1481	16·40
Scotland, towns (Glasgow not included)	1·1553	16·50
London, 1869	1·4345	20·49
Birkenhead, near Liverpool	1·6210	23·16
Runcorn	1·6537	23·62
Darmstadt, Germany	2·0417	29·17
St. Helens	2·3232	33·19
England, towns	2·3988	34·27
Liverpool	2·7714	39·59
Manchester, 1869	2·9163	41·66
Newcastle-on-Tyne	3·1111	44·44
Manchester, average of 1869 and 1870	3·1378	44·82
Manchester, 1870	3·3593	47·99
Glasgow	4·9139	70·19
Near an alkali-work	5·1310	73·30

TABLE IV.—Averages. Hydrochloric Acid (Chlorides).

Rain obtained from—	Hydrochloric Acid (Chlorides). Grains per Gallon.	Hydrochloric Acid (Chlorides). Parts per Million.
Darmstadt	0·0681	0·97
London, specimen for 1869	0·0872	1·25
German specimens	0 0919	1·31
Birkenhead, Liverpool	0·2217	3·17
Scotland, inland country places	0·2357	3·37
Near an alkali-work	0·2380	3·40
England, inland country places	0·2795	3·99
Manchester, 1870	0·4055	5·79
,, average of 1869 and 1870	0·4086	5·83
Scotland, towns (Glasgow not included)	0·4102	5·86
Manchester, 1869	0·4118	5·88
Newcastle-on-Tyne	0·5678	8·11
England, towns	0·6093	8·70
Glasgow	0·6282	8·97
St. Helens	0·6670	9·53
Liverpool	0·7110	10·16
Scotland, sea-coast country places (west)	0·8600	12·28
,, average of east and west	0·8819	12·59

TABLE IV.—*Continued.*

Rain obtained from—	Hydrochloric Acid (Chlorides) Grains per Gallon.	Hydrochloric Acid (Chlorides) Parts per Million.
Runcorn	1·8022	25·74
Waterloo, near Liverpool	2·5550	36·50
Ireland, Valentia	3·4067	48·67
England, sea-coast country place (west, only one)	3·9308	56·15

Early in 1874, through the kindness of different rain observers, the author was able to analyse most of the rainfall of North Devon. The result is here appended merely to show the value to health officers of this method of investigation.

TABLE V.

	Sulphuric Acid. Parts per Million.	Ammonia Free. Parts per Million.	Albuminoid Ammonia. Parts per Million.	Chlorine. Grains per Gallon.
Welcomb	00·1287	0·10	0·075	3·15
Meshaw	00·0181	2·50	0·065	0·45
Rose Ash	11·4448	3·50	0·085	0·90
South Molton	10·1520	0·50	0·040	1·56
Bideford	01·0870	0·15	7·000	2·30
Torrington	11·4488	2·00	0·070	0·60
Barnstaple	05·1804	0·15	12·080	0·65
Ilfracombe	06·4655	0·15	0·080	3·22

Welcomb is on the sea-coast. The rain was collected from a very clean glass conservatory roof belonging to a residence situated at a considerable height. There are no houses near. It shows a very pure rain as to organic matter. The chlorides are high, from the proximity of the sea.

Meshaw and Rose Ash are country places, the rest are towns; of these Bideford and Barnstaple show a very high figure for organic matter. The sulphuric acid in none of them is very high. *See* CLIMATE, RAINFALL, RAIN-GAUGE, WATER, ANALYSIS OF.

Rainfall—Of all atmospheric phenomena rain is the most uncertain, both as regards frequency and the amount which falls in a given time. In many parts of the world rain rarely or ever falls, whilst in others it rains almost every day. The "rainless" regions of the earth, as they have been termed, are the coast of Peru, the great valley of the rivers Columbia and Colorado in North America, the Sahara in Africa, and the desert of Gobi in Asia. In Chiloe and Patagonia rain is constant.

In calculating the rainfall by means of the rain-gauge, it has been found that less rain is collected if the gauge be high above the ground than if it be level with it. Professor Phillips found the rainfall at York for twelve months, during the year 1833–34, to be 14·96 inches at 213 feet from the ground, 19·85 inches at 44 feet, and 25·71 inches on the ground.

An extensive series of observations has been conducted by Colonel Ward, with the view of ascertaining the quantity of rain collected at different heights from the ground. The following is the relative rainfall at different times for the four years 1864-67: on a level with the ground, 1·07 inch; at a height of 2 inches, 1·05; 6 inches, 1·01; 1 foot, 1; 2 feet, ·99; 3 feet, ·98; 5 feet, ·96; 10 feet, ·95; and 20 feet, ·94. Observations at Castleton give at 1 foot, 1 inch; at 5 feet, ·96; and for 20 feet, ·90. R. Chrimes's observations at Rotherham, during 1866-67, give the following amounts: at 1 foot, 1 inch; 5 feet, ·94; 10 feet, ·91; 15 feet, ·90; 20 feet, ·89; and 25 feet, ·88.

Wherever the experiment has been tried the quantity of rain collected has always been greatest at the lowest levels. According to Sergeant Arnold of the Army Hospital Corps, this is merely the effect of wind; and he says that when the upper rain-gauge is inclined at a certain angle with the wind, there is as much rain above as below.

The following exhibits the average annual rainfall in different parts of the world:

	Inches.
Burmah, Southern	180·0 to 220
Barbadoes	56·0 to 58
Cherrapongee	600·0
Ceylon	38·0 to 70
China, with south-west monsoon	90·0
Canada, Lower	36·0 to 40
,, Upper	31·5
Gibraltar, mean of seventy years	32·8
,, greatest amount	75·8
,, lowest amount	15·1
Guiana, British	100·0
INDIA—	
Calcutta	56·8
Madras	50·0
Bombay	72·7
Bengal Presidency—	
Dinapore	31·1
Berhampore	49·8
Benares	37·4
Ghazeepore	41·4
Azimghur	40·0
Agra	27·9
Delhi	25·1
Meerut	18·0
Punjab	56·6
Madras Presidency—	
Bellary	21·7
Bangalore	25·0
Trichinopoly	30·6
Seeunderabad	34·6
Bombay Presidency—	
Belgaum	51·5
Poonah	7·6
Neemueh	34·1
Kamptee	41·8
Jamaica, in the plains	50·0 to 60
Malabar coast	130·0 to 160
Malta	32·0
Montreal	36·0 to 44
Triuidad	60·0 to 70

The rainfall in different parts of England in the year 1873 will be seen from the following:—

	Inches.
Allenheads	43·36
Barnstaple	37·94
Cockermouth	36·10
Carlisle	22·90
Guernsey	36·23
Gloucester	26·18
Hull	25·99
Helston	41·60
Llandudno	30·57
London, Camden Town	24·93
North Shields	26·17
Nottingham	26·81
Norwich	22·36
Oxford	20·97
Osborne	29·09
Royal Observatory	22·32
Truro	39·85
Tauuton	27·31
Worthing	23·68

The average mean rainfall of England and Wales Mr. Symons estimates to be 32 inches. As every inch of rain falling on an acre of space supplies 22,622 gallons of water, "we arrive at the immense total of 27,019,632 millions of gallons of water, which on an average of years falls on the surface at the feet of the population, exclusive of the deposition of dew, which forms no very small nor unimportant item in the water economy of the country."—(BAILEY DENTON.) *See* RAIN-GAUGE.

Rain-Gauge—This is an instrument for estimating in inches the rainfall in any particular part. If we say the rainfall is an inch, we mean that rain has fallen 1 inch in depth on any given area—say, a square inch of surface.

It is quite possible to use for the purpose of ascertaining the amount of rain falling in a locality almost any kind of open vessel, and then to measure the rain thus collected in a common druggist's ounce measure, an ounce being equal to 1·733 cubic inches. Such a method is of course not of great accuracy, and it is far preferable to use a regular gauge, the most simple form of which, known as Fleming's, is a metallic cylinder, from the bottom of which is a glass tube divided into inches and parts of an inch. This tube runs up externally at the side, and simple inspection of the gauge indicates the amount of rain falling. At the top of the cylinder is a funnel to prevent evaporation, and there is a stopcock at the bottom in order to empty it when full.

The best forms of gauges are, however, those made of metal, and with which a glass measure divided into fractions of an inch are supplied. The rain collected is poured into the measure, and the amount read off and entered. Other varieties of gauges are furnished with floats, the height of the float marking the amount of liquid, aud others are self-registering; but whatever form of gauge is selected, it is of some importauce that the diameter be neither too small nor too large. Gauges 1 or 2 inches in diameter register too little, and on the other hand there is no practical advantage in a diameter of 8 inches being exceeded. It may be safely said that any diameter between 4 and 8 inches will give equally good results, *cæteris paribus*.

The following are suggestions for securing uniformity of practice among rainfall observers, drawn up by G. J. Symons, Esq., F.R.S.:—

1. *Site.*—A rain-gauge should not be set on a slope or terrace, but on a level piece of ground, at a distance from shrubs, trees, walls, and buildings—at the very least as many feet from their base as they are in height. Tall-growing flowers, vegetables, and bushes must be kept away from the gauges. If a thoroughly clear site cannot be obtained, shelter is most endurable from north-west, north, and east; less so from south, south-east, and west, and not at all from south-west or north-east.

2. *Old Gauges.*—Old-established gauges should not be moved, nor their registration discontinued, until at least two years after a new one has been in operation, otherwise the continuity of the register will be irreparably destroyed. Both the old and the new ones must be registered at the same time, and the results recorded for comparison.

3. *Level.*—The funnel of a rain-gauge must be set quite level, and so firmly fixed that it will remain so in spite of any gale of wind or ordinary circumstances. Its correctness in this respect should be tested from time to time.

4. *Height.*—The funnel of gauges newly placed should be 1 foot above grass. Information respecting height above sea-level may be obtained from G. J. Symons, Esq., 64 Camden Square, N.W. London.

5. *Rust.*—If the funnel of a japanned gauge becomes so oxidised as to retain the rain in its pores, or threatens to become rusty, it should have a coat of gas tar or japan black, or a fresh funnel of zinc or copper should be provided.

6. *Float-Gauges.*—If the measuring-rod is detached from the float, it should never be left in the gauge; if it is attached to the float, it should be pegged or tied down, and only allowed to rise to its proper position at the time of reading. To allow for the weight of the float and rod, these gauges are generally so constructed as to show 0 only when a small amount of water is left in them. Care must always be taken to set the rod to the zero or 0.

7. *Can and Bottle Gauges.*—The measuring-glass should always be held upright. The reading is to be taken midway between the two apparent surfaces of the water.

8. *Time of Reading.*—Nine A.M. daily; if taken only monthly, then 9 A.M. on 1st.

9. *Date of Entry.*—The amount measured at 9 A.M. on any day is to be set against the previous one; because the amount registered at 9 A.M. of, say, 17th, contains the fall during fifteen hours of the 16th and only nine hours of the 17th. (This rule has been approved by the meteorological societies of England and Scotland, cannot be altered, and is particularly commended to the notice of observers.)

10. *Mode of Entry.*—If less than one-tenth (·10) has fallen, the cipher must always be prefixed; thus, if the measure is full up to the seventh line, it must be entered as ·07—that is, no inches, no tenths, and seven-hundredths. For the sake of clearness, it has been found necessary to lay down an invariable rule that there shall always be two figures to the right of the decimal point. If there be only one figure, as in the case of one-tenth of an inch (usually written ·1), a cipher must be added, making it ·10. Neglect of this rule causes much inconvenience. All columns should be cast *twice*—once up and once down—so as to avoid the same error being made twice. When there is no rain, a line should be drawn rather than ciphers inserted.

11. *Caution.*—The amount should always be written down before the water is thrown away.

12. *Small Quantities.*—The unit of measurement being ·01, observers whose gauges are sufficiently delicate to show less than that, are, if the amount is under ·005, to throw it away; if it is ·005 to ·010 inclusive, they are not to enter it as ·01.

13. *Absence.*—Every observer should train some one as an assistant; but where this is not possible, instructions should be given that the gauge should be emptied at 9 A.M. on the 1st of the month, and the water bottled, labelled, and tightly corked, to await the observer's return.

14. *Heavy Rains.*—When very heavy rains occur, it is desirable to measure immediately on their termination; and it will be found a safe plan, after measuring, to return the water to the gauge, so that the morning registration will not be interfered with. Of course, if there is the slightest doubt as to the gauge holding all that falls, it must be emptied, the amount being *previously* written down.

15. *Snow.*—In snow three methods may be adopted. It is well to try them all. (1.) Melt what is caught in the funnel by adding to the snow a previously-ascertained quantity of warm water, and then deducting this quantity from the total measurement, enter the residue as rain. (2.) Select a place where the snow has not drifted, invert the funnel, and turning it round, lift and melt what is enclosed. (3.) Measure with a rule the average depth of snow, and take one-twelfth as the equivalent of water. Some observers use in snowy weather a cylinder of the same diameter as the rain-gauge, and of considerable depth. If the wind is at all rough, all the snow is blown out of a flat-funnelled rain-gauge.

16. *Overflow.*—It would seem needless to caution observers on this head, but as a recent foreign table contains *six instances on one day* in which gauges were allowed to run over, it is evidently necessary that British observers should be on the alert. It is not desirable to purchase any new gauge of which the capacity is less than 4 inches.

17. *Second Gauges.*—It is often desirable that observers should have two gauges, and that one of them should be capable of holding 8 inches of rain. One of the gauges should be registered daily, the other weekly or monthly, as preferred, but always on the 1st of each month. By this means a thorough check is kept on accidental errors in the entries, which is not the case if *both* are read daily.

18. *Dew and Fog.*—Small amounts of water are at times deposited in rain-gauges by fog and dew. They should be added to the amount of rainfall, because (1) they "tend to water the earth and nourish the streams;" and not for that reason only, but (2)

because in many cases the rain-gauges can only be visited monthly, and it would then obviously be impossible to separate the yield of snow, rain, &c., therefore, for the sake of uniformity, all must be taken together.

19. *Doubtful Entries.*—Whenever there is the least doubt respecting the accuracy of any observation, the entry should be marked with a (?), and the reason stated for its being placed there.

Raisins—Dried grapes. Raisins are antiseptic, cooling, nutritious, and slightly laxative—the latter to a greater extent than the fresh fruit. *See* GRAPES, &c.

Raspberry—The fruit of *Rubus Idæus*, a small shrub of the natural order *Rosaceæ*. It is a native of Great Britain and of most parts of the world, but it has only been cultivated in gardens during the last one or two centuries. The fruit is cooling, antiscorbutic, agreeable, and mildly aperitive. On the Continent it is largely eaten at dessert.

The following statement exhibits the composition of raspberries :—

Composition of Raspberries (FRESENIUS).

	Wild Red.	Cultivated. Red.	Cultivated. White.
Soluble Matter—			
Sugar . . .	3·597	4·708	3·703
Free acid (reduced to equivalent in malic acid) .	1·980	1·356	1·115
Albuminous substances . .	0·546	0·544	0·665
Pectous substances, &c. . . .	1·107	1·746	1·397
Ash . . .	0·270	0·481	0·380
Insoluble Matter—			
Seeds . . . / Skins, &c. . .	8·460	4·106	4·520
Pectose . . .	0·180	0·502	0·040
[*Ash from insoluble matter included in weights given*]	[0·134]	[0·296]	[0·081]
Water . . .	83·860	86·557	88·180
	100·000	100·000	100·000

Rat—The rat usually seen in this country is the *Mus Decumanus* (Linn.), a prolific and destructive species of *Rodentia*. It is a native of Asia; but since its introduction into this country, it has spread all over the islands, and the old British species of this animal (*Mus Rattus*, Linn.) is now but rarely met with.

Certain species of the rat and its congeners have been from very ancient times used as food. The Romans used to eat grey mice seasoned with chestnuts; and Buffon relates that the natives of Martinique eat small rodents, especially the musk rat. According to W. Boer, the sweet rat, which without doubt owes its flavour to tuberculosis, is excellent fricasseed. The climbing rat is one of the principal foods of Cuba and Jamaica, and the Brazilian rat is consumed in Australia.

The Chinese have a great liking for rats. They place large-mouthed bottles in the holes and rat-runs, in which the animals make their home and breed. In this way the Chinese obtain the young ones, which are esteemed a great delicacy. They possess a dish made up of bats, the edible snail, rats, old dried fish, and rotten eggs.

Nor is the eating of rats confined to the less civilised nations enumerated. They were freely consumed at the siege of Paris, and there exists at this day in Belgium a "ratophagic" society.

Rats may cause great mischief about a house. They will gnaw through lead pipes, and burrow into the sides of ill-constructed drains, and thus may cause escapes of sewer gas or sewage, either into the house or into the well or cistern, and contaminate the water-supply. The sewer rat is also in the habit of cleansing himself, whenever soiled, by swimming in water, which may thus be fouled irrespective of rat-runs.

The best method to stop up a rat-hole appears to be a mixture of broken glass and tar, as the rat never soils his body with anything water will not remove.

Rats should never be poisoned, since besides the danger arising from having poisonous substances scattered over the house, the poisoned rats often die beneath the floor, or between walls, &c., and their putrefying bodies have frequently produced the most serious effects. Cases are on record of rats, overcome by poison, falling into the water-butt, and there remaining, contaminating the fluid long before their presence was suspected. When rats are found in a house, the best and simplest plan is to take up the floors, get a dog which is a good ratter to kill all that can be found, and stop up the rat-runs in the manner just described. Old brick drains, both in and outside the house, should be opened up, disinfected, and filled with concrete, since they only harbour rats and other vermin.

It will be found in the end that this course will be the cheapest and most efficacious, and it should be remembered that the earlier these measures are taken the less expensive will be the work, and the more certain the results.

Rates—The general powers of *urban* authorities with regard to rates are as follows:—

Every urban authority, before proceeding to make a general district rate or private improvement rate under the Public Health Act, must have an estimate prepared of the money required for the purposes in respect of which the rate is to be made, showing—

1. The several sums required for each of such purposes; and
2. The rateable value of the property assessable; and
3. The amount of rate which for those purposes it is necessary to make on each pound of such value;

and the estimate so made shall forthwith, after being approved of by the urban authority, be entered in the rate-book, and be kept at their office, open to public inspection during office hours thereat; but it shall not be deemed part of the rate, nor in any respect affect the validity of the same.—(P. H., s. 218.)

Any person interested in or assessed to any rate may inspect the same, and any estimate made previously thereto, and may take copies of or extracts therefrom without fee or reward; the custodian refusing or not permitting such inspection, &c., is liable to a penalty of five pounds or less.—(P. H., s. 219.)

Where the name of any owner or occupier liable to be rated under the Public Health Act is not known to the urban authority it is sufficient to assess and designate him in the rate as "the owner" or "the occupier" of the premises in respect of which the assessment is made, without further description.—(P. H., s. 220.)

An *urban* authority may from time to time amend any rate made in pursuance of the said Act, by inserting therein the name of any person claiming and entitled to have his name inserted, or by inserting the name of any person who ought to have been assessed, or by striking out the name of any person who ought not to have been assessed, or by raising or reducing the sum at which any person has been assessed, if it appears to the authority that he has been underrated or overrated, or by making any other alteration which will make the rate conformable to the provisions of the Act; and no such amendment shall be held to avoid the rate.

Provided, that any person who may feel himself aggrieved by any such amendment shall have the same right of appeal therefrom as he would have had if the matter of amendment had appeared on the rate originally made, and with respect to him an amended rate shall be considered to have been made at the time when he first received notice of the amendment; and an amended rate shall not be payable by any person the amount of whose rate is increased by the amendment, or whose name is thereby newly inserted, until seven days after such notice has been given to him. —(P. H., s. 221.)

All rates made or collected under the Public Health Act are to be published in the same manner as poor-rates, and shall commence and be payable at such time or times, and shall be made in such manner and form, and be collected by such persons, and either together or separately, or with any other rate or tax, as the urban authority may from time to time appoint: provided that no publication shall be required of any private improvement rate.—(P. H., s. 222.)

The production of the books purporting to contain any rate or assessment made under the Act is, without other evidence whatever, to be received as *primâ facie* evidence of the making and validity of the rates mentioned therein.—(P. H., s. 223.)

An urban authority may reduce or remit the payment of any rate on account of the poverty of any person liable to the payment.—(P. H., s. 225.)

They may also make any deduction they think just from the rate in cases where premises were sufficiently drained before the laying down of a new sewer by them.—(P. H., s. 224.)

None of the rating powers of the Public Health Act affect any contract between landlord and tenant.—(P. H., s. 226.)

Limits imposed by local Acts do not affect or apply to rates under the Public Health Act.—(P. H., s. 227.)

Nothing in the Public Health Act interferes or alters any liability under any local Act under which the Commissioners of Oxford and Cambridge act with respect to the contribution of the universities to paving, lighting, cleansing, and expenses. Any differences on this matter between the universities and the urban authority are to be settled by arbitration.

All rates, contributions, and sums of money which may become payable under the Public Health Act by the said universities respectively, and their respective halls and colleges, may be recovered from them in the same manner in all respects as rates, &c., may now be recovered from them by virtue of any such local Act.—(P. H., s. 228.)

Nothing in the Public Health Act is to affect the making or levying of any special district rates, or the discharge of sums borrowed on the credit of the same, or any remedy for their recovery under any provision of the Local Government Acts in force at the time of the passing of the Public Health Act.

If any person assessed for any rate made under the Public Health Act by any urban authority fails to pay the same when due and for the space of fourteen days after the same has been lawfully demanded in writing, or if any person quits or is about to quit any premises without payment of any such rate then due from him in respect of such premises, and refuses to pay the same after lawful demand thereof in writing, any justice may summon the defaulter to appear before a court of summary jurisdiction to show cause why the rate in arrear should not be paid; and if the defaulter fails to appear, or if no sufficient cause for nonpayment is shown, the court may make an order for payment of the same, and, in default of compliance with such order, may by warrant cause the same to be levied by distress of the goods and chattels of the defaulter.

The costs of the levy of arrears of any rate may be included in the warrant for such levy. —(P. H., s. 256.)

Rates may be appealed against.—(P. H., s. 269.) *See* APPEALS.

Rate, General District.—For the purpose of defraying any expenses chargeable on the district fund which that fund is insufficient to meet, the urban authority shall from time to time, as occasion may require, make by writing under their common seal, and levy in addition to any other rate leviable by them under the Public Health Act, a rate or rates to be called "general district rates."

Any such rate may be made and levied either prospectively in order to raise money for the payment of future charges and expenses, or retrospectively in order to raise money for the payment of charges and expenses incurred at any time within six months before the making of the rate: in calculating the period of six months during which the rate may be made retrospectively, the time during which any appeal or other proceeding relating to such rate is pending shall be excluded.

Public notice of intention to make any such rate, and of the time when it is intended to make the same, and of the place where a statement of the proposed rate is deposited for inspection, shall be given by the urban authority in the week immediately before the day on which the rate is intended to be made, and at least seven days previously thereto; but in case of proceedings to levy or recover any rate it shall not be necessary to prove that such notice was given.—(P. H., s. 210.)

With respect to the assessment and levying of general district rates the following provisions are to have effect, viz.—

1. General district rates shall be made and levied on the occupier of all kinds of property for the time being by law assessable to any rate for the relief of the poor, and shall be assessed on the full net annual value of such property, ascertained by the valuation list for the time being in force, or, if there is none, by the rate for the relief of the poor made next before the making of the assessment under the Public Health Act, subject to the following exceptions, regulations, &c., viz.—

a. The owner, instead of the occupier, may at the option of the urban authority be rated in cases—

Where the rateable value of any premises liable to assessment under the Act does not exceed the sum of *ten pounds;* or

Where any premises so liable are let to weekly or monthly tenants; or

Where any premises so liable are let in separate apartments, or where the rents become payable or are collected at any shorter period than quarterly; provided, that in cases where the owner is rated instead of the occupier he shall be assessed on such reduced estimate as the urban authority deem reasonable of the net annual value, not being less than two-thirds nor more than four-fifths of the net annual value.

And where such reduced estimate is in respect of tenements whether occupied or unoccupied, then such assessment may be made on one-half of the amount at which such tenements would be liable to be rated if the same were occupied and the rate were levied on the occupiers.

b. The owner of any tithes, or of any tithe commutation rentcharge, or the occupier of any land used as arable, meadow, or pasture ground only, or as woodlands, market-gardens, or nursery-grounds, and the occupier of any land covered with water, or used only as a canal or towing-path for the same, or as a railway constructed under the powers of any Act of Parliament for public conveyance, shall be assessed in respect of the same in the proportion of one-fourth part only of such net annual value thereof.

c. If within any urban district or part of such district any kind of property is exempted from rating by any local Act in respect of all or any of the purposes for which general district rates may be made under the Act, the same kind of property shall, in respect of the same purposes, and to the same extent within the parts to which the exemption applies (but not further or otherwise), be exempt from assessment to any general district rates unless the Local Government Board by provisional order otherwise direct.

2. If at the time of making any general district rate any premises in respect of which the rate may be made are unoccupied, such premises are to be included in the rate, but the rate is not to be charged while they continue to be unoccupied; and if any such premises are afterwards occupied during any part of the period for which the rate was made, and before the same has been fully paid the name of the incoming tenant shall be inserted in the rate, and thereupon so much of the rate as at the commencement of his tenancy may

be in proportion to the remainder of the said period shall be collected, recovered, and paid in the same manner in all respects as if the premises had been occupied at the time when the rate was made.

3. If any owner or occupier assessed or liable to any such rate ceases to be owner or occupier of the premises in respect whereof he is so assessed or liable, before the end of the period for which the rato was made, and before the same is fully paid off, he shall be liablo to pay only such part of the rate as may be in proportion to the time during which he continues to be such owner or occupier; and in every such case if any person afterwards become owner or occupier of the premises during part of the said period, he shall pay such part of the rato as may bo in proportion to tho time during which he continues to be such owner or occupier, and the same shall be recovered from him in the same manner as if he had been originally assessed or liable.

4. The urban authority may divide their district, or any street therein, into parts, for all or any of the purposes of the Public Health Act, and from time to time abolish or alter any such divisions, and may make a separate assessment on any such part for all or any of the purposes for which the same is formed; and every such part, as far as relates to the purposes in respect of which such separate assessment is made, shall be exempt from any other assessment under the Act: provided that if any expenses are incurred or to be incurred in respect of two or more parts in common, the same shall be apportioned between them in a fair and equitable manner. —(P. H., s. 211.)

For the purpose of assessing general district rates any person appointed by the urban authority may inspect, take copies of, or make extracts from, any valuation list or rate for the relief of the poor within the district, or any book relating to the same.

Any custodian of such book or rate refusing to admit inspection is liable to a penalty of £5 or less.—(P. H., s. 212.)

Rate, Highway—See HIGHWAYS.

Rate, Private Improvement.—Whenever an urban authority have incurred or become liable to any expenses which by tho Public Health Act are or by such authority may be declared to be private improvement expenses, such authority may, if they think fit, make and levy on the occupier of the premises in respect of which the expenses have been incurred, in addition to all other rates, a rate or rates to be called private improvement rates, of such amount as will be sufficient to discharge such expenses, together with interest thereon at a rate not exceeding five pounds per centum per annum, in such period not exceeding thirty years as the urban authority may in each case determine.

Provided that whenever any premises in respect of which any private improvement rate is made become unoccupied before the expiration of the period for which tho rate was made, or before the same is fully paid off, such rate shall become a charge on and bo paid by the owner for the time being of tho premises so long as the same continue to bo unoccupied.—(P. H., s. 213.)

Where the occupier by whom any private improvement rate is paid holds the premises in respect of which the rate is made at a rent not less than the rackrent, he shall be entitled to deduct three-fourths of the amount paid by him on account of such rate from the rent payablo by him to his landlord; and if he hold at a rent less than the rackrent, he shall be entitled to deduct from the rent so payable by him such proportion of three-fourths of tho rate as his rent bears to the rackrent; and if tho landlord from whose rent any deduction is so made is himself liable to the payment of rent for the premises in respect of which tho deduction is made, and holds the same for a term of which less than twenty years is unexpired (but not otherwise), he may deduct from the rent so payable by him such proportion of the sum deducted from the rent payablo to him as the rent payable by him bears to the rent payable to him, and so in succession with respect to every landlord (holding for a term of which less than twenty years is unexpired) of tho same premises, both receiving and liablo to pay rent in respect thereof.

Provided that nothing in this section shall be construed to entitle any person to deduct from the rent payable by him more than the whole sum deducted from the rent payable to him.—(P. H., s. 214.)

At any time before the expiration of the period for which any private improvement rate is made, the owner or occupier of the premises assessed thereto may redeem tho same, by paying to the urban authority tho expenses in respect of which tho rate was made, or such part thereof as may not havo been defrayed by sums already levied in respect of the same.

Provided that money paid in redemption of any private improvement rato shall not be applied by the urban authority otherwise than in defraying expenses incurred by them in works of private improvement, or in discharging tho principal of any moneys borrowed by them to meet those expenses, whether by means of a sinking fund or otherwise.—(P. H., s. 215.)

Rations (*ratio*, a proportion)—The daily allowances of necessaries, especially food, to a soldier or sailor. The following table exhibits the provisional amount of different articles of food furnished by different Governments to the soldier in the field. *See also* DIETARIES, &c.

	United States Army.	Austrian Army.	British Army in Crimea.	British Army in India.	French Army.	Prussian Army.	Russian Army in Crimea.
Flour . . .	18 oz. or	2 oz.	...	...	...	8 oz.	...
Cornmeal . .	20 oz. or	...	...	...	...	...	...
White bread . .	18 oz. or	26 oz.	24 oz. or	16 oz. or	26·5 oz. or	28 oz. or	...
Dark bread . .	16 oz.	...	16 oz.	16 oz.	18·5 oz.	15 oz.	...
Rye bread . .	...	...	...	...	...	...	16 oz.
Fresh beef . .	20 oz. or	5⅓ oz.	16 oz. or	16 oz. or	7 oz.	8 oz.	16 oz. or
Salt beef . .	20 oz. or	5⅓ oz. or	16 oz. or	16 oz. or	{ 8·75	5⅓ oz. or	16 oz. or
Salt pork or bacon	12 oz.	5⅓ oz.	16 oz.	16 oz.	oz. }	4 oz.	16 oz.
Potatoes . .	...	16 oz.	...	...	...	48 oz. or	...
Rice . . .	1·6 oz.	...	2 oz. or	4 oz.*	3 oz.*	3 oz. or	...
Barley . . .	...	4 oz.	2 oz.	...	...	4 oz. or	...
Peas . . .	2·4 oz. or	4 oz.	...	...	...	8 oz. or	...
Beans . . .	2·4 oz.	4 oz.	...	...	...	8 oz. or	...
Oatmeal . .	...	...	...	16 oz.	...	4 oz.	...
Oats, unhusked ..	...	...	...	...	...	...	...
Desiccated vegetables	...	...	2 oz.	...	2 oz.	...	...
Cabbage or sourcrout	...	...	1 oz.	...	...	10⅔ oz.	3·5 gills
Coffee, green . .	1·6 oz. or	...	1 oz.	...	...	...	...
Coffee, roasted .	1·28 oz. or	...	0 25 oz.	1·43 oz. or	...	½ oz.	...
Dried fruits . .	...	...	...	...	...	4 oz.	...
Butter . . .	...	...	...	...	...	1½ oz.†	...
Tea . . .	24 oz.	...	0·5 gill	43 oz.	...	...	1·5 gill
Brandy . . .	...	...	...	...	¼ oz.	...	...
Rum . . .	...	...	...	...	...	...	...
Wine . . .	...	...	...	...	8 oz.	16 oz.†	...
Beer . . .	...	...	...	...	16 oz.	32 oz.†	33 oz.
Tobacco . . .	...	1 oz.	...	...	...	1½ oz.†	...
Sugar . . .	2·4 oz.	...	2 oz.	...	1 oz.	...	...
Vinegar . . .	0·32 gill	...	...	...	...	...	1·75 gill
Lime-juice . .	...	...	1 oz.	...	...	...	{ quantity unknown
Mustard . .	...	...	...	...	...	...	3·86 gr.
Horse-radish . .	...	...	...	...	...	...	3·86 gr.
Pepper . . .	0·4 oz.	...	0·31 oz.	...	...	...	...
Salt . . .	0·6 oz.	½ oz.	0·62 oz.	1 oz.	½ oz.	¾ oz.	0·75 oz.
Candles . . .	{ 16 oz. to 100 rations }	...	...	...	...	...	...
Soap . . .	{ 64 oz. to 100 rations }	...	...	...	...	...	...
Wood . . .	...	...	...	48 oz.	...	...	...

* Or other vegetables.
† In exceptional cases.

Recruit—*See* HYGIÈNE, MILITARY.

Red-Lead—*See* LEAD.

Refuse, Disposal of—*See* SCAVENGING.

Relapsing Fever—*See* FEVER, RELAPSING.

Rennet, or **Runnet** (prepared calf's maw)—This consists of the fourth or true-digesting stomach of the calf, freed from the outer skin, fat, and useless membrane; washed; treated with either brine or dry salt for a few hours, and then hung up to dry. When well prepared, the dried "vells" somewhat resemble parchment in appearance. Rennet is employed to curdle milk, the gastric juice contained in it bringing about this change. The stomachs of all sucking quadrupeds possess the same properties.

Rentcharge—The provisions with regard to rentcharges under the Public Health Act are as follows:—

Where any person has advanced money for any expenses which by the Public Health Act are, or by the local authority may be declared to be private improvement expenses, the local authority, on being satisfied by the report of their surveyor or otherwise that the money advanced by such person has been duly expended, may issue a grant in the following form (Form K) to such person of a yearly rentcharge issuable out of the premises, in respect whereof such advance has been made, or out of such part thereof, to be specified in such grant, as the local authority may think proper and sufficient :—

FORM K.

Form of Rentcharge.

By virtue of the Public Health Act, 1875, the local authority under that Act for the district of do hereby declare and absolutely order that the inheritance of the [dwelling-house, shop, lands, and premises, *as the case may be*], situated in street, in the parish of , within the said district, and now in the occupation of , shall be absolutely charged with the sum of pounds, paid by of for the improvement by drainage and water-supply [*as the case may be*], of the same dwelling-house, shop, lands, and premises [*as the case may be*], together with interest for the same from the date hereof at pounds per centum per annum, until full payment thereof; and also all costs incurred by the said , his executors, administrators, or assigns, under this security, shall be fully paid and satisfied: And we hereby further declare that the said principal and interest moneys shall be paid and payable by the owner or occupier of the said premises to the said , his executors, administrators, and assigns, in manner following; (that is to say,) the interest on such principal sum of pounds, or on so much thereof as shall from time to time remain due and payable under this order, shall be paid and payable by equal half-yearly payments whilst payable on the day of and the day of in every year, the first payment thereof to be made on the day of next, and such principal sum of pounds shall be paid and payable by equal annual instalments on the day of in each of the next succeeding years, towards the discharge of the same principal sum, until the whole shall be fully satisfied and discharged.

Such rentcharge shall be personal estate, and shall begin to accrue from the day of completion of the works on which the money advanced has been expended, and shall be payable by equal half-yearly payments during a term not exceeding thirty years, in such manner that the whole of the sum advanced, with the costs of preparing the said grant, together with interest thereon respectively, at a rate not exceeding six pounds per centum per annum on the sum from time to time remaining unpaid, shall be repaid at the end of the said term.

The provisions of the Public Health Act with respect to deduction from the rent of a proportion of private improvement rates, and with respect to redemption of private improvement rates, apply, *mutatis mutandis*, to rentcharges granted under this section.—(P. H., s. 240.) *See* RATES.

Rentcharges and transfers issued in pursuance of the Public Health Act are to be registered in the same manner respectively as mortgages and transfers are required to be registered under the provisions of the Act.—(P. H., s. 241.) *See* MORTGAGE, RATES.

Reservoirs—A reservoir is a place for storing water, by retaining the excess of rainfall in times of flood and letting it off by degrees in times of drought. The simplest and most common form is a natural cavity bounded on each side by an embankment. It is situated on the valley line of the catchment basin, and therefore on the natural channel; but such a site is not always to be obtained, and the engineer will have to choose the best he can. The three principal things influencing his selection being the elevation, the configuration of the ground, and the materials.

The elevation of the site must neither be too high nor too low. If it is too high, there will not be a sufficient gathering-ground; if too low, there will not be sufficient fall for the pipes, conduits, &c.

The material of which a reservoir is constructed should be impervious to water, or if pervious, capable of easy removal, so as to leave a water-tight foundation. The nature of this foundation is ascertained by borings and trial-pits. The best material for the foundation is clay, the next, compact unfissured rock. If through want of care the foundation contains an outcrop of porous rock, the impounded water will of course be conducted away.

The size of the reservoir must be determined by the *demand* for water and the extent to which the supply fluctuates. Experience has shown that 120 days' demand is the least storage-room that has proved sufficient in the climate of Britain, and even this in several instances has proved insufficient. Some engineers advise that in every case a reservoir should contain six months' demand. Adopting the lower estimate, a town of 5000 inhabitants would require a reservoir holding at least 1,800,000 gallons.

"From data respecting various existing reservoirs and gathering-grounds given by Mr. Beardmore (Hydraulic Tables), it appears that the storage-room varies from one-third to one-half of *the available annual rainfall.*

"The best rule for estimating the available capacity required in a store-reservoir would probably be one founded upon a calculation taking into account the supply as well as the demand. For example, 180 *days of the excess of the daily demand above the least daily supply*, as ascertained by gauging and computation.

"In order that a reservoir of the capacity prescribed by the preceding rule may be efficient, it is essential that the *least available annual rain-*

fall of the gathering-ground should be sufficient to supply a *year's demand for water.*

"To enable the gathering-ground to supply a demand for water corresponding to the average *available annual rainfall*, the *greatest total deficiency* of available *rainfall* below such average, whether confined to one year or extending over a series of years, must be ascertained, and an addition equal to such deficiency made to the reservoir-room; but it is in general safer as well as less expensive to extend the gathering-ground, so that the least annual supply may be sufficient for the demand."—(RANKINE, Civil Engineering.)

Upon the strength of the embankments of a reservoir the security of life and property often depend, so that its design, construction, and maintenance are of the first importance. The cross-section of the embankment is a trapezium, with the side next the water at a slope of about 3 to 1, and the outer slope, or that furthest from the water, at an inclination regulated by the stability of the material, such as 1½ to 1, or 2 to 1. The height of the top varies from 3 to 10 feet above the highest water-level. The inner slope is usually protected by a pitching of dressed stone, and the outer by a covering of grass sods. The embankment must be water-tight; this is effected by making the core of clay-puddle. No trees or shrubs should grow on an embankment, as their roots pierce it and make openings for the penetration of water. The top of the embankment is most conveniently made a kind of roadway, with a proper convexity, so that the water may run off it. The outlet from a reservoir should be a train of cast-iron pipes carried through the embankment in a culvert; the culvert must be founded on the solid rock. It is constructed either of brick or dressed stone built in cement; the outside is coated with clay-puddle, and it makes a water-tight joint with the clay-puddle wall of the embankment. In the best-constructed reservoirs a *tower* stands on the inner end of the culvert, to contain outlet pipes for draining water from different levels, with valves, &c., for opening and shutting them. This tower is usually joined to the top of the embankment by a bridge. Strong gratings should be provided in front of the outlets, to prevent the access of stones or other matter that might injure the sluices or clog the pipes.

The other appendages to stone reservoirs are *waste-weirs* and waste-sluices. The waste-weir is a weir capable of discharging from the reservoir the greatest flood discharge of the streams which supply it, without causing the water-level to rise to a dangerous height. This weir is built of ashlar or square hammered masonry; the water is discharged into an open or covered channel, by which it reaches the natural watercourse. In some cases, instead of the waste-weir, a *waste-pit* is used. (For other details, works on engineering must be consulted.) For the storage of small quantities of water, *see* TANKS, WATER, &c.

The Public Health Act enacts that at least two months before commencing to construct, under the provisions of the Act, any reservoir (other than a service reservoir or tank which will hold not more than 100,000 gallons), the local authority are to give notice of the intended work by advertisement in one or more of the local newspapers circulated within the district where the reservoir is to be constructed. If any person affected by the intended work objects to it, and serves notice of such objection on the local authority at any time within the said two months, the work is not to be commenced without the sanction of the Local Government Board. The Local Government Board, on the application of the local authority, may appoint an inspector to inquire on the spot into the matter and report, and on reception of the report, may make an order allowing or disallowing, with such modifications as they may deem necessary, the intended work.—(P. H., s. 55.)

Resolutions—The rules as to the resolutions of owners and ratepayers are laid down with considerable minuteness in the 3d schedule of the Public Health Act as follows:—

SCHEDULE III.

Rules as to Resolutions of Owners and Ratepayers.

1. For the purpose of passing a resolution of owners and ratepayers under this Act, a meeting shall be summoned on the requisition of any twenty ratepayers or owners, or of any twenty ratepayers and owners, resident in the district or place with respect to which the resolution is to be passed.

2. The summoning officer of such meeting shall be—

In boroughs, the mayor.

In Improvement Act districts, the chairman of the Improvement Commissioners.

In local government districts, the chairman of the local board.

In places situated in any rural district or districts and having known and defined boundaries, the churchwardens or one of them having jurisdiction coextensive with the place; or if there are no churchwardens, the overseers or one of them having the like jurisdiction; or if there is none of the officers respectively above enumerated, or if such officer in any case neglects, is unable, or refuses to perform the duties hereby imposed on him, by any person appointed by the Local Government Board.

Where the boundaries of a place are settled by order of the Local Government Board, the board shall by such order appoint the summoning officer.

If any summoning officer appointed by the Local

Government Board dies, becomes incapable, or refuses or neglects to act, the Local Government Board may appoint another officer in his room.

3. Ratepayers or owners making a requisition for the summoning of such meeting shall, if required, give security in a bond, with two sufficient sureties, for repayment to the summoning officer, in the event of the resolution not being passed, of the costs incurred in relation to such meeting or any poll taken in pursuance of any demand made thereat; the amount of the security to be given by such sureties, and their sufficiency, and the amount of such costs, to be settled by agreement between the summoning officer and such ratepayers or owners, or, in case of dispute, by a court of summary jurisdiction.

4. The summoning officer shall, on such requisition as aforesaid, fix a time and place for holding such meeting, and shall forthwith give notice thereof—

By advertisement in some one or more of the newspapers circulated in the district or place.

By causing such notice to be affixed to the principal doors of every church and chapel in the place to which notices are usually affixed.

5. The summoning officer shall be the chairman of the meeting, unless he is unable or unwilling to preside; in which case the meeting on assembling shall choose one of its number as chairman, who may, with the consent of a majority of the persons present, adjourn the same from time to time.

6. The chairman shall propose to the meeting the resolution, and the meeting shall decide for or against its adoption: provided, that if any owner or ratepayer demands that such question be decided by a poll of owners and ratepayers, such poll shall be taken by voting papers in the Form O in Schedule IV. to the Act.

Form O.

Form of Voting Paper for Poll taken under Schedule III.

Voting Paper No. (.)

At a meeting held on the   day of   , at   , in the county of   , it was agreed that the following resolution should be proposed to the owners and ratepayers of   .

(*Set out the resolution.*)

	In favour of.	Against.	Number of Votes.	
			As Owner.	As Ratepayer.
Do you vote in favour of or against the adoption of this resolution?				

(Signed)____________
or the mark of____________
Witness to the mark ____________
or proxy for____________

Directions to the Voter.

The voter must write his initials under the heading "in favour" or "against," according as he votes for or against the resolution, and must subscribe his name and address at full length.

If the voter cannot write he must make his mark instead of initials, but such mark must be attested by a witness, and such witness must write the initials of the voter against his mark.

If a proxy votes he must in like manner write his initials, subscribe his own name and address, and add after his signature the words "as proxy for," with the name of the body of persons for whom he is proxy.

This paper will be collected on the   of   , between the hours of   and   .

The poll is to be taken in the same way and with the same incidents and conditions as to the qualifications of electors and scale of voting, as to notice to be given by the returning officer, delivery, filling up, and collection of voting papers, as to the counting of votes, as to penalties for neglect or refusal to comply with the provisions of the Act, and in all respects whatsoever as is provided by the rules for the election of local boards in Schedule II. to the Public Health Act. (*See* Local Boards.) Except that in districts or places where there is no register of owners and proxies under the said Act, any owner or proxy shall be entitled to have a voting paper delivered to him, if, at least fourteen days before the last day appointed for delivery of the voting papers, he sends a claim in writing to the summoning officer containing the particulars required by Schedule II. to the said Act, to be contained in claims to be entered on the register of owners and proxies, and except that the provisions with respect to certain specified days of the month shall not apply.

For the purposes of such poll the summoning officer shall be the returning officer, and shall have the powers and perform the duties of a returning officer under Schedule II. to the Public Health Act, so far as the same are applicable to a poll under this schedule.

If no poll is demanded, or the demand for a poll is withdrawn by the persons making the same, a declaration by the chairman shall, in the absence of proof to the contrary, be sufficient evidence of the decision of such meeting.

7. A copy, under the hand of the summoning officer, of every resolution so passed, shall be forwarded by him to the Local Government Board; and it shall be his duty to publish a copy thereof by advertisement for three successive weeks in some one or more of the newspapers circulated in the district or place, and by causing a copy thereof to be affixed to the principal doors of every church and chapel in the place to which notices are usually affixed.

8. Where in pursuance of a resolution passed in manner provided by this schedule any place is constituted a local government district, all costs incurred by the summoning officer in relation to the meeting, and any poll taken in pursuance of any demand made thereat, shall be a first charge on the general district rates leviable within such district; in the case of a resolution so passed by owners or ratepayers in any urban district, such costs shall be paid out of

the fund or rate applicable by the urban authority to the general purposes of the Public Health Act.

Respiration, Effect of on Air—*See* AIR, OVERCROWDING, VENTILATION, &c.

Revalenta—This preparation, so largely advertised, was found, when examined by Dr. Hassall, to contain the following ingredients. Three samples were analysed : one consisted of a mixture of the *red* or *Arabian* lentil and *barley-flour ;* the second, of the same ingredients mixed with *sugar ;* and the third sample consisted of the *Arabian lentil* and barley-flour, with the addition of saline matter, chiefly salt ; it also possessed a peculiar taste, as though flavoured with *celery seed.*

Rheumatism — This disease essentially consists of a peculiar inflammatory action in the fibrous tissues, more especially of the joints, sheaths of the muscles, tendons, &c. It is ordinarily divided into two kinds—*acute* and *chronic.* The acute form is attended with high fever and swelling of the joints, and it often attacks the pericardium or covering of the heart. The chronic has various forms, sometimes attacking one or two joints, attended with slight fever ; in other instances, only one or several muscles are affected. It is then often known under other names, such as pleurodynia when the intercostal muscles of the chest, and lumbago when the muscles of the back, are selected as the seat of the disease.

It appears now to be generally acknowledged that in rheumatism there is some abnormal state of the blood and nervous system, and this blood circulating in the fibrous tissues induces a special kind of inflammation, so that the swelling, &c., of the joints is merely the local expression of a general disease. Rheumatism is not contagious, its exact nature may be confidently asserted to be still unknown. It does not, however, belong to the scope of this work to enter into the discordant views of pathologists as to its real nature, nor to deal with the question of treatment, but rather to seek for the causes and effects of rheumatism.

Rheumatism is not an extremely fatal disease, even in its acute form, at the time of the attack ; but, on the other hand, if the effects of rheumatism were taken into account, it is probable that instead of occupying about the thirty-fourth place in diseases, arranged according to their fatality, it would rank tenth or eleventh. For, putting on one side the atheromatous affection and degeneration of the vessels which arise from rheumatic affections, there is one disease that annually kills the human race at the rate of 1000 deaths to every million living—viz., disease of the heart—and most certainly at least two-thirds of this disease are due, either directly or remotely, to rheumatism or its ally gout.

The annual and direct mortality from rheumatism, as estimated from the returns for the five years 1867–71, shows a mean of 2605, so that it may be said to kill about 2600 yearly.

If the twenty years 1850–69 are taken, they show an annual rate per million lives of 107·2 ; and if these twenty years be divided into two equal periods of ten years, we obtain the numbers 103·1 and 111·3 ; or if the twenty is divided into four periods of five years each, the numbers are 101·8, 104·4, 106, and 106·6. This small variation alone shows that it is not contagious, but an endemic disease influenced by weather, &c.

Rheumatism is a great cause of invaliding in the army, as is shown by the following extract from the Army Medical Report for 1871 :—

ANNUAL RATIO per 1000 Strength.

	Household Cavalry.	Dragoon Guards and Dragoons.	Royal Artillery.	Foot Guards.	Infantry Regiments.	Depot Brigade Royal Artillery.	Depots.	Army Service Corps.
Rheumatism { Admitted .	43·2	37·10	53·30	37·00	39·3	94·7	52·3	45·7
Rheumatism { Died . .	...	0·09	0·08	0·16	...	...	...	...

It is, however, yet more prevalent in the navy. This is most probably from the more frequent exposure to wet and cold.

The following table shows the comparative prevalence of this disease per 1000 in the years 1870 and 1871 :—

Stations.	Rheumatism. 1870.	Rheumatism. 1871.
Home	53·3	53·7
Mediterranean. . .	66·0	80·7
North America and West Indies	70·6	69·6
South-east coast of America	79·1	[illegible]
Pacific	81·9	91·4

Stations.	Rheumatism. 1870.	1871.
West coast of Africa and Cape of Good Hope	95·2	100·0
East Indies	72·2	62·9
China	79·3	70·3
Australia	70·5	68·2
Irregular	73·5	68·4

Men are less liable to be attacked than women, and children less liable than either. Out of seventy-three cases given by Chomel, two only were attacked under fifteen years, thirty-five for the first time between fifteen and thirty, twenty-two from thirty to forty, seven cases from forty-five to sixty, and seven cases after sixty.

There can be no doubt that occupations involving exposure to wet and cold are conducive to rheumatism, and it is a fact that railway officials, agricultural labourers, cab-drivers, &c., are as a class more subject to this disease than those who are not exposed to weather. At the same time, it must be remembered that it is not in the coldest climates that rheumatism is most prevalent, but rather in those which are remarkable for damp and variable weather.

"And thus," says Sir A. Tulloch, "we find in the mild and equable climate of the Mediterranean or the Mauritius the proportion of rheumatic affections even greater than in the inclement regions of Nova Scotia and Canada; and though some of the provinces of the Cape of Good Hope have occasionally been without rain for several years, yet rheumatism is more frequent in that command than in the West Indies, where the condition of the atmosphere is as remarkably the reverse."

With regard to the *prevention of the disease*, it is to be hoped that proper drainage of the ground, and strict care that no house or cottage has damp foundations, may do much in the future to decrease rheumatism, the acute form of which is so essentially a disease of the bread-winner. In our English winters, attention to clothing cannot be too much insisted upon. All persons subject to rheumatism in any form should wear flannels in the winter, and clothe lightly in the summer, instead of following the practice so common with many of the English people, of wearing almost the same underclothing in both the hot and the cold season, a course dictated neither by common sense nor by comfort. The author is also convinced that where rheumatism is prevalent beer and cider should be avoided.

Rhizopoda—The amœbæ forms are often detected in water, but whether they indicate the presence of putrescent organic matter is not at present certainly known. Ehrenberg has also discovered them in air, and he has found that if dried they will retain their vitality for months and even years. *See* AIR, WATER, &c.

Rhubarb—The species usually grown for alimentary purposes are the *Rheum Rhaponticum* and *Rheum hybridum*. The kind known to gardeners as true Turkey rhubarb, and which also yields an excellent edible product is the *Rheum palmatum*. It is a very useful fruit in a dietetic point of view, but since it contains oxalate of lime, it should be avoided by persons suffering from the oxalate of lime diathesis.—(PAVY.)

Rhubarb leaves are often used for mixing with tobacco, an adulteration which may be distinguished by the microscope, the chief difference of structure being in the fine striation observed in the rhubarb cells, the hairs of the leaf, the shape and course of the mid-rib and veins, and the gland-like bodies scattered throughout the lamina. *See* TOBACCO.

Turkey rhubarb is often adulterated with wheat-flour, turmeric (*see* FLOUR, TURMERIC, &c.), and English rhubarb. The flour and turmeric may be discovered by the microscope; turmeric also may be detected by boracic acid, which reddens it. In English rhubarb, starch is generally in large, oxalate of lime in small, quantities only. The proportions of these ingredients are reversed in the Chinese varieties.

Rice—The seed of the *Oryza sativa* denuded of the husk and inner cuticle. Rice, when associated with meat, fat, and salts, is a valuable article of diet; alone, it is too pure a starch to suffice.

Rice resembles the potato, but attempts made to substitute it in diets for potatoes have not been followed with satisfactory results. The experiment was recently tried in some of our unions, and the most serious consequences followed. In one of these nine or ten deaths from scurvy and allied diseases occurred in a single fortnight.

The proportion of gluten in rice-flour is about 6·3 per cent., and it rarely exceeds 7 (LETHEBY); and it cannot be made into bread unless it is mixed with wheaten flour.

The following analyses exhibit its composition:—

Composition of Rice (LETHEBY).

Nitrogenous matter	6·3
Carbo-hydrates	79·5
Fatty matter	0·7
Saline matter	0·5
Water	13·0
	100·0

Composition of Dried Rice (Payen).

Nitrogenous matter	7·55
Starch	88·65
Dextrine, &c.	1·00
Fatty matter	0·80
Cellulose	1·10
Mineral matter	0·90
	100·00

The following is the composition of the ash of rice:—

Potash	18·48
Soda	10·67
Lime	1·27
Magnesia	11·69
Oxide of iron	0·45
Phosphoric acid	53·36
Chlorine	0·27
Silica	3·35
	99·54

An oil may be obtained from the embryo of rice. It has a density of ·924 at 15° C., and at 5° C. acquires a butylaceous consistence. It contains a large quantity of oleic acid, and much albuminous matter.—(A. Pavesi and E. Rotondi, Gazzetta Chimica Italiana, iv. 192–195.)

The structure of the husk of the grain of rice cannot easily be determined, and it should be examined after it has been immersed in glycerine for some time. The outer surface of the seed is thrown up into ridges arranged both transversely and longitudinally, and describing between them square spaces. The ridges are formed in part of silica in the form of granules; here and there are openings of somewhat irregular form, and which are the mouths of stomata. The substance of the husk is made up of narrow and rather short fibres. Some of these are arranged longitudinally, others transversely. They are brittle, and their edges rough. That they are really fibres is shown by their being hollow, as is seen in transverse sections. Beneath the fibrous membrane is a thin layer of angular cells. —(Hassall.) The starch corpuscles themselves are very small, and scarcely average more than ·0003 of an inch in diameter. Their shape is angular, with a central depression (*see* fig. 73).

When the seed is enclosed in its paleæ or husk, it is known by the name of paddy.

The cultivation of rice is attended with considerable danger both to the actual workers in the fields and those living in the immediate neighbourhood of them. The land is for some time inundated, and the labourers in rice-fields have to stand for hours in stagnant water; and the emanations arising from the land when it is half dry are most deleterious. So large, indeed, was the mortality from this cause in Sardinia, that Charles Emmanuel endeavoured to abolish all the rice plantations in his kingdoms. His beneficent project was, however, strongly opposed, not only by the owners, but also by the poorer classes, and he was compelled to abandon it. It is said that rice plantations in Europe have produced more injurious effects than those which exist in Eastern countries, but we have not sufficient evidence before us to decide this

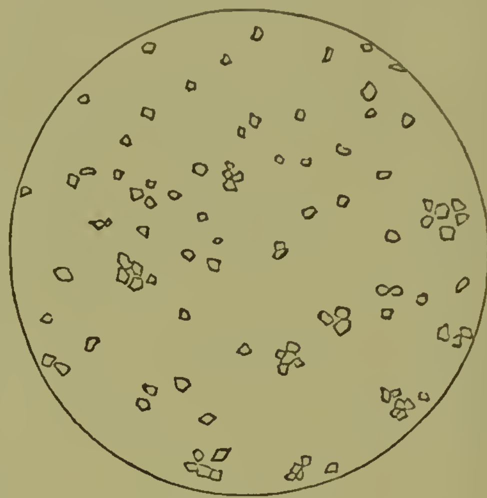


Fig. 73.

point. In France, however, we know that labourers in rice plautations become pale and emaciated, and are subject to intermittent fevers, dropsy, scurvy, and other diseases, few living over forty years of age.

Rice-flour is often used for the purpose of adulterating oatmeal, mustard, pepper, cayenne, curry powder, ginger, mixed spice, liquorice, &c.

Rivers, Streams, Pollution of, &c.—It is noticeable that the first acknowledged Sanitary Act in the statute-book was in point of fact a Rivers Pollutiou Bill, for in the year 1388 an Act was passed imposing the very high penalty (considering the value of money at that time) of £20 upon persons casting animal filth and refuse into rivers.

It may easily be premised that if, at a time when the country was sparsely populated, when towns were small, and wheu commercial industry was but feebly developed, legislation was required, it urgently needs it now, when for centuries, from the great centres of commerce down to the single cottage on the river's brink, each in its sphere has done its utmost to render river-water undrinkable by man, poisonous to fish, hurtful to animals, and offensive to the senses. The propagation of cholera along polluted streams, the complaints of individuals and of the press—complaints arising from witnessing the wholesale destruction of fish, and from the evidence of the senses—are a few of the many influences which have directed public attention so earnestly to the subject of river pollution.

From numerous successive reports of the two Royal Commissions, appointed respectively in 1865 and 1868, the magnitude of the evil, the polluting agencies, and the remedies may be appreciated; but the interests involved are so immense, that although there have been one or two attempts to pass temporary or permanent Acts in order to prevent river pollution, it yet remains a subject for future legislation.

The substances polluting rivers may be divided into two great classes—viz., (1) organic; (2) inorganic.

The *organic* are such as sewage, and the effluent drainage-waters from cotton, woollen, silk, flax, jute, print, dye, bleach, alkali, chemical, soap, starch, sugar, and other works, besides tanneries, paper-mills, distilleries, &c.

These all agree (however various may be the composition of the fluids) in holding in suspension and solution matters principally organic, and more or less putrescent; and the remedy for this class of polluting substances appears to be, not to permit them to be discharged into a stream until they have first been submitted to the operations of intermittent filtration and sewage irrigation. These two last remedies are of course only applicable to impurities of animal and vegetable origin. The details of this process will be found in article SEWAGE.

The *inorganic* polluting substances are those arising from mining operations and metal manufactures. From the first a large amount of worthless rubbish is derived, and is "tipped" into the nearest stream, with the effect of choking up its bed, and in the course of time diverting its course to the injury of riparian proprietors; but this is not the only injury to the stream. In the case of lead, zinc, copper, arsenic, tin, and baryta mines, a directly poisonous ingredient is added to the water, some part of which is dissolved, the remainder being in suspension, and after floods, the fine metal-bearing dust is deposited upon the herbage, with the result of poisoning the cattle; add to this, that in mining operations a large amount of washing of the ore is required, and that the washing water is usually taken from, and then added, laden with earthy detritus, to the nearest stream.

The pollution caused by metallurgical operations and metal manufactures does not appear, with one or two exceptions, very serious. The pollution from nickel-works, iron-works, and rolling-mills, from cutlery, from brass-foundries, and from German silver and electroplate works, is pronounced by the Commissioners to be comparatively unimportant; whilst the drainage from galvanising is far more serious, not merely on account of the large volumes of offensive liquors discharged from the works, but also "by the reckless manner in which these pernicious liquids are in many cases flushed out into sewers or rivers."

The effluent waters are extremely acid and corrosive, so much so that they dissolve the cement and loosen the brickwork of sewers.

The remedies proposed with regard to pollution from mines and metal manufactories are naturally rather preventive than curative, most of the mineral matters being in suspension. If the effluent water be allowed to rest undisturbed in pits for a longer or shorter time, according to the nature of the suspended substances, a fine mud will fall to the bottom, and the water, comparatively pure, may then be allowed to flow into the stream; whilst in the case of metal manufactories, the refuse liquid frequently admits of profitable treatment, and instead of permitting it to go forth as waste, may be utilised by the manufacturer. But whether the corrosive acid liquors of some metal trades may be utilised or not, certain it is that on no account should they be allowed to enter sewers or rivers.

The Commissioners recommend the following standards of purity for general adoption, but they wish in the case of mines to make an exception with regard to standards *d* and *e*:—

(*a.*) Any liquid which has not been subjected to perfect rest in subsidence ponds of sufficient size for a period of at least six hours, or which having been so subjected to subsidence, contains in *suspension* more than 1 part by weight of dry organic matter in 100,000 parts by weight of the liquid, or which not having been so subjected to subsidence, contains in *suspension* more than 3 parts by weight of dry mineral matter, or 1 part by weight of dry organic matter, in 100,000 parts by weight of the liquid.

(*b.*) Any liquid containing in solution more than 2 parts by weight of organic carbon, or 3 parts by weight of organic nitrogen, in 100,000 parts by weight.

(*c.*) Any liquid which exhibits by daylight a distinct colour when a stratum of 1 inch deep is placed in a white porcelain or earthenware vessel.

(*d.*) Any liquid which contains in solution in 100,000 parts by weight more than 2 parts by weight of any metal except calcium, magnesium, potassium, and sodium.

(*e.*) Any liquid which in 100,000 parts by weight contains, whether in solution or suspension, in chemical combination or otherwise, more than ·05 part by weight of metallic arsenic.

(*f.*) Any liquid which, after acidification with sulphuric acid, contains in 100,000 parts by weight more than 1 part by weight of free chlorine.

(*g.*) Any liquid which contains in 100,000 parts by weight more than 1 part by weight of sulphur, in the condition either of sulphuretted hydrogen or a soluble sulphuret.

(*h.*) Any liquid possessing an acidity greater than that which is produced by adding 2 parts by weight of real muriatic acid to 1000 parts by weight of distilled water.

(*i.*) Any liquid possessing an alkalinity greater than that produced by adding 1 part by weight of dry caustic soda to 1000 parts by weight of distilled water.

(*j.*) Any liquid exhibiting a film of petroleum or hydro-carbon oil upon its surface, or containing in suspension in 100,000 parts more than ·05 part of such oil.

Notwithstanding the general assent of the late Baron Liebig and other excellent chemists, the general opinion appears to be that the recommendations require considerable modification.

In particular, the volume and ratio that effluent matters bear to the volume and ratio of the river appear to have been quite overlooked. In all future legislation it must be remembered, if any standard of impurity is adopted, that a million of grains of any polluting substance thrown into a large wide river may do no harm whatever; while, on the other hand, the same amount in a small brook will kill all the fish, and be a great nuisance. Again, care must be taken that the manufacturer, by simply pumping into his refuse liquids water from the stream, may not be able to evade the law by diluting a very impure liquid down to the legal standard. In prohibiting metals, it is obvious that not alone arsenic, but also lead, copper, chromium, &c., should be dealt with as strictly as arsenic. Mr. Crookes proposed, " I would therefore say that no person should send into a river water which is less pure than the water of the river at the place at which it goes in. . . . If the river contained 100 grains per gallon of impurity, and if I turn into it water containing 90 grains per gallon of impurity, although that is a very impure liquid, I am doing the river good rather than harm." This proposal has certainly the merit of uniformity, is simple and capable of adoption, although it would evidently press extremely hard upon manufacturers at the heads of streams. Dr. Lyon Playfair has also suggested provisions against any discharge into a stream which will raise its sum total of impurities beyond a certain amount. He thus takes the stream as the standard, and not the refuse water. This, again, is a suggestion which is capable of being worked out in detail. Besides other evident and valid objections to the recommendations, the terms "organic carbon" and "organic nitrogen" have been with reason objected to, as applying to a method of analysis used by one of the Commissioners alone, and a method generally condemned by other chemists as faulty and inaccurate.

As it may hereafter probably fall to the medical officer of health to investigate the state of the streams in his district, it may be well here to give the amount of solid residue in a few of our rivers, and also a short notice of those substances which have been found to be most noxious to fish, referring the reader to article WATER, ANALYSIS OF, for further information.

The following table is compiled from the original paper of Drs. Adams and Penny,* detailing the effect of mixing chemical agents with water on the life of the minnow and goldfish. The results of the experiments are of great interest, and cannot fail to be of use to any one who has to investigate real or supposed pollution. In the tabular results the experiments on the minnow are here alone represented, the fractions indicating the *least* amount which the experimenters found destroyed life. Thus, sulphate of copper $\frac{1}{100000}$, means that 1 part of sulphate of copper dissolved in 100,000 parts of water was fatal to a minnow. It must be remembered that the latter is a very delicate fish, and extremely susceptible of impurities. On that account it was certainly one of the best fishes which could possibly have been selected for the purpose of experiment.

Acids.

Sulphuric	$\frac{1}{50000}$	Citric	$\frac{1}{5000}$
Nitric	$\frac{1}{50000}$	Tannic	$\frac{1}{14000}$
Muriatic	$\frac{1}{10000}$	Gallic	$\frac{1}{7000}$
Sulphurous	$\frac{1}{2045}$	Carbolic	$\frac{1}{70000}$
Acetic	$\frac{1}{5750}$	Arsenious	$\frac{1}{3500}$

Metallic Salts.

Sulphate of copper	$\frac{1}{100000}$	Chloride of tin	$\frac{1}{10000}$
Chloride of lime	$\frac{1}{1750}$	Oxymuriate of tin	$\frac{1}{10000}$
Do., saturated solution	$\frac{1}{15000}$	Carbonate of soda	$\frac{1}{1750}$
Nitrate of lead	$\frac{1}{4000}$	Carbonate of potash, impure	$\frac{1}{1755}$
Sulphate of alum	$\frac{1}{10000}$	Bicarbonate of potash	$\frac{1}{5000}$
Sulphate of iron	$\frac{1}{10000}$		

Special Chemicals.

Chlorine, saturated solution	$\frac{1}{1400}$	Lime	$\frac{1}{100}$
Iodine	$\frac{1}{35000}$	Caustic potash	$\frac{1}{35000}$
Bromine	$\frac{1}{35000}$	Ammonia	$\frac{1}{725}$

Drysalteries.

Galls	$\frac{1}{2508}$	Madder	$\frac{1}{2000}$
Garancine	$\frac{1}{5000}$	Catechu	$\frac{1}{5750}$
Sumach	$\frac{1}{7000}$		

Miscellaneous.

Foundry cake	$\frac{1}{10}$	Bisulphide of carbon	$\frac{1}{240}$
Furnace cinders	$\frac{1}{70}$	Sulphide of ammonia	$\frac{1}{140}$
Heavy pitch oil	$\frac{1}{15000}$	Sulphuretted hydrogen	$\frac{1}{120}$
Light pitch oil	$\frac{1}{34000}$		

* Fourth Report, Rivers Pollution Commissioners.

Waste Discharges.

Bleach liquor .	$\frac{1}{1000}$	Colour house washing . . .	$\frac{1}{2}$
Spent galls . .	$\frac{1}{80}$		

Or arranging the agents destructive of the life of delicate fishes into three classes, we find the most detrimental are—

1. Sulphate of copper, the mineral acids, the sulphates of alum and iron, iodine, bromine, caustic potash, the chloride and oxymuriate of tin, the heavy and light pitch oils, chloride of lime (saturated solution), and carbolic acid. These all destroy minnow life when existing in very small proportions, varying from 1 in 100,000 parts of water to 1 in 10,000 parts.

2. The next destructive are such as garancine, madder, sumach, catechu, acetic acid, citric acid, arsenious acid, gallic acid. These are all fatal when existing in the proportion of from 1 to 7000 of water, to from 1 to 3500.

3. The least destructive but *yet poisonous* agents are tartaric acid, salts of soda and potash, hydrate of lime, ammonia, bisulphide of carbon, sulphide of ammonium, sulphuretted hydrogen, foundry-cake, furnace cinders, bleach liquor, and spent galls. These different substances are fatal to minnow life, when existing in water in proportions varying from 1 in 2000 to 1 in 80.

The substances which are powerfully polluting and yet have little influence on fish life, except in large quantities and in a state of decomposition, are blood and urine. Large quantities of linseed and olive oils also did not appear to have any appreciable effect on the fish submitted to experiment.

In all probability there will be legislation on the subject of rivers shortly, and it is likely that on local authorities will be cast some duties and powers of supervising the streams in their district. Tho following enactment gives power to local authorities when necessary to proceed in cases of stream pollution :—

Any local authority, with the sanction of the Attorney-General, may, either in their own name or in the name of any other person, with the consent of such person, take such proceedings by indictment, bill in Chancery, action, or otherwise, as they may deem advisable for the purpose of protecting any watercourse within their jurisdiction from pollutions arising from sewage either within or without their district; and the costs of and incidental to any such proceedings, including any costs that may bo awarded to the defendant, shall be deemed to bo expenses properly incurred by such authority in the execution of the Public Health Act. — (P. H., s. 69.) *See* Sewage, Water.

Roads—*See* Highways.

Robur—This is a strong spirit flavoured with tea; the constituents are alcohol, sugar, tannin, ash, water, and extractive matter. The ash contains manganese derived from the tea.

Roofs—*See* Habitations.

Rooms—*See* Disinfection, Habitations, Overcrowding, Ventilation, &c.

Rosemary—The flowering tops of *Rosmarinus officinalis.* The oil possesses some antiseptic properties.

Rowing—*See* Heart Disease.

Rudesheimer—A German red wine. *See* Wine.

Rue—The leaf of the *Ruta graveolens.* The oil of rue contains slight antiseptic properties.

Rue has been criminally employed for procuring abortion. It is antispasmodic, diuretic, stimulant, nervine, and emmenagogue.

Rum—An ardent spirit obtained by distillation from the fermented skimmings of the sugar-boilers (syrup-scum), the drainings of the sugar-pots and hogsheads (molasses), the washings of the boilers and other vessels, together with sufficient recent cane juice or wort prepared by mashing the crushed cane to impart the necessary flavour. Like other spirits, rum is colourless when it leaves the still, and is tinged with partially burnt sugar, &c., to suit the taste of the consumer.

Rum is greatly improved by keeping, whereby it acquires a fine, mellow, soft flavour. As imported into this country, it has an average strength of 20 under proof. The best comes from Jamaica; and it is usual there to put a few slices of pine-apple into the best qualities of this spirit, hence the term *pine-apple rum.* The flavour of rum is due to a volatile oil and butyric acid. From a knowledge of this fact has proceeded the manufacture of a butyric compound (essence of rum), by the aid of which the dealer is enabled to manufacture a fictitious rum from malt or molasses spirit.

The following statement shows the characteristics of rum :—

Rum.

Specific gravity . .	0·874 to 0·926
Alcohol per cent. . .	60·000 to 77·000
Solids per cent. . .	1·000
Ash per cent. . .	0·100
Acidity per ounce reckoned as tartaric acid . .	0·500
Sugar per cent. . .	0·000

The late Dr. Edward Smith spoke of rum as being a true restorativo, sustaining and increasing the vital powers; and he considered the old-fashioned combination of *rum-and-milk* a most powerful restorative.

For the general effects of spirits, &c., *see* ALCOHOL, ALCOHOLIC BEVERAGES, ALCOHOLISM, &c.

Adulterations.—A flavouring has been prepared to imitate that of the pine, and is now extensively employed in this country, not only to convert ordinary rum, but even ordinary spirit, into "pine-apple rum." This flavouring may be prepared by distilling butter with sulphuric acid and alcohol, or by combining amylic or potato ether with butyric acid, and then dissolving it in alcohol.

Other adulterations which have been discovered in rum are water, cayenne pepper, *Cocculus Indicus*, sugar, lead, &c.

For methods of detecting these adulterations, *see* ALCOHOLOMETRY, BEER, BRANDY, GIN, &c.

Rye—The seed of the *Secale cereale*, a gramineous plant which is cultivated extensively on the Continent, and forms the chief food of northern nations, and though now rarely used here, was once a common article of diet amongst ourselves. The ordinary food of the lower orders throughout Holland, Germany, &c., is a dark-looking, sour-tasting bread made from this grain. Rye resembles wheat more nearly than any of the other cereals, but it is slightly less nutritious, smaller in size, and darker in colour. Rye-flour is less rich in nitrogenous principles than wheat-flour, but it contains more sugar. The "soluble gluten" of rye-flour may be obtained in the following manner: Wash its paste frequently in water until it breaks up and becomes diffused throughout the liquid, the bran only being left behind; the milky liquid (after having deposited the starch and after the separation of the albumen) may be evaporated, when the residue will consist of sugar-oil and the so-termed "soluble gluten," which may be dissolved out by means of alcohol. The nitrogenous matter of rye consists of fibrine, gluten, and albumen. Rye taken by those unaccustomed to its use causes diarrhœa, but custom soon overcomes this effect. Rye-bread contains less vegetable fibrine and more caseine and albumen than wheaten bread, and a peculiar odorous substance.

Composition of Rye-Meal (LETHEBY)

Nitrogenous matter	8·0
Carbo-hydrates	73·2
Fatty matter	2·0
Saline matter	1·8
Water	15·0
	100·0

Composition of Dried Rye (PAYEN).

Nitrogenous matter	12·50
Starch	64·65
Dextrine, &c.	14·90
Fatty matter	2·25
Cellulose	3·10
Mineral matter	2·60
	100·00

Composition of the Ash of Rye.

Potash	22·08
Soda	11·67
Lime	4·93
Magnesia	10·35
Oxide of iron	1·36
Phosphoric acid	49·55
Sulphuric acid	0·98
Silica	0·43
	101·35

The testa of rye differs from the testa of wheat in having the cells of the first and second coats smaller and much more delicately beaded. Those of the third coat are also smaller, and of a somewhat different form. The smaller starch grains are much smaller than the corresponding ones in rice, and several of the larger granules of rye-starch are furnished with a three or four-rayed hilum. Examined with the polariscope they exhibit a very strongly-marked cross.

None of the cereals are so liable to become ergotised—*i.e.*, become the seat of growth of a parasitic fungus—as rye. The affected grain becomes considerably larger, and may attain upwards of four times its ordinary size; hence it can readily be sifted from the unaffected grain, and care should be taken that it is so separated, or serious consequences may arise. *See* ERGOT.

Roasted rye is occasionally used as a substitute for coffee, and it is also employed in the adulteration of chicory, annatto, liquorice, &c. It furnishes an excellent malt for the distillation of spirit, and is much used in the making of hollands.

S.

Saccharometer—An instrument exactly similar in principle to the lactometer and hydrometer, but it is weighted and graduated expressly for saccharine solutions, and is of considerable and extensive technical use in ascertaining the richness of malt worts.

Saffron—The prepared stigmata or stigmas of the *Crocus sativus* or saffron crocus. The stigma, and part of the style of the flower, form a thin filament broad at one end and tripartite, of an orange-red colour. Dried carefully, it forms the *hay saffron*, and when packed and pressed into parcels, *cake saffron.* Saffron, moistened and pressed upon white paper, leaves an orange-coloured stain, and yields to water and alcohol an orange-red colouring matter called *polycroite*, changed into blue by oil of vitriol. It also contains a *volatile oil.* When pressed between folds of white filtering-paper, it yields no stain. Good saffron does not give upon incineration more than ·1 per cent. of ash.

Adulterations.—The adulterations of saffron are numerous. Some traders steep it in water, or put it in damp places, in order to increase its weight. Saffron thus treated acquires a peculiar odour, rapidly becomes mouldy, and more readily stains the fingers than good saffron. Another adulteration undertaken for the same purpose is the addition of *oil*, easily detected by the greasy stains left when the stigmas are pressed on paper.

Under the name of Persian saffron, Hagar (Pharm. Central Halle, 1870, No. 40, p. 364) has described oily cakes, containing scarcely any stigmatas, but chiefly consisting of petals impregnated with a thick fixed oil, supposed to be olive oil coloured with curcuma. This species of fraud may be recognised by its appearance, its chemical properties, and by the fact that it yields to petroleum its colouring matter, which true saffron does not. Spanish saffron is frequently adulterated with honey in order to increase its weight. This may be detected by treating the mass with water, and then estimating and detecting the sugar in the usual way.

But far the most frequent method of sophisticating saffron is the substitution of the stigmata, the petals, or the leaves of other plants. The flowers of *Carthamus tinctorius* (natural order, *Compositæ*), the corollas of the *Lyperia crocea* (natural order, *Scrophulariaceæ*), the flowers of *Calendula arvensis* (natural order, *Compositæ*), of arnica, of saponaria, and of fuminella, the young shoots of carex (probably *Carex pulicaris* or *C. capillaris*), variously treated so as to imitate saffron, have been found.

To complete the list of the above adulterations must be added the débris from the wood of campeche, and of *Rhus Cotinus*, ingeniously mixed and twisted together and impregnated with syrup, calcareous earth, chalk, glucose, and glycerine.

Sago—The fæcula (starch) from the stem of *Sagus lævis*, *S. Rumphii*, and perhaps of other species of palms.

The sago is obtained from the central or medullary part, commonly called pith, of the stems of several species of palm. When the tree is sufficiently mature it is cut down near the root and split perpendicularly. The medullary matter is extracted, reduced to powder, mixed with water, and strained through a sieve. From the strained liquid the starch is deposited, and after washing with water and drying, forms the *sago flour* or *meal* of commerce. Granulated sago is prepared from sago-flour by mixing it with water into a paste and then granulating. The starch of sago examined with the microscope is seen to consist of granules of considerable size and elongated form, being usually rounded at the larger end, and owing to the mutual pressure of the particles truncate at the other extremity. Sometimes the fucette is single, when the granules are more or less muller-shaped; in others there is a double fucette. The hilum when perfect is circular, but it is often cracked, when it appears as a cross-slit or star. Surrounding the hilum a few indistinct rings may usually be perceived. In some of the granules examined with the polariscope the particles usually exhibit a black cross, the hilum being the centre. In the granulated sago the starch granules are much larger and less regular, effects due to the heat employed in its preparation.—(HASSALL.) *See* fig. 74.

Fig. 74.

Sago is principally adulterated with potato-starch, this admixture may readily be detected by the microscope. *See* STARCH, &c.

Sainfoin (*Rhinanthus major* and *minor*, yellow rattle; natural order, *Scrophulariaceæ*)—This has been found in bread; it probably gets accidentally mixed with wheat. Bread containing sainfoin is described as having a bluish-black colour, a moist sticky feeling, and a disagreeable sweet taste; it is not known to be injurious.

Salicine ($C_{26}H_{18}O_{14}$ = 286)—Fusing-point, 248° F. (120° C.) Salicine is contained in the bark of most of the willows, and confers upon them their peculiar bitterness. It may be obtained by the cautious evaporation of the cold aqueous infusion of willow bark. It forms white silky needles and plates; is soluble in 5½ parts of water at 60°, and in much less at 212°; is insoluble in ether, but readily dissolves in alcohol. Heated in close tubes, it gives off acid vapours; when strongly heated, it is wholly dissipated; when kindled, burns with a bright flame, leaving a bulky charcoal.

Its solution is almost neutral to test-paper. Concentrated sulphuric acid causes it to agglutinate into resin-like lumps, with the accession of an intense blood-red colour. An aqueous solution mixed with some hydrochloric acid or dilute sulphuric acid, boiled for a short time, suddenly becomes turbid, and deposits saliritine under the form of a granular crystalline precipitate, which is its most characteristic reaction.

Salicylic Acid($HC_7H_5O_3$)—This substance presents itself in the form of needle-shaped crystals, sparingly soluble in water, devoid of odour, and free from unpleasant taste. Its only source until recently was the oil of wintergreen (*Gaultheria procumbens*), which consists almost entirely of salicylate of methyl; but lately it has been discovered that it may be produced artificially from carbolic acid by the action of carbonic acid on the former in the presence of caustic soda at a high temperature. Half of the carbolic acid passes over, and the other half becomes converted into salicylate of sodium, which upon decomposition by an acid yields salicylic acid. Although the acid itself is so sparingly soluble in water, it forms salts with soda, potash, &c., of great solubility. So far as is known it is not poisonous. From the experiments of Rolbe, Kiersch, and Godeffroy, it would appear that its disinfectant and antiseptic powers are great. According to Dr. Godeffroy (Pharmaceutical Journal, May 1, 1875), it is three times more powerful than carbolic acid in preventing fermentation; for 1 gramme of salicylic acid is capable of hindering the fermentative action of 18 grammes of yeast entirely; 36 grammes, fourteen hours; 72 grammes, one hour. And the same quantity of carbolic acid is capable of hindering the fermentative action of 5 grammes of yeast entirely; 17 grammes, twelve hours; 10 grammes, one hour.

The antiseptic and disinfectant properties of salicylic acid appear to be confined to the acid itself, and, so far as is at present known, are not shared by its salts.

Saliva—A slightly alkaline, thin, glairy liquid secreted from the parotid, sublingual, and submaxillary glands. The parotid secretion is the most watery, and the sublingual least so, while the consistence of the secretion from the submaxillary gland is intermediate between the two. *Ptyalin* is contained in these two latter secretions. Human saliva has a specific gravity of 1005, and the following is given as its composition:—

Water	995·16
Organic matter	1·34
Sulpho-cyanide of potash	0·06
Phosphate, soda, lime, magnesia	0·98
Chloride of sodium	0·84
Mixture of epithelium	1·62
	1000·00

As much as from 1 to 3 lbs. of saliva are secreted in the twenty-four hours. Its functions are to assist articulation, mastication, and deglutition. It assists the sense of taste, and it also carries oxygen to the stomach; but its greatest action is the conversion of starch first into *dextrine* and then into grape-sugar. This metamorphosis is accomplished by means of the *ptyalin*. One part of *ptyalin* will, according to Mialhe, convert 8000 parts of insoluble starch into soluble glucose. This is probably an exaggeration, but we know that 1 part of the ferment will convert 2000 parts of starch into sugar. Gastric juice is said to interfere with this conversion. Saliva has no action on fat or fibrine or albuminous bodies. An artificial saliva may be prepared from seeds which have sprouted or fermented, in which the diastase is abundant. *See* PTYALIN.

Salmon—The *Salmo salar* (Linn.) is a well-known, soft-finned, abdominal fish. Its normal locality is at the mouth or estuary of the larger rivers of the northern seas. In the summer months, during the breeding season, it ascends these rivers against all obstacles and deposits its spawn. The flesh of salmon approaches meat in redness, and in sustaining properties resembles it more closely than any other fish. Fatty matter is found incorporated with the muscular fibres, and there is also a layer of superficial fat beneath the skin; this is particularly abundant in the abdominal or thinner part of the fish. Salmon is not adapted to the delicate or dyspeptic, since it is rich, oily, and difficult of digestion. Pickled, salted, or smoked, it is excessively indigestible, and should only be taken by those possessing very strong assimilating powers.

Composition of Salmon.

Nitrogenous matter	16·1
Fat	5·5
Saline matter	1·4
Water	77·0
	100·0

Salt—*See* SODIUM.

Salting Provisions, &c.—The process of salting articles of food renders them hard and difficult of digestion, food which has been so treated should thereforo be avoided by the dyspeptic. An exception must, however, be made in the caso of bacon, which is usually more digestible thau pork or other pig-meat. For salt beef, *see* MEAT.

Saltpetre—Nitrate of potassium. *See* POTASSIUM.

Sanitary Authorities and **Sanitary Districts**—Tho whole of England (except the metropolis) and Ireland is divided into urban and rural sanitary districts, governed respectively by urban and rural sanitary authorities.

In England, an urban district and *urban authority* are, according to the Public Health Act, sect. 6, as follows:—

Urban District.	Urban Authority.
Borough constituted such either before or after the passing of this Act.	The Mayor, Aldermen, and Burgesses acting by the Council.
Improvement Act district, constituted such before the passing of the Public Health Act, 1872, and having no part of its area situated within a borough or Local Government district.	The Improvement Commissioners.
Local Government district constituted such either before or after the passing of this Act, having no part of its area situated within a borough and not coincident in area with a borough or Improvement Act district.	The Local Board.

Provided that—

1. Any borough, the whole of which is included in and forms part of a Local Government district or Improvement Act district, and any Improvement Act district which is included in and forms part of a Local Government district and any Local Government district which is included in and forms part of an Improvement Act district, shall for the purposes of this Act be deemed to be absorbed in the larger district in which it is included, or of which it forms part; and the Improvement Commissioners or local board, as the case may be, of such larger district, shall be the urban authority therein; and

2. Where an Improvement Act district is coincident in area with a Local Government district, the Improvement Commissioners, and not a local board, shall be the urban authority therein; and

3. Where any part of an Improvement Act district is situated within a borough or Local Government district, or where any part of a Local Government district is situated within a borough, tho remaining part of such Improvement Act district or of such Local Government district so partly situated within a borough shall for tho purposes of this Act continue subject to the like jurisdiction as it would havo been subject to if this Act had not been passed, unless and until the Local Government Board by provisional order othorwise directs.

For the purposes of the Public Health Act, the boroughs of Oxford, Cambridge, Blandford, Calne, Wenlock, Folkestone, and Newport, Isle of Wight, are not to be deemed boroughs. The borough of Cambridge is to be deemed to be an Improvement Act district, the borough of Oxford is to be included in the Local Government district of Oxford, and thero is a special provision in the case of the borough of Folkestone.

An English rural sanitary district and authority are thus defined (P. H., s. 9):—

The area of any uniou which is not coincident in area with an urban district, nor wholly included in an urban district (in this section called a rural union), with the exception of those portions (if any) of the area which aro included in any urban district, shall be a rural district, and the guardians of the union shall form the rural authority of such district: provided that—

1. An *ex-officio* guardian resident in any parish or part of a parish belonging to such union, which parish or part of a parish forms or is situated in an urban district, shall not act or vote in any case iu which guardians of such union act or vote as members of the rural authority, unless he is the owner or occupier of property situated in the rural district of a valuo sufficient to qualify him as an elective guardian for the union.

2. An elective guardian of any parish belonging to such uuion, and forming or being wholly included within an urban district, shall not act or vote in any case iu which guardians of such union act or vote as members of the rural authority.

3. Where part of a parish belonging to a rural union forms or is situated in an urban district, the Local Goverument Board may by order divide such parish into separate wards, and determine the number of guardians to bo elected by such wards respectively, in such manner as to provide for the due representation of the part of the parish situated within the rural district; but until such order has been made, the guardian or guardians of such parish may act and vote as members of the rural authority in the same manner as if no part of such parish formed part of or was situated in an urban district.

Where the number of elective guardians who are not by this section disqualified from acting and voting as members of the rural authority is less than five, the Local Government Board may from time to time by order nominate such number of persons as may be necessary to make up that number, from owners or occupiers of property situated in the rural district of a value sufficient to qualify them as elective guardians for the union; and the persons so nominated shall be entitled to act and vote as members of the rural authority, but not farther or otherwise.

Subject to the provisions of this Act, all statutes, orders, and legal provisions applicable to any board of guardians shall apply to them in their capacity of rural authority under this Act for purposes of this Act; and it is hereby declared that the rural authority are the same body as the guardians of the union or parish for or within which such authority act.

In Ireland, urban sanitary districts are—

The city of Dublin, other corporate towns above 6000, and towns or townships having commissioners under local Acts.

And *urban authorities* are—

In the city of Dublin, the Right Hon. the Lord Mayor, Aldermen, and Burgesses acting by the town council.

In towns corporate, the town council.

In towns exceeding 6000, having commissioners under the Lighting, Cleaning, and Watching Act of George IV.; or having municipal commissioners under 3 & 4 Vict. c. 108; or town commissioners under the Towns Improvement (Ireland) Act (17 & 18 Vict c. 103), the said commissioners, municipal or town commissioners, respectively.

In towns or townships having commissioners under local Acts, the town or township commissioners.—(37 & 38 Vict. c. 93, s. 3.)

The Irish rural sanitary districts and authorities are exactly analogous to the English.

In Scotland sanitary powers are exercised by town councils, police commissioners, and parochial boards, controlled and supervised by a Board of Supervision, but the names of urban and rural sanitary authorities have not yet been applied to them.

Under the English Public Health Act there may also be formed *united districts;* for example—

Where, on the application of any local authority of any district, it appears to the Local Government Board that it would be for the advantage of the districts, or any of them, or any parts thereof, or of any contributory places in any rural district or districts, to be formed into a united district for all or any of the purposes following,

1. The procuring a common supply of water; or
2. The making a main sewer or carrying into effect a system of sewerage for the use of all such districts or contributory places; or
3. For any other purposes of this Act;

the Local Government Board may, by provisional order, form such districts or contributory places into a united district.

All costs, charges, and expenses of and incidental to the formation of a united district are, in the event of the united district being formed, to be a first charge on the rates leviable in the united district in pursuance of P. H., s. 279.

Notice of the provisional order must be made public in the locality; and should the union be carried out, the incidental expenses thereto are a first charge on the sanitary rates of the united district. A united district is governed by a joint board consisting of such *ex-officio*, and of such number of elective, members as the provisional order determines. The business arrangements of the joint board differ little from those of a sanitary authority. The rules applicable to meetings of a joint board will be found in article COMMITTEES. The joint board is a body corporate, having a name—determined by the provisional order—a perpetual succession, and a common seal, and having power to acquire and hold lands without any licence in mortmain. The joint board has only business and power in matters for which it has been formed. With the exception of these special objects, the component districts continue as before to exercise independent powers. Nevertheless, the joint board may delegate to the sanitary authority of any component district the exercise of any of its powers, or the performance of any of its duties.—(P. H., s. 281.)

Sanitary authorities and districts may be also combined for the execution and maintenance of works (*see* WORKS), for the prevention of epidemic diseases (*see* EPIDEMIC), as well as for the purpose of appointing a medical officer of health (*see* MEDICAL OFFICER OF HEALTH.) Districts when once formed are not fixed and invariable, the Local Government Board having the most extensive powers over the *alterations of areas.*

1. The Local Government Board, by provisional order, may dissolve any Local Government district, and may merge any such district in some other district, or may declare the whole or any portion of a Local Government or a rural district immediately adjoining a Local Government district to be included in such last-mentioned district, or may declare any portion of a Local Government district im-

mediately adjoining a rural district to be included in such last-mentioned district; and thereupon the included area shall, for the purposes of the Public Health Act, be deemed to form part of the district in which it is included in such order; and the remaining part (if any) of such Local Government district or rural district affected by such order, shall continue subject to the like jurisdiction as it would have been subject to if such order had not been made unless and until the Local Government Board by provisional order otherwise directs.

2. In the case of a borough comprising within its area the whole of an Improvement Act district, or having an area coextensive with such district, the Local Government Board, by provisional order, may dissolve such district, and transfer to the council of the borough all or any of the jurisdiction and powers of the Improvement Commissioners of such district remaining vested in them at the time of the passing of the Public Health Act.

3. The Local Government Board may *by order* dissolve any special drainage district constituted either before or after the passing of the Public Health Act, in which a loan for the execution of works has not been raised, and merge it into the parish or parishes in which it is situated; but in the cases where a loan has been raised, the Local Government Board can only do this by *provisional order*. —(P. H., s. 270.)

Disputes with regard to the boundaries of districts are to be settled by the Local Government Board after local inquiry.—(P. H., s. 278.)

Where districts also are constituted for the purposes of main sewerage only, in pursuance of the Public Health Act, 1848, or where a district has been formed subject to the jurisdiction of a joint sewerage board, in pursuance of the Sewage Utilisation Act, 1867, such districts or district may be dissolved by provisional order, and the Local Government Board may constitute it a united district subject to the jurisdiction of a joint board.—(P. H., s. 323.)

For expenses of joint board, *see* EXPENSES.

The Local Government Board may also declare by provisional order any rural district to be a Local Government district. *See* LOCAL BOARDS.

The Local Government Board has also the important power of investing a rural authority with urban powers, as follows:—

"The Local Government Board may, on the application of the authority of any rural district, or of persons rated to the relief of the poor, the assessment of whose hereditaments amounts at the least to one-tenth of the net rateable value of such district, or of any contributory place therein, by order, to be published in the 'London Gazette' or in such other manner as the Local Government Board may direct, declare any provisions of this Act in force in urban districts to be in force in such rural district or contributory place, and may invest such authority with all or any of the powers, rights, duties, capacities, liabilities, and obligations of an urban authority under this Act, and such investment may be made either unconditionally or subject to any conditions to be specified by the board as to the time, portion of its district, or manner during, at, and in which such powers, rights, duties, liabilities, capacities, and obligations are to be exercised and attach: provided that an order of the Local Government Board made on the application of one-tenth of the persons rated to the relief of the poor in any contributory place shall not invest the rural authority with any new powers beyond the limits of such contributory place."—(P. H., s. 276.)

Powers and Duties of Sanitary Authorities. —In England, urban sanitary authorities have very extensive powers and duties under the Public Health Act, 1875; and in addition, they have to carry out the Bakehouse Regulation Act, and the Artisans' and Labourers' Dwellings Act.

They also have power to adopt the Baths and Wash-houses Acts, and the Labouring Classes' Lodging-Houses Acts; but where adopted or in force, the powers, rights, duties, &c., of these Acts belong to the urban authority. The powers of any local Act for sanitary purposes (except a River Conservancy Act) are transferred to the urban authority.

The powers of an English rural authority are exercised principally under the Public Health Act, but they have also to carry out the Bakehouse Regulation Act.

The powers given by the Irish Public Health Act to Irish sanitary authorities are similar. The Local Government Act is not in force there, and equal powers are given without distinction to urban and rural sanitary authorities.

The duties of sanitary authorities are to carry out the Acts which apply to them, and appoint certain officers, such as medical officers of health, inspectors of nuisances, clerk, treasurer, &c.

Speaking generally, all sanitary authorities have ample powers for health purposes. They can carry out, and it is their duty to do so, works of drainage, sewerage, and water-supply. In towns they have the control of the streets and houses, both private and public; in all places they have ample powers to repress every species of nuisance which is at all likely to injure health, and on the outbreak of infectious disease they are given many facilities to prevent its spread.

Provision is made by the Public Health Act to meet the case of an authority which neglects to do its duty. In such a case the Local Government Board has compulsory powers, and may compel the due performance of whatever is required. *See* LOCAL GOVERNMENT BOARD, LOANS, &c.

Sanitary Legislation—The following are the dates of the chief sanitary laws:—

First sanitary law in the statute-book imposing a penalty of £20 upon persons casting filth and refuse into ditches (12 Richard II.)	1388
Repealed in 1856.	
An Act to Prohibit Slaughtering of Cattle in Boroughs (4 & 5 Henry VII.) . . .	1489
Repealed 1856.	
The Statute of Sewers, authorising the issue of Commissions of Sewers. The duties of the Commissions were (within the particular district) overlooking sea banks and walls, cleansing rivers, public streams, and ditches (23 Henry VIII. c. 5) . . .	1532
Quarantine Act (6 Geo. IV. c. 78) . .	1825
Lighting and Watching Act (3 & 4 Will. IV. c. 90)	1833
Municipal Corporations Act (5 & 6 Will. IV. c. 76)	1835
An Act under which the Registrar-General of Births, Deaths, and Marriages was appointed (6 & 7 Will. IV. c. 76) . . .	1836
Vaccination Act (3 & 4 Vict. c. 29) . .	1840
,, ,, (4 & 5 Vict. c. 32) . .	1841
Nuisance Removal and Diseases Prevention Act (9 & 10 Vict. c. 96)	1846
It was to expire in 1848.	
Towns Improvement Clauses Act (10 & 11 Vict. c. 34)	1847
The Public Health Act (11 & 12 Vict. c. 63).	1848
Generally considered as the groundwork of our sanitary legislation.	
Establishment of General Board of Health .	1848
The Second Nuisance Removal and Diseases Prevention Act, in substitution of the first, which was to expire (11 & 12 Vict. c. 123)	1848
Amended in 1849.	
Reconstruction of General Board of Health.	1854
Repeal of Nuisance Removal Acts of 1848 and 1849, and substitution of Consolidated Nuisance Removal Act (18 & 19 Vict. c. 121)	1855
Diseases Prevention Act (18 & 19 Vict. c. 116)	1855
General Board of Health expires . .	1858
Its powers vested in the Privy Council (21 & 22 Vict. c. 97)	1858
Local Government Act (21 & 22 Vict. c. 98)	1858
Nuisance Removal Amendment Act (23 & 24 Vict. c. 77)	1860
Local Government Amendment Act (24 & 25 Vict. c. 61)	1861
Local Government Amendment Act (26 & 27 Vict. c. 17)	1863
Nuisance Removal Amendment Act (26 & 27 Vict. c. 117)	1863
Sewage Utilisation Act, applying to England, Scotland, and Ireland (28 & 29 Vict. c. 75)	1865
First Sanitary Act (29 & 30 Vict. c. 90) .	1866
Public Health (Scotland) Act (30 & 31 Vict. c. 101)	1867
Sewage Utilisation Act (30 & 31 Vict. c. 113)	1867
Second Sanitary Act (31 & 32 Vict. c. 115) .	1868
Sanitary Loans Act (32 & 33 Vict. c. 100) .	1869
Third Sanitary Act (33 & 34 Vict. c. 53) .	1870
Public Health (England) Act (35 & 36 Vict. c. 79	1872
Registration of Births and Deaths Act (37 & 38 Vict. c. 88)	1874
Public Health Amendment Act (Sanitary Laws Amendment Act) (37 & 38 Vict. c. 89)	1874
Public Health (Ireland) Act (37 & 38 Vict. c. 93)	1874
Public Health (England) Act (38 & 39 Vict. c. 55)	1875

There are also a number of subsidiary and special Acts bearing on, and more or less intimately connected with, public health, such as the Burial, Highway, Factory, Labourers' and Artisans' Dwellings, Sale of Food and Drugs, Pharmacy, Alkali, Smoke, Public Works, Loan, and Local Authorities Loan Acts, references to all of which will be found under their respective headings.

Sanitation—*See* HYGIÈNE.

Santonine ($C_{15}H_{18}O_3$, HELDT)—The crystalline and characteristic principle of several varieties of *Artemisia.* It consists of prismatic or tabular crystals, tasteless, inodorous, fusible, volatilisable; soluble in 4500 parts of cold and about 250 parts of boiling water; soluble in cold alcohol and ether; freely soluble in hot alcohol. Tannic acid and the chloriodide of potassium and mercury do not precipitate solutions of santonine. Sulphuric acid has no effect on it. The crystals acquire a brilliant yellow colour on exposure to sunlight without undergoing any change of form.

Santonine is a very useful anthelmintic, and is much used in the treatment of the round worm especially. It has a peculiar action on the brain, causing objects to appear yellow or green.

Several most lamentable accidents have occurred lately from dispensers mistaking strychnine crystals for santonine.

Saponification—The dead body sometimes becomes converted into a substance called *adipocere.* This process of conversion is termed saponification. Fourcroy first observed and described *adipocere* (*adeps*, fat; *cera*, wax), and so named this substance from its properties being intermediate between those of wax and fat. Chevreul made an examination of it, and found it to be a real ammoniacal soap, with some extraneous colouring matter, a bitter substance, and an odoriferous principle. He also detected in some specimens lime, potash, and salt. It is highly probable that the fibrine undergoes slow changes perfectly analogous to that of the caseine in cheese, so admirably investigated by Blondeau, and detailed in the article on cheese. *See* CHEESE.

The composition of adipocere is not constant, and it is liable to vary according to the nature of the medium to which the body has been exposed.

Neither pure fat nor pure fibrine, when kept apart, will become saponified; for the formation of adipocere it is indispensable that the animal fat should be in contact with substances containing nitrogen.

Every part of the body may undergo this transformation, and when the change is complete the body maintains its condition for many years. This process takes place most readily—(1.) In the bodies of young persons, the fat being chiefly external and very abundant. (2.) In those adults whose bodies abound in fat. (3.) In bodies exposed to the soil of water-closets. (4.) In those immersed in water, but somewhat less rapidly in stagnant than in running water. (5.) Readily in humid and fatty soils, especially in grave-yards, where numerous bodies have been piled in contact with each other, those situated at the lowest level becoming soonest saponified. —(TAYLOR.) The period required for saponification varies greatly. A body floating in water has been found converted into this adipocerous state in a little more than five weeks, but four or five years may elapse before the process is completed, all depending on the conditions under which the body is placed.

Sardines—The pilchard (*Clupea pilchardis*) is the sardine of commerce.

The fish are preserved in oil in hermetically-sealed tin boxes. The process is conducted on a large scale on the coast of Brittany. The fish are first washed in sea-water, then their heads are taken off and the intestines removed; they are then again washed, dried, and next immersed for a brief period in boiling oil; and lastly placed in tin boxes, which are exposed to a steam heat, and hermetically sealed.

Sardines are characterised by fatty matter incorporated with the flesh, and are consequently highly nutritious.

Sprats and other small fish are frequently substituted for or mixed with sardines.

Sauerkraut—The leaves of white cabbages, deprived of their stalk and midrib, cut into small pieces, and packed in a tub or vat in alternate layers of salt. They are then pressed and allowed to remain until lactic fermentation is set up and the mass becomes sour. Sauerkraut is used by the Germans and other northern nations of Europe extensively, instead of fresh vegetables, in winter.

Sausages—Diseased and unwholesome meat is frequently, especially in large towns, employed for the manufacture of sausages; and quantities of putrid and diseased pork, beef, &c., are weekly seized in London "on the way to the sausage-maker." Nor is this all, for many of the more enterprising of the manufacturers add horse-flesh, which practice cannot be too strongly condemned; although it must be allowed that good healthy horse-flesh is certainly preferable to diseased pork or decomposed beef.

Mr. Richardson, officer of the local board of health of Newton Heath, near Manchester, in his evidence some years ago before the Committee of Adulteration, said: "We have in Newton five knackers' yards, and there is only one in Manchester. The reason is, that they have so much toleration in Newton; and it has been a source of great profit to them, because they have the selling of the best portions of the horse-flesh to mix with potted meats. I can say for a fact that the tongues of horses particularly, and the best portions (such as the hind quarters of horses), are generally sold to mix with collared brawn—or pigs' heads, as they are called with us—and for sausages and polonies. I understand also, from those who have been in the habit of making them, that horse-flesh materially assists the making of sausages; it is a hard fibrine, and it mixes better, and it keeps them hard, and they last longer in the shop window before they are sold, because otherwise the sausages run to water and become soft and pulpy. I believe horse-flesh also materially assists German sausages; it keeps them hard."

Sausages bought in large towns in the usual way can *never be depended upon*, and it is surprising, considering the cheapness of sausage-making machines, and the ease with which they can be prepared, that such articles are not more generally manufactured at home.

Sausages, and more particularly the large sausages of Germany, frequently become poisonous from the development of a peculiar substance, the nature of which is at present unknown. Many believe it to be a rancid fatty acid produced during decomposition of the meat; others, that acrid pyrogenous acids are produced during the drying and smoking of the sausages; and some, again, that a poisonous organic alkaloid is developed during the decay of these articles.* Liebig ascribes the effects to an animal ferment; and M. Vanden Corput, one of the latest observers,

* This is not improbable, *see* note, p. 365.

tells us that the poisonous effects of sausages are due to a fungus of the nature of a sarcina, or what he calls *Sarcina botulina.* Subsequent observations have to a slight extent confirmed this view, since it is always noticed that in sausages so affected a peculiar mouldiness is present, and the poisonous property is usually observed in April, when these cryptogamic organisms are most active.—(Letheby, Chemical News, February 1869, and "Food.")

Dr. Taylor, however, carefully examined a slice of a sausage which had caused the death of a child, and did not detect a poisonous principle of any kind; but he does not state whether fungi were looked for.—(Principles of Jurisprudence, vol. i. p. 341.)

With regard to the symptoms of sausage-poisoning, in sixty-six cases which occurred at Kingsland (British and Foreign Medical Review, January 1860, p. 197), the symptoms were those of a narcotic irritant poison. One man died comatose, but the *post-mortem* inspection only showed inflammation of the lower end of the small intestine and distention of the gall-bladder. Nothing of a poisonous nature could be discovered in the food or the body.

The disease in question has been more often observed in Germany than in England. Four hundred cases of sausage-poisoning are stated to have occurred in Wurtemburg alone during the last fifty years, and of these 150 have been fatal.

A writer in a popular journal, speaking on sausages, recently affirmed that in London the best sausages were obtained from shops the proprietors of which did not object to selling to their customers *sausage-meat;* and that sausages obtained from those places where a request for a small quantity of such meat was met with a refusal were invariably bad.

A pea sausage was largely used by the Germans in the Franco-Prussian war. It was made by mixing pea-flour and fat pork with a little salt; and contained in 100 parts, 16·2 of water, 7·19 of salts, 12·297 of albuminates, 33·65 of fat, and 30·663 of carbo-hydrates. It is ready cooked, but can be made into a soup.

Savin—The fresh and dried tops of *Juniperus Sabina*, collected in spring from plants cultivated in Britain. These tops owe their activity to the volatile oil ($C_{10}H_{16}$), specific gravity, ·915; besides which, a *resin*, gallic acid, and the ordinary ingredients of young tops are present. The *fresh tops* consist of the young branches enveloped in minute imbricated appressed leaves, in four rows of a dark green colour, strong and peculiar disagreeable odour and taste. The tops can be detected when in coarse powder by means of the microscope, as the woody fibres exhibit the circular pores which characterise the gymnosperms.

This substance is used as a popular abortive, and has on several occasions proved fatal. It acts by producing violent pain in the abdomen, vomiting, and strangury. After death the gullet, stomach, and intestines, with the kidneys, have been found much inflamed or congested. It acts as an abortive by giving a violent shock to the system, under which the uterus may expel its contents. The means relied upon for the detection of savin are the odour evolved when the powder is distilled or boiled with water, and the microscopic characters.

Scammony—The gum - resin emitted from the cut root of *Convolvulus Scammonia* (Linn.), or Aleppo scammony plant. It occurs in masses irregular in shape and size, of a blackish-green colour, covered with a fine powder, porous, brittle, with a shining fracture. It is easily triturated, and forms an emulsion with water. It has a musty odour, and makes a lather when rubbed on the surface with water. The taste is nauseous and acrid after a few minutes. Hydrochloric acid dropped upon it emits no bubbles, nor does the powder digested in water at a heat of 170° F. become blue when iodide of potash and dilute nitric acid are simultaneously added. Out of 100 grains, 78 should be soluble in ether. The tincture of pure scammony is not turned green by nitric acid.

Scammony consists chiefly of a resin, sometimes in the form of a glucoside, sometimes in part as a resinous acid; the latter is soluble in ammonia. Scammony resin is soluble in alcohol and ether, but precipitated from its solution on the addition of water.

With water or saliva, scammony yields a milky fluid. It readily takes fire and burns with a yellowish flame. The following are the results of three analyses of the same number of samples of scammony by Dr. Christison:—

Pure Scammony.

	Old.	Old.	Moist.
Resin . . .	81·8	83·0	77·0
Gum . . .	6·0	8·0	6·0
Starch (fecula) .	1·0	...	...
Lignin and sand .	3·5	3·2	5·0
Water . . .	7·7	7·2	12·6
	100·0	101·4	100·6

There are three principal varieties or qualities of scammony known in the market—viz., *virgin* (specific gravity, 1·21), *seconds* (specific gravity, 1·460 to 1·463), and *thirds* (specific gravity, 1·465 to 1·500). The virgin scammony is the only kind which ought to be used in medicine. The powder of the virgin scammony examined with a ¼ - inch object-glass is observed to consist of numerous angular and resinous fragments of a greyish-brown colour, and of variable size, which are blackish or even quite black. These are best seen when the powdered scammony is viewed as an opaque object. In the residue left after the removal of the resin by sulphuric ether, considerable quantities of vegetable tissue, cellular tissue, woody fibre, fragments of spiral vessels, and stellate cells may frequently be detected by the microscope.

Adulterations.—Scammony is largely adulterated in the country of its production, and again on its arrival in England. The following substances are generally used for this purpose: chalk, starch, guaiacum, jalap, colophony, dextrine, gum tragacanth, bassorine, sand, and sulphate of lime.

Detection of Adulterations.—Jalap resin is insoluble in ether and oil of turpentine; digested in a watch-glass with oil of vitriol, a crimson-coloured solution is obtained.

Guaiacum.—A piece of paper moistened with the tincture becomes blue when exposed to nitrous acid fumes.

Starch may be detected by the microscope and by the iodine test. Corrosive sublimate with almond soap produces a blue colour, and if a solution of ammonia be mixed with any substance containing guaiacum, a very frothy liquid is the result.

Resin is dissolved by turpentine, which has a very slight action upon scammony. Sulphuric acid dropped upon resin *immediately* reddens it, whereas dropped upon scammony this red colouration is only produced after some minutes. The odour also of resin is very perceptible when scammony adulterated with it is triturated in a mortar.

Dextrine and *starch* may be detected by the microscope and the addition of iodine.

The inorganic adulterations will be easily detected by an examination of the ash.

Scarlet Fever—*See* FEVER, SCARLET.

Scavenging, Removal of Refuse—A proper disposal of refuse is as necessary in the case of an isolated country-house as in that of an urban dwelling. In the former case, where there is a garden there can be no difficulty about the matter, nor should there be any nuisance. The refuse—such as potato-parings, cabbage-stalks, ashes, and other solid débris—is used upon the garden, and in the meantime stored for use at a distance from the house in a water-tight, covered, ventilated receptacle, the grand rule to be kept in mind being that household refuse *must be kept dry*, and must be stored in small quantities only. The place for storing refuse is usually called an ashpit. A proper ashpit for an ordinary house should not be too large: it should have a proper sloping cover, fitting tightly, so as not to admit any rain; the bottom should be so constructed as to be perfectly dry, and there should be a small ventilating-pipe communicating with the interior.

The most difficult cases with regard to the disposal of refuse are villages where a house, and often a whole block of houses, have no back door nor any yard whatever, and the rest of the village so well provided in this respect that the appointment of a scavenger for the whole place is out of the question. In such a case the owner or owners should contrive to get a place where a common ashpit could be built for the whole, and the occupiers by subscribing a small sum could have this periodically emptied. This voluntary action failing, the sanitary authority have power to build a proper receptacle, and make bylaws, casting upon the occupier the duty of removing his refuse at certain intervals.

Another difficult case, which as it has actually occurred in the author's district, and as there may be others analogous to it, it may be of use to mention, is that of a small fishing hamlet situated close to the sea, whilst behind and on all sides arise precipitous rocks. Few of the houses in the place alluded to had any yards at the back whatever. The refuse itself was extremely offensive, consisting of the débris of fish. Removal by horses and carts was out of the question, and as it was a most romantic spot, visited by thousands, it was important that a good system of scavenging should be adopted. The difficulties were met by the erection of public ash-receptacles and the appointment of a scavenger, who by means of donkeys conveyed the refuse half a mile from the place to be utilised on the land.

In houses with deficient back premises most of the offensive refuse, especially that of a vegetable nature, can be thrown on the back of the kitchen fire, and allowed to smoulder harmlessly away; but these simple remedies dirty and careless people are slow to adopt.

It may be laid down that in all rural villages or places under the jurisdiction of rural authorities, there are at least two cases in which either a scavenger should be appointed, or at all events arrangements made for the removal of refuse by any of the legal provisions given at the end of this article—

1. Where any general nuisance arises from a want of facility for the removal of refuse.

2. In places sparsely populated during the winter, but which are in summer places of fashionable resort.

On the other hand, in places where there is every facility for the occupier to deal with his refuse, it is better to cast upon him the burden of dealing with it; but even in that case, villages of any size will require strict supervision by the local authority, and arrangements must be made for the cleansing of the streets, the removal of matters from the gratings which might choke the drains, and frequent inspection of the traps.

As for towns, scavenging of a public nature is one of those essential things so obvious as to need scarcely any notice. The urban authority should see that the ashpits are properly constructed, and that in those cases where, from past unhappy errors of construction, there are no other means of removing all kinds of refuse, including excretal matter, than by hand, the pails, buckets, or boxes are so made that when placed in the street awaiting the arrival of the scavenger no nuisance arises.

Scavenging of an offensive nature—such as the emptying of cesspools, the cleansing of privies, the removal of manure—should not be allowed to be effected except between the hours of 10 P.M. and 6 A.M. Ordinary removal of dust and daily refuse should be permitted at any time except between 9 A.M. and 10 P.M.

The place where street-sweepings, dust, &c., are deposited should be carefully selected by the local authority.

Dust-carts, &c., should have a bell attached to them, and those who have anything which requires removal should put a card in the window with the letter D upon it.

The scavengers should be paid by the local authority; nor should they be allowed, as they frequently are, to *extort* money in addition to their wages from those who require their services.

It is not lawful to erect or rebuild a house without an ashpit furnished with proper doors and coverings. Penalty for default, £20 or less.—(P. H., s. 35.) And if a house appears to be without a proper ashpit, the local authority is to give notice to the owner or occupier to provide the same. In default the authority may do the work, recovering the expenses summarily.—(P. H., s. 36.)

Provision is also made that houses used or *intended* to be used as a factory shall have a proper ashpit in which to deposit refuse. Penalty for neglect of notice £20, and 40s. per day during default.—(P. H., s. 38.)

Every local authority may, and when required by order of the Local Government Board shall, themselves undertake or contract for—

The removal of house refuse from premises;
The cleansing of earth-closets, privies, ashpits, and cesspools;

either for the whole or any part of their district: moreover, every urban authority and any rural authority invested by the Local Government Board with the requisite powers may, and when required by order of the said board shall, themselves undertake or contract for the proper cleansing of streets, and may also themselves undertake or contract for the proper watering of streets for the whole or any part of their district.

All matters thus collected by the local authority or contractor may be sold or otherwise disposed of, and any profits thus made by an urban authority shall be carried to the account of the fund or rate applicable by them for the general purposes of the Public Health Act; and any profit thus made by a rural authority in respect of any contributory place shall be carried to the account of the fund or rate out of which expenses thus incurred by that authority in such contributory place are defrayed.

If any person removes or obstructs the local authority or contractor in removing any matters thus authorised to be removed by the local authority, he shall for each offence be liable to a penalty not exceeding *five pounds*: provided that the occupier of a house within the district shall not be liable to such penalty in respect of any such matters which are produced on his own premises and are intended to be removed for sale or for his own use, and are in the meantime kept so as not to be a nuisance.—(P. H., s. 42.)

Where the local authority do not themselves undertake or contract for—

The cleansing of footways and pavements adjoining any premises,
The removal of house refuse from any premises,
The cleansing of earth-closets, privies, ashpits, and cesspools belonging to any premises,

they may make bylaws imposing the duty of such cleansing or removal, at such intervals as they think fit, on the occupier of any such premises.

An urban authority may also make bylaws for the prevention of nuisances arising from snow, filth, ashes, and rubbish, and for the prevention of the keeping of animals on any premises so as to be injurious to the public health.—(P. H., s. 44.)

Any urban authority may, if they see fit, provide in proper and convenient situations receptacles for the temporary deposit and collection of dust, ashes, and rubbish; they may also provide fit buildings and places for the deposit of any matters collected by them in pursuance of the Public Health Act.—(P. H., s. 45.)

If a local authority who have themselves undertaken or contracted for the removal of house refuse from premises, or the cleansing of earth-closets, privies, ashpits, and cesspools fail, without reasonable excuse, after notice in writing from the occupier of any house within their district requiring them to remove any house refuse or to cleanse any earth-closet or privy, belonging to such house or used by the occupiers thereof, to cause the same to be removed or cleansed, as the case may be, within seven days, the local authority shall be liable to pay to the occupier of such house a penalty not exceeding five shillings for every day during which such default continues after the expiration of the said period.—(P. H., s. 43.) *See* SEWAGE, DISPOSAL OF; SLOPS, &c.

Scents—*See* PERFUMES.

Schools, School Hygiène—The hygiène of schools is naturally subdivided into (1) the school itself as regards site, construction, &c.; and (2) the effect of school influences upon the children.

1. *Site, Construction, &c.*—In the matter of site, space is of the first importance; but, on the other hand, schools are essential in the most crowded parts of our cities, where suitable positions are difficult to obtain, and the enormous sum required to purchase ground of necessity frequently limits the space on which the school stands to a narrow strip. Here there only appears one remedy—that is, to build schools for poor children in suburban sites, and run free trains or coaches to them.

The most important part of a school is the schoolroom. The Privy Council have laid down certain rules as to minimum of space and the sanitary conditions of schoolrooms; for example, no school is entitled to receive any annual grant from this source unless it is held "in a building certified to be healthy, properly lighted, drained, and ventilated, supplied with offices, and containing in the principal schoolroom at least 80 cubical feet of internal space for each child in average attendance." On this point Dr Smith very properly remarks, "It is stated, and will not be denied, that a school cannot be properly worked, nor the children assembled in class, with a less amount of floor space; but it seems to me quite below what is desirable. I find that a boy's seat and desk require 4 square feet; and space in a class, at least 3 square feet per boy. But so far as space is concerned, the worst parts of most schools are the galleries or raised tiers of seats in which the infants are placed, as closely packed as flower-pots in a greenhouse."

The recent legislation on education, and the compulsory construction of new schools, with the enlargement of others, have greatly altered the aspects of the question. All public schools are now bound to have sufficient space, and properly constructed schoolrooms and offices. It is a question whether the actual cubic space, even in the best constructed schools, is sufficient, for it requires a perfect system of ventilation to keep the air sweet and pure. There are few schools in this country in which the air during class-time is not unpleasantly stuffy and disagreeable; and in a recent paper on school hygiène

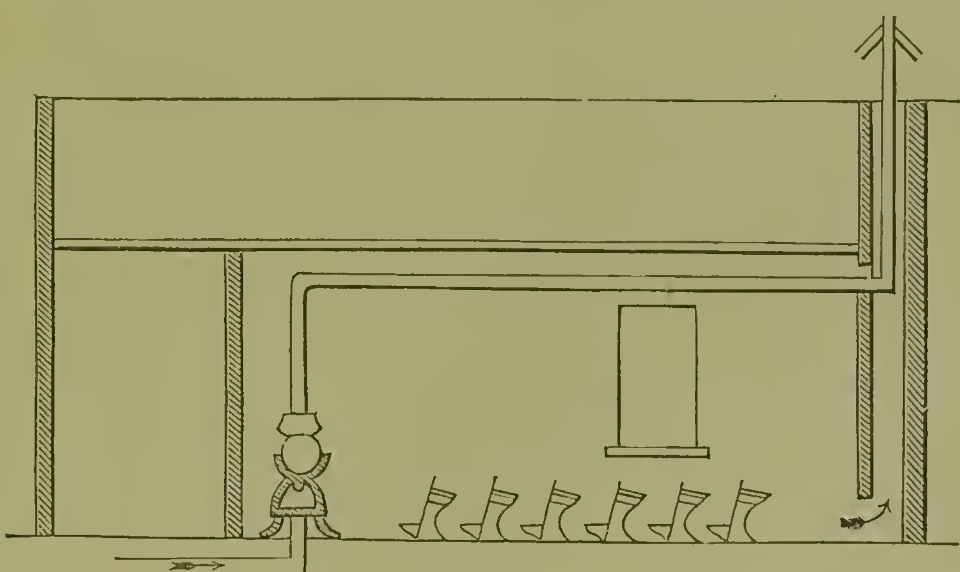


Fig. 75.

(Fifth Annual Report of the State Board of Health, Massachusetts), we find that in America the same defect is noticed, with some few exceptions. The principles on which schools should be ventilated are considered under VENTILATION. Fig. 75 will, however, show the excellent system devised by Mr. Mott, by which a constant current of warm air is maintained, and the products of respiration, &c., are rapidly carried away up the shaft shown in the figure, while at the same time there is no perceptible draught.

School Offices.—The offices consist of (1) the staircase; (2) the cloak-room; (3) the latrines; (4) the lavatory.

The *staircase* should be spacious, well ventilated, and the banisters provided with obstacles at equal distances to prevent the children from sliding down the rail.

The *cloak-room* is a very important appendage. In some schools the clothes are put in an indiscriminate heap into a basket, or into a dark closet. The result of heaping together a mass of foul garments may easily be imagined. Zymotic disease is propagated, vermin engendered, and the clothes acquire a disagreeable odour. It is of the greatest importance that every school should have a proper place in which clothes may be separately hung up and orderly arranged.

The *latrines.* It is a false economy to be niggardly in expense with regard to the latrines. As each child, as a matter of fact, either from necessity or more often as an excuse, pays a visit during each school-time to the closet, this part of the establishment should be as perfect as possible. Water-closets do not appear to answer. The earth system for schools is probably the best, as the requisite attention can always be given. In any town, however, where the Liernur system of sewage removal may hereafter be in operation, the pneumatic privies will leave nothing to be desired. *See* SEWAGE.

The *lavatory.* There certainly should be a lavatory to every school, even to day-schools. This should, of course, have a plentiful supply of water for washing and drinking purposes, and especial care should be taken that the water is pure. Many of the poorer children really require to be taught practical cleanliness, which at their own homes is almost impossible.

The *play-ground* should have no unhealthy surroundings. It should be as ample as possible, and every facility given to gymnastic exercises, especially those of a light character. No gymnastic exercises, such as marching or drilling, should be allowed in the school-room, as clouds of dust are necessarily raised, which cannot fail to be injurious.

The hours of study in all elementary schools should not be too long. The experience of the *half-time system*, which is a name given to a method of schooling provided by law for children employed in factories and workshops, and which secures to such children half the number of hours spent by children not at manual work in public schools, shows that these half-time scholars learn quite as much as the children who are in the same schools twice as many hours a day, and every practical teacher must know that a child who is in school six hours seldom really studies more than half that time. There cannot be a doubt that four hours a day is ample in elementary schools. More advanced and older scholars might study six without injury. All lessons should be learned in school, none taken out to be studied at home on any consideration.

2. *School-Life, Influences of.*—School-life is not without its evils. Even apart from those general insanitary conditions found in many schoolrooms, there are special influences which appear to exhaust themselves on the osseous and nervous systems principally. The third question of the State Board of Health bears upon this point, the question and summary of the answers were as follows:—

"Question III. Is the injury most apt to fall on the osseous, the respiratory, the digestive, or the nervous system?

"Answered substantially as follo s:—

'On the osseous system,' by . . .	1
'On the osseous system, between fifth and eighth year,' by	1
'On the osseous system, before puberty,' by	1
'On the respiratory system,' by . . .	2
'On the respiratory system in boys,' by .	1
'On the respiratory system after fifteenth year,' by	1
'On the digestive system,' by . . .	1
'On the digestive system in boys,' by .	1
'On the nervous system,' by . . .	95
'On the nervous system before fifteenth year,' by	1
'On the nervous system after puberty,' by.	1
'On osseous and nervous systems,' by .	3
'On osseous, respiratory, and nervous,' by	2
'On respiratory and nervous,' by . .	14
'On digestive and nervous,' by . . .	15
'On neither system,' by	4
'Uncertain,' by	7"

One of the most interesting answers was that of Dr. Buchanan, who says:—

My attention has been directed for several years to the effects of position in schools upon the *spinal column.* I was first induced to notice it in our high-school girls, from the fact that they could be pointed out from grammar-school girls of the same age by their awkward attitude and swinging step, and I was led to trace it to some cause satisfactory with theory. I found in the high-school that the desk was placed so far from the seat, in order that they might have room between seat and desk to stand during recitation, that they could not rest their books upon the desk without leaning forward to study, which fully accounted for the stooping and rounding of the spine and shoulders in six months after leaving the grammar school—which they did on an average at the age of twelve and a half years.

After a contention of a year against the objections of teachers and some of the committee, I succeeded in having the desk placed near enough to the seat to allow the pupil to rest the book with ease while sitting erect; and in another six months the effect was apparent in all classes, as one could select by the difference of form those who were admitted before and after the change.

I have also investigated the cause of so much awkwardness of position of the pupils while in

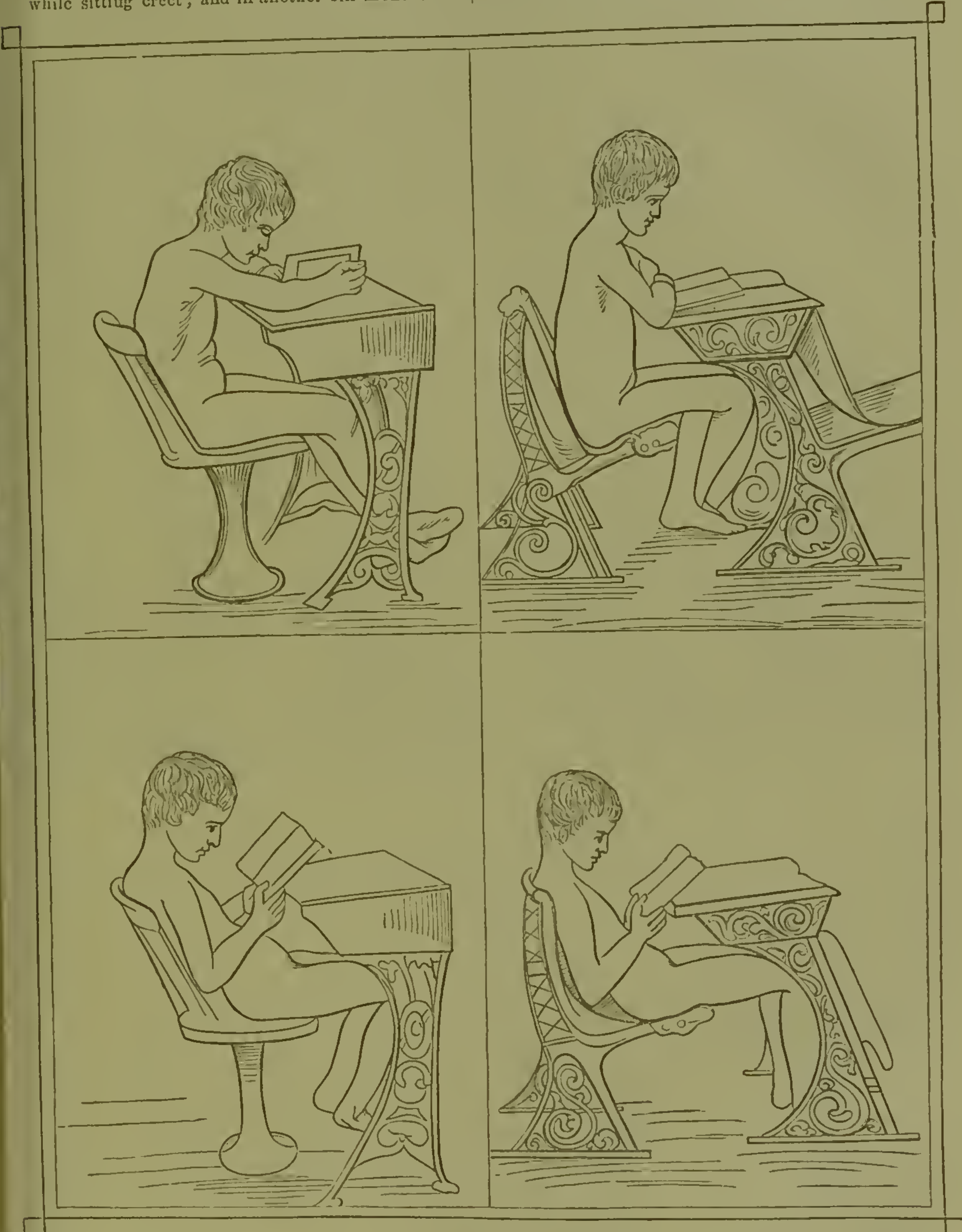


Fig. 76.

their seats in the primary schools, where but little care is taken in the making of small seats. In our schools they are but little better than a smooth board, and support only a very small surface (over the tuberosity of the ischium) on either side, and an inch or two of the thigh. This small surface soon grows painful, and then the children fall into all sorts of shapes to relieve the pressure over so small a surface. I then noted some of the common attitudes of the children after they had been in their seats for half an hour or more, and had a measure taken of their legs under the knee (which was done by an instrument constructed for the purpose, so that the whole school could be measured as fast as the figures could well be made), and this compared with the height of the chair.

Now, in order to prove the effect upon the muscles, and also to show the curvature of the spine, a boy of twelve years old, well developed, was selected and photographed, without clothing, in several of these attitudes, thus showing every shade of pressure, and the effects upon the muscles—not those under pressure, but more particularly those of the cavities, as the abdomen and thorax, and the various curvatures of the spine. A well-arranged skeleton was also photographed, and, to our surprise, the same positions gave the same curvatures as in the boy (*see* fig. 76).

I then had the same positions photographed in a chair of a different seat and back, and we obtained quite a different result. And we are now putting them into a new primary school, with the hope of giving the school a more comfortable seat and a more uniform attitude, as it admits and *ensures* a pressure over a surface at least four or six times as large as can be obtained in a common seat, and a movable desk to rest the book while studying. I should have said that the relative height of the chair for the boy (in taking his picture) was the same as those in school, as near as could be.

I do not intend to represent a permanent distortion of the spine; but these various attitudes do produce them so long as these attitudes are maintained, and your own eyes will convince you that the glance at the shoulder is proof enough.

There is a general impression (which may be well founded or not) that deformities of the vertebral column, formerly rare, are now on the increase; this is most certainly due in a measure to ill-constructed seats.

It is generally admitted that the best form of seat is one which is suitable to the size of the scholar, and which has a properly-shaped back so as to support the spinal column. The long forms and desks, and the arrangement in classes according to ability, is the worst system possible; there should be separate tables, one for each scholar, according to his stature and size.

Figs. 77 and 78 will show some of the forms used in America; both the seat and table are fixtures, and proportioned to the stature of the child. The height of the table and benches at which the different-sized children should sit has been determined experimentally by M. le Dr. Guillaume, who gives the following table (Annales d'Hygiène, 1874):—

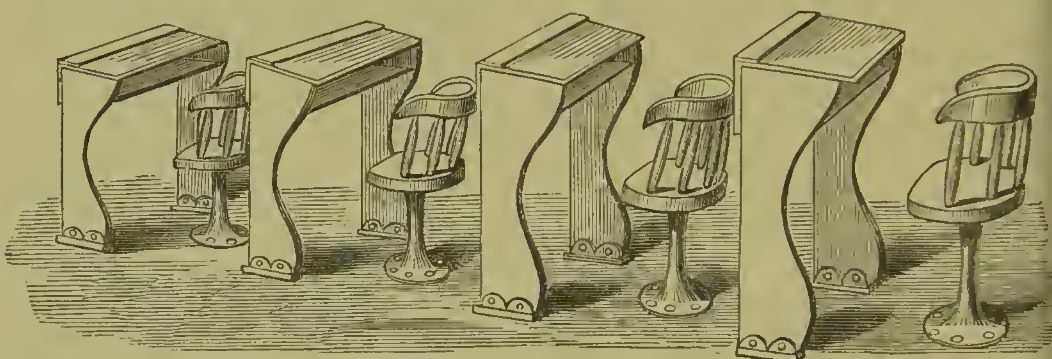


Fig. 77.

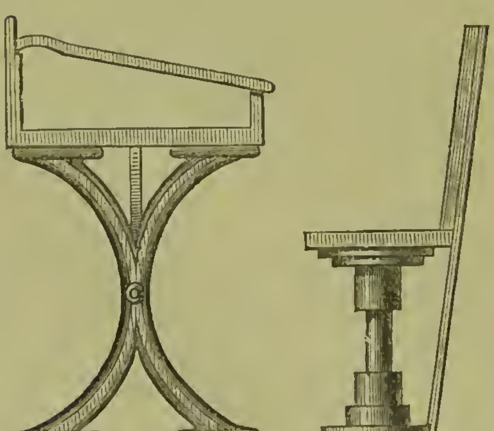


Fig. 78.

Height of Pupils.	Height of Table.	Height of Seat.	Height of Back of Seat.
Feet.	Inches.	Inches.	Inches.
3·0 to 3·3	13·5	7·5	9·8
3·3 ,, 3·6	14·7	8·5	10·8
3·6 ,, 3·9	15·8	9·5	11·9
3·9 ,, 4·2	17·0	10·3	12·9
4·2 ,, 4·5	18·1	11·2	14·0
4·5 ,, 4·8	19·2	12·2	15·0
4·8 ,, 5·1	20·4	13·1	16·1
5·1 ,, 5·4	21·6	14·1	17·2

According, then, to this scheme, tables and benches of eight different sizes would be required.

It would appear from the inquiries of the Massachusetts State Board of Health in

America, and from observations in our own country, that school-life has a serious influence on the sight.

"In Winchester, U.S., twenty-four children from a primary school (ages from five to ten), as many from a grammar school (ages from ten to fourteen), and as many from a high school (ages from fourteen to eighteen), sexes equally divided, were taken in separate squads to a well-lighted hall, where their eyesight was tested with the test-types of Dr. H. W. Williams, and in such a way that one child could not 'prompt' another, and with the following result:—

Primary......	12 boys......	1 slightly defective.
	12 girls.....	1 short-sighted.
Grammar....	12 boys......	1 very defective.
	12 girls.....	1 short-sighted.
High..........	12 boys......	2 very defective.
	12 girls.....	1 short-sighted, 1 defective.

"The teachers had been asked to send no child whose sight was known to be defective.

"In Wakefield twenty-four children were similarly tested in each of seven schools, the sexes being very nearly equally divided. Results as follows:—

Primary (7½ years)—2 very slightly defective, 1 slightly, 2 markedly.
First Intermediate (9 years)—3 very slightly defective, 2 slightly, 1 decidedly, 1 very.
Second Intermediate (10 years)—1 very slightly defective, 2 slightly, 1 decidedly.
First Grammar (11¾ years)—6 very slightly defective, 1 slightly, 1 decidedly.
Second Grammar (12½ years)—3 very slightly defective, 2 slightly.
Advanced Grammar (14¾ years)—6 very slightly defective, 1 slightly, 1 decidedly, 5 very.
High (16½ years)—4 very slightly defective, 1 slightly, 3 very.

"The nine whose sight was very defective were all females. The advanced grammar and the high school rooms are marked 'large and finely lighted on N., S., and W.'"—(Fifth Report, Massachusetts Board of Health.)

How much of this defective sight is congenital, and how much to be ascribed to straining the eyes in bending over desks and deciphering minute letters, it is impossible to say. It teaches us that great care is necessary to ensure the proper lighting of the desks. The light should come from behind and from the left hand; and if artificial light is used, attention must be given to see that it is thrown down from above as much as possible, and that the source of light be not so near as to heat the eyes and head. Large clear type should be insisted upon for all school-books, and maps, slates, &c., should be of the largest convenient size.

All schools, public and private, should be regularly inspected by every medical officer of health, and the result of these inspections should make a prominent feature in his annual report. The author in his own district has found schools the great centres of the propagation of diseases such as whooping-cough, measles, scarlet fever, &c.; so that, practically speaking, there is no single place more important to visit regularly than a school. In inspecting, the ventilation, the superficial area, the cleanliness of the children, their number, whether they have all been vaccinated, whether any child has come from an infected house, and the state of the privies and lavatories, should be particularly noticed. The regular daily inspection of the closets and drains should be insisted upon in all schools. In examining the children themselves it will be useful to look particularly for diseases of the skin and hair.

It has been proposed lately by several persons to utilise the schools in obtaining accurate information as to sickness in a district, since whenever a child is absent from school the master is obliged to enter the fact, and it certainly would not be much extra trouble if the *cause* of the non-attendance were also chronicled. "What we want," says Dr. Farquhar, in a very practical paper on the subject published in the "Lancet," November 22, 1873, "now is—first, a yearly return of the permanently-disabled children, and the causes which prevent their attendance at school; secondly, a weekly return of temporarily-sick children borne on the school register, and the diseases that prevent their attendance at school."

The utility of such returns is unquestionable.

Scurvy—This disease essentially consists in a profound alteration of the blood, caused by abstinence from a proper vegetable diet.

History.—Scurvy is noticed by Pliny as having occurred in the Roman army commanded by Germanicus, and it must have prevailed in the most ancient times, with its associates famine and scarcity.

For the most complete accounts of its prevalence and fatality we must refer to histories of the middle ages and modern times.

It especially afflicted nations in their progress from barbarism to civilisation, when the arts of war usurped the practice of horticulture, and its causes, effects, and prevention began to be studied as soon as the possession of the compass rendered possible the undertaking of long voyages.

History shows us that it is a disease of land as well as of the sea. Witness in 1260 the destruction of the army of Louis IX. from scurvy, the disablement of the English garrison at Oswego in 1756; and other instances, such as the besieged towns of Thorn, Breda, Rochelle, Stetting, and Gibraltar in 1780, and the Crimean war of our own times.

As an example of the terrible destruction of this disease in our navy, Dr. Guy cites the following instances :—

"Scurvy alone has sufficed to place a well-manned vessel at the mercy of the winds and waves. Witness Anson's own ship, the Centurion, in 1742, when the crew were so weakened by it that had the ship been compelled to keep the sea a very few days longer it could not have been brought to anchor at Juan Fernandoz, but must have gone adrift in the Pacific, the survivors perishing miserably, as happened to a Spanish ship under the like circumstances. Or take the figures that express the mortality in Anson's fleet. Out of 961 men 626 deaths in nine months, or very nearly 2 out of 3! And this was no rare or exceptional occurrence, for such things had happened in earlier, and did happen in later, times. Thus Sir Richard Hawkins, the great navigator of the age of Elizabeth and her successor, said that in the course of twenty years 'he had known of 10,000 seamen having perished by scurvy alone.' Even so late as 1780, Sir Gilbert Blane found that a fleet manned with between 7000 and 8000 seamen had in one year lost 1 in every 7. Fortunately for us, this high mortality was not limited to our own ships. A Portuguese historian, cited by Sir Gilbert Blane, speaking of the favourable case of an exploring expedition, says that 'if the dead who had been thrown overboard between the coast of Guinea and the Cape of Good Hope, and between that cape and Mozambique, could have had tombstones placed for them, each on the spot where he sank, the whole way would have appeared one continued cemetery.'"—(Dr. Guy's Lectures on Public Health. London, 1874.)

The expedition of Sir Francis Wheeler, the sickness in Admiral Hozier's fleet, 1726, and the state of our own armies in the American war, are practical instances of the disastrous influence of scurvy as a cause of inefficiency from disease of our fleets and armies.

But even in those times, as Dr. Guy remarks, "when other sanitary matters were neglected, or imperfectly carried out, there were not wanting striking examples of single ships and whole fleets maintained in perfect health and complete efficiency by fresh meat, vegetables, and fruit."

Dr. Guy instances as examples—

1. A ship under Fletcher, which was ordered three times up the Ganges, then fœtid from dead bodies, and each time the men preserved perfect health, which Fletcher attributed to the use of tea and sugar.

2. The fleet of Admiral Hawke in 1747, consisting of 14,000 men, who were pent up in their ships for six or seven months, and yet on the day of his victorious engagement there were not twenty sick sailors in the whole fleet —a result entirely attributed to the fact that the ships had been well supplied with fresh meat and greens.

Symptoms of Scurvy.—Scurvy is popularly believed to be a sort of scab or scurf on the skin; this is erroneous. It essentially consists in a profound alteration of the whole system. In well-marked cases there are blotches all over the body, called in the old Bills of Mortality "the purples." These blotches are really effusions of blood beneath the skin; the gums become spongy and bleed at the slightest touch, and often break out into ulcers. There is great anæmia and prostration of strength; sometimes old wounds break out afresh, and fractures become disunited. Death often occurs suddenly from some abrupt exertion. The disease is frequently complicated with dropsy, dysentery, and other affections.

Pathology.—The pathology of the disease points very conclusively (as the main seat of the affection) to the blood, which is so profoundly altered that it escapes through the walls of its natural channels.

"It often lies," says Lind, "in large concrete masses on the periosteum, while the bellies of the muscles of the legs and thighs seem quite stuffed with it, often an inch in thickness."

Patches of ecchymoses have been found under the pericardium covering the heart, and under the arachnoid membrane covering the brain, and in other parts. The epiphyses of the joints in extreme cases have separated, as well as the cartilages of the ribs, and old fractures have become disunited.

"The effusions of blood occur most frequently in the skin, the subcutaneous cellular tissue, between the muscles of the lower extremities and of the jaws, in the peritoneal coat, and in the muscular and mucous coats of the intestinal canal. The general paleness of the tissues shows that there is great deficiency of red particles in the blood; and the tendency to swoon so constant in scurvy, is undoubtedly owing in some measure to this deficiency, though it is evident that diminished proportion of red particles which is common to many diseases is not the only, nor the most important, change in scurvy."—(Budd.)

Chatin and Bouvier have discovered that the albumen of the blood is in some way altered in constitution, for it does not coagulate under a temperature of 74° C., or 165·2° F.—that is, from 5° to 8° F. above the normal standard—so that the albumen is increased in solubility. The cohesion of the fibrine they also noticed was so much lessened that they were unable to isolate it thoroughly from the red corpuscles; hence the *agglutinated blood*, the viscid and thickened crassamentum of the early writers.

Scurvy at the Present Time. — Scurvy can hardly be said to exist at the present time either in our army or navy. In the last report of the health of the navy it appears that out of a total force of 47,260 only four cases of scurvy occurred within the year.—(Statistical Report of the Navy, 1871.)

It is still to be found to a considerable extent in the merchant service, partly from the wilful and almost criminal carelessness of captains and owners, and partly from the bad quality of the lime-juice supplied. The Merchant Shipping Act (17 & 18 Vict. c. 104) provided that whenever a crew shall have been consuming salt provisions for ten days, lime-juice or lemon-juice and sugar shall be served out at the rate of half an ounce each per day; but no provision was made to ascertain the quality of this juice. Mr. Harry Leach, in his report on the hygienic condition of the mercantile marine, 1867, says:—

"We are prepared to maintain from the following table (and other statistics from which these have been taken) that the want of good lime or lemon juice was distinctly the cause of scurvy in the vessels below mentioned.

Name of Ship.	No. of Hands (all told).	Cases of Scurvy.	Result of examination of Lime-Juice.
Hermine . .	17	5	Sulphuric acid.
Merrie England	29	10	Stinking.
Stirling Castle .	32	6	Very weak.
Hoang-Ho .	21	5	Acetic acid.
Blanche Moore	35	8	Musty and nauseous.
St. Andrew's Castle	19	7	Citric acid.
Tamerlane .	21	4	Nauseous.
Marlborough .	23	8	Very weak.
Galloway . .	29	6	Short allowance.
Tamar . .	17	2	Very weak.
French Empire	27	7 or 8	Citric acid.
Eaglet . .	14	3	Thick and nasty.
Geelong . .	14	9	Taken irregularly.
Thorndean .	35	2	Spoiled. (Short supply of provisions.)

Taken from ships that, with others, have arrived in the port of London during the past two years with cases of scurvy.

"Of direct causes, this is undoubtedly first and foremost; but of indirect causes we have a few words to say. Dirt, bad provisions, and any form of disease to which sailors, in common with other men, are subject, will predispose to scurvy. This cannot and should not be denied, but it affords to parsimonious captains a very large peg whereon to hang sundry invectives as to the cry lately made about the continued prevalence of this disease in the mercantile marine. Such captains, with pardonable ignorance, consider scurvy a form of venereal disease, give the wretched subject thereof mercury, and bring him into port salivated as well as scorbutic."

The same writer says:—

"During the past thirteen years, it is found that 1230 cases of scurvy are recorded in the books of the Dreadnought Hospital Ship. By an analysis of these figures, we find that, after a decrease in the numbers admitted in 1855, the annual total varies but little until the year 1865, when the admissions rose to 102, or 20 per cent. over most of the previous ten years. The same result obtains in the year just past, 101 having been entered. From returns of the Liverpool hospitals, gleaned 1863, we learn that fifty cases were admitted during that year; and, by the courtesy of Mr. Reginald Harrison, we find that the numbers admitted into these institutions during last year rose to 116. By the kindness of Dr. Fowler, surgeon to the Civil Hospital in the island of St. Helena, we are informed that from 1860 to 1865, both inclusive, 178 cases of scurvy were admitted there, and that twice or thrice that number were treated as out-patients.

. . . .

"In summing up statistics of scurvy for the past year (1867), we find that a total of 235 accredited cases were admitted into British hospitals, giving no account of those who convalesced in Sailors' Homes or elsewhere. To this we may add, that seven sailors were left at St. Helena, from a ship recently arrived in the Thames; that a vessel put into Falmouth on the 29th ult., with no less than sixteen severe cases of scurvy on board, and that between twenty and thirty cases have arrived in this port during the present month. It would be well (as a supplementary aid to the prevention of scurvy by inspection of lime-juice) that the dues levied for the St. Helena Hospital should be abolished. It was stated to us some weeks ago by a very old inhabitant of that island, that this fact alone caused many ships to pass without calling for needful supplies of anti-scorbutic material. I would, however, remark that, if the system proposed by the Seamen's Hospital Society were put in force, no such aid to the prevention of this disease would be required, inasmuch as every ship would then be supplied with a sufficiency of good lime-juice."

That it has decreased since this report was written, to a certain extent, appears, however, from the following statistics of the admissions of cases of scurvy into the Seamen's Hospital:—

In 1865, from	British	vessels,	101;	foreign do.	1
In 1866	,,	,,	96	,,	5
In 1867	,,	,,	90	,,	4
In 1868	,,	,,	64	,,	10

In 1869, from British vessels, 31 ; foreign do. 9
In 1870 ,, ,, 30 ,, 21
In 1871 ,, ,, 24 ,, 16*

Deaths from scurvy are classed in the Registrar-General's reports with purpura, and as it is to be feared that deaths returned as purpura include various congenital heart affections, the figures are deprived somewhat of their value.

In the twenty-five years from 1847 to 1871 the number of deaths from purpura and scurvy amounted to 8761, or about 350 yearly. The proportional number of deaths from scurvy in the ten years 1862–71 to 1,000,000 persons living was as follows: 1862, 18; 1863, 20; 1864, 19; 1865, 20; 1866, 22; 1867, 22; 1868, 22; 1869, 19; 1870, 21; 1871, 24. And in the eight preceding years the numbers were respectively, 15, 17, 12, 13, 18, 18, 18, and 20.

Prevention of Scurvy.—The prevention of scurvy is so easy that it appears wonderful the disease should still exist. It may be summed up shortly as follows: A proper mixed diet of fresh vegetables, fruits, and meat, or where that is impossible, the drinking daily of a certain quantity of lime-juice. The important discovery that lime-juice prevents scurvy was probably due to John Woodfall. "At what period the truth dawned upon men's minds we do not know, but certainly as early as 1617 John Woodfall, master in surgery, knew that lemon-juice was the best of all remedies for the scurvy, and commended it accordingly; but, strange to say, this important fact was forgotten or overlooked for more than a hundred years. About 1770 Lind revived and diffused a knowledge of it; but nearly another quarter of a century was to elapse before our navy was supplied with it. This important step was taken in 1796."

Of vegetable acids experience has shown citric and tartaric to be the best preventives. Next to these comes acetic, then malic, and lowest in the list lactic; indeed, as regards the last, it is questionable whether lactic acid has any influence on scurvy whatever. These acids are efficacious if given pure, but still more so in their natural combinations, as in lime-juice and most fresh vegetables. When the vegetables are dried they appear to lose the antiscorbutic virtues to a considerable extent; whether this is due to a decomposition or destruction of the organic acids in the process of drying is not known. It is important also to remember that dried peas and beans are absolutely useless, while dried potatoes are of considerable value.

The practical details, then, of keeping men free from scurvy, whether on land or sea, is to see that, where they can be obtained, fruits and fresh vegetables be used at each meal. In war it is better to utilise any plant that is not injurious rather than have no vegetables at all. The cruciferæ are, however, so common all over the world that the army surgeons would in most places find a proper supply. Failing this, or in conjunction with vegetables, each soldier or sailor should drink an ounce daily of lemon-juice, which should be swallowed as soon as distributed, and on no account should the men be allowed to carry it off to their tents or cabins. Vinegar should be an essential part of the rations, and it is a good plan to issue little packets of the citrates or tartrates of potash, with instructions for use.

* The disgraceful fact must, however, be recorded, that two British vessels this year (1875) arrived at San Francisco, the crews decimated by scurvy. The brigantine Cecilia also arrived in London with two cases of the disease on board, and the captain was prosecuted and fined, it being distinctly proved that there was an insufficient supply of lime-juice. There have been one or two other similar cases.

Sea-Weeds—*See* ALGÆ, &c.

Semola—A preparation of wheaten flour, deprived, by washing in water, of a great quantity of its starch, and containing 48 per cent. of nitrogenous or albuminoid principles. It is intended as a food for infants, weakly children, and invalids.

Semolina (*Sémoule*)—"The large hard grains of wheat-flour retained in the bolting-machine after the fine flour has passed through its meshes." With the *sémoule* the fine white Parisian bread called "gruau" is baked. *See* BREAD, FLOUR, &c.

Senna—The leaves of various species of senna.

The commercial varieties are Alexandrian, Indian, Aleppo, and Tripoli senna.

Alexandrian senna should be composed of *Cassia lenitiva* and *C. obovata.*

Indian senna should consist entirely of leaves derived from *C. elongata.*

Aleppo senna should consist entirely of leaves derived from *C. obovata.*

The leaflets of all these varieties of senna are of a greenish colour, with a faint peculiar odour and a characteristic taste, and they are all unequally oblique at the base. *C. lanceola* are lanceolate, about an inch in length; *C. obovata* a little shorter, and ovate; and *C. elongata* about 2 inches long, lanceolate and acute.

Uses.—Senna is a well-known and much used drug, seldom employed for any other purpose than as an aperient or cathartic.

Adulterations.—Senna is very extensively adulterated, the sophistications almost entirely consisting of the admixture of various leaves, which may be easily detected, providing a person is thoroughly acquainted with the botanical structure of the leaves of senna itself. Descriptions should not be entirely relied upon, but actual specimens of the different varieties of senna kept at hand for comparison.

The following leaves have been found fraudulently mixed with senna: Leaves of *Colutea arborescens*, *Solenostemma Argel*, *Coriaria myrtifolia*, *Globularia Alyssum*, *Tephrosia Apollinea*, *Vaccinium Vitis idæa*, and *Cassia brevisse*.

Sewer, Sewage, Drains, Drainage, &c.—It will be convenient to treat in one article the various matters belonging to drainage and sewage.

In this article, therefore, first sewage, next sewers and drains, and lastly the legal provisions and enactments relating to them, will be considered.

Sewage.

It will be convenient here to accept the definition of the British Association Committee, and apply the term sewage to "all refuse of human habitations affecting the health of the country."

1. *Composition of Sewage.*—"Sewage is a very complex liquid; a large proportion of its most offensive matters is of course human excrement discharged from water-closets and privies, and also urine thrown down gully-holes. But mixed with this there is the water from kitchens, containing vegetable, animal, and other refuse; and that from wash-houses, containing soap and the animal matters from soiled linen. There is also the drainage from stables and cowhouses, and that from slaughter-houses, containing animal and vegetable offal. In cases where privies and cesspools are used instead of water-closets, or these are not connected with the sewers, there is still a large proportion of human refuse, in the form of chamber slops and urine. In fact, sewage cannot be looked upon as composed solely of human excrement diluted with water, but as water diluted with a vast variety of matters, some held in suspension, some in solution."—(First Report of Rivers Pollution Commissioners.) It will thus be seen that the composition must be variable—variable not only in different places, but also at different hours of the day. For example, the total combined nitrogen in London sewage alone varies from 3 to over 11 per 100,000 parts, and in all the samples given in the above-quoted report, the variation was from 2·371 to 24·325 parts. The average composition of sewage, speaking generally, however, is as follows:—

100,000 parts of sewage contains—

72·20 total solids in solution.
44·69 suspended matters.

Of the 72·20 dissolved solids there are—

4·696	parts of	organic carbon.
2·205	,,	organic nitrogen.
7·728	,,	combined nitrogen.
6·703	,,	ammonia.
10·660	,,	chlorine.

Of the 44·69 in suspension—

24·18 are mineral.
20·51 organic.

The following tables will also elucidate farther the composition of sewage:—

Composition of Sewer Waters (Way).

	Grains per Gallon.			
	1.	2.	3.	4.
Organic matters (soluble)	19·40	41·03	12·30	9·20 (soluble and suspended)
,, ,, (suspended)	39·10	17·00	24·37	
Lime	10·13	14·71	12·52	11·25
Magnesia	1·42	1·82	1·59	1·35
Soda	4·01	2·40	2·41	1·89
Potash	3·66	3·57	3·31	1·09
Chloride of sodium	26·40	22·61	34·30	5·58
Sulphuric acid	5·34	5·31	6·40	3·43
Phosphoric acid	2·63	5·76	2·48	0·64
Carbonic acid	9·01	8·92	11·76	4·77 (carbonic acid and silica)
Silica { Oxide of iron, Oxide of zinc }	6·20	13·55	6·46	
Ammonia	7·48	8·43	7·88	...
	134·78	145·11	125·78	39·20

LONDON SEWER WATER (LETHEBY).

	Grains per Gallon.		
	Day Sewage.	Night Sewage.	Storm Sewage.
Soluble matters .	55·74	65·09	70·26
Organic matters .	15·08	7·42	14 75
Nitrogen . . .	5·44	5·19	7·26
Mineral matters .	40·66	57·67	55·71
Phosphoric acid .	0·85	0 69	1·03
Potash . . .	1·21	1·15	1·01
Suspended matters .	38·15	13·99	31·88
Organic matters .	16·11	7·48	17·55
Nitrogen . . .	0·78	0·29	0·67
Mineral matters .	22·04	0·51	14·33
Phosphoric acid .	0·89	0·64	0 98
Potash . . .	8·08	0·04	0·16

2. *Disposal of Sewage.*—Whother collected in cesspools, privies, earth-closets, or conducted in sewers, some method of disposal must bo adopted or great evils necessarily follow. In all methods of hand removal, the sewago can and generally is applied directly to the soil—*e.g.*, in tho north of France, the sewage is received into closed vessels called *citernes à engrais*, and emptied in fields. In country places in England the greatest care is taken of the middens, the manure from which is applied to the ground without preparation, or mixed with straw. In many schools and public establishments the farmer supplies dry earth for closets, and receives in return the same earth after it has been used. But even where hand removal is employed, in some places the whole is wasted, although there would appear every facility to utilise it. Thus at Avignon, Marseilles, and other places in the south of France, the fæcal matters and urine are collected by the *tonneaux* twice a day, and transported to the sea. In most of our own sea-coast towns the sewers empty themselves in the sea; and though this, when perfectly carried out, may get rid of sewage without nuisance, yet there is a direct loss to the land of a valuable fertilising agent.

The most obvious means of getting rid of sewage is the nearest watercourse; and in times when sewers were ill constructed, and towns not so large as they are now, the evil, though appreciable, was not excessive; but at the present day, with well-constructed impervious sewers, in the case of large towns situated along the banks of a river, which each pollutes in turn, and in so doing poisons the principal water-supply for its inhabitants, the system can no longer be permitted or recommended.

"The effect of this conversion of the rivers into common sewers is most injurious; all complain, oven those who whilo suffering from the inconvenience and annoyance which such a state of things entails, add to the nuisance by themselves following the general example, while they whose property happens to lie on the stream, even many miles below tho towns, are sufferers in a variety of ways. Aro they farmers?—Their cattle cannot drink of the stream passing through their meadows. Are they dwellers on or near tho bank of the river?—They aro driven from homo by the stench which renders the place unbearable. Aro they compelled by duty to remain on the spot?—They are subject to perpetual annoyance, and, as alleged, in many cases to ill health. Have they property?—Its value is often diminished; a house remains tenantless; land is unsaleable except at a reduced price."—(First Report of Rivers Pollution Commissioners, 1870.)

In many places the old midden system still prevails, but this need only be mentioned to bo condemned. The different varieties of the system are thus summarised in the twelfth report of the medical officer to the Privy Council:—

"1. The midden system of old type—in all the old parts of almost all towns.

"2. Middens of large size, and permitting much accumulation, but compulsorily supplied with some means of keeping the contents dry (covers, drains, or both), and for preventing leakage into the earth—Preston, Leeds, Birmingham.

"3. The same (though smaller), with the addition of special constructions aiming at the effectual covering of excrement by ashes—

"By sloping bottom—Nottingham, Stamford.

"By hinged seats or steps—Manchester, Salford.

"By ashpit and shoot—Manchester.

"4. The same arrangement, with the midden reduced to a mere space under the seat—Hull."

The Pail or Tub System (*Fosses Mobiles*), with *Fosses Mobiles*, has for its object the collection of dejecta in a state of purity, without mixture with water, in a clean and odourless condition.

1. *Seat.*—This consists simply of a soil-pan of stoneware or *faïence*, without woodwork, the soil-pan merely projecting from the top of the descent pipe. Its borders are furnished with a groove filled with water or sand, into which the raised rim of the lid fits.

2. *Connecting Pipe.*—This pipe is straight, without a siphon, and joins the descent pipe at a very acute angle, 22°, and is about 4 inches in diameter inside. It is, liko the next, made of stoneware, glazed inside.

3. *Descent Pipe.*—This is from 6 to 8 inches in internal diameter[1]; it is vertical, and is composed of a series of pipes connected with each other by dry sand joints, without

cement, fixed to the wall by iron bands. It rests at the ground-floor level on a strong flagstone. Its prolongation, through and below this stone, consists of a sliding pipe of wrought copper capable of being lengthened or shortened, and solidly fixed to the stone by a cast-iron connector. A sort of circular shallow dish (*écuelle*), which can be hung under this last part of the descent pipe, serves at a given moment to shut its lower orifice.

4. *Tub* (*Tonneau*).—The excremental matters coming down the descent pipe fall into a tub of from 2 to 3 hectolitres (44 to 66 gallons), in a hole in the top of which the lower part of the pipe fits tightly. A cover fitted with a spring serves to shut and lute the tub when it is full. Placed on a stand furnished with wheels, the tub is easily managed. When filled, it is immediately replaced by another similar contrivance. If the tub is underground, the rails (on which the stand moves) should be placed on an incline, so that the removal and replacement may be easily effected. The underground chamber must be isolated, and the entrance to it placed outside the building. The thorough tarring of the interior of the tub not only preserves the staves, but also partly neutralises the effect of the mephitic gases which the excremental matters disengage.

5. *Ventilation-Pipe.*—To prevent the smells and gases which are given off from the mouth of the tub from spreading themselves (in the house) by means of the opening in the privy seat, at the upper extremity of the descent pipe is fixed a ventilation-pipe, which rises above the coping of the roof, and the action of which is increased by means of a vane, or any other contrivance producing the same effect. "The expenses of this apparatus are said to be relatively small, and are, besides, amply compensated for by the returns from the sale of the manure."—(Conseil supérieur d'Hygiène Publique. Rapports addressés à M. le Ministre de l'Intérieure, vol. ii., Bruxelles; quoted by Corfield.)

The German system of movable receptacles (*Abfuhrtonnen*) is in principle identical with the above.

Boxes are used in some places, either prepared or unprepared.

In Nottingham a little earth or ashes is put in the bottom of the box to prevent the contents adhering. The scavenging is done by night, and the refuse taken away by canal barges and sold as manure.

In Leeds boxes are used without any preparation.

Tubs or pails are much used in Rochdale and Edinburgh. In the former town they are made of disused paraffine casks, each cask being cut in two. Tight-fitting lids are supplied. The pails cost about 3s. 4d. each. They are changed twice or three times a week, and are unattended with nuisance. In Edinburgh there is literally no accommodation in many large houses, hence the custom of simply placing pails full of excrement, urine, &c., outside the houses for removal by the scavenger.

At Edinburgh and Glasgow there are closets supplied with movable metal pails, which are removed daily. These closets are roofed in, and are ranged in double rows, with a passage between them for the scavenger.

The Eureka System.—A box containing some disinfectant or deodorising mixture in this system was placed under the privy seat, with instructions that no slops were to be put into it, left for a few days, then, covered with a tightly-fitting lid, removed and a fresh one put in its place. The full box was carried off to a manure manufacture; the manufactory was a nuisance to the neighbourhood, and the manure unprofitable. It is certain, however, that it had not a fair trial.

The Goux System.—In this system the pails are lined with an absorbent material. "All kinds of vegetable and animal fibrous matters, useless for other purposes, are used as absorbents, and are to be mixed in such proportions as may be most convenient, together with a small percentage of sulphate of iron or sulphate of lime."

This absorbent material is pressed and hollowed so as to leave a cavity by means of a mould. Ordinary midden-closets can easily be converted into closets which admit of the use of this system.

The closets on the Goux system require intelligent management. When that is obtained there is no offensive smell nor pollution of the soil.

Reginald Smith's Process.—This is founded on the patents of M. Badin, and has been tried and reported favourably on at the Metropolitan Extension Works, Bishopsgate Street.

The apparatus consists of a truncated cone of wire gauze, which is fixed base downwards, in a cylinder of perforated metal. The cylinder is surrounded by, and nearly fills, a strong water-tight cylinder of galvanised iron, connected by a union joint with an air-tight cistern. The outer cylinder is about 3 feet high. The space between the cone and the inner cylinder is filled with some porous substance, such as spent tan, saturated with a powerful antiseptic. The excreta, both solid and liquid, fall into the cone. Here the solids are retained, while the liquids filter through the tan, are distributed in their passage, and finally pass into the outer cylinder, and thonce to tho tank. The cylinders must of course be changed when full and the tank emptied. The apparatus is large enough to retain the excreta of a family of six for two months. When full, the cylinders and liquid from the tank are taken to the company's works, the liquid boiled down, mixed with the solid tan, and all taken from the cylinder. The whole is then dried, pulverised, and sold as "human guano."

The Dry System.—The form of earth-closets and the best earth to be used are described under CLOSETS, *which see.*

The system has been extremely successful whenever it has been tried, where a number of people are *under control.* For instance, the camp at Wimbledon adopted the earth system. Rows of closets made of deal boards were placed back to back, with a passage between the rows, to which access was only attainable by an attendant under each row. A long pit was dug in the ground ($4\frac{1}{2}$ feet deep by 5 feet wide), into which the excrement fell. The weight of the person on the seat causing, by a mechanical arrangement, $1\frac{1}{2}$ lb. of dry earth to fall from the receptacle upon the excrement. The public closets were used once a day by 3000 persons. Notwithstanding the immense number in the camp, and the excessive heat, the earth-closet succeeded admirably; there was absolutely no annoyance of any kind. It has been applied to schools, barracks, and public institutions, both at home and in India; and where the system has received the necessary attention it has succeeded admirably. Where improper or insufficient earth has been used, or where intrusted to the hands of dirty and negligent people, it has failed.

The Water-Carriage System.—Water-closets with any mechanical arrangement, unless perfectly self-acting, are not suitable to a low-class population—this is the experience of all towns.

Certainly one of the best forms of latrines is the trough water-closet. They have been erected in various towns—in Liverpool, West Derby, and other places. Dr. Buchanan thus describes them. A long trough is placed below and behind the seats of a series of closets. At the one end is a communication with a drain leading into the sewer; this opening is closed by a plug connected with an iron rod, by which it can be raised or lowered into the drain mouth by the scavenger. Behind the back wall of the water-closet is a small chamber, to which the scavenger only has access, and it is from this chamber alone that the plug can be interfered with. The scavenger comes daily, lifts up the plug, lets the contents of the inclined trough run into the sewer, washes out the trough with hose which is placed in the chamber for the purpose and which is connected with a hydrant, sweeps it clean, charges the trough with water, lets down the plug into the drain mouth, and leaves it for twenty-four hours. The closets themselves are cleaned by the users in rotation, and an inspector calls every two or three days to see that it is done. If it is not done properly the offenders are summoned, and some have been sent to prison for the offence. The ashes and other refuse are put into the street and carted away daily by the scavengers.

On the authority of Dr. Buchanan the Liverpool arrangements work admirably, and there is a marked difference between them and the water-closets of the poorer parts of London and other towns.

In Leeds, Birkenhead, and Tranmere a self-acting closet, known as the "tumbler," is much used. Here also is a trough running under the seats; the water trickles into a swinging basin at the upper end, and this is so constructed that when full it capsizes and washes out the contents of the trough into the drain.

3. *The Utilisation of Sewage*—(1.) *Manufacture into Manure.* (a.) *Simple Filtration.*—This is in order to separate the solid from the liquid part. A mass of black semi-solid mud is thus obtained, which, mixed with ashes or street-refuse, sells for manure, while the liquid flows into the nearest watercourse. But this liquid is just as much sewage as before—it is merely deprived of suspended matters.

The actual results of the different varieties of simple filtration in several towns are as follows:—

Ashby-de-la-Zouch.—The solid matters are separated partly by subsidence and partly by filtering through upright screens. The result is a black rich-looking mould, which is bought at a low price by farmers. It finds a ready sale.

Banbury.—The solid matters were separated partly by subsidence in tanks, and filtered. The effluent water caused a nuisance in the river.

Ely.—Upward filtration. The solid part is removed in the winter, mixed with town-ashes and road-scrapings, and sells for 2s. 6d. a cubic yard, paying in great measure for the expense of dust removal and labour.

Rugby.—Part of sewage used for irrigation, part falls on a series of filtering beds. The black matter in the filters is easily disposed of at half-a-crown a load.

In each of the cases a large amount of the sewage is lost, and the effluent water is still most decided sewage.

French Process.—In France there is a rather celebrated manufactory in which the sewage is partly converted into ammonia and partly into *poudrette*, which appears to mainly consist of the dry organic matters, and makes a fair manure. The manufactory consists of two parts—viz., the pumping station at the Depotoir de la Villette; and the works themselves, situate in the Forest of Bondy.

The sewage is conveyed to Villette by the *tonneaux des fosses mobiles*, and emptied into large tanks, from which the liquid part of the sewage is pumped and conveyed through a conduit on one side of the embankment of the Canal de l'Ourcq. The solid portion is conveyed in boats to Bondy along the same canal.

Captain Liernur's Pneumatic System.—It is asserted of the Liernur system that it not only removes filth, but that it does so in such a manner that it is impossible for the germs of disease or noxious gases to escape into the atmosphere, and that it also keeps the soil and subsoil water in a pure condition.

The system is shortly this. There is a network of 5-inch cast-iron socket pipes branching into the various streets. These pipes originate from a powerful air-pump worked by steam, which *sucks* the sewage to the central manufactory, where it is immediately converted by evaporation into *poudrette*. Porous drain pipes are laid *above* the sewers, so that the subsoil water is kept permanently above the sewer.

The details of the system are as follows, tracing it from the water-closet or privy to the final manufactory:—

The water-closets and privies are peculiar; the former are about the size and shape of an ordinary chamber utensil, placed close under the seat. This basin is supplied automatically with a *quart only* of water, and by a suitable mechanism, empties itself, also automatically, into a siphon below. The pneumatic privy has no mechanism whatever, it is merely a deep funnel; and the excreta fall into a pocket below, the pocket being one arm of a short bent tube or siphon pipe, which is of course connected with the soil-pipe. Each funnel is ventilated by a 2-inch pipe, leading to the outside of the roof of the house, furnished at the top with a Wolpert's air-sucker. The pocket itself is also ventilated, and the ventilating-pipe has a charcoal filter attached to its upper part. The pipes leading from the water-closet or privies enter a main, which main is connected with a tank; the tank is underneath the pavement, and is a cast-iron horizontal cylinder with spherical ends. The tanks are usually put at the intersections of the streets. There is about one tank for an area varying from 30 to 50 acres. Each tank has as many mains attached to it as there are streets in the area which it exhausts. The tanks are directly connected with the central manufactory and air-pump. Each of the mains is guarded by a stopcock; the single central pipe from each tank going to the engine is also guarded by a stopcock. The way in which each of these tanks is filled is as follows: The engine maintains during the day a three-quarter vacuum in large reservoirs underneath the floor in the manufactory, and also in the central pipes. Workmen are engaged all day in going from tank to tank; first the stopcock of the central pipe is opened, and thus a communication being made with the air-pump, a vacuum is caused in the tank; now, any one of the stopcocks of the mains being opened, the whole of the privies and water-closets in that street are emptied at once into the tank by pneumatic action. In this way each tank is treated in succession. We must also state that the pipes are not horizontal, but consist of a series of downward lines, alternated by short vertical ones or risers.

From the tanks the sewage is similarly conveyed to the reservoirs of the manufactory. The sewage is there mixed with a little sulphuric acid to prevent the formation of ammonia and evaporated down *in vacuo*, the ultimate product being a dry powder. Until this stage is reached, the sewage has no connection with the external atmosphere; nuisance is impossible; the excreta is removed, and the manurial value of the product is high.

Voelcker's analysis of a sample is as follows:—

Moisture	8·64
Organic matter (containing nitrogen, 9·35)	62·96
Oxide of iron and alumina	3·29
Phosphoric acid	1·76
Lime	0·86
Chlorine	6·22
Sulphuric acid	6·02
Alkaline salts	8·20
Silica	2·05
	100·00

Value, £8, 10s. per ton.

Liernur's system is in use at Amsterdam, Leyden, Drodrecht, and a few other places. The original cost at Amsterdam appears to have been about £2, 10s. per inhabitant. It is said to have succeeded admirably wherever it has been tried, and even the financial results are good. The waste-water from manufactories is not allowed to enter into the system.

(b.) *Precipitation Processes — Precipitation by Lime.* — This operation is exceedingly simple, and has been carried out upon an extensive scale at Tottenham, Blackburn, and

Leicester. It consists in mixing with the sewage as it arrives at the works a certain proportion of milk of lime, and agitating it by appropriate machinery. A copious precipitate of highly putrescible mud takes place, and the effluent liquid flows off in a somewhat milky condition. But it appears to have failed in purifying the sewage so as to allow it to flow into a river, and also in a commercial sense.

Sillar's Process (*A B C*).—This is a precipitation process by means of alum, blood, clay, &c. The proportions for ordinary sewage is—

	Parts.
Alum	600
Blood	1
Clay	1900
Magnesia	5
Manganate of potash	10
Burnt clay	25
Chloride of sodium	10
Animal charcoal	15
Vegetable charcoal	20
Magnesian limestone	2

The A B C process is generally pronounced to be a failure.

Holden's Process consists in precipitating and deodorising the sewage by means of lime, common coal-dust, and sulphate of iron. The manure is said to be worthless, and much of the putrescible organic matters pass into solution. A treatment with crude sulphate of alumina and subsequent filtration through coke is carried out at Stroud. The value of the deposit obtained is said to be 30s. a ton, but the effluent water is too impure to be discharged into a stream.

Blyth's Process was based upon the idea, that on the addition of a salt of magnesia and some superphosphate of lime, the triple phosphate of magnesia, ammonia, and water would be thrown down in an insoluble condition, but it was overlooked that the salt mentioned is perfectly soluble in a water containing common salt.

The Phosphate Process, proposed by Messrs. Forbes & Price, consists in adding to the sewage a solution of native phosphate of alumina. The resulting manure has been estimated by Dr. Voelcker at £7, 7s. per ton. The precipitation is declared to be only a preliminary step to irrigation.

Hill's Process, as carried on at Wimbledon, precipitates sewage by lime and tar. The effluent water is filtered through charcoal. The expenses of the process are small.

Whitbread's Process consists in adding to the sewage a mixture containing two equivalents of dicalcic phosphate, one of monocalcic phosphate, and a little milk of lime. The resulting precipitation was found to be very rapid, and the supernatant fluid clear and inoffensive. Suspended matters were completely removed, and the organic nitrogen nearly so. The manure contains a considerable amount of lime phosphate and 3 per cent. of ammonia. The effluent fluid contains phosphoric acid and ammonia, and may be used for irrigation.

Carbon Filtration, or Weare's Process.—The sewage is filtered in underground tanks. It passes first through ashes and then through vegetable charcoal, lastly through layers of filtering cloth. The effluent water is still rather impure.

General Scott's Processes.—General Scott treated the sewage with a considerable mixture of lime and clay, and burnt the precipitate in kilns, and thus made a marketable cement. The same gentleman also took out a patent in 1873 for a process which he thus shortly describes: "Instead of converting into charcoal as heretofore the solid matters deposited from sewage by precipitation with lime, or lime and clay, I subject them to a temperature only sufficiently high to decompose their organic matters, and so far scorch or only partially char them, so as to develop in them compounds of a tarry nature, but not completely to expel such compounds, as is done in the preparations of charcoal. Sewage deposits thus treated exercise a remarkable effect in destroying the noxious smell of putrescent compounds, and they may be used with great advantage in deodorising nightsoil and rendering it innocuous."

Marsden & Collins' Process. — A patent was taken out by Marsden & Collins of Bolton in July 1873 for a precipitation process, which they thus specify: "Our invention consists in subjecting sewage-water to the action of certain agents, by which the solid and fertilising portion is precipitated to be converted into manure, and the water is cleared and allowed to run off. The agents we employ are lime, coal-ashes, or other refuse of coal, and charcoal or carbon, combined with a salt of soda, potash, iron, manganese, or the like."

Monasty's Process.—A patent taken out by Eugene Monasty in May 1873. According to the specification, sewage is treated with plaster or sulphate of lime, tar, wood—charcoal acid—phosphate of magnesia, phosphate or sulphate of iron, ammonia, sulphur, saltpetre, phosphoric acid, and nitrate of soda.

Hughan's Process.—Another patent taken out in the same year by W. H. Hughan of Lancaster, treats sewage, nightsoil, &c., by employing materials such as peat, sand, sawdust, coal, coke, sea-weed or other vegetable matters, and also domestic, town, farm, or other refuse or sweepings or ashes, in conjunction with clay, sand, Portland or other cement, magnesia or magnesian limestone, salt, or mixtures of two or more of the same, in order that the resulting combination, after having been submitted to a carbonising process, shall form what is termed a cement or carbonised product.

Treatment with Chlorides of Aluminum, Iron, &c.—Mr. Rich has patented a process for the treatment of aluminous schist with sulphurous acid gas, air, and steam ; and by subsequent lixiviation, the production of a liquor containing the sulphates of aluminum, iron, and magnesium. Under another patent he treats the liquor thus produced with chloride of sodium, and separates sulphate of sodium. By using a proper proportion of sodium chloride, a concentrated solution remains, containing the chlorides of aluminum, iron, and magnesium. This liquid may be used for treating sewage, or it may be first treated with a proportion of the original sufficient to convert the magnesium chloride into sulphate, which may be crystallised out, and the concentrated solution of aluminum and iron chlorides used for sewage purposes.

There are yet other processes, such as treatment with perchloride of iron alone, with chloride of iron, with carbolates of lime and magnesia, &c. Of these the perchloride of iron as a precipitant would appear to be the best.

Irrigation and Filtration.—Direct intermittent irrigation, where possible, and where it does not create a nuisance, is without doubt one of the best and most profitable methods of dealing with sewage; but where it is carried to a place by open conduits, pounded up in a foul cesspit, only to be let off occasionally, or where a farm is converted from well-drained ground into a loathsome swamp by simply observing no relation between the amount of land and the quantity of sewage, under such circumstances it is the worst method of dealing with sewage possible.

Irrigation is employed with two distinct objects, which ought to be combined—viz., the first is to apply the sewage for the purposes of agriculture, and the second merely to filter the sewage through earth, so that the effluent water may be so deodorised and purified that it may be allowed to enter a watercourse.

There can be no doubt of the purifying power of earth, and that sewage percolating through earth, provided there is a proper ratio between the volume of the sewage and the area of the earth, may be entirely deprived of its nitrogenous and putrescent matters.

Professor Way, in his evidence before the Select Committee on the Sewage of Towns, said: "In soils there resides a power, which previously to my examinations I believe was not recognised, to separate from liquids containing manure—containing ammonia, for instance, and potash, and phosphoric acid, and magnesia, that is to say, all the important elements of manure—these elements, to separate them from water, not by mere filtration, because these things would pass through a filter, but by the peculiar chemical attraction possessed by the ingredients of a fertile soil for these liquids; so that if we were passing a liquid containing manurial matters through a given quantity of soil, the water would pass through and these matters would be retained and fixed in the soil. I look upon this as a great arrangement and provision of nature for the preservation of manuring principles from being washed out of the soil by rains."

The Royal Commissioners thus strongly express themselves in favour of sewage irrigation: "We are therefore justified in recommending irrigation as a safe as well as profitable and efficient method of cleansing town sewage. Both safety and efficiency, however, of course depend upon the proper performance of the work; the profits of the process also hinge on this."

In order that the process may be carried out satisfactorily, it is necessary—

1. That the acreage be sufficient. This will depend in great measure on the looseness or porosity of the soil.

2. The land to be irrigated must be drained, and stiff clayey soils broken up and mixed with ashes, sand, or lime.

3. The surface must be irrigated on the intermittent system, to ensure sufficient aëration of the soil.

4. The ground should be laid out in broad ridges and furrows, the sewage being conveyed along the tops of the ridges in open carriers, and made to flow gently down the slopes by inserting temporary sluices in regular succession and at regular intervals. At Breton's Farm, near Romford, rented by Mr. Hope, the breadth of the ridge is 30 feet, giving a slope of 15 feet on either side of the carriers.

5. There must be a rotation of crops, such as ryegrass, peas, maize, different roots, cabbages, &c.

6. The sewage should be delivered in a fresh state, and freed from the greater portion of its suspended matters by precipitation, filtration, or screening.

We will now examine a few of the results of irrigation.

In very small towns, and in those villages where sewers exist, the most common method is to place the outfall of their sewers in a field and distribute it either continuously over it, or have a catchpit from which they let it out when required. In the continuous system carried on under such circumstances, with the outfall remote from houses, there is no nuisance, and the crops are productive. Such irrigation is indeed irrigation under very favourable circumstances; the amount of sewage is not excessive, and the fields never get saturated. The results of irrigation in Bedford, Warwick, Banbury, Romford, and the Lodge Farm, Barking, appear to be favourable.

At Bedford, in 1869, 47 acres under irrigation gave crops the total value of which was £647. A sewage farm receiving 300,000 gallons a day from Banbury produces good crops of mangolds, ryegrass, &c.

In Edinburgh, sewage irrigation (according to Mr. Miller, the proprietor of Craigentinny Meadows) has been going on for the last 200 years. The increase in the value of the land is remarkable. "The land which formerly let at from 40s. to £6 per Scotch acre is now let annually from £30 to £40; and poor sandy land on the sea-shore, which might be worth 2s. 6d. per acre, lets at an annual rent of from £15 to £20."

Irrigation systems are carried out at Milan, Walford, Carlisle, Warwick, Worthing, Colney Hatch, and many other large towns with somewhat similar results.

Downward Intermittent Filtration.—Where towns can obtain and prepare land favourably situated for this kind of irrigation, there can hardly be a better or more successful plan.

The conditions necessary for success are—"1. The soil of the land to be used must be porous. 2. A main effluent drain, which must not be less than 6 feet from the surface, must be provided. 3. The surface of the soil to be so inclined as to permit the sewage stream to flow over the whole land. 4. The filtering area should be divided into four equal parts, each part to be irrigated with the sewage for six hours, and then an interval of eighteen hours to elapse before a second irrigation takes place; each of the four parts would thus be used for six hours out of the twenty-four. An acre of land so prepared would purify 100,000 gallons of sewage per day." — (On the Downward Intermittent Filtration of Sewage at Troedyrhiw, near Merthyr-Tydvil, by T. J. Dyke, F.R.C.S.)

At Troedyrhiw, near Merthyr-Tydvil, the sewage is first treated with lime, and is strained in special tanks through cinders; it then flows on to the conduit, which conveys it to—

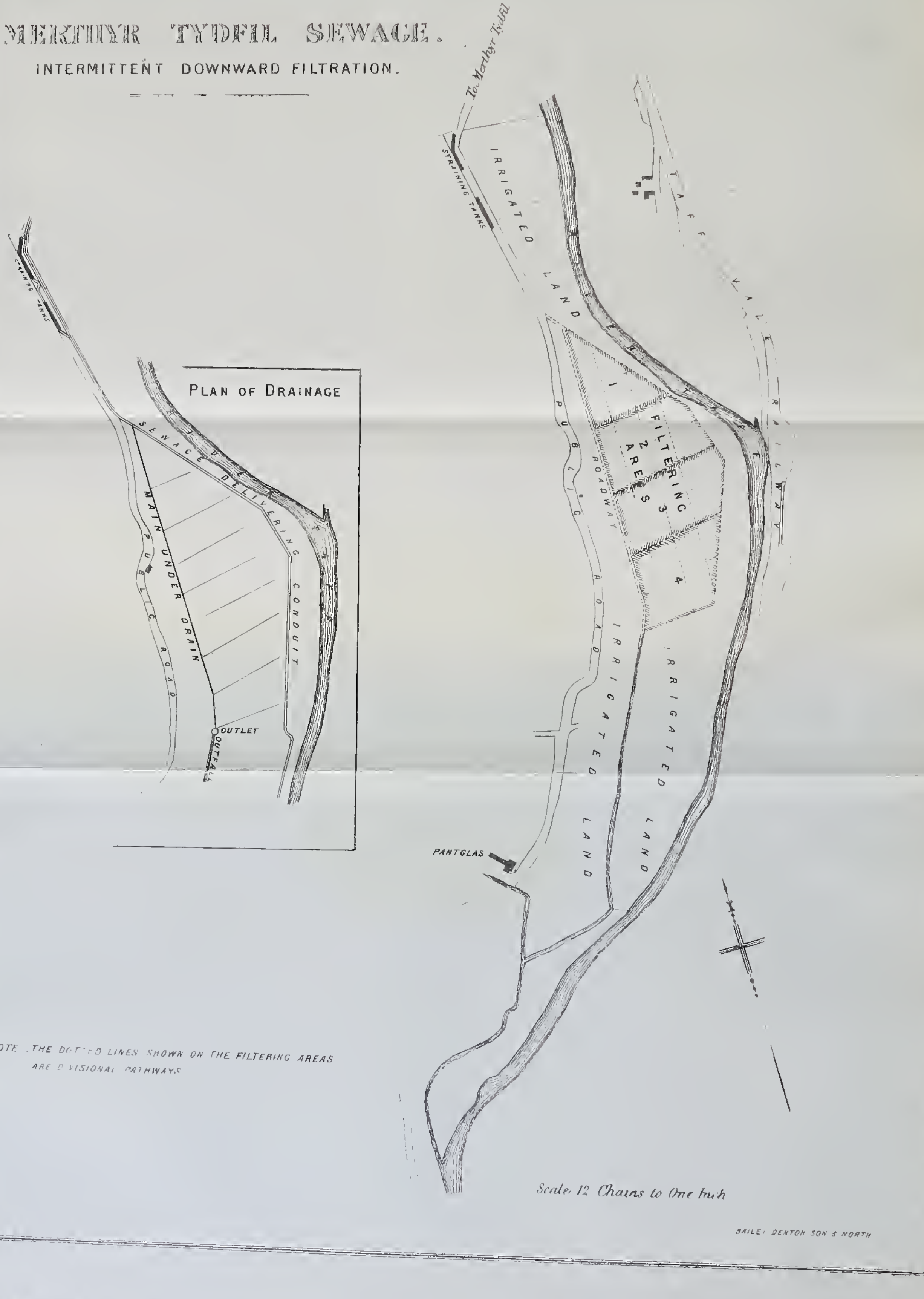
"*The Filtering Areas.*—About 20 acres of the land, immediately adjoining the road on which the tanks are placed, have been arranged into filtering areas or beds on a plan devised by Mr. J. Bailey Denton (*see* plan). The land is a loamy soil, 18 inches thick, overlying a bed of gravel. The whole of these 20 acres have been under-drained to a depth of from 5 to 7 feet. The lateral drains are placed at regular distances from each other, and run towards the main or effluent drain. This is everywhere 6 feet deep. The surface of the land is formed into beds; these have been made to slope towards the main drain by a fall of 1 in 150. The surface is ploughed in ridges; on these vegetables are planted or seeds sown; the line of the ridged furrow is in the direction of the under-drain. Along the raised margin of each bed in each area delivering carriers are placed, one edge being slightly depressed. The strained sewage passes from the conduits into the delivering carriers, and as it overflows the depressed edges, runs gently into and along the furrows down to the lowest and most distant part of the plot. The sewage continues to be so delivered for six hours; then an interval of rest of eighteen hours takes place, and again the land is thoroughly charged with the fertilising stream. The water percolates through the 6 feet of earth, and reaches the lateral drains, which convey it to the main effluent drain.

"The result of this plan of disposing of sewage, by downward intermittent filtration, may be seen in samples of the effluent water taken from the outlet of the main drain. Such water is bright, perfectly pellucid, free from smell, and tastes only of common salt. It may safely be drunk—in fact, is used by the workmen employed on the farm. During the process of irrigation no nuisance is caused, for the soil quickly absorbs all the fluids passed on to it; in fact, in two or three hours after the water has ceased to flow on the land, an observer would say that the ground had not been wetted for days. The workmen say that no unpleasant smell is noticed, nor has the health of the persons employed, in any one instance, been affected by any presumed poisonous exhalation. The only imperfection of the plan is that at the end of the furrows, nearest the lowest corner of a plot, a slight deposit of scum is found. This scum is formed by the fine insoluble precipitate, caused mainly by the addition of lime to the sewage stream. On the ridges of this prepared soil, cabbages, broccoli, carrots, turnips, parsnips, beans, peas, lettuces, onions, &c., are grown.

"*Irrigation Land.*—Adjoining the filtration areas, the town surveyor has laid out 55 acres to be used as irrigation lands. The whole has been drained by deep lateral drains running towards the main effluent drain. The

MERTHYR TYDFIL SEWAGE.

INTERMITTENT DOWNWARD FILTRATION.



NOTE. THE DOTTED LINES SHOWN ON THE FILTERING AREAS ARE DIVISIONAL PATHWAYS.

Scale, 12 Chains to One Inch

BAILEY DENTON SON & NORTH

principle adopted in the filtration areas, of allowing the sewage stream, flowing over each square yard of surface, to percolate through 2 cubic yards of soil, and thence to pass into the efflux, has been faithfully carried out, and the results, in every point of view, have been as satisfactory as those afforded by the filtration areas.

"In addition to these 55 acres, 160 acres of the lands taken under the powers of the Act of Parliament are now being prepared as irrigation lands; thus with the 20 acres of filtering areas, 235 acres of land will eventually be used for the reception and utilisation of the strained sewage of about 40,000 persons."

The *chemical results* are as follows:—

RESULTS of ANALYSIS expressed in Parts per 100,000 (Dr. ED. FRANKLAND).

Description.	Total Solid Impurity.	Organic Carbon.	Organic Nitrogen.	Ammonia.	Nitrogen as Nitrates and Nitrites	Total combined Nitrogen.		Chlorine.	Suspended Matters.		
									Mineral.	Organic.	Total.
Permitted by proposed Standards of Purity	Unlimited	2·000	0·300	Unlimited	Unlimited	Unlimited	...	Unlimited	3·00	1·00	...
Merthyr sewage, after treatment with lime, but before intermittent filtration, June 19, 1871........	54·00	2·788	0·783	4·854	...	4·780	...	0 700	6·68	10·12	16·80
Ditto, after intermittent filtration, June 19, 1871	34 60	0·249	0·056	0·075	0·231	0·349	...	0·300	trace	trace	traces
Merthyr sewage, after treatment with lime, but before intermittent filtration, October 20, 1871	40·20	1·282	0·952	1·280	0·052	2 058	...	5·25	7·88	6·56	14 44
Ditto, after intermittent filtration, October 20, 1871	33·48	0·323	0 107	0·058	0·300	0·455	...	2 60	trace	trace	traces
Mean of sewage, after addition of lime	51·60	2 035	0·867	3·067	0·052	3·419	...	6·12	7·23	8·34	15·62
Ditto, after intermittent filtration	34 04	0·286	0·081	0·066	0·265	0·402	...	2·80	trace	trace	traces
Total organic matter, after liming	...	...	...	...	...	...	5·454				
Ditto, after filtration	...	...	...	...	...	...	0·688				

"*Money Results.*—Upon 10 acres of the land prepared according to Mr Bailey Denton's plans, cabbages were planted and mangolds sown in June 1871. On the 30th August, seventy-seven days after the commencement of planting, &c., part of the crop was offered for sale by auction, and realised £17, 15s. per acre. In the present year the whole of the 20 acres are under crops. I have been informed by our surveyor that from some of the divisions planted with cabbages, the average gross return will be £27 an acre. A small plot, on which broad beans are being grown, has been sold for £40 an acre. On the 55 acres of irrigated land the crops are more productive. Italian rye-grass will yield five crops this season, averaging 60 tons an acre, and yielding a net profit of £24 an acre. A plot of cabbages (48 perches) planted in October has yielded a gross sum averaging £43 an acre. A plot of onions has lately been sold at the rate of £64 an acre.

"*General Results.*—These may be summarised in the words of the Rivers Pollution Commissioners, lately presented to Parliament: 'The experience of these filter beds at Merthyr has made plain what the experiments in our laboratory had previously established. Towns can cleanse their sewage within a much less quantity of land than any experience hitherto had might lead them to expect. Sewage irrigation (in which the quantity of land thus used bears a large proportion to the volume of the sewage cleansed) offers the great advantage of a remunerative return. Intermittent filtration (in which the quantity of land employed bears a very much smaller proportion to the volume of sewage to be cleansed) may also now be confidently accepted as a sufficient remedy for the sewage nuisance. These two methods are essentially one, wherever thorough drainage accompanies—as it always should—the extensive form of irrigation, and they are the only methods which are perfectly trustworthy for the abatement of this sewage nuisance.'

"In summarising these remarks, I would lay before you the following propositions as conveying my notions of a perfect system for the disposal and utilisation of excreta: 1. In order to diminish and limit to the smallest possible degree the chemical action which results when human or animal excretions are dissolved in water, the transmission and delivery of the sewage-water on the land prepared for its reception should be effected in the shortest possible time. By means of the system of sewers and drains planned and formed by our town surveyor, the time occupied by the water in passing from the furthest point (5 miles) of the system to the filtering areas does not exceed two hours. 2. The sewage-water should be delivered on the land in such a state that the rootlets of plants can at once absorb and assimilate it. In our old botanical studies you will remember that we were taught that each rootlet of a plant, formed of cellular tissue, was closed at its extremity—that is, was covered as the papillæ of the tongue are by mucous membrane, or as the end of the finger is covered by the skin. We were also taught that the fluids on which plants live were absorbed through the substance of that covering tissue, hence it was only that which was dissolved in water that the rootlet could take up. 3. I hold that no attempt should be made to precipitate from the sewage-water any of the fertilising materials it holds in solution, for as sewage-water does not hold in solution more of these fertilising matters than the earth can store, or the rootlets of a plant absorb, so to precipitate therefrom any of the dissolved matter is a waste of the fertilising material. 4. All insoluble matters floating in the stream should be removed by mechanical means. The extractor invented by Mr. Baldwin Latham seems well fitted for the purpose. 5. All fertilising matters, as yet undissolved, suspended in the stream, should be removed by proper filters, and then treated by such chemical and mechanical means as may tend to render them soluble. The filter formed by Mr. Harpur, and in use at the filtering areas, with the addition of the layer of sand, which comes down with the stream, fulfils the first of these requirements well. The second is a desideratum. 6. The sewage-water thus freed from insoluble matters, and from soluble matters as yet undissolved, being passed on to lands, prepared according to the principle suggested by Dr. Edward Frankland, and carried out according to the scheme of Mr. J. Bailey Denton, should so pass on to, through, and out of the soil, as to leave no scum on the surface of the soil, nor any polluting substance in the effluent water."—(*Op. cit.*)

Mr. Bailey Denton has recently greatly improved filtration and irrigation processes by constructing an apparatus which he calls "the automatic sewage-meter." It would appear to be suitable in a great variety of cases. It is thus described:—

"The object of this patent is to regulate the quantity of sewage delivered to land for either irrigation or intermittent filtration, independently of the flow or the delivery, which, as already pointed out, may be extremely variable, and so little at times that it would be absorbed within a few yards of the sewer-mouth. For this purpose the sewage, as it is discharged from the town, village, or mansion—whether in a dribble or in a copious stream—is allowed to flow into a tank called 'the meter-tank,' of such capacity that when it is full it holds the precise quantity which it is desired to deliver to a given area of land at one time. This tank is provided with a siphon outlet, which comes into action automatically as soon as the collected liquid rises to a given level. When this is the case, the contents flow out of the tank by the siphon until the level of the liquid in the tank sinks down to the inlet or inner mouth of the siphon, when, air being admitted, the discharge ceases. The tank will then again fill, slowly or quickly, according to the rate of influx, when the discharge will be repeated, and the liquid applied to the same land (after the interim of time required to refill the tank), or to other areas or beds as may be desired; and this automatic action will take place during the night, when there will be no one to guide the delivery, if the channels are prepared to receive it, with the same effect as during the day, when there may be attendants at hand. Between the mouth of the sewer (H in figs. 79 and 80) from the town, village, or mansion, and the 'meter-tank,' there are two chambers, the first (C), called the 'sluice-chamber,' in which are as many outlet pipes with sluices attached as there are meter-tanks, by which the sewage can be let into one or other of the meter-tanks as desired; and in this sluice-chamber there is also fixed a storm overflow (G), which at times of great downfalls of rain will dispose of any surplus liquid the meter-tank will not take. The other chamber (B) is called the 'straining-chamber,' the object of which is to intercept, separate, and retain the coarser particles, and allow the remainder to find its way into the meter-tank (A) through a double grating, with coarse filtering material placed between to help the straining. If it be further desired to clarify the liquid by separating the finer solid matter held in suspension from the liquid before it is discharged by the siphon, the tank may be deepened below the inlet or inner mouth of the siphon, so as to afford sufficient space to hold any desired quantity of the deposited matter; and this may be readily consolidated for removal by various means, such as making a false floor, under which filtering material may be placed, and through which any liquid detained with the deposited matter may be drained away into a well or cistern, from which it may be raised and added to the sewage under treatment. In the accompanying drawings of the tanks it will be seen that there is no special provision made for the deposition of the finer solid matter below the siphon; but this description will suffice to explain how it can be done. In small cases, however, this

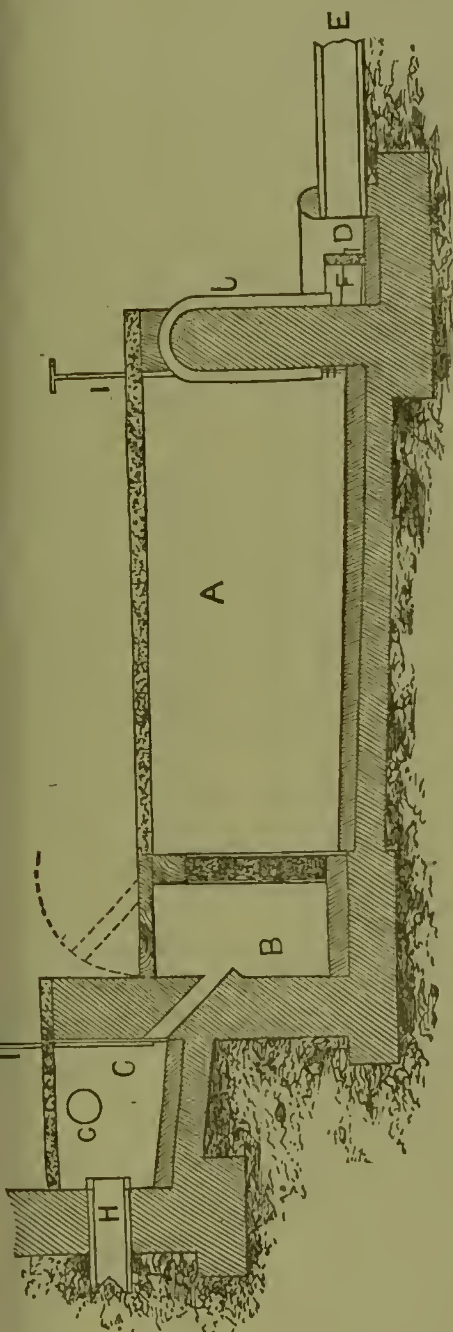


Fig. 79.—The Sewage Meter-Tank (Section).*

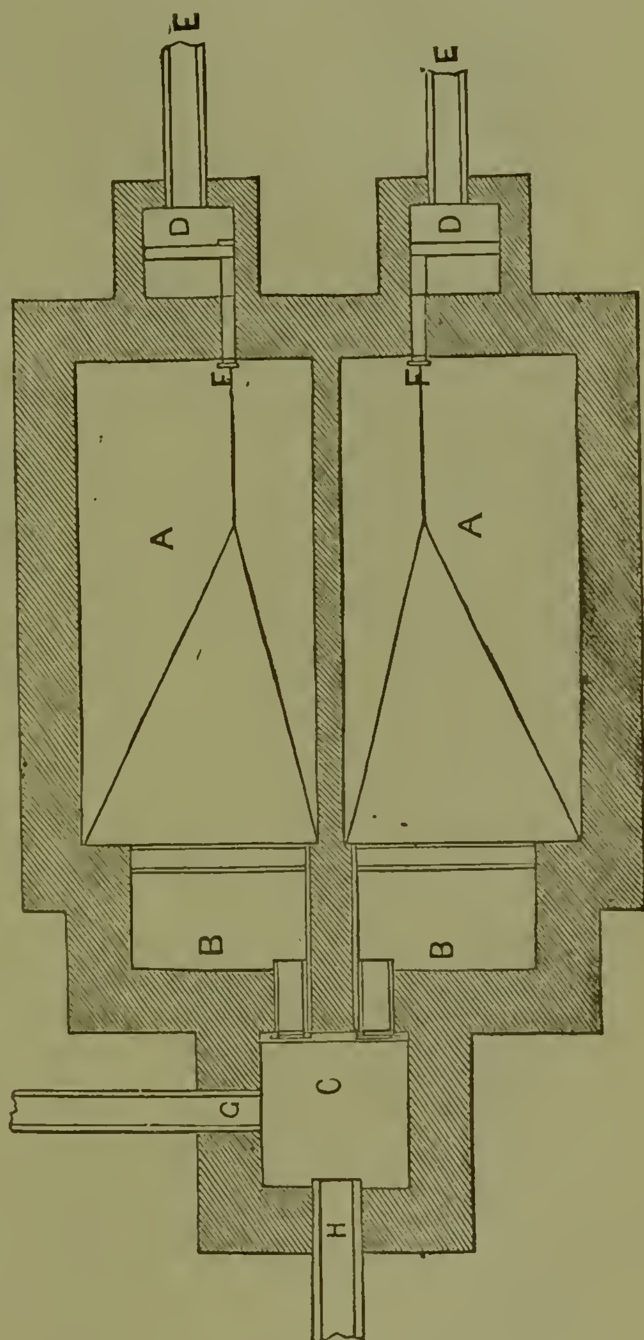


Fig. 80.—The Sewage Meter-Tank (Plan.)

will be unnecessary. Any deposition then taking place may be washed or flushed out as occasion requires through a pipe, and will find its way with the liquid sewage from the meter-tank on to the land to be dug or ploughed in.

"It will be understood from this description that as often as the sewage is discharged from the meter-tank by the siphon, it flows by the

* These diagrams are reproduced from Morton's "Farmer's Almanack."

delivering conduit to the precise area intended to receive it, and that to secure this automatic service during the night, if the meter-tank should fill, it is only necessary that the attendant, before leaving in the evening, should place the stops in the carriers and in the furrows, to ensure as even a delivery and distribution in the dark as in the broad daylight. The sewage collected in the meter-tank (which may have taken many hours to fill) will often be discharged in a comparatively few minutes, but the rate of discharge may be controlled by regulating the size of the siphon, or by a tap in the outfall limb of the siphon, so as to deliver just the quantity required to ensure even distribution under every variety of circumstances.

"From this explanation it will be seen that several of the difficulties attending the disposal of the sewage of small communities may be overcome by the use of the sewage-meter, and the expenses reduced by its adoption; and that as *intermittency* of application is essentially and necessarily the basis of action, a comparatively small quantity of land will suffice, though the facility with which the sewage may be turned from one plot of land to another, or from one crop to another, must be as favourable to irrigation when it is intended to economise the sewage, as to filtration, where the object is to economise land.

"In villages of 400 inhabitants, discharging 5000 gallons of sewage daily, one tank to hold 1250 gallons, with 2 or 3 acres of land to receive the sewage, will be an ample provision. The dimensions of the tank might be 10 feet by 5 feet, and 4 feet deep, or an equivalent.

"For isolated mansions smaller tanks and less land will of course suffice to secure to the occupiers freedom from those evils which attend the present arrangement of leaky cesspools with excrement-sodden soil surrounding their dwellings.

"In addition to the advantages already described, the following objects are secured in the automatic sewage-meter:—

"1. Economy in construction and first cost.

"2. Economy in space occupied by the meter-tanks, compared with the ordinary depositing and filtering tanks.

"3. Economy in labour and supervision; the whole of the arrangements being self-acting, and not requiring either special attention, skilled labour, or night control.

"4. Economy in maintenance, there being no moving parts in the automatic apparatus.

"5. Absence from nuisance — the liquid sewage being drawn off frequently in predetermined quantities, and any deposited putrescent matter being covered with fresh liquid sewage as it comes into the meter daily."

4. *Summary of the Methods of dealing with Sewage:—*

(1.) Places of deposit—such as privies, catch-pits, cesspools — unless made of absolutely water-tight materials, hermetically sealed, of small size, and frequently emptied, are a great nuisance and productive of injury to health.

(2.) Dry-earth systems are not suitable for towns, or for ignorant people; the system works excellently in the few places where there is proper control.

(3.) For towns, Captain Liernur's pneumatic system is most decidedly the best on the score of health; but the water-carriage system having been long used in large towns, and proved fairly efficient, it will probably be some time before this excellent process becomes common.

(4.) Of the different manufacturing processes by which it is attempted—by precipitation, carbonisation, and other means—to make an artificial manure, or other marketable product, we can only say that all such processes being commercial must be judged of by their commercial value. Experiments of this kind belong to capitalists rather than to sanitary authorities or local boards. There is, however, no doubt that some of the processes described may eventually become of great value, as they are now under trial in many places, and a few years will give the money and health results.

(5.) Irrigation and filtration have been proved incontestably both safe and profitable, provided these methods are carried out in a proper manner. We may say that:

"(*a.*) By careful and well-conducted sewage-irrigation, especially with the application of moderate quantities per acre, the purification of the whole liquid refuse of a town is practically perfect, and has been ensured in cases where it was not at all the object of the agriculturist; and that it is the only process known by which that purification can be effected on a large or small scale.

"(*b.*) That perfectly worthless land—blowing sea-sand, for instance—can be made in this way to support large and valuable crops.

"(*c.*) That the quantity per acre of all crops obtained from even the best land is enormously increased.

"(*d.*) That it reduces to a great extent, or renders entirely unnecessary, the usual amount of artificial manures of all kinds, by supplying a manure especially adapted, from its complex constitution, for the nourishment of crops, supplying it, moreover, in a state of solution—that is to say, in the most readily absorbable condition, and supplying at the same time that most necessary aid to vegetation, water, which often converts what would otherwise have been a very heavy loss into a very handsome profit.

"(*e.*) That by it the farmer is rendered entirely independent of drought, so that he can be practically certain of his crops, and, moreover, be able to transplant them as much as he pleases.

"(*f.*) That, with all these advantages, it is no wonder that it has been found to pay; and when its management is more thoroughly understood, it will doubtless be found to be a valuable source of income to towns."—(CORFIELD'S Treatment and Utilisation of Sewage, 2d edit.)

The chemical aspects of the different processes are summarised by Dr. Frankland in the following table:—

Name of Process.	Average Percentage of dissolved Organic Pollution removed.		Average Percentage of suspended Organic Pollution removed.
	Organic Carbon.	Organic Nitrogen.	
Chemical processes—			
Best result . . .	50·1	65·8	00·0
Worst result . . .	3·4	0·0	59·6
Average result . .	28·4	36·6	39·8
Upward filtration—			
Best result . . .	50·7	65·5	100·0
Worst result . . .	0·6	12·4	100·0
Average result . .	26·3	43·7	100·0
Downward intermittent filtration—			
Best result . . .	88·5	97·5	100·0
Worst result . . .	32·8	43·7	100·0
Average result . .	72·8	87·6	100·0
Irrigation—			
Best result . . .	91·8	97·4	100·0
Worst result . . .	42·7	44·1	84·9
Average result . .	68·6	81·7	97·7

5. *Value of Sewage.*—The sum of 6s. 8d. is the lowest value that has been assigned to the annual excreta of one individual, so that some idea may be obtained from this of the value of the sewage from any town by calculation of the number of inhabitants, and an analysis of several samples. The variable dilution unfortunately renders results obtained in this way extremely unsatisfactory. The chief substances of value in sewage are those which give the value to guano—viz., the nitrogenous matters, the phosphoric acid, and the salts of potash. The value given by the Rivers Pollution Commissioners is as follows: "The money value of these constituents dissolved in 100 tons of average sewage is about 15s., while the *suspended matters* contain only about 2s. worth of them—that is to say, that 100 tons of average sewage are worth 17s., or about 2d. a ton."

Others have estimated 1250 tons of liquid sewage as equivalent to 1 ton of guano. According to this estimate, the total amount of sewage on the north side of the metropolis—viz., 36,967,285,300 gallons yearly, or 168,033,115 tons—equals in value 134,426 tons of ordinary guano.

The total annual amount of London sewage, according to Baron Liebig and Mr. Ellis's estimate, is 266,000,000 tons; this, at 1d. a ton, equals £1,108,333, 6s. 8d. Baron Liebig indeed gave the very high and improbable estimate of its total value as £4,081,430 sterling. Hoffman and Wit's estimate is most likely as near the truth as any. They estimated the metropolitan sewage, without rainfall, to be 95,000,000 gallons daily, or about 158,000,000 tons* per annum, and worth £1,385,450 yearly. Such figures speak for themselves, and are a strong argument against waste. At the same time it must be remembered that the amount of worthless stuff in sewage is excessive, and brings to mind Professor Way's remark: "I say that if a man owes me the value of an ounce of gold (£4, 15s.), and if he comes and gives me a ton of quartz and says, 'There is an ounce of gold in this ton of quartz,' it is not paying me. That is precisely the condition of the sewage."

Sewage, Analysis of.—The solid residue, suspended matters, nitrates, chlorine, and nitrogen, are determined in exactly the same manner as in WATER-ANALYSIS, *which see.* It is of course obvious that in determining both kinds of ammonia only 5 or 10 cubic centimetres of sewage should be taken, added to some pure distilled water, and then proceeded with in the usual way.

To determine the phosphoric acid a considerable quantity should be evaporated down, so as to get about a gramme of solids. One part of this solid matter should be mixed with one part of carbonate of soda and one of nitrate of potash, and ignited. The residue is dissolved in hydrochloric acid, evaporated to dryness in the water-bath, treated with hydrochloric acid and water filtered; then ammonia is added to filtrate until alkaline, the phosphate of lime, which usually falls, is dissolved by acetic acid; and lastly acetate of sesquioxide of uranium is added. The fluid is heated to boiling, and a yellow phosphate of sesquioxide of uranium and ammonia separates. The precipitate is washed, dried, and ignited; it should be the colour of the yolk of an egg. 19·91 parts in every 100 of the precipitate, or about one-fifth, is phosphoric acid.

6. *Sewage, Deodorisation or Disinfection of.*—The different substances described under DISINFECTANTS and DISINFECTION, and most of the precipitating substances mentioned under *Precipitation Processes* (pp. 521–523),

* 220 gallons weigh a ton.

may be used with more or less success for the disinfection of sewage. We will here merely mention a few of the best disinfectants, whether as applied to a system of sewers or a mass of liquid sewage.

Perchloride of Iron—1 gallon of perchloride suffices for 15,000 gallons of sewage.

Sulphate of Iron—1 lb. dissolved in 8 gallons of water for 1000 gallons of sewage.

Carbolic Acid—3 gallons of the dilute acid to 1000 gallons of sewage.

Süvern's Deodorant—It is made thus: A bushel and a half of good quicklime is put in a cask, slaked, and 10 lbs. of coal tar thoroughly mixed with it; to this 15 lbs. of magnesium chloride dissolved in hot water is added, and finally additional hot water is poured in sufficient to make a mass liquid enough to drop from a stick inserted in it and then pulled out. The magnesium chloride forms deliquescent calcium chloride, and prevents the caking of the deodorant and the adherence to pipes.

Any one of the above used in proper and sufficient quantity is an effectual disinfectant and deodoriser of sewage.

Sewage as a Cause of Disease.—That the sewer gas does occasionally give rise to symptoms belonging to no known disease, to symptoms, in short, of poisoning, is without doubt. For example, Dr. Handfield Jones relates some remarkable cases in the "Medical Times and Gazette," 1871, vol. ii. p. 9, clearly attributable to sewer emanations. The first of these, a man, aged forty-nine, was taken with giddiness and shortness of breath whilst at work in a sewer which stank very badly. He complained of feeling numb all over, and there was œdema in the feet and legs; the abdomen was tumid, and the urine was albuminous. He was ill about three weeks.

The second case was a man aged forty-nine. In passing a gullyhole he was conscious of a most disagreeable odour. In half an hour he was taken with severe vomiting, which lasted all day. He was admitted into the hospital, and suffered from cramp, sickness, dimness of sight, &c. There was no diarrhœa nor other evident cause.

Dr. Handfield Jones also quotes a case from the Sydenham Society's Year-Book, in which a ground labourer, aged forty, after working for three hours in a sewer, was compelled to leave off on account of the horribly stinking atmosphere. He was ill for several days, and suffered from languor, anorexia, and sleeplessness, with slight nocturnal delirium. There was no fever, but slight jaundice, and on the eighth day hæmorrhage from the nares and pharynx supervened.

In Dr. Jones's remarks on the case he says, "In conclusion, let me observe, that as these were cases of acute poisoning by sewer emanations, so undoubtedly cases of chronic and slight poisoning by the same agent are vastly frequent."

As the germs of typhoid fever exist in some sewage in incredible number, it occasionally must happen that this disease is propagated by irrigation. Such an instance appears to have happened in Ecton, a parish in which are situated the Northamptonshire Irrigation Meadows. Dr. Buchanan, who inquired into it, thus summarises the case: "The facts of the Ecton occurrences, therefore, are now pretty clear. In the early days of July last, ten people are working on a meadow through which runs a brook containing Northampton sewage, of which a part is formed by the excrement of patients with enteric fever. Some at least of the ten people employed in this meadow drink of the brook, in ignorance of the nature of its contents. Almost all the workers become sick. Two of them, who cannot be followed, get diarrhœa; a third gets a protracted diarrhœa, which bears resemblance to that of enteric fever; a fourth and a fifth get distinct enteric fever, one of them ten days after the other. Of the two latter, first one and then the other goes home and infects the common privy, and doubtless the well of the yard in which their house stands. Other people living in that yard, themselves having nothing to do with Northampton sewage, begin to sicken with enteric fever two or three weeks after this introduction of the disease among them, and fall ill one after the other of the same fever, until fourteen out of the eighteen residents there have been attacked. Meanwhile, among the other 600 residents, there is no case of fever, except a solitary and presumably imported one. On the other hand, out of 120 people at work upon the sewage farm itself, there is no single case that can be affirmed to be fever, and the only case of illness that can be heard of is a case of diarrhœa."

Such isolated outbreaks are to be attributed to carelessness and want of knowledge. They are certainly exceptional—more so, indeed, than from theory one would imagine. There appears to be danger from drinking the water flowing from, but little in walking over, an irrigated soil.

The manufactories of manure at Bondy, near Paris, appear to be healthy, nor is there a history of the propagation of fever in any of the irrigation processes, save and except the one quoted above.

Sewage pent up in sewers, cesspools, or percolating into and infecting the soil and water near dwelling-houses, is certainly most injurious, quite irrespective of the propagation of cholera, typhoid and scarlet fever, &c.; but sewage in manure-works, undergoing chemical processes, and sewage in the open air, remote from houses, irrigating fields, is only in rare instances hurtful to health, altheugh at the same time it may be an annoyance, and therefore a nuisance.

The bad effects of human sewage on cattle appear to be *nil;* they grow and fatten on the most sewage-sodden soil, nor has there been an increase, as was feared, of entozoa in their bedies.

Sewers, Drains, &c.

Sewers.—The word "sewer" in its most extended sense is used to signify a channel (which is generally covered) for the reception and removal of impure and refuse liquids holding solid matter iu suspension derived from two or more habitations. The Public Health Act distinguishes for the purpose of the Act the word "sewer" and "drain" as follows:—

"'Drain' means any drain of and used for the drainage of one building only, or premises within the same curtilage, and made merely for the purpose of communicating therefrom with a cesspool or other like receptacle for drainage, or with a sewer into which the drainage of two or more buildings or premises occupied by different persons is conveyed.

"'Sewer' includes sewers and drains of every description, except drains to which the word 'drain' interpreted as aforesaid applies."

It hence follows that it is not the size or shape of a channel which determines whether it be a sewer or not, but its office, and whether it is used by more than one house.

The most ancient sewers—as, for instance, the *cloaca maxima* of Rome—were built to carry off rain and subsoil water, and hence they termiuated in the nearest watercourse. They afterwards were made channels for the removal of excreta, because it was the easiest and most obvious appliance.

The old sewers of modern towns were mostly open and extremely ill-constructed. Take, for example, the ancient system at Paris, which is thus described by Tardieu:—

"The Seine, the Meuilmontant, and the Bièvre have ever been the great outlets for Paris. It was towards these three lines of drainage that the ancient inhabitants directed their slops and surface-water, by means of gutters carried across the fields which surrounded the groups of houses forming the town. At a later period a part of the *fosses des enceintes* of Philip Augustus and Charles VI. also received the filthy waters of Paris. All the sewers, open, and for the most part badly levelled too, rapidly filled with refuse and stagnant water, and infected the air. They were little by little cleansed aud improved. The worst were suppressed; the bottoms and sides of others were built in masonry; and lastly, they thought of covering them with flags or stones."

A great change has taken place since those times, for Paris is now one of the most completely sewered cities in the world. Underneath all the principal streets, not only sewers but subways are constructed, the tributary mains are named, and the house drains numbered. "The total length of these sewers is about 170,000 metres, which added to the 290,000 metres in course of construction, and to the 80,000 metres which will perhaps be at some future time opened, may bring the number to 135 leagues as the total length of the subterraneous canals of Paris."—(Tardieu, 1862.)

Human excrement to a certain extent exists iu all sewers, but in some towns there have been attempts made to keep it entirely out of the sewers. For instance, in Paris the system of *fosses permanentes* and *fosses mebiles* diverts the bulk of the excreta away from the ordinary channels. It would also appear, from the discovery of enormous pits in Rome by Dr. Parker, that the main portion of the Roman sewage was collected in these pits, and did not find its way into the subterraneous conduits.

It is extremely important ever to remember that sewers and sewage not containing human excreta, and not communicating with water-closets, &c., are quite as offensive as if there were communication with privies and water-closets; still, as they do not contain the excretions of man, it necessarily follows that the germs of those contagious diseases which are found in typhoid, &c., are probably absent, and that any disease which such sewers may give rise to would be merely from the effect of putrid emanations.

Construction of Sewers. — Although the original idea of a sewer was the natural outcome of draining the subsoil, it is dangerous to construct the sewer of pervious materials, under the idea of making it a drain as well; sewers must be impervious. The larger kind are usually made of bricks specially moulded to radii, aud set in cement; the smaller are constructed with socketed pipes, the joints made water-tight with clay puddle, and the whole generally laid on a bed of concrete to prevent sinking of any portion of the track.

Shape of Sewers.—All main sewers of large towns should be oval; the section preferred is egg-shaped, the smaller end of the oval pointing downwards. The advantage of this particular shape is twofold: the sewers are stronger and more economical; and, besides, there is greater efficiency, for when the water is small in amount, the narrowness of the lower part gives a greater hydraulic depth, and when the body of water is increased, more capacity is obtained.

The smaller sewers or sewer drains are best constructed of round pipes. It is difficult to obtain accurate ovals with earthenware pipes—that is, so that each pipe will have exactly the same section—and in smaller drains the difference in shape is not practically of importance.

The old square brick drains are the worst, as to construction, efficiency, and economy, that can well be conceived. There is a maximum of friction and porosity; in addition to which, the rats burrow in them, so that the sewage may find its way into wells a considerable distance from the drains.

The Size of Sewers.—This must greatly depend upon whether they are intended to take storm-water as well as sewage, or not. The best way is to have separate brick drains for the surface and subsoil water, the brick drains being superficial and the sewers deep.

"It is calculated that a main sewer intended to receive all the sewage of a thickly-populated square quarter of a mile, with a water-supply of 20 gallons a head, and also the rainfall of the same surface, would only actually require for these purposes a sectional area of 4 feet square, but that practically, in order to provide for sudden storms, this size would have to be at least doubled."

A size much less than this would suffice if there were separate channels for the rainfall. Some of the sizes in actual use are as follows:—

"In London, in the streets the brick sewers are from 4 feet 6 inches by 2 feet 6 inches to 9 feet 6 inches by 12 feet, the latter being the size of the largest mains; in the courts and alleys the sizes are from 3 feet by 2 feet 2 inches to 4 feet by 2 feet 4 inches. In Dover the main valley sewer is 4 feet 6 inches by 3 feet. In Salisbury the new sewers are about the same size, and the mains are so constructed that the subsoil-water percolates into them freely. In Bristol the main outfall is 5 feet by 4 feet 6 inches, and the mains vary from this size to 2 feet by 1 foot 6 inches; and it will be found practically, that where the drain-sewer system is still carried on, the minimum size for the mains will be about 3 feet 6 inches by 2 feet. This size would allow a man to creep through the sewer easily, if necessary."

When we have towns sewered with impervious glazed stoneware pipes, we find the size at Dover to vary from 6-inch house pipes to 18-inch sewers, and opening into brick mains. At Rugby the pipes are only 6 inches and the main outfall 2 feet in diameter. At Stratford-on-Avon the smallest street sewer is a 9-inch pipe, but then the sewer collects the storm-water. It is considered that there is no necessity to make sewers either so large that men may creep through them or to take the whole of the storm-water. The small pipes at Rugby answer just as well as the enormous brick sewers of other places. The storm-waters will always find their way over the surface in natural or artificial drains to the nearest watercourse.

Sewers should be laid in as straight lines as possible, and placed in a bed which will not be likely to sink. They are laid generally on concrete. The gradients must be true throughout. If curves are necessary, the radius of the curve should be not less than ten times the cross-sectional diameter of the sewer. The fall for street drains is usually from 1 in 244 to 1 in 784. The flow through a sewer of any size should not be under 2 feet per second nor over 4 feet 6 inches. It is a mistake to imagine that the fall cannot be too great.

The following table of Mr. Weeksteed's may be useful:—

Diameter of the Sewer.	Velocity in Feet per Minute.	Gradient required.
4	240	1 in 36
6	220	1 in 65
8	220	1 in 87
9	220	1 in 98
10	210	1 in 119
15	180	1 in 244
18	180	1 in 294
21	180	1 in 343
24	180	1 in 392
30	180	1 in 490
36	180	1 in 588
48	180	1 in 784

To calculate the discharge from sewers, the most simple formula is as follows:—

$V = 55 \times (\sqrt{D \times 2F} \times A.$

V = velocity in cubic feet per minute.

D = hydraulic mean depth.

F = fall in feet per mile.

A = section area.

The hydraulic mean depth is one-fourth the diameter if the pipe is running full; if the pipe is not full, it is the section area divided by that part of the circle of the pipe wetted by the fluid, which is called the wetted perimeter.

No sewers or drains should join at right angles or directly opposite the entrance of others; two sewers joining together should always do so in the direction of the flow of the sewage at the junction; what is called a bell-mouth is formed with a ventilating-shaft up to the roadway (fig. 81).

Fig. 81.

Where the drain pipes of a house enter the sewer, flap traps are fixed in the sewer walls. *See* TRAPS.

Provision must be made for easy access to sewers for flushing and clearing them, without breaking up the roadway; this is effected by side-entrances, manholes, flushing-chambers, &c. When from any cause a part of a sewer is blocked, a man descends the manhole, another one lowers a candle down at the nearest point of access from the manhole, and the deposit is removed by means of proper instruments until the light of the candle or lamp is seen.

This is an expensive method of cleansing sewers; for instance, the cost of removing deposit from the tide-locked and stagnant sewers in London formerly amounted to a sum of about £30,000 per annum.—(BAZALGETTE.) A far better way is to provide a flushing apparatus, which in its simplest form consists of a dam of any kind, ponding up the water; this is then suddenly removed. The power of water in this way is surprising. In an experiment with a flushing-gate 4 feet high, the quantity of water ponded up for one flush was 26,665 cubic feet; three flushes carried brickbats 1300 feet. "In an instance where 6688 yards of foul deposit had been removed by flushing, it was calculated that as the whole cost of removing it by hand labour would have been £2387, while the cost of putting up the inside apparatus and flushing-gate was £1203, and the cost of men's time £644, 12s. 7d., there was thus a saving of £456 to the commission; besides the fact, that on account of the side-entrances the pavement would no longer require to be taken up as before, and the apparatus would remain to be used when required." It certainly is not well to wait until there is a deposit before flushing; sewers should be flushed and disinfected regularly, and in that way much expense may be saved as well as danger to the public health avoided, since, where no accumulation of filth is permitted to take place, foul gas is not generated.

Ventilation, Deodorisation, and Disinfection of Sewers.—All sewers should be ventilated, not only on account of bad odours, but because any change of temperature in the sewer liquid either expands or contracts the sewer air. If steam or hot refuse-water is thrown into a sewer the air expands, and may under certain circumstances force the traps. For example, let *a b* (fig. 82) be the commencement of a sewer system, with a trap *c*, and another trap *d*; supposing that at *b*, either from the sewer running full force or from temporary deposit, there is an obstruction, then without the ventilating-shaft *f* the space between *a* and *b* is a closed chamber—the upper part filled with impure air, the lower with liquid. Under such circumstances, sup-

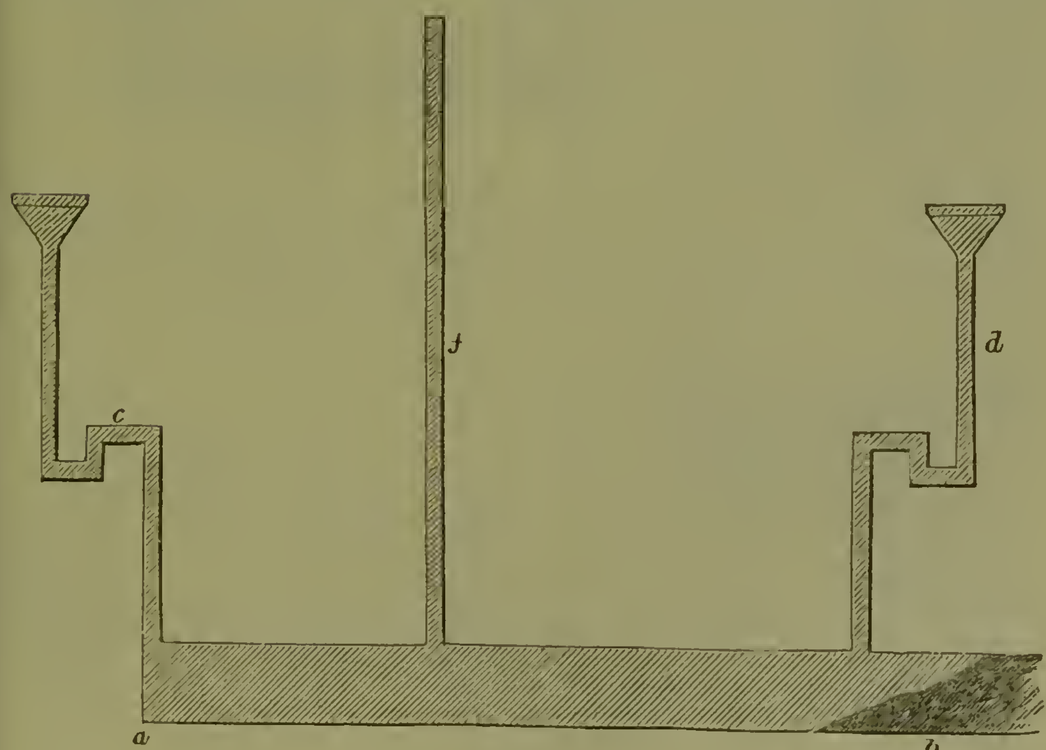


Fig. 82.

posing the sewer air was originally 50° F., warm slops thrown down either of the traps might raise the temperature of the air to 150°, and every 1000 volume of air would become

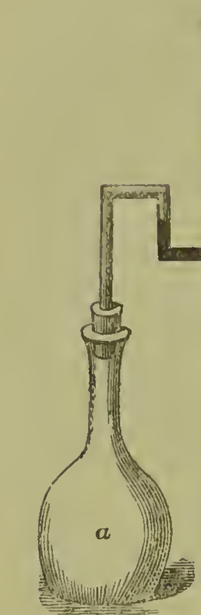


Fig. 83.

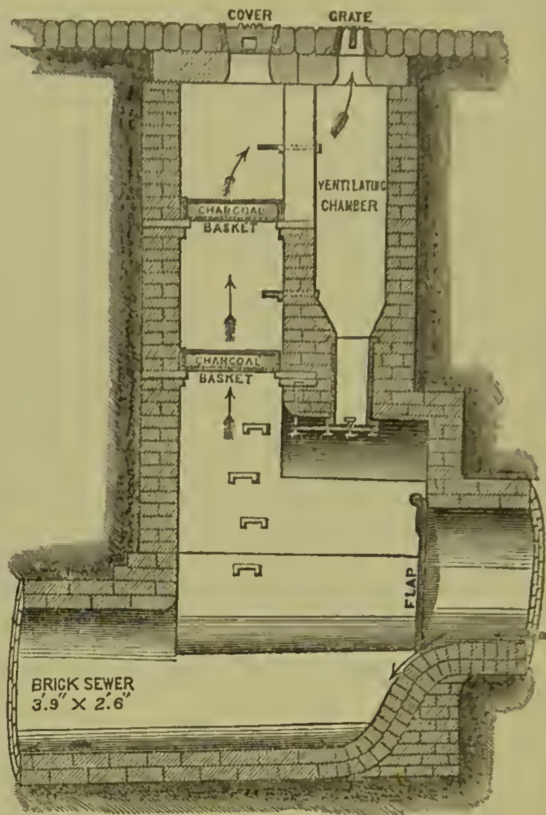


Fig. 84.

1200, causing a pressure which no trap could resist.

The same thing as suggested by Mr Latham can be shown by the following neat experiment: Bend a glass tube in the shape of a trap (fig. 83), and fix it carefully into a well-fitting cork to a flask *a*; put a little tincture of litmus or coloured water into the bend *b*; now, by taking hold of the flask *a*, the mere heat of the hand will jerk the liquid in *b* out of the trap.

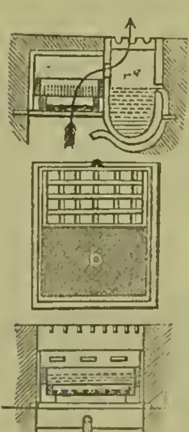


Fig. 85.

With regard to the distance between the ventilating-shafts, they should be placed about every 300 feet, or at all events all the manholes should be furnished with them.

Fig. 84 will give an idea of the ventilating-chambers furnished to some sewers. Those sewers which are likely to be ponded up by floods or tides should be ventilated with lofty shafts, the sectional area of which should be at least half as great as the sewers.

The shafts and chambers should each be furnished with trays of charcoal, and the

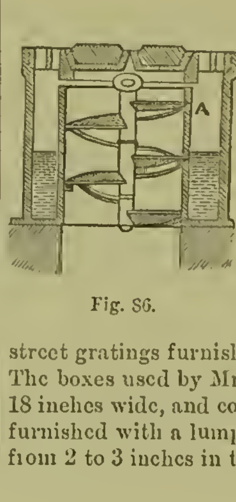


Fig. 86.

Fig. 87.

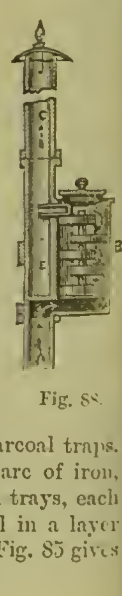


Fig. 88.

street gratings furnished with charcoal traps. The boxes used by Mr. Heywood are of iron, 18 inches wide, and containing six trays, each furnished with a lump of charcoal in a layer from 2 to 3 inches in thickness. Fig. 85 gives the usual arrangement as in actual use in the crown of many large sewers. D is a charcoal screen.

Mr. Baldwin Latham has invented a capital spiral ventilator, so constructed that neither dirt nor wet can get in contact with and spoil the charcoal. It is represented in fig. 86. The same arrangement may be applied to a shaft, as in fig. 87. Fig. 88 is a still more elaborate system of deodorisation; B carries the charcoal trays. A method of ventilating the connecting drain to a sewer is shown in fig. 89. Here an upright pipe is combined

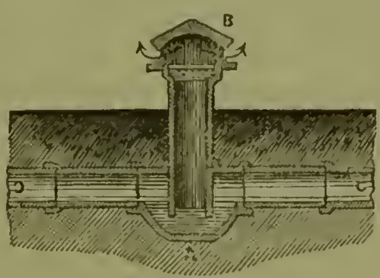


Fig. 89.

with a siphon; the top is capped with earthenware and carries charcoal trays. A patent method of ventilating and connecting is given in fig. 90; it is used in Birmingham. The drain, instead of being protected by a flap and entering in the middle of the wall, is at the bottom of the sewer, and is thus always trapped with water.

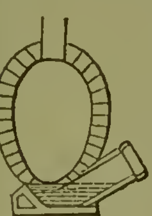


Fig. 90.

All ventilators should be made to open so that a lamp may be lowered into one, a reflector into another, and thus every 60 yards of sewer inspected.

All sewers should be regularly disinfected. This is of the utmost importance, especially in dry hot weather and where water is deficient. For the best chemicals to use, *see Sewage, Disinfection of*, p. 529.

The outfalls of sewers are frequently very unsatisfactory. It is not desirable that there should only be one outfall, as the position of the outfall must depend upon the irregularities of the ground upon which the town is built. On the other hand, a great many outfalls are liable to increase the difficulty of utilisation, and to increase the liability to nuisance.

Outfalls, where terminating in a river or exposed to the wind, should have proper flaps in order to prevent the wind or tide forcing back the gases. They should certainly be at such a distance from houses as not to create a nuisance.

Cost of Sewers.—This is best estimated by the actual sums towns have paid, remembering, however, that prices and wages have now risen considerably.

At Manchester, 280 miles of sewers cost £340,000; this includes both brick and pipe sewers, the brick varying from 6 feet by 3 feet to 3 feet by 2 feet, and the pipe from 25 inches by 18 inches to 12 inches by 9 inches, but it does not include flushing or ventilating apparatus. At Gorton, 1408 yards of 36-inch, 1520 yards of 30-inch, 980 yards of 24-inch, and 1165 yards of 18-inch by 27-inch brick sewers, with 2634 yards of 15-inch, 880 yards of 12-inch, 1349 of 9-inch, and 3705 of 6-inch pipe sewers, with gullies, manholes, and lampholes, cost £9579, 11s. 9d. At Blackburn, 19 miles cost £90,000. At Preston, 16¼ miles of stoneware pipes and 8¾ miles of brick sewers cost £50,000.

Large sewers are cheapest made of brick; small sewers of 18 inches diameter are cheapest when pipes are used. For village sewage, with socketed pipes without ventilators, &c., it is generally correct to estimate 2s. a foot; but this greatly depends upon the size of the pipes and the nature of the soil.

The influence of sewers upon the health of towns is great, but it is not so marked in those towns where impervious pipes are used, and no attempt at drying the subsoil with separate drains has been carried out. It may be laid down as a rule that sewers of towns should be impervious; and that therefore, to have the full benefits of drainage, a separate system must be constructed to drain the subsoil; or if a separate system be impossible, then an arrangement at less expense may probably be carried out by a pipe on the principle of Brooks' combined drain and subsoil pipe (*see* fig. 91).

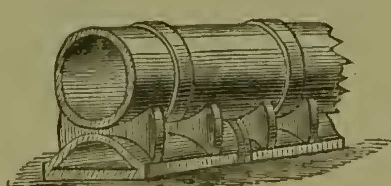


Fig. 91.

This is an excellent modification, and answers well. A separate system must increase the expense, but the benefit to the public health is incalculable.

For full details on Sewage, Disposal of, *see ante*, p. 518.

Drainage.

By this term is meant the collection and conveyance of water from the land, or the refuse fluids from houses, to watercourses, natural lines of drainage, sewers, or other suitable places. It is divided, then, into two parts—(1) drainage of the land generally; (2) house drains.

1. *Drainage of the Land.*—The general principles of land drainage take in the features, extent, levels of a district, and the course, dimensions, and discharge of its streams. The importance of a soil drained of its *ground-water* is now acknowledged; and often places are to be met with, in apparently the healthiest conditions as regards aspect, elevation, and beauty, where, notwithstanding, people express themselves as feeling "always ill," solely on account of the dampness of the soil. One of the greatest sanitary discoveries of the present day is, that consumption is always in excess in damp undrained soils.

2. *House Drains.*—What house drains should accomplish is to deliver quickly, to have no odour, never to choke, and to be so constructed as to allow of no leakage into the ground, nor reflux of gas from sewers. They are either open drains, pipe drains, or brick drains.

Open drains or *channellings* are useful to convey from the yards of a house simple pump or washing water. Some of these are merely paved with stones—a bad plan which should be avoided; others are constructed of channelled bricks or half pipes, socketed or not. A good, smooth, half-socket pipe, as shown in fig. 92, is undoubtedly the best, and will convey fluids a long distance.

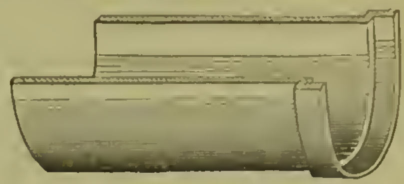


Fig. 92.

Pipe drains are made of pipeclay, with or without an admixture of fireclay, and salt-glazed or fire-glazed. It does not appear to be of any practical importance which kind is used, both being good. Such pipes may be made almost of any size, at all events varying from 2 inches to 36 inches in diameter.

Some of them are round, others oval; but the round form is the best for small drains, as the oval is difficult to make exactly true. In all long drains it is well to have a few access pipes—viz., pipes a portion of which is movable, and through the aperture of which a flexible rod can be introduced to clear them; if the obstruction is seen near the access pipe it may be removed. Various forms are shown in fig. 93, but others are in use.

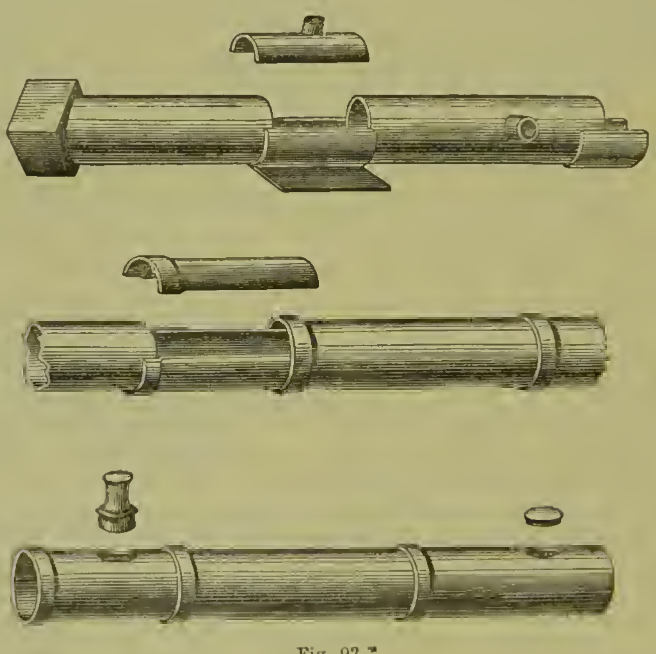


Fig. 93.

Brick Drains.—These are mostly very inefficient. They are constructed of all shapes, from the old-fashioned square form to the barrel or egg-shaped drain. Their disadvantages are that the amount of friction offered by the irregular walls of the drain is great; it frequently chokes, rats burrow in it, and may carry odours and even infection long distances.

It will be always better to take them up, replace them with pipe drains, and well disinfect the site, filling it with concrete.

In laying down drains it is well to drain to the back of a house, if possible, rather than to the front; and it is not advisable, if it can be avoided, to run a drain through any house. They should be laid on clay, or, better still, concrete, and the joints well cemented. If the pipes go through a garden, where the roots of trees may strike into the joints and disturb the cement, Mr. Mechi has proposed to coat them over with coal tar, as roots invariably turn away from this substance.

It is a common error to imagine that drains cannot be too large, nor have too great a fall: the best engineers hold quite the opposite opinion. Mr. Eassie states that a well-laid 6-inch pipe is sufficient for the largest house (*i.e.*, as a drain), and recommends 4-inch pipes for sinks, backyards, and basements. The best fall for a drain is 2¾ or 3 inches for every 10 feet. With regard to junctions, T and L shaped junctions are to be avoided. The best are curved, or with obtuse angles. It is considered well to give the drain a little extra dip wherever a bend or junction occurs, in order to lessen friction. It is recommended, in laying down systems of drains, to have a few *dummy junctions* in the course of the drain, as this may save trouble and expense hereafter. The orifice of the junctions are stopped up with discs.

Large pipes must not deliver into smaller ones, or even into those of the same size. The difference that should exist between is 3 inches for the larger, 2 for the smaller.

The waste - pipes from the sinks in the kitchen, or from the lavatories, should not terminate directly in a drain, as there is great danger of the foul sewer gas unsealing the traps and getting into the house. To connect a waste-pipe with a system of drains which terminate in public sewers is in fact to connect the house with the sewer. In each case the waste pipe or pipes should terminate outside, and deliver into a grating properly trapped. There are, however, a few traps that can be *directly* connected with the house without danger. *See* SEWER, WATER-CLOSETS, &c.

When the house drains are thus disconnected from the general drains, ventilation is not so much needed; but if they are obliged to be connected, ventilation is imperative; and long tubes should be fixed at the head of every drain, and, if required, in other places. The ventilating-shafts should equal half the sectional area of the drain. These pipes should be carried to the highest part of the building, and the aperture should be protected by a hood from rain or wet. If necessary, the top of the pipes may be made large enough to carry trays of charcoal, in order to deodorise the escaping air.

A very convenient method of drainage in certain cases, which has been followed out by Mr. Rogers Field, C.E., is to lead the drains of, say a row of cottages, *underneath* the ground into a field, the slops being thrown at the house-end of the drain into a peculiarly-constructed tank invented by Mr. Field, and called the Roger Field's tank (patented). The tank may be obtained of any size, and may be affixed to the sink of a gentleman's kitchen, or it may be in the backyard. It is exactly on the same principle as the meter - tank already described (p. 526), and empties the slops periodically. The drainage goes into the pipes, and forces its way into the surrounding soil. It is indeed intermittent irrigation; but the fertilising liquid, instead of being applied upon the land to filter to the roots, is applied directly to the roots themselves.

All house drains should be periodically disinfected with Cooper's salts, sulphate of iron, or other cheap disinfectant. If at any time they are accidentally blocked, and require opening, they should at the same time be disinfected.

The law as it now stands gives very extensive powers, rights, and duties to local authorities. With regard to sewers and sewage, the principal provisions are as follows.

Sewers are vested in the Local Authority.—All existing and future sewers within the district of a local authority, together with all buildings, works, materials, and things belonging thereto,

Except

1. Sewers made by any person for his own profit, or by any company for the profit of the shareholders; and
2. Sewers made and used for the purpose of draining, preserving, or improving land under any local or private Act of Parliament, or for the purpose of irrigating land; and
3. Sewers under the authority of any commissioners of sewers appointed by the Crown,

are vested in and are under the control of such local authority.

Provided that sewers within the district of a local authority which have been or which may hereafter be constructed by or transferred to some other local authority, or by or to a sewage board or other authority empowered under any Act of Parliament to construct sewers, shall (subject to any agreement to the contrary) vest in and be under the control of the authority who constructed the same, or to whom the same have been transferred.—(P. H., s. 13.)

Power to purchase Sewers, &c.—Any local authority may purchase or otherwise acquire from any person any sewer, or any right of making or of user or other right in or respecting a sewer (with or without any buildings, works, materials, or things belonging thereto), within their district, and any person may sell or grant to such authority any such sewer right or property belonging to him; and any purchase-money thus paid by such authority is to be subject to the same trusts (if any) as the sewer right or property sold was subject to.

But any person who, previously to the purchase of a sewer, by such authority, has acquired a right to use such sewer, is entitled to use the same, or any sewer substituted in lieu thereof, to the same extent as he would or might have done if the purchase had not been made.—(P. H., s. 14.)

Every local authority is to keep in repair all sewers belonging to them, and cause to be made such sewers as may be necessary for effectually draining their district, for the purposes of the Public Health Act.—(P. H., s. 15.)

Any local authority may carry any sewer through, across, or under any turnpike road, or any street or place laid out as or intended for a street, or under any cellar or vault which may be under the pavement or carriage-way of any street, and, after giving reasonable notice in writing to the owner or occupier (if on the report of the surveyor it appears necessary), *into, through, or under any lands whatsoever* within their district.

They may also (subject to the provisions of the Public Health Act relating to sewage works without the district of the local authority) exercise all or any of the said powers without their district for the purpose of outfall or distribution of sewage.—(P. H., s. 16.)

Nothing in the Public Health Act authorises any local authority to make or use any sewer, drain, or outfall for the purpose of conveying sewage or filthy water *into any natural stream or watercourse, or into any canal, pond, or lake*, until such sewage or filthy water is freed from all excrementitious or other foul or noxious matter such as would affect or deteriorate the purity and quality of the water in such stream or watercourse.—(P. H., s. 17.)

Any local authority may from time to time enlarge, lessen, alter the course of, cover in, or otherwise improve any sewer belonging to them, and may discontinue, close up, or destroy any such sewer that has in their opinion become unnecessary, on condition of providing an equivalent sewer for the use of any person who may be thus deprived of the lawful use of any sewer: provided that the discontinuance, closing up, or destruction of any sewer shall be so done as not to create a nuisance.—(P. H., s. 18.)

Sewers must not be a Nuisance.—Every local authority must cause the sewers belonging to them to be so constructed, covered, ventilated, and kept as not to be a nuisance or injurious to health, and to be properly cleansed and emptied.—(P. H., s. 19.)

Map of Sewerage.—An urban authority may, if they think fit, provide a map exhibiting a system of sewerage for effectually draining their district; and any such map shall be kept at their office, and shall at all reasonable times be open to the inspection of the ratepayers of their district.—(P. H., s. 20.)

Connection of Drains with Sewers. — The owner or occupier of any premises within the district of a local authority is entitled to cause his drains to empty into the sewers of that authority on condition of his giving such notice as that authority may require of his intention so to do, and of complying with the regulations of that authority in respect of the mode in which the communications between such drains and sewers are to be made, and subject to the control of any person who may be appointed by that authority to superintend the making of such communications.

Failure to comply with the conditions mentioned involves a penalty of £20 or less. The local authority may also close the communication between the drain and sewer, recovering the expenses in a summary manner from the offender.—(P. H., s. 21.)

The owner or occupier of any premises without the district of a local authority may cause any sewer or drain from such premises to communicate with any sewer of the local authority on such terms and conditions as may be agreed on between such owner or occupier and such local authority, or as in case of dispute may be settled, at the option of the owner or occupier, by a court of summary jurisdiction or by arbitration in manner provided by the Public Health Act.—(P. H., s. 22.) *See* ARBITRATION.

Where any house within the district of a local authority is without a drain sufficient for effectual drainage, the local authority shall by written notice require the owner or occupier of such house, within a reasonable time therein specified, to make a covered drain or drains emptying into any sewer which the local authority are entitled to use, and which is not more than 100 feet from the site of such house; but if no such means of drainage are within that distance, then emptying into such covered cesspool or other place not being under any house as the local authority direct; and the local authority may require any such drain or drains to be of such materials and size, and to be laid at such level, and with such fall as on the report of their surveyor may appear to them to be necessary.

If such notice is not complied with, the local authority may, at the expiration of the time specified in the notice, do the work required, and may recover in a summary manner the expenses incurred by them in so doing from the owner, or may by order declare the same to be private improvement expenses.

But where, in the opinion of the local authority, greater expenso would be incurred in causing the drains of several houses to empty into an existing sewer than in constructing a new sewer and causing such drains to empty therein, the local authority may construct such new sewer, and require the owners or occupiers of such houses to cause their drains to empty therein, and *may apportion*, as they deem just, the *expenses of the construction of such sewer among the owners of the several houses*, and recover in a summary manner the sums apportioned from such owners, or may by order declare the same to be private improvement expenses.—(P. H., s. 23.)

Where any house within a local authority's district has a drain communicating with any sewer, which drain, though sufficient for the effectual drainage of the house, is not adapted to the general sewerage system of the district, or is, in the opinion of the local authority, otherwise objectionable, the local authority may, on condition of providing a drain or drains as effectual for the drainage of the house and communicating with such other sewer as they think fit, close such first-mentioned drain, and do other necessary works, and the expenses relative to any of the foregoing are to be deemed expenses incurred under the Public Health Act.—(P. H., s. 24.)

It is not lawful in any *urban district* newly to erect any house or to rebuild any house which has been pulled down to or below the ground-floor, or to occupy any house so newly erected or rebuilt, *unless and until a covered drain or drains be constructed*, of such size and materials, and at such level, and with such fall as on the report of the surveyor may appear to the urban authority to be necessary for the effectual drainage of such house; and the drain or drains so to be constructed shall empty into any sewer which the urban authority are entitled to use, and which is within 100 *feet of some part of the site of the house to be built or rebuilt; but if no such means of drainage are within that distance, then shall empty into such covered cesspool* or *other place*, not being under any house, as the *urban* authority direct.

Penalty for contravention of the foregoing, £50 or less.—(P. H., s. 25.) *See also* BUILDINGS.

Disposal of Sewage.—For the purpose of receiving, storing, disinfecting, distributing, or otherwise disposing of sewage, any local authority may—

1. Construct any works within their district, or (subject to the provisions of the Public Health Act as to sewage works without the district of the local authority) without their district.
2. Contract for the use of, purchase, or take on lease any land, buildings, engines, materials, or apparatus either within or without their district.
3. Contract to supply for any period not exceeding twenty-five years any person with sewage, and as to the execution and costs of works either within or without their district for the purposes of such supply:

provided that no nuisance be created in the exercise of any of the said powers.—(P. H., s. 26.)

The local authority of any district may, by agreement with the local authority of any adjoining district, and with the sanction of the Local Government Board, cause their sewers to communicate with the sewers of such last-mentioned authority, in such manner and on such terms and subject to such conditions as may be agreed on between the local authorities, or, in case of dispute, may be settled by the Local Government Board: provided that so far as practicable storm-waters shall be prevented from flowing from the sewers of the first-mentioned authority into the sewers of the last-mentioned authority, and that the sewage of other districts or places shall not be permitted by tho first-mentioned authority to pass into their sewers so as to be discharged into the sewers of the last-mentioned authority without the consent of such last-mentioned authority.—(P. H., s. 27.)

Any local authority may deal with any lands held by them for the purpose of receiving, storing, disinfecting, or distributing sewage in such manner as they deem most profitable, either by leasing the same for a period not exceeding twenty-one years for agricultural purposes, or by contracting with some person to take the whole or a part of the produce of such land, or by farming such land and disposing of tho produce thereof; subject to this restriction, that in dealing with land for any of the above purposes, provision shall be made for effectually disposing of all the sewage brought to such land without creating a nuisance.—(P. H., s. 28.)

Where any local authority agree with any person as to the supply of sewage and as to works to be made for the purpose of such supply, they may contribute to the expense of carrying into execution by such person all or any of the purposes of such agreement, and may become shareholders in any company with which any agreement in relation to the matters aforesaid has been or may hereafter be entered into by such local authority, or to or in which the benefits and obligations of such agreement may have been or may be transferred or vested.—(P. H., s. 30.)

The making of works of distribution and service for the supply of sewage to lands for agricultural purposes is to be deemed an "improvement of land" authorised by "The Improvement of Land Act, 1864," and the provisions of that Act apply accordingly.—(P. H. s. 31.)

Sewage Works without the District.—A local authority must, three months at least before commencing the construction or extension of any sewage or other work for sewage purposes without their district, give notice of the intended work by advertisement in one or more of the local newspapers circulated within the district where the work is to be made.

Such notice must describe the nature of the intended work, and state the intended termini thereof, the names of the parishes, the turnpike roads and streets, and other lands (if any) through, across, under, or on which the work is to be made, and must name a place where a plan of the intended work is open for inspection at all reasonable hours; and a copy of such notice is to be served on the owners or reputed owners, lessees or reputed lessees, and occupiers of the said lands, and on the overseers of such parishes, and on the trustees, surveyors of highways, or other persons having the care of such roads or streets.—(P. H., s. 32.)

If any such owner, lessee, occupier, overseer, trustee, surveyor, or other person as aforesaid, or any other owner, lessee, or occupier who would be affected by the intended work, objects to such work, and serves notice in writing of such objection on the local authority at any time within the said three months, the intended work shall not be commenced without the sanction of the Local Government Board after such inquiry as hereinafter mentioned, unless such objection is withdrawn.—(P. H., s. 33.)

The Local Government Board may, on application of the local authority, appoint an inspector to make inquiry on the spot into the propriety of the intended work and into the objections thereto, and to report on the matters with respect to which such inquiry was directed; and on receiving the report of such inspector, the Local Government Board may make an order disallowing or allowing with such modifications (if any) as they deem necessary the intended work.—(P. H., s. 34.)

Entry upon Lands.—Whenever it becomes necessary for a local authority or any of their officers to enter, examine, or lay open any lands or premises for the purpose of making plans, surveying, measuring, taking levels, making, keeping in repair, or examining works, ascertaining the course of sewers or drains, or ascertaining or fixing boundaries, and the owner or occupier of such lands or premises refuses to permit the same to be entered upon, examined, or laid open for the purposes aforesaid or any of them, the local authority may, after written notice to such owner or occupier, apply to a court of summary jurisdiction for an order authorising the local authority to enter, examine, and lay open the said lands and premises, &c.

If no sufficient cause is shown against the application, the court may make an order accordingly, and on such order being made the local authority or any of their officers may, at all reasonable times between the hours of nine in the forenoon and six in the afternoon, enter, examine, or lay open the lands or premises mentioned in such order, for such of the said purposes as are therein specified, without being subject to any action or molestation for so doing: provided that, except in case of emergency, no entry shall be made or works commenced unless at least twenty-four hours' notice of the intended entry, and of the object thereof, be given to the occupier of the premises intended to be entered.—(P. H., s. 305.)

Special Drainage District.—Rural authorities from time to time may find it necessary to constitute a portion of their area a special drainage district, in order to charge upon it exclusively the works of sewerage, water-supply, &c. This can be done by a resolution of the authority, but the resolution must be approved of by the Local Government Board. Any place formed into a special drainage district becomes a separate contributory place.—(P. H., s. 277.)

Districts may be combined for the purposes of sewerage.—(P. H., s. 279.) *See* ARBITRATION; BUILDINGS; LANDS, PURCHASE OF; LOANS; NUISANCES; PENALTIES; SANITARY AUTHORITIES; WORKS; &c.

Shellfish—Nearly all descriptions of shellfish are difficult of digestion, and should be avoided by people with delicate stomachs. Perhaps the least objectionable is the oyster, particularly if eaten raw, for when cooked it becomes hard and tough. The crab, crayfish, lobster, mussel, prawn, periwinkle, whelk.

and shrimp should be eaten with the greatest moderation, especially in hot weather. Poisonous, indeed fatal symptoms, have been induced by partaking too freely of these varieties of shellfish. *See* LOBSTER, MUSSEL, OYSTERS, &c.

Sherry (*Vinum Xericum*)—The only wine ordered in the British pharmaeopœias. *See* WINE.

Ship Fever—*See* FEVER, TYPHUS.

Ships—*See* HYGIÈNE, NAVAL.

Shoddy—Old, used, and worked-up wool and cloth made into a fabric.

Shrimp (*Crangon vulgaris*)—The shrimp is a favourite article of food with all classes, and although not easy of digestion, it is not so likely to prove injurious to a weak stomach as the lobster or crab. Essence of shrimps frequently contains Armenian bole as a colouring matter.

Sickness, Returns of—*See* BIRTHS, DEATHS, AND SICKNESS RETURNS.

Siderosis—*See* TRADES, INJURIOUS.

Sieges—*See* WAR.

Slaughter-Houses—There is, perhaps, no trade which requires more constant supervision than that of the butcher. Thirty years ago, sanitary reformers arrived at the conviction that the slaughtering of animals ought not to be carried on in the midst of crowded populations. Parliament endorsed this view; but in consideration of vested interests, the system was allowed to proceed for a period of thirty years. Last year, therefore (1874), there should have come into force the prohibitory clauses of the Metropolis Building Act of 1844, by which the carrying on of certain trades and occupations in London is interdicted, except under special conditions, which in the vast majority of cases are unattainable. Among these trades was the slaughtering of cattle. If this Act had taken its course, at least 19,000 private London slaughter-houses would have been suppressed. The Legislature has, however, merely prohibited the formation of any *new* businesses or establishments (37 & 38 Vict. c. 67). This is truly a retrograde step, for even as early as Henry VII. butchering was forbidden in walled towns.

It is not, indeed, the mere act of slaughtering which is a nuisance, but the details of disposal of the offal, of the blood, of the fat, the catgut-spinning, the driving of animals through the streets, the ease with which unsound meat may be introduced, and other obvious attendant circumstances which render private slaughter-houses so decidedly objectionable in large towns, or indeed in towns of any size.

With the ancients, the slaughter-house and the place of sale were separate. In ancient Rome there were formed for the purchase and sale of oxen, companies or colleges of butchers, who confided to their substitutes the care of slaughtering the animals and preparing them for the use of the public. These butchers, at first spread over different parts of the town, were afterwards collected in one quarter, where other provisions were sold. Under the reign of Nero, the great market or butchery was one of the most magnificent ornaments of the city, and the memory of it has been transmitted to posterity by a medal. The police of the Romans extended to Gaul, and particularly to Paris, where from time immemorial there existed a company, composed of a certain number of families, charged with the purchase of beasts and the sale of their meat. There is a regular system of public slaughter-houses in large towns on the Continent at the present time, and our neighbours in this matter appear rather in advance of ourselves. A summary of the regulations in force in several of the principal Continental towns is as follows:—

1. All markets are under strict supervision.
2. Cattle sent to the public markets, and to the public slaughter-houses, are scrupulously examined by the inspectors or officers appointed for that purpose.
3. Diseased cattle are carefully kept from healthy animals, and are either destroyed or disposed of in such a way as to prevent their communicating disease to other cattle or being sold for human food.
4. In all large cities the slaughtering of animals is either conducted in public slaughter-houses, or is so regulated as to ensure the condemnation of diseased meat.
5. To guard the public against the mischief which arises from the use or consumption of unwholesome meat, the animals destined for food are examined not only before they are killed, but afterwards.

There can be little difference of opinion as to the wisdom and sagacity of the above regulations. The scope of this article does not permit us to enter into all the details relative to foreign abattoirs; we will, however, describe those of Paris, and one lately introduced at Brighton, United States.

An order of Charles IX., dated February 15, 1567, first promulgated the principle of the Paris abattoirs; but, notwithstanding this and proposals made as early as the year 1689 by the provost of the merchants and aldermen of Paris, and the officers of Sieur Chandoré in 1691, abattoirs were not definitely established until 1810. In that year five general abattoirs were instituted—three on the right, two on the left, bank of the Seine.

Besides buildings in which are situated the apartments of the officers, &c., each abattoir consists of the following departments: (1) the stables in which the animals to be killed are kept; (2) the abattoir, properly so called, with its accessories; (3) the place in which the offal is prepared; and (4) a building in which the fat and grease are rendered.

The days on which the animals arrive in Paris are seldom those on which they are killed; it is therefore necessary to have accommodation for their reception. These buildings, of the most simple form and construction, are about 29 feet 3 inches in width on the inside. Large stone arches supply the place of girders, and support the joists of the flooring of the upper rooms. A second range of arches supplies the place of principals for the roof, and receives the purlines. The upper floor is partitioned into as many divisions as there are slaughter-rooms, that each butcher may receive his own forage, and each building is supplied with a very large cistern.

The abattoir, properly speaking, or, as it is sometimes called, *échaudoir*, has several courts, all of which are paved so as to lead liquids to a sink placed beneath the level of the pavement. The joints both of the stone walls and of the paving are carefully stopped up with a mastic of iron filings, so that no offensive matter can lodge in the interstices. The courts are well supplied with water-taps. The buildings are divided into a certain number of slaughter-rooms, called *cases d'abat;* the floors all paved and provided with a tank for the blood, and with a system of blocks and pulleys for raising the carcases. The length of the slaughter-rooms is about 32 feet 6 inches; the breadth, 16 feet 3 inches. They are divided one from the other by partition walls of freestone.

The carcases of the oxen are hung upon a frame furnished with movable rails, those of the calves and sheep are suspended from iron brackets. The ceilings are whitewashed, and the roofs project 9 feet 9 inches beyond the exterior walls, thus affording the double advantage of protecting the slaughter-rooms from the heat of the sun, and the butchers from the weather while working in the court-yard beneath. Arrangements for ventilation are also made, and answer the purpose well. The cattle on arrival in the sheds are taken the greatest care of. Their bodies are first washed in a large granite bath, they are littered down with clean straw, and fed with the most tempting and nourishing food. After slaughtering in the yard of the abattoir, the animal is drawn up by the pulleys before mentioned, and the butchers "blow up" the carcase—that is, blow air into the subcutaneous cellular tissue—a practice common enough in all countries, but one to be reprehended; the real purpose being to make the meat look fuller, plumper, and heavier than it would in its natural condition. The butcher, however, excuses the practice by saying that he can by means of it remove the skin better and without injury to the flesh. The blood is carefully saved from every animal. It is principally used by the dyers, and is so valuable that it is said to pay the expenses of slaughtering. In England the butchers do not appear to find a ready market for this commodity, at all events there is great waste. Some is utilised in certain articles of diet, such as black-puddings, and some in the country is given to pigs, but much is wasted and allowed to decompose. The fat used to be rendered in the melting-houses before mentioned; some of it is still utilised there, but the greater portion is put into sacks, and carted away daily by the candlemakers and perfumers, who work it up in their own manufactories.

"There is no speck of the flesh of any animal that is not utilised, but particularly is this true of those meats that pass through this abattoir. The meats are graded not only at the wholesale market, but in their progress to the consumer. A constant separation of the qualities is being made until the dog and cat meat is reached, and even after they are supplied, there is a residuum, which goes to the growth of worms, which in turn feed the fish of the aquarium."—(Letter of Mr. SCHULTZ, Fifth Annual Report of the State Board of Health, Massachusetts.)

The model abattoir erected at Brighton, United States, is thus described in the report above cited:—

The following description of the Brighton abattoir is furnished by the architect, Mr. A. C. Martin:—

The abattoir now building at Brighton is well placed on the bank of the Charles river, in the most westerly suburb of Boston, and about 4 miles from the centre of the city. The grounds are about 50 acres in extent, bounded on the longest side by the river, and conveniently situated with reference to the Watertown and Brighton cattle market, the Boston and Albany Railroad, and the Watertown branch of the Filchburgh Railroad (*see* fig. 94).

Building operations were commenced in the spring of 1872, by the butchers of Brighton, under a charter granted by the Legislature. The original plan contemplates a central building, called the rendering-house, 200 feet by 80, and four stories high, around which are to be grouped ten or more blocks of slaughter-houses, with the necessary cattle-sheds,

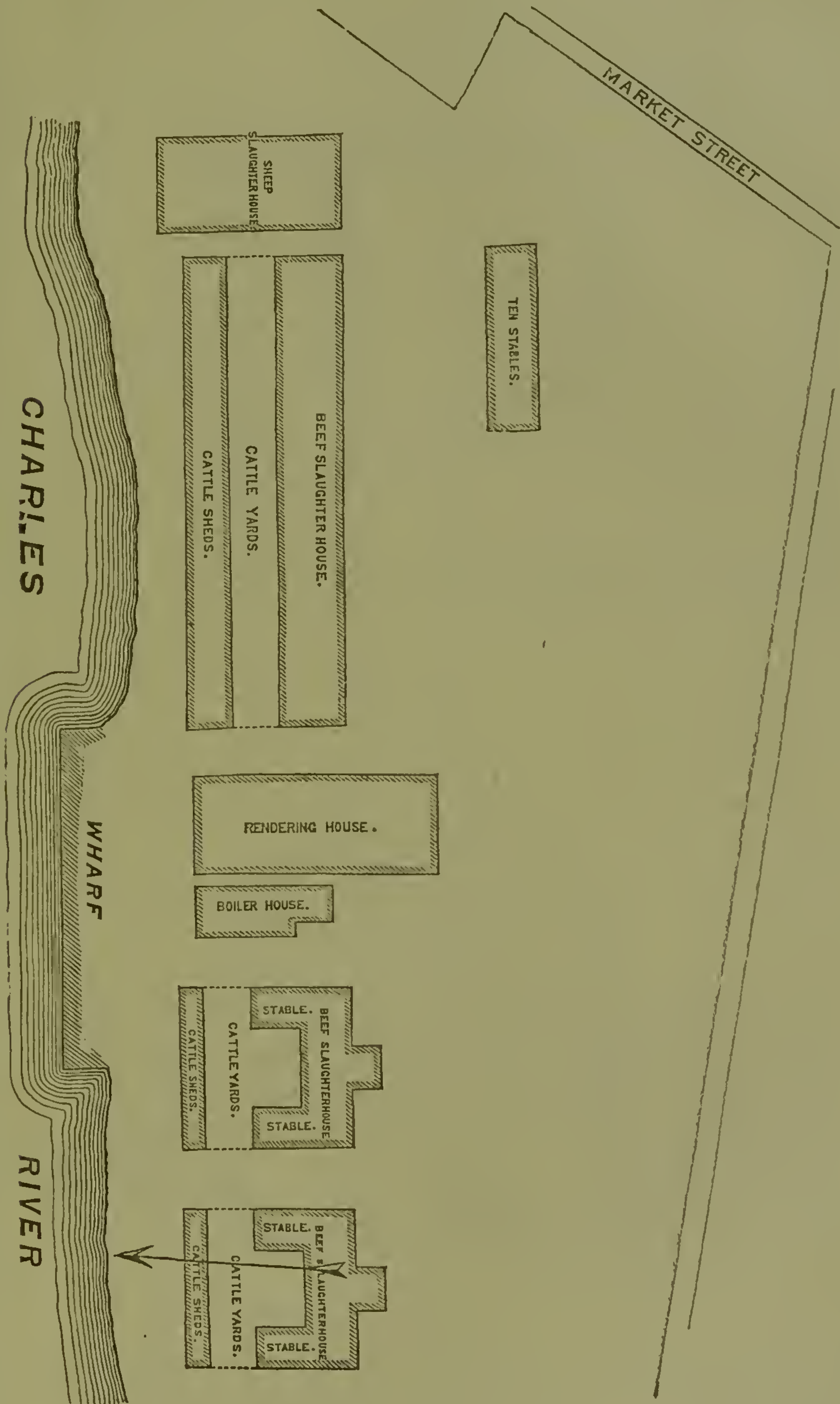

CHARLES RIVER
WHARF
MARKET STREET
SHEEP SLAUGHTER HOUSE
CATTLE SHEDS.
CATTLE YARDS.
BEEF SLAUGHTER HOUSE.
TEN STABLES.
RENDERING HOUSE.
BOILER HOUSE.
STABLE.
BEEF SLAUGHTERHOUSE
STABLE.
CATTLE YARDS.
CATTLE SHEDS.
STABLE.
BEEF SLAUGHTERHOUSE
STABLE.
CATTLE YARDS.
CATTLE SHEDS.

Fig. 94.

yards, stables, tripe-works, engine and boiler house, &c. At the present time a block of ten beef slaughter-houses and another block of five sheep slaughter-houses, with the requisite cattle-sheds, yards, and stables, have been built, and are now occupied. Several other beef slaughter-houses are in progress; one of these will be ready for use in a few weeks. The rendering-house, with the boiler and engine house, has also been finished, and the necessary machinery and steam apparatus put into the buildings.

Our abattoir differs from those in various countries of Europe in many respects. Foreign abattoirs have been built at public expense, and are under the

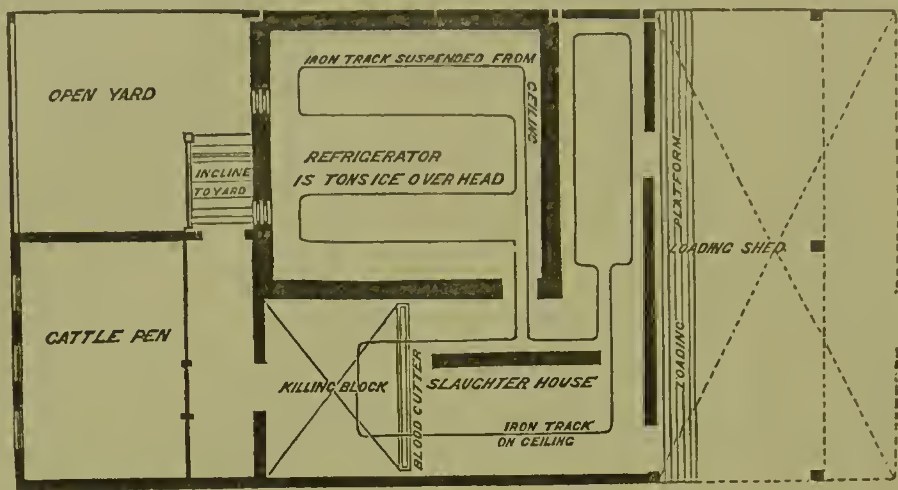


Fig. 95.

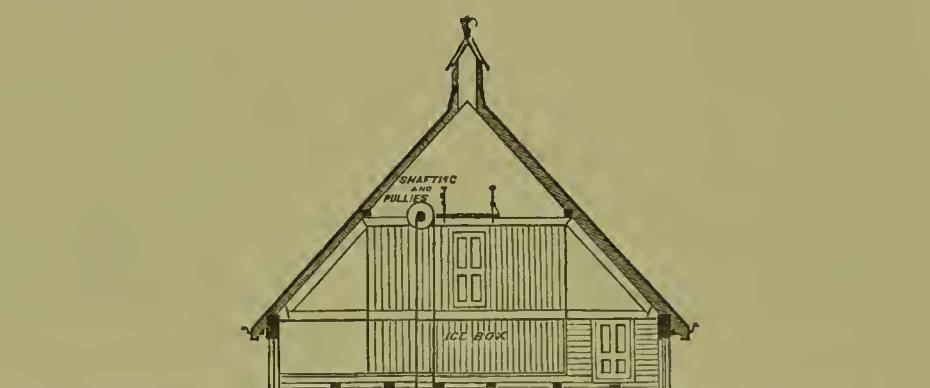


Fig. 96.

immediate charge of government officers. Ours has been built by private enterprise and at private cost, its sanitary arrangements being controlled by the State Board of Health. In the foreign abattoirs the slaughter-houses are all built of masonry, and are one story high, without basements. The slaughtering is done upon stone or asphalt pavement. No provision is made for cooling the meat before it is sent to market, and the blood and offal are carted away from the premises. At Brighton the buildings are all of wood, and are planned with reference to the individual interests of the butchers and their special modes of doing business.

The offal and the blood coming from each day's work are rendered and dried on the premises during the same day, and while they are yet perfectly fresh and untainted.

It has for a long time been the custom of the Brighton butchers to have, in connection with their slaughter-houses, a cooling-room or refrigerator, in which the meat is kept at a temperature of 40° F. for several days before sending it to market. These conditions required—

First, That the slaughtering should be done upon a raised floor, over a basement story, for convenience of handling the blood and offal.

Second, That "cool-rooms," with ice-chambers over them, should be provided for each slaughter-house. By reference to the plan and section (figs. 95, 96) of one of the beef slaughter-houses, it will be seen that each covers a space 38 feet wide by 30 long, or 1140 square feet. Out of this space a room 20 feet square is taken, with double walls (2 feet thick) packed with fine shavings, for a cool-room, in which the meat is hung for several days before being sent to market. The temperature is maintained in warm weather by the cold air from an ice-box of 15 to 20 tons capacity, built over the cool-room and connected with it. The circulation of air between the cool-room and the ice-box is regulated by means of valves in the air-ducts. The remaining space, 15 feet wide, is used for slaughtering the cattle. The floor is of double plank, calked water-tight like the deck of a ship, and laid upon iron beams, with a slope to an iron gutter which catches the blood and conveys it below. There are several trap-doors in this floor, through which the hides, offal, &c., are dropped into separate iron tanks on wheels in the basement. The slaughtering-place opens to the rear upon the close pen, the cattle yards and sheds; and in front is the loading-shed, where the meat is put into the waggons. The cool-rooms are 12 feet 6 inches high. The slaughtering-places have the whole height of the building up into the roof, and are lighted by windows above the roofs of the sheds. By means of pulleys and shafting from the rendering-house the cattle are hoisted for dressing, and the ice is lifted to the ice-chambers. Hot and cold water is supplied to each slaughter-house.

The basement story under the slaughter-houses is of brick walls, with a concrete floor, and has ample drainage. It extends, without partition, 380 feet from one end of the block to the other. In this story, under the trap-doors, are the iron tanks (on wheels) to receive the hides, heads, feet, tallow, tripe, blood, and offal. When filled, the tanks are wheeled into the rendering-house and their contents distributed—the hides being left in the basement, and the blood and offal taken to the rendering-tanks and driers by means of elevators.

The sheep slaughter-houses are similarly arranged with cool-room, slaughtering-place, &c.

The rendering-house, which forms the centre of the whole group of the abattoir, is 200 feet by 80 feet, and four stories high, including a brick basement, which has a concrete floor like the basements of the slaughter-houses. The accompanying section drawings (fig. 97) show the rendering-tanks in the third story suspended from the fourth floor. These tanks open at the top, on the level of the floor of the fourth story, where the offal is emptied into them from the small "tanks on wheels" coming from the slaughter-houses.

After the rendering-tanks are filled, the openings are closed and the contents cooked by steam. After sufficient cooking, the contents are dropped out of the tanks by openings at the bottom of them in the third story. Here the fat is separated from the watery part, and from the scrap or tankings, which latter portion is put into the driers. The blood from the slaughter-houses is also here put into the driers. The water is evaporated by steam-heat, and the residuum comes out as dry animal matter. This is passed through a mill and ground to powder. From the mill the powder drops into barrels, and is packed for market.

By an ingenious system of pipes the steam and offensive gases from the rendering-tanks and driers are passed through a condensing apparatus, where the steam becomes water, and the remaining gases are then mixed with common air, and, by means of a blower, are forced down and under the fires of the steam-boilers. After being thus purified by fire they are finally discharged through a chimney 160 feet high. The rendering process thus conducted gives no odour. There is nothing offensive about the fertiliser, and what slight odour it possesses is wholly imperceptible after it is packed.

The boiler and engine house, of brick, stand quite near the rendering-house, and around the central smoke-flue are constructed four large flues or shafts for ventilating the various rooms of the rendering-house. The boiler-house is planned for ten boilers; the engine-room for two fifty-horse-power engines. There is also a powerful steam-pump for throwing water.

The six months which have passed since the abattoir was opened have fully proved, that it is possible to carry on a great slaughtering and rendering establishment without its being offensive either to the workmen in it or to the community around it.

For the purposes of the Public Health (England) Act, 1875, the word "slaughter-house" includes the buildings and places commonly called slaughter-houses and knackers' yards, and any building or place used for slaughtering cattle, horses, or animals of any description for sale.

Any urban authority may, if they think fit, provide slaughter-houses, and they are to make bylaws with respect to the management and charges for the use of any slaughter-houses so provided; and for the purpose of enabling any urban authority to regulate slaughter-houses within their district, the provisions of the Towns Improvement Clauses Act, 1847, with respect to slaughter-houses are incorporated with the Public Health Act.

But the rights, powers, and privileges of any persons under any local Act passed before the Public Health Act, 1848, with regard to the working, &c., of slaughter-houses, are not to be affected.—(P. H., s. 169.)

The owner or occupier of any slaughter-house licensed or registered under the Public Health Act, must within one month after the licensing or registration of the premises, affix,

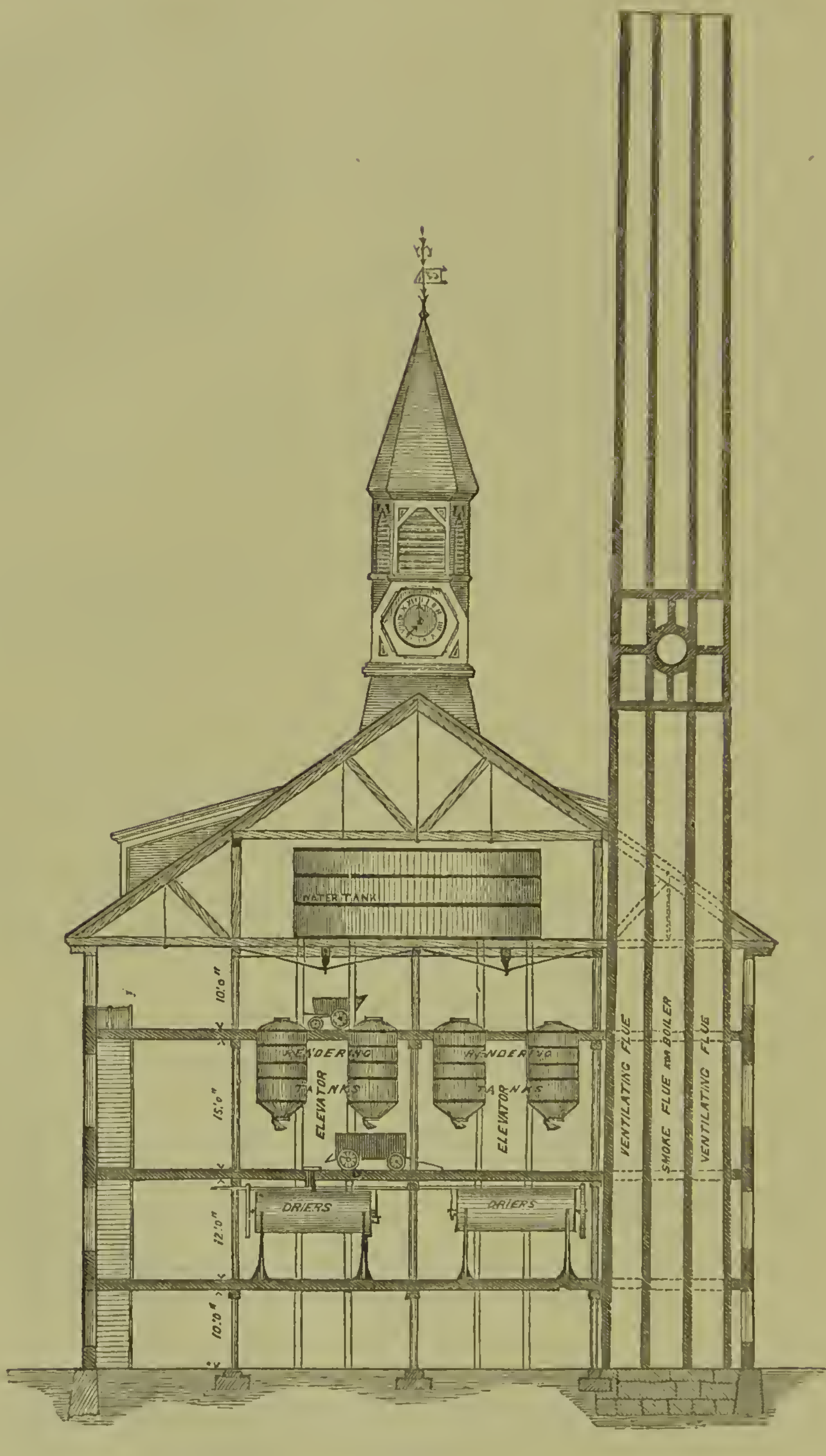

WATER TANK
10.0"
RENDERING TANKS
RENDERING TANKS
ELEVATOR
ELEVATOR
15.0"
DRIERS
DRIERS
12.0"
10.0"
VENTILATING FLUE
SMOKE FLUE FOR BOILER
VENTILATING FLUE

Fig. 97.

and keep undefaced and legible on some conspicuous place on the premises, a notice with the words "Licensed slaughter-house," or "Registered slaughter-house," as the case may be.

Any person who makes default in this respect, or neglects or refuses to affix or renew such notice after requisition in writing from the urban authority, is liable to a penalty not exceeding *five pounds* for every such offence, and of *ten shillings* for every day during which such offence continues after conviction.—(P. H., s. 170.)

There are special Acts applying to the metropolis with regard to the slaughtering of cattle. New slaughter-houses cannot be established without the sanction of the local authority; they are to be regulated by bylaws, and to be duly licensed (37 & 38 Vict. c. 37, &c.) *See* FOOD, MEAT, &c.

Slops—By slop-water is usually meant the ordinary liquid refuse of a household, *excluding* fæcal matter. Ordinarily speaking, it is composed of urine, soapy matters, fatty substances, and various organic matters in suspension and solution: it is indeed undoubted *sewage*, but although it is actually sewage, there appears a doubt whether in a legal sense it comes under that name; for the legal advisers of the Local Government Board, basing their opinion upon the case of Kindersley, V. C., in Sutton *v.* Mayor of Norwich, 31 L. T. 380, state that "it appears to them that mere slop-water, without fæcal matter, is not sewage within the strict meaning of that term."—(Letter from the Local Government Board to Dr. Cornelius Fox, Public Health, No. 28, vol. ii.)

The letter even goes the length of stating that the Local Government Board would not consider "it illegal under ordinary circumstances to convey slop-water into a canal communicating with a river, or with the sea, if the volume of the slop-water is but small as compared with that of the water in the canal;" and further, that "it might not be illegal to convey the slop-water, whether deodorised or not, into a watercourse, but in such a case there might be a breach of private rights."—(*Op. cit.*)

There can be little doubt that to act upon this opinion would cause great danger to the public health, for allowing that it is possible to be sure that the slop-water contains no fæcal matter, there is no evidence to show but that the urine may propagate disease—*e.g.*, every person suffering from scarlet fever casts off from his kidneys thousands of epithelial cells, which in all human probability are capable of conveying contagion.

Putting, then, on one side, the question of pouring slops into watercourses and canals, there are several ways of dealing with them. (1) In places where there is a system of properly-flushed sewers, the slops are naturally thrown into the drains and go with the sewage; but where there is a dry system of disposal, and no drains, this cannot be done, and other means must be adopted, one of the best of which is (2) to have a Roger Field's tank (*see* SEWAGE, TANKS, &c.) and pipes leading from thence into a field, *beneath* the soil. But this of course can only be done under certain circumstances, for there are cases in which both of the foregoing remedies are impossible: in such cases, either (3) a properly-constructed tank must be made, or some simple apparatus constructed, like Dr. Bond's slop-tub, and the slops deodorised.

Dr. Bond's slop-tub is a common wooden barrel of from 40 to 60 gallons capacity. On the top of the barrel is a loose metallic sieve to prevent superfluous solids—such as scrubbing-brushes, potato-peelings, &c.—from finding their way into the barrel. At the bottom of the sieve is a conical receiver for collecting the precipitate, with a vent-hole for running it off. A floating strainer attached to an indiarubber tube, which communicates with a tap placed at the lower portion of the barrel, completes the apparatus. To use it, some disinfectant—such as a mixture of ferrous and aluminic sulphates—is added from time to time, and the tub allowed to get full. When full it must stand a little time, and then a perfectly clear liquid can be drawn off, leaving a fatty sediment, which if mixed with meal is said to be a good food for pigs. Dr. Bond, however, very wisely does not recommend urine to be mixed with ordinary slops, but treated separately, or, after being first acidified, thrown into some suitable place.

It is difficult to imagine places so situated as not to allow one of the three methods of slop disposal given to be adopted.

Smallpox (*Variola*)—Smallpox is an infectious fever, attended with a marked and peculiar eruption.

History.—Without doubt, smallpox is one of the most ancient, as it is one of the most frightful diseases which ever afflicted humanity. Ancient Chinese and Brahmin manuscripts 3366 years old are said to refer distinctly to epidemics of smallpox. The Chinese call it the "bean disease," and trace it to the reign of the first emperor of the (Eastern) Han dynasty, Kwang Wu, who reigned A.D. 25–28. It is said to have been imported from some portion of Central Asia, or from some part of South-Western China, by some Chinese troops returning from a foreign campaign.

The earliest Chinese work on smallpox is a treatise called "Wan-jin-shi-tau-chin-lun," published in 1323, from which it appears that they have practised inoculation more than a thousand years.

Allowing that it entered Europe from the East, the exact date of its introduction is unknown, but it is certain that the Arabian army was attacked by it at the siege of Mecca in A.D. 569, and that in 570 it was both in France and Italy. In the eighth century all Europe was infected with it, the virus having been in many instances disseminated by the Saracens; and in the same century it was probably introduced into England, where it soon became naturalised.

The history of smallpox in England naturally divides itself into three parts—viz., the first period, from the eleventh and twelfth centuries to 1721, in which period it was altogether unchecked; the second epoch, from 1721 to 1802, during which it was palliated by inoculation; and the last, from 1802 up to the present time, during which it has been partly prevented by vaccination. The first period was one of the utmost severity; it raged from time to time throughout England in a horrible manner, the most fatal of all contagious disorders. Sir Gilbert Blane estimated that smallpox destroyed a hundred for every one that perished by the plague; and Dr. Black estimated the annual mortality from smallpox during this period, in Europe, to be 494,000.

In the second period, inoculation was introduced from Constantinople by Lady Wortley Montague (1721). This operation had, as we have mentioned, been practised from a very remote period by the Chinese, who inserted a smallpox crust or scab in the nose. It had also been practised one hundred years before this date in Wales, the method there being known as that of "buying the smallpox." The effect of inoculation was to induce a milder disease, the mortality from natural smallpox in those times being one in five; in inoculated smallpox, first one in fifty, and then when greater care was taken and more skilful operators possible, one in five hundred. Its value as a sanitary measure in those times was great, and this Dr. Guy proves by taking the ratios of deaths reduced to the common standard of a million for three decades—one ending 1719, in which no inoculation was practised; a second decade ending 1749, of partial inoculation; a third ending 1799, of general inoculation. For the first the figures are 31,416; for the second, 28,282; and for the third, 22,863.

At the same time it must be remembered that inoculation propagated smallpox, and that many instances occurred in which the natural disease was caught by contact from an inoculated person, that inoculation was far from being altogether safe, and that disfigurement and blindness often came from inoculation as well as from the ordinary kind. It must also be observed that during the whole eighty years 1721–1802, fatal epidemics of smallpox were very frequent, the London Bills of Mortality showing 9827 deaths from this cause alone during the last five years of the eighteenth century.

In 1801 Dr. Jenner's discovery of the prophylactic properties of vaccination (*see* VACCINATION) began to be widely known (vaccination was actually introduced in 1797, and Jenner published the results of his experiments in 1798), but it was not practised to anything like a general extent for a few years. The actual numbers of the vaccinated in 1801 are said to have been about 6000; but its marvellous power was soon felt, and is imperishable in the records of humanity. Dividing the last forty unvaccinated years of the eighteenth century into four decades, and taking six decades of the vaccinated nineteenth century, up to 1860, by calculating out the ratio of deaths from smallpox to deaths from all causes, we get the following remarkable series: For the four unvaccinated decades, 108, 98, 87, 88; for the six vaccinated decades, 64, 42, 32, 23, 16, 11.

These figures alone show what vaccination can do. That vaccination properly carried out all over the world would actually extinguish the disease there can be little doubt; but on the other hand, that vaccination slovenly performed (and that only once) imperfectly protects a nation, is proved by the recent epidemic, lasting no less than a year and a half, which has swept over our own isles, Europe, and America.

The following figures are compiled by Dr. Farr from the Bills of Mortality, and show the same fact in a somewhat different way. The figures relate to London alone, and are ratios of average annual deaths from smallpox and from all causes to 100,000 of the population in six groups of years:—

Years.	Smallpox.	All Causes.
1629–35	180	5000
1660–79	417	8000
1728–57	426	5200
1771–80	502	5000
1801–10	204	2920
1831–35	83	3200

The following table is still more exact, as registration commenced in 1838:—

Year.	Deaths from Smallpox.	Deaths per 100,000 living. Smallpox.	Deaths per 100,000 living. All Causes.
1838 . .	3817	208	2876
1839 . .	634	34	2428
1840 . .	1235	65	2498
1841 . .	1053	54	2404
1842 . .	360	18	2352
1843 . .	438	22	2466
1844 . .	1804	87	2500
1845 . .	909	43	2319
1846 . .	257	12	2330
1847 . .	955	43	2695
1848 . .	1617	72	2582
1849 . .	518	23	3014
1850 . .	498	21	2104
1851 . .	1066	45	2338
1852 . .	1166	48	2261
1853 . .	217	9	2441
1854 . .	676	27	2943
1855 . .	1024	40	2431
1856 . .	522	20	2209
1857 . .	154	6	2241
1858 . .	247	9	2390
1859 . .	1156	42	2269
1860 . .	877	32	2249
1861 . .	215	8	2318
1862 . .	345	12	2356
1863 . .	2012	69	2447
1864 . .	537	18	2653
1865 . .	646	22	2456
1866 . .	1388	46	2648
1867 . .	1332	43	2301
1868 . .	606	19	2360
1869 . .	273	9	2463
1870 . .	958	30	2112
1871 . .	7876	242	2465

Although this table terminates with the enormous mortality of over 7000, yet it shows very conclusively that vaccination prevented smallpox from making any great ravages—until, in fact, immunity produced carelessness, and, practically speaking, vaccination came to be but imperfectly performed in the first instance, while secondary vaccination was entirely omitted. The scarred and seamed faces, the blind and deaf, had faded from the memory of the present generation; the effects of the disease before Jenner's discovery only lived in history, in prints, caricatures, and lampoons. Many an old country surgeon had scarcely seen half-a-dozen cases of smallpox in his life, and those of a mild and discrete type, when suddenly in the latter part of 1870 smallpox began to increase, and in the years 1871 and 1872 attained most alarming proportions. There was not a town of any size in all England which did not suffer; nor was it confined to this country. It raged in Paris, Vienna, Holland, America, and other places. But in all countries, and in all places, observant men noticed that the thoroughly vaccinated took the disease lightly or not at all, while the worst and most fatal cases were those on whose arms the autograph of Jenner was absent. The maximum mortality in London was attained in May 1871, and it then gradually declined and faded away towards the middle of the year 1872. The deaths from smallpox in the principal large cities in 1871 were as follows: London, 7876; Portsmouth, 39; Norwich, 245; Bristol, 45; Wolverhampton, 284; Birmingham, 61; Leicester, 11; Nottingham, 144; Liverpool, 1919; Manchester, 267; Salford, 227; Bradford, 5; Leeds, 43; Sheffield, 406; Hull, 57; Sunderland, 850; Newcastle-on-Tyne, 695.

This epidemic has been cited by the anti-vaccinators as an argument on their side; yet the following table, showing the duration and the absolute and relative fatality of the smallpox epidemics which prevailed in London since the Registration Act came into operation, proves that smallpox has prevailed epidemically in twenty-one and a half years only, or 61 per cent., of the whole thirty-five, 1837-71—a striking difference when compared with the former tables:—

Periods.	Duration of Epidemic. Years.	Total Deaths.	Average Annual Deaths per 100,000 living.
1837-39 . .	2	5061	138
1840-41 . .	1¾	2220	65
1844-45 . .	1½	2531	80
1847-49 . .	2¼	2831	56
1850-52 . .	2	2349	49
1854-56 . .	2¾	2148	31
1858-60 . .	2	2077	33
1862-68 . .	5¾	6574	38
1870-71 . .	1½	8617	176

Nature of Smallpox.—The disease is essentially an infectious one. The contagion is conveyed in minute particles of living matter taken from a pustule. If this substance is inserted into the skin, or breathed so as to enter the circulation of an unprotected subject, this living matter, which may be so minute as scarcely to be seen with the naked eye, divides and multiplies within the body, and shows its effects by high fever, followed by the breaking forth, the erupting, of little pimples, each of a peculiar oval shape, with a central depression. If these pimples are solitary, each with a space around it, it is called *discrete;* if the pustules are so thick that they stand close together so that there is no space between, and they appear to, and actually do, run into one another, it is then called *confluent.*

General Course of the Disease.—Whether the smallpox be distinct or confluent, inoculated or natural, its course may be divided into—(1) the period of incubation; (2) the febrile stage; (3) the exudative stage; (4) the suppurative stage. The first and second periods are probably non-infectious, the third and fourth are most certainly infectious.

The periods of incubation of all zymotic diseases have a practical sanitary importance, especially as regards quarantine, isolation, &c. This period in ordinary smallpox is between thirteen and fourteen days, so that persons coming from an infected district cannot be pronounced safe until about eighteen days have elapsed. On the other hand, in the inoculated smallpox, the incubative stage is shortened, and is generally from seven to nine days. The febrile stage follows. In distinct smallpox it lasts four days, and then the eruption appears. In the confluent, the whole course is more rapid, the eruption appearing at the end of the third day or even on the second.

The eruption—at first a pimple, then a vesicle, next a pustule, and lastly a scab—is generally at its height on the eighth day, after which they begin to suppurate (this is the most dangerous time); and after suppuration, a scab is formed, which falls about the thirteenth or fourteenth day, though sometimes longer. Hence in ordinary smallpox the incubation period lasts a fortnight, the illness itself another fortnight. During the first period the patient walks about, and is non-contagious (unless, indeed, his clothes have become infected from the same source as his body); during the second period he is evidently ill, and in most of that period dangerous to society.

Mode of Propagation.—Smallpox may be derived from the cow, which is affected by this disease (then called cowpox), and this may be transmitted to man. The eruption appears on the teats of the animal, and the milkers occasionally become infected. It was in this way that the Gloucestershire milkers who had been taken with cowpox found themselves protected by it from the human smallpox, and so laid the foundation of Jenner's discovery. As the smallpox may be transmitted from the cow to man, so may the smallpox of man be transmitted to the cow. This has been done now both by inoculation, and also through infected bedding, &c., being placed in the field. This disease also afflicts the horse, and a variety of it the sheep. This last (the *variola ovina*, or the *clavelée* of French writers) is peculiarly interesting, because the sheep, although covered with large pustules, may be handled freely and without danger by their shepherds, as if (as Dr. W. Budd remarked) there was here a poison, and there was only one test for its presence—viz., the body of a sheep. The propagation of *clavelée* by starlings, flies, &c., which frequently happens, is instructive, and throws light upon infection and contagion generally.

Smallpox, then, may be communicated and propagated from the cow or horse, and probably other animals.

It is also communicated by direct contact, by inoculation, by emanations from the sick, by flies, by clothing, and articles of all kinds, such as books from circulating libraries, pence, letters, &c. There are instances of communication by all the methods mentioned above.

Prevention of the Disease.—First among the preventive means stands *effective vaccination.* By effective vaccination is meant *four large* distinct vaccine vesicles inoculated on the arm of every child under three months; a second vaccination, which may or may not take effect, at the age of ten or twelve; and a third vaccination in another ten or twelve years. Besides these, on the approach of smallpox, every individual should be *tested* whether he or she is susceptible of smallpox. Vaccine is a *test.* Those, *cæteris paribus*, who take smallpox readily, also have successful vaccine vesicles; those who are protected, the vaccine lymph scarcely affects.

When smallpox actually appears, every case, however mild, must first be isolated as much as possible. Thin curtains should be fixed to the open windows, so as to allow no flies to go out or in, and fly-catchers should be suspended in different parts of the room.* The patient's body should be well anointed with carbolic acid oil, the excreta received in vessels containing some disinfectant, and buried deep in the ground. The attendants should be thoroughly vaccinated, and all cloths, rags, &c., used to wipe discharges from the mouth should be burnt. If the patient recovers, he must not be allowed to go out until all desquamation ceases, which will be in about a week after the scabs drop off. And before going out he should have a thorough change of clothing, the skin should be rubbed over with oil and then washed. If the case should be fatal, a coffin should be prepared lined with chloride of lime; the body should be laid out only by some one who is protected by vaccination or a previous attack, and it should be covered with disinfectants. Burial as soon as possible is very desirable, and no one should follow the coffin who has not been revaccinated.

During the whole period of illness, &c., a clean cotton robe and cap should be hung up in a sheltered place outside, for the medical man to envelope himself in before visiting the case. Every medical man should leave his hat and gloves outside the house, and putting this cotton robe and cap on, with after-ablution, he will not be liable to carry the disease to other patients. There are various other minute details which common sense will suggest, especially with regard to baking or de-

* Nets of thread or string, with meshes fully an inch square, and so fine as almost to be invisible, will effectually prevent flies from entering into a room, providing the light enters the room on one side only. For a fuller account of these singular facts, *see* Kirby and Spence's Entomology, 7th edition. p. 69; also Trans. Ent. Soc., Lond., vol. i. p. 1; ibid. vol. ii. p. 45.

stroying bedding and clothing, whitewashing and cleansing the rooms, &c.

One thing should be specially mentioned—viz., that there is no dependence in this disease on gaseous disinfectants. According to Bakewell, the contagion of smallpox consists of minute particles of liquid enclosed in hardened pus.

Sanitary authorities, on the appearance of an epidemic, should take united action against the foe, by establishing temporary hospitals and means of conveying patients to them; they should also watch the railway stations, lest patients with the eruption on them should attempt to travel by rail, and thus carry the infection to distant places.

Librarians, and other custodians of public institutions of the kind, should require a certificate that the person to whom they intrust articles has no smallpox in his family. Schools, churches, and all public places should be well watched, and no one nursing a smallpox patient allowed to mix with any assembly.

Smoke—The inconveniences and dangers to the health produced by smoke are obvious. Dr. Angus Smith made an examination of the various smokes issuing from the chimneys of different manufacturing premises. The following tables show the results obtained from analysing several samples of the black smoke issuing from the flues of a sugar-factory:—

TABLE I.

Gases.	Sugar-Works, Large Chimney.			
	Smoke from Lower Opening, Nov. 21, 1868.		Samples taken at the Bottom of Chimney, November 5, 1868.	
	1.	2.	1.	2.
Carbonic acid...	7·67	7·47	7·25	7·09
Carbonic oxide.	none	none	3·80	4·46
Oxygen	12·61	8·11	7·41*	7·57
Olefiant gas......	none	none	none	none
Nitrogen..........	79·62	84·42	81·54	80·88
	99·90	100·00	100·00	100·00

TABLE II.

Gases.	Sugar-Works, Small Chimney.			
	Samples collected, December 21, 1868.		Samples collected, December 24, 1868.	
	1.	2.	1.	2.
Carbonic acid...	3·51	3·89	2·84	3·77
Carbonic oxide..	0·68	0·59	none	0·55
Oxygen	0·45	0·41	...	none
Olefiant gas......	13·54	14·08	18·46	16·52
Nitrogen..........	81·82	81·03	78·70	79·16
	100·00	100·00	100·00	100·00

* Oxygen found in this instance by absorption with pyrogallic acid.

TABLE III.

Gases.	Sugar-Works, Large Chimney. Samples taken from Opening 30 Feet above the Ground.			
	November 26, 1868.		December 2, 1868.	
	1.	2.	1.	2.
Carbonic acid..	6·17	6·75	6·64	6·32
Carbonic oxide.	1·55	0·48	0·40	0·98
Oxygen............	12·22	12·36	11·17	11·86
Hydrogen	none	none	none	none
Marsh gas.........	...	...	0·02	0·78
Olefiant gas	0·13	...	none	none
Nitrogen..........	79·93	80·41	81·77	80·06
	100·00	100·00	100·00	100·00

Black smoke contains also water, soot, and sulphurous acid.

100 cubic feet of black smoke contained—

	1.	2.	3.
Water . . .	none	797·41	1047·44
Soot	none	none	18·52
Sulphurous acid	33·48	none	none

"Whenever there is black smoke there is water in the smoke, because the black carbon is deposited from hydrogen compounds, which burn readily. Pure hydrogen uncombined was not found. Sulphuretted hydrogen also seems to be always absent. Sulphur does certainly come from coals in combination with hydrogen, but it is so easily separated that it never reaches the flues. There are several attacks on the hydrogen and sulphur compound—fortunately for us, as otherwise our towns would really be uninhabitable when fires were smoking. Sulphuretted hydrogen is decomposed by heat. When this occurs, in the absence of oxygen, the solid sulphur is deposited; but, as we see, there is always air enough in the smoke for this event, and so the sulphur burns. This is the chief source, if not the only source, of the sulphurous gases arising from smoke. If any of the sulphuretted hydrogen remained unburnt, the sulphurous acid would itself decompose, forming a deposit of readily combustible sulphur, and increasing the amount of the sulphurous acid. Then the gas itself is readily combustible, and forms sulphurous acid and water by burning. For these reasons that dangerous gas, sulphuretted hydrogen, is not allowed to pass up our chimneys when burning coal."—(ANGUS SMITH.)

Black smoke contains a much larger proportion of carbonic acid gas than ordinary smoke, is heavier and denser, and, it is needless to say, involves considerable waste of fuel; hence, whether considered in its relation to the manufacturer, or as a nuisance, it is equally undesirable.

An analysis of the common brown smoke, both from the large and small chimneys of the sugar-works, gave the following results:—

COMMON BROWN SMOKE.

Gases.	Sugar-Works, Large Chimney.		Sugar-Works, Small Chimney.	
	1.	2.	1.	2.
Carbonic acid...	4·26	4·14	2·53	2·08
Carbonic oxide.	none	none	none	none
Hydrogen	...	...	...	...
Marsh gas........	...	...	...	...
Nitrogen	79·11	80·02	78·86	80·22
Oxygen............	16·63	15·84	18·61	17·70
	100·00	100·00	100·00	100·00

The reader will find in article COMBUSTION a table showing the composition of the smoke issuing from a common house fire.

For the gaseous compounds found in tobacco smoke, *see* TOBACCO.

The carbon contained in the smoke collects on buildings, &c., giving them a dingy appearance. Rough surfaces take up a much greater quantity of carbon than smooth, and become black in proportion to their roughness. In examining some rough bricks from buildings in Manchester, Dr. Smith found that—

4·4 × 4·0, or 17·6 sq. in., gave 0·17 grs. carbon.
3·0 × 2·7, or 8·1, „ 0·02 „

"This last is equal to 320 grains—about ¾ of an ounce, or 21 grammes—on a wall 30 feet by 30. This is, I believe, a great deal above the mark, at least I believe a house will appear dingy with a minute portion of this."

To diminish the amount of sulphur given off by coal gas, it was suggested by Mr. Holme of Manchester to burn salt with the coal.

The following experiments illustrate the value of this idea:—

Amount of Sulphur driven off from a Specimen of Coal by Distillation.

	Sulphur, per Cent.
Coal alone—	
1. At a low red heat . . .	0·4692
2. At a higher heat . . .	0·5655
3. At a nearly white heat . .	0·6755
	Sulphur, per Cent.
Coal with common salt—	
4. With 5 per cent. salt . . .	0·4526
5. „ „ at a higher heat	0·4843
6. „ „ nearly white .	0·5557

The remainder, or cinder, contained—

	Sulphur, per Cent.
From No 3.	0·4332
„ 6.	0·5448

When lime was substituted for salt, the following results were obtained:—

	Sulphur, per Cent. in Distillate.
Coal distilled alone	0·4338
„ with 5 per cent. of lime .	0·1754
„ with 10 per cent. of lime .	0·0511
„ with 10 per cent. of lime .	0·0616

Many contrivances have been proposed for the prevention of smoke. The principles involved in attaining this result are — (1) the supply of fuel in small quantity at a time, taking care to maintain a strong steady fire, in order that the gases may be burnt as soon as they are generated; and (2) the supply of an adequate quantity of atmospheric air.

One of the earliest patents obtained for smoke-burning was that of Mr. Charles Wye Williams, in the year 1840. This gentleman's method consisted in admitting an abundant supply of cold air through a large number of small perforations in the door and front part of the furnace.

Lark's system is based on the admission of heated air, under due regulation, both through the door and at the bridge or back of the furnace, by which means combustion is rendered more complete and smoke thereby prevented. Ivison recommended the introduction of steam by minute jets over the fire, which is thus greatly increased in intensity without the production of smoke, and with a saving of fuel. In Jucke's arrangement the grate bars of a furnace are replaced by an endless chain web, which is carried round upon two rollers in such a way that each part of the fuel is exposed to conditions most favourable for perfect combustion. A variety of *smokeless* grates have been invented for private houses. They not only possess the advantage of consuming their own smoke, but also heat the room for a considerable time without attention. *See* WARMING.

It is the duty of sanitary authorities to enforce the provision of any Act that may be in operation in the district, requiring that furnaces, &c., all consume their own smoke.—(P. H., s. 102.) *See also* NUISANCES.

Every locomotive used on a highway or railway must be so constructed as to consume its own smoke. Penalty, £5 per day or less. —(8 Vict. c. 20, s. 114; 24 & 25 Vict. c. 70, s. 8; 28 and 29 Vict. c. 83.)

Steam-vessels plying to and fro between London Bridge and any place on the river Thames are liable to penalties for not consuming their own smoke.—(19 & 20 Vict. c. 107, s. 81.)

Under sect. 19 of the Act quoted it is not necessary in an information to show that black smoke sent forth from a chimney is injurious to health as well as a nuisance.

Snow—An *urban* sanitary authority has power to make bylaws for the prevention of nuisances arising from snow, &c. *See* BY-LAWS, SCAVENGING, STREETS, &c.

Snuff—*See* TOBACCO.

Soap is a true chemical compound. The basis of the hard soap is *soda*, of the soft, *potash*. The soda or potash, as the case may be, is united with the fatty acids, and forms compounds soluble in water. On the other hand, magnesium, calcium, &c., do not form soaps soluble in water; hence, when a solution of soap is added to hard water, double decomposition sets in, and the insoluble calcium soap is formed. *See* WATER, ANALYSIS OF.

The manufacture of soap is not in itself considered dangerous, but a very offensive smoke is emitted from the chimneys. Accidental cases of poisoning by soap lees have occurred, and occasionally the workers fall into the large soap-boilers, and so lose their lives. In the construction of premises for carrying on this industry the chimney should be built high enough to carry away all offensive smoke, &c., and every precaution taken to prevent the occurrence of such accidents as we have here indicated.

The business of a soap-boiler is not to be newly established in an urban sanitary district without the consent of the sanitary authority. The authority may make bylaws regulating the business.

Sodium (*Natrium*, Na = 23)—This metal does not exist native; when pure, it resembles silver in colour, but is soft; specific gravity, ·97. It rapidly oxidises and forms a protoxide, the alkali soda.

Sodium salts resemble greatly those of potassium, but may be easily distinguished from the latter. They are soluble in water, do not give any precipitate with the ordinary reagents, and they give a rich yellow colour to the flame from a Bunsen's burner. They can to a certain extent be also distinguished from the potassium salts by the carbonate being an easily crystallisable salt, effervescing in dry air, the carbonate of potassium being crystallised with difficulty, and deliquescent. Platinum chloride does not give a precipitate with sodium chloride, neither does picric acid, perchlorate of ammonium, nor tartaric acid.

Bicarbonate of Sodium ($NaHCO_3$) is largely used in the preparation of effervescing powders, 20 grains of the commercial bicarbonate of sodium neutralising 18 grains of crystallised tartaric acid, 17 grains of crystallised citric acid, ½ fluid ounce of lemon-juice. The compound of soda which has the most importance for us, and the only one which it will be necessary to enlarge upon here, is—

Chloride of Sodium ($NaCl = 58·5$. Specific gravity, 2·24; composition in 100 parts, Na 39·32; Cl 60·68) (*common salt*), so necessary for the alimentation of man, has been known from the earliest times. Moses commands, in the Book of Leviticus, that every offering of meat upon the altar shall be seasoned with salt; Homer in the Iliad (lib. ix. 214) mentions it, and the Romans used it in their sacrificial cakes; indeed, in the Latin Church its use is still continued.

Common salt exists in a large proportion in every one of the secretions, and it forms about half the total weight of the saline matters of the blood. The proportion in the blood is fixed, and does not appear to be capable of alteration. The dietetic value of salt has been recognised from the earliest times. Besides its dietetic value, salt is an important disinfectant. We may, indeed, term it the "original" disinfectant. It has been long employed for preventing the putrefaction of food, and there is no reason why it should not be similarly employed for keeping refuse substances of all kinds from decay. It is cheap, easily obtained, clean, and not poisonous; the only disadvantage is that it is not a deodoriser. *See* DISINFECTION.

Salt is obtained either from salt mines or by the evaporation of sea-water. This latter method was formerly practised to some extent upon the southern coast of our own island, but with us this mode of manufacture is now unimportant. In conducting the process, sea-water is allowed to run into shallow pools, in which the water evaporates and the liquor becomes concentrated by the heat of the sun; crusts of salt are formed, and are raked off from time to time. The rough crystals thus obtained furnish the *bay salt* of commerce. The concentrated sea-water or *bittern* is employed as a source of bromine. It has been found in France that when such "salt marshes" have been abandoned, as they often are, they become a source of disease.

The mean mortality of sixteen years in the town of Brouge, situated near a large abandoned salt marsh, was 1 in 21 (47·6 per 1000), while for the whole of France the rate was 1 in 40 (25 per 1000). It has been supposed that the salt water, in constantly coming in contact with fresh, destroys the animal matters contained in the latter, and the putrefaction of such substances gives rise to dangerous exhalations.

A thousand parts of the water of the British Channel contains 28·05948 parts of chloride of sodium.

The common salt of commerce usually contains small portions of chloride of magnesium, chloride of calcium, and sulphate of calcium, and hence deliquesces in air and has a slightly bitter taste. These may be separated by dissolving the salt in four times its weight of pure water, and dropping into the filtered solution first chloride of barium, and then carbonate of sodium as long as any precipitate falls; filter, and evaporate the clear fluid very slowly until the last crystallises, which is pure chloride of sodium.

Nitrate of Sodium ($NaNO_3$).—This substance is now largely used as a manure, and in the preparation of nitric acid. It has also recently been employed in the manufacture of fireworks. It has been utilised as a disinfectant in place of NITRATE OF POTASSIUM, *which see*.

For legislation respecting sodium, *see* ALKALI ACTS; NUISANCES; TRADES, DANGEROUS, &c.

Soils—For the purpose of this article, soils (including rocks) may be divided into permeable and impermeable. The impermeable are those which are solid, dense, having few interstices, and therefore containing little or no air—such as granite, trap, and metamorphic rocks, clay-slate, dense clays, oolite, hard limestone, dolomite, &c. The permeable are the reverse of the former, and comprise such as chalk, sand, sandstone, vegetable soils, &c.

This division is of practical importance. A cesspit in a stiff impermeable clay soil is not so liable to pollute wells as one which is excavated in loose gravel; while, on the other hand, surface-water collects on impermeable soils, and often causes dampness to the foundations of houses.

The amount of moisture and of air in a soil, its capacity for heat, and its chemical composition are the main points of interest.

The moisture of soils is derived from two sources—viz., from the rain above, and from the subsoil-water and springs beneath. It varies greatly; thus, in marble, granite, the primitive and metamorphic rocks generally, it is about 1 pint in every cubic yard. Loose sand in the same cubic area will hold 54 gallons, sandstone 27 gallons. Clay retains from 10 to 20 per cent., chalk 13 to 17 per cent., light clay loam soil from 20 to 30 per cent., and humus from 40 to 50 per cent.

The absorption of heat by different soils has been only as yet investigated by a few observers. Schübler gives the following table :—

Power of retaining Heat, 100 being assumed as the Standard.

Sand, with some lime	100·00
Pure sand	95·60
Light clay	76·90
Gypsum	73·20
Heavy clay	71·11
Clayey earth	68·40
Pure clay	66·70
Fine chalk	61·80
Humus	49·00

Hence, sand is the hottest, humus and clay are the coldest soils.

Chemical Composition of Soils.—Soils are composed of animal and vegetable matter and mineral substances. The organic matter is derived from life, the mineral from the disintegration of rocks. The preponderating or principal constituents of soils are aluminum, silicon, calcium, magnesium, iron, carbon, chlorine, phosphorus, potassium, and sodium, and in small quantity other elements.

The Influence of the various Soils on Health.—The impermeable rocks—such as the granite, &c., as well as the clay-slate—are generally considered healthy. Habitations or encampments are usually built on the sloping sides of some of the hills, and the water runs off readily, nor do impurities soak into the springs. For a good instance of a healthy site of this description Malvern may be cited. When such formations become disintegrated they are said to be unhealthy, but the evidence upon this point is not clear.

Limestone and magnesian formations abound in hard springs, which may cause goître. Marshes are also common. There are some limestone sites, however, which are the reverse of detrimental to health.

Chalk, permeable sandstones, and gravel are extremely healthy. The springs from gravel are generally derived from underlying clay, and are pure; those from the permeable sandstones may, if care be not taken, get polluted.

Sandy soils greatly vary. Those without organic matter are healthy; others, like the subsoil of the Landes in France, contain a vegetable sediment; others, again, from subsoil-water, are distinctly malarious; and some, as those of the Punjab, abound in soluble salts, so that the drinking-water is rich in common salt, carbonate of soda, lime, magnesia, &c. Constantly drinking such water cannot fail to induce a bad state of health.

Dry cultivated soils are healthy, *wet irrigated soils* are hurtful.

Clay, marly soils, &c., must be drained thoroughly or they are very unhealthy, and induce consumption and other evils. The water does not run off, but remains in the soil; and besides this, they are cold.

Made soils, such as the ground made by filling up large excavations with rubbish, are probably the most unhealthy of all; they, however, may become less dangerous after a number of years. On no account should such a site be selected for building purposes.

All soils, and especially argillaceous soils, possess the valuable property of purifying water impregnated with organic matter. Mere agitation of water with finely-divided clay is sufficient to remove a large amount of organic and saline matter. Clay decomposes sulphate and chloride of ammonia, because all clays contain lime, and the result is that the clay retains the ammonia, and sulphate and chloride of lime are formed. A similar reaction takes place with potassic nitrate.

But it must be borne in mind, that although all soils, especially when dry, are purifiers, deodorisers, and disinfectants, yet that this action does not extend to the germs of all diseases

—*e.g.*, the germs of typhoid fever, and perhaps of cholera, would appear rather to be preserved by the soil. *See* FEVER, TYPHOID.

Analysis of Soils.—For health purposes the two essential points are the amount of moisture and the permeability of the soil; the chemical constitution may also be required.

The moisture is easily obtained. About 10 grammes should be put in a platinum dish, and heated in a paraffine or air bath at 125° C. until it ceases to lose weight.

The permeability to air is best estimated by the ingenious method of Pettenkofer. The soil is crushed, dried, and powdered; it is then put into a burette, and the burette flipped and tapped so as to expel air from the interstices. This burette is connected by an elastic tube, provided with a clamp, to a second, into which water is poured, and the height of the water carefully noted. By opening the clamp, the water will of course go from the second into the first, expelling as it rises all the air in the soil. It is allowed to run in until a thin layer of water is seen above the soil, the height at which the water stands in the second burette is then read off, and the following calculation made :—

$$\frac{\text{Amount of water used, } \times 100}{\text{cubic centimetres of dry soil}} = \text{percentage of air.}$$

The analysis of soils is divided into two parts—one mechanical, the other chemical.

The mechanical analysis consists in separating the soil into stones, gravel, sand, coarse sand, fine sand, clayey substances, &c. This is done very expeditiously by Nobël's apparatus, which is figured and described in Fresenius's 'Quantitative Chemistry.' In default of apparatus, a rough and fairly accurate separation may be effected by hand-sieves and subsidence, each product being weighed.

The next process is to determine the carbonic acid in a portion of soil, which may be effected after the manner of Will and Fresenius. (*See* ACID, CARBONIC.) The soil is then usually treated in the following way :—

Four hundred and fifty grammes of properly dried soil are digested with 1500 cubic centimetres of concentrated hydrochloric acid; two-thirds of the liquid are decanted, diluted, filtered, and evaporated, with the addition of a little nitric acid towards the end. The dry mass is moistened with hydrochloric acid, warmed, and the silica separated. The filtrate is now made up to 1000 cubic centimetres.

Three equal portions of this liquid, each containing 300 cubic centimetres, are taken —*a*, *b*, and *c*.

In *a*, the iron, the manganese, the alumina, the lime, and magnesia are determined. The alumina and iron may be thrown down by ammonia, and the iron estimated by the solution of permanganate, described under the head of VOLUMETRIC SOLUTIONS; the lime separated by ammonium oxalate; and the magnesia in the solution, now free from iron, alumina, and lime, by sodium phosphate.

In *b*, the sulphuric acid and alkalies may be determined. The sulphuric acid is precipitated by chloride of barium; milk of lime is then added to the liquid; it is next filtered, and the alkalies determined.

In *c*, the phosphoric acid is determined as pyrophosphate of magnesia.

The portion insoluble in hydrochloric acid consists of quartz, clay, silicates of alumina, iron, lime, magnesia, and alumina. It will hardly be necessary to examine it farther; but if desired, a part of the insoluble portion should be ignited with carbonate of soda, and then treated with dilute hydrochloric acid: the insoluble residue is silica, and in the solution is probably iron, alumina, &c. Another portion may be decomposed by sulphuric acid.

If the nitrogen in the soil is to be determined, it must be burnt with soda-lime. *See* NITROGEN.

Soldier—*See* HYGIÈNE, MILITARY.

Soot—The soot of pit-coal, since it contains, besides empyreumatic matter, sulphate of ammonia, is, when not too freely applied, valuable as a manure; and it is also employed by gardeners for the purpose of killing insects. Wood-soot was formerly reputed vermifuge and antiseptic, and was officinal. Soot has been discovered as an adulterant of opium.

Soup—Soup may be defined as an aqueous solution of the soluble constituents of meat. Meat gives up to water—albumen, gelatine, creatinine, fatty matter, inosic acid, with baryta and potash, lactates, phosphates, and chlorides, combined with potash and magnesia, and traces of lime and soda, and these substances are usually present in properly prepared soup. The gelatine contained is of small nutritive value, and is liable to disturb the digestive organs; hence it is not advisable to employ means whereby a large proportion of gelatine may be extracted, as frequently is the case. Soup is rarely made from meat alone, it is usually flavoured with vegetables, &c.

The richest soup may be prepared by chopping lean meat into small pieces and dissolving out the soluble constituents by macerating the pieces of meat for a short time in water, which is then gradually heated and exposed to a prolonged but gentle boiling. A soup thus prepared contains the whole of the soluble constituents of the meat, amounting to about 5 per cent. of the quantity used.

The nutritive value of soup will of necessity vary with the matters from which it is made and with its mode of preparation.

According to Dr. E. Smith, in cooking-depôts where soup is made for the poor, 100 rations of soup are thus prepared : "The meat-liquor from 7 lbs. of beef and 1 lb. of bones; split peas, 13 lbs. ; carrots and Swede turnips, each 6¼ lbs. ; onions, 5½ lbs. ; leeks, ½ lb. ; salt, pepper, and dried herbs, enough to flavour." And the materials for 100 rations of Scotch broth are, according to the same authority : "The meat-liquor from 7 lbs. of beef and 1 lb of well-broken bones; 2¾ lbs. of split peas ; 3½ lbs. of Scotch barley; 3½ lbs. of carrots ; 3½ lbs. of turnips ; 7½ lbs. of cabbage or other green vegetables; with sufficient salt, pepper, and dried herbs." Reckoning the ration at 1 pint, it would contain the nutriment of only about 1¼ oz. of meat and bone, which is manifestly insufficient for dietetical purposes.—(LETHEBY.) *See* COOKING ; MEAT, EXTRACT OF, &c.

Soy, Indian—A species of thick black sauce imported from China. It is prepared by mixing certain definite quantities of seeds of *Soja hispida*, water, bruised wheat, and common salt together, and leaving the mixture to stand for some months. Most of the so-called Indian soy of the shops is made simply by saturating molasses or treacle with common salt.

Special Drainage District—*See* SEWAGE, p. 540.

Specific Gravity is the weight of a unit of the volume of a substance ; in other words, it is the relation between the weights of bulks of different kinds of matter. The specific gravity of all solids and liquids is referred to water, which is taken as 1000; and for gases the standard is generally air; but some chemists refer gases to hydrogen, as the lightest body known. In England the specific gravity is taken at 60° F. ; in France it is taken at 32° F. (0° C.)

To determine the specific gravity of a solid it is weighed first in air and then in water. The data obtained are—(*a*) weight in air; (*b*) weight in water; (*c*) difference or loss of weight; then $\frac{a}{c}$ = specific gravity. When a substance is lighter than water it may be attached to a piece of lead or other metal, the specific gravity of which is known, and then weighed as before, and calculated out by rule of three.

Specific Gravity of Liquids and Gases.—Liquids are usually estimated either by hydrometers, or by small bottles holding 10, 50, or 100 grammes or grains of water up to a mark in the neck. It is obvious that by putting other liquids, such as ether or oil of vitriol, in the same flasks up to the mark, we obtain the same bulk, but the weights will be different. For example, a specific-gravity bottle filled with water weighed 1000 grammes, filled with alcohol, ·792 grammes. The specific gravity of the alcohol is therefore ·792 grammes. But the most convenient and quickest method of estimation for liquids, and one indeed of great accuracy, is by means of Westphal's balances.

These balances, manufactured in two sizes, have the advantage over the well-known hydrometers, that with them the specific gravity of all liquids, whether heavier or lighter than water, can be accurately determined to the third decimal place, whilst hydrometers are adapted for one class of liquids only.

The balances consist of a support, a weigh-beam, a plunger to be immersed in the liquid, and a set of weights (fig. 98). The foot of the support F bears a hollow shaft L, provided with a set-screw P, so that the upper part of the support can be raised, lowered, and secured. The upper part of the support is fitted at one end with the fulcrum of the beam H, and at the other on the same level with the point J, which serves as a zero when weighing. The catch-block K prevents the beam from being lifted out of its bearings. The beam, a lever with unequal arms, is divided from H to A into ten equal parts, and terminates at the opposite end in a counterpoise, provided with a point, which serves as a tongue. The graduated arm is notched to receive the rider weights, A, B, and C.

At the upper end of the plunger a platinum loop is melted in, into which fits the suspension wire, and is in turn connected with the stronger suspension-link *m*. To make the wire more mobile and preserve it from breaking, it is not connected with the platinum loop of the thermometer directly, but by means of the double link *n*. The weights are so made that the two largest, A and A′, are equal to the weight of distilled water displaced by the plunger at 15° C. as normal temperature. The weight A′ is bent into a loop, and in determining the specific gravity of liquids heavier than water it is suspended, as may be seen in fig. 98, and = 1. The other three weights are riders, fitting into the notches on the beam, and with their ends curved up, so that one may be hung upon another in case of a repeating decimal—*e.g.*, ·888. The rider B is $\frac{1}{10}$ of, and C $\frac{1}{100}$ of A. A or A′ will therefore restore the equilibrium disturbed by plunging the thermometer into distilled water at 15° C., as shown in fig. 98. If placed in one of the notches, A indicates as many tenths of its entire weight as the figure under the notch amounts to; the rider B denotes as many hundredths, and C as many thousandths.

For use, the foot of the support is placed upon a table as horizontal as possible, the beam is laid upon its fulcrum, and the thermometer suspended in its place. The beam should now be in equilibrium, and its tongue should be opposite the point J. If this is not the case the table is not horizontal, and sheets of paper are placed under one or other side of the foot until the error is corrected. The vessel is now filled with distilled water at 15° C., and the thermometer immersed, when the equilibrium is disturbed. On hanging the weight A′ in the hook of

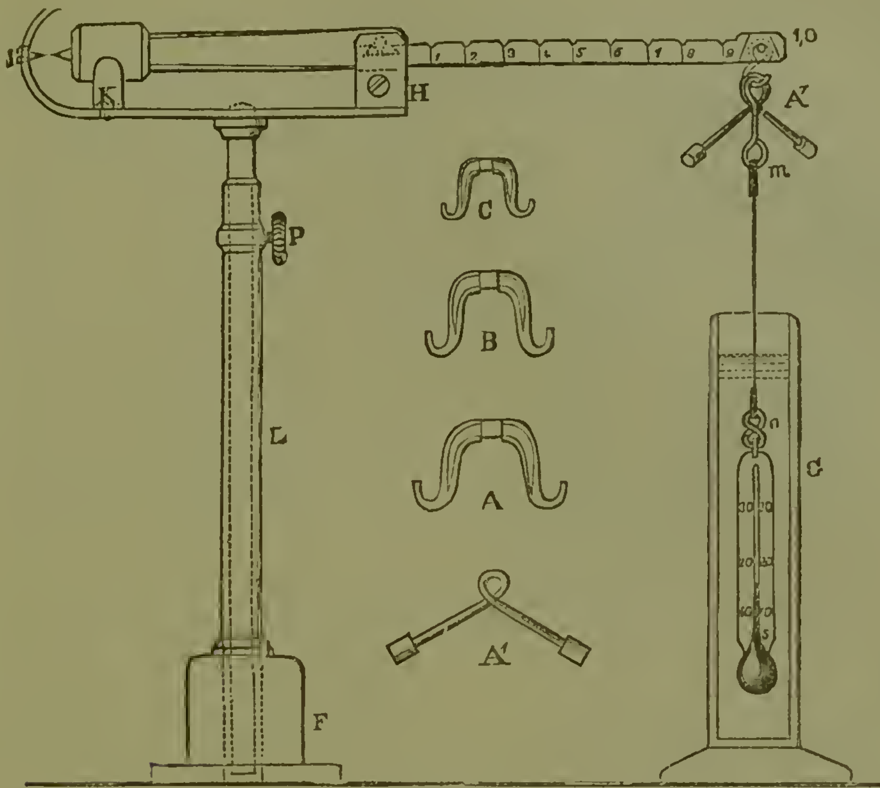


Fig. 98.

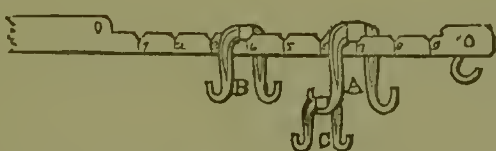


Fig. 103. 0·747.

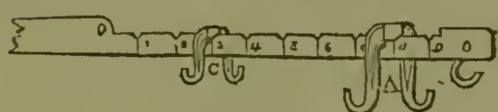


Fig. 102. 0·803.

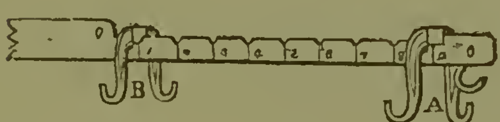


Fig. 101. 0·910.

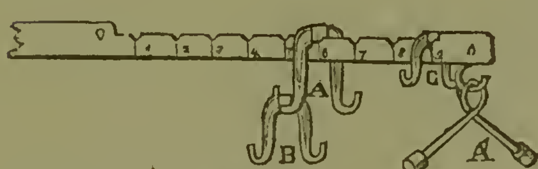


Fig. 100. 1·669.

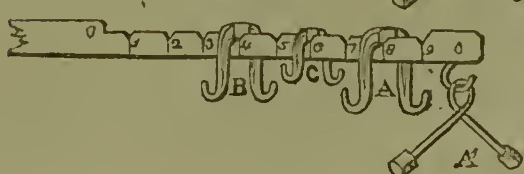


Fig. 99. 1·846.

the beam it is restored, and the result is 1 (fig. 98).

If the liquid is much heavier than water, in addition to A′ the riders A, B, and C are used, and fixed in the notches, until the beam is in equipoise, as shown in figs. 99 and 100. If the liquid is lighter than water A′ is removed, and A, B, and C alone are placed in the appropriate notches, as in figs. 101, 102, and 103. If, as in fig. 101, C is superfluous, a 0 comes in its place, the result being here ·910. The accuracy of the balance is such that three decimals can be determined with the greatest accuracy, and if the liquid is not adhesive—as sulphuric acid—even a fourth place. If the rider C in the fourth notch is a little too light, and in the fifth a little too heavy, it may be placed on the beam between 4 and 5 till a perfect equilibrium is attained, and its distance from 4 is estimated in tenths. The supporting wires are very fine, so that it may be assumed that a difference in the depth of immersion has no influence upon the result of the determination. Great changes of depth, however, are appreciable, and it is well in all determinations to observe the depth of immersion used in adjusting the weights. This was determined in such a manner that the twisted part of the wire and an equal length above it (fig. 98) were below the surface. This point can also be determined by an experiment with distilled water at 15° C.

The specific gravity of gases is determined by filling globes of known capacity with the gas upon the same principle as the specific-gravity bottle. Reference must be made on this point to standard works on chemistry.

Spirits—The Board of Trade Returns show a large increase in the consumption of spirits. In the year 1873 duty was paid on 28,908,501 gallons of home-made spirits for consumption in the United Kindom as beverage only—15,851,906 gallons for consumption in England, 6,832,437 gallons for consumption in Scotland, and 6,224,108 gallons for consumption in Ireland. The total in 1872 was 26,872,183 gallons, and in 1871, 24,163,644 gallons; so that the year 1873 shows an increase of more than two million gallons over 1872, or above 7½ per cent., and the increase of 1873 over 1871 is nearly 20 per cent.

All the principal spirits are described under their respective heads. *See also* ALCOHOLIC BEVERAGES, ALCOHOLISM, &c.

Sprat—The sprat is characterised by the presence of fatty matter incorporated with the flesh. It contains about 6 per cent. of fat, and hence is richer than the sole, cod, turbot, brill, plaice, flounder, &c. The yellow-bellied sprat of the tropical seas is said by Dr. Burrows to be so poisonous that both Europeans and negroes have been known to expire with the fish in their mouths unswallowed. The sprat is often used instead of the pilchard, and sold as the sardine. *See* SARDINES.

Starch ($C_6H_{10}O_5$) (*amylaceous matter*, or *fecula*)—An organised substance occurring in rounded or oval grains in the cellular tissue of certain parts of plants. The monocotyledonous seeds of the *Cerealia* contain it in large quantity, and it is also present in great abundance in all dicotyledonous seeds, particularly in those of leguminous plants, as beans, peas, &c. Wheat contains about 75 per cent., and the potato 15 per cent., of this substance. The grains of starch examined with a microscope are seen to consist of flattened ovate granules, which in the same plant are tolerably uniform in size, but which vary in magnitude in different species of plants. The size and form of the granule, the nature of its markings, and the position of the nucleus or hilum in different starches, as well as the appearance under polarised light, are the means by which the microscopist identifies the various starches.

The structure of the granule, according to Nageli, is a system of laminæ from a central nucleus to the outer envelope; these laminæ are, however, not formed at once, for the first beginning of the granule is that of a cell filled with a homogeneous substance, with neither hilum nor laminæ. A nucleus next makes its appearance, and there is finally a separation into layers or laminæ, alternating in density.

Starch is insoluble in cold water, in alcohol, and in most other compounds; but with water at about 175° F. it readily forms a gelatinous mass. Alcohol and most of the astringent salts precipitate it from its solutions. Infusion of galls throws down a copious yellowish precipitate, containing tannic acid, which is redissolved by heating the liquid; heat and dilute acids convert it into dextrine and grape-sugar; strong alkaline lyes dissolve it, and ultimately decompose it.

The specific gravity of starch is 1·53. Starch, in the form in which it is usually sold, contains about 18 per cent. of water; in order to render it anhydrous it should be dried *in vacuo* at a temperature of 260° (127° C.)

Like most organised structures, starch appears to retain as an essential component a small quantity of saline matter, consisting partly of potash; and it likewise contains a perceptible amount of some azotised compound, which is present chiefly in the integument of the grains.—(JACQUELAIN.)

Although starch, when pure, is a definite substance, it may be shown to really consist of several modifications—*e.g.*, when treated by not too concentrated acids, that portion which is coloured blue by iodine, and preponderates in the softer parts of starch, is dissolved, and a portion is left to which iodine imparts a yellow colour. This yellow modification is but slightly acted upon by acids or boiling water; it still possesses the structure of the granules, and its hardest portion is perhaps identical with cellulose. The blue and yellow modifications change gradually into each other, forming others, coloured by iodine violet, red, or orange. Potato starch contains a large quantity of the yellow modification, a smaller of the blue, and a still smaller of the orange. Wheat starch contains much violet and reddish-violet, less yellow, and scarcely any blue; but when it is boiled in water the blue modification increases. On boiling yellow starch with water for a long time, most of it dissolves, and the solution gives with iodine a violet colour. On evaporation, or allowing the liquid to freeze, *amylo-dextrine* separates out in discs, having a diameter of ·035 millimetres, and consisting of small needles, which may be obtained singly by carefully precipitating the solution with alcohol.

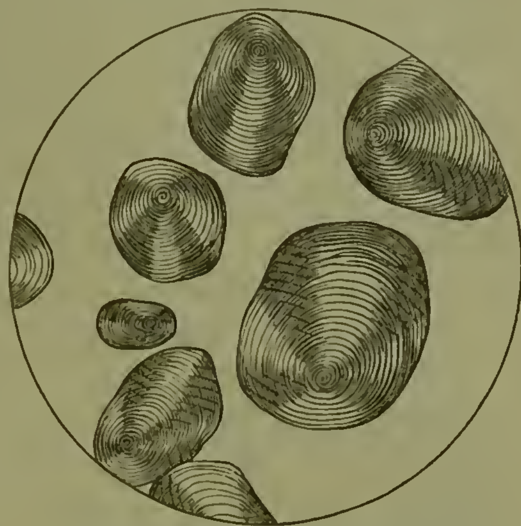
Amylo-dextrine, minus ·1 per cent. of ash (composed of phosphoric acid, potassium, sodium, and calcium), and dried at 100° C. (212° F.), may be represented by the formula ($C_{36}H_{60}O_{30} + H_2O$). Amylo-dextrine turns the plane of polarisation to the right. The solid substance is turned yellow by iodine, but the solution turns first violet and then red. Thus there appear to exist two modifications of this substance also.—(NAGELI, Ann. de Chimie, 218-227.)

The different kinds of starches are:—

Arrowroot Starches.—The name of arrowroot, originally applied to the fecula of *Maranta arundinaceæ*, has been extended to a great variety of starches, the principal of which are those known in commerce as Arum, Canna, Curcuma, Jatropha, Maranta, Tacca, and Natal arrowroots.

Arum Arrowroot (syn. Portland arrowroot) is obtained from the tubers of the *Arum maculatum*. Diameter of the grains varies from $\frac{1}{10000}$ to $\frac{4}{10000}$ of an inch. Hilum, eccentric, star-shaped; grains, globular or ovoid, or irregularly triangular; concentric rings distinct. By heat the grains rapidly double and treble their volume, and the hilum and rings are seen more distinctly.

Canna Arrowroot (*Tous-les-mois*) is furnished by the *Canna edulis*, natural order *Marantaceæ*. Tho grains vary in diameter from $\frac{1}{400}$ to $\frac{1}{250}$ of an inch. They present themselves under several forms—one, the smaller, being globular or ovoid: the other, the larger, are pyriform; whilst the largest granules are flat, oval, and pointed at their extremities. The hilum is eccentric, situated towards the narrow end, and the concentric lines are extremely fine, narrow, and regular. The starch dissolves easily in boiling water. Solution of potash causes them to swell rapidly, and gives to the hilum and lines remarkable clearness (fig. 104).



TOUS LES MOIS, POLARIZED

$\frac{1}{100}$th INCH

Fig. 104.

Tous-les-mois starch may be confounded with that of the potato. The most characteristic differences are in the size and shape of the granules, and the action of polarised light, which gives with *tous-les-mois* a much more regular cross.

Curcuma Arrowroot is furnished by the *Curcuma angustifolia.* The granules are elongated, triangular, or irregularly oval, flattened and almost transparent, the diameter of the long axes varying from $\frac{12}{10000}$ to $\frac{24}{10000}$ of an inch. The hilum is eccentric, very indistinct, and situated at the narrow extremity of the granule; the concentric lines are well marked, and form segments of a circle. The application of heat or a solution of potash deforms the grains in a very irregular manner.

Jatropha or Brazilian Arrowroot (syn. Manihot) is derived from the *Manihot utilissima*), the same plant which yields tapioca. The granules are similar to those of Tacca arrowroot, but smaller, the average diameter being $\frac{13}{10000}$ of an inch.

Maranta Arrowroot (syn. Jamaica, St. Vincent) is derived from *Maranta arundinaceæ.* The granules are long, somewhat ovoid, tending to a triangular shape in some, but the smaller ones may be almost circular. The long diameter of the granule varies in size from $\frac{1}{2000}$ to $\frac{4}{2000}$ of an inch. The concentric lines are numerous and distinct; the hilum in some is circular, in others linear (fig. 105).

Natal Arrowroot is probably the produce of

*Maranta arundinaceæ.** Tho granules sometimes aro circular, sometimes oval, and somewhat trigonal; their length averages from $\frac{12}{10000}$ to $\frac{17}{10000}$ of an inch. The eccentricity of the granule—that is, tho distance of the hilum from the upper part of the grain compared with its distance from the lower part—ranges between $\frac{1}{8}$ and $\frac{1}{3}$. The laminæ appear under water with special clearness. These granules have been mistaken for potato starch, but the differences in the eccentricity and in the size are characters which should not mislead the practical observer.

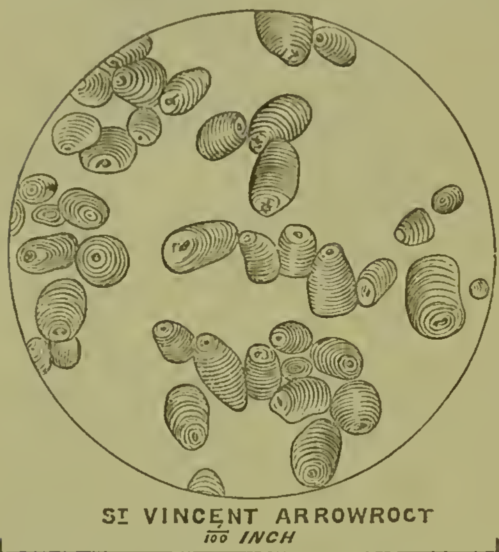


Fig. 105.

Tacca Arrowroot (syn. Tahiti Arrowroot) is extracted from the *Tacca Oceanica* and *pinnatifida*. The granules, when viewed sideways, are muller-shaped, with truncate or dihedral bases; when seen endways, they appear circular, occasionally angular or polyhedral: sometimes a sort of contraction gives them a sub-pyriform appearance. The hilum is well developed, and often starred. The average diameter of the granule is $\frac{1}{1250}$ of an inch.

Barley Starch.—See BARLEY.

Maize Starch.—See INDIAN CORN.

Potato Starch (syn. Potato Arrowroot, British Arrowroot).—This is starch derived from the tubers of the potato (*Solanum tuberosum*). The granulos vary greatly in shape and size, some being small and circular, others large, ovate, and oyster-shaped. Their average length is from $\frac{2}{10000}$ to $\frac{23}{10000}$ of an inch. The eccentricity averages $\frac{1}{6}$. The concentric lines or laminæ in the larger granules are numerous and distinct (fig. 106).

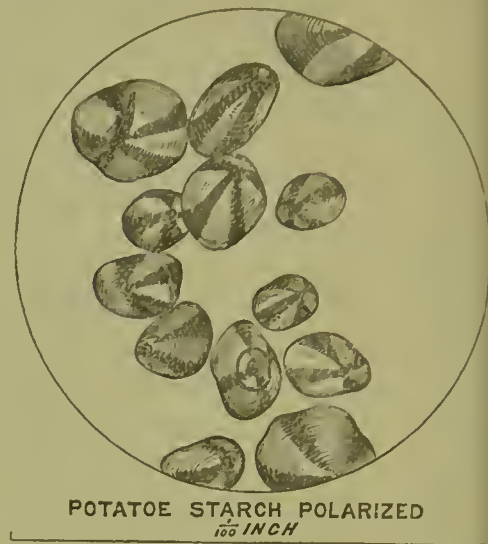


Fig. 106.

It is of great practical importance to distinguish potato starch from that of the different species of maranta, as it is a frequent adulteration of the latter.

The starch of the maranta differs from that of the potato in being on the average only two-thirds the size. The laminæ are (with the exception of Natal arrowroot) less distinct, and the shape of the hilum is generally that of a transverse fracture.

Besides the optical properties there are certain chemical tests—

1. Maranta arrowroot mixed with twice its weight of hydrochloric acid produces a white opaque paste, whereas potato treated similarly produces a paste transparent and jelly-like.

2. Potato starch evolves a disagreeable and peculiar odour when boiled with dilute sulphuric acid, which is not the case with maranta.

3. An acrid oil may be extracted from the starch of the potato, but not from that of the maranta.

Rice Starch.—See RICE.

Rye Starch.—See RYE.

Sago Starch.—See SAGO.

Tapioca Starch.—See TAPIOCA.

Starch-works *by fermentation* are placed by the French authorities in the first class of offensive trades, the complaints against them being smells, injurious emanations, and pollution of water. Starch-works by separation of tho gluten *without fermentation* are placed in the second class, the complaint in this case being pollution of the water only.

Starch as a food is useful for its carbonaceous properties, but it contains no nitrogen.

* Maranta arrowroot is derived from the same plant, the differences that the starch granule exhibits must be ascribed to the African climate and soil.

All starches have the same nutritive value, but they differ in digestibility. Starchy substances are digested by the ptyalin of the saliva, pancreatine of the pancreatic fluid, and the intestinal mucus. The solution is effected by conversion of starch into a low form of sugar—*glucose*—which is either freely absorbed into the circulation, or changed in the stomach into lactic acid, when it serves an important function in the digestion of nitrogenous matter. It may, by mal-assimilation, become converted into butyric acid, when it causes much discomfort.

For functions of starch, &c., *see* FOOD. The reader is also referred to CARBO-HYDRATES, FLOUR, POTATO, SUGAR, &c.

For the estimation of starch, *see* SUGAR,* &c.

Statistics may be defined as the science of figures applied to life. The term is said to have been first invented by Professor Achenwall of Göttingen, 1749; the science itself, founded by Sir William Petty, who died in 1687.

In 1832 a statistical office was established in the department of the Board of Trade for the purpose of collecting, arranging, and publishing statements relating to the condition and the various interests of the British Empire.

In 1833 a statistical section was formed in the British Association for the Advancement of Science during the period of its meeting at Cambridge, and in 1834 the Statistical Society of London, which publishes a quarterly journal, was established. Similar societies exist on the Continent. The science itself is indeed felt to be of such general importance that International Statistical Congresses are held occasionally. There was one at Brussels in 1853, a second at Paris in 1855, a third at Vienna in 1857, and a fourth in London, under the presidency of the Prince Consort, July 16–21, 1860.

Statistics, or the numerical method, are one of the most powerful aids of the hygienist. By figures the health of a town is shown at a glance; by figures the efficacy of preventive measures, such as vaccination, is tested, and the fatality of epidemics traced.

It is in matters of doubt that the science is most useful. Nobody would dream of using the mighty engine of statistics to illustrate any regular, known, and accepted phenomenon; but in such inquiries as the proportion of each sex born annually, or the proportion of deaths to the whole population, it is obvious that without the use of figures our knowledge must be vague, uncertain, and often erroneous. The usefulness of the numerical method may also be seen in the disproval of certain popular notions, especially those of *class.* For example, sailors often assert that the sea is as safe as the land, (!) but the registers show that the annual average of deaths from all causes in the navy is 14 per 1000, in the merchant service 21·7 per 1000 strength. In the navy two-thirds of these deaths are due to disease, in the merchant service two-thirds are due to other causes. Now, among the home population, at sailors' ages, the mortality from all kinds of violence does not exceed 1 per 1000. Suppose the progress of education is required, as estimated by the number of those who can write their name, this, again, is easily obtained from the marriage registers with but few sources of error. The Registrar-General gives the following table, which renders that certain which before might have been a matter of mere assertion :—

	To 100 Marriages the mean Annual Proportion of Cases in which a Mark instead of a Name was written in the Register.	
Years.	Men.	Women.
1841–45 . . .	32·6	48·9
1846–50 . . .	31·4	46·2
1851–55 . . .	30·2	43·5
1856–60 . . .	27·1	38·1
1861–65 . . .	23·6	32·9
1866–70 . . .	20·5	28·3
1871 . . .	19·4	26·8

The most important statistics required for health purposes are—

1. *The Annual Mortality.*—The deaths are most conveniently expressed as so many deaths to 1000, 10,000, 100,000, or 1,000,000 living, and not in percentage; for example, suppose it is asserted that the death-rate per cent. from smallpox during the twenty years 1850–69 was ·02041, this number is not so easily grasped by the mind as the number 204·1, calculated in the ratio to 1,000,000 living.* Statements relative to the annual mortality are more accurate if the deaths are calculated not only to the number of people living at the end of the year, but to that number plus a certain addition to be made on account of those persons who lived during part of the time, but died before its close. The difference is fractional.

* "There was no starch used in England till a Flanders woman, one Mrs. Duighen Vanden Plasse, brought in the use of starch, 1564."—(Harleian Miscellany, vol. iv. p. 218)

* To estimate the annual death-rate from a single quarter's returns, the following formula may be used. q = number of days in the quarter; d, the deaths; p, the population :—

$$\frac{91 \cdot 31}{q} \times d \times 4000 \div p = \text{annual death-rate.}$$

Or another convenient method is to use factors. For the March quarter the factor is 4·058; for the June quarter, 4·014; and for the September and December quarters, 3·969—

then $d \times \text{factor} \div p$ = annual death-rate.

Hygienists must not be satisfied with merely the annual rate of mortality, but the deaths should be grouped and classified into—(1) male and female; (2) under five years and over five; (3) grouped according to the age at death, &c. No general rule can be given as to arrangement, since this depends upon what the statistics are intended to show. Excellent examples of classification, grouping, &c., are to be found in the Registrar-General's returns.

2. *Annual Rate of Increase of Population.*—This is best calculated by logarithms, as most health statistics are. Suppose it is required to know the annual rate of increase in a town, the population of which was 500 in 1861, 1000 in 1871; the correct annual increase would not be 50, because it would be smaller in the first than in the last year of the decade. "By deducting the logarithms of the 1861 population (500) from that of the 1871 population (1000), the decimal rate of increase is obtained, ·30103, which can be turned into the annual rate by the insertion of a cipher to the right of the decimal point. The annual rate of increase is ·030103, which may be tested by adding it ten times to the logarithm of the population in 1861, the result being the logarithm of the population of each intervening year up to 1871.

"It will be found that the correct increase in the first year of the decade on this imaginary population of 500 was 36; whereas in the last year it was 67."—(Sanitary Record, December 12, 1874.)

3. *Causes of Death.*—Here caution is requisite on account of faulty returns. Causes of death may be expressed in ratios to a million living, or where it is required to know whether a particular disease—for example, consumption—is more prevalent in one locality than another, it is often convenient to express this in terms of the total mortality. Causes of death should always be classed, and it will be better to follow the classification of the Registrar-General's returns for the sake of uniformity and comparison.

4. *Amount of Sickness to Population.*—This is a very difficult matter to obtain with any accuracy (except in the army or navy).

5. *Births to Population.*—These returns will in time become most valuable.

6. *The relative number of live and still-born*, of premature and full-grown children.

7. *The State of Education in a District.*—This may be obtained by examining the registers of marriage, and noticing how many sign their names, and calculating it in percentage.

8. *Vaccination.*—Whether a district is well vaccinated or not, may be approximately obtained by examining the arms of school-children, and expressing the facts thus acquired in percentage.

9. *Mean Age at Death.*—This is obtained by simply adding up all the ages at death, and dividing by the sum.

10. *Mean Duration of Life.*

11. *Probable Duration of Life.*—This is the age at which a given number of children, born at the same time, will be reduced one-half.

12. *Expectation of Life.*—Life tables show at a glance the expectation of life at any age.

To use the numerical method, the facts from which results are expected to be obtained must be strictly comparable, and must be selected with care. It will be convenient to arrange them in some tabular form; these forms must vary according to the nature of the case; no definite rule can be laid down as to their selection, but a little practice will readily suggest the most convenient and best method.

The facts will then be enumerated, and average and extreme results obtained. Certain facts may also be grouped together, taking care only to associate such events as depend upon the same combination of causes. As a general principle, the more numerous the facts, the more trustworthy are the average and extreme results.

This is well shown by Dr. Guy, who compiled the following table of the ages at death of the male members of the aristocracy, from twenty-one years and upwards, to the number of several hundreds, and arranged his facts first into groups of 25 each; then two successive groups of 25 were formed into 50, the groups of 50 into 100, and so on until the last totals were obtained:—

Number of Facts.	Average Age at Death. Max.	Min.	Range.
25	69·40	50·64	18·76
50	66·44	55·20	11·24
100	63·70	56·85	6·85
200	62·38	57·61	4·77
400	61·10	58·24	2·86
800	60·84	59·67	1·27
1000	60·25		

If ·60 be assumed to be the true average of life among the members of the aristocracy who have attained their twenty-first year, and the whole numbers nearest to the decimals be substituted, the second column will represent the extreme error which would have been committed by relying on 25, 50, 100, &c., facts respectively:—

Number of Facts.	Error in Excess or Defect.
25	9½
50	5½
100	3½
200	2½
400	1½
800	0½

Still, although a large number of facts are required for any certainty, we are not precluded from reasonings based upon small numbers. There are many facts which from their very nature cannot be collected by hundreds or thousands, and it may be shown that there is always a balance of probability in favour of the average even of a small number of facts approaching closely to the true average.

The degree by which the numbers obtained from a large or small number of facts deviate from the truth may be obtained by calculation. Poisson gives the following rule :—

Let u be the total number of cases recorded, m the number in one group, n the number in the other; total, $m + n = u$.

The proportion of each group to the whole will be respectively $\frac{m}{u}$ and $\frac{n}{u}$

But these proportions will vary within certain limits in succeeding instances, and the extent of this variation will be represented

by $$\frac{m}{n} + 2\sqrt{\frac{2\,m\,n}{u^3}}$$

and $$\frac{m}{n} - 2\sqrt{\frac{2\,m\,n}{u^3}}$$

Hence it is obvious the larger the number of m the less the value of $\sqrt{\frac{2\ m\ n}{u^3}}$ and the less the limits of error in $\frac{m}{n}$

From this formula the following table is calculated :—

TABLE of the possible ERRORS corresponding to AVERAGE MORTALITIES deduced from different Numbers of OBSERVATIONS.

Number of Observations.	Average Mortality by Observation.	Number of Deaths.	Number of Recoveries.	Possible Error.
25	0·200000	5	20	0·226274
50	0·100000	5	45	0·120000
50	0·200000	10	40	0·160000
50	0·300000	15	35	0·183302
100	0·100000	10	90	0·084852
100	0·150000	15	85	0·100994
100	0·200000	20	80	0·113136
100	0·250000	25	75	0·122474
100	0·300000	30	70	0·129614
100	0·350000	35	65	0·134906
200	0·100000	20	180	0·060000
200	0·150000	30	170	0·071414
200	0·200000	40	160	0·080000
200	0·250000	50	150	0·086602
200	0·300000	60	140	0·091650
200	0·350000	70	130	0·095392
300	0·100000	30	270	0·048990
300	0·170000	45	255	0·058309
300	0·200000	60	240	0·065320
300	0·250000	75	225	0·070711
300	0·300000	90	210	0·074833
300	0·350000	105	195	0·077889
400	0·100000	40	360	0·042426
400	0·150000	60	340	0·050497
400	0·200000	80	320	0·056568
400	0·250000	100	300	0·061237
400	0·300000	120	280	0·064807
400	0·350000	140	260	0·067454
500	0·100000	50	450	0·037947
500	0·150000	75	425	0·045167
500	0·200000	100	400	0·050596
500	0·250000	125	375	0·054772

Number of Observations.	Average Mortality by Observation.	Number of Deaths.	Number of Recoveries.	Possible Error.
500	0·300000	150	350	0·057965
500	0·350000	175	325	0·060333
600	0·100000	60	540	0·034641
600	0·150000	90	510	0·041231
600	0·200000	120	480	0·046188
600	0·250000	150	450	0·050000
600	0·300000	180	420	0·052915
600	0·350000	210	390	0·055077
700	0·100000	70	630	0·032071
700	0·150000	105	595	0·038173
700	0·200000	140	560	0·042762
700	0·250000	175	525	0·046291
700	0·300000	210	490	0·048990
700	0·350000	245	455	0·050990
800	0·100000	80	720	0·030000
800	0·150000	120	680	0·035707
800	0·200000	160	640	0·040000
800	0·250000	200	600	0·043301
800	0·300000	240	560	0·045826
800	0·350000	280	520	0·047697
900	0·100000	90	810	0·028284
900	0·150000	135	765	0·033665
900	0·200000	180	720	0·037712
900	0·250000	225	675	0·040825
900	0·300000	270	630	0·043205
900	0·350000	315	585	0·044969
1000	0·100000	100	900	0·026833
1000	0·150000	150	850	0·031937
1000	0·200000	200	800	0·035777
1000	0·250000	250	750	0·038730
1000	0·300000	300	700	0·040988
1000	0·350000	350	650	0·042661

In order to use this table, let us suppose that in 1000 cases of some particular disease there were 300 deaths and 600 recoveries; it is required to determine the possible error inherent from so small a number of facts. The average mortality in this case would be $\frac{300}{1000}$, or ·300000 (see the second column of the table for 1000 facts and 300 deaths), or 300,000 deaths in a million cases (30 per cent.) Now, in order to obtain the possible error, refer to the column "possible error" and extract the number ·040988. This number added to 300,000 = ·340988, subtracted = ·259012; hence instead of 30 per cent., the real mortality is between the numbers 340,988 and 259,012 in a million, or approximatively between 30 and 34 per cent.

M. Gavarret (Statistique Médicale, 1840, p. 284) gives the following example to show how the formula is worked.

Louis in his work on typhoid fever has attempted to illustrate the treatment by analysing 140 cases. The question to be determined is, What is the mortality per cent., and how near is it to the true proportion?

$m = 52$, the number of deaths.
$n = 88$, the number of recoveries.

$u = 140$, total number of cases.

i.e., a mortality of $\frac{52}{140}$, or ·371430, or 371,430 in a million cases, or roughly, 37 per cent. Now, to determine how near this ratio is to the truth, we take the formula—

$$\sqrt[2]{\frac{2.m.n}{u\,3}} = \sqrt[2]{\frac{2.52.88}{140^3}} = 0{\cdot}11550.$$

This ·11550 is, then, the possible error in excess or defect, and the true influence of the treatment will be comprised between the following limits:—

$$\frac{m}{u} + \sqrt[2]{\frac{2.m.n}{u\,3}} = 0{\cdot}37143 + 0{\cdot}11550$$
$$= 0{\cdot}48693.$$

$$\text{And } \frac{m}{n} - \sqrt[2]{\frac{2.m.n}{u\,2}} = 0{\cdot}37143 - 0{\cdot}11550$$
$$= 0{\cdot}25593.$$

Thus we really learn that in 140 cases the mortality may be either 48,693 or 25,593 in 100,000 patients, or between 49 and 26 per cent., so that Louis's numbers are far too few to even approximate the true mean. They have, indeed, by themselves little practical value. All that physicians would learn would be, that under that particular treatment they might lose any numbers between about a fourth and a half of their patients.

The average or mean number of facts is obtained by adding together all the numerical values, and dividing by the number of facts. For example, six persons are aged respectively 19, 20, 50, 70, 30, and 35. By adding these together, we obtain the sum 224; dividing by 6, the number of facts, we obtain as the mean 37·33. In taking averages, it is very important to notice the two extremes. In such a case as the example, the two extremes are respectively 19 and 70. "As averages founded upon large numbers are numerical expressions of true probabilities, so extreme values are expressions in the same precise language of possibilities."—(Dr. GUY.)

Hence the use of the extremes is to check and test numerical theories, and to confirm and strengthen the conclusions drawn from averages. Besides the ordinary calculation as above, the method of successive means is very useful. An example will best show how this is done. Suppose the annual mortality of England to be in successive years 22, 23, 21, 22, 26, 22, 21 per 1000, the successive means would be—

$$\frac{22 + 23}{2} \qquad \frac{22 + 23 + 21}{3}$$
$$\frac{22 + 23 + 21 + 26}{4}$$
$$\frac{22 + 23 + 21 + 26 + 23}{5}$$

and so until the numbers are large enough to give each time the same result. The successive means may be also calculated, both directly and inversely, and the mean error obtained by taking the square root of the sum of the square of the errors (quadratic mean).

Another, but similar, method very much used is to divide the sum of a certain number of facts into two, three, or more parts, and then to see whether the results obtained from the smaller agree with that obtained from the larger.

Statistics are represented either in tables or graphically. The most usual way is to divide a square into a number of smaller squares by the intersection of vertical and horizontal lines drawn to scale. On one side of the square, numbers can be placed representing times, years, or dates; on the other, the number of events. A line drawn through the intersection of these quantities will represent to the eye events with greater clearness than columns of figures.

The following references to works relating to statistics may be useful: article, Statistics, Cyclopædia of Anatomy and Physiology. JULES GAVARRET, Principes Généraux de Statistique Médicale, ou Développement des Règles qui doivent présider à son Emploi. AUGUSTUS DE MORGAN, An Essay on Probabilities, and their Application to Life Contingencies and Insurance Offices. LAPLACE, Essai Philosophique sur les Probabilités. Professor RADICKE'S Essay on the Arithmetical and other Means, translated by Dr. Bond, Sydenham Society. POISSON, Recherches sur la Probabilité des Jugements. TWEEDY JOHN TODD, The Book of Analysis; or, A New Method of Experience. Dr. PARKES, Hygiène Statistics, &c.

Steam-Engine—*See* RAILWAYS.

Steam-Pipes—*See* WARMING.

Stewing—*See* COOKING.

Stoves—*See* WARMING.

Streams—*See* RIVERS.

Streets—The proper scavenging, sweeping, repairing, and paving of streets are of great sanitary importance. Filthy liquids collect in holes and ruts, refuse rots in the gutters, and the very mud exhales an unpleasant odour in places where no attention is paid to these matters. Nothing exhibits the indifference of our ancestors to public hygiène better than the state of the streets a few centuries ago. Worcester appears to have been one of the first cities which *pitched* its streets; this was done in 1281 by Bishop Gifford, but there was no foot-pavement for three centuries later. In 1533 an Act was passed for paving between Strand Cross and Charing Cross; and in 1555 a general Act was passed for paving London—certainly not before it was required, for at that period when the sovereign went to Parliament, fagots were thrown in the ruts in King Street, and the Act recites that "the streets were very foul and full of pits and sloughs, very perilous and noyous as well for the king's subjects on horseback as on foot."

The streets in other large towns followed the example of the metropolis at various dates—some not, indeed, until comparatively recently.

For the purposes of the Public Health Act, 1875, the word "street" includes any highway (not being a turnpike road), and any road, public bridge (not being a county bridge), lane, footway, square, court, alley, passage, whether a thoroughfare or not, and the parts of any such highway, road, bridge, lane, footway, square, court, alley, or passage within the limits of any district under the Act.

All streets, being, or which at any time become, highways repairable by the inhabitants at large within any urban district, the pavements, stones, and other materials thereof, all buildings, implements, and other things provided for the purposes thereof, are vested in and are under the control of the urban authority.

The urban authority from time to time are to cause all such streets to be levelled, paved, metalled, flagged, channelled, altered, and repaired as occasion may require; they may from time to time cause the soil of any such street to be raised, lowered, or altered, as they may think fit, and may place and keep in repair fences and posts for the safety of foot-passengers.

Any person who without the consent of the urban authority wilfully displaces or takes up or who injures the pavement stones, materials, fences, or posts of, or the trees in, any such street, is liable to a penalty of £5 or less, and to a further penalty of 5s. or less for every square foot of pavement stones or other materials injured or displaced; in the case of injury to trees, the court may award compensation.—(P. H., s. 149.)

Where any street within any urban district (not being a highway repairable by the inhabitants at large), or the carriage-way, footway, or any other part of such street, is not sewered, levelled, paved, flagged, metalled, channelled, and made good, or is not lighted to the satisfaction of the urban authority, such authority may, by notice addressed to the respective owners or occupiers of the premises fronting, adjoining, or abutting on such parts thereof, as may require to be sewered, &c., require them to sewer, level, &c., or make good or provide proper means of lighting, &c., within a time specified in the notice.

Before giving such notice, the urban authority are to cause plans and sections of any structural works thus intended to be executed, and an estimate of the probable cost thereof, to be made under the direction of their surveyor, such plans and sections to be on a scale of not less than 1 inch for 88 feet for a horizontal plan, and on a scale of not less than 1 inch for 10 feet for a vertical section, and, in the case of a sewer, showing the depth of such sewer below the surface of the ground: such plans and sections are to be deposited in the office of the urban authority, and to be open at all reasonable hours for the inspection of all persons interested therein during the time specified in such notice; and a reference to such plans and sections in such notice is to be sufficient, without requiring any copy of such plans and sections to be annexed to such notice.

If such notice is not complied with, the urban authority may, if they think fit, execute the works mentioned or referred to therein; and may recover in a summary manner the expenses incurred by them in so doing from the owners in default, according to the frontage of their respective premises, and in such proportion as is settled by the surveyor of the urban authority, or (in case of dispute) by arbitration (*see* ARBITRATION); or the urban authority may by order declare the expenses so incurred to be private improvement expenses.

The same proceedings may be taken, and the same powers may be exercised, in respect of any street or road of which a part is or may be a public footpath or repairable by the inhabitants at large as fully as if the whole of such street or road was a highway not repairable by the inhabitants at large.—(P. H., s. 150.)

Incumbents and ministers, as the owners of churches, chapels, &c., which places of religious worship are exempt from poor-rates, are exempt *in that capacity* from the foregoing expenses.—(P. H., s. 151.)

When any street within any urban district, not being a highway repairable by the inhabitants at large, has been sewered, levelled, paved, flagged, metalled, channelled, and made good and provided with proper means of lighting to the satisfaction of the urban authority, such authority may, if they think fit, by notice in writing, put up in any part of the street, declare the same to be a highway, and thereupon the same shall become a highway repairable by the inhabitants at large; and every such notice shall be entered among the proceedings of the urban authority.

Provided that no such street is to become a highway so repairable, if within one month after such notice has been put up, the proprietor or the majority in number of proprietors of such street, by notice in writing to the urban authority, object thereto, and in ascertaining such majority joint proprietors shall be reckoned as one proprietor.—(P. H., s. 152.)

Any urban authority may purchase any premises for the purpose of widening, opening, enlarging, or otherwise improving any street, or (with the sanction of the Local Government Board) for the purpose of making any new street.—(P. H., s. 154.)

The level, width, construction, and sewerage of new streets may be regulated by bylaws.—(P. H., s. 157.) *See* BYLAWS.

The provisions of the Towns Improvement Act (10 & 11 Vict. c. 34) are incorporated with the Public Health Act with respect to the following matters:—

1. Naming the streets and numbering the houses.
2. Improving the line of the streets and removing obstructions.
3. Ruinous or dangerous buildings.
4. Precautions during the construction and repair of the sewers, streets, and houses.—(P. H., s. 160.)

The provisions of "The Towns Police Clauses Act, 1847" (10 & 11 Vict. c. 89), are also incorporated with the Public Health Act with respect to the following matters, viz.:—

1. Obstructions and nuisances in the streets.
2. Fires.
3. Places of public resort.
4. Hackney carriages.
5. Bathing.—(P. H., s. 171.)

For powers with regard to the lighting of streets, *see* GAS.

Watering of Streets.—The watering of streets, when necessary, is one of the duties of an urban sanitary authority, and should be scrupulously seen to in dry weather. The laying of the dust by moistening it not only adds to our comfort, but also to our health. Dust irritates weak chests, may contain the germs of disease, and most certainly causes many painful affections of the eyes. Pure water was at one time used for this purpose, but it has the disadvantage of evaporating rapidly, and of possessing no disinfectant properties; on this account, sea-water, or water with certain salts dissolved in it, is preferable. Mr Cooper's process is to be specially recommended. This consists in the use of a compound of sodium, calcium, and magnesium chlorides, which may either be sprinkled on the road in the dry state, or mixed with the water in the water-cart. These refuse chlorides are extremely cheap, and when applied in this manner to macadamised roads, are economical, for 30 per cent. of road repairs are thereby saved. *See* HIGHWAYS, SCAVENGING, &c.

Strychnia ($C_{21}H_{22}N_2O_2$) — An alkaloid obtained from nux vomica. It consists of a white inodorous powder, or small, brilliant, transparent, colourless, octahedral crystals; soluble in about 7000 parts of water at 60°, and in 2500 parts at 212° F.; freely soluble in hot rectified spirit; insoluble in absolute alcohol, ether, and solutions of the caustic alkalies; imparts a distinctly bitter taste to 600,000 times its weight of water (1 part in 1,000,000 is still perceptible); exhibits an alkaline reaction; and forms salts with the acids, which are easily prepared, are crystallisable, and well defined. It is one of the most powerful poisons we possess.

The *symptoms* of poisoning by strychnia are those of general tetanus. The time of their commencement varies greatly, and depends upon whether the strychnia was taken in pill, in solution, in the nux vomica seed itself, or injected hypodermically. The average time at which the symptoms commence is from two to twenty minutes; but in one case related by Dr. Taylor, when strychnia was taken in a pill, there were no symptoms for three hours. The symptoms, once commenced, set in suddenly. Nearly the whole of the voluntary muscles are affected simultaneously, violent convulsions throw the limbs about in jerks, and the body may even be painfully bent into the form of a bow, the back being arched, and the weight supported by the head and heels. The course is very rapid either towards death or recovery. In a case which is likely to prove fatal, the severity and the frequency of the paroxysms increase, but the patient in all cases retains his consciousness to the last.

The fatal dose is variable, but it may be assigned at from $\frac{1}{2}$ grain to 2 grains. Half a grain is about the smallest dose known to have killed an adult; $\frac{1}{16}$ of a grain has proved fatal in the case of a child in four hours; $\frac{1}{4}$ grain blown into the throat of a small dog produced death in six minutes. Some constitutions appear to be extremely sensitive to the action of this drug. Dr. Taylor relates a case in which a gentleman was seized with the most alarming tetanic convulsions, continuing for some time, from taking at proper intervals five pills, each containing $\frac{1}{16}$ of a grain of strychnia, equal in all to $\frac{1}{3}$ of a grain; even $\frac{1}{24}$ of a grain will sometimes occasion tetanic twitchings in persons of delicate temperament.

In several cases of undoubted poisoning by strychnia, it has been found impossible to discover the *slightest trace* of the alkaloid, either in the stomach, intestines, liver, heart, or tissues; and the difficulty in detecting it is generally greater when the poison has been taken in solution, or when small doses have been injected beneath the skin. Commenting on a case of strychnia-poisoning, Dr. Taylor says: "This case shows that a large dose of strychnia rendered soluble will destroy life in half an hour; that within this short time four-fifths may be removed from the stomach, or at least not be discoverable there by careful chemical analysis after death; that in half an hour the poison may be distributed through the body and deposited in the soft organs, although no satisfactory evidence of its presence could be obtained from less than $\frac{1}{2}$ lb. of animal matter."

Although some difficulty is experienced in procuring strychnia from a druggist's shop, it is pretty generally known that many of the numerous *vermin-destroying powders* contain it in large amount, usually mixed with either soot or Prussian blue, and in this form it has frequently been used for criminal purposes. In cases of this description, soot or Prussian blue should always be sought for in the stomach.

It has been asserted that strychnia is occasionally used for the purpose of flavouring porter, stout, &c., but we believe this idea to be extremely doubtful. *See* BEER.

Tests, Detection, &c.—The poison can be separated from organic liquids or solids by the process given in article ALKALOIDS.

The tests for strychnia are the physical characters of the substance, the reactions described under article ALKALOIDS, and the following colour tests: A minute portion on a white porcelain plate, treated with strong sulphuric acid, shows no change of colour; but when the acid mixture is touched with bichromate of potash, or ferridcyanide of potash, or permanganate of potash, or peroxide of manganese, or lead, a purple colour is produced, changing shortly into crimson, then into a rich red brown, ultimately producing a bright red, permanent for some hours. If instead of any of the above substances the sulphuric acid mixture be touched with the sesquioxide of cerium, a beautiful blue colour is produced, changing into violet, and lastly into a cherry red, which is permanent for a long time.—(Archive der Pharmacie, cxciii. 252.) Dr. Letheby has proposed a galvanic test. A drop of the solution is evaporated on platinum foil, the spot moistened with concentrated sulphuric acid, the foil connected with a battery, and the acid touched with the platinum terminal of the negative pole.

Antidote. — Dr. Valenti of Vivo (Siglo Medico, April 1875) has made a series of researches on the action of monobromated camphor, and has proposed it as an antidote for strychnia. He asserts that the following conclusions are well established:—

1. Twelve dogs, after taking a fatal dose of strychnia, were saved by the use of monobromated camphor.

2. The tetanic convulsions produced by strychnia may be reduced in force and frequency by the use of the camphor. The action of the antidote is rapid and sure.

3. The physiological action of the monobromated camphor is comparatively limited. A strong dose of monobromated camphor is necessary to antagonise the effects of strychnia.

4. The hyposthenic action of the monobromated camphor mitigates the reflex activity of the poison.

5. The monobromated camphor acts on the sympathetic nerve. This is demonstrated by the myosis and the cardiac paralysis which were observed after its administration.

6. After an overdose of the camphor the united effects of the poison and the antidote produce death by syncope. When death takes

place during the strychnism, and without the antidote, cardiac impulses are observed *post mortem;* when it takes place after and through the use of bromide, cardiac impulses are never observed.

7. The experiments show that it is preferable to introduce the camphor by gastric ingestion and not subcutaneously, the latter method not giving very satisfactory results. Dr. Valonti considers that the dose of monobromated camphor in cases of poisoning by strychnia should be from 4 to 6 grammes.

Adulterations.—Brucia may be present in large quantities, rendering the alkaloid much less powerful; this may be detected by the red colour produced by *nitric acid.* The bark of *Strychnos nux vomica* (false Angustura bark), containing, like the seeds, strychnia, is sometimes employed to adulterate the true Angustura bark. *See* BRUCIA, &c.

Sturgeon—The common sturgeon is the *Acipenser sturio* of Linn. The flesh is firmer than that of other fish, and resembles veal in consistence. It is but little eaten in this country at the present day. The roe is made into caviare, and the swimming-bladder into isinglass.

Suet—*See* BUTTER, FAT.

Sugar ($C_{12}H_{22}O_{11}$)—The ordinary sugar met with in commerce in this country is extracted from the sugar-cane (*Saccharum officinarum*), and called caue-sugar or *sucrose.* In China it is obtained from the sweet sorgho (*Sorghum saccharatum*), in America from the sugar-maple (*Acer saccharinum*), and in France from the white beetroot (*Beta vulgaris*, var. *alba*). The sugar-cane, although so extensively cultivated in America, is really a native of the Old World. It appears to have been cultivated in China and the South Sea Islands long before the period of authentic history, but was almost unknown to the Greeks and Romans. In 1520 the Spaniards trausplanted it to St. Domingo from the Canary Islands, and from this island it has gradually spread over the West Indies and tho regions of the American continent.

The refuse water from sugar manufactories becomes rapidly fœtid, from the presence of large quantities of vegetable and animal organisms acting like ferments, and liberating sulphuretted hydrogen from the sulphates in the water. Herr Simon proposed to deodorise such water by a mixture of quicklime, coal tar, and magnesium chloride. The proportions are—quicklime (slaked), $1\frac{1}{2}$ bushel; coal tar, 10 lbs.; magnosium chloride, 15 lbs.

Chemical Composition.—The following statements illustrate the composition of the sugar-cane and cane-juice:—

Principal Analyses of Sugar-Cane.

	Dupuy.	Peligot.	Avequin. Tahiti Cane.	Avequin. Ribbon Cane.
Sugar	17·8	18·00	14·280	13·392
Cellulose . . .	9·8	9·09	8·867	9·071
Mucilaginous, resinous, fatty, and albuminous	...	...	0·415	0·441
Salts, silica, iron .	0·4	...	0·358	0·368
Water	72·0	72·21	76·080	76·729
Fresh sugar-cane	100·0	100·30	100·000	100·001

Principal Analyses of Cane-Juice.

	Avequin.	Peligot.	Playge.	Casaseca.
Sugar . .	15·784	20·090	20·8000	20·094
Various organic matters .	0·180	0·023	0·8317	0·012
Salts . .	0·236	0·017	small quantities	0·014
Water . .	83·840	78·070	78.3325	78·080
	100·000	100·000	100·0000	100·000

According to Fownes the juice contains cane-sugar, grape-sugar, gum, sulphates, potash, phosphates of lime, phosphates of magnesia, some other salt of the same bases, chlorides, soda, and a peculiar azotised matter.

Avequin gives the following as being the mineral constituents of the *brown sugar* of commerce: Silica, phosphate and subphosphate of lime, carbonate of lime, sulphate of potash, chloride of potassium, aud the acetates of potash aud lime.

Pure cane-sugar has a specific gravity of 1·606. The specific gravity of the cane-juice varies, according to Pareira, from 1·067 to 1·106; Mr. Fowues found it to range from 1·070 to 1·090.

The purest white sugar contains about ·069 per cent. of hygroscopic moisture, ·02 of ash, and 99·92 of sugar.

Pure sugar is remarkable in being the heaviest organic compound which does not contain either iodine or metals. At the common temperatures 100 parts of water dissolve 300 parts of sugar. Its solubility in boiling water is usually described as being indefinite. It is probable that no organic solution containing an equal percentage of organic matter has so high a specific gravity as a solution of cane-sugar. Sugar is insoluble in ether; it dissolves freely in weak alcohol, but in absolute alcohol it is not soluble. An aqueous solution is thick and syrupy. It acts powerfully on polarised light, rotating it to the right, whereas grape and fecula sugars bend it to the left. Under suitable conditions it crystallises very finely in double oblique prisms. In the form of large crystals it is known as sugar-candy. The ordinary loaf-sugar consists of a congeries of minute transparent crystals, and the dazzling whiteness of the purest specimens is produced by the numerous reflections and refractions which the rays of light experience within the mass, from the numberless crystals of which it is composed. Dilute acids alter the aqueous solution, and on their addition, its action on polarised light is inverted, and its power of crystallising destroyed.

Albuminous substances have the same effect. Oxide of copper is not in the slightest degree reduced by aqueous solutions of sugar; when, however, uncrystallisable sugar is present, the reduction of oxide of copper to red suboxide of copper is immediate at the boiling-point.

The loaf-sugar of commerce is, speaking generally, perfectly free from nitrogen, and is also devoid of uncrystallisable sugar. Writing on this point, Mr. Wanklyn says, "I once burnt up a considerable quantity [of sugar] with oxide of copper, and proved the entire absence of nitrogen gas in the products; and recently I have submitted it to the action of boiling permanganate of potash in the presence of much caustic potash, and proved the non-production of ammonia."

Structure of Sugar-Cane.—It consists of nearly cylindrical rods or stems, divided into joints at irregular distances, and it is made up of cellular tissue, woody fibre, vessels, and epidermis. The *cellular tissue* consists of a large number of cells which enclose the juice. Their length is generally greater than the breadth, and the membranes which form the walls of the cells are all finely dotted or punctated.

The *woody fibre* traverses the cane in a longitudinal direction in distinct bundles, which give to transverse sections a dotted appearance.

The *vessels* follow the same disposition as the woody fibre. There are two kinds—(1) interrupted spiral or dotted vessels; and (2) simple or continuous spiral vessels.

The *epidermis* is composed of elongated crenate cells, and contains stomata. At the distal extremity of each internode of the cane, the ordinary epidermic cells are replaced or overlaid by a layer of cells having totally different characters. They are usually a little longer than broad, more or less rounded or oval in shape, with their edges marked by short and well-defined lines disposed in a radiate manner. These cells resemble somewhat the cells found in the stones of fruit, and they form by their union a zone round the cane, polished hard, and of about the third of an inch in depth.—(HASSALL.) Fragments of sugar-cane are present in the raw sugars of the shops, and in "bastards," a product of the manufacture of loaf-sugar.

Sugar as an Article of Diet.—Sugar alone is insufficient to support life, but when mixed with other suitable food it evidently contributes towards force production in the body, and towards the formation and accumulation of fat. This last action of sugar is illustrated in the change that occurs in the condition of the negro during the sugar-making season in the West Indies. The workpeople grow conspicuously stouter, and they attribute this increase of fat to the habit that prevails of constantly chewing pieces of the succulent cane whilst they are working amongst it. It sometimes undergoes in the stomach an acid fermentation, and so may occasion distress to the dyspeptic; but usually being of a soluble and diffusible nature, it sits lightly on the stomach. Sugar is generally supposed to injure the teeth, but there is no trustworthy evidence on this point.

Sugar contributes to the formation of lactic acid, and supplies material for the maintenance of life. Ten grains of lump sugar, according to Letheby, possesses calorific power sufficient to raise 8·61 inches of water 1° F.; and it will lift 6647 lbs. 1 foot high.

Consumption of Sugar.—Dr. Edward Smith found that 98 per cent. of indoor operatives partook of sugar to the extent of 7½ oz. per adult weekly; 96 per cent. of Scotch labourers use it, and 80 per cent. of Irish. In Wales also it is commonly used to an average extent of 6 oz. per adult weekly; but there is a marked difference in the rate of consumption in the northern and southern portions of the country.

The sugar-mite—the *Acarus sacchari*—is often found in raw, but never in refined, sugar. This insect cannot, however, exist in a specimen of sugar destitute of nitrogen, and the possibilities of the presence of these insects may be judged of through a determination of the nitrogen (or still better, of albuminoid ammonia) in the sugar. From 100 parts of moist sugar not more than ·2 part of albuminoid ammonia may be obtained. —(WANKLYN.) The acarus can usually be detected by the unaided sight, if not, the microscope may reveal its presence. This insect is fully described in article ACARUS SACCHARI.

Adulterations of Cane-Sugar.—Other sugars, water, sand, plaster-of-Paris, chalk, glucose, and, as an *accidental* impurity, lead. Sporules and filaments of fungus are found in most raw sugars. The ordinary loaf-sugar of commerce is rarely adulterated, and the ash left on incinerating it does not exceed ·01 per cent. of the sugar.

The raw sugar of the shops is a much more genuine article than it is usually supposed to be; but it is not nearly so pure as the "lump" sugar, for it contains a certain proportion of mineral matter derived from the plant; this, expressed as ash, ranges from ·49 to ·61 per cent. of the sugar. The detection of admixtures of mineral matter with sugar is therefore very easy; all that is required to be done is to take the ash. The solubility is also a test for sand, plaster, chalk, &c., which remain undissolved when sugar is treated with water. If dissolved beneath the microscope, these sophistications are at once detected. Iodine may be added to determine the presence of starch. The percentage of water may be found by drying thoroughly 100 grains and again weighing.

For discovering the presence of other sugars the following may be employed:—

Tests, &c.—1. Boiled for a short time in water containing 2 or 3 per cent. of caustic potassa, the liquid remains colourless; but it turns brown if starch-sugar is present; even 2 or 3 per cent. of starch-sugar may be thus detected.

2. A filtered solution of 33 grains of cane or beet sugar in 1 fluid ounce of water, mixed with 3 grains of pure hydrate of potassium, and then agitated with $1\frac{1}{2}$ grains of sulphate of copper, in an air-tight bottle, remains clear even after the lapse of several days; but if starch-sugar be present, a red precipitate is formed after some time; and if it is present in considerable quantity, the copper will be wholly converted into oxide within twenty-four hours, the solution turning first blue or green, and then entirely losing its colour. —(E. KRANTZ.)

3. A solution of cane-sugar is mixed with a solution of sulphate of copper, and hydrate of potassium added in excess; a blue liquid is obtained, which on being heated is at first but little altered. A small quantity of red powder falls after a time, but the liquid long retains its blue tint. When grape-sugar or fecula-sugar is thus treated, the first application of heat throws down a copious greenish precipitate, which rapidly changes to scarlet, and eventually to dark red, leaving nearly a colourless solution.

The $\frac{1}{1000}$ part of grape-sugar may be thus detected. The proportion of oxide of copper produced forms a good criterion, not only of the purity, but also of the extent of the adulteration. The specific gravities and crystalline forms offer other means of distinguishing the varieties of sugar. The relative sweetening power of cane-sugar is estimated at 100, that of pure grape-sugar at 60, that of fecula or starch sugar at 30 to 40.

Lead may be detected in some refined sugars by passing through the solution a current of sulphuretted hydrogen, when, if the metal is present, the liquid will become more or less darkly coloured or precipitated, according to the amount present; it may also be detected in the ash.

Beetroot-Sugar is extracted by pressing out the juice from the ripe roots of the white beet; these are generally gathered in October. This juice contains about 10 per cent. of sugar, which in the fresh juice is entirely of the crystallisable kind; but it is seldom possible to extract in the crystalline form more than half the quantity the root contains. The crystals of beetroot-sugar are longer and flatter than those furnished by sugar from the cane, but they cannot otherwise be distinguished from the latter.

Grape-Sugar (starch-sugar, glucose, dextrose) ($C_6H_{12}O_6H_2O = 180 + 18$; specific gravity, 1·400).—This substance, since it has been legal to use sugar as well as malt in the manufacture of beer, is made on a very large scale. It is made from the cheapest starch procurable, which at present happens to be rice starch. The starch is crushed between rollers, and macerated with an alkaline liquid; by this means the gluten is dissolved out and the liquid thrown away. The next operation is the treatment of the starch with dilute sulphuric acid; then it is placed in a digester, and submitted to the action of steam at 20 lbs. pressure for about half an hour. After this operation it has become an impure solution of grape-sugar. The liquid is run into a vat neutralised with chalk, the sulphate of lime separated by filtration; and finally the sugar is evaporated *in vacuo*, and purified with animal charcoal in the usual way.

The yield of sugar from the rice is about 85 per cent. It is less sweet and soluble than cane-sugar; it requires for its solution $1\frac{1}{2}$ parts of water, and is in the form of granular warty masses, without distinct crystalline faces.

A good sample of glucose contains about 80 per cent. of sugar, and a mere trace of gum and mineral matter.

Milk-Sugar (lactin or lactose, $C_{12}H_{22}O_{11}H_2O$) —White, translucent, very hard cylindrical masses, or four-sided prisms. Soluble in about six parts of cold and in two parts of boiling water. Milk contains about 5 per cent. of it. It is not susceptible of vinous fermentation, except under the action of dilute acids, which convert it into grape-sugar. An alkaline solution when boiled with the salts of copper reduces them.

Effects of the Varieties of Sugar on Polarised Light.—Both cane-sugar and grape-sugar produce rotation upon a ray of polarised light. The plane of polarisation is rotated to the right by sucrose rather less powerfully than by dextrose. It is remarkable that the uncrystallisable sugar of fruits produces an opposite rotation—viz., to the left. Since the degree of rotation is proportionate in columns of equal length to the quantity of sugar present, it has been proposed to employ this property in order to determine the quantity of sugar present in syrups.

The following, according to Berthelot, are the rotatory powers of the different varieties of sugar, if equal weights of each are dissolved in an equal bulk of water; the quantities of each sugar are calculated for the formulæ annexed:—

				Temperature.	
				F.	C.
Cane-sugar	$C_{12}H_{22}O_{11}$	right	73·8°	...	...
Melerzitose	$C_{12}H_{22}O_{11}$	,,	94·1°	...	...
Myeose	$C_{12}H_{22}O_{11}$	,,	193·0°	...	...
Melitose	$C_{12}H_{24}O_{12}$	,,	102·0°	...	...
Grape-sugar	$C_6H_{12}O_6$	,,	57·4°	...	...
Malt-sugar	$C_6H_{12}O_6$	,,	172·0°	...	...
Fruit-sugar	$C_6H_{12}O_6$	left	106·0°	56°	13·3°
Eucalin	$C_6H_{12}O_6$	right	50·0°	...	...
Sorbine	$C_6H_{12}O_6$	left	46·9°	...	...
Milk-sugar	$C_6H_{12}O_6$	right	56·4°	...	...
Glucose of milk-sugar	$C_6H_{12}O_6$	,,	83·3°	...	...
Inverted cane-sugar	$C_6H_{12}O_6$	left	28·0°	57°	13·9°

The specific rotatory power of a sugar or other organic compound is expressed by the number of degrees that the plane of polarisation is rotated to the right or to the left by the pure substance dissolved in water, when a column of the solution 100 millimetres in depth is examined by polarised light in a suitable apparatus.

Sugar, Estimation of (Saccharometry).—There are two principal methods of estimating sugar—viz. (1) a chemical process; (2) an optical process.

1. *Chemical Processes.*—(*a.*) By reducing the oxide of copper to the suboxide, 10 cubic centimetres of the solution of copper (given under VOLUMETRIC SOLUTIONS) are measured into a small flask or porcelain dish, and 40 cubic centimetres of water added. This is heated to gentle ebullition, and the solution of sugar, which has been put into a burette, added in small portions slowly. The red suboxide is thrown down, and the sugar solution must be added until there is not the least blue tinge. The reaction is complete when the supernatant clear fluid neither contains copper nor a brown product of the decomposition of the latter substance. In order to ascertain this, it is well to filter off a little of the fluid while still hot. The filtrate should be colourless; it should not reduce the copper solution, nor give a precipitate with sulphuretted hydrogen. If the filtrate shows any of these reactions, a second estimation must be made.

Another method is simply to precipitate the suboxide, collect on a weighed filter, wash with boiling water, and weigh;—100 parts of anhydrous grape-sugar = 220·5 of oxide of copper, or 198·2 of suboxide of copper.

The sugar in the juice of grapes, apples, &c., may be submitted to the process without preparation; fermented liquids are best treated first with acetate of lead solution. Dark vegetable juices must be clarified, first by milk of lime, and then by animal charcoal.

Liquids containing cane-sugar, or cane-sugar itself, must be converted into grape-sugar by boiling for two or three hours with dilute sulphuric acid. 100 parts of grape-sugar = 95 of cane-sugar, ·475 gramme of cane-sugar decomposing 10 cubic centimetres of the copper solution. Milk-sugar, although reducing copper, does so in a different proportion, and must therefore first be converted into grape.

Starch and dextrine require very protracted boiling with dilute acid to change them into sugar; the best method most decidedly is to put about ·5 gramme into strong tubes, hermetically sealed, and heat for half a day in a bath of saturated common salt. 100 parts of grape-sugar = 90 of starch, ·045 gramme of starch reduces 10 cubic centimetres of copper solution.

(*b.*) *When sugar is fermented with yeast it undergoes alcoholic fermentation*, with elimination of carbonic acid. It would be an accurate process if these were the only products; but various other principles are derived from the sugar, such as glycerine, succinic acid, cellulose, and fats. The carbonic acid may be estimated and collected by an absorption apparatus. 47 parts of carbonic acid equal 100 parts of anhydrous grape-sugar. It is a process abounding with sources of error.

(*c.*) The specific gravity of saccharine solutions, whether taken by an instrument called a saccharometer, or in the ordinary way, fairly indicates the percentage, providing the solutions are those of pure sugar. The following tables will be useful for this purpose:—

TABLE I.

Showing the PERCENTAGE of SUGAR, by WEIGHT in VOLUME of SOLUTION, for all SPECIFIC GRAVITIES with FOUR DECIMALS, from Specific Gravity 1·0040 to Specific Gravity 1·0250, at a Temperature of 63° F. (17·2 C.)

Specific Gravity.	Percentage.	Specific Gravity.	Percentage.	Specific Gravity.	Percentage.	Specific Gravity.	Percentage.
1·0040	1·004	1·0093	2·346	1.0146	3·703	1·0199	5·074
1	·029	4	·372	7	·729	1·0200	·100
2	·054	5	·397	8	·755	1	·126
3	·080	6	·423	9	·780	2	·152
4	·105	7	·448	1·0150	3·806	3	·178
5	·131	8	·474	1	·832	4	·204
6	·155	9	·499	2	·858	5	·230
7	·180	1·0100	2·525	3	·883	6	·256
8	·206	1	·550	4	·909	7	·282
9	·231	2	·576	5	·935	8	·308
1·0050	1·256	3	·601	6	·961	9	·334
1	·281	4	·627	7	·987	1·0210	5·360
2	·307	5	·652	8	4·012	1	·386
3	·332	6	·678	9	·038	2	·412
4	·358	7	·703	1·0160	4·064	3	·438
5	·383	8	·729	1	·090	4	·464
6	·408	9	·754	2	·116	5	·490
7	·434	1·0110	2 780	3	·141	6	·517
8	·459	1	·805	4	·167	7	·543
9	·485	2	·831	5	·193	8	·569
1·0060	1·509	3	·856	6	·219	9	·595
1	·534	4	·882	7	·245	1·0220	5·621
2	·560	5	·908	8	·270	1	·647
3	·585	6	·934	9	·296	2	·673
4	·610	7	·959	1·0170	4·322	3	·699
5	·635	8	·985	1	·347	4	·725
6	·661	9	3·010	2	·374	5	·751
7	·686	1·0120	3·036	3	·400	6	·778
8	·711	1	·062	4	·426	7	·804
9	·737	2	·087	5	·451	8	·830
1·0070	1·762	3	·113	6	·477	9	·856
1	·787	4	·138	7	·503	1·0230	5·882
2	·813	5	·164	8	·529	1	·908
3	·838	6	·190	9	·555	2	·934
4	·864	7	·215	1·0180	4·581	3	·961
5	·889	8	·241	1	·607	4	·987
6	·914	9	·266	2	·633	5	6·013
7	·940	1·0130	3·292	3	·659	6	·039
8	·965	1	·318	4	·685	7	·065
9	·991	2	·343	5	·710	8	·092
1·0080	2·016	3	·369	6	·736	9	·118
1	·014	4	·395	7	·762	1·0240	6·144
2	·076	5	·420	8	·788	1	·170
3	·092	6	·446	9	·814	2	·196
4	·118	7	·472	1·0190	4·840	3	·223
5	·143	8	·498	1	·866	4	·249
6	·168	9	·523	2	·892	5	·275
7	·194	1·0140	3·549	3	·918	6	·301
8	·219	1	·575	4	·944	7	·327
9	·245	2	·600	5	·970	8	·354
1·0090	2·270	3	·626	6	·996	9	·380
1	·295	4	·652	7	5·022	1·0250	6·406
2	·321	5	·677	8	·048		

TABLE II.—Giving the SPECIFIC GRAVITY of SUGAR SOLUTION for every per cent. by Weight in Volume, from 5 to 35 per cent., at a Temperature of 63° F. (17·2 C.)

Percentage.	Specific Gravity.	Percentage.	Specific Gravity.
5	1·0196	21	1·0807
6	1·0235	22	1·0845
7	1·0274	23	1·0883
8	1·0313	24	1·0921
9	1·0351	25	1·0958
10	1·0389	26	1·0996
11	1·0427	27	1·1033
12	1·0465	28	1·1071
13	1·0503	29	1·1108
14	1·0541	30	1·1146
15	1·0579	31	1·1183
16	1·0617	32	1·1221
17	1·0655	33	1·1258
18	1·0693	34	1·1296
19	1·0731	35	1·1333
20	1·0769		

2. *Optical Processes.*—Solutions of the different kinds of sugar rotate the flame of polarised light. The degree of the rotation depends on —(1) the amount of sugar present in a certain volume of solution; (2) the length and temperature of the column of solution through which the light passes; and (3) the colour of the light.

Instruments determining the amount of rotation in saccharine solutions are called *polarising saccharometers.* The two most accurate ones are those of Soleil and Jellett.

Soleil's Instrument.—The essential parts of this instrument are, beginning at the end nearest the eye of the observer, an analysing Nicol's prism, two wedge-shaped plates of quartz, sliding by a suitable mechanical arrangement one over the other, and forming a plate of varying thickness. Next these is another plate of quartz, having the opposite rotating power of the preceding plate; then the tube holding the solution; then a quartz plate, cut at right angles to the principal axis of the crystal, and made half of right-handed and half of left-handed quartz, the line of junction of the two dividing the field into two equal parts; and lastly, a polarising Nicol. Through all these different structures the light has to pass.

To use the instrument, the index of the two wedges is placed at zero. If both Nicols are in a proper position, the double plate, in looking through the instrument, will be seen brilliantly coloured, and the colour of the two halves will be equal. If now a tube containing the sugar solution to be examined is interposed, an *inequality* in the colour of the two halves will be at once produced, but the equality of tint can be again restored by augmenting or diminishing the thickness of the plate formed by the two wedges. The amount of this may be seen at a glance on a scale affixed to the instrument, and this amount is the measure of the rotating power of the liquid.

Professor Jellett's instrument is more elaborate than Soleil's, and of great accuracy. The eye-piece or analyser of the apparatus consists of a suitably mounted prism, made from a rhombic prism of Iceland spar. The rhombic prism is cut by two planes perpendicular to the longitudinal edges, so as to form a right prism. The prism is next divided by a plane parallel to the edge just produced, and making a small angle with the longer diagonal of the base. One of the two parts into which the prism is thus divided is then reversed, so as to place the base uppermost, and the two parts are cemented together. Another distinctive feature in the instrument is that the mechanical rotation of the analyser for the finding of any particular plane is dispensed with, this function being transferred to a fluid which has the power of turning the plane of polarisation opposite to that of the solution to be examined. The analysing tube slips into and moves up and down in the compensating fluid, so that different thicknesses of the latter fluid can be readily interposed, and measured by a scale affixed to the instrument.

Sulphate of Potash—*See* ALKALI ACTS, POTASSIUM, &c.

Sulphate of Soda—*See* ALKALI ACTS, SODIUM, &c.

Sulphur (relative weight = 32)—An elementary body, found native, as virgin sulphur, and in combination, as sulphides, sulphates, &c.

Sulphur is capable of existing in several very remarkable allotropic conditions; but in commerce the common forms are roll sulphur or brimstone, flowers of sulphur, and precipitated sulphur.

Sulphur is a yellow solid, which is highly inflammable, burning with a blue flame, and emitting pungent fumes of sulphurous anhydride, between 455° and 500° F. (255° and 260° C.)

It may be distilled in closed vessels, the boiling-point being 836° F. (446° C.) The deep yellow vapour produced at this temperature has a specific gravity of 6·617. Sulphur combines readily with chlorine, bromine, and iodine. It also enters into combination with the metals, earths, and alkalies, forming bodies called sulphides.

Sulphur is extensively used in the arts, in the preparation of matches, of gunpowder, and of sulphuric acid. It is a powerful bleaching agent, and an excellent disinfectant.

The most frequent adulteration of the medicinal preparations of sulphur is that of mineral powders.* *See* ACID, SULPHUROUS; DISINFECTANTS, &c.

Sulphuretted Hydrogen (*Hydrosulphuric acid*, $H_2S = 34$. Theoretic specific gravity, 1·174 ; observed, 1·1912)—This substance is formed in small quantities when sulphur is heated in hydrogen gas, and spontaneously under a variety of circumstances. Whenever a soluble sulphate remains in contact with decaying animal or vegetable matter, the sulphate loses oxygen, which combines with the elements of the decaying substance, whilst sulphide of the metal remains—*e.g.*, 1 atom of sulphate of lime by the abstraction of 4 atoms of oxygen becomes converted into sulphide of lime ($CaSO_4 - 2O_2 = CaS$).

Soluble sulphides are in this manner formed in many springs, and sulphuretted hydrogen is generated in a somewhat similar manner in stagnant sewers and cesspools, &c.

Sulphuretted hydrogen is found in large quantities in the air of the Singapore marshes and the marshes of Italy, in mines, in sewer air often to the extent of 3 per cent., and in coal gas—indeed the amount found in the latter, even when fairly purified, is about ·29 per cent. Sulphuretted hydrogen is largely employed in the laboratory as a test for the discovery of metallic bodies.

Preparation.—Half an ounce (15 grammes) of *ferrous sulphide*, in small fragments, is placed in a bottle, and by means of an ounce (about 30 cubic centimetres) of sulphuric acid diluted with six or eight times its bulk of water the gas is formed in abundance without the aid of heat, the iron and hydrogen change places, ferrous sulphate is dissolved in the act of formation, and sulphuretted hydrogen is evolved.

Properties.—It is a transparent, colourless gas, with a nauseating odour resembling that of rotten eggs. It burns with a pale bluish flame, depositing sulphur if the supply of air be insufficient for complete combustion. It is immediately decomposed by chlorine, bromine, and iodine, sulphur being precipitated, and hydrochloric, hydrobromic, and hydriodic acid being formed by the union of the hydrogen with one of the halogens above mentioned. Under pressure sulphuretted hydrogen is reducible to a colourless mobile liquid. Water will at 32° dissolve 4·37 its bulk of this gas, 3·23 its bulk at 59°, and 2·66 at 75·2°. The solution smells and tastes of the gas, and is feebly acid. On exposure to the air the solution becomes turbid, the hydrogen is slowly oxidised, and the sulphur is separated.

Effects of Breathing the Gas.—Sulphuretted hydrogen is an active poison, and when breathed undiluted it is immediately fatal. It appears to be absorbed by the blood, and thus circulates in all the tissues of the body. According to Mr. Donovan's experiments, it even causes death in rabbits when they are placed in a bag of this gas, but at the same time allowed to breathe a pure atmosphere. The smallest amount of the diluted gas required to destroy life is not known. Men, according to Parent-Duchâtelet, work without injury in an atmosphere containing 2 or 3 per cent. of this gas ; 7 per cent. would probably be a dangerous mixture to breathe for a short time. In a public health point of view, it is well to insist upon the fact that minute traces of it breathed for a long time have caused serious illness and death. In a case related by M. d'Arcet, a lodging in Paris exhibited a singular fatality, no less than three young and healthy men having died successively in the course of a few years under similar symptoms. The cause was pretty well proved to be the sulphuretted emanations from a privy pipe.—(Annales d'Hygiène, 1836.) The men engaged in the Thames Tunnel during its excavation suffered severely. The air was much contaminated with sulphuretted hydrogen, and many strong men died from its effects. — (TAYLOR.) Six persons died at Cleator Moor, near Whitehaven, from sleeping in unventilated rooms into which this gas found its way. The cottages had been built on iron slag containing sulphides of iron and calcium.—(TAYLOR.) Men have also lost their lives when this gas has been evolved from foul drains, sewers, and cesspools. There can, therefore, be little doubt that whenever it is smelt, measures should immediately be taken to remedy it, a slight but constant odour of sulphuretted hydrogen being *a nuisance most decidedly injurious to health.*

The following substances are useful for preventing the evolution of sulphuretted hydrogen—they are arranged as nearly as possible according to their efficacy : Nitric acid, bichromate of potash, soda, solution of heavy oil of tar, watery solution of heavy oil of tar, chloride of lime, sulphite of soda, chloride of alumina, sulphuric acid, sulphate

* A druggist was summoned at Leeds for selling milk of sulphur adulterated with sulphate of lime. As it appeared in evidence that the presence of sulphate of lime had so long existed in the ordinary milk of sulphur that it could hardly be called an adulteration, the summons was withdrawn. Case fully reported in "Pharmaceutical Journal," February 6, 1875.

of alumina and ammonia, and M'Dougall's powder, &c.

Tests, Estimation, &c.—The tests for the presence of sulphuretted hydrogen are its odour, and the action of the gas upon the salts of lead. Gases or liquids containing sulphuretted hydrogen blacken a piece of paper which has been dipped in a solution of acetate of lead. Both of these tests are so delicate that any others are unnecessary.

The presence of the gas being ascertained, its amount may be required.

Hygienists may have to quantitatively determine the gas—(1) in air; (2) in liquids.

1. A known volume of air is drawn by means of an aspirator through a very dilute solution of iodine in iodide of potassium, the strength of which is exactly known after the operation; the iodine not existing in the free state, is estimated by a volumetric solution of hyposulphite of soda. (*See* VOLUMETRIC SOLUTIONS.) The difference in the amount of iodine existing before and after the process, is the quantity of iodine which has been converted by sulphuretted hydrogen into hydriodic acid, and consequently corresponds to the amount of sulphuretted hydrogen present—1 eq. of iodine (127) being equal to 1 eq. of sulphuretted hydrogen (17).

2. When liquids—such as a sulphuretted hydrogen water—are to be examined, a process based upon the same principle applies. A solution of iodine of known strength is added from a burette to a weighed or measured quantity of the liquid, to which has been previously added some starch paste, until a permanent blue colour is formed. The number of cubic centimetres used indicates the quantity of iodine which has been converted into hydriodic acid, and from this data the sulphuretted hydrogen present can be easily calculated.

Sulphuric Acid—*See* ACID.

Sulphurous Acid—*See* ACID, SULPHUROUS.

Sumach—A dye-stuff frequently employed in the adulteration of snuff.

Sun—*See* SUNSTROKE.

Sunstroke—Sudden insensibility, from the body attaining a temperature incompatible with the integrity of the nervous system.

Causes.—The principal cause of sunstroke is undoubtedly a dry and heated atmosphere. In all recorded cases the heat has been great—witness the three deaths of men belonging to the 73d Regiment in 1834, when, to attend a funeral, the regiment was marched out buttoned up in red coats and military stocks, exposed to the hot winds and the burning tropical afternoon sun. Witness also the effects of the march of the 43d Light Infantry from Jubbulpore to Calpee in 1858, during which seven men died from sunstroke in the Valley of Nagodo (the temperature being 115° to 127° F. in the tents); and when Calpee was reached no less than sixteen had been struck down by the disease.

If to tropical heat is added a vitiated atmosphere, such as may be found in crowded, badly-ventilated barracks, military surgeons bear testimony that then sunstroke is still more common. Fatigue, either mental or bodily—anything, in fact, of a depressing nature—is also an active predisposing cause.

The temperature of the air sufficient to cause sunstroke is unknown; whenever the thermometer is above 98° cases occur, below this it is improbable. Dr. Crawford also assigns as a cause a peculiar electrical state of the atmosphere, and Dr. Barclay has noticed that cases occur with increased frequency immediately before a thunderstorm, but cease afterwards. That it is not the mere heat of the sun's rays, but rather the heat of the air and the extent to which the bodily temperature is raised, which cause the disease, appears probable by the fact of the extreme rarity of sunstroke on board ship and at any elevation above the sea; in both cases cooling breezes are nearly always present.

Mortality.—Sunstroke is a most fatal disease; it may be said that of those attacked half die. Dr. Barclay estimates the mortality as equal to 42·734 per cent., Dr. Butler, 43·3.

Symptoms.—The symptoms in recorded cases are usually sudden insensibility, the face either intensely flushed and congested, or pale and bedewed with a cold sweat. The whole venous system is engorged, the heart's action rapid and irregular, the breathing stertorous, the conjunctivæ injected, and the skin dry, harsh, and intensely hot. In some cases the symptoms are more gradual, commencing with giddiness and sometimes boisterous delirium, or a curious half-insane sort of terror. In nearly all cases, inquiry shows that for days before the attack, the skin has been extremely inactive and micturition frequent.

Morbid Anatomy.—The most striking and characteristic *post-mortem* appearance of sunstroke is excessive engorgement of the lungs. This engorgement is far beyond what is met with in any other disease. There is generally some congestion of the cerebral centres, as evidenced by engorgement of the vessels of the pia-mater, the choroid plexus, &c. The blood is always fluid.

The physiology of sunstroke is believed to be this, that the heated blood circulating in the nervous centres arrests the nerve currents;

hence the blood accumulates on the right side of the heart and in the lungs, and death may take place by suffocation.

Treatment (*blood-letting* and the *cold douche*).—The great engorgement of the lungs alone shows that the abstraction of blood is the grand remedy required. The great success of venesection in sunstroke may be gathered from various published cases; see especially a case by Mr. Salter, "Medical Times and Gazette," 1872, vol. ii. p. 236. Dr. Benjamin Richardson also says: "In sunstroke the conditions of disease are closely analogous, if not identical, with those induced by lightning. One of my earliest experiences, an experience that has made me hold to the thoughtful practice of blood-letting, had reference to this disorder and its treatment. A man was carried from the harvest-field to the residence of a surgeon, a relative of mine, insensible from sunstroke. The patient was carried in like a dead man, unconscious, powerless. He was livid, but breathing at intervals, and there was still some audible motion of the heart. The surgeon, one of the school of Clive and Astley Cooper, and one who had no doubt as to what was the right thing to do, acted promptly. 'He will recover, if we can only get blood,' was the remark to me; and so the man was held up by his mates in a garden-chair, a fillet was put round each arm, and a vein was opened beneath each fillet. At first the flow of blood was slow, though the veins everywhere were distended to the utmost; then the stream became more determinate, and at last copious; and the result was that in five minutes the man was breathing freely, was becoming conscious, was recovering. He was simply cured, straightway was able to assist himself to walk away, and without any other touch of medical treatment was restored to full health in a few days."—(Medical Times and Gazette, 1870, vol. ii. p. 694.)

Prevention of Sunstroke.—Light clothing, large straw hats, non-exposure to the sun, abstinence from alcoholic drinks in hot climates, and, where it is possible, doing all laborious work in the coolest part of the day, are the chief precautionary measures. But besides these, there are those which the sanitary authorities may provide, such as public baths, planting trees where possible along the promenades, and ensuring that streets are frequently watered, a process which most decidedly cools the air, and renders it more agreeable. In the great heat we sometimes have at harvest-time, men should certainly be discouraged from working in the field at midday; it is far better for them to reap in the early hours of the morning, and as long as possible after sunset.

Surveyor—The word "surveyor," in a sanitary sense, includes any person appointed by a rural sanitary authority to perform any of the duties of a surveyor under the Public Health Act.

Any local authority may appoint a surveyor, and the office of nuisance inspector is compatible with it.—(P. H., s. 192.)

Suvern Disinfectant—*See* SUGAR.

Sweating Sickness—This disease appeared first in 1485, and raged in August and September of that year.

"Caius gives us a vivid notion of its severity, when he says of those whom it attacked, that it fearfully invaded them, furiously handled them, speedily oppressed them, unmercifully choked them; and that in no small numbers, many of them being persons of rank and mark. It immediately killed some in opening of their windows, some in playing with children in street doors, some in one hour, many in two, and, at the longest, to them that merrily dined, it gave a sorrowful supper. As it found them, so it took them: some sleeping, some waking, some in mirth, some in care, some fasting, some full, some busy, some idle, and in one house, three, five, seven, eight or more, or all; so that if the half in any town escaped it was thought great favour."—(GUY, Public Health, 1874.) The disease was a fever of a very short duration, with pains in the back, limbs, and head, accompanied with delirium and sleepiness. It appeared to terminate with profusely offensive sweats, and was frequently followed by one or more relapses. It prevailed extensively and suddenly over a large area—*e.g.*, London, Stettin, Dantzic, Augsburg, Hanover, Cologne, and others were all attacked simultaneously, as if by magic, and it disappeared as rapidly. The disease did not attack the poor and ill-fed, but rather the rich, the gluttonous and intemperate.

It appeared in 1506, 1517, 1528, and 1551. This last epidemic began at Shrewsbury in April, and made its way through Coventry, Ludlow, &c., to London, reaching London in July. From the 7th of July to the 30th it killed more than 904 people, and then passed on to the east, made its way from there to the north, and in September ceased.

It has been argued that the sweating sickness is identical with influenza. The symptoms are, however, more those of relapsing fever, although in almost every epidemic except the last, relapsing fever attacked famine-stricken and destitute people, whereas the sweating sickness selected the well-to-do: the relapses also were more frequent. *See* FEVER, RELAPSING; INFLUENZA, &c.

Sweep, Chimney—The trade of a sweep is a dusty and uncleanly one, and may therefore be presumed to be unhealthy. There are on this point, as yet, no reliable statistics. It is a generally-received opinion that sweeps are more subject to cancer, especially cancer of the scrotum, than men of other trades; but William Haynes Walshe gives in his statistics on this subject 649 deaths from cancer occurring amongst people following various occupations, and of these, three only were sweeps.

Sweetmeats—*See* CONFECTIONERY.

Swimming-Bath—*See* BATHS.

Swine—*See* NUISANCES, PIGS.

T.

Tænia—*Tænia* is the generic name given to tapeworms, the species of which are very numerous. Those which have been found in the human intestine are as follows: *Tænia solium*, or common tapeworm of this country; *T. mediocanellata*, the common tapeworm of the Continent, South Africa, and India; *T. flavopuncta*, *T. nana*, and *T. elliptica*: the last three are only of rare occurrence. Besides these, the cysticercus of the *T. marginata*, the cysticercus of the *T. Echinococcus*, and perhaps one or two others, have been found in the muscles or internal organs of man.

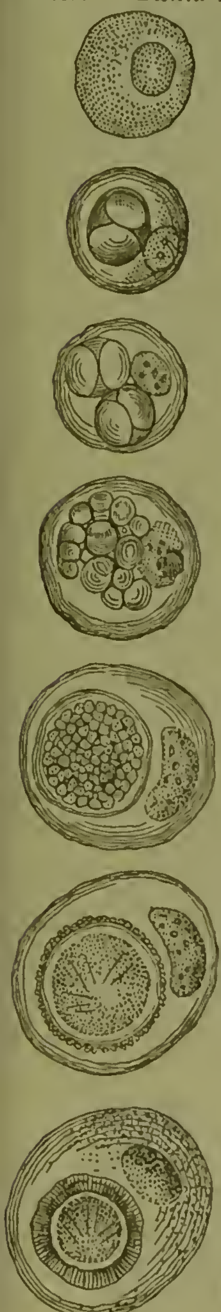


Fig. 107.

All the tapeworms are very similar in their history and appearance. It will therefore be convenient to trace out the life-history of the *T. solium*, as a type of the rest, beginning at the egg. The egg is very minute, about $\frac{1}{700}$ of an inch in diameter. Its shell is composed of an intimate mixture of calcareous matter with some organic material, and is very thick; it possesses an extraordinary power of resistance to chemical and even mechanical reagents. The segmentation of the yolk and its progressive development are well shown in fig. 107, after Leuckhart. These eggs are contained in countless myriads in the joints of the mature tapeworm. On the extrusion of the joints, putrefaction sets them free, to be carried by winds, water, or other agents wherever accident may determine; and they thus may be eaten by man and animals in food, or drunk in water. The embryo may then be set free by the rupture of the shell, whether this rupture take place by mechanical violence or other causes. The embryo itself is a little vesicle about $\frac{1}{1250}$ of an inch in diameter, armed with tiny spikelets on one side, as shown in the two lower diagrams of fig. 107. The embryo is now called a *proscolex*, and can make active migrations by means of its spikelets in the following manner: The different pairs are brought together in the shape of a wedge; the lateral pairs are then brought backwards, and in this manner, by alternate movements of the spikelets, analogous to the action of a man swimming, the proscolex accomplishes progression; usually, however, it pierces the coats of one of the mesenteric veins, and is swept on with the current to the liver, and there becomes encysted. A third stage of development consists in the formation of segments near that portion of the entozoon, next to its oscula and hooklets. These segments are first seen in the form of marks like girdles; the embryo is then called a *strobila*. This third stage completed, farther development cannot take place unless the liver or other organ affected is eaten by some animal whose intestine is suitable for its growth. The circlets of hooklets attach themselves to the intestine, and growth and development take place mainly towards the neck of the parasite by a process of transverse fission, the ultimate result being the production of the mature worm, consisting of the head (fig. 108) and body.

The head in the *T. solium* is of triangular form, having four circular projections. Between the suckers, and anterior to them, is a rudimentary proboscis with a double row of hooks; their shape, number, and arrangement are well shown in fig. 109, after Leuckhart.

The head is placed on a long neck, and the neck is continued into the body of the worm, which consists of a number of joints or

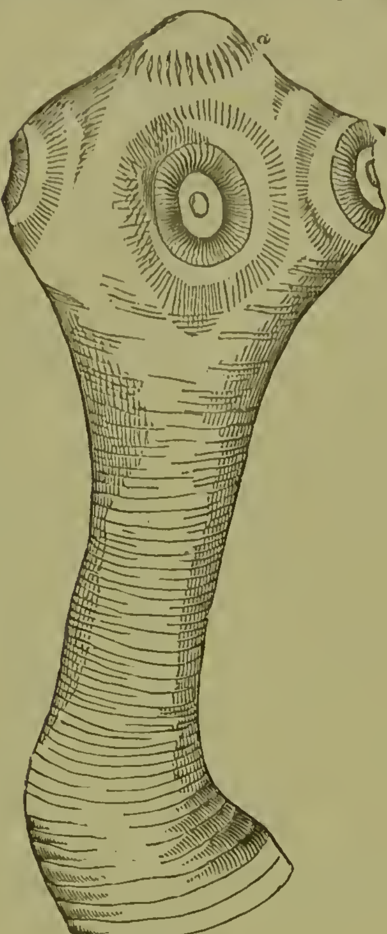


Fig. 108.

segments, united end to end in a single linear series. Each mature segment is called a

Fig. 109.

proglottis, and is hermaphrodite, containing male and female organs of generation. Fig. 110 (after Rokitansky) shows the parts of a mature proglottis of the *T. solium* magnified. *a* is the genital pore, with its preputial cover or sheath skin; *b*, the seminiscus or

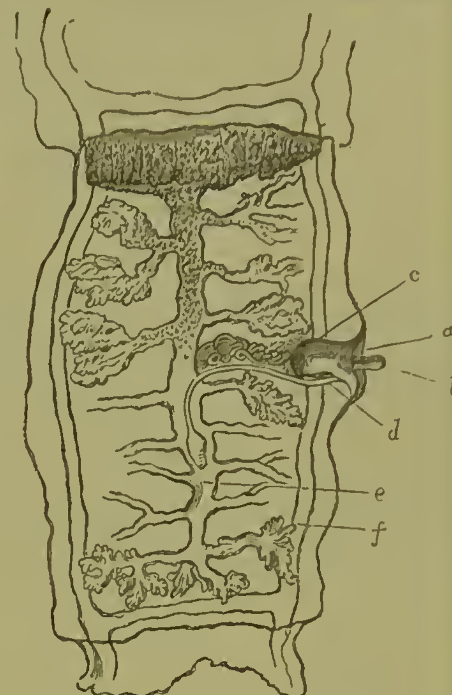


Fig. 110.

penis; *c*, the oviduct; *d*, the seed vessel; *e*, the uterus; and *f*, the vascular system of vessels.

The mature segments drop off, and are expelled with the excreta; they often exhibit very active movements for some time after their expulsion. The eggs become free generally by putrefaction, sometimes by passing along the genital pore, and then all the changes enumerated may take place.—(AITKEN.)

The *T. mediocanellata* differs considerably in shape from the *T. solium*; it is a hookless, flat-headed tapeworm (fig. 112).

The cause of tapeworm is usually diseased meat—that is, meat affected with the cysticercus or encysted embryo of a tapeworm. Pork affected with the *Cysticercus cellulosæ* (measly pork), if eaten partially cooked, is the cause of the *T. solium* of man; the cysticercus of the *T. mediocanellata* is found in the muscles of cattle, and this tape-

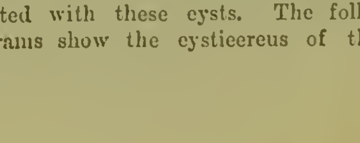


Fig. 111.

worm is developed in man from eating beef affected with these cysts. The following diagrams show the cysticercus of the *T.*

Fig. 112.

Fig. 113.

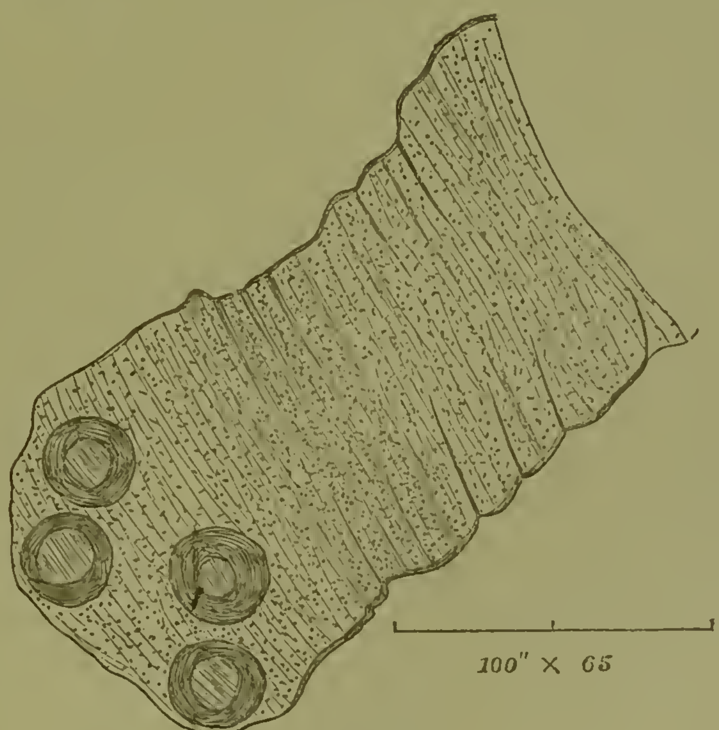


Fig. 114.

mediocancllata, natural sizo (fig. 111, *a* and *b*); the head of tho *T. mediocancllata* from ration beef (fig. 113); and tho head of *Cysticercus cellulosæ* from measly pork (fig. 114).

It is the opinion of those who have studied the subject, that with care in feeding cattle, and especially ensuring that they have a pure water-supply, these tapeworms might be effectually prevented. Meat should be thoroughly cooked, as it is very doubtful if any of the ova can exist without injury in a heat of 212° F. Meat affected with cysts should be *burnt*, not buried.

Tallow-Melter—*See* TRADES, OFFENSIVE.

Tamarind—The pulp or preserved fruit or pod of the *Tamarindus Indica*, or *T. occidentalis*. According to Vanquelin's analysis, tamarinds contain 9·40 per cent. of citric acid, 1·55 per cent. of tartaric acid, ·45 per cent. of malic acid, 3·25 per cent. of bitartrate of potash, and 12·5 per cent. of sugar, besides gum, vegetable jelly, parenchyma, and water. They possess refrigerant and mildly laxative properties. They have been found as an adulterant of opium.

Tanks, Cisterns—The distinction between tank and cistern is not very obvious, as they are both water-tight receptacles commonly used for the storing of fluids, and distinguished from reservoirs by their moderate size, and by the fact that they are generally covered.

The tanks within the scope of this work are those used for the storing of moderate quantities of water or sewage, whilst the cisterns are those which are used for the supply of water to houses, and generally have supply-pipes attached to them.

The size, the material, and the position of tanks will depend entirely upon the purposes for which they are required. If a tank is constructed for the purpose of storing rain-water for household purposes, it should be made of the cheapest water-tight material procurable. Mr. Bailey Denton strongly advises the use of concrete as a material for this purpose, and he remarks that the commonest lime, properly slaked and mixed in due proportions with clean gravel and sand, or with burnt clay, ballast, or even sifted chalk itself, if faced with Portland cement, will make admirable tanks. In some parts of the chalk districts an even simpler process has been adopted—viz., by merely excavating a cavern with an opening at the top, and lining it within by a water-tight cement.—(The Storage of Water, by BAILEY DENTON, C.E.)

In rural places where drinking-water is scarce, it is an excellent plan to supplement the ordinary supply by storing up rain in tanks of the cheap construction alluded to. There are few places in England in which 20 inches of rain cannot be collected even in the driest year. "Take an ordinary middle-class house in a village, with stabling and outbuildings; the space of ground covered by the roofs will frequently reach 10 poles, while the space covered by a farm-labourer's cottage and outbuilding will be 2½ poles. Assuming that the roof is slate, and the water dripping from it is properly caught by eave-troughing, and conducted by down pipes and impervious drain-pipes into a water-tight tank sufficiently capacious to prevent overflow under any circumstances, and that by this method 20 inches of water from rain and dew are collected in the course of the year, the private houses will have the command of 28,280 gallons, and the cottage 7070 gallons in a year. . . . A tank 16 feet long and 10 feet wide will hold 1000 gallons in every foot of depth, and where the water is not wanted for drinking, it need not be covered, except with a common boarded floating roof of half-inch boards fastened together. This floating roof keeps the water clean, and prevents evaporation."—(*Op. cit.*)

Where expense is no object, the very best material to construct tanks or cisterns of is slate. The slate slabs must be set in good cement, and not in mortar.

Mr. R. S. Burn strongly recommends wrought-iron cisterns, coated with a tar composition, which prevents corrosion. Zinc is also little acted upon by water, and is now much used. Lead, although durable, should never, if possible to avoid it, be selected.

Tanks or cisterns, if used for the supply or storage of drinking-water, should be frequently cleansed out, and should always be placed in such positions and so arranged as to be readily inspected.

Tanks have recently been fitted up with filters, and this has proved a valuable idea. Cisterns are often rendered unwholesome by the overflow-pipe passing directly into the sewer, so that sewer gases pass up and are absorbed by the water. The only effectual remedy for this is to disconnect entirely the sewer from this pipe, which should open above the ground over a trapped grating.

Separate cisterns should be provided for drinking and culinary purposes, and for supplying the water-closets, and on no account should the same receptacle be used for both these purposes, unless special precautions are taken to avoid pollution of the water by foul gas. A disinfectant fluid may with advantage be mixed with the water supplying the water-closets.

Dead vegetable or animal matter should never be able to find its way into the cistern, and frequent inspections should preclude the possibility of such substances remaining there for any length of time.

In ships there should be three tanks—one containing *salt*, another *fresh*, and a third *filtered* water—and the contents of each should be legibly written upon it. A store of salt water is useful on board ship for playing on the latrines, &c., and may prove invaluable in case of fire. It is much better to take water out in tanks than in casks, for it is not so liable to become bad, and tanks are much more easily and thoroughly cleansed than casks.

Fig. 115 shows a section of a tank fitted up with one of the London and General Water-Purifying Company's filters; it explains itself. This is an admirable arrangement.

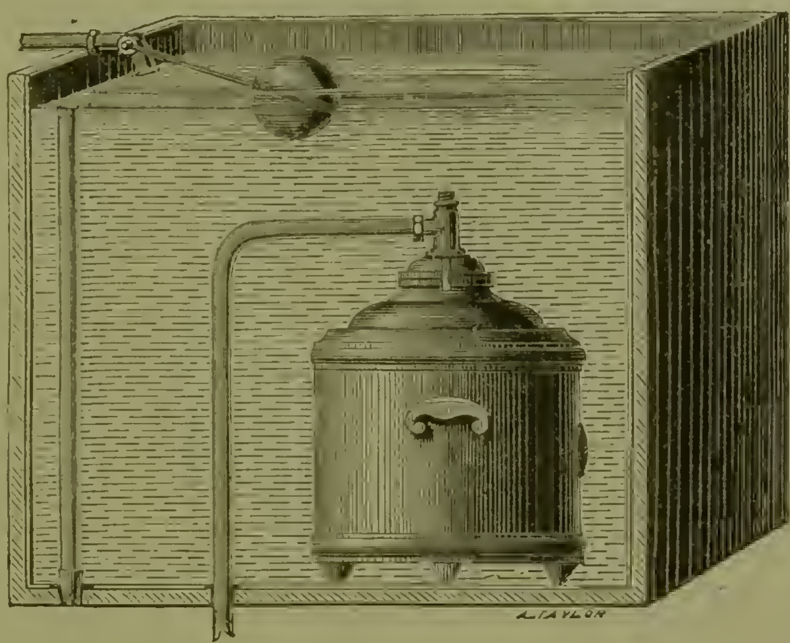


Fig. 115.

Cisterns, tanks, &c., used for the *gratuitous* supply of water are under the control of the local authority.—(P. H., s. 64, 70.) *See* FILTERS; SEWAGE; TANKS, FLUSH; WATER.

Tanks, Flush—These are tanks at the head of drains, or connected with sewers, for the purpose of flushing them.

One of the best is an automatic tank invented and patented by Mr. Rogers Field, C.E. It is on the same principle as the meter-tank described in article SEWAGE. It consists of a cylindrical iron or stoneware tank, which may be made of any capacity. The inlet is trapped, and the tank ventilated. The outlet is a siphon so fixed that no discharge can take place until the tank is filled with liquid, but when it is full the siphon immediately comes into action, and the tank empties. It is thus a useful little apparatus to connect with a back-kitchen sink, the drains of a country house, or the drains of two or three cottages. It is especially valuable where water for flushing purposes is scarce, as by this arrangement the slop-water itself clears the pipes.

Tannin, or **Tannic Acid** ($C_{27}H_{22}O_{17}$, STRECKER)—This acid is obtained in a state of purity from the nutgall, an excrescence produced upon the leaves of a species of oak (*Quercus infectoria*) by the puncture of a small hymenopterous insect. The nutgall contains as much as two-thirds of its weight of tannic acid, and about 2 per cent. of gallic acid.

Pure tannin is perfectly colourless, and is uncrystallisable. It has an astringent taste, and is freely soluble in water, less so in alcohol, and only very slightly in ether. It reddens vegetable blues. When boiled with acids, it assimilates water, and divides into gallic acid and grape-sugar; when heated in the dry state, it suffers decomposition, metagallic and pyrogallic acids being formed. It unites with the bases, forming salts called tannates, which are characterised by striking a deep black with persalts of iron (ink). Tannin forms a remarkable compound with gelatine, which constitutes the basis of leather. When a solution of gelatine or isinglass is added to an aqueous infusion of any vegetable containing tannic acid, a copious gelatinous precipitate occurs, which is soluble in excess of gelatine. If a piece of raw hide, freed from hair, be immersed in a solution of tannic acid, the gelatinous tissue gradually combines with the acid, and retains it in the form of leather, the supernatant liquid being ultimately completely freed from all traces of tannin, if the piece of skin be of sufficient size.

Estimation of Tannin—1. *Gelatine Process.*—Add a solution of gelatine to the liquid containing tannin, collect the precipitate, dry and weigh it. 100 grains equal 40 grains of tannin.—(MARCET.)

2. *Allen's Process for Estimating the Tannin in Tea.*—Five grammes (77·16 grains) of lead acetate are dissolved in water and diluted to 1 litre (35·27 fluid ounces), and the solution filtered after standing. The indicator is made by dissolving 5 milligrammes (·07715 grain) of pure potassium ferricyanide in 5 cubic centimetres (84·8 minims), and adding an equal bulk of strong ammonia solution. One drop of this test will detect ·001 milligramme of tannin, or 1 milligramme dissolved in 100 cubic centimetres of water. The precipitating power of the lead solution is ascertained by diluting 10 cubic centimetres of it to about 100 cubic centimetres with boiling water, and adding to it from a burette a solution of ·1 gramme of pure tannin in 100 cubic centimetres of water. After adding 10 cubic centimetres of the latter solution, about 1 cubic centimetre of the liquid is withdrawn with a pipette and passed through a small filter, the drops being allowed to fall on to spots of the indicating solution previously placed on a porcelain slab. If no pink coloration is observed, another small addition of the tannin solution is made, a small portion of the liquid filtered and added to the indicator as before, the process being repeated until a pink colour is observed. The greatest delicacy is obtained when the drops of the liquid from the funnel are allowed to fall directly on to the spots of the indicator, instead of observing the point of junction of the liquids. The reaction being complete, a second estimation is made, and in this case almost the full volume of tannin solution can be added at once. It is necessary to use the purest tannin for the purpose, as a serious error may otherwise occur, some samples of commercial tannin having little more than half the precipitating power of the best. Exactly the same process is employed for estimating the tannin in tea, the decoction being substituted for the standard tannin solution, and added to the lead solution as before.

The solution of tea is prepared by boiling 2 grammes of a finely-powdered sample with about 80 cubic centimetres of water for half an hour. The decoction is strained through fine muslin, the particles of leaf returned to the flask, and the boiling resumed for an hour with the same quantity of water as before. The process is repeated till no more colouring matter is extracted. The whole of the solution is set aside to allow any particles that may have passed through the muslin to subside, when the liquid is decanted from the sediment, the last portions passed through a filter, and the whole decoction made up to 250 cubic centimetres. This diluted solution is ready for use in the burette, the remainder of the process only occupying a few minutes. The volume of tannin or tea solution it is necessary to add to 100 cubic centimetres of pure water in order that a drop may give the pink reaction with the ferricyanide, is subtracted from the total amount run from the burette. If the solutions are made of the strength here described, 10 cubic centimetres of the lead solution will precipitate about 10 milligrammes of pure gallotannic acid, and therefore the volume of tea solution added contains ·01 gramme of tannin. If all the weights and volumes above mentioned are observed, 125 divided by the number of cubic centimetres of tea solution used will give the percentage of tannin.

Risler Beunat's method is extremely useful in those cases where a determination of tannin is of rare occurrence, as no volumetric solutions are required to be made. The tannin is precipitated by a solution of crystallised protochloride of tin, strength about 8 grammes to the litre, and to which has been added 2 grammes of chloride of ammonium. The precipitate of prototannate of tin is collected on a weighed filter, dried at 217° F. (100° C.), weighed, ignited, oxidised with nitrate of ammonia, and the binoxide of tin thus obtained is weighed; from this the corresponding amount of protoxide is calculated, and the weight of the dried precipitate deducted from the latter, the remainder representing the tannic acid.

Fleck's process, modified by A. Pavesi and E. Rotondi. This is a very convenient method to estimate tannin in wine. It is based upon the fact that an ammoniacal solution of cupric acetate precipitates tannin alone without affecting gallic acid, nor does it affect the other constituents of wine. The amount of tannin can be ascertained by estimating the copper remaining in solution, or that contained in the precipitate.

Hammer's process is based upon the principle that if the specific gravity of a liquid containing tannic acid with other substances in solution is determined, and then the tannic acid is removed—the fluid not being otherwise altered by the process—and if, finally, the specific gravity is redetermined, the loss of specific gravity will be proportional to the percentage of tannic acid present in the solution. The best material to remove the tannin is *hide-filings*—that is, a piece of hide which has been prepared for tanning, dried and reduced by means of a file to a coarse powder. Four parts of such a powder are sufficient to remove one part of tannin from a fluid.

The specific gravity of the liquid containing the unknown quantity of tannin is carefully determined, a sufficient quantity of the powder shaken up with it for a short time, and the specific gravity redetermined; to the difference add 1, and then the amount of tannin is found by the use of the following table:—

TABLE showing the SPECIFIC GRAVITY of DILUTE SOLUTIONS of TANNIN at 60° F.

Specific Gravity.	Tannin. Per cent.	Specific Gravity.	Tannin. Per cent.	Specific Gravity.	Tannin. Per cent.
1·0000	0·0	1·0068	1·7	1·0136	3·4
1·0040	0·1	1·0072	1·8	1·0140	3·5
1·0080	0·2	1·0076	1·9	1·0144	3·6
1·0012	0·3	1·0080	2·0	1·0148	3·7
1·0016	0·4	1·0084	2·1	1·0152	3·8
1·0020	0·5	1·0088	2·2	1·0156	3·9
1·0024	0·6	1·0092	2·3	1·0160	4·0
1·0028	0·7	1·0096	2·4	1·0164	4·1
1·0032	0·8	1·0100	2·5	1·0168	4·2
1·0036	0·9	1·0104	2·6	1·0172	4·3
1·0040	1·0	1·0108	2·7	1·0176	4·4
1·0044	1·1	1·0112	2·8	1·0180	4·5
1·0048	1·2	1·0116	2·9	1·0184	4·6
1·0052	1·3	1·0120	3·0	1·0188	4·7
1·0056	1·4	1·0124	3·1	1·0192	4·8
1·0060	1·5	1·0128	3·2	1·0196	4·9
1·0064	1·6	1·0132	3·3	1·0201	5·0

Tanyards—We have no reason for believing that tanyards, notwithstanding the disgusting exhalations which arise from them, produce any deleterious effects on the neighbouring inhabitants, and the mortality amongst men employed in these yards is not excessive.

Tapeworm—*See* TÆNIA.

Tapioca—A starch, in the form of small, rregular, transparent granules, prepared from he roots of the *Manihot utilissima*, a plant

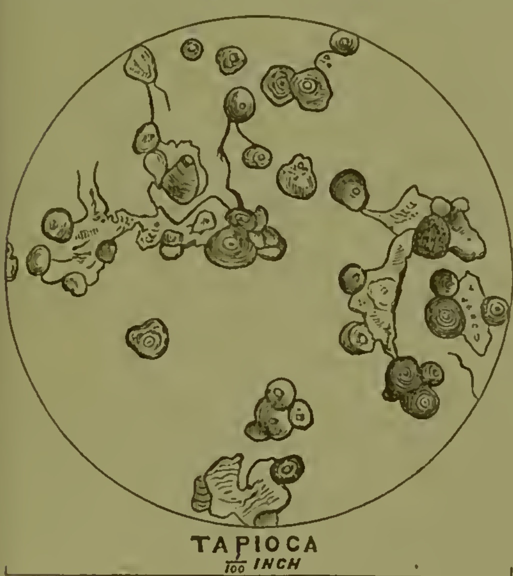


Fig. 116.

cultivated in Africa, India, and other hot countries. The microscopical appearances of tapioca may be gathered from fig. 116. *See* STARCH, &c.

Tar (*Pix liquida*)—A liquid bitumen prepared from the wood of *Pinus sylvestris* and other pines by "destructive distillation." It is a very complex substance; specific gravity about 1·040. It contains altered resin, an empyreumatic oil, in which numerous substances—such as creosote, paraffine, picamar, kapnomor, &c.—are found.

Coal tar, produced during the distillation of bituminous coal for gas, possesses a density of 1·120 to 1·150, the lightest tar containing the largest proportion of liquid oils. Coal tar contains ammonia, aniline, picoline, quinoline, and pyridine; acetic acid, phenic acid (carbolic acid), rosolic and brunolic acids; benzole, tolnol, cumol, and cymol; naphthaline, anthracene, chrysene, and pyrene, &c.

The oil of tar is a very powerful vegetable irritant. Ten drachms caused the death of a gentleman to whom it had been sent by mistake for a black draught. Its irritant qualities are due to the presence of CREOSOTE and CARBOLIC ACID, *which see*.

Both these varieties of tar have been employed for disinfecting purposes. The creosote in the wood tar and the carbolic and cresylic acid in the coal tar give this disinfecting power. From the earliest date it has been usual to burn tar-barrels during the time of epidemics, and some savages use petroleum as an application to wounds. Tar acids arrest decay and prevent oxidation; they antisept and disinfect, but do not prevent the oxidation of inorganic matters. *See* ACID, CARBOLIC; CREOSOTE; DISINFECTANTS, &c.

Tartar, Salts of (*Argal* or *Orgol*, *impure bitartrate of potassa*)—Crude tartar is the concrete deposit formed upon the sides of casks and vats during the fermentation of grape-juice. That obtained from white wine is *white argal*, and that from red wine *red argal*. After purification it forms *cream of tartar*.

Tartar Emetic (tartarated antimony, $KSbC_4H_4O_7H_2O$).—Prepared by mixing certain quantities of oxide of antimony and acid tartrate of potash with water, so as to form a paste, allowing the mass to stand for twenty-four hours, boiling in water for a quarter of an hour, filtering the solution, and allowing the clear filtrate to crystallise.

Tartar emetic has been taken with suicidal intent; it has found its way by accident or design into food, and it has been administered for the criminal purposes of producing death or inducing abortion.

The symptoms of acute poisoning by this salt are, shortly, those of an irritant metallic poison. Within a time varying from a few minutes to half an hour after taking something which had a nauseous metallic taste, there is great pain in the bowels, and a prostration and faintness amounting to collapse; vomiting and purging speedily come on, and in this way most of it may be eliminated, and recovery may take place from such large doses as 200 grains. On the other hand, in a few recorded cases vomiting has been absent, purging and convulsions, followed by death in a few hours, being alone noticed. Those who rally from the first effects of the poison, seldom recover entirely for several days, and in some cases a vesiculo-pustular eruption has been noticed about the fourth or fifth day.

In chronic poisoning by antimony, of which there are now several criminal cases on record, the symptoms, according to Mayerhofer and Taylor, are frequent vomitings, diarrhœa alternately with constipation; weak, frequent pulse; paleness of the face; loss of muscular power, accompanied often with jaundice and pustular eruptions. Death takes place generally from exhaustion. Of course there may be remissions, and the disease will be modified according to the frequency of the repeated doses.

It is difficult to say what would be a fatal dose of tartar emetic; as much as 200 grains have been taken by an adult, who yet recovered. On the other hand, the smallest fatal dose on record was that of ¾ of a grain, which killed a child, and 2 grains, which killed a man.—(A. TAYLOR.)

Post-mortem Appearances.—Congestion and inflammation of the mucous membrane of the stomach, extending sometimes to the small intestines; very often congestion of the lungs and of the brain, and occasionally a similar condition of the gullet.

Tests.—Tartar emetic, when heated, decrepitates at 380° F., sublimes at 480° F., and chars at 550° F. The metal antimony can be obtained in the form of a metallic bead by heating the salt in the blowpipe flame. Solutions of tartar emetic give an orange-coloured sulphide of antimony when treated with sulphuretted hydrogen, and when solutions of tartar emetic are evaporated in glass, they leave a crystalline deposit; the crystals are in the form of tetrahedra or some modification of the cube.

Antimony in the metallic state may be recovered from organic liquids by precipitating it on slips of copper after the manner of Reinsch (*see* ARSENIC), or it may be detected by adding a little of the fluid to a Marsh's apparatus; if antimony be present, a jet of the gas when inflamed gives a metallic crust, which is distinguished from that of arsenic by its *insolubility* in chloride of lime and its *solubility* in protochloride of tin.

Antidotes.—Tannin, and therefore any vegetable infusion containing tannin, such as infusion of tea, bark, &c.

Adulterations.—*Cream of tartar;* this can be detected by its being less soluble in water than tartar emetic, and by finding that, upon the addition of a small quantity of *carbonate of soda* to a boiling solution of the suspected salt, the precipitated oxide of antimony, which is at first thrown down, becomes redissolved from the presence of the free acid of the acid tartrate of potash. *Iron* is sometimes present; this is easily detected by the addition of a mixture of *ferro* and *ferri cyanide of potassium*, which will, if iron be present, throw down a bulky precipitate of Prussian blue.

Tea—The dried leaves of the Chinese tea plants *Thea Bohea* and *T. viridis*, which, according to the authority of Bentham and Hooker, form a section only of the genus *Camellia*, a tribe of plants with which we are all familiar in this country. *T. viridis* abounds in the northern districts of China, where it is cultivated on the fertile slopes of the hills. *T. Bohea* is cultivated in the southern parts of China, especially about Canton. The tea plant is indigenous in China, Cochin-China, Japan, and the northern parts of the eastern peninsula of India, and has been introduced into British India on the southern declivities of the Himalayas, Java, the Kong Mountains in Western Africa, Brazil, Madeira, and other warm and temperate countries. It is capable of flourishing in all latitudes between 0° and 40°.

Consumption.—The consumption of tea in the United Kingdom in 1853 amounted to 58,000,000 lbs. (25,000 tons). In 1858 the amount imported was as much as 75,432,535 lbs., representing a value of £5,206,618; and in the years 1871–72 the quantities imported were as follows: (1871) 169,898,303 lbs., valued at £11,635,644; (1872) 184,927,148 lbs., valued at £12,933,143.

Varieties of Tea.—Both black and green tea are obtained from each variety of the plant.

Green tea is prepared from young leaves which are roasted over a wood fire within an hour or two after being gathered. The *black tea* leaves, on the other hand, are allowed to lie in heaps for ten or twelve hours after they have been plucked, during which time they undergo a sort of fermentation; after going through certain processes, the leaves are dried slowly over charcoal fires.

The following are the chief varieties of *green* tea: Young Hyson, Gunpowder, Imperial, Hyson, Hyson skin, and Singlo (or Twankay).

Among the *black* teas may be cited the following, also placed in order of excellence: Pekoe, Souchy (caper), Souchong, Campoi, Congou, Oolong, and Bohea.

Lie tea "is so called because it is a spurious article, and not tea at all. It consists of dust of tea leaves, sometimes of foreign leaves and sand made up by means of starch or gum into little masses, which are afterwards painted and coloured so as to resemble either black or green gunpowder. The skill exhibited in the fabrication of this spurious article is very great, and we have met with at least a dozen varieties of it, differing from each other in the size and colouring of the little masses." —(Hassall.)

Brick tea is made from the refuse, &c., and the broken leaves and twigs of tea moulded into form. The Tartars use this tea. They reduce it to powder, and boil it with the alkaline water of the steppes, to which salt and fat have been added; and this decoction, mixed with milk and butter and a little roasted meal, they consume as an article of subsistence. It is also used in the same manner as other tea.

Dr. E. Smith carefully estimated the average weights of a spoonful of different kinds of tea. The results are as follows:—

	Weight of a Spoonful in Grains.	Number of Spoonfuls in a Pound.
Black—		
Oolong	39	179
Congou, inferior quality	52	138
Flowery Pekoe	62	113
Souchong	70	100
Congou, fine	87	80
Green—		
Hyson skin	58	120
Twankay	70	100
Hyson	66	106
Fine Imperial	90	77
Scented Caper	103	68
Fine Gunpowder	123	57

Many teas are artificially scented, it is not here necessary, however, to enter into the process pursued.

Structure of the Tea Leaf.—The border is serrated nearly, but not quite, to the stalk; the primary veins run out from the midrib nearly to the border, and then turn in, so that a distinct space is left between them and the border. The leaf may vary in size, shape, &c., being sometimes broader and sometimes long and narrow.

Figs. 117-120 show the tea plant, the leaves after infusion, and the shape of the various leaves which have been found as adulterants.

The leaf examined by the microscope is found to be made up of epidermic cells, stomata, parenchymatous cells, and hairs.

The epidermic cells vary greatly in size, according to the age and size of the leaf.

The *stomata* are confined principally to the under surface of the leaf; they are small,

TEA PLANT
Fig. 117.

Fig. 118.

numerous, and are formed of two reniform cells. Around the stomata are seen elongated and curved epidermic cells.

Fig. 119.

Fig. 120.

The *hairs* are also found only on the under surface of the leaf; in the young leaf they are very numerous, but when the leaf becomes old, they are often altogether absent. The cells are short, pointed, and undivided. The parenchyma of the leaf is made up of cells which possess no peculiarities.

Chemical Composition of Tea.—Tea contains a nitrogenous alkaloid called theine, quercitannic acid, gallic acid, boheic acid, quercetin, oxalic acid,* volatile oil, chlorophyll, gum, resin, wax, albuminous, woody, and colouring matters, and salts (ash).

The following is Mulder's analysis of tea:—

	Black Tea.	Green Tea.
Essential oil	0·60	0·79
Chlorophyll	1·84	2·22
Wax	0·00	0·28
Resin	3·64	2·22
Gum	7·28	8·56
Tannin	12·88	17·80
Theine	0·46	0·43
Extractive matter	21·36	22·80
Colouring substances	19·19	23·60
Albumen	2·80	3·00
Fibre	28·33	17·80
Ash (mineral substances)	5·24	5·56

The amount of theine is certainly understated, and dried tea probably contains 1·8 per cent. of theine;† 2·6 of albumen; 9·7 of dextrine; 22 of cellulose; 10 to 12 of tannin; 20 of extractives; 5·4 of ash and other matters—as oil, wax, resin. There is from 6 to 10 per cent. of water in black tea, and about 8 per cent. in green tea.

"There is rather more tannic acid, and more theine and ætherial oil, in green than black tea, and less cellulose, otherwise the composition is much the same."—(MULDER.)

The Ash.—The following table contains various analyses of the ash of tea leaves:—

	ZOLLER.	HODGES.		ZOLLER.
	Ash of fine young Himalaya Tea.	Tea from Cachar (indigenous).	Tea from Cachar (hybrid).	Exhausted Tea Leaves.
Potash	39·22	35·200	37·010	7·34
Soda	0·65	4·328	14·435	0·59
Magnesia	6·47	4·396	5·910	11·45
Lime	4·24	8·986	5·533	10·76
Oxide of iron	4·38	2·493	2·463	9·63
Manganous oxide	1·03	1·024	0·800	1·97
Phosphoric acid	14·55	18·030	9·180	25·41
Sulphuric acid	trace	5·040	6·322	trace
Chlorine	0·81	3·513	2·620	trace
Silica and sand	4·35	0·500	1·300	7·57
Charcoal	...	2·900	1·830	...
Carbonic acid	24·30	13·590	12·600	25·28
	100·00	100·00	100·00	100·00

* Hlaawek a Malin, J. für Chem., ci. 109.

† Amount of theine varies from 1·9 to 5·8 per cent.—(BELL.) Its determination, therefore, as a criterion of adulteration is valueless.

The composition of the ash of tea leaves differs considerably, according to the age of the leaf; young leaves are rich in potash and phosphoric acid, and poor in lime and silica, the amount of the latter increasing with the age of the plant.

The insoluble matter of genuine pounded teas was found by Mr. Allen to be as follows:—

	Per cent.
Green Tea.	
Highest amount of insoluble matter	45·6
Lowest ,, ,, ,,	39·0
Average	42·0
Black Tea.	
Highest amount of insoluble matter	53·6
Lowest ,, ,, ,,	46·7
Average of 13 samples	49·0

Preparation.—Water for making tea should neither be too hard nor too soft; and experiment has shown that water of from four to seven degrees of hardness, after being boiled, is best suited for infusions of tea. The infusion of tea should never be boiled, for a decoction of tea is disagreeably bitter on account of the coarse forms of extractive matter it contains, and the aromatic principle being very volatile, it would on boiling become lost. "Experimentally, it is found that infusions of tea are strong enough when they contain ·3 per cent. of extracted matter, so that a moderately-sized cup (5 oz.) should contain about 6·6 grains of extract of tea. This proportion will be obtained when 263 grains of tea (about 5 teaspoonfuls) are infused in a quart of boiling water, and the amount of the several constituents dissolved are about as follows:—

	Grains.
Nitrogenous matters	17·2
Fatty matter	...
Gum, sugar extractive	31·7
Mineral matters	9·1
Total extracted	58·0

Tea on an average yields to boiling water about 22 per cent. of its weight."—(LETHEBY.)

In China, tea is sometimes infused in a teapot, and sometimes in the cup from which it is drunk.

In Japan the tea leaves are ground to powder, and after infusion in a teacup, the mixture is beaten up till it becomes frothy, and then the whole is swallowed. The Chinese drink their tea in a pure state. The Russians take it with lemon-juice, and the Germans often flavour it with rum, cinnamon, or vanilla. In England it may be said to be customary to add milk or cream and sugar.

As an Article of Diet.—Much discussion has taken place regarding the part played by tea in the phenomenon of nutrition. Dr. Edward Smith says that tea *promotes* the chemico-vital functions of the body, for it increases the amount of carbonic acid exhaled from the lungs; that it aids in the transformation of starchy and fatty food; and that it increases the action of the skin. Tea is decidedly a stimulant, and does not produce subsequent depression. It has a restorative action on the nervous system, and the pulse becomes a little quickened. While it increases the activity of the brain, it soothes and stills the vascular system, and hence its use in inflammatory diseases, and as a cure for headache. Its exciting effect upon the nerves makes it useful in counteracting the effects of opium and of fermented liquors, and the stupor sometimes induced by fever.

According to Liebig, there are no drinks which, in their complexity and in the nature of certain constituents, have more resemblance to soup than tea and coffee. It is probable that tea in its composition is closely related to nervous tissue, and that it is suited for the reparation and renovation of an exhausted brain. Experiments made by Lehmann appear to show that both tea and coffee exhilarate the nervous system, and by lessening waste enable it to go further in its nutritive value.

Tea is not *food*, and should not be taken as such. Tea taken three hours after dinner is valuable. This is the moment which corresponds with the completion of digestion, when the food having been conveyed away from the stomach, nothing remains behind but the excess of the acid juices employed in digestion. These acid juices create an uneasy sensation in the stomach, and a call is made for something to relieve this uneasiness. Tea fulfils that object. What its *special* action is, however, we have yet to learn; for it is manifest that it must be the satisfying of some as yet unknown want of the system which induces inhabitants of all lands to resort to vegetable infusions containing the same active principles —namely, astringent matter, volatile oil, and a crystallisable body rich in nitrogen.

The above remarks refer to the moderate use and enjoyment of tea; but there is a large class who drink enormous quantities of this beverage, to the inevitable impairment of their health. Those who thus take it to excess are principally found among the poorer classes. They are pale and anæmic, much given to faintness and depression of spirits, and suffer from flatulence, loss of appetite, and constipation.

Adulterations of Tea.—The great adulteration of tea is without doubt exhausted leaves; but, besides this, foreign leaves,* astringent matters (such as kino and catechu), mineral substances used in facing (such as Prussian blue, indigo, turmeric, China clay, blacklead, sulphate of lime, carbonate of magnesia, &c.), are added; and in a great many inferior teas there is a considerable quantity of sand, generally of a ferruginous nature.

Examination of Tea. — The leaves after soaking should first be spread out on a plate of glass and carefully examined to see if any foreign admixture can be detected; another portion of the tea should be pounded in a mortar, spread out on a clean piece of paper, and a powerful magnet passed over it. Some inferior and adulterated teas treated in this manner at once yield lumps of earthy matter strongly impregnated with iron.

The Chemical Assay of Tea.—The data upon which the analyst bases his opinion as to the genuineness or quality of a sample of tea are—(1) the hygroscopic moisture; (2) the percentage of extract; (3) the percentage and characters of the ash; (4) the tannin; and (5) the total ammonia yielded by the aqueous infusion.

All these different determinations—thanks to the labours of Allen, Wanklyn, Wigner, and others—may be made expeditiously, and are of great value, the limits of variation in good teas being pretty accurately known.

1. *The Hygroscopic Moisture.*—The average hygroscopic moisture of thirty-five teas, consisting of Hysons, Capers, Souchongs, Gunpowder, and others, analysed by Mr. Wigner, was 7·67 per cent. (Chemical News, vol. xxxii. No. 827)—the driest teas being the Hysons and Gunpowders, the moistest the Congous, *e.g.*—

	Per cent.
The maximum amount of moisture found in Hyson	5·68
The minimum do.	4·84
The maximum amount of moisture found in Gunpowder . . .	6·55
The minimum do.	4·94
The maximum amount of moisture found in Congou	10·33
The minimum do.	6·56

The hygroscopic moisture is taken by carefully weighing about 1 gramme of tea, placed in a tared porcelain or platinum dish, which is then submitted to the heat of the water-bath until it ceases to lose weight; the last weighing deducted from the first gives the hygroscopic moisture.

2. *The Extract.*—Ten grammes of tea are weighed out and boiled in a large flask with 500 cubic centimetres of water (the flask is

* "A person at Verdun has discovered a method of imitating Chinese tea, by heating the leaves of the hornbeam, in a new earthen vessel, placed in the midst of boiling water, till they have acquired a brown hue, lighter or deeper at pleasure; they are then scented by being placed in a box together with the root of the Florence iris in powder, during several days, after which they may be used as tea. The imitation is said to be so perfect as to deceive those who are not informed of the preparation."—(Panorama, vol. ix. p. 768. Southey's Commonplace-Book, 2d series, p. 592.)

adapted to a small Liebig's condenser by means of a cork and bent tube), and 50 cubic centimetres are distilled over; these 50 cubic centimetres are returned to the flask, the boiling stopped, and one-tenth of the liquid, or, more accurately, 50·3 grammes of the hot solution evaporated down in a platinum dish and carefully weighed.

The following table gives results both by Peligot and Wanklyn, obtained by different methods :—

	Dried Tea. Percentage of Extract.	Tea in its Natural State. Percentage of Extract.	
Congo	40·9	36·8	Peligot.
Congo bon	45·8	41·5	,,
Cougo bou	45·0	40·7	,,
Bohea	44·4	39·8	,,
Caper	39·3	35·8	,,
Assam	45·4	41·7	,,
The Java	35·2	32·7	,,
Pekoe ordinaire	41·5	38·0	,,
Poudre à canon	51·9	48·5	,,
Poudre à canon	50·2	46·9	,,
Imperial	43·1	39·6	,,
Imperial	47·9	44·0	,,
Hyson	47·7	43·8	,,
Hyson fin	46·9	43·1	,,
Schoulang	45·9	42·3	,,
Hyson skin	43·5	39·8	,,
Toukay	42·2	38·4	,,
Specimens of tea direct from China	41·7	...	Wanklyn.
	40·2	...	,,
	41·2	...	,,
Himalayan tea	38·6	...	,,
Himalayan tea	35·4	...	,,
Indian tea	33·9	...	A. W. Blyth.

The lowest number representing the extract is 31·3; it may therefore be assumed that the extract in good tea should never be less than 30 per cent. The following formula is a useful guide to the analyst in determining the amount of spent leaves added to average tea. E represents the spent leaves, R the percentage of extract :—

$$E = \frac{(32 - R)\,100}{30}$$

A low percentage of extract alone is not conclusive of adulteration; when combined, however, with deficient soluble ash, it is tolerably conclusive.

3. *Ash.*—About a gramme of the tea is carefully weighed in a platinum dish, and heated to visible redness; when the ash ceases to diminish in weight the operation is finished. Its total weight should never exceed 8 per cent., it is mostly from 5 to 6 per cent. The ash after weighing is boiled up in a little water, the liquid filtered, evaporated to dryness, very gently ignited, and weighed; this gives the soluble ash, which is very important, as, if the tea is adulterated with exhausted leaves, there will be a deficiency in soluble ash. If no foreign leaves are present, the following formula will be a guide to the probable amount of adulteration :—

E = the percentage of exhausted leaves.
S = the percentage of soluble ash.

$$\text{Then } E = (6 - 2\,S)\,20.$$

The ash may also be titrated by an acid, and the result expressed as alkalinity due to potash. If reference be made to the first part of this article, it will be noticed in the analyses given of the ash how extremely deficient exhausted leaves are in potash; hence a deficiency in potash would confirm other indications of adulteration.

The portion of the ash insoluble in water should be boiled up with successive portions of hydrochloric acid, and the insoluble residue weighed and expressed as silica.

No practical advantage is obtained by a more complete analysis of the ash. Its total amount, the ratio of soluble to insoluble ash, the amount of silica, and the alkalinity, are all that the analyst requires.

The table on p. 590 is taken, for the most part, from the papers of Mr. Allen (Chemical News, May 1874), and that of Mr. Wigner (*Op. cit.*)

Food analysts consider that the total ash of tea should not exceed 8 per cent. calculated on the dried tea, of which at least 3 per cent. should be soluble in water; but it is the writer's opinion that the analyses quoted sufficiently show that genuine teas very rarely reach even 7 per cent., and that the limit should be at least half a percentage lower—viz., 7·5 per cent.

4. *Tannin, Estimation of.*—The estimation of tannin is very important, as a tea adulterated with or consisting of exhausted leaves will necessarily be deficient in tannin. Deficiency of tannin alone should not be relied upon, but if coupled with deficient soluble ash and deficient extract, the inference that the leaves are either not tea leaves, or that they are exhausted, is tolerably certain. Different processes for the estimation of tannin are given in article TANNIN; that which was elaborated by Mr. Allen is certainly one of the most convenient and best.

"The results obtained by this method agree fairly with those recently obtained by Mr. Bell by the gelatine process, as will be seen from the following figures :—

Tannin in genuine Black Tea.

	By Gelatine (BELL). Per cent.	By Lead (ALLEN). Per cent.
Highest amount	12·00	11·6
Lowest amount	9·50	8·5
Average of 8 samples	10·97	...
Average of 28 samples	...	10·0
[A sample of genuine Indian tea (BLYTH)	11·5]	

"Even after infusion, tea leaves still retain a sensible quantity of tannin, which varies from 1 to 4 per cent., according to the extent of the previous treatment. The usual amount is about 3 per cent. Taking the tannin in fresh tea at 10 per cent., and in exhausted leaves at 2 per cent., the extent to which a sample is adulterated would be found approximately by the following equation, in which E is the percentage of exhausted leaves, and T the percentage of tannin found:—

$$E = \frac{(10 - T)\,100}{8}$$

"Tannin found in genuine specimens of *green tea* varies considerably, 20 per cent. being about the usual amount."—(Chemical News, May 1, 1874.)

	Total Ash Per cent.	Ash Soluble in Water. Per cent.	Ash Soluble in Acid. Per cent.	Silica.	Potash.	Authority.
Average of 17 ordinary teas from original chest, consisting of 2 Indian, 12 Congous, 2 Gunpowders, and 1 Hyson	5·75	3·07	2·25	0·43	1·38	G. W. Wigner.
Maximum . . .	6·03	3·35	2·87	0·76	1·88	,,
Minimum . . .	5·53	2·75	1·99	0·15	1·17	,,
Average of 25 special teas	5·95	3·33	2·09	0·53	1·38	,,
Maximum . . .	7·02	3·88	2·68	1·67	1·96	,,
Minimum . . .	5·17	2·64	1·33	0·04	1·08	,,
Genuine Indian tea .	5·51	2·90	...	...	...	A. Wynter Blyth.
Common tea . . .	5·92	3·55	...	...	...	Wanklyn.
Paraguay tea. . .	6·28	4·22	...	...	...	,,
Average of 7 teas . .	5·75	...	...	...	...	A. S. Wilson.
,, 9 teas . .	5·66	3·00	...	...	...	A. H. Allen.
Horneman's p. black .	5·30	3·50	...	...	...	,,
,, green .	5·60	3·80	...	...	...	,,
Ambrosial black . .	5·60	3·40	...	...	...	,,
Genuine blk., 2s. 6d. lb.	5·60	3·09	...	...	...	,,
,, ,,	5·70	3·28	...	...	...	,,
,, ,,	6·02	3·26	...	...	...	,,
,, ,,	6·34	3·20	...	...	...	,,
,, ,,	6·10	3·96	...	...	...	,,
,, ,,	5·75	3·06	...	...	...	,,
,, 3s. lb. .	5·50	3·55	...	...	...	,,
Broken leaf with stalks	5·40	2·80	...	...	...	,,
Caper (4·8 silica) . .	11·40	1·50	...	...	...	,,
Mixed, dry, exhausted leaves from various teas . . .	4·30	0·52	...	...	...	,,
Coffee leaves . . .	10·32	3·77	...	...	...	,,
Beech	4·52	2·00	...	...	...	Wanklyn.
Bramble . . .	4·53	1·84	...	...	...	,,
Raspberry . . .	7·84	1·72	...	...	...	,,
Hawthorn . . .	8·05	3·78	...	...	...	,,
Willow	9·34	4·16	...	...	...	,,
Plum	9·90	5·66	...	...	...	,,
Elder	10·67	3·19	...	...	...	,,
Gooseberry . . .	13·50	7·83	...	...	...	,,

5. *Ammonia yielded by Aqueous Decoction.*—Mr. Wanklyn has extended the ammonia method used in water-analysis to other organic substances; the nitrogen in tea may in this manner be determined with great ease. Fifty cubic centimetres (= 100 milligrammes of tea) of the same infusion from which the extract has been determined, are heated up to 150° C. with 10 cubic centimetres of solution of potash (strength 10 per cent.), in the apparatus described and figured under AMMONIA. After being kept for a little time at this temperature, 50 cubic centimetres of water are added and more than half distilled over, the *free* ammonia in the water being estimated as described under WATER-ANALYSIS. Next, 50 cubic centimetres of the alkaline permanganate used in water-analysis are added, and distilled, the *albuminoid* ammonia being estimated in the usual way. It will be, however, quite as well and quicker to estimate the total ammonia at once, by omitting the

preliminary potash, and adding at once the alkaline permanganate. Mr. Wanklyn gives the following figures:—

	Milligrammes.
Free ammonia	0·28
Albuminoid	0·43
	0·71

So that the total yield from 100 milligrammes of tea should be about ·71 milligrammes.

The present writer found in a sample of Indian tea sent by Dr. Shortt of Madras, total ammonia, ·81.

Besides the above determinations, it is often useful to estimate the *gum*. The aqueous decoction is evaporated almost to an extract, this extract treated with methylated spirit, filtered, and the gum which is on the filter washed with spirit. The gum is then rinsed off with hot water, evaporated down, and weighed; the weight represents the gum plus saline matter, it is therefore necessary to ignite, and then the loss represents the gum.

Deficient extract, deficient soluble ash, deficient ammonia, and deficient tannin are absolutely conclusive of exhausted leaves. If the ash of tea exceed 8 per cent., the tea is adulterated with sand or other mineral matters. Every tea should yield 30 per cent. of extract, and not more than 8 per cent. of ash, at least 2·5 per cent. being soluble ash.

If it is wished to determine the theine in tea, the *dried* and pounded leaves may be treated first with sulphuric acid slightly diluted; the mixture is then heated on the water-bath for some time, the mass diluted with a little water, and mixed with excess of oxide of lead. The mass is then extracted with alcohol of 81 per cent., the alcoholic extract evaporated to dryness, and the residue extracted with ether, which on evaporation leaves the theine in an impure state. By treatment with animal charcoal and re-crystallisations, it may be obtained pure.

The Sale of Food and Drugs Act contains a special provision as to tea. *See* ADULTERATION, p. 24.

Temperature—*See* CLIMATE, THERMOMETER, &c.

Terebene $(C_{10}H_{16})_{12}$—This is a modification of oil of turpentine; it may be obtained readily by Deville's process, as follows: Any variety of oil of turpentine is mixed by brisk agitation with one-twentieth of its weight of oil of vitriol in a flask or suitable vessel, which is artificially cooled. After remaining at rest for twenty-four hours, it separates into two layers, the lower being black and acid.

The upper layer is decanted, and gently heated; it becomes converted into a mixture of terebene and colophene, and upon distillation terebene passes over in the first portions. It may be obtained pure by rectification from fresh oil of vitriol.

Terebene has powerful disinfectant properties, and would probably repay further study. It is a constituent of one of Dr. Bond's disinfectants. *See* FERRALUM.

Theatres — Sanitary authorities should most decidedly exercise an active surveillance over the hygienic arrangements of the theatres, especially *the ventilation, means of exit in case of fire, the prevention of fire, the actors' dressing-rooms*, and *the latrines.*

The ventilation of public places of amusement is notoriously faulty.

Two houses in London—viz., the "Gaiety" and the "Adelphi"—have done something towards rendering a visit to them less hurtful than it previously was; but at all the others little or nothing has been attempted. At the Adelphi a very large opening has been made in the ceiling immediately above the chandelier, and eight others round it, concealed by ornamental work. Each balcony box is fitted with a large square opening immediately above the door, covered externally with perforated zinc, and the top of the chief entrance to the balcony stalls is fitted with open wirework.

A writer in the "Lancet" (Oct. 26, 1872) says, "The temperature at the time of our visit at 9 P.M., with a tolerably full house, was as follows: Stalls, 78° F. (curtain up); centre of upper circle, 77°; upper gallery, 83°; pit, 85°. These observations were all taken in what appeared to be the warmest situations—*i.e.*, at the back and centre of pit and gallery. The urinals and closets, with both of which the theatre is well provided, are conveniently built, very cool, and exceptionally free from smell." Angus Smith, in his valuable work on "Air and Rain," has given the results of examinations of the air of many of the London theatres as follows:—

	P.M.	Carbonic Acid. Percentage by Volume.
Strand Theatre, gallery .	10	0·1010
Surrey Theatre, boxes .	10·30	0·1110
,, ,, .	12	0·2180
Olympic	11·30	0.0817
,, ...	11·55	0·1014
Victoria Theatre, boxes, .	10	0·1260
Haymarket Theatre, dress circle	11·30	0·0757
Pavilion (Whitechapel) .	10·11	0·1520
City of London . .	11·15	0·2520
Standard	11	0·3200

This author adds, "We all avoid an atmosphere containing ·1 of carbonic acid in crowded rooms; and the experience of civilised men is, that it is not only odious but unwholesome. When people speak of good ventilation in dwelling-houses, they mean, without knowing it, air with *less* than ·07 of carbonic acid. We must not conclude that because the quantity of carbonic acid is small, the effect is small; the conclusion is rather that minute changes in the amount of this acid are indications of occurrences of the highest importance."

What is required in most theatres is not alone a better system of ventilation, but also greater facilities for exit in case of fire. An ingenious plan for extinguishing fire has been lately applied to a few theatres, as it might well be to all. The arrangement is the connecting of the water and gas pipes in such a way that, by turning a particular tap, water rushes at once into the latter pipes, and gushes from the thousand and one gas-jets used to illuminate the front of the house, which is immediately deluged with water. Such an arrangement as this may prove valuable, but it must be remembered that most theatrical fires have their origin behind, and not in front of, the curtain.

The very last point which the builder of a theatre thinks of is the actors' and actresses' dressing-rooms, and when the edifice is completed, any room, however confined and inappropriate, is considered good enough for this purpose. Two or three tolerably decent apartments are provided for the influential people connected with the establishment, but for the others the dressing-rooms are almost always unhealthy, hot, suffocating, and ill-ventilated.

Theine (*Caffeine*, $C_8H_{10}N_4O_2$, H_2O = 194 + 18)—An alkaloid obtained from tea, and identical with caffeine. It is extracted from tea in the same way as from coffee.

The best gunpowder tea contains fully 6 per cent. of theine. *See* CAFFEINE, COFFEE, TEA, &c.

Theobromine ($C_7H_8N_4O_2$) — This is a peculiar principle discovered by Woskresensky in the seed of the *Theobroma Cacao*. It closely resembles CAFFEINE (*which see*), and can be obtained in a similar manner. It is but sparingly soluble in boiling water, and less so in alcohol or ether. It has a slightly bitter taste. It may be sublimed at a high temperature, part of it undergoing decomposition during the process. It forms crystallisable salts with some of the acids. Theobromine, when dissolved in ammonia and mixed with nitrate of silver, yields a gelatinous precipitate, which, by boiling with a solution of ammonia, becomes converted into a crystalline mass; if this be dried and heated in a sealed tube with anhydrous methyl iodide, iodide of silver is formed, and caffeine produced. —(STRECKER).

Theobromide Silver. Methyl Iodide.

$$\underset{\text{Theobromide Silver}}{C_7H_7AgN_4O_2} + \underset{\text{Methyl Iodide}}{CH_3I} = \underset{\text{Caffeine}}{C_8H_{10}N_4O_2} + AgI.$$

Theobromine appears in the form of a light white crystalline powder.

The chief influence theobromine exercises on the system would appear to be the prevention of waste of tissue. *See* CAFFEINE, COCOA, COFFEE, TEA, &c.

Thermometer—A thermometer is an instrument for measuring temperatures. In 1590 Sanctorio of Padua invented an air thermometer; in 1655 this instrument was improved by the introduction of wider tubes, having bulbs filled with alcohol. Romer also about this time introduced mercury into the construction of the instrument, and starting from the melting-point of ice, divided his tube into degrees representing the 100,000th part of the bulb. Fahrenheit, however, although not the inventor, must be considered the great improver of the thermometer, and practically his instrument is used at the present day with very few modifications.

The best liquids for thermometers are mercury and spirits of wine. Mercury is used for all ordinary temperatures varying from 37° up to near its boiling-point, but below 37° spirit thermometers are most convenient.

Tests of a good Thermometer.—A good thermometer plunged into melting ice indicates 32° F., or 0° C.; if suspended in the steam of boiling water, at a barometric pressure of 760 millimetres, it should indicate 212° F., or 100° C. (if the barometer stand at any other height, the proper correction must be made, every 27 millimetres making a difference of 1° C.); and lastly, the exclusion of air from the instrument should be shown by the mercury falling with a metallic click, and filling the tube when the instrument is inverted. It is also important to ascertain if the degrees are uniform, which may be easily done if it is possible to detach a small cylinder of mercury by a slight jerk, and then make it pass from one portion of the tube to another; if the scale be correctly graduated, the column in every portion will be of the same length.

Division of Temperature Scales.—For the comparison of different themometers, fixed points indicating the same temperature are necessary. Those which have been adopted are two—viz., the temperature at which water boils, and that at which it freezes—the barometric pressure being 760 millimetres (29·9 inches) reduced to 0° C. (32° F.)

The space between these two points has been divided in different ways. Fahrenheit fixed the zero-point at the greatest cold then known to have occurred in Iceland, and the space between the freezing and boiling point he divided into 180; and since his zero-point is 32 of these parts below freezing, the freezing-point of water is 32°, and the boiling-point 212°.

Celsius divided the scale between the two fixed points into 100 parts, the zero being the freezing-point. This instrument is called the *Centigrade* thermometer.

Réaumur has divided his thermometer into 80 parts, the freezing-point being zero.

On the scale of De Lisle the boiling-point of water is indicated 0°, and the freezing-point by 150°.

1. To reduce Centigrade degrees to those of Fahrenheit, multiply them by 9, divide the product by 5, and to the quotient add 32, thus—

$$\frac{\text{Cent.}^\circ \times 9}{5} + 32 = \text{Fahrenheit}^\circ.$$

2. To reduce Fahrenheit's degrees to Centigrade—

$$\frac{\text{Fahr.}^\circ - 32 \times 5}{9} = \text{Centigrade}^\circ.$$

3. To reduce Réaumur's to Fahrenheit's—

$$\frac{\text{Réau.}^\circ \times 9}{4} + 32 = \text{Fahrenheit}^\circ.$$

4. To convert Fahrenheit's to Réaumur's—

$$\frac{\text{Fahr.}^\circ - 32 \times 4}{9} = \text{Réaumur}^\circ.$$

Self-Registering Thermometers. — Thermometers for registering the highest temperature during the day and the lowest during the night have been devised. They are known as *maximum* and *minimum* thermometers.

Maximum Thermometers.—The three varieties most commonly employed are Phillips', Rutherford's, and Negretti and Zambra's.

Phillips' Maximum Thermometer.—A portion of the mercurial column is separated from the bulk of the mercury by an air-bubble. As the temperature rises, the detached portion is pushed upwards; but on the temperature falling, the portion detached remains, whilst the rest of the mercury recedes.

Rutherford's Maximum Thermometer is a thermometer provided with a steel index. The instrument is hung horizontally, and the index adjusted by a magnet.

Negretti and Zambra's Maximum Thermometer.—In this instrument the tube is bent at the part near the bulb, and the bore of the tube is contracted at the angle. It is hung horizontally. With a rising temperature, the column is pushed along the scale; but when the temperature begins to fall, the column of mercury breaks at the angle where the bore is narrowed, thus leaving the mercury in the tube at the highest point to which it has been driven.

Minimum Thermometers.—The best instrument of this class is Rutherford's. Spirit of wine is used, and in it immersed a steel index. It is hung horizontally. As the temperature falls the index is dragged with the fluid, which readily passes it, and leaves it lying at the lowest point when it rises. The mercurial minimum thermometer of Casella is an exceedingly valuable instrument, but its extreme sensitiveness renders it difficult to manage. An attempt has been made to combine the maximum and minimum in one column, but two instruments are found to answer best.

The *minimum* thermometer is read by noting down the degree on the scale at which the end of the index farthest from the bulb is lying. The *maximum* thermometer is read by noting down the degree at which the end of the index next the bulb is lying, if it is Rutherford's maximum; but in the case of the other two maximum thermometers described above, the reading is taken from the point on the scale at which the end of the mercury farthest from the bulb is lying. All observations should be taken without touching the instruments.

A box, called the louvre-boarded box, has been constructed by Mr. Thomas Stevenson for containing thermometers for meteorological purposes. It protects them from the action of the direct and reflected rays of the sun, and at the same time allows them to have the benefit of a free circulation of air.

The thermometers described are those used for meteorological purposes, but there are various others for chemical and scientific uses. One of the most delicate of these is Breguet's metallic thermometer, founded on the unequal expansion of metals. It consists of three strips of gold, platinum, and silver, which are made by means of a rolling-mill into a ribbon. This is then coiled in a spiral form, the silver forming the internal face of the spiral, the platinum the external. One end of the ribbon is fixed, the other is attached to a light needle, free to move round a graduated scale. The degrees are those of the Centigrade, and they are determined by comparison with a standard thermometer.

Mathieson's Differential Thermometer is an extremely useful one for determining the temperature of liquids; but those which are used in laboratories are for the most part ordinary thermometers, with the scale marked on the tube itself.

For the determination of heights by the boiling-point of liquid, a very delicate thermometer, graduated from 80° C. to 100° C., so that each degree occupies a considerable space in the scale, is fitted to a metallic vessel containing water. When an observation is taken the water is boiled up, and the rise of the mercury noted. Such an instrument is called an hypsometer or thermo-barometer.

The ordinary clinical thermometer used so extensively by medical men in the present day, is essentially a maximum thermometer. The index consists of a detached column of mercury; before every observation this must be shaken down to the lower part of the scale.

One of the important meteorological applications of the thermometer is the determination of mean daily temperature. As this is merely the average of that of the entire twenty-four hours, it is evident that the greater the number of the observations the more correct the mean will be; and where, as at Greenwich Observatory, the temperature is recorded every moment by photography, the mean thus obtained is absolute. Such accuracy is seldom attainable by ordinary observers, and the approximate mean may be obtained by taking the mean of the maximum and minimum of the same day.

Mr. Glaisher has published the following list of monthly corrections, which can be applied to bring these means nearer the truth. Subtract from the monthly mean of the maximum and minimum.

	Degrees.
January	0·2
February	0·4
March	1·0
April	1·5
May	1·7
June	1·8
July	1·9
August	1·7
September	1·3
October	1·0
November	0·4
December	0·0

The result is the approximate mean temperature *in this country*.

Other simple formulæ are as follows:—

If three daily observations are taken—at 7 A.M., 2 P.M., and 9 P.M.—let t, t', and t'' denote these hours respectively, then—

$$\frac{t + t' + 2t''}{4} = \text{mean of day.}$$

If the hours are 8 A.M., 3 P.M., and 10 P.M., then $$\frac{7t + 7t' + 10t''}{24} = \text{mean of day.}$$

Or take the mean of the maximum and minimum and call it t; if a single observation (t') is made, then $$\frac{2t + t'}{3}$$

If two observations (t' and t'') are taken besides the maximum and minimum, the rule is $$\frac{2t + t' + t''}{4}$$

The hours which come nearest the mean are the following: 9 A.M. and 9 P.M., 10 A.M. and 10 P.M., 3 A.M. and 3 P.M., and 4 A.M. and 4 P.M. The mean of four hours at equal intervals gives a result still nearer the true mean. The nearest approach to the mean annual temperature is given by the mean of the month of October.

Thyme—Oil of thyme possesses some slight antiseptic properties.

Tobacco—The prepared leaf of *Nicotina Tabacum* (Linn.), or other species of the same genus; it belongs to the family of *Solanaceæ*, which includes, amongst other medicinal plants, hyoscyamus, belladonna, and stramonium. From time immemorial the tobacco plant has been cultivated by the natives of Orinoco, but it was not until after the discovery of America that this weed was introduced into Europe.

Hermaudez de Toledo brought tobacco into Spain and Portugal, and Joan Nicot in 1559 conferred a like benefit on France. On the return of Sir Francis Drake with the colonists from Virginia in 1586, the practice of smoking was introduced into England.

The name *tobacco* was given to this herb by the Spaniards, because it was first seen by them at Tabasco, or Tabaco, a province of Yucatan in Mexico; and the generic appellation of *nicotina* is evidently derived from Nicot.

Structure of the Leaf.—Most of the tobacco leaves of commerce—including the American, German, and Dutch—are without stalks, being attached to the stem by the midrib or large central vein; and the margins of all tobacco leaves are *entire*—that is, even and unbroken. The lamina of the leaf is composed chiefly of cellular tissue, with veins of woody fibre and vessels, the whole being plentifully clothed with glandular hairs. A character which tobacco leaf possesses, in common with stramonium and hyoscyamus, is that sections of the veins and midribs have a horse-shoe shape; hence a knowledge of this fact may be frequently applied in the detection of foreign leaves.

Composition of Tobacco.—The following are some of the principal analyses which have been made of tobacco:—

Fresh Leaves of Tobacco (Posselt and Reinmanns).

Nicotina	0·060
Concrete volatile oil	0·010
Bitter extractive	2·870
Gum with malate of lime	1·740
Chlorophyll	0·267
Albumen and gluten	1·308
Malic acid	0·510
Lignin and a trace of starch	4·969
Salts (sulphate, nitrate, and malate of potash, chloride of potassium, phosphate and malate of lime, and malate of ammonia)	0·734
Silica	0·088
Water	88·280
	100·836

For the estimation of nicotina in dried tobacco, Schloesing has given the following process: Two drachms of tobacco are to be exhausted by ammoniacal ether in a continuous distillatory apparatus, the ammoniacal gas is to be expelled from the nicotina solution by boiling, and after the evaporation of the ether the amount of nicotina is to be estimated by the quantity of diluted sulphuric acid of known strength required to neutralise it.

The following tables were drawn up by Dr. Letheby, and they exhibit the composition of many of the more common tobaccoes met with in commerce; the analyses were performed upon *unmanufactured* tobacco:—

TABLE I.—Showing the General Composition of Six Samples of Leaf Tobacco as Imported.

	Havana.	Virginia.	Maryland.	Kentucky.	Turkey.	German.
Hygrometric moisture	12·0	11·4	13·4	13·2	12·4	10·8
Extractive soluble in cold water	43·2	40·8	60·0	48·4	58·6	49·0
Extractive soluble in boiling water	4·0	2·6	4·4	2·4	2·0	3·0
Ligneous matter and insoluble salts	40·8	45·2	22·2	36·0	27·0	37·2
	100·0	100·0	100·0	100·0	100·0	100·0

TABLE II.—Showing General Composition of Extractive taken up by Ammoniacal Ether.

	Havana.	Virginia.	Maryland.	Kentucky.	Turkey.	German.
Hygrometric moisture	12·0	11·4	13·4	13·2	12·4	10·8
Chlorophyll and fat	5·7	2·2	2·7	1·1	2·0	3·6
Nicotine	1·5	3·2	2·1	2·7	1·2	2·0
Total per cent. soluble in ether	19·2	16·8	18·2	17·0	15·6	16·4

TABLE III.—Showing Composition of the Cold and Hot Aqueous Extractive.

	Havana.	Virginia.	Maryland.	Kentucky.	Turkey.	German.
Sugar	0·1	0·03	0·4	traces	3·6	none
Gum	7·6	8·82	10·1	7·6	7·4	7·8
Acids (chiefly malic and colouring matter	4·4	6·58	11·9	3·4	3·4	2·2
Starch	4·0	2·60	4·4	2·4	2·0	3·0
Colouring matter	31·1	25·37	37·6	37·4	44·2	39·0
	47·2	43·40	64·4	50·8	60·6	52·0

TABLE IV.—COMPOSITION of ASH in 100 Parts.

	Havana.	Virginia.	Maryland.	Kentucky.	Turkey.	German
Carbonate of potash	0·5	2·0	4·9	4·25	3·0	4·1
Chloride of potash and a little soda	3·0	0·6	0·4	0·25	0·1	0·6
Sulphate of potash	2·7	2·0	1·1	1·50	0·9	1·3
Carbonate of lime	7·4	5·2	5·8	4·40	3·0	7·0
Carbonate of magnesia	2·9	2·5	2·6	1·60	1·0	3·3
Phosphate of lime	1·6	1·9	2·1	2·40	1·8	2·9
Phosphate of iron and alumina	traces	traces	traces	traces	traces	traces
Silica (chiefly sand)	0·5	7·4	2·3	0·60	0·8	3·4
Amount per cent. of ash	18·6	21·6	19·2	15·00	10·6	22·6

TABLE V.—COMPOSITION of TOBACCO STALK in 100 Parts.

	Havana.	Virginia.
Carbonate of potash	5·2	4·9
Chloride of potassium	0·5	1·5
Sulphate of potash	0·6	0·8
Earthy carbonates	7·0	8·4
Alkaline phosphates	2·6	2·3
Earthy phosphates	2·1	1·4
Iron and alumina	traces	traces
Silica	0·8	0·4
Per cent. of ash	18·8	19·7

Drs. Vohl and Eulenberg have recently (Vrtljhrsschr. f. gerichtl. Med., xiv. p. 249) made some careful and elaborate analyses both of tobacco and tobacco smoke.*

They found that commercial tobacco for *smoking* purposes invariably contained nicotine, amounting generally to 4 per cent. or more, but that tobacco manufactured for *chewing* purposes, and snuff, contained a minute trace only of this alkaloid. The gaseous products given off during the smoking of good tobacco were found to be oxygen, nitrogen, marsh gas, carbonic oxide, sulphuretted hydrogen, and hydrocyanic acid, and sometimes sulphocyanic acid (produced at a later stage by the action of sulphuretted hydrogen on hydrocyanic acid). The acid and non-basic products formed are formic, acetic, motacetic, butyric, valeric, and carbolic acids; creosote, and perhaps caprylic and succinic acids also. A solid hydrocarbon ($C_{19}H_{18}$) and a liquid hydrocarbon of the benzole series were also found. *No nicotine could be detected*, and thus the experiments of Zeise are confirmed.

The basic products of the distillate, besides ammonia, nearly all belonged to the picoline or pyridine series, well known to be produced during the destructive distillation of wood and many other vegetable products. The following were found and identified by their analysis, and the analysis of their platinum salts, and by the determination of their respective boiling-points: Pyridine (C_5H_5N), picoline (C_6H_7N), lutidine (C_7H_9N), collidine ($C_8H_{11}N$). In smaller amount—parvoline ($C_9H_{13}N$), coridine ($C_{10}H_{15}N$), rubidine ($C_{11}H_{17}N$), and others of higher boiling-points, such as viridine ($C_{12}H_{19}N$). Methylamine was not found, and ethylamine in very small quantity only. It would appear, from experiments made on pigeons, &c., by Drs. Vohl and Eulenberg, that the effects of tobacco smoking must be referred to pyridine bases, and not to nicotine. Pyridine bases are among the products of the distillation of opium, and these gentlemen are inclined to attribute the effects produced by smoking this drug not to morphia, but to the picoline series of alkaloids.

Effects of Tobacco Smoking.—M. Decroix recently published in the "Bulletin de l'Association Française contre l'Abus du Tabac et des Boissons Alcoholiques" a paper in which he enumerates no less than sixteen diseases—the list commencing with cancer of the tongue and ending with idiocy and premature old age—as resulting from the use of tobacco. Whether there is any foundation for this theory we leave our medical readers to decide. A fact, however, which goes far to show the error of so extreme a view may be deduced from the careful observations of Thackrah, Parent-Duchâtelet, and D'Arcet. We learn from them that workers in tobacco manufactories—men who are usually great smokers—are exceptionally healthy, and suffer less from contagious diseases than other workers whose hygienic conditions are similar. Looking impartially at the little reliable evidence we have on the effects produced by tobacco smoking, we may conclude that juvenile smoking is in *all* cases, and under any circumstances, bad, the effects produced being tobacco amaurosis, impaired eyesight, thinning of the hair, and other symptoms of excessive draughts on the trophic nerve centres; that to all consti-

* Dr. Emil Heubel's experiments show different results. *See* NICOTINA.

tutions it is hurtful in excess, and to many pernicious in any quantity however small, inducing dyspepsia, muscular tremors, and nervous palpitation; that it is in many instances certainly a *selfish* indulgence, and one likely to produce habits of dreamy, listless indolence. But that, on the other hand, to the poor man living and working hard, to the soldier ill-fed during a campaign, to the literary man, the artist, and others whose occupations demand great mental effort (more especially if the individual possesses a highly excitable, nervous organisation), tobacco is useful, soothing, and comforting. That tobacco in moderation is a brain-destroying agent is sufficiently disproved by the fact that many of our most eminent writers have been votaries of the pipe, and some of the most acute statesmen confirmed smokers.

Tobacco in large doses, either in the form of powder or infusion, acts as a violent poison; the symptoms are faintness, nausea, vomiting, giddiness, delirium, loss of power in the limbs, general relaxation of the muscular system, trembling, complete prostration of strength, coldness of the surface, with cold, clammy perspiration, convulsive movements, paralysis, and death.—(TAYLOR.)

Dr. Namias relates an instance of a smuggler being poisoned by reason of his having covered his skin with tobacco leaves with a view to defrauding the revenue. The leaves, moistened by the perspiration, produced all the effects of poisoning.

A curious case is reported by Mr. Morgan in "Public Health," No. 32, vol. iii., in which an eighth of a pound of tobacco (shag), placed either by accident or design in a shallow well, poisoned three people who drank the water—viz., a man, aged fifty-five; his nephew, aged four; and a girl, aged six. The whole three exhibited the most violent and marked symptoms, and one of them, the nephew, died in convulsions evidently produced by tobacco.

Notwithstanding that tobacco is a substance so easily accessible, it does not appear often to have been criminally employed, though Taylor believes that probably it is more extensively used to aid the purposes of robbers than is commonly believed, and that there is reason to suppose that porter and other liquors sold in brothels are sometimes drugged either with tobacco, or with snuff prepared from it. The powdered leaves of Indian tobacco (*Lobelia inflata*) contain an acrid principle which is capable of producing poisonous effects on the brain and spinal marrow, attended with irritation of the stomach and bowels.

According to German physiologists, tobacco affects the blood corpuscles in the following manner: They lose their round shape, and become oval and irregular at their edges; while instead of naturally attracting each other, and running together in *rouleaux*, they cohere closely or lie scattered on the field of the microscope. For tests, &c., *see* NICOTINA.

Adulterations.—According to the evidence of Mr. George Phillips, given before the Committee on Adulteration, in *cut tobacco*, liquorice, gum catechu, salt, saltpetre and various nitrates, yellow ochre, Epsom salts, Glauber salts, green copperas, red sandstone, wheat, oatmeal, malt-combings, chicory, and the following leaves—coltsfoot, rhubarb, chicory, endive, oak, and elm—have been found; in *fancy tobacco*, lavender and a wort called magwort have been detected; and in *roll tobacco*, rhubarb, endive, and dock leaves, sugar, liquorice, and a dye made of logwood and sulphate of iron, have been met with. The more common adulterations, however, are water, gum,* saccharine matter, and salts of various kinds. The water may be readily detected, and the sugar estimated in the usual way. It must be remembered that tobacco contains *all* these substances, and in variable quantities; and hence, unless they are present in large excess, the analyst would not be prepared to state that their presence indicated adulteration. Adulteration by means of foreign leaves is, we believe, rare in this country; but in cases where such fraudulent substitution is suspected, the analyst should make himself thoroughly acquainted with the structure of the leaves we have mentioned, and the appearance which they present beneath the microscope. Any salts added may be detected in the ash; the tests are given under their respective headings.

Cigars sold at fairs, reviews, in the streets, &c., sometimes consist of little else than paper and hay; their composition is, however, so apparent, that none but the most inexperienced would be deceived by them, and since they are usually bought by boys, it is perhaps an advantage that they are not composed of anything stronger.

Cigars are often steeped in various saccharine and saline infusions, whereby their weight is increased, and a tobacconist was recently prosecuted for selling cigarettes containing *half* their weight of *crude* sand.

The ordinary adulterations of *snuff* are starches of various kinds, pea-meal, bran, sawdust, malt rootlets, fustic, oxides of iron (for tests, *see* IRON) and lead (for tests, *see*

* See a recent prosecution instituted by the Inland Revenue, detailed in the "Sanitary Record," No. 81, vol. iv. 1876. The Government chemists assert that in a concentrated aqueous extract of tobacco acidulated with HCl, the addition of alcohol does not precipitate tobacco gum; but if gum arabic is present, arabin is immediately thrown down.

LEAD), and ground glass, and according to Mr. Prescott (*see* his valuable work, "Strong Drink and Tobacco Smoke," London, 1869), the acorn cup of the Valonia oak, growing on the shores of the Mediterranean, which is imported for the benefit of tanners.

Most of these adulterations may be detected by examining the powder with the microscope, and by tests already given.

Consumption.—In France the Government have the monopoly of tobacco, and in 1867 we learn that the imperial manufactories sold no less than 248,652,000 francs' (£10,360,500) worth of tobacco, and that the net profit which accrued to the revenue from this sale was 177,752,435 francs (£7,406,351, 9s. 2d.)

The following statement exhibits the amount and value of the tobacco imported into this country during the years 1870–72:—

		Lbs.	Valued at
1870	Manufactured cigars and snuff	3,235,215	£488,913
	Unmanufactured	45,557,887	1,680,140
1871	Manufactured cigars and snuff	3,852,237	862,236
	Unmanufactured	73,060,305	2,462,670
1872	Manufactured cigars and snuff	3,667,585	1,145,150
	Unmanufactured	45,549,700	1,563,882

Tortoise, Land—The land tortoise is eaten by the inhabitants of Italy and the Levant, by the natives of the Amazon, South Africa, India, and by the North American Indians. Payen considers its flesh a wholesome food, and the late Dr. Livingstone found it an agreeable meat.

Trades, Injurious—There are a variety of trades the exercise of which influences greatly the health of the workmen. Among these influences we do not, of course, include such as are in no degree connected with the nature of the employment—as, for instance, overcrowding in workshops, impure air from defective ventilation, draughty and damp rooms, &c. But there are hurtful conditions directly arising from the nature of certain avocations which may be traced usually to one of two causes (or to both combined)—viz., *dust* and *gases*, or *volatile emanations.*

Dust.—The diseases to which dust in the arts gives rise are, principally and primarily, chest affections. Dr. Hirt gives the following instructive table showing the relative frequency of phthisis in dusty trades (Die Krankheiten der Arbeiter, Leipzig, 1873) :—

RELATIVE FREQUENCY of PHTHISIS amongst Workmen working in Dusty Trades.

In 100 Patients.	Suffering from Phthisis.
1. *Metallic Dust.*	
Needlemakers	69·6
Filemakers	62·9
Lithographers	48·5
Cullender-makers	42·1
Grinders	40·4
Moulders	36·9
Watchmakers	36·5
Typefounders	34·9
Engravers	26·3
Dyers	25·0
Varnishers	25·0
Painters	24·5
Printers	21·6
Beltmakers	19·7
Tinmen	14·1
Pinmakers	12·5
Cutlers	12·2
Locksmiths	11·5
Farriers	10·7
Workers in copper	9·4
Workers in brass	6·0
2. *Mineral Dust.*	
Flintcutters	80·0
Grindstone-makers	40·0
Stonecutters	36·4
Plasterers	19·0
Porcelain-workers	16·0
Potters	14·7
Carpenters	14·4
Masons	12·9
Diamond-workers	9·0
Cement-workers	8·10
3. *Vegetable Dust.*	
Cigar-workers	36·9
Weavers	25·0
Ropemakers	18·9
Joiners	14·6
Coachmakers	12·5
Pastrycooks	11·6
Millers	10·9
Bakers	7·0
Chimney-sweeps	6·5
Charcoal-burners	2·0
Miners	0·8
4. *Animal Dust.*	
Brushmakers	49·1
Hairdressers	82·1
Upholsterers	25·9
Skinners	23·2
Turners	16·2
Harness-makers	12·8
Button-makers	15·0
Hatters	15·5
Clothmakers	10·0
5. *Mixed Dust.*	
Workers in glass	35·0
Glaziers	17·8
Journeymen	15·1
6. *No Dust.*	
Shoemakers	18·7
Brewers	11·2
Coopers	10·1
Glovers	10·0
Tanners	9·2
Butchers	7·0

It thus appears that mineral and metallic dust are the most active, vegetable and animal the least.

Dr. Hirt has given a convenient name to the various lung affections produced by dust—viz., pneumonoconiosis (πνευμων, lung; κονις, dust)—and has divided them into *anthracosis*, *siderosis*, *chalicosis*, *tabacosis.*

Anthracosis was discovered by Pearson in

1817. It is an affection specially distinguished by carbonaceous sputa, and prevalent amongst those working in dust, either of coal or charcoal. It is essentially a fibroid phthisis, brought on by irritation from carbonaceous dust.

Siderosis was first discovered by Zenker. It is a deposit of oxide of iron in the lung, and consequent phthisis. The sputa is frequently red from iron dust.

Chalicosis was first described by Jean Bubbe, and has also been investigated and described by Peacock, Beltz, Foltz, Porcher, and Greenhow. The lungs become diseased by infiltration with a dust which chemical analysis shows to consist mainly of silica.

Tabacosis was first described by Zenker; he found, on examining the bodies of two workmen in a tobacco manufactory, the lungs infiltrated with tobacco dust. When a similar affection comes from inhaling cotton fibres, it has been called *lyssinosis.*

With regard to metallic dust, it is pretty well established that the finer the dust, the more injurious are its effects.

Dr. Hirt gives the following table, showing the affections and mean duration of life among farriers, cutlers, lockmakers, and filecutters :

In 100 Patients.	Suffering from— Phthisis.	Chronic Bronchitis.	Emphysema.	Pneumonia.	Acute Maladies.	Chronic Digestive Maladies.	Rheumatism.	Diseases of Heart.	Mean Duration of Life.	Mortality per cent.
Farriers . .	10·7	9·8	0·5	6·6	37·5	24·2	9·8	0·9	55·1	1·854
Cutlers . .	12·2	12·2	3·7	3·2	35·3	27·1	6·3	2·0	?	2·518
Lockmakers .	11·5	9·2	2·6	5·8	38·2	19·4	10·3	3·0	49·1	1·431
Filecutters .	62·2	17·4	?	12·2	17·6	?	?	?	54·0	1·693

Most of the metallic dust simply acts mechanically, the effects varying in intensity according to the fineness and sharpness of the spiculæ; others act both mechanically and as poisons — for example, copper dust and the fumes to which brasiers, turners, and workers in bronze are exposed to.

Of trades giving rise to mineral dust more or less injurious we may mention diamond-polishers, grindstone-makers, workers in flint, in marble, in granite, in basalt, in mica, in gneiss, in sulphate of baryta, pumice-stone, and hæmatite. All these substances give rise to dusts which have induced various lung affections. According to Peacock, the mean age of the grindstone-makers does not exceed twenty-four years, and they nearly all become phthisical.

Workers in soft stone, in plaster, in chalk, and in clay suffer little from lung affections, perhaps because the particles are soft and large. It appears remarkable that carpenters and masons suffer from similar diseases, and their mortality is the same.

Plasterers, workers in serpentine, slate-quarriers, and workers in graphite are fairly healthy.

When we come to vegetable dusts, the mortality and liability to phthisis diminish.

Thus in 100 patients breathing—	Suffer from Phthisis. Per cent.
Inorganic dust	26·0
Organic dust	17·0
No dust	11·0
Charcoal dust	1·1

That the mortality from phthisis amongst workmen in charcoal is diminished requires farther investigation. At present it would appear that the dust of carbon exercises a preventive influence.

Dr. Hirt gives the mortality of miners as 1·505 per 100; of charcoal-burners as 1·330; and of chimney-sweeps as 2·291.

Workers in tobacco suffer severely at first, and some few are attacked by lung affections. The mean duration of life appears to be from fifty-three to fifty-eight years. — (Annales d'Hygiène, 1874.)

Of all the vegetable dusts, cotton fibre appears most hurtful. There is great irritation of the larynx, anæmia, frequent cough, and expectoration of a sputa containing cotton fibres. The mortality is greatest among the women.

The manufacture of *wadding*, of *linen* and *hempen* stuffs, also gives rise to dust—less injurious, however, than that produced from cotton. The mean duration of life among weavers, according to 336 observations, is 51 to 97. Among those who work in hemp it is still less —viz., from 42 to 45.

The mortality and maladies of workers in wood are given in the table at the top of the next page, and present nothing remarkable.

The dust of chicory and madder does not appear to have any injurious effect; the coloured woods—sandal, campechy, &c. — on the contrary, cause much irritation. Workers in quinine and cinchona barks suffer from an eruption on the skin, with itching and fever.

In 100 Patients.	Suffering from—								Mean Duration of Life.	Mortality per cent
	Phthisis.	Bronchitis.	Emphysema.	Pneumonia.	Acute Diseases.	Diseases of the Digestive Organs.	Rheumatism.	Heart Disease.		
Joiners	14·6	10·1	3·9	6·0	34·0	18·4	10·4	2·9	49·8	1·89
Carpenters . . .	14·4	0·5	0·9	0·9	29·2	14·4	17·4	4·3	55·7	..
Wheelwrights . .	12·5	0·2	1·3	5·2	11·6	18·7	9·2	1·3	...	

In the preparation of the two mushrooms *Boletus ignarius* and *fomentarius*, the spores affect the mucous membranes of the eyes and nose, and produce epistaxis, ophthalmia, headache, and other ailments.

The dust of corn, wheat, barley, &c., when in great quantity, produces bronchitic and emphysematous affections.

The most frequent disease among millers is pneumonia—viz., 20·3 out of every 100 patients. Their mean duration of life is forty-five years; mortality, 1·726 per cent. Bakers and pastrycooks do not suffer from chest diseases so much as millers; but, on the other hand, the irregular hours produce other diseases, especially of the digestive and nervous organs.

In 100 Patients.	Bakers. Per cent.	Millers. Per cent.
Phthisis	7·0	10·9
Emphysema . . .	1·9	1·5
Bronchitis . . .	10·9	7.3
Pneumonia . . .	8·4	20·3
	28·2	50·0

In the weaving of wool for cloth, some of the workmen become subject to a particular vesicular eruption, which causes great irritation, and frequently ulcerates; others, if engaged for a long time in cutting the thread, suffer from a disease of the palm of the hand. Their mean duration of life is from fifty-seven to fifty-nine years; mortality, 1·5 per 100.

The relative frequency of chest diseases of various trades inhaling other animal dust is shown in the following table:—

In 100 Patients.	Suffering from—								Mean Duration of Life.	Mortality per cent
	Phthisis.	Bronchitis.	Emphysema.	Acute Diseases.	Diseases of the Digestive Organs.	Rheumatism.	Heart Disease.	Pneumonia.		
Brushmakers .	49·1	28·0	3·4	12·2	3·7	...	...	7·0	?	1·603
Hairdressers .	32·1	47·8	2·5	25·4	14·6	...	...	10·7	57·9	2·390 (Hairdressers, Saddlers, Upholsterers, Farriers)
Saddlers . . .	12·8	7·5	2·5	40·1	22·6	7·6	1·9	5·0	53·5	
Upholsterers .	25·9	11·7	2·7	24·9	27·7	4·0	...	10·3	...	
Farriers . . .	23·2	10·7	4·7	23·3	10·9	12·6	2·5	8·1	50·5	
Hatters . . .	13·5	6·7	1·0	53·3	28·7	5·5	...	5·6	51·6	2·921

Women engaged in sorting feathers suffer considerably from inhalation of dust. Bone-dust does not appear very injurious, for workmen in the grinding of bones are fairly healthy.

Of mixed dust, one of the most dangerous is that which the artisan employed in cutting and polishing glass breathes. Diseases of the chest prevail amongst them in the large proportion of 80 per cent. The mean duration of life of the polishers does not exceed forty-two years. Ragpickers are not alone exposed to the mixed dust from the rags, but also to contagion. Papermakers are exposed to similar dust, at all events in the preliminary operations. The mortality is 1·20 per hundred.

Gases and Volatile Emanations.—With regard to gases, it appears certain, from the researches of Baiviston, Lombard, and others, that some produce phthisis, more especially the irrespirable gases, such as chlorine, sulphurous vapours, nitrous acid, vapours of lime, turpentine, &c. Others, especially the toxic, have no influence in this way, for they are absorbed by the blood and influence the whole economy. To the latter class belong carbonic oxide, carbonic acid, sulphuric anhydride, and carbonic disulphide.

In the manufacture of straw hats tho workpeople are exposed to emanations of sulphurous acid, which cause anæmia, cough, sneezing, and salivation. In the making of matches with common phosphorus, very deleterious fumes are given off, causing caries of the jaw. *See* PHOSPHORUS.

Jewellers in various operations—in the quartation, refining, &c., of gold or silver—are exposed to nitrous acid vapours. Phthisis prevails among them in the proportion of 18·6, pneumonia in the proportion of 8·4 for every 100 sick. Their mean duration of life is fifty-three years.

Gilders are more unhealthy than jewellers, probably from breathing mercurial fumes. Their mean duration of life does not exceed forty-four years.

Bleachers aro exposed to chlorine gas, alkaline vapours, smoke, and humidity; they are not healthy. Their mean duration of life is fifty-eight years.

Engine-drivers are exposed to unequal heat and continual commotion; they often breathe an impure atmosphere, especially in such places as the Metropolitan Railway, and suffer considerably from rheumatism, disorders of the digestion, &c. The mean duration of the drivers of locomotives on the Friborg-Breslau line is only thirty-five years.—(HIRT.) Those employed in tho engine-rooms of steamboats have a mean duration of life of fifty-seven years.—(LUBSTORFF.)

The nightmen and those engaged in sewers are sometimes overpowered by sulphuretted hydrogen and other noxious vapours; they also suffer much from disorders of digestion and other ailments, but we have no trustworthy statistics with regard to the prevalence of fever amongst them. According to Hirt, their average duration of life is from fifty-five to sixty years, so that it cannot bo extremely prejudicial.

Tanners, curriers, leathor-dressers, catgut-makers, soap and candle makers, and butchers are exposed to putrid emanations, without, however, any sensible effect. The following table gives the relative frequency of diseases in some of the classes mentioned :—

In 100 Patients.	Suffering from—								Mean Duration of Life.	Mortality per cent.
	Tubercle.	Chronic Bronchitis.	Emphysema.	Pneumonia.	Acute Diseases.	Diseases of the Digestive Organs.	Rheumatism.	Heart Disease.		
Tanners	9·2	7·4	7·4	7·4	31·9	12·9	16·8	...	61·2	1·847
Catgut-makers . .	...	...	...	...	...	...	...	...	60·62	1·200
Butchers	7·9	6·3	1·1	9·9	42·2	17·6	13·3	0·7	56·5	2·433
Soapmakers . . .	9·3	18·0	5·3	8·9	37·5	14·5	5·3	...	61·3	1·138

Workers exposed to zinc fumes are not unfrequently seized with symptoms of fever, which at the end of three or six hours terminates by a profuse sweat and a long-continued sleep.

In the grinding of oleaginous grains very disagreeable vapours are given out, but they have littlo influence on tho health. According to Dr. Hirt, only 3 per cent. of patients following this employment suffer from phthisis.

A large number of workmen in the arts are exposed to the vapours of turpentine—*e.g.*, painters, varnishers, and others. The characteristic odour of violets can often be detected in the urine of these men, showing that the turpentine has been absorbed. They frequently suffer from colic and derangement of the digestive organs.

In the preparation of caoutchouc, especially in its vulcanisation, there are large quantities of vapour given forth, particularly carbonic disulphide; great care is, however, taken in the ventilation of tho works, and poisoning is rare. The mean duration of life of caoutchouc-workers is about fifty-seven years; mortality, 1·393 per cent.

The tarry matter given out in the manufacture of paraffine is not very injurious, but eruptions of the skin are common among the workmen. Their mean duration of life is from sixty to sixty-two years.

In order to prevent the injurious effects of dust upon workmen engaged in such trades as dry grinding, &c., artificial ventilation inducing strong currents of air is absolutely necessary; and as in these particular trades there is always steam-power, some method either of propelling or extracting air is easily applied. But many of the cases require special treatment, especially with regard to noxious gases and vapours; for example, ammonia in small quantities prevents the bad effects of working in nitrate of silver, and saucers of turpentine distributed about a room greatly mitigate the vapours of common phosphorus. Chemical means of this kind should, however, be only considered as accessory to good ventilation.

For observations on miners, *see* MINES. *See also* PHOSPHORUS, &c.

It is absolutely certain that the odours from bone manufactories and tanyards, and a great many other very offensive trades, cause no injury whatever to the health of either those engaged in them or of those living in the vicinity; such odours are, nevertheless, nuisances of a public character.

Trades, Offensive—The general supervision of trades is expressly cast upon *urban* sanitary authorities by the enactments given at the end of this article.

The sections of the Public Health Act relative to the establishment and to the regulation of trades must be interpreted by sanitary authorities according to the spirit which evidently actuates the law on this point, and that is, not to interfere or control manufacturing industry, on which the wealth of England depends, unnecessarily; but, on the other hand, where there is evident and *considerable* public annoyance and injury, to take action at once, as authorised by the statutes.

As the initiation of proceedings will in nine cases out of ten be taken on the opinion or advice of the medical officer of health, it is absolutely necessary for such an officer to practically acquaint himself with the details of the different manufacturing industries in his district. These are always best studied in the building itself; for though printed descriptions will give a good idea of the general principles on which an industry is carried out, the details are far more easily learned by witnessing the different processes in operation.

The principal ways by which a trade becomes a nuisance are storage of offensive materials, the escape of volatile gases or emanations into the atmosphere, and the improper disposal of fixed refuse, whether liquid or solid.

As to the storage of offensive matters—such as raw hides, bones, hoofs, &c.—providing the sheds or storage-places are properly constructed, and the substances are conveyed from the storage-houses to the manufactory in closed air-tight boxes, carts, or other receptacles, offence is hardly possible; but if there is a nuisance from neglect of any of these precautions, there can be no excuse on the part of the manufacturer, and he should be made to abate the nuisance immediately.

Nuisances and injuries from the escape of volatile gases or emanations into the atmosphere, may be, for the sake of convenience, divided into—(1) organic vapours; (2) gases partly organic and partly of definite constitution; (3) acid gases.

1. By the term organic vapours is meant gases the greater portion of which are composed of highly offensive emanations of unknown chemical composition; many of them are probably bodies built upon the type of ammonia. Such vapours are evolved in the melting of fats, in the making of size and glue, of manure, in the boiling of oil, in the boiling of bones, in the dressing of tripe, in the manufacture of glucose, and in many other processes carried out on a considerable scale.

The general remedy for all these cases is to see that the operations are conducted in closed boilers, and that the organic vapours, deprived of steam, are carried into the furnace fire to be there consumed. (This is not always possible; for instance, in the case of making American cloth inflammable spirit is used, hence if the vapours were passed through a fire an explosion might result.)

2. In a great many operations the gases are of a very mixed character; for example, in the distillation of oils and fats, sulphurous acid, acrolein, and other fumes are evolved; and in the manufacture of superphosphate of lime, tetrafluoride of silicon is mixed with organic and acid vapour. In some of these cases, the gases have to pass through one or more chambers, scrubbers, or purifiers before they are permitted to mix with the atmosphere. Thus in the latter case, the gases evolved from the treatment with sulphuric acid, of coprolites, crushed bones, and animal refuse, are led by a shaft first to a chamber where they meet with a spray of water which decomposes the tetrafluoride of silicon, part being precipitated as hydrate of silica, and part dissolved as hydrofluosilicic acid; the gases then pass on to a coke scrubber or condenser, and lastly through a lime purifier.

In the case of the manufacture of coal gas, also, there are very numerous and complex products given off, but no simple means for its purification, and at the same time for the economical separation of its commercial products, can be devised; the mixed gases must pass through numerous condensers, as described in article GAS. In a very large number of operations, sulphuretted hydrogen is given off mixed with various other emanations; and if no gas is more offensive, at the same time there is no gas which is so easily decomposed or absorbed. In practice, either hydrated ferric oxide or slaked lime is found its cheapest and most convenient absorbent—the furnace fire its cheapest destroyer.

3. The acid gases causing nuisance are, for the most part, *muriatic*, *sulphurous*, and *nitrous* acids.

Muriatic acid is evolved from alkali-works, in the extraction of copper from spent pyrites, in the manufacture of bottle-glass from silica and common salt, in the glazing of coarse pottery, and in brick-burning; these fumes can be entirely condensed if led into a high and capacious tower containing coke, over which a stream of cold water is constantly flowing.

Sulphurous acid gas is produced in several manufacturing operations, among which that of sulphuric acid holds the first place.

Nitrous fumes are produced by refiners treating gold and silver alloys with nitric acid, in vitriol-works, by the makers of tin and iron liquors, of nitro-benzole, of picric acid, and in the manufacture of oxalic acid.

Both sulphurous and nitrous fumes may be absorbed by water; the latter, however, is more efficiently treated by passing it through milk of lime.

Dr. Letheby, who has paid some attention to nuisances arising from offensive trades, summarises his recommendations thus:—

"1. All noxious and offensive operations should be carried on, as far as possible, in air-tight chambers, which can be ventilated by means of fans or by the chimney draught.

"2. All condensable and absorbable gases and vapours should be passed through condensers and absorbents best suited for their absorption—as water in spray, and scrubbers charged with water, oil of vitriol, or alkaline solutions.

"3. When necessary these scrubbers should be supplemented with special purifiers, as hydrated oxide of iron, hydrate of lime, &c.

"4. Organic vapours, sulphuretted hydrogen, and empyreumatic matters should be conveyed to the furnace fire and destroyed.

"5. All offensive materials should be brought to the works or carried away from them in properly-constructed carts or tanks, which can be closely covered; and all such material, when stored at the works, should be kept in close tanks in chambers, ventilated when necessary to the scrubbers or furnace fire.

"6. The whole of the operations should always be managed with care and attention to details—there being no neglect of the sound condition of every part of the plant or working apparatus." — (Noxious and Offensive Trades, by Dr. LETHEBY; London, 1875.)

The chief points with regard to the liquid and solid refuse from manufactories are to be found in the article RIVERS, POLLUTION OF, *which see*.

The works in France are arranged in three classes, and as such a system gives a synoptical view of the chief causes of complaint, it is here reproduced.

ARRANGEMENT OF WORKS IN FRANCE, 1867.

First Class.

Names of Manufactures.	Cause of Complaint.
Acid, arsenic (manufacture of). By means of arsenious acid and nitric acid. When the nitrous products are not absorbed	Injurious emanations.
——, hydrochloric (production of). By the decomposition of the chloride of magnesium, of aluminum, &c. When the acid is not condensed	Do.
——, oxalic (manufacture of). By nitric acid. Without destruction of injurious gases . .	Fumes.
——, picric. When the injurious gases are not burnt	Injurious vapours.
——, stearic (manufacture of). By distillation . . .	Smell and danger of fire.
——, sulphuric (manufacture of). By the combustion of sulphur and pyrites	Injurious emanations.
Acids (refining of gold and silver by)	Do.
Aldehyde (manufacture of) . .	Danger of fire.
Archil (manufacture of). In open vessels . . .	Smell.
Blood. Workshops for separating fibrine, albumen, &c. . .	Do.
Depôts of, for the manufacture of Prussian blue and other industrial products .	Do.
Manufacture of powder of, for clarifying wines . . .	Do.
Bone fat (manufacture of) . .	Smell; pollution of waters; danger from fire.
Bones (torrefaction of) for manure. When the gases are not burnt	Smell and danger of fire.
——, fresh (depôts of, on large scale)	Smell; injurious emanations.
Bristles of swine (preparation of). By fermentation . . .	Smell.
Burning of marine plants in permanent establishments . .	Smell and smoke.
Carbonising of animal matters in general	Smell.
Carriage grease	Smell; danger from fire.

Chrysalides (workshop for extracting the silk)	Smell.
Coke (manufacture of).	
In the open air, or in kilns not smoke-consuming .	Smoke and dust.
Cyanide of potassium and Prussian blue (manufacture of).	
By the direct calcining of animal matters with potash .	Smell.
Dogs (infirmaries for) . . .	Smell and noise.
Ether (manufacture and depôts of)	Danger from fire and explosion.
Fat in the naked flame (melting of)	Smell; danger of fire.
—— or thick oil, for the use of chamois leather dressers and curriers (manufacture of) . .	Do. do.
—— varnish (manufacture of) .	Do. do.
Fatty waters (extraction of the oils contained in) for the manufacture of soap and other purposes.	
In open vessels . . .	Do. do.
Felts and patent shades (manufacture of)	Do. do.
Fireworks (manufacture of) . .	Danger from fire and explosion.
Flesh, débris, and offal (depôts of), arising from the slaughter of animals	Smell.
Fulminating mercury (manufacture of)	Danger of fire and explosion.
Glue (manufacture of) . . .	Smell; pollution of water.
Greaves (manufacture of) . .	Smell and danger of fire.
Guano (depôts of).	
When the quantity exceeds 25,000 kilogrammes . .	Smell.
Gut manufactures (working of fresh intestines for all purposes)	Smell; injurious emanations.
Ivory black and animal charcoal (distillation of bones or manufacture of).	
When the gases are not burnt	Smell.
Lignites (incineration of) . .	Smoke; injurious emanations.
Manures (depôts of) from middens.	
Animal remains.	
Not prepared or in uncovered stores	Smell.
—— (manufacture of).	
By means of animal matters .	Do.
Matches (manufacture of).	
With detonating and explosive substances . . .	Danger of explosion and fire.
——, quick (manufacture of).	
With explosive materials .	Do. do.
Menageries	Danger from animals.
Mud and impurities (depôts of), and sewers	Smell.
Nightsoil, desiccated, and other manures from animal matters (manufacture of) . . .	Smell and pollution of water.
Nitrate of iron (manufacture of).	
When the injurious vapours are not absorbed or decomposed	Injurious emanations.
Oil, fish (manufacture of) . .	Smell; danger of fire.
——, neatsfoot (manufacture of).	
With employment of matters in putrefaction . . .	Do. do.
Oils and other fatty bodies extracted from the remains of animal matters (extraction of) . .	Do. do.
—— (mixed, hot, or boiled).	
In open vessels . . .	Do. do.
—— of petroleum and other hydrocarbons (cleaning of tissues, and waste wool by) . . .	Danger of fire.
Oils of petroleum, of schist, and of tar and other hydrocarbons employed for lighting, heating, manufacture of colours and varnishes, the cleaning of cloths, and other purposes.	
Manufacture, distillation, and work on a great scale .	Smell; danger of fire.
Very inflammable substances —that is to say, emitting vapours liable to take fire at a temperature of less than 35° C.	
If the quantity stored is, even temporarily, 1050 litres or more . .	Do. do.
Less inflammable substances —that is to say, emitting vapours liable to take fire at a temperature of 35° C. and above.	
If the quantity stored is, even temporarily, 10,500 litres or more . .	Do. do.
——, red (manufacture of).	
By the extraction of greaves and fatty remnants, at a high temperature . .	Do. do.
——, resinous (manufacture of) .	Do. do.
Olive-oil cakes (preparation of).	
By sulphuret of carbon . .	Danger from fire.
Patent leather (manufacture of) .	Smell and danger of fire.
Pearl ashes.	
With discharge of fumes outside	Smoke and smell.
Phosphorus (manufacture of) .	Danger of fire.
Piggeries	Smell; noise.
Potash, arseniate of (manufacture of).	
By means of saltpetre.	
When the vapours are not absorbed . . .	Injurious emanations.
Powder and fulminating substances (manufacture of) . .	Danger of explosion and fire.
Powders, explosive (manufacture of)	Danger of explosion.
Printing ink (manufacture of) .	Smell; danger of fire.
Pyritous and aluminous earths (roasting of)	Smoke; injurious emanations.
Red, Prussian and English . .	Injurious emanations.
Resins, gallipot and common resin (work on a large scale for melting and purifying) . .	Smell and danger of fire.
Retting in quantity, hemp and flax	Injurious emanations and pollution of water.
Sabots (workshop for smoking).	
By the combustion of the horn or other animal matters, in the towns . . .	Smell and smoke.
Scalding-houses.	
For the industrial preparation of animal remains . .	Smell.
Skinning of animals . . .	Smell; injurious emanations.
Slaughter-houses, public . .	Smell and tainting of water.
Soda, raw, from sea-weed (manufacture of).	
In permanent establishments	Smell and smoke.
Starch-works.	
By fermentation . . .	Smells; injurious emanations, and pollution of water.

Sulphate of ammonia (manufacture of). By distillation of animal matters	Smell.
—— of copper (manufacture of). From roasting pyrites . .	Injurious emanations.
—— of mercury (manufacture of). When the vapours are not absorbed	Do.
—— of soda (manufacture of). By the decomposition of common salt by sulphuric acid, without condensation of the hydrochloric acid . .	Do.
Sulphuret of carbon (manufacture of)	Smell; danger of fire.
—— (manufactures in which they employ on a large scale the) .	Danger of fire.
Sulphurous minerals (roasting of)	Smoke; injurious emanations.
Taffeta and glazed or waxed cloth (manufacture of) . . .	Smell; danger of fire.
Tallow, brown (manufacture of) .	Do. do.
—— candles (melting-houses for). Using naked flame . .	Do. do.
Tarpaulings (manufacture of). By using oil	Danger of fire.
Tars (special processes for the boiling of). From various sources . .	Smell; danger from fire.
—— and vegetable resins (elaboration of). From various sources . .	Do. do.
Tobacco (calcination of the mid-ribs of)	Smell and smoke.
Triperies annexed to the slaughter-houses	Smell and pollution of water.
Turf (charring of). In open vessels . . .	Smell and smoke.

Second Class.

Names of Manufactures.	Cause of Complaint.
Acid, arsenic (manufacture of). By means of arsenious acid and nitric acid. When the nitrous products are absorbed .	Injurious vapours.
——, hydrochloric (production of). By the decomposition of the chloride of magnesium, of aluminum, &c. When the acid is condensed	Accidental emanations.
——, oxalic (manufacture of). By sawdust and potash . .	Vapour.
——, pyroligneous (manufacture of). When the gaseous products are not burnt . . .	Smoke and smell.
——, pyroligneous (purification of)	Smell.
——, stearic (manufacture of). By saponifying . . .	Smell and danger of fire.
Alcohol (rectification of) . .	Danger of fire.
Alkaline chlorides, eau de javelle (manufacture of) . . .	Smell.
Animal charcoal from refineries and sugar-works (revivification of)	Injurious emanations; smell.
Arseniate of potash (manufacture of). By saltpetre. When the vapours are absorbed	Accidental emanations.
Artificial fuel or bricks of coal (manufacture of). With fat resin . . .	Smell; danger of fire.
Asphalts and bitumens (working of). By the naked fire . . .	Do. do.
Baryta (decolorising of sulphate of). By hydrochloric acid in open vessels	Injurious emanations.
Bleaching. Of yarns, of cloths, and of pulp for paper by chlorine . .	Smell; injurious emanations.
Of yarns and woollen fabrics, and silks, by sulphurous acid	Do. do
Bones (torrefication of) for manure	Smell and danger of fire.
——. When the gases are burnt .	Do. do.
Carbonisation of woods. In the open air, in permanent establishment, and otherwise than in the forest .	Smell and smoke.
In close vessels, disengaging into the air the gaseous products of distillation . .	Do. do.
Carpet-beating on a large scale .	Noise and dust.
Chamois leather factories . .	Smell.
Chlorine (manufacture of). On a large scale . . .	Do.
Cocoons. Treatment of coloured cocoons	Pollution of water.
Spinning of cocoons (*see* "Cocoons," Class III.)	
Coke (manufacture of). In smoke-consuming kilns .	Dust.
Cooperage on a large scale. Working on casks impregnated with fatty and putrescent matters . . .	Noise, smell, and smoke.
Crockery (manufacture of). With kilns not smoke-consuming	Smoke.
Currying-works	Smell.
Cyanide of potassium and Prussian blue (manufacture of). By employing matters previously carbonised in close vessels	Do.
Dairies on a large scale, in the towns	Do.
Enamelled earths (manufacture of). With kilns not smoke-consuming	Smoke.
Engines and waggons (workshops for construction of) . . .	Noise; smoke.
Fatty matters (extraction for the manufacture of soap, and other uses of oils contained in). In close vessels . . .	Smell; danger of fire.
Felt, tarred (manufacture of) .	Do. do.
Forges and boiler-works for great works employing machine hammers	Smoke; noise.
Furnaces, blast	Smoke and dust.
Gases for lighting and firing (manufacture of) . . .	Smell.
For the public use . . .	Smell, and danger of fire and explosion.
Glass-works, crystal-works, and manufactures of mirrors. In kilns not smoke-consuming	Smoke, and danger of fire.
Hairs and pigs' bristles (preparation of).	

Without fermentation (*see* also "Bristles by fermentation," Class 1.)	Smell.
Indiarubber (working of).	
Employing essential oils or sulphuret of carbon	Smell; danger of fire.
—— (application of coatings of)	Danger of fire.
Ivory and animal black (distillation of bones or manufacture of).	
When the gases are burnt	Smell.
Laces and cloths of gold and silver (burning on a great scale of), in the towns	Do.
Lamp black (manufacture of).	
By the distillation of oils, tars, bitumens, &c.	Smoke; smell.
Leather, raw, and fresh hides (depôts of)	Smell and dust.
Limekilns.	
Permanent	Smoke; dust.
Manures (depôts of) from middens.	
Animal remains.	
Dried or disinfected, and in covered stores when the quantity exceeds 25,000 kilogrammes	Smell.
Murexide (manufacture of).	
In close vessels, by the reaction of nitric acid, and of the uric acid of guano	Injurious emanations.
Nitro-benzine, aniline, and matters derived from benzole (manufacture of)	Smell, danger of fire, and injurious emanations.
Oil, neatsfoot (manufacture of).	
When the matters employed are not putrefied	Smell.
Oilcloths for packing cloth, tarred cords, tarred papers, pasteboards, and bituminous tubes (manufacture of).	
By hot method	Smell and danger of fire.
Oils (burning).	
When alcohol and essential oils are used	Danger of fire and explosion.
—— (mixing by heat or boiling of).	
In close vessels	Smell and danger of fire.
—— of petroleum, of schist, and of tar, light oils, and other hydrocarbons employed in lighting and heating, and in the manufacture of colours and varnishes, cleaning stuffs, &c.	
Very inflammable substances—that is to say, emitting vapours liable to take fire at a temperature of less than 35° C. (or 95° Fahr.) on approach of a lighted match.	
If the quantity above 150 litres does not reach 1050 litres	Do. do.
Less inflammable substances—that is to say, emitting vapours liable to take fire only at a temperature of 35° C. and above.	
If the quantity stored above 1050 litres does not reach 10,500 litres.	Do. do.
Onions (drying of), in the towns	Smell.
Parchment factories	Do.
Pearl ashes.	
With combustion and condensation of the smoke	Smoke and smell.
Plaster (kilns for).	
Permanent	Smoke and dust.

Porcelain (manufacture of)	Smoke.
Potash (manufacture of).	
By carbonising the residue of molasses	Smoke and smell.
Protochloride, or salt of tin (manufacture of)	Injurious emanations.
Resinous torches (manufacture of)	Smell and danger of fire.
Retting (on a great scale) of hemp and flax.	
By the action of acids, of warm water, and of vapour	Injurious emanations and pollution of water.
Rogne (depôt of brine used for salting)	Smell.
Sal ammoniac and sulphate of ammonia (manufacture of).	
By employing animal matters	Smell; injurious emanations.
——, extracted from the waters of gasworks (special manufacture of)	Smell.
Salt provisions (establishments for) and smoking of fish	Do.
Salted fish (depôts of)	Unpleasant smell.
Sardines (preparation of preserved), in the towns	Smell.
Sausages (manufactures on a great scale of)	Do.
Silk hats or other preparations, by means of a finish (manufacture of)	Danger of fire.
Skins or fur of hares and rabbits (cleaning of)	Smell.
Slaughter-houses	Smell and danger from the animals.
Starch-works.	
By the separation of the gluten, and without fermentation	Pollution of water.
Stripping of flax, hemp, and jute on large scale	Dust and smoke.
Sugar refinery and manufacture	Smoke and smell.
Sulphate of mercury (manufacture of).	
When the vapours are absorbed	Slight emanations.
—— of peroxide of iron (manufacture of).	
By sulphate of protoxide of iron and nitric acid (nitro-sulphate of iron)	Injurious emanations.
—— of soda (manufacture of).	
With complete condensation of the hydrochloric acid	Do.
Sulphur (fusion or distillation of)	Injurious emanations; danger from fire.
Tallow candles (smelting-houses for).	
In the water-bath or by steam	Smell.
Tanneries	Do.
Tarpaulings (manufacture of).	
Without boiling in oil	Danger of fire.
Tars (treatment of) in gas manufactures	Smell and danger of fire.
—— and bituminous fluid matters (depôts of)	Do. do.
Tobacco (manufacture of)	Smoke and dust.
—— pipes (manufacture of).	
With kilns not smoke-consuming	Smoke.
Turf (carbonisation of).	
In close vessels	Smell.
Varnish (manufactures of).	
With spirits of wine	Smell and danger of fire.

Third Class.

Names of Manufactures.	Cause of Complaint.
Acid, nitric	Injurious emanations.
——, oxalic (manufacture of). By nitric acid. With destruction of injurious gases	Accidental fumes.
——, picric. With destruction of injurious gases	Injurious vapours.
——, pyroligneous (manufacture of). When the gaseous products are burned	Smoke and smell.
——, sulphuric (manufacture of). Of Nordhausen, by the decomposition of sulphate of iron	Injurious emanations.
Albumen (manufacture of). From the fresh serum of blood	Smell.
Alcohols other than from wine. Without works for rectification	Pollution of water.
—— (agricultural distillery)	Do.
Ammonia (manufacture on a large scale of). By the decomposition of ammoniacal salts	Smell.
Ammoniacal cochineal (manufacture of)	Do.
Archil (manufacture of). In close vessels, and employing ammonia to the exclusion of urine	Do.
Artificial fuel or bricks of coal (manufacture of). With dry resin	Do.
Asphalts, bitumens, resins, and bituminous solid matters (depôts of)	Smell; danger of fire.
Bacon (workplaces for smoking)	Smell and smoke.
Bark-beaters in the towns	Noise and dust.
Bleaching. Linen threads and tissues, hemp and cotton, by the alkaline chlorides (hypochloride)	Smell; pollution of water.
Breweries	Smell.
Brickworks. With kilns not smoke-consuming	Smoke.
Button-makers and other metal embossers by mechanical means	Noise.
Candles and other articles in wax and stearic acid	Danger of fire.
—— (manufacture of)	Smell; danger of fire.
—— of paraffine and others of mineral origin (moulding of)	Do. do.
Carbonising wood. In close vessels, with combustion of the gaseous products of distillation	Smell and smoke.
Ceruse, or whitelead (manufacture of)	Injurious emanations.
Cheeses (depôts of), in the towns	Smell.
Chloride of lime (manufacture of). In works manufacturing at most 300 kilogrammes per day	Do.
Chromate of potash (manufacture of)	Do.
Coal-washing	Pollution of water.
Cocoons (spinning of). Workshops on a large scale—that is to say, employing at least six winders	Smell; pollution of water.
Coffee (roasting on a large scale of)	Smell and smoke.
Copper (solution of). By acids	Smell; injurious emanations.
Cotton and greased cotton (bleaching waste of)	Pollution of water.
——waste (depôts of). On a large scale, in the towns.	Danger of fire.
Cowhouses. In towns of more than 5000 inhabitants	Smell and drainage of urine.
Distilleries in general; spirits, gin, kirschwasser, absinthe, and other alcoholic liquors	Danger of fire.
Dyeing	Smell and pollution of water.
—— of skins	Smell.
Earthenware (manufacture of). With smoke-consuming kilns.	Accidental smoke.
With kilns not smoke-consuming	Smoke.
Enamel (application of) on metals	Do.
Enamels (manufacturing). With kilns not smoke-consuming	Do.
Enamelled ware (manufacture of). With smoke-consuming kilns	Accidental smoke.
Fattening of fowls in the towns (establishments for)	Smell.
Felt hats (manufacture of)	Smell and dust.
Flints (kilns for calcining)	Smoke.
Founding and rolling of lead, zinc, and copper	Noise; smoke.
Foundries for the second fusion	Smoke.
—— of copper, brass, and bronze	Metallic fumes.
Gases for lighting and heating (manufacture of). For particular use	Smell; danger of fire.
Gasometers for particular uses, not adjoining manufacturing works	Do. do.
Gelatine for food, and gelatines derived from fresh skins and dressing, and fresh hides	Smell.
Gilding and silvering of metals	Injurious emanations.
Glass-works, crystal-works, and manufactories of mirrors. With smoke-consuming kilns	Danger of fire.
Glucose and syrups from fecula (manufacture of)	Smell.
Gold and silver beaters	Noise.
Goldsmiths' waste (treatment of). By lead	Metallic fumes.
Guano (depôts of). For sale by retail	Smell.
Gypsum (kilns for). Only working one month	Smoke and dust.
Herrings (salting of)	Smell.
Hungary leather tanneries	Do.
Leather-dressing establishments	Smell.
Lime-kilns. Not working more than one month in the year	Smoke and dust.
Litharge (manufacture of)	Noxious dust.
Manures (depôts of) from middens. Animal remains. Dried or disinfected, and in covered store, when the quantity is less than 2500 kilogrammes	Smell.

Massicot (manufacture of) . .	Noxious emanations.
Mechanical pounding of drugs .	Noise and dust.
Mills for grinding lime, flints, and puozzolane	Dust.
Mineral charcoal (manufacture of).	
By pounding the residue of distillation of bituminous schists	Smell and dust.
Morocco leather manufactories .	Smell.
Nitrate of iron (manufacture of).	
When the injurious vapours are absorbed or decomposed	Injurious emanations.
Oak bark (mills for) . . .	Noise and dust.
Oilcloths for packing textures, tarred cords, tarred papers, pasteboards, and bituminous tubes (manufacture of).	
By cold method . . .	Smell; danger of fire.
Oils (purification of) . . .	Do. do.
Oil-works and oil-mills . .	Do. do.
Olives (pickling of) . . .	Pollution of water.
Painted cloths (manufacture of) .	Smell.
Paper (manufacture of) . .	Danger of fire.
—— pulp (preparation of).	
By means of straw and other combustible matters . .	Pollution of water.
Pasteboard-makers . . .	Smell.
—— snuff-boxes (manufacture of)	Smell; danger of fire.
Plates and polished metals . .	Do. do.
Perchloride of iron (manufacture of).	
By solution of peroxide of iron	Injurious emanations.
Porcelain (manufacture of).	
With smoke-consuming kilns	Accidental smoke.
Puozzolane, artificial (kilns for) .	Smoke.
Quicksilvering of mirrors . .	Injurious emanations.
Rags (depôts of)	Smell.
Red-lead (manufacture of) . .	Injurious emanations.
—— prussiate of potash . .	Do.
Refrigerating preparations.	
By ammonia	Smell.
By ether, or other similar and combustible liquids . .	Danger of explosion and fire.
Salt of soda (manufacture of).	
With sulphate of soda . .	Smoke; injurious emanations.
Salting and preparation of meats.	Smell.
—— (depôts for), in the towns .	Do.
Scalding-houses.	
For the preparation of parts of animals proper for food .	Do.
Sealing-wax (manufacture of) .	Danger of fire.
Sheepskins (drying of) . . .	Smell and dust.
Soapworks	Smell.
Sponges (washing and drying of) .	Smell; pollution of water.
Starch manufactories . . .	Do. do.
Steel (manufacture of) . . .	Smoke.
Sulphate of iron, alumina, and alum (manufacture of).	
By the washing of roasted pyrites and aluminous earth	Smoke and pollution of water.
—— of protoxide of iron or green copperas (manufacture on a large scale of).	
By the action of sulphuric acid on old iron	Smoke; injurious emanations.
Sulphur (pulverising and sifting of)	Dust; danger of fire.
Thrashing and washing (spacious workshops for) worsteds, hairs, and waste of woollen and silk threads in the towns . . .	Noise and dust.
Thrashing, carding, and bleaching woollens, hairs, and feathers for bedding	Smell and dust.
—— hides (hammer for) . .	Noise and disturbance.
Tileworks.	
With kilns not smoke-consuming	Smoke.
Tinplate (manufacture of) . .	Do.
Tobacco-pipes (manufacture of).	
With smoke-consuming kilns.	Accidental smoke.
Wadding (manufacture of) . .	Dust and danger of fire.
Wash-houses	Pollution of water.
—— for wool	Do.
Whalebone (working) . . .	Unpleasant emanations.
White of zinc (manufacture of).	
By the combustion of the metal	Metallic fumes.
Wire-drawing works . . .	Noise and smoke.
Wood carbon, in the towns (depôts or stores of) . . .	Danger of fire.
Yards for firewood, in the towns .	Injurious emanations; danger of fire.

Any person who, after the passing of the Public Health Act, establishes within the district of an *urban* authority, without their consent in writing, any offensive trade—that is to say, the trade of blood-boiler, or bone-boiler, or fellmonger, or soap-boiler, or tallow-melter, or tripe-boiler, or any other noxious or offensive trade, business, or manufacture—shall be liable to a penalty of £50, or less, in respect of the establishment thereof; and any person carrying on a business so established shall be liable to a penalty of 40s., or less, for every day on which the offence is continued, whether there has or has not been any conviction in respect of the establishment thereof. —(P. H., s. 112.)

Any *urban* authority may from time to time make bylaws with respect to any offensive trades established with their consent, either before or after the passing of the Public Health Act, in order to prevent or diminish the noxious or injurious effects thereof.—(P. H., s. 113.)

Where any candle-house, melting-house, melting-place, or soap-house, or any slaughter-house, or any building or place for boiling offal or blood, or for boiling, burning, or crushing bones, or any manufactory, building, or place used for *any* trade, business, process, or manufacture causing effluvia, is certified to *any urban* authority by their medical officer of health, or by any two legally-qualified medical practitioners, or by any ten inhabitants of the district of such urban authority, to be a nuisance or injurious to the health of any of the inhabitants of the district, such *urban* authority *shall* direct complaint to be made before a justice, who may summon the person by or on whose behalf the trade so complained of is carried on to appear before a court of summary jurisdiction.

The court shall inquire into the complaint, and if it appears to the court that the business carried on by the person complained of is a nuisance, or causes any effluvia which is a nuisance or injurious to the health of the inhabitants of the district, and unless it be shown that such person has used the *best practicable means* for abating such nuisance, or preventing or counteracting such effluvia, the person so offending (being the owner or occupier of the premises, or being a foreman or other person employed by such owner or occupier) shall be liable to a penalty not exceeding £5 nor less than 40s., and on a second and any subsequent conviction to a penalty double the amount of the penalty imposed for the last preceding conviction, but the highest amount of such penalty shall not in any case exceed the sum of £200.

Provided, that the court may suspend its final determination on condition that the person complained of undertakes to adopt, within a reasonable time, such means as the court may deem to be practicable and order to be carried into effect for abating such nuisance, or mitigating or preventing the injurious effects of such effluvia, or if such person gives notice of appeal to the court of quarter sessions in manner provided by the Public Health Act.

Any local authority may, if they think fit, on such certificate as is in this section mentioned, cause to be taken any proceedings in any superior court of law or equity against any person in respect of the matters alleged in such certificate.—(P. H., s. 114.)

Training — The object of training is to render the system capable of undergoing some unusual feat of exertion, and to increase the powers of endurance, and the suppleness and activity of the limbs. The weight of the body is reduced, the muscular strength is augmented, and all superfluous fat and water are removed. In the words of a modern writer on this subject, "A concordant action is established between the heart and blood-vessels, so that the strong action of the heart during exercise is met by a more perfect dilatation of the vessels, and there is no blockage of the flow of blood. In the lungs the blood not only passes more freely, but the amount of oxygen is increased, and the gradual improvement in breathing-power is well seen when horses are watched during training. This reciprocal action of heart and blood-vessels is the most important point in training; the nutrition of nerves and muscular fibres improves from constant action, and the abundant supply of food; the tissue changes are more active, and elimination, especially of carbon, increases. A higher condition of health ensues, and if not carried to excess, 'training' is simply another word for healthy and vigorous living."

These effects are brought about by the combination of three things — (1) exercise, increasing in severity with the strength and endurance of the man in training; (2) food in which meat predominates; and (3) regularity in the hours for sleep, meals, and exercise.

Exercise and regularity of life in inducing a high state of health, require no comment, but the peculiar diet necessary to produce muscular development is a subject of great interest. It appears pretty well proved that carnivorous men can endure great fatigue for a short time better than herbivorous men. For example: "When the Mokololo go on a foray, as they sometimes do, a month distant, many of the subject tribes who accompany them *being grain-eaters* perish from sheer fatigue, while the beef-eaters scorn the idea of ever being tired."—(Livingstone, Zambesi.) And again, Sir Francis Head, in his "Journeys across the Pampas," 1828, p. 51, says, "I had been riding for three or four months, and had lived on beef and water. I found myself in a condition which I can only describe by saying that I felt no exertion would kill me. . . . This will explain the immense distances which people in South America are said to ride, which I am confident could only be done on beef and water."

Professor Haughton, while agreeing that meat is the best diet when we are called upon to exercise sudden bursts of muscular labour continued for short periods, affirms that for long-continued labour it is not so valuable as a farinaceous diet. "It is, however, worthy of remark that the muscular qualities developed by the two kinds of food (flesh and farinaceous) differ considerably from each other. The hunted deer will outrun the leopard in a fair and open chase, because the work supplied to its muscles by the vegetable food is capable of being given out continuously for a long period of time; but in a sudden rush at a near distance, the leopard will infallibly overtake the deer, because its flesh food stores up in the blood a reserve of force capable of being given out instantaneously in the form of exceedingly rapid muscular action. In conformity with this principle, we find among ourselves an instinctive preference given to farinaceous and fatty foods, or to nitrogenous foods, according as our occupations require a steady long-continued slow labour, or the exercise of sudden bursts of muscular labour continued for short periods."—(HAUGHTON, Address at Oxford, 1868.)

In training, the diet is almost exclusively meat, bread, and beer. Beef and mutton are the meats usually taken, and it is important that these be not overcooked. It is not necessary to exclude *all* the fat. Stale bread, potatoes, and a little green vegetable are allowed in conjunction. Pickles, sauces, &c., are to be prohibited, and sweets, pastry, and made dishes avoided. Small quantities only of fluids should be taken, and these sipped slowly to allow of absorption and thus satisfy thirst, without introducing a surplus amount into the stomach. Beer, light wines, tea, coffee, cocoa, barley-water, and toast-and-water are the fluids usually recommended. Spirits are rigorously excluded, and water alone is looked upon with some suspicion.

The following are a few of the dietaries used in training:—

King, in training, is said to have taken for his breakfast two lean mutton chops, somewhat underdone, with dry toast or stale bread, and a single cup of tea without sugar; for dinner, 1 lb. or 1¼ lb. of beef or mutton, with toast or stale bread, and very little potato or other vegetable, and half a pint of old ale, or a glass or two of sherry; for tea, a single cup of unsweetened tea, with an egg and some dry toast; and for supper, half a pint of oatmeal porridge, or half a pint of old ale.

"The effect of this," says Letheby, "is to produce only a shortlived state of effectiveness, for, carried a little beyond the appointed time, it leads to disease; and even after such a training there is often, as in the case of Heenan, terrible prostration of the system, and a necessity for returning immediately to an ordinary diet."

The Oxford System.

A Day's Training for the Summer Races.—Rise about 7 A.M. A short walk or run. Breakfast at 8·30, of meat (beef or mutton, underdone), bread (the crust only recommended), or dry toast, and tea (as little as possible recommended). Dinner at 2 P.M., of meat (much the same as for breakfast), bread and no vegetables (a rule, however, not always adhered to), with one pint of beer. About 5 a row twice over the course on the river, the speed being increased with the strength of the crew. Supper at 8·30 or 9, of cold meat and bread, with perhaps a jelly or water-cresses, and one pint of beer. Retire to bed about 10.

A Day's Training for the Winter Races.—Rise about 7·30 A.M. A short walk or run. Breakfast at 9, as for the summer races. Luncheon about 1, of bread or a sandwich, and half a pint of beer. About 2 row twice over the course. Dinner at 5, of meat, as for summer races; bread, vegetables, the same rule as for the summer races; pudding (rice) or jelly, and half a pint of beer. It is particularly impressed on men in training that as little liquid as possible is to be drunk—water being strictly forbidden.

The Cambridge System.

A Day's Training for the Summer Races.—Rise at 7 A.M. A run of 100 or 200 yards, as fast as possible. Breakfast at 8·30, of meat (beef or mutton, underdone), dry toast, tea (two cups, or towards the end of training a cup and a half only), and water-cresses occasionally. Dinner about 2, of meat (beef or mutton), bread, vegetables—potatoes, greens—and one pint of beer (some colleges have baked apples, jellies, or rice-puddings). Dessert, oranges, biscuits, or figs, with two glasses of wine. About 5·30 a row to the starting-post and back. Supper about 8·30 or 9, of cold meat, bread, vegetables — lettuce or water-cresses — and one pint of beer. Retire to bed at 10.

A Day's Training for the Winter Races.—Rise about 7 A.M. Exercise as for the summer races. Breakfast at 8·30, as for the summer races. Luncheon about 1, of a little cold meat, bread, and half a pint of beer, or a biscuit with a glass of sherry—perhaps the yolk of an egg in the sherry. At 2 a row over the course and back. Dinner about 5 or 6, as for the summer races. Retire to bed about 10.

Tramways—An urban sanitary authority may construct tramways under a Board of Trade provisional order, or the authority may purchase tramways, and may lease and take tolls in respect of the same; but the authority is prohibited from working them.—(33 & 34 Vict. c. 78, s. 4, 6–16, &c.)

A tramway cannot be constructed without the consent of the urban sanitary authority.

The working of tramways is regulated by bylaws, which require the sanction of the Board of Trade (*not of the Local Government Board*).—(Ibid., s. 4, 46–48.)

In establishing tramways there are various restrictions protecting the interests of road, gas, water, telegraph, and sewer authorities. (Ibid., s. 26–33.)

The expenses are to be borne by the general rate; the money may, however, be borrowed (with consent of the Board of Trade) in a similar manner to other sanitary funds.—(Ibid., s. 20, Schedule A.)

Transports—*See* Hospitals; Hygiène, Naval, &c.

Traps, Trapping—A trap, in a sanitary sense, is an apparatus affixed to the inlets of drains or sewers, so constructed as to prevent sewer gas from escaping into the air, but at the same time without impeding or obstructing the flow of liquids.

All sewers and drains (save and except those on the Liernur principle) require to be properly trapped and ventilated. The forms of traps in use are legion, but they are all on similar principles, and may be arranged into two classes—(1) those that interpose a body of water—an hydraulic seal between the atmosphere and the sewer; (2) those that interpose a solid body, such as a sheet of metal affixed to some mechanical arrangement.

The traps of the first class are usually automatic; the common siphon trap as affixed to a sink may be taken as an illustration (*see* fig. 121). It is evident that a layer of water will remain in the bend and prevent the gases escaping; but very little knowledge of the laws of fluids and gases is required to see that such an arrangement must, from time to time, get out of order; for if, on the one hand, the pipe runs full, the whole of the water will be sucked by a siphon action out of the trap; and if, on the other hand, a large quantity of gas is suddenly evolved in the drain or sewer, or a slight elevation of temperature takes place from the admission of hot liquids, the water is very likely to be driven out of the trap. Both these objections may, however, to a very considerable extent be obviated by inserting ventilating-pipes adjacent to important traps, or in the traps themselves.

Fig. 121.

Few traps will answer for all purposes; for example, those for drains carrying surface-water, &c., from roads, especially in hilly districts, where in heavy rains an enormous quantity of débris is carried down, require to have in connection with them large sludge-boxes, and arrangements to prevent the pipes being silted up. The traps for kitchens, sinks, and yards should for the most part be so constructed as to be easily examined and cleaned, for the proverbial carelessness of domestics frequently renders the best mechanism useless by stuffing it with solid refuse.

As the number of patents taken out for traps yearly is very large, an account of the different forms would far exceed the limits of this work; but as an example of an efficient hydraulic trap, Dean's patent drain trap, manufactured by Mr. J. C. Edwards of Ruabon, may be selected. It is made in a variety of forms—circular, square, and rectangular—and either double or single.

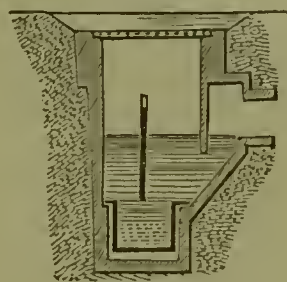


Fig. 122.

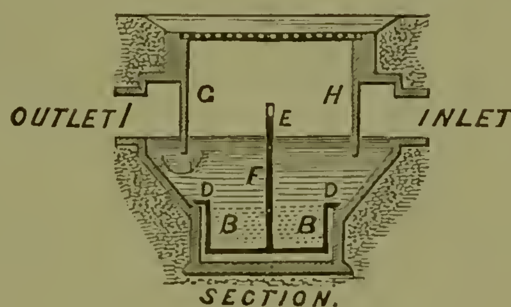


Fig. 123.

Figs. 122 and 123 show a section of a single and double trap. The double trap is generally used to trap externally sink or other house drains (except water-closet soil-pipes), and the single trap is for yard gulleys, cottage drains, &c. Many engineers, however, prefer the single trap for house drains, the trap being placed just outside the outer wall, and the sink or waste pipe discharging on to the top of grating. If, as is often the case, ventilation is necessary, the pipe next the outlet should be a junction, and a ventilating-pipe should be led therefrom to a suitable place.

It is made in two parts, the outer made of stoneware, and the inner a movable cast-iron receptacle *B B*, fitting into the bottom of the same, the configuration and construction being such that all solid matter must rest in the receptacle, which can be easily and readily removed, emptied, and cleansed. *G H* are two dips, and form a double trap; for if by any great pressure the sewer gas should force under the dip *G*, *H* would immediately rise to the surface, so that it could not force under the seal *H* and enter the house. These traps are now very extensively used.

As an example of a trap on a mechanical principle, and certainly one of the best yet invented, Banner's patent drain trap may be described (*see* fig. 124).

The trap consists of a small air-tight chamber A of cast iron, or other material, fitted with a 4-inch inlet pipe B, which projects several inches into its interior; the lower end of this inlet, surrounded by an indiarubber band, sprung on and slightly projecting beyond the end of the pipe, is closed and made air-tight by a copper cup C, of peculiar form, being pressed up to it by a suitable *weight* D mounted upon a lever fulcrumed on an air-tight centre, and having its outer end bent upwards at a right angle. The *weight* is suspended by a link on the raised end of the lever, and is so arranged that when the pan is in the act of tilting C′, the centre of gravity of *the weight* D′ is brought nearer the fulcrum, thus reducing the load and allowing the pan C′ to remain tilted, without at any time unsealing the trap, till it is thoroughly flushed, yet retaining sufficient power to completely close the trap again after flushing. A series of holes in the raised end of the lever permits of a proper adjustment of the *weight*, and a bend in the soil-pipe, just above the trap, breaks the force of the water

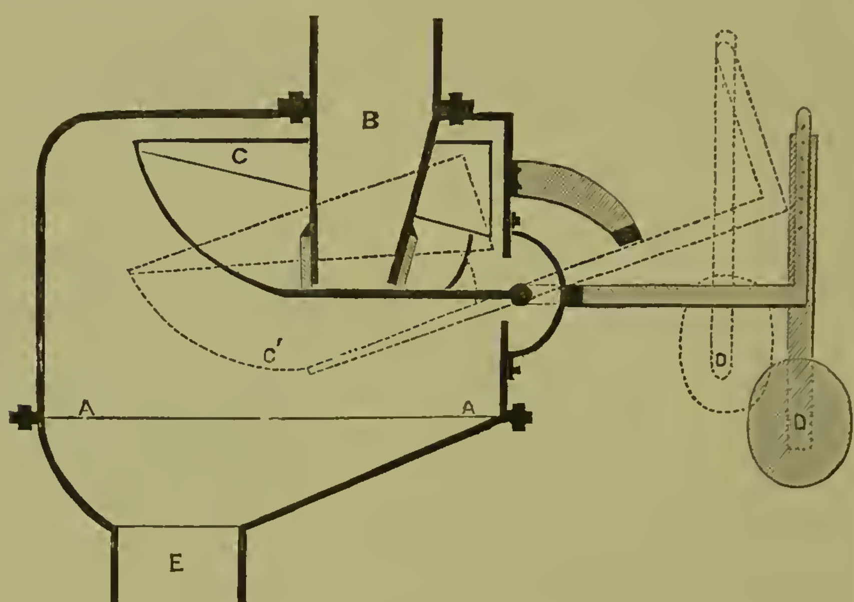


Fig. 124.

reaching the latter from above. The lower part of the chamber E is formed with sloping sides, terminating in an outlet in connection with the drain.

Before flushing, the cup when full weighs *over* 15 lbs., while the utmost weight opposed to it on the lever is *less* than 15 lbs.

After flushing, the cup and clean water left in it weigh *under* 7 lbs., while the weight on the lever after flushing is *over* 7 lbs.

The column of water in the soil-pipe B cannot rise more than 12 inches *above the chamber*, but the weight on the end of the lever is sufficient to maintain *in the soil-pipe* a permanent column of several inches of fresh overflow water, besides the clean water left in the bottom of the cup after each thorough flushing, till the closet is again used and its contents are discharged into the drain, when the copper pan filling again is again tilted and remains down sufficiently long to admit of a thorough flushing (*but at no time unsealing the end of the inlet pipe, as will be seen from the dotted lines in figure* 124, *which shows the pan in its tilted position*), after which the trap is brought back by the action of the weighted lever to its normal position, when, besides the air-tight valve thus formed, there is a water seal of 3 inches in the cup, and several inches up the soil-pipe.

This is a most advantageous form of trap for all low-lying districts, where there is danger, in times of flood or high water, of the drains returning their contents into the basements, as the greater the pressure of the returning sewage matter towards the chamber below the trap, the more tightly is the copper pan closed against the end of the soil-pipe inlet, so that no flood-water, sewage, or sewer

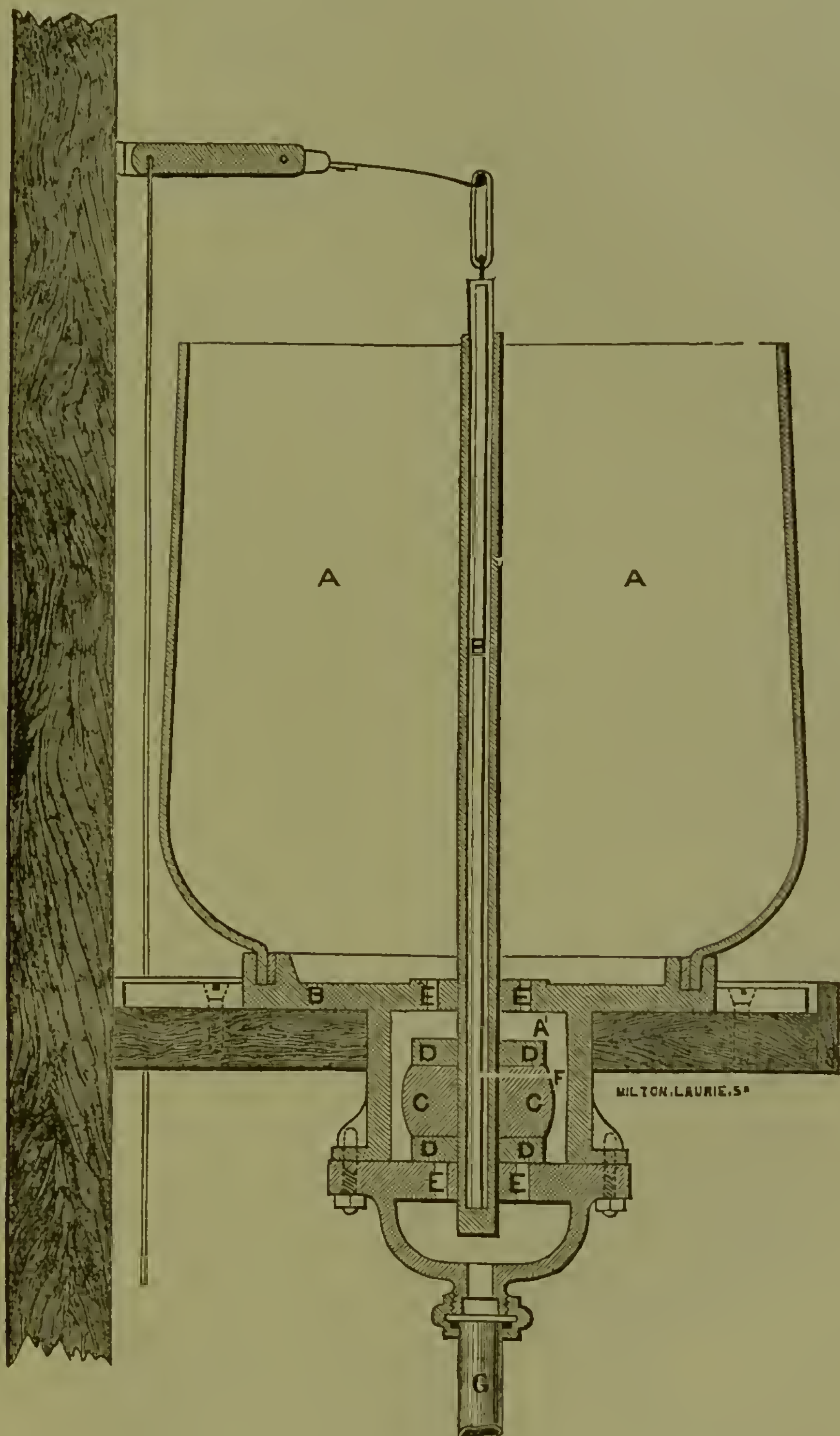


Fig. 125.

gas can possibly be forced past it into the basement or any other part of the house.

The outer end of the lever being exposed to view, in the event of any foreign substance causing a stoppage, it can be readily remedied by a domestic.

When the cup valve is in the position it takes while flushing, the opening is increased from the diameter of the inlet pipe above it to 12 inches.

Mr. Banner has also devised a very ingenious apparatus for disinfecting a trap (*see* fig. 125). A is a glass vase holding 1½ gallon of a disinfectant fluid; this is, in fact, the reservoir. The hollow tube B is fixed to a lead valve C, which has discs of indiarubber D attached to it above and below; E E are openings into and out of the small chamber A′, which admit of its filling or emptying as the indiarubber discs rest upon the lower, or are held up to the upper, side of the small chamber A′; F is an air-hole, and G is the outlet pipe through which the regulated charge of disinfectant passes to the D trap, on the valve being raised by the action of the lever spring fixed on the bracket above the vase A.

It is obvious that with the valve in the position represented, the chamber A′ is full of fluid; but upon raising the valve, the upper discs D D are closely applied to the openings from the reservoir, but leaving the lower openings E E open, the contents of the chamber A′ are discharged into the trap.

But whether the forms of traps described are used or not, this is certain, that the common bell trap is, under the most favourable conditions, extremely inefficient; that with the common siphon traps ventilation of the traps, as well as disinfection from time to time, is as a rule necessary, and that all require occasional supervision. *See* SEWER.

Trees—*See* PENALTIES, PLANTATIONS.

Trichina Spiralis—A minute round worm, enclosed in a more or less transparent capsule, that has been found as a parasite in the muscular system of man and animals.

Fig 126.

Figs. 126 and 127, after Virchow, represent the appearance of the parasite both free and in the cyst.

Fig. 127.

The following is Dr Cobbold's description of the parasite:—

1. The *Trichina spiralis* in its mature state is an extremely minute nematode helminthe; the male in its fully-developed and sexually-mature condition measuring only $\frac{1}{18}$ of an inch, whilst the perfectly-developed female reaches a length of about $\frac{1}{8}$; body rounded and filiform, usually slightly bent upon itself, rather thicker behind than in front, especially in the males; head narrow, finely pointed, unarmed, with a simple, central, minute, oral aperture; posterior extremity of the male furnished with a bilobed caudal appendage, the cloacal or anal aperture being situated between these divergent appendages; penis consisting of a single specula cleft above, so as to assume a V-shaped outline. Female shorter than the male, bluntly rounded posteriorly, with the genital outlet placed far forward, at about the end of the first fifth of the long diameter of the body; eggs measuring from $\frac{1}{1270}$ from pole to pole; mode of reproduction viviparous.

2. The sexually-mature trichina inhabits the intestinal canal of numerous warm-blooded animals, especially mammalia (also of man), and constantly in great numbers.

3. At the second day after their introduction the intestinal trichina attain their full sexual maturity, lose their spiral figure, and become stretched, whilst they grow rapidly, and their generative organs are developed.

4. Most females contain from 300 to 500 ova. In six days the female parasites will contain perfectly-developed and free embryos in the interior, and these, on attaining full size, pass out at the vaginal opening. The eggs of the female trichina are developed within the uterus of the mother into minute filaria-like embryos, which, from their sixth day, are born without their eggshells.

5. The new-born young soon afterwards commence their wandering. They penetrate the walls of the intestines, and pass directly through the abdominal cavity into the muscles of their bearers, where, if the conditions are otherwise favourable, they are developed into the form hitherto known.

6. The direction in which they proceed is in the course of the intermuscular connective tissue.

7. The majority of the wandering embryos remain in those sheathed muscular groups which are nearest to the cavity of the body, the abdomen, and thorax, especially in those which are smaller and most supplied with connective tissue.

8. The embryos penetrate into the interior of the separate muscular bundles, and here already, after fourteen days, acquire the size and organisation of the well-known *Trichina spiralis*.

9. Soon after the intrusion of the parasite the infested muscular fibre loses its original structure.

The fibrillæ collapse into a finely granular substance, whilst the muscular corpuscles change into oval nucleated cells.

10. The infested muscular bundle retains its original sheathing up to the time of the complete development of the young trichinæ, but afterwards its sarcolemma thickens, and begins to shrivel at the extremities.

11. The spot inhabited by the rolled-up parasites is converted into a spindle-shaped widening, and within this space, under the thickened sarcolemma, the formation of the well-known lemon-shaped or globular cysts commences by a periphic hardening and calcification. One cyst may have from one to three trichinæ.

12. The migration and development of the embryos also take place after the transportation of impregnated trichinæ into the intestines of a new host.

13. The further development of the muscle trichina into sexually-mature animals is altogether independent of the formation of the calcareous shell, and occurs as soon as the former have reached their completion. The male and female individuals are already recognisable as sexually distinct in their larval state. —(Entozoa; an Introduction to the Study of Helminthology, with Reference more particularly to the Internal Parasites of Man, by J. Spencer Cobbold, M.D., F.R.S. London, 1864.)

So far as it is at present known, the disease does not attack sheep, oxen, or horses. According to Virchow and Zenker, the most favourable organism for the development of trichina is the human.

When meat affected by this parasite is taken into the human stomach, a period of five or six days elapses without symptoms; but in that period the worms have multiplied prodigiously. They become free, leave their capsules, and produce young, which migrate through the intestines into the muscles.

Very serious results have followed the ingestion of meat affected with trichinæ. In 1863, out of 103 persons who ate sausages made of an affected pig, at Hettstadt, no less than 83 died from trichinosis (British Medical Journal, January 16, 1864, p. 75), and several similar instances are on record. The symptoms are often strikingly like those produced by an irritant poison—such as loss of appetite, sickness, pain, general weakness of limbs, diarrhœa, swellings of the eyelids, profuse perspiration, and very frequently peritonitis. There is no known method of treatment likely to be of any service.

In searching for trichinæ by the microscope the tendinous extremities of muscles should be selected, as there the cysts are most numerous. A small portion of the muscle is cut off by a pair of scissors, and teased into shreds by needles, thus freeing the cysts, which should then be treated with a drop of hydrochloric acid, which will dissolve the lime and make the cyst transparent.

Another way is to put the suspected flesh into a watch-glass and digest it in a liquid composed of one part of liquor potassæ to eight of water; the muscles become decomposed, and the capsules, from being unaffected, are seen as minute white specks.

Tricocephalus Dispar—This is a round worm (first mentioned by Morgagni) that has been found in the human intestines. Its anterior extremity is narrow and hair-like, and is buried in the mucous membrane of the intestine, while the remainder of the body moves freely in the cavity. The manner of its introduction is unknown.

Tripe—Tripe consists of the paunch or first portion of the ruminant stomach of the ox. It is easily digestible, except when very fat.

Composition of Tripe (Letheby).

Nitrogenous matter	13·2
Fat	16·4
Saline matter	2·4
Water	68·0
	100·0

Tripe-Boiler—*See* Trades, Offensive.

Trout—There are several varieties—*Salmo furio* (Linn.), *S. eriox*, *S. ferox*, *S. trutta*. All these varieties are in their finest condition from the end of May to late in September. The trout contains about 6 per cent. of fat. It should be cooked as soon after it is caught as is practicable.

Turbot—The *Rhombus maximus* (Cuvier). Except the halibut, this is the largest of our flat fish. The following is its composition: Nitrogenous matter, 18·1 per cent.; fat, 2·9 per cent.; saline matter, 1·0 per cent.; and water, 78 per cent. The Dutch turbot is usually considered the finest.

Turmeric (*Curcuma*)—The rhizome of *Curcuma tinctoria*. Two species are known in commerce, the *round* and the *long*; the first is yellow without, compact and yellowish brown within; the second is of a greyish colour externally, compact and reddish brown within. The following is an analysis of an average sample of *C. longa*:—

Water	14·249
Curcumin	11·000
Turmeric	12·075
Volatile oil	1·000
Gum	8·113
Starch	3·627
Extractive	3·388
Woody fibre	46·548
Ash included in above weights	[5·463]
	100·000

The structure of turmeric is very characteristic; the microscope shows a cellular tissue containing large loose yellow cells, with here and there small but very distinct starch granules, similar in shape and size to those in curcuma arrowroot, and some woody fibre and dotted ducts. The yellow granular cells can readily be identified wherever they occur.

Turmeric is used very extensively as an adulterant and as a colouring agent. When ground it has not unfrequently been found to be itself adulterated with yellow ochre, carbonate of soda, and potash. A careful microscopical examination of the powder and a determination of the ash will easily detect any foreign admixture.

Turnip (*Brassica Napus*, Lindley)—This vegetable is too well known to require any description here. The following table showing its composition illustrates its nutritive value, which is low. Turnips require to be well cooked to be rendered easy of digestion.

Composition of Turnips (Letheby).

Nitrogenous matter	1·2
Starch	5·1
Sugar	2·1
Salt	0·6
Water	91·0
	100·0

Turpentine, Oil of ($C_{10}H_{16}$. Specific gravity of liquid, ·864; of vapour, 4·76; relative weight, 68; boiling-point, 320° = 160° C.)—An oleo-resin flowing from the trunk of various species of pine. The *common turpentine* is obtained from the *Pinus abies*, *Venice turpentine* from the *Larix Europœa*, and the *Chian turpentine* is derived from the *Pistacia Lentiscus*.

Commercial oil of turpentine consists of a great variety of isomeric hydrocarbons which act differently on polarised light. They have been very carefully studied by Deville and Berthelot (Ann. de Chimie, II. lxxv. 37, and III. xxvii. and xxix.) in their chemical aspects, and would well repay investigation as to their disinfectant powers.

All the varieties of turpentine preserve organic structures from decay, and are therefore antiseptic; but there have been few investigations as to the useful hygienic properties which they may possess. *See* Terebene.

Typhoid Fever—*See* Fever, Typhoid.

Typho-Rubeoloid—A term used by Roupell in 1831 to denote what we call typhus, in the belief that it was a new disease. *See* Fever, Typhus.

Typhus Fever—*See* Fever, Typhus.

U.

Ultramarine—This pigment is obtained from the blue mineral azure stone, *lazulite* or *lapis lazuli*, the finest specimens of which are brought from China, Persia, and Great Bucharia. It is employed for the purpose of colouring confectionery. The ash of sugar articles so coloured is of a bright blue tint, and the colour is fixed in the fire. This colour being somewhat expensive, a substitute is sometimes used, called *German* or *French ultramarine;* this consists of a double silicate of alumina and soda, with sulphuret of soda. *See* Confectionery.

Umber—Employed for the purpose of colouring sugar, confectionery, &c. It contains iron, and may be distinguished by testing for this metal. *See* Confectionery, Iron, &c.

Union, Poor-Law—A union is a group or collection of parishes. They were formed, in the first place, by assistant commissioners. The principles guiding their selection were, that the area should not be inconveniently great, and that the population of the parishes should be extensive enough to warrant the formation of a union. Local Acts had also to be taken into account; and where these local Acts were in force, the consent of certain persons had to be obtained.

From this and other causes, there was often want of coincidence in area with the county; and in some cases, where a town was surrounded by a country district, the town was placed in one union and the country district in another, although the latter formed a circle or half circle round the town.

It is of the greatest importance for sanitary purposes that one area should be available for registration, sanitary and poor-law administration; and as the union appears to have been already taken as the sanitary unit in country-places, and answers fairly, it would be still more useful if the areas were made to coincide with the counties.*

Poor-law unions are, with certain exceptions, rural sanitary districts, and one or more may, by permission of the Local Government Board, combine together for sanitary purposes. The Local Government Board has also the power to compel combination. *See* SANITARY DISTRICTS, &c.

Urban Sanitary Authorities — *See* SANITARY AUTHORITIES.

Urinals—A urinal should be fitted up in all water-closets, otherwise the closet pan is used for the purpose, and the *safe* underneath becomes filled up with an objectionable and foul-smelling liquid.

Fig. 128 represents the best form of urinal; it is fitted up with a trap underneath, which can, when it is considered desirable, be ven-

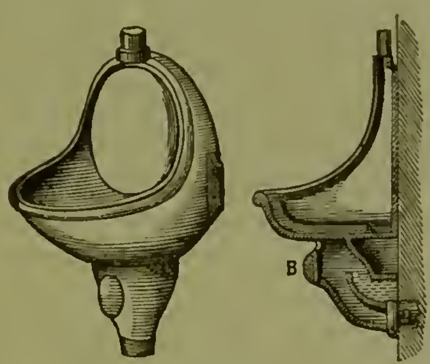


Fig. 128.

tilated by a pipe leading outside, and is intended to be fixed above a treadle plate, which when stood upon provides a rush of water into the basin from the pipe at the top, the flushing supply ceasing when the weight of the foot is removed. A disinfecting apparatus can be applied here similar to that which will be found described under the head of TRAPS and WATER-CLOSETS. These urinals should be constructed of glazed ware, and are best when the basin and trap form one piece of earthenware. Public urinals should be lined with glazed stoneware tiles, or composed of enamelled slabs of smooth slate. An arrangement allowing a small quantity of water to trickle down them constantly will keep them perfectly clean and inodorous. The old stone latrine is to be condemned, and enamelled iron does not always answer well.

* The Act of 1844 gave absolute power to the then Poor-Law Board to separate and to add parishes to unions, so that unions overlapping county boundaries might gradually and cautiously be revised and redistributed.

Any *urban* authority may provide and maintain *public urinals*.—(P. H., s. 39.)

Urine—The urine appears in all animals to form the principal outlet for the nitrogen of the effete azotised tissues of the system, though the compounds in which it is excreted vary with the kind of animal. Urine has a peculiar odour, and a saline bitter taste. Its specific gravity varies with the diet and state of health of the individual, but it usually averages about 1·020. The amount of urine voided in the four-and-twenty hours also varies, but on an average it may be estimated in the adult at from 40 to 50 ozs. Urine, when left to itself, speedily begins to undergo change. In most cases it first exhibits an increase of acidity, and after standing a few days it begins to putrefy, and acquires a powerfully alkaline reaction and an ammoniacal odour, due to the conversion of the urea into ammonium carbonate. Urine will keep good longer in a clean smooth vessel than in one with rough sides, and longer still if protected from the influence of the atmosphere. The following table shows the composition of an average sample of healthy human urine:—

Composition of Urine (MILLER).

Specific gravity, 1·020.

				In 100 Parts of Solid Matter.
Water			956·80	
Solid matters, 43·2.	Organic matters, 29·79.	Urea . .	14·23	33·00
		Uric acid . .	0·37	0·86
		Alcoholic extract	12·53	29·03
		Watery extract .	2·50	5·39
		Vesical mucus .	0·16	0·37
	Fixed salts, 13·35	Sodic chloride .	7·22	16·73
		Phosphoric anhydride	2·12	4·91
		Sulphuric anhydride	1·70	3·94
		Lime . . .	0·21	0·49
		Magnesia . .	0·12	0·28
		Potash . .	1·93	4·47
		Soda . . .	0·09	0·12
			999·08	100·00

The amount of urine secreted, as already noticed, is greatly influenced by the nature of the food; a meat diet largely increases the quantity. The amount of urea is also augmented, and there is an increase in the sulphates and phosphates. Under the influence of animal food its reaction becomes strongly acid, whilst a vegetable diet renders it alkaline.

It is probable, though we have no very satisfactory evidence on the point, that urine may be a carrier of infection; hence the importance of disinfecting, as soon as possible, the urine voided by patients suffering from any infectious disease. In cases of suspected poisoning, the urine as well as the stomach should be sent to the analyst, since many poisons make their appearance in that fluid. *See* EXCRETA.

V.

Vaccination—Vaccination is the implanting or inserting, by means of one or more punctures, the lymph originally derived from cowpox pustules into the human body, whereby a mild and tractable disease is induced, attended by pustules on the inoculated part and sometimes elsewhere, and whereby the vaccinated individual is to a considerable degree protected from smallpox.

History.—Vaccination was discovered by Dr. Jenner, who made his first experiment in 1792, and published his results in 1798. The train of thought which led to the discovery was suggested by the popular belief in Gloucestershire, Jenner's native county, that cowpox was a prophylactic against smallpox. The real date of the introduction of vaccination in England may be said to be 1796. In 1802 it had made such progress in public estimation that a Parliamentary grant was bestowed upon Jenner, followed by a second in 1807, amounting in all to £30,000.

The results of vaccination immediately after its introduction were extraordinary. In the ten years ending 1799, the deaths by smallpox in London were 22,863 to the million. In the ten years ending 1819, a vaccinating decade, they were 8045 to the million; and in the ten years ending 1849, they were still further reduced to 4798. So that vaccination might fairly claim to have reduced the mortality from about 23,000 to 5000 in fifty years.

Some remarkable figures relative to this point will be found in article SMALLPOX. We have, however, notwithstanding the supposed constant practice of vaccination, recently experienced (1870-71) a serious epidemic of smallpox. The inevitable conclusion demonstrated by this is that vaccination, in point of fact, is imperfectly carried out in the first instance, and that, moreover, revaccination is absolutely neglected, except under the influence of panic. Nevertheless, the following figures of mortality in a smallpox hospital amply show that if vaccination does not entirely procure immunity from the disease, it greatly diminishes the mortality:—

Mortality.	1863.	1864.	1865.	1866.	1867.	1868.	1870.
General	17·0	12·9	13·0	13·0	12·66	11·0	15·4
Unvaccinated . . .	48·0	36·0	38 0	35·7	36·80	34·0	38·5
Vaccinated . . .	12·0	8·7	7·4	7·3	8·29	6·2	7·9

The objections of anti-vaccinators are mainly two—

1. That vaccination really does not protect from smallpox, because so many vaccinated persons suffer out of proportion to the unvaccinated. To this the reply is, that the vaccinated now form the great bulk of the community. In the early days of vaccination, the vaccinated constituted a small portion of the community, and people seeing the charmed life, as it were, of those who had subjected themselves to the operation, were forcibly struck by its efficacy; whereas now, the memory of smallpox ravages having, until recently, almost died away, it is the exceptions which attract attention.

2. The second objection is, that vaccination produces ill-health, and may implant other diseases, such as syphilis.

There cannot be a doubt that among the millions who have been vacciuated, both these accidents may have occurred; but they are so rare as to be no argument against the actual saving of life, protection from disfigurement, and preserving of sight and hearing, which this inestimable boon to mankind has afforded.

The Operation.—The operation itself, as practised, consists in taking on the point of a lancet or other instrument a small drop of the colourless fluid or lymph which exudes from a vaccine pustule upon being pricked, and inserting it in four or more places in the skin covering the insertion of the deltoid muscle. There are, however, endless varieties in the operation. Some insert the point of the infected lancet obliquely under the skin; others take the matter on little bone or ivory *points*, and after making the puncture, insert the *points*, there leaving them for a few seconds; others deposit a drop of the matter on the skin, and then scratch it in with the point of a lancet; and some, indeed, do not use a cutting instrument at all, but slightly vesicate the skin, and then apply the vaccine to the raw surface. Good results are obtained by all the above processes, with the exception of the last. Each operator uses that in which by practice he is most skilled.

The lymph is taken from the human subject about the eighth day. Jenner recommended the sixth, the day on which the lymph is most active but less plentiful. It is possible, indeed, that the matter on the sixth day is more protective, and that a reform is needed on this head.

In order that a district should be vaccinated thoroughly, it is absolutely necessary that the vaccination should be carried out from "arm to arm," and that vaccine preserved on points, tubes, &c., should only be used on emergencies.

The number of vaccine pocks is all-important—four or five well-formed separate pocks on the arm are essential for adequate protection. Mr. Simon constructed the following table, based upon 6000 cases of smallpox contracted after vaccination:—

CASES of SMALLPOX classified according to the VACCINATION MARKS or CICATRICES borne by each Patient respectively.

Classes.	Number of Deaths per cent. in each Class respectively.
1. Stated to have been vaccinated, but having no cicatrix . .	21¾
2. Having one vaccine cicatrix .	7½
3. Having two vaccine cicatrices .	4⅛
4. Having three vaccine cicatrices .	1¾
5. Having four or more vaccine cicatrices	¾
Unvaccinated . . .	35½

It is important to remember that one mark cannot be called efficient vaccination, and that it is necessary to insist upon over two for thorough protection.

Revaccination.—Revaccination may be defined as a physiological test by which it may be shown whether the human body is liable or not to be attacked with smallpox. It is established beyond a doubt, that vaccination does not adequately protect the individual more than a certain number of years—the exact time probably varies in different individuals. Whether the primary vaccination influence still exists, and whether an individual is extremely susceptible of smallpox, may be known by revaccination. In the former case the vaccination will be abortive, or only show an irritant effect; in the latter, the vaccine pocks will run their normal course; so that it is a *test*, and as such, should be compulsorily applied to every individual at the age of sixteen.

Dr. Heim of the Wurtemberg army has collected statistics relative to 40,000 vaccinations. The subjects were young recruits, from twenty to twenty-one years of age, who had all been vaccinated in infancy; of these, one-half were successfully vaccinated, the vesicles running the normal course. The inevitable conclusion is that the 20,000 were susceptible to smallpox. As soon as the Wurtemberg Government ordered revaccination, there was a marked decrease of smallpox in the army; thus in 1824 there were 619 cases; in 1835, 250; 1836, 159; and in 1837, 94.

The success and the good results of revaccination are also shown in the records of its practice in the armies of Prussia, Russia, Denmark, Bavaria, and in our own. In 1858 an order was issued, by which every recruit on joining his regiment was to be revaccinated. This regulation continues in force, and its results will be found tabulated in the Army Medical Reports.

On the outbreak of smallpox, all sanitary bodies and officers should have the district thoroughly vaccinated and revaccinated. It is one of the moral but unwritten duties of every health officer to inspect the arms of every school-going child in his district, and to tabulate the results, in order that both the locality and the Government should know how far the Vaccination Acts are carried out.

The principal Act now in force on the subject of vaccination is the 30 & 31 Vict. c. 84, which contains the penalties for breach of its enactments, and provides (sect. 33) for the costs of prosecutions, while sect. 38 provides for the expenses incurred in certain other proceedings in respect of vaccination. That Act also contains the provisions for penalties for breach of its regulations. It has been amended by 34 & 35 Vict. c. 98. *See* SMALLPOX, VACCINE, &c.

Vaccine—The vaccine virus is a colourless, somewhat viscid, fluid. It mainly consists of the bioplasm of Beale. The highest powers of the microscope show in it no definite forms, but a multitude of minute molecules. Vaccine is really the infectious matter of cowpox, and cowpox is nothing more than smallpox modified by passing through the body of the cow. Vaccine was originally obtained from the pocks on the body of the cow, but is now taken from the human subject, as an uninterrupted series of pocks have been assiduously kept up and transmitted by vaccinators.

Vapour—*See* AIR, HYGROMETER, &c.

Vapours, Noxious—*See* NUISANCES; PUTREFACTION; TRADES, OFFENSIVE, &c.

Veal—This meat is not so digestible as beef or mutton, and its sustaining power is certainly less. The following table shows its composition:—

Composition of Veal.

Nitrogenous matter	16·5
Fat	15·8
Saline matter	4·7
Water	63·0
	100·0

See Meat.

Vegetables—Vegetables are eaten not so much on account of their nutritive qualities, as for the salts they contain. All the more important vegetables have been separately considered, and in our articles on Food, Meat, Training, &c., we have examined the results produced by a purely vegetable diet.

Preserved vegetables are now largely employed, and although their antiscorbutic properties are considerably less than the same articles when fresh, they are valuable where others cannot be obtained. *See* Scurvy, &c.

Venereal Diseases—Under this generic term we include the various sores and lesions, local and constitutional, arising from impure sexual connection. These affections come mainly under three distinct heads—1. True syphilis, as evidenced at the seat of inoculation by a primary non-suppurating sore, hard and indurated at the base, and after a more or less variable time affecting the system. 2. Soft chancre, a local ulcer, often phagedænic in character, and often from its ravages even dangerous to life, but not infecting the system with any specific disease, only affecting it by its local effects. 3. Gonorrhœa; an entirely different disease from the two first forms, being an inflammation, a catarrh of the mucous membrane of either the urethra or the vagina.

All these kinds are contagious, and propagated by contact with the infected discharge or matter.

That venereal diseases are propagated to an alarming extent amongst all classes of the community does not admit of a doubt, and that this propagation is nearly always the result of vice is also incontrovertible. Cases, however, occasionally occur where contagion of this kind may affect a great number of most innocent people; for example, in the town of Brivé fifteen women contracted syphilis from being attended by a midwife who was suffering from a chancre on the finger. The women in their turn infected some of their husbands and their children.—(Annales d'Hygiène, 1874, i. 42.) It has also been communicated to infants by the vaccinator in one or two rare instances, and the jurist must allow, however rare or improbable in practice, that any of the venereal infections may be produced by such accidents as using a public latrine, the seat of which is soiled by infectious matter, drinking from an infected cup, &c.

Of the three chief venereal diseases, primary or true syphilis is most to be dreaded, as it is a chronic disease whose course is not marked by days or weeks, but by years, and is liable to infect the offspring and the most innocent women. Its victims are almost exclusively the youth and manhood of the State, and it is therefore a subject of national importance to prevent its extension. Its ravages in the civil population can never be accurately known, as nine-tenths of the cases are contracted, cured, and treated with the greatest secrecy. Its prevalence in the army may be gathered from the following table, divided into two sections—(1) stations under the operation of the Contagious Diseases Act; (2) stations not under the Act:—

Admission of Primary Venereal Sore, per 1000 Strength.

	1867.	1868.	1869.	1870.	1871.
Stations under the Act.					
Devonport and Plymouth	76	66	74	58	50
Portsmouth	116	86	62	51	41
Chatham and Sheerness	71	63	41	47	65
Woolwich	88	46	52	43	58
Aldershot	81	77	63	67	65
Stations not under the Act.					
London	163	148	144	160	180
Sheffield	163	107	146	77	126
Manchester	177	115	160	92	70
Edinburgh	63	46	60	99	69
Dublin	129	139	180	128	117
Belfast	89	56	52	43	61

Prevention of Venereal Diseases.—The only practical means are regular inspection of prostitutes, the establishment of dispensaries for the gratuitous treatment of syphilitic disorders, and early marriages. These questions are dealt with in the articles Contagious Diseases Act, Prostitution, &c.

Venetian Red—A species of ochre brought from Italy, and used for colouring anchovies, annatto, cayenne, cheese, cocoa, and tobacco.

Venison—Venison differs from ordinary butcher's meat, in containing less fat and being darker in colour. It is very digestible and nutritious. *See* Meat.

Ventilation—We live at the bottom of a vast aërial ocean, five miles in depth, which is in continual movement from the slightest difference of temperature or pressure. In the open air every part of this ocean is of very similar constitution, but as soon as man closes and shuts himself up in houses, which are more or less air-tight boxes, the enclosed air rapidly gets contaminated (1) by carbonic acid from the breath; (2) by organic matter from the same cause; (3) by carbonic acid and other products of combustion; and (4) by dust, which is always present in greater or less quantity.

It is the aim and object of ventilation to renew the air of a room or other place in order to keep it fairly pure. In order to do this, ventilation should be effectual, and at the same time imperceptible; it should not be influenced by the wind; the currents of air themselves should be pure, and in cold weather warm, whilst in tropical climates or extremely hot weather the currents of air should be cold.

In the methodical examination of ventilation, the observer requires to know—

1. The cubic space.
2. The number of people ordinarily living in the room.
3. The number of openings, their area, and whether they ordinarily act as inlets or outlets. If there are tubes (and a chimney is a tube), the height of the tube as well as its area is required.
4. The difference of temperature between the external air and the room, and the difference of temperature in the shafts, tubes, &c. (if there are any), in the room.
5. The rate of movement in the inlets and outlets, as determined by calculation or the anemometer.
6. The amount of carbonic acid existing in the room.
7. The amount of moisture in the air.

For the accurate determination of ventilation all the above observations are necessary; while for a rough estimate, the sectional area of the openings, the height of the chimney, the amount of carbonic acid, and the difference of temperature are all the data required.

The quantity of carbonic acid in the air may be taken as a measure of its impurity (*see* AIR, &c.); and Dr. Parkes recommends the standard of ·6 cubic foot per 1000 volumes of carbonic acid as the limit of permitted impurity. The quantity of air required to pass into a room to keep it to this standard per head per hour may be calculated from the following formula:—

Let R be the ratio of CO_2 naturally present in the air—viz., ·0004 per cubic foot; r', the additional ratio per cubic foot of air of vitiation by respiration of one male adult in an hour, the usual amount being ·6 cubic foot of carbonic acid; r, the ratio per cubic foot to which it is desired to be reduced; c, the capacity of the cubic space; d, the delivery of fresh air in cubic feet; v, the entire volume of air, viz., $c + d$—

then $$\frac{r' - R}{r - R} \times c = v;$$

and $$v - c = d.$$

The velocity of currents of air is most accurately determined by the anemometer. (*See* ANEMOMETER.) In the absence of such an instrument, the most generally applicable method by calculation is to determine the external and internal temperatures, and the height at which the current enters the room, then the following formula will give the required velocity:—

First the difference of pressure must be obtained. h equals the height; d, the difference of temperature—

$$\frac{h \times d}{491} = p,$$

i.e., the difference of pressure;

then the velocity $= 8\sqrt{p}$.

In practice an allowance must be made for friction.

If it is required to calculate the size of opening, whether for inlets or outlets, the following formula was proposed by Dr. de Chaumont, no correction being made for friction:—

h = the height of the heated column of air; t = temperature; ·002 is the expansion of air for each degree Fahrenheit; D, the delivery per hour; I, total inlet and outlet area in square inches—

then $$\frac{D}{100\sqrt{h(t - t) \times \cdot 002}} = I.$$

There are numerous other formulæ, but the foregoing are the most useful.

Ventilation is usually divided into natural and artificial.

1. *Natural Ventilation* is that which is owing to natural causes, and the forces which in this instance cause the renewal of air are —(1) *Diffusion.* Every gas diffuses inversely as the square root of its density, and this diffusion is constantly going on through the chinks and cracks left by imperfect carpentry, and even through ordinary brick and stone walls. (2) *External air, currents, winds, &c.* (3) *Unequal atmospheric pressures.*

The last-named is the cause of all currents of air; cold air rushes into a warm room because the warm air has become lighter, greater in bulk, and has partly escaped, therefore the heavier cold air immediately fills its place. Every degree of Fahrenheit dilates the air $\frac{1}{491}$ part of its volume.

Simple Processes of Ventilation.—In mild weather, or in summer, open doors and windows are the very best means which can be adopted of thoroughly aërating a room; and in addition to this obvious method, there are various costless plans, most of which are really practical.

Mr. Hinckes Bird directs the lower sash of the window to be raised, and he places a piece of wood at the bottom rail, so as to block it up; a space is thus left between the meeting rails at the middle of the window, through which the air goes to the ceiling. Others have recommended double panes of glass, spaces being left at the bottom of the outside pane, and the top of the inner one—glass louvres, windows made so that when open they slope inwards, slits in the wall, with a picture or board hanging over them, &c. All are upon the same principle—viz., direct communication with the open air, and the cold air directed up to the ceiling.

The Sheringham valve is another example of the same principle; the air passes through a perforated brick or iron plate, and is directed upwards by a valve. Mr. Boyle uses for the same purpose a round plate working on a screw; the air impinges on the plate and radiates over the wall. Perforated bricks are also in use, but as they cause direct draughts they should be avoided; open iron frames, covered with gauze, and supporting a valve, are preferable.

A method of ventilation advocated by Mr. Tobin has been recently brought before the public very prominently, and some of the leading journals have mentioned it in terms so eulogistic that the public actually consider some great discovery to have been made in the matter; this, however, is not so, it is merely a simple means of conveying *cold air* into rooms, and as such will be found useful in summer and mild weather. The plan is to introduce the air through horizontal shafts under the floor, and deliver it into the room through perpendicular shafts at different points about 5 feet from the floor; the current of fresh air ascends to the ceiling, and then curves down inperceptibly into the room. In fact the principle is exactly the same as that of Mr. Hinckes Bird; indeed it is questionable whether carrying out Mr. Bird's suggestion would not be quite as effective as *tobination*, and it certainly is cheaper.

With any or all of these simple means of admitting air, there should also be an opening for getting rid of the foul air; this may be accomplished by a valve in the chimney opening over the gas-chandelier, or a slit near the cornice having a valve. All the methods mentioned may be practically applied, and the cost is extremely small, but in none of them is the air warmed.

Special Tubes, Flues, &c.—The proposals and inventions in this respect are too numerous to find a place here; the most practical will only be mentioned. Most houses have to be ventilated after they are built, but if the ventilation is considered (as it should be) at the time of building, it is a wise thing, as Mr. Eassie remarks, to provide in the walls of a room a shaft 4 or 5 inches square leading up to the top of the house, the upper orifice of which is covered or valved, so that there be no down draught. A foul-air extraction-shaft can also be led up the chimney, with gratings just below each ceiling. Such a shaft is very efficient.

The wind in many systems is taken advantage of, as in the system of Mr. Sylvester, who ventilated buildings by establishing large cowls, which, by properly fixed vanes, were constructed so that they always turned to the wind. The air rushing down the cowls, passed through an underground channel into the basement of the house, where it was warmed by a *calorifère;* thence it ascended by tubes into the rooms, and ultimately passed out by other tubes in the roof, the openings being covered with cowls turned from the wind. Thus the air in this system is moved both by the propulsive as well as the aspiratory force of the wind; it is warmed in its passage, and is conducted by pipes to all parts of the house. Van Hecke has modified this plan by the use of a motive power—viz., a fan worked by an engine, which drives the air into the basements, where it is warmed and distributed as before. A modification of Sylvester's method is also used by Mr. Ritchie.

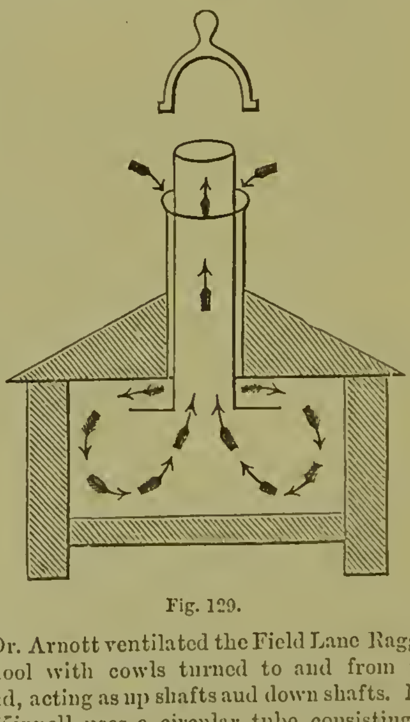


Fig. 129.

Dr. Arnott ventilated the Field Lane Ragged School with cowls turned to and from the wind, acting as up shafts and down shafts. Mr. M'Kinnell uses a circular tube consisting of two cylinders, one within the other, the outer one being the inlet tube, the inner the outlet (*see* fig. 129). It is well suited for square or round rooms.

2. *Artificial Ventilation.*—There are two rival systems in use—viz., ventilation by extraction and ventilation by propulsion.

Ventilation by Extraction.—The cowls and tubes already mentioned are examples of ventilation by extraction. Mr. Banner's ventilating cowl acts in the same way, and is a very powerful and useful extractor (*see* fig. 130).

Its action is as follows: The larger end of a funnel-shaped tube A′, placed horizontally, is always directed towards the wind, and a current of air passing in there, is pressed forward through the annular space between the two cylinders A B, and when it reaches the end of the inner one B, it expands round

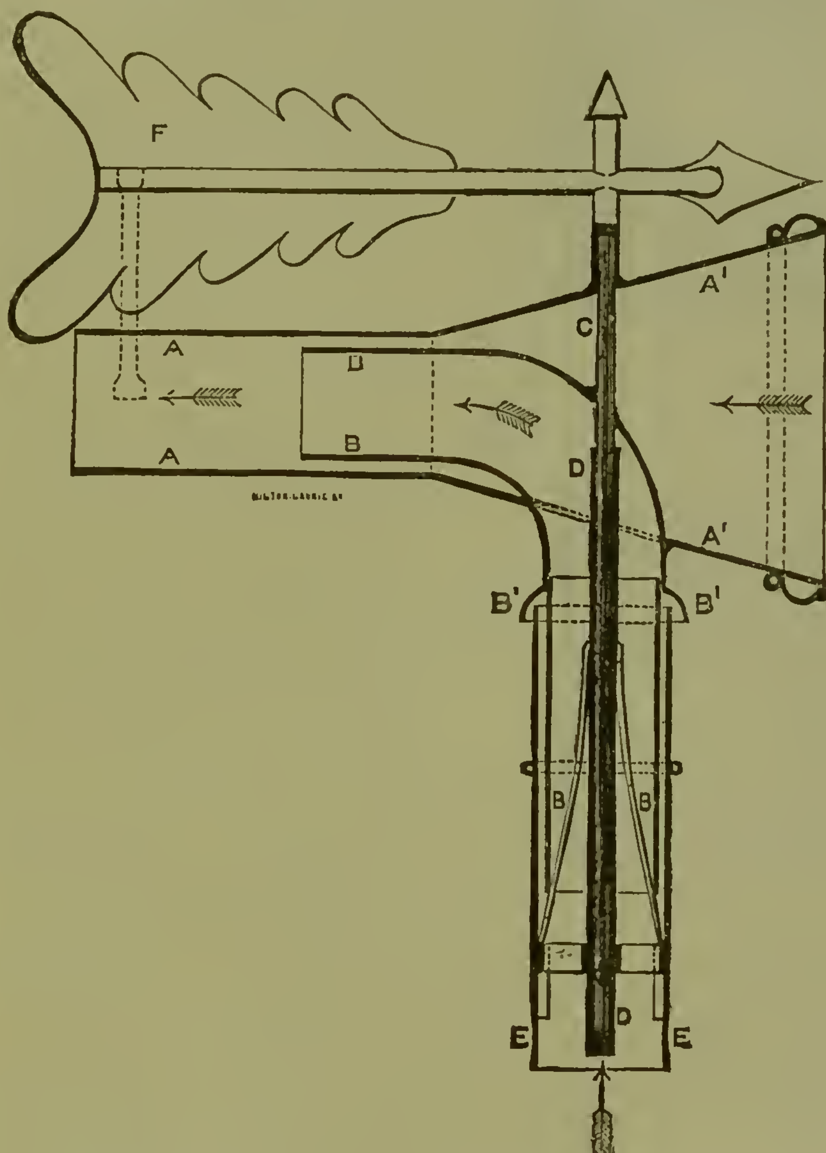


Fig. 130.

it, and in its passage out at the smaller end of A A, a vacuum is created round *the point* of the inner cylinder B, which, by suction, *draws out* its contents into the open air, and thus induces an upward current of air from the shaft or pipe leading from the place to be ventilated.

Mr. Banner recommends the thorough ventilation of the house, the soil-pipe, and the sewer by means of three separate shafts, the whole three of which can be connected to one cowl, which will effectually extract the foul air, and is not influenced by wind.

Another example of ventilation by extraction is the ventilating action of a fire; the fire heats a current of air equal in height and area to the capacity and height of the chimney, this column of air ascends, and cold air rushes along the floor, under, over, and through the fire, to restore the equilibrium. Now, as a great deal of the heat is wasted by ordinary fireplaces, and as there must be a

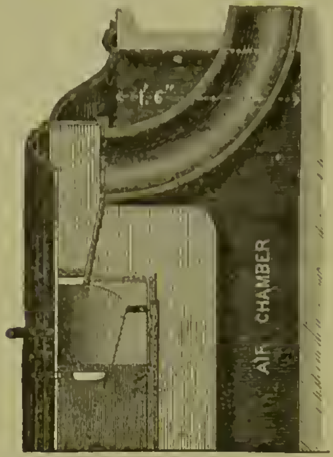


Fig. 131.—Section of grate (GALTON).

continual draught of cool air along the floor chilling the feet, open fireplaces are coming into use, which, by means of an air-chamber at

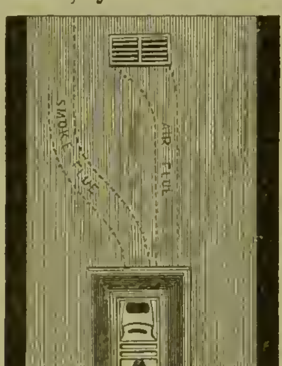


Fig. 132.—Elevation showing air and smoke flues (GALTON).

the back, heat fresh air supplied to them from the external atmosphere, and this warm air passes into the room, both ventilating and

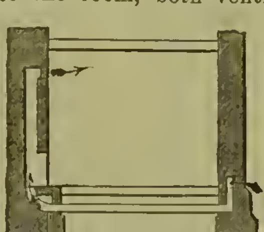


Fig. 133.—Section of a room showing air duct and flues (GALTON).

warming it. There are so many modifications of this form of grate that it is impossible to enumerate them here; but in order to exemplify the principle, we will describe the Galton ventilating fireplace. This (*see* fig. 131) has an air-chamber at the back of the grate. The air-chamber is fed with air from without by a special channel. On the back of the grate

Fig. 134.—Plan of grate and chamber (GALTON).

there are iron gills projecting backwards into the chambers. The smoke-flue is of iron, unconnected with the air-chamber, and projecting into and continuous with the chimney (*see* fig. 132). The grate itself is constructed so as to give the greatest amount of reflected heat possible, and so as to consume as far as practicable the smoke. The air heated by the air-chamber passes into the room by an opening near the ceiling. It is of course warmed by having been in contact with the heated back of the grate. Grates on similar principles are constructed so as to lead this hot air over the whole house, into any room. The principle is, then, extraction by the chimney, and supply of air to the room by a special channel, heating it on its passage. This system is certainly the best that can be adopted for private houses.

The calorigen or gas-stove of Mr. George is on a somewhat similar plan. The body of the stove is of thin rolled iron, and contains (*see* fig. 135) a coil D of wrought-iron tubing, open at the top H. This coil is contained in the body of the stove, and is fed with air from without by the pipe G. The products of combustion go up the chimney in the ordinary

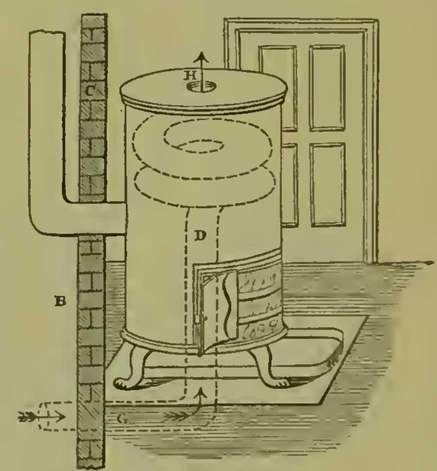


Fig. 135.

way. The fire may be of ordinary coal, or of gas. It is fed with air, either from the room or by special channels, as in fig. 136.

In large houses and public buildings, in which the method of heating by hot water or steam-pipes is in use, the same pipes may be employed to cause currents of air in suitable extraction - shafts. This system has been

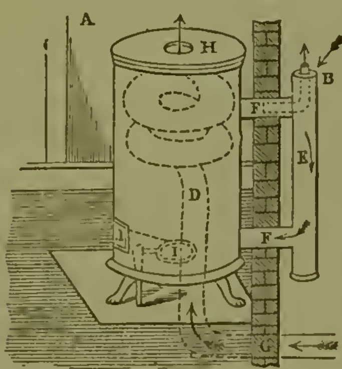


Fig. 136.

adopted in the hospitals Lariboisière and Beaujon, and other public institutions in France, and has been used for some time in England.

In all manufactories and places where steam-engines are employed, the heat of the boiler or the steam, or both combined, may be utilised in ventilation. In this way steam-ships may be ventilated by enclosing the steam apparatus in an iron casing, leaving a space between the casing and the heated surfaces. A strong current rushes up this space, and air to feed it can be directed down every hatchway.

In places where gas is used there should be no difficulty in the ventilation; a single Argand gas-burner at the bottom of an extraction-shaft will cause a most powerful current. General Morin found by experiment that 1 cubic metre of gas would cause the discharge of 1000 cubic metres of air.

The way in which several of the French theatres are ventilated is by utilising the central chandelier and every single gas-jet. The entering air is warmed by *calorifères.* There are numerous tubes to draw off the foul air, which unite or empty themselves principally into the central tube surrounding the chandelier; in this way both the products of combustion and the foul air are drawn off.

Fig. 137 is a reduced section after *Eassie* of a house ventilated by Dr. Drysdale and Hayward's system, in which a jet of gas lit in the common abstraction-shaft will keep it at the proper temperature, so that it will act efficiently. In the sketch given, however, the air enters through a primary inlet; is filtered through a canvas screen; is heated by a coil of hot-water pipes in the lobby; circulates through the rooms in the course of the arrows, always leaving a room at the top by special openings into flues which empty themselves into a foul-air chamber at the top of the house, whence it is extracted by a shaft which in the sketch is represented running downwards to the floor of the kitchen, and then up behind the fire, round the smoke-flue,

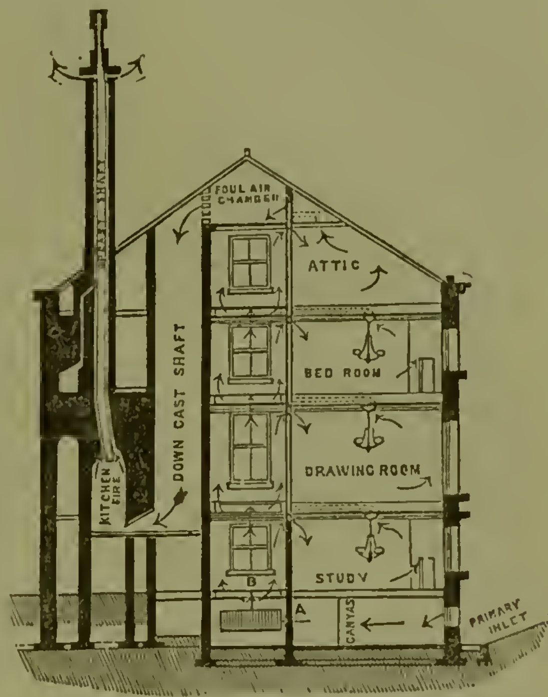


Fig. 137.

and out at the chimney—a most thorough and effective system. Another general plan of ventilating a house is that of Dr. Ancell Ball. This system, not alone providing for the ventilation and warming, but also for the simultaneous disinfection of a house, is described under article WARMING.

In mines, workshops, &c., extraction is often effected by large fans or steam-jets; under such circumstances, mechanical power is cheap and easily applied.

Ventilation by Propulsion. — This is invariably mechanical; the air is driven into the proper channels by vanes, bellows, or pumps. It is a system seldom suited for private houses, but may be often applied in factories, vessels, and in any place where there is machinery. In factories and workshops, in addition to the purposes of ventilation, currents of air are often required to blow away or extract dust. Here the principle must never be forgotten, that for dust the openings should be, generally speaking, near the floor; for foul air, near the ceiling.

Summary of Ventilation.—For hospitals it is generally considered that natural ventilation is best, and that the supply should be large; for factories, workshops, ships, and wherever there is machinery, artificial ventilation, whether by extraction or propulsion, is certainly most convenient and economical; and for public buildings, a regular system of ventilation, in which the gas and all the fires assist, or else a mechanical system—such as that of Van Hecke, of Banner, and others—is absolutely necessary.

In private buildings, or single rooms, ventilating grates or stoves, or some of the simpler methods of ventilation described, will suffice to keep the air pure; but every case must be studied upon its merits. For the complete ventilation of a whole house, Drs. Drysdale and Hayward's system, or Dr. Ball's, in which warming is combined with ventilation, is perhaps the best. *See* AIR, ANEMOMETER, WARMING, &c.

Veratrine (*Veratria*, *Veratrina*, *Sabadilline*)—An alkaloid discovered by Pelletier and Caventon in the seeds of *Asagræa officinalis* (sabadilla), and in the rhizomes of *Veratrum album* (white hellebore). This alkaloid is excessively poisonous, one-tenth of a grain having produced the most alarming symptoms. It is in the form of a pale brown-coloured uncrystalline powder, which is very acrid to the taste. It is also remarkable for producing violent sneezing, which lasts for some time.

Tests.—The temperature at which it sublimes, the reactions with sulphuric acid, and the amount of ammonia evolved when distilled with alkaline permanganate, as detailed under article ALKALOIDS, will readily identify veratrine. An additional test of some value is the fact that an acetic solution treated with *chloride of tin*, and evaporated to dryness, becomes of a blood-red colour.

Verdigris (*Vert-de-gris*, Fr.)—This is a mixture of several basic acetates of copper which have a green or blue colour. It is obtained in the wine districts of the south of Europe by the action of refuse grapes, from which the juice has been expressed, on thin sheets of copper. When pure, it should dissolve almost entirely, and without effervescence, in dilute sulphuric acid. It is excessively poisonous, and the tests, &c., for its detection will be found described under COPPER.

Vermicelli—Wheat rich in gluten is employed for making this preparation, which is largely consumed in Italy, and usually imported into this country from Naples or Genoa. The vermicelli is made by kneading the flour into a stiff paste with hot water, and then pressing it through holes or moulds in a metal plate, or else it is stamped so as to give the desired form, and afterwards dried. Vermicelli is highly nutritious, but it is hardly so easy of digestion as many other wheaten preparations. *See* BREAD, FLOUR, &c.

Vermilion (*Bisulphuret of Mercury*)—This substance is often employed for the purpose of colouring confectionery. Methods for its detection will be found in articles CONFECTIONERY and MERCURY.

Vibriones—*See* BACTERIA.

Vinegar—Dilute acetic acid more or less contaminated with gum, sugar, vegetable matter, &c.

The dietetic value of vinegar is hardly yet understood. The acetates become changed in their passage through the body into carbonates, and as such appear in the urine; it undoubtedly often assists digestion, and in all probability renders certain articles, such as mussels, oysters, &c., less likely to prove hurtful. It is also of some value as an antiscorbutic. The English law permits 1 part of sulphuric acid to be added to every 1000 parts of vinegar. This is probably unnecessary, for we have very satisfactory evidence to show that well-made vinegar will keep without this addition, which indeed is not allowed on the Continent, and it is to be hoped that the Legislature will soon alter a system which opens the way to the wholesale adulteration of so important an article of food. Vinegar is an agreeable fumigant, and has considerable antiseptic powers, which are utilised in the preservation of vegetable and animal substances. As a disinfectant it is untrustworthy, since it supports many low forms of animal and vegetable life.

Varieties, &c.—The strength of vinegar is distinguished by the makers as Nos. 24, 22, 20, 18, and 16; the specific gravities of these should respectively be 1022, 1020, 1019, 1017, and 1015. The acidity of English vinegar should not be less than 3 per cent.

The varieties of vinegar met with in commerce are wine vinegar, malt vinegar, sugar vinegar, and wood vinegar. The first three are produced by fermentation of alcoholic liquids, the last by destructive distillation of wood, and subsequent separation of the acetic acid.

Adulteration of Vinegar.—The chief adulterations are an undue amount of sulphuric acid, tartaric acid, hydrochloric acid, glucose, pyroligneous acid, lead, sometimes copper; and in rare instances arsenic has been found, derived from impure sulphuric acid.

Examination of Vinegar.—The principal matters required to be estimated are—(1) the acetic acid; (2) the extract; (3) the ash; 4) sulphuric, hydrochloric, and tartaric acids.

1. *The Acetic Acid* can be determined by distilling it over from a retort into a suitable receiver, and then estimating it by acidimetry, or more conveniently, but less accurately, by adding a standard solution of caustic soda, or carbonate of soda, directly to the vinegar. The former process should always be preferred, as then sulphuric and tartaric acids remain in the retort, and can be estimated separately. The amount of acetic acid found varies from 2·5 to 5 per cent. The Orleans vinegar made from wine contains, according to Guibourt, 6 to 8 per cent. of acetic acid. If the acetic acid exceeds 8 per cent., it is certainly too strong; if less than 3 per cent., it is too weak.

2. *The Extract.*—A hundred grammes or 1000 grains are evaporated to dryness over the water-bath in a suitable dish. The extract from the best French wine vinegar varies from 1·7 to 2·30 per cent. It ought not to have a empyreumatic odour, nor a sweet taste. The extract from ordinary commercial malt vinegar is often less than 1 per cent.

If the extract indicates sugar, 50 grammes of the vinegar may be evaporated to the consistence of a syrup, heated with alcohol, filtered, decolourised by animal charcoal, and the sugar estimated by Fehling's process.

3. *The Ash* is determined by igniting the extract. It should be very minute. It may contain carbonates of potash, especially if it be a wine vinegar, but should not contain metals, such as copper, &c., nor should it contain sulphate of lime. It may be examined in the same way as the ash of wine. *See* WINE.

4. *Fixed Acids—Sulphuric Acid.*—In all prosecutions with regard to the adulteration of vinegar with sulphuric acid, the defence set up is that the sulphates found have their origin in the water from which the vinegar is manufactured; hence it is not sufficient for the analyst to estimate the total sulphuric acid, which may be easily effected by precipitation with chloride of barium, but the amount of sulphuric acid existing in the free state must also be known.* At present there is no very reliable process for the estimation of free sulphuric acid in vinegar.

M. Strohl proposes to take advantage of the insolubility of calcium oxalate in acetic acid and its solubility in dilute mineral acids. He has determined by experiment the amount of calcium oxalate (produced by ammonium oxalate and calcium chloride) necessary to cause a distinct turbidity in a certain volume of vinegar, also the minimum quantities of sulphuric, hydrochloric, and nitric acids respectively required to produce a transparent solution. If, then, on adding the determined amount of calcium oxalate to a suspected sample of vinegar, the solution remains transparent, there is present not less than a certain minimum quantity of one or more of the above-mentioned mineral acids.—(J. Pharm. Chem., [4,] xx. 172–175.)

Thresch's process is a modification of Strohl's, and is said by the author to detect 10 per cent. of H_2SO_4.

Take two beakers, and place in each 2 ozs. of the vinegar; to one add five or six drops of liquor ammoniæ, and then to both ten drops of a solution of ammonium oxalate. The one to which the NH_3 was added will remain distinctly turbid; the other, if it contain more than ·100 per cent. of H_2SO_4, will remain perfectly clear; with ·070 per cent. it will be turbid, but only slightly so when compared with the other.

He proposes to estimate the chlorine in the vinegar, then to evaporate down and ignite, and calculate out the loss of chlorine as so much displaced by sulphuric acid. The author gives some experiments which show that it is a fairly accurate method of detecting and estimating free acid; but it must be remembered that the great source of error is that chlorides are more or less volatile, according to the temperature in ignition.—(Pharm. Journal, No. 262, iii.)

M. Witz suggests that advantage may be taken of the fact that methyl aniline undergoes no change of colour in contact with acetic acid, but the least trace of mineral acid changes it to a greenish blue; hence a process might be easily worked out by means of this reaction to detect and estimate the free acid in vinegar.

Tartaric acid may be estimated by evaporating the vinegar to dryness, or nearly so, diluting with water, separating the sulphuric acid by chloride of barium, and then titrating, the result being calculated as *tartaric acid.*

Hydrochloric acid may be estimated in the usual way by precipitation with nitrate of silver, and collecting and weighing the resulting *chloride.*

Arsenic, copper, lead, &c., must be tested

* A case of alleged adulteration of vinegar was lately heard at the Stone police court. Dr Letheby and Professor Voelcker found *no free* sulphuric acid, but 112 grains of combined sulphuric acid to the gallon; "but that was a constituent of the water from which the vinegar was made, and was not injurious to health"! On the other hand, Dr Thudichum certified that it was adulterated with sulphuric acid (115 grains to the gallon), and Mr Scott also gave evidence that the specific gravity of the vinegar was 1·0168, and that he found 119 grains of sulphuric acid, 35 of which were free.—(Pharm. Journal, June 5, 1875.)

for in the way recommended in the different articles treating of those metals.

Vitellin—The yolk of egg contains from 16 to 17 per cent. of an albuminoid substance called vitellin. Vitellin contains more hydrogen and oxygen than albumen, it is not precipitated by the salts of lead or copper, and it is coagulated by ether.

Volumetric Solutions—Under this title we propose to give a few of the volumetric solutions most likely to be useful to the health officer and analyst.

The French weights and measures are so universally employed for scientific purposes that the quantities and proportions of substances used in the solutions will be expressed in French weights, but as the cubic centimetre bears the same relation to the gramme that the grain measure bears to the grain, the one system may be substituted for the other with no difference in the results. In such a case, however, it will be convenient to increase the values one-tenth by moving the decimal points; for example, 6·3 grammes of oxalic acid in 100 grammes of water, if required in grains, had better be translated 63 grains in 1000 grains of water.

Bichromate of Potash, Volumetric Solution of.—14·75 grammes of bichromate of potash is dissolved in 1 litre of distilled water. One hundred cubic centimetres contain 1·475 of potassic bichromate, and are capable of converting 1·68 grammes of iron from the state of proto-salt to that of per-salt.

Copper, Volumetric Solution of.—For sugar estimation 34·639 grammes of pure crystallised sulphate of copper are dissolved in about 200 cubic centimetres of water; 173 grammes of crystallised tartrate of soda and potassa are dissolved in 480 cubic centimetres of pure soda solution of 1·14 specific gravity. The first solution is added gradually to the second, and the blue fluid diluted to 1000 cubic centimetres. Ten cubic centimetres of the solution contain ·34639 gramme of sulphate of copper, and = ·050 gramme anhydrous grape-sugar, or ·045 of starch or dextrine.

It may be used to determine the amount of grape-sugar in diabetic urine, in grapes and fruits, alcoholic liquids, and the amount of starch in substances (first converting the starch into grape-sugar by boiling with a dilute acid).

Hyposulphite of Soda, Volumetric Solution of.—Twenty-eight grammes of hyposulphite of soda are dissolved in a litre of water. A portion of this fluid is put into a burette and dropped into the volumetric solution of iodine until the brown colour is discharged. The number to produce this effect is noted, and the solution diluted so that a litre is equivalent to 12·7 grains of iodine, and contains 24·8 grains of the hyposulphite.

This solution is employed for the purpose of estimating free iodine, an operation of great importance in chemistry, since it is thus an indirect means of estimating all those substances which, when brought in contact with iodide of potassium, separate from the same a definite quantity of iodine, or when boiled with hydrochloric acid, yield a definite quantity of chlorine.

Iodine, Volumetric Solution of.—12·7 grms. of iodine are dissolved in water, and the solution made exactly up to 1 litre; 100 cubic centimetres are then equivalent to ·17 gramme of sulphuretted hydrogen, ·32 of sulphurous acid, and ·495 of arsenious acid.

This solution is used for the quantitative determination of the above. It is dropped into the liquid to be tested until free iodine appears, or, in other words, until it ceases to be decolourised.

When the solution is added from a burette to a liquid containing free iodine a decomposition takes place, which may be represented by the formula $2Na_2H_2S_2O_4 + I_2 = Na_2S_4O_6 + 2NaI + 2H_2O$; and as iodide and tetrathionate of sodium, the result of the decomposition, are both colourless salts, when the reaction is complete the solution is decolourised, and the amount of free iodine may be calculated from the number of centimetres of the hyposulphite solution used.

Iron, Volumetric Solution of.—One gramme of pianoforte wire is dissolved in nitro-muriatic acid, it is then precipitated by ammonia, the resulting peroxide is washed, dissolved in a little hydrochloric acid, and the solution diluted so that 1 cubic centimetre contains 1 milligramme of perchloride of iron.

This solution may be diluted ten or a hundred times, according to circumstances, and is extremely useful in the quantitative colorimetric methods for the determination of iron. For example, supposing we require to estimate minute quantities of iron existing in a liquid, the latter is first acidified with hydrochloric acid, or if the iron exist partially or entirely in the state of protoxide, it must be oxidised by the action of nitric acid; then the solution, or 50 cubic centimetres of it, is transferred to a cylinder of glass, and 1 or 2 cubic centimetres of a solution of ferrocyanide of potash added. This produces a certain colour, which must be *exactly imitated* by adding the standard iron solution to the same quantity of distilled water in another cylinder, and treating it in an exactly similar way. The whole process is analogous to nesslerising, is very easy, and especially suitable to the estimation of the minute quantities of iron which are met with in water, the ash of bread, &c.

Oxalic Acid, Volumetric Solution of.—Dissolve 63 grammes of the pure crystallised acid in 1 litre of distilled water. Fifty cubic centimetres of this solution equals ·315 gramme crystallised oxalic acid, ·28 gramme of iron.

It is used in alkalimetry, in the determination of protoxide of iron, &c.

Soda, Volumetric Solution of.—Dissolve 42 grammes of sodium hydrate in a litre of water, pour 25 cubic centimetres into a capacious beaker, and find how many cubic centimetres of the volumetric solution of *oxalic acid* it takes to neutralise it, then calculate how much water will be required to be added to the litre solution of soda so that 50 cubic centimetres of the oxalic acid solution will exactly neutralise 50 cubic centimetres of the alkaline solution. For example, 27 cubic centimetres of standard acid neutralised 25 cubic centimetres of alkali, therefore multiplying each by 4, we get 108 = 100; therefore to every 100 cubic centimetres of the latter 8 cubic centimetres of water are required to be added. One cubic centimetre of such a solution equals ·06 of hydrated acetic acid, ·063 of crystallised oxalic acid, ·192 of citric acid, ·15 of tartaric acid, ·04 of sulphuric anhydride, and ·049 of sulphuric acid.

It is best kept in a similar bottle to that represented by fig. 3, p. 31.

Voting, &c.—All questions brought before a sanitary authority are decided by a majority of votes, unless more than a simple majority is required by statute in a particular case.

The names of all present are to be recorded, and when a division takes place, the names of the members voting should be recorded. Voting by ballot is certainly not admissible.

The chairman of any sanitary authority may vote on all questions, and in case of equality has a second or casting vote.

The following form is the voting paper prescribed by the statute in the case of local boards:—

FORM N.

FORM OF VOTING PAPER AT ELECTIONS OF MEMBERS OF LOCAL BOARDS.

Voting Paper.

District of

No. of Voting Paper.	Name and Address of Voter.	Number of Votes.	
		As Owner.	As Ratepayer.

Initials of the Voter against the Names of the Persons for whom he intends to vote.	Names of the Persons nominated.	Residence of the Persons nominated.	Quality or Calling of the Persons nominated.	Name of the Nominator or one of the Nominators.	Address of such Nominator.

I vote for the persons in the above list against whose names my initials are placed.

(Signed)______________

or the mark of ______________

Witness to the mark ______________

or __________ proxy for______________

Directions to the Voter.

The voter must write his initials against the name of every person for whom he votes, and must subscribe his name and address at full length.

If the voter cannot write, he must make his mark instead of initials, but such mark must be attested by a witness, and such witness must write the initials of the voter against the name of every person for whom the voter intends to vote.

If a proxy votes, he must in like manner write his initials, subscribe his own name and address, and add after his signature the name of the body of persons for whom he is proxy.

This paper will be collected on the of between the hours of and .

For the rest of the voting machinery in the case of local board elections, see LOCAL BOARDS.

W.

Wards—The Local Government Board may on application, in pursuance of a resolution of owners and ratepayers, divide any district into wards. See articles LOCAL BOARDS, RESOLUTIONS, &c.

Warming—In cold and temperate climates artificial heat is necessary for the comfort and health of man. A house or room at a constant temperature of 50° to 60° F. is both pleasant and healthy, and it is not advisable to attempt to warm habitations to a higher temperature. Artificial heat acts by radiation, convection, and conduction; of these, radiation is at the same time most common and most wasteful. The effect, as is well known, lessens according to the square of the distance: if the heat at 1 foot distant from the fire be said to be 1, then the heat at 4 feet will be 4^2, or sixteen times less; the heat at 8 feet will be 8^2, or sixty-four times less, and so on. Every common open fireplace heats the room mainly by radiation, and in order to obtain the greatest possible radiation, the width of the back of the grate should be one-third of the width of the hearth recess, the depth from the front backwards equal to the width of the back, the sides and back made of nonconducting material, and the chimney throat contracted so as to lessen the draught. A house or room may be heated artificially by (1) open fireplaces; (2) stoves; (3) steam, hot air, water, oil, &c., carried in pipes; (4) gas.

The principles which ought to be, but seldom are, followed are, that there should be no cold draughts perceptible; that the fuel where open grates are used should be perfectly consumed; that the products of combustion should be carried away perfectly; and that the room should be heated in a fairly equal manner. In large houses and public institutions the passages and lobbies require to be warmed, for if no attention is paid to this matter, directly a door is opened, the cold air rushing in from the lobbies and passages effectually lowers the temperature.

Open Fireplaces.—In England long-established custom and prejudice render open fireplaces the means of heating nine-tenths of the habitations, and although ordinary grates of this kind are objectionable, the great improvement and introduction of ventilating fireplaces have remedied many of the defects. Mr. Galton's ventilating fireplace is illustrated and explained under VENTILATION. There are many varieties elucidating the same principle, such as the London school-grate, &c.—viz., that of an air-chamber at the back communicating with the external atmosphere, and pouring warm air into the room near the ceiling.

Some of these grates may be also used for other purposes; for example, at Charing Cross Hospital one serves the purpose of a hot-closet as well.

All ordinary grates may be fed by air from outside by a special channel-opening in the hearth, and thus obviate the cold draught to the feet.

Smokeless grates economise the coal; one of the most ingenious is that based upon Franklin's idea—viz., a reversible one. The grate is a kind of basket which can be turned upside down. When the coals get red-hot and require replenishing, some coal is put on in the usual way, and then the basket lid is shut down and the whole affair turned upside down. The red coals are now at the top, the unburnt at the bottom; a slow and effectual combustion is the result.

Another effectual smoke-consumer is one in which by a mechanical arrangement the burning fuel can be raised and coals deposited beneath. There is also another kind, in which the coal is stored in a box beneath the fire bars, and a lifting bottom raises the coal as it is consumed.

Stoves.—All sheet-iron stoves when red-hot allow injurious gases, carbonic oxide, &c., to pass through, and hence are to be avoided, unless in rooms amply ventilated; this porosity may, however, be prevented, according to Dr Bond, by coating them with a good coating of silicate solution. The stove patterns are legion, and therefore to attempt to notice them is impossible; the best are undoubtedly those which, like the *calorigen* described and illustrated under VENTILATION, act like the ventilating stoves—viz., pour currents of warm air into the room. There is also a stove called the pyropneumatic, the inner part of which is constructed of fireclay lumps, having vertical air-passages communicating with the external air by a special channel, this warmed air escaping into the room from the top of the stove. This is an open stove, and the fire can therefore be seen. Close stoves are useful where a fire is required to be kept alight night and day, or where—as, for instance, in a lobby, picture-gallery, &c.—a fire is required to burn many hours without attention. For such purposes the Arnott stove, the Belfast stove, or those upon a similar principle, are most convenient. A very useful slow-combustion stove is shown in fig. 138. It consists of a firebox A, a body C, having an exterior casing and perforated with holes, the space between the casings being filled with powdered terra cotta; the top D fits in a groove filled with dry sand; the smoke, &c., pass into the flue at E; there is a damper at B. To light the fire, the firebox is nearly filled with small lumps of coal and coke, then some paper and sticks and a little coal are placed on the top of this, lighted, and the top D replaced. The fire is thus really lighted at the top, and burns gradually down; it may be extinguished at any time by closing the damper B.

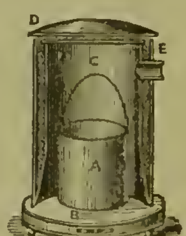


Fig. 138.

Steam, Water, &c., Pipes.—The case by which every portion of a building can be heated by water or steam pipes is evident, and accordingly it is rapidly supplanting all other systems in large buildings, such as churches, hospitals, &c. Heating by steam is now, generally speaking, abandoned, and water either at high or low pressure is found in practice most convenient. In the high-pressure system the water is heated to about 300° or 350° F.; in Perkins' patent no boiler is used, but a portion of the tube passes through the fire; the pipes are about half an inch in diameter, with thick walls of welded iron. In the low-pressure system there is a boiler, and explosions have occurred; there has been introduced, however, an improved system by which the boiler is at the back of the fire, and is extremely small, only holding about a quart of water. Under the low-pressure system 5 feet of a 4-inch pipe will warm 1000 cubic feet to 55°, and 12 feet will warm 1000 cubic feet to 65°; but under the high very much less is required, as the heating power is greater—indeed it is said that the heating power is two-thirds more, and therefore two-thirds less piping is required.

Gas.—Gas is now applied to heating and cooking; for the latter purpose it is admirably adapted, being economical and cleanly; for heating purposes it is either applied in open fireplaces by having a large atmospheric burner or row of burners at the bottom of the grate, which is filled with lumps of asbestos; or in stoves; or, again, it may be used to heat a small hot-water service of pipes. Undoubtedly the best gas-stove is that on the calorigen principle, described and figured under VENTILATION.

A method of heating two apartments by one fire, first described by Dr. Franklin, merits revival. Supposing there are two adjacent rooms with a chimney between, it is quite possible to make a fireplace of cast iron, so arranged that it may turn round on a pivot, so that the fire may be in either room, whilst at the same time the room in which the fire is not seen is heated by the red-hot back. In order to have the full benefit of the arrangement, it is necessary to put two flues (say two common stove-pipes) in the lower part of the chimney, and the one that the fire is not under is closed by a valve, which must of course be opened when the fireplace is revolved.

"By this means a servant could at any hour in the morning make a fire in the study, which would also warm the bedroom without disturbing the master by going into his chamber; and the master when he rose could with a touch of his foot turn the fireplace on its pivots and bring the fire into his bedroom, and keep it there as long as he wished, and at going out turn it back again into his study. When retiring to rest in the evening he would find his bed-chamber comfortably warmed by the hot back-plate; and if he wished to have a sight also of the fire he could turn it towards him. If it were desired to have hot air introduced into the room in which there was no fire, the back-plate might be made hollow, and an opening made at the bottom for the admission of the cold air into the cavity, and another at the top of the air-box for its emission into the room."—(BERNAN'S History and Art of Warming.)

Dr. Ancell Ball of Spalding is the inventor of a plan for simultaneously warming, disinfecting, and ventilating a house. It appears to be applicable to any class of house, from a small cottage to a large mansion, and by utilising to the utmost every fire, must be without doubt very economical. The details of the plan are as follows:—

Cottages.—A five-roomed cottage (of two sitting and three bedrooms) is so arranged that in the partition wall between the two lower rooms an aperture is left, with only one chimney, beneath which is placed in the said aperture a double-faced or Janus little grate, on each side of which is a hot-air chamber, provided with a water-evaporating pan, so that heated moist air, after being diffused into the sitting-rooms, can be conveyed through a hole in each brick up a *lofty* coach-house into a hay-chamber above, where 140° are obtained. The same kind of air can be conveyed into a lobby in each lower room, or a passage or hall, where it is admitted through openings, which can be plugged with a stopper at night before bed-time, when the said air can be conducted up to the three cottage bedrooms, which will be comfortably warmed before retiring to rest. The Janus grate has two very *different-looking* faces, the one for the sitting-room looking like an ordinary, cheerful fireside, with the front flush with the wall, which does not project into the room; whilst the *kitchen side face* presents a complete *range*, with three holes in the hot-plate for a large pot with tap, as a substitute for boiler—one for a frying-pan, and a central one for a kettle, &c., which can, by means of a little door above the grate, be conveyed from one room to the other—a very useful and ingenious contrivance. Beneath the grate a large oven is placed, and the flame is conveyed completely round three sides of it, at the same time imparting heat to the two hot-air chambers, so that the maximum of heat is abstracted before the little smoke that remains passes into the chimney. This is not all, for the *two* faces abstract so much air that cheap coke is readily consumed in the upper two-thirds of the grate, whilst a grated drawer slides in beneath to consume the best riddled small yet cheaper coals, called "*nuts*," the *smoke* from which ascends through the incandescent coke, where it is *consumed*, at the same time emitting light and additional heat. The hot ashes are frequently falling upon the *top* of the oven, which is thus well heated through four of its surfaces.

A drawing-room and dining-room can also be heated by a single grate in the same manner, the range of course being dispensed with, and another face substituted. A breakfast-room and office can also be heated in a similar manner; likewise two kitchens, the lesser one being supplied with a corresponding face.

The *ventilation* is provided for by first admitting the outer cold winter and pure air into the two lobbies of the cottage, by conducting it to the ceiling through the finely-perforated zinc and muslin, which not only excludes an excess of air, but also divides the cold curreut so finely that it becomes rapidly heated by the hot, moist air, which it meets in the lobbies, so that when a person opens the inner lobby door to enter the sitting-room, no current of cold air or disagreeable draught is experienced by those sitting there—a cheap comfort which many much higher-rented houses cannot yet boast of. This plan is only adopted in the cold weather, for in the summer-time the windows above the outer doors work on pivots, in order that a full current of air can be commanded in the hotter months.

Having thus admitted the outer pure air after first warming it, the next important thing to be done is to carry off as fast as it is generated in the rooms the impure air proceeding from the breath, from gas, lamps, and perspiration, &c.; and this is admirably accomplished through a cheap flue formed by an opening in bricks placed one above the other, from a part near to the ceiling to a certain distance up the breast of the chimney, having no communication, however, with the smoke-flue, although warmed by it; for the said ventilating-flue is formed in and through the brickwork in the breastwork itself; and in order to prove its successful action a feather is suspended over the entrance, where it is powerfully drawn by the upward current into the chimney, thus emptying a room of impure air quite as cheaply as the House of Commons is by the steam-pumping apparatus, and perhaps, also, quite as agreeably.

If there should be an infectious fever in the house, a more powerful up-current can be obtained by placing a lamp or a horizontal wheel worked by four conical cavities at the top, at the commencement of the ventilator.

One of the bedrooms is so constructed that it can be immediately converted into a little hospital for the infectious diseases of childhood, by first admitting pure air into the bed-room, through louvres and other openings in the lower panels of the door, over which a piece of perforated zinc, covered with muslin, slides, so that the air is admitted without any objectionable draught. At the bottom of the panels is placed a vessel containing ozone, and there is a bottle of disinfectant provided with a wick, and so arranged that the upper edge of the muslin is continually kept wet with it. The impure air in this case is not extracted by the usual shaft, but by an additional one, commencing in an opening in the partition wall, and terminating in a zinc chimney. An up-cast current is ensured by a small gas or paraffine lamp, which is thus made to both light and ventilate two rooms simultaneously. By the side of the lamp is placed a bottle charged with some disinfectant—(*e.g.*, carbolic acid—which is conveyed by means of the siphon action of a wick to the sides of the heated cone; by this means the impure air is saturated with a disinfectant before it mixes with the atmosphere.

Ballard and Pitt's patent is also an attempt to combine on a large scale ventilation and warming. The apparatus consists of a series of hollow copper vessels, standing erect, side by side, and a few inches apart, the whole being enclosed in an ornamental wooden casing. These vessels are filled with hot water from a hot-water circulating boiler. The cold air is brought direct from the outside of the house by a suitable channel entering the apparatus at its lowest point; the cold air in ascending passes over the copper plates, and is discharged warm into the house. This method of warming the air answers well, for it can never be overheated. Of course the apparatus is entirely beyond the reach of small householders, but it is well adapted for the houses of the middle and upper classes.

Washer-Women—Their laborious work, humid atmosphere, cramped position, and constant contact with acrid irritating liquids expose washer-women to many diseases, the more common of which are rheumatism, colds, amenorrhœa, œdema of the legs, varicose veins, ulcerated legs, and according to Benoiston de Châteauneuf, extreme liability to phthisis. It does not appear that they often contract disease from washing the garments, &c., used by persons suffering from infectious disorders. Eillotson has, however, quoted a case in which a washer-woman, after washing the linen worn by a man suffering from glanders, was seized with the same disease. Hallé has attributed to the refuse-water of wash-houses the ulcerated throats and intermittent fevers noticed by him to be very prevalent amongst the washer-women inhabiting the huts on the banks of the "*rivière des Gobelins.*" *See* WASH-HOUSES.

Wash-Houses—In all large cities, especially in their more ancient quarters, space is so lamentably deficient that not alone do the poor have to wash their clothes in the solitary room in which they live, but they have to exert all their ingenuity to dry their linen after cleansing it; and thus is seen the curious spectacle of under-garments of every kind and shape hanging from poles pushed out of the windows, lines stretched across the narrow streets, or in some cases on the very roof itself. In such towns it is the moral duty of an urban sanitary authority to establish properly-constructed wash-houses, in order to give every facility to those classes who have no conveniences at home to wash and dry their linen, and thus encourage cleanliness.

The establishment of public baths and wash-houses is provided for by the 9 & 10 Vict. c. 74; 10 & 11 Vict. c. 61; 21 & 22 Vict. c. 98, s. 47; and the Public Health Act, 1875, s. 65. *See* BATHS.

Water—The true constitution of water was not discovered until the year 1781, when Cavendish and James Watt, independently of each other, showed it to be a compound of hydrogen and oxygen. The chemical composition of absolutely pure water is proved, both by analysis and synthesis, to be the combination and condensation of two gases, hydrogen and oxygen, in the proportion *by volume* of two of the former to one of the latter; *by weight*, eight of oxygen to one of hydrogen. Its chemical formula is therefore H_2O, and its relative weight 9.

The specific gravity of water as a vapour (steam) is ·622; as a liquid, 1000; as a solid (ice), ·918. A litre of water at 4° C. weighs 1000 grammes; a cubic inch at 62° F. weighs 252·456 grains; 1 cubic foot, 997 ounces avoirdupois; and it is convenient also to remember that 1 gallon equals ·1604 cubic foot, and 1 cubic foot equals 6·2335 gallons—or, for practical purposes, 1 gallon equals ·16 cubic foot, and 1 cubic foot equals 6¼ gallons.

Pure water is a liquid, colourless, transparent, and destitute of odour or taste. It freezes at or below 32° F. (0° C.), and boils at the ordinary barometric pressure at 212° F. (100° C.)

Water contracts regularly on the abstraction of heat until it reaches a temperature of about 39·2° F. (4° C.); it then expands and continues to do so until it freezes. At 39·2° it attains its greatest density, and when it congeals it occupies a space as great as it did at 48·2° F. (9° C.); but notwithstanding this gradual dilatation its refractive power on light continues to increase regularly, as though it contracted. Above 39·2° F. (4° C.) water expands regularly as the temperature rises.

Water is the standard with which the specific gravities of liquids and solids are compared, its maximum density at 39·2° being taken as 1000.

Water absolutely pure is never found naturally; the whitest snow, the clearest rain-water, the most transparent ice, all contain air, small quantities of salts, and a little organic matter. It is only by special processes, indeed, that the chemist can obtain it chemically pure; for Fresenius found by distilling 42·41 grammes of water from a glass flask with great care that it subsequently left on evaporation and ignition ·0018 gramme of solid residue.

Mr. Crookes, in determining the atomic weight of thallium, found it necessary to redistil water in a special apparatus *in vacuo* (Chemical News, vol. xxix. No. 741); but it may also be obtained pure in small quantities by combining proper volumes of oxygen and hydrogen by the electric spark; in larger, by transmitting dry pure hydrogen over ignited oxide of copper and collecting the water formed. Water distilled in the usual way, however, answers all the ordinary requirements of the chemist.

The different varieties of natural water may be divided into fresh and salt, the former again being subdivided into rain-water, snow-water, spring-water, river-water, mineral water, &c.

Sea-Water.—The composition of the water of the ocean varies somewhat in different parts of the globe. Its main characteristic is its saltness, derived from the large amount of salts it contains, the total saline matter amounting usually to 3½ per cent. The density of sea-water is about 1·0274. The salts are chiefly chlorides of sodium and magnesium and sulphate of magnesium.

The following are analyses of sea-water—the British Channel by Schweitzer, the Mediterranean by Usiglio (Ann. de Chimie, III. xxvii. 104):—

	British Channel.	Mediterranean.
Water . .	963·74372	962·345
Sodic chloride	28·05948	29·424
Potassic chloride	0·76552	0·505
Magnesic chloride	3·66658	3·219
Magnesic bromide	0·02929	0·556
Magnesic sulphate	2·29578	2·477
Calcic sulphate	1·41662	1·357
Calcic carbonate	0·03301	0·114
Iodine . .	traces	...
Ammonia .	traces	...
Ferric oxide .	...	0·003
	1000·00000	1000·000
Specific gravity	1027·4	1025·8

Sea-water is a great stimulant to the skin, and gives tone to the nervous system. Many people suffering from skin diseases can neither bathe nor approach the sea without becoming worse; but its action, speaking generally, is beneficial upon man, and those who live near the coast are healthy. Sea-water, owing to the large proportion of dissolved chlorides in it, is an excellent disinfectant.

Waters, Drinking. — The drinking-waters include spring, river, lake, and well water. It is impossible to say, abstractly, which is the most healthy supply. A water free from human or other contamination, not too hard, well aërated, and containing no microscopic life, from whatever source derived, is a good water.

Examination of Drinking-Water.—The hygienist, in examining drinking-water, has to solve the question whether the water is fit for domestic and other uses. This may easily be determined by several very satisfactory methods.

Collection of the Sample.—One or more chemically-clean transparent wine-bottles answer admirably. They may first be cleansed with caustic soda or potash, then washed with hot water, and finally treated with a little strong sulphuric acid, and again rinsed. Too much care to have the bottle clean can hardly be taken; the corks should fit properly, and be perfectly new and clean. In taking samples from whatever source, the bottle should be washed out again, in addition to the cleansing mentioned, with the sample to be examined. In the case of town supplies, the water should be allowed to run a little time before filling the vessel, and the same remark applies to pumps. If a sample from the source of a spring is required, it is often impossible to get a satisfactory collection without digging the previous night a small excavation, into which the spring falls in a miniature cataract; and the placing of a little glass or porcelain spout, over which it flows, will facilitate greatly the subsequent operations.

A fairly complete examination of a drinking-water comprises—

1. A physical examination by which (*a*) its general appearance as to colour, smell, turbidity, sediment, &c., and (*b*) its microscopic characters are determined.

2. A chemical examination by which the (*a*) amount of suspended matter, (*b*) total solid residue, (*c*) chlorine, (*d*) hardness, (*e*) nitrates and nitrites, (*f*) ammonia and organic matter, (*g*) metals, are all *quantitatively* determined.

It is, however, only in very important cases that the whole process is gone through, a very slight examination sufficing in bad waters to condemn them; while in the case of doubtful waters, a microscopic examination, with the quantitative determination of (*b*), (*c*), and (*f*) will give certain indications whether the water is a potable one or not.

Preliminary Physical and Chemical Examination of a Water.—First, the water should be examined as to clearness by holding a large flask in front of a dark wall, while a strong light falls on it from above; next, the colour may be noted by filling a flask with distilled water, and placing the two flasks side by side on white paper. The flask may now be shaken up and smelt, to ascertain whether there is any odour, in which warming the water, and the addition of a little caustic potash, will assist; if this produces any odour, a considerable quantity of organic matter is sure to be present.

Nitrites may also be tested for by iodide of potassium, acetic acid, and starch paste. For this purpose it is best to take 100 cubic centimetres of water in a glass cylinder; if a blue colour is the result, nitrites are present. To another 100 cubic centimetres, some Nessler test (*see* NESSLER) may be added; if this produce a discolouration or precipitate, ammoniacal salts are present. Another 100 cubic centimetres can be boiled with a few drops of acid, and tested with sulphuretted hydrogen for metals. A good water neither gives a blue colour with the iodide of potash and starch, a brown colour with Nessler, nor a dark colour with sulphuretted hydrogen; it does not contain much suspended matter, nor has it a bad smell.

Microscopical Examination of Water.—No examination of a drinking-water is complete unless it has been submitted to microscopical examination; in fact, by the microscope alone a water may be pronounced pure or the reverse. The writer has lately paid considerable attention to the connection between chemical analysis and the microscopical characters of a water. The method employed was simply to allow the water to stand from twelve to twenty-four hours in a tall jar or bottle of transparent glass, the mouth of the vessel being covered with filtering-paper; at the end of that time the water was siphoned off, and the sediment, if any, taken up by a pipette and examined under the microscope; the water thus freed from the matters held in suspension was then analysed in the ordinary way. In every case it was found that the microscopical characters supported the chemical analysis; for the best waters, even on standing a couple of days, will only leave the slightest sediment, which sediment will contain no animal or vegetable life, visible at all events with ¼-inch power. The following table gives a few examples of this:—

	Solid Residue. Grains per Gallon. Saline.	Organic.	Total.	Chlorine. Grains per Gallon.	Free Ammonia. Parts per Million.	Albuminoid Ammonia. Parts per Million.	Microscopical Examination of Sediment, and Remarks.
River-water from near Chileompton	23·00	25·00	48·00	1·4	00·09	00·15	After standing 24 hours, a copious deposit settled at the bottom of the bottle; this on examination was found to be principally composed of débris of vegetable and animal life. *Rotifer vulgaris*, *Brachionus*, *Glaucoma*, *Anguillula fluvialis*, *Actinophrys sol*, and other infusorial forms were identified.
Mill Spring, Chilcompton	21·00	8·00	29·00	1·0	00·04	00·03	Entire absence of animal life, and sediment very scanty.
A hard spring-water from Kingsbridge	28·00	11·00	39·00	2·4	00·00	00·05	After standing 36 hours, a slight sandy deposit; no life; a little vegetable débris.

Mr. Jabez Hogg also gives the following analyses of waters by Dr. Dugald Campbell, and his own microscopic observations:—

A water gave to analysis—

	Grains per Gallon.
Saline	3·200
Volatilised matter which blackened when heated	1·200
Total	4·400
NH_3	0·006
Alb., NH_3	0·020

The water was brown in colour, and abounded in animal and vegetable organisms, chiefly paramæcium, trichoda, rotifers, cercomonas, Protococcus fluvialis, confervæ, and numerous fragments of decaying mosses and vegetable matter.

Another water from the red sandstone, containing 11·8 grains of solid matter per gallon, and ammonia as follows:—

	Grains per Gallon.
NH_3	0·002
Alb., NH_3	0·001

was found by Mr. Hogg to be perfectly free from all living organisms.

It is impossible to enumerate all the forms which the microscopist may meet with in water, a few of the most common may, however, be mentioned.

1. *Inanimate Substances.* — Sand, chalk, clay, marl, and other earthy or mineral matters.

Vegetable matters—such as the débris of plants, bits of cotton, linen, &c.

Animal matters—such as bits of hair, wool, epithelium, wings and legs of insects, and the débris of fishes.

2. *Living Animal and Vegetable Forms.* —These are various. Bacteria, rhizopoda, euglenæ, various ciliated free infusoria moving rapidly, algæ and diatoms, hydrozoa, worms, and fungi, are the principal classes to which the microsopic life of water is to be referred.

The principal living forms in water are easily learned by the aid of diagrams and practical observation, but of course, in order to identify every animalcule, desmid, or diatom, and to name it accurately, requires an immense amount of study in a special direction. The plate illustrating this article (fig. 139) will be found of use for the sake of reference, as it contains a representation of most of the common species.

No

1. Closterium.
2. Semidesmus obtusus.
3. Spores of a fungus.
4. Conferva floccosa.
5. Englena viridis.
6. Diatom vulgare.
7. Pleurosigma angulatum.
8. Navicula viridis.
9. Surirella splendida.
10. Colony of vorticella.
11. Cyclidium glaucoma.
12. Brachionus.
13. Rotifer vulgaris.
14. Oxytricha lingua.
15. Pellionella.
16. Glaucoma scintillans.
17. Glaucoma Gibba.
18. Leucophrys striata.
19. Paramæcium aurelia.
20. Paramæcium caudatum.
21. Paramæcium chrysalis.
22. Actinophrys sol (budding).
23. Monura dulcis.
24. Daphnia.
25. Amœba.
26. Chiloden.
27. Cypris.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W. J. WELCH Sc

Fig. 139.

With regard to the interpretation which should be put upon microscopic results, the fewer living forms met with, as before said, the purer the water.

Cotton fibres, epithelium, potato starch, hairs, and similar structures, although they may be harmless in themselves, are evidences that the water is susceptible of human contamination.

Confervoid growths, algæ, and desmids (Nos. 1, 2, 4, 5, 6, 7, and 8, fig. 139) are met with in running streams of great purity; and if these are *the only structures* met with, a water should not be condemned; but, in the writer's experience, when such forms have been numerous, infusorial life is also present.

On the other hand, ciliated forms (such as Nos. 14, 15, 16, 17, 18, 19, 20, 21, and 23, fig. 139) are, as a rule, indicative of sewage contamination; it is indeed said that waters containing paramæcium are even injurious to animals.

Anguillula fluvialis, a small and active eel-like worm so frequently met with in river-water, is said to be the origin of *trichina*, but of this there is no proof.

Fungi and much decaying vegetable matter are always suspicious.

Microscopic results, unless very definite, should be supplemented by chemical analysis.

Water, Chemical Examination of.—The apparatus required for the entire examination of water are—1. A balance that will turn with a milligramme when each scale is loaded with 50 grammes, and that has room on the pans to take a platinum dish of 100 cubic centimetres capacity. 2. Accurate weights. 3. Measures; of these, flasks are convenient: one of 70 cubic centimetres, one of 100 cubic centimetres, one of 50 cubic centimetres, and one of 500 cubic centimetres, will answer the purpose admirably; they have a mark cut on the neck, and are gauged to hold the exact quantity. 4. Pipettes. 5. One or more burettes. 6. Large retorts, holding at least 1600 cubic centimetres. 7. A large Liebig's condenser. 8. A platinum dish of 100 cubic centimetres capacity. 9. Glass cylinders, holding about 160 cubic centimetres.

Colour.—It is sometimes necessary to make a definite statement about the colour of water, and Mr. Falconer King has proposed a method by means of which this may be measured and referred to a standard. The process consists of adding an aqueous solution of caramel of a certain strength from a burette to a known quantity of distilled water, which may be contained in an ordinary nesslerising cylinder. The standard solution of caramel is made by adding caramel to distilled water until the proper depth of tint has been attained. "The depth of colour which it should possess is ascertained as follows: To 8 oz. of pure water, perfectly free from ammonia, contained in a glass tube, and forming a column 12 inches long, add 10 grains by volume of solution of ammonium chloride, containing 3·17 grains of the salt in 10,000 grains of water (or ·001 grain of ammonia in 1 grain of solution). To this mixture, after proper agitation, add 25 grains by volume of Nessler's solution, of the usual strength; allow this, after mixing, to repose for ten minutes at a temperature of 60° F., when the colour produced will equal about 30° in my scale. That is, 300 grains by volume, or 30° (a degree being equal to 10 grains by volume), of caramel solution, if of proper strength, will produce exactly the same depth of colour when added to the same amount of distilled water (8 oz.) in a column 12 inches long."—(Process for the Estimation of Colour in Water, by J. Falconer King, Chemical News, No. 800, 1875.) The rest of the process is exactly similar to nesslerising.

Suspended Matters.—The best way of estimating matters in suspension is to take the solid residue of the water unfiltered, then filter a portion of the water, and again take the solid residue; the difference between the two determinations is the *suspended matters*.

Solid Residue.—All natural waters hold various matters in solution, and when the water is driven off by heat, a sediment remains—this is the solid residue. In order to take it, the best way is to evaporate 100 cubic centimetres to dryness in a platinum dish over the water-bath and then weigh; the result may be expressed in French weights as so much per litre, or in English as grains per gallon, by simply multiplying by 7 and dividing by 100; for example, 100 cubic centimetres evaporated down gave ·0892 of residue; this by calculation = 62·44 grains per gallon.

A still more convenient way is to evaporate 70 cubic centimetres down, then each milligramme is equal to 1 grain per gallon; for example, if 70 cubic centimetres had given ·0892 of residue, the solids per gallon would be 89·2 grains. If a quantitative examination of the salts present in water be wanted, a very large bulk will require to be concentrated (say 4 or 5 litres) first in a flask and lastly over the water-bath. The solid residue obtained by evaporating down 100 cubic centimetres is generally ignited at a dull red heat; the loss represents volatile and organic matter, but too much stress must not be placed upon any loss which may occur in this manner, as much volatilisation of the chlorides may take place. If, however, there is blackening, it is a sure indication of organic matter. If the solid residue is high and inorganic, the sample is a hard water; if low, it is a soft water.

The following are examples of solid residue:—

	Grains per Gallon.
Sea-Water.	
Atlantic Ocean	2688·00
Mineral-Waters.	
Seltzer	290·00
Spa	83·00
Tunbridge	8·60
Seidlitz	1928·00
Cheltenham	805·00
Harrogate	940·00
River-Waters.	
Avon	7·77
Severn at Newtown	6·02
Thames, as supplied to London	21·66
Rhine at Basle	11·86
Danube near Vienna	9·89
Spree at Berlin	7·98
Garonne at Toulouse	9·56
Irwell, near its source	5·46
Mersey, above Warrington	19·85
Lake-Waters.	
Loch Katrine	2·30
Bala Lake	3·18
Bassenthwaite	3·27
Windermere	4·05
Lake of Geneva	10·64
The Great Salt Lake	936·40
Spring and Well Waters.	
Norwich artesian well, 400 feet deep	26·70
Rochdale spring	25·93
Worthing deep well in the chalk	22·71
A spring near Exmouth	109·00
Wells near Kingsbridge	51·70
Wells from the red sandstone (Devon)	10·00

Hardness.—Waters abounding in calcareous and magnesian salts use or destroy much soap before a lather is formed. The explanation of this is that the soap forms insoluble salts with the lime, &c. Such waters are said to be hard, the converse soft. Now it is obvious that the soft waters have a small solid residue; the hard, a large. A water with 8 or 10 grains of solid residue is a moderately soft water; the lake-waters with from 2 to 3 grains of residue are extremely soft, whilst those with 50, 60, 70, and 80 grains of saline residue must be hard; so that any other test except taking the solid residue is really superfluous. If, however, the soap test of Dr. Clarke is required to be used, the modification proposed by Messrs. Wanklyn and Chapman is most convenient and most accurate. A standard solution of pure chloride of calcium is first prepared, the strength being 1·110 grammes to the litre. Each cubic centimetre equals 1 milligramme of carbonate of lime. The soap test is made by pounding together two parts of lead plaster and one of carbonate of potash, exhausting them with alcohol of about 90 per cent. (about thirty times as much alcohol as there is lead plaster is used in this operation); it is then diluted with about its own volume of water, and standardised in the following manner: 10 cubic centimetres are put in a bottle with 70 cubic centimetres of water, the standard chloride of calcium solution added until frothing stops; it is then easy to calculate so as to dilute the soap solution, so as to make 17 cubic centimetres of standard soap solution to exactly neutralise 16 cubic centimetres of the calcium solution, each cubic centimetre of the soap solution will then be equivalent to 1 milligramme of carbonate of lime. In order to use the test, 70 cubic centimetres of water are put in a flask, the soap solution added gradually from a burette, or other convenient graduated instrument. After each addition the flask should be well shaken, and when a permanent lather is formed, the number of soap cubic centimetres used is noted down, each cubic centimetre used being equal to 1 grain of carbonate of lime, or its equivalent, in a gallon of water.

In testing the hardness of waters, it is convenient to take first water previous to boiling and treat it as detailed, this gives the *temporary hardness;* then boil another 70 cubic centimetres of the water for a little time, again test, this gives the *permanent hardness.*

By a modification of this method the magnesia and lime salts may be very readily and quickly estimated, for if first the total hardness is taken, and then the lime is precipitated in a fresh portion (say a litre) by oxalic acid, the liquid filtered, and the soap test added, it is evident that any hardness it may possess now must be due to magnesia, for the lime has been removed; if the number of cubic centimetres of soap solution used be now subtracted from those used previous to separation of the lime, we get hardness due to lime.

Chlorine.—The importance of determining the amount of chlorine arises from the fact, that as the excreta of man and animals abound in chlorides, if liquid sewage leak into a well, the chlorides must necessarily be increased, nor can there be extensive *sewage pollution* without high chlorides. There are, however, certain springs of hard water which naturally contain a considerable amount of chlorides; in such a case, the absence of organic matter and undue nitrates, and the character of the springs in the vicinity, will generally guide the analyst to a correct conclusion. The chlorine in water may be determined gravimetrically by adding a solution of nitrate of silver to the water acidulated with nitric acid, washing first by decantation, then transferring the precipitate to a filter, drying, and lastly igniting in a crucible (the whole process is best done in a room only just light enough to carry on the operation). The weight of the resulting chloride of silver, multiplied by ·2474, equals the chlorine. The most usual and best way is, however, by a volumetric process. Dissolving ·479 gramme of nitrate of silver in a litre of water, we obtain a solution, of which 1 cubic centimetre equals ·1 milligramme of chlorine; to use it, a small crystal of neutral chromate of potash is dissolved in 100 cubic centimetres of the water to be tested, and the silver solution added drop by drop from a graduated pipette or burette. Now, as the nitrate of silver does not form the red chromate until all the chlorides are exhausted, the chromate of potash acts as an indicator; for directly enough nitrate of silver has been added, there is a permanent shade of red. A little practice soon hits the exact moment, and this method is of great delicacy; but as chromates often contain chlorides, it is necessary to ascertain how much standard silver solution is used with a definite weight of the chromate, and make the necessary correction. If it be required to express the amount of chlorine in grains, 70 cubic centimetres of the water are taken; the number of cubic centimetres of silver solution then equals tenths of a grain of chlorine in a gallon of water. For instance, 70 cubic centimetres of water used 15 cubic centimetres of silver solution; chlorine per gallon then equals 1·5 grains.

The following are examples of chlorine in natural water, both pure and polluted:—

	Grains per Gallon.
Sea-water	1330·840
Rivers.	
Thames at Kew	0·847
Rhine at Basle	0·105
Severn at Worcester	2·800
Elbe at Hamburg	1·900
Lakes.	
Bala	0·706
Ullswater	0·693
Derwentwater	0·906
The Great Salt Lake	515·200
Springs and Wells.	
Surface wells from the red sandstone (Devon)	1·350
Hard water from wells near Kingsbridge	6·750
A well in a North Devon parish which propagated typhoid fever	8·850
Wells in the neighbourhood of the last found to be pure	1·250
A well in village east of London (WANKLYN)	15·610

Nitrates and Nitrites, Determination of.—A great many rival processes have been adopted for this purpose. Nitrates may be determined—

1. By conversion of nitric acid into ammonia.

2. By reducing the nitric acid to nitric oxide and retransforming it into nitric acid.

3. By reducing the nitric acid to nitric oxide and measuring it as such.

4. Determining the amount by the oxidising action of nitric acid in a solution of indigo.

The first method, proposed by Schultze and modified by Chapman and Wanklyn, is very convenient and is much employed. It essentially consists of converting nitrates and nitrites into ammonia by means of metallic aluminum acting on a cold alkaline solution. A hundred cubic centimetres of water are introduced into a non-tubulated retort, and 50 to 70 cubic centimetres of a solution of caustic soda, which must be free from nitrates, added; the contents of the retort are then boiled until water distils ammonia free; it is then allowed to cool, thin sheet aluminum introduced into it, the mouth of the retort closed with a cork provided with a small tube containing broken-up tobacco-pipe wet with dilute hydrochloric acid; this tube is connected with a second filled with pumice-stone moistened with sulphuric acid. The retort is now left at rest for several hours; it is then attached to a condenser and distilled, the ammonia estimated by nesslerising or by titration.

The present writer, however, prefers to put the water, soda, and aluminum into a flask with a lateral tube connected with a small Liebig's condenser, the delivery tube of the latter dipping into some distilled water very faintly acidulated with hydrochloric acid, and to let the apparatus stand overnight; the next morning heat is applied, and the ammonia distilled over. The proposed modification has this advantage, that no ammonia, if the flask is properly corked and the tube carefully fitted to the condenser, can possibly be lost, nor does the apparatus require to be handled until the operation is finished.

In the determination of nitrates, &c., by conversion into ammonia, the following table will be useful:—

Ammonia NH_3	Nitrogen.	Nitric Acid.
1	0·824	3·71
2	1·647	7·41
3	2·471	11·12
4	3·294	14·82
5	4·118	18·53
6	4·941	22·24
7	5·765	25·94
8	6·588	29·65
9	7·412	33·35
10	8·235	37·06
11	9·060	40·76
12	9·900	44·47
13	10·701	48·18
14	11·530	51·88
15	12·353	55·59
16	13·176	59·29
17	14·000	63·00
18	14·823	66·71
19	15·647	70·41
20	16·470	74·12

The second method (Schlosing's)—viz., conversion first into nitric oxide, and then into nitric acid—is an excellent one, but too complex for general purposes.

The third method, first proposed by Walter Crum—viz., the conversion of nitrates, &c., into nitric oxide, and measuring as such—has been much employed by Frankland, modified by Schultze, and still farther perfected by Ziemann.

One hundred to 300 cubic centimetres of water are evaporated down to 50 cubic centimetres, and placed in a flask (fig. 140). A, the flask, has an indiarubber stopper having two apertures, through these pass two bent tubes, *a b c*, *e f g*. The *a b c* tube is drawn to a point and passes through the stopper to a depth of 2 centimetres, the other ends exactly at the underside of the stopper. At *c* and *g* are indiarubber connecting tubes, provided with pinchcocks; at *h* the tube turns up, and is covered with a piece of indiarubber tubing to prevent breakage. B is a glass trough filled with soda lye; C is a measuring tube. The water is first boiled in A to expel air, the tube *f g h* not being immersed; after boiling for some time,

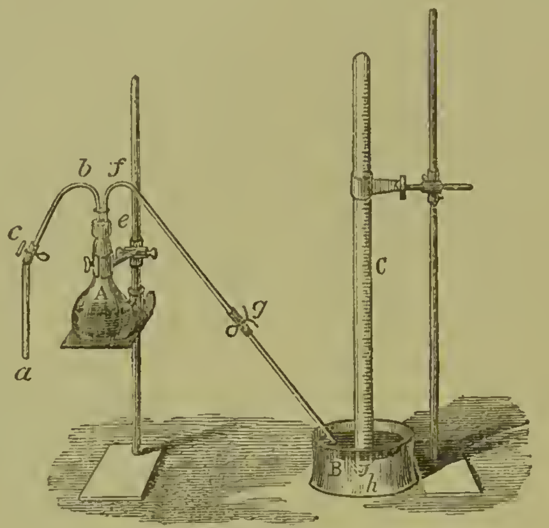

Fig. 140.

the end *h* is put in the soda lye, the pinch-cock applied at *g*, and the vapours now escape by *d*, when about 10 cubic centimetres of water only remain. The lamp is now withdrawn, a pinchcock applied at *c*, and *c d* filled with water; now the end *h* is placed under the measuring tube. Solution of protochloride of iron is poured into a beaker, and concentrated hydrochloric acid in another beaker is also held in readiness; the tube *c d* is then placed in the iron solution, and 15 to 20 cubic centimetres allowed to flow in, which it readily does by opening the stopcock, on account of the vacuum in the flask. The iron is cleared out of the tube by allowing two successive portions of hydrochloric acid to flow in. Gentle heat is now applied, and when there is evidence of internal pressure, the nitric oxide is allowed to pass over into C. The volume of nitric oxide must of course be corrected by the barometer and for temperature. One milligramme of nitric acid = ·41 cubic centimetres of nitric oxide at a pressure of 760 millimetres, and a temperature of 0° C.

The fourth method—viz., the oxidation of indigo—is very convenient, and is sometimes employed. There are various modifications of the process, but Trommsdorf's is perhaps the best; he takes 25 cubic centimetres of the water, and 50 of sulphuric acid, finds approximatively by a preliminary experiment the amount of indigo solution necessary to add to produce a green colour. The value of the solution of indigo is first ascertained by experimenting on a solution of nitre of known strength, and then the final assay can be made quickly, so that the error arising from prolonged action is avoided.

If the nitrites alone in water require estimation, one of the three following processes may be used (ED. NICHOLSON, Chemical News, vol. xxxii. No. 827):—

1. *Volumetric Estimation by Arsenious Acid.*—To 500 cubic centimetres of water in a stoppered white bottle add 5 cubic centimetres of potassium iodide solution ($\frac{1}{10}$), and then 5 cubic centimetres of dilute ($\frac{1}{10}$) pure sulphuric acid. Allow the reaction an hour for full development. If the iodine be liberated in very small quantity, or if it be masked by turbidity of the water, add a drachm of benzine or chloroform, and agitate; the iodine will give

it a pink colour, which is quite as sensitive as the blue colour given by starch, and disappears more quickly when the iodine is absorbed. The iodine is estimated by neutralising the acid by a slight excess of sodium carbonate, and the centinormal arsenious solution is dropped in until the iodine colour disappears.

2. *Mr. P. Holland's Colorimetric Process.*—A solution of pure nitrite is prepared containing ·01 centigramme of nitrous acid in each cubic centimetre. A solution of iodine (about 4 grammes per litre) in potassium iodide is also prepared, and adjusted to such strength that 10 cubic centimetres made up to 200 cubic centimetres with pure water shall produce the same colour as 10 cubic centimetres of the standard nitrite solution made up to 200 cubic centimetres with water containing potassium iodide, and some dilute sulphuric acid. The iodine reaction being developed in a certain quantity of water containing nitrites (as in the preceding process), an equal colour is produced in an equal quantity of pure water by the addition of the standard iodine solution. Each cubic centimetre = ·01 centigramme of nitrous acid.

3. *Mr. Nicholson's Process.*—This is founded on the liberation of iodine by a permanganate under the same circumstances as its liberation by nitrous acid. ·01 centigramme of active oxygen contained in 1 cubic centimetre of the dilute standard solution of permanganate commonly used (·395 gramme per litre) liberates ·159 centigramme of iodine, while ·01 centigramme of nitrous acid liberates ·40 centigramme of iodine under the same circumstances. The application of this principle to colorimetric estimation is obvious; ·01 centigramme of active oxygen contained in 1 cubic centimetre of the dilute standard permanganate solution, in a comparative experiment, liberates the same quantity of iodine as ·004 centigrammes of nitrous acid. Let the iodine reaction be produced, as in the first process, in 500 cubic centimetres of the water under examination. When the colour is fully developed, add in the same way potassium iodide, and sulphuric acid to 500 cubic centimetres of pure water, and then drop in the dilute standard permanganate solution until an equal iodine colour is produced. The development of the colour is immediate.

It is evident that by these volumetric processes, nitrates by reduction to nitrites may also be quantitatively estimated.

Estimation of the Ammonia and Organic Matter.—Most potable waters contain a minute quantity of ammonia; this is expelled by boiling, and if such water is distilled, this free ammonia collects in the first portions of the distillate; it therefore admits of great concentration, for the distillate may be again distilled, and so on. In this way the presence of ammonia may be shown by the Nessler test, even when it exists in so small a quantity as 1 part in 200,000,000 of water. The presence of organic matter in water may be shown in various ways. The chlorides of silver and gold when boiled with impure water, become reduced; and a dilute solution of permanganate of potash is decolourised by the oxidation of the organic matter, and subsequent reduction of the permanganate. On this reaction was founded a means of estimating the impurities, which was formerly much used, but now Mr. Wanklyn's ammonia process has entirely superseded it.

The Ammonia Process.—By this process the organic matters, which consist of vague indefinite nitrogenous bodies, are converted into a definite compound—viz., ammonia—and estimated and expressed as ammonia. The reagents required are — 1. *Nessler test* (see NESSLER TEST). 2. *Distilled water*, free from ammonia, which may be obtained by redistilling ordinary distilled water, or distilling a large quantity of water, and rejecting the first and last portions. 3. *Alkaline permanganate.* This is made by dissolving 200 grammes of caustic potash and 8 grammes of crystallised permanganate of potash in 1 litre of water. 4. *A standard solution of ammonia* containing $\frac{1}{100}$ of a milligramme of ammonia in 1 cubic centimetre of water (·03882 gramme of sulphate of ammonia, or ·0315 of chloride of ammonia to the litre). As well as these reagents, the apparatus — retort, condenser, &c. — before mentioned is required.

The actual analysis is thus performed: Half a litre of the water to be examined is put in the large retort and adapted to the condenser and 100 cubic centimetres are distilled over into a glass cylinder. Now, this 100 cubic centimetres probably contains ammonia, accordingly $1\frac{1}{2}$ cubic centimetres of Nessler are run into it; if there be the slightest discolouration, as seen by holding the cylinder over a sheet of white paper, into another glass cylinder some of the standard solution of ammonia is dropped from the burette, then some distilled water is added, so that the two cylinders have an equal column of water, $1\frac{1}{2}$ cubic centimetres of Nessler run in, and the two cylinders narrowly compared; if the colour of the test is too dark or too light, another cylinder is taken, and so on until they correspond, each cubic centimetre of the standard solution equalling ·00001 of NH_3. This is the *free ammonia.* Next, 50 cubic centimetres of the permanganate solution are added to the retort, and 200 or 250 cubic centimetres distilled over in successive portions, nesslerised, and the ammonia estimated as before; the quantities added together give the *albuminoid ammonia*. Of course, both the free and the albuminoid ammonia require to be multiplied by 2 to give the quantity in a litre—that is, parts per million.

The process described is equally applicable to sewage, wine, milk, urine, or other organic fluid, the only difference being that minute quantities must be taken. In like manner very bad water cannot conveniently be analysed in bulk; 5, 10, or 25 cubic centimetres may be taken, and put in half a litre of pure distilled, ammonia free, water, and the process carried out as before.

The following are examples of pure, indifferent, and bad samples of water from original and other sources:—

	Free Ammonia. Parts per Million (Mgrms. per Litre).	Albuminoid Ammonia. Parts per Million (Mgrms. per Litre).	Quality.	Name of Authority.
Loch Katrine	0·004	0·08	Good.	Wanklyn.
West Middlesex County (London).	0·010	0·06	,,	,,
Surface well, red sandstone (Devon)	0·010	0·08	,,	A. Wynter Blyth.
Ilfracombe supply	0·010	0·08	,,	,,
Edinburgh water-supply (Colinton, September 1867). . . .	0·140	0·08	Indifferent.	Wanklyn.
A well-water (North Devon) . .	0·080	0·12	,,	A. Wynter Blyth.
Thames (London Bridge) . .	1·020	0·59	Bad.	Wanklyn.
Water from a pump in Edinburgh	0·210	0·29	,,	,,
A well which propagated typhoid fever (North Devon) . . .	0·160	0·12	,,	A. Wynter Blyth.
Do. (Martley, Worcestershire) .	0·150	0·30	,,	,,

Metals.—To search for metals it is necessary to evaporate down at least a litre to a small bulk, after first adding soda or potash, in order to render it alkaline. The metals to be looked for are lead, copper, iron, manganese, zinc, and arsenic. Arsenic may be detected by Marsh's apparatus. This impurity is extremely uncommon. Manganese, by taking a little of the saline residue on a hot bead of carbonate of soda and submitting it to the blow-pipe flame; the pink manganate of soda is very characteristic. Iron may be detected by adding a drop of a solution of the mixed ferro and ferrid cyanides; if iron be present, the result will be a blue colour. The quantity can be estimated by the process described under VOLUMETRIC SOLUTIONS, or by reducing the whole of the iron to the state of protoxide by sulphurous acid, and then estimating it volumetrically. The white precipitate zinc gives in neutral or alkaline solution with sulphuretted hydrogen is very characteristic, but the resulting precipitate must be collected and further identified. But the most frequent and most important of all metals to be looked for is lead. Lead gives a dark colour with sulphuretted hydrogen, or if in any quantity, a black precipitate. Copper also acts similarly, but the precipitate, if copper, will dissolve in cyanide of potassium. Copper also gives a reddish-brown precipitate with potassic ferrocyanide. To estimate small quantities of lead in water, Mr. Wanklyn proposes the following easy method: A standard lead solution, containing ·1 milligramme of lead in each cubic centimetre, is prepared. Four hundred cubic centimetres of the water to be examined are directed to be taken, treated with 4 cubic centimetres of saturated sulphurous acid and 1 cubic centimetre of dilute sulphuric acid put into a retort, and 210 cubic centimetres distilled over; then 100 cubic centimetres are transferred to a glass cylinder, 5 cubic centimetres of sulphuretted hydrogen added, and into another cylinder a small quantity of the standard lead solution run from a burette, the cylinder being filled to the same height as the other with acidulated water. It is then treated with the same quantity of sulphuretted hydrogen as the former. If the colours correspond, the amount of lead in each is equal; if not, another cylinder is taken, and a different quantity of standard lead solution run in, and so on until a correct determination is made.

The Estimation of Air and Organic Volatile Bases.—All water contains air. If necessary to estimate it, a flask of 400 cubic centimetres capacity must be taken, with a tightly-fitted perforated cork to which is fitted a tube; to this again is adapted an indiarubber tube with pinch-cock, which may, when necessary, cut the connection off from a bulb tube, which again is connected with a very long barometer tube terminating in an inverted cylinder filled with mercury. The water in the bulb is made to boil, and all air expelled from the apparatus; the flask is then boiled for hours, and the resulting air collected in the mercury tube and ultimately measured.

Some waters, especially those much contaminated by sewage, yield a distillate the alkalinity of which is greater than indicated by the Nessler test. This distillate, if redistilled with alkaline permanganate, yields a distillate containing more ammonia than at first; the difference is due to organic volatile bases. The subject demands farther investigation.

On the Examination of Small Quantities of Water.—The ordinary chemical examination of water embraces merely four things—viz., solid residue, chlorine, free and albuminoid ammonia—for with these four data a definite opinion may be given as to its purity and wholesomeness. The four cannot be *conveniently* estimated with less than 640 cubic centimetres—viz., 500 cubic centimetres for the ammonia, 70 cubic centimetres for chlorine, and 70 cubic centimetres for solid residue; but of course the chlorides can be estimated by redissolving the solid residue, which reduces the quantity to 570 cubic centimetres. Bad waters, or even moderately bad, may also be analysed satisfactorily in so small a quantity as 100 cubic centimetres—viz., 70 cubic centimetres for solid residue and chlorine, and 10 to 30 cubic centimetres for ammonia process.

Purification and Softening of Water.—Water may be purified by filtration, subsidence, distillation, and the addition of chemical agents. Full details on filtration will be found in the article FILTERS. Distilled water is used for drinking purposes on a large scale in some parts of the world; as, for instance, some of the sea-coast towns in the rainless districts of Peru, where a company distil sea-water. The navy is also furnished with a proper apparatus for this purpose. Water distilled from the sea has at first a mawkish taste, on account of volatile organic matters; these may be got rid of by aëration of the water, or redistillation. Of all methods for the purification of water, distillation is the most effectual, but, generally speaking, the least practical. Organic matter may briefly be said to be got rid of by aëration, prolonged boiling, filtration or admixture with charcoal, the addition of alum, potassium, permanganate, and certain astringents, such as tea, kino, &c.

Waters are most easily softened by Dr. Clarke's process, which consists in adding lime to a hard water. Nearly all the calcium carbonate dissolved in the water is thrown down; some organic matter is also destroyed.

With regard to the action of iron pipes on the purifying of water, *see* WATER-SUPPLY.

Effects of Impure Water.—Water contaminated by human sewage cannot but be hurtful, although the sewage of healthy persons has, to the author's knowledge, been drunk in a diluted form for a long period without effect; but the sewage matter from patients suffering under any form of zymotic disease—cholera, typhoid fever, &c.—is most contagious and poisonous. There can also be little doubt that some organic substances in water produce diarrhœa, dysentery, and other affections, whilst some waters have contained metallic impurity sufficient to produce illness; *e.g.*, a factory at Basle discharged water containing arsenic into a pond, whence the water leaked into the neighbouring springs. —(ROTH and LEX, Militair. Gesundheitspflege.) The ordinary water-supply of Cheddar was found to contain so large a quantity of lead as to be poisonous.

It is tolerably certain that most of the parasites—such as worms, &c.—are sometimes introduced into the body by impure water.

Very hard waters, especially those from the limestone rocks, appear to cause goître; and in the districts in England possessing the most calcareous waters, calculous affections are frequent. *See* LEAD, WATER-SUPPLY, &c.

Water-Closets—*See* CLOSETS, NUISANCES, PRIVIES, &c.

Water, Protection of—There is now ample power to protect water-supply efficiently from pollution in every part of the British Isles. In Scotland, unwholesome water is declared to be a nuisance by 30 & 31 Viet. c. 101, s. 16 (*b*), and may be dealt with as such. In Ireland and England—by the Public Health Act, Ireland, 1874, and the Public Health Act, England, 1875—there are provisions which, if carried out, will prevent to a great extent the drinking of polluted water.

On the representation of any person to any local authority that, within their district, the water in any well, tank, or cistern, public or private, or supplied from any public pump, and used, or likely to be used, for drinking or domestic purposes, or for manufacturing drinks for the use of man, is so polluted as to be injurious to health, such authority may apply to a court of summary jurisdiction for an order to remedy the same; and thereupon such court shall summon the occupier of the premises to which the well, tank, or cistern belongs if it be private, and in the case of a public well, tank, cistern, or pump, any person alleged in the application to be interested in the same, and may either dismiss the application, or may make an order directing the well, tank, cistern, or pump to be permanently or temporarily closed, or the water to be used for certain purposes only, or such other order as may appear to them to be requisite to prevent injury to the health of persons drinking the water; and the court may, if they see fit, cause the water complained of to be analysed at the cost of the local authority applying to them under this section.

If the person on whom an order under this section is made fails to comply with the same, the court may, on the application of the local authority, authorise them to do whatever may be necessary in the execution of the order, and any expenses incurred by them may be recovered in a summary manner from the person on whom the order is made. The expenses incurred by any rural authority in the execution of this section, and not recovered as aforesaid, shall be *special expenses*.—(P. H., s. 70.) *See also* GAS, SEWAGE, &c.

Water - Rights—There is no sanitary law which interferes with any definite water-right. The Secretary of State, it is true, may alter the course of streams on certain conditions by awarding compensation, or sanitary authorities may, by agreement or otherwise, obtain a water-supply; but they have no power, to the injury of private persons or the public, to divert any watercourse or stream flowing in a *definite channel* without consent of the riparian or other owners.

It would appear that there is no right of water except the water flow, whether above the ground or under the ground, in *definite* channels. "The law respecting the right to water flowing in definite visible channels may be considered as pretty well settled by several modern decisions, and it is very clearly enunciated in the judgment of the Court of Exchequer in the case of Embrey *v.* Owen (6 Exchequer Reports, 369); but the law, as laid down in those cases, is inapplicable to the case of subterraneous water not flowing in any definite channel, nor indeed at all in the ordinary sense, but percolating or oozing through the soil more or less according to the quantity of rain that may chance to fall" (Chasemore *v.* Richards, 29 L. J. Ex., 81; 3 L. T. (O. S.), 350, Glenn). So that, on the one hand, an owner may appropriate surface-water flowing on his ground in no definite channel (Harrop and another *v.* Hirst, 19 L. T. (N. S.), 426; L. R. 4 Exch., 43; 34 L. J. Exch., 1); and on the other, subterranean water may be appropriated by an owner by sinking a well, even although sinking it may drain his neighbour's well, or injure a neighbouring stream; nor would a sanitary authority, or an individual, according to this principle, have any right to complain in the still greater evil of subterraneous works—such as mines, &c.—draining and depriving a whole village of water, for an owner may drain his land although such drainage is to the detriment of his neighbour (Rawstron *v.* Taylor, 11 Exch. Rep., 369; 25 L. J. Exch., 23. Popplewell *v.* Hodgkinson, 20 L. J. (N. S.), 578).

With regard to running streams, each riparian proprietor has a right to use the water in whatever manner he pleases so long as he does not interfere with the rights of others below him (Embrey *v.* Owen, 6 Exch. Rep., 369); and by the case of Sutcliffe *v.* Booth (32 L. J. 2 B., 136) it would appear that an artificial stream may acquire all the rights of a natural one. But although an adjacent proprietor has a right to the reasonable use of the water, an action will lie for any unreasonable and unauthorised use, for the right of water is analogous to that of air and light (6 Exch., 353; 20 L. J. Exch., 212); nor may a riparian proprietor interrupt the regular flow (12 Moo. P. C. C., 131 and 156).

Water-Supply—It is the duty of every sanitary authority to see that every place under their supervision has a fairly pure and wholesome supply of water. The amount required for towns is as follows:—

	Gallons per Day per Inhabitant. Least.	Average.	Greatest.
Water required for domestic purposes	7	10	15
Washing streets, extinguishing fires, supplying fountains, &c.	3	3	3
Trade and manufactures	7	7	7
	17	20	25
Waste about	2	2	2½
Total demand	19	22	27½

An enormous quantity is often used for manufacturing purposes, therefore in some towns this amount is greatly exceeded. For small villages 19 gallons per head daily is generally enough, for moderate-sized towns 25, and for manufacturing towns at least 30. In some places there exist springs at such a height and of such copiousness that by simply laying on the pipes the water will by gravitation alone be supplied to the top story of every house. This convenient state of things is found in many of the villages and small towns of hilly districts; but in the great majority of towns a storage reservoir, and very frequently pumping-engines and other expensive machinery, are required. Mr. Bailey Denton recommends in rural districts underground tanks made of concrete. "The commonest lime properly slaked and mixed in due proportion with clean gravel and sand, or with burnt clay ballast, or even sifted chalk itself, if faced with Portland cement, will make admirable tanks. Selenitic cement will probably be found on trial to be equally applicable as a water-tight facing, using perhaps twice as much more than Portland cement, which can be done without increase of cost, for it is to be bought at half the price. . . . In some parts of the chalk districts underground tanks have been made by burrowing into the earth and making a chamber or cavern (with an opening at the top for the removal of the soil), which being lined inside with a thin covering of cement, is made perfectly water-tight. Thus the most capacious tanks may be provided for comparatively a few pounds, and districts may be supplied with water which are now destitute of it. This mode of constructing tanks might also be adopted in other geological formations besides the chalk, when the water-level is low in the earth, with a considerable depth of drained subsoil above it, within which to make the cavern tank. I need hardly say that such a receptacle for water can only be adopted where the soil is naturally drained, and where there is no pressure of external subsoil-water. No dwelling or set of buildings, of which the roofs are slate or tile, should be without its tank, unless the occupants are otherwise abundantly supplied."—(The Storage of Water, by J. BAILEY DENTON, C.E., &c.)

The same author shows that by careful storage and collection of the rain-water, an ordinary middle-class house, and a cottage in a village, would command respectively 20,280 gallons and 7070 gallons yearly; that in villages, by supplementing the individual supply with a common tank holding a month's supply, "water may be delivered in the village street from these reservoirs at from 20s. to 25s. per person, including purchase of land for the reservoir, iron pipes, stand pipes, and taps. Assuming that the money required be borrowed, and paid off in thirty years by instalments not exceeding in amount 5 per cent. on the outlay, the result would be a charge of 1s. to 1s. 3d. per person per annum."—(*Op. cit.*)

It would also appear certain that immense subterranean reservoirs of water exist in the new red sandstone, the chalk, the upper and lower greensand, and other porous geological strata, which only require deep artesian borings to reach them.

Of all the natural waters, those from deep subterranean sources are the purest; they are well aërated, perfectly free from human contamination, and destitute of life.

But in recommending the sinking of an artesian well, which is a work of considerable magnitude and cost, the ground must be very carefully studied, and the geology of the district accurately known.

As one of the most remarkable artesian wells in existence, and an instance of the practical application of geological knowledge, the Grenelle artesian well may be cited. The boring of this well, its initiation and completion, is entirely due to M. Mulot; it took eight years in sinking, but the ultimate success exceeded all expectations. The water immediately rose, then as it does to this day, 122 feet above the surface of the ground; it has a temperature above 81° F., and its flow is computed to be about 800,000 gallons daily. The depth of the well is no less than 1802 feet. The great success of this undertaking has stimulated in a marked manner artesian borings, and most of those in our own country and the Continent have been successful:* the most unfortunate one perhaps being the Southampton well, where, after an expenditure of £13,000, and reaching a depth of 1317 feet, the work was abandoned.

There are two systems of supply—viz., (1) the constant service, in which all the distributing pipes are kept charged with water at all times; (2) the intermittent service.

The advantages of the former are great. The pipes being always full, are not liable to rust, and the necessity for cisterns is obviated. With an intermittent supply, on the water

* As an example of the benefit of an artesian well in some cases, the following may be cited: "At Bulphan Fen, near Aveley, Essex, is a large tract of grass-land, situated at a low level and liable to be much flooded in the winter season. Its value was formerly little, as in the summer-time it was destitute of good water, being wholly dependent upon the pools and ditches which retained the remains of the winter's rain and floods. This rendered it unfit for stock, as in addition to the small quantity of water remaining, even that was rendered bad by the heat of the weather. The landowners in the neighbourhood were induced to bore, and being successful in finding springs, the water from which overflowed the surface of the ground, their example was followed by the proprietor of the artesian well under consideration, who together with his father suffered much inconvenience from the scarcity of water upon 300 acres of low grass-land at Aveley. A spot was fixed upon at the edge of the uplands, and about the level of high-water mark of the Thames. The work was commenced during the month of August 1835. After carrying the boring successively through alluvial soil, soft boggy ground, and sand into the chalk, at a depth of 35 feet the auger and rods suddenly dropped 7 feet into a cavity of very soft, almost liquid chalk, from which the water rose to within 1 foot of the surface of the marsh. The water was conducted by a 2-inch pipe inserted 3 inches under the water-level into ditches traversing the land. The water ran white for some days, but ultimately perfectly clear, and continues to run night and day. The temperature is 51° F. winter and summer, and the quantity delivered in twenty-four hours about 30,000 gallons; it supplies two miles of ditches 10 feet wide, from which it runs into the sea."—(BURNELL's Well-Sinking, London, 1875.)

being turned off, a powerful suction action takes place at certain portions of the service through private and other taps being opened and drawing off the water. This suction action is liable to draw sewer gases, dust, and other impurities into the pipes; besides this, there is another objection—viz., the necessity for cisterns, which frequently get contaminated and dirty.

The water is conveyed to the streets and houses in towns by distributing pipes. The capacity of these pipes must be adapted to the greatest hourly demand for water, and to the requisite head in the streets, which head of pressure * ought to be, when the flow is most rapid, equivalent to an elevation of about 20 feet above the adjoining houses in order to supply the upper stories, or to be able in case of necessity to throw a jet to the top of the highest building without the necessity for a fire-engine. The total length of the distributing pipes required is stated to be about a mile for every 2000 or 3000 inhabitants.

The pipes laid along a street are divided into mains and service pipes—the mains being, as the name implies, the chief channels; the service, branches to supply a single or double row of buildings. It is of some importance in large towns to have two service pipes, one for each side of the street, so that in case of repairs being required, the traffic would not be interrupted. The mains and service are now generally of iron, the house pipes of lead. The author has found that water conveyed from a reservoir in closed iron pipes greatly improves in its transit; for example—

	Ammonia. Parts per Milligramme.	Albuminoid Ammonia. Parts per Milligramme.
The Ilfracombe reservoir water after passing through the filters	0·060	0·14
The same water in the service pipes	0·030	0·09
The Barnstaple reservoir water after passing through the filters	0·060	0·09
A. A pipe half a mile from reservoir	0·040	0·08
B. Half a mile from *A*	0·035	0·075
C. Half a mile from *B*	0·010	0·06

Whether this progressive diminution of the organic matter takes place also in other pipes besides iron, and whether it is due to oxide of iron or to the air in solution, is as yet unknown.

The legal provisions relating to water-supply are as follows:—

All existing public cisterns, pumps, wells, reservoirs, conduits, aqueducts, and works used for the gratuitous supply of water to the inhabitants of the district of any local authority shall vest in and be under the control of such authority, and such authority may cause the same to be maintained and plentifully supplied with pure and wholesome water, or may substitute, maintain, and plentifully supply with pure and wholesome water other such works equally convenient; or they may (subject to the provisions of the Act) construct any other such works for supplying water for the gratuitous use of any inhabitants *who choose to carry the same away, not for sale, but for their own private use.*—(P. H., s. 64.)

Any *urban* authority may provide their district or any part thereof, and *any rural authority may provide their district or any contributory place therein*, or any part of any such contributory place, with a supply of water proper and sufficient for public and private purposes, and for those purposes or any of them may—

1. Construct and maintain waterworks, dig wells, and do any other necessary acts.

2. Take on lease or hire any waterworks, and purchase any waterworks, or any water or right to take or convey water, either within or without their district, and any rights, powers, and privileges of any water company.

3. Contract with any person for a supply of water.—(P. H., s. 51.)

Before commencing to construct waterworks within the limits of supply of any water company empowered by Act of Parliament or any order confirmed by Parliament to supply water, the local authority shall give written notice to every water company within whose limits of supply the local authority are desirous of supplying water, stating the purposes for which and (as far as may be practicable) the extent to which water is required by the local authority.

It shall not be lawful for the local authority to construct any waterworks within such limits, if, and so long as, any such company are able and willing to supply water proper and sufficient for all reasonable purposes for which it is required by the said authority; and any difference as to whether the water which any such company is able and willing to lay on is proper and sufficient for the purposes for which it is required, or whether the purposes for which it is required are reasonable, or (if and so far as the charges are not regulated by Parliament) as to the terms of supply, are to be settled by arbitration.—(P. H., s. 52.) *See* ARBITRATION.

Where a local authority supply water within their district, they shall have the same powers and be subject to the same restrictions for carrying water mains within or without their district as they have for carrying sewers within or without their district respectively by the law for the time being in force.—(P. H., s. 54.)

A local authority shall provide and keep in any waterworks constructed or purchased by

* The "head of pressure" is the intensity of the pressure in feet of water.

them a supply of *pure and wholesome water;* and where a local authority lay any pipes for the supply of any of the inhabitants of their district, the water may be constantly laid on at such pressure as will carry the same to the top story of the highest dwelling-house within the district or part of the district supplied.—(P. H., s. 55.)

A local authority supplying water to any premises may charge in respect of such supply a water-rate to be assessed on the net annual value of the premises, ascertained in the manner prescribed by the Public Health Act with respect to general rates. They may, moreover, enter into agreements for supplying water on such terms as may be agreed on between them and the persons receiving the supply, and shall have the same powers for recovering water-rents or other payments accruing under such agreements as they have for recovering water-rates.—(P. H., s. 56.)

For the purpose of enabling any local authority to supply water the Waterworks Clauses Act, 1863, is incorporated with the Public Health Act, and the following provisions of the Waterworks Clauses Act, 1847 (namely),

With respect (where the local authority have not the control of the streets) to the breaking up of streets for the purpose of laying pipes; and

With respect to the communication pipes to be laid by the undertakers; and

With respect to the communication pipes to be laid by the inhabitants; and

With respect to waste or misuse of the water supplied by the undertakers; and

With respect to the provision for guarding against fouling the water of the undertakers; and

With respect to the payment and recovery of the water-rates.

Provided—

That the provisions with respect to the communication pipes to be laid by the undertakers and the inhabitants respectively, shall apply only in districts or parts of districts where the local authority lay any pipes for the supply of any of the inhabitants thereof; and

That any dispute authorised or directed by any of the said incorporated provisions to be settled by an inspector or two justices shall be settled by a court of summary jurisdiction; and

That section forty-four of the Waterworks Clauses Act, 1847, shall for the purposes of the Public Health Act have effect as if the words "with the consent in writing of the owner or reputed owner of any such house, or of the agent of such owner," were omitted therefrom; and any rent for pipes and works paid by an occupier under that section may be deducted by him from any rent from time to time due from him to such owner.—(P. H., s. 57.)

A local authority may agree with any person to supply water by measure, and as to the payment to be made in the form of rent or otherwise for every meter provided by them; they shall at all times at their own expense keep all meters and other instruments for measuring water let by them for hire to any person in proper order for correctly registering the supply of water, and in default of their so doing, such person shall not be liable to pay rent during such time as such default continues. The local authority shall for the purpose aforesaid have access to, and be at liberty to remove, test, inspect, and replace any such meter or other instrument.—(P. H., s. 58.)

Where water is supplied by measure by any local authority, the register of the meter or other instrument for measuring water shall be *primâ facie* evidence of the quantity of water consumed; and if the local authority and the consumer differ with respect to the quantity consumed, the difference shall be determined on the application of either party, by a court of summary jurisdiction, and such court may order by which of the parties the costs of the proceedings before them shall be paid, and its decision shall be final and binding.—(P. H., s. 59.)

If any person wilfully or by culpable negligence injures or suffers to be injured any meter or fittings belonging to a local authority, or fraudulently alters the index to any meter, or prevents any meter from duly registering the quantity of water supplied, or fraudulently abstracts or uses water of the local authority, he shall (without prejudice to any other right or remedy of the local authority) be liable to a penalty not exceeding *forty shillings*, and the local authority may in addition thereto recover the amount of any damage sustained. The existence of artificial means, under the control of the consumer, for causing any such alteration, prevention, abstraction, or use shall be evidence that the consumer has fraudulently effected the same.—(P. H., s. 60.)

Any local authority for the time being supplying water within their own district may, with the sanction of the Local Government Board, supply water to the local authority of any adjoining district on such terms as may be agreed on between such authorities, or as, in case of dispute, may be settled by arbitration.—(P. H., s. 61.) *See* ARBITRATION.

Where on the report of the surveyor of a local authority it appears to such authority that any house within their district is without a proper supply of water, and that such a supply of water can be furnished thereto at a cost not exceeding the water-rate authorised by any local Act in force within the district, or where there is not any local Act so in force, or at such other cost as the Local Government Board may, on the application of the local authority, determine under all the circumstances of the case to be reasonable, the local authority shall give notice in writing to the owner, requiring him, within a time therein specified, *to obtain such supply*, and to do all such works as may be necessary for that purpose.

If such notice is not complied with within the time specified, the local authority may, if they think fit, do such works and obtain such supply, and for that purpose may enter into any contract with any water company supplying water within their district, and water-rates may be made and levied on the premises by the authority or company which furnishes the supply, and may be recovered as if the owner or occupier of the premises had demanded a supply of water and were willing to pay water-rates for the same, and the expenses incurred by the local authority in doing such works may be recovered in a summary manner from the owner of the premises, or may by order of the local authority be declared to be private improvement expenses.—(P. H., s. 62.)

Any water company may contract to supply water or may lease their waterworks to any local authority; and the directors of any water company, in pursuance, in the case of a company registered under the Companies Act, 1862, of a special resolution of the members passed in manner provided by that Act, and in case of any other company of a resolution passed by three-fourths in number and value of the members present, either personally or by proxy, specially convened, with notice of the business to be transacted, may sell and transfer to any local authority, on such terms as may be agreed on between the company and the local authority, all the rights, powers, and privileges, and all or any of the waterworks and other property of the company; but subject to all liabilities to which the same are subject at the time of such purchase.—(P. H., s. 63.)

For the section of the Public Health Act relative to the alteration of water or gas pipes, *see* article GAS, p. 250.

Districts may be united by a provisional order of the Local Government Board for the purpose of procuring a common supply of water.—(P. H., s. 279.) *See* FIRES; GAS; RIVERS, POLLUTION OF; SEWAGE; WATER, SUPPLY OF; WELLS, &c.

Watering of Streets—*See* STREETS, &c.

Weights and Measures—The General Medical Council of Great Britain resolved (1863) that "the weights used in the British Pharmacopœia shall be the imperial or avoirdupois pound, ounce, and grain; and that the terms 'drachm' and 'scruple,' as designating specific weights, shall be discontinued;" and the same system is adopted in the edition of 1867.

WEIGHTS (Ph. B., 1867).

Avoirdupois Weight.

Pound.		Ounces.		Drachms.		Troy Grains.
1	=	16	=	256	=	7000
		1	=	16	=	437·5
				1	=	27·34375
The weight of $\frac{1}{252\cdot456}$ cubic inch of pure water					=	1

Measures of Capacity (Ph. B., 1867).

1 gallon	=	8	pints.
1 pint	=	20	fluid ounces.
1 fluid ounce	=	8	fluid drachms.
1 fluid drachm	=	60	minims.
1 minim is the measure of		0·91	grains of water.

The gallon holds 10 pounds avoirdupois of distilled water at a temperature of 60° F.

Measures of Length.

1 line	=	$\frac{1}{12}$	inch.		
1 inch	=	$\frac{1}{39\cdot1393}$	seconds pendulum.		
12 inches	=	1	foot.		
36 inches	=	3	feet	=	1 yard.

	Inches.
Length of pendulum vibrating seconds of mean time in the latitude of London, in a vacuum at the level of the sea	39·1393

Relation of Measures to Weights.

		Grains of Water.
1 minim is the measure of		0·91
1 fluid drachm is the measure of		54·68
1 fluid ounce ,, ,,	1 oz. or	437·5
1 pint ,, ,,	1·25 lbs. or	8,750·0
1 gallon ,, ,,	10 lbs. or	70,000·0

Metrical System of Weights and Measures.

		Grammes.
1 gramme	= the weight of a cubic centimetre of water, or	1·0
1 decigramme	= the tenth part of 1 gramme, or	0·1
1 centigramme	= the hundredth part of 1 gramme, or	0·01
1 milligramme	= the thousandth part of 1 gramme, or	0·001
1 decagramme	= 10 grammes, or	10·0
1 hectogramme	= 100 grammes, or	100·0
1 kilogramme	= 1000 grammes, or	1000·0

Measures of Capacity.

1 myrialitre	= 10 cubic metres, or the measure of 10 milliers of water.
1 kilolitre	= 1 cubic metre, or the measure of 1 millier of water.
1 hectolitre	= 100 cubic decimetres, or the measure of 1 quintal of water.
1 decalitre	= 10 cubic decimeters, or the measure of 1 myriagramme of water.
1 litre	= 1 cubic decimetre, or the measure of 1 kilogramme of water.

1 decilitre	=	100 cubic centimetres, or the measure of 1 hectogramme of water.
1 centilitre	=	10 cubic centimetres, or the measure of 1 decagramme of water.
1 millilitre	=	1 cubic centimetre, or the measure of 1 gramme of water.

Measure of Length.

			Metres.
1 myriametre	=		10,000
1 kilometre	=		1,000
1 hectometre	=		100
1 decametre	=		10
1 metre	=	the ten-millionth part of a quarter of the meridian of the earth.	
1 decimetre	=	the tenth part of 1 metre, or . . .	0·1
1 centimetre	=	the hundredth part of 1 metre, or . .	0·01
1 millimetre	=	the thousandth part of 1 metre, or . .	0·001

Relation of Measures of Capacity of British Pharmacopœia to Metrical Measures.

		Litres.		Cubic Centimetres.
1 gallon	=	4·543487		
1 pint	=	0·567936	or	567·936
1 fluid ounce	=	0·028396	,,	28·396
1 fluid drachm	=	0·003549	,,	3·549
1 minim	=	0·000059	,,	0·059

Relation of Metrical Weights to Weights of British Pharmacopœia.

		Grains.
1 milligramme . . .	=	0·015432
1 centigramme . . .	=	0·15432
1 decigramme	=	1·5432
1 gramme	=	15·432
1 kilogramme	=	2 lbs. 3 oz. 119·8
or		15432·348

Relation of Metrical Measures to Measures of British Pharmacopœia.

		Inches.
1 millimetre . .	=	0·03937
1 centimetre . .	=	0·39371
1 decimetre . .	=	3·93708
1 metre . . .	=	39·37079 or 1 yard 3·7 in.

		Grain Measures.
1 cubic centimetre	=	15·432
1 litre	=	1 pint 15 oz. 2 drs. 11 m., or 15432·348

To reduce Grammes to Grains.

Log. grammes + 1·188432 = log. grains.

To reduce Cubic Centimetres to Cubic Inches.

Log. cubic centimetres + (−2·78555007) = log. cubic inches.

To reduce Millimetres to Inches.

Log. millimetres + (−2·5951663) = log. inches.

To convert Grains into Grammes.

Log. grains + (−2·8115680) = log. grammes.

To convert Cubic Inches into Cubic Centimetres.

Log. cubic inches + 1·2144993 = log. cubic centimetres.

To convert Inches into Millimetres.

Log. inches + 1·4048337 = log. millimetres.

Wells—*See* WATER; WATER, PROTECTION OF; WATER-SUPPLY.

Wheat—*See* FLOUR.

Whelks—These shellfish, resembling in appearance large periwinkles, are eaten in great quantities by the poorer inhabitants of our larger towns. They are extremely indigestible, and occasion with many people intense discomfort. Were they capable of being easily assimilated, they would prove a valuable food, as they are certainly nutritious.

Whey—The liquid portion of milk after the curd has been separated. It holds a little caseine in solution, as well as the sugar and saline matter of the milk. It is seldom employed in this country as a food, but is usually given to the pigs. Its nutritive value is very small. The Swiss credit it with possessing medicinal qualities, and believe it to be particularly valuable for the cure of chronic disorders of the abdominal organs. It is prepared by the addition of various agents to milk, such as rennet, white wine, cream of tartar, tamarinds, alum, &c. *See* MILK.

Whisky—The term "whisky" is said to be a corruption of the Celtic word *usquebaugh*, "water of life." It constitutes one of the corn spirits, and is usually made from malted grain. Inferior qualities of this spirit are prepared from barley, oats, or rye, a small portion only of which is malted, or from potatoes mashed with a portion of barley malt, the resulting wash being carelessly fermented and distilled, and purposely suffered to burn to impart the peculiar empyreumatic or smoky flavour so much relished by the lower orders of whisky-drinkers.

The following figures will give an idea of the percentage of alcohol, &c., found in whisky:—

Specific gravity from ·915 to ·920.

	Per cent.
Alcohol from	50 to 60
Total extract, about . . .	0·6
Ash per cent.	trace
Acidity per ounce as tartaric acid	0·2
Sugar	0·0

The adulterations are very similar to those of gin. *See* BRANDY, GIN, &c.

White Hellebore—*See* HELLEBORE.

Whiting—The *Gadus merlangus* (Linn.), a member of the Cod family of fishes. This fish is delicate, tender, and easy of digestion, but possesses little flavour.

The following shows its composition:—

Nitrogenous matter	18·1
Fat	2·9
Saline matter	1·0
Water	78·0
	100·0

Whooping-Cough (syn. *Hooping-Cough*, *Pertussis*)—An infectious disease, mainly of childhood, the most prominent symptom of which is a peculiar convulsive cough, succeeded by a loud, sonorous, characteristic inspiration commonly called the "kink" or "whoop."

History.—It is a remarkable fact that there is no evidence of a trustworthy character of the existence of whooping-cough earlier than the commencement of the sixteenth century; if it existed previous to that date, one can hardly imagine how such a very distinct and well-marked complaint could possibly have escaped description: it therefore appears likely that in this instance we have to do with *a modern—a new disease.*

Symptoms and Propagation of the Disease.—After a child or person, susceptible of the disease, has been exposed to the infection of whooping-cough, there is a period of incubation of unknown duration; it is probably from five to six days, but there is an almost insuperable obstacle to any great accuracy on this point, on account of the difficulty of diagnosing the disease in its earliest stage. Its first visible onset is almost invariably marked by slight fever and catarrh, to all appearance differing in no single respect from a common cold. The catarrhal symptoms having lasted a variable time, the peculiar cough sets in, and the patient may in the intervals of the paroxysms be in the enjoyment of very fair health. The fits of coughing occur at variable intervals, and are generally very distressing to witness. The following is a brief outline of what may be noticed in a moderately severe paroxysm. The sufferer suddenly grasps at something with the violent energy of a person about to be suffocated by drowning, the countenance has a peculiar, anxious expression, and a series of rapid expirations succeed each other until the chest is entirely emptied of air, and the first symptoms of asphyxia commence, as seen by the swollen purple face and the turgid veins; at last, after some viscid mucus has been expectorated, the spasm relaxes and the breath is drawn shrilly in, causing the peculiar noise called the "whoop." These frequent paroxysms not unfrequently induce convulsions from the intense cerebral congestion, and they almost invariably damage—at all events, for the time—the respiratory apparatus; indeed, the fatality of whooping-cough is mainly due to complications, such as bronchitis, pneumonia, &c.

Propagation of the Disease.—There is really nothing known as to what the physical nature is of the animal poison producing whooping-cough; that it is infectious, and capable of striking or infecting susceptible children or persons a considerable way off, is certain. Thus the present writer recently investigated an epidemic of whooping-cough in a workhouse, and found that at a time when it was not in the neighbourhood, a woman tramping the country came into the "house" with a child, the latter suffering from whooping-cough. Both mother and child were separated for a long time from the rest, until one day some charitable person gave a treat to the inmates, and this child and mother partook of tea at the common table in an open field, the child being on the lap of its mother. In about a week, seven children who were seated at the same table, but not in contact with the child or mother, all simultaneously or nearly so became affected with whooping-cough. It is from seeing such cases as the one just related, that writers on the subject appear to favour the idea that the specific poison is of a volatile nature—a kind of vapour. But if this view were entirely corect, the poison would hardly be conveyed and retained so long by "fomites," for there are instances on record where it would appear tolerably certain that the disease has been conveyed by persons in their clothes, walking some considerable distance from one place to the other. Looking at the whole of the evidence, the most probable supposition is that the specific poison of whooping-cough consists of material particles of extreme lightness and tenuity, capable of being expelled by the cough for some distance as well as floating in the atmosphere.

Pathology and Morbid Anatomy.—The morbid anatomy of the disease has hitherto done little to clear up its mystery, for children, as before said, die mainly from complications. It is therefore difficult to separate those changes induced by the poison itself from those which may be caused by, one may almost say, its mechanical effects. It is, however, probable that the morbific germ mainly determines to the vagus nerve, which is not unfrequently found either red, or dense in texture, or otherwise morbidly altered. The chief and most constant lesion, however, observed after death is collapse of the lung.

Mortality.—The mortality from whooping-cough in most years is between 500 and 600 in every million living persons. The mean number for the fifteen years, 1854–71, was 631 per million, the maximum and minimum being respectively 751 and 416. Ninety-five per cent. of the total deaths from whooping-cough occur in children under five years of age.

Prevention of Whooping-Cough.—There are no known means to prevent the propagation of whooping-cough save strict isolation. The infection is of a most intense character, and unless the isolation is practically perfect, it is liable to spread. Disinfectants of any kind are not known to be of practical value.

Wind—*See* ANEMOMETER, CLIMATE, &c.

Wine—Wine has been very accurately defined by Dr. Dupré to be "the fermented juice of the grape, with such additions only as are essential to the stability or keeping quality of the wine." This definition admits as unadulterated those wines which require the addition of spirit in order to preserve them—as, for instance, those of Spain and Portugal—whilst it excludes, if similarly fortified, the wines of Spain, Portugal, and other southern countries which require no such addition.

The principal constituents of wine may be gathered from the table on p. 652, which was drawn up by Dr. Hassall.—(Food and Air, May 1874.)

Besides the constituents enumerated in the table, wine contains glycerine, formic, succinic, malic, and other acids, œnanthic ether, colouring matters, and other principles. Natural wines contain from 6 to 12 per cent. of absolute ethylic alcohol by weight (7·5 to 14·6 by volume). In fortified wines the alcohol varies from 12 to 22 per cent. In all wines traces of other alcohols exist.

The adulterations of wine are very numerous.

Ports are fortified with brandy, coloured with jerupiga, elder-berry, and other matters, plastered with gypsum, and mixed with inferior wines. Salt of tartar is also often added to give it an appearance of age, alum to increase the brilliancy of its colour, and occasionally lead is found, which has been probably added to clear it.

Sherries are plastered and fortified to a very great extent.

Clarets, *Madeira*, *Champagnes*, are all subject to very similar adulterations.

Analysis of Wine.—The analysis of wine, in order to detect adulterations, or to form an opinion as to its quality, should never be undertaken by any one unless he is thoroughly versed in the practical operations of chemistry.

A complete analysis of wine embraces the following:—

1. Determination of alcohol.
2. Percentage of solid residue.
3. Estimation of succinic acid and glycerine.
4. Estimation of volatile and fixed acids.
5. Estimation of ethers.
6. Estimation of sugar.
7. Estimation of albuminous matters and ammonia.
8. Estimation of tannin.
9. Estimation and analysis of ash.

1. *Determination of Alcohol in Wine.*—The percentage of alcohol may be determined by the processes described in article ALCOHOLOMETRY, or by Tabarie's method.

The method of Tabarie is an indirect one, and is much used in those laboratories in which a large number of wines are examined, for it possesses the advantages of expedition, and is sufficiently accurate for all practical purposes.

The specific gravity of the wine having been determined, 100 cubic centimetres are taken and the alcohol driven off by evaporation in an open porcelain dish; distilled water is then added until the original bulk is obtained; or if still greater accuracy be desired, Balling's modification of the process may be employed, which consists in weighing a certain quantity of wine, driving off the alcohol by evaporation, and then bringing the product up to the original weight by distilled water. In either case the percentage of alcohol may be found by the following formula:—

$$D' : D = 1000 : X.$$

D' is the specific gravity of the dealcoholised liquid; D the specific gravity of the wine itself; and X will be the specific gravity from which, on reference to the tables in article ALCOHOLOMETRY, the percentage of alcohol may be found.

With wines containing but little sugar or extractive, the following simpler and easier formula is sufficiently accurate:—

$$D + 1000 - D' = X.$$

The letters in each have the same significance.

2. *Solid Residue.*—The solid residue or amount of total solid constituents in wine may be estimated by two methods, the first of which is evaporating 10 or 20 cubic centimetres in a porcelain or platinum dish to dryness, a process at once tedious, uncertain, and inaccurate, as it has been proved conclusively that decomposition of the organic solids to some extent invariably takes place.

The second method, which Dupré and Thudichum and most other chemists prefer, is simply to take the specific gravity of the dealcoholised wine, and to use the tables given under SUGAR, ESTIMATION OF; for Balling has shown that the specific gravity of solutions of malt extract is the same as that of solutions of cane-sugar, and if true for malt extract, it may be assumed true also for wine extract. In wines, however, containing much ash, as the mineral constituents of the ash seriously affect specific gravity, for in a given specific gravity they contain about twice as much substance in solution as a sugar solution of the same gravity, it is necessary to subtract from the percentage of extract thus estimated the percentage of ash found in the same wine; or if the amount of extract without the ash is required, twice the percentage of ash has to be subtracted from the percentage found. Dupré and Thudichum give the following examples (p. 653):—

AVERAGES OF ANALYSES OF WINE.

Description of Wine.	Specific Gravity.	Alcohol.	Fixed Acid as Tartaric Acid.	Volatile Acid as Acetic Acid.	Total Acid as Tartaric Acid.	Real Tartaric Acid.	Residue found.	Residue calculated.	Grape-Sugar.	Bitartrate of Potash.	Ash.	Alkalinity as Caustic Potash.	Phosphoric Acid.	Phosphoric Acid in Soluble Part of Ash.	Alcohol in Ethers Fixed.	Alcohol in Ethers Volatile.	Alcohol found in Ethers expressed in per cents of Alcohol calculated in Ethers.	Sulphuric Acid.	Cane Sugar.
German white (Thudichum)	993·5	9·98	·440	·217	·538	·1241	1·337	2·180	0·310	·079	·182	·025	·031	·022	·0190	·0258	96·0	...	...
French white ,,	992·2	10·84	·435	·169	·634	·1020	1·257	1·894	0·088	...	·197	·024	·031	·015	·0147	·0232	65·7	...	...
,, red ,,	999·8	10·44	·374	·137	·580	·1296	2·145	3·677	2·255	·081	·223	·044	·031	·016	·0184	·0230	79·2	...	...
Hungarian red ,,	992·5	10·81	·386	·191	·628	·1222	1·677	1·979	...	·122	·192	·054	·035	·015	...	...	77·6	...	...
,, white ,,	991·6	10·23	·419	·179	·644	·0567	1·026	1·587	...	·047	·189	·025	·031	·017	·0174	·0272	73·8	...	...
,, (Griffin)	...	10·35	·49	·10	·62	...	5·53	...	3·20	...	·23	·07	...	...	...	...	...	...	...
Greek white (Thudichum)	1004·2	11·24	·377	·185	·710	·0599	6·567	8·719	6·171	...	·348	·470	·032	·019	·0304	·0214	88·5	...	...
,, ,, (Griffin)	...	10·45	·51	·19	·95	...	8·62	...	7·04	...	·34	·09	...	...	...	...	...	...	...
,, red ,,	...	9·82	·42	·17	·63	...	2·79	...	none	...	·25	·09	...	...	...	...	...	...	...
Australian white ,,	989·5	13·37	·336	·211	·602	·0525	1·639	1·938	0·183	...	·234	·031	·012	·012	·0169	·0389	83·5	...	...
,, red ,,	1000·9	13·19	·371	·332	·783	·0700	4·055	5·048	2·642	...	·266	·038	·024	·015	·0154	·0379	72 6	...	...
,, ,, (Hassall)	992·4	12·12	·710	·140	·885	...	2·337	...	0 076	·058	·253	·018	·035	...	...	...	...	...	...
,, white ,,	995·9	12·60	·790	·146	·992	...	2·020	...	0·042	·087	·188	·081	·066	...	...	...	...	...	...
So-called natural sherry (Thudichum)	989·7	14·85	·292	·131	·454	...	1·188	1·901	0·119	...	·481	·009	·026	...	...	...	...	...	...
Sherries ,,	993·9	17·28	·291	·149	·475	·0187	3·098	4·078	1·796	...	·529	·012	·022	·016	·0279	·0363	88·7	...	...
,, (Hassall)	992·9	17·89	·390	·055	·458	...	3·955	...	2·043	...	·437	·012	·023	...	...	...	...	·141	...
,, (Griffin)	...	16·91	·36	·11	·50	...	3·81	...	1·81	...	·38	·06	...	...	...	...	...	...	...
Dry sherries (Hassall)	988·0	16·98	·379	·045	·435	...	2·803	...	0·934	...	·567	·027	·022	...	...	...	...	·136	...
Sweetened do. ,,	994·1	18·43	·378	·055	·447	...	4·882	...	1·743	...	·448	·010	·022	...	...	...	...	·181	1·267
Deplastered do. ,,	989·5	14·32	·310	·069	·396	...	2·716	...	1·309	...	·268	·089	·026	...	...	...	...	·031	...
Hamburg do. ,,	994·4	17·85	·275	·047	·334	...	5·352	...	4·483	...	·171	·023	·014	...	...	...	...	·026	0·869
Imitation sherry (Thudichum)	996·0	16·48	·257	·111	·397	·0100	3·603	4·956	2·230	...	·327	·028	·027	·015	...	...	...	...	...
Madeira (Hassall)	1001·3	16·12	·528	·071	·610	...	6·167	...	3·000	...	·345	·049	·076	...	...	...	...	·133	...
Marsala (Thudichum)	999·5	16·38	·241	·117	·389	...	3·572	5·007	2·750	...	·312	·021	·024	·010	·0294	·0202	99·5	...	...
Port ,,	999·5	17·73	·271	·122	·424	·0150	4·234	6·607	3·332	...	·237	·067	·510	·024	·0303	·0239	86·9	...	...
Ports (Griffin)	...	19·22	·30	·07	·309	...	5·90	...	4·38	...	·35	·10	...	...	...	...	...	...	...
,, (Hassall)	992·2	12.082	·556	·048	·616	...	2·778	...	0·669	...	·247	·084	·035	...	...	...	...	·032	...

Rauenthaler, 1859 (£15 *Ohm*).

Specific gravity of dealcoholised wine, 1008·101.

	Per cent.
Percentage of sugar [see table, SUGAR, ESTIMATION OF] . .	2·041
Percentage of ash found . .	0·170
Total solid constituents .	1·871
To find total solids, minus ash, subtract again . .	0·170
	1·701

Sherry, 1865.

Specific gravity of dealcoholised wine, 1017·56.

	Per cent.
Percentage of sugar corresponding to this	4·467
Percentage of ash found . .	0·515
Total solids	3·952
Subtract ash . . .	0·515
	3 437

3. *Estimation of Succinic Acid and Glycerine.*—Half a litre or a litre of wine is decolourised with animal charcoal, filtered, and the charcoal well washed with water; the filtrate and washings are then evaporated down nearly to dryness on the water-bath, and the drying finished in a vacuum. The residue when dry is treated with a mixture of one part of strong alcohol, and two and a half parts of rectified ether. The ether is driven off by floating the dish in warm water, and the whole evaporated again on a water-bath; the residue is now neutralised with lime-water, which combines with the succinic acid, and forms succinate of calcium. The next step is to remove the glycerine, which can be extracted by the ether-alcohol before mentioned. The glycerine can be estimated by weighing the residue before and after extraction, when the loss equals glycerine, or by evaporating the ether-alcohol in a tared dish to dryness.

The succinate of calcium remaining behind is impure, and should be digested in spirit to remove extractive and other matters before it is finally weighed.

4. *General Method of estimating Acids in Wine.*—The free acids in wine are partly volatile and partly fixed; the volatile are, for practical purposes, estimated as acetic acid, the fixed as malic and tartaric.

The general method of estimation is an acidimetric process.

Twenty cubic centimetres of wine are suitably diluted, and a few drops of an alcoholic tincture of logwood added. To this mixture a decinormal solution* of caustic soda is added from a burette until the colour changes to pink or red. As in some wines this change is very difficult to observe, a few drops of tincture of logwood may be sprinkled on a porcelain plate, and then when some change in the aspect of the wine takes place, a drop may be taken by a glass rod, and mixed with one of the logwood drops. In this way the coloration may readily be observed. So long as the liquid is acid, the tints will be yellow brown or bluish green; but as soon as the alkali is slightly in excess, a very distinct pink colour will be seen.

* *i.e.*, containing 4 grammes of hydrate of soda in 1 litre of water.

The volatile acids are best estimated by difference; for this purpose 20 cubic centimetres are evaporated down to a thick viscid fluid, dissolved in water, and neutralised as before. The difference between this and the first determination is due to volatile acids, and may be expressed as acetic acid.

Estimation of Tartaric Acid and Bitartrate of Potash.—Berthelot's method, although tedious, is perhaps the most accurate of all for this purpose. Twenty cubic centimetres of wine are mixed with 100 cubic centimetres of a mixture of equal volumes of alcohol and ether in a well-stoppered flask. The same process is employed to another 20 cubic centimetres, but with the addition of potash in sufficient quantity to neutralise about one-fifth of the free acid present. Both bottles are allowed to stand two or three days. At the end of that time, owing to the insolubility of bitartrate of potash in strong alcohol, there will be a deposit of that salt in both bottles; the first will represent the bitartrate of potash present as such, the second the whole of the tartaric acid the wine contains. There is, however, always a small quantity of bitartrate in solution, amounting to about ·004 gramme, which equals ·21 cubic centimetres of the decinormal solution of soda, and this quantity must be added to that which is found. The precipitates from both bottles are collected on separate filters, washed with the alcohol-ether mixture, finally dissolved in water, and the free acid determined by soda, as previously described, making, as before said, the requisite correction.

Direct Estimation of Malic Acid.—Fifty or 100 cubic centimetres of wine are precipitated with lime-water, added in slight excess only. The filtrate is evaporated down to one-half, and absolute alcohol added in excess; the resulting precipitate, consisting of malate and sulphate of lime, is collected on a filter, washed, dried, and weighed. If now the sulphate of lime be estimated in another quantity, and the amount subtracted from the total weight of the precipitate, the remainder equals malate of lime.

5. *Estimation of Ethers in Wine.*—As all ethers, when heated with an alkali, break

up into their respective acid alcohol, it is therefore possible to estimate their amount by indirect means. The ethers in wine are partly fixed and partly volatile; it is therefore possible to separate these ethers by distillation, and estimate them separately, and this plan has been adopted by Dupré. Two hundred and fifty cubic centimetres of wine are introduced into a flask with a bilateral tube, and 200 cubic centimetres distilled over, with special precautions to prevent loss; the distillate is made up to 250 cubic centimetres with water, and the free acid, estimated in 100 cubic centimetres; another 100 cubic centimetres are decomposed by an alkali, and the free acid again determined. The second 100 cubic centimetres will of course be more acid than the first; this increase of acidity is due to the ether which has been decomposed, and therefore the amount of volatile ether can be calculated from such increase.

The fixed ether is determined by evaporating half a litre of wine down to 50 or 60 cubic centimetres in an open dish on the water-bath; the residue, which of course contains *no alcohol*, is rendered alkaline with sodium hydrate, some tannin added, and the whole put into a flask and connected with a condenser, and slowly heated; the fixed ether present is resolved into an acid and an alcohol, and the latter distils over; the distillate is rendered slightly acid by sulphuric acid, and redistilled. This second distillate, which may amount to 20 or 25 cubic centimetres, contains all the alcohol present as fixed ethers in the wine, and is put in a small, strong, assay flask, mixed with 10 cubic centimetres of an oxidising solution composed of 147 grammes of bichromate of potash and 220 grammes of sulphuric acid made up to 1400 cubic centimetres by water. The flask is well stoppered by caoutchouc, and firmly tied down by canvas and string. It is then suspended upright in a water-bath, the neck being *above* the water, and heated for an hour or two. The flask is next removed, the excess of bichromate reduced by zinc and sulphuric acid, the solution transferred to a small retort, some sulphuric acid and bits of tobacco-pipe added, and distilled over from a spermaceti-bath. It will be found necessary to distil at least three times nearly to dryness, each time adding water to the contents. The united distillates contain acetic acid, which is the result of the oxidation of the alcohol. This acetic acid may be determined by volumetric solution of soda in the ordinary way, and the amount of alcohol to which it is equivalent calculated out. Although this process would appear complex, yet the quantity of alcohol from fixed ethers is so small that unless the alcohol be converted into acetic acid, it can hardly be estimated accurately.

The estimation of ethers is of some practical importance, for Berthelot has shown that the amount of ethers found in mixtures of alcohol and acids is, when etherification is complete, a constant quantity, and he gives the following formula for the calculation of the amount of alcohol present in the compound ethers of any wine:—

$$y = 1{\cdot}17\,A + 2{\cdot}8.$$

$$x = \frac{y \times a}{100}.$$

A is the percentage of alcohol by weight in the wine; a is the amount of alcohol equivalent to the total free acid (reckoned as acetic) contained in 1 litre of wine; y is the proportion per cent. of a present; and x is the amount of alcohol present in the compound ethers of 1 litre of wine. It hence follows that if the amount of alcohol present as ether found by experiment fairly agrees with the calculated amount, etherification is complete, and the wine must be of a certain age; if the compound ethers exceed the proper amount, the probability is that it is an artificial wine; and lastly, if the amount of ethers is below the theoretical standard, either etherification is not complete on account of its youth, or alcohol has been recently added.

6. *Estimation of Sugar in Wine.*—Wine contains a mixture of grape and fruit sugar, and the total quantity of sugar can be determined by the reduction of copper process described under SUGAR, ESTIMATION OF. Most wines will have to be decolourised by treatment with acetate of lead and charcoal, and diluted more or less according to indications furnished by a previous determination of the total solids; if not only the amount of sugar, but the relative proportions of grape and fruit sugar be required, an optical method must be combined with the chemical. If for this purpose Jellett's saccharometer is employed (*see* SUGAR, ESTIMATION OF), the following formula may be used:—

(1.) If, as is usually the case, the mixture turns to the left, let x = the percentage of fruit sugar; y, the percentage of grape-sugar; b, the total amount of sugar as determined by the copper process; a, the number of inches of 10 per cent. cane-sugar solution compensating b;

then $$x = \frac{a + 0{\cdot}836\,b}{2{\cdot}338},$$

and $$y = b - x.$$

(2.) If the mixture turns to the right—

$$x = \frac{0{\cdot}836\,b - a}{2{\cdot}338},$$

$$y = b - x.$$

If the amount of fruit-sugar should be, as occasionally happens, in the proportion of one-half to one of grape-sugar, the wine will show no polarisation, for these proportions exactly neutralise each other.

7. *The Albuminous Matters and Ammonia* may be estimated in wine by Wanklyn's process, fully described under WATER-ANALYSIS.

The ammonia and albuminoid ammonia in certain wines are as follows (THUDICHUM and DUPRÉ):—

	Ammonia free. Per cent.	Ammonia Albuminoid. Per cent.
Ingelheimer, red	0·0051	0·3730
Port, 1851	0·0046	0·0888
Sherry, thirty years in bottle	0·0073	0·1807
Madeira	0·0021	0·1581
Mersteiner	0·0021	0·3550
Natural port	0·0019	0·0527
Port, 1865	0·0012	0·1760

An excess of albuminous matter frequently causes the wine to become sour, and to be attacked with fungoid growths.

8. *The Tannin* may be estimated as described in article TANNIN.

9. *The Estimation and Analysis of the Ash* of wine are very important, and are never neglected.

About 20 cubic centimetres of wine are evaporated down to dryness, and then burnt in a platinum crucible or shallow dish in the usual way, and carefully weighed; the weight multiplied by 5 is the total amount of mineral matter in 100 cubic centimetres of wine. The soluble portion of the ash is now dissolved out by water, and the solution titrated with decinormal acid (*see* ALKALIMETRY); the phosphoric acid is now estimated by the Uranium process (*see* p. 529); the chlorine precipitated by nitrate of silver and weighed, and the sulphuric acid in like manner by solution of chloride of barium. The insoluble portion consists almost entirely of phosphate and carbonate of calcium; hence if it is dissolved in hydrochloric acid, the solution neutralised by ammonia, reacidified by acetic acid, and the phosphoric acid determined volumetrically, and the result expressed as phosphate of calcium, this can be subtracted from the total weight of the insoluble residue, and thus the carbonate of calcium be obtained.

The percentage of potassium and sodium must be found by taking another weighed portion of ash, boiling it with water, and adding a slight excess of barium chloride and hydrate of baryta to the boiling solution; the precipitate is then filtered off, and thoroughly washed; to the filtrate carbonate of ammonia must be added in excess, and the precipitate filtered off as before. The liquid, thus free from all substances except the chlorides of potassium and sodium, must now be evaporated to dryness, and very gently ignited to expel any ammonia, and the weight carefully taken; the mixed chlorides are again dissolved in water, a solution of bichloride of platinum added, and the whole again evaporated. Lastly, the dry residue is extracted frequently with spirit of 80 per cent., and the pure insoluble double chloride of platinum and potassium collected and weighed on a tared filter (100 parts = 28·16 of chloride of potash); this weight subtracted from the total weight gives the amount of chloride of sodium.

The foregoing analysis of the ash is fairly complete, as other constituents are seldom present in any quantity. The chlorine of the ash (if any) is, however, seldom a trustworthy indication of the amount of chlorides present, and the same may be said in some cases of the sulphuric acid; hence both of these should always be estimated by precipitation in the ordinary way in the wine itself.

The ash from a litre of wine examined by Boussingault contained—

	Grammes.
Potash	0·842
Lime	0·092
Magnesia	0·172
Phosphoric acid	0·412
Sulphuric acid	0·096
Chlorine	a trace
Carbonic acid	0·250
Sand and silica	0·006
0·19 per cent. —	1·870

Although the amount of the various constituents of the ash will vary a little in different wines, the above may be taken as a fair guide of the actual composition of the mineral or saline matter of unadulterated wine.

Colouring Matters of Wine.—Various colouring matters are added to wine, especially to port. Black cherries, elder-berries, logwood, are all extensively used, and many tests have been proposed for detecting their presence. The juice of the elder-berry, as well as the dye from logwood, has a peculiar spectrum when fresh, but the absorption bands get faint if the wine is old. Many observers are now diligently working at this subject, and in all probability some really reliable tests will shortly be discovered.

Wood, Products of, Combustion of —*See* COMBUSTION.

Wool—Wool is the fine, soft, elastic hair obtained from various animals, especially from the Sheep tribe.

The filaments of wool vary in thickness from $\frac{1}{1500}$ to $\frac{1}{1000}$ of an inch, and may be recognised under the microscope by their cylindrical shape, and by being clothed with thin scales or epidermic cells.

The adulteration of woollen textures with cotton or linen may be recognised by boiling for a short time a square inch of the fabric in a solution of caustic soda or potash. If it is pure wool it will be entirely dissolved. If any threads remain undissolved, they consist either of cotton or linen. Of these, such as have acquired a dark yellow tinge are linen, while those which have retained their whiteness are cotton.

Works—Local authorities have considerable powers to execute *works* of a sanitary nature.

In the case of permanent works, such as sewerage, public notice must be given of the scheme, and facilities given to the ratepayers to fully acquaint themselves with all the details (P. H., s. 32 and 33); and in case any person affected serve notice in writing on the authority that he objects to the plan, it would appear that whether his objection be a just one or not, there is no way of proceeding except by asking the Local Government Board to appoint an inspector to make an inquiry upon the spot (P. H., s. 34). And since the inquiry is always expensive, the law as it stands causes occasionally considerable obstruction to sanitary works, as it puts a very great power into the hands of any obstinate, quarrelsome individual, who may choose for the mere sake of opposition to object to a scheme which may be for the public good.

By the cases of the Attorney-General *v.* Birmingham (22 J. P., 561; 4 K. & J., 528), and Southampton Bridge Company *v.* Local Board of Southampton (28 L. J. Q. B., 41; 8 El. & Bl., 801), it is apparent that an authority in constructing works of any kind, sewerage or other, must not commit a nuisance, and an individual damnified may obtain an injunction to restrain farther proceeding in such works.

Where a notice, plan, or description of any work is required by any bylaw made by an *urban* authority to be laid before that authority, the urban authority shall, within one month after the same has been delivered or sent to their surveyor or clerk, signify their approval or disapproval of the intended work to the person proposing to execute the same; and if the work is commenced after such notice of disapproval, or before the expiration of such month without such approval, the urban authority may cause so much of the work as has been executed to be pulled down or removed.

Where an urban authority incur expenses in or about the removal of any work executed contrary to any bylaw, such authority may recover in a summary manner the amount of such expenses either from the person executing the works removed or from the person causing the works to be executed, at their discretion.

Where a local authority may, under this section, pull down or remove any work begun or executed in contravention of any bylaw, or where the beginning or the execution of the work is an offence in respect whereof the offender is liable in respect of any bylaw to a penalty, the existence of the work during its continuance in such a form and state as to be in contravention of the bylaw shall be deemed to be a continuing offence, but a penalty shall not be incurred in respect thereof after the expiration of one year from the day when the offence was committed or the bylaw was broken.—(P. H., s. 158.)

Any local authority may, with the consent of the local authority of any adjoining district, execute and do in such adjoining district all or any of such works and things as they may execute and do within their own district, and on such terms as to payment or otherwise as may be agreed on between them and the local authority of the adjoining district; moreover, two or more local authorities may combine together for the purpose of executing and maintaining any works that may be for the benefit of their respective districts or any part thereof. All moneys which any local authority may agree to contribute for defraying expenses incurred under this section shall be deemed to be expenses incurred by them in the execution of works within their district.—(P. H., s. 285.)

Any person who wilfully damages any works or property belonging to any local authority shall, in cases where no other penalty is provided by the Public Health Act, be liable to a penalty not exceeding *five pounds*.—(P. H., s. 307.)

FORM E.

Form of Order to permit Execution of Works by Owner.

County of [*or* borough, &c.,] to wit. } WHEREAS complaint hath been made to me, *E. F.*, Esquire, one of her Majesty's justices of the peace in and for the county [*or* borough, *&c.*] of , by *A. B.*, owner, within the meaning of the Public Health Act, 1875, of certain premises [*describe situation of premises so as to identify them*], that *C. D.*, the occupier of the said premises, doth prevent the said *A. B.* from obeying and carrying into effect the provisions of the said Act in this, to wit, that he the said *C. D.* doth prevent the said *A. B.* from [*here describe the works generally, according to circumstances, for instance, thus:* constructing and laying down, in connection with the said house, a covered drain, so as to communicate with a sewer, which the local authority under the said Act of the district of are entitled to use, such sewer being within one hundred feet of the said premises]: And whereas the said *C. D.* having been duly summoned to answer the said complaint, and not having shown sufficient cause against the same, and it appearing to me that the said works are necessary for the purpose of enabling the said *A. B.* to obey and carry into effect the provisions of the said Act, I do hereby order that the said *C. D.* do permit the said *A. B.* to execute the same in the manner required by the said Act.

Given under my hand and seal, this day of 18 .

J. S. (L. S.

See NUISANCES, SEWER, &c.

Worms—*See* BOTHRIOCEPHALUS, PARASITES, TÆNIA, &c.

Y.

Yam—This plant forms a large esculent tuber derived from several species of the genus *Dioscorea*, a group of climbing plants belonging to tropical climates. It is eaten by the inhabitants of New Zealand as well as by those of the East and West Indies and the South Sea Islands, and holds as important an alimentary position in tropical countries as the common potato does in Europe. Parkes gives the following as being its composition :—

Composition of Yam (Dioscorea sativa).

Water	74·0
Albuminates	2·0
Starch	16·0
Sugar	0·2
Pectine	2·8
Cellulose	2·2
Fat	0·5
Salts	1·3

Yeast—The popular definition of yeast is, that it is the froth or the deposit, according to the character of the fermentation, of fermenting worts. It is, however, very well known that yeast is in reality a plant, the microscope showing that it consists of a number of vegetable cells, and experiment having proved that under particular conditions it develops into a mould or fungus with aërial fructification. The commercial varieties of yeast are principally brewer's yeast, German yeast, and patent yeast. The first is obtained from breweries; the second consists of sporules only, with little adherent moisture, and is imported in bags; whilst the third is made artificially by preparing an infusion of malt and hops, and then adding a little yeast to the liquid. Yeast may, however, be prepared artificially without the aid of a ferment. For example, Mr Fownes gives the following receipt: Wheat-flour mixed with water into a thick paste, is to be slightly covered and set aside in a moderately warm place. An agreeable vinous odour about the seventh day replaces its previous disagreeable sourness, and it is then suitable for use as a ferment. If not required at once, it may be made into thin cakes and dried.

Yeast, however produced, and under whatever name, appears to be the produce of the same fungus. This has received the name of *Torula cerevisiæ;* but the researches of various mycologists would rather appear to show that "it matters little whether we take yeast, achorion, or penicillium spores, the resultant is the same, and depends much more on the food or nourishment supplied; whether the pabulum contains more or less of a saccharine, albuminous, or nitrogenous material, lactic acid, &c., together with light and temperature; whether we have a mould (green or blue), an achorion, or yeast fungus produced."—(JABEZ HOGG.)

The yeast plant is chiefly made up of oval cells, about $\frac{1}{3000}$ of an inch in diameter, filled with granular or nucleated matter.

There would appear to be two modifications of yeast—viz., *oberhefe* (surface yeast), and *unterhefe* (sediment yeast). The *unterhefe* is the ferment of the Bavarian beer, and is produced at a low temperature—viz., one not above 45° F. The *unterhefe* is propagated mainly by spores thrown out from the larger cells. Surface yeast, on the other hand, is propagated by buds or offshoots, and requires for its rapid development a temperature of between 70° and 80° F.

The development of surface yeast may be watched under the microscope. On adding the cells to wort, the nucleus increases and nearly fills the parent cell, which becomes ovoid, and ultimately the young cell buds and becomes separated from its parent or continues attached to it; in about three hours, groups of bodies, by this process, are developed, and as time goes on, if the plant continues under favourable conditions, jointed filaments are produced.

These favourable conditions are a saccharine solution containing an azotised substance (which may be simply obtained through the death and decomposition of pre-existing cells), the maintenance of a suitable temperature, and the absence of any substance destroying the vitality of the cells.

The strong mineral acids, the alkalies, metallic salts — such as nitrate of silver, corrosive sublimate, sulphate of copper, &c. — a strong solution of common salt, sulphurous acid, and most disinfectants, affect the vitality of the yeast plant, and at once check fermentation when commenced. A number of substances also *prevent* fermentation taking place, such as black oxide of manganese, mercuric oxide, strychnia, quinine, creosote, turpentine, and many essential oils.

The presence of 20 per cent. of alcohol or upwards also prevents fermentation, nor can a solution containing more than one-fourth of its weight of sugar be fermented.

The changes which take place in a saccharine liquid are very interesting, the yeast plant assimilates sugar, and grows at the expense of the nitrogenised matters in the liquid, changing the sugar into alcohol and carbonic acid.

Chemical Composition of Yeast.—Mitscherlich gives the following analysis of yeast—(1) when in a condition to excite fermentation; (2) when partially exhausted:—

	1.	2.
Carbon	47·0	47·6
Hydrogen . . .	6·6	7·2
Nitrogen	10·0	5·0
Sulphur	0·6	...
Oxygen	35·8	...

The ash of yeast is entirely composed of phosphates of potash, soda, lime, and magnesia.

Adulterations of Yeast.—Dr. Letheby found one sample of German yeast adulterated with 30 per cent. of pipeclay. Payen found in one case 35 per cent. of starch, and others have occasionally identified chalk.

The starch is easily detected by the microscope and the iodine reaction, whilst any inorganic adulterations must be looked for in the ash, which should, as before said, consist entirely of phosphates.

Yellow Arsenic (*Orpiment*) — *See* ARSENIC.

Yellow Fever—*See* FEVER, YELLOW.

Yucca (*Manihot utilissima*)—The root of this plant is a good substitute for the potato, and is more digestible than the yam.

Z.

Zea Mays—*See* INDIAN-CORN.

Zinc (Zn = 65. Specific gravity, 6·8 to 7·1; fusing-point, 773° = 412° C.)—Zinc is a metal which has been known from very ancient times. It is found as *calamine* (zincic carbonate) in Silesia and in Belgium; as *blende* (zincic sulphide) in the Mendip Hills, Somersetshire; and as *red oxide of zinc* in New Jersey.

It would appear well established that neither in the distillation of zinc, in the manufacture of the oxide, nor in that of the salts of zinc is there the slightest injury to the workman; nor has it been proved, although often asserted, that the fumes and dust from zinc-works have injured cattle grazing in the adjacent meadows, or have destroyed vegetation.

MM. Petry and Labaye some years ago were requested by the Royal Academy of Medicine, Belgium, to undertake an inquiry into the *maladie calaminaire*, the alleged injury done to animals and vegetation by zinc fumes; they carefully examined the carcases of forty beasts, analysed the water in the neighbourhood of the works, and studied the aspect of the vegetation, and came to the conclusion that there was no ground for complaint on any one of these heads.

Properties.—Zinc is a bluish-white metal, rather brittle at ordinary temperatures. At a very moderate heat — between 302° and 312° F. (150° and 155·5° C.)—it may be laminated and wrought with ease; but at a little higher temperature it again becomes brittle, at a still higher heat it fuses, and at a bright red heat it is volatilised, the fumes taking fire if exposed to air, and being instantaneously converted into the oxide.

Zinc, when exposed to a moist atmosphere, becomes covered with a thin coating of oxide perfectly insoluble in water. This film protects the metal from further change. All the mineral acids attack zinc, as also does a solution of potash. It precipitates most of the basylous metals less oxidisable than itself in the metallic state from their solutions.

MM. Payen and Chevallier made several experiments on the action of brandy, wine, vinegar, olive oil, weak soup, strong soup, milk, &c., on zinc, the general result of their investigations being the fact that zinc is very little acted upon by olive oil, milk, or water, but that alcoholic, acetic, saline, and fatty liquids dissolve a notable quantity. M. Schaufele has repeated these experiments with similar results. For example, he determined the amount of zinc dissólved in fifteen days by different liquids from out of a galvanised iron as well as a zinc vessel. The amounts found in grammes in a litre of the respective liquids were as follows :—

	The Liquid from the Zinc Vessel.	The Liquid from the Galvanised Iron Vessel.
Brandy	0·95	0·70
Wine	3·95	4·10
Orange-flower water .	0·50	0·75
Vinegar	31·75	60·75
Fatty soup . . .	0·46	1·00
Weak soup . . .	0·86	1·76
Milk	5·13	7·00
Salt water . . .	1·75	0·40
Seltzer water . . .	0·35	0·30
Distilled water . .	traces	traces
Ordinary water . .	none	traces
Olive oil	none	none

Uses.—Disregarding its great commercial utility, and looking upon it in a sanitary light only, it is very evident that zinc is a metal which will in a great measure displace lead. Lead in cisterns, in pipes conveying water, in pigments, and in vessels used for the carrying of water, has been proved to be injurious, and often seriously injurious; on the other hand, zinc, neither as a metal nor in the shape of oxide, has ever appeared to do any harm whatever, and is capable of replacing lead in all the above uses. It may indeed be stated that, as a carrier of common water, and of milk, zinc is absolutely safe; but acetous liquids, or those liable to become acetous, with others which have been mentioned, act so powerfully on zinc, that its use appears limited in the latter direction, and must not be recommended for vessels employed in the preparation of food.

Salts of Zinc.—The only salts of zinc of any importance are the chloride and the sulphate. The chloride is a most powerful disinfectant, and is the basis of Burnett's fluid; it is especially adapted for the preservation of animal bodies, and is therefore much used in the dissecting-room.

Several cases of poisoning by chloride of zinc are on record; it is a powerful corrosive and irritant poison, destroying the membrane of the mouth, throat, gullet, and stomach. The symptoms begin at once, and the patient may die in a couple of hours from the immediate effects of the poison, or life may be prolonged for a variable time, and yet death may occur from the secondary effects. Recovery has, however, taken place from large doses.

The sulphate of zinc has some disinfectant powers, but there are so many disinfectants superior to it that it is not likely to be used extensively. It is an irritant poison, and in large doses has destroyed life.

Tests.—The salts of zinc in *acid* solutions give no precipitate with sulphuretted hydrogen, but in *neutral* solutions the white sulphide is thrown down. Sulphide of ammonia gives a white precipitate of sulphide of zinc; caustic potash and soda precipitate the white oxide; carbonates of the alkali metals throw down a white zincic carbonate; and ferrocyanide of potassium also causes a white precipitate.

From organic liquids zinc may be detected by placing the liquid in a platinum crucible and inserting a strip of magnesium; zinc is then deposited in the metallic state.

Very minute quantities of zinc may be detected by treating a neutral solution with sulphuretted hydrogen, filtering, dissolving off the filter the supposed sulphide with hot nitric acid, and mixing it with a little nitrate of cobalt. It is now precipitated with carbonate of soda, collected on a filter, dried, and incinerated in a platinum dish. If zinc is present, a green colour will be produced. This test will detect 1 in 100,000 parts.—(BLOXAM.)

Zymotic Diseases—The term "zymotic," first proposed by Dr. Farr, is commonly used merely as a synonym for "preventible," comprehending all the principal diseases which have prevailed as epidemics or endemics; in fact, its signification is so loose that it would be advisable to confine the term "zymotic" to infectious or contagious non-parasitic diseases in which there is a multiplication, a zymosis, of the active principle in the body.

If this definition be accepted, zymotic diseases would include such diseases as—

Smallpox.	Cholera.
Cowpox.	Typhus.
Chicken-pox.	Plague.
Measles.	Relapsing fever.
Scarlet fever.	Malignant pustule.
Dengue.	Puerperal fever.
The "strangles" of horses.	Glanders.
	Farcy.
Erysipelas.	Diphtheria.
Eczæma epizootica (foot-and-mouth disease of cattle).	Whooping-cough.
	Cerebro-spinal fever.
	Syphilis.
Typhoid fever.	Pneumonia?
Dysentery.	Cancer?
Rinderpest.	

When sufficient knowledge of these diseases has been acquired, it is probable that they will admit, like different species of plants and animals, of a more or less strict and philosophical classification; even with our limited knowledge, several of them show alliances of a striking character. Thus typhus, relapsing fever, and plague are all extremely analogous. The true exanthemata—such as erysipelas, measles, scarlet fever, and dengue—are another natural group. The enanthematous diseases—typhoid, dysentery, and rinderpest—form a third; whilst the exanthemata are connected with the enanthemata by the foot-and-mouth disease of sheep and oxen, the latter being both enanthematous and exanthematous, eruptions on the teats, body, muzzle, coinciding with eruptions in the mouth and intestines when the disease is seen in its most intense form. *See* BLINDNESS; CHOLERA; ERYSIPELAS; FEVER, RELAPSING, TYPHOID, TYPHUS, &c.

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