With the Authors Compt

AN INQUIRY

INTO THE

THEORY AND PRACTICE

OF

ANTISEPTIC SURGERY.

A GRADUATION THESIS

FOR WHICH

A GOLD MEDAL WAS AWARDED BY THE UNIVERSITY OF EDINBURGH,
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BY

JAMES CUMMING, M.D., M.R.C.P.E., L.R.C.S.E.,

LATE RESIDENT SURGEON, CLINICAL WARDS, ROYAL INFIRMARY, EDINBURGH.

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INTRODUCTION.

THIS Thesis consists of three Parts:—

Part I. On the Germ Theory.

Part II. On Antiseptic Surgery.

Part III. The Appendix (Clinical Cases and Experiments).

Part I. really serves as an introduction to Part II., as it contains the principles on which the Antiseptic Treatment is founded. It contains:—

1. A brief history of the more important Researches of those who have written on the Germ Theory (1600–1870), with special reference to Redi, Spallanzani, Schultz, Schwann, Gay Lussac, C. de la Tour, Todd, Schroeder, Dusch, Pasteur, Pouchet, Joly, Mussy, Child, Beale, and Tyndall.

2. On Bacteria and Vibriones.

3. A Classification of those minute organisms and fungi (founded on their size, general appearance, and movements).

4. Concluding Remarks.

Part II. contains:—

1. A brief history of Carbolic Acid and its introduction into Surgical practice.

2. The terms Antiseptic and Disinfectant defined.

3. Introduction of the Antiseptic Treatment.

4. General Remarks on Compound Fractures (including (*a*) Organization of Blood-Clots, (*b*) Organization of Sloughs, and (*c*) Organization of Bone).

5. The mode of dressing a Compound Fracture, 1866–1871.

6. On Granulation and Suppuration.

7. General Remarks on Abscess,—(*a*) Chronic Abscesses, (*b*) Abscesses connected with Joints, and (*c*) Abscesses in connexion with Diseased Bone.

8. The mode of dressing an Abscess, 1866–1871.

9. The effect of the Antiseptic Treatment on Caries.

10. „ „ „ Affections of Joints.

11. „ „ „ Loose Cartilages of Joints.

12. „ „ „ Suppurative Synovitis.

13. „ „ „ Tumours of the Mamma.

14. „ „ „ „ Sup. and Inf. Maxilla.

15. „ „ „ Burns and Scalds.

16. „ „ „ Ligature of Arteries (including the Ligature of the common carotid of a rabbit with catgut).

17. The mode of dressing an Amputation.

18. List of Preparations used in the Antiseptic Dressings, 1866–1871.

19. On Fermentation and Putrefaction.

20. The Effect of Noxious Emanations, such as those evolved from Marshes, Cesspools, etc., on Fermentation and Putrefaction.

21. Hospitalism (including the Effect of the Antiseptic Treatment on Erysipelas, Hospital Gangrene, and Pyæmia).

In conclusion, I may state, that as it would have occupied too much space to have detailed the Experiments (122), and Clinical Cases (76),—each of which in the original contained full reports and remarks,—they have been reduced in this extract to a series of tables.

A Catalogue of the Pamphlets, Journals, and Books referred to, also a list of Authors, will be found at the end.

THEORY AND PRACTICE

OF

ANTISEPTIC SURGERY.

PART I.

ON THE GERM THEORY.

The following is a brief résumé of the more important works of those who have written on the Germ Theory.

In the beginning of the seventeenth century, Harvey, in "Exercitationes de Generatione," supported the doctrine of Epigenesis, as opposed to the older views of re-formation entertained by the Ovists or Spermatists.

In the year 1668, Francesco Redi, an Italian, published his "De Generatione Insectorum," and was really the first to advocate the theory, *Omne vivum ex vivo*—no life without antecedent life. He maintained the doctrine of Biogenesis in opposition to Abiogenesis, that living matter may be produced by not-living matter, and subdivided Biogenesis into (*a*) Homogenesis, that is to say, the living parent giving rise to offspring which pass through the same cycle of changes as itself, and (*b*) Heterogenesis, the living parent giving rise to offspring which pass through a totally different series of states from those exhibited by the parent, and which do not return into the cycle of the parent. For this latter term, Milne Edwards substituted Xenogenesis—the generation of something foreign.

Grew, Leuwenhoek, Swammerdam, Lyonet, Vallisneri, and Reaumur, were all supporters of the doctrine of Biogenesis.

In 1745, two eminent physiologists, Needham and Buffon, wrote against Redi's theory,—in short, upheld spontaneous generation.

Towards the latter end of the eighteenth century (1799), an Italian, the Abbé Spallanzani, then Regius Professor of Natural History in the University of Pavia, arguing that Needham in his experiments might not have properly excluded the air, and again that his infusions had not been sufficiently heated to destroy all the organisms they contained, made a series of experiments in which the fluids were boiled for three-quarters of an hour, and the necks hermetically sealed, and found, on microscopical examination, that no organisms ever appeared. A review of his elaborate researches into the characters and species of infusoria (well worthy of careful perusal) would occupy too much space here, but I may state briefly, that he alludes to three great species: (*a*) Umbellated, (*b*) Cylindrical, (*c*) Globular. Now, in a putrescible fluid such as urine exposed for several days to the air, six or seven species may readily be detected (that is to say, bodies differing in size, form, and movement). He states, in another part of his work, that the same race of infusoria occurs invariably in urine. But this is really not the case, as four species of bacteria at least may be observed in portions of the same urine, placed in different localities and exposed for varying periods.

In 1836, Messrs Schultz and Schwann made a series of experiments on this theory. Schwann found that when a decoction of meat is effectually screened from ordinary air, and supplied solely with air which has been raised to a high temperature, putrefaction never sets in. Therefore, he inferred, that putrefaction was caused by something derived from the air which could be destroyed by a sufficiently high temperature. His experiments were repeated and confirmed by Helmholtz and Ure. He also proved that the death of those minute organisms was not due to the deprivation of oxygen, as stated by Gay Lussac. Gay Lussac's assertion was, that when a putrescible fluid had been boiled and thus preserved free from organisms, some change had taken place in the contained air, rendering it incapable of sustaining organic life. This plausible theory was again refuted by Pasteur in his simple experiment of the flask with the contorted neck.

Cagniard de la Tour at this time discovered the yeast plant,—a living organism which, when placed in a proper medium, feeds, grows, and reproduces fermentation; thus proving fermentation to be a product of life instead of decay. He dectected in yeast a microscopic fungus, the Torula cerevisiæ, which appeared to be the essential constituent of the former, and attributed the resolution of sugar into alcohol and carbonic acid to the influence exerted by the growth of the plant. In fermentation carbonic acid and alcohol are produced with a small percentage of glycerine succinic acid. I may mention here, that Schwann at this time published the results of an investigation into the causes of putrefaction, in which he too independently discovered the yeast plant.

Todd, in 1839, in a paper published in the "Encyclopædia of Anatomy aud Physiology," alludes to the supposed analogy between spontaneous generation and the origin of minerals, due to the union of their component parts simply.

In 1843, Helmholtz repeated and confirmed the experiments of Schwann. He separated a putrefying or fermenting liquid from one which was simply putrescible or fermentible, by a membrane which allowed the fluids to pass through and become intermixed, but at the same time arrested the passage of solids. Thus, the putrescible or fermentible liquid becomes impregnated with the result of the putrescence or fermentation that was going on on the other side of the membrane. They neither putrefied nor fermented, nor were any of the organisms which may be so easily observed in fermenting or putrefying liquids generated. From this, and other experiments, he inferred that putrefaction was the result not of a gas or diffusible liquid, but of a solid material.

In 1854 to 1857, Schroeder and Dusch made a series of experiments on the same principle as Helmholtz. Schroeder filtered the air by passing it through cotton, and found that when infusions previously boiled were exposed to the atmosphere thus filtered, no decomposition took place. Schroeder and Dusch found that in all the putrescible materials they used, except milk and the yolk of egg, an infusion boiled, and then allowed to come in contact with no air but such as had been filtered through cotton-wool, neither putrefied, fermented, nor developed organisms. They thus inferred that there was something in the air besides oxygen, the presence of which was necessary to the production of putrefaction, and again in this manner accounted for the preservation of fruits, which are boiled and then covered with a bladder, or other materials serving to filter or exclude the air.

These experiments of Helmholtz, Schroeder, and Dusch prove—

1. That it is not the deprivation of oxygen which proves fatal to those minute organisms, as a plug of cotton introduced into the neck of a flask cannot make it airtight.

2. That something floating in the atmosphere, which by a simple mechanical process can be excluded, is the exciting cause of fermentation or putrefaction.

3. That a fluid previously prepared, that is by boiling, which

kills all the living organisms it contains, can be protected from putrefaction and fermentation for an indefinite period.

In 1858, Pasteur commenced his able and elaborate researches and experiments in connexion with this theory. By a simple process, viz., inserting a plug of gun-cotton into an aspirator (for full details of this experiment see "Comptes Rendus de l'Académie," vol. l.), and after several days dissolving it in alcohol and ether, he was enabled to submit the sediment thus obtained to a careful microscopic examination. Thus he detected corpuscles of various sizes, whose form and structure showed that they were organized. Some resembled the spores of minute plants. (Starch granules may be readily recognised by the action of sulphuric acid, which dissolves them.) In one experiment, after the contents of the flask had been boiled for several minutes, the neck was hermetically sealed at the blowpipe, and the flask placed in a hot-air bath maintained at a temperature of from 28° to 32° Centigrade. This flask will remain for an indefinite period free from organisms. Again, if a small tube of glass containing a piece of prepared gun-cotton be introduced into this flask, organisms will be developed in from thirty-six to forty-eight hours. In another part of his paper he remarks, there is nothing in the air capable of producing or rather of giving rise to life but the germs which it carries; that the oxygen comes between only to hold together the life of beings furnished by those germs; that gases, fluids, electricity, magnetism, ozone, etc., have alone no effect upon the production of life, vegetable or animal.

Thus Pasteur proved—

1. That germs do exist in the atmosphere, and can, by a simple process, be collected and submitted to microscopic examination.

2. That a putrescible fluid can be maintained free from organisms for an indefinite period by simply boiling it and closing the neck of the flask at the blowpipe.

3. That those germs may be sown in a fluid which has been thus preserved, and in a few hours organisms will make their appearance.

4. That milk and mercury require special conditions, viz., boiling maintained at a higher temperature, and for a longer period, than most infusions.

In some experiments I made with milk, where the temperature was not increased, it separated into scum, whey, and caseine, and numerous bacteria and vibriones were found in active motion. (See experiments 10, 13, 14, and 15.)

The albuminous matter of the milk becomes altered and ferments. This ferment acts upon the sugar of milk, and is transformed into lactic acid, which then precipitates the caseine and causes the coagulation.

Pasteur made some further investigations, among which perhaps the most interesting was the experiment of the flask with the contorted neck. He took two flasks, each filled with some putrescible fluid, and boiled them for several minutes. In one, the neck was drawn out in a straight line (vertical), and in the other, the neck drawn out and bent at various angles. In both, the orifice is left patent. After several days, on examination, he found the fluid in the former muddy and discoloured by different mucors, and swarming with living organisms. In the case of the latter, the liquid remained perfectly clear, not only for hours, but for several months, and free from living matter. Now, although the air enters rapidly at first (to fill the vacuum produced on the withdrawal of the spirit-lamp), the hot steam destroys the organisms, and after a time it enters very slowly, allowing the solid particles of the air to fall into the angles of the tube, and which are thus prevented from reaching the fluid. Pasteur also found that if the fluids be not maintained at a sufficient temperature or period of boiling (as, for instance, kept under 212° F., and for less than five minutes), even in flasks where the necks have been contorted, they will putrefy after a short period.

I may allude here briefly to some experiments made by myself on the principle of Pasteur and Lister, the details of which are given in the Appendix. Into a series of flasks were introduced the following liquids:—Urine, claret, yeast, and saturated solution of sugar; each liquid being introduced into two flasks of the same dimensions, the one with the neck left vertical, the other with the neck bent at various angles and curves. They were then placed in a cabinet (in the Physiological Laboratory of the University). I may mention here, that this cabinet contained a number of jars filled with the legs of frogs and other preparations, which had been steeping in water alone for several months, and emitted a very fœtid odour of putrefaction. A bent chimney led from the roof of this cabinet to the main chimney, soot and dust constantly falling on the flasks. After a few days they were exposed on a shelf where they were well covered with dust, which collected there in considerable quantities. The fluids contained in the flasks (with vertical necks) have now decomposed. (See experiments 1, 4, 7, 10, 16, and 38.) Whereas the flasks with contorted neck remain perfectly clear and unaltered. (See experiments 5, 11, 42, and 45.)

Pasteur again asserts that fermentation and putrefaction are not the result of the union of an albuminoid substance with oxygen, but that the latter merely acts as food to nourish and rear those germs which fall from the air.

We have seen that the presence or absence of oxygen is quite immaterial to the life of these organisms. Several species have been observed in nitrogen. I detected both bacteria and vibriones alive and in active motion in the following potent poisons:—Tincture of aconite, tincture of Calabar bean, tincture of digitalis, cyanide of potassium, and liquor strychniæ. (See experiments 96, 98, 99, 100, and 101.)

Pasteur also ascertained that air, gathered from a high mountain, is comparatively pure. He opened some flasks on the Mont Anvers, in wind blowing from a glacier (exposing the neck to the flame of a spirit-lamp while filing it, and breaking it with long forceps similarly treated, to guard as much as possible against the introduction of living organisms from the instruments employed, or from his person). The pure air thus introduced has indeed, in one flask out of twenty, the effect of inducing very slowly the appearance of an organic element, but in all the rest the liquid remained perfectly unchanged for an indefinite period. These experiments he repeated at various elevations on the Jura, etc. Then, again, he found that air collected in low localities, under the shade of trees, for instance, contained a large proportion of those germs, increasing in direct ratio as you approach the haunts of civilisation and densely-populated districts. I hope to show further on, what an important bearing those simple ascertained facts have on the practice of medicine and surgery (especially the latter).

In 1858–59, Pouchet, of Rouen, commenced a series of experiments on the same principle as Pasteur, professing to demonstrate the existence of spontaneous generation (Comptes Rendus de l'Académie). He is the great supporter of heterogenesis, and considered his results had completely overturned the panspermists. In one of his experiments, he filled a large vessel with boiling water, and introduced into it oxygen and hydrogen, in the proportions in which they exist in the atmosphere, and then placed in it some hay, previously heated to the temperature of boiling water. In a month, it was full of infusoria; a mercury bath was employed in the preparation.

Now, we know that the mere heating of an infusion to the boiling point is not sufficient to destroy all the life it may contain. It requires to be maintained at that temperature for a considerable period; and I am inclined to think that certain infusions, as well as certain fluids, require both a higher temperature and a longer period of ebullition than others (such as milk and the following highly albuminous compounds, pease, beans, lentils, etc.). Then, again, Pouchet employed a mercury bath. Now, Pasteur expressly states that mercury itself contains germs, and requires to be specially purified (calcined) before being employed in any experiment on this theory. In another experiment, he takes two bottles, one provided with three necks and the other with two, A and B, and two open glass vessels, C and D, and places them alternately; the three-necked bottle A being on the right hand; the open vessel C, the two-necked bottle B, and lastly, the other open vessel D, these being all connected as follows:—through the middle neck of bottle A, a syphon tube passes from half way down this bottle, to nearly the bottom of the open vessel C. From the left-hand neck of A, another tube passes, reaching nearly to the bottom of bottle B. Through the left-hand neck of B a similar tube passes from half way down B to nearly the bottom of the open vessel D. Through the right-hand neck of the three-necked bottle passes a bent tube connected with a tube of porcelain, maintained at a red heat. The bottle A is then filled with boiling water, and B with a decoction of hay. C and D contain a little mercury. A stream of air is then pumped through the red-hot porcelain tube connected with the bottle A, and the decoction of hay is forced over into the remaining open vessel. This apparatus was left for six weeks, and, on examination, Pouchet states that bacteria, vibriones, and tufts of penicillia, were found in large quantities.

I think, after reading over the working of this complicated apparatus, it is not at all surprising that organisms were found, after so short a period. The number of tubes, of course, necessitates joints and stopcocks, which at once render the results of the experiments very doubtful; it is so difficult to have the joints perfectly soldered and airtight, and the stopcocks in good working order. If one of the joints be imperfect, and a portion of cooled air (however minute) reach the contents of the flask, it is quite sufficient to give rise to life. Then, again, mercury is employed, which forms a dangerous complication. In another experiment, Pouchet filled two similar glass vessels with the same decoction of hay: one left uncovered to the air, the other placed in a dish of water, under a bell-jar. In both cases, after eight days small organisms were found in equal proportions. This experiment proves nothing. If he had allowed the vessel under the bell-jar to remain several days longer, he would probably have found that a number of the organisms had died, and fallen to the bottom of the fluid. Some of these infusoria will live for a long time deprived of air, but not increasing in quantity. Pouchet's experiments are, as a rule, characterized by difficult and serious complications. In *theory*, it sounds very well to say, "Well, we are not content to submit our infusions to 212° F. for several minutes or even hours, but we cause the air to pass through bulbs containing sulphuric acid, caustic potash, platinum tubes at a white heat, any one of which is sufficient to destroy life, but combined, render the chances against life surviving infinite." The nature of the experiment requires no explanation. How difficult, nay impossible, would it be to perform this experiment *practically!* Each individual bulb, each individual tube, joint, and stopcock, must be maintained constantly at the same high temperature, else the results of the experiments are rendered fallacious. The following simple rule might be borne in mind when making researches on this difficult question. *The more complicated the apparatus employed, in an inverse ratio is the chance of success.*

What could well be more simple than the preparation of the flask with the contorted neck, or the flask plugged with cotton? The only apparatus required is a pair of dressing forceps to bend the neck, and a spirit-lamp.

In 1860-62, Messrs Joly and Mussy experimented with the air contained in the close cavities of organized bodies, such as the swimming-bladder of fishes, fruit of the bladder-nut, the ordinary cucurbitaceæ. One of their *simple* experiments with a pumpkin was as follows:—A tube blown into a pear-shaped bulb at one extremity, open and drawn out at the other, was heated for half an hour, until the glass was softened, and the open end hermetically sealed at the blowpipe. When cold, the point is plunged into a burning decoction of sheep's liver, and broken off under the surface. A portion of the fluid thus enters the tube, which is immediately placed on burning charcoal. Ebullition then commences, and the tube is again closed, whilst the steam is escaping. When the apparatus is cool, the point of the tube is inserted into the flesh of the gourd, and broken off, after it has entered some distance. On its reaching the cavity of the fruit, a small quantity of air enters the tube containing the decoction. *In order to take every precaution*, a thick layer of copal varnish, thickened with vermilion, was placed around the wound made by the entrance of the tube. A criterion apparatus is placed alongside. At the end of six days, numerous bacteria were observed, many already dead, and others in a dying condition. The criterion apparatus presented the same organisms, only more numerous and more lively.

The only remark I can offer on the result of this cxperiment is, that it would have been a matter of wonder had bacteria not appeared. It is scarcely necessary to add why.

The researches of Von Siebold, Von Bunder, Leuchart, Kuchenmeister, etc., showed that one of the arguments on which the abiogenists rely is a mere fallacy, viz., the production of organisms in closed cavities, such as galls, tapeworm, bladder-worms, etc.,—that, in short, they are really the result of cggs deposited by insects, and not generated spontaneously.

I think the experiments and arguments of Joly and Mussy seem rather to support than overthrow the theory, *Omne vivum ex vivo.*

Dr Child (Procecdings of the Royal Society, vol. xiii.) made a series of interesting experiments, where he found that organisms lived in the presence of such gases as carbonic acid, hydrogen, and nitrogen. This we can readily believe, for they may be found in the presence of sulphuretted hydrogen, and in air deprived of its oxygen. They were present simply because they had not been killed by boiling. Dr Child again employed apparatus fitted with joints, indiarubber joints (which are apt to crack), which alone render the results fallacious.

Let me briefly allude to a work published by Dr Beale, of London, on Disease Germs. The results of the following experiment, he evidently thinks, bear strong testimony in favour of spontaneous generation. A porcelain tube, the central portion of which is filled with roughly powdered porcelain, is connectcd at one extremity with a glass holder, and the other with the bulb which contains the substance to bc experimented on. This bulb is provided with two narrow necks, each of which is drawn out before the experiment is bcgun. One neck is then connected with the porcelain tube by an indiarubber cock, the other is bent down and inserted in a basin containing sulphuric acid. The central part of the porcelain tube is hcatcd by means of a furnace, and when red-hot the bulb is joined on the end of the tube, which projects from the furnace, being made thoroughly hot bcfore the cork is inscrted; the cork itself being taken out of boiling water, and the neck of the tube also heated with the spirit-lamp before being inserted into the cork. A stream of air is now passed through the apparatus, by mcans of the gas-holdcr, and bubblcs through the sulphuric acid at the other end. The substance of the bulb is then boiled for from fifteen to twenty minutes, while the stream of air is still passing through the porcelain tube, maintained at a red heat. Then the necks are sealed at the lamp. In many cases undoubted organisms could be detected.

This is another example of the complicated apparatus used by the abiogenists theoretically, apparently infallible, but practically very much the reverse.

In another part of his work, alluding to Professor Lister's papers on the Antiseptic Treatment, he says, "To me it appears much more probable that the carbolic acid acts directly upon the growth and multiplication of the bioplasm of the part." Now, I need scarcely state, that it is by no means a necessary part of the antiseptic treatment, that the carbolic acid should actually come in contact with the diseased part. For instance, in psoas abscess, the antiseptic never reaches the affected part. It operates by *obviating the noxious influences of the atmosphere, and not by acting directly on the bioplasm.* The indiarubber-tube dressing for amputations, is another illustration of this principle (where carbolic acid never touched the wound, but was applied so as to keep the parts simply in an antiseptic atmosphere).

Tyndall permitted the air of his laboratory to pass through two tubes, one cold, the other heated, and found that invariably the cold tube was filled with particles, and the heated one optically empty. The phrase "optically empty," shows that when the conditions of perfect combustion were present, floating matters totally disappeared. They were wholly burnt up, leaving not a trace of residue. Again, when the passage of air was so rapid as to render imperfect the combustion of the floating matter, instead of optical emptiness, a fine blue cloud made its appearance in the experimental tube. He then proceeded to examine the air, filtered through cotton, as follows:—The nozzle of a pair of bellows was plugged with cotton, and the air urged through it, which, filtered of its floating matter, formed a clear band of darkness. He then took a glass tube and breathed upon it, when a luminous white cloud of delicate texture was formed. On placing a handful of cotton against the mouth and nostrils, inhaling, and then expiring through this, the glass tube was found to be free from organic matter, thus proving that the cotton completely intercepted the floating matter on its way to the lungs.

Tyndall thus rendered visible those organic particles which Pasteur demonstrated by the aid of the microscope. Thus we can readily understand how, when the organisms contained in a flask are destroyed (as by boiling), a plug of cotton introduced prevents putrefaction—a simple mechanical construction preventing those minute organisms from falling into the fluid.

On Bacteria, Vibriones, etc.

On looking over the works of several authors on those minute organisms, I find that there is no standard classification adopted, each forming a series according to the result of his own observations. Again, many differ in drawing a definite line between certain forms of fungi and that class generally known as vibriones.

Let me allude briefly to the researches of one or two authors.

Frau Lüders wrote a paper on the development of various of the lower fungi, which was first communicated in the *Botanische-Zeitung* for 1866, in which she asserts that vibriones are developed from the spores and germinal filaments of various fungi, such as mucor, penicillium, botrytis, torula, manilia, aspergillus, septosperium, anthrobotrys, acrenynum, and verticillum. She also stated that the blood of living animals contains vibriones, quiescent during life, but appearing when putrefaction commences. Also that milk contains minute isolated germs in still greater abundance, and which, as blood, are motionless till putrescence commences: That in the epithelium of the tongue, the vibrio germs exist in the form of leptothrix-buccalis (Remak): That when leptothrix or fungus spores are cultivated in pure water, the rods exhibit very little indication of movement till placed in flesh or bloody water, when they exhibit all the characteristic phenomena observed when appearing in putrefying fluids.

Professor Hallier says, yeast may be produced from leptothrix, and this has been confirmed by Bail, Berkely, and Hoffman.

Oehl and Cantoni observed in an extract of beans, after the disappearance of the vibrio fauna, the entrance of a flora eventually passing into the development of fungi.

Dr Lewis says:—"The term micrococcus is now pretty generally adopted on the Continent by the class of writers who advocate the pre-existence of a germ." Hallier thinks the micrococcus or germ of cholera is the disintegrated spore of a special fungus, which, escaping into water, may be swallowed, or, after being wafted by the air, reach the interior of the human body, developing themselves at the expense of the nitrogenous material. He calls the single corpuscles *monads* (see species *a*); when united in twos (dumb-bell), *bacteria;* when the bodies are still more elongated, *vibriones;* when these vibriones have a linked appearance, *leptothrix* (identical with species *c*).

In an able article in the *Quarterly Journal of Microscopical Science* for 1870, allusion is made to the origin of the bacterium. "That molecules having different polarities aggregate into different crystalline forms and molecules, whose polarities are feeble, will aggregate into amorphous colloidal masses. Between a solution of colloidal matter, there is a distinct step in integration which does not exist in the formation of a crystal at all, and is therefore not really analogous to the formation of bacterium from such a solution. If there is little analogy between the supposed origination of such entities as bacteria and crystallization, still less is there in the case of fungi. A germ, apparently extremely simple in structure, potentially may be rather complex, and in proportion its production of mere segregation from a solution of colloidal matter is *a priori* improbable."

Professor Huxley, at a meeting of the British Association, Sept. 1870, read a paper on the relations of penicillium, torula, and bacterium. "Penicillium is what is popularly known as mould; torula is the yeast plant; bacterium has received no proper name. The torula grows without oxygen and light, and is often associated with excessively minute bodies generally joined in pairs (see species *b*); also little red bodies, which are called bacteria." Then he adds, "Some present a serpentine appearance when connected like a chain, and are then known as vibrios. When a solution containing bacteria and vibrios is boiled, although dead, they often retain a peculiar trembling motion, which ceases when the boiling point is maintained for some time, which brunonian movements must not be confused with true living movements."

Cohn asserted that bacteria really grow and reproduce even without moving; that those bacteria proceed from torula cells, as the latter do from conidia; that, in short, the bacterium is the simplest stage in the development of the fungus.

Mr Samuelson, in the *Quarterly Journal of Science*, vol. i., says, he observed monads moving in rotatory motion in distilled water which had been exposed to the air for some time. He also observed specimens of cercomas-fusiformis, various amœbeæ, vorticella, euchlis, kerona, and larval forms of entromostraca, vibrios, and monads, in distilled water containing dust obtained from the window-sill.

Dr Beale says, that the most minute vegetable germs which are developed in an infusion of animal and vegetable matter, are for the most part of an oblong oval form, frequently exhibiting the constriction which corresponds to the point of division. These most minute germs (bacteria) may be magnified 5000 diam.

Thus each author not only has his own theory with regard to the origin and development of those minute organisms, but also differs in allocating them in distinct classes.

Lüders states that vibriones are developed from minute spores and germ filaments of the lower fungi; that the formation of the fungi, yeast cells, and vibrios, is always *successive.* She again does not allude to bacteria, probably including them under the more general term vibrio.

The author in the *Microscopic Journal* talks of the elongated form of the bacteria, so I suppose he refers to what are generally known as vibrios, as shortly after he alludes to the rounded form of the monad.

Huxley gives a clear rendering of the respective differences between penicillium, torula, and bacterium. He mentions little bodies which correspond to the minute organisms observed in experiments 99, 100, and 110; then further on speaks of bacteria in active motion.

Samuelson includes bacteria under monads.

Beale describes the most minute germs observed in infusions, as bodies with a constriction in the centre, which, in all probability, correspond to ordinary dumb-bell bacteria.

Finding so many thus differ in the nomenclature of these lower organisms, I have ventured to form the following classification founded on their size and general appearance.

Classification.

There are two great classes—Class I. Living Organisms; and Class II. Fungi.

Class I. The microscopic organisms are arranged under six genera, Genus I. being subdivided into six species.

Genus I. First, with regard to what may be termed generally, Bacteria. Bacteria are those minute bodies met with in infusions, consisting either of single corpuscles, or two corpuscles joined together, communicating by a neck. The latter correspond to those bodies figured by Huxley and Beale, 88. The bacteria may be subdivided into species, and are distinguished by their movements.

First, with regard to their movements; the characteristic movements are denoted by large capitals.

A. *Rotatory*, turning round and round on their own axis without making any perceptible progress. It sometimes causes them to appear as if provided with ciliæ. This peculiar movement was observed to characterize the bacteria of the following experiments, 4, 56, 96, 105, 108, 117.

B. *Lateral*, that is, progressing by a lateral movement rapidly across the field, often rebounding off little particles of dust on their way. (Observed in experiments 4, 10, 97, 98, 99, 101, 109, 110, 112.)

C. *Tremulous*, that is, progressing by a peculiar tremulous or vibratory motion quite distinct from B. (Observed in experiments 60, 71, and 116.)

D. *Sluggish*, progressing by a marked sluggish motion. (Observed in experiments 79 and 111.)

E. *Oscillating*, that is, neither progressing nor rotating, but simply waving from side to side. Probably brunonian. (Observed in experiments 70 and 119.)

Species of bacteria classified according to their appearance (denoted by small letters of the alphabet).

a. Bacteria, consisting of a single corpuscle, or having the appearance of a single nucleus, surrounded by a transparent cell-wall. They are of large size, and exist in considerable quantities in infusions. (Observed in experiments 4, 9, 10, 56, 58, 66, 70, 71, 75, 96, 98, 101, 108, 109, 110, 112, 114, 116, 117, 118, and 119.) Correspond to the Monads of many authors.

b. Dumb-bell-shaped Bacteria, consisting of two cells joined and connected by a narrow neck, or of two nuclei surrounded by a transparent cell-wall. They do not occur in such large quantities as *a*. (Observed in experiments 4, 7, 10, 56, 58, 60, 66, 71, 75, 76, 101, 105, 108, 109, 110, 112, 114, 117, and 119.) *a* and *b* taken collectively constitute the Monads of Samuelson and other authors; the Monads and Bacteria of Hallier.

c. Bacteria of a smaller size than a or b, single and dumb-bell. (Observed in experiments 44, 72, 97, 100, 106, 113, 118.)

d. Bacteria of a larger size than a or b, and of the same form. (Observed in experiments 47, 58, 79, 96, 101, and 115.)

e. Bacteria that appeared as if provided with minute ciliæ in rotatory motion. (Observed in experiment 60.)

f. Minute bodies closely resembling *a* and *b*, but stationary, embedded as it were in the fluid. (Observed in experiments 99, 100, 101, 110, 113, 106, 107.) Were they dead bacteria?

Genus II.—*Vibrio.* Vibriones are bodies consisting of from three to ten segments, varying greatly in length, breadth, and mode of progression. They exist in much smaller proportion in infusions than bacteria.

With regard to their formation, some say they are formed by the aggregation endwise of bacteria; certainly some of those vibriones consisting of a few rounded segments, connected in a moniliform manner, seem as if they had just been formed by a few bacteria (species *d*) adhering together. Others differ much in appearance from the bacteria with which they are associated, consisting of small flattened segments, while the bacteria around them are of the large circular and dumb-bell forms. Others, again, whose segments are small, and very delicately marked. Lastly, vibriones where no segments can be detected (simply undulating black lines).

I have frequently observed a long vibrio having a joint, as it were, in the centre, and each half wriggling independently as if two small vibriones had either just joined or were going to separate. I have watched one of those fields for two hours at a time, but have never been fortunate enough to observe them either in the act of uniting or separating. As a rule, bacteria are present in a greater proportion than vibriones, but in some *advanced* fluids, I have seen the field crowded with vibriones, and scarcely a bacterium visible. This, again, rather favours the view of their being formed by the aggregation of bacteria or monads. Some authors state that they are formed *directly* from the filaments of microscopic fungi, these filaments becoming after a time embued with life and motion. (I do not mean that the vibriones spring from the spores, but from the fungus itself.) Again, I have distinctly observed slender yellow filaments (not segmented) resembling closely some of the fungi often present in milk, quinine, etc., slowly bend and then straighten themselves, crossing the field at a very gradual pace, while some filaments in the same field lay perfectly motionless (see experiment 112), differing markedly from the long slender segmented vibriones described further on.

May it be from the observation of the latter phenomena that some authors have thus ascribed their fungoid origin (direct)?

The following distinct movements have been observed in some of the experiments detailed in the Appendix. (The movements denoted by large accentuated capitals.)

A′. *Serpentine*, darting across the field by a peculiar wriggling motion, like the tail of a fish. (Observed in experiments 58, 97, 100.)

B′. *Sluggish*, progressing across the field by a very slow lateral movement. (Observed in experiments 44, 60, 71, 76, 78, 111, and 112.) Characterized the black line vibriones (species *d*).

C′. *Separate*, one long vibrio having a joint in the centre, each half-wriggling separately, apparently independently. (Observed in experiments 58 and 116.)

D′. *Coiling*, curling up and then slowly uncoiling like a serpent, not progressing. (Observed in experiments 107, 111, 116.)

Species of vibriones classified according to their appearance. (Species denoted by small accentuated letters of the alphabet.)

a′. *Long delicately-marked Vibriones*, where the segments are very indistinct. (Observed in experiments 4, 44, 111, 115.)

b′. *Long Vibriones distinctly segmented.* (Observed in experiments 7, 56, 60, 78, 116, 118.)

c′. *Long Vibriones, formed of rounded segments*, as if several bacteria had just joined endwise. (Observed in experiments 47 and 108.)

d′. *Vibriones where no segments* could be made out; undulating black lines simply. (Observed in experiments 60, 71, and 118.)

e′. *Short Vibriones rather thicker* than usual. (Observed in experiments 9, 70, 97, 107, 114, 116.)

f′. *Short thin Vibriones.* (Observed in experiments 76, 99.)

g′. *Short Vibriones as if provided with ciliæ.* (Observed in experiments 100, 109, 110, 113.)

The following genera of those lower organisms differ essentially in character from both bacteria and vibriones, properly so termed.

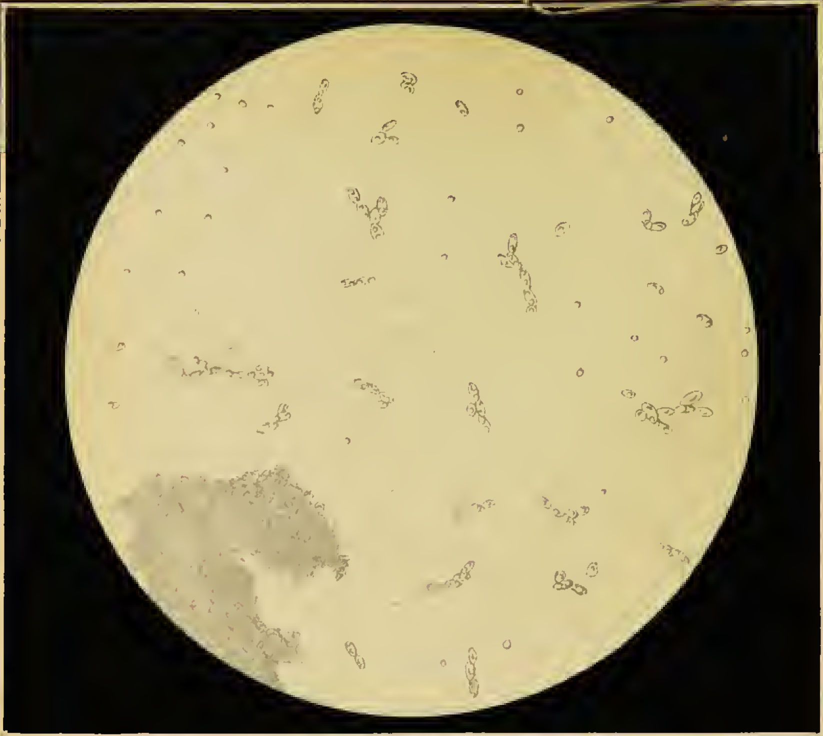
Genus III.—*White bodies*, shorter than ordinary vibriones, but double the breadth of large bacteria. Characterize those fluids which have been exposed to fœtid matter and sulphuretted hydrogen gas. (Observed in experiments 75, 78, and 96.)

Genus IV.—*Large oval bodies*, nearly twice as large again as Genus III., darting very rapidly across the field. Characterized the fluid exposed to the fœtid matter. (Observed in experiment 75.)

Genus V.—*Large oval bodies*, perfectly motionless. (Observed in experiment 78.) Resembled some of the corpuscles in the flocculi from a case of cholera.

Genus VI.—*Long and short yellow filaments* not segmented, which progressed very sluggishly. They closely resembled the mycelium of a fungus, and also some long unsegmented vibriones, represented in a plate from a case of cholera.—*Hallier*. (Observed in experiment 112.)

Claret *Page 21*



Tincture of Digitalis *Page 26*

Class II.—*Microscopic Fungi.*

Dr Bourdon (*Bullétin Générale de Thérapeutique, Méd. et Chir.*, 1868), in a paper on the instability of solutions used for hypodermic injection, states that after several months numerous filaments of a reddish-yellow colour appeared in a solution of sulphate of quinine acted on by tartaric acid, and also that 1-15th part of the salt of quinine had disappeared, showing that exposure to the air considerably altered that therapeutic agent. Further on, he remarks, the microscopic fungi in their growth have either decomposed a portion of the organic salt, deriving certain of these elements to develop themselves, or a portion of the salt has been deposited on the organic products, and the crystals have remained with them upon the filter. Also, that a similar kind of fungus develops itself in a solution of the sulphate of atropia.

Now, in experiment 107, the following solution was exposed to the air:—

℞ Quin. sulph., gr. xii.; acid. sulph. dil., ♏ xviii.;
aquæ, ℥ ii.—Solve;

and after several weeks submitted to microscopic examination, when branching yellow filaments were observed interlacing all over the field. (These I had observed and sketched before reading the above paper, kindly lent me by Dr T. R. Fraser.)

The following classification of microscopic fungi has been founded on their size and general appearance. They are arranged under two genera—Genus I. *Corpuscular*, and Genus II. *Filamentous*.

Genus I. contains ten species (which are denoted by small letters of the alphabet, with a double accentuation).

a″. Round colourless corpuscles, scattered here and there over the field. Observed in the following fluids—Claret, cyanide of potassium, solution of carbolic acid, solution of sulphate of magnesia, and infusion of coffee. (See experiments 10, 100, 102, 104, 115, 119.)

b″. Minute round colourless corpuscles scattered over the field. Observed in the following fluids—milk, saturated solution of sugar, urine, cyanide of potassium, and infusion of coffee. (Experiments 7, 16, 76, 100, 119.)

c″. Oval corpuscles scattered over the field, some attached in a moniliform manner, observed in saturated solution of sugar. (Experiment 16.)

d''. Large oval corpuscles, each containing on an average two nuclei, scattered in groups over the field. Observed in claret (experiment 66). To the naked eye it is a beautiful reddish-coloured fungus, creeping up the sides of the flask.

e''. Large narrow elliptical cells, also provided with nuclei, but attached in a moniliform manner. (See experiment 66.)

f''. Small elliptical cells attached by the extremities, some separate, scattered over the field. Resembled a form of fermentation described by Pasteur. Observed in urine and yeast. (Experiments 56, 67, 69.)

g''. Round nucleated cells. Observed in an infusion of coffee. (Experiment 118.)

h''. Groups of minute round yellow corpuscles scattered over the field. Resembling the fermentation of urea described by Pasteur in "Comptes Rendus," vol. lviii., 1864. Observed in tincture of digitalis. (Experiment 99.)

i''. Large round yellow corpuscles. Observed in phosphate of ammonia, infusion of coffee, and tincture of aconite. (See experiments 96, 105, 118.)

j''. Yeast cells, in yeast. (Experiment 116.)

I think that, after repeated examinations of the various solutions, there is no doubt that different species of corpuscular fungi characterize special fluids. For instance, I invariably found the same form of fungus in digitalis, in aconite, and in claret (after intervals of time varying from three weeks to four months). Thus essentially differing from bacteria, vibriones, etc., which *do not* characterize special fluids.

Genus II. *Filamentous.*—(The species are denoted by small letters of the alphabet thrice accentuated.)

a'''. Long narrow filaments interlacing all over the field. Observed in milk and sulphate of quinine. (Experiments 9 and 107.)

b'''. Short oblong bodies scattered over the field, not unlike sarcinæ. Observed in a saturated solution of sugar. (Experiment 16.)

c'''. Long tubes resembling bamboo cane, arranged in a moniliform manner, resembling in appearance the oidium lactis (cholera fungus of Thomè). Observed in milk. (Experiment 61.)

d'''. Long filaments arranged in a stellate form. Observed in milk; resembling the vibriones of butyric fermentation (described by Pasteur, in "Comptes Rendus," v. lviii., 1864). (Experiment 61.)

e‴. A peculiar fungoid growth, which commenced in a flask with a vertical neck containing urine, and was about the size of a pin-head, gradually increasing in dimensions till it is now 1¼ inch in diam. It resembled the winged seed of some plant when small, and now a sea-anemone.

f‴. Peculiar formation resembling chips of wood, which formed in a flask with vertical neck containing urine, and which could not be extracted (choking up the orifice of the tube).

The above are some of the more characteristic forms of fungi, observed in a series of different fluids exposed to the air. All those fluids contain in addition numerous bacteria, vibriones, and specimens of Genus III.

Many of these fluids after exposure to the air altered much in appearance. In some the fluid evaporated, leaving deposits of crystals; in others a grayish or yellowish deposit.

Dr Fraser informs me, he has frequently found that solutions of alkaloids in water become less active after a time, and that usually, if not always, this change coincided with the appearance of fungi in the solution.

Dr Burdon stated that the occurrence of fermentation was followed by a loss of activity in the solutions of certain alkaloids.

Notwithstanding the presence of fungi, bacteria, vibriones, etc., several of the poisons (previously detailed) seem to retain in great measure their potent therapeutic properties.

Concluding Remarks.

With regard to the experiments detailed in the Appendix, let me offer a few explanatory remarks.

The experiments have been divided into four series.

The first series, contained in Tables I., II., and III. (fifty-eight in number), are on the principle of those described and performed by Pasteur. The flasks were in the majority arranged in sets of three (that is, a portion of the same fluid introduced at the same time into a flask with vertical neck, a flask with contorted neck, and a flask plugged with cotton), so that the results might be compared and conclusions deduced accordingly. They were all boiled for the same period, and were placed side by side, exposed at the same elevation and temperature. Now, in the majority of those flasks with vertical necks, the contents decomposed after a time, the exact period varying in direct ratio with the length of the neck; while the flasks with contorted necks and those plugged with cotton remained clear and unaltered (exhibiting neither scum, deposit, smoky cloud, nor alteration in colour, except in one, where the urine became of a dark tint from bright amber) up to the present date. On glancing at the tables the results are at once evident. Flask 1 became turbid, and was crowded with bacteria, vibriones, etc., in three or four weeks. Flask 2, again, remained clear and apparently free from putrefaction till 1st March, when the neck unfortunately was broken off short, and in a few days the contents became turbid and swarmed with living organisms. Flask 3 remains clear and unaltered.

The above results may be explained as follows:—

Flask 1, being provided with a vertical neck 9 inches in length, and only 1-12th in. diam. at orifice, protected the contents from putrefaction for several weeks, as the solid particles floating in the atmosphere had a considerable journey to make to reach the fluid. The mechanical obstacles presented in flask 2 preserved its contents till the neck was broken off short, when the air allowed direct access caused putrefaction after a lapse of a few days. The cotton plug of flask 3 intercepted the solid particles in its meshes, and thus effectually protected the contents from their influence.

Let us take the next individual series.

Flask 4 has a vertical neck of only 6 inches, and was observed to lose its transparency, become turbid, and contain a number of organisms, a fortnight earlier than flask 1; while flasks 5 and 6 remain clear and unaltered.

Passing on to a later series, flask 44, with a vertical neck of 10 inches, preserves the contents for three months, when they gradually become turbid and contain life. Flask 43, with a vertical neck of 20 inches, is preserved for nearly four months, when at last the urine becomes slightly cloudy, and then rapidly a scum and thick deposit appear; while flask 45 (contorted neck) remains clear and unaltered up to the present date. From these and other observations, I inferred that *the contents of a flask with a vertical neck will decompose after an interval of time, varying in proportion with the length and diameter of the neck.*

Table I. shows us that the contents of all the flasks but one (which has preserved its original colour) have decomposed simply because the germs constantly floating in the atmosphere had a free and direct access to the fluid.

Table II. contains the results of twenty-four flasks with contorted necks, of which six have apparently decomposed. The first one (flask 8) not having been maintained at a sufficiently high temperature, or long enough period of ebullition, decomposed, separating into scum, whey, and caseine, a result which was naturally anticipated; again observed in experiments 13 and 14. The neck of flask 2 was broken off (as explained above), and thus putrefaction is accounted for. Flask 37 contained very phosphatic urine (which renders the results, as judged from external appearance only, somewhat difficult and unsatisfactory).

Let us glance at Table III., and see what the results teach us. Of eighteen flasks, the contents of four only have decomposed. Flasks 9 and 15 contain milk, and therefore are at once accounted for. The urine of 54 was very phosphatic; 49 decomposed probably from some error in its preparation. The explanations of Schroeder, Dusch, Pasteur, Huxley, and Tyndall, clearly account for the fact of the contents of these flasks being preserved unaltered; viz., that the cotton acts as a filter detaining the organized germs in its meshes.

Further on, I shall explain by another series, how fluids may be preserved effectually by acting on those low organisms by a powerful therapeutic agent.

Second Series.

The experiments contained in Tables IV., V., and VI., were instituted in order to compare their results with the first series. They were *not* submitted to boiling. Table IV. contains flasks with vertical necks, where the contents were observed to be in an advanced state of decomposition, after a period varying from ten to thirty days (much earlier than in those flasks which had been submitted to boiling).

Table V. contains flasks with contorted necks. Decomposition occurred in about the same time as in Table IV. The organisms of the air were retained, it is true, in the angles and curves, but those already existing in the fluid, not having been destroyed, were sufficient in a very short time to give rise to fermentaion and decomposition. Table VI. shows similar results.

Two flasks, 70 and 71, one plugged, and the other left exposed, were observed to be turbid on the same day. The contents of flask 72 were boiled and exposed to the air, and it was also observed to be turbid on the 9th of February.

This last series shows that it makes little differenee whether the external organisms be prevented from reaching the fluid or not, provided those already existing are permitted to live.

If you place a flask containing urine which has been submitted to boiling aside for some time, the following phenonema occur. In a few days a fine grayish-white scum appears on the surface, gradually increasing in thickness till it is, say, the 1-12th of an inch depth, and on examining the flask a few days later you will probably find that the scum has disappeared from the surface. It has simply gravitated to the bottom, forming a dirty yellow deposit. Then another scum will appear on the surface, which in its turn gravitates, and so on, till the deposit may have reached a quarter of an inch in depth. On shaking this, the fluid will become instantly quite opaque, and flakes of considerable size may be observed floating about in the middle.

I may mention here, that this second series allowed me to examine at length the development, character, movements, etc., of those low organisms and fungi, and also to form the classification previously described.

Third Series.

As it has been already proved that organisms can exist in atmospheres, such as air deprived of its oxygen, in nitrogen, in hydrogen, sulphuretted hydrogen gas, etc. (fatal to both man and the lower animals), I thought I would ascertain if they would exist and propagate equally well in some of the more potent animal and vegetable poisons. Accordingly, six glass saucers, each containing two drachms of a different poison (tincture of aconite, 96; hydrocyanic acid, 97; tincture of Calabar bean, 98; tincture of digitalis, 99; cyanide of potassium, 100; and liquor strychniæ, 101), were laid side by side on a shelf in the laboratory.

On microscopical examination some time after, all were found to contain living organisms, alive and in active motion, and some, in addition, torulæ and plant-like structures. In order to ascertain if they had retained their therapeutic properties (as it might be said that the bacteria and vibriones did not appear till after the poison had lost its influence), I injected subcutaneously a small quantity of aconite into a rabbit, which proved fatal in less than four minutes. A similar result followed the injection of strychnia in 55 seconds. The Calabar bean produced all the symptoms of poisoning. The cyanide of potassium produced doubtful effects. Thus, I was led to infer that certain poisons fatal to man and the lower animals are life and nourishment to those lower organisms.

To ascertain if distinct species of organisms and fungi characterize special fluids, twenty-one saucers, each containing a different fluid, were exposed on a shelf in the laboratory, and after some time submitted to a careful microscopic examination. They nearly all contained bacteria, vibriones, etc., and some fungi in addition. The results showed that *peculiar species do not characterize special fluids*, but that the *same species may be observed in several infusions.* For instance, Genus III. was detected both in a portion of urine which had been exposed to fœtid emanations and in tincture of aconite. The species, etc., probably depend more on the *locality and length of exposure.* Of three specimens of carbolic acid, after repeated examinations, only in one a bacterium could be detected. Coffee and claret, again, were remarkably prolific.

The FOURTH SERIES were instituted with an entirely practical (if I may so express it) end in view; viz., to ascertain if carbolic acid was really a powerful germicide, and might be implicitly relied on as the antiseptic reagent or medium. (From the results of the surgical cases I had seen treated by it, I was convinced that it did possess this property, but was anxious if possible to verify it by a series of flask experiments.) The experiment was conducted as follows:—A flask was half-filled with urine, and the neck bent at a right angle, and connected with the following apparatus by elastic tubing—a glass tube, 7·3 inches long, with a round bulb blown in the centre of it. This tube is open at both ends, the smaller end fitting to the elastic tubing. There is a small hole at the side of the bulb to admit of the introduction of the spray. This bulb is 2·2 inches in diameter. The urine is then kept at boiling point for six minutes, and before removing the spirit-lamp, the spray machine charged with a solution of carbolic acid is started at the small hole, and maintained till the lower fourth of the bulb is filled with the lotion (*i.e.*, the result of the spray). Thus all the air that enters the flask passes through this carbolized atmosphere. The neck of the flask is then hermetically sealed at the blowpipe. The strength of the lotion varied from 1-20th to 1-100th. Table IX. shows that each of the flasks remained perfectly clear and unaltered, proving that the spray was quite effectual in destroying the agents of putrefaction floating in the atmosphere.

I am convinced that 1-100th is quite as effectual as 1-20th, and may be relied on with perfect confidence.

By diminishing the percentage of carbolic acid used in the dressing, one of the great drawbacks will be removed, viz., the tendency to induce antiseptic suppuration.

Table X. contains a series of experiments where several other disinfectants were employed. In experiment 86 the atmospheric air was allowed to regurgitate into the flask unprotected by the acid, and the result is, that the contents are evidently far advanced in putrefaction.

Sulphurous acid has, like carbolic acid, preserved the contents.

Condy, hyposulphite of soda, and chloride of zinc did not seem to exert that specific poisonous action on the germs, judging from the appearance of the flask.

Conclusions.

1. That the air at all times contains organized products capable (on receiving a suitable nidus) of giving rise to putrefaction and fermentation.

2. That the air can be filtered of these products by a simple mechanical apparatus.

3. That the air can also be purified by acting directly on those organized products (as, for instance, by an antiseptic).

4. That carbolic acid, when applied on the antiseptic principle, prevents putrefaction (with its attendant evils), by acting as a specific poison, destroying those organisms effectually.

5. That fermentation and putrefaction are due to the presence of those organisms and fungi.

6. That those organisms can exist unaffected in air deprived of its oxygen, in hydrogen, in nitrogen, in sulphuretted hydrogen, and in many vegetable and animal poisons; in short, in atmospheres and poisons instantly fatal to man and the lower animals.

PART II.

ON ANTISEPTIC SURGERY.

THE term antiseptic (αντι, against; σηπτος, putrid) literally means, an agent which has the power of arresting or preventing putrefaction.

Among some of the most efficacious rank carbolic acid, chloride of zinc, and quinine.

Carbolic acid has become intimately associated with what is termed the antiseptic treatment, simply because it was employed as the reagent or medium in the dressings, etc., from its known poisonous properties on the lower forms of infusorial life. The use of carbolic acid as an external dressing, and the "antiseptic treatment," have been by some erroneously supposed to be synonymous terms. That is to say, "that if you simply dress a wound with carbolic lotions or plasters, you are doing all that is necessary in adhering to the principles laid down by that treatment." Now, I need scarcely state, *that the application of carbolic acid as a dressing without any precautions, and the application of carbolic acid on the antiseptic principle, are treatments essentially different.*

It is possible that some day a reagent may be discovered possessing the germicide properties of carbolic acid, and, in addition, qualities which may render it preferable (less of an irritant, although now, the percentage of carbolic acid in the dressings has been so much lessened, that that objection has, in a great measure, been obviated).

Let me give a very brief history of carbolic acid as used generally.

Carbolic acid, the hydrated oxide of phenyl or phenic acid, is a white substance, which crystallizes in long prisms, fusible at 93° Fahr., and boiling at 370°. It has a slight tarry and aromatic smell, resembling that of wood creasote, is freely soluble in alcohol, ether, and glycerine, partially so in glacial acetic acid, and only slightly so in water. It is prepared by treating the oils of tar, which distil between 350° and 400°, with caustic lye; removing the caustic lye solution from the neutral oils, and adding hydrochloric acid to the alkaline solution, when the carbolic acid is set free and rises to the surface as an oily fluid, from which, by distillation, the above therapeutic agent is obtained.

Equivalent — $HO,C_{12}H_5O$, or HC_6H_5O. Specific gravity — 1·065. Appearance—colourless, acicular crystals. There are two qualities, (1) coarse, (2) fine.

It has been known more or less to the chemist for upwards of forty years.

Lebœuf, in 1850, wrote on coal-tar as a surgical application.

Lemaire, of Paris, published a work on phenic acid, mentioning its beneficial effects when used as an external surgical dressing, but laid down no rules for its use. He took no precautions to exclude the atmospheric air *during the whole period of the healing process.*

Grace-Calvert, in 1863, recommended carbolic acid as an application in polypi, ozæna, sore throat, ulcers, hæmorrhoids, lupus, sloughing wounds, and phthisis.

Velpeau, more than ten years ago, used carbolic acid as a disinfectant in surgical operations, but condemned it on account of its causing irritation, and being inferior to other disinfectants.

Wolf, several years ago, recommended carbolic acid in the treatment of phthisis.

Keith administered carbolic acid in small doses in scarlatina, measles, and smallpox, and mentioned the following physiological effects as resulting from its use :—*i.e.*, profuse perspiration, rapid fall of the pulse (as in twenty-four hours from 160° to 60°). Skin cool and moist, subsidence of fever, tongue cleaned, improved appetite. In scarlatina the throat affection is lessened.

Porter, of Dublin, injected a nævus situated on the forehead, immediately above the nose (venous in character, and of the size of half-a-crown), with carbolic acid, repeating the operation seven times, when the mass became consolidated, and in due time was absorbed.

Eade, on the principle of carbuncles and boils being of parasitic origin, after making a free crucial incision, dressed the wound with carbolic oil, 1—5, and met with good results.

Lund, of Manchester, used carbolic acid in its undiluted form in the treatment of lupus.

Sedgwick used it as a gargle in diphtheria and ulcerated tonsils : —℞ Acid. carb., ♏20; acid. acet., ʒj.; mellis, ʒij.; tinct. myrrhæ, ʒij.; aquæ, q. s. ad ℥vi. Solve.

The following compound is alluded to in the *Medical Times*:— "Liq. carbonis detergens," an alcoholic solution of coal-tar, containing carbolic and other acids, and differing from carbolic acid, as the liq. cinchonæ does from quinine.

Erasmus Wilson used carbolic acid in a case of herpes preputialis, which acted as an anæsthetic, and eventually cured the disease. I have frequently observed the anæsthetic properties of carbolic acid in the treatment of compound fractures, and when applied to superficial granulating sores. It seems to benumb the part.

Yates, of Canada, employed a carbolic ointment to prevent the pitting of smallpox, spread upon black cotton wadding, changed every second day. It seemed to prevent the secondary fever.

Vigla read a paper relating to the use of coal-tar as a disinfectant nearly twelve years ago.

Small doses of carbolic acid have been found extremely useful in the treatment of obstinate vomiting, nausea, morning sickness of pregnancy, etc.

In the form of a vapour, it has been inhaled in gangrene of the lung, ulcerated sore throat, foul breath, phthisis, etc.

Messrs Salt, of Birmingham, have constructed an apparatus for fumigating wards and private chambers.

Russell, of Glasgow, used the vapour in the fever wards of the Glasgow Infirmary.

In short, carbolic acid, more especially of late years, has been tried in most diseases, medical and surgical. It is not surprising that an agent so universally employed should have received much abuse, as well as commendation.

In the year 1864, an epidemic raged among the cattle in Cumberland, and was particularly virulent in the immediate neighbourhood of Carlisle. Among some of the more important disinfectants tried was carbolic acid, which seemed to exert a specific action on the entozoa feeding on the cattle, destroying them effectually.

Dr Lonsdale informs me that carbolic acid was used in large quantities to mix with the sewage of Carlisle, preparatory to that sewage being applied for irrigation upon the pasture lands in the neighbourhood. It was also applied to byres and other outhouses during the rinderpest.

Now, it is evident that carbolic acid proved efficacious in this epidemic, from its direct poisonous action on the entozoa, etc., when other disinfectants would probably have failed. Hence, the question came to be, since carbolic acid has proved so efficacious, will it not prove equally so in the case of those minute organisms constantly present in the atmosphere?

Before entering on the antiseptic treatment, let me offer a few explanatory remarks regarding

The terms Antiseptic and Disinfectant.—Antiseptics (αντι, against, and σηπτος, putrid) literally mean agents which have the power of arresting or preventing putrefaction. Among some of the best known rank carbolic acid, chloride of zinc, and quinine.

Dr Geiselen found that the preservative property exerted on fresh meat by pure quinine was greater than that by many other substances, including cinchona. He first tried it in a case of extensive carbuncular inflammation affecting the lower half of the calf of the leg, which rapidly put on a healthy appearance. Also in a case of noma in a child, where it proved equally efficacious. He then used it in bed-sores, caries, sloughing of malignant growths, etc.

May not the wonderful powers of quinine in malarious fevers, etc., be traced to its action on the lower organisms and minute fungi, which seem to be so closely connected with their origin?

Chloride of Zinc.—As a local application where putrefaction has already taken place, or where the antiseptic treatment is inapplicable, as in maxillary tumours, it is invaluable. Mr C. de Morgan has advocated its use very strongly, but its caustic properties are too severe to be used in general surgical practice (in skin-flap amputations there is a risk of sloughing). There are some situations in the body where it is difficult to fix the dressings, and if perchance the patient, during the night, rub them off, and thus expose the wound, the injection of chloride of zinc, 40 grains to the ounce, is very beneficial, and will completely arrest putrefaction.

Disinfectants.—The term disinfectant has many definitions. It is more, if I may so express it, a medical term, as it is generally used in connexion with fevers, *i.e.*, smallpox, typhus, typhoid fever, cholera, etc. (disinfectans, *dis*, and *inficio*, I infect). The following are some of its definitions:—(*a.*) Mechanical or other agents which destroy miasmata, both odorous and inodorous, or, in short, morbific effluvia. (*b.*) Agents which can remove any impurity from the atmosphere. (*c.*) Substances which can prevent infectious diseases from spreading, by destroying their specific poisons. (*d.*)

Antiseptics, or agents that are capable of removing any incipient or fully formed septic condition of the living body, or of any part of it.

The last definition is evidently incorrect, as, in the first place, the terms antiseptic and disinfectant differ etymologically; and, secondly, because the former act by destroying agents which would, if unmolested, create putrefaction.

Then many disinfectants act simply as deodorizers, concealing by their strong odours the effluvia emanating from the part affected. Some are supposed to act by oxidizing, others again by deoxidizing. They have been employed in medicine from the earliest times.

In India, it is a traditional Hindoo custom, when a person is suffering from fever, particularly malarious fever, to keep near him various domestic animals, which are believed to act as absorbents of the noxious principles, or, at least, as preservatives and disinfectants for the attendants. These unfortunate animals are killed by relays, the number employed depending on the resources of the patient.

The observance of the need-fire is an ancient superstition of the north of England. It consists in creating a fire by the friction of two sticks, and collecting a quantity of fuel, by which a great fire is maintained for several days. Cattle affected with murrain, and various epidemics, were supposed to be cured by being held for a short period exposed to the smoke.

The following are some of the more popular disinfectants:—*Chlorine*, *chlorinated lime*, *chlorinated soda*, *permanganate of potash*, *carbolate of lime*, *preparations of sulphur*, *logwood*, *charcoal*, *sulphite of soda*, *iodine*, *bromine*, *hydrochloric acid*, *green vitriol*, *nitrous acid fumes*, *vapour of vinegar*, etc.

Desmartis believes extract of logwood superior to every other agent for disinfecting wounds. He applied it in the form of an ointment to a cancer, and found it immediately destroyed the odour, and also seemed slightly to affect the discharge.

Chlorine has been used largely to disinfect sewers, drains, etc.

Chlorinated soda, a few grains to the ounce, is a favourite disinfectant lotion with some.

The various preparations of sulphur received great prominence at one time. Sulphurous acid lotion was largely used as a dressing, applied in the form of spray, to ulcerated sore throats, and also inhaled. In the Clinical Surgical Wards, this lotion was used to a considerable extent, before the introduction of the antiseptic treatment. A small quantity of sulphite of soda was placed in a saucer, and some sulphuric acid poured over it. Thus, by chemical decomposition, sulphate of soda was formed, and the sulphurous acid gas liberated; and it certainly removed, to a slight extent, the offensive odour from the wards. But this treatment did not seem to exert any beneficial influence on the wounds, nor had it any effect in reducing the average of erysipelas, hospital gangrene, or pyæmia.

Polli, of Milan, on the principle that many blood diseases were the result of some morbific ferment, and that some remedy might be given which would neutralize this, recommended the sulphites of soda and magnesia. He found, as the result of some experiments, that if a dog be previously sulphited, it will survive an injection of pus, which, under ordinary circumstances, would have proved fatal.

The hyposulphites have been largely administered in surgical practice, in the hope of acting as preventive in cases of pyæmia, but without any satisfactory results.

Dr C. Paul, in an outbreak of cholera, used a solution of the hyposulphite of soda as a disinfectant for the extremely offensive emanations, and stated that it proved a great comfort to those in attendance. Also in the form of enemata, which not only destroyed the odour of the emanations, but gave considerable relief to the patient. He then used it sprinkled on napkins, as a preventive of puerperal fever, when it was found to act also as an anæsthetic.

Bonjean, of Chambéry, recommends a mixture of charcoal and sulphite of iron, to be used as a disinfectant in cholera.

In the Clinical Surgical Wards, Condy's fluid, sulphurous acid, and carbolic acid, were largely used, simply laid upon the wound as dressing, without antiseptic precautions ; but had no effect in controlling putrefaction—amply testified on opening the folding doors which shut off Mr Syme's department from the rest of the hospital, when one was greeted with a draught of this offensive odour.

Introduction of the Antiseptic Treatment.—For several years previous to 1864, Professor Lister had directed his attention to the subject of suppuration, more especially in its relation to putrefaction, and had employed various disinfectants, such as Condy's fluid, etc., in large quantities in the treatment of wounds, but with no marked results.

It was not till the spring of 1865, that he first used carbolic acid, according to the antiseptic principle (in a compound fracture, which, however, proved unsuecessful from improper treatment). The next case was in August 1865, when a compound fracture of the leg was treated with liquid carbolic acid, and made a good recovery. The strong carbolic acid mixing with the blood, formed a hard crust, which mechanically effectually excluded the air, and prevented putrefaction occurring in the deeper parts, and thus many a serious wound healed, and became soon superficial under this treatment. But there were certain disadvantages connected with this, as, for instance, if the blood continued to ooze for some time after the application of the acid, the latter was washed away, and thus its power was lost. Then, again, carbolic acid is very volatile, and requires something to retain it. Sheet-lead, and afterwards block-tin, were introduced to act as a "protective" to the crust.

The antiseptic principle may be best explained by taking an illustration from the treatment, say, of

Compound Fractures.—A simple comminuted fracture will make a rapid and good recovery, even if accompanied by considerable bruising. But if a wound, however slight and apparently trivial, communicate with the seat of fracture, even if there be neither bruising nor comminution, it at once renders the case serious, and a cause of anxiety to the surgeon. This seems strange, until accounted for.

From earliest times, the numerous alterations in surgical dressings have been founded on one great principle, viz., *exclusion of the air;* all authors recommend, if possible, the conversion of the compound into the simple fracture, by closure of the external wound, that the risk of putrefaction and suppuration may be avoided. Many who have written on this subject, state that the atmospheric air gaining access to the seat of fracture eauses the dangers that we apprehend.

That the air must at all times contain some noxious element (not a gaseous compound), is simply a matter of logical inference. We know from the researches of Pasteur and others, that it is not a vapour or a gas; that it is something solid, something which, by mechanical appliances, can, if not excluded, be at any rate deprived of its poisonous influences. (See experiments 5, 45, 48, and 57.) Now, we cannot apply an apparatus to a wound which will effectually exclude the air (as in the infusion preserved by the hermetieally-sealed flask), as the discharge must be allowed free vent. Again, it would be equally impracticable to apply an apparatus (as in the flask with contorted neck) to filter the air. But we may apply an apparatus that will act directly on the solid particles floating in the atmosphere, and deprive them of their influence. Carbolic acid possesses this property (see experiments 84, 85, 88, 91, and 92), and therefore has been employed as the reagent or medium.

Some have stated that the antiseptic treatment consists in the exclusion of the air. I need scarcely reiterate, that this is quite erroneous, and at variance with the principle. *The atmospheric air is purified (filtered) not excluded.*

From the introduction of this mode of treatment in the spring of 1865 to the present time (May 1871), although many alterations in the character of the dressings have taken place, the principle is always the same. The plan of washing-out the interior of the wound with carb. lot., and dressing it under the protection of the spray, reduces the risk of putrefaction to a minimum, and is especially useful in cases where the wound is large, and where a considerable interval has elapsed since the receipt of injury.

Several years ago, when carbolic acid was used in a much more concentrated form than at present, it was not uncommon to find, on removing the crust covering the wound, a small quantity of pus ooze away. This was simply due to the stimulating action of the acid on the tissues, inducing granulation and suppuration (antiseptic), which latter must not be confounded with suppuration consequent on putrefaction.

I am convinced that a much weaker proportion of the acid is quite sure to ensure complete absence of putrefaction, judging from experiments 92 and 85.

To ensure healing without suppuration, we must not only prevent the spread of putrefaction, but also protect the raw surface from the stimulating action of the acid (by introducing a "protective" between the raw surface and the dressings). In connexion with compound fractures, let me direct your attention to a few interesting pathological facts.

Organization of the Blood-Clot.—In a case of compound fracture of the leg, in May 1866, on examining the crust some weeks after, the deeper portion was found to have become converted into living tissue. Now, in many cases of compound fracture since then, when the wound has been dressed, first, every day, and then every second day, the entire clot was found after a time to have become organized (proved by gently scraping the surface, when blood was seen to ooze away). Observed in cases 2, 5, 11, 12, 56, and 61. The first case in which I observed this was in a compound fracture of the radius, caused by indirect violence, where the small wound produced by the fragment passing through the soft parts was closed by a clot of blood, which, instead of decomposing, remained soft and intact, till, on gently scraping it some weeks after, it was found to be closely incorporated with the surrounding tissues, and bled slightly. The second case was in a compound comminuted fracture of the leg, caused by direct violence, where a clot of considerable size was, on the second day, observed to close the orifice of the wound, and which, as in the preceding case, remained soft and intact, eventually becoming living tissue. (At one time, in this case, on account of the serious nature of the accident, it was feared that sloughing might ensue, with disorganization of the clot; but neither happened, the case progressing as successfully as any of the others.) The third case was also a compound fracture of the leg, the result of direct violence, where the wound was small, and, considering the exciting cause, did not promise favourably; as, if deep-seated suppuration occurred, the pent-up discharge would have proved a very serious complication. But the discharge being trifling in amount, the clot was allowed to remain, eventually becoming organized. The fourth case was one of compound fracture of the forearm, where this interesting point was again observed. The fifth case, a compound dislocation of the ankle, the result of direct violence, where, after some time, the clot was observed to be of an orange-brown colour, and which bled on being scratched. The sixth case was after an operation for a badly-united fracture of the forearm, where the clot covering the wound became converted into vascular tissue.

John Hunter once remarked, "*If you allow the clot of blood over a small wound in a compound fracture to form a crust, the blood beneath becomes organized and absorbed as in a simple fracture.*" The explanation is evident: when the blood coagulates and forms a hard crust, it protects the parts beneath from the influence of the atmosphere, and thus freed from irritating influences becomes rapidly organized. Now, the antiseptic dressings act on exactly the same principle, by protecting not only the parts beneath, but also the surface of the crust (superficial parts) from the noxious influences of the atmosphere, and thus complete organization is allowed to take place. Again, if oozing to any extent occur, in John Hunter's case, the clot is necessarily prevented from forming. But the antiseptic treatment has this advantage, that even after considerable oozing, the clot will form. (Observed in several cases the result of direct violence.)

The next pathological point of interest of equal importance with the preceding is

The Organization of Sloughs.—It is apparently of the same nature as that which occurs in subcutaneous injuries. In a severe simple fracture, the soft parts bruised, and perhaps lacerated beneath the skin, undergo in process of time a change by which they become as it were reorganized. Again, bruised and lacerated patches of skin, etc., when left exposed to the air, putrefy, and this putrefaction may spread through the subcutaneous tissues till it reaches the seat of fracture. Now, there is no reason why, in a compound fracture, provided the bruised parts surrounding the wound be protected from the action of the atmosphere, the textures immediately beneath the skin should not also become reorganized, as in the simple fracture. The following rule may be kept in mind in connexion with what I may now fairly term, the "*Preventive Treatment of Sloughs.*" *In compound fractures and wounds generally; the result of direct violence, if on the second or third day a dusky discoloration on the skin—in short, if you have any reason to anticipate sloughing—treat that part exactly as if it had been a wound (see that the dressings overlap the entire portion of the discoloration), remembering, also, to interpose the "protective," which will prevent the risk of superficial antiseptic suppuration.*

The following cases will serve to illustrate the above remarks. See cases 5, 6, and 56. In the first case, several days after the accident, a patch two inches square was observed to be *white* and *dead* (and from the remarks of Mr Syme, we were prepared for sloughing of that portion). The area of this dead portion gradually contracted; a distinct red line marking its original dimensions, and eventually a few fine scales were all that separated, showing that the subcutaneous structures had become reorganized. Now, if sloughing and suppuration had occurred with their attendant evils, irritative fever, etc., how different, probably, would have been the result! In the second case, a compound fracture of the humerus, from the character of the injury, and the appearance of the wound, sloughing might certainly have been anticipated. In the third case, a compound dislocation of the ankle, sloughing of the skin, etc., was prevented by the antiseptic precautions. The following case shows how, the "preventive" treatment being neglected, a large slough separated. I remember, in Oetober 1869, in a ease of simple fraeture of the humerus, admitted into Ward V., the result of the blow from a wineh, a diseoloured pateh appeared, and eventually a portion of it sloughed, eonfining the patient for several weeks to his bed.

Professor Lister reeords a ease of eompound fracture of the fore-arm, in which the antiseptie treatment had been pursued with thoroughly efficient means; but after the lapse of some days he was asked to look at the limb, in eonsequence of unsatisfaetory appearances. The dressings had been applied perfectly correctly, but the wound emitted an offensive diseharge. On investigation, a small slough was observed, about half an ineh in diameter, situated some inches from the wound, and just beyond the limit to whieh the lae plaster had been extended. On injeeting some of the watery solution into this slough, it passed freely beneath the integument to the seat of fraeture, and to the external wound. Had all the discoloured patehes in this ease been well overlapped, this would have been avoided.

The next point of interest in eonnexion with eompound fraetures to whieh I wish to direct your attention, is

The Organization of Bone.—Observed in cases where the bone has been exposed (subantiseptie) for some time, and eventually beeome eovered with granulations neither separating nor causing the slightest eonstitutional disturbanee. Let me refer you to eases 8, 20, 36, and 56. In the first case, a severe compound eomminuted fracture, where a portion of the tibia $2\frac{1}{2}$ inches in length lay exposed and to all appearanee dead. After a time little granulations appeared, whieh gradually covered the bone, and no exfoliation occurred. (If necrosis had set in, the patient would, in all probability, have lost his limb.) In the seeond ease, when operating for a periosteal abseess, a eonsiderable portion of the tibia was found to be bare. Healing rapidly took plaee without any exfoliation. In the third ease, a portion of the frontal bone, about half an ineh in diameter, lay bare, and eventually became eovered with granulations, unaeeompanied by eonstitutional symptoms. In the fourth ease, an exposed portion of bone, resulting from a sealp wound, healed without any exfoliation, ete. Professor Lister reeords a fifth case, where, in a eompound fraeture, "an extensive portion of the shaft of the tibia had lost its vitality, and lay exposed in a large granulating sore. The granulations grew up and enclosed the dead bone, whieh, being prevented from putrefaetion, was destitute of the usual aerid properties of an exfoliation, so that the granulations, being not stimulated by it, not only formed no pus from the surface in contact with it, but gradually consumed the dead mass by absorption."

The results of the above cases teach us that, in cases of compound fracture, where, in consequence of the severity of the exciting cause (even if sloughing does occur), a portion of bone lies exposed, necrosis, etc., may be prevented by carefully persisting in this treatment.

In connexion with compound fractures, a chapter was devoted to "The Mode of Dressing a Compound Fracture, its History and Progress, from 1865 to 1871," which must be omitted in this extract, with the exception of the mode followed in 1869–70.

On 27th December 1869, a compound fracture of the leg was treated as follows:—The patient having been removed from the cart to the general waiting-room (previous to his removal to the ward), a quantity of carb. lot. 1—40 was poured upon that portion of the stocking from which the blood trickled. His trousers and boots were then gently removed; the stocking slit up on the opposite side of the limb from the wound, and then removed under a stream of carb. lot. A piece of calico dipped in the solution was then slipped on the wound. The nozzle of the syringe, containing about 4 oz. of the lot. 1—20, was introduced into the wound, and freely injected in all directions, the external parts being at the same time kneaded to allow the lotion to permeate the neighbouring tissues. A piece of oil-silk, 2 × 2 inches, dipped in the watery solution, was then placed upon the wound (slipping the guard from beneath) to act as "protective;" then four slips of lac plaster 1—3 wrapped round the limb, extending several inches above and below the wound, applying a double layer over that part corresponding to the wound; dressing-cloth and bandage; side pasteboard splints, well padded; provided with a "bird-nest" for the external malleolus; a couple of Gooch splints to mould them to the limb. The limb was then laid on its outer side. On the following day the dressings were changed in the usual manner, with the assistance of the syringe and guard.

At the present time (May 1871), antiseptic gauze has been substituted for the lac, and this, I may mention, has several advantages. It is porous, allowing the air (purified, that is, rendered antiseptic) to reach the parts. (In fact, even when in many folds you can breathe through it like a respirator.) It renders the application of dressing-cloths unnecessary, and thus simplifies the process. The green protective is substituted for the oil-silk, and a hand spray-producer for the syringe.

On Granulation and Suppuration.—Professor Lister (*Phil. Tran.*, 1858) demonstrated, thirteen years ago, "that the tissues of the living body are liable to a temporary impairment or suspension of vital energy, as the result of extreme irritation, and that this condition may be brought about in two ways—(1.) Either by the direct operation of a noxious agent upon the tissues; or (2.) Indirectly through the medium of the nervous system. That this is also true with regard to the causes of the exaggerated but feeble cell-development, which results from the continued action on the tissues of some abnormal stimulus in a less intense form, giving rise to the various phenomena of inflammatory hypertrophy, granulation, and suppuration; the pus-cells being the extreme of excess of quantity and impairment of quality in the products of abnormally excited nutrition."

Thus Mr Lister divided the causes of suppuration into two groups—first, those that operated through the nervous system; and, second, noxious agents or stimuli acting directly on the tissues. The results of the following three simple experiments will serve to illustrate the latter of the two causes of suppuration:—

Exp. 1.—On a small granulating surface apply a piece of block-tin (fitting closely to the surface), and fix it with broad pieces of adhesive plaster. On removing this on the following day, the discharge from the sore will be found to consist of thin serum, and no pus.

Here, the access of air is effectually prevented, and putrefaction does not occur. I remember observing this in a case of carbuncle in Ward V., where, some time after the operation, a healthy granulation formed, which gradually healed by contraction. It was situated posteriorly between the scapulæ, in an admirable position for the experiment (a flat surface).

Exp. 2.—Leave another granulating surface exposed to the air, or dress it simply with water-dressing, and in twenty-four hours the granulations will be found to be studded with little points of pus.

Suppuration is here induced as the result of putrefaction (noxious agents from the atmosphere).

Exp. 3.—Dress a third granulating surface with a concentrated solution of carbolic acid, and, in a corresponding time, it also will be found to have secreted pus.

Suppuration is here induced by the direct stimulating action of the acid (destroying the vitality of the tissues superficially). This latter form is termed "antiseptic suppuration."

The above observations show that granulations have no inherent tendency to form pus.

Abscess.—Professor Lister, in the *Lancet* of July 1867, alluded to the difference between compound fractures and abscesses. "In the latter, there has been no communication with the air, and, therefore, no septic organisms are present in the interior to give rise to putrefaction. It is only when the abscess has been opened, and free access allowed to the air, that suppuration is induced. The lining wall of an abscess is similar in nature to the granulations of a sore, and has been regarded by many as essentially 'pyogenic;' but if the abscess be opened antiseptically, the pyogenic membrane being relieved from the inflammatory stimulus which the tension of the pus before induced, and being at the same time protected from the access of the stimulus of putrefaction, is left free from all disturbance, and never forms another drop of pus."

In evacuating an abscess, all the contents should be steadily pressed out under the curtain (as the pyogenic membrane is not injured thereby). So different from the old treatment of applying a poultice to absorb what remains after the operation. I may state here that, at the first dressing after the operation, you not unfrequently find several drops of pus on the cloth ; but this is merely what has not been pressed out on the previous day.

In the treatment of abscesses, surgeons, from the earliest times, seem to have been aware of the evil effects following the admission of atmospheric air. Abernethy, on the supposition that the bad symptoms which so often supervene on the opening of a chronic abscess were due to the entrance of air, recommended a small valvular opening. Again, the treatment of evacuating a chronic abscess by the trochar and canula, or the exhausting syringe (by no means recent), is founded on the principle of excluding as much of the atmospheric air as possible. But there are disadvantages connected with these forms of treatment, as, if a small quantity of the pus remain, it decomposes, and gives rise in many cases to irritative fever, etc., attended often with profuse suppuration ; and death by pyæmia is not of very unfrequent occurrence.

The "antiseptic" has, as in wounds generally, materially altered the treatment of chronic abscesses, abscesses connected with joints, and abscesses in connexion with diseased bone.

Chronic Abscess.—Under the old treatment, we are taught to be chary in opening them in patients of weak, strumous habit, as bad consequences are apt to follow. Thus, a favourite treatment with some, is to draw off the contents at stated intervals, which may prolong the case for many weeks. The drainage-tube is also tedious, and seems to keep up the suppuration by acting as a local irritant; but, with antiseptic precautions, we may confidently lay a chronic abscess freely open, and have the best results. See cases 16, 24, 25, and 28.

Abscesses in connexion with Joints.—Mr P. Hewett says, "that in cases where we have reason to conclude that pus has formed in the joint, rest and discutient remedies should be persevered with as long as there is any chance of absorption," referring probably to the danger of irritative fever, etc., following the operation.

Suppuration in the joint may be followed by superficial erosion or disintegration of the cartilage, and eventually complete disorganization of the interior of the articulation, and to more or less complete anchylosis. Is it not, then, a great advance in surgery when, confident in our treatment, we can freely evacuate the pus, and have a speedy recovery unaccompanied by constitutional disturbance? Let me refer you to cases 44, 45, 46. In the first case, as a proof that putrefaction had not taken place, a large plug of lint was extracted perfectly "sweet," after having lain embedded in the tissues for the long period of six weeks. The second case seems to illustrate how rapidly a joint will heal when laid frecly open with antiseptic precautions. The third case slso shows us how a suppurating joint may be freely laid open, all the contents freely squeezed out, and yet heal rapidly.

Abscesses in connexion with Diseased Bone.—It has long been considcred dangerous practice to evacuate an abscess in connexion with diseased bone, as the risks of such sequelæ as profuse suppuration followed by hectic fever are great. But cases 31, 32, 33, and 34 show that an abscess in connexion with carious bone may be opened and still be followed by good results. I remember hearing Mr Syme remark, after evacuating a very large psoas abscess by a free incision (antiseptically), that "formerly he would have feared giving vent to the matter on account of the dangers of profuse suppuration, hectic, and emaciation, but now he was confident the patient would rapidly recover his health." The result proved that he was right. In the Appendix are detailed a few cases of lumbar and psoas abscess treated successfully. There were either two or three perfect recoveries during the winter scssion of 1869, but I have not been able to find full reports of them.

Concluding Remarks on Abscess.—That acute abscesses, when evacuated subcarbolically, heal rapidly, see cases 13, 15, 18, 21, 26, and 27. Complete absence of constitutional disturbance is another point observed by those who have given this treatment a fair trial.

Dr Bernard, senior Surgeon to the Royal Naval Hospital, Plymouth, informed me more than a year ago, that what first drew his attention to the antiseptic treatment was the marked change after evacuating an abscess antiseptically, from the treatment he had formerly pursued, by the absence of constitutional irritation, etc. He eventually published some instructive cases in the Naval Blue-Book, 1870.

There is no doubt that irritative and hectic fever are due in great measure to putrefaction, and therefore we can easily account for their absence when antiseptic precautions have been faithfully carried out. Let me add, that some of the objections formerly urged against this treatment are entirely surmounted by the present applications. (Carbolic paste was considered uncleanly and difficult to manage.) Nothing could be more simple, nothing more cleanly, than the application of prepared gauze folded two or three times.

I shall allude further on to the pathology of lumbar and psoas abscess, when speaking of the effect of the antiseptic treatment on diseased bone.

The Mode of Dressing an Abscess: its History and Progress from 1866 to 1871.—1866. Briefly as follows: A piece of rag, 4 by 6 inches square, is dipped in a sol. of carb. acid and olive or linseed oil 1—4, and laid upon the skin where the incision is to be made. The lower edge being raised, while the upper is kept from slipping by the finger of an assistant, the bistoury, dipped in the above sol., is plunged into the cavity of the abscess, and an opening of about ¾ of an inch made; the instant the knife is withdrawn the rag is dropped upon the skin as an antiseptic curtain, beneath which the pus flows out. The cavity of the abscess is firmly pressed so as to force out all existing pus as nearly as may be, and, if there is much oozing, a piece of lint dipped in the above sol. may be introduced into the wound, to act as a drain, doing this under the curtain, and then immediately dressed with carb. paste spread upon a sheet of block-tin 6 in. square, forming a layer ¼ in. thick. The tin is then fixed by adhesive plaster, and a folded towel placed over, to absorb discharge, secured by a bandage. To change the dressings, a second piece of tin spread with putty is prepared; then a piece of lint dipped in the oily sol. is placed on the incision the moment the tin is removed, so that the discharge may be squeezed out beneath it. The strength of the putty may be reduced to from 1—5 or 1—6, if necessary. In probing an abscess, dip the probe in an oily sol. and introduce it between the folds of the rag. A piece of lint dipped in carb. oil 1—4 may be put next the skin and maintained there permanently, care being taken to avoid raising it with the putty. When all discharge has ceased, the rag is left adhering to the skin, removing the putty, and allowing it to heal by scabbing.

1868.—A double layer of plaster (lined with gutta-percha and brushed over with bisulphide of carbon) was substituted for the paste dressing.

1869.—The precautions for evacuating the abscess remain unaltered (anoint the neighbouring parts well with the oily sol., and remove any hairs). A strip of lint, dipped in carb. oil 1—10, may be introduced into the wound to act as a drain. A new preparation, consisting of shell-lac 1—3, is applied as dressing, overlapping the wound by several inches, fixed by pieces of adhesive plaster 2½ inches in breadth (applied equally on the plaster and on the skin). The syringe, charged with carb. lot., is used in changing the dressings, inserting the nozzle beneath the edge of the plaster to refresh the wound. In morbus coxarius the following lot. may be injected into the sinuses, to prevent putrefaction :—℞ Spt. methyl., ℥v. ; acid. carb., ℥i. ; solve. Shell-lac plaster 1—6 may be used after the discharge has lessened in amount.

Aug. 1869.—A plug of lint, soaked in carb. oil 1—20, may be used as a drain. A double fold of lint dipped in the same sol. laid over the wound covered by oil-silk, dressing-cloth, and bandage.

Dec. 1869.—The oil sol. is altered to 1—5, and copal plaster used as protective. Putrefaction may be prevented, or at any rate arrested, by injecting ℞ Zinci chloridi, gr. xl. ; aquæ, ℥i. ; solve.

If an abscess is pointing, but you wish to postpone opening it for a day, it may be as well, as a precautionary measure, to apply the dressings in the usual manner. If it should burst, it is in an antiseptic atmosphere.

May 1871.—Antiseptic gauze is now employed as a substitute for the lac, secured by gauze bandages. The green protective is used as formerly.

The Effect of the Antiseptic Treatment on Caries.—Caries has always been regarded as a very formidable affection, and by many as incurable (except in situations where it can be completely removed by operation). Mr Syme at one time compared it with cancer, on account of its obstinacy. Professor Lister regards caries as "merely the suppurated stage of chronic inflammation in a weak form of tissue, and that it exhibits the tendency of inflammatory affections generally, viz., a disposition to spontaneous cure on the removal of the irritation." Mr Syme latterly remarked, that "caries is the effect instead of the cause of suppuration." We know that necrosed bone lying exposed for a considerable time may not only be completely covered, but even absorbed, if antiseptic precautions be persevered with throughout. As confirming Mr Lister's remarks, let me refer you to cases 31, 32, 33, 34, and 37, of which the first four are all cases of psoas abscess connected with diseased bone; and in two, fragments of diseased bone were detected in the discharge. The fifth case was one of caries of the elbow-joint, treated successfully. Dr C.'s case illustrates how patience and perseverance may be rewarded.

The Effect of the Antiseptic Treatment on Affections of Joints.—The conservative influence of the antiseptic treatment on surgery, is well exemplified by its results in the treatment of joints generally, more especially in diseases of the knee-joint. In bursitis patellæ, we do not hesitate to operate by a free incision. The injection of stimulating lotions, such as tincture of iodine, etc., is quite unnecessary, as the membrane has no tendency to form pus (treated antiseptically). See case 40.

Loose Cartilages of Joints.—The method of removing the cartilage by the direct operation may be adopted fearlessly. It is the simplest and most effectual treatment, provided we are safe from the risk of suppuration, etc. See case 43, and one of Mr Bickersteth's, where the wound in both cases healed rapidly, unaccompanied by fever, etc.

Suppurative Synovitis, generally regarded as a very formidable affection of the joint, may be treated "radically" with confidence. See cases 44, 45, and 46.

Tumours of the Mamma.—Professor Lister has adopted, in scirrhus of the mamma, a most effectual mode of treatment for the removal of the disease, viz., dividing the pectoral muscles and dissecting out the axillary glands. Patients on whom this operation had been performed recovered as rapidly as cases of removal of simple adenoid growths; see cases 48, 49, 50, and 51. The peculiar odour proper to the axilla and groin was remarked in several of the above cases. It must not be confounded with that of putrefaction.

Tumours of the Superior and Inferior Maxilla.—The application of an external antiseptic dressing would be useless, as the contents of the mucous cavity constantly furnish the germs of putrefaction. But a strong solution of chloride of zinc has been found to answer admirably, having a remarkably persistent antiseptic influence, the discharge remaining "sweet" for several days. It is a great improvement on the old treatment of plugging the cavity with lint (unprepared), which when extracted, after a few days, is very offensive from decomposition. Case 62 shows how Condy's fluid was tried on account of the fetid odour, but did not seem to have been effectual. For cases illustrating the use of chloride of zinc, see 63, 64, and 65.

Burns and Scalds.—In the Appendix are detailed a few cases of burns and scalds, where the application of a mixture of carbolic acid and Carron oil, covered by gutta-percha tissue, was employed. Carbolated wool may also be used with advantage.

Effect of the Antiseptic Treatment on the Ligature of Arteries.—Professor Lister states, "that when an ordinary ligature is applied to an artery the internal and middle coats are ruptured, while a portion of the tough external coat is pinched together and deprived of its vitality. The dead tissue, being contaminated by the putrefaction which occurs in the interstices of the silk fibres, acts, together with the septic ligature, as a cause of irritation to the neighbouring parts of the arterial wall, which consequently degenerates into an imperfect structure, inadequate to withhold the powerful cardiac pulse; hence, if a considerable branch takes origin close to the part tied, the formation of a clot being prevented by the current of blood, secondary hæmorrhage is the inevitable consequence." Thus, it is evident that the great risk in those cases is putrefaction, occurring at a point where the vessel is of degenerate structure, and sudden hæmorrhage taking place. But being able to prevent this putrefaction, we thus have a direct control over suppuration, one of the commonest causes of death. We can readily comprehend that if large portions of dead tissue, pieces of exposed bone, and blood-clots become organized, how the small dead portion of the external coat of an artery becomes, after a time, absorbed.

In this treatment silk ligatures were first used, which had been steeped in a watery sol. of carb. acid. They caused no irritation, remaining embedded in the tissues, just as any hard impermeable substance, but were, of course, not absorbed. Catgut ligatures were next tried and proved successful in an eminent degree. They are prepared by suspending the catgut in a mixture of carb. acid, water, and olive oil (in the following proportions—carb. acid crystals 25 oz., water 1¼ oz., and olive oil 125 oz.), so that it may be kept clear of the water (precipitated). The vessel should be kept cool, say at a temperature of 46° F. The ends are cut close off at the knot, which eventually become absorbed.

Let me briefly state the result of the following experiment:—

Ligature of the Common Carotid of a Rabbit with Catgut.—18*th March* 1871. The animal being put under chloroform, an incision about two inches was made, and the skin carefully divided. On dissecting down, a very large vein was exposed, which lay superficial to the sterno-mastoid. This was gently held aside by a blunt hook ; the artery was then exposed, lying close to the trachea, having the pneumogastric nerve on its outer side. Two ligatures of the thickest kind of gut were applied, the ends cut short, and the intermediate portion of the vessel removed and submitted to microscopic examination (to be quite sure it was the artery). The wound was then carefully sponged out with carb. oil 1—5, and the edges brought together with prepared silk sutures. Several folds of lint dipped in this lotion were then applied as dressing, and the animal placed in a basket before the fire. The instruments, etc., were dipped in the 1—40 lot. The animal cried a good deal when first put under chloroform, and seemed to be thrown into a state of hyperæsthesia. About an hour after the operation it was nibbling at its food as if nothing had happened.

19*th March.*—The boy who has charge of the rabbits informs me that this rabbit consumed a greater quantity of food in the twenty-four hours than another, which had not been experimented on.

23*d March.*—Wound perfectly healed ; animal quite healthy ; no suppuration. Exactly three weeks and two days after the operation, the animal was killed.

Post-mortem Examination.—The skin was reflected by a quadrilateral flap including the cicatrix. The textures beneath the cicatrix were slightly adherent. Both knots were exposed (the cardiac one dissected down to the heart, which was removed along with it). *General appearance.*—On making a section of one of the knots, a dark speck was observed in the centre, which, on being gently

Section of Catgut Knot

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Section of Catgut Knot
with Acetic Acid

drawn out by the point of a needle, proved to be the artery, reduced to about one-fifth of its original size, and firmly embedded in the surrounding tissue, which had a faintly pink hue, as if injected. *Microscopic examination.*—On making a fine section of the knot, and teasing it out with needles, it was found to consist of delicate parallel wavy lines—in short, areolar tissue (showing its ordinary characters). On the addition of acetic acid, the field became almost transparent, and showed a good many nuclei. There was not sufficient time allowed for the entire absorption of the ligature, as the animal was killed only three weeks after the operation. This was done purposely to observe how far matters had progressed. I may add, that, in the dissection, the knots were with difficulty separated from the surrounding tissue, with which they had become closely incorporated. Thus it was evident, that the greater portion of the ligature had become organized.

The Mode of Dressing an Amputation: its History and Progress from 1866–71.—1866. Amputations were dressed at this time in a similar manner to compound fractures. Large pieces of lint, soaked in carb. acid, applied, enveloping the stump, covered with gutta-percha or lint, dipped in the oily sol.

1867.—Carbolic paste, applied in the same manner as in abscesses.

1868–69.—Amputations were dressed with indiarubber tubes as follows:—The stump was enclosed in an indiarubber tube, and a knot tied at the face of the stump. Then a fold of lint, dipped in the following sol., placed within the tube, and a second knot applied, keeping this close against the stump, but not touching it: ℞ Acid. carb., ℥i.; glycerine, ℥iv. Solve. Then two long strips of lint, dipped in the same sol., applied around the upper part of the stump to act as antiseptic reservoirs. A folded towel wrapped round the upper part to absorb discharge, and the stump laid on a pillow. The tube is easily removed (like pulling off a finger-glove), the nozzle of the syringe being inserted beneath to refresh the wound, and a large piece of calico dipped in the 1—40 sol. slipped on immediately on the withdrawal of the tube. The lint, dipped in the glycerine sol., is then changed, and the dressings reapplied. Thus the wound is exposed to a constant antiseptic atmosphere.

I have entered into this rather minutely, as it explains so well the "principle." The dressings do not come in actual contact with the wound, but still preserve it in a thoroughly antiseptic atmosphere. This also serves to explain the principle on which the antiseptic acts when applied in cases of psoas abscess.

1869.—A large 40-oz. bottle of carb. lot., 1—40, is taken into the theatre, from which the basins are filled. One basin is placed aside, into which all the instruments to be used are dipped. The sponges are also wrung out of the lotion. The saw is anointed with oily sol., 1—10. The operator and his assistant dip their fingers in the lot. The large vessels secured with catgut, the ends cut short, and the smaller ones twisted. The wound is then sponged out with the watery sol., and the flaps brought together, except at the most dependent part, to allow vent for the discharge. A strip of lint, dipped in the oily sol., 1—10, is introduced into the wound to act as a drain. Then the stump is enveloped in a double layer of lac, 1—3 (stripped of its calico), and a large piece of oil-silk applied, to prevent the risk of air entering by any cracks. Dressing-cloth and bandage. It should be dressed on the following day as follows: Remove the plaster gently, inserting the nozzle of the syringe; then slip on the guard. Take an ordinary towel, and soak it in the watery sol., 1—20, and apply it, so as to envelop the stump (funnel-shaped), so that, lifting the edges, you may examine the stump and remove the drain. Then a broad piece of lac is applied around the stump and towel; from the interior of which the latter can steadily be withdrawn, closing the lac over the face of the stump. Then apply the dressings in the usual manner. On the fourth day, a strip of lint, two inches in length, dipped in the 1—20 carb. oil, may be applied along the wound as "protective." If the stump require strapping, cut two strips of lac, and with a dry towel remove the gutta-percha. Then lay over it pure carb. acid.

Nov. 1869.—A towel soaked in the following sol. was wrapped round the stump and kept moist during the first twenty-four hours: ℞ Acid. carb., ℥i.; glycerine, ℥v.; water, ℥xx. Solve. A piece of lac, 8 × 8, laid on the pillow to act as an antiseptic basis. On the following day it is dressed in the usual manner. The stitches (that were merely inserted loosely) are tightened as follows: An assistant steadily drops the lotion on each stitch as it is being tightened, and a little piece of calico is at the same time slipped on it, and so on till they are all finished. The "protective" is pinned to the guard, and thus applied.

1871.—Amputations are performed and dressed under the carbolic spray. Prepared gauze applied as dressing with green "protective."

The following is a list of the various preparations used in the Antiseptic Dressings, 1866–71 :—

1866.—Liquid carbolic acid.

1867.—Carbolic paste.

1868.—(*a.*) Emplastra. (*b.*) Bees-wax; carbolic acid. (*c.*) Emp. plumbi; bees-wax, $\frac{1}{4}$; carb. acid, $\frac{1}{10}$. (*d.*) Shell-lac. (*e.*) Shell-lac; gutta-percha. (*f.*) Shell-lac, 3; gutta-percha, 1; carb. acid, 1; bisul. of carb., 30. (*g.*) Shell-lac, 6; carb. acid, 1.

1869–70.—(*a.*) Shell-lac, 3; carb. acid, 1.

The "Protective."—(*a.*) Carbolic acid; blood. (*b.*) Calico dipped in the oily sol. (*c.*) Sheet-tin.

1869.—Oil-silk; watery sol. Gum copal, 3; carb. acid, 1.

Feb. 1870.—Oil-silk, coated with copal, and brushed over with carb. acid and dextrine; gold-leaf.

On Fermentation and Putrefaction.—Pasteur stated that there are at all times suspended in the air organized corpuscles; that the dust of the air, when placed in the presence of an appropriate liquid, in an atmosphere of itself quite inactive, gives rise to various products, such as the Bacterium Termo, and many varieties of fungi. Again, that the lactic and butyric fermentation were always associated with the presence of organized beings; that, in fermentation, yeast, appropriating a certain percentage of sugar, causes the rest to be transformed into carbonic acid and alcohol (the products of fermentation); that the presence or absence of oxygen was immaterial to the production of putrefaction and fermentation.

With regard to Fermentation.—The investigations of Redi, Schwann, Helmholtz, Ure, etc., proved that putrefaction was caused by solid matters constantly present in the atmosphere, which only required time and a suitable nidus to develop themselves.

That the atmospheres of certain localities are more prejudicial, as it were, than others to putrefaction, is to be inferred.

Let us see what bodies may be found in the neighbourhood of fetid discharges and noxious emanations.

Chalvet, of Paris, made a series of investigations into the salubrity of hospitals, and found, by a careful analysis, that the air in the wards of St Louis contained a considerable percentage of starch corpuscles; that a large quantity of putrescible matter was collected on the bed-curtains, on the walls and windows, etc.; also that the linen returned from the laundry was stained with organic detritus, linseed, and spots of various kinds. He also showed that water condensed in the neighbourhood of a suppurating focus is strongly charged with irregular corpuscles, resembling dried pus. Dust collected from the walls of St Louis (wards) furnished no less than 36 per cent. of organized matter.

Eiselt, of Prague, found small cells, resembling pus-corpuscles, spread through the air of a ward in which an epidemic of purulent ophthalmia was raging.

Reveil found that those cells floating in the air, and the debris of epithelial cells, become yellow on the application of nitric acid; also that pieces of charpie abounded in those corpuscles. The dust in his laboratory furnished 46 per cent. of organic matter.

Kallman found organic debris encrusted with a granular substance, which gave a reaction of copper, the dust having been collected in the ophthalmic hospital, where sulphate of copper was much used.

Thus, the researches of Chalvet, Eiselt, Reveil, and Kallman, prove that the atmosphere of the surgical wards of an hospital is largely impregnated with organic matter. What condition could be more favourable for the development of those morbid germs and ferments than the surface of a wound exposed unprotected to such atmospheres? On the theory of catalysis—that is, the introduction of a small quantity of virus, and the septic changes which take place in the blood to which it has gained access—we can readily understand how important it is to exclude the most minute portion of the air of a ward containing such a large percentage of organic matter. But we know that exclusion is unnecessary, provided the air be filtered or purified, thus rendering it innocuous.

Davaine showed that those low germs of life seriously affect the blood of the higher animals. He discovered Bacteria (probably including vibriones, etc., under the general term Bacterium) in the blood of malignant pustules, in the blood of *typhoid fever*, and in the blood of sheep which had suffered from splenic apoplexy.

Tigri and Signol corroborated the statements of Davaine.

The Effect of Noxious Emanations such as those evolved from Marshes, Cesspools, etc., on Fermentation and Putrefaction.—The theory that such affections as cholera, typhoid fever, smallpox, diphtheria, intermittent fever, etc., may be traced to what are termed "germs" generally, is by no means of recent date. It is a subject of the most vital importance, involving such questions as drainage, isolation, the use of antiseptics and disinfectants, and affects essentially the treatment of such diseases (preventive and curative). Dr Barker conducted the air of a cesspool, containing sulphuretted hydrogen and sulphide of ammonium, into a box in which animals were confined, and the symptoms which resulted resembled the minor forms of continued fever, common to the dirty and ill-ventilated houses of the lower classes. This he attributed to the gaseous matters. Now, I think that these symptoms resulted from the quantity of organic matter (low organisms and fungi) contained in such an atmosphere.

Dr D. Thomson recognised the importance of organic matter as a constituent of the air of towns, and held that the gases evolved during putrefaction are not the main source of danger.

Place a globe filled with ice over a cesspool, and in a short time the matter contained in the aqueous vapour will be condensed on its surface. The liquid will be turbid, have an offensive odour and alkaline reaction, and contain small flakes of matter, which, under the microscope, have the appearance of organic debris, and contain vibriones, monads, and other forms of low life, with fungoid filaments. A similar result may be obtained on placing a bell jar over putrid meat. Can we be surprised at fermentation and putrefaction being readily set up in such neighbourhoods?

Dr Salisbury says, that the spores of fungi are, at least, the vehicles by means of which the malaria-poison gains entrance into the human frame; that a disease analogous to measles, which occurred as an epidemic during the American war, arose from the prevalence of a fungus (*penicillium*). This he concluded from a large number of men arising with symptoms of measles, after sleeping on straw which was muddy and had a peculiar odour; and by inoculation with this fungus he set up in many persons, in from twenty-six to ninety-six hours, a disease closely resembling measles.

Dr Snow says, that although cholera is disseminated by a special cell, it offers no objection to the view that the structure of the cholera-poison cannot be recognised by the microscope; for the matters of smallpox and chancre can only be recognised by their effects, and not by their physical properties.

Dr Halford states, that when a person is bitten by the cobra, minute living germinal matters are thrown into the blood, which speedily grow into cells, and as rapidly multiply, so that in a few hours millions upon millions are produced.

Dr Kennedy, in 1863, relates the case of a disease, in all respects resembling measles, produced in a young lad who had some fusty linseed-meal thrown in his face, entering his eyes, nostrils, and mouth.

During the epidemic of malarious fever in the Mauritius, the presence of fungoid spores identical with cryptogams, found in the stagnant pools of Grande and Petite Rivière, occurred throughout all the mucous surfaces, and in most of the secretions, of patients labouring under the disease.

Dr Massy, in the Army Indian Reports, remarks, that in the dry season there was an unusual quantity of aerial spores of Mucor in

Jaffera, where there was an increased prevalence and intensity of intermittent fever. He detected similar organisms in almost all the specimens of the drinking water of the island which he examined. He found them in the pus crusts and hairs taken from a form of ringworm (*frambœsia*). These ulcers are common among badly-nourished native children, and are now treated by the application of sulphurous acid. He detected a residue, consisting of torula spores, mycelia, and active vibriones, in the urine, perspiration, and fæces of patients suffering from malarious fever.

I have alluded to those researches of Halford, Kennedy, Massy, Salisbury, and Snow, to show how many forms of fever, etc., may be traced to the absorption of these low organisms and fungi.

Take typhoid or enteric fever — the pythogenic fever of Murson (πυθογενης, from πυθων, πυθομαι (putresco), γενναω). It generally arises in the neighbourhood of decomposing matter, cesspools, stagnant water, drains, etc.—in short, where putrefaction and fermentation are prevalent. It is not contagious, but is communicated by means of the alvine secretions, which doubtless contain the poison. It has been remarked that the stools of enteric fever are very prone to decomposition and fermentation; again, that it occurs most frequently in hot weather (favourable to putrefaction).

Now, that it is from the quantity (and, possibly, from the virulent character) of the organism and fungi contained in such atmospheres that typhoid fever owes its origin, is, I think, evident.

In connexion with this subject, I may here briefly refer to an experiment instituted to test the effect of an atmosphere emanating from fetid matter on a putrescible fluid.

A small basin, filled with very fetid matter (collected from jars containing frogs' legs and other preparations steeped in water, and which had been laid aside for several months, pus, blood, etc.), was placed on a ledge outside the laboratory window, Physiological Laboratory of the University. A Wolfian jar half filled with urine, fitted with two glass tubes, one bent over the basin and the other connected by elastic tubing with a Sprengle's air-pump, was placed beside the basin. A second Wolfian jar, similarly charged, was placed on a shelf in the laboratory. Then a small flask was also half-filled with a portion of the same urine, but boiled and plugged with carbolated wool, and placed beside the basin containing the fetid matter. The Sprengle pump was then started, and thus the air emanating from the matter was drawn over the urine. On examining this jar after the lapse of seven days, it presented the following appearance:—Colour, muddy yellow, thick white scum on surface; odour very fetid. *Microscopic Examination.*—Field literally crowded with organisms; numerous bacteria and other minute organisms. The jar placed in the laboratory presented the following characters:—Colour, muddy yellow, but not so marked as in the other jar; very thin scum on surface. *Microscopic Examination.*—Numbers of bacteria, and a few thin, short vibriones, of a dark colour, moving sluggishly. The contents of the flask plugged with cotton remained perfectly clear, and apparently unaltered; the plug had a very fetid smell, and was quite black with dust, etc.

The differences thus—as observed from the general appearance of the urine, the quantity and character of the organisms in the jar exposed to the fetid atmosphere—contrast forcibly with the contents of the laboratory jar, where decomposition was evidently in a much less advanced stage. The fact of the plugged flask remaining unaffected, shows that the gases evolved produced no bad effect, therefore it is clear that the exciting causes of putrefaction were filtered and retained by the meshes of the cotton.

Professor Lister, alluding to the noxious influences of the atmosphere, says,—"Grave results are induced by access of the atmosphere in compound fractures, etc. The decomposition of the blood effused among the interstices of the tissues, losing by putrefaction its naturally bland character, assumes the properties of an acrid irritant, occasioning both local and general disturbance."

The theory of fermentation and putrefaction, in its application to medicine and surgery, especially the latter, is not based on logical inference solely, but on the results of observations and experimental research. It is no longer a matter of conjecture that impure air, more especially air emanating from noxious sources, may account for the disastrous consequences so frequently met with in the crowded wards of a surgical hospital.

Hospitalism.

The Effect of the Antiseptic Treatment on Erysipelas, Hospital Gangrene, and Pyæmia.—The theory that pyæmia is due to some atmospheric influence is not of recent date.

Ambrose Paré (1582) first taught that secondary abscesses in surgical cases were due to a changed condition of the fluid produced by some unknown alteration in the atmosphere, and determining a purulent diathesis.

Solly considers that the presence of pyæmia at the present time is dependent on some occult atmospheric cause over which we have no control, and that the secondary suppurations are owing to purulent absorption.

Callander remarks, that an animal or septic poison introduced into the system is the exciting cause of the primary disease—systemic infection. It is connected in some subtle manner with a vitiated condition of the blood. The blood undergoes decomposition, or passes into a state of fermentation.

Wilkes considers that pus or its elements, or germs, give rise to purulent deposits, as the cancer germs give rise to cancer.

Savory ascribes it to some putrid fluid poisoning the blood.

Wood supposes the alterations in the blood to be of a zymotic nature.

Polli ascribes to this morbid process a fermentative character.

Braidwood gives to pyæmia the term "suppurative fever," and states that it is not contagious, and, although sometimes prevalent, cannot be strictly spoken of as epidemic; in another part of his work, that "pus, as such, has nothing to do with inducing suppurative fever, nor do its liquid contents produce this condition; but it is probable that some catalytic process is excited by purulent fluids in contact with imperfectly oxygenized blood."

Polli, at the British Medical Association, 1867, remarked,—"It has long been admitted that there are diseases whose cause and origin is a specific ferment, either generated in the system or introduced from without."

Batailhé treats cases of pyæmia by dressing their wounds with alcoholic fluids, so as to prevent the putrefaction of the discharge, and to close the mouths of the open veins and lymphatics.

Savory remarks, in some very bad cases the blood is putrid at the time of death, judging from the odour and changes which the blood and soft tissues present by rapidly-advancing decomposition.

Castleman and Ducrest made experiments on animals, and came to the following conclusions:—1. That multiple abscesses are due to a changed condition of the blood, which is most frequently produced by the presence of a foreign principle in this fluid. 2. That when abscesses are developed in certain other diseases, the principle is that which gives rise to the disease itself. 3. That in those abscesses which are developed in the puerperal state after traumatic lesions, surgical operations, or phlebitis, the principle is pus. 4. That the progress, prognosis, and treatment of these abscesses entirely depend on the nature of the cause that has produced them.

Pyæmia is grouped in many surgical works with erysipelas, diffuse inflammation of the cellular tissues, and other inflammations of a low or sthenic type. Erysipelas, however, is contagious, whereas pyæmia is not.

The exciting cause of that surgical fever known as pyæmia has been a matter of dispute for hundreds of years. Some stated that it was due to an atmospheric influence, but did not, or rather could not, define it; others, again, that it was due to the absorption of decomposed matter; others that it was due to some ferment. Nothing definite, however, has ever been stated with regard to its etiology. Now, I think we may venture to hope that a solution of this hitherto inexplicable question is not far distant. That the antiseptic treatment has effectually driven pyæmia from the wards (where it has been faithfully carried out) is a matter of fact, the result of detailed statistics.

Mr Lister published, in a pamphlet in 1869, statistics taken from a period preceding and subsequent to the introduction of the antiseptic treatment, in which he showed that only two cases of pyæmia (the causes in both of which were accounted for) had occurred in his ward during the latter period. Again, in the *Lancet* of August 1870, he stated that no cases of pyæmia had occurred in his wards during the nine preceding months (that is, since his appointment to the Edinburgh Infirmary).

I remember, in 1866, in the clinical surgical wards, pyæmia, hospital gangrene, and erysipelas were all very prevalent. In Ward IV., there were, at the same time, two cases of pyæmia, two cases of hospital gangrene, and one of erysipelas. The two cases of hospital gangrene are particularly impressed on my memory, as I attended both of them subsequent to their removal from the hospital. In one case, a patient was admitted suffering from a small callous ulcer of the leg; and, as it was a typical case, he was taken in to lecture, where Mr Syme, after describing the case and explaining the treatment, remarked that in a very short time he would be quite well. That day week a small grayish spot appeared on the edge of the sore. It was immediately and thoroughly cauterized with strong nitric acid (the truth is, we were too well acquainted with these cases, and could diagnose them early), and poultices applied, but all to no purpose. It spread very rapidly, and at Mr Syme's recommendation he was removed to his own house. The gangrene ate nearly to the bone; and when at last the disease was arrested, a sore 6 by 4 inches remained. Gradually, however, he recovered, although for some time he appeared to be in a dying condition. The other case, in the same ward, was one of abscess of the head of the tibia, where, two days after the operation, the gray spot appeared, extending rapidly. He also was removed home (two miles to the west of Edinburgh). In this case, like the former, the disease was not arrested till several inches of the tibia was exposed. He eventually made a slow recovery, and was still an invalid when I last heard of him (two years later). Both the cases of pyæmia were fatal. In short, death from pyæmia was, alas! of too common occurrence.

During the last two and a half years, there has not been a single case of pyæmia. I have not seen or heard of any cases of hospital gangrene since the time referred to above. Two cases of superficial erysipelas, indeed, occurred in December 1869, both the result of sudden exposure to cold. One, an amputation above the knee, was taken, five days after the operation, to the theatre, and dressed at lecture. It was a bitterly cold, foggy morning (the gas had to be lit), and, shortly after, a slight erysipelatous blush appeared, which very soon subsided.

Do not these simple facts speak for themselves?

Thus, a relationship between pyæmia, hospital gangrene, and erysipelas (the dreaded scourges of our large hospitals) may be traced, from the fact of their disappearance coincident with the introduction of Antiseptic Surgery.

TABLE I.—*Series of Experiments with Flasks containing various Fluids.*

Flasks with Long Straight Necks (Vertical).

Nature of Fluid.	Nos. of Experiments.	Dimensions of Flasks in Inches. Length of Flask.	Length of Neck.	Diameter of Flask.	Diameter of Neck.	Diameter at Orifice.	Time of Boiling.	Date. Date when Introduced.	Observation. Date of Turbidity.	Date when Fluid was quite Clear.
								1870.	1871.	1871.
Urine, .	1	2·8	9·	2·3	·6	·083̇	6 min.	Nov. 21	Feb. 3	
Urine, .	4	2·8	6·	2·3	·6	·083̇	,,	Nov. 23	Feb. 5	
Milk, . .	7	2·7	12·	2·3	·6	·083̇	,,	Nov. 24	Jan. 4	
Claret, . .	10	2·9	14·	2·2	·5	·083̇	,,	Nov. 25	Mar. 27	
Sat. sol. of sugar,	16	2·9	9·2	2·3	·6	·083̇	,,	Nov. 30	Mar. 27	
Yeast, .	19	2·7	6·2	2·1	·5	·083̇	,,	Dec. 7	May 12	
Yeast, . .	23	1·	3·	1·	·2	·0416̇	,,	Dec. 7	...	May 12
Urine, .	43	2·8	20·	2·4	·6	·083̇	,,	Dec. 16	April 5	
Urine, .	47	1·	3·	1·	·2	·0416̇	,,	Dec. 16	Mar. 24	
Urine, .	56	1·	3·	1·	·2	·0416̇	,,	Dec. 19	Mar. 24	
Urine, . .	44	2·8	10·	2·4	·6	·083̇	,,	Dec. 16	Mar. 14	
Sat. sol. of sugar,	29	1·	3·	1·	·2	·0416̇	,,	Dec. 8	May 12	
Urine, . .	34	2·8	7·5	2·7	·8	·083̇	,,	Dec. 10	Mar. 18	
Urine, . .	38	2·8	4·5	2·3	·5	·083̇	,,	Dec. 15	Mar. 18	
Urine, . .	41	1·	3·	1·	·2	·0416̇	,,	Dec. 15	Mar. 26	
Urine,	51	1·	3·	1·	·2	·0416̇	,,	Dec. 17	Mar. 24	

URINE

MILK

J. Bartholomew, Edin.

URINE

TABLE II.—*Series of Experiments with Flasks containing various Fluids.*
Flasks with Necks Bent at Angles.

Nature of Fluid.	Nos. of Experiments.	Dimensions of Flasks in Inches.						How long Boiled.	Date. Observation.		
		Length of Flask.	Length of Neck.	Diameter of Flask.	Diameter of Neck.	Diameter at Orifice.	No of Angles.		Date when Introduced.	Date of Turbidity.	Date when Fluid was quite Clear.
									1870.	1871.	1871.
Urine, .	2	2·8	9·	2·3	·6	·083	11	6 min.	Nov. 21	May 12[1]	
Urine, . .	5	2·8	6·	2·3	·6	·083	7	„	Nov. 23	...	May 12
Milk, . . .	8	2·7	12·	2·3	·6	·083	9	„	Nov. 24	Jan. 6	
Claret, . .	11	2·9	14·	2·2	·5	·083	18	„	Nov. 25	...	May 12
Sat. sol. of sugar,	17	2·9	9·5	2·3	·6	·083	14	„	Nov. 30	...	„
Yeast, . .	20	2·7	10·	2·1	·5	·083	19	„	Dec. 7	...	„
Yeast, . .	21	3·3	20·	2·5	·5	·083	23	„	Dec. 7	...	„
Yeast, . .	24	1·	3·	1·	·2	·0416	6	„	Dec. 7	...	„
Yeast, . .	25	1·	3·	1·	·2	·0416	7	„	Dec. 7	...	„
Urine, . .	45	2·8	20·	2·4	·6	·083	23	„	Dec. 16	...	„
Urine, . .	48	1·	3·	1·	·2	·0416	5	„	Dec. 16	...	„
Urine, . .	57	1·	3·	1·	·2	·0416	7	„	Dec. 19	...	„
Milk, . . .	13	2·6	6·3	2·2	·5	·083	...	„	Nov. 28	Feb. 12	
Milk, . . .	14	2·6	9·3	2·2	·5	·083	...	„	Nov. 28	Feb. 8	
Sat. sol. of sugar,	26	2·8	2·5	2·2	·5	·083	4	„	Dec. 8	May 12	
Sat. sol. of sugar,	27	2·8	18·	2·2	·5	·083	19	„	Dec. 8	...	May 12
Sat. sol. of sugar,	30	1·	3·	1·	·2	·0416	8	„	Dec. 8	...	„
Urine, . .	31	2·6	5·5	2·3	·8	·083	5	„	Dec. 10	...	„ [2]
Urine, . .	32	2·6	13·	2·3	·8	·083	14	„	Dec. 10	...	„ [2]
Urine, .	33	2·8	20·	2·7	·8	·083	19	„	Dec. 10	...	„ [2]
Yeast, .	35	2·8	6·	2·3	·5	·083	6	„	Dec. 12	...	„
Yeast, .	36	2·8	24·	2·3	·5	·083	24	„	Dec. 12	...	„
Urine, . .	37	2·8	3·5	2·3	·5	·083	2	„	Dec. 15	Mar. 18	
Urine, .	42	1·	3·	1·	·2	·0416	6	„	Dec. 15	...	May 12

Remarks.—[1] Neck broken off on 1st March. [2] Slightly dim, but not turbid.

TABLE III.—*Series of Experiments with Flasks containing various Fluids.*
Flasks with Short Necks Stuffed with Cotton.

Nature of Fluid.	Nos. of Experiments.	Dimensions of Flasks in Inches.					Length of Time Fluid Boiled.	Date. Observation		
		Length of Flask.	Length of Neck.	Diameter of Flask.	Diameter at Neck.	Diameter at Orifice.		Date when Introduced.	Date of Turbidity.	Date when Fluid was quite Clear.
								1870.	1871.	1871.
Urine,	3	2·3	3·	2·3	1·	·7	6 min.	Nov. 21	...	May 12
Urine, .	6	2·5	2·8	2·5	1·	·8	„	Nov. 23	...	„
Milk, . .	9	2·7	2·1	2·7	1·	·6	„	Nov. 24	Jan. 6	
Claret, . .	12	3·	2·6	3·1	1·1	·9	„	Nov. 25	...	May 12
Sat. sol. of sugar,	18	2·5	2·1	2·4	·9	·8	„	Nov. 30	...	„
Yeast, . .	22	2·5	3·	2 8	1·	·8	„	Dec. 7	...	„
Urine, . .	46	2·4	2·2	2·4	1·	·7	„	Dec. 16	...	„
Urine, .	52	2·5	2·2	2·4	1·	·7	„	Dec. 19	...	„
Urine, . .	53	2·5	1·7	2·5	·9	·7	„	Dec. 19	...	„
Urine, . .	54	2·7	2·2	2·5	·8	·6	„	Dec. 19	May 12	
Urine, .	55	3·3	2·	3	1·	·8	„	Dec. 19	...	May 12
Milk, . .	15	2·2	2 5	2·3	1·	·6	„	Nov. 28	Jan. 3	
Sat. sol. of sugar,	28	2·5	2·6	2·4	1·	·6	„	Dec. 8	...	May 12
Urine, .	39	2·2	3·	2·4	1·	·6	„	Dec. 15	...	„
Urine, . .	40	2·4	3·	2·4	1·	·6	„	Dec. 15	...	„
Urine, .	49	2·4	2·5	2·3	1·	·6	„	Dec. 17	Mar. 1[1]	
Urine,	50	2·4	2·5	2·3	1·	·6	„	Dec. 17	...	May 12
Urine,	77	2·3	2·2	2·3	·9	·7	„	...	Feb. 22	

Remarks.—[1] Slight dusty cloud.

TABLE IV.—*Series of Experiments with Flasks containing various Fluids.*

Flasks with Long Straight Necks (Vertical).

Not Boiled.

Nature of Fluid.	Numbers of Experiments.	Dimensions of Flasks in Inches.					Date. Observation.	
		Length of Flask.	Length of Neck.	Diameter of Flask.	Diameter at Neck	Diameter at Orifice.	Date when Introduced.	Date of Decomposition.
Urine, . .	58	2·1	8·	1·8	·4	·083	Jan. 20, 1871	Jan. 30, 1871
Milk,	61	2·8	10·5	2·1	·8	·083	Jan. 20, 1871	Feb. 11, 1871
Claret, . .	64	2·7	12·	2·2	·6	·083	Jan. 20, 1871	Feb. 22, 1871
Yeast,	67	2·8	6·	2·2	·5	·083	Jan. 20, 1871	Feb. 9, 1871

TABLE V.—*Series of Experiments with Flasks containing various Fluids.*

Flasks with Necks bent at Angles.

Not Boiled.

Nature of Fluid.	Numbers of Experiments.	Dimensions of Flasks in Inches.						Date. Observation.	
		Length of Flask.	Length of Neck.	Diameter of Flask.	Diameter at Neck.	Diameter at Orifice.	Number of Angles.	Date when Introduced.	Date of Decomposition.
Urine, . .	59	2·8	22·5	2·3	·5	·083	24	Jan. 20, 1871	Feb. 10, 1871
Milk, . .	62	2·8	1·5	2·2	·7	·083	1	Jan. 20, 1871	Feb. 11, 1871
Claret, .	65	2·6	14·	2·2	·5	·083	19	Jan. 20, 1871	...
Yeast, . .	68	2·8	5·2	2·2	·5	·083	5	Jan. 20, 1871	Mar. 1, 1871
Urine, . .	73	2.9	6·	2·3	·6	Sealed	1	Jan. 31, 1871	Feb. 12, 1871
Urine, . .	74	2·9	6·	2·3	·6	Sealed	1	Feb. 1, 1871	Feb. 12, 1871

TABLE VI.—*Series of Experiments with Flasks containing various Fluids.*

Flasks with Short Broad Necks, some stopped with Cotton.

Not Boiled.

Nature of Fluid.	Numbers of Experiments.	Dimensions of Flasks in Inches.					Date. Observation.	
		Length of Flask.	Length of Neck.	Diameter of Flask.	Diameter at Neck.	Diameter at Orifice.	Date when Introduced.	Date of Decomposition.
Urine, .	60	2·8	2·2	2·2	·9	·7	Jan. 20, 1871	Jan. 30, 1871
Milk, .	63	2·6	2·2	2·2	·9	·6	Jan. 20, 1871	Feb. 11, 1871
Claret, . .	66	2·2	2·5	2·4	1·	·8	Jan. 20, 1871	Feb. 11, 1871
Yeast, .	69	2·1	2·5	2·2	1·	·8	Jan. 20, 1871	Feb. 9, 1871
Urine, . .	70	2·1	2 4	2·2	·9	·7	Jan. 31, 1871	Feb. 9, 1871[1]
Urine, .	71	2·1	2·4	2·2	·9	·7	Jan. 31, 1871	Feb. 9, 1871
Urine, . .	72	2·1	2·4	2·2	·9	·7	Jan. 31, 1871	Feb. 9, 1871[2]

Remarks.—[1] No plug introduced. [2] Urine boiled for 6 minutes, but no plug introduced.

Table VII.—*Poisons.*

Exposed in Glass Saucers to the Air.

Nature of Poison.	Nos. of Experi-ments.	Quan-tity.	Date. Observation. Date when Exposed.	Date when Examined.	Bacteria.	Vibrios.	Plant-like Structures.	Semi-transparent Bodies.	Corpuscles.	Crystals.	Bodies of Genus III.
			1870.	1871.							
Tinct. of Aconite .	96	ℨij.	Dec. 20	Feb. 13	Yes	...	Yes	...	Yes	...	Yes
Hydrocyanic Acid .	97	„	Dec. 20	Mar. 7	Yes	Yes					
Tinct. of Calabar Bean	98	„	Dec. 20	Feb. 13	Yes	Yes	...	Yes			
Tinct. of Digitalis .	99	„	Dec. 20	Mar. 3	Yes	Yes	...	Yes	Yes		
Cyanide of Potassium	100	„	Dec. 20	Feb. 13	Yes	Yes	...	Yes	...	Yes	
Liquor Strychniæ .	101	„	Dec. 20	Mar. 3	Yes	...	...	Yes	Yes	Yes	

Table VIII.—*Various Fluids.*

Exposed in Glass Saucers to the Air.

Nature of Fluid.	Numbers of Experi-ments.	Quantity.	Date. Observation. Date when Ex-posed.	Date when Ex-amined.	Bacteria.	Vibrios.	Scum.	Semi-transpa-rent Scales.	Corpuscles.	Crystals.	Plant-like Structures.
			1870.	1871.							
Acid. carb. gr. ½, aqua ℨij.,	102	ℨij.	Dec. 23	Mar. 7	...	...	...	Yes	Yes	Yes	
Acid. carb. gr. iij., aqua ℨij,	103	„	Dec. 23	Feb. 14	Yes	...	...	...	Yes		
Carbolic acid, ...	104	„	Dec. 23	Feb. 13	...	...	...	Yes	Yes		
Ammon. phosph. aqua,	105	„	Dec. 23	Feb. 10	Yes	...	...	...	Yes	Yes	
Plumb. acet. aqua, . .	106	„	Dec. 23	Mar. 7	...	...	...	Yes	...	Yes	
Quin. sul. acid. aqua, .	107	„	Dec. 23	Mar. 13	Yes	Yes	...	...	...	Yes	Yes
Antim. tart. aqua, . .	108	„	Dec. 23	Mar. 7	Yes	Yes					
Tea, .	109	„	Dec. 23	Mar. 13	Yes	Yes	Yes				
Sugar, . . .	110	„	Dec. 23	Mar. 13	Yes	Yes	...	Yes	Yes		
Port, .	111	„	Dec. 23	Mar. 2	Yes	Yes	Yes	Yes			
Sherry, .	112	„	Dec. 23	Feb. 14	Yes	Yes	...	Yes			
Claret, . . .	113	„	Dec. 23	Feb. 18	Yes	Yes	Yes	Yes	Yes		
Milk, . . .	114	„	Dec. 23	Feb. 17	Yes	Yes	...	...	Yes		
Magnes. sulph. aqua, .	115	„	Dec. 26	Feb. 16	Yes	Yes	...	Yes	...	Yes	
Yeast, . .	116	„	Dec. 26	Feb. 20	Yes	Yes	...	Yes	Yes	...	Yes
Urine, .	117	„	Dec. 26	Feb. 14	Yes	...	Yes	...	...	Yes	
Coffee, . .	118	„	Dec. 26	Feb. 20	Yes	Yes	Yes	Yes	Yes	...	Yes
Hay, . .	119	„	Dec. 26	Feb. 20	Yes	Yes	...	Yes			
Chlorine, ...	120	„	Dec. 24								
Chloride of zinc, . .	121	„	Dec. 24								
Hyposulphite of soda, .	122	„	Dec. 24								

Table IX.—*Series of Experiments to test the Carbolic Acid Spray. Flasks of Various Dimensions.*

Boiled for six minutes. Carbolic Acid Spray used.

Nature of Fluid.	Numbers of Experiments.	Dimensions of Flasks in Inches.						Observations.			Strength of Carbolic Acid Spray.
		Length of Flask.	Length of Neck.	Diameter of Flask.	Diameter at Neck.	Diameter at Orifice.	Number of Inches.	Date when Introduced.	Date of Turbidity.	Date when Fluid was quite Clear.	
								1871.		1871.	
Urine,	84	2·9	14·	2·2	·5	·083	1	Feb. 14	...	May 12	1–40
Urine,	85	2·9	14·	2·2	·5	·083	1	Feb. 18	...	May 12	1–20
Urine,	88	2·4	2·5	2·3	1·	·6	...	March 6	...	May 12	1–40
Urine,	90	2·9	14·	2·2	·5	·083	1	March 6	...	May 12	1–40
Urine,	92	2·9	14·	2·3	·5	·083	1	March 6	...	May 12	1–100

Table X.—*Spray Experiments. Flasks of Various Dimensions.*

Nature of Fluid.	Numbers of Experiments.	Dimensions of Flasks in Inches.						Date. Observations.			Character of Spray used (if any).
		Length of Flask.	Length of Neck.	Diameter of Flask.	Diameter at Neck.	Diameter at Orifice.	Number of Angles.	Date when Introduced.	Date of Turbidity.	Date when Fluid was quite Clear.	
								1871.	1871.	1871.	
Urine,	86	2·9	14·	2·2	·5	·083	1	Feb. 18	Mar. 18	...	No Spray.[1]
Urine,	87	2·9	14·	2·2	·5	·083	1	Feb. 18	Mar. 1	...	No Spray.[2]
Urine,	89	2·4	2·5	2·3	1·	·6	...	March 6	Mar. 18	...	No Spray.[3]
Urine,	91	2·9	14·	2·2	·5	·083	1	March 6	...	May 12	Sulphurous Acid.
Urine,	93	2·9	14·	2·7	·5	·083	1	March 24	May 12	...	Condy's Fluid.[4]
Urine,	94	2·5	2·6	2·7	1·	·6	...	March 24	May 12	...	Hyposulphite of Soda.[5]
Urine,	95	2·7	2·4	2·8	1·	7	...	March 24	May 12	...	Chloride of Zinc.[6]

Remarks.—[1] Interval allowed. [2] Urine not boiled. [3] Interval allowed.
[4] Slightly dim. [5] Slightly dim. [6] Slightly dim.

Clinical Cases.

Table XI.—*Compound Fractures.*

	Name.	Ward.	Age.	No. of Case.	Date of Admission.	Disease.	Date of Dismissal.	Event.
I. Compound Fractures resulting from *Indirect Violence*, as for instance—								
(*a.*) A simple converted into a compound fracture by tbe bone being thrust through tbe soft parts when carried to the hospital; particularly liable to occur in small oblique fractures,	Thomas Pollock,	III.	5	1	Sept. 30, 1867	Compound fracture and wound of leg	Oct. 16, 1867	Recovered.
(*b.*) A patient falling or jumping from a height, and the fractured end thrust through the soft parts,	Name unknown,	Waiting Room	50	2	Sept. 27, 1869	Compound fracture of radius	Jan. 10, 1870	,,
	Ann Law,	III.	25	3	Nov. 18, 1867	Compound fracture of tibia and fibula	Dec. 31, 1867	,,
	John Smitb,	V.	...	4	Feb. 29, 1868	Compound fracture of tibia and fibula	May 7, 1868	,,
II. Compound Fractures resulting from *Direct Violence*—								
(*a.*) Caused by a sbarp instrument,	...	...	...	...	...	......	...	...
(*b.*) Caused by the blow of a piece of metal attached to machinery in rapid motion, or by the blow of a windlass,	James Cowie,	V.	35	5	Dec. 27, 1869	Compound comminuted fracture of tibia	Feb. 1870	,,
	James Geehone,	V.	30	6	July 4, 1868	Compound fractnre of humerus, radius, and ulna	Oct. 3, 1868	,,
	Albert Tronskasski,	V.	18	7	Aug. 10, 1865	Compound fracture of bumerus	Sept. 20, 1865	,,
(*c.*) Caused by a weight falling on tbe limb, as a stone or loose debris,	David Johnstone,	VI.	23	8	June 26, 1869	Compound comminuted fracture of tibia and fibula	Sept. 14, 1869	,
	James Cupples,	II. P.	17	9	July 30, 1869	Comp. fracture of lower jaw	Sept. 11, 1869	,,
	Edward Sweenie,	VI.	16	10	June 27, 1869	Compound fracture of tibia and fibula	Aug. 19, 1869	,,
(*d.*) Caused by a lorry or cart wbeel, or railway truck, passing over the limb,	Thomas Howard,	IV.	40	11	Nov. 22, 1869	Compound fracture of tibia and fibula	Jan. 1870	,,
	Name unknown,	Waiting Room	11	12	Dec. 23, 1869	Compound fracture of radius and ulna	Feb. 1870	,,

Clinical Cases.

Table XII.—*Abscesses.*

		Name.	Ward.	Age.	No. of Case.	Date of Admission.	Disease.	Date of Dismissal.	Event.
Acute.	Circumscribed.	Thomas Graham,	R.W.B.	23	13	Oct. 18, 1869	Acute circumscribed abscess (post auricular)	Oct. 27, 1869	Recovered.
		John Gardiner,	R.W.B.	54	14	Nov. 29, 1869	Abscess on forehead	Dec. 7, 1869	,,
		Hector Park,	III.	6	17	Dec. 18, 1869	Abscess on occipital region	Jan. 3, 1870	,,
		Jane Beattie,	III.	23	18	Dec. 29, 1869	Abscess, sub-maxillary	Jan. 4, 1870	,,
		Eliza Wilson,	III.	6	19	Jan. 4, 1870	Abscess, post scapular	Jan. 14, 1870	,,
		Walter Stewart,	III.	5	20	Aug. 3, 1869	Periosteal abscess of tibia	Sept. 10, 1869	
		Mary Macdonald,	III.	11	23	Nov. 26, 1868	Acute periostitis of tibia	Dec. 26, 1868	,
		Mary Mackay,	II.	25	29	April 18, 1868	Abscess, axillary	May 2, 1868	,,
	Diffuse.	William Nelson,	V.	36	15	Dec. 24, 1869	Diffuse abscess of thigh	Jan. 8, 1870	
		Jemima Collins,	III.	27	21	June 8, 1868	,, ,, of ,,	July 6, 1868	
		James Jack,	IV. P.	44	22	Sept. 1, 1868	,, ,, beneath scalp	Sept. 21, 1868	,,
		Thomas Dawson,	VI.	59	26	Dec. 4, 1867	,, ,, of forearm	Dec. 12, 1867	,
	Infiltrated.	Andrew Ramsay,	R.W.B.	...	27	Feb. 24, 1868	Infiltrated abscess of thigh	March 2, 1868	
Chronic.		Mary Mackie,	III.	5	16	Nov. 29, 1869	Chronic abscess of leg	Dec. 14, 1869	,
		Jessie Kay,	I.	8	24	Sept. 6, 1869	,, , of cheek	Oct. 2, 1869	,
		Christina Allen,	II.	25	25	Dec. 1, 1867	, ,, of mamma	Dec. 9, 1867	,
		Alexander Black,	IV.	...	28	March 14, 1868	,, ,, of side	March 14, 1868	,
Lumbar abscess.		William M'Farlane,	III.	6	30	Sept. 12, 1867	Lumbar abscess	Nov. 18, 1867	,
Psoas abscesses.		William Helbert,	IV.	47	31	Oct. 28, 1867	Psoas ,,	Dec. 17, 1867	,,
		No name,	Glasgow	27	32	Jan. 22, 1870	,, ,	Feb. 5, 1871	,,
		No name,	Glasgow	25	33	July 27, 1867	,, ,,	Aug. 1867	,,
		No name,	Glasgow	...	34	June 1867	,, ,,	July 1867	,,
Abscess connected with carious bone.		No name,	Glasgow	...	37	Sept. 1867	Abscess of elbow connected with caries	Nov. 1867	,,

Clinical Cases.

Table XIII.—*Affections of Joints.*

	Name.	No. of Ward.	Age.	Date of Admission.	Disease.	Date of Dismissal.	Event.
I. Acute Bursitis,	Mich. Benson,	IV. P.	40	Aug. 8, 1869	Acute bursitis of elbow	Aug. 14, 1869	Recov'd.
II. Chronic Bursitis,	Margt. Mackay,	II.	16	Oct. 9, 1869	Chronic bursitis of knee	Oct. 27, 1869	,,
	Edward Jones,	VI.	45	Jan. 16, 1868	Thickening of the bursa patellæ	Feb. 18, 1869	,,
III. Bursal Swelling,	Name unknown	Glasgow	...	Aug. 8, 1869	Bursal swelling of the palm of hand and wrist	Sept. 2, 1869	,,
IV. Loose Cartilages in Joints,	Name unknown	Glasgow	...	June 28, 1868	Loose cartilage in knee-joints	July 1868	,,
V. Synovitis,	Name unknown	L'pool	...	Apr. 14, 1869	Suppurative synovitis of the knee-joint	May 28, 1869	,,
	Name unknown	London	...	June 22, 1868	Acute synovitis of the knee-joint	July 1, 1868	,,
	Name unknown	L'pool	...	Nov. 30, 1868	Suppuration of knee-joint	Dec. 1868	,,
VI. Wounds of Joints,	James Dunbar,	R. W. B.	52	Aug. 10, 1867	Wound of knee-joint	Sept. 13, 1867	,,
	Name unknown	Waiting Room	...	......	Fracture of metacarpal bone and wound of thumb	......	,,

Table XIV.—*Compound Dislocations.*

Name.	Ward.	Age.	No. of Case.	Date of Admission.	Disease.	Date of Dismissal.	Event.
No name,	IV.	...	56	Feb. 1870	Compound dislocation of the ankle	Mar. 1870	Recov'd.
No name,	...	...	57	......	,, ,, ,,	......	,,
No name,	Glasgow	...	58	......	,, ,, ,,	......	,,
No name,	Glasgow	60	59	......	,, ,, ,,	......	,,
No name,	Glasgow	...	60	......	,, ,, ,,	......	,,

Table XV.—*Burns and Scalds.*

Name.	Ward.	Age.	No. of Case.	Date of Admission.	Disease.	Date of Dismissal.	Event.
J. Renwick,	IV. P.	33	66	Dec. 17, 1869	Burns of face, chest, and arms	Jan. 15, 1870	Recov'd.
No name,	Aberd'n	...	67	Nov. 1869	Burn of chest	Nov. 1869	,,
No name,	...	...	68	......	Severe scald of forearm	......	,,
No name,	...	...	69	......	Scald of breast and shoulder	......	,,
W. Burnett,	IV. P.	24	70	Oct. 28, 1870	Burn of lower extremities	Jan. 30, 1871	,,
Ann Gibson,	III.	36	71	Dec. 23, 1870	Burn of thighs, etc.	Feb. 1871	,,

TABLE XVI.—*Tumours of Mamma.*

Name.	Ward.	Age.	No. of case.	Date of Admission.	Disease.	Date of Dismissal.	Event.
Jane Malcolm,	II.	58	48	Jan. 17, 1871	Scirrhus of mamma	Feb. 1871	Recov'd.
Janet Square,	I.	26	47	Aug. 30, 1869	Adenoid tumour of right mamma	Sept. 17, 1869	,,
A. M'Naughton,	II.	38	50	Nov. 9, 1870	Scirrhus of mamma	Jan. 5, 1871	,,
M. M'Bain,	II.	64	51	Jan. 9, 1871	Scirrhus of mamma	Feb. 1871	,,
Eliz. Dick,	II.	68	52	Jan. 30, 1871	Recurrent scirrhus in cicatrix of mamma	Feb. 18, 1871	,,

TABLE XVII.—*Tumours of the Superior Maxilla.*

Name.	Ward.	Age.	No. of case.	Date of Admission.	Disease.	Date of Dismissal.	Event.
Jessie Scott,	II.	35	62	Aug. 9, 1868	Tumour of superior maxilla	Aug. 29, 1868	Recov'd.
Sarah M'Ilroy,	II.	40	63	Dec. 1, 1870	Malignant epulis of superior maxilla	Jan. 30, 1871	,,
Tumours of Inferior Maxilla.							
Ann M'Gee,	II.	31	64	Jan. 21, 1871	Myeloid tumour of inferior maxilla	Feb. 1871	Recov'd.
No name,	Glasgow	...	65	Feb. 1869	Encephaloid tumour of inferior maxilla	Mar. 1869	,,

TABLE XVIII.—*Ligature of Arteries.*

Name.	Ward.	Age.	No. of case.	Date of Admission.	Disease.	Date of Dismissal.	Event.
No name,	...	...	72	Jan. 1868	Aneurism of femoral artery	Feb. 1868	Recov'd.
Alex. Brown,	IV.	47	74	July 27, 1870	Diffuse popliteal aneurism	Sep. 1870	,,
No name,	Liverp'l	...	75	Mar. 1869	Aneurism of carotid	Mar. 1869	,,
No name,	...	...	76	Nov. 1868	Ligature of the left common carotid	Dec. 1868	,,

TABLE XIX.—*Miscellaneous Cases.*

Name.	Ward.	Age.	No. of case.	Date of Admission.	Disease.	Date of Dismissal.	Event.
Alex. Young,	V.	8	38	Oct. 28, 1868	Necrosis of tibia	Nov. 14, 1868	Recov'd.
No name,	...	...	36	...	Necrosis of frontal bone	...	,,
Thomas Perkin,	R.W.B.	30	55	Sept. 9, 1870	Lacerated wound of thumb	Oct. 22, 1870	,,
Robert Bayne,	IV.	18	61	Dec. 7, 1870	Badly united fracture of ulna, and dislocation of radius	Jan. 1871	,,

Table XX.—*Classification*

Class I. Microscopic Organisms

Genus I. Bacterium—
- Species *a*. Single corpuscles.
- „ *b*. Dumb-bell.
- „ *c*. Small *a* and *b*.
- „ *d*. Large *a* and *b*.
- „ *e*. Corpuscles, as if provided with ciliæ.
- „ *f*. Stationary bodies.

Genus II. Vibrio—
- Species *a*. Long delicately marked vibriones (indistinctly segmented).
- „ *b*. Long vibriones distinctly segmented.
- „ *c*. Long vibriones formed of rounded segments
- „ *d*. Vibriones not segmented.
- „ *e*. Short thick vibriones.
- „ *f*. Short thin vibriones.
- „ *g*. Short vibriones, as if provided with ciliæ.

Genus III. Shorter than vibriones, and broader than bacteria.

Genus IV. Large oval bodies, twice the size of Class III.

Genus V. Large oval bodies motionless.

Genus VI. Long and short yellow filaments in motion.

Table XXI.—*Classification.*

Class II. Microscopic Fungi.

Genus I. Corpuscular—
- Species *a*. Round colourless corpuscles.
- „ *b*. Minute round colourless corpuscles.
- „ *c*. Oval corpuscles.
- „ *d*. Large oval corpuscles.
- „ *e*. Large narrow elliptical cells.
- „ *f*. Small elliptical cells.
- „ *g*. Round nucleated cells.
- „ *h*. Minute round yellow corpuscles.
- „ *i*. Large round yellow corpuscles.
- „ *j*. Yeast cells.

Genus II. Filamentous—
- Species *a*. Long narrow filaments.
- „ *b*. Short oblong bodies.
- „ *c*. Long tubes resembling bamboo cane.
- „ *d*. Long filaments arranged in a stellate form.
- „ *e*. Peculiar fungoid growth.
- „ *f*. Peculiar bodies resembling chips of wood.

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Abernethy.
Bail.
Barker.
Batailhé.
Beale.
Béchamp.
Berkeley.
Bernard.
Berzelius.
Bickersteth.
Bonjean.
Bonnet.
Bourdon.
Braidwood.
Buffon.
Von Bunder.
Callander.
Calvert.
Cameron.
Cantoni.
Castleman.
Chalvet.
Child.
Cohn.
Davaine.
Desmartis.
Ducrest.
Dusch.
Eade.
Milne Edwards.
Eiselt.
Erichsen.
Franklin.
Fraser.
Geiselen.
De Graaf.
Grew.
Halford.
Hallier.
Harvey.
Helmholtz.
Hewitt.
Holme.
Hoffman.
Hunter.
Joly.
Kallman.
Keith.
Kennedy.
Kuchenmeister.
Lebœuf.
Leibnitz.
Lemaire.
Leuchart.
Leuwenhoek.
Lewis.
Liebig.
Lister.
Lonsdale.
Lüders.
Gay Lussac.
Lyonet.
Massy.
Malpighi.
Michelotti.
C. de Morgan.
Mussy.
Needham.
Oehl.
Pasteur.
Paul.
Polli.
Porter.
Pouchet.
Reaumur.
Redi.
Reveil.
Russel.
Salisbury.
Samuelson.
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Schroeder.
Schultz.
Sedgwick.
Von Siebold.
Signol.
Snow.
Solly.
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Spence.
Spencer.
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On the more Recent Mode of Treating Surgical Wounds, Lund.

PLATE VI FIG I EXPERIMENT TO TEST THE EFFECT OF NOXIOUS EMANATIONS.

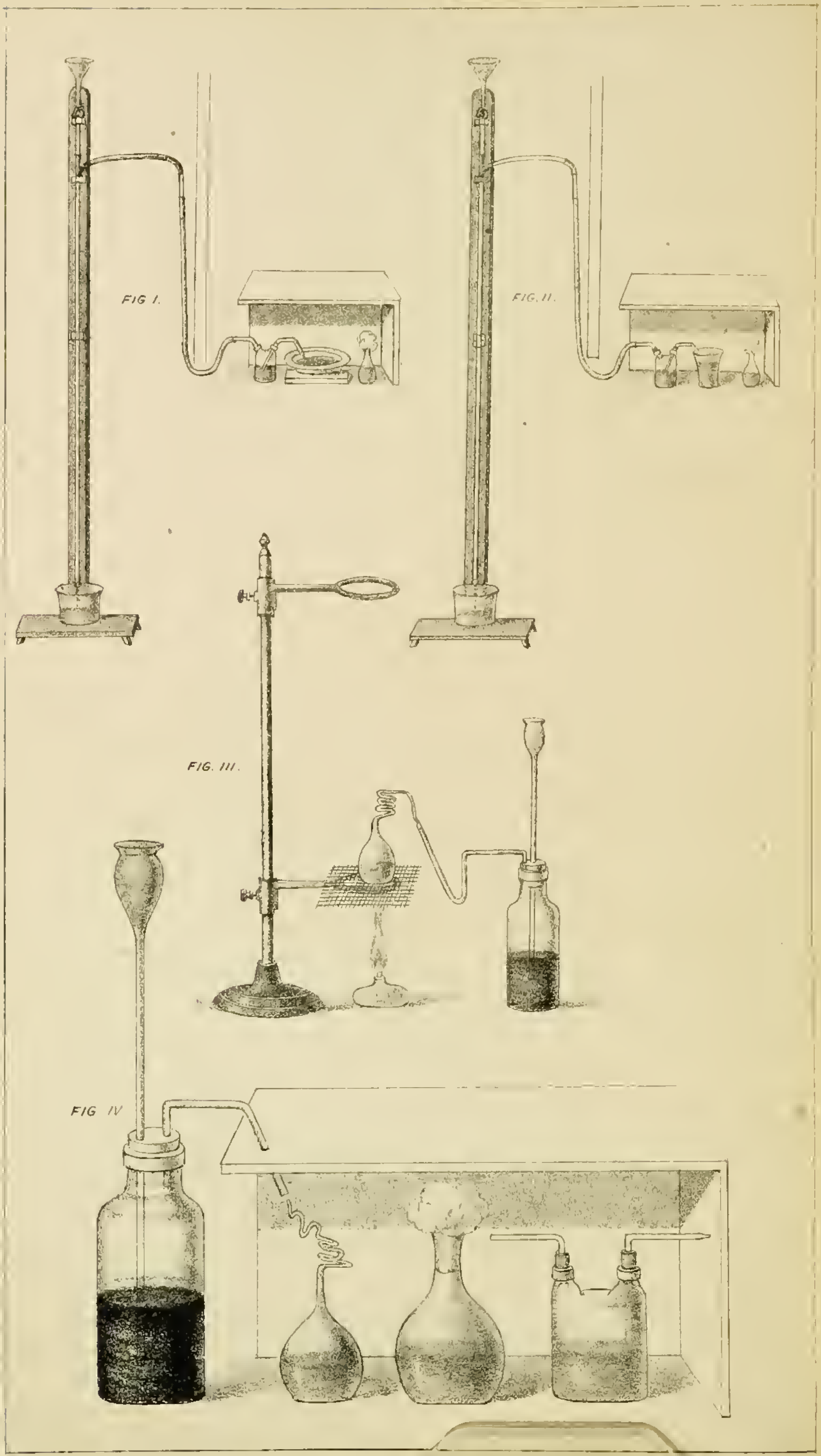


FIG. II, III. & IV. EXPERIMENTS TO TEST THE EFFECT OF SULPHURETTA HYDROGEN.

CARBOLIC ACID SPRAY EXPERIMENTS

FIG. I.

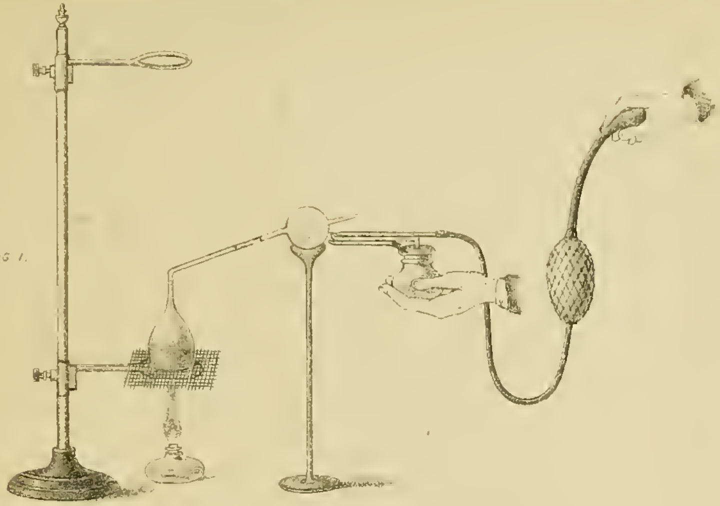


FIG. II.

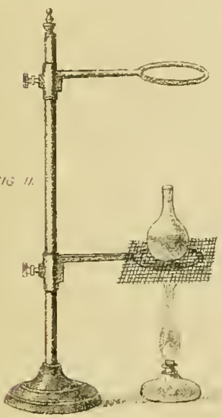


FIG. III.

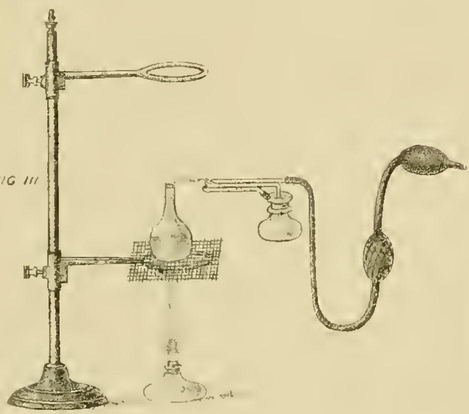
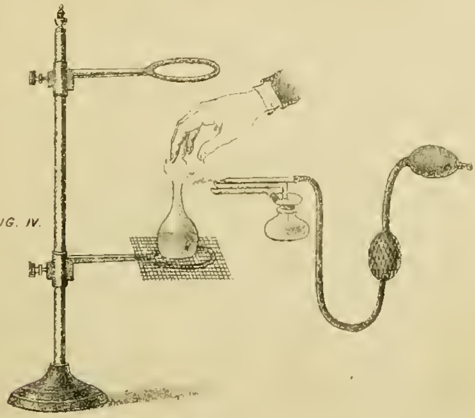


FIG. IV.



SHOWING PROCESS OF PREPARING THE FLASKS.

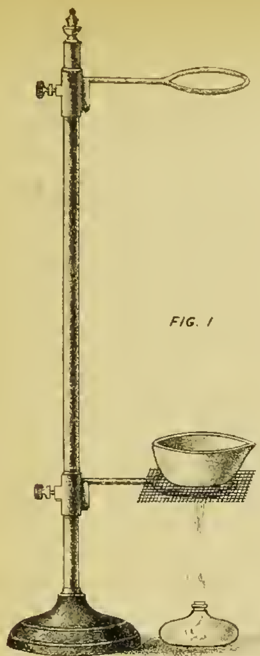


FIG. I

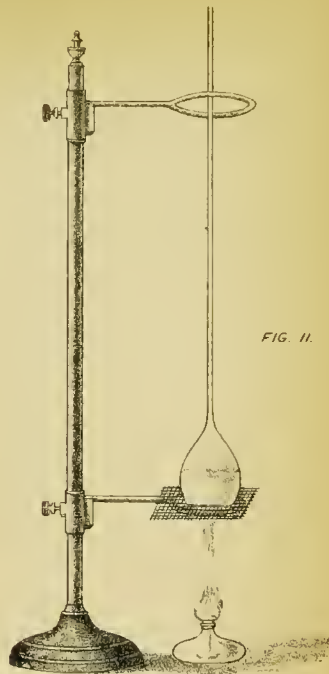


FIG. II.

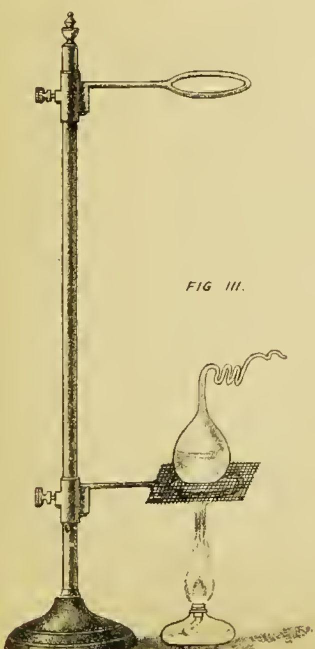


FIG III.

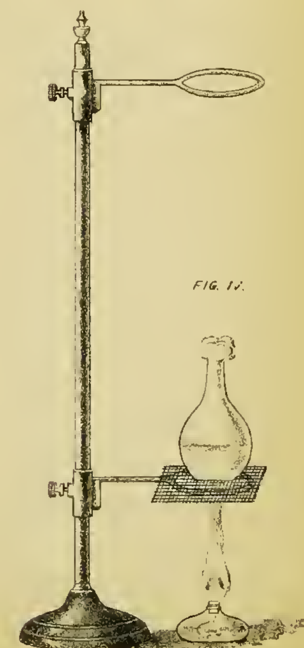


FIG. IV.

APPENDIX II.*

"Nothing extenuate nor set down aught in malice. *Othello Act* V.

Through the courtesy of my Publishers I have been placed in possession of the rejoinder of the *Glasgow Medical* to my comment in "*A Word with Reviewers.*" There happen now to lie before me recent issues of the *Boston Canada* and *Pacific Medical Journals*, *Canada Record*, *Philadelphia Reporter*, *American Journal of Insanity*, *Independente* of Milan, *Gazetta Medica* of Padua, *Barcelona Restorador*, *Progreso Medico* of Cadiz, *Pabellon* of Madrid, *Abeille Médicale* of Paris, *Allgemeine Wiener Medicinische Zeitung* with others, and yet in a single one of these manifestations of human intelligence as directed to medicine, I do not discover an approach even to the *animus*, the arrogance, and the inconclusive reasoning characteristic of certain communications in their North British contemporary.

My adversary indeed, number one, employed his bludgeon freely. Tripped up by his own blind vehemence however, as such assailants are apt to be, number two whose accents betray him, brandishing a weapon not commonly found in the *armamenta medicorum*, rushes headlong to the rescue. Shall he prove more successful than his predecessor—*videbimus*. Meanwhile, I should like to ask these doughty fellows why, instead of dragging a question of science through the mire of a personal altercation and stabbing in the dark, they do not like some Castor and Pollux,

Κάστορά θ' ἱππόδαμον καὶ πὺξ ἀγαθὸν Πολυδεύκεα,

emerge from their shady covert and deliver their assaults in the open—ah why indeed. Nothing in truth short of the interests of the magnificent secret won, as I venture to hold it, from natures grasp, interests in effect of transcendent moment to the welfare of our kind, could induce me to bandy words with opponents—such opponents. I do not object were it to the very hardest blows in the way of fair argument and reply, but misstatement and

* *Consumption and the Breath Rebreathed*, London, Longmans, 1872.

abuse it is more difficult to stomach. Instead of bounce and bluster then, some genial bearing to begin with, a practical knowledge of the subject and more or less conversancy with its literature as well as tincture of general culture, are needful absolutely to every species of right reviewing, much more the sufficient maintenance in its various dignity and usefulness of the physicians noble calling. How far the writers in the *Glasgow Medical*, or some of them, come up to this standard, I leave to the profession and the public to decide.

With honest dulness and were it even inflated self conceit, it is comparatively easy to deal, but not so easy with disingenuousness and what the French, with greater felicity of expression than we can lay claim to, term a *parti pris*. How modest are Scotsmen, well then some Scotsmen, in airing their pretentions, and what *κῦδος* does it not confer, what wit and wisdom does it not imply, to write for the anonymous pages of a Scottish medical periodical. Who would not be such a contributor. "The adoring letters of the alphabet" which so provoke the incredulousness and inflame the choler of my adversary, are the respective initials of Dr. Frank of Cannes, Dr. Trench of Liverpool, Dr. Rumsey of Cheltenham, Surgeon General Stromeyer of Hanover, Dr. Sieveking of London, and Dr. Eadon of Banbury, Oxon. A portion if not the whole of my citations, all of them be it observed from medical men my opponent, contrary to my showing and averment, has the effrontery to insinuate are not authentic, and to term my reference "depraved." Is there then no depravity in stabbing in the dark, or in preferring misstatements. It was not indeed my purpose to attach the names of my correspondents to excerpts from their private communications, nor should I do so now unless it were to meet the charges with which this Glasgow licentiate would fain essay to saddle me.

Even since the publication of my pamphlet, I have received yet further assurances in respect of my doctrines with regard to the genesis of tubercle. Dr. Norman Chevers, now in London, Principal and Professor of Medicine in the Medical College of Bengal, in a communication dated 22nd October, 1872, thus expresses himself. "Your invaluable work on Consumption—the great doctrine which you have always maintained in a manner which is to me so convincing that I am unable to comprehend the feeling of those who lose their temper in attempting to overthrow it." Dr. Paul Niemeyer, author of the admirable "*Handbuch der Percussion und Auscultation*," in his *Atmiatrie* p. 191, not to mention his "*Die Lunge ihre Pflege und Behandlung* p. 151," states with insurpassable force and vigour, his deep conviction of the evil influence of an atmosphere choked with the products of prior respiration. As he takes care to show, he is perfectly at one with me as to the efficacy of open windows as a prophylactic in Consumption. In a letter dated Magdeburg, 11th December last, he tells me that in his forthcoming Lectures, *Vorlesungen*, he entirely adopts my principles, with those of Baudelocque and Fourcault. Your excellent treatise, he says, I place in the foreground of my work or, to cite his own words. "*Ich stehe im Begriff Vorlesungen über der Schwindsucht herauszugeben, und folge darin ganz den von Ihnen Fourcault und Baudelocque vorgezeichneten Principien. Ihr treffliches Werk stelle ich mich in den Vordergrund meiner Arbeit.*" This promise Dr. Niemeyer has very fully redeemed.*

*"Dieses nachgeholt, ja das Capitel von der Stubengiftluft zu einer Art von Specialität ausgebildet zu haben, ist das Verdienst des Iren Mac Cormac, dessen im Jahre 1855 erschienene Schrift 'Consumption' sogleich, wenn auch leider sehr mangelhaft in's Deutsche übertragen und zweimal von einem nicht Geringeren als R. Virchow der Beachtung dringend empfohlen wurde. Trotz dieses Ecce von hervorragender Hand ist die Schrift an den deutschen Praktikern so gut wie spurlos vorübergegangen und von den Autoritäten der Clinik sogar unbeachtet gelassen worden. Das apostelmässige Pathos des Vortrags wie die naturalistische Methode der Forschung, welche aus jenem Buche sprechen, mögen allerdings wunderlich anmuthen und selbst im eigenen Lande hat Mac Cormac, wie aus den Zusäzen zu seiner zweiten Auflage hervorgeht, noch nicht durchzuschlagen vermocht. Der deutsche Eklektiker aber wird sich durch den ersten fremdartigen Eindruck, den er empfängt, nicht bestimmen lassen, das Werk sofort bei Seite zu legen, sondern sich von der Zuversichtlichkeit der Sprache lebhaft angeregt fühlen und prüfen, ob nicht ein gesunder Kern darin stecke, aus dem sich eine gute Frucht ziehen liesse." *Vorlesungen*, p. 33.

"Der Grundgedanke der Mac Cormac'schen Specialität lässt sich in folgendem Saze geben: die Lungenschwindsucht ist die Folge des gewohnheitmässigen Einathmens der verdorbenen Luft, welche durch das Leben in geschlossenen Wohnräumen entsteht; diese Luft enthält nämlich die von den Lungen der Insassen ausgeschiedene Kohlensäure und der Tuberkel ist das unmittelbare Produkt dieses successive in den Körper geführten und verhärteten Giftes. Die Verhütung und Heilung dieser Krankeit ist daher nur möglich durch Verbannung der Kohlensäure aus der Stubenluft und diese wird bewerkstelligt durch Offenhalten der Fenster, namentlich durch das Schlafen bei offenem Fenster. Des kürzeren Ausdrucks wegen stellt der Verfasser eine Reihe von originellen Schlagwörtern auf, zu deren Bildung das englische Idiom sich

"I feel strongly," observes Mr. Wagstaffe of St. Thomas' Hospital, in a statement to which I omitted to refer before, "that the principle upon which you insist is the right one, and one of immense importance to all civilized communities."

I might indeed adduce yet other extrinsic testimony in aid of positions founded, as I believe, on the eternal verities of physics and physiology directed, as I assume to have directed them, to the elucidation of consumptive tubercular disease. The self constituted representatives of the medical culture of West Scotland however, instead of acceptance and encouragement, meet me with disparagement and abuse. The opinions which I cite they deride, and their authenticity they or at least one of them affects to question. It would yield me nothing but pleasure to find these, my would be critics, more conversant with the authors whom I quote and the languages which are the vehicles of those authors' opinions, better aware of the principles of physiology and pathology, as of the rules which are supposed to govern the relations of men of science and of gentlemen than I am myself, but have they shown it. In a little we must go hence. Even the *Glasgow Medical* will be forgotten or peradventure only remembered by its persistent attempt to trample on the rights of opinion, and for taking sides against me in my stand up fight with thick ribbed prejudice and destroying ignorance, no where perhaps, more inveterate or destructive than in Scotland itself.

besonders gefügig zeigt. Die verdorbene Luft im Allgemeinen ist ihm *foul* oder *effete air;* für den Eintretenden wird sie zur *prebreathed air* d. h. schon von Anderen geathmeten, für den habituellen Stubenhocker zur *rebreathed air* d. h. von ihm selbst schon einmal geathmeten; die atmosphärische Luft ist in dem Zusammenhange eine *unprebreathed air* d. h. nicht schon durch Athmen verbrauchte. Von der Radicalwirkung des offengehaltenen Fensters ist er so eingenommen, dass er Phthisiker, die diesen Rath nicht befolgten, an 'geschlossenem Fenster sterben' (*die of closed windows*) lässt." *Id.* p. 34.

"Wenn Sie, meine Herren, bedenken, wie die Koryphäen in die Ferne schweiften, um die "influences tuberculifères" zu ergründen, und wenn Sie dann das Mac Cormac'sche Werk lesen, so dürfte sich leicht die Reminiscenz aufdrängen."

"Was kein Verstand der Verständigen sieht
Das übet in Einfalt ein kindlich Gemüth." *Id.* p. 38.

APPENDIX III.

"At this moment Scotland is the best educated nation (*query*, country) in Europe, and, wherever you meet a Scotsman you usually meet a man more intelligent than others." Professor Witherow, *John Knox and his Times*, p. 6.

What, all Scotland, oh Mr. Witherow. Would only that it were so, then we should not meet such scenes as are recorded in the *Weekly Scotsman* and *Daily News*, the harrowing outlines furnished by Dr. Alison, the distressing particulars related by Bailie Lewis of the lapsed masses in Edinburgh, those furnished by Dr. John Strahan of Dollar shewing that nine percentum of the Scottish people are not born in holy wedlock, the facts elicited in respect of the starving children of profligate parents in the Scottish capital, the saddening condition of the mill workers and factory operatives generally of Glasgow and Paisley, and, lastly, the articles to which I found it necessary to take exception in the *Glasgow Medical*. In fact, Scotsmen by dint of iteration, like the drop,

saepe ac saepius cadendo,

have not only indoctrinated themselves with the cardinal conviction that they are superior to all other men, but have even gone some way to convince the world that they are so. But were it indeed thus, were Scottish men and women, as Professor Witherow declares they are, "usually more intelligent than others," in fine, "the most moral and intelligent on the globe,"* could certain statistics prove true, unless it were, as I once read in a Scottish journal, commenting on Irish as contrasted with Scottish morals, that when Ireland grew more civilised she would, like Scotland, also become more criminal.

How are people to improve who imagine that they have already reached the climax of human excellence. Who however would not side with the immortal Greek who laid claim to nothing, rather than with persons were it even the "best educated" in Europe. Every one must gladly admit that there are Scotsmen of the greatest goodness and most disciplined intelligence, but such Scotsmen would be the very last to prefer a claim so invidious and

* *Vid. Scotsman*, May 1870.

preposterous. One need only take up a Scottish journal to read of some John Mac Millan who sent out his daughter Leonora at all hours of the night, or Andrew Crombie and John Fox, lazy souters if not worse, found begging in Leith and Princes Streets,* or George Farrie charged with wife murder at Linlithgow,† Burgh and Parish schools notwithstanding. The utterest extremes of demoralisation and civilisation are perhaps no where more conspicuous than in Glasgow and Edinburgh. And for all her five universities and floods of graduates, Scotland hardly turns out as many thoroughly intelligent persons as did, two thousand years ago, the little country of Greece or even the single state of Athens without any university at all.

Exclusive of imperfect modes of culture infinitively prejudicial to progress, Scottish intelligence is, at this moment, placed in gyves and shackles contrasted with whose tenacity iron is as a silken fetter and adamant a spiders web. We owe it alike to ourselves to our fellows and to Him who made us what we are and hope to become, the utterance of our entire convictions, the furtherance of all our powers. Yet how can this be so where minds are bound down and manacled to conclusions that outrage the understanding and lacerate the heart, conclusions framed at a period when witches and warlocks were not only believed in but too often helped out of this lower world, torturing them frightfully as Alison Balfour did a poor witch by the way. Dogmatic theology, whether of Calvin or the Inquisition, is essentially cruel and unreasoning, looks with unblenching gaze on the sad destiny of its victims whether actually in this life or as imagined in the life to come. A woman was burnt alive at St. Andrews when John Knox resided there, and when a word from him, a word which was not uttered, would have averted her infamous calamity ‡

If John Calvin thought fit to think for himself, why should not also we. We owe no allegiance to his theology, but we do owe absolute allegiance to that diviner theology which recites that all our powers are lent for development, and that every human being is designed for growth in power and beauty and goodness for ever and for ever. Morality is not the ancilla of religion, but religion of morality, nor can a religious profession prove any sort of substitute in face of moral and spiritual short-

* *Scotsman*, 11 January 1873, p. 4.

† *North British Daily Mail*, 4th February, 1873.

‡ Froude, *Short Studies on Great Subjects* p. 122.

comings. If I might I would invite the Scottish clergy to devote the six working days of the week to the effective furtherance of every species of secular culture,* so that Scotland in deed and in verity might become an example to the nations, a *civitas Dei* in a yet higher sense than Augustine ever dreamed.

Scottish jurisconsults should fuse their distinctions into one and, approximating their procedures to English practice, merge their provincialism in the extended study of the great Roman English American German French and Italian jurists.

The period of medical study ought to be prolonged, and the qualification, which should be one and embracing every branch of medical science, very largely enhanced. No one ought to be permitted to enter the precincts of the temple of Esculapius who was not at least a graduate in arts. It is an utter reproach to medicine and a serious loss to the community as well, to suffer youths devoid of that superior preliminary training short of which professional knowledge is liable to run in false directions or even remain stationary altogether,† to commence a study which assuredly as much as any needs liberal culture and a highly disciplined intelligence. Every day, more or less, ought to be occupied with practical anatomy and hospital attendance, while the examining body, the members being elected by the graduates and very liberally salaried, should be entirely distinct from the local teachers and professors.

The foregoing suggestions, if adopted in their entirety, would I submit greatly improve the general status, moral and material, of the Scottish community, while criminal pauperism and brute incompetence, along with all the varieties of preventible disease, would experience corresponding diminution. If the mind be shut out from expansion in one direction, it is so more or less in all. And as any radical deficiency in early training is difficult or impossible effectively to retrieve in after life, the opportunity, even when the desire exists to embrace it, rarely recurs again, and the advance, in so far as concerns the current generation, is for ever forfeited. As for myself I must, like the rest of my fellow medical men, soon follow the great army of physicians our predecessors, but even so it will be as the soldier goes, with drums beating and colours flying, I shall never give in. If I except a writer in the Edinburgh

* Mac Cormac, *On Synthesis in Culture*, London, Longmans 1867.

† Bréal, *Quelques Mots sur L'Instruction Publique*, p. 391.

Medical and Surgical Journal, and the President, for the time being, of the Edinburgh Medical and Surgical Society, no Scottish practitioner of standing and position, so far as I know, has embraced my views. Dr. Bennett* of Edinburgh, indeed, commends my advice to people to keep open windows, but this is hardly a sufficient admission for a member of so intelligent a community. It is, indeed necessary to place in the very strongest relief the certain fact that air already breathed, is deadly when respired again, and that when air not prebreathed is habitually respired consumption is impossible. A single fact, and I claim to have set forth many such facts, as Frauenstädt pregnantly remarks, sets aside centuries of systems. It is vain, as Friedrich Mohr observes, and I commend the sentences to the luculent scribes of the *Glasgow Medical*, to struggle against truth. "*Es ist auch am Ende gleichgültig ob eine Wahrheit anerkannt werde oder nicht. Sie hat einen innern Werth als solche, der Irrthum erlangt nur Bedeutung durch die Zahl seiner Anhänger.*"†

The noblest thinker, it is the remark of Max Pettenkofer, may mistake a truth, but only the base and mindless can persistently oppose it. With no power on earth is peace more honourable. And again, "*Vires in universo adhuc obviae sufficient ad explicanda phaenomena naturalia.*" To the truthseeker indeed, as Friedrich Rückert in his noble lines has worded it, the gods are open handed. They give him—

"Ihm geben die Götter das reine Gemüth,
Wo die Welt sich, die ewige, spiegelt;
Er hat Alles gesehn, was auf Erden geschieht,
Und was uns die Zukunft versiegelt.
Er sass in der Götter urältestem Rath,
Und behorchte der Dinge geheimste Saat."

HENRY MAC CORMAC, M.D.

Belfast, 7*th February*, 1873.

χαλεπὰ τὰ καλά.

* *Theory and Practice of Medicine.*

† *Geschichte der Erde*, p. 509. *Id.* 511.

Date Due

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