FIG. 1. INFANT AT BIRTH,

2

FIG. 2. INFANT AT BIRTH.

LESSONS

ON THE

ANATOMY, PHYSIOLOGY AND HYGIENE

OF

INFANCY AND CHILDHOOD

FOR

JUNIOR STUDENTS.

CONTENTS.

LIST OF ILLUSTRATINS.

ILLUSTRATIONS.

LIST OF ILLUSTRATIONS IN TEXT.

INDEX.

INDEX.

INDEX.

PREFACE.

During twenty years of medical teaching the author has found one of the greatest obstacles to advancement in a special study to be a condition of unpreparedness on the part of the student.

It happens that many, who in their senior year take up the subject of the Diseases of Children, although fairly well grounded in a knowledge of general anatomy and physiology, display a lack of information especially applicable to the developing period of infancy and childhood.

Since much valuable time must be spent upon these special subjects before the clinical and pathological phases of pediatrics may be profitably considered, the author has inaugurated two courses at Rush. The first for Junior students embraces the anatomy, physiology and hygiene of infancy and childhood. The second for Seniors takes up clinical pediatrics and includes etiology, pathology and therapy.

In the following pages no claim is made other than that expressed in the title "Lessons for Junior Students," although the more advanced student and even the busy practitioner may profit by the saving of time necessary for a review of the more extended treatises.

The apparent want of condensed text on the anatomy physiology and hygiene of the growing period, and the solicitations of former students have induced the author to publish at this time under separate cover these few chapters which may subsequently appear as Part First of a more extended work now in hand.

To acknowledge at this late day all the authorities and sources of information from which the substance of these lectures has been drawn is obviously impracticable. In addition to references found in the text the writer acknowledges his indebtedness to the following authorities: Sym.

ington, McClellan, Quain, Holden, Treves, Monti, Gray, Schaefer, Kirkes, Clarkson, Minot, Cabot, American Text-book of Physiology and Keating's Cyclopædia.

The author wishes at this time to express his apprecia-tion of the clinical work of his assistants, Doctors C. A. Wade, F. S. Churchill, J. W. Vanderslice, W. J. Butler and J. D. Merrill. To Dr. Merrill especially, thanks are due for valuable assistance in research, revision, and reading of proof, in the preparation of this volume.

INTRODUCTION.

If a student be well grounded in anatomy, physiology, diagnosis and pathology of the adult why is it necessary to devote special study to the diseases of children?

Infancy is a transitional stage in which the functions that minister to growth are widely different from those similarly named in the adult. The disorders of infancy are oftenest due to a want of symmetrical development of different organs or to a "clashing of functions." Infants change daily until their organs arrive at the stage where they assume the fixed type of the adult.

By far the greater number of disorders of infancy and childhood is due to neglect of the commonest principles of hygiene which, for obvious reasons, must differ widely in many respects from the hygiene of adults. Until quite recently the hygiene of infancy has received but a limited degree of attention; the result of which shows in the high rate of mortality in this period of life.

In this connection it is noticeable that the death rate of infants has shown a decrease whenever efforts at improvement, either dietetic or environmental, have been made; as in cities whose sanitary regulations have been enforced, or where the food supplies, especially milk, have been made a matter of rigid supervision.

The importance of a familiarity with all that pertains to the disorders of infancy and childhood might be emphasized, if necessary, by the well known fact that, almost without exception, the young physician's early work is made up largely of calls to sick children. Moreover, the study of the developmental period of man, and a knowledge of the causes which operate to disturb the balance of important functions of the growing body must be thorough in order that pathological conditions resulting later in life from

these disturbances may be understood. If the proper study of mankind is man, we believe that this study should begin with infancy. Early efforts at prevention are more profitable than late efforts at cure.

It would seem hardly necessary to state that the most approved methods of diagnosis applicable to adult cases often prove inadequate when applied to disorders of infancy. Nor is it uncommon for the skillful diagnostician of large experience and familiarity with the varied manifestations of disease in adults to stand confused in the presence of some of the commonest disorders of early life. So apparent has this been that even the laity are apt to suggest that you cannot tell much about a baby's disorder, because of his inability to describe his symptoms. Too frequently this assertion finds an echo in the consciousness of the physician who admits, tacitly at least, the truth of the statement.

A thorough study of symptomatology has been too much neglected in recent years, especially since the study of bacteriology, microscopical pathology and allied branches have led the student away from the grosser manifestations of disease.

Symptomatology in the fullest meaning of the term, including all departures from the normal in posture, contour and expression, is not as well known to the present as it was to the past generation of practitioners. We do not undervalue the above mentioned studies of recognized importance, but would call attention to the fact that without the knowledge obtained from them, the physicians of yesterday made diagnoses and prognoses which to us seem little short of marvelous, largely, I believe, through their intimate knowledge of temperament, physiognomy and symptomatology. If the foregoing be true in the diagnoses of adults, still more does it apply to infantile disorders, where thoroughly trained inspection must still be the leading means of diagnosis.

To-day no one questions the importance of the studies of

anatomy and physiology as preparatory to the practice of medicine. This granted, is it not pertinent to inquire by what right we assumed the role of practitioners to diseases of infancy without a knowledge of the anatomy and physiology of that age? No physician would consider himself competent to practice veterinary medicine without some additional instruction in regard to the peculiarities, anatomic, physiologic and pathologic, of his four footed patients. A special course of instruction is an unquestionable requisite. By what logic, then, does he consider himself thoroughly prepared for pediatric work when his little patients present peculiarities differing from the adult type much more widely?

That the medical profession is recognizing the importance of a special study in this direction is evidenced by the rapidly increasing interest the world over in pediatric subjects.

Although the practice of medicine antedates the Christain era, it is to the work of the last three decades that most of the contributions to pediatric science are due. Whereas twenty years ago no medical curriculum in the English language included a chair on the diseases of children, neither was there a medical society nor medical journal devoted exclusively to the discussion of that subject; today there is no medical college in the world without a special teacher of pediatrics, and numerous societies and ably conducted periodicals emphasize the growing importance of special work along this line. Ten years ago the pediatricians of the world might be counted on one's fingers. Today the work is engaging the exclusive attention of scores of the brighest minds of the profession.

To the thoughtful mind, appreciating that the science of medicine devotes her disciples to the alleviation of human suffering and to the prolongation of human life, comes the question, why, in the face of the startling mortality, this fruitful field was not earlier cultivated. It would be a sad

commentary upon the humanity of man towards his progeny to reply that the lives and comfort of his little ones were overlooked in the fierce struggle to secure the same blessings for himself.

Within the last decade the large cities have shown a reduction in the death rate of infants and children, to which the increased interest in the disorders peculiar to this class bears admittedly a causative relationship.

Today the lay mind, as well as that of the profession, is awakening to the need of a more thorough preparation. In compliance with this spirit Rush college has extended her curriculum to include a junior course in pediatrics, comprising twenty hours of recitations in terms of six weeks, a senior didactic course covering the same period, and an extension of Children's clinic to 104 hours a year; thus more than doubling the time previously given to this subject.

The junior is arranged as preparatory to the senior work, and for that reason should include the elemental branches. In accordance with this idea we will take up anatomy, physiology and the normal development and hygiene of infancy and childhood.
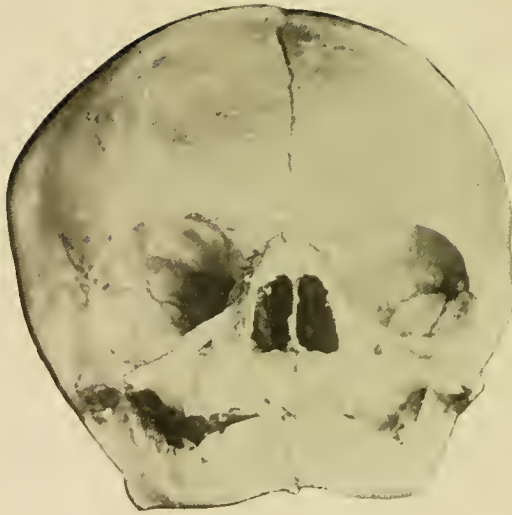
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SKULL OF NEW BORN.

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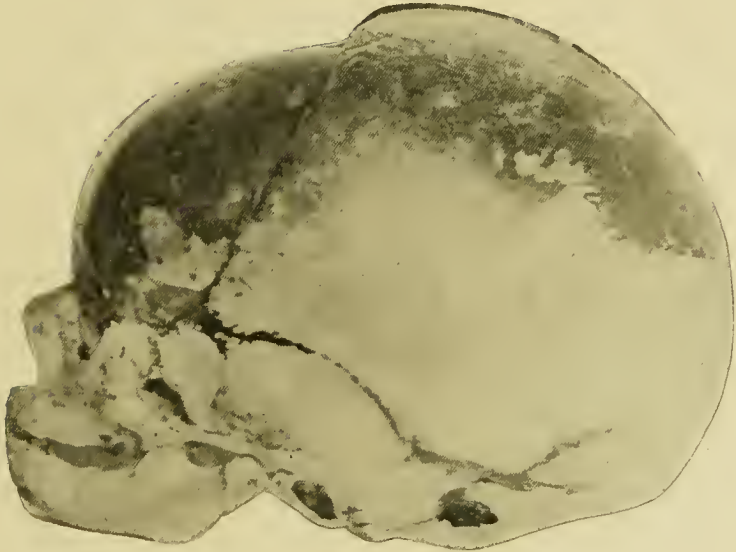
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SKULL OF NEW BORN.
FIG. 6 Showing Tympanic Membrane and notch of Rivinus.

CHAPTER I.

ANATOMY OF THE NEW BORN.

The infant's integument at birth is usually more or less covered with a thick whitish substance, the vernix caseosa, which is most abundant in the flexures and depressions, and upon the scalp. It consists of a mixture of cast-off epithelium, lanugo and the product of the sebaceous glands.

Usually upon delivery the color is a dusky blue, owing to venous stasis from the long pressure to which the infant has been subjected. After a few full inspirations this color changes to the "boiled lobster" hue. About the third day an exfoliation of the skin begins, which continues for a week or ten days. During this time the hyperæmia is marked; this gradually subsiding, the skin assumes an icteroid tint.

The texture of the skin is very delicate and the downy growth, lanugo, which was more abundant in the sixth and seventh months of intra-uterine life, still covers the body.

The margin of the nails projects far over the ball of the fingers. It was formed at an early period and is much thinner than the part resting on the bed of the nail which was formed later. This margin breaks readily and becomes detached soon after birth.

At first scrutiny of a new born infant the marked deviation from the adult standard, in regard to the relative size of the different parts, attracts our attention. The large head, small chest, enormous abdomen and insignificant extremities seem, at first, out of all proportion. Nor until we have gained a knowledge of development and growth up to this period, can we adjust our ideas to accept these proportions as normal.

Upon comparing the records of many hospitals in this and other countries, we find the average weight at birth for boys to be 3,280 gm. and for girls 3,130 gm. (about $7\frac{1}{5}$ and 7

pounds). The average length is 46 to 50 cm. (18 to 20 inches).

A large number of observations has shown a constant proportional relationship between the different members of the normal infant at birth. Any marked variation in these proportions is considered an abnormality of development. The following simple rule will aid the student in remembering this relationship. The circumference of the thorax in centimeters should equal one-half of the length plus ten. If estimated in inches add four to half the length. The circumference of the head should equal that of the thorax plus two. The abdomen is usually one to two cm. larger in circumference than the head, e. g.,

Length	.46	cm.	18	inches.
Circum. of thorax	33	"	13	"
" " head	35	"	$13\frac{4}{5}$	"
" " abdomen	36	"	$14\frac{1}{2}$	"

From the abundant deposition of subcutaneous fat, the contour of the body and limbs is well rounded, the location of the articulations being marked by dimples. A marking never absent from a normal, plump infant after the first month is a deep sulcus extending around the inner aspect of the thigh. Anteriorly this crease is nearly parallel with the inguinal groove; posteriorly above with the nates and below with two other grooves equidistant, the lower of which constitutes the flexure of the knee.

THE HEAD.

The head, being plastic, shows the pressure effects of recent parturition, sometimes presenting a great elongation. Not infrequently the contour is still further modified by the caput succedaneum. By the end of the first week the head has resumed its normal shape.

The integument covering the head is thicker than that of any other part of the body and is closely adherent to the aponeurosis of the occipito-frontalis muscle. The extreme mobility of the scalp in infancy is due to the loose attachment of the above mentioned tissues to the pericranium,

points to be remembered in considering extravasations in this region. The pericranium may be regarded as the remains of the outer layer of the developing membrane which surrounded the bones in foetal life. It is very slightly attached, except at the sutures where it blends with the dura mater between the soft and growing bones.

It is the generally received opinion that bones vary in the proportions of their chemical constituents at different periods of life. Recent investigators have questioned the correctness of the statement that the bones of infants contain more animal matter than do those of adults, viz: $33\frac{1}{3}$ per cent. Their analyses go to prove that equal weights of bone contain, at all ages, and in all bones, nearly the same relative proportions of animal and earthy matter. A particle of bone, they say, is a definite, not a variable compound. Hardness and compactness depend upon the quantity of bone condensed in a given space. The softness and elasticity of the bones of infancy are due to their vascularity, the sponginess of their texture, and from the layers of cartilage and membrane not yet ossified. Equal weights of corresponding sections of adult and infant bones would certainly yield different percentages of earthy and animal matter. The error lies in regarding the sections as containing equal amounts of bone. A peculiarity of infant bone is seen in the composition of the red marrow which is found in *all* the bones of the infant. It consists of 75 per cent. water, the 25 per cent. solids containing only 1 per cent. fat, while the yellow marrow of adult bones contains 96 per cent. fat.

The centers of ossification do not all appear at once, some not until after birth, but all in regular succession and at stated periods. The early ossification corresponds directly with the functional importance of the bone, e. g., that of the lower jaw and ribs which renders possible respiration and suction from birth.

The skull at birth presents marked peculiarities not only in its entirety, but also as to its individual bones, and further in the persistence of some of its chondral portions.

Considered as a whole the large size of the head com-
pared with that of the body and the predominance of
cranial over facial proportions are marked features; the
proportion of face to cranium has been put as one to eight,
(Fig. 5.) while in later life it is as one to two. The parietal
eminences are large and conspicuous; sutures are absent,
strictly speaking, the connection of the cranial bones by
interdigitating processes not yet having been accomplished.
Adjacent margins of the bones of the vault are separated
by septa of fibrous tissue continuous with the dura mater
internally and the pericranium externally. The bones of
the vault consist of a single layer without any diploe. At
the angles of the parietal bones are membranous spaces,
called fontanelles. The largest and most important of
these is the anterior median, which is situated at the
junction of the frontal, sagittal and coronal sutures. (Fig.
4). It is lozenge-shaped, from 2 to 4 cm. long and 1 to 2
cm. wide and immediately after birth it is slightly depressed.
In this space there is a regular pulsation corresponding in
frequency with the action of the heart. The posterior
median fontanelle is smaller and triangular in shape. The
remaining four lateral spaces are found at the inferior
angles of the parietal bones and are irregular in outline.
Supernumerary (Wormian) bones are frequently found in the
line of sutures or at the fontanelles.

At the base of the skull the most striking points are
first, the absence of the mastoid processes, and second, the
large angle which the pterygoid plates form with the skull
base. (In the adult the angle is almost a right one). The
base is relatively short, and the lower border of the mental
symphysis is on a level with the occipital condyles. The
facial skeleton is relatively small in consequence of the
small size of the nasal fossæ and the undeveloped condition
of both jaws. (Fig. 3.). The external auditory meatus is
found anterior to the middle of a straight line connecting
the symphysis mentis and the occipital condyle. In the
adult it is decidedly posterior to the center of this line.
Embryology shows that the vault of the skull is formed in

membrane and the base in cartilage. Although in foetal life ossification begins first in the vault, at birth it is always more advanced at the base. Pathology often makes this distinction more manifest. Among the more common of the gross malformations is that which shows an entire absence of all parts of the cranium formed in membrane, while the base is more or less perfectly developed, as in the anencephalus.

The *occipital* bone consists of four distinct plates: the sqamo-, the basi- and two ex-occipitals united by strips of cartilage. The first named portion, which is formed in membrane and belongs to the vault, presents two lateral deep fissures. (Fig. 7.) These are of interest for they have been mistaken for fractures. The fact is, it is difficult to fracture the skull of a young infant, as the bones are soft and yielding so that a blow on the vault indents without fracturing. Another membranous space extends from the squamo-occipital portion to the foramen magnum and it is here that a hernia of the membranes or brain occurs. (Fig. 8.) There is no jugular process and the grooves of the lateral sinus are absent or but rudimentary.

The *sphenoid* consists of three pieces, the median, containing the basi-sphenoid, and the two lateral which are made up of the greater wings and internal pterygoid plates. The dorsum ephippii is cartilaginous; there are no air-sinuses and the optic foramina are large and triangular. (Fig.3).

The *temporal* is also made up of parts which are easily separable, viz., squamous, petrosal and mastoid. The mastoid process is not developed, and the jugular fossa is only a shallow depression.

The antrum is relatively large and resembles the tympanic cavity in having a very thin roof separating it from the cranial cavity, but it approaches much nearer the outer surface of the skull than does the tympanum. (Fig. 48). The mastoid cells are not present at birth and it is of interest in this connection to know that they are not present in twenty per cent of *adult* mastoids. The petrosal is of a loose and open texture, resembling unglazed porcelain, thus offering

a striking contrast to the dense and ivory-like petrosal of adult life.

The *ear* at birth presents some interesting conditions, for growth has been by no means uniform, and some parts are of full adult size and form, while others do not attain full development until after puberty. To the first class belong the internal ear, (Fig. 14) tympanic cavity with its ossicles and the mastoid antrum; in the second class are found the external auditory meatus, Eustachian tube and the mastoid process. The external meatus is extremely short on account of the non-development of its bony portion, which is now represented by a mere ring. (Fig. 6 & 7.) It consists of an external part which is cartilaginous and an internal part which is osseo-fibrous. The canal passes inward (Fig. 45) with a decided downward inclination, so that the floor of the meatus lies nearly parallel with the outer surface of the membrane. The latter was formerly described as being more nearly horizontal than in the adult, but more recent investigation has proved that there is no perceptible difference between the inclination of the membrane of the newborn and that of maturity The cavity of the middle ear is of about adult size, but there is one peculiarity in connection with the roof in the infant which is worthy of notice, viz., the existence of a petro-squamous suture. While it exists, it facilitates the extension of inflammatory action from the mucous membrane of the tympanum to the dura mater. The mucous membrane is described as being in a swollen condition. To this and to the absence of air is ascribed the deafness of the first hours of extra-uterine life. Generally there is a deficiency in the upper part of the groove to which the membrane is attached the *notch* of *Rivinus*, which is merely covered by the skin lining the meatus. At this unprotected area may occur the escape of fluid from within the middle ear without perforation of the membrane. The membrana tympani is less securely attached at this notch than at the rest of its circumference; therefore when it is subjected to any violent concussion it is liable to give way at this point.

The Eustachian tube differs from that of the adult in

its length, the size of its lumen, its direction and in the condition of its walls   The length is from seventeen to eighteen millimeters—about half that of the adult. The tympanic orifice is as large in the infant but the pharyngeal opening is much smaller. The growth of the tube occurs mainly iu the anterior portion and is associated with a projection of the posterior lip of the pharyngeal orifice on the lateral wall of the pharynx. The tube is nearly horizontal, forming an angle with the horizon of not more than ten degrees, while in the adult the inclination is about forty-five degrees. There is scarcely any osseous Eustachian tube, six-tenths of it being cartilaginous. (Fig. 45.)

In the *parietal* bones (Fig. 9), the eminences, which indicate the spots in which ossification commences, are large and conspicuous. The grooves for the blood-sinuses are absent or but slightly marked, as is the case in the other cranial bones.

The *frontal* consists of two bones separated by a median (metopic) suture. The supercilliary ridges and frontal sinuses are wanting. The nasal spine is absent and the orbital plates are often incomplete. There is no temporal ridge.

The *ethmoid* is made up of two scroll-like bones, very delicate and covered with depressions which give it a worm-eaten appearance. Tho ethmoid cells do not appear before the third year. It may be noted here that a constant communication exists between the nasal veins and the superior longitudinal sinus through the foramen cæcum. This connection may, in part, serve to explain the occurrence of intra-cranial mischief as a consequence of certain inflammatory affections of the nasal cavity.

When the mouth is formed in the fœtus, (Fig. 20), there is at first no separation between it and the nose; but the general cavity is gradually closed in by the horizontal plates of the superior maxillary and palate bones advancing towards each other, and the septum of the nose descending from above to join them in the middle line. Normally the only trace of the original fissure is the naso-palatine canal.

(Fig. 8). Cleft palate is simply an imperfect closure of the foetal gap in this region. It is in the median line and often involves the soft palate and uvula. If the cleft in the hard palate includes the alveolar border, it leaves the median line and follows the suture between the maxillary proper and the os incivisum. This defect is usually associated with a corresponding fissure in the upper lip,—hare-lip—which hardly ever occurs in the middle line. The alveolar border presents five sockets for the temporary teeth. The infra-orbital foramen communicates with the floor of the orbit by a deep fissure. (Fig. 3). The antrum of Highmore is merely a shallow groove.

At birth the peculiarity of the *palate* bones is the equal length of the vertical and horizontal plates.

The *inferior maxillary* is represented by two nearly horizontal troughs of bone lodging the unerupted teeth. Each half is joined at the symphysis by fibrous tissue. (Fig. 8). The gums, composed of dense, fibrous tissue, form a tough protecting covering to the developing teeth. The margins of the superior and inferior maxillæ do not approximate at birth. (Fig. 5). The alveolar arch in the new-born discribes almost the segment of a circle; in the adult it is semi-elliptical.

At birth, remnants of the primitive chondral skull are abundant. Cartilaginous tracts exist between the various portions of the occipital and also at the lines of junction of adjacent bones. The dorsum ephippii is entirely cartilaginous, as are the styloid processes and a large portion of the hyoid.

FACE.

The rotundity of the face is due to the generous deposit of subcutaneous fat, especially over the cheeks. Over the buccinator muscles, in addition to the ordinary subcutaneous layer of fat, there is an arrangement of fatty lobules surrounded by a capsule on either side. They have been called "sucking cushions," because they are thought to prevent the buccinator muscles being pressed inward between
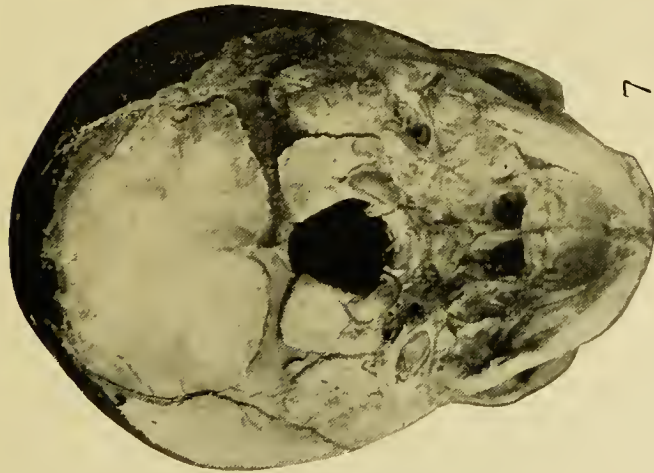
SKULL OF NEW BORN.
Showing membranous spaces and teeth exposed by dissection.

SKELETON AT BIRTH.

the alveolar arches when a vacuum is produced in the mouth. (Fig. 51.) The skin of the face is very thin and exceedingly vascular, hence it is often the seat of nævi. It is attached to the adjacent structures by loose, cellular tissue, excepting over the alæ of the nose and over the chin where it is closely adherent to the parts beneath.

By some writers it is stated that the *eye* at birth is anatomically complete. However, others have claimed that the macula lutea is not fully developed, that the cornea has not attained a full degree of transparency and that the *recessus opticus* is more marked, all of which would preclude the possibility of perfect optic function, even if the brain were ready to receive and interpret impressions. Examinations of the eyes of many new-born infants have shown them all to be hypermetropic. The color of the iris is a bluish gray. The pupils are large and sensitive to light. The lachrymal glands are not fully developed.

The *nose* is of relatively small size and the respiratory portion is very small. The septal cartilage is usually straight.

The *tongue* is rarely the seat of congenital defect, and "tongue-tied" babes are not often seen. If it be necessary to divide the shortened frænum, care should be exercised not to divide too freely, for there is the possibility that the child, in nursing, will tear further the lax fibres and the tongue be forced down upon the epiglottis, producing suffocation. The tongue contains much lymphoid tissue, a considerable part of which is massed under the mucous membrane of the posterior third.

The arch of the hard palate varies in different individuals; a high, narrow arch being considered a stigma of degeneration. (Fig. 54.) The height of the posterior nares is six to seven milemeters, and the breadth between the pterygoid processes at the hard palate is nine milemeters. With these dimentions it is easy to see how congestion would nearly obliterate the small passage and the resulting obstruction by a source of danger.

The *pharynx* is always widest near the hyoid bone and

narrowest opposite the cricoid cartilage; hence foreign bo-
dies which become lodged in the pharynx may be reached
by the finger. The connective tissue between the pharynx
and the spine is very lax, allowing large accumulations of
pus, as in post-pharyngeal abscess and cervical necrosis.
The internal carotid artery and the pneumgrastric, glosso-
pharyngeal, and hypo-glossal nerves are in relation to the
walls on either side, a point of interest from the symp-
toms caused by compression of these important struc-
tures from tumors in this region. The importance of the
naso-pharynx is due to the vascularity and the abundant
supply of lymphatic glands and vessels in this region, par-
ticularly in the posterior wall. The opening of the Eusta-
chian tube is at the level of the hard palate at birth. The
horizontal direction of the tube and its unguarded orifice
facilitates the infection of the middle ear from the naso-
pharynx. (Fig. 45).

<center>NECK.</center>

The neck is usually described as relatively very short.
An examination of the skeleton shows the cervical portion
of the spine is actually relatively long, and on ac-
count of the slight development of the facial part of the
skull, the lower jaw occupies a high position, so that the
length is still more increased. It is true the manubrium
sterni is higher than the adult, but this does not compen-
sate for the slight vertical extent of the face. The thick
layer of subcutaneous fat tends to make the neck appear
short and thick, as the same condition does in later years.

Certain congenital fistulæ are sometimes met with in
the neck, which are due to the partial persistence of one of
the branchial clefts. In the fœtus these clefts occur be-
tween the branchial arches which are five in number. (Fig.
20). The first lays the foundation for the lower jaw; the
second, the incus, styloid, stylo-hyoid ligament and the
lesser cornu of the hyoid bone. From the third are formed
the body and greater cornu of the hyoid, while the fourth
and fifth take part in the formation of the soft parts of the

neck below the hyoid. When present at birth these fistulæ appear as very fine canals opening into minute orifices in one or both sides of the anterior surface of the neck, leading backwards and upwards towards the pharynx or œsophagus. The length may be from five to ten mm. and the diameter from that of a bristle to an ordinary probe. They usually exist about the line of the third or fourth cleft, and are often found just above the sternoclavicular joint. Certain polycystic, congenital tumors, occurring as hydrocele of the neck may be developed from imperfectly closed clefts.

CHAPTER II.

(Anatomy Continued.)

VERTEBRAL COLUMN.

In the new-born infant the cervical and lumbar regions are nearly equal in length, while in the adult the ratio is 2:3 Much investigation has been made concerning the curvature of the spine at this period. In the living body it is impossible, from the great flexibility and the influence of muscular contraction and gravity, to estimate correctly the normal curve. The effects of gravity in frozen sections render the results by this method unreliable. Most authorities state that the spine presents two curves with their concavities forward, one in the dorsal region, and the other formed by the sacro-coccygeal vertebræ.

A peculiarity of the infant spine is its extreme flexibility. It is, in fact, almost wholly cartilaginous at birth, the centers of ossification being present but the process only sligtly advanced. (Fig. 12b,). There are three nuclei for each vertebra, one for the body and one for each lateral mass. Ossification of the bodies begins about the center of the column (ninth dorsal) and extends upwards and downwards; while ossification of the laminæ commences above and proceeds gradually downward. Arrest of development of the laminae gives rise to a cleft, *spina bifida*, allowing a

hernia of the membranes and sometimes of filaments of the cord. This usually occurs in the lumbar arches and upper part of the sacrum. (Fig. 58). Because of surgical interest, it will be well to remember that the fourth lumbar vertebra, at all ages, is on a level with the highest point of the crest of the ilium.

<div align="center">UPPER EXTREMITY.</div>

The *clavicle* is peculiar not only in that it is the first bone of the skeleton to ossify, but that ossification in it begins in its primary substance before the deposition of cartilage. At birth the entire shaft is bony, the ends only being cartilaginous. (Fig. 14). This bone is more frequently fractured during delivery than is any other bone. It is stated that one-half the cases of broken collar bone occur before the age of 5 years. This is explained by the fact the clavicle is in a breakable condition at a time when most of the long bones still present much unossified cartilage in their parts. That the periosteum is comparatively thick and not closely attached to the bone are circumstances that favor sub-periosteal or green-stick fracture, which is characteristic of early years.

The *scapula* is chiefly osseous, only the coracoid and acromion processes, a narrow rim of the posterior border and the tip of the inferior angle being cartilaginous. (Fig. 16). Sometimes a failure of union between the acromion process and the spine occurs, the junction being effected by fibrous tissue. In some cases of supposed fracture of the acromion, with ligamentous union, it is probable that the detached segment was never united to the rest of the bone.

It may be said of the shafts of all the long bones at birth, that they are mainly cylindrical and free from ridges. The long bones afford the best example of the process of ossification, for it depends upon both membranous and cartilaginous formation. The process begins in the center of the shaft (diaphysis), and proceeds towards the extremities (epiphyses) which remain cartilaginous until some time later, when centers of ossification occur in them

also. The extremities are separated from the shaft by a layer of epiphyseal cartilage until the growth of the bone is completed. Simultaneously with the ossific changes in the center of the cartilage, a very vascular membrane is developed around the shaft. This is the periosteum, and consists of two layers which serve as a nidus for the ramifications of vessels which pass from it into the bone. In infants it is thick and vascular and is only connected at the epiphyseal cartilages at either end of the shaft, being separated from the latter by a layer of soft blastema containing osteoblasts, from which ossification proceeds on the surface of the growing bone. Bones grow in length chiefly by deposition taking place upon the extremities of the diaphysis and in the extension of the ossific centers of the epiphyses. They increase in circumference by deposition from the periosteum on the external surface, while the medullary canal is produced by absorption from within.

Owing to the long bones having separate centers of ossification, and the interposition of the layers of cartilage between them and the shaft until its full length is attained, the bone is indurated in the parts where the greatest strength is required, while the longitudinal growth is facilitated. About the center of the shaft there is a large foramen leading obliquely into the medullary canal; through this passes the medullary artery, usually a branch of the main artery of the part of the limb to which the bone belongs.

The *humerus* is nearly ossified in its whole length; the extremities only being entirely cartilaginous. (Fig. 12). The danger of separation of the epiphysis from external violence or undue traction in infancy and early childhood is apparent. The ligamentous attachments at the articulations have been shown to offer greater resistance than the epiphyseal union, so that separation at that point would precede joint luxation or bone fracture as a result of rough handling. Just below the external condyle of the humerus there is a pit or dimple in the skin which ls an important landmark, as here the

head of the radius can be felt rolling in pronation and supination of the forearm.

It is well to note that the epiphyses which meet at the elbow unite with their shafts earlier than those at the opposite ends of the bones; also that the foramina of the nutrient arteries are directed toward the elbow.

The bones of the wrists and hands are nearly all cartilaginous at birth. Fig. 14. Of the lower extremities, all that need be said is that owing to the peculiarities of foetal circulation, they have received less nourishment and are not as far developed as the upper extremities. Fig. 15.

THORAX.

A characteristic feature of the infant thorax is the relation between the antero-posterior and transverse diameters. In the adult the ratio is 1:3, while in the infant it is 1:2 or even less. Another peculiarity is the extreme compressibility. Owing to incomplete ossification, cartilaginous tissue predominates in the structure. It suggests in form a truncated cone, and in structure, an inverted basket.

The sternum is practically a strip of cartilage in which there are varying numbers of bone centers. The upper border of the manubrium is usually about the level of the middle of the first dorsal vertebra, a higher position than in adult life, when it is at the level of the lower border of the second dorsal vertebra. It forms a considerable portion of the anterior surface of the thorax.

The ribs are more horizontal, particularly the upper six or seven. (Fig. 10 & 11). They are also flatter and more elastic than in later life.

LARYNX.

The larynx extends from the level of the body of the axis to the lower border of the fourth cervical vertebra. This is fully two vertebrae higher than in adult life. The chief characteristics of the larynx, beside the location, are the small size and the comparative slightness of the organ and the smooth rounded form of the thyroid cartilage.

The high position of the infant larynx, with the low sloping pharyngeal vault must be remembered in manipulations such as laryngoscopy and intubation, which in many instances are accomplished with extreme difficult in very young children. On the other hand, the shortness and width of the oval cavity, the compressibility of the base of the tongue and flexibility of the neck render comparatively easy in most cases a *direct visual* examination of the epiglottis, the upper portion of the larynx, arytenoid and vocal cords. The lax attachment of the larynx to surrounding structures allows of its being brought more clearly into view by upward pressure on the cricoid cartilage, combined with downward and forward pressure on the median glosso. epiglottidean ligament by a properly constructed tongue depressor.

TRACHEA.

As a rough rule it may be said that the caliber of the trachea corresponds to the size of the patient's forefinger. In the foetus the trachea is flattened before and behind, its anterior surface being even somewhat depressed; the ends of the cartilages touch; and the sides of the tube, which now contains only mucus, are applied to one another. The effect of respiration is at first to render the trachea open, but it still remains flattened in front, and only later becomes convex. In consequence of the high position of the larynx, the cervical part of the trachea is relatively longer at this period of life, but the increase in length is somewhat diminished by the higher position of the manubrium. The point of bifurcation of the trachea is opposite the third dorsal vertebra, about one vertebra higher at birth than in the adult.

LUNGS.

Rapid and remarkable changes occur in the lungs with the commencement of respiration. In the foetus at full term the lungs, comparatively small, lie towards the back (heart)of the chest, and do not bulge forward at the sides of the (Fig. 18) after respiration has been established they expand

and completely cover the pleural portion of the pericardium and are also in contact with almost the whole extent of the thoracic wall. At the same time their previously thin, sharp margins become more obtuse, and their whole form is less compressed. In utero the sides of the alveoli and of the small air passages are in apposition. During the first inspiration, comparatively little air is taken into the lungs, because of the force necessary to overcome the adhesions of the sides of the bronchioles and alveoli; but as one full inspiration follows another, inflation increases more and more until full distension is accomplished. If once the lungs have been filled with air, they are never completely emptied of it.

The introduction of air and of a greatly increased quantity of blood into the fœtal lungs converts their tissues from a compact, heavy, granular substance into a loose, light, rose-pink, spongy structure which floats. These changes occur first at the anterior borders and proceed backward through the lungs; they, moreover, appear in the right lung a little sooner than in the left.

The absolute weight of the lungs, having gradually increased from the earliest period of development to birth, undergoes at that time, from the quantity of blood then poured into them, a very marked addition, amounting to two thirds of their previous weight. Before birth the weight is one and one half ounces, but after complete expansion it has risen to two and one half ounces. Relative to body weight at the end of intra-uterine life the weight of the lungs is 1.70; after expansion it is 1.35 or 1.40, a ratio not materially altered through life. The specific gravity changes from 1.056 to 0.342.

During fœtal life the alveoli are entirely lined with small granular cells, but with the distension following the first respiratory efforts, many of the cells become transformed into large, thin epithelial elements.

The lower border of the lungs will be found to reach posteriorly as low as the tenth rib on the right side and the eleventh rib on the left; in the mid-axillary line to the ninth

INFERIOR MAXILLA OF INFANCY.
MATURITY AND SENILITY. (TO SCALE.)

14

SKIAGRAM OF INFANT AT BIRTH.

15

SKIAGRAM OF INFANT AT BIRTH.

ADULT

NEWBOR[I]
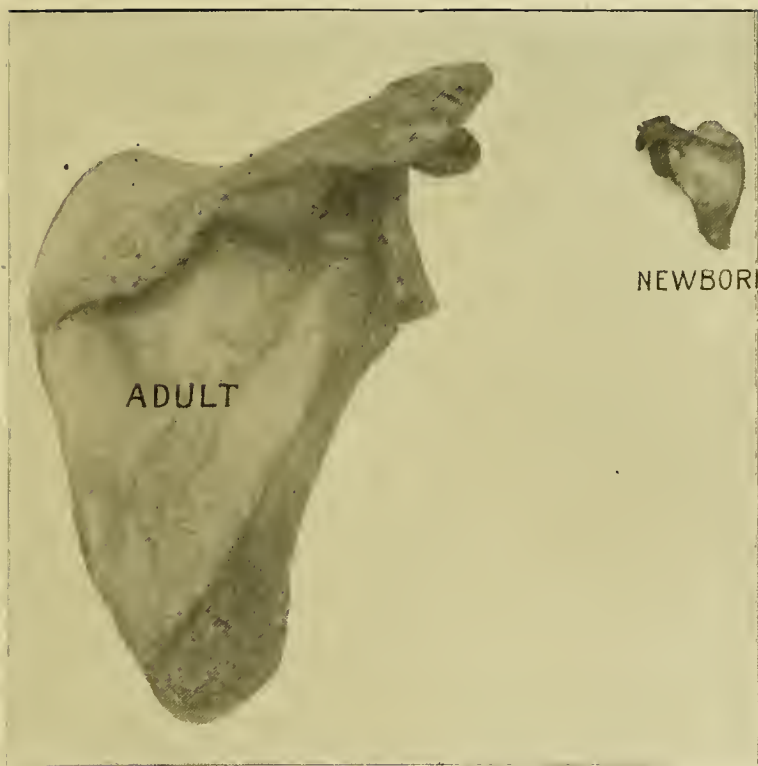
16

17

SCAPULA, UTERUS, OVARIES AND TUBES AT BIRTH.

rib, and in the mammillary line to the sixth rib on the left side and the fourth or fifth on the right. The degree of approximation of the lungs anteriorly is not as close as in later life.

HEART.

Weight 20.5 gm., or two-thirds of an ounce. In the early stages of foetal formation the heart occupies nearly the whole of the thoracic cavity, and, comparatively speaking, is much larger than it is subsequent to birth. The auricular portion exceeds the ventricular, and the right auricle is more capacious than the left, the right ventricle being also larger than the left. The organ is placed vertically within the thorax at this early period. Just before birth, however, these peculiarities disappear, and the ventricular portion becomes the larger, the left having the thicker walls, and the whole organ rapidly approaches its permanent condition for life. It is yet somewhat larger in relation to body weight, the ratio being at birth 1.120, while in the adult it is 1.160. In contrast with this, it will be remembered that one of the characteristic features of the infantile thorax is the shortness of its transverse diameter. Since the vertical extent of the heart in relation to the anterior chest wall differs but little in infants and adults, it will naturally follow that the transverse diameter of the heart, as compared with that of the chest, is relatively greater in the former than in the latter. This naturally causes an extension outwards of the position of the apex beat in relation to the nipple. Hence it is normal for the apex beat to be either in the mammillary line or external to it. Clinicians are divided in opinion as to the intercostal space in which the apex beat is to be felt. Most observers put it at the fourth intercostal space.

The internal structure of the foetal heart differs from that of the adult chiefly in having an oval opening (foramen ovale) (Fig. 21) between the auricles, which allows a communication from side to side, and in the presence of the Eustachian valve which directs the blood from the inferior vena cava through the foramen ovale. The latter generally

becomes closed within the first week or ten days after birth, but may remain open longer, and in some instances has been found to be slightly pervious at a great age. The Eustachian valve soon atrophies after the establishment of the function of the lungs and the changed circulation of the blood. Contemporary with these structural alterations, there occur changes in the great vessels which are requisite for the independent circulation of the blood. The pulmonary artery of the fœtus, after leaving the right ventricle, gives off the right pulmonary branch, and then divides into two other branches, the first of which is as large as the pulmonary artery itself and which directly joins the aorta at the termination of its arch, while the other goes to the left lung. The connecting branch between the pulmonary artery and the aorta is named the *ductus arteriosus.* It is really the continuation of the pulmonary artery.

The fœtal circulation consists of the entrance of arterial blood from the placenta into the body of the child at the umbilicus, by means of the umbilical vein, which ascends to the under surface of the liver. (Fig. 21). Within this organ the greater part of the blood first communicates with the branches of the portal and hepatic veins, and thence passes to the inferior vena cava, but a portion of the blood conveyed by the umbilical vein is conducted by a small vein directly to the inferior vena cava, without passing through the substance of the liver; this vessel is called the *ductus venosus.*

The inferior vena cava empties all its blood into the right auricle, whence it is directed by the Eustachian valve through the foramen ovale into the left auricle. From the left auricle it passes into the left ventricle, and thence by means of the aorta it is distributed chiefly to the head, neck and upper extremities. The more immediate supply of pure blood to these parts accounts for their greater proportionate development at birth. The venous blood from the upper part of the body is returned into the superior vena cava and by it to the right auricle, from which it passes to the right ventricle. From the latter it issues by the pulmonary artery,

and is chiefly conveyed by its continuation, the ductus
arteriosus, into the upper portion of the descending aorta,
where it mixes with the blood from the left ventricle pass-
ing through the arch of the aorta. From the descending aorta
the blood passes through the abdominal aorta into the
iliac arteries. The external iliac arteries carry part of this
blood to the lower extremities, but the most of it is returned
to the placenta by means of the hypogastric arteries, which
are the continuation of the superior vesical branches of
the internal iliac. They pass out at the umbilicus, where
under the name of the umbilical arteries, they twine around
the umbilical vein in the substance of the cord, and return
their impure blood to the placenta to be re-oxygenated.

The umbilical vein and ductus venosus, after ligation at
birth, atrophy and become converted into a fibrous cord
which constitutes the round ligament of the liver. The
coagula usually disappear from these vessels within five
days. The ductus arterosus and hypogastric arteries also
contract after birth and become closed, the former usually
within the first ten days, and the latter within the first three
or four days. The remains of the ductus arteriosus consti-
tute the ligamentum arteriosum, which is attached to the
concavity of the aorta. The bands resulting from the oblit-
eration of the hypogastric arteries form the lateral false
ligaments of the bladder.

A review of the development of the embryonic heart,
sheds some light on the character of many congenital defects.
It is claimed that pulsation has been noted in the human
embryo as early as the fifth day, the entire circulatory ap-
paratus being then represented by a few cells. From this
in a few days is evolved a tube, the foundation of the heart
and great vessels. By the end of the second week is seen an
S shaped organ which is still monololocular with two sets
of vessels, the primitive veins and arteries. At the fourth
week we find the cavity being divided by the growing sep-
tum into two compartments, one for the admission, the other
for the discharge of blood. By the end of the eighth week
a membranous process, which appeared early at the lower

part of the apex and at the margins of the orifices of exit, has developed into a septum dividing the great efferent vessel into the aorta and pulmonary artery and forming the interventricular partition. The last part of this septum to be completed is the upper portion, lying immediately below the auriculo-ventricular walls. During this time the auricular portion of the heart is divided iu a similar manner into right and left chambers by the interauricular process which pushes inward and is not completed until after birth, the foramen ovale being the last part to close. The septum ventriculorun also not infrequently shows at birth a foramen. When present it is invariably in its upper portion. By far the commonest defect in development is seen at the pulmonary orifice either as (1) malformation of its valves, uot infrequently two only being found, or the three coalescing in the form of a perforated circular diaphragm, or (2) there may be a narrowing below the valves, a stenosis of the conus. It is easy to understand how a primary stenosis of the pulmonary orifice or conus might influence the development not only in the septa but in the muscular walls of the right ventricle, through the obstruction of outflow from this cavity. In fact, a patulous septum ventriculorum is usually associated with pulmonary stenosis with accompanying hypertrophy of the right ventricle. (Fig. 22).

Occasionally arrest of development in the intervascular septum leaves a common trunk or chamber attached to the ventricular portion of the heart, from which arises the aorta and pulmonary vessels. (Fig. 23).

An entire absence of the septum ventriculorum has been observed, as also has that of the auricles; so that we may have bilocular and trilocular hearts among the anomalies of arrested development with a great variety of abnormalities in the position and formation of the vessels.

CHAPTER III.

(Anatomy continued.)

THYMUS GLAND.

This is a temporary organ which reaches its greatest size about the end of the second year. It appears as a narrow, elongated, glandular body, situated partly in the thorax and partly in the lower region of the neck, (Fig. 18). below it lies in the upper anterior mediastinal space, behind the sternum as far down as the fourth rib cartilage and in front of the great vessels and pericardium; above, it extends upwards upon the trachea in the neck as high as the lower border of the thyroid cartilage. Considerable variation in size and shape has been found. The color is a grayish pink; the consistence soft and pulpy and the surface is distinctly lobulated. It consists of two lateral lobes which touch each other along the middle line. Occasionally the whole body forms a single mass and often there is an intermediate lobe. It measures about 60 mm. (2¾ in.) in length, 37 mm. (1½ in.) in width about 8 mm. in thickness, and weighs from 5 to 14 grammes. Its function is not fully understood, although it is probable that it is in some way connected with the elaboration of the blood.

THYROID GLAND.

The thyroid at birth is of relatively large size. being in proportion to body weight as 1:240; while in the adult it is 1:1800. It consists of two lateral lobes united towards their lower ends by a transverse portion called the isthmus (Fig. 18). Each lateral lobe lies on the side of the trachea, extending from the fifth or sixth ring to the thyroid cartilage. The isthmus commonly lies across the second, third and fourth rings of the trachea.

Variations in the size, shape and number of the lobes of the thyroid gland are common. (Fig. 24) At times the gland consists of two separate parts on each side of the trachea, or there may be only one lateral lobe, or the three lobes may not be united.

The occurrence of accessory glands is of clinical interest, inasmuch as it helps to explain in certain cases the lessened severity of the symptoms following extirpation of the gland. These accessory glands are found in the region of the aorta, in the supra-clavicular fossæ, and to the side of and behind the pharynx and large vessels of the neck.

It is extremely vascular, its anastomosing veins, the superior, middle and inferior thyroid opening directly into the internal jugular and innominate, suggest the possibility of an air embolus in operations.

Like the thymus the thyroid has no duct after birth. It has recently been claimed that the remains of an embryonic duct has been found leading to the foramen caecum at the angle formed by the circumvallate papillæ. To the occasional persistency of this duct, a causative relationship has been claimed for the rare development of accessory thyroid tissue found as tumors at the base of the tongue.

BRONCHIAL GLANDS.

The bronchial lymphatic glands are found in three groups, the location of which is of interest on account of their relationship to adjacent vessels and nerves. The first group is in intimate relation with the trachea, the superior vena cava, recurrent laryngeal and pneumogastric nerves; the second set is found at the bifurcation of the trachea and roots of the lungs where their enlargement would encroach on the œsophagus, pneumogastric nerves and the aorta; the third follows the larger bronchioles into the substance of the lungs along with the bronchial and pulmonary vessels and nerves.

DIAPHRAGM.

The diaphragm forms a muscular partition between the chest and abdomen. It is described as occupying a higher position than in adults. The lungs in their pleurae rest upon the muscular portions, while the heart in the pericardium lies above the central tendon. On each side of the ensiform cartilage is a triangular space which gives passage

to the vessels to the anterior mediastinum. Occasionally this becomes the seat of a diaphragmatic hernia.

ABDOMEN.

In the child at full term and for the first two years the umbilicus marks the middle of the long axis of the body. The cord usually drops off at the end of five to seven days (occasionally this period will be much longer, fourteen to twenty-three days), leaving a slightly reddened areola and moistened surface. An abnormality that rarely occurs is a congenital hernia in the cord, which must be distinguished from the umbilical hernia developed after birth. In the congenital form, the intestines works its way in among the structures of the cord and receives its coverings from them. There are a few cases reported of the intestine being included in the accoucher's ligature.

In the fœtus the intestinal canal is cut off from the yolk sac by the gradual growth of the ventral plates and their ultimate union in the middle line. This union occurs latest at the umbilicus. In some cases of imperfect development the anterior wall is more or less entirely absent, and the viscera are either entirely uncovered or protected only by a scanty membrane. This condition, congenital exomphalos, is usually associated with other deformities which are inconsistent with any but very brief existence. One of the most remarkable deformities is exstrophy of the bladder. (Fig. 25) Here, not only is there deficiency of the abdominal wall, but also of part of the genito-urinary apparatus. In complete cases of extroversion there is absence of the umbilicus and of the anterior wall below it. There is no symphysis, a gap existing between the pubes; there is absence of the anterior wall of the bladder, of the greater part of the penis, and of the roof of the urethra. The scrotum is also bifid and the testicles are usually undescended.

THE ALIMENTARY TRACT

When the alimentary canal first assumes a tubular form, it is a simple, straight cylinder, placed in front of the vertebral canal, attached to it and to the rest of the embryo

by a membranous fold or rudimentary mesentery. By degrees the canal, growing in length, becomes looped at the center and straight at the upper and lower ends, while the part destined to be the stomach, is dilated. This gradually turns over on its right side, so that the border which is connected to the spine by a membranous fold comes to be turned to the left. The stomach becoming further dilated is at first placed vertically, then obliquely and then transversely, carrying with it in all its changes the membranous fold from which the omenta are afterwards produced.

ŒSOPHAGUS.

The œsophagus, commencing at the termination of the pharynx opposite the body of the fourth cervical vertebra and the upper border of the thyroid cartilage, passes down through the posterior mediastiuum and enters the stomach a little to the left of the median line. It presents three slight constrictions, (Fig 26) the most marked being at the cardiac orifice where it passes through the diaphragm.

STOMACH.

Contrary to generally accepted statements, the general form and position of the stomach are very similar to those of the empty and contracted stomach of the adult, but in consequence of the large size of the left lobe of the liver, the whole of the anterior surface is usually covered by that organ. When the stomach is filled, the movements of its pylorus towards the right side is probably impeded by the large liver, thus tending to make the axis nearly vertical instead of inclining obliquely. The fundus is usually less pronounced and the valvular constriction of the cardiac orifice is wanting, allowing easy regurgitation of the stomach contents, The capacity at birth is less than an ounce. (Fig. 27-28) The thinness of its walls is quite noticeable and its mucous membrane presents numerous slight elevations due to the accumulation of lymphoid tissue and resembling in appearance the solitary follicles of the intestines.

INTESTINES.

In the fœtus the small intestines occupy at one time the right side of the abdomen, while the large is represented by a straight tube that passes on the left side vertically from the region of the umbilicus to the pelvis.

At full term the duodenum forms a loop very suggestive of mature arrangement, namely, with its openings at the highest level. As seen in casts, it presents more of a V shape than the modified horse shoe of later life. The ends do not show the marked constrictions of the more advanced organs and the lining membrane does not present so distinctly the numerous folds, *valvulae conniventes*, so prominent later.

The division into jejunum and ileum is arbitrary, but the upper part of the small bowel usually occupies the left iliac fossa, and the lower the right.

The caecum, situated in early fœtal life near the umbilicus, ascends in the abdomen towards the left hypochondrium. It next passes transversely to the right hypochondrium, descending thence into the iliac fossa. It may find permanent lodgment at any time during its development, thus explaining the many anomalous situations of this viscus.

The length of the small intestine is given as nine feet, five inches; the caecum and colon measure one foot, exclusive of the sigmoid flexure which is about ten inches in length. The latter is curved in form and lies chiefly in the abdominal cavity, though it often presents great variations both in form and extent, at times extending in an irregular loop as high as the umbilicus.

The shallowness of the pelvis, (Fig. 12), the slight concavity of the sacrum and the amplitude of the rectile tissues give to the upper part of the rectum several lateral flexures, (Fig. 29), so that a mesial section of the infant pelvis includes not infrequently three or four folds of the rectum. Its attachments to surrounding structures do not extend as high up in the pelvis as in later development. These conditions, with

the more vertical position of the lower third, offer some explanation of the proneness to prolapsus ani in infancy.

During the early weeks of embryonic life, the alimentary canal is a closed tube. Its upper and inferior openings, at the mouth and anus, are formed by the infolding of the epiblast, with absorption of intervening tissue, thus joining the integument with the mucous membrane of the digestive tract. A failure in this absorption, occurring most frequently in the inferior end, results in imperforate anus. A still earlier arrest of development may result in the absence of the lower rectum, a point to be considered before operation for occluded anus

Figures 33-38 after Moliere and Wharton present a few of the many congenital anomalies of the rectum and lower urinary tract. Aside from arrest of development, there is reason to believe that occlusions of the rectum, as well as atresia of other portions of the digestive tract, may be due to prenatal peritonitis.

LIVER.

This important glandular organ begins to be formed at a very early period of foetal life by a process from the intestinal tube. It was probably at first a symmetrical organ, but became pushed to the right by the rapid growth of the abdominal organs. Its growth is very rapid so that at the third or fourth week of intra-uterine existence it constitutes nearly one-half of the entire body weight, almost filling the abdominal cavity. At birth its relative weight to that of body is as 1:18.

The superior border of the right lobe extends in the mid-scapular line to the seventh rib, in the mid-axillary to the sixth and in the mammillary line to the fifth rib. Its inferior border extends in the median line almost, and occasionally to the umbilicus. Generally speaking its lower border may be defined by a line from the lowest point of the ninth rib to the eighth left costo-chondral 'junction. The great variation in the size of the liver has led to differing statements by various writers. Recent observations, however, tend to show that enlargement of the liver is a very

common condition in the newborn. The lateral margin of the left lobe may be found an inch to the left of the median line, or occupying nearly the entire left hypochondrium (Fig. 39) completely covering the stomach. The upper border of the left lobe is difficult to outline on account of its substernal dullness being continuous with that of the heart.

SPLEEN.

At birth the average weight of the spleen is one-fourth of an onnce. Being situated in close apposition to the posterior and descending wall of the diaphragm, opposite the ninth, tenth and eleventh ribs and covered anteriorly by the large end of the stomach, it is seldom revealed by palpation or percussion- Not infrequently a supernumerary spleen is found varying in diameter from 5 to 15 mm., sometimes attached to, at other times having no connection with the primary organ. Fig. 19 shows one of three found in a recent series of eight autopsies on the newborn. The fact that the spleen may be outlined is evidence of its enlargement.

PANCREAS.

The pancreas is well formed at the second month of fœtal life, at about the same time as the salivary glands which it resembles in arrangement and function.

In its gross anatomy it presents nothing to characterize its different periods of growths.

KIDNEYS.

The kidneys are comparatively large; on the other hand, the lumbar part of the spine is relatively small. It is not surprising that they extend lower down in relation to the vertebrae and the iliac crests than in the adult. At all ages the kidneys are found with their upper portions partly concealed behind the twelfth rib. Frozen sections show that, contrary to accepted opinion, the right is frequently as high as the left and not crowded down by the large liver, its position being posterior to that organ.

A gross peculiarity is the distinct lobulation of the surface, the lobules corresponding in number with the interna

pyramidal divisions. (Fig. 19 & 43). Occasionally the kidneys are joined at one extremity, producing the horse-shoe form shown in (Fig. 41). Sometimes a double ureter is found on one (Fig. 42) or both sides. The latter condition was found in the case of an eleven years old boy shown in the writer's clinic.

At birth sections of the kidneys often show uric acid infarctions which appear to the naked eye as fine, brown, fan-shaped striae.

There is a congenital form of movable kidney where the gland is suspended in a peritoneal fold of its own and with the renal vessels of undue length. In such cases the kidney may be found near the anterior abdominal wall.

SUPRARENALS.

These are as large at birth as in the adult, covering as well as surmounting the kidneys. (Fig. 19).

BLADDER.

The bladder is derived from the urachus which is part of a membranous sac (the allantois) appended to the umbilicus in the early fœtal state. At first the shape of the bladder is an elongated tube situated in the lower part of the abdomen. In the new born the capacity is from two to four drachms. It is usually described as an abdominal organ, but this is not strictly accurate. The small pelvic cavity is occupied mainly by the rectum and there is little room for the bladder, but if a line be drawn from the sacral promontory to the top of the symphysis, one half of the bladder will lie below it. The pelvis is more oblique, so that the whole organ lies above the pubic crests and it is so loosely attached to the pelvic walls that it requires but little force to push it upward into the abdomen.

It is ovoid in shape when distended, with the larger end directed downwards and backwards. There is no marked fundus. The urethral orifice is at the level of the upper border of the symphysis, In front of the orifice the bladder extends forwards and upwards in close contact with the pubes, until it reaches the anterior abdominal wall,

against which it lies until within one centimetre of the umbilicus. The anterior surface is entirely uncovered by peritoneum; posteriorly, the peritoneum reaches as low as the level of the orifice of the bladder. (Fig. 29). From the mode of development it is easy to see how a congenital urinary fistula at the umbilicas may result from persistent patency of the urachus.

URETHRA.

The infant urethra in the male averages 6 cm. It is delicate in structure, quite distensible and shows a marked constriction at the meatus, points to be remembered in the use of instruments.

The prostate gland is small, its weight being about thirteen grains.

At birth the glans penis is closely invested by the prepuce, which is frequently elongated, presenting a very small opening. The cohesion of the mucous membrane lining the prepuce with that covering the glans, may be so firm as to border npon the pathological.

Congenital deformities are frequently seen in these parts, due to arrested development. Sometimes the inferior wall of the urethra and corresponding part of the corpus spongiosum are wanting, as in hypospadias; or there may be a deficiency in the superior wall of the canal and adjacent parts of the corpora cavernosa, as in epispadias.

TESTICLES,.

The testicles are formed below the kidneys in the lumbar region and at about the eighth month of intra-uterine life present at the internal opening of the inguinal canal, gradually finding their way into the scrotum. (Fig. 43). The canal is relatively short and straight. In fact, about the time the testicle reaches the groin the internal abdominal opening is just behind the external and its course is nearly direct. The descent is accompanied by formation of the cord by an aggregation of its developing constituents, namely, vas deferens, veins, arteries, lymphatics, nerves and gelatinous tissue. The process of peritoneum which

passes through the inguinal tract always precedes the descent of the testicle, although it is not pushed before it, as formerly described, for in cases where the testicles have remained within the abdomen, the vaginal process occupied its normal position in the scrotum. Ordinarily this process after birth becomes adherent to adjacent structure and is separated from the rest of the peritoneum, becoming gradually blended with the cord above the testicle. A failure in this results in a congenital hernia in which the testicle is enveloped by intestine. The complete closure of the tunica vaginalis is peculiar to man and has been considered as connected with his adaptation to the erect posture.

OVARIES.

In early fœtal life the location of the ovaries corresponds to that of the testicles. At birth they have only descended to the brim of the pelvis, with the uterine ends projecting into its cavity. They are whitish, smooth and elongated bodies attached to the free ends of the ample convoluted tubes, the latter showing but one or a very few fimbriae. (Fig. 44). Ova are developed at an early period in the life of the embryo from germinal epithelium and it is doubtful if their formation proceeds after birth. It is currently stated that there are 70,000 egg cells in the human ovary at birth. In any case, the number is very large.

UTERUS.

The uterus at birth is from one to one and one quarter inches long and appears undeveloped. (Figs. 17 and 44). There is no fundus but the body approaches the two horned form prevalent in lower animals. The cervix is longer, thicker and firmer than the body. On opening the uterus the arbor vitae will be found extending along its whole length, and there is no constriction corresponding to the internal os.

The urethra and vagina of the infant are comparatively large and distensible. There is occasionally seen an abnormality resulting from the non-absorption of the septum formed by the infolding at the cloaca. This results in an imperforatehymen.

MAMMARY GLANDS.

At birth these are from 5–8 mm. (one fifth to one third inch) in diameter. The nipple with dartos is well formed and the secreting structure is represented by slightly ramified ducts which contain a milky fluid.

BRAIN.

The development and growth of the brain is very active during intra-uterine life, so that at birth this organ is of relatively large size, and in general form and relation of its parts it presents a close approximation to that of the adult. The anterior lobes and cerebellum, however, are relatively small. The ratio of brain weight to that of the body at birth is as one to eight.

The dura is quite closely adherent to the skull, so that extravasations can with difficulty take place between them. The blood vessels of the pia mater are exceedingly delicate. so that oue can not wonder at the frequency of cerebral hæmorrhage at birth.

The fissure of Sylvius is high and that of Rolando less vertical. The convolutions and sulci are somewhat shallow and simple. In fact, at an early stage of embryonic life the surface is quite smooth.

The brain substance is of a nearly uniform whitish color. On account of its large percentage of water, it is of a soft, pulpy consistency, requiring great care in handling.

SPINAL CORD.

In the earlier months of fœtal life, the medulla spinalis occupies the whole length of the vertebral canal, but as development proceeds, the spinal column grows more rapidly than the contained cord, so that the latter appears as if drawn up, until at birth it terminates at the third lumbar vertebra.

CHAPTER IV.

NORMAL GROWTH.

For the purpose of discussion, growth and development may be divided arbitrarily into many periods, but certain fairly well defined physiologic processes suggest four epochs, viz., early infancy, infancy, childhood and youth.

In this classification early infancy will include the period from birth to the end of the twelfth month; infancy extending to the completion of first dentition; childhood from two and one half years to puberty; youth including the remaining years to maturity.

Early infancy, then, would correspond with the "*Sauglingsalter*" or sucking period of the Germans. The first dentition is usually complete at the end of thirty months, which, in this classification, would mark the beginning of childhood. Some prefer to divide the third epoch into early and late childhood, the dividing line being placed at the appearance of the permanent teeth, or about the sixth year.

The importance of a familiarity with the rate of growth during the different periods of infancy and childhood can not be over estimated, as it is well known that irregularities in the growth ratio are frequently the first intimations of disturbed nutrition or developing disease.

It is needless to add that to the alert physician early recognition of a tendency to nutritional disorders is of the utmost value in the care and treatment of infants and children. Increase in body weight, length, and the measurements of the different members bear normally a certain constant relation at different periods of life. No period of extrauterine life compares in rapidity of growth with that of the first six months.

Taking the birth weight as 3,280 gms. (about seven and one-fourth pounds) statistics show that the loss of weight in the first three days is about ten per cent. This is usually regained by the end of the first week. The reason for this early loss is quite apparent. It is due partly to the loss of fluids from the viscera as well as from the surface of the

19

18

FIG. 18. THYROID, THYMUS, HEART AND LUNGS AT BIRTH.
FIG. 19. KIDNEY AND SUPRA-RENAL. PANCREAS AND SUPERNUMERARY
SPLEEN.

FOETAL CIRCULATION. (GRAY.)
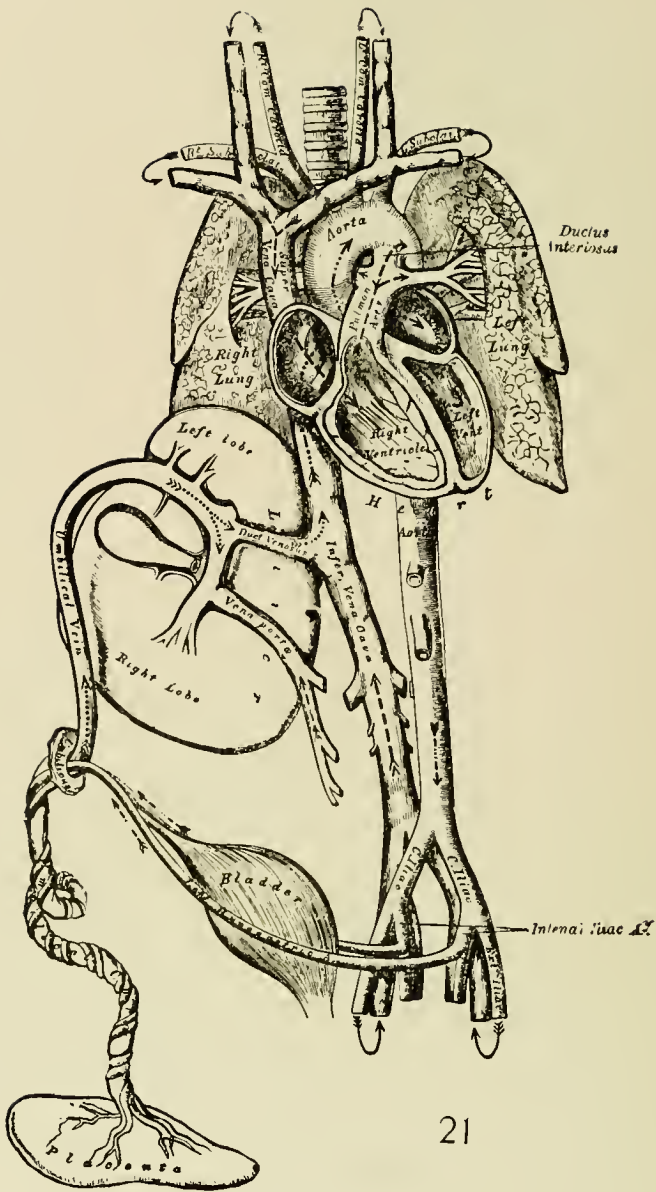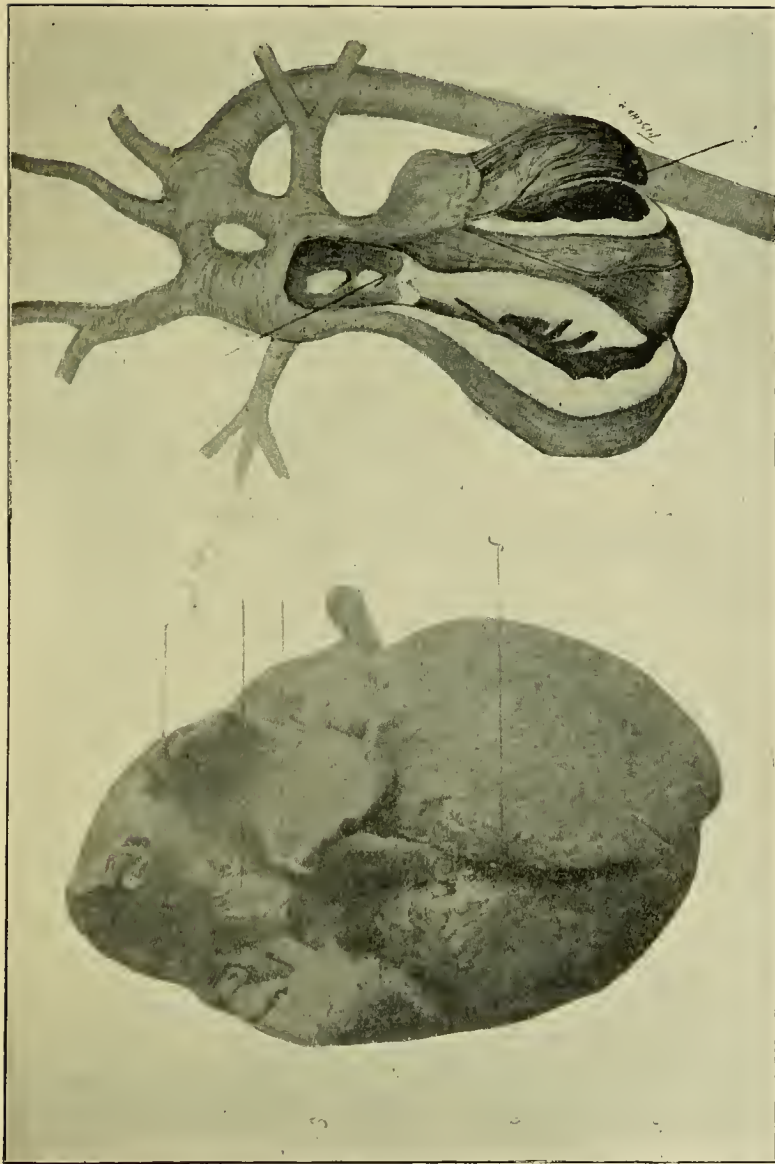
22. STENOSIS OF PULMONARY CONUS.
1 1, Cusps of Pulmonary Valve. 2, Pulmonary Artery cut open lying over Aorta. 4, Stenosis of Pulmonary Conus. 5, Incision into Left Ventricle. 6, Incision into Right Ventricle. (From author's clinic, Necropsy by DR. E. P. LE COUNT).

23. CARDIAC MALFORMATION.
Common trunk for Aorta and Pulmonary Artery. Bristle passed through Foramen Ovale. (From author's clinic, Necropsy by PROF. HEKTOEN.)

24

CONGENITAL ENLARGEMENT OF THYROID
(From author's clinic.)

25

EXSTROPHY OF BLADDER.
1, Umbilicus. 2, Everted Bladder. 3, Complete Epispadias.
4, Scrotum. 5, Undescended Testicle.
(From author's clinic.)

body, and partly to consumption of stored material prior to the establishment of lactation. This consumption is rapid as there is increased metabolism incident to a greater muscular and circulatory activity in the presence of an increased supply of oxygen. From the examination of many tables it appears that the normal infant doubles his birth weight by the sixth month and trebles it soon after the twelfth month, growth being most rapid during the first four months of life.

The following charts from Holt give a fair idea of the weight curves for the first three weeks and twelve months, respectively.

DAILY WEIGHT CHART.

Name,.................................... Date of Birth,...................189

Gms.	Lbs.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
4420	9¾																				
4310	9½																				
4200	9¼																				
4080	9																				
3970	8¾																				
3850	8½																				
3740	8¼																				
3630	8																				
3510	7¾																				
3400	7½																				
3290	7¼																				
3180	7																				
3060	6¾																				
2940	6½																				
2830	6¼																				
2720	6																				
2610	5¾																				
2490	5½																				
2380	5¼																				
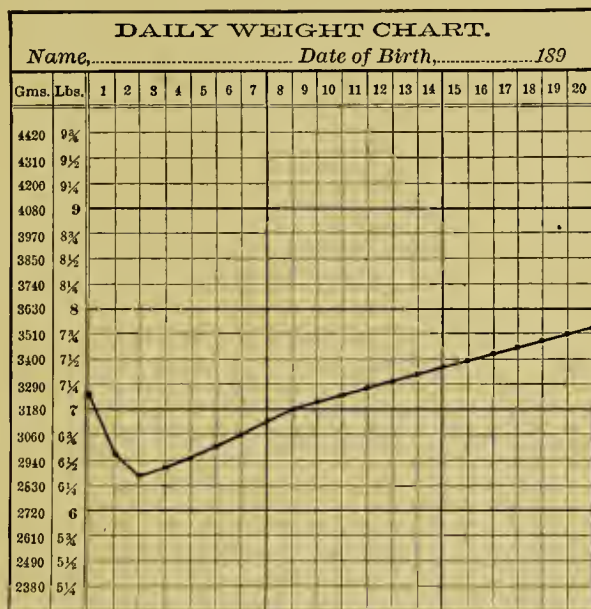
CHART I—Weight curve of first twenty days.

LENGTH.

Accepting the average length at birth as 48.2 cm., (nineteen inches), we find a somewhat regular ratio of increase which doubles the birth length at the end of the fourth year, increase in length as in weight being most rapid in the early months of life. The increase during the first year

(about half of the initial length) is nearly double that of any succeeding year.
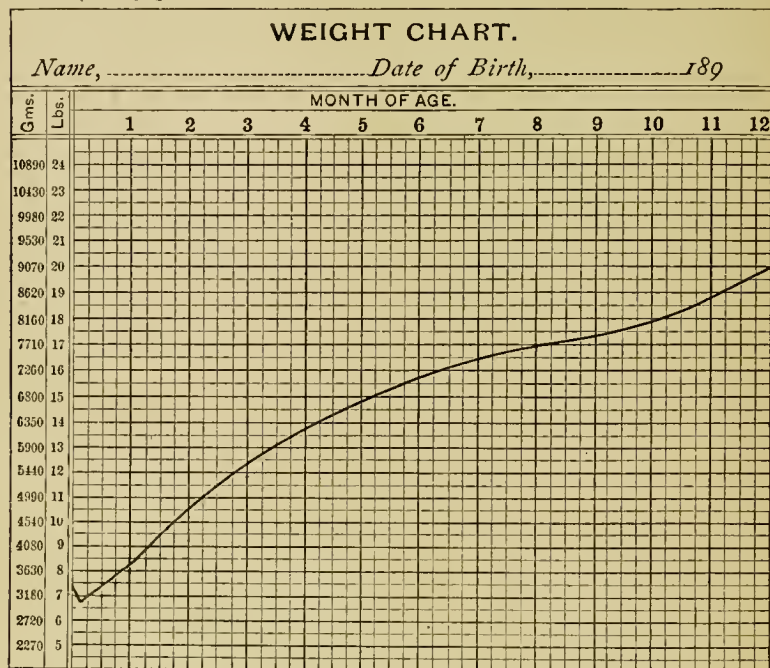
CHART II—Weight curve of first twelve months.

A notable difference in ratio of increase appears during acute febrile disorders, as the exanthemata, when the weight invariably diminishes, while the length increases, in fact may even be accelerated.

The average increase of the second year is about 10 cm., (four inches), and from that on to the age of eleven or twelve years from 5 to 8 cm., (two to three inches) annually. After this period, for a year or two, for the only time, the height of girls exceeds that of boys.

Development in length is most rapid in the lower extremities, which fact constantly changes the relation of the umbilicus to the center of the body until maturity when the center is about the upper border of the symphysis.

Exceptions to this rule are seen in rachitis and cretinism where the long bones show retardation in longitudinal growth.

The following table, from statistics of the Boston Infant's Hospital and the Reports of the Wisconsin and Massachusetts State Boards of Health, compiled by Rotch, shows the average heights and weights from birth to fourteen years.

Boys.				Age.	Girls.			
Height.		Weight.			Height.		Weight.	
Centimetres.	Inches.	Kilogrammes.	Pounds.		Centimetres.	Inches.	Kilogrammes.	Pounds.
49 37	19.75	3.25	7.15	Birth.	48.12	19.25	3 15	6.93
61.87	24.75	6.50	14.30	5 months.	59.12	23.25	6.30	13 86
73.82	29.53	9.54	20.98	1 year.	74.17	29.67	9.00	19.80
84.55	33.82	13.80	30.36	2 years.	82.35	32.94	13.31	29.28
92.65	37.06	15.90	34.98	3 years.	90.77	36.31	15.07	33.15
98.27	39.31	17.27	37 99	4 years.	97.00	38 80	16.53	36.36
103.92	41.57	18 64	41.00	5 years.	103.22	41.29	17.99	39.57
109.37	43.75	20.49	45.07	6 years.	108.37	43.35	19.63	43.18
114.35	45.74	22.26	48.97	7 years.	113 80	45.52	21.50	47.30
119.40	47.76	24.46	53.81	8 years.	118.95	47.58	23.44	51.56
124 22	49 69	26.87	59.00	9 years.	123 42	49.37	25.91	57.00
129 20	51 68	29.62	65 16	10 years.	128.35	51.34	28.29	62.23
133.32	53 33	31.84	70.04	11 years.	133.55	53.42	31.23	68.70
137.77	55 11	34.89	76.75	12 years.	139.70	55.88	35.53	78.16
143 02	57.21	38 49	84.67	13 years.	145 40	58.16	40.21	88.46
149.70	59.88	42.95	94.49	14 years.	149.85	59.94	44.65	98.23

CHART III.

Porter's observations of a large number of school children of St. Louis from six to sixteen years show an average of nearly two pounds lower weight than the above table.

Of extreme interest is the relative growth of head and chest in infancy and childhood. Taking the average circumference of the head at birth, measured at the level of the occipital protuberance as 34 cm., (thirteen and two-fifths inches), and that of the thorax just below the nipples and the angles of the scapulae as 33 cm., (thirteen inches) we find the ratio steadily decreasing until the two circumferences are equal before the end of the second year. From this on, the ratio is reversed, the chest increasing more rapidly up to maturity.

COMPARATIVE GROWTH OF HEAD AND CHEST.

Age.	Head.	Chest.
Birth	35 cm. (13.8 in.)..	33 cm. (13 2 in.)
6 months	41.5 cm. (16.8 in.)	40.6 cm. (16 in.)
12 months..	43.2 cm. (17.9 in.)	44.3 cm. (17.6 in.)
2 years.	47 cm. (18.6 in.)	46.5 cm. (18.4 in.)
3 years	48.3 cm. (19 in.)	49 cm. (19.3 in)
4 years.	49.4 cm. (19.5 in.)	51 cm. (20.2 in)
6 years	49.6 cm. (19.6 in.)	55.5 cm. (21.9 in.)
10 years.	51.4 cm. (20.3 in.)	59.8 cm. (23 6 in.)
12 years.	53.3 cm. (21 in)	64.0 cm. (25.2 in.)

The increase in the circumference of the head in early life is remarkable and like that of body weight is more rapid during the first year. Reference to the above table shows the average growth of the head is 7.6 cm., (three inches) during the first six months; 2.5 to 3 cm. (a little more than one inch) the second six months; 2 cm. (three-fourths of an inch) the second year and less than 1.2 cm. (one-half an inch) the third year. By the seventh year the head has attained nearly its full development. The growth is most noticeable in the antero-posterior diameter.

This rapid growth of the head during the first six months apparently increases the anterior fontanel, which, however, diminishes in size towards the end of the first year and is ordinarily completely ossified at the close of the second year. The sutures show the beginning of firm union about the ninth month. Differentiation between the outer and inner tables of the skull with the formation of the diplöe proceeds gradually. Bony deposition in the vitreous table deepens the outlines of the great venous sinuses. The mastoid process becomes distinct about the first year. From infancy to puberty there is a continuous formation of new bone from the periosteum on the surface of the mastoid portion of the temple bone. (Figs. 47, 48, 49). This process consists of cancellous tissue and can be readily penetrated by the knife in operations for mastoiditis. Towards puberty, rarely earlier, the process becomes hollowed into air cells (Fig. 50.) The cells are lined with a delicate mucous membrane and communicate with the antrum and with one another. They vary in size in different bodies and on the two sides of the same head. The proximity of the lateral sinus, renders it liable to become involved by extension of inflammation in

suppurative disease of the mastoid cells, owing to the thinness of the bony septa between the cells and the sinus.

As the mastoid increases in thickness, the antrum comes to lie at a greater depth from the surface and becomes relatively smaller.

The bony ring, which represents nearly all of the osseous portion of the external auditory meatus at birth, has grown outwards to form the walls and the floor. The Rivinian notch generally persists until puberty and is not infrequently found in the adult.

It is calculated that in the adult the osseous portion forms two-thirds of the total length of the meatus. At the end of the first year, only the inner third has bony walls, and even in a child of six years, scarcely half is osseous. A knowledge of the length of the external auditory meatus at different ages is obviously important. The following from Symington shows this, also the difference in length of the floor and roof of the meatus: In a child of two months the length of floor was 17 mm.; of roof 13 mm. In a child of six months, length of floor was 19 mm.; roof 14 mm. In a child of two years the length of floor was 22 mm., roof 16 mm.

The only important change in the tympanum is the obliteration of the petro-squamous suture which generally occurs by the end of the first year.

The Eustachian tube doubles its length between infancy and maturity, the growth being especially rapid during the first few years after birth, so that by the fifth or sixth year, its length is not far from that of the adult. The growth seems to occur mainly in its anterior or pharyngeal portion. The tube changes its almost horizontal direction to form an angle of at least 45 degrees with the horizon. This descent of the tube does not keep pace with that of the nasal floor. At birth it is found at the level of the hard palate, while at the age of four years it is 3 or 4 mm. above, and in the adult 10 mm above.

Unlike that of the head, the growth of the face is a gradual process, going on steadily from birth to adult life. The small size may be attributed to the rudimentary condi-

tiou of the teeth and the smallness of the maxillary sinuses.

Ankylosis of the frontal bones begins early and there may be no trace of the suture in the adult skull. The frontal sinuses appear about the seventh year. The ethmoidal cells appear at the third year, The communication through the foramen caecum is closed about puberty.

The septum of the nose is usually straight up to the seventh year; after which it very commonly inclines to one side. The nasal sinuses increase in height simultaneously with the lengthening of the vertical plates of the palate bones.

During the first year the two halves of the inferior maxilla ankylose, union taking place from beiow upwards, but is not complete until the second year.

NASO–PHARYNX.

As mentioned previously, the naso-pharynx is richly supplied with lymphoid tissue. There is an aggregation of follicles in the posterior wall known as the third, pharyngeal, or Luschka's tonsil.

The different findings of surgical anatomists in respect to this area may well raise the question whether Luschka's tonsil is a normal anatomical entity. The rapid growth which this mass of lymphoid tissue frequently takes on in early years makes it of pathological interest.

From the lengthening of the face, the increasing distance between the pterygoid plates, the diminishing obliquity of the vomer and the subsidence of the soft palate which becomes more vertical, the vault of the pharynx becomes more capacious.

The posterior nasal openings, extremely small in infancy, develop irregularly. It is stated that their size is doubled in the first six months, then remaining stationary to the end of the second year, they again pass through a period of increased growth. The subsidence of the hard palate increases the capacity of the nasal respiratory tract, principally in the height of its inferior meati, the middle por-

tions being wider than the openings; a point to be remembered in the lodgment of foreign bodies.

The antrum of Highmore, although small, is from birth lined with a mucous membrane which may become the seat of infection.

As stated before, the frontal sinuses assume their relationship to the respiratory tract about the seventh year.

CHAPTER V.

(Growth Continued.)

DENTITION.

The development of the temporary teeth begins with the first formation of the jaws, about the sixth week of intra-uterine life. Briefly stated, they are simply calcified mucous membrane. At the time of birth the crowns of all the temporary incisors and canines are fairly advanced in calcification, (Fig. 8) but it is not until about the age of four and one half years that the milk teeth are fully formed. Separated cusps of the temporary molars have also blended at birth, and calcification of the first permanent molar is just beginning in the form of a separate cap for each cusp. These do not fuse until six months after birth. Dissection shows the germs of the permanent incisors and canines posterior and external to the corresponding milk teeth; but there are no traces of the bicuspids or second permanent molars. These appear between the fourth and sixth months of life.

The temporary teeth are distinguished from the permanent by the marked bulging of the crown close to the neck, so that the latter shows a well marked constriction. They are of smaller dimensions, especially those of the canines. The temporary molars are larger than the bicuspids which succeed them. The roots are smaller and more divergent.

With the completion of the crown and beginning of calcification of the root, the process of eruption commences.

The growth of the root propels the crown towards the surface of the gum, the super-imposed tissue, disappearing by absorption. Synchronously with the development of the root, the jaw increases in depth by the addition of new osseous material. The bony crypt is rebuilt around the neck of the tooth and forms the alveolus of the milk tooth.

The eruption of the teeth is not a gradual and continuous process, but it occurs in groups, with intervals of repose between the successive groups. The lower central incisors appear from the sixth to the the ninth month, their eruption being completed in about ten days, then follows a resting period of two or three months, after which the upper incisors appear, both central and lateral. After a rest of a few months, come the lower lateral incisors and first molars; four or five months later the canines, and finally, about the second year, the second molars.

ORDER OF THE ERUPTION OF THE TEMPORARY TEETH.

Lower central incisors............ ..6th to 9th month.
Upper incisors.....................8th to 10th month.
Lower lateral incisors and first molars. 15th to 21st month.
Canines...........................16th to 20th month.
Second molars.....................20th to 30th month.

Scarcely a year elapses after calcification of the milk teeth is complete before absorption begins. There is still much to learn of the cause of this absorption as it seems to be quite independent of the presence and pressure of the permanent set. Normally, absorbtion begins at the apex of the root and advances towards the crown. Shortly after the root has disappeared the crown is removed either by the advancing permanent tooth or by an accidental rupture of the attachment between the neck of the tooth and the mucous membrane of the gum.

We have mentioned that the calcification of the permanent teeth begins before birth. The process extends to about the 12th year. Just before the shedding of the temporary teeth, i. e., about the 6th year, there are more teeth in the jaw than at any other time of life. Fig.   ). There are present all the temporary teeth and the crowns of all

FIG. 26. FOREIGN BODY IN UPPER CONSTRUCTION OF OESOPHAGUS.
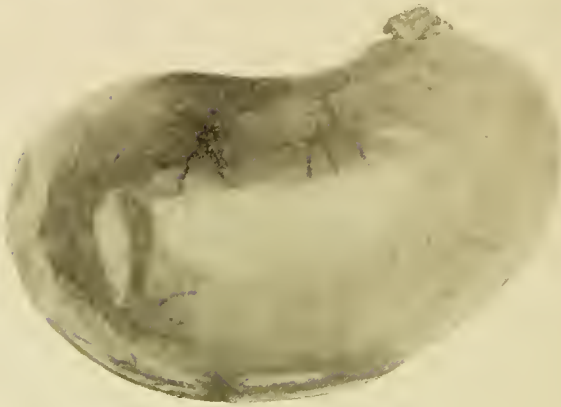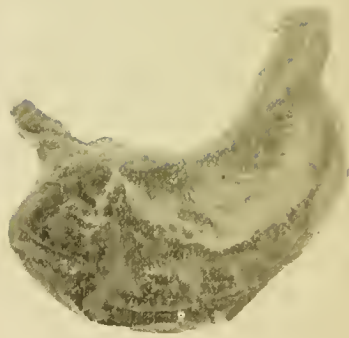
28
STOMACHS OF NEW BORN.

the permanent set, excepting the wisdom teeth, in all forty-eight.

The permanent teeth may be divided into two sets—the ten anterior which succeed the milk teeth and six others that are superadded farther back in the jaw. They arise from successive extensions of the common dental laminæ carried backwards. During the growth of the teeth the jaw increases in depth and length and undergoes changes in form.

The space taken up by the ten anterior permanent teeth very nearly corresponds with that which has been occupied by the ten milk teeth; the difference in width between the incisors of the two sets being compensated for by the smallness of the bicuspids in comparison with the milk molars which they succeed.

The room necessary for the accommodation of the three permanent molars in the alveolar arch is obtained by absorption of the anterior part of the coronoid process. This absorption is accompanied by a new formation of bone at the posterior part of the ascending ramus. This gradual remodeling of the bone is naturally a slow process. At certain periods in the growth there is not sufficient room in the alveolar arch for the growing sacs of the permanent molars; hence the latter are found enclosed in the base of the coronoid process of the lower jaw, and in the maxillary tuberosity of the upper, but they afterwards assume their ultimate position as the bones increase in length.

As the permanent teeth erupt, the sockets of the temporary teeth disappear by absorption and new alveoli are built for the second set.

ORDER OF ERUPTION OF PERMANENT TEETH.

First molars............... ....6th year.
Central incisors... ....7th year.
Lateral incisors.............................8th year.
First bicuspids......... ....10th year.
Second bicuspids...... ....11th year.
Canines.......... ....12th to 13th year.

Second molars.....................12th to 15th year.
Third molars......................17th to 21st year.
The lower teeth usually precede the upper.

VERTEBRAL COLUMN.

As the spine develops and ossification proceeds the lig-
amentous attachments become firmer and the vertebral col-
umn loses some of the great flexibility of early infancy.

The development of the curvatures, due in part to the
superincumbent weight and in part to the action of the great
muscles attached to the vertebrae, may be rendered abnor-
mal by persistent vicious attitudes or unusual muscular con-
tractions, resulting in unnatural curves as in kyphosis, lor-
dosis and scoliosis. The maintenance of the permanent
curvatures is due to changes in the thickness of the inter-
vertebral substance. A very common curvature found in
young children is due to muscular weakness, such as occurs
in rickets. In these cases the back in the lower dorsal or
lumbar region is found to curve backwards when the child
is made to sit. On taking the weight off the spine the cur-
vature disappears.

There may be great variation in the time of ossification
of the vertebrae. The process begins before birth and is
not fully completed before the thirtieth year.

THORAX.

As age advances the transverse diameter increases more
rapidly than the antero-posterior, so that a cross section of
the thorax from being, at birth, nearly circular becomes
more elliptical. (Figs. 52 and 61.)

With the increasing ossification of the bony frame work,
the thickening of the ribs, firmer articulation, and the in-
crease in muscular development, the thorax gradually
assumes a rigidity approaching the adult type.

The backward and downward curvature of the ribs be-
comes more and more pronounced through the period of
childhood. It is accompanied by the subsidence of the
sternum and attached costo-chondral areas, changing the

chest from the more or less cylindrical form of infancy to the cone shape of the adult. On account of the compressibility due to the predominance of cartilaginous tissue, during the subsequent ossification, the shape of the thorax depends largely upon the continuous action of the muscles; hence the deformities so frequently observed as the result of retarded bone development.

LUNGS.

From infancy to puberty there is a gradual change in the structure of the lung. The air cells increase in number and size, encroaching upon the connective tissue and diminishing the vascularity of the organ. The air spaces developed from the terminal bronchi are covered with a continuous layer of nucleated epithelial cells, which, during the more extended growth of the alveoli become flattened, lose their nuclei and form thin plates. The blood vessels become less tortuous and distensible. The changes in the lung result in a condensation of interstitial tissue, with increased firmness of the bronchioles and a more intimate relation to the parenchyma. The air capacity, which is small in early infancy, increases rapidly as the age advances,

As the thorax shows an excess of growth over other parts of the body, so the lungs have an even greater growth, since they not only keep pace with the increased capacity of the thorax but finally fill a portion of the space formerly occupied by the thymus, and also cover to a greater extent in front the heart and great vessels. The backward curvature of the ribs, a feature of thoracic development, gives additional space for the lungs posteriorly on either side of the spinal column. As in the adult, the apices of the lungs extend two finger breadths above the clavicle (Fig. 60) and there is no constant difference in the location of the inferior borders.

A marked change occurs in the anterior boundaries; the wide angle between the anterior lower borders of the lobes which is due in part to the encroachment of the abdominal viscera and in part to the flaring of the chondral arch, becomes less as childhood succeeds infancy.

There is no difference in the gross arrangment of the bronchi, save that in the development of the thorax the bifurcation of the trachea gradually assumes a lower relation to the spinal column until maturity, when it is found opposite the fourth dorsal vertebra.

The right bronchus occupies a more vertical position than the left, a point of interest, as it is more liable to the lodgment of foreign bodies and to infection from the larynx.

The descent of the inferior maxilla, the larynx and the upper end of the sternum, keep nearly equal pace during the development period until the age of puberty, when the larynx in the male takes on a remarkable growth, especially in its antero-posterior dimensions. bringing into prominence the well known landmark, the Pomum Adami.

In the adult the space between the top of the sternum and the chin with the head retracted is double that which it measures when the head is in the natural position, this increase occurring mainly between the chin and the cricoid cartilage. In the child, however, with the head similarly placed, the increase in space occurs between the cricoid cartilage and the top of the sternum, because in the child the cricoid cartilage occupies relatively a higher position in the neck.

HEART.

We have stated that the heart at birth is relatively large. The capacity of its two sides and the thickness of their walls are nearly equal, the auricular portion being still comparatively large. During infancy the weight of the heart increases rapidly, its rate being estimated at 80 per cent., the left ventricle showing the greatest increase, ist wall doubling in thickness that of the right by the end of the second year. From the third to the tenth year the weight or the heart seems to fall behind in the general growth of the body, showing an increase of only ten per cent. At the approach of puberty it takes on a remarkable growth, stated to be as high as one hundred per cent.

The limit of the growth of this organ it said to be about fifty years.

The position of the heart in its relation to the anterior thoracic wall has been a subject of much controversy; different observers locating the apex beat in early childhood all the way from the fourth to the sixth interspace, and from one to two finger breadths on either side of the nipple line.

That clinicians should differ so widely in their conclusions would suggest either that hearts vary in their positions in different children or are subject to variations in the same individual. It is more than probable that both are true. It can be demonstrated that peculiar conformations of the thorax affect the position of the apex, as the crowded viscera must conform to their more rigid surroundings.

Again, the position of the individual, whether upright or horizontal, is known to change the position of the apex through the influence of gravity. So, too, any crowding from distended abdominal organs may lift the freely movable apex. In all probability there is no marked change in the relative height of this organ, though the more rapid expansion of chest wall as compared with heart growth may bring the apex impact nearer the median line.

In very young infants the exact location of the apex is not always easy to determine, owing partly to the interposition of adipose and the want of systolic vigor. In early infancy the relatively large right ventricle, moreover, comprises the entire anterior aspect of the heart. The left ventriclar apex, lying posteriorly does not impinge against the chest wall with the definiteness of advanced childhood. The more transverse position of the heart itself and the sharper curvature of the left costo-chondral region obscures somewhat the apex behind the shelving border of the left lung, increasing the indefiniteness of the infantile apex beat. But later in childhood the heart beat is easily felt and may be more plainly noted than in the adult.

As a rule the apex beat is located beyond the nipple line in early childhood, but in or within that line in later childhood and usually in the fourth or fifth interspace. The accompanying diagrams of von Starck's "Types" represent

with a fair degree of accuracy the comparative areas of cardiac dulness at different ages of childhood. The large majority of observers have located the right border of the heart to the right of the sternum at all periods of childhood.
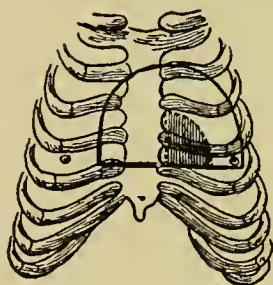
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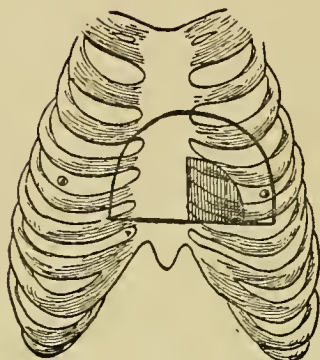
TYPE II.
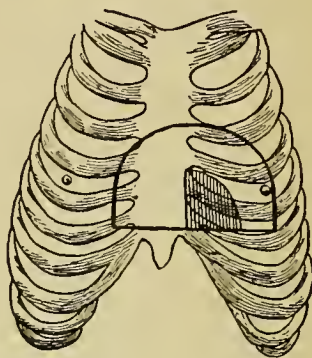
TYPE III.

BLOOD VESSELS.

There are some changes in the blood vessels that should be mentioned. The relative capacity of the arteries to the heart is greater in infancy and childhood, thus rendering the arterial tension low. The enormous growth of the heart at puberty produces a marked change in their relation.

The growth of the arteries is not uniform. This is best seen in the femoral and renal as compared with the carotid and pulmonary, the two latter showing but little post-natal growth, while the former develop in a marked degree. This

is a point of interest as it explains the tendency to renal congestion and inflammation so noticeable in young children.

THYROID.

As childhood advances, with the disappearance of sub-cutaneous fat and the sinking of the manubrium sterni, the thyroid gland becomes more evident and can more easily be outlined. The fluid contained in its cells, which in the fœtus and new born is serious in character, changes gradu-ally to a colloid material. Not infrequently the thyroid in-creases in size at the approach of puberty.

THYMUS.

The thymus increases in size up to the end of the second year; it is then stationary until the sixth year, after which it gradually atrophies, disappearing from the neck and from behind the middle third of the sternum, its only vestige being a mass of fatty tissue in the superior mediastinal space. The atrophy is associated with a closer approxi-mation of the pleuræ and lungs, behind the sternum.

CHAPTER VI.

(Growth continued).

ALIMENTARY TRACT.

Within the first few weeks of life the mucosa of the mouth loses its dusky hyperaemic appearance and at the same time the so-called epithelial pearls—small, yellowish white nodules frequently found in the median line of the hard palate—disappear.

The tongue and buccal surfaces become more moist with the increasing secretions from the buccal, labial and salivary glands.

The characteristic coating of the baby tongue persists during the greater part of the nursing period. The roof of the mouth gradually becomes more arched with the develop-ment of the alveolar ridges. The velum palati becomes ampler as it descends to its more vertical position, the

uvala elongates and the tonsils increase in size.   The masses
of fat ("sucking pads") (Fig. 51) found in the buccal parietes
diminish, although traces of them remain in later life.

Between the pharynx and the vertebral column is a
considerable amount of loose connective tissue, containing
the post-pharyngeal glands; of interest as they may be the
seat of retro-pharyngeal abscesses.   With the body growth
the pharynx and œsophagus lengthen, the latter curving
somewhat as it follows the spine with which it is in close
relation

STOMACH.

The stomach develops rapidly, especially in the region
of the fundus, increasing greatly in its longer curve, the
walls thickening and becoming more muscular.

The patulous cardiac orifice assumes gradually its valve-
like arrangement which is characteristic of later life.

The lymphoid tissue, which is abundant in the mucosa
of the young stomach, gradually diminishes as the peptic
glands increase in size and activity.

The position of the stomach, at first completely covered
in front by the left lobe of the liver, changes with its own
rapid growth so that by the sixth month a portion of the
lower border presents below that organ.   After one year of
age percussion should enable us to outline at least a third of
the normally distended stomach.

A great deal has been written in regard to the growth
of the stomach in infancy.   The difficulties in the way of
measuring the capacity of this viscus during life, and its
distensibility when filled post-mortem, render unsatis-
factory all attempts to determine accurately its size at
different periods.   Were the pylorus closed we could easily
fill the stomach with a known quantity of fluid or, by weigh-
ing before and after nursing, determine the amount taken.
But even this method would lack accuracy as allowance
must be made for absorption from the surface, always an
unknown quantity.   As the result of many observations
upon recent post mortem specimens and many tables of

weights before and after nursing, also measures employed in long series of artificial feedings, some fairly approximate conclusions have been generally accepted.

The following table represents fairly the average capacity of the stomach at different ages:

At birth..................... 32	cc m	oz	1.
At end of 1st month........... 75	"	"	$2\frac{1}{2}$.
At end of 2nd month..........105	"	"	$3\frac{1}{2}$.
At end of 3rd month..........132	"	"	$4\frac{1}{2}$.
At end of 4th month..........145	"	"	$4\frac{3}{4}$.
At end of 5th month·····.......155	"	"	5.
At end of 12th month..........250	"	"	8.

The growth of the stomach is most rapid in the first half of the first year, of which the first three months exhibit by far the greater rate of increase. By comparing the above with the tables of growth in the preceding chapter, it will be observed that the gastric capacity maintains a very constant ratio of increase with that of body weight in the first year of life.

NOTE:—Gastric capacity as mentioned above must not be confounded with the amount of food an infant may take, concerning which reference will be made in the chapter on foods.

INTESTINES.

Much has been said concerning the changes in the lower digestive tube during the era development. A few measurements may be given here.

Small intestine at birth—286 cm. (nine ft. five in.)

Small intestine at end of second month—296 cm. (nine ft. nine in.)

After this its growth is very irregular.

Large intestine at birth—56 cm. (one ft. ten in.) of which the sigmoid represents 25.5 cm. (ten inches) and the imperfect cæcum about 5 cm. (two inches.) The growth is slight or even none for the first four months, but the following measurements have been verified.

End of 1st year........... 76 cm. (two ft. six in.)

End of 6th year...........91.5 cm. (three ft.)

End of 13th year . . . . .106 cm. (three ft. six in.)

In the progress of growth differentiation occurs between the various portions, as duodenum, small intestine, cæcum, colon and rectum.

That the growths of the different portions of this tube are not uniform and bear no constant relation to the growth of the body would seem to explain the apparent anomalies of position and dimensions noted by different observers. Descriptions of aberrant bowels need occasion no surprise. The colon may extend directly from the hepatic flexure diagonally to the left iliac region, or from the splenic flexure to the right iliac with the rectum on the right side of the sacrum. Or an immense loop may be thrown out from the left iliac fossa which, reaching to umbilicus, returns to the rectum, as a rudimentary sigmoid.

It has not been demonstrated that the small intestine follows a very definite course or bears during its growth any constant relationship to other viscera, varying little in form or structure throughout its length until it joins the caecum, which in the earliest infancy shows marked departure from the preceding tube. Many descriptions agree that this important organ is found in the very young relatively high without, however, any fixed habitat for itself or its appendix, the angle at the ileo-caecal junction maintaining no constant value.

From this point on, the tube assumes the sacculated form which is characteristic of the colon. The ileum gradually descends to its permanent position and the flexures assume their definite relations to the liver and spleen, though the lower termination exhibits vagaries in the length and position of that part known as the sigmoid. The rectum loses its relative redundancy as it adjusts itself to the increasing depth and posterior curvature of the pelvis. One peculiarity of the lower digestive tube in infancy is the ample mesentery, an arrangement which allows adaptation of this convoluted tube to the rapidly increasing dimensions of the abdominal cavity.

LIVER.

The increase in the weight of the liver does not keep pace with that of the body, showing a tendency to fall behind throughout life. The relative reduction of liver weight at birth is not surprising, when we take into consideration the change in blood circulation at that time. (Fig. 21). Tables of findings show that the decrease in area of liver dullness is, to a considerable extent, more apparent than real. It is due partly to the increasing prominence of the rapidly growing stomach, the elongation of the abdominal spine and the change in the shape of the lower ribs having exposed a large portion of this organ in infancy.

The retardation of growth is most marked in the left lobe, retiring as it does from a point midway between xiphoid and umbilicus to the restricted area found later in front of the pylorus. Advancing childhood with its lowered diaphragm shows the superior border of the liver one rib lower than in infancy.

The lower margin at birth frequently found midway between costal margin and crest of ilium, *apparently* ascends until, at puberty it may correspond with the lower border of the ribs.

SPLEEN.

The peculiarity of the spleen in infancy and childhood is its ready tendency to enlargement.

KIDNEYS.

The kidneys maintain their lobulated appearance for several years, assuming gradually the smooth surface characteristic of adult life.

The relative slowness of their growth as compared with that of the spinal column sufficiently accounts for the apparent change of position of the superior and inferior borders.

BLADDER.

From the semi-abdominal position at birth, the bladder sinks downward as the pelvis develops in depth and breadth.

This subsidence is, no doubt, favored by the weight of the urine and the assumption of the upright position, The upper part descends more rapidly than the lower and this process is associated with the formation of a fold of the bladder behind the urethral orifice.

Of surgical interest is the relation of the peritoneum to the bladder at different periods of growth. As previously stated, the extensive anterior surface of the bladder at birth is devoid of peritoneal covering and lies in intimate relationship with the anterior abdominal wall, occupying the lower two-thirds of the space between the symphysis and the umbilicus. (Fig. 29).

In contrast, the posterior surface is invested with peritoneum as low down as the commencement of the urethra. In the growth of this viscus the broadening base is partially uncovered, the peritoneum being reflected upon the rectum, forming the recto-vesical fold.

From about two drachms at birth to an ounce at six months the capacity of the bladder shows great variations and is susceptible of great distension in later life. (Fig. 32).

UTERUS.

The high position of the infantile uterus and ovaries changes with the pelvic development, the fundus maintaining its rudimentary form and structure until the approach of puberty, at which time differentiation from the cervical portion is rapidly established. About the same time the vagina assumes a more horizontal position, which, with the increasing anteversion of the uterus, diminishes the intervened angle.

No marked changes occur in the generative organs until the approach of puberty.

With the growth of the lower abdominal walls the internal and external inguinal rings, which were originally in apposition, become separated, the intervening tissue being elongated into a canal lying obliquely between the muscular layers.

NERVOUS SYSTEM.

By comparing the weight of the brain with that of the body at different ages, we find that their growth follows a quite similar course during the first year. From this time on the ratio decreases as is seen by the following table: Rate of brain to body weight at birth, 1:8; during the first year, 1:6; second year, 1:14; third year, 1:18; fourteenth year, from 1:15 to 1:25; adult 1:43. The entire brain substance attains nearly its adult size by the seventh year.

From the large size at birth, the growth of the brain, *en masse*, is not remarkable, but the alteration in the consistency of the substance, the increasing differentiation of its gray and white substances, the deepening of the fissures and sulci and the increasing complexity of the convolutions, all show the occurrence of a marked progressive change.

The most rapid growth of the cerebrum is seen in the frontal lobes, altering the position and direction of the fissures of Sylvius and Rolando.

Cellular multiplication in the cortex is said to cease in the human being at the third month of fœtal life. Although all the cells may be present at birth, they are in a very rudimentary state and may require years for growth before they attain the condition necessary for perfection of function. The term elaboration has been used to describe the change from the simple cell of the new-born, with its large nucleus and small amount of protoplasm, to the highly complex body of the adult period. Out of the great number of cells present at birth. a considerable part are, probably, never highly developed even in the brains of those are well educated and skillfully trained.

In the development of the nerve cell, a prolongation occurs, varying in dimensions from the infinitesimal to half the length of the body.

This early process is called a *neuron* and it is by means of these that distant cells are brought into relationship with one another. Later in the development of the cell, there are seen numerous finely branching processes, interacing with the adjacent cells in a manner analogous to the

leaves and twigs of a forest. To these divisions are given the name of *dendrons*. The older idea of their function was that they were nutritive, but it is now generally believed that they serve as association paths for receiving and transmitting varied impulses and are the index of the nervous activity of the individual. In the adult the medullary substance has been estimated as about thirty per cent of the entire weight of nerve tissue. Therefore the highest rate of brain development throughout infancy and early childhood occurs in the medullary portion. In very early infancy the peripheral nerves have sheaths of myeline, which later may be traced in the spinal cord, medulla oblongata and finally in the cerebrum. The extent of medulation of any tract is an index of the degree of development of that tract.

In the same way may be traced the earlier development of those nerve areas which control merely bodily functions and reflexes. The higher intellectual functions show evidence of their activity later, although ultimately they monopolize the greater portion of the cortex.

The weight of the spinal cord to body-weight at birth is as 1:500; in adult life, 1:1500. In its longitudinal growth the spinal cord does not keep pace with that of its canal. It is due to this relative shortening of the cord that the roots of the lower spinal nerves assume an increasingly higher relationship to the respective segments from whose foramina they emerge (a point of diagnostic and surgical interest). It will be remembered also in this connection that the tips of the spinous processes vary considerably at different ages in their relations to their respective vertebrae.

CHAPTER VII.

PHYSIOLOGY AND HYGIENE OF THE NEW-BORN.

The most noticeable physiological processes in the very young infant are respiration and circulation. The latter, having begun during pre-natal existence, seems to be better established.

It is asserted that, at the instant of birth, the heart's action is suspended, to be resumed a fraction of a moment later. Be that as it may, it is quite evident that the radical change in the plan of circulation produces a disturbance of equilibrium, resulting in a marked increase of blood pressure in some vessels with corresponding diminution in others.

The diminished pressure in the right auricle upon the ligation of the umbilical vein, tends to reduce the blood flow through the foramen ovale. Diminished pressure in the right ventricle would tend to encourage blood flow through the tricuspid opening. The increased afflux of blood to the lungs would diminish the current through the ductus arteriosus. The inflation and sudden congestion of the lungs, increasing the inter-thoracic pressure, is claimed by some to exert a special influence on the vessels at the base of the heart, favoring the occlusion of the ductus arteriosus. The early return of the pulmonic circulation, increasing the pressure in the left auricle, still further checks the tendency of the current through the foramen ovale and favors its early closure, at the same time increasing the pressure in the left ventricle, which now sustains, for the first time, the burden of circulation, with resulting rapid increase in the thickness of its walls.

The heart, undoubtedly, has imposed upon it increased labor in the new arrangement, which, probably accounts for the slowing of its its action noted by some observers.

Shortly after birth, the pulse rate may vary from 120 to 140 per minute, although the disturbance of rate by slight causes allows considerable latitude.

The arterial tension is low in early infancy, owing

partly to the relative large size of the vessels to the heart, and partly to their great distensibility. Before the age of six months the pulse is not always easily counted at the wrist. The child's position has little or no effect on the rapidity of the heart's action. It is usually less frequent during sleep, although at the same time less regular.

The rhythm, like the rate of the heart's action, is subject to great variation even in health.

Physiologists have held that the infant at birth 'had relatively less blood than has the adult, the ratio being 1:15, against 1.13 at maturity. The importance of a few grammes of blood, more or less, to the very young infant has not until recently been fully appreciated. It has long been recognized clinically that babies bear a loss of blood poorly, but the importance of saving, at the time of birth, some of the maternal blood that was lost with the placenta, has recently attracted attention.

The practice of waiting before severing the cord until all pulsation has ceased has been improved upon, it is claimed, by some accoucheurs who strip the cord towards the umbilicus, thus forcing its contained blood into the vessels of the infant before ligation. It is claimed that this procedure produces results in the early nutrition which are susceptible of clinical demonstration.

BLOOD.

During the first few days after birth the iufant's blood shows great variations in the size and shape of the cells as if the type were not yet quite fixed. The majority of observers also find a few normoblasts at this time. These are not invariably present, doubtless because in some children the blood at the time of birth is more developed than in others. The hæmoglobin is relatively high at birth and during the first few weeks of life. The high percentage is due not only to a polycythemia but to a genuine increase of hæmoglobin in the individual cells.

The following table from Cabot, of the blood of the newborn will show a great leucocytosis.
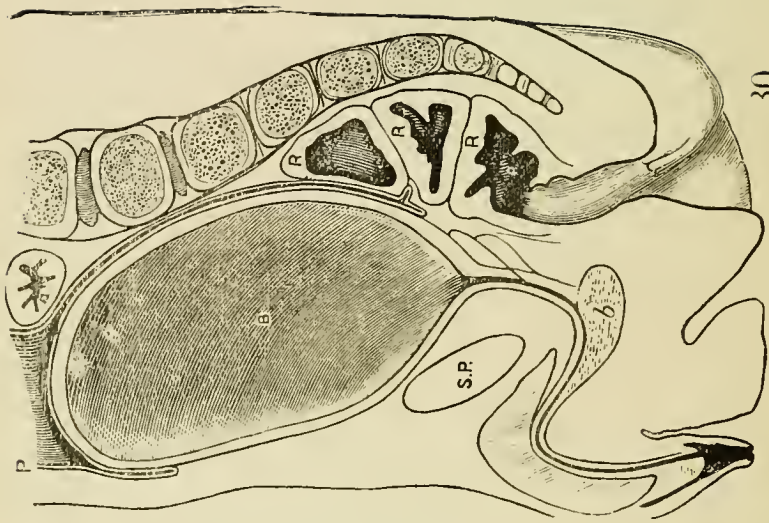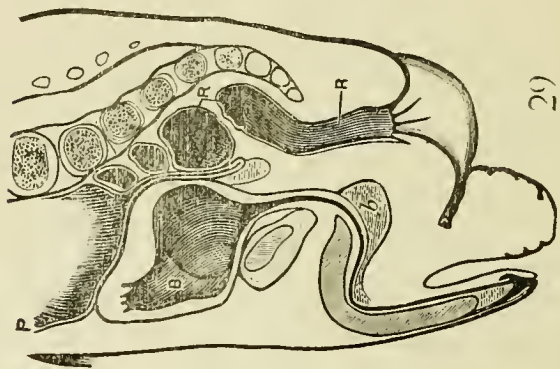
Fig. 29. SECTION SHOWING FOLDS OF RECTUM AT BIRTH. (SYMINGTON.)
Fig. 30. DISTENDED BLADDER IN INFANT OF 7 MONTHS. (SYMINGTON.)
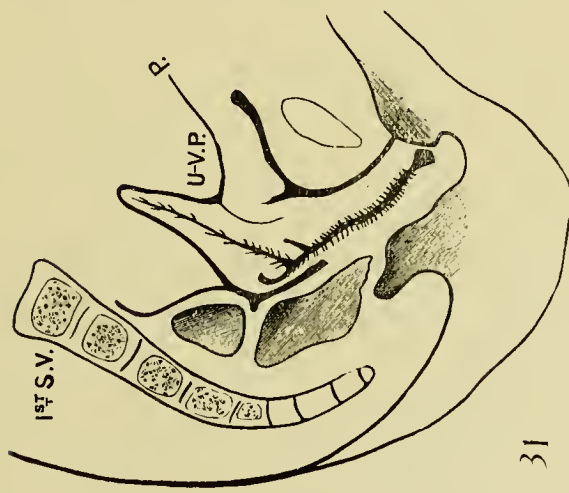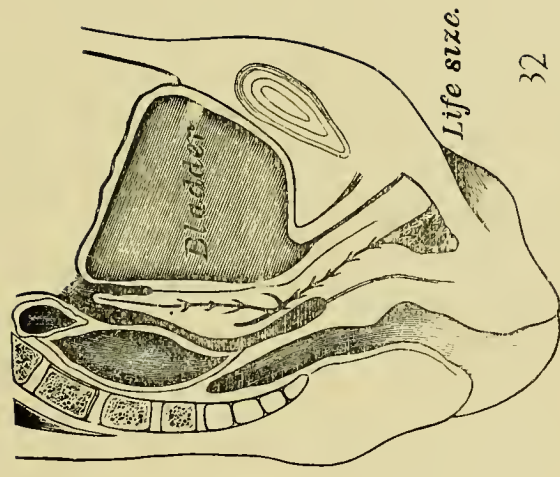
SECTION SHOWING RELATION OF BLADDER TO UTERUS.

Fig. 31. Empty Bladder in Infant of Two Months. Fig. 32. Distended Bladder in Infant of Fifteen Months. (Symington.)

At birth: Red cells, 5,900,000. leucocytes, 17,000 to 21,000; 26,000 to 36,000 after the first feeding.

End of first day: Red cells, 7,000,000 to 8,800,000; leucocytes 24,000.

End of second day: Red cells, increased; leucocytes 30,000.

End of fourth day: Red cells, 6,000,000; leucocytes, 20,000.

End of seventh day: Red cells, 5,000,000; leucocytes, 15,000.

This increase is explained by some as a combination of blood concentration with large digestion leucocytosis. Of the white cells there is a relative increase in the lymphocytes in healthy infants. It is stated that the amount of fibrinogen is small and that the blood of this period coagulates slowly. This is of interest in relation to the hemorrhagic diseases of the new-born.

During the first few weeks the characteristics of the blood of the new-born, viz. the increase in number and varying size and shape of the red corpuscles, the great increase in the white, especially of the lymphocytes, the high percentage of hæmoglobin and the high specific gravity gradually disappear. But always, in examining the blood of an infant, we should remember that the question of a normal condition of the blood must depend on the backwardness or forwardness of the infant's development. After the first few weeks the hæmoglobin and specific gravity sink to a lower level than in the adult, the percentage of hæmoglobin as low, even, as 60 to 80 per cent. in a healthy infant. It is suggested that the eosinophilia usually present may be connected with the great activity in bone growth. The marked diminution of corpuscular elements, hæmoglobin and specific gravity after the first week is presumably due to the increased metabolism incident to rapid tissue formation.

That the growth of different organs and increase of function is in direct ratio to the blood supply, is seen in the brain which receives its blood directly from the aortic arch through the great vessels of the neck, its relation to the left

heart being the most intimate. The same is true of the lungs. The liver, being supplied through the great portal vein securing, it is claimed, one seventh of the entire blood, would also illustrate this point. The rapid development of the lower extremeties keeps pace with the marked increase in size of the femoral vessels. So, too, as was mentioned in a preceding chapter, the long bones show complete ossification earlier at the extremities toward which the nutrient arteries are directed. It may be stated as an axiom that growth and function are in direct ratio to blood supply. As the latter not infrequently depends upon the muscular activity of the part the deduction is plain that restrained activity or interference with blood supply by any means retards both function and growth. In the care of the young infant too much stress can not be laid upon the importance of unrestrained freedom of motion for all the members and avoidance of anything that tends to compress the vessels, as long continued recumbency in one position, with possibly the addition of hypostasis in the dependent parts. In this respect, also, the clothing demands attention, that no bands nor seams may press upon the vessels of distribution or the return supply of blood, resulting in local deficiency or congestiou.

RESPIRATION.

From birth to death the oxygen necessary for the metabolism of the body is supplied through the alveoli of the lungs. From the cessation of the placental supply, life is sustained through oxygenation of the blood through the lungs. If any vital process is pre-eminent in its importance, it is that of respiration.

It has been demonstrated that young infants inhale more oxygen and exhale more carbon dioxide, relatively, than adults. This is a result, no doubt, of the more rapid tissue change in the growing organism. It is claimed, however, that when completely deprived of air, life is sustained for a longer period by the very young infant than by the adult. This should be remembered in our efforts at resuscitation of he asphyxiated infant.

Respiration, beginning with post-natal life, is, probably the least developed of the vital functions. Its want of vigor is partly due to the compressibility of the chest walls, to the lack of full development of the respiratory muscles, the yielding character of their points of origin and insertion, and partly to the narrowness of the upper air passages. Added to which we have the enormous thymus and obtruding liver and frequent abdominal flatus restricting respiratory movement. Fortunately for the young infant its respiratory process has no fixed type. It may be partly thoracic, unilateral, but generally it is abdominal, adjusting itself to the ever varying conditions of environment. Hence it is not strange that the rate and rhythm of respiratory movements are, in infancy, extremely variable. The average of many observations gives the rate from thirty to sixty per minute. A healthy infant may sigh or hiccough or exhibit Cheyne–Stokes type of respiration without evidence of any serious abnormality.

The ratio of respiration to pulse in the very young infant is so inconstant that it is of little value. The yielding character of the thorax, due to the large amount of cartilage in its structure, as well as the undeveloped state of its intercostal muscles, renders him very susceptible to disturbances by compression, so that great care should be exercised, not only in the handling of the infant, but also in the clothing, that no constriction of the chest be allowed. So care, also, of the nasal and pharyngeal tracts is necessary that no accumulations or growths interfere with the free access of air.

Inspiration is accomplished partly by the contraction of the muscles attached to the ribs, but principally by the contraction of the powerful muscular portion of the diaphragm, which, lengthening the vertical diameter of the thorax, causes the air to enter the glottis by atmospheric pressure. Expiration is due to the resiliency of the diaphragm, thoracic walls and lung tissue, as they resume their former position.

Since inspiration is the result of muscular contraction,

any circumstance that impedes, whether it be due to weight
upon the chest walls, abdominal distension, or partial oc-
clusion of the air passages, demands extra muscular exer-
tion.

TEMPERATURE.

The temperature in early infancy does not exhibit that
stability which is seen in later life, apparently trifling
causes producing great variations. Observers agree that
the rectal temperature of the new-born is from 99 to 100 de-
grees F., and that, within the first hour, it falls two or three
degrees. It fluctuates without apparent reason for a few
days, with a general average of 98 degrees. At the end of
the first week it is about 99 degrees, which may be taken as
the average normal during early infancy.

The variability of temperature in infants is not surpris-
ing when we consider the conditions, viz., the relatively
great radiating surface of the body, the dilatability of the
superficial capillaries and the thinness of their investments,
including the integument, also the undeveloped state of the
heat regulating centers.

The temperature in infancy, as in later life, shows a
cycle of diurnal oscillations which corresponds with obser-
vations in regard to the daily variation in the heart's action
and the older idea of fluctuation of the vital force. Most
observers have found the temperature to be the highest in
the afternoon and the lowest from 12 to 4 A. M. Rectal
temperature, as a rule, is the only reliable one, as in the
young infant the mouth can not be utilized for that pur-
pose, and the surface of the body, for reasons before stated,
shows a temperature two or three degrees lower than that
of the blood.

In view of the above mentioned facts. it would seem
hardly necessasy to warn the accoucheur against undue ex-
posure of the new-born to influences which lower the tem-
perature. Still, the practice of chilling the infant by un-
necessary exposure, even to the extent of subjecting it to
the plunge bath, is so common that it can not be too em-
phatically denounced.

It is suggested that a thorough application of warm oil to the surface, and the envelopment in warmed material, as soft wool, is more rational.

Keeping in mind the intra-uterine temperature from which the new-comer has emerged, the intelligent accoucheur will not neglect that of the lying-in room. The transition from 99 to 75 F. is certainly radical enough for stimulation of the respiratory and circulatory functions.

In his subsequent care it must never be forgotten that uniformity of the surrounding temperature should be maintained and the child protected from excessive radiation by clothing. Nothing is more appropriate for this purpose than wool, and as lightness is a desideratum, two thicknesses, or even three when necessary, are better than one containing the same amount of material. As before stated, clothing must not be allowed to interfere with freedom of muscular movement or of blood circulation. The evils of the pinning blanket, the restraining diaper, the tight abdominal and thoracic bands, of the padded closely enveloping wrap, the constricting sleeves and tapes and strings are too apparent to require prolonged criticism. The loading of the garments with embroideries, laces and useless decorations is hardly worthy of being denounced.

To secure the benefits of clothing, and at the same time freedom from their injurious effects, is a problem, the solution of which has been long sought. The ideal protection would seem to be afforded by a large blanket of light, flexible, non-conducting material enveloping loosely the entire infant below the neck, but his normal restlessness makes it difficult to keep him within the folds of this covering. A more definite garment, that can not be thrown off, while still allowing unrestrained freedom of necessary movements, is in use in the infant's wards of some of the hospitals of this and other cities. The garment is a bag, so constructed that it envelops loosely the entire body below the chin, closure being secured above by safety pins, and below by a draw string. (Fig. 78).

Additional protection against cold is afforded by

separate under garments, as a light knitted shirt, (c) of silk
or wool, free from seam or band, and one or more sleeveless
slips, (b) as occasion may require. The diaper should be light,
with no more material than is absolutely necessary for the
absorption of the discharges   Absorbent cotton, either
loose or in pads, preferably the latter, retained by a "T"
bandage of some firm material, secured by a safety pin, has
been found to meet all the requirements.   In exceptional
cases some departure from the simplicity to the above may
be desirable.
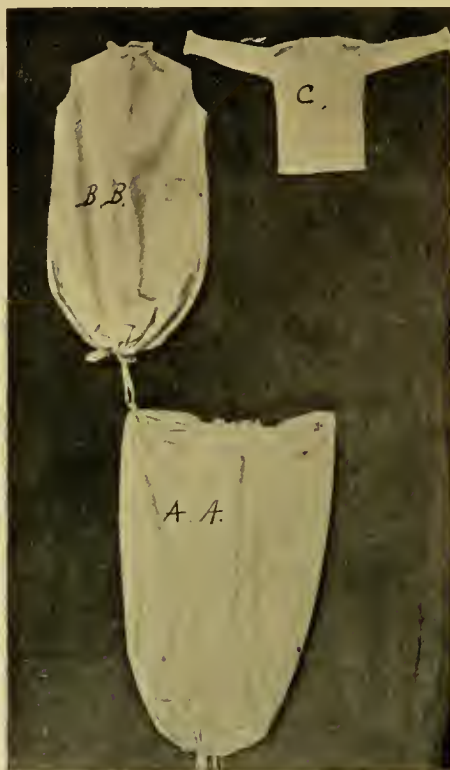
ALIMENTARY CANAL.

The labial and buccal glands of the new born secrete mucus which serves for protection. The salivary secretion is established but feebly, especially in the parotid. The physiological properties of this secretion at birth have been a
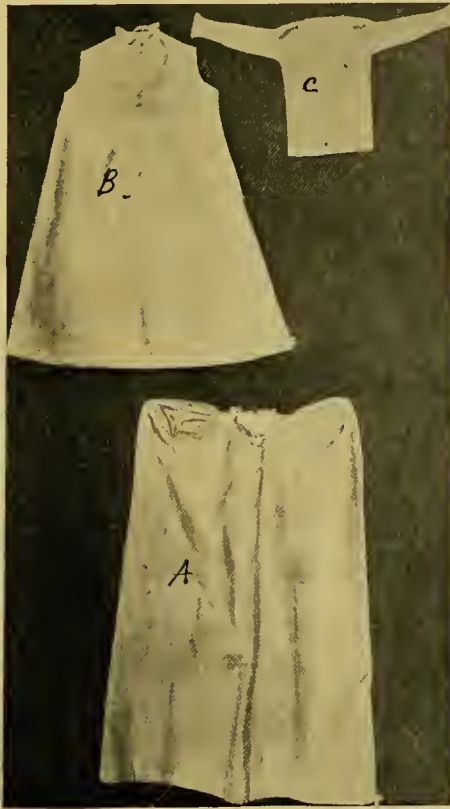
subject of extended investigation and animated discussion. It seems to be established that the saliva possesses very slight, if any, amylolitic power, on acconnt of the]small amount of ptyalin at this early day.

At birth the gastric glands secrete pepsin in very small

quantity. Free hydrochloric acid is not found. Lactic, which is mentioned as the principal acid of the infant stomach, is found only after the ingestiou of milk. The mucous follicles secrete freely. The stomach at this early age is usually cousidered more as a receptacle for food than as a digestive organ, coagulation of albumen, by the rennet ferment representing nearly the whole extent of digestion accomplished in this viscus. It is claimed, however, that a considerable amount of fat is absorbed from its surface, through the agency of the lymphoid corpuscles, in which the stomach is particularly rich at this period.

The duodenum exhibits, besides the intestinal juices, the secretions from the liver and pancreas. The importance of the liver as a digestive organ has long been recognized, but much difference of opinion in regard to the exact role played by its secretion still exlsts.

"The bile of the new-born is distinguished by its poverty in the inorganic salts, (with the exception, however, of iron salts) its poverty in cholesterin, lecithin and fat, and particularly by the small percentage of special bile acids."—Jacubowitch. If the above is true it would seem fortunate that the young infant is well supplied with lymphoid tissue, whose corpuscles are supposed to aid iu the absorptiou of fat.

The paucity of bile acids, it is said, allows a more complete action of the pepsin and pancreatic secretion, which is usually retarded in the presence of these acids. It is believed to-day that the bile has little, if any bacteriacidal property.

Of the pancreatic secretion, it has been shown that three of its ferments are present at birth, viz., trypsin steapsin aud a milk curdling ferment. No amylolytic action has been demonstrated, although its proteolytic and liptolytic ferments are unquestionably active. It is thus seen that digestion is carried on to the greater extent in the duodenum and small intestine.

No bacteria are found in the intestine or contents at birth. However, within twenty-four hours, two varieties,

at the least, are found in great abundance, viz., bacterium lactis ærogenes in the small intestines and bacterium coli commune in the large intestines and feces. Shortly after birth, and sometimes before, meconium is discharged. This continues until the feces are changed by the ingestion of food.

Meconium is a viscid, tarry colored, odorless substance, feebly acid, containing no bacteria. According to Foster, it is composed of intestinal mucus, bile, vernix caseosa, epithelial cells from the epidermis, hair, fat-globules and cholesterin crystals.

<center>URINE.</center>

The size and complete development of the kidneys at birth would suggest a somewhat prolonged previous function. The finding of the constituents of the urine in liquor amnii is evidence of their eliminative activity. Urine is normally present in the bladder at birth and is usually voided within a short time, any delay beyond twelve hours occasioning some anxiety. The first urine voided is clear and of a pale amber color, unless long retained, in which case it is dark and cloudy. Its specific gravity varies from 1,012 to 1,005, and the reaction is acid.

A frequent marked peculiarity in the new-born is the presence of uric acid crystals, so abundant sometimes, as to form infarcts in the straight tubules of the kidneys, even to the extent of their complete occlusion.

Traces of albumen and hyaline casts occasionally appear. Urea and inorganic salts are not found in large amounts during the first week, hence the low specific gravity. The quantity of urine in the first twenty-four hours varies from nothing to two ounces. With the ingestion of fluids there is a corresponding increase in the amount voided; so that by the end of the first week it may range from five to thirteen ounces daily. Because of the small size of the bladder and the lack of inhibitory control of the sphincter, micturition is frequent at this age, often thirteen to fifteen times in twenty-four hours.

The delicate skin of the infant demands constant care to prevent irritation and excoriations about the buttocks, from the urine and feces. It seems hardly necessary to remark that the napkin should be removed as soon as it is soiled.

SKIN.

The part played by the integument in the animal economy is such as to necessitate great activity in its growth and repair. Hence it is not surprising to find that it has the most abundant blood supply, with the greatest glandular activity. The skin of the infant is thin, delicate, velvety to the touch, and elastic to accommodate the varied movements. Its thinness and numerous capillaries give to it the characteristic pinkness of infancy. It is evidently well prepared histologically for the enormous growth made necessary by the constant attrition and expansion.

The projecting portions of the nails, on account of earlier production, show a brittleness that soon causes separation from the newer portions. Disappearance of the laungo, and exfoliation of the primitive epidermis begin with the exposure to the air, and continue throughout the first two or three weeks. During this time the stump of the umbilical cord separates from the surface of the abdomen, by a line of demarkation, leaving a cicatrix, occasionally denuded of epithelium.

SEBACEOUS GLANDS.

The function of the sebaceous glands, active from the middle of intra-uterine life, continues after birth, hence unremittent care is required to prevent accumulations, especially on the scalp. If crusts are once formed, frequent oiling may be necessary to soften them. Too frequent use of strong soap and water, as well as friction, should be avoided.

SWEAT GLANDS.

The sudoriferous glands are inactive at birth, and perspiration is not usually seen during the first weeks.

LACHRYMAL GLANDS.

The function of the lachrymal glands is not as a rule

established at birth, tears usually making their appearance about the third month.

NERVOUS SYSTEM.

In regard to the functions of the nervous system, it may be said that at birth the infant is merely a bundle of reflexes, although its reflex excitability lacks the intensity shown in later development. The most authentic information we have on the subject of nervous phenomena during early periods is derived from the observations of Preyer.

SIGHT.

It appears that, although the eye is complete in formation at birth, the infant has but feeble vision It is evident from the play of features, that a difference in the intensity of light is appreciated before the end of the first day. On the second day the eye is quickly closed on bringing a candle flame near.

HEARING.

The sense of hearing is probably not present at birth, but is established within the first day or two, as the tympanum fills with air and the congestion of its mucous membrane subsides.

SMELL.

In all probability smell is the last of the special senses to develop.

TASTE.

The sense of taste is evidently well developed from birth, the young infant readily distinguishing milk from water.

TOUCH.

Tactile sensation is very acute in the lips, tongue and eyes, although feebly developed in other areas. Many reflexes as respiration, peristalsis, swallowing, winking, coughing and sneezing exhibit a remarkable pre-natal development of mechanism.

RESUME OF THE CARE OF THE NEW-BORN.

From the foregoing it is evident that the new-born is

entirely at the mercy of his surroundings.   In fact, of all
the mammalia, the human infant is the most absolutely
helpless.   A few more words concerning his care would not
be out of place.

The first duty after delivery is to see that his respira-
tory passages are free from obstruction, either from com-
pression or accumulation of secretions.   The larynx may
be freed from tenacious mucus by the finger wrapped with
a dry piece of cloth, or by a catheter or canula properly
curved. (Fig. 67.) The eyes should be cleansed from secre-
tions by washing with pure water or boric acid solution.
The child should be received in a warm dry blanket and the
surface annointed with warm olive oil or lard.   The cord
may be freely dusted with boric acid and covered with dry
absorbent cotton.   Placing the baby on the right side pre-
sumably favors the closure of the foramen ovale, and pre-
vents undue pressure from the heavy liver, in which posi-
tion he may be left undisturbed for half an hour or more.
After this the thoroughly emulsified vernix caseosa is easi-
ly removed by further inunction and gentle wiping with
soft gauze.   The navel dressing should be retained by a
light flannel abdominal band, the simple garments adjusted,
and the child laid in a warm dark place for necessary re-
pose.   It is well to administer at this time a teaspoonful or
two of warm sterilized water.

Too much stress can not be laid upon the avoidance of
all that tends to shock or fatigue, and the observance of ab-
solutely antiseptic details.

It is advisable to place the infant at the breast within a
few hours after birth (the nipples and mouth having previ-
ously been cleansed with boric acid solution) as it is be-
lieved that the colostrum at this time is adapted to the needs
of the infant's digestive tube.

It must always be remembered that an infant's needs
are few but imperative.   Warmth, food and repose.   He
should be disturbed only when necessary for his daily in-
unctions, change of clothing, care of eyes, mouth and nose,

for fresh napkins or for drink.   He should be put to the breast every two or three hours during the day and once at night.   The practice of allowing the child to sleep by the side of the mother should not be encouraged.

CHAPTER VIII.

PHYSIOLOGY AND HYGIENE OF THE PRE-MATURELY BORN.

It is only in recent years the subject of the care of the prematurely born has engaged the attention of the profession.   Formerly it was the accepted belief that the majority of infants born four to eight weeks before term were insufficiently developed to survive.   In fact, this opinion was the logical outgrowth of the high rate of mortality at this age.   The exception to the rule was seen in an occasional survival, evidently the result of unusual care in management.

The picture presented by the infant after seven months of intra-uterine gestation is certainly not encouraging, and it is not strange that he is often laid away as unworthy of any effort at preservation.   The respiration is shallow, irregular, frequently suspended for long intervals and coming at times in gasps.   The breath is sometimes cold as of one dying from ex-sanguination.   The heart's action is reduced at times to an almost imperceptible flutter, no wave being apparent in the arteries.   The absence of subcutaneous fat (a deposition of the later weeks of gestation) gives the appearance of extreme emaciation, the muscles showing like strings under the pallid integument.   The nails are undeveloped and the integument on the dorsal surfaces is covered with lanugo.   The eyes are sealed with a gummy secretion, the hair extends low on the forehead, the bones of the head are widely separated and very compressible in their membranes.   These conditions with the feeble wail, or even absence of cry, and the almost motionless limbs, present a

contrast to the normal infant which may afford some excuse
for the lack of attention previously accorded this class.
(Fig. 65).

Fig. 67.

The idea of the incubator or *couveuse*, wherever origi-
nated, was brought to the attention of the public by Crede
and Tarnier, who reported great saving of life by this
means; the former having a mortality of but 18 per cent.and
the latter of 33 per cent. However, Crede would not accept
infants that weighed less than five and one-half pounds,
while the limit placed by Tarnier was four pounds. The
reports of these observers established the fact that lack of
full development at birth was not necessarily an obstacle to
survival and growth. The incubator, whether of the sim-
ple primitive type employed in the Leipsic Maternity by
Crede, or the intricate, complicated device of the present
day, has, for its purpose the fulfillment of the hygienic
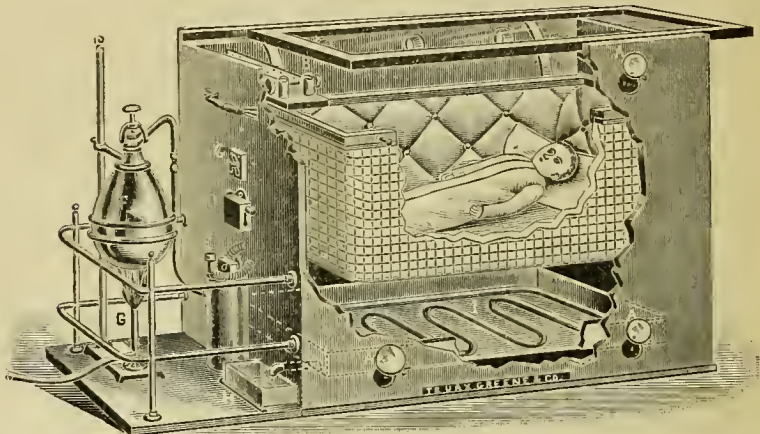
Fig. 68.

principles enumerated in the preceding pages, namely, avoidance of shock, mainténance of warmth and the supply of pure air. (Fig. 68).

In the *couveuse* a temperature of from 88° to 98° F. is maintained by hot water which may be introduced between the double walls of the apparatus, or through coils of pipe, or by flasks of hot water placed in the false bottom. The nude infant rests in the upper portion on soft wool, covered with the same, light being excluded by a lid. Air is supplied through an opening in the bottom, escaping through another at the top. The more elaborate apparatus includes a thermometer, a gas jet for maintaining the heat, a thermostat for its regulation, mechanism for regulating air supply, and scales for weighing. In the absence of the *couveuse* most excellent results may be secured by the exercise of a little ingenuity, with a padded clothes basket, hot water bottles, a pound of wool and a blanket. This is suggested because of the extreme importance of the *immediate* application of these principles, as even a temporary delay may allow a reduction of temperature that will endanger life.

As close an approximation as possible to the conditions existing before delivery is the object sought, with the substitution of air and food. The former, without doubt, must be pure, warm and moist. The food must be of the character and administered in quantities best adapted to the immature digestive tract. Milk sugar solution is well borne, and furnishes heat. Fats are absorbed in smaller quantity and proteids are tolerated in extremely reduced percentage. A generous supply of water should not be overlooked. It has been suggested that the urine be watched for uric acid as an indication for the reduction of proteids in the food. For the purpose of nutrition and to prevent desiccation, daily oiling should be practiced, when not found irritating to the skin.

The disturbance incident to nursing and the usual inability to nurse from muscular weakness, puts breast feeding out of the question. The breasts should be pumped

regularly (Fig. 69) and the milk given by a spoon or feeding tube, preferably the latter, until the infant has gained sufficient strength to use the nipple. This tube is so con· structed that compression of the bulb forces the fluid through the small nipple into the infant's mouth. (Fig. 70). Small quantities, sometimes not exceeding a gramme, should be given hourly, keeping in mind that errors are usually on the side of overfeeding. Failure to observe this point may induce regurgitation of food or even cause death from embarrassed heart action.

Fig. 69.　　　　Fig. 70.

It is generally accepted that the size and vigor of a full term infant bears a direct ratio to his chances for survival and rate of growth. This is no less true when applied to premature infants. Some babies at full term are born to die, notwithstanding the best of attention, the full forty weeks of gestation failing to provide sufficient vigor for the maintenance of their vital functions. It is hardly reasonable to suppose that their chances would have been improved by premature delivery.

Reference has been made in the preceding chapter to the burden imposed upon the heart at birth, as seen in its

uncertain, irregular action. It is not surprising that at this earlier stage of development, the heart should be less well prepared to assume the burden of systemic circulation. In fact, there is imminent danger from syncope from the slightest disturbance. To guard against this the horizontal position must be maintained, reducing the work of the heart to the minimum of physiological requirements. It may be even necessary to administer alcoholic stimulation in appropriate doses. The continued use of brandy with the food at this time has the sanction of the highest authorities.

As to the respiration and pulse no definite ratio has been recorded. It is seen that the management of the premature infant requires constant watchfulness and extreme care as to details. By regular weighing and by watching the discharges we obtain evidence as to his condition, which may serve as a guide for the amount and character of the food.

It is not unusual, when nutrition is well established, to find the temperature of the premature ranging higher than that of the full term infant, which would seem analogous to its incompleted intra-uterine existence, when growth and development are seen at their highest.

If evidences of satisfactory progress appear in continuous weight gain, improved respiration, steadier heart action, undisturbed digestion, accompanied by rotundity of figure and livelier movements, a cautious reduction of temperature may be attempted, and he may be gradually accustomed to the light and to the environment and hygiene of the newborn at full term.

CHAPTER IX.

PHYSIOLOGY AND HYGIENE OF THE FIRST YEAR.

In order to diagnose pathological conditions in infancy or to differentiate between abnormalities of functions it is essential that the physician have a definite knowledge of what constitutes *normal* functions.

Upon reflection it will be seen that this is no simple matter as through the period of development not only are organs growing but their separate and co-relative functions are developing.

At first view these constantly changing relations appear almost kaleidoscopic but patient observation begins to show results in the form of some definite facts. That some functions are developing earlier than others has been apparent. That some mechanisms reach their complete perfection as to histological structure while others are still in the formative stage has of late been amply demonstrated. Thus Schiller's observations on the motor-oculi nerve show the perfection, not only of its mechanism, but also of its function at an early period of infancy. This illustrates the method of growth in so much that this mechanism furnishes one of the channels of information before the higher centers are capable of utilizing it, the process being an educational one. Thus it is seen that all the special senses contribute to the development of the higher centers from which comes the evolution of ideas, these (special senses) in turn having been preceded by the lowest form of nervous phenomena, viz., reflex action.

The nervous system of the infant shows well developed sensory and motor tracts, but the inhibitory power of the higher centers is tardier in its growth.

We have seen that taste and smell, also tactile sensibility, especially of the lips and tongue, are the first of the special senses to show activity; fortunately, as these three are necessary in the instinctive efforts of the young to obtain sustenance.

Hearing, although demonstrated as present in the first

twenty-four hours, is not developed sufficiently to differenti-
ate between the mother tones or the sounds accompanying
the preparation of food and other noises irrelevant to the
infant's daily requirements, before the end of the third
month.

Contemporary with the function of hearing is that of
vision.   Although sensitiveness to light and blinking on the
near approach of objects has been observed from the first
weeks, still it is not until the end of the second month that
the infant may recognize his mother by sight.

From birth the grasp of the hand upon any object
touching the palm is remarkably tenacious and the normal
position of the fingers is that of extreme flexion.

We have seen that voluntary muscles show movements
which are purposeless, irregular and asymmetrical, and sug-
gestive of the mere continuance of the intra-uterine exist-
ence.   Co-ordinate, voluntary movements are first seen in
the face and upper extremities, the hands in addition to
grasping showing prehensile propensities by the end of the
third month. Objects are carried to the mouth at about this
time.   The many ineffectual attempts to locate the mouth
indicate the vast amount of energy necessary to develop co-
ordination.   Although the apparatus including muscles and
nerves, both afferent and efferent, is fairly complete it is
seen that multiple repetitious of sensations, impressions,
volitions and efforts at volition must occur ere the establish-
ment of perfect co-ordination for the performance of the
simplest voluntary motion.

The early cry of the infant may be said to express noth-
ing more than the degree of physical vigor indicated by its
intensity and volume.   It is not until about the end of the
third month that the cry is recognized as expressing emo-
tions such as anger, hunger, pain and the articulate sounds
indicative of pleasure.   The transition from cry to voice de-
pends upon the co-relation of larynx, mouth and tongue.
About this time tears are observed to accompany the crying.
It is interesting to note that prespiration is not common be-

fore the end of the third month.   Exceptionally the appear-
ance of these two secretions has been observed at a much
earlier period.   The salivary glands, also, seem to develop
activity, drooling being a marked feature after the third
month.

It is claimed that the saliva at this time possesses the
power of starch conversion to a limited degree.

Following the development of the senses of sight and
hearing to the extent of differentiating as to the color and
size of objects and the quality and direction of sound, we
find co-operation of the muscles of the neck to a degree
that the infant's head is held erect, balanced and turned
at will.

Although at birth well supplied with sensory apparatus
and well developed tactile corpuscles, sensitiveness, with
the exception of mouth and lips, is dull in the young infant,
or rather, slow to respond to irritation; the association
paths of nerve force not yet having become established by
frequent repetition of impressions.   After the third month
sensation is generally well developed over the entire body;
the forehead and external auditory meatus, it is said, being
particularly sensitive.

From the eighth to the tenth month the infant should
sit without support and soon develop automobility as seen
in creeping, rolling or hitching toward desired objects.
About this time he usually utters a few indefinite sylables,
singly or repeated; as, pa, ma, go, goo, etc., etc.

By the twelfth month he shows a disposition to get up
on his feet, is usually able to stand by a chair or with
assistance and exceptionally may walk alone at the end of
the first year.

Infants exhibit a marked variation as to the time of the
development of these different requirements, depnedent
largely upon muscular vigor, education and family tend-
ency.   A child left much alone will learn to develop earlier
his resources.

During the first six months of life the respiration con-

tinues superficial and irregular, auscultation giving a soft indistinct murmur because, for want of inspiratory vigor the air does not fully expand the alveoli. The rate]has been variously stated from twenty-five to thirty-five or even higher in the earlier months.

The pulse rate averages from 120 to 140, is somewhat slower during sleep, and shows no dicrotic wave.

During the earlier months the temperature exhibits a tendency to fall below the normal. Pyrexia is frequently the result of trivial causes. The eruption of the teeth at this period often occasions an elevation of three or four degrees.

The urine increases from about six ounces at the end of the first week to eight or sixteen ounces at six months. Considerable variation is noticeable, however, dependent upon the secretions from the skin and bowels and the amount of fluids imbibed. The marked tendency to micturition is variable from causes not well understood, occurring sometimes every hour during the day and twice or thrice at night, while at other times several hours may elapse without urination. The urine is usually light in color, of low specific gravity, 1004 to 1010, rarely staining the diaper in health. The inorganic salts (phosphates, chlorides, and sulphates) increase in quantity as age advances and urea is more abundant, dependent somewhat upon the amount of proteids ingested. Sugar sometimes appears in the urine of infants in the early months, the result, it is believed, of an excessive amount of saccharine material in the food.

The fecal discharges after the first few days are an orange yellow, frequently turning to green on exposure to air, are of the consistency of batter and homogeneous throughout, inoffensive but of somewhat sour odor and slightly acid reaction. The fæces contain about eighty-five per cent of water and average from three to five movements daily. These characteristics vary somewhat with the quality of food taken and the completeness of the digestive process.

The stomach of the infant at birth was found to be little more than a receptacle for food in which the action of rennet coagulating the milk, prepares it for the first step in the digestive process. The absence of bacteria renders less important the want of hydrochloric acid secretion at this stage, its place as a digestive acid being taken by the feebler lactic acid evolved from the food.

As the infant grows the capacity of the stomach increases rapidly, its walls thicken, the gastric glands develop at the expense of the mucous follicles and lymphoid tissue, so that fat absorption is relatively less free and pepsin and hydrochloric acid secretions gradually become more abundant. These changes, it is evident. increase the importance of the stomach as a digestive organ.

During the latter half of the first year we find the stomach emptying itself of a digested meal in two or three hours; the time depending upon the quality of the food taken, cow's milk requiring the longer time.

The various complicated changes in the food during digestion have been described by physiologists under different names, both as to processes and products, resulting in much confusion of ideas. According to Kirke, the food is first changed into parapeptone or acid-albumin; the next step results in propeptones or albumenoses; the third or final step is represented by the diffusible peptones, the finished product of gastric digestion. The latter process, however, applies only to a limited portion of the stomach contents, for in the infant the food soon escapes because of active peristalsis and unguarded pylorus; early relaxation occurring from the easily exhausted muscular structure. A portion of the water, milk-sugar, fats and salts are absorbed from the surface of the stomach directly into the blood.

The bile, by neutralizing the acidity of the chyme as it emerges from the pylorus, favors the process of pancreatic digestion, which is active only in alkaline media. As we have previously observed the pancreatic secretion in the newborn showed proteolytic action(the power of digesting albumi-

noids), liptolytic action (the power of reducing fats) and the presence of milk curdling ferment; but the amylopsin (the starch digesting ferment) was wanting.   It is claimed that although a trace of this ferment has been found as early as the second month it is not present in sufficient quantity to exert much influence on starch until toward the end of the first year.

The importance of the different times of development of these active agents in the pancreatic secretion is evident in its relation to the different constituents of food acted upon, because it suggests the varying quality of aliment demanded by the child at the different stages of his growth.

A striking analogy is seen between the gastric and duodenal digestive processes; the pancreatic juices exercising in alkaline media functions quite similar to those of the gastric juices in acid media.   It is a common error to assume that the stomach is responsible 'for a certain completed change in the ailment, converting it into a substance called chyme, wholly unlike that ingested, and that secondarily the duodenum further changes this chyme into a totally different substance, known as chyle, in which form only, absorption is possible.   The facts seem to be that digestion in its entirety, does not begin with the stomach and end with the ileum; but that this process, accompanied by absorption, begins and ends in the mouth, in the stomach, in the duodenum and, throughout the alimentary tract.   The saliva, which is known to act, not only in the mouth but in the stomach as well, proceeds with its conversion of starch until rendered inert by the presence of hydrochloric acid, a period of from fifteen to forty minutes.   The amylopsin from the pancreas acts similarly on the starches later on in in the duodenum.   The milk curdling ferment of the stomach coagulates albumin in the acid media, while that of the pancreas is acting similarly in an alkaline media. The pepsin of the stomach, after the action of the HCL., converts acid-albumin into peptones.   The trypsin of the pancreas, after the action of the bile, converts alkali-

albumin into peptones. In this manner the changes proceed throughout the small intestine, absorption taking place wherever and whenever the histological structures of the digestive tube and the character of the adjacent aliment favor that process

That a very large percentage of the aliment is absorbed in the normal infant normally fed, is shown by analysis of the fæces. Their physical characteristics have been already described. As a result of his observations upon infants fed wholly upon milk, Escherich states that the fæces cousist of 84% to 86% water; that digestion and absorption of proteids in the alimentary canal are so efficient that but little is lost; that the whitish flakes and clots, nearly always seen, are composed largely of fat and fatty and lactic acids in combination with lime; while colesterin, traces of bilirubin, intestinal epithelium and mucus may also be detected. In addition large quantities of bacteria are always present; a fine slender bacillus, named by this author the bacterium lactis aerogenes and the polymorphic bacterium coli commune being the two chief kinds. Milk acids are always found and to their presence should be attributed the acid reaction. Fermentation of milk-sugar leads to the development of carbon-dioxide and hydrogen, which are the principal gases in the intestinal tract of an healthy infant fed purely on milk, foul smelling gases being conspicuous by their absence. Though the amount of fæces varies much in sucklings yet three per cent. of the milk ingested is the average proportion.

It is by the study of the digestive processes at different periods that we may hope to solve the problem of physiological feeding. To him who would not only secure the highest results in infant nutrition, but also determine some of the questions as to the etiology of digestive disturbances with their intricate pathological sequelæ, the study of the physio-chemics of digestion will be fraught with interest.

Nature is proverbially forbearing and pardons many gross violations of her laws; but he who follows persistently
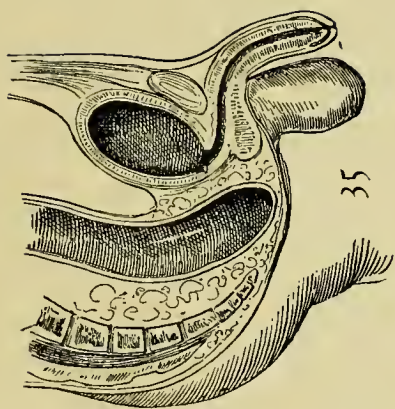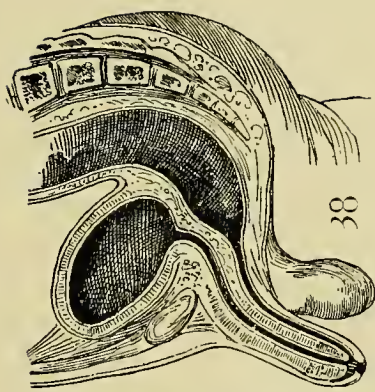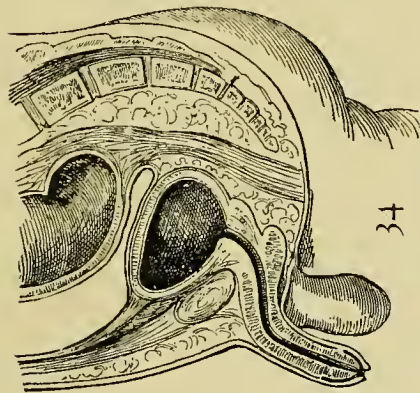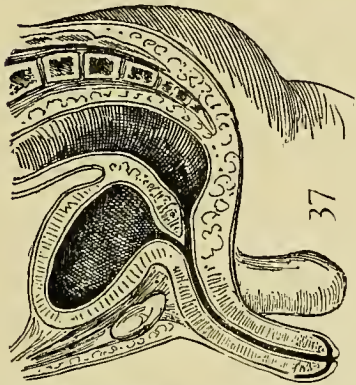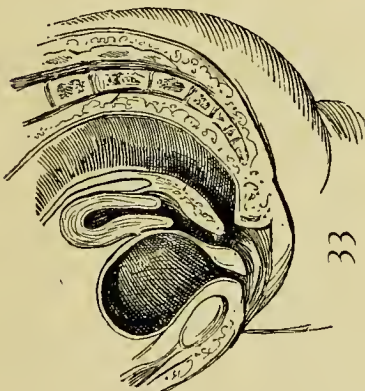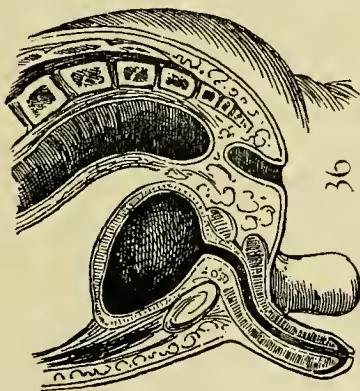
FIGS. 33-34-35-36-37-38. DEVELOPMENTAL ABNORMALITIES OF RECTUM. (KEATING.)

FIG. 40. DISSECTION OF NEW BORN, SHOWING DILATED STOMACH DISPLACING LIVER, AND APPENDIX VERMIFORMIS BENT UPON ITSELF.

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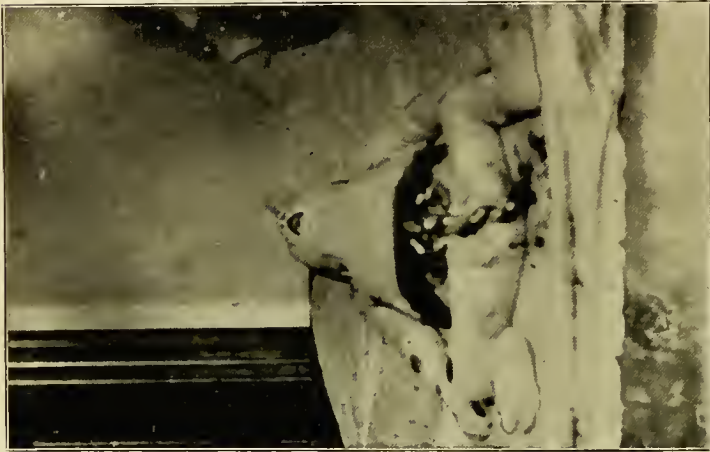
FIG. 39. DISSECTION SHOWING EXTENT OF LIVER AT BIRTH.

39

any course of procedure contrary to her teaching, ultimately meets with merited failure. It is true that much remains to be learned concerning the processes of digestion. assimilation and nutrition, but our confessed ignorance in regard to certain ultimate processes, affords no excuse for our gross disregard of the knowledge already obtained. We must feed with due reference to the physiological demands of the period or stage of development of the growing organism.

CHAPTER X.

HYGIENE OF THE FIRST YEAR.

(Continued).

We have given considerable time to the study of infantile anatomy, and to the consideration of physiology, sufficient, it is hoped, to at least lay the foundation for the study of the phenomena to be observed in early infancy. That the purpose of this method of study may be more apparent, we will take up the subject of hygiene of the infant at this period. In fact the ultimate purpose of our study should find its consummation in the establishment of some general principles or rules of management, by the application of which we may secure to the infant all the best conditions required by the peculiarities of his organization.

Man, as a finished entity, furnishes a study of great complexity as to his physiologic and hygienic requirements. How much more intricate, then, must be the problem as to the requirements of the independent and co-related 'processes, during the ever changing phases of the transitional periods of infancy. Hygiene, in its broadest sense, embracing all that pertains to the environment in its relation to the present and future well-being of the infant, demands a fairly comprehensive knowledge of a great number of widely different subjects.

Thus, to a knowledge of general anatomy, physiology, histology, morphology, biology, chemistry and physics, in

their special application to early life, must be added a
familiarity with the general principles of physiology,
heredity, evolution, climatology, dietetics and culinary
science. It may be objected that the requirements here
enumerated are too extended, or that the subject is pre-
sented on too grand a scale. However, the scale of require-
ments appears insignificant when compared with the
grandeur of the possibilities of one infant life.

To the objection that no mother or guardian may com-
pass these requirements for the purpose here given, the
reply would be the citation of instances in which mothers
have done this and more, and that it is to be hoped that
these special accomplishments may become general. There
is no doubt that the coming ideal mother will eventually
rise to these, at present, ideal requirements for the care of
her infant. The widely prevalent lack of such preparation
on the part of mothers, only emphasizes the importance of
the physician's increasing his information in all that per-
tains to this subject. This, as advisor and scientific referee,
he should do to the extent of all available knowledge on
these and correlated subjects.

Among all the obstacles to be overcome, two things
particularly stand in the way of the application of the
principles of hygiene of infancy. First, there is a want of
information on the part of the physician, or a disinclination
to apply his knowledge. Second, the unwillingness of the
mother to be guided in this respect. These two conditions,
by acting and reacting, each upon the other, establish a
"vicious circle." Two erroneous conclusions have taken
firm hold of the lay mind, and to some degree of the pro-
fessional mind also. One is, that the maternal instinct
endows the mother with a knowledge that is sufficient for
all the requirements of the infant, (affection versus
science); the other is, that the representative of science,
however highly endowed, knows but little of the require-
ments of the babe, because of its inability to furnish verbal
information.

That these are not merely fanciful obstacles to the application of scientific hygiene, the consciousness of every experienced practitioner will bear out, and the enthusiastic young reformer should be cautioned against being too sanguine of their immediate overthrow.

These grossly palpable errors, among a host of others, will present themselves in a great variety of forms and modifications, at every turn and in most unexpected places. It is a question whether any crusade against practices or observances entrenched in erroneous belief and fortified by repetition will avail much. Repeated unostentatious demonstrations of the utility of sanitary hygiene and of the value and applicability of special scientific knowledge are the only arguments that will prove effective in bringing the lay mind in accord with that of the physician. The establishment of absolute confidence in the physician's ability and especial fitness will depend upon his successes as demonstrated by results.

The absolute wants of the infant are few and simple, and may be expressed in two words—protection and food. The relative wants, which are the outgrowth and elaboration in detail of the former, are numerous and complicated, since many new wants are created in our efforts to supply those which already exist.

PROTECTION.

The infant must be protected from shock, to which he is peculiarly susceptible. Normal functions, as, for example, digestion, may be arrested or perverted through shock alone. It may occur from sudden changes of temperature, from noise, from blows or jars, from unaccustomed motion, from fear or anger, from intense light and from excessive or prolonged pain.

He should be protected from fatigue of the muscles, due either to excessive use or prolonged restraint, from protracted crying and from efforts to overcome obstructed respiration.

Protection should be secured from infectious or irritating substances which may be introduced into the cavities of the body; from such irritations of the surface or mucous membranes as are caused by accumulations from bladder, bowels and sebaceous follicles, or from extraneous matter, as strong soaps, corrosive substances and rough clothing, also from rough handling as in bathing, and finally from traumatisms with or without infection, as falls and blows especially on the head, bites of insects, scratches or abrasions from pins or neglected nails.

He also needs protection from air contaminated by exhalations from other people, or by gases from defective heating apparatus, sewers, cess pools, garbage or accumulations of filth, from decomposing vegetable matter, as from swamps or from filthy streets and alleys; from flies, not only because annoying but as carriers of infection; from household pets, as cats, dogs, rabbits and poultry; from contact with colored picture books and garments; from promiscuously laundried clothing and bedding and from general refrigeration or a lowered temperature of a single part, as cold hands or feet.

The above enumeration suggests a few of the many agencies through which normal metabolism and growth may be disturbed. That all these items should be carried in the mind of the nurse, and the infant properly protected in unspecialized environment, is practically impossible. The multiplicity of needs viewed from the above standpoint, not to mention the item of regularity in feeding, bathing, sleeping etc., makes an imperative demand for a systematic *regime*. This can only be secured by means of a separate nursery in which the means to the end are under full control.

The room selected for this purpose should be remote from those in daily use by the family. It should receive direct sunlight during some portion of the day; should be of sufficient size to secure ventilation without noticeable drafts; finished and furnished with special reference in the

minutest detail to antisepsis, []hence ·carpetless, except for
rugs that may be aired daily, curtainless so far as heavy
and unchangeable materials are concerned, devoid of mould-
ings, pictures and fixtures which invite lodgment of dust. The
walls should be painted to permit of thorough cleansing with
water or antiseptic applications. There should be double win-
dows to protect against drafts and to diminish direct radiation,
with a system of heating and ventilation which is under abso-
lute control. A thermometer is a necessary fixture. It is desir-
able to maintain an even temperature of from 75 to 80° F.
during the first weeks, after which time until the child is
three months old about 75 degrees is recommended. After
that it may be gradually lowered to 70 degrees. In emer-
gencies, such as the failure of the heating apparatus, or in
extremely cold weather, the use of heat by bottles or flasks
placed in the crib should be resorted to.

Closets, cupboards or wardrobes should have no con-
nection with the nursery, nor should the family bath room,
and plumbing should be omitted. In fact, the room should
contain nothing save the furniture and articles indispen-
sible for the care of the infant. The crib should be of
metal, of simple construction and fitted with noiseless
rollers. The mattress should be filled with selected hair
and if any pillow is used it should be a very thin one of the
same material. The bed should be protected by a rubber
sheet and pad and the covering should be of light wool.

The different articles necessary in a nursery are a
noiseless clock; a shaded gas light or wax taper; a bath tub,
flexible rubber (Fig. 71) prefered; a bath thermometer (Fig.

Fig. 71.

7 2); scales (Fig. 73) and measuring rod; a double ewer; soap
dish; soft towels and wash cloths of gauze, as sponges are
liable to be neglected; powder box, puff ball omitted; soft

hair brush and diapers.   A light, high, folding screen is a
necessary adjunct.   Door hinges should be oiled and floors
deadened.
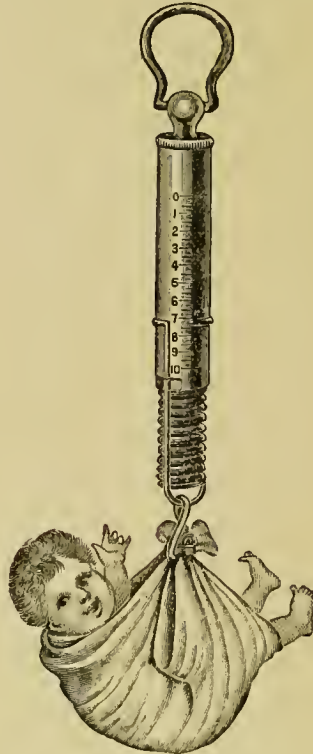
Fig. 72.   Fig. 73.

The nurse's bed should occupy an adjoining room with
direct communication.

SLEEP.

A very young infant should sleep twenty hours out of
the twenty-four, in fact, all the time when not being nursed,
bathed or changed.   No definite statement can be made as
to the exact number of hours that a babe should sleep at a
given age. No error will be made if the child is encouraged to
sleep all that he will during the first year, being guarded

against all noise and disturbances. Sleep is largely a matter of education. It is constantly being demonstrated that infants can be taught to sleep, waking at regular intervals for nourishment. Rocking or carrying are advised against as unnecessary and possibly harmful. Putting foreign bodies in the mouth, as the thumb or an artificial nipple for the purpose of inducing sleep or quiet is so unhygienic and irrational as hardly to require mention.

The normal position of the young infant during sleep is characteristic and suggestive of intra uterine life, the limbs flexed, the hands under the chin, the body turned to one side or the other and the spine assuming a continuous convex curve. Any continued departure from this attitude should call for medical examination.

The sleep during the first few days is profound, but during the rest of the year it is easily disturbed. Care should be observed that the position of the child is changed during the longest sleep of the night.

A healthy child upon waking or after a bath usually indulges in a vigorous stretching of his body and limbs.

CLOTHING.

The object of clothing for the infant is to secure uniformity of temperature. In the ideal nursery no other possible use occurs to the mind of the writer nor can he conceive of any reason why one portion of the body requires heavier clothing than another, hence material of uniform thickness is suggested for the protection of the trunk and limbs. Physiology, as well as clinical experience, furnishes good reasons for leaving the head uncovered in ordinary temperatures.

An almost universal error in clothing infants is the neglect to allow unrestrained freedom of movement of all the muscular structures, whether toes, fingers, feet, hands, legs, arms, abdomen, dorsum or thorax.

As to the form and texture of the clothing, we should refer to the chapter on the care of the new-born, merely emphasizing the advantages of including the hands in the

covering as a prevention of the habit of putting the fingers in the mouth. This is a most unhygienic practice; first, because it favors the introduction of infections; second, because the subsequent chilling of the parts from rapid evaporation of moisture induces local congestions, causing symptoms of indigestion, colic, etc.

You will remember that buttons were not provided, as much discomfort and sometimes positive injury results from their pressure upon the delicate tissue. This is especially true, when, as is frequently seen, garments are buttoned down the back. The period during which the hands should be included in the outer garment may cover the first six or eight weeks of life, or even more under some circumstances.

The need of protection from lowered temperature can not be too greatly emphasized. First, the infant is peculiarly susceptible to the temperature of the surrounding air, on account of his extensive superficial area, as compared with weight. This, in connection with the great vascularity and thinness of the integument gives a relatively enormous proportion of the blood in close relation to the surrounding atmosphere. Remembering further the fact that the total quantity of blood is comparatively small, it is easy to see that the circulating fluids may be quickly chilled in a medium of lower temperature. Second, all metabolic processes require a certain uniform temperature, and interference is especially disastrous during this period of rapid growth. Cold diverts the process of constructive metamorphosis into that of heat production, so that undue lowering of temperature interferes with growth. It also results in local disturbances and pathological conditions, as congestions, catarrh of mucous tracts, etc., etc.

The adult is admirably adapted to the varying requirements of his surroundings. In no respect is this better shown than in his adaptibility to the extremes of temperature, rendered possible through the automatic operation of the nervous and circulatory mechanisms.
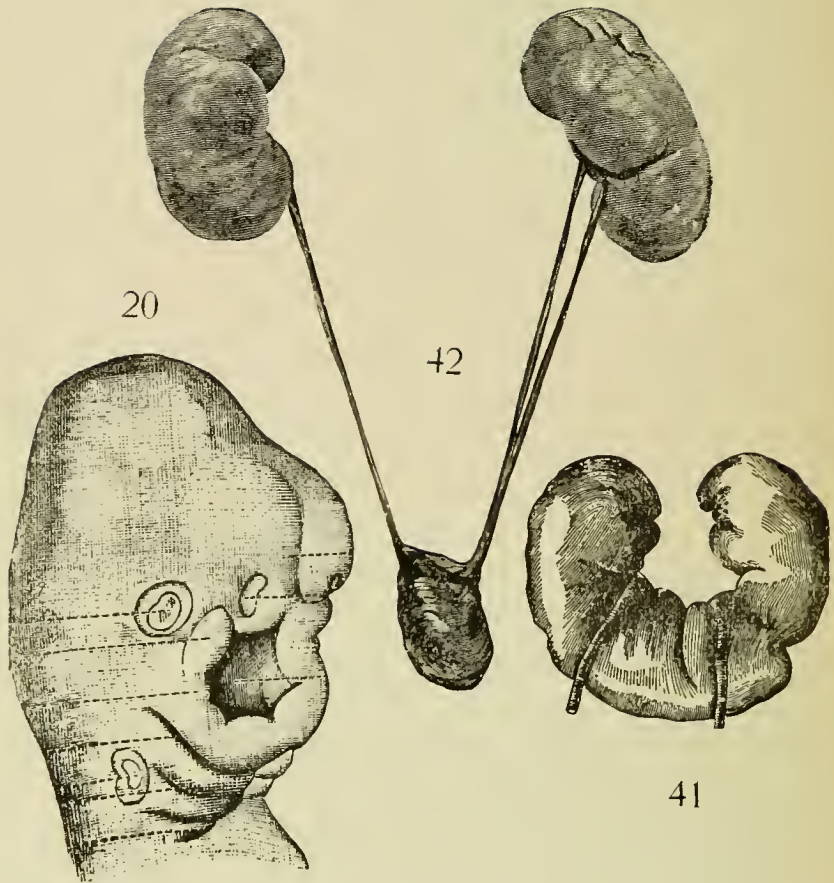
FIG. 20. BRANCHIAL CLEFTS.
FIG. 41. FUSED OR HORSESHOE KIDNEY.
FIG. 42. KIDNEY WITH DOUBLE URETERS. (KEATING.
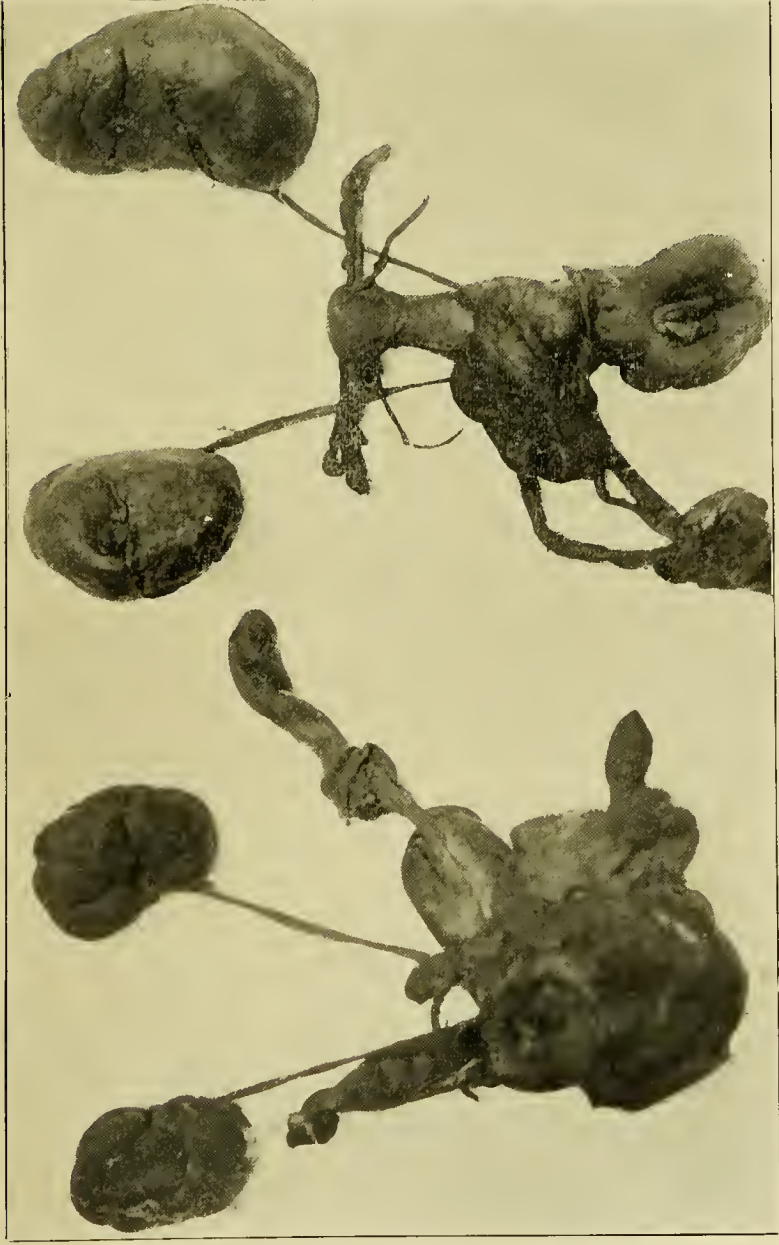
Fig. 43. Male.   Fig. 44. Female.

GENITO-URINARY ORGANS AT BIRTH.

In the infant, however, we observe a want of that
harmonious co-operation. "An unstable equilibrium," ex-
presses the condition of the partially developed nervous
system as well as of the secretory and excretory appara-
tuses. Many disturbances from which the adult organism
will recover easily its equilibrium may result in serious or
permanent injury to the infant. The exaggerated reflexes,
the imperfected vaso-motor apparatus, the undeveloped
muscular structures and the transitional conditions of the
glandular organs may furnish some explanation as to the
indelible impressions resulting from marked vascular dis-
turbance or interrupted function, so often seen in the
young.

That the morbid tendencies and processes which deter-
mine the pathology of later life are thus established there is
little reason to doubt. Figuratively, the seeds of disease
are sown in infancy followed by the well known crops of
morbid conditions familiar to the diagnostician of later
years. Verily, hath heredity suffered unjust blame for con-
ditions which were originated in the neglect of hygiene in
early infancy.

BATHS.

After the first week, the strong, healthy baby should
be bathed daily, and it is not necessary to repeat reasons
why this should be done in a warm room, by the heater in
cold weather, with all currents of air shut off by the screen.
The temperature of the first baths should be about blood
heat—98° F. Gradual reduction should be practiced so
that at the end of the month the temperature should be 95°;
at six months 90° and by the end of the year 90 to 85°.
It is well to finish bathing and drying the head before
undressing the baby. The convenience of the double ewer
is seen in having a supply of water free from soap for
rinsing. Little soap is required and if the skin is delicate,
that known as "superfatty" is advised. Unless some irrita-
tion is present, no powder should be used. The addition of
bran to the bath for children with a tendency to eczema, and

of salt for its stimulating properties to the infants needing it, is recommended.

The daily bath should be given midway between feedings; and there should be the same regularity in this as in all other details of the care. It should not last longer than five minutes, and the toweling, though thorough, must be lightly and quickly done.

The special care of the eyes, nostrils and mouth must never be omitted. As soon as the temporary teeth have erupted, they should receive as faithful attention as the permanent; since they are as subject to caries, moreover the effects in gastro-enteric disturbances are greater in the infant.

In hot weather a rapid sponging with warm water at night will secure a more restful sleep.

The duration of the bath, as well as the frequency, should depend entirely upon the reaction as seen by its effects on the capillary circulation. A cyanotic hue, chilliness of the surface, or signs of exhaustion are always contra-indications for frequent or prolonged bathing.

Preparation in every detail before taking the child from the crib and dexterity in execution will lessen many of the evils of the bath.

The general bath may occasionally have to be omitted but nothing short of a moribund condition should prevent local bathing and attention to the orifices; nor should the systematic changing of the clothing, properly aired and warmed, be omitted for any less reason.

It is well to bear in mind the difference between tub and local bathing, as the effects upon the infant organism differ widely.

It is hardly necessary to state that, after bathing, the bath water, towels and wet cloths should be removed immediately from the room. Nor should the nursery ever be used as a drying room for any fabrics. The filthy custom of hanging soiled diapers to dry should be condemned. In fact, they should be immediately washed and boiled. Dia-

pers soiled with fecal discharges, kept for the inspection of the physician, should be removed at once from the nursery, as should all others.

EXERCISE.

Exercise is absolutely essential to the normal growth and development of all the muscular structures. Lusty crying, if not prolonged to the point of exhaustion, has a beneficial effect, in the deeper respiration thereby induced, with consequent improvement in oxygenation and circulation. So stretching, kicking, squirming, and waving of arms secure in a measure the needed exercise. Once or twice in the twenty-four hours the clothing may be removed and the infant allowed the utmost freedom of movement. Occasional gentle massage is advised, the infant's expression of pleasure being one of the immediate evidences of its beneficial effects. After the creeping age the infant usually secures enough muscular exercise and must be guarded against fatigue. The creeping pen, raised a few inches above the floor, is recommended for cleanliness and protection against the floor draughts and contact with the articles of furniture.

No matter how well ventilated the nursery may be, it is essential that the baby have frequent change of air. Direct sunlight is a great desideratum. Differences of opinion exist among competent observers as to the age at which infants should be taken into the open air. The difference is probably due to local peculiarities of climate, and no rule of procedure may be laid down without taking into consideration climatic conditions, as temperature, humidity and wind. It is advisable before taking the baby out of doors, that he be gradually accustomed to the outside air by opening the windows of the nursery for a short period each day, keeping in mind the need of additional clothing in cold weather.

With the ideal nursery the needs for early outing are not so imperative as where the home surroundings are not conducive to the best hygiene. On general principles the child

should have the benefit of open air and sunshine daily after the first month.   The more weakly the child the greater the need.   One caution should never be disregarded; in his outing, the infant must be protected from disturbance in securing his requisite amount of sleep.   No reasonable objection occurs to the writer why a baby should not spend the greater part of the day in the open air, if properly protected from wind and sun.

Rocking, walking with and much coddling of infants should be discouraged, as habits are quickly established and the continuation is not always feasible.

The subject of the care of the young infant should not be dismissed without reference to a practice that is as pernicious as it is common, viz.: tne custom of regarding the baby as a plaything, an animated toy for the entertainment of the family as well as a large circle of admiring friends. Children are fond of babies and never tire of stimulating their funny performances.   The same is unfortunately true of parents and other friends, but, from a purely economic point of view, such amusement is exceedingly expensive, and the mortality statistics are constantly increased for the amusement of the elders.   Nervous and mental wrecks too frequently owe the origin of their disorders to want of repose in early infancy, due to injudicious stimulation.   In this connection let it be understood that all evidences of mental precocity, called "smartness", should be regarded as danger signals and call for repression, rather than encouragement.   Axiom—An infant during the first year should neither be amusing nor amused.

CHAPTER XI.

HYGIENE OF THE 1ST. YEAR, Continued.

NOURISHMENT.

For the second essential requirement of the infant, namely, *nourishment*, ample provision has been made by nature in an apparntus admirably adapted to its requirements.

Whatever may have been its origin, whether evolved through cycles of physiological development, from the laceratations produced by the mandibles of the young marsupials as they clung to the pectoral integument of the mother for protection, or whether created in its full perfection of function, the mammary gland in its adjustment to the needs of the nursing infant furnishes the highest example of organized mechanism seen in the human body.

The interest which centers about the method of milk production, whether viewed from the histologic or physiologic standpoint, is an ever increasing one. The study as to its composition, and the classification of the glands producing it—whether secretory, excretory or both, is engaging the attention of our best physiologists. So, too, the influences and conditions that may affect its production either by increasing or diminishing its quantity, or by changing its quality, promise a fruitful field for the hygienist. It is not without good reason that attention is directed to the subject of lactation, for in the disturbance or perversion of this function we find, perhaps, the most prolific cause of the disorders of infancy. The increase of interest in this line of study is largely due to a rapidly growing tendency to interference in the normal method of nourishing the young. As a result of this tendency we see increased pathologic conditions and a higher rate of mortality in infancy, with sub-normal develepment and diminished vigor of those who survive the suckling period. The subject of disturbed lactation, its causes and effects, would require a separate chapter for a consideration of even a meager outline, in-

cluding as it should the anatomy. physiology, hygiene and pathology of the mother.

During gestation the evidences of provision for the establishment of this function are seen in increased physiological activity of the mammary glands. The increase in size and firmness of the breasts, the changes in color and texture of the integument, areolas and nipples, and the enlargement of superficial veins, are all phenomena which so commonly accompany the pregnant state as to be accepted signs of that condition.

Even during gestation a milky substance is not infrequently seen to exude from the orifices of the nipples. At full term the mammary glands are evidently prepared for their function, viz: furnishing aliment for the child. It is exceptional, however, that lactation is fully established at the time of parturition, and usually forty-eight hours elapse before milk is secreted in an appreciable quantity.

It is evident from the anatomy of the infant that he is especially adapted for the act of nursing. The pliable, prehensile lips and tongue, the absence of teeth, the well developed musculature of the cheeks and jaws, the fatty pads increasing the buccal resistance to atmospheric pressure, all go to form an incomparable mechanism for grasping the nipple and promoting the outflow of milk by establishing a vacuum. This the infant does instinctively.

We should observe also, the peculiar adaptation of the mother, in the relative arrangement of the breasts to the upper extremities with the shortened clavicles, in the conformation of the breasts with their soft and yielding walls which collapse readily as the milk is drawn, in the position, size and shape of the nipple with the many minute orifices and richness in erectile tissue; also in the manner in which the breasts are filled—the process going on most rapidly during nursing and, finally. in the sympathetic arrangement which facilitates extrusion of milk under stimulation of the infant's lips and hands.

That no fully developed milk is found in the breasts at

the time of birth has been generally accepted as conclusive
evidence that the new-born is in no immediate need of food.
In fact, as stated in a previous chapter, his deportment, if
undisturbed, suggests the need of rest during the first forty-
eight hours of extra-uterine existence. This belief is so
universal that attempts at feeding before nature has fur-
nished the supply have not met with general approval. To
be sure it is recommended that the child be put to the breast
early, in the belief that the scanty secretion of colostrum
plays some role in stimulation of peristalsis of the alimen-
tary tract, and the expulsion of meconium. Probably, by
so doing, the infant secures a modicum of the water so much
needed at this time. The infant's habitual loss in body
weight during the first days, as shown by tables in a pre-
vious chapter on growth, has been regarded by some as un-
necessary. In fact, it is claimed to be unfortunate as inter-
fering with the rate of subsequent growth. On this account
it has been recommended that some nourishment be substi-
tuted during these first two days. It remains for more ex-
tended clinical observation to determine tne value of this
procedure, but, with necessary hygienic precaution, it seems
permissable to administer some attenuated solution, as of
milk sugar, the water of which at least, should meet a phy-
siological demand.

The normal infant usually makes known his wants in no
uncertain tones by the time the maternal fount is supplied.

The subject of suckling, proclaimed by many to be
purely instinctive in both its maternal and infantile rela-
tions, is well worthy of careful study and the application of
the best known principles of hygiene. Given normal moth-
ers with normal infants, the disturbances of digestion, nutri-
tion and growth are yet sufficiently frequent to raise the
question of their etiology. Further than this, the great
mortality of infants at the breast, from disorders occasioned
by improper methods of suckling, makes it evident that in-
stinct is not a sufficient guide. Reasoning from analogies
furnished from lower mammalia is not profitable in refer-

ence to this point, since it would appear that in the higher
intellectual development with the enthronment of reason,
woman's instinct becomes perverted or deranged to a certain
extent.

Be that as it may, it is readily susceptible of demonstra-
tion that intelligent control or supervision of the act of suck-
ling averts or corrects many evil effects of its abuse when
left entirely to instinct. A few rules, the outgrowth of
many observations, may be formulated, the observance of
which is manifestly important in the hygiene of nutrition.

RULE FIRST.—*Asepsis must be observed*, since one of the
commonest causes of infantile disorders is infections intro-
duced into the alimentary tract. To this end the nipple, as
well as the infant's mouth must be cleansed before and after
nursing, as it is well known that milk remaining exposed to
the air shortly swarms with micro-organisms, many of which
are pathogenic when introduced into the digestive tract.
Even the milk in the orifices of the ducts often becomes in-
fected; hence the expression of a few drops is recommended
before the application of the child.

RULE SECOND—*The infant should be put to the breast every
two hours during the day, and once at night for the first six
weeks.* From six weeks to three months the intervals be-
tween feedings should be increased to two and one-half
hours. During the latter part of this period the night feed-
ing may be discontinued. Between three and six months
the interval should be increased to three hours, representing
seven feedings from 5 A. M. to 11 P. M. inclusive. Six feed-
ings a day should be sufficient for a child at six months. By
the end of the year he may be accustomed to five. If sleep-
ing, he should be wakened at the proper time for nursing
until the habit becomes established.

This rule, though not so arbitrary in its requirements as
Rule First, should be somewhat rigidly applied, for, with
few exceptions, nothing is more evident than that disturbed
digestion with all its train of evil consequences is the com
mon result of too frequent or irregular feeding. Without

mentioning the effect upon lactation of irregularity in nursing, it must be borne in mind that the operation of the digestive function is a periodical one, and, within certain physiological limits, a matter of education and habit, so that regularity as to ingestion of food meets with corresponding regularity of the secreting organs. Passing the feeding hour induces over ingestion from an over-distended mammary gland. This undue amount taken at an unusual time finds the digestive fluids unprepared; hence their incapacity for proper disposition of the unusual burden.

The *frequency* of *feeding*, as laid down in the rule, is the result of many comparative observations upon healthy infants and of the known physiology of the digestive processes. A certain definite time, as has been stated in a previous chapter, is necessary to the physiological disposition of an ingested meal. After this an interval of rest is requisite for the re-establishment of the function in its highest perfection. Nothing is more abhorrent to nature than "meals at all hours." The practice of the mother sleeping with the babe on her arm and quieting his restlessness throughout the night by offering the breast is, unfortunately, too prevalent, the result being that, instead of receiving one definite feeding, the helpless infant is made the victim of a perverted instinct, and sooner or later permanently injured.

We have seen that the digestive process is one of varied stages, each dealing with a changed condition in the mass of aliment. It is apparent from this last that the digestive secretions, some of which make their appearance only as certain stages are reached, are not at all suitable for freshly ingested aliment. This is no mere theory, as every observer well knows the pernicious results of too frequent feeding, and probably no vicious practice presents such vexatious problems in our efforts at correction.

RULE THREE—*The time occupied in nursing and the quantity ingested should be controlled by the mother.* At first thought this rule may seem impracticable, but a little reflection will show that it is not, and evidence is abundant as to the neces-

sity for its observance.   Certain it is that the differences in
the formation of the nipple and in the function of the gland
in different mothers affect nursing more or less. There is a dif-
ference, too, in the nursing energy of different infants, so that
one infant will occupy half an hour in securing his dinner,
while another may gorge himself in ten minutes.   The act
of nursing in its perfection is the result of the mutual co-
operation of mother and child, and is a performance worthy
of their undivided attention; in fact, it should demand it.
A child cannot properly nurse the passive breast of a sleep-
ing, or even an inattentive, mother.   In breasts where the
nipple formation is imperfect, rendering the abstraction of
milk laborious to the infant or painful to the mother, or
where milk secretion is tardy or insufficient, the mother
should aid and encourage the babe by placing herself in full
harmony with the pleasurable duty of the moment, and en-
deavor to secure a full response to the stimulating appeal of
the tiny solicitor for a better supply.   No verbal description
can compass the art in which fingers, arms, bosom, eyes,
voice, and the whole sentient being of the mother enables
the infant to collect his due.

On the other hand, where the breasts gush through
patulous nipples their bountiful supply, or in case of infants
who nurse with such avidity that the process from begin-
ning to completion resembles a struggle against suffocation,
the mother should control the outflow.   This may be done
by dexterous manipulation of the nipple between the fingers,
by withdrawing from the infant's mouth, by diverting his
attention, and in various ways prolonging the process.   It is
safe to say that twenty minutes should be given to each
nursing.   Prolonged too much, the infant, as well as the
mother, suffers fatigue.   Interference with digestion oc-
curs also under the principles above enumerated.   Too rapid
feeding throws into the stomach a large quantity of food
with the result of over-distention and early escape from the
pylorus of milk insufficiently converted.   This is further
augmented by the hydrostatic pressure of a super-imposed

column filling the œsophagus. Hasty feeding invariably
means over feeding. Not infrequently the stomach resents
this abuse by immediate regurgitation of a portion of its
contents, which has led to an erroneous belief quite preva-
lent, that the stomach is endowed with some sentient quality
which enables it to reject superfluous aliment. That this is
a pernicious error, the frequent occurrence of gastric dilata-
tion and intestinal indigestion is ample evidence. It may
be suggested to mothers who experience difficulty in restrict-
ing the over ingestion of milk, that the nursing be preceded
by the administration of a little sterilized water, possibly
sugar of milk solution, to partly satisfy the voracity which
may be due largely to habit. Instinct is no guide as to the
amount a child should nurse.

RULE FOUR.—*Give water systematically and freely.* The
baby's food, as will be shown when we consider the
composition of milk, is made up of several widely
different constituents. Although all of them are essential
for perfect nutrition, one or more may be tempo-
rarily omitted without any immediate perceptible inter-
ference with vital processes. In fact, one only must be
present under all circumstances, and this is *water*. Without
water no digestion, absorption, or elimination is possible.
Water enters largely into the composition of the infant's
food, milk containing about 88 per cent. It has been shown
that water is essential to peptone absorption, and many ab-
normal and even pathological conditions result from an in-
sufficient supply. The restlessness of an infant is frequently
only an expression of his thirst. and many of the symptoms
of hunger are merely evidences of a demand for water. How
often the pathetic spectacle is witnessed of forcing unre-
quired and even injurious food upon an unwilling stomach
in response to the infant's appeal for water. "If his son
ask bread will he give him a stone?" seems a pertinent
inquiry when we see milk offered where water alone is
needed. There is no difference of opinion upon this point
that infants need water between feedings, although among

the laity it is seldom recognized. This is as true in early as in later infancy, in fact, a tendency at birth to excessive uric acid formation (before mentioned) becomes pathologic unless water be freely supplied to dissolve the solid crystals, clear out the renal tubules, and render the urine less irritating. Evidences of pain, usually ascribed to intestinal colic, are too frequently indicative of uric acid irritation and point to a need for more water. Fortunately the doping of the baby with carminative teas for the supposed intestinal spasm occasioually fulfills the indication through the water of the decoction.

CHAPTER XII.

(Nourishment Continued).

Concerning the composition of human milk much has been written and quoted that can not be accepted in the light of our present knowledge. Either because of improved technique or from a greater number of observations, our recent analyses do not corroborate the findings of former chemists. Upon this subject we have drawn freely from Schaefer, Foster, Kirke, Leffman and Beam, Harrington, Wittmaack, Siegfried, Leeds, Hammersten and the Adriances.

Milk is an emulsion of innumerable minute globules of fat floating in plasma. Its white color is produced, as in other emulsions, by reflection from the surface of the numerous cells.

As it is a perfect emulsion, the fat globules remain distinct. The older opinion, that a thin membrane of albuminous material surrounded each cell, is no longer generally held. From experiments, Quincke has proved that each fat globule, by molecular attraction, is surrounded by a more closely adherent layer of milk plasma, and not by a membrane. Among the globules are smaller particles of proteid matter (caseinogen or nuclein?).

Monti, from the examination of milk from a large number of women, gives the specific gravity as 1.030 to 1.034.

All the five principal classes of foods are found in milk, viz; *water*: *fats*; *proteids*; (caseinogen, lactalbumin and lactoglobulin) *carbohydrates* and *salts*; besides extractives and gases.

That these classes of foods are essential to normal nutrition and growth is susceptible of demonstration, both by well known principles of physiology and by daily clinical observation. It is probable that perfect metabolism is dependent upon the presence of *all* these food principles, although life may be maintained for a longer or shorter time if one or more be omitted from the diet (always excepting water). Thus an infant may exist for a time on water and carbohydrates, as solution of sugar of milk, or on water and proteids, or on water and salts; the result, however, in each case invariably showing the deficiency of the constituents in impaired nutrition. This is so well recognized clinically that the absence of one or more of these essential constituents is not infrequently determined by the condition of the infant. This is a fact of such clinical importance, that the need of a definite knowledge of the part played by these substances in the plan of nutrition can not be too strongly emphasized.

A symmetrical development requires not only the presence of all the constituents but that they should maintain a certain definite quantitative ratio.

The proteids furnish the only source from which the tissues obtain nitrogen, without which no protoplasm can exist, nor cell life be possible. A deficiency, even, in the group, invariably results in retardation of development. Insufficient nitrogen means diminished metabolism, interrupted gain in body weight, lessened muscular force, anaemia with the weakened heart's action and dyspnoea, arrested secretions and all the familiar evidences of lowered nutrition.

It was formerly taught that the purpose of fats was to produce heat, a very important function, as a certain degree

of heat is necessary for tissue metamorphosis. It can be demonstrated that fat plays a double role and that in addition to the maintenance of body heat it aids the proteids in cell development, especially in the formation of bone and nerve tissue. Besides its synergistic agency in increasing the activity of the proteids, it serves another purpose by promoting absorption of the salts from the intestines. It also maintains the healthy function of the lower bowel by promoting the passage of the faeces, of which it normally forms about 10 per cent. A deficiency of fat produces results distinctly characteristic, not only such as always follow diminished metabolism, but also a group of signs of impaired nutrition so uniform as to have been classified under the one term, rachitis.

The carbohydrates, in the form of milk sugar, have occasioned no little discussion as to their value as compared with the preceding class. Some authorities place them third in importance, v. Noorden and Kayser, however, have found that carbohydrates are of greater value as proteid sparers than are fats, as the latter cannot be substituted for their caloric equivalent of carbohydrates without loss of proteids occurring. It has long .been known that sugar increases the formation and deposition of fat, babies frequently showing a remarkable plumpness. even though fat and proteids are lacking in the food.

The fourth group—*the salts*—consisting chiefly of calcium phosphate; potassium carbonate, sulphate and chloride; sodium chloride and a trace of iron, forms a small but fairly uniform and very important percentage of the total constituents. As a result of his analyses, Bunge claims that, with two exceptions, the percentage of salts in milk corresponds quite closely with the salts in the tissues of the nursling.

A very essential and comparitively abundant salt is calcium phosphate, which is required for bone formation. Lime is taken in and assimilated by the organism in the of organic compounds with the proteids.

The potassium salts, also abundant, are needed in the

formation of muscular tissue and in the red blood cell. A significant fact is the greater amount of potassium and lesser amount of sodium salts in milk than in the tissue of the infant. During post-natal growth there is a relative increase in the muscles which are rich in potassium and a diminution in the cartilages which are rich in sodium.

Sodium chloride, as is well known, performs an important office in digestion, for during the passage through the body, it facilitates the absorption of proteid food, and increases tissue metabolism.

Wittmaack and Siegfried from their analyses found that nucleon or phospho-carnic acid accounts for 41.5 per cent of the phosphorus in human milk. Practically all the phosphorus is in organic combination (nucleon and caseinogen).

The iron, so essential to the formation of blood, and to a less degree, of the other liquids of the body, is present in mother's milk in extremely small quantity. The percentage is only one sixth of that fonnd in foetal tissues. Infants appear to enter the world with a store of iron in the liver, and to some extent in the spleen, which lasts them until they are able to take food other than milk.

As stated the salts vary but little in percentage, but should a deficiency be present, the osseous, nervous, digestive, muscular or circulatory system would suffer the sooner according to the individual constituent most at fault.

Were the other ingredients present in normal mother's milk in proper proportions, the absence of water would render them valueless for food. It is only in a state of solution that most of these substances can undergo digestion in the intestines of the infant, or absorption through the villi. The normal secretions are relatively scant in proportion to the enormous work accomplished during the growing period. Hence the necessity for water at all stages. Attention is again called to what nas been said in the preceding pages, as the importance of the demand for water can hardly be over estimated.

From the forgoing it is not surprising that deficiency of water—or in other words—an excess of the solid constituents, is early recognized in inabilily of the stomach to dispose of the proteids, in imperfect elimination, constipation, scanty concentrated urine. and in all the train of evils resulting from imperfect nutrition and retarded elimination.

The first group—the proteids—is chiefly represented by three albuminous substances, differing somewhat in their physical properties. The most important and most abundant of these is caseinogen. It is this proteid which is acted upon by rennet and converted into casein or curd.

The formation of casein from caseinogen is a double process: the first action is that of the ferment which converts the caseinogen into what may be called soluble casein; the second action is that of the calcium salt, which precipitates the casein as curd, which is probably caseate of lime.

The action of rennin upon caseinogen is not a simple conversion of that proteid into one of a more soluble kind, but the rennin splits the caseinogen molecule into two parts; one part is the curd or casein, the other is a soluble proteid which passes into whey and is termed "whey proteid" by Hammersten.—Schæfer.

The lactalbumin is not so abundant in fully formed milk as caseinogen. It differs from it in that it contains sulphur, does not contain phosphorus, is soluble in water and coagulates at 70 to 75° C. It is not identical with serum albumin, although resembling it in many respects.

The lactoglobulin is present in very minute traces ordinarily. Like albumin, it is in a state of solution and coagulates at the same degree of heat.

The carbohydrates are found in the form of lactose, a sugar peculiar to milk, differing from other sugars in its inferior solubility in water, and lack of sweetness to taste. It also resists the tendency to alcoholic fermentation, but yields readily lactic acid when attacked by the bacterium lactis ærogones. Another carbohydrate has been described
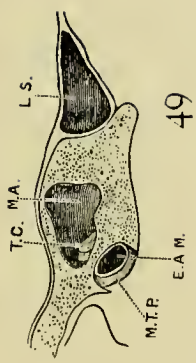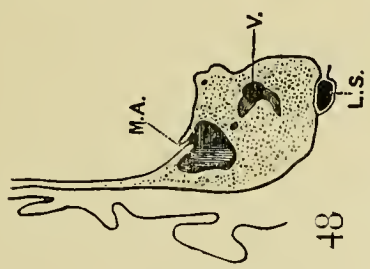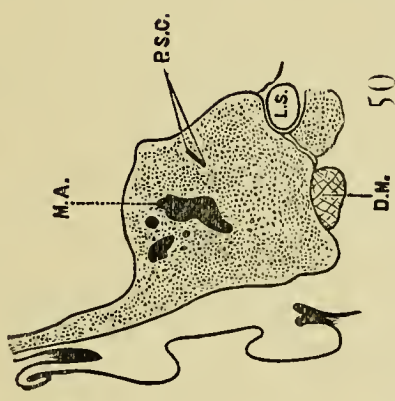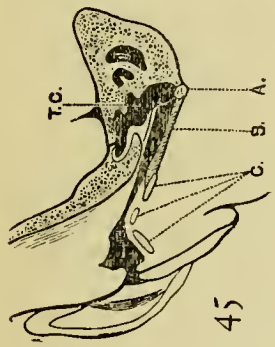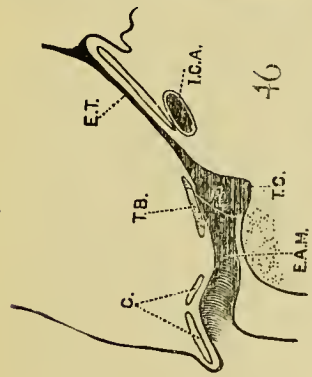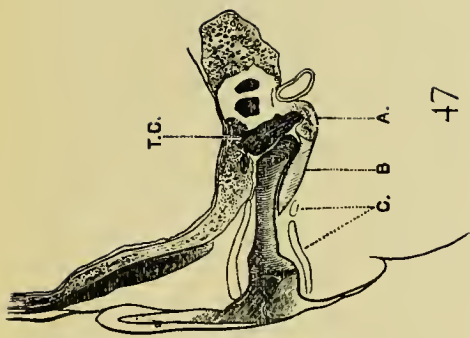
FIG. 45. SECTION OF EAR OF NEW BORN. T. C. tympanic cavity, A. tympanic bone, B. fibro-cartilage. Petro-squamous suture in roof of tympanum represented by a black line.

FIG. 46. SECTION OF EAR OF INFANT OF 15 MONTHS. E. A. M. Ext. auditory meatus, T. B. tympanic bone, I. C. A. internal carotid artery, E. T. Eustachian tube. (SYMINGTON.)

FIG. 47. SECTION OF EAR OF INFANT OF TWO MONTHS.

FIG. 48. SECTION OF EAR OF INFANN OF SIX MONTHS. M. A. Mastoid antrum. V. Vestibule, L, S. Lateral sinus.

FIG 49. SECTION OF EAR OF INFANT OF FOUR MONTHS. M. T. P. Membranous Tympanic plate.

FIG. 50. SECTION OF EAR OF GIRL NINE YEARS OLD. D. M. Digastric muscle. P. S. C. Posterior semicircular canal.
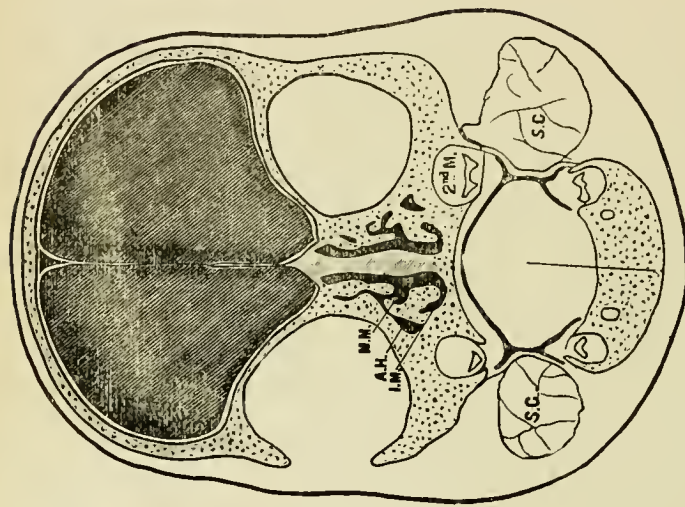
M.M. middle meatus of nose. I.M. inferior
meatus. A.H. antrum of Highmore. S.C. suck-
ing pad. 2nd. M. 2nd temporary molar.
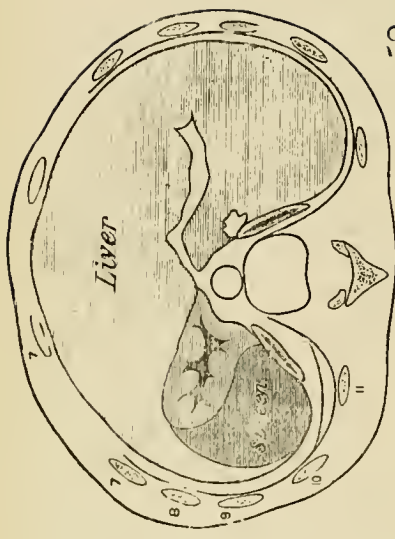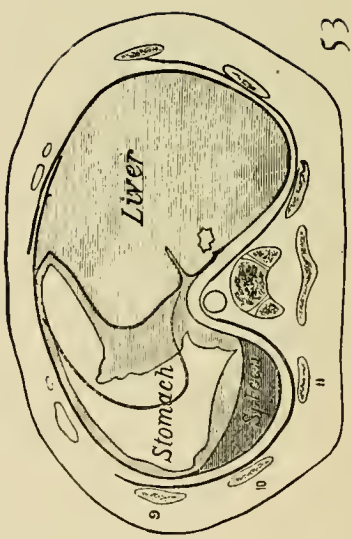
FIG. 51. CORINAL SECTION OF HEAD OF INFANT TWO MONTHS OLD.
FIG. 52. HORIZONTAL SECTION OF BOY OF FIVE YEARS, made at the level of the disc between the eleventh and twelfth dorsal
vertebræ.
FIG. 53. HORIZONTAL SECTION OF CHILD OF TWELVE YEARS, opposite the eleventh dorsal vertebra, showing the effect of a
distended stomach in pushing over the liver to the right side. (SYMINGTON.)

as existing in milk, named variously by different observers as, "animal gum," "dextrin," "animal amyloid."

The following table from the analyses of Harrington and Kennicutt quoted by Rotch, represents the different proportions of mineral constituent in human milk.

Calcium phosphates........................	23.87
Calcium silicate...........................	1.27
Calcium sulphate..................	2.25
Calcium carbonate........................	2.85
Magnesium carbonate...	3.77
Potassium carbonate........	23.47
Potassium sulphate........................	8.33
Potassium chloride........................	12.05
Sodium chloride...........................	21.77
Iron oxide alumina....ʼ....................	0.37
	100.00

CHAPTER XIII.

(Nourishment Continued.)

As before stated, normal milk is made up of these five constituents; moreover, they maintain a fairly constant percentage relationship. Frequent variations, however, are observed in normal milk, as in different mothers, or in the same mother at different times, or in the same mother in different breasts, or, as is well known, in the same breast at the same milking, drawn at different times, as fore, middle and last milk.

Of these constituents the percentage of fat is subject to the widest variation; next the proteids; the carbohydrates and salts rarely showing much change. Nor would these variations be considered as indications of abnormality, the only criterion being its effect upon the child. An infant at the breast, digesting well, gaining steadily in weight and strength, is ingesting normal milk, regardless of what the analysis may show. As seen from the foregoing, it is evi-

dent that repeated analyses are necessary to determine the average constituents of one woman's milk.

The personal equation—the capacity of any particular infant to digest the varying constituents must always be recognized as an unknown quantity in our estimates. It is a fact of common clinical observation that the breast, at which one infant thrives, may not meet the requirements of another child of the same age.

The careful work of the Adriances has illustrated the varying quantities of these constituents at different stages of lactation. Their averages are fairly represented in the following table:

Proteids.................... 1–2
Fat....................................... 3–4
Lactose................................... 6–7
Salts...................................... 0.2
Water..................................... 88

Average specific gravity, 1030; reaction, alkaline.

Additional significance attaches to their conclusions from the advantages they enjoyed of observing a large number of healthy women during long periods. A review of their observations leads to the following conclusions:

(1) The fat shows no constant changes during lactation Its most marked characteristic is its variability.

(2) The carbohydrates, on the second day of lactation are low, but rise rapidly during the first few days. This increase continues, but less rapidly up to the end of lactation.

(3) The proteids pursue a course the reverse of the carbohydrates.

(4) The salts diminish similiarly to the proteids.

(5) The colostrum period has low carbohydrates, with a tendency to increase rapidly, and high proteids and salts, with a tendency to decrease rapidly.

(6) The milk of the later months of lactation shows a deficiency in proteids, ash and total solids. Archives of Pediatrics, Jan. and Feb. '97.

The milk of the first ten or fourteen days possesses pe-

culiarities that are not normally found at any subsequent period of lactation, and is known as colostrum. The characteristics of the milk of this period are:

(1) The presence of colostrum corpuscles. Normally these persist in the milk from seven to ten days. These are believed by Schæfer to be leucocytes which have migrated through the connective tissue. In the warm stage they show amœboid motion.

(2) The laxative effect upon the infant.

(3) The yellow color of the milk.

(4) Chemical characteristics ; the fat may be very high or very low; the sugar is lower on the second day than at any other time, but increases rapidly up to the end of the second week; the proteids pursue the opposite course, being the highest on the second day but falling rapidly the first few days; the salts, like the proteids, are higher than subsequently. The most interesting feature of the above is seen in the excess of the proteids during the colostrum period.

Having considered normal milk it will be well to discuss the changes which constitute departures from the normal, as seen by their effects upon the infant's nutrition. Before entering upon this subject we might consider briefly the physiological process by which the milk is produced, in order to better appreciate some of the influences that affect these changes. As stated in a previous chapter, the mammary gland represents the highest type of mechanism in the body. A peculiarity of its function is that it persists during a more or less definite time, then it subsides. Exceptions are seen in some cases of prolonged lactation and in curious instances of the function established even in women who have never conceived, under stimulation of the nipple by sucking, a point of clinical value.

We will not take time to review the structure of the gland, but merely call attention to the fact that the alveoli are lined with columnar epithelium, and it is by means of these cells that this composite emulsion is produced.

The exact mode of its production from the circulating fluids has been a subject of much discussion and extended research. The results of these observations have led to different theories.

The older belief that the cells of the glands operated as a sort of filter, the milk being derived directly from the blood has been rejected as unscientific. To-day there are three theories that are generally accepted.

Stated briefly—the first explains the production of fat by an actual breaking down of the lining cells—a fatty degeneration—a process, which it is estimated, would require the renewal of the epithelium of the alveoli at least five times in the twenty-four hours. This is held by some to be preposterous. The second theory is a modification of the first, in as much as only the free ends of the cells, after a stage of increased activity, appear to break down, liberating their products of metabolism, the fixed ends with the nuclei remaining to renew the process.

A third hypothesis attributes to the cells of the mammary gland, through the agency of protoplasm, an energy analogous to other secreting structures, viz.; that they have the power of elaborating from the fluids a secretion peculiar to themselves, cell destruction being no more necessary than in other secreting glands. A more exact knowledge on this subject, it is claimed, would be valuable in its bearing upon the subject of changing the constituents of the milk by physiological methods, as feeding, etc., a matter which has hitherto been determined exclusively by clinical observation and experiment. Were the glands mere filters, as was formerly taught, it is reasonable to expect that the quality of their products would partake of the nature of the blood constituents, and that changes in the latter would produce corresponding changes in the milk, a result which repeated observations have disproved.

No secretory nerves have yet been demonsrated in the mammary gland but analogy would compel us, were clinical data wanting, to accept the hypothesis of nerve influence

and control in the secretion of milk, probably through the cranial and sympathetic nerves. It is a fact of such common observation that mental conditions influence the milk supply that no teacher denies it.

HYGIENE OF LACTATION.

Milk secretion is subject to variations in quantity as well as in quality. In the majority of cases it is regulated to meet the requirements of the infant, although instances are not uncommon in which the quantity is insufficient. On the other hand, it frequently occurs that the mother may successfully nurse two infants, as in cases of twins, or in wet-nursing in foundlings' homes, etc. From this it may be inferred that in some mysterious way, and to a limited extent, the supply is regulated by the demand.

Some interesting observations have been made to determine the quantity of milk secreted during normal lactation. By careful weighing of the child immediately before and after nursing the amount taken can be easily ascertained. This work has been thoroughly done by Haehner, Laure and Ahlfeld, with the following results as quoted by Holt.

Average quantity of milk secreted daily under normal conditions:

At the end of first week..............oz. 10–15 (300–500 gm.)
During the second week............ " 13–18 (400–550 ")
During the third week .... " 14–24 (430–720 ")
During the fourth week .... " 16–26 (500–800 ")
From the fifth to the thirteenth week " 20–34 (600–1030 ")
From the fourth to the sixth month.. " 22–38 (720–1150 ")
From the sixth to the ninth month .. " 30–40 (900–1220 ")

It will be observed by comparing the above table with those in chapters III. and IV. that the increase in quantity of milk ingested corresponds quite closely with the increase in stomach capacity and body weight. In the same manner we observe that this increase in quantity is most rapid during the first three months, to meet the increasing demand for nutrition during this period. Further analysis of the

reports of these cases shows that the larger infants took, not only absolutely but relatively, more than the smaller. As before noted, the growth of large babies is relatively more rapid than that of smaller ones. Attention is again called to the wonderful automatic adjustment of the quantity of milk to the needs of the child.

It is a question whether the daily quantity of milk can be increased by any medicinal agent at our commad. It is well known, however, that the mammary secretion is quite sensitive to many influences, both as to its quantity and composition.

A so-called "dry diet" in which there is a deficiency of water, usually diminishes the secretion, while, on the other hand, it may be increased by a liberal allowance of water, milk, cocoa, beer and other fluids.

Attention is again directed to the mental attitude of the mother during nursing, as influencing the quantity of milk. It must not be forgotten, however, that *over anxiety* to produce, defeats its very object.

Loss of fluids from any cause, as copious perspiration, menstruation or diarrhœa may lessen the amount.

The secretion of milk, when scanty, may be increased by any agency that increases normal metabolism; as diet, exercise, massage, electricity, fresh air, sunlight, congenial surroundings, freedom from discomfort and an equable temperament. Sudden emotion, as profound grief, anxiety, anger, fear, or anything that produces shock or profoundly impresses the nervous system, may not only diminish the secretion, but occasionally cause total suppression. It is suggested that regularity be observed in putting the child to the breast, even though there be little evidence of milk as the secretion is undoubtedly promoted by the act of nursing.

The frequent disturbances of nutrition of the nursling have led to much study, not only concerning the qualitative changes in his food, but also as to their causes. From our limited knowledge of the exact physiological processes in

milk production, we have been compelled to turn to the field of clinical observation for facts relating to this subject. Here, indeed, is abundance of material, but as in all knowledge obtained from such sources, an immense number of painstaking comparisons and deductions is requisite to establish a principle.

It is accepted that constituents of the milk may be influenced by variations in the hygiene, especially in the diet of the mother. The former belief that the fat of the milk was increased by the fat ingested has been repeatedly disproved by actual experiment, although Winternitz, of Berlin, claims to have demonstrated the contrary in lower animals. It is believed to-day that the proportion of fat in the milk depends largely upon the amount of proteid in the mother's food, increase or diminution in the latter causing a like change in the former. This relation of proteids in the food to fats in the milk is a matter of daily observation to all who study intelligently lactation. A mere ingestion of albuminoids, however, is not sufficient to produce a "rich milk," since thorough digestion and assimilation are essential to fat elaboration Fat may be scanty in the milk, not only from an insufficiently nitrogenous diet, but also as a result of *excess* of *fats* in the food. Examples are not wanting of mothers, who in their efforts to enrich their milk, defeat this object by inordinate ingestion of cream.

The familiar spectacle of a rachitic infant at the breast of the mother, whose diet consists largely of amylaceous and saccharine constituents, with a milk of a high specific gravity, and low fats, emphasizes the importance of our knowledge of fat production. The substitution in this case, of a diet of eggs for breakfast, meat for dinner and supper, with a cup of beef broth between times and a limited supply of vegetables and sweets, will, almost invariably, show an increased percentage of fat in the milk, with subsequent improvement in the nutrition of the child.

It occasionally occurs that the infant shows the effects of excessive fat in the so-called "fatty diarrhœas," in which

fat is seen in the diapers in glistening masses or floating as a pellicle on the surface of the water. Again in the "spitting babies," who regurgitate their food shortly after nursing, analysis of mothers' milk shows sometimes as high as seven per cent of fat. In such cases meats should be restricted and vegetables and bread stuffs encouraged in the mother's diet.

The proteids are rarely low, except in cases of exhaustion or debility, as from sickness or insufficient food. In this condition the milk is poor and watery, there being a deficiency in all the solids. In such cases the hygiene of the mother requires a liberal diet, with all the accessories for the improvement of her general nutrition. Here nitrogenous foods are necessary to increase proteids in the milk. It may occur that the mother's milk, in cases of debility, shows an excess of proteids with a deficiency of other constituents, the debilitated infant exhibiting evidences of indigestion, in constipation or in diarrhœa and vomiting.

Excessive proteids may appear, also, in the over-fed mother of sedentary habits, for whom exercise in the open air must be prescribed, with reduction of diet. Idleness and discontent may be replaced by congenial occupation, to the improvement of the milk in this respect. The relief of constipation or the alleviation of any bodily discomfort may alone be sufficient.

Sudden disturbances in the digestion of a healthy nursling leads the physician, at times, to startling conclusions in his search for their etiology. Violent agitation of the nervous system of the mother may change the quality of the lacteal secretion almost instantly: the milk, quite frequently under these circumstances, resembling colostrum in its changed proteids, low fat and colostrum corpuscles. Instances are known where convulsions, and even death to the nursing infant have followed.

The analysis of the mother's milk frequently leads to the cause of the indigestion of the infant. The secretion of the colostrum milk has been known to follow undue fatigue,

FIG. 56. EFFECT OF THUMB SUCKING.
FIG. 57. BOTH SETS OF TEETH IN POSITION. (TALBOT.)
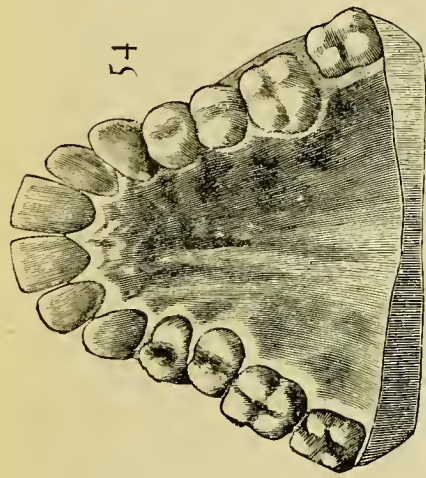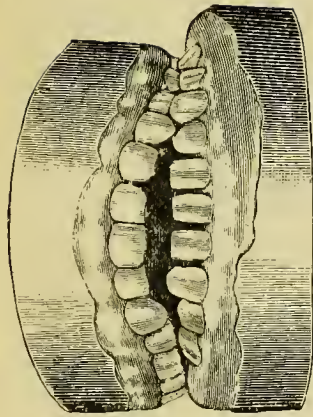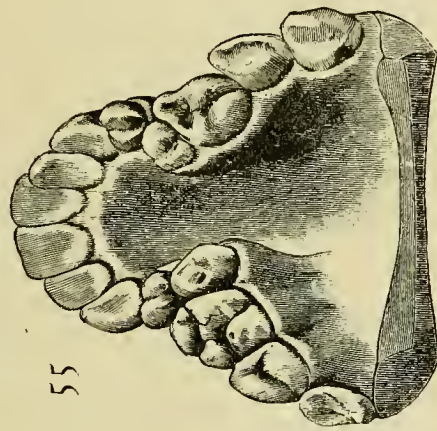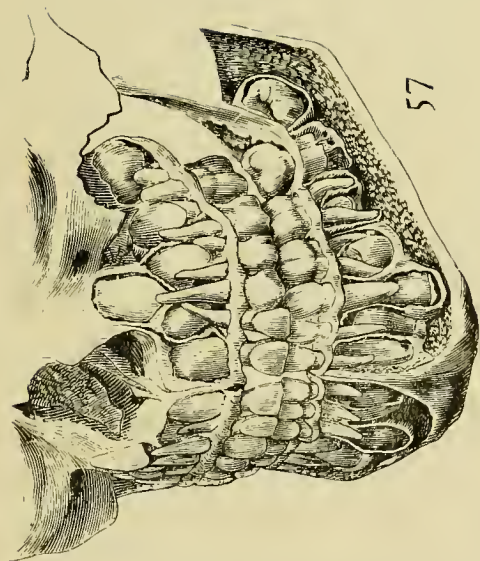
FIG. 54. HIGH ARCHED PALATE.
FIG. 55. SADDLE SHAPED PALATE.

FIG. 58. SPINA BIFIDA. (Author's clinic.)

58

FIG. 59. SPINA BIFIDA. (Hektoen.)

59

excitement, anger, grief, coition, also menstruation and conception. In fact, disturbances of digestion in the infant are frequently the first intimation of pregnancy in the mother. In the event of these disturbances, and analysis of the milk show colostrum, the child should be removed from the breast until (excepting in pregnancy) the secretion approaches the normal. Meanwhile the breasts should be emptied regularly by the pump.

Both the quantity and quality of the milk is influenced by the frequency of nursing. Poor milk usually results from prolonged or irregular intervals in nursing. The more frequently the breasts are emptied the higher will be the percentage of solids, especially the proteids. The infant, restless from indigestion induced by excess of proteids, is unfortunately given the nipple at short intervals to quiet him. The result is increased indigestibility of the milk from greater excess of proteids. What is needed is water for his thirst, rest for his stomach and rest for the mammary glands.

In conclusion, a table may best express a summary of the means at our command for regulating the composition of mother's milk.

The percentage of proteid is increased by
       Increased frequency of nursing.
       Increased liberality of proteid food.
       Insufficient exercise.

The percentage of proteid may be diminished by
       Diminished frequency in suckling.
       Diminished proteid food.
       Increased exercise.

The percentage of fat is increased by
       Increased proteid diet.

The percentage of fat is diminished by
       Deficiency of proteid food.
       Excess of fatty foods
       Fasting

The percentage of water is increased by

Increased fluid diet.

The percentage of water is diminished by

Saline cathartics.

Diminished fluid diet.

As previously stated, the percentages of sugar and ash vary but little.

CHAPTER XIV.

MILK ANALYSIS.

The relationship of the quality of the milk to the nutrition and well being of the infant is a subject of ever growing interest. The more we study lactation, the greater significance attaches to its disturbances. It has been generally recognized that the relation was a causative one and such expressions as "milk not agreeing with the baby" have in a vague way expressed our ideas. As to *why* it failed to agree we have had but dim conceptions and have looked to the physiologist for explanation. Until very recently the best informed based their knowledge of this relationship upon purely theoretical grounds. Failures in the nutrition of infants were explained upon the hypothesis that some constituent was wanting or in excess in the mother's milk. Since no verification of this supposition was practicable even possible, no satisfactory corrective measures could be undertaken. In other words, the determination of the causes of digestive or nutritional disturbances amounted to little more than guess work. It is true that careful chemical analyses were occasionally made, but these were so infrequent as to be of little value from the paucity of data thus obtained. That the mind of the profession has been frequently returning to this great field of possibilities in the search for etiological factors, is evident from the references made to the quality of breast milk in the discussions of infant feeding. Former methods, however, for determining good breast milk were crude enough to be pathetic—the more so when we take into consideration the want of knowledge concerning the

chemistry of this secretion. As previously stated, more recent and extended analyses have demonstrated the erroneousness of the conclusions of the older chemists, so that the proportionate constituency accepted to-day differs quite widely from that of the chemists of the preceding generations. So, too, the principles of the regulation of the secretion enunciated in Chapter XIII, are the result of quite recent deductions and widely at variance with former ideas.

In the older treatises on this subject, we find oft-times, dogmatic assertions based upon the mere physical appearance of the secretion. Certain standards were adopted as of color, opacity, tenacity, co-agulability, chemic reaction, specific gravity, taste, odor, quantity of cream on standing, appearance of the residuum, microscopical appearance as to the number and size of fat globules, or the presence or absence of colostrum corpuscles. Necessarily there was much difference of opinion as to the significance of their variations.

The relative quantity of fat was early recognized as important, and frequent attempts at its determination for clinical purposes were made. It was not until the importance of the relation of fat to specific gravity, in estimating total solids, was appreciated that our efforts at milk examination began to assume practical value. The method, in general practice, of determining the percentage of fat, consists in allowing a sample of the milk to stand for a certain time at a given temperature until the line of demarkation between cream and milk is sharply defined. The percentage of fat is to cream as 3 to 5.

A number of devices for the determination of fat percentage have been employed, among which may be mentioned Holt's and Chevalier's cremometers, Soxhlet's areometer, Feser's lactoscope, Marchand's tube, the lactocrit of de Laval, and Babcock's and Leffman and Beam's methods. Several more elaborate chemical methods have been omitted as impracticable for the ordinary practitioner.

Of the many devices four only, will be described, the

others being various modifications of the four principles therein employed.

(1)   The gravity process employed by Holt.

(2)   The optical test of Feser.

(3)   The action of re-agents as shown by Marchand.

(4)   The combined action of re-agents and centrifugation as employed by Babcock and by Leffman & Beam.

Holt's apparatus for this purpose consists of a slender glass cylinder, graduated to a hundred divisions. (Fig. 74) This cylinder is filled to the zero mark and allowed to stand at a temperature of 70° F. for twenty-four hours, or until the cream line is sharply drawn, when the percentage may be read from the graduations on the glass.

Fig. 74   Fig. 75   Fig. 76
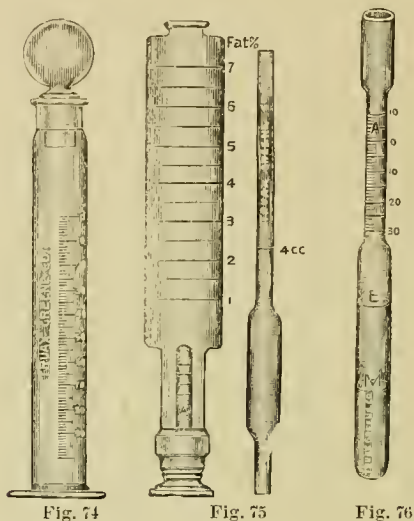
Feser's lactoscope consists of a slender glass cylinder, resting on a foot piece containing a short procelain column projecting upwards from the bottom (Fig. 75.) This column is marked with black transverse lines. The test is applied by introducing a given quantity of milk, by means of the pipette shown in the figure, which renders the central column

invisible. This milk is gradually diluted with pure water, with frequent shaking to secure thorough admixture. The process is continued until a degree of attenuation is reached, sufficient to bring into view the striae on the central column. The surface of the cylinder is so graduated that the quantity of the mixture is made to express the percentage of fat in the sample.

In Marchand's method a graduated glass tube is employed. (Fig. 76). Pour in 5 c. c. of milk and a drop of caustic soda solution; add 5c. c. of ether and shake the tube until the fat is extracted. On adding absolute alcohol and warming, the fat rises and can be calculated from the depth of the layer in the tube.

In the Babcock method as well as in that of Leffman & Beam, the milk is acidified in order that the proteids may be changed to soluble acid albumin which offers less resistance to the rising and aggregation of the fat globules. This is done in a peculiarly constructed bottle, having a long, slender, graduated neck. (Fig. 77.)
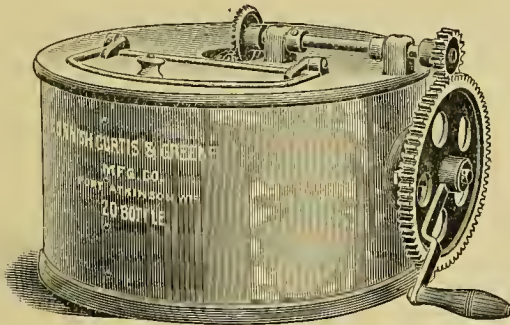
Fig. 77   Fig. 79

The bottle is then placed in a centrifugal machine (Fig. 79) and rotated from two to five minutes, the time depending upon the speed of rotation, when the separated fat ap-

pears as a distinct layer in the graduated neck where the
percentage is easily read.

In the Babcock method only sulphuric acid is employed
as follows: 17.5 c. c. of milk is poured into the bottle through
a slender pipette, care being taken not to smear the neck,
then 17.6 c. c. of strong commercial sulphuric acid is slow-
ly added, at the same time the test bottle is given a gyra-
tory motion to facilitate admixture without too sudden co-
agulation. The bottle thus filled nearly to the shoulder is
revolved for five minutes with the speed of, at least, 1,000.
Sufficient boiling water is then introduced to fill the bottle
well up into the graduated neck, when it is again centri-
fuged for one minute, after which the percentage of the su-
pernatant fat may be read off.
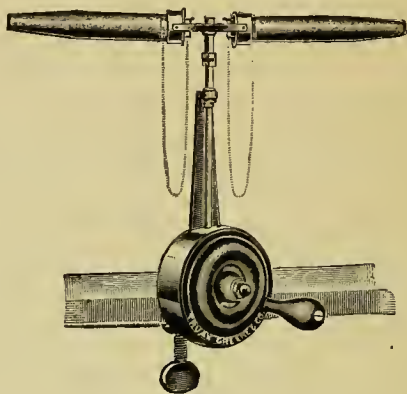
Fig. 80   Fig. 81

The principle of the Leffmann & Beam method is similar.
Their test bottles (Fig. 80) have a capacity of about 30c. c. and
are provided with a graduated neck, each division of which
represents one-tenth per cent by weight of butter fat. 15c.
c. of milk are measured into the bottle, 3c. c. of a mixture
of equal parts of amyl alcohol and strong hydrochloric acid
added, the bottle filled nearly to the neck with concentrated
sulphuric acid and the liquids mixed by holding the bottle
by the neck and giving it a gyratory motion. The neck is

now filled to about the zero point with a mixture of sulphuric acid and water. It is then placed in the centrifugal machine (Fig. 81). After rotation for from one to two minutes the fat will collect in the neck of the bottle and the percentage may be read off, allowance being made for the meniscus. It is convenient to use a pair of dividers in making the reading. A smaller bottle is manufactured for this test and should it be used the following rule for the proportions of reagents may be employed. First, determine the capacity of the bottle to the shoulder: 50 per cent. of this for the milk, 10 per cent for the mixture of amyl alcohol and hydrochloric acid and 40 per cent. for the sulphuric acid.

Of these methods for obtaining the percentage of fat, that of Holt has the advantage of simplicity. Its drawbacks are, first, the length of time, twenty-four hours being necessary for making the test; second, the employment of the arbitrary algebraic proportion, the ratio of fat to cream as equaling 3 to 5 being questioned.

The Feser's lactoscope, being purely an optical test, is open to the objection of all color tests, that different eyes give different estimates. Furthermore, the fact that the same weight of fat retards more light when in the form of small globules than when in the form of large globules, renders this method of testing unreliable.

Marchand's test has not given the satisfactory results obtained by other methods.

For simplicity of detail and accuracy in results, the Babcock machine is rapidly displacing all others. A cheap machine, from which most excellent results are obtained, carrying as low as two bottles, (Fig. 82). may be secured from any dairy supply company. Nor is the water jacket of the larger Babcock machine essential to good work, since by the admixture of sulphuric acid with the milk, sufficient heat is evolved to maintain fluidity of the fat long enough for the reading of one or two specimens. Where one sample only is rotated, the opposite arm of the centri-

fuge should be balanced with an equal weight to prevent accident.

The Leffmann & Beam process is here detailed, because of the two advantages it possesses. First, the bottles are adapted by their form and size to the ordinary office centrifuge. Second, their capacity allows of the determination of fat from a smaller sample, a feature of practical importance because of the frequent difficulty in securing a larger quantity of breast milk.

The amount of fat in a given quantity of milk may be determined, it is claimed, to within three-tenths of one per cent by the above methods.

The differing effects upon the specific gravity of milk, produced by variations in its different constituents. enables us to form some estimate of the quantity of the other solids when the specific gravity and amount of fat are known. Thus increasing the fat diminishes the specific gravity, while it is augmented by increasing other solids. Conversely, diminishing the fat increases the specific gravity; while diminishing the other solids, diminishes it. To illustrate; in milk of average specific gravity, the fat being high, the total solids must be relatively high. Conversely the fat being low, the total solids may be low. In a sample of high specific gravity the fat being high, the remaining solids must be very high; the fat being low, the total solids may be relatively low. In other words, the higher the fat, the higher, of necessity, must be the total solids to maintain an average specific gravity since fats have a tendency to lessen it.

Since the sugar and salts maintain a fairly constant proportion in milk, the determination of the proteids is next in importance. A number of mathematical formulæ have been employed for estimating more definitely than the above, the percentage of total solids, from the known fat and specific gravity. A method recommended by Richmond (in Analyst" March '95, p. 57) which furnishes uniform results, within he limits of ordinary variations, is here given. The total

solids equal the sum of one-fourth the last two figures of the specific gravity, plus six-fifths of the percentage of fat, and the arbitrary decimal fourteen one-hundredths. The algebraic expression of the equation being as follows: T. S. $= \frac{Gr}{4} + \frac{F6}{5} + .14$

In this method we assume that the sugar maintains a constant percentage of of 6.5 per cent, and the salts of 0.2 per cent. To illustrate the application of this equation, take, for example, milk with a specifiic gravity of 1.028 and fat of 4 per cent.

T. S. $= \frac{28}{4} + \frac{6}{5}$ of 4 $+ .14$

T. S. $= 7 + 4.8 + .14$

T. S. $= 11.94$

Fig. 82　　　　　　Fig. 83

11.94 minus 10.70 (the sum of the fat, 4. the sugar, 6.5; and the salts 0.2;) equals 1.24, (the remaining proteids.)

The objection, that the above method yields approximate, rather than positive, quantitative results, may be met by the statement that uniformity of procedure secures a standard of comparison of great clinical value, even though the determination in a given case may be lacking in chemic accuracy. The microscope is of value in ascertaining the

size and uniformity of the fat globules, the presence of colostrum corpuscles, or other bodies foreign to milk, as bacteria, pus or blood.

The specific gravity may be obtained by any standard hydrometer at sixty degrees F. (Fig. 83.) The specific gravity should be increased or diminished by 1, for every ten degrees above or below sixty degrees F.

Milk, on account of its viscidity retains minute air-bubbles after agitation, a fact to be borne in mind when obtaining specific gravity.

CHAPTER XV.

WEANING AND SUBSTITUTE FEEDING.

In the hygiene of infancy the question of substitute feeding is of secondary importance only to that of lactation. We are relieved of the responsibility of its consideration in the care of every nursling by one circumstance alone, namely; the death of the infant, since from the first establishment of lactation, conditions may develop at any time which render breast feeding impracticable. The character of the lacteal secretion is subject to variations as a result of some well known influences and from many that are still unknown. One series of changes, so constant as to be accepted as physiologic, consists in a steady decrease in the proteids and salts. The total solids maintaining a somewhat uniform percentage until the seventh month, on account of the constant increase of the sugar. After this time however, the decline in salts and proteids is so rapid that the percentage of total solids is steadily reduced. That the nutrition of the child should be affected visibly by the decline of these important constituents, at a time, especially, when material is demanded for rapid growth, is not a matter of surprise. This would appear to furnish good reasons both physiological and clinical, for the commencement of supplementary feeding. Moreover the eruption of the teeth, the changes in the salivary secretion, as well as those of the

stomach and pancreas, suggest preparation for digestion of a different class of foods.

The word supplementary is here used, not to indicate a total change in the infant's food, but merely a reinforcement, particularly in those constituents which the waning function of the mammary gland evidently fails to supply. In addition, the changed digestive secretions, especially in the development of amylolytic power, afford more than a hint of a preparation for starch digestion.

The changes in breast milk, above referred to as constantly progressive, show considerable variation as to the time of their occurrence in different women. Thus one mother may have, apparently, expended her best physiologic energy of milk elaboration by the end of the seventh month; while on the other hand, another may not show the same degree of deterioration at the fifteenth month. To the queries when shall supplemental feeding begin, or when shall substitute feeding be inaugurated, in other words, shall weaning be effected gradually or abruptly and at what time, it must be evident that no decisive answer can be given.

The indication for weaning, so far as the infant is concerned should be evidences of deficiency in normal development, which is frequently best shown by a failure to gain in weight. However, weight gain is not always evidence of normal nutrition, as many rachitic babies make fat rapidly.

Due reference should be had also to the season, as it is well known that radical food changes should not be inaugurated at the commencement of or during the heated term, when infants are especially susceptible to digestive disorders. Moreover, the eruption of an unusually troublesome tooth might well delay the change in food. Many other circumstances, which need not be enumerated, should be taken into consideration, nor must it be understood from the foregoing, that a radical change in the infant's diet is contemplated by the term "weaning." In fact the process should be gradual, the infant having been accustomed to supplemental feeding as often as once a day, through a period of

several weeks, and the food selected should conform some-
what closely to the milk of the mother, differing at first, in
the lower per centage of proteïds, as determined by repeated
analyses of the breast milk.

Aside from the normal time of weaning, occasions may
arise during the first year, when the decision must be made
as to whether the child can thrive on the milk of his nurse.
The relation of an infant to his food is sometimes arbitrary,
the explanation of which is ofttimes beyond our knowledge.
Thus one infant fails steadily at the breast upon which
another thrives. This has been observed even in the case
of twins. Transient disagreement should not be considered
sufficient cause for rejecting the breast, since many tempo-
rary disturbances may be corrected by attention to hygiene.
Without taking time for an extended presentation of the
advantages of breast feeding over all other methods, we
would merely state that the consensus of opinion deprecates
early weaning unless the fact is established that the mother's
milk cannot be made to agree. In this connection it is well
to call attention again to the immense advantages to be de-
rived from frequent examinations of the mother's milk, also
to the principles of hygene discussed in Chapter XIII for the
modification of the mammary secretion.

In the event of the occurrence of any acute disease in
the mother, rendering nursing unadvisable, the same plan
of procedure should be followed. A child should be im-
mediately removed from the breast upon the appearance of
acute infectious disease in the nurse. So, also; even well-
grounded suspicion of the existence of syphilis or tuber-
culosis demands immediate change. A suitable wet nurse
should be secured in case the infant is free from taint of
specific infection.

The development of mastitis renders the affected breast
unfit for nursing while suppuration continues.

The growing tendency on the part of both laity and
physicians to recommend weaning upon the slightest pre-
text, suggests the need of more emphasis upon the injunc-

tion not—to adopt substitution for breast feeding until it is clearly demonstrated that the latter can not be made to agree. It should not be forgotten, in considering the advisability of substitution, that no a priori reasoning will decide what food will agree in every case, and that often it is

> "Better to endure those ills we have,
>   Than fly to others that we know not of."

In the majority of cases, change in food is largely a matter of experiment. On the other hand, it must be remembered that many infants are deprived of their right to a fair start in life, by being confined to the breast which fails to furnish all the requisites for normal nutrition.

Reference is made in chapter XIII to the many influences that disturb lactation, transiently or permanently. The question as to the influence of menstruation and coitus upon lactation is of paramount importance and one concerning which the physician is often consulted. Concerning the latter, evidence is accumulating to show that excessive indulgence very frequently deteriorates the quality of the milk of the nursing mother, causing an increase in proteids, with the appearance of colostrum corpuscles. Under these circumstances the infant commonly gives evidence of acute gastro-intestinal disturbance.

Menstruation frequently disturbs lactation. Its early appearance may not require weaning but a later return should suggest its advisability.

The occurrence of conception is an indication for the immediate removal of the child from the breast, as this condition renders the milk insufficient, if not positively injurious.

When it becomes evident, from any of the conditions enumerated, that substitute feeding is necessary, the question *what* shall be substituted is of the greatest importance. *Errors in the management of substitute feeding are probably responsible to a greater extent than any other cause for the high infant mortality.*

Without entering upon an extended discussion it may be claimed that the best substitute is the wet nurse. The drawbacks to wet-nursing are many and extremely trying. It is probably on account of these that this substitution is not more frequently resorted to in this country. The diffi. culties attending the securing and selection of a suitable wet nurse, undoubtedly, lead many physicians and parents to shut their eyes to its importance, and accept the dictum of some eminent teachers—that artificial feeding can be conducted successfully in ninety per cent. of the cases They forget that the tacit admission, that the remaining ten per cent. may only survive upon the breast, is the strongest argument in favor of giving to *all* infants the implied advantages of this best method of feeding. Who is willing to admit that he deliberately rejects the best, simply because something inferior may, with care, be made to do? It is to be hoped that with the growing appreciation of the importance of breast milk for young infants, systematized organization for the supply of properly certified wet nurses will soon supersede the hap-hazard method of selection now in vogue.

The wet nurse should be chosen with definite reference to her temperament, the quantity and quality of her milk and her freedom from syphilis or tuberculosis. Her milk should be examined both analytically and microscopically. The breasts and nipples should give evidence of abundant and free lactation. A firm small gland is preferable to the large fat variety. A point to be observed is that after nursing there should be a marked decrease in the size of the gland which should refill within three hours. The nipple must be of good proportions and free from fissures and excoriations. On the whole, the best test for a nurse is the condition of her own child, who should always be carefully examined as to his nutrition and freedom from syphilitic stigmata. On this account a nurse whose child is at least three months old, is usually to be preferred. Nor is it essential that the ages of the infants should exactly correspond, providing

that lactation has become well established. Other things being equal, there are some reasons why a multipara should be selected.

It should be remembered that the function of lactation is at its best between the ages of twenty-one and thirty-five years. A nurse who has lost her child is more likely to give her undivided attention, than one whose child has been displaced. Should the first wet nurse's milk fail to agree it need be no cause for discouragement, as sometimes success crowns our efforts only after repeated trials.

In case a wet nurse is not available, it will become necessary to adopt artifical feeding. More has been written and said concerning this subject during the past ten years than on all other pediatric subjects combined. Text books and treatises on infant feeding too often show a tendency to complicate where they should simplify the subject. Many times long lists of dietary formulæ fill the pages with only empirical suggestions as to the reasons for their employment.

Having studied the physiology of normal lactation and infant digestion and nutrition, we should have a fairly practical knowledge of the quantity and quality of food required at different ages, and also the time and methed of feeding. That we should keep close to nature, both in the composition and physical properties of the food seems hardly necessary to state. Yet we see infants fed (?) on compounds differing so widely from those which their organs are prepared to digest that it is surprising so many survive.

Considerable partisanship has developed concerning the subject of infant feeding, and teachers have been designated as belonging to this or that class of feeders.

A few "essentials" from Cheadle may be of value in assisting the student to a practical application of some of the principles already laid down:

First. The food must contain the different elements in the same proportions as found in human milk, viz.: Proteids, one to two per cent.; fats, three to four per cent.;

carbohydrates, six to seven per cent.; salts, two-tenths per cent.; water, eighty-eight per cent.

Second. It must possess the anti-scorbutic property.

It is not yet known in what this consists. It is known that infants at the breast very rarely suffer from scurvy, and that the disease is found among those fed upon condensed or sterilized milk, or upon dessicated preparations. Prompt recovery, with the food unchanged, except the discontinuance of sterilization has been reported by several observers. Fresh milk, therefore, possesses, in addition to the important principles, this anti-scorbutic element, but not in large proportion, for milk in extreme dilution will not prevent the development of this disease.

Third. The total quantity in twenty-four hours must represent the equivalent, in nutritive value, of from one to three pints of human milk, according to age.

No fixed arbitrary rule can be given for all children. Careful observation of the infant as to whether he rejects some of his food soon after ingestion or seems hungry half an hour after feeding may prove a guide. The best indication that he is receiving his full equivalent is a steady weekly gain of two or three ounces or more in the early months.

Fourth. It must not be purely vegetable, but must contain a large proportion of animal matter.

Most vegetable substances are deficient in proteids and yield but a small quantity of fat. Moreover, it is known that the infant does not assimilate them as easily and fully as those derived from animal sources, even though these ingredients be supplied in the proper percentages.

Fifth. It must be in a form suited to infantile digestion.

The digestive organs, it will be remembered, have only recently assumed their function and are designed to deal solely with the bland, dilute and easily dissolved nutriment of mother's milk. In the natural method of feeding, the infant gets his nourishment in the same form at every

meal; so in artificial feeding variety is not desirable.
It is presumed that infants under six months
are unable to digest starches from the absence of ptyalin
and amylopsin; hence, for this age, any considerable amount
of starch in a food is enough to condemn it. As the walls
of the stomach are lacking in muscular power and the
glands produce but little secretion, it is evident that it is
not right to ask this organ to deal with large masses of
solid or semi-solid matter. Solids can be digested only in
a state of minute subdivision.

Sixth. It must be sterile.

Hydrochloric acid has antiseptic properties, it is true,
but in the first half year the stomach secretes little or
none of it. Hence infants are extremely susceptible to
gastro-enteric disorders, having little resistance to bacteria
and toxins. The products of fermentation are highly irri-
tating and the sensitive unstable nervous system of the in-
fant may be profoundly affected thereby.

CHAPTER XVI.

FOODS.

It has been stated that the substitute feeding of infants
is a broad subject. If the breadth of this subject be indicated
by the number and apparent variety of infant foods on the
market, a student may well quail before it. To the query
why such a large number of foods and preparations, the re-
ply has been made that commercial enterprise is responsible
for this, as it is also for the innumerable foods and prepara-
tions for adult use; also that manufacturing ingenuity is
stimulated to furnish presumed nutriment in a great variety
of forms by the whims, caprices and tastes of individual ap-
petites.

However reasonable the analogy may appear at first
sight, a little reflection will show its fallacy. Man is an
animal with educated or perverted tastes, which result in a
demand for variety in his viands. He is capable, also, of

determining, to some extent, the nutriment derived there-
from.   At any rate he may recognize some of the more im-
mediate effects from the ingestion of different foods.   The
infant, on the other hand, has no consciousness of food ef-
fects, either immediate or remote.   Rarely in early life has
he tastes, either acquired or perverted.   Instinctively he
craves nourishment, and is almost invariably satisfied with that
furnished normally by the breast.   Variety in form or flavor
is neither desired nor desirable.   Reference to the principles
enumerated in Chapter XV, Rule V, will show that uni-
formity of food, containing the five constituents, is what
the infant requires and with which he is satisfied.   The
great variety of baby foods in the market, no doubt due to
commercial enterprise, is partly the result of prejudice and
ignorance.   Nor is the ignorance confined exclusively to
the laity.

The average mother's withdrawing her breast from the
infant is likened to a vessel at anchor in a safe roadstead,
slipping her cable in the absence of pilot, chart or compass.
The baby knows not what he needs, the mother knows little
more; but she can read, and the claims of the enterprising
food agents attract her attention.   Too often physicians, al-
so, derive their supposed knowledge of infant dietetics from
the same source.   Frequently so called infant foods owe
their popularity to the vociferous claims of the dealer, sup-
ported by certificates from members of the profession as to
their clinical observations.   In the majority of cases these
certificates assert little more than that infants have partaken
of these foods and lived.

The spectacle is by no means uncommon of anxious par-
ents running the entire gamut of the advertised prepara-
tions in the market in the hope of stumbling upon some-
thing which will agree with the baby.   Nor is this practice
confined exclusively to the laity.

On account of its cheapness and abundant supply,
it is not strange that, in his quest for a substitute food,
man should turn to the milk of the lower animals, posses-

sing as it does the grosser physical characteristics of mother's milk, with the confirmation of its apparent identity by the earlier chemic analyses. So in different portions of the globe mammals, including the cow, goat, ass, mare and camel, have contributed their lacteal product for the orphaned human infant. But little question was raised in former years as to its value and availability as a substitute. Now and then, to be sure, in the discussion of infantile disorders, some astute observer might refer parenthetically to the fact that in critical conditions infants at the breast afforded more favorable prognosis than the bottle fed. It was not until the attention of the world was arrested by the startling mortality in the latter class that the differences between the milks of different mammals in their relation to the requirements of the infant began to be studied systematically.

The result is seen in the immense impetus given to the study of the food question, to the extent that the deductions of yesterday are refuted by those of to-day, and the accepted conclusions of last year's text book may be obsolete ere a second edition leaves the press. In this critical research and rapid advance of knowledge, the whole world has furnished contributions from the best minds; but from no section have been drawn the valuable practical applications that have been made within the present decade by a brilliant coterie of Americans. Leeds, Chittendon, Babcock, Harrington, Leffman and Beam, Jacobi, Rotch, Holt, Starr and the Adriances have placed infant feeding in America on an advanced plane not found in other couutries.

As a result of this work, some of the reasons why cow's milk does not meet all the requirements of the infant have been demonstrated. The results of recent analyses give the constituents of cow's and mother's milk as follows:

Average composition	Cow's.	Mother's
Specific gravity	1032.	1030
Total solids	%14–13	%13–12
Albuminoids.	%4.00	%1–2

Fat.................... .. %4.00............. %3–4
Sugar................... .%4.50............. %6–7
Salts.................... %0.7 .... %1–0.2
Reaction.....................Acid*.......Alkaline
Bacteria...................Swarming with* None

It will be seen at a glance that they differ but little in specific gravity, in the quantity of their total solids and water, and in their percentage of fat; more widely in their salts, sugar and proteids; most widely in regard to chemic reaction and presence of bacteria.

So far as known, the fats and lactose in cow's milk have the same food value as similar constituents in breast milk. Many disturbances of infant digestion are traceable directly to the proteids. Their excess in cow's milk has been considered as the principal factor in its disagreement. As a result of this belief, reduction of this constituent has been practiced by the addition of water; so that rules for dilution of cow's milk in proportion to age of infant are found in older text books. Results, however, showed that in these dilutions the nutrition suffered from a coincident diminution of fats and sugars. Consequently, it was recommended that the percentage of lactose and fats be maintained by the addition of sugar of milk, and cream, while the reduction of proteids was effected by the proper addition of water. This process of modification came to be known as the Rotch method from the energy displayed by that eminent teacher in perfecting the details. Laboratories for this modification have been established in the leading American cities, to which orders are sent for definite percentages of modified milk, as drugs are ordered by prescription from a pharmacy. Too much praise can not be accorded the distinguishd originator of the milk laboratory, since more than any other agent, it has been the means of leading the proession to the habit of definite percentage feeding. It will be seen from the accompanying order blank, that the physi-

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*This refers to cow's milk as it reaches the consumer.

cian may, at will, control the amount of different ingredients, varying their percentages to meet the varying requirements of the little patient. For some of the indications for these variations, the reader is referred to Chapters XI and XII.

℞	PER CENT.		REMARKS.
Fat............			Number of feedings.... ....
Milk·Sugar......			Amount of each feeding... ....
Albumoids			Alkalinity...............%
Mineral Matter..			Heat at.... ....°F
Total Solids......			Infant's age...............
Water. ....ad.	100	00	Infant's weight.. ....
Order...................................			
....			

Date	Signature,
......................190	....

That many disorders of infancy are due to the presence of bacteria in cow's milk has long been suspected and recently demonstrated. Passing over the infections from the presence of such micro-organisms as those of tuberculosis, typhoid fever, scarlet fever, diphtheria, etc., etc., for the time being, it may be stated that the proneness of cow's milk to decomposition, with its effect upon the nursling was early recognized as constituting one of the commonest dangers of milk feeding. Hence the hygienic dairy management became a

question of the highest importance. It has been demonstra-
ted that milk production may be so guarded as to furnish a
product comparatively free from pathogenic micro-organ-
isms. The same care in the selection of the cow as was recom-
mended in the selection of the wet nurse, the same antisep-
tic details in her care and in the handling of the milk were
required in the chapters on infant hygiene, will insure food
that is practically sterile.

At least two dairy farms are in operation in this vicinity,
Chicago, in which all the details of aseptic milk production
are carried out to the fullest requirements.

In case the milk supply or its handling is not above
suspicion, sterility may be secured by the application of
heat. Different sterilizing devices are in use, from the mere
scalding of the milk in a farina kettle to the more elaborate
apparatuses of Soxhlet or Bœckman (Fig. 84). A tempera-
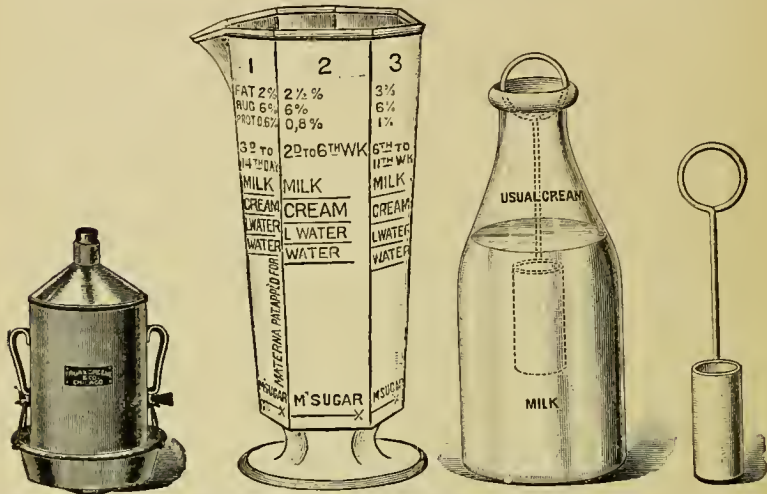
Fig. 84   Fig. 85   Fig. 86

ture of 212° F. maintained for over an hour is required for
complete sterilization. Milk thus treated and protected from
subsequent infection will resist decomposition changes for
more than a week at ordinary temperature. For prolonged
keeping, three sterilizations. after intervals of twenty-four

hours, are necessary. For immediate use, however, pasteurization (exposure to a temperature of 157° F. for forty minutes) is believed by many to meet all the requirements. Objections to prolonged boiling are due to changes in the nutritive quality of milk thus treated; the coagulation of the lactalbumin causing a loss in food value estimated at twenty per cent of the proteid; at the same time the casein is rendered less soluble, the fats more refactory to digestive processes and the flavor is perceptibly changed.

The acid reaction of cow's milk renders the addition of an alkali necessary. For this purpose bicarbonate of sodium or potassium, or liquor calcis may be used, (preferably the latter, of which five to forty per cent. may be necessary). Of the sodium bicarbonate, one or two grains to the ounce will be sufficient.

The expense incident to the laboratory manipulation, and the impracticability of its establishment except in larger cities, will necessarily limit the field of operation for this very valuable adjunct. Consequently home modification is of greater interest to the majority of practitioners. In this connection, the protection of the supply will ever continue to be the most important consideration in substitute feeding with cow's milk.

Of rules and methods for home modification a great number and variety have appeared, with the promise of more to come. Some are so crude as to amount to little more than dilutions, while others are so intricate, in their formulæ and equation reductions, as to be of little value except as mathematical curiosities. A rule from Baner, which commends itself on account of its simplicity and efficiency, is here given. Its application presupposes the percentages of fat, proteids and sugar in cow's milk to be four each.

First determine the quantity needed for the day's feeding and the percentages of ingredients. To find the amount of cream that will have to be used in the mixture, subtract proteid per cent. from fat per cent. and multiply the remainder by the total number of ounces of mixture divided

by twelve.   This gives the cream (16 per cent.) in ounces
e. g. $(Fat-Proteid) \times \frac{Quantity}{12} = Cream.$

For estimation of milk, multiply quantity of mixture by
proteids per cent. and divide by four.   This gives total mix-
ture of milk and cream.   Subtract from this the amount of
cream,   the   remainder   will   represent   the   milk, e. g.
$\frac{Quantity \times Proteids}{4}$ = mixture of cream and milk.
Mixture—cream=milk.

To obtain the amount of milk sugar, multiply the dif-
ference between sugar per cent. and proteid per cent., by
quantity of mixture and divide by 100, e. g. $\frac{Sugar-Proteid \times Quantity}{100} =$
amount of milk sugar (in ounces).

For 20 per cent. cream the denominator of the cream
formula should be 16 instead of 12, and for 12 per cent.
cream 8 would be required for the denominator.   After the
quantities of cream and milk have been determined, the
rest of the total quantity of mixture is made up by the ad-
dition of water or other diluent.   Note—The use of the
centrifugal separator in our best dairies brings definite per-
centage cream within the reach of the majority of city con-
sumers.   Gravity cream from good 4 per cent. milk may be
obtained in approximately definite percentages as follows:
set the milk in a deep vessel on ice for 12 hours, the upper
fifth will represent 16 per cent. cream, best secured by si-
phoning from the bottom the lower four fifths.   Ordinary
gravity cream represents 16 per cent. fat, from this 12 per
cent. cream may be obtained by taking two parts 16 per
cent. cream and one part milk of 4 per cent. fat.

Many busy practitioners, who have not had previous
drill, can not spare, or will not take the time to work out
these formulae for themselves.   For their assistance many
rules, approximately correct, in table spoonfuls and ounces
have been suggested.   A seven paneled glass graduate,
called the "Materna" (Fig. 76) has been presented by a New
York firm, on each panel of which markings indicate the
necessary amount of milk, sugar, water, lime water, and
cream, respectively, to secure certain percentages, which

Fig. 60
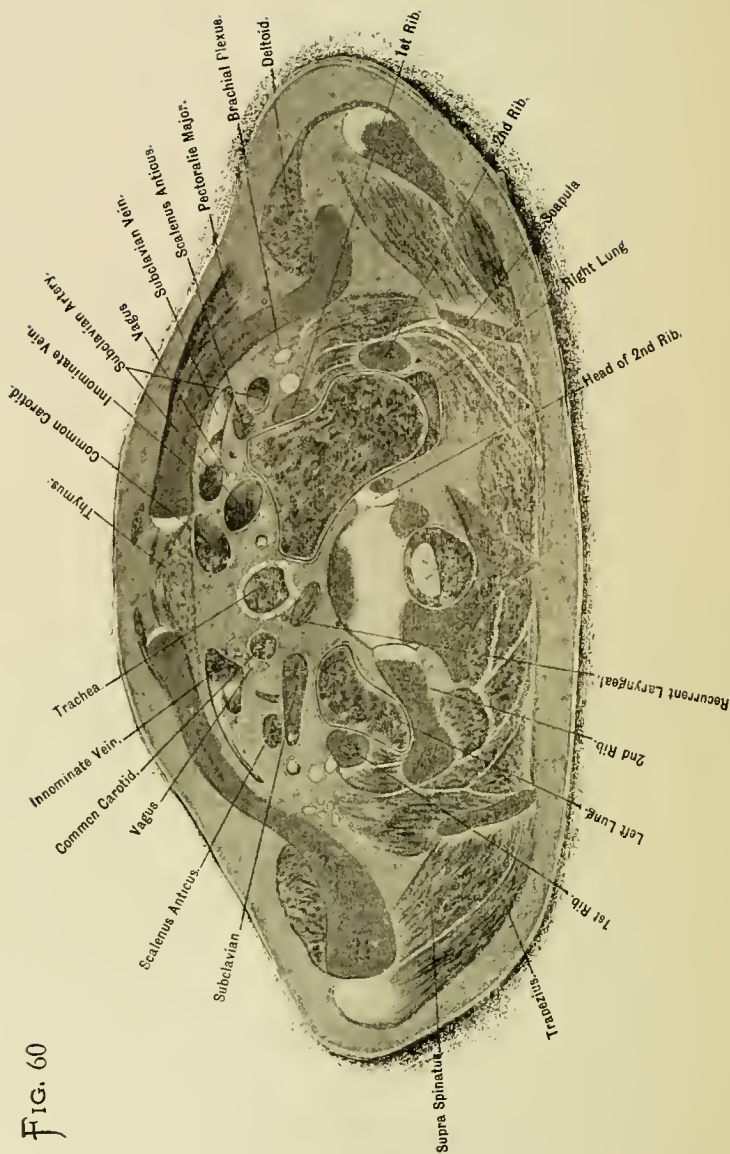
FIG. 60. HORIZONTAL SECTION OF GIRL BETWEEN FIVE AND SIX YEARS OF AGE AT THE LEVEL OF THE CLAVICLES. (SYMINGTON.)

Deltoid.

Brachial Plexus.

Pectoralis Major.

Scalenus Anticus.

Subclavian Vein.

Vagus.

Subclavian Artery.

Innominate Vein.

Common Carotid.

Thymus.

Trachea.

Innominate Vein.

Common Carotid.

Vagus.

Scalenus Anticus.

Subclavian.

Supra Spinatus.

Trapezius.

1st Rib.

2nd Rib.

Scapula.

Right Lung.

Head of 2nd Rib.

Recurrent Laryngeal.

2nd Rib.

Left Lung.

1st Rib.

Fig 61

Deltoid

Teres Minor

Subscapularis

3rd Rib.

4th Rib.

3rd D.V.

Trapezius.

Oesophagus.

Thoracic Duct.

Serratus Magnus.

Subscapularis.

Infra-spinatus.

Long Head of Biceps.

Axillary Artery

Pectoralis Minor

Pectoralis Major

Left Vagus Nerve.

Left Phrenic Nerve

Arch of Aorta.

Thymus

Manubrium Sterni.

1st Costal Cartilage.

Left Innominate

Right Phrenic.

Superior Vena Cava.

2nd Rib.

Trachea.

Right Vagus Nerve.

Tip of Coracoid Process

FIG. 61. HORIZONTAL SECTION OF SAME SUBJECT AS IN FIG. 60, at level of third dorsal vertebra. (SYMINGTON.)

are also marked on the panel. It is possible that this device may be of some assistance to the busy practitioner. Two objections should be noted: its routine employment may tend to divert the physician from *thinking*; the other is suggested by the directions for feeding by age of patient, which is about as uncertain a standard as color of hair. Some physicians employ slips, carrying printed directions to nurse or mother, so arranged that they may be changed easily to meet the requirements of particular cases.

Dr. H. D. Chapin has devised a new method of removing the top-milk from the milk bottle for home modification, which he claims is especially applicable to the needs of the nursery. He employs a small tin dipper with a vertical wire handle (Fig. 77). This dipper holds one ounce of cream or one ounce of granulated sugar, and a dipper and one half represents an ounce of milk sugar. As a result of experiment and numerous assays, Dr. Chapin has found that if nine ounces are removed from the top of the bottle and mixed together the product represents, with great uniformity, 12 per cent. cream. To get 8 per cent. cream it is only necessary to remove and mix 16 ounces from the top of the bottle. The above is applicable only to milk which has been bottled long enough to allow segregation by gravity.

To prepare 24 fluid ounces of food containing 3 per cent. fat, 1 per cent. proteids and 6 per cent. sugar, use 6 fluid ounces of 12 per cent. cream, 18 fluid ounces of diluent, and $1\frac{1}{5}$ ounces of sugar. Similarly to prepare 40 fluid ounces of food containing 4 per cent. fat, 2 per cent. proteids and 7 per cent. sugar, use 20 fluid ounces of 8 per cent. cream, 20 fluid ounces of diluent and 2 ounces of sugar.

In regard to all devices it is suggested that the young physician first form the habit of thinking and formulating for himself, after which he may best judge of their value.

In substitute feeding the aseptic care of the bottle, nipples and all utensils can not be unduly emphasized. The familiar death trap, known as the long tube nursing bottle, has at last attracted the attention of the legislators, so that

in some localities not only the use but also the sale is pro-
hibited by law.

CHAPTER XVII.

FOODS—Continued.

Since the milk of other mammals so closely resembles
the human product, and its abundant supply is co-extensive
with man, the question may again be raised, why the multi-
plicity of baby foods, especially when it is known that milk
is the cheapest. In this instance "commercial enterprise"
will not serve as an answer, for the demand must have ex-
isted to which the latter has responded. Without further
argument it is quite evident that cow's milk has failed to fulfill
all the requirements of substitute feeding, and in their need,
both laity and profession have turned to other sources.
Some of the objections to cow's milk as ordinarily obtained
by the consumer have been already memtioned, (the high
percentage of proteids, low percentage of sugar, reaction
and infection). These objectionable features having been
overcome, partly by the improved hygiene in production and
handling and partly by the elaborate percentage modifica-
tion referred to in Chapter XVI, the question of substitute
feeding would appear to have reached a solution. In this
case the only obstacles to its universal adoption would seem
to be the cupidity of the manufacturer of Baby Focds and the
credulity of the consumer. In fact, this is the view
taken by many conscientious baby feeders. Were
the solution of this problem attained, however, we
should not find the most eminent observers and
thinkers still struggling with it. As it is, med-
ical literature and reports of society proceedings teem with
discussions upon this ever interesting subject. We have
found that cow's milk modified never so wisely, cannot be
made to suit all requirements of infant digestion. Many
infants, no doubt the majority, thrive on it, and the careful

modification of its constituents has largely increased this number. There still remains however an appreciable percentage of cases in which the proteids of .cow's milk are not tolerated.

The lowest reduction possible, in the milk laboratory manipulations according to Rotch, leaves the proteids as o.22 per cent. It is hardly necessary to state that no infant will long survive this reduction. A higher percentage of digestible proteids is absolutely essential to nutrition and growth. As shown in a previous chapter their place cannot be filled by any known substitute. Moreover, the albuminoids of mother's milk differ essentially from those of cows milk. By taking two watch crystals, filled with a weak solution of acetic acid, and letting fall into them from a height of two or three inches, a drop of mother's milk and a drop of cow's milk respectively, one of these differences becomes apparent, mother's milk coagulating in light loose flocculi, which disseminate throughout the fluid; that of the cow's showing dense and heavy curds which fall to the bottom. In other words, the proportion of proteid coagulable by acid (caseinogen) is much greater in cow's milk than in human milk. According to König, the proportion of lactalbumin to caseinogen is as 1:4 in cow's milk, while in human milk it is as 1:2. It seems hardly necessary to repeat the statement that the finely sub-divided precipitate favors the action of the digestive secretions, while the dense curds of cow's milk resist this action so long that fermentation often ensues, with all its train of intestinal disturbances. Wroblewski lately demonstrated that human casein retains, during digestion, its nuclein in solution; it is fully digested; while in cow's casein the nuclein is not fully digested; a "paranuclein" is deposited undisolved and undigested.

From his studies of nucleon Siegfried found that cow's milk contains 0.057 and woman's milk 0.124 per cent. nucleon. In cow's milk the phosphorus of the nucleon amounts to six per cent. of the total amount of phosphorus contained in the milk; in woman's milk 41.5 per cent. Prac-

tically all the phosporus in human milk is in inorganic combination (nucleon and caseinogen). Concerning this point Salkowski says: "These conditions are evidently of the greatest moment in the nutrition of the nursling. As the development of the bones is more rapidly accomplished in the nurslings fed on woman's milk than in those fed on cow's milk, the probable conclusion is this: that nucleon has an important part in the absorption and assimilation of phosphorus. The same should be said of calcium, which also combines with nucleon. Although woman's milk contains less calcium than cow's milk, more calcium is utilized and the nucleon is evidently an important factor in its absorption."

From the above, some explanation may be drawn: First, as to why some infants can not be induced to tolerate cow's milk in any of its possible modifications; second, why normal nutrition can not be maintained even though digestive toleration be established. The assertion made by many writers that strong children may tolerate cow proteids even though not largely reduced, does not help us out, for the reason that it is for the weakly infant with the feeble digestion that the skill of the physician is sought. It was formerly believed that some of the mammals furnished a more digestible proteid than the cow; hence the goat, ass and mare respectively, have been extolled for this quality of their product. The following analyses by König gives the relative percentages of constituents, but clinical observation shows no advantages over cow's milk.

	Casein.	Albumin.	Fat.	Sugar.	Ash.
Goat	3.20	1.09	4.78	4.46	0.76
Ass	0.67	1.55	1.64	5.99	0.51
Ewe	4.97	1.55	6.86	4.91	0.39
Mare	1.24	0.07	1.21	5.67	0.35

On account of the indigestibility of the casein, partial predigestion of the milk has been practiced in some instances: thus, the addition of pancreatic extract, commonly used in Fairchild's process called peptonization, has proved effica-

cious in many cases. Fairchild's tubes contain extractum
pancreatis and sodium bicarbonate in sufficient quantity for
the treatment of one pint of cow's milk. The milk is first
gently warmed, then the contents of the tube stirred in and
the mixture brought to a boil in ten minutes. The boiling
arrests the peptonizing process and destroys the ferment.
This partial conversion renders the casein more flocculent
and less coagulable in the stomach.

Koumiss, matzoon and kephir-milk are merely expres-
sions of an effort to rid cow's, mare's and goat's milk of this
offending substance. From time immemorial attempts to
diminish casein coagulation by rennet or by pepsin have
been made.

Into a pint of warm milk stir two drachms of Fair-
child's essence of pepsin. After coagulation (about twenty
minutes) break up the clot with a fork and strain through
thin muslin, without pressure. The whey, containing some
lactose and salts, may be enriched by the addition of cream
and sugar (milk sugar), and the deficient albuminoids may
be supplied from egg albumen. Egg white is also success-
fully used in laboratory modification for cases intolerant of
cow casein. A liberal estimate would give one per cent.
albuminoid from the white of one egg in a pint mixture, so
that a prescription might be written as follows:

Fat...................	3.00 per cent.	
Lactose..............	6.50 "	"
Albuminoid..........	2.00 "	"
(Whites of 2 eggs)		
Ash	0.20 "	"
Water, ad...........	100.00 "	"
Alkalinity...........	6 "	"

Number of feedings 8.
Amount at feeding....4 oz.
Infant's age..........3 mo.
Infant's weight.......13 lbs.

In the above perscription some of the proteids are still

retained from the cream, necessary to secure the 3 per cent
fat. The egg, as a source of albumin, so long recognized as
valuable in tiding over critical periods of indigestion in
infants, has not received the consideration it deserves. Its
ready solubility, its sterility when fairly handled, its rich-
ness in albumin, steady supply and cheapness, all commend
it; while its ready digestibility and assimilation by the
most intolerant stomachs have long been recognized facts.
The objection by Leeds that it is "troublesome and
messy" would apply equally well to most of the
food preparations. An objection that sometimes it induces
ill smelling dejections, might be met by the suggestion that
sulphuretted hydrogen is innocuous; or the quantity of egg
in the mixture might be reduced.

It has been fashionable of late to decry the cereals as a
source of the constituents for substitute feeding; and not
without some reason, as the weazen infant starved on
starch, and the over-fatted, rachitic, sugarfed baby are familiar
pictures. From the fact, early established by the physiol-
ogists, that the salivary and pancreatic secretions of young
infants show limited amylolytic power, it was believed
by many that starch should have no place in the diet of the
infant. Indisputable clinical evidence, however, has dem-
onstated that a limited amount of well cooked starch, in the
form of cereal gruels and jellies, when mixed with milk, is
not only tolerated but favors nutrition; probably on account
of its own partial conversion by the secretions, and partly
through its influence in preventing the too dense coagula-
tion of the cow proteids. Analysis of barley water, given
below, affords no explanation for the nutritive value it dis-
plays in many pathologic conditions in which, for a time, it
is the only food ingested.

$$
\begin{array}{lr}
\text{Water} & 99.27 \\
\text{Fat} & 0.02 \\
\text{Albuminoids} & 0.03 \\
\text{Starch} & 0.39 \\
\text{Sugar} & 0.05 \\
\end{array}
$$

Ash 0.03

Many of the so called baby foods contain little more than starch and on that account cannot be too severely condemned; but the practice somewhat in vogue, of denouncing the entire array of proprietary foods on that account, is thoughtless and unjust.

There is enough reason for the condemnation of the majority of these foods because of the excess or deficiency of some constituents, but each should be judged upon its merits. On the other hand, there is much to recommend in some of these prepations, since intelligent manipulation, by supplying a deficiency, may convert easily a much despised patent preparation into a most valuable adjunct in substitute feeding.

The multitude of preparations may be divided into four general classes, as to their composition, mode of preparation etc.

1st. Milk foods; which consist wholly or partly of milk, with or without the addition of other ingredients, all or a portion of the water having been evaporated.

2nd. So called Dextrinized Foods; derived from cereal flour, in which the starch is partly converted by cooking and its own diastase, the great bulk, however, remaining as starch.

3rd. So called Leibig's Foods; in which the diastasic action of malt is secured by its admixture with the ground cereal. It is then submitted to heat, with the result of partial or entire conversion into dextrin and maltose.

4th. A combination of class 2 or 3 with milk or meat juice or egg albumen. A list of a few of the best known preparations in our market with their analyses is hereby tabulated for convenience of compraison with human and cow's milk.

Composition of some infant foods as prepared for the nursing bottle, in comparison with mother's milk. Prepared according to directions for infants of six months.

	Total Solids.	Fat.	Prot.	Insol. prot.	Lac-tose.	Carbohy-drates. Solo.	Insolu.	Ash
Mother milk[1]	13.26	4.13	2.00	0	6:93	0	0	0.20
Cow's milk[1]	12.61	3.75	3.76	0	4.42	0	0	0.68
Condensed milk[2]	5.18	0.53	0.65	0	.78	3.12	0	0.10
Peptogenic milk pow-der[4]	13.97	4.38	2.09	0	7.26	0	0	0.26
Milkine[3]	8.09	0.59	1.12	0	(5.09)		I.13	0.11
Malted milk[4]	7.43	0.68	1.15	trace	1.18	4.20	0	0.29
Mellin's food[4]	12.00	2.85	2.62	0	3.25	2.73	0	0.47
Nestles' food[4]	7.24	0.36	0.36	0.45	0.84	3.01	1.99	0.13
Imperial Granum[4]	8.47	1.54	1.67	0.48	2.71	0.58	1.22	0.34
Eskay's albumenized food[5]	11.33	4.16	1.72	0	(	5.41		)

As stated these analyses represent the constituent per-centages as they appear in the nursing bottle ready for feeding. The condensed milk is attenuated with 12 parts of water, and its 3.12 per cent. of soluble carbohydrates is cane sugar added as preservative.

Peptogenic milk powder is prepared for feeding by heating the powder in a given quantity of milk, cream and water. Mellin's Food, Imperial Granum and Eskay's Food, all require the addition of milk or milk and cream for use. Milkine, Nestle's Food and Malted Milk are prepared with water only.

The most noticeable feature in these foods is the paucity of fat, which important ingredient when present is due almost entirely to the added milk or cream. Much the same may be said of the proteids in these foods, with per-haps the exception of Milkine and Malted Milk. All are low in lactose and four show from one to two per cent. in-soluble carbohydrates, probably starch. Of the entire group nothing appears which is necessarily injurious to vig-orous digestive organs. The excess of cane sugar in con-densed milk is frequently criticised as favoring fermenta-tion, if its use be long continued.

Applying our "essentials" quoted in chapter XIV., it

1. Leeds. 2. E. E. Smith. 3. Minn. Dairy Rep. 1896. 4. Chittenden. 5. Leffmann.

will be seen that no food, as presented here, fulfills all the requirements of nutrition, even if well borne.

It is easy to see how some of these foods might prove very valuable by the addition of cream or milk sugar or both. Thus Milkine and Malted Milk would be improved by an increase of fat. Nestle's Food shows difficulties in adaptation to the requirements of the infant, in the presence of insoluble proteids and carbohydrates and in the low percentage of essential constituents

Four things are to be kept constantly in mind in substitute feeding:

First. That the long-continued use of food deficient in fat tends to the production of rickets.

Second. Deficiency in soluble proteids retards all development. It is slow starvation.

Third. The use of cooked foods may result in scorbutus, hence even sterilized food should not be administered continuously.

Fourth. Food which would not meet the requirements of nutrition for a long-continued period, because deficient in some essential constituent, may be used temporarily, as in traveling, weaning, or temporary removal from the breast.

CHAPTER XVIII.

HYGIENE OF LATER INFANCY.

At the beginning of the second year the average child shows six teeth, two lower and the four upper incisors. The remaining twelve should appear in the following eighteen months, as described in chapter III. After an interval of two or three months, a group appears, including the lower lateral incisors and first molars. The canines should have been cut before the end of the second year. The eruption of the second molars terminates first dentition, which should be completed by the thirtieth month. Too much emphasis cannot be placed upon the care of the temporary

teeth. Mechanical injuries to the enamel and necrosis should be guarded against. All defects should be repaired in order to preserve them in situ until complete absorption of the roots by their permanent successors. By this means, the normal conformation of the maxillary structures is secured during the rapid facial development. Many irregularities of the permanent teeth may be prevented by early care of the temporary. Further, hygiene of the mouth is demanded because the decomposition of particles of food favors development of toxines and accumulation of many varieties of bacteria, the warmth and moisture affording favorable conditions for culture.

The use of a tooth brush and antiseptic washes should be earnestly insisted upon. Of equal importance is the care of the fauces, nasal passages and pharynx. The above mentioned areas, from the bacterio-pathological standpoint, are ordinarily the most filthy cavities of the body. Their intimate relation to the three vulnerable tracts, viz., the respiratory, digestive and auditory systems, lends special significance to the demand that they be kept the freest possible from infective material or germs. During infancy and childhood the toilet of the mouth, nose and naso-pharynx is vastly more important than that of the integument.

It is easy to accustom the infant to inspection and cleansing of the mouth and nose, if begun early; a point of practical value aside from prophylaxis, when later, such inspection and treatment become necessary in acute pathologic conditions. The latter, however, it is believed with good reason, would rarely be necessary, if the former were strictly observed. The infant's toilet outfit is incomplete without a tooth brush, nasal syringe (Fig. 87) and an atomizer. (Fig. 88).

From standing by the chair, the infant soon acquires independent locomotion, so that the second year is fraught with danger seldom encountered while in the nurse's arms, such as liability to traumatism, undue changes of temperature, besides infection from substances introduced into the

mouth, the common receptacle for all newly found articles.
There is also a tendency to introduce foreign bodies into the
nasal and aural cavities, the trachea and œsophagus.

"Learning to walk involves a whole series of prelimin-
ory accomplishments, first among which is the ability to
hold the head in equilibrium. This is usually accomplished
about the fourth month. The next stage is reached a month
or two later. in the ability to sit alone upright, when this is
successfully accomplished for the first time. The soles of
the feet are frequently turned towards each other—a partial
re-assumption of the intra-uterine posture. To stand alone
is the next stage; and anyone who has watched the attempts
of a little child to stand upright and walk will be convinced
that he is moved to this by a natural instinct.
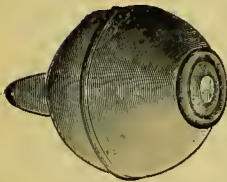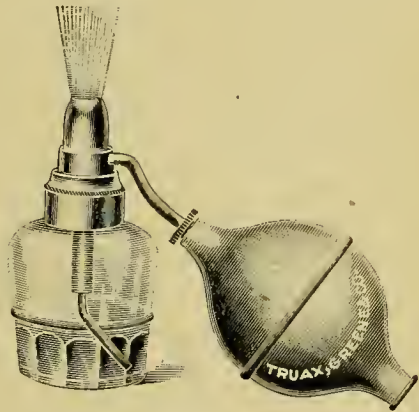
Fig 87   Fig. 88

It is an important epoch in a child's life when he suc-
ceeds in standing aloue   Whole sets of muscles, heretofore
scarcely used are now brought into activity, and his devel-
opment, is, from this time on, more all-sided and symmetri-
cal.   Hitherto, his locomotion has been only in the form of
creeping, but for the child who has learned to stand alone,
the transition to walking is, in a very literal sense "only a
step." The first conscious steps are taken very timidly,
and with an evident fear of falling. But frequently the first

steps are taken unconsciously. Sometimes a child who has learned to walk, partially or wholly, reverts for a season, to creeping, for no apparent reason. At first the feet are placed disproportionately wide apart, giving rise to a curious waddling motion; while sometimes a child runs instead of walking and staggers, with the body inclined forward, and the hands outstretched as though afraid of falling, the feet, too, being lifted higher than is necessary."—Tracy.

Care should be observed that children be not encouraged too much in this new accomplishment, as permanent injury to ligaments and articulations with deformity may result. According to Dane, quoted by Rotch, the arch of the foot is well formed at birth, and generally protected by a pad of fat, which has led to an erroneous impression of flat foot. During the first two years the arch suffers from the superincumbent weight, more particularly in heavy babies. With increased muscular development, however, the recuperative power of nature tends to the correction of this flattening, so that by the fifth year the arch has resumed its normal integrity. Infants instinctively protect themselves against this breaking down of the arch by turning the toes in, so as to bring the pressure to bear more upon the outer side. Efforts on the part of misguided parents to compel the turning out of the toes should be discouraged. The shoes usually made for infants are a good illustration of civilized barbarity. A wide toed mocassin of flexible material, allowing free expansion to the foot, made rights and lefts, is recommended. The same may be said of socks. When old enough to walk out of doors the soles may be further protected by doubling the material, rather than by the use of stiff soles so much in vogue. Heeled shoes were never intended for human beings.

The relation of the "Orthopædic shoe" to the child's foot is very well shown in figs. 89 and 90.

The natural bow legs of early infancy Figs. 1, 2 and 15 disappear in the third year provided proper precaution has been observed against keeping the baby on his feet too long.

With development of the muscles, the routundity of the form
('s gradually lost by the disappearance of subcutaneous fat,
so that the child appears comparatively slender.

By the end of the second year the thoracic circumference
exceeds that of the head, and the belly is less prominent.

The fontanel has closed by the eighteenth month and
the frontal and malar eminences begin to assert themselves.
The pulse respiration-ratio gradually establishes itself as 3:1,
the respiration giving hint of the future thoracic type. The
pulse is normally about 100 to 115 during the second year; with
the respiration 25 to 35. Both are subject to disturbances
from trivial causes.

Fig. 89   Fig. 89

The kidneys, at the beginning of the second year attain
their greatest relative weight.

The stomach, from this time on, falls behind the growth
ratio of the body. In fact the same may be said of all the
viscera, with the exception of the left lung.

The eruption of the teeth has long been recognized as a

suggestive indication for more solid forms of food. The changes in the salivary, gastric and pancreatic secretions, bespeak the increasing power of starch conversion and proteid digestion. The process of mastication, after the advent of the molars, stimulates, not only the saliva flow, but also that of the lower digestive secretions, which suggest the permissibility of foods in more concentrated forms. So that it is not unusual to find farinaceous foods well borne early in the second year. In modifications of milk, higher percentages of proteids are required and a lower percentage of sugar is allowable, since this ingredient is formed from
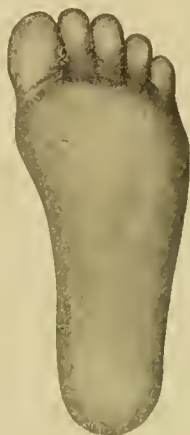
Fig. 90   Fig. 90

the starches. A liberal dietary for a normal infant twelve to fourteen months of age might be represented by the following: breakfast 6 a. m. carefully cooked and strained oatmeal ℨ3½, milk, ℨ4, and cream ℨ½; luncheon, 10 a. m., 8 to 10 ounces of warm whole milk; dinner 2 p. m. mutton beef or chicken broth, salted, with zwiebach or water biscuit—as much as he will take up to twelve ounces; supper 6 p. m. a cup of warm milk or oat meal gruel; if he wakens at night a cup of milk may be given. Water should

be supplied between times *ad lib.*, but not immediately pre-
ceding a meal. As the year advances the quantities of pro-
teids and starches may be cautiously increased. Not infre-
quently a good Leibig Food may be used to advantage, en-
riched with cream. The need for fat should be borne in
mind, also that the food should contain some raw principle
as an anti-scorbutic—as raw meat juice, expressed from
lean beef, raw egg albumen stirred up with cool water and
milk, and occasionally orange juice or a well baked apple.
Toward the close of the year hard water cracker or zwiebach
may be munched as an accompaniment to milk. Stale bread
or toast may be used with butter or soft poached egg, or
meat gravies from the table roast. The following affords
ample latitude for the selection of an appropriate diet; oat-
meal with its high percentage of fat and salts; stewed apple;
well cooked rice; thoroughly baked white potato with but-
ter and salt; custards; junket; gelatine preparations; sago;
corustarch; tapioca well cooked and served with cream.

To children prone to constipation should be given ripe
bananas rubbed through a sieve, served with cream; also
the juice from selected stewed prunes. Further than this
fruits are not advised during the second year, with perhaps
the exception of the pulp of well ripened, seeded grapes.
Meat fibre is not advised during this period, excepting a
little scraped beef and thoroughly cooked fish. Sweetmeats
are not recommended, because of the tendency to develop a
distaste for the more staple articles of diet. The common
practice of taking infants to the family table is strongly
advised against.

It would seem hardly necessary to refer again to the
necessity for absolute asepsis, not only in foods, drinking
water and dishes, but in every detail of the daily care.

The infant cannot sleep too much. He should sleep
from fourteen to sixteen hours out of the twenty-four during
the second year, protection from noise, strong lights and
insects being necessary to secure rest. He will rarely go
to sleep unless his stomach be filled.

An infant's nervous system is in so unstable a condition
that no strain should be put upon his faculties.   It is easy
to see that by seemingly slight causes, it may be injuriously
affected.   With Oppenheim, we believe that ''where the
organic elements are so delicate, where their relations are
so changing, where so long a time is necessary to insure
their normal and healthy completion of growth, it must be
clearly evident that the artificial conditions which consti-
tute their environment must play an important part in de-
ciding the value of their ultimate activity.   Such things,
taken together, go to form a child's nutrition, for this term
cannot rightly be used to designate his food alone.   The
problem is finally one of nutrition in the broadest sense.
Whatever makes for the fullest development of cells is
properly included in this term.   Food, rest, tissue changes,
stimulation, over-stimulation are all merely parts.   As the
previous chapters clearly show, the child is in practically
every respect different from the adult, and every part of
him is constantly changing.   The only conclusion which
one may draw from these facts is that his environment
should be designed to further the proper growth, that his
needs are different from those of his matured relatives, that
disturbances of mind and body occur to him with the great-
est readiness and may produce irremediable injury.   These
disturbances are usually due to the environment.   Faulty
food, faulty methods of rest, faulty ideas of excitement are
some of the causes involved.   Considering the importance
of the matter, it is really wonderful that greater attention
has not been paid to it.   One of the natural results is that
the standard exacted among most persons, instead of being
very high, is very low.   With them the main test of whether
a child is being properly fed is that he does not die, the test
whether he is properly clad is that he does not freeze, the
test of whether he is properly taught is that he sits quietly
and passes a sufficient number of examinations.   As a mat-
ter of fact it would doubtless, be better in many cases, that
he should die or starve or remain uninstructed.''

FIG. 62

Lacrymal Gland.
Obliquus Superior.
Ethmoidal Sinus.
Rectus Inferior.
Infundibulum.
Antrum of Highmore.
Socket for Perm Canine.
2nd Bicuspid.
2nd Temp. Molar.

Levator Palpebræ Superioris.
Rectus Superior.
Rectus Externus.
Obliquus Inferior.

Sublingual Gland.

FIG. 63

Great Longit. Fissure
Lateral Ventricle
Fornix
Internal Capsule
Nucleus Lenticularis
Optic Thalamus
Third Ventricle
Temporo-sphenoidal Lobe
Pons
Tympanic Cavity
Ext. Auditory Meatus.
Internal Jugular Vein.
Odontoid Process
Body of Axis

Corpus Callosum
Nucleus Caudatus.
Horizontal Limb of Sylvian Fissure.
Island of Reil.
External Capsule.
Middle Commissure.
Internal Capsule.
Claustrum
Post Perforated Spot.
Cochlea
Basilar Artery.
Internal Carotid Artery
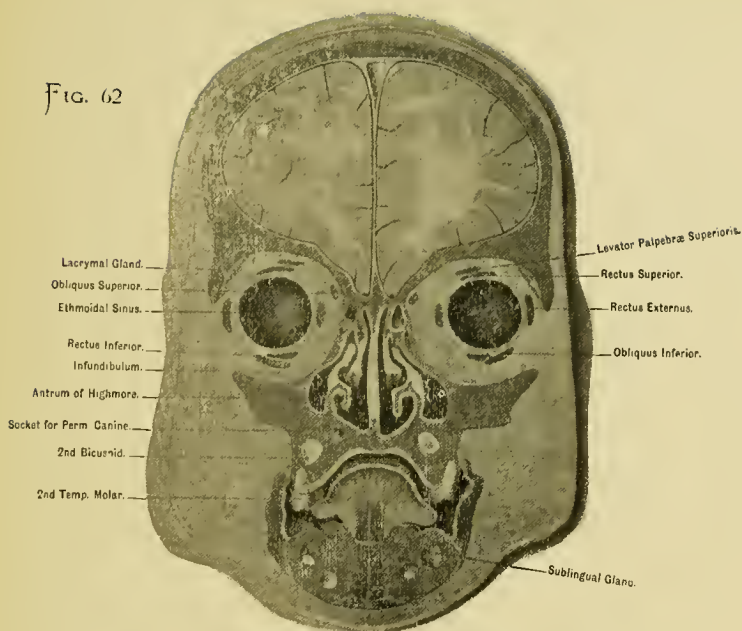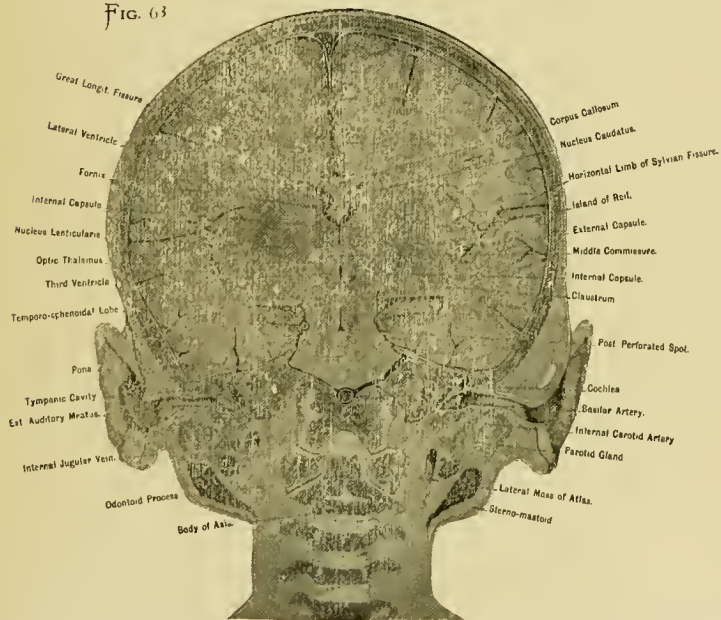Parotid Gland
Lateral Mass of Atlas.
Sterno-mastoid

FIG. 62.   CORONAL SECTION OF HEAD, same subject as Figs. 60 and 61.
FIG 63.   CORONAL SECTION OF HEAD. same subject as Figs. 60, 61 and 62, taken
at a plane with the external auditory meatus.   (SYMINGTON.)
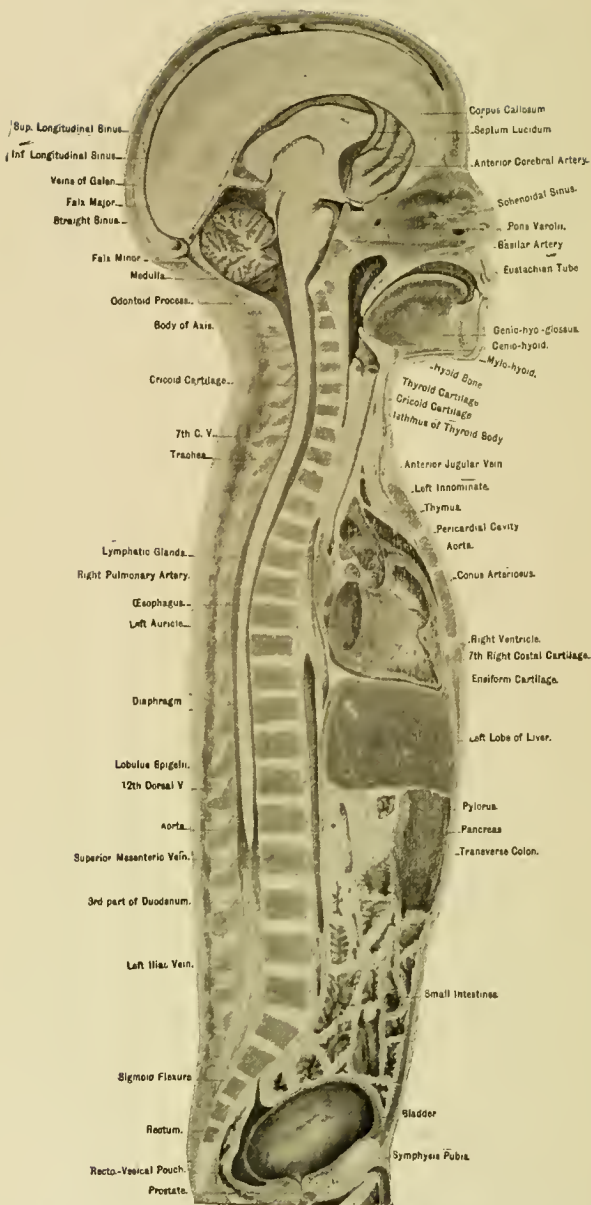
FIG. 64. VERTICAL MESIAL SECTION OF A BOY 6 YEARS OLD.

CHAPTER XIX.

PHYSIOLOGY AND HYGIENE OF CHILDHOOD.

By the end of the third year the child's head and face may serve as an index of normal growth and development. The circumference of the head should measure not less than nineteen, and not more than twenty-one inches. The head should be symmetrical in outline and free from bossae   The forehead should not be prominent and bulging and should be free from ridges, horizontal or vertical.

The eye should exhibit no inco-ordination nor errors of refraction or accommodation.

The hearing should be unimpaired and the voice clear and resonant.   The nostrils should be ample and well developed.

The teeth should be symmetrical in their arrangement and free from erosions and defects.   The roof of the mouth with the teeth and soft palate should form a symmetrical low vault, free from angles.

The angles of the maxilla should have begun to assert themselves, with a perceptible broadening of the lower face.

The mastoid processes should be distinctly outlined and the ears normal in size and symmetrical in form.

The cervical, dorsal and lumbar curvatures in the spinal column should be fully established and there should be no lateral deviations.

The circumference of the chest should exceed that of the head by about one inch.

The thorax shonld be free from sulci or ridges, the sternum flattened and the ribs free from beadings.   Auscultation should give respiratory sounds audible in all parts of the lungs and puerile in character.   Precordial dullness should not extend to the right of the midsternal line, although the majority of observers find relative dulness to the right of the sternum at all periods of childhood.   (Page 46).   The heart rhythm should be trochaic rather than iambic in meter, as expressive of the relatively low arterial

tension. The pulmonic second sound, compared with the
aortic, seems accentuated from the normally higher tension
on that side. Liver dullness may extend two fingers'
breadth below the right anterior margin of the ribs.   The
epigastric depression should be noticeable.   The umbilicus
should be slightly above the center of longitudinal measure-
ment

The hips should be perceptibly broadened and the limbs
symmetrical, showing neither bow-legs nor knock-knees.

There should be no marked disturbances of general
co-ordinated movements. 'By this time the child's vocabu-
lary may embrace from three hundred to five hundred
words, including some indicating color, and he has acquired
the use of the first personal pronoun.

The above enumeration includes a few of the phenome-
na of normal development, from which the degree of devia-
tion may indicate the extent of malnutrition, used in the
broadest sense.

The idea of protection as given in the nursery should
extend throughout childhood, with such modifications as
the changing anatomy and physiology demand.   Although
he has acquired a considerable degree of digestive strength,
as compared with the early infancy, still he needs watchful
care over food and environment.   In regard to the former,
complete nutrition requires the five principle elements in an
easily digestible form.   The same regularity in feeding is
important, although its frequency and the quantity, as well as
the material, should vary with the changing requirements.
With advancing age a greater variety in articles of diet is
advisable.   A caution is necessary on account of the ten-
dency to furnish the child the varied dietary of the adult,
too frequently allowing him to select the article which best
tickles his palate or pleases his fancy.   No error would
be greater, as the palate is no guide to the requirements of
nutrition, and one-sided or mal-nutrition is invariably the
result.   A child regularly fed on properly selected foods
will rarely injure himself by overeating.   The use of con-

diments (other than salt) and flavors to tempt the appetite, as well as tea, co8ee and stimulants is deprecated.

Milk should hold first rank among the leading staples throughout childhood. Cultivation of the appetite for milk, too often neglected, proves extremely valuable, when in sickness it is necessary to restrict the food to liquids. It might be mentioned, as a hint in domestic economy, that milk is one of the cheapest as well as the best of foods. The tendency to decry the use of milk as an alleged source of tubercular infection has probably been carried further than later pathological findings would warrant. From the third year the child should gradually be accustomed to meat as a source of proteid, although it should not form a part of more than one meal a day, until after the sixth year. At any time it should represent only a portion of the entire meal.

Thorough mastication should be made a feature of the child's training and he should not be allowed to "wash down" imperfectly masticated food. From the end of the third year, fruits, at least once a day, should be given. Pastry, even though not positively injurious, tends to pervert the appetite and leads to a distaste for the plain essential part of the dietary.

Excretions should be watched for indications for changes in the diet. Concentrated highly acid urine would suggest diminution in proteids, especially meats, with increase in fluids, vegetables and fruits. More particularly do lithæmic children with tendency to eczema etc., need to be guarded in this respect,

Constipation may be corrected by the establishment of regularity in evacuating the bowels, preferably in the morning after breakfast, when the ingestion of food stimulates intestinal peristalsis. Constipation suggests the addition of more liquid and fruits. Sometimes it may be corrected by increasing the bulk of residue by coarser breads and vegetables.

No hard and fast rules can be made in regard to bathing.

The temperature and duration of the bath should depend upon the reactionary effects upon the child. The wisdom of dragging the screaming child to the cold shower bath is not apparent when the previous admonitions concerning shock are remembered. Parents may err in the too frequent repetitions of the bath. General bathing should never follow immediately the ingestion of food.

During childhood retiring should follow soon after the light supper. Allowing children to study, read or play by gas light is not conducive to the rest and recuperation demanded after the day's fatigue.

The child under six is especially fortunate if he live in the country, where nature furnishes a great kindergarten for the symmetrical development of all his faculties. The inherent tendency of the normal child to develop himself is but the expression of the dynamics of the organized energy of perfect nutrition. His pertinacious instinct for investigation, the inherent curiosity of the child, furnishes a most complete training of brain and muscles.

The kindergarten of the city is but a makeshift, called into existence by the artificial environment of the home. The very fact that the education of the child in kindergarten and school is under control renders it all the more dangerous and necessitates the exercise of the finest judgment and broadest knowledge on the part of the teacher If this be required for the normally developed child, how much greater the necessity in the various abnormal developments. "During those fits of rapid growth, which sometimes occur in childhood, the great abstraction of energy is shown in an attendant prostration bodily and mental. The brain, which during early years, is relatively large in mass but imperfect in structure, will, if required to perform its functions with undue activity, undergo a structural advance, greater than is appropriate to its age; but the ultimate effect will be a falling short of the size and power that would else have been attained.

Various degrees and forms of bodily derangement, often

taking years of enforced idleness to set partially right, result from this prolonged over exertion of the mind. Sometimes the heart is chiefly affected. Sometimes the conspicuous disorder is of the stomach. In many cases both heart and stomach are implicated. The sleep is often short and broken. Excessive study is a terrible mistake, from whatever point of view regarded."—Spencer. This quotation suggests that there is a natural course of development of nerve and muscle cells, evolved from exercise. We may err in forcing the exercise of function too early or in prolonging the exercise to its impairment. It should be remembered that young nerve cells tire quickly, not yet having the stored energy of maturity.

The earlier education is naturally restricted to the grosser movements of the free limb type. During this stage of development, encouragement of the child to occupations requiring the finer co-ordinations is clearly an error, which results not only in fatigue of the cells involved, but also in their permanent impairment. As a general axiom it may be stated that permanent injury surely follows prolonged exercise of any function, physical or mental, out of its order in the sequence of natural development. With this in mind young children will not be urged to occupations requiring refined differentiations, whether in the use of the needle, pencil, musical instrument or in the study of numbers.

The artistic products of the kindergarten, displayed by proud parents and teachers as evidences of progress in the little pupil's training, too often suggest the fearful cost to future development of the overstrained faculties exercised in their production. That the children enjoy it should have no more weight than that the athlete enjoys the victory in the contest which ruined his heart.

As shown by the observations of Bowditch, Gilbert, Porter, Roberts and Stephenson, growth is not represented by a uniform rate; but periods are observed during which marked increase or retardation in the rate occurs. In fact in one organ positive loss of weight is recorded, as in the

brain, which at thirteen years weighs 1465 gms., but at fourteen years only 1300 gms. The loss, however, is more than recovered in the fifteenth year when the average weight is 1500 gms.—(Vierodt)

The heart shows a decidedly increased area of dullness after the sixth year. The great increase in its systolic vigor, however, awaits the remarkable hypertrophy of pubescence. Christopher has called attention to a pronounced deficiency in the physical vigor of children of from seven to nine years of age, which is termed the "period of fatigue". This is manifested not only in physical but also in mental fatigue, and explains the exhibition of many nervous symptoms otherwise unaccountable. It would appear that the proverbial laziness of this age has its foundation in normal physiologic conditions. No doubt the immortal bard had observed this phenomenon from his clinical picture of the secondage of man.
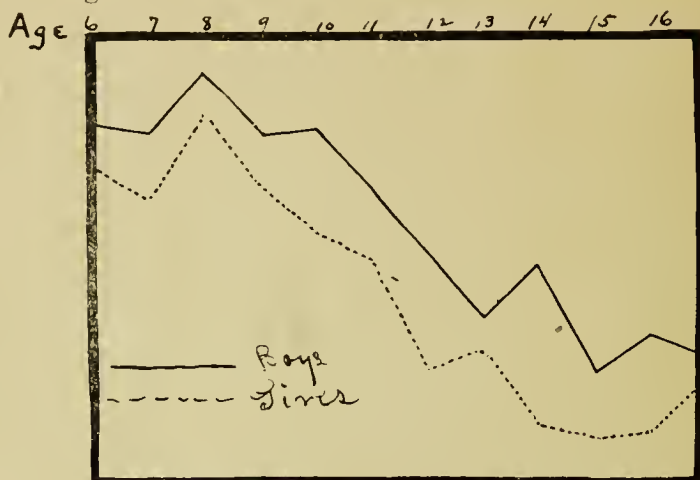
Christopher says of Krohn's diagram shown above: "This chart represents the readiness with which children of different ages fatigue. From its examination it will be seen that the child of seven fatigues less readily than the child of six, but that the child of eight fatigues more readily

than the child of either six or seven. The child of nine fatigues less readily than the child of eight but has a fatigue limit about equal to that of the child of seven. As the years advance the readiness of fatigue diminishes materially until the period of puberty is reached when again at this period fatigue more readily occurs than in the years immediately preceding."

Dr. Gilbert, in his examination of the children of New Haven found that "girls tire more easily at thirteen than at twelve, while with boys, the variance comes a year later, from thirteen to fourteen. In close connection with this is the growth in weight. Boys increase 18.3 pounds between fourteen and fifteen years and 17 pounds between fifteen and sixteen, but between sixteen and seventeen years the increase is only 3 pounds.

The most rapid growth of girls ceases at thirteen, while at fourteen rapid growth of boys is just beginning. At about this age the girl reaches her maximum brain weight, just at the time that the boy's brain loses considerable weight, due to the large amount of blood being withdrawn from the brain to nourish viscera during their rapid revolutional changes at this period. Krohn states that at the onset of pubescence individual characteristics and idiosyncrasies are intensified. Furthermore, the greatest of the hereditary qualities come out and the most dangerous of hereditary defects manifest themselves. It is at this time that nervous diseases, especially in higher centers and also mental peculiarities select the onset for their first real appearance.

From the foregoing it would appear that the conclusion is obvious that, in the allotment of tasks in our arbitrary routine of exercises styled educational, the burdens must be distributed with due reference to these physiologic periods of development. To expect the same degree of progress during the fatigue period as may be secured in the preceding or subsequent years, would result not only in disappointment to parents, but also in permanent mental and physical inju-

ry to the child.   At about this age the dilated ventricle with
its mitral insufficiency is a familiar picture in pediatric cli-
nics.   The unstable equilibrium, characteristic also of pub-
escence, should warn us of diminished capacity for pro-
longed effort.   The researches of Edwin Chadwick furnish
us with statistics which are of interest as indicating the
limit of mental concentration at different periods of growth
in children.   Thus he finds that fifteen minutes is the limit
of time that children of from five to seven years can concen-
trate attention upon one subject.   That twenty minutes' at-
tention is all that may be expected of children from seven
to ten years, twenty five minutes for those between ten and
twelve, and that pupils from twelve to eighteen rarely exceed
thirty minutes.   It is seen from the foregoing that the
capacity for sustained attention, in point of duration, is below
the usually accepted belief as illustrated by the recitation
schedules of our schools.   The exhaustion of the power of
attention renders every subsequent moment spent in the
school room worse than futile from an educational stand-
point.   This is particularly true because the habit of inat-
tention thus engendered is so fatal to educational progress.

The capacity for attention may be reduced below the
normal by attending circumstances, so that, in certain cases,
exhaustion speedily follows apparently reasonable school-
room demands.   Instances of this kind are not infrequently
due to inferior nutrition from inadequate home hygiene, or a
child may be worked beyond the capacity of his strength
from mistaken notions of economy on the part of the parents.

It has been repeatedly demonstrated that eye strain is
a prolific cause of early exhaustion of nerve force,, in school
children and that want of knowledge, or of the application
of the principles of optics, is constantly laying the founda-
tion for a great variety of pathological processes which
handicap the future and may shorten the lives of the pupils.
Much good has been accomplished where attention has been
given to better lighting, seating according to powers of visual
distances, substitution of the clear tablet for the indistinct

slate, improved size and forms of type in text-books, shorter hours of study, systematic testing of visual power and the application of corrective lenses or cylinders when needed.

Somewhat analogous to the preceding are the effects upon the child of *ear* strain, whether due to defects in the organ of hearing, to imperfect acoustic arrangement of the room or to indistinct enunciation of the teacher. A little observation will show that apparent dullness in the pupil is frequently the result of imperfect hearing, or of exhaustion from the undue effort to grasp the meaning of sentences but partially comprehended. Hence tests of hearing should be applied with a view to correction in this direction.

The tests of physical endurance inaugurated by Gilbert in New Haven, and Christopher in Chicago, bid fair to establish a standard for the amount of work to which pupils of different ages may be rationally assigned.

Muscular fatigue from constrained positions, as evidenced by restlessness of pupils so familiar to every teacher, has received much attention so that the instructor may well be considered negligent who does not vary the monotony of study and recitations with frequent brief exercises in physical culture.

It would hardly appear necessary to mention the absolute need of fresh air and deep inspiration so long has physiology demonstrated the true function of respiration. Still the school room visitor often finds the need of much improvement in this direction. In proof of this may be cited the contrast in the attitude and facial expression of pupils immediately preceding and following the recess.

Vicious attitudes, resulting in permanent physical deformities, are too often caused by improper school furniture or its arrangement with reference to the light. The desk too high or too low, the relation of feet to floor and the want of support to the spinal column, particularly to the dorso-lumbar region, too frequently show their baleful effects in spinal curvature with hip or shoulder deformities.

In regard to the length of sessions, and study out of

school hours, there can be no difference of opinion. In the lower grades especially, nothing is gained, though much may be lost, by requiring pupils to study their tasks at home. Overwork, if insisted upon, will give inferior results and that too, at the expense of the impairment of the newly developing functions, far reaching in consequences.

The subject of child labor both from the humane and economic standpoint has received so much attention in recent years that mere mention of the conclusions must suffice. By those who have thoughtfully studied this question the unwisdom of employing children during prolonged periods has been demonstrated in various ways. Reference to preceding pages will show some reasons why children, during the process of development, are incapable of continued effort requiring manual dexterity, even of the simplest type.

The limited store of energy at this stage allows early exhaustion of the nerve cells, with impairment of co-ordination. Thus it has been shown that accidents due to clumsy or awkward motions occur with significant frequency in the latter part of the day. The laws restricting child labor are not only humane and protective to a class who rightly should be protected, but also to the state which in many instances must become responsible for the crippled.

"The child comes into the world as a mass of potentialities, for months he is the most neutral of creatures, whose functions are largely reflex and automatic, whose mental vigor is really *nil*. Little by little he gathers strength, the parts of his body gradually spread out in the irregular ways of rapid growth. Measured by the standard of normal maturity, every piece of him is out of measure, is provisional almost pathological. His whole constitution is temporary. and cannot even be regarded as the foundation of what he eventually will be. With added growth he approaches very slowly to the ordinary level; but all his movements of mind and body are marked by the clumsiness, the wavering uncertainty of an unprepared state. He is in no condition to bear burdens, it is hard enough for him to find out that there

are such things. His principal work should lie in being formed, in getting a straight back, big lungs, and a clear mind; in possessing a nervous constitution which, as one of its functions, is capable of elaborating a moral sense that points staight." –(Oppenheim)

"A well-trained nervous system is the greatest friend that the mind can have."—(Halleck).

"The weaker the body is, the more it commands; the stronger it is, the more it obeys."—(Rousseau).

"The medical man does not do his full duty to the child when he cares for it only in sickness. His broadest duty is to prevent sickness. He must note carefully the hereditary tendencies with which the child is endowed and strengthen it at the weak points; develop it along the lines which may be expected to be deficient, act generally as the director of the conservation and development of the child."—(Christopher.)

CHAPTER XX.

PHYSIOLOGIC ABNORMALITIES OF THE NEWLY BORN.

This term is made to include all marked departures from the physiologic normal at the time of, or shortly following birth; excluding from the group conditions generally recognized as due to traumatism. The infant at birth has been described in Chapter VII, no abnormalities there having been noted, with the exception of prematurity. This group is not meant to include those gross anatomical deviations which properly come under the classification of monsters, viable or otherwise.

In the parturient chamber the most welcome sound is the cry of the child, not only as a signal of the termination of the most difficult stage of labor, but as an indication of the establishment of the most important function of the newly born, The experienced ear of the accoucheur interprets

that cry as to its prognostic value, a loud and sustained quality indicating unquestioned respiratory vigor.

If, however, the cry be feeble or absent, his attention is immediately engaged as to the presence or absence of respiration, the depth and frequency of the movements involved, the color of the skin and the action of the heart. Pulmonary respiration may not be established immediately after delivery, and as placental respiration ceases with the ligation of the cord, vital processes are reduced rapidly and the child may die of asphyxiation; literally for want of breath. The exact instant at which death occurs in these cases of pulmonary asphyxiation, no one can determine, and probably no condition so frequently presents itself to the physician, in which his skill and timely services may unquestionably maintain the vital processes.

It is well known that perseverence in his efforts is often rewarded by the establishment of respiration, in cases where, for many minutes, the results seemed hopeless. Occasionally asphyxiation occurs after pulmonary respiration has been established, at times coming on suddenly with almost complete arrest; at other times, gradually, the feeble respiration becoming more and more shallow until finally suspended.

As before stated, there is marked cyanosis of the superficies, the mucosa particularly showing a deep purple hue. The general indications of intense congestion, swollen appearance of the face, slow labored heart action, all give evidence of pulmonary obstruction. As the coma deepens, from accumulation of carbon dioxide, the heart's action becomes more rapid and feeble, the extremities cold and the surface pallid, with final cessation of heart beat. On the other hand, we may have from the beginning shallow, irregular inspiration, feeble and rapid heart, colorless surface, flaccid limbs, all evidences of feeble vital processes. These two pictures represent different types of suspended animation, from deficiency of oxygen, and may be due to quite different causes; the first, to mechanical obstruction

to the entrance of air from any cause; the second, to an enfeebled condition of the musculature of the circulatory and respiratory systems. Between these two distinct types, namely:*asyphyxia livida*—the sthenic condition with evidence of mechanical respiratory interference, and *asphyxia pallida*—the asthenic condition with its feeble response to stimuli, many variations may occur.

In his efforts for the relief of asphyxia neonatorum, the term applicable to all of these conditions, the physician must be governed by the type to which the individual case most inclines. Efforts at cardiac or respiratory stimulation are entirely out of order when the trouble is due to mechanical obstruction from inspired mucus in the glottis or fluids in the pulmonary tubes. On the other hand, worse than useless are such violent measures as artificial respiration by swinging through the air the chilled body of the pallid infant, whose fluttering heart shows the need of warmth and cardiac support. Fortunately asphyxia may be relieved by the prompt aid of the physician in a great majority of cases, particularly of the sthenic variety, and occasionally of the asthenic type.

The indications are plain, viz., the removal of obstruction from the respiratory passages, whether nasal, pharyngeal, laryngeal or tracheal. As mentioned in a previous chapter, the first may be accomplished by a pledget of absorbent cotton, the second, by a finger wrapped with dry gauze. The glottis may be freed from tenacious secretion sometimes by skillful manipulation of a curved canula (Fig. 67), with bulb attachment for exhaustion of the air, or by direct suction through a catheter by the mouth of the operator. These efforts should be aided by inversion of the child, thus securing the influence of gravity in the escape of fluids, and also determination of blood to the medulla. Artificial respiration should be practiced when there is suspended action from feebleness of the respiratory muscles. Alternating hot and cold applications and faradization for cardiac, as well as respiratory stimulation may be useful.

Rhythmic traction of the tongue is sometimes successful in establishing respiration. Too often a vital requirement is overlooked in allowing the infant to become chilled, maintainance of warmth being the great desideratum ·

ATELECTASIS.

In many infants at birth, the inflation of the lungs is not complete, a portion retaining its fœtal condition. This state, known as atelectasis, probably obtains to a limited extent in all new born during the first few days. The atelectatic portions gradually extend with the normally increasing vigor of respiration. It is usually the lower posterior borders that remain unexpanded, although their consolidation is often masked by the emphysematous condition of overlying superficial vesicles. In fact, the extent, or even the existence of congenital atelectasis is rarely diagnosed by physical signs, this condition being most frequently indicated by the symptoms. Slight degrees of atelectasis may produce no symptoms, the condition escaping notice entirely. Shallow, rapid respirations, recurring cyanosis, feeble cry and subnormal temperature with tendency to collapse, are symptoms strongly indicative of unexpanded lung. Atelectasis may be due to any of the causes of asphyxia neonatorum. Paresis of the respiratory centres, brain pressure and premature birth are also frequent factors.

Long continued maintenance of one position favors atelectasis, through interference in circulation from pressure and hypostasis. By reference to the chapter on hygiene of the new born, it is seen that frequent changing of position and occasional massage are advised. Hence one objection to institutional management of infants is that they are confined too closely to cribs, leading a purely vegetative existence. As previously stated, lung capacity is the exponent of infant vitality. Hence it necessarily follows that impairment of vitality is in direct ratio to the extent of unexpanded lung. The atelectatic condition is susceptible to spontaneous correction, failing in which, it continues a menace to

life.   The fatal ending of a mild bronchitis is often due to pre-existing atelectasis.

The treatment is purely rational, viz., efforts to secure expansion through deep inspiration.   For this purpose prolonged crying, short of exhaustion, must be encouraged. Massage, flagellation and sprinkling the chest with cold water will assist.   The longer the condition persists the more difficult will be its correction.   Hence early efforts should be continued.   Fresh air supply and maintenance of bodily warmth are especially insisted upon, nor must it be forgotten that the defective lung will poorly endure pressure, as from distended abdominal viscera, sudden death from this added cause being not infrequent.   For threatened collapse due to respiratory enfeeblement, inhalation of oxygen and hypodermics of strychnia are indicated.

The prognosis depends upon the extent of involvement and the persistence of the condition.

INSPIRATION PNEUMONIA OF THE NEWLY BORN.

There is a popular belief that the infant is sometimes "born with a cold."   In corroboration of which, symptoms of catarrhal involvement of the bronchial tree, including cough dyspnœa and fever, are cited   In brief, the classical symptoms and sometimes signs of infantile broncho-pneumonia are seen in the new born.   Inspiration Pneumonia is a term applied to this condition.   The infection is evidently due, as the term implies, to material drawn into the lungs of the infant during his passage through the parturient canal; and presupposes the presence of micro-organisms or the pre-existence of endometritis, vaginitis etc.

The treatment is chiefly prophylactic and should be directed toward early disinfection of the birth canal.   As to the infant, the existence of a lobular pneumonia requires supporting measures, stimulation, rest etc.

CYANOSIS INFANTUM.

The term "blue baby" is frequently used by the laity; and occasionally seen in the older literature, under the title

of *morbus cæruleus*,   Broadly speaking it is applicable to any form of cyanosis and includes in its etiology all the causes of deficient oxygenation of the blood.   The term is usually applied to infants with congenital malformations or structural defects of the heart and great vessels (Figs 22–23).With few exceptions it is the right heart that is affected, the most frequent lesion being stenosis of the pulmonary orifice, with or without anomaly of its valves.   The patulous foramen ovale and ductus arteriosus, formerly considered the causative lesion, are now regarded as secondary to the pulmonary obstruction.   So too, as a result of increased pressure in the right ventricle must be regarded the occasional incomplete ventricular septum.   A long continuance of pulmonary stenosis usually results in enormous hypertrophy of the right heart.   The skin does not always exhibit the distinctive hue, but occurrences of cyanosis are induced upon active exertion, and if the patient survive to the age of childhood the finger-tips show the characteristic clubbing, due to retarded circulation. This disorder may rise from a variety of vasculo-cardiac malformatious regarded as pathologic curiosities, the differentiation of which is extremely difficult prior to the autopsy.

The prognosis and treatment depend largely upon the symptoms, drugs proving of but little avail.   Freedom from exertion and excitement is absolutely necessary for comfort and safety.   Though the mortality is high, the patient not infrequently survives to maturity.

ICTERUS NEONATORUM.

The normal hyperæmia of the infant, to which attention was called in an early chapter, instead of changing to a salmon tint by the end of the first week, may develop into an orange color, causing much anxiety to parents and occasionally to the physician.   This color of the skin, known as *icterus neonatorum* has been the subject of much discussion by pathologists.   With Virchow, many hold that its etiology is hæmatogenous and due to retrograde changes in the corpuscular elements.   More recent opinions attribute to

FIG. 65. PREMATURE INFANT. 10 weeks premature; weight at birth 3½ lbs.; 2 weeks of age 2½ lbs , 10 weeks of age 8 lbs. (Author's clinic.)

Fig. 66. CONGENITAL MALFORMATION AT AORTIC ORIFICE. STICK IN-
SERTED THROUGH FALSE PASSAGE BEHIND SEMILUNAR VALVE.
(Author's clinic, Necropsy by Hektoen.)

hepatogenous conditions, this apparent retention in the blood of biliary coloring matter. Whatever its etiology may be, icterus neonatorum, as usually seen, is considered little more than a curiosity, though of quite frequent occurrence. Reports from the Sloane Maternity of New York give over 30 per cent and some German reports claim as high as 80 per cent of cases in which icterus followed normal labor.

The jaundice, which is often intense, ordinarily develops about the third day and rarely persists more than two weeks clearing up gradually with no untoward symptoms.

No treatment is necessary.

The point of interest is in the differentiation from grave conditions, in which icterus is a frequent symptom, namely, hepatitis of the newborn due to congenital syphilis and septic conditions due to undetermined micro-organisms. The main points of difference are seen in the absence of hepatic tenderness or enlargement, in the freedom from the febrile symptoms of septicæmia, the non-involvment of the sclerotics in the general discoloration and the absence of bile pigments in the urine.

MASTITIS NEONATORUM.

During the first week of life it is not unusual for the infant's mammary glands to show undue prominence. Upon pressure there exudes a whitish fluid resembling breast milk, with which, in fact, it is identical. This curiosity is all the more interesting in that it may occur in both sexes. The old dames of the lying-in chamber not infrequently consider the expression of this secretion as a part of the infant's toilet, as a result of the old superstition, that by the removal of this "witches' milk" future trouble might be averted. Whatever may be the the prophylactic benefit, certain it is that as a result of this rough usage, the gland sometimes becomes infected and mastitis follows. That this mastitis of the new born is always dependent upon traumatism is difficult of demonstration. That it is an infection from the entrance of septic bacteria from without is unquestionable,

and occasionally it results in extensive] suppuration and breaking down of tissue.

Its treatment should be prophylactic, care being necessary to prevent irritation of the enlarged glands from pressure of clothing, especially of the tight abdominal band. In case of abscess, evacuation and dressing with the usual antiseptic precautions are necessary.

SCLEREMA NEONATORUM.

Sclerema neonatorum, representing a condition rather than a disease, is rarely seen in this country, although it is reported as of not infrequent occurrence in European institutions. As its name signifies the characteristic feature is a hardening and condensation of the skin, which process extends to the subcutaneous fat and areolar tissue. It is not a true œdema as there is no pitting on pressure. This disease is sometimes congenital, occurring oftenest in premature infants and is frequently associated with pulmonary atelectasis.

Beginning upon the dorsum of the foot or in the cheeks, the induration extends rapidly to other portions, usually to the fatty cushions of the body, as the nates, and may within a few days involve the entire cutaneous surface. The skin has a hard feel and can not be picked up or moved upon the subjacent tissues, giving a rigidity to the whole body as though encased in leather. At times the stiffness renders nursing impossible from inability to move the jaw. The temperature is invariably subnormal, having been observed as low as 80° F. The heart's action is slow and feeble, and the respiration is retarded and shallow. Discoloration is commonly observed, a dusky or somewhat icteroid hue prevailing. Death is the usual termination within the first week, Occasionally recoveries are noted after a somewhat prolonged convalescence.

The most rational etiology of this strange disorder is that of solidification of the subcutaneous fat from continuously lowered temperature, incident to malnutrition and atrophic conditions. It is claimed that the fat of the

infant solidifies at 86.6 F., while that of the adult with-
stands a temperature below 32° F. The fact that the fat
of infants is rich in palmitine and stearine may help to
explain its ready solidification. In the treatment attention
should be especially paid to artificial heat, the *couveuse*
being admirably adapted to the purpose. Cardiac and
respiratory stimulation, with the exhibition of alcohol,
should be employed and nutrition be kept up by forced
feeding and nutrient enemata, care being observed not to
embarass the feeble heart and respiration by overdistention
of the stomach.

INANITION FEVER.

McLain and Holt have called attention to a pyrexia
developing during the first four days of life. They claim
that want of nutrition is the etiologic factor and this
claim is supported by the excluson of other possible cause
and by the rapid disappearance of the fever upon the
administration of proper nourishment. This inanition
fever, as Holt calls it, has been observed by many others
and for the present, at least, must take its place in the
nosology of the new-born. From the first to the fourth
day of extra-uterine life the temperature may range from
99.5 to 106° F., approaching the normal usually abruptly
upon the establishment of lactation or upon the adminis-
tration of artificial food. In these febrile cases it has been
noticed that the loss of weight is more marked than in the
non-febrile. The importance of recognizing this condition
from the pyrexias due to known infections is apparent.
The treatment, which may be prophylactic as well as
curative, would emphasize the principles of hygiene given
in an early chapter, viz., to begin from the first day with
properly attenuated artificial food. By this means, it is
believed that the so-called normal loss of weight may be
reduced to the minimum, if not altogether prevented. It is
known that inanition is frequently the cause of death at
this early age, even when the child is apparently taking
the breast normally. It is a duty of the physician to assure

himself that the child is actually getting a sufficient amount of suitable food, and the first sign of pyrexia or failure to gain should lead to examination of the breast and its secretion.   Water, of course, is always indicated.

ANURIA.

Anuria in the new-born is a condition that has received too little attention. From a trivial functional disturbance to the gravest organic lesion, such a variety of causes may obtain in this condition that the question of early micturition must ever be regarded as one of importance.   A new-born child who has not urinated during the first twenty-four hours of life demands special care at the hands of the physician. The causes of anuria may be stated briefly, as: occlusion of the urethra, ureters or renal tubules or the obliteration of the secreting structures by cystic degeneration, inflammation or neoplastic growths.   The urethra may be occluded by a mucous plug or the meatus closed by a gummy secretion sufficient to prevent the outflow of urine.   The ureters may be blocked by calculi or the uriniferous tubules may be plugged by uric acid crystals.   The extrusion of urine may be prevented by pressure from tumors, abnormal anatomical relationship, torsion, flexion or constriction of the ureters. The urethra may be imperforate from arrested development.

Without entering into the differentiation of the various causes of anuria, it should be stated here that the physician must satisfy himself of the patency of the lower urinary apparatus, the absence of neoplastic growths and cystic degeneration before venturing upon a favorable prognosis.   Even then, fatal terminations have occurred where the post mortem showed no abnormality other than a persistent general blocking of the tubuli uriniferi with uric acid.

In a large majority of these cases urination is established by merely freeing the urethra and by a liberal use of water, which presumably dissolves the uric acid concretions and prevents their re-accumulation by flushing out the tubules.   Water should be administered not only by mouth but also by free colonic flushing, and elimination by the in-

testinal tract promoted by repeated doses of calomel.   To these may be added hot baths and fomentations over the lumbar and hypogastric regions.   Diuretics other than water are of doubtful utility, with the exception, perhaps of a modified Simola Mixture, of which a teaspoonful may be given four to six times a day.

R   Sod. iodid.... ....gr. iss
"   Sod. phosphate........˙.....gr. iii
"   Sod. chlorid...............gr. x
"   Aq. dest.....................℥ iv

Strange as it may appear, convulsious due to this cause alone are of rare occurrence and, when present, constitute one of the late symptoms.

CEPHALHÆMATOMA.

Cephalhæmatoma, as its name suggests, is caused by an extravasation of blood between the cranial bones and their investments.   Different varieties are recognized, due to different locations of the effused blood, as sub-aponeurotic, sub-periosteal, sub-dural and sub-arachnoid.   Thus it is seen that the tumor may be due to an extravasation purely external to the skull or the blood may be connected with an accumulation within the cranium.

As stated in the chapter on anatomy, from the close attachment of the pericranium to the dura at the sutures, a cephalhæmatoma must be limited in its area by the borders of the bone over which it occurs.

Hence it need never be mistaken for a hernia cerebri which protrudes at an aperture or unprotected area.   The apparent crater-like opening beneath the cephalhæmatoma, with the feeling of crepitation at its periphery, is due to the rapid deposition of bony material at the margin of periosteal separation where the osteoblasts are still actively at work.

From a caput succedaneum it may be easily distin guished by the pitting of the latter and its early dis appearance.

The restricted hemorrhage is presumably due to pres sure upon unusually fragile blood vessels under peculiar hæmic conditions. It is not necessarily due to pressure during passage through the birth canal, since cases are recorded of cephahæmatoma in infants delivered by Cæsarian section. Breach presentations also occasionally show this lesions, and instances are not wanting in which the tumor has been found on the head of the prematurely born.

The prognosis is usually favorable in the absence of symptoms indicative of extensive intra-cranial extravasations.

A mild astringent placebo may be applied as a prevention to surgical interference, absorption usually occurring in from two to ten weeks.

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