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8.A.22

The first sprig of the crop — for E. N. —

from R. K. Fitz.

A

COMPEND OF DIAGNOSIS

IN

PATHOLOGICAL ANATOMY

WITH DIRECTIONS FOR MAKING POST-MORTEM EXAMINATIONS

BY

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RESPECTFULLY AND GRATEFULLY DEDICATED

TO MY TEACHERS

EDUARD RINDFLEISCH

AND

RUDOLF VIRCHOW.

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AUTHOR'S PREFACE.

THE present volume is the result of a practical want which has long been felt, particularly in Berlin, the seat of the central commission for the examination of practitioners of medicine and medical officials. This has become more evident of late, since the establishment of a separate examination in Pathological Anatomy, the great increase in the theoretical and practical requirements of the civil examination, and the promulgation of the new Regulations for the performance of autopsies for medico-legal purposes by forensic physicians. Although the existing works on Pathological Anatomy are excellent, their scope includes too little of the practical details of the subject, and there is actually no book which contains comprehensive directions for making post-mortem examinations, for recognizing pathological changes in the fresh organs, and for establishing the diagnosis.

It is, of course, very evident that such absolutely practical knowledge can only be fully obtained from actual experience in performing autopsies; but in order to make this experience the more profitable it is necessary that a theoretical knowledge should first be acquired, not only of the course and method of the examination, but also of the alterations which may take place in the several parts, and of their characteristic peculiarities. This is all the more necessary as but

few students or physicians are able to secure special opportunities for practical training. It has been my aim to give such preliminary information for practical purposes, and it is my desire that the book may be judged from this standpoint.

Having been engaged for several years in giving instruction in both these directions, I have acquired a certain degree of experience in those particulars which present the greatest difficulty to students and physicians, and in those mistakes which are most commonly met with. I have therefore endeavored to make the former as clear as possible, and to guard against the latter. It may result that certain apparently trivial matters are more comprehensively and diffusely treated of than others which are of greater importance; should this prove to be the case, my excuse is that the main object has been to supply practical needs.

In the arrangement of the contents, and in the directions for the performance of the autopsy, the new Prussian Regulations for forensic physicians have been closely adhered to, which prescribe exactly the same method which has long been employed in the Pathological Institute at Berlin. In the sections treating of diagnosis, both gross and microscopic appearances have been described, the latter only so far as they may be verified by an examination of fresh specimens, without entering into details requiring prolonged methods of preparation. Those who desire such information will find the necessary directions in the respective text-books.

There is unfortunately at the present day a general tendency in the scientific world, for fellow-workers in the cause of science, to suspect the worst motives if their names are not mentioned. I have no wish to detract from their labors, and desire to state that the names of authors have been in-

serted in but few instances, for the sole purpose of diminishing the size of the volume and to carry out its practical aim, and that I have no intention of claiming all the various statements herein made as original observations or explanations. I need not say that I have made use of the text-books treating of this subject, especially the more recent ones, of Virchow, Rindfleisch, Klebs, Rokitansky, Förster, and others.

J. ORTH.

Berlin, *May* 1, 1876.

REVISER'S PREFACE.

THE want of a suitable practical manual of Pathological Anatomy has been strongly felt in this country as well as in Germany. Some years ago, however, an important work was prepared by Dr. Francis Delafield, of New York, which has proved of great service in filling this gap.

Since then, certain familiar appearances have received a new interpretation, attention has been called to recently discovered affections, decided improvements in method have been made, and numerous technical terms have been employed which are not sufficiently explained in the usual text-books. A work, therefore, giving information of this sort, and which may also be regarded as representing Virchow's teaching, has a strong claim for consideration, and those who are acquainted with the sayings of the Professor can best judge of the value of his assistant's presentation of them.

Dr. Orth, as is well known, has taken a prominent part in recent investigations, and his opportunities for practical work are probably unsurpassed. The reception which his book has met with abroad may be inferred from the fact that a Russian translation has been undertaken, and will soon appear, if it has not already been issued.

By special arrangement with the author, the English translation is enriched with numerous additions, which he has

prepared for a subsequent edition of the original work, many of them representing the results of the most recent researches. The translators have fully realized the importance of their labor, which they have undertaken with great earnestness, and have conscientiously performed. Whatever may have been sacrificed in style, has been for the sake of expressing the author's views as exactly and concisely as possible. A correct translation has been deemed of greater importance than an elegant one.

Two plates have been added, the drawings for which were made by Dr. H. P. Quincy, and are modified from those contained in Virchow's "Sections-Technik," lately published. They illustrate the method of opening the heart, and the anatomical points which require consideration in the removal of the sternum. They are sufficiently explained in the text.

To Dr. D. F. Lincoln hearty thanks are offered for his kindness, patience, and promptness in assisting in the correction of the proof-sheets.

Boston, *October* 20, 1877.

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DIAGNOSIS IN PATHOLOGICAL ANATOMY.

INTRODUCTION.

THE method of examination of the human body after death may vary according to the object in view. If this object be merely to confirm a diagnosis or to obtain more accurate knowledge of the condition of one or more special organs, the parts in question may be simply removed and examined out of the body; but if we wish to obtain a clear and broad idea of the change in the general organism brought about by any disease, of the effects of the combination of different diseases, of latent morbid changes in this or the other organ, it is only by a thorough and methodical examination of the whole body that we can obtain our end. Again, our object may be to ascertain the cause of death. In this case, too, the examination must be thorough and methodical; otherwise an important point might be easily overlooked. Finally, medico-legal cases may be put in a class by themselves, though they are partially included under the preceding division. It was formerly the custom to separate medico-legal from the so-called pathological autopsies, and in forensic cases to limit the examination to those changes which were immediately connected with the legal question at issue. But this was all wrong, for one can never know beforehand how important the morbid condition of any special organ may become during the course of the investigation, nor is one in a position to give a final and weighty opinion as to the fatal disease, the cause of death, or the condition of particular organs, unless each and every organ in its individual and

associated capacity has been accurately studied and made out. For these reasons the new Regulations for procedure in medico-legal cases in Prussia prescribe a careful and methodical examination and description of all parts of the body in their several relations, and, at the present time, a medico-legal is only distinguished from a pathological autopsy in that everything which may serve the ends of justice is treated with even greater accuracy and detail than is the case in an ordinary autopsy.

In order to make a thorough examination, it is absolutely essential to note accurately the relative position of each part to neighboring parts before disturbing them, and to take care that no part be removed if its removal interfere with the subsequent examination of other parts.

The method prescribed in the Regulations is practically that which Virchow[1] introduced into the Pathological Institute at Berlin; it meets the above named requirements, and has, therefore, been used as the basis of the present volume. A few words only on necessary preliminaries and instruments.

PRELIMINARIES.

A room to be suitable for autopsies should be spacious, well ventilated, and well lighted, good light being indispensable for the recognition of the finer changes in the structure of organs. Artificial light is bad on account of its yellowness, which modifies the natural color of parts; indeed, the Regulations do not allow an autopsy to be made by artificial light unless circumstances are such that it cannot be postponed. The best position for the operator is on the right of the body, and the table should be high enough to render much stooping unnecessary. It is true that in private houses, and in medico-legal cases, the external surroundings are often very unfavorable, and it is not always easy to comply with these conditions, some ingenuity being necessary to contrive a suitable

[1] During the progress of this work, and in time to be available in its revision, Virchow himself has published a description of his method of conducting autopsies, — *Die Sectionstechnik im Leichenhause des Charité-Krankenhauses*, etc., Berlin: Hirschwald, 1876.

support for the body out of tables, chairs, blocks of wood, planks, etc.; but one can nearly always get a table and an old door or some boards to lay upon it. The head, during the examination of the brain, or the back, during the examination of the neck, should be supported on a block of wood, with one edge rounded and hollowed at the middle, but if this be not at hand, any block of wood, or even a brick may be made to serve the purpose.

In moving the body, and especially in moving it from one place to another, care should be taken that it be done gently, and that the great cavities be kept in the horizontal position as nearly as may be, lest a part be ruptured or dislocated.

INSTRUMENTS.

Section five of the Regulations contains a list of those which are most needful.

Four to six scalpels, two small with a straight edge, and two larger with a bellied edge, a section-knife, two stout cartilage knives, two pair of forceps, two double hooks, a pair of large scissors, with one blade blunted and the other sharp at the point, a pair of smaller scissors, one blade being probe-pointed, an enterotome, one coarse and two fine probes, a saw, a mallet and chisel, a pair of bone cutters, a blow-pipe with stopcock, six curved needles of different sizes (sail-needles), a pair of callipers, a meter or yard measure with fine divisions, a large graduated vessel for measuring fluids, scales with weights up to ten pounds, a good magnifying glass, blue and red test paper. Besides these it is desirable to have a double saw for opening the spinal canal (rachitome), one or two tenon saws which are very convenient in examining the bones at the base of the skull, sponges, and a little cup for scooping up small quantities of fluid. The sharper the knife the better, and it is not to be held like a pen, as in the dissecting room, but grasped firmly in the hand; incisions should be begun with the heel of the blade, not the point, and the knife swept along from the shoulder rather than the wrist, thus making a long, smooth cut. The

larger an incision the more surface does it expose, and Virchow even affirms, '*that a large cut, though made in the wrong place or direction, is, as a rule, preferable to one or many small cuts which are correct in these respects.*" It is also very important that incisions should be *smooth*, as may be insured by avoiding excessive pressure on the organ or part and drawing the knife firmly and steadily through it. This latter remark applies with especial force to the softer organs, and above all to the brain, in connection with which Virchow says, "*better false cuts, if smooth, than jagged ones which are correct.*"

The utmost possible neatness should be observed in everything, and a vessel of clean water should be constantly present to rinse the knife and hands when soiled; the body also should be kept as clean as possible. Besides the vessel of water for the knife and hands, the use of which should be reserved exclusively for them, means should be provided for cleansing the organs as they are removed from the body; a common watering-pot, from which the nose has been removed, answers this purpose remarkably well, and has the further advantage of enabling one to regulate the force of the stream of water at will. A special receptacle should be provided for such waste as blood, exudations, transudations, etc. Shallow wooden dishes with raised edges are very convenient; one for receiving an organ during its examination, and a larger one for those organs which have already been examined.

APPLIANCES FOR CHEMICAL AND MICROSCOPICAL EXAMINATION.

It is often convenient to have a microscope at hand for immediate use, though generally it will be found better to take home anything which requires the use of the microscope and there examine it at leisure.

The following are the chief *instruments* necessary to prepare specimens for microscopic examination. A razor, several scalpels, scissors, forceps (those intended for coarser

pathological work are rather clumsy, but may be used in default of better), a pair of stout needles set in handles, watch-glasses, object and cover glasses, a camel's hair-brush, bibulous paper, and a double knife, the latter almost indispensable for fresh specimens. Such a knife consists of two parallel blades, one of which is fixed in a handle and the other movable. The movable, by an arrangement of springs and screws, can be approximated as desired to the fixed blade, and both blades are ground plane on the juxtaposed surfaces. In using it care should be taken that the blades be as nearly parallel as possible, to insure uniform thickness of the section, and the degree to which they are approximated depends on the thickness of the section which is desired and the consistency of the organ to be cut. In general, if the organ be lax in structure the blades should be more widely separated than if it be dense. The knife should be dipped before using in a mixture of alcohol two parts, and water and glycerine in equal proportions one part, to prevent the section from adhering to the blade and being torn; water alone does not moisten the knife uniformly enough. After the knife has been thus moistened it should be held like a fiddle bow, and the anterior extremities of the blades laid on that portion of the organ from which it is desired to obtain a section, and which should be put on the stretch in some way; the section is then made by pushing the knife forward its whole length with moderate pressure downwards, and drawing it backwards again as far as necessary. Sometimes the section remains sticking in the organ after the knife has been drawn through it, but this may be obviated by giving the knife a slight sideward turn before withdrawing it.

The character of the *fluids* in which a section is examined has much to do with its usefulness. Liquids can generally be examined in their natural condition, and for fresh sections, especially if reference be had only to relatively coarse pathological changes, common water usually suffices. But if more delicate examination be desired, and especially if it be the object to preserve blood corpuscles in as natural a con-

dition as possible, a so-called "indifferent" fluid must be made use of. This fluid may be one which is found already formed in the organism, as the aqueous humor or serum, or may be artificially prepared. A one half to one per cent. solution of common salt usually answers very well. Both iodine and osmic acid have the property of hardening protoplasm, and hence are often of great value, especially when the cells are very delicate and easily broken up; the latter may be used in very dilute solution — one eighth to one tenth of one per cent. Tincture of iodine being in frequent demand as a reagent, it is well to keep the following solution on hand: Iodine one part, potassic iodide three parts, water one hundred parts. Before addition to a microscopic preparation this solution should be diluted to a pale yellow color with water. Stained specimens are generally examined either in glycerine or a concentrated solution of potassic acetate; the parts which are not acted upon by the coloring matter are thus rendered more transparent, and the stained parts become still more prominent.

One of the most important *reagents*, on account of its property of rendering connective tissue more transparent as well as of contracting the nuclei and thus bringing them out more clearly, is acetic acid, which should always be on hand both in the anhydrous (glacial acetic acid) and in the dilute form (one to five per cent.). Caustic soda or potassa should also be on hand; their chief use is in the detection of fatty granules which they do not dissolve, while they do dissolve all soft tissues except elastic tissue. It is well to have two solutions of the alkali, one of one per cent., and one of thirty-three to thirty-five per cent. Finally, one should have a five to ten per cent. solution of muriatic acid as a solvent of the salts of lime. The best way of using these reagents is to allow a few drops to flow from one side of the cover glass to the preparation while a bit of bibulous paper on the other side absorbs the fluid which is under the glass; the action of the reagent on the preparation can thus be followed step by step under the microscope. If a current be

thus developed strong enough to carry the specimen out of the field, one of the following methods must be resorted to: one drop of the reagent may be placed at the edge of the cover glass and allowed to diffuse itself gradually underneath, in which case somewhat stronger solutions should be used; or else, abandoning the idea of watching the actual action of the reagent, the preparation may be from the commencement examined in a drop of the solution.

Much may often be gained, even in the examination of fresh specimens, by the employment of various coloring matters, all of which have this in common, that they stain the protoplasm (especially the nuclei), either exclusively or at any rate more deeply than the intercellular substance. *Methyl-aniline* is a very convenient coloring matter on account of the rapidity with which it acts, and in an aqueous solution of one to one thousand stains the nuclei of the cells a beautiful blue in a few minutes. The fact that it stains bright red those tissues which have undergone amyloid degeneration, adds to its value. After removal from this staining fluid the preparation should be washed and then examined, in either water or a concentrated solution of potassic acetate; the color fades rapidly in glycerine. *Hæmatoxyline* is also a valuable coloring matter. The following formula for its preparation is that recommended by E. Klein: —

Rub together thoroughly 5 grams of the officinal extract of hæmatoxyline and 15 grams of powdered alum in a mortar, adding gradually 25 cubic centimeters of distilled water; filter and add to the filtrate 5 grams of alcohol. Rub the residue again in a mortar with 15 c. c. of water, which should be added gradually, and add, after filtering again, 2 grams of alcohol to the filtrate. Mix the two fluids, and preserve in a well stoppered bottle. If it become turbid filter again. For use put several drops into a watchglass full of distilled water. After straining put the preparations for some minutes into distilled water and examine in pure glycerine or a solution of potassic acetate.

The inconvenience of hæmatoxyline is that the color is decomposed by the presence of the smallest quantity of any acid, while though acetic acid destroys the above mentioned aniline color, a preparation may be restained in it even after

it has been boiled in glacial acetic acid. *Carmine* is not affected by acids at all, but is not so well adapted for rapid tingeing, as it then stains the interstitial tissue somewhat, as well as the protoplasm.

A neutral solution of carmine may be prepared by rubbing powdered carmine with an equal amount of concentrated aqua ammonia, and leaving the mixture exposed to the air in an open glass till it has become perfectly dry. Then dissolve the resulting powder in a quantity of distilled water equal to three times the original mixture, filter, and add one gram of carbolic acid for every hundred cubic centimeters of the solution as a preservative (Ranvier). This strong solution may be diluted before using if desired.

After staining in carmine, preparations should be washed in water, then put for a few minutes into a one per cent. solution of acetic acid, and examined in glycerine or potassic acetate.

EXAMINATION OF THE BODY.

Two grand divisions may be made of every autopsy: —

A. External examination or inspection.

B. Internal examination or section.

A. INSPECTION.

In medico-legal cases, especially, this may yield important information, — as to the time when death occurred, the manner of it, etc., — but in purely pathological cases the external appearances are, as a rule, of very subordinate interest. It scarcely lies within the scope of this compend to treat exhaustively those conditions which are important solely from the point of view of legal medicine, and the reader is therefore referred for the discussion of such to the text-books of medical jurisprudence, while we propose to confine ourselves to those points which are of importance in pathological as well as in most medico-legal cases.

Inspection may be general or special; general as applied to the condition of the body as a whole, and special as applied to the condition of its several parts.

I. INSPECTION OF THE BODY AS A WHOLE.

(*a.*) GENERAL ATTRIBUTES OF THE BODY.

Under this head may be included age, sex, stature, frame, general nutrition, and general character of the skin.

The *frame* may be powerful, feeble, delicate, deformed,

etc.; if deformed, rachitis is generally the cause. The *degree of general nutrition* is indicated by fullness and roundness of form or their absence, and by the degree of prominence and thickness of the muscles. *Emaciation* may be dependent on either of two conditions: 1st. On atrophy of the fatty layer of the skin, in which case the integument is loose, and can everywhere be raised up in large thin folds. If a fold be rolled between the fingers it is easy to appreciate by the sense of touch the amount of subcutaneous fat. It is also evident that the thinner the integument the more sharply will the contour of the muscles be defined. 2d. On atrophy of the muscles, in which case they are thin and slender, their contours are ill-defined, the prominence of the biceps and the calf of the leg have disappeared, etc. Of course both these forms of atrophy are very often associated, and, indeed, in many wasting diseases but little more than skin and bones are left.

In raising a fold of skin we can also determine its *tension* and *elasticity;* the former is in an inverse ratio to the length of the uplifted fold. If the elasticity be normal the fold will resume its former position as soon as it is released; sometimes, in those dead of cholera, for example, it does not do this.

The general *color* of the skin should also be noted, and this can be properly done only when the body is clean. The usual color is pale grayish white, and is most marked on those parts of the body which have been protected by clothing. Those parts which have become browned by exposure to light and air during life remain so after death, and one sometimes meets with individuals, generally from the lower classes of society, in whom this is so marked and so widely extended over the neck and chest, that one is almost in danger of confounding it with that bronzed hue of the skin which is so prominent a feature in Addison's disease. This latter hue, however, extends over the whole body, and is especially marked on the belly, while if the brownish color be due to atmospheric influence, such is not the case. It may as well be incidentally mentioned here that the bronzing of the

skin, even if it extend to the mucous membrane of the mouth, does not point with absolute certainty to disease of the suprarenal capsules. These bodies may be diseased and the skin not bronzed, and the reverse. The coloring matter of the bile gives rise to a uniform pale yellow (lemon color) discoloration of the skin (*icterus*), which is usually most marked in the face and on the forehead. If the jaundice be of long duration and very intense, the discoloration may be dark yellow or even nearly black (*icterus melas*). A waxy pallor of the skin indicates *anæmia* or *oligæmia*, either acute (from loss of blood) or chronic. A clayey tinge is associated with various cachexias, such as carcinoma, etc.; and a peculiar dirty grayish hue, especially on those parts which have been exposed to the sunlight, occurs in those who have been taking the salts of silver for a long time (*argyria*).

(*b.*) SIGNS OF DEATH AND DECOMPOSITION.

Those changes of color in the skin which result from decomposition, naturally lead to the consideration of the signs of death and commencing putrefactive change, and are of importance in all cases on account of the light which they throw on the condition of the internal organs. In medico-legal cases their importance is still greater. Two different kinds of discoloration are to be carefully distinguished from each other: 1st. A greenish discoloration which is due to decomposition in the tissue, and first appears in those situations where the viscera lie nearest the surface, at the sides of the belly, the intercostal spaces, etc. 2d. That light or dark red, faded red, or livid discoloration which occurs in underlying portions of the body in discrete spots (suggillations), or more or less uniformly diffused over the body, and is due to blood. These spots, again, may be divided into two classes; those which depend on simple *gravitation* of the blood within the vessels (*hypostasis*, *hypostatic spots*), and those which depend on *diffusion* of the coloring matter of the blood in the vessels into the surrounding tissue. These conditions are readily distinguishable. If the discoloration be due merely

to gravitation it disappears on pressure, but if it be due to diffusion of the coloring matter of the blood, though originally less distinct, it does not disappear. Dull livid streaks, which are due to diffusion of the coloring matter of the blood from the larger cutaneous veins, indicate a high degree of the latter condition. Sometimes the whole venous cutaneous network is thus mapped out, as it were. In the usual position of the body these discolorations appear first and most markedly on the back and neck ; but they appear first on the chest, neck, and face, if these parts happen to have been undermost. This fact should be borne in mind to avoid the error of considering a normal post-mortem appearance to be of cyanotic or pathological nature.

In medico-legal cases these *post-mortem discolorations* (which never give rise to elevation of the surface) should always be incised, to avoid the risk of confounding them with extravasations of blood. In the hypostatic form fluid blood from the small vessels which are severed appears on the cut surface of the undiscolored tissue ; diffusion of the coloring matter of the blood is indicated by diffuse redness which persists even after pressure ; while extravasation, which more often causes slight elevations of the surface, is shown by the presence of blood, whether fluid or coagulated, in the tissue itself, more or less of which blood can generally be removed. The more fluid the blood in a body (as in cases of suffocation, of the acute infectious diseases, etc.), the more numerous and extensive are the post-mortem discolorations.

Cadaveric rigidity is another important sign of death. It appears first in the muscles of the jaw, gradually progresses from above downwards, and disappears in the same sequence. The more robust the individual and the shorter the duration of the disease, the more marked and persistent is this muscular rigidity, which attains its maximum in cholera. The sharply defined and thick bellies of the muscles, the contraction of which can scarcely be overcome, combined with the cyanotic hue of the skin, enables us to recognize this disease from a distance. Cadaveric rigidity disappears earliest in

those dead of a disease attended by hectic. After having been forcibly overcome it does not reappear.

II. INSPECTION OF THE SEVERAL PARTS OF THE BODY.

In examining the *several parts* of the body, one should begin with the head, and then take up in order the neck, the chest, the abdomen, the surface of the back, the anus, the external genital organs, and, finally, the extremities. In medico-legal cases special regard must be paid to the possible presence of foreign bodies or substances in the natural outlets of the body, the condition of the teeth, the condition and situation of the tongue, and, finally, the presence of injuries. Evidences of suppuration, of the formation of granulations or cicatricial tissue in a wound, the presence of gaping edges with adherent coagulated blood, warrant with more or less certainty the conclusion that the wound occurred before death.

Further changes to be noted are: —

(*a.*) *Modifications of Size and Form.* — Under this head are included distention and retraction of the abdomen, also swelling, especially of the extremities, due to *œdema* of the skin and subcutaneous cellular tissue. The latter is made evident by the doughy consistency of the parts, and the fact that they pit on pressure. On section the fatty tissue is flabby and infiltrated with clear fluid, which gradually collects more and more in the lowest part of the cut; if the œdema has existed for a long time the connective tissue is white and thickened. It is noteworthy that in trichinosis, where an œdematous swelling exists in the neighborhood of striped muscular fibre, there is no œdema of the external genitals, which become so extensively œdematous in other affections. Besides the relative proportion of the parts in general, that of the skin and its component parts are also to be noted. The epithelium and the true skin, one or both, may be either thickened or atrophied, and an idea of their relative proportion is to be obtained by incisions in several places.

(*b.*) When noting the *color* of a part it must be borne

in mind that when the color of parts depends on the amount of blood in the vessels, they generally lose it after death in great measure. Yet the bluish or livid hue of the nose, lips, ends of the fingers, etc., called "cyanotic," which depends on venous stasis, and is generally associated with dilatation of the vessels, is usually quite distinct after death. The presence of changes due to extravasation of blood should be carefully noted. Sometimes these are of large extent (traumatic), sometimes small or even punctate (purpura hæmorrhagica, acute hæmorrhagic exanthemata, ulcerative endocarditis). When post-mortem discoloration can be excluded, indistinct redness of the skin points to extravasation before death, while a yellowish or greenish yellow zone around an extravasation (partial hæmatogenous icterus) shows that it is of some standing.

A brownish discoloration, especially when occurring in numerous small, scattered spots, is generally the result of circumscribed inflammatory processes, and hence is often met with near scars — in connection with ulcers of the leg, for instance; or else it is congenital, as in pigmentary nævi. White cicatrices are also met with; their effect is striking in proportion to the degree of pigmentation of the rest of the skin (in Addison's disease, for example, they are very conspicuous); irregular white spots (partial albinismus) are sometimes met with, especially on the genitals.

III. INSPECTION OF NEW-BORN CHILDREN.

It being often of the utmost importance to decide as to the viability and period of development of a new-born child, we will now take up systematically the points which aid in the solution of these questions, and which have not already been mentioned.

The average *length* of new-born children at full term is 50–51 cm., the figures being rather larger for boys than for girls. During the last five lunar months of fœtal life the length in centimeters is five times the number of the lunar month which the child has reached in its development (at the

sixth month $5 \times 6 = 30$, at the eighth month $5 \times 8 = 40$, etc). The average *weight* of boys at full term is 3,300 grams, that of girls, 3,250 grams. The normal skin is firm and somewhat on the stretch, not wrinkled ; its color is no longer red but white, and it is more or less covered with light downy hairs. At full term this down is chiefly marked on the shoulders. The umbilical cord, the average length of which is about 48–56 cm., is inserted somewhat below the middle of the body and falls off from five to eight days after birth.

The head should be examined with great care. The length of the hair should first be noted : at full term this is generally 2–3 centimeters. Next the size of the fontanels ; the anterior or great fontanel measures 2–2.5 cm. in length at full term. Next come the different measurements of the head — the circumference of the head, 34.5 cm. ; the longitudinal diameter from the glabella to the occiput, 11.5 cm. ; the anterior transverse at the end of the coronal suture, 8 cm. ; the posterior transverse at the eminences of the parietal bones, 9 cm. ; the long oblique, from the chin to the highest point of the occiput, about 13.5 cm. ; the short oblique, from the anterior border of the nape of the neck to the farthest point of the forehead (inexact), about 9.5 cm. Then the eyes should be examined, the pupillary membrane disappearing about the commencement of the eighth lunar month. The cartilages of the nose and ears are hard to the touch at full term. The finger nails are hard and horny, and project somewhat beyond the end of the fingers. The width of the shoulders should also be measured (11 cm.), and likewise the distance from one trochanter major to its fellow (9 cm.). Finally, the genitals should also be examined. The testicle descends into the scrotum during the seventh month, and at full term both testicles should occupy the wrinkled scrotum. In girls at full term the labia majora are generally long enough to hide the clitoris and labia minora, though this is not always the case. (We shall speak of the examination of the centre of ossification of the femur under the head of Bones of the Extremities.)

IV. MORBID CONDITIONS OF THE SKIN AND SUBCUTANEOUS CELLULAR TISSUE.

Before entering on the consideration of morbid conditions of the skin and subcutaneous cellular tissue, we must state that we do not consider it to lie within the scope of this work, which is only a compend of diagnosis in pathological anatomy, to treat exhaustively all those diseases of the skin which may be met with in the dead body, but which are to be seen in their full development only during life and are described in the text books of dermatology. We shall discuss in detail only those modifications which are, or may be, connected with disease of the internal organs, or which have special pathologico-anatomical interest.

(*a.*) GENERAL MORBID CONDITIONS.

1. On our way from without inwards we first come to certain changes in the **epidermis.** The first of them to be mentioned is abnormal separation or detachment of the upper horny layers. While from healthy skin the older layers of the epidermis are gradually and insensibly cast off, the epidermis is often cast off in larger or smaller coherent masses, not only as a result but also as a part of many cutaneous affections. In psoriasis and pityriasis versicolor, *desquamation* takes place in small scales, which in the latter disease are distinguished by their brownish shade; rather larger masses are shed after many of the acute exanthemata — measles, for example; finally, if the epidermis be detachable in large strips, or from a whole finger or hand, scarlatina is pretty clearly indicated. The desquamation from an otherwise healthy skin should not be confounded with the post-mortem detachment of epidermis over inflamed surfaces as in erysipelas, or with the same condition resulting from inflammation of the subcutaneous cellular tissue (phlegmon), in which cases the surface from which the epidermis has become separated is always moist and usually reddened or of a dirty greenish color. A like condition may be met with, not

dependent on inflammation but on decomposition. In this case other evidences of decomposition will also be present and prevent our falling into error.

The epidermis may be separated from the true skin by circumscribed collections of fluid (blisters), which are generally of a pale, dirty-red color, when the result of decomposition. The same appearance may be met with in fresh bodies, provided that decomposition had begun during life, — over spots of gangrene, for example.

An eruption of small vesicles, attended with but slight elevation of the epidermis, is not an accidental complication, but rather an actual morbid condition. According to the character of the contents, a distinction is drawn between *vesicles* or *bullæ*, both of which contain a clear watery fluid, and differ only in size, and *pustules*, which contain pus. The latter may be a later stage of the former, in which case both are found associated.

2. The integrity of the deeper layers of the skin, the **cutis** proper, depends on that of the epidermis. If the latter be detached from any cause, the cutis dries by evaporation into a stiff brown parchment-like substance. Whether this drying up involves only the upper layers of the cutis, or its whole thickness, is readily seen on cutting into it. Great distention or pressure may cause atrophy of the cutis; hypertrophy, however, is more common. If such hypertrophy take the form of hard elevations from the size of a hempseed to that of a bean, they are called *papules*, and may be due to inflammation, hæmorrhage, morbid growths, etc. Discoloration of the skin has been already discussed.

(*b*) SPECIAL MORBID CONDITIONS.

1. **Hæmorrhage** into the skin may be divided according to its size and form into *petechiæ*, small round effusions of blood, *vibices*, small longitudinal effusions, and *ecchymoses*, larger effusions. The latter are generally of traumatic origin, and are less interesting than the smaller effusions, which are usually associated with the acute exanthemata, purpura hæmor-

rhagica, etc. The most minute form of all occurs in ulcerative endocarditis, as a result of embolism of the cutaneous arteries, and is associated with similar hæmorrhages into the conjunctiva and buccal mucous membrane, as well as with minute abscesses. To these latter we shall return later.

2. **Inflammation** is met with ; —

(*a.*) In *small isolated spots* more or less numerous. The affections which come under this head concern rather the dermatologist, and hence will receive but little attention here. *Psoriasis* represents *squamous* inflammation and is characterized by the detachment of the epidermis in small scales. Among the *vesicular* inflammations are *miliaria* (*sudamina*), characterized by multiple minute vesicles, either perfectly transparent like dew-drops, or whitish or reddish, presenting no trace of inflammatory action at their circumference, — and *herpes* (facial, progenital, zoster). In the latter affection the vesicles likewise contain clear fluid, but show evidences of inflammation at their base, and, if ruptured, may be either scabbed over or remain as raw surfaces. The first stage of *eczema* (eczema vesiculosum) is also characterized by clear vesicles whose base is much inflamed, and swollen by collateral œdema : in their later stages they may become pustules or form scales and crusts. *Pemphigus*, with bullæ containing either serum alone or a mixture of serum and pus, comes also under this head. In the form of *pemphigus neonatorum* it is met with in new-born children and in the dead fœtus, is most marked on the palm of the hand and sole of the foot, and suggests syphilis. The blisters are easily ruptured, and one finds there only large, round, more or less detached bits of epidermis and under these a moist, dark red, or livid surface.

It may be questioned whether *variola* should not also come under this head, as its eruption contains at first a clear watery fluid, though at a later period it becomes purulent, and is distinguished from all those vesicles of which we have spoken above by being umbilicated in the centre. The pustule of variola lies between the mucous and the horny layer

of the skin and has a honey-combed character. Effusion of blood may take place into a small-pox vesicle as well as into any other, that of pemphigus, for instance. It is then called *hæmorrhagic small-pox*, but the eruption is, in this case, usually rather papular, and but little characteristic. Not only the contents of the vesicles of variola, especially before they have begun to be converted into pustules, but the underlying skin as well, are remarkable for the presence of micrococci, which are easily demonstrated in fresh sections with the double knife, after treatment with glacial acetic acid or dilute caustic alkalies.

There are but few truly *pustular* eruptions (without vesicular initial stage), unless we include under this head acne and furuncles, which we shall treat of in connection with the glands and hair. *Impetigo* and those *minute abscesses of embolic origin* to which we alluded under Hæmorrhage, constitute the class. These latter occur scattered over the whole body and appear as minute yellow spots, which may or may not be surrounded by zones of hæmorrhage ; they occur only in connection with the malignant form of ulcerative endocarditis in which, as will appear later more in detail, the thrombi contain large nests of micrococci. If thin transverse sections be made of the skin, either fresh or rapidly hardened in absolute alcohol, and laid under the microscope, it is easy to demonstrate the presence of a vessel filled with micrococci in the centre of each hæmorrhage or abscess.

Papular inflammations form the last subdivision of this group, and include *lichen*, *prurigo*, and the *papular syphilide*, with inflammatory growth in the papillary layer.

(*b.*) *Erysipelas* (dermatitis) and its congener *phlegmon* (cellulitis) are distinguished by their *diffuseness* from those inflammations which are met with in small circumscribed spots and which we have already dwelt upon. The blush which is so characteristic of erysipelas during life often disappears entirely after death, and the indications of its having existed resolve themselves into diffuse swelling of the skin and subcutaneous cellular tissue, and their infiltration with an opaque

fluid rich in cells. In the early stage we see in a section placed under the microscope numbers of young cells, particularly along the course of the vessels, which cells later undergo fatty degeneration. Micrococci have been found in the lymph vessels, as well as in the contents of the vesicles which often spring up on erysipelatous skin.

Since the subcutaneous cellular tissue always participates in the swelling and infiltration with young cells resulting from simple erysipelas, it can readily be seen that increase in the intensity of these conditions may result in purulent inflammation of this tissue (*cellulitis*). In this case, while the cutis is red and infiltrated, the subcutaneous tissue is swollen and its meshes are filled with opaque, yellowish, puriform or purulent fluid, *erysipelas phlegmonosum.*

Such suppuration may, of course, occur independently of erysipelas, and is then often of traumatic origin. It tends to spread horizontally, the superficial fascia preventing its deeper progress. If of long standing, the skin may be separated from the fascia over a large territory and a great cavity be formed, hanging from the walls of which, in greater or lesser number, bits of suppurating cellular tissue may be found. This is especially liable to occur if the inflammation is of an infective character (*malignant, ichorous, gangrenous cellulitis*), and in consequence of it the skin may become necrotic from disordered nutrition. Malignant cellulitis is often the result of contusions which are attended with hæmorrhage, and the contents of the cavity may thus acquire a dirty brownish color. The walls are often studded with fresh hæmorrhages, and are of a dirty greenish slate color.

3. In that form of **necrosis of the skin,** which we have just mentioned (*sphacelus*), the tissue is transformed into a soft, greasy, pulpy, dirty greenish or brownish colored mass (*humid* or *moist gangrene*). This is sometimes of considerable extent, usually taking the form of *bed-sores*, so called, and is seated on the sacrum, the trochanters, the spinous processes of the vertebræ, the heels, etc. The gangrene which sometimes follows frost-bite, and occurs chiefly in the

feet, is of the moist variety, though after detachment of the epidermis it may be eventually converted into the dry form. Special mention should be made of *noma* (*cancrum oris*), a form of gangrene of the skin of the cheeks, lips, and nose, which is endemic in certain places, and which is not primary in the skin but extends outwards from the oral mucous membrane. Microscopic examination of the opaque foul-smelling fluid, into which in all these cases the tissue is resolved, shows granular masses of detritus, quantities of fat in both fluid and crystalline form, needle-shaped crystals of leucine and tyrosine, the latter arranged in the form of sheaves, crystals of triple phosphate resembling a coffin-lid in shape, and numberless bacteria, of all sizes and shapes, in active motion. A rosy-red color is produced, according to Virchow, by the addition of sulphuric acid to this gangrenous fluid.

Another form of gangrene, called *dry gangrene*, to distinguish it from the humid variety, next claims consideration. This form is also called *mummification*, and transforms the skin and subcutaneous tissue into a hard, black, or brownish black, mass. Sometimes it also is the result of pressure, and then occupies the same situations which have been enumerated above, but its usual seat is the ends of the lower extremities, and its cause plugging of a large artery or some other disturbance of the circulation. Thus in *senile gangrene* a predisposing cause is calcification of the arterial walls and the resulting diminution in calibre. It is true that it is uncommon for these changes, and the arterial thrombosis to which they give rise, to result directly in gangrene; the immediate cause is rather to be found in small peripheral wounds or injuries which become inflamed, and this inflammation then assumes a progressive gangrenous character. Secondary arterial thrombosis may supervene on this and extend upwards toward the trunk, and may be recognized as secondary by the evidences of gradual progression in the structure of the thrombus itself. In all cases of so-called *spontaneous gangrene*, the vessels which relate to the part should be carefully examined.

A form of gangrene has been described and characterized as *white gangrene*, which is a result of great distention of the skin, over tumors, for example, and is also sometimes the result of burns, the skin being transformed into a white, friable mass.

Hospital gangrene (*gangræna nosocomialis*), a poisoned condition of wounds, differs from the above described forms of gangrene, which all have one factor in common, their dependence on disordered nutrition. Wounds affected with hospital gangrene present a gray, coated surface, from which the gray mass can be only partially removed owing to the fact that it is infiltrated into the tissue, — *local diphtheritis*. This gray mass consists chiefly of micrococci (minute spherical bodies either aggregated in masses, or strung together like beads on a rosary, and characterized by uniformity in size and a peculiar lustre), and bacteria (staff-like bodies of various lengths, sometimes darting and wriggling about, sometimes strung together in chains or collected in masses, in which latter case they are distinguished from collections of micrococci by the presence of a transparent and gelatinous intermediate substance in considerable amount). To bring out these bodies clearly it is advisable to add to the microscopical preparation a little dilute caustic potash, which dissolves most organic structures but does not affect these organisms. An appropriate opportunity will be taken further on for showing the distinction between micrococci and fat drops.

4. **Ulcers** of the skin may be divided into *simple or superficial* and *cavernous*, and the latter class may be again divided into *sinuous*, with undermined edges, and *fistulous ulcers*. In the latter case ulceration extends in only one direction, forming a canal of varying width. These are usually concomitants of affections of the bones and joints, and are due to the burrowing of pus outwards ; but they also occur in connection with affections of the serous cavities in the same way, and in both cases are called *perforating fistulæ* or *sinuses*. If the fistula discharge one of the natural secre-

tions, it receives a special name, as lachrymal, salivary, or urinary fistula. With reference to the condition of the granulations at its base an ulcer may be *indolent*, with feeble and pale granulations, or *fungous*, with luxuriant granulations (proud flesh). If the granulations develop rapidly into tough and firm connective tissue, an *indurated* ulcer is the result; if, on the contrary, they tend to break down rapidly, a *suppurating*, *phagedenic*, or *gangrenous* ulcer is the result.

Many of the affections of the skin which we have already mentioned may give rise to ulceration, as indeed we specified in some instances; when we come to the discussion of new growths in the skin, we shall find that some of them may also give rise to ulceration, but of a progressive character. A few forms still remain for discussion here, the most common of which is the well-known *chronic ulcer of the leg*.

This is a typical indolent ulcer, with thick, indurated edges; its base and circumference are indurated and in a state of chronic inflammation, and it shows but little tendency to cicatrization. In the neighborhood of such ulcers, scars, resulting from antecedent ones, are often met with, and usually present a brownish pigmentation. The ulcers may be of large extent in either direction, and may, indeed, involve the greater part of the leg. They are prevented from penetrating inwards by the tibia, which is often affected with superficial ossifying periostitis, but it may also become more deeply involved in the process, and thus superficial necrosis, or even osteomyelitis, be produced.

Of the remaining kinds of ulcers we shall only mention the *varicose*, which occur over dilated veins; the *gouty*, which are the result of the rupture of gouty deposits outwards; and the *scorbutic*, which are characterized by hæmorrhage.

5. Ulcers result in **cicatrices**, which sometimes are characteristic of the special process which has given rise to them. For example, radiating, elevated, broad scars, generally indicate an extensive burn or cauterization; kidney-shaped, glossy, irregularly depressed and pigmented scars, remain

after syphilis; small, longitudinal, transversely striated scars of a silvery whiteness, occupying the deeper layers of the skin, and most abundant on the belly and thighs — the cicatrices following pregnancy — depend on rupture of bundles of the cutaneous connective tissue from great distention, and hence are not cicatrices at all, strictly speaking. The distention is usually dependent on pregnancy, but may be due to ascites, anasarca, or great accumulation of fat.

6. Apart from parasitic diseases, to which we shall come later, there are but few changes in the **epithelial appendages** of the skin, the hair and the nails, or in the glands, which need detain us here.

a. Premature baldness may be dependent either on individual peculiarity or disease (typhoid fever, syphilis, etc.). *Alopecia areata* or *vitiligo*, is indicated by loss of the hair in round patches, and consists, strictly speaking, in a breaking off of the hair at the surface of the skin in consequence of a peculiar disturbance of nutrition. A furuncle or *boil* consists in acute purulent inflammation about, and necrosis of, the hair follicles, especially those of the downy hairs. If several furuncles be closely aggregated — more common on the back than elsewhere — they form what is called a *carbuncle*, the skin over which, after the necrotic hair follicles have come away, is riddled and honey-combed.

b. The *nails* may be variously distorted, in consequence of inflammation of the bed, especially of that portion of the matrix which forms the fold (paronychia), or in consequence of increased cellular formation in the matrix; in this latter case they are thickened and incurvated (onychogryphosis), and appear as if raised from their bed by a laminated mass. Sometimes a double nail, especially on the thumb, is met with, and even a double terminal phalanx.

c. The cutaneous *glands*, apart from new formations, present little of importance. The most common affection to which they are subject is purulent inflammation about the sebaceous glands, especially of the face (*acne*). If this be associated with considerable redness and inflammatory swell-

ing of the surrounding skin it is called *acne rosacea*, and is met with chiefly on the nose. If the inflammation start from the glands belonging to the hair of the beard, it is called *acne mentagra* or *sycosis*, but must not be confounded with sycosis parasitica, which depends on a vegetable growth.

7. **Morbid growths in the skin.** (*a.*) **Hypertrophy** of the skin, involving sometimes chiefly the epidermis, sometimes chiefly the connective tissue, forms the connecting link between those affections which we have considered above, and tumors of the skin and subcutaneous cellular tissue. Many of the forms of hypertrophy are of so little importance, and so easy of diagnosis, that their mere mention almost suffices. Such are: *callus* (*tyloma*), *corn* (*clavus*) — both mere thickenings of the epidermis. *Ichthyosis*, which is generally of considerable extent, consists in increased formation of, and horny change in, the epidermis, and transforms the skin into a sort of horny coat of mail which breaks off in scales and plates.

A similar, but local process, leads to the formation of *horny excrescences* (*cornua cutanea*). Common *hard warts* (*verrucæ*), which consist chiefly of epithelium, although they involve also increase in the papillary layer, and the so-called *vegetations* (especially common on or near the genitals), in the formation of which the papillary layer plays a great part, the papillæ becoming very long, pointed, and even giving off branches, *condyloma acuminata*, also belong in this class. The epidermis does not increase enough to cover over all these papillary outgrowths, the result of which is that some of the papillæ project from the surface. These growths sometimes are of considerable extent, particularly when seated at the outlet of a canal lined with mucous membrane, *papilloma*.

Elephantiasis Arabum is rather an affection of the true skin and the subcutaneous tissue, and is chiefly met with in the feet, legs, and genitals. In well-marked cases the foot and leg are much enlarged, the angle between them is more or less effaced, the surface of the skin is sometimes smooth,

sometimes studded with nodules and excrescences, and often pours out a secretion, which may have a milky appearance. The secretion is more often met with where flat superficial ulcers with brawny bases are present. Sometimes, especially on the genitals, elevations of variable size are met with, from which this fluid exudes in enormous quantities. On section cavities appear which are easily recognized as enlarged lymph spaces (*pachydermia lymphangiectatica*). On cutting into the extremities the enlargement is found to consist of a tough, firm, whitish tissue, which has replaced the true skin and in great measure also the subcutaneous tissue, and may even penetrate the intermuscular spaces as far as the bone (the diffuse fibroma of Virchow). The microscope shows a great increase in the number of vessels, and an enlargement of the papillæ, especially at the seat of the warty protuberances. Bundles of dense connective tissue cross each other in all directions, and the more complex structures which are inclosed between them, as fat, muscle, and nerves, are gradually destroyed; the bone shows signs of extensive, irregular ossifying periostitis (hyperostosis).

The rare affections *sclerema neonatorum* and *scleroderma* of adults also belong in this class. They are characterized by fibrous thickening of the skin, which, in its later stages, gives rise to atrophy and retraction of the same. The skin then is smooth, shiny, and so tense as to distort the joints in various ways.

Soft warts or *moles*, when congenital, are called *mother's marks* (*nævi materni*) and belong almost exclusively to the true skin. They are more or less sharply elevated above the surface of the skin; are seen on section to consist of a soft gray tissue, which is strongly contrasted with the structure of the skin; extend to a variable depth into the cutis, and sometimes even into the subcutaneous tissue; and are covered by an epithelial layer which is but little, if at all, thicker than normal. They are often pigmented, the pigment lying partly in the lower layers of epithelial cells, but

chiefly in the richly cellular connective tissue of which the mole is composed. These formations are interesting chiefly from the frequency with which sarcomatous tumors spring from them.

b. Of the actual **tumors** which are found on the skin, **cystic tumors** (1) first demand our attention. Some of these are due to retention of the secretion of the hair follicles and sebaceous glands. The simplest form of these is the small yellow nodule, very common on the nose, called *comedo*, which on pressure allows the escape of a little yellow wormlike body with a black head (dirt) from the dilated hair follicle. This little body consists of epithelial cells and fat, and is merely retained secretion. *Milium* is a rather larger yellow nodule (the size of the head of a pin); it has no external opening like the comedo, which it resembles, however, in structure, and occupies the deeper portion of the hair follicle. The largest of these retention-cysts is the *wen* (*atheroma*) which is ordinarily from the size of a pea to that of a hazel-nut, but may, in rare instances, reach the size of the head. Its contents consist sometimes of soft, thick, yellow, glistening plates of cholesterine, sometimes of a buttery or even chalky mass, and are inclosed by a membrane of connective tissue, the cyst wall, which contains but few vessels, and often has points of cretification. When of a certain size they remain seated in the cutis, but on further growth encroach upon the subcutaneous tissue, and become entirely imbedded in it. Under the microscope the contents are resolved into horny epithelial cells, fatty degenerated cells, free fat drops, and crystallized fat, particularly cholesterine.

The so-called *dermoid cysts* resemble wens closely, but are much more rare. They range from the size of a walnut to that of a hen's egg, and consist of a sack, containing a soft, yellowish, greasy mass of fat, cholesterine, epidermis, etc. Sometimes hair or even more organized structures are found in them. The wall is not, as in a wen, a simple fibrous investment, but contains all the elements of the outer skin, —

epidermis, cutis richly supplied with vessels, hair, and sebaceous glands, which are not always distributed uniformly throughout the circumference but may be confined to more or less limited portions of it. The whole skin is thus here represented, and the contents are only retained sebum and cast-off epidermis. The formation of sebum predominates over that of epidermis — the reverse is the case in wens — and hence a large cavity containing chiefly sebum or a honey-like matter may nearly always be classed as a dermoid cyst (Virchow).

Other cystic formations are met with in the subcutaneous and intermuscular tissue, and even by the side of the bones, which are distinguished from those already described, in that they do not contain retained glandular secretion but a clear, highly albuminous fluid, varying in consistency from that of water to that of honey (meliceris).

The *hygromata*, the most common of which is hygroma præpatellare (*housemaid's knee*), also belong in this class, and are dilatated normal or newly formed bursæ. They form ill-defined cavities in the connective tissue, sometimes with prolongations, and are often traversed by bands and septa of connective tissue, or are rough on their inner surface.

Another subdivision includes those accumulations of synovial fluid in the sheaths of the tendons called *ganglion*, or *weeping sinew*. They are chiefly found on the wrist and ankle. If the secretion is thick, they are called meliceris cysts, or cysts with honey-like contents. Sometimes a sort of papillary growth takes place on the inner wall. These growths may become pedunculated and then detached, thus forming those small, flattened, grayish-white free bodies which are sometimes found in large numbers in these cysts.

There is still another form of cyst which results from the dilatation of lymph spaces. They are commonly seated on the neck (*hygromata colli*), and are sometimes congenital.

2. **Vascular Tumors** (*Angiomata*). These are very common on the skin. We do not mean to include under this

head aneurismal dilatations of the arteries or varicosities of the veins, which may also cause prominence of the skin, and will be described under disease of the vessels, but refer here to dilatation, and, what is still more common, new formation of the capillaries (*telangiectasis*). These tumors project but little above the surface of the skin, are either bluish or bright red in color, are sometimes of large extent, and often congenital (*nævi vasculosi*). *Cavernous tumors*, so called, are much less common, and depend on the new formation of vessels larger than capillaries; they generally spring from the subcutaneous fat tissue.

3. **Lipomata** (*fatty tumors*) are often met with on the skin and are to be regarded as local hyperplasiæ of the subcutaneous fat tissue. They are distinctly lobulated, the lobules are separated by vascular connective tissue, and the fat cells are plainly visible to the naked eye. These tumors are more or less elevated above the surface, and sometimes, indeed, are only connected with it by a small pedicle (*lipoma pendulum*). If the interstitial connective tissue be abundant and dense, the tumor is harder, and white bands are seen running through it (*lipoma fibrosum* or *durum*); if the tissue softens — this is more liable to occur at the centre — the fat escapes from its limiting membrane, and a cavity is formed, filled with an oily mass. Telangiectasis is often associated with these tumors (*lipoma telangiectodes*): this form is congenital. A remarkable formation of fatty tissue often takes place about old hernial sacs.

A growth of mucous tissue is sometimes found in lipomata, especially at the centre (*lipoma myxomatodes* or *myxoma lipomatodes*, according as either structure predominates). The myxomatous portion is somewhat transparent, gelatinous, and becomes white on the addition of acetic acid, as can be seen with the naked eye. Under the microscope — a bit snipped off with the scissors will generally answer the purpose — one sees a perfectly transparent substance, in which the addition of acetic acid produces a filamentous or granular opacity, which does not disappear on adding an ex-

cess of the reagent, and which contains a network of star and spindle-shaped cells with anastomosing processes.

4. Pure **myxomata** also occur, both in children (connected with the umbilicus) and adults. Their origin, in the latter, is often in the deeper tissues, and their presence in the skin is only secondary.

5. The same remark applies to **enchondromata,** which generally spring from the bones or their vicinity. They may attain great size, may cause ulceration of the skin, and consequent exposure of the bluish-white cartilaginous tissue of which they are composed. Like the lipoma they are lobulated, and the lobules are surrounded by connective tissue. Sections may readily be prepared for the microscope, which shows their structure to be that of hyaline cartilage, except that sometimes, particularly near the edges of the smallest lobules, the cells are star-shaped (star-celled cartilage). The various structures of the enchondroma, the myxoma, and the lipoma are often combined in the same tumor. True bony tumors of the skin (osteomata) are very rare.

6. Three forms of **granulomata** (granulationsgeschwülste, Virchow) occur in the skin, the lupous, the leprous, and the syphilitic.

(*a.*) The microscopic appearances of *lupus* are very varied. The typical form consists of multiple bluish-red nodules, from the size of a hemp-seed to that of a pea, springing from the cutis and projecting above the surface of the skin (*lupus tuberculosus* or *nodosus*). An earlier stage in which the nodules have not as yet become raised above the surface, but appear only as brownish-red stains, from the size of the head of a pin to that of a lentil, is called *l. maculosus.* If the nodules have become confluent and thus an extensive new formation project above the surface, it is called *l. hypertrophicus;* if the skin over the infiltration be covered with epithelial scales, it is called *l. exfoliativus* ; and, lastly, if the nodules have burst and formed an ulcer or ulcers, it is called *l. exulcerans.* According to that view of the subject which is now prevalent, a nodular small-celled growth in the co-

rium extending outward into the papillary, as well as inward into the cellular layer, constitutes the histological base of these changes. Ulceration depends on a disintegration of these cells, and heals, leaving scars and great contraction. All the stages of the process (growth, ulceration, and cicatrization) may be found near each other in the same subject. According to Rindfleisch, lupus is to be regarded as adenoma of the cutaneous glands; according to Friedländer as local tuberculosis.

The name *lupus erythematodes* or *erythematosus* has been given to an affection which is not attended by either the formation of nodules or by ulceration, but by the formation of minute cellular masses in the cutis. This growth is very apt to involve the sebaceous glands (causing enlargement of the glands and milium), and often starts from them; it is almost strictly confined to the face, and when it extends from the nose symmetrically over either cheek forms a figure very like a butterfly.

Lupus of long standing with its attendant cicatrices is much more commonly met with on the dead body than the recent form. The favorite seat of the disease being the face, it is here that its ravages are most marked; all the prominent parts of the face, the tip of the nose, the lips, the eyelids, may be destroyed; the skin of the face is smooth, tense, and glistening; the nostrils are mere apertures in the face; the mouth is transformed into a more or less rounded hole surrounded by cicatricial tissue; the eyeballs are exposed, ulcerated, or destroyed, having been deprived of the protection of the lids. There is one point in regard to the distortion of the nose which is of special importance. Lupus attacks first the anterior portion (the soft parts and cartilages), while syphilis attacks the bone first and allows the bridge of the nose to sink in.

(*b.*) *Leprosy* (*elephantiasis Græcorum*), only sporadic in Middle Europe, is characterized by much larger nodules, from the size of a hazel-nut to that of a walnut, the chief seats of which are the face and extremities. The nodules occupy

the corium, though they may extend into the subcutaneous tissue, and consist of richly cellular granulation-tissue, which, according to Virchow, evidently springs from the cells of the connective tissue. The condition of the nodules remains unchanged for a long time, though, when old, their cells may undergo fatty degeneration and thus the nodules diminish in size. Ulceration is rare, and is always dependent on external influences.

(*c.*) *Syphilis* may be the cause of tumor-like growths in the skin, as well as of more inflammatory processes (psoriasis, pemphigus, rupia, etc.). These growths are called *gummata* and consist of a soft, small-celled tissue with an intercellular substance soaked in a sticky fluid, which fluid exudes from the cut surface on pressure. The nodules may soften in consequence of fatty degeneration of the cells, and open ulcers result from the destruction of the superficial tissues. The base of such ulcers is formed by gummy tissue, which is constantly breaking down; it thus acquires a yellowish, brawny appearance, and becomes dense and indurated to the touch.

Many authorities class here the primary syphilitic sore, the so-called *hard chancre*, which has exactly the character we have just described. A second form is the *mucous patch* (*condyloma latum*, *plaque muqueuse*), which is attended by growth of the individual papillæ, the epidermis covering which is thinned, softened, and moist, thus resembling that covering mucous membranes. A third form is the so-called *lupus syphiliticus*, especially common on the extremities. In this form numerous nodules, varying in size from that of a hemp-seed to that of a pea, are seated in the cutis or even in the subcutaneous tissue; in their early stages they are dense, but later they become softer (much more rapidly in the skin than elsewhere), and form open sores partly through fatty degeneration and partly through suppuration. These ulcers are at first round, but becoming confluent, they assume all sorts of irregular shapes, and in healing leave scars which are remarkable for the degree of contraction which they may undergo.

(*d.*) *Glanders* or *farcy* (*maliasmus*) is also classed here by Virchow. This disease is attended by the formation of nodules in the skin which differ from those before described in that they tend to break down by suppuration, but like them consist of a small-celled growth. The nodules on breaking down leave ulcers which likewise, by becoming confluent, may acquire an irregular contour. There is an acute as well as a chronic form, the formation of nodules being common to both; in the acute form more or less extensive cellulitis is coexistent with the nodules.

7. **Fibromata** of the skin are developed either from the cutis or the subcutaneous tissue, are often multiple, sometimes very dense (*fibroma durum*), sometimes softer (*fibroma molluscum*). The former consist of tough dense connective tissue, and contain, where the formation is most recent, spindle and round cells. In the recent forms, the fibres of connective tissue are not so closely interwoven, but form a coarse network, the interspaces of which are occupied by a still finer network, which in its turn contains a quantity of yellowish albuminous fluid.

That growth to which Alibert gave the name *keloid*, is also classed with the fibromata. Its most common seat is over the sternum, where it takes the form of divergent bands of fibrous tissue, elevated above the surface, and more or less rich in cells; this tissue is finally transformed into a species of cicatrix.

8. The **sarcomata** may be primary in the skin, and may equal the head in size; when very large they are generally coarsely lobulated. They often assume the shape of a mushroom. The majority of them, and especially those which are superficial, are hard, and consist of spindle cells; but those which spring from the subcutaneous tissue are often composed of small cells. The former appear on section of a grayish or reddish-white color, and are either uniform or slightly striated in structure; as a rule no fluid can be expressed from the cut surface. By teasing a small bit with needles the spindle cells can generally be isolated, and there is usually no difficulty in

making sections with a double knife or sharp razor, of sufficient thinness to show that the cells are united together in bundles which are more or less interwoven, but chiefly radiate outward toward the skin; this peculiar structure can be still more clearly brought out by staining the specimen in methyl-aniline or hæmatoxyline. In oblique sections there is some danger of mistaking the transversely divided spindle cells for round cells, but careful examination will generally show that the individual roundish bodies vary in size, — according as the section happened to cross the middle or the extremities of the spindle cells, — and that the nuclei are not always distinct but may be wholly wanting; the latter is the case if a spindle cell is cut transversely near its extremity.

These tumors sometimes spring from ulcers, — chronic ulcers of the leg, for instance, — as may be recognized by the presence of irregular brownish cicatrices of old ulcers in the immediate neighborhood.

They also sometimes spring from soft warts and pigmented nævi, and then often share in the blackish or brownish pigmentation of these formations. These *melano-sarcomas* are usually softer than the others, consist indifferently of spindle or round cells, and sometimes contain spots of softening, which appear as cavities, with black contents, like india-ink. This form must be carefully distinguished from some non-pigmented sarcomatous growths which are very vascular, and in which hæmorrhage often takes place (*sarcoma telangiectodes hæmorrhagicum*). The color of the latter is always a light brownish-red, and is shown by the microscope to depend on yellowish or brownish-red deposits of hæmatoidine, chiefly outside of the cells; while in the melanotic form the pigment is in the form of minute dark-brown or black kernels of a round or angular shape which, to some extent even in the softened portions, are still enclosed within the cells. Moreover, in the hæmorrhagic form, as a rule, the pigment is irregularly, in the melanotic form uniformly distributed. Exceptions to this rule do, however, occur, especially as regards the melanotic form.

The *epithelial tumors* now remain to be considered; among these are the *adenomata* (hyperplasiæ of the cutaneous glands) which are very rare, unless we adopt the view of Rindfleisch, who regards lupus as an adenoma of the sebaceous glands.

9. True **carcinomata** of the skin are always secondary, and occur in the form of nodules from the size of a hempseed to that of a walnut. Their origin may be metastatic (through the blood current), or by contiguity as accessory nodules. The former are generally seated in the subcutaneous tissue, and, as long as they remain small, the skin over them is freely movable; but the latter are seated in the cutis and move with it. These latter are most commonly met with near the gland in connection with cancer of the breast, are often very numerous, and extend over a large surface. They may become confluent and transform a large extent of skin into a tough cancerous mass, at the periphery of which only isolated nodules are to be seen (*cancer en cuirasse*).

The structure of a carcinoma of the skin depends on that of the primary growth: it may be hard — scirrhous; or soft — medullary or encephaloid, mucous or colloid. The latter form, which is relatively rare, is peculiarly apt to involve large tracts of skin about the breast (in which it originates), and to give rise to *cancer en cuirasse.*

Apart from their external appearance and manner of growth the carcinomata may be distinguished from other growths as follows: —

The cut surface is not uniform and homogeneous, but on close examination is seen to present grayish-white and often distinct retiform bands which enclose a white or yellowish-white substance. An opaque and often milky fluid (cancer juice) can be scraped off with the knife, which the microscope shows to consist of irregular angular cells of varying size, with large vesiculate nuclei and large shining nucleoli (epithelioid cancer cells). This fluid varies greatly in quantity, and there are hard cancers from which the cells cannot be squeezed out, and the nature of which can only be deter-

mined by the aid of the microscope. Sections of these show larger or smaller compact collections of cells without intercellular substance, in character similar to that above described, which are separated by septa of variable width consisting of connective tissue — sometimes dense, sometimes looser and rich in cells. The cells may be removed by firm brushing under water with a camel's hair pencil, and the stroma thus be brought to view. The diagnosis of carcinoma can be considered as final, only when it has been demonstrated that the structure consists of masses of cells more or less distinctly epithelioid in character and lying in alveoli with fibrous walls. Colloid cancer is easily recognized with the naked eye by the presence of masses of transparent gelatinous substance which can often be readily isolated. The microscopic appearance of these masses is very characteristic; they are enclosed in a network of connective tissue, are transparent, become opaque on the addition of acetic acid (the reaction of mucine), and contain a cellular detritus which has undergone either mucoid or fatty degeneration.

10. The last division of malignant new growths is formed by the **epitheliomata** (*cancroid*, *keratoid cancer of Waldeyer*). They occur in two different forms, and are chiefly found at the junction of mucous membranes with the skin, also on the face and scalp. The *infiltrating* form is the more common, occurring chiefly on the face; it is seated in the cutis, and is elevated but little above the surface. The *warty* or *papillary* form implies more or less elevation above the surface.

(*a.*) The *infiltrating* form may, again, be subdivided, according to the depth involved by the growth, into *superficial* and *deep-seated* epithelioma.

Superficial epithelioma results quickly in superficial ulceration, which may heal by cicatrization, while the growth extends obstinately in other directions (rodent ulcer). The recent new formation breaks down so rapidly that it is sometimes difficult to recognize this form as epithelioma, and it is only near the edge of the ulceration, which is generally some-

what thickened and indurated, that nodules are to be found. Nevertheless this form, which occurs chiefly in the face, may make great ravages.

The usual and typical form of epithelioma — the deep-seated variety — involves the skin, the subcutaneous tissue, and even the deeper tissues. In its early stages it appears in the form of a hard nodule which subsequently breaks down and leaves a sinuous irregular ulcer with dense everted edges and a hard indurated base. On the cut surface the naked eye can distinguish whitish plugs embedded in the tissue, and on pressure these plugs spring out like comedones. Their structure is very different from that of cancer juice; they are coherent, dry, sometimes friable, and are shown by the microscope to consist of large, perhaps horny, cells which resemble those of the epidermis in all respects, and which are generally concentrically aggregated together in places, thus forming the spheroidal onion-like bodies called *epithelial pearls* or *pearl globules*. The whole surface is rather dry, like these little conical masses of cells, and it is moreover extremely dense, manifestly in consequence of the horny change which the cells have undergone. In vertical microscopic sections of the edge of the growth it is readily seen that all the epithelial structures of the skin — the epidermis proper, the hair follicles and sebaceous glands, and sometimes the sweat glands — take part in the new formation and thrust cone-shaped processes into the deeper tissues. The relation borne by the connective tissue into which the growth pushes its way, is not always the same, and even the gross appearances may be essentially modified in consequence. In some cases the connective tissue seems to have disappeared entirely, but in others — particularly in epithelioma of the lower lip, which is the most common seat of the affection — it may greatly predominate over the epithelial masses, so that difficulty in diagnosis results. Careful examination will, generally, reveal their presence, however ill defined and scattered they may be.

No tissue offers permanent resistance to the cancroid which

increases continuously both in extent and depth. Even the bones may become so far involved as to break spontaneously (lower jaw, tibia). A cancroid never spreads by the formation of accessory nodules in the vicinity, it is thus sharply distinguished from the true carcinomata.

(*b.*) In the second grand division of the epitheliomata — the *warty* or *papillary* form — the growth of the epithelial cells, which takes place in the manner we have described above, is associated with a growth of the papillæ of the skin. Large tumors may result from the arborescent ramifications of these papillæ, which project above the surface, producing a roughened appearance, and from the resemblance thus suggested has arisen the term *cauliflower excrescence*. Such a cauliflower look is, however, not peculiar to epitheliomata, but may be met with in simple hypertrophies of the skin (papilloma or wart). It is only with the aid of the microscope that we can ascertain whether the epithelium between the papillæ actually dips down in tongue-like processes into the cutis and subcutaneous tissue. The sections which are to decide this point, must, of course, be made vertically through the papillæ, which are generally very long and delicate and contain vessels and a little fibrous tissue. It is on the genitals that these growths are chiefly met with.

8. The only **parasitic** affections of the skin which we shall mention are those caused by vegetable parasites.

(*a.*) *Pityriasis versicolor* is one of the most common of these, and is found chiefly on the chest, neck, and back, but rarely on the face or other portions of the body. It gives rise to roundish and isolated, or large irregular and confluent groups of brownish spots covered by scaly epidermis. The color as well as the scales can be removed by scratching, a peculiarity which distinguishes this affection from true pigmentation of the deeper layers of the epidermis, chloasma. On putting the scales in water, under the microscope small rounded spores, or conidia, and perhaps a little chain-like mycelium (*microsporon furfur*), are seen between the epithelial cells.

(*b.*) The chief seat of *favus* is the scalp (though it does occur on other parts of the body), where it is found in the form of cup-shaped crusts, the outer layers of which are yellow and brittle, the deeper whitish and firmer. These crusts lie in depressions in the skin and have a peculiar mouldy odor. On removing them the skin is found to be covered with a thin and shining layer of epidermis, or, it may be ulcerated if the affection is of long duration ; indeed, in very old cases, cicatrices may be found. The hairs which penetrate the crusts are lustreless, look as if covered with dust, and are very brittle. In the lower layers of the crusts, between the epithelial cells, the microscope shows the presence of a matted mycelium, which ramifies in all directions, and the branches of which are prolonged into delicate threads or ribbons, composed of elongated cells ; from these are formed elongated, oval, nucleated cells — spores or conidia, — which are invested with a thick, greenish, glistening membrane, and which form the chief part of the uppermost layer of the growth. In addition to this parasitic growth (*achorion Schönleinii*), the presence of which gives rise to the disease in question, various adventitious spores — penicillium, aspergillus, etc. — are also found.

(*c.*) *Herpes tonsurans*, or *ring-worm*, occurs chiefly on the scalp, and gives rise to circular bald spots, the skin over which is generally covered with a whitish granular coat of epithelial cells and spores. The hairs are broken off close to the skin, and are split at the ends. The fungus is found in the cells of the outer root-sheath, and of the shaft of the hair itself, as well as in the outer layers of the epidermis, in the form of a close network of mycelium composed of long ramifying branches which divide lengthwise into rows of short, broad, round or quadrangular spores (*trichophyton tonsurans.*)

The development of the fungus in the beard is accompanied by severe inflammation (*sycosis parasitica*) and nodules are formed which may ulcerate ; the hair follicles are also altered as in acne.

This fungus is one of several which may give rise to disease of the nails (*onychomycosis*). They become rough, uneven,

fissured, of a dirty yellow color, loose, brittle, and easily chipped; the seat of the fungus is beneath the nails.

9. The **congenital malformations** which are met with in the skin are mostly due to defective union between the lateral epidermal plates, a *fissure* being the result.

Hare-lip, which may be either single or double, is the commonest instance of this. A fissure of the chest or of the sternum may also occur. The abdominal fissure, when extensive, is associated with prolapse of the abdominal viscera — *eventratio.*

If the cleft be in the hypogastric region the anterior wall of the bladder is also wanting, and the reddened mucous membrane of the posterior wall is exposed to view (*extroversion*). Such a fissure may extend downwards and involve the clitoris (*fissura clitoridis*), or be prolonged on the upper surface of the penis (*epispadias*). The latter — and in like manner *hypospadias*, non-union on the inferior surface of the penis — may be met with in varying degree as independent malformations.

As contrasted with fissure, *occlusion* remains to be mentioned — atresia ani, urethræ, vaginæ; microstomia, symbleraphon; this condition depends, doubtless, on cicatrization during fœtal life.

B. INTERNAL EXAMINATION.

The three great cavities of the body should be examined in their successive order from above downward. The abdominal is actually opened before the thoracic cavity, but is *examined* later. The reason for beginning with the head is, that the amount of blood in the brain and its membranes may be determined before the section of the great vessels in the neck. In medico-legal cases, in which a well-founded suspicion may be formed as to the cause of death, the rule is to begin with that cavity in which the suspected changes are to be found. The vertebral canal need be opened, in medico-legal, or in other cases, only when there is reason to

think that important information may be gained by so doing. In ordinary cases, if it be desirable for any reason to examine the spinal cord, this should be done first of all, partly on account of the inconvenience of turning the body oftener than is absolutely necessary, but chiefly in order to render the examination of the brain and cord — organs which are so intimately related physiologically — as connected as possible. In medico-legal cases, if it seem likely that by turning over the body we might essentially modify the relative position of parts — as might occur in the case of incised wounds, — the vertebral canal should be left to the last, and, generally, the chest and abdomen should be opened before the head. In examining a particular organ or part certain attributes of the organ or part as a whole — *size*, *shape*, *color*, *consistency* — should be first noted, and then its interior be laid open by an incision which should be as long and deep as circumstances allow. The points which it is of importance to note in examining the interior of an organ or part vary according to its structure. In medico-legal cases it is of special importance to note the amount of blood in the body as a whole, as well as in its several parts or organs.

I. EXAMINATION OF THE SPINAL CANAL.

In order to reach the spinal cord a deep incision should be carried along the spinous processes of the vertebræ, and the tissues then freely dissected off from the laminæ. Thus we are enabled to look for —

(*a.*) Morbid conditions of the *soft parts*, and *bones* as far as exposed (in medico-legal cases fracture must be borne in mind). We have already discussed the changes which may be found in the soft parts, and general modifications of the vertebræ themselves will receive consideration in detail later on; we are now concerned with those changes which are confined to the spinous processes and arches of the vertebræ. The chief of these is a congenital defect in the laminæ which have not reached the median line in their development, so that the spinous process and a larger or smaller portion of

the laminæ are wanting. This condition may be confined to one, or involve several vertebræ, and is called *spina bifida.* In adults it is found only in the lumbar or sacral portion of the column, and is of limited extent; in young children its localization is generally the same as in adults, but its extent is greater. A fissure of this kind in the upper portion of the column is commonly connected with the condition known as *anencephalia*, which will shortly demand our consideration. The higher degrees of spina bifida are always associated with gross changes in the cord and its membranes.

Next, by means of a chisel or a rachitome, the spinous processes and adjoining portions of the laminæ should be detached and removed.

(*b.*) The thickness (translucency), degree of tension, color, and amount of blood in the exposed *dura mater* should now be noted, it should then be carefully opened by a longitudinal incision and the presence of any abnormal contents, especially fluid (cerebro-spinal fluid, pus, blood), noted. Next the condition of the posterior surface of the *pia mater* as to thickness, tension, color, and amount of blood should be noticed, and the resistance of the *spinal cord* estimated by drawing the finger along it with gentle pressure.

The roots of the spinal nerves should next be severed on either side, the lower end of the cord gently removed from its bed with the hand, its anterior attachments divided one after another, and, lastly, it should be divided obliquely as near the occipital foramen as possible; or simply extracted in case the brain has already been examined.

Throughout all these procedures great care should be exercised neither to compress the cord, nor to bend it at a sharp angle, and, in case the cord is very soft, it is often safer to avoid touching it directly, but to remove it together with its dura. After removal, the condition of the anterior portion of the pia, the external appearance of the cord as to size and color, and, finally, the internal condition of both the white and gray portions should be noted, cross sections being made at frequent intervals with a sharp and thin-bladed

knife, which should be dipped in water before each cut. The dura should then be separated from the bodies of the vertebræ, unless this has already been done, and hæmorrhage, injury to, or disease of, the bones and intervertebral disks should be sought for.

In examining the spinal cord attention is first to be directed to its —

(*a.*) *General Appearance.*

Modifications in *color*, especially in the columns of the cord, should be carefully examined into, since they may be simulated by inequalities in the surface of the section and peculiarities of illumination; it is important for this reason to examine both cut surfaces, and to let the light fall upon them from all directions in turn. Although actual modifications of color may be thus made out with tolerable accuracy, it must be remarked that it is very difficult to decide as to the exact significance of such modifications, and that even a very experienced observer may be deceived into regarding as normal, portions of the cord which the microscope shows to be diseased. Hence one should never neglect a microscopical examination, which is very readily made with sufficient thoroughness for diagnostic purposes. It generally suffices to snip out a bit with scissors, tear it up with needles, and flatten it with a cover glass.

(*b.*) *Special Morbid Conditions.*

The special structural modifications of the parts enumerated above are so similar to those of the brain and its membranes that, for the sake of simplicity, we refer the reader to them.

1. The *spinal* differs from the cerebral *dura mater* chiefly by not being at the same time enveloping membrane and periosteum, but only the former. Hence it is never the subject of bone-forming or ossifying inflammation so common in the cerebral dura mater. Pachymeningitis interna hæmorrhagica is not nearly so frequent in the spinal as in the cerebral dura; but the other forms of inflammation, both external and internal, occur with nearly equal frequency in

both. Hæmorrhage is not so common, on account of the protected situation occupied by the cord; but chronic internal inflammations, attended with the formation of very small fibrous nodules, closely resembling tubercles, are, on the contrary, rather more common. These nodules may become calcified and thus form little bodies like grains of sand (pachymeningitis arenosa) which, when aggregated together in larger masses, are called *psammoma.*

2. Inflammatory changes in the *spinal*, are similar to those in the cerebral *pia mater;* but are, in general, less commonly met with. Arachnitis ossificans alone is more common in the spinal pia, and results in the formation of bony plates with smooth external, and jagged internal surfaces. The veins of the pia are usually more distended with blood in its posterior and inferior portions, in consequence of the position in which the body is generally laid.

3. The *cord* is liable to much the same sort of affections as the brain, but not with the same degree of frequency; this remark applies particularly to such processes as softening, and is not to be wondered at when one considers how much better adapted to the establishment of collateral circulation the vessels of the cord are than those of the brain.

Thus inflammation or myelitis, red, brown, and yellow softening, and hæmorrhage are all found; as are also new growths of all kinds, including the so-called *solitary tubercles*, so beautifully concentric in structure. There are, however, a few affections which are either sufficiently common, or so peculiar in appearance as to call for detailed description.

Chief among these is the anatomical lesion of *locomotor ataxia*, *gray degeneration of the posterior columns of the cord*, *posterior spinal sclerosis.* In well marked cases of this affection a gray stripe on either side of the posterior median fissure is visible even through the pia, and these stripes are usually more distinct inferiorly than superiorly (*ascending degeneration*). On section, either the whole or a portion of the posterior columns — generally those portions adjacent to the median fissure, the posterior median columns (Goll's

columns) — are seen to be of a transparent gray, or rather brownish-gray, color; they are hard, and depressed below the level of the neighboring portions. Changes are almost always found in the posterior roots also, which are gray (*non-medullated*) and atrophied. The microscope shows in needle preparations an abundance of fibrous tissue, but few medullated nerve fibres, and many of the so-called *corpora amylacea* — rounded little bodies concentric in structure, which become brownish on the addition of iodine, and blue on the addition of sulphuric acid. Chronic spinal arachnitis, which, according to Virchow, is the excitant of the process found in the cord, is always associated with this affection (*meningomyelitis corticalis interstitialis*). *Disseminated gray degeneration*, also called *insular sclerosis*, *disseminated sclerosis*, *antero-lateral sclerosis*, is an affection of another nature and is not confined to the posterior columns, but may even occur in the brain. Microscopically this affection only differs from that before described in that it is not uniformly distributed, and thus the cord appears nodulated, the nodules indicating relatively healthy tissue. The microscope is said to show more signs of inflammation — thickening of the walls of the vessels, etc., — the absence of corpora amylacea, but a more active cellular growth in the neuroglia and the formation of granular corpuscles (*Rindfleisch*). There is, finally, a third kind of degeneration — *descending* or *secondary degeneration*, so-called, — which causes discoloration of the white matter; this is an atrophy of the lateral, and particularly of the posterior lateral, columns, and is secondary to local cerebral lesions. The diseased portions are rather grayish yellow than gray in color, are very soft, and non-transparent. Needle preparations show, when placed under the microscope, numerous granular corpuscles and fatty degenerated nerve fibres. The same changes are found both above and below those local lesions of the cord which are accompanied by destruction of nerve fibres.

There is, finally, a congenital condition, called *hydromeningocele* to be mentioned, the cause of the previously de-

scribed spina bifida. This consists in a sac of variable size, the wall of which is formed by the skin and the membranes of the cord, and is traversed by the roots of the nerves, while the cord itself is contained within the sac. The sac contains also a clear, watery fluid, and the whole affection starts from a collection of fluid in the network of the arachnoid. The usual seat of the affection is the sacral and lumbar regions, and it has been known to persist into adult life. When seated higher up it is called *hydromyelocele*; it is here generally due to dilation of the central canal, and involves complete disorganization of the cord at that place.

II. THE CRANIAL CAVITY.

In medico-legal cases attended with injury to the head the seat of such injury should always be disturbed as little as possible, and the best method of opening the head varies according to the individual peculiarity of the case in hand. Ordinarily, however, the best method is to carry the knife through the scalp in a line over the vertex from one mastoid process to the other; and then to reflect the soft parts forward as far as the superciliary ridges, and backward behind the external occipital protuberance. (Changes in the soft parts have been already described.)

The *pericranium* which is thus laid bare should now be examined as to thickness, color, consistency, and continuity, and the periosteum should then be scraped off with a chisel or periosteum-scraper so as to expose the bony vault of the skull. The ordinary affections of periosteum and bone will receive but brief mention here, as they will be discussed in detail under Bones of the Extremities. We shall confine ourselves therefore chiefly to those changes which are peculiar to the skull and its periosteum.

1. MORBID CONDITIONS OF THE PERIOSTEUM.

The various forms of inflammation may be found (ossifying, purulent, and gummy periostitis), as also hæmorrhage,

etc. Under the head of hæmorrhage are included those collections of blood between the pericranium and the bone which are sometimes found in new-born children — *cephalhæmatoma neonatorum.* The tumor thus formed is usually limited to the region of the right parietal bone, never extends across the sagittal suture, and after a certain lapse of time becomes surrounded by a bony wall — the result of ossifying periostitis. Still later, small plates of bone, which at first have no connection with each other, make their appearance on the more elevated portions of the tumor and thus the whole tumor may become encapsulated. Sometimes instead of blood the tumor contains a reddish-yellow puriform mass, which indicates that suppuration has taken place.

2. EXAMINATION OF THE BONE FROM WITHOUT.

(*a.*) *General Appearance and Character.*

1. The *size* of the skull varies widely in different individuals. Very large skulls with prominent frontal bones are generally associated with and caused by hydrocephalus.

2. The *form* of the skull is for many reasons more important than its size; though it, too, is subject to great variations. In modern times the influence of race on the form of the skull has received much attention, and a heated controversy has arisen as to the relative significance of "long heads" and "short heads." One should never neglect, therefore, to measure both the transverse and longitudinal diameters. In a *mesocephalic* skull the transverse stands in an average ratio to the longitudinal diameter of 70–80 to 100; if the transverse diameter fall short of this the skull is called *dolichocephalic;* if it exceed this it is called *brachycephalic.* The symmetry of the two sides of the skull is of greater pathological interest. Oblique asymmetry is called *plagiocephalia.*

The chief classes into which abnormally shaped skulls have been divided are as follows: the platycephalic skull, with small vertical and large transverse diameters; the oxycephalic, with large vertical and small transverse diameters;

the scaphocephalic, in which the parietal bones incline toward one another like the sides of a roof; clinocephalic, with saddle-like depressions in the temporal regions; sphenocephalic, with wedge-like prominence of the region of the great fontanel.

3. The normal *color* of the external surface of the calvaria is gray, or yellowish-gray (if there be much fatty marrow in the diploe), and but few red points are to be seen. Morbid processes in the bone or periosteum may give rise to a more or less uniform and pronounced reddish hue; a circumscribed lemon-yellow shade is associated with gummata, a dirty greenish-yellow or slaty shade with osteomyelitis, etc.

4. The chief affection attended by modification in the *consistency* of the bones is *craniotabes* or *soft occiput*, in which the bone becomes flexible like parchment; this is one of the manifestations of rickets. Sometimes the cranial bones of adults are more or less softened and replaced by connective tissue in connection with tumors, epithelioma for instance.

The *sutures* should always be carefully examined on account of the part which they play in the development of the skull. All the above mentioned modifications in the form of the cranium are dependent on *premature synostosis* of the sutures in whole or in part. A suture is to be regarded as existent so long as its delicate zigzag lines are visible. Contrasted with premature ossification of the sutures is partial or complete *persistence* of the frontal suture, which normally disappears at the end of the fifth year. Small bones called *ossa triquetra* or *Wormian bones* are often found imbedded in the sutures, particularly in hydrocephalic skulls; they are more common in the occipito-parietal suture than elsewhere. Sometimes they result from independent ossification of a fontanel, and are then called *fontanel bones*.

The *os Incae*, as found in old Peruvian skulls, is due to separation of the tabular portion of the occipital bone by a suture.

(*b.*) *Special Morbid Conditions.*

Of the special morbid conditions to which bone is liable

there are but few which are peculiar to the skull or appear there in a peculiar form. *Atrophy* may depend on pressure, by tumors, etc., on the process of involution, as in senile atrophy, which first takes place at the parietal eminences and may result in complete absorption of the bone, or in actual disease of the bone. In atrophy of the external surface of the skull the openings for the transmission of vessels assume greater prominence and, in consequence of this, the atrophied portions are indicated by red spots.

The new formation of bone is very common and may appear under a variety of forms, but every bony prominence must not be considered as a new formation, since the bone may also be elevated by a growth at its inner surface — a Pacchionian body, for instance. Even in this case a new formation of bone may be said, strictly speaking, to take place, new bone being deposited externally as the old bone is absorbed from within ; bone which has reached its full development is non-distensible. There is an irregularly distributed form of external hyperostosis which is found associated with numerous irregularly shaped indentations of the skull and is nearly always of syphilitic origin ; in recent cases of this nature the diagnosis of syphilis is confirmed by the presence of masses of a soft and yellowish or gray substance between the hyperostoses.

Fractures of the skull, which may be of very great importance medico-legally, can, as a rule, be better studied on the inner surface of the skull, for the reason that, whether attended with depression or not, the injury of the inner is greater than that of the outer table ; old fractures which have been entirely recovered from are sometimes found. When the examination of the external surface has been completed,[1] a circular incision should be made down to

[1] In cases in which there is no reason to expect changes in the calvaria it is more convenient to have the bone sawn through beforehand by an attendant ; but even then the points which we have enumerated above, and especially those which bear on the form of the skull, should be noted before the calvaria is removed.

the bone through the temporal muscles and other soft parts which still remain, from the glabella to the occipital protuberance, and the bone then sawn through in this line, care being taken not to injure the brain.[1] A great saving in labor can be effected by sawing only partially through the bone and completing the work with the mallet and chisel. The latter should then be inserted into the track of the saw, and a turn of the handle will generally suffice to remove the calvaria entirely. Slight pathological adhesions between the bone and the dura, such as are chiefly met with in the frontal region, can often be broken up by trying to pry off the calvaria from behind forward instead of from before backward; but if, as is common enough, the adhesions be strong or extensive, the calvaria and dura must be removed together.

In order to do this the dura should be divided in the track of the saw, and then its attachment to the crista galli should be put on the stretch by drawing the frontal portion of the calvaria firmly backward, when it may be severed. This method must also be followed in children under seven years of age, for the reason that in them the dura still serves as internal periosteum and is hence firmly adherent[2] to the bone. The dura can then generally be torn from the bone, though it may be necessary to use a little force and the examination can be continued in the usual way. In case, however, that it cannot be torn off even then, all idea of examining the inner surface of the bone and the outer surface of the dura must be given up, and the longitudinal sinus should then be opened.

[1] When it is desirable to avoid the chance of disfiguring the corpse this incision should be wedge-shaped, the apices of the wedge being at the base of the mastoid processes. The temporal fascia adhering to the calvaria should be united by sutures to that portion attached to the lower part of the skull. Rev.

[2] The examination of the brain can be much simplified in many cases, and particularly in young children, in whom the brain is normally softer than in adults, by the adoption of Griesinger's method, which consists in sawing through the bone and brain together. The injury which the brain receives thereby is but trifling; often, indeed, less than when the usual method is followed.

3. EXAMINATION OF THE BONE FROM WITHIN.

(*a.*) By examining the *sawn edge* of the calvaria information may be gained as to its gross *thickness*, as to the relative thickness of its several parts — outer table, diploe, inner table — and as to the amount of blood present. The calvaria should also be examined by transmitted light in order to ascertain from the degree of translucency and color the thickness of the skull in general, and that of the diploetic portion in particular, as well as the amount of blood in the latter. Although we shall postpone the description of the various morbid changes which may occur in these parts till we come to the bones of the extremities, we must call attention here to the importance of carefully noting the coloration of the diploe. A greenish-yellow or slaty discoloration of the diploe suggests the existence of severe inflammatory affections (as osteomyelitis, particularly its infective form) whose presence might otherwise be overlooked owing to the small amount of cancellated tissue present.

(*b.*) The *inner surface* should next be examined, and its *configuration* be noted; this may be varied by the presence or absence of juga cerebralia, hyperostoses, exostoses, digital impressions, abnormal depressions due to internal atrophy, etc. Depressions on either side of the longitudinal groove caused by the Pacchionian bodies are nearly always present; these are of very subordinate importance, although the bone may be actually perforated. The width and depth of the grooves in which the meningeal arteries lie should also be noted; these may be deepened by internal hyperostosis, though it should be remembered that their normal limit of variation is very wide.

The *color* of the surface, which in the normal state is a grayish-yellow, should be carefully noted, for the reason that discoloration is often the sole indication of the presence of a morbid condition. I refer particularly to that chalky-white discoloration which occurs in isolated spots in the form of a network, and depends on the presence of osteophytes which

are so little elevated above the surface as, otherwise, easily to escape detection (puerperal osteophytes of the frontal bone, etc.). The presence of adherent coagula on any portion of the inner surface of the skull should always awaken suspicion of fracture through that portion, and induce further careful examination.

4. THE DURA MATER OF THE CONVEXITY FROM WITHOUT.

(*a.*) *The Membrane itself.*

On the removal of the calvaria the **dura mater** comes into view, and is to be examined with reference to its thickness, tension, color, and amount of blood. The *thickness* of the dura is indicated by the greater or less distinctness with which the veins of the pia and the convolutions are visible through it. The veins have a bluish color, the convolutions a yellowish gray, and both can, in the normal condition, be everywhere clearly distinguished. The degree of *tension* should always be tested near the anterior margin, for the reason that posteriorly the membrane is put on the stretch by the gravitation of the brain against it. In the usual position of a body (on the back), one should be able to raise up the membrane in a small fold near the apex of the frontal lobe; if a pretty large fold can thus be lifted, the contents of the skull are diminished; if no fold at all can be raised, they are increased (hæmorrhage, hydrocephalus, tumor, abscess, etc.). The membrane is commonly gray in *color*, but grows whiter as it increases in thickness. It is only the larger vessels, and particularly the arteries, which contain blood, as a rule; the arteries are easily recognizable as such by their venæ comitantes. Sometimes, the smaller vessels also are full of blood, but the membrane is relatively so feebly vascular that it does not, even then, appear very red; another consequence of this anatomical peculiarity is that the membrane is never reddened around recent injuries.

Hæmorrhage between the dura and the bones is called *extrameningeal*, and may be of traumatic origin, even though

the bone itself be intact. One of the most common affections of the external surface of the dura, is *ossifying inflammation* (*pachymeningitis externa ossificans*), which renders the membrane firmly adherent; if it then be forcibly detached, fibrous shreds remain adherent here and there to the bone, which shreds are portions of the dura itself and are not to be confounded with new-formed false membranes as found on serous surfaces. *Purulent* inflammation (*pachymeningitis externa purulenta*) is less common on the convexity, and is usually dependent on injuries in which the bone may or may not be involved. The membrane is then thickened, opaque, yellowish in color, and covered with a thin film of pus which is never found in large quantities.

True *syphilitic* inflammation (*pachymeningitis externa gummosa*) is generally associated with similar changes in the bone. Recent gummata are yellowish-gray in color, and have a gelatinous appearance; older gummata present this gelatinous appearance only at their periphery and contain in their interior bright yellow masses of irregular form. Needle preparations of the recent formations show great numbers of round and spindle cells; those of the old and yellow formations contain great numbers of fatty degenerated cells and fatty detritus. *Tubercular* inflammation is rare and always associated with tubercular change in the adjacent bone.

The true *new formations* which are met with in the dura will demand consideration in another place, and here I will only call attention to those small gray nodules consisting of several rounded lobules which are so often seen near the longitudinal sinus in a spot corresponding to the anterior extremity of the sagittal suture. These appear to be outgrowths from the dura, but in reality have made their way *through* it and belong to the pia (*Pacchionian bodies*).

(*b.*) *The Longitudinal Sinus.*

The longitudinal sinus is now to be opened; its superior wall should be made tense with two fingers of the left hand, and then be divided with the knife, the blade of which should be kept parallel with the surface of the membrane. Some-

times the sinus is found empty, sometimes it contains fluid, or freshly coagulated blood. It may not be amiss to mention the fact that not infrequently the Pacchionian bodies penetrate the inferior wall of the sinus, and project into its cavity without causing further trouble. When the dura is more or less forcibly removed, they are often torn off with it, and one might be deceived into regarding them as portions of it; but if the dura is carefully dissected off they retain their connection with the pia, and the former is found to be perforated at its points of contact with these bodies: the same thing may also occur on other portions of the dura.

Occasionally the longitudinal sinus contains a more or less decolorized old blood clot which may be firm throughout or softened at its centre, and more or less adherent to the wall (*thrombosis of the sinus*). This condition is generally met with in children, and results from general disturbances of the circulation (marantic thrombosis); while thrombosis of the transverse sinus is more phlebitic in nature — as, for instance, in caries of the petrous bone — and affects adults.

5. THE DURA MATER OF THE CONVEXITY FROM WITHIN.

The *dura* of the right side should be divided near the sawn edge of the bone from one extremity of the falx to the other, the blade of the knife being kept as nearly parallel with the surface as possible, and the left hand drawing the upper portion of the membrane away from the brain as precautions against injuring the latter. The portion which is thus partially separated from its attachment should be then reflected over on the opposite side, so that its whole *inner surface* is exposed to view. If adhesions between the dura and the pia are present, they are to be divided.

(*a.*) *General Appearance and Character.*

The *color* of the inner surface is like that of the outer, sometimes gray, sometimes whitish. A common pathological condition consists in the presence of a more or less marked brown discoloration which may be diffused over a pretty

large surface or limited to smaller circumscribed patches, but generally occurs in the form of more or less minute specks (hæmatoidine formed from old hæmorrhage). Most of the modifications of color are due to blood within or without the vessels. The vessels of the dura in its normal condition, are small and form a coarse network; whenever they are relatively large and closely interwoven, they are to be regarded as newly formed. *Hæmorrhage* may occur either in the substance of the membrane — *intrameningeal* — or on its inner surface; in the latter situation it may vary in extent from the size of a point merely to that of the hand. It is always of great importance to decide whether the hæmorrhage is free on the surface (*intermeningeal*), or whether it is separated from the pia by a membrane (*hæmatoma of the dura mater*). In the case of small hæmorrhages as well as in that of newly formed vessels or of brown pigmentation, it is important to ascertain whether they are seated in the old tissue of the dura or in false membranes. The character of the surface often throws light on this question, for the surface which normally is smooth and reflects light, often becomes uneven and dull when a morbid deposit is present; but absolute certainty may be attained by scraping the surface with the edge of the knife, which readily removes any existent deposit.

Apart from the presence of deposits, the inner surface may have lost that moist glistening appearance which normally belongs to it, if, for any reason (hæmorrhage, hydrocephalus, tumor, abscess), the volume of the brain be increased and thus pressure be exerted on the dura and its inner surface rendered dry. In such a case, however, the surface always remains smooth. Increased moisture of the surface and, especially, the presence of free fluid on the inner surface, are artificial conditions, and depend on cerebro-spinal fluid which has escaped from an injury of the pia.

(*b.*) *Special Morbid Conditions.*

Of the changes which are met with on the inner surface of the dura the most frequent and hence the most important are those which are due to —

1. **Inflammation.** *Purulent inflammation* (*pachymeningitis interna purulenta*) is, as on the outer surface, rare and gives rise to much the same appearances. So, also, *ossifying inflammation* (*pachymeningitis interna ossificans*), which results in the formation of thin, irregular, and angular bits of bone on various parts of the dura, but particularly on the falx. That form of inflammation which is attended with fibrinous exudation, on the contrary, occurs only on the inner surface of the dura (*pachymeningitis int. fibrinosa*). Such exudation may later become organized and converted into a fibrous false membrane (*pachymeningitis int. fibrosa*). It is in this latter case that not only the above mentioned newly formed vessels are chiefly met with, but also hæmorrhages (*pachym. chronica int. hæmorrhagica, hæmatoma*) and pigmentation (*pachym. chronica int. pigmentosa*),—the two latter conditions being sequelæ of and dependent on the former. It is a very simple matter to examine any of these conditions microscopically: it is only necessary to scrape off the fibrinous exudation or the false membrane, and spread it out under a covering glass with the addition of a drop of a solution of common salt. The membranes consist of cells and fibrous tissue in varying proportions, and the more abundant the cells are, the more recent is the membrane. The blood-vessels, which are often present in enormous numbers, are remarkable for their large caliber as contrasted with the extreme tenuity of their walls, which consist of little more than a layer of endothelium; and thus, also, is explained their extreme liability to rupture. If one of the brownish spots is examined under the microscope the discoloration is seen to depend on the presence of collections of reddish-brown or yellowish-red pigment which is generally amorphous, but may occur in the form of crystalline rhombic plates (*hæmatoidine*).

Adhesive inflammation, which is so common in serous membranes, is rare in the dura, and when it does occur is usually of syphilitic origin — especially if the dura and pia be adherent over a large extent. I should not think it necessary to mention the fact that the membranes are, in their

normal condition, necessarily connected together where the veins of the pia empty into the longitudinal sinus, if I had not learned by experience how liable beginners are to forget it. It is somewhat more difficult to distinguish between these vessels and inflammatory adhesions which, beginning at some little distance from and extending as far as the longitudinal sinus, sometimes unite the dura and pia; though error may always be avoided by carefully observing the character and distribution of the vessels in such adhesions.

The inner resembles the outer surface also in the rarity with which it is the seat of *tubercular* inflammation; when this does occur here, it is merely an extension of the process and never results in the formation of relatively large cheesy nodules; should these be found, they may be regarded as in all probability the remains of gummata. These are often adherent to the pia, are associated with changes in the brain itself, and always set up at their periphery chronic pachymeningitis (fibrinous, hæmorrhagic, etc.).

2. True **neoplasms** of various kinds are met with in the dura. *Sarcoma*, generally the spindle-celled variety, occurs primarily in this situation, and may attain great size and perforate the bone (*fungus duræ matris*). Sometimes such a degree of inflammatory action accompanies the sarcomatous growth as to mask its characteristic nodules. *Carcinoma*, on the contrary, is always secondary and either metastatic or an extension of a process which originated elsewhere. There is a peculiar kind of morbid growth which is sometimes found and is composed entirely of large flattened cells which may show a concentric arrangement; this was formerly considered by all authorities to be epithelioma of the dura mater; but of late it has received the name of *endothelioma*, and has been referred to a growth of the endothelial cells of the membrane.

6. THE PIA MATER OF THE CONVEXITY.

The next step after the examination of the right half of the dura is to examine that of the corresponding half of the pia.

(*a.*) *General Appearance and Character.*

The *pia mater* is a thin, colorless membrane, the *proportions* of which may be modified in either of two ways. Its network may contain fluid (blood, dropsical fluid, pus), or else the fibrous groundwork of the tissue may be thickened and appear in the form of gray or white bands. The two conditions — and particularly œdema and thickening — are very often coexistent. All these changes, with the exception of simple œdema, involve *discoloration* of the membrane, which becomes gray or grayish-white from fibrous thickening; yellow, from pus; red, from blood, etc. Marked dryness of the surface, as in the dura, points to undue pressure from within.

Before drawing any conclusions from the *amount of blood* in the pia, it is well to remember that the distribution of the blood is greatly influenced by the position of the body, and that the fullness of the large veins in the posterior portions, which is usually present, is chiefly hypostatic. It is a notorious fact that beginners are very apt to diagnosticate congestion when it does not exist. One should, therefore, not be satisfied with a general impression, but follow up particular vessels, and notice whether they are completely or only partially filled with blood, whether some portion or portions of a vessel are more full of blood than others, etc. The arteries, as a rule, lie in the furrows, the veins are superficial, but when the nature of a vessel is doubtful a solution may sometimes be reached, in this situation as in others, by pressing the blood out of it and noting the nature of the larger vessels with which it communicates directly. The capillaries not being visible to the naked eye, capillary congestion can only be diagnosticated when the red spots cannot be resolved into a collection of delicate red lines — the finest arteries and veins. *Thrombosis* of the larger veins is secondary to thrombosis of the sinus.

(*b.*) *Special Morbid Conditions.*

1. **Hæmorrhages** are met with either on the surface of the pia (*hæmorrhagiæ intermeningeales*), or in the tissue of the

pia or arachnoid itself (*hæmorrhagiæ arachnoidales*, formerly called *subarachnoidales*). The former, as we have already mentioned, may come from the dura as well as the pia. That form of intermeningeal hæmorrhage which sometimes occurs in new-born children from rupture of the large veins of the pia at their junction with the sinus, in consequence of great compression and overlapping of the bones of the head, is chiefly important from a medico-legal point of view. With regard to hæmorrhage in general, it may be remarked that if the blood be coagulated one is justified in drawing the conclusion that the hæmorrhage took place before death. This rule is subject to the exception that blood which was still fluid may coagulate during the progress of the autopsy if mixed with cerebro-spinal fluid. On the other hand, fluidity is not positive proof that the blood escaped after death; especially if the blood be infiltrated within the tissue of the pia instead of lying free on its surface.

2. **Inflammation.** The most common form of inflammation which is met with in the pia is *arachnitis* or *leptomeningitis chronica fibrosa*, and is characterized by thickening, whitish opacity, and, as a rule, by œdematous swelling, which latter is most strongly marked in the sulci where the membrane is thickest. The pia, when perfectly normal, lies in immediate contact with the convolutions and follows them into the sulci; but when œdematous, its outer layer passes directly over the sulci from one convolution to another, and if the œdema be very marked may be actually separated from the surface of the convolutions by a layer of fluid. Œdematous infiltration is not always uniformly distributed, but may assume the form of large vesicles (*œdema cysticum*, *hydrops multilocularis*). *Pacchionian bodies* are, indeed, often found without the above mentioned signs of chronic inflammation, but it is in connection with these signs that they are most numerous and attain their largest size. They form villous, gray nodules which are thickly aggregated along the superior longitudinal fissure (though at times farther outward also), and are shown by the microscope to consist of papillary col-

lections of connective tissue enveloped in a layer of endothelium. Small laminæ of bone are sometimes found, but not so often as in the pia of the spinal cord. Virchow draws a distinction between *superficial* and *deep chronic arachnitis;* the latter is the more important on account of its intimate relation with the vessels which pass from the pia into the cortex cerebri, and hence its tendency to set up inflammation in the brain tissue itself (vide *meningo-encephalitis*).

Acute, more or less *fibrinous, purulent inflammation* (*arachnitis suppurativa*), is characterized by an infiltration of the tissue of the pia with fibrine and pus, which imparts to it a whitish-yellow, or, if, as sometimes happens, the inflammatory product be pure pus, a yellow discoloration. The favorite seat of this affection being the convexity, it is sometimes called *meningitis of the convexity.* The pus is chiefly collected along the larger veins in the form of yellow strips of variable width; this is especially the case in *deep suppurative arachnitis*, while in the *superficial* form the vessels are often completely obscured by the pus. Circumscribed purulent inflammation is nearly always of traumatic origin. *Tubercular inflammation* of the convexity is rare, and if present has spread upward from the base in almost every instance.

3. **Cysticerci** occur in the form of cysts from the size of a pea to that of a hazel-nut, as well as in the form of yellowish-white, fatty degenerated and cretified nodules. The cysts are filled with transparent watery fluid, floating in which the naked eye can discern a whitish body about the size of a hemp-seed; this is the head of the animal, and with the aid of a lens the hooks and four suckers can easily be distinguished. Even after the animals are dead, their presence may be demonstrated by tearing a portion of the nodule to pieces with needles, dissolving the lime salts with hydrochloric acid, and pressing the glass cover firmly down upon the specimen; the large hooks with their strong attachments will thus be brought to view. Cysticerci very often cause depressions on the surface of the brain and sometimes complete circumscribed atrophy of the cortex.

4. We shall postpone what we have to say about **Tumors** till we come to the consideration of the surface of the brain itself.

When the examination of the *right* side has been completed a small cut should be made into a fold of the dura near the left anterior extremity of the falx; the knife should then be held like a fiddle bow, with the ends of the thumb and fingers, and its point, with the cutting edge outward, is to be inserted into the small incision; then, the *left side* of the dura, the left hand meanwhile drawing the membrane away from the brain, should be divided as far as the posterior extremity of the falx, reflected, and examined in the same way as on the other side. One should never neglect to compare the two sides, especially as to the fullness of the vessels. Both halves of the dura should then be firmly grasped in the left hand and drawn upwards and backwards in order to put the attachment of the falx to the crista galli on the stretch. The knife with its edge directed forwards should now be passed, parallel with and to the left of the falx, down to the cribriform plate of the ethmoid; the edge should then be turned toward the right, and the attachment severed, when the knife is withdrawn, its edge being turned forward. By drawing the membrane firmly backward the veins of the pia can be cut through at their entrance into the sinuses, and thus the whole brain as far as the tentorium be laid bare.

7. REMOVAL OF THE BRAIN FROM THE SKULL.

In order to remove the *brain* the opposed fingers of the left hand should be introduced under the frontal lobes, these drawn gently backward, and the nerves which are given off from, as well as the vessels which go to, the base, should be divided one after another; in this procedure one should cut from within outwards; *i. e.* against the bone. When the tentorium is reached, beginning at its right anterior extremity and keeping the knife close to the bone, it should be divided by a series of short, sawing cuts, as far back as

possible. The same operation should then be repeated on the left side while the left hand gives the hemispheres support from behind to prevent the base from being lacerated. Then, after severing the roots of any cranial nerves which may remain undivided, the knife with its edge turned to one side should be inserted as far as possible along the anterior wall into the vertebral canal, and the spinal cord be divided by elevating the handle of the knife. The knife should then be withdrawn at the side and the vertebral artery be divided at the same time.[1] Lastly, the knife should be reintroduced into the canal, but this time with its edge turned toward the other side, and the operation repeated. Now, the left hand still supporting the weight of the hemispheres from behind, the right hand should be so applied to the inferior surface of the brain that the medulla oblongata rests between the fore and middle fingers, and the brain may then be raised completely from the skull. The base of the skull should be examined with reference to abnormal contents.

8. THE PIA MATER AT THE BASE.

The *lateral and basal portions* of the pia should now be examined in the same manner as that of the convexity; but special attention should be given to the great arteries, and especially the artery of the fissure of Sylvius, which should be examined in its whole course on account of its being the favorite seat of emboli, aneurisms, etc.

(*a.*) *Changes in the Great Vessels.*

The great *vessels* of the base of the brain, although of arterial nature, are characterized by the relative thinness of their walls; hence any *fatty* or *atheromatous* changes in their intima can be readily seen from the outside, and are indicated by the presence of grayish, or yellowish-white spots of variable size and more or less diminution in the calibre of the vessel at the seat of the spots. The smaller branches opened longitudinally may be placed with the in-

[1] If the cord has already been removed it is only necessary to divide the lateral attachments of the portion which remains.

tima upward, under the microscope, and the cells of the inner coat are then often seen to be transformed into angular groups of minute, refractive, dark-contoured granules which are altered by neither acetic acid nor dilute alkalies — fatty degeneration.

Aneurismal dilatation is another morbid condition which is often found, and, as has already been mentioned, occurs with greatest frequency in the arteries of the fissures of Sylvius and their branches. Such aneurisms are generally saccular, vary in size from that of a pea to that of a cherry-stone, but seldom exceed the latter, and generally prove fatal from rupture. They should always be borne in mind in cases of profuse hæmorrhage at the base, and the vessels carefully examined for their presence, as this otherwise might easily be overlooked in a large clot. *Embolism* gives rise to a third morbid condition. The plugs are readily recognizable by their dryness and pale, grayish-red color, and are most frequently met with either at the origin, or at the first bifurcation of the arteries of the Sylvian fissures; these large emboli generally prove rapidly fatal, and hence are but seldom adherent to the wall of the vessel.

(*b.*) *Changes in the Pia itself.*

The most important changes which are found in the pia of the base are those which are due to *arachnitis tuberculosa*, and, from the fact that they are generally confined to the base, the disease has received the name of *basilar meningitis.* The anatomical appearances consist in the presence of collections of a yellowish, gelatinous substance of varying consistency in the network of the pia within the circle of Willis, and, especially, about the optic commissure; the exudation may, also, extend far into the fissure of Sylvius. The diagnosis is confirmed by the discovery of minute miliary tubercles which seem to follow the course of the blood-vessels, and are most abundant on the under surface of the frontal lobes or on the island of Reil. The tubercles may also be met with in the connective tissue of the pia apart from any vessels. For microscopical examination a small bit should

be cut away from the pia, and carefully separated from the surface of the brain, with the aid of a stream of water, and then the bits of cerebral substance which still adhere to it are to be removed under water with a camel's-hair brush. The tubercles may now be seen in the walls of the vessels with the naked eye, and when examined in water under the microscope appear as round-celled fusiform swellings of the adventitia. The nuclei are rendered more distinct by acetic acid and the preparation may be readily stained. Giant cells are never found in these tubercles.

Purulent arachnitis is rare at the base of the brain, though not so rare as the tubercular form on its convexity; epidemic cerebro-spinal meningitis, however, is nearly always attended with the formation of pus, and is most marked at the base.

9. EXAMINATION OF THE BRAIN FROM WITHOUT.

When the examination of the pia of the base has been completed, the brain should be turned over and the pia mater removed, that the surface of the brain itself may be the better seen. The best method of removing the pia is to cut through the artery of the corpus callosum near the genu in front and over the posterior border, and then seizing the intermediate portion of the vessel with forceps to detach the membrane as carefully as possible. When the surface of the convexity is reached it is better to use the finger than the forceps; but if the pia gets torn at any place it should be seized with the forceps again in a sulcus, this being the situation of the larger (arterial) vessels. In case the brain is very soft the hemisphere must be supported with the other hand, meantime, to avoid injury to the corpus callosum and roof of the lateral ventricle. A hint as to manipulation may not be out of place: with the thumb on the inner and the fingers on the outer surface of that portion of the pia which has been already detached, the brain should be gradually pressed away from the membrane, from without inwards, by the finger tips and the dorsal surface of the last phalanges; the force can thus be carefully regulated, and it is not neces-

sary to touch or soil the exposed surface of the brain. If circumstances allow, it will be found a great assistance to let an attendant pour on water in a gentle stream. The pia is not always detached with ease, on account of more or less extensive adhesions between it and the brain, portions of which may remain sticking to the membrane. These adhesions are due to chronic inflammatory changes in the cortex (*encephalitis chronica corticalis*), which changes Virchow attributes to deep-seated chronic arachnitis, and the condition has hence been called *meningo-encephalitis*. It is in paralysis of the insane, so called, that this condition chiefly occurs. After the pia has been removed the general size and form of the brain can be determined (for the weight see page 75), but the general condition of the convolutions should receive special attention. The *form* of the *convolutions* is often indicative of changes in the brain itself; in general atrophy of the brain they are narrow and sharp on top, but they are broad and flattened from pressure against the calvaria, if from any cause the volume of the brain be increased. The *amount of blood* in the cortex as a whole is not easy to determine from without, for the reason that the superficial vessels are torn out with the pia; still, the presence of numerous and well-marked reddish points (puncta vasculosa) is pretty clearly indicative of congestion. Sometimes more or less extensive portions of the surface of the pia, which normally is of a uniform gray tint, present a reddish or even violet discoloration; such portions are particularly liable to become torn when the pia is removed, and are very apt to be the seat of the adhesions of which we have spoken above.

Punctate as well as moderately large *hæmorrhages* may be met with in any situation in consequence of injury; they also occur in connection with recent inflammation, embolism of the arteries, and thrombosis of the veins secondary to that of the sinus: in these two latter cases the territory supplied by the affected vessels is generally softened. True hæmorrhages differ from the puncta vasculosa, the presence of which, to a moderate extent, is physiological, in that

the blood being effused into the tissue cannot be readily washed away.

The surface of the convolutions is sometimes somewhat depressed and brownish in color (hæmatoidine), in consequence of old injuries, and Virchow has found the ganglion cells of the cortex cretified in these *plaques jaunes*. By tearing a small bit of the cortex with needles, in a drop or two of water, and pressing lightly on the cover glass, a specimen is readily prepared for the microscope. The ganglion cells are, as a rule, recognizable from their pyramidal shape. Local, circumscribed lesion of the surface may also depend on the presence of the following tumors: *tubercular nodules*, wrongly called solitary tubercles, *gummata*, and *sarcomata*, the last of which are generally larger than either of the other two. The differential diagnosis is often very difficult, and sometimes impossible, or rendered possible only by the condition of other parts. The most distinctive characteristic of tubercle is the presence of gray submiliary tubercles in the grayish transparent zone which surrounds the yellow and cheesy centre; these miliary tubercles are easily isolated with the aid of needles, and often contain enormous giant cells. Again, tubercles are more entirely and uniformly caseous than gummata, the cheesy portions of which are either surrounded or penetrated by more strongly marked zones of tissue of varying consistency. Finally, tubercles — the larger ones, at all events — show central softening much oftener than gummata, although the surrounding cerebral substance is more liable to softening in syphilis than in tuberculosis. The distinction between sarcomatous or glio-sarcomatous and syphilitic growths, is often attended with the greatest difficulty, for the reason that the sarcomata are so prone to partial fatty degeneration. A tumor which is composed of a gray and transparent or tough and fibrous groundwork, with numerous yellow and homogeneous masses scattered through it, — and especially if these masses are relatively dense, — may, nevertheless, be regarded as of syphilitic origin.

Needle preparations of gummy tumors in the fresh state

show either richly cellular granulation tissue or tough cicatricial connective tissue with clearly defined spindle and stellate cells. The yellow portions are seen to consist of a compact and amorphous groundwork which is here and there striated, and great numbers of small fat drops, but no true granular corpuscles are to be seen; these, on the other hand, are usually very prominent in the fatty degenerated portions of the sarcoma, and occur isolated in the groundwork of the tumor. The tissue surrounding a sarcomatous growth often contains large and highly developed cells, but that surrounding a gummy tumor does not.

Cysticerci are also found in the cerebral tissue, and when in the stage of fatty degeneration and cretification might give rise to error in diagnosis, were it not that they are invested by a tough capsule of connective tissue; their microscopical characteristics we have already described.

10. EXAMINATION OF THE INTERIOR OF THE BRAIN.

The time has now arrived for cutting into the brain, which should be opened in such a way as to permit the examination of the ventricles first and then of their neighboring parts.

(*a.*) *Examination of the Ventricles of the Cerebrum.*

The brain being placed in the position which it occupies in the body in the erect posture, a shallow vertical incision should be made in the roof of the left lateral ventricle about one or two millimeters from the raphè of the corpus callosum (the incision should not be too deep lest the great ganglia be injured), and prolonged backwards and outwards into the posterior cornu as well as forwards and somewhat outwards into the anterior cornu. The two extremities of the cut should then be connected by another vertical cut outside of the great ganglia to the depth of the cortex of the inferior surface, and the left hemisphere will then be laid to one side like a prism which is convex on its under surface. The brain should then be turned round, and the right hem-

isphere treated in the same manner. The *lateral ventricles* are now exposed, together with their anterior and posterior cornua, and are to be examined with reference to their *size*, *contents* (a teaspoonful at most in the normal state), and the condition of the *ependyma*.

1. *Dilatation* of the ventricles, due to an accumulation of clear watery fluid, but very seldom of pus, is called *internal*, or *ventricular hydrocephalus*, and may be either congenital or acquired. If the latter, it may be either of inflammatory or purely mechanical origin, — pressure of a tumor of the cerebellum on the vena Galeni, for instance. In acquired hydrocephalus the skull is rigid, and thus the brain, especially the white portion, becomes greatly atrophied; in the congenital form, however, the skull which is still growing yields to the pressure of the dilated brain, and becomes larger itself. Abnormal openings are, indeed, sometimes thus caused in the skull, through which the brain may project under the skin: the favorite seats of this condition (*hydrencephalocele*) are the occipital regions and the lower portion of the frontal. These tumors do not always contain brain substance, but may be due also to a high degree of cystic œdema of the pia mater (*hydromeningocele*). Hydrencephalocele in its highest development constitutes the condition known as *acrania* or *anencephalia*, in which the whole bony vault of the skull is wanting, or else only vestiges of it remain, and sometimes the brain itself is in large measure destroyed by rupture of the surface of the tumor. Spina bifida is often coexistent with this condition.

2. The normal *ependyma* forms a thin, smooth, colorless, and translucent investment of the inner walls of the ventricles, but may, pathologically, be either softened, or hardened and thickened. In chronic hydrocephalus it is generally softened, and may be separated from its attachments in the form of a coherent gelatinous mass. On the other hand, it is hardened in chronic conditions of the brain substance, attended with induration, such as sclerosis, and may resemble the toughest connective tissue in density (*ependymitis chron-*

ica) ; it is then usually thickened, either generally or locally, in the form of small nodular or warty prominences (*ependymitis proliferans*). These local thickenings are common enough in all sorts of conditions, and are usually associated with thickening of the pia mater; in the lateral ventricles their favorite seat is along the border of the corpora striata at either side of the septum lucidum, but they are still more common in the fourth ventricle. They often appear like minute dew-drops, and then might be mistaken for very young tubercles, but they may attain the size of a hemp-seed, and, in rare cases, even of a pea. When torn to pieces, and placed in water under the microscope, they are seen to consist of a close network of the most delicate connective tissue fibres, which swell when placed in acetic acid, and enclose a variable number of cells, and, as a rule, great numbers of corpora amylacea. The ependyma may become *adherent* in consequence of chronic inflammation. Such adhesions are usually only partial, and are chiefly met with in the posterior cornua: the peripheral portion of the cornu is thus shut off from the central cavity of the ventricle, and *hydrocele of the posterior cornu* results: there may be a series of these detached cavities.

A rich network of large veins lies under the ependyma of the lateral ventricles, and these veins communicate with the vena magna Galeni through the velum interpositum. Small multiple hæmorrhages are not very unfrequently found in and under the ependyma, especially in cases of arachnitis tuberculosa. If it be desired to obtain a view of the *middle* or *descending cornu*, and the pes hippocampi, the former must be cut into externally to the optic thalamus. The choroid plexus can be easily raised from its place and examined. The amount of blood which it contains should be noted as well as the presence of any pathological conditions, the most common but least important of which are cysts containing clear fluid, and varying in size from that of a millet-seed or pea to that of a cherry-stone; these are not to be mistaken for cysticerci, which may also be found in this situation.

To open the *third ventricle*, the corpus callosum and the fornix should be severed from below upwards and the posterior portions reflected backwards; in doing this they are to be raised up midway in their course, and the knife is to be passed into the foramen of *Monro*. The ventricle is still hidden by the *velum interpositum;* the handle of the scalpel should be inserted under this, and it should then be likewise reflected from before backwards over the pineal gland and the corpora quadrigemina, the presence or absence of congestion or other morbid conditions being noted. In basilar meningitis, tubercles are sometimes found in the velum interpositum and choroid plexus, but are recognized with difficulty, from the fact that small papillary growths greatly resembling tubercles occur normally in these situations. They can be distinguished microscopically from tubercles by placing the suspected portion on a dark colored support of some kind; if they are tubercles they will be seen to lie along the course of the vessels. The condition of the velum interpositum should receive special attention in all those cases in which abnormal contents are found in the ventricles, for the reason that effusions generally, though not invariably, come from the velum interpositum. The part played by the vena magna Galeni in those cases of hydrocephalus which are due to passive congestion, has been already alluded to.

(*b.*) *The Cerebrum.*

1. *Examination of the Hemispheres.*

Supporting the everted left *hemisphere* in the palm of the left hand it should be laid open by long, straight, vertical incisions extending to the depth of the cortex; the little finger, meanwhile, being kept immediately under the place where each incision is made, and serving by a slight upward movement to make the two surfaces of the cut fall apart; thus all danger of injuring or soiling the parts, whether with knife or finger, is avoided. By taking care to make the incisions always along the upper edge of the ridges which result from the cuts made in the previous stage, the whole white

substance can be thoroughly examined. The cuts should not be so deep as completely to sever the connection of the parts, but should be deep enough to expose the cortex in various places. The brain should then be turned round, and the right hemisphere treated in the same way.

The *degree of moisture* of the cut surface is to be noted — whether glistening with the moisture of œdema, or dry, — as also the number and size of the *red spots* (*puncta cruenta*) where the blood-vessels have been divided. These red spots differ from punctiform hæmorrhages in that they cannot be permanently washed away, while the latter can. If, after washing with a stream of water, the red spots reappear rapidly and in great numbers, considerable injection of the vessels of the white substance is present. It is very important to note the *relative proportion* both of one hemisphere to the other, and of the white and gray portions of each hemisphere; but, above all, the width of the cortex should be noted. By noting whether the white and gray portions occupy the same *level* on the cut surface, one is greatly assisted in determining the presence of either swelling or atrophy of one or the other portion. The most important form of atrophy is that which is characterized as *senile*, and affects chiefly the cortical portion. The causes of *swelling* or *enlargement* are threefold: 1st. simple *hyperæmia*, as indicated by the color of the brain, and the large size and number of the puncta cruenta; 2d. *œdema*, as indicated by excessive moisture of the cut surfaces; 3d. inflammatory proliferation of the neuroglia. The last form may be called *parenchymatous* enlargement, and is especially common in young children. It is very difficult, and sometimes even impossible, to distinguish the two last forms from each other. (*Vide* Encephalitis neonatorum.)

We shall have something to say about *circumscribed lesions* at the close of our remarks on the examination of individual portions of the brain.

2. *Examination of the Great Ganglia.*

The *great ganglia*, the corpora striata and optic thalami,

may be laid open either in the direction of their fibres by incisions radiating like the sticks of a fan from the peduncle, or by simple transverse incisions. The latter method is better suited for instituting a comparison between the two sides, and is best carried out by cutting through corresponding portions of the ganglion of either side at one incision; for this purpose a large thin-bladed knife should be used. In order to make the cut surfaces fall well apart the left hand should be introduced under the brain, and the tips of the fingers in close apposition should be placed under the portion where the incision is being made; by then raising the finger tips slightly the cut is made to gape open widely. There is normally a lack of uniformity in the grayish shade of the ganglia: the corpus striatum, and particularly the outer zone of the nucleus lenticularis are darker and rather brownish in color, while the two other zones of the nucleus lenticularis as well as all three of the optic thalamus are lighter and of a more yellowish-gray.

(*c.*) *The Fourth Ventricle.*

In order to spare the fornix, it, together with the velum interpositum and the pineal gland, should be laid over to the left; the corpora quadrigemina are thus exposed to view, and may be laid open by transverse cuts. The left hand should then support the cerebellum from below, and an incision be carried along the vermiform process, remembering that the cavity of the ventricle lies deeper behind than in front. If the cut has been made exactly in the median line, the aqueduct of Sylvius will also be opened to view. The fourth ventricle is to be examined with reference to the same points as the other ventricles have been. The granular thickening of the ependyma, which is so often found here, has been already alluded to, and we should not neglect to note the degree of prominence of the auditory striæ.

(*d.*) *The Cerebellum.*

The hemispheres of the cerebellum, which have already been separated by the cut which opened the fourth ventricle, should now be further divided, one at a time, by a cut extending from the ventricle in the direction of the middle branch of the arbor vitæ, and through the substance as far as the convexity; the surfaces resulting from this cut are fan-shaped, white at the centre, and gray at the periphery. The corpus dentatum is seen imbedded in the white matter, and surrounded by a delicate gray capsule. The examination of the cerebellum, and at the same time of the brain from above, is now to be completed by cuts radiating out from the cerebellar peduncle.

(*e.*) *The Pons and the Medulla Oblongata.*

It only remains to open the pons and the medulla, and to examine the cranial nerves. In order to do this the hemispheres should be folded together like the leaves of a book, thus restoring the brain to its normal shape, and then, the palms of the hands being placed under the sides, it should be turned over on its transverse axis. If it be desirable to investigate the condition of special vessels more minutely this can still easily be done, and then the size and color (whether grayish or not) of the *nerves* should be noticed; finally the *pons* and *medulla oblongata* are to be cut transversely while the left hand supports them from beneath. In the cerebellum and in these parts, just as in the brain proper, the points which should receive special attention are the color and the amount of blood. It is advisable in all cases, and absolutely necessary when calcification is present, to dissect off the vertebral and basilar arteries from behind, and then lay them over forwards before cutting into the pons.

(*f.*) *Other Methods of laying open the Brain.*

It is not always necessary and may be undesirable to cut up the brain in the minute manner which we have laid down above; especially when a local affection which can be recognized from the outside — tumor, abscess, large effusion of blood — is present. For the sake of the clinical interest which attaches to such cases the attention should be chiefly directed to determining the size and exact seat of the lesion, what portions of the brain are completely disorganized by the same, and what portions are only secondarily affected in consequence of pressure, softening, etc. The best method of procedure in these cases is — without removing the pia or making any other cut at present — to make a transverse cut completely across the brain and through the middle of the lesion with a long and thin-bladed knife, thus laying open the healthy as well as the diseased hemisphere, at as nearly the same level as possible, and securing a standard of comparison. A general view of the seat, extent, and nature of the lesion may thus be obtained, but, if it be desired to pursue the examination further, it will be found of advantage to harden the brain before doing so, for the reason that the diseased portions are usually so soft that the relative position of parts must inevitably be greatly modified if further incisions are made.

Meynert's method of opening the brain is entirely different from that which is usually adopted, but is followed by many specialists in mental disease. The chief end to be gained by this method is the determination of the weight of each of the three great portions of the brain (brain-covering,[1] brain-stem, cerebellum) taken separately. The pia mater is not removed, but the brain being placed with its base upwards, the islands of Reil [2] are dissected away from

[1] The brain-covering is composed of the cerebral lobes, olfactory nerves, corpus callosum, fornix, and septum lucidum.

[2] By leaving the islands of Reil attached to the brain-stem, about 24 grams, according to Meynert, are added to the weight of the latter.

their attachments so freely as to allow the three fissures which bound each of them to be clearly seen. The pia over the great transverse fissure of the brain is then detached laterally and behind so that on raising the medulla oblongata, pons, and cerebellum, the descending cornu of the lateral ventricle may be directly exposed. The anterior portion of the parietal lobe is next grasped, drawn somewhat backwards, and its connection with the stem cut through by keeping close to the posterior furrow of the island of Reil externally, and to the outer wall of the descending cornu internally. The island is then separated from its base by holding the knife nearly horizontal, and cutting through the outer limiting furrow, care being taken to keep close to the outer angle of the lateral ventricle formed by the corpus callosum and the great cerebral ganglia, which may readily be seen by lifting the cerebral stem.

These cuts having been made on both sides, the knife is passed into the longitudinal fissure, and a horizontal section (parallel with the orbital surface of the frontal lobes) and about three centimeters deep, is made through the depression just in front of the anterior perforated space, then following the anterior furrow of the island of Reil, with a slight curve concave outwards until the cut previously made through the outer furrow is met.

The stem and cerebellum are now raised and made tense, the pillars of the fornix and the septum lucidum are cut through from below, just in front of the anterior commissure, and finally the brain-stem is completely detached by separating from below the remaining adhesion in front of the corpus striatum. This portion is readily separated from the cerebellum by cutting through the several processes connecting the two.

The following figures are Meynert's, and are based on the examination of 157 bodies at the Vienna Insane Asylum. The average weight of the whole brain between the ages of twenty and sixty-nine years, is 1,296 grams in the male, the maximum being in persons between forty and fifty years of

age, and 1,169 grams in the female, the maximum being in those between fifty and sixty years of age. The average weight of the brain-covering is 1,018 grams in the male, 917 in the female; of the brain-stem 143 grams in the male, 129 in the female; of the cerebellum 135 grams in the male, 123 in the female.

(*g.*) *Morbid Conditions of the Brain.*

Of the local lesions which are met with in different portions of the brain, the first to claim our attention is, —

1. **Hæmorrhage.** This may be of *large extent* or *punctate* — sometimes incorrectly called *capillary* — though the two forms are very often coexistent, and the punctate variety is almost always found in the vicinity of large hæmorrhages. If the bleeding be of traumatic origin it is very apt to be seated directly opposite the point where the injury was inflicted (hæmorrhage from contre-coup), while this point is absolutely or nearly free from hæmorrhage. Those hæmorrhages which are due to disease of the vessels are found chiefly in the great ganglia where the arteries ascend into the brain from the fissure of Sylvius, and often break through into the lateral ventricles. Large cells filled with red blood corpuscles are often found in these apoplectic clots on microscopic examination, and are merely white corpuscles with red ones incorporated in them; they are easily found by tearing apart a small portion of the clot in a one per cent. solution of common salt, but water and acid should not be used for the reason that they destroy the coloring matter of the red cells and render them indistinct.

2. **Softening of the brain** (*mollities cerebri*) is so often dependent on hæmorrhage that it, in its various forms, comes naturally next in order. The form of softening which is generally qualified as "red," results from partial breaking down of portions of cerebral substance between and about hæmorrhages, and acquires its color — which later is somewhat brown — from admixture with blood. Red softening may be of traumatic, embolic, or inflammatory origin; and it is very

often impossible, especially in the later stages, to arrive at the exact mode of origin from the local appearances alone, though sometimes the history of the case and the condition of other organs or parts throw light upon the question. If softening be found in the occipital lobe it is more likely to be of inflammatory origin, for experience teaches us that embolism rarely takes place in this situation, and softening in general is less common in the cerebellum than in the brain proper.

The microscope shows the softened portion to consist of blood, disorganized brain matter in the form of free globules of myeline, and irregularly varicose nerve fibres.

If the process to which the red softening is due has been arrested the part is generally separated from the surrounding healthy structures by a growth of connective tissue. The coloring matter of the blood is removed in part, and in part converted into hæmatoidine, to which the brownish shade is due. The formed elements, which with the lapse of time consist largely more and more of colorless cells, undergo fatty degeneration, forming granular corpuscles, and, finally, a fatty detritus (*yellow softening*) results, which again may be absorbed, and, in large softenings, replaced by clear fluid. Thus originate the so-called *apoplectic cysts*, the formation of which requires two or three months. When the softening is of slight extent union takes place between the walls, and all that remains is a little band of tough, and perhaps pigmented, fibrous tissue (*apoplectic cicatrix*). The term "*cyst*" is not well chosen, as there is no true capsule or even cavity in the strict sense of the word; but the cerebral substance is replaced by a delicate and vascular network of connective tissue, the interstices of which contain fluid and the remains of the cells which have become fatty degenerated. If a small portion of this be laid in water under the microscope, there is seen a fine reticulum of connective tissue containing cells and greatly resembling the fibrous form of mucous tissue which is found in the umbilical cord of the fœtus near the full term; a proof that the neuroglia, from which this structure is developed, is closely allied to mucous tissue.

Yellow softening, as has already been remarked, may be a later stage of the red form, but is not necessarily so, since it also occurs as a result of embolism, in the vicinity of tumors — gummata for instance — and from other causes. The elements contained in the softened mass, especially those of the vessels and nerve fibres, are shown by the microscope to be fatty degenerated; granular corpuscles are present in large numbers, and the *corpora amylacea*, which were mentioned in connection with the spinal cord, are often found. Softening may also occur in numerous small spots which, after absorption has taken place, assume the form of small spaces filled with an œdematous tissue, the so-called "*porous softening*." That form of softening is of special importance which is found in the brain and cord of new-born children in numerous small and more or less whitish-yellow spots; this is to be regarded as an *interstitial encephalitis* (*encephalitis interstitialis neonatorum*) in the stage of fatty degeneration, and as usually dependent on syphilis (Virchow).

White softening is found chiefly in those portions of the brain which adjoin the ventricles, and like the softening of the ependyma of which we have already spoken, is a post-mortem change, and is almost always associated with internal hydrocephalus.

3. **Inflammation of the brain** has been already mentioned as a cause of softening, and the chief diagnostic peculiarities of its later stages have been described.

The most common form of recent inflammation is the *encephalitis interstitialis neonatorum*, to which we have already alluded. The brain in this affection is enlarged, soft, sometimes much redder than normal, sometimes a pale grayish-yellow, and the distinction between the white and gray portions is more or less effaced. Specimens are readily prepared for the microscope by flattening out a small bit of the brain by means of gentle pressure on the cover glass; they show, according to Virchow, an increase in the cells of the neuroglia, particularly in that of the white portion, where they are very often found in the process of conversion into

granular corpuscles; this degenerative process, in its later stages, may result in the formation of those local spots of softening of which we have spoken above. In adults recent inflammation is but seldom met with, and when it does occur is usually recurrent and in the neighborhood of older centres. It is characterized by swelling and change of consistency of the brain substance, diffuse yellowish discoloration (*yellow œdema*), and punctate hæmorrhages (*encephalitis hæmorrhagica*).

Inflammation of the brain may also terminate in suppuration (*encephalitis apostematosa*), and give rise to a larger or smaller collection of pus, which is more apt to occupy the white substance; such an abscess, when recent, is surrounded by brain tissue which is swollen, reddened, and contains hæmorrhages; but after a certain length of time (three to five weeks), it becomes encysted, and is then much less likely to cause further mischief. Cerebral pus has an acid reaction, and very often an offensive odor from chemical changes in the nervous tissue, although actual decomposition has not taken place; the individual cells of which it is composed generally contain several very distinct nuclei. Whether abscesses also may undergo fatty degeneration (yellow softening), and result in cysts, is not as yet accurately determined.

It remains to mention the *chronic* forms of inflammation which, still more than the acute, are apt to be limited to small territories; but which, on the other hand, are generally multiple. Spots of chronic inflammation are chiefly found in the white matter, and are remarkable for their gray, transparent appearance, their firmness and clearly defined edges. There is, however, a form of sclerosis which is found in the gray matter, and especially in the cortex; it gives rise to a whitish discoloration with considerable induration and atrophy, effacing the distinction between the white and gray portions, and is especially marked on the convolutions. This form is sometimes also congenital.

That form of chronic inflammation of the cortex which occurs in general paralysis of the insane (*encephalitis corti-*

calis, or *meningo-encephalitis*), has been already mentioned in connection with the surface of the brain.

4. The most important as well as most common class of **brain tumors** are the *sarcomata* or *glio-sarcomata*, which may be either single or multiple. They are often extremely vascular, and may be the seat of large or small hæmorrhages, which are sometimes rapidly fatal. From the fact that these vascular tumors are also very soft, a large hæmorrhage may readily disorganize a larger or smaller portion of the new formation, and one should, therefore, always carefully examine the vicinity of hæmorrhages of doubtful origin.

The cells of these tumors, like all sarcoma cells, are very fragile, so that in examining fresh needle preparations, one often finds but little more than free nuclei ; this peculiarity is, indeed, so marked that Virchow, in his famous book on tumors, says that he classes every morbid growth in which he finds those free nuclei, unless otherwise controlled, as a sarcoma. This extreme fragility of the cells can be somewhat obviated by the use of certain hardening fluids which act quickly, one of the best of which is dilute Liquor Iodin. Comp., — "Lugol's Solution of Iodine," — which stains the cells light yellow, the protoplasm being more affected than the nuclei. Cells which may have one or several nuclei are often found in these tumors, and resemble closely those many-armed cells of the neuroglia called *spider* and *penicillate* cells ; their processes are interwoven with one another, and thus a finely fibrillated structure is formed very similar to that of the neuroglia (*glioma*). The microscope shows us how hæmorrhage, which is so often multiple in these tumors, takes place. If a small vessel be picked out of the growth with forceps, brushed under water with a camel's hair pencil, and then examined, it will be seen that its wall has undergone sarcomatous change, perhaps to such a degree that it consists of nothing but closely aggregated sarcoma cells, and is thus easily ruptured.

The brain is not a common seat for tumors of any kind, and the rarer forms are *carcinoma* (it is doubtful whether

this is ever primary in the brain), *psammoma*, *cholesteatoma*, *melanoma*, and, most rare of all, *osteoma*. The diagnosis of *carcinoma*, as is well known, involves necessarily two things, — aggregations of epithelioid cells and an alveolar stroma of connective tissue. The cells may be obtained by simply scraping the cut surface of the growth, and their integrity be preserved by the addition of a dilute solution of iodine or of osmic acid; while the stroma may be demonstrated by brushing a small bit snipped off with the scissors under water. A *psammoma* is easily recognized by its sandy bodies, a *cholesteatoma* by its pearly lustre, a *melanoma* by its color. The sandy bodies — lime salts — when placed under the microscope, are black by transmitted and white by reflected light, and are readily dissolved by hydrochloric acid; the pearly lustre of the second results from delicate and closely aggregated glistening scales, while the cells of the melanoma contain brown or black pigment. The extremely rare occurrence of gray matter within the midst of the white substance should also be mentioned.

5. Finally, the cysts of **animal parasites** are occasionally found in the brain; those of the *cysticercus* (already described in connection with the surface of the brain), are small, and may be either single or multiple; while those of the *echinococcus* may be as large as an apple, or even larger, are rare and generally single. The latter, in the brain as elsewhere, are enveloped in a wall of connective tissue, within which is a thick, distinctly laminated, gelatinous membrane belonging to the animal, and presenting on its inner surface numbers of whitish dots — the scolices. These scolices are readily scraped off, and when placed in water under the microscope, closely resemble those of the cysticercus, except that the heads and hooks are smaller. The head is often folded into its little vesicle, but may be forced out by gentle pressure on the cover glass. The laminated structure of the membrane may be demonstrated on a thin section snipped off transversely with the scissors and laid in water.

11. THE DURA MATER AND BONE AT THE BASE.

The last steps in the examination of the cranial cavity are the removal and inspection of the dura mater and its sinuses, and the inspection of the basal and lateral portions of the skull. What has been said with regard to the upper portion of the dura mater, applies also to its lower portion, except that purulent inflammation, not of traumatic origin, but due to caries, etc., as well as gummous inflammation, are more common here. Thrombosis of the *transverse* sinus is usually of phlebitic nature — as in caries of the petrous bone. Next to fractures, which are readily recognized after removal of the dura, and to which the attention is usually directed by the discovery of an effusion of blood between the dura and the bone, the most common lesions are those of the petrous bone, which is sometimes perforated in the course of *caries of the inner ear*, and thus purulent inflammation of the dura, or even abscess of the brain, may be set up. Myxochondromatous tumors are sometimes found on the posterior surface of the *clivus Blumenbachii*.

The *pituitary body* is usually allowed to remain in the sella turcica on account of its trifling importance, but is occasionally the seat of tumors which may need careful examination. In this case, before removing the brain, one should cut through the dura on either side of the sella turcica, and endeavor to remove the brain and pituitary body together.

12. THE FACE.

When it is desirable to examine the deeper parts of the *face*, the *parotid gland* or the *ear*, the best manner of doing so is generally to prolong the incision which was made over the vertex behind the ear as far as the neck, and then to dissect off the integument forward after subcutaneous division of the external ear.

(*a.*) *The Parotid Gland.*

The most common affection of this gland is interstitial inflammation and suppuration (*suppurative parotitis*), in

which affection the connective tissue surrounding the lobules becomes infiltrated with pus, and may even be converted into abscesses into which the lobules project. The salivary glands in general and the parotid in particular, are not infrequently the seat of the *enchondromata* or *myxochondromata*, which are recognized by their cartilaginous appearance, and by the presence of disseminated gelatinous spots which acquire a whitish opacity on the addition of acetic acid.

That peculiar new formation which has received the name of *cystosarcoma*, is also found here. Its cut surface looks very much like a transverse section through a cabbage head, and the papillary growths can easily be extracted from the cavities which they fill out more or less completely (*vide* Cystosarcoma of the Breast).

(*b.*) *The Bones of the Face.*

If it be necessary to examine the maxillary bones also, a new incision must be made from behind the ear along the depression between the neck and the under jaw; the reason for choosing this situation is to avoid any injury to the face.

There are independent affections of the maxillary bones as well as those which they share in common with neighboring parts; we have already mentioned, for instance, that *epithelioma* of the lip sometimes involves the lower jaw. The independent affections are chiefly new formations of various kinds, and are very apt to come under the surgeon's knife. The most common varieties are *carcinoma* and *fibroma*, both of which are more common in the upper jaw; *cystoid disease*, starting generally from a tooth-germ, sometimes from a fibroma; and *sarcoma*, especially *giant-cell sarcoma*, in this situation known by the name of *epulis*. A peculiarity of this latter growth is that it often becomes brownish in color on exposure to the air. Microscopically it is composed of round and spindle cells, between which enormous many-nucleated giant cells are often found: these can be readily isolated in needle preparations, and generally present numerous irregular notches and processes of variable size on the periphery. The above named tumors often

spring from the antrum, which they may gradually fill out and distend, thus giving rise to great deformity of the face.

Passing mention must also be made of *periostitis* and *necrosis*, so often met with in the lower jaws of those whose employment brings them in contact with phosphorus; and of the inflammatory processes (periostitis) which may originate from the teeth, and are included under the term *parulis*.

13. THE NASAL CAVITY.

Thorough examination of the cavity of the nose is only possible after removal of the ethmoid bone and the parts which are attached to it. To do this the bone must be sawn through on either side of the ethmoid from the great occipital foramen as far as the frontal bone, and then these two saw-tracks should be united anteriorly by a third. If only the mucous membrane of the anterior nares is to be examined, this may easily be done by separating the upper lip from its bony attachments, and then cutting away as much of the cartilaginous septum and of the sides as may be desired.

A rare but important affection, the chief seat of which is the mucous membrane of the nose, is *glanders*. This is characterized by inflammation which may be more or less intense and even hæmorrhagic; also by the presence of small uniformly yellow nodules, and ulcers with yellow, somewhat transparent base, and scanty secretion; the ulcers increase in size and become confluent by the breaking down of nodules which are often present in their edges.

Gummy formations occur both in the mucous membranes and the nasal bones, and by destroying the septum and the nasal bones may cause the nose to fall in near its root. The chief new formations which occur in this situation are *polypi of the nose*, so called. Some of these are due to hypertrophy of the mucous membrane — *mucous polypi* — while others are firm *fibromata*, and may arise from the base of the skull; in this case they are called *naso-pharyngeal polypi*.

The mucous membrane of the nose participates in many

affections of the throat — diphtheritis, for instance; but not in any peculiar manner.

14. THE EYES.

The daily increasing importance which is assumed by changes in the eyes, not only for their own sake, but also for the sake of their diagnosis during life, renders it often desirable to examine the retina and choroid, at least. This can easily be done without injuring in any way the external portions of the eye, by removing the roof of the orbit with the mallet and chisel from the inside of the skull; the orbital fatty tissue and the muscles are then to be removed, and the globe to be drawn backwards, when the posterior half should be cut through with the scissors. The anterior portion of the globe, which is left behind, may be kept in place by plugging the orbit, and thus all deformity be avoided. If one does not happen to have a mallet and chisel at disposal, the bone scissors generally serve the same purpose.

(*a.*) The important changes which take place in the papilla of the *retina* can be seen better with the ophthalmoscope during life than after death, but the degree of fullness of the vessels, the size and number of hæmorrhages, if present, and the presence of those white spots which are due to fatty degeneration of the tissue, and occur in retinitis albuminurica, are all easily seen in the retina after its removal. Hæmorrhages are almost always present in ulcerative endocarditis, often in chronic nephritis, basilar meningitis and other affections of the brain. The retina is so transparent that a preliminary microscopic examination is easily made by spreading out a bit of it in water, or, better still, in the aqueous humor.

(*b.*) The condition of the *choroid* which is of greatest interest to the practicing physician, is the presence of *tubercles*, which appear as small, gray nodules projecting into the cavity of the eyes; they also are readily prepared for the microscope by simply spreading out the membrane after having brushed off the pigment epithelium, which, indeed, should be done before the microscopic examination, in order

to avoid being deceived by small yellow spots which are due merely to defects in the pigment. In ulcerative endocarditis we almost always find, both in the retina and choroid, minute metastatic foci of inflammation which look very much like tubercles; their centre is occupied by a collection of micrococci, which may be brought out more clearly by the addition of glacial acetic acid. For a description of the other changes which are met with in the eye, and are of less general interest, the reader is referred to the text books of ophthalmology.

(*c.*) The most important modification of the *optic nerve* is *gray atrophy*, which, as the name indicates, consists in a diminution in size, and a change from the normal white color to a transparent gray. The atrophy is seldom uniform, but the nerve is generally flattened or ribbon-like, and the degeneration may be either complete or partial. As in the spinal cord, one may be deceived as to the color, unless great care is exercised. In some cases of hæmorrhage at the base of the brain I have found effusion of blood between the nerve and its sheath.

15. THE INNER EAR.

It is but seldom that the *inner ear* presents conditions which are of interest to the general practitioner; but if an examination be desired, it may be made as follows: The whole petrous portion should be separated from its attachments by two saw-cuts which come together in the sella turcica, and it may then be removed from its place, put into a vise, and sawn through from the posterior border of the external, to the anterior or inner border of the internal, auditory canal. The internal parts are thus laid open, and the drum membrane left nearly intact. In the anterior portion may be seen the tympanic cavity and the external canal; in the posterior the vestibule, the posterior wall of the tympanic cavity with the fenestræ, etc. The stapes is generally left in place, the cochlea is divided in the middle, and the anterior portion of the mastoid cells laid bare. An admirable view of

the inner ear may be obtained by removing the roof of the tympanic cavity, which is easily done with either bone scissors, or mallet and chisel.[1]

Caries is almost the only affection for which it is necessary to examine the inner ear. We have already alluded to the disastrous effect which this affection sometimes has on the membranes of the brain, the brain itself, and the transverse sinus. Varying with the duration and intensity of the process, more or less extensive mischief is to be found; such as perforation of the drum membrane, or enlargement of the tympanic cavity and vestibule, and the formation of a large cavity containing the ossicula freed from their attachments; or a considerable portion of the bone — the cochlea, for instance — may have become necrotic, and more or less completely detached by peripheral inflammation. It is in those who are predisposed to scrofula and tuberculosis — and above all in children — that these changes are generally found, though chronic catarrh may also result in caries; in the latter case the mucous membrane of the tympanic cavity, which normally is extremely thin, is very much thickened, covered with granulations, and contains masses of a dry whitish substance (cholesteatoma, so-called) consisting of desquamated epithelial cells which have become cornified.

III. THE THORACIC AND ABDOMINAL CAVITIES.

The usual method of opening the neck and the thoracic and abdominal cavities is by means of a single long incision, extending from the chin to the symphysis pubis, and passing to the left of the umbilicus; this incision should be made with the belly of the knife rather than the point, the latter being apt to penetrate too deeply and cause mischief. At the root of the neck, where there is generally a more or less deep depression, especially in thin subjects, it is well to put the skin on the stretch with the thumb and forefinger of the

[1] For more minute directions the reader is referred to Prof. Lucae's article, Klebs' *Handbuch der Pathologischen Anatomie*, 1, 12.

left hand. Over the thorax the incision should be made at once completely down to the bone, but over the abdomen only into the muscular layer. The right flap should then be grasped firmly below the ensiform cartilage, the abdominal wall drawn upwards, and a small incision made with care completely through the still undivided tissues into the peritoneal cavity. In thus opening the peritoneum any escape of gas — as evinced by a hissing noise — or of fluid should be noted. Two fingers should then be introduced into the cavity one after the other, the wall drawn away from the viscera and, the fingers being spread apart like the arms of a V, the incision prolonged between them as far as the symphysis. In order to get more space for working, it is well to sever subcutaneously the attachments of the recti muscles to the pelvis, especially if cadaveric rigidity is still present.

In new-born children the surroundings, contents, and walls of the umbilical vessels are first of all to be carefully examined. In order to do this conveniently, and at the same time to alter the relative position of the parts, and particularly of the arteries, as little as possible, a second cut should start from the main incision a little above the umbilicus, pass round the other (right) side of that point, and join the main incision again a little below that point, thus separating it completely from the rest of the anterior abdominal wall. The vein and ligamentum teres can then be examined and divided, and the arteries may afterwards be followed up by turning downward the flap which lies between the two incisions.

The pathological conditions which are found here are chiefly of inflammatory origin, and occur generally in the children of mothers who are the subjects of puerperal disease. In *umbilical arteritis* the walls are thickened and the vessels filled with a puriform mass, which is often limited by a healthy thrombus near the urinary bladder. *Thrombophlebitis* and *periphlebitis* derive their importance chiefly from their connection with the portal vein and liver, and will be treated more in detail in another place.

First on one side and then on the other, the abdominal wall is now to be lifted and drawn tight over the margin of the ribs, and a long incision, reaching from the ensiform cartilage to the eleventh rib, made completely through the muscles. Now, with the thumb of the left hand on the cut surface, and the fingers on the external integument, after having divided the anterior attachments of the muscles, the soft parts are to be drawn away forcibly from the ribs and the submuscular tissue which is thus made tense, cut through in long sweeping incisions. The cuts should always be made where the tension is greatest, and begun with the heel of the knife. As a general thing it is not necessary to dissect off the soft parts farther than the junction of the cartilaginous with the bony portions of the ribs; but this may be done if it is desired to examine the mammary gland from behind, or if external inspection has given grounds for suspecting the presence of changes beyond this line. In the neck, only the superficial muscles are to be dissected off with the skin, and in cutting the lower attachments of the sterno-mastoid muscles, care is to be exercised not to injure the great vessels.

I. THE SOFT PARTS.

As in the skull, so here, the soft parts are to be first examined.

(*a.*) The *thickness* of the *panniculus adiposus* can be more accurately estimated now than during external inspection; its *color* becomes deeper and sometimes orange or reddish-yellow, when it is the seat of atrophy. Its most important modifications have been already described in connection with the skin.

(*b.*) The *muscles* of the *neck*, *thorax*, and *abdomen* are next to be examined, and

1. *Their General Characteristics*,

such as size, color and consistency, noted. *Atrophy* of the muscles, which may reach its highest degree on the thorax, has been already described; the *color* of healthy muscle is a

deep red, but in anæmic and emaciated subjects it becomes pale, or even grayish-red, and in some diseases — typhoid fever, for instance — is very dark red. In typhoid fever, acute mania and some other affections, the muscles of the abdomen, in particular, sometimes present a grayish, semi-translucent appearance. The *consistency* usually stands in a direct ratio to the color; pale muscles are generally flabby, dark muscles firm and hard. The cut surface is sometimes very dry and dull, — as in typhoid fever, again, — sometimes very moist and œdematous.

2. *Special Morbid Conditions.*

(*a.*) *Hæmorrhage* is not uncommon and may be due to injury, the application of cups, etc. Extensive hæmorrhage sometimes occurs in the abdominal muscles, and particularly in the recti in typhoid fever (*hæmatoma recti abdominis*).

(*b.*) Those changes which reach their highest development in many cases of typhoid fever, and which consist sometimes in *granular opacity* and disappearance of the transverse striæ of the muscular fibres, sometimes in that peculiar form of *degeneration* to which Zenker has given the name *waxy*, are to be regarded as due to parenchymatous inflammation (*parenchymatous myositis*). As in all parenchymatous inflammations the granules are at first of an albuminoid nature, as is proved by their disappearance on the addition of dilute caustic potash, but later are converted into fat and are unaffected by potash (*fatty degeneration.*) In waxy or hyaline degeneration, the relation of which to the fatty form is still obscure, the fibres are converted into a translucent substance which retains for a time traces of transverse striation but later becomes perfectly homogeneous and presents transverse cracks. These cracks finally extend completely across the fibres, and the sheath of sarcolemma contains only isolated masses of this hyaline substance. Although hyaline degeneration may produce an appearance bearing the very closest resemblance to that produced by amyloid degeneration, it never presents those reactions with iodine and aniline violet which we shall describe in detail in connection with amyloid degeneration in

the spleen. Microscopically, the hyaline change is betrayed by a grayish homogeneous and transparent look, as has been already hinted at. To prepare for the microscope muscle, which is the subject of this or almost any other morbid condition, a small bit should be snipped out with scissors, parallel with the course of the fibres, and should be teased with needles in a solution of common salt. In order to isolate the primitive fibres in as long strips as possible, it is well to put the needle points close together in the middle of the bit to be examined, and then to tear it completely through in opposite directions with the course of the fibres. This procedure should be continued till the bits become too small to allow further division.

(*c.*) Interstitial inflammation (*interstitial myositis*) may be either acute or chronic. The *acute* or *purulent* form may be either primary — when of traumatic origin it is usually so — or secondary and extended from neighboring parts. For instance, the muscles of the chest may become involved from the pleura, or those of the abdomen from the pelvis, in which latter case, as well as in the muscles of the neck after tracheotomy, gangrene is often superadded. This kind of inflammation never results in the formation of a true abscess, but rather in a purulent infiltration of the muscles, the separate bundles and fibres of which are ensheathed in pus, and are also, as a rule, the seat of either fatty or hyaline degeneration. *Chronic* interstitial inflammation, characterized by increase in the interstitial connective tissue and consequent atrophy of the muscular tissue, is associated with and depends on all sorts of chronic changes in neighboring parts — affections of the ribs or of the cervical glands, pleurisy, etc. The muscles thus affected are firm and dense, reddish-gray in color, and present even to the naked eye thick fibrous intermuscular bands.

(*d.*) *Tumors* are more common in the muscles of the extremities and will be described in that connection.

(*e.*) It is precisely in the muscles of the neck, the intercostals and the diaphragm that the important *parasitic* mus-

cular disease — *trichinosis* — has its favorite seat. In old cases the diagnosis is easy, the cretified capsules appearing as small, oval, white bodies ; and if the animals are very numerous the muscles look as if strewn with fine white sand. The less complete the cretification the more difficult it is to discern the capsules, which are gray in their earlier stages, it is only after the formation of the capsule that the disease can be recognized with the naked eye, though the microscope will reveal its presence in muscle prepared in the manner which we have already described. The search may be facilitated by compressing a bit of the suspected muscle between two glass slides and looking at it by transmitted light. In microscopic examination it is better to use a low power, a higher power being substituted if anything suspicious is found. Trichinæ when found in muscle are smaller than when found in the intestines, and have a pointed head and a larger, rounded tail. During the first fourteen days of their sojourn in muscle they lie at full length within the sarcolemma, the contractile substance of which is broken down while the nuclei show signs of commencing growth ; but after this period the animals are coiled up spirally within the sarcolemma, which is considerably thickened, forming a fusiform dilatation. The lumen of the sarcolemma then becomes gradually closed up at either end by progressive cellular growth, and the animal is finally invested in an oval capsule of connective tissue, which increases somewhat in thickness before calcification makes its appearance at the ends. A secondary formation of fatty tissue is often found on either side of old capsules which, when completely cretified, must be treated with dilute hydrochloric acid to render the parasites themselves visible. They retain life for years when thus encysted. This fact may readily be demonstrated by opening the capsule by pressure on the cover glass or with needles and freeing the occupant, which may be distinctly seen to move ; its movements can be made more vigorous by warming the microscope. If it be wished to determine microscopically whether trichinæ are present or

not, it is absolutely necessary to prepare and examine a large number of specimens — twenty or thirty — from different localities, and particularly from the cervical and intercostal muscles and the diaphragm. The specimens should also be as large as is convenient, since the creatures are very irregularly distributed, being sometimes thickly aggregated in one place while another is entirely free from them. It is a matter of experience that they are most numerous near the tendons, and specimens should, therefore, always be taken from such situations if possible. The object of these investigations being usually to determine merely the presence or absence of the parasite, time and labor can be saved by adopting the following method. Bits of muscle the size of a split pea are to be snipped out and coarsely teased on a glass slide in glycerine or dilute caustic alkali; another glass slide is then to be laid over them, the specimens compressed between the two, and examined rapidly with a low power (fifty to seventy diameters.)

(*c.*) The *mammary gland* may be laid open and examined from behind without injury to the skin.

(*a.*) *General Appearance.*

The size of the mammary gland in the female varies with the age of the individual, attaining its full development at the age of puberty, and becoming atrophied to a mass of dense and almost pure connective tissue after the menopause. The appearance of the gland is essentially modified during lactation.

When at rest it consists chiefly of a very dense and whitish fibrous tissue, scattered about in which at considerable intervals grayish-red nodules of glandular tissue the size of a pin's head may be seen. Toward the termination of pregnancy, and in a still higher degree during lactation, the condition of things is reversed: the gland is increased in size, its general color is grayish-red, and its cut surface has a granular look which reminds one of the salivary glands, except that the granular masses of the breast are rather smaller. It is only near the nipple that much fibrous tissue is to be seen.

Numbers of deep yellow, creamy drops exude from the cut surface of the gland when functionally active, either spontaneously or on gentle pressure: these drops somewhat resemble pus but consist solely of colostrum. The microscope shows innumerable fat drops, a variable number of colostrum corpuscles which look not unlike mulberries, on the abundance of which the intensity of the yellow color of the fluid depends, and granular corpuscles with smooth margins and distinct nuclei.

(*b.*) *Special Morbid Conditions.*

1. In *suppurative mastitis*, which is generally limited to circumscribed portions of the gland, the pus may be either infiltrated into the connective tissue between the acini or collected in the form of abscesses. The affection is never the direct cause of death. Sometimes the pus is fetid, as, for instance, after a surgical operation in the vicinity. These abscesses sometimes, though rarely, dry up and leave cavities with cheesy contents.

2. Chronic *inflammation* (chronic interstitial mastitis) is characterized by an increase in the connective tissue, and is generally confined to small portions of the gland. It may be associated with *cystic dilatation of the milk ducts.*

3. The female breast is frequently the seat of *tumors*, so frequently that we shall describe them briefly, although they have generally been removed by the surgeon before the patient comes to the autopsy table.

(*a.*) *Carcinoma* is the most common as well as most important, and may be divided into three forms according to the relative proportion of stroma and cells. These forms are: hard cancer or scirrhus, soft or medullary cancer, and mucous or colloid cancer, which latter occupies an intermediate position between the other two. The general characters of these forms both to the naked eye and microscopically have been already described, so we shall here confine ourselves to a few details. Cancer of the breast has the peculiarity that its cells (which are very small, especially in the scirrhous variety) are very prone to undergo fatty degen-

eration; this is shown by yellow spots, and a reticulated appearance, which has given rise to the term "reticulated cancer." The scirrhous variety rarely attains great size. Contraction may take place in the stroma, and thus bring about fatty degeneration and atrophy of the cells (atrophic cancer) and partial arrest of the growth. There is, indeed, no well marked dividing line between the scirrhous and the medullary varieties. The same growth may be scirrhous at its centre and medullary at its periphery; and secondary formations from a hard cancer may be much softer than the primary growth.

Mammary cancer is generally primary and unilateral; it may, however, be secondary, and has been known to be primary in one gland and secondary in its fellow. The outward growth of cancer, toward the skin, has been already described; its inward growth, toward the pleura, as also the infection of the glands of the axilla, will be considered in another place.

Epithelioma or *cancroid* is less common in the breast, and may originate in the external integument (pavement-cell cancer) or in the ducts of the glands (cylindrical-cell cancer). Simple hypertrophy or pure *adenoma* of the breast is properly classed under cancer, for the reason that transition forms occupying an intermediate position between the two are sometimes found. This form of growth occurs generally in the form of circumscribed nodules, the structure of which is precisely that of alveolar gland tissue.

(*b.*) *Sarcoma* comes next in importance, and attains a large size oftener than carcinoma. Both varieties occur, the spindle-cell and the round-cell, and often stand in a peculiar relation to the glandular tissue. The cut surface has neither a homogeneous nor yet a fibrous appearance, as is usual in the sarcomata, but looks very like a cross section of a cabbage head, presenting peculiar indented lobe-like masses which are surrounded by fissures or clefts. Cysts which are otherwise scarcely appreciable can be brought to view by extracting these masses. Sections with the double knife show

that the more minute resembles the gross structure, in that wart-like or papillary growths project into and distend the ducts. The surface of all these growths is invested with a layer of cylindrical epithelium, a proliferation of that belonging to the ducts. This form of *cystic sarcoma* or *cystosarcoma proliferum* is very often combined with other forms, and especially with mucous tissue, forming *myxosarcoma.*

(*c.*) *Fibroma* also occurs in the breast (*cystofibroma*), though in smaller nodules: it is easily recognized by its toughness and peculiar striated appearance.

(*d.*) Other tumors are rare, with the exception of *hyperplasia of the fatty tissue*, which may be either independent or secondary to carcinoma, and particularly the atrophic form of that affection.

The axillary lymphatic glands participate so often in affections of the mammary gland, and especially in the carcinomatous affections, that they may be examined now as well as later. They are most easily reached by an incision in the axilla in the direction of the arm, but if one is unwilling to make a fresh incision they can be reached by dissecting the skin off still farther, particularly the skin above the clavicle. When they are the seat of cancer they are more or less enlarged, have lost their normal structure in whole or in part, and yield a milky fluid when compressed.

2. INSPECTION OF THE ABDOMINAL CAVITY.

When the examination of the soft parts has been completed the wall should be everted on either side, and the contents thus exposed to view. Unless there is some special reason for examining these first, as in medico-legal cases in which it is suspected that the cause of death may be found in the abdominal cavity, the next step in order is to open the thorax. Before doing this, however, a *general inspection* of the abdomen should be made with reference to the position and color of the organs, especially in so far as the latter is dependent on congestion or its opposite — and the presence of any abnormal contents noted, inasmuch as the position of

the organs is modified by opening the thorax, and blood or other fluid is liable to find its way from one cavity to the other.

(*a.*) *The Position of the Abdominal Organs.*

From the fact that the *liver* and the *stomach* are the organs which are most liable to undergo changes of position during the progress of the autopsy, they should receive special attention. The left border of the liver reaches nominally into the left hypochondrium, but may extend pathologically far under the left ribs and even beyond the spleen. The relation of the anterior border of the margin of the ribs is very important: it generally coincides with the margin of the ribs, though it very often reaches two to five centimeters below this in the mamillary line. The left lobe of the liver usually covers up the pyloric end of the stomach completely. Pathological changes in the position of the stomach will be spoken of in connection with that organ.

The displacements to which the *intestine* is subject are very numerous and differ greatly in importance. The coils of the small intestine in whole or in part, are specially liable to displacement, being found sometimes in the pelvis and sometimes in either the right or left side of the abdominal cavity. The transverse colon is sometimes depressed in the form of a loop, which may extend even into the pelvis, and the sigmoid flexure may reach to the right side of the abdomen, or, if the mesentery be very long indeed, to the liver.

Of far more importance are *herniæ* or *ruptures*, those malpositions of larger or smaller portions of the intestines, and particularly of the small intestines, which are enclosed in a pouch of peritoneum. The most common form of these is *inguinal hernia*, generally divided into *external* or *indirect*, and *internal* or *direct*. In the former the coil of intestine lies in the inguinal canal, in the latter it perforates the abdominal wall. They are more simply distinguished by their anatomical relations to the deep epigastric artery; the *external* lying outside of the artery, and the *internal* inside

towards the median line. If the sac of an external inguinal hernia end within the inguinal canal, it is called *hernia of the spermatic cord* or *bubonocele;* if it extend into the scrotum, it is called *scrotal hernia;* if the tunica vaginalis remain patent so that the testicle occupies the extremity of the sac, it is called *congenital hernia.* A hernia may consist of intestine alone, *enterocele;* of omentum alone, *epiplocele;* or of both combined, *entero-epiplocele.*

All the other forms of hernia are much less common. In *femoral hernia* the sac is contained within the sheath of the femoral vessels, and comes out below Poupart's ligament. We shall content ourselves with simply mentioning the *obturator*, *ischiatic*, and *umbilical* varieties, as well as that which issues through the linea alba and is called *epigastric* or *hypogastric*, according as it is seated above or below the umbilicus. In these latter varieties, and particularly in the umbilical, the sac may contain other organs — the liver, for instance. *Diaphragmatic hernia*, so called, is very often not a true hernia at all, but a mere dislocation of abdominal organs without a peritoneal sac into one or the other pleural cavity. The opening in the diaphragm is generally closed on the right side by the liver, a portion of which may project into the pleural cavity, but if the defect be on the left side, this cavity may contain the stomach and spleen in addition to coils of intestine, etc. Such defects may be either congenital or the result of injury, and the former variety possesses some medico-legal interest, from the fact that children who are the subjects of it generally die almost immediately from suffocation.

We now come to a class of malpositions which is of very great importance, and not infrequently proves directly fatal; we refer to twists and invaginations. *Twists* — the condition has received the name of *volvulus* — are chiefly liable to occur in a small intestine with a very long mesentery, and in the sigmoid flexure; when they occur in the latter, not only is the mesentery apt to be very long, but the two arms of the coils are usually attached near together to the abdom-

inal wall. *Invagination* or *intussusception* results when a portion of intestine — generally the small — becomes introverted into a lower portion — generally the large — in such a way that three separate layers of intestine lie one within another. The outer and middle layers have their mucous surfaces, the middle and inner their serous surfaces in apposition. The mesentery is, of course, also carried in with the intestine, and is thus put tightly on the stretch. In recent cases the invagination can be reduced by drawing on the mesentery, but if the condition be of some standing, reduction is prevented by adhesions between the opposed surfaces. It is not every invagination which has pathological significance. In children it is not uncommon to find a single or even several invaginations, the trifling extent of which and the entire absence of any secondary change, even hyperæmia, show that they must have taken place during the agony. Their presence shows that violent peristaltic action took place shortly before, and at the time of death.

The importance of all these malpositions lies in their tendency to narrow the capacity of the intestinal canal and thus obstruct the passage of its contents. The same result may, however, ensue on some other and still rarer malpositions; as, for instance, when coils of intestine become displaced into pouches of peritoneum within the abdominal cavity (the cavity of the lesser omentum, fossa duodeno-jejunalis, fossa subcœcalis), into holes in the great omentum or mesentery, or between peritonitic adhesions, etc. Whenever symptoms of intestinal obstruction have been present during life the intestine itself and its position must be examined minutely and carefully, since the seat of obstruction is often very difficult to find.

In this connection we will also mention that rare condition, *transposition of the viscera*, in which the position of all the organs is laterally reversed.

(*b.*) *Color of and Amount of Blood in the Presenting Parts.* The *color* depends chiefly on the *amount of blood*, and in order that we may be enabled to inspect the whole

small intestine from every side, it must be raised out of the true pelvis. This is best done as follows: the right hand, with its palmar surface toward the pelvic wall, should be introduced into the pelvis on a level with the cœcum, the thumb, meanwhile, remaining outside to the right of the root of the mesentery; the fingers are then to be passed over to the left side of the vertebral column between the rectum and intestines and the whole hand passed up the vertebræ until the entire mesentery lies between the thumb and fingers. The small intestine can then be removed from the pelvis and examined thoroughly with ease.

The most dependent coils show evidences of passive congestion in proportion to the degree of general congestion or anæmia.

(*c.*) *Abnormal Contents.*

It is necessary to remove the small intestine from the pelvis for the additional reason that any abnormal contents are most likely to be found in this part of the abdomen, though one must not neglect to examine the hypochondria as well.

If abnormal contents are present their *quantity* is to be noted, and, if it seem desirable, measured. So also their *color*, pale yellow, icteric, reddish, milky, brownish, etc.; their *consistency* — watery, semi-fluid, pultaceous, firm, etc.; and their *admixture*, — clear, containing large or small flocculi, blood, etc.

1. It is very important to distinguish between simple serous *transudation* and inflammatory, sero-fibrinous *exudation*. The presence of pus or large quantities of fibrine point to exudation, but it is not so easy to determine the character of a fluid which contains small flocculi. The question is in such a case whether these flocculi are fibrine or only shreds of free endothelium such as are found also in transudations. *Flakes of fibrine* are generally larger and thicker, more or less opaque and grayish-white in color, while *shreds of endothelium* are thin, of a transparent gray color, and often are not distinct until the fluid is examined by transmitted light of moderate intensity. The microscope shows the former to

consist of delicate fibrils which become greatly swollen on the addition of acetic acid, while the latter are found to consist of a membrane composed of closely apposed flat cells with large nuclei and nucleoli and perhaps large numbers of fat granules.

2. *Purulent* exudations are of a yellow color and are fluid; *pyo-fibrinous* exudations are yellow and soft in proportion to the amount of pus they contain, and usually assume the form of membranes covering the peritoneal surface. *Fetid* and *fæcal* exudations are betrayed by their odor and dirty brownish or gray color. The microscopical examination presents no difficulties. In the latter form great numbers of bacteria or fæçal matter are always found. In the exudation of *puerperal* peritonitis great numbers of micrococci are always found, which may be joined together in the form of a long rosary, and the pus corpuscles are in process of fatty degeneration.

3. A red color may be imparted to the fluid either by the blood disks or by the coloring matter of the blood. A distinction is easily made with the microscope, but may also be generally made with the naked eye. Uniformity in color and the absence of even the smallest coagula indicate the coloring matter of the blood; all the more if the color of the fluid does not change on standing, inasmuch as the blood disks always sink more or less to the bottom, which therefore becomes of a deeper shade than the upper portions.

Hæmorrhage into the abdominal cavity may be inflammatory or non-inflammatory. The latter is usually the result of injury but may depend on other causes — spontaneous rupture of the spleen, for instance. Hæmorrhagic, inflammatory exudations, on the other hand, show that inflammation has existed for some time or else is recurrent, and are very apt to be associated with tubercular and carcinomatous processes.

4. When particles of *undigested* or *semi-digested food* are found in the abdominal cavity the greatest care should be used in order to determine whether an ulcerative process or

the so-called *post-mortem digestion* has perforated the wall of the stomach.

5. Small lipomata, fibromata, and chondromata are sometimes found as *free* bodies in the abdominal cavity, having become detached from the wall of the intestine (appendices epiploicæ), and sometimes entozoa, particularly the lumbricus, escape through a perforation.

Before closing these remarks on the contents of the abdominal cavity — and they apply equally to all serous cavities — we will mention the peculiar *slippery* feel, which indicates a diminished secretion from the peritoneal surface, resulting from disordered circulation in general and obstruction to the venous current in particular. It is most marked in cholera, and is due to the presence of a large amount of albumen in the fluid, causing it to become frothy when intimately mixed with water.

(*d.*) *Position of the Diaphragm.*

The preliminary examination of the abdominal cavity is closed by the determination of the *position of the diaphragm.* This is to be done by introducing the right hand, with its palmar surface outwards, under the margin of the ribs as far as the highest point of the diaphragm, the finger tips then being pressed against the corresponding portion of the abdominal wall. It is well always to take the measurement in the line of the junction of the costal cartilages with the ribs, if possible, for the sake of a standard of comparison. The normal position of the highest point of the diaphragm in this line on the right side, on account of the presence of the liver, will be found at the fourth rib, or the fourth intercostal space, while on the left side it is at the fifth rib. If the contents of the abdomen are greatly increased in volume, the vault of the diaphragm may rise as high as the second rib or even higher, and on the contrary an increase in the thoracic contents may depress the diaphragm more or less, and even invert it. It cannot always be determined with absolute certainty whether the low position of the diaphragm is due to enlargement of the lungs or to abnormal accumu-

lations in the pleural cavity, though if fluctuation can be obtained fluid must be present. Depression of the diaphragm when due to diseases of the heart or pericardium is generally more or less local.

In new-born children who have never breathed, the usual position of the diaphragm is at the fourth rib on the right side and the fifth rib or fourth intercostal space on the left; if respiration, however, has taken place it is at the fifth or sixth rib on the right and the sixth on the left.

(*A.*) THE THORACIC CAVITY.

Before the chest is opened it should be inspected from the outside.

1. INSPECTION OF THE THORAX.

(*a.*) *Enlargement* may be brought about by many different affections, and may be general, unilateral, or circumscribed. General enlargement is found in emphysema, and unilateral enlargement may depend on an accumulation of fluid alone, or of fluid and air together. The chest may undergo a general diminution in size, on the other hand, in chronic phthisis, the contraction being more marked at the apex and the clavicles being very prominent. Chronic pleurisy, and still more frequently empyema, often give rise to unilateral contraction or even incurvature. There is a peculiar deformity called *pectus carinatum* or *pigeon-breast*, which consists in a great prominence of the sternum with trough-shaped depressions at the junction of the ribs with their cartilages. It is usually — in children always — the result of rachitis, but in adults may be due to osteomalacia.

(*b.*) *Sternum and Ribs.*

1. The *sternum* presents occasionally curvatures and indentations varying in degree, which may depend on a deviation from the perpendicular in the skeleton as a whole, or be due to the occupation of the person (shoemakers, etc.). Congenital defects in the bone also occur, and may assume the form of genuine fissures, or, what is more common, of small

round holes in the median line, which are sometimes multiple. The ensiform cartilage is very often cleft and hence double.

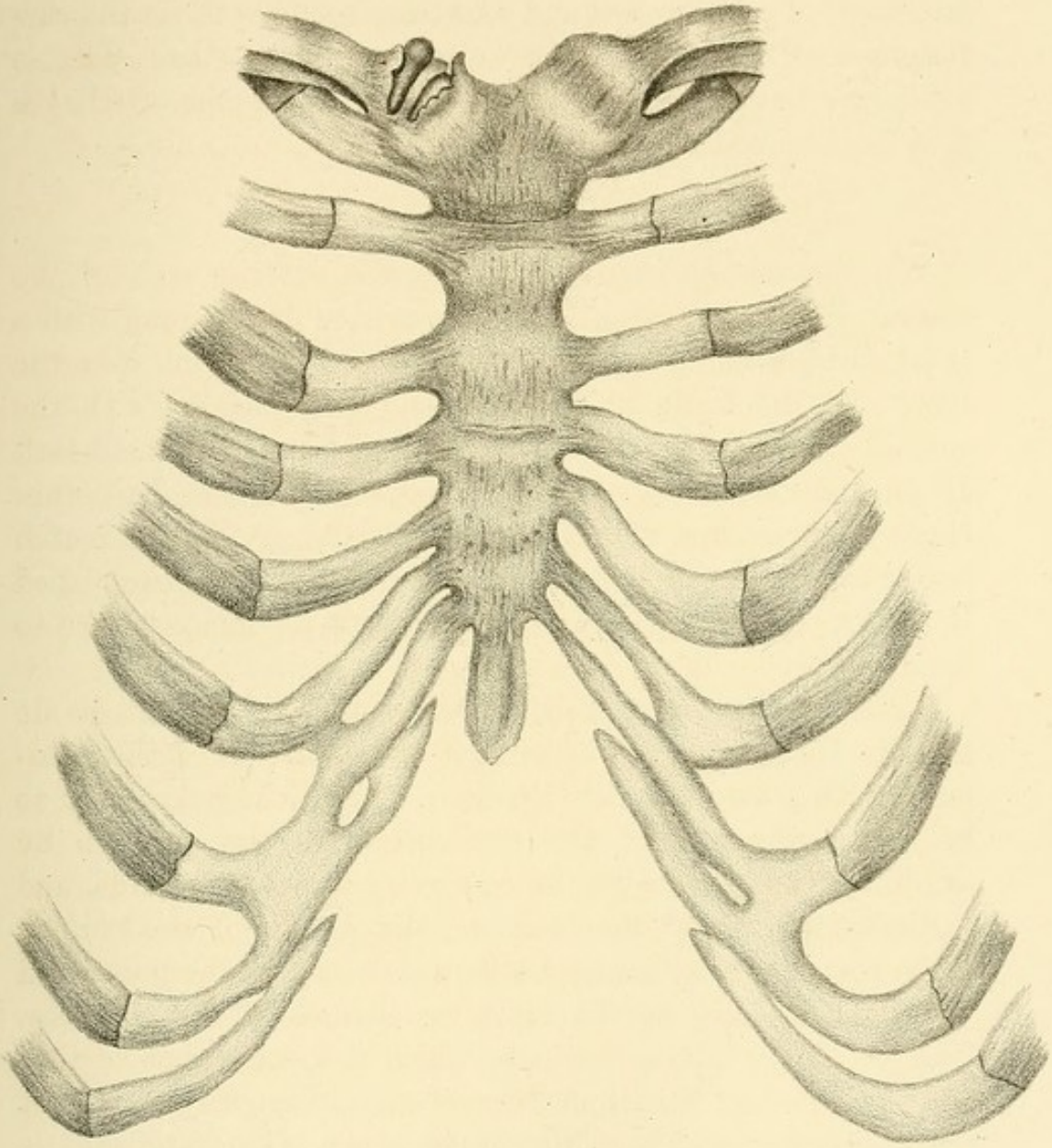
2. The *ribs* are not infrequently the seat of congenital fissure which may involve the cartilage alone, the bone alone, or both at the same time; the second is perhaps the most frequent. Ecchondroses and exostoses occur both on the cartilages and bones and may unite contiguous ribs. This is often the case after fractures. Fractures of the cartilages may heal by either bony or fibrous union.

2. OPENING THE THORAX.[1]

We can now proceed to remove the anterior wall of the chest. The cartilages of the ribs are to be divided with a stout knife a few millimeters from their insertions into the bony ribs, the knife being kept as nearly parallel with the surface as possible to avoid injuring the lungs or the heart. If *pneumo-thorax* be suspected it should be noticed whether there is any escape of gas at the first cut. A lighted match held over the opening will either flare up or be extinguished if gas is present, and its escape can thus be demonstrated to lookers on.

If the cartilages have become *calcified*, it is better to divide the ribs themselves just outside of the insertion of the cartilages with a saw or bone-nippers. The clavicles are then to be disarticulated from the manubrium of the sternum by semilunar incisions with the convexity directed inwards, and in the latter part of the incisions the handle of the knife is to be somewhat depressed backwards to avoid the lower and inner prominence of the articular surface of the clavicles. The cartilage of the first rib, which lies somewhat farther from the median line than those of the other ribs on account of the greater width of the upper piece of the sternum, is then to be divided with the knife, or, if ossified, with the forceps. If the knife be used its point should be inserted vertically into the first intercostal space close up to the cartilage and the handle then depressed. If this be done carefully injury to the subjacent great vessels may be avoided.

[1] See Plate.



The attachments of the diaphragm, which are included between the two great lines of incision, are then to be severed close to the false ribs and the ensiform cartilage, and the sternum being drawn strongly upwards, the mediastinum is separated from the bone by transverse cuts, great care being taken not to injure the pericardium and great vessels. In case, however, the vessels should be cut, they must be immediately tied, or, at all events, closed with a sponge, to prevent the escape of blood into the pleural cavity.

3. THE INNER SURFACE OF THE BONE.

(*a.*) The chief affections of the inner surface of the sternum are *caries* and *erosion* (fibrous atrophy). The former is usually of a tubercular character, and starts from cheesy mediastinal lymphatic glands, while the latter is often the result of pressure of an aneurismal tumor, and may go on to perforation. The *marrow* of the sternum can be exposed by a longitudinal incision; it is of a red color even in adult life, and often presents leucæmic, tubercular, and other changes, identical with those found in the bones of the extremities.

(*b.*) The portions of the *ribs* which contain the centres of ossification, are decidedly enlarged and swollen in rickety children, and these swellings, taken all together, form what has been termed the *rosary of rickets*. On cutting into these enlargements they are seen to consist chiefly of a soft, gray tissue, into which the normal, milk-white, hyaline cartilage has been converted, and, instead of the narrow, white line which normally exists close to the bone, a broad, irregular, and indented stripe is to be seen. In longitudinal sections, prepared for the microscope, and examined in a solution of common salt, or, still better, in iodine, very marked hyperplasia of the cartilage cells is seen, and both the cells and the intercellular substance are more transparent than in the normal condition. The zone of ossification between the enlargements and the bone (normally very narrow and with perfectly even edges) is converted into a broad, usually,

though not necessarily, calcified, layer, with irregular projections into the cartilage. Great numbers of medullary spaces and vessels, both of which are here entirely out of place, are seen to have made their way from the medullary spaces of the bone far into the cartilage.

Caries of the ribs as well as of the sternum, may also be found, and often takes its origin from inflammations of the pleura.

This seems a suitable place for a brief description of the changes which take place in the costal cartilages as age advances. These changes can be studied to great advantage in fresh sections, and are typical of pathological processes of great importance.

The cartilage early acquires a brownish shade which becomes gradually deeper, and is due to a finely granular opacity of the intercellular substance; the cells are enclosed in a thick capsule, which is often seen to consist of several layers, and to show active proliferation. Here and there the naked eye can discern small spots with a lustre like that of asbestos, in which the intercellular substance has undergone fibrous degeneration, while the cells have increased greatly in numbers, and form large, elongated masses. This fibrous degeneration of the intercellular substance is the forerunner of mucous degeneration of the same, and the last change is calcification, which also takes place in small spots appreciable to the naked eye; these differ from the spots of fibrous degeneration in being hard and of a chalky whiteness. The microscope reveals the presence of very minute collections of lime salts which are black by transmitted and white by reflected light, are readily soluble in hydrochloric acid, and appear first at the extremities of the somewhat elongated capsules, and later completely fill the cells.

(*c.*) The *sterno-clavicular articulation* is often the seat of chronic rheumatic arthritis, and often of purulent (metastatic) inflammation, with caries of the articular ends. The *clavicle* should also be examined for fractures, whether recent or old, tumors, etc.

4. INSPECTION OF THE THORACIC CAVITY.

(*a.*) After the sternum has been removed, the *degree of distention* and *general appearance* of the *lungs* as far as exposed, should be noted. Healthy lungs collapse from their inherent elasticity when the thorax is opened. They may, however, be prevented from collapsing by loss of elasticity, by inflammatory adhesion to the chest wall, by the presence in the alveoli of solid or liquid substances, or by pent-up air — as in stenosis of the larynx or trachea.

Complete distention of the lungs, as seen in those dead of drowning or suffocation, is very characteristic. The *color* of the lungs depends on the amount of pigment (carbon) they contain in the first place, and in the second on the amount of blood and the presence of certain pathological products.

(*b.*) The condition of the *pleural cavity*, and the presence of any *abnormal contents* (the description given in connection with the abdominal cavity applies also here) are then to be noted. If, as is so very often the case, the pleural surfaces be united by inflammatory adhesions of connective tissue, these should be torn if of moderate extent and toughness, for it often happens that they cover an exudation in the inferior and posterior portions of the cavity. If, however, the adhesions are very extensive and tough, as they become with age, it is better to postpone further manipulation until, after having removed the heart, the lungs are removed in their turn. The mediastinum should also be examined, including the thymus gland, and the external appearance of that portion of the great vessels which lies without the pericardium; the degree of fullness of the veins should also be noted, but the vessels must on no account be opened as yet.

5. THE MEDIASTINUM AND ITS CONTENTS.

(*a.*) Artificial *emphysema* of the connective tissue of the mediastinum is very apt to be caused by the removal of the sternum, and is chiefly marked over the heart, while patho-

logical emphysema, from rupture of the pulmonary tissue, is generally found higher up, and very often extends into the neck. *Hæmorrhages*, apart from those of traumatic origin, are found in this situation in phosphorus poisoning, acute yellow atrophy of the liver, etc., in great number. *Suppurative inflammation* sometimes extends from the neck hither. Clinical observers have of late had their attention directed to *chronic inflammations* of this part (mediastinitis chronica fibrosa), leading to fibrous thickening, induration, opacity and whiteness of the connective tissue.

(*b.*) A *cheesy* (tubercular) condition of the **lymphatic glands** of the mediastinum is not infrequently met with in adults, but is still more common in children.

(*c.*) The **thymus gland** attains its full development at the end of the second year, and then begins gradually to disappear, though it may persist to the thirtieth year, or even longer. In still-born children it often contains numerous hæmorrhages. Suppurative inflammation (syphilitic?) and cheesy degeneration are very rare. This gland is sometimes the starting point of large nodulated tumors which resemble the lymphatic glands in structure, and may occupy the whole mediastinum, or even extend above the sternum (*lymphosarcoma thymicum*).

6. THE PERICARDIUM.

To open the pericardium a longitudinal fold should be raised at the middle point of the anterior surface and a small incision should be made through its left side. Two fingers should then be introduced into the cut, and, just as in opening the abdominal cavity, it should be prolonged between them as far as the diaphragm, first downwards and to the left, and then downwards and to the right. The last step in opening the pericardium is to draw the right border of the first cut forwards and then to carefully prolong the incision upwards as far as the point of reflection from the great vessels.

If the sac contain much fluid it is better to scoop this out before making the last incision, which would allow its escape

and thus render accurate quantitative determination impossible. As a rule, however, it is better to wait till the sac is completely opened before the fluid, which normally never exceeds a teaspoonful, is removed. The fluid collects chiefly behind the heart, and to reach it the apex of the organ should be raised.

(*a.*) *Contents.*

What was said in connection with the contents of the peritoneum holds good here also, but there are a few special points to which we shall refer. Though normal pericardial fluid never contains flakes of fibrine, it may coagulate on exposure to the air, so this fact alone should not induce one to diagnosticate inflammation. *Hæmorrhage* in the pericardial as in the peritoneal sac may come either from the great vessels, from the heart, or from newly formed vessels of inflammatory origin. In the latter case the blood is mingled with the fluid of exudation, while in the former it is coagulated in large masses which may completely envelop the heart. Fluid blood is never the result of simple hæmorrhage, but depends on injury, spontaneous rupture of the heart, or some other condition which will be revealed during the subsequent examination.

(*b.*) *Morbid Conditions of the Pericardium.*

The most important of these are those due to —

1. *Inflammation.* Simple fibrinous inflammation may be attended with the formation of a dry exudation small in quantity (*dry pericarditis*), or of an abundant sero-fibrinous exudation (*sero-fibrinous pericarditis*). The first may be hard to observe; the second is always easily recognized. In the first form the membrane is generally much reddened, especially in the transverse furrow where minute hæmorrhages may be found, and its surface has lost its lustre and become opaque, as may be best seen by oblique light.

When the effusion is slight, the fibrinous layers often have a very characteristic form in consequence of the cardiac movements. Warty and villous projections of varying height lie upon the surface, especially upon that of the posterior

wall of the right ventricle; ridges are also prominent, especially in front over the origin of the pulmonary artery. This condition is so peculiar that it has given rise to the term *cor villosum.*

Suppurative pericarditis is less common, and if it cannot be attributed to injury, suppurative mediastinitis, caries of the ribs, or gangrene of the lung, when the pus is often fetid, is very apt to be of metastatic origin. In many cases we may be able to discover on either the parietal or visceral (epicardium) layer the point from which the process started, in the form of a circumscribed patch of more intense inflammation, or perhaps of an actual necrosis.

The pericardium, normally, is a thin and perfectly transparent membrane, but is often the seat of a more or less circumscribed thickening and milky opacity, the result of circumscribed *chronic inflammation:* such spots are not of great importance. Sometimes, precisely at these spots, the remains of old and more intense inflammation are found in the form of *fibrous adhesions* between the two layers of the membrane, but these are not nearly so common as in the pleural cavity; or the layers may be closely united over a considerable, or even the whole, area (*obliteration* of the cavity), at times to such a degree that they cannot be separated. If a *fibrinous* or *purulent* exudation preceded the formation of adhesions, it may have become wholly absorbed, or portions may have become cheesy and calcified, and thus persist as cheesy and cretaceous nodules, or bone-like masses in the midst of the fibrous adhesions.

2. *Tubercles* are very often found in connection with these remains of former inflammation, and are apt to be imbedded in the adhesions (*pericarditis fibrosa tuberculosa*). In general tuberculosis the tubercles may exist without giving rise to inflammation (*tuberculosis pericardii*), in which case the tubercles are usually scattered along the course of the vessels, but they may also be associated with fibrinous, hæmorrhagic inflammation. In the latter case they may be completely hidden by masses of fibrine, which should therefore always be

detached at several points and the condition of the subjacent membrane examined. The occurrence of tubercular pericarditis in old people without the existence of any discoverable cheesy focus deserves special mention. Cheesy nodules of tubercular character rarely attain great size in this situation.

3. Secondary nodules of carcinoma, sarcoma, etc., are quite rare in this locality.

(*c.*) *Changes in the Subpericardial Fatty Tissue.*

The *subpericardial fatty tissue* varies widely in quantity and is not always proportional to the panniculus adiposus. In cachectic states it is found to have undergone a peculiar change, being transformed into a soft transparent and gelatinous mass, which shows a whitish opacity on the addition of acetic acid, and under the microscope is seen to consist of a transparent finely fibrillated substance which reacts like mucine and in which are imbedded large cells containing either fat drops or serous fluid (*mucous metamorphoses*). Small *lipomata* are sometimes found, especially toward the apex. Special medico-legal interest attaches to the presence of small hæmorrhages into this tissue, the so-called *subpericardial ecchymoses.* They are most common at the base and on the posterior wall, and are very liable to occur in death from suffocation.

7. THE HEART.

(*a.*) *External Examination.*

Before any incision is made into the heart or it is removed from the body, its position, size and form, color and consistency (whether contracted or not) are to be noted, as well as the degree of fullness of the coronary vessels and of the individual compartments (auricles and ventricles) of the heart.

1. The heart may be pushed out of *position* by pleuritic effusion, etc., or it may be hypertrophied and its boundaries thus changed. The position of the apex is an important indication and is not infrequently found to be in the axillary line.

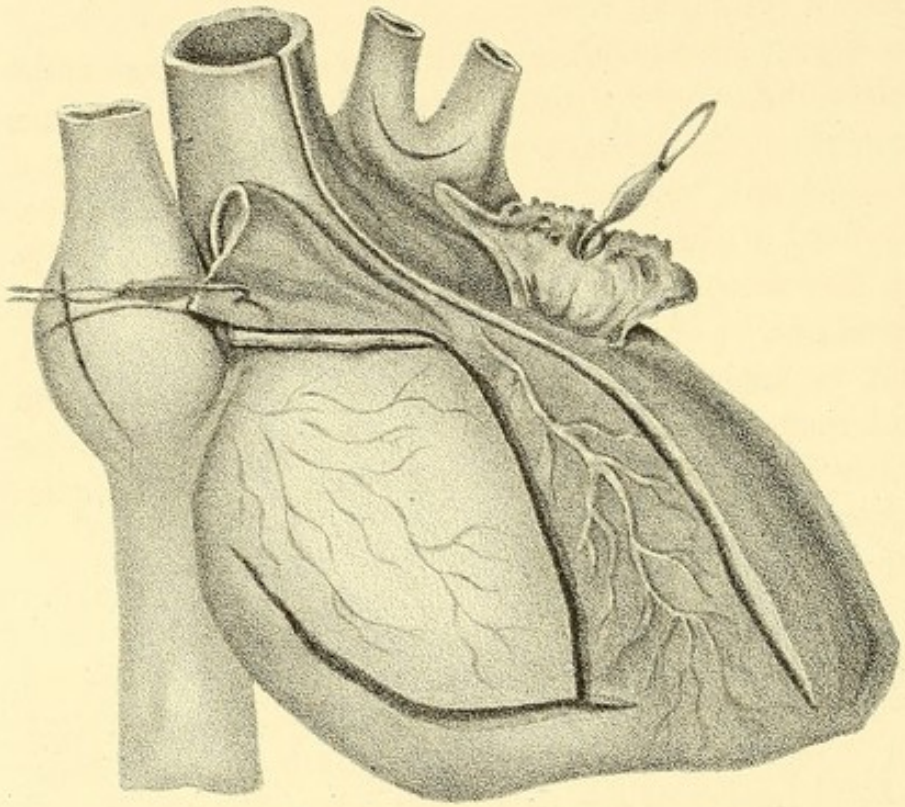
2. The closed fist of the right hand is a very good standard of comparison for the *size* of the normal heart. Bizot has found the average dimensions between the ages of twenty and sixty years to be as follows: length, 85–90 millimeters in the male, 80–85 mm. in the female; breadth, 92–105 mm. in the male, 85–92 mm. in the female; thickness, 35–36 mm. in the male, 30–35 mm. in the female. The size is diminished, sometimes excessively, in all cachectic diseases, and often in chronic pericarditis with abundant effusion; it is increased in diseases of the heart itself as well as in those of other organs, such as the lungs, kidneys, aorta, etc.; when due to diseases of other organs the enlargement is usually partial.

3. Alteration in *form* depends generally on enlargement predominating on one side or the other. In enlargement of the left ventricle the organ is elongated and relatively narrow, conical or cylindrical; while in enlargement of the right ventricle the chief increase is in the transverse diameter. The formation of the apex affords a good indication of the presence or absence of enlargement of the right side. In the normal heart the apex is formed solely by the left ventricle, but when the right ventricle shares in its formation an enlargement has taken place. A depression of greater or less depth is sometimes met with between the apices of the ventricles as a congenital deviation from the normal form.

4. The *color* of the heart's surface depends largely on the condition of the pericardium and its subjacent fat. The auricles are dark blue in color, especially when distended with blood; but the color of the ventricles depends in great measure on the condition of the muscular substance, which will be considered later.

5. The *consistency* of the different portions depends chiefly on the degree of muscular contraction, but in a measure also on the amount and character of their contents. In simple contraction nothing like a cavity can be felt through the muscular wall, while in simple distention the contents always yield somewhat to pressure.

6. The *coronary arteries* and *veins* are readily distinguished



from each other by the difference in the thickness of their walls and in their course. Marked distention, particularly of the larger veins, points to an impeded flow of blood from the right auricle (suffocation, etc.), provided that such distention be not confined to the posterior surface of the organ (hypostasis), while an almost empty condition may depend on general anæmia or on calcification or endarteritis of the coronary arteries. These latter changes may often be recognized externally by the rigidity, hardness, and whitish-yellow color to which they give rise.

7. The *degree of distention* of *individual portions* of the heart is often indicated by the external shape. If the surface be flat or sunken, the contents must be small in amount, but if it be convex and tense, the contents must be considerable. The right heart is abnormally distended in death from suffocation in its various forms; the left heart in death from cardiac paralysis.

In order to determine the *quantity* and character of the blood contained in the individual cavities, they must be opened while the heart still remains connected with its natural attachments.

(*b.*) *Opening the Heart in situ.*[1]

To open the right side the left hand should be so placed under the posterior surface of the organ that the forefinger lies in the transverse furrow, and the thumb a little behind the sharp right border of the right ventricle. By now drawing the heart somewhat downwards and to the left, and making it tense over the left forefinger, the points at which the venæ cavæ empty into the auricle are brought into view. The incision into the auricle should begin between the cavæ, be prolonged as far as the transverse furrow, there intermitted for the space of about one centimeter, in order to avoid the tricuspid valve, and then again continued in the same direction as far as the right border of the right ventricle, but not prolonged as far as the apex on this side, the apex being

[1] See Plate.

normally composed entirely of the left ventricle. After removing and examining the contents of the auricle and then of the ventricle, two fingers of the left hand should be introduced from the auricle into the tricuspid valve, which should be large enough to allow the introduction of still a third finger between the other two. The left ventricle should then be grasped in the left hand in such a way that the apex lies in the fold between the thumb and forefinger, the first on the posterior, the second on the anterior surface of the heart; or else the organ may be taken in the palm of the hand with the thumb on the anterior and the fingers on the posterior surface, drawn downwards and to the right, and an incision made into the auricle in the upper of the two left pulmonary veins, which are thus clearly brought into view. At the transverse furrow the cut should be interrupted and then continued again at the left border as on the right side, except that here it is to be prolonged as far as the apex. The contents of the cavities should then be examined, and, after having overcome the rigor mortis, the size of the mitral valve is determined. This should admit two fingers with ease.

(*c.*) *The Blood.*

The changes undergone by the blood are some of them gross, some microscopic; some depend on quantitative or qualitative modifications in the constituents of the blood, others on pathological admixtures with other substances. The latter, as a rule, cannot be recognized without the aid of the microscope.

1. *Coagulation* is subject to the greatest variations, since the blood may be found in any condition between the extremes of entire fluidity, and coagulation into very dense and firm masses of fibrine, containing scarcely any red corpuscles (polypi of the heart). The presence of *firm coagula of pure fibrine*, particularly when they are attached to the wall of the heart, indicates that death came on so gradually (the action of the heart growing weaker and weaker) that the fibrinous portion of the blood was deposited by degrees on the walls,

while the corpuscles were still kept in circulation. Fibrinous coagula may, however, also occur in consequence of the presence of an increased amount of fibrine in the blood; as, for instance, in acute inflammatory affections. In this case the fibrinous masses are not so strictly limited to the walls, but all the clots contain large quantities of this substance. The amount of fibrine, moreover, varies somewhat with the situation of the clot, even when the blood, as well as the coagulation itself, is perfectly normal. The clot which occupies the conus arteriosus of the right ventricle and the commencement of the pulmonary artery is almost always very rich in fibrine. Firm and voluminous coagula are often marked with moulds of the inequalities of the wall — the sinuses of Valsalva, the musculi pectinati, etc.

Coagulation may be *incomplete* or *entirely wanting*, in consequence either of diminution in the amount of fibrine (hypinosis), as in dropsical blood, or of the presence of certain substances which prevent coagulation, the first place among which belongs to carbonic acid. All processes, therefore, which overload the blood with carbonic acid diminish or prevent coagulation; such are all affections which end in suffocation, as well as those where death is directly dependent on closure of the air passages from without.

2. Another peculiarity of the blood in these cases is its dark *color*, though the distinction between arterial and venous blood gradually disappears after death, and the blood of the pulmonary veins even becomes dark (venous). In cases of poisoning with carbonic oxide gas, the hæmoglobine unites with the gas and imparts a bright cherry-red color to the blood.

Decomposition brings about marked changes in the color of the blood. The coloring matter leaves the solid constituents and is taken up by the serum, the color becomes indistinct and dirty, and on standing, the superficial layer of clear serum which is formed in healthy blood does not appear. The microscope shows that the red blood disks have lost their color, and have become converted into pale globular bodies, which float in a yellowish-green fluid.

3. *Changes in the composition* of the blood also produce a varying appearance. These are due to deviations from the normal proportion between the blood corpuscles and the serum on the one hand, and the red and white corpuscles on the other. If the serum is diminished, the blood becomes thick, even resembling tar, as in cholera; if increased, the blood becomes watery or *hydræmic*, as in some affections of the heart, lungs, kidneys, and liver. A similar effect may be produced by a diminution of the cellular elements, either of both together or of the red alone, but in this case the blood mass is diminished, while in hydræmia it is increased. In either case the blood is pale in color. In no affection are the cellular elements so much diminished as in pernicious anæmia, so called, in which disease the blood in many situations may resemble a faintly colored serum.

Increase in the white corpuscles causes still other modifications in the appearance of the blood; this takes place in a moderate degree in the acute inflammatory, infectious, and other diseases, but is most marked in leucæmia. There is, however, more than a mere difference in degree under such circumstances: in the former class of affections the white corpuscles are increased merely (*leucocytosis*), but in *leucæmia* the red cells are also diminished.

The appearance of the white corpuscles themselves is somewhat modified in leucæmia, and indeed in such a way as to indicate their origin. The ordinary white corpuscles consist of a granular protoplasm, the single or multiple nuclei of which come out distinctly only after the addition of water or, better still, of acetic acid. Leucæmic cells, however, are either larger with a single distinct nucleus, — splenic cells, splenic leucæmia, — or else smaller with a very large nucleolated nucleus, and but little protoplasm, — lymph-gland cells, lymphatic leucæmia. In some cases nucleated red corpuscles are found, that transitional form between the red and the white corpuscles occurring normally in the embryo, and which, as has been shown by Cohnheim, is also found in the blood and bone marrow in cases of pernicious anæmia.

In moderate cases of leucæmia the blood is of a light raspberry-red color, but in very severe cases, and particularly at the junction of the thoracic duct with the right auricle, it has a yellowish color, and looks not unlike pus. The red corpuscles are then often collected in the form of small red stripes between the pale coagula. The white corpuscles often present a peculiar arrangement in simple leucocytosis, collecting in small groups which vary in size between that of a poppy-seed and that of a grain of millet, but rarely exceed the latter, and may bear a close resemblance to tubercles; these groups are best seen in the coagula from the pulmonary artery, and are found in the very finest branches of that vessel.

4. We now come to the last class of modifications in the blood, those, namely, which are due to its *admixture with abnormal morphological material.*

(*a.*) *Cellular elements* sometimes find their way into the blood. The blood of the splenic vein, and occasionally also that of the peripheral vessels, in typhoid and typhus fever, in particular, often contains white corpuscles in which one or several red blood-disks are imbedded; such cells may also be found in the spleen, lymphatic glands and bone marrow. Fatty degenerated endothelial cells from the walls of the blood-vessels also occur. In those cases in which it can be demonstrated that portions of a morbid growth have been carried into other organs by the blood-current, — as is sometimes the case with the melano-sarcomata, etc., — as well as in those cases in which a soft morbid growth makes its way into the larger veins (sarcoma of the kidney, for instance), cells derived from the growth may possibly be found in the blood.

(*b.*) Two distinct kinds of abnormal *coloring matter* are sometimes found in the blood. In the first place, irregularly shaped granules, which may be reddish or brownish, but are generally almost black, and are evidently derived from the blood-pigment; these are sometimes found in all parts of the body, though chiefly in the blood of the splenic vein, both free in the serum and imbedded in the colorless cells, con-

stituting *melanæmia.* In the second place, the coloring matter of the bile may find its way into the blood, and occur either in solution or in the form of crystals. In solution it is found chiefly in the jaundice of adults, and betrays its presence by imparting the yellow color of bile to the fibrinous coagula. In the form of pointed, acicular, brownish-red crystals of *bilirubine* it occurs as a post-mortem change in the blood in icterus neonatorum, and in the acute yellow atrophy of the liver of adults. In the former case the crystals are often so numerous that their presence may be recognized by the naked eye by the reddish-yellow color which the fibrinous coagula retain even after being thoroughly washed in water.

(*c.*) A milky, opaque condition of the blood is due to the suspension in it of very minute *fat drops*, and is known as *chylæmia.*

(*d.*) Of all the modifications which the blood undergoes, the least understood, and, at the same time, the most important, is unquestionably that which is due to an *admixture with low organisms.* Recent researches leave no doubt whatever that in some diseases the blood contains during life, though to a far higher degree after death, certain low forms of animal or vegetable life. Those organisms which have a thoroughly characteristic appearance can be detected without any great difficulty with very high powers, provided that the layer of blood which is examined be very thin or that the red corpuscles have been destroyed with acetic acid or alkalies. The number of diseases in which these organisms are found is small. During the paroxysms of *relapsing fever* the blood contains delicate, spiral, thread-like bodies (*spirilla*) which move by turning in the direction of their axes and disappear after death. In *anthrax* or *malignant pustule*, a rare affection in the human subject, the blood contains small rod-like bacteridia which are often joined together as long serpentine threads. These are, indeed, not constant, but may be replaced by exceedingly minute spherical bodies (*micrococci*), the detection of which requires very high powers.

They can be easily distinguished from the rod-like bacteria seen transversely, by gently tapping on the cover glass and thus causing movement in the fluid. They lead us to the consideration of a second group of parasites, the certain diagnosis of which is difficult and sometimes, indeed, impossible. It has long been known that extremely minute, spherical granules are found in the blood in health, but in far greater numbers in any or every kind of disease, the formerly so-called *primitive vesicles*. They are to be regarded as in part portions of the red blood corpuscles, in part of the white corpuscles, and again in part as fat molecules resulting from the fatty degeneration of cells. They cannot be distinguished from parasites with certainty, even with the aid of reagents, inasmuch as both show molecular movement. If, however, the micrococci, instead of being isolated, are united in rosary-like chains, their nature is less doubtful. It is true that fat granules may give rise to a similar appearance, but this is very unusual, and fat granules are seldom so uniform in size as micrococci. If, therefore, chains of equally sized spherules are found in the blood, they can be diagnosticated as micrococci with a certainty which is somewhat proportional to their numbers. The most characteristic form in which micrococci occur, is that of large collections or groups in which the separate granules preserve a uniform size and a uniform distance from each other.

Hitherto we have confined ourselves solely to the presence of parasites in the serum of the blood, but many authorities refer to their being contained in the cellular elements. The white corpuscles are so prone to take up all manner of strange substances (granules of coloring matter, etc.) that it is not surprising if they take up these bodies also, but it appears to me very questionable whether the red corpuscles do so. Those irregularities in the outline of the red corpuscles which are due to evaporation and shrinkage may easily be misinterpreted in cases of septicæmia and the like, especially if the edge of the corpuscle lies uppermost and presents these irregularities to the observer, in which case they look like

superimposed minute granules. To avoid this source of error one should always add water to the specimen and thus cause the corpuscles to swell. Micrococci have been found in the blood in the most various diseases, but chiefly in septicæmia, puerperal diseases, diphtheritis, etc. They are, however, not constant even in these affections. The best method of rapidly determining the presence or absence of parasites in the blood is to treat it with acetic acid or a dilute alkali, both of which reagents dissolve the red corpuscles as well as any fibrinous coagula which may have formed.

Decomposed blood always contains all sorts of micrococci, bacteria, etc., and the latter are often in active movement, especially if a slight degree of heat be applied.

(*e.*) Decomposed blood often contains *bubbles of gas* also, sometimes in such numbers as to give rise to a frothy appearance. Air-bubbles in fresh blood, especially when found in coagula, suggest that air made its way into the veins during life.

(*d.*) *Removal and Complete Opening of the Heart.*

The heart is removed from the body by inserting the left thumb into the right and the forefinger into the left ventricle, and then drawing the organ well upwards, the vena cava, pulmonary veins, and both large arteries are severed from below as far from the heart as possible. The possibility of *closure* of the *semilunar valves* should then be tested with water. In doing this, care should be taken that all coagula have been removed from the orifice, and that no tension be exerted on the valves; the heart should, therefore, neither be laid on the hand nor be hung from the attached vessels, but should be held by the auricles in such a way "that the plane of the orifice which is being examined is perfectly horizontal and not distorted in the least." (Virchow.) Care must also be taken to avoid injury to the coronary arteries, through which the water might escape and thus another source of error arise.

After having laid the heart on a dish in the position which it occupies in the body, in order to leave the tricuspid

valve untouched, a cut is to be made from above the papillary muscle, which occupies the anterior wall of the right ventricle, into the pulmonary artery; this cut should be made as far to the left as possible, for the reason that two segments of the valve come together at this point and both may thus be left intact. The cut which lays open the left ventricle is to be begun at the apex, carried along near the septum, and then between the auricle and the pulmonary artery into the aorta. One of the segments of the semilunar valve lies directly in the path of the cut, and hence must unavoidably be divided.

(*e.*) *The Interior of the Heart.*

1. General Appearances.

We are now able to determine the *size of the ventricles* and their relation to that of the heart, as well as the condition of the muscular substance, its thickness, color, consistency, and special affections. The walls of the right ventricle between the trabeculæ are nominally 2–3 millimeters *thick* (the figures are usually rather smaller in the female than in the male), but pathologically may be 7–10 millimeters, or even more in thickness. The left ventricle is nominally 7–10 millimeters thick, but may reach 15–25, or more. The papillary muscles and trabeculæ often, but not invariably, participate in modifications in the thickness of the wall; in case, for instance, of great intraventricular pressure, the papillary muscles are very thin and flattened although the walls are enormously hypertrophied. In estimating the increase or diminution of the myocardium it should be borne in mind that the thickness of the wall affords an indication only of relative, not of absolute, atrophy or hypertrophy. To determine the latter the size of the cavities must also be taken into consideration. In marked dilatation there may be an absolute increase in the muscular tissue, although the thickness of the wall is below the average, and when the wall is thickened, the absolute muscular hypertrophy is greater in proportion to the dilatation. In very anæmic persons in par-

ticular, hypertrophy may be simulated by a simple contracted condition of the muscle; this, however, can be easily overcome and then the real thickness of the wall appears.

The *weight* of the organ affords the most accurate indication of absolute hypertrophy. The average weight in women is 250 grams, in men 300 grams, but pathologically may reach 500–1,000 grams.

The *color* of the myocardium depends greatly on the amount of blood present, but is always of a more grayish-red than the voluntary muscles, and is paler. It may be more or less brownish-red or, even in conjunction with anæmia, simply brown; or it may be more or less yellow, at times almost of the color of butter. This yellow color is not uniformly diffused as a rule, but is apt to be confined to either the outer or inner layers and appears in the form of small specks or intersecting lines, especially in the papillary muscles.

The *consistency* occupies a certain relation to the color, brown hearts being quite firm, while yellow hearts are soft and flabby in proportion to the depth and extent of their yellowness. The consistency also increases as a rule with the degree of hypertrophy, and may become almost like that of a board; this hardness is also associated with rigidity, and a collapse of the walls of the ventricles, particularly of the right, is thus prevented after the heart has been opened. Decomposition renders the muscular substance flabby and imparts to it a dirty red color.

2. Special Morbid Conditions.

(*a.*) *Of the Muscular Tissue.*

Atrophy and *hypertrophy* are the most common pathological conditions.

(*a.*) The commonest form of **atrophy,** again, is that to which the term *brown atrophy* has been applied, and which, as the name indicates, is characterized by a more or less distinct brownish color and a general atrophy of the muscular structure.

Needle preparations show that this discoloration depends on the presence of irregular brownish granules, which are first deposited at the ends of the nuclei (in the muscular corpuscles), and later elsewhere between the fibrils. The broad, dark, transverse striæ which normally limit the territories of the individual cells become very strongly marked in this affection. Brown atrophy appears physiologically with advancing years, and is also associated with all cachexias, whether of phthisical, cancerous, or other nature.

A second form of atrophy is caused by penetration of the external fatty tissue between the muscular layers, on which it exerts a mechanical pressure. In such hearts one is immediately struck with the large quantity of subpericardial fat, which sends out projections of varying width into the muscle, — in the right heart even as far as the endocardium, — thus producing a fatty infiltration. This is the so-called *obesity of the heart.* Microscopic specimens show distinctly that fatty tissue is really present between the muscular bundles, and it is evident that the general color of the heart must become essentially modified in consequence.

This fatty infiltration of the cardiac walls must not be confounded with the third form of atrophy, —*fatty degeneration*, — which differs from the two other forms in being still more limited to individual fibres, and often occurring in hearts which are absolutely enlarged.

Scattered about here and there on the walls of one or both ventricles, and particularly on the papillary muscles, which are chiefly liable to suffer from mechanical pressure, etc., light yellow points may be observed, and also streaks which sometimes form a beautiful network or spotted appearance. These places, when examined microscopically with a low power and transmitted light, appear as black spots ; but with a high power they are seen to consist of large and small highly glistening and dark-contoured globules, the fatty nature of which is demonstrated by their remaining unchanged when treated with acetic acid and the dilute caustic alkalies. The fat drops are found between

the fibrils also, and the transverse striation becomes indistinct in the lower, while it is completely lost in the higher grades of fatty degeneration.

Besides these partial forms, there is also a general fatty degeneration, in which the muscular tissue is of a uniform yellowish color, though rarely of so intense a shade as in the partial form; both forms are not infrequently associated. In the lower grades of the affection under consideration, but especially in partial fatty degeneration with dilatation, in consequence of valvular lesions, etc., the appearances are confined to — or at all events most marked in — the inner layers of the wall; fatty degeneration in the outer layers is always secondary, often associated with pericarditis, and betrays its presence on the external surface of the organ. The higher grades of the process are found in acute yellow atrophy of the liver, phosphorus and arsenic poisoning, pernicious anæmia, etc., and involve the entire thickness of the myocardium more or less uniformly.

There is a peculiar form of fatty degeneration which appears in circumscribed spots of varying size, usually in the left ventricle, and results from changes in the vessels. We do not allude to the local changes which are brought about by septic emboli, to be described in another place, but refer only to those pultaceous, fatty masses which are generally of some size, and lie near the apex of the left ventricle; their cause being sclerosis and calcification of the arteries, thrombosis of the veins, etc. They give rise not infrequently to *rupture* of the cardiac wall and sudden death.

It is sometimes important to be able to distinguish such ruptures — which are called "spontaneous" — from those of traumatic origin. Of course this can be done only when the injury was not the direct cause of a rupture through such a preëxistent spot of softening. In traumatic cases the rent is generally larger, its edges are smooth and tolerably straight, and its neighborhood is neither infiltrated with blood nor shown by the microscope to be fatty degenerated. In spontaneous rupture, on the other hand, the rent is often

very small, and its canal so irregular that a sound can be passed through it with difficulty; the adjoining tissue is infiltrated with blood and the muscular tissue fatty degenerated.

(*b.*) **Hypertrophy** may be confined to either side of the heart alone, or may affect both sides, and it is usually not difficult to discover its mechanical cause. For instance, in insufficiency and stenosis of the aortic valves, both ventricles are generally hypertrophied; the left directly in consequence of the valvular lesion, the right secondarily from stasis of the blood in the pulmonary circuit, and the increased demand which is thus made upon it. Hypertrophy of the right ventricle may depend either on changes in the heart itself (stenosis and insufficiency of the mitral valve) or on changes in the lungs. If extensive destruction of the pulmonary capillaries has taken place, — from phthisis, for instance, — or if in any other way the circulation has been appreciably impeded, the explanation of the hypertrophy is easy; we are, however, not yet able to give a satisfactory explanation for the fact that a higher degree of hypertrophy is often associated with chronic bronchial catarrh than can be accounted for by the amount of emphysema present, or by other changes in the pulmonary parenchyma. Fatty degeneration confined to the right ventricle is very common in all these cases. The conditions which may give rise to hypertrophy of the left ventricle are much more numerous, and cannot be treated in detail here. We must, however, mention the interesting connection which exists between hypertrophy of the left ventricle and atrophy of the kidneys. Many recent writers have endeavored to connect hypertrophy of the left ventricle and of the whole heart, without discoverable anatomical cause, with overwork — *idiopathic cardiac hypertrophy.* This condition is often met with in soldiers, etc.

(*c.*) **Inflammatory changes** may be divided into parenchymatous and interstitial, the former involving the true muscular, the latter the intermuscular fibrous tissue, though it never occurs independently of the former.

1. *Parenchymatous* changes may be either general or partial. The general form is found in almost all infectious diseases, and is characterized in its earlier stages by a grayish-red opacity of the flaccid muscular walls, while later fatty changes arise. The muscular fibres in the first stage, when examined microscopically, contain granules resembling those of fat but really of an albuminous nature, as is shown by their disappearance on the addition of acetic acid or the dilute alkalies. The partial form is a result of a plugging of the branches of the coronary arteries by septic emboli, as in puerperal fever, pyæmia, ulcerative endocarditis, glanders, etc.; it is manifested by the presence of small abscesses as large as or somewhat larger than the head of a pin, which are generally multiple, with a red areola, and contain pus cells and a large amount of fatty degenerated muscular tissue (the second stage of parenchymatous inflammation). This affection is the precursor, as it were, of —

2. *Interstitial* inflammation, since the pus cells are to be regarded as evidences of acute, purulent, interstitial inflammation (*interstitial suppurative myocarditis*). The malignant character of the emboli is explained by the usual presence of collections of micrococci within them, such as are also to be found at the point from which the embolus was detached.

Chronic interstitial inflammation is more common than the acute form, and may also be limited to small areas. It is attended with the formation of fibrous tissue, — *chronic fibrous interstitial myocarditis*, — which has replaced the muscular fibres at the surface of the apices of the papillary muscles, or at the surface of the trabeculæ, or else appears in the midst of the muscular wall in the form of dense gray streaks. In the latter case the changes are best brought to view by a horizontal cut through the muscular substance, for instance, through the triangular portion of the wall which results from the opening made into the aorta. The microscope reveals a conversion of the interstitial into cicatricial tissue and an atrophy of the intermediate muscular

fibres. There is a remarkable condition known as *chronic saccular aneurism of the heart*, the chief seat of which is the apex of the left ventricle. It depends on fibrous myo- and endocarditis, which may so diminish the thickness of the cardiac wall that the latter gradually yields to the pressure of the blood at this point, and may finally be ruptured.

(*d.*) Among **tumors** we will first mention *gummata*, which sometimes are found in the form of large yellow nodules. Syphilis may also give rise to fibrous myocarditis, but, as in other organs, the true nature of this change can be recognized with certainty only when gummy formations are present at the same time.

Tubercles occur occasionally in this situation in general miliary tuberculosis, but very rarely in the form of cheesy masses; these are always here the result of syphilis. *Sarcoma*, and particularly *myxosarcoma*, may be primary in the heart; so also *myoma*, with stellate, transversely striated muscle cells, in new-born children. Secondary nodules of general carcinoma, sarcoma, melanoma, etc., may also occur, and the latter may give rise to embolism of the pulmonary arteries.

(*e.*) The **entozoa** are rarely formed in the heart. Trichinæ are never found, but both cysticerci and echinococci have been known to occur.

(*f.*) Among **congenital malformations** we will mention persistent patency of the foramen ovale, and deficiencies of varying size in the ventricular septum. The former is relatively common, but can be easily overlooked, as the communication between the auricles is not always direct, but may be formed by an oblique canal or fissure resulting from defective union between the membranes which are formed on either side and normally close the opening. Supernumerary muscular and tendinous bands are often met with, especially between the anterior wall of the left ventricle and the septum.

(β.) *Of the Endocardium.*

The last important part of the heart, *the endocardium*, is

ordinarily nowhere separated from the myocardium by fatty tissue, but in very fat persons, as well as in those laboring under obesity of the heart, a thin layer of fat is sometimes deposited in this place. Such a layer is very sharply defined in a transverse section, and its glistening fat cells are sufficiently characteristic. Slight *effusions* of florid *blood* are also occasionally found in this situation.

The endocardium is very often stained red by the coloring matter of the blood, and this redness, apart from its diffuse and indistinct character, cannot be attributed to inflammation on account of the low degree of vascularity of the membrane.

Pathological conditions are found with far greater frequency in the valvular than in the parietal endocardium.

(*a.*) The **parietal endocardium** is often the seat of circumscribed fibrous thickening (*chronic fibrous parietal endocarditis*), especially in connection with superficial fibrous myocarditis. The membrane may also be the seat of general thickening with circumscribed verrucous and ulcerative inflammation (*verrucous and ulcerative parietal endocarditis*), the latter almost always an extension of similar changes in the valves; the left ventricle is chiefly affected by this condition. Local ulceration of the parietal endocardium, by permitting the direct action of the blood current upon the muscular wall and the pericardium, may give rise to an aneurismal dilatation of a portion of the wall — *acute aneurism of the heart.*

(*b.*) It is a well-known fact that *valvular disease* which has arisen during life is generally seated in the left heart, very rarely in the pulmonary, and only exceptionally in the tricuspid valve; while during fœtal life the valves of the right heart are much more liable to suffer than those of the left. The commonest pathological condition, generally associated with atheroma of the aorta, is not an inflammatory but a simple regressive metamorphosis, and appears as irregularly shaped yellow spots of varying size, which are due to fatty degeneration of the connective tissue corpuscles of the part, and do not interfere in any way with the function of the valve.

The most important pathological conditions are those which are due to *inflammation* (*valvular endocarditis*), and may be divided into two classes, acute and chronic. The line of closure of the valves is the favorite seat of both these classes of changes; this lies at a little distance from the free borders of the curtains of the mitral, and in the segments of the aortic valves describes two curved lines which intersect the free borders at their middle points, the corpora arantii. Occasionally the changes are limited to the line of junction of the valves with the parietes (basilar valvular endocarditis), but they more commonly occur in both these lines at the same time. They first make their appearance, moreover, on that side of the valve which is turned toward the blood current — the ventricular surface of the aortic valves, the auricular surface of the mitral.

We will take up the chronic form first on account of its greater frequency. This may be a simple fibrous thickening of the valve curtains (*chronic fibrous endocarditis*), with which more or less retraction is apt to be associated; if the mitral valve be thus affected, the process almost always involves some or all of the chordæ tendineæ which are thickened and retracted. Fusion may also take place between the contiguous free borders of the segments, beginning at their extremities; this condition occurs chiefly in the aortic valve, and gives rise to stenosis and insufficiency. Small papillary elevations sometimes occur in the valves, either in conjunction with or independently of these fibrous changes, and may become largely calcified, even of a stony hardness.

The acute form may be either primary or the recurrence of a preëxistent endocarditis. It, too, may be attended by the formation of soft papillary elevations on the line of closure of the valves, resembling a cock's comb, of a white or gray color and somewhat translucent; these are shown by the microscope to consist of papillary connective tissue, which may perhaps be derived from the small projections which often are normally present in this situation. Or else we may find on the valves bodies varying in size between that of a

cherry-stone and that of a hazel-nut, soft, gray, grayish-red, or grayish-yellow in color, and, as a rule, easily separable from their attachments ; the microscope and acetic acid show these to consist of fibrine derived from the blood. The subjacent surface of the valve is not smooth as in the papillary variety, but it is ulcerated and often increased in thickness (*ulcerative endocarditis*). In the papillary variety the remaining portions of the curtains may be quite intact, while in the ulcerative form they are apt to be swollen and of a dirty yellowish hue. This form occurs chiefly in puerperal fever, pyæmia, etc., and has been called *malignant* or *diphtheritic endocarditis*, from the fact that the microscope reveals, in the tissue of the valves as well as in the thrombi, the presence of numerous colonies of micrococci, such as are also found within the multiple emboli which are so frequent in these cases. The organisms may be easily demonstrated by boiling the specimen in absolute alcohol and ether, and then examining it in glacial acetic acid. This form is more apt to be recurrent than primary, and the ulceration may extend from its origin in the line of closure of the valves and involve the parietal endocardium. There are, however, cases of acute ulcerative endocarditis which do not possess this malignant character ; ulceration in rare instances, for example, may be set up mechanically by the repeated impinging of a cretified nodule on the aortic valve against the mitral curtain, the ventricular layer of which may be thus completely destroyed while the auricular layer is dilated in the form of an aneurism (*acute valvular aneurism*). This dilated portion may finally become perforated and the ulceration extend somewhat on the other side. (It is scarcely necessary to mention the fact that perforation of the valves may also take place in the malignant form.) *Chronic valvular aneurism* is found only in the left ventricle, and consists in a sacculation of all the layers of the valve, the convexity being always opposed to the blood-current — in the aortic valve toward the ventricle, in the mitral toward the auricle. The formation of thrombi may then give

rise to secondary changes, and sudden death result from embolism of the carotid; or else rupture may take place, and insufficiency be the result. Similar aneurismal dilatation occurs also in the upper part of the interventricular wall (septum fibrosum) and in the sinuses of Valsalva, particularly the right.

Both papillary and ulcerative inflammation occur also on the chordæ tendineæ, which may be completely separated by the latter form, and thus incomplete valvular closure be brought about.

There is a peculiar appearance which is sometimes met with in young children on the line of closure of the valves, called *hæmatoma of the valves;* it consists in the presence of a number of small prominences, which sometimes occupy the whole circumference of the line of closure, and thus form a circle — the apices of which are dilated and contain small collections of blood. *Fenestrated valves*, semilunar valves with one or more defects between the line of closure and the free border, still retain their function unimpaired, and hence possess no special clinical interest. So also the occasional presence of four segments in the semilunar valves. In cases of valvular lesion a deposit of fibrine is often formed on the intact ventricular wall as well as on the diseased valves (*parietal thrombosis*). Mechanical interference with the circulation may also give rise to this condition without the intervention of valvular lesion (marantic thrombosis). Hence it is especially liable to occur in the right heart, at the apex, between the trabeculæ and in the auricles, the points at which the circulation is least rapid. Such thrombi may be small and scarcely project above the surface of the trabeculæ, or they may be as large as or even larger than a cherry, and project boldly into the cavity (*the globular vegetations of Laennec*); in the latter case they are usually firm and gray, or grayish-red at the periphery, and soft, reddish-gray, yellow, or brown at the centre. They are not to be confounded with those firm and tough grayish-yellow masses of fibrine which are formed just before death, and can always be disentangled from the trabeculæ with comparative ease.

(γ.) *The Commencement of the Aorta and the Coronary Arteries.*

The *commencement of the aorta* and the *coronary arteries* should be examined in connection with the heart. The intima of these vessels may present conditions similar to those of the valves in chronic endocarditis. Yellow irregular spots are due to fatty changes in the cells of the intima; chronic inflammation of the intima (chronic deforming endarteritis) leads to local thickening or sclerosis, with which is associated cellular fatty degeneration and calcification. It is precisely this calcification of the patches of sclerosis within the coronary arteries which often causes considerable diminution in their calibre, and thus impairs the nutrition of the myocardium. The fatty change in the cells of the sclerosed patches may also involve the connective tissue, so that finally a cavity is formed containing a mixture of fat and cholesterine (atheromatous abscess), which may rupture inwards, and thus form an atheromatous ulcer. On and about this, fibrine may then be deposited, and a place of origin formed for embolism of other organs or parts.

These changes in the intima are often associated with dilatation of the wall — aneurism. This condition, as well as a diminished calibre or hypoplasia, so often associated with chlorosis, etc., will be described in another place.

Under congenital changes may be mentioned the tolerably frequent variations in the origin of the coronary arteries, which are sometimes given off high up on the aortic wall, instead of in the sinuses of Valsalva, or both may communicate with the aorta through the same opening. The ductus arteriosus sometimes remains open in adult life.

8. THE LUNGS.

To examine the *lungs* thoroughly they must first be removed from the thorax, but this must be done with great care, that the pulmonary tissue may be neither lacerated nor crushed. If extensive or old adhesions are present they are not to be torn through, but the costal pleura is also to be

removed at these places according to the following method. A longitudinal incision is to be made in the costal pleura, and a finger of the right hand worked behind the lower edge of the cut along an intercostal space; by a lateral movement of the finger and simultaneous traction inwards, space can generally be made for the hand, with the aid of which the detachment may be completed. In order to protect the back of the hand from being injured by the costal cartilages, which are very apt to be calcified in such cases, the external integument should be folded over the cut ends, while the other hand draws them forcibly outwards. After the surface of the lungs has been freed from its attachments, the root of the left lung should be included between the index and middle fingers on the outer side, and the ring and little finger on the inner, drawn directly downwards, and divided carefully. In removing the right lung the position of the fingers is, of course, reversed.

(*a.*) *The Pulmonary Pleura.*

The surface of the lungs should be again carefully examined, after their removal from the body, with special reference to the *pleura* and the presence of commencing *inflammatory* exudation, which is indicated by a dull and opaque appearance of the normally smooth and glistening membrane; this appearance can be brought out more distinctly by allowing the light to fall on the surface obliquely. In general, what has been already said with regard to the pericardium applies equally to the pleura, but affections of the latter are much more frequent, especially the eruption of gray, submiliary nodules, — *tubercles*, — which may take place over a large surface, or be limited to the immediate vicinity of nodules within the lung. They may be conjoined with fresh, often hæmorrhagic, inflammatory exudation, as well as with the results of chronic pleurisy; in the latter case they are very often found in the fibrous adhesions. In chronic tuberculosis, nodules of considerable size are often formed by the confluence of smaller ones, and they may become cheesy; **a**

favorite seat of these large cheesy masses is in the interlobular fissures. *Cancerous* nodules occur not unfrequently in connection with cancer of the breast. The pulmonary pleura is, more often than the pericardium, the seat of *circumscribed necrosis*, as indicated by a yellowish-gray discoloration, friability, and softness; the lung tissue beneath such spots is generally ulcerated or gangrenous. It is a very interesting fact that these necrotic portions of the pleura always retain their smooth and reflecting surface — *i. e.*, show no signs of inflammation, — although the whole surrounding membrane may be covered with a fibrinous deposit. Perforation may result from the process, the hole usually being from three to five millimeters in diameter, and a communication is thus established with the pulmonary lesion, which is usually a cavity. Certain peculiar changes in the appearance of the surface of the lungs are to be explained by the arrangement of the superficial *lymphatic vessels*, which, as is well known, lie between the lobules and form a subpleural network. These lymphatic vessels are subject to inflammatory changes of an acute as well as of a chronic nature; the latter give rise to a thickening of the walls, especially at the points of anastomosis (pseudo-tubercle), and to a dilation of the vessels; the presence of puriform material within the vessels (purulent pleural lymphangitis), is due to an acute process. This lymphangitis may be closely counterfeited by the presence of portions of a new formation within the vessels, as is not very rare in cancer of the stomach or breast, in lympho-sarcoma, etc. The vessels which contain the new formation appear as a network of whitish or gray bands, which are here and there interrupted by nodular masses of the growth, particularly at the points of anastomosis. When, as is often the case, the process starts from the root of the lung, the largest lymphatic vessels and the greatest number of nodules are found at and about that point, and gradually diminish in size and numbers as the periphery is approached.

(b.) Special Examination of the Lungs from without.

The examination of the pleura is followed by that of the various divisions of the lungs with reference to size, form, color, degree of distention with air, and consistency.

1. The *size* of the lungs as a whole should have been noted before the heart was opened, but we are now enabled to examine individual portions with especial reference to their mutual relations. As a basis of comparison it is well to take the size of the lungs in moderate expiration. Enlargement of one lobe is usually due to emphysema, pneumonia, or œdema; diminution in the size of one lobe often results from compression by pleuritic exudation, which, if it has lasted a long time, may give rise to vicarious emphysema of another lobe.

2. Alterations in *form* are either congenital — unusual fissures and increase in the number of the lobes — or acquired; the latter include those changes which are due to local cicatricial contraction of the pleura or lung itself, circumscribed increase in size by emphysematous blebs, and circumscribed diminution in size from collapse of the surface over pulmonary cavities of considerable size. Peculiar changes in form are sometimes brought about by a large pleuritic effusion when small areas of the compressed lung are firmly attached to the chest-wall, the two being connected by long, nipple-shaped processes.

3. The *color* of the surface varies with the age and occupation of the individual, as well as with the amount of blood and air which the organs contain. If the individual be of advanced age or for any other reason have inhaled much coal-dust, the surface acquires a bluish-gray (slaty) or blackish discoloration, which appears first about the interlobular lymphatic vessels, forming a network with dilatations at the points of anastomosis, but later extends to the bases of the lobules and becomes more uniform. It is not uncommon to find on the pleural surface of these carbonaceous lungs small grayish-white nodules which cover the points of anastomosis

of the lymph vessels, and might easily be mistaken for tubercles; they are in reality nothing more than local thickenings of the connective tissue of the pleura, due to the chronic irritation. This slaty color, which is more or less marked in almost every adult, often masks completely the color of the pulmonary parenchyma, which varies between gray and red according to the amount of blood which it contains. Spots of atelectasis are easily recognized externally by their bluish-red color. A light brownish color, which is usually most marked in the upper lobes, owing to the comparative want of blood, depends on the presence of brownish or brownish-red pigment (hæmatoidine), and occurs in passive pulmonary congestion — brown induration. The color of the surface may also be modified by an affection of the pulmonary parenchyma itself, and one must take care not to mistake small, cheesy nodules, the color of which is transmitted through the pleura, for tubercles in that membrane.

4. The *amount of air present* in the lungs and their *consistency* are alike tested by the sense of touch. The lung which is normal in these respects is soft, easily compressible, and crepitates. Great softness and indistinct fluctuation indicate softening and the formation of cavities; firmness and density with lack of crepitation indicate diminution or absence of air. If a portion of lung, however, which presents the latter characteristics be at the same time of undiminished, or even of increased size as compared with neighboring portions whose distention corresponds with that of moderate expiration, abnormal substances must be present in the air spaces. Relative diminution in size, on the other hand, points to atelectasis from compression or other cause. It is often of clinical interest in these cases to ascertain whether such portions were capable of inflation, or whether retraction of the pleura, or changes within the lungs, had rendered their distention impossible. This can be done by attempting to blow up the affected portion artificially from one of the large bronchi, but the external examination should first be completed. The same expedient may be resorted to in cases of

pneumothorax when the perforation cannot be readily found. By immersing the lung in water and blowing air into it, the opening will be indicated by the stream of air-bubbles which escapes through it. The sensation produced by firm, hard nodules, varying in size from that of a millet grain to that of an apple, and enveloped in lung tissue containing air, is very characteristic: these nodules are generally the result of bronchitis, peribronchitis, and slaty induration. Cavities give rise to a sensation of fluctuation or quivering, whether filled with air or fluid.

The size of the alveoli can best be determined at the apices and edges of the lungs. The normal alveoli appear as minute vesicles, but when diseased may reach the size of the head of a pin, a millet-grain, a pea, or may be even larger in *alveolar* or *vesicular* emphysema. The tissue is then soft and rarefied to the touch (Rokitansky). Emphysema may be only local, and is then especially apt to appear in the form of blebs as large or larger than a cherry or walnut; the small projecting ridges found on their inner surface show that the larger blebs result from the confluence of a number of smaller vesicles.

There is still another variety of emphysema, — *interstitial* or *interlobular emphysema*, — which is brought about by the rupture of vesicles and the escape of air into the interlobular connective tissue, in consequence of obstructed expiration or the development of gas from decomposition. It is made evident by the presence of air-bubbles of various sizes, arranged like the beads on a rosary, between the lobules and beneath the pleura, though it sometimes gives rise to an interlacing network resembling that described in connection with the lymphatic vessels. These bubbles of air can sometimes be displaced and moved about by pressure with the finger.

(*c.*) *Internal Examination of the Lungs.*

To examine the *pulmonary parenchyma* each lung in turn is to be placed on its diaphragmatic surface, its root so grasped in the left hand that the primary bronchus lies in

the fork between the thumb and forefinger, and is then laid open from top to bottom in such a way as to expose the largest possible surface: the incision should pass near the root so as to open the larger bronchi and vessels at the same time. The right middle lobe is to be laid open independently by a cut from behind forwards — its greatest diameter. Both the bronchi and vessels should then be followed up and opened with narrow scissors, one blade being probe-pointed, as much of the pulmonary tissue as possible being always included between the blades. If nothing of importance has thus far been detected it may not be necessary to carry the examination further; if certain portions have already been recognized as the seats of local trouble, a number of smaller longitudinal cuts should be made through them.

1. General Condition and Appearance.

The *amount of blood* contained in the organ is indicated in part by the quantity which flows out over the cut surface from the vessels or can be squeezed out of them, but chiefly by the coloration of the tissue. A normal lung deprived of its blood is light gray, but the color varies according to the amount of blood present, from a bright brick-red (medium amount) to a dark, reddish-brown or purple. The color is also influenced by the amount of air contained in the lung. The brownish-red lung of a child which has never breathed, for example, changes to a bright brick-red when blown up artificially, and *vice versa*, a portion of the lung of an adult may be dark in color from imperfect expansion with air, and consequent limitation of the usual blood supply to an area smaller than that which it normally occupies. The blood supply is not the only factor in modifications of the normal color of the lungs. Carbonaceous pigment is present in the lungs of almost every adult, varying in quantity according to the mode of life, and produces a bluish-gray or slaty appearance, as has already been mentioned in connection with the pleura. The higher degrees of this condition are called *anthracosis*, and, when evidence of chronic inflammation is

superadded, *anthracopneumonoconiosis*. A similar discoloration may also depend on the presence of metamorphosed blood-pigment, — hæmatoidine ; and this form occurs almost invariably in connection with those chronic inflammatory processes which accompany pulmonary consumption (*slaty induration*). There is also a brown discoloration from metamorphosed blood-pigment (*brown induration*), which is found in connection with certain cardiac lesions. While the first two forms are generally confined to the newly formed connective tissue, or to the normal interlobular bands, the latter is very apt to extend also to the cells which lie free in the alveoli as well as to those which line the alveolar walls. These cells are easily obtained for microscopical examination by simply scraping the cut surface, while to examine the yellow or yellowish-brown pigment contained in the connective tissue (also largely contained in its cells), a small fold of pulmonary tissue must be raised with forceps, snipped off with fine scissors, and somewhat teased apart in water. The alveolar capillaries are also found to be of unusual size and to project into and encroach upon the air spaces, thus producing a general diminution in the air contained in these lungs, as well as an increased firmness and density.

2. Special Morbid Conditions.

(a.) *Of the Parenchyma and Smallest Bronchi.*

The *alveoli* constitute the most important part of the parenchyma, and are to be examined with reference to their degree of distention with air and the presence of abnormal contents.

(*a.*) *Alveolar* or *vesicular* **Emphysema,** as has been already mentioned, causes apparent dilatation of the alveoli, but in reality the abnormally large air-spaces result from atrophy and subsequent rupture of the partition walls ; the capillaries are thus destroyed also, and emphysematous portions have consequently a pale and anæmic appearance. Emphysema may be widely diffused or limited to small areas, and in the latter case is usually vicarious ; it is almost

always associated with bronchial catarrh and bronchiectasis.

(*b.*) **Atelectasis,** absence of air and consequent collapse of the alveoli, may originate in four different ways. In *fœtal atelectasis*, which may be either limited to single lobules or extend over considerable areas, air has never entered the affected portions. *Atelectasis from compression* is due to pressure from without, is usually quite extensive, and depends commonly on chronic inflammatory pleuritic effusion. In this form the blood-vessels are very apt to be compressed also, and the affected portions hence acquire a dirty-grayish appearance; while in simple collapse of the lungs, on the other hand, the affected portions seem to contain even more than the normal amount of blood. Thirdly, atelectasis may depend on *plugging of a bronchus*, in which case, the vessels not being compressed in any way, the affected portions are dark-red or purple in color. This form always occurs in wedge-shaped masses, the apices of which are directed toward the bronchus, and the bases of which lie, as a rule, at the surface of the lung. Atelectatic portions of lung, whatever their mode of origin may be, are always diminished in size, and are hence always depressed below the level of the surrounding normal tissue. Lobular atelectasis has a very characteristic appearance and, inasmuch as it is the result of capillary bronchitis, is an important diagnostic sign of that affection. Partial atelectasis, finally, may be the result of great prostration, and feebleness of the respiration, — *marantic atelectasis*, — in which case it always occupies the posterior and inferior portions of the lungs; the blood also settles into these portions (hence the term *hypostasis*) which become greatly congested and very dark-red in color. In these cases, as well as in those in which atelectasis is due to compression, the alveoli are very apt to be subsequently filled with the fluid of œdema, which causes the shrunken portions to swell up, and converts them finally into soft bluish-red masses, devoid of air and resembling the spleen, — hence *splenization.* When the œdema is very marked, it may, in turn, compress the blood-

vessels, and the affected portions then acquire a gelatinous appearance like frog's spawn — *the gelatinous pneumonia of Laennec.*

We are naturally led to consider next those conditions of the alveoli in which, though deprived to a greater or less degree of their air, they are not collapsed, but are filled with abnormal matters. The cut surface of portions thus affected varies in color, consistency, and character, according to the character of the alveolar contents; and on the accurate observation of these three points depends, therefore, the differential diagnosis.

(*c.*) The simplest of these conditions is **pulmonary œdema,** the presence of a clear, watery fluid within the alveoli, whether throughout the lung or only in limited portions of it. The tissue still contains more or less air, but is heavier, denser than normal, has often a peculiar translucent appearance, and pours out from its cut surface spontaneously, though in larger quantities on pressure, a fluid containing small air-bubbles and more or less tinged with blood. The presence of these small air-bubbles in extensive œdema is a sign that the condition was established during life, while the absence of air-bubbles indicates that it did not take place till after death (a very common occurrence in the lower lobes). That form of œdema which is sometimes found in normal portions of diseased lungs is known as *collateral œdema*, and may be the direct cause of death in spite of its limited distribution.

(*d.*) **Hæmorrhage.** The alveoli may be filled with blood; the most remarkable form of this condition is that known as *hæmorrhagic infarction*, found in connection with valvular lesions of the left heart (especially mitral lesions), and depending on rupture of the vessels from increased pressure in the pulmonary circuit. It is possible that rupture may also be brought about by fatty degeneration of the intima consequent on dilatation, and the pulmonary artery should, therefore, always be examined. A hæmorrhagic infarction is always pyramidal in shape, with its base at

the surface and its apex directed inwards; it varies in size, is sharply circumscribed, of great density, very dark-red in color, and usually projects, under the pleura, somewhat above the level of the surrounding tissue. As is readily seen from the exterior, its borders always coincide accurately with those of the lobules, and it is never limited to a portion of a lobule but involves invariably the whole. On section, the affected portion is seen to be very dark-red or almost black, and is distinguished from a very similar condition, which is of inflammatory origin and will presently be described, by its clearly defined pyramidal shape, its nearly smooth and but very faintly granular surface, from which a certain quantity of fluid blood can usually be scraped, its great density, and its localization at the periphery. A plugged artery can often be found at the centre of the mass — secondary thrombosis. When the contents of the alveoli are examined microscopically in a solution of common salt, they are seen to consist of the usual constituents of coagulated blood, quantitatively as well as qualitatively. Sections can easily be made with the double knife and show that the alveoli are not only filled, but distended with blood, while the capillaries, from being thus compressed, are often entirely empty. The subsequent changes undergone by a hæmorrhagic infarction depend on this latter circumstance. The affected portion becomes practically a foreign body, and is separated from the surrounding parts by purulent circumscribed inflammation. The softened mass is then seen to be surrounded by a narrow yellow line which, in its turn, is limited by a zone of redness gradually disappearing toward the periphery. Progressive suppuration may thus completely detach the mass from the adjoining tissue and leave it in a cavity which may cicatrize and heal up after its contents have been discharged. The course of affairs is not always, however, so favorable; the blood may decompose and thus set up circumscribed gangrene, in which the compressed and bloodless tissue within the infarction naturally becomes involved, so that finally a cavity filled with greenish-brown and highly offensive fluid is formed,

from the inner wall of which the remains of the pulmonary tissue hang in shreds. Such a gangrenous cavity is usually surrounded by inflamed tissue, — *fibrinous inflammation*, — which when widely extended may eventually prove fatal. Pleurisy is almost invariably associated with pulmonary gangrene, and, when the gangrenous spot extends as far as the pleural surface, is very apt to be of a putrid character.

The decomposed masses are shown by the microscope to be of a highly composite character, and are remarkable for containing elastic fibres from the alveoli. The presence of these fibres is, as is well known, of great diagnostic value during life, and their detection may be facilitated by the addition of dilute caustic soda. Immense numbers of bacteria of spherical as well as rod-like form, crystallized fatty acids, fat drops, etc., are always present; and these constituents are often combined in the form of small whitish bodies of the most offensive character. The oïdium albicans is also sometimes found here.

Embolic infarction, the result of the plugging of a branch of the pulmonary artery, resembles the hæmorrhagic variety very closely, and cannot, indeed, always be distinguished from it. These infarctions are also peripheral as a rule, but instead of being sharply defined are merged gradually into the surrounding healthy tissue, and are seldom of considerable size, for the reason that partial plugging of the larger branches never gives rise to infarction, while complete plugging of such branches is rapidly fatal. Complete plugging of the smaller branches is not, moreover, necessarily followed by the formation of an infarction, as is well seen in cases of multiple emboli, some of which have led to infarction, while others have not. Embolic infarction, pure and simple, occurs only when the emboli are derived from a bland thrombus, and exert a purely mechanical influence; if, on the other hand, the emboli contain septic material, then the peripheral infarctions are associated with small abscesses (*embolic pneumonia*), though the latter may alone be present, and occupy the periphery or the centre of the lung indiffer-

ently. Or the two may be combined in such a way that an abscess occupies the centre of the mass, while the periphery is infiltrated with blood. Septic emboli are usually so brittle that their resulting infarctions are small. A peculiar but apparently pretty common condition in cases of injury to the brain, and particularly to the pons and medulla oblongata, consists in hæmorrhage (usually in the form of infiltration) and œdema. These two conditions are often, indeed, so closely associated that, in unilateral injuries to the above-named portions of the brain, sometimes only the lung of the same side is found to be the seat of change (vagus).

(*e.*) **Inflammation.** Those forms of inflammation in which the air of the alveoli is replaced by inflammatory products are the most important, and may be divided into two classes: 1st, *cellular pneumonia*, in which the inflammatory product is chiefly cellular; and, 2d, *fibrinous pneumonia*, in which it is chiefly composed of fibrine.

1. **Fibrinous pneumonia** usually affects a whole or the greater part of a lobe, and is always diffuse, or, in other words, the transition from the normal tissue to the point of maximum intensity is always gradual. The appearances vary according to the stage which the process has reached. The first stage, that of engorgement, in which the lung becomes dark-red from great congestion of the vessels, cannot, of course, be diagnosticated as such, for the reason that we cannot know with certainty what the result of the hyperæmia might have been; it is only when infiltration has begun, or hyperæmia is found in a part contiguous to an already existent infiltration, that we can properly speak of the initial stage of the inflammation. In the second stage, the affected portion is enlarged, heavy, and resistent, and its cut surface has a grayish, or dark-red, and coarsely granular appearance; the latter characteristic is more clearly brought out by scraping the cut surface firmly with the edge of the knife, and thus squeezing out of the alveoli solid plugs, which are sufficiently large to be recognized by the naked eye, and are shown by the microscope to be casts of one or more of the

alveoli. These plugs, as is readily seen in sections of the tissue, occupy all the alveoli without exception, and, as their color would indicate, consist chiefly (not entirely, as in hæmorrhagic infarction) of blood, and also of a large amount of fibrine, and some colorless cells. The coarsely granular character of the cut surface permits us to distinguish pneumonia from hæmorrhagic infarction without the aid of the microscope, and it depends on this richness in fibrine. From the resemblance in consistency which the inflamed lung bears to the liver, the condition has been termed *red hepatization.*

This is followed by *yellow hepatization*, the only gross distinction between which and the red variety is the color; but the microscope shows that the blood has disappeared, and is replaced by great numbers of small lymphoid and larger epithelioid cells, which latter have been derived from proliferation of the alveolar epithelium. The vessels have been compressed by the exudation, and the lung is therefore anæmic. Lungs which contain large quantities of black pigment are gray rather than yellow in this stage (gray hepatization).

The fourth and last stage is that of *resolution*, in which the density gradually diminishes, the cut surface loses its granular character, and the color becomes more distinctly yellow. A tenacious, opaque, and grayish-yellow fluid can now be squeezed out from the cut surface in large quantities, and is found, on microscopical examination, to consist of fatty degenerated cells, and a viscid fluid into which the fibrine has been converted. The pulmonary tissue is often so soft in this stage that in removing the lungs from the body portions lying under the pleura may be crushed and disorganized; cavities thus arise which become filled with a puriform fluid and may be mistaken for abscesses. It sometimes happens, however, that genuine abscesses are formed from undue participation of the connective tissue in the inflammatory process. A more common result is *diffuse gangrene* of the lung, a condition which may also depend on antecedent

bronchiectasis and putrid bronchitis, or occasionally on a strongly marked hæmorrhagic character of the inflammation. Diffuse gangrene may resemble the circumscribed form in every respect, except in sharpness of definition.

Fibrinous pneumonia is found with greater frequency in the lower than in the upper lobes, and progresses upwards, so that the several stages are often coexistent and portray the course of the affection. The hepatized portions are always the seat of collateral œdema, which is very apt to be found in the healthy lung in unilateral pneumonia also.

Fibrinous pneumonia is almost invariably associated with fibrinous pleurisy, as is indicated by the old term *pleuro-pneumonia*, which, however, is not quite appropriate, inasmuch as both catarrhal and cheesy pneumonia are very often associated with pleurisy, and might hence be included under the term. Cases also sometimes occur in which this order of things is reversed and a primary pleurisy gives rise to fibrinous pneumonia in the adjoining tissue. The inflammation may extend to the bronchi too, and then set up either *fibrinous bronchitis* with the formation of grayish-white casts or masses of fibrine within the tubes, or *simple bronchitis*, with redness and swelling of the mucous membrane and increased secretion. As a rare event fibrinous pneumonia becomes chronic in character. Instead of undergoing resolution the affected portion is converted into a dense, airless, uniformly red and fleshy mass — *carnification*. The microscope shows that the alveoli are replaced by vascular connective tissue into which, as in the organization of thrombi, the inflammatory alveolar contents have been converted.

The second class — *cellular pneumonia* — may be again subdivided into pneumonia with soft, partly fluid and partly cellular, exudation, and pneumonia with firm and dry exudation. To the former subdivision belongs —

2. **Catarrhal pneumonia,** or *broncho-pneumonia*, as it may often be called, for the reason that the parenchymatous affection is secondary to that of the finer bronchi. This form of pneumonia is generally lobular, and, even when of consid-

erable extent, is not in its earlier stages distributed uniformly through the tissue, but appears in the form of numerous small gray or grayish-yellow spots embedded in reddened lung substance; these represent minute foci of pneumonia limited to the region of the smallest bronchial tubes, — true broncho-pneumonia. When the process is extremely acute, as well as in its later stages, the tissue may be uniformly infiltrated throughout; in this case the cut surface is of a grayish color, is smooth or at the most finely granular, and pours out from the alveoli on pressure large quantities of a gray, opaque fluid which contains no air. The microscope shows this fluid to contain great numbers of small, round, and some epithelial cells.

Chronic catarrhal pneumonia is a very common affection, and has a very characteristic appearance; it may either be confined within narrow limits, or, in a more extensive form, may complicate other chronic inflammatory affections. The tissue which is the seat of this process is devoid of air, œdematous, of a general grayish color, but sprinkled with minute light yellow spots, and pours out on pressure a highly albuminous, tolerably clear fluid, in which are suspended minute yellow punctate bodies. These bodies are shown by the microscope to be fatty degenerated catarrhal cells, — granular corpuscles, — which are sometimes so large that a single one of them forms the whole minute speck which is visible to the naked eye. Rindfleisch holds that the above described condition is not to be regarded as the final stage of catarrhal inflammation, but is the result of atelectasis to which œdema has been superadded — persistent (inveterirtes) œdema. There is another inflammatory affection of the lungs which occupies a somewhat peculiar position. I refer to that form of pneumonia which is met with chiefly in the insane and is due to the inhalation of particles of food. It originates as broncho-pneumonia, but the exciting cause is such that decomposition is very liable to set in, and even diffuse gangrene sometimes ensues. Solid particles of foreign substances generally find their way into the lower lobes when drawn into

the lungs, and the lower lobes are consequently the chief seats of this form of pneumonia as well as of those forms which depend on the inhalation of portions of diphtheritic, cancerous, or other masses from the throat or upper air passages.

The differences between the fibrinous and catarrhal forms of pneumonia are much less marked in *childhood* than in adult life. In consequence of the greater activity of cellular growth, and particularly of the larger size of the alveolar epithelium in children, the exudation is seldom purely fibrinous, but contains great numbers of cells, especially of the epithelioid variety. The cut surface is not granular but smooth, and grayish-red rather than dark-red, for the reason that the hæmorrhagic element is almost entirely wanting. The two forms can nevertheless be distinguished from each other by the character of the exudation, which in the fibrinous form still contains sufficient fibrine to render the alveolar contents firm and cohesive.

White hepatization, so called, originates during fœtal life and is always the result of syphilis. The lungs are dense, devoid of air, and of a whitish appearance; and the microscope shows the epithelial cells of the alveoli and small bronchi to be fatty degenerated.

3. Contrasted with these soft, cellular forms of pneumonia is the hard form, which, from the character of the change undergone by its products, may be called **cheesy pneumonia.** Like the fibrinous variety it has several stages, which are distinguished by the color they impart to the cut surface. In the first stage it is of a red color, not the dark-red of the fibrino-hæmorrhagic form, but of a lighter, more grayish-red, which later becomes grayish-yellow, and finally yellow. The two latter stages are those of caseation, the progress of which is always attended by increasing yellowness.

This form of pneumonia is characterized in all its stages by dryness of the cut surface, density, and, at least in the earlier stages, by a finely granular appearance, each granule corresponding with a collection of cells in an alveolus. When

the alveolar contents are placed under the microscope they are seen to be of a somewhat different composition from those of catarrhal pneumonia, consisting chiefly of large epithelioid cells closely aggregated together — old and young desquamated epithelium; the process has hence been called *desquamative pneumonia.* According to Virchow the later developments of the process are due chiefly to the distention of the alveoli, while Buhl and Rindfleisch lay more stress on the condition of the interstitial tissue, in which they always find collections of large and thickly aggregated cells (tubercular inflammation of Rindfleisch). The cellular growth is indeed so active both within the alveoli and in their walls that the blood-vessels are compressed, and the cells then undergo a species of fatty degeneration or caseation. The microscope shows that caseation is not a pure fatty degeneration, but that the cells lose their water and shrivel also.

Cheesy pneumonia, like the catarrhal variety, sometimes appears in the form of broncho-pneumonia, and is generally lobular, or, in other words, involves uniformly whole lobules; it is not infrequently, however, met with in the form of small disseminated nodules, — *miliary cheesy pneumonia,* — sometimes extends uninterruptedly over large areas, and, in rare cases, indeed, over entire lobes, then constituting the most acute form of what has been termed *galloping consumption.* Nodules of cheesy pneumonia are distinguished from those of bronchitis and peri-bronchitis, which we shall describe in another place, chiefly by their finely granular cut surface.

4. **Metastatic pneumonia,** to which we alluded in connection with embolic infarction, has some peculiarities worthy of mention. It usually occurs in the form of multiple peripheral nodules lying immediately beneath the pleura, terminating in abscesses which are often fœtid or gangrenous, and sometimes contain at their centre a softened mass of necrotic material which may be more or less detached by suppuration. Although the origin of the nodules and abscesses cannot always be demonstrated as embolic, it is such without exception, and the emboli are furthermore always of a malignant or septic

character, and so soft and pliable that the local irritation to which they give rise never results in changes of great extent, the part affected being rarely larger than a cherry. Inflammation of the pleura is always set up by these abscesses, and this inflammation is often likewise of a septic or malignant character, and attended with foul exudation. Septic pleurisy may, indeed, be the sole indication leading us to suspect metastatic processes in the lungs, and should always induce us to institute careful search for such processes whenever its presence cannot be readily accounted for in any other way. As is always the case in septic suppuration, the cells become destroyed with great readiness, and the fluid when examined microscopically is found to contain little more than broken down pus cells, detritus, and often large masses of micrococci.

5. We have now reached the last class of the inflammatory affections of the pulmonary parenchyma, **interstitial pneumonia,** the primary seat of which is the interstitial or interlobular connective tissue.

Acute suppurative interstitial pneumonia is rather rare; one variety of it we have already mentioned as an unusual complication of some cases of fibrinous pneumonia. In cases of empyema we sometimes find yellow bands of suppuration which start from the surface of the pleura, extend inwards along the septa, and in the interior may be connected with one another, and follow the course of the bronchi and vessels. There is generally no difficulty in ascertaining that the pus is contained in spaces with smooth walls, the course and distribution of which is such that they must be lymphatic vessels, and the process, therefore, is a *suppurative lymphangitis.*

Chronic interstitial pneumonia, or *cirrhosis of the lung*, is a far more common affection, and results in fibrous thickening of the septa. The pulmonary tissue, which may or may not be involved in the inflammation, is seen to be traversed by narrow bands of connective tissue, which may gradually compress it more and more, finally converting it into dense

fibrous masses. Large quantities of black pigment derived from the blood are always deposited in these places — *slaty induration*, — and show them to have been the seat of an acute process at one time. Chronic interstitial pneumonia, pure and simple, is always suggestive of syphilis, but is rather rare. It is far more apt to be associated with other chronic and sometimes cheesy conditions of the parenchyma and bronchi, and then represents a sort of cure of these processes. This form occurs chiefly in the apices, and may completely surround small cheesy or calcified nodules; retraction of the upper part of the chest results, as is also evident from clinical experience.

6. **Peribronchitis,** inflammation of the connective tissue surrounding the bronchi, is sometimes an affection of great importance. In the form of *acute suppurative peribronchitis*, it is rather rare and occurs only in connection with very rapid phthisis. It is far more common in the chronic forms of *fibrous* and *cheesy peribronchitis*, and is then manifested on section by great numbers of small, round, and closely aggregated nodules which may easily be, and indeed often are, mistaken for tubercles; these really represent cross sections of clusters of minute bronchial tubes close to their junction with larger branches. On careful inspection a minute dark point may sometimes be seen at the centre of each of these nodules — the open end of the tube — but this is not always the case, since the tubes may be either obliterated or completely plugged with cheesy material. The lung substance which intervenes between these nodules of peribronchitis is very often the seat of slaty induration, and the lung then contains hard masses of the size of a walnut or larger, which can be felt from the outside, and consist of dense slate-colored fibrous tissue in which the gray or yellow peribronchitic nodules of the size of a pin's head or millet seed are imbedded. The affection does not remain stationary but continues to progress, and it is consequently at the edge of the slaty portions that we find the most typical peribronchitic nodules.

7. It is our purpose in this place to touch on inflammation

of the smaller bronchi, **bronchitis,** or better, *bronchiolitis*, only as far as it is directly connected with inflammation of the parenchyma. Thus limited it is always essentially a chronic process. In connection with peribronchitis it has already been mentioned that *fibrous bronchitis* causes obliteration of the smaller tubes. *Cheesy bronchitis* is an affection of greater importance, the products of catarrhal inflammation remaining within the tubes, and there undergoing caseation. Cheesy inflammation of the larger bronchi is easily recognized, and can be demonstrated by cutting the tubes open with scissors; when the same affection involves the smaller bronchi and, as happens so often, is associated with fibrous peribronchitis, it may easily be mistaken for tuberculosis on account of the strong resemblance which the nodules with yellow, cheesy centres and gray, fibrous circumferences (encysted tubercle of the older authors) bear to old tubercular deposits which have become cheesy. They can always be recognized as belonging to the bronchi by their arrangement in clusters.

(*f.*) **Tubercles** are found in the lungs in three forms which differ essentially from one another.

1. The simplest, and at the same time the rarest form is *disseminated tuberculosis*, which is but part of a general or widely distributed process and is characterized by the presence of minute gray nodules which are scattered pretty uniformly through the tissue, but which, especially in the upper lobes, may be of large size, yellow at the centre, and gray and translucent at the periphery. The smaller miliary tubercles in particular often project like little spheres above the level of the cut surface and can be easily isolated from their connections. The diagnosis is decidedly strengthened when the nodules are found along the blood-vessels also, in the territory of the lymphatic vessels which accompany them. The large nodules to which we have already referred are usually in part the result of a desquamative pneumonia which is set up by and surrounds the tubercles.

2. *Localized tuberculosis* may be further subdivided into

two forms, the first of which may retain the term *localized tuberculosis*, though in a narrower sense, and bears a similar relation to the lungs as the disseminated form to the body in general. It is characterized by the development of single tubercles about a cheesy nodule or cheesy ulceration in the lung as well as about the bronchial glands. The tubercles are generally surrounded by normal pulmonary tissue, are apt to be more closely aggregated, larger, and further advanced in caseation immediately about the cheesy centre, and to become more scattered, smaller, and younger as we recede from that point. This resembles the disseminated form also in being more commonly met with in children than in adults.

The second subdivision of localized tuberculosis in its broader signification is characterized by the deposition of tubercles in inflamed pulmonary tissue, near and in the midst of the inflammatory products. The forms of inflammation which are thus complicated are cheesy pneumonia and peribronchitis, those forms which are especially prone to result in destruction of tissue. To adopt a nomenclature analogous to that which is employed with reference to serous membranes, this form may be termed *tubercular inflammation* of the lungs. Of all the forms it is the most difficult of recognition ; it may, indeed, be said that it is generally impossible to decide in any given case without the aid of the microscope, whether the pulmonary disorganization is of a purely inflammatory or of a tubercular inflammatory nature. As one would naturally expect, but little is to be gained by even microscopic examination of a fresh specimen, for a knotty point like this can be solved in only the thinnest and most delicate sections. It is pretty safe to assume, however, in most cases that the affection is not purely inflammatory, but of a mixed or tubercular and inflammatory character, even when the pathological changes must be ascribed in great measure to true inflammatory processes.

3. The third and last variety of pulmonary tuberculosis is tubercular inflammation of the bronchial tubes, particularly of the smaller ones — *bronchitis tuberculosa.* In very re-

cent cases, the tubercles usually appear to the naked eye as very minute dots or points in the bronchial mucous membrane and are more likely to occur in the upper lobes. They almost never attain considerable size, and least of all, become cheesy, for the reason that they are very prone to break down rapidly and to leave superficial ulcerations with everted edges and grayish-yellow bases. If the mucous membrane is inflamed and reddened the ulcers are easily recognized; but if, on the other hand, it is pale and anæmic, then recognition is often attended with great difficulty. In the latter case they can sometimes be brought to view by rubbing a little blood gently over the surface; the blood adheres to their edges and thus renders them easier of recognition. The ulcers increase both in size and depth by the constant formation and breaking down of fresh tubercles, and may finally perforate the bronchial wall and involve the surrounding pulmonary tissue, which is generally more or less inflamed.

(*g.*) To complete our sketch of these latter processes, all of which are very intimately connected with pulmonary consumption or phthisis, we will next take up the chronic formation of **cavities** in the lungs.

1. Dilatation of the bronchi or *bronchiectasis* may be either pretty widely distributed and uniform (*cylindrical ectasis*), or limited to small areas and without uniformity (*saccular ectasis*). It may again be vicarious or secondary, when for any reason contiguous bronchi have become impervious to air, or it may result simply from chronic bronchitis. The dilated tubes are everywhere lined with mucous membrane, which retains its ciliated epithelium unimpaired. In the saccular form, especially, the secretions are very often retained, become decomposed, and set up inflammation (*putrid bronchitis*); or else inflammation follows inspissation and caseation of the secretion. These dilatations are also a favorite seat of the above described tubercular ulcers, which soon transform the dilated bronchi into ulcerating cavities.

2. Cavities or *vomicæ* may also be formed by the breaking down of pulmonary substance which has become the seat of

the above mentioned cheesy processes. Such cavities may be completely closed and contain a soft mixture of pus and cheesy material, or they may be in direct communication with a bronchus through which their secretion is emptied; the fact that such a communication exists does not in itself prove that the cavity is the result of bronchiectasis, for the reason that a cavity which increases in size must sooner or later become connected with one or more of the larger bronchi. It is only by the presence or absence of a mucous membrane that we can determine the nature of these cavities. If a communicating bronchial tube can be followed up for some distance along the inner wall of the cavity, or if traces of mucous membrane are found here and there within it, bronchial dilatation must have been present at this place at some time; if such, however, is not the case, it is impossible to make a differential diagnosis from the local condition alone. Smoothness of the inner wall of the cavity proves nothing, of course, when taken alone, since a pulmonary cavity, the result of ulceration, may become perfectly smooth after the ulcerative process is arrested, but can still be distinguished from simple bronchiectasis by the absence of a lining of ciliated epithelium.

Several contiguous cavities may be gradually united into one, and thus form an irregularly scolloped cavity, the origin of which is betrayed by the persistence of portions of the septa.

The only component parts of the lungs which show much resistance to destructive processes are the branches of the pulmonary artery, which often traverse cavities in the form of rounded cords, or project prominently from their inner walls and are still pervious to the blood-stream. The wall which lies toward the cavity is sometimes the seat of aneurismal dilatation, when it is greatly weakened, and may rupture and give rise to fatal hæmorrhage. The vessels which traverse cavities sometimes eventually break down after thrombosis has taken place within them, and leave only small, hard, grayish stumps or prominences projecting from

the wall. The presence of these prominences on the inner wall of a cavity may be regarded as proof positive that such a cavity — at all events in its present condition — is the result of ulceration. The appearance of the walls varies according to the condition which they may happen to be in. If the destructive process has been progressing actively they seem to be formed of yellow, cheesy, and broken down masses, which often contain tubercles. We also meet with cases which have run a very rapid course where cavities are found filled with larger or smaller portions of lung tissue, which have been cut off from the circulation, have become cheesy, and are almost completely detached from the wall; if the process has become stationary, the walls are formed of dense fibrous tissue, the surface of which may be of a bluish-gray color or covered with granulations. Cavities occasionally become closed, contract, and heal completely, but this is by no means the rule.

We have now described all the processes which are comprised in what is generally known as *pulmonary consumption*, or **phthisis.** It would be a great mistake to suppose that any one of these processes singly brings about all the changes which are found in a case of phthisis; as a rule several or many processes are coexistent, and this accounts for the great variety of appearance in phthisical lungs, of which scarcely any two are to be found alike. For this reason we cannot undertake to describe the manifold appearances to which combinations of the processes may give rise, but hope that what has been already said will enable the reader to distinguish the several processes from one another, and thus understand their sum. We would only repeat that many cases which at first were of a purely inflammatory nature are subsequently complicated with tuberculosis, which also takes its part in the destruction of tissue. The condition receives its name from the process which may happen to be predominant, and we speak of inflammatory or pneumonic phthisis when inflammation and caseation are chiefly prominent, or of tubercular phthisis when the reverse of this is the case.

It should be mentioned, in conclusion, that cheesy masses, whether in the bronchi or in excavations of the pulmonary tissue, may become in a measure harmless through calcification; they become first thick and gritty, then grow gradually harder and more stony until they form concretions known as *pulmonary* and *bronchial calculi*. On the other hand the destruction of tissue may be greatly hastened if putrefaction takes place in and about the collections of cheesy material — *gangrenous phthisis*. The cavity then contains dirty greenish-yellow necrotic material instead of cheesy pus, and its walls are ragged and gangrenous.

(*h.*) **Tumors** are not uncommonly found in the lungs, and, although almost any form may be primary here, they are generally the result of contiguity (as in cancer of the breast), or else of metastatis (mammary, gastric, œsophageal cancer, sarcoma of the neck or glands, etc.). We have already described the characteristics of the various forms of new growths, but one should take care not to mistake the normal pulmonary alveoli, which often persist toward the edges of the tumor, for the alveoli of cancer. By adding dilute caustic soda or potash to the microscopic specimen, the elastic fibres and their peculiar arrangement may be clearly brought out, and thus error avoided.

There are a few manifestations to which tumors sometimes give rise in the lungs, which are so peculiar as to deserve special mention. All the forms of cancer are, in these organs, peculiarly prone to break down, and may form cavities communicating with a bronchus or with each other, very similar to those which result from cheesy pneumonia. An ulcerative destruction of the lungs may be thus brought about, and has been justly termed *cancerous phthisis*. A second peculiar manifestation is that which is due to *cancerous, sarcomatous, etc., lymphangitis*. The tissue is traversed by narrow bands of the morbid growth, with dilatations or nodules at the points of anastomosis, very much as in superficial, or subpleural, and deep, or parenchymatous, purulent lymphangitis. This form is chiefly met with in connection

with cancer of the breast and stomach, lymphosarcoma of the cervical glands, etc. Careful examination of the contents of the lymphatic vessels with the microscope will generally throw light on the nature of the process, though the undertaking is not always an easy one.

(*i.*) **Echinococci** are sometimes found, and may give rise to the formation of abscess and perforation: their characteristics were described in sufficient detail in connection with the brain.

(*β.*) *Morbid Conditions of the Larger Bronchi.*

Although the bronchial affections, and tubercular bronchitis in particular, of which we have already spoken on account of their intimate connection with parenchymatous changes, are also met with in the larger bronchi, these latter are more commonly the seat of independent processes, chiefly of an inflammatory nature — *catarrhal* and *purulent bronchitis*. The catarrhal form is manifested by swelling and redness of the mucous membrane and increase in its secretion; the purulent form by more intense redness and swelling, and gray or yellowish-white muco-purulent, or light yellow purulent secretions, which may be poured out in such quantities as to completely fill the larger tubes. In both forms alike the mucous membrane is always infiltrated with small cells. It is a serious matter when the purulent form attacks the smallest tubes — *capillary bronchitis* — as is so commonly the case in children, the practical result being very like that of pneumonia. These very small tubes cannot be followed up and laid open with scissors, and one must therefore get at the character of their contents by squeezing them out from the cut surface. Minute drops of pus welling up at a certain distance from one another on pressure, indicate the presence of capillary bronchitis. The connection between this form of inflammation and lobular atelectasis has been already alluded to.

Chronic catarrhal bronchitis, such as is usually associated with emphysema, and, as has been already mentioned, is so often the cause of bronchiectasis, leads to considerable thick-

ening of the mucous membranes; the transverse and longitudinal fibrous striæ are brought out with great prominence, especially at the bifurcations, where they may give rise to actual stenosis. The portions of the wall which intervene between these projecting fibrous bands sometimes become bulged out and form minute diverticula.

In those cases in which *fibrinous* or *croupous bronchitis* occurs independently of fibrinous or croupous pneumonia, it is generally secondary to laryngeal croup. The larger bronchi are found to be lined with a pretty dense, fibrinous false membrane, sometimes as much as two millimeters in thickness, which forms complete hollow casts of the tubes, and can be removed from them as such. Cases of uncomplicated fibrinous bronchitis are very rare, and usually run a chronic course.

Tumors are very rarely primary in the bronchi. Small ecchondroses, or simple outgrowths from the cartilaginous rings, sometimes occur, and when metastatic deposits are very abundant in the lungs they are also sometimes found in the bronchial mucous membrane.

(γ.) *The Pulmonary Vessels.*

The *vessels* are the only important parts of the lungs which still await our consideration. Some of the changes which they undergo have been already alluded to, as brown induration, the result of dilatation of the capillaries, the larger branches, and even the main trunk of the pulmonary artery sometimes, in consequence of passive congestion dependent on valvular disease of the left heart; fatty degeneration of the intima is also to be sought for, a condition which predisposes to hæmorrhagic infarction, and is manifested by the presence of irregularly-shaped yellow spots, or even small losses of substance, on the inner surface of the arteries. Then emboli which may escape demonstration, but give rise to embolic infarction and metastatic abscess; likewise aneurisms which are sometimes formed in cavities in the lung, and on bursting may give rise to fatal hæmorrhage. Something still remains to be said, however, about emboli, of the larger branches of the pulmonary artery in particular, which

neither give rise to infarction nor abscess. An embolus sometimes rides, as it were, on a point of bifurcation, extending only a moderate distance into either branch, and does not completely stop the circulation. In such a case it may pass through its various stages, and give rise to no very great disturbance. It loses its color gradually from without inwards, becomes dryer, firmer, smaller, and adherent to the wall; eventually it is reduced to a dense and firmly attached substance, which may be colored reddish or ochre-yellow by hæmatoidine. On tearing a bit apart with needles, and placing it under the microscope, the pigment will be found either in the form of masses or of crystalline rhombic plates or prisms. If, on the other hand, the embolus blocks a larger vessel completely, life is usually of short duration; and if the vessel be relatively small, the portion of tissue which is thus cut off from the arterial circulation may become gangrenous, secondarily to gangrene of the infarction caused by the embolus. Emboli have sometimes undergone decolorization and other changes at the seat of their formation, before they have got into the lungs, hence before they have become adherent to the wall of the pulmonary vessel.

In searching for the origin of a pulmonary embolus the right heart should first be examined, particularly its auricular appendage, and the depressions between the trabeculæ of the ventricle. If the place of origin cannot be found there, it must be sought in the veins, and, above all, in the veins of the lower extremities, and in the periprostatic, periuterine, and perivaginal plexuses of the pelvis. In recent cases, a correspondence in character between the pulmonary emboli and the thrombi in a particular part, render it probable that the former were derived from the latter.

There is another species of embolism of the pulmonary arteries and capillaries —*fat embolism*— which occurs in almost every case of extensive fracture of the bones, and cannot be demonstrated without the aid of the microscope. It is only necessary to remove a small bit of the lung with scissors, and spread it out in water, in order to see that the

capillaries, and even rather larger vessels, are more or less extensively filled with glistening and highly refractive masses of fat.

(δ) *The Bronchial Lymphatic Glands.*

These glands present many pathological conditions, which may be either primary or secondary to changes in the lungs. They are almost always more or less *pigmented*, sometimes so much so that a black fluid resembling ink may be squeezed from the cut surface. This pigmentation generally corresponds in degree with that of the pulmonary tissue, though it is usually rather more intense.

Almost all *inflammatory* processes in the lungs are complicated with redness, swelling, and softening of these glands, from the cut surface of which considerable fluid is poured out; in phthisis the glands are almost invariably more or less *cheesy*, and often contain gray nodules, isolated as well as in groups at the circumference, which are readily recognized as *tubercles*. Sometimes, however, particularly in children, the cheesy or scrofulous condition of the glands is evidently of longer standing than that in the lungs, and may be completely wanting in the latter. Cheesy masses in the bronchial glands are much more frequently *calcified* than in the lungs, and entire glands, with the exception of the thickened fibrous capsules, may become thus altered.

Sarcomatous and cancerous changes also occur in this situation; the former usually, and the latter always, being secondary. The bronchial glands are a favorite seat of lymphosarcoma (pseudo-leucæmia, Hodgkin's Disease).

9. THE COSTAL PLEURA AND THE POSTERIOR PORTIONS OF THE RIBS.

As a rule, it is unnecessary to pursue the examination of the costal pleura further, and in some cases it is removed and examined together with the lung. This, as we have already mentioned, is to be done when there are very extensive adhesions; and it is desirable to do so in cases of chronic fibrinous and purulent pleurisy, for the reason that the size

of the sac, the effects of the process on the lung itself, etc., are thus more easily seen. The corresponding half of the diaphragm should also be removed, together with the lung in these cases, and, for this purpose, it is better to employ scissors, as involving less risk of injury to the adjoining abdominal viscera.

The pathological conditions of the two layers of the pleura are, of course, essentially the same, but each present certain peculiarities from the fact that the relations of the two layers are not identical. For instance, cancer of the breast, when it extends inwards, usually attacks the costal before the pulmonary pleura; as do also inflammation, ulceration, and perforation, in caries and fracture of the ribs, and in external wounds. Miliary *tubercles* sometimes present peculiarities of distribution on the costal layer. They are often much more thickly aggregated in the intercostal spaces than over the ribs; collections of cheesy material, such as are often found in chronic tuberculosis, also occupy the intercostal spaces as a rule. More or less subserous fatty tissue is normally present in these situations, and may become much increased, and form long, narrow, intercostal lipomata. Old pleuritic false membranes, and particularly the thickened costal layer, are often the seat of extensive calcification, and contain smooth and nodular plates resembling bone in hardness. Small *lymphatic glands*, from the size of a hempseed to that of a pea, are sometimes found in the costal pleura, and are congenital; they are occasionally long and pendulous, with narrow necks.

The posterior portions of the ribs may be examined together with the costal pleura.

10. THE ORGANS IN THE NECK.

(*a.*) *Method of Examination.*

The Regulations (§ 20) laid down for medical jurists, in examining the neck, should be followed in all cases, and direct as follows: —

"The neck may be examined either before or after open-

ing the chest and removing the lungs, according to the peculiarities of each individual case. It is the duty of the examiner to investigate the condition of the larynx and air passages by themselves whenever special importance is attached to them, as in cases of drowning or hanging.

"As a rule, it is desirable to examine the great vessels and nerve trunks first, and then to open the larynx and trachea from before, and note their contents, if any. The last indication is best fulfilled by exerting careful pressure on the lungs while in *situ;* any abnormal fluids, etc., will thus be squeezed out, and their character easily determined."

In cases of injury to the larynx or trachea, and whenever important changes are suspected in them, the air passages should be first removed, together with the other organs of the neck, and opened afterwards. The best method to pursue is the following: The knife is passed through into the mouth at the left angle of the jaw close to the inner surface of the bone and carried round as far as the right angle, being kept close to the bone all the time. Near the chin the handle of the knife should be depressed, to prevent the point from piercing the tongue instead of merely severing the attachment of the genio-glossus muscle. After the tongue has been completely freed from the lower jaw it is to be drawn downwards with the left hand, while with the knife in the other hand the attachments of the soft to the hard palate are divided. The posterior wall of the pharynx is then to be divided as high up as possible, and the knife is passed round either tonsil, then by firm traction on the tongue, the pharynx and œsophagus are detached from the vertebral column and the deep muscles of the neck. On reaching the chest the vessels of the upper extremities are to be divided on either side by a cut directed outwards and backwards from the sternal end of the clavicle; the œsophagus and bronchi may then either be cut across above the arch of the aorta or, if it be not desired to examine the latter separately in its whole course, it may be detached from the vertebral column also, and together with the œsophagus cut across just above

the diaphragm. This latter method should be pursued whenever an important affection of the œsophagus is suspected, and sometimes in cases of poisoning and of cancer of the cardiac orifice it is well to remove the stomach and œsophagus entire.

In all cases in which it either is, or may be, of importance to determine the effects of disease in the organs of the neck and chest whether deep seated or more superficial, especially the heart and lungs, it is better to preserve their mutual connection as far as possible and to remove all the organs of the neck and chest together; after their topography has been accurately noted they can then be examined in detail.

(*b.*) *The Individual Parts or Organs.*

(1.) The Great Vessels and Nerves of the Neck.

(*a.*) Next to rupture of the intima of the carotids, which acquires medico-legal importance from its occurrence in cases of hanging, the most important morbid condition which is found in the *vessels of the neck*, particularly in the carotids by reason of their contributing so largely to the blood supply of the brain, is narrowing and obliteration of their calibre. Narrowing depends on chronic inflammation and calcification of the intima, like that which occurs on the valves of the heart; obliteration is due to large emboli which sometimes turn out to be the unsuspected cause of sudden death. Among the morbid conditions of the veins dilatation may be mentioned, such as is often found in connection with heart disease, or aneurism of the aortic arch, and thrombo-phlebitis of the upper portion of the internal jugular vein, dependent on inflammatory thrombosis of the transverse sinus.

(*b.*) The cervical *sympathetic* nervous system, and particularly the three ganglia, the middle of which is often wanting, are of special interest. The superior of these is usually selected for examination on account of its larger size and easier isolation; it lies near the transverse processes of the

second and third cervical vertebræ, on the deep muscles of the neck, and behind the internal carotid and vagus, which may serve as guides.

Most of the changes found in these ganglia proceed from their vessels; hæmorrhage, in the various diseases which are accompanied by delirium and sunstroke; varicose dilatation of the vessels in unilateral hyperidrosis. The nerve fibres of Remak have further been found in a condition of fatty degeneration in diseases attended with hectic and in pneumonia with marked delirium, and the ganglion cells are abnormally pigmented in all cachexias.

Hæmorrhage has also been found in the *vagus* in hæmorrhagic small-pox, and in sunstroke (Köster); secondary changes, chiefly of an atrophic nature, may be produced by tumors, etc., in the neighborhood. Inasmuch as the pressure exerted by tumors, aneurisms, etc., on the laryngeal branches of the vagus, often results in important changes within the larynx (paralysis and fatty degeneration of its various muscles), it is sometimes interesting to follow the course of these branches. The superior laryngeal nerve runs down to the larynx along the inner side of the carotid artery and divides into two branches, the inner of which pierces the hyo-thyroid membrane in company with the laryngeal artery, while the outer ramifies in the muscles outside of the larynx. The inferior or recurrent laryngeal nerve is longer on the left than on the right side; it passes back round the subclavian artery on the right side, the arch of the aorta on the left, and runs upwards on both sides alike between the trachea and œsophagus to supply the muscles within the larynx.

(2.) The Mouth and the Pharynx.

To examine the mouth and pharynx the soft palate may either be cut through at the side of the uvula, or, if it is not important to preserve the connections of the left tonsil with external neighboring parts, outside the tonsil; a clear view having been thus obtained of the mucous membrane of the

soft palate and its relations to the tonsils, the latter may then be laid open longitudinally.

The *color* of the palatal and pharyngeal mucous membrane varies between a pale gray, a bright red, and a dark purple (death from suffocation, etc.). The darker shades of color are apt to be associated with more or less swelling, which may, however, exist in connection with a somewhat yellowish tinge (œdema). Both redness and swelling generally diminish decidedly after death.

Stenosis of the isthmus of the fauces or of the naso-pharyngeal cavity by bands of cicatricial tissue is usually due to syphilis, the scars resulting from which are notoriously prone to great contraction. Radiating cicatrices of limited extent are often seen on the surface of the tonsils and reduce them more or less in size.

Wounds of the edges of the tongue near the teeth are often inflicted during spasms, particularly of an epileptic nature, and, when found after death, may throw great light on the preceding symptoms.

The most important changes found in the mucous membrane of the mouth and pharynx are due to *inflammation* in its various forms.

Acute *catarrhal inflammation* is characterized by marked injection and swelling of the mucous membrane with a coating of thick, tenacious mucus, and is often accompanied by considerable swelling of the follicles. In the higher degrees of inflammation the mucus is replaced by thick grayish-yellow pus. In chronic catarrhal inflammation the most prominent changes are those of the follicles — *granular pharyngitis*. The *tonsils* participate in these conditions, are swollen, and their crypts are full of a soft, yellowish, puriform material, which is shown by the microscope to be composed of desquamated epithelium, mucus, and fatty detritus. In the chronic forms this secretion is much more dense, often more or less slate-colored, and the crypts contain offensive yellowish-gray plugs, which may be more or less calcified. The follicles at the base of the tongue are also swollen.

The affections known as *croup* and *diphtheritis* represent still higher degrees of inflammation. The term croup being originally of purely clinical significance, misunderstanding will best be avoided by applying the adjective *fibrinous* to that form of inflammation which is characterized by the exudation of a coagulable albuminous material on the surface of the mucous membrane, forming a continuous and easily detachable membrane. It must not be thought, however, that the process involves absolutely no change in the mucous membrane itself. On the contrary, after removal of the false membrane, the mucous coat appears intensely red and swollen, often containing numerous hæmorrhages, and — as is readily seen in fresh sections with the double knife when placed under the microscope and made clear with acetic acid — is always infiltrated with cells, even in its deeper layers. This form of inflammation occurs on the palate and pharynx, and the false membranes, which are easily detached without injury to the true and underlying membrane, are often found on the posterior surface of the palate, on the uvula, and above all in the sinus pyriformes. It is by no means rare to find at the same time in other situations, and particularly on the tonsils, that species of inflammation which is known as *diphtheritic*. This may be either primary or secondary (in variola, scarlatina, etc.), and is characterized by the formation of a false membrane which not only covers the mucous surface but is also firmly adherent to it and extends more or less deeply into its substance. The underlying mucous membrane is infiltrated with fibrine and granular matter as well as with cells, and thus easily becomes necrotic; recovery is then only possible through separation of the slough and cicatrization of the open surfaces which remain behind. A fresh yellowish-gray diphtheritic deposit may be formed over these open surfaces, constituting what are known as diphtheritic ulcers.

To ascertain the depth of the diphtheritic infiltration incisions must be made in different portions of the affected parts. The microscope shows invariably the presence of great num-

bers of low organisms, the most common of which are nests of micrococci; these are very often of a brownish shade, especially under low powers, and may occupy the mucous membrane itself as well as the diphtheritic deposit, as is well seen on the addition of glacial acetic acid or very dilute caustic potash. When colonies of micrococci have been often seen, they are not likely to be confounded with detritus or granular matter, and he who affirms the contrary has either never examined a case of diphtheritis, or else is unfit to use the microscope at all. The parasitic nature of the granules can be clearly demonstrated by boiling the specimen first in glacial acetic acid, then in a mixture of equal parts of absolute alcohol and ether, finally examining it in glacial acetic acid and glycerine. In purely fibrinous membranes they are by no means constant, needle preparations showing an albuminous substance which becomes swollen in acetic acid and is infiltrated with a variable number of cells.

Mucous membrane which is the seat of the diphtheritic process is often very prone to break down, become gangrenous, grayish-green in color and ragged, with a most offensive smell: these are the cases which present the most marked changes in the pharynx and fauces, and in which the swelling reaches its highest pitch.

There is another form of inflammation which is not superficial, but attacks the deeper layers of the mucous membrane, and, especially the submucous tissue, and which from its resemblance to phlegmonous inflammation of the external integument may be called *suppurative sore throat* (*angina phlegmonosa*). The tonsils are the favorite seat of this form (though it occurs also elsewhere in the throat) and may become so swollen as to exceed a pigeon's egg in size. In the earlier stages of the affection the interstices of the tissue are filled with an opaque, grayish-yellow fluid containing large numbers of pus cells; while in the later stages the fluid becomes even more opaque and yellow — *i. e.* more purulent, — and may form abscesses, especially in the tonsils, which empty outwards. This form of inflammation may be of an infective character, as in malignant pustule, erysipelas, etc.

The changes which are brought about by syphilis and tuberculosis next demand our consideration. That early manifestation of *syphilis* to which the term *mucous patch* has been applied is naturally not often met with in the corpse; but when found is covered with a grayish secretion resembling that of the chancre. As a rule we find only the *cicatrices* resulting from these patches, which, as we have already mentioned, give rise to stenosis and other deformity of the parts. A cicatricial condition is often found at the base of the tongue, and, if present, may prove of material assistance in diagnosis. When the base of the tongue is found to be flattened and depressed, to have lost its follicles, and its mucous membrane is thickened and grayish-white in color, it is highly probable that we have to deal with the results of syphilis. The muscular substance of the tongue may be the seat of yellow gummy nodules as well as of the cicatrices which they occasionally leave behind them. Perforation of the hard palate, whether large or small, is almost sure to be due to syphilis, provided only that the congenital condition known as *cleft palate* can be excluded.

Tubercular affections of the mouth and pharynx are less common than the syphilitic, though they are met with in the form of miliary tubercles, as well as in the form of tubercular ulceration. The character of the latter is betrayed by its uneven edges, and the presence of small cheesy, or recent and gray nodules, both on the base and edges. The adjoining tissue is sometimes considerably hypertrophied, thus causing papillary elevation of the edges of the ulcer. Tubercular ulcerations as well as disseminated tubercles are occasionally found in and upon the tongue in the course of the lymphatic vessels.

Lupus and *leprosy* belong to the same group of tumors as gummata and tubercles, and the same forms appear in the buccal mucous membrane as in the external integument. Lupus, especially, may on cicatrization give rise to great deformity.

Cystic tumors occur in various portions of the mouth; the

most common of these is *ranula*, which is seated under the tongue alongside the frænum, and is due to a plug in the duct of the submaxillary gland and the resulting retention of secretion. The tongue is subject to a very peculiar hypertrophy — *macroglossia* — due to enlargement of its lymph spaces and vessels. *Epithelioma* of the tongue, in common with the two affections mentioned, comes rather within the domain of surgery; it starts from those portions of the tongue which are in contact with the teeth, and spreads both backwards and forwards, often very widely. The tonsils are sometimes the seat of the soft varieties of cancer.

The appearances of *thrush* in the mouth and pharynx are the same as in the œsophagus, in connection with which they will be described.

(3.) The Œsophagus.

The organs of the neck should be so placed in examining the œsophagus, that the latter lies uppermost, and it may then be opened with scissors along its left border (to the right of the operator).

(*a.*) *General Morbid Conditions.* The *œsophagus* may be either dilated or contracted. *Dilatation* may be either general or local, the former being usually due to stenosis lower down in the intestinal canal; its wall, and particularly the muscular layer, is very apt to become hypertrophied at the same time. A relaxed condition of the muscular coat may simulate dilatation, but the flaccidity of the muscle, and the absence of any other cause of widening, will generally reveal its true nature. Local dilatation is found above a contraction, whether the latter is caused by tumors or by cicatricial tissue. The forms we have thus far considered involve the whole circumference of the tube; limited portions, however, may be involved, and thus arise what are known as *diverticula*. These may attain considerable size, and are usually seated between the œsophagus and vertebral column.

Contractions or *stenoses* are almost always local, resulting

from cicatricial tissue or cancerous growths, and occur chiefly on a level with the cricoid cartilage or the bifurcation of the trachea; the tube may be contracted without being actually diseased, as for instance, below a marked stenosis.

The *color* of the mucous membrane is almost always a pale gray, but may be yellowish from contact with icteric contents of the stomach. Hyperæmia of the pharynx, however marked, very rarely extends into the œsophagus. Thickening of the epithelial coat renders the surface whiter; the post-mortem action of the contents of the stomach on the lower portions renders them brown and soft — *brown softening.*

(*b.*) *Special Morbid Conditions.* We need not dwell long on *inflammation* of the œsophagus. Simple inflammation is associated with abundant desquamation of the epithelium; the fibrinous and diphtheritic forms are rare, though they sometimes occur, especially in scarlatina and hæmorrhagic small-pox. The latter forms bear a strong resemblance to thrush.

The œsophagus is not unfrequently the seat of *injury*, from the accidental or intentional introduction of hard bodies (among which bougies may be included) or corrosive liquids. The latter are especially important from their frequent use as poisons. Sometimes they leave only slight traces from the rapidity of their passage, but they may give rise to extensive alterations. When the mucous membrane is acted on mildly by acids, it presents a grayish or yellowish discoloration, and is hard and wrinkled; the action of alkalies causes it to become softened and to present a brownish discoloration resembling post-mortem softening, but differing from that condition by its action on test-paper. Both acids and alkalies, when very concentrated, corrode the tissue, and color it brown or black. In cases in which life is more or less prolonged, the eschars may come away with suppuration, and cicatricial tissue be formed; this contracts over a larger or smaller surface, producing a varying degree of stenosis.

Under *tumors* we will mention the occasional occurrence of a varicose condition of the veins, especially in the lower

portion, and phlebolites. The lipomata, myomata, and fibromata are rare in this situation ; but *cancer* is quite frequent, and from mechanical causes is very apt to occupy that portion of the œsophagus which crosses the left primary bronchus. It is generally of the epithelial variety, soon ulcerates, and may finally lead to perforation into the trachea, pleura, pericardium, etc. Congenital œsophago-tracheal fistulæ are sometimes met with.

The *parasitic* affection known as *thrush* (mycosis oïdica) occurs in the œsophagus, and derives most of its importance from the fact that it may easily be mistaken for inflammation attended by the formation of a false membrane, particularly of the fibrinous variety. This affection, which may also occur in the pharynx, is found chiefly in cachectic adults, and in children who are ill-nourished and fed from the bottle ; it gives rise to the formation of a soft whitish membrane, which is easily stripped off the mucous surface, and often closely resembles a fibrinous false membrane, but is distinguished by its softness. Needle preparations, however, when placed under the microscope, show that it is composed of the superficial layers of the epithelium covering the mucous surface, and of great numbers of fine, thread-like, jointed formations (oïdium albicans), from which elongated conidia have become freely detached.

(4.) The Larynx and Trachea.

To *lay open* these parts the organs of the neck are placed in the same position as in opening the œsophagus, and, after inspection of the position of the vocal cords from above, the posterior wall is cut through with scissors along the median line, where the cartilaginous rings are defective ; the cut edge of the œsophagus, on the left, should, meanwhile, be drawn out of the way, toward the left of the operator. The organs are then to be laid on the fingers of both hands, and the interior of the larynx brought clearly into view by spreading it open with the thumbs, one being placed on each corner of the thyroid cartilage. If the cartilages are ossi-

fied, they must be forced apart, even if they are broken in the process.

The *morbid conditions* of the larynx and trachea are, in the main, identical with those of the mouth and pharynx, which we have already described.

A very important condition, to which children are especially liable, is œdematous swelling of the mucous membrane of the cords and ary-epiglottic folds — *œdema of the glottis.* It should never be forgotten that œdema is always much less marked after death than during life; a degree of swelling which involved danger to life may, indeed, have almost entirely disappeared when the section is made. The degree of tension of the mucous membrane may be of considerable value in this connection. If, instead of being smooth and even, it lies in folds and wrinkles, we can be sure that œdema has been present. Œdema is almost invariably of inflammatory origin, and is very seldom really primary in the larynx, but is secondary either to affections of the larynx and pharynx, or to erysipelatous or phlegmonous inflammation of the face.

Modifications in form. Unimportant changes in the form of the trachea may be brought about by pressure from without, calcification of the cartilaginous rings, cicatrices, etc., and sometimes the tube is thus flattened like a scabbard. A very remarkable condition, however, is that known as the *suffocative position of the epiglottis.* The surface of this organ is normally but very slightly curved from side to side, but in all forms of death from suffocation its edges are found to be more or less approximated, in extreme cases producing a wedge-shaped appearance.

The *color* and *amount of blood* in the upper air passages are of great interest to the medical expert, who gains information from the intensity of a green or greenish-brown discoloration as to the time at which death took place, and from the presence of a bluish tinge as to the cause of death (suffocation). The caution which we enjoined with regard to œdema applies equally here; the color and degree

of injection after death may convey but a very imperfect idea of the condition of things during life. Quite commonly, particularly in children, the trifling changes which are found in the mucous membrane of the larynx in general, and of the vocal cords in particular, afford no adequate explanation of the violent symptoms which preceded death.

Although the simple superficial *fibrinous* inflammations are less common in the mouth and pharynx than the diphtheritic inflammation with infiltration, the reverse is the case in the larynx and trachea. Tubular casts of the interior of these latter parts are common enough, and small isolated patches of false membrane are still more common. The membranes vary greatly in thickness; the more delicate often present to the naked eye a reticulated appearance even, which is yet more distinct under the microscope. This peculiar appearance is due to the secretion of the mucous glands, with the duct of one of which each individual depression in the false membrane corresponds.

Fibrinous false membranes sometimes extend continuously far into the bronchial tubes, and retain the same character throughout, but, as a rule, they become thinner, and more broken as they enter the lung, being gradually merged into a simply catarrhal muco-purulent secretion. The pulmonary parenchyma itself is sometimes involved, but the resulting pneumonia, instead of being fibrinous, as the ill-chosen term *croupous* would lead one to expect, is always and without exception of the catarrhal form.

Diphtheritic affections of the larynx and trachea, though more rare, are not uncommon. These parts, as well as the epiglottis, are sometimes the seat of a false membrane which can be detached only with the greatest difficulty, and the underlying mucous membrane presents a grayish infiltration. The parts of the trachea which are more commonly the seat of this affection are those adjoining the wound of tracheotomy. Those forms of inflammation in the larynx and trachea which complicate many infectious diseases, and particularly the acute exanthemata, often acquire a diphtheritic charac-

ter. In variola small diphtheritic patches are often found in the trachea — chiefly over the cartilaginous rings — and have been erroneously supposed to be the peculiar eruption of that disease. Pneumonia, very often of a malignant type, and involving rapid destruction of tissue, is sometimes set up by the inhalation of particles of diphtheritic material from the pharynx as well as from the larynx and trachea.

We need only allude to the fact that *phlegmonous inflammation* may extend from the pharynx to the entrance of the larynx. That œdema of the glottis may thus be caused has already been mentioned.

Chronic inflammation is very common, and varies in appearance according to its intensity and duration. A trifling degree of the condition is often found in those whose occupation involves more or less strain of the vocal organs (singers, etc.), and is manifested by a bluish-white discoloration, and thickening of the vocal cords, especially their posterior portions. The thickening and discoloration are almost wholly due to a moderately tough membrane-like substance, which can be easily stripped off the mucous membrane with forceps, leaving it quite intact, and when placed under the microscope is seen to consist of epithelial cells, which have become decidedly horny. The condition is, therefore, a simple thickening of the epithelial layer; a sort of pachyderma. In higher degrees of the process the mucous membrane itself, both that covering the cords as well as that lining the cavity, is thickened, of a grayish-white shade, and denser than normal. This condition is sometimes found in children after prolonged whooping-cough. The mucous glands share actively in chronic catarrh; they are enlarged, their ducts are dilated, and actual cysts sometimes result from them.

Ulceration in its various forms is very common, of great importance when found in the larynx, and is generally due to phthisis, typhoid fever, or syphilis. *Syphilitic* ulceration is most common in the edges of the epiglottis, which may become extensively destroyed, but it also occurs in the larynx, and, more rarely still, in the trachea. It is characterized by

a yellowish, lardaceous appearance of the base and a rounded protrusion of the edges, the mucous membrane over which is often the seat of polypoid formations. The favorite seat of *tubercular* and *typhoid* ulceration is near the posterior attachment of the vocal cords, and both forms not infrequently attack the cartilage. According to Rokitansky, the typhoid ulceration is the result of gangrene, and has discolored gangrenous edges; while the edges of tubercular ulcers are always uneven, more or less scalloped, and of a yellowish color, like their bases. Tubercular ulcers are not confined to this limited locality, but may be found anywhere from the top of the epiglottis to the interior of the trachea. They are often, particularly on the epiglottis, so superficial, and, in common with the surrounding mucous membrane, so pale, as to be scarcely distinguishable; sometimes, the mucous membrane at their edges is much thickened, like that around syphilitic ulcers.

Ulceration, particularly when seated on the cords, is very often associated with purulent inflammation of the perichondrium of the arytenoid cartilages (*perichondritis arytænoidea*), which may, however, also occur without ulceration, — in phlegmonous laryngitis, for instance. The perichondrium is separated from the cartilage by pus, and the latter is thus cut off more or less from the circulation, and becomes necrotic. The abscess generally breaks, without much delay, into the larynx, and leaves an opening of greater or less size communicating with a cavity within which the necrotic cartilage lies loose. If the process still persists, the arytenoid cartilage becomes detached in whole or in part, — may be gotten rid of, a cavity the size of a cherry-stone being left in its place. Sometimes the inflammation extends to the cricoid cartilage, and runs the same course there.

Tracheal ulcers are chiefly *tubercular*, and may be very small and indistinct, or very extensive and confluent. Deep ulceration leads occasionally to perichondritis of the cartilaginous rings, one or more of which may become necrotic in whole or in part, and lie exposed at the base, or project from the edge of the ulcer.

The tubercular ulcers of the larynx and trachea are often associated with miliary tubercles, although the latter may be present without the former, particularly in the trachea; these bodies are here usually extremely minute, gray, and translucent. The appearance of miliary tuberculosis may be exactly counterfeited in cases of simple catarrh, in which the mucous glands are involved, if the glands are compressed in forcing open the parts after the longitudinal incision has been made; a minute gray drop, consisting chiefly of cast-off epithelium, is thus forced out of the duct of each gland, but the condition is easily distinguished from tuberculosis as the drops disappear when the finger is passed lightly over the surface of the mucous membrane. Cicatrices resulting from old ulceration are found in the larynx and trachea — particularly in the former, as is the case with the pharynx, — and generally point to syphilis, especially if the cicatricial bands radiate from the centre, are very thick and prominent, and have caused great deformity.

The most common laryngeal *tumors* are polypoid, which are found near and upon the cords, are often lobulated, and possess a varying degree of consistency. Cancer also occurs in this situation, and is as characteristic here as elsewhere. The external wall of the trachea is sometimes the seat of cystic tumors of the size of a pea or cherry, having small pedicles; these are dilated mucous glands, as is shown by the fact that they communicate with the interior of the tube by an opening which is sometimes large enough to admit the passage of a good sized probe. Small multiple ecchondroses of the tracheal cartilages are occasionally met with.

(5.) The Submaxillary Glands.

The submaxillary and sublingual glands are to be laid open by longitudinal incisions, though they are but seldom the seat of important pathological conditions. Tumors, both syphilitic and other forms, often take their origin here, but the only other change which occurs with any frequency is interstitial suppurative inflammation (*adenitis apostematosa*)

of metastatic nature, in connection with such acute infective diseases as typhoid fever, septicæmia, etc. One or both glands may be affected. They are enlarged, and in recent cases the individual lobules are separated by broad gray lines, in more advanced cases by yellow lines of pus. As the glandular tissue is usually much reddened, the appearance of the whole is very characteristic. If the process advance still further, collections of pus may be formed both in and about the glands (*periadenitis apostematosa*), which may finally be more or less extensively destroyed. In very severe cases of phlegmonous sore throat or diphtheritis of the fauces the submaxillary glands sometimes become involved in the process.

(6.) The Thyroid Gland.

The lobes are to be laid open by longitudinal incisions. The chief pathological conditions assume the general form of *enlargement*, which may be general, or confined to either lateral lobe, or to the middle or pyramidal lobe: the terms *bronchocele* or *goitre* include all, and even cancer and sarcoma have in this situation been called *carcinomatous* and *sarcomatous bronchocele*. Bronchocele in the more restricted sense, however, comprises enlargements originating in either the glandular or interstitial tissue, or in the vessels. The first of these three varieties is called *parenchymatous* or *hyperplastic*, though in accordance with the more modern nomenclature it should perhaps be classed among the adenomata, and consists in simple hyperplasia of the glandular alveoli. Its cut surface appears granular and of a uniform brownish-red color. The most common form is called *gelatinous* or *colloid*, and is characterized by a dilatation and distention of the alveoli with a translucent yellowish or brownish substance, the collections of which project slightly above the level of the cut surface, and are larger in proportion as the process is the more advanced. The entire gland may be affected, or only limited portions, which are usually surrounded by capsules of fibrous tissue.

This is closely allied with the *cystic* form, also originating in the glandular alveoli, which are filled with a soft or even fluid substance, and are greatly dilated. These cysts may be the seat of hæmorrhage, which imparts a brownish-red color to their contents — *hæmorrhagic bronchocele.*

The variety of bronchocele which is characterized as *fibrous* or *osseous* originates and runs its course chiefly in the interstitial tissue, which becomes greatly increased in amount, and dense, gradually replacing the glandular elements more and more, and finally may become calcified. Any or all of the above-mentioned forms are often found in combination, and, in fact, scarcely any two bronchoceles are exactly alike.

We now come to the third variety, comprising those forms which originate in the vessels. These may be further subdivided into *aneurismal* and *varicose* bronchoceles, according as the dilatation is arterial or venous. The latter form is very apt to be combined with some one or more of the preceding forms. *Amyloid* bronchocele is the result of amyloid degeneration of the arteries, and may also occur in the form of encapsulated nodules.

Small tumors not exceeding a cherry in size, and identical in structure with true bronchoceles — *supplementary* bronchoceles, so called — are sometimes found, and are considered by Virchow to proceed from portions of the gland which became detached during fœtal life. Since, however, Cohnheim's recent observation of the possible occurrence of a metastasis from bronchocele, the question must be raised whether these forms are not lymphatic glands which have become secondarily diseased. Tubercles are sometimes found in the thyroid as in most other glands, and purulent interstitial inflammation, such as was described in connection with the salivary glands, is found here in rare cases.

(7.) The Cervical Lymphatic Glands.

The pathological conditions of the *cervical lymphatic glands* are essentially the same as those of the bronchial and

mediastinal glands, and hence need not be described in this place. We will merely state that the left supraclavicular glands are sometimes secondarily affected in cancer of the stomach.

11. THE DEEP MUSCLES OF THE NECK AND THE CERVICAL VERTEBRÆ.

The most important changes which are found here are those which are due to *caries* of the vertebral column. The initial stages of this affection are often very difficult of recognition, but when fully developed it may lead to *retropharyngeal abscess* seated on the anterior surface of the bodies of the vertebræ, and extending a variable distance downward, sometimes into the muscles.

12. THE HYDROSTATIC TEST.

As it is at times of interest, apart from medico-legal cases, to determine whether a new-born child has breathed or not during or after birth, we will describe the modifications of procedure which are enjoined by the Regulations (§ 24) as necessary to ascertain this fact.

The examination is to be begun with the thoracic and abdominal cavities, not with the head; and after inspection of the abdominal cavity (particular attention being directed to the height of the diaphragm) a ligature is to be passed round the trachea just above the sternum and drawn tight. The sternum and costal cartilages are then to be removed in the usual way, the external condition of the thoracic organs noted, and the heart examined before its removal. The larynx and that portion of the trachea which is above the ligature are next to be laid open longitudinally, and the attention directed to the character of their contents and the condition of their walls. "The trachea is then to be divided above the ligature and its lower portion removed from the body, together with all the thoracic organs. The thymus gland and heart are next to be dissected off with care — the interior of the latter may now be examined — and the lung

is then to be placed in a spacious vessel filled with fresh cold water to see whether it will float. The lower portion of the trachea and the primary bronchi are then to be laid open and the character of their contents accurately noted. Incisions are to be made in both lungs and it is to be noted whether the lungs crepitate; the quantity and character of the blood which is squeezed out over the cut surface on gentle pressure are likewise to be recorded. Incisions are also to be made in the lungs when held under water, in order to see whether any air bubbles escape from them; they are further to be separated into their individual lobes, these again into smaller portions, and all the pieces thrown into water to see whether they will float. The œsophagus is next to be opened, and its contents noted. Finally, in case it is suspected that the lungs contain foreign or pathological material (vernix caseosa, meconium, or an exudation), and are thus rendered impermeable to air, they must be examined microscopically."

(*B.*) THE ABDOMINAL CAVITY.

The usual order in which the abdominal organs are removed is deduced from the rule already laid down, that no organ should be removed, the absence of which would materially interfere with the subsequent examination of other organs. After examining the peritoneum of the anterior abdominal wall, the organs are to be removed and examined in succession as follows: (1) omentum, (2) spleen, (3) left kidney and suprarenal capsule, then the same organs on the right side, (4) urinary bladder, (5) organs of generation (in the male, prostate gland and vesiculæ seminales, testes, penis and urethra; in the female, vagina, uterus, the pelvic fibrous tissue, Fallopian tubes and ovaries), (6) rectum, (7) duodenum and stomach, (8) the common bile-duct, and the portal vein between the layers of the gastro-hepatic omentum, (9) gall-bladder and liver, (10) pancreas, (11) mesentery, (12) small and large intestine, (13) the great blood-vessels on the anterior surface of the vertebral column, and the retroperitoneal lymphatic glands.

It is evident that it will often be found necessary and desirable to modify this order of procedure; the operator must decide as to the best method to be pursued in any particular case, and always choose the lesser of two evils. In many cases of chronic peritonitis with extensive adhesions, and when the intestines are glued together by a cancerous formation, it may be desirable to remove all the abdominal viscera, in one mass, in order to be able to examine their mutual relations from behind as well as from in front. The intestines, when much distended with gas or fluid, will often be found to be in the way, and to add greatly to the difficulty of ascertaining the precise relations of the pelvic organs, kidneys, ureters, retroperitoneal lymphatic glands, etc. It will be found advantageous, therefore, in these cases, to separate the intestine from its mesentery, and remove it from the body at the very commencement of the section of the abdominal cavity, although it is better to postpone opening it till later.

1. THE PERITONEUM OF THE ANTERIOR ABDOMINAL WALL.

This portion of the *peritoneum* is often the seat of changes of an *inflammatory* nature. These, when acute, are manifested by marked redness and injection of the blood-vessels, often followed by hæmorrhage, and a more or less abundant deposit of fibrino-purulent material (*fibrino-purulent peritonitis*); when chronic, by either simple thickening of the membrane or more commonly by adhesion between the parietal and visceral layers (*chronic adhesive peritonitis*). Adhesions, as well as other results of inflammation, may be either general or local. Both the peritoneum and the adhesions are often darkly pigmented from old hæmorrhage, and this pigmentation may also occur in the non-adhesive form of inflammation.

A peculiar form of inflammation, which was long thought to be confined to the recto-vaginal and recto-vesical pouches, has recently been occasionally observed in the peritoneum

of the anterior abdominal wall. This form is completely analogous to what has already been described as chronic internal hæmorrhagic pachymeningitis, and hence may be termed *chronic hæmorrhagic peritonitis;* it may be accompanied with profuse hæmorrhage into the newly formed false membranes — *hæmatoma of the peritoneum.*

Portions of the membrane enclosed by local adhesions may be the seat of a suppurative or gangrenous inflammation, and the resulting ulceration may deeply implicate the subperitoneal tissue (*ulcerative peritonitis*), and even give rise to perforation, the most common seat of which is in the vicinity of the pelvis, though it also occurs over the gall-bladder and intestine.

Tuberculosis of the peritoneum is a common affection, and may occur in the form of *disseminated miliary tubercles* alone, or, as is more usual, inflammatory products may also be present. Such a tubercular inflammation, when acute (as has already been mentioned in connection with Abnormal Contents of the Abdominal Cavity), is usually associated with hæmorrhage; when chronic, with adhesions in which the tubercles are deposited in great numbers.

Cancer in like manner is met with in both the disseminated and the inflammatory forms. *Lipomata* sometimes start from the subperitoneal fatty tissue, and may attain considerable size, projecting into the abdominal cavity.

2. THE OMENTUM.

The position and color (the amount of blood which it contains) of the *omentum* having been already referred to in another place, it merely remains to describe the special morbid conditions of the part. The normal omentum contains a large quantity of fat, especially along the course of the blood-vessels, on either side of which it is collected in masses like minute bunches of grapes; in all cases of general wasting of the body this fat disappears to a greater or less extent. *Atrophy* is, however, not confined to the fat, but may affect also the fibrous tissue, which becomes sometimes ex-

tremely delicate and may disappear entirely, leaving holes of larger or smaller size. Thickening of the fibrous portion of the omentum is the result of chronic inflammatory processes (*omentitis chronica fibrosa*), which may be only local and lead to local cicatricial contractions (*omentitis fibrosa retrahens*), or band-like adhesions (*omentitis adhæsiva*) in and between the omentum itself and its adjoining parts. Such adhesions occasionally form sacs, into which coils of intestine may find their way and become incarcerated. If the inflammatory process be widely extended, and if no adhesions have been formed with other parts, the whole omentum may shrivel into a thick, dense, grayish white, fibrous band lying in front of the colon. When the seat of *suppurative inflammation* it is greatly reddened, opaque, and covered with a fibrino-purulent deposit; it also shares actively in *tubercular* and *cancerous* inflammation of the peritoneum, and in these latter affections is very often greatly retracted. On cutting into the mass, it is not uncommon to find that most of the tubercular or cancerous nodules are superficial, while the interior consists chiefly of the normal fat. These as well as other new formations are also met with in the omentum without inflammation; in general miliary tuberculosis, indeed, this is a favorite seat of the tubercles. It is not always an easy matter to distinguish between the larger tubercular nodules and the smaller aggregations of fat, especially when the latter are somewhat atrophied, and, instead of being yellow, have become rather grayish in color. The localization of the bodies in question sometimes throws light on their nature, collections of fat always following the course of the vessels, while tubercles are often isolated in the midst of the fibrous net-work. Tubercles, moreover, are always round and usually distinctly spherical, while collections of fat are generally oval and somewhat flattened; the smallest tubercles, again, though translucent, are never so translucent as collections of fat. If the tubercles are of the true miliary type there can be no doubt whatever as to their nature.

Small *lipomata*, and single or multiple *echinococcus cysts*, are occasionally met with in the omentum.

There are few structures the pathological changes in which are so easily examined microscopically as in the omentum; it is only necessary to cut out a small bit from a portion containing the least amount of the fat and spread it out in water, — or in glycerine, or a solution of potassic acetate, in case it has been thought best to stain the specimen with hæmatoxyline, aniline, etc. In the fœtus which has become decomposed in the uterus as well as in the icteric new-born child, the presence of yellowish-brown rhombic and needle-shaped crystals, both within and without the vessels, is thus easily demonstrated, as is also the inflammatory infiltration with granulation cells, taking place especially along the course of the vessels, and which possess a marked affinity for staining fluids. Beautiful specimens may, in like manner, be obtained of the individual nodules in the disseminated forms of tuberculosis, carcinoma, or other new formations.

If the rules which have been laid down in another place are strictly followed, no great difficulty should be encountered in determining the nature of a new formation; it should be remarked, however, that tubercles in this situation do not invariably contain giant-cells, and that they are, as a rule, not so distinctly reticulated here as elsewhere, their groundwork being formed of the fibres of the omental tissue itself, which are forced apart by collections of tolerably large cells. When, in describing the gross appearances, it was asserted that tubercles in the omentum are found at a distance from the vessels, the remark was not meant to imply that they are never found along the course of the vessels also; on the contrary, the microscope shows active proliferation of the fat cells with loss of their fatty contents, and the substitution of tubercles in many places for the normal collections of fat.

The study of tubercular as well as of purely inflammatory affections of the omentum affords an excellent opportunity for verifying another fact which has an important bearing on

general histology; namely, that the endothelial cells, with which the whole fibrous framework of the omentum is invested, increase in size, while their protoplasm becomes granular and their nuclei are multiplied, thus forming large multinucleated giant-cells. That these may develop into tubercles, appears to me questionable, or, at all events, to require further proof than has yet been given. I have never been able to satisfy myself that pus corpuscles are developed from proliferating endothelial cells in inflammatory processes; the great numbers of fat-drops which are always found in these cases suggest rather that the endothelial cells undergo fatty degeneration and disappear.

3. THE SPLEEN.

After freeing the omentum from its attachment to the transverse colon, the next step is to remove the spleen, which lies behind the fundus of the stomach, and is attached to it by delicate areolar tissue. The organ is to be firmly grasped in the left hand and drawn far enough forwards to admit of severing its vessels near the hilus, attention being directed meanwhile to the amount of blood which they contain or the presence in them of any pathological change, such as calcification, aneurismal dilatation, etc. If, as is very often the case, the spleen is firmly adherent to the diaphragm, care must be exercised in breaking up the adhesions lest the capsule be torn off and left behind. The gastro-splenic omentum sometimes contains one or more rounded bodies, from the size of a pea up to that of a cherry — *accessory spleens* — which generally present the same pathological changes as the main organ.

(*a.*) *External Examination.*

1. *General Appearance.*

(*a.*) The *position* of the spleen may be modified by tumors in its neighborhood, and in rare instances the organ lies primarily much lower than normal — the movable or wandering spleen: the splenic vessels in these cases are in every

way normal, except that — in common with the fibrous attachments of the organ — they are much lengthened, and occasionally are twisted on their axes, obliterated, etc. The possibility of the escape of the spleen into the left pleural cavity through a diaphragmatic hernia has been already alluded to.

(*b.*) It is often of great importance to determine the *size* of the organ with accuracy. In the adult its average weight is 250 grams, its length, eleven to thirteen centimeters, its breadth, eight to nine cm., its thickness, four to five cm.

The following method should be followed when it is desired to ascertain the exact dimensions of the spleen as well as of other organs. Laying the organ on a wooden table or board, it should be firmly fastened down by passing a scalpel through it vertically, after which the transverse and longitudinal diameters can be easily measured. The thickness may be ascertained by passing the scalpel vertically through the thickest portion of the organ, marking the part of the knife to which it penetrates with the finger, withdrawing the knife, and determining the distance by a measure. The spleen may be either increased or diminished in size, the former being relatively more common. *Diminution* in size is usually the result of atrophy of the pulp, in consequence of which a small spleen is very apt to be at the same time dense and hard, and to have a thickened capsule. It occurs in old people and those who have been the subjects of general atrophy. The spleen may be *enlarged* to two, three, four, or more times its normal size. Acute enlargement occurs in all the acute infective diseases (typhoid and typhus fevers, relapsing fever, pyæmia, etc.), the organ being soft and swollen, with a thin and tense capsule, while the enlargement which occurs in intermittent fever (ague-cake), leucæmia, and pseudoleucæmia is chronic, and is associated with induration of the organ. In amyloid degeneration the enlargement is considerable, and the consistency resembles that of dough ; in passive congestion, dependent on disease of

the liver, lungs, or heart, the enlargement is only moderate and the tissue is usually dense. New formations of various kinds and echinococci are occasional causes of enlargement.

(*c.*) The modifications in *form* which may be undergone by the spleen are manifold, but most of these are of no great importance. Congenital fissures of varying depth are sometimes found on the anterior border, but the chief causes of deformity are circumscribed lesions, such as infarctions, tumors, or echinococci, which generally produce local elevation of the surface. Local depressions, and constrictions dividing the organ into lobes, are sometimes met with as results of cicatricial formation which, in its turn, may be the result of infarction, syphilis, or injury.

(*d.*) The *color* of the surface is largely dependent on the thickness of the capsule, which transmits the color of the parenchyma in an inverse ratio with its thickness. If the capsule be thin some idea may be gained of the amount of blood contained in the organ, the color being due in a great measure to this. The coloration of the surface as a whole is less important than that of circumscribed lesions, the nature of which can often be determined from their color alone. Hæmorrhagic infarctions, for instance, when recent are almost black, but with the lapse of time grow more and more yellow at the centre, and become surrounded by a narrow zone of deeply congested tissue.

(*e.*) The *consistency* of the spleen varies within wide limits — from that of a mere pulp to that of a dense fibrous structure — and depends on the condition of the capsule as well as on the composition of the parenchyma. If the former be tense, as in acute enlargement, the organ is firmer than if it be relaxed, as is the case when an enlarged spleen is returning to its normal size. The thickness of the capsule may also have much to do with the consistency of the organ. The condition of the parenchyma, on the other hand, is not without its effect in this regard, a spleen which is the subject of chronic enlargement being as a rule firmer than one which is acutely swollen.

2. *The Capsule.*

The normal *capsule* is smooth, thin, and transparent; but it is very liable to *thickening*, which may be either general or local. There is a form of thickening (*perisplenitis chronica fibrosa*) which is generally confined to a portion of the surface, and in its higher degrees — amounting to several millimeters — results in the formation of whitish homogeneous masses as hard as cartilage, which may further be largely calcified. Such thickening, in its lower degrees, is extremely common, and appears in the form of nodules or as a network. These nodules are so irregularly shaped and, however small they may be, of so opaque a gray color, that they are easily distinguished from tubercles, which are met with here as on all other serous surfaces. In the place of nodules small papillary growths are occasionally found, often merely the remains of preëxistent adhesions which have been ruptured. *Adhesions* of greater or less extent are very common (*perisplenitis chronica adhæsiva*), particularly to the diaphragm, and may be either very close and firm, or long and lax. Suppurative inflammation (*perisplenitis purulenta*) occurs here as elsewhere in the peritoneum. The changes which are met with in the capsule over the seat of circumscribed affections of the spleen, have already been described; *rupture* sometimes follows the softening and necrosis which occasionally takes place over the seat of softened infarctions or abscesses, but may also occur independently of changes in the capsule, as after injury, and rarely after marked acute enlargement.

(*b.*) *Internal Examination.*

The *parenchyma* is to be exposed by a longitudinal incision extending completely to the hilus, and by such subsequent smaller incisions as the circumstances of the case may require.

1. *General Conditions.* The most important of these is the *amount of blood* contained in the organ, — a point which must always be noted in medico-legal cases. It is indicated

by the freedom with which the blood flows from the cut surface of the larger vessels, and by the color of the parenchyma, which, in the spleen more than in any other organ, by reason of its peculiar anatomical structure, is dependent on the amount of blood. The *color* of the normal spleen is dark red, darker and more inclining to purple in children than in adults, but it varies pathologically from a light reddish-gray or reddish-brown to a reddish-black.

There are also certain other coloring matters which may modify the appearance of the organ: hæmatoidine imparts a brownish shade, the coloring matter of the bile a yellowish tint, and in intermittent fever the spleen is deeply pigmented with a black material which is derived in some way from the blood. There are finally some pathological processes, which render the organ almost uniformly gray, among which the hyperplasia of the fibrous framework which is met with in chronic enlargement (intermittent fever, leucæmia) is the most worthy of mention.

In studying pathological changes in the parenchyma its three chief component structures must be borne in mind — pulp, follicles, and trabeculæ — for the reason that they may be affected independently of one another; all three may be the seat of hypertrophy, either singly or conjointly. The *follicles* vary in size, from that of a poppy-seed to that of a pin's-head; the *trabeculæ* appear as delicate gray lines, as a rule, but are rather coarser at their junctions with the capsule or the larger vessels. General hyperplasia of the fibrous framework is most marked when due to passive congestion; local hyperplasia of the superficial portions of the organ is rather the result of a chronic perisplenitis. The follicles vary considerably both in size and number, and often participate in the enlargement of other lymphoid structures in the body. When the *pulp* is the seat of acute enlargement, it projects from the cut surface, rendering it somewhat uneven, and hides the follicles and trabeculæ more or less from view. Careful examination shows that the irregularity of the cut surface is due to isolated prominences, the size of

a split pea, each one of which represents an arterial twig, and the tissue supplied by it. The pulp is without question the most important of the three constituents of the organ, since its hyperplasia plays the chief part in the formation of most of the so-called *splenic tumors*. Even acute swelling, though due in considerable measure to accumulation of blood in the organ, depends essentially on genuine hyperplasia, or cellular growth, as may readily be seen in fresh needle preparations; the large splenic cells with single clearly defined nuclei are those which especially show signs of an active growth, many of them becoming multinucleated, especially in the spleen of typhoid fever. In this disease, as well as in others which are associated with acute swelling of the spleen, the organ contains great numbers of cells with red blood disks imbedded in them; these cells are also found in the normal spleen, particularly of young people, but in vastly fewer numbers. In relapsing fever, especially, the blood of the splenic vein contains many granular corpuscles, and fatty degenerated endothelial cells derived from the walls of the smaller veins. In the hyperplastic spleens of infective parasitic diseases — and above all, in malignant pustule,—the parasites are found in abundance in the tissue.

In chronic hyperplasia of the pulp we find in the place of round cells a formation of fibrous tissue which encroaches on and destroys the pulp itself; but in these cases it is impossible to draw a close distinction between hyperplasia and inflammation. In chronic enlargement we find almost invariably numbers of cells containing granules of pigment.

Atrophy also may involve any or all of the structures which enter into the composition of the organ, but is most common and most marked in the pulp. It often happens that the trabeculæ are thus rendered more prominent than they are in the normal condition, and one might easily be led to consider them the seat of hyperplasia, as indeed they sometimes are in atrophy of the pulp and follicles. Atrophy of the pulp is indicated by a brownish-red or rust-colored

appearance, and the presence of cells containing granules of brownish-red pigment.

2. *Special Morbid Conditions.*

(*a.*) One of the most common and characteristic of these is **amyloid degeneration,** which occurs in two separate forms, easily distinguishable by the naked eye, though both cause more or less enlargement of the organ, and a change in its consistency. In both the organ is firm, and so inelastic as to pit very markedly on pressure, but this change is more pronounced in the second of the two forms which we are now about to describe. The first form, and the easier of recognition, is amyloid degeneration of the follicles, a degeneration which starts in the arteries, but subsequently invades the whole structure of the corpuscles, which are enlarged beyond the size of a millet-grain, and project above the level of the cut surface as glossy, translucent nodules, bearing a close resemblance to boiled sago — hence the term *sago-spleen.* The centre of each of these nodules sometimes appears as a small gray point, corresponding with the position of the arterial twig to which the follicle is attached, and the enlarged follicle is not uncommonly surrounded by a narrow red zone of collateral hyperæmia. Amyloid change occurs not only in follicles surrounded by otherwise normal splenic tissue but also in those imbedded in diseased tissue — in hæmorrhagic infarction, for instance.

The reaction with iodine presented by a tissue which has undergone amyloid degeneration is very peculiar and characteristic. All albuminous substances, when brought in contact with this reagent, become of a yellow color, which is more or less deep according to the intensity of the reaction; but the tissues which have undergone amyloid degeneration become dark mahogany-red, at times almost brown, and are thus clearly brought into view, especially when acetic acid has been poured over the cut surface to render it more transparent. If the amyloid change be very slight the microscope should be used, and it will generally be found that fresh sections with the double knife answer every purpose. Iodine

stains the amyloid portions wine-red, the others light yellow. Methylaniline hydriodide is a reagent which may be used with great advantage, a weak solution staining the normal cells and nuclei blue and the amyloid masses light red; the colors remain permanently in specimens put up in glycerine and potassic acetate, while the effect of iodine is very evanescent.

The second form is very difficult of recognition in its early stages, and does not always respond to reagents with sufficient distinctness to spare us the use of the microscope. In this form the amyloid change attacks the vessels of the pulp, and in well-marked cases renders the spleen smooth, somewhat glistening, firm, inelastic, reddish-gray in color, and somewhat translucent. Such a spleen is called *lardaceous* or *waxy* (Speckmilz, Rokitansky; Schinkenmilz, Virchow).

The reaction with iodine alone is often very feebly marked in the early stages of the process, and great practice is then required to recognize the change even when this reagent is supplemented by sulphuric acid, which changes the dark-red color produced by iodine in the diseased portions to a blue; sometimes, indeed, however practiced the eye may be, the use of the microscope is indispensable. This form of amyloid degeneration renders the tissue so firm and dense that sections are made with relative ease, and by staining the sections with methylaniline the extent of the process is clearly shown, as well as its predominance in the walls of the vessels of the pulp.

(*b.*) Acute **inflammation** terminating in suppuration is not common in the spleen, but does occur both as a result of inflammation near the organ and as a primary condition in relapsing fever, embolism, etc. The great increase in size and firmness, and the more or less dark-brownish or slaty look which occur in intermittent fever, are really due mainly to chronic inflammation. The septa are thickened, and appear as distinct gray lines running in every direction, and the dark color of the cut surface is due to pigment contained in the splenic cells which can easily be isolated by means of

needles. This pigmentary change must not be confounded with the small black spots found scattered throughout the spleen of aged people; in this latter case the pigment is deposited only in the walls of the larger vessels and in their vicinity, but not in the pulp itself; both forms of pigment are derived in some way from the blood.

The spleen of *leucæmia*, characterized by its density and reddish-gray color, is also to be regarded as the result of a chronic inflammatory process. In the earliest stage of leucæmia the process consists solely in cellular hyperplasia of the pulp in consequence of some irritation (inflammation), and the organ is soft and of a dark-red color; the next step is the conversion of the tissue of the pulp into fibrous tissue, a process to be regarded as inflammatory. In very many, though not in all, cases, the hyperplasia involves the follicles also, rendering them as large as a hemp-seed, pea, or even larger; they acquire an elongated-oval shape, though they are sometimes more pointed at one end than the other, and have an opaque, whitish shade. In cases of long standing, granules of brownish pigment are often deposited in the cells of the pulp. Leucæmic spleens invariably contain large numbers of colorless octahedral crystals, the chemical composition of which has not as yet been ascertained. The blood of the splenic vein contains vast numbers of white blood corpuscles, many of which resemble in every respect the cells of the pulp of the spleen.

Metastatic inflammation and abscesses occupy a special position in the spleen as in the lungs, and though closely allied to hæmorrhagic infarction, differ from this condition since the embolus which acts as the cause has a septic character. Embolic abscesses, as was observed in connection with the lungs, are usually small, and often surrounded by a zone of inflamed tissue; the pus is of a dirty reddish-yellow color, from admixture with the spleen substance. Micrococci in enormous numbers are easily demonstrated in the softened portions.

(*c.*) **Hæmorrhagic infarctions** vary greatly in size, some-

times being of the size of a pea, though usually larger than that, sometimes involving half the organ. They project above the level of the surrounding surface, are wedge-shaped, with the apex toward the hilus, firm, and, according to their age, of a dark-red, yellowish-red, or simple yellowish-white color. The yellow forms are always of relatively long standing, and were formerly called *fibrinous deposits*, their real nature not having been made out; in some rare cases, the follicles within their limits are found to have undergone most marked amyloid degeneration, a proof that the actual splenic structure is the seat of the change. Infarctions are almost always surrounded by a dark-red zone of hæmorrhage, which but rarely passes over into one of inflammation; as in other organs, the early stages present on microscopic examination a fatty degeneration of the cellular elements, and a subsequent conversion of the latter into minute granules of fatty detritus. It sometimes happens that the infarctions are absorbed and narrow fibrous cicatrices are left, which may contain small deposits of lime salts, and betray their mode of origin by an orange-yellow pigmentation due to hæmatoidine. Infarctions may also undergo softening, and a cavity with soft, brownish contents result.

(*d.*) *Syphilitic* affections of the spleen are rare, whether in the form of gummata or in that of circumscribed interstitial inflammation; **tubercular** changes, on the other hand, are very common. Primary tuberculosis of the spleen must be very rare, if, indeed, it ever occurs; but nowhere is secondary tuberculosis more common than in this organ. There are two forms in which the affection may appear: in the first and most frequent, the tubercles are disseminated and very small; the largest do not surpass a millet-grain in size, and these alone present a central opacity and a yellowish tinge, evidences of commencing caseation. The great majority of the tubercles are very minute, but may be thousands in number, and are gray and translucent. When only moderate numbers are present, they are not always easily to be distinguished from the Malpighian follicles. Tubercles have a

somewhat foreign appearance, as if they did not belong in the tissue; they project above the level of the cut surface as little spheres, and can be removed entire from their attachments, while the follicles do not project at all, and, when it is attempted to pick them out, they break down, liquefy as it were — the reason why they were formerly called "vesicles." The microscope further shows that the follicles invariably contain a small artery, which tubercles never do.

The second form of tuberculosis is chiefly met with in young subjects (scrofulous children), and is characterized by the large size of the tubercular nodules, which are often manifestly conglomerate and always more or less cheesy. They appear as discrete yellow masses when seen through the capsule, of the size of a hemp-seed or pea, or even larger, and are evidently composed of an aggregation of smaller nodules; on laying the organ open they are found scattered through the tissue, but never in such great numbers as is the case with the first variety. These nodules, as is seen with special distinctness when they lie under the capsule, are surrounded by narrow bright-red zones, composed of hyperæmic blood vessels (collateral hyperæmia).

(*e.*) In the rare cases of *malignant lympho-sarcoma*, so called — particularly when it originates in the cervical lymphatic glands — the spleen is the seat of a **new formation** of a peculiar character. The follicles are universally enlarged to a varying degree, sometimes to the size of a cherry or a walnut, and the spleen may then greatly resemble that variety of leucæmic spleen in which the follicles, as well as the pulp, are hyperplastic; it is to be distinguished from the latter, however, by the absence of any increase in the colorless blood corpuscles,— hence Cohnheim's term, pseudoleucæmia. The enlarged follicles vary somewhat in consistency, the firmer ones being composed of spindle-cells and fibrous tissue; the larger ones are sometimes yellow at the centre from fatty degeneration. Other *tumors* — carcinoma, sarcoma, etc. — are rare and almost exclusively secondary.

(*f.*) **Ecchinococci** are sometimes single, sometimes multi-

ple; the former are sometimes so large as to occupy nearly the whole spleen.

(*g.*) Of the affections of the **splenic vessels** we have already mentioned aneurism and embolism; in cases of infarction the veins are sometimes the seat of secondary thrombosis, and they occasionally contain calcified thrombi, *phlebolites*, sometimes in large numbers, the origin of which cannot be traced.

4. THE KIDNEYS AND SUPRA-RENAL CAPSULES.

Each kidney and supra-renal capsule are to be removed together, first the left and then the right. After detaching the splenic flexure of the colon where its attachments hide the left kidney, the fundus of the stomach and the tail of the pancreas are to be raised sufficiently to expose the supra-renal capsule in its full extent, when this body is to be freed with the knife anteriorly and superiorly. A long incision then being made over the outer convex border of the kidney, this organ is to be separated with the left hand from its investing loose cellular tissue, and drawn forcibly upwards, being removed from the body with its accompanying supra-renal capsule after a simple cut has been made across the vessels and ureter. As the right supra-renal capsule is firmly attached to the inferior surface of the liver, the latter organ must be turned upwards and the former dissected away from it, great care being taken to avoid injury to the inferior vena cava; the steps then to be followed are the same as those on the left side. In all cases in which such changes are suspected in the ureters as might give rise to hydronephrosis, as well as in all cases in which the disease is still obscure, the size of the ureters should be carefully inspected before the kidneys are separated; the kidneys, ureters, and bladder connected together may then be removed from the body, that the seat and nature of the possible obstruction may be accurately determined. The whole course of the left ureter lies open to inspection without further dissection; but in order to expose the right ureter, the peritoneum must be

divided where it is reflected from the posterior abdominal wall over the cœcum and ascending colon, the membrane being put on the stretch, and injury to the subjacent parts at the same time avoided by strong traction on the intestines. It is usually necessary to remove only the upper portion of the ureter with the kidney.

The method of procedure which we have thus described can, of course, only be followed when there is no *malposition* of the kidneys, and, as should not be forgotten, malposition of the kidneys does not necessarily involve malposition of the supra-renal bodies also. Malposition may be either acquired — that is, the organ is not fixed, but freely movable with lengthened vessels, and is thus characterized as *floating*, *wandering* (ren mobilis, most common on the right side) — or congenital; in the latter case the organ is attached in an abnormal position, sometimes at the entrance of the true pelvis, and its vessels are not, as in the former case, given off in the regular way, but may be several in number for each kidney instead of one. Another congenital condition, always involving dislocation downwards, is fusion of the two organs into one (ren concretus, coalitio renum). The seat of the fusion, which varies considerably in extent, is invariably at the lower ends, and, in its most typical form, constitutes what is known as the *horse-shoe kidney*, lying across the vertebral column. In this case, also, the origin of the vessels deviates from the normal.

(*a.*) THE SUPRA-RENAL CAPSULES.

After noting the external appearances of these organs, their size, form, etc., and the condition of the fibrous and fatty tissue which surrounds them, they are to be opened in their longest diameter through their flattened surface.

The supra-renal capsules — which are often accompanied by similar small accessory bodies — are relatively larger in children than in adults, and are flattened and somewhat triangular in shape: the cortical portion is light-yellow in adults, grayish-red in children; the medullary portion is

gray, and the narrow zone of intervening tissue is brown; the consistency is firm. Since this intermediate zone softens very rapidly after death, and is liable to be torn open in removing the organ, a cavity may be produced; the term bestowed on these bodies by the ancients — capsulæ atrabiliares — thus arose. The cortical portion loses its fat in all wasting diseases and becomes gray instead of yellow.

In cases of extensive *amyloid degeneration* the capsules are not spared, but become enlarged, very firm, and turn brown on the addition of iodine; this change attacks chiefly the cortical portion. *Acute inflammation* is rare, but is met with both in the suppurative and the hæmorrhagic forms; effusions of blood of considerable size are sometimes found. The capsules, like the thyroid gland, are sometimes the seat of *hyperplasia*, which may be either nodular and circumscribed, or distributed uniformly throughout the glands, a condition to which the term *struma suprarenalis* has been applied by Virchow. This increase of the glandular tissue originates invariably in the cortex, and hence usually presents the same light yellow color and fatty cells as that portion. Small cysts are sometimes found. There is another form of lobulated hyperplasia which originates in the medullary portion, and resembles it in its grayish color; according to Virchow this form arises from the fibrous groundwork of the (nervous?) medullary portion, and he has therefore termed it *glioma*.

The most interesting affection of the supra-renal bodies is *cheesy degeneration*, usually associated with similar changes in other organs, but sometimes limited to one or both of these organs; it may occur in the form of small, isolated, cheesy nodules, or involving the whole organ uniformly, may often cause a considerable increase in its size. The cheesy masses, as a rule, are homogeneous, firm, and dense; but are sometimes soft, friable, and even puriform. Their origin is in some cases manifestly tubercular, as isolated tubercles are found in their immediate vicinity, though this is not a constant appearance: Virchow nevertheless regards cheesy

degeneration in these bodies as invariably of genuine tubercular origin. The connective tissue surrounding the capsules which have undergone this change is sometimes the seat of chronic inflammatory thickening.

Gummata are rare, *sarcoma* is tolerably rare, and *cancer* somewhat more common. The latter is occasionally primary, more commonly secondary to cancer of the liver, sexual organs, stomach, etc., and may be either unilateral or bilateral.

In connection with a peculiar brown discoloration of the skin, we referred to its association with diseases of the suprarenal bodies (*Addison's disease*), and stated at the same time that such association is by no means constant. The cutaneous discoloration is least constant in cancerous, most common in cheesy, degeneration; but even the latter condition may be present without bronzing of the skin, while the skin may be bronzed precisely as in Addison's disease without the existence of cheesy degeneration, or of any other change in the suprarenal bodies. These facts have induced many observers to attribute the cutaneous discoloration rather to changes in the neighboring sympathetic nerves — the solar plexus and the semilunar ganglia — which, together with the connective tissue investing them, should therefore always be carefully examined.

(*b.*) THE KIDNEYS.

After inspection of the capsular portions (the fatty, and the fibrous, or true, capsule) they are to be divided by a superficial incision along the convex margin of the kidney and stripped off that organ, the external condition of which is then, in its turn, to be noted. The next step is to lay open the kidney itself as far as its pelvis by a longitudinal incision in the same line as that through the capsule, and then to examine the parenchyma, the calices, the pelvis, and the ureter. In making this incision the organ should be held firmly in the left hand, with the hilus and the reflected layers of the capsule in the angle between the thumb and fingers, and laid open from end to end as far as the hilus so as to expose the largest possible surface.

1. The Capsules of the Kidney.

The *fatty tissue* of the outer capsule participates in the general changes of the fatty tissues of the body as a whole, and is peculiarly subject to mucous atrophy (see Heart). In corpulent persons it is very thick and may prove a source of error in estimating the size of the kidneys, though there is still greater danger of this in cases of local hyperplasia of this tissue, a condition sometimes found as a sort of compensation in cases of atrophy of the kidney itself. The *fibrous capsule* is usually thin, translucent, easily detached from the surface of the kidney, and is composed of two layers which may become separated, the inner remaining attached to the kidney. In chronic inflammation of the kidney, this capsule becomes thickened and adherent, so much so that in stripping it from the kidney small portions of that organ are also torn off, and remain attached to it; similar thickening may also be caused by chronic inflammation in the tissue about the kidney (*chronic fibrous perinephritis*). Purulent inflammation about the kidney (*suppurative perinephritis*) may originate in that organ itself (rupture of abscesses, etc.), or in neighboring organs (psoas-abscess, caries of the vertebræ, etc.).

Accessory kidneys are sometimes found between the two layers of the fibrous capsule as well as between that structure and the kidney, and are easily recognized as such by the three layers of which they are composed.

2. The Outer Surface of the Kidney.

(*a.*) *General Conditions.*

1. The ordinary *size* of the kidneys, assuming the average normal weight to be one hundred and fifty grams, is represented approximatively by the following figures, but may surpass them as well as fall short of them : length, eleven centimeters; breadth, five centimeters; thickness, three-fourths of a centimeter. *Enlargement* occurs in acute parenchymatous and interstitial affections, — especially in sup-

purative nephritis and in pyelo-nephritis, — also in connection with new formations, to a less degree in passive congestion, and finally, when the kidney is considered as a whole, in hydronephrosis. Very marked compensatory enlargement of the kidney takes place when its fellow is atrophied; such enlargement is not, however, strictly speaking, pathological.

The simplest form of *atrophy* is that which is unassociated with any other special change, and is met with in cases of general wasting of the body; the most important forms are those which are the result of inflammation, which is then always chronic in character, and involves either the parenchyma or interstitial tissue alone, or, more commonly, both together. According to the character of the surface of the organ, a distinction is drawn between smooth atrophy, the result of interstitial inflammation, and granular atrophy, the result of parenchymatous inflammation or of the latter in combination with the interstitial form. The prominences which are seen on the surface in granular atrophy vary somewhat in size, but are generally about as large as a pin's head, and consist of true renal tissue which has become more or less altered in character, while the depressions are the atrophied portions. In this connection it is important to remember that the Malpighian corpuscles are never normally found in the tissue immediately underlying the capsule, but are always separated from it by a layer of convoluted tubes; atrophy must hence be present when these bodies are found to be superficial.

2. The *shape* of the kidney is modified in cases of enlargement, of atrophy (particularly when local), and of all circumscribed lesion, as would naturally be supposed. The normal fœtal kidney is lobulated, and this condition often persists into advanced life, the surface being more or less deeply fissured and divided into distinct portions. Kidneys which are the seat of congenital malposition are very apt to be flattened in their transverse diameter (from the hilus to the convex border) with the hilus in the midst of the flattened, and, as a rule, superior, surface. The horse-shoe kidney has been already described.

3. The *color* of the surface depends on the amount of blood contained in the organ, the number of stellulæ Verheynii, and the condition of the parenchyma — particularly that of the epithelium of the convoluted tubes. The normal color is grayish-red, but passes over into whitish-gray, and finally yellowish-gray, as a result of parenchymatous changes. Chronic jaundice produces a peculiar yellowish, greenish, or almost black, discoloration, or a combination of these shades, resulting in a mottled appearance. Local change of color is caused by all circumscribed lesions, hæmorrhage, infarction, abscess, tubercle, and tumors. A portion of the right kidney is often found after death to be stained with the bile, and decomposition extending from the intestine may impart a dirty greenish shade to the surface of the left kidney.

4. The *consistency* of the kidney is generally firm and elastic; it is increased in passive congestion, in the various forms of atrophy, in chronic interstitial processes, etc. The consistency is greatly diminished in parenchymatous inflammation, whether in the stage of cloudy swelling or in that of fatty degeneration, and somewhat so in acute interstitial inflammation.

(*b.*) *Special Morbid Conditions.*

Some valuable conclusions as to the nature of *circumscribed lesions* of the kidney may be drawn from the inspection of its external surface alone. We have already alluded to the fact that the glomeruli become visible here in atrophy, and when they assume the form of small white or whitish-yellow dots, we are justified in assuming them to be calcified. Hæmorrhagic nephritis, which may be either parenchymatous or interstitial, is shown by the presence of minute punctiform hæmorrhages scattered over the surface. The intestinal gases sometimes change the color of these hæmorrhages from red to black; but this can be recognized as a post-mortem change by its being usually limited to the lower border of the left kidney, which portion is thus apt to be the seat of a general slaty discoloration. Old points of hæmorrhage are also black, or nearly so, in consequence of

the changes undergone by the blood-pigment; these are readily distinguished from those black spots due to decomposition which we have just described by their uniform distribution over the whole surface of the organ.

The changes which are brought about by hæmorrhagic infarction are very characteristic, and resemble closely those in the spleen, which are due to the same cause; the peripheral zone of hyperæmia is generally very clearly defined.

The arrangement of the renal vessels is such that embolic or metastatic abscesses, when present, are apt to be very numerous, though of small size, thickly studding the whole surface of the organ with yellow nodules which project somewhat above the surface, varying in size between that of a pin's-head and that of a hemp-seed. Each is surrounded by a red zone of inflammation, and is often covered by a thin layer of injected tissue; sometimes they are collected together in groups at one or more places, forming a large red spot within which the isolated yellow nodules are still clearly defined. Occasionally they are of larger size and cannot be mistaken for anything else than what they really are — abscesses. Every minute abscess in the kidney cannot, however, be summarily attributed to embolism, since they may be due to non-embolic suppurative interstitial nephritis, such for instance as is sometimes associated with purulent or diphtheritic inflammation of the efferent urinary apparatus (pyelo-nephritis). All doubt is dissipated after the organ has been laid open. Gray submiliary or miliary tubercular nodules are also met with on the surface of the organ, not infrequently collected in little groups, and are distinguishable from minute abscesses by their greater firmness of structure. Large tubercular nodules are but rarely met with in this situation.

All the varieties of tumors to which the kidney is subject may, of course, make their appearance on the surface, but present no peculiarities here which they do not possess elsewhere; cysts, however, are so very common here, and so peculiar in some respects, as to deserve more than mere pass-

ing notice. Cysts are of the most variable size, some being scarcely appreciable, some as large as the fist; but small cysts are much more common and are generally multiple, while the largest ones are always single, and being found in kidneys which are otherwise healthy, may therefore be looked upon as congenital. There is a peculiar variety of congenital cystic kidney (hydrops renum cysticus) which is found chiefly in new-born children (those which are still-born as well as those which die at an early period), but is also exceptionally met with in adults, and is always bilateral. The kidneys are enormously enlarged, and appear to be composed almost exclusively of thickly aggregated cysts with pale, clear, watery and albuminous contents; in young subjects these cysts vary between the size of a pin's head and that of a cherry-stone, but are apt to be rather larger in adults, sometimes attaining the size of a walnut.

All other small multiple cysts are acquired, consisting of dilated and confluent urinary tubules, and, according to Virchow, are the results of chronic interstitial inflammation. The contents of the smaller cysts are often firm and gelatinous, those of the larger ones are usually a thin and clear liquid; hæmorrhage often takes place into individual cysts, the contents of which are then generally reddish or brownish in color, but are occasionally yellow, rather thick, and fatty. All varieties of cysts have a thin wall of fibrous tissue, which is lined by tessellated epithelium; the walls of congenital cysts are always smooth, while those of the acquired varieties often present projections and ridges, the remains of the walls of the tubes.

3. The Surface of the Section of the Kidney.

(*a.*) *General Considerations.*

After having laid the kidney open, the first point to be noted is the *relative proportion* of the cortical and medullary portions, a point which may throw great light on the nature of the pathological process, if such be present. The width of the cortex is of especial importance, the average in adults

being from five to six millimeters. Increase in the cortex points to recent inflammatory processes (chiefly of the parenchyma), while diminution points to chronic inflammation and consequent atrophy; a diminution in the height of the papillæ of the medullary portion or their effacement, on the other hand, is a mechanical result of excessive distention of the calices (hydronephrosis, etc). It is a noteworthy fact, that the inner portions of the cortex, which fill out the spaces between the pyramids of the medullary portion, and are called septa Bertini, do not always show the same degree of change as the rest of the cortex; they may, for instance, be unduly swollen in parenchymatous inflammation, or, on the other hand, be relatively little diminished in size in atrophy.

The *amount of blood* contained in the organ, as a whole, and the relative distribution of the blood in the several parts, are next to be considered. In many forms of parenchymatous inflammation, the contrast between the gray or yellow opacity of the cortex and the deep congestion of the medullary portion, is very marked and characteristic. In the cortex a distinction must be drawn between the amount of blood contained in the glomeruli and that contained in the other vessels. When the former are full of blood they appear as minute red dots; when empty, they are either not visible at all or appear as minute pale dots or specks, especially when the light is allowed to fall obliquely on the cut surface. The color which belongs to the tissue itself, apart from the amount of blood present, is especially noteworthy from the light which it throws on the condition of the secretory portions of the organ. These portions lie chiefly in the cortex, and this part should, therefore, be closely examined.

A distinction must be drawn in the cortex between the pyramids of Ferrein and the region of the convoluted tubes; the former are composed solely of bundles of straight tubules, which are gray, translucent, and somewhat conical in shape, with their bases resting on the medullary portion. The region of the convoluted tubes is the labyrinth which contains the vessels and Malpighian bodies, all the convoluted

tubes and a portion of the looped tubes of Henle. These latter portions are of a more whitish gray than the pyramids of Ferrein, if the part which the blood plays in their coloration be disregarded. They also show the most frequent modifications of color, since it is in them that parenchymatous inflammation first makes its appearance, and often remains confined to them alone. Modification of color in these parts depends first on an opacity of the tissue, which looks as if it had been boiled in water, though the convoluted tubes are more clearly to be distinguished than in the normal condition, and appear as minute lines and dots; and, secondly, on the presence of a more or less marked and pure yellow color, which varies between a very indistinct yellowish-gray and an intense lemon- or butter-yellow.

The pyramids of Ferrein are less subject to changes of color, but are sometimes increased in width, and become the seat of a grayish opacity, or a yellow discoloration in the form of narrow and delicate lines.

This latter remark applies also to the tubes of the medullary portion, of which those lying within and in the immediate vicinity of the papillæ are occasionally found to be the seat of marked white, yellow, yellowish-red, or brown discoloration. Jaundice gives rise to a yellowish-green discoloration which is more widely distributed, but is most marked in the medullary pyramids, and, above all, in their papillæ.

Decomposition gives rise to a dirty, dark-red discoloration of the whole parenchyma, which discoloration subsequently assumes a greenish cast. The tissue is then soft and easily crushed, and, if decomposition is well advanced, contains numbers of small bubbles of gas which (especially when seen from the outside of the organ) have some resemblance to small circumscribed points of fatty degeneration.

(*b.*) *The Separate Affections.*

When the separate affections are described in general, the first to be considered is —

1. **Hæmorrhage.** This may occur as a simple hæmorrhage, as for instance in the papillæ in cases of hæmorrhagic small-

pox, or as a part of some other affection, as in inflammation. In the latter case it is usually more marked on the surface than in the deeper portion of the cortex, though not altogether absent. Brown or blackish pigment granules are found within the convoluted or straight tubules, as a result of old hæmorrhages. *Hæmorrhagic infarction* is next to be considered. It presents a defined wedge-shape and extends, according to its size, to or into the pyramidal portion. The wedges are either red, reddish-yellow, or yellow "fibrinous deposits," surrounded by a red areola, and the structure of the kidney (especially the glomeruli) may be recognized within them. Very minute septic emboli produce miliary hæmorrhagic infarctions which are usually connected with the formation of abscesses. This subject will be again referred to in connection with metastatic inflammation.

2. Among the diseases which proceed from the vessels **amyloid degeneration** is to be mentioned, as it always first appears in them and usually in the afferent arteries of the glomeruli. This affection may often be diagnosticated with the unaided eye and without the help of reagents, by the great prominence and the peculiar vitreous appearance of the glomeruli upon the cut surface. The diagnosis becomes positive if they are turned brown upon the application of iodine. In a more advanced stage the other vessels of the cortex are affected, also the vasa recta of the pyramids, which in some cases are most changed, and finally the degeneration advances to the tunicæ propriæ of the urinary tubules, which, however, can only be recognized by the aid of the microscope. Sections may be most conveniently made with the double knife, cutting perpendicularly (in the direction of the tubules of Ferrein) through the cortex and pyramidal portion. They are then to be stained with aniline-blue, when the amyloid material will appear red in contrast with the healthy tissue, which will be colored blue. The degeneration of the tunicæ propriæ is most easily recognized by picking apart the sections which have been colored with aniline, for in so doing there is less liability of confounding the tu-

nicæ with the accompanying vessels. In recent cases the partially affected glomeruli look very pretty, the intact coils presenting a blue and the degenerated portions a red color.

3. Finally, **thrombosis** of the renal veins should be mentioned among the affections of the vessels; this may be observed to extend from the spermatic veins (especially the left), or to occur spontaneously, for instance in the new-born (marantic thrombosis) and in adults with tumors of the kidneys. In many cases of carcinoma and sarcoma of the kidney, a thrombus of the veins is formed by the extension of the new formation into them, and in this way the vena cava inferior, and even a portion of the right auricle, may become filled with the growth.

4. The most frequent form of **inflammation** of the kidneys, and the most difficult to recognize, in the early stage, is what has been called by Virchow —

(*a.*) **Parenchymatous nephritis,** which occurs as a complication in very many diseases, especially in those of an infectious nature, and as a primary affection. When combined with hæmorrhage, as is often the case, it represents the hæmorrhagic parenchymatous form. In the first stage, that of cloudy swelling, the cortex is either very slightly increased in thickness or not at all, the consistency being somewhat greater than usual, and only the slight opacity of the region of the convoluted tubules is present to indicate the process. On microscopic examination of sections picked to pieces, the granular epithelium of the convoluted tubules appears still more granular, the nuclei are less distinct, and the granules cause these tubules to appear as if tinted with India ink. If upon the addition of acetic acid the granules mostly disappear, it is proof that they were albuminoid in character. The further the process advances the greater is the swelling, softening, and opacity of the cortex, while the former gray appearance of the convoluted tubules becomes more yellow. The granules within the cells increase, and do not disappear upon the addition of caustic potash or soda, their fatty nature being thus indicated.

Such a kidney, as a whole, is very considerably enlarged, flaccid, and soft, and isolated groups of convoluted tubules may be seen upon the surface as yellowish spots, which are prominent when contrasted with the perfectly opaque grayish-yellow ground substance. When the kidney is laid open the cortex appears thickened and swollen, projecting beyond the pyramidal portion. The tubules of Ferrein are to be recognized as gray, often as still translucent lines, while the region of the convoluted tubules appears opaque and is traversed by clear, yellow streaks and spots, the fatty degenerated tubules. The vessels of the cortex are usually but slightly injected, while those of the pyramidal portion are very full, so that a contrast in the color of the two regions becomes very apparent, especially when viewed from a short distance. Amyloid degeneration is frequently associated with parenchymatous nephritis, in which case the glomeruli, as has already been stated, appear upon the cut surface as translucent, vitreous, enlarged granules, and assume a brown color upon the addition of iodine.

Sufficiently thin sections for microscopic examination may be obtained with a razor, by placing the half or even a smaller portion of such a kidney over the forefinger, and making it tense with the middle finger on one side and the thumb on the other. The double knife works still better, by which sections made perpendicularly through the cortex and pyramidal portion, furnish a very good general view when examined with a low power. It may be thus recognized that the process, even when very severe, is limited almost exclusively to the convoluted tubules, which are sometimes continuously fatty degenerated, while again (and this is most frequently the case) the degeneration appears in spots. The contrast produced by transmitted light, between the translucent pyramids of Ferrein and the dark appearance of the convoluted tubules furnishes quite a characteristic picture.

The condition which is known as granular atrophy is regarded by Virchow as the third stage of parenchymatous

nephritis. When the epithelial cells are completely fatty degenerated, the detritus may be absorbed, the canals then naturally collapse, their tunicæ propriæ, which undergo a fibrous degeneration, become united and form a hard cicatricial mass, which occupies much less space than the parenchyma from which it was formed, and when seen from the surface is much deeper than the surrounding portion. The projections are still relatively normal, not wholly so, because their frequent yellow color indicates that here also a fatty degeneration of the urinary tubules has taken place. The vascular coils in the atrophic places become obliterated, shrink, and finally are changed into little clumps of connective tissue, which sometimes become impregnated with lime salts, and consequently appear, even to the naked eye, as yellowish-white points. Upon microscopic examination they appear black, as the lime does not allow the light to pass through. Upon the addition of a little hydrochloric acid the black mass completely dissolves with the development of gas-bubbles.

(*b.*) By **interstitial nephritis** is understood an inflammation which runs its course essentially in the interstitial (intertubular) tissue, although the proper glandular tissue also appears to be affected. Two forms are to be distinguished: (1.) the fibrous, generally of a chronic character; (2.) the purulent, running an acute course.

The first form, when total, as in the parenchymatous affection, produces an enlargement of the cortical portion, which, however, presents a more uniform grayish-white appearance, as the contrast between the tubules of Ferrein and the region of the convoluted tubes disappears more or less. In microscopic sections, collections of granulation cells may be seen, especially about the glomeruli, and also between the urinary tubules which have become pressed apart. A certain number of cases occur in which the inflammatory changes are situated almost wholly within the capsules of the glomeruli, so that they become converted into rounded masses of granulation tissue (*nephritis interstitialis glomerulo-capsularis*).

This affection must not be confounded with that first described by Klebs, as *glomerulo-nephritis*, in which the inflammation is situated between the coils of the glomeruli, in the connective tissue which is there in small amount and which is provided with stellate cells. In a later stage the round cells become more and more spindle-shaped, then transformed into fibrous tissue, and thus a kind of cicatrix is formed within which all the tissues perish; the epithelial cells become fatty, the tunicæ propriæ are fused, the glomeruli become converted into little connective tissue clumps so that nothing remains but a tough fibrous tissue. The kidney as a whole appears atrophied, but possesses a smooth surface; on section the cortical portion is especially atrophied and consequently of increased consistency. Remnants of urinary tubules are still present, which appear as yellow lines and points between the gray masses of connective tissue.

The above description applies to those cases in which the inflammation is total, where the entire kidney is affected. Fibrous interstitial nephritis also occurs very frequently as a circumscribed affection, usually multiple, the result being a number of cicatricial depressions upon the surface of varied size, and corresponding with which wedge-shaped depressions of the cortex are usually seen when the section of the kidney is examined; these depressed portions and less frequently a corresponding part of the pyramid are converted into a grayish-white, dense, fibrous (cicatricial) tissue. Microscopic examination shows that the same changes have taken place as were previously described. This form of inflammation (*nephritis interstitialis chronica fibrosa multiplex*) occurs in syphilis, and a kidney that has undergone this change ought always to arouse suspicions of this disease, although the latter can never be diagnosticated from this affection alone. Cicatrices which have resulted from old hæmorrhagic infarctions bear a great resemblance to those of syphilitic origin, and cases will frequently occur where it will be impossible to make a differential diagnosis from this local condition alone. The appearance of the other parts of the body must then be

taken into consideration. In other cases the local affection furnishes a point for differentiation. The syphilitic scars are always of a gray color, while brownish, greenish, or blackish flakes of blood-pigment remain for a long time in those resulting from hæmorrhage.

Although circumscribed interstitial nephritis occurs most frequently in the cortical portion, still it is not altogether absent from the pyramids, where, for instance, according to Virchow, the gray fibromata arise from such a circumscribed inflammation, as the urinary tubules may be followed into them. These vary in size from that of a millet-grain to that of a pea, and may be easily distinguished from tubercles by the absence of cheesy degeneration. The interstitial inflammation is frequently situated within the papillæ (nephritis interstitialis papillaris) apparent by their gray color.

The pyramids are also a favorite seat for *cysts* caused by chronic interstitial inflammation. These are large or small, the former being produced by the confluence of smaller ones, as may be recognized by the projections upon their walls. In the earlier stages of the affection, several small cystic enlargements may be seen with the microscope, situated along the course of a single tubule, the interior of which is filled with a peculiar glistening gelatinous mass.

The second form of interstitial inflammation is what is known as *purulent interstitial nephritis*, which tends from the beginning to interstitial suppuration. Certain varieties of this affection constitute *metastatic nephritis*, which is produced by septic emboli and is characterized by the appearance of metastatic abscesses. These rarely attain a large size and are usually situated in the cortical portion, though sometimes in the pyramids. In the latter case, however, they are never found within the apices of the papillæ, but rather in the middle and outer portions. The contents of the little abscesses are not composed of actual pus, but of disintegrated, fatty degenerated glandular tissue. It often happens in this affection (for instance in connection with endocarditis ulcerosa) that it is possible to recognize micrococci

in the centre of each abscess; they may lie in the glomeruli, in other vessels, in the urinary tubules, or in the interstitial tissue. When sections made with the double knife are first soaked in absolute alcohol and ether, then in acetic acid, and finally are tinged with aniline-violet, the micrococci will assume a beautiful blue color, while all the fat, which is produced in large quantities in the surrounding tissues by parenchymatous inflammation, is dissolved. To this class belong a number of varieties of inflammation which result from disease of the urinary tract, and which produce at the outset changes in the pyramidal portion. Such alterations consist of small yellow lines which often contain spherical enlargements, and which follow the course of the urinary tubules from the apices of the papillæ towards the periphery. On the surface of the papillæ a tough, grayish, diphtheritic infiltration is often found. A little later the cortical portion becomes involved, when the striped appearance of the abscess is less marked, and it assumes more the form of a circumscribed collection of pus.

It has already been stated that the abscesses appear on the surface as small yellow points of the size of a millet-grain, and are arranged in small groups. On examining the surface of the section, they may usually be followed through the cortical into the pyramidal portion; still it is not always possible to discover that the affection of the two portions is continuous. When larger abscesses have formed in the renal tissue they may rupture into the calices, when a suppurating ulcer is formed (*phthisis renalis purulenta*). It was precisely in this affection, spreading from the pelvis to the kidney, and associated with marked alteration in the mucous membrane of the former and of the calices (hence called *pyelo-nephritis*), that Klebs first recognized the constant appearance of lower organisms. The disease almost always accompanies inflammatory and often actually diphtheritic processes in the bladder, being considered as the direct result of a wandering of the organisms along the ureters and renal pelves into the urinary tubules. The results here, as

in case of embolic affection, are not abscesses properly speaking, but the pus is mingled with the products of fatty and broken-down epithelial cells, and frequently there may be no real pus formed at all. Careful examination shows that the urinary tubules are completely plugged, and even distended, with micrococci; that the epithelial cells, not only of these but of the neighboring tubules, are fatty degenerated, and that only finally a zone of interstitial suppuration surrounds these centres.

There is, however, another affection quite similar to the preceding, as far as the local trouble is concerned, and which agrees etiologically also, as micrococci are always found in the centres of inflammation. In certain diseases, especially in those of a septic nature, and when moreover there is no local cause for metastasis, yellowish, or frequently yellowish-brown, linear or round spots of inflammation are seen within the pyramids and especially in the papillæ (*nephritis papillaris diphtheritica*); these are very similar to those already described, and upon microscopic examination are seen to be composed of three constituents, — micrococci which lie within the tubules or vessels, fatty degenerated epithelial cells of the former, and an inflammatory infiltration of the surrounding tissue.

Such preparations deserve careful attention, as they are especially fitted to illustrate the difference between micrococci and fat granules. The former are small and uniform in size, lying at equal distances from each other, and present a sharp and dark contour; the fat granules on the contrary are of unequal size, lying at unequal distances from each other, and disappear when treated with glacial acetic acid, alcohol, and ether. It is clear that in this affection the organisms come from the blood, as the urinary tract is unaltered while the glomeruli and other vessels are filled with micrococci.

(*c.*) The last form of renal inflammation to be considered is the catarrhal (**nephritis catarrhalis**), which affects principally the trunks of the straight tubules (tubes of Bellini).

The bundles of straight tubules within the pyramids and

also the tubules of Ferrein appear widened, their translucent gray is changed into an opaque gray or grayish-white color, and it is possible to press out of the papillæ a large quantity of milky fluid of a cloudy gray or grayish-yellow color; with the microscope this is found to contain numerous large and small cells, free nuclei and detritus, with only comparatively few cells of ordinary size. It is possible to distinguish by examining this fluid, the gray color of the papillæ caused by catarrhal inflammation from that due to the interstitial form, as in the latter affection it is possible to press out only a very small quantity of fluid and cells.

In connection with the inflammatory processes may be mentioned the microscopic masses contained in the urinary tubules, and known as casts (*hyaline casts*, incorrectly called fibrinous). They occur both in the straight and looped tubules, and those in the latter sometimes undergo amyloid degeneration. They are often best seen with a low power, when they may be recognized by their peculiar fatty lustre. The casts extend into the cortical portion only in extreme cases.

5. The different forms of **renal infarction** are to be considered in concluding the subject of the inflammatory processes, especially those of the papillæ. Four forms are to be distinguished, — the lime, the uric acid, the hæmatoidine, and the bilirubine infarction. The first occurs only in adults, the second and fourth in children only, and the third in both, though under very peculiar conditions in adults.

(*a.*) *Lime infarctions* appear in the form of white lines, which radiate from the apex of the papilla and extend as far as the middle of the pyramid, or even further. Upon section, especially when made transversely (with the double knife), very small lime granules appear, either free in the interior of the tubules, or, as is more frequently the case, deposited in the walls of the same. Upon the addition of hydrochloric acid they become dissolved with the evolution of gas. The deposition of the granules takes place not only within the straight tubules but also in the looped ones, and

on this account these kidneys are particularly fitted to show the loops of Henle in the easiest manner possible. Lime infarctions always indicate interstitial inflammation.

(*b.*) *Uric acid infarctions* occur only in very young children, usually in the first week of life, still they have been observed in the sixth week, and even later. Their presence has an important medico-legal bearing, as they are found almost exclusively in children who have breathed. These infarctions appear as yellow, brick-red, or yellowish-red lines extending from the papillæ; similar yellow lines are only rarely seen in the cortical portion. By tearing apart a small bit of the papilla, or pressing the epithelium out of the straight tubules, it will be seen that they are completely filled with a mass that appears either light or dark-brown by transmitted light, and yellow or rose-red by reflected light. These masses are dissolved by the addition of hydrochloric or acetic acid, crystals of uric acid being formed upon the evaporation of the resulting solution. When examined with the microscope, the mass is found to be composed of globules of varied size, often in pairs, and covered upon their surface with thorn-like projections (urate of ammonia). The other uric acid salts (soda) occur less frequently. The urates are found exclusively in the urinary tubules.

(*c.*) *Hæmatoidine infarctions* appear in adults only under very peculiar conditions (after transfusion of blood from the lower animals, burns, etc.). Masses are then found in the papillæ, filling the tubules, which appear like brown lines, and are composed, in recent cases, of course, of blood corpuscles. In cases of long standing they consist of blood pigment. According to Virchow the hæmatoidine infarctions in the new-born, present a clear brown, brownish, or reddish-brown color, and consist of a deposition of yellowish-red or reddish-brown granular or crystalline hæmatoidine, which appears both in the canal of the tubules and in their epithelial cells. The coloring matter is due to small hæmorrhages.

(*d.*) *Bilirubine infarctions* are of more frequent occur-

rence, either alone or combined (the usual form) with uric acid infarction. They occur only in the new-born, in those that were jaundiced. The pigment has the form of rhombic tablets, of fine needles often arranged in arborescent or stellate groups, and of clumps which occur both in the interior of the tubules, in the epithelial lining, in the intertubular tissue, and especially in the vessels. Their principal seat is in the papillæ, but in cases of great intensity they are not wanting in the cortical portion. (The same crystals appear, though not constantly, in the blood, and in fact in all the organs.) The well-known reaction of biliary coloring matter is very readily obtained from them. It is only necessary to treat a little piece of the affected tissue with liquor potassæ (under a covering glass), then washing away the excess of the fluid with water, finally add nitric acid of the proper strength, in order to produce successive rings of green, blue, violet, and red extending from the periphery toward the centre. The bilirubine infarctions may be distinguished from those due to hæmatoidine by the fact that the former occur very irregularly, and as a rule only upon single papillæ, while the latter affect all the papillæ equally.[1] In adults, yellow, green, brown, and black granules of bile pigment occur, both in the convoluted tubules and in the straight ones, combined with chronic inflammation, in cases of icterus of long standing.

(*e.*) *Nephritis urica* also depends upon a deposition of crystalline masses, and is due to gout. Small, chalky, white spots or lines may be seen in the pyramids or (less frequently) in the cortical portion. Upon microscopic examination, they are found to be composed of masses of crystalline urate of soda, which appear not only in the form of very fine needles, as in the joints, but also in the form of large crystals

[1] In distinguishing hæmatoidine and bilirubine infarctions the question of the identity of the chemical composition of those two bodies is not considered; their origin only is indicated by the name, hæmatoidine originating from the effused blood by a direct local change, while bilirubine is excreted from the blood, where it is already present as biliary coloring matter.

(rhombic prisms). Chronic interstitial inflammation exists around them. Whenever these changes are found to exist in the kidney, the examination of a number of joints, especially that of the great toe, for gouty deposits, must never be omitted.

6. **Tuberculosis** occurs in two forms in the kidney; sometimes as a disseminated, secondary affection, which has its favorite seat in the cortex, and again as a localized and primary tuberculosis, which takes its origin in the calices and apices of the papillæ. In the first form submiliary and miliary nodules are scattered through the cortex, especially on the surface. Upon the surface of the section the nodules often appear arranged in a narrow row following the direction of the vasa interlobularia; as changes (fatty metamorphosis) in the neighboring tubules are usually connected with them, the appearances may be easily mistaken for small hæmorrhagic infarctions. The presence of the minute gray nodules prevents any mistake. Leucæmic and typhoid nodules, which are rare, resemble these tubercles.

The second form, which has its principal seat upon the apices of the papillæ, shows less plainly its origin from separate tubercles. A yellow, cheesy mass of variable size, softened and disintegrated upon the surface, and in which separate tubercles are no longer to be seen, takes the place of the apex of the papilla, and occupies the contiguous portion of the calyx. Isolated tubercles occur at the periphery, diminishing in size and number the more distant they are, and extend, in cases of long standing, to the outer surface of the kidney, where they may be recognized, but, of course, cannot be distinguished from those occurring in the disseminated form. Those lying next to the cheesy mass are yellow, and even cheesy; those farther off are gray, translucent, in other words, perfectly fresh. Since the disintegration of the nodule continually extends from within outwards, larger and larger portions of the pyramidal substance, and, finally, the whole pyramid, and even a portion of the cortex, may be destroyed. As the superficial portions of the cheesy mass become de-

tached, the calyx, which was at first narrowed, now becomes widened (*phthisis renalis tuberculosa*). This affection is frequently associated with a similar one of the urinary tract (bladder) and sexual apparatus.

7. **Gummata** are seldom met with. They appear when recent, in the form of nodules, which vary in size from that of a millet-grain to that of a pea, are of a uniform yellow color, have a firm, elastic consistency, and are situated within a fibrous tissue, produced by chronic interstitial inflammation. Upon microscopic examination one finds the usual granulation-like tissue rich in cells, with fatty degeneration of the latter.

8. The **new formations** which occur here, include adenomata, carcinomata, and sarcomata (both primary and secondary), fibromata, and, more rarely, others, such as lipomata, angiomata, etc.

Adenomata appear in the form of yellowish nodules, the size of which varies from that of a millet-grain to that of a bean. They frequently contain numerous small cysts, and are surrounded by a connective-tissue capsule. Upon microscopic examination the urinary tubules are found to be widened and furnished with offshoots, their cells frequently fatty; hæmorrhages are often situated within the canals, giving rise at times to a brownish-red color.

Carcinomata and *sarcomata* are to be recognized here by the rules already laid down; still it ought to be mentioned, that a mixed form of the two (carcinoma sarcomatosum) occurs in the kidney, the diagnosis of which is extremely difficult, and can only be made by a very careful examination of hardened specimens. The growth of malignant tumors of the kidney into the renal veins, and through these into the inferior cava, etc., has already been referred to.

4. Examination of the Calices, Pelves, and Ureters.

Certain affections of the *calices* and *pelves*, which occur in connection with diseases of the kidney, have already been considered. *Œdematous* swelling of the mucous membrane with hæmorrhage occurs in many varieties of renal inflamma-

tion. *Hæmorrhage* occurs here, especially in hæmorrhagic small-pox, etc.; *purulent* and *diphtheritic inflammation*, as elsewhere. It is worthy of mention, that while diphtheritis is present, both in the bladder and pelves of the kidneys, it is replaced by a simple, generally hæmorrhagic inflammation of the ureters, so that it is possible to recognize a continuity of the inflammation, but not of the diphtheritis. *Tuberculosis* is usually combined with phthisis renalis, and possesses similar appearances; a thickening of the whole wall, cheesy degeneration of the surface, and gray tubercles in the mucous membrane about the cheesy places and at remote points in the more advanced cases. Cheesy ulcerations begin both in the pelvis of the kidney and in the ureter as lenticular ulcers, which are small, round, and either isolated or arranged in groups. These will be more minutely described in connection with the affections of the bladder.

Chronic inflammation of the calices, which is frequently combined with a reticulated or linear thickening of the mucous membrane, is most frequently met with as a result of an irritation caused by *concretions*, either in the form of small brittle masses (gravel) or larger compact stones. Cases occur in which the whole cavity of the pelvis and calices is filled with one continuous mass of concretion. The character of the stones varies greatly according to their composition. Very compact ones of a dark brownish-yellow, or grayish color with a mulberry-like surface, are composed of the salts of oxalic acid, *oxalate of lime calculi*. *Urate calculi*, composed principally of uric acid salts, are usually smooth or but slightly uneven, of a clear brownish-yellow color, frequently streaked and of medium consistency; finally, those composed of *phosphates* and *carbonates* are very soft, white, and chalky. As the latter are usually produced as a result of catarrh, or the decomposition of urine accompanying it, a layer of phosphates is frequently met with covering other stones. The excretion of oxalates and urates, apparently depends upon changes in the blood, and they may alternate in layers, so that under proper conditions all possible forms

of precipitates may be found upon one stone. It has already been mentioned that purulent inflammation of the urinary tract and kidneys (nephritis calculosa) may be produced by urinary calculi. It is necessary to add that they often produce dilatation of the tract, concerning which a detailed description will be directly given.

It may be first mentioned that in rare cases a multiple *cystic formation* is found connected with chronic inflammation of the mucous membrane of the pelvis and ureter. The little cysts are often present in large numbers, their average size varying from that of a pin's head to that of a millet-grain. They project far above the mucous membrane, and usually contain a perfectly clear and often colloid material. Nothing definite is known in regard to their origin.

One of the most important affections of the upper portion of the urinary tract is *dilatation*, resulting from a retention of urine, caused by an obstruction to its discharge. According to the situation of the obstruction, which may be at a greater or less distance from the kidney, the ureter, pelvis, and calices, or only the two latter are involved, the kidney being affected in both instances (*hydronephrosis*). The kidneys are converted in extreme cases into fluctuating sacks, in which only small portions of glandular substance are seen here and there, forming a part of the walls. The calices and pelvis form one large cavity, and the ureter, when the obstruction is situated near the bladder, is converted into a canal as large as the finger. A less degree of the affection is indicated by a slight fullness of the calices and pelvis, and also by more or less flattening of the otherwise pointed, wedge-shaped papillæ. Between the two extremes all degrees of the affection occur. In all cases of hydronephrosis of any severity, the kidney is very anæmic, firm, tough, and in a state of chronic interstitial inflammation. The destruction of the parenchyma by atrophy begins in the papillæ, and passes from here outwards.

The narrowing of the tract producing the hydronephrosis, is usually caused by external pressure upon the ureter, or by

obstruction of the latter by a stone. In other cases no such cause exists, and it is then often found that the ureter leaves the renal pelvis at an acute angle, so that a valve-like projection from its wall becomes possible, which is sufficient to cause an obstruction at the beginning of the ureter. Unilateral hydronephrosis usually presents an extreme degree of degeneration, while the other kidney assumes a portion of its function by compensatory hypertrophy. The dilatation is bilateral in many diseases of the uterus, especially in carcinoma, in which affection the ureters are often included within the cancerous growth. When this condition of things is found, it is necessary to examine the size of the ureters by the rules already laid down, before removing the kidneys.

Finally, a *congenital anomaly* of the kidneys and of the upper portion of the urinary tract sometimes occurs, which consists in a doubling of the parts, and sometimes affects the ureters alone, and again the pelvis and kidneys. In the latter case a wide glandular septum is usually seen upon making a section, separating the two ureters, but in such a way that it belongs more to the one than to the other. In rare cases a complete division of the kidney also occurs.

5. THE PELVIC VISCERA.

The examination of the bladder and urethra follows that of the kidneys, and as the former should only be removed in connection with the sexual apparatus and rectum, the *pelvic viscera* as a whole are now to be considered. After the relative position of the organs has been accurately determined, and especially the height of the uterus when that organ may happen to be enlarged, the examination begins with the consideration of the *bladder*, its size, form, and degree of fullness. It is to be drawn somewhat away from the symphysis, and a longitudinal incision is made in its anterior wall that the character and quantity of its *contents* may be determined.

(*a.*) THE CONTENTS OF THE BLADDER.

The *color* of the urine varies, as is well known, from that of the clearest amber to a yellowish-red, brownish-red, or even perfectly black. If the latter shades are produced by drugs, as senna or rhubarb, the color disappears upon the addition of a mineral acid, otherwise it is due to an admixture of blood. When this is present in small quantity, and when the corpuscles have been so long soaked as to be deprived of their pigment, a cherry-red color results. A uniform discoloration indicates diffused coloring matter, while that which increases towards the bottom of the vessel by standing, points to a fresh admixture of blood. The point may be very easily and accurately determined by microscopic examination. The stroma of the soaked blood corpuscles may often be recognized as pale spheres possessing a delicate contour. Biliary coloring matter in the urine is easily recognized by the yellowish-red or brown color, and by the reaction with nitric acid. Granular or crystalline bile pigment adhering to cells or casts is occasionally met with, both in jaundiced children and in adults.

Pus may be mixed with the urine in varying quantity. When only a very small amount is present the most superficial layers of the contents of the bladder may be perfectly clear, while a thick yellow pus is found at the fundus, when the body is in the usual dorsal position. When the bladder contains but little fluid, the latter has a more or less purulent quality. The pus corpuscles may be easily recognized with the microscope. A cloudy, dirty, grayish-yellow mass, which becomes brown when mixed with blood, may be present instead of pus, the ammoniacal odor of which indicates that it has already commenced to decompose. Yellow sand-like concretions are often to be found floating in this material. Large numbers of the different forms of micrococci and bacteria may be seen under the microscope.

The different forms of *hyaline casts* may be briefly mentioned among the admixtures in the urine which change its

gross appearances but slightly. These are sometimes perfectly transparent; again, tinged with yellow and studded with blood corpuscles, fatty cells, bacteria, etc.; also with small numbers of pus corpuscles, and in rare instances with cells from various tumors.

The principal solid sediments consist of urate of soda, which appears in the form of small amorphous granules, and of pure uric acid in the form of whetstones or sheaves; colorless triple phosphates in the form of a coffin-lid (ammoniaco-magnesian phosphates) are also met with, and finally, the envelope form of oxalate of lime. What has been said in regard to renal calculi applies in general to those of the bladder. In order to ascertain the above mentioned admixtures, the urine is to be allowed to stand for a while in a conical glass, the supernatant fluid is then to be poured off, and the remaining portion used for examination.

(*b.*) GENERAL METHOD OF REMOVAL.

After the urine has been removed the rectum is to be separated from the colon, and the latter drawn somewhat upwards (when the contents of the large intestine are thin and abundant a double ligature should be applied before the separation is made). The rectum is then to be drawn forwards with a good deal of force, and a large knife is deeply inserted perpendicularly between the rectum and sacrum, to separate with a sawing motion the loose connective tissue from the latter along the lineæ arcuatæ as far as the os pubis. The separation of the rectum from behind is to be continued by a few horizontal cuts extending to the anus. The rectum is now grasped with the last three fingers of the left hand, while the index finger of the same is placed in the opening in the bladder, then drawing firmly all the pelvic organs upwards and backwards, they may be removed by cutting through their attachments to the walls of the pelvis, keeping the knife close to the symphysis in front. By depressing the handle of the knife backwards and to the right when cutting, especially at the bottom of the symphysis of the male, the

whole prostate and even a portion of the urethra may be removed in connection with the bladder.

In removing the penis, the abdominal incision may be extended as far as its middle, the posterior attachment of the corpora cavernosa separated, and the organ be then cut through subcutaneously as far forwards as one wishes. If it be desirable to preserve the attachment of the urethra to the bladder (strictures, false passages), the penis is cut through in the manner just mentioned, before the pelvic organs are removed. It is then to be separated from the attachments about it, especially to the pubes, and drawn backwards under the symphysis into the pelvis, from which it may be removed with the organs in the manner already described. The testes can be examined very easily without injury to the scrotum, by enlarging the spermatic canal somewhat from the inside and pressing them out from below. If it is desirable to allow them to remain attached to the pelvic organs, both are to be pressed out of the spermatic canal in this manner, and the vasa deferentia separated from the sides of the pelvis as far back as the bladder, before the pelvic viscera are removed.

The female sexual organs, including the entire urethra, vagina and nymphæ, rectum and anus, may be removed, as before, by detaching the rectum and drawing the organs forcibly backwards. When it is desired to remove the outer genitals also, the pelvic viscera are first to be wholly detached from the sides of the pelvis, the legs are to be separated, and the external genitals are to be enucleated to such an extent as may be necessary. They are now detached from the pubes by carrying the knife under the symphysis in the longitudinal axis of the body, and separating them in front and on the sides. When this has been done, the genitals are to be drawn backwards beneath the symphysis into the pelvis, the left index finger is to be placed in the anterior orifice of the vagina, instead of in the incision in the bladder, then the viscera are to be raised up, as has been already described, and separated from the integument behind the anus. After the organs are removed, they are to be placed in their normal

position, the bladder uppermost, and examined separately, from above downwards, in their natural order.

(*c.*) EXAMINATION OF THE BLADDER AND URETHRA.

The section of the *urethra and bladder* is made from the former into the latter; in the male the corpora cavernosa should be separated through the septum. The incision into the bladder must terminate in that already made.

1. The Bladder.

(*a.*) *General Morbid Conditions.*

The *distention* of the bladder naturally depends upon its contents; still there are cases where it is rather owing to some mechanical obstruction, outside the bladder, to the discharge of urine, or to muscular paralysis of the bladder itself. In the former case the walls are thickened also, to be diagnosticated from the appearance of the inner surface, as the bundles of unstriped muscular fibre are thickened and become very prominent, *trabecular hypertrophy*, while between them very deep pockets are often situated (*diverticula*). Thickening of the vesical mucous membrane alone is produced by œdematous swelling, which may result from many kinds of inflammation of the bladder itself, or in its immediate vicinity.

The *shape* of the bladder is frequently altered when the place where the urachus formerly opened is made prominent as a small conical projection. This represents the lowest degree of the more marked deformity, where the urachus remains open to a greater or less extent. Another variation in shape is produced by small pocket-like projections of the walls, *diverticula*, which are usually situated on the posterior wall and are partly congenital, and partly acquired in the manner already described.

In most cases the *color* of the mucous membrane is pale gray, though injected veins are often prominent in the trigonum, and near the origin of the urethra, especially in old females. In recent inflammation the color becomes red, when

very severe a dark red, but it is seldom uniform over the whole surface, being often confined to the projecting muscular bundles, and always more marked here than in the surrounding portions. A slaty color indicates chronic inflammation, and is distributed in like manner.

The *consistency* of the vesical walls increases with the thickness. The mucous membrane if œdematous is often soft and gelatinous.

(*b.*) *Special Morbid Conditions.*

Hæmorrhages are the first affections to be mentioned, and may be the accompaniments of inflammatory processes, or may result from a general hæmorrhagic diathesis (phosphorus poisoning, etc., endocarditis ulcerosa).

Inflammation of the bladder is either simply *catarrhal*, when the mucous membrane is swollen and more or less reddened, or it is *purulent* with intense reddening, swelling, and a purulent secretion ; it may also be *fibrinous* (more rarely), with the formation of a false membrane easily removed, or *diphtheritic* and necrotic, which produces different appearances, according to the extent and degree. In recent cases gray deposits are occasionally seen tightly adherent to the reddened and hæmorrhagic mucous membrane of the trigonum, and to that covering the muscular bundles of the fundus. In more advanced cases these are increased both in area and in depth, and on section a gray infiltration within the mucous membrane may be seen. In the most severe and certainly in the rarest cases, the whole mucous membrane may become necrotic, and separate as a complete cast from the muscular tissue. In such cases it is usually studded with concretions and consequently has a sandy feel.

Tuberculous *affections* of the cystic mucous membrane possess great interest and have a characteristic appearance. The two forms which have often been mentioned occur here also, the disseminated, acute miliary tuberculosis rarely, but the localized form leading to the formation of ulcers is met with more frequently. In relation to the first, it is to be remembered that *lymphoid follicles* exceptionally occur, which

may be easily mistaken for tubercles. They may be distinguished from tubercles by their size, frequent regular distribution, and the absence of any trace of cheesy degeneration in their centre; their appearance without other tuberculous affections is also of importance, and the presence of vessels within them is easily recognized by the microscope.

The second form is especially interesting, as the tubercles in the bladder tend to form in a typical manner the characteristic so-called *lenticular ulcers.* These are the ulcers which have been already described as occurring in the bronchi, being characterized by a flat cheesy base and a sharp jagged border, within which intact nodules are situated. The mucous membrane around them is often reddened, and they frequently coalesce, forming larger ulcers which have a scalloped outline. The favorite seat of these ulcers is also the trigonum and fundus. They occur only in extensive tuberculous affections of the urinary and sexual apparatus, especially of the male.

Tumors of the bladder are relatively rare, especially the primary form. *Secondary carcinoma* of the posterior wall in cases of carcinoma uteri, is the most frequent. In the beginning, merely rounded projections of the mucous membrane are to be seen; later, however, small nodular tumors appear upon the surface and may finally attain a considerable size, and also break down by the extension of the ulcerative process from the vagina, thus producing a *vesico-vaginal fistula.* Sometimes the secondary nodules are situated around the opening of one of the ureters, so that hydronephrosis results; still obstruction of the ureter by tumors is more frequent when they are situated behind or near the bladder.

Among the primary tumors, besides the soft cancers which appear in the form of large nodules, there are the so-called *villous cancers* (carcinoma papillosum). These send projections into the bladder in the form of papillæ, which are often arborescent, and contain cylindrical cancer cells and numerous vessels, so that vesical hæmorrhage often results Their favorite seat is on the trigonum Lieutaudii. The ends of the

papillæ often become enlarged by incrustations of uric acid salts, when they become of a light yellow color, and float very freely when water is poured upon them. They must not be confounded with condylomata, which also possess villi. The means of distinguishing them were mentioned in treating of cancer of the skin.

Rupture of the bladder, besides resulting from tuberculous and carcinomatous ulceration, may also be produced by direct mechanical injury, especially during child-birth and in the operations attending it. It usually follows partial necrosis of the posterior or often of the anterior wall only, where it presses against the symphysis. Such an injury and consequent necrosis is followed by a violent gangrenous inflammation of the connective tissue about the bladder (*pericystitis gangrænosa*).

2. The Urethra.

Many affections of the *urethra* are similar to those of the bladder, and not unfrequently diseases in the latter extend into it, especially into the posterior portion of the male urethra. Only those alterations therefore which are peculiar to this tract will now be considered. An affection of the *blood-vessels*, which appears more particularly in females, has been incidentally mentioned in considering the bladder; it consists in a dilatation and injection of the veins at the neck of the bladder, and of those of the urethra, the so-called vesical varix. Simple thrombosis (even phlebolites) and the inflammatory form (thrombophlebitis) may occur, followed by embolism of the lungs.

In general, the more complex male urethra is much more subject to disease than that of the female. One of the most important is *narrowing, stricture of the urethra.* It may occur in all degrees, from the very slightest contraction to an almost complete closure, through which it is next to impossible to pass the smallest probe. The stricture is usually situated within the membranous portion, and a fibrous thickening (from chronic inflammation) or cicatrices (from ulcers of the mucous membrane) may be observed, both at the place

where the stricture is situated and in its immediate vicinity. Lacerations are often present in cases of stricture, *false passages* being made by improper catheterization. Some of these may be recent, while others are of long standing and already partially healed. The same thing happens when the canal is narrowed by enlargement of the prostate, and one then sees, especially in the prostatic portion, long canals which run outside the urethra and into the prostate. Such a laceration may cause suppuration about the urethra within the gland (peri-urethritis), and when the abscess (peri-urethral) discharges into the urinary tract, an extensive gangrenous inflammation of the cellular tissue may result, owing to the effect of the urine upon the tissues. Such an effect may also be brought about by anything which causes perforation of the urethra.

Of the remaining affections tuberculosis may be borne in mind. This occurs only in the male, and has the same appearance as in the bladder, but more frequently causes extensive destruction of the walls, especially in the pars prostatica. The wider female urethra is more frequently the seat of tumors, of which the condylomata are most frequently found.

(*d.*) THE PROSTATE.

The *prostate* is to be examined by dividing it transversely in front of the colliculus seminalis ; variations in its *size* are very common, as it is frequently enlarged, especially in old men. The enlargement may involve both lateral lobes, and is then of comparatively little importance, or it may affect the so-called middle lobe, which, as is well known, first appears in consequence of its enlargement. It then projects more or less into the neck of the bladder, and may be the cause of hypertrophy and catarrh of the bladder, and of lacerations of the urethra from catheterization (false passages).

Atrophy may be the result of chronic inflammatory processes, and also occurs in old subjects. In such cases the section is very frequently found to be covered with black or

brown pigment, as though sprinkled over with snuff. These little brown concretions, the so-called *prostatic calculi*, may, under certain conditions, attain a very considerable size, and in part show the amyloid reaction.

Purulent inflammation (prostatitis apostematosa) affects sometimes only one lobe, and again, the whole organ; all degrees may be found between abscesses the size of a pea and suppuration involving the whole gland. In the latter case, the discharge may take place on either side, especially on the posterior.

When *tuberculosis* exists in the urinary organs, the prostate, as a rule, is also affected. In recent cases, only small, cheesy nodules are seen, and fresh, gray tubercles are situated in their neighborhood. Later the cheesy masses increase in size, soften in the centre, and large cavities filled with soft, cheesy material, are then seen; they are surrounded by a firm, dry, yellow mass, around which an indistinct tubercular eruption is frequently met with.

Hypertrophy may be due to either an increase (hyperplasia) of the glandular portion or of the interstitial tissue. The former is soft, grayish-yellow, and a fluid rich in cells may be pressed (adenoma) from the section; when the cut surface is examined the ducts of the gland are seen provided with conical projections. No fluid can be pressed from the latter form, and upon section, only the fibro-muscular interstitial tissue is seen to be increased (*fibromyoma*). The two forms may occur combined.

Tumors of a carcinomatous or sarcomatous nature also are met with, though but seldom.

(*e.*) THE VESICULÆ SEMINALES AND THE VASA DEFERENTIA.

In order to examine the *vesiculæ seminales*, the floor of the fossa between the rectum and bladder is to be turned upwards, so that the prostate may lie upon the left index finger, the posterior wall of the bladder is then to be strongly drawn away with the thumb from the anterior wall of the

rectum, which is held by the middle finger. The two sacs will then be seen as two long projections behind the neck of the bladder. They are then opened for examination by making a longitudinal incision through them. The ends of the vasa deferentia may be easily seen at the same time, and may be slit open with a pair of small scissors.

The contents of the vesiculæ seminales are subject to many variations, both in respect to quantity and composition. It is not always possible to find spermatozoa, even when the contents of the vesicles are present in large quantities; in their stead are round cells, which contain, especially in old subjects, and cachectic individuals, abundant brown pigment-granules. These may give to the whole fluid a brown color, apparent to the naked eye. The consistency of this fluid is frequently thick and gelatinous, in which case round or cylindrical colloid masses, often containing empty spaces, are found with the microscope. Inflammation is rare, but chronic, fibrous, and purulent forms occur. The changes most frequently found both in the vesiculæ seminales and their excretory ducts, are those produced by tuberculosis, which presents the same characters here as in the ureters, and is associated with general genito-urinary tuberculosis. In an early stage the innermost layer of the mucous membrane is of a yellow color, and covered with a thin layer of cheesy material. Later, the canal becomes filled with this mass, and the yellow color (cheesy degeneration) of the wall extends further in. At the same time a chronic inflammation is set up at the periphery, giving to the connective tissue a fibrous character.

(*f.*) THE TESTIS, EPIDIDYMIS, AND SPERMATIC CORD.

In examining the *testes* their *position* is first to be noted. As is well known, it not unfrequently happens that either one or both do not lie in the scrotum but in the abdominal cavity, or somewhere within the spermatic canal (*monorchis*, *cryptorchis*). In the latter case it is often possible to determine their position by feeling upon the outside. In such

instances their size is almost always abnormal, being usually small, and the tissue atrophied; sometimes, however, they are enlarged. Such retained testes are liable to be the seat of various kinds of tumors.

1. The Spermatic Cord and Tunica Vaginalis Propria.

The *spermatic cord* demands attention, before the testis, occupying its normal position within the scrotum, is reached. Various affections may be found bearing the generic name of cele. First *varicocele*, a thickening of the whole spermatic cord, caused by a varicose dilatation and coiling of the veins of the plexus pampiniformis (most frequent on the left side). Then comes *hydrocele* with its various subdivisions. *Congenital hydrocele* is that variety in which the pocket of peritoneum (processus vaginalis peritonei), produced by the descent of the testis, remains open; the testis lies as a prominent body at the bottom of and within the pouch. Another form is *hydrocele of the cord*, in which the walls of the peritoneal pocket are united above the testis, and at the origin, while the portion between these two points is converted into a cystic enlargement, varying in size and position. If there are several cystic dilatations present, the term *cystic hydrocele of the cord* is used. This may be easily mistaken for a *hydrocele herniosa*, which is produced by a collection of fluid within a hernial pouch the orifice of which is obliterated. As a rule this sac lies near the peritoneum, and is often surrounded by a thick, fatty capsule. *Hydrocele tunicæ vaginalis propriæ testis* leads us directly to the testis, it being an affection characterized by a collection of fluid between the parietal layer of the pouch and the testis. The fluid is sometimes clear, watery (with fibrinogenous substance), at others purulent, and very frequently bloody, especially in large hydroceles. The blood has often undergone changes, and the contents of the sac then have a chocolate color and a pulp-like consistency (*hæmatocele*). Sometimes the watery fluid is cloudy, like milk, due to the presence of cells containing fat granules, granular

corpuscles, or to fat drops. At the upper extremity of the testis, cysts, which may attain the size of a walnut, project into the sac and are connected with the spermatic canals, and consequently contain spermatozoa (*spermatocele*). Cysts may also arise from what is known as the hydatids of *Morgagni.*

The walls of a true hydrocele of long standing show many changes of an *inflammatory nature*, so that there is no sharp line of demarcation between the two. The changes consist principally in a sclerotic thickening (*periorchitis fibrosa*), which is often partial and may become cartilaginous or calcified. At other times, growths resembling warts, papillæ, etc. (*periorchitis prolifera*), make their appearance; these also consist of a dense fibrous tissue, and may become detached (free bodies), often being calcified in their centre.

Finally other cases may present an adhesion between the tunica vaginalis and testis (*periorchitis adhæsiva*), which may cause a partial or even total obliteration of the sac. These are often of syphilitic origin. Purulent inflammation (*periorchitis* or *vaginitis suppurativa*) is easily recognized by the purulent character of the contents of the sac. It may be traumatic in its origin, or secondary to some other affection of the testis.

2. The Exterior of the Testis and Epididymis.

The testis, in consequence of various processes (inflammatory or the growth of tumors), may undergo a *hypertrophy*, sometimes exceeding the size of a man's fist. *Atrophy* is constant in old subjects, and also occurs as the result of an arrest of development after puberty, from the compression of hydrocele, and finally from chronic fibrous inflammation, especially that of syphilis. The epididymis is independent of the testis, with reference to changes in size. In many forms of inflammation, especially in those which affect similarly other portions of the genito-urinary organs (gonorrhœa, tuberculous inflammation), the epididymis is enlarged. The *consistency* of the testis, which is very soft, becomes

still softer and more compressible, in the atrophy of old age and in that arising from pressure, provided the tunica albuginea is not unusually thickened. In fibrous atrophy the gland is decidedly firmer, also in most inflammatory changes, whereas in many tumors the consistency is perfectly soft (medullary).

3. The Interior of the Testis and Epididymis.

In order to examine the *parenchyma* a longitudinal incision is to be made, beginning on the side opposite the epididymis and extending through the body of Highmore into the epididymis. The latter, especially its head, may also be examined by a separate incision.

The *color* of the normal parenchyma is, according to the amount of contained blood, gray or grayish-red. When it is pale yellow or yellowish-brown, and the parenchyma is very soft, it is an indication of fatty degeneration of the cells within the tubules of the testis, which appears usually in atrophy, especially in that of old age. A grayish-white color, combined with fibrous hardness, arises from the development of fibrous tissue. The clear yellow color of cheesy masses is, in the majority of cases, to be attributed to tuberculosis.

Hæmorrhages, *hæmorrhagic infarctions* (*embolic*), and *embolic abscesses*, occur here also, but much less frequently and more extensively than in other organs.

The *acute* **inflammations** are rarely met with. As is well known, the epididymis is the favorite seat of purulent inflammation (*epididymitis apostematosa*), so frequently gonorrhœal, still the testis is not always free. In the latter, cavities of various size are sometimes found, containing greasy yellow masses, composed of fat and glistening cholesterine crystals (atheroma of the testis), or of such petrifactions as result from former abscesses. Cicatricial bands, which often extend to the integument and thus produce a deep depression, may also be due to abscesses which have led to the formation of fistulæ and then healed. While the

fistulæ exist they are frequently lined with a layer of granulation tissue, which may project upon the surface like a tumor. *Chronic inflammation* is recognized by the fibrous thickening of the interlobular septa, on account of which the intervening glandular tissue is more or less atrophied.

Tuberculous and *syphilitic* affections of the male generative glands, are of the utmost importance. They may be distinguished in a general way from each other by the fact that the former first attacks and has its principal seat in the epididymis, while the latter first attacks and has its principal seat in the testis proper.

Among the **tuberculous** affections, two varieties may be distinguished. In the first the epididymis forms a sausage-like swelling, and has often undergone complete cheesy degeneration, while in the parenchyma of the testis there is no apparent change, or there are very scattered gray, miliary or submiliary, tubercular nodules, which diminish in number from the corpus Highmori towards the periphery, and may be cheesy. In recent cases it may be easily ascertained that the process begins in the walls of the epididymis and vas deferens, for the latter, and other portions of the genito-urinary organs, usually share in the disease; the wall is thickened, gray, and translucent, the superficial portions are infiltrated to a slight extent with cheesy material, and the inner surface is covered with a layer of the same. As a rule, the tissues are so firm that sections may be made with a sharp razor, and in these the presence of tubercles in the peripheral layers of the walls may easily be seen. The greatest development of the affection is, as a rule, in the head of the epididymis, which in cases of long duration may be converted into a cavity filled with a greasy, cheesy mass. Not unfrequently perforation takes place, a fistulous opening of greater or less width is then found on the scrotum, leading directly into the interior (*fistula testis tuberculosa*), from which a caseo-purulent secretion is discharged. In the testis proper the tubercles are situated in the interstitial tissue, which is increased and appears in the form of gray lines, radi-

ating from the corpus Highmori, or as round gray spots. The tubercles may become very numerous in the testis, and by their confluence produce large cheesy masses, so that finally the testis may attain the size of a hen's egg, or even that of a lemon. The affection is unilateral, or bilateral; in the latter case one side is often more affected than the other. According to Gaule the formations which have always been looked upon as tubercular nodules are the result of an inflammation of the tissue about the tubules of the testis (*perispermatophoritis*), combined with changes within them, just as the peribronchitic pseudo-tubercles are the product of an inflammation of the peribronchial tissue, except that in the latter case each nodule involves but one small bronchus, while in the former a number of tubuli are involved.

The second variety is met with especially in boys who are suffering from general tuberculosis. It has its seat from the beginning in the testis proper, and is essentially a disseminated miliary tuberculosis, which may however produce large cheesy masses by the confluence of the nodules.

The **syphilitic** affections of the testis vary according as they are manifested by a simple interstitial fibrous inflammation (orchitis interstitialis fibrosa), or the formation of gummata (sarcocele syphilitica).

The former somewhat resembles in its gross appearances the first form of tuberculous inflammation, since the changes are greatest in the corpus Highmori, and disappear gradually towards the periphery. Firm, fibrous, cicatricial bands are seen, varying in width, at first connected with each other, but becoming more and more separated as they approach the surface; they correspond to the direction of the septula testis, in which the affection essentially runs its course. The fibrous bands give off numerous lateral branches, so that their combined appearance upon the surface of the section may be compared to a stag's horns. The affection is frequently only lobular, but it may extend over the whole parenchyma. The parenchyma lying between the fibrous bands naturally undergoes atrophy from compression, so that

the testis, at least in the later stages, is always diminished in size. When the affection is extreme, total fibrous atrophy may finally result.

Gummata of the testis never occur alone, but always in connection with an interstitial fibrous orchitis. The yellow, dry, tough, elastic, fatty masses of the gummata lie imbedded in the fibrous product of interstitial inflammation, and consequently have a much more irregular appearance than the first form. The gummata are sometimes in the form of miliary nodules; again they form large irregular masses, which lead to considerable enlargement of the testis. The fatty masses here, as in other organs, may gradually disappear by absorption, so that only a fibrous cicatricial tissue remains, which sometimes is only to be distinguished from the fibrous tissue of interstitial inflammation by its unusual situation, it being separated from the corpus Highmori by relatively normal tissue. A chronic fibrous periorchitis, and frequently the adhesive form also, are usually combined with the syphilitic processes.

The testis is a favorite seat for all varieties of **tumors.** These are sometimes simple; again (and in this respect the peculiarity of the testis consists), they are mixed, presenting the most peculiar combinations. The teratoid tumors, which have their favorite seat in the ovaries, occur rarely in the testis. The most frequent forms are the mixed tumors of the histioid class, especially *myxosarcoma;* also *chondrosarcoma*, the character of which is sometimes so apparent that the position of the separate parts of which it is composed may be determined with the unaided eye. While the different tissues which form the mixed tumors are more distinct in other organs, in many chondrosarcomata of the testis both tissues are intimately mixed. The cartilage appears as a worm-like deposit in the sarcomatous mass, easily removed, and evidently situated within preëxisting spaces (lymph vessels), which are somewhat distended.

Myxosarcoma and *chondrosarcoma* also occur here. What has been already said in regard to distinguishing these tu-

mors applies to them here. In general, mixed tumors possess a sarcomatous base. Pure sarcoma and pure carcinoma may often be distinguished from each other by their general gross appearances. (In carcinoma it is possible to scrape off a milky fluid; a coarse network is often apparent to the naked eye, and from its interspaces the milky fluid exudes. Sarcoma, which has a more even surface, does not permit such a fluid to be pressed out.) In the most malignant growths, the soft encephaloid tumors, the differential diagnosis can be made only with the aid of the microscope. Tumors of the testis are often remarkable for the abundance of vessels which they contain, and the thinness of their walls, so that hæmorrhagic forms are of frequent occurrence. Other forms than those already mentioned appear exceptionally, for instance, myomata, osteomata, etc. Bony tumors must not be confounded with petrification of the testis, which is occasionally found, and has already been mentioned as the result of a purulent inflammation.

(*g.*) THE VULVA.

The *external female genitals* may be examined in the manner already described, either *in situ* or after they have been removed. The changes in size, due to the *enlargement* of the labia majora from *œdema*, and *elephantiasis*, have already been considered in treating of the skin. The labia minora, in women who have borne children, are often incompletely covered by the greater labia, and sometimes form long, red pendulous projections, of varying thickness. From one or both sides of the prepuce of the clitoris also, especially where it is continuous with the nymphæ, masses resembling pads or polypi, hang down near the orifice of the urethra, in front of the vaginal orifice, and even project from the opening between the nymphæ. Occasionally the clitoris itself shows congenital enlargement, which is then frequently associated with other anomalies of formation, constituting what is known as hermaphroditism.

Solution of continuity of the parts, especially a rupture of

the frenulum, extending into the perinæum even, is almost always the result of childbirth. Partly superficial and partly deep *lacerations* may be found in all possible places; when connected with marked swelling, redness, and even purulent inflammation of the parts, they always suggest the suspicion of an attempt at rape, especially in children, where immissio penis is impossible, owing to the disproportion in size. A traumatic laceration of the tissues, without any rupture of the surface, occurs in the labia majora of puerperal women; these parts may appear much enlarged, owing to the great effusion of blood into their tissues (*hæmatoma vulvæ*). The consequent inflammation may cause gangrene, which readily extends to the pelvic cellular tissue. *Purulent inflammation* always runs its course as a virulent catarrh, with marked redness and swelling of the parts.

Of the remaining inflammatory processes the *diphtheritic*, associated with puerperal lacerations, is worthy of mention. It may be easily recognized by the gray infiltration upon the base of the ulcers. These ulcers are frequently of a perfectly *gangrenous* character, and may be recognized as such by their unusual grayish-black appearance, and the necrotic condition of their edges and base. If the puerperal lacerations are followed by no complication they are immediately converted into purulent ulcers, called *puerperal ulcers*.

The growths upon the external genitals, known as the pointed and broad *condylomata*, and the *chancre*, have been sufficiently described, in treating of the skin.

Of the true neoplasms, *carcinoma* and *melanoma* originate principally from the *clitoris*. Peculiar *atheromatous* cysts, containing a butter-like mass, occur in the nymphæ, also *fibromata* (*papilloma*), etc.

(*h.*) THE VAGINA.

The *vagina* is to be examined by opening it longitudinally on the left side, and then separating it from the anterior surface of the uterus, when it may be laid open and all its parts be conveniently inspected.

In order to preserve the bladder in certain cases, it is well to separate it from the uterus, at least on the left side, before opening the vagina.

1. *General Appearances.*

Changes in *position*, not of the vagina as a whole, but of certain parts, are sometimes primary, and at other times dependent upon a change in the position of the uterus. In the first class are included the protrusion of the anterior wall of the vagina (*cystocele vaginalis*), or of the lower part of the posterior wall, caused by the rectum (*rectocele vaginalis*), and of the upper from the sinking of the small intestine into *Douglas's fossa* (*enterocele vaginalis*). To the latter class belong the eversion of the vagina from prolapsus uteri, and the displacements due to tumors of the uterus. When the vaginal mucous membrane projects from the vulva, its epithelium becomes so changed as to resemble the epidermis; the cells collect in thick layers (*pachydermia*), and cause a whitish, at times almost milk-white appearance of the surface.

Variations in the *size* and *shape* of the vagina are sometimes congenital and sometimes acquired. Besides the instances above referred to, enlargement is apt to follow numerous confinements, or long continued catarrh; in such cases the surface usually becomes smoother, owing to a diminution in the size or a disappearance of the folds. Narrowing is of more importance, sometimes affecting the whole vagina (in congenital hypoplasia of the genitals, and in hermaphroditism), or certain portions of it. The latter deformity is either congenital (atresia) or acquired (by the contraction of cicatrices). The narrowing from scars is seldom total, and can be recognized by the cicatricial changes in the contracted portion and in its neighborhood. Small projections in the middle of the anterior or posterior wall are also congenital, and indicate the manner of the formation of the vagina by the coalescence of the two Müller's ducts. A greater degree of this arrest of development is reached when a membranous septum divides the vagina into two portions; this is

limited either to the upper portion or extends to the entrance. It may occur with or without a double uterine cavity.

The *color* of the vaginal mucous membrane is generally a light or dark reddish-gray; decomposition causes it to assume rapidly a dirty gray hue, especially when a gangrenous or diphtheritic process is present in the vagina or in the uterus. The white color in pachydermia has already been referred to. A uniform gray color combined with fibrous induration is found when leucorrhœa has existed for a long time; a slaty color arises from hæmorrhagic inflammation.

2. *Special Morbid Conditions.*

Non-puerperal *inflammation* of the vaginal mucous membrane is often met with. A purulent or gangrenous inflammation with a very offensive discolored secretion, is less common than the chronic form, which is to be recognized by the gray, smooth, and indurated mucous membrane (*kolptis chronica fibrosa*). The vagina, like the external genitals, often suffers much in childbirth, especially when it is necessary to aid labor by instruments (*puerperal affections*). When the pelvis is narrow, or the head abnormally large, and the forceps are applied, the blades very commonly produce lacerations, which sometimes heal readily and cicatrize, and at other times become infective ulcers. This subject will be again referred to directly. Cicatrices situated on the lateral walls of the vagina and running longitudinally, justify the diagnosis of a difficult labor. Lacerations and cicatrices occur in a like way at the vault of the vagina, and extend outwards from the os uteri, being frequently connected with similar ones in the uterus; they are also found at the entrance of the vagina, where they are connected with others on the external genitals.

If the force used was very great, and especially such as to cause extensive crushing, a simple ulcer does not result, but the tissues *necrose*, and an offensive, greenish-black loss of substance with a ragged base results on both sides. In particularly bad cases the whole thickness of the vaginal walls

may be involved, so that perforation results, and an extensive gangrenous phlegmon of the pelvic cellular tissue follows, which may extend to the abdominal walls. In other cases the trouble is situated either on the anterior or the posterior wall, and its location is to be explained by the peculiarities of the bony pelvis (spinous pelvis), or by irregularities in the birth (strong pressure of the head against the symphysis).

Although these lesions usually heal without further trouble when the necrosis does not extend too deep, they are liable to result in very painful fistulæ, not so much in consequence of direct lacerations, but as a rule through subsequent necrosis. The most common form is that between the bladder and vagina (*fistula vesico-vaginalis*); less common are those between the vagina and rectum (*fistula recto-vaginalis*); while those between the bladder, vagina, and rectum (*fistula vesico-recto-vaginalis*), are the most rare.

When the traumatic injury is followed by no deep-seated necrosis, a very serious affection frequently follows, arising from an infection of the wounded surface. *Diphtheritis*, i. e., diphtheritic ulcers of the vagina, is characterized by a gray or grayish-yellow infiltration of the wounded surface, which can neither be removed by a stream of water nor by scraping with a knife. The diphtheritic affection does not remain confined to the wounds, but extends over the contiguous surface also, and appears by preference upon the folds of the anterior and posterior walls. At the commencement of the affection, these folds and the neighboring portions appear dark red, even hæmorrhagic, and their ridges are of a grayish tinge. In the same place, also, the first and most intense diphtheritic change occurs in all cases where the diphtheritis is not an accompaniment of the puerperal state, but supervenes in typhoid fever, variola, etc.

Connected with the sexual life of the female though not with childbirth are *syphilitic ulcers*, seldom observed as such in the cadaver, but more frequently in the form of their after-effects, viz., firm, strongly contracted, radiating cica-

trices, which of course cannot always be distinguished with certainty from those of puerperal origin. It is known that syphilitic ulcers may also lead to perforation, especially into the rectum, forming recto-vaginal fistula (*fistula recto-vaginalis*).

Tuberculous and *carcinomatous* ulcers of the vagina are much more rare. Tuberculous affections of the female genitals are, in general, rare, and tuberculous ulcers of the vagina are especially so, and never occur alone, but only in connection with tuberculosis of the uterine mucous membrane. Their most frequent appearance is that of shallow lenticular ulcers with sharp borders, as though punched out, and a slightly uneven bed. Sometimes they become confluent, and in this way large portions (of the vault and upper half of the vagina) may be deprived of their mucous membrane.

Carcinomatous ulcers are much more frequent, but only when secondary to cancer of the cervix uteri; the primary forms are rare. The term carcinomatous ulcer is used because large, circumscribed, cancerous tumors do not occur here; all cancers of the vagina observed after death have an ulcerated surface. In treating of the primary tumors, this subject will be referred to, and we will only mention here, that these ulcers may produce an extensive destruction of the vaginal walls, with an extremely penetrating odor due to decomposition of the secretion and to gangrene of the ulcerated surface. This odor may result without perforation of the walls and the consequent formation of a vesico-vaginal fistula, which not unfrequently happens. The surface of the ulcer is discolored, ragged, and disintegrated, and there is but little of the carcinoma to be seen; the edges of the ulcer often project above the normal vagina like a wall, and on cutting through them and the base, the growth will be seen as a tough, grayish-white mass, from which cancer juice or the plugs resembling comedones may be pressed. Perforation of these ulcers into the rectum is rare, still it does happen.

There are thus a great number of processes which lead to

the formation of fistulæ between the vagina and bladder, also between the vagina and rectum. Congenital fistulæ, so called *cloacæ*, also occur. It will not be difficult, after what has already been said, to discover the cause of the trouble in each separate case.

(*i.*) THE UTERUS.

1. External Examination.

Previous to opening the *uterus* certain general conditions are to be noted, such as the size, form, and length. The *length* of the fully developed virgin uterus, according to Huschke, is five and one half to eight centimeters; the breadth, three and one half to four centimeters; the thickness, two to two and one half centimeters. After childbirth it remains permanently enlarged, and in multiparæ it measures nine to nine and one half centimeters in length; five and one half to six centimeters in breadth, and three to three and one half centimeters in thickness. *Diminution in size*, except when the result of senile atrophy, is rare. It is constantly associated with fibrous degeneration of the walls, and usually of the mucous membrane. It is very frequently connected with old adhesive peritonitis, so that the uterus is very often completely imbedded in a firm pseudo-membrane.

Enlargements vary greatly in degree. Aside from those forms which are produced by tumors upon the exterior, the uterus itself may attain the size of a child's head, or even exceed it (hydro- and pyometra, etc., intraparietal and submucous fibromata, etc.). Enlargement is not always a symmetrical one of the body and neck, but sometimes one and sometimes the other is the more enlarged. Hypertrophy of the lips of the os is at times especially marked; both or only one, more particularly the anterior lip, may be enlarged.

Variations in shape are seldom found in a uterus which occupies its normal position, but usually in one which is abnormal in this respect. To the first class belongs the congenital bicornous uterus (uterus bicornis), which is sometimes merely suggested by a longitudinal furrow in the middle of

the fundus, while at other times a complete separation of the two horns exists. The rounded form in hydro-, pyometra, etc., also belongs here. The changes in shape which are connected with a *change in position* are of the utmost importance. An elongated and flattened uterus is produced by many subserous tumors, and by adhesions of the uterus to some of the abdominal viscera which are situated high up. In such cases the vagina is almost always elongated.

What are termed the *flexions* and *versions* of the uterus are of a somewhat different nature. The uterus may undergo a change in position without any change in the relative position of its parts, so that the long axis becomes more or less horizontal, and according as the fundus is tipped forwards or backwards, it is designated *ante-* or *retroversion*. Most frequently the position of the cervix and body relative to that of the fundus is changed, so that their axes do not coincide but form more or less of an angle (a right or even an acute angle), and the uterus is bent abruptly upon itself near the internal os (*ante-* and *retroflexion*). If the uterus is pushed over to one side it is termed *lateroversion* or *lateroflexion*. When such changes of position exist, the cause must be sought for, and, aside from the cases where tumors have developed in the walls of the uterus, will be found at times in a chronic inflammation of the cellular tissue immediately surrounding the uterus, and of the broad ligaments (parametritis chronica fibrosa retrahens), or of the serous coat of the uterus (perimetritis chronica adhesiva); or finally in certain congenital irregularities in its supports (insufficient length of one broad ligament, etc.).

In the first series the direct traction of the adhesions, due to a shrinking of the inflammatory material, draws the uterus out of its position; in the last the immediate causes vary, the most important being those affecting the intra-abdominal pressure (pressure from intestines, etc.), which, however, can only act when combined with the more remote cause, the congenital deformity. As the neck of the uterus is firmly attached to the posterior wall of the bladder, the

force which displaces the uterus will first take effect at the point where this attachment ceases, and this corresponds to the internal os, where the flexion is always situated. After a while the nutrition of the wall, at the point where the angle is formed, naturally becomes seriously disturbed; atrophy takes place, and the muscular elements become fatty, but these changes are the effect of the flexion and not the cause. The common anteflexion of the puerperal uterus is due to flaccidity of the tissue.

The change in position, called *prolapsus uteri*, depends upon too lax a condition of the uterine ligaments and the tissues of the vagina, such as exists especially after childbirth. The uterus, without changing its shape, sinks into the vagina, and the latter is more and more everted till the external os finally projects from the vulva. On the other hand the change in the vagina (cystocele or rectocele) may be primary, the effect of which is to draw down the uterus. A considerable hypertrophy, usually most marked at the neck, is always combined with prolapse. The cervical enlargement may be primary and so extreme that the external os reaches down to the entrance of the vagina without the body of the uterus being drawn down in the least. It is not difficult to recognize this apparent prolapsus, when the position of the fundus is noted, and also the absence of pockets, which are produced on the anterior and posterior surfaces of the uterus in true prolapse. The abnormally projecting portion is often of a whitish color and covered with a firm, tough, epidermis-like layer, the same *pachydermia* which has been referred to in speaking of prolapse of the vagina. Ulcers, also, especially about the os, are very frequently associated.

Finally, *inversio uteri* must be mentioned. By this is understood a condition in which the uterus is so inverted that the fundus enters the neck, and consequently the mucous membrane of the former is turned outwards. This condition is the result of external force upon the puerperal uterus (traction upon the cord, etc.), or less frequently of tumors (submucous polypi).

2. Internal Examination.

All the changes which have thus far been considered, are best observed upon the unopened organ. For a more extended examination the uterus is to be opened by a T shaped incision, the long arm of which is made through the middle of the anterior wall, and the two shorter ones extend from its middle to the point where the Fallopian tubes are given off.

(*a.*) *General Characteristics.*

The thickness of the walls is first to be noted. This in no way corresponds to the size of the organ; for instance, in hydrometra, it may be from one to two millimeters thick only, and on the other hand, it sometimes reaches three centimeters (when not impregnated). The average thickness is ten to fifteen millimeters in the virgin, and twenty millimeters in the uterus of the adult.

The relative *size* of the body and neck is of the utmost importance in judging of the previous condition of the uterus. In the normal virgin uterus the length of the body and neck are about equal (in childhood the cervix is larger than the body), so that a diminution in the size of the neck with an opposite condition of the body, points to previous pregnancy; this is rendered more probable by the absence of the spindle form of the virgin neck. For the same reason the condition of the uterine walls, their thickness, and the relation of their component parts, is important. In the absence of other local affections, a large, thick uterus indicates a previous pregnant condition; the same inference is to be drawn from the presence of wide, thick-walled vessels, especially in the outer portion of the uterine walls, as after having become enlarged in pregnancy, they never resume their normal size. If the well-known changes in the vaginal portion of the cervix be also taken into consideration, there will be points enough to make the diagnosis of previous pregnancy with tolerable accuracy. These changes consist in a conversion of the external os, which is normally a transverse,

oval, smooth-edged slit, into an irregular round opening with a border notched by cicatrized lacerations.

There is a group of changes, namely, *enlargements of the uterine cavity*, which may depend upon all possible affections, but which have for their immediate cause an obstruction of the cervical canal. When this exists, there is a retention of fluid in the uterine cavity, and by its constant increase the cavity, likewise the whole uterus, becomes distended and, as other organs under similar circumstances, tends to assume the spherical form, and may finally become almost globular. According as the contents are a clear watery, purulent, or bloody fluid, the condition is designated as *hydro-*, *pyo-*, or *hæmatometra*. If gas is also present (from decomposition of pus, etc.), it is termed *physometra*. The cause of the obstruction is varied. The ordinary hydrometra in old women is due to closure of the internal os from chronic endometritis. The retained fluid is always watery, while in dilatation of the cervix, which also occurs, the contained mass is a tenacious mucus. Sometimes the obstruction is due to a tumor, which either directly, or through the bulging of the walls, narrows or closes the cavity; at other times it is due to a cicatrix, and a complete closure may be thus caused, as the result of ulcers, or of congenital disturbances.

After the *color* of the walls and their *consistency* also have been observed, the mucous membrane is to be examined in respect to its thickness, color, and consistency. The walls are usually reddish-gray, in fatty degeneration clear yellow, brittle, and easily cut; in chronic fibrous inflammation they are of a uniform grayish-white color, very tough, and impart a grating sensation when cut. The *mucous membrane* is increased in *thickness* in acute, and chronic proliferating inflammation, decreased in the chronic fibrous form. Its *color*, normally gray, or grayish-red, becomes dark-red in hæmorrhagic inflammation, slaty in the chronic hæmorrhagic variety, and grayish-white in chronic fibrous inflammation, etc. The *consistency* is soft when the mucous membrane is swollen, hard and fibrous in chronic fibrous inflammation.

The recognition of the *menstrual* or *puerperal* condition of the uterus is especially important. During menstruation, the uterus is enlarged (to the size of a hen's egg), its substance soft and juicy; the mucous membrane is swollen, succulent, reddened from the engorgement of the blood-vessels, and covered with a more or less pure or watery blood, according to the duration. Menstrual blood coagulates with difficulty, but it is by no means devoid of that property. The puerperal uterus will, of course, present a very different aspect, according to the time which has elapsed since confinement, and according as the pregnancy had continued to its full term, or was cut short (abortion). The signs easily recognized soon after confinement, are the size of the uterus (from that of the fist to that of a goose-egg), the seat of the placenta, characterized by the warty growths, and the lacerations in the external os, in connection with the presence of large, wide vessels in the walls. Later these gradually disappear, the seat of the placenta differs but little from the surrounding surface, the lacerations heal, and the puerperal uterus resembles the ordinary menstrual organ. In order to distinguish the two, the examination of the ovaries will be of service; in the former case a small, old corpus luteum will be found, in the latter a recent, very large hæmorrhagic one. An important point in the diagnosis of a recent labor at full term, or of a premature labor, is an orange discoloration of the mucous membrane of the neck of the uterus, which is often present. The width of the internal os is also important; this becomes narrow in the process of involution, and in chronic inflammation, in the latter abnormally narrow as a rule.

(*b.*) *Special Morbid Conditions.*

The *puerperal* uterus is subject to a very great number of *affections*, and they are of especial interest to the pathologist, as they are so frequently the cause of death, while the inflammatory affections of the non-puerperal uterus are only occasionally found, the acute forms being very rare.

1. Mechanical **lacerations,** are the simplest injuries to the uterus from the effects of childbirth; they have already been spoken of as occurring at the neck, and especially in the external os, and often reach into the vagina. Among the rarest accidents is *rupture* of the body of the uterus or of the neck. The rent is usually in the body, and the ovum, entire or in part, may pass through it. Recovery from so extensive an injury is exceedingly rare, but the preëxistence of the less severe forms is indicated, as has already been mentioned, by the frequent presence of scars.

Closely connected with the simple lacerations are those affections which, when extreme, were formerly called *putrescentia uteri*, and which have already been spoken of in connection with the vagina. The surface of the wounds, the neighboring parts, and often the whole inner surface of the uterus, is found converted into a pulpy, stinking, grayish-green, and sometimes, when hæmorrhage has occurred, brownish mass, extending more or less deeply. This condition is one of true gangrene (gangræna uteri, *endometritis gangrænosa*, ichorosa). The destruction of the tissue, as in the vagina, may vary in depth, and a complete necrosis of the walls with perforation, is liable to occur, especially in the cervical portion, where the mechanical injury is greatest. The *perforation* is followed by the results already mentioned, only here the peritoneum may become involved, owing to its proximity.

2. The **inflammatory** changes depend less directly upon the mechanical injuries than upon a resulting infection; they may be confined to the mucous membrane, to the muscular tissue, or they may affect both. In the first case they are manifested by a diphtheritic inflammation (*endometritis diphtheritica*), which is undistinguishable from that of other mucous membranes. It presents the same gray, grayish-yellow, or grayish-white color upon the surface, from which thick gray masses may frequently be removed. There is also an infiltration of the mucous membrane itself, which may be best seen by cutting perpendicularly into the walls.

The liability of confounding these appearances with remnants of the decidua is thus prevented. The latter also usually possess a grayish-yellow color, but lie loosely upon the surface, so that they may be easily removed, frequently by means of a stream of water only. They consist of decidual tissue, which has undergone fatty degeneration, while the diphtheritic masses, when examined microscopically, present colonies of micrococci, as seen in other mucous membranes.

The locality and extent of the diphtheritic affection, both in area and depth, are very variable. It usually takes its origin in the lacerations of the cervical portion, or in the place where the placenta was attached, both of which afford particularly favorable conditions for infection. Not infrequently the diphtheritis remains confined to the place of the placental attachment, and the mucous membrane of the remaining portion becomes simply inflamed, swollen, and intensely reddened. Sometimes, while the surface of the placental insertion is diphtheritic, the opposite wall presents the very commencement of a similar infiltration. Such a condition is important as throwing light upon the method of extension of this form of inflammation. The infiltration in the uterus, as in the vagina, first appears upon the most prominent places, and this is usually most marked at the place of placental attachment, a condition which may be considered as direct evidence of infection from an external source.

The changes within the *uterine walls* vary according as they affect the blood-vessels, lymphatics, or the parenchyma. In order to learn the condition of the blood-vessels, perpendicular incisions must be made, especially through the place of placental attachment, for here they are largest and most numerous, and some are always found open after confinement. These are closed by thrombi in the physiological involution of the uterus.

A more or less firm blood clot is sometimes seen on the seat of the placenta (rarely after normal labor, more frequently after abortion), varying in size from that of a plum

to that of a walnut, or even larger, which projects into the uterine cavity, at times filling it (fibrinous, placental polypus, *hæmatoma polyposum*, Virchow). Remnants of the placenta, besides the blood, are frequently found within this. Soft, crumbly, yellowish-red thrombi frequently appear in the vessels of the placental attachment instead of normal, firm clots, and are surrounded by a thickened yellow wall (*thrombophlebitis placentaris*). Such a thrombophlebitis may also take its origin at other points, especially in the cervical lacerations, so that longitudinal incisions are always to be made here. The blood-vessels within the outer layers of the uterine walls are found empty when normal, but the thrombophlebitic process frequently extends into them, when it is possible to press from their interior a dirty brown or yellowish-red mass.

Similar affections of the lymphatics are quite as frequent if not more so, and appear with or without changes in the veins. As blood is not their natural contents they are filled with a clear yellow, puriform mass, and are characterized by the thinness of their walls, so that their nature may be diagnosticated from this property alone, independent of the fact that the contiguous blood-vessels may always be recognized as such. Their walls are also frequently inflamed, which condition is indicated by the yellow color resulting from purulent infiltration. A dilatation, which occurs with the described changes in the blood-vessels, is usually very marked in the lymphatics, so that they may form cavities as large as a cherry. Their contents are especially well suited for the recognition of micrococci. In many cases the whole mass filling them consists solely of these little bodies.

The third variety of inflammation is that of the parenchyma, *metritis phlegmonosa* or apostematosa. It is characterized by the occurrence of numerous circumscribed collections of pus of varying size, which may be distinguished from sections of lymphatics by their not being bounded by a smooth wall. All forms of inflammation of the uterine parenchyma

very frequently occur, combined with similar changes in the pelvic cellular tissue (*parametrium*). The latter and inflammation of the serous covering (perimetritis) will be described hereafter.

Total fatty degeneration of the uterine walls can only be considered in connection with the above affections, on account of its being due to the puerperal state. It originates after confinement, and is usually due to general marasmus, in which condition the normal fatty degeneration of the muscular wall becomes excessive, and is not compensated for by a new growth of muscular cells. Such a fatty degenerated uterus may often be somewhat enlarged, and is more or less yellow, and remarkably soft, so that when cut into it often resembles butter. The mucous membrane may present a similar change.

Acute inflammatory affections of the *non-puerperal* uterus are seldom found at the autopsy. This applies especially to the purulent forms of severe *endometritis*, which may moreover be easily diagnosticated. Phlegmonous inflammation within the muscular tissue occurs only very exceptionally as an independent affection.

Catarrhal endometritis is more frequently met with. It is characterized especially by the quantity of tenacious, glossy mucus, which not only covers the mucous membrane of the actual uterine cavity, but also frequently fills the cervical canal.

Endometritis hæmorrhagica may be defined as a condition of the mucous membrane, in which it is rendered dark red, not only by great engorgement of the blood-vessels, but also by numerous small hæmorrhages. The resemblance to the menstrual condition may be very great, but an examination of the ovaries will serve to distinguish the two conditions.

Finally, an endometritis fibrinosa also occurs, in which a complete cast similar to that occurring in dysmenorrhœa may be formed. The latter possesses a rough, papillary outer surface, and often occurs in the form of a sac, which

may be cut open, while the former always possesses a perfectly smooth surface, and is frequently solid. The differential diagnosis is very easily made with the microscope.

Chronic forms of inflammation, of the mucous membrane and of the muscular tissue, are much more frequently met with than the acute forms. Here, as in all mucous membranes, the term chronic inflammation is not perfectly correct, because the conditions found relate more to the effects of inflammation than to the process itself. Such are the slaty color of the mucous membrane, due to previous small hæmorrhages; also the frequent fibrous induration by which the whole membrane is converted into a smooth, firm mass, cut with difficulty, and found, upon microscopic examination, to be devoid of glandular elements (*endometritis chronica fibrosa*). Finally, there are the little cysts which almost always occur in large numbers, especially in the cervical portion, and which vary from the size of a millet-grain to that of a split pea, and contain a clear watery or colloid material. These are known as the Nabothian glands (*ovula Nabothi*). They are retention cysts, produced by compression of the mouths of the glands, as is proven by the presence of ciliated epithelium upon their walls.

A second form of chronic endometritis is accompanied by hyperplasia of the mucous membrane, appearing first in the form of little protuberances which later resemble warts, and finally polypi (*endometritis prolifera, polyposa*). These growths are not confined to single layers of the mucous membrane, but involve the whole thickness, so that the glands also become enlarged; the ducts of the latter may finally be closed, thus a retention of the secretion and cystic enlargement result, under which conditions the polypi may consist wholly of cysts (*polypus hydatidosus*). These polypi are usually seated in the cervix, while the molluscum form (small growths situated upon a wide base) occurs in the body of the uterus.

Chronic inflammation of the muscular tissue (*metritis chronica*) is characterized by a whitish-gray color and ex-

treme hardness, so that the wall is frequently cut with difficulty and grates when cut. An enlargement of the organ (formerly called chronic uterine infarction) accompanies the fibrous degeneration, but may later become extremely atrophied, by the complete destruction of the muscular elements and a retraction of the fibrous tissue. Hypertrophy does not always affect all the parts uniformly, the neck being more frequently enlarged than the body. Very frequently the uterine cavity presents a peculiar hour-glass form, the lower part of the cervix being dilated like a funnel. Chronic endometritis is a constant associate of chronic metritis.

While considering the subject of inflammation, an affection which frequently occurs on the portio vaginalis of the neck is to be mentioned, namely, the shallow, round, and frequently confluent *erosions*, which have a reddened base, and are commonly known as catarrhal ulcers of the external os. Occasionally purulent cysts, varying from the size of a pin's head to that of a millet-grain, occur in the immediate neighborhood of the ulcers, imbedded in the tissue. These originate in part from the suppuration of the Nabothian glands, and in part from the inflammation of glands, the mouths of which have subsequently become closed. By their rupture the so-called follicular ulcers are produced. When the above changes are combined with general or partial hyperplasia of the mucous membrane, an acne-like formation results, so that the cervix bears a very great resemblance to a "Burgundy nose" (Virchow).

3. The changes produced in the uterus by **tuberculosis** serve as a connecting link to the **tumors** proper. Tuberculosis of the uterus is rare, being much less frequent than in the male generative organs. It occurs as a disseminated, pure, so-called miliary tuberculosis, and in the form of cheesy degeneration, which might be termed *phthisis uterina*. Both forms have their seat, *i. e.*, point of origin, in the mucous membrane; the former, however, remains confined to it, while the latter extends to a greater or less depth into the

uterine parenchyma. The diagnosis of the first and rarer form is easily made by the presence of small, translucent, gray, submiliary nodules, which form little prominences upon the surface; that of the second is equally easy, the surface of the mucous membrane being converted into a crumbly, yellow, cheesy mass, of greater or less depth, from the freshest portions of which it is possible to isolate small yellow or gray nodules. If it were possible for the cheesy material to be carried away, as in the kidney, for instance, a cavity, *i. e.*, ulcerative enlargement of the uterine cavity, would result here; but the whole mass remains in the place where it is formed, and, as it constantly increases, the interior of the uterus finally becomes completely filled. Horizontal sections, made through the diseased uterine wall with a double knife, show the nodules plainly at the outer edge of the cheesy mass.

Carcinoma, next in order after tuberculosis, belongs to the tumors proper. This rarely takes its origin in the body of the uterus, but very frequently in the cervical portion, and especially at the external os. It occurs in two essentially different forms. The first is rare, and occurs in the form of an actual tumor originating from the external os, and when extensive involves the whole vaginal portion of the cervix, completely filling the upper portion of the vagina. The tumor does not present a compact mass with a smooth surface, but is composed of separate papillæ, which are situated so near together that they resemble a cauliflower, hence the name *cauliflower excrescence* has been applied to it. As it extends, the vagina and also the body of the uterus may become involved, their walls thickened, and the well-known masses of cancer cells, cancer bodies, may be pressed from their cut surface. These are found, upon microscopic examination, to be composed of clumps of large, flat, horny, epithelial cells, arranged concentrically. The presence of these is evidence that the growth is a cancroid.

Upon the surface of the cauliflower growth an ichorous disintegration of the tissue is very liable to occur, so that it

is converted into a stinking, dirty greenish-gray mass of shreds which float in water.

This condition occurs still more frequently in the second form, which differs from the first in the complete absence of the appearance of any tumor, and in its resemblance to an ulcer. The process may be compared in this respect to the well-known rodent ulcer of the nose, and it possesses the eroding quality also in an extreme degree. This may terminate in a complete destruction of the portio vaginalis, the whole cervix, a large portion of the vagina, and finally of the uterine body itself. Perforations into the bladder, rectum, and even into the abdominal cavity, are relatively frequent. On account of the common gangrenous character of these ulcers their presence is most offensive. In order to make sure of their nature, it is necessary to make incisions in all possible directions through their edges and base, when the still intact new formation will be brought to view. Moreover, the presence of parametric, or sacral lymphatic glands, which have undergone carcinomatous degeneration, is usually sufficient to decide the nature of the affection.

Primary carcinoma of the body of the uterus, which is rare, produces a thickening of the walls, and like the secondary forms is usually quite extensive. Upon section, it has the appearance of a grayish network, from the meshes of which white or yellowish-white cancer juice may be pressed out. The surface of the uterine cavity may be perfectly intact (not ulcerated). The form of the cells of this cancer, which is usually soft, is often cylindrical, thus indicating their origin distinctly (from the utricular glands). The common *fibroid* is the most important of the remaining tumors, as it is by far the most common; it is of very frequent occurrence, especially in old subjects. Virchow has shown that these tumors are not pure fibromata, but rather **fibromyomata** or *myomata*, and that they are to be considered as a hyperplasia of the elements in the uterine walls. The consistency is softer or harder, according as the fibrous tissue or the smooth muscular cells preponderate, the color upon

section being reddish in the former case, in the latter whitish. The cut surface has a striated appearance due to an intertwining of the bundles of muscle, or of fibrous tissue. The striæ become more apparent when there are white fibrous bundles present by the side of the more reddish muscular tissue. In the small tumors, and in the pure myomata, a simple system of bundles is present; while the larger ones, especially the fibroids, possess several systems, so that they appear to be composed of a number of lobes.

The size of these tumors varies from that of a pea to that of a man's head. Their favorite seat is in the body of the uterus, more particularly in the fundus and posterior wall, which is normally somewhat thicker than the anterior. According to their situation in the walls, they are termed subserous, submucous, or intraparietal. It is perfectly evident that the *intraparietal* forms may easily become subserous or submucous, by increasing in size; still tumors of the size of a man's head occur, surrounded on all sides by the uterine walls. Of course this is only possible when there is an enormous general hyperplasia of the walls. The soft varieties are not sharply defined, but the hard fibrous forms often project from the surrounding surface, when cut through. The *subserous* tumors are usually multiple, and may attain a very considerable size. It is often difficult to make out the connection of the larger ones with the uterine muscular tissue, although they have originated from it, as the pedicle is liable to atrophy, and consequently the tumor appears to be separated from the uterine walls, and to simply lie near them. The *submucous* growths do not generally attain the enormous size of the above mentioned forms, and belong rather to the softer variety. They hang polypus-like, often by an extremely delicate pedicle, in the correspondingly enlarged uterine cavity. As they are always covered with mucous membrane, they are liable to be confounded with mucous polypi, from which they are to be distinguished by their greater hardness, the striated appearance of their cut surface, and the absence of cysts. These tumors are fre-

quently accompanied by a soft swelling of the uterine walls, with hyperplasia of the muscular bundles, a condition resembling that of the pregnant uterus. It is possible for a large myomatous polypus to produce an inversion of the uterus. The subserous tumors may cause versions, flexions, and other displacements of the uterus. Fresh sections are easily made, and show, on microscopic examination, interlacing fibrous and muscular bands, the elements of the latter with their rod-like nuclei being very apparent, especially after the addition of acetic acid; sections colored with aniline violet and hæmatoxyline make very pretty preparations. The contractile cells may be isolated by the usual reagents (twenty per cent. strength of nitric acid, or a thirty-three per cent. solution of caustic potash).

The uterine myomata may undergo many secondary changes, some of which are of a progressive and others of a retrogressive nature. The former consist in a partial or complete purulent inflammation; the latter in fatty degeneration combined with softening, in partial mucous degeneration (cyst formation); or in calcareous infiltration (petrifaction), which occurs especially in the subserous and intraparietal varieties. The whole tumor may be converted into an uneven mass of stony hardness, in which, however, the smooth muscular cells may be brought out by treatment with hydrochloric acid.

A peculiar variety of intraparietal myoma is the *telangiectatic* or *cavernous fibroma*, which, as its name implies, is characterized by the great size and large number of its blood spaces. These may constitute the greater part of the tumor, and at times contain thrombi. Other varieties are produced by the union of other new formations with the muscular tissue, as, for instance, the *myxomyoma* and *myosarcoma*. Other tumors of the uterus, for example, *sarcoma*, which Virchow mentions only as "infiltrated" sarcoma of the mucous membrane, and gummata, are very rare.

4. The congenital **malformations** include, besides the persistence of the infantile condition (uterus infantilis), and

those deformities which occur in hermaphroditism, the duplicature caused by an arrest of development, which is sometimes complete (*uterus duplex*), and again only partial, so that the cavity which is single below, becomes divided into two horns higher up (*uterus bicornis*). These malformations, as has been already stated, may be apparent upon the outer surface of the organ, not in all cases, however, but only in those where the uterine cavity is divided by a longitudinal septum (*uterus septus*, *bicameratus*).

(*k.*) THE PARAMETRIUM AND BROAD LIGAMENTS.

The examination of the *pelvic cellular tissue* (parametrium) and *broad ligaments* is best made after that of the uterus. Their affections stand in very close relation to those of the uterus, as they often appear to simply extend from it, and on the other hand changes in the ligaments may affect the uterus. The most important of the latter is an inequality in the length of the broad ligaments, which causes lateral flexion or version of the uterus, and may either be congenital, or caused by the contraction which follows chronic inflammation. The processes which extend from the uterus are essentially puerperal affections, which, when they run an acute course, may occur, as in the uterine walls, in three forms, thrombophlebitis, lymphangitis, and phlegmonous, *i. e.*, purulent inflammation. *Thrombophlebitis* may be followed directly into the uterus, or it may first be met with at a little distance from, and apparently disconnected with, that organ. It is characterized by a thickening, and a yellow or greenish-yellow color of the walls of the vessels, by an increase of calibre, and the filling of their cavity with a more or less reddish-brown puriform material. Its favorite seat is the large veins which run along by the side of the Fallopian tubes and empty directly into the vena spermatica, into which the thrombosis and phlebitis may also extend (frequently to the point where it empties into the vena cava, or left renal vein).

Lymphangitis is to be recognized by the presence of puri-

form masses (lymph thrombi containing numerous granules) within thin-walled, dilated, varicose vessels. *Phlegmonous parametritis* often results quickly in abscesses situated within the connective tissue about the uterus, sometimes, however, it consists only in an œdematous swelling and gelatinous infiltration of the tissue. This infiltrated tissue is of a yellow color, has a lardaceous appearance, and is frequently of a very firm consistency. If the course of the parametritis is chronic, a thickening and fibrous degeneration of the connective tissue takes place, which gradually continues to shrink, so that a displacement of the uterus is produced when the affection is unilateral. This chronic affection occurs independently of the puerperal condition in all possible affections (tumors, syphilitic ulcers of rectum, etc.).

Putrid inflammation and gangrene of the broad ligaments, and of the whole pelvic cellular tissue also, may arise from various causes; a dirty, stinking, brownish or slaty-green mass results, containing thick shreds of connective tissue. Perforation of the uterus, vagina, bladder, rectum, etc., may thus be brought about.

The veins around the puerperal uterus (plexus uterinus), are always to be examined with care even in non-puerperal cases, as *marantic thrombi* are very liable to occur here, and in the corresponding place in the male. Secondary troubles in distant organs (emboli of the pulmonary artery), may thus arise. *Phlebolites* sometimes occur here also.

Cysts of various size are often found either upon or within the broad ligaments, especially near the ovaries and the abdominal extremity of the Fallopian tubes. These cysts, when small, contain a jelly-like material; most of them originate in the parovarium, as is suggested by the fact that they are situated between the two layers of the ligament, and by their lining of ciliated epithelium, which, however, often becomes squamous in the larger cysts. The parametrium very frequently contains *cancerous nodules*, when carcinoma is present in the uterus.

The important evidence to be obtained from the lymphatic

glands enclosed in the pelvic cellular tissue, when affected by cancer, has been referred to. They also become red and swollen in inflammatory processes.

(*l.*) THE FALLOPIAN TUBES.

Variations in the size and shape of the *tubes* are very frequent in old people. Elongations, bends, etc., may be caused by tumors or other affections of the uterus; tortuous curves are also produced by pseudomembranes, and cystic dilatations, especially of the abdominal portion, may result from the closure of their openings (by adhesions, bends, obliteration, etc.).

Before the mucous membrane is displayed, the *fimbriæ* (especially in the puerperal condition) are to be examined; these become swollen and dark-red in inflammation of the mucous membrane, and the attempt should be made to press out of the infundibulum any secretion (catarrhal, purulent), for it is possible for peritonitis to originate from inflammation here. Still the reverse is more frequent, the mucous membrane of the tubes presenting only a catarrhal condition, while a purulent peritonitis exists.

The tubes are next to be slit open along their whole length from the fimbriated extremity, in order that the *mucous membrane* may be carefully examined. Simple *catarrh* (salpingitis), with swelling, redness, and increased secretion (containing abundant epithelial cells), occurs here, also purulent inflammation, and, finally, *tuberculosis*, which usually appears in connection with general tuberculosis of the genito-urinary apparatus, and has the same appearance as in the uterus. The changes from tuberculosis are always further advanced in the tubes than in the uterus. *Chronic inflammation* with induration, both of the mucous membrane and the whole thickness of the wall, may be met with.

Cystic dilatations are always lined with mucous membrane, the function of which varies, as it sometimes and most frequently secretes a watery fluid, containing many mucous corpuscles (*hydrops tubæ* or *hydrosalpinx*), at other

times the secretion is purulent (*pyosalpinx*). It is a very common occurrence for hæmorrhage to take place into the interior of the dilated tube, in consequence of which the fluid in the so-called hydrops assumes, in most cases, a brown color (*hydrops tubæ sanguinolentus*).

Rupture of the tubes occurs in tubal pregnancy, a detailed account of which will be given in treating of extra-uterine fœtation.

(*m.*) THE OVARIES.

(*a.*) *External Examination.*

The *position* of the ovaries is subject to but very few primary changes, which consist in a greater proximity to the uterus, or in dislocation to some place within the recto-uterine fossa. On the other hand, their position frequently becomes changed with that of the uterus, as may be easily observed.

Their *average size* is about half that of a pigeon's egg. This may vary in either direction. They may shrink to the size of a bean, or may attain that of a hen's egg, even when free from tumors. When these are present, they may become so large as to fill the greater portion of a very distended abdominal cavity. In considering their *shape*, which may be altered in many ways by tumors, their general form (flat oval) is of much less importance than the surface; the latter is perfectly smooth even at the commencement of puberty, but as ovulation advances it contains irregularities in the form of little depressions, the cicatrices of ruptured follicles. These increase in number when pregnancies follow, as the corpora lutea of the latter leave long, deep, cicatricial depressions upon the surface. The surface of the ovaries of old women who have given birth to many children presents an extremely uneven, knobbed appearance.

The grayish *color* of the ovaries of young persons is also subject to changes corresponding to the changes in form, as the cicatrices of the ruptured follicles appear of a slaty color, owing to transformed blood coloring matter. A gray-

ish-white color is produced by a thickening of the tunica albuginea, while reddish tints result from inflammatory processes.

The *consistency*, independent of pathological conditions, depends upon the number and size of the Graafian follicles present. The normal tissue is firm, and may become denser from chronic fibrous inflammation, even to such a degree as to be cut with difficulty. On the other hand, inflammatory processes may cause it to so soften as to become quite fluid.

(*b.*) *Internal Examination.*

In order to examine the internal structure of the ovary, the gland is to be divided by a longitudinal incision, corresponding to the broadest plane and extending to the hilus, so that the two halves may be entirely laid apart.

The *amount of blood* within the parenchyma varies very much, according to the physiological condition of the organ at the time. At the menstrual period it is very considerable, the cut surface is intensely red, and the full tortuous vessels are apparent, especially at the hilus. The condition is similar during pregnancy. At other times the *color* of the cut surface is not uniform, as the gray of the stroma is frequently interrupted by the whitish trabeculæ, and by the slaty cicatrices of ruptured follicles.

In examining the ovary in detail, it is necessary to consider the condition of the follicles separately from that of the stroma, as either may undergo changes independently of the other.

1. In considering the **follicles**, it is often desirable and important to know, in order to judge of the case as a whole, and of certain changes within the uterus, whether a recently ruptured follicle (corpus hæmorrhagicum) or a true corpus luteum is present. In order to determine this point, it is often necessary to make numerous small incisions in the direction of the original one. The corpora hæmorrhagica are of the size of cherries, and appear as dark- or brownish-red, soft masses, according to their age. The recent corpus lu-

teum is somewhat smaller (the size of a hazel-nut to that of a cherry-stone); it has a yellowish border one or two millimeters in width, which is usually somewhat zigzag (convoluted), and a brown or grayish-brown interior.

In preparations made with needles from the corpus hæmorrhagicum, quantities of granular corpuscles and fat granules are found, and in those from the corpus luteum hæmatoidine pigment, sometimes in the form of elegant rhombic crystals. In the course of the normal retrograde changes the fat becomes absorbed, and the corpus luteum becomes converted into a small radiating cicatrix, colored black by blood pigment. Occasionally very firm grayish-white bodies, which may attain the size of a cherry, originate from the capsule of the follicles, and appear in the place of the corpora lutea. These appear upon section to be composed of a wavy, fibrous, peripheral portion, and a somewhat deeper seated centre containing hæmatoidine crystals, which indicate the real character of this *fibroma folliculi* (corpus fibrosum).

The changes within the unruptured follicles are principally confined to their contents. An increase in the follicular fluid produces the very common *cystic enlargement*, which is sometimes confined to single follicles, and at other times affects a large number. Frequently the enlargement is not extreme, but cysts occur of the size of a walnut or of a man's head (*hydrops folliculorum*). The contained fluid is limpid and contains but few morphological elements. Sometimes it is possible to discover the ovum in the smaller cysts, by cutting them out and opening them with great care upon an object glass. Small cystic dilatations of the follicles occur even in the new-born. In puerperal affections the follicles are often found filled with pus (*oophoritis apostematosa follicularis*), either with or without a change in the stroma, so that they appear like little abscesses, the origin of which may be recognized by the character of their walls. Hæmorrhage also occurs in the follicles without their bursting, especially when the walls are thickened by chronic inflammation.

2. The **stroma** may be affected by *œdematous swelling*,

which very frequently accompanies the inflammatory processes of the uterus and its appendages, and of the peritoneum. *Acute inflammation*, of which there are three varieties, the phlegmonous, thrombophlebitic, and lymphangitic, is also important. All have their origin and principal seat in the hilus and in the so-called medullary substance. The two latter are characterized by the changes which have already been described as occurring in the corresponding vessels of the uterus, and the former (*oophoritis phlegmonosa*), when slight, by an infiltration of the tissue with a yellowish, gelatinous material, and when more severe, by an infiltration with pus. In many cases the inflammation has an ichorous character; the swelling and softening are then the greatest, and perforation with resulting peritonitis is most frequent.

Acute inflammation, which is almost always of puerperal origin, is much less frequent than the *chronic* form, which is sometimes confined to the outermost layers of the tunica albuginea, and results in the formation of a tough, white capsule some millimeters in thickness; at other times it involves the whole organ, producing fibrous degeneration and atrophy (*oophoritis chronica fibrosa*).

3. Among the tumors of the ovary the *cystoma* occupies an important place. One variety of cystic formation, the hydrops folliculorum, has already been described in speaking of the affections of the follicles. There is another, the true *colloid cysts* (myxoidcystoma), which are characterized by their thick, viscid, frequently yellow or brownish (bloody) gelatinous contents. They are always multiple at the outset (multilocular cysts), and are usually present in large numbers. In cases of long standing it often happens that one or several cysts are much larger than the rest, and finally there may be but one present (unilocular cyst), which is formed by the union of many smaller ones. Such a mode of origin may often be recognized by the presence of projections from the walls, and of a more or less regular network of streaks in the contents, composed of fatty degenerated epithelial cells from the walls of the small cysts which have been destroyed.

The inner surface of the cysts is lined with cylindrical epithelium, projections of which, resembling follicular glands, extend into the wall; when these are detached from their base they give rise in turn to smaller cysts. The latter at first lie within the walls, but as they increase in size they soon project into the interior, and produce the impression of their origin from the exterior. As the manner of growth of these cysts has a great resemblance to that of the normal Graafian follicles, they have been called *adenomata*. By a conversion of the colloid contents into a more fluid substance, and by a constant secretion of liquid from the walls, the epithelial cells of which often perish, what is known as *multilocular ovarian dropsy* originates. Polypoid growths are often seen on the inner surface of these cysts, and extend into their interior; they are usually small, but may attain such a size in many cases as to fill the whole interior, or even to break through the walls.

The cysts may undergo secondary changes by the admixture of blood with their contents, which gives them a brown color. Suppuration may take place from the wall, and the contents may become ichorous, usually in consequence of operative interference (puncture). In the case of large cysts, adhesions to the abdominal walls, intestine, etc., are almost constant.

Besides the pure (adeno-) cystomata there are a large number of cystic tumors of different natures, for most ovarian tumors are prone to become cystic. Thus there is a *cystofibroma*, *cystocarcinoma*, *etc.* The *fibroma*, in all cases rare, may occur pure, or in the form of fibromyoma, as in the uterus, but pure myoma is rare, and the fibrous element usually predominates, so that the tumor is hard. As is the case in the uterus, these tumors occur combined with sarcoma (*fibrosarcoma*, *myosarcoma*), but pure sarcoma is rare.

Carcinoma is more common, and both the hard and soft forms occur. One peculiar variety, villous cancer (*carcinoma papillosum*), which appears elsewhere only in mucous

membranes, is frequently met with in the ovary. It seldom appears upon the surface of the ovary, but usually in cysts, and retains the general characteristics, even that of metastasis. The branched arborescent, fibrous villi, covered with cylindrical epithelium constituting the stroma, may be recognized by isolating portions with needles and a brush. Ovarian tumors, especially cystomata, are very frequently bilateral, and are usually further advanced on one side than upon the other. When they are of equal size upon the two sides, and of a malignant nature, it may always be suspected that they are secondary (for instance, in cancer of the stomach).

Finally, the ovary is the place of origin for the so-called *organoid* and *teratoid* tumors, *i. e.*, those tumors in which whole organs, or parts of a skeleton, are produced. The most frequent is the appearance of skin in the so-called *dermoid* tumors or cysts, the outer wall of which consists of connective tissue, and the inner of epidermis; from the latter both glandular and horny formations (hair) take their origin. The cavity of the cyst is filled with greasy, yellow pulp, which is more or less mixed with hair, and in which sebum, epidermis, cholesterine, etc., may be discovered by microscopic examination. In other cases the reproduction of normal organs, and of groups of tissue, is more extensive, and bones, teeth, muscles, nerves, etc., may be found.

(*n.*) THE PELVIC PERITONEUM.

The changes taking place upon the outer surface of the uterus, Fallopian tubes, and ovaries still remain to be considered, and also those which the peritoneum in the recto-vesical fossa undergo.

The most frequent are those caused by chronic adhesive inflammation (*perimetritis*, *perioophoritis chron. adhæsiva*). False membranes of varying thickness extend from the posterior surface of the uterus to the anterior portion of the rectum, or to the lateral walls of the true pelvis. Others connect the Fallopian tubes and the ovaries with the rectum

and the lateral pelvic walls, or with the uterus; the tubes are consequently often variously curved, even closed, the ovaries displaced, and frequently so packed in pseudomembranes as scarcely to be found. This process usually extends from the uterus, but it may also be secondary to disease in the rectum and elsewhere. The same form of inflammation gives rise to adhesions between the surface of the uterus and intestinal (large and small) coils, so that the recto-uterine fossa is often shut off from the rest of the abdominal cavity, a condition which may also occur in many other processes in this region accompanied by acute inflammatory changes.

The chronic inflammation of the peritoneum which has been described as resembling pachymeningitis hæmorrhagica, occurs with relative frequency in the true pelvis. The hæmorrhages which occur in the layers of the newly formed connective tissue, give rise in the female to the so-called *retro-uterine hæmatocele*, the *hæmatoma retro-uterinum* of Virchow, a blood tumor which also occurs in the same manner in the male within the recto-vesical fossa. The hæmorrhage may give rise to a purulent inflammation, which may cause a rupture into the vagina, rectum, etc.

Purulent inflammation may be confined to the true pelvis (*pelvic peritonitis*), but when there are no old adhesions present, it usually extends over the whole peritoneum. The same is true with regard to the ichorous inflammation produced by perforation of the rectum, vagina, etc. *Tuberculous* and *carcinomatous* inflammations of the peritoneum, especially the disseminated forms, affect this portion in a very peculiar, and in many respects interesting, manner. Frequently, when there are but very few tuberculous and carcinomatous nodules in other localities, their number is quite large in the excavatio recto-uterina, as though the greatest number of germs had fallen here, in the deepest portion of the abdominal cavity, from which the tubercles or cancerous nodules might have sprung. This view of their origin is illustrated by the frequent occurrence of *echinococcus cysts* in the same place, when they occur multiple in the abdominal cavity.

All that has been said in regard to the recto-uterine fossa applies, *mutatis mutandis*, to the recto-vesical fossa.

Extra-uterine fœtation must not be omitted from the list of affections of the true pelvis. Its effects are very varied according to its duration, the size of the ovum, and the number and extent of the secondary changes which are produced in the peritoneum and surrounding organs by the growth of the latter. As extra-uterine pregnancy usually terminates in rupture and internal hæmorrhage, the direct cause of death, a varying quantity of coagulated blood is found on making a post-mortem examination, either free in the abdominal cavity, or more or less completely confined by peritoneal adhesions. The recto-uterine fossa is completely filled with a thick mass, which might appear to be the result of a simple hæmorrhage from the newly formed vessels of peritoneal adhesions, a retro-uterine hæmatocele, with which affection these pregnancies are frequently confounded during life. It is consequently necessary to examine such masses of blood with great care. When pregnancy is far advanced the fœtus is, of course, easily found; in the earlier stages, however, it is found only after most careful examination. The umbilical cord leads to the seat of the ovum, which may be so altered by chronic inflammatory processes, especially by adhesions to neighboring parts, as to be recognized with difficulty. Different forms of extra-uterine pregnancy are distinguished according to the seat of the placenta; the *abdominal*, which is denied by many authors, when the ovum is attached to any place within the pelvic cavity; the *tubal*, when it was situated within the Fallopian tube, and by perforation may have passed into the abdominal cavity; finally, *ovarian* pregnancy, when the ovum has never left the place of its formation, but has become further developed within the ovary. In this form, it is, of course, impossible to find any corpus luteum, and it should, therefore, be carefully looked for in all cases where the ovum is attached to the ovary, and there is a possibility of ovarian pregnancy. In order to be sure of recognizing tubal pregnancy, which is divided into

tubo-uterine or *interstitial*, pure *tubal*, and *tubo-ovarian* or tubo-abdominal, it is necessary to examine both tubes throughout their whole extent, to see if they are intact. This is often a very difficult matter, because the tubes, ovaries, uterus, rectum, and ovum, are bound together in one inextricable mass. As a rule, the ovum proper and especially the placenta, will no longer be found in a normal condition. Nodules of varied size project from the inner surface of the latter, and present a dark-red, bright grayish-red, or grayish-yellow color. Upon section these will be found to consist of fresh, or old and decolorized masses of blood.

Not all cases of extra-uterine fœtation cause death so suddenly by rupture and hæmorrhage. In rare cases the fœtus dies, becomes incrusted with lime salts, and converted into a stone fœtus (*lithopædion*), which is imbedded in numerous dense false membranes, and is often found only by accident at the autopsy. In other cases, which are rather more frequent, inflammatory processes result from the pregnancy, the fœtus suppurates, and a perforation results, usually into the rectum, through which parts of the fœtus may be discharged. In other cases perforation of an adherent intestinal coil may occur, producing an ichorous inflammation about the ovum which may in turn perforate in different directions.

(*o.*) THE RECTUM.

The rectum is to be laid open from the anus through the middle of the posterior wall, after the mass of pelvic viscera has been turned over, so that the bladder lies underneath and the rectum on top.

(*a.*) *General Characteristics.*

Among the variations in the *size* of the rectum there is found, besides the congenital complete closure (atresia ani), a narrowing of the lumen (stricture of the rectum) from cicatrices or tumors. It may be dilated by fæcal masses, and, in rare cases, by prolapsed portions of intestine, resulting from invagination higher up. The latter condition must

not be confounded with *prolapsus ani*, which is produced by a *displacement* of the rectum itself, and is to be distinguished by the fact, that in the latter the skin is continuous with the mucous covering of the mass which projects from the anus.

Changes in the rectum affect principally the mucous membrane, still the muscular layer takes a secondary part in many affections; for instance, it becomes thickened in chronic ulcerative processes (syphilitic and diphtheritic inflammation, tumors), or it may be the seat of the same affections which have become established in the mucous membrane (ulceration, tumors, etc.).

The *mucous membrane* not unfrequently appears *thickened* or swollen, the swelling being partly œdematous and partly inflammatory. As the layer beneath it (muscular) is not swollen, the distention can only take place with the formation of folds. Complete absence of the mucous membrane only occurs as a result of syphilitic ulcers; the diphtheritic ulcer, which may cause great destruction, leaves in the rectum, especially in the lower portion, a relatively intact mucous membrane.

The *color* is usually gray, but frequently becomes red or bluish-red toward the anus, owing to the great number of dilated veins. In acute inflammation it becomes brighter or darker red; after chronic inflammation, slaty; the latter color, with grayish-white, is usually present when the mucous membrane is completely destroyed, especially by syphilitic and diphtheritic ulcers.

The *consistency* is correspondingly soft and flabby in extreme œdematous swelling, firm and fibrous in chronic ulcerative processes.

(*b.*) *Special Morbid Conditions.*

First among the separate affections of the rectum may be mentioned the dilatation of the hæmorrhoidal veins at its lowest part, above and at the anus (*hæmorrhoids*). They appear as thick, blue, varicose projections in the mucous

membrane; when more developed they are in the form of nodules, which present upon section only thin septa of connective tissue, and contain little else than blood. They may attain the size of a pea, cherry, or even plum, and project at the anus beyond the external skin. Under certain conditions thrombi will be found, composed of firm or softened coagula, although the latter occur less frequently than might be expected *a priori*. It is more frequently the case that the thrombi have become organized, when the nodule consists of a vascular fibrous tissue. Similar nodules may also arise in the neighborhood of the varicose vessels from hyperplasia of the connective tissue of the mucous membrane.

Simple *inflammation* of the rectum (*proctitis*) may be acute or chronic. The first is characterized by swelling and marked reddening of the mucous membrane, which is covered with mucous secretion or a puriform mass; the latter by the slaty and often completely black color of the mucous membrane.

The *syphilitic* affections of the rectum are very characteristic, nothing analogous being observed with certainty in the other portions of intestine. The condylomata belong to this class. They are situated at and about the anus, and are usually produced by the flow of secretion from the female genitals, which are similarly affected, and exhibit the same condition. Recent syphilitic ulcers are scarcely met with in the rectum proper, but their resulting cicatrices are usually found. They have only been described as occurring in the female cadaver, their favorite seat being immediately above the anus and in the cloaca, which fact is important in making a differential diagnosis; under certain circumstances they may extend higher up. The affected mucous membrane is replaced by a somewhat uniform, tough, fibrous, cicatricial tissue, which appears upon section to extend to the muscular coat, which is always much thickened. The diseased portion is sharply defined, so that the mucous membrane appears at the line of junction as though cut through. The cavity of the affected portion of intestine is always en-

croached upon, and sometimes there is very marked stenosis. Perforation of the ulcers, with resulting inflammation about the rectum (*periproctitis*), is occasionally met with, and also perforation into the recto-uterine fossa, with the formation of encapsuled foul exudation, which may in turn perforate into the abdominal cavity and quickly cause fatal, general peritonitis.

Diphtheritic ulcers which have healed, resemble the syphilitic in respect to the changes produced in the intestine. They differ, however, very materially in their seat, as they are almost always situated at the commencement of the rectum (at its junction with the sigmoid flexure), or, at least, are more marked here, so that the affection constantly increases in extent and severity from the anus upwards. Moreover, according to Virchow, the diphtheritic cicatrices, instead of being regular and flat like the syphilitic, are ragged and irregular, both upon the surface and at the circumference. The appearances of recent diphtheritis are quite characteristic. It always attacks first the prominent points, as the tops of the folds, which are, of course, not so well developed in the rectum as in the upper portion of the large intestine. At first these points appear much reddened and as if sprinkled with bran, later they appear as infiltrations of a gray, or, through the presence of fæces, of a brown color, which begin to involve the portions between the folds. Then there occurs a loss of substance, which constantly extends wider and deeper, till, finally, a large portion of the much thickened muscular coat, which is recognized by its horizontal, parallel fibres, is laid bare, and only very small islets of mucous membrane remain; the latter present the first stages of the affection (redness and hæmorrhages, bran-like deposits), and may be easily taken for the portions which have suffered the greatest change, and not for those which are the least altered.

Ulcers very similar to the diphtheritic forms are sometimes found in the rectum, and are the result of very irritating injections, for instance, vinegar. In these cases also the

tops of the folds are ulcerated or covered with grayish infiltrated mucous membrane, the contiguous portions being reddened and swollen. When such an affection is limited to a small area, the remaining portion of the intestine being free, a chemical cause must always be thought of.

In all cases of wounds and ulcers situated near the anus, and in an otherwise healthy mucous membrane, a *mechanical* origin must always be thought of, especially when they are situated longitudinally. These lacerations are usually due to the improper use of a syringe.

Certain peculiarities of diphtheritis, also follicular inflammation, and the changes due to tuberculosis and typhoid fever, will be fully described in treating of the colon. It is sufficient to mention here that they may occur in the rectum.

The *tumors* of the mucous membrane of the rectum still remain to be described. Among the histioid tumors *polypi* of varied size are found, sometimes multiple, when the condition may be termed *proctitis polyposa vel prolifera;* at other times they are solitary and of considerable size. All that was said concerning them in the uterus applies here, especially in regard to their inflammatory origin.

The *carcinomatous* tumors are of more importance, of which there are two principal varieties, the *cylindrical-cell* and the *gelatinous* or *colloid cancer* (carcinoma colloides vel mucosum); the latter occurs here more frequently than in any other locality, with the exception of the stomach. Tumors seldom attain a large size here, as they are usually prevented by ulceration, which gives rise to an uneven and nodular, foul ulcer, situated, as a rule, in the middle third or upper half of the rectum. When the tumor is of the colloid variety, masses of the gelatinous material, varying in size from that of a pin's head to that of a millet-grain, are often seen upon this surface. At the circumference of the ulcer the mass of the tumor projects like a wall, and is sometimes soft (common cancer), again hard (colloid cancer, scirrhus). When this is cut through the medullary or colloid mass is presented to view. The same is the case with the bed of

the ulcer, where the wall appears more or less thickened, due partly to cancerous material in the submucous tissue, and partly to an enormous thickening of the muscular coat, between the muscular bundles of which cancerous masses may be seen appearing like white threads. Sections sufficiently thin for microscopic examination may be made with the double knife. Perforation with its different results may occur into the vagina or the uterus, and also into the abdominal cavity.

Melanoma of the rectum is very rare.

Atresia ani is an important *congenital affection* of the rectum, in which the intestine does not open externally, but terminates in a blind extremity at a greater or less distance from the integument. The point at which it ought to open is usually indicated by a little depression in the skin. It occurs not only in children born prematurely, but in those who are in other respects perfectly formed.

6. THE DUODENUM AND STOMACH.

(*a.*) *External Examination.*

The examination of the *duodenum* and *stomach* commences with the inspection of their exterior, which is made by first placing the coils of small intestine (which were thrown up in removing the pelvic organs) as far down and to the left as possible, and by drawing the transverse colon firmly downwards. The adhesions which frequently occur in the neighborhood of the descending portion of the duodenum, between the colon and liver, or gall-bladder, are then to be separated with the knife, until the stomach with the horizontal and descending portion of the duodenum are completely brought into view. The external examination is principally confined to the stomach.

(1.) General Characteristics.

The *size* or distention of the stomach is evidently dependent, above all things, upon the quantity of the food

which it may contain, although this always varies but little. Abnormal dilatations are frequent, partly acute (distention from gas), partly chronic (dilatation proper); the latter may be so extreme that the greater curvature reaches down to the true pelvis. This affection is usually the result of stenosis in some of the deeper portions of the digestive tract, especially from tumors in the duodenum; it may be, however, idiopathic, being produced by constant overfilling for a long time, and eventual paralysis of the muscular coat. Partial dilatation of the fundus and cardiac extremity also occurs, especially in connection with stenosis of the middle portion from cicatricial contraction (large chronic gastric ulcers, etc.). When the muscular coat is greatly stretched, it is sometimes marked by lines similar to those in the skin of the abdomen when the latter is greatly distended. Contraction of the stomach is much more rare than dilatation. It occurs with relative frequency accompanying the so-called atrophying cancer, scirrhus, which may involve the whole mucous membrane, and cause a great diminution in the size of the stomach by the contraction of its walls.

Variations in *shape* occur as congenital anomalies, in the form of a diminution in size at or near the middle (furrow), so that the stomach is of an hour-glass shape. Frequently the same variation is pathological, caused by cicatricial contraction, which may be due to a chronic ulcer, or to a cancer situated at this point. Secondary variations in shape of different kinds, due to external mechanical influence (adhesions, tumors, etc.), are, of course, liable to be met with.

Variations in *position*, either with or without a change in shape, are observed, and usually consist in a lower position of the pylorus than usual, the stomach occupying its fœtal position (directed from above downwards) more or less.

The *color* of the outer surface is usually gray. This assumes a whitish shade similar to that of fibrous tissue, when the serous coat is thickened by chronic processes of various sorts. When the walls are softened by acid contents, they appear translucent, gray, and gelatinous. They appear blackish from the effects of sulphuric acid, etc.

In cases of so-called softening the *consistency* may become like that of mucus, whether the softening is due to the acid contents of the stomach, or to poisons which have been introduced. It is increased in all those affections which are accompanied by a thickening of the serous, and especially of the muscular, coat; in the case of diffuse scirrhus cancer of the stomach, the hardness may be like that of a board (formerly frequently called cirrhosis of the stomach).

(2.) Affections of the Serous Coat.

The *serous coat* of the stomach becomes involved in many affections of the mucous membrane, as well as in those of the peritoneum. *Perigastritis chronica*, which is frequently adhesive, is characterized by the thickening and white color of the serous covering, and by the adhesions to the liver, transverse colon, spleen, or diaphragm which it produces. It seldom extends over the whole stomach or over a great area, but is more frequently partial, being situated over circumscribed affections of the mucous membrane (ulcers, tumors), and decreases in intensity towards the periphery.

Acute *purulent inflammation* is, in the majority of cases, a part of a similar general peritonitis. There is, however, a peculiar form of purulent inflammation, *purulent lymphangitis*, which is confined to the stomach, and is due to disease of the mucous membrane (tumors). In these cases delicate, varicose (in consequence of valves) vessels, some of which may be one centimeter in diameter, are seen beneath the serous coat, filled with yellow purulent material. They originate principally from one point, which corresponds to the place in the mucous membrane where the tumor is situated. The affection may extend to the diaphragm, and the pleura, when the previously described lymphangitis purulenta pleuralis and pulmonalis even results.

The serous coat of the stomach becomes affected in general *tubercular* peritonitis, as well as in the purulent form. This affection is frequently not uniform, the anterior wall being more affected from its exposure, so to speak, to the

tubercular germs in the abdominal cavity, than the protected posterior wall. Sometimes the anterior surface is found thickly studded with tubercles, while they are seen only in groups upon the posterior wall, and frequently follow the course of the vessels.

Carcinomatous perigastritis may be a part of general carcinoma of the peritoneum, or it may occur alone as a secondary affection of the gastric mucous membrane. The latter is the most frequent form. Small nodules of varied size are seen at the point where the cancer is situated in the mucous membrane, which is usually indicated by depression and marked thickening of the serous coat, and frequently by adhesions. The nodules are usually arranged in groups, becoming smaller and more isolated towards the periphery of the latter. This secondary formation of cancer may occur in connection with lymphangitis purulenta. The lymphatic glands situated especially along the lesser curvature of the stomach, also become involved, and undergo carcinomatous degeneration.

In all cases where *perforation* is suspected, the examination must be made with the greatest care.

The post-mortem rupture of the stomach must be distinguished from those forms occurring during life. In the former case a varying quantity of the contents of the stomach is found free in the abdominal cavity, without any appearance of inflammatory reaction. The walls of the stomach, especially at the fundus, are much softened, and are frequently converted into a translucent, slimy mass. The cause of this change is found to be due either to abundant, strongly acid (fermenting) food, especially in children that have drank much milk, or to the presence of poisonous substances (for instance, sulphuric acid), which have a similar effect. The effect produced by perforations occurring during life, range according to the relations of the surrounding parts ; a communication may be established with the abdominal cavity, or with a closed sack resulting from chronic inflammation, or the hole in the wall may become closed by the formation of

adhesions between the stomach and other organs. In the first instance the result is a general peritonitis which is quickly fatal; in the second, a circumscribed purulent or ichorous inflammation, which is frequently of long standing; and in the last, as a rule, a chronic progressive ulceration. In such cases it is frequently necessary to vary from the usual method of performing the autopsy, and to remove the stomach in connection with the other organs, most frequently the pancreas and liver.

In the first two classes of cases the opening in the walls is relatively small, and in the first, frequently not more than one to three millimeters in diameter, but usually appears as though made with a punch. Very often such perforations are closed by very delicate adhesions, which may be accidentally torn, thus making it doubtful whether the perforation previously existed or was artificially made.

Similar perforations occur in the duodenum, but less frequently. The most frequent cause here, as in the stomach, is the so-called chronic, round or perforating ulcer, less frequently carcinoma.

(*b.*) *The Internal Examination.*

The examination of the interior is commenced by making a little horizontal cut with the scissors, at the lower extremity of the descending portion of the duodenum, and cutting through the middle of its anterior wall from below upwards; the course of the incision is then changed in the direction of the horizontal portion, the anterior cut edge being drawn upwards. The incision is continued through the anterior wall, as the stomach is to be opened along the greater curvature. At the junction of the duodenum with the stomach, the blade of the scissors must be pushed forward as nearly as possible in the axis of the canal, otherwise it may catch against the fold which is formed by the projecting sphincter.

The stomach is to be opened at first only as far as the fundus, that the contents may be easily removed with a cup.

(1.) The Contents.

In opening the *duodenum* it is necessary to notice both the nature and quantity of the *contents*, also any difference in them which may exist above and below the papilla of the gall duct, and the presence of biliary coloring matter in the lower part, or in the upper as well.

In examining the *contents of the stomach*, the quantity, color, consistency, reaction, smell, and composition, and especially the morphological ingredients that may be present, are to be noticed. This is not only necessary in judging of the contents, but also of the mucous membrane, for peculiar post-mortem changes of the latter are produced by the contents under certain circumstances. For instance, there are numerous substances which, owing to their acid nature, possess the property of producing a kind of digestion of the mucous membrane, having nothing to do with pathological changes. The alteration may extend beyond the mucous membrane, finally involving the entire walls (softening of the stomach), when the contained food is of a kind liable to undergo acid fermentation, as is the case with milk, for instance. The *reaction* of the contents may often be recognized by the smell, but is determined accurately by the use of litmus paper.

A *bloody condition* of the contents, caused by swallowing blood, or by a direct admixture of this fluid, deserves careful consideration. When blood which has come from the lungs is swallowed, it is filled with air bubbles and is frothy, while that which has come directly from the stomach is devoid of air bubbles, and is either in the form of large, compact, dark-red masses (hæmorrhage from a large vessel), or uniformly mixed with mucus (hæmorrhage by diapedesis in cirrhosis, inflammation, etc.), or in the form of small, dark-brown masses resembling coffee-grounds (old hæmorrhages from numerous small vessels, cancer). A yellowish or greenish tinge is due to biliary coloring matter. The contents are often of a leek-green color, when the digestive tract is obstructed, and in general peritonitis.

Besides the various admixtures of coarse morphological substances that may often be recognized with the naked eye as remnants of food, and the non-edible things that may be accidentally or purposely swallowed (coins, sticks, toys, needles, stones, etc.), there are a number of parasites that may be met with. With regard to *remnants of food*, peculiar roundish, white or yellowish-white, brittle clumps, are sometimes found in the stomachs of young children, and are composed wholly of coagulated milk, as may be easily proven by microscopic examination. Similar masses composed of fat (mutton or beef tallow) occur less frequently in adults.

Animal *parasites* are rarely found (only a variety of ascaris is sometimes met with); on the other hand, the *vegetable* growths are very common. These, of course, can only be recognized with accuracy by the use of the microscope. The *thrush parasite*, which was described as occurring in the cavity of the mouth and œsophagus, occurs in the stomach, but much less frequently than in the former localities, and is found rather on the walls than in the contents. On the other hand, a form of parasite resembling the *leptothrix* of the mouth, is very frequently met with in the contents. The greatest development is in those cases where the fluids of the stomach are undergoing *fermentation*, and especially where that organ is distended. Besides the leptothrix, a parasite resembling the *yeast plant* is always present in large quantities, and also the *sarcina ventriculi*. The former is in the form of small oval bodies, which often contain glistening oil drops, and are frequently arranged like a chain (also branched). The latter consists of small bodies resembling dice with rounded corners, which present on each surface a furrow in the shape of a cross, so that four planes of equal size are formed. This shape has been compared to a well-bound bale of goods. These bodies usually lie together in large clumps, which in turn often possess the dice form; they are often present in inconceivably large numbers in the lower stratum of the contents of a distended stomach, and the frequent brown color of the latter is due to them.

The secretion of the gastric mucous membrane will be considered hereafter, as it can be examined best in connection with the consideration of that subject.

(2.) The Duodenal Mucous Membrane.

After the removal of the contents of the *duodenum*, the examination of its *mucous membrane* is to be continued. What will be said hereafter about the changes in the other portions of the small intestine or stomach will apply here, except that the duodenum presents those alterations which proceed from the lymph follicles much less frequently, and in a much smaller degree, than the lower portions of the small intestine. In this class are included follicular abscesses and ulcers, tubercular ulcers, and the changes occurring in typhoid fever, the latter being relatively the most frequent. It presents, on the other hand, certain changes that do not occur in the other portions of intestine. Among them is the *chronic ulcer of the duodenum*, which resembles the so-called round ulcer of the stomach, and like it tends to perforate into the abdominal cavity or into other organs (including the aorta), and in this way may cause death. Among the causes of these ulcers are very extensive burns of the integument. The changes (ulceration) that may arise from the presence of gall stones within the biliary tract are also peculiar to the duodenum, as well as those resulting from cancer of the head of the pancreas.

Finally, perforation sometimes takes place, especially in the lower portion, by the side of an aneurism of the aorta or of one of its large branches.

(3.) The Gastric Mucous Membrane.

In order to examine the *mucous membrane of the stomach* carefully, it is best to remove the organ from the body. It may be desirable under certain circumstances (ulcers with adhesions, etc.) to remove it in connection with other organs. The lesser curvature is grasped, drawn downwards and separated from its surroundings, the lower end of the œsophagus

and a small piece of the horizontal portion of the duodenum being removed with it.

(*a.*) *General Appearances.*

That portion of the contents, which still remains adherent to the inner surface is to be removed with a small stream of water.

1. The *secretion* of the mucous membrane is then to be carefully examined. As is well known, the gastric mucous glands are confined to the pyloric portion, and consequently their secretion is to be looked for here. Usually there is only a very thin layer of mucus present, which may, however, under certain circumstances, be greatly increased, so that the whole surface is completely covered with a thick layer. The character of this mass varies greatly: sometimes it is soft, opaque, and gray; at other times transparent, and so tenacious that it can only be scraped off with great difficulty.

The last condition is characteristic of acute gastric catarrh, while the first occurs more frequently when the affection is chronic. The mucus may also contain various admixtures, as blood, or gall, which change its color. It has already been mentioned that a uniform admixture of blood is due to a very slight hæmorrhage from a large number of small vessels.

2. The *changes in volume* of the mucous membrane consist chiefly in thickening of the same. This may be determined by the examination at the point of junction with the œsophagus. Normally the lower, jagged edge of the œsophageal mucous membrane projects over that of the stomach; when the latter is thickened this relation is changed, so that both either occupy the same level, or the mucous membrane is the more prominent. Very frequently the mucous membrane is thrown into folds when it becomes hypertrophied (chronic catarrh), as the muscular layer, which is not increased, is no longer large enough to remain everywhere in contact with the hypertrophied mucous coat. The folds which are caused by a contraction of the muscular coat (on the same principle)

must not be confounded with the above. They disappear if the walls of the stomach are stretched in a direction vertical to them, while in the former case they will remain under similar treatment. Not every enlargement of the mucous membrane causes folds, as there may be more or less swelling (œdema), which produces only an increase in thickness; this may be very marked, but the mucous membrane is soft and gelatinous. Partial thickening of the mucous membrane frequently appears in the form of little granules, or larger wart-like growths, which are caused by chronic gastric catarrh, and which will be fully described in treating of that subject.

3. The *color* of the mucous membrane, and the *quantity of blood contained* in it, are of great importance. The normal membrane is gray and translucent, and, as a rule, but few vessels filled with blood are found, and these are situated at the cardiac extremity, and at the fundus. An extensive, and more or less uniform redness usually points to an inflammatory process. In examining the blood-vessels, it must be borne in mind that the arteries terminate in capillaries in the deeper layers of the mucous membrane, so that only venous capillaries and very small veins are found upon the surface.

The color, besides being varied by the amount of blood present, may depend upon different pathological processes. As has already been stated elsewhere, a slaty color, which was brownish during life, and was changed to black by gases containing sulphur, points to previous hyperæmia (gastritis chronica). Biliary coloring matter produces, especially in icterus neonatorum, a jaundiced color. Finally an opaque, yellow color, is of importance, due to cloudy swelling and fatty degeneration of the glandular epithelium.

4. In order to be able to judge accurately of the pathological changes in the gastric mucous membrane, it is necessary to have a perfect knowledge of the great number of *post-mortem changes* which it undergoes. It has already been stated that these depend in great measure upon the quantity and character of the contents, and arise, aside from decomposition, especially from acids. The post-mortem

changes are, as a rule, most intense at the fundus, where the contents collect. The least degree of acidity produces a gray opacity; when greater, a sort of digestion of the mucous membrane itself follows, so that it is converted into a soft, slimy, transparent mass, which is easily scraped off, and then the submucous tissue, or muscular layer, is laid bare. Finally, the softening may go still further and involve the muscular and serous coats, when the already described softening of the stomach results. If this occurs in a stomach free from blood, it is termed *white softening;* if, on the other hand, the vessels are filled with blood, this is affected by the acid so as to present a brown or brownish-black color, the neighboring parts are infiltrated with the coloring matter, and a soft, more or less brown mass, results,—*brown softening* of the stomach. A dirty green color is due here, as in most other organs, to actual putrefaction.

(*b.*) *Special Morbid Conditions.*

The most frequent of the **inflammatory** affections are acute and chronic *catarrh.* The acute form is especially characterized by the large quantity of tough, transparent mucus, and by reddening of the mucous membrane; the chronic, by abundant, soft, gray mucus, projections of the mucous membrane, and by the slaty color that occurs, especially near the pylorus. Besides these simple inflammations a second form occurs (especially in drunkards), which is characterized by circumscribed hypertrophies of the whole mucous membrane (*gastritis prolifera*), and produces little warty projections (*gastritis verrucosa*); later, larger polypoid growths result (*gastritis polyposa*). Dilatation of the glands, due to compression at their outlet, very frequently accompanies hypertrophy here, as was stated with regard to the uterine mucous membrane, so that small cysts result, which are especially met with on the divided surface of the polypoid growths. In order to determine the part taken by the separate elements of the mucous membrane in the process of hypertrophy, thin sections made with the scissors, and then torn apart, answer

every purpose. An attempt may also be made to obtain a section with the double knife. The arrangement of the pigment between the glandular tubes in cases of slaty discoloration of the mucous membrane can be best recognized in a horizontal section, made from the surface with the scissors.

The next in frequency is what is called by Virchow parenchymatous inflammation (*gastritis parenchymatosa vel glandularis vel gastroadenitis*), and like the corresponding affection of the kidneys, liver, etc., which appear in certain cases of poisoning (phosphorus, arsenic), in acute infective diseases and similar affections (acute atrophy of the liver), consists in a cloudy swelling, and, at a later stage, fatty degeneration of the cells of the gastric glands. In this affection the mucous membrane generally appears to the naked eye swollen and opaque, at a later stage, yellow. In horizontal sections made with the scissors, the gland cells at an early stage of the fatty degeneration, may be seen to be filled with dark granules. These do not disappear upon the addition of a weak solution of caustic potash, like the granules that normally make their appearance in the formation of the gastric juice, and they are thus proven to be fat granules. When the process is more advanced, the glandular tubules are completely filled with fat granules, which become converted into little drops, and a similar appearance may be seen in the intertubular tissue.

Inflammation of the submucous tissue (*gastritis phlegmonosa*), which is accompanied by marked swelling not only of this but also of the mucous membrane, is rare, and only occurs in certain infective diseases, for instance, in malignant pustule, where the membrane may become so changed as to resemble a carbuncle. Suppuration of the submucous tissue is extremely rare.

2. Hæmorrhage into the gastric mucous membrane is of common occurrence, both as a result of simple stagnation, and of inflammation. It appears very frequently in the vicinity of the cardiac portion and in the fundus, its favorite seat being the tops of the folds. It may be either recent,

when it possesses the bright or dark-red color of clotted blood, or old, when it will have assumed a more black or blackish-brown color. In the latter case, small losses of substance in the mucous membrane are frequently seen, and will be directly considered.

3. Peculiar to the stomach is the occurrence of the **simple ulcer,** which is so frequently found in its different stages, especially in females. The simplest variety is a very shallow loss of substance, round and often oblong in shape, which is usually situated on the tops of the folds, the long axis corresponding to that of the folds; upon its base blackish or brownish masses composed of blood are frequently found, and easily scraped off. Small unaltered hæmorrhages in the mucous membrane are frequently observed in the neighborhood of these ulcerations, and directly suggest that the gastric juice dissolves the mucous membrane at these points, and a loss of substance results, which has been termed *hæmorrhagic erosion.* These occur very frequently with stasis in the gastric veins in disease of the liver, heart, or lungs, and often also after severe vomiting.

The so-called simple, round, or perforating gastric ulcer (*ulcus ventriculi simplex, rotundum, perforans*), appears quite different from these slight losses of substance. It varies from the size of a five cent piece to twice that of a silver dollar and over, and possesses a sharp border, as if made with a punch. They are always situated along the lesser curvature, or in its immediate neighborhood, and are funnel-shaped. They do not penetrate the walls regularly but in the form of terraces, so that the loss of substance is greater in the mucous than in the sub-mucous tissue, greater in the latter than in the muscular coat, and in the muscular greater than that in the peritoneal coat, except, of course, where the ulcers do not extend beyond the mucous and sub-mucous layers. The axis of the funnel-shaped cavity formed by the ulcer, does not extend perpendicularly through the walls of the stomach, but obliquely, from within and below (from the pylorus) outwards and upwards (towards the car-

dia), *i. e.* in the direction taken by the branches of the gastro-duodenal artery; the edges are much more abrupt towards the cardia than towards the pylorus. Upon very careful examination, it is possible to find the stump of a small vessel in the deepest portion of many of these ulcers; others are covered with a blackish-brown mass like the hæmorrhagic erosions, which make it extremely probable that many of these ulcers differ from the erosions only in degree, *i. e.*, they are also hæmorrhagic ulcers. Microscopic preparations show only a thin layer of tissue at the base of the ulcer, infiltrated with small granules possessing a dark contour. The surrounding tissue is devoid of all inflammatory infiltration, and there is an entire absence of purulent disintegration or necrosis.

The termination of these ulcers is various. Many heal after more or less of the wall is destroyed, when a white stellate cicatrix results, which is often difficult to find. Others extend constantly deeper and wider, and may cause death in two ways. They either perforate into the abdominal cavity and produce a fatal peritonitis, or they cause the opening of some large vessel and a fatal hæmorrhage results. If it is desired in such a case to find the opened vessel, it is best, after the stomach has been opened and washed, to inject the coronary arteries with water, when it will spurt from the eroded branch.

They may terminate in another way. The walls may be eaten through, but perforation into the abdominal cavity is prevented by adhesions to other organs (pancreas, liver, spleen). The advance of the ulcer is not prevented by this means, but it extends into the adherent organ, and may attain a very large size. In such cases it is well to remove together all the organs that are involved, which are usually held together by firm adhesions, as the examination can thus be made more conveniently in all respects.

4. Next in the list, after the ordinary gastric ulcers, are the **new formations,** of which the *tuberculous* and *cancerous* are among the first to be mentioned, as they almost invaria-

bly appear in the form of ulcers (ulcus tuberculosum, carcinomatosum). *Disseminated miliary tuberculosis* scarcely ever occurs in the stomach, although a structure appears in the mucous membrane in certain cases, namely, the *lymph follicles*, which may be easily mistaken for tubercles. These follicles have precisely the same appearance and the same characteristics as those in the intestine. They are gray, slightly prominent bodies, of the size of a pin's head, and uniformly distributed over the whole surface, or situated more upon one side or the other. If a vertical section is made with the scissors, the tubules may be seen to be pressed apart by the interposed follicle, which is composed of lymphoid cells closely crowded together, and contains small vessels. The presence of vessels, together with the entire absence of cheesy degeneration in the centre, form the surest guide in distinguishing them from tubercles. These follicles may become involved in inflammation like those of the intestine.

Tuberculous ulcers, which are rather rare, and, as a rule, seldom attain any considerable size, do not differ in their appearance from those of the intestine, which will be described hereafter in detail.

The *cancerous* growths are most often seated at the two extremities of the stomach, at the cardia and pylorus; the pyloric end being far more frequently affected. Three diferent forms may be distinguished, the soft (medullary) glandular cancer, the atrophic (scirrhus), and the colloid or gelatinous form. The statement that they appear generally in the form of an ulcer, applies to all three, a peculiarity that is evidently attributable to the effects of the gastric juice. Only the first class, the simple glandular carcinoma, appears in two forms, as ulcerated and as fungous growths; the latter, as the name indicates, are characterized by the formation of a large fungous mass, which projects beyond the general surface. Of course, ulceration upon the surface of these is not excluded, but the growth predominates, and *a potiori fit denominatio.*

It is not difficult to distinguish the three forms in well-

marked cases; *simple glandular carcinoma* is, as a rule, very soft, rich in cells, and admits of cancer juice being easily pressed from the cut surface; this fluid contains well-marked cylindrical cells, especially in the fungous variety (consequently also called cylindrical-cell epithelioma). This form is also frequently very vascular, and the fungous growth is often so richly supplied with large vessels, that the term telangiectodes seems appropriate. This formation gives rise to numerous small hæmorrhages, and causes the contents of the stomach to appear like coffee-grounds.

The characteristics which belong to the *scirrhous* form in all other localities are especially well marked in the stomach, namely, the abundant formation of a tough, white, fibrous tissue, that creaks under the knife; forms even occur in the stomach in which the development of cancer cells is relatively very slight, and in which it is impossible to discover the least trace of cancer juice. Frequently it is only possible to determine their real character after a most thorough microscopic examination. It is relatively often the case that the new formation extends over the whole stomach, or the greater part of it, and the various forms of so-called induration of the stomach, gastric cirrhosis, are produced, which for a long time were not considered as cancerous. It also produces a diminution in the size of the whole organ, by the contraction of the newly-formed fibrous tissue, which has already been referred to.

Gelatinous cancer is recognized by little, transparent clumps of colloid material in the meshes of the gray network of the stroma, which are most distinct at the oldest portions. It must not be forgotten that only typical cases can be distinguished by this appearance, and that numerous cases occur which can only be recognized by microscopic examination. This is especially true of those forms in which ulceration is the most prominent characteristic, and the mass of the tumor is consequently reduced to a minimum. It is then necessary to make sections perpendicularly through the edges, especially where they appear slightly everted, and

through the base, extending to the serous coat. The muscular coat is always involved in the formation, both actively, as the muscular tissue becomes thickened, and also passively, as the growth pushes forwards into the spaces between the muscular bundles, and even extends through them, frequently forming nodular masses in the subserous tissue. The latter being the part in which the disease is still progressing, microscopic sections, which may be easily made with the double knife, should be taken from here.

A careful examination of sections made through the edges, or horizontally through the base of the ulcer, is necessary in all cases where a differential diagnosis is to be made between cancerous and simple ulcers. Although small hæmorrhagic ulcers of typical shape differ greatly from well-developed cancerous forms, larger ones, on the other hand, which have nearly lost their peculiarities, may be confounded with the latter, when the growth of the tumor is very slight; then they can only be discriminated by the most careful microscopic examination. The diagnosis will be greatly aided by examining the epigastric lymphatic glands, which are almost always involved in cancerous degeneration.

There is but little to be said concerning the remaining forms of tumors of the stomach. *Sarcoma* occasionally occurs and originates in the submucous tissue. The ordinary well-known methods of examination are used for its diagnosis. Small *myomata* (usually from the size of a millet-grain to that of a bean) also occur, and arise from the muscular tissue, the mucous membrane over them being freely movable; there may be also a combination of the two forms, myosarcoma, and finally lipomata, etc., may be found.

5. In conclusion **amyloid** degeneration is to be considered, and it is seldom absent in extreme cases affecting the intestines. The walls of the vessels constitute the essential seat of the change, although the tunicæ propriæ of the glands may be affected in severe cases. In applying the iodine test to this change, there is danger of deception, owing to the unclean condition of the surface (especially from starch in

food), and it is therefore absolutely necessary to remove all the mucus, etc., by scraping and washing, from the place where the test is to be applied. It is also necessary to choose a point which is as free from blood as possible, as this fluid, when acted upon by iodine, gives a color similar to that produced by amyloid material and this reagent.

(*c.*) *The Stomach in Cases of Poisoning.*

Cases of poisoning demand special consideration, both on account of the peculiar appearance of the stomach, and their medico-legal importance, and especially as they require a different method of examination.

1. *Method of Examination.* In order to observe at once and on the same preparation the effects of corrosive poison in different places along the digestive tract, the physician is recommended to remove the organs of the throat and the œsophagus first, in connection with the stomach and duodenum, and in opening the œsophagus to extend the incision along the greater curvature of the stomach. In medico-legal cases, the Regulations direct that when poisoning is suspected, the internal examination is to begin with that of the abdominal cavity, and that before taking any further step, the external appearance of the upper abdominal organs, their position and degree of fullness, the condition of their vessels, and whatever smell they may happen to possess, are to be ascertained. "In considering the vessels it is necessary to determine, here as in other important organs, whether arteries or veins are being dealt with, whether the smaller ramifications also are filled, or only branches and trunks of a certain size, and whether the distention of the canal is great or not." The left lobe of the liver is then to be raised, and by pulling on it, the diaphragm is drawn as far downwards as possible, that the œsophagus may be tied just above its entrance into the stomach and just below the diaphragm. The œsophagus ought not to be separated from its surroundings by a cutting instrument, as it is liable to be wounded in so doing, but should be isolated more in accord-

ance with the method employed in ligating arteries in the living subject, by the use of a director, scalpel-handle, or forceps. The duodenum is to be tied in two places in a similar manner, below the entrance of the gall duct, and preferably at the end of the descending portion. Care must be taken here also that the ligatures are situated at a certain distance from each other (two to three centimeters), otherwise they may be easily cut or may slip off, when the intestine between them is cut through. "The stomach is then to be removed in connection with the duodenum, all possible injury to them being carefully avoided."

They are opened in the usual way. After the contents have been examined in the manner already mentioned, they are to be put into a glass or porcelain vessel, in which the stomach and duodenum are also placed after being further examined. The Regulations give the following detailed directions concerning the examination: "The mucous membrane is to be washed off, and examined with regard to its thickness, color, surface, and consistency, special attention being paid at the same time to the condition of the blood-vessels and the texture of the mucous membrane, and every part is to be noted separately. It is very necessary to determine whether the blood which is present is within the vessels or outside of them, whether it is fresh or altered by putrefaction, or softening (fermentation), and in this condition has infiltrated (been imbibed by) the neighboring tissues. If the blood has escaped, whether it lies upon the surface or within the tissue, whether it is coagulated or not, etc."

"Finally, particular attention is to be paid to the continuity of the surface, with reference to the presence of losses of substance, erosions, or ulcers. It must always be borne in mind whether certain changes may not have possibly been produced by natural post-mortem decomposition, from the action of the fermenting contents of the stomach."

The remainder of the examination is made in the usual manner, except that the œsophagus is ligated "near the

neck" before being taken out, and is then cut off above the ligature and put in the vessel containing the stomach. In those cases where the stomach contains but little, the contents of the jejunum are also put in the same vessel. "Finally, other substances and parts of organs, as blood, urine, pieces of liver, kidney, etc., are to be removed from the body, and given to the legal authority for further examination. The urine is to be kept in a vessel by itself, and the blood also in those cases where it may be possible to draw important conclusions from a spectrum analysis. All the other material is to be put in one vessel."

2. *Changes produced in Poisoning.* The substances which commonly cause poisoning may be divided into two classes, according as they do or do not corrode the surface. The two act differently, the former by causing a direct lesion of the mucous membrane, the second by entering the blood, and thus causing changes in different organs, which are injurious only secondarily. To the first class belong the alkalies, a great number of mineral acids, as sulphuric, hydrochloric, nitric, and also a few vegetable acids, as oxalic, etc. To the second group belong phosphorus and arsenic, substances which produce marked anatomical changes in the organs, and the alkaloids, hydrocyanic acid, etc., which do not cause any appreciable changes, death being caused by the effects upon the nervous system.

(*a.*) The changes produced by the substances belonging to the first group vary considerably according to the nature of the substance; still the differences are not so great, as was formerly supposed, especially when the effects are produced by large quantities. The *alkalies* cause a marked swelling of the mucous membrane, and later of the submucous tissue and muscular coat also, which become converted into a soft, greasy, brown, or blackish mass. The *acids*, on the other hand, especially nitric, when their action is not intense, first produce a parchment-like induration of the surface of the mucous membrane, of a yellowish, brownish, or blackish color. This, however, becomes converted after con-

tinued or very intense action, into a brown or black pulp, very similar to that produced by alkalies. The muscular layer of the œsophagus and stomach is strongly contracted, so as to diminish greatly the size of the lumen and to throw the mucous membrane into folds. As may be readily understood, the changes are most marked in those places where the substance remains longest in contact with the surface, consequently the effects are found to be only slight in the mouth and œsophagus, and along the lesser curvature of the stomach, and between the very prominent folds produced by the strong contraction; on the other hand, they are the most intense at the fundus, and along the tops of the folds. It not unfrequently happens that the action is so intense at the fundus that the whole thickness of the walls is found softened and perforated. An opposite condition of things may occur, especially when there is but a small amount of fluid taken, for this may run along the lesser curvature as far as the pylorus, where its further progress is obstructed, and consequently its effects greatest. On account of the slight intensity of the poisoning, the individual lives longer, so that at the autopsy, only ulcers, or even firm cicatrices, which may cause more or less stenosis, are found. In the most severe cases of poisoning, the blood in the gastric veins is very often altered in such a manner as to be converted into a black mass, that is often quite firm, and distends the vessels. The effects of the substance are not confined to the digestive tract, but constantly extend to the contiguous organs, within which the blood contained in their vessels undergoes the above change. The spleen, liver, heart, and left lung, are the organs most frequently affected.

(*b.*) The condition produced by poisoning with *phosphorus* or *arsenic* is entirely different. Here there is absolutely no trace of deep corrosion, and even inflammatory hyperæmia and hæmorrhages are only met with when death has been sudden. Of course it is not intended to state that no ulcerative process can then arise, though if produced it is the result of accompanying circumstances (for instance, pieces of

matches swallowed at the same time, vomiting, etc.). The changes produced are parenchymatous inflammation of the liver, kidneys, heart, and stomach, all of which have been or will be considered under their respective heads. Poisoning by arsenic may often be diagnosticated by a portion of the poison appearing in the mucus in the form of a white deposit, which is found under the microscope to be composed of octahedral crystals.

7. EXAMINATION OF THE LIGAMENTUM HEPATO-DUODENALE.

Before removing the liver from the body the *ligamentum hepato-duodenale*, together with the *ductus communis choledochus* and *portal vein*, are to be examined.

(*a.*) The Common Bile-Duct.

The *bile* and *pancreatic* ducts have a common opening in the posterior wall of the duodenum at a point where there is a slight projection (longitudinal fold), the papilla of the gall-duct. In order to find the opening quickly, the head of the pancreas, which is easily felt, is to be sought for, the intestine stretched out transversely, and the papilla will be seen situated just below the middle of the head. The next step is to see whether the duct is *pervious* in its whole extent, more especially in the duodenal portion, the stoppage of which by catarrhal secretion gives rise to the so-called catarrhal icterus. In order to determine this latter point the gall-bladder must not be pressed upon, as the force thus produced is too great, and no conclusions can be drawn as to the condition during life; but the duct itself is to be pressed upon in a direction towards the intestine to see if the bile is forced through. While this is being done the papilla is to be carefully watched, as the plug, composed principally of desquamated epithelium, which closes the duct is often very small, and therefore liable to be overlooked. After this part of the examination is completed, the gall-bladder is to be pressed upon to see if the duct is pervious

throughout its whole extent, and then a probe is to be introduced (care being taken at the same time to introduce it into the pancreatic duct), and the duct slit open with the scissors.

The size of the duct is to be observed, the color of its surface, and its other conditions. The normal size is about that of a small goose-quill. Under pathological conditions it may attain that of a large finger. The usual cause of this dilatation is the presence of gall-stones, and, consequently, when it exists one may conclude with tolerable certainty that gall-stones were present here for a long time, although they may not be found at the autopsy. The *color* of the surface is of great importance in determining the point whether bile flowed through the duct during life or not, or how far it was possible for it to advance. When an obstruction existed at any point, only that portion posterior to it is colored with bile, the lower portion being uncolored; in this connection the amount of coloring caused by the bile in the oblique extremity of the duct, the portio duodenalis, which passes through the intestinal walls, is of great importance in the recognition of simple catarrhal icterus.

Among the remaining *alterations of the surface* are the *ulcers*, which are also most frequently caused by gall-stones. They are usually situated at those points where the stones are wedged in, *i. e.* at the entrance of the duct into the intestine, also in front of the portio duodenalis. A *perforation* of the walls of the duct and of the intestine may be caused at this point by ulceration, so that there will be two openings leading into the small intestine, a large one produced by the ulceration and extending perpendicularly through the wall, and a smaller passing through obliquely — the physiological duodenal portion of the duct. The former opening may become obliterated after the gall-stone or stones have been discharged. In such a case it is still possible to judge of the previous conditions by the dilatation of the duct, and by the cicatrix at the above-mentioned point. *Complete closure* of the common gall-duct may result from ulceration, or rather

from the cicatrix produced by it, and usually occurs also in the duodenal portion. *Purulent* and *diphtheritic inflammations* are very rare here, though they occasionally occur in diphtheritic dysentery, typhoid fever, etc.; *tumors* are also exceptional, though small papillary growths of the mucous membrane are sometimes seen near the orifice of the duct.

(*b.*) The Portal Vein.

Another very important structure lies within the ligamentum hepato-duodenale, viz., *the portal vein*, which is easily found behind the common duct. The *surface* and *surroundings* of the vessel are first to be examined, as very important inflammatory changes (*periphlebitis portalis*) are sometimes found here. These are either acute and purulent (periphlebitis apostematosa) or chronic, with a resulting formation of fibrous tissue and contraction of the same (periphlebitis chronica fibrosa). The acute forms especially are usually continued from the neighboring parts, and when this is the case they too must be carefully examined. The trunk of the vessel is then to be opened throughout its whole length, that the condition of its walls and contents may be examined. The *walls* may be somewhat contracted in parts, owing to chronic periphlebitis, in consequence of which the canal is narrowed, whilst, on the other hand, it may be dilated and the walls rendered thinner. The condition of the contents is most important; they may consist of liquid or clotted blood, which may be variously altered, and of pus or morbid growths.

Simple *thrombosis* is sometimes found in connection with cirrhosis of the liver, as a result of pressure from tumors, etc. Softened thrombi, or those mixed with pus, occur associated with inflammation of the wall (*thrombophlebitis*). These conditions usually commence at the roots of the portal vein; they are most common in new-born infants, in consequence of thrombophlebitis of the umbilical vein, but often occur in adults, as a result of disease of the intestine, especially in cases of perityphlitis. A purulent periphlebitis may also lead to secondary thrombosis and perforation of the wall

with the escape of pus into the canal, where it becomes mixed with the softened thrombus. Cancerous masses sometimes perforate the wall from without and grow in the vein, thus acting as a cause for the formation of a thrombus.

8. THE GALL-BLADDER AND LIVER.

After completing the examination of the common gall-duct and portal vein, which is carried as far as possible while they are *in situ*, the *relation* between the *liver* and *gall-bladder* and their surroundings is to be determined, if this has not already been fully ascertained. The liver is then to be removed from the body for further examination, the method of its removal being dependent upon the conditions present (adhesions from gastric ulcers, pericystitis felleæ with perforation, fistula, etc.). The removal is best accomplished by raising the side of the right lobe and separating all the attachments, as far as the middle of the spine, so that the lobe may be laid over the edges of the ribs of the same side; the left lobe is then to be raised and the remaining attachments separated. In so doing it is not necessary to exercise great care, as there are no important organs here which have not been already examined. If there are very extensive abnormal adhesions between the liver and diaphragm, the latter is also to be removed at the same time, and it is always well to do this whenever tuberculous or cancerous nodules are situated upon the peritoneal covering of the diaphragm, as they usually hold a very important relation to the surface of the liver.

(*a.*) The Gall-Bladder.

The exterior is first to be examined, and subsequently the interior of the gall-bladder.

1. External Examination.

(*a.*) *General Appearances.*

The *size* (distention) depends essentially upon the quantity of the contents, and consequently may vary under nor-

mal conditions very considerably; an increase or diminution in size may, however, result from pathological causes. Enlargement arises from an increase in the contents, and is therefore due to closure of the cystic duct. A diminution in size, which sometimes becomes extreme, may depend upon many different causes; as chronic fibrous inflammation with contraction, cancerous degeneration (scirrhus), etc.

The *color* of the external surface is usually light or dark yellow, reddish- or greenish-yellow; a gray or even white color results from thickening of the capsule, or from alteration of the contents. In the latter case the bladder is enlarged, in the former usually diminished in size. Blood-vessels are generally seen in very small numbers, and are most apt to be found at the part where the bladder is in contact with the liver. They are more numerous in inflammatory affections, especially in those of the serous covering (pericystitis), and the color is, consequently, more or less red.

The *consistency* depends upon the degree of fullness and the condition of the walls. The greatest distention occurs in closure of the duct; a tough consistency, in the absence of the previous condition, arises from fibrous thickening of the walls.

(*b.*) *Changes in the Serous Covering of the Gall-Bladder.*

The changes of the *serous coat* are mostly of an *inflammatory* nature. The most frequent forms are chronic, and are, in part, simply fibrous, and in part adhesive (pericystitis chronica fibrosa and adhæsiva). Adhesions between the colon and fundus of the gall-bladder, are very commonly met with; they also occur between the fundus and the abdominal wall, and also other parts. Acute inflammations of this coat and the immediate surroundings (excepting in cases of general peritoneal affection) proceed from the gall-bladder or the neighboring parts, especially the transverse colon, or they occur without any apparent anatomical cause. They generally present an ichorous character (pericystitis ichorosa or gangrænosa), since they are often associated with *perforation* either of the intestine or gall-bladder. The peri-

cystitis resulting from perforation is usually due to dysenteric processes, or cancer in the colon, to calculi in the gall-bladder, which cause ulceration and perforation, or to other ulcers in this organ (typhoidal, etc.). All perforations of the gall-bladder, however, do not extend from within outwards, but some proceed from without inwards, in consequence of pericystitis. The direction which the perforation has taken may be determined here, as elsewhere, by the greater extension of the ulceration upon the mucous membrane or upon the serous coat. A general peritonitis results when perforation takes place from within, before adhesions to the neighboring parts have been formed. If adhesions between the gall-bladder and colon or abdominal walls have arisen before the perforation occurs, of course the pericystitis does not extend, but the bile is discharged directly into the intestine or externally through a fistula in the abdominal walls, as the skin usually becomes perforated in these cases.

In order to be able to determine accurately the above conditions, the liver is, of course, not to be previously removed; if it is taken out the affected parts must also be removed in connection with it.

2. Internal Examination.

(*a.*) *The Contents.*

After the examination of the exterior is completed, the gall-bladder is to be opened by a longitudinal incision, in order to examine the *contents*, which normally vary considerably in quantity, color, and composition. The *color* is either light or dark yellow, reddish-yellow, greenish-yellow, or sometimes almost black. The bile is sometimes thick, again quite fluid, and always stringy. A large quantity of fluid, which is but slightly, or not at all tinged with bile, constitutes the so-called dropsy of the gall-bladder (from closure of the outlet).

The most common pathological conditions met with are *concretions* (cholelithiasis), which appear either in the form of small particles, rendering the contents gruel-like, or as

large compact calculi, which may even attain the size of the gall-bladder in extreme cases, so that one stone completely fills the cavity. The number of stones is often very large. When such is the case their size is generally correspondingly small. When several are present they are angular, possess sharp edges and smooth facets, in consequence of which they are enabled to lie in close contact with each other. These surfaces are not the result of attrition, as the angular shape is due to the fact that the addition of new concretion can only take place at those points where contiguous stones do not lie in contact with each other. The appearance of the stones varies according to the chemical composition. Most calculi are composed of two constituents, pigment-lime and cholesterine, which occur either alone or variously combined. The *pigment-lime calculi* vary greatly in color, from yellowish-brown to black, and are always very soft, so that when pure they are liable to be broken while still in the bladder. The *cholesterine* forms, on the other hand, are very hard and possess a crystalline structure; they are colorless and translucent, with a radiating appearance on section. If a small piece is examined with a high power, the characteristic crystalline plates may be seen arranged eccentrically over one another; these become of a sea-green color upon the addition of iodine and concentrated sulphuric acid. The combined forms occur in great number, and the nucleus may be pigment-lime surrounded by cholesterine, or the latter surrounded by lime; the two components, either alone or mixed with each other, may alternate in layers — and this is the usual structure of most (concentric) biliary calculi.

The gall-stones do not always lie free in the cavity of the bladder, but sometimes in small pockets (diverticula) connected with the wall; the communication between the diverticulum and bladder may become closed by inflammation, so that the stone appears to lie entirely outside of the bladder.

Closure of the cystic duct (which must always be slit open when not perfectly free) is usually due to gall-stones which

become wedged in it; this condition may, however, be caused in other ways, for instance, by pressure from tumors, the contraction of inflammatory false membranes, or even by a simple abrupt bend (displacement), which is sometimes observed, especially in children. The result is that the bile cannot be discharged and its constituents gradually disappear, till finally a watery, slightly stringy fluid fills the cavity (*hydrops vesicæ felleæ*). This fluid is not merely that contained in the bile, but is secreted by the mucous membrane, for the distention of the bladder increases in proportion to the duration of the stoppage, so that the bladder may become twice or thrice its normal size.

(*b.*) *The Walls.*

The examination begins with the surface, which is remarkable for its peculiar *folds*, presenting a honey-combed appearance, which disappears when the bladder is distended in hydrops. These folds disappear also in chronic fibrous inflammation, such as often appears in cases of cholelithiasis of long standing, in carcinoma, etc.

The most frequent variety of *inflammation* is the chronic fibrous, which is recognized by the white color and firm consistency of the mucous membrane. The *ulcerative* form is the most important, and sometimes results from gall-stones, at other times occurs in certain diseases, in severe cases of typhoid fever (diphtheritis), for instance, and is very liable to lead to perforation, as has already been stated. The submucous tissue may become inflamed after the mucous membrane has become ulcerated, and should be exposed in such cases by a few longitudinal incisions. Inflammation in it is usually of a necrotic character; the tissue is of a yellowish-brown color, and saturated with an opaque, grayish-brown fluid, so that the whole layer, and consequently the wall, is thickened. The connective tissue is often quite rotten and easily torn.

The *tumors* of the gall-bladder are confined almost wholly to the carcinomata. Occasionally the so-called *villous cancer* occurs, which is always accompanied by a dilatation of the

cavity, into which the papillary masses project; the ends of the papillæ are sometimes incrusted with biliary deposit, in the same way as those in the urinary bladder are coated with salts from the urine.

Scirrhus of the gall-bladder is much more common, and is usually connected with a diminution in the size of the cavity, at least in those cases which are examined. The interior of the bladder is then often completely filled with gall-stones. The growth almost always extends to the liver and peritoneum, and the secondary growth so often predominates that the bladder may be easily overlooked, especially as it is usually greatly shrunken, like the stomach when similarly affected; it must therefore be closely looked for, especially in cases of general scirrhous adhesions between the abdominal organs.

(*b.*) The Portal Fissure and Lymphatic Glands.

The examination of the *porta hepatis* follows that of the gall-bladder and its duct. That of the bile-ducts and the primary branches of the portal vein may now be completed, and the portal *lymphatic glands* are also to be examined, as these may not only be diseased (cancerous and cheesy degeneration), but may cause secondary trouble in neighboring parts by exercising pressure upon them. Intense icterus, for instance, is sometimes produced by the mere pressure of the portal glands upon the bile-ducts of children affected with general cheesy degeneration of the abdominal lymphatic glands.

(*c.*) The Liver.

After all the foregoing parts have been examined, attention is to be directed to the exterior of the liver.

1. External Examination.

(*a.*) *General Appearances.*

The dimensions of the normal liver of an adult, weighing from two thousand to three thousand grams, are as follows: total width, twenty-five to thirty centimeters, width of right

lobe, eighteen to twenty centimeters; width of left lobe, eight to ten centimeters; height of right lobe, twenty to twenty-two centimeters; height of left lobe, fifteen to sixteen centimeters; the greatest thickness, six to nine centimeters.

These normal *dimensions* are often greatly exceeded in various affections. The latter may be arranged in the following order, according to the enlargement produced by them: parenchymatous inflammation, fatty infiltration, and amyloid degeneration, cancerous, leucæmic, and adenomatous affections (Rindfleisch), the latter giving rise to the greatest increase in size. A diminution in size is in general less common than enlargement; it occurs to a moderate degree as the simple atrophy of old age, and as brown atrophy. In so-called cirrhosis (interstitial inflammation), and in syphilitic atrophy it becomes more marked, and finally the extreme degrees are reached in acute yellow atrophy, in which affection the organ is often less than half the normal size.

Circumscribed alterations in size are very common, especially the atrophy produced by pressure (from lacing, etc.). A circumscribed enlargement occurs as a compensatory condition in connection with limited atrophies, and happens most frequently in livers altered by syphilitic disease.

Congenital *deformities* of the liver are often met with, the most frequent occurring as one or more furrows which extend through the convex portion of the right lobe, parallel to the long axis of the body (expiratory furrows of Liebermeister). The fact that the capsule is everywhere equally thin and unaltered, indicates that the affection is congenital.

The elongation and flattening of the left lobe, which is sometimes observed, is also congenital; a tongue-like shape thus arises reaching as far as the spleen, with which it is often connected by false membranes.

All furrows and notches which are covered with a thickened and whitish capsule depend upon pathological processes. The most common of these conditions is a wide furrow of varying depth, which extends transversely across the right lobe at a short distance from the lower border, and some-

times across a part of the left lobe. This deformity is produced by pressing the edges of the ribs inwards, especially by tight lacing. In rare cases this furrow may be so deep that the greater part of the tissue becomes atrophied, and the lower half of the right lobe becomes separated from the upper, so that it is possible to fold the two together. Irregular furrows and depressions which are usually directed towards the suspensory ligament are caused by syphilitic affections. Finally, many irregularities in shape, especially at the edge, may be caused by interstitial hepatitis, so that the liver sometimes has the appearance of a racemose gland.

Variations in shape very frequently accompany spinal curvature and the resulting deformity of the whole thorax; they also accompany peritonitis, especially when caused by perforations, with the entrance of gas into the abdominal cavity. The clinical symptoms (diminution in the area of dullness) indicate that the gas is seated between the liver and abdominal walls, and in these cases the outer and upper surface of the right lobe is flattened, the depression, caused by the accumulated gas and exudation, extending to a varying distance towards the suspensory ligament. The small conical portions of liver which project into an opening in the diaphragm (hernia diaphragmatica) have already been referred to.

The *color* of the surface, like that of all other organs covered by a fibrous capsule, depends essentially upon the condition of the latter. This is normally very thin and transparent, so that there are a large number of affections of the parenchyma which may be recognized by the altered color of the surface. In the more extreme degrees of fatty infiltration, the normal brown or reddish-brown color is converted into a more or less bright-yellow; in the lesser degrees, a few spots only are seen. If the bright yellow is occasionally tinged with bile, the presence of jaundice is indicated. Very intense yellow spots, with intervening red patches, occur in acute yellow atrophy, while a dark-brown color characterizes brown atrophy, etc.

Putrefaction produces a dirty, greenish slate color, which is also sometimes found, soon after death, in cases of ichorous peritonitis. It is then frequently confined to the right lobe, corresponding to the place where there is the greatest collection of exudation or gas, and is often combined with the alteration in shape which has been previously referred to. Both conditions frequently cease abruptly at those places where the peritoneal reflections are attached, the liver beneath being consequently protected.

Besides the more general alterations in color, or those that extend uniformly over a large space, there are others appearing as small and defined yellow spots, which are due to circumscribed fatty infiltration. These should not be confounded with pale spots, which are less yellow and more gray, and are more or less parallel with the ribs; the latter are simply anæmic spots, such as may be easily produced by firm pressure with the finger. Circumscribed spots possessing a purulent color arise from abscesses, or, more rarely, from embolism. Small, bluish-black spots, varying from the size of a small pea to that of a ten-cent piece, are due to venous tumors (cavernous). Superficial cancers, etc., of course produce an abnormal color, corresponding to their appearance.

The *consistency* of the liver compared with that of other organs is rather firm, and depressions made with the finger are quickly obliterated. It is increased in fatty infiltration, but the elasticity is somewhat diminished, so that the depressions made with the finger become slowly obliterated. The amyloid liver is still more firm, and impressions remain permanently. In brown atrophy the liver is also dense, but less so than in amyloid degeneration or cirrhosis; in the latter affection the consistency is firmer than in any other alteration, and the liver frequently creaks when cut through.

Softening occurs especially in parenchymatous inflammation. The organ loses all its elasticity and in the more advanced cases is flabby, a condition which is most marked in acute atrophy, where it has the consistency of a "dish-

cloth." Fluctuation occurs, though imperfectly, when large abscesses or echinococcus cysts are situated near the surface.

(*b.*) *The Capsule of the Liver.*

The capsule of the liver becomes involved, not only in diseases of the liver, but also in those of the general peritoneum; chronic inflammatory thickening (*perihepatitis chronica fibrosa*), very commonly occurs, and is usually circumscribed. The subcapsular lymph vessels may sometimes be very easily traced in such cases, and the thickening often becomes first visible within their walls, as is the case with the lungs. *Adhesive perihepatitis* may cause adhesion of the liver to the diaphragm, stomach, intestine, spleen, etc. In purulent peritonitis a large collection of pus is usually found over and about the right lobe. *Tubercles and carcinoma* not unfrequently occur, but the former are less common here than in the parenchyma, in which they may often be seen through the capsule.

2. The Interior of the Liver.

In order to examine the interior of the liver, a single long incision usually suffices, extending transversely across and entirely through the left and right lobes. If circumscribed affections are suspected, or if such are seen upon the surface, the number of incisions can be increased at pleasure, but they ought always to be made in the same direction, otherwise the organ will be so hacked as to render the remainder of the examination difficult.

(*a.*) *General Appearances.*

1. *The Parenchyma as a Whole.*

The first thing to be observed is the *amount of blood*, both in the large and small vessels, upon which the *color* of the parenchyma mostly depends.

It is very easy to distinguish between the branches of the two venous systems of the liver, which alone are specially important in this connection. The walls of the hepatic

veins are extremely thin, and lie in direct contact with the parenchyma, to which they are firmly adherent, so that these vessels, when cut through, do not collapse, but remain widely open. Besides, they always occur alone, *i. e.*, unaccompanied by any other large blood-vessels or bile-ducts. The portal branches, on the other hand, are always accompanied by gall-ducts and branches of the hepatic artery, all of which are surrounded by connective tissue (Glisson's capsule), which decreases in quantity with the size of the vessels. In consequence of this arrangement the branches of the portal vein never remain open like those of the hepatic.

In determining the quantity of blood within these vessels, it is not sufficient to confine the examination to that which flows from the cut surface, but the parenchyma must be squeezed in order to see how much more can be forced out.

The condition of the contents of the vessels will be considered hereafter in treating of partial thrombosis (simple or cancerous). The blood is usually fluid, and of a very dark color; when frothy, and of a faded red or greenish color, putrefaction is indicated, a change which occurs quite early in the liver.

The quantity of blood in the parenchyma varies greatly, and is greatest in all those affections where there is an obstruction to the flow of blood through the right heart. It is seldom uniformly distributed, and its color is frequently modified by the proper color of the liver. This is usually reddish-brown; a white or grayish-yellow color is always due to fat (usually fatty infiltration), an orange-yellow, greenish-yellow, or even actual green, to icterus. An excess of gray results from an increase in the connective tissue (interstitial, fibrous hepatitis), a translucent gray from amyloid degeneration; a dark brown is due to a deposit of brown pigment in the cells (brown atrophy), and a slaty or even black color occurs in melanæmia. An opaque, usually grayish-brown, color is characteristic of parenchymatous inflammation. Putrefaction produces in the liver, as in most other organs, a dirty red, greenish, or blackish color; this may also appear

upon the surface in circumscribed spots (three to five centimeters in width) under ichorous peritoneal exudation, or in the parenchyma about the vessels or gall-ducts, thus indicating that under certain circumstances putrefaction commences at these points. The color thus arising appears very quickly about the vessels in all septic diseases.

The *consistency* of the liver is also to be tested in the examination of the cut surface, the previous general statement as to which still applies. A granular feel is usually characteristic of cirrhosis, and when less marked, of an extreme degree of fatty infiltration. The consistency is always very considerably diminished by putrefaction, and the tissue becomes friable and easily crushed, a condition which is especially marked when (in an advanced stage of putrefaction) gas has been generated in the parenchyma.

2. *The Lobules.*

After this general consideration, the *lobules* or *acini* are to be also examined in respect to their size, shape, and color, all of which are very important, as nearly all diseases of the liver stand in very particular relation to the lobules.

Their *size* varies greatly, according to the direction in which these oblong angular bodies are cut through. More will be stated with regard to their recognition in treating of the color. They are from one to two millimeters long and about one millimeter in width, though their size is usually estimated from their general appearance. Enlargement of the lobules, which does not necessarily occur in all enlargements of the whole liver or of portions of it, is found without any pathological alteration of the component parts, especially of the cells, in various forms of hypertrophy or hyperplasia (compensatory, simple); it is also found in a great number of diseases which cause an alteration within the cells (parenchymatous hepatitis, fatty liver, amyloid liver). Diminution in size occurs in the various forms of atrophy, the simple, brown, fibrous, etc.

The lobules frequently undergo a sort of alteration in *shape*, owing to the disappearance of the more or less

sharply defined boundary which they usually possess, which is especially marked in certain pathological conditions (fatty infiltration). Under such circumstances they can no longer be distinguished from each other, as happens, for instance, in many cases of parenchymatous hepatitis.

The *color* is the most important quality which the lobules present, and depends upon the normal differences between the separate portions of the same, which are essentially due to the distribution of the blood. After death, the blood collects mainly in the hepatic veins and the nearest capillaries, so that the central portion of the lobule where the capillaries empty into the hepatic vein (vas centrale or intralobulare), contains more blood, and is consequently of a darker color than the periphery, where the capillaries belong to the portal system and are empty. The borders of the lobules are therefore normally lighter in color, more gray than the centre, and this color is most marked at those points where the portal veins and connective tissue (Glisson's capsule) lie. This normal difference in color is increased in certain pathological conditions, but at the same time is somewhat modified. The central dark color is increased, and becomes extremely dark red in passive congestion of the hepatic vein, and brown in brown atrophy of the cells; the yellow, yellowish-red, or greenish color in jaundice, also appears in the centre; on the other hand, the bright grayish-yellow, or pure yellow of varying width at the periphery, arises from fatty infiltration, while a wide gray or grayish-white zone at the periphery, or perhaps more correctly speaking, between the lobules, points to an increase of the connective tissue (interstitial fibrous hepatitis). Tubercles frequently appear as small gray specks on the borders of the lobules. Finally, a slaty discoloration is found, especially at the periphery, which is due to a deposition of black pigment (melanæmia). The translucent gray color of amyloid degeneration, which also possess a dull, waxy lustre, belongs rather to the intermediate zone, at least in mild cases.

The *microscopic examination* of the liver is generally

quite simple, as ordinary needle preparations, in which the changes in the hepatic cells can be readily recognized, are quite sufficient for the diagnosis of many affections. For further examination sections are necessary; these are made with a razor in the same manner as in the kidney, or with the double knife, which is still simpler. As a detailed description of the pathological conditions occurring in the liver is soon to be given, it is merely necessary to mention here briefly certain normal appearances which seem to characterize the lobules, and are of great importance in the examination of pathological changes. The distinction between the hepatic (intralobular) and the portal (interlobular) vein is of prime importance, and the points to be considered in the microscopical examination are the same as those already referred to in describing the gross appearances. The hepatic veins are recognized by their very thin walls, which are firmly attached to the parenchyma, and by the consequent patency of the canal; they are always surrounded by capillaries and never accompanied by another large vessel, either artery, gall-duct, or portal vein. The branches of the portal vein, on the other hand, run along the edges of the lobules (therefore interlobular), and are surrounded by a certain quantity of fibrous tissue, which permits their collapse. They are, moreover, always accompanied by other vessels, usually branches of the hepatic artery, and gall-ducts, which are also enclosed in Glisson's capsule. A knowledge of this distinction is all the more important in the examination of the human liver, as the division into lobules depends wholly upon the peculiar course of the vessels, and they are not entirely separated from each other by connective tissue, as is the case in swine. It is still more important in those places where Glisson's capsule and the portal vessels are not present, and adjoining acini are directly continuous. The recognition of the separate lobules is necessary in examining the condition of the liver, because different diseases produce changes in different portions of them. Another difficulty arises, in addition to the one just stated, from the fact that

differences in color, which are so important in relation to the gross distinction of the different parts of the lobule, become of less value the higher the power used, and in every section there are contiguous lobules cut through in all possible directions (transverse, longitudinal, and oblique).

In describing the changes which may occur, it has always been customary, for the sake of simplicity, to consider them with reference to a transverse section of the lobule, and the same course will be pursued here.

(*b.*) *Special Morbid Conditions.*

1. **Atrophy** is first to be mentioned among the special affections of the liver. The simplest form of destruction of the liver substance is *atrophy from pressure*, which may be the result of pressure from without (from lacing, for instance), or from within (contraction of fibrous tissue). In the atrophied portions a part of the cells have wholly disappeared, and only a small mass of connective tissue remains instead of the substance of the liver.

Atrophy of the whole organ occurs in connection with general atrophy in cachectic individuals, and also as a change belonging to old age. It further occurs in a form which is characterized by an atrophy of the whole organ and of the separate acini, and also by a deep brown color of the parenchyma (*brown atrophy*, *atrophia fusca*). The color is produced by brownish, angular granules of pigment which occur in the cells, especially of the central zone. These livers are always of a very firm consistency, and are therefore particularly suited for the making of sections for microscopic examination; and all the more so as the lobules are very easily seen, owing to their small size, and the fact that they are very sharply defined.

There is another (rare) form of pigment-atrophy, the *melanæmic atrophy*, which follows an enlargement of the organ. It is characterized by a slaty, blackish, or chocolate color, which is frequently distinct only at the periphery of the lobules, and is due to the deposition of specks of black pigment

in the canal of the capillaries and even larger branches of the portal vein, and in the surrounding tissue. This change only occurs in severe intermittent fever, in connection with similar pigmentation of the spleen.

Still another form of atrophy is recognized by the dark red color of the centre of the lobule (the *red atrophy* of Virchow, *cyanotic atrophy*). It depends upon a marked dilatation of the hepatic veins and the central portion of the capillary network, which in turn causes an atrophy of the liver-cells lying within it. These cells constantly decrease in size and take up more pigment, so that both they and the vessels unite in forming the central dark, reddish-brown color. As the atrophy of the cells is secondary to the distention of the capillaries, the liver does not appear diminished in size, in the early stage of the affection, but, on the other hand, is enlarged (liver of passive congestion), as is the case in many kinds of atrophy of this organ.

Cyanotic atrophy is neither always uniform in all parts of the parenchyma, nor does it always affect large portions, but is often limited to small regions, where it may finally involve whole acini, so that dark, reddish-brown atrophic streaks are produced; and when they reach the surface, small furrows with slight thickening of the capsule may result. The so-called *yellow atrophy* will be considered in connection with parenchymatous hepatitis, and *cirrhosis* (*granular atrophy*) with interstitial hepatitis.

2. **Hypertrophy** of the liver, when due to an increase of its active, homologous substance, is either general or partial. The term does not necessarily imply an increase of the entire liver, nor of single acini, nor even of single cells, but all these conditions are to be discriminated, namely, simple hypertrophy (enlargement of the cells), simple hyperplasia (an increase in the number of cells within the lobules), and hyperplasia of the acini. *General hypertrophy* occurs in many infective diseases, sometimes in leucæmia and pseudoleucæmia, in diabetes mellitus; in the latter the cells present a wine-red color when treated with iodine (glycogen).

The *partial hypertrophies* are more interesting, and are observed as vicarious or compensatory conditions when a portion of the liver is destroyed (often very distinct in the left lobe in cases of syphilis). Partial hypertrophy occurs sometimes also in the form of nodules, varying from the size of a pea to that of a cherry, which are scattered in numbers throughout the liver, and are characterized by the size of their acini, and by their frequent pale red color as compared with that of the surrounding tissue.

Besides these true forms of hypertrophy, there are other changes which usually cause an enlargement of the whole liver and especially of the individual cells, not however by the presence of a homologous but of a heterologous material. These are the following.

3. **Fatty infiltration**, which occurs normally but temporarily in digestion, is met with as a permanent pathological change in various cachectic conditions (phthisis, atrophy of children, etc.), and in chronic alcoholism. The lowest degree of the affection is met with very often as a small, pale, not yet distinctly yellow, but rather grayish-white border at the periphery of the lobule. As the affection becomes advanced this border is wider and more yellow, while the dark central portion is correspondingly smaller, till finally, when the highest degree is reached (the true *fatty liver*, hepar adiposum, Strasburg goose liver), the whole acinus assumes a yellow color resembling that of butter, as, of course, the whole parenchyma does; a pure yellow is present only when the liver is anæmic. When it contains blood, a reddish tint appears, and when it is congested the red may so predominate over the yellow that very close inspection is necessary lest the fatty condition be overlooked. The diagnosis is aided in such cases by the condition of the surface of the knife used in making the section of the liver; this becomes smeared with a layer of fat, so that water poured upon it flows off and has no tendency to remain.

This affection is due to the reception of fat in the hepatic cells, at first in those at the periphery, and later in those sit-

uated in the central portion of the lobule. The size of the cells becomes consequently greater, and thus an increasing enlargement of the lobules and the whole organ takes place as the affection advances. When the cells are isolated by teasing a bit of the tissue with needles, the fat contained in them may be easily recognized as large and frequently single drops; it is often more difficult to see the body of the cell, as the fat drops may be so large that the protoplasm surrounds it in the form of a thin film. The gross appearances are exactly reversed in sections, from which very satisfactory pictures may be obtained with a low power (when the affection is mild); the small, closely-packed fat drops with dark outline now produce a dark gray, even black color in thick sections, in the edge of the lobules, instead of the white color seen with the naked eye.

Instead of taking place at the edges, fatty infiltration may occur exceptionally, without any reason for the exception, around the central vein; the yellow color does not then appear in the form of rings, but as small spots (on transverse sections), which are separated from the gray periphery by a small brownish zone.

Fatty infiltration is very frequently associated with other affections which are partly produced by it, many cases of icterus, for instance. *Icterus* of the liver, like brown pigmentation, first appears in the centre of the acini, and a very pretty picture is seen when these bile-colored centres are surrounded by yellowish-white rings. When the cells are isolated, some of them are seen to be filled with diffused, clear yellow coloring matter; others with irregular, pale or dark yellow, yellowish-red or brownish-red granules, and rarely with crystalline pigment. In such preparations the reaction of biliary coloring matter may be easily obtained in the manner described in treating of the kidney. In order to complete the subject of jaundice of the liver, it is to be mentioned that when the icterus has continued for a long time, and with great intensity, a green color replaces the yellow, and the so-called *icterus viridis* is produced. In certain

cases, for instance in acute yellow atrophy, to be more accurately described hereafter, and in cases of complete closure of the excretory ducts, the biliary coloring matter is found not only in the hepatic cells, but also in the dilated biliary capillaries, which appear in every section as small varicose canals filled with olive-green masses, which are often bifurcated.

The fatty liver is frequently combined with that produced by chronic passive congestion, and the central portion of the lobules is then colored dark-red by the latter process, while as a result of the former the periphery becomes bright yellow; this combination furnishes a very characteristic appearance, resembling that of the cut surface of a nutmeg, and hence is called *nutmeg liver*. If the previously described cyanotic atrophy is also present the atrophied nutmeg liver results. The combination of fatty infiltration with parenchymatous hepatitis (which in its last stages produces the condition of fatty degeneration), with interstitial hepatitis (cirrhosis), and with amyloid degeneration will be considered when those affections are described.

4. **Amyloid degeneration** of the liver is next in frequency to that of the spleen, and a very marked enlargement of the organ sometimes results, even in children. In extreme cases the liver is considerably enlarged and very dense, the outlines of the lobules are quite indistinct when the cut surface is examined, and the parenchyma presents a translucent, glassy appearance and peculiar lustre characteristic of amyloid infiltration; here and there small portions remain unaffected by the process, though they are often of a yellow color from fatty infiltration. The greater portion of the cut surface assumes a deep brown color when iodine is applied.

If the lobules in such cases are closely examined, it will be observed with the naked eye, and still better with the aid of the microscope, that the amyloid change is present everywhere. If, on the other hand, the affection is but slight, the degeneration is confined to the middle zone (for purposes of description the lobule is divided into three concentric zones) while the outer is prone to fatty infiltration, and the central

to the formation of pigment. It is characteristic of the origin of amyloid degeneration that the capillaries of the hepatic artery unite with the others in this middle zone especially. Although the degeneration spreads from the smallest arteries, which are always first diseased, it extends in many cases to the liver cells, which become converted into irregular vitreous clumps. This is very prettily shown by the application of methylaniline to sections or teased preparations.

Mild cases of amyloid degeneration are recognized with difficulty by the eye alone, even when iodine has been applied, as the brown color produced by iodine may be masked by the brown color of the liver. It is well in such cases to make as thin and large a section as possible with the scalpel, and lay it for a short time in a small saucer containing iodine; the section should then be washed with water, and placed upon some white support, where even very small quantities of amyloid material cannot be easily overlooked.

5. **Inflammation.** The processes thus far considered and relating principally to the cells, have nothing to do with *inflammatory* changes. There is, however, one alteration of the cells which, at least according to the definition of Virchow, is to be considered inflammatory, and is consequently called: —

(*a.*) **Parenchymatous hepatitis.** This affection, like parenchymatous inflammation elsewhere, has two stages, the one of cloudy swelling of the cells, and the other of fatty degeneration. The latter stage is quite rare in the liver, and is generally limited to certain definite forms of disease, although quite common in the kidney. In those diseases which are usually accompanied by parenchymatous changes (acute infective diseases, acute exanthemata, etc.), the liver appears, as a rule, in the condition of *cloudy swelling.* This is characterized by great flaccidity of the organ, by enlargement of the individual lobules and the entire liver, by indistinctness of the acini, and by a comparatively uniform opaque gray color of the cut surface, which suggests that the latter has been dipped in boiling water (coagulation of the albuminates). The recognition of the milder form of paren-

chymatous hepatitis is one of the most difficult things in pathological anatomy, and long practice is requisite for this to be done with a certain degree of sureness. In these cases the diagnosis cannot be greatly aided by observing closely the details; but the liver, like the kidneys, is to be looked at from a little distance, as the opacity can be thus most easily noticed. Much experience is also necessary in order to make a microscopical examination of use in the diagnosis, as the normal liver cells are very granular, and it is difficult to recognize a slight excess of those granules. In the more severe forms the appearances are quite characteristic, the cells then being opaque, as if spattered with India-ink, the nuclei more or less indistinct under the mass of dark granules, and the volume of the cell increased. On the addition of acetic acid or caustic alkalies the greater part of these granules (albuminates) disappear, but fat granules, if present, remain unchanged.

The more extreme degrees of parenchymatous inflammation, where the cloudy swelling results in *fatty degeneration*, occur principally in two affections, in poisoning by phosphorus (also arsenic, etc.), and in acute atrophy of the liver, the ætiology of which has never yet been ascertained. In cases of *phosphorus poisoning* the nature of the process is by no means universally agreed upon, as an abnormally large, bright, yellow liver with icterus, greatly resembling the ordinary jaundiced, fatty liver, is often found; in consequence of this resemblance certain authors have maintained that the two are identical, and deny the existence of the parenchymatous inflammation. Other authorities (Virchow, Rindfleisch) contend that the essence of the process is a parenchymatous inflammation in which, according to Rindfleisch, large fat drops are formed, while according to Virchow both fatty degeneration and fatty infiltration occur, and the latter may also be due to the phosphorus, which may possibly render the cells more capable of retaining fat. At any rate, upon microscopic examination, besides the cells containing large *fat drops*, like those seen in fatty infiltration, others are

found beginning to disintegrate, which is usually not the case in infiltration. This question might be positively settled if atrophy of the liver resulted by the absorption of the fatty detritus, but death always occurs before this can take place, and a well authenticated case of atrophy after phosphorus poisoning has never been observed.

The characteristic appearances in *acute yellow atrophy*, on the other hand, depend upon this absorption. This affection is met with much more frequently in women than in men, and particularly during pregnancy and the puerperal state. The early stages, which greatly resemble those produced in the liver by phosphorus poisoning, are seldom observed, and if found their consistency is usually less than that occurring in the latter affection, and the liver, instead of being diminished, is increased in size (yellow hypertrophy). In ordinary typical cases the organ is frequently reduced to half its normal size, is flabby and wrinkled, but still rather tough; icteric, yellow elevations of varied size project from the outer surface of the liver, and still more from the cut surface, and are imbedded in a red ground which is often traversed by single delicate gray trabeculæ. Sometimes the yellow and at other times the red portion predominates, while in the midst a varying number of punctate hæmorrhages are seen, which also occur in many other places, especially in the connective tissue, as is the case also in phosphorus poisoning. The microscopic examination can only be very incompletely made when the organ is fresh, owing to its soft condition, but it shows that the yellow portions are the more nearly normal, as they still contain liver cells, which are filled with fat drops of varied size; a large quantity of biliary coloring matter is also found, either diffused, granular, or crystalline (crystals of bilirubine), likewise bile-capillaries filled with olive-green bile, which have already been referred to. In the red portions, on the other hand, there is no longer a trace of the liver cells to be found, merely a confused mass of fibres and granular detritus. At the junction of the red and yellow portions the progressive destruction of the liver

cells may be followed. The change is greatest in the red portions, where the structure of the organ is completely lost (*red atrophy*, Klebs). Sometimes small islets of granulation tissue (interstitial hepatitis) occur here and there, especially at the edge of the lobules in the yellow portion, also clusters of epithelial cells, the nature of which is still uncertain (hyperplasia of the epithelium lining the gall-ducts?). Certain observers have found numerous colonies of micrococci in the atrophied livers, but as yet they have not been able to establish an ætiological connection between the two.

When the liver of acute atrophy is exposed to the air for some time after its removal, the cut surface and the walls of the vessels are usually found coated with a thin, white, frost-like layer, which is found upon microscopic examination to be composed of crystals of leucine and tyrosine, especially the latter. *Leucine* occurs in the form of spherical crystalline masses, which are often arranged in groups; *tyrosine*, on the other hand, is in the form of acicular crystals arranged in sheaves, somewhat resembling crystals of fatty acids, though generally larger; they may be easily distinguished, however, as they are not affected by heat, while the latter readily liquefy when warmed.

(*b.*) There are still a number of inflammatory affections in which the cells are altered as a secondary condition.

First among these are the **metastatic** (*embolic*) **inflammations**, which are in general rare, but often occur in certain affections, as, for instance, endocarditis ulcerosa. The infarctions usually lie just beneath the capsule, are wedge-shaped and of a yellow color. The acini are still apparent in the recent forms, but as the infarctions become older the central lobules disappear and are replaced by a soft, puriform mass. This so-called metastatic abscess is always separated from the normal surrounding tissue by a zone of somewhat enlarged yellow lobules (parenchymatous inflammation). Numerous colonies of micrococci are seen in microscopic sections, especially after acetic acid, caustic potash, or soda has been added, and are situated not only in the larger, interlob-

ular vessel, but fill the capillaries also for a long distance. Very few pus corpuscles are present, the greater part of the infarction being composed of disintegrated liver cells.

If sections are made from places which appear to be still unchanged, the micrococci will almost always be found on thorough examination; there may be no changes in their vicinity, or slight traces of inflammation may be present, which become more pronounced, till finally the inflammatory alterations are evident to the naked eye. This gradation of appearances leads to the conclusion that the micrococci are the cause of the disturbances.

(*c.*) The **interstitial inflammatory affections** of the liver include: —

1. *Purulent* inflammation, which appears in the form of *abscesses* and is of rare occurrence. Two sorts of abscesses, the acute and chronic, are to be distinguished; the latter is characterized by the formation of a firm fibrous tissue, in addition to the pus, which may not only surround the abscess (encapsulated abscess), but also extend through it in the form of numerous septa. The abscesses may be of traumatic origin (the greater number of which are found in connection with injuries of the head, and have nothing to do with metastasis), or they may arise from the roots of the portal vein (in the spleen, stomach, intestine [especially in perityphlitis], also from the umbilical vein), or from the gall-ducts; in the latter case the abscesses may be caused by inflammation which is continued from the intestine (typhoid fever, dysentery), or by the formations of concretions in the ducts, or by the entrance of parasites (ascaris).

The abscesses may cause secondary changes, by an extension of the inflammation, both in the portal (pylephlebitis) and in the hepatic veins (hepatophlebitis); these veins are then filled with softened thrombi, of a puriform, or dirty grayish-brown appearance, which extend into the larger branches, and the thrombi in the hepatic vein may even give rise to embolism of the lungs. It is frequently possible to see that the suppuration follows the course of the inflamed

vessels. Under the microscope the pus corpuscles, especially in old infarctions, are found to have become disintegrated. These abscesses must not be confounded with suppurating echinococcus cysts, in which the presence of membranes or hooklets will render the diagnosis certain.

2. The inflammatory processes which have been thus far considered are more or less acute in character. There remains a very important chronic inflammation to be described, namely, *chronic interstitial hepatitis.*

The volume of the liver is increased or diminished in this affection, according to the stage of the process, as is the case in parenchymatous inflammation. It is only accidentally met with in its early stages, as it is then not detrimental to life. The principal change produced in the liver consists in an increase of the interlobular tissue, and the appearance of small grayish masses at the periphery of the lobules. The consistency of the liver is increased. The cause of this change may be seen in microscopic sections to consist of a growth of granulation tissue from Glisson's capsule, from which small projections extend into the acini. Even in this early stage, the disposition of the newly formed tissue to become more highly organized may be recognized, for besides the round cells there are numbers having a spindle shape. All the further changes depend upon this peculiarity.

In the later stages of chronic interstitial inflammation the liver is more or less diminished in size, in rare cases fully one half; its surface is uneven and covered with prominences, which vary from the size of a millet-grain to that of a pea (*granular atrophy*), and are usually of a yellow, icteric color. At the edge of the liver, especially in front where it is sharp, single nodules are frequently found, completely isolated, as the capsule belonging to the two surfaces comes in contact here. Upon section a similar condition of things is seen; numberless islets of parenchyma, from the size of a millet-grain to that of a pea, project from the cut surface in the form of round masses, which are infiltrated with fat and bile (hence the old name *cirrhosis* from κιρρός, tawny,

orange-tawny). These are separated by bands of varying width, composed of very tough, grayish fibrous tissue, which creaks under the knife, and within which little yellow spots are scattered about. Sometimes this process produces a thrombosis of the portal vein.

Upon microscopic examination round cells are still found in very few places within the tough interstitial tissue, but more frequently those of a spindle shape; the bands are essentially composed of tough, interlacing connective tissue fibres, between which wide vessels are met with, which may be injected from the hepatic artery or portal vein. The projecting granules consist of fatty infiltrated and icteric liver tissue. They do not always represent single lobules or groups of them, for although the process extends from the interlobular connective tissue, it does not always follow the boundaries of the lobules in its progress, as these do not possess a connective tissue capsule; they are frequently composed only of very small portions of acini or groups of acini, which are detached by the irregular penetration of the granulation tissue into them.

The most common cause of this form of interstitial hepatitis, which extends uniformly over the whole organ, is usually considered to be the intemperate use of alcohol (gin-drinker's liver), still this is not necessary; most drunkards do not have a cirrhotic but a fatty liver, and many persons with cirrhosis are not in the habit of dram-drinking. There is another quite different form, in which the formation of fibrous tissue is confined to certain regions, so that large lobes, and not small granules, are separated by the contraction of the fibrous tissue (*lobulated liver*). This form is usually due to syphilis. The greater part of this fibrous tissue usually occurs in the vicinity of the suspensory ligament, and fibrous bands extend from this region into the surrounding tissue. The variations in shape which it produces in the organ are sometimes very great. For instance, the right lobe may become so atrophied as to be much smaller than the left, which then, of course, frequently undergoes compensatory hypertrophy.

3. In addition to this pure interstitial syphilitic affection of the liver, which of itself can never be diagnosticated as due to syphilis, another form occurs, more rarely but still rather frequently; this is manifested by irregular and rounded, homogeneous, yellow, tough, and elastic masses (*gummata*), which are imbedded in the fibrous tissue (hepatitis interstitialis gummosa). The structure of these nodules does not differ essentially from that of the similar formations in the testis and other places, which have been fully described.

6. The foregoing affections lead to the consideration of the **tumors** of the liver.

(*a.*) **Gummata,** without interstitial inflammation, are almost never observed in adults, but there are hereditary forms, which occur in new-born children, where the interstitial inflammation at least is less prominent, so that the affection has more the character of a true new formation. In these cases the gummata are sometimes in the form of large, separate tumors. Again, the whole liver, in which the lobules are almost indistinguishable, is studded with an endless number of small, pale yellow bodies of irregular shape, very minute gummata.

(*b.*) **Tuberculosis** of the liver usually appears in one of two forms, either as a disseminated miliary tuberculosis of the parenchyma, or as tuberculosis of the gall-ducts. *Disseminated* tuberculosis is always secondary, and of very frequent occurrence; it is never absent from the liver, after even a few organs have become affected by secondary tuberculosis. The tubercles of the liver are among the smallest known, and are consequently very liable to be overlooked. In order to be perfectly sure of their presence the microscopic examination must always be made whenever there is the least possibility of tuberculosis of this organ; it can then be seen how many thousands of tubercles would escape notice, without the aid of the microscope. The largest ones are evident to the naked eye as minute gray granules the size of a pin's head. They are situated at the periphery of

the lobules, but the microscope shows that they are not only between but also within them, so that a portion of the parenchyma is replaced by the nodules. Some of the nodules are situated upon the smallest bile-ducts, and, consequently, have a yellowish-green color, which thus renders them more readily recognized. In children the tubercles become larger, from the size of a millet-grain to that of a pea; they are then composed of an aggregation of minute tubercles.

Upon microscopic examination the tubercles often present the frequently described reticulated structure and giant-cells, but both giant-cells and a coarse reticulum are frequently absent.

The second form is chiefly seated within the walls of the *bile-ducts*, not in the small ones between the lobules but in the larger tubes. The disintegration of the tubercles leads to ulceration of the surface, as in the ureters, and the canal is filled with cheesy material and bile, so that a cavity of the size of a pea, bean, or even cherry, is seen on section, the walls of which are composed of a firm cheesy mass, and the contents are pultaceous, stained yellow or green by bile.

Although large tubercular nodules are rare in the liver, it is necessary to know that they are occasionally met with from the size of a walnut to that of the fist. These are distinguished from cancer, which they may greatly resemble in form, by their uniformly dry and cheesy character, and the entire absence of any milky fluid when squeezed. Isolated submiliary nodules are seen with the microscope in the most recently affected places, which indicate that these nodules also consist of a conglomeration of small tubercles.

(*c.*) The tumor-like **lymphomatous growths**, which are occasionally found in the liver in *typhoid fever*, and more frequently in *leucæmia*, are closely allied to tubercles. In leucæmia, especially, they may cause a very considerable enlargement of the organ. They appear as grayish nodules of varying size, which are wholly composed of granulation cells. Even when they are absent in leucæmia, the liver is usually

considerably enlarged; and the cut surface, after being exposed to the air, is soon covered with a white film, which is composed of crystals of tyrosine. Colorless octahedral crystals are also found in great numbers, both upon the cut surface and in the substance of the organ, of the same character as those which have been spoken of in connection with the spleen.

(*d.*) By far the most interesting of the other tumors of the liver, are the **carcinomata**. Both primary and secondary forms occur, the latter being further divided into continued and true metastatic growths. *Primary* cancer, which is extremely rare, takes its origin, as a rule, from one spot; a large maternal nodule is surrounded by a number of smaller accessory growths, and as the latter increase in size they gradually become united with the former. Cancers which are continued from some other point present a similar arrangement, and consequently often appear as if primary; all the more so because the new formation in the liver is often much more extensive than at its point of origin. On this account, before taking it for granted that a tumor is primary in the liver, it is necessary to examine carefully the neighboring organs, especially the gall-bladder, and the primary tumor will often be found in them.

In the case of *metastatic* cancers there are usually a number of isolated tumors present; they do not stand in the relation of maternal and filial nodules, but are of uniform size, so that no one of them can be looked upon as giving rise to the others. They proceed from primary tumors of different varieties; most frequently from cancer of the stomach, also from cancer of the uterus, rectum, breast, œsophagus; in fact, metastases from almost all recognized forms of cancer have been observed in the liver. Their microscopic structure consequently varies, as the cells and often the entire structure of the secondary nodules possess the same characteristics as those of the primary growth. The metastatic nodules arising from cancer of the stomach, uterus, rectum, and ovaries possess, therefore, cylindrical cells; those arising from

cancer of the œsophagus, cervical portion of the uterus, etc., are the so-called cancroids, while those arising from cancer of the breast are composed of irregular cancer cells resembling glandular epithelium.

Carcinoma of the liver may also be divided into hard cancer, which possesses an abundant stroma (*scirrhus*), and the soft or *medullary* forms ; the *telangiectatic* growth, which is a subdivision of the latter, also occurs here. All these, especially scirrhus, are liable to undergo central fatty degeneration and atrophy, in consequence of which the superficial nodules possess an umbilicated depression corresponding to the atrophy caused by the absorption of the fatty detritus from the centre. These fatty degenerated nodules present a peculiar variegated appearance on section, as yellow streaks alternate with medullary or gray ones (the cancer reticulatus of Johannes Müller).

The *cancer stroma* may be easily demonstrated by brushing the alveolar contents from thin sections; the resemblance is thus often seen between the stroma of the smaller nodules, and the network of liver capillaries with its minute quantity of surrounding fibrous tissue. It has already been proved that the growth of a great number of cancers takes place within the vessels.

The cancerous growth sometimes extends from the larger nodules into large branches of the hepatic vein ; these then become filled with a *cancerous thrombus*, which may be prolonged into the vena cava.

(*e.*) The metastatic *sarcomata*, *melanomata*, *etc.*, which occasionally occur in the liver, do not differ in any respect from similar growths existing elsewhere. The small *cavernous* tumors (cavernomata), which are easily recognized by their dark red color and bloody contents, have already been spoken of. Occasionally *small cysts* lined with ciliated epithelium, are found even in large numbers. These are supposed to be congenital and due to the cutting off and dilatation of portions of the bile-ducts. Cysts formed after birth also originate from partial dilatation of the bile-ducts

and are characterized by their tough fibrous walls, and by their contents; in the latter are found, at first at least, bile, cholesterine, and less frequently, concretions. Both forms are always situated directly beneath the capsule.

7. **Parasites** of the liver.

(*a.*) The most important of these are **echinococci,** the most common form of which is the *echinococcus unilocularis* that sometimes occurs alone and again in numbers, the size of the cyst varying from that of a small nut to that of a man's head. The substance of the liver appears to be arranged in concentric layers about the parasite, owing to the compression of the lobules, but it is separated by a fibrous tissue capsule of not more than one millimeter in thickness. This capsule is lined with a translucent, gelatinous echinococcus membrane, which is frequently several millimeters in thickness. The cyst contains a clear, watery fluid, and often a varying number of smaller cysts, usually as large as cherries, which are either sterile or dotted upon their inner surface with very small white points (the same occur in single cysts). These points are the scolices, within which, by the aid of the microscope, the head provided with suckers and a double row of hooklets may be seen inverted within a little cyst. It is possible in many cases, by slight pressure, to cause the head to protrude, so that the typical form of the cestoid, composed of head, neck, and cyst, is obtained. This is the appearance of living echinococci. When dead their appearance varies according to their age. The fluid first disappears and then the cyst is filled with a confused mass of membrane, which is always the most important guide in making a diagnosis from the gross appearances. Later, fatty degeneration follows, which begins at the periphery and finally leads to the filling of the cavity with a soft, yellow pulp in which remnants of membrane are still to be recognized. The fat then becomes absorbed, and lime salts appear in its place, a large or small cretaceous nodule being the sole remnant. The importance of this mass is indicated by the echinococcus hooklets, which are easily found by means of the microscope.

The whole sac may suppurate or become putrid as a result of various external causes (trauma, puncture, etc.), in which cases also the microscope is to be resorted to in making a correct diagnosis. In many cases, either recent or old hæmorrhages (hæmatoidine), pus, fibrous thickening, or calcification, are found upon the inner surface of the fibrous capsule, that is, between it and the actual cyst.

Another and much rarer form is the *echinococcus multilocularis*, which appears as a very firm, and rarely prominent tumor. This is composed of numerous cysts which are surrounded by a thick fibrous capsule, and contain a gelatinous mass in the form of lamellæ, but scolices are not always present. According to Virchow these cysts are developed within the lymph vessels.

(*b.*) A small worm, the *pentastomum denticulatum*, is occasionally met with upon the surface of the liver, and deserves merely a passing notice. It occurs as a little white cyst, with a very tough wall, one millimeter in thickness, flattened upon the surface but arched as it extends into the parenchyma; within this is a crumbled calcareous mass in which it is possible, after adding hydrochloric acid, to find the chitinous shell of the parasite, studded with rows of spines.

(*c.*) In closing the subject of parasites in the liver, the *distoma* may be mentioned. This occurs in the bile-ducts and usually gives rise to a severe fibrous inflammation.

9. THE PANCREAS.

After the removal of the stomach and the displacement downward of the transverse colon, the *pancreas* appears; both the outer surface and the interior are to be examined, the latter by making a longitudinal incision through the organ. The excretory duct is easily found in making this incision, and may then be laid open with the scissors; it is also easily found when the duodenum is examined.

On account of the slight pathological importance of the pancreas, only the most important changes which occur in the glandular tissue or the ducts will be considered.

(*a.*) *Morbid Conditions of the Parenchyma.*

The *normal* pancreas like all the salivary glands, possesses a coarsely granular appearance, firm consistency, and also a light yellow color; the latter has, however, a faintly reddish tinge soon after death, owing to an infiltration with blood-coloring matter.

1. A relatively frequent change in this organ is *atrophy*, which may be so extreme that only a thin band of fibrous tissue remains in its place, within which, possibly by the use of the microscope, small traces of the normal glandular tissue are still to be found here and there. The relatively frequent occurrence of atrophy in diabetes mellitus deserves mention. An *interstitial formation of fat*, similar to the fatty infiltration of muscle, occurs here, especially in cases where there is a general increase of the fatty tissue. This causes an atrophy of the gland substance, which is of a dirty yellowish-red color whenever it is still present.

2. A *parenchymatous* change similar to that occurring in the other abdominal glandular organs, takes place in the pancreas (in typhoid fever, etc.). In the earlier stages (during the first or second week) it is large, much reddened, and firm; later, however, it is pale, grayish-yellow, or even pure yellow, and very flaccid. In the latter stages the gland cells become fatty. Zenker has recently described peculiar cases, where sudden death was apparently caused by a *hæmorrhage* into the pancreas, which, in certain instances, had undergone complete fatty degeneration.

3. *Purulent interstitial inflammation* seldom occurs, but suppuration around the gland is more frequent (proceeding from lymphatic glands, *peripancreatitis apostematosa*). Fibrous interstitial inflammation on the other hand (*pancreatitis interstitialis chronica fibrosa*) is quite common in cases of hereditary syphilis. Under such circumstances the gland loses more or less of its granular structure, its surface being smooth and usually of a grayish color, and its consistency so firm that it grates under the knife. It has already been

mentioned, in speaking of gastric ulcer, that the pancreas frequently become adherent to the stomach, thus preventing perforation. A circumscribed inflammation is set up in it by the extension of the ulcer, so that its contiguous surface becomes converted into a smooth fibrous mass.

4. Among the different variations of *tumors* which occur in the pancreas, are tubercles and gummata, both of which are extremely rare, and *carcinoma*, which is the most common. The latter is seldom metastatic, but usually extends from neighboring parts, especially the stomach, or is primary. The favorite seat of the latter form is in the head, and it is very liable to extend from here to the duodenum. The epigastric glands then quickly become involved, and the pylorus lies so near that it often requires a very careful examination in order to discover the true seat of the growth. Several incisions must therefore be made through the head of the pancreas, in order to see if the normal granular structure may not still be observed. Most of these cancers belong to the scirrhous variety, and their microscopic examination is made in the usual manner.

5. Peculiar *congenital malformations* sometimes occur here in the form of small *supplementary spleens* inclosed within its head, or of isolated portions of the pancreas in the walls of the duodenum (supplementary pancreas), and less frequently in those of the jejunum or stomach.

6. *Amyloid degeneration* of the pancreas occurs under the usual conditions, and affects principally the vessels of the interstitial tissue.

(*b.*) *Morbid Conditions of the Excretory Ducts.*

The most frequent affection of the excretory ducts is the *formation of cysts.* First, those liable to be confounded with abscesses, which are small, varying from the size of a millet-grain to that of a bean, and are sometimes filled with a clear, watery, and at other times yellow and even thick contents. These are often multiple and arranged in groups, — retention cysts of the interlobular ducts which are filled with

catarrhal secretion (*acne pancreatica*). Then the chief excretory duct becomes dilated, usually owing to its being closed by a tumor, or by the contraction of a cicatrix (*ranula pancreatica*). This dilatation may involve either the entire duct (varicose dilatation), or only that portion lying behind the constriction (cystic dilatation). The glandular tissue is usually atrophied in such cases. Frequently the dilated duct contains small concretions (*pancreatic calculi*), which are chiefly composed of phosphate and carbonate of lime.

10. THE CŒLIAC GANGLION.

The examination of the cœliac ganglion follows that of the pancreas ; it lies above this organ, around the cœliac axis, and upon the aorta, below and in front of the aortic opening in the diaphragm. Generally there is but little to see with the naked eye ; still it is important to notice the condition of the surrounding fibrous tissue (chronic inflammation), and the color of the ganglion, which is brown when there is great pigmentation of the ganglion cells. According to Rokitansky, it is very hyperæmic, and even hæmorrhagic at times in typhoid fever, cholera, etc. *Atrophy* of the ganglion accompanies chronic inflammation of the fibrous tissue about the neighboring supra-renal capsules in certain cases of Addison's disease, and has already been referred to in connection with the latter affection. It has also been found atrophied in diabetes mellitus. In all cachexias the *nerve cells* present a considerable increase in the *brown pigment granules*, which they normally contain, and the cells are also atrophied, the nuclei disappear, etc. The pigment is also increased in old age. The *vessels* of the ganglion become affected by *amyloid* degeneration, but only in extreme cases where the disease is general.

11. THE MESENTERY.

The examination of the mesentery is to be made before that of the large and small intestine. It varies in *thickness*, according to the amount of fat present, and may become as thick as the fingers. It varies greatly in form and length,

along the large intestine, where it is not attached throughout. In many cases it is even a foot in length, especially at the sigmoid flexure, and then readily becomes twisted.

(*a.*) *Morbid Conditions of the Mesenteric Fibrous Tissue.*

The mesentery, like all the abdominal connective tissue, is the seat of *hæmorrhage* in poisoning with phosphorus, in acute atrophy of the liver, etc., and of *phlegmonous* swelling in malignant pustule, etc. One of the commonest affections is *circumscribed chronic inflammation* (mesenteritis), leading to the formation of radiating, contractive, cicatricial tissue, which occurs in the mesentery of the small, and especially of the large intestine. That of the sigmoid flexure is very marked in this respect.

The affections of the peritoneal covering, especially *tuberculosis* and *carcinoma*, have already been considered in connection with the parietal peritoneum, and they are only mentioned here to prevent their being confounded with small multiple, fatty papillæ, which so stud the mesentery in some cases, that the latter has a velvety appearance. The mesentery is occasionally the seat of larger tumors, among which are the *fibroma*, *fibrosarcoma*, *dermoid* and *vascular tumors* (*chylangioma*), etc.

(*b.*) *Morbid Conditions of the Mesenteric Glands.*

The *lymph* apparatus within the mesentery of the small intestine, both vessels and glands, is possessed of great interest, as it takes part in nearly all affections of the intestinal canal. All the inflammatory intestinal diseases may be accompanied by *swelling* and *marked redness* (hyperæmia) of these mesenteric lymph-glands; these alterations occur most frequently in typhoid fever and tuberculosis, where the changes in the glands are of a like specific character. The *typhoid* process leads to extreme swelling, which involves the glands in succession, beginning with those in the neighborhood of the ileo-cæcal valve (*ileo-cæcal chain*). Typhoid glands attain the size of pigeons' eggs, are very soft, juicy,

sometimes much reddened, and again paler and more grayish, so that they present the so-called medullary appearance. The enlargement is due to a hyperplasia of the cells, as may be easily seen by teasing bits of gland in a one per-cent. solution of common salt, and examining them with the microscope; an abnormally large number of multinucleated cells are also found, especially large round forms which often contain from twelve to fifteen nuclei. Beside these, there are the very peculiar cells containing red-blood corpuscles, probably due to the continued hyperæmia and consequent slight hæmorrhages.

The typhoid process usually causes no other changes than the medullary swelling, but still cases occur where larger or smaller portions of the glandular parenchyma become of a yellow color, and are sometimes in a state of complete softening. This partial necrosis of the parenchyma is the result of a compression of the blood-vessels by the constantly increasing number of cells. In microscopic preparations made from such parts, fatty degenerated cells and fat granules (fatty detritus) are found.

In *tuberculous* affections of the mesenteric glands, the manner in which the process advances from the intestine towards the root of the mesentery may also be easily seen; it is always the row of glands which is nearest the intestine that first presents the tubercular eruption or the greatest changes. The connection between them and tuberculous ulcers of the intestine is very often made apparent by the development of tubercles in the walls of the lymph vessels (lacteals), which run from the intestine to the affected gland, and by chronic inflammation combined with thickening of their walls. These vessels are sometimes very sharply defined, and even distended by yellowish-white contents — retained chyle, — its flow being obstructed by the development of tubercles in the walls. This retention of chyle may also occur alone, when, of course, the nodular thickening of the walls is not present.

The tubercles first appear in the cortical portion of the

glands, but the medullary portion is not exempt, and as they undergo cheesy degeneration, the former in the first place, and then the latter, the whole glandular parenchyma may become converted into a homogeneous, yellow, cheesy mass. The glands are then enlarged, but usually not so much so as in typhoid fever, or in the so-called *scrofulous affection* of the glands, which is most frequently found in children (*tabes mesenterica*), and which is very closely allied to tuberculosis (considered by many to be identical). In this affection the glands also become cheesy, and at the same time much enlarged (in children they become as large as pigeons' eggs, and in adults still larger). The largest nodules are formed by the confluence of a number of glands, and are frequently seated in the root of the mesentery. They appear so firm, homogeneous, and yellow upon section, that Virchow has compared the appearance of the surface with the section of a raw potato, the moisture only being absent. This cheesy material softens, often assuming a greenish tinge; that the softening arises in the centre is evinced by the presence of a still firm, cheesy capsule, completely surrounding the mass.

This cheesy substance may become *calcified*, as in the lungs and bronchial glands, and the frequently irregular cretified masses, which replace either a part or the whole of the glands, call attention to the processes which they have passed through.

Differing from these affections, which advance from the intestine towards the root of the mesentery, are others which first involve the glands situated nearest the root. Among these are *leucæmia* and *pseudo-leucæmia* (adénie of the French, malignant lymphosarcoma, Hodgkins' disease), and the changes produced in *malignant pustule*. In these diseases the glands undergo the same changes as those which have been described as occurring in the bronchial and tracheal glands.

Carcinoma of the glands is rather rare, and is readily recognized by its usual characteristics. In extreme cases

of *amyloid degeneration* the mesenteric, like other lymph glands, become involved. This change is recognized by their pallor, translucent gray color, firm consistency, and the brown color produced by iodine.

(*c.*) *Morbid Conditions of the Large Mesenteric Blood-Vessels.*

The contents of the large blood-vessels of the mesentery are sometimes liable to changes (*thrombosis*) which oftener originate in the portal vein (in cirrhosis of the liver, etc.), than in the intestine (ulcers). *Embolism* and *aneurisms* rarely occur here; the latter, when present, are usually seated near the point of origin of the primary branches of the superior mesenteric artery.

12. THE INTESTINE.

(*a.*) External Examination.

The large and small intestines are to be examined in connection, with regard both to their general condition, and, especially, to that of the serous coat.

1. *General Appearances.*

The *size* of the intestinal canal depends upon two conditions, the quantity of the contents and the degree of contraction of the muscular coat. The contents may be either fæcal matter or gas (meteorism); the presence of fluid fæcal matter may be recognized by the weight, and the peculiar gurgling produced by raising a coil of intestine. Of course the greatest degree of distention occurs when there is a relaxation of the muscular fibres in connection with an increase of the contents, as is the case, for instance, in cholera, above strictures, etc. Paralysis of the muscular coat is always present also in acute peritonitis. On the other hand, strong contraction of the muscular coat prevents distention from the contents, and even lessens the calibre of the intestine, as is seen in very recent cases of severe intestinal inflammation, in paralysis of the insane (starvation), etc.

The *color* of the exterior depends upon the degree of dis-

tention, contents, and amount of blood present. Other things being equal, the greater the distention, the paler and the more grayish-white is the color; if the fæces are colored with bile, the intestine presents a yellowish or brownish color, the intensity of which is proportionate to the color of the former; and if much blood is mingled with the contents it will be indicated by a faded red color of the walls. This color is distinguished from that of hyperæmia, which appears, for instance, in severe inflammation, stasis, etc., by its diffuse, pale character, while in hyperæmia the injected vessels are always easily recognized. The hyperæmic vessels do not, however, always lie near the surface only, but are faintly seen in the deeper portions (mucous and submucous coats), in cholera, for example, while in other instances the hyperæmia is principally confined to the superficial subserous vessels. This latter condition indicates that the cause of the trouble is local, and exists within the abdominal cavity (peritonitis). Not only the acute, but also the severe chronic inflammations may be frequently recognized by the dark color of the outer wall, for instance, in dysentery; these cases are also distinguished by the deep seat of the color from those superficial slaty discolorations, which have been described elsewhere as the results of chronic peritonitis.

2. *Changes in the Peritoneal Coat.*

The affections of the serous coat of the intestines, which is merely a part of the general lining of the abdominal cavity, do not differ from those of the peritoneum which have already been described. This layer takes a prominent part in all general inflammatory, tuberculous, and cancerous processes. It may be mentioned, in addition, that in extensive adhesive inflammation, for instance, in such as is produced by diffuse cancer, all the coils of intestine may be so bound together in one large mass, that it is impossible to trace the separate ones. It is then necessary, in order to obtain any idea of their relations, to make one or more incisions through the centre of the mass.

The circumscribed changes which result from deep ulcers of the mucous membrane are not less important than those extending over large areas. Such ulcers occur in typhoid fever and tuberculosis. The *tuberculous* forms, which usually run a very chronic course, generally produce changes upon the surface, which, when extensive, consist of rounded, circumscribed spots, thickening of the peritoneum, of a dark or bluish-red color, and an outgrowth of small gray tubercles. The peritoneal tubercles offer the strongest proof of the nature of the process in the mucous membrane, and extend much further in all directions than the other changes. This extension always takes place with great regularity, following the course of small, gray, branched and arborescent vessels (lacteals), which run from the usual seat of the ulcer, opposite the attachment of the mesentery, toward the latter, uniting in their course to form larger branches. It has already been stated, in speaking of the affections of the mesentery, that the tubercles, following the course of the lymph vessels (lacteals), may extend as far as the mesenteric glands. If the tuberculous nodules of the peritoneum are closely examined, it cannot be doubted that they originated from a point corresponding to the seat of the ulcer, because they are greatest in number and size here, and have already become opaque, or even cheesy in the centre; they become smaller, more isolated, and translucent, that is, younger, the further they are situated from this point. In the large intestine, the ulcers do not exhibit the same regularity in regard to their seat, but the growth of the tubercles takes place in those parts where the serous coat is absent, namely, in the fibrous tissue which lies in immediate contact with the intestinal wall. The same is the case with the newly formed fibrous tissue, the peritonitic membranes, which sometimes appear at the seat of tuberculous ulcers; thus offering an indication that the tubercles are formed here secondarily, and become a relatively late associate of the ulcer.

When the ulcers extend very widely and deeply, another alteration arises at a point corresponding with the deepest

portion of the ulcer; this is a *necrosis* of the serous coat, which may very readily cause its complete destruction, and thus gives rise to a perforation of the intestine. The necrotic portion is soft, of a dirty yellow color, and is very rarely more than one centimeter in diameter.

The *typhoid* process generally runs a much more rapid course than the tuberculous affection, and produces much less frequent and extensive alterations of the outer surface of the intestine, especially those of a circumscribed character, since the intestine as a whole, and particularly its vessels, are more often involved. The places where the ulcers are situated are indicated by a somewhat greater redness; but in the rare instances where they extend very deeply down to the serous coat, the latter becomes necrotic and perforation results, as in the case just mentioned of the tuberculous process. There are no tubercles, however; while these are always present when the ulcer is tuberculous. This means of distinguishing the two is not always a sure guide, since there are exceptional cases of typhoid fever in which small gray nodules (typhoid lymphomata) are developed in the serous coat of the intestine, as well as in the liver, kidneys, etc.; the diagnosis might become doubtful were it not that the medullary swelling of the mesenteric glands indicates the actual condition.

The changes produced upon the external surface of the intestine by strangulation, also proceed from a circumscribed region, but still are expanded over a somewhat large extent. The surface nearest the point of strangulation, is of a faded dark-red or violet color, which is diffused over a much greater area above the seat of the stricture than below it, but gradually diminishes towards the more distant portions of the intestine. If the strangulation has existed for a long time, the intestinal walls become rotten, necrotic, and perforation may have occurred.

The alterations may finally be mentioned, which often take place in the coils of intestine which form a part of the walls of an encapsulated peritonitic abscess or ichorus cavity.

The changes may be limited to a simple thickening of the serous coat; or an *ulceration* may take place, especially when the contents of the cavity are septic, and by constantly extending, finally cause perforation. In order to determine whether perforation has taken place from within or without, the different layers of the intestine are to be closely examined. As the ulcer does not extend directly through, but usually has a terraced appearance, the layer which is last perforated will present the least amount of ulceration; hence, if the perforation has advanced from within, the serous coat will be but slightly altered, while if it has taken place from without, the peritoneum will be more diseased than the muscular and mucous coats, which are last perforated.

There is but little to state with regard to *tumors*, which are limited to the surface of the intestine. It is well known that the appendices epiploicæ of the large intestine may become abnormally enlarged, and thus form actual lipomata.

The most common *congenital* alterations are the diverticulum ilei, and the pouches of the colon resembling diverticula. The *diverticulum of the small intestine* is usually situated at the beginning of the ileum; it is sometimes very short and narrow, and again as wide as the intestine itself and several inches long. The free end is either simply rounded, or (less frequently) terminates in two small rounded ends. Its mucous membrane is like that in the rest of the intestine, and is subject to the same affections.

The so-called *diverticula of the colon* never attain a very large size, being usually of the size of beans, never larger than cherries, and are due to marked projection of the longitudinal and transverse folds.

Congenital abnormal openings (*fistulæ congenitæ*) and *obliterations* of the intestine usually occur in connection with other malformations in non-viable monstrosities.

(*b.*) Method of Opening the Intestine.

After the examination of the exterior of the intestine is completed, and also that of the vermiform appendage, the

small and large intestine are to be removed in continuity. This is best done by separating the large intestine from its mesentery and the adjoining fibrous tissue, beginning at the cæcum and keeping close to the wall of the intestine, and laying the latter between the thighs of the person. The cæcum is then to be seized, and the small intestine freed from its mesentery, proceeding from below upwards, and cutting as near the intestine as possible. This separation is accomplished by making the intestine tense with the left hand, and holding the knife like a violin-bow, while the stretched mesentery is cut through with a sawing motion. The edge of the knife must be somewhat turned towards the intestine, in order to prevent its following the direction of the traction, which would leave small bits of the mesentery attached ; these would later prove to be troublesome, when the intestine is opened, because they prevent the intestine from being straightened. The detachment is to take place as far as the duodenum, and as much of the ascending portion of the latter is to be removed as possible. The intestines should be laid at the left of the body that they may be more conveniently handled ; the upper end is to be seized, and they are to be opened from here with the large blunt-pointed shears or enterotome. The small intestine is to be cut through along the mesenteric attachment (because Peyer's patches, and the possible important affections of them, are situated opposite this), and the colon along one of the three longitudinal bands, the so-called tæniæ. During this operation, which is performed by simply drawing the intestine through the firmly held, half-opened enterotome, the left cut edge of the intestine is to be held between the thumb and forefinger of the left hand, while the remaining fingers are separated so that the opened portion may be immediately spread over them and its contents examined. In all cases where it is desired to examine the contents of any particular portion (for instance, the upper portion of the small intestine for trichinæ), they must be collected at once. In medico-legal cases, both ends of such a portion

ought to be ligated, to prevent any of the contents from being lost or mixed with other substances. When the intestines have been wholly opened the bulk of the contents is to be removed by beginning at the rectum, and drawing the intestine between the second and third fingers of the left hand, which are outspread or approximated as may be necessary. Those portions which are freed from their contents are to be placed directly in a dish or pail containing water, to be more thoroughly cleansed, and the upper end of the small intestine is to be left hanging over the edge of the vessel, that it may be easily found when the intestine is more closely examined. As soon as it is washed it is to be again drawn between the two fingers of the left hand, but now from above downwards with the mucous membrane uppermost, in order that the different portions may be accurately examined.

In many cases, another method, used by the butchers, may be employed; it consists in turning the intestines completely inside out without opening them, so that the mucous membrane lies without and the serous coat within. This may be easily done by everting a small portion of the upper extremity of the small intestine like a cuff, and directing a strong stream of water into the groove thus formed. The eversion then constantly progresses till finally the mucous surface of the whole intestine, or at least of the entire small intestine, is turned outwards.

(*c.*) The Contents of the Intestine.

In examining the contents of the intestine, attention is to be paid to their general characteristics, and to any abnormal admixture. With regard to the former, the quantity, color, consistency, and odor are to be noted; of the admixtures, there may be those arising from the food, from the individual himself, or from parasites.

1. *General Appearances.*

The quantity of the contents depends both upon the amount of food taken and that expelled, also upon the quan-

tity of exudation from the intestinal walls. If the small intestine contains much partially digested food, it is an indication that nourishment has been taken within a short time; copious masses in the large intestine, especially when very hard and rounded, forming scybala, indicate sluggish evacuation, constipation, or coprostasis. An abnormally small quantity of intestinal contents indicates that but little food has been taken; when the contents are copious and abnormally liquid, they are due to exudation from the walls; fluid contents in the large intestine, instead of the normal pulp in the upper portion, and the firm masses in the lower, indicate that diarrhœa existed.

The *color* depends essentially upon the quantity of bile present; when the latter is entirely absent (icterus), the fæces are gray. When blood is present, the color is light or dark red, according to the quantity, or it may even be perfectly black, as is also the case when certain drugs, especially iron, have been given. Calomel stains the intestinal contents dark green. Typhoid stools have a peculiar yellow color, resembling pea-soup, and those in cholera are whitish, resembling rice-water.

The *consistency* varies from a watery condition to a stony hardness. Cholera stools are the most liquid (rice-water), and typhoid evacuations are pulpy. In very severe constipation (coprostasis), small round fæcal masses of almost stony hardness are found in the pouches of the colon.

The *odor* depends wholly upon the quantity of fæcal matter: fresh cholera stools are entirely free from smell; the thin stools of dysentery have a very offensive odor; those in typhoid fever possess but little odor, while the gray stools in jaundice have a most offensive stench.

2. *Abnormal Constituents.*

Among the abnormal constituents which arise from *indigestible food*, are peculiar round balls of fat, which resemble the large balls of caseine found in the stomachs of children; when found in adults they represent undigested, and spheri-

cally moulded fat. The remains of animal food, undigested portions of fruit (seeds, orange peel), etc., may also be found.

The abnormal ingredients *arising from the body* may be either secretions (mucus, especially in the small intestine), or desquamated epithelium (for instance, the white flakes that give the peculiar appearance to the cholera stools [post-mortem]), or strips of mucous membrane, such as are present in many forms of dysentery. Finally, fæcal concretions (see vermiform appendage), gall-stones, etc., are sometimes found. Blood is found in connection with ulcers, especially the dysenteric and typhoid forms, and in extreme passive congestion, particularly in cirrhosis of the liver. In these cases it is often impossible to discover the point at which the blood escapes from the vessels, as it usually comes from a great number of small ones. It is then intimately mixed with the contents, as has been mentioned in connection with the stomach, while considerable masses arise when the hemorrhage comes from a large vessel.

The most interesting of the **parasites,** on account of their bearing upon the life of the individual, are *trichinæ*, which remain but temporarily in the intestine. They are almost wholly confined to the upper part of the small intestine, and consequently, when their existence is suspected, the greatest care must be exercised in looking for them. Their sexual organs become fully developed about eight days after the meat containing the trichinæ has been eaten, and they then begin to discharge their young, which immediately leave the intestine and migrate into the muscles. The females (some three millimeters in length) may be easily distinguished from the smaller males (about one and a half millimeters long) not only by their greater size, but by the presence of young in them. The breeding period lasts from four to five weeks, but solitary individuals have been found in the intestine at a still later period. In endeavoring to find them, it is sufficient to dilute a drop of the intestinal contents with a little water, and examine it thoroughly with a

low power; still it is possible, even with the naked eye, to recognize them, especially the females, by bearing in mind what has already been stated.

There are three varieties of *cestoid* parasites: the tænia solium, tænia mediocannelata, and the bothryocephalus dispar, all of which usually live in the jejunum.

The *tænia solium*, the most common and smallest of these (two to three meters long), originates from the cysticercus cellulosæ of swine. The head, which is as large as that of a pin, is provided with four lateral suckers, and has a protuberance (rostrum) on the top, armed with a row of hooklets. When the individuals are old the suckers and rostrum become black. Next the head is a very narrow neck, about one inch in length, composed of joints which can only be recognized with the microscope. The joints of the body nearest the neck are wider than they are long, about one meter from the head they become square, and further along the length exceeds the width. The genital opening is situated on the alternate sides of the joints, and the uterus has from seven to ten lateral branches. Cyst-like, dropsical projections are often seen on single joints, especially at the point where the genital opening is situated.

The *tænia mediocannelata* may be four meters in length, and also has four suckers, but is destitute of the rostrum and hooklets, so that the head is plumper in shape. The black pigmentation on the heads of old individuals is usually very intense. The joints increase at first more rapidly in width than in length, but those which are mature are much longer than wide; the genital opening is at the side, a little below the middle and is found in alternate joints. Twenty to twenty-five branches extend from each side of the uterus.

The *bothryocephalus latus* may attain a length of five to eight meters. The head is elongated, club-shaped, flattened from side to side at right angles with the joints, and has two long, grooved suckers without hooklets, which are situated on the narrowest surfaces. The width of the joints (twenty-four millimeters) greatly exceeds their length (three to three

and a half millimeters), and the separated sexual openings are upon one of the flat sides, while the uterus is a small dark body resembling a rosette. Single joints are sometimes perforated (fenestrated) owing to the rupture of excessively distended ovaries. In this manner one or even a number of contiguous joints may be so completely divided as to give them the appearance of being double.

The commonest of the larger intestinal parasites are the *lumbricoid worms* (ascaris lumbricoides) which belong to the class of round worms, and may be easily recognized by their resemblance to earth-worms. They live in the middle of the small intestine, but frequently appear in the duodenum and even in the stomach.

The class of round worms also includes the *oxyuris vermicularis*, which inhabits the rectum but sometimes ascends higher, rarely as far as the small intestine. It is cylindrical in shape, has a narrow neck and a vesicular projection of the chitinous covering at the cephalic end. The male is four millimeters in length and has a rounded tail, while that of the female (whose length is ten millimeters) is long and pointed. The females are much more numerous, and owing to their size are more readily seen than the males. They are most easily discovered by spreading the mucus from the large intestine upon a glass slide and examining it by transmitted light.

The *long thread-worm* (*trichocephalus dispar*) which occurs in small numbers in the cæcum, is another of this class of round worms. They are from forty to fifty millimeters long, the males being somewhat smaller than the females. The anterior portion of the body is thread-like, and usually firmly adherent to the intestinal surface; the posterior is about one millimeter thick, in the male coiled in the form of a spiral and containing the prepuce and penis, while in the female this end is comparatively straight.

The *cercomonas intestinalis* belongs to the class of infusoria, and may be described as an oblong, oval animalcule 0.018–0.011 millimeter long, and 0.009–0.011 millimeter

wide, rounded at one end and provided with a slender thread-like appendage at the other. They are especially found in the dejections of typhoid fever and cholera, and frequently show active movements. The balantidium coli has also been observed, though but a few times. This animalcule is small, cylindrical, the anterior extremity egg-shaped, the mouth lateral; it is entirely covered with ciliated epithelium, and in its finely granular body is a nucleus and contractile vesicles. There are still other varieties of infusorial animalcules which occasionally occur in the intestinal contents.

In addition to the animal parasites *vegetable* organisms are always present in the intestine, belonging to the group *schistomycetes*, which has recently become so important. Both the small spherical forms (micrococci), and the rod-like forms (bacteria) occur in every drop of the intestinal contents and in very large numbers, especially in cases of diarrhœa. They are present in extremely large quantities in the intestinal contents of those dead from cholera, and are found also equally numerous, and apparently possessing the same characteristics, for example, in the liquid contents in cases of arsenical poisoning. There is only one intestinal affection in which the same typical forms constantly occur, namely, mycosis intestinalis, which must be considered from recent investigations as a form of *malignant pustule*. The parasites appear only in circumscribed portions of the mucous membrane, which present definite visible alterations. These organisms are long narrow rods (bacteridia), which unite in forming long, single, motionless threads, that are entangled with each other in a very complex manner. Of course large colonies of micrococci often occur in addition to these, which appear to stand in close genetic relation to the rods. The highest powers (immersion) are required in examining these micrococci in order to obtain accurate results; still medium powers (Hartnack's No. 7) enable a somewhat trained eye to recognize them. With reference to distinguishing the rods from the granules, the mistake may be again mentioned, which results from considering the trans-

verse sections of the rods turned towards the observer, as globules which they then resemble. By moving the bodies the deception may easily be prevented.

(*d.*) The Walls of the Intestine.

In examining the intestinal walls especial attention is to be paid to the villi, folds (valvulæ conniventes), solitary and agminated follicles (Peyer's patches).

1. *General Characteristics.*

(*a.*) An *increase in the thickness* of the whole intestinal wall, and also of its separate layers, is frequently observed. A thickening of all the coats over a large area is a frequent result of general chronic peritonitis; the same occurs in a circumscribed form in the vicinity of chronic ulcers, etc. Hypertrophy of the muscular coat accompanies chronic ulcerating processes, tumors, etc., in a similar manner as in the rectum.

Thickening of the mucous and submucous layers alone, or of certain portions of them, is more frequent. The swelling is either purely œdematous, when it has a soft, gelatinous appearance, or it is caused by an increase in the solid elements, producing a more opaque and grayish color. Simple swelling is indicated in the small intestine, especially by an elongation and thickening of the *folds*, and by the formation of folds where none normally exist (ileum). Swelling of the mucous membrane in the lower portion of the ileum may be diagnosticated by such folds alone.

Enlargement of the *villi* is usually due to an increase in their morphological parts, especially of the epithelium in catarrh, or to a cellular infiltration of the substance. They may be easily recognized with the naked eye, in such cases, as small gray bodies, which are movable in various directions, while in the normal condition the individual villi can only be recognized with difficulty, and their presence can only be inferred from the general velvety appearance of the surface of the mucous membrane.

Swelling of the *follicles* also depends upon an increase in the tissue elements. The normal solitary and agminated follicles are often just capable of recognition, as small round bodies, projecting but slightly, or not at all, above the surface. When they are distinctly seen at the first glance, therefore, it is generally safe to conclude that they are enlarged. They attain the size of a pin's head, when swollen, or that of a millet-grain (in catarrh, cholera, etc.), or even become as large as peas (in typhoid fever). When Peyer's patches are enlarged, either the follicles alone are swollen, or there exists also a swelling of the interfollicular substance (in extreme cases of typhoid fever). Swelling of the interfollicular substance also occurs alone, without that of the follicles (in simple catarrh), the patches then present a reticulated appearance (surface reticulée). This condition also occurs in the stage of resolution of typhoid fever, but, according to Virchow's teaching, is often a post-mortem condition, due to the rupture of the follicles and the discharge of their contents into the intestine.

(*b.*) The normal *color* of the mucous membrane itself is a light gray, but is modified at times by the amount of blood present, and, again, by the nature of the contents. The discoloration produced by the latter is more commonly owing to the presence of bile or blood, sometimes also to drugs which give rise to a black color, as has already been mentioned. The *quantity of blood* in the walls produces different shades, according as the capillaries (a uniform red color), or the branches of the vessels (distinct red lines), or both together (uniform dark-red color with distinct red lines) are filled. When there is a complete absence of blood, the gray color belonging to the mucous membrane appears, a condition suggestive of amyloid degeneration, when it is apparently not due to general anæmia.

Preëxisting congestions are indicated by a slaty color, sometimes confined to the villi, which then appear as little movable black points, or to the follicles, within which a black point is then visible. The mucous membrane and

villi of the small intestine, or the mucous membrane of the large intestine, may present this slaty color, while the follicles appear as very distinct gray bodies. Finally, Peyer's patches may be alone pigmented, the follicles or the interfollicular tissue being affected. By careful examination, the black discoloration of the mucous membrane, especially in the large intestine, is seen to be in the form of a net-work; the non-pigmented spaces being the glandular openings, as may be easily seen by examining horizontal sections, made with scissors, under the microscope. A white spotted appearance of the intestine, especially of the upper portion of the jejunum, is produced by the retention of chyle in the villi. The connection of these spots with the villi may be shown by moving them to and fro; when they are examined microscopically, they are often seen to be clubbed at their ends, and to contain fat molecules with dark outlines.

2. *Special Morbid Conditions.*

In treating of the separate affections of the intestine the alterations proceeding from the vessels will be considered first.

(*a.*) **Hæmorrhage** may accompany all affections which are characterized by a distention of the vessels, whether the hyperæmia is due to obstruction or to inflammation. The circumscribed forms occur more frequently at the edges of ulcers, whether the latter are of tuberculous, typhoid, or diphtheritic origin. They also result from obstruction of the vessels in cases of endocarditis ulcerosa. They then occur in connection with *embolic abscesses*, even actually continuous with them, so that the small abscesses are surrounded by a hæmorrhagic ring. These forms are distinguished from the preceding by the presence of the obstructed vessel in their centre (particularly well seen when the intestine is made tense and observed by transmitted light), the vessel giving rise to a decided prominence. The size of the embolic abscess varies from that of a mere point to that of a pea, and they are easily distinguished from other abscesses

by their connection with the vessels. *Embolic ulcers* result from the rupture of these abscesses into the intestine, and their origin is diagnosticated from the association with the abscesses. When the emboli are benign, abscesses do not occur, but the extravasated blood and the embolus become converted into a dark-red, hard body, the centre of which is often decolorized, the whole resembling a recent phlebolite. Such an appearance is often found when the trouble from which it arose no longer exists, at least is no longer apparent. Very similar alterations occur as the result of small *varices* of the intestinal veins, which may extend over large areas, and when filled with thrombi, may be very easily mistaken for emboli; careful examination of the arterial or venous nature of the affected vessels will determine this point.

The embolic nodules resulting from malignant endocarditis may exist by the hundred throughout the entire intestine, and, like those occurring elsewhere from the same cause, contain emboli which are composed of micrococci. These may be easily recognized by making as thin sections as possible from the inflamed part with the scissors, teasing them somewhat, and treating them with acetic acid. The micrococci will then be often found as large masses filling the arteries.

(*b*). **Inflammation.** 1. The appearances of **intestinal catarrh** (*enteritis catarrhalis*), which is sometimes confined to limited portions, and again is general, do not differ essentially from those of catarrh of the stomach. *Simple*, *acute*, or *purulent catarrh* is indicated by a reddening of the mucous membrane with slight swelling, the secretion of a tough vitreous or gelatinous mucus (especially in children), proliferation of the epithelium, which causes the villi to appear thickened and somewhat opaque, and in certain cases by the secretion of pus. *Chronic catarrh* is also usually indicated here by a slaty discoloration. When it has existed for a very long time, the mucous membrane appears thickened, and is often smooth, firm, and gray. Proliferating inflammation, such as has been described as occurring in the stomach, is

less often found here, and then occurs principally in the colon (*colitis prolifera vel polyposa*); a circumscribed form is found more frequently in the small intestine also, around chronic ulcers, especially those of a tuberculous or dysenteric origin.

Another rare form of chronic inflammation of the mucous membrane is met with, which, like the proliferating affection, attacks the large intestine chiefly, and occurs especially in *chronic dysentery*. The mucous membrane is decidedly thickened, and small mucous cysts are often formed in great quantity. These are produced by a swelling of the intertubular tissue, especially near the surface, so that the mouths of the tubular glands become constricted or completely closed; a retention of the secretion follows, and finally, cystic dilatation of the deeper portions of the gland (*enteritis chronica cystica*). The mucus may be easily pressed from those glands which are not completely closed, and the entrance to the little cavity may then be seen with the unaided eye. It is difficult to make a microscopic examination of this condition in fresh preparations, although the infiltration of the mucous membrane with small cells, and the displacement and dilatation of individual tubules may be seen in very thin sections made with the scissors or double knife.

2. Deep seated inflammation of the mucous and the submucous coats (*enteritis phlegmonosa*), is rare here as in the stomach, and is confined almost wholly to cases of an infective nature. The affections (*mycosis intestinalis*) allied to malignant pustule also occur here, and more frequently than in the stomach. They are characterized by marked, circumscribed, phlegmonous swelling of the mucous membrane, (around the fungous growths), and by necrotic destruction of the surface and the formations of ulcers. The development of the typical bacteridia of malignant pustule (in the form of the previously described long threads), and also of micrococci, is not confined to the surface, but extends into the tissue, where masses of these organisms are sometimes very plainly seen in the vessels of the submucous layer.

Secondary purulent inflammation is met with in the submucous tissue, associated with follicular abscesses, and due to an extension of the latter into the surrounding parts. Extensive submucous suppuration, with detachment of the mucous membrane, may thus occur.

3. **Enteritis follicularis.** Inflammatory changes in the *follicles*, whether in the solitary, or agminated, or in both together, are associated with most inflammations of the mucous membrane. In many cases the follicles themselves are especially altered. They are swollen in simple inflammation, often from mere œdema, and are then translucent, like small pearls; more often the swelling is due to an increase in their cells, when they are light gray and opaque. They present the frequently mentioned slate color in chronic catarrh. They become still more swollen in the higher degrees of acute inflammation, and are finally converted through suppuration into small abscesses (*follicular abscesses*). When the latter break into the intestine, the *follicular ulcers* are produced. These are evidently small (*lenticular*), and have sinuous edges which are elevated when water is poured into the cavity, owing to the fact that perforation takes place only at the top of the abscess, without destroying the whole covering.

The suppuration is, of course, not confined to the glands, but extends further, especially into the submucous layer, so that large areas of mucous membrane are loosened from their bed. Neighboring abscesses may unite, thus leaving bridges of mucous membrane, under which a probe may often be passed for a long distance. These severe forms are most common in the large intestine, in so-called *follicular dysentery*. They are then usually combined with the already described chronic inflammation of the mucous membrane.

Besides the above affections, which form a part of the changes occurring in *dysentery*, there is still another to be mentioned, namely: —

4. **Diphtheritic inflammation** of the intestine. This occurs either alone or combined with the previous changes, and

constitutes the second anatomical form, *diphtheritic dysentery.* It is also principally confined to the large intestine, although it may extend far into the ileum in extreme cases. The anatomical changes are such as have already been described in connection with the rectum, and generally diminish in intensity from below upwards. The inflammation begins as grayish bran-like spots on the surface of the mucous membrane, accompanied by marked swelling of the mucous and submucous layers, owing to an acute (erysipelatous) œdema. These spots then become united, and the subjacent tissue becomes affected (infiltration of the mucous membrane) ; superficial necrosis and ulcers follow, and the base of the latter becomes in turn diphtheritic, so that by the constant extension of the necrosis, the ulcers increase both in size and depth, till, finally, in rare cases, the whole thickness of the walls is destroyed and perforation results. The gray color of the small deposits becomes yellow, or greenish-yellow as the infiltration advances, owing to the absorption of biliary coloring matter by the necrosed tissue.

Gangrene of the mucous membrane may result (*gangrenous dysentery*), when the inflammation is very severe and extends rapidly.

The localization of the diphtheritic process in the colon and ileum is more characteristic than even in the rectum. The diphtheritic infiltration is situated, almost without exception, on the projecting portions, as would be the case if a strong caustic had been rubbed over the intestinal surface. These portions are the three longitudinal bands (tæniæ) of the large intestine, and the transverse folds which unite with them in forming the boundaries of the pouches; in the small intestine, the parts affected are the transverse folds, and even the separate villi. When the process continues for a long time the intervening portion, of course, becomes involved, but the changes are always more advanced upon the folds and ulceration first takes place here, so that the diphtheritic ulcers of the large intestine have a very peculiar figure. They often bound quite regular spaces, or form long broad

bands, from which smaller branches proceed (like the map of a mountain chain).

There is another form of intestinal diphtheritis, less common than the one just described, where the process is limited to the surface of the projecting follicles (*diphtheritis follicularis*). The progress of the affection is similar to that of the previous form, and follicular ulcers result, which, however, differ materially from those already described as resulting from abscesses. In the latter variety, the whole follicle always suppurates before discharging into the intestine, and an ulcer results; while in the diphtheritic forms the process gradually extends inward from the surface, so that ulceration may be present, and follicular tissue still remain at the base. The ulcer is consequently open and not sinuous, and the edges are flat, as the ulceration extends not only downwards but also somewhat laterally, and the mucous membrane covering the follicle is completely destroyed.

The localization of the diphtheritis is not only peculiar in detail, but as a whole; it follows certain fixed rules. It has already been mentioned that the changes usually diminish in intensity and extent from below upwards; they are also more advanced where fæcal matter is most liable to be retained, namely, in the cæcum, or commencement of the colon, and at the various flexures (flexura hepatica, lienalis, and iliaca), of the latter. The effect of this factor is so important, that the central portion of the transverse colon is very frequently found entirely unaltered, or only in the early stages of the disease, and even then but slightly affected, while a continuous infiltration, and even ulcers, exist at both flexures bounding this portion.

The result of this affection, and the changes undergone by the mucous membrane remaining between the ulcers and infiltrated portions, have already been considered in connection with the same affection of the rectum. It may, however, be repeated, that these remaining portions are usually much reddened and swollen, even studded with

hæmorrhages; that the ulcers constantly increase in width and depth, till the greater part of the membrane is destroyed, and the muscular coat is laid bare over a correspondingly large area, as may be recognized by the exposure of its transverse fibres, which have become in the mean time greatly thickened (hypertrophied). A slaty discoloration of the ulcers and the entire intestine may result from the very great hyperæmia which exists from the beginning of the affection, and from the hæmorrhages, so that the existence of dysentery may frequently be suspected from the external appearances of the intestine. As has already been stated, perforation and peritonitis may result from a still further extension of the ulceration.

Cicatrization of the ulcers may also take place, and represents the more favorable result, although its occurrence is limited to cases where the process is less violent, and confined to a small space. Under such circumstances the intestinal surface has a dark slate color, and the mucous membrane is replaced by numerous, isolated, irregular scars, or perhaps studded here and there with clean ulcers which are beginning to cicatrize. The muscular coat is more or less thickened in these places.

It has already been stated that diphtheritic inflammation seldom extends from the large to the small intestine. When it does, it never becomes so intense as in the former; the ulcers are usually wanting, and only the infiltration is present, which diminishes in degree the higher it ascends, till, finally, only the small bran-like deposits are present. The inflammatory reddening and swelling, of course, extend still further upwards.

The description of intestinal diphtheritis has thus far been confined to diphtheritic dysentery, but not every diphtheritis is therefore dysentery, and, on the other hand, in what is clinically considered to be dysentery very different affections, diphtheritis (diphtheritic dysentery), follicular ulcers (follicular dysentery), or even merely catarrh (catarrhal dysentery), may be present. Diphtheritic changes are also found

in cases of simple *fæcal accumulation*, but then usually only at the flexures of the intestine, and not in the rectum; they are also found in *cholera*, principally in the small intestine, in *puerperal affections*, in the small and large intestine, less frequently in *typhoid* fever, *variola*, and other *infective diseases*.

The recognition of these different forms is aided by other evidence found at the autopsy. Both the diphtheritic and follicular changes, when they are limited to the large intestine, are very extensive, and present the characteristic localization, are generally due to dysentery. The follicular changes occur in other diseases also, as in the small intestine in phthisis.

5. **Scrofulous and tuberculous inflammation.** These processes differ from the dysenteric, in being seated usually, and by preference, in the small intestine, though not to the exclusion of the large intestine. Besides the processes that are undoubtedly tuberculous, all those will be considered which lead to cheesy degeneration and ulceration of the follicles; although the latter do not admit of being directly termed tuberculous, and are not considered as such by many authors, still they are very closely related to them. Such processes were formerly called *scrofulous*, as they occur especially in scrofulous individuals. The follicles, both solitary and those included in Peyer's patches, though not all of the latter, become swollen (attaining the size of a millet-grain or even that of a split pea), cloudy, and gray, then perfectly opaque and yellowish in the centre, till finally the whole follicle is converted into a yellow, cheesy mass. When they are incised, pus does not appear, as in the case of suppuration of the follicle, but a crumbling, cheesy mass is brought to view, which presents, upon microscopic examination, the well-known appearances of cheesy material (shrivelled cells and fatty detritus). When the alterations are more advanced, the mucous membrane covering the follicles is destroyed, the cheesy material is discharged, and an ulcer results, which has a cheesy base, and projecting, cheesy

edges (the *primary tubercular ulcer* of Rokitansky). These may unite and form large, irregular, sinuous ulcerations (Rokitansky's secondary tubercular ulcer). When this stage is reached, unequivocal tuberculosis (secondary) appears, which is characterized by the development of small gray nodules in the base, upon the edges, and in the immediate neighborhood of the ulcer. By the constant formation of such nodules and by cheesy degeneration of the older ones, the ulceration extends continuously, both in depth and surface. The shape of the ulcers at the outset is round, and is often maintained in those of a half-inch in diameter; still, as a rule, it becomes oblong, the long diameter being transverse to the axis of the intestine. This configuration is due to the fact that the development of the tubercles follows the course of the lymph-vessels, which extend from the side opposite the attachment of the mesentery, where the greater number of ulcers are situated, towards this structure. When the ulcer has reached its greatest development, it may completely encircle the intestine (annular ulcer). Both the base and edges are uneven, the latter appearing as if gnawed, and gray or yellow tubercles may be occasionally seen; they are also met with when the floor of the ulcer is formed by the muscular coat, the different layers of which may be recognized by the direction of their fibres, the innermost being transverse, the outer longitudinal. Recent tubercular nodules are situated on the peritoneum, which fact has been already fully considered. Hyperæmia and also hæmorrhages are of frequent occurrence, especially at the edges, and the mucous membrane in the vicinity is often hypertrophied. Large vessels are sometimes, though rarely, eaten into by the ulcer. Tubercular ulcers of large size may exceptionally lie parallel to the axis of the intestine instead of being transverse, thus involving a whole Peyer's patch, as is the case in typhoid fever. The differential diagnosis is readily made from the accurately described characteristics. Recent, or cheesy tubercular nodules may be recognized in the base and edges, and often at a distance from the ulcer, when sec-

tions are made through it with the double knife. The contractile muscular cells which are situated beneath the ulcer, are usually found to have generally undergone fatty degeneration.

The *termination* of the ulcers in necrosis and perforation of the intestinal walls, has already been spoken of, and it remains to be stated that tuberculous ulcers may undoubtedly heal. Transverse cicatrices are occasionally met with, which can be attributed to nothing else. Ulcers are often found which have become quite narrow and slit-like, owing to cicatricial contraction of their base. The normal mucous membrane extends over their edges down to the base, and all indications of tubercles are absent. The age of the ulcer is made evident by the slaty discoloration.

The cheesy follicles and the tuberculous ulcers are most constantly seated just above the ileo-cæcal valve, and from this point upwards the changes are, as a rule, less in number and extent; still there are many exceptions. The large intestine is less frequently affected than the small, and when the latter contains numerous large ulcerations, there are but few small ones in the large intestine, especially in the cæcum and ascending colon. There is another class of cases in which the principal changes are situated in the large intestine, where the ulcers are so numerous and large (larger than a silver dollar), that they could not exist in the small intestine owing to its limited size.

6. The principal changes in **typhoid fever** are seated in the ileum, hence the name "ileo-typhus"; in certain cases the large intestine is also greatly involved ("colo-typhus").

The typhoid changes in the intestine are almost wholly limited to the follicles, especially to Peyer's patches, which are altered throughout their whole extent, and therein differ from the tuberculous affection.

In recent cases of typhoid fever the changes consist in a marked swelling of the solitary follicles and Peyer's patches, which is most intense at the ileo-cæcal valve, and gradually or quite suddenly diminishes from this point upwards, till it

finally disappears altogether. The swelling is not confined to the follicles of the patches, but involves the interfollicular tissue also, so that the whole patch stands out like a flower-bed, often two to four millimeters high, while the edges are sometimes overhanging like those of a mushroom. The swollen solitary follicles may attain the size of a pea, from the associated changes in the surrounding tissue. The larger rounded swellings, which occur in various places upon the intestinal wall, at a greater or less distance from the attachment of the mesentery, do not arise from solitary follicles, but from small patches composed of three to five or more follicles. All the swollen portions are of a grayish-red color and soft consistency (*medullary swelling*). The rest of the intestine is, as a rule, of a dark red color, and in a state of catarrhal inflammation. The microscopic examination of teased preparations reveals large multinucleated cells in these swollen follicles similar to those occurring in the mesenteric glands.

At a later stage, instead of the medullary swelling of the solitary follicles and patches, yellowish-gray or yellowish-brown (stained by biliary coloring matter) necrotic masses, *sloughs* (sphaceli), are seen; these do not necessarily exist throughout the patch, but are frequently confined to a small portion. When a section is made through the part, it may be seen that the *sloughs* extend to a varying depth into the swollen tissue, and the limits of the *typhoid ulcer*, which is formed by their separation, are controlled by this fact. The earliest ulcers appear in the lower portion of the ileum, and they, or partially detached sloughs, may be found here, while higher up the sloughs are still firmly attached and the recent medullary swelling exists.

The ulcers which arise from solitary follicles, or from small patches, are rounded, and do not, for the most part, lie opposite the mesenteric attachment; those, on the other hand, which are due to sloughing of the larger Peyer's patches, are oblong, and, unlike the tubercular forms, are parallel to the intestine, owing to the fact that the swelling and ulceration

do not extend beyond the limits of the patch, except in the most severe cases. In the severest cases ulcers occur which almost completely surround the intestine, especially just above the ileo-cæcal valve.

Serious results sometimes result from the separation of the sloughs, namely, perforation, and arterial hæmorrhage, which act as immediate causes of death, as will be discovered on making the post-mortem examination. The seat of the *perforation* may be found without difficulty before the intestines are opened, but care must be exercised in opening them lest a perforation be artificially made. Perforations occur when the swelling and subsequent sloughing have extended very deeply into the intestinal walls. A circumscribed necrosis of the peritoneum follows, and this part is finally ruptured by some mechanical cause, for instance, by gas, muscular contraction, etc.

Profuse *arterial hæmorrhage* is due to the extension of the sloughing process into the walls of the vessels, and is characterized by the large quantity of blood which is found in the intestinal canal. It is a difficult matter to find the opened vessel. Its discovery may be aided somewhat by noticing the upper limit to which the blood extends, as the source may be looked for in the neighborhood of this point. It is necessary to examine the ulcers very carefully for adherent coagula, as they frequently indicate the place from which the hæmorrhage has taken place. In many cases the vessels will be sought for in vain.

In a still later stage the swelling is diminished, the color of the swollen portions is more red, the consistency more flabby, and the ulcers (having become clean) possess a smooth base, which frequently presents muscular fibres, and is diminished in size from the progressive extension of the edges over it. Recurrences usually take place at this stage, and are to be recognized by the acute medullary swelling in connection with the old ulcers. When healing takes place all traces of the swelling disappear, the ulcers have a smooth glistening surface, and the edges are no longer everted. Still

a certain amount of slaty discoloration in the surrounding tissue indicates the preëxisting hyperæmia.

It is scarcely necessary to state that all medullary swellings do not inevitably end in ulceration, for most of them disappear without the occurrence of any slough whatever. This is inferred from those cases in which death results from some other cause soon after recovery from typhoid fever, and no trace of the disease remains, except perhaps a slight amount of slaty discoloration around the lowermost Peyer's patches.

In the large intestine the typhoid process is of course limited to the solitary follicles, but in other respects it runs the same course as in the small intestine.

(*c.*) The tumors of the intestine require but little consideration. Besides the small *polypi*, small *myomata* and *lipomata*, the only important forms are the *carcinomata*, which may be primary or secondary. Primary carcinoma is either *cylindrical-cell cancer* (frequently combined with papillary growth), *scirrhus*, or *gelatinous cancer*. It is usually found in the vicinity of the ileo-cæcal valve, where it involves the whole intestinal wall over a varying extent, and leads to obstruction, which can only be partially relieved by ulceration. The general characteristics of these tumors have been sufficiently treated of in connection with cancers of the rectum.

Secondary carcinoma is very rare, except when it originates in the peritoneum, or extends directly from neighboring parts. It is situated in the more superficial portion of the mucous membrane, either as small nodules, or large masses involving even the entire circumference of the intestine. The surface of the larger growths is usually ulcerated, and peculiar plate-shaped forms result, the edges of which project far over the surrounding mucous membrane.

(*d.*) *Amyloid degeneration* of the intestinal mucous membrane remains to be considered. This affection, as a rule, appears in the intestine after some of the glandular organs have become infiltrated, though in rare cases it may be seated in the former at the outset. Some general cause (cachexia)

usually exists, but in very rare cases such cause may be absent. The more severe forms can be recognized, without the aid of reagents or the microscope, by the pale and waxy appearance of the mucous membrane, in connection with enlargement of the villi; but it can be diagnosticated with absolute certainty only by means of reagents. When a solution of iodine containing iodide of potash is applied, the villi appear to be the parts first affected; still the larger vessels are already degenerated, as may be easily demonstrated by removing them from the mucous tissue, and treating them with iodine. Not only the vessels, but also the epithelium and the rest of the tissue of the villi are affected. Even in very severe cases, Peyer's patches usually remain unaltered and become very conspicuous after the application of iodine, owing to the contrast between their bright yellow color and that of the surrounding surface. It is desirable to pour a little acetic acid upon the portion of the intestine which has been treated with iodine to prevent the possible alkaline condition from causing a rapid disappearance of the color. Both the large and the small intestine may be degenerated; still the latter is more frequently the seat of the change, and more extremely diseased.

Affections of the **vermiform appendage** are often fatal, yet may produce at times such slight alterations as to be readily overlooked. The Regulations, therefore, give explicit directions that, in every case of peritonitis at least, this part of the intestine shall be carefully examined.

The vermiform appendage, as is well known, is situated in the iliac fossa and bound to the brim of the true pelvis by a small mesentery. It is very frequently *displaced*, however, owing particularly to the contraction of false membranes or to chronic inflammatory cicatrices in the mesentery itself. It is then sometimes drawn towards the spine, or the outer abdominal walls, and again may be bent upon itself in various ways. When this is the case the mucous membrane usually undergoes alterations; it becomes *inflamed*, the interior of the appendage is filled with mucus or pus, es-

pecially when the opening into the intestine is closed by compression or abrupt bends. By constant accumulation of the secretion dilatation may be produced, and when the secretion (as in the case of the gall-bladder) becomes converted into a clear albuminous fluid, the term *dropsical dilatation* (hydrops processus vermiformis) is applied. These displacements also give rise to the retention of fæcal masses, and the formation of *fæcal concretions*, which are usually oblong or oval in shape, and possess a brown or brownish-black color. The fæcal concretions often act as foreign bodies (cherry-stones, etc.) when they become lodged in the appendage, and excite inflammation. *Ulceration* of the contiguous portions of the mucous membrane follows, which extends deeper and deeper till *perforation* finally occurs. Perforation may also result from the *tuberculous* or *typhoid* ulcerations, which are very common here on account of the large number of follicles in the mucous membrane. The effects of perforation vary according to the condition of the neighboring parts. If the appendage lies free in the abdominal cavity, a general peritonitis is immediately produced, and is usually of an ichorous character, owing to the escape of fæces; if, on the other hand, it is separated from the general cavity by old adhesions, a circumscribed ichorous abscess about the appendage and cæcum (*perityphlitis*) results, which may extend either upward, downward, or forward, into the connective tissue of the abdominal walls. Such adhesions do not always prevent perforation into the abdominal cavity, because they may be destroyed by ulceration and a fatal general peritonitis still be produced.

In other cases the inflammation extends to some vein (*thrombophlebitis*), and may proceed as far as the vena portæ even, and give rise to a fatal pylephlebitis.

It is scarcely necessary to mention that in the examination of the vermiform appendage the greatest care is to be exercised, lest an artificial opening be made at some point or other.

13. THE GREAT VESSELS AND ADJACENT LYMPHATIC GLANDS.

The only organs of the thorax and abdomen left for examination are the great vessels and the lymphatic glands which lie near them. In order to reach them conveniently the mesentery is to be cut off at its root, when the whole aorta, and so much of the vena cava as remains after the removal of the liver, will be laid bare.

The changes taking place in the smaller vessels (those supplying the extremities) will be here treated of, as well as those occurring in their trunks, since the alterations are often directly related, and it is frequently necessary to dissect the branches for some distance beyond the pelvis.

(*a.*) THE VEINS.

The *inferior vena cava* and its branches are first to be examined *in situ* by slitting the anterior wall.

Attention is to be paid to the *contents*, both in respect to quantity (great engorgement owing to an obstructed outflow) and especially with reference to their composition. The latter stands in very close relation to the condition of the *walls*, so that the two must be considered together.

The **coagulation of blood** (*thrombosis*) may take place, as the result of various causes, partly outside the vessels (marasmus, compression, etc.), and partly within their walls (varicose enlargement, old periphlebitis and phlebitis, etc.). The thrombi are found in the small peripheral branches, or within the pockets behind the valves of the larger veins (*valvular thrombosis*), which may constantly increase till the thrombus finally extends through the iliac veins and for a varying distance into the inferior cava. Thrombi occurring during life are distinguished from post-mortem clots by the fact that they are lamellated, being usually composed of alternate gray and red layers, are more fibrinous, and contain many more white corpuscles. The color varies according to the age of the thrombus, as the dark-red color which it has at

the outset becomes continuously lighter (decoloration) until it is reddish-gray; a brownish-red, yellow, or even orange-yellow color results from the frequent presence of hæmatoidine which is gradually formed. An alteration in consistency accompanies this change of color, and the clot becomes constantly dryer and firmer; finally, the organizing thrombus becomes firmly united and adherent to the walls. Bits of old thrombi, when torn to pieces under water, present the faded and shrivelled stroma of the red blood-corpuscles, often appearing as hemispheric crescents; masses of hæmatoidine, often in the form of beautiful crystalline rhombic plates, finely granular detritus, and colorless corpuscles are also found; the latter become more numerous at a later period, and constantly increasing numbers of spindle-shaped cells, vessels, etc., are added. A certain number of hours are always necessary that a thrombus may form, and its organization, under ordinary circumstances, takes place so rapidly that, according to Rindfleisch, vessels are always found in them at the end of eight days.

When a thrombus does not completely fill the vessel (obliterating thrombus), but only partly obstructs it (parietal thrombus), a progressive shrinkage takes place, till finally only a little mass of pigmented fibrous tissue remains. In other cases it sometimes becomes harmless by undergoing the *sinus-like metamorphosis*, being transformed into separate, projecting, valve-like membranes of fibrous tissue, which are frequently in the form of a spiral, and through which, although very tortuous, the blood may again circulate.

Small thrombi, especially the valvular forms, may calcify, and thus form the common *phlebolites*, which are round, usually more or less yellow, and vary in size from that of a millet-grain to that of a pea.

Thrombi do not possess the same structure throughout, but usually a more recent and an older portion may be distinguished, the former being situated at the end nearest the heart when the thrombus is still advancing.

When an extending thrombus in the branch of a vessel

reaches the main trunk, it usually proceeds but a short distance along the wall of the latter, constantly diminishing in size; when, on the other hand, it is situated in a larger vessel and reaches a branch, the latter either becomes gradually plugged or its canal is reduced to a very narrow furrow, which often exists as such for a long time. In both cases, portions of the upper, rounded, and usually pointed end of the clot are readily broken off, and become lodged in the pulmonary artery. By examining carefully the end of the thrombus in such cases it can be determined whether an embolus may have been detached.

In this benign form of thrombosis the walls of the vessel are not in the least involved at first, and later they take part in the organization only.

1. The reverse is the case in the second form of thrombosis, *i. e.* **thrombophlebitis**, which depends upon malignant inflammatory processes. This form most frequently originates in the uterine veins, from which it extends into the internal spermatic, hypogastric, or even into the inferior vena cava. The thrombi in this affection do not become firm, but are rapidly converted into a soft, reddish-brown, or yellow puriform mass. The walls of the veins become thickened, and, especially the internal layers, have a yellow, or greenish-yellow appearance, are frequently studded with small hæmorrhages, and the nutrient vessels are distended (*thrombophlebitis*).

The minute vessels of the adventitia and media, and also the hæmorrhages, are plainly seen by examining transverse sections with the microscope; all the coats are infiltrated with great numbers of pus corpuscles.

The microscopic examination of the contents shows quantities of detritus, fat granules, disintegrating colorless corpuscles, and colonies of parasites in the form of micrococci. It is very evident that portions may be much more easily separated from this soft mass, and carried into the lungs than from the thrombi first spoken of; also that emboli which originate from the former should be much smaller, as

they are more easily broken into pieces at every point where the vessels branch.

2. A third form of thrombosis belongs to the tumor formations and is due to the growth of cancerous, or more often sarcomatous masses, into the interior of veins. This has already been treated of in connection with the liver and kidneys.

3. Besides this acute inflammation of the walls depending upon (secondary to) malignant thrombosis, there is a **primary acute inflammation** (although not of the intima), occurring either with or without the formation of thrombi. Small collections of pus may result, which project like pustules from the inner or outer surface, hence, called *phlebitis pseudopustulosa*. Inflammation affecting the tissue around a vein (*peri-* and *paraphlebitis*) may easily extend to its walls, as has been stated in speaking of hepatic abscess.

4. **Chronic inflammatory processes** which so often affect the aorta, are rarely found in the intima of veins; still sclerotic plates, which usually calcify and do not undergo fatty degeneration, are sometimes met with, especially at those points where some mechanical influence is brought to bear, for instance, over tumors which obstruct the canal.

5. **Varicose dilatations** finally remain for consideration. They are most often found in the veins of the lower extremities, especially below the knees, where they may appear as large, bluish projections beneath the skin. These consist of tortuous veins with thin walls, which are dilated, first upon one side, then upon the other, and it is often difficult to display the canal on account of their tortuous, labyrinthine course. The greatest dilatation is always just above the valves. It is well known that they are essentially due to mechanical causes.

(*b.*) THE ARTERIES.

The *aorta* and its two great branches, the *iliacs*, with their primary branches, are usually removed unopened for subsequent careful examination. The upper end of the aorta is to be seized (it will be found convenient to insert one finger

into the canal), drawn strongly forwards and separated, together with the lumbar lymphatic glands, from the spine by oblique cuts made from above and the median line, downwards and outwards. When aneurismal dilatations are present, it is necessary, before removing the vessel, to notice their relations to the surrounding parts, especially the bones. Such a condition is, in general, readily diagnosticated in advance, and the aorta is then removed, together with the contiguous thoracic or abdominal viscera, in order that their relations may be better made out.

It is well to observe the diameter of the canal before opening the vessel, as it can then be best determined. The aorta of adults should admit the forefinger, or even the thumb, while it is sometimes so narrow as to scarcely admit the little finger. The artery should then be opened throughout its whole length, along the anterior wall, and the incision carried directly into the iliac and hypogastric arteries. Attention should be paid to the contents (often wanting), diameter of the canal, thickness and elasticity of the walls, and the alterations which result from the special diseases.

1. *General Characteristics.*

The *width* increases with age, the average in the adult male being, in the ascending portion from seven to eight centimeters, in the thoracic portion from six and a half to five and a half centimeters, in the abdominal portion from four and one half to four centimeters (in the female it is somewhat less); it is subject to great variations. Circumscribed dilatations may occur, attaining the size of a man's head, and others are found which involve the whole length or a large portion (thoracic or abdominal aorta), so that it is one third or one half larger than normal. On the other hand, it may be so narrow, for instance in the female, as hardly to permit the insertion of the little finger.

The *thickness of the wall* is in general proportional to the size of the vessel, the average being two millimeters, while the thickness of the wall of small aortæ is often scarcely one

millimetre. Exceptions occur in dilatations, where a thinning sometimes takes place despite the enlargement.

The *elasticity* usually varies inversely with the size, a dilated aorta being always perfectly inelastic, while the elasticity is increased in those which are narrow. This fact is very important in connection with the measurement of the length of the vessel after its removal. As an inelastic vessel does not contract in the least, it appears very long, while those which are elastic shrink considerably, and consequently diminish in length. Another result is that the inelastic vessels can be stretched but little, while the elastic ones may be stretched like India-rubber, quickly contracting afterwards.

2. *Special Morbid Conditions, particularly of the Intima.*

The normal inner surface of the aorta is perfectly smooth and uniformly yellow, but may undergo various changes, all of which may essentially result from two conditions: first, simple retrograde metamorphoses, which occur principally in the layers nearest the blood-current; secondly, the chronic inflammatory processes (commonly called atheromatous) which are situated in the deeper layers.

1. The **retrograde metamorphoses** include the transformation of the intima into a soft, gelatinous material, which resembles mucous tissue, even when examined with the microscope (*gelatinous metamorphosis*), and the very common *fatty degeneration of the cells of the intima*. The latter produces a white or lemon-yellow color of the surface, appearing in the form of spots, streaks, or irregularly reticulated and striated figures. This change is very often seated in the posterior wall of the aorta about the orifices of the intercostal arteries, and longitudinal lines also usually appear in this region. Sections may be easily made for microscopic examination by stretching the aorta over the forefinger, and cutting parallel to the surface with a sharp razor, or by tearing off thin layers with a small pair of forceps. In such preparations, great numbers of large and small fat drops

are seen in the centre of the yellow patch, irregularly distributed throughout the intima. At the edge, however, and in those parts where the change is less advanced, the fat granules are fewer, of much more uniform size, and are arranged in triangular or stellate groups, which correspond with the enlarged and more plump stellate cells of the intima. Such an object is especially fitted to illustrate the differences between fat granules and micrococci. Although these fat granules are in general of uniform size, they never possess that perfect uniformity belonging to the micrococci, and may be made to disappear entirely by boiling the preparation in equal parts of absolute alcohol and ether, and in glacial acetic acid, which is never the case when micrococci are similarly treated.

Simple fatty degeneration of the cells of the intima produces merely a slight elevation of the surface, but may result in very important secondary changes, through the detachment and transportation of the endothelium and layers of the fatty patch, by the mechanical effect of the blood-current. Superficial losses of substance (fatty erosion) thus arise, which do not in general materially affect the resistance of the aorta. When this change takes place in smaller vessels, for instance those of the brain and pia mater, which is especially the case in drunkards, *rupture* may result, as the blood forces its way among the cells of the media and forms a dissecting aneurism, the outer wall of which, together with the adventitia, may be subsequently torn through.

2. The second form, the **inflammatory** processes, leads to greater deformities. At the outset, small, multiple, smooth elevations of the surface arise, which often have abrupt edges and usually feel very firm (*sclerosis*). Such thickenings are frequently found in the arch of the aorta and at those points where the lateral branches are given off, which localization is perhaps due to some mechanical cause. The microscopic examination of vertical sections readily shows that the most superficial layers of the intima are least altered, while there is quite an accumulation of small cells in

the deeper layers and a thickening of the fibrous lamellæ. *Fatty degeneration* of the cells very quickly follows this thickening, and begins in the lowermost layers of the intima, in consequence of which the sclerotic patches present a spotted, yellow appearance. At a later stage the fatty degeneration results in a complete disintegration of the tissue, and the formation of a cavity filled with a pulpy mass composed of fat granules, cholesterine crystals, and detritus. This is the *atheromatous abscess*, which constantly increases in size towards the cavity of the vessel, till it breaks through at the thinnest point. The mass is then washed out by the blood current, and an irregular *atheromatous ulcer* results, resembling the follicular ulcer of the intestine, which may be easily distinguished from the fatty erosion by its depth and overhanging edges. These ulcers necessarily exert an influence upon the blood flowing over them, and numbers of thrombi are often found (*parietal thrombi*), which constantly increase in size, and are floated away and give rise to embolism. The thrombi which fill up these ulcers may become organized, and the latter are then replaced by *scars*, the origin of which is usually indicated by the slaty color.

Another result of the atheromatous process is the conversion of the sclerotic and fatty masses into correspondingly large *calcareous plates*, which are usually smooth on the surface facing the canal of the vessel, and irregular externally; they are thus distinguished from the occasional calcified parietal thrombi, the entire surface of which is irregular. These plates are sometimes of a slaty color, owing to the absorption of blood-pigment and the formation of hæmatoidine. When the calcification occurs at a part where there is great thickening, large, irregular, calcified excrescences may result. Each of the changes which have heretofore been described may occur separately, or, as is usually the case, in conjunction, so that the inner surface of the aorta presents an exceedingly diversified appearance, and the outside is very uneven and misshapen (*endaortitis chronica deformans*). In these extreme degrees of the affection the vessel is always consider-

ably dilated and its walls are thickened and deprived of their elasticity.

3. **Calcification of the media** must not be confounded with the calcification in the intima just mentioned. This process does not take place in the aorta, but is often found in the arteries supplying the extremities, especially in old people. The vessels are converted into long, rigid tubes, which often crack under even slight pressure. This change is caused by a calcification of the unstriped muscular tissue of the media, while the intima may remain relatively intact. Its origin in the media may often be directly recognized by the annular deposition of the yellowish-white calcareous mass.

It is very evident that arterial walls thus altered must greatly obstruct the flow of blood, and the predisposition of old people to *gangrene* (senile) from slight injuries is thus accounted for. The blood clots which are present in such cases are due to secondary venous thrombosis. The arteries take part in the origin of still another variety of gangrene, the embolic form, in which the clot plugging the vessel is often situated at a long distance from the gangrenous part (for instance, in the popliteal artery in gangrene of the foot), while in the senile form the thrombus extends upwards from the seat of the gangrene.

The collective alterations in any individual case are composed of those already described, and are to be sought for accordingly. Circumscribed dilatations of the vessels, aneurisms, remain to be considered, and also the congenital alterations of the aorta, to the importance of which Virchow has recently called attention.

4. *Dilatations of the arteries* (**aneurisms**) are either limited to a small portion of the vessel, or involve large sections, and even entire vascular territories (*serpentine or cirsoid aneurism*). The last, as its name implies, appears as a tortuous winding of the elongated and widened vessel, and is met with in the peripheral arteries (frontal, occipital, etc.), and very frequently in the iliacs. The other forms produce

either a general dilatation (*cylindrical or fusiform*), or one limited to a part of the wall (*sacculated*); they are most commonly found at the arch of the aorta and the adjacent portions, though not always confined to these, but extend to the branches which are given off from the arch, especially the innominate. The direction followed in the growth of the aneurismal sac may vary greatly, and neither soft parts nor bones can offer any permanent resistance. Great losses of substance may take place, both in the sternum and spine, from an advancing aneurism. The bone is destroyed by a fibrous metamorphosis, as may be easily seen by microscopic examination of small bony spiculæ removed from the eroded surface.

In the majority of cases the whole aneurismal sac is not empty, but more or less filled with thrombotic deposits from the blood, which are usually very firm and dry, of a pale-red color, and, upon section, are evidently composed of layers. Microscopic examination shows that the lamellæ contain fibrine, red and white corpuscles, and also hæmatoidine.

The early stage of the aneurism is likely to be overlooked, as there is only a slight partial dilatation of the walls, whereas the fully formed aneurism cannot escape notice. Slight aneurismal dilatations are often found in the ascending portion of the aorta, and should always be looked for when this part is examined. In searching other places, assistance is obtained from the changes taking place in the intima of the dilated part, which are similar to those in large aneurisms, and consist of the sclerotic and atheromatous conditions already described. These are probably of causal importance in the origin of the aneurism (by diminishing the elasticity and power of resistance of the walls). Circumscribed atrophy of the muscular coat (chronic fibrous inflammation?) may be found instead of the inflammatory process in the intima, and, like the similar affection in the heart, may be looked upon as a cause of the dilatation. In all large aneurisms the media has almost wholly disappeared, and often the intima also. Traumatic injury may be mentioned as an occasional exter-

nal cause for the development of aneurisms. Syphilis holds a prominent position among the causes which result in the endaortitis antecedent to aneurismal dilatation.

There is a peculiar variety of (false) aneurism, the *dissecting aneurism of the aorta*, which consists in a separation of the outer from the middle coat by a current of blood, which has entered through a rent in the intima and media at the upper part of the vessel; the blood is now forced downwards, even as far as the aortic opening in the diaphragm, splitting the two coats apart, and then often returns to the interior of the aorta through a second rupture of the intima. In this form also, atheromatous changes in the intima, or fatty degeneration of the media, are probably the cause of the rupture. These aneurisms are classified among the so-called false aneurisms, as are also those of *traumatic* origin, in which the blood-sac lies wholly outside of the artery, and is composed of the surrounding fibrous tissue. The *varicose aneurism*, which is also usually of traumatic origin, and consists of a sac between an artery and vein communicating with each, comes under this head also.

5. **Congenital alterations** of the aorta include the rare stenosis or atresia which usually results in immediate death, and the very important *aplasia*, or more correctly speaking, *hypoplasia*, which manifests itself in the first place by a *narrowness* of the vessel. Such a hypoplastic aorta in adults is often scarcely large enough to admit the little finger, the diameter of the thoracic portion being from three to four centimeters and that of the abdominal portion from two to three centimeters. A *thinness of the walls* is present, and also an *increase of the elasticity*, so that when the aorta is removed it shrinks very much and may be stretched out like braces. There is also present an *irregularity in the origin of the intercostal arteries*, which are absent at one point, too numerous at another, etc., and further, a *bright-yellow, figured appearance* and *wavy thickening* of the intima, especially on the posterior wall, along and between the orifices of the intercostal arteries. Virchow has demonstrated the connec-

tion between this hypoplasia of the aorta (observed especially in the female), which sometimes occurs with, and sometimes without, a similar alteration in the heart, and general disease (*chlorosis*), also with disease of the heart (*endocarditis*).

(*c.*) THE RETROPERITONEAL LYMPHATIC GLANDS.

The lumbar lymphatic glands, which are situated about the aorta and inferior vena cava, are subject to many changes, which do not differ greatly in their nature from those of other lymphatic glands, so that it will be sufficient to give them a passing notice.

Swelling results from inflammatory affections of any sort situated at the origin of the afferent lymphatic vessels (true pelvis, etc.), and especially in syphilis, in which affection suppuration, like that observed in the inguinal glands, may take place. The lumbar glands also undergo degeneration in connection with tumors, especially tumors of the testis, though less frequently in consequence of cancer of the uterus, etc. They become involved, moreover, in the *leucæmic* and *pseudoleucæmic* affections (lymphosarcoma), also in *malignant pustule* and other similar general diseases. Syphilis gives rise to chronic swelling and induration of the glands. They undergo *amyloid degeneration* as a result of the general amyloid process, and become *cheesy* in connection with a similar change in other organs, especially the intestinal and mesenteric glands. Finally, there are a number of *primary tumors* (fibromata, sarcomata, lipomata, carcinomata [?]), which originate in part from these lymphatic glands, and in part from the surrounding (retroperitoneal) fibrous tissue.

(*d.*) THE THORACIC DUCT.

The examination of the thoracic duct and receptaculum chyli, which by the way is seldom necessary, naturally follows that of the glands. The receptaculum chyli lies to the right and behind the aorta, upon the second or third lumbar vertebra; the duct lies behind and to the right of the aorta.

The changes to which it is subject are dilatations, either throughout its whole length or limited to a small portion, and are usually due to pressure. Partial obliteration may also be found, and may possibly result from inflammation, fresh signs of which have been but very rarely found. The duct may sometimes contain bloody fluid or a clot.

14. THE INTERNAL MUSCLES OF THE TRUNK.

In order to complete the examination of the thoracic and abdominal cavity, the internal muscles and the bones must not be omitted.

(*a.*) The *diaphragm* may be first mentioned, although its alterations are essentially dependent upon those of its serous coverings, which have already been sufficiently treated of. There are three conditions, however, yet to be noticed: in the first place, the diaphragm is earliest and most affected by *trichinæ*, and is therefore always to be examined when their presence is suspected. Secondly, the muscular fibres of the diaphragm often undergo fatty degeneration (also brown atrophy), and then the process is often associated with a similar change of the heart. Finally, the diaphragm is especially adapted, from its richness in lymph-vessels, to illustrate the advance of *inflammatory processes* along the course of the lymphatics. The observation made by Waldeyer is quite characteristic in this respect, namely, that in puerperal peritonitis the lymph-vessels were completely plugged with micrococci. Actual purulent inflammation (*diaphragmatitis phlegmonosa*) is more rare; where it occurs a marked thickening of the diaphragm is also present.

6. The muscles belonging to the pelvis are next to be examined, the most important of which is the *ilio-psoas*, from its being the very frequent seat of purulent inflammation (*psoas abscess*). This affection is always secondary, sometimes to trouble in the spine (caries), and again to trouble in the pelvis (caries, coxitis), and may be unilateral or bilateral; when the latter is the case, affections of the spine must always be thought of. The presence of the disturbance

may be suspected, even before the muscle is cut into, by the greenish color of its surface and by the more or less distinct fluctuation. When the abscess is opened it may be found of various size, so large even that the muscle itself may be completely destroyed, in which case the abscess is surrounded only by the thickened perimysium and surrounding connective tissue. The walls are usually uneven, ragged (remnants of muscle), and frequently of a slaty color. The pus, especially in case of caries, of the pelvis, contains more or less numerous bits of bone, which suggest the admixture of sand, and indicate the origin of the trouble. The abscess may sometimes be traced into the true pelvis and as far as the hip-joint, which may be perforated secondarily and suppurate. On the other hand it may extend upwards for a considerable distance, especially when the bones of the upper part of the trunk are affected; still the track is not always easily followed, as the seat of the caries is frequently connected with the abscess only by a very narrow and tortuous fistula. Perforation of the descending colon may take place from the abscess, and fæcal matter may then be discharged into the latter; if the abscess should also discharge through the skin an indirect fæcal fistula would result.

Secondary tumors are quite often formed in the ilio-psoas, owing to its proximity to numerous organs; the nature of the primary affection determines the composition of such secondary growths.

15. THE FRONT OF THE SPINE.

(*a.*) *General Characteristics.*

Alterations in shape are among the most noticeable pathological changes in the *vertebral column*, and are most marked in the dorsal portion. The different varieties are *scoliosis*, or lateral curvature (usually to the right side in the dorsal portion), *kyphosis*, or curvature backwards, and *lordosis*, or curvature towards the front. Very frequently scoliosis is combined with one of the other forms, occurring especially as

kypho-scoliosis. When a curvature occurs at any one point it is counterbalanced by a curve in another direction elsewhere, — the most common example is this, a kypho-scoliosis in the dorsal, counteracted by a lordosis in the lumbar region. In case of lateral curvature the vertebræ themselves are always turned upon their axis, so that the body is turned towards the convexity of the curvature. The bodies of the vertebræ are also altered in shape, being shorter on the side towards the concavity, as is also the intervertebral substance, which may be wholly wanting here, being replaced by a synostosis of the vertebræ. Kyphosis may consist in a simple or a more or less angular curvature, the latter being due to deep-seated local disease of the bone (Pott's disease). As the usual cause of angular curvature is caries, which has either run its course or still exists, it is always necessary in such cases to count the vertebræ in order to see that one or even more are not wanting. In order to determine accurately the number of the bodies of the vertebræ which have been destroyed, the spinous processes, which usually remain intact, are to be counted. In making a careful examination it is necessary to remove the affected portion completely, and saw through it longitudinally, otherwise pathological changes in the bodies of the vertebræ, or intervertebral substance, may be easily overlooked. In order to accomplish the removal, a high block of wood is to be placed under the back, directly beneath the portion to be removed, and, if necessary, the corresponding ribs are to be severed with the bone-shears. The intervertebral substance which bounds the desired portion is then cut through with a cartilage-knife, when both the upper and lower portions of the body will fall back by their own weight, and the portion to be removed will be retained only by the lateral joints. It is best to cut through these with a chisel, and then a finger, the chisel, or something convenient, is to be thrust into the spinal canal, and by drawing the piece firmly forwards, the muscles lying behind the vertebræ can be separated from them.

(*b.*) *Special Morbid Conditions.*

Fractures of the spinal column may be transverse or longitudinal, and are frequently comminuted or combined with a crushing of a portion of the bodies. Both the fractures and dislocations, the latter being necessarily partial, are liable to produce deformities of the spine, like the carious affections, and a longitudinal section is also best adapted for their examination.

The *inflammatory processes* in the vertebræ usually manifest themselves as *caries*, and are included under the name of *spondylarthrocace*. Two forms, however, must be distinguished, the simple carious (purulent) and the cheesy inflammation. The first may occur at any time of life, sometimes being primary in the vertebræ (at times of traumatic origin), and again extending from neighboring abscesses. As a rule, a great quantity of pus is formed (*prevertebral abscess*), which by constantly extending into the connective tissue of remote parts, especially of the psoas muscle, produces a large abscess which may finally discharge outwardly (cold abscess).

The second form occurs almost exclusively in scrofulous and tuberculous children, and is chiefly produced by a *cheesy osteomyelitis*. When a section is made through the bodies of the vertebræ, the cancellated tissue is found to be filled with cheesy material, in the vicinity of which small tubercles may often be plainly recognized. The bodies of the vertebræ are destroyed as in simple caries, and prevertebral abscesses are formed, which extend in the manner above described. A minute description of the process will be given in considering the bones of the extremities.

Cartilaginous, and especially bony new formations are very common, particularly in the form of *supracartilaginous exostoses*, which will be hereafter described (with the bones of the extremities). These sometimes originate from the contiguous sides of two vertebræ and then become fused, thus forming a bridge over the intervertebral substance.

Heteroplastic growths, especially sarcoma and cancer, sometimes occur by extending from neighboring parts, and the former also occur primarily.

16. THE PELVIC BONES.

(*a.*) *General Characteristics.*

The most important pathological conditions of the bony *pelvis* are the *deformities* and the resulting alterations of the internal dimensions. In order to examine these thoroughly the entire pelvis should be completely removed from the body, and freed, as thoroughly as possible, from the muscular tissue. In the majority of cases, however, it is sufficient to observe the general shape and to take accurate measurements of the inlet; and in most cases it is customary to take no further steps. It would require too much space were all the deformities described, as they are fully treated of in all the current text-books upon obstetrics; certain general points only may be now stated. The pelvis is seldom widened in all directions (large pelvis), though very frequently narrowed (contracted pelvis). It is either uniformly narrowed, or only in the direction of certain diameters, while the others are of normal or increased length; the narrowing upon the two sides is either about equal (symmetrical pelvis) or it may be unequal (unsymmetrical pelvis). The cause of the deformities lies in the pelvis itself, or in pathological changes in the vertebral column, or hip-joints. In the latter case the deformity is usually unilateral (unsymmetrical pelvis) and results from inflammation in childhood, anchylosis, or dislocation (coxalgic pelvis). The spinal curvatures produce a compensatory displacement of the sacrum, and the pelvis becomes consequently distorted (kyphotic pelvis). The pathological changes of the pelvis itself, which result in deformity, are tumors, the rare synostosis of the sacro-iliac synchondrosis (synostotic pelvis, usually unsymmetrical), osteomalacia, and lastly, rickets, which is extremely common. In cases of *osteomalacia* the pelvis has a very characteristic

shape (heart-shaped), due to the pressure of the thigh bones upon the acetabula, in consequence of which the latter are approximated, the pubic bones become pointed, and the sacrum projects forwards into the pelvis. Rickets does not always produce the same alterations; the most common deformity consists in the sacrum being depressed and pushed forwards more than in the normal condition, so that the antero-posterior diameter is diminished, while the transverse is sometimes even increased. The projection of the sacrum is due to the rachitic changes in the sacro-iliac synchondrosis and the accompanying extreme softness and mobility which will be more fully described hereafter. When a similar pressure is exercised upon the ilio-pubic synchondrosis, the resulting deformity may resemble that due to osteomalacia. Besides these alterations in the shape of the true pelvis, a diminution in size and flattening of the hip bones also results from rickets.

(*b.*) *Special Morbid Conditions.*

Fractures of the pelvis are produced only by great violence, and are usually associated with great injury to very important organs, so that death soon results, often preceded by extensive gangrenous inflammation and necrosis of the bones. Separation of the synchondroses is sometimes observed in connection with fractures.

The *inflammatory, carious processes*, when not caused by injury, usually proceed from the hip-joint or a psoas abscess; still any and all other processes in the neighboring parts, which are characterized by suppuration, may by extending produce caries of the pelvis. Caries is thus very commonly found on the posterior surface of the sacrum as a result of decubitus (bed-sore).

In addition to the formations of bone which results from processes originating in the hip-joint, small *exostoses* sometimes occur, seated on the ilio-pectineal line, or symphysis pubis; they project like spines into the pelvis, and may cause lacerations during childbirth. The other tumors which occur

here are *enchondroma*, *osteoma*, *sarcoma*, and *carcinoma*. The latter is said to occur as a primary growth of great softness, and is often infiltrated throughout all the bones, so that the shape of the softened pelvis may resemble that affected with osteomalacia.

IV. THE EXTREMITIES.

In the majority of cases, when the examination of the abdominal cavity is finished, the autopsy may be considered completed; but in others the extremities must still be examined. In these parts the lymphatic glands and vessels, the blood-vessels, nerves, muscles, joints, and bones deserve special consideration. The examination, of course, is limited to those parts only where in certain cases pathological changes are known to exist, or at least are suspected.

1. THE LYMPHATIC GLANDS.

The lymphatic glands of the extremities usually examined are those which lie nearest the trunk. These include the axillary and inguinal glands, both of which are not only connected with the lymphatic vessels of the extremities, but with other important parts. The axillary glands receive the lymph-vessels of the breasts also, and the inguinal glands those of the generative apparatus, so that they are liable to become involved when disease exists in either of these regions.

The results of primary acute **inflammation** of these glands are rarely met with at the autopsy, though sometimes accidentally found; evidences of secondary inflammation in cases of extensive inflammatory processes in the subcutaneous and intermuscular connective tissue, etc., are more common. The glands are swollen, more or less reddened, and sometimes contain pus (*lymphadenitis apostematosa*). The surrounding tissue is often inflamed and infiltrated with pus (*periadenitis*). The pus corpuscles are distinguished from lymph corpuscles by their size and several small nuclei, while only a single large nucleus exists in the lymph corpuscle.

Chronic inflammation is manifested either by induration, combined with a diminution in the size of the glands, in which case the reticulum is thickened and the cells of the gland are less numerous, or by hypertrophy, in which alteration the reticulum is also found to be thickened, but the meshes are still filled with cells.

Cheesy (tuberculous?) *inflammation* occurs less frequently in these peripheral glands than in those already described, and when present is most likely to be seated in the cervical glands. The specific *syphilitic* affection (indolent buboes), on the contrary, is very common, especially in the inguinal glands, which become enlarged and hard, presenting a gray color on section, and are filled with cells. *Leucæmia* and *lymphosarcoma* give rise to enlargements, which sometimes may be very great. Primary tumors are very rare, but secondary ones are more common, especially *cancer*. As has already been suggested, when the axillary glands are affected, the primary cancer is usually seated in the breast, while the inguinal glands become secondarily cancerous from the external genitals (cancroid of the penis or clitoris), or from the internal (cancer of the uterus).

2. THE LYMPHATIC VESSELS.

The lymphatic vessels are sometimes dilated (in central obstruction), owing to induration and atrophy of the glands (*elephantiasis*). They may also present inflammatory changes (*lymphangitis*), which are usually secondary to *perilymphangitis* (phlegmasia alba dolens). Portions of new formations are sometimes found in their interior, especially of those near or among the axillary glands. They may also contain blood when hæmorrhage has taken place in the region from which they came, and the blood is then found also in the lymphatic glands, at an early stage in the sinuses surrounding the follicles.

3. THE BLOOD-VESSELS.

The pathological changes occurring in the blood-vessels have already been described in connection with the aorta and vena cava; it is only necessary to add, that in examining the vessels of the extremities the incision is always to be made along the course of the main branches, since it is important to determine exactly their relation when changes in the larger vessels are continued from those of the extremities.

4. THE NERVES.

The most important pathological change in the *peripheral nerves* is *atrophy*, which may often be roughly determined by their small size; when teased preparations are examined with the microscope, the nerve fibres are found to have disappeared, usually in consequence of fatty degeneration.

Acute *inflammatory* changes have been described by Virchow under the term *neuritis interstialis proliferans.* They are characterized by an abundant cell proliferation between the nerve fibres and atrophy of the latter. Chronic inflammatory changes are manifested by a fibrous thickening of the perineurium, and frequently occur in stumps after amputations (*false neuroma*).

The first to be considered among the *tumors* are the *neuromata*, which may be defined as enlargements occurring in the course of a nerve, or at its termination in an amputated stump; they are usually somewhat fusiform, varying from the size of a pea to that of a hen's egg, and are composed of nerve fibres. If the tumor contains white substance it is termed *neuroma myelinicum*, if not it is designated as *neuroma amyelinicum.* Formerly, many other tumors of a similar shape occurring along the course of nerves were incorrectly called neuromata. Among these may be mentioned *fibromata*, *myxomata*, and *sarcomata.* The latter are occasionally developed in the course of many different nerves at the same time. *Carcinoma* is very rare.

5. THE MUSCLES.

(*a*). *General Characteristics.*

In examining the muscles of the extremities their *size* is first to be noticed. All the muscles or single groups only may present variations in this respect, and atrophy is more common than hypertrophy. In general atrophy their size can, of course, be only approximately determined, but when the atrophy is circumscribed, it is possible to estimate exactly the diminution in size, by comparing the affected part with the opposite side.

The *color* of muscles varies from a bright grayish-red to the darkest shade of red, according to the amount of blood contained in them (color of smoked goose-breast in typhoid fever and cholera); they become yellowish-red (fatty degeneration or infiltration) or brownish-red (brown atrophy), in consequence of changes taking place in the substance of the muscles; in the vicinity of ichorous abscesses, and generally when putrefaction is present, they assume a dirty grayish-green or dark green color.

The *consistency* depends principally upon the degree of post-mortem rigidity; it is diminished in most diseased conditions, especially in atrophy and acute inflammation, and the tissue is then often perfectly soft, brittle, and even pulpy. The consistency may be increased, on the other hand, for instance, in chronic interstitial inflammation.

(*b.*) *Special Morbid Conditions.*

1. **Hypertrophy.** *True hypertrophy* seldom occurs, and when it does, it is always confined to single groups, and is usually the result of excessive use. The term *false hypertrophy* has been applied to a condition in which the belly of the muscles appears to be enlarged, although the actual muscle is not increased in size. The enlargement is due to an interstitial development of fat (*fatty infiltration*), which may very easily be distinguished by the eye, by the wide

and narrow, yellowish-white lines which penetrate the muscular substance in all directions.

2. **Atrophy.** One form of atrophy (*atrophy due to fatty infiltration*) essentially agrees with the previous condition, and is very frequently found when the muscles are no longer used, whether owing to affections of the joints or nerves. The gross appearances are similar to those above described, except that the muscular tissue is less strongly contrasted with the fat the longer the process has continued, while the circumference of the muscle is actually lessened. When examined microscopically, not only are fat cells found between the muscular fibres, as in the first case, but the fibres themselves are diminished in size, of course very irregularly; the transverse striæ are very obscure, apparently broken into separate pieces, and the picture is thus presented of the most extreme degree of atrophy.

The muscles are sometimes found under similar conditions to be very much diminished in size; they are not, however, of a pale grayish-red, but of a light or dark brown color (*brown atrophy*). This condition is found (in teased preparations) to be due to the presence of small, irregular, brown pigment granules, as is the case with the similar change in the heart.

There is also a *fatty atrophy* (*atrophy due to fatty degeneration*), which corresponds with that occurring in the heart, and is characterized by its pale-yellow color and, when examined microscopically (teased preparations also), by the absence of transverse striæ and the presence of glistening fat granules, which are insoluble in dilute caustic alkali. It is usually the result of an inflammatory process, and belongs under the head of parenchymatous myositis. It is supposed to be the cause of the so-called pernicious progressive muscular atrophy.

Simple atrophy is by far the most common form, and appears constantly in old age and in all cachectic diseases (phthisis, cancer, etc.). It depends upon a simple diminution in size of the contractile substance, and differs from the

above-mentioned forms of atrophy in being more uniformly diffused.

3. **Hæmorrhages** into the muscles are moderate, small, or punctiform. The first form is usually traumatic in its origin, and the others occur in septic diseases, and especially in the vicinity of inflammatory processes, whether the latter are situated within the muscles or in the neighboring parts. When blood is effused, the muscular fibres are separated by the extravasated blood, and if the hæmorrhage is extensive, they are so much injured as to become disintegrated, the resulting detritus being mixed with the blood.

4. The **inflammations** may be divided into those which involve the muscular tissue proper, and those which involve the interstitial tissue.

(*a.*) In the former (*myositis parenchymatosa*) the well-known results, cloudy swelling and fatty degeneration, are presented, evident by the disappearance of the transverse striæ, and the pale grayish or yellowish-red color and soft consistency of the muscle. This form occurs as a general affection in many infective diseases, the changes occurring in *typhoid fever* being the most familiar. In this disease the adductors of the thigh are most often affected, and may contain spots of actual softening. Circumscribed (local) forms may occur when the muscular substance takes part in inflammatory processes, for instance, in purulent interstitial inflammation, and especially in embolic affections (pyæmia, ulcerative endocarditis, etc.).

A pathological change occurring in typhoid fever with true parenchymatous myositis has been described by Zenker as *waxy* (hyaline) *degeneration*, in which the contractile substance is converted into a homogeneous vitreous mass, the transverse striæ completely disappearing. Later it becomes broken up transversely into rounded fragments, which are held together merely by the unaltered sarcolemma. These masses do not present the amyloid reaction, neither can they be looked upon as a specific typhoid alteration, as they appear in other diseases also, especially in those which

are characterized by great muscular activity, for instance, in acute mania, and they may even be produced artificially.

(*b.*) *Interstitial* inflammatory affections of the muscles are divided into acute and chronic. The *acute* are accompanied by suppuration (*myositis interstitialis apostematosa*), and they may vary greatly in extent. Very large abscesses occur in consequence of injury, in affections of the joints, bones, etc. In the latter disturbances the process, which is at first acute, may become chronic, and the abscess becomes encapsuled, owing to a fibrous induration of the surrounding muscles. When an abscess is of long standing its walls bear a greater or less number of sulphur-yellow spots, which are due to fatty degeneration of the cells; when this appearance is present it may be regarded as a sure sign of the long duration of the abscess. The contents of abscesses which have originated from bones are not often composed of laudable pus, but form an ichorous mass. So-called muscular abscesses even are not always true abscesses, namely, cavities with liquid, purulent contents, but consist of purulent infiltrations with mortification of the muscular tissue, which is then often found as shreds floating in the fluid.

Small, multiple muscular abscesses, of a foul character from the beginning, and which do not contain laudable pus but a dirty, grayish-yellow, thin, greasy mass, containing myriads of micrococci, are very important, especially with reference to the general diagnosis. They always excite suspicion of the presence of glanders. The small abscesses from emboli, which are consequently associated with hæmorrhage and occur in ulcerative endocarditis, belong in the same category. The infective masses which obstruct the vessels (emboli of micrococci) give rise to a very severe interstitial and parenchymatous inflammation, the latter sometimes causing a pulpy disintegration of the muscular fibres before any considerable quantity of pus is formed.

Chronic interstitial myositis, like all other chronic interstitial inflammations, results in the formation of fibrous tissue (*myositis interstitialis fibrosa*). It is always circumscribed,

and is either primary, for instance, after chronic rheumatism (rheumatic callosities), or traumatic injury (muscular scars), among which are the results of morphine injections, or it appears secondarily after chronic inflammatory affections of neighboring organs, especially of the bones. It is easily recognized by the gray fibrous masses which are frequently scattered through the atrophied muscle in the form of streaks. The microscopic examination of such changes is best made by using teased preparations, or still better, horizontal sections.

In exceptional cases bone is found instead of fibrous tissue (*myositis interstitialis ossificans*). This ossifying myositis appears as a sanatory process in the vicinity of fractures, producing the *parosteal callus;* it may also occur in the same locality, though independent of fractures, as the so-called *parosteal exostoses*, which are usually started by processes taking place in the bones. It is sometimes the result of long-continued mechanical irritation (bone growths in the adductor muscles of riders), and still more rarely the process may appear without any apparent cause scattered over the whole skeleton; in the latter case the muscles are converted into masses of bone for a greater or less distance from their insertions (*myositis ossificans multiplex progressiva*). This condition must not be confounded with the very rare calcification of the contractile substance.

5. **New formations** may result from *tuberculosis and syphilis*, both of which very rarely affect the muscles. Tuberculosis never occurs in the disseminated, miliary form, and very rarely as cheesy nodules or submiliary tubercles. The same may be said of the gummy tumors, which may be met with varying from the size of a hazel-nut to that of a walnut. Both they and the tubercles are found most frequently in the vicinity of similar pathological changes in the bones. Their diagnosis is made according to the rules already given in speaking of these tumors.

The most common tumor is the *sarcoma*, which appears either as a primary growth or (by extension from bone, for

instance) as a secondary form, and may become larger than a man's head. It is usually soft and composed of round cells, and is very often combined with other tumors, especially with myxoma (*myxosarcoma* of the thigh, etc.). The greater number of the muscular fibres at the periphery of the tumor become atrophied and destroyed, although the development of sarcomatous tissue from muscular substance has been described. The origin of these so-called muscular sarcomata is very rarely found in the muscles themselves, but they usually originate from the fasciæ, ligaments, etc.

Carcinoma never occurs primarily in the muscles, but secondary eruptions, which are in part accessory (filial nodules) and in part metastatic, are at times found; as a rule, they do not attain a very large size. The muscles take no active part in their development, but are frequently very much distorted, having rounded depressions upon their surface, etc. Cancer cells are sometimes found within the sarcolemma, although they have probably entered from without. These conditions may be very well seen even in fresh teased preparations.

All other tumors (*fibromata*, *lipomata*, *myxomata*, etc.) are less frequent, and easily diagnosticated.

6. The **parasites** which occur in the muscles still remain to be considered. The most important of these are the *trichinæ*, and they have already been spoken of in connection with the muscles of the neck and thorax. The *cysticercus cellulosæ* is also frequently found in the muscles. It always lies between the separated muscular fibres, surrounded by a fibrous capsule, and is usually of the size of a pea or bean. Several specimens are usually found in different parts of the body, although solitary individuals are sometimes observed. When cysticerci have been found in the brain, they must always be sought for in the muscles. *Echinococci* are rare.

6. THE JOINTS.

The examination of the joints begins with that of the exterior, and the condition of the capsule is then to be especially noticed.

(*a.*) *External Examination.*

The first point to be noticed is the *degree of distention* of the capsule, which determines at the same time the size of the cavity. This of course depends greatly upon the normal anatomical structure of the joints, since those provided with a loose elastic capsule (knee for instance), may undergo a greater amount of distention than others which have a very tense capsule (hip-joint, metatarsal joints, etc.).

Partial or total obliteration of the cavity of the joints may occur as well as their distention; the two articular surfaces are then united by the formation of fibrous or bony tissue. When the latter occurs the term *bony anchylosis* is applied; while the former is spoken of as *fibrous anchylosis*. The resulting immobility of the joint must not be confounded with *pseudo-anchylosis*, which depends upon a shrinking of the capsule, ligaments, fasciæ, etc., usually due to chronic inflammation.

The *form* of the capsular ligament may become altered by projections (herniæ) which may sometimes occur at certain portions of the wall.

The *color* of the external surface of the capsule is of but little importance, as it is usually the grayish-white of common fibrous tissue; the *consistency*, on the other hand, varies greatly, according as the cavity of the joint is filled with fluid (fluctuating) or solid material (firm).

It is very important to notice any alterations in the *continuity* of the capsule. *Perforation* may be very often suspected when a fistulous opening is observed in the integument, and a probe should then be carefully inserted. Periarticular abscesses may also occur, and their presence should likewise suggest the possibility of perforation. The cautious employment of the probe in these cases, is of great use.

Traumatic lacerations of the capsule differ from the perforations which result from ulceration. They are almost invariably caused by the protrusion of the articular head of the bone through a rent (*dislocation*), so that the external ap-

pearance of the joint is changed in the manner described in detail in every work on surgery. The term *partial dislocation* is applied when the two articular surfaces are carried out of their normal relative position while the capsule is intact. Dislocation may also result from the destruction of the capsule by ulceration as well as when it has been torn by violence, if the internal ligaments, or (in case of ball and socket joints, especially the hip) the cotyloid depression is destroyed.

(*b.*) *Internal Examination.*

When the external examination has been completed, during which the capsule is not to be cut into even if perforation exists, the capsule is to be opened as freely as possible; the directions for disarticulation are to be followed, and care must be taken to avoid injury to the surface of the joint. The *contents* are now to be examined.

1. The Contents.

Normal joints contain merely a few drops of *synovia*, which is a perfectly clear, viscid, yellow fluid; in the knee-joint, however, about a teaspoonful is usually found. When the contents of the joint are pathological, either a clear, colorless, *serous* fluid is present, or this fluid is mixed with *fibrine* or *pus;* the latter is often of an ichorous character, especially when the cavity of the joint communicates with the external air.

Loose bodies (corpora libera articulorum, mures articulares) sometimes occur in joints which present no other gross changes. These vary from the size of a millet-grain to that of an almond, are of a flat oval, irregular, or faceted shape, usually of a whitish color, and are either of a soft, cartilaginous, or bony consistency. When sections or teased fragments are examined microscopically, these bodies are found to be composed of fibrous tissue, frequently containing fat cells, or cartilage (hyaline and fibrocartilage), or bone. These tissues may also occur in combination.

2. The Internal Ligaments.

The internal ligaments (ligamentum teres, ligamenta cruciata), which exist in certain joints, are next to be mentioned. It is necessary to cut them through, in order to separate the articular surfaces from each other for the purpose of thorough examination. They become involved in many inflammatory affections of the joints, and may consequently suppurate, become necrosed, or ruptured.

3. The Synovial Membrane.

The synovial membrane, as is well known, is found only on the capsular ligament, and does not cover the articular surfaces. It may be *thickened*, both by simple œdematous swelling, and by an increase of its substance. Its *color* is pale-gray, but may become bright or dark-red from inflammatory distention of the blood-vessels, or from the presence of new-formed vessels.

The synovial *surface* may be covered with pus, or more rarely with fibrinous false membrane; it may be smooth, or transformed into a granulating surface. *Hæmorrhages* and small spots from *embolism* (ulcerative endocarditis), are found within the membrane; also gray submiliary tubercles (secondary forms), which are frequently recognized with difficulty. The *villi*, which arise from the normal synovial membrane, especially near its attachment to the bones, become unusually prominent (forming *papillary growths*) in all chronic, inflammatory affections of the joints, and are very important in connection with the origin of loose bodies. They are composed of a soft, vascular, fibrous tissue, rich in cells, and frequently contain small cartilaginous nodules, which may assume a bony hardness, from calcification.

These villosities must not be confounded with arborescent lipomata (*lipoma arborescens*), which consist of the projection of papilliform growths of the subsynovial fat tissue into the cavity of the joint. These may also become separated from their attachment, and then form free bodies.

Ulcerative processes also occur in the synovial membrane, and the latter is of course perforated when perforation of the capsule takes place. The perforation may proceed from within or from without, and it is sometimes very important to decide this question. The extent of the ulceration in the different layers of the wall is the important element to be considered, as in the cases of perforation of the intestine; if the ulceration is larger in the synovial membrane than in the fibrous capsule, it may be inferred that the perforation has taken place from within; if on the other hand it is larger in the capsule, it has probably taken place from the opposite direction.

4. The Articular Surfaces.

In examining the articular surfaces the condition of the articular cartilage is to be noted, also the possible presence of any bony surface, and the appearance of the articular sockets.

(*a.*) The *articular cartilage* is quite singular with respect to alterations in *volume*. At the point of greatest friction, namely, in the middle, atrophy takes place, while at the periphery the cartilage becomes hypertrophied; and these two changes may take place either singly or in combination.

Enlargement appears in the form of *excrescences*, which sometimes form a continuous projection entirely around the bone. *Atrophy* may be more or less extreme, even leading to complete destruction of the cartilage. If this is not connected with a separation of portions of the cartilage, it is due to *chondromalacia* and superficial *erosions*, or to *chondronecrosis* with separation of the necrosed portions. These separated portions may then be found as yellowish-white plates floating in the contents (pus) of the joint. Their cartilaginous structure and the constant fatty degeneration of the cartilage cells may still be plainly recognized with the microscope. Granulations often project from the surface of the bone which has been thus uncovered, and form fungous masses spreading over the surface and the surrounding cartilage.

Fibrillation of the intercellular substance gives rise to a velvety appearance of the surface, and to an apparent enlargement of the cartilage. In fresh vertical sections, which may be easily made, the surface of the cartilage is seen to be composed of papillæ (fibres) of varying size, and the cells are found to be greatly increased (formation of mother-capsules), but in a state of fatty degeneration. The fatty degenerated cells are set free by the disintegration of the intercellular substance, and may be found floating in the fluid of the joint.

Another pathological change which belongs under the head of atrophy, is the *fibrous degeneration* which cartilage undergoes in various affections, for instance, in adhesive arthritis, and in the cotyloid cavity after dislocation of the hip, etc., of long duration.

An alteration in *color* accompanies all these changes of volume and shape. The translucent bluish-white appearance of normal cartilage becomes rather grayish-white or yellowish-white, both in fibrous degeneration and in necrosis. When the layer of cartilage is very thin, its color becomes modified by that of the bone beneath. In one peculiar affection (arthritis urica), the cartilage (in other respects but little altered) has a perfectly white, chalky color, which is distributed in the form of spots of varying size. Examination with the microscope shows that the appearance is due to a deposit of crystalline urate of soda in the form of very fine needles, both within the cells and in the intercellular substance.

It has already been stated that the *consistency* of the cartilage is diminished in malacia, which precedes the erosions, and in fibrous degeneration. In the latter condition the consistency as well as the appearance, resembles that of velvet. The deposition of uric acid salts produces an increased hardness of the cartilage, but at the same time a certain amount of brittleness.

(*b.*) The *articular ends of the bones* lie exposed to a greater or less extent, according to the quantity of cartilage which has been destroyed. The *condition of their surfaces* permits a general conclusion to be drawn as to the acute or chronic

character of the process. In chronic affections, the surface of the bone appears as a compact but thin layer, so that none of the spongy portion is to be seen, while in acute processes the spongy masses are quite superficial and are usually in a state of disintegration (caries). In the latter case it is usually possible to determine the condition of the bone by the contents of the joint (pus), as extremely small pieces of necrosed bone are found in suspension, and produce a sand-like feel. Their bony character is easily determined by the microscope.

The *shape* of the articular ends of the bones is very much altered in acute and chronic affections, especially in the latter. The alteration of shape in the former is easily understood to result from the constant superficial detachment of the cancellated tissue of the articular ends; in the latter form the cause of the alteration of shape is by no means so evident. The change may be so great that in the hip-joint, for instance, the head of the femur is no longer recognizable. The greatest changes occur in the form of the so-called *friction-lines*, which appear at those points especially where motion causes the greatest amount of friction of the articular surfaces. The upper surface of the head of the femur, for instance, frequently appears perfectly flat, while the curve of the lower portion is scarcely altered. This, however, is not always the case, for upon careful examination it is frequently found that the head of the femur has completely disappeared, and with it a portion of the neck also, so that the apparent head is situated close to the shaft. This newly formed head is the result of two diametrically opposed processes, one of which is the gradual attrition of the old bone, and the other the formation of new bone at the periphery. Furthermore, in the old bone there is not only a constant destruction, but new bone is at the same time formed from the marrow (*osteosclerosis*), which closes the medullary spaces, and forms a compact narrow layer upon the surface, otherwise the spongy structure would be laid bare as in the acute process.

The *color* of the surface of the bone in chronic affections,

is that of ordinary bone; in the acute it is sometimes red, especially when granulations are present, sometimes yellowish when suppuration is taking place, and again greenish, when the process is one of an ichorous character. The *consistency* of the surfaces is soft in proportion to the number of granulations.

(*c.*) Ball-and-socket joints require further attention from the changes which may take place in the *socket* (acetabulum). The *dimensions* of the latter may be increased or diminished. The socket may be widened by acute or chronic inflammatory processes, and deepened by the formation of bone at the periphery, or by erosion and ulceration at the bottom, or by both these processes combined; the latter may even result in perforation. A diminution in the size of the socket resulting in its total obliteration, and at the same time accompanied by a conversion of the articular cartilage into fibrous tissue, occurs when the head of the bone is dislocated. In such cases a new socket, which is more or less perfectly formed and even lined with cartilage, is found near the old one, at the point where the head rests upon the adjoining bone. All of these processes occur principally in the hip-joint (coxitis, malum coxæ senile).

5. Special Morbid Conditions.

Most of the affections of the joints are of an inflammatory character, and all the parts are more or less involved, for when one is affected (synovial membrane, cartilage or bone) the others become so very quickly.

(*a.*) **Inflammations** are divided into the simple *serous* or *fibrino-serous* and the *purulent* form. In both the synovial membrane is either the first or one of the first parts affected. The first group is found in *rheumatism*, especially, and is characterized by a reddening and swelling of the synovial membrane, especially of its folds, and by a disturbance of its secretion. When much serous fluid is secreted, it is termed *hydarthrus;* an excess of fibrine on the other hand characterizes *arthritis rheumatica sicca;* if abundant so as to form a

membrane covering the bones and cartilage, the condition is spoken of as a *fibrinous* or *croupous arthritis*. Besides the synovial membrane, the bones, periosteum, and surrounding connective tissue are involved, being swollen, reddened, etc. The cartilage remains unaffected till the later stages of the trouble, when chondromalacia occurs. In the fibrinous forms fibrous tissue may replace the layer of fibrine covering the cartilage, and may become united to that lying upon the opposite surface, and thus lead to an obliteration of the articular cavity (*arthritis rheumatica adhæsiva*). The cartilage also is then either found to be actually converted, or in the process of conversion, into connective tissue. Ossification of the fibrous adhesions is seldom met with.

Chronic rheumatic inflammation may be defined as an affection of the joints, which is characterized on the one hand by a retrograde metamorphosis of the cartilage, even destruction of the articular end of the bone, usually without any excessive secretion; and on the other, by a growth of periosteum around the articular surface (peripheral bone formation), and also of the perichondrium (supracartilaginous exostoses, especially on the vertebral column). In the early stages the cartilage presents the cell proliferation already described; then fibrous degeneration and softening of the intercellular substance, which gives to the surface a velvety appearance. Later, the articulating surface of the cartilage has disappeared to a greater or less extent, but the edge is surrounded with a projecting ruff of cartilaginous nodules, and the bone becomes eroded, and deformed in the manner already described. Finally, the synovial membrane also becomes involved, and papillæ are formed which may contain fat, cartilage, or bone, and have suggested a resemblance between the membrane and a sheep's skin (Volkmann). The increase in the amount of secretion (secondary hydarthrus), which is sometimes met with, is to be attributed to the affection of the synovial membrane. The villi may become detached in the manner already described and remain as free bodies in the joint; still the detachment of

the peripheral nodular growths and the consequent formation of loose bony bodies occurs in this affection. The principal seat of this process is in the hip-joint (malum coxæ senile), where the socket may be worn away, and spontaneous dislocation with the formation of a new socket may occur.

Certain forms of chronic arthritis are due also to *syphilis*, and are especially characterized by the fact that when an erosion occurs in the bone, it is covered by a thin layer of connective tissue which extends through the cartilage into the bone ; a sort of scar results, which resembles the syphilitic cicatrices in other localities, owing to its irregular notched shape. Adhesions between the two articular surfaces are also frequent in this form.

Purulent articular inflammation may be acute or chronic. *Acute purulent arthritis*, unlike the forms already described, is rare, seldom occuring except in those cases where there is a special predisposition; its origin is either rheumatic, oftener traumatic, or is due to conditions present elsewhere, metastatic, in which case, as in the rheumatic form, many joints are affected (the polyarthritis of certain writers). It originates in the synovial membrane (purulent synovitis), but very soon extends to the cartilage and bone. The pus in the joint may be laudable or not (sanious, ichorous) ; it is usually ichorous in the metastatic form, and very often so when the disease is of traumatic origin, or has extended from some other point. Its character in these cases can usually be explained by a communication with the air or with ichorous abscesses, while in the first instance it must be attributed to the infective nature of the material which excites the disease. It is very probable, though rarely demonstrated, that emboli may act as a cause, for they produce purulent inflammation in other localities in the same general processes (ulcerative endocarditis, pyæmia, puerperal fever, etc.) in which the metastatic forms of synovitis occur.

The *synovial membrane* is much swollen, reddened, and covered with a layer of pus, appearances corresponding with the violence of the inflammation. With the microscope it is found to be completely infiltrated with granulation cells.

Perforations, whether primary or secondary, are of very frequent occurrence, and often of large size; those of secondary origin are situated at the points where the capsule is thinnest. *Periarticular abscesses* are then found outside of the joints and are frequently of large size.

The *cartilage* always becomes involved in purulent synovitis. In recent cases it is found to be thinned, and may even disappear, the bone being laid bare, especially at the sides where it is normally thinnest, and at the points of greatest friction. The cause of the disappearance is usually malacia (chondritis and ulceration of the cartilage, according to Rindfleisch and others), less frequently necrosis or separation resulting from osteomyelitis.

When the *bone* becomes involved the arthritis becomes a caries. The superficial layers of spongy tissue assume a yellow color, owing to the formation of pus among the trabeculæ, and the cancellated structure is necrosed (molecular necrosis of Volkmann). When the finger is passed over the surface little sand-like particles are felt, and the pus from the joint imparts the same sensation, as it frequently contains these particles, and little pieces of necrosed cartilage. The surface of the bone becomes more and more eroded, chiefly from friction, as may be recognized from the fact that the *friction-lines* are present, corresponding to the points of greatest pressure. This attrition takes place on the articular ends, and in the sockets of the joints, for instance, in the acetabulum, where it may reach such a degree that dislocation finally occurs, owing to the enlargement of the cavity.

The neighboring parts are always involved in these inflammations; osteomyelitis (even with partial necrosis), periostitis, parostitis, etc., occur.

Chronic purulent arthritis may be recognized externally, by the enormous swelling of the entire joint (the knee and tarsus are most frequently affected). When a section is made through the diseased portion only a firm, white fibrous tissue (hence *tumor albus*) is seen, which is produced by chronic

inflammation of the periarticular, intermuscular, and subcutaneous fibrous tissue, and which is often traversed by numerous sinuses lined with thick masses of granulations. In the joint itself little or no pus may be found, but the synovial membrane is converted into a soft, thick, vascular mass of granulations, which frequently nearly fills the articular cavity. The bone presents similar changes, which, according to Rindfleisch, represent the primary affection. An osteoporosis results from a growth of the marrow, the bony trabeculæ become diminished in size and partly necrosed, and the whole bone, the tarsal bones, for instance, becomes consequently so softened that a probe may be passed entirely through it with ease (*fungous caries*). The cartilage is also secondarily affected by malacia and necrosis, for the granulations which spring from the bone attack it from below, while its upper surface is covered with granulations which grow from the synovial membrane and erode it from above. In such cases the granulations perforate the cartilage and spread out like a fungus upon the surface. The cartilage also takes an independent part in the process, as the cartilage cells proliferate, the capsules become enlarged, and finally communicate with one another; a system of canals thus traverses the cartilage, and these canals constantly increase in size, owing to the disappearance of the intercellular substance, until the latter is entirely destroyed. These changes may be examined in suitable fresh preparations, but it is necessary to make vertical sections near the point where a perforation exists.

Tubercles are often found in the granulations arising from the bone, the synovial membrane, and the fistulæ, and in consequence of their presence Köster, Rindfleisch, and others have been led to consider this affection as essentially tuberculous; a view which is not shared in by others, Virchow, for instance, as the tubercles are not always present. One rare form of articular affection, *arthritis urica*, gout, still remains to be spoken of. The changes which take place in this affection are due to the presence of nodules (tophi) of varying size, composed of brittle, white, chalk-like masses, which are

seated in the membrane of the joints, in the neighboring parts, and may protrude externally through the perforated skin. These masses are composed of crystalline urate of soda and a very little fibrine. When the crystals are examined with a low power they appear to be acicular, but the use of high powers shows that they are rhombic prisms. The tophi also occur in the cartilage and bone, and may be very easily examined in sections made from the former. They are situated in the cellular cavities and in the intercellular substance. The crystals appear black with transmitted, and white with reflected, light. They disappear upon the addition of hydrochloric acid, and after a time whetstone crystals of pure uric acid are formed.

(*b.*) The subject of *dislocations* of the individual joints belongs to surgery, and detailed information may be found in the text-books on this branch. The anatomical changes, however, which the articular surfaces (especially the head of the femur and the acetabulum) undergo in long-standing dislocations, may be alluded to. The head of the bone presents the changes already described as occurring in chronic arthritis deformans, the old socket disappears and a new one is formed, to which, however, the head of the femur is frequently firmly adherent.

7. THE BONES.

The examination of the bones has for a long time been confined to those cases in which some disturbance could be recognized from without, or was suspected from the clinical history. In all other cases, unless attention was called to the bones by appearances elsewhere, their examination has been omitted in order to avoid possible mutilation, and also from the difficulty necessarily to be encountered in displaying the marrow. The frequency of different affections of the bones, and especially of the marrow, is therefore greatly underestimated. At the Pathological Institute in Berlin, for instance, metastatic tumors, especially cancer, disseminated tubercles, gummy osteomyelitis, etc., are not unfrequently

found; the simple reason being that in every case of extensive tumor formation, constitutional syphilis, and miliary tuberculosis, the osseous system is always examined. It is, of course, not possible to examine the whole skeleton, and the examination of one long bone usually suffices, at least in all general diseases, and also when no clinical symptom points elsewhere. The *femur* can be most conveniently removed, and should be sawed through longitudinally.

The *removal* is best accomplished in the following manner, as it necessitates the least amount of mutilation. A deep incision, extending to the bone, is to be made in the direction of the large femoral vessels (which also frequently need to be examined), from Poupart's ligament to the middle third of the thigh. The ligamentum patellæ is then cut through subcutaneously, and the knee-joint isolated by separating the skin from the upper part of the leg and the muscles from the lower part of the thigh. The capsular ligament is next cut through and the attachments to the femur separated from below upwards, till finally the capsular ligament of the hip-joint is stretched over the head of the bone, as is done in disarticulation, and the latter is enucleated. By means of a vise and saw the bone is usually sawed through in the direction of its neck, and the sawdust removed from the surface by means of a stream of water and sponge. Whenever pathological changes are seen on the exterior of the bone the direction of the cut may, of course, be changed. In the case of small children a very fine saw must be used, and it is often possible to divide the articular ends, which are frequently the only points of interest (in rickets, syphilis), with a stout cartilage knife.

In examining the *centre of ossification in the lower epiphysis of the thigh* of new-born children, which is very important in medico-legal cases, the knee is to be strongly flexed and the ligamentum patellæ cut through transversely. The patella is now freed somewhat at the sides, and a series of thin sections are to be made through the epiphysis parallel to its surface. The diameter of the centre of ossification in

the fully developed new-born child is from two to five millimeters; at the thirty-seventh and thirty-eighth week of fœtal life it is from one to one and a half millimeters; previous to the thirty-seventh week it is entirely absent.

The examination of the bones includes that of the bones in general and of the various component parts.

1. The Bones in General.

Variation in the number of bones frequently occurs, especially in the form of supernumerary joints in the fingers and toes, or of supernumerary fingers or toes. In such cases the external appearance does not always indicate the condition of the bones; for instance, the bones of a sixth finger may be present without any sixth finger, or the reverse may be the case.

An absence of joints is also met with, especially in monstrosities, the description of which is not within the plan of this book.

An increase in the *size* of the bones of one extremity or of the extremities of one side may be congenital (giant-growth); it may also be due to certain pathological processes and may affect many bones, as in rickets, or a single bone may be enlarged, from fracture, for instance. An abnormal diminution in size is much more frequently observed than an abnormal enlargement. The whole skeleton may be involved (rachitis), or a single extremity (after dislocation, paralysis, etc.), or single bones (after fracture, necrosis, affections of the epiphyses, etc.). Alterations in *shape* are very common, and are in part the result of curvatures following fractures or rickets, and in part due to circumscribed thickening or thinning, or both together. The "sabre-bones" (bow-legs) are caused by rickets; these terms are applied to the bones of the lower extremities, when bowed out and flattened.

The *color* of the surface of bones is usually grayish-white, but reddish spots are present in simple inflammation; a yellowish color is found in purulent inflammation and a slaty green in ichorous inflammation. The surface of the various

tumors is either white, like cartilage, gray, grayish-red, etc., according to their composition.

The *consistency* is diminished in osteomalacia and frequently also in rachitis, and may even become as soft as that of wax. The different tumors vary greatly in consistency, some being soft (medullary), others hard (fibrous), or cartilaginous and bony.

The consideration of bone in general also includes *solutions of continuity*, which sometimes appear as incomplete fractures (fracture of one side of a bone combined with angular deformity), especially in children, and again as ordinary fractures (complete solution of continuity). The subject of fractures belongs properly to the domain of surgery, and consequently it will only be mentioned here in brief, that different forms of *displacements* are distinguished when the ends of the fractured bone are not placed in exact contact, according to their normal relation. Dislocatio ad axin when the fragments form an angle; ad longitudinem, when one fragment overrides the other; ad peripheriam when a rotation upon the axis has taken place, so that the corresponding points of the periphery of the fractured surfaces do not coincide; dislocatio ad latus when the fractured surfaces present a lateral displacement. Impaction is a special variety of displacement (dislocatio per implantationem) in which one fragment (neck of femur, for instance), is driven into another (shaft of femur).

Spontaneous fractures are to be distinguished from the traumatic forms, which are always accompanied by laceration of the periosteum. The former are also usually produced by external causes, though these may be trivial, but the effect is due largely to the localized disturbances in the osseous tissue which have taken place, from the growth of tumors, etc. Very frequently large portions of the bone are then completely destroyed, so that displacement, in the ordinary sense of the term, cannot be spoken of.

2. The Component Parts of Bone.

After the general characteristics have been considered, the component parts of bone, namely, the periosteum, osseous tissue, and marrow are to be examined.

(*a.*) The Periosteum.

1. *General Appearances.*

In examining the *periosteum* the first thing to be determined is its *relative position.* It may be *separated* from the bone in consequence of injuries, abscesses, tumors, etc., or may present *lacerations* or *defects*, which may also be due to injury, inflammation, etc.

It is increased in *thickness* in acute and chronic inflammation; in the former by an increase of its cells and interstitial fluid, and in the latter by the formation of a dense fibrous tissue. Its normal color is grayish-white, but in acute inflammation it becomes dark-red, the tint varying according to the intensity of the inflammation; in purulent inflammation the color is frequently yellowish, in ichorous greenish, and in chronic inflammation white.

It has a soft *consistency* in acute inflammatory swelling, owing to the absorption of fluid and its richness in cells, and becomes very firm in the chronic forms.

2. *Special Morbid Conditions.*

(*a.*) The **inflammations** are the most frequent and the most important of the *periosteal affections.* Simple inflammation presents peculiar characteristics, as it may give rise to the formation of masses of bone (*periostitis ossificans*); this is in fact but an exaggeration of the physiological purpose of the periosteum, which serves as the matrix for the growth of bone in thickness by the apposition of new layers. In very recent cases the periosteum appears thickened, its deeper layers denser, but still capable of being cut. In thin vertical sections made through the membrane several trabeculæ will be found, composed of osteoid tissue, in the midst of a tissue containing numerous round and spindle-cells. Some

of these trabeculæ are perpendicularly to the surface of the bone and others join them together (*spongoid*). These osteoid columns differ from true bone in the absence of lime salts and in the appearance of their corpuscles, which are rather plump, more rounded, and the projections are thicker. They then become converted into true bone by the reception of lime salts, and form the spongy or laminated *osteophyte.*

At a later period the sponge-like character of the new formation disappears. It is converted into a compact bony mass by the formation of concentric plates of bone in the spaces between the trabeculæ of the spongoid osteophyte, till merely a small space (for the blood-vessel) remains. This mass is firmly adherent to the bone, while the spongoid osteophyte is the more easily detached the younger it is.

Finally, there is a still later stage in which a partial absorption (*osteoporosis*) of the compact osseous tissue takes place secondarily by the formation of the true medullary spaces. The *callus* which forms in the healing of fractures is a peculiar variety of this ossifying periostitis. It differs from the preceding in the production of a great quantity of material, and in the fact that the newly formed mass remains longer in the stage of osteoid tissue.

A third form occurs in *rachitis.* The soft, internal layer of periosteum is considerably thickened and of a dark-red color, owing to its very vascular condition. This soft tissue contains very thin and delicate osteoid columns, which frequently are not converted into true bone till the rickets has run its course.

Purulent inflammation of the periosteum is characterized by the presence of pus between the thickened and reddened membrane and the bone; the pus arises from the deepest layer of the periosteum, and its formation causes the detachment of the latter. When the acute stage is completed granulations are formed upon the inner aspect of the periosteum, from the surface of which the pus is then produced. The important secondary changes in the bones will be considered later.

The periosteum may become perforated and the pus escape into the neighboring parts, an event which is very likely to take place when the suppuration is of an ichorous character.

Periostitis with cheesy metamorphosis of the inflammatory products (*periostitis caseosa*) is rare, but *gummy periostitis* is more common although less frequently met with in the dead body. In the earlier stages the deeper portions of the thickened periosteum appear to be converted into a soft gelatinous mass, in which numerous round cells may be recognized with the aid of the microscope; while in the more superficial and denser layers fusiform and stellate cells, and also fibres are generally found. The innermost layers very quickly undergo the well-known retrograde metamorphosis (fatty degeneration), and then appear as a homogeneous, rather tough but elastic, sulphur-yellow mass, which presents a great contrast to the reddened portion surrounding it, in which an ossifying periostitis is always present. Vestiges (loss of bone) of this process are much more frequently met with than these recent forms, and will be more fully considered directly.

(*b.*) These varieties are allied to the **tumors** of the periosteum, the bony forms of which are first to be considered. They cannot be separated from inflammatory periosteal growths of bone, and the greater number of them are of this nature.

These tumors are termed *exostoses* (more exactly external exostoses). They consist of the circumscribed production of bone in the form of a tumor, firmly attached to the bone, and as a rule apparently belonging rather to this than to the periosteum, although their development takes place from the latter in the same manner as the periosteal ossification, which has been described. The secondary formation of medullary spaces (*exostosis spongiosa*), which has been spoken of, does not take place in all, but some of them consist of an extremely dense, white, osseous tissue (*exostosis eburnea*). These exostoses never attain a large size.

The *sarcomata* are next in frequency to these, and all varieties occur, round-, spindle-, and giant-cell forms. The sar-

coma which arises from the periosteum is usually hard, that from the marrow soft, and they both possess to a remarkable degree the same power to ossify that exists in the tissue from which they spring (osteosarcoma). Giant-cell sarcomas frequently possess a brownish-red or brownish-green color, which is in part due to hæmorrhages and in part is an essential characteristic of the tumor itself.

True *enchondromata*, perhaps, do not occur in the periosteum, as the possibility always exists that they have sprung from the osseous tissue. There is a form of tumor, however, which arises chiefly from the periosteum, and which, although it does not contain hyaline cartilage, still is composed of that cartilaginous transitional tissue which has been termed osteoid tissue. These tumors have therefore been called *osteoid tumors*. They frequently contain portions composed of bone, and metastases of similar structure may take place in the internal organs (malignant osteoid of Johannes Müller).

The existence of primary *carcinoma* in the periosteum is likewise very questionable. Epithelial cancer with its familiar large epithelial plugs, may be found in the tibia, for instance, but it always originates in the skin, although it may be less extensive in the latter. Soft tumors, which are commonly called cancer, sometimes originate in the periosteum, but ought, perhaps, to be considered as *alveolar sarcoma*. In most cases of cancer in bone the tumors proceed from the marrow.

(*b.*) The Osseous Tissue.

1. *General Appearances.*

In examining the substance of the bone the part first to be considered is: —

(*a.*) The *surface*, where *thickenings* may be found as the result of inflammation and tumor formation in the periosteum. It has already been stated, that after the acute process has run its course, the resulting new-formed mass appears to belong to the bone. If the formation of bone extends over

the whole or the greater part of the surface, the term *hyperostosis* is applied; if it extends over only a small portion, *periostosis;* while, if it appears as a circumscribed tumor, it is then called an exostosis, as above described.

There is also an external atrophy, *concentric atrophy*, which is not only found in normal bone, but also as a very sanatory process in that which is newly formed, for instance, in callus. Wegner has demonstrated the interesting fact that pathological atrophy also is caused by giant-cells, myeloplaxes, Kölliker's osteoclasts, and consequently the giant-cells may be obtained for microscopic examination by scraping the surface of atrophied portions.

The *color* of the surface of the bone may often be of great diagnostic value. A whitish, chalk-like, and irregular discoloration is characteristic of the smallest osteophytes; necrosis of the bone is often only to be recognized by the uniform grayish-white color contrasted with the grayish-yellow of normal bone. Redness of the surface always indicates an abnormal formation of medullary spaces and vessels.

(*b.*) In a *section* through the bone, especially in the interior of the latter, *hypertrophy* may also be seen. It is present principally in the spongy portion, and consists of a diminution in the size of the medullary spaces, owing to a thickening of the cancellated structure (*osteosclerosis*), and may become so extreme that a perfectly compact bony tissue results. This change is of an inflammatory nature, and originates in the marrow (*osteomyelitis ossificans, vel ostitis ossificans*), as external hypertrophy arises from the periosteum. A second form is also recognized, and appears as an increase in the thickness of the bone toward the medullary canal, which may become completely closed (in fracture, for instance), and is also due to an ossification of the marrow.

Atrophy is represented by *osteoporosis*, a condition in which the normally compact bone becomes filled with medullary spaces, and resembles spongy tissue; or the normal cancellated structure of the spongy tissue becomes more delicate and less abundant. This condition is also the result of an

inflammation (*rarefying ostitis*), and consists of a transformation of the osseous tissue into red marrow.

Osteomalacia also belongs under the head of atrophy, according to Virchow, and is to be considered as an excessive metamorphosis of bone into marrow, occurring in unusual places, and during which the intervening stage of osteoid cartilage is present. Red, yellow, and gelatinous atrophy, are distinguished according to the character of the newly formed marrow, and the first of these forms is acute, occurring in young subjects. Microscopic preparations may be easily obtained from this spongy bone, by making sections or by breaking off spiculæ of bone. The atrophied trabeculæ are very distinctly seen surrounded by a border of osteoid tissue, which is deeply stained with carmine, and the medullary spaces are dilated and filled with hyperæmic, even hæmorrhagic marrow. When the *color* is white, or grayish-white, it is important as indicating necrosed portions. The *consistency* is diminished in osteomalacia and in extreme cases of rickets.

2. *Special Morbid Conditions.*

(*a.*) The most important affections of the osseous tissue are the *purulent* inflammations (caries), which have been mentioned in connection with the articular ends of the bones. The necrotic destruction of the minutest portions of bone (molecular necrosis) takes place in other portions, as well as in the ends of the bone, as the result of the extension of inflammation from the periosteum or marrow, and an ulcer of the bone results. Purulent inflammation in compact bone is always combined with osteoporosis, as a transformation of osseous tissue into marrow first takes place, after which pus is formed in the latter and gives rise to necrosis. The pus is formed at the same time in different localities which do not directly communicate, and is therefore infiltrated through the osseous tissue, and does not collect in abscesses as in fibrous tissue. There is a second form of purulent inflammation of bone which differs from the above extended variety in its method of origin; it is limited to the vicinity of dead pieces

of bone (necrosis) where it produces *inflammatory demarcation*, as happens in other organs, in which dead parts are separated from the living by a purulent inflammation around the former.

Necrosis, the death of a large piece of bone, may be due to various causes, the most common of which is external violence (necrosis from concussion); it may also be due to inflammation of the neighboring parts. For instance, necrosis of the most superficial lamellæ of bone (*superficial necrosis*) always follows the detachment of the periosteum from the bone by pus, and the same result occurs in the interior of the bone (*central necrosis*), when the marrow is inflamed. The necrosed fragment is characterized by its white color, complete deprivation of blood, and by its being more or less separated, according to the duration of the process, from the surrounding parts by purulent inflammation (caries). A peculiar form of caries is produced by *syphilitic processes*, as gummata are developed in the superficial portions of the bone in connection with a gummous periostitis, and a depression (scar) remains in the bone after they become disintegrated. There is no formation of pus in such places, though a purulent ostitis may accompany the process.

(*b.*) There are but few **tumors** developed in the osseous tissue. Small osseous growths of a tumor-like character are found in the spongy tissue (*enostoses*); but the most important forms are the peripheral *enchondromata*, the development of which Virchow is very much inclined to attribute to the inclusion of portions of cartilage which remain undeveloped within the bone (rickets). The osseous tissue plays a negative part in the formation of many tumors of the marrow.

(*c.*) There are certain **alterations of the epiphyseal cartilage** which occur at the *line of ossification*, and affect both cartilage and bone. The changes occurring in *rachitis* are first to be mentioned, and are evinced by an increase in the width of the translucent, bluish-gray zone of proliferation in the cartilage; also by an increase in the width and an irregular course of the white layer of provisional calcifica-

tion, and by an irregular extension of the medullary canals with their loops of vessels. With the microscope the normal growth of the cartilage cells is seen to be greatly increased, the cells and intercellular substance are dropsical, the zone of calcification is very wide and provided with numerous, often wide projections; the formation of bone takes place in a similar irregular manner, and a direct ossification of the cartilage is often apparent. It may be stated in general that those processes which normally follow one another in the transformation of cartilage into bone, pursue their course side by side in rickets. Many pieces of cartilage never ossify, and it is from them that enchondromata may be developed at a later period.

Another very interesting and important affection of this zone is due to intra-uterine *syphilis*, and indicates hereditary syphilis. In this, too, there is great irregularity in the calcification, very similar to that in rickets, and a layer of soft, yellowish-white tissue lies between the calcified portion and the bone, which is considered by Wegner as inflammatory (hence *osteochondritis*), and by Waldeyer and Köbner as *gummous*. A very great development of this tissue may cause a separation of the epiphyses.

A special form of osseous tumor, the *cartilaginous exostosis*, originates in the epiphyseal cartilage. It may occur as a multiple growth on the same or on several bones. A long bony process, the point of which is covered with cartilage, projects from the joint. It seems as if the epiphyseal cartilage retained its natural function of producing bone even in its pathological outgrowths.

(*c.*) The Marrow.

1. *General Appearances.*

The marrow of the long bones varies greatly in *quantity*, the medullary spaces of the spongy portion, in particular, being sometimes increased in size (osteoporosis), and sometimes diminished (osteosclerosis). The *color* is rather more important, not only that of the marrow as a whole or of large

portions of it (red, yellow, fatty, translucent, and brown), but also of small circumscribed portions (red, dull yellow, lemon-yellow, greenish, etc.). The *consistency*, which is ordinarily very soft, may become decidedly gelatinous, even quivering, or else more or less indurated; the latter condition is usually limited to small circumscribed portions of the tissue.

2. *Special Morbid Conditions.*

The marrow undergoes considerable change in the normal processes of development and growth, and is liable to a large number of pathological changes, as has been more and more made evident in recent times. In young people the marrow of all the bones is red and very rich in round, colorless cells with large nuclei; but after puberty the red color, though retained in the flat bones, vertebræ, etc., is replaced in the long bones by a yellow color, fat being deposited in the cells and fatty tissue formed. This yellow or fatty marrow often becomes of a light brownish color, translucent, and of a jelly-like consistency (gelatinous marrow) in old age. A pathological reversion to the red variety sometimes takes place in the fatty marrow of adults, in consequence of inflammation or the development of new formations, and may involve the whole marrow of the bone in which the process is seated, or only limited portions of it; this reversion invariably takes place before fatty marrow is converted into pus or a new formation. The fatty marrow, on the other hand, sometimes passes over prematurely into the gelatinous variety, as a rule in consequence of some cachexia, and this gelatinous atrophy is generally associated with atrophy of the cancellated structure of the epiphyses, or osteoporosis.

(*a.*) Of the different forms of **inflammation** to which the marrow is subject, the ossifying form (*osteomyelitis ossificans*) is rather reparative or protective in its nature, and often forms a barrier to the extension of more dangerous processes; it is by this process, for instance, that the medullary cavity is sealed up and recovery rendered possible in fractures, amputations, and disarticulations of the bones, and also by this process that a bony capsule is sometimes formed round tumors, etc.

Purulent osteomyelitis is manifested by circumscribed yellow spots from which a thin fluid can be squeezed out, and occurs by preference in the epiphyses, especially of young subjects. The yellow spots of suppuration are always surrounded by the red variety of marrow. The pus corpuscles are generally found to be much disintegrated, and the pus is so corrosive in character that the operator must be on his guard against infection. Purulent osteomyelitis may give rise to *necrosis* of portions of the bone, especially in those cases in which the inflammation is of a putrid character (*osteomyelitis ichorosa*); these cases are indicated by a more or less dark greenish discoloration of the marrow.

Pus may undergo cheesy degeneration in the bones, as well as in other organs, of *scrofulous* subjects, and the cheesy masses are always surrounded by a red zone. *Osteomyelitis caseosa* occurs chiefly near the articular ends of the bones and there forms the anatomical basis of caries of the joints.

(*b.*) *Syphilitic osteomyelitis* (*osteomyelitis gummosa*) bears a very close resemblance to the cheesy form, the yellow masses to which it gives rise being only rather more dense, of a shade more like that of sulphur, and, as elsewhere, presenting under the microscope evidence of fatty degeneration. This affection is much more common than was formerly supposed, and leads us next to the consideration of tumors in this locality.

Tubercle occurs in the marrow both as the circumscribed or secondary form about collections of cheesy material, and as the miliary, disseminated form; in the latter, the granules are often very difficult of recognition from their close resemblance to transverse sections of the bony trabeculæ; but their true nature is shown by the facility with which they can be isolated and removed from the red marrow in which they are imbedded.

Myelogenous or *endosteal sarcoma* is generally softer than periosteal sarcoma and, even after having attained the size of the head of an adult, may be enclosed in a thin shell of bony tissue (tumeurs enkystes) which cannot be regarded as

the remains of the old bone, but as newly developed from the periosteum. These tumors may be of either the round-, spindle-, or giant-cell variety, and the soft round-cell sarcomas, in particular, are very vascular and often the seat of large multiple hæmorrhages (*sarcoma telangiectodes*, *fungus hæmatodes*). Cysts, usually multiple, may result from hæmorrhages as well as from partial mucous degeneration. *Myxoma* is rather more rare, *enchondroma* more common, while primary *carcinoma* is very rare and, if indeed it occurs at all, would perhaps be more properly classed as *alveolar sarcoma*. Metastatic nodules of carcinoma, on the other hand, are very common, multiple, and rarely exceed a bean in size. A highly vascular form of carcinoma is also met with which pulsates during life, and may be the seat of hæmorrhages and their consequences, precisely like the similar form of sarcoma. The occasional occurrence of fracture, in consequence of the development of a soft variety of tumor, has been already alluded to.

It only remains to mention a few rare changes which are sometimes found in the marrow in certain diseases. In *relapsing fever* a species of local necrobiosis occasionally takes place, and forms a circumscribed mass consisting of disintegrated cells and fatty degenerated capillaries.

In many cases of *leucæmia*, etc., a peculiar enlargement or swelling of the marrow is sometimes found, which is associated with a grayish-purple, yellowish, or even puriform, discoloration; the enlargement as well as the discoloration depends on the presence of masses of the lymphoid, transition form of red blood-corpuscles (nucleated red blood-corpuscles). Even when the leucæmia is not absolutely myelogenous there are invariably found large numbers of those colorless octahedral crystals which have already been spoken of, and which are usually found after death in all bone-marrow, though in smaller numbers. Cohnheim has called attention to a change which he finds in the marrow in *pernicious anæmia*, and which is very similar to that above described. The marrow is deeply reddened, and is said by him to con-

tain numbers of colored corpuscles with colored nuclei, in addition to the large and small colorless marrow-cells and normal red blood-disks.

In *typhoid fever* it is not uncommon to find that the reddened bone-marrow contains a few nucleated red blood-disks and many cells containing red blood-disks.

3. Morbid Conditions of the Bones in General.

The changes which occur in the individual component parts of bone having been described, some of their chief combinations in these different parts remain for consideration.

(*a.*) **Fracture** of bone is attended with changes in all the parts of which bone is composed and in the neighboring tissues, and the age of a fracture can be approximately determined only through an acquaintance with the modifications which these changes undergo with the lapse of time. The length of time which is required for the reparative process depends in any given case on the extent and nature of the fracture, and the reaction of the bone and soft parts, etc.; it is therefore impossible to lay down exact rules which will include all cases. In general, however, in simple fracture of a long bone, without excessive displacement of the broken ends, more or less effusion of blood takes place soon after the injury, between the surfaces of the fracture as well as in the surrounding soft parts, and from the condition of this blood a conclusion can be drawn as to the age of the injury. At the beginning of the second week the blood gradually disappears, while the surrounding soft parts and periosteum become thickened and reddened, and the marrow changes from yellow to red at the seat of fracture. In the third week, while the inflammatory swelling leaves the soft parts, the *callus* (*periosteal*, *myelogenous*, *parosteal*) is formed from the periosteum, the marrow, the fractured surfaces of the bones, and (especially when there is considerable displacement) from the neighboring connective tissue. This callus, consisting at first of fibrous, and later of osteoid tissue, begins to be converted into bone from within outwards in the

fourth week, and between the seventh and ninth week is converted into bone throughout. It is then diminished in size and loses its angles and roughness by concentric atrophy from without, while *excentric atrophy* begins simultaneously in the medullary cavity, which was more or less closed by the myelogenous callus; the cavity in both ends of the fractured bone is not only thus restored, but the two cavities are united into one, even when one fragment overrides the other. This osteoporosis of the inner layers is the third change undergone by the callus, and compact bone is left only on the outside. The duration of these changes is from ten to twelve weeks in the simplest fractures, but may continue for years in cases of great displacement.

A *false-joint* is said to exist when the fractured ends fail to unite by bone, but this term should be properly limited to those cases in which the medullary cavities are closed by a myelogenous callus, the surface of which is covered with cartilage, and a true articular cavity lined by connective tissue is consequently formed between the two fractured ends. In spurious false-joint the fractured ends are merely more or less closely united by a fibrous callus.

(*b.*) **Rachitis**, or *rickets*, is a disease of early childhood (from six months to five years), but sometimes produces changes which persist up to extreme old age or death. The first stage has already been described, and consists in thickening of the articular ends of the bones (double-joints); the second consists in the deposition under the periosteum of soft, osteoid, but uncalcified layers; and the third stage of the process consists in greatly increased absorption of the bone from within, consequent widening of the medullary canal, and unnatural redness of the marrow from vascular dilatation, especially in the more severe cases. The two latter processes greatly impair the rigidity of the bones, so much so that bones which are thus affected bend very easily and can readily be cut with a knife, like the bones in osteomalacia; this affection may, however, be distinguished from rickets by the fact that in it the old bones lose their lime-salts

and disappear, while in rickets, the new bone fails to acquire them. Curvature and deformity thus easily result, and may remain permanently after the condition which gave rise to them has been recovered from by a subsequent deposition of lime-salts, sometimes more abundantly even than is normal.

(*c.*) The various forms of **inflammation** are very often found combined in the same bone, and even in the same portion of the same bone. Nothing is more common, for instance, than a combination of purulent osteomyelitis and ossifying periostitis, which latter reaches its greatest intensity at that part of the surface corresponding to the seat of the former, but is more widely extended. Ossifying periostitis is also found in the neighborhood of abscesses or gummata of the periosteum, and in the caries of the articular ends of bones which results from suppurative arthritis. The height of complication is, however, reached in *necrosis*, particularly when it involves a central portion of the bone. The bit of dead bone, or *sequestrum*, is surrounded and detached by caries of the bony tissue; new bone is thrown out from the periosteum, sometimes over the greater part of the surface of the bone and in large quantities, but chiefly over the sequestrum, which thus becomes enclosed in a sort of capsule, in which are fistulous passages of greater or less size leading down to the dead bone. The surrounding soft parts are in a condition of chronic inflammation, and are likewise more or less riddled with fistulæ, while ossifying inflammation is set up in the marrow; the latter process assists in the formation of the capsule of the sequestrum, and may lead to closure of the medullary cavity.

(*d.*) A few words may be said with regard to **syphilis** in bone. As in other tissues, any or every form of inflammation (ossifying inflammation inclusive) may be indirectly of syphilitic origin, though the only forms of a true specific nature are gummous periostitis and osteomyelitis, and these forms can be recognized as specific only when the gummy formation has not been absorbed. If absorption has taken place irregularly shaped depressions and defects are found

on the surface of the bone, which may be the result of other and entirely different affections, but always awaken the suspicion of syphilis, especially when they are multiple. This very element of multiplicity may, indeed, excite suspicion of the real nature of inflammations which are apparently perfectly simple, but never justifies the positive diagnosis of syphilis unless it is supported by other evidences. The partiality which is shown by syphilitic inflammation for the anterior surface of the tibia is well known and of clinical value; its cause may perhaps lie in the extreme liability of the part to mechanical injury.

(*e.*) Brief allusions must finally be made to the condition of the bony tissue bordering on **growing tumors.** Ossifying inflammation is very apt to be set up both in the periosteum and marrow, and osteoporosis is often combined with these processes, especially when the growth originates in the marrow. These myelogenous tumors often make great demands on the periosteum, which is obliged to form new bone constantly in order to cover the increasing surface of the tumor (encysted tumors).

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