few small blood clots" (*Medical News*, May 2d, 1896). In some cases, after standing for a short time, the entire mass of the urine coagulates so as to resemble *blanc-mange*.

Diagnosis.—There is no difficulty whatever in making the diagnosis of chyluria. Lipuria, which signifies literally the presence of fat in the urine, should never be confounded with it. In chyluria the fat is in the form of an emulsion so fine as to require the strongest objectives to resolve the droplets of fat. In lipuria, on the other hand, fat globules are seen with comparatively low powers, either free or enclosed in cells or tube casts. It is very seldom that lipuria exists in such degree as to alter the macroscopic appearance of the urine, while in chyluria it commonly resembles milk. The presence of clots is also diagnostic of chyluria. The fat may be separated from chylous urine by shaking it up with ether. The ether, with the dissolved fat, rises to the surface and is then decanted. On its evaporation the fat is deposited. The urine from which the fat has been thus extracted and consequently rendered more or less transparent may now be tested for albumin, which is constantly present in greater or less degree. In addition, chylous urine contains cholesterin and lecithin, and among the albuminous bodies, in addition to serum albumin, it contains fibrinogen, hemialbumose or propeptone, and peptone. It is stated positively by Senator that chylous urine does not contain sugar. This remarkable fact—namely, the absence from chylous urine of a constant ingredient of chyle—has given rise to the opinion that chyluria is not caused by a direct admixture of chyle with the urine. In the opinion of the writer this view is absolutely refuted by the post-mortem appearances observed in cases of fatal chyluria. These consist, for the most part, of a state of varicosity of the lymphatics in immediate relation with the urinary tract. In a case of my own, "the lymphatic vessels, especially those of both renal vessels, were enormously dilated and convoluted, many of them being of the calibre of an ordinary lead pencil. The dilatation was most marked on the right side, and in the pelvis of the corresponding kidney there was a pale lymph clot similar to the coagula passed with the urine during life" (*loc. supra cit.*). In this case the communication between lymphatic and urinary tracts was practically demonstrated. It is possible that the absence of sugar from chylous urine may be due to the presence of some as yet unrecognized glycolitic ferment in the renal secretion.

In all cases of chyluria both the blood and the urine should be examined for the filaria. In the former there is little difficulty in finding it provided the blood be withdrawn (by needle puncture of finger or ear) during the night. In the urine the parasite is apt to escape detection because it is frequently enclosed in coagula. These should therefore be broken up with a glass rod and the urine allowed to stand in a conical glass, at the bottom of which the liberated filariæ may be found.

Prognosis.—The prognosis of chyluria is not unfavorable, but depends largely upon the mode of life of the patient. Manual labor and severe physical exertion of any kind tend both to develop and to perpetuate the disease. In women the pregnant condition is a serious complication.

Treatment.—With a view to prophylaxis, a sedentary occupation should be recommended in preference to one demanding physical exertion, and with the same object in view, straining at stool should be avoided by the occasional use of laxatives. As long as the urine is chylous, the strength should be maintained by nutritious food, tonics, and stimulants, and the patient kept at rest. It is doubtful whether any among the numerous remedies employed in chyluria are of the slightest direct benefit. With a view to their supposed efficacy in checking the discharge, astringent preparations of iron, gallic acid in large doses, and various vegetable decoctions containing tannin have been administered. In the parasitic form of the disease attempts have been made to destroy the filaria with thymol and other vermicides, none of which, in the opinion of the writer, has the slightest effect in this direction. I have elsewhere discussed the treatment of filariasis, and will therefore confine myself to the statement that there is no drug that will kill either the adult filaria or its embryos while they circulate in the blood, and that even if such a drug were known it would be wisest to refrain from its employment. When the adult filaria has its seat in one of the extremities and dies, an abscess usually results; or it is perhaps more correct to say that adult filariæ have been found in such abscesses, the presumption being that the latter are caused by the former. If, however, the adult filaria should die in the thoracic duct, with consequent abscess, the result would be of necessity fatal.*

Frederick P. Henry.

* F. P. Henry, M.D.: Report of a Case of Indigenous Parasitic Chyluria; Med. News, May 2d, 1896. Remarks on Filaria; Proceedings of the Academy of Natural Sciences of Philadelphia, 1896, p. 271.

CHYME.—The term chyme is applied to the contents of the small intestines, or, in a more restricted sense, to the matter ejected from the stomach into the duodenum during the course of digestion. It consists of food in various stages of digestion mixed with the different digestive juices. It is a mixture of extreme complexity and of very variable composition. Its composition at any one time is determined by a number of factors, the most important of which are as follows: (1) The character and composition of the food; (2) the digestive juices—the saliva, gastric, and pancreatic juices, the succus entericus and the bile; (3) the extent to which absorption has occurred; (4) the motility of the stomach and small intestines. Under normal conditions the food ingested is the most important factor in determining the character and composition of the chyme. The food not only contributes its own constituents, which may be extremely complex, but also determines, to a large extent, the amount and nature of the secretions of the glands of the alimentary tract which are added to the chyme; further, one secretion may influence another, and both a third, and all undergo certain chemical reactions with the food and with each other. The movements of the stomach and intestines are influenced largely by the character of the food and the secretions caused by it; the chyme may remain a longer or a shorter time in the intestines, and so offer the digestive juices varying opportunities to act upon it. All these factors—character of food, the secretions, and especially the intestinal movements—influence the absorption of certain constituents by the intestines.

It is obviously impossible, when dealing with such a complex and variable mixture as chyme, to give any account of either the chemical or physical properties which will apply to any but individual cases. In considering these properties it will be necessary to discuss in each case the influences modifying them.

A great many of the facts known concerning the chyme have been obtained from experiments upon the lower animals, but there have been reported a number of cases in man in which the contents of the small intestines have escaped through an artificial anus. Elaborate studies have been made in some of these cases. The case most carefully studied was one reported by Macfayden, Nencki, and Sieber (*Archiv für exper. Path. und Pharmakol.*, xxi., p. 93, 1891). These authors had under investigation a woman in whom, as a result of an operation for strangulated hernia, an *anus præternaturalis* had been established at the lower end of the ileum, and from which the chyme could be collected. Jankowski (*Archives des sciences biologiques publiés par l'instit. de méd. exper. à St. Petersbourg*, i., p. 567, 1892) studied a case very similar to the above. Other cases which may be mentioned are those of Busch (Virchow's *Archiv*, 14, p. 140, 1858), in which the fistula was but a very short distance below the duodenum; of Lossnitzer (Dissert., Leipsic, 1864); of Braune (Virchow's *Archiv*, 19, p. 470, 1860), and of Ewald (*ibid.*, 75, p. 409, 1879). The objection has been made to all such cases as these that the intestine is not in its normal condition; that when an artificial anus is established the part of the intestine immediately above becomes, functionally, the rectum; and it is thought by some that

bacteria normally present in the large intestine may develop here and produce changes not normally occurring. Entirely satisfactory evidence that such objections are valid has not yet been offered, but it is important to remember them and to check the observations on patients with such fistulæ by experiments on normal animals whenever possible.

Chyme, as obtained from a fistula in man or directly from the small intestines in an animal, is a fluid or semi-pasty mass with a yellow or yellowish-brown or orange color. The chyme of the stomach or of the upper part of the duodenum is usually more grayish in appearance, although it may be colored brown from partly digested blood, or green from chlorophyl of the food. The yellow color observed in the lower part of the small intestine is due largely to the admixture of bile.

The odor of chyme is usually not very marked; that which is present resembles that of fatty acids. Occasionally it has a slightly fæcal odor (resembling indol) like that of the large intestine; but this is rare, as very little putrefactive decomposition of proteids (which is the cause of the odor of the contents of the large intestine) occurs in the small intestines.

The consistence of the chyme varies in different parts of the small intestine. When it leaves the stomach, it is a thin fluid holding solid masses of various sizes in suspension. As it passes down the intestine water (and bodies soluble in water) are absorbed; but this loss is about balanced by that added by the secretions of the digestive glands, so that the consistence remains nearly uniform in the upper two-thirds of the small intestine. In the lower third or fourth, however, the water absorbed exceeds that secreted, and the chyme becomes thicker and may be pasty or semi-solid. The nature of the food has, moreover, an important effect upon the consistence of the chyme.

The quantity of chyme which passes from the ileum into the cæcum varies greatly, being dependent largely upon the character of the food. The following figures are taken from the paper of Macfayden, Nencki, and Sieber. The patient was fed upon a diet consisting of 260 gm. of bread, 100 gm. of meat, two eggs, 200 gm. of barley gruel, 20 gm. of peptone, 60 gm. of sugar, 100 gm. of milk, and 1,050 gm. of bouillon; in addition to this she was allowed 200 gm. of water, 200 gm. of wine, and 150 gm. of "grog." The chyme was collected as it escaped from the lower end of the ileum. With the above diet, in which nitrogenous food preponderated, the intestinal contents were of thin consistence and contained on an average 5 per cent. of solids and 95 per cent. of water. At times they had the appearance of diarrhœic stools. When the patient received a vegetable diet the discharge became more consistent and contained on an average 10 per cent. of solids. The maximum amount of the thin discharge in twenty-four hours was 550 gm. with 4.9 per cent. of solids. The maximum amount of the more consistent discharge was 232 gm. with 11.23 per cent. of solids. Very similar figures were obtained by Busch, although in his patient the fistula was above the middle of the small intestine.

The solid constituents of the chyme are derived almost entirely from the food, and hence show great diversity. Before the food reaches the small intestines it has been exposed to the action of the saliva and the gastric juice and undergone marked changes—the character and extent of which are determined by the time during which it has been exposed to the action of these secretions. Foods containing proteids and gelatin are most profoundly modified. Thus, in a fragment of meat the muscle fibres have been usually separated from each other by the solution of the connective tissue binding them together; the fibres themselves are in a partially disintegrated condition, some having been split longitudinally, others transversely, forming the so-called "Bowman's discs." Some of the muscle may be completely dissolved by the gastric juice, but the chyme always contains many more or less altered muscle fibres; these are frequently in the form of a granular mass. The red corpuscles contained in the blood-vessels of the meat are partially digested in the stomach, and the hæmoglobin changed into hæmatin; the latter appears in the chyme and is one of the substances contributing to the brown color which this fluid now assumes. If much milk has been taken, masses of casein, coagulated by the rennin of the gastric juice, are found in the chyme; part of the fat is free while part is enclosed in the coagulum.

The walls of the fat cells of adipose tissue and the connective tissue binding the cells together are also dissolved by the gastric juice; the fat thus freed forms larger or smaller drops and appears in the chyme in this form. A little fat is broken up, in some way, into fatty acid in the stomach.

Pieces of tendon, elastic fibres, bone, and cartilage are not attacked by the gastric juice, and so appear in the chyme almost unaltered. Uncooked vegetable tissues are not much changed by the gastric juice owing to the membrane of cellulose, which is not dissolved in the stomach, protecting the cell contents. If the vegetables have been cooked, however, many of the cell walls have been burst and the proteids, starch, etc., of the contents exposed to the action of the gastric juice; the proteids may be for the most part dissolved, but the starch granules are scarcely altered.

Many gas bubbles are present; these consist largely of nitrogen and carbon dioxide and, to a smaller extent, of hydrogen. The nitrogen comes from the air swallowed with the food; the carbon dioxide is derived from the blood by diffusion, from fermentation of carbohydrates, and from the neutralization of the acid of the gastric juice by the carbonates of the intestinal secretions. Oxygen is not found, or is found in very small amounts; that swallowed with the air is soon absorbed.

While the chyme contains much matter in suspension, there is but very little substance in solution. If the solid parts be filtered off, the filtrate is found to contain salts, hydrochloric acid, and a small amount of peptones and albumoses and usually sugar. A piece of proteid added to this clear filtrate is rapidly dissolved, showing the presence of pepsin.

The above description applies to the chyme of the stomach, or to that which has just reached the duodenum. In the duodenum the chyme undergoes marked changes both in appearance and in chemical composition; these are brought about largely by the admixture with the bile, pancreatic juice, and succus entericus, and the chemical reactions resulting therefrom. Other factors in producing changes in the chyme are bacterial decomposition and the absorption of some of its constituents. The flow of the secretions into the intestines has long been known to be closely dependent upon the presence of the chyme in the duodenum, but the details of this relation have been worked out only in very recent years by Pawlow and his pupils (see the *Archives d. sciences biolog.*, St. Petersburg). These investigations of Pawlow, which form one of the most marked advances in the physiology of digestion of late years, show that not only does the quantity of the pancreatic juice and the bile and their rate of secretion depend upon the presence of food in the digestive tract, but also that there is a wonderful adaptation of the constituents of these secretions to the character of the food to be digested. The experiments were made upon dogs with permanent fistulæ; a few of the more important results which are of interest in this connection will be noted. We will begin with the pancreatic juice.

When the stomach was empty and the dog fasting, there was no flow whatever from the pancreatic duct; the mere sight of food, however, caused some secretion, this being brought about in part by the entrance of the acid gastric juice into the intestines. As soon as food entered the stomach an active secretion of pancreatic juice began; the amount and character of this depended upon the kind of food which had been taken. Thus, in one experiment 600 c.c. of milk caused 45 c.c. of pancreatic juice to be secreted, while 250 gm. of bread caused a secretion of 151 c.c., and 100 gm. of meat a secretion of

141 c.c. Examination of the ferments in these experiments showed that in the pancreatic juice secreted after milk the fat-splitting ferment was very abundant, whereas but little was present in that obtained after bread; the amylolytic ferment was present in larger quantities after bread than after meat. These differences in the relative amounts of the ferments were not proportional to the differences in the amount of the secretion; in fact, they might occur in an inverse proportion. Thus after milk twice as much of the fat-splitting ferment was found as after bread, although a much larger amount of pancreatic juice was obtained in the latter case. After the introduction of an emulsion of pure fat into the stomach, the fat-splitting ferment was much increased. These variations in the amounts of the ferments of the pancreatic juice show, in a marked way, an adaptation to the kind of food ingested; the secretion contains that ferment in greatest abundance which is most needed. This regulation is brought about by the nervous system; the different constituents of the food stimulate different nerve endings in the mucous membrane of the alimentary canal, and thus cause reflex changes in the pancreas of such a nature that the secreting cells produce the ferments called for. The nerve endings respond only to their specific stimuli, *i.e.*, to certain constituents of the food. Another constituent of the chyme having a specific effect upon the secretion of the pancreatic juice is the acid of the gastric juice; this causes an increase in the alkalinity of the pancreatic juice as well as an increase in the amount of fluid secreted.

A similar series of experiments has been carried out by Bruno (*Archives d. sciences biologiques*, St. Petersburg, 1899) on the factors determining the flow of bile into the intestine. His chief results may be summarized as follows: 1. The rate of the secretion of bile into the intestine is more or less typical for the various kinds of food. 2. the reaction of the contents of the small intestine is not a factor in the excretion of the bile; this is contrary to the generally accepted view. The excretion of the bile differs in this respect from that of the pancreatic juice, with which, as we have seen, the reaction of the chyme is an important factor. 3. Proteid does not act as a stimulus to the excretion of bile, although some of the products of proteid digestion do have this action. 4. Starch does not stimulate the flow of bile. 5. Fat acts as a powerful stimulus to the excretion of bile; it stimulates nerve endings in the gastro-intestinal mucous membrane, and thus causes a marked reflex excretion of bile into the intestine. Meat extract has a similar effect.

The above experiments show that the character of the food ingested has a remarkable effect upon two of the secretions into the intestine—the pancreatic juice and the bile. The relation between the food and the third of the intestinal secretions—the succus entericus—has not been very thoroughly studied, but the experiments, as far as they go, show a similar adaptation of the secretion to the food. Thus a ferment, lactase, which has the power of hydrolyzing milk sugar, can be extracted from the mucous membrane of the intestine of some animals. Weinland (*Zeitschrift für Biologie*, xxxvii., p. 229) finds that by feeding milk this ferment can be obtained from animals (*e.g.*, adult rabbits), in which it is not normally present.

We may now briefly sketch the changes which the chyme undergoes after it comes into contact with these secretions; the details of the chemical changes produced by the enzymes are discussed elsewhere in this HANDBOOK (see articles on *Digestion*, *Bile*, *Enzymes*, etc.). One of the first changes occurring in the chyme after it enters the duodenum is a change in its reaction. (In what follows we refer to the reaction which the chyme shows to litmus. As is well known, the same substance may show an alkaline reaction with one indicator and an acid reaction with another; much confusion has arisen from writers neglecting to specify the indicator used.) The chyme of the stomach has a strongly acid reaction, due largely to the hydrochloric acid of the gastric juice; all the secretions into the intestine are alkaline, largely from the presence of sodium carbonate. The hydrochloric acid and the sodium carbonate react with the formation of carbon dioxide, water, and sodium chloride. If new factors were not introduced the chyme would soon become alkaline; this was formerly universally believed to be the case. But as the hydrochloric acid is neutralized other acids are produced, so that the chyme has a variable and changeable reaction. In fact, the reaction of the contents of the small intestine has been a matter of much dispute among physiologists; this has resulted in part from the fact that different experimenters have used different methods and different animals, and in part from their neglecting the influence of food. The reaction further varies in different layers of the chyme. At the beginning of the duodenum it is doubtless acid throughout; farther down, the layer next to the intestinal wall, which comes into more intimate contact with the alkaline succus entericus, bile, and pancreatic juice, becomes alkaline while the central part is still acid. Finally toward the end of the small intestines the contents may be neutral or alkaline throughout; the latter, however, seldom seems to be the case in man—at least with a mixed diet. Thus in the patient studied by Macfayden, Nencki, and Sieber the chyme as it escaped from the lower end of the ileum was, with an ordinary diet, invariably acid; the same has been noticed in other cases. Braune, for example, found the chyme as it escaped from a fistula at the end of the ileum to be acid; if, however, the litmus paper were applied to the wall of the intestine the reaction was alkaline. Cushing (Johns Hopkins Hospital Bulletin, x., p. 136, 1899) reports a case of fistula of the upper jejunum in which the chyme expelled was invariably acid, although it had been mixed with the pancreatic juice. Busch, however, found the reaction to be alkaline in a similar case. This acid reaction is due, according to Macfayden, Nencki, and Sieber, to organic acids, and chiefly to acetic acid; hydrochloric acid is never found in the lower part of the small intestine. This acid was found to be equivalent to 0.1 per cent. acetic acid; besides acetic acid small amounts of lactic and succinic acids and volatile fatty acids were found. These acids were thought by the above-mentioned authors to be formed from carbohydrates by bacterial decomposition. Results in entire accordance with these have been obtained by Jankowski.

The results of the above authors differ from those obtained by Moore and Rockwood (*Journal of Physiology*, xxi., p. 373, 1897) in experiments upon lower animals. These investigators found the reaction of the small intestine in various classes of animals (dog, rabbit, sheep, guinea-pig, etc.) to be alkaline, the alkalinity increasing in the lower part of the intestine. Fat in the food of carnivora caused an acid reaction which persisted until the lower third of the intestine was reached; this acid reaction was, according to Moore and Rockwood, probably due to fatty acids dissolved by the bile. A carbohydrate diet caused an alkaline reaction of the chyme in carnivora—a result which would not be expected if any extensive formation of organic acids occurred from decomposition of carbohydrates. Moreover, the alkalinity of the chyme of the herbivora, which consume large quantities of carbohydrates, is normally greater than that in carnivora. These results are opposed to the view that normally much bacterial decomposition of carbohydrates occurs in the small intestine. Moore thinks it is doubtful whether the intestines in the above-mentioned patients with fistulæ were in a sufficiently normal condition to allow of trustworthy inferences being drawn as to the reaction in the intestine of man under ordinary circumstances. As regards the general health of some of these patients, there can be no doubt that it was entirely satisfactory; in fact, it seems to have been much more nearly normal than that of some of the dogs in which similar fistulæ were made for the purpose of studying the reaction of the chyme. Moreover, it is interesting to note that when Macfayden, Nencki, and Sieber's patient was given a purely vegetable diet the reaction of the chyme became neutral. On the whole, the evidence seems to be that in man with a mixed diet the chyme is acid throughout the length of

the small intestine; the layer next to the walls is doubtless alkaline.

When the chyme of the stomach comes into contact with the bile in the duodenum, certain constituents of each are precipitated. Thus some of the products of the gastric digestion of proteids (syntonin and peptone) are more or less completely precipitated by the bile salts; these precipitated proteids adhere to the intestinal walls, and are consequently longer subjected to the action of the pancreatic juice than they would be if they remained in solution. The mucin of the bile is precipitated, as are also the bilirubin and cholesterin and glycocholic acid; these form a thick, resinous, colored coating of the mucous membrane. The pepsin is carried down with these precipitates, and as bile has, independently of this precipitating action, a retarding influence upon peptic digestion, the latter ceases; as soon as this mixture becomes alkaline the pepsin is destroyed. The tryptic digestion of the proteids now begins; the solid fragments of meat, etc., are eroded and the proteid converted, apparently directly, into deutero-albumose. Primary albumoses, such as are formed in peptic digestion, do not seem to be formed at all in tryptic digestion. There is some doubt as to how far the tryptic digestion of proteids is carried in the small intestine. When proteids are subjected to the action of pancreatic juice outside of the body, not only is peptone formed, but some of this is broken up into crystalline compounds of much simpler composition; among these latter are leucin, tyrosin, aspartic and glutamic acids. Macfayden, Nencki, and Sieber found neither leucin nor tyrosin in the chyme of the person upon whom they experimented; they think that if these compounds are formed in the small intestine at all, their amount must be very small and their absorption very rapid.

Fats, when they enter the duodenum from the stomach, are in the form of large drops. The pancreatic juice splits the fat (or at least a part of it) into fatty acid and glycerin; the former may be dissolved by the bile or may unite with alkalies to form soaps. When fat, soaps, and alkalies (such as are present in the bile and pancreatic and intestinal juices) are brought together an emulsion results. The conditions in the intestine are favorable for the formation of an emulsion, and, in fact, the fat of the chyme is usually in a state of fine emulsion. This change in the condition of the fat, brought about by the bile and pancreatic juice, aided, perhaps, by the peristaltic contractions of the small intestines, causes a change in the appearance of the chyme; it now becomes a creamy-looking fluid. Although the fats are usually emulsified, this is not always the case, and it does not seem necessary for their absorption; there can be no doubt, however, that their absorption is rendered much more easy and rapid when they are emulsified. What proportion of the fat is broken up into fatty acid and glycerin in the small intestine is not known. The earlier investigators thought that only a very small amount of fatty acid was formed, but this view rested upon insufficient evidence; some now hold that practically all the fat is decomposed into fatty acids, and that they are absorbed either in this form or after they have combined with alkalies to form soaps. It is also not known to what extent soaps are formed in the small intestine; the fact that very little soap can be obtained from the chyme at any one time has led to the view that it is not formed to any great extent. Others maintain, however, that the reason why so little soap is found is that it is absorbed almost as rapidly as it is formed; according to these, it is converted into neutral fat as it passes through the villi, and appears in the chyle in this form. In any case very little soap is found in the lacteals.

In whatever way the fats are absorbed, whether as an emulsion as is generally believed, or as fatty acids and soaps as some recent writers maintain, it slowly disappears from the chyme, and all observers are agreed that the pancreatic juice and bile play an important rôle in its absorption. After removal of the pancreas, or occlusion of its duct, the amount of fat absorbed is greatly diminished, and exactly the same result is observed when the bile is prevented from reaching the small intestine.

Much of the starch disappears from the chyme under the influence of the pancreatic juice; it is converted, with the formation of certain intermediate products, into sugar, which is then absorbed. The succus entericus may have an action upon carbohydrates similar to, but much less powerful than, that of the pancreatic juice. Cane sugar is inverted by the succus entericus and the invert sugar absorbed. The decomposition of starch is often not very complete, so that some of it, or of one of its decomposition products, dextrin, may be obtained from the lower part of the small intestine or from the large intestine.

Besides the changes produced in the chyme by the intestinal secretions there are others caused by the action of bacteria; there is considerable difference of opinion as to the extent and importance of these latter changes. It has even been supposed that the changes produced in the small intestine by bacteria are essential to life, but this view has been shown to be erroneous by the experiments of Nuttall and Thierfelder (*Zeitschrift für physiol. Chem.*, xxi., p. 109, 1895, and xxii., p. 62, 1896). These authors removed guinea-pigs from the uterus by Cæsarean section under strict aseptic precautions; the animals were then kept in an aseptic chamber and fed upon sterilized food. The guinea-pigs lived and did as well as normal ones fed on a similar diet. The alimentary canal was found to be entirely free from bacteria of any kind.

The most elaborate studies on the bacteria of the small intestine were made by Macfayden, Nencki, and Sieber. A number of bacteria were isolated by these investigators from the chyme as it escaped from the lower end of the ileum; the flora varied considerably from time to time and with change of diet. No bacteria were discovered which seemed to be specially bound to and constantly found in the small intestine, as is the case, for example, with the bacillus coli communis in the large intestine. "One characteristic mark, however, for the bacteria of the small intestine is this—that by preference, so to say, they decompose carbohydrates and not proteids." None of the characteristic products of the bacterial decomposition of proteids (indol, skatol, phenol, etc.) could be found; acetic, lactic, succinic, and butyric acids, ethyl alcohol, and other products of the action of bacteria upon carbohydrates were isolated. The organic acids seemed to prevent the putrefaction of the proteids. The bacteria and other micro-organisms attack not only the sugar, but also starch and cellulose; in addition to the organic acids, carbon dioxide and hydrogen are formed in considerable quantities as a result of this action. The relative amounts of these gases are determined in part by the kind of food, in part by the relative activity of the various micro-organisms. With a leguminous diet hydrogen is formed in large quantities; the same is true when the butyric-acid fermentation predominates. In other cases the amount of hydrogen may be very small; thus there was found in the small intestine of an executed criminal twenty-eight per cent. of carbon dioxide, sixty-eight per cent. of nitrogen (and oxygen), and only four per cent. of hydrogen. Marsh gas is also present at times in large amounts; this is especially abundant in the intestines of herbivora, which consume large amounts of cellulose.

From the moment when the chyme enters the duodenum until it passes into the large intestine its composition is being altered by the absorption, through the walls of the intestines, of some of its constituents. The rate and extent of absorption are dependent upon the character of the food and the time during which it remains in the small intestine. All the forms of food-stuffs are absorbed from the small intestine, but they do not all take the same path; carbohydrates, proteids, salts, and other soluble constituents pass into the blood-vessels while the fats are taken up by the lacteals. Under normal conditions the absorption in the small intestine is so complete that the chyme as it leaves the ileum has largely lost its nutritive value; Macfayden, Nencki, and Sieber, for example, found the chyme at the lower end of the ileum to contain less than one per cent. of albumin and from 0.3

to 4.75 per cent. of sugar. Some of the constituents of the secretions poured into the small intestine are reabsorbed by it; the best-known case of this kind is the reabsorption of the bile salts. Some of the water is also reabsorbed, but most of this reaches the large intestine and is absorbed there. The completeness of the absorption of the food in the small intestine is shown by the fact that patients with intestinal fistulæ through which the contents escaped without reaching the large intestine have remained in a condition of good nutrition for years. The patient of Jankowski, for example, had had a fistula at the lower end of the ileum for thirty-five years and had remained in good health; the large intestine was found atrophied from the cæcum to the rectum. Similar cases have been reported by others, and the same results obtained in experiments on animals. Harley (Proc. Roy. Soc., London, 64, p. 255) removed the entire large intestine from dogs and found that they did not suffer from malnutrition; on the contrary, they gained weight.

While all of the food-stuffs are absorbed to a greater or less extent by the small intestines, some authors state that one kind (proteids, for example), others, that other kinds (fats or carbohydrates) are best absorbed. These differences seem to depend upon the form in which the food is given rather than upon its chemical composition. In the experiments of Harley removal of the large intestine had no effect upon the absorption of fats and carbohydrates; that of proteids was decreased by ten per cent. The completeness of the absorption of proteid from the small intestine may be illustrated by the following figures from Macfayden, Nencki, and Sieber. Food containing 10.6 gm. of nitrogen was given the patient; only 1.6 gm. of nitrogen was found in the liquid escaping from the fistula in the next twenty-four hours. Thus, about six-sevenths of the proteids had been absorbed by the stomach and small intestine. That a large amount of proteid may be absorbed from the upper part of the small intestine (and stomach) is shown by the observation of Busch upon a patient who had a fistula near the lower end of the duodenum; five-eighths of the albumin and two-thirds of the gelatin given by the mouth were absorbed by this small part of the alimentary tract. In the case reported by Cushing, however, in which the fistula was also in the upper part of the jejunum, the patient suffered extremely in nutrition, not, however, from any inability on the part of the mucous membrane to absorb the food, but because the peristaltic contractions were so powerful that the food did not remain in the intestine long enough for much absorption to take place; if food of such a character was given that it did not escape easily from the fistula but occluded the opening, then considerable absorption occurred. In all cases the extent of absorption is determined in part by the time during which the chyme remains in the small intestine, and this in turn is determined to some extent by the composition of the chyme. Chyme is, in fact, the normal stimulus to the movements of the small intestine; when it contains abnormal constituents, or certain normal ones (such as cellulose and organic acids) in excessive amounts, it may so stimulate peristalsis that the contents of the small intestine are expelled before much absorption has taken place. The time during which the chyme normally remains in the small intestine was investigated by Macfayden, Nencki, and Sieber; boiled unmashed green peas (which escaped from the small intestine unchanged) or salol (which can be easily detected by its chemical reactions) were given to the patient, and the time at which they were found in the liquid escaping from the fistula observed. It was found that at least two hours elapsed before these substances appeared at the opening of the fistula, and that they continued to be discharged for nine to fourteen hours. The passage of the food mass from the ileum to the cæcum was a constant one. During the night it sank to a minimum, probably because the patient received only a stimulant now, whereas during the day she broke her fast five times. The evacuation took place without the patient being conscious of the act.

Reid Hunt.

CIBOTIUM.—*Penghawar-Djambi.* The hairy mass obtained from the rhizomes and stipes of *Cibotium Djambianum* Hook, and some other large ferns of tropical Asia and Polynesia. Besides a very extensive use in mattress-stuffing and similar work, this substance has been considerably employed as a hæmostatic. Although the juice of the rhizome is astringent and styptic, the cibotium appears to act in a purely mechanical way, like lint. In ordinary surgery we have many preferable agents, but these natural substitutes should be known to all army surgeons and others likely to require them in extreme cases.

Henry H. Rusby.

CICATRIX.—(Synonyms: Cicatrice, scar; Lat., *cicatrix;* Ger., *Narbe;* Fr., *cicatrice.*) The new tissue formed in the healing of wounds, or during the process of repair of loss of substance by disease or injury, is a cicatrix.

Old cicatrices are usually whiter than the normal skin, but may be pink or bluish, and are often pigmented. Usually depressed, smooth, and glistening, they may be elevated, or, more rarely, on a level with the surrounding skin. Pigmentation is found especially in the cicatrices of chronic and syphilitic ulcers, or when pigments or particles of coal or gunpowder have been left embedded in the skin.

Once fully formed, cicatrices are a permanent part of the body, growing with its growth, so that, if they occur of a certain relative size in a child, this relation will be found to persist in the adult. Small cicatrices occasionally entirely disappear, but this never happens when the cicatricial tissue is at all abundant. Cicatrices are thus of great importance in establishing identity. They also frequently furnish reliable information of previous disease, as in the case of cicatrices following syphilitic lesions of the skin, suppurating bubo, or suppurating joint diseases.

The structure of cicatrices is the same in all parts of the body. When a wound of skin and subcutaneous connective tissue has just healed, the young cicatrix is redder, firmer, less pliable and yielding than the surrounding parts. It may be on a level with the adjacent skin, or elevated above, or depressed below it. Its shape and size depend chiefly on those of the original gap in the tissues which it fills in. The new scar is composed of granulation tissue or embryonic connective tissue covered by a thin pellicle of epithelium. It contains no papillæ, nerves, lymphatics, muscle, or glandular tissue. In most cases the epithelial cells have been derived from the rete Malpighii of the surrounding skin. During the process of cicatrization its cells form new nuclei, and increase in size and number, and send out epidermal wandering cells. These wandering cells spread over the granulations of the wound, forming a delicate epithelial membrane that gradually diminishes in thickness toward the middle of the wound. This transparent, glistening pellicle can almost always be seen to spread inward on all sides from the edges of the wound. But it is sometimes observed to advance centrifugally from an "island" of epithelium in the midst of the wound. Usually the cells originate from sweat glands, sebaceous follicles, or epidermis that have survived the original injury. Sometimes they are derived from new cells scattered on the granulating surface by design, as by the application of skin grafts, or by accident, the cells falling unobserved on the wound while the dressings are removed. Beneath this pellicle, numerous small polygonal nucleated cells, separated by soft transparent or granular intercellular substance, are irregularly arranged in the meshes of embryonic blood-vessels. The cells are either white blood cells or connective-tissue cells. The blood-vessels are derived from those of the adjoining part by the channelling of protoplasmic sprouts. The tendency of this tissue is to develop into the white fibrous tissue found in old cicatrices. Many of the young cells are destroyed in this process; the rest become at first spindle-shaped, and finally acquire the characters of connective-tissue cells. The intercellular substance, at first not very abundant, becomes fibrillar and separates the remaining cells more widely. The whole cicatrix is now denser and drier than at first. Then the fibrillar intercellular substance contracts and condenses still further, the process only terminating when dense white fibrous tissue is formed. The contraction pulls on the neighboring parts, causing more or less wrinkling near the scar and drawing the adjacent tissues from their places. The blood-vessels also undergo changes. Many of them disappear entirely, and those which persist form a delicate anastomosing network of capillaries and small vessels communicating with those in the normal tissues on all sides of the cicatrix. The whole process is analogous to the development of embryonic tissue into adult connective tissue. In course of time, the cicatrix becomes loosened from its adhesions by the formation of adipose tissue beneath it. It becomes flexible, pliable, and easily movable, losing its adhesions to fasciæ and bone in many cases. Lymphatics and nerves also reappear, and in old cicatrices there are sometimes found a few elastic fibres. But cicatrices never contain hair, papillæ, sweat glands, or sebaceous follicles, except when they remain from the original tissue, not having been destroyed by the injury or disease that has preceded the cicatricial process. Cicatrices of mucous membranes are similar to those of the skin. They are more apt to be the cause of serious trouble on account of the greater frequency of damaging contractions, producing strictures of the mucous tubes, as of the œsophagus or urethra. Cicatrices of the glands are composed of fibrous tissue. Wounds of nerves and muscle are at first united by cicatricial tissue, but regeneration often occurs in these tissues under favorable circumstances.

Cicatrices produce certain changes in adjoining parts of the body, and are liable to defects and diseases.

The amount of contraction depends on the quantity of new cicatricial tissue and the resistance of the neighboring parts. Wounds healed by first intention are followed by much less shrinking than when allowed to granulate and suppurate. The cicatrices of burns and scalds, wounds in the flexures of joints, and lacerated wounds usually produce the greatest deformities. The remarkable contractions that follow burns are due not to any peculiarities in the structure of the cicatrix, but to the great amount of new tissue and the facility with which the surrounding tissue yields. Slight contractions at the flexures of joints may seriously interfere with their functions and greatly impair the usefulness of the limb. In many cases disfiguring and disabling contractures follow burns and wounds treated with the utmost care. They are only to be avoided by securing, where possible, the primary union of the wound. Cicatrization must be hastened by the application of skin grafts, and by careful attention to bring about the most rapid healing of the wound possible under the circumstances. Splints and bandages are sometimes of service in preventing deformities, if properly employed during and after cicatrization. But untoward results occasionally are seen, contraction beginning when the apparatus is laid aside, weeks or months after the completion of cicatrization. Or the wound may remain obstinately open while contraction is prevented, and healing will occur only at the expense of more or less extensive deformity. For the relief of deformities resulting from cicatricial contractions, apparatus may be used to stretch the scar, or various operations may be performed.

Weak cicatrices are frequently found when, during cicatrization, the granulations have been inflamed or pale and flabby. They are most common in the lower extremities and over the subcutaneous bones.

Cicatricial bands and masses may do serious damage when they contain or compress important vessels or nerves. Obstinate œdema of parts supplied by the blood-vessels may follow. Impaired motion and sensation sometimes occur when nerve trunks are compressed by cicatricial tissue. The only remedy is to dissect out the flattened nerve from the dense cicatrix, hoping that it may be subject to less pressure in its new position. When nerves are divided and their ends contained in cicatrices, besides the loss of motion and sensation the cicatrix is apt to be painful. The nerves are sometimes found to be bulbous, or the seat of fibrous degeneration. Here a portion of the nerve may be excised, or the ends dissected out of the cicatrix and sutured together.

Cicatrices also suffer from inflammation, wounds, contusions, and tumors.

Inflammation occurs in the same way as in other connective tissue. Abscess often occurs in recent cicatrices as a result of retention of some foreign body, or of infection.

Wounds of cicatrices usually heal readily.

Cicatrices sometimes undergo degenerative changes, leading to the formation of elevated, scaly, itching nodules, called keloid. This is a fibrous or fibro-cellular tumor, often of a pink color. The only treatment is excision, and the keloid is very apt to recur. It follows even slight cicatrices—for example, those of acne and chickenpox. It is more frequent, however, in cicatrices of burns and lacerated wounds.

Carcinoma of cicatrices may be either primary or secondary.

Primary carcinoma is usually of the epithelioma variety. It occurs most commonly in cicatrices situated over bones, and following burns and gunshot wounds. It usually appears in cicatrices that have been much irritated or exposed to pressure and ulcerated, and presents no unusual phenomena.

Secondary carcinoma in cicatrices usually develops in three weeks or six months from the time of operation. It may appear in the cicatricial tissue, but usually in nodules in the subjacent or surrounding connective tissue.

Sarcoma is also found occasionally in cicatrices.

Wm. G. Le Boutillier.

CICUTA AND CICUTOXIN. See *Poisonous Plants.*

CIENEGA (Manantiales de la).—These springs are situated in the low grounds between Sisal and Campeche. They are said to contain large quantities of iron.

N. J. Ponce de Léon.

CIENEGA DE MATA.—These springs, situated in the district of Jimenez, Chihuahua, Mexico, are employed in the treatment of rheumatism. *N. J. Ponce de Léon.*

CIMICIFUGA.—*Black Snakeroot. Black Cohosh.* "The rhizome and roots of *Cimicifuga racemosa* (L.) Nutt. (fam. *Ranunculaceæ*)" (U. S. P.). This is a large, perennial herb, with slender, upright stems, from one to two and a half metres high, smooth and cylindrical; they bear two or three ternately compound leaves, the lower very large, twice or thrice pinnate; the upper ones successively smaller and more simple; leaflets pointed, serrate, ovate, or more or less three-lobed. Inflorescence of one or several long, slender, upright, cylindrical racemes (25 to 50 cm. long). Flowers very numerous, something over a centimetre across, consisting of four white, concave sepals, which drop as they expand, very numerous, free, slender, spreading stamens, and a single, one-celled, ovoid pistil, containing several ovules. Petals none, a few of the outer stamens somewhat petaloid.

Cimicifuga is a common American plant, growing in Canada and in most of the United States. It is collected in various parts of the country, and has been used as a medicine for nearly a century.

The official description of the dried rhizome is as follows: "Horizontal, hard, 2 in. (5 cm.) or more long, about 1 in. (25 mm.) thick, with numerous, stout, upright, or curved branches, each terminated by a cup-shaped scar, and with numerous wiry, brittle, obtusely quadrangular roots, about one-twelfth of an inch (2 mm.) thick; the whole brownish black, nearly inodorous, and having a bitter, acrid taste. Rhizome and branches have a smooth fracture, with a large pith, surrounded by numerous sublinear, whitish wood rays, and a thin, firm