lignant tumors in the retroperitoneal lymph glands are of frequent occurrence in carcinoma of the uterus, etc. (See also *Omentum*.) *Aldred Scott Warthin.*

PERITONEUM, SURGICAL AFFECTIONS OF.—The anatomy and physiology of the peritoneum are discussed under the heading *Abdomen.* (*Anatomical.*). The pathology of acute and tuberculous inflammation will be found in the article on *Peritonitis, Septic and Tuberculous*, in The Appendix. Under the heading *Diaphragm* will be found a description of subphrenic abscess and its treatment, while additional information in regard to the peritoneum may be found in the articles entitled *Abdomen.* (*Surgical.*); *Abdominal Tumors*; *Appendicitis*; and in the article immediately preceding this. In the present article the surgical treatment of lesions of the peritoneum is briefly given.

Acute traumatism of the peritoneum is of little significance apart from traumatism of the organ which the peritoneum covers. The effect of direct injury to the peritoneum is often the formation of adhesions between opposed peritoneal surfaces. A familiar illustration of this is seen in umbilical and inguinal herniæ. Such adhesions will produce slight or serious symptoms, according to their situation and extent. If the attachments are between unimportant organs (for instance, between the omentum and the parietal peritoneum), occasional discomfort may be the only result. If more sensitive organs are involved (for example, the stomach or the intestine) the pain suffered may be very great and the function of the affected organ may be seriously interfered with. Furthermore, such adhesions in the form of bands are a not infrequent cause of intestinal obstruction.

Adhesions due to a single traumatism or to an acute attack of inflammation tend to atrophy, and in the course of time they may completely disappear. Thus the scar of a laparotomy may for a time be attached to visceral peritoneum, while at a second laparotomy performed some months afterward it may be found entirely free. Adhesions are due to a loss of peritoneum resulting from traumatism or inflammation. If, therefore, raw surfaces can be avoided at operation, resulting adhesions will be reduced to a minimum. This can be accomplished in several ways. The peritoneum can be sutured over the pedicles of tumors and over fresh wounds. Or, if the peritoneum in the vicinity is not sufficient for the purpose, the omentum may be used to cover the raw surface by stitching it in place; or grafts may be cut from the omentum and stitched over the raw surface; or, finally, sterile peritoneum from the ox may be stitched over the raw surface. This method has been recently advocated by Morris, who has given the name "cargile membrane" to artificial peritoneum of this sort.

For clinical and therapeutic purposes acute inflammation of the peritoneum is best divided into circumscribed and diffused, or general peritonitis. If the circumscribed peritonitis is not purulent, it may be treated by rest, external cold, etc., unless the organ from which it springs requires more radical treatment—for example, circumscribed peritonitis due to threatened perforation of the appendix. If the circumscribed peritonitis is purulent, such symptomatic treatment is dangerous, since no one can say how soon the inflammation may break through the fibrinous adhesions which circumscribe it and spread to other parts of the peritoneum. Therefore it should be relieved by incision and drainage.

The prognosis and treatment of diffuse or general peritonitis are in a most unsatisfactory state, partly on account of the difference of opinion as to what constitutes a diffuse peritonitis, and partly because of the difficulty of determining, even when the abdomen is open, how extensively the peritoneum is inflamed. Some surgeons would limit the term general peritonitis to those cases in which every portion of the peritoneal cavity is involved in the inflammation. Such a widespread inflammation rarely occurs, and is perhaps never recovered from. It seems better, therefore, to use the term diffuse or general peritonitis as indicating inflammation, not limited by well-marked adhesions, having a tendency to extend and sufficiently widespread to make the general symptoms much more prominent than the local ones. Such general symptoms usually become prominent when the inflammation extends to the peritoneum covering the small intestine. Thus peritonitis may exist for a long time in the pelvis, or in the lesser peritoneal cavity without giving rise to the well-known symptoms of general peritonitis. There are also many cases of appendicitis in which, if operation is performed early, the appendix is found not shut away from the general peritoneal cavity. To describe such a case as one of general peritonitis, merely because the surrounding coils of intestine are more or less covered with a fibrinous exudate which has not had time to mat them firmly together, is entirely misleading, and yet this is frequently done by writers who have reported cures of general peritonitis. It is therefore impossible to state the prognosis in a given case or a hundred cases of true diffuse peritonitis other than to say that the prognosis is bad. But it is by no means hopeless.

Unfortunately, the ideas of treatment of diffuse peritonitis are widely at variance, so that one can do no more than to state the different methods by which responsible surgeons believe that they have saved their patients. If diffuse peritonitis is threatened, though not well established, the action of the intestine can be stimulated by the use of cathartics or stopped by opiates, while the rectum and perhaps the colon can be emptied by injections of water, salt solution, soap-suds, oil, etc. Some surgeons employ opiates to decrease peristaltic action, on the ground that peristalsis tends to spread the inflammation; while others claim that the salvation of the patient depends upon increased peristalsis, which will increase the resorptive power of the peritoneum. To decide between these two plans of action is particularly difficult, because no one can say whether a threatened diffuse peritonitis would or would not have spread and killed the patient had the treatment been of a different character. When the inflammation has extended to the peritoneum covering the small intestine, the intestine is paralyzed, and cathartics have no effect, and there is certainly no indication for the use of opium.

In considering the operative treatment of diffuse peritonitis it will be well to take up the steps in the operation one at a time, since there is no general agreement in regard to any one of them. Some surgeons advocate a single incision and some multiple incisions, the latter in the hope of obtaining a more thorough drainage. At any rate, the incision or incisions should permit the surgeon to inspect and cleanse so much of the peritoneal cavity as may be involved in the inflammation.

The second step in the operation is the cleansing of the affected peritoneum from pus, fibrin, and foreign materials, fæces, etc., if such be present. This may be done by irrigation with sterile hot one-per-cent. salt solution or by wiping the peritoneum with gauze compresses wrung out of such solution, or with dry compresses. If irrigation is employed, it should be abundant, so that the abdominal cavity may be quickly flushed. Some surgeons bring the small intestine out of the abdominal wound and others omit this step, which is spoken of as evisceration. The object of cleansing is to remove in the shortest possible time and with the least possible loss of heat the greater portion of the infectious exudate. How best to accomplish this with the least injury to the peritoneum is a question to be settled by the individual surgeon. Probably moist gauze is less irritating to the peritoneum than dry gauze.

If irrigation is employed the fluid which remains after cleansing may be sponged out, or it may be left in place. Some surgeons fill the abdomen with salt solution and close the abdominal wound, claiming that the dilution of the infectious material and the increased resorption from the peritoneum thereby produced are of the greatest benefit to the patient.

If the intestine is greatly distended with gas, some

surgeons empty it by puncture or by one or more short incisions. Such openings are forthwith closed by Lembert sutures. Others take advantage of the operation to inject into the lumen of the small intestine an ounce or more of saturated solution of sulphate of magnesia, believing that the strong peristaltic action which often follows will markedly benefit the patient.

Those who leave fluid in the abdominal cavity suture the wound without drainage. The patient is then placed in bed with the hips elevated so that the diaphragmatic portion of the peritoneum in which the lymphatic circulation is the most active shall be the most dependent portion. Others pass gauze or glass or rubber drains in various directions, either through the chief abdominal wound or through other wounds made especially for drainage in the lumbar and iliac regions, or into the vagina, or even into the rectum in case of pelvic suppuration. Mikulicz's handkerchief drain may also be used. [See *Abdomen.* (*Surgical.*).] Rehn recommends that a tube be passed through the mesentery of the small intestine and allowed to emerge in either loin, so that irrigation may frequently be made through it.

After-treatment consists in the application of heat externally and within the rectum, the subcutaneous injection of cardiac stimulants if necessary, and the subcutaneous or intravenous injection of salt solution; the object of all of these procedures being to combat shock. If the patient is troubled with vomiting, the stomach should be washed out. No opium should be given, and only so much morphine subcutaneously as is absolutely necessary to control pain.

Tuberculosis of the peritoneum may be accompanied by an abundant serous exudate or it may give rise to a fibrinous exudate with adhesions and contractions, or it may assume an ulcerative form.

The prognosis is in general an unfavorable one, although many cures have been reported as the result of both internal and surgical treatment. Recovery is more likely to follow operation when the disease is present in the serous form; but even in such cases one should be careful not to mistake a temporary improvement after operation for a permanent cure. As far as is known Spencer Wells was the first to open the abdomen of a patient having tuberculosis. He did so through a mistake in diagnosis. The patient recovered. Since then many surgeons have operated intentionally, and the good results have been variously attributed to the entrance of light or air, to the mechanical irritation of the peritoneum, or to a simple escape of the serous exudate. A more careful examination of the results of operation makes it doubtful whether such an exploratory laparotomy has any great therapeutic effect. It seems more probable that most of the patients who have recovered after such a laparotomy would have recovered without it, while operation has often a distinctly bad effect upon a patient whose tuberculous peritonitis is associated with fever. The abdomen is usually opened by a three- or four-inch incision in the median line. The fluid which is present is allowed to escape and is carefully sponged out and the various peritoneal pouches may or may not be dusted with powdered iodoform. The abdominal wound is closed by suture, or a drain may be left in its lower angle for a week or more. The shock of such an operation is naturally slight and most patients rapidly recover. A certain amount of fluid quickly appears, but may be resorbed. If it is not, a second operation may be performed. Such a quick recovery from operation may be looked for in the serous and fibrinous forms of the disease, while operation performed upon a patient suffering from purulent or suppurative tuberculous peritonitis will very likely be followed by intestinal fistula and death. Of course, if a focus for the disease is found in some organ which can be safely sacrificed it should be removed. An accompanying disseminated serous tuberculosis will probably be cured if its original focus is removed. But, as stated above, many patients who appear cured at first afterward suffer from a recurrence of the disease or die from tuberculosis in some other organ. However, as the risk of operation is so slight, it seems justifiable in these cases even if it is a mere aid to the natural forces of the body in their effort to overcome the disease.

Benign tumors of the peritoneum, or, strictly speaking, of the subserous tissue, are fibroma, lipoma, and myxoma. Such tumors usually develop in the root of the mesentery, in the mesocolon, or in the omentum, and are described under the headings *Omentum* and *Retroperitoneal Tumors*. In the mesentery are also found serous, chylous, and hemorrhagic cysts as well as congenital dermoid and teratoid cysts. Echinococcus cysts are found in the peritoneal cavity, where they develop after the rupture of some primary cyst of the liver or other organ. Actinomycosis, starting usually from the cæcum, may produce in the peritoneum inflammatory swellings, some of which will contain the characteristic pus of this disease.

The treatment for benign tumors is their radical removal. This also applies to echinococcus cysts when they are so situated as to make removal feasible. If they are not removable, they should be drained externally. Actinomycosis should be treated by removal, if possible, but, if this is not practicable, by curetting, cauterization and drainage, and by the internal administration of iodide of potassium.

Malignant tumors of the peritoneum are secondary to malignant disease of some abdominal organ. Under such circumstances hundreds of metastatic nodules may be scattered over the peritoneum. There is generally a sero-hemorrhagic exudate. Such a condition is of course inoperable and the abdomen should be closed at once. A metastatic nodule in the peritoneum may be excised for microscopical diagnosis and the wound closed by one or two stitches. Thus one avoids the risk of troublesome hemorrhage which may follow excision of a portion of the primary growth.

Plastic operations upon the peritoneum for the sake of covering raw surfaces have been spoken of above and are also described under the heading *Omentum*, for it is the omental peritoneum which is usually employed for grafting. *Edward Milton Foote.*

PERITONITIS, SEPTIC AND TUBERCULOUS. See The Appendix.

PERITYPHLITIS. See *Appendicitis*.

PERONINE—benzyl-morphine hydrochloride, C_6H_5-$CH_2.O.OH.C_{17}H_{17}NO.HCl$—is an odorless, bitter, white powder, composed of prismatic crystals and having the nature of an alkaloid. It is soluble less than one per cent. in cold water and in ten parts of boiling water, and is nearly insoluble in alcohol and chloroform. It is closely related to codeine, dionine, heroin, and morphine.

For the treatment of the cough of tuberculosis, Schroeder, who was the first to study this drug, considered it intermediate in value between codeine and morphine. His report, however, covers only twelve cases, in two of which it produced sweating and difficult expectoration, and in two others of which it failed to influence the cough. Nowak, in eighteen cases, found the cough less frequent and intense, but dry, and expectoration more difficult. At times there were burning in the bronchi and copious perspiration. Munk reports good effects on cough even after morphine and codeine had proved inefficient. He also found peronine calmative to an epileptic who suffered from frequent attacks of frenzy. All the writers agree that there is no habit formation. Mayor found it to be three times as toxic to rabbits and guinea-pigs as is codeine, and believes its cardio-depressant effects too pronounced to permit its use in medicine. Other writers, however, report no unpleasant effect on cardiac, respiratory, or digestive functions.

Besides its antitussive action, peronine is slightly analgesic and hypnotic. It is employed in tuberculosis, whooping-cough, emphysema, bronchitis, and similar affections in doses of 0.02–0.05 gm (gr. $\frac{1}{3}$–$\frac{5}{6}$). Schroeder had no untoward effect from 0.08 gm. (gr. 1¼), though nausea and constipation followed larger doses.

W. A. Bastedo.

PERRY SPRINGS.—Pike County, Illinois. Two hotels, capacity 350.

ACCESS.—Viâ Wabash Railroad to Griggsville or Perry station, thence by hack nine and six miles, respectively; also from St. Louis viâ Illinois River to Naples, seven miles distant, where steamers land daily.

This attractive health and pleasure resort is located among some hills on the west bank of the Illinois River. The surrounding country is covered by luxuriant forests and intersected by numerous deep ravines, narrow valleys, and clear, winding streams. The extreme temperature ranges are 100° F. in summer to —20° F. in winter. The climate is moderately dry and clear most of the time. The springs are three in number, and are located about two hundred yards from one another. The temperature of the water ranges from 50° F. in summer to 48° F. in winter. The water from the iron spring is supplied, hot or cold, to fourteen bath-rooms. The following table contains the analyses of the three springs, as furnished by Dr. Engleman, No. 1 being the iron, No. 2 the magnesia, and No. 3 the sulphur springs:

ONE UNITED STATES GALLON CONTAINS:

Solids.	No. 1. Grains.	No. 2. Grains.	No. 3. Grains.
Calcium bicarbonate	15.89	19.75	19.66
Magnesium bicarbonate	17.01	14.81	10.49
Iron bicarbonate	.55	.40	.27
Aluminum silicate	......	......	.27
Potassium and sodium silicate	2.64	2.28	3.45
Sodium silicate (salt)	0.12	.38	.58
Sodium sulphate	.44	1.10	1.49
Potassium carbonate	1.59	1.45	1.46
Total	38.24	40.17	37.67

No organic matter.

The waters are said to be of considerable efficacy in stomach, liver, and kidney troubles.

James K. Crook.

PERSIMMON.—*Diospyros.* Under the name persimmon, both the bark and the unripe fruit (chiefly the latter) of *Diospyros Virginiana* L. (fam. *Ebenaceæ*) are considerably employed as astringents, particularly in the southern United States. The bark looks not unlike oak bark with the corky layer still upon it. The fruit in the unripe condition is green, drying dark brown, of globose form, and nearly an inch in diameter. It contains several flattened oval or ovoid seeds. Before maturity the persimmon is one of the most astringent of substances, but after thoroughly maturing, and especially after being attacked by frost, this astringency is mostly lost and it becomes sweet and edible. The only important constituent of both drugs is the tannin, and their uses are purely astringent, similar to those of geranium, sumac, etc. The common method of employment in the household is in the form of an infusion or decoction; only the fluid extract is employed by the medical profession. The dose of either the bark or the fruit should amount to 2, 4, or even 8 gm. (ʒ ss. to ʒ i. or ij.).

Henry H. Rusby.

PERSODINE. See *Persulphates.*

PERSPIRATION. See *Skin, Functions of.*

PERSULPHATES.—The alkaline persulphates have recently come into notice because of their excessive content of oxygen and the ease with which this is liberated. Their action may be likened to that of hydrogen dioxide. A five-per-cent. solution of *sodium persulphate* kills most bacteria, and a half-per-cent. solution will check their development. The fatal dose for a rabbit (*Bull. gén. de Thérap.*) is 0.4 gm. per kilogram of body weight, and for a dog 0.75–1.0 gm. per kilogram.

In three- to five-per-cent. solution it constitutes a good wet dressing for lupus and ulcers (Kionka). Internally, it acts as an antipyretic in fever, and is said to improve the appetite and digestion in tuberculosis, anæmia, neurasthenia, etc. The dose of sodium persulphate is 0.1 gm. (gr. iss.), or from one to two teaspoonfuls of *persodine*, which is a 12 to 1,000 aqueous solution of the sodium salt.

Ammonium persulphate is useful as a test for albumin or indican in urine. In the presence of albumin a ten-per-cent. aqueous solution forms a turbid, grayish zone at the line of contact.

In testing for indican a crystal of ammonium persulphate is added to a mixture of equal parts of hydrochloric acid and urine. On shaking this with chloroform, the latter on settling forms a blue layer if indican is present.

W. A. Bastedo.

PERUSCABIN, benzoic acid benzyl ester, is an artificial product representing the active constituents of balsam of Peru. It is odorless, non-staining, and non-irritating, and is highly recommended by R. Sachs for the treatment of scabies. Diluted with three parts of castor oil, it is applied over the whole surface every twelve hours. The cure is absolute, and no irritation whatever is produced, even in an area affected with eczema or dermatitis.

W. A. Bastedo.

PES GIGAS.—Pes gigas, or macropodia, is the name given to a condition of congenital hypertrophy affecting either the foot alone (whence the name) or the leg and the foot. It may be unilateral or bilateral, the former being the more common; the left side is more often affected than the right. Pes gigas is found in two forms:

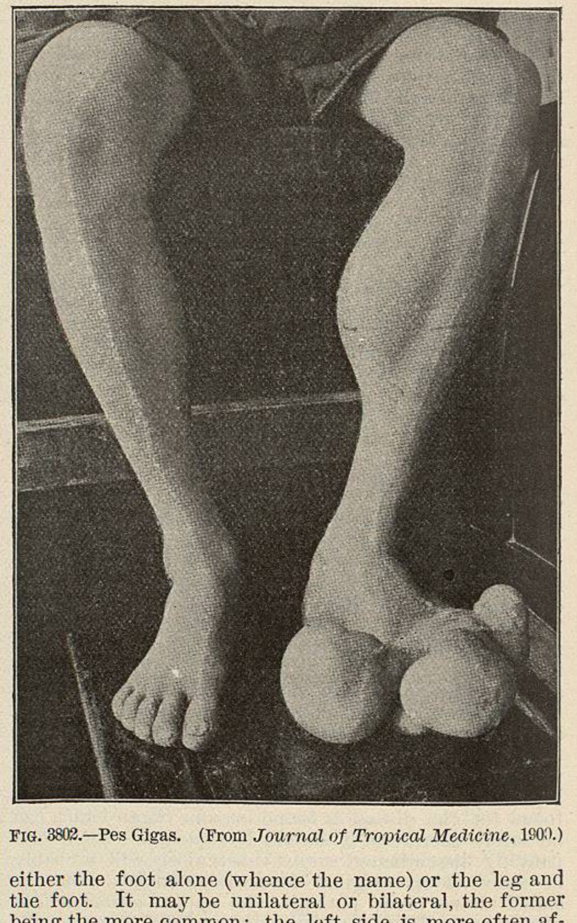

FIG. 3802.—Pes Gigas. (From *Journal of Tropical Medicine*, 1900.)

(1) a form in which the hypertrophy is *true* or *symmetrical*; here the whole foot, or leg and foot, suffer a general hypertrophy, the symmetry and contour of the part being observed, and the only abnormality being the enormous size. (2) The *false* or *asymmetrical form*, in which only certain parts are affected; this is the more common variety, and generally shows itself in the enormous development of one or two toes, or in large fatty excrescences, or in hypertrophy of some of the muscles of the calf of the leg. (See Fig. 3802.) The cause of pes gigas is unknown.

The skin is always involved, and, in addition to the hypertrophic condition, the cutaneous sensibility may be absent or diminished; it is never increased. In hypertrophy of the toes the nails generally enlarge *pari passu* with the other parts. The subcutaneous fat is increased in amount and is apt to be irregularly disposed in lumps. When the toes are affected the metatarsal and phalangeal bones are always enlarged; but this enlargement is general, and the only deformity noted is an outgrowth at the extremity of the bone, at the junction with the articular cartilage. The condition of the joints involved is variable; sometimes the motion is normal, sometimes it is limited, and sometimes there is complete ankylosis. Passive mobility may or may not be elicited; the ligaments are thickened.

The *treatment* is not satisfactory. (1) *Pressure* in various forms has been recommended; but, besides being tedious in its application, uncertain in its effects, and decidedly painful, it is not free from danger; and hemorrhage, ulceration, and erysipelas have ensued from this method of treatment. (2) *Ligature of the main artery* has also been suggested; but this method, too, has not been characterized by brilliant results. (3) *Amputation of colossal toes* and judicious trimming of superfluous tissue will give a presentable and serviceable extremity. This is probably the best procedure.

R. J. E. Scott.

LITERATURE.

Anderson: St. Thomas' Hosp. Rep., N. S., 1882, vol. xi.
Jacobson: Article "Pes Gigas," in Heath's Dict. of Practical Surgery.

PETECHIÆ.—These are small, round, blue-red or purple spots or points in the skin, or in the serous or mucous membranes, that cannot be made to disappear by pressure. They are usually not elevated above the surface. They are caused by minute extravasations of blood into the subepithelial or subserous tissue. They arise for the greater part through diapedesis, and occur chiefly, though not exclusively, on the dependent portions of the body, particularly over the legs. They are often localized in the hair follicles. In the serous membranes they are found most often in the posterior wall of the pleural cavity, and on the posterior portion of the epicardium and pericardium. In the mucous membranes they occur most frequently in the conjunctivæ and mouth, but may be found in any part of the body. According to their etiology petechiæ may be classed as *traumatic, infectious, toxic,* and *neuropathic.*

Petechiæ may be produced by the bites of fleas (*purpura pulicosa*). These may be mistaken for purpura or other hemorrhagic diseases. They may be distinguished from the latter by the fact that the puncture caused by the flea shows as a darker point in the centre of the spot, and by their greater abundance over the trunk. Localized petechiæ may occur also as the direct result of certain forms of trauma, and may be of medico-legal importance in the establishment of the occurrence of trauma.

Petechiæ occur also in the course of many of the acute infections: *scarlet fever, variola, diphtheria, endocarditis, plague, yellow fever, cholera, anthrax, septicæmia, measles, typhus fever, rheumatism, typhoid, acute yellow atrophy, etc.* The cases in which such hemorrhages occur are usually more severe than the non-hemorrhagic ones. The different forms of the primary purpuras are also characterized by the occurrence of petechiæ in the skin and mucous membranes: *purpura simplex, purpura rheumatica, morbus maculosus Werlhofii,* and *Barlow's disease.* In the last-named, innumerable minute hemorrhages may occur throughout all of the internal organs. In *scurvy* petechiæ occur in the skin, in the mucous membranes, and in the pleura, pericardium, endocardium, and peritoneum. It is very probable that the purpuras are infectious diseases, in part caused by the streptococcus, in part by bacteria not yet recognized.

Petechiæ may result also from a lowered nutrition of the vessel walls, as in *starvation, pernicious anæmia, leukæmia, cachexia of malignancy,* etc. It is very probable that in these conditions there is an intoxication which is the chief factor in causing the changes in the capillary walls. Petechiæ occur also in *icterus, nephritis,* poisoning with *bromine, iodine, phosphorus, arsenic, snake-venom,* etc. Petechiæ have also been observed to follow the use of *quinine.*

In chronic passive congestion of marked degree petechiæ may be formed in the body surfaces and also in the internal organs.

Petechiæ may arise as the result of excessive emotion, or during the hysterical or hypnotic state (stigmatization).

As diagnostic and prognostic aids petechiæ are of great significance. The size, location, conditions of occurrence, etc., are all very important factors.

Aldred Scott Warthin.

PETRIFACTION.—The deposition, in the tissues, of solid, crystalline, amorphous, or granular salts of lime, magnesium, or uric acid is known as *petrifaction* or *petrifying infiltration.* When the deposit consists of lime salts or of a combination of salts of lime and magnesium, the process is usually spoken of as *calcification* or *calcareous infiltration.* A physiological calcification takes place during the process of ossification of the skeleton; in this case the deposit of lime in osteoid tissue is an essential step in the development of a new tissue. All other deposits of lime salts within the body tissues must be regarded as being of a pathological nature.

With the exception of the new formation of bone in the repair of fractures and in tumors, calcification is essentially a retrograde change, the precipitation of the phosphates and carbonates of lime and magnesium occurring only in degenerating, dying, or dead tissues. In old age a deposit of lime salts occurs in the walls of the arteries, in the costal and laryngeal cartilages, in the walls of the capillaries of the lungs, stomach wall, and kidneys. This phenomenon is explained as due to an excess of lime salts in the blood, resulting from an excessive absorption of lime salts from the bones. Preceding the deposit of lime salts there occur certain retrograde changes characteristic of old age—hyaline change of the blood-vessel walls, etc. This calcification of old age is of such common occurrence as to warrant its being regarded as physiological. The resorption of lime salts from one tissue and their deposit in another is known as *metastatic calcification.* Calcification of the mature placenta is also of such frequent occurrence as to be regarded as physiological. The presence of brain sand in the choroid plexus and pineal gland is so universal that this may also be included under the head of physiological.

Calcification occurs most frequently as a sequel to fatty degeneration, hyaline change, cloudy swelling, simple or caseous necrosis. It is found in sclerotic vessels, endocardial thickenings, hyaline thickenings of dura, peritoneum, pleura, and pericardium, in the interstitial tissue of hyaline goitre, in corpora fibrosa of the ovary, old tubercles, gummata, old abscess cavities, inflammatory exudates, and in thrombi (arterioliths or phleboliths). A deposit of lime salts may occur in anæmic or hemorrhagic infarcts, focal necroses, in dead ganglion cells, in encysted trichina, and in the necrotic areas of tumors. It occurs also in osteoid and hyaline connective tissue of tumors, and in psammomata. The connective-tissue stroma of both carcinomata and sarcomata not infrequently shows calcification (*sarcoma* and *carcinoma petrificans*). Myofibromata of the uterus very frequently show a greater or less degree of calcification. Lime salts are also deposited in the dead fat cells in cases of fat necrosis. Calcification of the renal epithelium follows the cloudy swelling produced by such poisons as mercuric chloride, carbolic acid, bismuth, aloin, etc. Retained decidua or chorion, or portions of the dead fœtus and its membranes, may become calcified (lithocelyphopædion), or the sac may rupture and the fœtus escape into the peritoneal cavity, later becoming calcified (lithopædion). In diseases of the bones characterized by a resorption of the lime salts, the latter may be deposited in other tissues of the body.

Calcified tissues are hard and white and sharply outlined; the area affected may be large or small. The lime salts may be dissolved out by the action of acids, in the case of carbonates with the formation of carbonic acid. Microscopically, deposits of carbonates or phosphates stain deep blue or violet with hæmatoxylin.

A deposit of uric-acid salts occurs particularly in gout. The gouty deposits consist chiefly of sodium urate with small amounts of carbonate and phosphate of lime. The tendon sheaths, synovial membranes, ligaments, articular cartilages, kidneys, skin, and subcutaneous tissues are chiefly affected, but the deposits may ultimately be found in nearly every organ of the body. The larger deposits, called *tophi*, form large rounded masses, of a white, plaster-like substance, which are found particularly in the joints and tendons.

The individuals exhibited in museums as "petrifying" or "ossifying," are either cases of myositis ossificans or of scleroderma.

Petrifaction of the tissues of the body after death may occur under certain conditions, but is probably very rare. The majority of cases reported as such are in reality examples of adipocere formation. Very little is known with certainty regarding the petrifaction of the cadaver. Petrified or fossilized bones of the human race are very rare. Such have been reported to have been found in caves and in bog deposits whose waters were impregnated with iron and lime. In old bones there may sometimes occur a crystalline arrangement of phosphate of lime, or the bony structure may become so impregnated with mineral elements that its color and consistency become greatly changed. It is very probable, however, that a complete replacement of the elements of the bone or of the body tissues with mineral constituents is of very rare occurrence. (See also *Calcification*.)

Aldred Scott Warthin.

PETROLATUM.—The word *petrolatum* stands, both in Latin and in English, as the official title in the United States Pharmacopœia for an unctuous derivate of petroleum, obtained by distilling off the lighter and more volatile constituents of the oil and purifying the residue. Three grades of petrolatum are official, the difference being in consistence only. They are entitled, severally, *Petrolatum Liquidum*, Liquid Petrolatum; *Petrolatum Molle*, Soft Petrolatum; and *Petrolatum Spissum*, Hard Petrolatum. The first of these grades is of the consistence of oil; the second is soft, like lard, and corresponds to the well-known proprietary substances *vaseline* and *cosmoline;* and the third is hard, like cerate. When the word "petrolatum," without modification, is used in prescription, "soft" petrolatum is dispensed. Petrolatum consists principally of a mixture of paraffins (hydrocarbons of the formula C_nH_{2n+2}), but probably also contains some olefins (hydrocarbons of the formula C_nH_{2n}), which, by their softer consistence, tend to increase the unctuousness of petrolatum. Petrolatum is a whitish or yellowish material, more or less fluorescent, tasteless, and with no odor, except when heated when a faint odor of petroleum is perceptible. It is entirely amorphous, and, in fluid condition, makes a transparent liquid. It is neutral in reaction. It is insoluble in water; scarcely soluble in alcohol, or in cold absolute alcohol; but soluble in boiling absolute alcohol, and readily soluble in ether, chloroform, disulphide of carbon, oil of turpentine, benzin, benzol, and in fixed or volatile oils. When heated on platinum foil, it is completely volatilized without emitting the acrid vapors of burning fat or resin.

Petrolatum owes its medicinal value to its combining with the physical attributes of the semi-solid fats the chemical peculiarity of the paraffins, of being practically unalterable and indifferent to chemical agents. Petrolatum neither hardens nor turns rancid by exposure, and can be treated with any chemical likely to be prescribed medicinally in an ointment without being itself attacked thereby. The substance is therefore available, either by itself as a simple unguent, perfectly bland and changeless, or as the fatty basis for medicated ointments.

Edward Curtis.

PETROSULFOL is a sulphur-containing bituminous product closely resembling ichthyol, but with a less disagreeable odor. It is miscible with water or oil, and is used as a general succedaneum for ichthyol.

W. A. Bastedo.

PHAGOCYTOSIS.—Phagocytosis is the term applied to the ingestion of solids by living cells. That leucocytes were capable of taking up inert particles when introduced into the animal body or even when mixed with the freshly drawn blood of such animals as the newt had long been known, when Haeckel pointed out the similarity between such processes and the engulfing of food particles by unicellular organisms. Roser went further in suggesting that resistance to infection by bacteria and other living irritants was due to the phagocytic properties of the cells of immune animals.

It is to Metchnikoff and his followers, however, that we are indebted for much of our knowledge concerning this particular physiological function of cells. In his researches on the comparative pathology of inflammation phagocytosis in many types of organisms was studied and the capacity of their cells for dealing with various solid particles determined.

It does not lie within the scope of this article, however, to give *in extenso* the opinions held by Metchnikoff and others relative to immunity excepting in so far as they bear upon the mechanism of phagocytosis, the factors which influence it, the fate of the matters enclosed by cells, and the value of the process as illustrated in the life histories of organisms.

The Mechanism of Phagocytosis.—Before the ingestion of solid particles by cells is possible the two must be brought together. In the case both of the amœboid unicellular organisms and of the wandering cells of the higher animals, this is brought about by the attraction of the cell to the particles. (See the section on Leucocytes, under *Blood.*) The attraction exerted by particles upon motile cells is probably operative only over a limited area, and although there is some difference of opinion concerning the matter, it would appear that a certain amount of the solid particles being dissolved in the fluids containing the cells may stimulate them to approach the particles or under other conditions to repel them.

Amœbæ or other single-celled organisms are brought into the sphere of influence of food particles and bacteria by diffusion currents, and micro-organisms may by their own motility come into such a position as to be more easily engulfed. Jennings and Moore have shown that when paramecia and other infusoria pass by their own movements from a less attractive into a more attractive solution, they tend to remain there because their movement in the initial direction is arrested and reversed just as they are about to leave the agreeable environment. By a series of reverses they are kept swimming backward and forward across this attractive sphere and thus accumulate, not by initial attraction toward, but by inability to go away from, the agreeable environment. It remains to be proved whether any such explanation can be adapted to the accumulation of leucocytes in the neighborhood of bacteria and their toxins.

In the higher organisms provided with lymph or blood channels or both, the transportation of wandering cells to the vicinity of foreign particles is passive, although

their arrest at the margin of the vessel walls and their later emigration is an active process in response to stimulus. Fixed cells like the endothelium of the lymph- and blood-vessels, serous cavities, and the spleen pulp may throw out pseudopodia and entangle and ingest bacteria which are brought to them by the circulation. They may even bud off the large mononuclear leucocytes which are so markedly amœboid and phagocytic, but proof that these after engulfing bacteria or other particles may again become fixed is wanting. It is a common thing for a wandering phagocytic cell to be later engulfed with its contents by fixed cells, especially endothelial cells.

Phagocytosis is to be observed in a multitude of ways, but perhaps as simple a demonstration as any is a modification of that used by Kanthack and Hardy. A drop of fluid from the posterior lymph sac or peritoneum of a frog is withdrawn by a capillary pipette, placed in the centre of a clean cover-slip and lightly inoculated with a fresh culture of *bacillus anthracis, bacillus filamentosus*, or some other large non-motile organism. The drop is inverted over a vaselined hollow ground slide, or, better still, a ring of filter paper may be placed upon a slide and the drop of inoculated lymph inverted over the hole (Miss Greenwood's method). The filter paper should be thick enough to prevent the drop from coming in contact with the slide, and should be moistened with water from time to time to prevent the desiccation of the lymph. This method provides plenty of oxygen. Such a preparation may be kept under observation for hours at room temperature, and the leucocytes, of which in the frog there are fewer varieties than in mammals, remain active and may be seen to attack the bacteria according to a definite plan. A better method, especially for demonstration to large classes, is to inoculate a culture directly into the peritoneum of the frog and to withdraw drops for microscopic study from time to time. Observation may be made while the cells are living as outlined above, or smears stained with eosin and methylene blue may be prepared at various stages.

It will be seen that the coarsely granular oxyphile (eosinophile) and hyaline (large mononuclear) leucocytes are actively attracted to the chains of bacilli, the former being generally the first to attach themselves. Their granules exhibit streaming movements before, and usually disappear immediately after contact. The lymphocytes (small mononuclears) seem to take no active part, although they become included in the plasmodium formed by the other two varieties of leucocytes and the chains of bacilli which become bent into sharp angles and finally tightly compressed. The individual cells seen to become a part of the plasmodium, soon lose their outline, and in unstained specimens cannot be differentiated. The plasmodium later breaks up, and the component cells again become free in from five to nine hours. The coarsely granular oxyphile cells which have lost their granules and whose protoplasm has become amphophilic upon contact with the bacilli sometimes regain their granules with their oxyphilic reaction. In the hyaline (large mononuclear) cells, however, at this stage frequently one or more vacuoles can be seen which contain chains of bacilli doubled upon themselves so that from two to five or more bacilli are included. The included bacilli are undergoing degeneration as evidenced by their swollen, granular, or generally "wilted" appearance. Kanthack and Hardy after a very extended series of observations concluded that with fully virulent bacilli the coarsely granular oxyphile cell is called into action first, and through contact with the bacilli, by a process of "extra-cellular" digestion or neutralization, works them harm, after which phagocytosis on the part of the hyaline cells becomes possible. They maintained that this is true not only for frogs but for mammals, and were convinced that phagocytosis as the initial movement is possible only where non-virulent bacteria or other relatively inert particles are employed.

The difference in the *modus operandi* of these two leucocytes has been very graphically illustrated in a more recent publication by Hardy in which he was able to measure accurately under the microscope the rate of growth of chains of bacillus filamentosus (non-virulent) which had been introduced into a drop of frog lymph and observed under the microscope for a number of hours. He found that in those bacilli which had come into contact with coarsely granular oxyphile cells no growth took place. Those in contact with hyaline cells or lymphocytes grew out into long filaments, as did also the free bacilli. Where one end of a chain was enclosed within a vacuole of a hyaline cell growth in that direction was arrested, although division of the bacilli at the other end of the chain went on. It will be seen that the material ("slime") extruded or exuded by the coarsely granular oxyphile cell at the time of the disappearance of its protoplasmic granules, or perhaps, more correctly speaking, that contact of the bacilli with the changed protoplasm—true phagocytosis not taking place—had the same inhibitory effect upon the growth of bacilli as had the contents of the digestive vacuole of the hyaline cell. The vacuoles of phagocytic cells probably all contain a ferment. Such has been shown to exist in the food vacuoles of the amœba by Krukenberg, Reinke, and Greenwood. Further, the ferment fluid has been shown to be acid, although secreted by an alkaline protoplasm. In these vacuoles whatever is capable of digestion goes into solution and serves as food for the cell, while the insoluble remnants are extruded.

It is impossible to hazard any opinion concerning the exact nature of such digestive fluids or mechanism, particularly when considering the destruction by phagocytosis of bacteria against which animals have been rendered immune. It has been suggested by Ritchie as quite possible "that by virtue of one set of powers a phagocyte may kill a bacterium, by virtue of another set of powers it may digest it, and the latter process may be the same as ordinary proteolysis, as it occurs in connection with the intestinal glands of an animal." It must be remembered, however, that typhoid bacilli will develop in solutions of pancreatic ferment possessing sufficient activity to digest fibrin, and it is well known that in artificial digestions with all the common ferments antiseptics must be employed in order to prevent overgrowth of putrefactive and other bacteria. Certain observers, including some of the Pasteur school, even go so far as to suggest that nearly all kinds of ferment activity in the animal body are facilitated by, if not largely dependent on, the presence of bacteria.

One is therefore forced to ask whether the phagocytic inclusion and digestion of bacillus typhosus by the cells of an animal immunized against that micro-organism is accomplished in exactly the same manner and by the same ferment activity as would be the cholera vibrio had the animal been rendered resistant against that organism. It does not seem possible that by repeated immunizing doses of a given micro-organism the phagocytic cells can be so altered as completely to change their digestive mechanism. It is well known, however, that bacteria are frequently englobed, and later during their growth, or by their production of substances which may neutralize or destroy the digestive ferment, the phagocytes may be destroyed, although similar cells may later by a process of immunization acquire the property of seizing and also digesting the same bacteria.

Further discussion of these matters will be necessary in considering the questions of what cells are phagocytic, the fate of enclosed bacteria and other masses, the economic uses of phagocytosis, and the relation of phagocytosis to present-day theories of immunity.

What Cells are Phagocytic?

In unicellular organisms phagocytosis affords a means of securing food and for defence. In more highly developed organisms with the greater specialization in other functions that of phagocytosis is assigned to definite cells, particularly those of mesodermal origin. When micro-organisms or particles obtain access to the body fluids they may be carried to any part of the body unless dis-