above the fixation needles and tied." The Esmarch bandage is then removed, and if the operation is to be completed according to Dr. Wyeth's plan, a circular incision is made, the skin flap is turned up, the muscles are divided at the lesser trochanter, and the bone is sawed through. All vessels are then tied. The remaining portion of the femur is then removed by division of the attachments of the muscles.

Methods.—Although a large number* of methods of amputation at the hip have been devised, only a few of

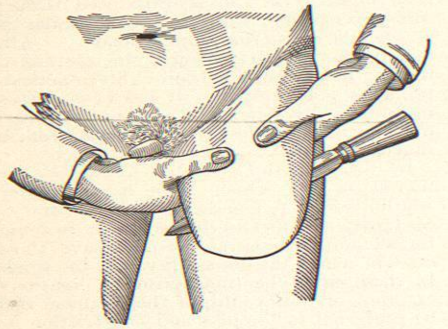

FIG. 193.

them are of practical value, and are, therefore, commonly employed. The methods which will be considered are, that by musculo-tegumentary flaps, that by cutaneous flaps and circular division of the remaining soft parts, and that by a high circular amputation with subsequent excision.

Musculo-tegumentary Flaps.—Amputation at the hip can be most quickly accomplished by means of antero-posterior muscular flaps, of which the anterior is made by transfixion, and the posterior by cutting from within outward. With able assistance the operation can easily be performed in less than twenty seconds. At least three assistants are required in this, as in all amputations of the hip. One of these is entrusted with the control of the circulation in the limb, the second follows the knife to grasp the flap before the artery is divided (Fig. 193, Hueter) and then to retract it, and the third takes charge of the condemned limb.

The patient's body having been brought to the foot of the table, the nates are made to project over its edge, and the scrotum and sound thigh are held out of the way. While the condemned limb is slightly flexed, the operator, standing on the left side, enters the point of an amputating knife, the blade of which is at least a foot long, midway between the anterior superior spinous process of the ilium and the trochanter major. It is carried deeply into the limb in a direction parallel to Poupart's ligament, across the anterior surface of the joint, which is thus opened, and made to issue on the inner surface of the thigh close to the perineum and just in front of the tuberosity of the ischium. Transfixion accomplished, a broad rounded flap, five to seven inches in length, is made by carrying the knife downward in front of the bone and cutting outward. This flap is at once reflected and held out of the way. By a transverse incision on the head of the bone the capsule is then widely opened, while the limb is forcibly abducted and everted. Hyperextension then causes the head of the bone to start from its socket with a "popping" noise when the ligamentum teres is cut. The knife being then introduced behind the head of the femur, the posterior portion of the capsule is divided and a posterior flap four inches in length is cut from within outward (Liston). When the operation is made on the right side, the knife is entered from the inner side just above the ischial tuberosity. When the posterior flap is cut from within outward, the cutaneous margin of the wound is generally irregular and not well suited for close coaptation with the anterior flap. It is advisable, therefore, particularly in robust limbs, either to outline this flap by an incision through the skin, or to cut it altogether from without inward (Fig. 194, Esmarch) (Manec). Indeed, both flaps may advantageously be cut in this manner (Guthrie).

The great advantage of the operation just described is in the rapidity with which it can be executed. Its disadvantages are in the excessively large wound which it leaves, the tendency to the retention of pus in the intermuscular spaces, and the great probability of excessive hemorrhage from the posterior flap.

A wound better suited for drainage is that made by lateral flaps. In this form of operation a semicircular incision is made, beginning at the tuberosity of the ischium, and terminating on the outer side of the femoral vessels in the centre of the groin. The incision crosses the outer surface of the thigh four or five inches below the trochanter. The flap thus outlined is then reflected over the latter and the joint opened. The inner flap is then made by cutting from within outward.

Tegumentary Flap Method.—This is an admirable method to overcome the superfluity of muscular tissue in the wound and the consequent tendency to purulent infection, and it is therefore preferred by a number of operators, among whom are Agnew and Volkmann. The operation is described by Agnew as follows: "The surgeon makes a semilunar incision in front of the limb, with its convexity downward, and, commencing midway between the anterior superior spinous process and the trochanter on the outside, descending the thigh in a longitudinal direction for five inches, then passing across the front of the limb in an oval course, adding thereby an inch to the length of the flap, and, last, ascending the inner border of the thigh, and terminating one inch below the ramus of the pubes. The integument is now rapidly dissected up from the deep fascia and entrusted to the fingers of an assistant."

The next step is to isolate the femoral vessels above the origin of the profunda, and to apply separately to

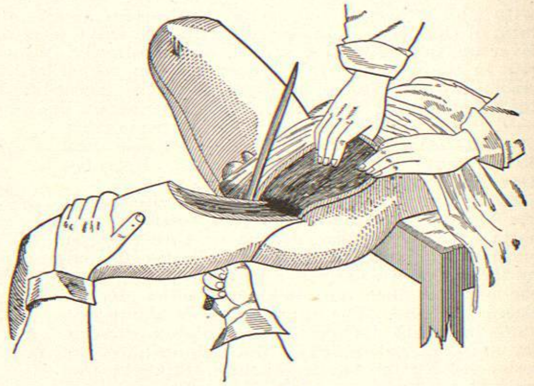

FIG. 194.

the artery and vein a strong ligature.* By displacing the pectineus muscle the obturator artery can be readily found and ligated below the obturator membrane.

The limb being now raised, the surgeon proceeds to cut a semilunar tegumentary flap from the back of the thigh, one inch shorter than the anterior. With an amputating knife the muscles are then severed circularly in front of the joint, "when after liberation of the head of the bone, as in other methods, the operation is completed by dividing through the soft parts posteriorly."

* According to Ashhurst there are forty-five.

* Volkmann divides the vessels between two ligatures.

According to Agnew, this operation can be completed in forty seconds.

Circular Amputation.—In order to make a smaller wound, and to divide the vessels where they are smaller, a circular amputation of the thigh at the lower part of the upper third is made. This may be accomplished by a single incision in thin subjects, while in robust extremities it is preferable to resort to a double incision. When the amputation in this part is effected, all the blood-vessels that can be recognized must be ligated. An incision is then made along the outer side of the stump from a point two inches above the trochanter to the circular wound, and dividing everything down to the bone (Dieffenbach). The operator then seizes the stump of the femur with a lion-jawed forceps, and while the edges of the vertical incision are separated by an assistant, the soft parts, including the periosteum, are stripped from the bone, and the capsule is opened and disarticulation effected as in other procedures. Fig. 191, from Wyeth, shows the circular amputation wound with pins *in situ* and before the head of the bone has been removed. In 1880, Mr. Furneaux Jordan, of Birmingham, published a method of amputating at the hip which does not differ essentially from the method just described. In his operation the outer incision is first made, disarticulation is effected, and the circular incision forms the last step of the operation.

Finally, mention must be made of the methods of Verneuil and Ed. Rose, and more recently of Senn,* who, in amputating at the hip, treat the lower extremity as they would a neoplasm that is to be removed, cutting from without inward, and tying each vessel as it is encountered. A shorter internal and longer external incision is made through the skin when the femoral artery and vein are to be divided between two ligatures. The incisions are then gradually carried through the muscles in front and on the outer side until the articulation is reached, when, after disarticulation has been effected, the adducted muscles are divided last of all.

Amputations at the hip of necessity present a deplorable mortality. Of 633 cases tabulated by Dr. F. C. Sheppard for Ashhurst, 393 terminated fatally, and in 20 the result was undetermined. The general mortality of the operation is, therefore, 64 per cent. The most unfavorable results obtained are those from military practice. Of 249 cases of this character in which the result was ascertained, including 66 operations performed during the War of the Rebellion, only 27 patients recovered, the mortality being 89.1 per cent.; 25 of the 66 cases referred to were primary amputations, of which 3 recovered; 23 of the operations were secondary, and all terminated fatally. Of 9 secondary operations, 2 survived, and of 9 reamputations, 6 recovered. Of 71 cases of hip-joint amputation for injury in civil practice, 47 died, the mortality being 66.1 per cent. Of 276 cases of hip-joint amputation for disease, of which 15 were undetermined, 105 terminated fatally, the mortality being 40.2 per cent.

Owing to the improved methods of preventing hemorrhage, and particularly through the use of Wyeth's method, the mortality of amputations at the hip has been very greatly reduced. Two years ago Wyeth† collected 69 cases with only 11 deaths. Of the fatal cases, 5 had severe injuries. I have collected 138 cases of amputations at the hip, published between 1889 and 1900, including the 69 cases collected by Wyeth. The total mortality of the 139 cases was 27 fatal, with a mortality of a little over 19 per cent. Of the amputations there were 121 for disease, with 21 deaths—in this estimate I include 3 cases of my own, 1 of which was fatal—or a mortality of 17 per cent. I find that 6 amputations were done for injury, with only 1 recovery—the cases reported by McBurney. In 15 cases the cause for the amputations was not stated; of these 1 died.

Joseph Ransohoff.

* Chicago Clin. Rev., 1892, p. 343.
† Annals of Surgery, vol. xxv., p. 129.

AMYGDALIN.—The source, occurrence, and general nature of amygdalin have already been stated in discussing hydrocyanic acid. It is not official and is scarcely used in its own form, although occurring in commerce. Boiling alcohol is used to extract it from almond oil cake, after which it is precipitated by ether. It occurs in crystals or scales which are soluble in twelve parts of water. It is odorless, but very bitter. If entirely free from emulsin, it does not yield prussic acid and is not poisonous.
H. H. Rusby.

AMYGDOPHENIN.—Phenyl-glycolyl-phenetidin, $C_6H_4OC_2H_5,NH,OC,CH,OHC_6H_5$. This is a substance formed by the introduction of amygdalic acid and carboxyethyl into paraamidophenol. It is a grayish-white, light, crystalline powder, dissolving but slightly in water. Stüve finds it to be analgesic, but not antipyretic, and recommends it in neuralgia, rheumatism, and the pains of locomotor ataxia. The dose is gr. xv., given from one to six times a day in powder, tablet, or capsule.
W. A. Bastedo.

AMYL IODIDE.—Iodamyl, $C_5H_{11}I$, is an oily liquid obtained by distilling together iodine, isoamyl alcohol, and red phosphorus. It is purified by washing with water and redistilling. This liquid is about as heavy as chloroform, boils at 148° C., is freely soluble in alcohol, and insoluble in water. It is used to replace amyl nitrite as sedative and antispasmodic in asthma, angina pectoris, etc. Dose, ♏ ii.–v. by inhalation. *W. A. Bastedo.*

AMYL VALERIANATE.—Apple oil, apple essence, $C_5H_{11}C_5H_9O_2$, is obtained by the action of valerianic acid on isoamyl alcohol, in the presence of sulphuric acid. It is a clear, colorless liquid, lighter than water, having an odor like that of apples and a sharp ethereal taste. It is insoluble in water, soluble in alcohol and ether, and it boils at 188°–190° C.

Amyl valerianate is used in place of valerian in functional nervous disorders, and also as a liver stimulant. As it is a solvent for cholesterin, it was thought to have the power to diminish the size of gall stones, but it is hardly probable that this solvent action could take place in the system. In fact, alcohol and other cholesterin solvents taken in large quantities have no effect whatever on the size of the stone. Amyl valerianate is administered in dose of ♏ ii.–v. in capsules, or in five-per-cent. alcoholic solution with an equivalent quantity of the amyl acetate. *W. A. Bastedo.*

AMYLENE.—*Valerine*, C_5H_{10}. Amylene is a volatile and inflammable ethereal fluid of an unpleasant odor, resembling that of cabbage. It was experimented with by Snow in 1856, as an anæsthetic, and proved itself powerful, after the manner of chloroform; but proving itself also capable of killing, it never came into accepted service.
Edward Curtis.

AMYLENE CHLORAL. — Dormiol-chloral-dimethyl-ethyl-carbinol, $C(CH_3)_2C_2H_5OH,CCl_3COH$, is made by fusing together molecular quantities of amylene hydrate and chloral. It is a colorless, oily-looking liquid, with a camphoraceous odor and a pungent, followed by cooling, taste. It is insoluble in water, and is freely miscible with alcohol, ether, acetone, and volatile and fixed oils. It goes under the trade name of dormiol, and is claimed by Meltzer and by Fuchs and Koch to be a certain hypnotic without depressing effect on the heart or respiration. Its dose is gr. viii.–xl., given in syrup, or in emulsion with a small amount of olive or almond oil, and flavored with lemon or cinnamon. *W. A. Bastedo.*

AMYLENE HYDRATE.—Tertiary Amyl Alcohol, Dimethyl-ethyl-carbinol. This is a clear, colorless, thin, neutral liquid, with a burning taste and an aromatic odor somewhat resembling camphor. It is soluble in eight parts of water and in alcohol, ether, glycerin, and oils; specific gravity, 0.812 at 53.6° F. It was recommended in 1888 by Professors Jolly and von Mering for its soporific properties. It is said to occupy a place between chloral and paraldehyde, two parts being equal to one of the former or three of the latter. Its advantage over chloral is, that it has no depressing effect on the heart. Its smaller dose and less disagreeable odor make it preferable to paraldehyde in many cases. It produces a calm, refreshing sleep, which lasts for six or eight hours, from which the patient awakens without any bad symptoms. It is used in insomnia due to nervousness, debility, mental excitement, and delirium tremens, morphiomania, and in fevers. It has not proved of much use when the sleeplessness is due to pain. It does not cause headache, nausea, or deranged digestion. In very large doses it produces a lowered temperature, shallow respiration, feeble pulse, loss of reflexes, and paralysis of extremities. It is given in doses of ♏ xxx.–xlv. Its taste and odor often prove objectionable, and may be disguised by combining with extract of licorice or some aromatic. It may also be used as an enema with mucilage of acacia, in doses of ♏ xl.–xc.

Beaumont Small.

AMYLOFORM.—A proprietary compound, stated to be a condensation product of formaldehyde and starch. It is a white powder, odorless, non-toxic, and insoluble in all ordinary solvents, and is used as a substitute for iodoform.

Dextroform is a similar compound of formaldehyde and dextrin, and it possesses the advantage of being soluble in water and of setting free its formaldehyde more readily.

W. A. Bastedo.

AMYLOID.—(From *amylum*, starch, so called from the fact that the amyloid substance gives with iodine and sulphuric acid a reaction similar to that of starch. Also called waxy, lardaceous, or albuminous degeneration. French, *Dégénérescence amyloïde;* German, *Amyloidentartung, Wachsentartung, Speckentartung.*)

The term amyloid degeneration is applied to the appearance, in the body, of a clear, colorless, shining, homogeneous, highly refractive, and translucent body, greatly resembling wax, firm in consistency, and possessing but little elasticity. When treated with iodine solution, it takes on a mahogany color, which in marked cases may become bluish or green (see Plate VII.) If the specimen thus treated is further subjected to the action of dilute sulphuric acid, zinc, or calcium chloride, the mahogany color may be intensified, or a play of colors—red, violet, blue, or green—may be produced. This action, however, does not always occur.

Because of this characteristic reaction with iodine, so analogous to that of starch, Virchow was led to believe that the newly discovered substance was devoid of nitrogen and closely allied to cellulose or starch, and for this reason gave it the name amyloid. It was further designated as "animal cellulose." On the other hand, Meckel believed it to be closely related to cholesterin. Several years after, the chemical investigations of Friedrich, Kekulé, Schmidt, Rudeneff, and Kühne proved conclusively that the so-called amyloid was in reality a nitrogenous body of an albuminous nature. According to Tschermak, it is a coagulated, albuminous substance, and is possibly an intermediate product between the proteids on one side and fat and cholesterin on the other.

It bears also a very close chemical relation to the hyaline deposit found in blood-vessels and connective tissue, as is shown by the fact that amyloid organs sometimes contain hyaline masses in no way distinguishable from the neighboring amyloid except by the application of specific staining methods. In some cases the periphery of large masses of amyloid give the reactions for hyalin and not for amyloid. Litten found that pieces of amyloid tissue lost their characteristic reactions and became changed to hyaline when introduced into the abdominal cavity of animals. The strong general resemblances between the two bodies, their similarity of location, and the frequent coincidence of occurrence make it very probable that the two substances are very closely related and that they may change from one to the other.

Amyloid differs from other albuminous bodies in its characteristic staining reactions, in its resistance to the action of pepsin, and in its very slight tendency to putrefaction. When exposed for a long time to the action of the gastric juice it slowly dissolves, so that it is possible that its resistance to pepsin and agents of putrefaction is due to its great density, which hinders the penetration of fluids. It is likewise resistant to acids and alkalies, and is not altered by alcohol and chromic acid. Through the prolonged action of dilute sulphuric acid tyrosin and leucin may be obtained from amyloid, its end products thus harmonizing with its albuminous nature.

But little is known with certainty regarding the causes and nature of amyloid formation. It is one of the most common pathological conditions of the body, and may exist as a local change, or be widely distributed through many organs and tissues. It usually occurs as a slowly progressing disease in association with various cachectic conditions. In these cases of widespread formation it must be the result of some general disturbance of metabolism. The amyloid substance does not exist in the blood as such, but the material from which it is formed is, without doubt, derived from the blood. Though called amyloid degeneration, the process is not to be classed with the true degenerations of cell protoplasm, but is rather to be regarded as a pathological deposit, in the tissues, of a substance derived from the circulation. It has been conclusively shown that the cells of the affected tissue take no active part in the formation of amyloid. The location of the deposit is practically always in the walls of the blood-vessels or in the interstices of the tissues immediately around the vessels, and the organs which show the greatest degree of the change are those abundantly supplied with blood, as the liver, spleen, and kidneys. It is possible that the amyloid substance is the result of the union of some albuminous material derived from the blood with some constituent of the tissues, and that the lowered vitality of the tissues resulting from general or local disturbances of nutrition favors its formation; or, as the result of impaired nutrition, a peculiarly modified albuminous body may be separated from the blood through the activity of the secretory cells of the blood-vessel walls. As the chief seat of the amyloid deposit is always just outside the endothelium of the blood-vessels, it becomes highly probable that it is a *product of endothelial cell activity*, and is deposited in the tissues outside the endothelium in a manner analogous to the deposit of hyalin, lime salts, or silver pigment. This pathological secretion may be the result of general changes in the circulation whereby the secretory function of the cells of the vessels is changed, or the changes may be primary in the cells themselves. The fact that local deposits of amyloid occur without apparent general changes of nutrition favors this view. In the widespread deposit of amyloid in cachectic conditions the pathological condition of the cells may be produced by the altered state of the blood; in the local deposits it may be due to local changes in the vessels, caused by local inflammatory processes.

In the majority of cases the deposit of amyloid appears as a secondary phenomenon in various cachectic states, being most commonly associated with chronic tuberculosis of the lungs and bones, chronic suppurative processes, syphilis, chronic dysentery, and leukæmia. In these diseases the most extensive deposits may be found. It rarely occurs in the cachexia of carcinoma, and usually only when there is ulceration of the growth. It is also found, though less frequently, in association with pseudoleukæmia, chronic arthritis, nephritis, chronic diarrhœa, typhoid fever, prolonged malaria, and after severe forms of rachitis. Occasionally there may occur in children a widespread deposit of amyloid without any discoverable cause.

According to Cohnheim, amyloid deposits may become well developed in from two to three months. Czerny and Krawkow claim to have produced it in animals in

from three to sixty days through the establishment of suppurative processes, caused by injections of turpentine and of staphylococci. Experiments made in Ziegler's laboratory throw doubt upon these investigations. As a rule, the formation of amyloid takes place very slowly. It occurs most frequently between the tenth and thirtieth years, but may be found in new-born infants (congenital syphilis), and also in extreme old age.

Localization.—Amyloid occurs most frequently as a widespread deposit in one or several organs, especially affecting the spleen, liver, kidneys, and lymph glands. Next to these the mucosa of the intestine, the adrenals, and the omentum may show a marked degree of the change. In all of the organs it may occur to such an extent that it affects greatly the gross appearance. It is less frequently found in the intima of the great vessels, mucosa of the respiratory and urinary passages, thyroid, lungs, ovaries, testicles, prostate, bone marrow, salivary glands, and muscle. In these its occurrence is usually so limited that its presence can be made out only by means of the microscope.

The degree of the change varies very much in different cases. The kidneys may show a marked deposit, while the other organs may contain but little amyloid; in other cases the liver or spleen may be the chief seat of the change. The primary seat of the deposit and the order in which the different organs are affected vary with the individual case, and bear no definite relation to the associated pathological condition.

Local deposits of amyloid occur in single lymph glands following inflammatory processes (mesenteric glands after typhoid), in scars, local inflammations, hyperplastic growths, tumors (osteo-fibroma of tongue, chondroma of lung), in the tongue, tonsils, and larynx following syphilitic processes, and in the scars of liver gummata. Klebs obtained the amyloid reactions in a hard chancre. Numerous authors have found amyloid in pathological conditions of the cornea and conjunctiva (trachoma, staphyloma, etc.). It has also been found in old blood clots and thrombi, and frequently in the cartilages of old individuals who have presented none of the pathological conditions with which amyloid is usually associated. These local deposits of amyloid sometimes form tumor-like masses under conditions in which it is impossible to establish any relationship between them and any other pathological process. The corpora amylacea found in the prostate, nervous system, lung, etc., sometimes give a reaction resembling that of amyloid (see *Corpora Amylacea*).

Macroscopical Appearances.—When the deposit of amyloid is at all extensive, it is readily recognizable by the naked eye; but the degree and nature of the deposit and of the associated degenerative conditions vary so much that no general description can be given which will apply to all cases. The organ is usually swollen and plumper than normal, its edges are more rounded and its fissures deepened. Its volume and weight are increased, the latter sometimes four- to fivefold. The consistency is greatly increased; in severe cases the organ may have a wooden hardness. There is also a great loss of elasticity, so that pressure indentations made upon the surface of the organ remain for a long time. The blood-content of the affected organ is usually greatly diminished, so that its color becomes grayish or yellow if much fatty change is present. Very characteristic is the shining, translucent, waxy appearance of the cut surface, resembling that of bacon (lardaceous). The differences in histological structure of the various organs lead to individual appearances when amyloid is present, and these will be described separately.

The iodine test is best applied to fresh tissue. A moderately strong Lugol's solution should be used after washing out the blood, as the color resulting from the combination of the red hæmoglobin and yellowish-brown iodine very closely resembles the mahogany red of the amyloid. The iodine solution is poured over the freshly cut surface, allowed to stand for a minute or so, and then washed off. The amyloid areas are reddish brown, the non-amyloid ones yellow. If dilute sulphuric acid is now applied, the amyloid portion becomes dark green to black, or dark violet, while the unaffected tissue is of a clear gray color. This gross reaction is plainly seen, as a rule, only when the amyloid deposit is marked; but sometimes, as in the intima of the large arteries, it may be brought out very distinctly when no other appearances point to the presence of amyloid (see Plate VII.).

Microscopical Appearances.—Microscopically, amyloid appears as a homogeneous, hyaline substance, of rather high refraction, which is deposited almost exclusively in the walls of the capillaries and smaller arterioles. In its earliest stages it appears as a homogeneous layer outside the endothelium, but in more advanced cases, owing to the atrophy of the intervening tissue, the masses of amyloid increase greatly in size and may finally become confluent, so that the entire tissue, or a large part of it, may be replaced by amyloid. In this way large nodules or tumor-like masses are formed. It must be emphasized, however, that in its earliest stages the first appearance of amyloid is always next to endothelium.

It is never deposited in living cells. The tissue cells proper take no active part in the process, and the changes found in these cells are to be regarded as secondary. The lumen of the affected vessel is soon narrowed by the increasing deposit, and the resulting disturbance of blood supply leads to degenerative changes (atrophy and fatty degeneration) of the cells of the affected region. The deposit of amyloid between and around the cells near the blood-vessels leads to similar changes. The individual vessels are not equally affected throughout, and different vessels of the same organ may show the change in very different degrees.

The microscopical appearance of amyloid in sections stained with hæmatoxylin and eosin is so similar to that of hyalin that a differential diagnosis between the two deposits can be made only by means of some specific staining reaction. Of these the best and most practical is the Van Gieson's method. The sections are overstained in hæmatoxylin and then stained for one-half to one minute in a concentrated water solution of picric acid to which enough of a concentrated water solution of acid fuchsin has been added to give it a distinctly red color. By this method amyloid is stained a pinkish brown or yellow, while hyalin takes a deep red color.

The iodine reaction does not show so well in hardened material, so is best applied to fresh tissue. The specific reactions of amyloid with various aniline dyes are classic in the history of microchemistry, and it is largely to the wonderful amount of interest bestowed upon these that this branch of pathological technique owes a very great part of its development. The aniline stains most commonly used are methyl and gentian violet, methyl green, and iodine green. The amyloid tissue is best hardened in alcohol and cut without embedding. The sections are then stained for five to ten minutes in a two to five per cent. solution of the stain, differentiated with dilute acetic acid, and mounted in glycerin or syrup. With all of these stains amyloid exhibits a metachromatosis. Methyl and gentian violet and iodine green stain the amyloid portion ruby red, while the non-amyloid is stained blue. Methyl green stains the amyloid a sky-blue, the non-amyloid a bright green. None of these reactions is permanent; the sections so treated gradually fade. On the whole, the Van Gieson's method, which can be applied to either paraffin or celloidin sections, is the most convenient and practical stain for the differentiation of amyloid.

Liver.—This organ is very frequently the seat of amyloid deposit. Outside the endothelium of the liver capillaries, between it and the liver cells, there is deposited a layer of amyloid, which, as it increases in thickness, presses upon the liver cells and separates them from their normal relations with the blood, so that they undergo atrophy and degeneration, and finally may entirely disappear. The amyloid masses thus become confluent, the capillary walls are pressed together, and the only cells