speculum is introduced and the operator, standing behind the patient, seizes the growth near the apex with suitable forceps, and with an iridectomy knife, which is but slightly bent, cleanly dissects it from the cornea, taking especial care to detach its margins from the corneal limbus. Its more loose attachments to the sclerotic are also separated for a short distance (2 or 3 mm.) from the corneal margin. Then, with a pair of slender scissors, curved on the flat, the whole of the corneal and a very small part of the conjunctival portion of the growth is removed by two converging cuts. If decided traction is made with the forceps upon the detached portion of the growth while the scissors are being used, and if the latter are pressed against the sclerotic, a very much larger piece of the pterygium will be removed than is desirable. Only very slight traction, therefore, should be exerted, and in using the scissors it should be borne in mind that we are more apt to remove too much than too little tissue. If the edges of the conjunctival wound are now slightly undermined, so as to detach them in a measure from the underlying fascia, one or two stitches of fine black silk will suffice to close the wound, and, unless more tissue has been sacrificed than is necessary, will bring its edges together without undue traction. The closure of the wound in this way hastens the healing process, and the removal of the stitches on the second or third day, as may seem more desirable, can be accomplished without pain by the instillation of a drop or two of cocaine. A light bandage should be applied, and may be worn until the stitches are removed. A collyrium of boric acid (gr. x. to aq. destill., ℥ i.), used three or four times a day, soothes the eye, and helps to subdue the inflammation. Should there be much ciliary irritation from inflammation of the corneal tissue, atropine is indicated, while, on the other hand, if there is considerable conjunctival secretion, without ciliary irritation, a very little sulphate of zinc (gr. $\frac{1}{4}$–$\frac{1}{2}$ to ℥ i.) or alum (gr. ss.–i. to ℥ i.) may be added, with benefit, to the boric acid solution. The patient should be warned that the improvement in the appearance of the eye will be slow, else he may suppose the operation has not been successful, and may mistake the vascularity which remains for some time about the former site of the pterygium for a return of the growth. When the pterygium has encroached upon the cornea, he should also be made to understand that after its removal a more or less perceptible opacity will remain. Should this opacity involve the central portion of the cornea, which in exceptional instances is the case, an iridectomy may be necessary in order to obtain a pupil behind a part of the cornea which is clear.

Traumatic Lesions of the Conjunctiva.—The conjunctiva is occasionally torn or cut without injury to the deeper coats of the eye. Considerable extravasation of blood into the loose underlying connective tissue and pronounced œdema are apt to supervene, and the appearance of the eye suggests that the injury is much more serious than is actually the case. The edges of the wound, if they show a disposition to gape, should be brought into apposition with fine, black-silk sutures, and a light bandage should be applied. A collyrium of boric acid is often useful.

Foreign bodies entering the eye frequently lodge upon the cornea, but rarely attach themselves to the conjunctiva of the bulb or to that of the lower lid. Their favorite resting place, however, is the tarsal conjunctiva of the upper lid; and here they give rise to an especial amount of discomfort, because through the movements of the eyeball and the lids they constantly scrape the surface of the sensitive cornea. When the eyelid is everted they are brought into view and can be easily removed—most conveniently by means of a wooden toothpick, about the sharp end of which a very little absorbent cotton has been wound. The writer recalls but one instance in many years' experience in which a foreign body—a small fragment of coal—was found in the superior retrotarsal fold. Probably, when foreign substances enter this region they are carried by the movements of the lid toward the inner canthus and are then easily removed.

Caustic substances, such as lime, lye, and the stronger acids, and molten metal, when they find their way into the conjunctival sac, are likely to do serious damage. An obstinate inflammation of the conjunctiva is almost sure to ensue; but when the caustic action has involved neighboring parts of the bulbar and palpebral conjunctiva, a much more formidable condition is apt to result —an adhesion may occur between the lid and the eyeball, and the condition known as *symblepharon* be established. The treatment of these cases, if they can be seen at once, is the application of an agent which will tend to neutralize the caustic substance that has entered the eye. In the case of an alkaline caustic the conjunctival sac should be washed out with vinegar or acetic acid diluted with water, and if the caustic be an acid a solution of bicarbonate of soda should be similarly employed. The application of castor oil affords relief and does good by protecting the burned surfaces. Still greater relief may be obtained by using a solution of atropine (the alkaloid) in castor oil. Holocaine is another useful remedy.

If a disposition to union between the bulbar and the palpebral conjunctiva manifests itself, every effort should be made to prevent this. The lid should be frequently drawn away from the eyeball and the apposed surfaces should be kept coated with castor oil or vaseline. Success will probably be attained if the retrotarsal fornix has escaped the action of the caustic; but if this has been seriously involved a symblepharon will almost certainly develop in spite of all we may do. And, under such circumstances, any subsequent efforts which we may make to undo the mischief by operative procedure is likely to be equally barren of results. On the other hand, if the symblepharon is band-like and does not extend to the fornix, a good result may be almost always obtained by operation.

Atropinism, etc.—An inflammation of the conjunctiva of follicular type, accompanied usually by considerable itching, is occasionally excited by the long-continued use of collyria containing atropine, eserine, and other drugs of similar character. Indeed, there are individuals in whom a single application to the eye of a solution of atropine will produce a marked conjunctivitis, and not infrequently such individuals are equally susceptible to all of the commonly employed mydriatics, though this is not always the case. For example, the writer has under observation at the present time a case in which neither atropine nor hyoscyamine was tolerated, and another in which atropine excited after a few days' use a marked conjunctivitis, in each of which he is now using sulphate of duboisine without ill effect. The withholding of the drug to which the susceptibility is shown and the use of a collyrium of boric acid will soon restore the eye to its normal condition.

Subconjunctival Hemorrhage.—This condition, which usually manifests itself suddenly, may occur spontaneously or be of traumatic origin. Spells of violent coughing, vomiting, or sneezing may produce it, while in some instances it occurs, perhaps during sleep, without assignable cause. The existence of angiosclerosis predisposes to it as to hemorrhages in other parts. It not infrequently encircles the cornea and spreads over the whole eyeball, giving to it a bright-red appearance, which often leads to the belief that something very serious has happened. It is usually mistaken for "inflammation"; but an inspection of the eye shows at once that the redness is not due to injection of the conjunctival vessels. It may give rise to a slight soreness of the eyeball; but beyond this it causes no inconvenience apart from its unsightliness. During the process of absorption, which may occupy two or three weeks, the bright red color of the extravasated blood changes to a greenish-yellow. Treatment is scarcely called for; but if it is a matter of moment to hasten the restoration of the normal appearance of the eye, a compress bandage and the internal administration of potassium iodide may be of some avail.

Argyria Conjunctivæ.—From the long-continued application to the eye of nitrate of silver a permanent stain, usually of the lower tarsal and retrotarsal conjunctiva, but occasionally of the bulbar conjunctiva as well, may result. The "white of the eye" assumes an olive color, while the retrotarsal conjunctiva and the inner surface of the lids are stained a bluish-gray or slate color. A similar discoloration of the conjunctiva is said to occur in persons who, owing to the nature of their employment, are constantly exposed to the action of silver dust (Fuchs). Cases of argyria from protargol have been reported, and as this preparation of silver is more penetrating in its action and is used more liberally than the nitrate, it is probable that in the future this condition will be met with more frequently than has been the case hitherto. The stains are indelible. Different agents have been employed to remove them, but without success. *Samuel Theobald.*

CONNECTIVE TISSUE.—Connective tissue, as its name suggests, connects and binds together other structures. If we attempt to remove the skin from the underlying tissues we find it bound to them by delicate, fibrous bands. On further dissection of the body we find the muscles bound together by tissue which, even to the naked eye, is like that under the skin. Sheaths of the same sort are found about the vessels and nerves, beneath the mucous and serous membranes and in many other places. This is connective tissue. Under the microscope it is characterized by an extensive development of the intercellular substance, and it is the intercellular structures and not the cells which are of functional importance. Not only does it comprise the fasciæ, the subcutaneous and subepithelial areolar tissue, and the packing substance about the great vessels and nerves, but, in modified forms, it makes up the groundwork of the spleen, lymph glands and marrow, the tendons, aponeuroses and ligaments, the periosteum and perichondrium, the sclera of the eye, and the membranes of the central nervous system. The supporting tissues—bone and cartilage—are closely related to it both histologically and embryologically. Indeed, no tissue occurs so universally in the body, and it would be useless to try to give a list of places where it is found. All the blood-vessels lie in tracks of it. With them it penetrates every solid organ, and binds together its most delicate parts—the fibres of the muscle or the tubules of the gland. Though inconspicuous, it is as indispensable in the make-up of any organ as are the rivets in the building of a ship.

In order properly to understand the histology of connective tissue and to appreciate the relationship of one of its forms to another we must approach the subject from the embryological standpoint. We will therefore consider first embryonic connective tissue, then the typical adult form, and afterward take up successively the various modifications.

If we look at a section of a young chick embryo we see nothing but cells. We see, moreover, that these cells are of two sorts—differing markedly in shape and still more markedly in their relations to one another. The covering of the body, and the intestinal canal, the rudiments of the central nervous system, and any viscera that may be present will be seen to consist of cells tightly packed together, forming layers or membranes. Such a layer of closely compacted cells is called an epithelium. Lying between these organs, in a position comparable to the straw in a barrel of crockery, is the other kind of cells. These are not united to one another in continuous layers, but are far apart and loosely packed, the interstices appearing empty in the section. This is the "mesenchyma." It gives rise in the further development of the animal to many other things than connective tissue. Still, in the embryo it corresponds so closely, in structure and relations to other parts, to our conception of connective tissue in the adult that it is justifiable to call it "embryonic connective tissue."

If we trace the development of the mesenchyma back we find that it arises from the mesoderm or middle germ layer. A discussion of the development of the mesoderm would be out of place here; but it is enough to say that at one period it forms a fairly compact layer in which subsequently a cavity arises. The epithelium-like lining of this cavity makes up the mesothelium. The rest of the cells of the mesoderm form the mesenchyma.

Embryonic Connective Tissue or Mesenchyma consists histologically of (*a*) cells and (*b*) an intercellular matrix (see Fig. 1490).

The cells have large and round or oval nuclei with one or more granules of chromatin. In stained sections the nucleus appears to be distinctly vesicular, and does not

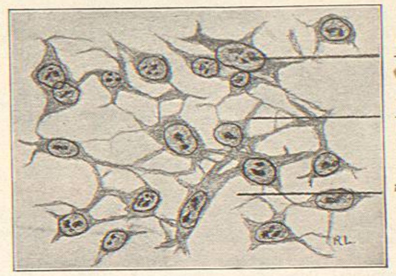

Fig. 1490.—Embryonic Connective Tissue (Mesenchyma) from Embryo Chick. × 700.

color deeply. It often shows karyokinetic figures. In early embryos the nucleus is surrounded by but little protoplasm. Later the amount is greater. The protoplasm is finely granular and no cell wall is recognizable. The shape of the individual cell is stellate, with irregular tapering and branching processes projecting in all directions. The branches of each anastomose freely with those of its neighbors, so that the protoplasm is continuous from cell to cell. Indeed, the anastomosis is often so free and the cell bodies so inconspicuous that the mesenchyma may be described as a network or spongework of protoplasm, with the nuclei at the thick places where the strands meet.

The matrix is an albuminous fluid of slight consistence. It is the intercellular juice of the embryo.

The further development of the mesenchyma into adult structures takes place by virtue of (1) changes mainly in the intercellular substance, (2) changes mainly in the cells, or (3) more complicated changes involving both the matrix and the cells and giving rise to special structures. Thus, for instance, we have fat cells and smooth muscle fibres arising by differentiation of the mesenchymal cells. In such tissues, to be sure, the intercellular substance undergoes modification, but the function of adipose or muscular tissue depends rather upon the cells. The walls of the blood-vessels are examples of the third class of mesenchymal tissues; they show complicated changes both in the cells and in the matrix. But it is with the first class that this article has chiefly to deal—with tissues differentiated from the mesenchyma mainly by changes in the intercellular substance.

This class includes the supporting tissues and the connecting tissues. The supporting tissues are bone and cartilage. Their cells differ from those of the mesenchyma in shape and arrangement, but bone is bone and cartilage is cartilage because the fluid matrix has been replaced by lime salts or chondrin. The same is true of connective tissue. Its distinguishing features and the physical characters to which it owes its function are due to the intercellular structures.

Ordinary Adult Connective Tissue consists of the following elements: (*a*) Matrix; (*b*) fibres; (*c*) elastic network; (*d*) cells. The cells and the matrix are present in the embryonic form. All the cells of the adult form of connective tissue are developed from cells of the mesenchyma. The elastic network and the fibres are not found in embryonic connective tissue. These various elements may best be studied by excising small bits of the subcutaneous connective tissue of a rabbit and examining them fresh in normal salt solution (see Fig. 1491).

(*a*) The *matrix* of adult connective tissue is not much different from that of the embryonic form. It is still a soft, homogeneous, albuminous substance.

(*b*) The *fibres* are perhaps the most important, from a physiological point of view, of the constituents of connective tissue. They are long, wavy bundles, running

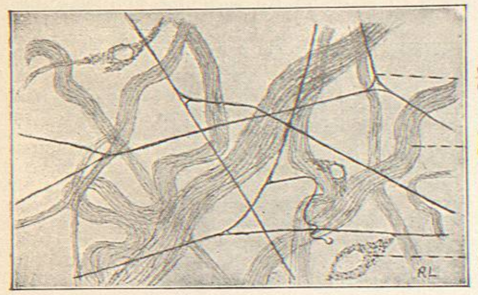

FIG. 1491.—Subcutaneous Connective Tissue of Rabbit. Fresh, "teased" specimen. × 350.

through the matrix amongst the cells. Each fibre is composed of a large number of fine fibrillæ. The latter are filaments of the most extreme delicacy. They do not vary much in diameter, the size of the fibre depending upon the number of fibrillæ, and not upon the calibre of the individual elements. Large fibres may split into smaller ones, but the individual fibrillæ do not branch. The arrangement and relative number of fibres vary in different forms of connective tissue, as will be presently described. They are best stained with Mallory's connective-tissue stain. In large masses they are white in appearance. They are not elastic.

On boiling the fibrillæ are converted into gelatin. They swell up and become transparent when treated with acetic acid, and are destroyed by alkalies.

The origin of the fibres is not thoroughly understood. They were formerly thought to arise from the transformation of elongated cells. At present, however, that they arise in the matrix, entirely apart from the cells themselves, by a process more comparable to the formation of fibrin in clotting, seems more probable.

(*c*) The *elastic network* is also intercellular. It differs from the fibres already described in appearance and structure, in chemical and physical properties, and in physiological function. It consists of solid strands of a highly refractile substance. Unlike the white fibres these strands are homogeneous—not composed of fibrillæ. They anastomose freely so as to make a network. In fact, this characteristic is so well marked that it is better not to use the term "fibres" at all in speaking of them, but to speak of the "network," reserving the word "fibres" for the white, non-elastic, fibrillated structures described in a preceding paragraph (Minot). The strands differ greatly in calibre. They may be extremely fine, so that the network is delicate and open-meshed, as in Fig. 1491, or they may be so thick, especially at the anastomosing points, that the network presents the appearance of a solid plate perforated by sieve-like openings. Such a dense mass of elastic material is represented in Fig. 1492. Where one of the delicate strands is broken it usually curls up, as is shown in Fig. 1491. But, throughout all of its variations, the elastic material is always a continuous network.

FIG. 1492.—Elastic Network from Wall of Artery. × 700 and reduced.

Chemically the network is composed of elastin. This is not converted into gelatin by boiling. It resists the action of acids, so that when tissues containing both fibres and network are treated with acetic acid the fibres swell up and become inconspicuous and the elastic network is brought out very clearly and sharply. It differs from the fibres also in staining reactions and is evidently not at all of the same chemical nature. It is best differentiated by staining with Weigert's resorcin fuchsine. According to Mall the strands of elastin are enclosed in delicate sheaths of a different chemical nature.

In mass the elastic material is yellow, and, as its name implies, possesses elasticity. These properties are the distinguishing features of connective tissue in which it predominates, as contrasted with the white, inelastic tissue in which the fibrillated fibres are in the ascendant.

Concerning the embryological origin of the elastic network there is still some doubt. According to certain observers the network arises from the protoplasm of anastomosing cells, and special relations of the network to the nuclei of the connective-tissue cells have been demonstrated. But the significance of this connection is not clearly shown. This view, like the similar one in regard to the white fibres, is warmly supported by those who, from theoretical considerations, believe that all parts of the organism are composed of cells or their derivatives. A much more plausible view is that the elastic network, like the fibres, is deposited in the matrix and is not formed by direct transformation of cells. Indeed, Ranvier has shown conclusively that elastin is deposited first in the form of little globules arranged in rows which subsequently fuse into plates or anastomosing strands.

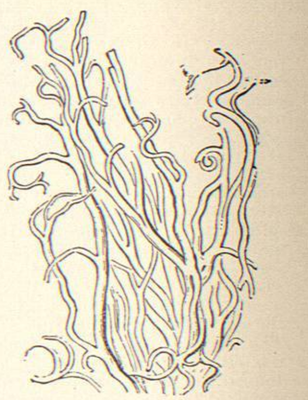

FIG. 1493.—Elastic Network from Ligamenta Subflava. (From Quain's "Anatomy.")

(*d*) The *cells* of adult connective tissue are often much modified from those of the mesenchyma which are their ancestors. The greater part of them are still stellate in outline—and still retain the protoplasmic processes connecting them with each other. But the great development of the intercellular structures has resulted in marked changes in form and appearance. They are flattened and grouped in various ways. They are comparatively few in number. Not only do they tend to be flattened between the fibres, but they form more or less definite sheaths about some of the larger bundles. Such sheaths are at times so complete that the cells are united by their edges as in an epithelium. Perhaps close to these will be found other cells, farther apart and united to one another and to the cells in the sheaths only by their long protoplasmic processes. They may be wavy or elongated. Thus they differ much in appearance.

In addition to these ordinary connective-tissue cells, two special varieties have been described—plasma cells and granular or mast cells. Much confusion exists in the use of these terms, as the original cells described by Waldeyer as plasma cells were afterward described by Ehrlich as mast cells; while Unna applied the term plasma cells to the granular cells of Waldeyer. In this article the terms will be used as applied by Unna and Ehrlich.

Plasma cells are distinguished by the absence of prominent granules in the protoplasm. The latter stains with basic aniline dyes and is often irregularly colored

or vacuolated. The cells may be elongated or branched. Although observed in normal tissues they are more characteristic of pathological conditions. Their derivation, significance, and function are unknown.

Granular or mast cells are connective-tissue cells having prominent granules in their protoplasm. These granules stain intensely with certain aniline dyes and have also given the name "eosinophile" to the cells. The latter are more apt to be spherical than the plasma cells. They occur in normal as well as in diseased tissues. As in plasma cells we do not know their significance or function.

Leucocytes are often found wandering about in the intercellular fluid. But they are to be regarded as invaders and not as elements of connective tissue at all.

Besides the protoplasmic granules mentioned as occurring in certain connective-tissue cells the latter may contain two other important visible substances—pigment and fat. Pigment is deposited in the form of dark-brown granules of a substance called melanin. It is found in the irregular, branching cells. The amount varies from a few granules to such a large number that the nucleus is completely hidden. The coloring of many portions of the body, both in man and in animals, is due to cells of this sort. Moreover, the pigment of the epithelium is probably originally of this nature, being formed in connective-tissue cells which wander into the epithelium and deposit their pigment there. Fat is deposited in the cells of connective tissue in much the same way as pigment is laid down in them. Little droplets of fat appear in the protoplasm—mainly in the granular cells. These droplets, at first small, become larger and more numerous till finally they fuse into one large drop. This fills the cell and distends it to many times its original size. The protoplasm remains about the globule of fat as a thin envelope containing at one point the flattened nucleus. Accumulations of such cells bound together by the ordinary elements of connective tissue, and abundantly supplied with blood-vessels, constitute adipose tissue.

To recapitulate: adult connective tissue consists of cells and a fluid matrix, in the latter of which are present two structures, differing from each other histologically, chemically, and physiologically—viz.: white, non-elastic, fibrillated fibres, and a homogeneous, yellow, elastic network. The cells are of four kinds: common flattened or lamellar cells, plasma cells and granule cells, all of which are true connective-tissue elements, and wandering leucocytes which are not to be regarded as connective-tissue cells at all. Connective-tissue cells may contain fat or pigment.

Adult connective tissue may be classified according to the predominance of one or the other of its intercellular elements, as fibrous, elastic, and fibro-elastic.

In *fibrous connective tissue*, which is perhaps the most typical and widespread form, the fibres predominate over the elastic network. Examples are seen in the aponeuroses, the tendons and ligaments, the periosteum and the dura. All these structures are white when seen in mass and will not stretch.

FIG. 1494.—Section of Connective Tissue from Wall of Vagina. Only the nuclei of the cells—not the protoplasm—can be seen. × 700.

In *elastic connective tissue* the network predominates over the white fibres. The resulting tissue is yellow in macroscopic amounts and is capable of stretching much and then returning to its original condition. The classical example is the *ligamentum nuchæ* of large quadrupeds, like the horse. In these animals the ligament extends from the vertebral spines to the occiput and supports the head. When the head is depressed the ligament is stretched, and it acts as a sort of spring when the head is elevated again. In man, according to Shäfer (Quain's "Anatomy," vol. i.), it occurs as follows: (1) In the *ligamenta subflava*, between the vertebral arches, where its elasticity permits the spine to be flexed. (2) In the stylo-hyoid and crico-thyroid ligaments and in the vocal cords and trachea. (3) In the coats of the blood-vessels.

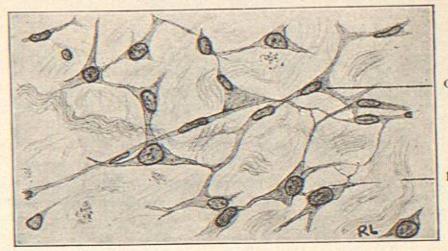

FIG. 1495.—Mucous Connective Tissue from the Umbilical Cord. × 332.

In *fibro-elastic connective tissue* both fibres and elastic network are present in considerable quantities. Stretching is hence allowed, but the elasticity is limited. It will of course approach fibrous tissue on the one hand and elastic tissue on the other. The classification here given is merely one of degree, and no sharp boundary lines can be drawn. The best example of fibro-elastic connective tissue is perhaps the adventitia of the larger arteries. Here we can readily recognize both the fibres and the elastic material. Other good examples are seen in the submucous layers of the œsophagus and of the vagina (see Fig. 1494).

In stained microscopical sections of ordinary connective tissue we recognize all the elements described. The fibres usually make up the greater part of the section. Their direction and compactness will be evident at a glance and will of course depend on the source of the specimen examined. The elastic elements are white (yellow only in macroscopical amounts), glistening, and highly refractile. They usually form thick, wavy bands lying amongst the fibres. Though not difficult to recognize in stained sections, it is impossible in a drawing like Fig. 1494 to even approximate their actual appearance. They are best studied by the beginner in the walls of the arteries.

The cells, in dense forms of connective tissue, are flattened between the wavy bundles of fibrillæ. This makes it difficult to recognize the protoplasm, so that about all we see of them in sections is the nuclei. As the latter also conform to the pressure of the surrounding fibres they are elongated and wavy and often have characteristically pointed tips. This pointed shape, together with their deeper staining, is in sharp contrast to the nuclei of smooth muscle fibres with which students are disposed to confuse them. They stain very deeply and homogeneously, so that in ordinary specimens little or no intranuclear structure can be made out.

In the foregoing description, I have dealt with the typical form of connective tissue, such, for example, as occurs beneath the skin or mucous membranes. There remains to be described the various special modifications, all of which are best understood by remembering their embryological evolution. We have also to define certain more or less appropriate terms in common use.

Mucous connective tissue or "Wharton's jelly" (Fig. 1495) is only slightly modified from the mesenchyma. The cells remain almost unchanged. Their small, protoplasmic bodies surrounding the rather large, vesicular nuclei send off tapering processes. The latter branch and anastomose freely with those of neighboring cells. The large intercellular spaces are filled with mucin, and

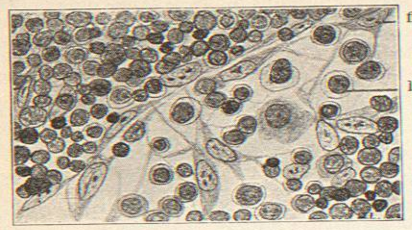

FIG. 1496.—Reticular Connective Tissue from Lymph Gland of Dog. The upper left-hand portion of the figure consists of adenoid or lymphoid tissue. × 600.

there are also a few poorly developed fibres. The mucin gives the whole the peculiar jelly-like, translucent look in gross amounts. which is familiarly seen in the umbilical cord. The umbilical cord represents its only normal occurrence in man. It is more abundant in lower forms of life. In the human adult it is not normally present at all. Pathologically it is seen in myxomata, the commonest example of which is the ordinary nasal polyp.

Reticular connective tissue is a highly specialized form of connective tissue found in the spleen, lymph glands, tonsils, the solitary and agminated follicles of the intestine, the submucosa of the digestive tract, and in other places. Its structure has always been obscure. Ordinary microscopical sections show little more than a mass of nuclei. These are easily seen, however, to be of two sorts (see Fig. 1496). Some are small, deeply stained, and round. Others are often oval, larger, vesicular in character with a well-marked nuclear membrane and with nuclear contents staining but faintly save for one or more granules of chromatin—in other words, nuclei like those of the mesenchyma. Careful study of favorable sections will show some of the protoplasmic bodies of the cells to which these nuclei belong. The outlines of the cells to which belong the small dark nuclei are simply circles—in other words the cells are like the young mononuclear leucocytes and are hence called "lymphoid" cells. The other nuclei are sometimes surrounded by irregular masses of protoplasm with obscure branches. They are the fixed connective-tissue cells of the part. The lymphoid cells are not fixed, but may be regarded as simply floating in the matrix. The differences between the two types of cells are well shown in the accompanying illustration (Fig. 1496).

If we treat a section in appropriate reagents and shake it vigorously before mounting, most of the lymphoid cells may be removed and the other parts show more clearly. Such a section shows a network of rather large anastomosing strands containing the nuclei of the fixed cells. Its appearance resembles very closely that of the omentum of certain animals, such as the dog. Here instead of being two layers of flattened epithelial cells with a little connective tissue between, as in man, the omentum consists of an open-meshed network of delicate fibres, the latter being surrounded by tube-like sheaths of cells, so that the whole is like a sieve full of holes. Ordinary specimens show neither fibres nor cell outlines, but only the nuclei lying upon the strands of the network. Now shaken sections of reticular tissue look like this, except that the fibres are not all in one plane, but run in many directions.

This appearance has given rise to a controversy in which the last word has not yet been spoken. Does the reticulum consist of a network of cells alone, or of fibres alone, or of fibres with cells in close relation to them? It seems to the writer that this question is answered by specimens in which all of the cells have been removed by digestion, or in which only the fibres are stained. In such sections we still see a network of fibrillated fibres interlacing and crossing one another in all directions so as to make a framework. These fibres, in organs like lymph glands, are continued directly into the more densely packed fibres of the capsule. In the fresh state the fibres are surrounded by the flattened connective-tissue cells which make sheaths, more or less definite, about them, in much the same way as do the endothelial cells in the dog's omentum. That this is the case is also proven by staining in such a way as to show the outlines of the individual cells. This flattening out of mesenchymal cells to form membranes is seen in many other regions,—notably in the endothelia of the blood-vessels. The intercellular, anastomosing processes are doubtless preserved, and if we assume that these fixed cells are also connected by their protoplasmic processes with the connective-tissue cells in the capsule the relations become clear. Each of the fibres of reticular connective tissue, then, consists of a central core of fibrillæ surrounded by a more or less definite tube of flattened mesenchymal (endothelial) cells. According to Mall the fibres in reticular connective tissue differ both from the white fibres and from the yellow elastic network, and consist of a third substance called reticulum.

The terms *adenoid tissue* and *lymphoid tissue* refer to a form of reticular tissue whose spaces are filled full of floating lymphoid cells, so that the fixed cells are vastly outnumbered. Such tissue is found in the tonsils, the secondary nodules of the lymph glands, the Malpighian corpuscles of the spleen. the solitary follicles, and Peyer's patches of the intestine. This tissue is represented in a portion of Fig. 1496.

Areolar or *interstitial tissue* is a loose form of connective tissue where the fibres and strands of the elastic network run in all directions, not being disposed in layers. Such is the tissue shown in the teased specimen represented in Fig. 1491. It is perhaps the most typical form of connective tissue. It occurs underneath the skin and mucous membranes, about the vessels and nerves, and in the various places where its function is to connect loosely parts between which a considerable degree of motility is required.

Fibrous membranes, like the periosteum and perichondrium, the fasciæ and the dura are made up of connective tissue of the adult type. The fibres are especially well developed and make up the greater bulk of the tissue. They are densely packed together so that there is little fluid matrix. A small amount of elastic network is present even in places where elasticity is hardly a feature of the gross membrane, as in the periosteum.

Ligaments and tendons (Figs. 1497 and 1498) are also made up of dense connective tissue, the most marked histological peculiarity being that the fibres all run in the same direction and are gathered into parallel bundles. The cells occur between these bundles, their form and

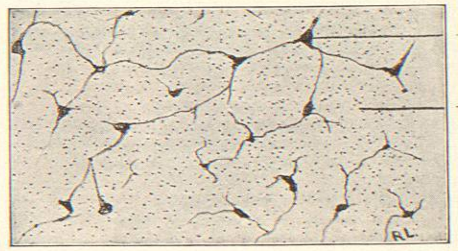

FIG. 1497.—Cross Section of Tendo Achillis. × 332.

arrangement being determined by the positions in which they lie. Thus they form characteristic chains, as is well shown in Fig. 1498. It will be noticed in such longitudinal sections that the nuclei are generally near the ends of

the cells. Often the cells appear to be in groups of two, for the reason that the nuclei of a pair of cells are in the adjacent ends of their respective cell bodies. The nuclei may be flat or they may be round or oval. In such longitudinal sections we see little trace of the stellate form that the cells once had when they formed part of the embryonic mesenchyma. In cross sections (Fig. 1497), however, we see a strikingly different picture. We now have stellate cells whose long processes anastomose freely—those of one cell with those of another. In fact, each tendon corpuscle sends out lateral lamellar processes, lying in planes parallel to the general direction of the

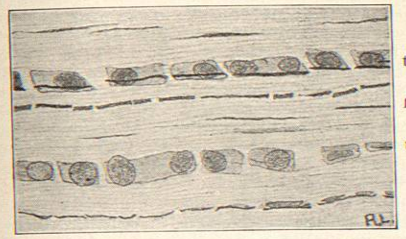

FIG. 1498.—Longitudinal View of Tendon of Rat's Tail. × 450.

tendon, and these lamellæ break up into the anastomosing branches. Hence the striking difference in appearance between cross and longitudinal sections.

There are many other special modifications of connective tissue, such as the submucosa of the uterus and the cornea and sclera of the eye, but these are best treated in connection with the organ to which they belong. There are also tissues belonging to the third group in the classification of mesenchymal tissues—structures developed from the mesenchyma by changes both in the cells and in the intercellular matrix. These are not commonly classed as connective tissue at all, but they are closely allied to it. Take, for example, the walls of the arteries. Nothing enters into their composition but mesenchymal cells and the various intercellular structures of connective tissue. The flattened endothelial cells of the intima are modified mesenchymal cells, as are also the smooth muscle-fibres of the media. The elastic plate of the intima and the fibres and elastic tissue of the adventitia are the same intercellular structures found in connective tissue.

Such structures as these are not classed ordinarily as connective tissue at all. In concluding this article, however, the writer wishes to emphasize the importance of the embryological aspect in understanding not only the histology of the various forms of connective tissue, but also their essential unity. *Ralph C. Larrabee.*

For bibliography, consult: Quain's Anatomy, vol. i., 1891. p. 243. C. S. Minot: Human Embryology, 1892. J. Disse: Das retikuläre Bindegewebe, in Ergebn. d. Anat. u. Entwickelungsgesch., Anat. Hefte, vii., 1897, p. 9.

CONSANGUINITY.—This term denotes blood relationship, and is to be distinguished from affinity, which signifies relationship by marriage. The husband bears the same relation to certain individuals by affinity that the wife bears by consanguinity. But two persons, each related to a third person by affinity, have thereby no affinity for each other.

The principal importance, from a medical point of view, of the subject of consanguinity is in the effect produced upon offspring by the fact of such a relation existing between the parents. In part from a belief in the injurious effects upon offspring of marriages between near kin, in part from the influence of authority, and in part from a natural repugnance to such unions, legal prohibitions have been placed in many countries upon marriages between persons who are within certain specified degrees of consanguinity. In some instances these restrictions have been extended from the field of consanguinity to that of affinity. In England, for example, for the past two hundred years it has been illegal for a man to marry his deceased wife's sister, a relation obviously not within the bounds of consanguinity at all.

Consanguinity may be either lineal or collateral. The former is reckoned between persons in the direct line of descent, either downward from progenitor to descendant, or upward from descendant to progenitor. Collateral consanguinity exists between two persons descended, not the one from the other, but both from some common ancestor. The degree of consanguinity is measured in the first instance by the number of generations separating the two individuals. Thus grandfather and grandchild are in the second degree of lineal or direct consanguinity. In defining the degree of collateral or indirect consanguinity two different methods have been used, which have given rise to some confusion. By the civil law the degree is measured by counting the number of generations upward from one individual to the common ancestor, and thence downward to the other. By the canon law the number of degrees are counted only in one line (that which is the longer of the two) from the common ancestor.

Thus, supposing F and G to be great-grandchildren of A, and hence second cousins, as by the accompanying diagram, according to the civil law they would be in the sixth degree of consanguinity, while by the canon law they would be in the third. The imperfectness of the latter mode of reckoning is shown by the fact that G would also be in the same degree of consanguinity, viz., the third, to A, B, and D; but in the fourth degree to H, the count then being made in the other, or longer line. Evidently, a prohibition of marriages within the third degree, made by the civil law, would become much more onerous if interpreted in accordance with the canon law. This was actually done by Pope Gregory I. (A.D. 590–604).

	A	
B		C
D		E
F		G
H		I

Much diversity has prevailed among different nations in their views concerning the marriage of kin. The traditions of the ancient mythologies, in their account, for instance, of the relations between Jupiter and Juno, and between Osiris and Isis, show that unions in the closest collateral degrees of consanguinity were not considered abhorrent. On the other hand, the story of Œdipus and Jocasta indicates that marriages in the direct line of descent were looked upon as impious. The ancient Egyptians intermarried very closely, and in the history which we possess of the dynasty of the Ptolemies, a large proportion of the marriages are seen to be between brother and sister. In other nations of the East, notably among the Persians, marriage in the nearest degrees, even of direct consanguinity, prevailed. There is evidence that prior at least to the time of Moses this custom prevailed among the children of Israel. This very nation was descended from consanguineous unions. Abraham married his half-sister, Sarah, Isaac married Rebecca, his first cousin once removed, and Jacob his two first cousins, Rachel and Leah. Yet no one has ever questioned the vigor of the Israelites, who, in the first fourteen generations from their origin, became six hundred thousand fighting men. Indeed, a literal interpretation of the record in the Book of Genesis would indicate that the sons of Adam must have married their sisters, and that the whole human race is the product of a consanguineous marriage in the closest degree. The restrictions placed upon the marriage of relatives by the Mosaic law are worthy of special attention, because they have remained, to a great degree, in the usage of Christian nations in modern times. The following marriages were prohibited on the score of kinship by the Levitical law (Leviticus xviii.): That with a parent, or with a step-mother; with a sister, or half-sister; with a granddaughter; with an aunt, or an uncle's wife; with a son's wife; with a brother's wife; with a step-daughter, or a step-granddaughter; with a wife's sister, *during the lifetime* of the former. The Greeks, while forbidding marriages in the direct line of descent, permitted them be-