and still more rarely above or below it. It usually develops very slowly, and many months, or even years, may elapse without its extending far enough toward the centre of the cornea to impair vision. It is rarely met with in children, and is more prevalent in tropical than in temperate countries. The apex of a pterygium occasionally reaches, but rarely passes beyond, the centre of the cornea. The writer has met with one case, however, in which a pterygium of unusually large size, starting from the nasal side of the eye, grew entirely across the cornea to its external margin. The other eye of the same individual (a woman advanced in years) also exhibited a large pterygium, which had already passed beyond the centre of the cornea. So long as the growth is confined to the conjunctiva and the periphery of the cornea it usually causes little or no inconvenience; but as soon as it encroaches upon the area of the pupil it greatly impairs vision, not only because it obstructs the passage of light into the eye, but because the curvature of the corneal surface about its apex is so altered as to produce a high grade of irregular astigmatism.

In the text-books of forty or fifty years since, four or five varieties of pterygium are described. There seems to be little reason, however, for making even the two

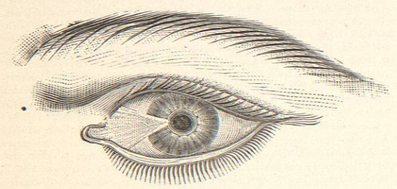

Fig. 1489.—Pterygium.

varieties which more recent authors mention; although, as some pterygia are thin and scantily supplied with blood-vessels while others are thick and vascular, there is some warrant, perhaps, for calling the former variety *pterygium tenue*, and the latter *pterygium crassum*. The *pterygium pingue* of the older authors is the pinguecula of the present day, which is no longer regarded as a variety of pterygium; while their *pterygium malignum* was, as its name implies, simply a malignant growth involving the cornea, which at the present day one would, of course, not think of confounding with true pterygium. It is possible for several pterygia to develop upon the same eye, advancing upon the cornea from different directions, and cases of this character have been reported, but are of extreme rarity.

The question of the etiology of pterygium has from time to time been discussed, and various theories have been suggested to account for its development and growth. Arlt, some years ago, suggested that the starting-point of pterygium is the existence of a superficial ulcer or abrasion at the margin of the cornea, to which the neighboring swollen conjunctiva becomes adherent, and that the dragging and irritation which result from this is the cause of its subsequent growth; and this theory at one time met with very general acceptance. It takes no account of the fact, however, that ulcers and abrasions of the cornea are not especially frequent upon its nasal margin, while pterygium, as we have seen, occurs only very rarely elsewhere; nor of the further fact that many cases of pterygium can be recognized as such before the apex of the growth has even reached the corneal limbus, and, therefore, before the process which is assumed to be the first step in its development has taken place. That pterygium is produced in this manner, in exceptional cases, there is no doubt; but this fact was recognized before Arlt's day, notably by W. Lawrence, who refers to cases of pterygium following purulent ophthalmia, in which the conjunctiva of the upper part of the globe had become adherent to an ulcer upon the lower part of the cornea.* He distinguishes, however, between these cases and true pterygium, and mentions his suspicion that the pterygia said to have been seen on the upper part of the globe were cases of this character, as he had never seen true pterygium in this situation.

It is manifest that any theory which would satisfactorily account for the development of pterygium must also account for the fact that it occurs in so large a proportion of cases to the nasal side of the cornea. This Arlt's theory fails to do; for it is beyond question that if pterygium were, as a rule, produced in the way he describes, we should find it encroaching upon the cornea from every possible direction, and not much more frequently from one direction than from another. The theory proposed by Poncet—that pterygium is a parasitic disease, and that its advance over the cornea is due to the presence of microbia (parasitic "vibriones") which he finds beneath the head of the pterygium, and which are supposed to tunnel their way under the corneal epithelium—fails equally in this respect; and, besides, the precedent ulcer which he regards as the starting-point of the process, and as essential to it, has not been clinically demonstrated, but, rather, assumed to be present.

In endeavoring to reach a satisfactory explanation of the origin of pterygium, it is important that we should bear in mind the fact (which seems usually to have been lost sight of) that in its incipient stage the growth does not, as a rule, involve the cornea at all, but is confined to the sclerotic conjunctiva. As Lawrence very aptly puts it: "It begins with the appearance, in the conjunctiva sclerotica, of a few vessels rather larger than natural, and running from behind forward nearly parallel to each other. After some time the membrane is found, on accurate inspection, to be a little raised, but the surface is smooth and entire. It gradually assumes the triangular shape, the basis extending toward the circumference of the eye, while the apex passes over the junction of the sclerotica and cornea and advances on the latter." This description of the development of pterygium entirely agrees with the writer's observations, and it suggests at once that the primary cause of pterygium is to be sought for elsewhere than in diseased conditions of the cornea. Fuchs holds that pterygium always originates from pinguecula. The writer cannot accept this view; nevertheless he is convinced that pinguecula does, not infrequently, precede pterygium, and he has occasionally met with transitional types which resembled as closely one as the other of these conditions.

It has long been taught that the development of pterygium is favored by conditions which bring about persistent hyperæmia of the conjunctiva, as, for example, when the eyes are exposed to the heat of a tropical sun, as in long sea voyages, or to the heat from furnaces, as is the case with stokers and founders, or to the irritant action of dust and vapors, as in mills and other manufacturing establishments; and the evidence in favor of this view is much too strong to be put aside. Assuming, then, that hyperæmia of the conjunctiva is an important factor in the production of pterygium, is there any reason why this condition should occur especially where pterygium usually makes its appearance—to the nasal side of the cornea? The writer is not aware that it has been suggested heretofore that the recti muscles of the globe have anything to do with the production of pterygium; but it seems to him highly probable that such is the case. In the first place, it is an extremely rare occurrence to meet with a pterygium which does not lie over the insertion of one of these muscles, usually the rectus internus, less frequently the rectus externus. Again, the vascular system of the conjunctiva in the neighborhood of the corneal border (anterior conjunctival vessels of Van Woerden) is so intimately connected with

* The writer also has met with a case of this character as a result of gonorrhœal conjunctivitis. Only the apex of the pterygium, however, was adherent to the cornea, and a probe could be passed between the corneal surface and the body of the pterygium.

that of the recti muscles, through branches derived from the anterior ciliary arteries, that the possibility of the blood supply of the former being influenced by that of the latter can scarcely be doubted. There is nothing improbable, therefore, in the assumption that an undue determination of blood to the recti muscles may bring about a hyperæmic condition of the overlying conjunctiva, and that this condition, as we have seen, may in time lead to the development of pterygium. Moreover, it is manifest that the recti interni muscles would be likely to exert a more decided influence in this respect than any of the others; for they are not only the largest of the straight muscles, and the ones which perform by far the greatest amount of work, but their attachment to the sclerotic is considerably nearer the corneal border, and they are, therefore, more intimately connected with the conjunctiva. Thus, in accordance with the theory suggested, the location of pterygium to the nasal side of the cornea is explained.

What condition is there, then, likely to produce an undue determination of blood to the lateral muscles? The answer is, an insufficiency of these muscles—an exophoria or an esophoria. In a word, the writer believes that insufficiency of the internal recti muscles is an important factor in the causation of pterygium. His belief is based not only upon the theoretical grounds just set forth, but upon the clinical observation that exophoria is very frequently found in association with pterygium situated upon the nasal side of the cornea. In support of this view of the origin of pterygium (which to the writer seems at least to be more satisfactory than those which have as yet been offered), it may be mentioned, as a matter of observation, that persons who have pterygium not infrequently complain that the pterygium itself, and the conjunctiva in its neighborhood, become bloodshot when the eyes are much used in near work. It remains to be added that pterygium sometimes has its origin in traumatic lesions of the conjunctiva, as, for example, to cite from the writer's experience, a burn from a scale of hot iron or from partially slaked lime splashing into the eye.

In regard to the *Treatment* of pterygium, little is to be expected except from operative interference. In its incipient stage, however, its growth may possibly be arrested by correcting any error of refraction or any muscular defect which may exist; and, even when it has reached a more advanced stage, its development may, perhaps, be favorably influenced in this way. So, too, after any operation which may be resorted to for its cure, the good which glasses may do by lessening the tendency to a recurrence should not be lost sight of. It should be borne in mind that the asthenopic symptoms, of which persons having pterygium often complain, are much more likely to be due to an error of refraction or a muscular defect than to the mere presence of the growth. The propriety of resorting to operative treatment will be determined by several considerations: If the pterygium is confined to the conjunctiva, it may be advisable to operate upon it, provided it is narrow and well defined. If, on the contrary, it is broad and ill defined, it will be wiser not to interfere with it, as the condition and appearance of the eye after the operation will probably not be better than before. If, however, it has encroached upon the cornea, it is better, as a rule, to operate, because, as has been said, it usually advances farther and farther upon this membrane, and, as it does so, it produces such changes in its structure as leave behind a permanent opacity, even when the growth is most carefully removed. Patients will frequently assure the surgeon that the pterygium is not growing, and that for months or years it has made no progress; but their testimony upon this point is not always to be relied upon, and to prevent the possibility of the sight eventually becoming impaired, unnecessary delay in resorting to operation should be avoided.

The operative procedures which have been suggested for the cure of pterygium are numerous. Until a comparatively recent period, excision was the only operation which was in vogue. The results obtained by this method were, however, by no means uniformly successful, the removal of the growth, as it was commonly practised, being not infrequently followed by its recurrence. In consequence of this, various substitutes for this operation were proposed. For example, Des Marres suggested transplantation of the pterygium; Szokalski its destruction by strangulation, while Knapp introduced a modification of the former, and Galezowski of the latter procedure. Pagenstecher recommended that the growth should be dissected from its corneal, and in part from its sclerotic, attachments, and then be allowed to atrophy, the edges of the conjunctival wound being united beneath the partially detached pterygium by means of sutures. Arlt also preferred a method essentially the same as that of Pagenstecher. In Des Marres's operation the pterygium is detached from the cornea and sclerotic quite up to its base, and is then inserted in an incision made in the conjunctiva near the lower edge of the cornea, where it is retained by sutures. Knapp's modification of this method, applicable to cases in which the pterygium is of large size, consists in splitting the pterygium longitudinally, after having removed its corneal portion, and inserting the upper half in an incision made in the conjunctiva above its base, and the lower half in one made below. He also unites the edges of the conjunctival wound by sutures, and, to facilitate this, separates the conjunctiva from the subjacent tissue above and below the wound. In Szokalski's operation the strangulation is accomplished by passing two needles, which have been threaded with the opposite ends of a fine silk ligature, beneath the pterygium, one near its apex, the other near its base, and then, after cutting out the needles, by tying together the ends of the three threads which are thus left in position, so as to cut off its vascular supply near its base, near its apex, and from its sclerotic surface. Galezowski, after dissecting up the pterygium, "takes a thread, armed at each end with a curved needle, and pierces the apex with both needles, so as to include it in a small loop. Then turning the needles inward, he brings them out at the base of the growth, one near the upper and the other near the lower margin. The two ends are then tied in a tight knot, and thus the apex of the pterygium is turned inward toward the base, and the latter is strangulated by the knot." It is claimed for each of these procedures that a recurrence of the growth is less apt to happen than when simple excision is practised.

The operation of excision has, in the writer's experience, yielded such satisfactory results that he has not been tempted to make trial of any of these proposed substitutes. The end which they all aim to accomplish seems to him to be the same—to minimize the loss of conjunctival tissue, and this is, undoubtedly, a most important thing; but, if the excision be performed as it should be, the loss of tissue is insignificant. Although the ill effects of a too free excision of the growth were long ago pointed out, especially by Scarpa, the writer is inclined to think that the poor results which many have obtained from this operation are due to unnecessary loss of conjunctival tissue. Even when but little more than the apex of the growth is removed the gap which is left in the conjunctiva is of considerable size, and when the whole pterygium is cut off, the size of the gap which results, owing to the retraction of the conjunctiva, is surprising. Under such circumstances the healing process is slow and difficult, and not infrequently a conspicuous vascular cicatrix is left, which is as unsightly and as likely to cause trouble as the pterygium itself.

Since the employment of cocaine in ophthalmic surgery the removal of pterygium has been rendered much easier, as the operation is entirely painless. The method of operating which the writer has adopted, and which, as has been said, has yielded satisfactory results, being very rarely followed by a return of the pterygium, is as follows: The eye having been brought under the influence of cocaine, and the patient being seated in a chair, a

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., ʒ 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. ¼–½ to ʒ i.) or alum (gr. ss.–i. to ʒ 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

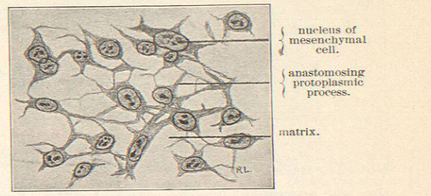

Fig. 1490.—Embryonic Connective Tissue (Mesenchyma) from Embryo Chick. × 700.

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