THE ANATOMY OF THE HUMAN EYE

AS ILLUSTRATED BY

ENLARGED STEREOSCOPIC PHOTOGRAPHS

BY ARTHUR THOMSON, M.A., M.B., F.R.C.S.

PROFESSOR OF HUMAN ANATOMY IN THE UNIVERSITY OF OXFORD

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PREFACE

To the Delegates of the University Press I am greatly indebted for the generous assistance they have rendered in the production of this work.

The Public hardly realizes how much the University does through the agency of this Delegacy for the encouragement of scholarship and research, since without such help much unremunerative work would remain unpublished.

To Mr. W. Chesterman, my Museum Assistant, I am greatly obliged for the skill and patience which he has displayed in carrying out my instructions: without his co-operation it would have been wellnigh impossible for me to have attained the present results.

I have also to thank my Senior Demonstrator, Mr. S. E. Whitnall, M.B., for his aid in revising the proof-sheets.

ARTHUR THOMSON.

OXFORD. *Jan.* 1, 1912

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ERRATA

Page 42 *l.* 10, *for* 2 mm. *read* 3 mm. to 3·5 mm.
Page 54 *l.* 6 *from foot, for* No. 67 *read* No. 65

Thomson, Anatomy of the Human Eye

May 1912

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INTRODUCTION

The accompanying stereoscopic views of the interior of the eye were prepared in illustration of a course of lectures on the gross anatomy of the eye, delivered to the graduates preparing for the diploma in ophthalmology of the University of Oxford. They were so generally appreciated that it is hoped their publication in the present form may make them accessible to those who would not otherwise have an opportunity of seeing them. Many of the structures in the human eye are so small that it is only possible, under ordinary circumstances, to obtain a satisfactory view of them by means of a lens of low power. This usually involves their examination by monocular vision, and consequently entails a loss of that stereoscopic effect which is so necessary to determine their exact relations. With the object of overcoming this defect, the present illustrations were prepared in such a way as to preserve the stereoscopic effect, and at the same time to provide for such a magnification as would render clear most of the detail desired. In many instances a millimetre-scale is photographed alongside the preparation, so that the student may have some approximate idea of the size of the structures he is viewing. It is not suggested that the present series of views should be a substitute for the experience gained by the actual dissection of human or other mammalian eyes, but when one considers that such, more particularly human, material is not easily obtainable in a sufficiently fresh condition to display all the details of structure, the accompanying plates may serve as a reminder of the features previously examined, and prove useful as a handy means of reference when permanent preparations or museum specimens are not readily accessible.

In most instances the specimens from which the photographs were taken were removed within four hours after death. They were hardened in a 4% solution of formol, subsequently frozen and then cut. The further dissections, where necessary, were then performed, and the preparations photographed under spirit. Care was taken, as far as possible, to eliminate all specimens which appeared faulty, and only those which preserved the natural form and tension of the globe were utilized. Every possible care was taken to avoid doubtful examples, and the majority of the specimens, in so far at least as their major parts are concerned, may be regarded as affording an approximately accurate representation of their normal condition. Doubtless the more delicate structures undergo some alteration in the hardening

process, but the same may be said of nearly all the other methods of preparation that have been suggested. Opportunity was also taken to secure some typical examples of foetal eyes, and photographs of a few of these have been included with the object of illustrating structures and relations of practical interest.

Whilst much may be learned from the dissection of a fresh eye, such as that of the pig or ox, yet the student will find that even in these cases a previous hardening of the specimens employed will be of service in assisting him to obtain a more satisfactory view of the structures involved. The brief description given in the succeeding chapters lays no claim to be a complete systematic account of the tissues concerned, but merely sets forth the more important details in their arrangement, such as may be readily demonstrated in the sections or dissections employed—details which any student may verify for himself by employing like or similar methods. For this reason the photographs have been grouped according to the method of section employed, or as illustrative of different stages in a dissection, so that before proceeding to their examination the student would do well to render himself familiar with the systematic account of the structure of the eye given in any of the current textbooks.

The photographs have been mounted on cards of standard size, so that they will fit any of the numerous stereoscopes already on the market.

CHAPTER I

ANTERO-POSTERIOR SECTIONS OF THE EYE

This section includes those specimens which have been divided antero-posteriorly. The plane of the section may either be vertical or horizontal, or possibly oblique. It is not always possible to say exactly how the section was made, as in some instances no note was taken of the orientation of the eye.

The preparations here reproduced, Nos. 1–18, give the student an opportunity of studying the general arrangement of the parts within the globe, and enable him to familiarize himself with the disposition of the different layers which form its coats. Of these latter, the external or **sclerotic coat** or **sclera** is seen to form about 5/6 of the circumference of the globe. Behind, where it is pierced by the optic nerve, this, the protective covering of the eye, is thickest; here it measures 1 mm. or a little over; it gradually thins until it reaches the region of the equator, where it averages about 0·5 mm. in thickness. Anterior to this, however, it again becomes stouter owing to its fusion with the tendons of insertion of the recti muscles, where it measures about 0·7 mm., a thickness which is maintained and increased until it reaches the sclero-corneal junction, where on an average it measures 0·9 mm. in thickness.

Anteriorly there is a large opening in this coat in which the cornea is bedded, the *corneal aperture* (*foramen sclerae anterius*). The edges of this aperture, in the adult, are bevelled so as slightly to overlap the circumference of the cornea; the average diameter between the external margins of the bevelled edge measures a little over 10 mm. (10·5 mm.), whilst the width between the inner or posterior edges is about 11 mm.

About 3 mm. to the inner side of the vertical meridian (see Nos. 1, 2), and 1 mm. below the horizontal meridian, the sclera is pierced posteriorly by the optic nerve. This, the *optic foramen of the sclera* (*foramen opticum sclerae*), is narrower internally, where it measures 2 mm. in diameter, than externally, where its width is a little over 3 mm. As will be seen from an inspection of the photographs (Nos. 1, 2, 3, 4, 5, 6, 9), the outer layers of the sclera are reflected on to the dural sheath of the optic nerve, whilst the inner layer passes across the narrowest part of the foramen, forming the *lamina cribrosa*, thus appearing to pinch up the nerve as it passes through the opening. Nos. 1, 4, 5, 6 show very clearly how the fibres of the optic nerve undergo a change at this point, for within the lamina the nerve fibres

are devoid of the medullated sheath which they acquire external to it. This change in structure is indicated by the difference in colour so clearly shown in the photographs.

In No. 13 the inner surface of the sclera is exposed by the complete removal of the contents of the eyeball, an operation which has included stripping away from the inner surface of the sclera both the nervous and vascular coats. The latter—the *chorioid*—is separated from the inner surface of the sclera by the *perichorioidal* space, through which pass forward the posterior ciliary arteries and the ciliary nerves, the courses of which are indicated by the lighter tracts revealed upon the inner pigmented surface of the sclera, the colour of which is mainly due to the remains of the *lamina fusca*, a finely trabecular pigmented layer which bridges across the perichorioidal space. When the chorioid is torn away this trabecular tissue splits into two layers, one of which remains adherent to the inner surface of the sclera, as has just been explained, whilst the other still clings to the outer surface of the separated chorioid forming the non-vascular layer which is oftentimes referred to as the *lamina suprachorioidalis*. The anterior part of the inner surface of the sclera, which corresponds to the position of the *orbiculus ciliaris* and the *ciliary body*, is much lighter in colour owing to the absence of pigment: a darker zone usually indicates the position of the *ora serrata*. On the inner aspect of the sclera the oblique openings of the *vorticose veins*, commonly four in number, an upper and a lower pair, can usually be seen 2 or 3 mm. behind the equator, at some distance on either side of the vertical meridian.

In the foetal eyes figured (Nos. 15, 16, 17, 18), it will be seen that in the newborn child the sclera constitutes 4/5 of the circumference of the globe instead of 5/6 as in the adult. This, as will be shown later, is due to the proportionately greater size of the cornea in the foetus. The sclera does not display the variations in thickness characteristic of the adult and tends to be proportionately thicker in front, where it receives the cornea within the foramen sclerae anterius. Here, too, the way in which the cornea is embedded differs from that already referred to in the adult, for the edges of this opening are not bevelled as in the fully grown eye, but rather grooved, so that there is little or no difference between the measurements across the external and internal margins of the aperture, the greatest width corresponding to a point intermediate between the two margins. For further details concerning the sclera see pp. 40 and 53.

The **cornea** in the adult forms a little more than 1/6 of the circumference of the globe in section. In thickness the cornea averages about 0·95 mm. for its central part, whilst at its periphery the radial diameter is increased to 1·19 mm. It measures from 10·5 to 11 mm. from side to side, and is bedded within the *foramen sclerae anterius* in such

a way that the bevelled edge of that aperture overlaps it slightly around its circumference, where the tissues of the sclera and cornea are blended.

As a result of the differences in the lengths of the radii of the circles of which the cornea and sclera form arcs, the external corneal surface projects beyond a chord passing through its circumference, where it unites with the sclera externally (*sulcus sclerae externus*) to the extent on an average of 2·5 mm., ranging from 2·2 to 3·2 in the specimens examined.

Owing to the bevel of the sides of the *foramen sclerae anterius*, the area of the cornea, when viewed from within, is about 1 mm. wider in its diameter than that exposed externally.

The inner surface of the cornea not only forms part of the arc of a smaller circle than that of the external surface, but the centres of the two circles do not coincide, that of the smaller circle lying anterior to the centre of the larger circle by a distance equal to that of the central thickness of the cornea. The measures taken from the specimens examined yield an average radial length for the curve of the external surface of 8·4 mm., ranging from 10 mm. to 8 mm., whilst for the inner surface the radius of the curve averages 6·8 mm., ranging from 9 mm. to 6 mm.

In this way the increased thickness of the cornea at its periphery is accounted for, but some arrangement is necessary whereby the thicker corneal margin may accommodate itself to the bevelled edge of the corneal aperture of the sclera. This is provided for by the rounding off of the inner corneal margin, where it becomes confluent with the inner surface of the scleral margin, so that in place of forming with the latter a uniform flowing curve, it makes, by the abruptness of its overhang, a sulcus, or groove, at the point where it becomes blended with the scleral tissue. This can be well seen in Nos. 4, 11. It is here, in the neighbourhood of the filtration angle, that the groove so formed lies, to which the name *sulcus circularis corneae* has been applied. The further consideration of this arrangement is postponed until the gross anatomy of the filtration angle is considered (see p. 15); meanwhile, it may be sufficient to note that the presence of this groove is again clearly demonstrated in Nos. 12 (*d*) and 13 (*b*), where in the former the iris has been removed, whilst in the latter the whole of the uveal tract has been stripped off from the inner surface of the sclera. A further view of the sulcus is also obtained in No. 47, where the inner surfaces of the cornea and sclera are displayed.

In the full-time foetus (No. 15), the cornea amounts to about 1/5 of the circumference of the globe on section; its transverse diameter measures about 10·6 mm. in the specimens examined, so that there is comparatively little increase in its growth requisite to reach the adult proportions. It

follows, then, that the increase in the size of the globe after birth is mainly due to the expansion of the scleral part of the eyeball and its contents. At birth the thickness of the cornea is not only proportionately, but also absolutely greater than the thickness of the cornea in the adult. In the full-time foetus it measures 1·40 mm. at the centre, and increases to 1·60 mm. at the periphery. In a 6½-months' foetus the corresponding measurements were 1·30 mm. and 1·40 mm. respectively. The manner in which the cornea is bedded in the sclera within the *foramen sclerae anterius* also differs from that which is characteristic of the adult: whereas in the latter the cornea is set within the bevelled edge of the sclera, it appears in the foetus to be sunk in a groove within the scleral substance, the edges of which overlap it to a slight extent both in front and behind. For further details concerning the cornea see p. 41.

The **uveal tract** or **vascular coat.** This comprises the **chorioid,** the **ciliary body,** and the **iris**, and constitutes the middle coat of the eyeball.

The **chorioid** (*choroid*). This vascular layer clothes the inner surface of the sclera as far forward as the *ora serrata*, the scalloped edge of the nervous layer of the retina. In front of this the *chorioid* is continuous with the *ciliary body*, a structure which reaches anteriorly to near the internal *sclero-corneal junction*, at which point it becomes continuous with the curtain of the aqueous chamber, the *iris*. The inner surface of the ciliary body anterior to the ora serrata exhibits a smooth, striated appearance, the *orbiculus ciliaris*, which is replaced in front by numerous folded processes, the *ciliary processes*, the rounded anterior extremities of which project behind the *iris* and are directed inwards towards the circumference of the lens, from which they are separated by an interval (the *circumlental space*) measuring on an average about 1 mm. across.

As has been said, the outline of the ora serrata marks the anterior limit of the *chorioid* proper. The position of this edge varies considerably in different eyes and in different parts of its circumference. From measurements taken on my own specimens I find that the ora serrata lies on an average about 6·2 mm. behind the *external sclero-corneal junction* (*sulcus sclerae externus*) .

As the chorioid lies within the sclera it is separated from it by the perichorioidal lymph space, a space which, as already described, is seen to be broken up by the trabecular tissue of the lamina fusca, which unites the chorioid to the sclera. Owing to rough handling or inequalities in the hardening process, the chorioid has a tendency to separate from the inner surface of the sclera, in which case the lamina fusca is either stretched or torn into two layers, the outer of which adheres to the sclera and imparts to it its brown pigmented appearance, whilst the inner still remains attached to the vascular chorioid,

constituting what is often described as the *peri-* or *suprachorioidal* membrane, the presence of which gives the fluffy appearance to the outer surface of the separated chorioid.

These appearances may be seen in some of the photographs (Nos. 7, 8, 10, 12, 15), where a partial separation of the chorioid from the sclera reveals in some instances the finely stretched open tissue of the *lamina fusca*. In the region around the optic nerve the adherence of the chorioid to the sclera is more intimate, owing to the passage of the short posterior ciliary arteries from one coat to the other. A short distance behind the equator the emergence of the four or five great *vorticose veins* at more or less regular intervals apart, on their way to pierce the sclera, serves to link together the chorioidal and scleral coats more intimately. The inner layer of the chorioid is formed of condensed connective tissue called the *lamina basalis* or *lamina vitrea*. This lies in contact internally with the pigment layer of the retina, and so intimate is the connexion that if an attempt be made to separate the retina from the chorioid the pigment layer of the retina almost invariably remains adherent to the inner surface of the chorioid, a circumstance which explains why that pigmented layer was formerly regarded as one of the constituents of the middle coat, before its true significance was revealed by a knowledge of its development. It is a matter of great difficulty in the preparation of eyes for demonstration purposes to preserve intact the union of these several layers, and in the photographs there are numerous examples (Nos. 3, 4, 5, 6, 10, &c.) in which the retina is separated from the chorioid; but note that in every case the separated retina, comprising its nervous elements, appears white, owing to the fact that its pigment layer still remains united to the chorioid, the line of cleavage through the retina corresponding to the cleft which in early development separates the outer from the inner layer of the secondary optic vesicle.

Between the lamina basalis internally and the lamina suprachorioidea externally, the structure of the chorioid consists of a connective-tissue stroma, containing many blood-vessels and a considerable amount of pigment. As this region derives its blood supply from the short posterior ciliary arteries, it follows that the chorioid is thicker behind than in front, the thickness ranging from 0·1 mm. in the region around the entrance of the optic nerve to 0·06 mm. in the neighbourhood of the ora serrata. Within its substance the vessels of the chorioid are so arranged that the larger vessels form an external layer, the *lamina vasculosa*, whilst a thinner internal layer, made up of fine capillaries, constitutes the *chorio-capillaris*. Distributed most externally in the lamina vasculosa are the whorl-like groups of the tributaries of the *vorticose veins*, an arrangement which is readily displayed, as in photograph No. 65, where the chorioid has been stripped away from the

sclera so as to expose its outer surface. In Nos. 11 and 12 the inner or retinal surface of the chorioid is exposed by the removal of the nervous layers of the retina; here the pigmented retinal layer is still in most part in contact with the chorioid. The lighter tracts which are seen on the surface of the chorioid correspond to areas where the pigment layer has to a greater extent been removed owing to its more intimate adherence to the nervous layers of the retina, which in corresponding situations were thrown into folds, produced either by the irregular contraction of that membrane under the influence of hardening agents, or by post-mortem changes.

In the full-time foetal eye exhibited in No. 5, the chorioid is characterized by a greater proportionate thickness, and is also remarkable in that its anterior limit, determined by the position of the ora serrata, is placed much further forward than in the adult. For further details concerning the chorioid see pp. 41 and 54.

In front of the ora serrata the *middle coat* or *uveal tract* of the eye extends forwards to reach the region of the sclero-corneal junction, from which it passes inwards to form the *iris*.

The **ciliary body** is that part of it which stretches from the ora serrata to the internal sclero-corneal junction. The inner surface of this area is deeply pigmented, and is divisible into two parts. The posterior, called the *orbiculus ciliaris*, lies immediately in front of the ora serrata, and forms a zone measuring on an average 3·6 mm. from before backwards, with a range between 4 mm. and 3·5 mm. in individual cases. This zone presents a smooth deeply pigmented appearance, displaying a radial striation due to the arrangement of the vessels which lie within its substance, for here the chorioid, with which it is continuous posteriorly, loses its chorio-capillary layer, and the vessels of the vascular lamina, rearranging themselves in parallel bundles which are connected in front with the ciliary processes, give rise to the striation aforementioned. The other constituents of the chorioid here persist, the inner basal membrane being continued forward, with the pigment layer of the retina overlying it and closely adherent to its inner surface.

Be it remembered that the nervous layer of the retina does not extend in front of the ora serrata.

The anterior part of the inner surface of the ciliary body is marked by a series of alternating ridges and furrows like the folds of a ruff. These together constitute the *corona radiata*, or *corona ciliaris*, which is made up of from 67 to 84 *ciliary processes*, the average number being about 76 or 77.

The anterior extremities of these *ciliary processes* are club-shaped, and project inwards, behind the iris, towards the circumference of the lens, from which they are separated by a variable interval, the *circumlental space*, which measures on an average 1 mm. On meridional section

these processes appear pyriform in shape, their external surface being directed towards the inner surface of the sclera, from which, however, they are separated by the *ciliary muscle*, another important constituent of the ciliary body. The ciliary processes are unequal in their disposition; their length from the point where they arise from the orbiculus to their blunt rounded extremity, measures on an average 3 to 3·5 mm., but they are not all the same size, and not unfrequently the corona displays an arrangement in which the large and small processes appear to alternate with each other. Not uncommonly, these deeply pigmented folds exhibit a lighter appearance along their edges, just as if some of the pigment had been rubbed off.

Lying to the outer side of the ciliary processes, and constituting quite half the thickness of the ciliary body, is the *ciliary muscle*. This consists of a zone of smooth muscle divided into two parts. The external portion, the fibrae meridionales of Brücke, is wedge-shaped; the edge of the wedge corresponds to the attachment of the muscle to the annular ligament at the internal sclero-corneal junction; from this point its fibres pass backwards in a meridional direction, to be lost in the substance of the ciliary processes and the outer surface of the orbiculus. The external surface of this part of the muscle is exposed when the ciliary body is torn away from the inner surface of the sclera, and differs from the rest of the uveal tract by its lighter grey colour, as may be seen in photographs Nos. 20, 26 and 65. Lying to the inner side of the summit of the wedge formed by the above-mentioned fibres, and corresponding to the bases of the free projecting extremities of the ciliary processes, as well as to the attachment of the periphery of the iris, is a group of fibres of varying degrees of thickness arranged circumferentially; these constitute the circular fibres of Müller. For further details concerning the ciliary body see pp. 36 and 42.

Overlying the inner surface of the ciliary process are seen certain delicate layers which are intimately connected with them. These layers, which separate towards the anterior extremity of the ciliary processes into two more or less distinct laminae, bridge across the interval between the ends of the ciliary processes and the circumference of the lens, and form the *zonule of Zinn*, or the *suspensory apparatus* of the lens. They will be described in greater detail hereafter (p. 37); meanwhile they are mentioned now because they are well seen in photographs Nos. 8 and 9, in which it clearly appears that they form a partition which separates the *aqueous chamber* in front from the *vitreous* behind.

In the same photographs the so-called *canal of Petit* is displayed as the interval, shown in section, which surrounds the circumference of the lens between the anterior and posterior fibres of the zonule of Zinn.

The **iris** (Nos. 1, 2, 3, 4, 8 and 10), in a meridional section of the eye, appears like a diaphragm, measuring on an average 11 mm. in diameter,

placed within the aqueous chamber. By its circumference it is continuous with the rest of the uveal tract, and blends with the tissue immediately in front of the fore part of the blunt extremities of the ciliary processes, and immediately to the inner side of the summit of the wedge-shaped mass of the ciliary muscle, the circular fibres of which lie just external to, and behind, its attachment.

Note that this attachment is the thinnest part of the iris. I find its average thickness in the specimens at my disposal is 0·2 mm.; it tends to become thinner when the iris is stretched during contraction of the pupil, and is thicker when the pupil is dilated. Further, it should be observed that this, the attached edge of the iris, is turned slightly backwards to blend with the fore parts of the ciliary processes, so that the interval between these two structures, or what corresponds to the lateral extension of the *posterior camera* of the *aqueous chamber*, displays in section the appearance of curving round the extremities of the ciliary processes. This will of course be subject to modification according to the tension of the iris.

In most instances the section has passed through the *pupil*, the width of which will vary according to its state of contraction. The circumference of the pupil is bevelled at the expense of its anterior margin, so that it displays a chisel-shaped edge on section. The thin margin, however, is not sharp and clean cut, but is finely crenated owing to the disposition of the minute folds which are arranged radially on the posterior surface of the iris close to the pupillary edge. The body of the iris will vary in thickness according to its state of contraction. With a widely dilated pupil it may measure 0·75 in thickness, whilst with a contracted pupil it may be reduced to 0·3 mm. The posterior surface usually displays an evenly flowing outline, whilst the anterior surface exhibits a series of folds and depressions, particularly when the pupil is dilated.

The relation of the iris to the *aqueous chamber* can now be studied. It serves as a partition which subdivides that cavity into two chambers, an anterior and posterior, which lie respectively in front of and behind the iris, and which communicate freely with each other through the pupillary aperture.

The **anterior chamber,** bounded in front by the concave inner surface of the cornea, is limited behind by the anterior surface of the iris. Laterally, these two walls meet in the region of the *internal sclero-corneal junction*, where they form what is known as the iridial or *filtration angle*. Centrally, the posterior wall of the anterior chamber corresponds to that portion of the anterior surface of the lens which is exposed through the pupil. The depth of the anterior chamber, i.e. the measurement from the posterior surface of the central part of the cornea to the anterior surface of the lens, exposed through the pupil, varies in the same

individual according to the varying degree of convexity of the anterior surface of the lens in different states of accommodation. Age also affects its depth: it is stated to be deeper in the young and to become shallower with advancing years. In myopic eyes its antero-posterior diameter is greater than in the hyperopic. In the specimens examined the depth of the anterior chamber ranges from 2 mm. to 3 mm., yielding an average of 2·2 mm.

The **posterior chamber** corresponds to that part of the cavity of the aqueous chamber which lies between the iris in front and the anterior surface of the lens lateral to the pupil, the zonula ciliaris, and the anterior rounded extremities of the ciliary processes and the recesses between them behind. At, and for some little distance from, the pupillary margin the posterior surface of the iris lies in contact with the anterior surface of the lens, over which it can glide freely. It passes from the lens, however, in a tangential fashion so as to stretch across the interval which separates the lens from the ciliary processes, in front of and on a plane anterior to the anterior lamina of the zonula ciliaris, and some little distance in front of the rounded extremities of the ciliary processes, around which it gently curves towards its circumferential limit. In front, the posterior chamber communicates with the anterior chamber through the pupil, whilst posteriorly it is separated only by the *zonula ciliaris* or *zonule of Zinn* from the vitreous chamber, as may be seen in many of the photographs of the succeeding series, Nos. 27, 31, 39 and 40.

In the foetus at birth (No. 15) the anterior chamber is shallow, owing to the greater convexity of the anterior surface of the lens; and in the posterior chamber, the part of the posterior wall formed by the zonula ciliaris is represented in deep shadow. In this specimen the width between the fore part of the ciliary process and the equator of the lens measures 0·5 mm.

In the eye of the 6½-months' foetus (No. 16) the aqueous chamber, including under that name the space between the cornea and lens, is only about 0·5 mm. in depth. As will be seen, this is subdivided by the *pupillary membrane*, which arises from the anterior surface of the iris a little wide of the pupillary margin, and stretches across that aperture so as to completely divide the anterior from the posterior camera of the aqueous chamber. What corresponds to the anterior chamber in the adult, i.e. that part of the aqueous chamber which lies between the iris and the cornea, is at this stage reduced to the proportions of a linear cleft. For further details concerning the iris see pp. 32 and 43.

The region around the **Filtration Angle.**

The iridial or filtration angle coincides in position with the circumference of the cavity of the anterior chamber, and corresponds to the

cleft between the iris and the internal sclero-corneal junction. Here a number of important structures demand attention.

Good views of this region are displayed in Nos. 1, 2, 3, 4, 5, 8 and 10; but it will be noticed that the appearance in all of these photographs does not correspond. It will be observed that these differences bear some relation to the state of contraction of the iris, for in No. 1, where the specimen exhibits a small pupil with a thin and stretched iris, the form of the iridial angle is not the same as that shown in the photographs Nos. 3, 4, 5, 8 and 10, in which the pupils are more widely dilated and the iris thickened owing to its radial contraction.

Taking a specimen with a pupil of intermediate size, such as that seen in No. 4, it will be observed that at the internal sclero-corneal junction the cornea is thicker than the sclera; in order that the two edges may be brought into harmony the postero-internal margin of the cornea is rounded off so as to form a projecting shoulder, which overhangs the sloping surface of the sclera with which it unites: this is well seen on the left side of the photograph. The result of this arrangement is that a recess or groove is formed immediately behind the sclero-corneal junction which corresponds with the extreme periphery of the anterior chamber. When describing the manner in which the ciliary border of the iris was attached to the ciliary body, attention was drawn to the fact that the attached edge of the iris was turned somewhat backwards. Consequently, as may be seen in Nos. 4, 8 and 10, when through contraction of its radial fibres the iris is thickened its outer circumference forms a bevelled edge, in front of its attached margin, which fits into the groove in the outer wall of the angle immediately behind the internal sclero-corneal junction, the fore part of the groove corresponding to the overhanging shoulder of the cornea, the outer wall being formed by the slope of the sclera immediately behind the internal sclero-corneal junction. In this way a recess is provided wherein the thickened margin of the iris can be withdrawn, without, however, necessitating the obliteration of the space between the opposing surfaces. The deepest part of the intervening recess is thus left open for the free circulation of fluids. A better view of this groove, which for convenience may be called the *sulcus circularis corneae*, can be obtained by tearing the iris away from its ciliary attachment; this is shown in No. 12, where the groove is displayed as a double contour lying in front of the linear area from which the iris has been detached. Further dissections of the same features are represented in Nos. 12 and 47, and in No. 14 the groove is further demonstrated by the expedient of pulling back the iris after the lens has been removed. But the bottom of the recess between the iridial attachment and the inner surface of the sclera is not so clean-cut as might be supposed. Curving round the bottom of this, from the iris on the inner

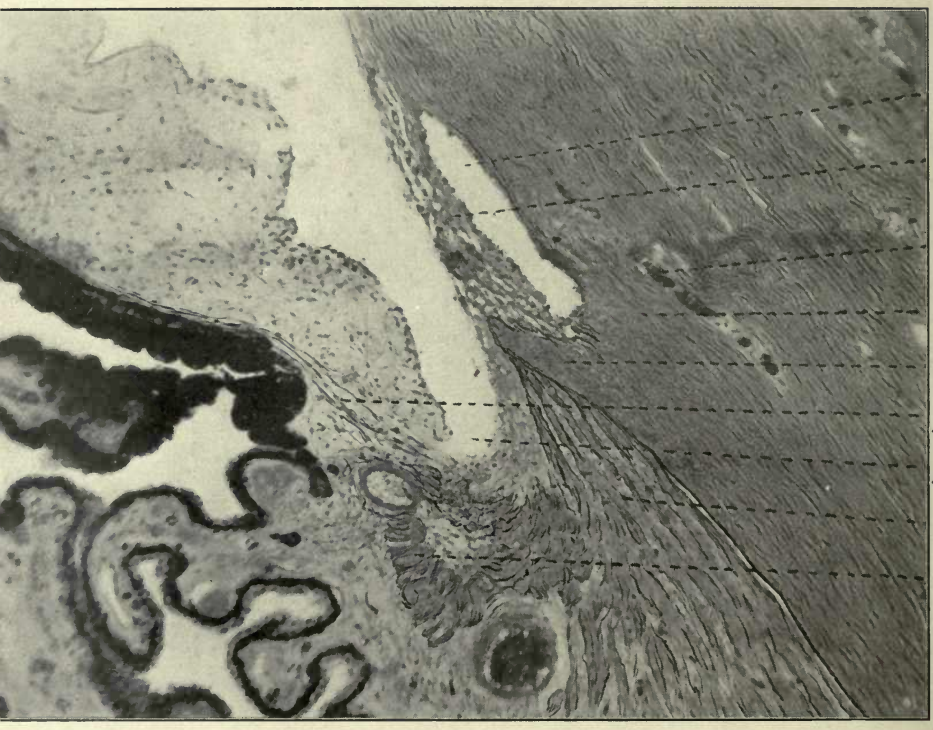


FIG. 1. ENLARGED GENERAL VIEW OF THE IRIDIAL ANGLE.

a. Canal of Schlemm.
b. Trabecular tissue of pectinate ligament.
c. Scleral vein.
d. Dense scleral tissue.
e. Scleral process or spur projecting inwards and forwards from the sclera close behind the canal of Schlemm; this corresponds to the annular ligament in section.
f. Radial muscular fibres of the iris extending outwards below the iridial angle.
g. Iridial angle.
h. Meridional fibres of the ciliary muscle.
i. Circular fibres of the ciliary muscle.

The microphotograph has been slightly touched up so as to emphasize the differentiation of tissue which is revealed by the Malory stain.

To face p. 17

side to the sloping surface of the sclera just behind the internal sclero-corneal junction, is a small amount of lax trabecular tissue, the surface of which, directed to the anterior chamber, is overlain by an endothelial covering continuous in front with the endothelial layer lining the inner surface of the *posterior limiting membrane* of the cornea (*Descemet's membrane*), and confluent behind with the anterior endothelial layer of the iris. This, together with the lax trabecular tissue beneath formed by the splitting up of Descemet's membrane, is the feeble representative in man of the much more extensively developed structure seen in mammals other than the Primates, called the *pectinate ligament.* The laxity and elasticity of this tissue can easily be demonstrated in a recent specimen by gently pulling on the iris, under which conditions the groove, as such, tends to be obliterated, so simulating the appearance displayed in photographs Nos. 1 and 2, where the iridial angle now exhibits an appearance more closely resembling the figures of it presented in the various textbooks. In these specimens (Nos. 1 and 2) the pupil is contracted and the iris is thinned and much stretched; under these conditions the traction exercised through its attached margin pulls out the lax tissue which forms the floor and outer wall of the iridial angle, and so leads to the more or less complete obliteration of the groove so well displayed in the other photographs (Nos. 3, 4, 8 and 10).[1] A more detailed examination of this region under a higher degree of magnification will enable the student to realize the general arrangement of the parts around the iridial angle. Fig. 1 is a photomicrographic view of the appearances displayed. The upper edge of the figure passes through the cornea and sclera at the level of the internal sclero-corneal junction. The *iridial* or *filtration* angle (*g*) lies between the *periphery* or *ciliary attachment* of the *iris* internally and the *sclera* (*d*), with its associated structures externally. The dense scleral tissue (*d*) traversed, as may be seen in the section, by a scleral vein (*c*), lies to the outer side of an elongated cleft (*a*)—the *canal of Schlemm*—the outer wall of which it forms. Posterior to the canal of Schlemm a wedge-shaped process of scleral tissue (*e*) is seen projecting inwards and forwards from the substance of the outer coat. This represents the appearance displayed by the *annular ligament* on section, and has been named the *scleral process* or *spur* (*calcar sclerae*). Lying in front of this and to the inner side of the canal of Schlemm (*a*) is the trabecular tissue of the *pectinate ligament* (*b*): this consists of an open meshwork of fibro-elastic tissue, continuous in front with Descemet's membrane, which lines the inner surface of the cornea. Posteriorly, the majority of the fibres of the pectinate ligament are

[1] For a fuller account of this region see a paper 'On the Gross Anatomy of the Filtration Angle of the Human Eye', A. Thomson, *The Ophthalmoscope*, September, 1910, and July, 1911.

seen to be attached to the front of the scleral process (*e*); a few of them, however, pass backwards over the summit of the scleral process and blend with the connective tissue which surrounds the bottom of the iridial angle (*g*), becoming continuous internally with the stroma of the iris. Behind the scleral process (*e*) and closely applied to the inner surface of the sclera (*d*), are the *meridional fibres* of the *ciliary muscle* (*h*); these, be it noted, do not pass in front or over the summit of the scleral process (*e*). To the inner side of the meridional fibres lie the *circular fibres* of the *ciliary muscle* (*i*), and to the mass of these, as shown in section, may be traced a few of the scattered radial fibres of the *dilator pupillae* (*f*).

The *canal of Schlemm* (*d*) is revealed as an empty, open, endothelial-lined cleft, having its outer wall formed by dense scleral tissue (*d*), whilst its inner wall is made up of the trabecular tissue of the pectinate ligament (*h*). As the canal lies in this position its hinder part occupies the angular recess formed by the inward and forward projection of the scleral process (*e*). The trabecular tissue of the pectinate ligament, as it lies to the inner side of Schlemm's canal, is traversed by many narrow channels, which are lined by an extension of the endothelial layer which overlies Descemet's membrane, and afford a passage-way for fluids from the anterior chamber into the canal of Schlemm. The canal of Schlemm is therefore a channel or series of channels possessing more or less rigid external walls, due to the density of the scleral tissue which here invests it; whilst its inner wall, formed as it is by the open trabecular tissue of the pectinate ligament, will be subject to such changes as may be induced by the stretching of that tissue.

It has been suggested[1] that the scleral process (*e*) is not a fixed point, but responds to the influence of the combined contraction of the ciliary muscle and the sphincter of the pupil, moving backwards and inwards, thereby stretching the pectinate ligament and opening up the iridial angle, at the same time that it pulls inwards the inner wall of the canal of Schlemm, so increasing its lumen and thereby establishing a condition of negative pressure within it. When the muscles cease to contract the scleral process is pulled forward again by the elasticity of the pectinate ligament, the lumen of the canal is reduced, and a gentle pressure is exercised on its contents so as to force them onwards into the surrounding circulation. For the evidence on which this suggestion is based see the article already cited.

The **Retina**, or nervous tunic. The reader may be reminded that this layer is formed by the invagination of the wall of the primary optic vesicle to form the optic cup. The two walls of which the cup is formed are originally separated by the cavity of the optic vesicle,

[1] *Ophthalmoscope*, vol. ix, July, 1911, 'The Filtration Angle, &c.'; A. Thomson, p. 470.

a space which at an early stage of development is continuous with the ventricular cavity of the brain. This double-walled optic cup, of which the inturned edge corresponds in the adult to the circumference of the pupil, comes to have developed around it the uveal tract or vascular coat. The outer wall of the optic cup is therefore closely applied everywhere to the inner surface of the uveal tract, viz. to the chorioid, the orbiculus ciliaris, the ciliary processes, and the iris. To the inner side of the outer wall of the optic cup lies the inner wall of the cup, separated at first by the remains of the cavity of the optic vesicle—a space which in the adult is represented by the intervals between the rods and cones and the processes extending from the pigment cells. There seems good reason for believing that these intervals constitute a lymph space between the two layers. Now the two walls of the cup undergo remarkable changes in the process of development. The whole of the outer wall becomes converted into a thin pigmented layer, the *pigment layer* of the retina. This, as has been stated, is applied to the inner surface of the uveal tract, and so intimate is the union that in dissecting the coats of the eye it generally adheres to the vascular tunic, thus accounting for the view which was formerly held that it was to be regarded as one of the constituents of the uveal or chorioid layer. Its separation from the inner wall of the optic cup takes place along the line of the cavity of the primitive optic vesicle, where the union of the two layers appears to be weaker than the connexion between the pigment layer of the retina and the inner surface of the uveal tract.

The inner wall of the optic cup, which is everywhere applied to the inner surface of the outer wall or pigmented layer, undergoes in the process of development changes which vary in accordance with the position which it occupies. From the optic nerve as far forwards as the *ora serrata*, the inner wall of the cup forms the *nervous layer* or *pars optica retinae*. In contrast with this relatively thick stratum, the inner wall of the optic cup in front of the ora serrata becomes reduced to the thickness of a single cellular layer, which, now more firmly adherent to the pigment layer, overlies the inner surface of that structure, and is continued onwards over the *orbiculus ciliaris*, the *ciliary processes*, and the posterior surface of the *iris* until the two layers, viz. those developed from the inner and outer walls of the optic cup, become continuous with each other at the circumference of the pupillary aperture.

According as this stratum, developed from the inner wall of the optic cup, overlies the orbiculus and ciliary processes, it is spoken of as the *pars ciliaris retinae*, whilst where it is applied to the posterior surface of the iris it is referred to as the *pars iridica retinae*.

A consideration of the foregoing details will enable the student to realize the complexity of the layer which is now being considered, and

will account for the apparent discrepancies which the dissections reveal when we attempt to examine the retina as one organic layer. The facility with which the pars optica retinae separates from the external or pigmented layer is one of the difficulties which the *préparateur* has constantly to endeavour to overcome in the making of large sections, and it is only in exceptional cases, due partly to the efficiency of the hardening reagent, and also to the avoidance of post-mortem change, that satisfactory results can be obtained.

Owing to the changes which take place after death, and the influence of the hardening reagents employed, the *pars optica retinae* loses its normal transparency and acquires a mat-white semi-translucent appearance; further, in place of being evenly spread over the surface of the chorioid, it tends to become creased and wrinkled in a meridional direction. These appearances are well seen in Nos. 1, 2, 3, 4, 8 and 10. In some of the specimens more or less extensive separation has taken place between the internal nervous layer and the pigmented lamina of the retina. Nos. 1 and 2 are the photographs which exhibit it with least disturbance of the parts. In the other photographs, where separation has occurred between the two layers, it will be noticed that by the inturning of the cut edge the outer surface of the nervous layer is often exposed, and this, it will be observed, is free from pigment, the pigmented layer to which it was applied being retained *in situ* in contact with the inner surface of the chorioid.

Proceeding now to examine the *pars optica retinae* as displayed in meridional sections of the eye, it will be seen to form the inner lining of the wall of the eyeball as far forwards as the *ora serrata*, which as a rule is situated about 6 mm. (6·2, see also p. 10) behind the *external sclero-corneal* junction.

According to whether the meridional section has been made in the horizontal or vertical plane, a difference is to be noted in the relative position of the passage of the optic nerve through the scleral coat. Photographs Nos. 1 and 2 exhibit this appearance when the section is carried horizontally through the optic nerve; here the nerve is seen to pierce the sclerotic 3 mm. to one or other side of the posterior pole of the eye. In consequence of this arrangement, the one side of the *pars optica retinae*, as seen in section, is shorter than the other. The shorter side is always that which corresponds to the nasal surface of the globe, whilst the longer side lines the inner surface of the temporal aspect of the eyeball. When the meridional section is made in a vertical plane passing through the optic nerve, the point of entrance of the nerve corresponds more closely to the posterior pole, being situated only about 1 mm. below it; consequently there is only a slight difference in the extent of surface covered by the upper and lower parts of the retina. This is well displayed in Nos. 3, 4, 5, 6 and 9.

The appearance of the retina exhibited in the various specimens photographed (Nos. 1, 2, 3, 4, 5, 6, 9 and 10) varies considerably. In some (Nos. 1 and 2), owing to a greater degree of transparency in the hardened retina, the vessels of that layer are fairly well displayed; whilst in the others, due doubtless to the difference in the action of the hardening reagent in conjunction with the post-mortem changes in the specimen at the time it was received, the retina is seen to be more opaque, and consequently the course of the vessels is not so well displayed. For the same reasons the evenness with which the pars optica retinae is spread over the inner surface of the chorioid varies in the different specimens. In Nos. 1 and 2 there has been the least disturbance of the layers; here, along the edges of the section, the retina is shown but little displaced, the only appearance of the surface of the retina which we may regard as abnormal being the elevation of the nervous layers here and there into folds, the disposition of which is mainly meridional. In the other examples (Nos. 3, 4, 5, 6 and 10) a greater or less degree of separation has taken place between the nervous and pigmented layers of the retina. This natural form of dissection is not without its advantages, since it enables us to estimate more accurately the varying degrees of thickness of the nervous layer in different situations.

All the specimens show that the pars optica retinae is thickest at its junction with the optic nerve, where on an average it measures 0·56 mm. in thickness. As it spreads out over the posterior surface of the cavity of the eyeball it gradually thins, till at the equator it measures no more than 0·18 mm. in thickness; in front of this its gradual attenuation continues until it ends abruptly in the region of the ora serrata, where it is about 0·1 mm. thick. At the point where the retina becomes confluent with the optic nerve, there is in correspondence with the centre of the optic nerve a little pit or depression, the *physiological excavation* or *cup*, surrounded by a slightly everted circular lip, formed by the converging nerve fibres as they pass over the edges of the tunics of the eye surrounding the inner circumference of the *foramen opticum sclerae.*

It is this arrangement which gives rise to the slight circular elevation (about 1·5 mm. in diameter) of this part above the level of the surrounding retina, and hence justifies the name of *optic papilla* frequently applied to it, though it is only fair to say that the existence of this projection is denied by many, and is accounted for as being an optical illusion. An inspection of the various photographs in which this region is displayed appears, however, to justify the conclusion that the slight elevation referred to is determined by the structural arrangements of the parts. (See further, p. 57.)

About 3 mm., or a little over, to the lateral or temporal side of the optic nerve in the horizontal plane lies the *macula lutea*, within which is a depression, called the *fovea centralis*, formed by the thinning of the

layers of the retina, so as to leave here only the cones and their associated cells. The appearance and position of these parts will be better understood when the fundus of the globe is examined (see p. 59), but in meridional sections their position may also be made out. Unfortunately, after death the retina in this region undergoes usually a tumefaction of its layers, so that the position of the macula is generally recognized by the presence of a pronounced fold extending outwards from the *papilla optica* for the space of 5 mm. or so, having at a point about 3 mm., or a little over, from the centre of the optic disk or papilla a distinct dimple or depression. The latter indicates very precisely the position of the *fovea centralis*. To this fold the name *plica centralis* was applied, and it was formerly described as a normal condition of the retina; now, however, it is recognized as a post-mortem change, induced no doubt by the more ready absorption of fluids by this part of the retina. The two conditions are very clearly shown in the photographs, Nos. 58 and 59; in the first of which the fundus was photographed in the fresh condition, twenty minutes after removal during life, whilst in No. 59 the same specimen was photographed after subjection to the influence of a 4% hardening solution of formalin. Though the fold is not here present in its most typical form, the reader will have no difficulty in recognizing the altered appearance due to the swollen and oedematous condition of the parts.

In the meridional sections the disposition of the fold will vary according to the plane in which the section is made. Thus, if the section be a horizontal one (see No. 1), the fold will stretch from the outer side of the optic nerve towards the posterior pole, coincident with which, or nearly so, the *fovea centralis* is placed; whilst, if the section be vertical, the fold will be seen to pass at right angles to the plane of the section towards the temporal or outer side of the fundus, as is shown in Nos. 3, 4, and 6—an arrangement which enables us to distinguish the lateral or temporal from the mesial or nasal half of any eye examined, though unfortunately we are not able, without further data, to say definitely whether the eye belongs to the right or left side.

From the optic entrance to the ora serrata and in front as far as the ciliary processes, the retina is spread out and forced against the middle coat by the pressure exercised by the *vitreous humour*, the external investing membrane of which—the *hyaloid membrane*—is everywhere in contact with the inner surface of the retinal layers. It is not easy in all the sections to make out the existence of this hyaloid membrane as an independent layer, but in No. 10 quite a good view of it is obtained, where to the right side of the entrance of the optic nerve it has in part become separated from the inner surface of the underlying retina.

The **ora serrata**, as has been stated, marks very definitely the anterior limit of the visual retina—the *pars optica retinae*. In front of this border the retina, no longer composed of nervous elements, is continued forwards as the thin cellular layer, the *pars ciliaris retinae*, which in conjunction with the pigment layer overlies the inner surface of the ciliary body.

As a rule, the ora serrata is situated 6 mm. behind the external sclero-corneal junction. It displays a variety of form, as may be seen in the different photographs, Nos. 1 to 10, but in all there is evidence that this edge of the nervous retina is here more firmly connected with the subjacent layers, for, as may be seen by an inspection of the specimens, although the pars optica retinae tends to separate readily from the underlying pigment layer behind this margin, this separation never takes place in front of it. This condition is further emphasized by the fact that just at this edge the pars optica retinae, owing, it may be, to the action of post-mortem changes or the influence of the hardening reagent, tends to form a swollen fold along this margin, as may be well seen in Nos. 2, 10 and 14. In other examples, however (Nos. 7, 8 and 9), though similarly treated, this appearance is not displayed. Careful measurement reveals the fact that the ora serrata reaches further forwards on the nasal than on the temporal side of the globe. Thus the average distance of the ora serrata from the corona ciliaris on the medial side of the eye is 3·3 mm., whilst on the lateral aspect of the globe the mean distance between these two structures is 4·2 mm.

In some of the specimens the ora serrata displays a scalloped edge (Nos. 5, 7 and 14). Here the margin is interrupted by a series of pointed processes separated by backwardly directed concave notches. From the pointed processes there occasionally extend forwards on to the orbiculus ciliaris for a variable length thin white lines; these lines, when present, are usually directed towards the valleys or intervals between the ciliary processes, or it may be to smaller ciliary folds which lie between the larger ones. Oftentimes a more deeply pigmented strand replaces the white thread-like bundle, passing forwards from the points of the serrated edge of the ora. If in an orbiculus which has been dissected off from the scleral coat these be viewed by strong transmitted light, the darker radial strands will be seen to correspond to leashes of fine vessels, often with a larger one in their centre, passing back from the ciliary processes or the intervals between them.

It is also noteworthy that the spiny appearance imparted to the edge of the ora serrata by the presence of these pointed processes is always better seen on the nasal side, where the orbiculus is narrower, than on the temporal side, where the ora serrata usually displays a more even appearance. Indeed, it is not at all uncommon to find evidence of the pointed processes only along the nasal side of the edge of the ora.

More commonly, too, they are best seen in young adults, and seem to tend to disappear in the eyes of older subjects, the ora serrata then presenting a more even appearance such as is displayed in Nos. 2, 8 and 9. The photograph, No. 9, is that of a pathological specimen, introduced into the series for another purpose, but it exhibits a remarkably even ora serrata and is here noticed on that account.

The number of these pointed processes is extremely variable; in some they are large and well-pronounced, as in Nos. 7 and 14; in others they are smaller and more numerous, as in No. 10. As many as 34 have been counted; in other cases only 17 or 18 have been noticed, whilst in some instances it has been impossible to recognize their presence at all.

What strikes one first on examining the *pars optica retinae* in the foetal eye (Nos. 15, 16, 17 and 18) is the apparent redundancy of this layer. Whether this condition is more apparent than real it is difficult to say, as possibly the relatively thicker and softer character of the tissue may render it more susceptible to post-mortem changes; but in most of the specimens examined the appearance suggests that the retinal layers are not yet adequately stretched over the inner surface of the vascular and protective coats of the eye, which would seem to indicate that the expansion of the retina over the inner surface of the globe was not completely effected by its own intrinsic growth, but rather by a stretching and spreading out of its layers on the inner surface of the growing and expanding chorioid and sclera. Support is given to this view by the ophthalmoscopic examination of the eyes of young children, in whom the 'watered silk' appearance displayed by the retina is accounted for on the supposition that that membrane is not yet evenly stretched over the fundus, but is thrown into folds.

As has been said, in briefly describing the development of the retina (p. 19), at the level of the ora serrata the inner lamella of the optic cup undergoes a rapid transition in structure. The nervous elements disappear, and all that remains to represent this wall is a thin lamina composed of a single layer of columnar cells which now becomes intimately connected with the externally placed pigment layer, from which it can, only with difficulty, be separated. We are not here concerned with a consideration of the question what element in the retina is represented by this layer of cells which constitutes the *pars ciliaris retinae*. It is sufficient for our purpose to note that as we trace this layer forwards it undergoes a gradual thinning, involving a reduction in the length of the columnar cells, so that, whereas in the immediate vicinity of the ora serrata these cells are of considerable height (the figures given are from 0·040 to 0·050 mm.), we find on examining them as they overlie the ciliary processes that they only measure 0·015 mm. The inner surface of this layer has been described as forming a glassy membrane, the *membrana*

limitans ciliaris. The exact nature of this layer is not well understood, but its interest from the present standpoint is based upon the fact that it affords a means of attachment to the fibres and lamellae which stretch from the ciliary body towards the lens, forming the *zonule of Zinn.*

The *pars iridica retinae* is merely the forward extension of the pars ciliaris retinae lining the inner surface of the pigment layer which clothes the posterior surface of the iris; at the pupillary edge of the iris these two layers become structurally continuous with each other by a folded edge, which, in the adult, represents the rim of the secondary optic vesicle or cup. The cells of the layer forming the pars iridica retinae have, however, lost the columnar arrangement characteristic of the pars ciliaris retinae, and now exhibit a more cubical form. As they pass on to the posterior surface of the iris they become loaded with pigment, so that it is impossible to distinguish them from the pigment layer proper of the retina upon which they rest.

The **pigment layer** of the **retina.** Sufficient reasons have been already advanced for regarding this layer as morphologically a part of the retina, since, as has been shown, it is developed from the outer wall of the ectodermic optic cup. Nor need much space be devoted to its description, for in describing both the nervous retina and the chorioid it has been repeatedly referred to as occupying a position intermediate between these two structures.

Its tendency to adhere to the chorioid has also been alluded to, a tendency which involves its separation from the layer to which it more properly belongs, viz. the pars optica retina. The probability of the existence of a lymph space between these two lamella has also been referred to, and it has been pointed out that in the fully developed eye this cleft represents the cavity of the primary optic vesicle.

The pigmented layer of the retina lines the whole of the interior of the uveal tract from the entrance of the optic nerve to the pupillary margin of the iris; internally it is overlain by the *pars optica retinae* as far forwards as the *ora serrata*, in front of which, in the hardened and fixed eye, its colour is revealed through the thin *pars ciliaris retinae*, whilst where it passes over the back of the iris its intensity of colour is reinforced by the pigment within the cells of the *pars iridica retinae*, which is in contact with it. As has been said, although the connexion between this pigmented layer of the retina and the pars optica is feeble and easily ruptured, its union with the pars ciliaris and iridica is much more complete and difficult to separate. For further details concerning the retina see pp. 44, 56.

The **lens.** In meridional sections of the eyeball the lens appears suspended within the cavity of the globe in such a position as to seem to plug posteriorly the pupillary aperture; it is thus brought into

relation with the iris, which touches it tangentially in front; its circumference is directed towards the blunt projecting ends of the ciliary processes, from which, however, it is separated by the circumlental space, the width of which as a rule averages about 1 mm.

It is here that by careful inspection and the use of suitable light one may observe the arrangement by which the lens is suspended and held in position. A good view of this, which constitutes the *suspensory ligament* of the lens or *zonule of Zinn*, is seen in No. 8 and also in No. 9. The latter, which is from a pathological preparation in which the entire iris is adherent to the posterior surface of the cornea, is included, since the iris being pulled forward permits the better illumination of the ligament, which in this case is not lying in shadow behind the iris. The same appearances are faintly seen in Nos. 2 and 4. Behind, the lens rests on the anterior surface of the vitreous humour, in a shallow depression called the *fossa patellaris* or *hyaloid fossa*. Opinions differ as to whether or no this fossa is lined by an extension of the hyaloid membrane. My own observations confirm the views of Stuart that the membrane is continuous over the surface of the fossa. The preparations on which this conclusion is based are not here represented, but in No. 8 there is evidence to show that the hyaloid membrane on the left side of the section is separate from the suspensory ligament, whilst in No. 10 the same arrangement would seem to be suggested. But perhaps the best demonstration of the independence of this layer from the suspensory ligament is given in No. 9, where it may be seen distinctly passing behind the lens. Unfortunately, the preparation is taken from a pathological eye, but in this instance that does not invalidate the proof which it exhibits.

It is in the centre of the bottom of this saucer-shaped depression that the anterior extremity of the *hyaloid canal* opens: here it is somewhat enlarged, forming what is known as the *post-lental space*. A suggestion of this may possibly be seen in No. 15, the eye of a full-term foetus.

What most attracts attention concerning the lens, in the series of meridional sections of the eye, is the fact that its form varies very much. As we pass from the foetal form (Nos. 15, 16 and 17) to that displayed in advanced life (Nos. 1 and 2), it is evident that the degree of convexity of the anterior surface of the lens displays a marked reduction. During foetal life the lens approaches more nearly the spherical form; in the aged it becomes thinner and of more compressed shape. This appears to be effected at the expense more particularly of its anterior surface, which becomes flattened, an appearance which is particularly well seen in Nos. 1 and 2, where the anterior aspect of the lens has practically become a plane surface. Intermediate forms are displayed in Nos. 3, 4, 5, 8, 10 and 11. What appears noteworthy is

that this reduction in the anterior curvature takes place evenly and uniformly throughout, and not, as will be presently referred to, unequally, as appears to happen in the case of the posterior surface.

If the posterior aspect of the lens be examined in all the photographs reproduced, with the exception of those of the foetal eyes, the curvature of this surface is always more pronounced in the centre than towards the circumference. Whether this is a natural appearance or due to the influence of the hardening reagent it is difficult to say. The fact that the more pronounced central convexity corresponds to the denser *nuclear* part of the lens, whilst the flatter circumferential part coincides with what is termed the *substantia corticalis*, the softer and more compressible part, would seem to suggest that the forms represented in the photographs are unnatural, and the results of the irregularities produced by the hardening reagents. If this be so it is a proof that, taken as a whole, the lens is more plastic around its circumference just where it is most subject to the influence of the suspensory ligament. Another feature which seems important is that this circumferential flattening of the posterior surface of the lens only affects that part of it which lies wide of the area of its normal optical efficiency. As a consequence of the forms here described it follows that the equator of the lens does not, as one is led to believe, correspond to a linear strip coinciding with the summit of its greatest width, but harmonizes with a somewhat broad and flattened zone, which intervenes between the attachments of the anterior and posterior lamellae of the suspensory ligament. It is this zone which forms the inner wall or base of the triangular space which forms the so-called *canal of Petit.* The *equatorial region* of the lens may therefore be described as that circumferential area which lies between the attachment of the anterior and posterior layers of the zonule of Zinn, the implantation of which on the capsule of the lens is marked by two well-marked edges between which, as shown in meridional section, the lens exhibits different degrees of flattening. This is displayed in various forms in Nos. 1, 2, 3, 4, 8, 9, 10 and 11. In No. 9 the flattening of the equatorial region is most marked, but this, as has been already stated, is a pathological specimen, the result of a wound of the cornea. It would appear from a consideration of these observations that the influence exercised by the fibres of the suspensory ligament are rather of the nature of a traction than a pressure effect, since the former would tend to emphasize the presence of the ridges which limit it in front and behind the equatorial zone, whilst a pressure effect, squeezing upon the intervening tissue, would cause it to bulge up into the floor of Petit's canal.

The lens, as measured in the specimens at my disposal, gives results as follows:—

The equatorial width varies from 8·0 mm. to 9·9 mm., yielding an

average of 8·6 mm. for the series, numbering fourteen in all. The antero-posterior thickness varies both with age and the condition of accommodation, consequently we expect to find greater differences in this measure. The figures deduced from the series range from 2 mm. to 4 mm., with a mean for ten specimens of 3·02 mm.

The relations of the lens are well displayed in the photographs of the meridional sections reproduced. Anteriorly the central part of the lens forms the posterior wall of the anterior compartment of the aqueous chamber; the extent of this surface depends on the size of the area uncovered by the pupil. External to the pupillary margin, which rests in contact with the anterior surface of the lens, the front of the lens as far as the attachment of the anterior fibres of the zonule enters into the formation of the posterior wall of the posterior camera of the aqueous chamber. The extent of the surfaces of the iris and lens in contact with each other is seen to vary in the photographs. It seems to depend on the degree of tension of the iris and the extent of the curvature of the lens. In some, as in No. 10, the area of contact corresponds to a point, the edge of the pupillary margin, from which the iris extends tangentially outwards; in others, as in Nos. 3, 4 and 8, the two surfaces have a wider area of contact; whilst in Nos. 1 and 2 the two structures, owing to the flatness of the front of the lens, lie parallel to each other in close relation. In the preparations in my possession, the depth of the anterior chamber, as taken from the central point of the inner surface of the cornea to the front of the middle of the lens, measures from 2 mm. to 3 mm., giving on an average a depth of 2·2 mm. Equatorially the lens is related to the projecting rounded ends of the ciliary processes, from which it is separated by the circumlental space, the width of which I find to range from 1 mm. to 1·1 mm., with an average of 1·01 mm. This space, be it noted, is bridged across by the fibres of the *zonule of Zinn*, which, as shown in Nos. 8 and 9, are subdivided into two more or less well-defined laminae, between which lies the interval known as the *canal of Petit*. This so-called canal is triangular in meridional section; the inner side or base, measuring on an average about 1 mm., is formed, as has been stated, by the *equatorial zone* around the circumference of the lens. Posteriorly the lens rests in the *fossa patellaris* of the vitreous humour, and is thus brought into relation centrally to the anterior extremity of the hyaloid canal. The equatorial axis of the lens lies 2·4 mm. behind the limbus conjunctivae, or the external sclero-corneal junction.

The most noticeable features in connexion with the foetal eye are the large proportionate mass of the lens and its more spherical form. In consequence, the anterior chamber is shallower, whilst the fossa patellaris is deeper. The region of the equator corresponds to the summit of the curve formed by the coalescence of the anterior and

posterior surfaces, and does not display any indication of those borders to which the fibres of the *zonule of Zinn* are attached as in the adult. The circumlental space is narrower, and in the earlier specimen what corresponds to the ciliary processes appears to abut against the circumference of the lens.

These details may be seen in No. 15, which is the eye of a full-time foetus, and in Nos. 16 and 17, which are photographs of the eye of a 6½-months' foetus.

For further details concerning the lens see pp. 38, 45 and 50.

The **zonule of Zinn**. As has been stated in the foregoing description of the lens in these meridional sections, the **suspensory ligament** of the lens, or the **zonule of Zinn,** is faintly seen in Nos. 2 and 4. The difficulty in viewing it depends on the fact that it is far from easy to get it suitably illuminated, since owing to the fact that it lies behind the iris, it is apt to be thrown into shadow by that structure. In No. 8 these difficulties have been happily overcome, and on the left-hand side of the specimen the arrangement of its fibres is well displayed. Whilst not denying the existence of fibres which occupy an intermediate position, or which cross each other, the preparation clearly shows that the majority of the fibres of the zonule are arranged in two lamellae. The anterior layer passes to be united to the capsule of the lens in front of the true equator, where its attachment corresponds to a fairly abrupt margin; whilst, in similar fashion, the posterior sheet of fibres passes to the back of the capsule, to which they are similarly attached, along a more or less pronounced border just behind the equator. The interval between the laminae, formed by the circumference of the lens, has been described as the *equatorial zone*, and in the different sections shown exhibits varying degrees of convexity, though in the main a tendency to display a flattened form. As the fibres constituting these layers arise from the ciliary processes, they appear to spring in greater number from the valleys between the processes, and here, being closer together, the two sheets separate as they cross the circumlental space to reach the lens; the anterior layer passing inwards and slightly forwards, its lenticular attachment lying in the same plane as the anterior curved edge of the bulging ciliary processes, whilst the hinder lamina is recurved inwards and backwards, so as to lie, where it is connected with the lens capsule, on a level with the spring of the posterior border of the ciliary processes. In consequence of this arrangement the interspace between the two layers displays a triangular form, the base corresponding to the equatorial zone of the lens, whilst the sides, both back and front, are formed by the diverging sheets of fibres; the summit of the triangle is obscured by the inward bulge of the ciliary processes and, thus interrupted, will form a series of pointed processes extending outwards in the valleys between the processes.

To this interspace has been given the name of the *canal of Petit*, the nature of which will be more fully discussed when some of the other photographs have been considered (see pp. 48 and 51).

In No. 8 it is worth noting that the posterior sheet of the fibres of the *zonule of Zinn* is independent of the thin *hyaloid membrane* encasing the vitreous, as may be faintly seen on the left side of No. 8, and also on both sides in No. 9. This latter print, although from an injured eye, has been introduced because it gives so excellent a view of the zonule, owing to the fact that the iris, having become adherent to the cornea, has been pulled forward, carrying with it the ciliary processes. In this way a natural dissection of the parts has been the result, and the iris being drawn out of the way the suspensory ligament of the lens is more clearly exposed.

Stretching across the *circumlental space* the layers of the suspensory ligament are seen to intervene between the *aqueous chamber* in front and the *vitreous* behind. The anterior layer of the zonule forms in part the hinder wall of the *posterior camera* of the aqueous chamber, being separated from the posterior surface of the iris by an interval averaging 0·93 mm. from before backwards, a measure which indicates the depth of the posterior chamber at this particular part. The distance from the back of the iris to the front of the posterior layer of the zonule measures on an average 1·9 mm. This includes not only the posterior chamber, but also the so-called canal of Petit.

For further details concerning the suspensory ligament see pp. 37, 47 and 50.

The **vitreous.** Owing to the apparently structureless nature of this constituent of the eyeball, but little evidence of its presence can be seen in the photographs. Its existence is demonstrated in most of the prints by the presence of particles of dust which have become embedded in it, or by the air bubbles within its substance which tend to make their appearance in the preparations when they are being thawed after having been cut in the frozen condition.

The *vitreous* is enclosed in the *hyaloid membrane*, the outer surface of which is closely applied to the inner surface of the retina. Under ordinary circumstances in these meridional sections there is no evidence to prove the existence of this layer, but exceptionally, as in No. 10, the hyaloid membrane has become separated from the retina, and appears as a delicate filmy structure lying in front of the retina to the right of the entrance of the optic nerve; the delicate strands of tissue which connect the two are distinctly noticeable. In the same preparation the hyaloid membrane is seen separated from the surface of the ciliary processes on the left side of the section.

Attention has been already directed to the fact that in Nos. 8 and 9 the hyaloid membrane has also been shown as distinct from the posterior

lamina of the fibres of the suspensory ligament, from which it stands as a layer apart.

In the foetal eyes, the vitreous displays more evidence of structure, particularly in the earlier stages. In the full-time foetus, No. 15, the vitreous has shrunk away from the retina posteriorly. A suggestion of a *post-lental* space in the centre and at the bottom of the *patellar fossa* also appears visible.

In the foetal eyes of 6½ months the vitreous is traversed by layers of filmy-looking tissue, and does not appear to fill up the entire space within the retina. This is probably due to irregularity in the shrinkage. In No. 17 the *hyaloid artery* can be very clearly seen passing through the substance of the vitreous from the optic papilla posteriorly to the back of the lens in front.

For further details concerning the vitreous see pp. 48 and 61.

CHAPTER II

DISSECTIONS OF THE EYE FROM THE FRONT

This includes the series of photographs from Nos. 19 to 32 inclusive. These comprise an illustrative series of dissections designed to expose the different structures in relation to the aqueous chamber.

In No. 19 the anterior surface of the globe of the eye is exposed. The cornea has been removed by cutting it through along the line of the sclero-corneal junction. Wide of this the *scleral conjunctiva* is seen *in situ*, displaying a cut edge externally where it has been snipped through; beyond this, the external surface of the *sclerotic*, cleared of its muscular attachments, is shown.

By the removal of the *cornea* the *anterior camera* of the aqueous chamber has been laid open, and the structures which form its posterior boundary are thus exposed. These are, within the area of the pupil, the anterior surface of the *lens*, and, external to the pupillary margin, the anterior surface of the *iris*, which is here displayed.

In another preparation, No. 20, the dissection has been carried a stage further, so as more fully to expose the *iris* and its attachments. Here the sclera has been stripped off from the front of the eye, exposing the outer surface of the *ciliary body* and *chorioid*; but be it noted that in tearing away the sclerotic a narrow ring of condensed tissue, the so-called *annular ligament*, has been left: this is seen just where the iris and the ciliary body become confluent, and is well displayed in the upper half of the left side of No. 20, where the arrangement of the light throws it into relief. This is the structure to which the meridional fibres of the ciliary muscle are attached, and it is from the front of this ridge that the fibres of the *pectinate ligament* have been torn away in removing the sclerotic and cornea. The reader should remember that it is this ring of tissue which in microscopic meridional sections of this region forms the projecting process called the scleral process or spur, and that the *canal of Schlemm* lies immediately to the outer side of this ring of condensed tissue, and has necessarily been laid open by the removal of the sclera, since, as has been stated (p. 17), the outer wall of Schlemm's canal is formed by the dense scleral tissue, whilst its inner wall is constituted by the loose trabecular substance of the pectinate ligament.

The anterior surface of the **iris** is well displayed in both Nos. 19 and 20. In the hardened condition, in both these preparations, the iris appears thicker around the pupil, where it forms a smooth elevated ring crossed

transversely by a number of radial folds. This appearance of thickness is due to an actual increase in the thickness of the tissue of the iris in this region, as may be seen in the meridional section, No. 4; but may possibly be exaggerated by the bending between that part which is in contact with the lens and the portion which lies circumferentially, as shown in No. 3. This appearance is further enhanced by the inward slope of the iris towards the *pupillary margin*, which has a thin chisel-like edge, the margin of which is finely notched, and exhibits a narrow black border. In No. 20, close to the pupillary edge, the constituent fibres of the iris are seen arranged in a festooned or arcaded fashion, within which, here and there, are seen small depressions leading into the stroma of the iris. These are regarded by Fuchs as the *stomata* of lymph canals.

Sometimes, as shown in Nos. 21 and 22, about 0·5 mm. from the pupillary margin, the iris exhibits at different points what appears like a free edge of tissue. The same may be seen in meridional section in Nos. 7 and 10, where it presents the appearance as if the iris were composed of two strata, one terminating in the pupillary margin, the more superficial layer ending, as has been described, in a free edge a little without and in front of the pupil. The interest attaching to this particular arrangement is that the position of this irregular edge marks the line of attachment to the iris of the pupillary membrane which existed at an earlier period of development, as may be seen in meridional section in No. 16. The *pupillary stomata* aforementioned lie to the inner side of this attachment, and thus provision is made whereby filtration of the contents of the posterior camera of the aqueous chamber may take place prior to the opening up of the communication through the pupil with the anterior chamber.

The *radial folds* which traverse the iris are determined by the vessels and nerves of the iris which form the elevations between them, as is demonstrated in No. 26, where the arrangement of these structures is well displayed, but no doubt towards the pupillary margin contraction folds are also present.

Wide of the smooth elevated zone already referred to, the iris exhibits a number of *concentric folds*, intensified during dilation of the pupil, and obviously produced by the contraction and wrinkling of the tissues. At its periphery the iris undergoes a change in its appearance and structure; its surface becomes irregular, pitted, and depressed. In the accompanying photographs, Nos. 19, 20 and 26, in which the cornea and sclera have been removed, it will be recognized that the ciliary attachment of the iris corresponds to the bottom of the *iridial* or *filtration angle*. As will be seen, its connexion with the ciliary body lies immediately to the inner side of the annular ligament, the ring of condensed tissue which on meridional section forms the scleral spur.

Bearing in mind the connexions of the pectinate ligament, as have been described (see p. 17), it will be obvious that the internal fibres of that structure, as they pass on to the circumference of the iris, will have been torn in the removal of the cornea, and one would expect evidence of this, as may be seen in No. 20, where some of the torn ends of these ruptured fibres are distinctly visible. Just within the *annular ligament* are a number of *crypts*, the orifices of which are intersected by a number of delicate fibres. The depressions into which these crypts open correspond, as may be observed in No. 26, to the intervals between the elevations caused by the bundles of vessels. It is through these crypts, sometimes called the *ciliary stomata* of the iris in contradiction to the pupillary openings already referred to, that the anterior chamber communicates with the *spaces* of *Fontana* which are disposed around the bottom and outer wall of the *filtration angle.*

An examination of the anterior aspect of the iris, as displayed in photographs, Nos. 19, 20, 21 and 26, proves that this surface of the iris exhibits considerable differences in different individuals. Apart from the question of pigment, it will be seen that in No. 21 the anterior surface appears much more rugged than any of the others, there being several large depressions on it, the edges of which are sharp and well defined; here, too, near the pupillary margin there is an irregular border, the margin of which appears free and outstanding. This arrangement has been alluded to already. In No. 26 the front of the iris is shown as much more regular. Owing to the absence of pigment, the radial arrangement of the vessels and nerves is well seen. The crypts at its ciliary border are not so well defined, but here and there the torn fibres of the pectinate ligament are indicated by the woolly appearance imparted to this edge.

In No. 24 the dissection has been carried farther by the removal of one half of the iris. In this way the *posterior camera* of the aqueous chamber has been laid open by the removal of its anterior wall, thus fully exposing the structures which form its posterior boundary. Viewed in the stereoscope the right side of the photograph displays the anterior surface of the *lens* now fully exposed. A small quantity of pigment close to the pupillary edge of the divided iris shows where that structure has rested in contact with the lens. The *circumlental* space is revealed as a dark ring round the lens. Crossing this, in radial fashion, the delicate fibres of the *zonule of Zinn* are to be seen. Where these are attached to the lens capsule they impart a crenated appearance to the circumference of the lens. In front of these, which form the anterior layer of the *suspensory ligament* of the lens, and about 0·5 mm. from the periphery of the lens, may be seen the rounded knob-like extremities of the *ciliary processes.* Anterior to these are a number of thin, projecting, light-coloured folds. These are even better dis-

played in No. 25, where the entire iris has been taken away. It is evident that these folds have been divided when the iris has been removed, and consequently one would expect to see evidence of their continuity on the back of the iris, as may be seen, here and there, in No. 23. It is difficult to say whether these folds correspond to the ciliary processes, or whether they alternate with them. The appearance displayed would seem to indicate that they were a forward extension of these processes. Their number is approximately sixty-eight to seventy, which would bring them into harmony with the number of ciliary processes in the corresponding specimen. The presence of these folds must cut up the posterior camera into a series of compartments corresponding to the intervals between them, and those who deny the existence of a posterior chamber will have to account for the disappearance of these interspaces by the compression of the folds against the anterior surface of the lens and the projecting fore parts of the ciliary processes.

It may be well now to examine the posterior surface of the iris. This is exposed in the separated *iris* shown in No. 23. Owing to the deeply pigmented condition of this side of the iris, it is extremely difficult to get a photograph of it which will show up the detail. In this preparation, however, the fluted and folded arrangement of the back of the iris is fairly well seen. The appearance, however, is better displayed in No. 46, where the iris is represented *in situ* along with the *corona ciliaris*. Here, owing to the bleaching action of peroxide of hydrogen, its structural details are better displayed. Around the pupillary margin there is a zone about 1 mm. in width, in which the posterior surface of the iris is thrown into a series of very fine radial folds. These overlie the part of the iris in which the sphincter muscle of the pupil is placed, and form the *contraction folds* of the pupillary zone (Schwalbe). A careful examination of the pupillary edge, as displayed in No. 23, will prove that this margin is not an evenly flowing line, but exhibits a crenated appearance due to the projecting rounded ends of these fine folds.

Wide of the pupillary zone (No. 46), the *structural folds* of Schwalbe, much more pronounced in form, are seen to radiate outwards towards the ciliary attachment of the iris, where they both widen and deepen, giving to this aspect of the iris a pleated appearance. It is these folds which we have already noticed in a divided condition in the dissections where the iris has been removed (Nos. 24 and 25).

The magnification in No. 46 is not sufficient to reveal the *concentric folds* described by Fuchs, though some suggestion of them may be recognized in the right-hand lower quadrant of the iris.

The iris measures on an average 11 mm. in diameter; the diameter of the pupil ranges from 3 mm. to 5·9 mm. in my preparations.

For other details in connexion with the iris see pp. 13 and 43.

Returning to a further examination of the dissection displayed in No. 20, it will be seen that, surrounding the annular ligament, there is a light-coloured circular zone about 2 mm. in width, the convex surface of which presents a fine fluffy appearance. This is the outer surface of the **ciliary body,** and corresponds directly to the external portion of the meridional fibres of the ciliary muscle. Externally, it has been separated from the sclera, which has been removed. Passing to this zone may be seen the filaments of the *ciliary nerves*, together with branches from the *anterior* and *long posterior ciliary arteries.*

Wide of this ciliary zone the outer surface of the **chorioid** is exposed, overlain by some of the ciliary nerves and exhibiting the whorl-like arrangement of the radicles of the *vorticose veins.* In No. 25 a further dissection of this region has been displayed in this preparation; the tissue comprising the ciliary muscle has been stripped off on the left-hand side of the photograph. The cut edge of the muscle is seen at the right and lower corner of the preparation. Here the tissue removed includes both the *meridional* and *circular* fibres of the *ciliary muscle*, but as the strip has been pulled away, an ever-increasing number of the circular and finally some of the radial fibres have remained *in situ*, so that the transition from complete absence to presence of the entire muscle is a gradual process, as may be recognized by examining the upper part of the preparation. A portion of the strip removed is seen stretched out in No. 66. It gives an admirable view of the *ciliary plexus* (*plexus gangliosus ciliaris*) formed by the splitting up of the ciliary nerves. The same photograph displays a thin and delicate membrane which, from the fact that it lies within the plane occupied by the ciliary nerves and has been removed without carrying with it any trace of the vascular chorioid, must be regarded as the *lamina suprachorioidea*, a point of some interest, as this would appear to suggest that such may be the main insertion of the meridional fibres of the ciliary muscle.

Returning to a further consideration of the dissection displayed in No. 25, it will be observed that the outer surface of the *orbiculus* and *corona ciliaris* has been exposed by the removal of the ciliary muscle. This, as has been explained, is most complete in the lower part of the preparation. The most noticeable feature in connexion with the surface thus exposed is the fact that the vessels of the chorioid, as now exhibited, display an arrangement of parallel bundles meridional in their disposition, thus contrasting with the appearance of the vorticose veins which lie wide of the ciliary zone. These groups of vessels appear to correspond with the position of the *ciliary processes* which lie internal to them.

If the photograph (No. 25) be examined immediately to the left of the cut edge of the ciliary muscle, the surface from which the muscle

has been removed appears as a well-marked groove. The deepest part of the groove lies immediately outside the roots of the divided structural folds of the iris, and immediately in front of the free rounded ends of the ciliary processes. It is here that the circular fibres of the ciliary muscle lie, and it is against these structures that the compressing action of the muscle must necessarily be exercised, thus leading to considerable alterations in the posterior chamber, and so reducing its capacity, at the same time forcing inwards the ciliary attachment of the iris, and so stretching and opening up the *filtration angle* which lies in front of this part of the iris.

The account of the ciliary muscle as seen in meridional section will be found on p. 18.

Nos. 27 to 32 inclusive are designed to show the **zonule of Zinn** under different conditions of light. In all, the cornea, iris, and part of the sclerotic have been removed, so as to expose fully the *lens*, the *circumlental space*, and the *ciliary processes*. In each case the globe of the eye had been divided equatorially, so that it was possible to view the structures as seen from the front either by reflected or transmitted light, or by a combination of both. What is characteristic of them all, with the exception of the preparation taken from the eye of an eighth-month foetus (No. 32), is that the circumference of the lens is not an evenly flowing outline, but is toothed and irregular where some of the zonular fibres are attached to its capsule. The appearance displayed is indicative of the strain exercised by these fibres. In every case the fibres of the zonule as they stretch across the circumlental space are represented in a state of tension; in no instance is there any indication that the fibres are relaxed. Nor, though the fibres appear to be grouped in bundles, is it possible to say from these photographs whether they arise from the valleys between the ciliary processes or no; all that can be asserted is that they are placed at some little distance behind the rounded extremities of the ciliary processes. No. 27 has been photographed under a combination of reflected and transmitted light; in it the fibres of the zonule stand out as dark strands; above and to the right there appears within the zonule a darker zone, the significance of which is undetermined; below and to the left there is a certain amount of delicate fluffy tissue, as if entangled amongst the fibres of the zonule. It will be quite evident when viewed stereoscopically that the fibres of the suspensory ligament do not lie on the same plane. No. 28 is a photograph of another preparation taken by reflected light alone. In this the zonular fibres appear as faint pale striae, some of which may be traced for a short distance on to the front of the lens; a point of interest is, that on the left side in this preparation the lens casts a shadow on to the surface of the vitreous, thereby indicating the presence of a membrane, and

proving the existence of a space between the structure which throws the shadow and that on which it falls; some of the fibres of the zonule lie clearly in front of the shadow.

In No. 29, the same preparation as No. 28, viewed by a combination of transmitted and reflected light, the striae of the zonule are but faintly represented; the same observation holds good of No. 30, which is a photograph of the same preparation viewed by transmitted light only.

In No. 31 an enlarged view of the same structures is shown; the only detail which need be referred to is, that the ciliary processes at the lower part of the preparation cast a shadow on the front of the zonule in such a way as to suggest that it forms a continuous membrane.

No. 32, from the eye of an eighth-month foetus, has been taken with a combination of reflected and transmitted light. The fibres of the zonule show up well, but their connexion with the lens is devoid of the spine-like processes so common in the adult specimens. This would seem to point to the fact that the occurrence of these irregularities in the circumference of the lens in the adult is associated with the traction effects exercised by the fibres of the zonule during the practice of accommodation. Note the greater anterior convexity of the lens as contrasted with the other preparations.

For further references to the suspensory ligament see pp. 13, 29, 47 and 50.

The **Lens.** In the various preparations which have been studied the anterior surface of the lens is, in part or in whole, exposed exhibiting in divers forms the appearance of the *lens stars* under different conditions of light. In No. 20, as seen through the pupil, the anterior surface of the lens exhibits a star form, of rosette appearance, with five petals; in No. 19 an indication of wedge-shaped masses meeting at the centre is suggested; whilst in No. 26 the division of the lens by a tri-radiate series of dark lines is clearly seen. In the preparations where the anterior surface of the lens is entirely exposed, dark, narrow, wedge-shaped masses are displayed: these vary in number from ten to thirteen. The bases of the wedges, which are of rounded form, approach the circumference, whilst their apices are directed to the centre of the lens (see Nos. 25, 27, 28, 29 and 31). In No. 32, from the eye of an eighth-month foetus, these wedges are not revealed by differences in tone; here the front of the lens is traversed by four dark lines, which meet in H-shaped fashion in the centre of the lens, and divide it up into four unequal parts.

In most of the preparations the front of the lens retains some of the iridial pigment on it, marking precisely the line of contact of the pupillary margin at the time of death.

Reference has been already made to the irregular appearance of the circumferential margin of the lens. The toothed-like arrangement of

the edge has been explained as evidence of the strain exercised on the capsule by the tension of the fibres of the *zonule*. To this arrangement there is one exception, viz. that of the foetal specimen (No. 32), where the circumference of the lens exhibits quite an even edge, due probably to the fact that it has not been subjected to the strain exercised on it during accommodation. The greater degree of convexity of the anterior surface of the foetal lens has been already alluded to.

For other details concerning the lens see pp. 25, 45 and 49.

CHAPTER III

ANTERIOR HALF OF THE EYE SEEN FROM BEHIND

This includes the series of photographs, Nos. 33 to 47, which exhibit the arrangement of the structures within the anterior half of the eye as seen from behind, the globe having been bisected in the equatorial plane.

Externally, the coats of the eye are seen divided; outside lies the **sclera,** displaying an average thickness in this situation of 0·53 mm.

Not unfrequently the *perichorioidal space* is revealed by the separation of the chorioid from the sclera, as in Nos. 33 and 34, the tissue which intervenes between them being split into two lamina, of which the external, the *lamina fusca*, adheres to the internal surface of the sclera, and imparts to it its pigmented appearance, whilst the inner layer, the *suprachorioidal membrane*, remains united to the external surface of the vascular chorioid. The tissue which unites these two layers is permeated with lymph spaces and traversed by the *ciliary nerves* and the *long ciliary arteries.*

In No. 47 the sclera has been cleared of all the structures which lie within it; its inner surface is irregularly pigmented owing to the adherence of the lamina fusca. In front its union with the cornea is seen, and here a good demonstration is given of the groove (*sulcus circularis corneae*) which lies immediately behind the *internal sclero-corneal junction.* This groove, as has been explained (p. 16), is formed by the projection of the circumference of the cornea internally and in front, whilst its outer wall is formed externally and behind by the inner surface of the sclera overlain by the *pectinate ligament*; this, be it remembered, forms the outer wall of the *filtration angle* of the *anterior chamber.* The pigmented inner surface of the sclera ends abruptly in front, just wide of the circular sulcus, in a light-coloured well-defined edge; it is from this that the *annular ligament*, to which the *ciliary muscle* and the *iris* are attached, has been removed in detaching the ciliary body, and it is along this margin that the fibres of the *pectinate ligament* passing to the front of the iris will have been torn across. The *canal of Schlemm*, which lies immediately in front of the light zone which indicates the position of the annular ligament, will, in all probability, have been laid open here and there in the course of the dissection, but it is too minute to be seen in the preparation.

For further details regarding the sclera see pp. 7 and 53.

Occupying the centre of the preparation (No. 47), the inner surface

of the **cornea** is exposed. As has been stated, it bulges somewhat at its circumference so as to take part in the formation of the groove which surrounds its periphery. The bottom of the groove is angular and forms a crisp furrow which on meridional section appears as a definite kink; this marks the position of the *internal sclero-corneal junction*, and it is here, seen very clearly in the lower part of the preparation, where it appears as a dark line, that Descemet's membrane, which covers the inner surface of the cornea, abruptly alters its character, and breaks up into the trabecular tissue of the *pectinate ligament*, the outer surface of which is related to the externally placed sclera, the *canal of Schlemm* intervening. The irregular appearance displayed by the inner surface of the cornea is due to the wrinkling of Descemet's membrane under the influence of the hardening reagent.

For further details relating to the cornea see p. 8.

The **chorioid coat.** In the majority of the preparations this layer can be seen distinctly at the cut edge of the section as it lies between the *sclera* externally and the *pars optica retinae* internally. In some instances it is separated from the sclera by the opening up of the *perichorioidal space*, in which condition it has overlying it externally the *suprachorioidal membrane* (see Nos. 33 and 34). In other of the preparations it has separated from the nervous layer of the pars optica retinae, as in Nos. 35 and 43; but here be it noted that its inner surface is dark in colour owing to the fact that the pigment layer of the retina is still adherent to it. The separation takes place, therefore, not between the *chorioid* proper and the *retina*, but between the nervous and pigmented layers of the retina, as has been fully explained on p. 11. Little more need here be said regarding the *chorioid*, as it has been described at length in Chapter I (p. 10).

The anterior extension of the *uveal coat*, as seen from within, may now be considered, though it should be clearly understood that in front of the *ora serrata* of the pars optica retinae it is overlain internally by the *pars ciliaris* and *pars iridica retinae*, which impart to it its pigmented appearance. In front of the ora serrata there is a fairly smooth circular pigmented zone, about 3·6 mm. in width, exhibiting the appearance, when the vitreous is in position, of faint radial striation (see Nos. 33 and 34). This is the **orbiculus ciliaris.** After the removal of the vitreous this area can be more readily examined; it will then be obvious that the striation is due to the disposition of the vessels which are here seen running radially from the ciliary processes in front towards the ora serrata behind. These are the veins of the ciliary processes which are passing backwards to drain into the *vorticose veins*. As will be observed in No. 37, some of the larger of the vessels arise from the ciliary processes, others appear to begin in the valleys between them. In the same preparation, and also in No. 36, some of the fibres of the zonule of Zinn are seen to

arise from the tissue overlying the fore part of the orbiculus, immediately behind the inspring of the ciliary processes: these appear as tense delicate glistening strands which require careful focusing and good light to show them.

Within the orbiculus lies the **corona ciliaris,** composed of the ciliary processes, which vary in number from 67 to 84. They impart a goffered appearance to this part of the ciliary body, and stretch forwards and inwards towards the circumference of the lens, from which, however, they are separated by the *circumlental* space. These processes measure on an average 2 mm. long, about 0·5 mm. wide, and rise 1 mm. from the surface.

In Nos. 33, 34, 35, 36 and 37, the *circumlental* space appears as a dark ring immediately surrounding the lens, and careful examination in the stereoscope reveals the presence of faint radial striae crossing it: these are the fibres of the *zonule of Zinn.* A better view of the *circumlental space* is obtained when the cornea and iris have been completely removed from the front of the eye; then, if the preparation be viewed by a combination of reflected and transmitted light, the circumlental space appears as a light ring around the lens, whilst the rounded anterior extremities of the ciliary processes as well as the fibres of the zonule are better displayed (see Nos. 39, 40 and 41).

The **ciliary processes** consist of upstanding folds containing a number of tortuous vessels in their interior; each fold is laterally compressed, and the free edge of the fold, thick and rounded, rises gradually from the fore part of the orbiculus, and, gently curving inwards, ends abruptly by a rounded extremity which projects into the *posterior camera* of the *aqueous chamber* immediately behind the ciliary attachment of the iris. These folds, to the number of 70 or 80, are placed side by side in radial fashion, so that there are a corresponding series of interspaces or valleys between them.

In their appearance and arrangement they display considerable differences. In some the free edges of the folds are fairly straight and regular (No. 34); in others (Nos. 39 and 40) they are irregular and tortuous. On the other hand, it is not uncommon to meet with an arrangement such as that exhibited in No. 43, in which, between each pair of processes (which in this case number about 68), there are subsidiary folds occupying the valleys; these are not so large as the major processes, but, though smaller, are fairly prominent and well defined. These have been named the *ciliary folds* to distinguish them from the *ciliary processes.*

When the lens is *in situ* the fibres of the **zonule of Zinn** pass from it across the *circumlental* space to the region of the *corona ciliaris.* In several preparations (Nos. 37, 39 and 40), the arrangement of these fibres and their relation to the ciliary processes are well displayed. As has

been said, some of the fibres spring from the fore part of the orbiculus behind the position of the ciliary processes, but the majority arise from the ciliary body in the region of the corona. An inspection of Nos. 37 and 39 clearly demonstrates how this takes place: the fibres take their origin from the surface of the ciliary body in the intervals or valleys between the ciliary processes, and not from the processes themselves. As several fibres appear to spring from each valley, this accounts for the appearance displayed by the zonule as if the fibres were grouped in bundles.

A further dissection, which entails the removal of the lens and the division of the suspensory ligament, completely exposes the ciliary processes and exhibits the relation of the corona to the back of the **iris.** This has been done in Nos. 43, 44, 45 and 46. In Nos. 44 and 45 the darker colour of the back of the iris contrasts with the lighter tint of the corona. The preparation, of which No. 46 is a photograph, has been subjected to the bleaching action of peroxide of hydrogen, which, curiously enough, although it has extracted all the pigment from the region of the corona, does not materially seem to have affected the uvea of the iris. In No. 46 the ciliary processes are beautifully shown. Their summits are devoid of pigment: this is not an uncommon appearance, and cannot be explained on the supposition that the removal of the vitreous and hyaloid membrane has entailed the loss of such an amount of pigment as may have adhered to them, for the same unpigmented condition along the summits of the processes may be seen in specimens where the vitreous has not been taken away (No. 33). In No. 46 the processes clearly display their vascular structure by the tortuosity which they exhibit on their surfaces; this is well shown on the right side of the preparation, where, emerging from the root of each process, may be seen a vessel of considerable size passing backwards into the orbiculus. The preparation also shows that the tissue underlying the valleys between the processes is likewise beset with tortuous vessels, as the irregularities on the overlying surface prove. A certain amount of fluffy tissue may be seen floating in the fluid overlying the processes (the preparations were photographed under fluid): this is the remains of the *zonule*, whilst here and there a stray fibre is seen, indicating the nature of that structure.

In No. 44, a similar view, the anterior extremities of the ciliary processes exhibit what seems to be a deflection of the process to one or other side, imparting to it a club-shaped appearance. In the bleached preparation (No. 46), the processes themselves along their free edge are fairly even and regular, but on their sides and in the valleys between, down which the *ciliary folds* may be traced, they present anteriorly a pitted and honeycombed appearance, as may be well seen on the right side of the preparation. These are doubtless the openings of the *ciliary*

glands of Collins; and be it noted that their position, lying in front, as they must do, of the *hyaloid membrane* of the vitreous, will direct their secretions into the *posterior camera* of the aqueous chamber. At the lower part of the preparation a few scattered fibres of the zonule are seen arising from the valleys.

For further details concerning the ciliary processes, see p. 12.

In front of the anterior extremities of the ciliary process, but at some little distance from their free ends, as indicated by the shadows they cast (see the right side of the photograph No. 46), the posterior fluted surface of the **iris** can be seen: this has been already described (see p. 35). In the foetal eye at term (No. 38), the *ciliary processes* are somewhat more club-shaped and not so compressed; their anterior extremities lie closer to the lens so that the *circumlental space* is narrower than in the adult. In No. 42, from the eye of an eighth-month foetus, the ciliary processes are shown in shadow and the circumlental zone appears as a light ring around the lens, the cornea and iris having been removed and a certain amount of reflected light having been used in taking the photograph. The ciliary processes appear square at their ends and more irregular in form.

The **Retina.** The internal coat is best seen in those preparations (Nos. 33 and 34) where the vitreous is still *in situ*, the inner or nervous layer of the *pars optica* is seen as a pale-grey translucent layer lining the inner surface of the globe as far forwards as the *ora serrata*. This margin, owing to the structures being viewed in perspective, is not so well displayed as in the meridional sections, since the swelling of its edge, due to the oedematous condition induced by the hardening reagents or post-mortem changes, obscures the margin which marks the definite transition of the *pars optica* to the *pars ciliaris*. In each of the photographs, however, on the left side, the crenated border of the ora serrata may be seen, and from the summits of some of the spine-like processes a light-coloured slender thread may be observed passing radially over the surface of the orbiculus (see also No. 43). In the preparations where the vitreous has been removed these appearances are not well shown, since a certain amount of the vitreous, together with its hyaloid membrane, has remained attached to the inner surface of the retina. In all the preparations, however, at the cut edge of the section the retina is exhibited in such a way as to demonstrate its division into two layers. This is perhaps best displayed in No. 43, where the vitreous no longer supports the inner layer in position; and here that layer, which is entirely constituted of nervous elements, is shown separated from the dark pigmented layer which lies external to it, and which has remained adherent to the inner surface of the chorioid. The same may be seen in lesser degree in Nos. 33 and 34, where the separation of the two layers is, at points

around the circumference, indicated by a dark line. In these preparations the nervous tunic will be seen to equal double the thickness of the surrounding *chorioid.*

In the foetal eye at full term, represented in No. 38, the nervous layer of the retina is seen to be proportionately and absolutely thicker than in the adult; its appearance suggests that it is not so tightly stretched over the inner surface of the globe, and it exhibits a velvety look, as if looser and less compact in texture. Its anterior edge, which is swollen and rounded, reaches nearer the coronary zone, thus involving a narrowing of the orbicular zone. In this preparation the vessels of the retina embedded within its inner surface are beautifully displayed. It is not easy to distinguish between the arteries and the veins, but it is quite evident that at this stage of development there is a free anastomosis between these vascular channels, as may be seen especially along the edge of the *ora serrata*, where these anastomoses form a series of vascular arcades. This detail is of some interest, as direct anastomosis between arteries or veins has been denied in the case of the adult: possibly by the stretching of the retina to accommodate itself to the increased area of the growing globe these connecting channels have disappeared. Noteworthy, too, is the fact that the swollen edge of the ora is almost free from vessels. In the eye of the eighth-month foetus the redundancy of the nervous layer of the retina is very obvious. It is difficult to imagine that this infolding of the nervous stratum is due either to post-mortem changes or the influence of hardening reagents; it seems more reasonable to suppose that it is a provision whereby it may accommodate itself to the growth of the globe. Its thickness, too, is remarkable, and it is seen to extend well forwards towards the ciliary processes; only a few vessels are seen coursing through its internal layers.

The anterior extension of the retina over the surface of the *orbiculus ciliaris* and *ciliary processes* has been already referred to (p. 24). Nothing further need be said than that, by its pigment layer, the *pars ciliaris retinae* imparts the coloured appearance to the structures which it overlies. It will, however, be noticed, in such preparations as Nos. 43, 44, 45 and 46, in which the lens has been removed, that the further extension of the retina (*pars iridica retinae*) on to the posterior surface of the *iris* exhibits a greater depth of colour, as here not only its pigment layer but the cells which lie within it are loaded with colouring matter, constituting what is sometimes called the *uvea* of the iris.

For further details concerning the retina see pp. 25 and 56.

The **Lens.** The lens, as seen *in situ* from behind, exhibits different appearances according to the nature of the light. In Nos. 39 and 40, both from the same preparation, the *lens star* consists of a stellate arrangement of the lamellae of which the lens is composed, with nine

or ten processes radiating from the centre and gradually tapering until they reach the circumference; the angular intervals between these spokes are occupied by folded lamellae arranged like the sides of a Gothic arch; the summits of the arches, or the folded edges of the lamellae, being directed towards the angles formed by the spokes. In No. 35 the lamellar arrangement is not so well shown; here the star consists of a rosette-like arrangement, having ten lanceolate petals; there are also indications of lines of cleavage near the centre on the right-hand side. In No. 33 there are faint indications of a radial striation, and in No. 34 there are ten or eleven lighter lines all converging towards the centre, while, close to the circumference, small wedge-shaped dark masses lie between these lines. The other preparations only faintly disclose any appearance of structure.

On p. 27 the greater convexity of the central part of the posterior surface of the lens, as seen in meridional section, was referred to. The same appearance can be made out stereoscopically in the view of its posterior surface, as displayed in Nos. 33, 34 and 41; the incidence of the lighting in each case reveals the fact that the central portion of the lens rises with a more pronounced degree of convexity from the flatter and less convex peripheral portion. The circumference of the lens in most cases displays that irregularity of outline to which attention has been already directed (p. 37). Hereto the fibres of the *zonule of Zinn* are attached, but in Nos. 39 and 40 the equator of the lens is seen to correspond to a flattened zone between two borders, as has been already described. In both these photographs the double borders are seen, each receiving its quota of fibres from the zonule, the space between the two strata of fibres corresponding to the so-called *canal of Petit*, the inner side of which is formed by the circumference of the lens lying between the two borders, the surface to which the name *equatorial zone* has been applied. Another feature, to which attention should be directed, is illustrated in No. 41, wherein a delicate membrane is seen, here and there raised from the circumference of the lens by the traction of the fibres of the zonule. This appears to confirm the observations of Retzius, and demonstrates the existence of a *pericapsular membrane*, to the dragging out of which by the fibres of the zonule Retzius attributes the toothed and irregular outline of the circumference of the lens. In the foetal eye at birth, shown in photograph No. 38, the circumference of the lens is even and regular. The posterior surface appears as if puckered in the centre by a four-rayed cleft, the limbs of which spread and branch irregularly into the surrounding tissue. Curiously enough, the appearance presented by the photograph of an eighth-month foetus (No. 42) exhibits the posterior surface of the lens full, rounded, and structureless, and without any evidence of the condition displayed in No. 38. Possibly the appearance exhibited in the latter

is due either to post-mortem changes or to some error in development. In the eighth-month eye the circumference of the lens is quite regular and without any evidence of the attachment of the fibres of the zonule.

For further details concerning the lens see pp. 29, 38 and 50.

The **circumlental space,** which measures on an average 1 mm. in breadth, is seen from behind, under different conditions of light. By reflected light, with the fore part of the eye intact, it appears as a dark ring around the lens. When viewed by a combination of transmitted and reflected light, the cornea and iris having been removed, it shows up as a light annular zone. Under the latter conditions the fibres of the zonule which cross it are better displayed, since they stand out as dark strands against a light ground. In this fashion they are displayed in Nos. 39, 40 and 41. Externally, the circumlental space is bounded by the goffered surface of the *corona radiata*, for be it remembered that the rounded extremities of the ciliary processes project somewhat in front of the equatorial plane of the lens; so that the widest part of the interval between the lens and the ciliary processes will lie slightly behind their anterior rounded extremities. The inner limit of the space coincides with the equator of the lens; but since, as we have seen, this is not always a linear surface but often a more or less flattened border, it is better to describe its inner margin as corresponding to the *equatorial zone* of the lens, viz. that surface around the circumference which lies between the attachment of the two strata of the fibres of the *suspensory ligament.*

The **zonule of Zinn,** or the **suspensory ligament** of the lens. The fibres which constitute this structure, as seen from behind, are best displayed in No. 40, where they appear as dark strands against a light ground; the cornea and iris having been removed, a certain amount of reflected light passes through the *circumlental space* and thus renders more apparent any structures which cross it. In this preparation, in which the vitreous has been removed, the fibres of the zonule display the appearance of being grouped in bundles, with interspaces between, in which the fibres are not so closely packed together. This arrangement is doubtless due to the fact that the majority of the fibres arise from the *corona radiata* in the valleys between the *ciliary processes*, where they may be seen springing from the bottom and sides of these recesses in different equatorial planes. It may be well to point out in this connexion that some of the fibres arise not from the valleys but from the fore part of the *orbiculus* immediately behind the attachment of the ciliary processes, as may be seen in Nos. 36 and 37, where their connexion with the orbiculus lies in line with the position of the valleys. From a study of photograph No. 40 in the stereoscope it will be evident, particularly in the upper part of the preparation, that, in the main, these fibres are disposed in two strata, which are attached

respectively to the two borders which include between them the *equatorial zone* around the circumference of the lens. It is not disputed that other of the fibres may be attached at intermediate points along this zone, but the majority of the fibres appear to have the attachments indicated. The interval between these two strata corresponds to the so-called *canal of Petit*, which surrounds the lens and in part corresponds to the *circumlental space*, though it would appear that this interval has extensions which pass outwards between the fibres as they occupy the valleys between the ciliary processes. In the right-hand lower side of this region, in No. 40, the fibres of the posterior stratum have been torn away in removing the vitreous and its hyaloid membrane, thus proving the intimate connexion which exists between these layers. Here the attachment of these fibres to the posterior border of the *equatorial zone* is clearly demonstrated, as they are turned towards the spectator.

The fibres of the zonule are clearly seen in the eighth-month foetal eye (No. 42); their arrangement requires no further description, except to point out that there are no irregularities around the circumference of the lens to indicate their attachment to that structure.

For further details concerning the suspensory ligament see pp. 29, 37 and 50.

The **Vitreous.** Little need be said about this, as owing to its transparent nature but slight evidence of its structure can be made out. It is seen *in situ* in Nos. 33 and 34, where a faint cloudiness of its tissue indicates its presence. In these preparations it serves to keep in position the structures which surround it, and its external *hyaloid membrane* is everywhere applied to the inner surface of the retina. In most of the other preparations of this series it has been, in whole or in part, removed; under the latter conditions, the structure of the hyaloid membrane, with some of the vitreous tissue still clinging to it, is seen overlying the retina (see Nos. 35, 36, 37 and 40), the surface of which is thereby obscured. In No. 37 the *hyaloid membrane* overlies the *orbiculus*, where its presence is demonstrated by a tear in it, visible in the left-hand lower corner of the preparation; through the torn portion the pigmented surface of the orbiculus is more clearly displayed. In the zonular region its presence is indicated by the filmy appearance represented in No. 36, and its intimate connexion with the posterior fibres of the zonule is exhibited in No. 40 (right-hand lower side), where, in attempting to remove it, some of these fibres have been torn away from their ciliary attachment.

In the foetal eyes, Nos. 38 and 42, the vitreous is still *in situ*; in neither is there any indication of the remains of a *hyaloid canal.* In No. 42 a delicate smoky look indicates some appearance of structure.

For further details concerning the vitreous see pp. 30 and 61.

CHAPTER IV

LENS

This series includes a number of preparations (Nos. 48 to 57) designed to exhibit more clearly the connexion of the **lens** with its **suspensory ligament.**

The specimens in some instances have been subjected to the influence of staining reagents, so as to render more obvious the differentiation of the tissues. No. 48 is a photograph of the anterior surface of the *lens*, lying in the *patellar fossa* of the *vitreous*. The preparation was made, after the ciliary body had been removed, by snipping through the *hyaloid membrane* at some distance from the circumference of the lens; the tissue of the vitreous was then carefully brushed away, leaving the hyaloid membrane intact; the specimen was then stained in picro-nigrosin. An inspection of the photograph in the stereoscope shows the lens lying in front of the stained hyaloid membrane, the anterior surface of which in the upper part of the photograph exhibits a goffering around the peripheral cut edge in correspondence with the *ciliary processes*, which have been taken away from its surface. The folding of the membrane, as here displayed, is not so deep as to suggest that it follows accurately the contours of the surface of the corona, but rather that it dips down only slightly into the valleys and bridges across the interval between the processes, thus leaving a space in front between the floor of the valley and the external surface of the membrane. In this way are formed the *recesses of Kuhnt*, which are in communication anteriorly with the *posterior camera* of the *aqueous chamber*, and into which (see p. 44) the *ciliary glands* of Collins discharge their secretion. These recesses are, of course, traversed by some of the fibres of the zonule. Lying in front of the hyaloid membrane and quite distinct from it are seen the fibres of the *suspensory ligament*. These are no longer stretched, since their connexions with the ciliary body have been torn away, but their attachment to the lens capsule is clearly shown, and, with a little care, will be distinctly seen to be disposed in two more or less definite strata where they join the lens, both quite distinct from the hyaloid membrane, which lies behind. No. 49 is a posterior view of the same preparation; in this position the hyaloid membrane lies in front of the lens, and its inner or posterior surface is seen to be irregular and ragged where the trabecular extensions from it into the substance of the vitreous have been torn across. A point of particular interest, in this specimen, is that it clearly demon-

strates the existence of the hyaloid membrane over the surface of the patellar fossa, since, as may be seen in the photograph, there is a tear in it across its centre, through which the lens is clearly visible. This detail will be further referred to presently. On the hyaloid membrane the impress of the ciliary processes is seen, and if carefully inspected in the stereoscope the fibres of the zonule can, in places, be observed through the hyaloid membrane. This is rendered difficult by the amount of loose tissue attached to the posterior surface of the hyaloid, but in the lower left-hand corner of the photograph the *suspensory fibres* are clearly visible lying on the farther side of the membrane.

In No. 50 the same preparation has been subjected to a further dissection. The photograph, like the last, is a view of the posterior surface of the specimen; but here one half of the hyaloid membrane has been removed, and as the membrane has overlain the back of the lens it has been stripped off from the posterior surface of the capsule. This convincingly proves that this layer is continuous over the surface of the patellar fossa, since on the left side it is still seen in greater part overlying the lens, and although the continuity of the peripheral part of the membrane and that which covers the posterior surface of the lens has been interrupted in places by a tear, yet if the upper torn vertical edge of the membrane be examined carefully it can with certainty be traced on to and over the posterior surface of the lens. The connexion of this layer with the posterior surface of the capsule must be fairly intimate, as proved by the manner in which it has been torn away from the lens on the right side, since the part which remains on the left side displays no free or independent edge, but is apparently evenly united to the posterior lens capsule. But the removal of the right half of the *hyaloid membrane*, as will be seen, has not carried with it the *zonular fibres*, for these are free and independent of the hyaloid membrane and still remain attached to the lens, where on the right and lower side their arrangement into two more or less distinct strata is clearly seen. It thus appears that the fibres of the zonule must be regarded as structures distinct and apart from the hyaloid membrane, though there can be no doubt that the relation between them must be very intimate, especially at their peripheral part, and particularly in the case of the fibres which form the posterior stratum of the zonule. In Nos. 51 and 52 the lens and lens capsule have been removed with the fibres of the zonule still adherent, care having been taken to strip the latter off the *corona ciliaris* as far back as possible. No stain has been employed, so that if the hyaloid membrane, or parts of it, are still adherent to the preparation, these owing to their transparency do not show; but care was taken as far as possible to remove the hyaloid, and that this has been successful is suggested by the somewhat fluffy appearance of the posterior surface of the lens as exhibited in the lower specimen in No. 52. The point of

interest, for the display of which these preparations have been introduced, is this, that whilst for the space of about 1·5 mm. from the circumference of the lens the fibres of the zonule appear independent and separate, yet when they are traced further outwards they become confluent, so as to form a thin and delicate membrane, which, from its disposition, must have been torn away from the surface of the *pars ciliaris retinae*, and which in its relation thereto must have lain between that layer and the hyaloid membrane internally. It thus appears that we must regard the fibres of the zonule, or *suspensory ligament*, as formed by the shredding of a delicate membrane blended posteriorly with the layers of the *pars ciliaris retinae* as it overlies the forepart of the *orbiculus* and the furrows between the *ciliary processes*. As has been shown, these fibres of the zonule, having a common origin, as they pass to the circumference of the lens tend to arrange themselves into two layers, each attached respectively to the anterior and posterior borders of the *equatorial zone* of the lens. A few, doubtless, occupy an intermediate position, whilst the interval between the two strata corresponds to the *canal of Petit*.

The common origin of the fibres from the membranous layers described is shown also in No. 53, and in this preparation their separation into two layers, as suggested, is also fairly clearly shown in the stereoscope.

In those preparations in which the zonule has been separated from its peripheral attachment, although the connexion of its fibres with the circumference of the capsule of the lens is clearly seen owing to their now relaxed condition, the points of attachment to the capsule do not exhibit the same evidence of strain as when the parts are examined *in situ*, with all the connexions of the zonule complete.

Nos. 54 and 55 have been introduced because in these specimens the corona ciliaris has been separated from its scleral attachments, and in consequence, having lost that fixity of position which is their normal condition, the fibres of the zonule, as revealed by transmitted light, crossing the circumlental space are no longer represented in a tense and stretched condition, but appear in places somewhat loose and relaxed.

No. 56 has been added to the series because it exhibits an unusual arrangement in the appearance of the zonule. In this preparation, as seen on the right side and also in the lower left-hand corner of the photograph, there are some delicate fibres having a concentric arrangement. These appear to lie between the two strata of the zonule, and consequently within or around the *canal of Petit*. Their nature is not clear; possibly they may be due to the presence of a fine endothelial lining, partial or complete, to that space.

No. 57 is a view of the *lens* with its associated parts from a 6½-months'

foetus. The lens, which more nearly approaches the spherical form than in the adult, is surrounded at its equator by a collar consisting of the *corona ciliaris* internally and that part of the retina which ultimately forms the *ora serrata* externally. The vitreous enclosed in its *hyaloid membrane* is still in position, and exhibits within its substance what is the particular feature of interest in this preparation, viz. the *hyaloid artery*, passing forwards to the posterior surface of the lens, where it may be seen breaking up into a number of branches.

For further details regarding the lens and the zonule of Zinn see pp. 29, 37 and 47.

CHAPTER V

POSTERIOR HALF OF THE EYE

This includes Nos. 58 to 67 of the series of photographs. These are taken from preparations designed to show the contents of the posterior half of the globe, the eyeball having been divided equatorially. Some other specimens are also introduced to exhibit the structure of the uveal tract.

In Nos. 58, 59, 60, 62 and 63 the circumference of the section displays the coats of the eye divided. Externally the cut edge of the **sclera** is seen, within which lies the *chorioid.* In only one preparation, No. 62, is this latter seen separated from the sclera. The narrow cleft thus exposed is visible in the upper and right part of the preparation, and corresponds to the position of the *perichorioidal* lymph space, and is formed by the splitting of the tissue which unites the sclera and chorioid into two layers—the *lamina fusca*, which adheres to the inner side of the sclera, and the *suprachorioidal membrane* which remains connected with the external surface of the chorioid. It is along this line of cleavage that the contents of the globe have been removed from the inner surface of the sclera in the preparation of which No. 64 is the photograph. In the view of the inner aspect of the scleral coat thus exposed, the pigment adherent to its inner surface is that deposited within the lamina fusca. Near the centre of the preparation, on the summit of a slight elevation, as displayed in this specimen, is the inner opening of the *scleral optic foramen* (*foramen opticum sclerae*). The width of this opening measures on an average 2 mm.; around its circumference is seen a narrow ring of adherent pigment. The white area within it corresponds to the divided optic fibres, which have been rendered opaque by the action of the hardening reagents, thus obscuring any view of the *lamina cribrosa* which in the unfixed condition would probably be seen. In the centre of the divided nerve three little dark spots are visible. These are vessels; the smaller and darker of the points is probably the *arteria centralis retinae*, whilst the fainter and slightly larger spots mark the position of the companion veins, which have probably not yet united. At a distance of two or three millimetres from the circumference of the scleral optic foramen there is a zone in which appear a number of light strands with a double outline. Some of these are definite structures, but others seem to be the unpigmented paths in the substance of the lamina fusca, which mark the position of

the vessels and nerves which here pierce the sclera; some of these are undoubtedly vessels and correspond to the *posterior ciliary arteries* which, after passing forward for some little distance in the *perichorioidal space*, enter the substance of the vascular *chorioidal layer*. Others of a larger size, of which over twenty can be counted, take a meridional course towards the cut edge of the section, and are either the ciliary nerves themselves or the paths which indicate their position. In the upper part of the preparation, corresponding to a line passing north and south in the compass, an artery of some length is seen: it is not unlikely that this is one of the *long posterior ciliary arteries* which has been torn across in part of its course through the perichorioidal space. At the bottom of the photograph, a little to the right of south, is what seems to be one of the vorticose veins piercing the sclera. In the part of the preparation which is in shadow (the right side of the photograph), there are appearances in the distribution of the pigment which suggest the arrangement of the radicles of the *vorticose veins* of the chorioidal layer which lies immediately internal to this exposed surface of the sclera.

Further details referring to the sclera may be found on pp. 7 and 40.

In Nos. 58, 59, 60 and 62, the next layer, divided at the edge of the section, immediately internal to the sclera, is the **chorioid**. In the majority of instances it is represented as in contact with the sclera, the intervening layer, as has been stated, consisting of the *lamina fusca* and *lamina suprachorioidalis*. These have a tendency to separate, as has been explained; under normal conditions, however, there is only an irregular lymph space between, through which pass the ciliary nerves and the long posterior ciliary arteries on their way to the ciliary region anteriorly. Across this space posteriorly the posterior ciliary arteries take a course to enter the chorioid layer, whilst in the region of the equator the large *vorticose veins*, usually four in number, traverse it so as to enter the substance of the sclera, through which they pass very obliquely in a backward direction. These veins are usually arranged in an upper and lower pair, their points of emergence through the sclera being about 90° apart.

Nos. 58, 59 and 62 show the chorioid separated from the nervous layer of the *pars optica retinae*. The pigmented appearance on the inner surface of the chorioid, thus exposed, is due, as has been previously explained (see p. 19), to the adherence to it of the *pigment layer* of the *retina*. In No. 67 the whole of the outer surface of the uveal tract has been exposed by the removal of the sclera and cornea from its outer surface. This aspect of the structure is covered with the non-vascular *suprachorioidal membrane*, formed, as has been elsewhere described, by the splitting of the tissue which unites it externally with the sclera. The line of cleavage has taken place through the irregular lymph space

called the *perichorioidal space*, which lies between the sclera externally and the chorioid internally. In this space thus laid open by the removal of the sclera, the vessels and nerves which traverse the loose connective tissue within it on their way to the ciliary zone anteriorly are now displayed. These are the *ciliary nerves*, of which eight or nine can be seen passing forwards to break up anteriorly into branches which unite to form the *ciliary plexus* (*plexus gangliosus ciliaris*) on the outer exposed surface of the ciliary region, where they lie external to the *orbicularis ciliaris* and *ciliary muscle*, as may be seen in the upper part of the preparation. Accompanying one of these nerves, near the left side of the photograph, a long slender vessel is seen. This is one of the *long posterior ciliary arteries* passing forwards to the fore part of the ciliary zone to form with its fellow of the opposite side, together with the branches of the anterior ciliary arteries, the arterial circle placed within the substance of the ciliary attachment of the iris. This arterial ring is known as the *circulus iridis major*.

The outer surface of the *uveal tract* exhibits a division into zones in correspondence with the differentiation in structure displayed by its inner surface. Thus, anteriorly (seen in the upper part of the photograph) there is a lighter coloured zone, which corresponds to and is formed by the outer surface of the *ciliary muscle*. Behind this is a more deeply tinted zone, limited posteriorly by a lighter ring with less pigment. This latter corresponds to the position, within, of the *ora serrata*, and the surface lying between this and the zone of the ciliary muscle in front overlies and harmonizes with the *orbiculus ciliaris* as seen from the inner side. At the lighter ring, corresponding to the attachment of the ora serrata, the parallel arrangement of the veins which drain into the *vorticose veins* is well displayed. Behind the attachment of the ora serrata that portion of the outer surface of the uveal tract which constitutes the *chorioid* is exposed. Internally, this is overlain by the *pars optica retinae*. Externally, the colour which it exhibits is largely due to the presence, internal to it, of the pigment layer of the retina; but here the converging radicles of the vorticose veins are well displayed as light tracts directed towards a centre from which one of the vorticose veins arises—a large vessel which, traversing the suprachorioidal space, escapes through the capsule of the globe by piercing the sclera obliquely in the manner already described. The layer of the chorioid occupied by the larger vessels, of which these veins are the more superficial in this view, constitutes its *vascular lamina*, and as thus exposed is merely covered by the lamina *suprachorioidalis*. Within the vascular layer, and separating it from the pigment layer of the retina, is the *chorio-capillary layer*, of which no distinct evidence is visible in the photograph.

No. 67 exhibits a view of the inner surface of the *uveal tract*, except

the iris, which has been removed. Throughout nearly its entire extent it is covered by the pigment layer of the retina. Along a line which corresponds to the position of the *ora serrata* of the *pars optica retinae*, and also for some distance in front of it, corresponding to the surface of the *orbiculus ciliaris*, this pigment layer has been in part stripped off, suggesting a more intimate connexion in this region between the constituent layers of the retina than appears to hold good elsewhere. Anteriorly (above in the photograph), the *ciliary processes* are seen, forming the *corona ciliaris*. In front, their connexion with the annular ligament is displayed; from the latter, however, the iris has been detached. The cut edge of the section in this region reveals the form of the ciliary body here due to the shape and thickness of the ciliary muscle. Behind the corona the *orbicular zone* is seen, limited posteriorly by a somewhat lighter narrow zone which corresponds to the position of the *ora serrata*. In the places where the pigment layer of the retina has been stripped off from the orbiculus, the arrangement of the small veins, which are here passing from the ciliary processes to the tributaries of the *venae vorticosae*, is well shown. Where these lie in the same meridian with the main trunks of the venae vorticosae the vessels appear arranged in parallel lines, but wide of this meridian they pass with varying degrees of obliquity to join the area drained by the tributaries of the vorticose veins. Behind the line of attachment of the ora serrata, the part of the uveal tract which constitutes the *chorioid* is displayed; it is here overlain, however, by the pigment layer of the retinae, the nervous lamina of which has been removed. This pigmented stratum appears as a flocular-looking layer of varying thickness and intensity, due no doubt to the irregularity of its removal or to the treatment to which the specimen has been subsequently subjected. The fact that this layer and the subjacent *choriocapillary* layer overlie the *vascular lamina* of the chorioid, in which the tributaries of the venae vorticosae are disposed, accounts for the more obscure display of these vessels in this view, as compared with that shown in the last preparation (No. 65).

In two or three places the pigment layer has been torn through, and in one of the holes so produced (see the left-hand lower side of the photograph) the much lighter clear structure of the chorioid is revealed. The fainter view of the tributaries of one of the vorticose veins, seen through the overlying layers above referred to, exhibits the same arrangement as that displayed in No. 65.

For further reference to the details of the uveal tract and the pigment layer of the retina see pp. 10, 25, 41.

In Nos. 58, 59, 60, 62 and 63 the **fundus oculi** has been exposed by the removal of the anterior half of the globe of the eye. Unfortunately, the orientation of the specimens, when being photographed, has not

been such as to represent them in the normal living position, nor could this defect be remedied by rotating the prints so as to display the parts in their approximate position, since such would interfere with their stereoscopic effect. In consequence, in the descriptions given of them, the points of the compass are taken as a means of interpreting the horizontal plane. Unfortunately, too, it is not always easy to determine the side to which the eye belongs. With these reservations the description of the specimens may now be proceeded with. No. 58 exhibits the appearance of the fundus of an eye which was removed some time after receipt of an injury. The specimen was cut and photographed within twenty minutes of the operation, no hardening or fixing agents being employed. The appearances displayed, though there is some optic neuritis, are as near an approximation to the conditions in the living eye as can reasonably be expected. The retina, though dimmed and having to some extent lost its transparency, has not yet acquired the semiopaque translucent look which is so characteristic of hardened preparations. Nor has it become irregular in its disposition, a condition which is associated with the appearance of oedematous-looking folds and elevations, which are so constantly met with in the ordinary museum preparations. In this preparation the *pars optica retinae* appears evenly spread over the inner surface of the globe, except at the edge of the section, where already a separation of the nervous from the pigmented layer tends to make its appearance. Within the cup formed by the posterior half of the globe two spots may be readily recognized, separated by a distance from centre to centre of about 4 mm., the one light in colour, the other dark. The former is the *optic disk* or *papilla*, the latter the *yellow spot* or *macula lutea*. In the photograph a line connecting the two points corresponds to the direction of the compass SE. by E. To place the preparation approximately in its correct position, this line should be rotated until it points slightly south of east, that is to say until it nearly falls into the horizontal plane. As so oriented the optic disk is situated 4 mm. to the medial or nasal side of the macula, whilst the latter, which lies pretty nearly in the visual axis of the globe, is placed very slightly below its horizontal meridian.

The **optic papilla,** placed, as has been already stated, about 4 mm. to the nasal side of the axis of the globe, displays a disk-like appearance with an average diameter of about 1·5 mm. The white colour of the disk is due to the fact that the transparent retinal fibres reveal the white tissue forming the *lamina cribrosa*, which plugs like a sieve the *foramen opticum sclerae*, and beyond which the nerve fibres passing through it become myelinated. In No. 58 the centre of the disk appears as a clear white spot, around which there is a slightly darker zone, which appears to slope outwards into the surrounding retinal

tissue. This elevated surface forms the *colliculus nervi optici*, and is due to the increased thickness produced by the convergence of the retinal optic fibres as they enter the anterior opening of the *foramen opticum sclerae*, the circumference of which is sometimes marked by a pigmented ring which corresponds to the abrupt cessation of the pigmented layer of the retina. This is distinctly seen in preparation No. 59. In No. 58, there is an appearance of faint pale striation radiating from the optic disk into the surrounding retina; this may possibly be due to the reflection of light from fibres of the optic nerve layer, or in this case may be evidence of pathological change. Not unfrequently there is a shallow hollow within the disk; this is the *physiological cup* or *excavation*. It is well seen in No. 60, where the elevated rounded margin of the *colliculus* is seen to throw a deep shadow across the nasal half of this centrally placed depression. In this view of it, the excavation appears to have a more abrupt wall on its nasal side than on its temporal aspect, in which situation it seems to slope more gradually towards the edge of the colliculus. A dimpled appearance of the optic papilla is also seen in No. 61. It is within the disk that the *retinal vessels* enter and leave the globe. In their general distribution throughout the retina the veins accompany the arteries, the larger branches pass forwards in the nerve-fibre layer, close to the *lamina limitans interna*, so that in the surface of the retina here exposed they occupy a superficial position. The veins can usually be distinguished from the arteries by their greater diameter and their less tortuous course.

Though individual variations are met with, the distribution of the vessels seen in Nos. 60 and 62 is probably the most typical. The *arteria centralis retinae*, as it lies within the optic nerve, divides at or before its emergence through the anterior opening of the foramen opticum sclerae, consequently, when it lies within the area of the optic disk, it usually appears as two or three branches, of these an upper and lower branch usually turn over the rounded edge of the *colliculus* to supply the upper and lower segments of the retina; each primary branch divides into a medial and lateral branch; which are distributed respectively to the nasal and temporal areas of the upper and lower retinal segments. Not unusually a medial horizontal branch passes over the inner lip of the physiological excavation, in line with but away from the position of the macula lutea. Toward the region of the *macula* two secondary branches, derived from the upper and lower primary branches, curve outwards so as to enclose an elliptical area within the centre of which the macula is placed. This, which may be regarded as the typical arrangement, is well represented in Nos. 60 and 62, and is seen also, though not so clearly, in Nos. 58 and 59. The emergence of the vessels through the tissue, which forms the lip of the physiological

cup, is often represented by an abrupt bend on their course, as is to some extent displayed in No. 61, but better seen in the foetal eye No. 63. The veins which take a corresponding course need not be further described; they unite to form a trunk which accompanies the arteria centralis retinae within the substance of the optic nerve.

The **macula, or yellow spot,** lying, as has been stated, nearly exactly in the position of the posterior pole of the visual axis of the eye, is seen in No. 61 as a slightly elevated oval area, from 1·6 to 2·0 mm. in diameter. This appears in the photograph NNW. from the optic disk. The two should, of course, lie nearly in the same horizontal plane. The swollen appearance of the macula is, in this preparation, no doubt a post-mortem change emphasized by the hardening reagent employed; but it exhibits very clearly the depression in the centre of the macular area called the *fovea centralis*, the sides of which are formed by the rapid reduction in the thickness of the constituent layers of the nervous stratum of the *pars optica retinae*. The dark colour imparted to the fovea, which reaches its greatest intensity in the centre of that spot, is due to the retinal pigment layer shining through the rapidly thinning layers of the nervous retina. In No. 58, the photograph of the fresh unhardened eye, only the dark spot corresponding to the fovea is displayed; there is no evidence of the surrounding macular area, due probably to the failure of the photographic plate employed to reproduce the difference in colour by which that area is defined. As seen in both these preparations, the fovea has a diameter of about 0·5 mm.

In No. 60, in which the macula and the optic disk happen to lie more nearly in the horizontal plane, the fovea is again represented as a dark spot surrounded by a light area displaying a somewhat puckered appearance; beyond this a darker zone again intervenes between a lighter circular area placed externally. This latter exhibits a somewhat swollen look, and from it there passes, to the temporal side of the optic disk, an elevated fold along the edges of which two vessels may be seen. These appearances are described in detail, since they appear to present a transition stage between the conditions already described in Nos. 58 and 61 and those which are displayed in Nos. 59, 62 and 63. In these latter preparations the fundus of the eye is traversed by an elevated irregular fold, extending from the optic disk internally to the region of the macula externally, where it encloses the fovea, which always remains as a distinct pit; from this it tails outwards into the temporal segment of the retina, on the surface of which it is gradually lost. With the specimen oriented approximately in its normal position the fold lies nearly in the horizontal plane. This appearance, long known as the *plica centralis*, is undoubtedly the product of a post-mortem change, as may be seen by comparing photographs Nos. 58 and 59, both taken from the same eye, the former in the fresh condition,

the latter after it has been subjected to the influence of a hardening reagent; but here the fold is not represented in its characteristic form, no doubt due to the fact that sufficient time was not allowed to elapse before the specimen was put into the hardening fluid for the post-mortem changes to exercise their influence.

In No. 62 the fold which lies SSE., instead of horizontally as it should, is represented in what may be termed its typical form. In numerous preparations in my collection the shape and disposition of this fold are so remarkably alike, as may be seen by comparing No. 62 with that of the foetal eye No. 63, that one is forced to the conclusion that the configuration of the fold is due to some structural difference in the retina which determines its shape, for here the retina seems particularly prone to acquire an oedematous condition due to the imbibition of fluid. Possibly an explanation of this condition is to be found by a consideration of the vascular supply of this region. The macula is abundantly supplied with vessels, but the central region of the fovea is described as devoid of them. May not the oedematous condition induced by post-mortem changes demonstrate the natural method of nutrition of this region by the transudation of lymph from the surrounding vessels?

In No. 63 the appearance of the fundus of a foetal eye at full term is exhibited. Here the ill-stretched condition of the pars optica retinae is apparent. Numerous well-defined swollen folds pass radially forwards from the optic disk; the larger of these usually correspond in position and direction to the larger veins, which appear not infrequently to run along their most prominent surfaces. The largest and broadest fold, however, disposed in the photograph almost due north, but which in the normal position of the eye would be directed horizontally, differs from the others in not being associated with any large vessels; only a small twig can be traced along its right edge from the region of the disk. This is the plica centralis. Its remarkable resemblance to the configuration of the corresponding fold in No. 62 has been already referred to. At its widest part and some 4 mm. from the centre of the optic disk, it exhibits a well-defined pit, in deep shadow, which marks the position of the *fovea centralis*. The blood-vessels in this preparation are well displayed, the veins being distinguished from the arteries by their greater size; as they pass over the thickened lip of the *colliculus* to enter the physiological excavation of the optic disk a pronounced curvature on their course is well seen. Immediately to the left of the plica centralis, in the vicinity of the fovea, there seems to be an anastomosing loop between two of the branches of one of the larger veins.

The optic disk is ill defined. The edge of the colliculus is thick and rounded, through its substance the vessels are seen converging to pass along the sides of the physiological cup. At the edge of the

section the nervous layer of the retina appears relatively thick, as compared with that of the adult.

For further details concerning the retina the reader is referred to pp. 18 and 44.

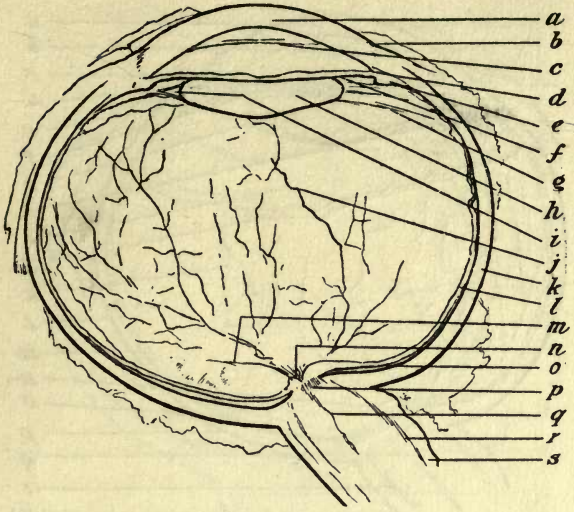
The only evidence of the **vitreous** displayed in the photographs of this series is seen in No. 62, where a slight cloudiness near the centre is indicative of its presence, whilst around the circumference of the section, within and close to the retina on the right and lower side of the photograph, a filmy appearance seems to suggest the presence of the hyaloid membrane.

For further details concerning the vitreous see pp. 30 and 48.

No. 66, a photograph of the separated *ciliary muscle*, together with its nerves, has been already described in Chapter II, p. 36. No further account of it is therefore necessary.

KEY TO PLATES

PLATE 1

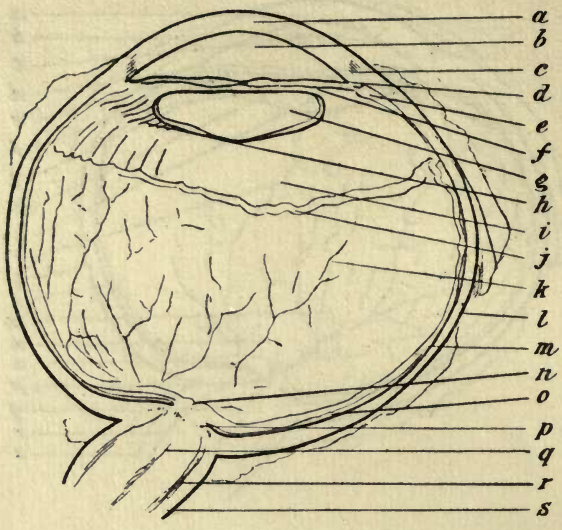


Horizontal antero-posterior section through the globe of the eye of an adult, viewed slightly from the front: this is the other half of the preparation represented in Plate 2.

The iris is here divided to one side of the contracted pupil; the remarkable flattening of the anterior surface of the lens is well seen. About 3·8 mm. to the left of the centre of the optic papilla is a dark spot (*m*) indicating the position of the fovea centralis, which is here placed on the surface of a swollen fold of retina, the plica centralis, a post-mortem appearance which affects the retina in the region around the macula lutea.

a Cornea. *b* Sulcus sclerae, corresponding to and just behind the outer sclero-corneal junction. *c* Attached ciliary margin of iris; this is seen to be finely irregular owing to the fibres of the ligamentum pectinatum iridis; above it, will be seen the faint linear shadow thrown by the anterior edge of the sulcus circularis corneae, which will be better demonstrated in other plates. *d* Just outside the angulus iridis, which is here shown as acute owing to the stretching of the iris round the contracted pupil; *d* also marks the point where the annular ligament is divided, to which ligament the iris, the ciliary muscle, and the fibres of the pectinate ligament are attached (see Fig. I, p. 17). *e* Ciliary process. *f* The iris stretched straight across the aqueous chamber; note that in this specimen the iris is cut to one side of a very contracted pupil. *g* Thickened edges of retina at ora serrata. *h* Lens (lens crystallina); the anterior flat surface is in contact with the posterior surface of the iris. *i* Placed in the so-called canal of Petit between the fibres which form the zonule of Zinn (zonula ciliaris). *j* Retinal vessels; the veins are seen better than the arteries. *k* Sclerotic (sclera). *l* Retina (pars optica). *m* The fovea centralis on the surface of the plica centralis. *n* Optic papilla (papilla n. optici) with the physiological excavation (excavatio papillae n. optici) in its centre. *o* Chorioid (chorioidea). *p* Lamina cribrosa. *q* Arteria centralis retinae. *r* Subarachnoid space. *s* Dura-matral sheath, lined by arachnoid membrane surrounding the optic nerve, which has a pia-matral investment.

PLATE 2

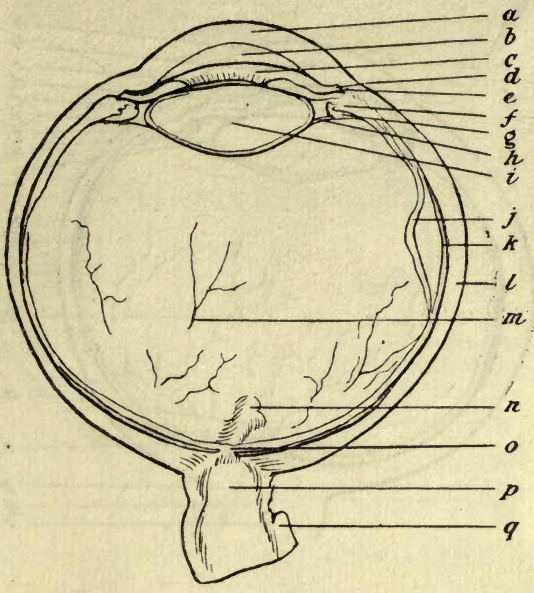


Horizontal antero-posterior section of the globe of the eye of an adult; opposite half of eye represented in Plate 1.

The pupil is much contracted, and the anterior surface of the lens is quite flat. As will be seen on comparison with the other photographs this is an unusual appearance, but in no other preparation is the pupil so contracted as in that seen here. The retina at the margin of the ora serrata forms a double-folded edge, probably a post-mortem change.

a Cornea. *b* Anterior chamber (camera oculi anterior). *c* Sclero-corneal junction. *d* Angulus iridis. *e* Ciliary body (corpus ciliare). *f* Iris stretched right across the aqueous chamber and cut to one side of a small pupil. *g* Lens (lens crystallina); anterior surface of lens remarkably flattened. *h* Ciliary processes (processus ciliares). *i* Orbiculus ciliaris displaying a striated appearance and covered by the pars ciliaris retinae. *j* Ora serrata: along this edge the retina forms a thickened fold. *k* Retinal vessels. *l* Sclerotic (sclera). *m* Retina (pars optica retinae). *n* Optic papilla (papilla n. optici) with excavation in its centre (excavatio nervi optici). *o* Chorioid (chorioidea). *p* Lamina cribrosa. *q* Central artery of retina (arteria centralis retinae). *r* Subarachnoid space. *s* Dura-matral sheath of optic nerve lined internally with arachnoid.

PLATE 3

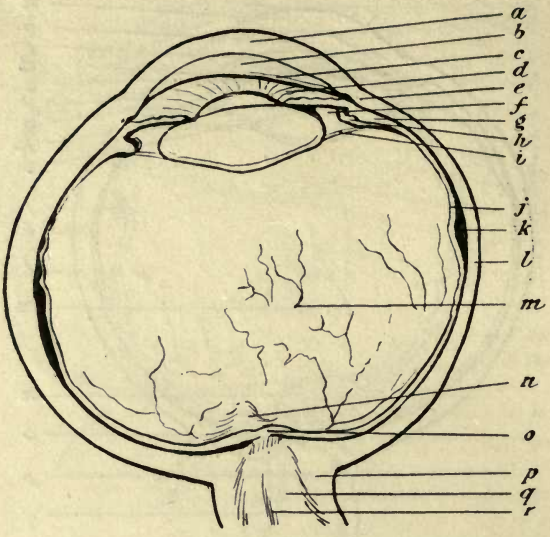


Vertical antero-posterior section of left eye.

Immediately behind the point of entrance of the optic nerve a worm-like swelling of the retina is seen; this is the so-called plica centralis, a post-mortem change due to the action of the hardening reagent; it corresponds in position to the macula lutea. This section shows very well the sulcus circularis corneae (*d*) cut across. The section also divides the ciliary body on either side in the furrow between adjacent ciliary processes. It is here that the fibres of the ligament of the lens are attached. Some of these fibres can be faintly seen on the right-hand side of the section.

a Cornea. *b* Anterior chamber. *c* Iris. *d* Sulcus circularis corneae. *e* Canal of Schlemm (sinus venosus sclerae). *f* Ciliary body (corpus ciliare). *g* Ciliary process (processus ciliaris). *h* Ligament of lens (fibrae zonulares). *i* Lens crystallina. *j* Retina. *k* Chorioid. *l* Sclerotic (sclera). *m* Vessels of retina. *n* Plica centralis corresponding in position to the macula lutea. *o* Papilla n. optici. *p* N. opticus. *q* Dura-matral sheath of optic nerve (vagina n. optici).

PLATE 4

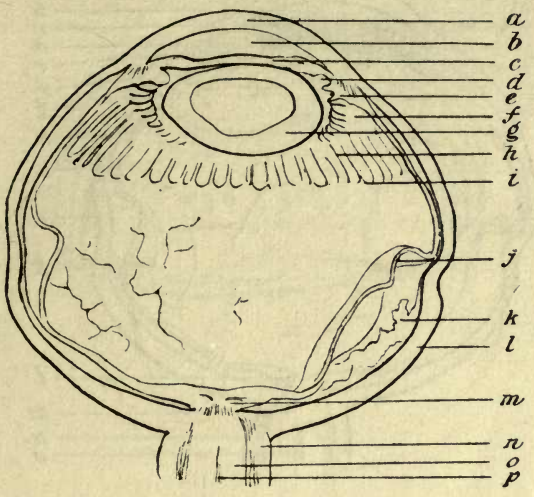


Vertical antero-posterior section of eye.

To the further side of the optic papilla the plica centralis, marking the position of the fovea centralis, is seen. In front of the attachment of the iris the edge of the sulcus circularis corneae can be seen in shadow (*c*). The pupillary edge and anterior surface of the iris is well displayed; a dark spot on either side marks the position of the canal of Schlemm (*e*). The difference between the cortical and central part of the lens is clearly shown. The fibres of the ligament of the lens can be seen but faintly (*i*).

a Cornea. *b* Anterior chamber (camera oculi anterior). *c* Sulcus circularis corneae. *d* Iris. *e* Canal of Schlemm (sinus venosus sclerae). *f* Posterior chamber (camera oculi posterior). *g* Ciliary body (corpus ciliare). *h* Ciliary process (processus ciliaris). *i* Ligament of lens (fibrae zonulares). *j* Retina. *k* Chorioid (chorioidea). *l* Sclerotic (sclera). *m* Vessels of retina. *n* Plica centralis: corresponding to position of macula lutea and fovea centralis. *o* Optic papilla (papilla n. optici). *p* Dura-matral sheath of optic nerve (vagina n. optici). *q* Optic nerve. *r* Arteria centralis retinae.

PLATE 5

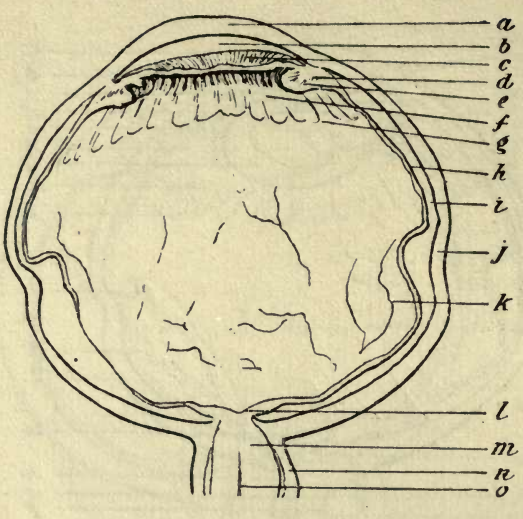


Antero-posterior section of the eye of a man aged thirty-nine.

The section passes through the optic papilla posteriorly and divides the iris in front to the near side of the pupil. The preparation shows very well the ora serrata and the pars ciliaris retinae (orbiculus ciliaris). The retina has in places separated from the chorioid, and the chorioid is observed apart from the sclerotic. In this view the ligament of the lens is not seen.

a Cornea. *b* Anterior chamber (camera oculi anterior). *c* Iris, cut across to the near side of the pupil. *d* Posterior chamber (camera oculi posterior). *e* Ciliary body (corpus ciliare). *f* Ciliary processes (processus ciliares). *g* Lens crystallina. *h* Pars ciliaris retinae, orbiculus ciliaris displaying a striated appearance. *i* Ora serrata—the edge of the pars optica retinae. *j* The retina detached from the chorioid. *k* Chorioid (chorioidea), detached from the sclera, here displays the fibres of the lamina fusca. *l* Sclerotic (sclera). *m* Optic papilla (papilla n. optici) with the optic cup (excavatio papillae n. optici) in its centre. *n* Dura-matral sheath of optic nerve (vagina n. optici). *o* Optic nerve. *p* Arteria centralis retinae.

PLATE 6

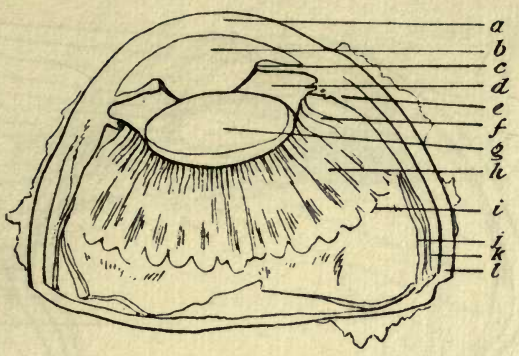


Antero-posterior section through the eye of a man aged thirty-nine. Same specimen as Plate 5.

The lens with its capsule and the vitreous have been removed; immediately in front of the attached margin of the iris the shadow cast by the sulcus circularis corneae can be seen. The ciliary processes are well displayed and the orbiculus ciliaris is well shown. The retina is in great part detached, but along the line of the ora serrata it is seen to be more firmly fixed to the subjacent structures; posteriorly the optic cup is clearly shown.

a Cornea. *b* Anterior chamber (camera oculi anterior). *c* Iris: immediately in front of its attached circumference evidence of the sulcus circularis corneae may be seen. *d* Ciliary body (corpus ciliare). *e* Ciliary process (processus ciliaris). *f* Orbiculus ciliaris with meridional fibres. *g* Ora serrata. *h* Retina (pars optica retinae). *i* Chorioid (chorioidea). *j* Sclerotic (sclera). *k* Retinal vessels. *l* Optic papilla and optic cup (excavatio n. optici). *m* Optic nerve. *n* Dura-matral sheath of optic nerve (vagina n. optici). *o* Arteria centralis retinae.

PLATE 7

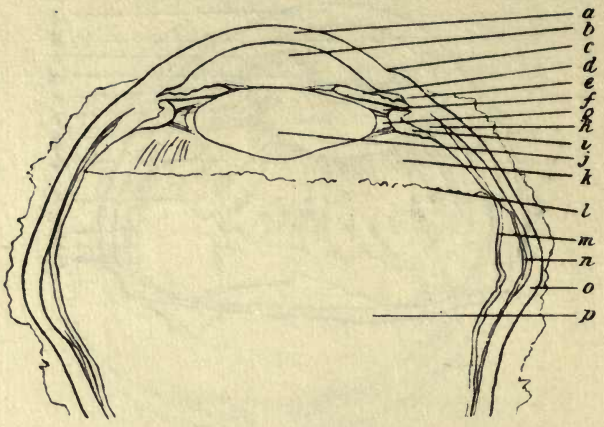


Anterior half of an antero-posterior section of the eye viewed obliquely from behind.

The ora serrata is well seen; along this goffered edge the retina is seen to be more firmly attached to the subjacent chorioid than it is posteriorly. The radial arrangement of the orbiculus ciliaris is clearly shown on the left of the specimen. The pigmented posterior surface of the iris (pars uvealis iridis) is displayed, forming the anterior wall of the posterior chamber (camera oculi posterior). In this photograph the light has failed to catch the fibres of the ligament of the lens, so that they are not revealed in the specimen.

a Cornea. *b* Anterior chamber (camera oculi anterior). *c* Pupillary margin of iris. *d* Posterior chamber (camera oculi posterior) with the posterior pigmented surface of the iris in front, and the blunt anterior extremities of the ciliary processes projecting into it posteriorly; the zonule of Zinn is not here seen. *e* Ciliary body (corpus ciliare). *f* Ciliary processes (processus ciliares). *g* Lens (lens crystallina). *h* Orbiculus ciliaris overlain by the pars ciliaris retinae. *i* Ora serrata. *j* Retina. *k* Chorioid (chorioidea). *l* Sclerotic (sclera).

PLATE 8

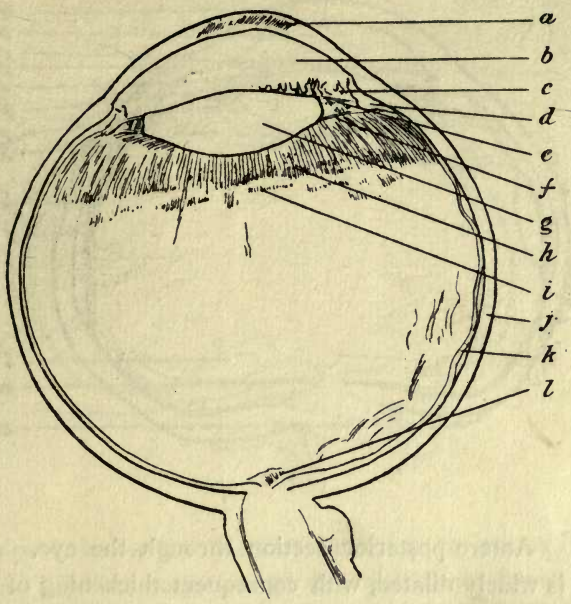


Antero-posterior section through the fore part of the globe of the eye.

This section shows very well the suspensory ligament of the lens, particularly on the left side. As will be seen, the fibres of the zonule of Zinn (zonula ciliaris) spring from the ciliary body and the orbiculus ciliaris (see Pl. 37); they separate as they pass to the lens, some going to the front, others to the posterior surface of that structure; between the diverging fibres and the circumference of the lens is a space shown in section *g*, the canal of Petit or the spatia zonularia. The section also displays the relationship of the sulcus sclerae (*c*), at the junction externally of the cornea and sclerotic, to the sulcus circularis corneae (*e*) situated at the angulus iridis.

a Cornea. *b* Anterior chamber (camera oculi anterior). *c* Sulcus sclerae. *d* Iris. *e* Sulcus circularis corneae. *f* Posterior chamber bounded behind by the ciliary processes and the ligament of the lens. *g* The canal of Petit (spatia zonularia) with the zonular fibres (fibrae zonulares) in front and behind. *h* Ciliary body (corpus ciliare). *i* Ciliary process (processus ciliaris). *j* Lens crystallina. *k* Orbiculus ciliaris. *l* Ora serrata. *m* Retina. *n* Chorioid. *o* Sclera. *p* Corpus vitreum.

PLATE 9

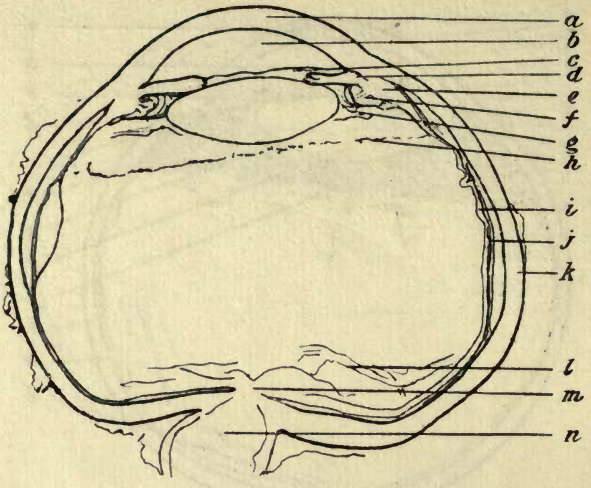


Antero-posterior section through an eye in which, owing to the result of an injury, the anterior surface of the iris has become closely adherent to the internal surface of the cornea.

The posterior chamber has thus become enormously enlarged at the expense of the anterior chamber, which has in consequence been completely obliterated. As a result a sort of natural dissection has ensued, and the specimen has been included because it affords an admirable demonstration of the two layers of the zonule of Zinn with the so-called canal of Petit between. As is well seen here, and also in some of the other sections (Pls. 1, 2, 8), the circumference of the lens is blunt and furnished with two edges, to the anterior of which the fibres of the suspensory ligament can be seen passing to be attached to the capsule of the lens, whilst the posterior sheet, in contact with the hyaloid membrane, is seen to blend with the capsule of the lens at its posterior edge.

a Injured cornea. *b* Greatly distended posterior chamber (camera oculi posterior); the uveal surface of the iris is exposed, as the iris is spread over the inner surface of the cornea. *c* The anterior ends of the ciliary processes pulled forwards by the structural folds of the iris. *d* Ciliary body (corpus ciliare). *e* Anterior fibres of zonule of Zinn, forming the suspensory ligament of the lens. *f* Posterior layer of zonule of Zinn; between the two is the so-called canal of Petit. *g* Lens (lens crystallina): note its blunt circumference. *h* Orbiculus ciliaris. *i* Ora serrata. *j* Sclerotic (sclera). *k* Retina (pars optica retinae). *l* Optic papilla with excavation.

PLATE 10

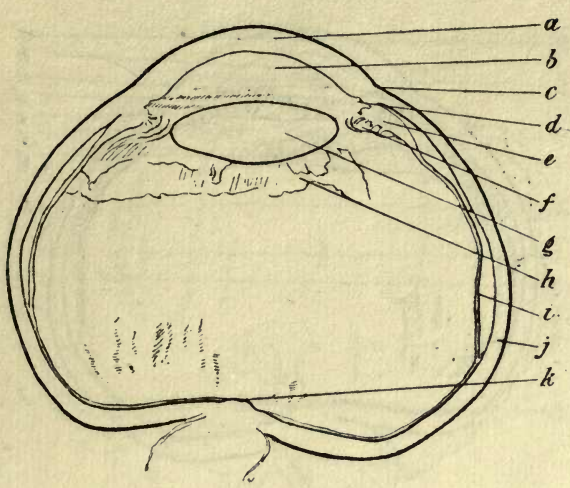


Antero-posterior section through the eye.

The pupil is widely dilated, with consequent thickening of the iris, which at its circumference is now seen to occupy almost completely the sulcus circularis corneae (*d*). The vitreous is *in situ*; its delicate hyaloid membrane (membrana hyaloidea) is well displayed to the right of the entrance of the optic nerve; its fine connexions with the surface of the retina are also seen.

a Cornea. *b* Anterior chamber (camera oculi anterior). *c* Iris, with widely dilated pupil. *d* Sulcus circularis corneae, fully occupied by the contracted and thickened iris. *e* Ciliary body (corpus ciliare). *f* Processus ciliaris. *g* Faint indications of the ligament of the lens. *h* Ora serrata. *i* Retina. *j* Chorioid (chorioidea). *k* Sclerotic (sclera). *l* Hyaloid membrane (membrana hyaloidea): its connexions with the retina are also visible. *m* Optic nerve.

PLATE 11

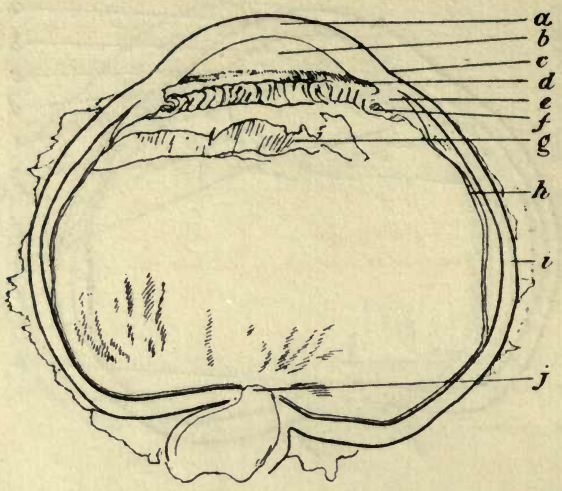


Antero-posterior section through the eye (same eye as Plate 10).

The vitreous has been removed with the hyaloid membrane, a tag of which is seen still attached to the circumference of the lens on the left side. The retina has been taken away, and the iris has also been removed. The sulcus circularis cornea is well shown; immediately below the sulcus on the left side may be seen the surface from which the iris has been torn away, corresponding to the annular ligament (ligamentum annulare). The relation of the sulcus circularis corneae (*d*) to the sulcus sclerae (*c*) is also displayed. The pigmented pars ciliaris retinae has been stripped off from a considerable surface of the orbiculus ciliaris immediately in front of the ora serrata.

a Cornea. *b* Anterior chamber (camera oculi anterior): through the removal of the iris the anterior and posterior chambers have been thrown into one. *c* Sulcus sclerae at outer surface of sclero-corneal junction. *d* Sulcus circularis corneae: on the left-hand side of the section this is seen quite distinct from the surface from which the iris has been torn away. *e* Ciliary body (corpus ciliare). *f* Ciliary processes (processus ciliares). *g* Lens (lens crystallina) *in situ*. *h* Surface of orbiculus ciliaris from which the pigmented pars ciliaris retinae has been stripped off. *i* Chorioid (chorioidea). *j* Sclerotic (sclera). *k* Optic papilla (papilla n. optici).

PLATE 12

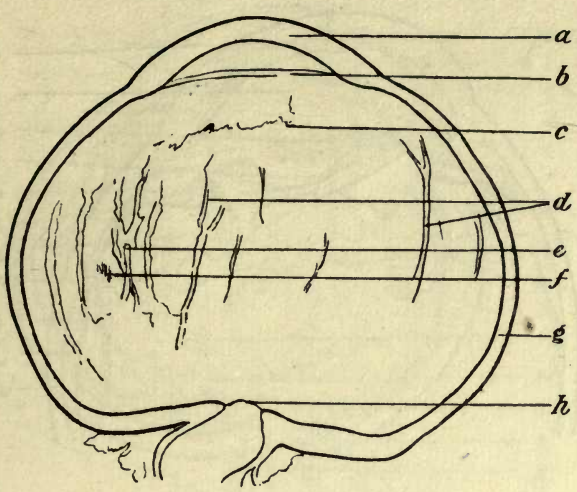


Antero-posterior section through the eye (same preparation as Plates 10 and 11).

The lens with its capsule and the vitreous have been removed. The iris has been torn away from its attachment, and the retina has been taken away, leaving much of its pigment layer attached to the chorioid. Along the line of the ora serrata the pigmented portion of the pars ciliaris retinae has been completely stripped away, though anteriorly it remains as it passes forwards over the ciliary processes. The relation of the sulcus sclerae (*c*) to the sulcus circularis corneae (*d*) is well displayed, and the latter is well seen immediately in front of the surface from which the iris has been torn away near the corneo-scleral margin.

a Cornea. *b* Anterior chamber (camera oculi anterior). *c* Sulcus sclerae at corneo-scleral margin. *d* Sulcus circularis corneae: on the left-hand side of the section this is seen quite distinct from the surface from which the iris has been detached. *e* Ciliary body (corpus ciliare). *f* Ciliary processes (processus ciliares). *g* Surface of orbiculus ciliaris from which the pigmented pars ciliaris retinae has been stripped. *h* Chorioid (chorioidea). *i* Sclerotic (sclera). *j* Optic papilla (papilla n. optici).

PLATE 13

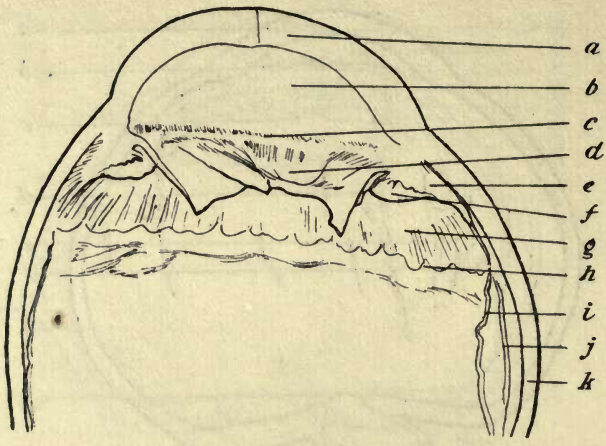


Antero-posterior section through the eye (same eye as Plates 10, 11, and 12).

All the contents of the globe have been removed, leaving only the cornea and sclerotic. The proportionate thickness of the cornea to the sclerotic is well seen. The perichorioideal space, between the choroid and the sclerotic, has been exposed by the removal of the choroid; and the lamina fusca, which connects the latter to the former, has been torn through, leaving a certain amount of pigmented tissue adherent to the inner surface of the sclerotic. The perichorioidal space is traversed by the posterior ciliary arteries and the ciliary nerves, the courses of which are indicated by lighter tracts running through the pigmented tissue.

a Cornea. *b* Sulcus circularis corneae. *c* Indicates the line of attachment of the ora serrata. *d* Light tracts, indicating the course and position of some of the ciliary nerves. *e* One of the posterior ciliary arteries. *f* Marks point of exit through the sclerotic of one of the venae vorticosae. *g* Sclerotic (sclera). *h* Optic papilla (papilla n. optici).

PLATE 14

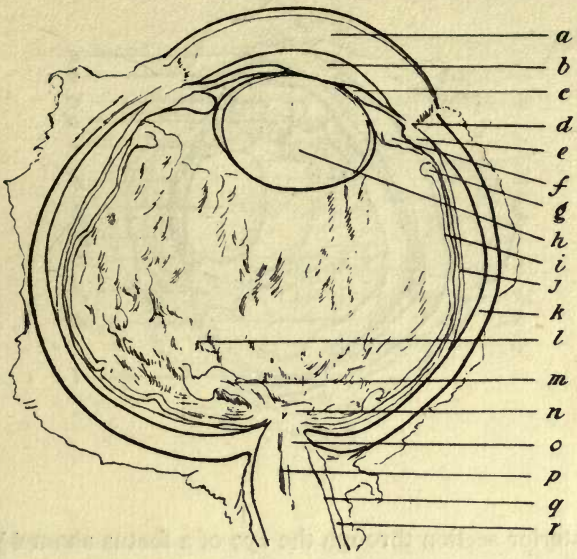


This view represents a quarter of the ocular globe cut from pole to pole.

This method of section has been adopted so as to enable the iris to be pulled back without any damage. The lens with its ligament and the vitreous have been removed. The quadrant of the iris has been drawn back in order to open up the angle of the iris and thus expose the sulcus circularis corneae (*c*). The vertical striae revealed at the bottom of the sulcus are due to the arrangement of the fibres of the ligamentum pectinatum iridis, the intervals between which communicate with the spaces of Fontana.

a Cornea. *b* Anterior chamber (camera oculi anterior). *c* Sulcus circularis corneae, at the bottom of which the vertically disposed fibres of the pectinate ligament (ligamentum pectinatum iridis) can be faintly seen. *d* The iris pulled back. *e* Ciliary body (corpus ciliare). *f* Ciliary process. *g* Orbiculus ciliaris. *h* Ora serrata: here the oedema of the pars optica retinae, due either to post-mortem changes or the influence of the preservative, is very definitely limited in front in harmony with the attached edge of the ora serrata. *i* Retina. *j* Chorioid (chorioidea). *k* Sclerotic (sclera).

PLATE 15

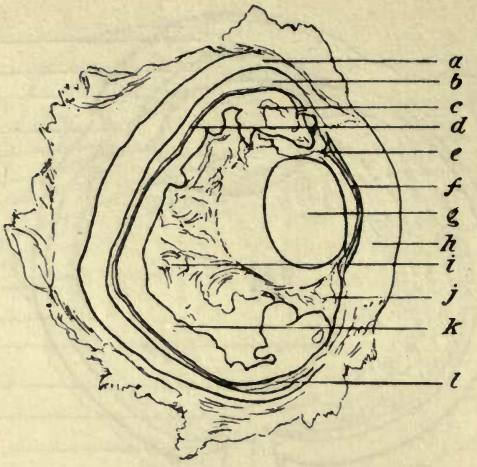


Antero-posterior view through the eye of a full-time foetus (lived one day).

Note the absolute and proportionately greater thickness of the cornea, the shallow anterior chamber, the more spherical lens, and the smaller ciliary body. The retina is thicker and thrown into folds. How much of this is due to post-mortem change or the use of preservatives it is difficult to say, but possibly the occurrence of these folds in the living accounts for the 'shot' or 'watered silk' appearance of the retina revealed on the ophthalmoscopic examination of the eyes of young children. There is a tag of tissue (*m*) extending forwards from the optic papilla; this is probably a fold of retina which has been divided on the near half of the section. The ora serrata is seen to lie much nearer the ciliary body than in the adult.

a Cornea. *b* Anterior chamber (camera oculi anterior). *c* Pupillary margin of iris. *d* Canal of Schlemm (sinus venosus sclerae). *e* Ciliary body (corpus ciliare). *f* Ciliary processes (processus ciliares). *g* Ora serrata, placed nearer the ciliary body than in the adult, and forming what appears to be a thick reduplicated margin. *h* Lens (lens crystallina), much more spherical than in the adult. *i* Retina. *j* Choroid (chorioidea). *k* Sclera. *l* The shrunken vitreous with hyaloid membrane (membrana hyaloidea). *m* Tag of tissue, due probably to a cut fold of retina. *n* Papilla n. optici. *o* Optic nerve. *p* Arteria centralis retinae. *q* Spatium intervaginale. *r* Dura-matral sheath of optic nerve.

PLATE 16



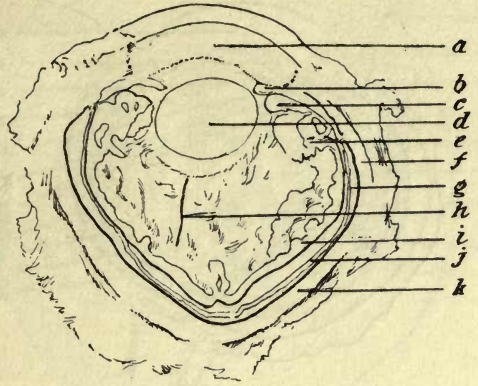
Antero-posterior section through the eye of a foetus about $6\frac{1}{2}$ months.

Note the very thick cornea, the spherical lens, and the redundant and folded retina, particularly anteriorly on the region which ultimately develops into the ora serrata.

The pupillary membrane, extending across the anterior chamber, is seen in section immediately behind the posterior surface of the cornea.

a Sclerotic (sclera). *b* Perichorioidal space. *c* Redundant fold of retina corresponding to position of ora serrata. *d* Chorioid (chorioidea). *e* Ciliary border of iris. *f* Pupillary membrane (membrana pupillaris). *g* Lens (lens crystallina), spherical in shape. *h* Cornea: note its great proportionate thickness. *i* Vitreous and hyaloid membrane. *j* Ciliary process (processus ciliaris). *k* Thick retinal layer. *l* Chorioid.

PLATE 17

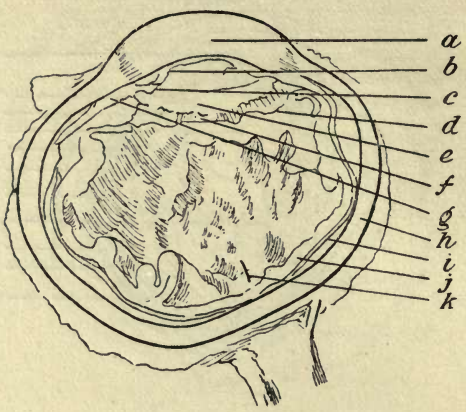


Antero-posterior section through the eye of a foetus of 6½ months.

This is the same specimen as Pl. 16, only differently lighted and viewed so as to exhibit the hyaloid artery running forwards from the back of the vitreous chamber to the posterior surface of the lens.

a Cornea. *b* Iris. *c* Ciliary process (processus ciliaris). *d* Lens (lens crystallina). *e* Redundant anterior margin of retina (pars optica). *f* Sclerotic (sclera). *g* Perichorioidal space. *h* Hyaloid artery (arteria hyaloidea). *i* Retina. *j* Chorioid (chorioidea). *k* sclerotic (sclera).

PLATE 18

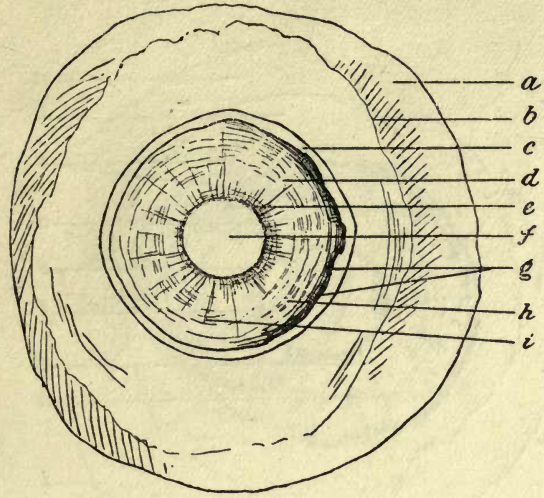


Antero-posterior section through the globe of the eye of a 6½-months' foetus (same foetus as Pls. 16 and 17).

The lens with the vitreous, together with part of the retina (pars optica) near the ora serrata, and part of the pars ciliaris (see Pl. 57), have been removed. Note the great proportionate thickness of the cornea, the pupillary membrane (*b*), and the thick and redundant retina (pars optica). The stalk of the hyaloid artery (*k*) torn across before it enters the vitreous.

a Cornea. *b* Pupillary membrane: its connexion with the iris (*c*) is seen. *c* Iris. *d* Retina near the ora serrata; the edge is torn here, as some of the retina has been removed: see the specimen photographed in Pl. 57. *e* Ciliary processes (processus ciliares). *f* Orbiculus ciliaris, from which the pars ciliaris retinae has been torn away. *g* Ciliary body (corpus ciliare). *h* Sclerotic (sclera). *i* Chorioid (chorioidea): the suprachorioidal layer is well seen. *j* Thick retina (pars optica). *k* Remains of hyaloid artery torn away anteriorly.

PLATE 19

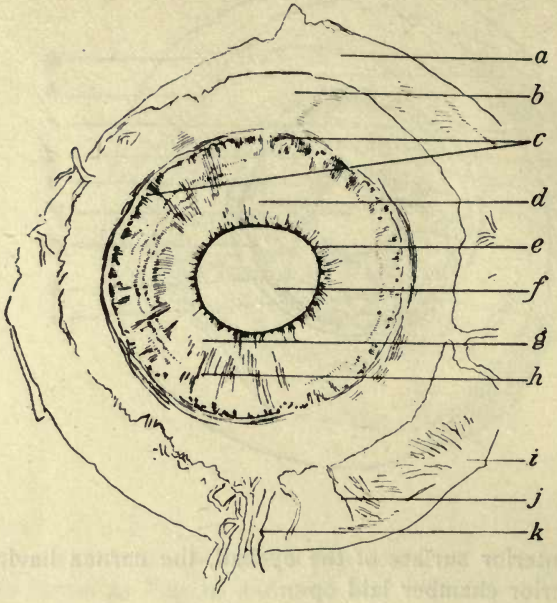


View of the anterior surface of the eyeball, the cornea having been cut away and the anterior chamber laid open.

Under the thin edge, where the cornea has been cut away on the right side of the preparation, some of the fibres of the pectinate ligament can be seen, (*g*) with the openings of the spaces of Fontana in between them.

a Outer surface of sclerotic (sclera). *b* Cut edge of ocular conjunctiva. *c* Sclero-corneal margin cut through and cornea removed. *d* Anterior chamber (camera oculi anterior), with anterior surface of iris behind. *e* Pupillary margin of iris (margo pupillaris iridis). *f* Lens (lens crystallina) seen through pupil. *g* Fibres of the pectinate ligament (ligamentum pectinatum iridis), with openings of the spaces of Fontana (spatia anguli iridis). *h* Circular folds of iris. *i* Radial folds of iris (plicae iridis).

PLATE 20

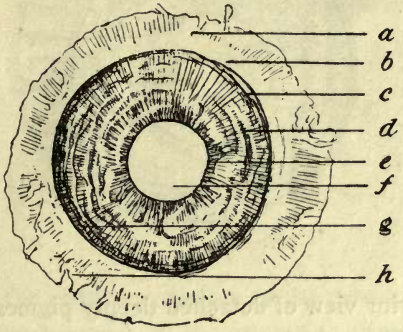


Anterior view of the eye, the cornea and sclerotic having been removed.

The angulus iridis is thus exposed from the front (*c*), and the fibres passing from the cornea to the front of the iris, which constitute the ligamentum pectinatum iridis, are well displayed; in the intervals between these fibres there are openings leading into the crypt-like spaces—the spaces of Fontana. Just external to the margo ciliaris of the iris (*c*) may be seen a narrow annular band surrounding the iris: this marks the anterior attachment of the meridional fibres of the ciliary muscle to the internal scleral process (ligamentum annulare).

a Chorioid (chorioidea). *b* Scleral surface of the ciliary body (corpus ciliare). *c* Marks the position of the spaces of Fontana (spatia anguli iridis), the openings of which appear between the fibres of the pectinate ligament (ligamentum pectinatum iridis). Just external to *c* may be seen the line of attachment of the anterior ends of the meridional fibres of the ciliary muscle. *d* Convexity of the iris overlying the sphincter pupillae. *e* The pupillary margin of the iris (margo pupillaris iridis). *f* Lens seen through pupil. *g* Circular folds of the iris. *h* Radial folds of the iris (plicae iridis). *i* Venae vorticosae of the choroid. *j* Long posterior ciliary artery (arteria ciliaris posterior longa). *k* Ciliary nerve (n. ciliaris).

PLATE 21

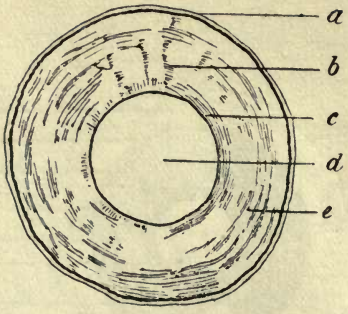


Anterior view of the front of a deeply pigmented iris, with the annulus ciliaris (ciliary muscle) of the ciliary body attached.

On the front of the iris concentric and radial folds are seen; just outside the ciliary attachment of the iris (*c*) there is a ring of white tissue; this is the annular ligament (ligamentum annulare), which has been torn away from the sclerotic close to the sclero-corneal junction (see Plate 47); hereto are attached the fibres which pass to the iris (ligamentum pectinatum) and the fibres which afford attachment to the anterior insertion of the meridional fibres of the ciliary muscle. The iris is too deeply pigmented to show well the fibres of the pectinate ligament and the openings of the spaces of Fontana, but slight indications of the former can be seen at the point marked *g*.

a Scleral surface of ciliary body (corpus ciliare). *b* Annular ligament torn through (ligamentum annulare). (*c*) Ciliary border of iris (margo ciliaris iridis). *d* Concentric folds on front of iris. *e* Pupillary margin, thick and rounded in front, thin and sharply defined behind (margo pupillaris iridis). *f* Pupillary aperture (pupilla). *g* Indicates the position where some of the fibres of the ligamentum pectinatum can be faintly seen. *h* Ciliary nerves forming plexus.

PLATE 22

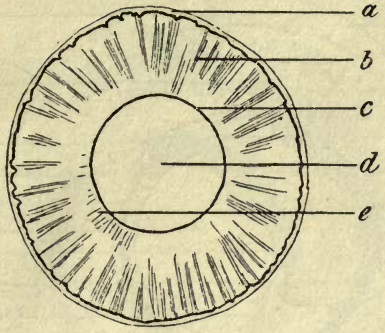


Anterior view of detached deeply pigmented iris.

The pupil (*d*) is fairly widely dilated, its posterior margin is thin and sharp, but its external circumference is thick and bevelled, as seen in shadow on the right side of the specimen. The concentric furrowing (*e*) of the anterior surface is well marked, as are also the radial plicae (*b*).

a External margin of iris torn away from the ciliary body (margo ciliaris iridis). *b* Radial plica. *c* Pupillary margin of iris (margo pupillaris iridis). *d* Pupillary aperture (pupilla). *e* Concentric plicae.

PLATE 23

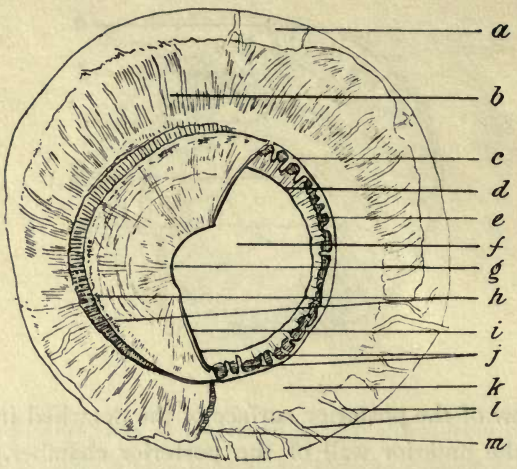


View of the posterior surface of the detached iris.

This forms the anterior wall of the posterior chamber. Owing to the presence of the deeply pigmented uveal layer (pars iridica retinae or stratum pigmenti iridis) this surface is difficult to photograph and the details of its structure are necessarily obscure. Numerous radial folds (the *structural folds* of Schwalbe) are seen passing from the ciliary attachment inwards towards the pupil (*b*). Some of these folds are seen torn across at the upper part of the ciliary margin, and to their presence is due the irregular outline of the inner edge of the torn ciliary border. About 1 mm. from the pupillary edge these large folds are replaced by numerous smaller ones (*e*). These are the so-called *contraction folds* of Schwalbe, and form the pupillary zone (Fuchs).

a Ciliary margin of iris, torn through (margo ciliaris iridis). The inner edge of this margin is irregular in outline, due to the structural folds being torn across. *b* Posterior surface of iris covered with the uveal layer formed by the pars iridica retinae; here the structural folds passing from the ciliary border inwards to the pupil may be seen. *c* Pupillary margin (margo pupillaris iridis): as seen from behind, this is a thin edge with a finely crenated border. *d* Pupillary aperture (pupilla). *e* Faintly seen are the fine folds (contraction folds of Schwalbe) forming the pupillary zone of Fuchs.

PLATE 24

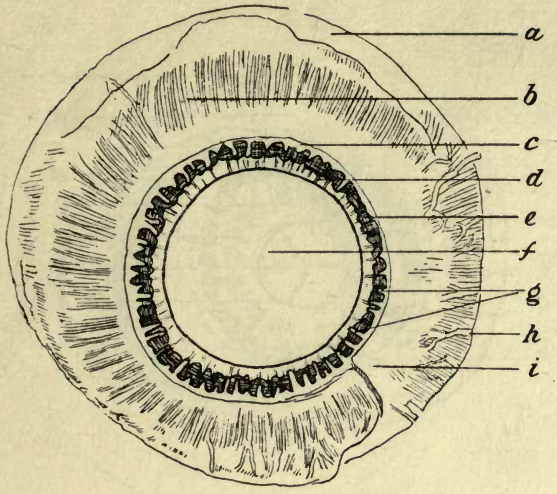


View of the anterior surface of the eye, the sclerotic and cornea having been removed.

The right half of the iris has been cut away so as to open the posterior chamber, the posterior wall of which is thus exposed; this is seen to be formed from without inwards by the blunt anterior extremities of the ciliary processes (*e*), the zonule of Zinn (zonula ciliaris) (*d*), composed of the fibres which form the ligament of the lens; and the anterior surface of the lens (*f*). The cut edge of the ciliary margin of the iris (*c*) is shown, and certain narrow folds (*j*) are seen divided. These are the radially arranged folds which pass from the fore part of the ciliary body and ciliary processes on to the posterior surface of the iris, converging towards the pupillary margin (see Pls. 42, 52). On the left and upper side of the preparation the outer layer of the ciliary body has been dissected away so as to expose the meridional fibres of the ciliary muscle and the vascular and nervous plexuses within its substance. Close to the ciliary margin of the iris on the left side can be seen some of the fibres of the pectinate ligament and the openings of the spaces of Fontana.

a Chorioid (chorioidea). *b* Meridional fibres of ciliary muscle, together with vessels and nerves. *c* Cut peripheral attachment of iris (margo ciliaris). *d* Zonule of Zinn, suspensory ligament of the lens. *e* Anterior extremities of the ciliary processes seen in shadow. *f* Lens (lens crystallina). *g* Pupillary margin of iris (margo pupillaris). *h* Fibres of the pectinate ligament with the openings of the spaces of Fontana (spatia anguli iridis). *i* Cut edge of iris. *j* Folds cut passing from ciliary body and processes to posterior surface of iris (structural folds of Schwalbe). *k* Outer surface of ciliary body (corpus ciliare). *l* Ciliary nerves breaking up to form plexus. *m* Divided edge where superficial part of ciliary body has been removed.

PLATE 25

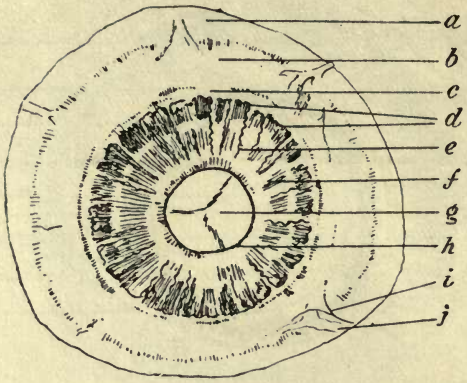


This is the same specimen as Pl. 24, except that the iris has now been completely removed, thus laying open the whole of the posterior chamber.

The lens in the centre is suspended by its ligament (zonule of Zinn), the fibres of which are faintly visible in the shadow surrounding the lens, passing from the circumference of the lens towards the inner surface of the ciliary body; the rounded ends of the ciliary processes are dimly seen on a plane anterior to the zonule of Zinn. In front of these are seen a number of thin white projecting folds. These are the structural folds of Schwalbe, which have been divided as they pass from the fore part of the ciliary body and processes to the posterior surface of the iris. The other details are the same as in Pl. 19.

a Chorioid (chorioidea). *b* Meridional fibres of ciliary muscle, together with vessels and nerves. *c* Cut peripheral attachment of iris (margo ciliaris iridis). *d* Zonule of Zinn; suspensory ligament of lens seen in shadow. *e* Anterior rounded extremities of the ciliary processes (processus ciliares), seen in shadow. *f* Lens (lens crystallina). *g* Divided folds (structural folds of Schwalbe), passing from fore part of ciliary body and ciliary process to the posterior surface of the iris. *h* Ciliary nerves breaking up to form plexus. *i* Outer (scleral) surface of ciliary body; near this the cut edge is seen where the superficial layer has been removed to expose the ciliary muscle.

PLATE 26



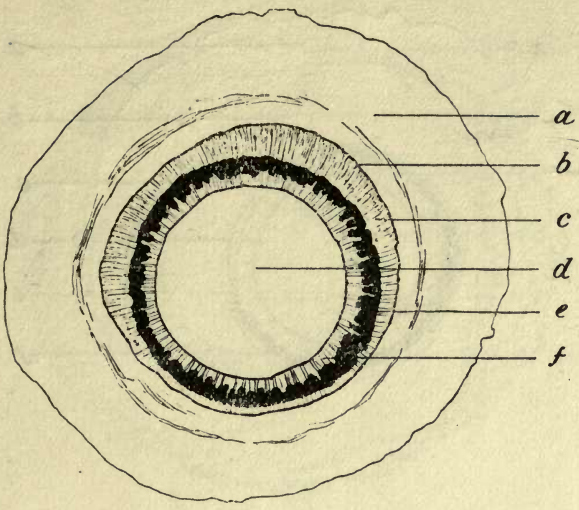
View of the anterior surface of the eye of a full-time foetus.

The cornea and sclerotic having been removed, the anterior chamber is laid open and the angulus iridis (*e*) is thus exposed. Here some of the fibres of the ligamentum pectinatum iridis are exposed, with the openings between them of the spaces of Fontana (spatia anguli iridis); these, however, are better seen in Pl. 20. Immediately external to the attached margin of the iris (margo ciliaris) is an annular band of tissue, sometimes called the annular ligament (ligamentum annulare, annulus tendinosus), from which the meridional fibres of the ciliary muscle arise.

This preparation likewise shows the radial arteries of the iris (*e*), passing from the circulus major externally to the circulus minor near the pupillary edge.

a Chorioid (chorioidea). *b* External or scleral surface of the ciliary body (corpus ciliare). *c* Annular ligament (ligamentum annulare). *d* Fibres of pectinate ligament (ligamentum pectinatum), between which are the openings of the spaces of Fontana (spatia anguli iridis). *e* Radial folds in which may be seen vessels passing from the circulus major externally to the circulus minor near the pupillary edge. *f* Anterior surface of iris, forming posterior wall of anterior chamber. *g* Lens (lens crystallina), seen through the pupil. *h* Pupillary margin of iris (margo pupillaris). *i* Long posterior ciliary artery. *j* Ciliary nerve.

PLATE 27

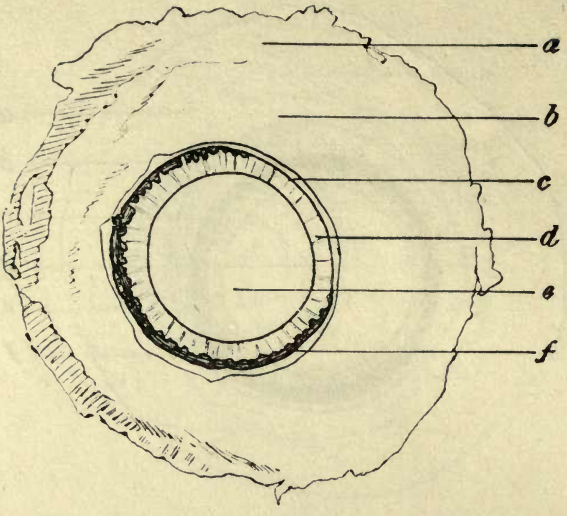


View of the anterior surface of the eye, the cornea and a ring of sclerotic having been removed.

The iris has also been completely torn away. The posterior chamber is fully exposed. The lens, surrounded by the zonule of Zinn, is well shown, and the relation of the ciliary processes thereto is clearly seen. The specimen has been photographed by a combination of reflected and transmitted light; the latter shines through the anterior half of the globe of the eye, which has been divided equatorially. In this way the details of the ligament of the lens (zonule of Zinn) are better displayed.

a External surface and sclerotic (sclera). *b* Cut edge of sclerotic, which has been divided wide of the sclero-corneal junction. *c* Fore part of the external surface of the ciliary body (corpus ciliare), exposed. *d* Lens (lens crystallina). *e* Figured in solid black, the anterior extremities of the ciliary processes (processus ciliares), which project into the posterior chamber. *f* Fibres of the suspensory ligament (zonula ciliaris), passing from the inner surface of the ciliary body to the circumference of the lens. As will be seen from an inspection of the photograph stereoscopically, these do not all lie in the same plane.

PLATE 28

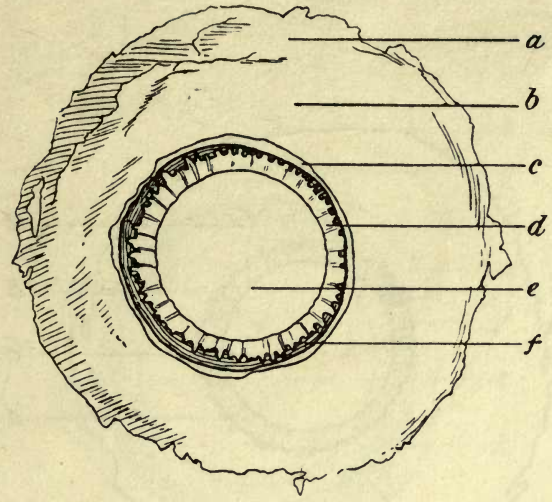


View of the anterior aspect of the eye. Same specimen as Pl. 29.

The cornea has been removed at the sclero-corneal junction, and the iris has been completely taken away, thus opening up the posterior chamber, and exposing its posterior wall, formed from without inwards by the anterior extremities of the ciliary processes (*f*), the zonule of Zinn, and the anterior surface of the lens. The fibres of the zonule are well seen, and on the left side of the specimen a faint shadow cast by the lens is seen on the anterior surface of the vitreous.

a External surface of sclerotic (sclera). *b* Ocular conjunctiva. *c* Sclerotic, cut close to sclero-corneal junction. *d* Zonule of Zinn, with the fibres of the suspensory ligament of the lens faintly seen. *e* Lens with spots of pigment indicating the position of the pupillary margin of the iris. *f* Anterior extremities of the ciliary processes (processus ciliares).

PLATE 29

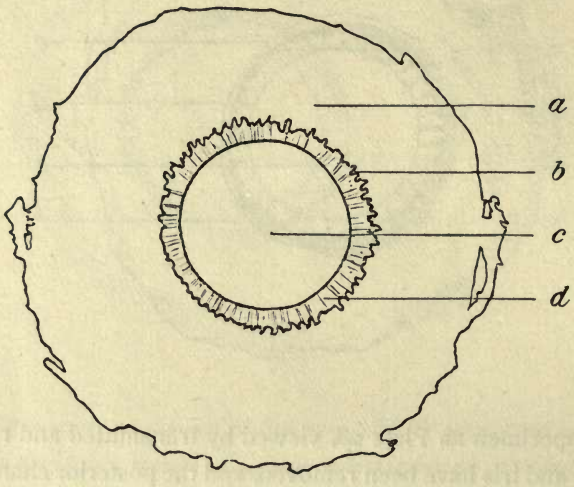


The same specimen as Plate 28, viewed by transmitted and reflected light.

The cornea and iris have been removed, and the posterior chamber has been laid open, displaying its posterior wall; from without inwards this is formed by the rounded anterior ends of the ciliary processes (*f*), the zonule of Zinn (*d*), and the anterior surface of the lens.

a External surface of the sclerotic (sclera). *b* Ocular conjunctiva. *c* Sclerotic, cut at sclero-corneal margin. *d* Zonule of Zinn (zonula ciliaris), with the fibres of the suspensory ligament of the lens faintly seen. *e* Anterior surface of the lens (lens crystallina), with spots of pigment on it derived from the posterior layer of the iris, indicating the position of the pupillary margin. *f* Anterior extremities of the ciliary processes (processus ciliares).

PLATE 30

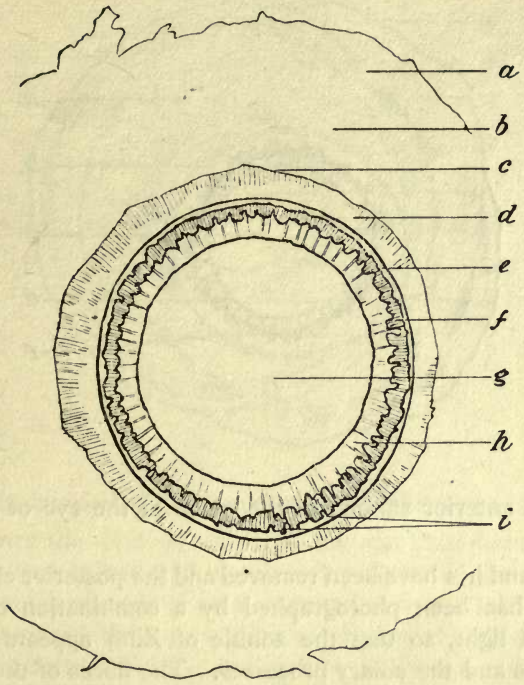


The same specimen as Plates 28 and 29, viewed by transmitted light only.

The cornea and iris have been removed. The clear ring corresponds to the zonule of Zinn (*d*) and exhibits the faint striation due to the fibres of the suspensory ligament of the lens. Externally the zonule is limited by the irregular outline of the ciliary processes (*b*), whilst internally its edge corresponds to the circumference of the lens (*c*).

a Sclerotic, covered anteriorly by the ocular conjunctiva. *b* Irregular outline due to the projection of the anterior extremities of the ciliary processes (processus ciliares). *c* The lens (lens crystallina); the edge appears crenated where the fibres of the suspensory ligament are attached to it. *d* Zonule of Zinn (zonula ciliaris); the faintly striated appearance is due to the fibres of the suspensory ligament of the lens.

PLATE 31

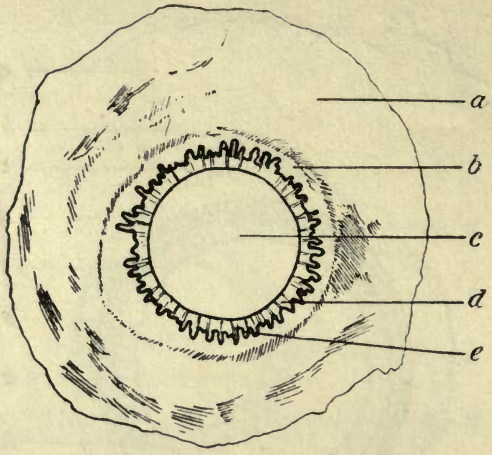


View of the anterior aspect of the globe of the eye; the cornea, part of the sclerotic, and the whole of the iris having been removed.

The posterior chamber is fully exposed; the structures which lie in relation to its posterior wall are fully seen, viz.: the anterior ends of the ciliary processes externally (*f*), the zonule of Zinn with the fibres of the suspensory ligament of the lens (*h*), and the anterior surface of the lens internally (*g*). The anterior part of the scleral surface of the ciliary body is also seen, and the edge where the iris has been torn away (*e*) is shown.

a Outer surface of sclerotic (sclera). *b* Ocular conjunctiva overlying the sclerotic. *c* Cut edge of sclerotic wide of sclero-corneal junction. *d* Scleral surface of anterior part of ciliary body (corpus ciliare). *e* Edge where iris has been torn away from ciliary body. *f* Anterior rounded extremities of the ciliary processes (processus ciliares). *g* Anterior surface of the lens, with some pigment adherent to it derived from the pupillary margin of the iris. *h* Zonule of Zinn (zonula ciliaris); the fibres of the suspensory ligament of the lens are clearly shown, and their attachment to the circumference of the lens, where they form a crenated edge, is well seen. *i* One or two of the folds (structural folds of Schwalbe), passing from the ciliary body to the posterior surface of the iris, are shown torn across.

PLATE 32

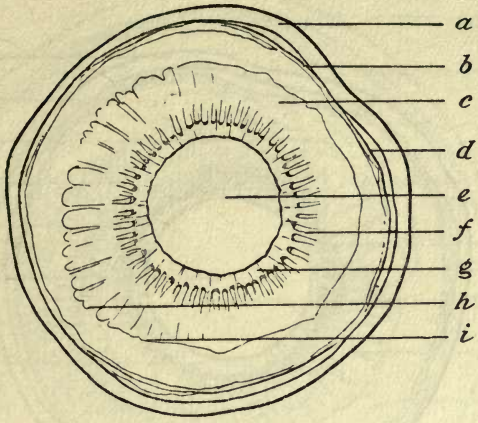


View of the anterior surface of the globe of the eye of an eighth-month foetus.

The cornea and iris have been removed and the posterior chamber exposed. The specimen has been photographed by a combination of both reflected and transmitted light, so that the zonule of Zinn appears as a light ring between the lens and the ciliary processes. The fibres of the ligament of the lens are visible as a series of fine striae radially disposed; it is worthy of note that their attachment to the circumference of the lens is not marked by any crenation of the margin as seen in the older specimens, due probably to the fact that these attachments have not been strained by the use of the mechanism of accommodation.

a External surface of sclerotic (sclera). *b* Thick divided edge of sclerotic near sclero-corneal junction. *c* Lens (lens crystallina), faintly marked with four radial striae. *d* Zonule of Zinn (zonula ciliaris), with radial striae indicating the fibres of the suspensory ligament of the lens. *e* Ciliary processes (processus ciliares).

PLATE 33

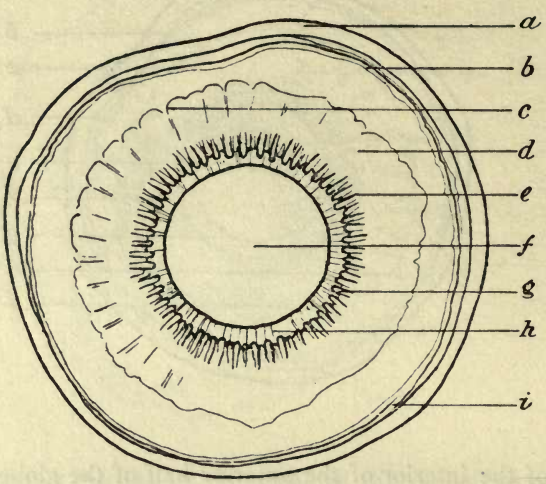


View of the interior of the anterior half of the globe of the eye.

In this specimen the vitreous body is *in situ* and little disturbed, its hyaloid membrane being undetached and closely adherent to the inner surface of the retina. In the centre the lens is seen surrounded by a dark ring, the zonule of Zinn, external to which the corona ciliaris is displayed; the orbiculus ciliaris, lying between the corona and the ora serrata, is shown, and the striation of its structure is clearly visible. On the left side the serrated edge of the ora serrata is seen, and the tendency of the retina to form a thickened fold immediately behind it, due probably to post-mortem changes or the action of the preservative, is very distinctly demonstrated.

a Sclerotic (sclera). *b* Retina. *c* Orbiculus ciliaris. *d* Chorioid (chorioidea). *e* Lens (lens crystallina). *f* Corona ciliaris, formed in this preparation of sixty-seven ciliary processes (processus ciliares). *g* Zonule of Zinn (zonula ciliaris); owing to the shadow but faint traces of the fibres of the ligament of the lens are to be seen. *h* Ora serrata. *i* Thickened fold of retina close to posterior edges of ora serrata.

PLATE 34

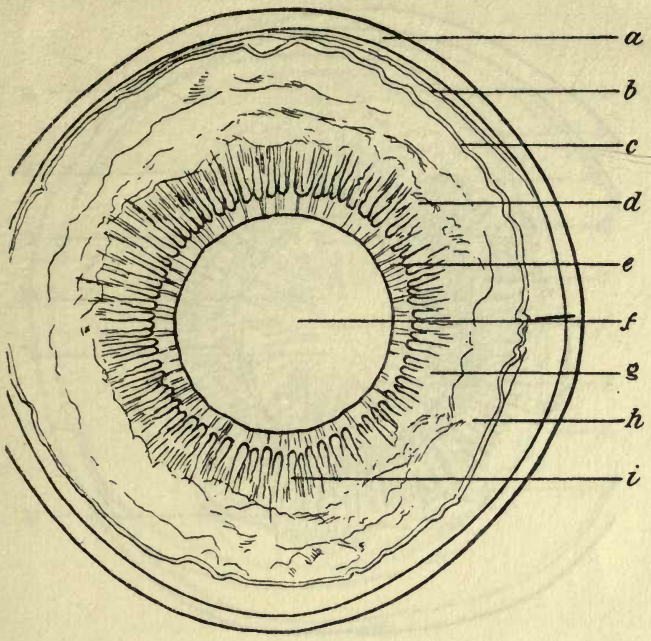


View of the interior of the anterior half of the globe of the eye, taken by reflected light.

In the centre is the lens, surrounded by the zonule of Zinn; in deep shadow only very slight suggestions of the striated arrangement of the suspensory ligament of the lens can be seen. Surrounding the dark zonule is the corona ciliaris, made up of seventy-eight ciliary processes in this specimen. In this preparation the ciliary processes are not all equal in size; large and small seem to alternate, particularly in the upper part of the corona. Between the corona and the ora serrata the orbiculus ciliaris with its radial striae is visible. The position of the ora serrata is apparent, and its notched border is well displayed in the upper part of the specimen.

a Sclerotic (sclera). *b* Retina (pars optica). *c* Ora serrata. *d* Orbiculus ciliaris. *e* Corona ciliaris, made up of seventy-eight ciliary processes. *f* Posterior surface of the lens (lens crystallina). *g* Ciliary process (processus ciliaris). *h* Zonule of Zinn (zonula ciliaris). *i* Chorioid (chorioidea).

PLATE 35

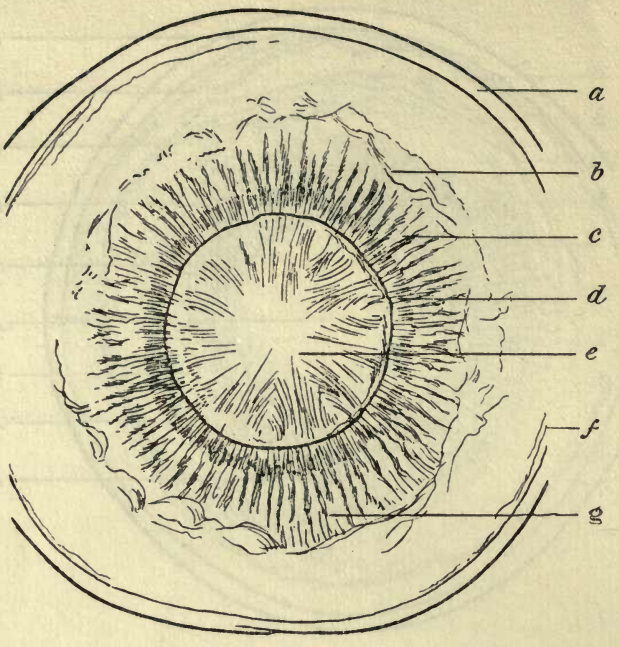


View of the interior of the anterior half of the globe of the eye, viewed by reflected light: the same specimen as Plate 31.

In the centre is seen the lens; around its circumference there is a narrow dark annular zone, the zonule of Zinn; here and there the striation produced by the fibres of the suspensory ligament can be faintly seen (*e*). External to the zonule, the corona ciliaris, formed by seventy or more ciliary processes, is well displayed (*d* and *i*). Wide of the elevations produced by the ciliary processes the orbiculus ciliaris is shown. The ora serrata of the retina is somewhat obscured by the puckering of the hyaloid membrane of the vitreous body.

a Sclerotic (sclera). *b* Chorioid (chorioidea). *c* Retina (pars optica retinae). *d* Orbiculus ciliaris. *e* Zonule of Zinn (zonula ciliaris): the fibres of the suspensory ligament of the lens can be faintly seen. *f* Posterior surface of the lens (lens crystallina); along its circumference may be seen the points of attachment of some of the suspensory fibres. *g* The corona ciliaris, formed by the eighty-one ciliary processes here present. *h* The vitreous and puckered hyaloid membrane. *i* Ciliary process (processus ciliaris).

PLATE 36



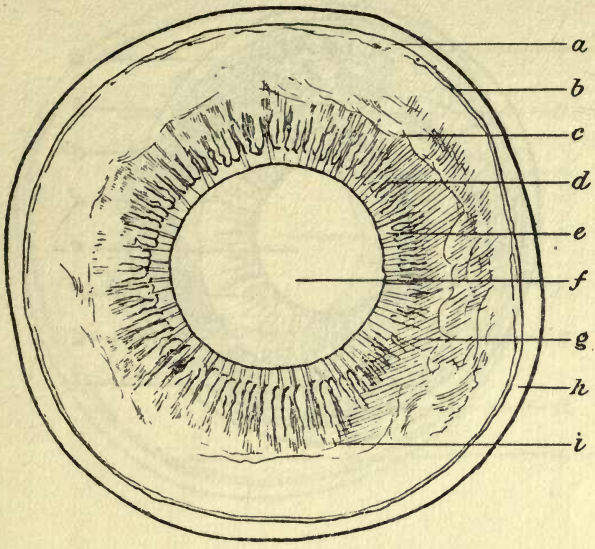
View of the interior of the anterior half of the globe of an adult eye.

This photograph has been introduced because it shows very well the arrangement of the lamellae of the lens, as seen from behind, to form the posterior lens star. As will be seen in this specimen, the tissue of the lens is disposed in eight wedge-shaped masses.

The lens also displays around its circumference the two-edged appearance exhibited in Plate 39. The vitreous and hyaloid membrane have been removed from the posterior surface of the lens, but the connexion of the two seems to correspond to the posterior edge of the circumference of the lens. To the anterior margin of the circumference may be seen passing the fibres of the suspensory ligament of the lens.

a Sclerotic (sclera). *b* Torn edge of the hyaloid membrane. *c* Corona ciliaris, formed of eighty-one ciliary processes (processus ciliares). *d* Zonule of Zinn (zonula ciliaris); the fibres of the suspensory ligament of the lens are here seen passing to the anterior aspect of the circumference of the lens. *e* Posterior surface of the lens (lens crystallina), showing the lens star. *f* Retina (pars optica). *g* Ridged and striated orbiculus ciliaris.

PLATE 37



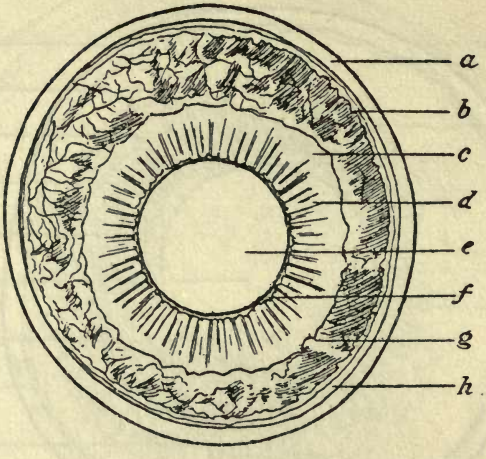
View of the interior of the anterior half of the globe of the eye of an adult.

The vitreous has been removed, but the torn edge of the hyaloid membrane is seen at *c*.

This preparation is included because it displays very well the disposition of the fibres of the zonule of Zinn which are derived from the pars ciliaris retinae of the orbiculus ciliaris. These fibres are particularly well seen on the right side of the specimen, in which, owing to the removal of the vitreous, they appear as withdrawn from the furrows which lie between the ciliary processes. The circumference of the lens displays a double edge: one in front, to which the fibres of the anterior part of the zonule are attached ; and one behind, where the lens lies in contact with the fossa patellaris formed by the anterior surface of the hyaloid membrane of the vitreous body.

a Chorioid (chorioidea). *b* Retina (pars optica). *c* Torn edge of hyaloid membrane. *d* Corona ciliaris, formed of eighty-two ciliary processes (processus ciliares). *e* Zonule of Zinn (zonula ciliaris). *f* Posterior surface of lens (lens crystallina). *g* Placed where some of the fibres of the suspensory ligament are well seen uplifted from the grooves between the ciliary processes. *h* Sclerotic (sclera). *i* Ridged and striated surface of the orbiculus ciliaris.

PLATE 38

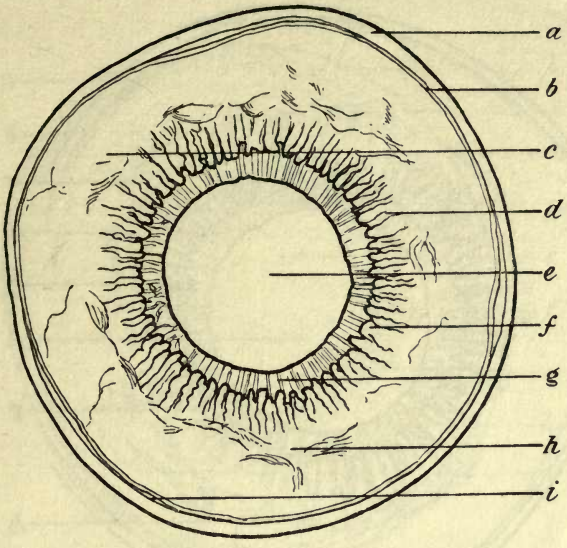


View of the interior of the anterior half of the globe of the eye of a full-term foetus.

The retina is thick and fleshy looking; at the margin of the ora serrata it forms a rounded swollen edge. How far these appearances are due to post-mortem changes or the influences of preservation is uncertain. At this stage the vascularity of the retina is well displayed. Another feature of some interest is that the zonule of Zinn is represented by but a narrow dark ring round the lens. The ciliary processes, of which there are seventy-five, come much nearer the circumference of the lens than in the adult. In this case the posterior surface of the lens exhibits a four-fissured appearance.

a Sclerotic (sclera). *b* Thick retina (pars optica). *c* Orbiculus ciliaris. *d* Corona ciliaris, made up of seventy-five ciliary processes. *e* Posterior surface of lens (lens crystallina), with evidence of four fissures in its substance. *f* Zonule of Zinn (zonula ciliaris), here seen as a narrow interval between the circumference of the lens and the ciliary processes. *g* Swollen edge of pars optica retinae where it forms the ora serrata. *h* Chorioid (chorioidea).

PLATE 39

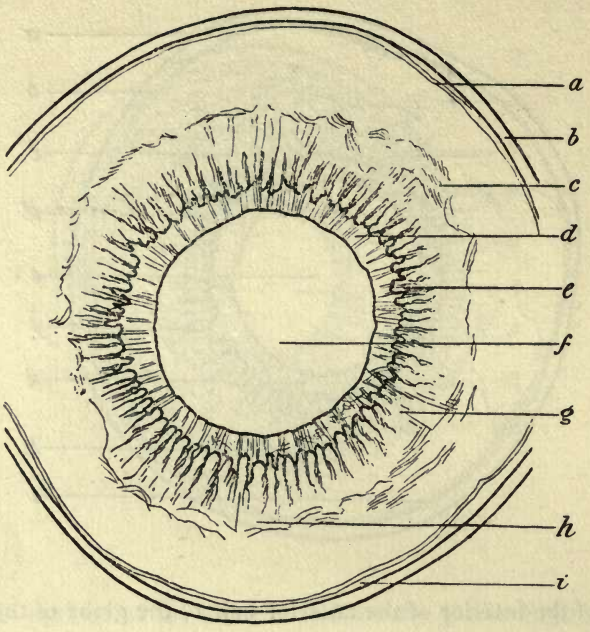


View of the interior of the anterior half of the globe of the eye.

Photographed by combined reflected and transmitted light. The cornea and iris have been removed from the front of the lens. The zonule of Zinn is seen as a light, faintly striated, annular zone surrounding the darker lens in the centre of the preparation. The circumference of the lens displays an anterior and posterior edge, to which are attached the fibres of the anterior and posterior lamellae of the zonule of Zinn respectively; these edges here and there show the pointed attachments of the fibres of the suspensory ligament. External to the zonule is the ring of the corona ciliaris, formed in this specimen by eighty folds or ciliary processes. The orbiculus ciliaris is not well seen, and the ora serrata is obscure. The vitreous has been removed, but here and there patches of hyaloid membrane still remain attached to the inner surface of the retina.

a Sclerotic (sclera). *b* Retina (pars optica). *c* Shows a patch of hyaloid membrane attached to the retina. *d* Corona ciliaris, formed in this instance by eighty ciliary processes. *e* Posterior surface of the lens, its circumference marked by the attachment of the fibres of the ligament of the lens. *f* Ciliary process (processus ciliaris). *g* Zonule of Zinn (zonula ciliaris), displaying the fibres of the suspensory ligament of the lens. *h* Part of the orbiculus ciliaris is here seen. *i* The chorioid (chorioidea) seen between the sclera and retina.

PLATE 40

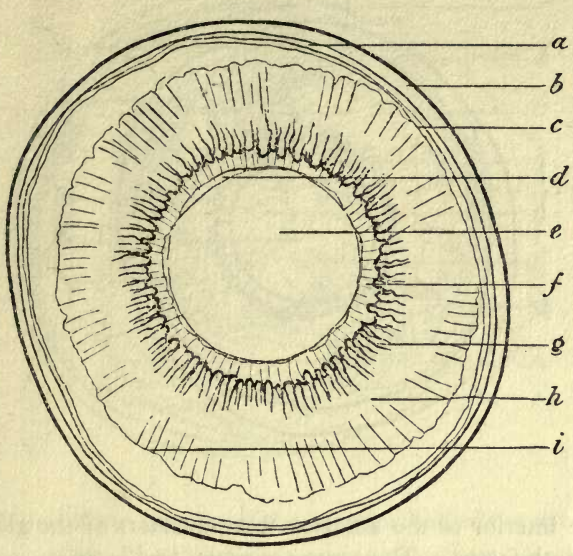


View of the interior of the anterior half of the globe of the eye, taken by reflected and transmitted light combined. The same specimen as Pl. 39.

In the centre is the lens, surrounded by a light finely striated zone, the zonule of Zinn ; here the transmitted light shows up well the fibres of the suspensory ligament (the cornea and iris have been removed from the front of the lens). Wide of the zonule is the corona ciliaris, formed in this case by eighty ciliary processes. External to the corona may be seen the orbiculus ciliaris (*h*), and wide of that the general line of the ora serrata can be discerned, though to some extent obscured by the vitreous and its hyaloid membrane (*h*).

a Retina (pars optica). *b* Sclerotic (sclera). *c* Vitreous and hyaloid membrane. *d* Zonule of Zinn (zonula ciliaris), with the fibres of the suspensory ligament passing from the ciliary body to the lens ; where they are attached to the latter the capsule of the lens is here and there elevated and irregular. *e* Ciliary process (processus ciliaris). *f* Posterior surface of the lens (lens crystallina). *g* Corona ciliaris, made up of eighty ciliary processes surrounding the zonule of Zinn. *h* Orbiculus ciliaris. *i* Chorioid (chorioidea).

PLATE 41

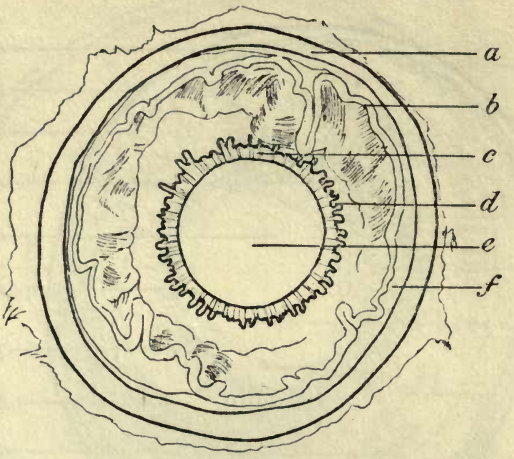


View of the interior of the anterior half of the globe of the eye, photographed by a combination of transmitted and reflected light.

This preparation is interesting because it displays an appearance not seen in any of the other plates. Here, along the circumference of the lens, the lens capsule is seen separated from the lens substance; or may it be the separation of what Retzius calls the pericapsular membrane from the capsule itself?

a Chorioid (chorioidea). *b* Sclerotic (sclera). *c* Retina (pars optica). *d* Separation of the layers investing the lens, either the lens capsule from the lens, or the pericapsular membrane of Retzius from the capsule. *e* Posterior surface of lens (lens crystallina). *f* Zonule of Zinn (zonula ciliaris), with the fibres of the suspensory ligament faintly showing. *g* Corona ciliaris, made up of eighty-four ciliary processes (processus ciliares). *h* Orbiculus ciliaris. *i* Ora serrata, over which the hyaloid membrane may be seen in part detached.

PLATE 42

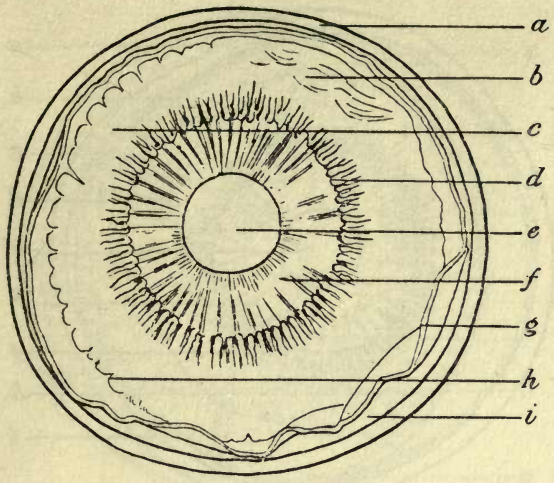


View of the interior of the anterior three-quarters of the globe of the eye of an eighth-month foetus. The same specimen as Pl. 32.

The cornea and iris have been removed so that the specimen could be photographed by a combination of reflected and transmitted light. The most noticeable feature about this view is the redundancy of the retina; how much of this folding and puckering is due to post-mortem changes or the effects of the reagents employed it is difficult to determine, but it may be pointed out that it displays a transition stage between that represented in Pl. 17, the eye of a six and a half months' foetus, and that shown in Pl. 15, the eye of a full-term foetus.

a Sclerotic (sclera). *b* Thick and folded retina. *c* Zonule of Zinn (zonula ciliaris). The delicate radial fibres of the suspensory ligament of the lens are revealed by the transmitted light: note that there is no unevenness corresponding to their attachment to the circumference of the lens. *d* Ciliary processes (processus ciliares), shown in shadow. *e* Lens (lens crystallina): its marked convexity is clearly indicated. *f* Chorioid (chorioidea).

PLATE 43

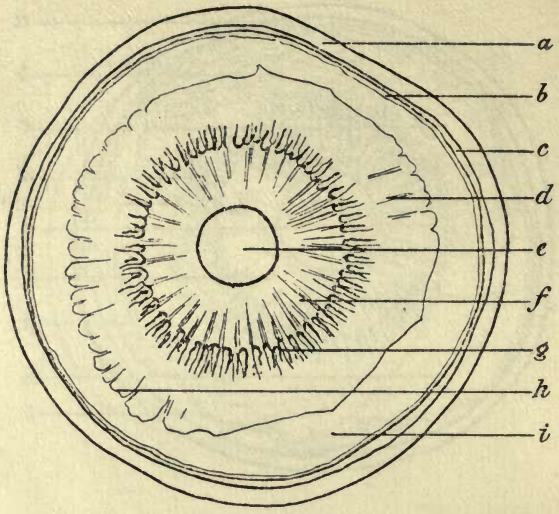


View of the interior of the anterior half of the eye.

The vitreous and lens having been removed, the posterior chamber of the aqueous chamber is laid open, and the posterior or uveal surface of the iris is exposed. In the centre is the pupil, through which the cornea is seen with the faint shadow of the pupillary margin cast on it. Wide of the iris the corona ciliaris is seen, made up of seventy-seven ciliary processes. The intervals between the largest folds seem tightly packed with smaller folds. Outside the corona lies the orbiculus ciliaris, and external to that is the ora serrata. Along the left edge of the preparation the retina is separated from the chorioid.

a Sclerotic (sclera). *b* Remains of some of the vitreous and hyaloid still attached to the retina. *c* Orbiculus ciliaris. *d* Corona ciliaris, made up of seventy-seven ciliary processes (processus ciliares). *e* Pupillary aperture (pupilla): the posterior surface of the cornea is seen through it; the pupillary margin, very thin, is seen to be finely notched in correspondence with the fine furrows and folds which are disposed on the posterior surface of the iris in the pupillary zone. *f* Posterior or uveal surface of the iris. In a good light this is seen to be traversed by radial folds converging to the pupil; these are the structural folds of Schwalbe. *g* Retina (pars optica). *h* Ora serrata. *i* Chorioid (chorioidea).

PLATE 44

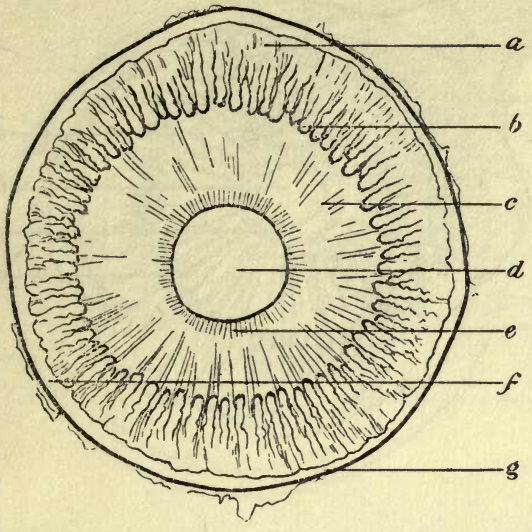


View of the interior of the anterior half of the eye, the vitreous and the lens having been removed.

The posterior chamber of the aqueous chamber has thus been laid open. A noteworthy feature of this specimen is the unpigmented condition of the corona and orbiculus ciliaris. The uveal surface of the back of the iris is deeply coloured. In the centre the aperture of the pupil is seen, through which a shadow is cast on the concave inner surface of the cornea. Around the pupil is the broad dark ring formed by the pigmented posterior surface of the iris; little or no detail of its structure can be seen. The corona ciliaris lies external to this, made up of sixty-eight ciliary processes. Extending from the corona to the ora serrata is the orbiculus ciliaris, the striated arrangement of which is well displayed; the more prominent fibres appear to pass from the base of a ciliary process to one of the points which separate the lunules of which the serrated edge of the ora is formed. In between these more evident fibres, a number of parallel striae run forward to the edge of the corona; a narrow, more lightly coloured zone appears just in front of the ora serrata.

a Sclerotic (sclera). *b* Retina. *c* Chorioid (chorioidea). *d* Orbiculus ciliaris. *e* Pupillary aperture (pupilla), through which is seen the posterior surface of the cornea. *f* Uveal surface of posterior aspect of iris. *g* Corona ciliaris, comprising sixty-eight ciliary processes (processus ciliares). *h* Ora serrata. *i* Remains of vitreous and hyaloid membrane still adherent to retina.

PLATE 45



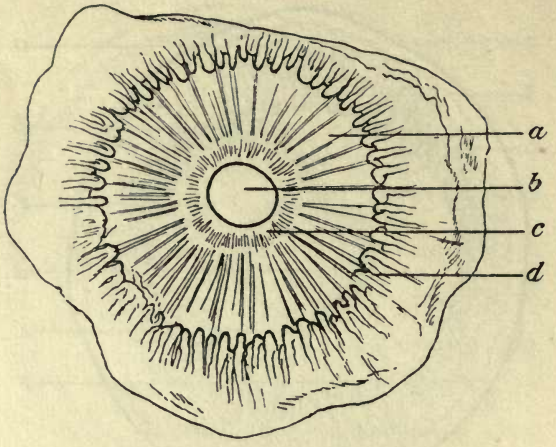
View of the posterior surface of the ciliary body and iris, detached from the rest of the structures of the globe.

In the centre is the very dark pupil, surrounded by the slightly lighter posterior uveal surface of the iris ; in a good light the radially arranged structural folds of Schwalbe are seen, replaced near the pupillary margin by a series of fine folds—the contraction folds of Schwalbe : this constitutes the pupillary zone of Fuchs. It is this surface of the iris which forms the anterior wall of the posterior chamber of the aqueous cavity. The corona ciliaris, made up of seventy-one ciliary processes, forms the posterior circumferential boundary of the posterior chamber.

The varying thickness of the ciliary body can be seen : thick where it is cut near the outer edge of the corona, thinner where the section passes through the orbiculus at some distance from the corona. Within the corona there appear what seem to be some of the torn fibres of the zonule of Zinn—the suspensory ligament of the lens.

a Orbiculus ciliaris. *b* Corona ciliaris, formed of seventy-one ciliary processes. *c* Ciliary zone of posterior or uveal surface of the iris : here are seen the structural folds of Schwalbe. *d* Pupil (pupilla). *e* Pupillary zone of posterior surface of the iris near the pupillary margin : here are seen a series of very fine folds (contraction folds of Schwalbe). *f* Ciliary body, cut near the corona. *g* The orbiculus, cut through where the tissue is thinner.

PLATE 46

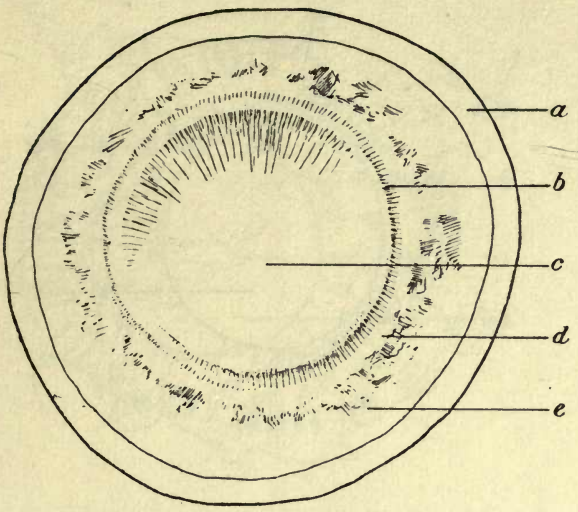


View of posterior surface of iris and ciliary body detached from the other structures of the globe.

The ciliary processes and the orbiculus have been bleached by the action of peroxide of hydrogen. This reagent does not appear to have removed the pigment so completely from the posterior pigmented layer of the iris, for here it is more dense. The arrangement of the folds on the posterior surface of the iris is well seen. In the pupillary zone (*c*), near the pupillary margin, the folds are fine and very numerous: these constitute the contraction folds of Schwalbe. In the ciliary zone (*d*) the structural folds of Schwalbe are seen radiating outwards and deepening towards the ciliary margin of the iris. Here and there the uveal layer on the posterior surface of the iris is injured and the lighter tissue beneath is seen. The corona ciliaris, made up of seventy-one ciliary processes freed from their pigment, stands out clearly. Fragments of the torn fibres of the suspensory ligament of the lens can here and there be seen around the inner margin of the corona.

a Ciliary zone of posterior surface of iris with structural folds of Schwalbe. *b* Pupil (pupilla). *c* Pupillary zone of posterior surface of iris with fine contraction folds. *d* Corona ciliaris, formed by seventy-one ciliary processes (processus ciliares).

PLATE 47

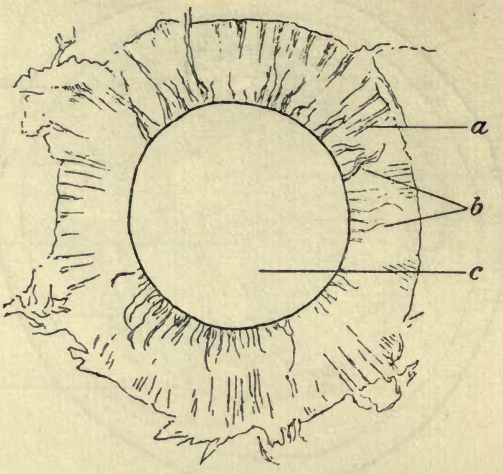


View of posterior surface of cornea, sclero-corneal junction, and internal surface of anterior part of sclerotic.

The sulcus circularis corneae (*b*), around the scleral circumference of the cornea, is well seen ; immediately outside it a narrow ring of unpigmented tissue marks the position of the annular ligament (*d*), to which the ligamentum pectinatum of the iris and the anterior insertion of the meridional fibres of the ciliary muscle are attached. External to this the inner surface of the sclerotic is exposed, with some of the pigmented tissue of the lamina fusca, which connects it with the choroid, still attached.

a Sclerotic (sclera). *b* Sulcus circularis corneae. *c* Posterior surface of cornea, forming the anterior wall of the anterior chamber ; here the posterior lamina is wrinkled by the action of the preservative. *d* Torn surface of the annular ligament (ligamentum annulare), to which the pectinate ligament of the iris and the meridional fibres of the ciliary muscle are attached. *e* Chorioidal surface of sclerotic, with remains of the pigmented lamina fusca attached.

PLATE 48



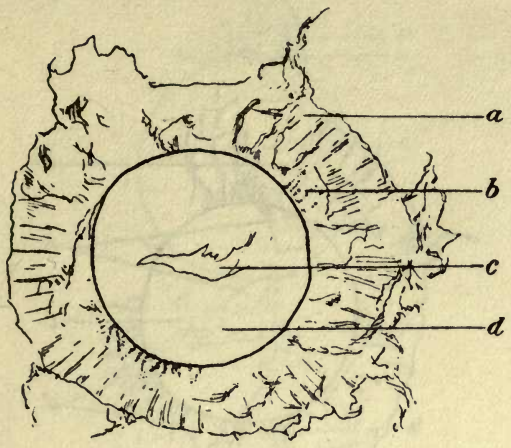
View of the front of the lens, with the hyaloid membrane and fibres of the suspensory ligament attached.

The preparation has been stained with picro-nigrosin, and photographed by a combination of reflected and transmitted light.

The hyaloid membrane (*a*) when viewed in the stereoscope is seen to be convex forwards around the lens; but the lens indents its anterior surface and lies in the fossa patellaris, to which it is adherent. The membrane displays the impressions of the ciliary processes on its surface; this is best seen above. Radial striae also indicate the position of the fibres of the suspensory ligament of the lens, which lie in contact with its anterior surface. These fibres (*b*) are seen distinct and apart from the membrane on a plane anterior to it, and the majority of them are clearly seen passing to be attached to the circumference of the lens capsule near its anterior margin.

a Hyaloid membrane. *b* Fibres of suspensory ligament of the lens. The space between *a* and *b*, close to the circumference of the lens, corresponds to the so-called canal of Petit. *c* Anterior surface of lens.

PLATE 49

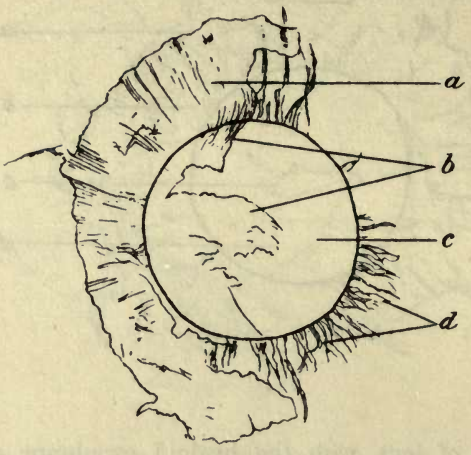


Posterior view of lens, with the hyaloid membrane and fibres of the suspensory ligament attached. Stained. The same specimen as Plate 48.

Wide of the lens the surface of the hyaloid membrane appears concave in the stereoscope; centrally it turns over the posterior surface of the lens, to the capsule of which it is attached. In the centre, the hyaloid membrane, where it forms the bottom of the fossa patellaris, is torn through and in part stripped off from the posterior surface of the capsule of the lens. Arising from the posterior surface of the hyaloid (viz. that towards the spectator) there are numerous trabeculae which have been torn away from the vitreous substance. The membrane bears the impressions of the ciliary process and also exhibits a striated appearance; faintly through the membrane and on a plane anterior to it (i.e. farthest away from the spectator), here and there, the fibres of the suspensory ligament of the lens can be seen. The space between the two near the circumference of the lens corresponds to the so-called canal of Petit.

a Hyaloid membrane, with trabeculae attached to its near surface. *b* Indicates a spot where the fibres of the suspensory ligament can be seen through the hyaloid membrane lying on a plane anterior to it; i.e. on the far side of the preparation. *c* Rent in the hyaloid membrane where it forms the floor of the fossa patellaris; the posterior surface of the capsule of the lens is exposed through the opening. *d* Posterior surface of the lens, covered with the hyaloid membrane.

PLATE 50



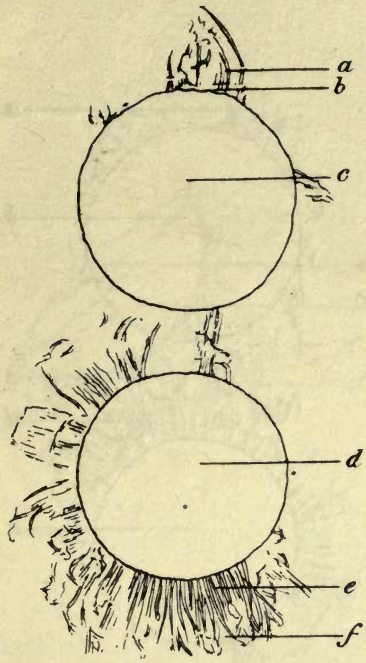
View of the posterior surface of the lens, with part of the hyaloid membrane still attached.

The fibres of the suspensory ligament are clearly seen on the right side of the specimen, which has been stained with picro-nigrosin and photographed by reflected and transmitted light combined. This is the same specimen as Plates 48 and 49.

The hyaloid membrane has been removed from the right side of the preparation; its ragged and torn edge is seen where it has been stripped off from the posterior surface of the capsule of the lens, to which it is adherent. In the stereoscope the fibres of the suspensory ligament of the lens are seen distinctly in front of the upper torn edge of the hyaloid membrane. From the near surface of the hyaloid membrane there are numerous ruptured trabeculae passing; these have been torn away from the substance of the vitreous.

a Hyaloid membrane. *b* Torn edge of the hyaloid membrane where it forms the floor of the fossa patellaris, and where it has been stripped off from the posterior surface of the capsule of the lens. *c* Posterior surface of lens and capsule. *d* Fibres of the suspensory ligament attached to the circumference of the lens capsule, mainly near its anterior border.

PLATE 51



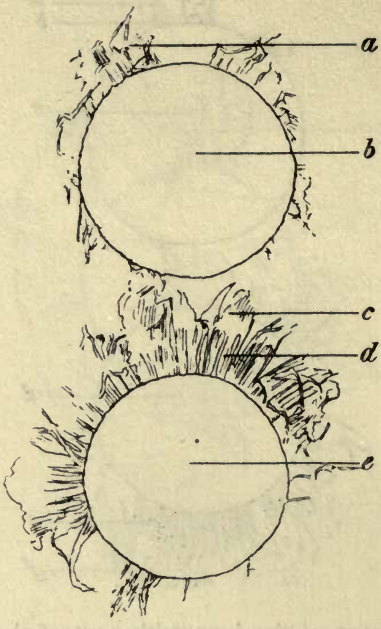
Two views of the front of the lens, with part of the suspensory ligament attached.

In both instances a ring of pigmented spots on the surface of the lens marks the position of the pupillary margin; in the lower preparation, due possibly to post-mortem changes, there is a marked increase in the convexity of the anterior surface of the lens, corresponding to the area circumscribed by the pupillary margin.

In the lower specimen a portion of the ligament of the lens is seen. This, at a distance of about 2 mm. from the circumference of the lens, is seen to consist of a delicate transparent membrane, probably continuous posteriorly with the inner stratum of the pars ciliaris retinae; nearer the lens it breaks up into a fine shredded membrane, the fibres of which are seen to be attached in a nearly uniform line to the anterior portion of the circumference of the lens. On comparing these specimens with the other photographs in which the ligament of the lens is shown *in situ*, it will be seen that there is not that depth and variation in the planes of attachment of the fibres of the zonula which is so apparent in the other preparations; here seemingly we have to deal only with the anterior part of the zonule, the posterior portion having been removed. This is further explained in Plates 49 and 52.

a A few scattered fibres of the suspensory ligament of the lens, seen attached at *b* to the capsule of the lens. *c* Anterior surface of lens, with ring of pigment spots marking the position of pupillary margin. *d* Anterior surface of lens, showing a more marked convexity within the pigmented ring which marks the position of the pupillary margin. Whether due to post-mortem change or no, this appearance indicates that the iris can exercise some restraining influence on the convexity of the lens. *e* Fine fibres of the anterior portion of the suspensory ligament of the lens. These are seen to be derived from the splitting up or shredding of a continuous membrane at *f*.

PLATE 52

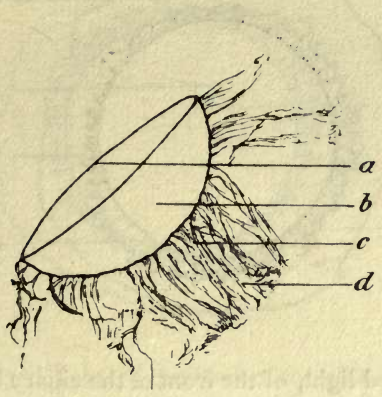


View of the lens, with parts of the suspensory ligament connected with it. Upper specimen is the front of the lens, lower specimen the back.

The anterior surface of the lens, shown in the upper print, is marked by a ring of pigment spots which indicates the position of the pupillary margin. The posterior surface, represented in the lower figure, has slightly floccular appearance as if something had been torn away from it. It is here that the lens is in contact with the hyaloid membrane of the vitreous. Note particularly that there are no indications of definite fibres having been torn away from the posterior aspect of its circumference. The fibres attached in the anterior part of the circumference form a very definite shredded sheet, the filaments of which unite externally to form a delicate membrane, in all probability continuous posteriorly with the internal stratum of the pars ciliaris retinae which overlies the orbiculus and ciliary body. These are the fibres of the suspensory ligament of the lens which lie in front of the so-called canal of Petit.

a Scattered fibres of the suspensory ligament of the lens, attached to the front of the circumference of the capsule. *b* Anterior surface of the lens, with pigment marks showing position of pupil. *c* Fine striated membrane which becomes shredded nearer the lens (*d*), the fine isolated fibres being attached very definitely to the front of the circumference of the capsule of the lens. *e* Posterior surface of the lens; this is seen to display a delicate floccular appearance, due probably to its separation from the hyaloid membrane. It is markedly more convex towards the centre.

PLATE 53

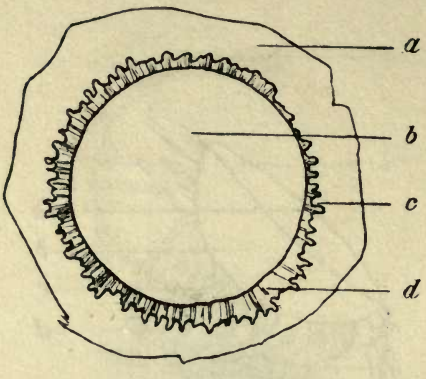


Anterior view of half of lens, divided sagittally with part of suspensory ligament attached.

The fibres here displayed are the strands of the zonule of Zinn. As will be seen, the filaments are formed by the splitting up of a membrane (*d*), the shredded fibres of which pass to be attached to points on the capsule of the lens occupying different planes around its circumference; it is between these strands that the so-called canal of Petit is placed. The specimen was stained with picro-nigrosin.

a Cut edge of posterior surface of lens (lens crystallina). *b* Anterior surface of lens. *c* Shredded fibres of the suspensory ligament of the lens, forming the fibres of the zonule of Zinn. *d* Delicate membrane from which, by the splitting of it up, these fibres are derived. This membrane is probably in continuity with the internal stratum of the pars ciliaris retinae.

PLATE 54

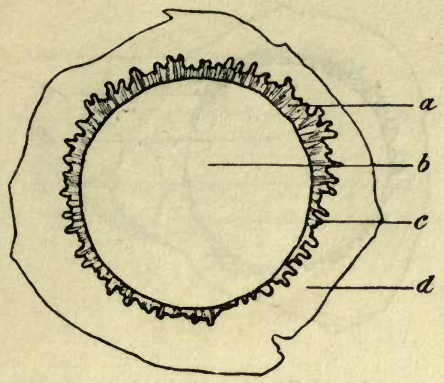


View, by transmitted light, of the front of the ciliary body, lens, and suspensory ligament, separated from the other structures of the globe.

The specimen has been stained with picro-nigrosin so as to render more distinct the fibres of the suspensory ligament. In the stereoscope the divergence of the strands of the suspensory ligament as they pass to the circumference of the lens can be made out distinctly; the angular interval separating them around the circumference of the lens forms the so-called canal of Petit.

a Scleral surface of ciliary body (corpus ciliare). *b* Lens (lens crystallina), so deeply stained as to be opaque: note here and there on the circumference the pointed attachments of the fibres of the ligament of the lens. *c* Fore part of ciliary processes (processus ciliares). *d* Zonule of Zinn (zonula ciliaris): the fibres of the ligament of the lens are deeply stained, and show up well by transmitted light. In the stereoscope it will be seen that the fibres are arranged radially in different planes. Between them runs the so-called canal of Petit around the circumference of the lens.

PLATE 55

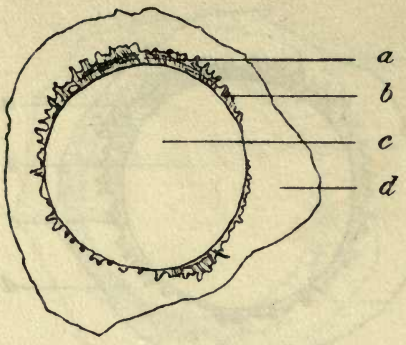


View, by transmitted light, of the back of the ciliary body, lens, and suspensory ligament, separated from the other structures of the globe.

The specimen is the same as that represented on Plate 54, and has been stained with picro-nigrosin so as to render more distinct the structure of the zonule of Zinn. The shredded appearance of the ligament of the lens is well displayed, and it will be apparent that all the fibres are not attached in the same plane at the circumference of the lens. The interval around the circumference of the lens between the anterior and posterior main zones of attachment of these fibres is the so-called canal of Petit. At numerous points on the circumference of the lens, the capsule of the lens exhibits traction effects corresponding to the attachment of the fibres of the suspensory ligament.

a Zonule of Zinn (zonula ciliaris): the fibres of the suspensory ligament are seen radially arranged. As will be seen in the stereoscope, some of the fibres lie in front of the others. The space between is the so-called canal of Petit. *b* Lens (lens crystallina): the points of attachment of some of the fibres of the suspensory ligament are clearly indicated by elevated points on the circumference of the lens. *c* Anterior extremities of the ciliary processes (processus ciliares). *d* Inner surface of the ciliary body, here forming the corona ciliaris. The details of the ciliary processes are not seen, owing to the fact that the specimen has been photographed by transmitted light.

PLATE 56

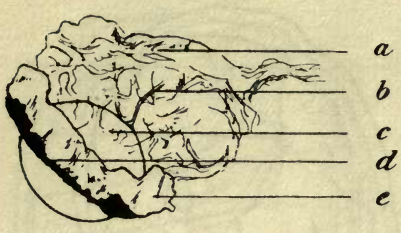


The ciliary body, zonule of Zinn, and the lens, separated from the other structures of the eye, stained with van Gieson, and photographed from behind by transmitted light.

In this specimen, in addition to the radial fibres of the zonule of Zinn, which have been amply demonstrated in many of the other photographs, there are very definite indications, particularly in the upper part of the zonule, of fibres having a circular disposition.

a Placed where the circular fibres of the zonule of Zinn (zonula ciliaris) are best displayed. *b* Zonule of Zinn, with the radial fibres of the suspensory ligament of the lens. *c* Lens (lens crystallina). *d* The ciliary body (corpus ciliare): the projection of the anterior ends of the ciliary processes (processus ciliares) form the outer notched outline of the zonule of Zinn.

PLATE 57

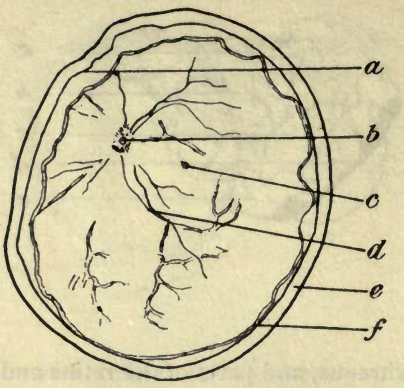


View of the lens, vitreous, and parts of the retina and chorioid of the eye of a six and a half months' foetus, removed from the specimen shown on Pl. 18.

The shrunken and distorted vitreous body, with its hyaloid membrane, is well seen; within it the anterior part of the hyaloid artery is clearly displayed, passing towards the posterior surface of the lens and there breaking up into a number of fine branches. The lens, which tends to be more spherical in shape, is shown surrounded by a collar consisting of the pars ciliaris retinae (marked in solid black) and the cut and everted edge of the anterior part of the pars optica retinae.

a Shrunken vitreous body (humor vitreus), surrounded by its hyaloid membrane. *b* Central hyaloid artery, which occupies the position of the hyaloid canal (canalis hyaloideus) of the adult; it may be seen splitting up into fine branches to supply the posterior surface of the lens capsule. *c* lens. *d* Ciliary body (corpus ciliare), in solid black. *e* Everted cut edge of the fore part of the pars optica retinae.

PLATE 58



View of the interior of the posterior half of the globe of the eye of a child two years old. The photograph was taken twenty minutes after the removal of the eye for an accident.

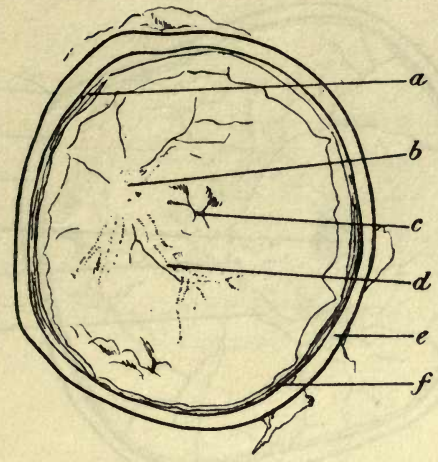
The retina is translucent; the optic disk and the macula lutea are seen; unfortunately, the specimen is not so oriented that the two lie on the same horizontal plane.

The optic disk (papilla n. optici), which exhibits evidence of optic neuritis, is seen with a circular lighter area in the centre, the porus opticus (*b*); the light and shade do not reveal the physiological excavation (excavatio papillae nervi optici), but the retinal vessels can be seen as two dark spots above and below the porus opticus as they turn over the edge of the excavation. About 4 mm. from the centre of the porus opticus, to the outer side, a dark spot marks the position of the fovea centralis (*c*), with the slightly darker yellow spot (macula lutea) around it.

The retinal vessels are well displayed (*d*), the veins being darker than the arteries.

a Chorioid (chorioidea). *b* Optic disk (papilla n. optici), with the porus opticus in the centre; immediately above and below this the retinal vessels can be seen turning over the lip of the excavation. *c* Fovea centralis: within a somewhat darker area, the yellow spot (macula lutea). *d* Retinal vessels; the veins are darker and slightly larger than the arteries. *e* Sclerotic (sclera). *f* Retina (pars optica retinae).

PLATE 59

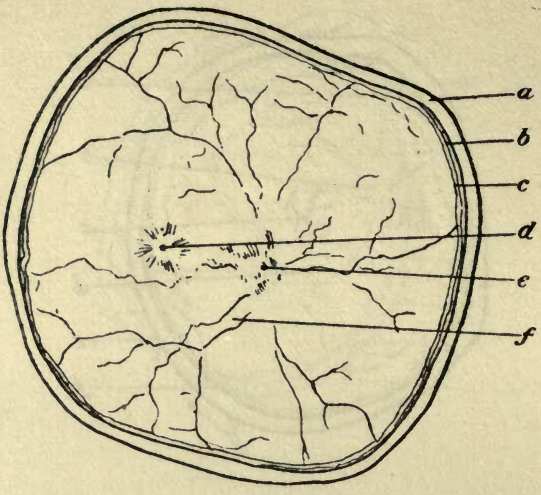


View of the interior of the posterior half of the globe of the eye of a child two years old.

This is the same specimen as that represented on Pl. 58, with this difference—that the preparation has been subjected to the influence of formalin for 48 hours and then photographed. The retina is now opaque, and the retinal vessels are less clearly seen. The optic disk, with the porus opticus in its centre, is not so well defined; around it, however, a ring of pigmented spots, the chorioidal ring, is well shown immediately above it. The position of the fovea centralis is marked by a recess with puckered and swollen edges round it.

a Chorioid (chorioidea). *b* Optic disk (papilla n. optici), with porus opticus in the centre; immediately above may be seen indications of the chorioidal ring. *c* Fovea centralis, with puckered and swollen retina around it. *d* Retinal vessels. *e* Sclerotic (sclera). *f* Retina (pars optica).

PLATE 60



View of the interior of the posterior half of the globe of the right eye of an adult after fixing.

The optic disk (*e*) is seen with a well-marked excavation, the right edge of which throws a shadow across the bottom of the hollow. Around the edge the retinal vessels may be seen passing to their distribution ; about 4 mm. to the outer or left side of the disk the fovea centralis is seen, immediately surrounded by a lighter zone ; there is also a very faint indication of a lighter annular zone about 1·5 mm. from the fovea.

a Sclerotic (sclera). *b* Chorioid (chorioidea). *c* Retina (pars optica). *d* Fovea centralis, surrounded by a light ring due to the thickening of the retina ; outside this there is a darker zone bounded by another lighter ring about 1·5 mm. distant from the fovea. *e* Optic disk (papilla n. optici), with a well-marked depression (excavatio papillae nervi optici), over the lip of which the retinal vessels are seen running outwards. *f* Retinal vessels.

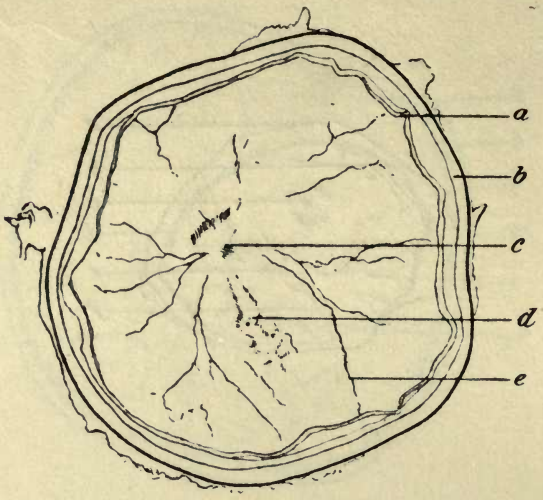
PLATE 61

View of portion of the fundus of an adult eye fixed soon after death.

The optic disk is not very clearly defined; a slight depression is seen in its centre (*e*). About 4 mm. from the centre of the disk the fovea centralis is seen above it and to the left (the two, of course, would lie very nearly in the same horizontal plane if the preparation were in its right position). The fovea here shows as a pit in the centre of an elevated zone of swollen retinal tissue; this appearance is probably post-mortem.

a Sclerotic (sclera). *b* Chorioid (chorioidea). *c* Fovea centralis, surrounded by a swollen and thickened ring of retinal tissue. *d* Retina (pars optica). *e* Optic disk, not very clearly defined, with a slight central depression; the retinal vessels are seen passing over the edge of the depression. *f* Retinal vessels (vasa sanguinea retinae).

PLATE 62

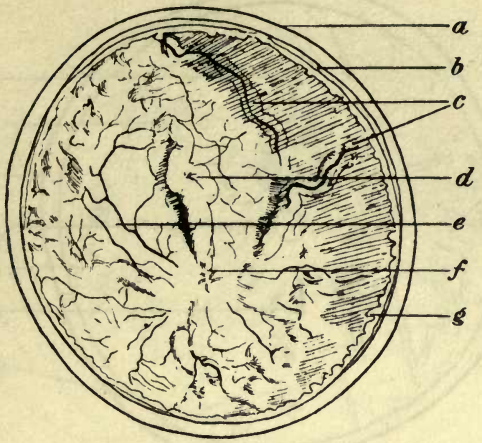


View of the interior of the posterior half of the globe of the eye in an adult.

At *c* the optic disk is seen with the retinal vessels radiating from it; extending from it in a downward direction, and to the right, is a thickened and swollen fold of retina; in this, about 4 mm. from the centre of the optic disk, a little pit is seen: this marks the position of the fovea centralis. Unfortunately, the specimen is not correctly oriented; if it had been, the fold would have extended horizontally outwards from the disk. This fold, the so-called plica centralis, is a very constant feature in eyes that are examined some time after death. The configuration of the fold is remarkably alike in all such specimens examined, and would suggest either a looser attachment of the retina in this particular region or a texture more prone to the absorption of fluids.

a Retina (pars optica). *b* Sclerotic (sclera), with the chorioid attached to its inner surface. *c* Optic disk (papilla nervi optici): indications of a central depression, with a thickened outer lip over which the retinal vessels are seen passing. *d* Plica centralis: a post-mortem appearance, with the fovea centralis close to the lead line. *e* Retinal vessels.

PLATE 63

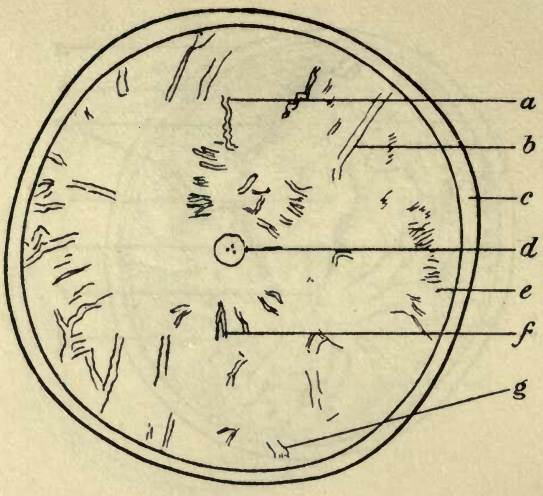


View of the interior of the posterior half of the globe of the eye of a full-term foetus. Same eye as Plate 38.

The retina appears thick and fleshy; here and there, more particularly along the line of the retinal veins, it is thrown into prominent folds. In the centre of the optic papilla (*f*) is seen the excavation, over the edges of which the retinal vessels may be seen passing. Extending upwards from the optic papilla (had the specimen been properly oriented it would have been almost horizontally outwards) is a thick fold of characteristic form (see Pls. 3, 4, 62), the plica centralis, due undoubtedly to post-mortem changes; on this, at the point *d*, is a recess, the fovea centralis, situated about 4 mm. from the centre of the optic papilla. The vessels of the retina are well displayed (*e*), the veins showing up thicker than the arteries.

a Sclerotic (sclera). *b* Chorioid (chorioidea). *c* Thick folds of swollen retina, corresponding to the direction of some of the larger veins. *d* Fovea centralis, on the surface of the plica centralis. *e* Retinal vessels. *f* Optic papilla with optic recess or excavation. *g* Thick retina.

PLATE 64



View of the interior of the posterior half of the sclerotic.

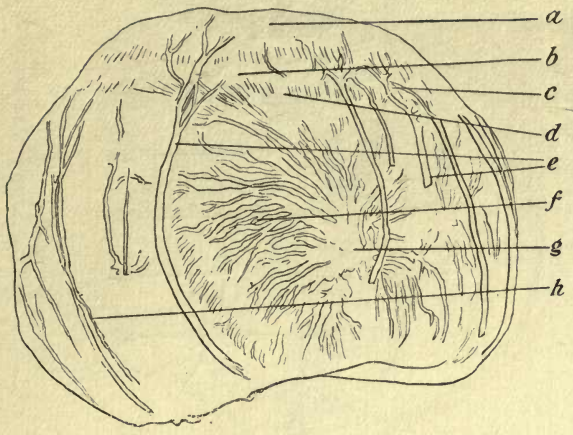
The contents of the globe of the eye having been removed, the supra-chorioidal layer has been torn through, together with the lamina fusca; a certain amount of pigment derived from the latter, however, remains; in this is outlined the position and direction of the various vessels and nerves as they pass through the peri-chorioidal space.

The entrance of the optic nerve is seen passing through the summit of a gentle elevation. The central artery of the retina is seen with two companion veins.

a Part of one of the long posterior ciliary arteries torn across anteriorly. *b* One of the ciliary nerves. *c* The sclerotic (sclera), shown cut through. *d* Entrance of optic nerve: within the nerve, in the centre, may be seen the central artery; to its right its two companion veins are seen. *e* Indicates the impression of the ramifications of the venae vorticosae. *f* The impressions of the short ciliary arteries. *g* One of the venae vorticosae piercing the sclerotic (?)

A view of the surface of the sclerotic, covered with the choroid, is not included, as it shows little of interest except the pigment layer of the retina covering its internal surface.

PLATE 65



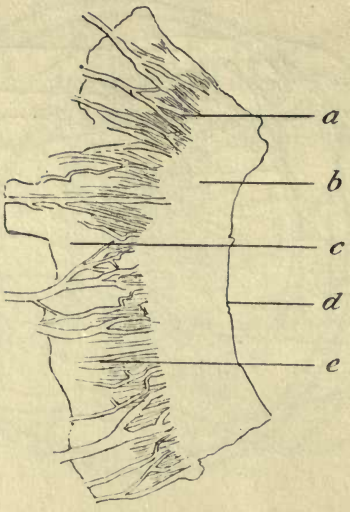
View of the outer or scleral surface of the chorioid, photographed from the same specimen as in Plate 13, showing the various zones of the chorioid as seen from the outer side when the sclerotic is removed.

In front the ciliary body (*a*), behind that the outer surface of the orbiculus ciliaris (*b*). At (*c*), the surface which overlies the line of the ora serrata of the retina is seen, whilst behind the external surface of the vascular layer containing the ramifications of the venae vorticosae is revealed. Overlying this, the long ciliary nerves (*e*) are displayed running forwards to the ciliary body to form a plexus, whilst one of the long posterior ciliary arteries is also visible (*h*).

In the removal of the sclerotic the pigmented lamina fusca and the suprachorioidal layer have been torn apart.

a Outer surface of ciliary body (corpus ciliare). *b* External surface of the orbiculus ciliaris. *c* The nervous plexus (orbiculus gangliosus), formed by the splitting up of the long ciliary nerves. *d* Overlies the position occupied on the inner surface of the chorioid of the ora serrata of the retinae. *e* Long ciliary nerves running forwards to form the orbiculus gangliosus. *f* Ramifications of the venae vorticosae. *g* Great vorticose vein. *h* Long posterior ciliary artery (arteria ciliaris posterior longa).

PLATE 66

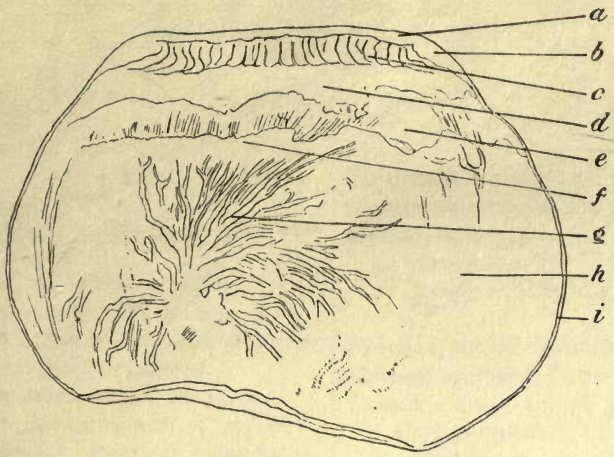


View of the scleral surface of a portion of the ciliary body separated from its connexions; this has been dissected off from the left-hand side of the specimen shown in Plate 24.

The anterior margin, where the iris has been separated from its connexion with the ciliary body, corresponds to the annular ligament (see Plates 24 and 25). Thinning posteriorly, the outer surface of the orbiculus ciliaris is seen (*e*), whilst to the left of this the thin layers of the pars ciliaris retinae (*c*) are shown. Where the orbiculus joins the ciliary body the ciliary nerves may be seen (*a*) breaking up to form a plexus (orbiculus gangliosus), the fibres derived from which enter the substance of the ciliary body.

a Ciliary nerves breaking up to form the orbiculus gangliosus. *b* Scleral surface of ciliary body (corpus ciliare). *c* Pars ciliaris retinae. *d* Anterior edge of ciliary body attached to the annular ligament at the sclero-corneal junction; from the inner surface of this margin the iris has been torn away. *e* External or scleral surface of the orbiculus ciliare.

PLATE 67



View of the inner (retinal) surface of the separated chorioid.

The retina has been peeled off from this surface, leaving its pigment layer in greater part connected with the inner surface of the chorioid and ciliary body. Over the greater part of the inner surface of the orbiculus ciliaris this pigment layer has been stripped off, as if there it were more readily detachable from the chorioid. The iris has been removed, and the free anterior edge of the ciliary body corresponds to the divided annular ligament at the sclero-corneal margin. The ramifications of the venae vorticosae are seen through the thin chorio-capillary layer.

a Divided annular ligament (ligamentum annulare), which connects the ciliary body anteriorly with the sclero-corneal circumference; the iris has been torn away from the inner side of this ligament. *b* Ciliary body (corpus ciliare) in section. *c* Ciliary processes (processus ciliares). *d* Orbiculus ciliaris. *e* Orbiculus ciliaris with the pigmented layer of the pars ciliaris retinae stripped off. *f* Corresponds to the attachment of the ora serrata; here the pigment seems particularly thick. *g* Ramifications of the venae vorticosae, showing through the chorio-capillary layer. *h* The inner surface of the chorioid with much of the pigment layer of the retina attached. *i* The chorioid (chorioidea) in section.

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