

A
CONCISE DESCRIPTION
OF THE
Anatomy and Physiology
OF
The Eye
AND ITS APPENDAGES

ACCOMPANYING THE PLATES OF THAT ORGAN

PREPARED BY
LUDOVIC HIRSCHFELD

Senior Professor of Anatomy and Surgery to the Medical Faculty, Paris; Senior Chief of the Clinic, Hôpital de Dieu; Laureate of the Institute of France; Member of the Anatomical Society, and of the Biological Society; Member of the Society of the Medical Sciences, and of the Society of American Physicians, Paris; Member of the Society of Medicine of Varsovia; Cor. Member of the University of Cracow; Cor. Member of the Medical Societies of Florence, Lima, Bohemia, Vilna; Correspondent of the Academies of Rio-de-Janeiro, and DEI QUIRITTI of Rome

DRAWN AND COLORED FROM NATURE BY

J. B. LÉVEILLÉ
PARIS

A
CONCISE DESCRIPTION
OF THE
Anatomy and Physiology
OF
The Eye
AND ITS APPENDAGES

ACCOMPANYING THE PLATES OF THAT ORGAN

PREPARED BY
LUDOVIC HIRSCHFELD

Senior Professor of Anatomy and Surgery to the Medical Faculty, Paris; Senior Chief of the Clinic, Hôte Dieu; Laureate of the Institute of France; Member of the Anatomical Society, and of the Biological Society; Member of the Society of the Medical Sciences, and of the Society of American Physicians, Paris; Member of the Society of Medicine of Varsovia; Cor. Member of the University of Cracow; Cor. Member of the Medical Societies of Florence, Lima, Bohemia, Vilna; Correspondent of the Academies of Rio-de-Janeiro, and DEI QUIRITTI of Rome

DRAWN AND COLORED FROM NATURE BY

J. B. LÉVEILLÉ

PARIS

A CONCISE DESCRIPTION
OF THE
Anatomy and Physiology
OF
The Eye
AND ITS APPENDAGES

The *Appendages of the Eye* are, the orbits, the eyebrows, the eyelids, the conjunctiva, the lachrymal apparatus, the muscles, the aponeurosis and vessels and nerves of the orbit.

The *Orbits* are two quadrilateral hollow cones situated in the upper part of the skull and intended for the reception of the eyeballs with their muscles, vessels and nerves, and the lachrymal glands.

The *Eyebrows* are two projecting arches of integument covered with short thick hairs, which form the upper boundaries of the orbits.

The *Eyelids* are two thin movable veils placed in front of the eye, protecting it from injury by their closure. The upper lid is the larger, the more movable of the two, and is supplied by a separate muscle, *Levator palpebrae superioris*. When the eyelids are opened an elliptical space is left between their margins, the angles of which correspond to the junction of the upper and lower lids, and are called *canthi*. The *outer canthus* is more acute than the inner, and the lids here lie in close contact with the globe; but the *inner canthus* is prolonged for a short distance inwards, towards the nose, and the two lids are separated by a triangular space, the *lacus lachrymalis*. At the commencement of the lacus lachrymalis on the margin of each eyelid is a small conical elevation; the *lachrymal papilla*, the apex of which is pierced by a small orifice, the commencement of the lachrymal canal.

Structure of the Eyelids.—The eyelids are composed of the following structures, taken in their order from without inwards: Integument, areolar tissue, fibres of the Orbicularis muscle, tarsal cartilage, fibrous membrane, Meibomian glands, and conjunctiva. The upper lid has, in addition, the aponeurosis of the *Levator palpebrae*.

The *Integument* is extremely thin, and continuous at the margin of the lids with the conjunctiva.

The *Subcutaneous Areolar Tissue* is very lax and delicate, seldom contains any fat, and is extremely liable to serous infiltration.

MUSCLES.

Orbital Group.—Orbicularis palpebrarum, Corrugator supercillii, Tensor tarsi, and the Levator palpebrae muscle.

The *Orbicularis Palpebrarum* is a sphincter muscle, surrounding the orbit and eyelids. It arises from the internal angular process of the frontal bone, from the nasal process of the superior maxillary, and from a short tendon (*tendo oculi*) which extends between the nasal process of the superior maxillary bone, and the inner extremities of the tarsal cartilages of the eyelids. The fibres encircle the orbit and eyelids, forming a broad and thin muscular plane, which is inserted into the lower border of the *tendo oculi* and into the nasal

process of the superior maxillary bone. Upon the eyelids the fibres are thin and pale, and possess an involuntary action.

The *Corrugator Supercilii* (*cutaneo-surcilier*) is a small, narrow and pointed muscle, situated immediately above the orbit and beneath the upper segment of the orbicularis palpebrarum muscle. It *arises* from the inner extremity of the superciliary ridge, proceeds upward and outward, and is blended with the orbicularis palpebrarum, and at about the middle of the arch of the orbit is *inserted* into the skin of the eyebrow.

The *Tensor Tarsi* is a thin plane of muscular fibres, about three lines in breadth and six in length. It *arises* from the orbital surface of the lachrymal bone and passing across the lachrymal sac, divides into two slips, which are *inserted* into the lachrymal canals as far as the puncta.

The *Levator Palpebrae Muscle* is a long, thin, and triangular muscle, situated in the upper part of the orbit, and arises from the upper margin of the optic foramen and the sheath of the optic nerve, and is inserted into the upper border of the superior tarsal cartilage. It raises the upper eyelid.

The *Tarsal Cartilages* are two thin, elongated plates of fibro-cartilage, about an inch in length. They are placed one in each lid, contributing to their form and support.

The *Superior*, the larger is of a semi-lunar form, about one-third of an inch in breadth at the centre, and becoming gradually narrowed at each extremity. Into the fore part of this cartilage the aponeurosis of the Levator palpebrae is attached.

The *Inferior* tarsal cartilage, the smaller, is thinner, and of an elliptical form.

The *free*, or *ciliary margin* of the cartilages is thick, and presents a perfectly straight edge.

The *attached*, or *orbital margin*, is connected to the circumference of the orbit by the fibrous membrane of the lids. The outer angle of each cartilage is attached to the malar bone by the external palpebral or tarsal ligament. The inner angles of the two cartilages terminate at the commencement of the lacus lachrymalis, being fixed to the margins of the orbit by the tendo oculi.

The *Fibrous Membrane of the Lids*, or tarsal ligament, is a layer of fibrous membrane beneath the Orbicularis, attached, externally, to the margin of the orbit, and internally to the orbital margin of the lids.

The *Meibomian Glands* are situated upon the inner surface of the eyelids, between the tarsal cartilages and conjunctiva, and may be distinctly seen through the mucous membrane on everting the eyelids, presenting the appearance of parallel strings of pearls. They are about thirty in number in the upper cartilage, and somewhat fewer in the lower. They are imbedded in grooves in the inner surface of the cartilages, and correspond in length with the breadth of each cartilage; they are, consequently, longer in the upper than in the lower eyelids. Their ducts open on the free margin of the lids. These glands are a variety of the cutaneous sebaceous glands, each consisting of a single straight tube or follicle. The cells are charged with a sebaceous secretion, the use of which is to prevent adhesion of the lids.

The *Eyelashes* (*Cilia*) are attached to the free edges of the eyelids; they are short, thick, curved hairs, arranged in a double or triple row at the margin of the lids; those of the upper lid, more numerous and longer than the lower, curve upward; those of the lower lid curve downwards, by which means they do not interlace in closing the lids.

The *Conjunctiva* is the mucous membrane of the eye. It covers the whole of its anterior surface, and is then reflected upon the lids so as to form their internal layer. The duplicatures formed between the globe of the eye and the lids are called the *superior* and *inferior palpebral sinuses*, of which the former is much deeper than the inferior. Where it covers the cornea, the conjunctiva is very thin and closely adherent, and no vessels can be traced into it. Upon the sclerotica it is thicker and less adherent, but upon the inner surface of the lids is very closely connected, and exceedingly vascular. It is continuous with the general gastropulmonary mucous membrane, and sympathizes in its affections, as may be observed in various diseases. From the surface of the eye, it may be traced through the

lachrymal ducts into the lachrymal gland; along the edges of the lids it is continuous with the mucous lining of the Meibomian glands, and at the inner angle of the eye lines the lachrymal canals into the lachrymal sac, and thence downwards through the nasal duct into the inferior meatus of the nose.

The *Caruncula lachrymalis* is the small reddish body which occupies the lacus lachrymalis at the inner cantus of the eye. In health it presents a bright pink tint; in sickness it loses its color and becomes pale. It consists of an assemblage of follicles similar to the Meibomian glands, embedded in a fibro-cartilaginous tissue, and is the source of the whitish secretion which so constantly forms at the inner angle of the eye. It is covered with minute hairs, which are sometimes so long as to be visible to the naked eye.

Immediately to the outer side of the caruncula is a slight duplicature of the conjunctiva, called *plica semilunaris*, which contains a minute plate of cartilage, and is the rudiment of the third lid of animals, the *membrana nictitans* of birds.

Vessels and Nerves.—The palpebræ are supplied internally with *arteries* from the ophthalmic, and externally from the facial and transverse facial. Their *nerves* are branches of the fifth and of the facial.

The *Lachrymal apparatus* consists of the lachrymal gland with its excretory ducts, the puncta lachrymalia, and lachrymal canals, the lachrymal sac and nasal duct.

The *Lachrymal Gland* is situated at the upper and outer angle of the orbit, and consists of two portions, orbital and palpebral. The *orbital portion*, about three-quarters of an inch in length, is flattened and oval in shape, and occupies the lachrymal fossa in the orbital plate of the frontal bone. It is in contact superiorly with the periosteum, with which it is closely connected by its upper and convex surface; by its inferior or concave surface it is in relation with the globe of the eye, and the superior and external rectus; and by its anterior border with the broad tarsal ligament. By its posterior border it receives its vessels and nerves. The *palpebral portion*, smaller than the preceding, is situated in the upper eyelid extending downwards to the superior margin of the tarsal cartilage. It is continuous with the orbital portion above, and is enclosed in an investment of dense fibrous membrane. The secretion of the lachrymal gland is conveyed away by from eight to twelve small ducts which run for a short distance beneath the conjunctiva, and open upon its surface by a series of pores, about one-twentieth of an inch apart, situated in a curved line a little above the upper border of the tarsal cartilage.

Lachrymal Canals.—The lachrymal canals commence at the minute openings, puncta lachrymalia, seen upon the lachrymal papillæ of the lids at the outer extremity of the lacus lachrymalis, and proceed inwards to the lachrymal sac, where they terminate beneath a valvular semi-lunar fold of the lining membrane of the sac. The *superior* duct at first ascends, and then turns suddenly inwards towards the sac, forming an abrupt angle. The *inferior* duct forms the same kind of angle by descending at first, and then turning abruptly inwards. They are dense and elastic in structure, and remain constantly open, so that they act like capillary tubes in absorbing the tears from the surface of the eye. The two fasciculi of the tensor tarsi muscle are inserted into these ducts, and serve to draw them inwards.

The *Lachrymal Sac* is the upper extremity of the nasal duct, and is scarcely more dilated than the rest of the canal. It is lodged in the groove of the lachrymal bone and is often distinguished, internally, from the nasal duct by a semi-lunar or circular valve. The sac consists of mucous membrane, but is covered in and retained in its place by a fibrous expansion, derived from the tendon of the orbicularis, which is inserted into the ridge on the lachrymal bone; it is also covered by the tensor tarsi muscle, which arises from the same ridge, and in its action upon the lachrymal canals may serve to compress the lachrymal sac.

The *Nasal Duct* is a short canal about three-quarters of an inch in length, directed downwards, backwards, and a little outwards to the inferior meatus of the nose, where it terminates by an expanded orifice. It is lined by mucous membrane which is continuous with the conjunctiva above, and with the pituitary membrane of the nose below. Obstruc-

tion from inflammation and suppuration of this duct constitutes the disease called fistula lachrymalis.

Vessels and Nerves.—The lachrymal gland is supplied with blood by the lachrymal branch of the ophthalmic artery, and with nerves by the lachrymal branch of the ophthalmic artery, and orbital branch of the superior maxillary.

MUSCLES.

The following six muscles move the eye:—The Superior, Inferior, Internal and External Recti; and the Superior, and Inferior Oblique.

The *Rectus Superior* (attollens) *arises* from the upper margin of the optic foramen, and from the fibrous sheath of the optic nerve, and is *inserted* into the upper surface of the globe of the eye at a point somewhat more than three lines from the margin of the cornea.

The *Rectus Inferior* (depressor) *arises* from the inferior margin of the optic foramen by a tendon (ligament of Zinn) which is common to it, the internal and the external rectus, and from the fibrous sheath of the optic nerve; it is *inserted* into the inferior surface of the globe of the eye at a little more than two lines from the margin of the cornea.

The *Rectus Internus* (abductor), the thickest and shortest of the straight muscles, *arises* from the common tendon, and from the fibrous sheath of the optic nerve; and is *inserted* into the inner surface of the globe of the eye at two lines from the margin of the cornea.

The *Rectus Externus* (abductor), the longest of the straight muscles, *arises* by two distinct heads, one from the common tendon, the other with the origin of the superior rectus from the margin of the optic foramen; the nasal, third, and sixth nerves passing between its heads. It is *inserted* into the outer surface of the globe of the eye at a little more than two lines from the margin of the cornea.

The *Obliquus Superior* (trochlearis) is a fusiform muscle *arising* from the margin of the optic foramen, and from the fibrous sheath of the optic nerve; it passes forwards to the pulley beneath the internal angular process of the frontal bone; its tendon is then reflected beneath the superior rectus muscle to the outer and posterior part of the globe of the eye, where it is *inserted* into the sclerotic coat, near the entrance of the optic nerve. The tendon is surrounded by a synovial membrane, while passing through the cartilaginous pulley.

The *Obliquus Inferior*, a thin and narrow muscle, *arises* from the inner margin of the superior maxillary bone, immediately external to the lachrymal groove, and passes beneath the inferior rectus to be *inserted* into the outer and posterior part of the eyeball, at about two lines from the entrance of the optic nerve.

APONEUROSIS.

The *Orbito Ocular Aponeurosis* is a fibrous membrane starting from the base of the orbit contiguous with the periosteum of that cavity; it forms a conical envelope which extends backwards to the optic nerve, enclosing the eyeball, its muscles, accessories, and fat, and is suspended in the fat of the orbit.

THE EYE.

The form of the eyeball is that of a sphere of about one inch in diameter, having the segment of a smaller sphere engrafted upon its anterior surface, which increases its antero-posterior diameter. The axes of the two eyeballs are parallel with each other, but do not correspond with the axis of the orbits, which are directed outwards. The optic nerves follow the direction of the orbits, and therefore enter the eyeballs to their nasal side.

The *Globe of the Eye* is composed of *tunics*, and of refracting media called *humours*.

The *tunics* are three in number, the

1. Sclerotic and Cornea.
2. Choroid, Iris, and Ciliary processes.
3. Retina and Zonula ciliaris.

The *humours* are also three—Aqueous, Crystalline (lens), Vitreous.

FIRST TUNIC.—The Sclerotic and Cornea form the external tunic of the eyeball, and give it its peculiar form. Four-fifths of the globe are invested by the sclerotic, the remaining fifth by the cornea.

The *Sclerotic* is a dense fibrous membrane, thicker behind than in front. It is continuous, posteriorly, with the sheath of the optic nerve, which is derived from the dura mater, and is pierced by that nerve as well as by the ciliary nerves and arteries. Anteriorly it presents a bevelled edge, which receives the cornea in the same way that a watch-glass is received by the groove in its case. Its anterior surface is covered by a thin tendinous layer, the *tunica albuginea*, derived from the expansion of the tendons of the four recti muscles. By its posterior surface it gives attachment to the two oblique muscles. The *tunica albuginea* is covered, for a part of its extent, by the mucous membrane of the front of the eye, the conjunctiva; and by reason of the brilliancy of its whiteness, gives occasion to the common expression, "the white of the eye."

At the entrance of the optic nerve, the sclerotic forms a thin *cribriform lamella* (*lamina cribrosa*), which is pierced by a number of minute openings for the passage of the nervous filaments. One of these openings, larger than the rest, and situated in the centre of the lamella, is the *porus opticus*, through which the *arteria centralis retinae* enters the eyeball.

The *Cornea* (corneus, horny) is the transparent projecting layer that constitutes the anterior fifth of the globe of the eye. In its form it is circular, concava-convex, and resembles a watch-glass. It is received by its edge, which is sharp and thin, within the bevelled border of the sclerotic, to which it is very firmly attached, and it is somewhat thicker than the anterior portion of that tunic. When examined from the exterior, its vertical diameter is seen to be about one-sixteenth shorter than the transverse, in consequence of the overlapping above and below of the margin of the sclerotica; on the interior, however, its outline is perfectly circular.

The cornea is composed of four layers, namely: of the conjunctiva; of the cornea proper, which consists of several thin lamellæ connected together by an extremely fine areolar tissue; of the cornea elastica, a "fine, elastic, and exquisitely transparent membrane, exactly applied to the inner surface of the cornea proper," and of the lining membrane of the anterior chamber of the eyeball. The cornea elastica is remarkable for its perfect transparency, even when submitted for many days to the action of water or alcohol; while the cornea proper is rendered opaque by the same immersion. Another character of the cornea elastica is its great elasticity, which causes it to roll up when divided or torn in the same manner as the capsul of the lens. The use of this layer is to preserve the requisite permanent correct curvature of the flaccid cornea proper.

The opacity of the cornea, produced by pressure on the globe, results from the infiltration of fluid into the areolar tissue connecting its layers. This appearance cannot be produced in a sound, living eye, although a small quantity of serous fluid (*liquor corneæ*) is said to occupy the cells of the areolar tissue.

SECOND TUNIC.—The second tunic of the eyeball is formed by the *choroid*, *ciliary ligament*, and *iris*, the *ciliary* processes being an appendage developed from its inner surface.

The *Choroid* is a vascular membrane of a rich chocolate-brown color upon its external surface, and of a deep black color within. It is connected to the sclerotic externally, by an extremely fine areolar tissue (*membrana fusca*), and by nerves and vessels. Internally it is in simple contact with the third tunic of the eye, the retina. It is pierced posteriorly for the passage of the optic nerve, and is connected anteriorly with the iris, ciliary processes, and with the line of junction of the cornea and sclerotic, by a dense white structure, the *ciliary ligament*, which surrounds the circumference of the iris like a ring.

The choroid membrane is composed of three layers: an *external* or *venous* layer, which consists principally of veins arranged in a peculiar manner, hence they have been named *venae vorticosae*. The marking on the surface of the membrane, produced by these veins, resembles so many centres to which a number of curved lines converge. It is this layer

which is connected with the ciliary ligament. The *middle* or *arterial layer* (*tunica Ruyschiana*) is formed principally by the ramifications of minute arteries. It is reflected inwards at its junction with the ciliary ligament, so as to form the ciliary processes. The *internal layer* is a delicate membrane (*membrana pigmenti*) composed of several laminæ of nucleated hexagonal cells, which contain the granules of pigmentum nigrum, and are arranged so as to resemble a tessellated pavement.

In animals, the pigmentum nigrum, on the posterior wall of the eyeball, is replaced by a layer of considerable extent, and of metallic brilliancy, called the tapetum.

The *Ciliary Ligament*, or circle (*annulus albidus*), is the bond of union between the external and middle tunics of the eyeball, and serves to connect the cornea and sclerotic, at their line of junction, with the iris and external layer of the choroid. It is also the point to which the ciliary nerves and vessels proceed previously to their distribution, and it receives the anterior ciliary arteries through the anterior margin of the sclerotic. A minute vascular canal is situated within the ciliary ligament, called the ciliary canal, or the canal of Fontana, from its discoverer.

The *Iris* (iris, a rainbow) is so named from its variety of color in different individuals; it forms a septum between the anterior and posterior chambers of the eye, and is pierced somewhat to the nasal side of its centre by a circular opening, which is called the *pupil*. By its periphery it is connected with the ciliary ligament, and by its inner circumference forms the margin of the pupil; its anterior surface looks towards the cornea, and the posterior towards the ciliary processes and lens.

The iris is composed of two layers, an *anterior* or *muscular*, consisting of *radiating* fibres which converge from the circumference towards the centre, and have the power of dilating the pupil; and *circular*, which surrounds the pupil like a sphincter, and by their action produce contraction of its area. The posterior layer is of a deep purple tint, and is thence named *uvea*, from its resemblance in color to a ripe grape.

The *Ciliary Processes* (*corpus ciliare*) may be seen in two ways, either by removing the iris from its attachment to the ciliary ligament, when a front view of the processes will be obtained, or by making a transverse section through the globe of the eye, when they may be examined from behind.

The ciliary processes consist of a number of triangular folds, formed apparently by the plaiting of the middle and internal layer of the choroid. According to Zinn, they are about sixty in number, and may be divided into large and small, the latter being situated in the spaces between the former. Their periphery is connected with the ciliary ligament, and is continuous with the middle and internal layer of the choroid. The central border is free, and rests against the circumference of the lens. The anterior surface corresponds with the uvea; the posterior receives the folds of the zonula ciliaris between its processes, and thus establishes a connection between the choroid and the third tunic of the eye. The ciliary processes are covered with a thick layer of pigmentum nigrum, which is more abundant upon them, and upon the anterior part of the choroid, than upon the posterior part. When the pigment is washed off, the processes are of a whitish color.

THIRD TUNIC.—The third tunic of the eye is the *retina*, which is prolonged forwards to the lens by the *zonula ciliaris*.

The *Retina* is composed of three layers: *External*, or Jacob's membrane,
Middle, nervous membrane,
Internal, vascular membrane.

Jacob's Membrane is extremely thin, and is seen as a mere film when the freshly dissected eye is suspended in water. Examined by the microscope, it is found to be composed of cells having a tessellated arrangement. Dr. Jacob considers it to be a serous membrane.

The *Nervous Membrane* is the expansion of the optic nerve, and forms a thin, semi-transparent, bluish-white layer, which envelopes the vitreous humour, and extends forwards to the commencement of the ciliary processes, where it terminates by an abrupt scal-

loped margin. According to Treviranus, this layer is composed of cylindrical fibres, which proceed from the optic nerve, and, near their termination, bend abruptly inwards, to form the internal papillary layer, which lies in contact with the hyaloid membrane, each fibre constituting by its extremity a distinct papilla.

The *Vascular Membrane* consists of the ramifications of a minute artery, the *arteria centralis retinae*, and its accompanying vein; the artery pierces the optic nerve, and enters the globe of the eye through the *porus opticus*, in the centre of the *lamina cribrosa*. This artery may be seen very distinctly by making a transverse section of the eyeball. Its branches are continued anteriorly into the *zonula ciliaris*. The vascular layer forms distinct sheaths for the nervous papillæ, which constitute the inner surface of the retina.

In the centre of the posterior part of the globe of the eye, the retina presents a circular spot, which is called the *foramen of Soemmering*; it is surrounded by a yellow halo, the *limbus luteus*, and is frequently obscured by an elliptical fold of the retina, which has been regarded as a normal condition of the membrane. The term foramen is misapplied to this spot, for the vascular layer and the membrane *Jacobi* are continued across it; the nervous substance alone appearing to be deficient. It exists only in animals having the axes of the eyeballs parallel with each other, as man, quadrumana, and some saurian reptiles, and is said to give passage to a small lymphatic vessel.

The *Zonula Ciliaris* (*zonula of Zinn*) is a thin vascular layer, which connects the anterior margin of the retina with the anterior surface of the lens near its circumference. It presents upon its surface a number of small folds corresponding with the ciliary processes, between which they are received. These processes are arranged in the form of rays around the lens, and the spaces between them are stained by the *pigmentum nigrum* of the ciliary processes. They derive their vessels from the vascular layer of the retina. The under surface of the *zonula* is in contact with the hyaloid membrane, and around the lens forms the anterior fluted wall of the *canal of Petit*.

The connection between these folds and the ciliary processes may be very easily demonstrated by dividing an eye transversely into two portions, then raising the anterior half, and allowing the vitreous humour to separate from its attachment by its own weight. The folds of the *zonula* will then be seen to be drawn out from between the folds of the ciliary processes.

HUMOURS.—The *Aqueous Humour* is situated in the anterior and posterior chambers of the eye; it is a weakly albuminous fluid, having an alkaline reaction, and a specific gravity very little greater than that of distilled water. According to Petit, it scarcely exceeds four or five grains in weight. The *anterior chamber* is the space intervening between the cornea in front, and the iris and pupil behind. The *posterior chamber* is the narrow space, less than half a line in depth, bounded by the posterior surface of the iris and pupil in front, and by the ciliary processes, *zonula ciliaris*, and lens behind. The two chambers are lined by a thin layer, the *secreting membrane of the aqueous humour*.

The *Vitreous Humour* forms the principal bulk of the globe of the eye. It is an albuminous and highly transparent fluid, enclosed in a delicate membrane, the *hyaloid*. From the inner surface of this membrane, numerous thin lamellæ are directed inwards, and form compartments in which the fluid is contained. According to Hannover, these lamellæ have a radiated arrangement, like those on the transverse section of an orange, and are about 180 in number. In the centre of the vitreous humour is a tubular canal, through which a minute artery is conducted from the *arteria centralis retinae* to the capsule of the lens. This vessel is injected without difficulty in the fœtus.

The *Crystalline Humour* or *lens* is situated immediately behind the pupil, and is surrounded by the ciliary processes, which slightly overlap its margin. It is more convex on the posterior than on the anterior surface, and is embedded in the anterior part of the vitreous humour, from which it is separated by the hyaloid membrane. It is invested by a peculiarly transparent and elastic membrane, the capsule of the lens, which contains a small

quantity of fluid, called *liquor Morgagni*, and is retained in its place by the attachment of the zonula ciliaris. Dr. Jacob is of opinion that the lens is connected to the capsule by means of areolar tissue, and that the liquor Morgagni is the result of a cadaveric change.

The lens consists of concentric layers, of which the external are soft, the next firmer, and the central form a hardened nucleus. These layers are best demonstrated by boiling, or by immersion in alcohol, when they separate easily from each other. Another division of the lens takes place at the same time: it splits into three triangular segments, which have the sharp edge directed towards the centre, and the base towards the circumference. The concentric lamellæ are composed of minute parallel fibres, which are united with each other by means of scalloped borders, the convexity on the one border fitting accurately the concave scallop upon the other.

Immediately around the circumference of the lens is a triangular canal, the *canal of Petit*, about a line and a half in breadth. It is bounded, in front, by the flutings of the zonular ciliaris; behind, by the hyaloid membrane; and within, by the border of the lens.

The *Vessels* of the globe of the eye are the long and short, and anterior ciliary arteries, and the arteria centralis retinæ. The *long ciliary arteries*, two in number, pierce the posterior part of the sclerotic, and pass forward on each side, between that membrane and the choroid, to the ciliary ligament, where they divide into two branches, which are distributed to the iris. The *short ciliary arteries* pierce the posterior part of the sclerotic coat, and are distributed to the middle layer of the choroid membrane. The *anterior ciliary* are branches of the muscular arteries. They enter the eye through the anterior part of the sclerotic, and are distributed to the iris. It is the increased number of these latter arteries, in iritis, that gives rise to the peculiar red zone around the circumference of the cornea which accompanies that disease.

The *Arteria Centralis Retinae* enters the optic nerve at about half an inch from the globe of the eye, and passing through the porus opticus, is distributed upon the inner surface of the retina, forming its vascular layer; one branch pierces the centre of the vitreous humour and supplies the capsule of the lens.

The *Nerves* of the eyeball are, the optic, two ciliary nerves from the nasal branch of the ophthalmic, and the ciliary nerves from the ophthalmic ganglion.

Observations.—The sclerotic is a tunic of protection, and the cornea a medium for the transmission of light. The choroid supports the vessels destined for the nutrition of the eye, and by its pigmentum nigrum absorbs all loose and scattered rays that might confuse the image impressed upon the retina. The iris, by means of its powers of expansion and contraction, regulates the quantity of light admitted through the pupil. If the iris be thin, and the rays of light pass through its substance, they are immediately absorbed by the uvea, and if that layer be insufficient they are taken up by the black pigment of the ciliary processes. In Albinos, where there is an absence of pigmentum nigrum, the rays of light traverse the iris, and even the sclerotic, and so overwhelm the eye with light, that sight is destroyed, except in the dimness of evening, or at night. In the manufacture of optical instruments, care is taken to color their interior black, with the same object, the absorption of scattered rays.

The transparent lamellated cornea and the humours of the eye have for their office the refraction of the rays in such proportion as to direct the image in the most favorable manner upon the retina. Where the refracting medium is too great, as in over convexity of the cornea and lens, the image falls short of the retina (myopia, near-sightedness); and where it is too little, the image is thrown beyond the nervous membrane (presbyopia, far-sightedness). These conditions are rectified by the use of spectacles, which provide a differently refracting medium externally to the eye, and thereby correct the transmission of light.

EXPLANATION OF THE PLATES

PLATE 1

FIGURES 1 and 2.

External view of eyebrows and eyelashes.

FIGURE 3.

A portion of the eyelid, showing the eyelashes, and their bulbs.

FIGURE 4.

Orbicularis palpebrarum muscle, the fibres of which are traversed by those of the corrugator supercilii which is inserted into the skin.

FIGURE 5.

Fibrous layer.—This figure represents: *a*, external angular ligament;—*b*, internal angular ligament, or tendon of the orbicularis;—*c, c*, Tensor tarsi, and *d*, superciliaris.

FIGURE 6.

Muscular layer of the superior eyelid, and palpebral portion of the Levator palpebræ; the orbital fasciculus, and its connection with the lachrymal gland.

FIGURE 7.

The Levator palpebræ seen from above in connection with the muscles of the eye and the lachrymal gland.

FIGURE 8.

Tarsal cartilages, showing the Meibomian glands.

FIGURE 9.

a, The Meibomian glands as seen on the conjunctival surface of the eyelids.—*b*, Orifices of the canals of the lachrymal gland.—*c*, Lachrymal orifices.

FIGURE 10.

Meibomian glands enlarged.

FIGURE 11.

Conjunctival layer.—*a*. Small semi-lunar fold of the conjunctiva.—*b*, Caruncula lachrymaris.—*c, c*, Anterior border of the eyelid showing the eyelashes.—*d, d*, The orifices of the Meibomian glands.

FIGURE 12.

Palpebral and ocular portion of the conjunctiva.

Fig. 1.



Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.

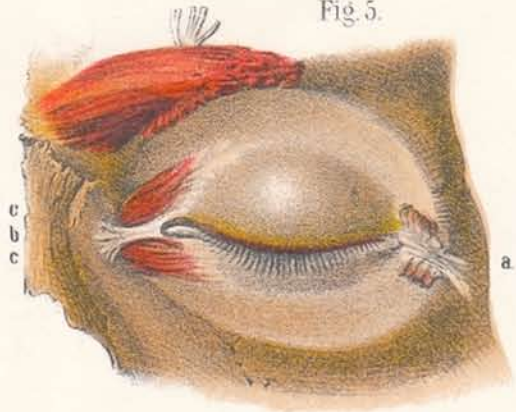


Fig. 6.

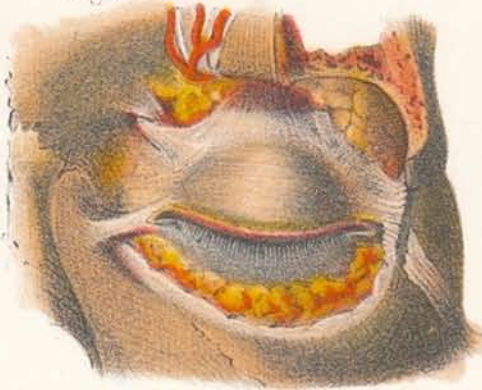


Fig. 7.



Fig. 12.

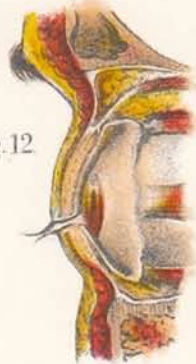


Fig. 9.

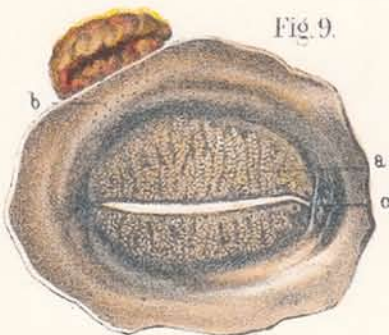


Fig. 10.



Fig. 11.

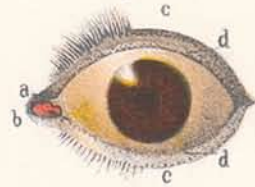


Fig. 8.



PLATE 2

FIGURE 1.

Vascular System.—(Arteries) A, A. Superior and inferior branches of the palpebral arteries.—B. Nasal branch.—C. Frontal branch.—D. Sub-orbital branch. All these branches are formed by the ophthalmic artery.—E, E. Palpebral and temporal branches.—F. Palpebral and Sub-orbital branch.—G. Palpebral branch of the facial.

FIGURE 2.

Veins.—H. Ophthalmic vein.—I. Temporal vein.—J. Facial vein, and branches from the eyelids.

FIGURE 3.

Nervous System.—1. External frontal nerve.—2. Internal frontal.—3. Nasal.—4. Lachrymal.—5. Sub-orbital.—6. Malar. All branches of the fifth pair furnishing the cutaneous ramifications to the eyelids.—7, 7. Facial branches supplying the muscles of the eyelids.

FIGURE 4.

a. Orbital portion of the lachrymal gland.—*b.* Palpebral portion of the lachrymal gland.—*c.* Fibrous lamina separating the gland.—*d, d.* Orifices of the lachrymal canal.—*e, e.* Branches of the lachrymal canal.—*f.* Lachrymal sac.

FIGURE 5.

g. Lachrymal canaliculi and their orifices.—*h.* Lachrymal sac.—*i.* Nasal canal, in the interior of which are located three valves.—*j, j.* Middle and inferior turbinated bones.

FIGURE 6.

k. Middle turbinated bone turned aside and held by a hook.—*l.* Inferior turbinated bone.—*m.* Interior of nasal canal and its three valves.—*n.* Canal leading to the maxillary and frontal sinuses.

Fig 1.

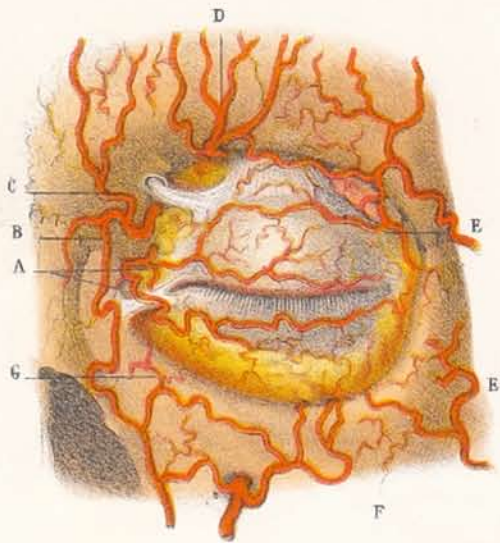


Fig 3.

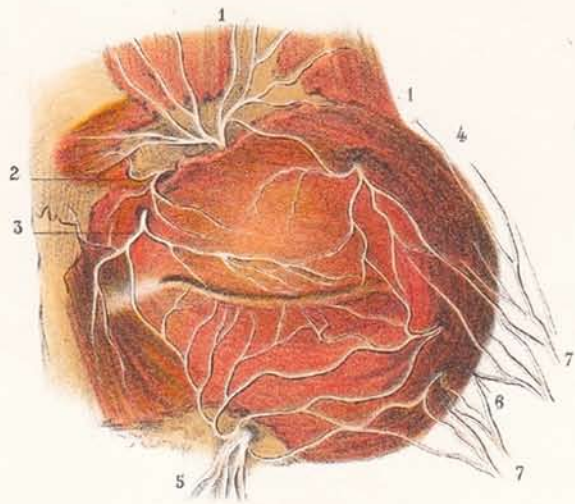


Fig 2.

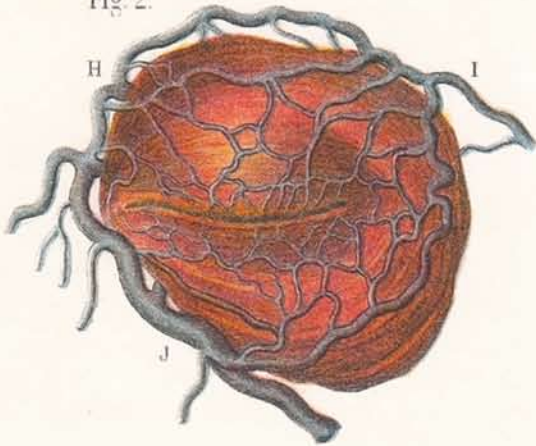


Fig 4.

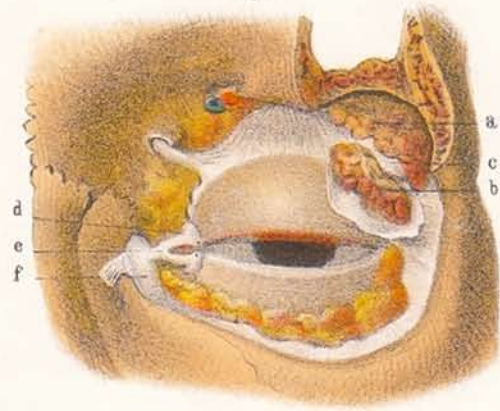


Fig 5.

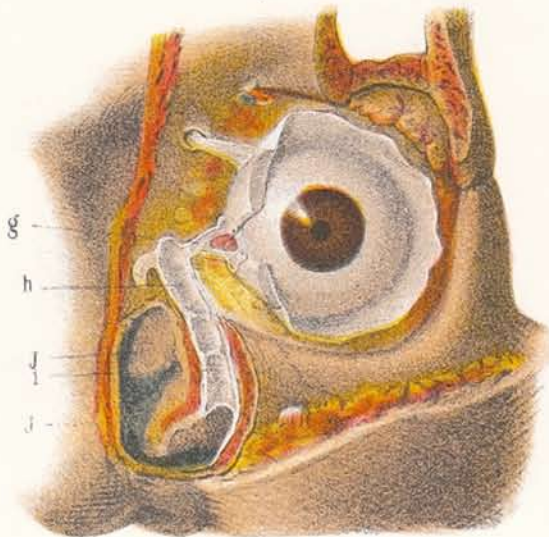


Fig 6.

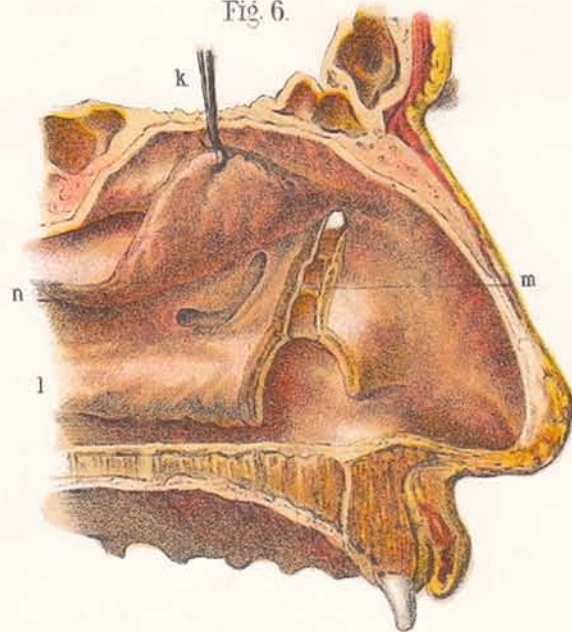


PLATE 3

FIGURE 1.

a, a. Levator palpebræ superior.—*b.* Superior rectus.—*c.* External rectus.—*d.* Internal rectus.—*e.* Superior oblique muscle traversing, *f,* the cartilaginous pulley inserting itself on the ocular globe behind the recti muscles.—*g.* Posterior insertions of the preceding muscle on, *h,* the internal ring for the passage of the optic nerve, and on, *i,* the external ring for the passage of the common ocular motor nerves. Nasal branch of the ophthalmic and external ocular motor.—*j.* Inferior oblique muscle.

FIGURE 2.

a, a. Levator palpebræ superior.—*b.* Superior rectus.—*c.* Inferior rectus.—*d.* External rectus.—*e.* Internal rectus.—*f.* Inferior oblique. All these muscles in the ocular globe are viewed in profile.

FIGURE 3.

a, a. Superior and inferior eyelids turned aside after having been cut on their external commissure. *b.* Anterior concave face of the orbito aponeurosis.—*c.* Section of the optic nerve.—*d, e, f, g, h, i.* Portions of the recti and oblique muscles.

FIGURE 4.

a. Posterior face of the orbito ocular aponeurosis which sends posteriorly a sheath on, *b, c, d, e,* the four recti muscles, and, *f,* and *g,* the superior and inferior oblique muscles, crossing the sheath of the inferior rectus.—*h.* Levator palpebræ with its two orbicular fasciculi, external and internal, also enveloped by the aponeurosis.—*i.* Section of the optic nerve.

FIGURE 5.

A, Section of internal carotid artery giving birth anteriorly to, B, B, the ophthalmic artery. This furnishes thirteen branches which are, C, the central artery of the retina; D, Lachrymal artery; E, Sub-orbital artery; F and G, Superior and inferior muscular; H and I, Anterior and posterior ciliary; J, Posterior ethmoidal artery; K, Anterior ethmoidal artery; L, Superior palpebral; M, Inferior palpebral; N, Frontal; and, O, Nasal, anastomosing with, P, the facial.

FIGURE 6.

A, A, Ophthalmic vein, which is shown in connection with, B, B, the ophthalmic artery; it passes through C, the ophthalmic sinus.

FIGURE 7.

A, A, Ophthalmic vein viewed in profile. The branches divide themselves in nearly the same direction, they bear the same distribution, and the same name as the branches of the artery.

Fig 1.

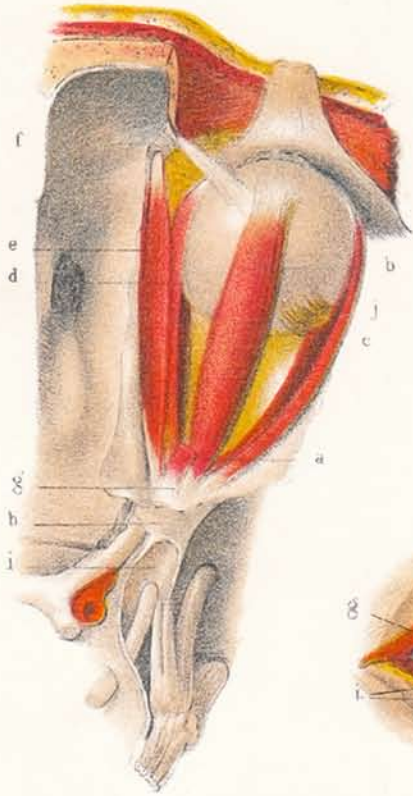


Fig. 2.

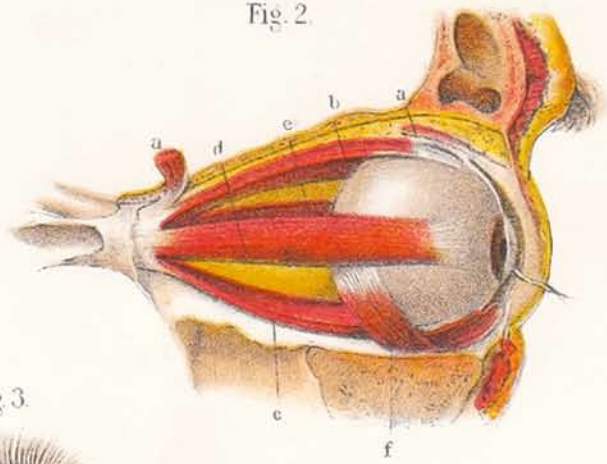


Fig 3.

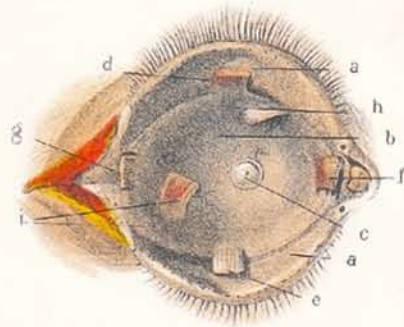


Fig 6.

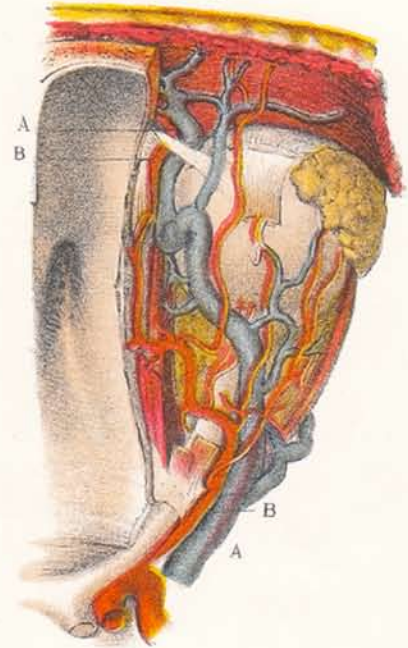


Fig 5.

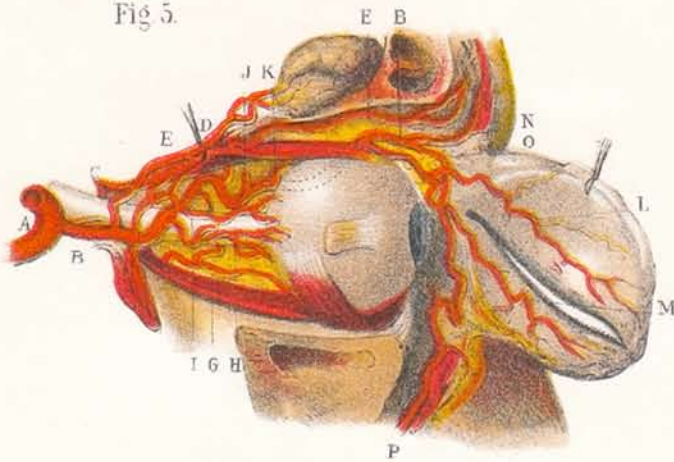


Fig 4.

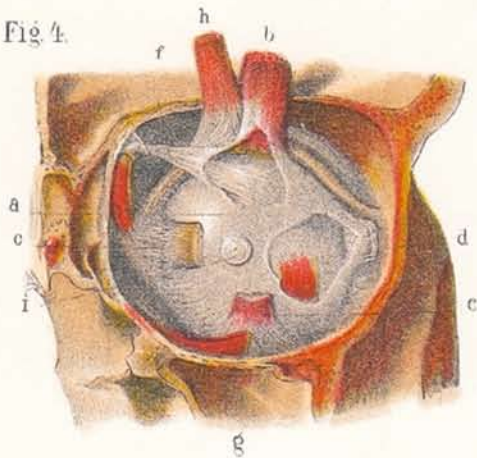


Fig 7.

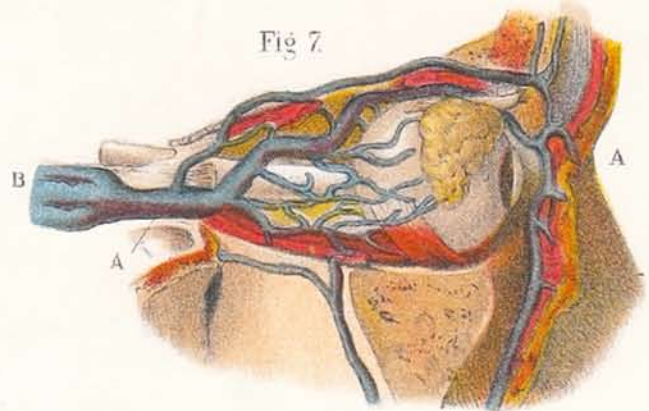


PLATE 4

FIGURE 1.

a. Optic nerve and its fibrous sheath.—*b.* Exterior surface of the sclerotica.—*c.* Transparent cornea through which is seen the iris.

FIGURE 2.

a. Anterior face of the sclerotica.—*b.* Transparent cornea.

FIGURE 3.

Sclerotica traversed backwards and forwards by the ciliary vessels which also send ramifications on its exterior surface.

FIGURE 4.

a. Interior surface of the sclerotica.—*b.* Sheath of the optic nerve.—*c.* Interior surface of the cornea. This figure, as well as Fig. 7, allows us to appreciate the difference in thickness that the sclerotica presents anteriorly and posteriorly and on a level with the insertions of the recti muscles, and shows the transparent cornea is thicker at its centre than at its circumference.

FIGURE 5.

a, a, a. Section of the sclerotica.—*b.* Exterior surface of the choroid on which is shown, *c, c,* vasa vorticosa. On a more superficial plane is shown, *d, d,* the ciliary nerves, which after having traversed the sclerotica, interlace, and form between the sclerotica, and choroid.—*e.* Ciliary ring (Ciliary ganglion).—*f.* Anterior face of the iris.—*g.* Pupillary opening.

FIGURE 6.

a, a. Exterior surface of the choroid and iris, showing the arterial terminations of this two membranes furnished by the ciliary arteries, which after having traversed the sclerotica divide at, *b, b,* the posterior ciliary to supply the choroid, and at, *c, c, c,* the anterior ciliaries destined to the iris.

FIGURE 7.

a, a. Section of the sclerotica.—*b.* Section of the cornea.—*c.* Interior surface of the choroid.—*d.* Ciliary bodies and processes.—*e.* The iris receiving in a circular furrow formed posteriorly, by the ciliary bodies, and, anteriorly, by, *f,* the ciliary ganglion.—*g, g.* Section of the Canal of Fontana.—*h.* Portion of the retina continuing posteriorly with, *i,* the substance of the optic nerve.—*j, j.* Sheath of the optic nerve continuous with the sclerotica.

Fig 1.

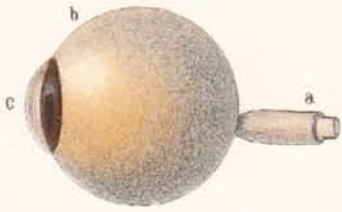


Fig 2.

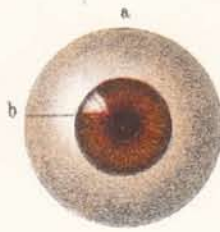


Fig 4.

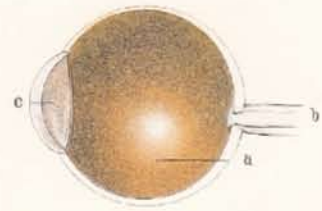


Fig 3.

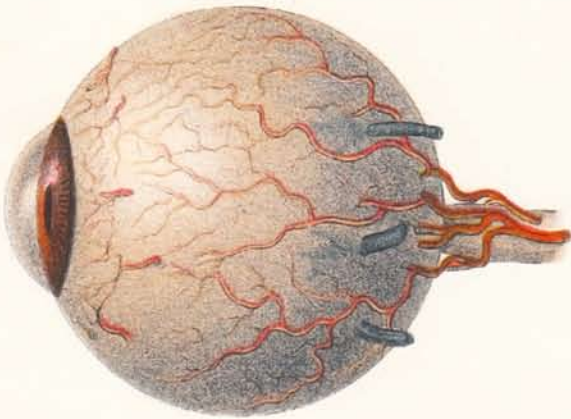


Fig 5.

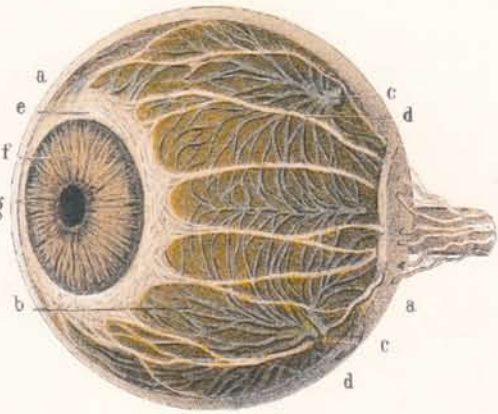


Fig 6.

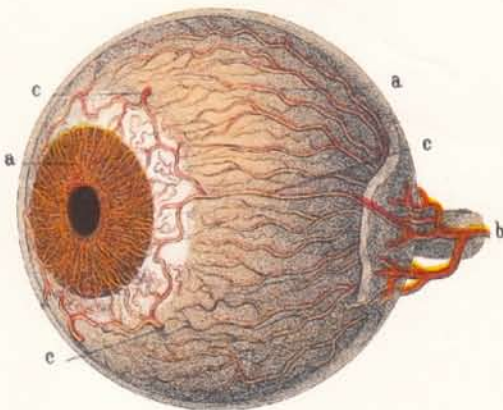


Fig 7.

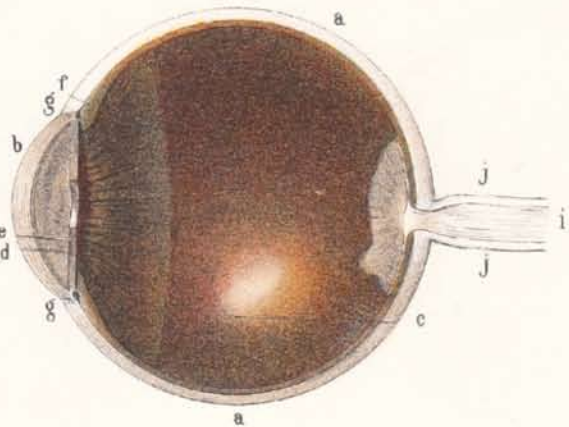


PLATE 5

FIGURE 1.

a, a. The Sclerotica reversed.—*b.* Choroid.—*c, c.* Ciliary nerves traversing the sclerotica and lying between it and the choroid.—*d.* Retina divided.—*e.* Vitreous humour.—*f.* Crystalline lens.—*g.* Middle section of the iris.—*h.* Middle section of the transparent cornea.—*i.* Anterior chamber.—*j.* Posterior chamber.—*k.* Canal Fontana, placed between the ciliary circle and the iris of the one part, and the sclerotica and cornea of the other part.

FIGURE 2.

a. Cornea, cut at the expense of its exterior face to inclose in the cut on the interior surface of, *b, b,* the sclerotica.—*c.* Iris.—*d.* Pupil.—*e.* Ciliary circle.—*f.* Choroid, on which is shown the distribution of the ciliary nerves forming the ciliary circle.—*g.* Ciliary process.—*h.* Crystalline lens.

FIGURE 3.

a, a. Section of the sclerotica.—*b, b.* Choroid.—*c, c.* Ciliary bodies.—*d, d.* Ciliary process, of which a part is reversed from without.—*e.* Posterior face of the iris.—*f.* Pupillary opening through which the cornea is seen.

FIGURE 4.

A, A. Ciliary arteries dividing and anastomosing to form the mesh of the pupillary membrane.

FIGURE 5.

a, a. Retina viewed in profile continuing backwards with the substance of the optic nerve.—*b.* Ciliary ring of Zinn, impinging on, *c,* the external circumference of the lens.—*d.* The choroid reversed.—*e.* The sclerotica reversed.—*f.* Arteries of the retina seen transparent and without injection.

FIGURE 6.

a, a. Retina.—*b, b.* Ciliary circle of Zinn.—*c.* Lens, full face view.

FIGURE 7.

a, a. Interior surface of the posterior half of the retina with its mesh of arteries.—*b.* Limbus luteus.—*c.* Insertion of the optic nerve.—*d.* Choroid.—*e.* Sclerotica.

Fig 1.

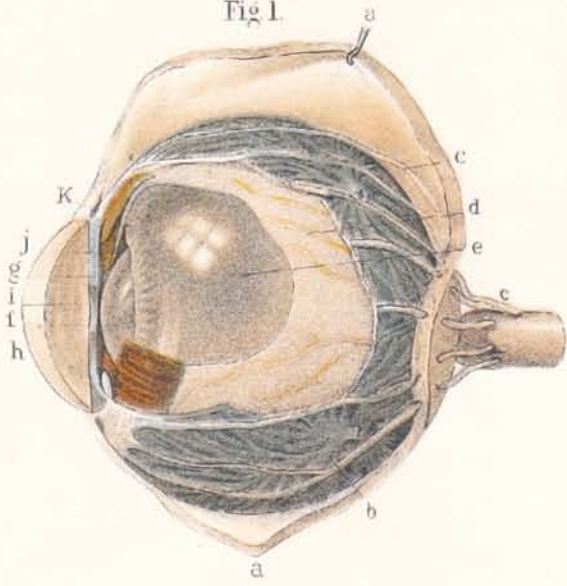


Fig 2.

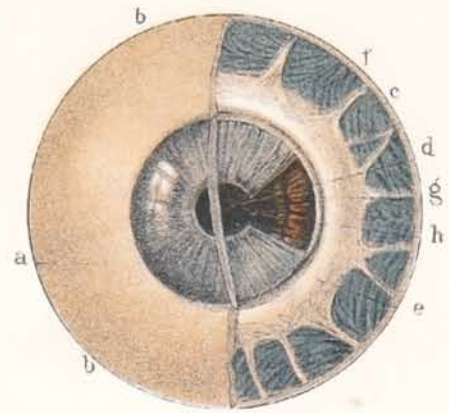


Fig 3.

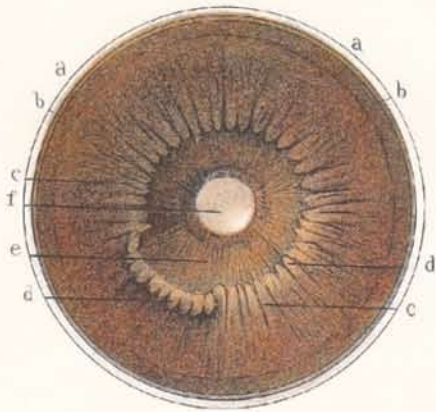


Fig 4.

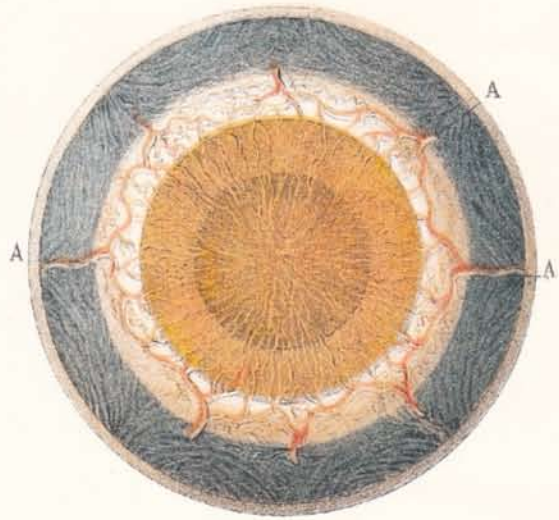


Fig 5.

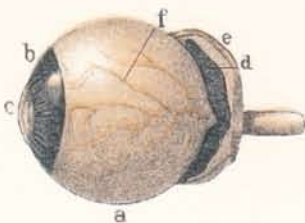


Fig 6.

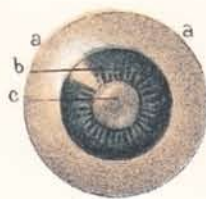


Fig 7.

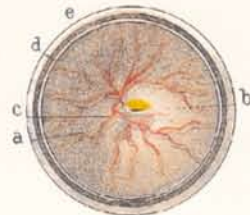


PLATE 6

FIGURE 1.

a, a. The vitreous humour seen in profile; its anterior excavation moulded on the crystalline lens.

FIGURE 2.

a, a. Anterior segment of the vitreous humour, and, *b, b.* of the crystalline lens.—*c.* Ciliary circle of Zinn denuded of the pigment.

FIGURE 3.

Vertical and anterior posterior section of, *a.* Crystalline lens; *b.* Hyaloid membrane; *c.* Ciliary circle of Zinn; *d.* Vitreous humour; and, *e.* Canal of Petit.

FIGURES 4, 5 and 6.

a. Infantile crystalline lens.—*b.* Adult crystalline lens.—*c.* Crystalline lens of the aged.

FIGURES 7 and 8.

a, a, a. The three segments of the anterior face of the crystalline lens.—*b.* Anterior pole.—*c, c, c.* The four segments of the posterior face.—*d.* Posterior pole.

FIGURE 9.

Segmentation of the anterior face of the crystalline lens.—*a.* Kernel of the crystalline lens partly covered.

FIGURE 10.

a. View of the crystalline lens in profile.—*b.* Anterior pole.—*c.* Posterior pole.

FIGURE 11.

Vertical and anterior posterior section of the crystalline lens, on which is seen the concentric disposition of its laminae.

FIGURE 12.

a. Superior eyelid.—*b.* Posterior eyelid showing its different layers.—*c, c.* Reflection of the conjunctiva on the posterior face of the eyelid, and on the anterior face of the ocular globe.—*d, d.* Orbito-ocular aponeurosis, prolonged on, *e.* the sheath of the optic nerve, and on the sheaths of the muscles.—*f.* Superior rectus, and *g.* Inferior rectus.—*h, h.* Sclerotic coat thickened posteriorly by the sheath of the optic nerve, and anteriorly by the expansion of the aponeurosis of the recti muscles.—*i.* Transparent cornea cut to show its laminated texture.—*j, j.* Choroid coat.—*k.* Ciliary circle.—*l.* Ciliary bodies and processes.—*m.* Iris and pupil.—*n, n.* Canal of Fontana.—*o, o.* Retina, continuous with the substance of the optic nerve.—*p.* Ciliary circle of Zinn.—*q, q.* Hyaloid membrane.—*r.* Capsular artery lodged in the hyaloid canal.—*s, s.* Vitreous humour and its cells.—*t.* Crystalline lens and its capsule.—*u, u.* Ruffled canal, or, Canal of Petit.—*v.* Anterior chamber.—*x.* Posterior chamber.

Fig 1.



Fig 2.

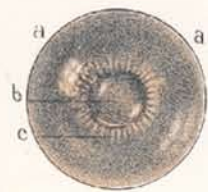


Fig 3.

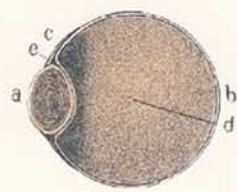


Fig 7.

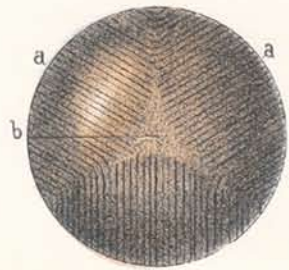


Fig 4.



Fig 5.



Fig 6.



Fig 8.

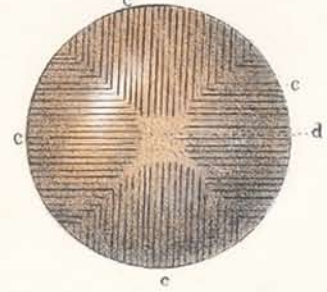


Fig 9.

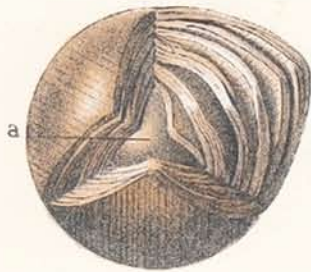


Fig 10.

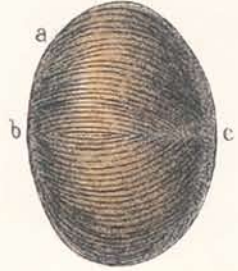


Fig 11.



Fig 12.

