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Matric Number : 17/mhs01/126

Department Medicine and Surgery

1] Write an essay on histological importance of eye in relation to their cellular Function .

## Eye and Retina

### A. Corneal/Sclera

The sclera is the opaque part of the outermost coat or tunic of the eye (the tunica externa) that covers about 5/6 of the eye. The anteriormost 1/6 of the tunica externa is optically transparent and is known as the cornea, which is comprised of three cellular layers and two noncellular layers. The outermost layer is the corneal epithelium which is a **stratified, non-keratinized epithelium** that is continuous with the conjunctival epithelium overlying the adjacent sclera. Deep to the epithelium is Bowman's membrane which is the basement membrane of the corneal epithelium. Underneath Bowman's membrane is the connective tissue of the corneal stroma which makes up much of the cornea. The stroma contains regular, orthogonally arranged bundles of type I collagen as well as FACITs such as collagen type V and hydrated ground substance critical to the optical properties of the cornea. Deep to the stroma is Descemet's membrane which is the basement membrane of the corneal endothelium. The corneal endothelium is a **simple squamous epithelium** facing the anterior chamber of the eye. Transparency of the cornea requires precise control of the hydration of the stroma and it is cells of the corneal endothelium that perform this function. Unlike the corneal epithelium, **corneal endothelial cells have very limited proliferative potential**, so severe damage to this epithelium can only be repaired by transplantation.

The limbus is the region where the cornea transitions to sclera and you'll see this is also where the cornea meets with the tissue of the iris at what is known as the **irideo-corneal angle**. Within the connective tissue of the angle lies a network of endothelial lined channels which is the trabecular meshwork, and deep to the meshwork within the connective tissue of the sclera is the venous canal of Schlemm. Fluid of the aqueous humor produced by the ciliary body (discussed below) in the posterior chamber is absorbed within this meshwork and is drained via the canal of Schlemm into episcleral veins thus maintaining intraocular pressure at around 15 mm Hg.  
**What structural problems in the eye can lead to glaucoma?**

[Answer](https://histology.medicine.umich.edu/resources/eye#answer)

In glaucoma, intraocular pressure of the eye is elevated. This can lead to atrophy of the optic nerve fibers and result in impaired or loss of vision. One cause of this is a backup of aqueous humor in the eye due to blockage of the trabecular meshwork or the canal of Schlemm.

B. Chambers and Lens

There are three recognized chambers of the eye:

1. anterior chamber, the space between the cornea and the iris
2. posterior chamber, the space between the posterior surface of the iris and the anterior surface of the lens.
3. vitreous chamber (or cavity), the space between the posterior surface of lens and the retina

The anterior and posterior chambers contain aqueous humor, which is a watery fluid produced by the ciliary body (discussed below) whereas the vitreous chamber contains the gelatinous vitreous body which is comprised of collagen type II fibers suspended within a highly hydrated gel of hyaluronan, extracellular matrix, and water.

Separating the aqueous chambers from the vitreous chamber is the lens. The lens (particularly the core) is very difficult to section so it is frequently damaged during preparation of microscope slides. However, there is are several features that can still be seen. On the anterior surface (the side facing the direction of incoming light) is the lens capsule, which is actually the basement membrane of the underlying lens epithelium which consists of a layer of epithelial cells that are more squamous toward to the anterior apex of the lens and become taller as you move posteriorly toward the lens equator. At the lens equator, the lens epithlelial cells differentiate into lens cells that elongate and rotate such that they extend from the anterior aspect of the lens to the posterior surface of the lens. As new cells are added peripherally, older cells are pushed inward. The cells eventually become entirely filled with lens crystallin proteins and lose their nuclei as they are pushed toward the core of the lens, at which point they are called lens fibers.  
**What are cataracts and how do they form?**

[Answer](https://histology.medicine.umich.edu/resources/eye#answer)

In older individuals, a pigment collects in the fibers of the lens, reducing its transparency. With time, this pigment builds up and eventually becomes opaque. There are numerous causes of cataracts, some of which are high glucose levels in diabetes and exposure to UV light. Cataracts can be treated by replacing the damaged lens with a new, artificial one.

Upon observation of the areas peripheral to the equator of the lens, you should note the presence of delicate collagenous strands. The fibers constitute what is collectively known as the suspensory ligament or zonule (of Zinn) which runs from the equator of the lens to the ciliary body (discussed below). These fibers anchor the lens in space and allow the ciliary body to affect the curvature of the lens.

### C. Uveal Layer

#### 1. lris

* Iridial stroma with its "uncovered" anterior surface and melanocytes

The iris controls the amount of light that enters through the pupil and divides the anterior chamber from the posterior chamber. On the side facing the anterior chamber is the connective tissue of the irideal stroma. Note that it is not covered by any sort of epithelium and that it consists of a loose connective tissue containing fibroblasts and a variable number of melanocytes. At the pupillary margin of the iris is a band of circularly arranged smooth muscle (so cut in cross section here) known as the sphincter or constrictor pupillae muscle. This muscle receives postganglionic **parasympathetic innervation** from the ciliary ganglion (the preganglionic fibers originate from the accessory occulomotor nucleus (of Edinger-Westphal), and its contraction causes the pupil to **constrict**. Continuing around the pupillary margin, you should note that the portion of the iris facing the posterior chamber consists of two prominent cell layers, the most obvious being the posterior pigmented epithelium. The pigment serves the obvious function of blocking light such that only that coming through the pupil is focused through the lens onto the retina. Just above the pigmented epithelium is a slightly less pigmented anterior epithelium which actually consists of myoepithelial cells that are specialized such that they project their contractile portions (the eosinophilic layer just above the pigmented portion) in a radial manner so that they cause the pupil to **dilate** when they contract. Thus, this muscular portion of the anterior epithelium constitutes the dilator pupillae muscle, and you should recall that this muscle receives postganglionic **sympathetic innervation** from the superior cervical ganglion. Note that these two muscles are in a constant "tug of war" such that **inhibition of sympathetic input** (e.g. Horner's syndrome) will result in obvious **constriction of the pupils** (a condition known as "miosis") whereas**inhibition of parasympathetic input** (such as treatment with eye drops containing a parasympathetic antagonist like atropine) will **result in dilation of the pupils** (a.k.a. "myadriasis").

#### 2. Ciliary body

* ).

The ciliary body functions primarily to control the shape of the lens and produce aqueous humor. Just behind the iris, the surface of the ciliary body is thrown into folds known as ciliary processes. The innermost cells facing the "lumen" of the eyeball are non-pigmented and are ultimately continuous with the ganglion cell layer of the neural retina, however these cells are obviously NOT neural. Instead, you should note that they are cuboidal and, particularly along the ciliary processes, quite eosinophilic which is due to their high content of mitochondria and ion channels essential for their primary role in the **production of aqueous humor**. Recall that aqueous humor produced here flows from the posterior chamber through the opening at the iris into the anterior chamber and is then drained via the trabecular meshwork and the canal of Schlemm. Deep to the non-pigmented epithelium is a layer of pigmented cells which is ultimately continuous with the pigmented cells of the visual (or "neural") retina. Above the pigmented epithelium is a rich vascular bed which is ultimately continuous with the choriocapillary layer of the neural retina. This vascular supply is particularly necessary for metabolic support of the aqueous humor-producing cells and the ciliary muscle, discussed below.

The bulk of the ciliary body consists of longitudinally, radially, and circularly arranged bundles of smooth muscle which is collectively known as the ciliary muscle within what is also technically part of the choroid layer. Like the sphincter pupillae, the ciliary muscle also receives postganglionic **parasympathetic innervation** from the ciliary ganglion (the preganglionic fibers originate from the accessory occulomotor nucleus (of Edinger-Westphal). During the process known as accommodation, the circularly oriented muscle fibers contract, thus constricting this ring of muscle. This, in turn, **releases** tension on the suspensory ligaments (or zonules of Zinn) that run from the ends of the ciliary processes to the equator of the lens thus causing the lens to become **more spherical** to increase its focal power necessary for near vision. Because the sphincter pupillae is also innervated by the same parasympatheitc fibers, the pupil will also constrict during this process thus increasing the "depth of field" which also helps for near vision.

#### 3. Choroid

**Slide EYE-2** [Webscope(link is external)](http://141.214.65.171/Histology/Central%20Nervous%20System/EYE-2_HISTO_20X.svs/view.apml?x=0.2639450185&y=0.1851506130&zoom=100.0000000000&transform=) [ImageScope(link is external)](http://141.214.65.171/Histology/Central%20Nervous%20System/EYE-2_HISTO_20X.svs/is.sis?x=0.2639450185&y=0.1851506130&zoom=100.0000000000&transform=&chost=141.214.65.171)

* Melanocyte layer
* Choriocapillary layer
* Glassy (Bruch's) membrane (a thickened "basement membrane" composed of the basal laminae of the pigment epithelial cells and choroid capillary endothelium plus some intervening choroid elastic and collagen fibrils)

The choroid is an element of the tunica vasculosa and consists of three obvious layers. Closest to the connective tissue sclera is a layer of pigmented melanocytes. Next is an extensive capillary bed of the choriocapillary layer followed by Bruch's membrane, which is a common basement membrane shared by the capillary endothelial cells and the adjacent pigmented epithelium of the retina (discussed below). The cells of the "outer retina" (e.g. the rod and cone photoreceptors) receive metabolic support from the choriocapillaris via exchange of materials across this basement membrane.

### C. Retina

#### 1. Ora serrata

This line marks the termination of the photoreceptive cells of the retina anteriorly. Anterior to this point, the "retina" appears just as a two layered structure with an inner, non-pigmented columnar-cuboidal epithelium and an outer layer of pigmented epithelium that forms the lining of the ciliary body and posterior surface of the iris. (Think of the embryology. The pupillary margin of the iris marks the folded anterior edge of the developing optic cup. This may help you figure out where basement membranes ought to be.)

#### 2. Layers of the retina

1. retinal pigment epithelium (RPE)
2. layer of rod and cone cells outer segments
3. outer limiting membrane
4. outer nuclear layer
5. outer plexiform layer
6. inner nuclear layer
7. inner plexiform layer
8. ganglion cell layer
9. nerve fiber layer
10. internal limiting membrane

The retina actually consists of two components: an outermost layer of **retinal pigment epithelium** (RPE), which is composed of single layer of cuboidal melanin-containing cells and the **neural retina** which is a multilayered structure containing photoreceptors as well as neurons and glia. In life, these two components are fused into what we typically call the retina, and it is subdivided into 10 recognizable layers.

As mentioned above, the outermost layer (closest to the choriocapillaris) is the retinal pigment epithelium which is a single layer of pigmented cells that absorb light, thus preventing stray light from inappropriately reflecting back onto the rods and cones which have their outer segments in close contact with the apices of the pigmented epithelial cells. Tight junctions between the RPE cells also establish a blood-retina barrier to regulate the exchange of materials from the blood to the retina. The next layer is the layer of rod and cone outer segments, which, for the rod cells, are cylindrical whereas for the cone cells these outer segments are conical. Recall that rods are more sensitive to light and thus are the receptors primarily used in periods of low light intensity, but the resulting image is monochromatic. Cones, on the other hand, are sensitive to specific wavelengths of light allowing you to discern colors and more detailed visual information, but they require more intense lighting.

After the rod and cone outer segments is the outer limiting membrane, which is a dense line formed by the junctional complexes between the rod and cone cells and the supportive Müller glia. It separates the outer segments which are rich in photosensitive pigments from the rest of the retina which functions primarily to integrate and process the signals initiated by the rod and cone cells. Next is the outer nuclear layer consisting of the somata and nuclei of rod and cone cells. In general, the rod cell nuclei are typically small and spherical and located at all levels of the layer whereas the cone cell nuclei are larger and more ovoid and usually located just to the inside of the outer limiting membrane. From this layer, the rod and cone cells project their processes into the outer plexiform layer where they synapse with neuronal elements from the inner nuclear layer which is a highly complex layer containing the cell bodies of bipolar cells, horizontal cells, amacrine cells, and Müller glia cells (these cannot be told apart in routine H&E sections, but you should be aware that they are in this layer). The Müller glia, of course, are the primary support cell of the neural retina whereas the other cells of this layer are neurons that perform the initial processing of visual information and then relay that on to the retinal ganglion cells. The relaying of this information takes place in the inner plexiform layer which contains the axons of bipolar and amacrine cells and the dendritic trees of the retinal ganglion cells, the somata and nuclei of which reside in the retinal ganglion cell layer. The cells of this layer are indeed sensory neurons of variable size (correlated with slightly different functional characteristics) that receive input from the amacrine and bipolar cells and send that along to other components of the visual system via axons that travel in the nerve fiber layer containing **non-myelinated axons** and supportive **astroglia**. These axons coalesce at the optic disc and then exit the eye via the optic nerve. The final element of the neural retina is a thin internal limiting membrane consisting of the expanded terminal portions of Müller glia and a basement membrane that delimits the neural retina from the vitreal cavity.

#### 3. Location of blood vessels

Note that there is a dual blood supply for the retina with the outer layers supplied from vessels in the choriocapillaris and the inner layers supplied by retinal vessels that branch from the central retinal artery.

#### 4. Where retinal detachment occurs

The retina develops from two opposing epithelia of the optic cup that eventually fuse into a single structure with the apical domain of the outer epithelium (the pigment epithelium) ultimately coming into contact with the apical domain of the inner neuroepithelium (rod and cone outer segments of the neural retina). As a result, the **weakest** point of the retina is at this interface of the pigment epithelium and the rod and cone cell outer segments and **it is along this plane where "retinal detachment" usually occurs**. Because the outer layers of neural retina are so dependent upon the pigment epithelium and choriocapillaris for metabolic support, the result of such detachment can be irreversible ischemia and necrosis of the rod and cone cells, thus causing permanent blindness.

#### 5. Emergence of optic nerve (optic disc)

**Slide EYE-2** [Webscope(link is external)](http://141.214.65.171/Histology/Central%20Nervous%20System/EYE-2_HISTO_20X.svs/view.apml?x=0.2814771263&y=-0.0711572619&zoom=16.1505582890&transform=) [ImageScope(link is external)](http://141.214.65.171/Histology/Central%20Nervous%20System/EYE-2_HISTO_20X.svs/is.sis?x=0.2814771263&y=-0.0711572619&zoom=16.1505582890&transform=&chost=141.214.65.171)

The point at which all of the axons from the retinal ganglion cells converge and exit the eye via the optic nerve is the optic disc. You should note that there is a break in the retina at this point, so this area is incapable of detecting light and therefore produces a blind spot in your lateral visual field. demonstration of blind spot caused by the optic disc [Image](https://histology.medicine.umich.edu/sites/default/files/blindSpot768x1024.jpg)

#### 6. Fovea

**Slide EYE-1** Posterior eye (monkey) (retina) H&E [Webscope(link is external)](http://141.214.65.171/Histology/Central%20Nervous%20System/EYE-1_HISTO_20X.svs/view.apml) [Imagescope(link is external)](http://141.214.65.171/Histology/Central%20Nervous%20System/EYE-1_HISTO_20X.svs/is.sis?chost=virtualslides.med.umich.edu)

The fovea is a small shallow depression in the central region of the eye located such that most of the incident light collected by the cornea and lens is focused onto this region. Most of the inner layers of the retina are markedly reduced or absent and what dominates is a layer of photoreceptors **composed entirely of cone cells** that are more slender and rodlike than they are elsewhere to accommodate their dense packing. Peripheral to the fovea, you should note that the inner nuclear layer and ganglion cell layer is much thicker compared to other parts of the retina. This is because unlike other areas of the retina where ganglion cells may receive input from many photoreceptors, for the fovea, there is close to a 1:1 ratio of ganglion cells to photoreceptors to allow for **very fine discrimination of colors and details**. However, in order to allow light to pass unimpeded to the photoreceptors, the all of the associated ganglion cells and cells of the inner nuclear layer are heaped up on the sides of the fovea. Retinal vessels are also absent in the region of the fovea for the same reason.

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2] corona virus enters the eyes and implicate the immune system

The virus circulates through droplets in the air spread by coughing or sneezing, and enters the body through the eyes . It can remain viable on surfaces for hours to days, and may be able to enter the lungs directly when inhaled.

After entering the body, the virus spreads to the back of the nasal passage and to mucous membranes in the throat, attaching to the body’s cell receptors.

### The viral particles hook onto the outer walls of the host’s cells, the virus’s genetic material breaches the cell membrane, and it then hijacks the cell into making more copies of the virus. The virus copies proliferate, break out of the cell, and infect other cells in the body. A single cell can churn out millions of copies of the virus before it dies.

### Into the lungs

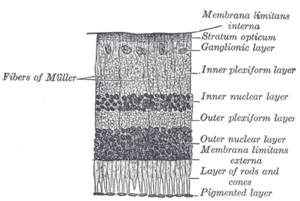
The infection can then reach the lungs, causing inflammation in their mucous membranes and damaging their air sacs. The inflammation hampers the lungs’ ability to oxygenate the blood and remove carbon dioxide from the bloodstream. The COVID-19 lung infection appears to start on the outer parts of the sides of the lung, then moves to more central areas, including the upper respiratory tract and trachea.

The virus can also enter the bloodstream, and may be able to infect the gastrointestinal system, causing symptoms like diarrhea and indigestion. The infection can also directly damage organs including the heart, kidneys, and liver, and cause bone marrow to become inflamed. Small blood vessels may also be vulnerable to inflammation.

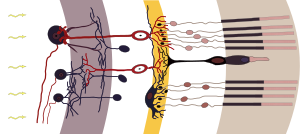
The body’s own immune response to the infection can cause inflammation and organ malfunction. It is still unclear if the brain is affected.

3] Briefly Discuss the layers of the Retina

Retina Layers

[](https://en.wikipedia.org/wiki/File:Gray881.png)

Section of retina

[](https://en.wikipedia.org/wiki/File:Retina-diagram.svg)

Rods, cones and nerve layers in the retina. The front (anterior) of the eye is on the left. Light (from the left) passes through several transparent nerve layers to reach the rods and cones (far right). A chemical change in the rods and cones send a signal back to the nerves. The signal goes first to the [bipolar](https://en.wikipedia.org/wiki/Retina_bipolar_cell) and [horizontal cells](https://en.wikipedia.org/wiki/Retina_horizontal_cell) (yellow layer), then to the [amacrine cells](https://en.wikipedia.org/wiki/Retina_amacrine_cell) and [ganglion cells](https://en.wikipedia.org/wiki/Retinal_ganglion_cell) (purple layer), then to the optic nerve fibres. The signals are processed in these layers. First, the signals start as raw outputs of points in the rod and cone cells. Then the nerve layers identify simple shapes, such as bright points surrounded by dark points, edges, and movement. (Based on a drawing by [Ramón y Cajal](https://en.wikipedia.org/wiki/Santiago_Ram%C3%B3n_y_Cajal), 1911.)

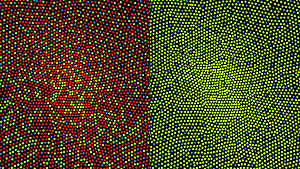
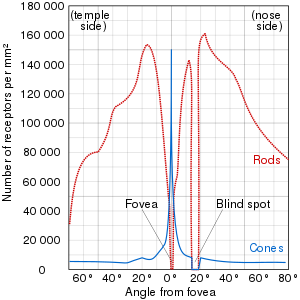
[](https://en.wikipedia.org/wiki/File:ConeMosaics.jpg)

Illustration of the distribution of cone cells in the fovea of an individual with normal colour vision (left), and a colourblind (protanopic) retina. Note that the center of the fovea holds very few blue-sensitive cones.

[](https://en.wikipedia.org/wiki/File:Human_photoreceptor_distribution.svg)

Distribution of rods and cones along a line passing through the fovea and the blind spot of a human eye[[12]](https://en.wikipedia.org/wiki/Retina#cite_note-12)

The vertebrate retina has ten distinct layers.[[13]](https://en.wikipedia.org/wiki/Retina#cite_note-13) From closest to farthest from the vitreous body:

1. [Inner limiting membrane](https://en.wikipedia.org/wiki/Inner_limiting_membrane) – basement membrane elaborated by [Müller cells](https://en.wikipedia.org/wiki/Muller_glia).
2. [Nerve fibre layer](https://en.wikipedia.org/wiki/Nerve_fiber_layer) – axons of the [ganglion cell](https://en.wikipedia.org/wiki/Retinal_ganglion_cell) bodies (note that a thin layer of Müller cell footplates exists between this layer and the inner limiting membrane).
3. [Ganglion cell layer](https://en.wikipedia.org/wiki/Ganglion_cell_layer) – contains nuclei of ganglion cells, the axons of which become the optic nerve fibres, and some displaced [amacrine cells](https://en.wikipedia.org/wiki/Retina_amacrine_cell).[[2]](https://en.wikipedia.org/wiki/Retina#cite_note-eb-2)
4. [Inner plexiform layer](https://en.wikipedia.org/wiki/Inner_plexiform_layer) – contains the synapse between the [bipolar cell](https://en.wikipedia.org/wiki/Retina_bipolar_cell) axons and the dendrites of the [ganglion](https://en.wikipedia.org/wiki/Retinal_ganglion_cell) and amacrine cells.[[2]](https://en.wikipedia.org/wiki/Retina#cite_note-eb-2)
5. [Inner nuclear layer](https://en.wikipedia.org/wiki/Inner_nuclear_layer) – contains the nuclei and surrounding cell bodies (perikarya) of the [amacrine cells](https://en.wikipedia.org/wiki/Amacrine_cells), [bipolar cells](https://en.wikipedia.org/wiki/Retina_bipolar_cell), and [horizontal cells](https://en.wikipedia.org/wiki/Retina_horizontal_cell).[[2]](https://en.wikipedia.org/wiki/Retina#cite_note-eb-2)
6. [Outer plexiform layer](https://en.wikipedia.org/wiki/Outer_plexiform_layer) – projections of rods and cones ending in the rod spherule and cone pedicle, respectively. These make synapses with dendrites of bipolar cells and horizontal cells.[[2]](https://en.wikipedia.org/wiki/Retina#cite_note-eb-2) In the [macular](https://en.wikipedia.org/wiki/Macula) region, this is known as the *Fiber layer of* [*Henle*](https://en.wikipedia.org/wiki/Friedrich_Gustav_Jakob_Henle).
7. [Outer nuclear layer](https://en.wikipedia.org/wiki/Outer_nuclear_layer) – cell bodies of rods and cones.
8. [External limiting membrane](https://en.wikipedia.org/wiki/External_limiting_membrane) – layer that separates the inner segment portions of the photoreceptors from their cell nuclei.
9. Inner segment / outer segment layer – inner segments and outer segments of rods and cones. The outer segments contain a highly specialized light-sensing apparatus.[[14]](https://en.wikipedia.org/wiki/Retina#cite_note-14)[[15]](https://en.wikipedia.org/wiki/Retina#cite_note-15)
10. [Retinal pigment epithelium](https://en.wikipedia.org/wiki/Retinal_pigment_epithelium) – single layer of cuboidal epithelial cells (with extrusions not shown in diagram). This layer is closest to the choroid, and provides nourishment and supportive functions to the neural retina, The black pigment melanin in the pigment layer prevents light reflection throughout the globe of the eyeball; this is extremely important for clear vision.[[16]](https://en.wikipedia.org/wiki/Retina#cite_note-16)[[17]](https://en.wikipedia.org/wiki/Retina#cite_note-17)[[18]](https://en.wikipedia.org/wiki/Retina#cite_note-18)

These layers can be grouped into 4 main processing stages: photoreception; transmission to [bipolar cells](https://en.wikipedia.org/wiki/Retina_bipolar_cell); transmission to [ganglion cells](https://en.wikipedia.org/wiki/Retinal_ganglion_cell), which also contain photoreceptors, the [photosensitive ganglion cells](https://en.wikipedia.org/wiki/Photosensitive_ganglion_cell); and transmission along the optic nerve. At each synaptic stage there are also laterally connecting [horizontal](https://en.wikipedia.org/wiki/Retina_horizontal_cell) and [amacrine cells](https://en.wikipedia.org/wiki/Retina_amacrine_cell).

The [optic nerve](https://en.wikipedia.org/wiki/Optic_nerve) is a central tract of many axons of ganglion cells connecting primarily to the [lateral geniculate body](https://en.wikipedia.org/wiki/Lateral_geniculate_body), a visual relay station in the [diencephalon](https://en.wikipedia.org/wiki/Diencephalon) (the rear of the forebrain). It also projects to the [superior colliculus](https://en.wikipedia.org/wiki/Superior_colliculus), the [suprachiasmatic nucleus](https://en.wikipedia.org/wiki/Suprachiasmatic_nucleus), and the [nucleus of the optic tract](https://en.wikipedia.org/w/index.php?title=Nucleus_of_the_optic_tract&action=edit&redlink=1). It passes through the other layers, creating the [optic disc](https://en.wikipedia.org/wiki/Optic_disc) in primates.[[19]](https://en.wikipedia.org/wiki/Retina#cite_note-19)