Oghene-Karo Samuel Ifoto

17/MHS01/149

medicine and surgery

Neurohistology assignment

**QUESTION 1**

The eye is A complex and highly developed photosensitive organ that permits an accurate analysis of the form, light intensity, and color reflected from objects.

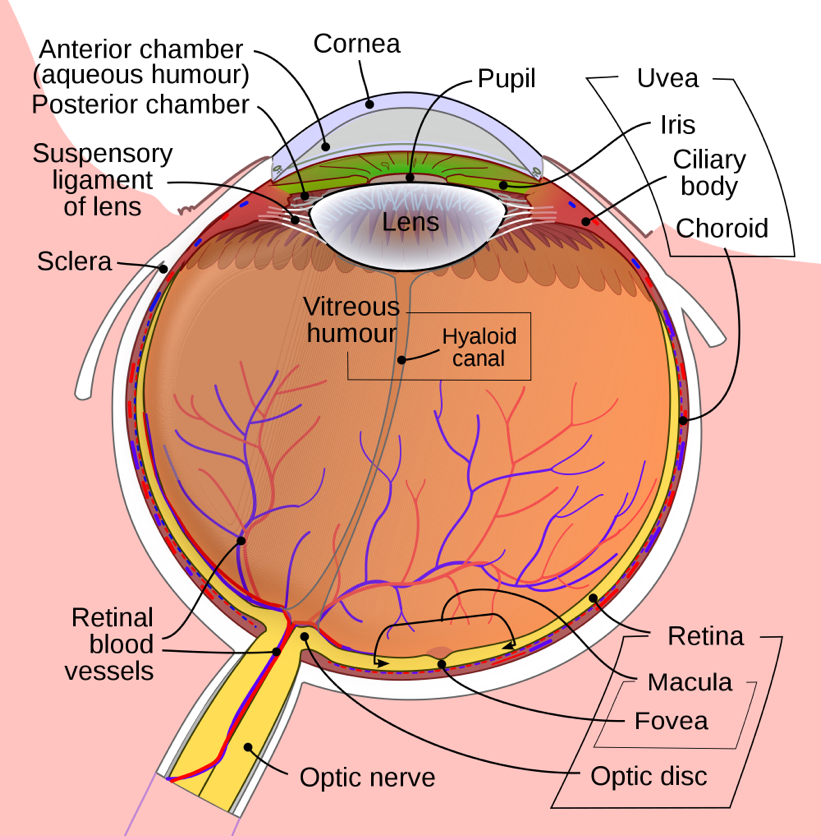
Each eye is composed of three concentric layers:

- an external layer that consists of the sclera and the cornea.

- a middle layer also called the vascular layer consisting of the choroid, ciliary body and the iris.

- an inner layer of nerve tissue, the retina, which consists of an outer pigment epithelium and an inner retina proper.

The photosensitive retina proper is part of the central nervous system and communicates with the cerebrum through the optic nerve and extends forward to the Ora serrata.



**DIAGRAM OF THE EYE**

*External layer*

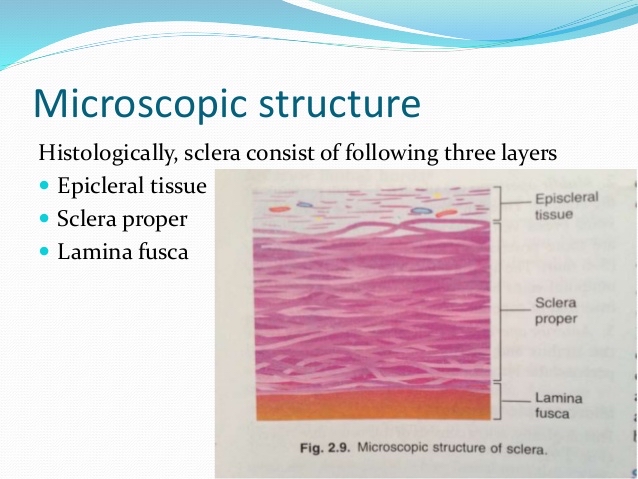
**THE SCLERA**

The sclera is dense connective tissue made of mainly type 1 collagen fibers, oriented in different directions. The lack of parallel orientation of collagen fibers gives the sclera its white appearance, as opposed to the transparent nature of the cornea. However, the collagen of the sclera and cornea are continuous.

The four layers of the sclera from external to internal are episclera, stroma, lamina fusca, endothelium.

The episclera is the external surface of the sclera. It is connected to the Tenon capsule by thin collagen fibers. At the corneoscleral junction, also known as the limbus, the Tenon capsule contacts stroma of the conjunctiva.

The exposed front surface of the eye, including the cornea is lined by a thin, non-ketatinized stratified squamous epithelium.



***Histological importance of the sclera***

The sclera is the opaque, fibrous, tough, protective outer layer of the eye that is directly continuous with the cornea in front and with the sheath covering the optic nerve behind . The sclera provides protection and form to the eye which is evident from its cellular features.

**CORNEA**

The cornea Consists of type I collagen fibers oriented in a uniform parallel direction to maintain transparency. Consists of five layers: epithelium (non-keratinized, stratified squamous epithelium), Bowman layer, stroma (also called substantia propria), Descemet’s membrane, corneal endothelium.

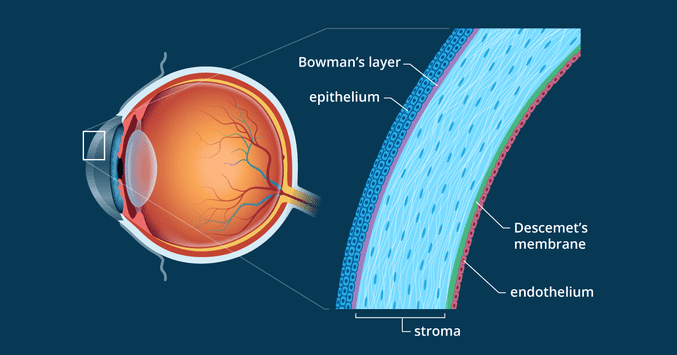
*Corneal epithelium*: fast growing, regenerating multicellular layer which interacts directly with the tear film.

*Bowman layer*: This is a layer of subepithelial basement membrane protecting the underlying stroma. It is composed of type 1 collagen, laminin, and several other heparan sulfate proteoglycans. There are no cells in this layer. **Bowman’s membrane contributes greatly to the stability and strength of the cornea.**

*Stroma*: The largest layer of the cornea, the stroma has collagen fibers arranged in a regular pattern. Keratocytes maintain the integrity of this layer. The function of this layer is to maintain transparency, which occurs by the regular arrangement, and lattice structure of the fibrils, whereby scatter from individual fibrils gets canceled by destructive interference, and the spacing of less than 200 nm allows for transparency.

*Descemet’s membrane*: an acellular homogenous layer made of fine type IV collagen that serves as a modified basement membrane of the corneal endothelium

*Corneal endothelium*: a one cell thick layer made of either simple squamous or cuboidal cells. Cells in this region do not regenerate and have pumps that maintain fluid balance and prevent swelling of the stroma. When corneal endothelial cells are lost, neighboring cells stretch to attempt to compensate these losses hence is responsible for maintaining the transparency of the cornea.



LAYERS OF THE CORNEA

***Histological importance of the cornea***

The **cornea** is a transparent avascular tissue that acts as a structural barrier and **protects the eye** against infections. Along with the tear film, it provides proper anterior refractive surface for the **eye. Cornea** contributes to two-third of the refractive power of the **eye**.

The cornea's main function is to refract, or bend, light. The cornea is responsible for focusing most of the light that enters the eye.

The cornea tends to repair itself quickly from minor abrasions. However, deeper abrasions may cause scars to form on the cornea, which causes the cornea to lose its transparency, leading to visual impairment.

**CORNEOSCLERAL JUNCTION or LIMBUS** is an area of transition from the transparent collagen bundles of the cornea to the white opaque fibers of the sclera. It is highly vascularized, and it’s

Blood vessels assume an important role in corneal inflammatory processes.

*Middle or Vascular layer*

The middle or vascular layer of the eye consists of three parts: the choroid, ciliary body, and iris. Known collectively as the uveal tract.

**CILIARY BODY**

Consists of the ciliary muscle and the ciliary epithelium. The ciliary muscle, via the lens zonules, controls the structure of the lens, which is vital for accommodation. Zonules are connective tissue fibers that connect the ciliary muscle and lens.

The ciliary epithelium produces aqueous humor which fills the anterior compartment of the eye.

***Histological importance of the ciliary body***

contains ciliary muscle that is composed of smooth muscle. Contraction and relaxation of the Ciliary muscles changes the tension of the zonular fibers, or suspension ligaments, of the lens. This allows the lens to change shape, a process known as **accommodation**.

The **ciliary processes are folds of connective tissue** that are covered by two layers of epithelium. There is also a complex vasculature they cannot be seen easily. Fluid from these vessels is processed and transported by the epithelial cells to the posterior chamber as **aqueous humor**. The epithelial cells constitute the blood- aqueous barrier.

**IRIS**   
Consists of (1) stromal layer with pigmented, fibrovascular tissue and (2) pigmented epithelial cells beneath the stroma

The sphincter pupillae and dilator pupillae muscles connect to the stroma

The pigmented layer of cells blocks rays of light and ensures that light must move through the pupil to reach the retina

The angle formed by the iris and cornea contains connective tissue with

endothelial channels called the trabecular meshwork, which drains aqueous humor in the anterior chamber into the venous canal of Schlemm. From here, fluid drains into episcleral veins.

***Histological importance of the iris***

The anterior surface of the iris contains loose, variably pigmented stroma. It is open to the circulating aqueous humor within the anterior chamber.

Two layers of heavily pigmented epithelium cover the posterior surface of the iris.

Note that the sphincter pupillae muscle can be easily seen near the pupil margin. It is smooth muscle controlled by parasympathetics. The dilator pupillae muscle is more difficult to identify, but it dilates the pupil upon sympathetic innervation.

**CHOROID**

Consists of a dense network of blood vessels supplying nourishment to structures of the eye, housed in loose connective tissue.

The choriocapillary layer is located in the innermost part of the choroid and supplies the retina

The Bruch membrane is an extracellular matrix layer situated between the retina and choroid and has significance in age-related macular degeneration, where an accumulation of lipid deposits prevent diffusion of nutrients to the retina.

***Histological importance of the choroid***

**Choroid**. The vascular (major blood vessel), central layer of the eye lying between the retina and sclera. Its **function** is to provide nourishment to the outer layers of the retina through blood vessels. It is part of the uveal tract.

*Innermost layer: Lens, Vitreous, Retina*

1. Lens: separates the aqueous and vitreous chambers

Consists of an outer capsule, a middle layer called cortex, and an inner layer called the nucleus.

The capsule is the basement membrane of the lens epithelium which lies below

New lens cells differentiate from the lens epithelium and are incorporated peripherally, pushing older lens cells towards the middle.

***Histological importance of the lens***

The **lens** is a transparent and flexible biconvex structure in the eye that, along with the cornea, helps to refract light to be focused on the retina. The flexibility allows the lens to be easily manipulated by the ciliary muscles, bu changing the curvature of the lens, one can focus the eye on objects at different distances from it.

2. Vitreous: a jelly-like space made of type II collagen separating the retina and the lens. The vitreous humor is a transparent, colorless, gelatinous mass that fills the space in the eye between the lens and the [retina](/wiki/Retina" \o "Retina). It is surrounded by a layer of [collagen](/wiki/Collagen" \o "Collagen) called the [vitreous membrane](/wiki/Vitreous_membrane" \o "Vitreous membrane) (or hyaloid membrane or vitreous cortex) separating it from the rest of the eye. It makes up four-fifths of the volume of the [eyeball](/wiki/Eyeball" \o "Eyeball).[[1]](" \l "cite_note-Grays2008-1) The vitreous humour is fluid-like near the centre, and gel-like near the edges.

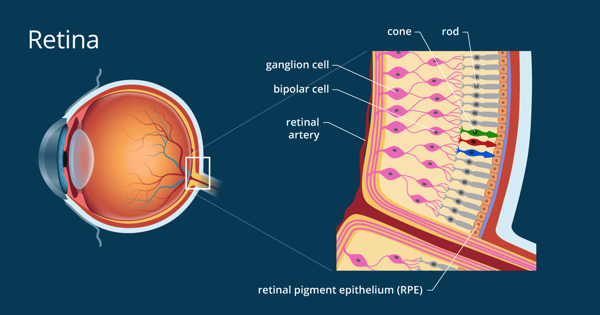
***Histological importance of the vitreous body***

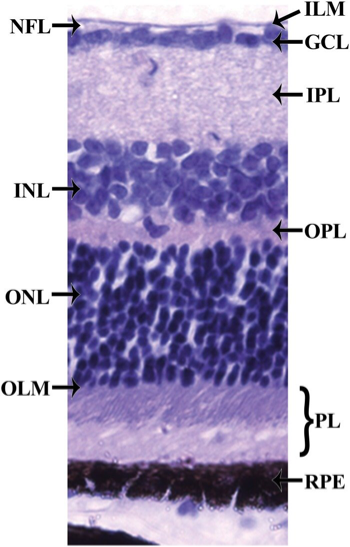
The **vitreous body** provides physical support holding the **retina** in place next to the choroid, the blood supply for the outer **retina**. (Neural **retina** and choroid are only connected to each other at the disc and the ora serrata.)

3. Retina: nervous tissue of the eye where photons of light convert to neurochemical energy via action potentials

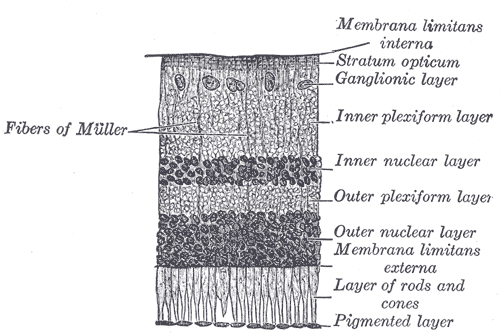
The **retina** serves a **function** analogous to that of the film or image sensor in a camera. The neural **retina** consists of several layers of neurons interconnected by synapses, and is supported by an outer layer of pigmented epithelial cells.

# **QUESTION 2**



The **retina** is a thin layer of tissue that lines the back of the eye on the inside. It is located near the optic nerve. The purpose of the **retina** is to receive light that the lens has focused, convert the light into neural signals, and send these signals on to the brain for visual recognition.****

# Histology of the retina. The retina can be divided into 10 layers including (1) the inner limiting membrane (ILM); (2) the nerve fiber layer (NFL); (3) the ganglion cell layer (GCL); (4) the inner plexiform layer (IPL); (5) the inner nuclear layer (INL); (6) the outer plexiform layer (OPL); (7) the outer nuclear layer (ONL); (8) the outer limiting membrane (OLM); (9) the photoreceptor layer (PL), and (10) the retinal pigmented epithelium (RPE) monolayer.



**Retinal layers**

The vertebrate retina has ten distinct layers. From closest to farthest from the vitreous body:

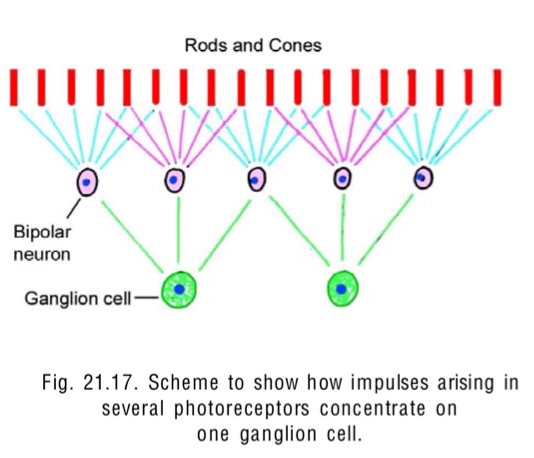
1. [Inner limiting membrane](/wiki/Inner_limiting_membrane" \o "Inner limiting membrane) – basement membrane elaborated by [Müller cells](/wiki/Muller_glia" \o "Muller glia).
2. [Nerve fibre layer](/wiki/Nerve_fiber_layer" \o "Nerve fiber layer) – axons of the [ganglion cell](/wiki/Retinal_ganglion_cell" \o "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](/wiki/Ganglion_cell_layer" \o "Ganglion cell layer) – contains nuclei of ganglion cells, the axons of which become the optic nerve fibres, and some displaced [amacrine cells](/wiki/Retina_amacrine_cell" \o "Retina amacrine cell).
4. [Inner plexiform layer](/wiki/Inner_plexiform_layer" \o "Inner plexiform layer) – contains the synapse between the [bipolar cell](/wiki/Retina_bipolar_cell" \o "Retina bipolar cell)axons and the dendrites of the [ganglion](/wiki/Retinal_ganglion_cell" \o "Retinal ganglion cell) and amacrine cells.
5. [Inner nuclear layer](/wiki/Inner_nuclear_layer" \o "Inner nuclear layer) – contains the nuclei and surrounding cell bodies (perikarya) of the [amacrine cells](/wiki/Amacrine_cells" \o "Amacrine cells), [bipolar cells](/wiki/Retina_bipolar_cell" \o "Retina bipolar cell), and [horizontal cells](/wiki/Retina_horizontal_cell" \o "Retina horizontal cell).
6. [Outer plexiform layer](/wiki/Outer_plexiform_layer" \o "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. In the [macular](/wiki/Macula" \o "Macula) region, this is known as the *Fiber layer of [Henle](/wiki/Friedrich_Gustav_Jakob_Henle" \o "Friedrich Gustav Jakob Henle)*.
7. [Outer nuclear layer](/wiki/Outer_nuclear_layer" \o "Outer nuclear layer) – cell bodies of rods and cones.
8. [External limiting membrane](/wiki/External_limiting_membrane" \o "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.
10. [Retinal pigment epithelium](/wiki/Retinal_pigment_epithelium" \o "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.

**transmission of information along the retina**

Connections of retinal neurons

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

The [optic nerve](/wiki/Optic_nerve" \o "Optic nerve) is a central tract of many axons of ganglion cells connecting primarily to the [lateral geniculate body](/wiki/Lateral_geniculate_body" \o "Lateral geniculate body), a visual relay station in the [diencephalon](/wiki/Diencephalon" \o "Diencephalon) (the rear of the forebrain). It also projects to the [superior colliculus](/wiki/Superior_colliculus" \o "Superior colliculus), the [suprachiasmatic nucleus](/wiki/Suprachiasmatic_nucleus" \o "Suprachiasmatic nucleus), and the [nucleus of the optic tract](/w/index.php?title=Nucleus_of_the_optic_tract&action=edit&redlink=1" \o "Nucleus of the optic tract (page does not exist)). It passes through the other layers, creating the [optic disc](/wiki/Optic_disc" \o "Optic disc) in primates.



Mechanism of firing of bipolar neurons

1. When no light falls on the retina, photoreceptors are depolarized. Exposure to light causes hyperpolarisation.

2. When a photoreceptor is depolarized it releases inhibitor at its junction with a bipolar neurons. This prevents the bipolar neurons from firing. Release of inhibitors is controlled by voltage gated calcium channels.

3. Hyperpolarization of photoreceptor, caused by exposure to light, leads to closure of calcium gates and release of inhibitor is stopped. This causes the bipolar neurons to fire.

4. Rhodopsin, present in photoreceptors, is a complex of a protein **opsin** and **cis-retinal** that is sensitive to light. When exposed to light cis-retinal is transformed to trans-retinal. This leads to decrease in concentration of cyclic GMP that in turn leads to closure of sodium channels. Closure of sodium channel leads to hyperpolarization of photoreceptors.