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Question  
1. Write an essay on the histological importance of eye in relation to their cellular functions.

2. Corona virus can penetrate the body through eye and implicate the immune system , briefly discuss the layers of retina for information penetration.

ANSWERS

1. Broadly, from an anatomical perspective, the eye can be viewed as a series of overlapping layers of tissue.
2. External structures of the eye include the eyelashes, lids, muscles, accessory glands, and conjunctiva.
3. The internal structures of the eye consist of three layers of tissue arranged concentrically**:**

* The sclera and cornea make up **THE EXTERIOR LAYERS. 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 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.
* The **UVEA** is **THE VASCULAR LAYER** in the middle, subdivided into the iris, ciliary body, and choroid. The **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[[8]](https://www.ncbi.nlm.nih.gov/books/NBK544343/). From here, fluid drains into episcleral veins. The **CILIARY BODY** is the tissue that divides the posterior chamber and vitreous humour, 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. The **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.

* TheLens, Vitreous and Retina constitutes the **INNERMOST LAYER** and is made up of nervous tissue. The **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. The **VITREOUS** a jelly-like space made of type II collagen separating the retina and the lens. The **RETINA** is anervous tissue of the eye where photons of light convert to neurochemical energy via action potentials. Moreover, the retina itself is divided into various layers as follows;

Retinal pigment epithelium: made of cuboidal cells containing melanin which absorbs light. These cells also establish a blood-retina barrier through tight junctions.

 "Rod and cone cells": the layer of cells with photoreceptors and glial cells. Rods are located peripherally and are more sensitive to light and motion than cones. Cones have higher visual acuity and specificity for color vision.

*"Outer limiting membrane"*: a layer of Muller cells and rod/cone junctions which serves to separate the photosensitive regions of the retina from the areas that transmit the electrical signals.

*"Outer nuclear layer"*: This layer consists of nuclei of rod and cone cells.

*"Outer plexiform layer"*: This layer contains synaptic processes of rod and cone cells.

*"Inner nuclear layer':* This layer contains the cell body of glial, amacrine, bipolar, and horizontal cells

*"Inner plexiform layer"*: This layer relays information from cells of the inner nuclear layer. Thus, this layer has axons of amacrine, bipolar, and glial cells and dendrites of retinal ganglion cells.

*"Ganglion cell layer"*: This layer contains nuclei of retinal ganglion cells.

*"Nerve fiber layer"*: This layer contains axons of retinal ganglion cells and the astroglia which support them. Collectively, these axons constitute the optic nerve.

*"Internal limiting membrane"*: A thin layer of Muller glial cells and basement membrane which demarcates the vitreous anteriorly from the retina posteriorly.

* The layers of the eye perform distinct functions which coalesce to create a unified, perceptual experience. The essential role of the external eye structures is to protect the delicate tissue of the internal eye. The eyelid prevents foreign bodies from entering the inner eye and helps refresh and distribute the tear film by blinking. Eyelashes are finely sensitive to touch and warn the eye of possible debris and particles that may cause injury.

Internal parts of the eye have primarily structural and visual functions. The cornea serves a protective role and is responsible for two-thirds of the refractive properties of the eye. The remaining one-third of refraction is performed by the lens, which is functionally adjustable through the action of the zonular fibers and ciliary muscles. At the end of the visual process, as rays of light bend through the cornea and lens, photon energy is converted to neurochemical action potentials by cells of the retina, which then send these impulses to the brain, via the optic nerve.

The uvea of the eye is a crucial mediator of nutrition and gas exchange, as blood vessels course through the ciliary body and iris, while the choriocapillaris in the posterior eye help support the retina. This abundant blood supply is implicated in uveitis, as inflammatory mediators enter the eye through this vascular network.

1. Retina is organized in superimposed layers, formed by the different cells. The retina contains five mayor types of cells: photoreceptors (rods and cones), bipolar cells, horizontal cells, amacrine cells and ganglion cells (RGC). In general, cell somas are grouped in three distinct nuclear layers, separated by two connecting layers plexiform layers, where synapses between cells are formed. The innermost layer is the ganglion cell layer, which contains the cell bodies of the ganglion cells and displaced amacrine cells. The next cell layer is the inner nuclear layer, which contains the cell bodies of the amacrine cells, the bipolar cells, and the horizontal cells; it may also contain some displaced ganglion cells. The next cell layer is the outer nuclear layer, which contains the cell bodies of the photoreceptors. Outside of these layers, the layer of photoreceptor outer segments contains the light-sensitive elements of the retina. Light must pass through vitreous humor and the different layers of the retina before reaching the outer segments of the photoreceptors. Interspersed between the ganglion cell layer and the inner nuclear layer is the inner plexiform layer, which contains the axons of bipolar cells, dendrites of ganglion cells and cell processes of amacrine cells (axons and/or dendrites). Between the outer and inner nuclear layers is the outer plexiform layer, which contains the axon terminals of photoreceptors, the dendrites of bipolar and cell processes of horizontal cells (axons and/or dendrites). The basic system of retinal information processing consists on a direct pathway of visual information that flows from photoreceptors to bipolar cells to ganglion cells. The ganglion cells fire action potentials in response to light, and these impulses propagate down the optic nerve to the projection nuclei in the brain. This direct pathway is influenced by two transverse fluxes of modulatory signals coming from horizontal in outer plexiform layer and amacrine cells in inner plexiform layer. Horizontal cells receive input from the photoreceptors and project their processes laterally to influence surrounding bipolar cells. Amacrine cells receive input from bipolar cells and project their processes laterally to influence surrounding bipolar and ganglion cells. Both, horizontal and amacrine cells usually make electrical and chemical synapses with neighbor cells of the same type.