ASSIGNMENT ON HISTOLOGY OF SPECIAL SENSES

BY

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

The eye has internal structures which consist of three layers of tissue arranged concentrically:

- ***Outermost Layer***: the sclera and cornea make up the exterior layers.
- ***Middle Layer:*** The uvea is the vascular layer subdivided into the iris, ciliary body, and choroid.
- ***Innermost layer:*** The retina constitutes it and is made up of nervous tissue and external structures include the eyelashes, lids, muscles, accessory glands, and conjunctiva.

Internal Structures of the Eye:

I. **Cornea:**

Consists of type I collagen fibers oriented in a uniform parallel direction to maintain transparency. The cornea 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.

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 cancelled by destructive interference, and the spacing of less than 200 nm allows for transparency.

Descemet's membrane: an acellular layer made of 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[7]. When corneal endothelial cells are lost, neighbouring cells stretch to attempt to compensate these losses.

II. **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.

III. **Iris:**

Consists of:
-stromal layer with pigmented, fibrovascular tissue and
-pigmented epithelial cells beneath the stroma.

The sphincter pupillae and dilator pupillae muscles connect to the stroma and 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.

IV. **Ciliary Body:**

This is the tissue that divides the posterior chamber and vitreous body. It 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.

V. **Choroid:**

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 prevents diffusion of nutrients to the retina.

VI. **Lens:**

It separates the aqueous and vitreous chambers and 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.

VII. **Vitreous:**

It is a jelly-like space made of type II collagen separating the retina and the lens.

VIII. **Retina:**

The retina is the nervous 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.

External Structures of the Eye:

I. **Conjunctiva**:

The conjunctiva lines the inner part of the eyelids.

The tarsal plate lies beneath the conjunctiva and contains meibomian glands, which secrete an oily substance to decrease the evaporation of the tear film.

II. **Tear Film:**

The tear film consists of aqueous, mucus, and oily secretions.

III. **Accessory glands:**

Apocrine glands of Moll, meibomian glands, lacrimal glands.

IV. **Muscles:**

Orbicularis oculi, levator palpebrae superioris, superior tarsal muscle.

V. **Eyelid**:

The eyelid, likewise known as the cover of the eye, a mobile layer made up of skin and also muscular tissue and also covers the eyeball.

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

The retina is the innermost of the three tunics (Sensory Tunic) and the light-sensitive layer of tissue of the eye. The human retina is located on the inner surface of the posterior two-thirds to three-quarters of the eye. It surrounds the vitreous body and continuous posteriorly with the optic nerve.

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

i). **Inner layer:**

A thin layer of Muller glial cells and basement membrane which demarcates the vitreous anteriorly from the retina posteriorly.

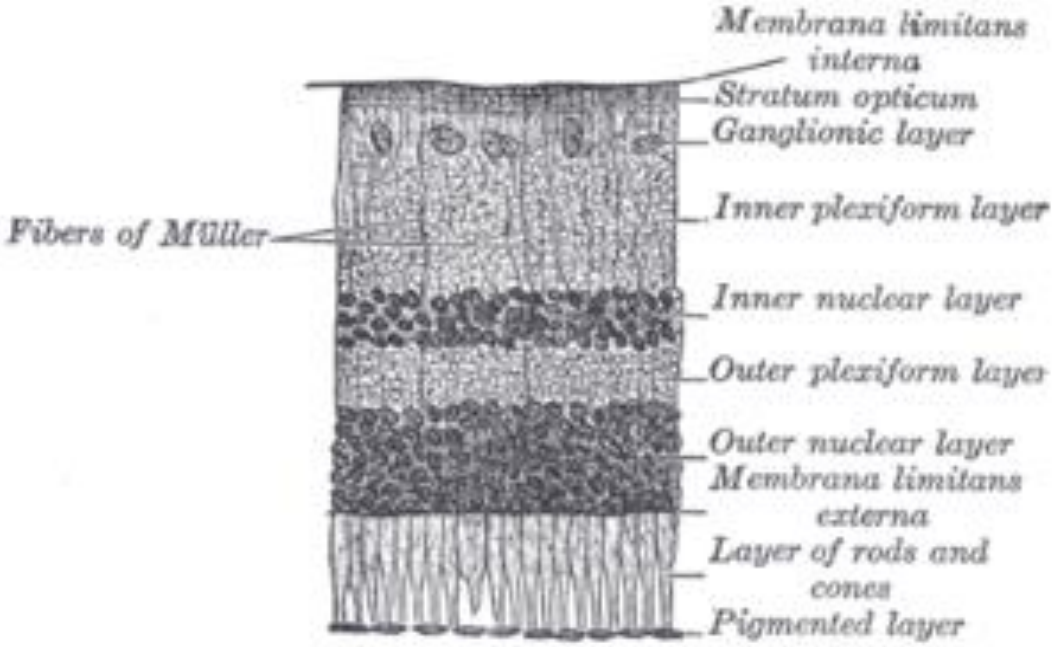


DIAGRAM SHOWING THE LAYERS OF THE RETINA

ii). **Nerve fibre layer (stratum opticum):**

Consists of axons of the ganglion cell bodies (note that a thin layer of Müller cell footplates exists between this layer and the inner limiting membrane). Their course runs parallel to the retinal surface; the fibers proceed to the optic disc, turn at a right angle, and exit the eye through the lamina cribrosa as the optic nerve. The fibers generally are unmyelinated within the retina.

iii). **Ganglion cell layer:**

Contains nuclei of ganglion cells, the axons of which become the optic nerve fibres, and some displaced amacrine cells.

iv). **Inner plexiform layer:**

Contains the synapse between the bipolar cell axons and the dendrites of the ganglion and amacrine cells.

v). **Inner nuclear layer:**

Contains the nuclei and surrounding cell bodies (perikarya) of the amacrine cells, bipolar cells, and horizontal cells.

vi). **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 region, this is known as the Fiber layer of Henle.

vii). **Outer nuclear layer:**

Consists of cell bodies of rods and cones.

viii). **External limiting membrane:**

Layer that separates the inner segment portions of the photoreceptors from their cell nuclei.

ix). **Inner segment /outer segment layer:**

Inner segments and outer segments of rods and cones. The outer segments contain a highly specialized light-sensing apparatus.

x). **Retinal pigment epithelium:**

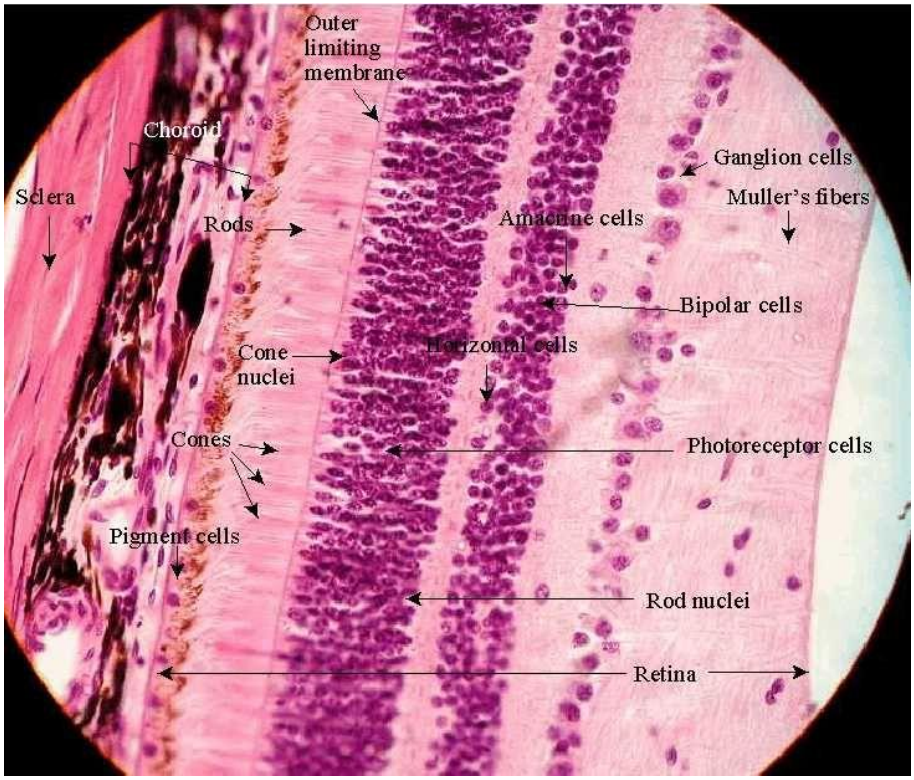
Single layer of cuboidal epithelial cells (with extrusions not shown in diagram). This layer is closest to the choroid, and provides nourishment and supportive functions to the neural retina, the black pigment melanin in the pigment layer prevents light reflection throughout the globe of the eyeball; this is extremely important for clear vision.

The following are the cells in the above-mentioned layers of the retina:

Horizontal cells: These cells are connected to the photoreceptors that surround the bipolar connected photoreceptor cells and help the help integrate and regulate the input from multiple photoreceptor cells, increasing your visual acuity.

Bipolar cells: The dependence of each layer of the retina on each other is exemplified here. These cells take the electrical information from the photoreceptor cells and pass it along to other retinal cells.

Ganglion cells: These cells extend to form an optic nerve that conveys information to the brain and take the electrical information from the bipolar cells and process it to determine shapes, contrast and color.



Amacrine Cells: Amacrine cells are intermediate neurons that release the inhibitory neurotransmitter GABA or glycine. However, given their unique gap junction physiology, they can be both inhibitory or excitatory. There is great diversity among amacrine cells, and they fulfill a variety of jobs and functions within the retina; serving as the ultimate utility cell of the retina.