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Matric no.: 17/mhs01/107

Department: MBBS

Level: 300

Question 1: the histological importance of the eye relating to the cellular functions

1) Fibrous tunica (External layer)

a) Sclera: it is a dense irregular connective tissue that supports eye shape, protects the delicate internal structures and extrinsic eye muscles attachment site.

b) Cornea: it has two layers of epithelium with organized connective tissue in between which protects the anterior surface of the eye and refracts (bends) incoming light.

2) Vascular Tunica (Middle Layer):

a) Choroid: it is made up of Areolar connective tissues which are highly vascularized which supplies nourishment to the retina and aids in pigment absorption of extraneous light.

b) Ciliary Body: it is mad e up of ciliary smooth muscles and processes covered with secretory epithelium which supports this structure by holding suspensory ligament that attach to the lens and change lens shape for far and near vision (i.e. rod and cones function), it also secrets aqueous humor in the epithelium.

c) Iris: it has two layers of smooth muscles (Sphincter and dilator papillae) and connective tissues with a central pupil which aids in controlling the pupil diameter and thus controls the amount of light entering the eye.

3) Retina (Internal layer):

a) Pigmented layer: It is made up of pigmented epithelium cells which aids in absorbs extraneous light and provides vitamin A for photoreceptor cells.

b) Neural layer: It consists of Photoreceptors, bipolar neurons, ganglion cells and supporting Muller cells which aids this structures by detecting incoming light rays (light rays are converted to nerve signal and transmitted to the brain)

Question 2: covid 19 can penetrates the body through the eye and implicates the immune system discuss the layers of the retina for info penetration

**The Retina**

It is the innermost tunic of the eye which develops with two fundamental sub layers from the inner and outer layers of the embryonic optic cup.

1. The outer pigmented area is a simple cuboidal epithelium attached to Burch’s membrane and the choroidocapilliary lamina of the choroid. This heavily pigmented layer forms the other part of the dual epithelium covering the ciliary body and posterior iris.
2. The inner retinal region (Neural layer) is thick and stratified with various neurons and photoreceptors. Although its neural structure and visual function extends anteriorly only as far as the Ora serrata. This layer continues as part of the dual cuboidal epithelium that covers the surface of the ciliary body and posterior iris.

**Retina Pigmented Epithelium**

This consists of cuboidal / low columnar cells with basal nuclei and surrounds the neural layer of the retina. The cells have well- developed junctional complexes, gap junctions and numerous invaginations of the basal membrane associated with mitochondria.

The apical ends of the cell extend processes and sheath-like projections that surround the tip of the photoreceptors, melanin granules are numerous in these extensions and the apical cytoplasm, this region also contains numerous phagocytic vacuoles and secondary lysosomes, peroxisomes and abundant smooth ER specialized for vitamin A isomerism. This region include the following function

* This layer absorbs scattered light that passes through the neural layer (supplementing the choroid in the region)
* With many tight junctions, cells of this region form an important barrier (protective blood retina barrier)isolating the retina photoreceptors from the highly vascular choroid and regulating ion transport between these compartments
* Phagocytosis of shed components of the adjacent photoreceptors and degradation of this material occurs in the epithelium cells
* Etc.

**The Neural Retina**

It functions as an outpost of the CNS with glia and several interconnected neuronal subtypes in well-organized strata, there are 9 distinctive layers with their functional significance:

a) Three major layers contain the nuclei of the interconnected neurons:

- Near the pigmented epithelium, the outer nuclear layer (ONL) contain cell bodies of photoreceptors (Rod and cone cells) which receive O2 and nutrition by diffusion from the choroidcapilliary lamina of the choroid.

- The inner nuclear layer (INL) contains nuclei of various neurons, notably the bipolar cells, amacrine cells and horizontal cells all with specific connections with other neurons and integrated signals from rods and cones over a wide area of the retina.

-Near the vitreous, the ganglionic layer (GL) have various ganglion cells with much longer axons which make up the nerve fiber layer (NFL) and converge to form the **OPTIC NERVE** which leaves the eye process to the brain. The GL is thickest near the central, macular region of the retina but it is thin peripherally to the one layer of cell.

Between these 3 layers, they are 2 fibrous regions containing only axon and dendrites connected by synapse:

* The outer plexiform layer (OPL) includes axons of the photoreceptors and dendrites of associated neurons in the INL.
* The inner plexiform layer (IPL) consist of the axons and dendrites connecting neurons of the INL with the ganglion cells

All neurons in the retina are supported metabolically by elongated, regularly arranged glial cells (Muller cells) with their perikarya in the INL, they can extend processes that snap the entire thickness of the neural retina.

From the major Muller processes, small lateral extensions ramify in each layer and ensheat virtually all the neural processes, cell bodies and blood vessels. These cells are essential for retinal functions like providing neurotropic substances, removing waste products, regulation ions etc. muller’s cells also organize 2 boundaries that appear as very thin retina layers:

* The outer limiting layer (OLL): Poorly stained but well defined series of junction between the photoreceptor and Muller cells.
* The inner limiting membrane (ILM): consist of terminal expansions of the Muller cells process that cover the collagenous membrane of the vitreous body and forms the inner surface of the retina.