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COURSE: NEUROHISTOLOGY OF SPECIAL SENSES

1) Write an essay on the histological importance of the eye and their cellular functions.

The histological importance of the eye and its cellular functions is the relationship between the histological structures of the eye, and how they aid the eye in carrying out its functions.

The eyes are highly developed photosensitive organs for analyzing the form, intensity and colour of light reflected from objects and provides the **sense of sight**. The eyes have three layers namely:

1. EXTERNAL FIBROUS LAYER: This layer consists of the posterior sclera and anterior cornea.

A. The Sclera: The sclera is the white posterior five-sixths of the external layer. It is made up of dense irregular connective tissue made up of type 1 collagen fibres. It has micro vasculature present near its outer surface. The sclera:

- Protects the internal structures of the eye
- Supports the eye shape
- Aids the attachment of tendons of extraocular muscles on its anterior region.

B. The Transparent Cornea: The cornea is the anterior one-sixth of the external fibrous layer. It protects the anterior surface of the eye and refracts (bends) incoming light. It is completely avascular and has five distinct layers:

- i. An external stratified squamous epithelium: The epithelium protects the anterior surface of the eye. It has protective adaptations such as having microvilli projecting into the protective tear film and it equally has a rich sensory nervous supply.
- ii. Anterior limiting membrane (Bowman's membrane): this membrane provides stability and strength to the cornea, helping to protect against infection of the underlying stroma.
- iii. A thick stroma: The uniform array orthogonal array of collagen fibrils contributes to the transparency of the cornea.
- iv. A posterior limiting membrane (Descemet's membrane): it supports the internal simple squamous corneal epithelium.
- v. An inner simple squamous epithelium: maintains the descemet's membrane and ensures proper hydration of the corneal stroma to enhance or provide maximal transparency and optimal light refraction

Limbus: The limbus is where the transparent cornea merges with the opaque sclera. It contains stem cells for the corneal epithelium. The conjunctiva begins from this point to cover the anterior part of the sclera and lines the eyelids. It has a trabecular meshwork which aids the drainage of the aqueous humor from the anterior chamber through the **sclera sinus venous** into veins of the sclera.

2. **THE MIDDLE VASCULAR LAYER:** This part is known as the uvea. It consists of three parts;
- i. **The Choroid:** located in the posterior two-thirds of the eye, it is made of loose well vascularised connective tissue. It contains melanocytes which gives this layer a characteristic black colour thus making it the black layer of the eye. It prevents light from entering into the eye except through the pupil. It has other layers, the choroidocapillary lamina is made of microvasculature which provides nutrition to the outer retinal layers and the bruch's membrane which surrounds the basal lamina of the retina's pigmented layer.
 - ii. **The Ciliary body:** the anterior extension of the uvea that surrounds the lens. Its stroma is made up of smooth muscle. The contraction of the smooth muscles adjusts the diameter of the lens. Its ciliary processes secrete the aqueous humor. Its Ciliary zonule extends to the lens and attaches to its surface thus holding it in place.
 - iii. **Iris:** The most anterior portion of the uvea that partly covers the lens leaving a round central, the pupil. It has two layers of smooth muscle (sphincter pupillae and dilator pupillae) and connective tissue, with a central pupil. It **controls** the pupil diameter and thus the amount of light entering the eye.

The Lens: this is a transparent biconvex structure, suspended immediately behind the iris which **focuses** light on the retina. It is held in place by fibres of the ciliary zonule. Together with the ciliary muscles, the structure allows the process of visual accommodation.

Vitreous Body: it is a transparent gel-like connective tissue that is 99% of water with collagen fibres and hyaluronate contained within a vitreous membrane, and occupies the large vitreous chamber behind the lens. It helps to hold the spherical shape of the eye and acts as the film of a camera in the case of a retina.

3. **THE INNER SENSORY LAYER:** This layer consists of the Retina.
- THE RETINA:** The retina communicates with the cerebrum via the posterior optic nerve. It is the screen in the eye where the images are formed. It has two layers:
- i. **Pigmented layer:** It is made up of pigmented epithelial cells. absorbs extraneous light and provides vitamin A for photoreceptor cells

- ii. **Neural layer:** it is made of photoreceptors, bipolar neurons, ganglion cells and supporting muller cells. It detects incoming light rays which are converted to nerve signals and transmitted to the brain

ACCESSORY STRUCTURES OF THE EYE:

1. **Conjunctiva:** a thin transparent mucosa that covers the exposed, anterior portion of the sclera and continues as the lining under the inner surface of the eyelids. Mucus secretions from conjunctiva cells are added to the tear film that coats its stratified columnar epithelium and the cornea.
2. **Eyelids:** these are pliable structures containing skin, muscle and conjunctiva that protect the eyes. It has tarsal gland (meibomian glands) which secretes sebum that forms a surface layer on the tear film and reduces the rate of its evaporation and helps lubricate the ocular surface.
3. **Lacrimal glands:** produces fluid continuously for the tear film that moistens and lubricates the cornea and conjunctiva and supplies oxygen to the corneal epithelial cells.

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

The retina is the screen at the end of the eye where all the images are formed. It communicates with the cerebrum via the optic nerve.

LAYERS OF THE RETINA

1. **OUTER PIGMENTED LAYER (RETINA PIGMENTED EPITHELIUM):** this is a simple cuboidal epithelium attached to Bruch's membrane and the choroidocapillary lamina of the choroid. This layer is equally found in the dual epithelium covering the ciliary body and posterior iris. The apical ends of the cells extend processes and sheath-like projections that surround the tips of the photoreceptors. Functions of the retinal pigmented epithelium include:
 - i. It absorbs scattered light that passes through the neural layer, thus supplementing the choroid.
 - ii. Due to its tight junctions, it forms a part of the blood-retina barrier
 - iii. It plays key roles in the visual cycle of retinal regeneration
 - iv. It phagocytises shed components from the adjacent photoreceptors and degraded materials
 - v. It removes free radicals by various protective antioxidant activities
 - vi. It supports the neural retina by secretion of ATP, various polypeptide growth factors and immunomodulatory factors.
2. **INNER NEURAL LAYER:** this is a thick and stratified layer with various neurons and photoreceptors. It continues as part of the dual cuboidal epithelium that covers the

surface of the ciliary body and posterior iris. Nine distinct layers comprise the neural retina. Three major layers contain the nuclei of the interconnected neurons:

- i. **Outer nuclear layer:** contains cell bodies of photoreceptors (rods and cone cells)
- ii. **Inner nuclear layer:** contains nuclei of various neurons e.g. bipolar neurons, amacrine cells, horizontal cells. These cells make specific connections with other neurons and integrate signals from the rods and cone cells over a wide area of the retina.
- iii. **Ganglionic layer:** It has neurons (ganglion cells) with much longer axons.

The three layers contain plexiform regions in between containing only axons and dendrites connected by synapses. These are:

- i. **The outer plexiform layer:** includes axons of the photoreceptors and dendrites of association neurons in the inner nuclear layer.
- ii. **The inner plexiform layer:** consists of axons and dendrites connecting neurons of the inner nuclear layer with the ganglion cells.

The rod and cone cells which are named for the shape of their outer segments, have their photosensitive portions aligned in the retina's rod and cone layer and their axons in the internal plexiform layer.

The Muller cells are the glia cells of the retina. Their nuclei are located in the inner nuclear layer and their axons extend as fine processes and branching lamellae that serve as scaffold for the neurons and their fibres. Muller cells organize two boundaries that appear as very thin layers within the retina. Which are:

- i. **Outer limiting layer:** this forms one side of the compartment that encloses the rods and cones. It is a faint but well defined series of tight and adherent junctions that form at the level of the rod and cone inner segments between the photoreceptors and the muller processes.
- ii. **Inner limiting layer:** consists of terminal expansions of other muller cell processes that cover the collagenous membrane of the vitreous body.

