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ANA 305 Assignment; Special Senses.

Course Title: - Histology of Special Senses and Neurohistology.

1) Essay on the histological importance of the eye in relation to their cellular functions.

Broadly, from an anatomical perspective, the eye can be viewed as a series of overlapping layers of tissue.

External structures of the eyes include the eyelashes, lids, muscles, accessory glands, and conjunctiva.

The Internal structures of the eye consist of three layers of tissue arranged concentrically: -

- The sclera and cornea make up the exterior layers.
- The uvea is the vascular layer in the middle, subdivided into the iris, ciliary body, and choroid.
- The retina constitutes the innermost layer and is made up of nervous tissue.

All these layers can further subdivide and undergo histological classification.

a) External structures of the eye.

- **Conjunctiva:-**
The conjunctiva lines the inner part of the eyelids.
The tarsal plate lies beneath the conjunctiva and contains Meibomian glands, which excrete an oily substance to decrease the evaporation of the tear film.
- **Tear film:-**
The tear film consists of aqueous, mucus, and oily secretions.
- **Accessory glands:-**
Apocrine glands of Moll, Meibomian glands, lacrimal glands.
- **Muscles:-**
Orbicularis oculi, levator palpebrae superioris, superior tarsal muscle.

- **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.

b) **The Internal structures of the eye:-**

The innermost structures of the eye are organized in the three layers as follows:-

i) **Outermost layer: - Sclera and Cornea.**

- **The sclera (white of the eye):-**

The sclera is a 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, and endothelium. The episclera is the external surface of the sclera. It is connected to the tenon capsule by thin collagen fibers.

- **Cornea (transparent front layer of the eye):-**

It consists of type 1 collagen fibers oriented in a uniform parallel direction to maintain transparency.

It consists of 5 layers: epithelium (non-keratinized, stratified squamous epithelium), Bowman layer, stroma (also called substantia propria), Descemet's membrane, and 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 heparin 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 200nm allows for transparency.

-Descemet's membrane:-

An acellular layer made of type 4 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, neighbouring cells stretch to attempt to compensate these losses.

ii) Middle Layer: Uvea (Iris, Ciliary Body, Choroid):-

- Iris:-

It 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. 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.

- Ciliary Body:-

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.

- Choroid:-

It 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.

iii) Innermost layer: Lens, Vitreous, Retina:-

- Lens:-

It separates the aqueous and vitreous chambers. It 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.

- Vitreous:-

This is a jelly-like space made of type 2 collagen separating the retina and the lens.

- Retina:-

This 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:

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

ii) 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 activity and specificity for colour vision.

iii) 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.

- iv) Outer nuclear layer: - this layer consists of nuclei of rod and cone cells.
- v) Outer plexiform layer: - this layer contains synaptic processes of rod and cone cells.
- vi) Inner nuclear layer: - this layer contains the cell body of glial, amacrine, bipolar, and horizontal cells.
- vii) 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.
- viii) Ganglion cell layer: - this layer contains nuclei of retinal ganglion cells.
- ix) Nerve fiber layer: - this layer contains axons of retinal ganglion cells and the astroglia which support them. Collectively, these axons constitute the optic nerve.
- x) Internal limiting membrane: - this is a thin layer of Muller glial cells and basement membrane which demarcates the vitreous anteriorly from the retina posteriorly.

2) Layers of retina for information penetration.

a) The pigmented epithelium:-

It is adjacent to the choroid, absorbs light to reduce back reflection of light onto the retina.

b) The photoreceptor layer:-

It contains photosensitive outer segments of rods and cones and glial cells. Rods are located peripherally and are more sensitive to light and motion than cones. Cones have higher visual activity and specificity for colour vision.

c) 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.

d) Outer nuclear layer:-

It contains cell bodies of the rods and cones.

e) Outer plexiform layer:-

It contains synapses between axons of photoreceptors and dendrites of intermediate neurons.

f) Inner nuclear layer:-

It contains cell bodies of intermediate neurons and Muller cells.

g) Inner plexiform layer:-

It contains synapses between intermediate neurons and ganglion cells of the optic tract.

h) Ganglion cell layer:-

It contains cell bodies of ganglion cells.

i) Optic nerve fiber layer:-

It contains axons of ganglion cells and the astroglia which support them. Collectively, these axons constitute the optic nerve.

j) Inner limiting membrane:-

It serves as an interface between the vitreous body and the retinal nerve fiber layer.

k) Vitreous:-

It holds the spherical shape of the eye and also comes in contact with the retina.