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MATRIC NO: 17/MHS01/148

HISTOLOGY ASSIGNMENT

1. Histological importance of the eyes

Eyes are highly developed photosensitive organs for analyzing the form, intensity and color of light reflected from objects and providing the sense of sight.

The eye is composed of three concentric tunics or layers that can be seen under the microscope. These layers consist of different structures that assist the eye in performing its function. The layers of the eye include:

- A tough external fibrous layer consisting of the sclera and the transparent cornea

Sclera - thick collagenous capsule provides structural support for the eye, it is the point of attachment for extraoccular muscles and is in continuity with the conjuctiva.

Cornea - continous with the sclera at the limbus

- A middle vascular layer that includes the choroid, cilliary body and iris. This layer is highly vascularised and heavily pigmented. It is also known as UVEA.

Choroid - vascular supply to the retina

Ciliary body - ciliary muscle regulate shape of the pupil for visual accomodation, and ciliary epithelium produce aqueous humor that fills the anterior and posterior chambers

Iris - the optical diaphragm that forms the margin of the pupil

- An inner sensory layer, retina composed of photoreceptors (rods and cones), neuronal integrative circuitry and retinal pigment epithelium

KEY OCCULAR STRUCTURES AND THEIR CELLULAR FUNCTIONS

CORNEA

- transparent and avascular

- directs light to the lens

Layers of the Cornea

- epithelium

- Bowman's membrane

- Stroma

- Descemet's membrane

- Endothelium

Corneal epithelium

- stratified squamous non-keratinized cells

- it has a high rate of turnover for repair of damage due to abrasion

- stem cells in the basal layer near the limbus undergo differentiation, epithelium migrates

Stroma of the cornea

- corneal fibroblasts are called keratocytes

- stroma is multilayered with alternating layers of keratocytes and ECM fibrils and proteoglycans. The orientation of collagen fibrils changes layer to layer

Corneal endothelium

- simple cuboidal epithelium mediates hydration and nutrition of the stroma and corneal epithelium

COMPONENTS OF THE VASCULAR LAYER, UVEA

Choroid: highly pigmented, high vascular layer interposed between sclera and retina

- larger vessels linked to the sclera by collagen and elastic fibrils

- chorlocapillary layer: smaller vessels that supply the retina

- Bruch's membrane: collagen I with an elastic fiber core separates choroid from retinal pigment epithelium

Cillary body: thickened portion of uveal tract at the level of the lens

- contraction and relaxation of the ciliary muscles regulates the shape of the lens

- cillary zonules (cillary ligaments or cables) connect the cillary body to the lens, running from the cillary epithelium to the lens capsule.

Production of aqueous humor maintains intraocular pressure and provides nutrition to the lens

- cillary processes: highly vascular, finger-like processes project into the posterior chamber.

- cillary epithelium: two layers of cells alligned apex to apex

- outer layer is heavily pigmented and is continous with the retinal pigment epithelium

- inner layer (close to vitreous body) is composed of fluid transporting cells

  - apical cell surface faces pigment epithelium

  - highly flooded basolateral membrane borders posterior chamber

  - blood aqueous barrier = occluding junctions at apex of inner epithelium

Iris: regulates pupillary diameter

- posterior surface is lined by pigmented epithelium which is continuous with the pigmented epithelium of cillary body

- pigmented myoepithelium (dilator muscle of the pupil) is deep to the pigmented epithelium

- constrictor muscle of the pupil occupies the margin of the iris

- anterior surface of the iris has no epithelium

- stroma of the iris is highly vascular fibroblastic connective tissue that contains many melanocytes

Lens of the Eye: Unique epithelial structure- biconvex, transparent, avascular

- lens epithelium: simple cuboidal epithelium located only on the anterior surface of the lens
- lens fibers

  - elongated (7-10nm), highly differentiated cells

  - oriented anterior-posterior (span depth of lens)

  - originate in germinal zone at periphery of lens

  - high content of crystallins (90% of protein content of the cell) contribute to the refractive index of the lens.

  - lens fibers nearest center of lens have highest crystallin content.

  - lens capsule: basement membrane serving as attachment point for cillary zonules

RETINA

Two main layers:

- retinal pigment epithelium (RPE)

- neural retina

Retinal Pigment Epithelium

- simple cuboidal, ion fluid transporting epithelium rests on Bruch's membrane (adjacent to choriocapillary layer of the choroid

- apical membrane of the RPE cells contact outer segments of rods and cones

Function of RPE

1. Produces fluid to norture rods and cones
2. Synthesizes melanin- absorbs light, limits reflections and scatter
3. Phagocytoses photoreceptor discs shed by rods
4. Pools (and esterifies) Vitamin A used in regeneration of rhodopsin by rods

Neural Retina

Sensory neuron receptors (rods and cones) plus supporting cells and integrative neurons

Rods- night vision (scotopic), low acuity

Cones- daylight (photopic), high acuity

Other occular structures

Ora serrata- anterior margin of neural retina; one point of attachment for vitreous body

Fovea centralis- located with the macula, near the center of the fundus

- cones only, so is area of highest visual acuity at center of the visual axis

Optic disc- coalescence of ganglion cell processes forming the optic nerve

- 'blind spot', no photoreceptors are located here.

2. Layers of the Retina for Information Transmission

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

- The outer pigmented layer

This is a simple cuboidal epithelium attached to Bruch's membrane and the choroido-capillary lamina of the choroid. This heavily pigmented layer forms the other part of the dual epithelium covering the ciliary body and posterior iris.

- The neural layer

Also known as the inner retinal region is thick and stratified with various neurons and photoreceptors.

Although its neural structure and visual function extend 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

NEURAL RETINA

The neural layer is responsible for information transmission.The neural retina functions as an outpost of the CNS with glia and several interconnected neuronal subtypes in well-organised strata. Nine distinct layers comprise the neural retina, described here with their functional significance.

Three major layers contain the nuclei of the interconnected neurons

- Outer Nuclear Layer - contains cell bodies of photoreceptors (the rod and cone cells)
- Inner Nuclear Layer - contains the nuclear of various neurons, notably the bipolar cells, amacrine cells and horizontal cells all of which make specific connections with other neurons and integrate signals from rods and cones over wide area of the retina.
- Ganglion layer - contains ganglion cells that have longer axons. Nerve fiber layer is made up of the axons of ganglion cells which converge to form the optic nerve.

Between the three layers are two fibrous or plexiform regions containing only axons and dendrites connected by synapses.

- The Outer Plexiform Layer - It includes axons of the photoreceptors and dendrites of association neurons in the Inner Nuclear Layer.
- The Inner Plexiform Layer - It consists of axons and dendrites connecting neurons of the Inner Nuclear Layer with the ganglion cells.

The rod and cone cells, named for the shape of their outer segments, are polarized neurons with their photosensitive portions aligned in the retina's rod and cone layer and their axons in the Inner Plexiform Layer.

All neurons of the retina are supported physically by glial cells called Muller Cells. Muller cells also organize two boundaries that appear as very thin layers within the retina:

- The Outer Limiting Layer (OLL) - This 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 Muller cell processes. The OLL forms one side of the compartment that encloses the rods and cones.
- The Inner Limiting Layer - consists of terminal expansions of other Muller cell processes that cover the collagenous membrane of the virteous body.