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 COURSE:HISTOLOGY OF SPECIAL SENSES AND NEUROHISTOLOGY

 MATRIC NO: 17/MHS01/305

 DEPARTMENT: MEDICINE AND SURGERY

ASSIGNMENT TOPIC: SPECIAL SENSES

Histological importance of the eye

 A histological understanding of the layers of the eye is essential for appreciating disease pathophysiology and also understanding certain therapeutic approaches. Broadly, from an anatomical perspective, the eye can be viewed as a series of overlapping layers of tissue. External structures of the eye 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.

 **External Structures of the Eye**

1. Conjunctiva

* The conjunctiva lines the inner part of the eyelids.
* The tarsal plate lies beneath the conjunctiva and contains meibomian glands, which secretean oily substance to decrease the evaporation of the tear film.

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

3. Accessory glands: Apocrine glands of Moll, meibomian glands, lacrimal glands.

4. Muscles: Orbicularis oculi, levator palpebrae superioris, superior tarsal muscle.

5. 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.

**Internal Structures of the Eye**: The innermost structures of the eye are organized in the three layers as follows

**(A)- "Outermost Layer: Sclera and Cornea":**

1. **The sclera (white of the eye)**: The sclera is dense connective tissue made of mainly type 1 collagen fibers, oriented in different directions. 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.

2**. Cornea (transparent front layer of the eye)**: Consists of type I collagen fibers oriented in a uniform parallel direction to maintain transparency. 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 canceled 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. When corneal endothelial cells are lost, neighboring cells stretch to attempt to compensate these losses.

**(B). Middle Layer: Uvea (Iris, Ciliary Body, Choroid):**

1. Iris: Consists of

1. stromal layer with pigmented, fibrovascular tissue and
2. 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

2. Ciliary Body: The tissue that divides the posterior chamber and vitreous body. 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.

3. 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

 **(C)- Innermost layer: Lens, Vitreous, Retina:**

1. Lens: separates the aqueous and vitreous chambers. 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.

2. Vitreous: a jelly-like space made of type II collagen separating the retina and the lens

3. Retina: nervous tissue of the eye where photons of light convert to neurochemical energy via action potential.

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.

**Function**

 The layers of the eye perform distinct functions which coalesce to create a unified, perceptual experience. The essential role of the external eye structures is to protect the delicate tissue of the internal eye. The eyelid prevents foreign bodies from entering the inner eye and helps refresh and distribute the tear film by blinking. Eyelashes are finely sensitive to touch and warn the eye of possible debris and particles that may cause injury.

 Internal parts of the eye have primarily structural and visual functions. The cornea serves a protective role and is responsible for two-thirds of the refractive properties of the eye. The remaining one-third of refraction is performed by the lens, which is functionally adjustable through the action of the zonular fibers and ciliary muscles. At the end of the visual process, as rays of light bend through the cornea and lens, photon energy is converted to neurochemical action potentials by cells of the retina, which then send these impulses to the brain, via the optic nerve. The uvea of the eye is a crucial mediator of nutrition and gas exchange, as blood vessels course through the ciliary body and iris, while the choriocapillaris in the posterior eye help support the retina. This abundant blood supply is implicated in uveitis, as inflammatory mediators enter the eye through this vascular network.

 **Clinical Significance**

Chalazion: A sterile lump often in the upper eyelid caused by obstruction of the meibomian oil glands.

Conjunctivitis: Inflammation of the transparent conjunctiva that may be caused by bacterial or viral infections, allergies, or exposure to certain chemicals.

Cataracts: A sclerotic nuclear cataract is the most common and is due to opacification in the central nucleus of the lens. Cortical cataracts are due to opacifications in the cortex and have a distinct wedge-shaped appearance. Posterior subcapsular cataracts arise from behind the sac-like structure of the lens.

Layers of retina for information transmission

 **Retina**

The retina, the inner layer of the eye, is derived from the embryonic optic cup . Like the optic cup, the retina consists of two major layers. The inner one, the neural retina, contains the neurons and photoreceptors. The diverse functions of the cells in the retinal pigmented epithelium include the following:

* serve as an important part of the blood-retina barrier,
* absorb light passing through the retina to prevent its reflection,
* phagocytose shed components from the adjacent rods and cones,
* remove free radicals, and
* isomerize and regenerate the retinoids used as chromophores by the rods and conesGeneral structure and organization of the retina.

 The retina is the thick layer of the eye inside the choroid. Between the rod and cone cell layer and the bipolar cells is a region called the outer plexiform layer that contains fibers and synapses connecting the neurons in these two cellular layers. The similar region of synapses between the bipolar and ganglion cells is called the inner plexiform layer.The retina has an inverted structure, with the light first passing through the ganglion layer and then the bipolar layer to reach the rod and cone cells .

 Between the vitreous body (VB) and the choroid (C), the retina can usually be seen to have ten distinct layers. Following the path of the light, these are: the inner limiting layer (ILL); the nerve fiber layer (NFL), containing the ganglionic cell axons that converge at the optic disc and form the optic nerve; the ganglionic layer (GL),containing cell bodies of the ganglion cells and of somewhat variable thickness throughout the retina; the inner plexiform layer (IPL), containing fibers and synapses of the ganglion cells and the bipolar neurons of the next layer; the inner nuclear layer (INL), with the cell bodies of several types of bipolar neurons which begin to integrate signals from the rod and cone cells; the outer plexiform layer (OPL), containing fibers and synapses of bipolar neurons and rod and cone cells; the outer nuclear layer (ONL), with the cell bodies and nuclei of the photosensitive rod and cone cells; the outer limiting layer (OLL), which is a fine line formed by the junctional complexes holding the rod and cone cells to the intervening glia called Müller cells; the rod and cone cell layer (RCL), which contains the outer segments of these cells where the photoreceptors are located; and the pigmented layer (PL) which is not sensory, but has several supportive functions important for maintenance of the neural retina. The rods and cones, named for the shape of their outer segments, are polarized neurons. At one pole is a single photosensitive dendrite and at the other are synapses with cells of the bipolar layer.

**ROD CELLS** The human retina has approximately 120 million rod cells. They are extremely sensitive to light, responding to a single photon, and allow some vision even with light low levels, such as at dusk or nighttime. Rod cells are thin, elongated cells (50 m x 3 m), composed of two distinct segments. The outer segment is photosensitive; the inner segment contains the metabolic machinery for the cell's biosynthetic and energy-producing processes. The inner segment is rich in glycogen and mitochondria near the base of this cilium. Abundant polyribosomes located inside the mitochondrial region produce proteins that are transported to the outer segment, where they are incorporated into the membranous discs. These proteins include the visual pigment rhodopsin (visual purple) which is bleached by light and initiates the visual stimulus CONE CELLS. The human retina has 6 or 7 million cone cells, which are less sensitive to low light than rod cells and are specialized for color vision in bright light.

Medical Application

leading cause of blindness in elderly individuals of developed countries is age-related macular degeneration, which causes blindness in the center of

the visual field. Degenerative changes in the retina around the macula include depigmentation of the posterior epithelium, focal thickening of the adjacent

Bruch's membrane, major changes and blood loss in the capillaries in the choroid and retina, and eventual loss of the photoreceptor cells producing blind

spots. There appears to be a genetic predisposition to the disorder, along with environmental triggers such as excessive exposure to ultraviolet radiation.

Progression of the disease can be slowed by laser surgery to destroy the abnormal and excessive retinal capillaries.