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**QUESTION 1. Write an essay on the histological importance of eye in relation to their cellular functions.**

The EYE is a sense organ and it is used for the purpose of SEEING. It is a complex and highly developed photosensitive organ that permits an accurate analysis of the form, light intensity, and color reflected objects. Each eye is composed of ***External and Internal Features***.

EXTERNAL FEATURES of the Eye:

They are Conjunctiva, Tear film, Accessory glands, Muscles and Eyelids and Eyelashes.

INTERNAL FEATURES of the Eye:

They are organized in 3 layers as follows;

* The Outermost Layer of the eye consists of the Sclera and Cornea;
* The Middle layer is also called the **vascular layer** which consists of the **Uvea** (Choroid, Ciliary body and Iris);
* The Innermost layer of the eye consists of Lens, Vitreous and Retina.

**EXTERNAL FEATURES**

* Conjunctiva: It lines the inner part of the eyelids. The tarsal plate lies beneath the conjunctiva and contains meibomian glands, which secrete an oily substance to decrease the evaporation of the tear film.
* Tear film: The tear film consists of aqueous, mucous, and oily secretions
* Accessory glands: Apocrine glands of Moll, Meibomian glands and Lacrimal glands
* Muscles: Orbicularis oculi, levator palpebrae superioris, superior tarsal muscle.
* Eyelid: It is likewise known as the **cover of the eyes**; a mobile layer made up of skin and also muscular tissue and also covers the eyeball. It prevents foreign bodies from entering the inner eye and helps refresh and distribute the tear film by blinking.
* Eyelashes: They are the hair-like structures located in the eye. They are finely sensitive to touch and warn the eye of possible debris and particles that may cause injury.

**INTERNAL FEATURES**

a) Outermost Layer:

* SCLERA:

It consists of tough, dense connective tissue made up of flat collagen type I bundles intersecting in various directions while remaining parallel to the surface of the organ, a moderate amount of ground substance and a few fibroblasts. The sclera is the '**White**' of the eye. The collagen of the sclera is continuous with the cornea. The sclera is made up of 4 layers arranged from the external to internal which 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. At the corneoscleral junction also known as **Limbus**, the Tenon capsule contacts the stroma of conjunctiva.

HISTOLOGICAL IMPORTANCE of Sclera:

It is the outer protective layer. It is with a sheath which covers the optic nerve from behind. The sclera basically provides protection and form.

* CORNEA:

The cornea is colorless and transparent. It consists of type I collagen fibers which are oriented in a uniform parallel direction to maintain transparency. The cornea consists of 5 layers which are: Corneal Epithelium, Bowman's membrane, Stroma, Descemet's membrane and Corneal Endothelium.

* The Corneal Epithelium, is **stratified non-keratinized squamous epithelium** consisting of 5/6 layers of cells. The basal part of the epithelium is numerous mitotic figures that are responsible for the cornea's remarkable regenerative capacity. This epithelial tissue is covered by protective layer of lipid and glycoprotein which is about 7m thick. The cornea has one of the richest sensory nerve supplies of the tissue.
* The Bowman's Membrane consists of collagen fibers crossing at random. It possesses no cell. This membrane contributes greatly to the stability and strength of cornea.
* The Stroma, is the **largest** of the cornea and it is formed of many layers of parallel collagen bundles that cross at approximately right angles to each other. The collagen fibrils within each lamella are parallel to each other and run the full width of the cornea. It is also known as **Substantia propria**.
* The Descemet's Membrane is a thick homogenous structure composed of fine collagenous filaments organized in a three-dimensional network.
* The Corneal Endothelium is a **simple squamous epithelium**. These cells possess organelles for secretion that are characteristic cells engaged in active transport and protein synthesis and that may be related to the synthesis and maintenance of the Descemet's membrane.

The corneal epithelium and endothelium are responsible - for maintaining the transparency of the cornea. They both are capable for transporting sodium ions towards their apical surfaces.

HISTOLOGICAL IMPORTANCE of Cornea:

The cornea serves a protective role and is responsible for the two-thirds of the refractive properties of the eye. It functions like a window that controls and focuses the entry of light into the eye.

b) Middle Layer

* Iris:

It consists of stromal layer with pigmented fibrovascular tissue and pigmented epithelial cells beneath the stoma. The sphincter pupillae and dilator pupillae muscles connect to the stroma. The pigmented layer of cells block rays of light and ensures that light must move through the pupil to reach the retina.

HISTOLOGICAL IMPORTANCE OF THE IRIS

It is responsible for controlling the diameter and size of the pupil and thus the amount of light reaching the retina.

* Ciliary Body:

The tissue that divides the posterior chamber and vitreous body. It consists of -ciliary muscles and ciliary epithelium.

* Ciliary Muscles: These via the lens zonules, controls the structures of the lens which is vital for accommodation. Zonules are connective tissue fibers that connect the ciliary muscles and lens.
* Ciliary Epithelium: It produces aqueous humor which fills the anterior compartment of eye.

HISTOLOGICAL IMPORTANCE of Ciliary Body:

It is important for the functions of accommodation, aqueous humor production and resorption. It also functions in the maintenance of the lens zonules for the purpose of anchoring the lens in place.

* Choroid:

It consists of dense network of blood vessels supplying nourishment to structures of the eye, housed in a 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 regeneration, where an accumulation of lipid deposits prevents diffusion to the retina.

HISTOLOGICAL IMPORTANCE of Choroid

It is important in providing nourishment to the outer layers of the retina through blood vessels.

c) Innermost Layer:

* Lens:

It separates the aqueous and vitreous chambers. It consists of 3 parts which are: 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 the older lens cells towards the middle.

HISTOLOGICAL IMPORTANCE of Lens

By changing its shape, it changes the focal distance of the eye. In other words, it focuses the light rays that pass through it (and onto the retina) in order to create clear images of objects that are positioned at various distances.

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

HISTOLOGICAL IMPORTANCE of Vitreous

It performs a vital role in protecting the eye. Most importantly, it helps to hold its spherical shape. Along with maintaining the eye shape, it helps to absorb shock to the eye and keep the retina properly connected to the back of the eye. The light passes through the vitreous on its way to the retina.

* Retina:

This is the nervous tissue of the eye where photons of light convert to neurochemical energy via energy potentials. Moreover, the retina is divided into 10 distinct layers from innermost to outermost, they are: the inner limiting membrane, the optic nerve fiber layer, the ganglion cell layer, the inner plexiform layer, the inner nuclear layer, the outer plexiform layer, the outer nuclear layer, the external limiting membrane, the rod and cone layer, the retinal pigment epithelium.

HISTOLOGICAL IMPORTANCE of Retina:

The retina receives light that the lens has focused and convert the light into neural signals and sends these signals on to the brain for visual recognition membrane.

**QUESTION 2. Corona Virus can penetrate the body through eye and implicate the immune system, briefly explain the layers of the retina for information penetration.**

The retina is the innermost, light-sensitive of tissue of the eye of most vertebrates and some molluscs. The retina serves a function analogous to that of the film or image sensor in a camera. The retina has several distinct layers and they are 10 in number which are arranged from the innermost to the outermost, they are:

I. The inner limiting membrane

II. The Optic nerve fiber layer

III. The ganglion cell layer

Iv. The inner plexiform layer

V. The inner nuclear layer

VI. The outer plexiform layer

VII. The outer nuclear layer

VIII. The external limiting membrane

IX. The rod and cone layer

X. The retinal pigment epithelium

* The Inner limiting membrane: This membrane is the boundary between the retina and the vitreous body; it is the **innermost** of all layers of the retina. It is formed by astrocytes and it consists of the terminations of the Muller cell processes and their basement membranes.
* The Optic nerve fiber layer: This layer consists primarily of unmyelinated axons of ganglion cells which forms the **fibers of the Optic Nerve**. As each fiber pierces the sclera, it acquires myelin sheath.
* The Ganglion layer: This layer contains the somata of ganglion cells which forms the final link in the retina's neural chain. The ganglions are typical neurons that projects their own axons to a specific region of the retina called **Optic disk**.
* The Inner plexiform layer: This layer contains the **axodendritic synapses** between the axons of bipolar cells and dendrites of the ganglions. The processes of the amacrine cells are located in this layer.
* The Inner nuclear layer: This contains the cell bodies of the bipolar cells, amacrine cells, horizontal cells and nuclei of the Muller cells.
* The Outer plexiform layer: This layer contains the axodendritic synapses between the axons of photoreceptor cells and dendrites of bipolar and horizontal cells. It displays the **synaptic** **ribbons** within the rods and cones cells at synaptic sites.
* The Outer nuclear layer: The layer consists primarily of nuclei of rods and cones.
* The External limiting membrane: It is not a true membrane but an area where **zonulae** **adherens** (belt desmosomes) are located between the photoreceptor cells and the retinal glial cells (Muller cells). It also contains the microvilli that projects from the Muller cells.
* The Rods and cones layer: This 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.
* The Retinal pigment epithelium: This is a single layer of cuboidal epithelial cells firmly attached to the **Bruch** **membrane**. This is the layer closest to the choroid and provides nourishment and supportive functions to the neural retina. The black pigment melanin in the pigment layer prevents light reflection throughout the globe of the eyeball, this is extremely important for clear vision. The retinal pigment epithelial cells esterify Vitamin A (used in the formation of visual pigment by rods and cones) and they phagocytize the shed tips of the outer segment of rods and cones.

These layers can be grouped into 4 main processing stages, they are:

1. Photoreception.
2. Transmission to bipolar cells.
3. Transmission to ganglion cells, which also contain photoreceptors called the **photosensitive** **ganglion** **cells**.
4. Transmission along the optic nerve.

Note that, at each synaptic stage, there are also laterally connecting horizontal and amacrine cells.