

ANA 305

HISTOLOGY OF SPECIAL SENSES AND NEUROHISTOLOGY

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QUESTIONS

1. Write an essay on the histological importance of eye in relation to their cellular functions.
2. Coronavirus can penetrate the body through eye and implicate the immune system, briefly discuss the layers of retina for information penetration.

ANSWERS

1. HISTOLOGICAL IMPORTANCE OF EYE IN RELATION TO THEIR CELLULAR FUNCTIONS

Eyes are highly developed photosensitive organs for analyzing the form, intensity, and color of light reflected from objects and providing the sense of sight. Each eyeball consists externally of a tough, fibrous globe that maintains its overall shape. Internally the eye contains transparent tissues that refract light to focus the image, a layer of photosensitive cells, and a system of neurons that collect, process, and transmit visual information to the brain.

Each eye is composed of three concentric tunics or layers:

- A tough external fibrous layer consisting of **sclera** and the transparent **cornea**;
- A middle vascular layer that includes the **choroid**, **ciliary body**, and **iris**; and
- An inner sensory layer, the **retina**, which communicates with the cerebrum through the posterior optic nerve.

SCLERA AND CORNEA

The sclera is the white of the eye. The sclera is a tough layer of dense connective tissue consisting of collagenous fibres and networks of elastic fibres. Melanocytes are also present in it. These features make it suitable to be distended by the intraocular pressure and still maintain the shape of the eyeball. Its so strong that it serves as a site of attachment of the ocular muscles.

The cornea is formed by three cellular layers, which are separated from each other by two thin, acellular layers. Blood vessels are not normally found in the

cornea, and the cells are pigmented. The anterior surface is lined by a stratified squamous epithelium. The basement membrane of this anterior corneal epithelium rests on the first acellular layer, the anterior limiting lamina or Bowman's membrane. It separates the epithelium from the corneal stroma and consists of densely packed collagen fibrils embedded in ground substance. The cornea is as smooth and clear as glass but is strong and durable. Its features are adapted to its functions. These functions are it serves to shield the rest of the eye from germs, dust, and other harmful matter (it serves as a filter for some of most damaging ultraviolet (UV) wavelengths of sunlight). It also refracts light coming into the lens. Its acts as the eye's outermost lens.

CHOROID, CILIARY BODY AND IRIS

The uvea is a collective term for the vascular tunic which includes; the choroid, ciliary body and iris.

The choroid consists of loose connective tissue, which houses a dense network of blood vessels it has numerous melanocytes which give it its dark colour. The choroid is made up of four different layers; Haller's layer (large blood vessel layer), Sattler's layer (medium-size blood vessels), Choriocapillaris (capillaries), and Bruch's membrane (membrane on the innermost part of the choroid). Its dark pigment absorbs light and limits reflections within the eye that could degrade vision. Its vascular nature serves as a major supply of oxygen and blood supply to the retina.

The ciliary body consists of two epithelial cell layers, the non-pigmented (facing the aqueous humor) and the pigmented epithelium (connected to the stroma). The ciliary body has short extensions called the ciliary processes. It is a dense network of capillaries. The cells of the non-pigmented epithelium generate the aqueous humor of the eye from the plasma from the capillaries of the ciliary processes. The ciliary body contains ciliary muscle that is composed of smooth muscle. Contraction and relaxation of the ciliary muscles change the tension of the zonular fibres, or suspensory ligaments of the lens. This allows the lens to change shape, a process known as accommodation.

The iris consists of loose, highly vascular connective tissue and is composed of three different layers – (1) endothelium, (2) stroma and sphincter muscle, and (3) epithelium and dilator muscle. The endothelium is composed of fibroblasts and pigmented melanocytes. The connective tissue stroma is composed of pigmented and non-pigmented, collagen fibrils, and extensive ground substance. The iris stroma is continuous with the stroma of the ciliary body. The sphincter (sphincter pupillae) muscle lies within the stroma and is composed of smooth

muscle cells joined by tight junctions. The sphincter muscle contracts in response to bright light, making the pupil smaller and reducing the amount of light entering the posterior segment. The anterior surface of the epithelium is composed of unique myoepithelial cell. The muscle fibres extend into the stroma forming three of five layers of the dilator muscle fibres joined by tight junctions. The dilator (dilator pupillae) muscle will cause the pupil to dilates in dim light, thus increasing the light entering the posterior segment. The iris acts like the diaphragm of a camera. The posterior surface of the epithelium of the iris is covered in cells that contain pigment melanin and that prevent light from entering the eye through the iris. The remaining part of the iris has varying amounts of pigment responsible for the resultant eye colour.

LENS

The lens consists of a lens capsule, the subcapsular epithelium and lens fibres. It does not contain blood vessels or nerves. The crystalline lens sits just behind the pupil and acts like an autofocus camera lens, focusing on lose and approaching objects. The lens substance is an important factor in the transparency of the lens.

RETINA

The retina proper forms the photoreceptive layer of the eye. Similar to the retinal lining of the iris and the ciliary body, the outer layer of the light sensitive retina forms a single layer of cuboidal cells – the pigment epithelium. The inner layer of the retina contains the photoreceptors, the first neurons which process the sensory information, and the neurons which convey the pre-processed sensory information to the central nervous system. Receptors, neurons, supporting cells and their processes are segregated into nine layers.

2. LAYERS OF THE RETINA

The retina is a layered structure with ten distinct layers of neurons interconnected by synapses. The cells subdivide into three basic cell types: photoreceptor cells, neuronal cells, and glial cells. The layers from the closest to the front anterior of the head towards the posterior of the head are as follow:

- a. Inner limiting membrane
- b. Nerve fiber layer
- c. Ganglion cell layer
- d. Inner plexiform layer
- e. Inner nuclear layer

- f. Outer plexiform layer
- g. Outer nuclear layer
- h. External limiting membrane
- i. Inner segment / outer segment layer
- j. The layer of rods and cones

Inner Limiting Membrane

The inner limiting membrane is the retina's inner surface bordering the vitreous humor and thereby forming a diffusion barrier between the neural retina and vitreous humor. The ILM contains laterally contacting Muller cell synaptic boutons and other basement membrane parts.

Nerve Fibre Layer

The nerve fibre layer is the second innermost layer of the retina from the vitreous. It contains axons of the ganglion bodies.

Ganglion Cell Layer

This layer contains the nuclei of retinal ganglion cells the axons of which become the optic nerve fibres, and displaced amacrine cells. As a rule of thumb, smaller retinal ganglion cells dendrites arborize in the inner plexiform layer while larger retinal ganglion cell arborize in other layers.

Inner Plexiform Layer

The inner plexiform layer is an area comprised of the synapse between the bipolar cell axons and the dendrites of the ganglion and amacrine cells.

Inner Nuclear Layer

This layer of the retina contains the nuclei and cell bodies of bipolar cells, horizontal cells, and amacrine cells.

Outer Plexiform Layer

This layer of the retina contains a neuronal synapse of between rods and cones with the footplate of horizontal cells. Capillaries are also found to be primarily running through the outer plexiform layer.

Outer Nuclear Layer

This layer contains the rod and cones granules that sense photon, extensions from the rod and cone cell bodies.

External Limiting Membrane

This layer contains the bases of the rod and cones photoreceptors cell bodies. The external limiting membrane forms a barrier between subretinal space, into which the inner and outer segments of rods and cones project to be in close association with the pigment epithelial layer behind the retina, and the neural retina proper.

Inner Segment / Outer Segment Layer

Inner segments and outer segments of rods and cones. The outer segments contain a highly specialized light-sensing apparatus.

Retinal Pigment Epithelium

A single layer of cuboidal epithelial cells (with extrusions). This layer is 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.

It is thought that the transmission of the coronavirus through the eyes might enter the body through the blood vessels within conjunctiva and then spread through the body through blood vessels within the conjunctiva. Although the coronavirus is not directly related to the retina