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DEPARTMENT: MEDICINE AND SURGERY

COURSE: HISTOLOGY

ASSIGNMENT

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

ANSWERS

1)HISTOLOGICAL IMPORTANCE OF EYE IN RELATION TO CELLULAR FUNCTIONS

The histological importance of the eyes is complex. To understand the importance, a clear breakdown of the parts of the eye is needed. Each eye constantly adjusts the amount of light it lets in, focuses on objects near and far, and produces continuous images that are instantly transmitted to the brain. The orbit is the bony cavity that contains the eyeball, muscles, nerves, and blood vessels, as well as the structures that produce and drain tears. Each orbit is a pear-shaped structure that is formed by several bones. The outer covering of the eyeball consists of a relatively tough, white layer called the sclera which acts as a tough protective membrane for the eyeball. The sclera is covered by a thin, transparent membrane (conjunctiva), which runs to the edge of the cornea. The conjunctiva also covers the moist back surface of the eyelids and eyeballs and It keeps the eyes moist and clear by secreting small amounts of mucus and tears. Light enters the eye through the cornea, the clear, curved layer in front of the iris and pupil. The cornea serves as a protective covering for the front of the eye and helps focus light on the retina at the back of the eye. After passing through the cornea, light travels through the pupil (the black dot in the middle of the eye). The iris—the circular, coloured area of the eye that surrounds the pupil—controls the amount of light that enters the eye. The iris allows more light into the eye (enlarging or dilating the pupil) when the environment is dark and allows less light into the eye (shrinking or constricting the pupil) when the environment is bright. Thus, the pupil dilates and constricts like the aperture of a camera lens as the amount of light in the immediate surroundings changes. The size of the pupil is controlled by the action of the pupillary sphincter muscle and dilator muscle. Behind the iris sits the lens. By changing its shape, the lens focuses light onto the retina. Through the action of small muscles (called the ciliary muscles), the lens becomes thicker to focus on nearby objects and thinner to focus on distant objects. The retina contains the cells that sense light (photoreceptors) and the blood vessels that nourish them. The most sensitive part of the retina is a small area called the macula, which has millions of tightly packed photoreceptors (the type called cones). The high density of cones in the macula makes the visual image detailed, just as a high-resolution digital camera has more megapixels. The nerve fibers from the photoreceptors are bundled together to form the optic nerve. The optic disk, the first part of the optic nerve, is at the back of the eye. The photoreceptors in the retina convert the image into electrical signals, which are carried to the brain by the optic nerve. There are two main types of photoreceptors: cones and rods.

Cones are responsible for sharp, detailed central vision and colour vision and are clustered mainly in the macula.

Rods are responsible for night and peripheral (side) vision. Rods are more numerous than cones and much more sensitive to light, but they do not register colour or contribute to detailed central vision as the cones do. Rods are grouped mainly in the peripheral areas of the retina.

The eyeball is divided into two sections, each of which is filled with fluid. The pressure generated by these fluids fills out the eyeball and helps maintain its shape.

The front section (anterior segment) extends from the inside of the cornea to the front surface of the lens. It is filled with a fluid called the aqueous humor, which nourishes the internal structures. The anterior segment is divided into two chambers. The front (anterior) chamber extends from the cornea to the iris. The back (posterior) chamber extends from the iris to the lens. Normally, the aqueous humor is produced in the posterior chamber, flows slowly through the pupil into the anterior chamber, and then drains out of the eyeball through outflow channels located where the iris meets the cornea. The back section (posterior segment) extends from the back surface of the lens to the retina. It contains a jellylike fluid called the vitreous humor. Vitreous Humour (Chamber) is the transparent, colorless gelatinous mass that fills rear two-thirds of the eyeball, between the lens and the retina. It has to be clear so light can pass through it and it has to be there or eye would collapse.

2) LAYERS OF RETINA FOR INFORMATION PENETRATION

The photosensitive retina forms the inner lining of most of the posterior compartment of the eye and terminates along a scalloped line, the ora serrata, behind the ciliary body. Anterior to the ora serrata, the retinal layer continues as a non-photosensitive epithelial layer which lines the ciliary body and the posterior surface of the iris. The visual axis of the eye passes through a depression in the retina called the fovea which is surrounded by a yellow-pigmented zone, the macula lutea. The fovea is the area of greatest visual acuity. Afferent nerve fibres from the retina converge to form the optic nerve which leaves the eye through a part of the sclera known as the lamina cribrosa. The retina overlying the lamina cribrosa, the optic papilla (optic disc), is devoid of photoreceptors and thus represents a blind spot.

The retina consists of two components:

a) an outermost layer of retinal pigment epithelium (RPE), which is composed of single layer of cuboidal melanin-containing cells
b) the neural retina which is a multi-layered structure containing photoreceptors as well as neurons and glia.

In life, these two components are fused into what we typically call the retina, and it is subdivided into 10 recognizable layers. These are

1. **Retina Pigmented Epithelium:** This layer consists of cuboidal or low columnar cells with basal nuclei and surrounds the neural layer of the retina. The cells have well developed junctional complexes, gap junctions and numerous invaginations of the basal membranes associated with mitochondria. The apical ends of the cells extend processes and sheath like projections that surround the tips of photoreceptors. This cellular region also contains phagocytic vacuoles and secondary lysosomes, peroxisomes and abundant smooth ER specialized for retina isomerization. This layer absorbs scattered light, forms an important part of the blood-retina barrier and play key roles in the visual cycle of retinal regeneration.
2. **Layer of Rods and Cones:** The rods are processes of rod cells, and cones are processes of cone cells where the photoreceptors are located. The rod cells are cylindrical whereas for the cone cells outer segments are conical. Rods are more sensitive to light and thus are the

receptors primarily used in periods of low light intensity, but the resulting image is monochromatic. Cones, on the other hand, are sensitive to specific wavelengths of light allowing you to discern colors and more detailed visual information, but they require more intense lighting.

3. **Outer Limiting Layer:** It is a dense line formed by the junctional complexes between the rod and cone cells and the supportive Müller glia. It separates the outer segments which are rich in photosensitive pigments from the rest of the retina which functions primarily to integrate and process the signals initiated by the rod and cone cells.
4. **Outer Nuclear Layer:** The external nuclear layer contains the cell bodies and nuclei of rod cells and of cone cells. These cells are photoreceptors that convert the stimulus of light into nervous impulses.
5. **Outer Plexiform Layer:** The external plexiform layer (or outer synaptic zone) consists only of nerve fibres that form a plexus. The axons of rods and cones synapse here with dendrites of bipolar neurons. Processes of horizontal cells also take part in these synapses.
6. **Inner Nuclear Layer:** The internal nuclear layer contains the cell bodies and nuclei of three types of neurons.
   (a) The bipolar neurons give off dendrites that enter the external plexiform layer to synapse with the axons of rod and cone cells; and axons that enter the internal plexiform layer where they synapse with dendrites of ganglion cells
   (b) The horizontal neurons give off processes that run parallel to the retinal surface. These processes enter the outer plexiform layer and synapse with rods, cones, and dendrites of bipolar cells.
   (c)The amacrine cells also lie horizontally in the retina. Their processes enter the inner plexiform layer where they synapse with axons of bipolar cells, and with dendrite of ganglion cells.
7. **Inner Plexiform Layer:** The internal plexiform layer (or inner synaptic zone) consists of synapsing nerve fibres. The axons of bipolar cells synapse with dendrites of ganglion cells; and both these processes synapse with processes of amacrine cells. The internal plexiform layer also contains some horizontally placed internal plexiform cells, and a few ganglion cells.
8. **Ganglionic Layer:** The layer of ganglion cells contains the cell bodies of ganglion cells. We have seen that dendrites of these cells enter the internal plexiform layer to synapse with processes of bipolar cells and of amacrine cells. Each ganglion cell gives off an axon that forms a fibre of the optic nerve.
9. **Nerve Fiber Layer:** The layer of optic nerve fibres is made up of axons of ganglion cells. The fibres converge on the optic disc where they pass through foramina of the lamina cribrosa to enter the optic nerve.
10. **Inner Limiting Layer:** This layer consists o terminal expansions of other Muller cell processes that cover the collagenous membrane of the vitreous body.