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Assignment Title: Special senses assignment
Course Title: Histology of Special Senses and Neuro histology
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Question
1. Write an essay on the histological importance of eye in relation to their cellular functions.

The retina transmits light signals into chemical signals that are sent to the brain. This process requires the ability to sense the stimulus of light and transmit that signal from cell to cell.

Vertebrate retina is organized in superimposed layers, formed by the different cells. The retina contains five mayor types of cells: photoreceptors (rods and cones), bipolar cells, horizontal cells, amacrine cells and ganglion cells (RGC). In general, cell somas are grouped in three distinct nuclear layers, separated by two connecting layers’ plexiform layers, where synapses between cells are formed. The innermost layer is the **ganglion cell layer,** which contains the cell bodies of the ganglion cells and displaced amacrine cells. The next cell layer is the **inner nuclear layer**, which contains the cell bodies of the amacrine cells, the bipolar cells, and the horizontal cells; it may also contain some displaced ganglion cells. The next cell layer is the **outer nuclear layer,** which contains the cell bodies of the photoreceptors. Outside of these layers, the layer of photoreceptor outer segments contains the light-sensitive elements of the retina. Light must pass through vitreous humor and the different layers of the retina before reaching the outer segments of the photoreceptors. Interspersed between the ganglion cell layer and the inner nuclear layer is the inner plexiform layer, which contains the axons of bipolar cells, dendrites of ganglion cells and cell processes of amacrine cells (axons and/or dendrites). Between the outer and inner nuclear layers is the outer plexiform layer, which contains the axon terminals of photoreceptors, the dendrites of bipolar and cell processes of horizontal cells (axons and/or dendrites). The basic system of retinal information processing consists on a direct pathway of visual information that flows from photoreceptors to bipolar cells to ganglion cells. The ganglion cells fire action potentials in response to light, and these impulses propagate down the optic nerve to the projection nuclei in the brain. This direct pathway is influenced by two transverse fluxes of modulatory signals coming from horizontal in outer plexiform layer and amacrine cells in inner plexiform layer. Horizontal cells receive input from the photoreceptors and project their processes laterally to influence surrounding bipolar cells. Amacrine cells receive input from bipolar cells and project their processes laterally to influence surrounding bipolar and ganglion cells. Both, horizontal and amacrine cells usually make electrical and chemical synapses with neighbour cells of the same type.

 **Photoreceptors (rods and cones)**: The detection of light begins at the deepest cell layer in the retina, the photoreceptors, located in the outer nuclear layer. Rods are very light sensitive and are responsible for dim-light vision. Cones, on the other hand, are not very light sensitive but are specific for a particular wavelength of light. Thus, cones are responsible for high acuity color vision.

**Bipolar cells**: Photoreceptors use the neurotransmitter, glutamate, to communicate at the synapse with bipolar cells within the outer plexiform layer. Bipolar cell bodies are just shallow to this layer at the inner nuclear layer. At the inner plexiform layer, bipolar cells are responsible for transmitting an impulse to retinal ganglion cells.

**Retinal ganglion cells**: These are the final receivers and transmitters of the initial stimulus. They send the information they receive down their axons, which eventually form the optic nerve and project to higher brain centres.

**Amacrine cells**: Amacrine cells modulate the excitation of the retinal ganglion cells through contact with ganglion cell dendrites or bipolar cell axon terminal bulbs, using the neurotransmitters GABA and glycine.

**Horizontal cells**: These cells function to modulate the communication between photoreceptors and bipolar cells. Bipolar cells contact ganglion and amacrine cells at the inner plexiform layer.

**Müller cells**: These are cells are of glial origin and are essential for proper retinal function. They contact almost every cell type in the retina, spanning the entire width from the photoreceptors to the inner retina. They serve to recycle neurotransmitters, prevent glutamate toxicity, and regulate nutrient homeostasis in the retina.

2. Corona virus can penetrate the body through eye and implicate the immune system, briefly discuss the layers of retina for information penetration.

#### **Ganglion cell layer**

This layer consists of ganglion cells and displaced amacrine cells, Muller cell bodies and astroglial cells. Ganglion cells are separated from each other by glial processes of Muller cells and are generally a single cell thick except near the macula, where they are several strata (about 8–10 cells thick) and the temporal side of the optic disc (where it is 2 cells thick). Current measures of visual function in glaucoma as based on conventional techniques such as the appearance of the optic disc, NFL, and standard achromatic perimetry, are relatively insensitive because research has shown that 25% – 35% of retinal ganglion cells may be lost before an abnormality appears on standard achromatic perimetry. Therefore, modern technologies such as OCT which provide an in vivo cross-sectional images of ocular structures should be used.

#### **Inner plexiform layer**

Commonly referred to as the inner synaptic layer, this layer consists of cell processes and synapses of bipolar cells, amacrine cells, interplexiform cells, and ganglion cells. This layer also contains synapses between the bipolar cell axons and the dendrites of the ganglion and amacrine cells. This layer is responsible for initiating the processing of motion detection, changes in brightness, and recognition of contrast and hue.

#### **Inner nuclear layer**

The inner nuclear layer consists of nuclei and cells bodies of bipolar cells, horizontal cells, interplexiform cells, and amacrine, as well as the nuclei of the Muller’s cells and sometimes displaced ganglion cells. The main function of this layer is to receive input from the inner plexiform layer and project it to the outer plexiform layer. Haemorrhages in the inner nuclear layer appear rounded and often are called dot and blot haemorrhages.

#### **Outer plexiform layer**

Also known as the outer synaptic layer, the outer plexiform layer has synaptic connections between photoreceptor cells, bipolar neurons, and horizontal cells. The projections of rods and cones end in the rod spherules and cone pedicles, respectively. These pedicles make synapses with dendrites of midget bipolar cells in the Fibres of Henle in the macula region. It is thought to be a membrane, known as middle limiting membrane, which demarcates the extent of the retinal vasculature. The middle limiting membrane may prevent the spread of retinal exudates and haemorrhages into the outer retinal layers.

#### **Outer nuclear layer**

This layer contains the nuclei and cell bodies of the photoreceptor cells (rods and cones) and varies in width, being thickest in the fovea where it contains about 10 layers of cone nuclei. The outer nuclear layer is relatively thicker on the nasal edge of the disc (where it is 8–9 cells thick) compared to the 4 rows thick at the temporal edge.

#### **External limiting membrane**

The external (outer) limiting membrane is not a true membrane and is composed of adherent junctions between Muller’s cells and photoreceptors separating the inner segment portions of the photoreceptors from their cell nuclei. The adherent junctions can act to restrict the passage of large molecules, thus creating a metabolic barrier.