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# RETINAL CHANGES IN MYOPIA

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## ANATOMY OF THE RETINA

### Anatomy Of The Retina

The retina is the innermost or nervous tunic of the eye. It is a thin membrane which is transparent and of a purplish - red colour in the living state.

The retina extends from the entrance of the optic nerve to the pupillary margin of the iris. Thickness of the retina is about 100 microns at the Ora Serrata, 350 microns around the macula, 180 microns at the equator and about 90 microns at the centre of the fovea. (Wolff, 1976).

If we attempt to separate the retina from the Choroid, we find that, the retina proper is attached only at two regions, namely; around the optic disc , and in front at its dentate termination; the Ora Serrata which extends further forwards on the nasal than on the temporal side, and above than below. ( Wolff, 1976 ).

The whole retina is usually described as having ten layers from without inwards : Fig.(1).

1. The Pigment Epithelium.
2. The Layer of Rods and Cones.
3. The External Limiting Membrane.

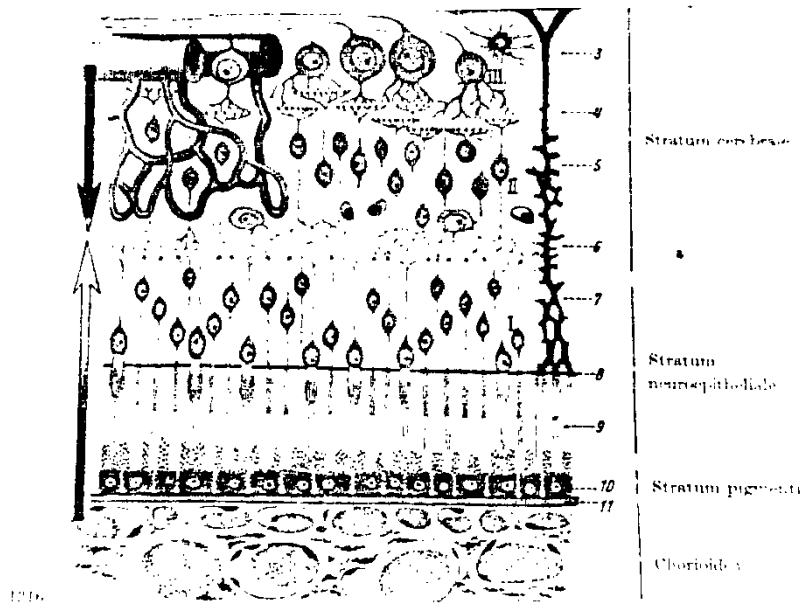


Fig. (1) :

Section through the retina.  
(Schematic diagram of retinal neurons.)  
(Thiel, 1963).

4. The Outer Nuclear Layer.
5. The Outer Molecular (Plexiform) Layer.
6. The Inner Nuclear Layer.
7. The Inner Molecular (Plexiform) Layer.
8. The Ganglion Cell Layer.
9. The Stratum Opticum or Nerve Fibre Layer.
10. The Internal Limiting Membrane.

1) The Pigment Epithelium :

It forms a continuous brown sheet extending from the Optic nerve to the Ora Serrata. The colour is not uniform, there is a fine mottling due to the fact that, the cells are not equally pigmented.

The retinal pigment epithelium consists of a single layer of cells which is firmly attached to the basal lamina of the choroid, but only loosely to the rods and cones.

Under light microscopy, the pigment cells, as seen in tangential section, are regularly hexagonal, and appear to be separated by a considerable space. Electron microscopy demonstrates a unit membrane cell wall, which on the lateral



aspect of the cells is united to its neighbours by zonulae occludentes and other forms of junction. The residual space is filled with mucopolysaccharide.

The basal aspect of cells is much folded and is adherent to a basement membrane forming a part of Bruch's membrane. The basal region contains a large nucleus.

The apical part of the cells are formed by microvilli which project amongst the rods and cones processes with a length of 5-7  $\mu\text{m}$ . There are no contact between these processes and the receptors.

The pigment granules are of various shapes many being ovoid or fusiform. They occur throughout the cytoplasm but are mostly congregated in its basal part. ( Wolff, 1976) .

## 2) The Layer Of Rods & Cones :

Rods and Cones form the photoreceptors of the retina, both may be called "Neuroepithelium". They are arranged like a plate across the external limiting membrane.

Each rod, whose length varies from 40-60  $\mu\text{m}$ , consists of two segments an outer and an inner. The outer is cylindrical

highly refractile and transversally striated and contains the visual pigment. The inner segment is slightly thicker than the outer, and stains with nuclear stains, while outer segment stains with osmic acid.

From the inner end of each rod, runs a thin outer fibre, passing through external limiting membrane, swells out into rod granule, then terminates as an inner fibre in outer molecular layer, whose dendrites of bipolar cells arborise around it.

Each cone, whose length varies from 40  $\mu\text{m}$  to 85  $\mu\text{m}$ , consists of two segments. The outer segment is conical in shape, much shorter than that of the rod. It contains no visual pigment. The inner segment is bulged and continuous with its nucleus.

Different areas of the retina have different proportion of rods and cones.

The total number of cones is about 6.3-6.8 millions, while the rods number is about 110 to 125 millions in the human retina. In the fovea and foveola, there are no rod photoreceptors but only tightly packed cones which become relatively scarcer towards the periphery. (Wolff, 1976).

### 3) The External Limiting Membrane :

It is a widely fenestrated membrane extending from the Ora Serrata to the edge of the optic disc.

Through the holes in the net pass the processes of rods and cones.

Light microscopy suggested that, the external limiting membrane is formed by the apposition of the terminal expansion of the fibres of Muller's cells. Arey (1932), suggested that, it consists of junctions known as "terminal bars" between the cell membranes of rods and cones processes and Muller's cells.

Anteriorly, at the ora serrata, the external limiting membrane ends at the same level as the pigment epithelium by becoming continuous with the cement substance between the pigmented and non-pigmented portions of the ciliary epithelium. ( Wolff, 1976 ).

### 4) The Outer Nuclear Layer :

This consists of nuclei of rods and cones. The rod granule is round while the cone granule is larger, oval

and stains differently. As the cone fibres are very short, the granules lie as a single layer situated close to the external limiting membrane.

The rod and cone inner fibres continue into the outer plexiform layer to end among dendrites of the bipolar cells. The rod fibre ends in a small knob " rod spherule ", while cone fibre ends in a conical swelling with lateral processes " cone pedicle ". ( Wolff, 1976 ).

#### 5) The External Plexiform Lamina :

The connection in this lamina between rod spherules and cone pedicles with dendrites of bipolar and horizontal cells have long been known through the classical studies of Polyak (1941), and others.

Rod spherules make contact with two to seven dendrites, whereas cone pedicles display about 25 invaginations containing "triads" of horizontal and bipolar dendrites.

In addition, simpler contacts are made by bipolar dendrites upon cell membrane of the pedicles. The pedicles also display lateral "inter-receptors" contacts with adjacent cones and rods.

The rod spherule and cone pedicle are in their structure complex synaptic invaginations, the invaginated photoreceptor termination shows in both forms organelles of synaptic significance including vesicles, ribbons , mitochondria and microtubules. (Wolff, 1976).

#### 6) The Inner Nuclear Layer :

This consists of the following elements principally cell somata :

- a- The bipolar neurons.
- b- The horizontal neurons.
- c- The amacrine neurons.
- d- Somata of the cells of Muller.
- e- Capillaries of the central retinal vessels.

The bipolar neurons are the neurons of the first order. They have their nuclei in the inner nuclear layer and their dendrites arborize in the outer molecular layer with the rod and cone fibres. The bodies of the bipolar cells resemble the granules of the outer nuclear layer and consists of nucleus with very little protoplasm.

The horizontal neurons are flat cells whose processes spread horizontally, that is parallel to the surface of the

retina. They have one long process or axon, and a considerable number of short dendrites with branching terminals.

The amacrine neurons have a piriform body and a single process which passes inwards and ends in the inner plexiform layer.

The cells of Muller show processes which extend from the cell somata through all retinal laminae except the pigmented epithelium and the zone containing the outer segments of the photoreceptors. The cells of Muller are glial cells and have a supportive role. (Wolff, 1976).

#### 7) The Inner Plexiform (Molecular) Layer :

This consists essentially of the arborization of the axons of the bipolar cells with dendrites of the ganglion cells. It comprises also the processes of the amacrine cells, fibres of the Muller cells, branches of the retinal vessels and few scattered nuclei.

This layer consists of the junction of the first and second order sensory neurons of the visual pathway and contains complex synapses between bipolar ganglion and amacrine cells. (Wolff, 1976).

#### 8) The Ganglion cell Layer :

This layer consists essentially of ganglion cells of the retina, also fibres of Muller cells, neuroglial cells and branches of retinal vessels are found in it.

The ganglion cells are neurons of the second order , they are multipolar nerve cells. They have a clear round or oval nucleus. The cells vary greatly in size and shape.

As we approach the macula, they increase in depth , they decrease again towards the fovea, where they disappear entirely. Towards the ora serrata, the ganglion cells are sparser and gradually make their way into the nerve fibre layer.

The connections between the bipolar axons, neurites of amacrine neurons and dendrites and somata of the ganglion cells are complex. (Wolff, 1976).

#### 9) The Nerve Fibre Layer :

This layer consists essentially of the axons of the ganglion cells which pass through the lamina cribrosa to form the optic nerve.