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# UNIT 5 ANATOMY OF THE INNER COAT OF THE EYEBALL AND ANATOMY OF VITREOUS

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## Structure

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## 5.0 OBJECTIVES

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After reading this unit, you should be able to understand:

- anatomy of inner layer of eyeball;
- its different layers;
- description of special region of retina; and
- anatomy of vitreous.

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## 5.1 INTRODUCTION

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In previous units you have studied the structures, outer and middle coats of the eyeball. In this unit you will study the structure of inner coat of the eyeball, i.e., retina, together with its special regions. You will also study the anatomy of vitreous, a gel like, optically empty, structure of the eyeball. It lies in close approximation of retina and lens.

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## 5.2 ANATOMY OF RETINA AND ITS SPECIAL REGIONS

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Retina functions like film in a camera. Retina is the most sensitive layer of the eyeball. Basic function of eyeball is to focus image on the retina. From the retina, visual impulses pass to the brain through optic nerve. Essentially optic nerve is an extension of retina. Optic nerve fibres are the axons of one type of cell in retina called ganglion cell.

### 5.2.1 Anatomy of Retina

Retina is the innermost layer of the eye. It is a thin membrane and transparent. From vision point of view retina is the most important layer. Light rays fall at this layer and from retina visual image passes to the vision centres of brain. Retina sends its impulses to the brain through the optic nerve.

## Structure of Retina

Retina is a thin, delicate layer of nervous tissue.

**Extension:** Retina extends from the optic disc to the point where ciliary body ends. This junction is known as ora serrata.

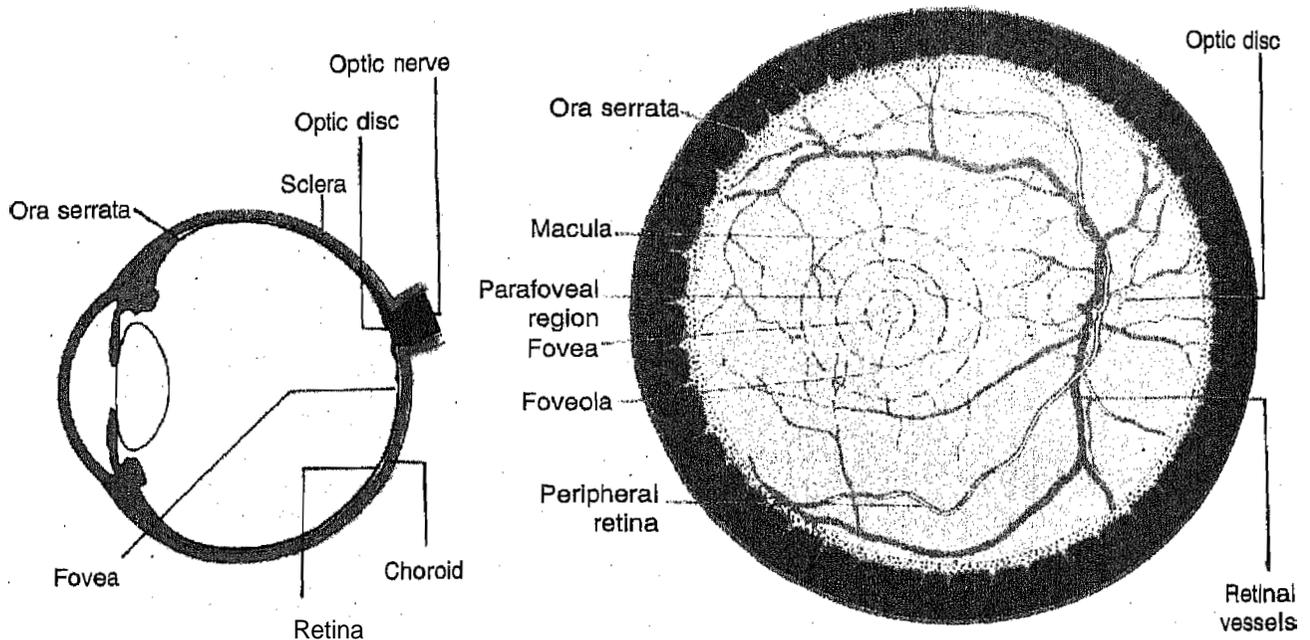


Fig. 5.1: Gross anatomy of the retina

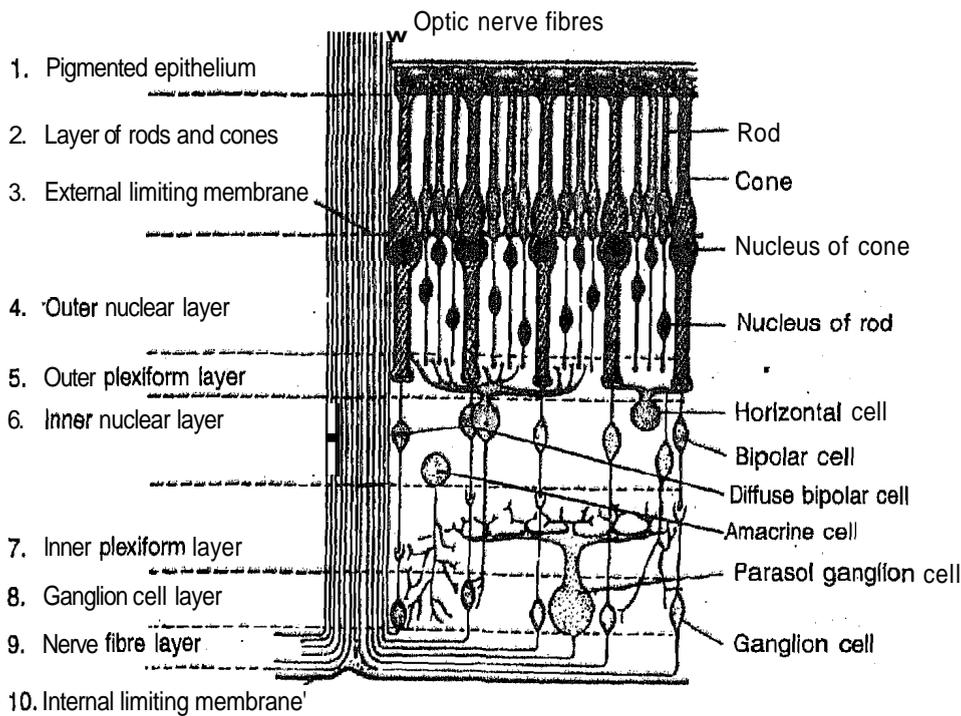
### Thickness of Retina

- At ora serrata—100  $\mu\text{m}$
- At macula—350  $\mu\text{m}$
- At equator of eye—180
- Near the optic cup—560  $\mu\text{m}$

### Layers of Retina

There are 10 layers in the retina. From posterior to anterior these include:

- 1) Retinal pigment epithelium
- 2) Layers of rods and cones
- 3) External limiting membrane
- 4) Outer nuclear layer
- 5) The outer plexiform layer
- 6) The inner nuclear layer
- 7) The inner plexiform layer
- 8) Ganglion cell layer
- 9) The nerve fiber layer
- 10) The internal limiting membrane



**Fig. 5.2: Microscopic structure of the retina**

### 1) *Retinal Pigment Epithelium*

Retinal pigment epithelial layer is the most posterior layer of retina. It consists of single layer of cells. The shape of cells is hexagonal. The pigment epithelial cells are joined to one another by tight junction forming a barrier. The estimated total number of cell in retinal pigment epithelium is 5 million. In the posterior part of retina, retinal pigment epithelial cells measure 12-18  $\mu\text{m}$  in width and 10-14  $\mu\text{m}$  in height. With increasing age, the pigmented cells in the macular increase in height and decrease in width; the inverse occurs in the cells at the periphery.

#### *Function of Retinal Pigment Epithelium*

- 1) Absorption of scattered light by melanin, and
- 2) Transport of nutrients and metabolites

The pigment epithelium cell is so named because these cells contain melanin, Melanin absorbs light when it falls on the retina.

### 2) *Layers of Rods and Cones*

Rods and cones are the visual cells also called photoreceptor cells. There are about on an average 92 million rods and 4.5 million cones. The density of cones are maximal at fovea. The average horizontal diameter of the rod-free area at the fovea is 0.35 mm.

#### *Structures of Rods*

Length: 40 to 60 mm

Parts: Outer Segment  
Inner Segment

#### *Outer Segment of the Rods*

Shape cylindrical

**Lightly** refractive

Transversely striated

Contains visual purple .

*Inner Segments of Rods*

Thicker than outer segment

**Structure of Cones**

**Length** at the posterior pole 85 mm

**At** the periphery 40 mm

*Parts of Cones*

Outer segment

Inner segment

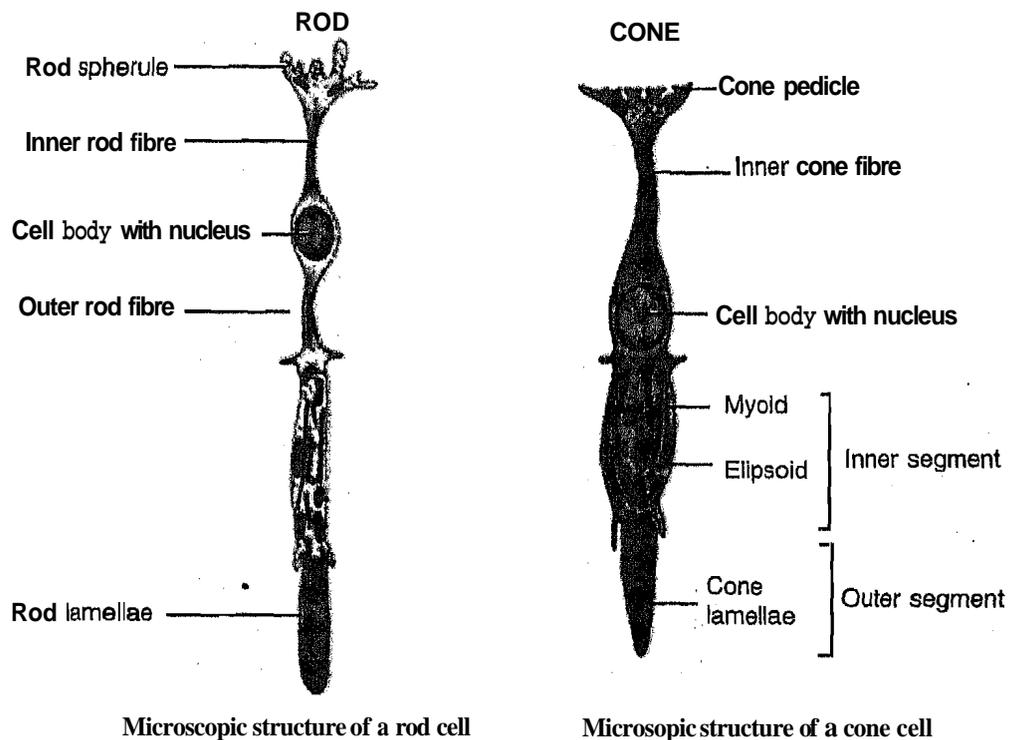


Fig. 5.3: Microscopic structure of rods and cones

*Outer Segment of Cones*

Shape-conical shorter than rods

*Inner Segment of Cones*

Bulged and directly continuous with the nucleus.

3) *External Limiting Membrane*

It is a membrane having lot of openings through which processes of rods and cones pass.

4) *Outer Nuclear Layers*

This layer consists of nucleus of the rods and cones. The nucleus of cone is 5-7  $\mu\text{m}$  in diameter and that of rod is 5.5  $\mu\text{m}$ .

### 5) *Outer Plexiform Layer*

This layer consists of the junction between the rods and cones with the bipolar and horizontal cells. It represents the junction of the first and second order neuron. The outer 2/3rd of this layer composed of inner fibres of photoreceptors and inner 1/3rd consists of dendrites of the bipolar and amacrine cells. This layer is thickest at the macula, measuring about  $51\mu\text{m}$  and consists predominantly of oblique fibres that have deviated from fovea. This layer is also known as *Henle's fibre layer*.

### 6) *The Inner Nuclear Layer*

This layer consists of 8-12 rows of closed packed cells. This layer consists of:

- a) The bipolar cells
- b) The horizontal cells
- c) The amacrine cells
- d) Capillaries of central retinal, vessels

#### *Bipolar Cells*

These cells form the second order neuron in the visual pathway. The processes of these cell form anastomoses with the process of the rods and cones in the outer plexiform layer. The bipolar cells also anastomoses with the ganglion cell processes in the inner plexiform layer.

#### *Horizontal Cells*

These are flat cells. The processes of these cells spread horizontally, parallel to the surface of retina.

#### *The Amacrine Cells*

The cells have piriform body. The processes of these cells end in the inner plexiform layers.

### 7) *Inner Plexiform Layer*

This layer essentially consists of the anastomosis between the processes of the bipolar cells and the ganglion cells. This layer is absent at the macula.

### 8) *Ganglion Cell Layer*

This layer consists of ganglion cells, The axons of this layer form optic nerve. The ganglion cells form the 3rd order neuron in the visual pathway. Nearly 1.2 million ganglion cells are present in the retina.

### 9) *Nerve Fiber Layer*

This layer essentially consists of the axons of the ganglion cells. The nerve fibers are arranged in bundles and run parallel to the surface of the retina. The nerve fibers coverage to the posterior pole of the eyeball and exit the eyeball as optic nerve. The diameter of these fibres varies from  $0.6\mu\text{m}$  to  $2\mu\text{m}$  in diameter. The nerve fibre layer is thickest at the nasal edge of the disc and measures about 20-30  $\mu\text{m}$ . The thickness decreases from optic disc to the ora. The papillomacular bundle represents the thinnest portion of the nerve fibre layer and contains fibres from macular area to the optic disc,

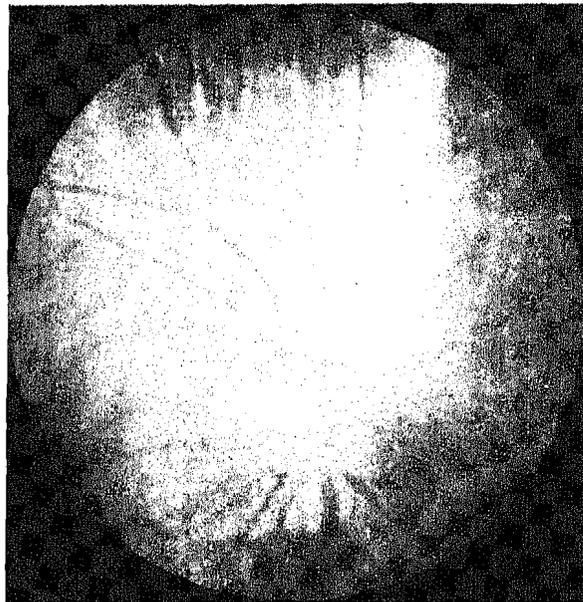


Fig. 54: Arrangement of nerve fibres in the retina

#### 10) *The Internal Limiting Membrane*

This is membrane like structure and forms the inner most layer of the retina and separates the retina from vitreous.

### 5.2.2 Special Regions of the Retina

- 1) Optic disc
- 2) Macula
- 3) Ora serrata

#### Optic Disc

This is situated at the posterior pole of the eyeball and oval in shape. The vertical diameter is ~~more~~ than horizontal diameter. Its size is about 1.5 mm. The central part of the optic disc is depressed and is known as cup. The average size of cup in relation to the size of the disc is about 0.3 to 0.4. In patients of glaucoma as the progressive damage to the optic nerve fiber occurs, there occur enlargement of cup. Clinically it is called increased cup disc ratio.

#### Macula

**Macular area** is situated temporal to the disc margin. Average diameter of macular is about 5.5 mm and corresponds to approximately 15° of visual field.

#### Parts of the Macula

- i) **Foveola:** Central depressed portion of the macula, It measures 0.35 mm in diameter and 0.13 mm in thickness and represents area of the highest visual acuity in the retina.
- ii) **Fovea:** It surrounds the foveola and its size is about 1.9 mm in average.
- iii) **Macula lutea:** Thickness is 0.25 mm.

It is an oval zone of yellow colouration within the central retina. The yellow colouration is due to the presence of xanthophylls present in the region of ganglion and bipolar cells.

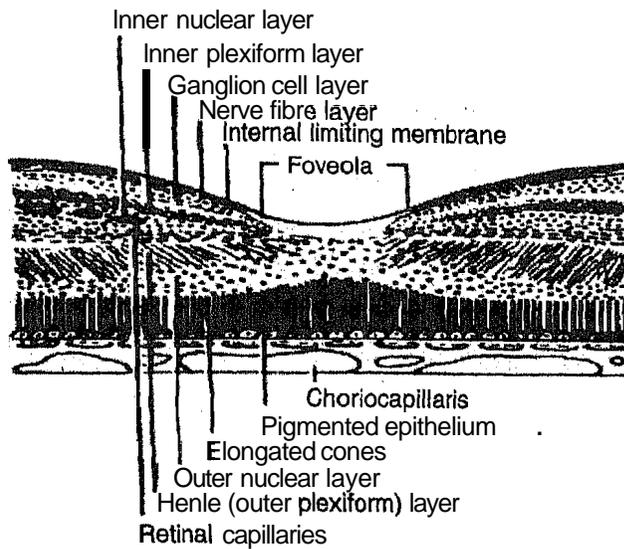


Fig. 5.5: Microscopic structure of the fovea centralis

In the fovea and foveola there are no rod photoreceptors, only cones are present.

### Ora Serrata

This layer forms the most anterior region of the retina. It is situated 8-8.5 mm from the limbus and 25 mm from the optic nerve. This point retina is firmly adherent to the choroid.

### Blood Supply of Retina

#### Sources

- 1) Central retinal artery
- 2) Choroidal blood supply

The inner layers of the retina are supplied by the central retinal artery. The outer layer gets their nourishment from choroidal vascular system.

### Check Your Progress 1

- 1) Retina consists of how many layers?  
.....  
.....
- 2) Mention the most sensitive part of retina.  
.....  
.....
- 3) Optic nerve fibres is the axon of which cell?  
.....  
.....

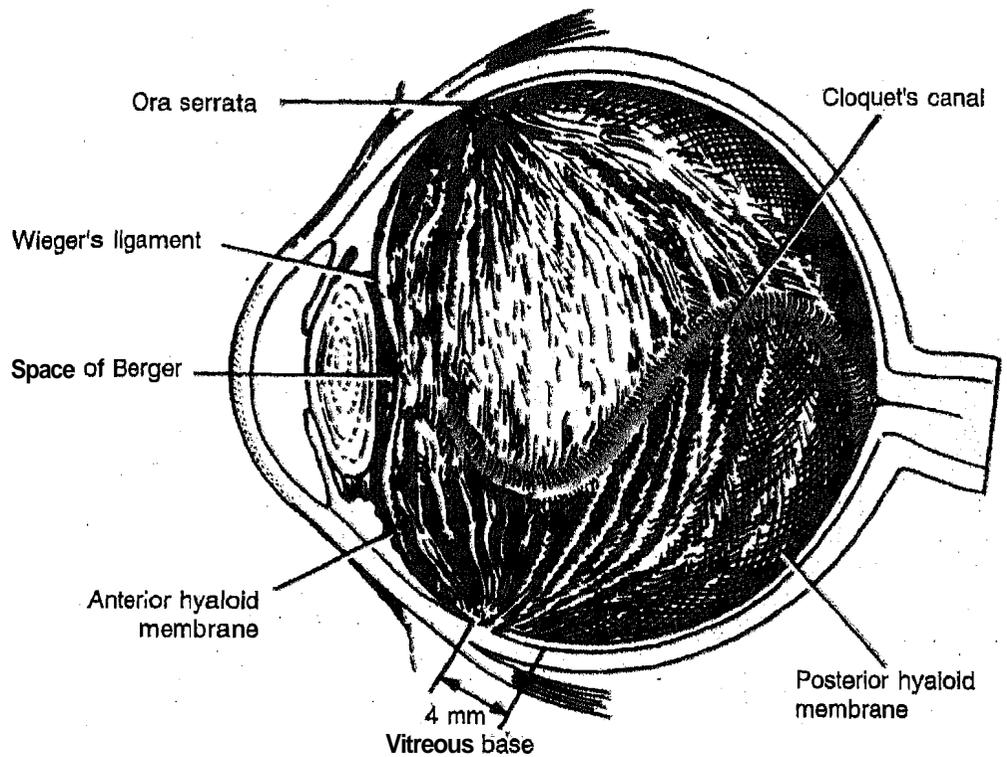
## 5.3 ANATOMY OF VITREOUS

Vitreous is a transparent, gel like structure filling the posterior four-fifth of the globe. It extends from the posterior surface of the lens anteriorly to the anterior surface of the retina posteriorly. Average volume of vitreous is about 4 ml. The

vitreous cavity is roughly spherical but is flattened anteriorly. Anterior concavity at which lens is situated is called patellar fossa. The anterior surface is known as anterior hyaloid phase. The space between the anterior surface of vitreous and posterior surface of the lens is called Berger's space.

**Components of Vitreous**

- 1) Cortex: Anterior hyaloid  
                   Vitreous base  
                   Posterior hyaloid
- 2) Central Vitreous
- 3) Vitreous cells



**Fig. 5.6: Gross anatomy of the vitreous**

**Cortex of Vitreous**

This forms the dense zone bordering the posterior and anterior surface of the vitreous. The dense zone covering the posterior surface of vitreous is known as posterior cortex and those covering the anterior surface of vitreous is called anterior cortex. Average thickness of cortex is about 100-200 µm.

**Central Vitreous**

Histologically central vitreous consists of collagen fibres loosely bonded to the hyaluronic acid ground substance. Hyaluronic acid maintains a physical separation of collagen fibrils to which helps in maintaining optical transparency of vitreous.

**Vitreous Cells**

Vitreous cells which are otherwise known as hyalocytes are present only in the cortex adjacent to the retina and ciliary body. The central vitreous and cortex adjacent to lens and posterior chamber do not contain vitreous cells.

### *Functions of Vitreous Cells*

- 1) Phagocytic activity
- 2) Synthesize hyaluronic acid

### *Composition of Vitreous*

Volume: 4 ml.

Water content: 99 per cent

Concentration of hyaluronic acid 0.03-1 per cent

Type of collagen: Type II collagen changes in vitreous with ageing.

Young: (Vitreous usually have a gelly like structure and empty optically.

Old age: More of a liquid type with a fibrillar appearance

**Blood Supply:** Vitreous is completely avascular. But under some pathological conditions retinal blood vessels may grow into the vitreous.

### *Vitreo-Retinal Attachments*

Posteriorly vitreous is loosely attached to the retina. However at certain points vitreous is closely attached to the retina. The sites of these vitreo-retinal attachments include:

Around the optic disc,

Around the macula,

Along the retinal blood vessels,

At the vitreous base.

### *Vitreous Base*

It is broad band of vitreous condensation and its attachment run circumferentially from a point 2 mm anterior to the ora to a point 2-4 mm behind it. This is situated near the ora serrata and vitreous is strongly attached to the retina. Anterior to the ora, vitreous fibrils blend with the nonpigmented epithelium of the ciliary body.

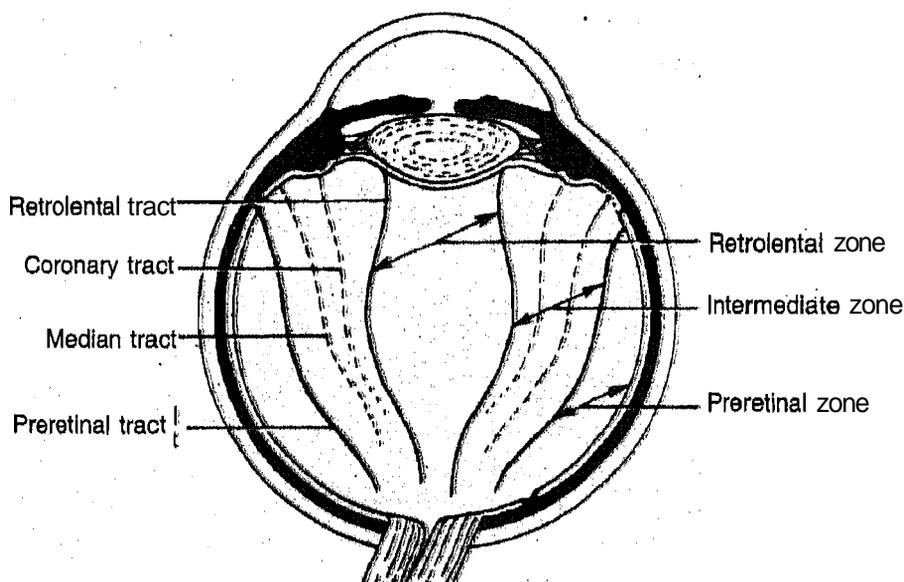


Fig. 5.7: Vitreous tracts and zones of vitreous space

Anterior **surface of the** vitreous also known as anterior hyaloid surface is concave, in which the lens is situated. Vitreous is almost in direct contact with the posterior capsule of the lens. So during cataract surgery if damage or rupture of the posterior capsule occur vitreous may come out.

**Check Your Progress 2**

1) What are the attachments of vitreous with retina?

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.....  
.....

2) What is the optical property of vitreous?

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.....  
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## 5.4 LETUSSUM UP

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Retina is the inner layer of eyeball. It is a transparent structure. Most sensitive part of retina is foveola. There are 10 layers in retina. Optic nerve fibres are the axons of ganglion cells of retina. Vitreous is a jelly like substance. Vitreous is situated in space between retina and lens.

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## 5.5 ANSWERS TO CHECK YOUR PROGRESS

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Check **Your Progress 1**.

- 1) Ten
- 2) Foveola
- 3) Ganglion cell

Check **Your Progress 2**

- 1) ● Around the optic disc,
  - Around the macula,
  - Vitreous base, and
  - Along the retinal blood vessels.
- 2) Optically empty.