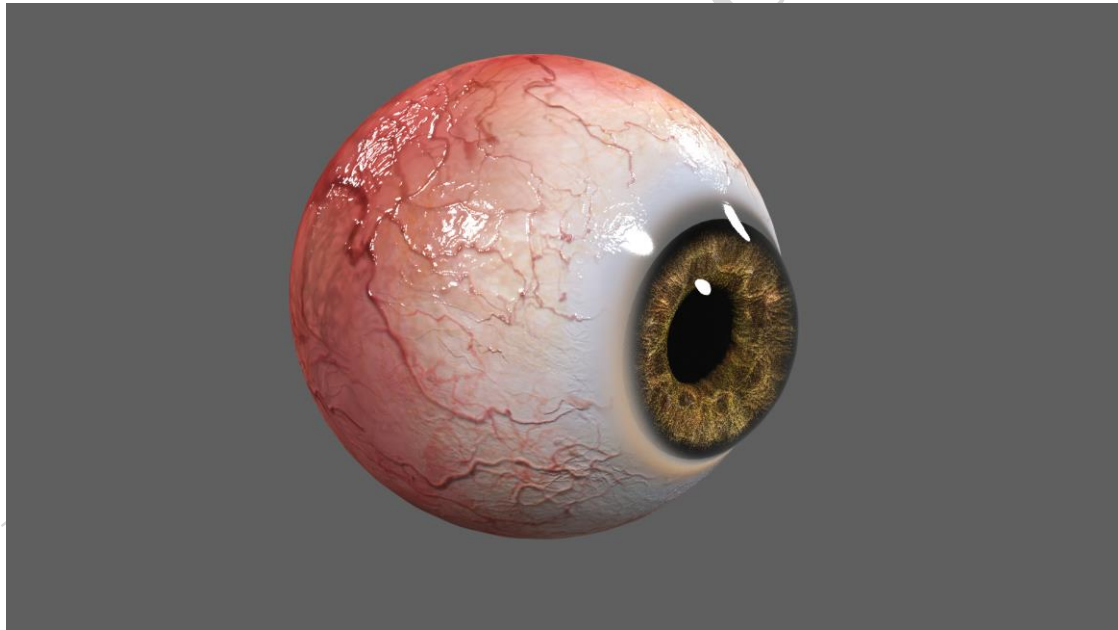


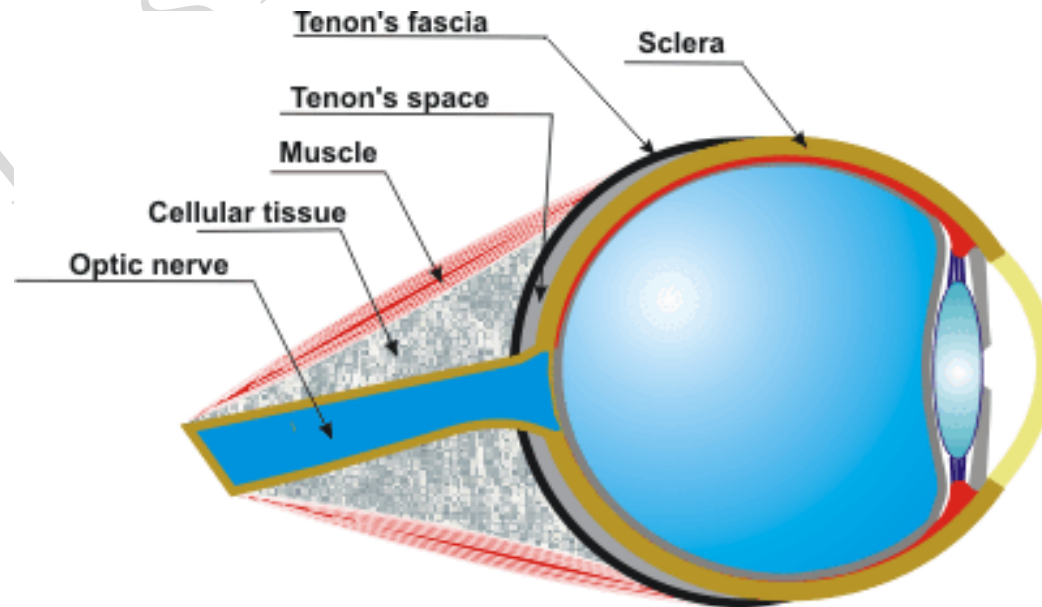
# EYE

Centre

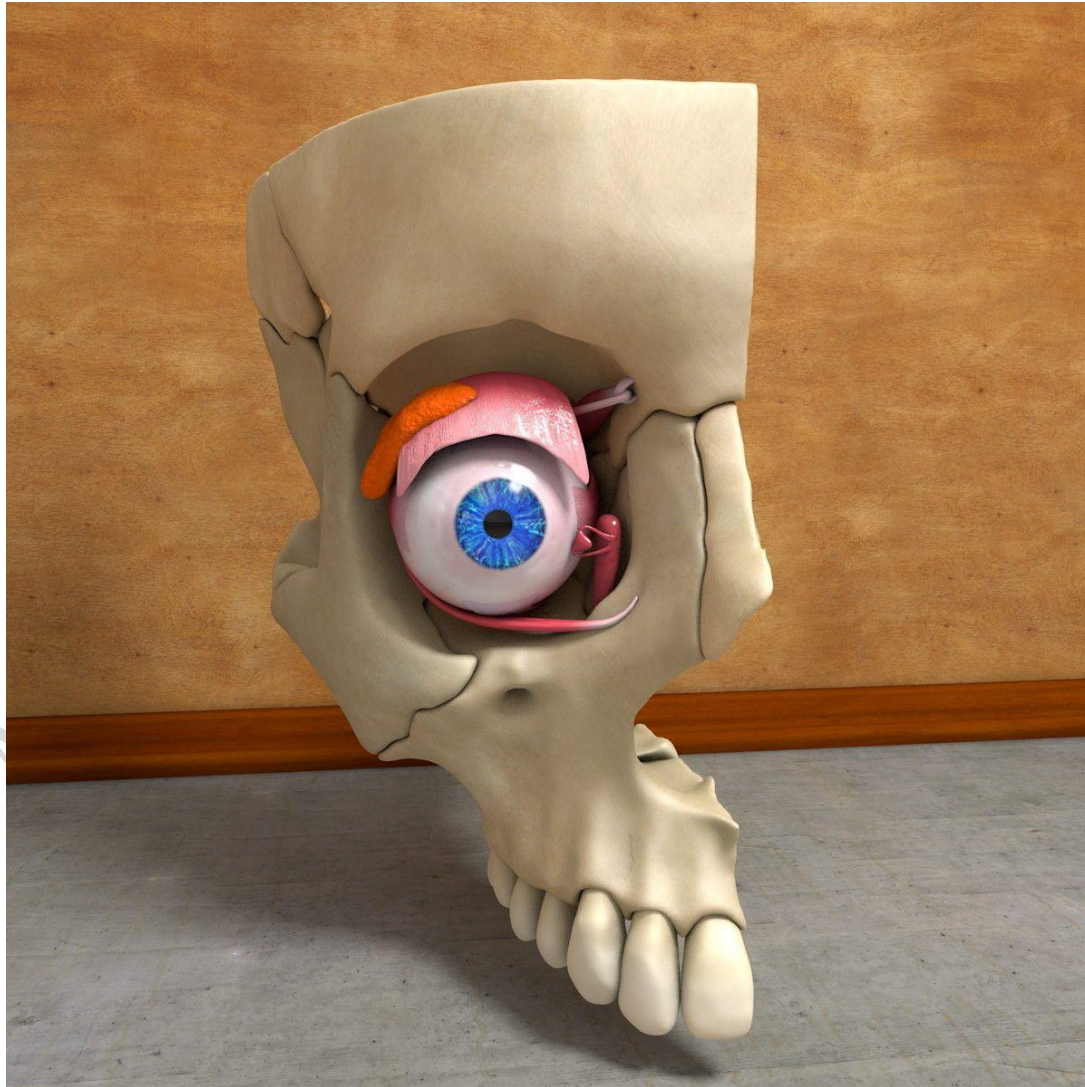


**Eyeball is the peripheral organ of vision, spherical in structure, 2.5cm in diameter.**

- it contains
  - 1. REFRACTIVE MEDIA**
  - 2. INTRAOCULAR MUSCLES**
  - 3. PHOTSENSITIVE RETINA**
- Eyeball is located in the **orbital cavity**, covered by **fascia bulbi** or **tenon's capsule**.
- Eyeball develops from **neuroectoderm**, **surface ectoderm** and the **mesenchyme**.



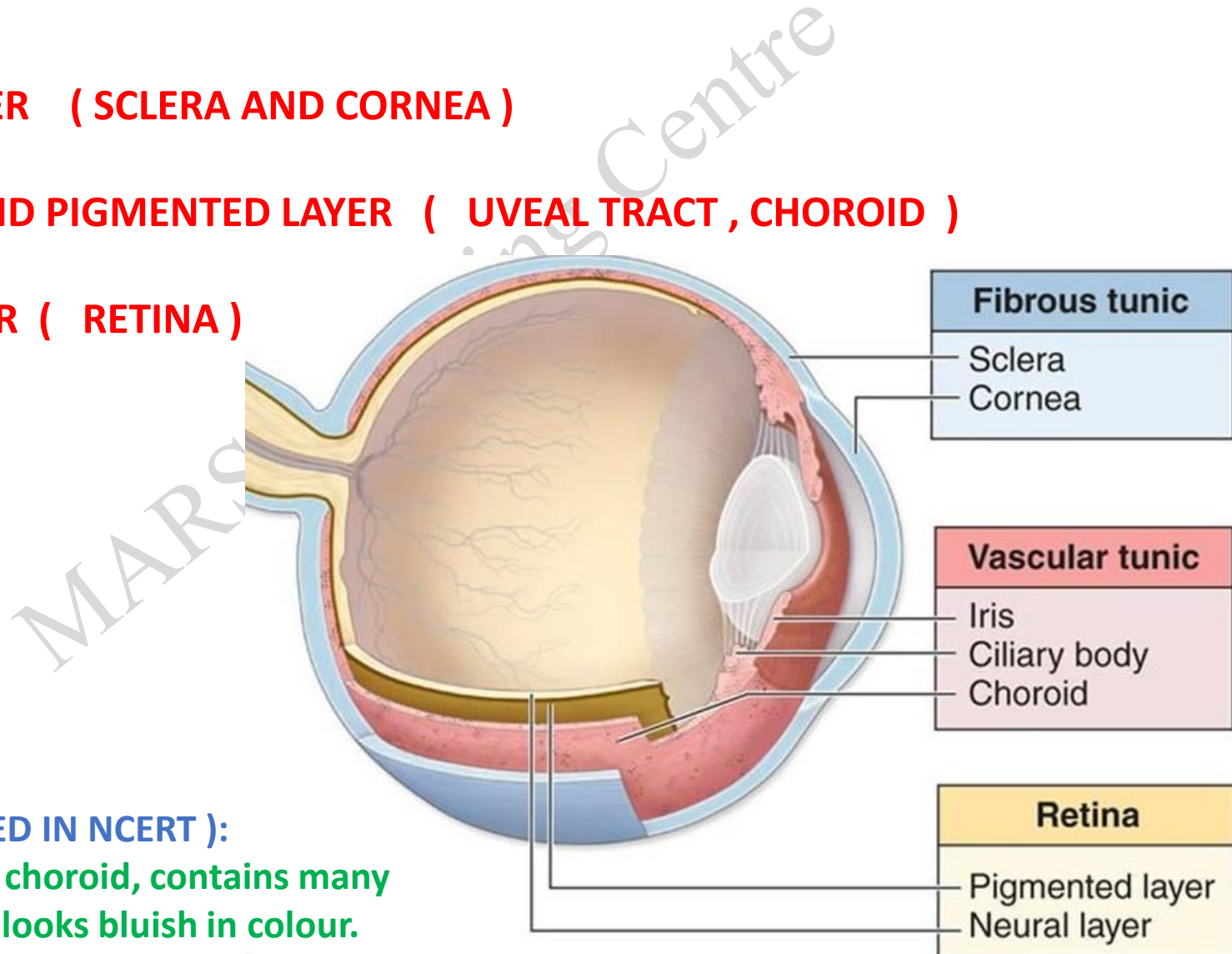
Our paired eyes are located in sockets of the skull called **ORBITS**.



# COATS OR TUNICS OF EYEBALL

EYEBALL CONSISTS OF 3 LAYERS

1. FIBROUS LAYER ( SCLERA AND CORNEA )
2. VASCULAR AND PIGMENTED LAYER ( UVEAL TRACT , CHOROID )
3. NEURAL LAYER ( RETINA )



**NOTE ( MENTIONED IN NCERT ):**

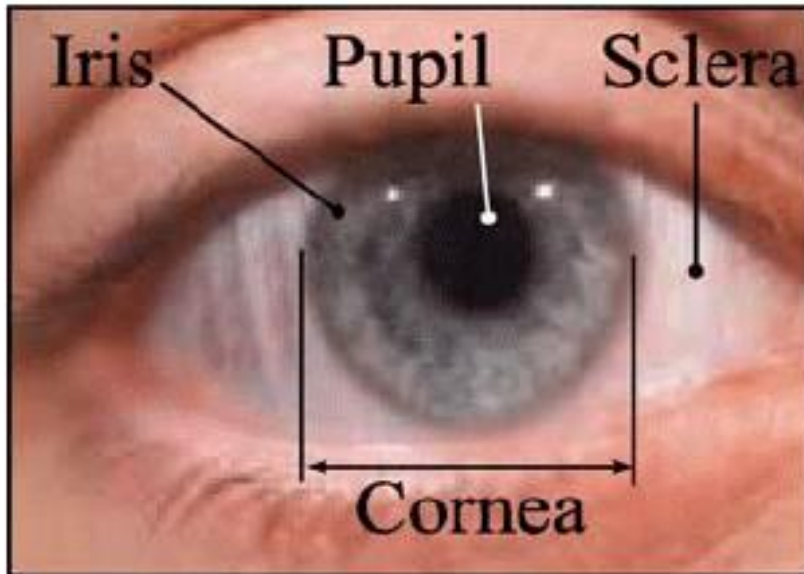
The middle layer , choroid, contains many blood vessels and looks bluish in colour.

# FIBROUS COAT OF EYEBALL

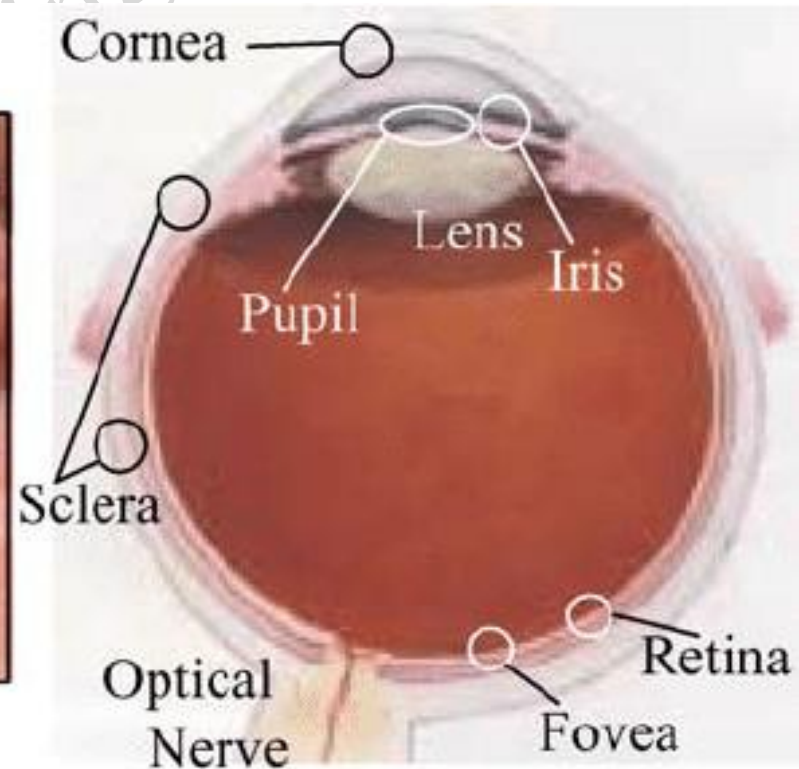
FIBROUS LAYER CONSISTS OF

**TRANSPARENT CORNEA**

**OPAQUE SCLERA**



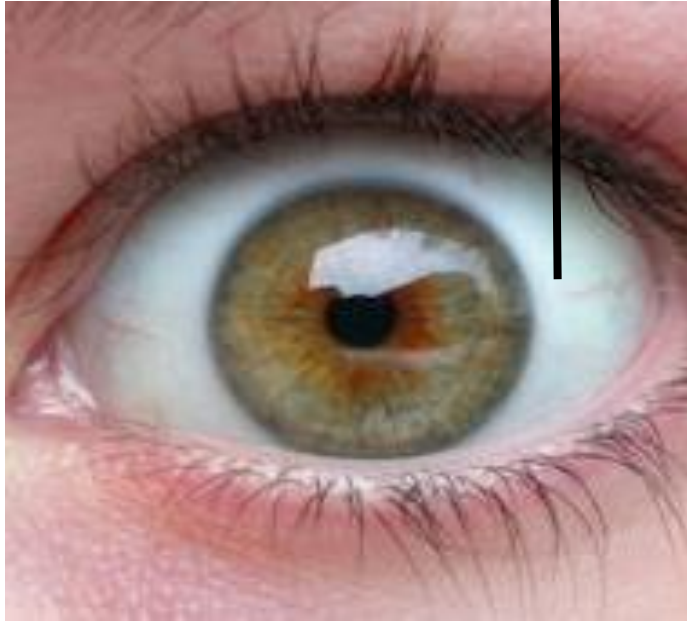
(a) External View



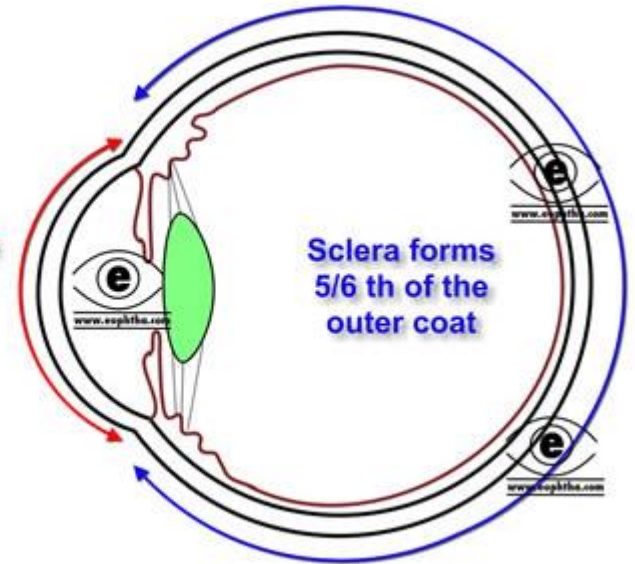
(b) Cross Section



# SCLERA



Cornea forms  
1/6 th of the  
outer coat

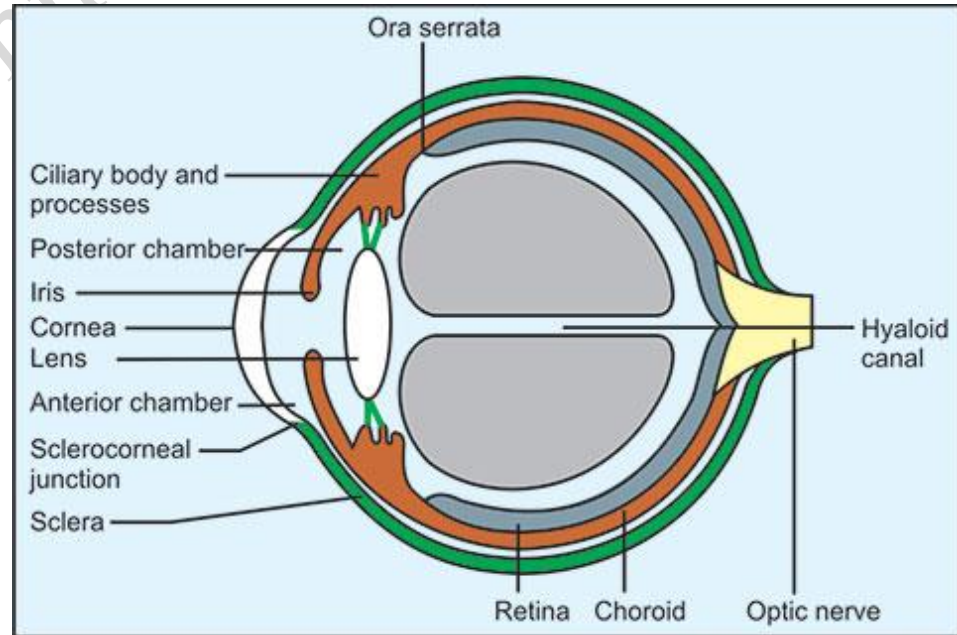
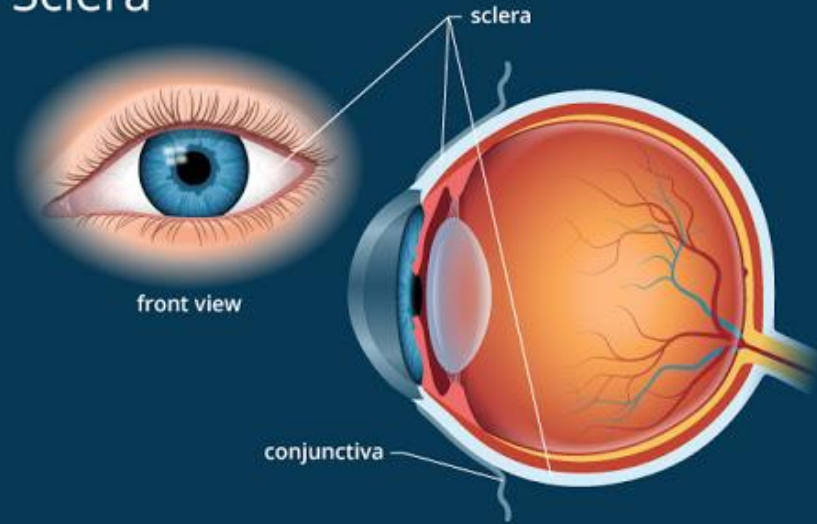


Sclera forms  
5/6 th of the  
outer coat

# SCLERA

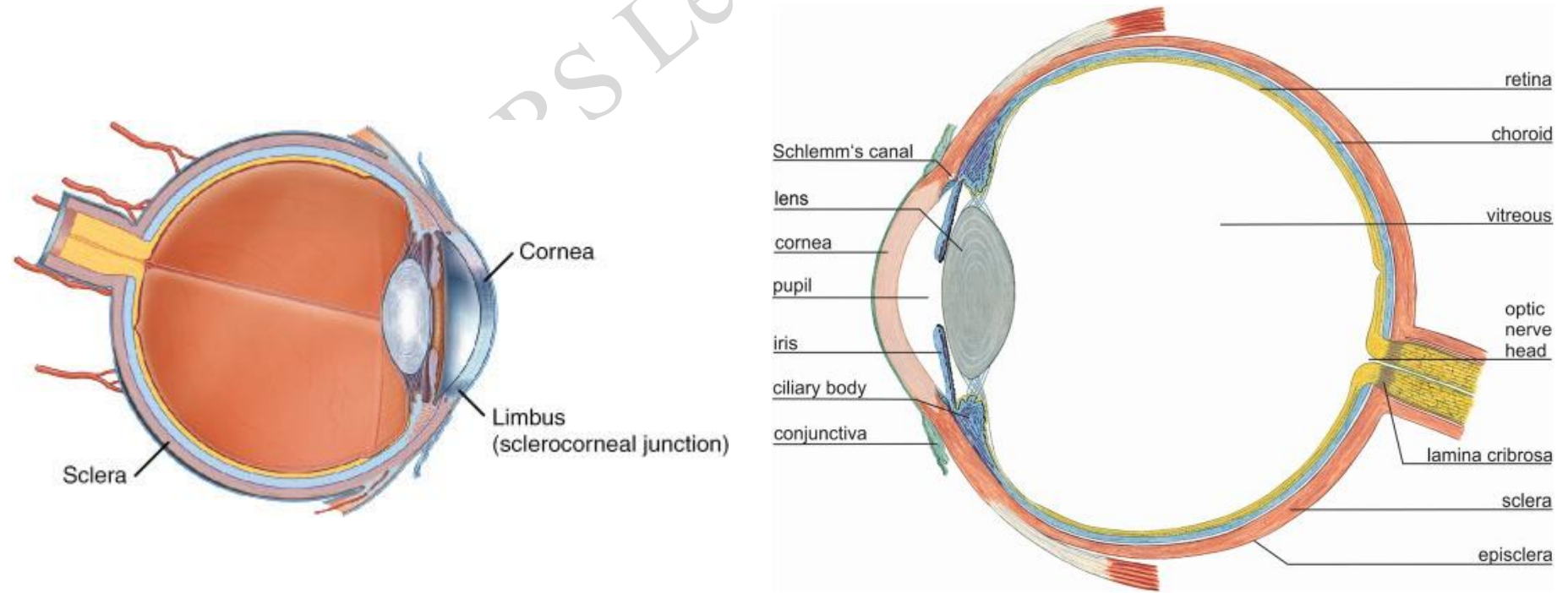
- It is **white and opaque** & forms posterior 5/6<sup>th</sup> of the eyeball. Internal surface of sclera is brown.
- The anterior part of sclera known as white of eye is covered with transparent **conjunctiva**

## Sclera

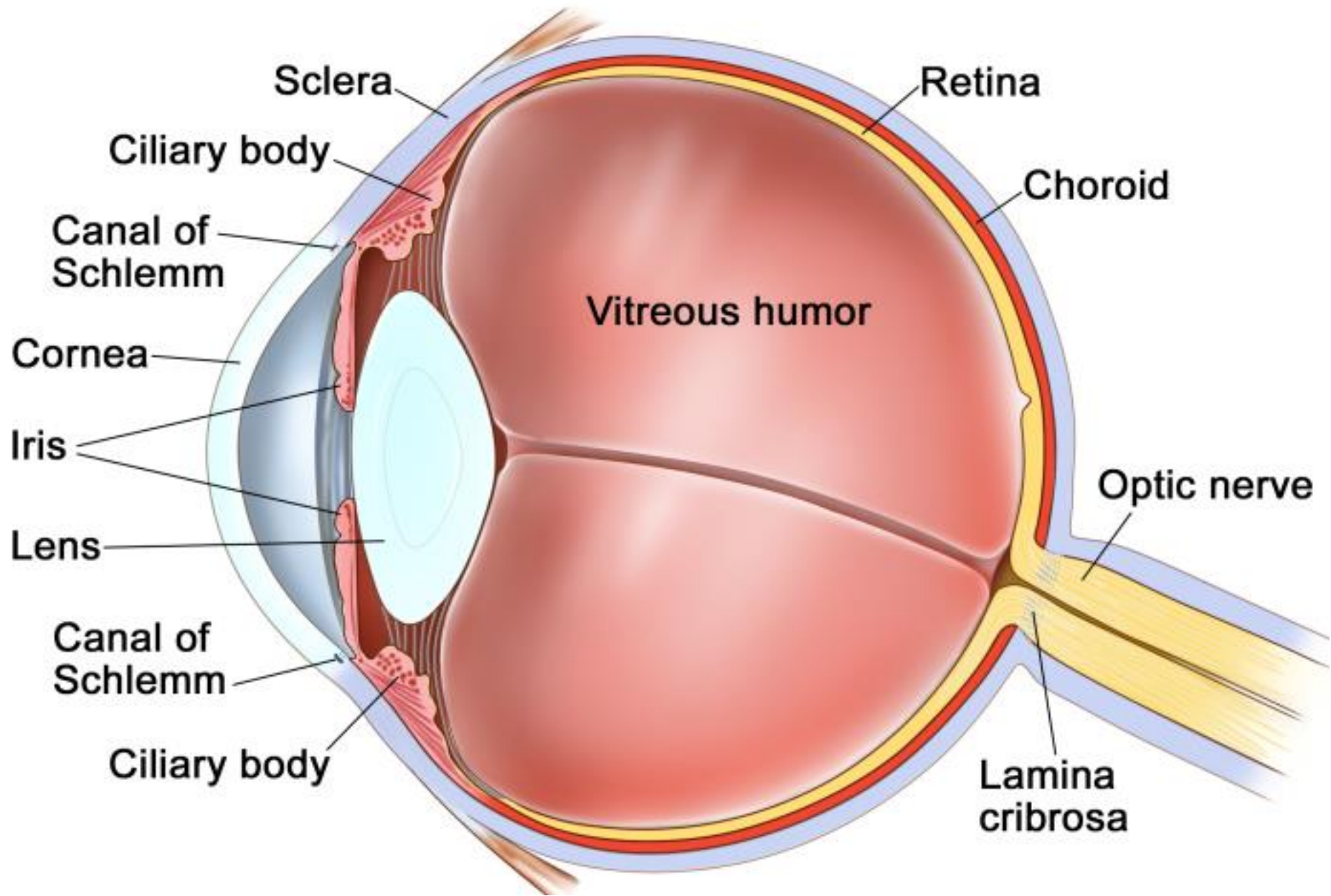


# SCLERA

- Firm, maintains the shape of eyeball
- Sclera is continuous with cornea at the **sclerocorneal junction or limbus.**
- A circular channel called **sinus venosus sclerae or canal of Schlemm** is located in the sclera just behind limbus.
- The weakest part of the sclera is called **lamina cribrosa**, where the axons of optic nerve pierce the sclera to leave the eyeball.







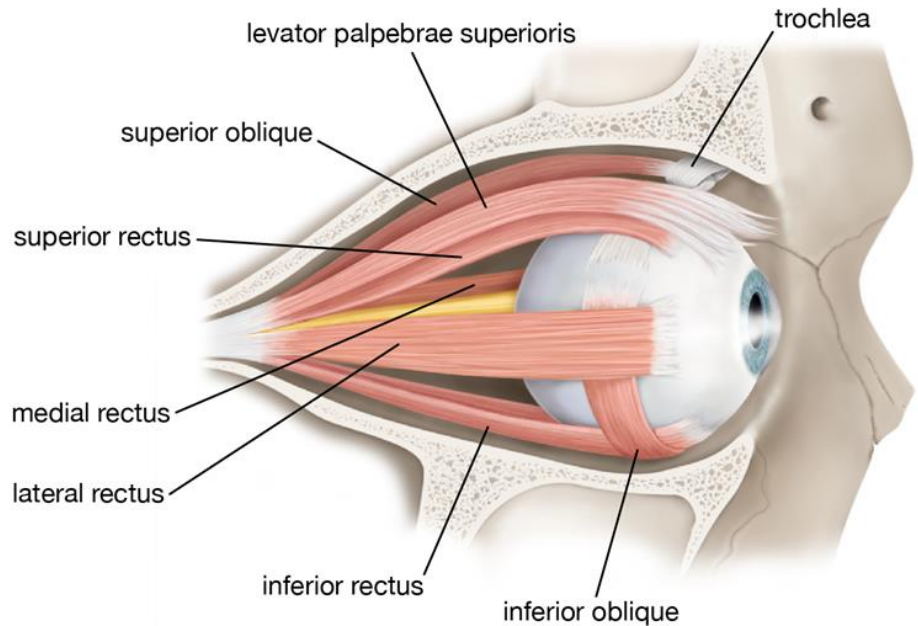
# FUNCTIONS OF SCLERA

**Maintains the shape of the eyeball due to its nondistensible character**

**It helps to maintain normal intraocular pressure ( 15 to 20 mm of Hg )**

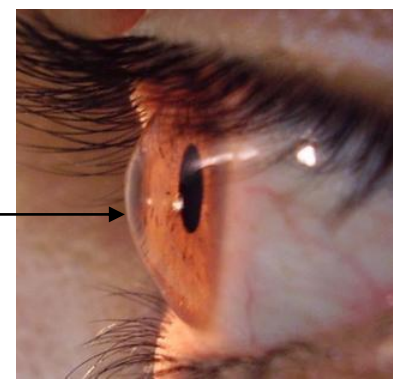
**6 extraocular muscles are inserted to sclera , which help in the movement of eyeball. They are.....**

- 1. superior rectus**
- 2. inferior rectus**
- 3. medial rectus**
- 4. lateral rectus**
- 5. superior oblique**
- 6. inferior oblique**



# CORNEA

CORNEA



- Transparent and forms 1/6<sup>th</sup> of the eyeball
- **Convex and avascular, insensitive to pain and does not contain lymphatic vessels.**
- Thickness of the cornea is 1mm at the periphery and 0.5 mm at the centre.
- Separated from iris by the aqueous chamber of eye
- Transparency of cornea is due to **absence of blood vessels & arrangement of uniform collagen fibers.**

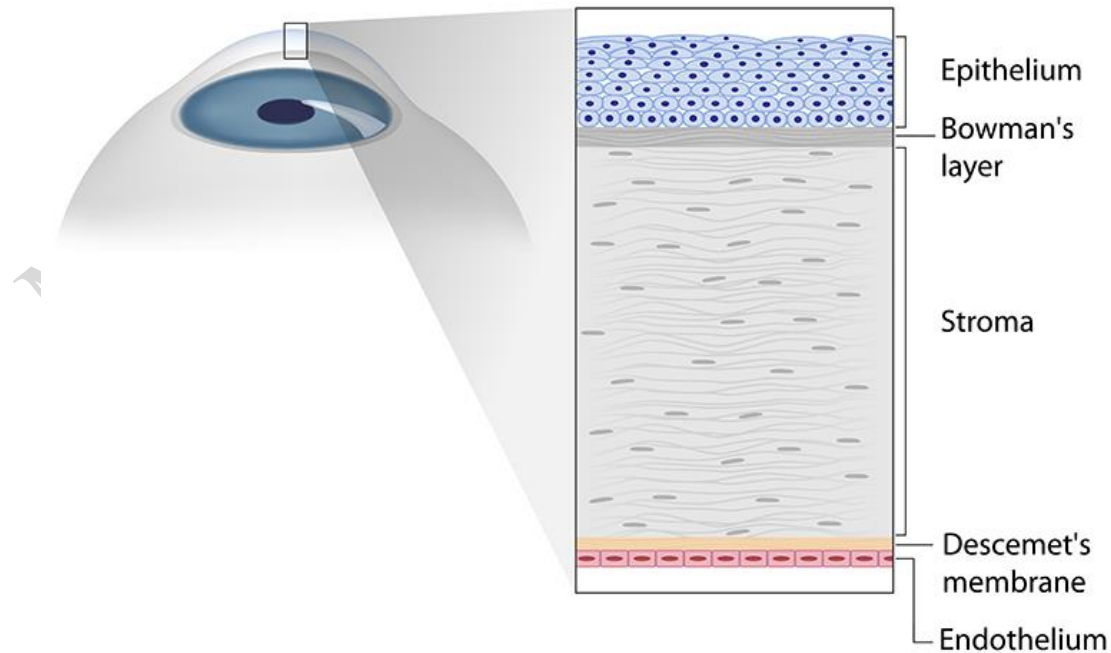


**Outer surface of cornea is lined by nonkeratinized stratified squamous epithelium.**

**Middle coat of cornea contains collagen fibres and fibroblasts**

**Inner surface is lined by squamous epithelium.**

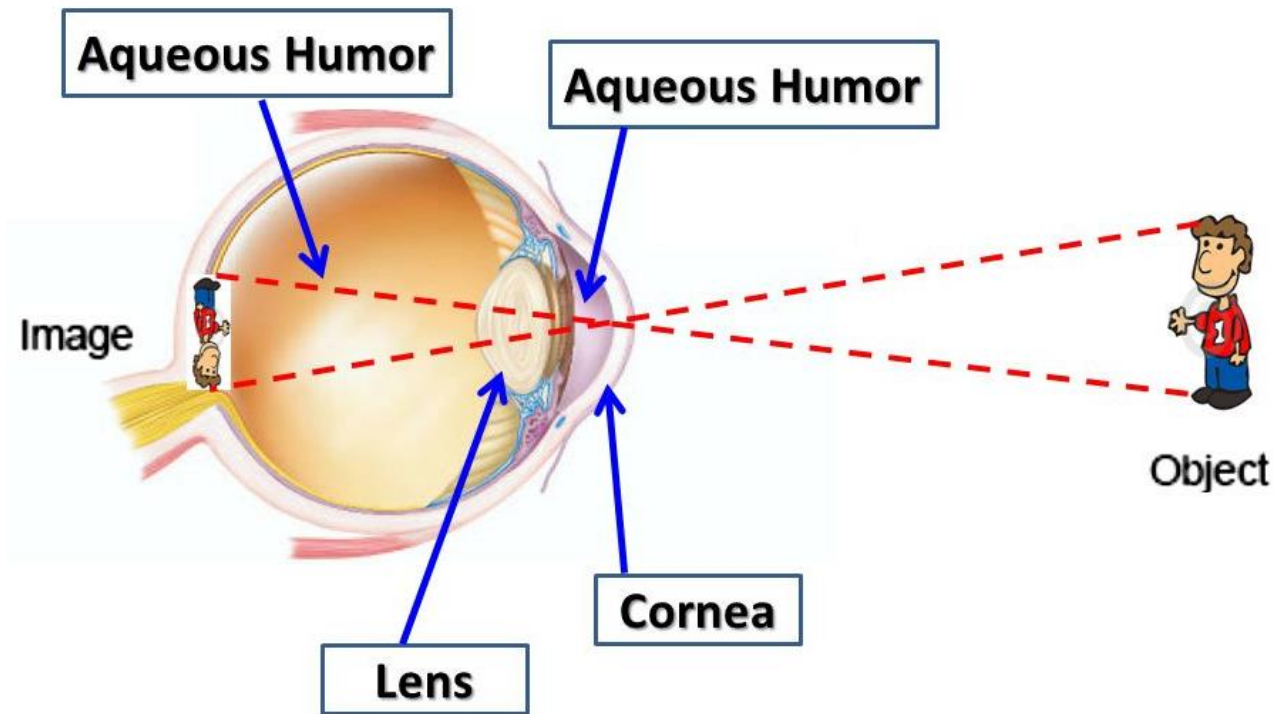
### Structure of the Cornea



# CORNEA

The cornea is the **main refractive medium of the eye** as the maximum refraction of light takes place from it.

Cornea is **nourished by diffusion** from capillaries at its edge and from **aqueous humor** at its internal surface.





# CORNEA

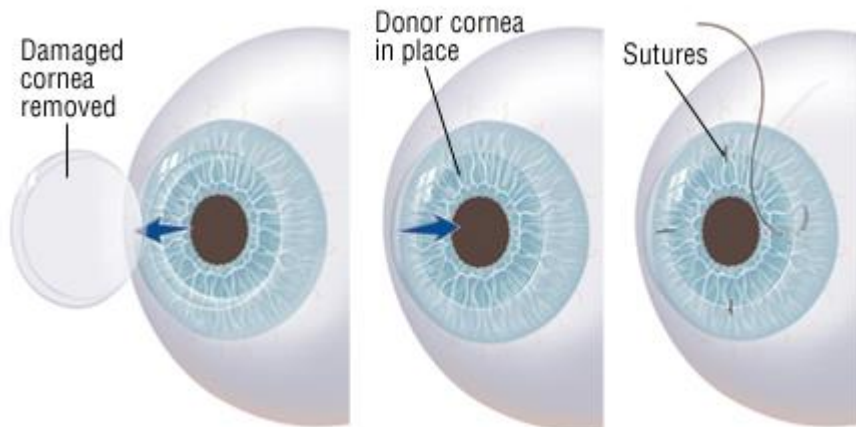
The central part of cornea receives atmospheric oxygen dissolved in tear film.

Avascularity of cornea is of advantage in placing surgical incisions on it to approach the lens or the iris

Injuries to cornea can lead to corneal opacities resulting in blindness. It is possible to restore sight in such cases by **corneal transplantation ( keratoplasty )**

The corneal transplants are very readily accepted because the **cornea is immunologically inert.**

On touching the cornea with a wisp of cotton there is bilateral reflex closure of eyes.



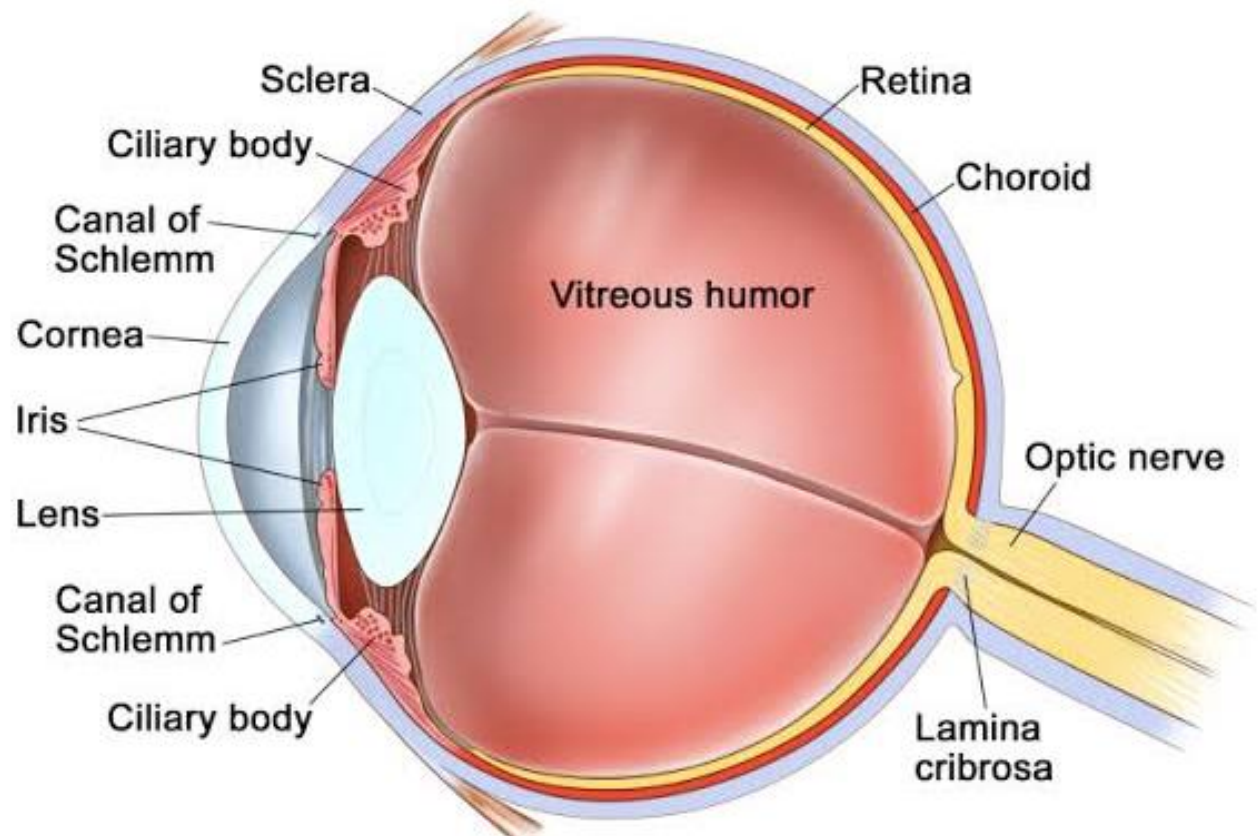
# VASCULAR AND PIGMENTED COAT ( UVEAL TRACT )

- The vascular and pigmented layer of the eyeball forms the middle coat.
- It consists of 3 parts , from behind forwards:

**CHOROID**

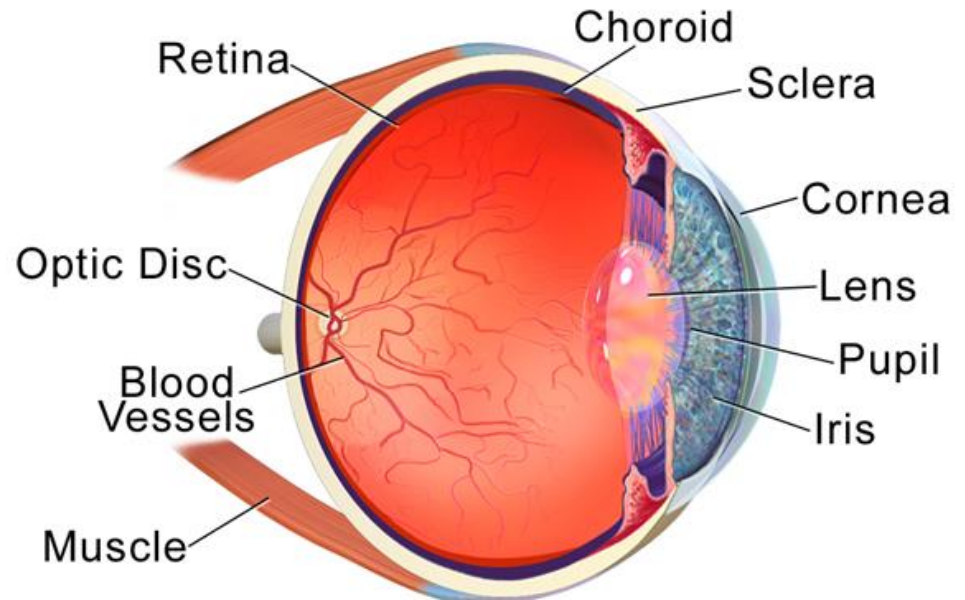
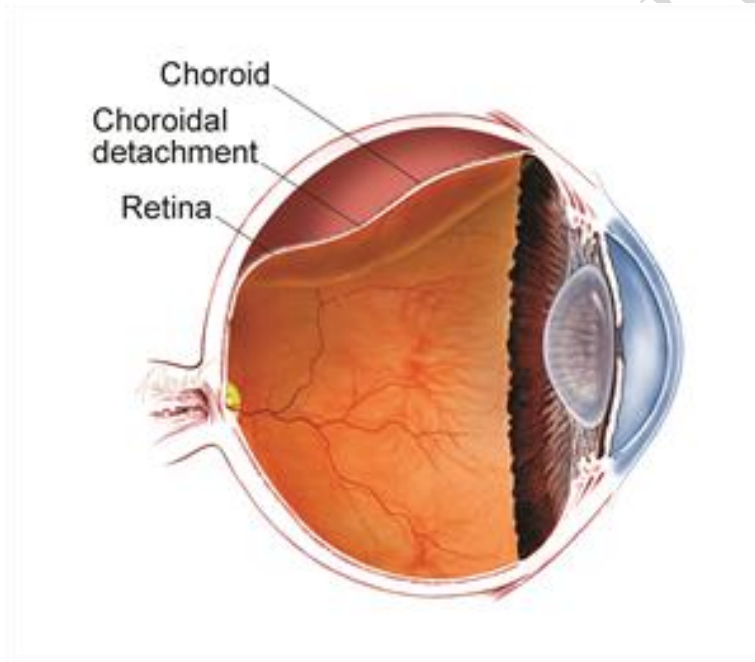
**CILIARY BODY**

**IRIS**



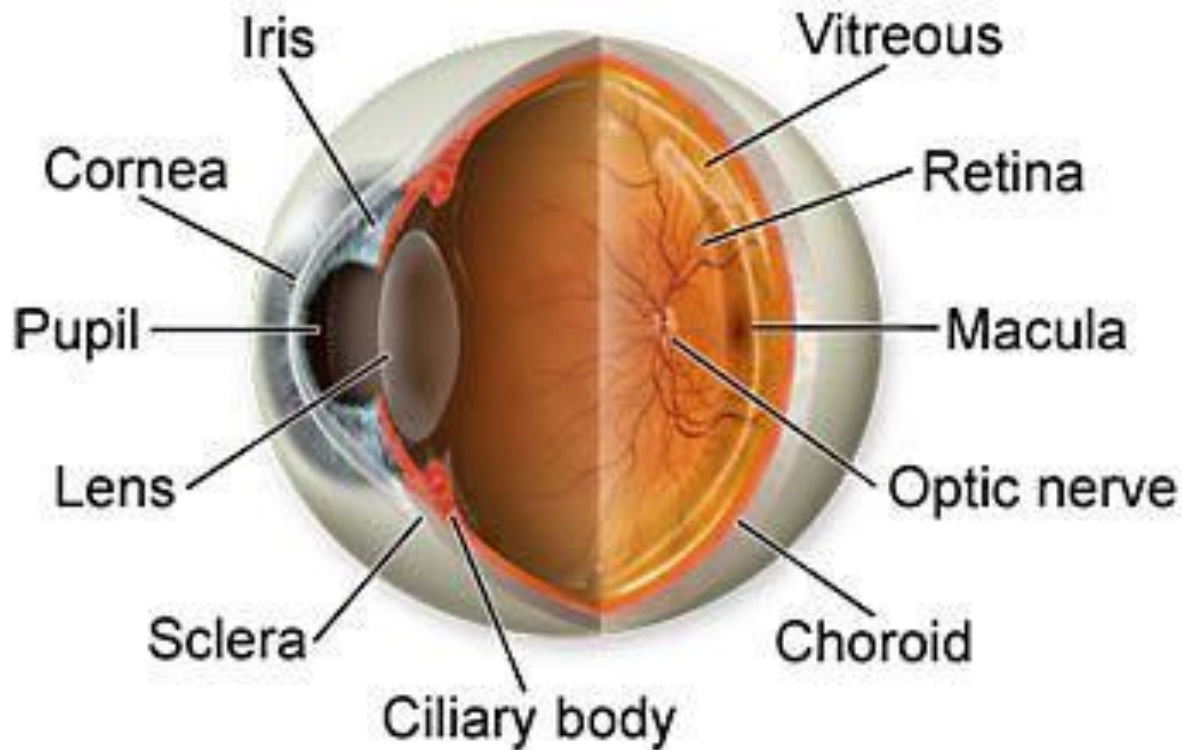
# CHOROID

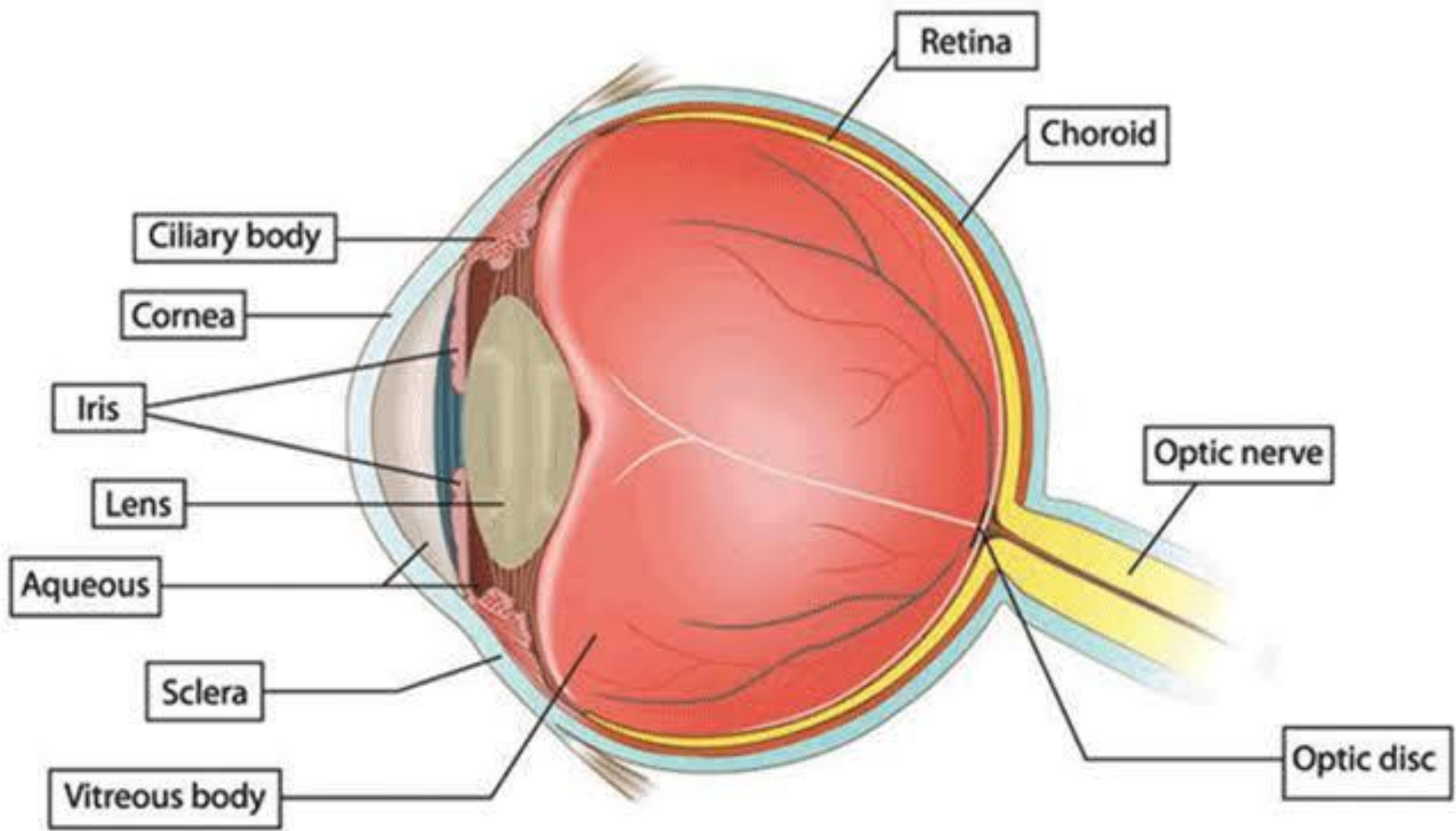
- It's a **pigmented , highly vascular layer** which separates the posterior part of sclera from retina.
- It is **dark brown in colour because it contains melanocytes** which produce the pigment melanin.
- **Melanin in the choroid absorbs stray light rays, which prevents reflection and scattering of light within eyeball.** As a result , the image cast on the retina by the cornea and lens remains sharp and clear.



# CHOROID

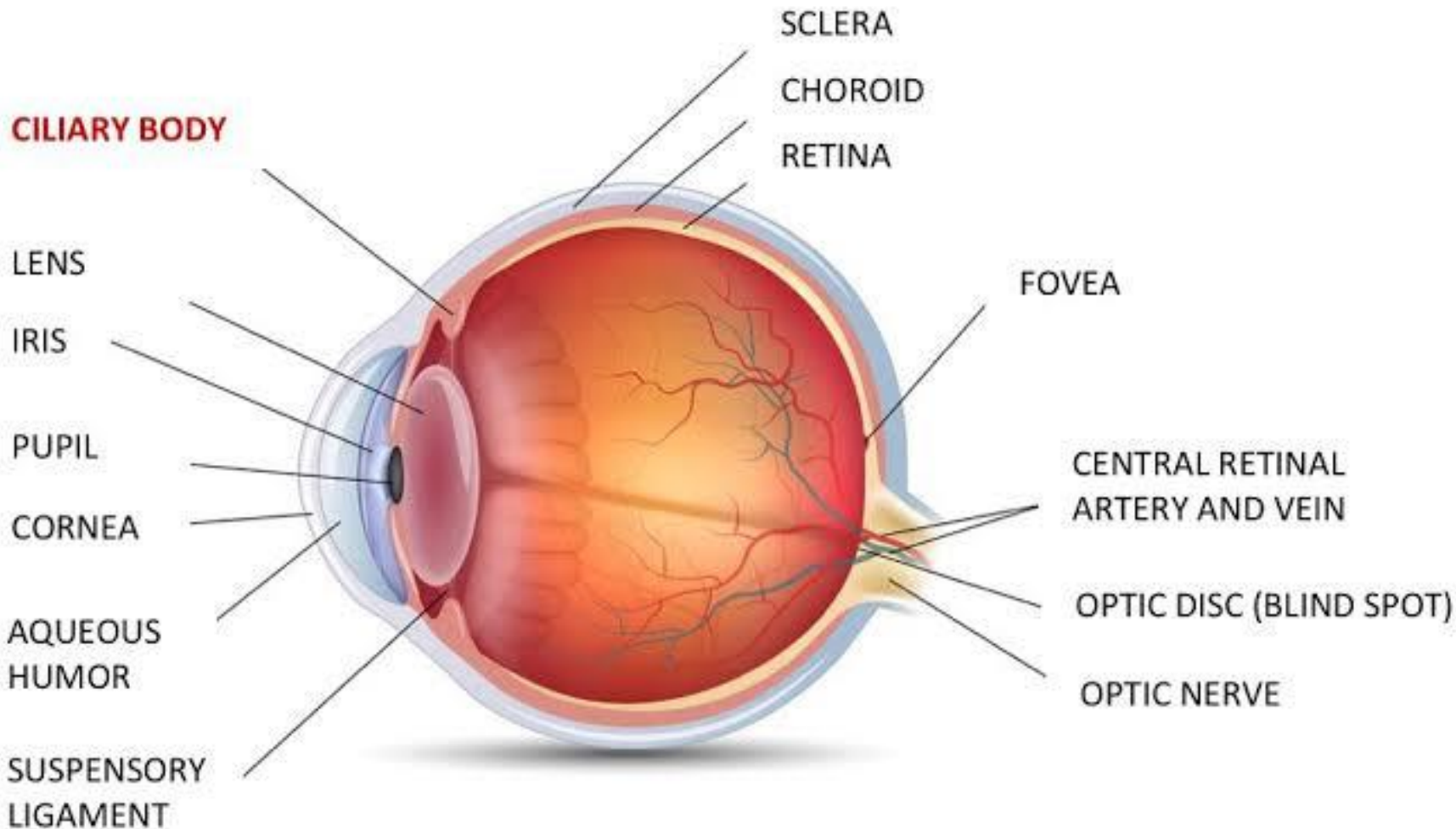
- Albinos lack melanin hence even moderately bright light is perceived as bright glare due to light scattering.
- Its inner surface is firmly attached to the pigment layer of retina.
- Anteriorly ends in the ciliary body.



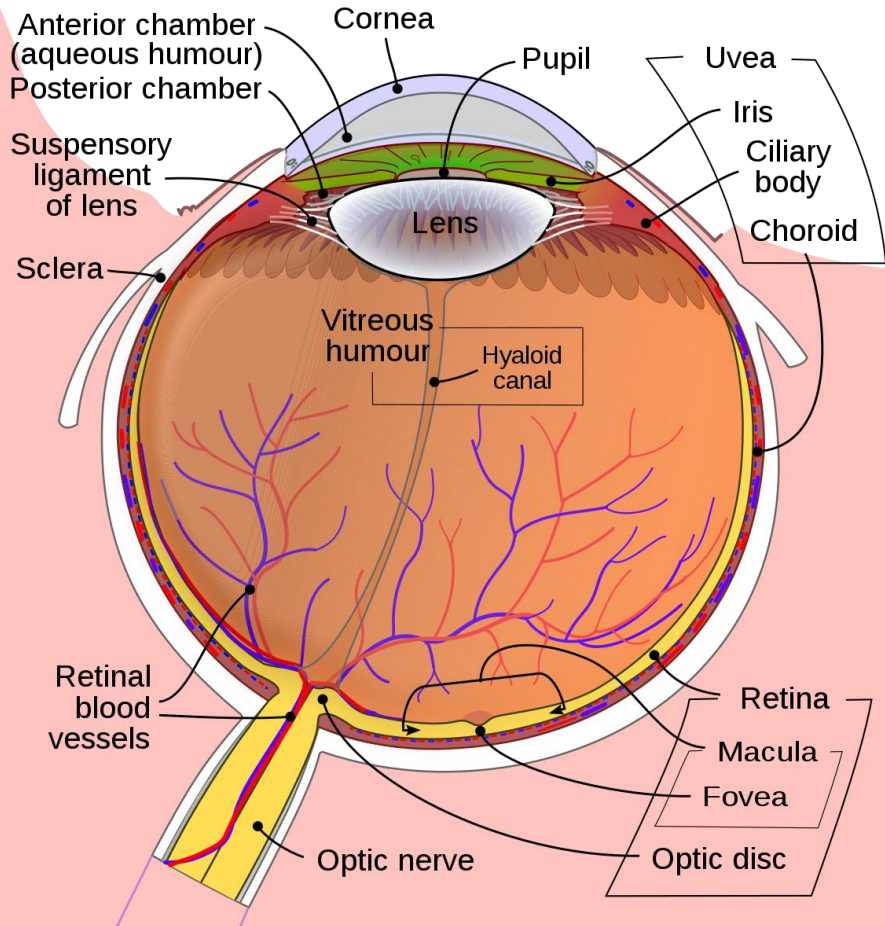




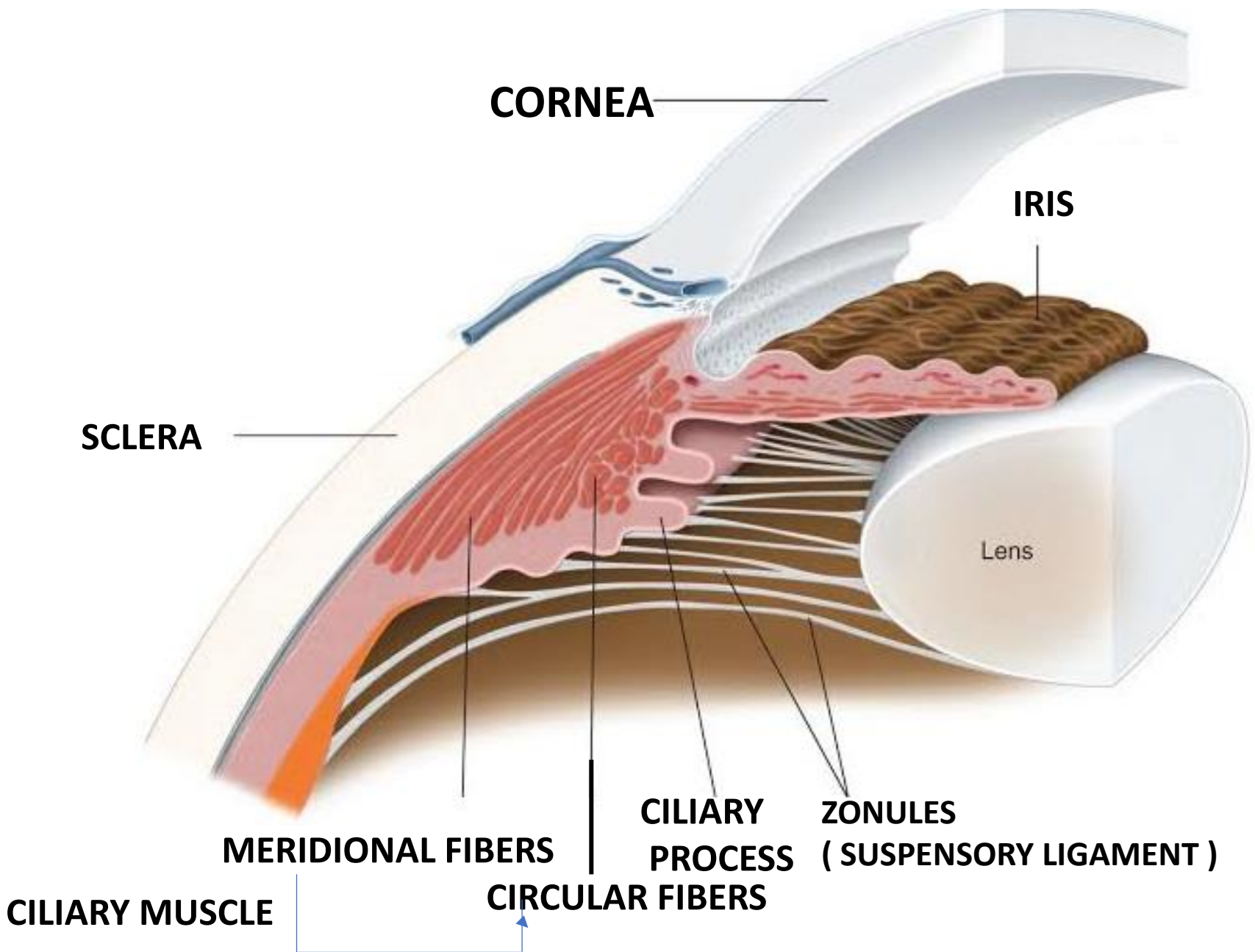
# CILIARY BODY



# CILIARY BODY



- **Thickened part of the uveal tract and highly vascular. Contains melanin.**
- **Anteriorly continuous with iris posteriorly with choroid.**
- **Inner surface presents the ciliary processes which give attachment to suspensory ligament of lens.**
- **It is composed of vessels, nerves, ciliaris muscle and pigmented connective tissue.**



# FUNCTIONS OF CILIARY BODY

The ciliary body suspends the lens and helps the lens in the process of Accomodation for near vision.

It is the **only source of aqueous fluid** , which is poured into the posterior Chamber.

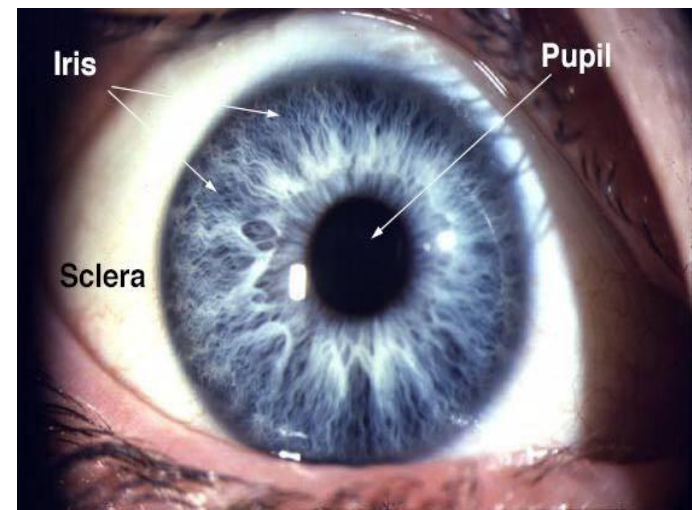
**Ciliary muscle or ciliaris is a smooth muscle.**

It is the **muscle of accomodation.**

The contraction of the meridional and circular fibers of the muscle relaxes the suspensory ligament of the lens thereby increasing the convexity of the lens. This enables the lens to focus images of near objects on retina.

# IRIS ( RAINBOW )

- It's a circular diaphragm & forms anterior part of the uveal tract
- It is positioned between the lens behind and the cornea in front
- The aperture surrounded by the IRIS is called the — PUPIL
- The main function of the iris is to regulate the amount of light that reaches the lens by regulating the size of the pupil. The diameter of the pupil is regulated by the muscle fibres of IRIS.
- 2 muscles – sphincter pupillae & dilator pupillae.
- The amount of melanin in the iris determines the eye colour.
- The eyes appear brown to black when the iris contains a large amount of melanin, blue when melanin is very low and green when moderate.





The amount of melanin in the iris determines the **eye colour**

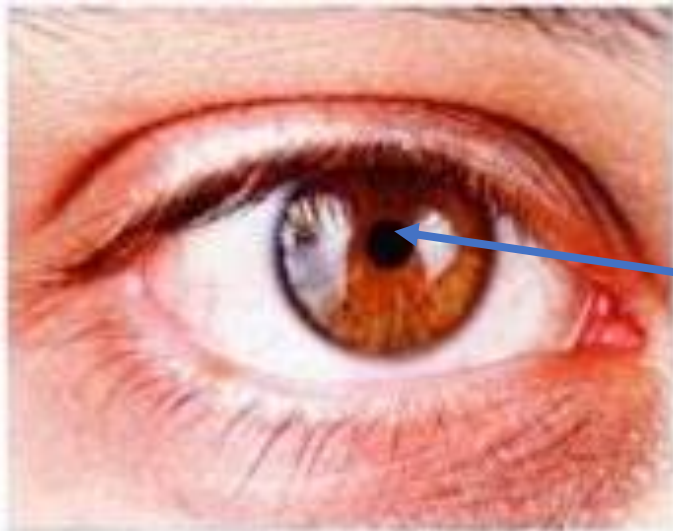


Colour of iris varies from light blue to dark brown

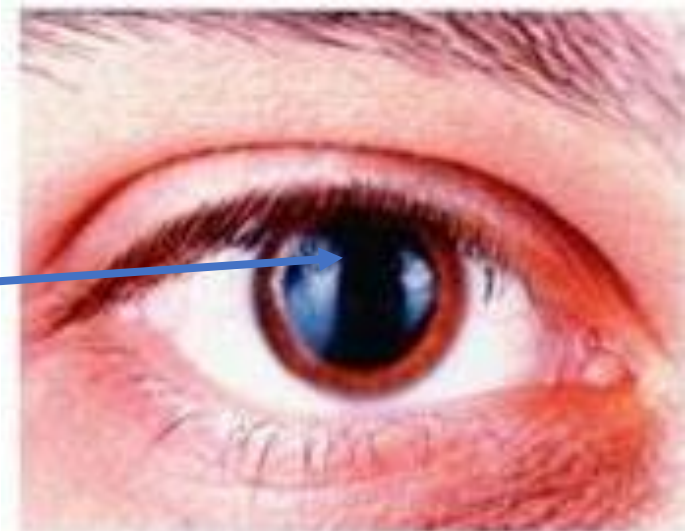
Sphincter pupillae is a smooth muscle that encircles the pupil. When the muscle contracts the pupil is narrowed ( **miosis** )

Parasympathetic drugs like atropine relax the sphincter pupillae muscle there by causing dilatation of the pupil.

Dilator pupillae is a thin smooth muscle . On contraction , the muscle produces dilatation of the pupil ( **mydriasis** )



**MIOSIS**

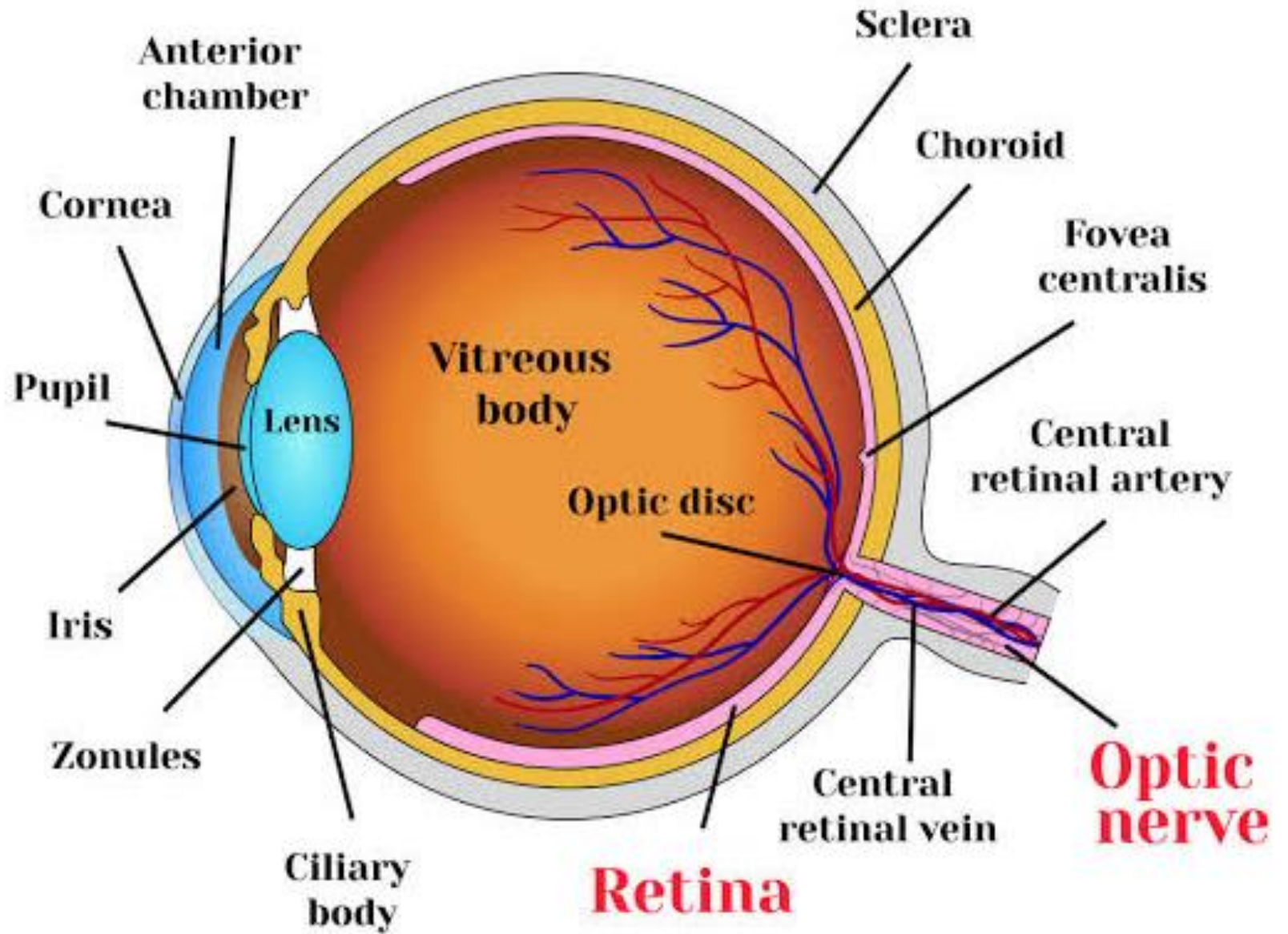


**MYDRIASIS**

**PUPIL**

# RETINA OR INNER NERVOUS COAT OF EYEBALL

- Inner delicate photosensitive layer of eyeball – nervous coat
- Externally attached to choroid & internally separated from vitreous body by hyaloid membrane
- Extends anteriorly upto ora serrata
- Structurally consists of many sensory neurons & supporting cells arranged in ten layers.
- Rods & cones are photoreceptors ( 6 million cones, 120 million rods )



# RETINA

## DISTINGUISHING FEATURES OF RETINA:

**Macula lutea** is the yellowish area near the centre of the retina

It has a central depression known as **fovea centralis**, where the retina is thinnest.

Because of high concentration of cone cells the **visual acuity is greatest at fovea**

The optic disc lies 3mm medial to the macula lutea.

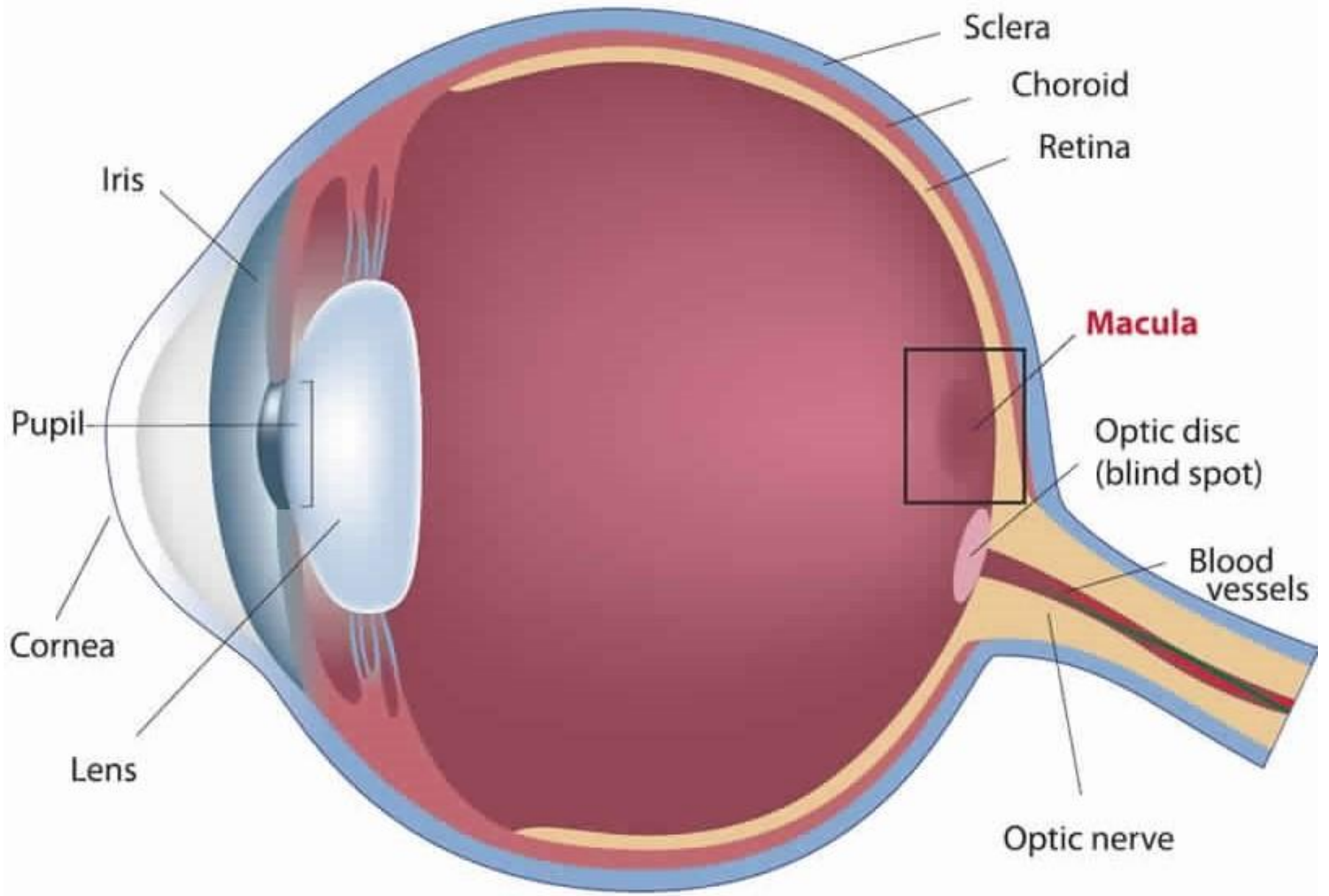
At this point the **optic nerve emerges from the retina.**

The central artery of the retina pierces the disc in the center.

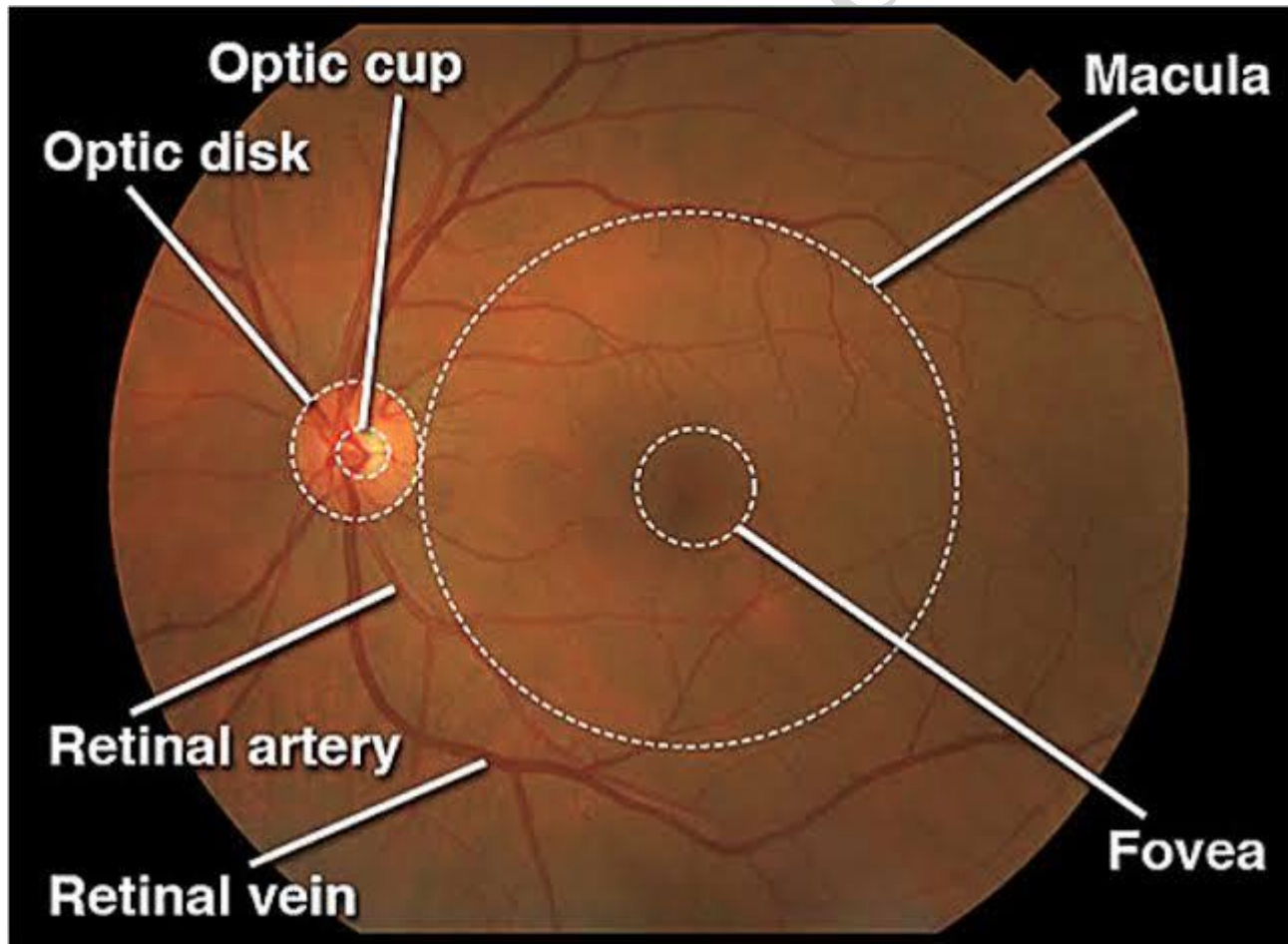
The disc is also called as **blind spot** because it is **devoid of photoreceptors**  
( rods and cones )

Swelling of optic disc is known as **papilledema**





- **Retina is the only place in the body , where the arteries can be examined directly with the help of the ophthalmoscope** to note pathological changes in diseases like diabetes and hypertension.
- Detachment of retina is a condition in which the neural layer of retina separates from the pigment layer.



# LAYERS OF RETINA

There are 10 layers

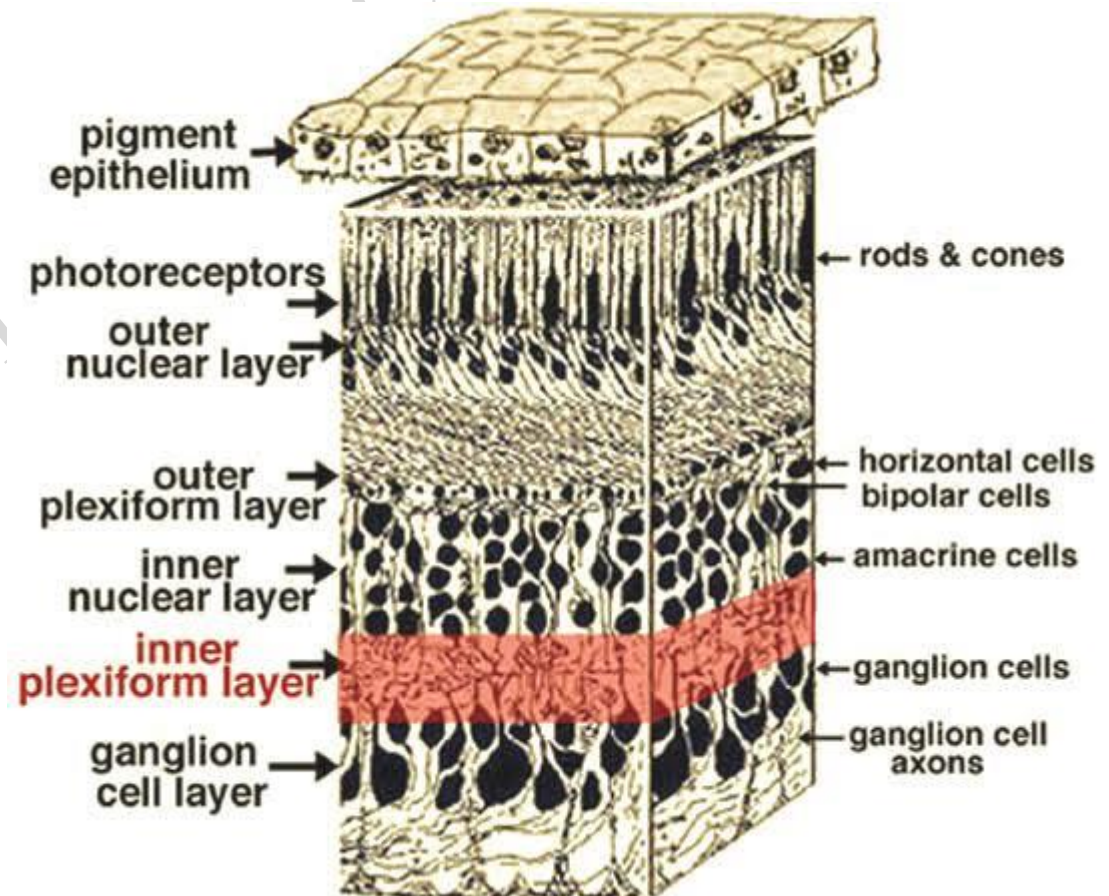
The first layer is adjacent to choroid and 10<sup>th</sup> layer is adjacent to vitreous body.

NEURAL LAYERS ARE 3

PHOTORECEPTORS

BIPOLAR NEURONS

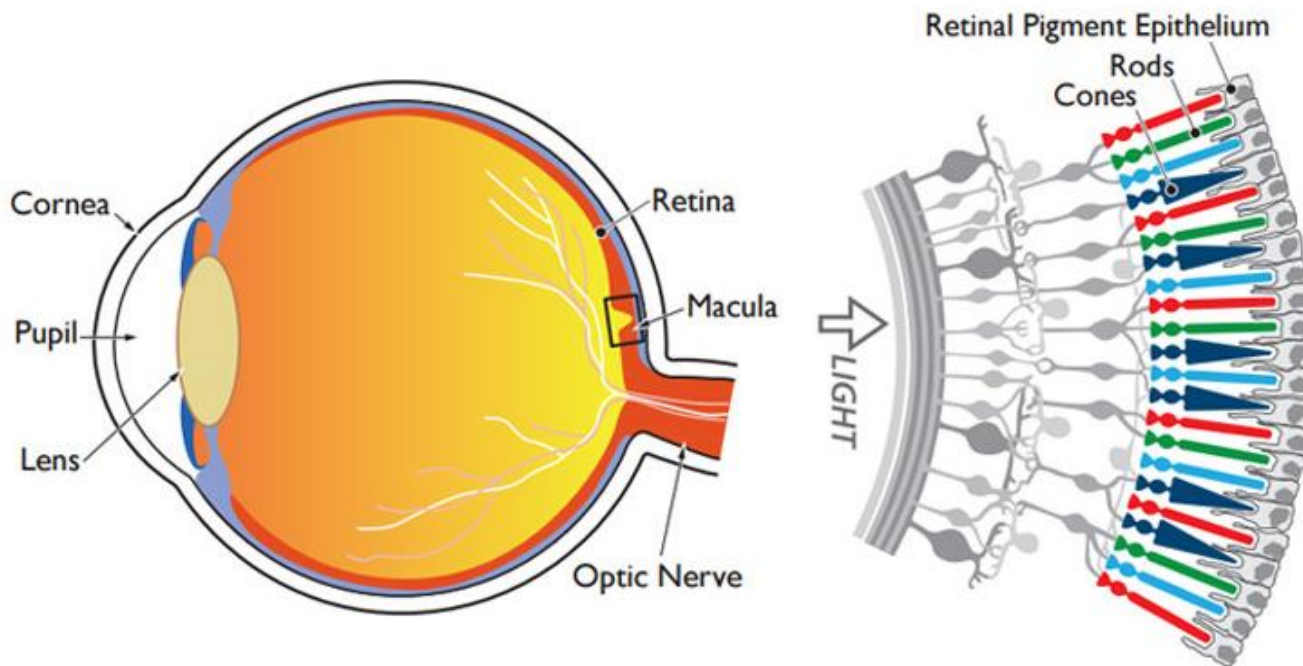
GANGLIONIC LAYER



# 1. RETINAL PIGMENT CELLS - cuboidal cells contain melanin.

Pigment cells absorb the excess light rays and prevent bouncing of light back in to the retina.

Phagocytose parts of rods and cones, forms **blood – retinal barrier**.



The **blood–retinal barrier (BRB)** is composed of retinal capillary endothelial cells (inner BRB) and retinal pigment epithelial cells (outer BRB).



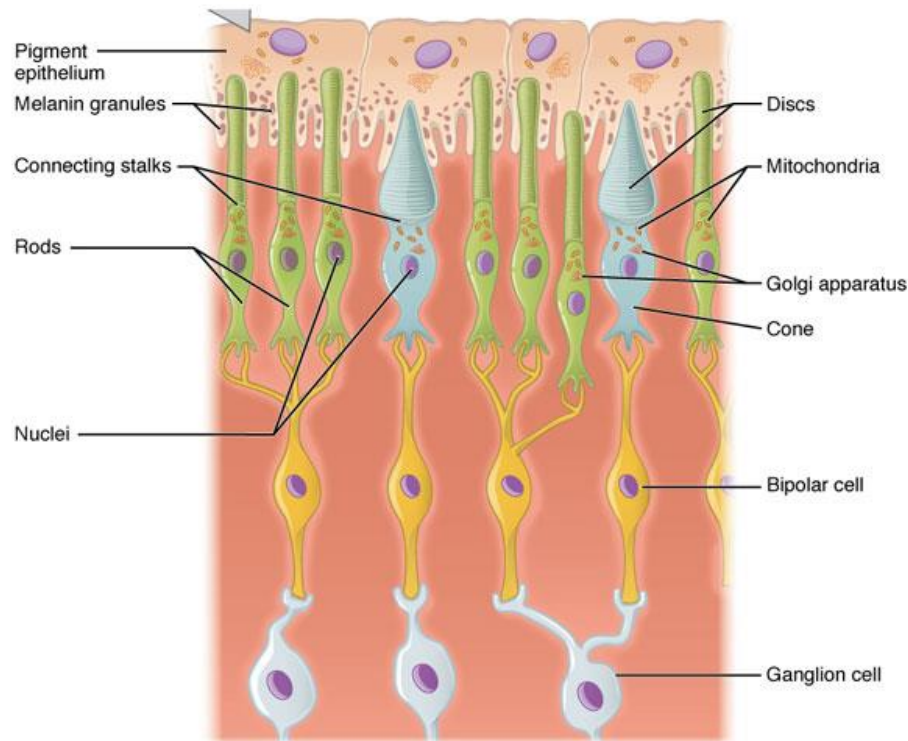
## 2. LAYERS OF RODS AND CONES

**They are the photoreceptors**

These cells contain the light sensitive proteins called the photopigments.

**Daylight ( photopic ) vision and colour vision** are functions of cones.

**Twilight ( scotopic ) vision** is the function of rods.



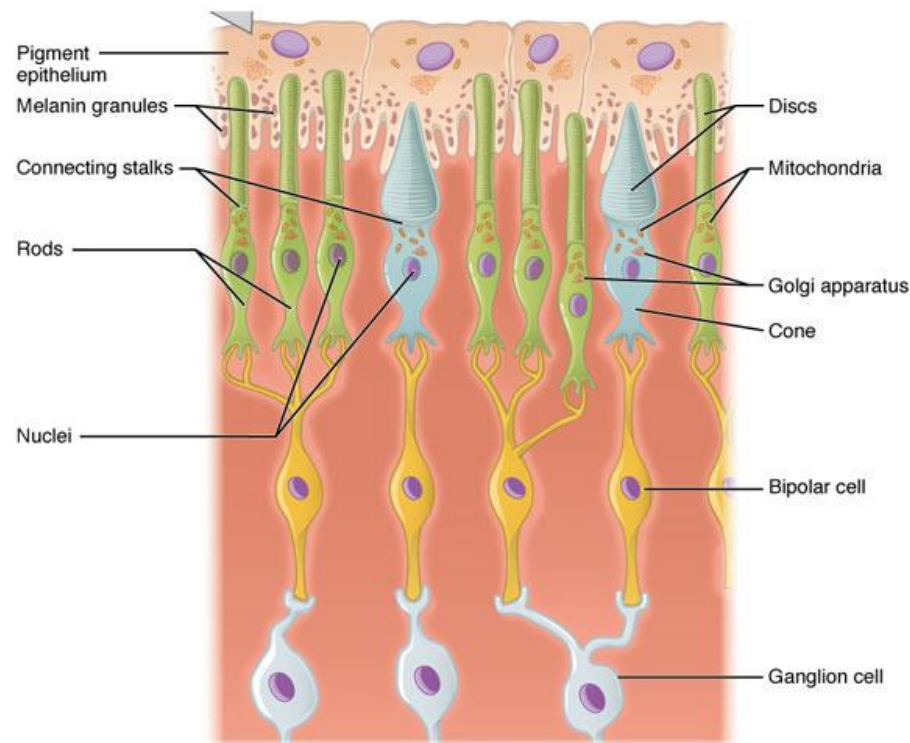


## 2. LAYERS OF RODS AND CONES

**Rods are cylindrical** and larger in numbers compared to cones in the peripheral part of retina.

**They are absent at fovea centralis.**

**They contain rhodopsin or visual purple ( purplish red protein )** which senses black and white colours. They contain a derivative of vitamin A.



## CONES ARE FLASK SHAPED

Only cones are present in fovea centralis so **visual acuity is highest at fovea.**

**Cones contain iodopsin**, which senses bright light and colors.

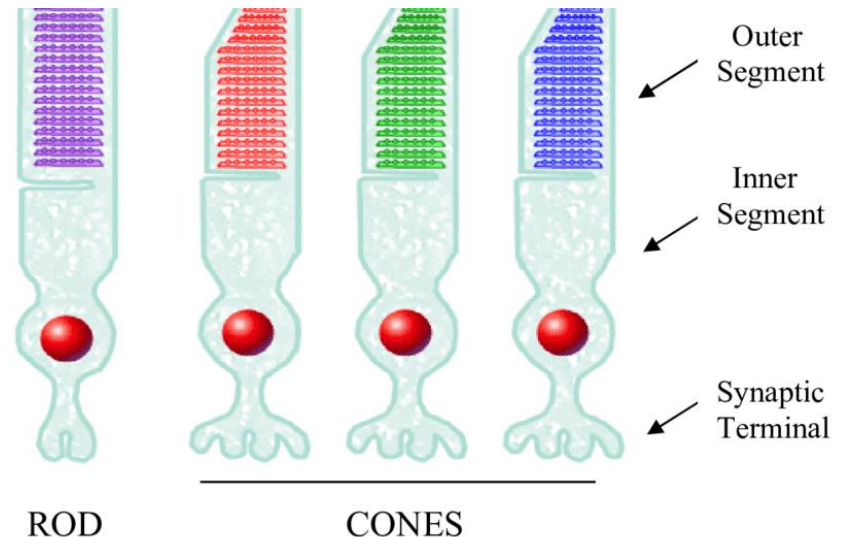
3 types of cones are present in the retina.

1. **blue cones**, which are sensitive to blue light
2. **green cones**, which are sensitive to green light
3. **red cones**, which are sensitive to red light

3. EXTERNAL LIMITING LAYER

4. OUTER NUCLEAR LAYER

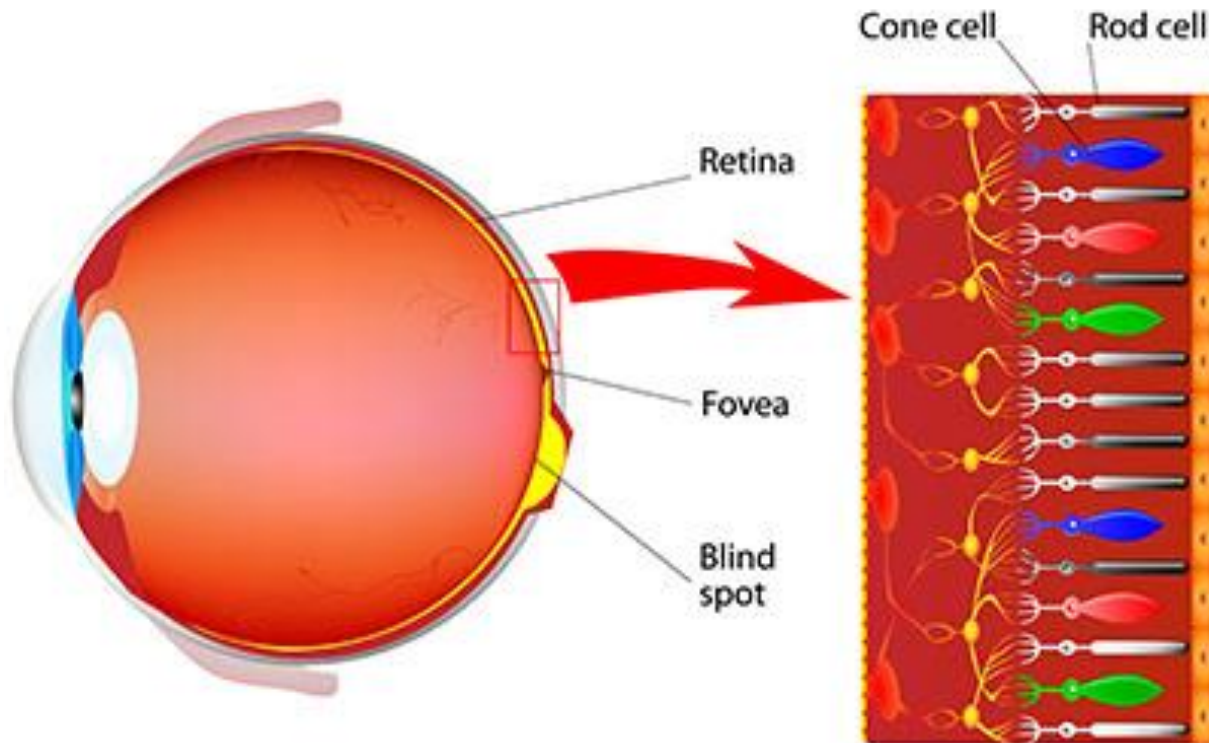
5. OUTER PLEXIFORM LAYER



The sensations of different colours are produced by various combinations of these cones and their photopigments.

When these cones are stimulated equally, a sensation of white light is produced.

### Photoreceptor cell



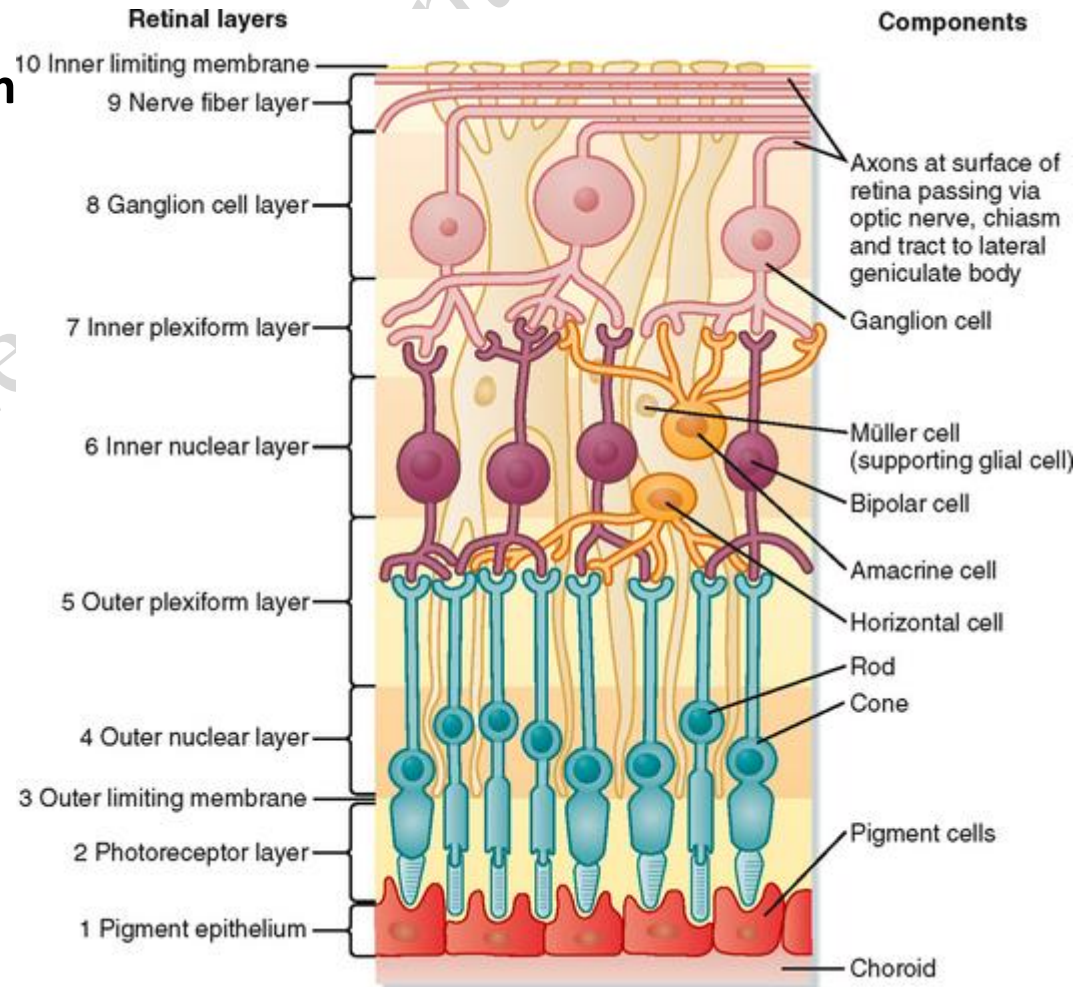
6. Inner nuclear layer is composed of cell bodies and nuclei of bipolar cells, amacrine cells, horizontal cells and the muller's cells (retinal gliocytes). Amacrine cells contain only dendrites.

7. Inner plexiform layer

8. Ganglion cell layer contains the m

9. Nerve fiber layer contains the unmyelinated axons of ganglion cells. These axons aggregate at the optic disc to form the optic nerve.

10. Internal limiting lamina.



# REFRACTIVE MEDIA

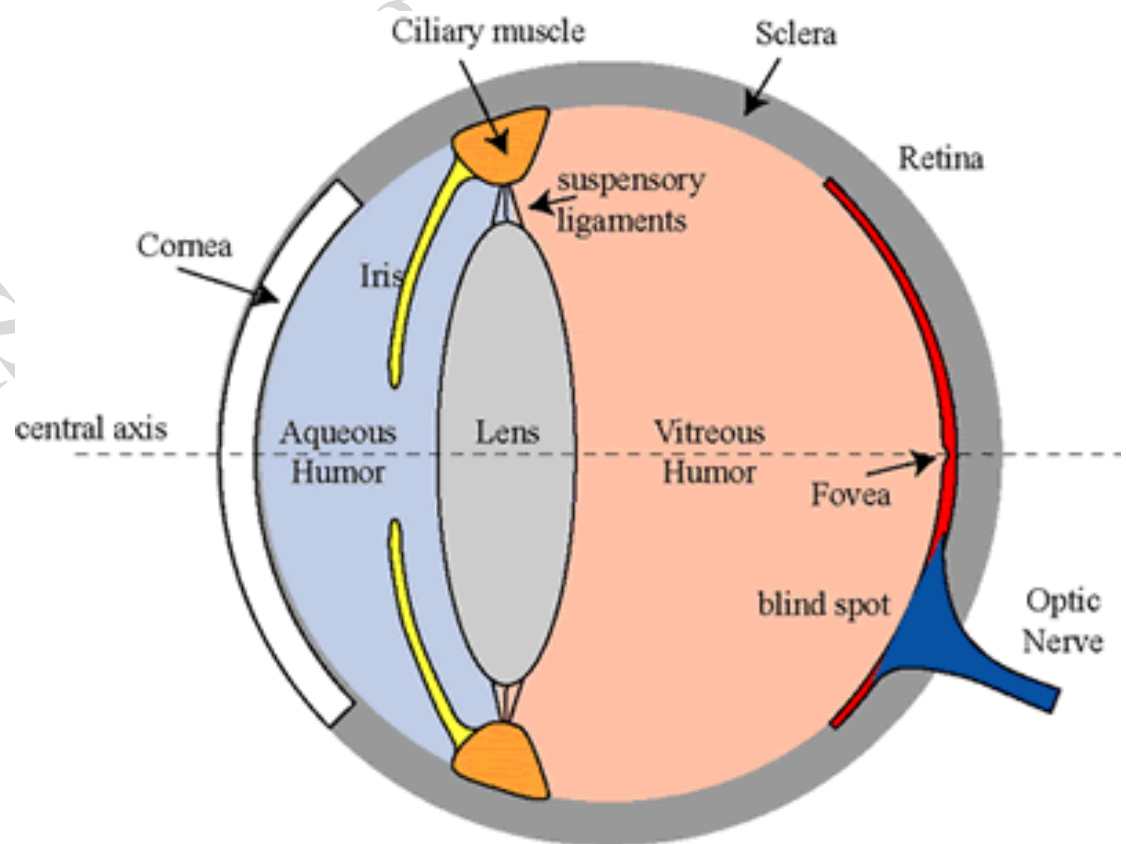
EYEBALL CONSISTS OF 4 TRANSPARENT MEDIA

**CORNEA**

**AQUEOUS HUMOR**

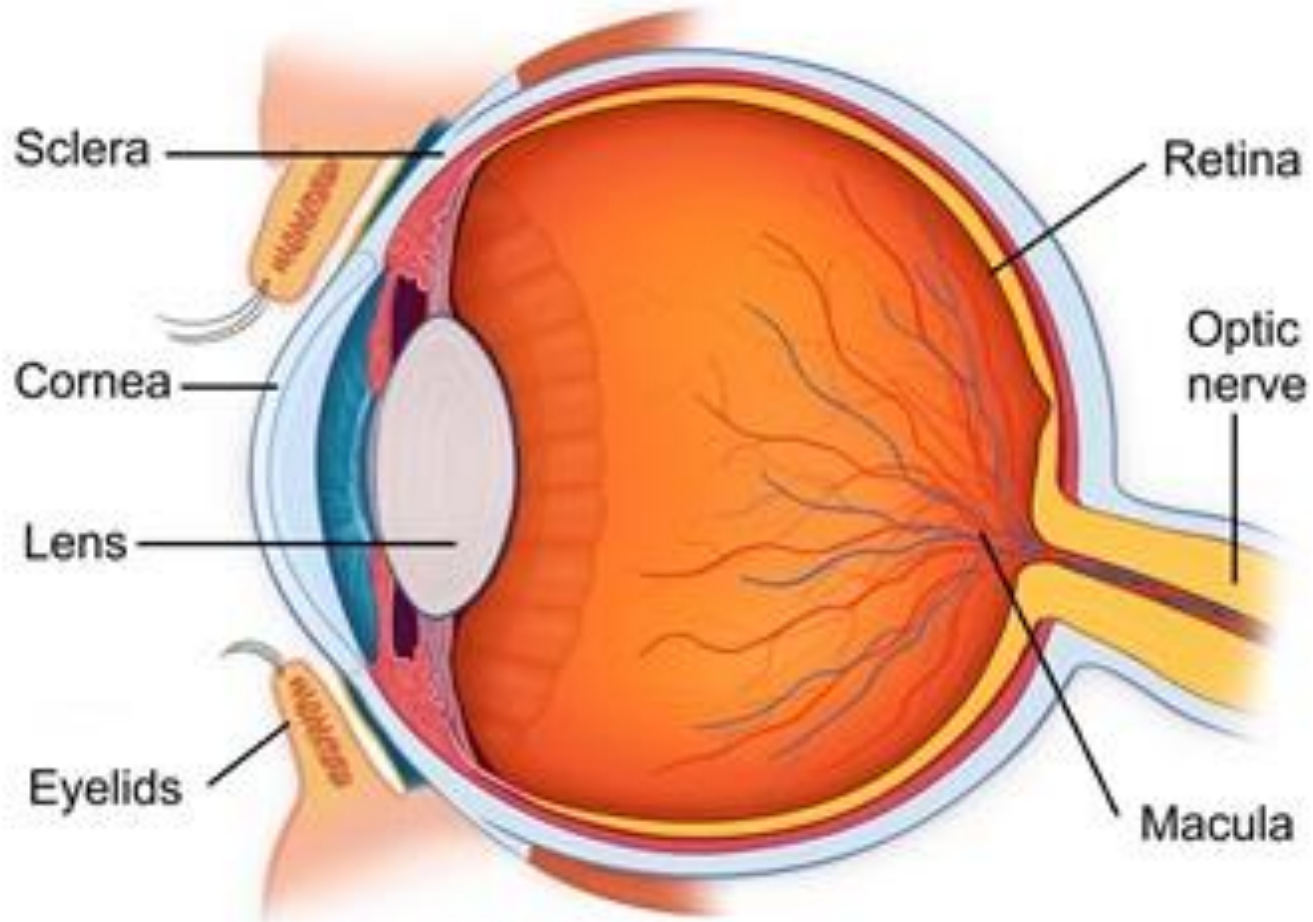
**CRYSTALLINE LENS**

**VITREOUS BODY**





**1. CORNEA** - is exposed to the air hence maximum refraction of light takes place from its epithelium (stratified squamous nonkeratinised epithelium )



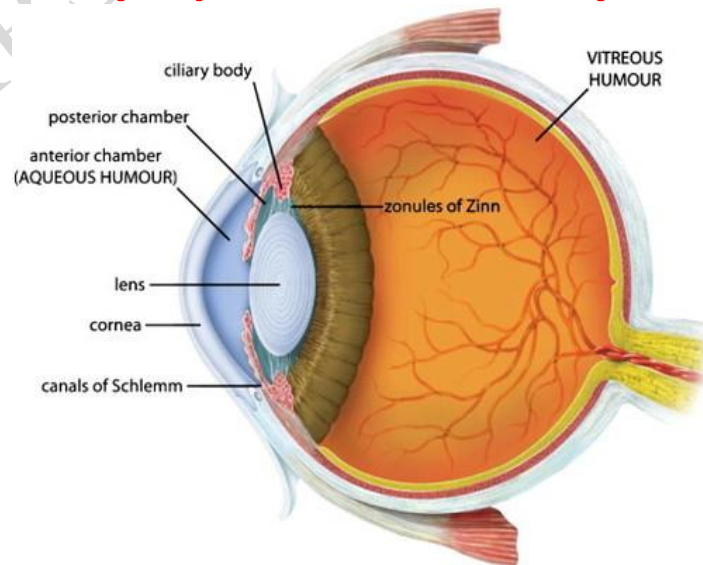
## 2.AQUEOUS HUMOR -

Is a thin watery fluid that fills the spaces in front of and behind the iris namely anterior and posterior chambers of the eyeball.

It is **secreted by the epithelium of ciliary processes.**

The aqueous humor provides nourishment to the lens and cornea and maintain the intraocular pressure ( 15 to 20 mm of hg ) and helps in refraction of light.

**Aqueous humor is completely replaced about every 90 minutes.**



### 3. CRYSTALLINE LENS

**Is avascular , transparent and biconvex in shape**

Within the cells of the lens, proteins called **crystallins**, arranged like the layers of an onion , make up the refractive media of the lens, which normally is perfectly transparent and lacks blood vessels.

It is **suspended from the ciliary body by the suspensory ligament or zonular fibres.**

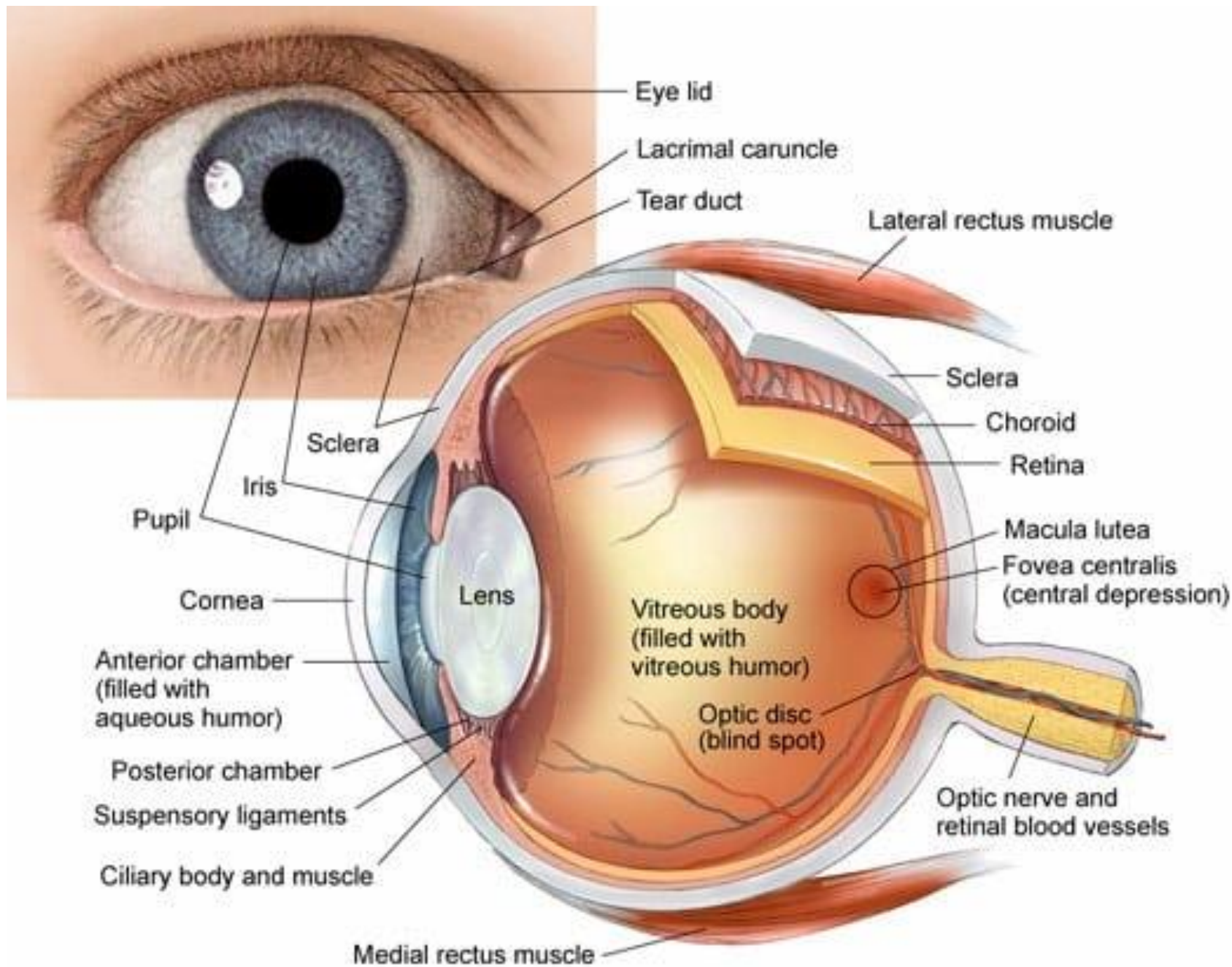
The lens is placed between the posterior chamber and the vitreous chamber

Curvature of lens is **adjusted by ciliaris muscle.**

This is useful for **accommodation for near vision.**

**Aqueous humor and vitreous body nourish the avascular lens.**

The lens helps focus images on the retina to facilitate clear vision.



**4.VITREOUS BODY** – occupies a large vitreous chamber, which is located behind the lens and ciliary body and in front of retina.

**The vitreous body is a jelly like material , vitreous body does not undergo constant replacement.**

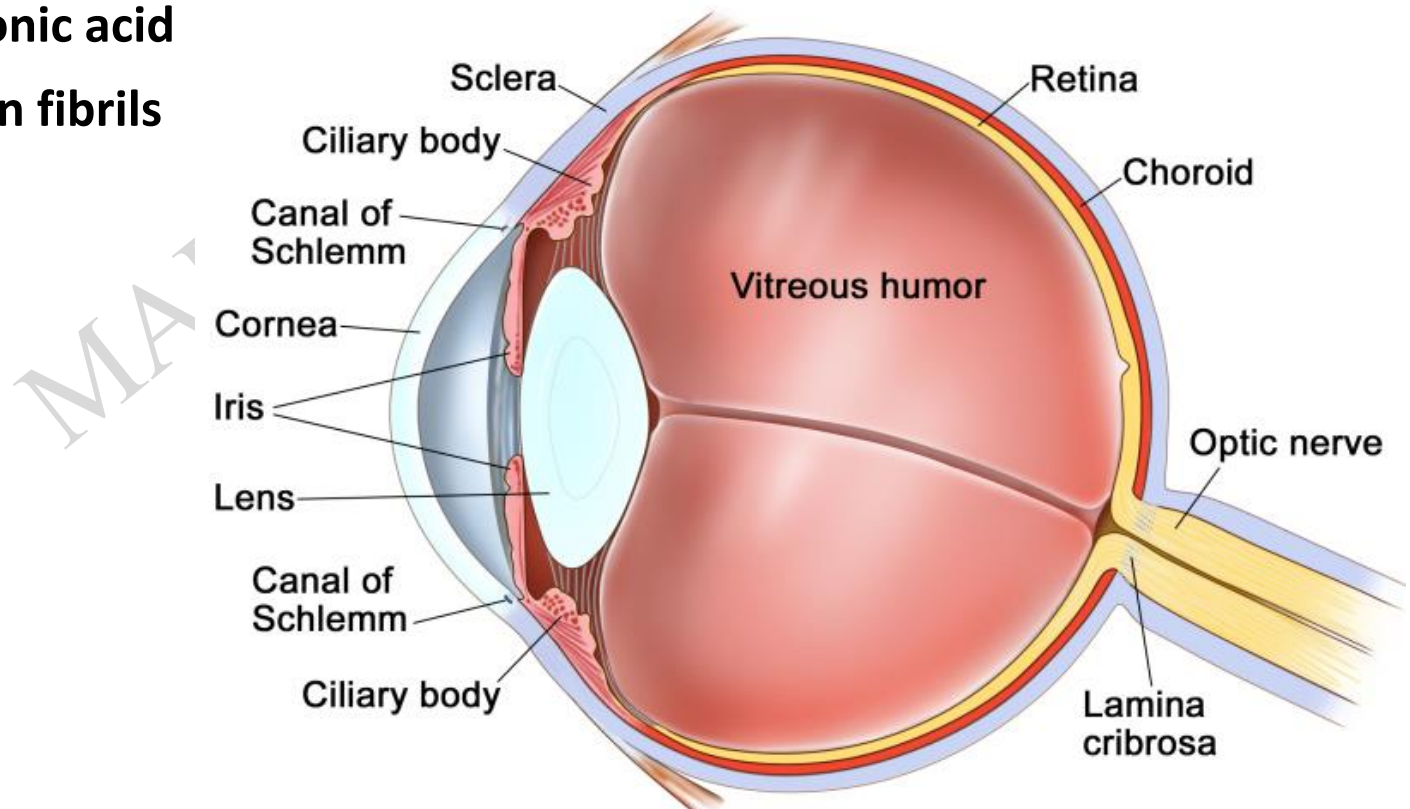
It is formed during embryonic life.

It is composed of

water

hyaluronic acid

collagen fibrils

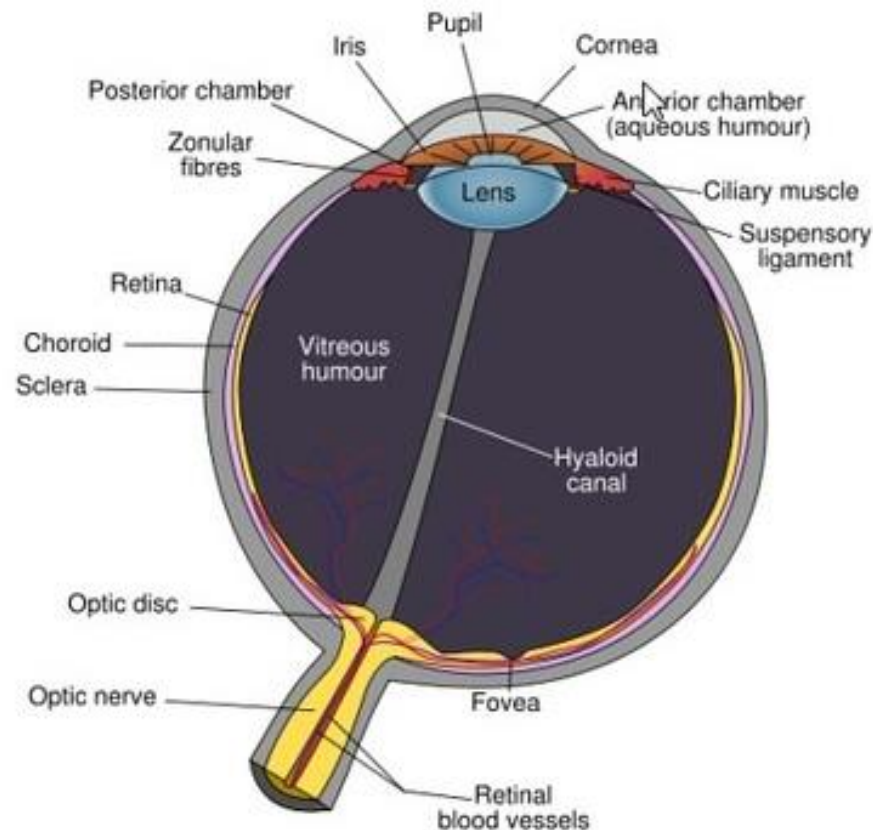




**Vitreous body also contains phagocytic cells** that remove debris, keeping this part of the eye clear for unobstructed vision.

Vitreous body is **enveloped by hyaloid membrane**, which separates it from the retina, ciliary body and lens.

A small passage called as **hyaloid canal** extending from the optic disc to the center of the posterior surface of the lens passes through the vitreous body.



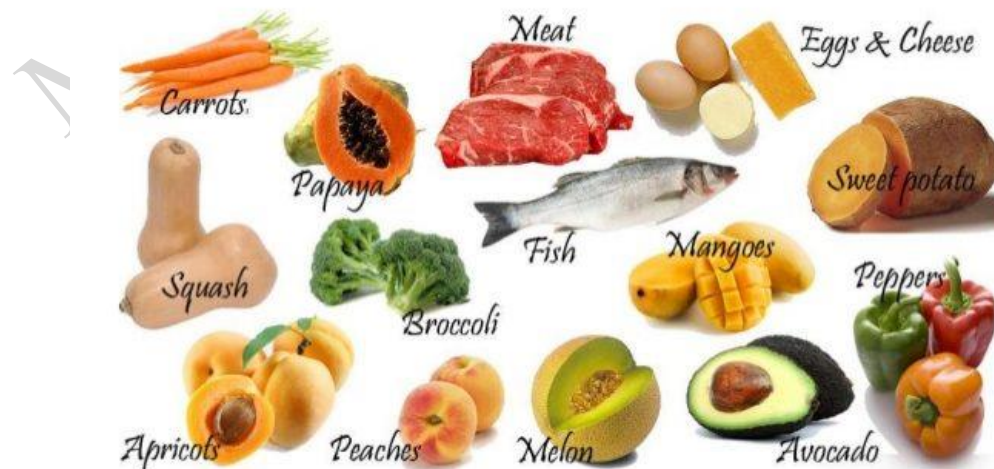
All photopigments associated with vision contain two parts: a glycoprotein known as **opsin** and a derivative of vitamin A called **retinal**. Vitamin A derivatives are formed from carotene, the plant pigment that gives carrots their orange color.

Good vision depends on **adequate dietary intake of carotene-rich vegetables** such as **carrots, spinach, broccoli, and yellow squash**, or foods that contain vitamin A, such as **liver**.

Retinal is the light-absorbing part of all visual photopigments. In the human retina, there are four different opsins, three in the cones and one in the rods (rhodopsin).

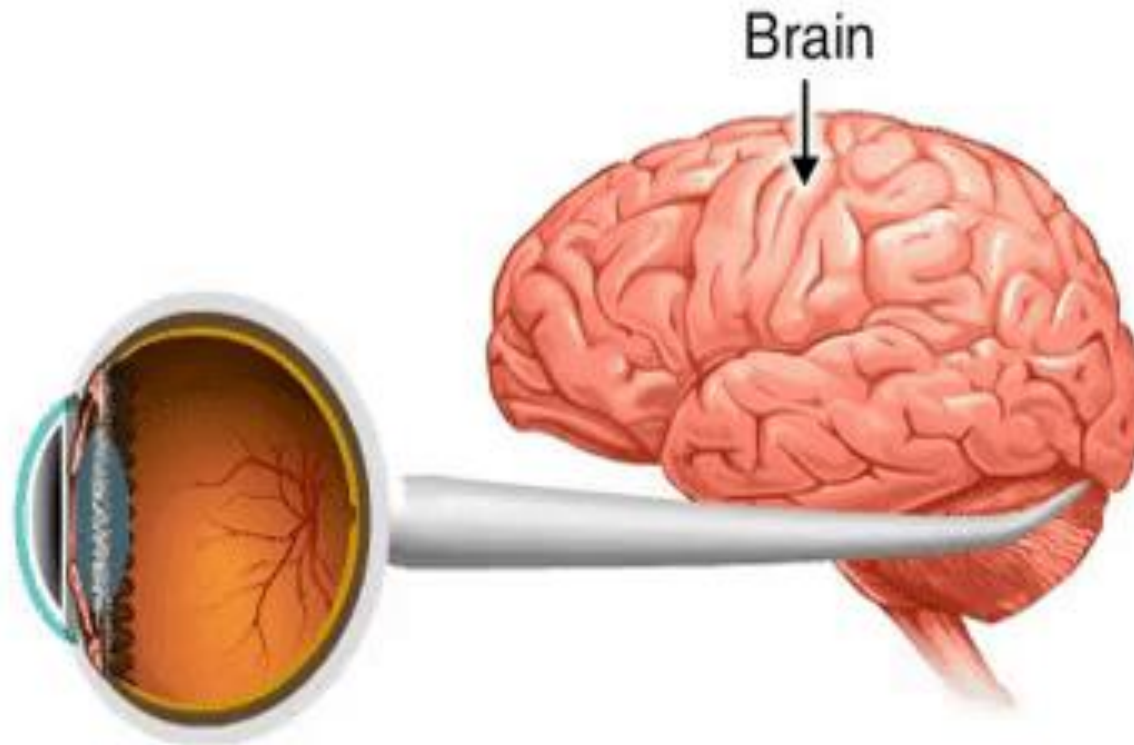
Small variations in the amino acid sequences of the different opsins permit the rods and cones to absorb different colors (wavelengths) of incoming light.

### Sources of Vitamin A

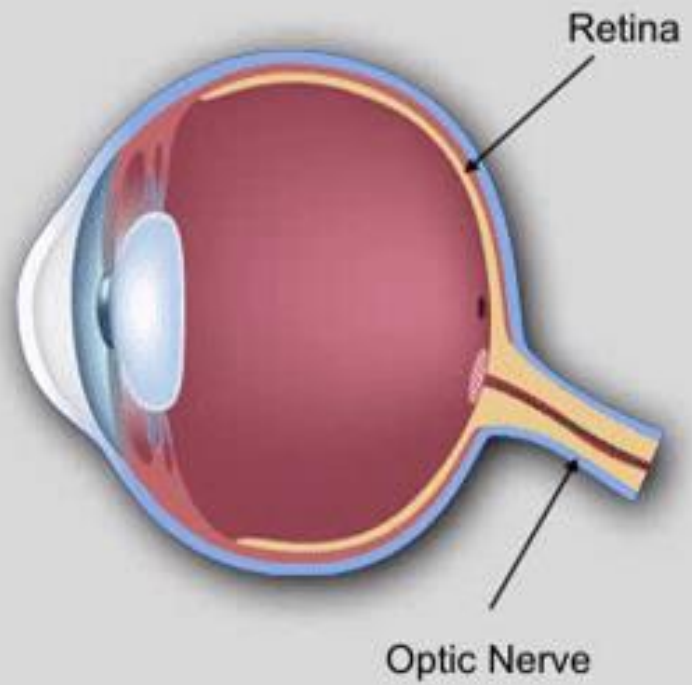


# MECHANISM OF VISION

1. The light rays in visible wavelength focused on the retina through the cornea and lens generate potentials in rods and cones.
2. The photosensitive compounds ( photo pigments ) in the human eyes is composed of **OPSIN** ( a protein ) and **RETINAL** ( an aldehyde of vitamin A )
3. Light induces dissociation of the **RETINAL from OPSIN** resulting in changes in the structure of the OPSIN. This cause membrane permeability changes. As a result, potential differences are generated in the photoreceptor cells. This produces a signal that generates action potentials in the ganglion cells through the bipolar cells.
4. These action potentials ( impulses ) are transmitted by the optic nerves to the **VISUAL CORTEX ( LOCATED IN THE OCCIPITAL LOBE )** area of the brain, where the neural impulses are analysed and the image formed on the retina is recognized based on earlier memory and experience.



**PRIMARY VISUAL AREA IS PRESENT IN THE OCCIPITAL LOBE OF THE BRAIN**





## CLINICAL CORRELATION

- Glaucoma** - blockage in the circulation of aqueous humor results in rise of intraocular pressure. This is called glaucoma. It may lead to degeneration of retina and blindness.
- Presbyopia** - is a condition caused by decreased elasticity of the lens in people over the age of forty. The lens loses power of accommodation.
- Cataract** - is the opacity of lens. Treatment consists of surgical removal of the lens . intraocular implantation is nowadays a popular procedure to restore vision after cataract surgery.

Normal

Eye with cataract

Normal lens

Clouded lens

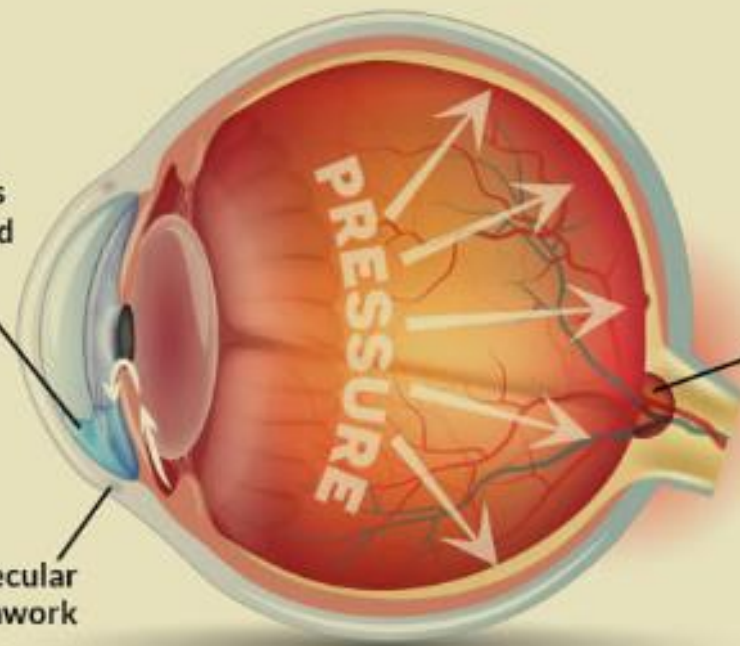




**NORMAL EYE**

Build Up  
of Aqueous  
Humor Fluid

Trabecular  
Meshwork



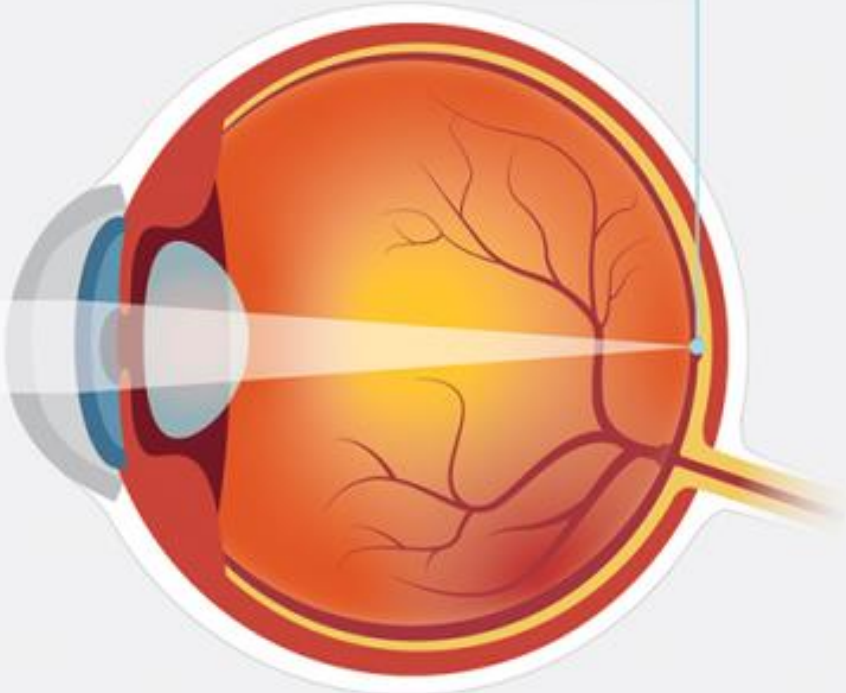
**PRESSURE**

Damage to the  
optic nerve

**GLAUCOMA**

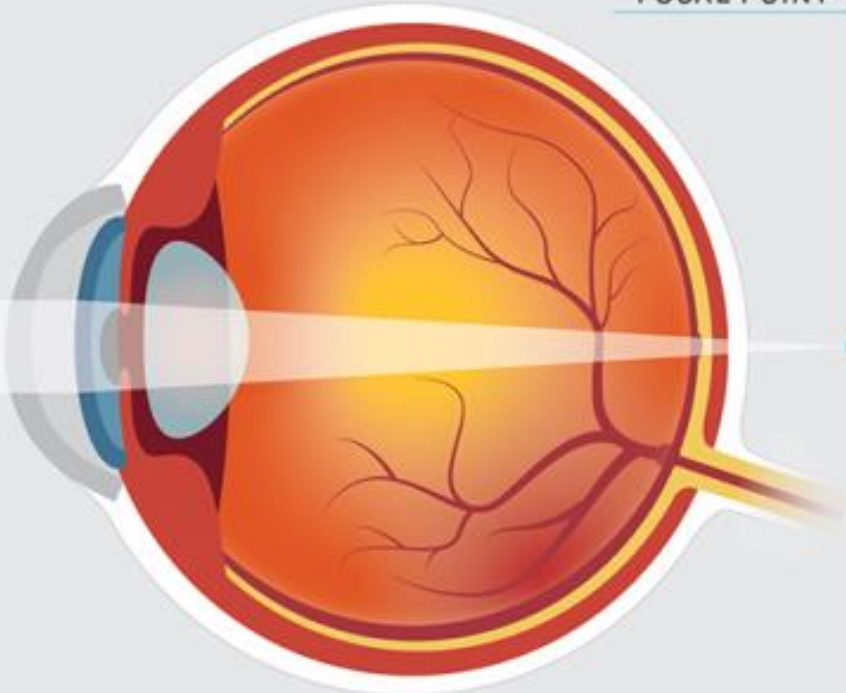
# Normal Vision

FOCAL POINT



# Presbyopia

FOCAL POINT



**Muller's cells are the retinal gliocytes**

**The axons of ganglion cells aggregate to form optic nerve**

**Visual acuity is highest at fovea centralis where only cones are present.**

**The optic disc is called the blind spot as it is devoid of photoreceptors.**

MARS Learning Centre



**THANK YOU**

MARS Learning Centre