

# Histology : the eye

- The eye is the organ of vision
- Photosensitive: detect light and convert it into electrochemical signals that travel in neurons to the cerebrum
- The eyes located in bony cavities in the skull called orbits

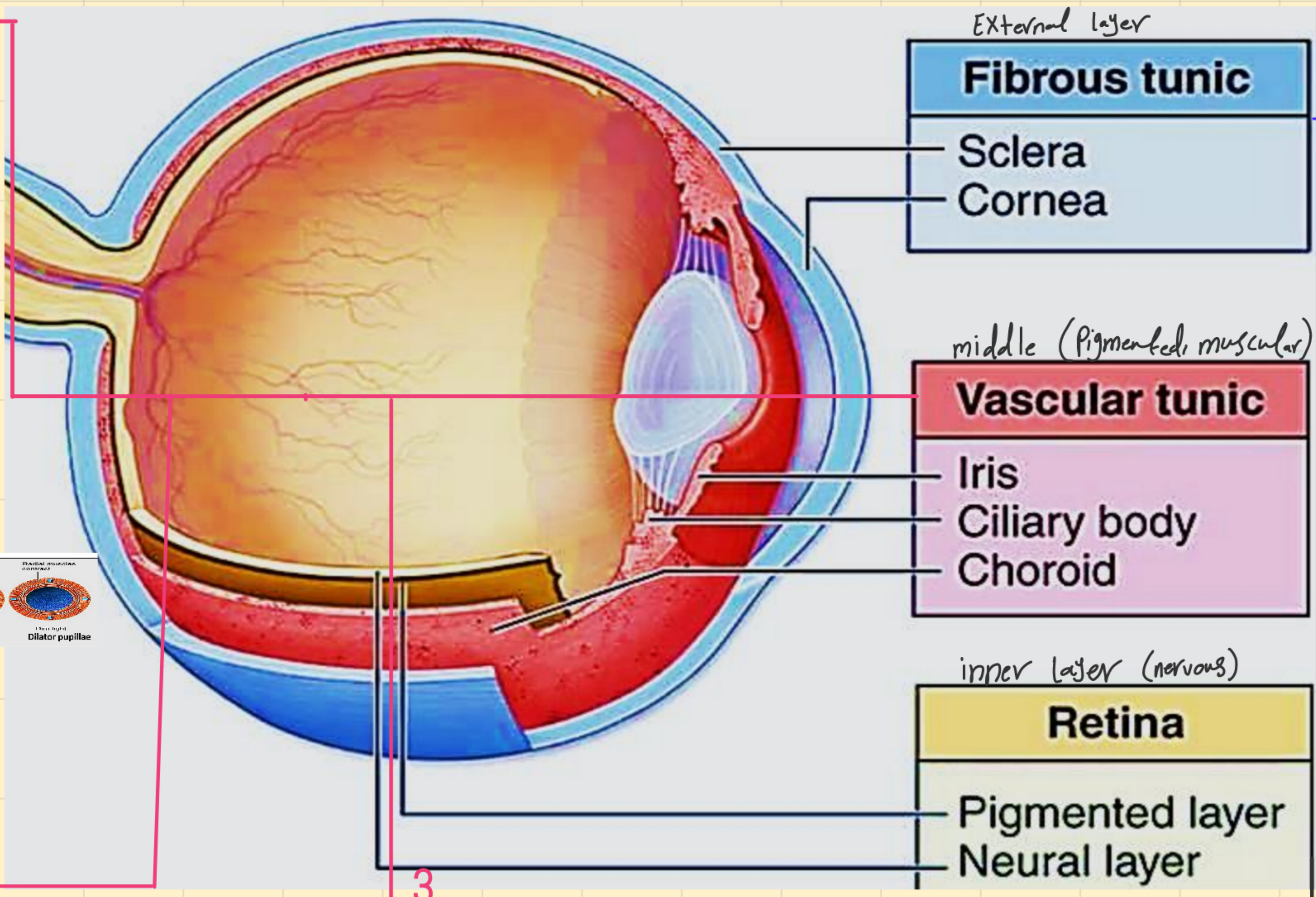
**Why is the cornea transparent?**

1. Avascular, no lymphatics
2. The surface epithelium is non-keratinized
3. Regular arrangement of C.T. fibers & cells in the stroma
4. Cells, fibers & matrix of corneal stroma have the same refractive index
5. The degree of hydration of the cornea is perfectly regulated

**LASIK:**

- Surgical technique used to improve the shape or curvature of cornea to correct certain visual abnormalities
- In this technique the corneal epithelium is displaced as a flap and the stroma is reshaped by an excimer laser which parts of the stroma in a highly controlled manner with no damage to adjacent cells or ECM
- Then the epithelium is repositioned and the rapid regenerative response of the epithelium will reestablish normal corneal physiology

## composed of three layers (tunics)



## Iris

- is the colored disc present between the anterior & posterior chambers of the eye (diaphragm of the eye)
- The pupil is the round open in the center of the iris
- The iris changes the pupil size to control amount of light & the depth of focus
- Its posterior surface share in the formation of aqueous humor

### \* Structure of the iris

**1 Anterior Surface** → lined by fibroblast & melanocytes is continuous with that covering the posterior surface of the cornea

**2 Stroma** → a. Loose vascular C.T., rich in BV, fibroblasts, melanocytes  
b. Muscles of the iris:  
• The **dilator pupillae muscle** is myoepithelial cells partially pigmented Radially arranged at the periphery of the iris. Its contraction → dilate pupil (sympathetic)  
• The **sphincter pupillae muscle**: circular band of smooth ms, encircling the pupil. Its contraction → constrict the pupil (parasymp)

**3 Posterior Surface** → made of 2 layers of pigmented cuboidal epithelium continuous with that covering the Ciliary body, which prevents stray light rays from interfering with image formation

## The ciliary body

- Is a thick, triangular part at the level of the lens (composed of **Ciliary processes & Ciliary muscles**)
- The Ciliary processes are attached to the suspensory ligaments of the lens & its epithelium form aqueous humor
- Ciliary body has 3 functions:  
1. Accommodation  
2. Production of aqueous humour  
3. Maintenance of lens zonules (ligaments)

### \* structure of Ciliary body

**1- The ciliary epithelium** → a) It composed of two layers of cuboidal epithelium.  
b) The surface cell layer is non-pigmented (A) ??? while the deep cell layer is pigmented (B) rich in melanin & continues with retinal pigmented epithelium  
c) It secretes the aqueous humor

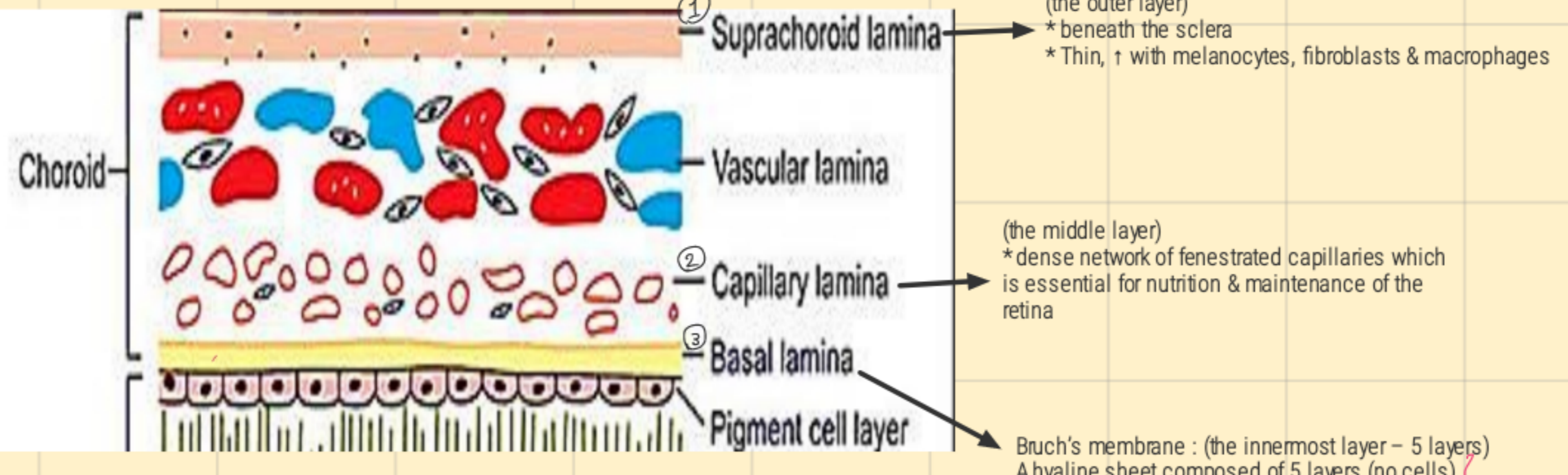
**2- Vascular stroma** → loose, highly vascular C.T., elastic fibers, & melanocytes

**3- The ciliary muscle** → a. smooth muscles attached to the suspensory ligament of the lens.  
b. They are responsible for the process of Accommodation

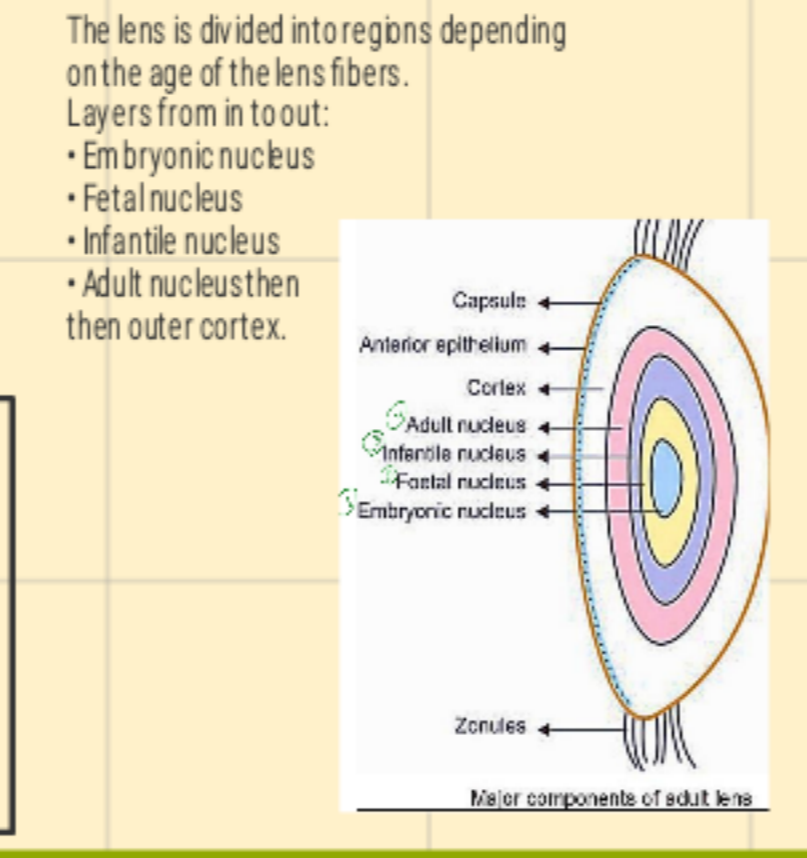
## The choroid

- Is the **highly vascular, pigmented part** of the uvea. lies posterior to the Ciliary body
- Presents between the sclera & the retina
- Highly pigmented & highly vascular it absorbs light & provides retina with O<sub>2</sub>

### \* Structure of the Choroid



### \* Arrangement of layers lens nucleus



## The lens

- Is transparent, avascular biconvex disc, behind the pupil
- Attached to the Ciliary body by **zonule** (suspensory ligament of lens)
- Lens composed of 3 parts: **capsule, cortex, nucleus**

### \* Structure of the lens:

- I. Capsule
  - II. Subcapsular (lens) epithelium
  - III. Lens fibers (cortex)
  - IV. Nucleus
- The capsule is transparent, surrounds the lens completely, elastic & is composed of type I collagen. It is synthesized by the lens epithelium
  - single layer of cuboidal cells covers the anterior & lateral surfaces of the lens located between the lens capsule cortex (lens fibers) → **subcapsular** functions of the lens:  
• The lens epithelium regulate most of the **homeostasis**  
• The lens epithelium also serve as the progenitors for new lens fibers
  - the fibers filled with proteins (**Crystallins**) which highly specialized for light reflection  
• The lens fibers stretch lengthwise from the posterior to the anterior poles and, if cut along the equator, it appears as a honeycomb

## Cornea

- Dome shape, transparent (colorless), non vascular anterior part of the outer (fibrous) layer
- Is richly supplied with sensory nerve endings
- Is kept wet by the secretion of the tarsal & lacrimal glands

### \* cornea composed of 5 layers (A,B,C,D,E)

**1- Epithelium** → non-keratinized stratified squamous epithelium consists of 5-6 layers of cells

**2- Bowman's Membrane** → It is a thick, non-cellular membrane BELOW the epithelium basement membrane  
• Formed of protein fibers (collagen types I & V)  
• It acts as protective barrier to the stroma (next layer) against infection & provide support to sub-epithelial nerve plexus  
→ protect the epithelial innervation  
• If injured heals by scar, and causes corneal opacity

**3- Stroma** → C.T. (Connective Tissue)

**4- Descemet's Membrane** → It is a thick, homogeneous, non-cellular membrane composed of fine collagen fibers (type I & VIII)  
• Formed by the endothelial cells of the next layer (the basement membrane of the endothelial cells)  
• Membrane breaks occur in congenital glaucoma

**5- Endothelium** → It is a thin, simple squamous epithelium (regenerate)  
• Cells of this layer are active:  
• protein synthesis to maintain the Descemet's membrane  
• pumping sodium ions into the adjacent anterior chamber → dispose of any excess fluid in stroma → maintain corneal transparency  
• The endothelium responsible for maintaining state of hydration within the cornea that provide maximum transparency & optimal light refraction

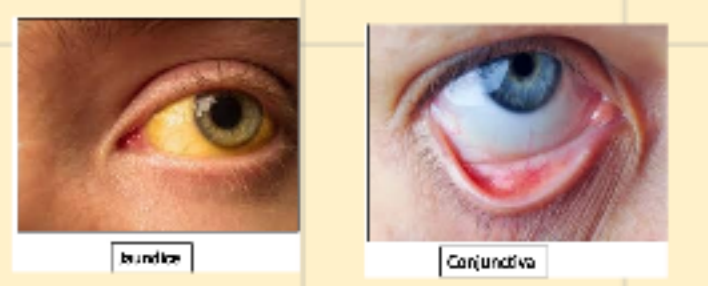
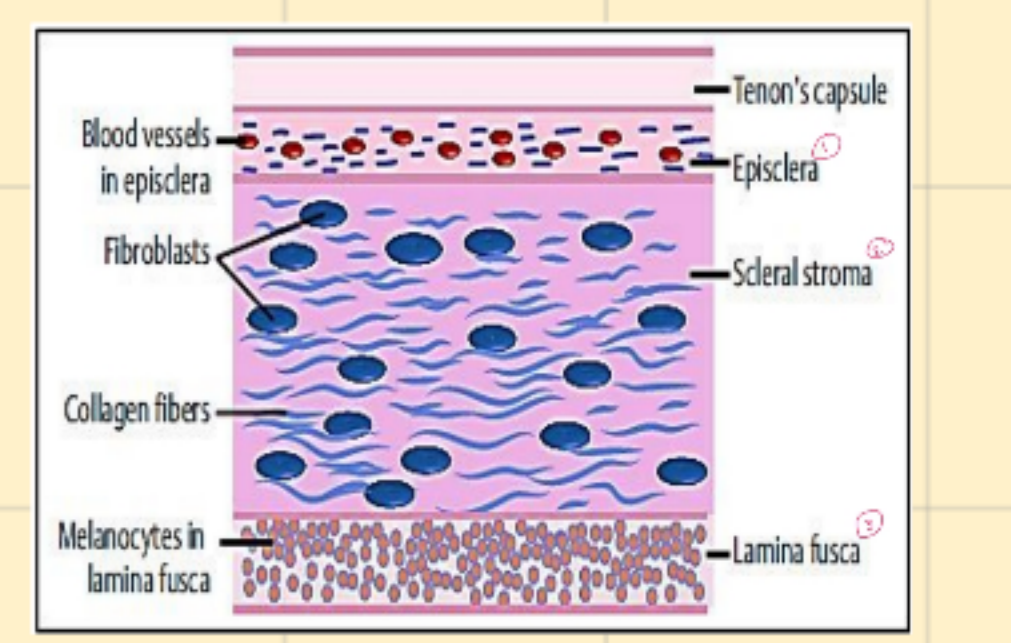
**Tear film structure:**  
1- **Mucus layer:** covers microvilli & forms a network over the conjunctival surface, secreted by conjunctival goblet cells & the stratified squamous cells of the conjunctive & corneal epithelium.  
Function: Convert corneal epithelium from hydrophobic to hydrophilic layer → stabilize the tear film, provide lubrication for eyelid movements

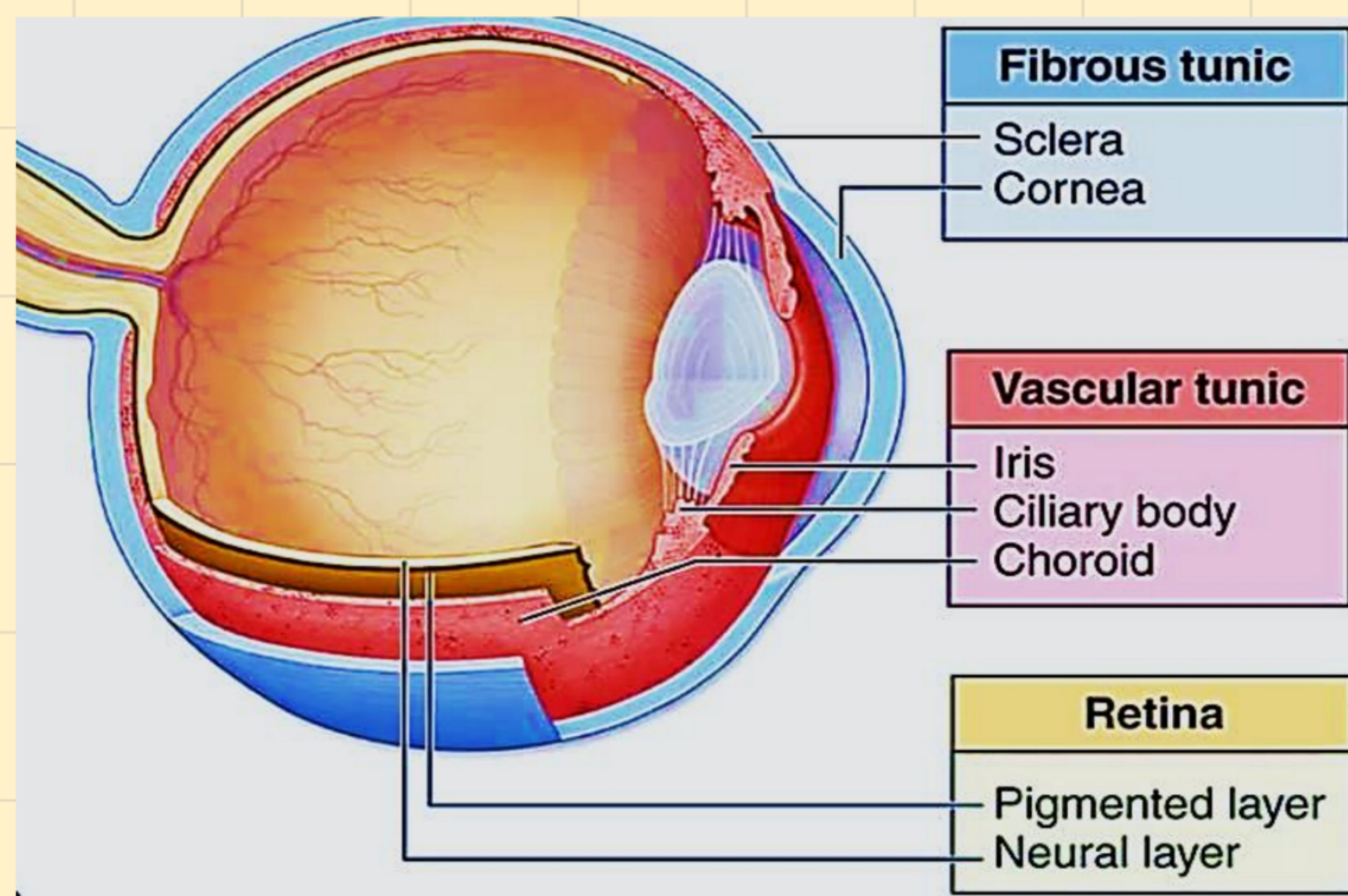
2- **Aqueous layer:** Secreted by lacrimal glands & accessory lacrimal glands (watery secretion)  
Function: supply oxygen to the avascular corneal epithelium & maintain constant electrolyte composition over the ocular surface epithelium

3- **Lipid layer:** Secreted by tarsal glands (Meibomian glands, Glands of Zeis & Glands of Mollis)  
Function: prevent evaporation, maintain hydrophobic barrier that prevents tear overflow by increasing surface tension

## Sclera

- Is thick white, opaque, fibrous layer (5/6)
- It provides sites for ocular ms. Insertion, protection & shape to the eye
- It consists of irregular white (**type I collagen fibers**), intersect in various directions, elastic fibers & fibroblasts
- Formed of 3 layers: Episclera Sclera proper (stroma) & Lamina fusca
- Is covered by **conjunctiva** (clear mucus membrane)
- The sclera is surrounded with **Tenon's capsule** (fascia) which provides attachment to the extra-ocular muscles





# Retina

- \* is the inner most layer , responsible for Photoreception
- Composed of 2 layers : pigmented epith. & photosensitive layers
- Photosensitive layers consists of layers of neurons interconnected with each other by synapses
- It contains the photoreceptor cells : Rods & Cones
- Rods function mainly in dim light and provide black-and-white vision
- Cones support day time vision and the perception of color

## \*Layers of the retina (10):

1. pigmented epithelium
2. Rods & cones layer *photoreceptor*
3. Outer limiting membrane
4. Outer nuclear layer
5. Outer plexiform layer
6. Inner nuclear layer
7. Inner plexiform layer
8. Ganglion layer
9. Optic nerve layer
10. Inner limiting membrane

• Single layer of cuboidal cells e basal rounded nuclei their basal surface attached to the Bruch's membrane of choroid  
 • Their apical surface has many microvilli which interdigitate with the tips of rods & cones (**Retinal detachment**)  
 • They contains numerous **melanin granules**  
 • The lateral membrane of adjacent cells shows tight junctions together with bruch's membrane form **blood-retinal barrier**  
 • Their cytoplasm contains mitochondria, **phagocytic vacuoles**, 2ry lysosomes, sER

**Function**

- Form a dark layer that absorb light & prevent glaring (melanin G)
- Store , release, transport **vit. A** to rods & cones
- Form the blood-retinal barrier
- Phagocytize old discs present at the tips of rods & cones

Dark line represent junctional complexes between processes of Muller cells ( glial cells) & the photoreceptors

Contains the cell bodies of rods & cones (**1st order neuron**)

contains the synapses between synaptic processes of rod & cone cells and the dendrites of the bipolar & horizontal cells

contains the cell bodies of 4 cells:

- **Bipolar nerve cells (2nd order neuron)** : its dendrites synapse with the synaptic processes of rods & cones
- **Horizontal cells**: large branched cells, interconnect the synaptic terminals of rods & cones with bipolar cells
- **Amacrine cells**: interconnect axons of bipolar nerve cells & dendrites of ganglion cells
- **Muller cells: neuroglia**, their processes extend from the inner limiting membrane to the outer limiting membrane

• contains synapses between axons of bipolar nerve cells & dendrites of ganglion cells, also synapses of amacrine cells

• Ganglion cells (**3rd order neuron**), are nerve cells with vesicular nuclei & basophilic cytoplasm. Their dendrites synapse with axons of bipolar cells .  
 • Their axons form the fibers of **optic nerve**. Retinal B.V. present between ganglion cells

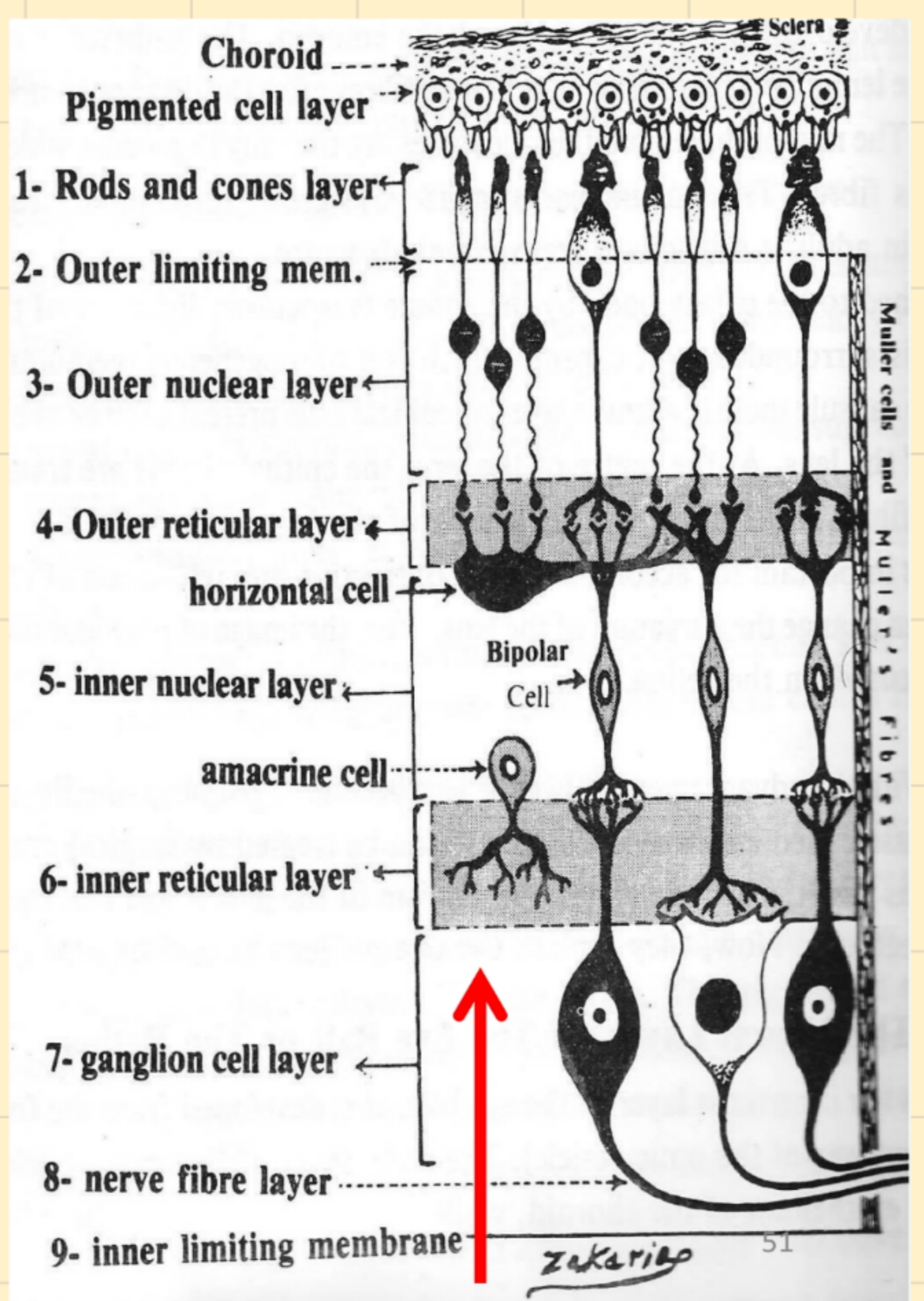
• Dark line formed by terminal processes of Muller cells

**Rods** *dim light vision*

- **Outer thin segment**: contains transverse discs filled with Rhodopsin, discs are continuously renewed & separated from cell membrane
- **Connecting stalk**: contain modified cilium
- **Inner segment**: contains cell organelles that form the Rodopsin
- **Cell body**: contains nucleus
- **Synaptic region**: which synapse with bipolar nerve cells & horizontal cells

**Cones** *bright light, color vision*

- **Outer cone shaped segment**: contains flat discs which contains iodopsin pigment. These discs are infolding of cell membrane
- **Connecting stalk**: contains cilium
- **Inner segment** : contains all cell organelles & forms iodopsin
- **The nuclei** of cones are arranged in one horizontal level near the outer limiting membrane
- **Synaptic region** which synapse with bipolar nerve cells & horizontal cells



\* **Fovea centralis:**

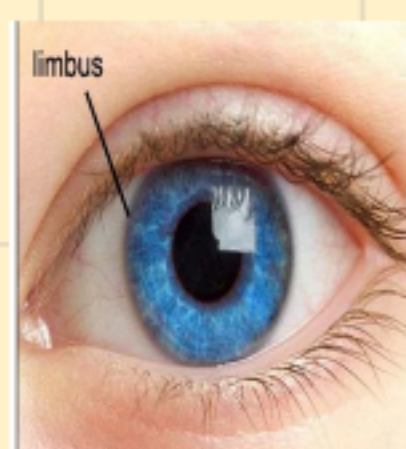
- It is the area of **highest visual acuity** (sharp vision)
- Is a central shallow depression of **macula** of the retina
- Lacks retinal blood vessels
- Contains Cones only



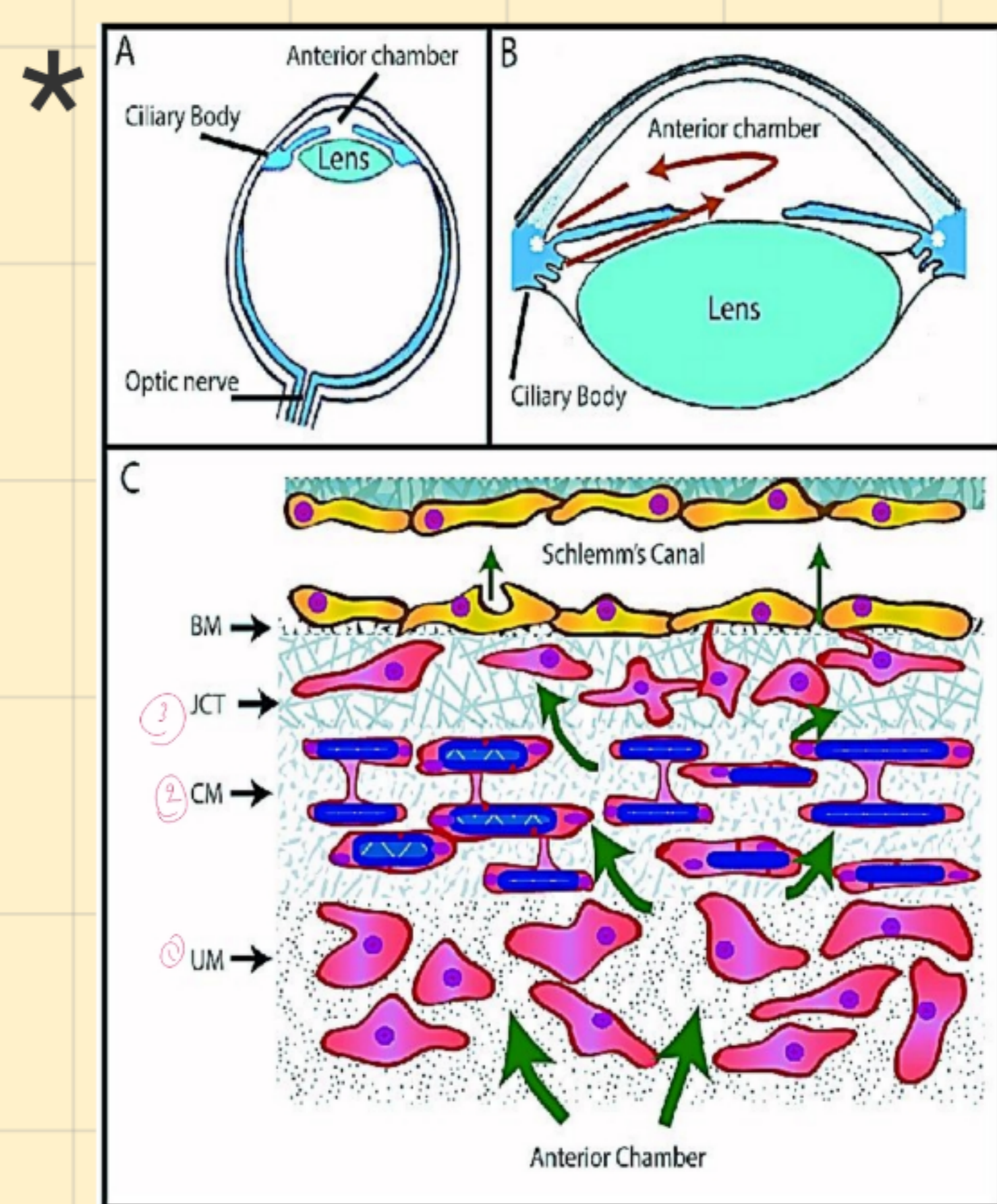
**Optic disc ( blind spot):**

- has no photoreceptors . Consists of optic nerve fibers

## The corneo- scleral junction ( limbus)



- \* Transitional area between cornea & sclera, contains **stem cells** for the corneal epithelium (Palisades of Voget)
- Site for surgical incisions for cataract & glaucoma
- **Is a highly vascular zone**
- \* The **corneal epithelium** is continuous at the Limbus with the bulbar conjunctiva which covers the sclera
- **Bowman's membrane** stops abruptly at Limbus
- The regular **stroma** of the cornea is continuous with the irregular stroma of the sclera. At that point locate the canal of Schlemm( the aqueous humor is drained through that canal → venous system) .. (**Glaucoma**)
- **Descemet's membrane** become continuous with the Trabecular meshwork (**spaces of Fontana**)
- The **endothelium** on the posterior surface of the cornea extend & become reflected on the anterior surface of iris



• **Schematic of the trabecular meshwork and Schlemm's canal**

Aqueous humor flows from the anterior chamber through the 3 layers of the trabecular meshwork called :

- 1- Uveoscleral meshwork (UM)
- 2- Corneoscleral meshwork (CM)
- 3- The juxtacanalicular tissue (JCT)

Aqueous humor (arrows) then crosses the basement membrane (BM) of Schlemm's Canal either paracellularly or transcellularly and enters into Schlemm's Canal.

\* The limbal epithelial stem cells are important for corneal epithelial cell renewal and closure of wound defects. Corneal epithelial cells **have a lifespan of 7-10 days**

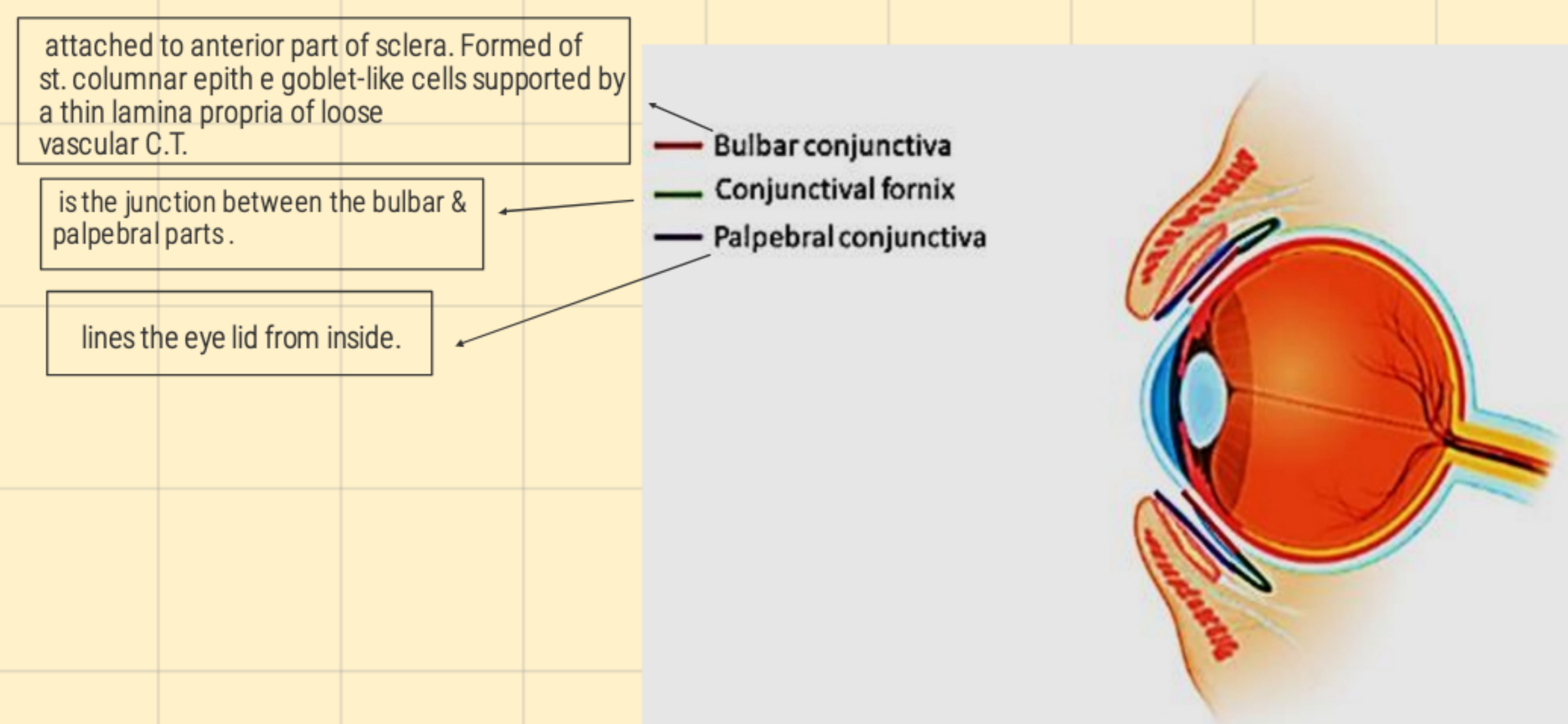
Limbal stem cell deficiency (LSCD) causes include: chemical & thermal burns, multiple ocular surgeries involving the limbal region, contact lens wear, and ocular surface inflammatory diseases

• The axons of ganglion cells pass at right angle to form optic nerve. The optic nerve fibers are non myelinated at their origin , then they become myelinated after they traverse the sclera

# \* Accessory structures of the eye

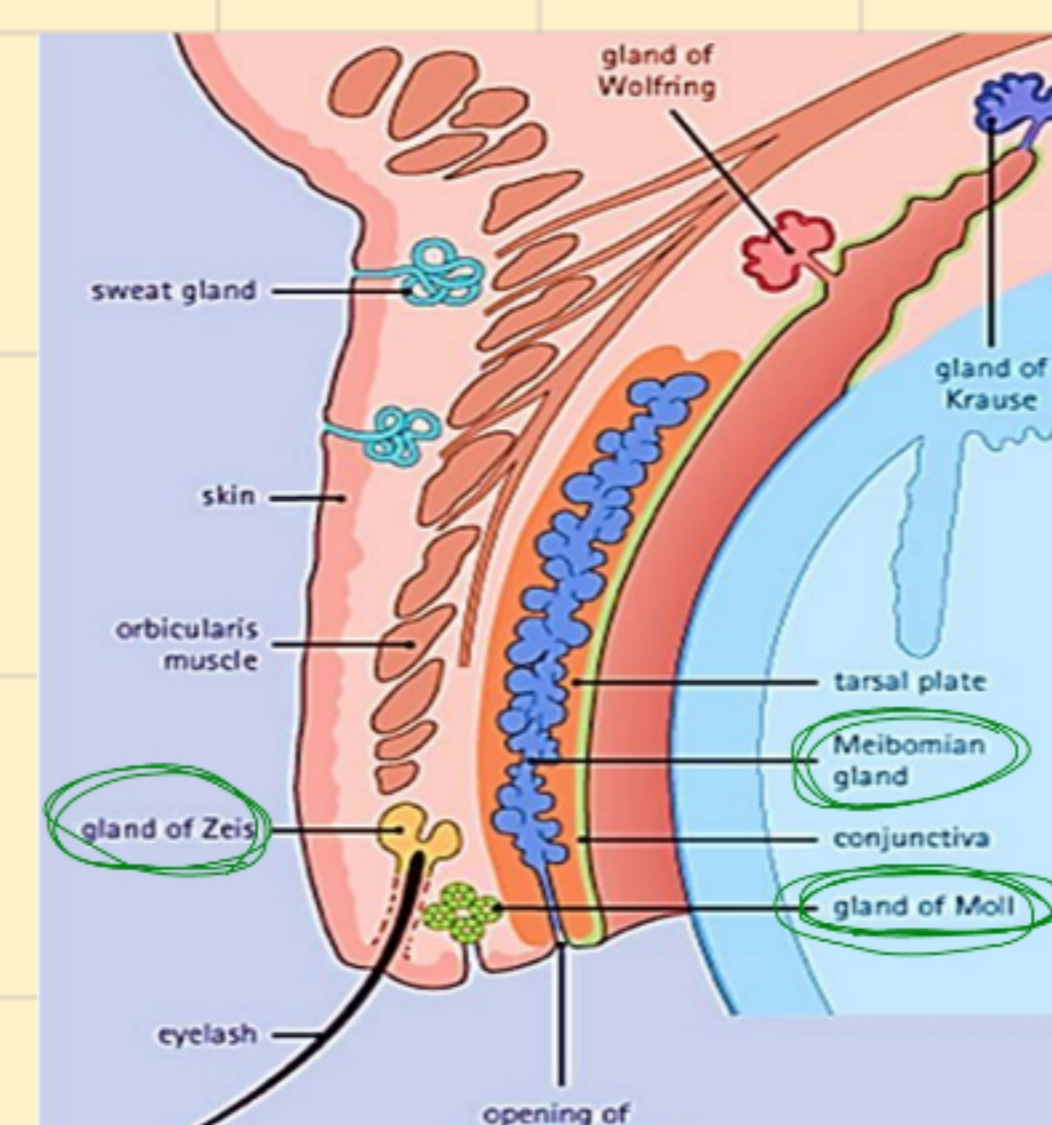
## Conjunctiva

- Very thin transparent mucus membrane
- Covers the anterior part of the eye except the cornea & lines internal surface of the eye lids



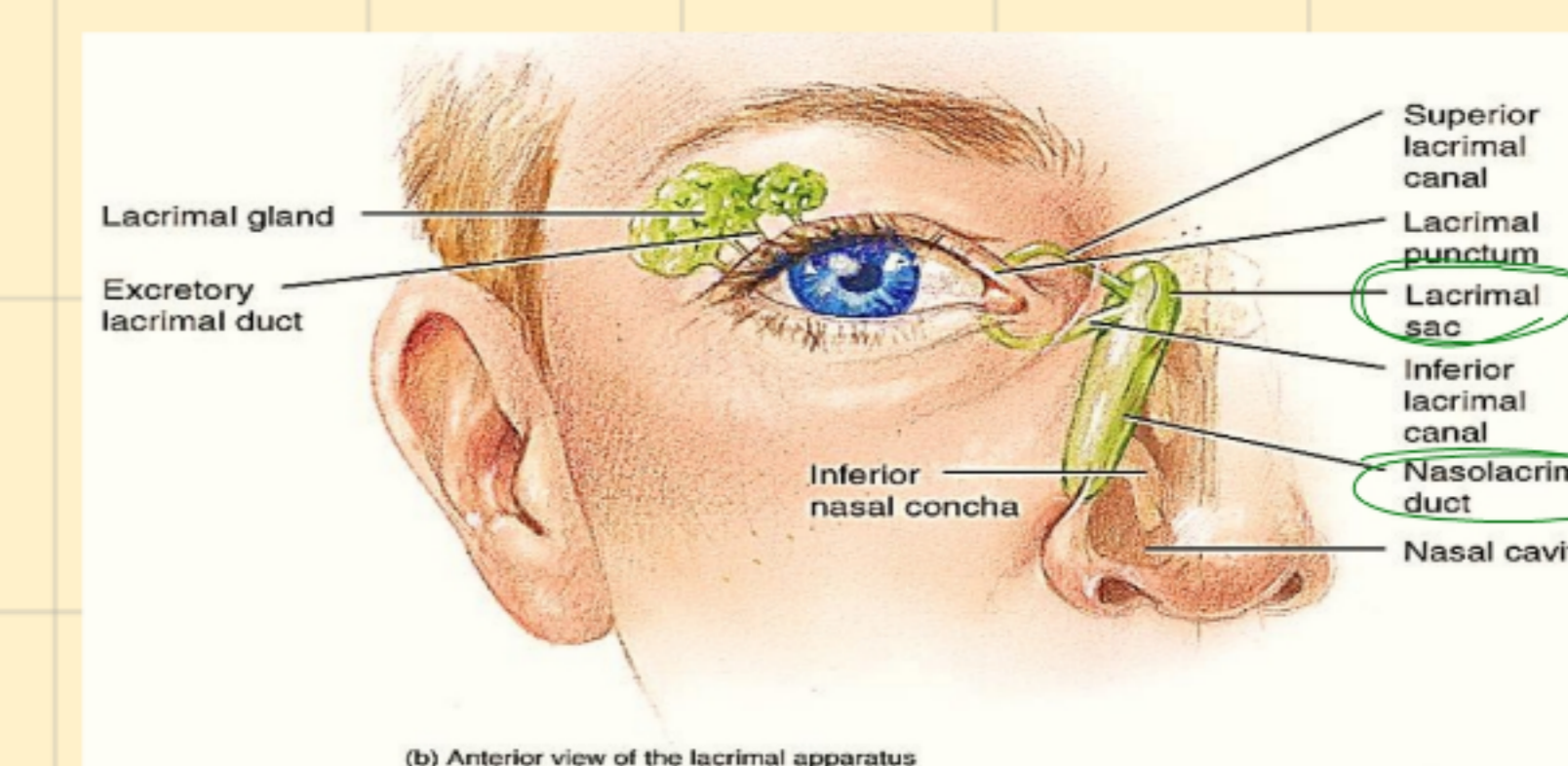
## Eye lid

- From outside is covered e thin skin that has no subcutaneous fat. From inside is lined with palpebral conjunctiva.
- 3-4 rows of eye lashes at lid margin. **Zeis glands** are sebaceous glands open at the follicles of eye lashes.
- **Moll glands** are sweat glands open between the eye lashes
- bundles of Skeletal muscle: orbicularis oculi
- The **tarsal plate** is fibrous plate contains the **Meibomian gland** (modified sebaceous gland) oily secretion) which add to the surface of tear to minimize evaporation



## Lacrimal apparatus

- The lacrimal glands: are compound tubulo- alveolar. They secrete tears



- **Lacrimal canaliculi**: present on the medial aspect of both upper & lower eyelid margins. They open into lacrimal sac. They drain the tears. Lined with stratified squamous epithelium
- **Lacrimal sac**: wide tube, lined with pseudo- stratified columnar ciliated epithelium (motile cilia) & goblet cells
- **Nasolacrimal duct**: opens in the nasal cavity below inferior concha

## chambers of the eye

- **Anterior chamber**: between the cornea & iris contains Aqueous humor
- **Posterior chamber**: between the iris & lens contains aqueous humor
- **The vitreous chamber**: between the lens & retina contains transparent, colorless gelatinous mass called vitreous body  
Eye floaters ....?

