

# Histology

The Eye

2012

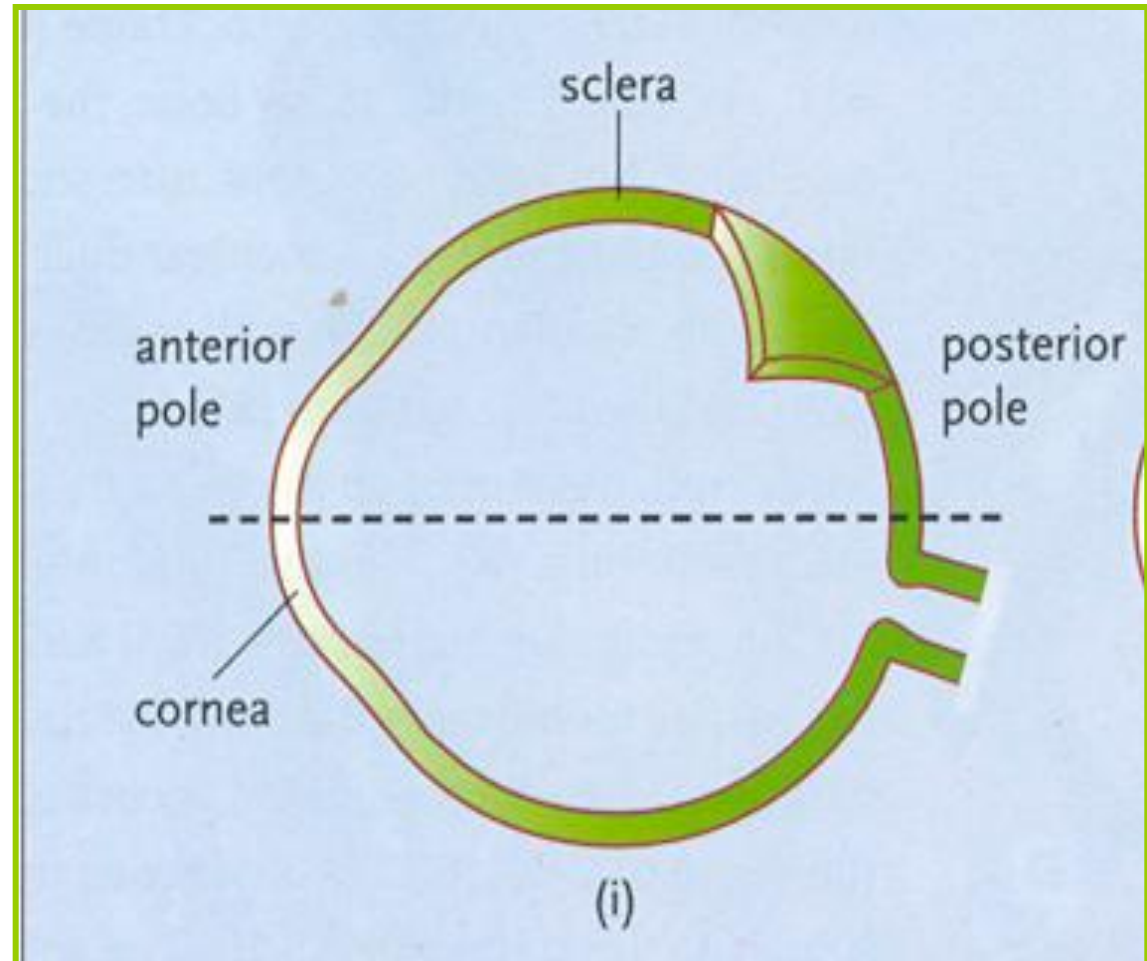
# Eye Ball *bulbus oculi*

## Three layers

- Outer supporting layer
- Middle layer
- Inner layer
  
- Accessory structures

# Outer supporting layer

- (i) cornea
- (ii) limbus
- (iii) sclera



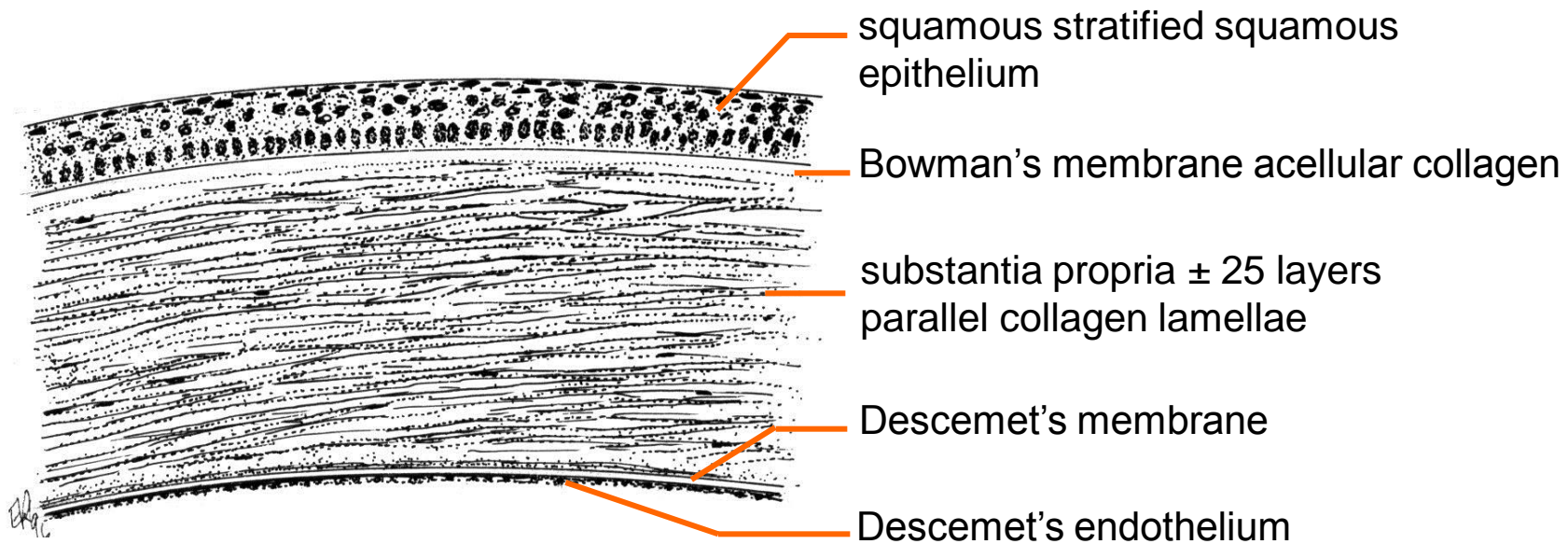
## (i) Cornea

- Anterior supporting layer
- Transparent and avascular
- Nutrition: From endothelium

## Cornea consists of:

1. Outer layer: squamous stratified epithelium
2. Membrane of Bowman: acellular, collagen
3. Substantia propria/stroma:
  - Thickest layer, 25 lamellae parallel collagen fibers
4. Membrane of Descemet: basement membrane
5. Inner layer: endothelium of Descemet

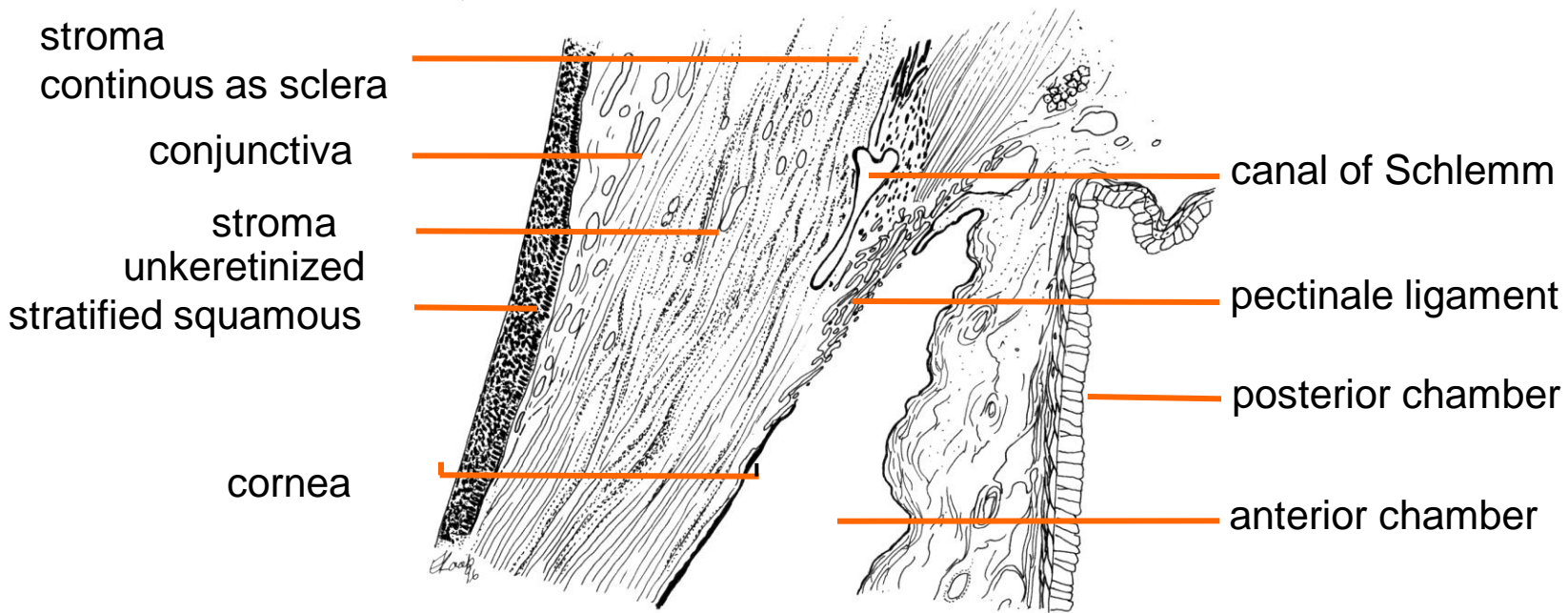
# Cornea



(ii) Limbus = Transitional zone between cornea + sclera ( $\pm$  1mm)

- o Corneal epithelium thickens and passes over into scleral epithelium
- o Lamellae of substantia propria changes to irregular dense connective tissue
- o Descemet's membrane + endothelium continue and become part of pectinate ligament
- o Scleral spur - where the sclera meets the limbus

# Limbus





## (iii) Sclera

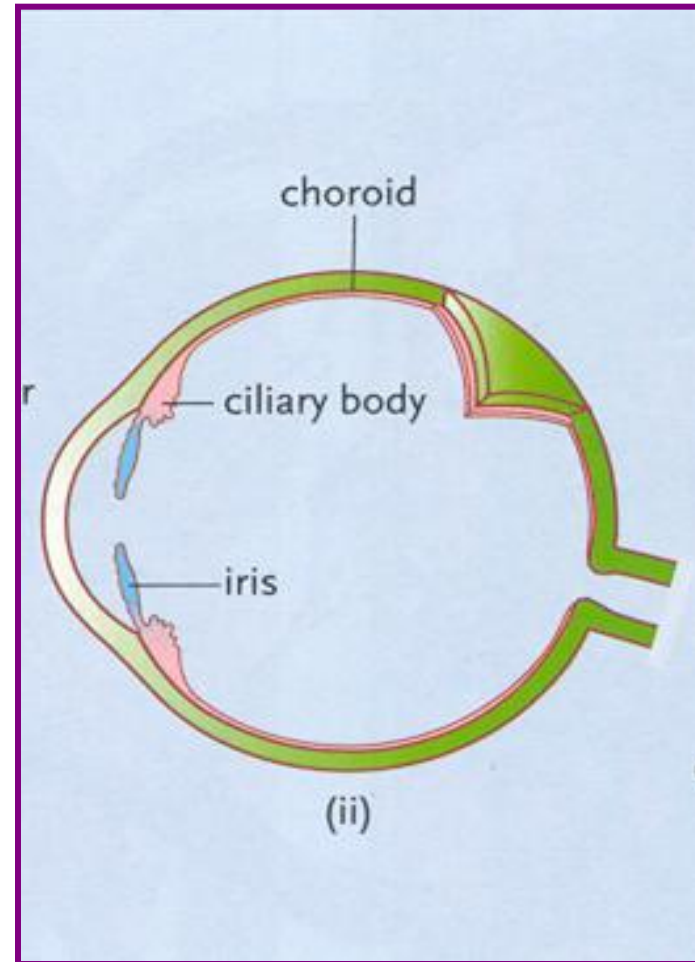
- Protects eye from trauma
- Maintains intraocular pressure
- Insertion for extrinsic ocular muscles

### Sclera consists of:

- dense connective tissue
  - collagen fibers
  - some elastic fibers
  - and flattened fibroblasts between fibers
- few blood vessels and no lymphatics

# Middle layer

- (i) choroid
- (ii) ciliary body
- (iii) iris



# 1. Choroid

Vascular, fibroblasts, macrophages, lymphocytes, mast cells

Supplies the retina with essential nutrients

## Four layers:

1. Suprachoroid: collagen, elastic fibers + melanocytes
2. Vessel layer: thickest, many blood vessels with loose connective tissue and melanocytes
3. Choroicapillary: single layer capillaries, wide lumens, fenestrated endothelium
4. Bruch's membrane: 5 layers

# 1. Choroid

## 4. Bruch's membrane: (5 layers)

1. Outer basal membrane of the choriocapillary layer
2. Collagen fibers
3. Network of elastic fibers
4. Collagen fibers
5. Inner basal lamina of the pigment epithelium

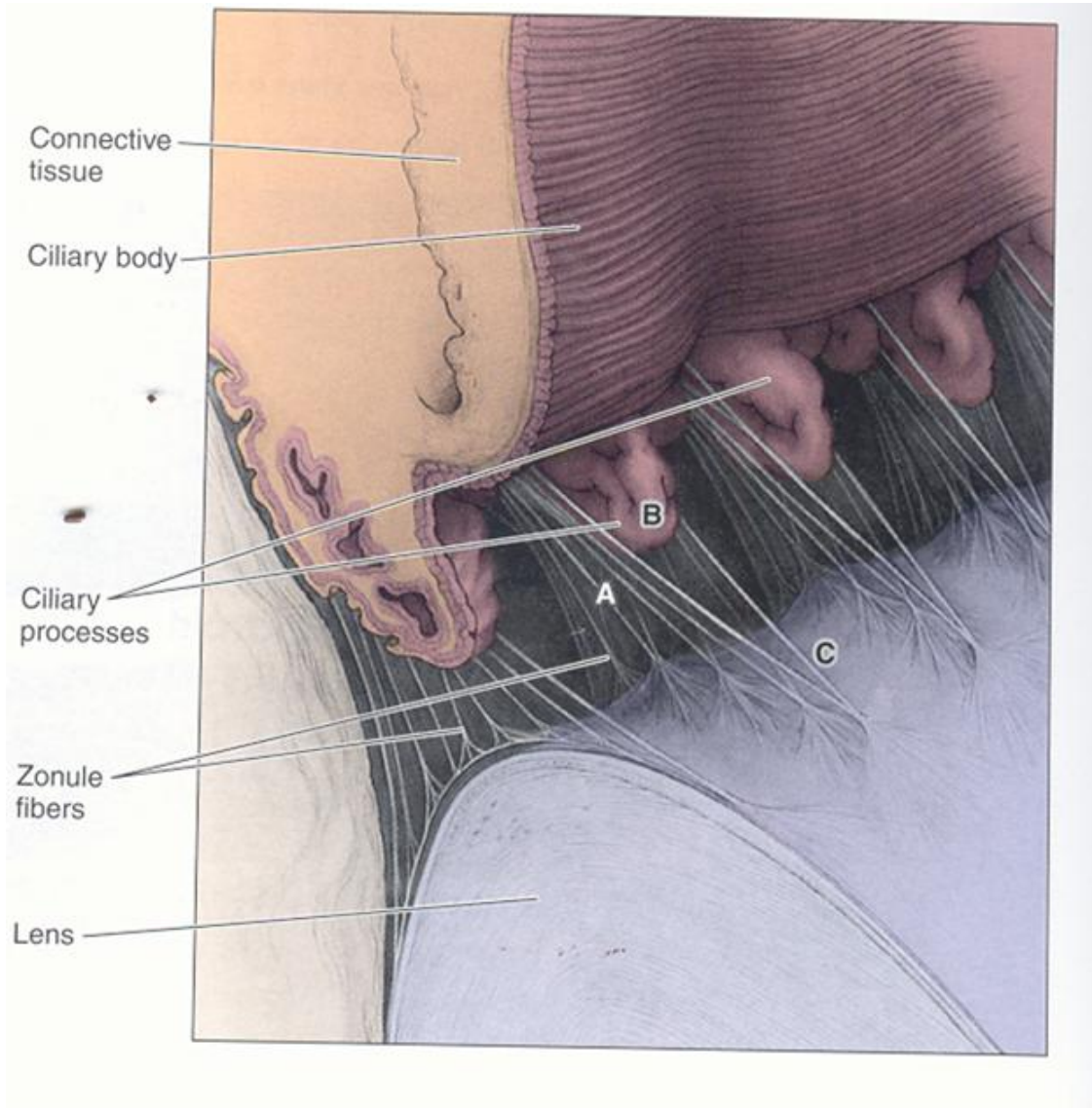
*Bound to the sclera by suprachoroidal lamina =loose  
connective tissue with melanocytes*

## 2. Ciliary body

Triangular = defined by vitreous body, sclera, lens + posterior chamber

### Structure

1. Loose connective tissue (rich in elastic fibers, vessels and melanocytes)
2. Surrounded by ciliary muscle (2 bundles smooth muscle)
3. Simple columnar cells rich in melanin
4. Derived from sensory layer of the retina = simple non pigmented columnar epithelium



# Ciliary process

- Ridge like extensions of the ciliary body
- Loose connective tissue core
- Numerous fenestrated capillaries
- Covered by same epithelium
- From ciliary process zonule fibers insert in lens capsule

## 3. Iris

- Circular diaphragm
- Distensible aperture = pupil
- Extension of the choroid partially covering the lens
- Anterior surface irregular, rough with grooves and ridges



## 3. Iris

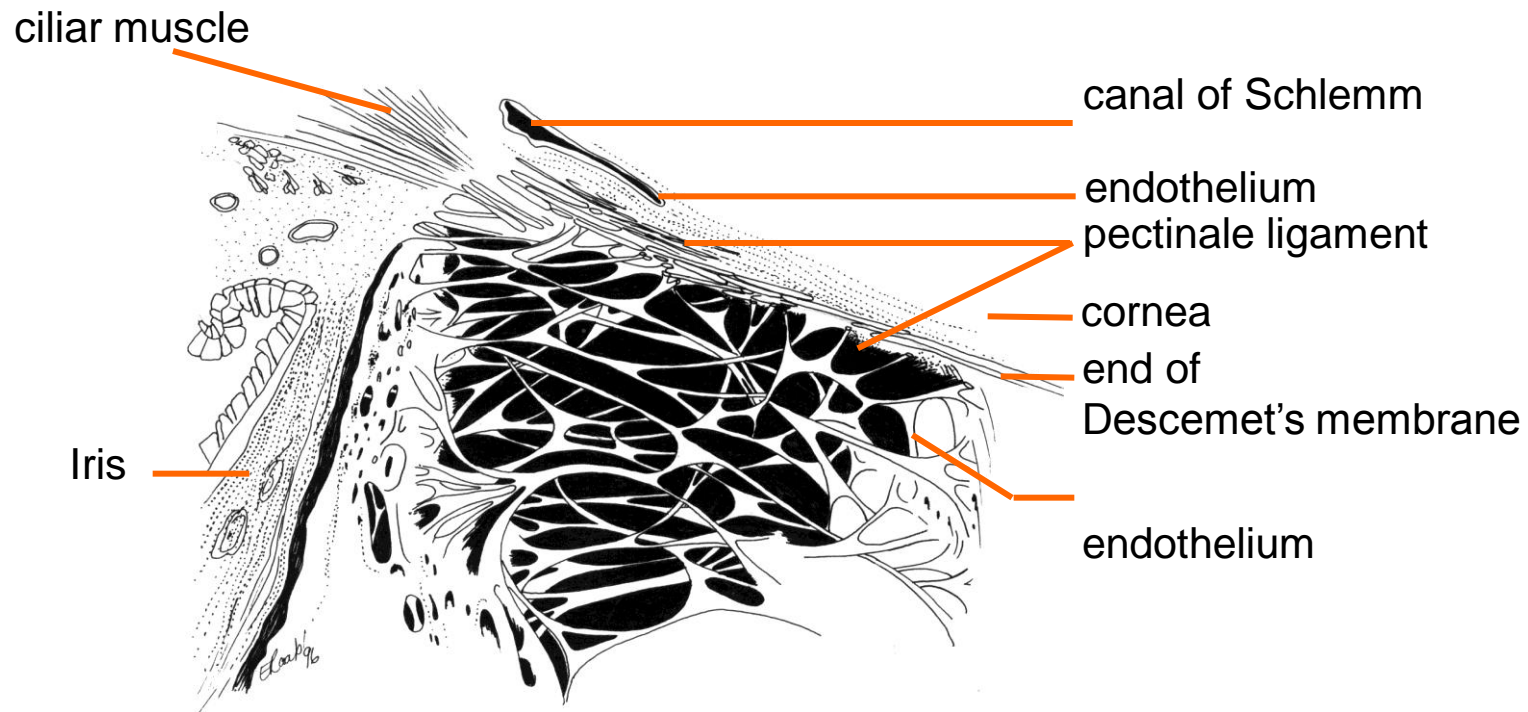
### Consists of (anterior to posterior):

1. Endothelium
2. Stromal layer
3. Vessel layer
4. Smooth muscle layer
5. Pigmented epithelium layer

# The iris angle

- Meeting of the iris, ciliary body, scleral spur and limbus
- Pectinate ligament
- Connective tissue forms loose trabecular meshwork with some spaces lined with endothelium (sinuses)
- Aqueous Humor - drains from these sinuses into canal of Schlemm

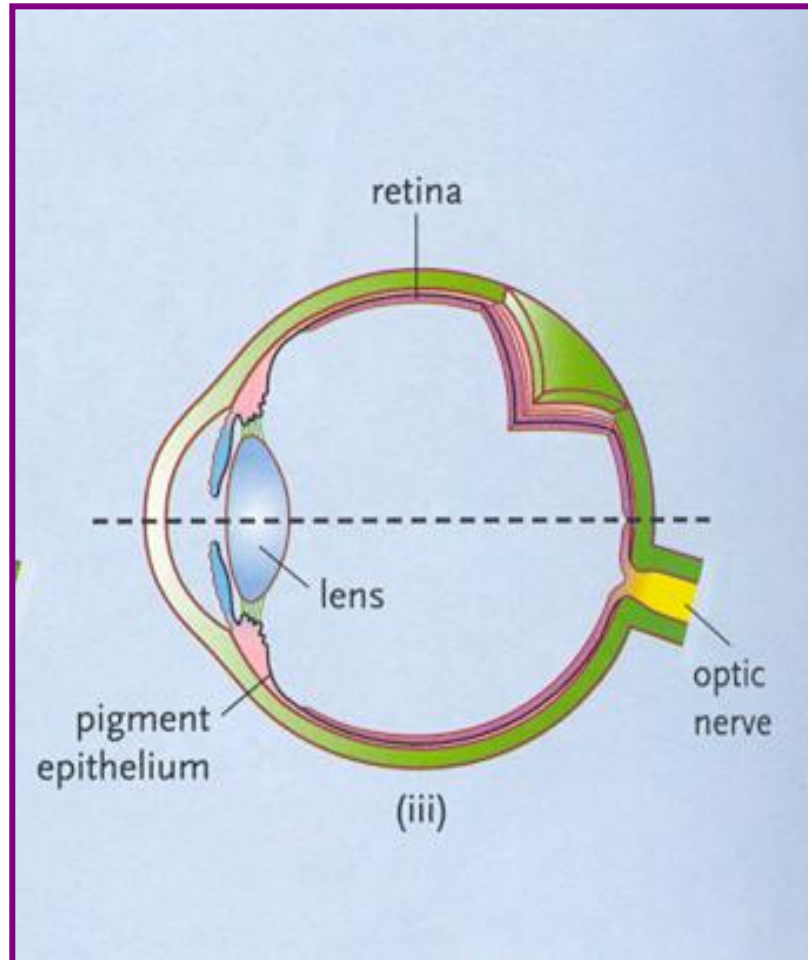
# Iris angle



# Inner layer

(i) retinal layer

(ii) lens



# Lens

- 3 Components:

## Lens capsule

- Resembles a basement membrane
- Serves for implantation of the zonula of the ciliary body on the equator of the lens

## Anterior epithelium

- Cuboidal epithelium

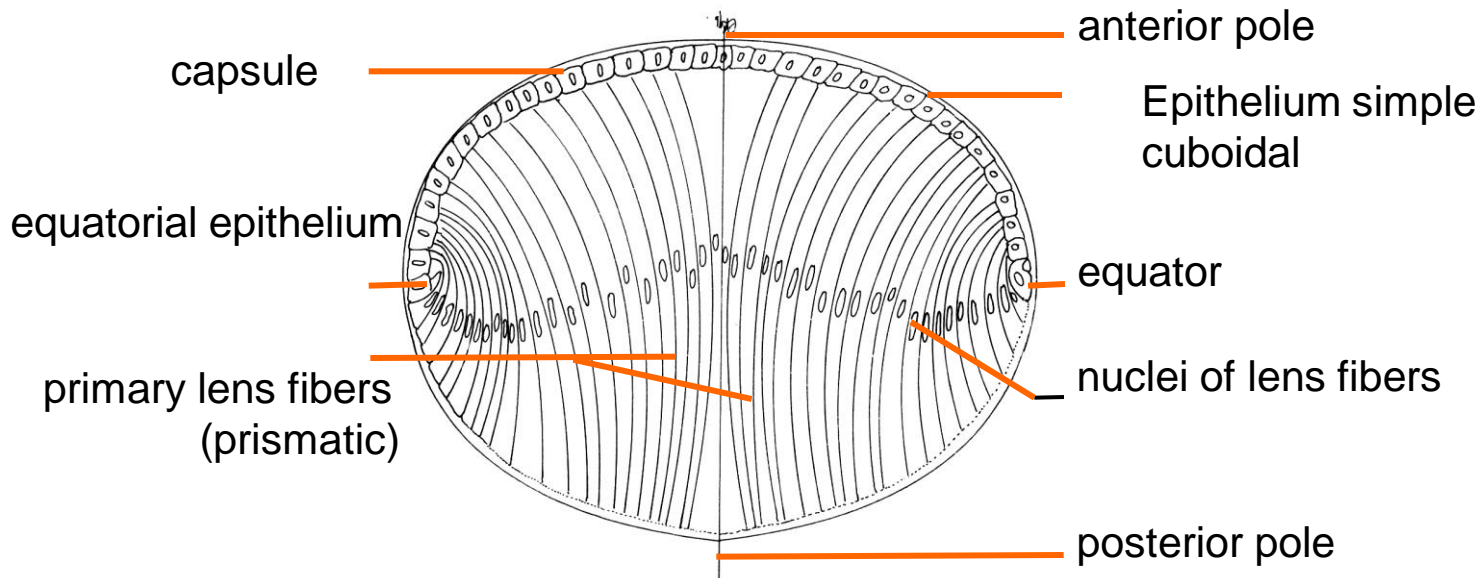
## Lens substance

- Elongated prismatic lens fibers

# Zonula

- Suspensory ligaments of lens
- Consists of filaments and bundles of fibers
- Attached to ciliary body and lens equator

# Lens



# Retina

## Anterior

- Pigmented epithelium (**non-light sensitive**)

## Posterior

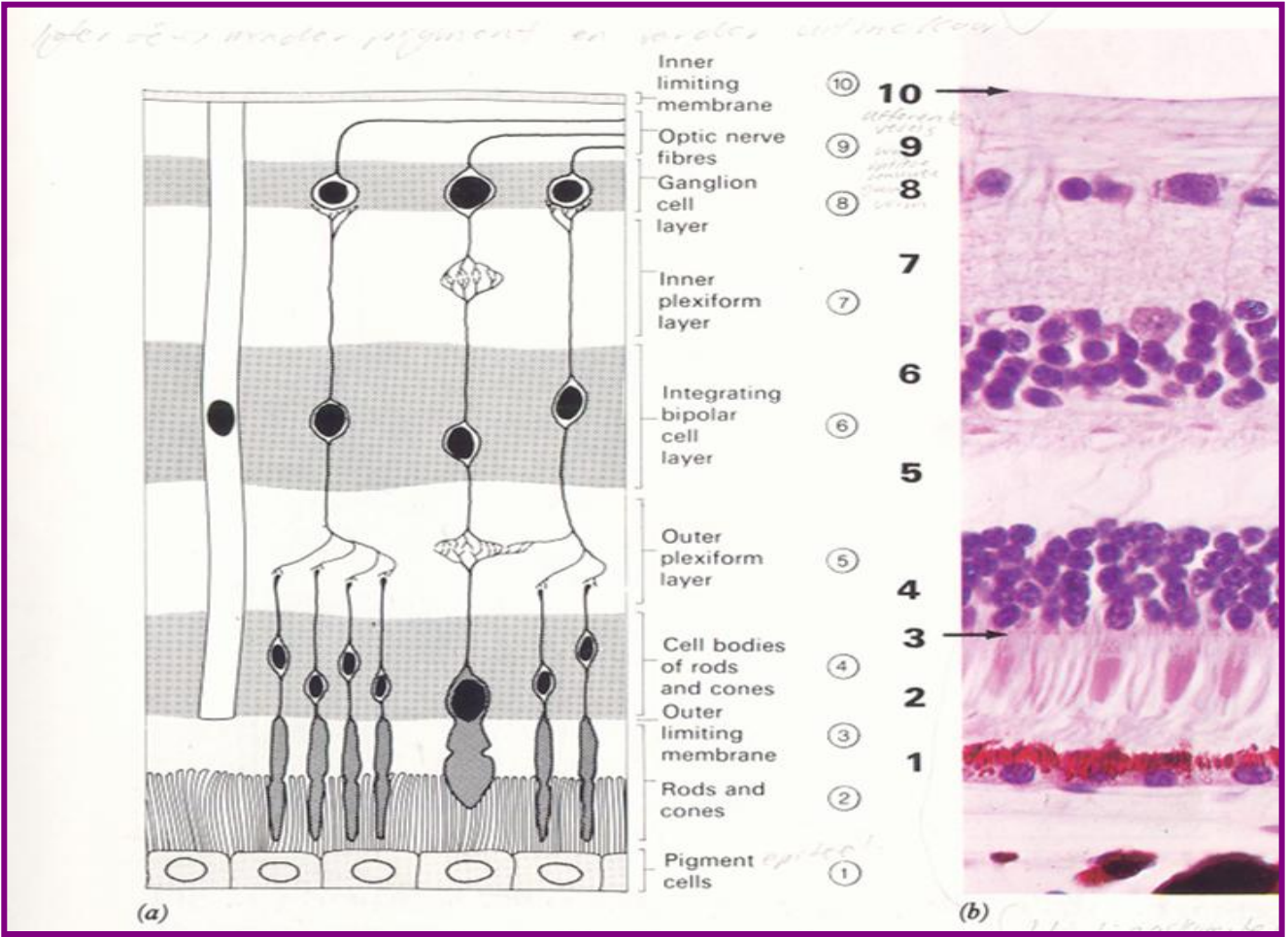
- Neural retina (**light sensitive, photoreceptive organ**)
- Two modification sites:
  - Posterior pole of eye at fovea = macula lutea
  - Optic papilla



# Retina

## 10 Layers

1. Pigmented epithelium
2. Layer of rods and cones
3. External limiting membrane - tight junctions between Müller's cells and photoreceptors



4. Cell bodies of rods and cones (nuclei of photoreceptors)
5. Outer plexiform layer - axons of photoreceptors synapse with bipolar and horizontal cells
6. Integrating bipolar cell layer - nuclei of bipolar cells, horizontal cells, amacrine cells and Müller's cells

7. Inner plexiform layer - axons of bipolar cells, processes of the amacrine cells and dendrites of the ganglion cells
8. Ganglion cell layer - nuclei and cell bodies of multipolar ganglion cells
9. Optic nerve fibers: Axons of the ganglion cells
10. Inner limiting membrane: Terminal endings Müller's cell processes and their basal laminae

# Cells of the region

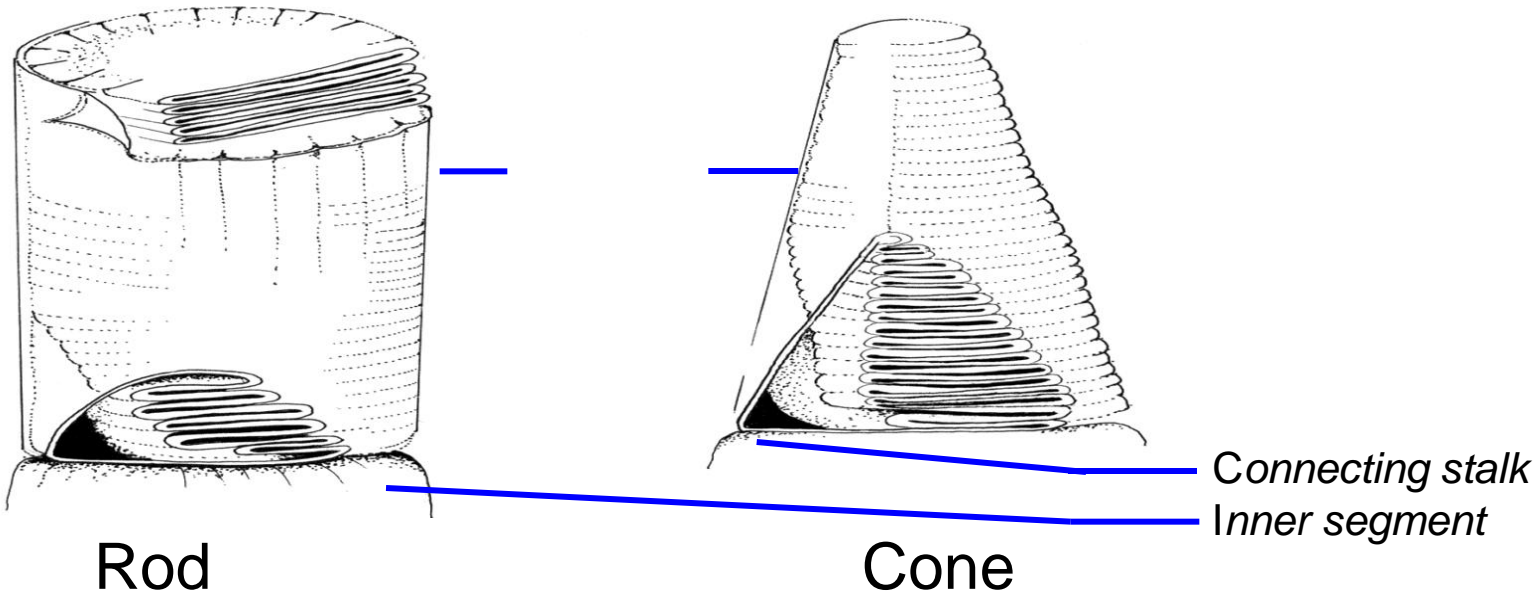
## 1. Pigmented epithelium

- Single layer columnar cells with tight junctions
  - inner surface - microvilli
  - melanin granules
- Function
  - absorption of light
  - prevention of reflection of light
  - responsible for the nutrition of photoreceptors

## 2. First order neurons

### Photoreceptors = rods and cones

- modified dendrites
- 120 million rods
- 7 million cones
- fovea centralis - only cones
- rods function in poor light
- cones function in bright light and responsible for colour observation



Rod

Cone

*Connecting stalk*  
*Inner segment*

## 2a) Rods

Contains rhodopsin or visual purple

- Three parts

### 1. Outer segment

- Elongated and rests against the pigment epithelium
- Light sensitive
- Encapsulated with cell membrane
- Flattened membranous sacs piled in stacks

### 2. Connecting segment

- narrowed connects the outer and inner segments
- modified cilium

### 3. Inner segment

- mitochondria, free ribosomes and Golgi-apparatus



## 2b)Cones

- Structure similar to rods
- Except
  - The outer segment is cone shaped
  - Membranous vesicles are attached to the cell membrane at some places
  - Contains iodopsin

### 3) Second order neurons

- Bipolar neurons
  - Dendrites synapse with the axons of the rods and cones
  - Axons synapse with the neurons of the third order
- Horizontal cells
  - synapse in horizontal plane
  - dendrites synapse with axons of rods
  - axons synapse with axons of cones

## 4) Amacrine cells

- No axons only dendrites
- Connected to bipolar cells and ganglion cells in a horizontal plane

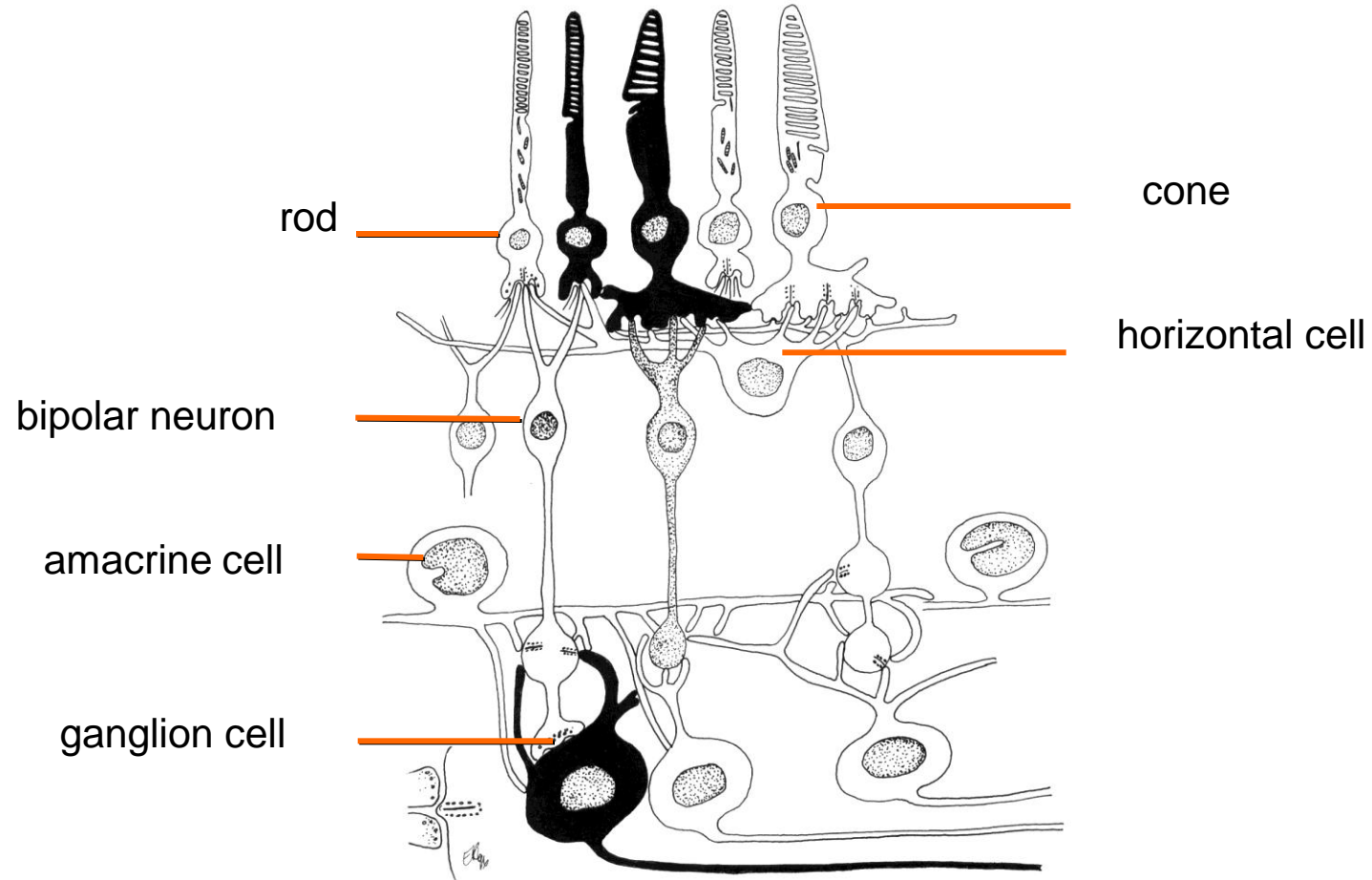
## 5) Third order neuron

- Ganglion cells
  - resemble other ganglion cells

### Axons:

- Unmyelinated
- Along the inner surface of the retina
- Axons come together form optic nerve
- Exiting at the optic disc

# Communication between the three orders of retinal neurons



- Neuroglia: Between the ganglion cells
- Müller's cells: throughout the thickness of retina, type of neuroglia

# Blood supply

## Pigmented epithelium

- No blood vessels
- Diffusion of nutrients from choriocapillary layer

## Layer of axons

- Blood vessels originate from central artery that enters eye through optic nerve
- Also supplies other layers of the retina

# Optic nerve

- Axons from retina
- Congregate at optic disc
- Turn outwards
- Runs through the *lamina cribrosa* as optic nerve
  
- The nerve fibers are unmyelinated, arranged into bundles and surrounded by neuroglial processes before they enter the lamina cribrosa.
  
- After cribrosa nerve fibers acquire myelin sheaths



# Accessory structures:

## Conjunctiva

- Transparent mucosal membrane covering eyeball (*bulbar conjunctiva*) that continues on inner surface of eyelid

### Epidermis

- 3 layers stratified columnar epithelium that changes at the eye margin to stratified squamous epithelium and then joins the epidermis of the skin

### Lamina propria

- Delicate loose connective tissue with infiltrated lymphocytes

# Eyelids

**Anterior surface:** Thin skin, fine hair, sebaceous/sweat glands

## Border of the eyelid

- Meibomian glands: Large sebaceous glands from tarsal plate
- Hair follicles arranged in 3-4 rows
- Glands of Zeiss: Sebaceous glands of hair follicles
- Glands of Moll: Modified sweat glands (large lumen)

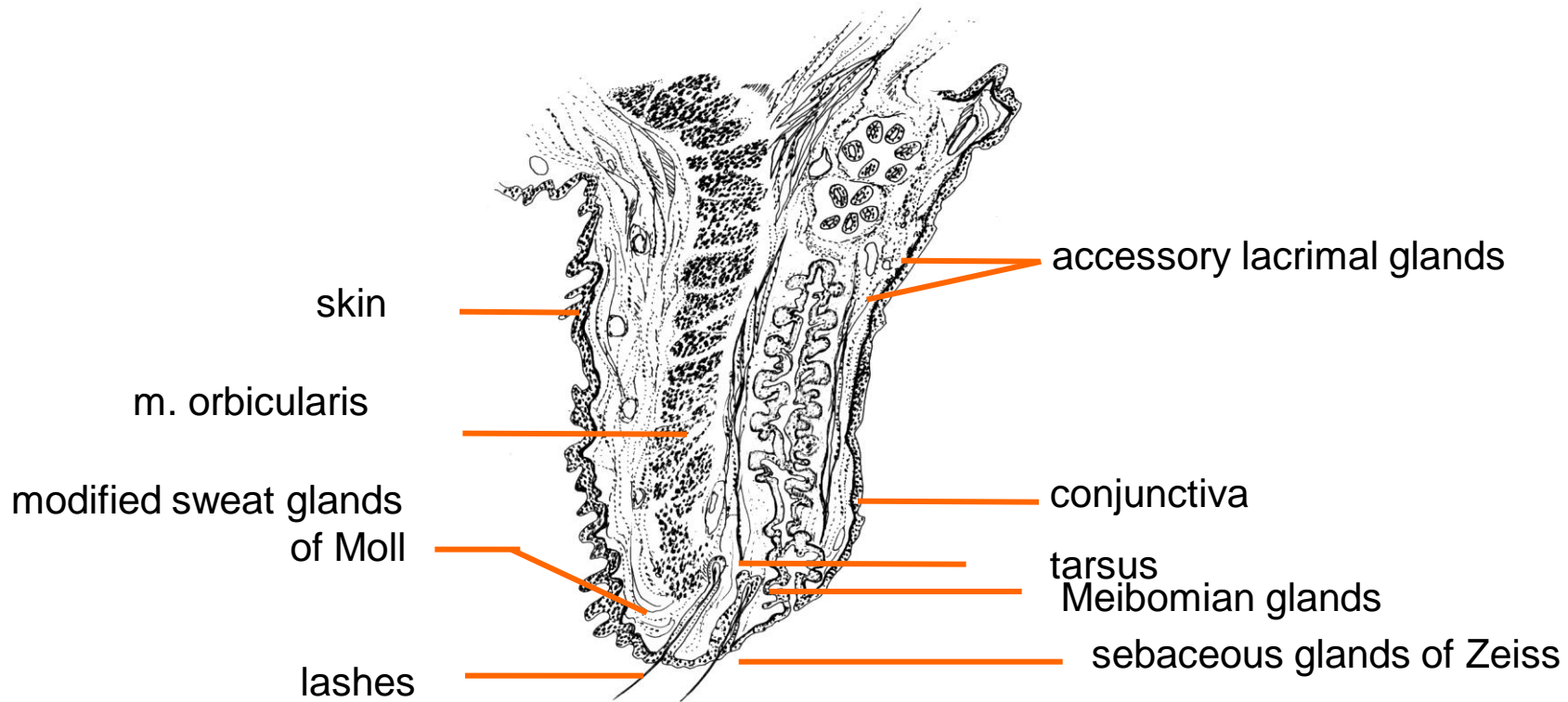
Dermis: Loose structure

Tarsal plate (tarsus): Dense connective tissue (firmness)

Skeletal muscle: (*orbicularis oculi*)

**Posterior surface:** Unkeratinized stratified squamous epithelium changing to stratified columnar epithelium that rests on thin connective tissue layer

# Eyelid



# Lachrymal gland (tear secreting)

- In superolateral angle of orbit
- Opens via +/- 12 secretory ducts
- Serous compound tubulo-alveolar glands
- Glands of Krause: Accessory lachrymal glands
- Function of secret  
– Keeps the eye moist  
– Is bactericidal  
– Fluid that flushes foreign bodies from eye

# Lachrymal gland

