

Vision I

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Course News

Coffee Hour

Tuesday (Oct 16)
9:30-10:30am

Surdyks Café in Northrop Auditorium

Stop by for a minute or an hour!

Course News

Review Session with Dr. Riedl

Tuesday (Oct 16)
4:00-5:00pm

in MCB 3-146B (the main lab room)

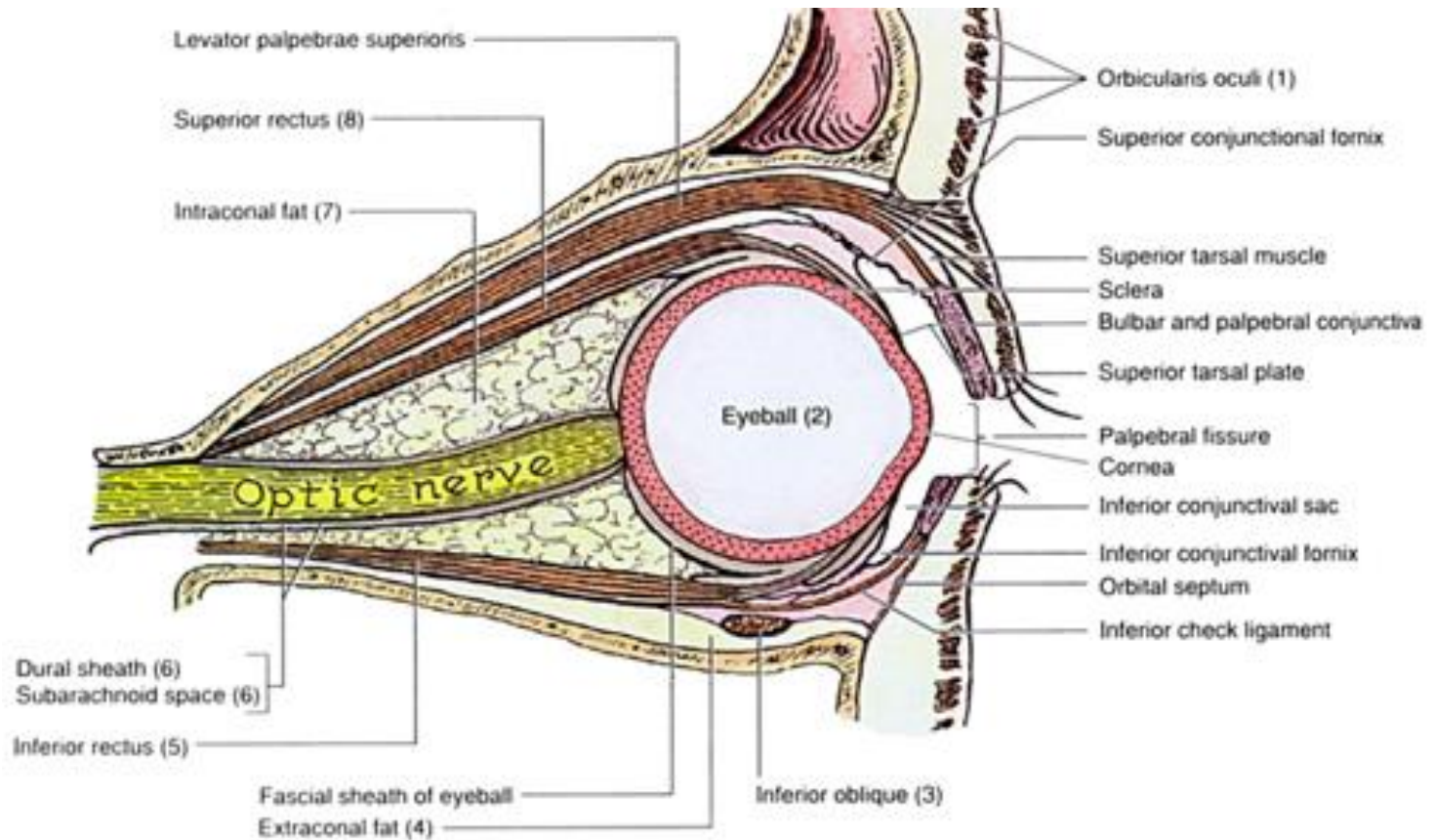
Eye

- Cornea
- Sclera
- Conjunctiva



Eye

- The conjunctiva lines the inner surface of the eyelids and outer surface of the sclera.



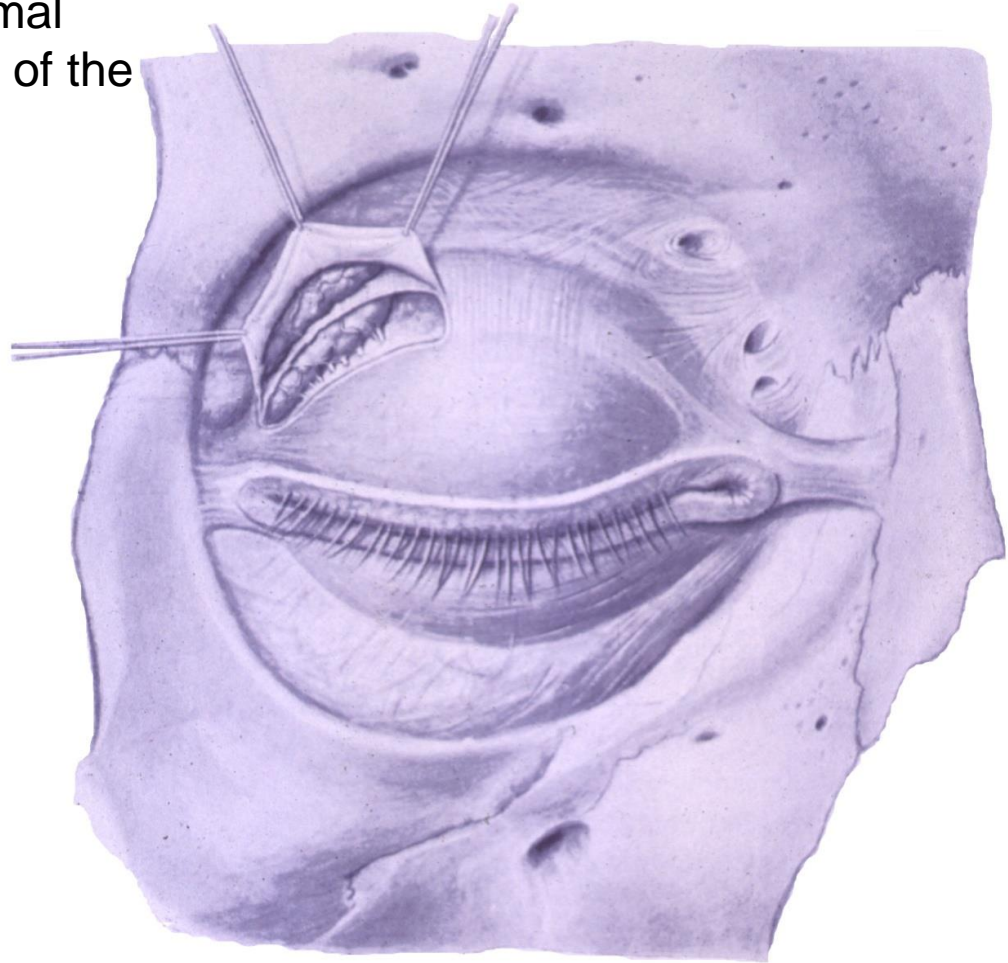
Eye

- Conjunctivitis (pink eye) is inflammation of the conjunctiva and is usually associated with an infection.



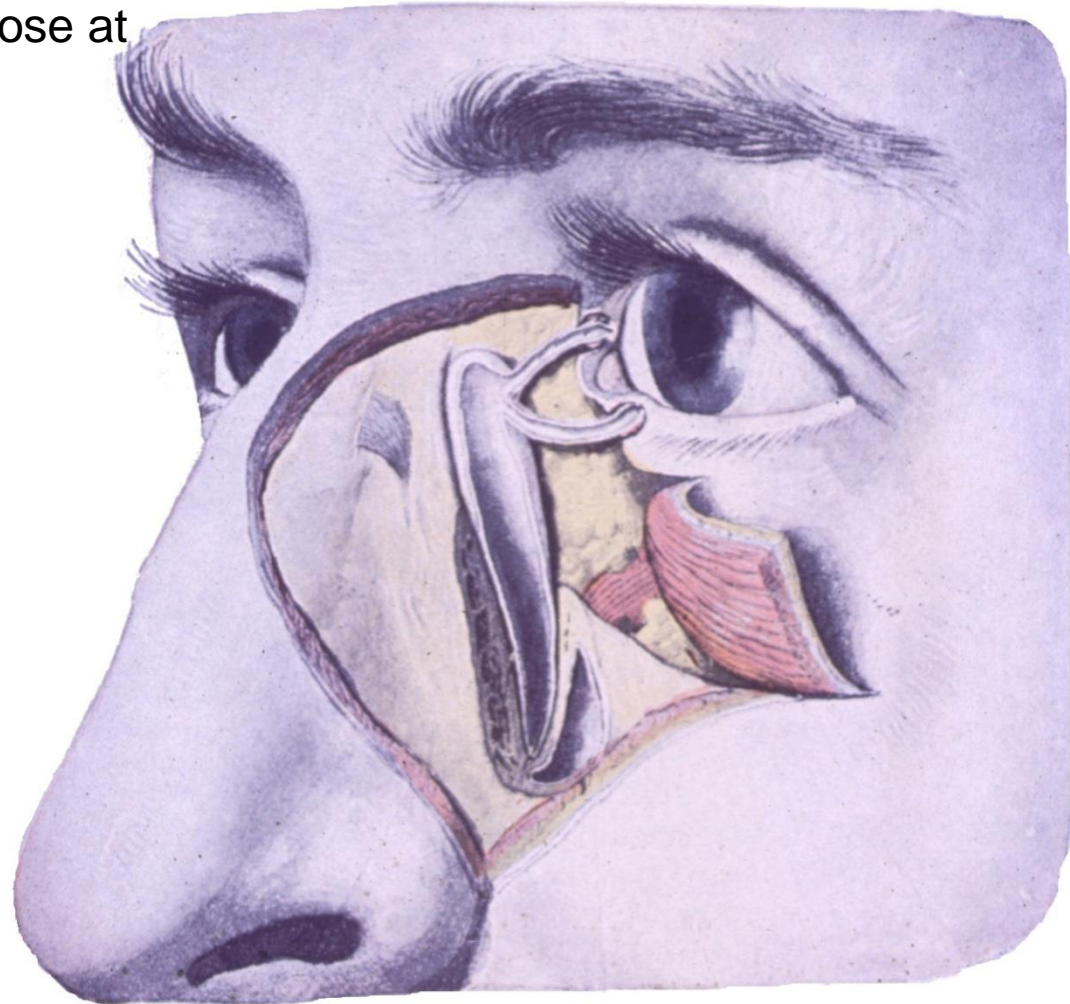
Eye

- The lacrimal gland secretes lacrimal fluid (tears) that keep the surface of the conjunctiva and cornea moist.



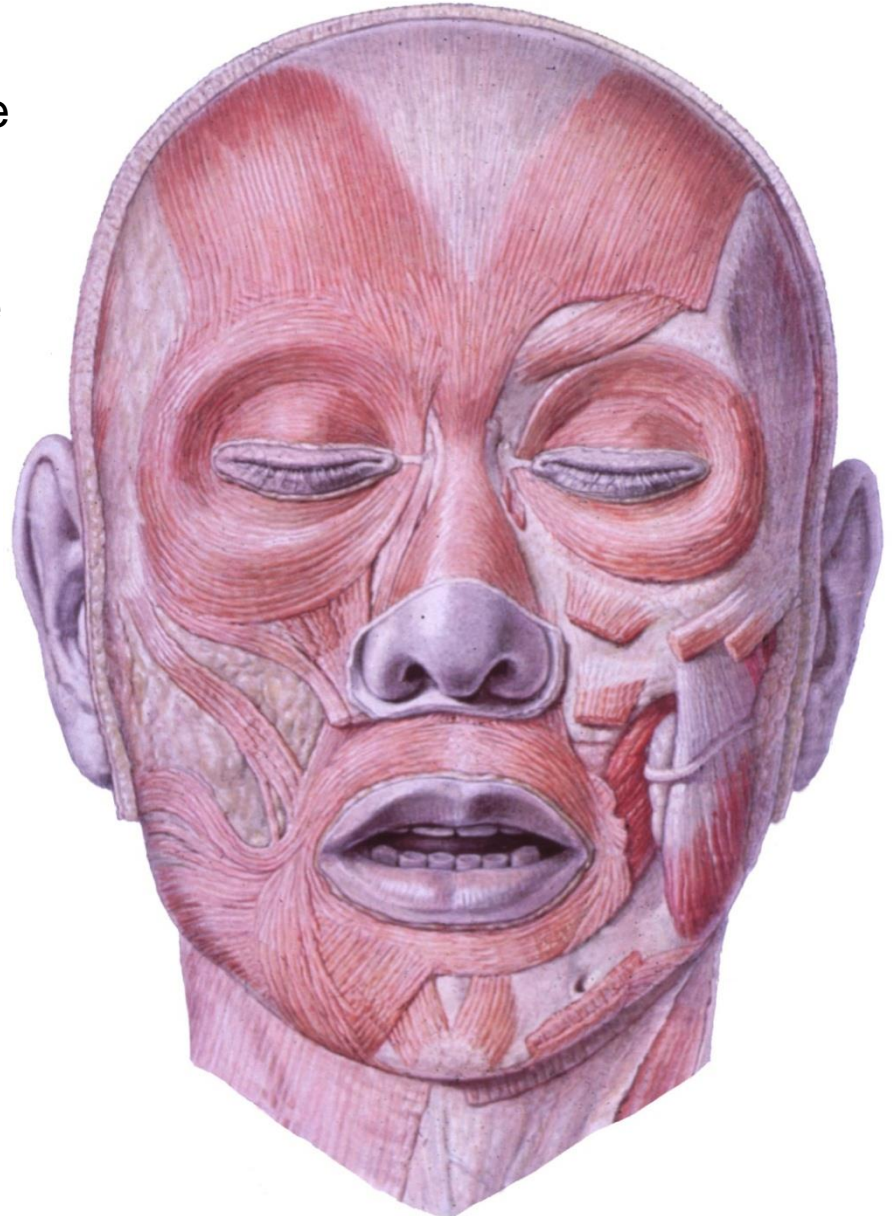
Eye

- Lacrimal fluid drains into the nose at the medial corner of the eye.



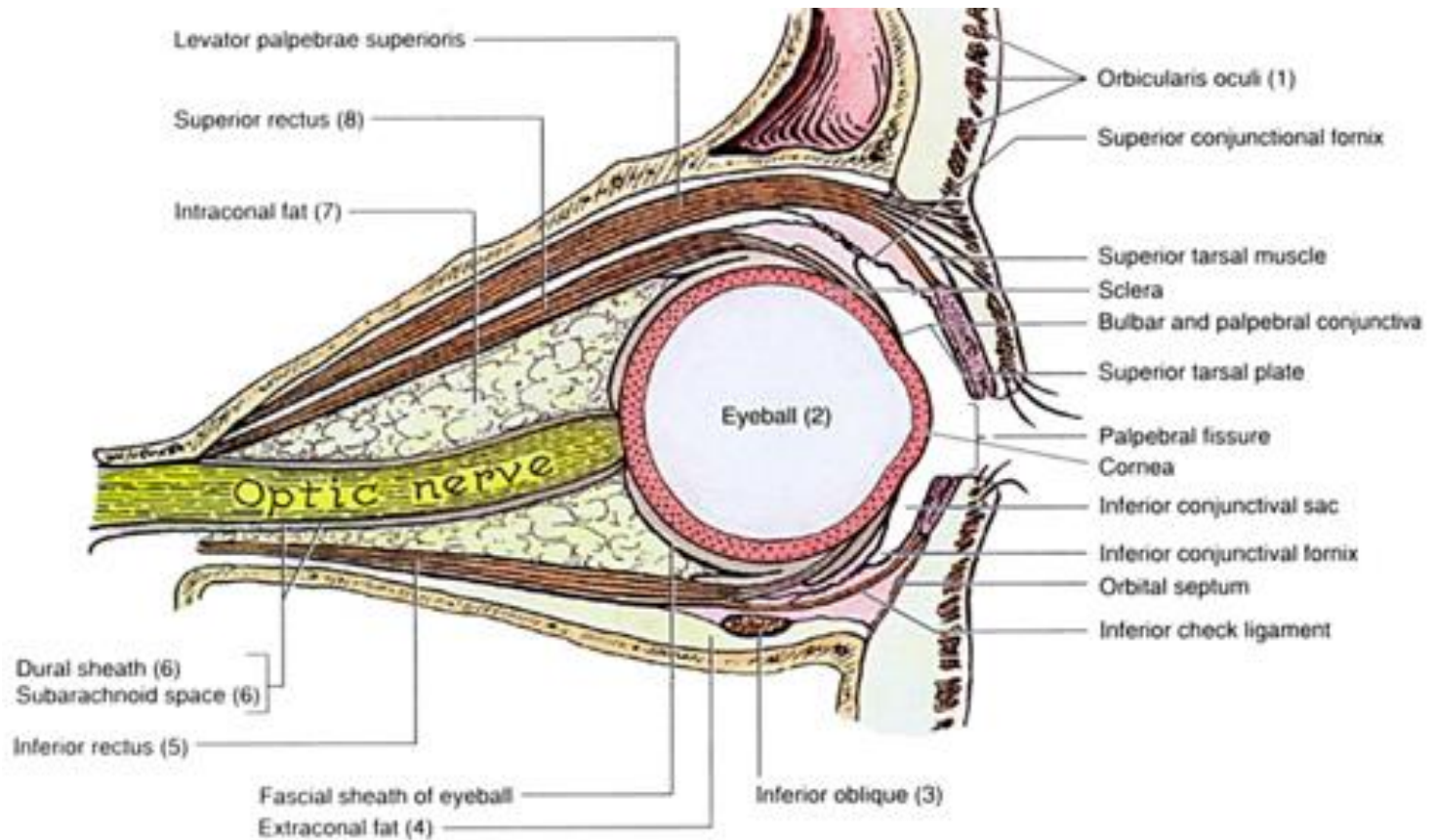
Eye

- Tears are swept across the eye by the closing of the eyelid.
- The eyelid is closed by muscles in the eyelid innervated by the facial nerve (CN VII).



Eye

- The eyelid is opened by a muscle inside the orbit that is innervated by the oculomotor nerve (CN III).



Eye

- Iris
- Pupil
- Lens

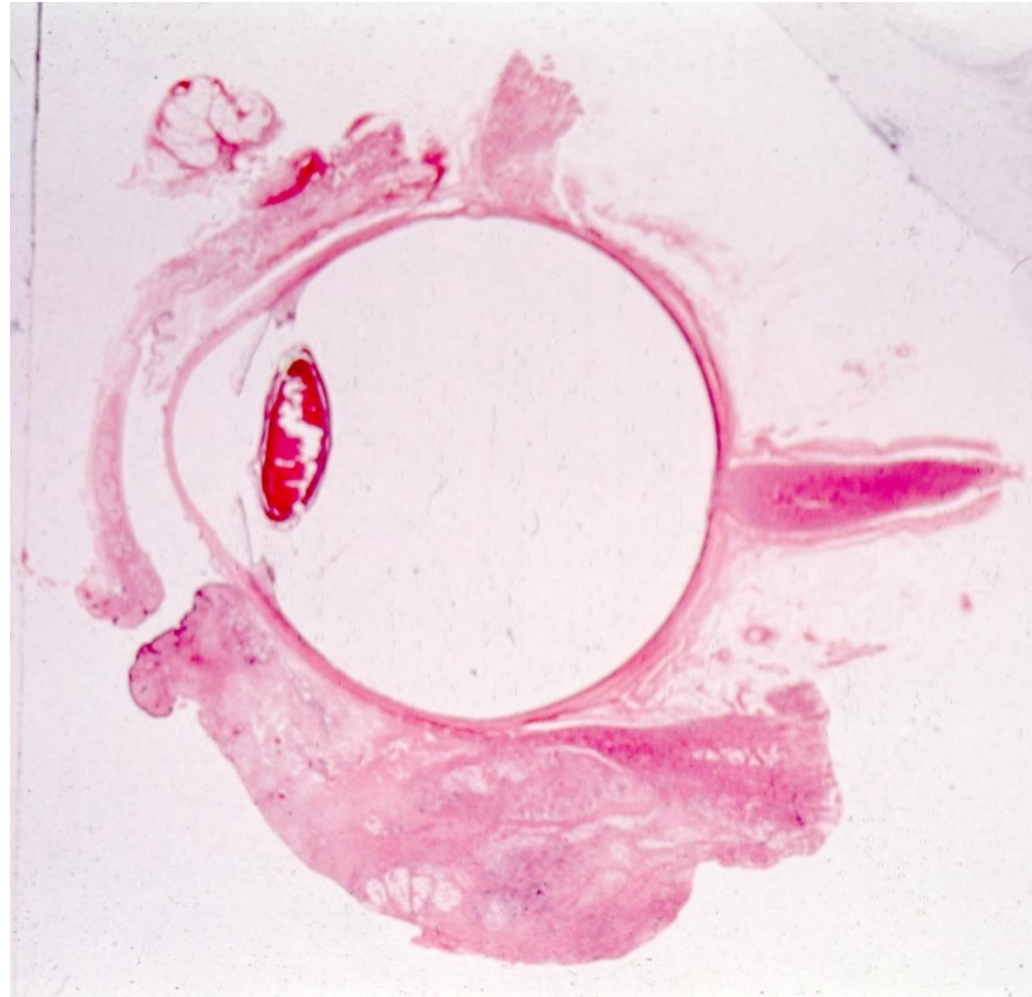


Eye

- Cornea – main focusing element
- Iris – regulates amount of light
- Pupil – hole in the iris
- Lens – fine focuses
- Ciliary body – suspends lens

- Vitreous chamber
- Vitreous humor

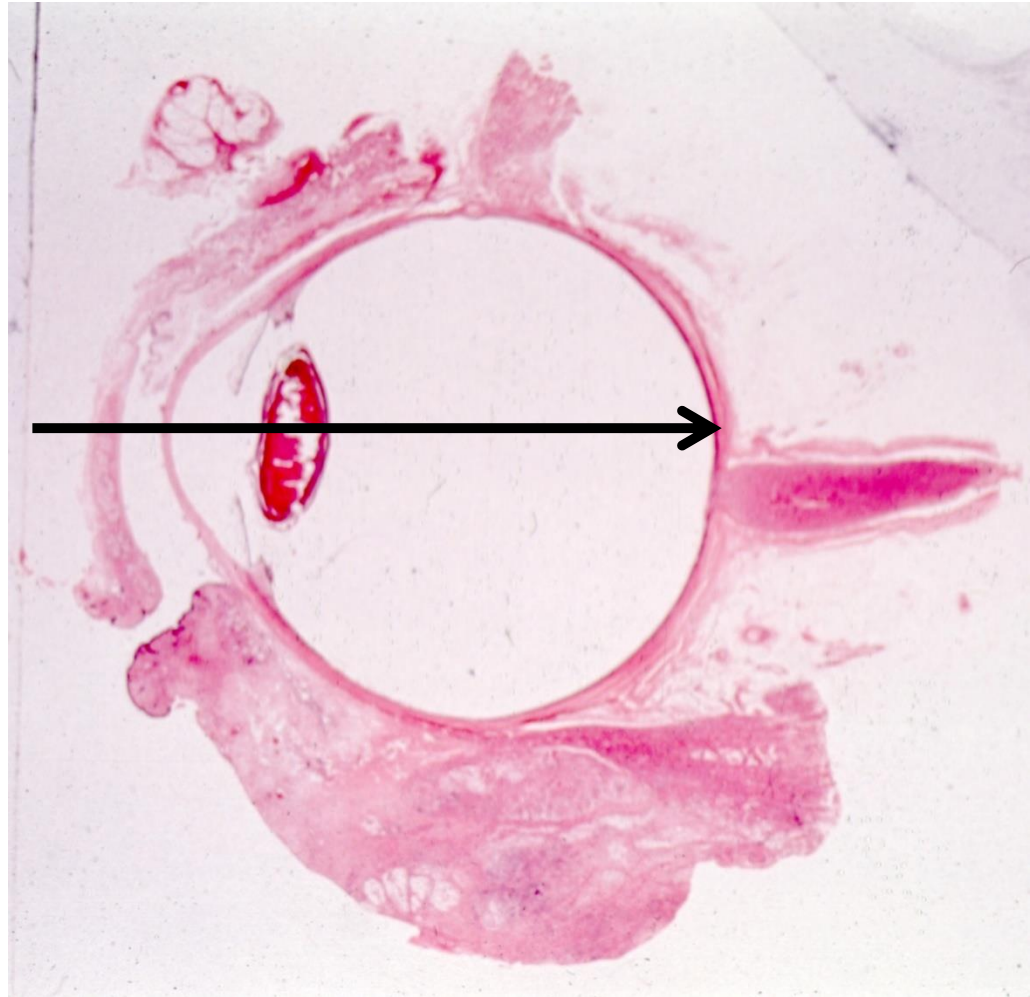
- Anterior & posterior chambers
- Aqueous humor – continuously made by the ciliary body, maintains intraocular pressure, drains via canals into the blood (glaucoma)



Eye

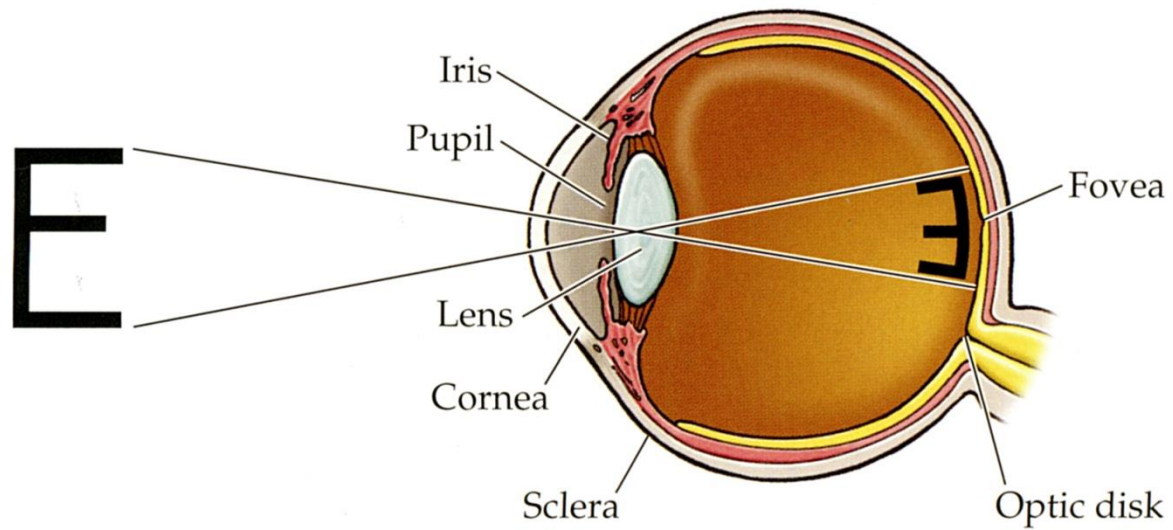
Path of light:

- Cornea
- Anterior chamber
- Pupil
- Posterior chamber
- Lens
- Vitreous chamber
- Retina



Eye

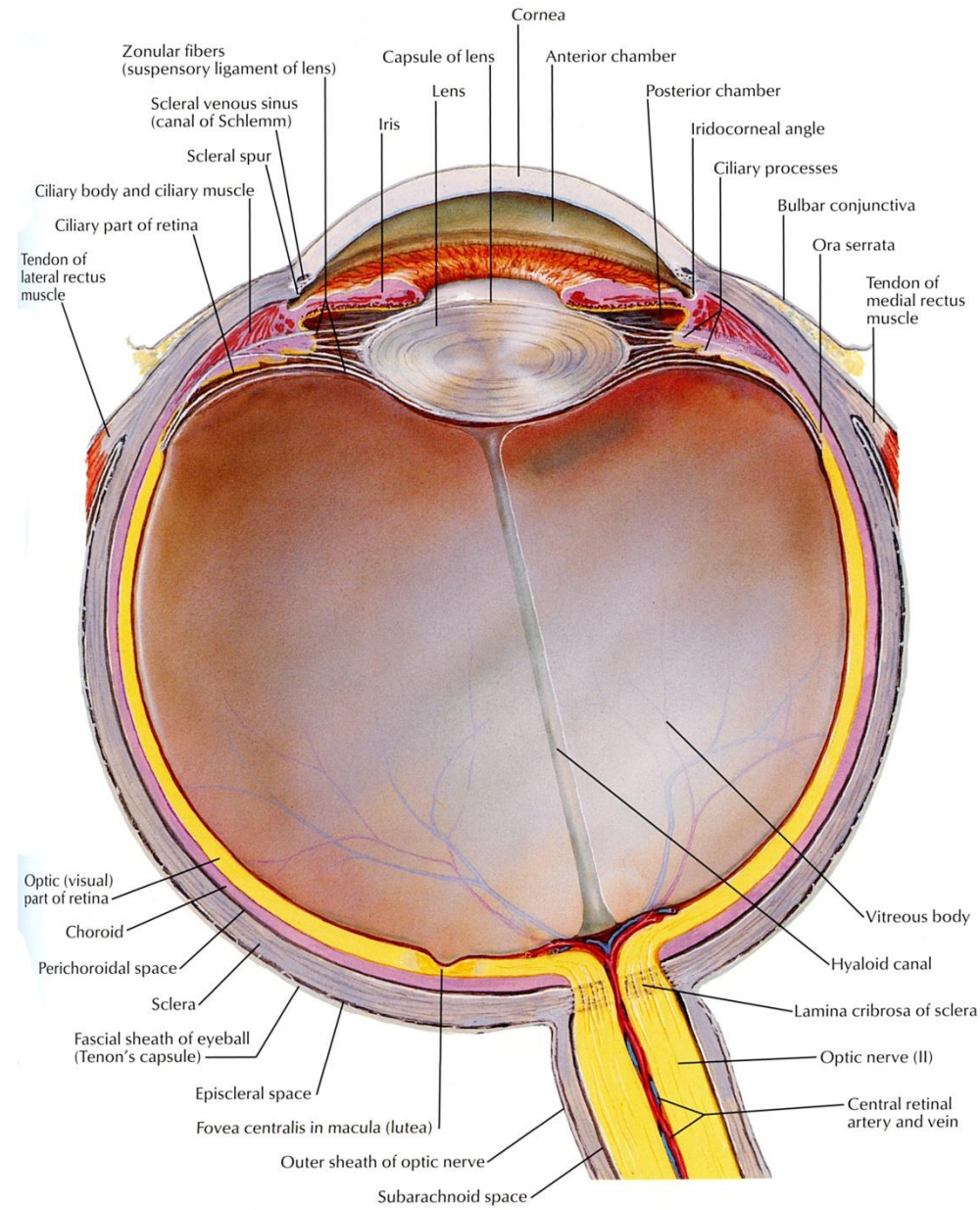
- The lens inverts and mirrors the image on the retina.



Eye

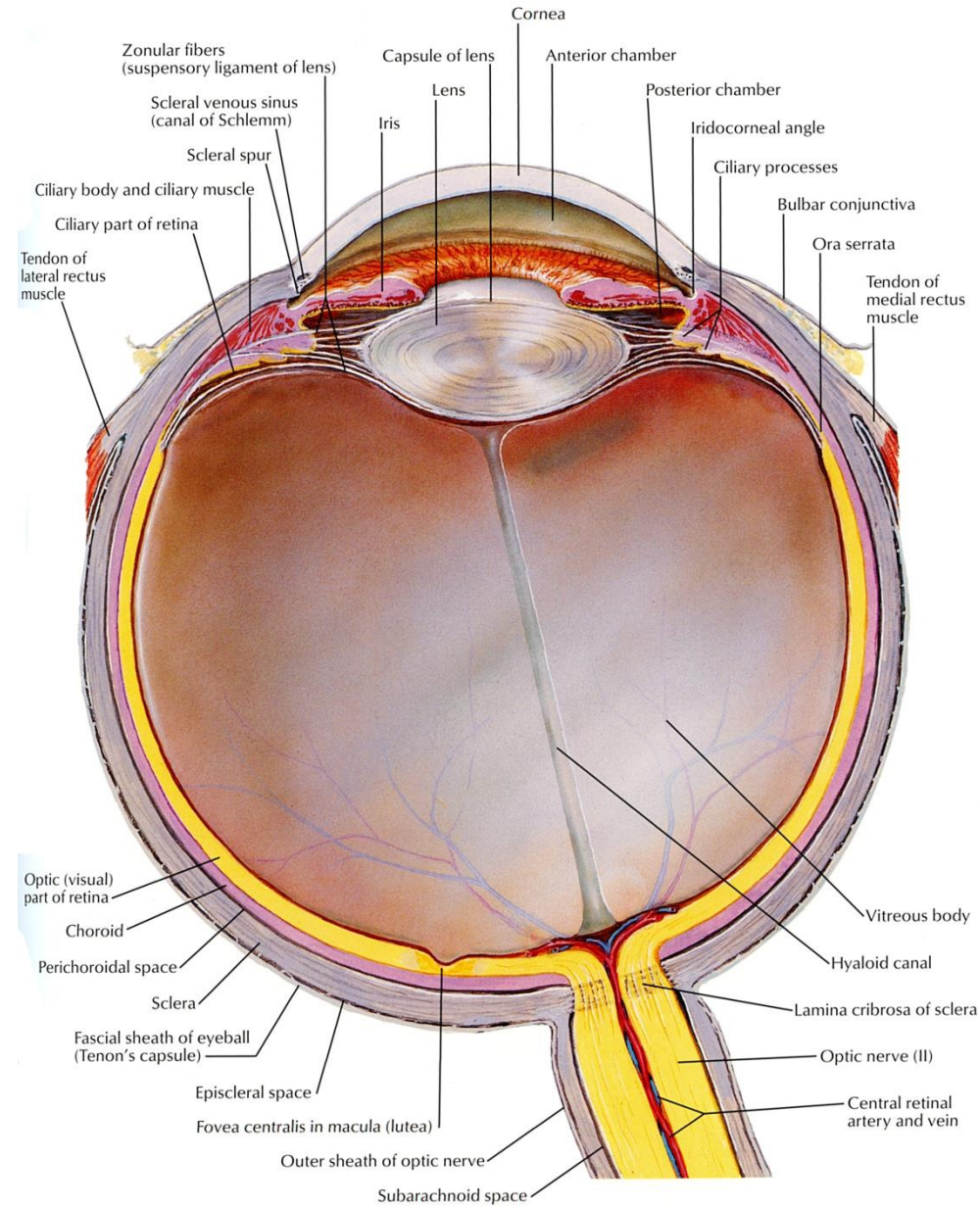
Three layers of the eye:

- Outer
 - Cornea
 - Sclera
(continuous with dura)
- Middle
 - Iris
 - Ciliary body
 - Choroid
(continuous with pia/arachnoid)
- Inner
 - Retina
(continuous with optic nerve & brain)

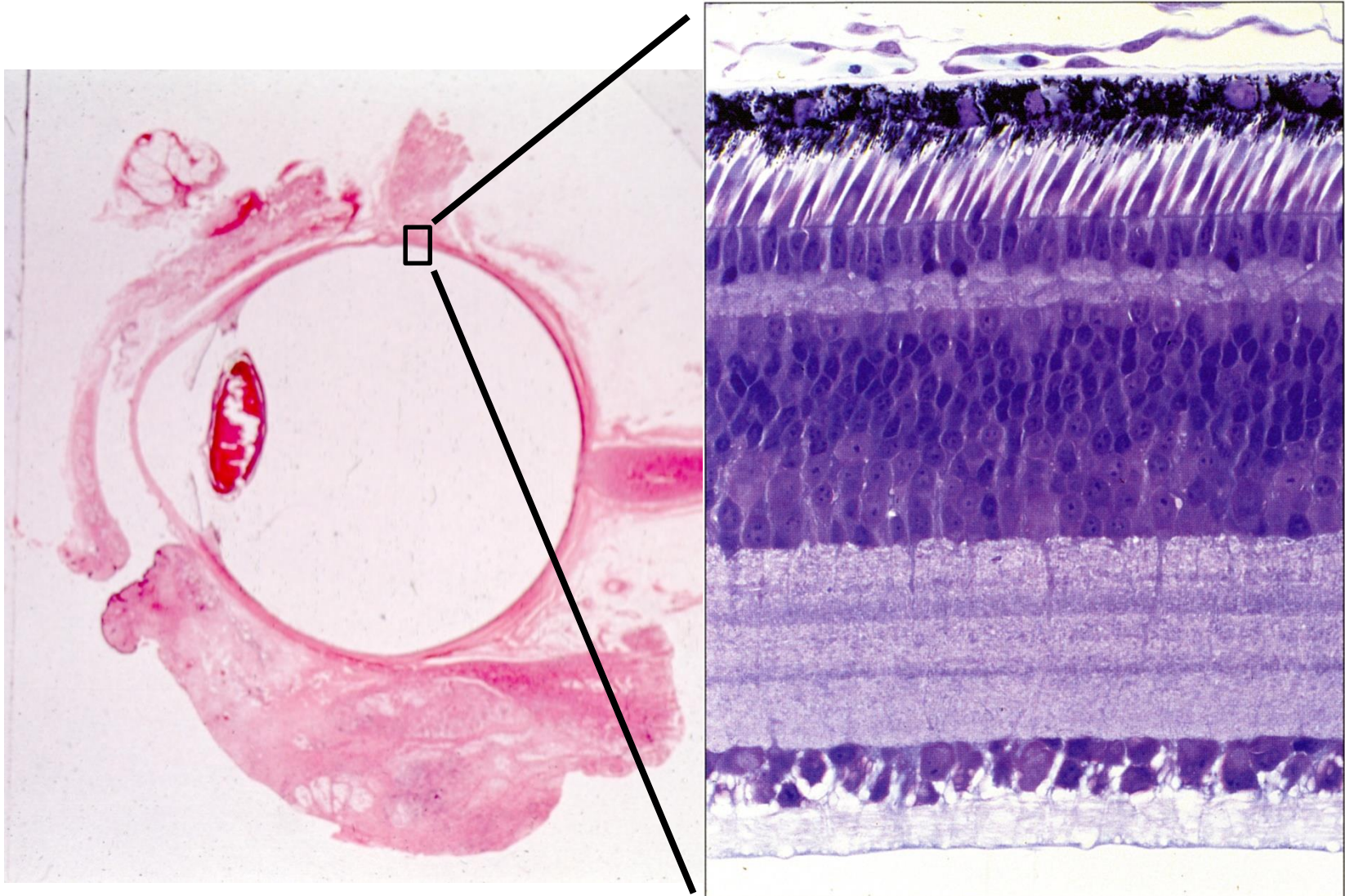


Eye

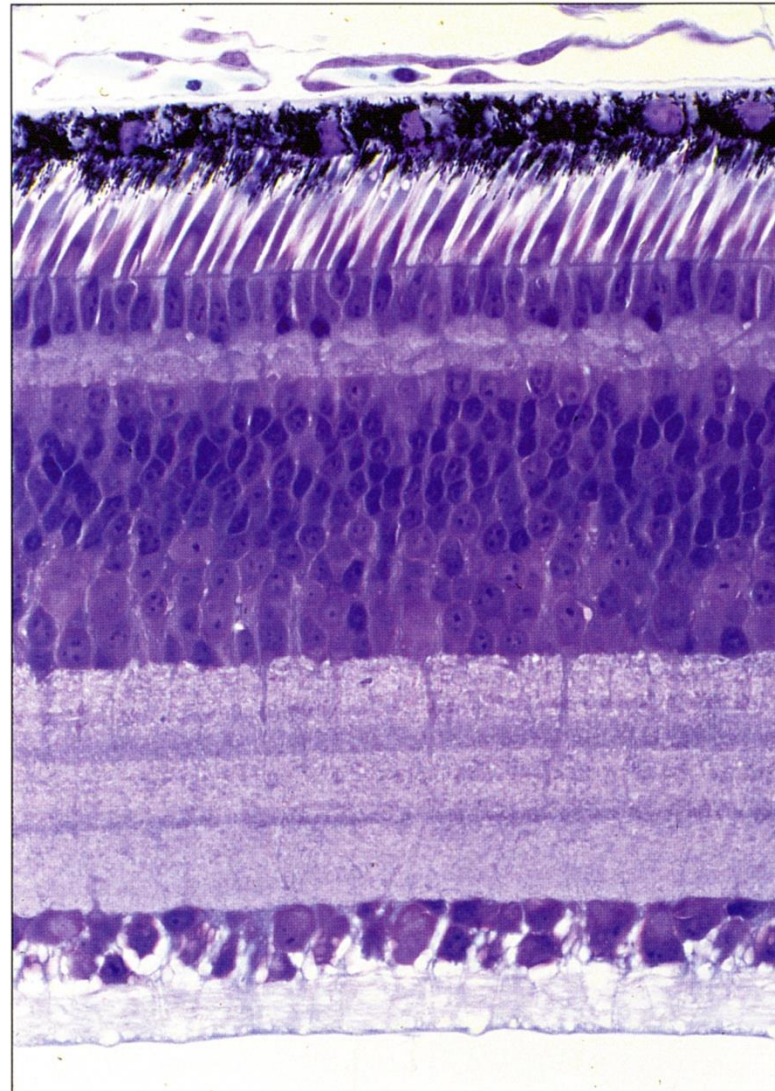
- Iris
 - Iris (pupil) dilator muscle
 - Iris (pupil) sphincter muscle
 - Pigment cells
- Ciliary body
 - Suspends lens
 - Ciliary muscle for near focus of lens
 - Makes aqueous humor
- Choroid
 - Highly vascularized



Retina



Retina



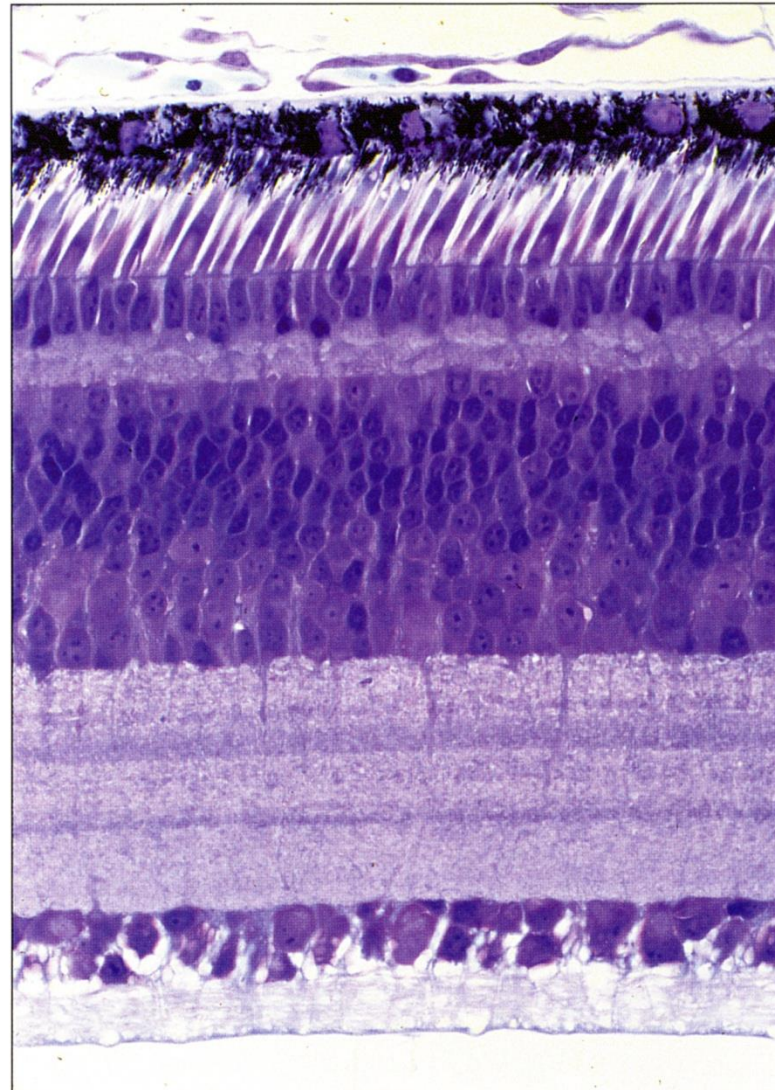
retinal pigment epithelium (RPE)

outer nuclear layer

inner nuclear layer

ganglion cell layer

Retina



retinal pigment epithelium (RPE)

inner & outer segments
(receptor apparatus)

outer nuclear layer

outer plexiform layer

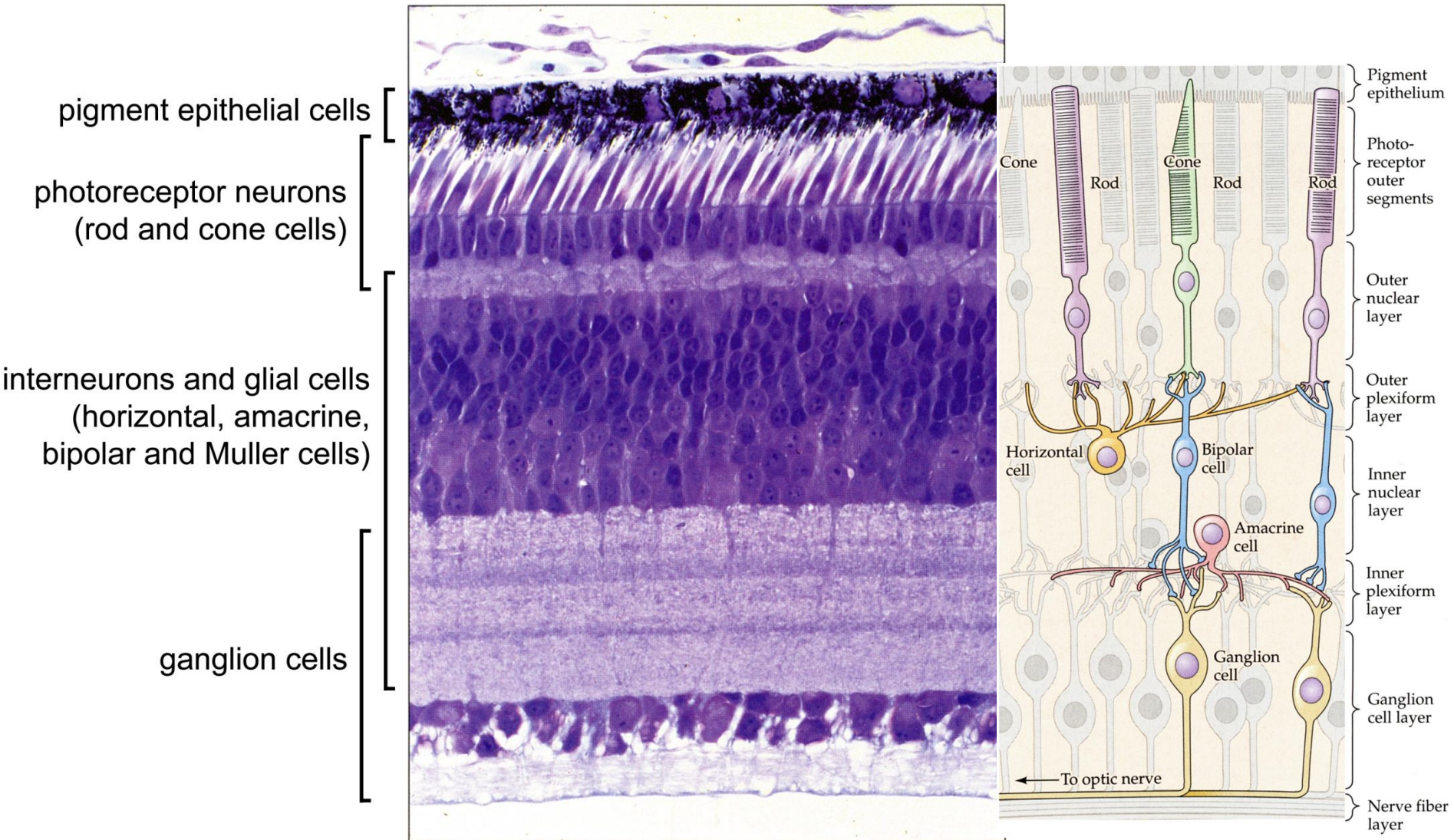
inner nuclear layer

inner plexiform layer

ganglion cell layer

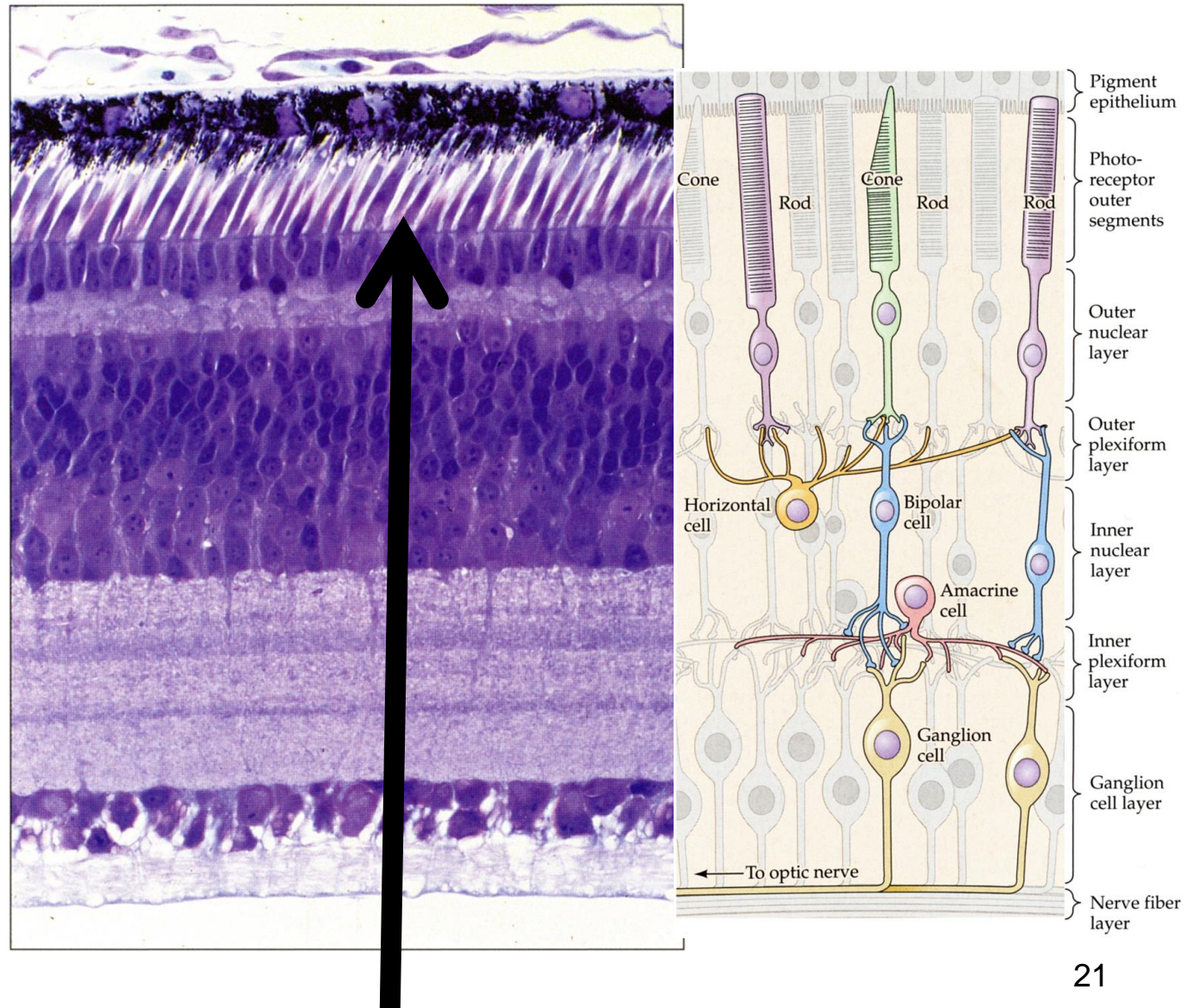
optic fiber layer
(axons of ganglion cells)

Retina



Retina

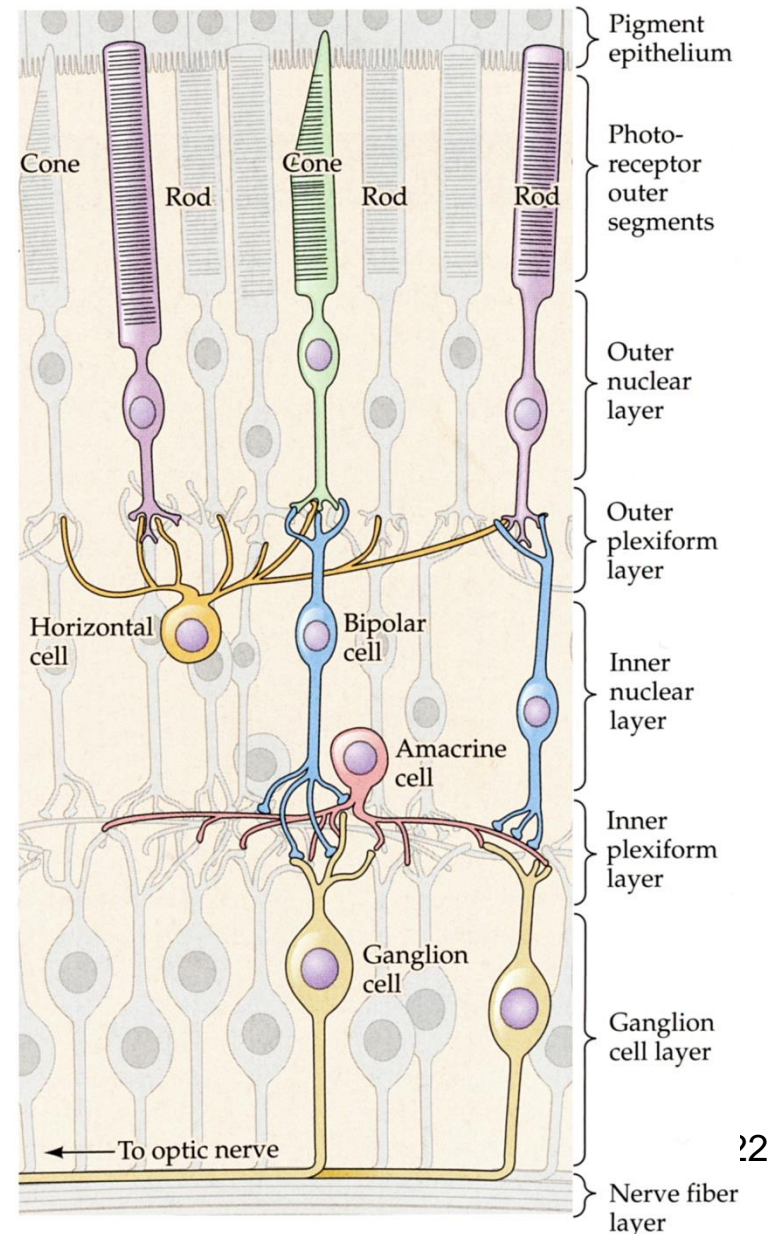
The path of light through the retina



Photoreceptor Cells

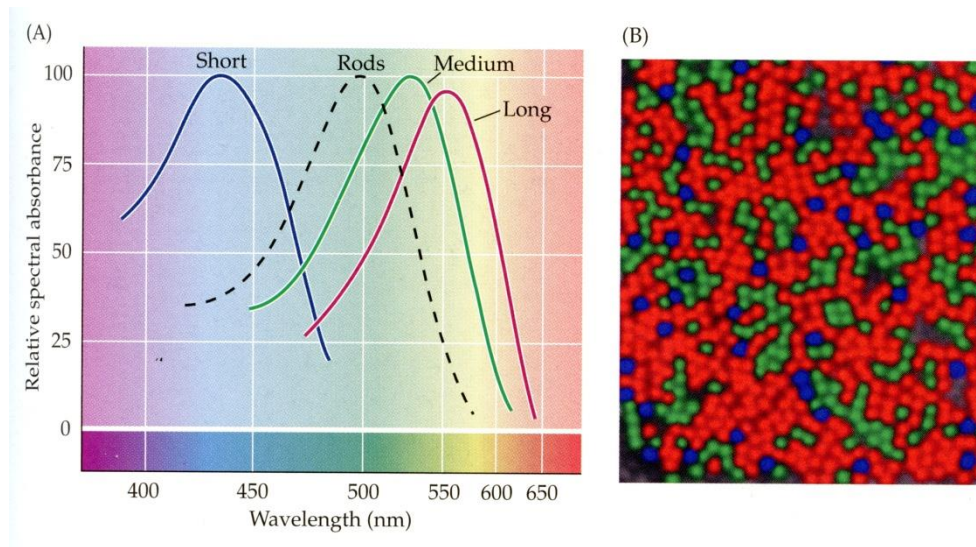
Two types of photoreceptor cells:

- Rods:
 - Most sensitive in low light
 - Important for motion detection
- Cones:
 - Most sensitive in bright light
 - Color sensitive
 - Important for high acuity vision



Photoreceptor Cells

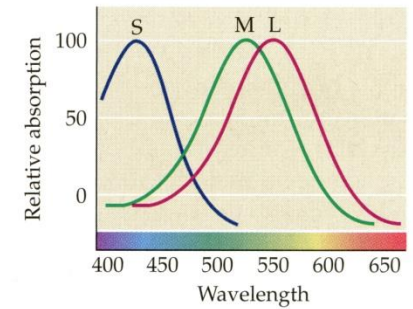
- Opsins are light sensitive proteins in photoreceptors; opsins bind retinal, which is a vitamin A derivative.
- Different opsins are sensitive to different wavelengths of light.
- There are three types of cone cells, each with a different opsin and sensitive to a different wavelength.
- Rhodopsin is the light sensitive protein in rod cells.



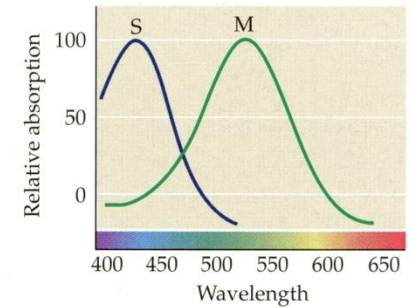
Photoreceptor Cells

- 8% of men and somewhat fewer women are color blind.

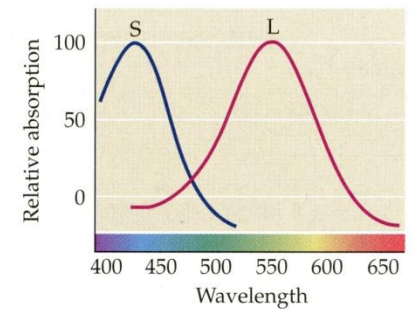
(A) Normal (trichromat)



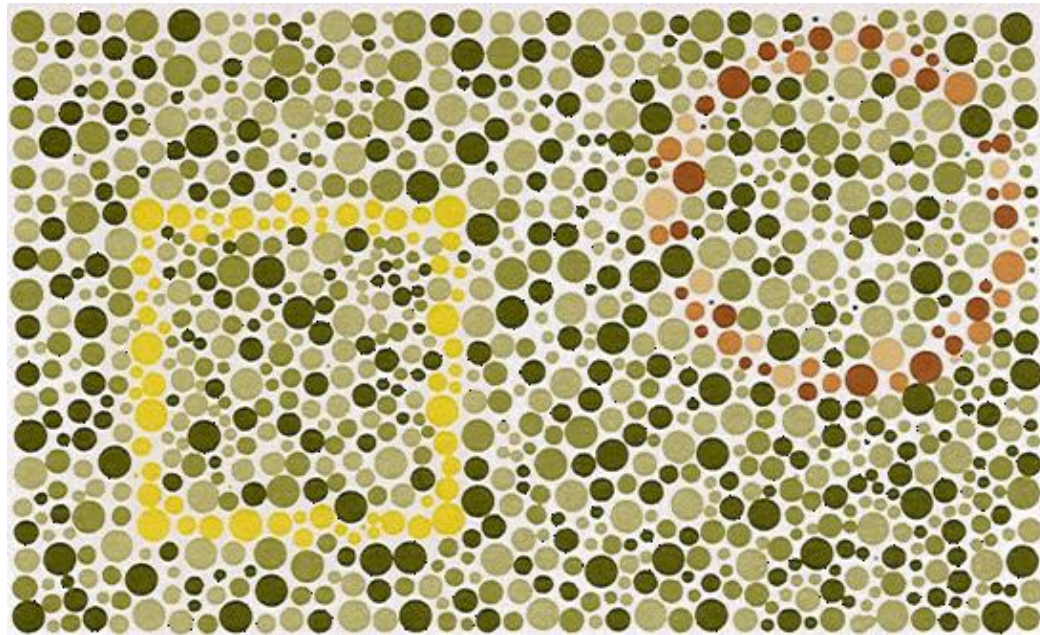
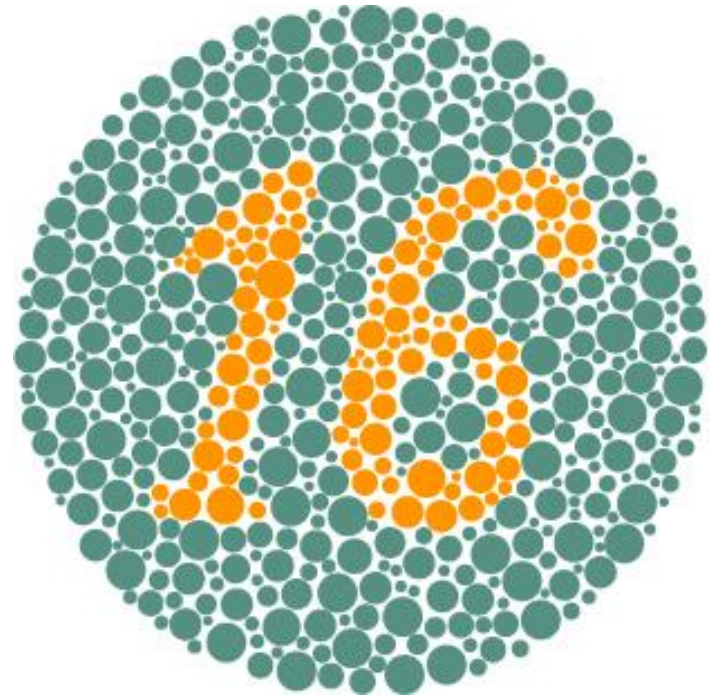
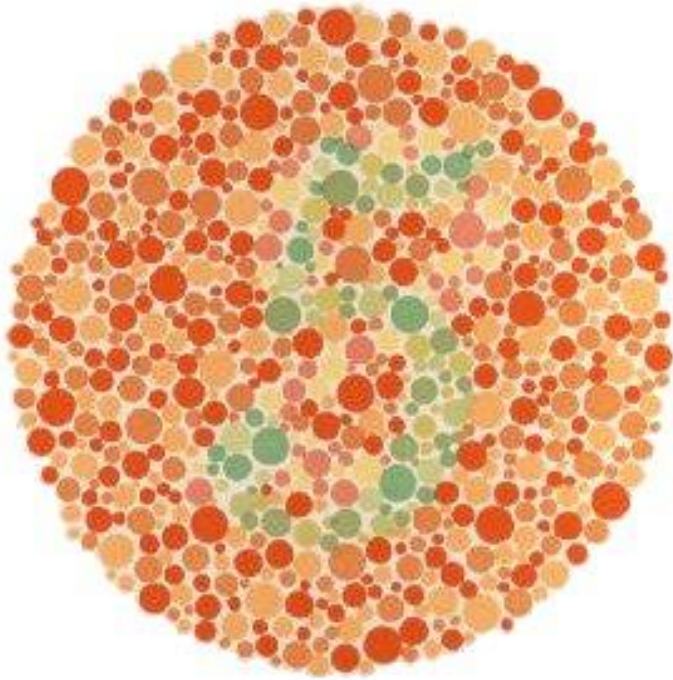
(B) Protanopia



(C) Deuteranopia



Ishihara Color Vision Test



Photoreceptor Cells

Night vision:

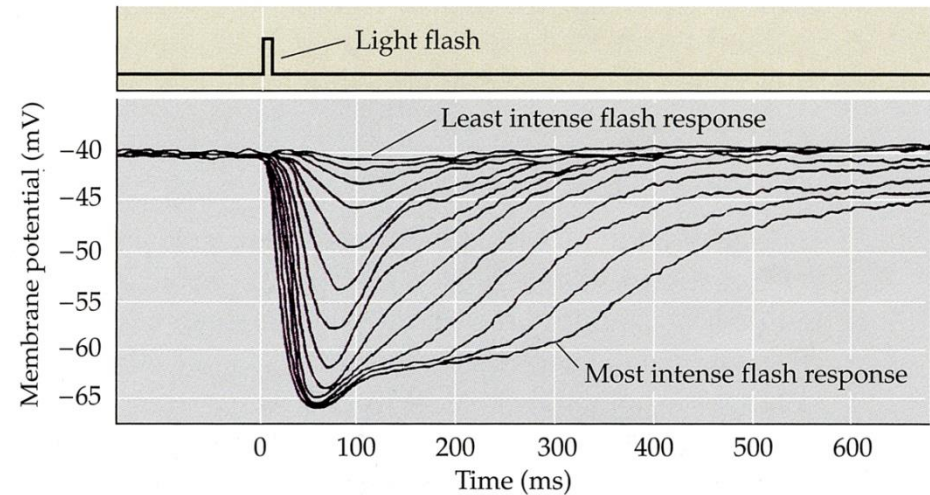
- Rhodopsin is required for night vision.
- Vitamin A is required for synthesis of rhodopsin.
- Vitamin A deficiency can result in night blindness.
- The mineral zinc is needed for transport of vitamin A, and zinc deficiency can exacerbate night blindness.
- Food high in vitamin A:
 - liver ***
 - orange & green vegetables



- Food high in zinc:
 - shellfish ***
 - wheat germ
 - chocolate

Photoreceptor Cells

- Photoreceptors in the dark are depolarized.
- Light causes photoreceptors to hyperpolarize.
- Light reduces release of transmitter from photoreceptors.

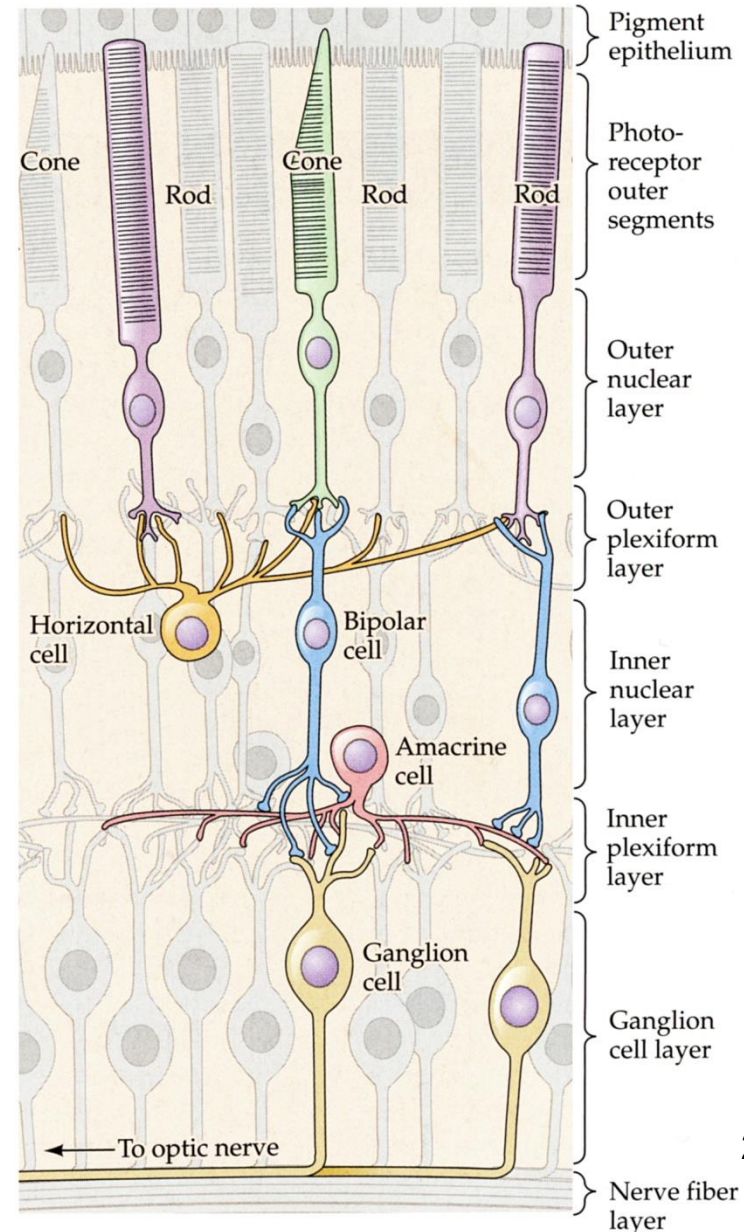


Intracellular recording from a single cone cell stimulated with different intensities of light. (Purves et al., 2012)

Inner Nuclear Layer

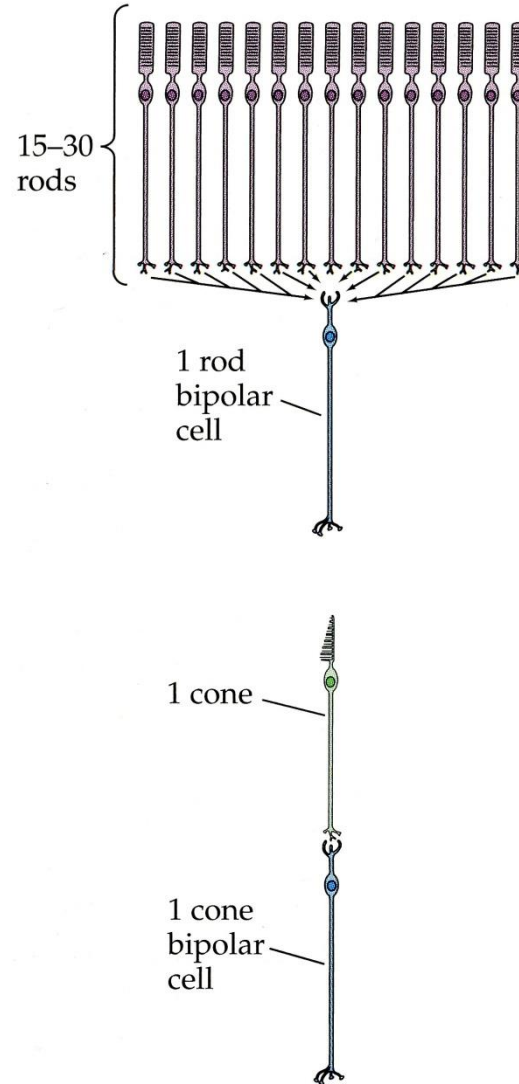
Bipolar cells:

- Synapse with all other types of retinal neurons.
- Most direct route of transfer of visual information from photoreceptors to ganglion cells.
- Select type of information to relay to ganglion cells.



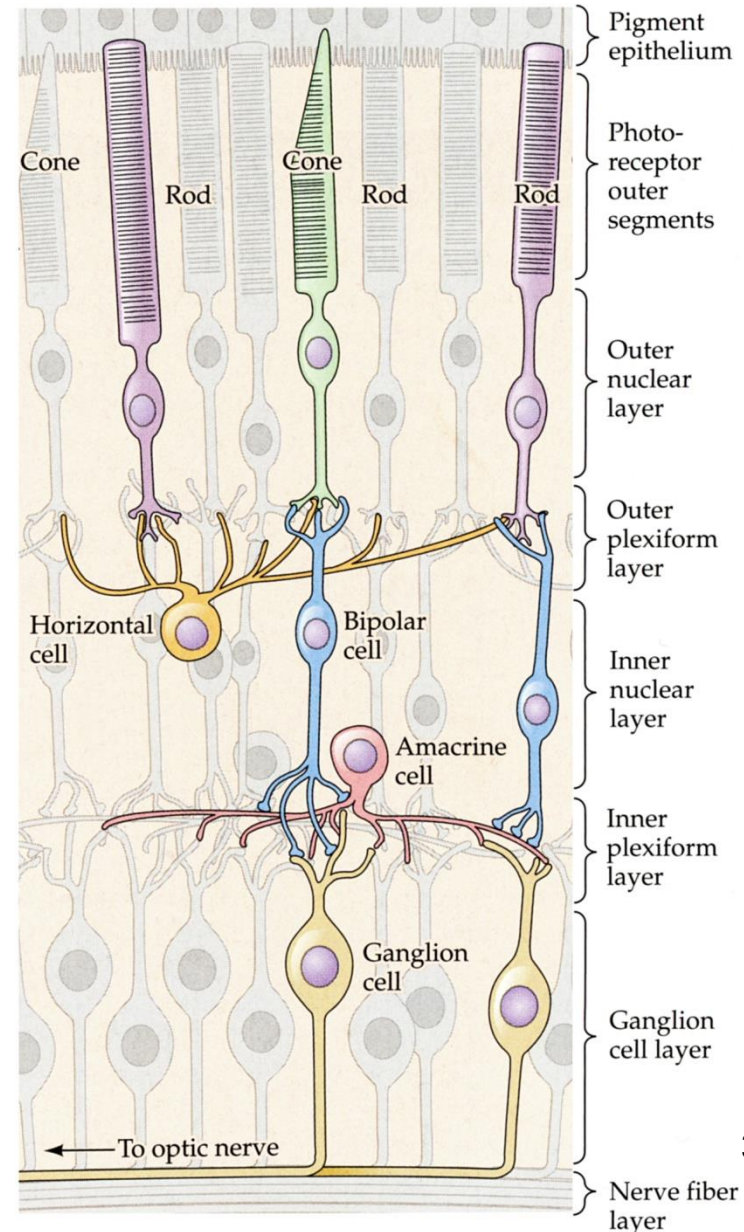
Inner Nuclear Layer

- 15-30 rods cells normally connect to a single rod bipolar cell.
- One cone cell can connect to one cone bipolar cell, particularly in the fovea.



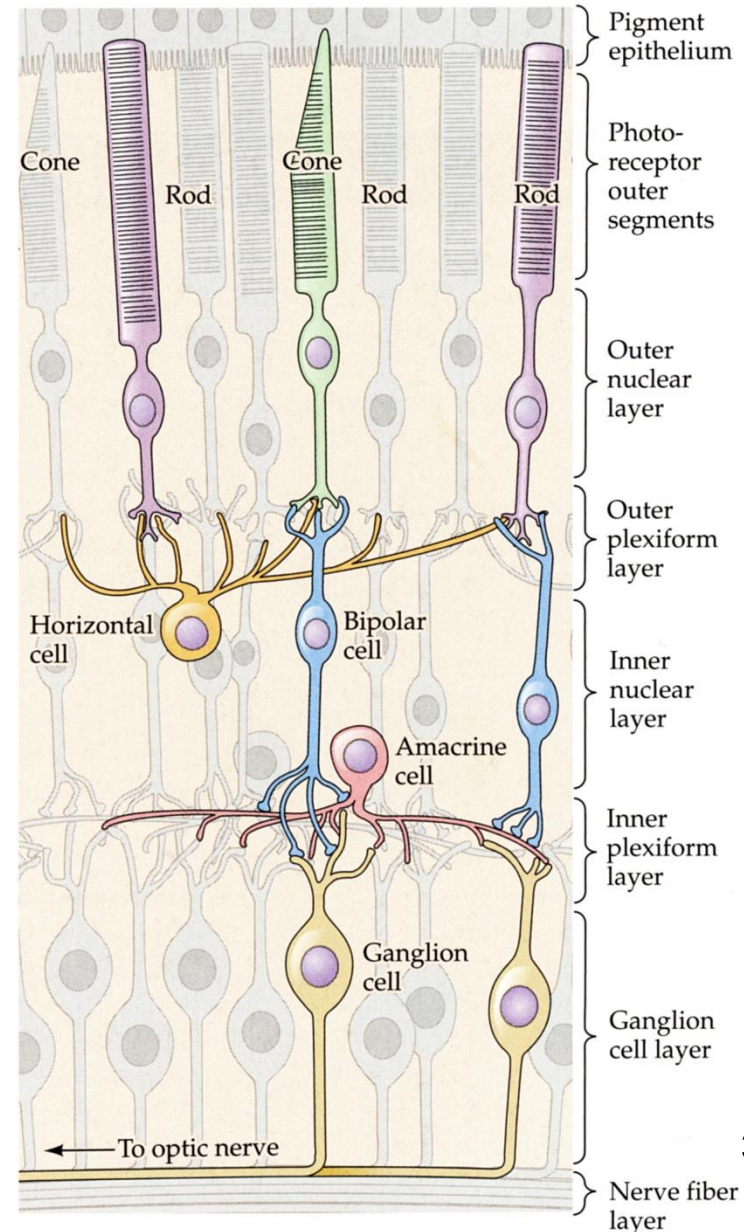
Inner Nuclear Layer

- Horizontal cells:
 - Synapse with photoreceptor and bipolar cells.
 - Enhance contrast through lateral interactions.
- Amacrine cells:
 - Synapse with bipolar and ganglion cells.
 - Helps adapt to changing light conditions.



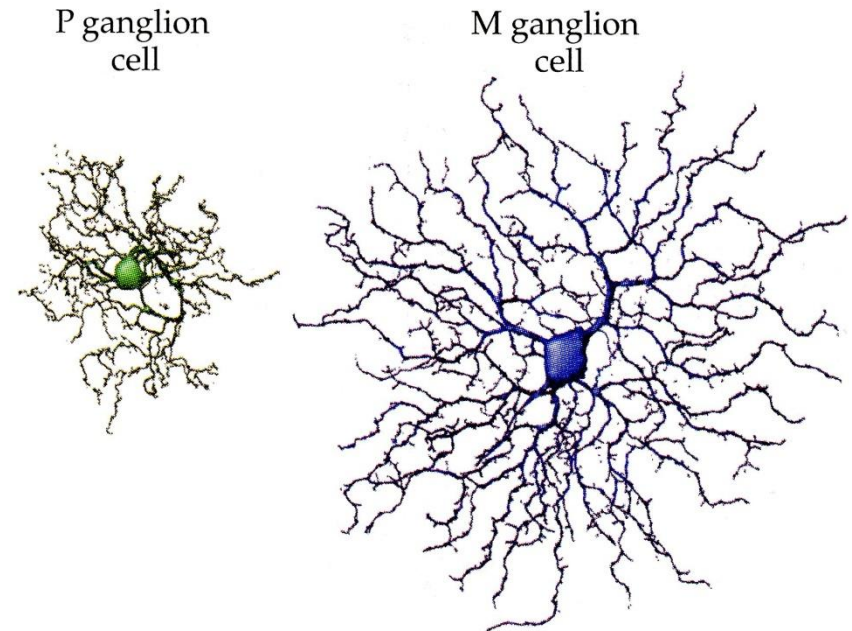
Ganglion Cells

- Retinal ganglion cells receive synapses from bipolar and amacrine cells.
- Most retinal ganglion cells receive information originating from rod and cone photoreceptor cells.
- Cone bipolar cells synapse directly on ganglion cells.
- Rod bipolar cells relay information via amacrine cells.



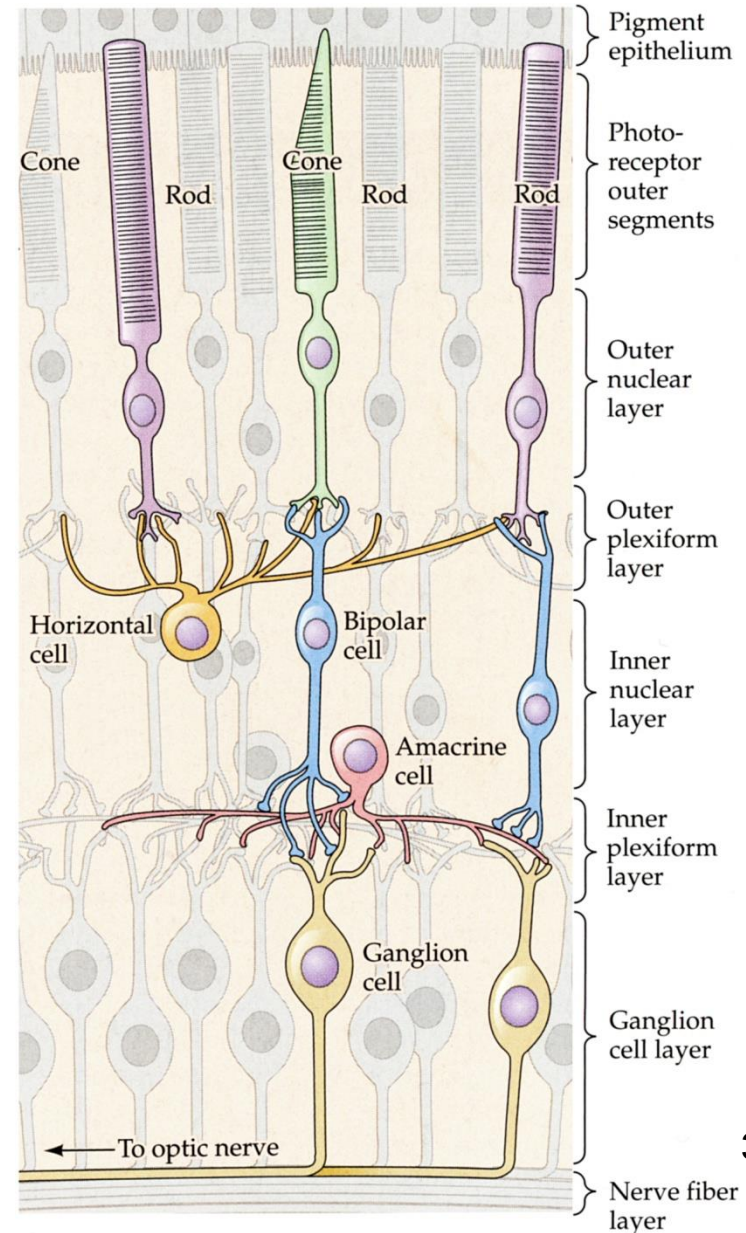
Ganglion Cells

- P type ganglion cells:
 - small dendritic arbor; receive information from few bipolar cells
 - important for color and form perception
- M type ganglion cells:
 - large dendritic arbor; receive information from many bipolar cells
 - important for motion perception



Ganglion Cells

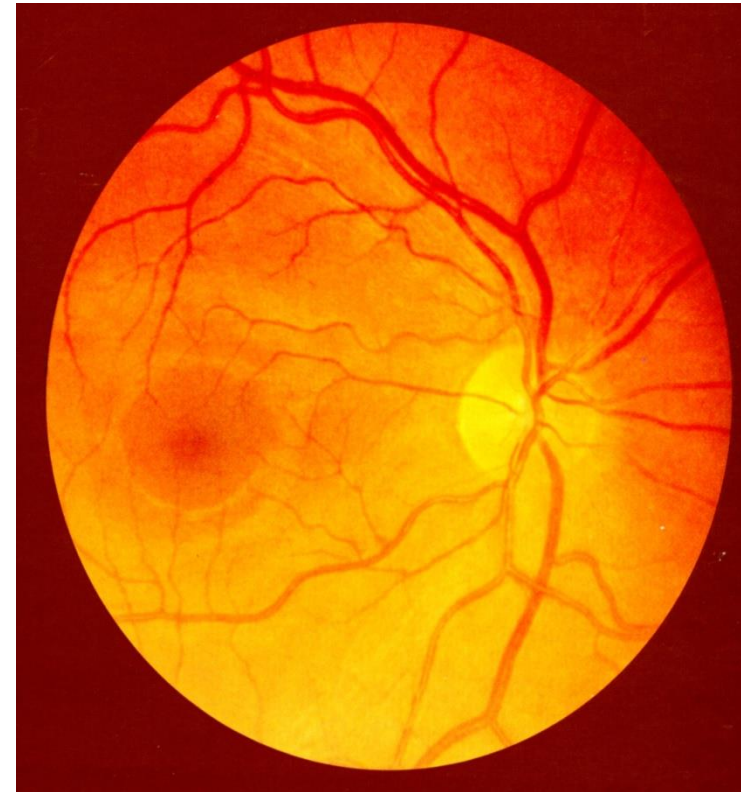
- The axons of the retinal ganglion cells form the optic nerve and carry visual information into the brain.



Retina

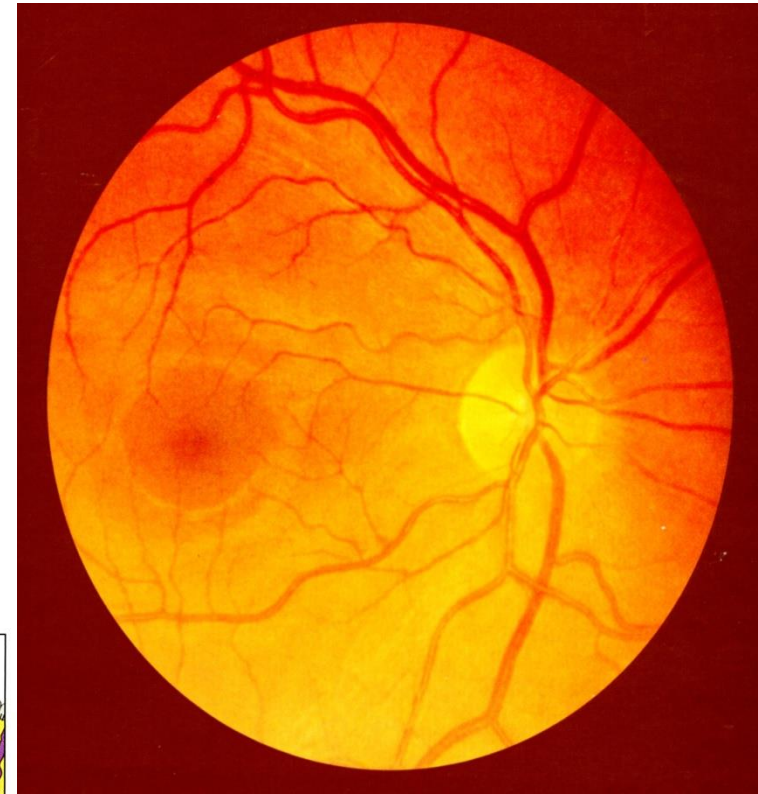
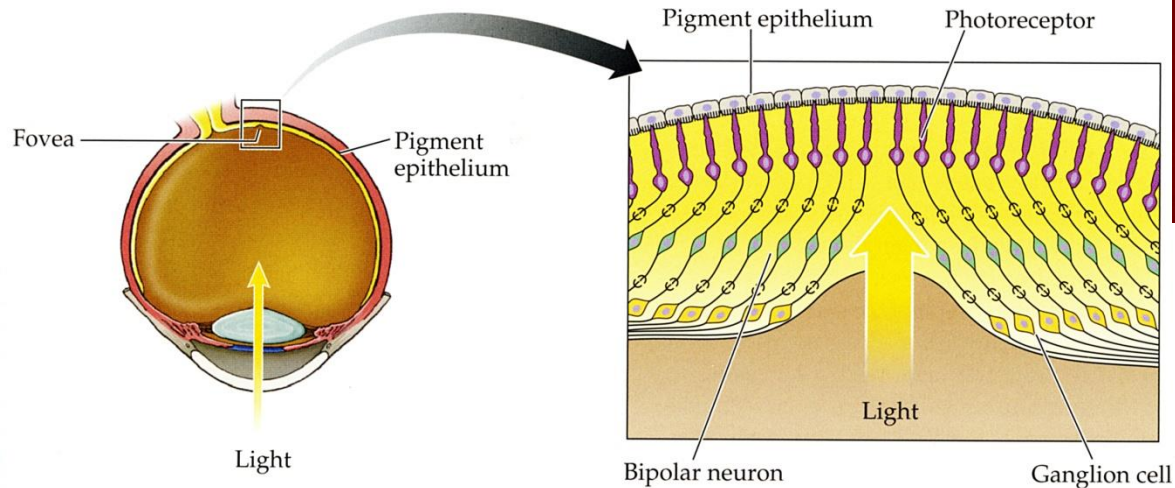
Retina can be examined non-invasively with an ophthalmoscope:

- Central artery & vein
- Optic nerve head
- Macula & fovea



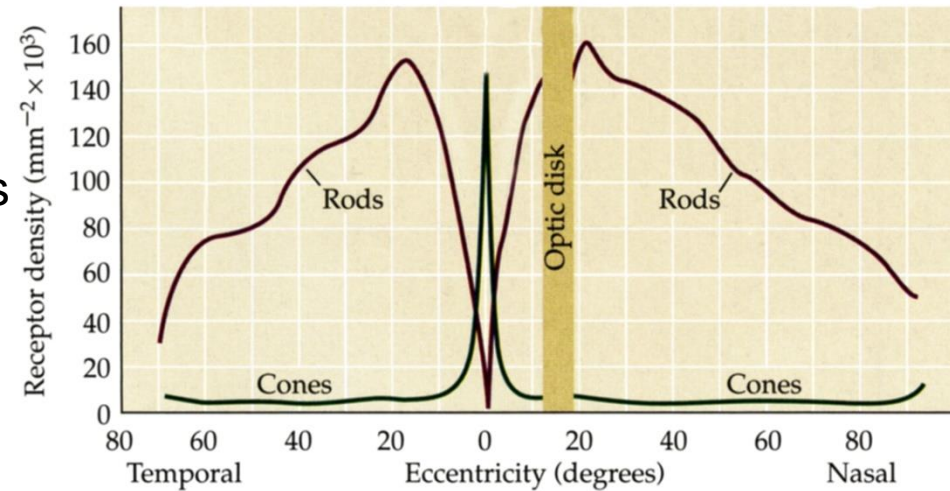
Retina

- The fovea is specialized for high acuity vision:
 - No blood vessels
 - Only cone photoreceptors
 - Other retinal cell types are pushed to the side.



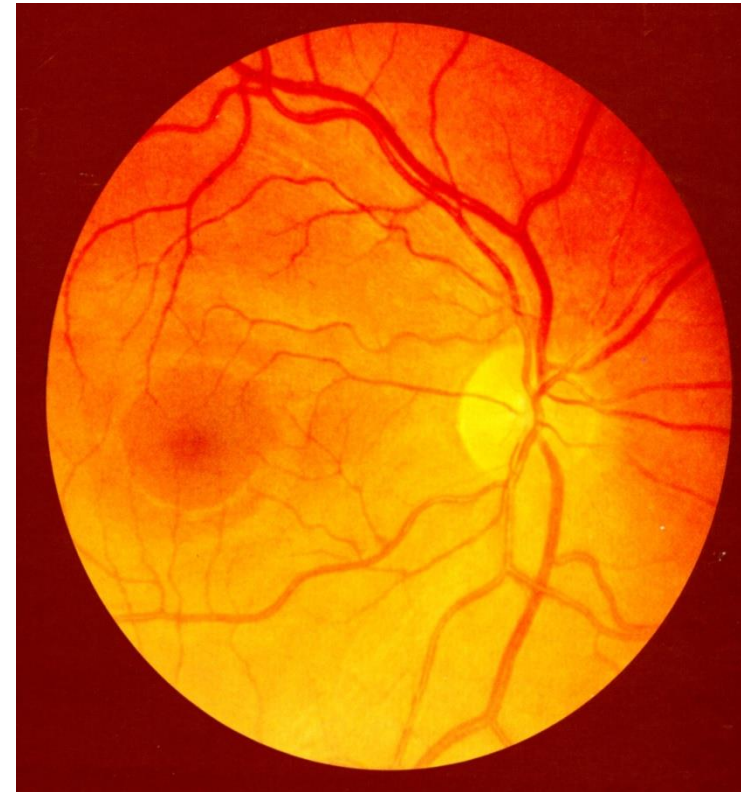
Retina

- The fovea has only cones.
- The rest of the retina has more rods than cones.
- The density of photoreceptor cells decreases towards more peripheral retina.



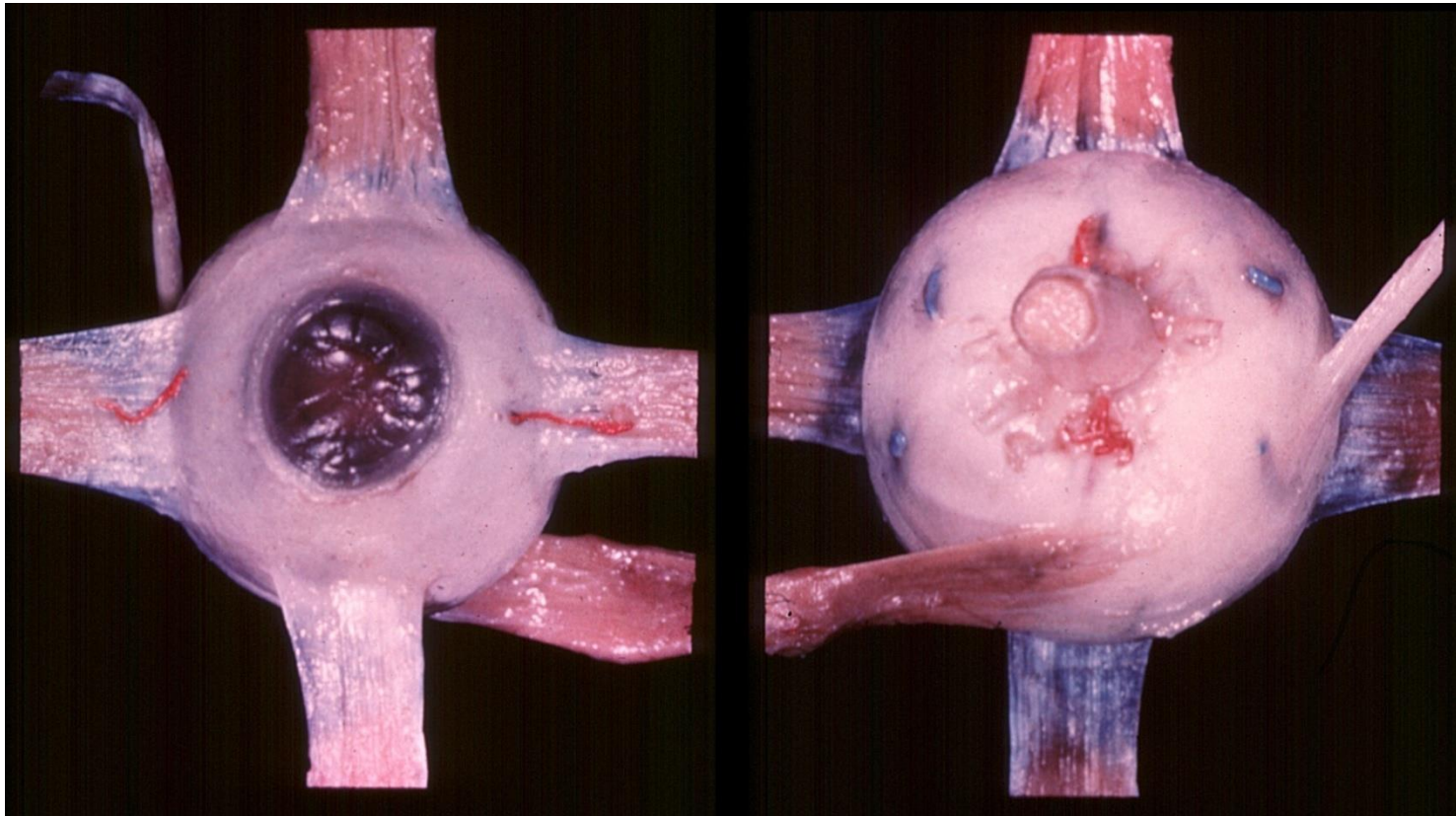
Retina

- We use the fovea for high acuity vision such as reading or identifying faces.
- We use the peripheral retina mostly to detect movement to attract our attention.



Retina

- One of the most important functions of the extraocular muscles is to move the eyes so that the object of interest falls on the fovea.



Optic Nerve (CN II)

- The axons from retinal ganglion cells across the retina run to the optic nerve head.
- The optic nerve head is the start of the optic nerve.
- There is no retina at the optic nerve head (blind spot).
- The retinal axons become myelinated at the optic nerve head.

