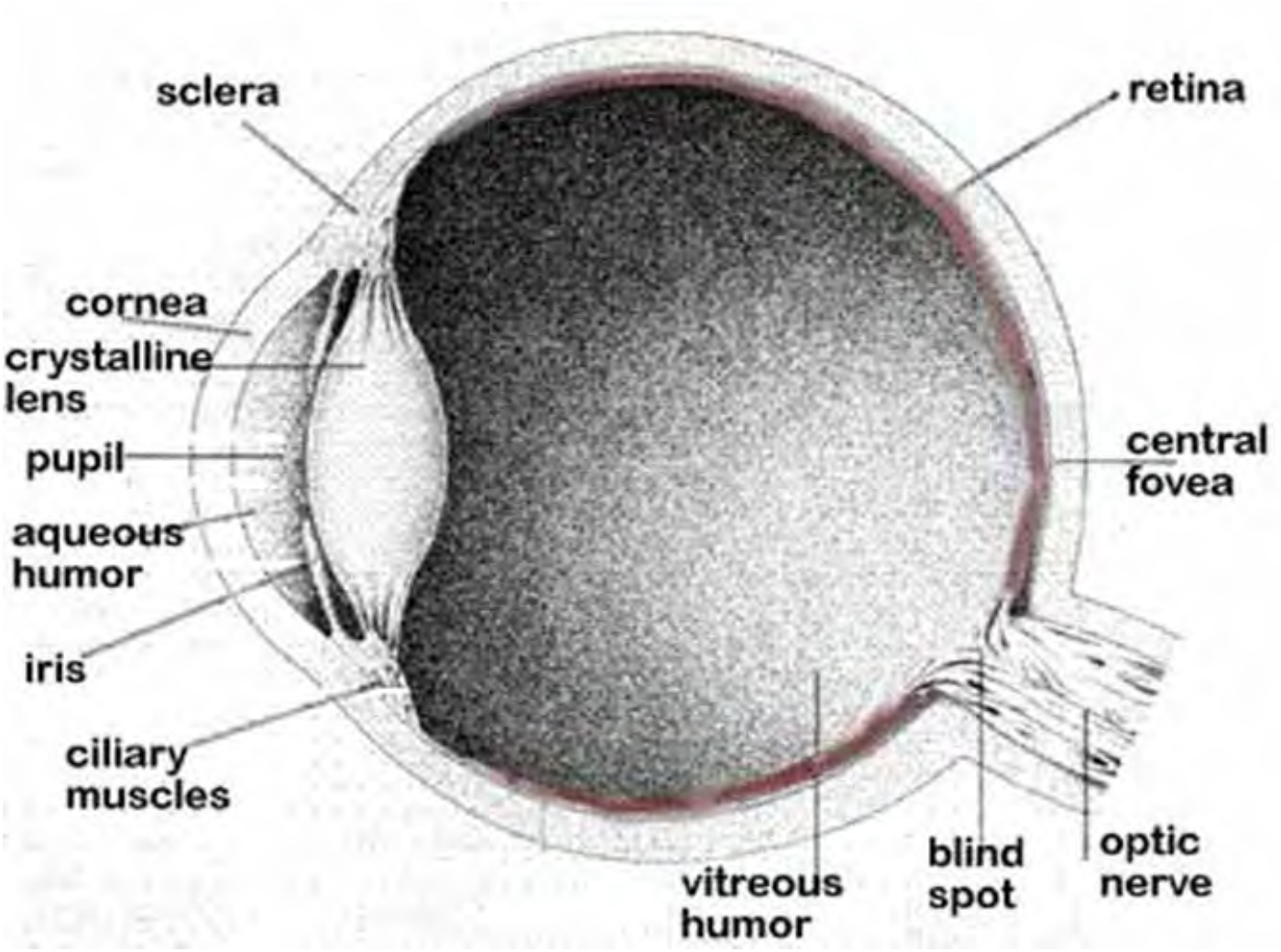
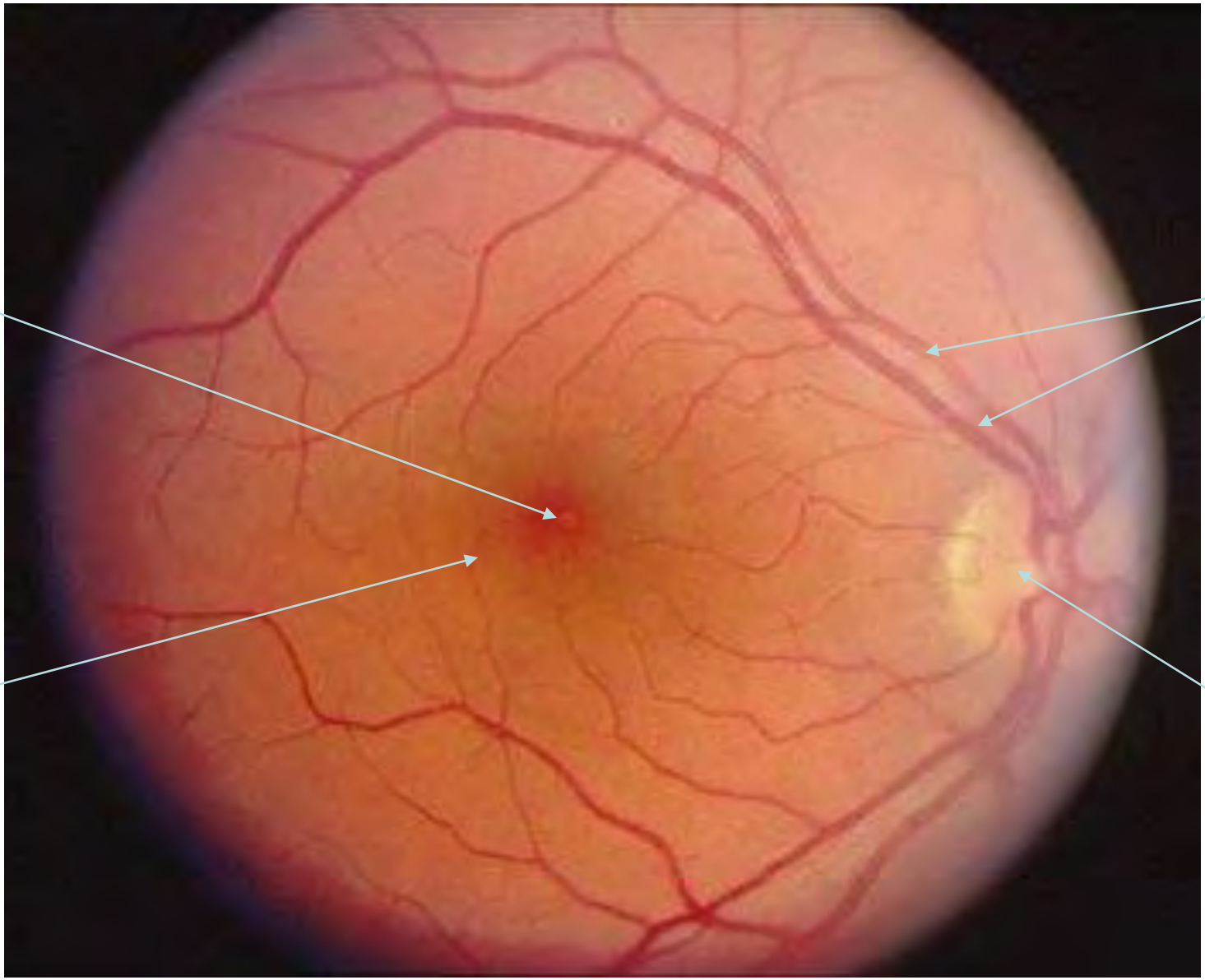
The Human Visual System

Jack Fein and Leathem Mehaffey

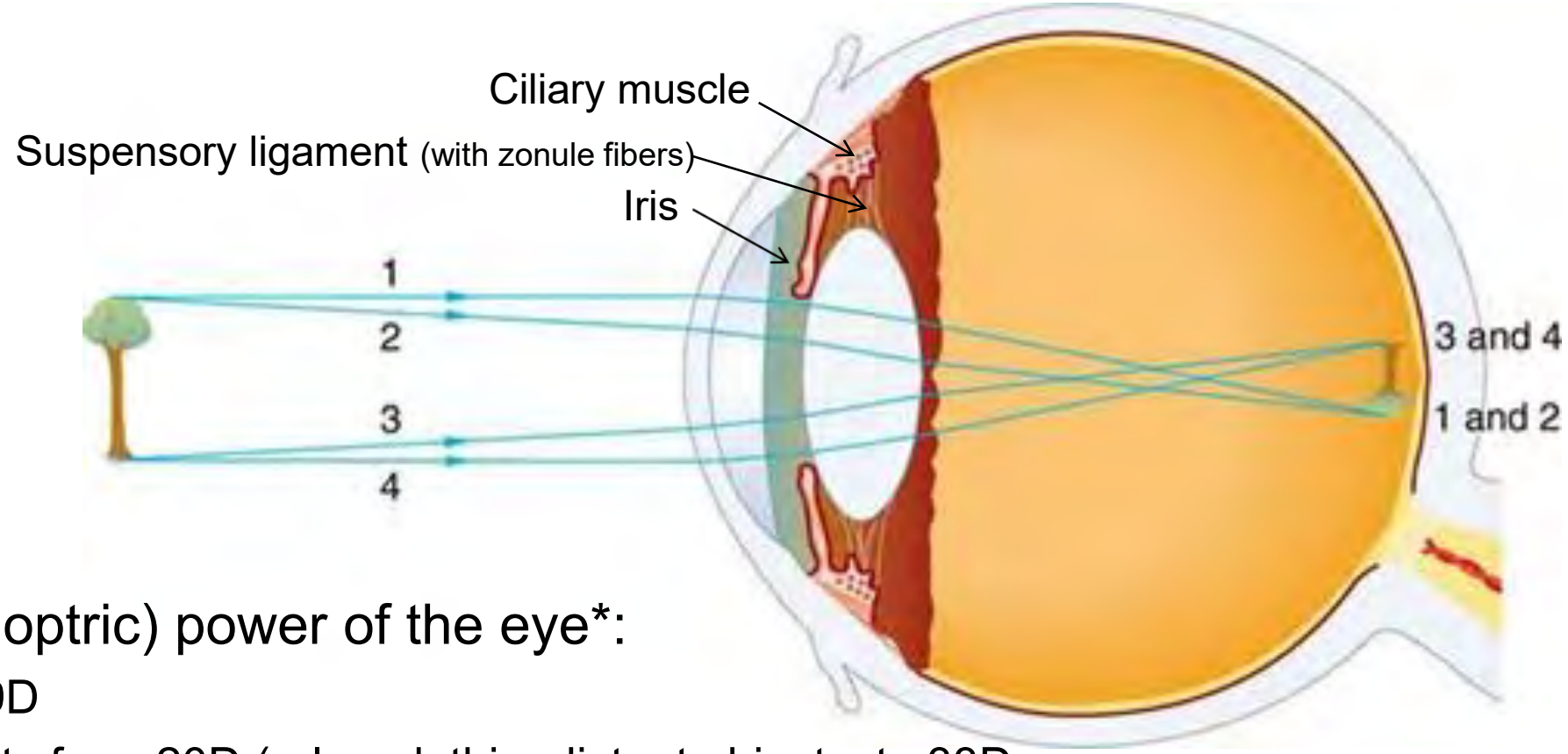
The Anatomy of the Human Eye



Fundus of the Human Eye



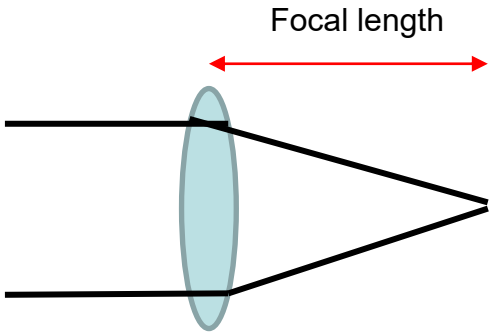
The Human Eye as a Camera



- Focusing (Dioptric) power of the eye*:
  - Cornea: 39D
  - Lens: adjusts from 20D (relaxed; thin; distant objects to 33D (fully accommodated; thick; near objects)

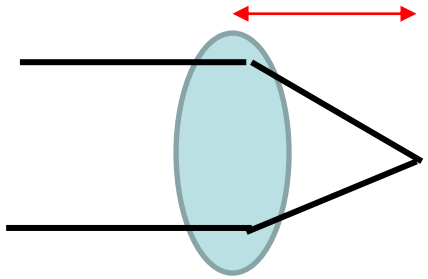
*Diopter: 1/focal length in meters. For 39D, focal length is 0.026 meters, or 26mm

Accomodation



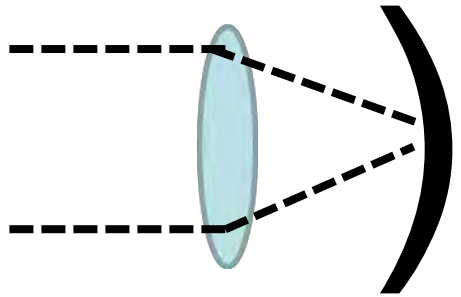
20D

lens flattened for distance vision

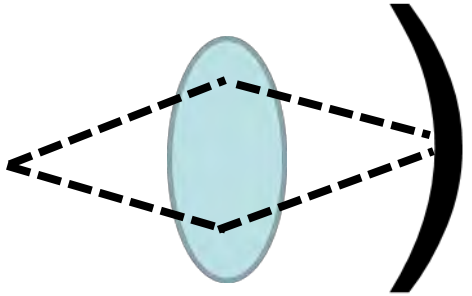


33D

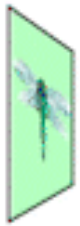
lens rounded for near vision



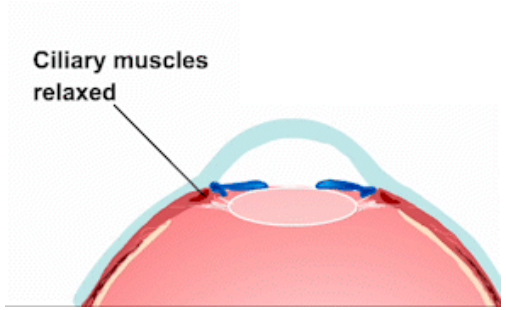
Far object

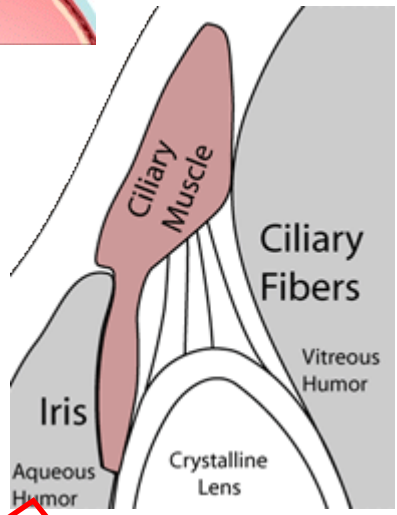


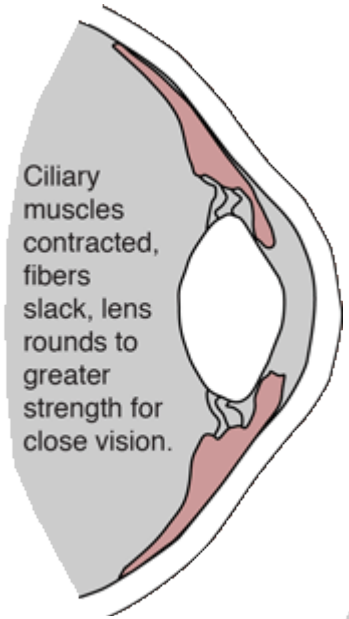
Near object

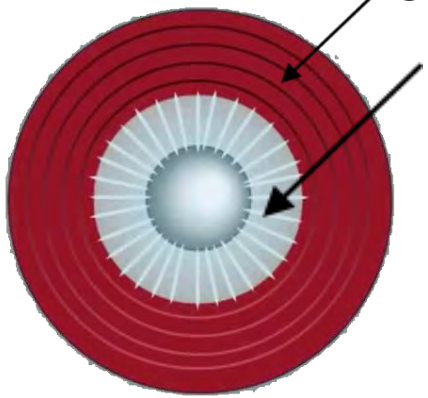


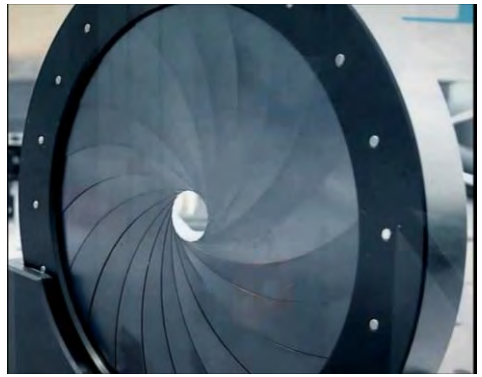
Mechanism of Accommodation

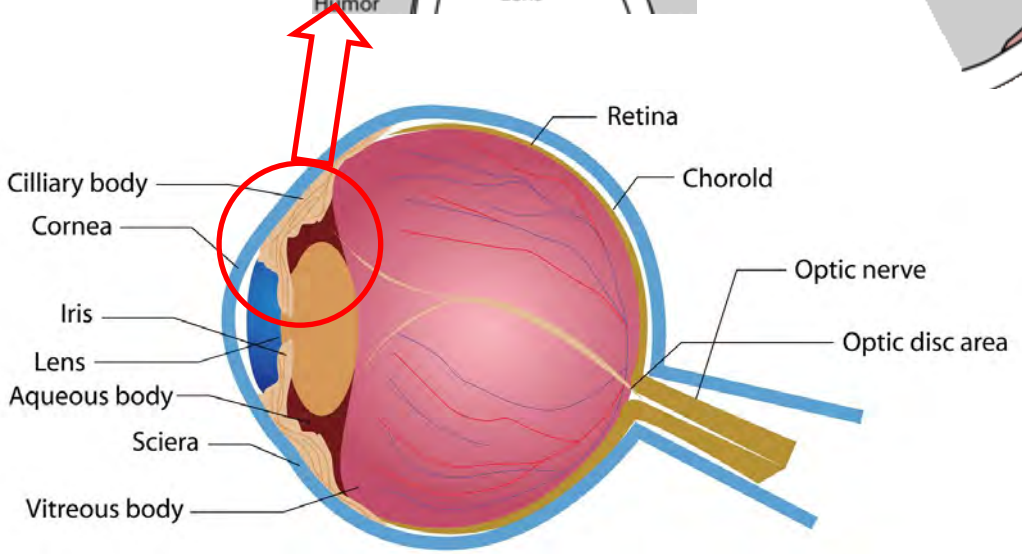


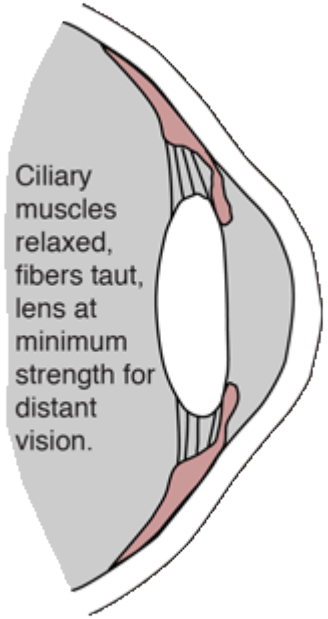


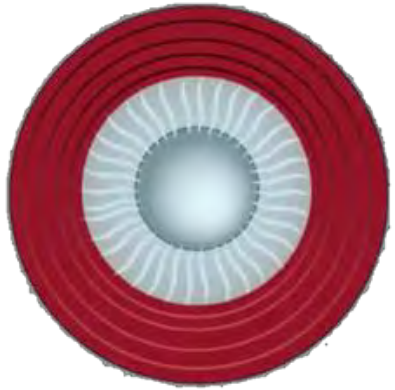




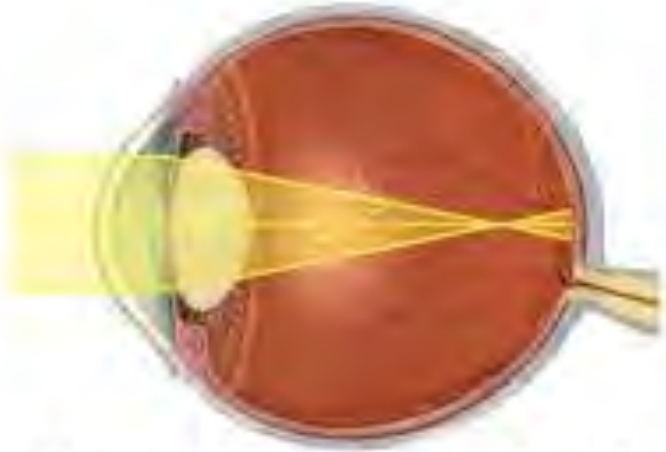




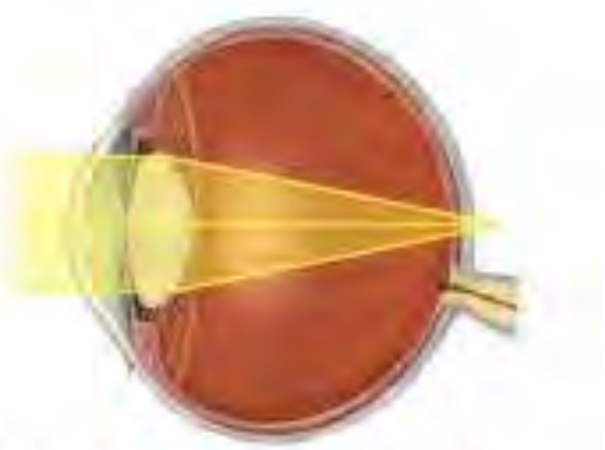




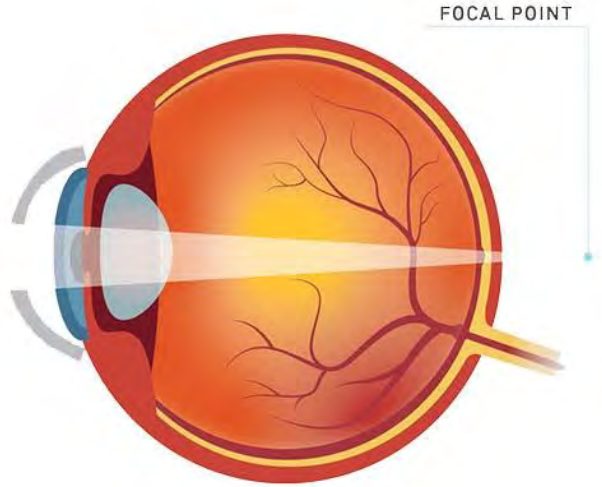
Myopia, Hyperopia, and Presbyopia



Nearsightedness: visual image is focused in front of the retina

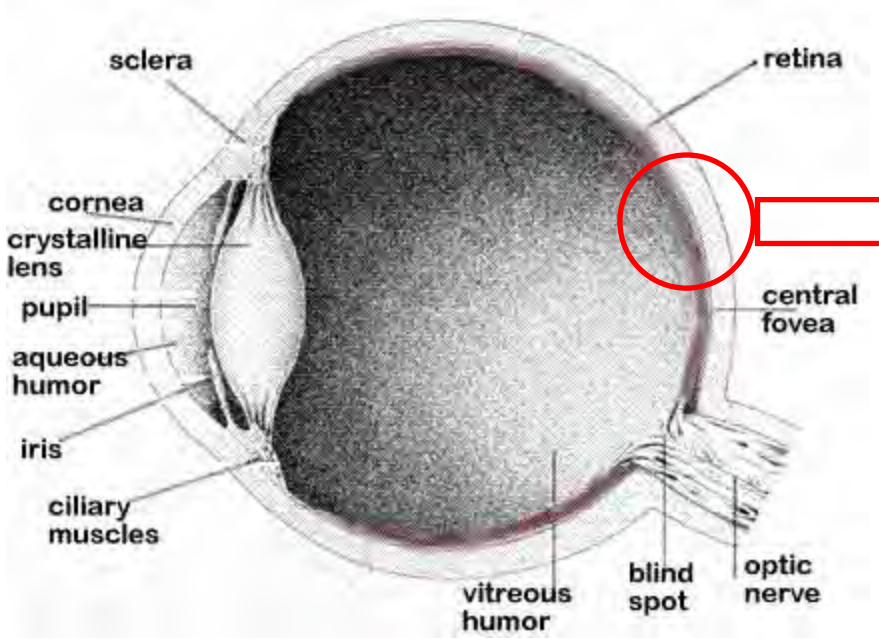


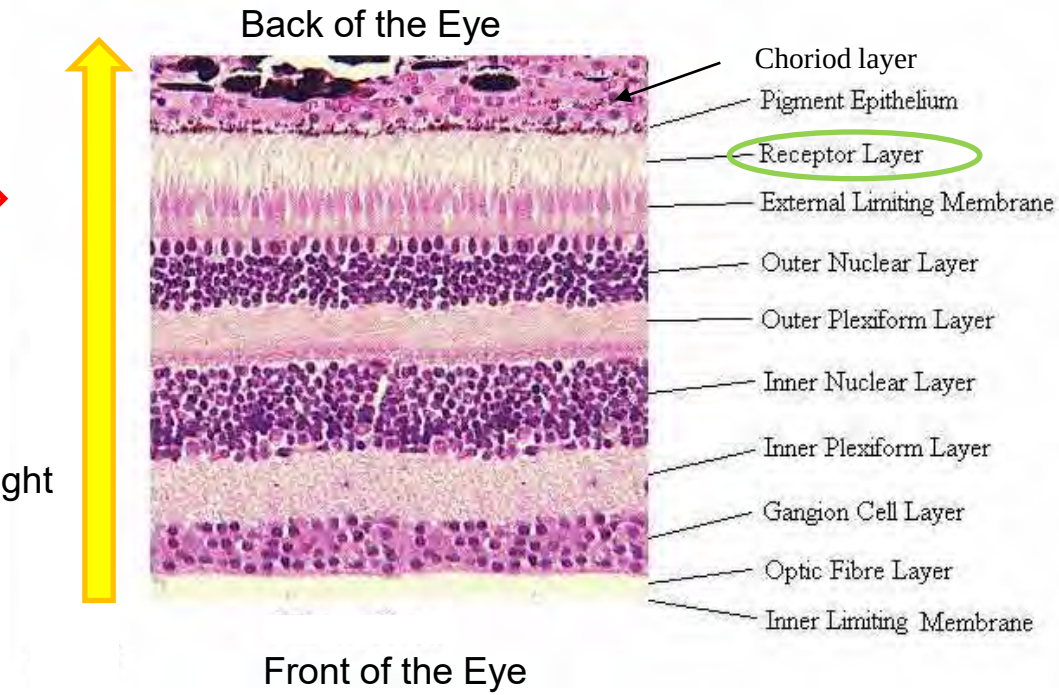
Farsightedness: visual image is focused behind the retina

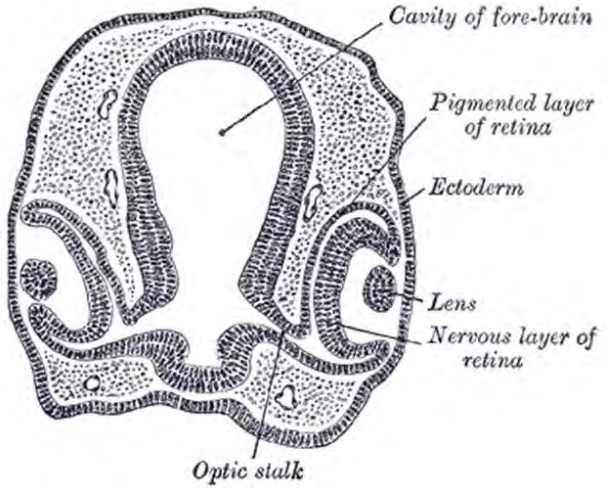


Presbyopia: lens loses flexibility, becomes fixed.

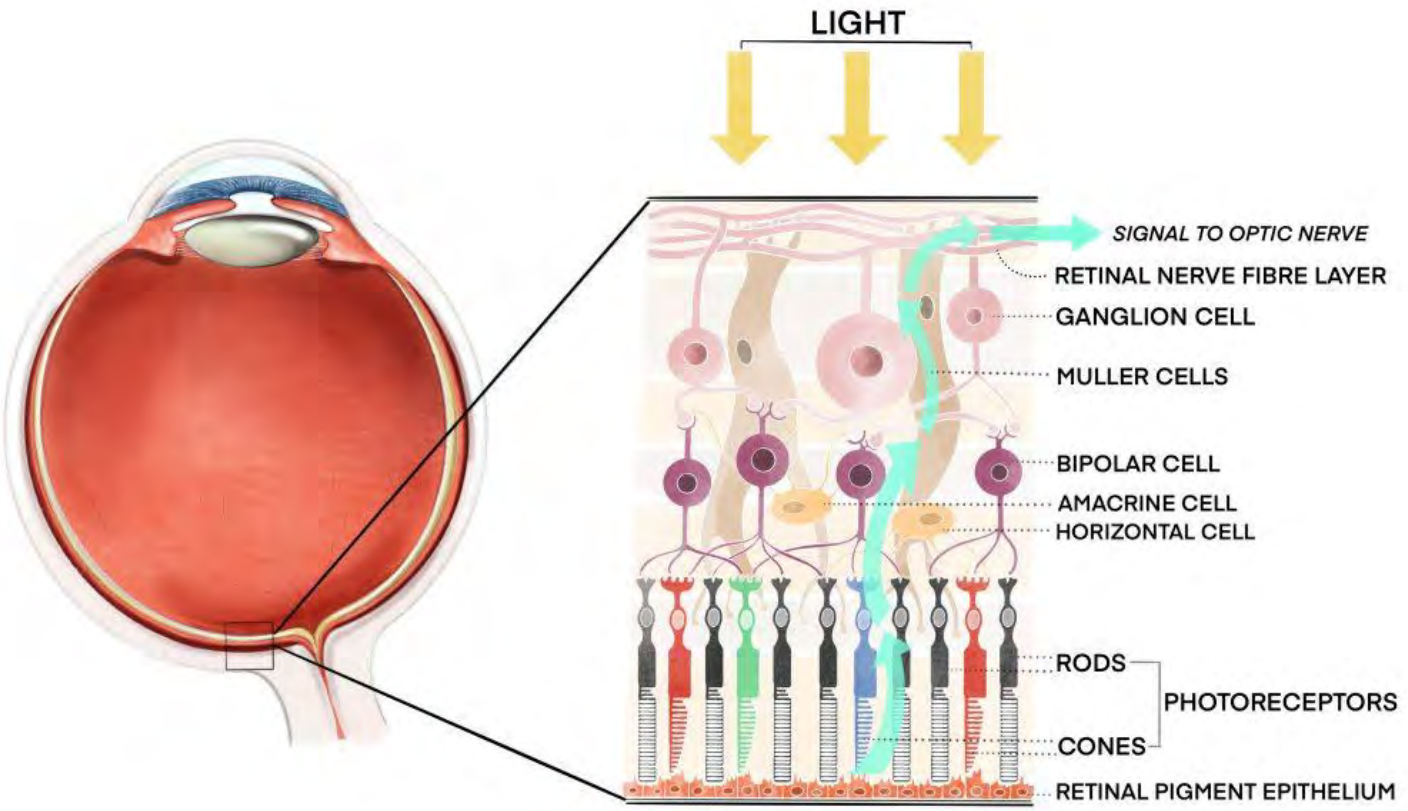
Light to Neural Impulses: The Retina





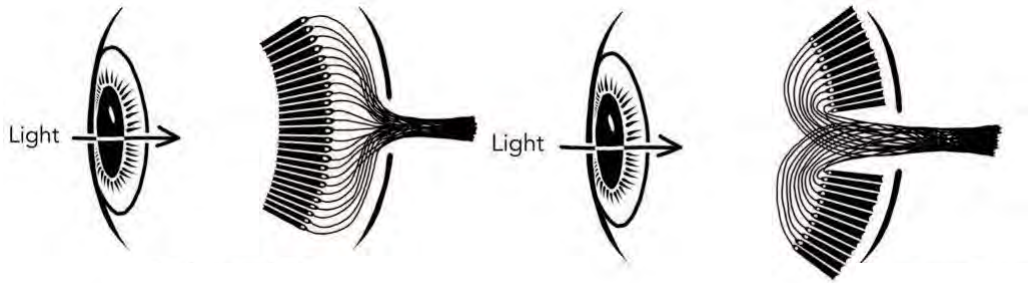


Organization of the Retina



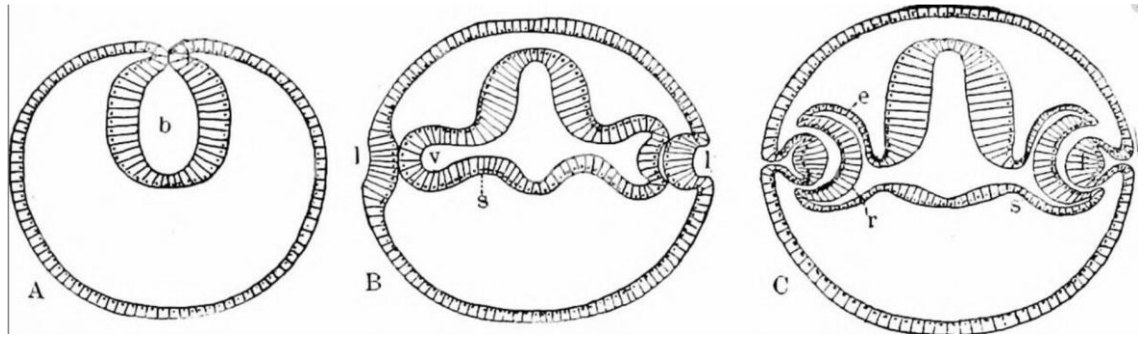
Note that light passes through all layers *before* arriving at the photoreceptors. This is evolution at work!

Origin of the Retina, or Why is it backward??



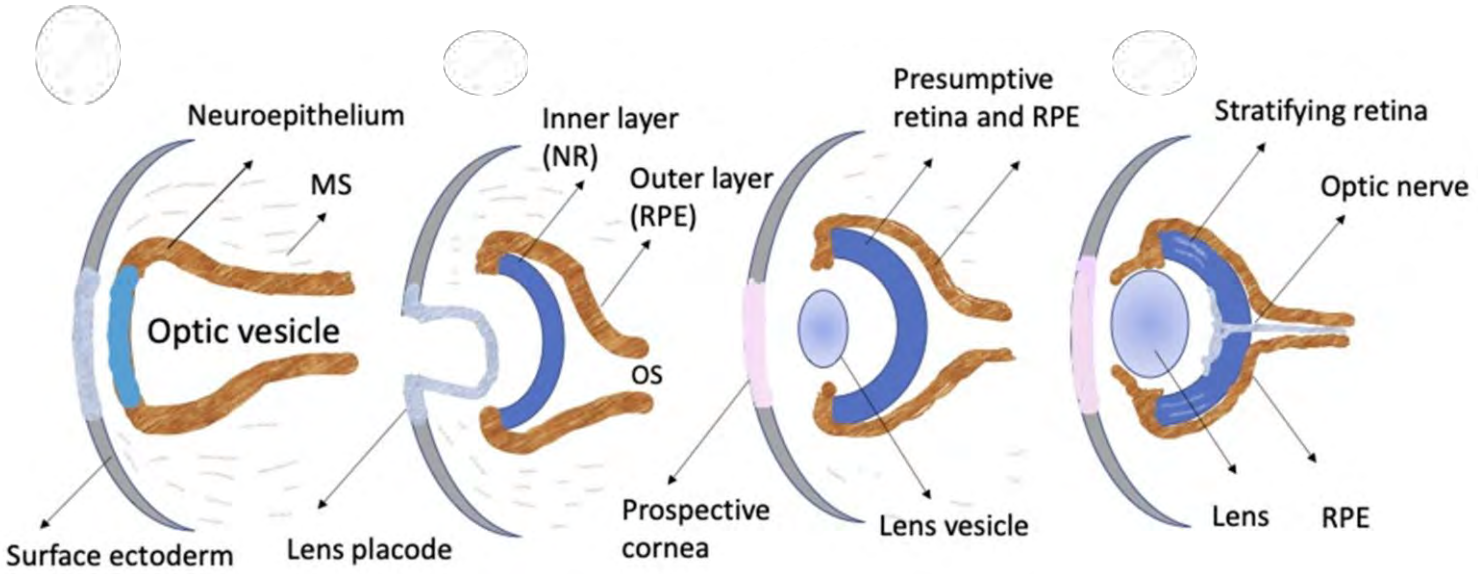
Octopus and Squid

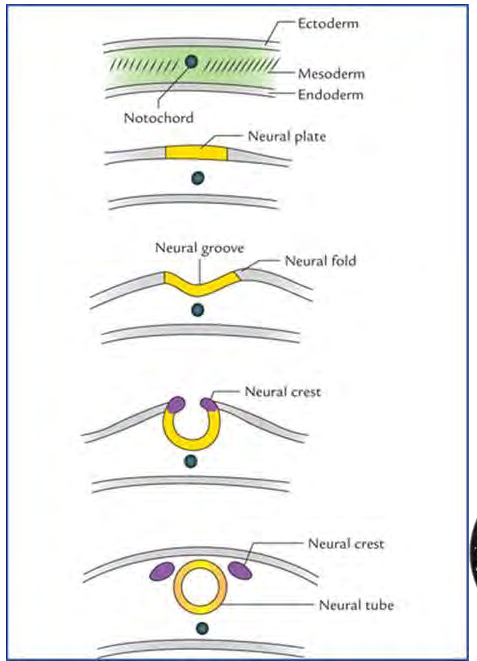
Vertebrate (human)



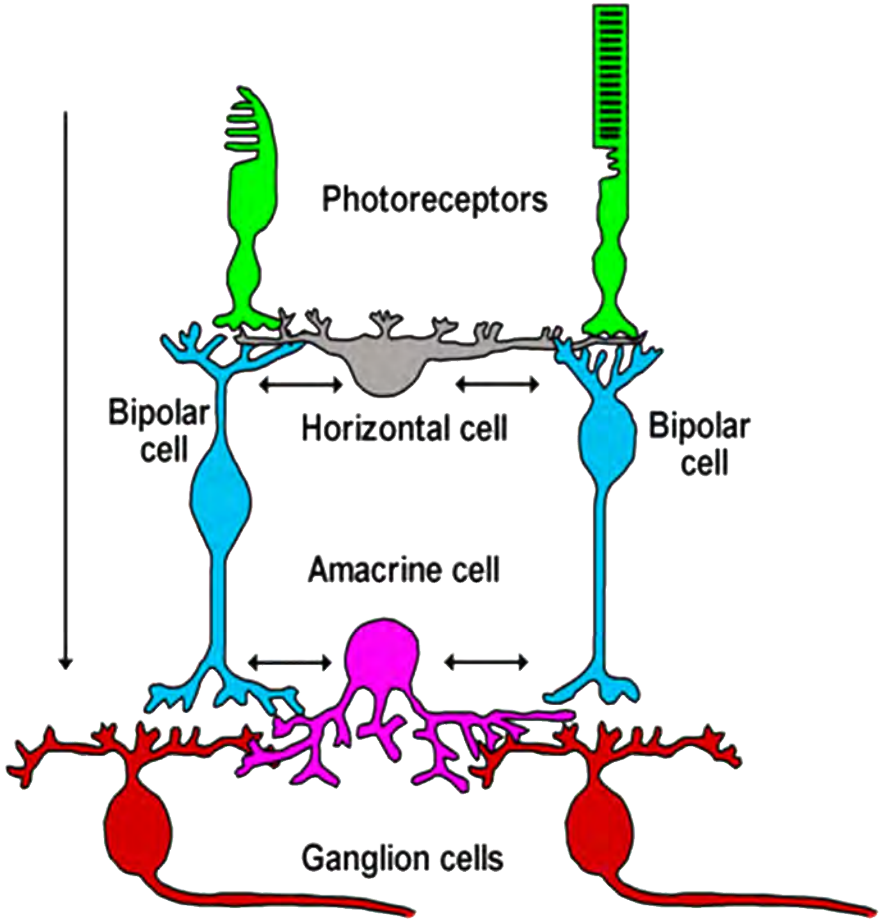
Ours is a product of our development path

Mollusks got it right





Retinal Cell Types

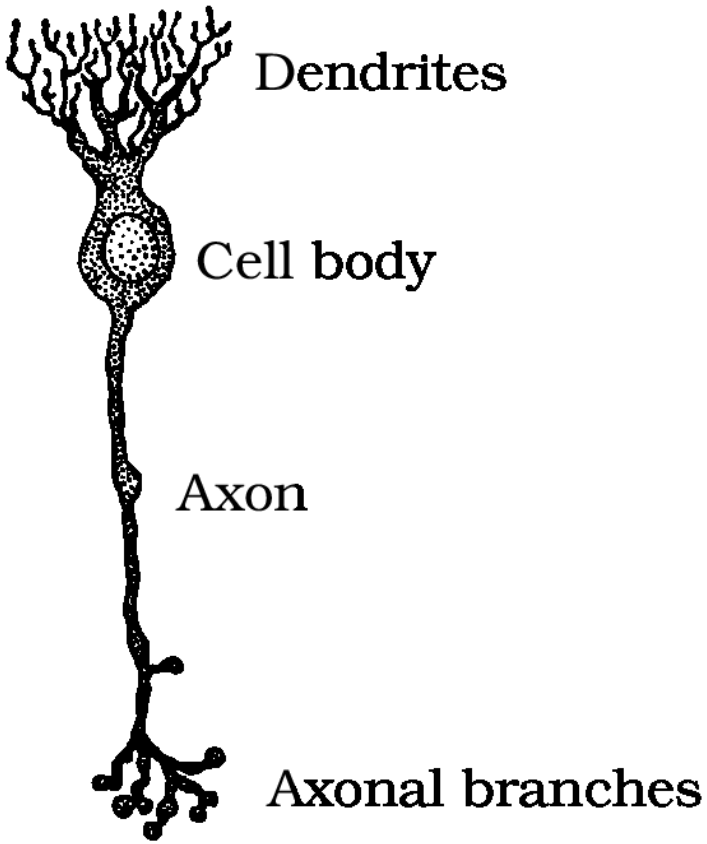


(b)

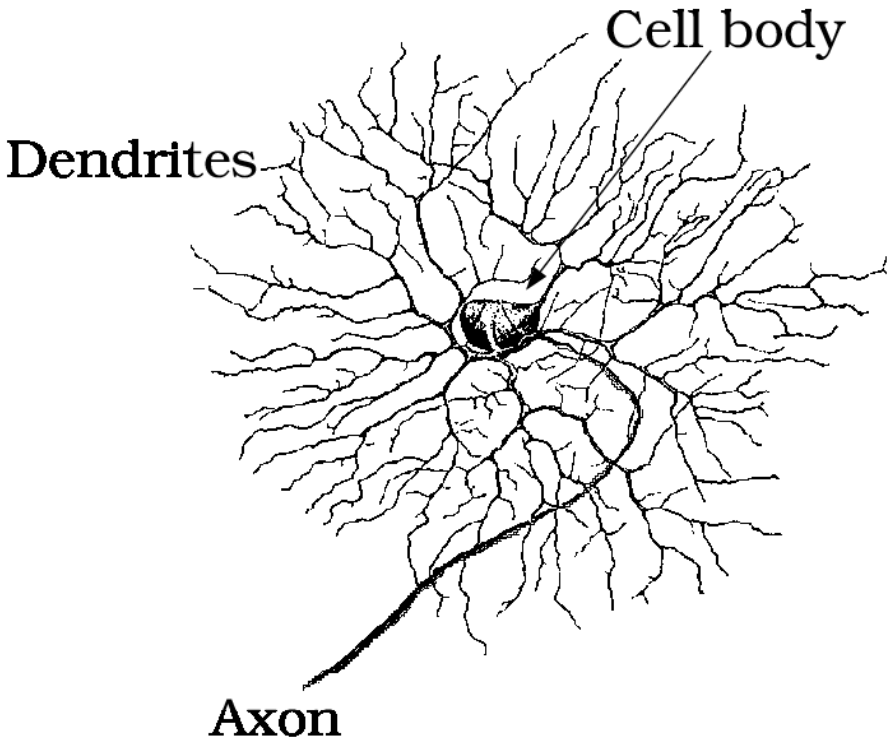
- Three types:
  - Photoreceptor cells:
    - Rods
    - Cones
  - Relay cells:
    - bipolar cells
    - ganglion cells
  - Integration cells:
    - horizontal cells
    - amacrine cells

Retinal Cells

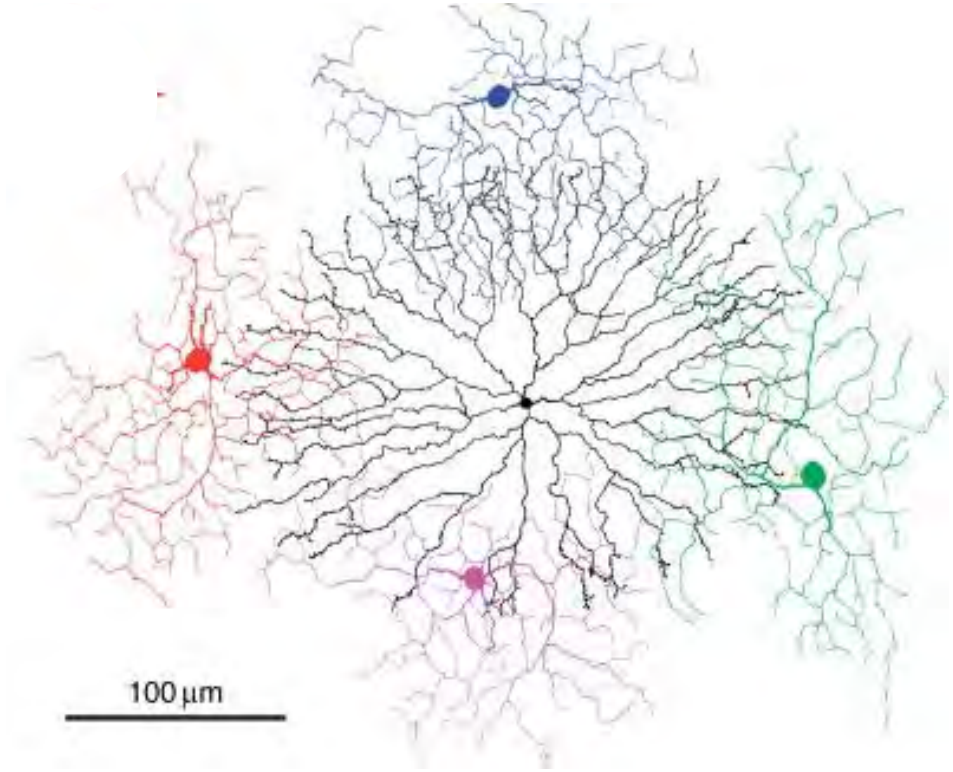
BIPOLAR CELL



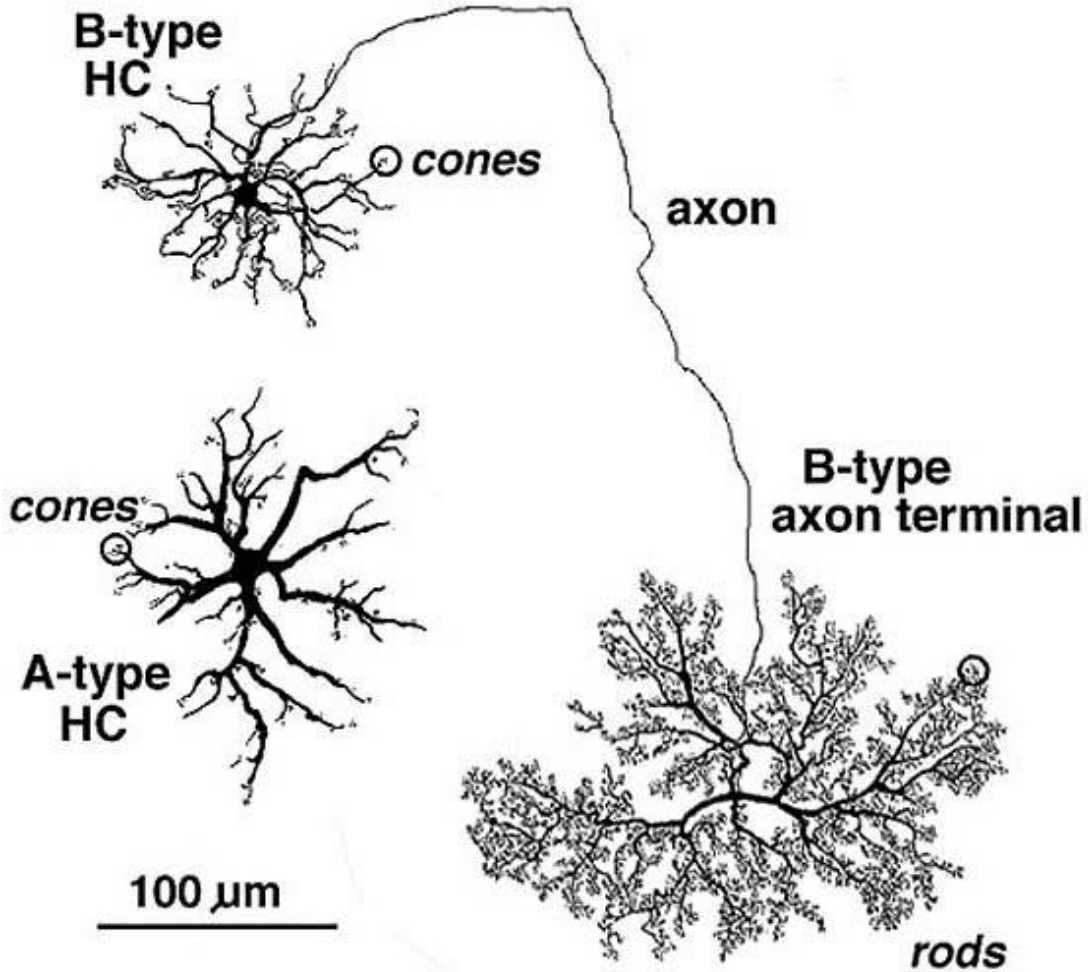
GANGLION CELL



Retinal cell types



Amacrine Cell

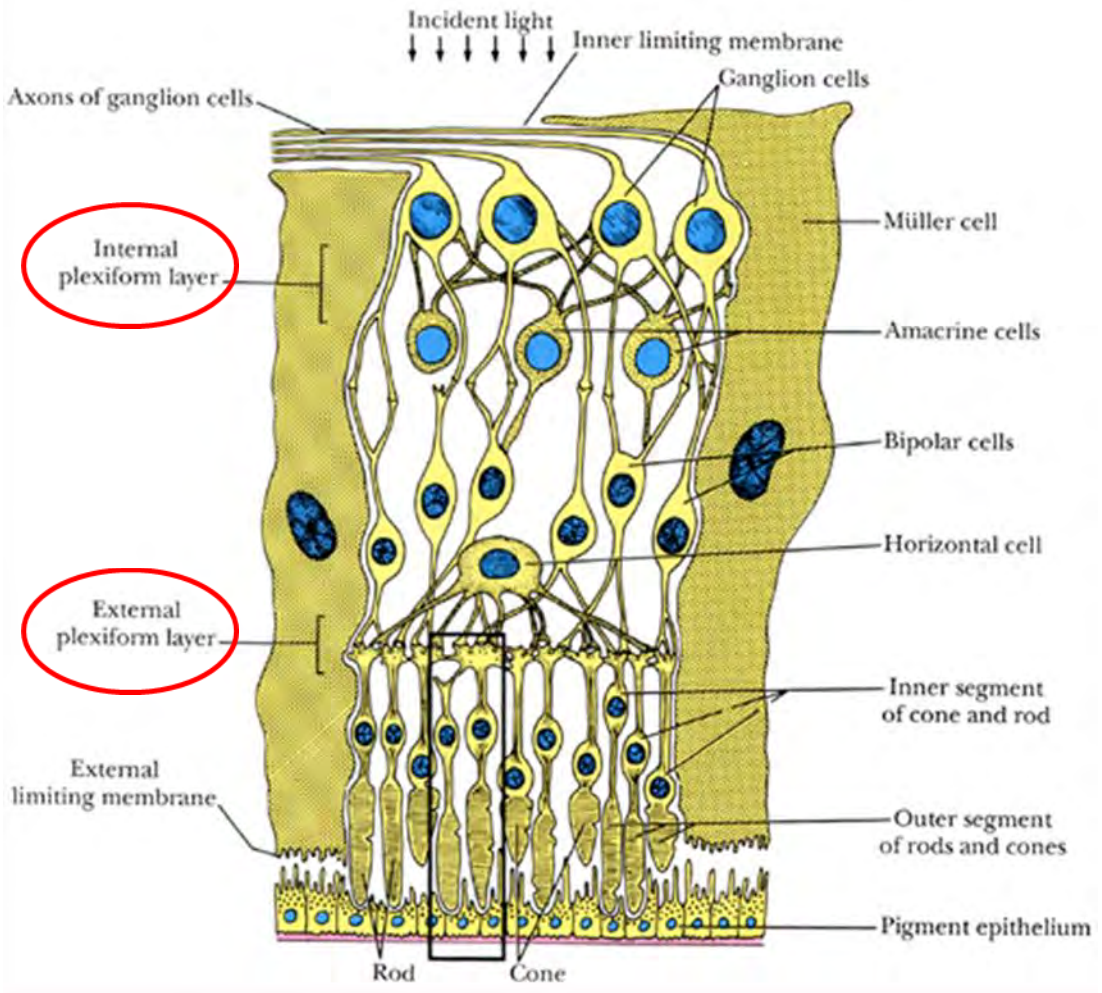


Horizontal cells

Information Flow in the Retina

Organization by information handling:

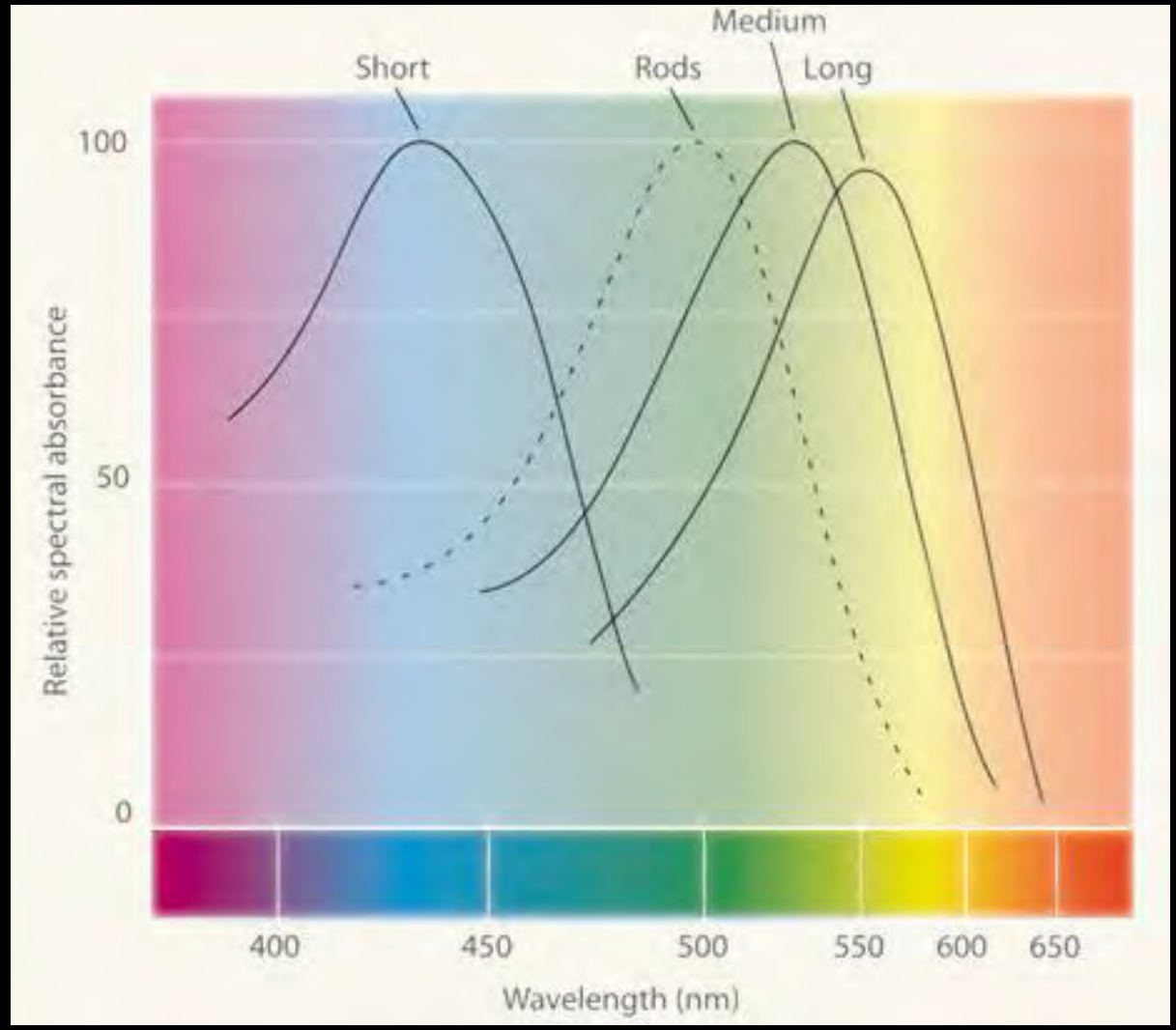
- Vertical transmission
  - Bipolar cells
  - Ganglion cells
- Horizontal transmission
  - Horizontal cells
  - Amacrine cells
- Information Processing
  - Outer (External) Plexiform layer
  - Inner (Internal) Plexiform layer



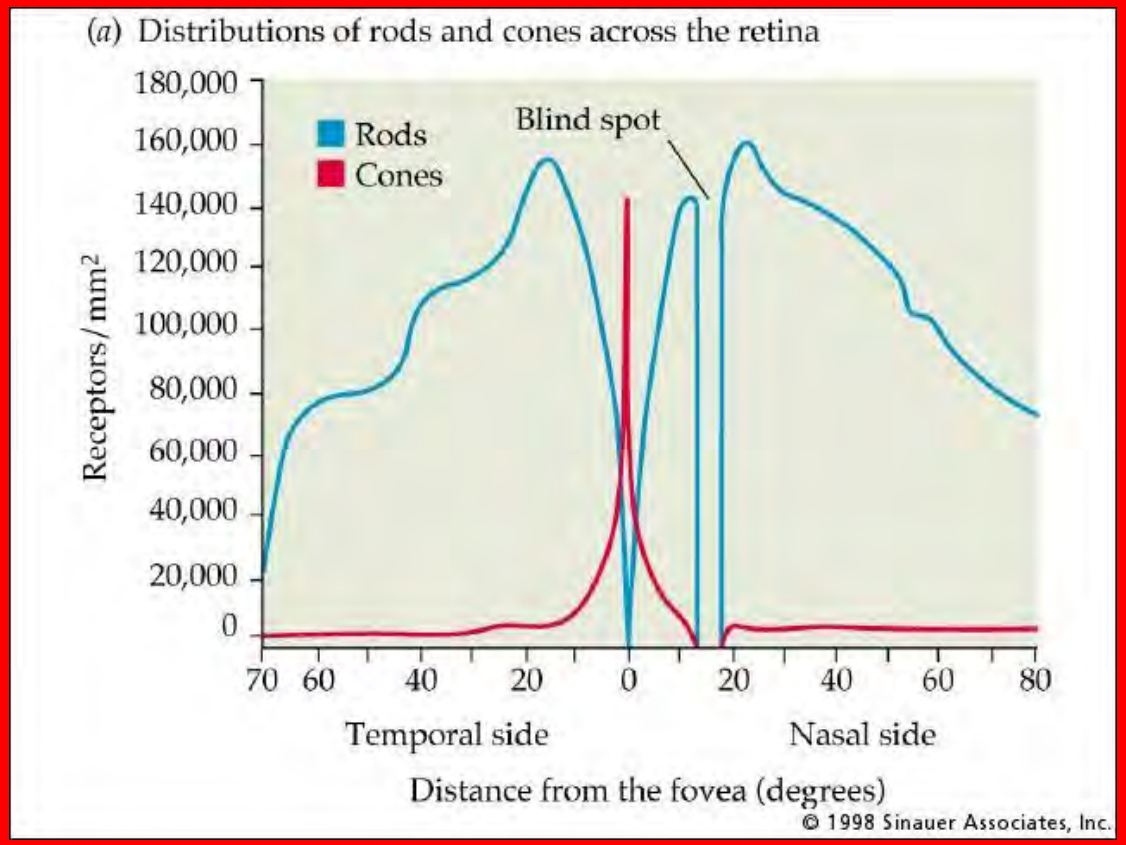
Rods and Cones

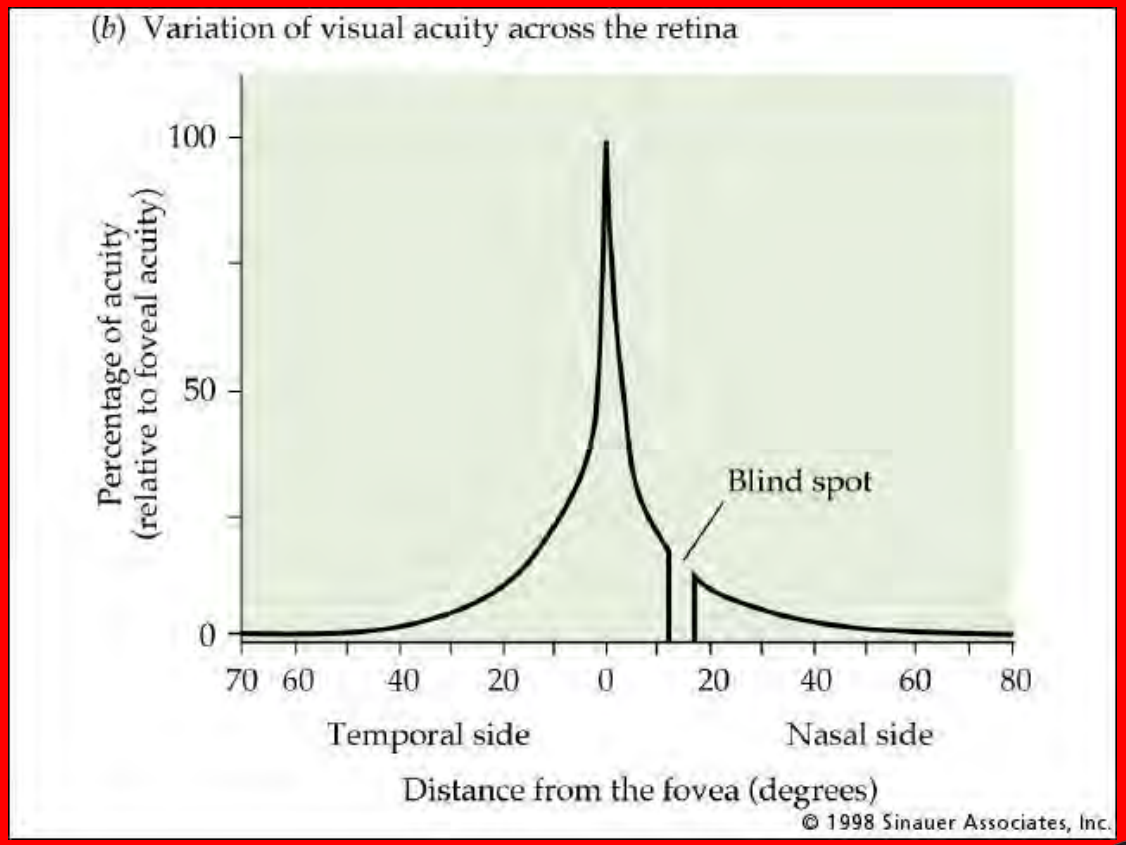
- Rods:
  - Low spatial acuity (ca. 20/100, or second row on Snellen chart)
  - Numerous (120 million in human retina)
  - High sensitivity (1000x cones; can detect a single photon)
  - No color vision (single visual pigment)
  - Good temporal discrimination
  - Used for night vision (scotopic)
- Cones:
  - High spatial acuity (in fovea)
  - Fewer than rods (6-7 million in human retina)
  - Low sensitivity
  - Three kinds with different color (wavelength) sensitivity
  - Less sensitive to motion than rods
  - Used for daytime vision (photopic)

Spectral sensitivity of rods and cones

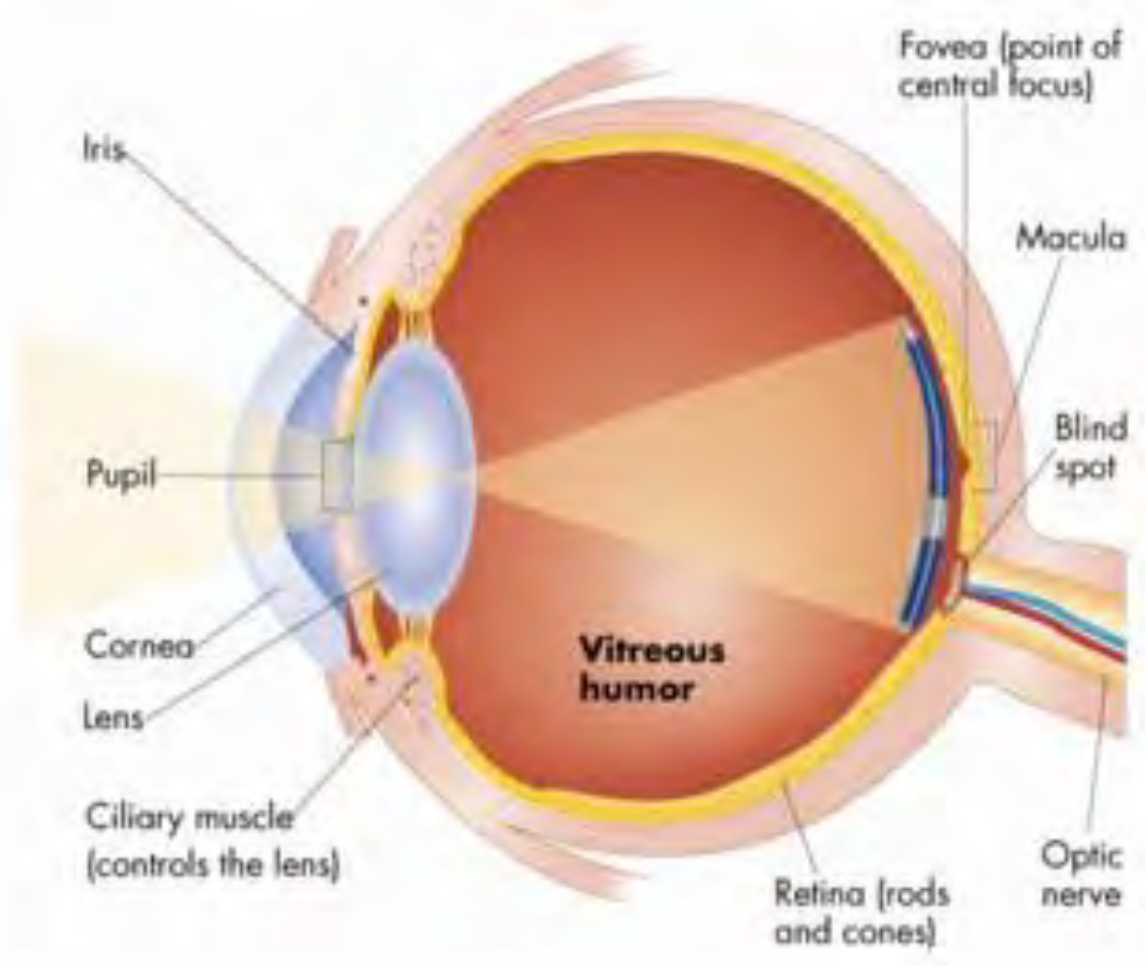


Photoreceptor distribution and acuity





The Blind Spot



To draw the blind spot tester on a piece of paper, make a small dot on the left side separated by about 6-8 inches from a small + on the right side. Close your right eye. Hold the image about 20 inches away. With your left eye, look at the +. Slowly bring the image closer while looking at the +. At a certain distance, the dot will disappear from sight...this is when the dot falls on the blind spot of your retina.

Other tests show how your brain fills in the missing information at the blind spot:

Acuity is limited to the fovea