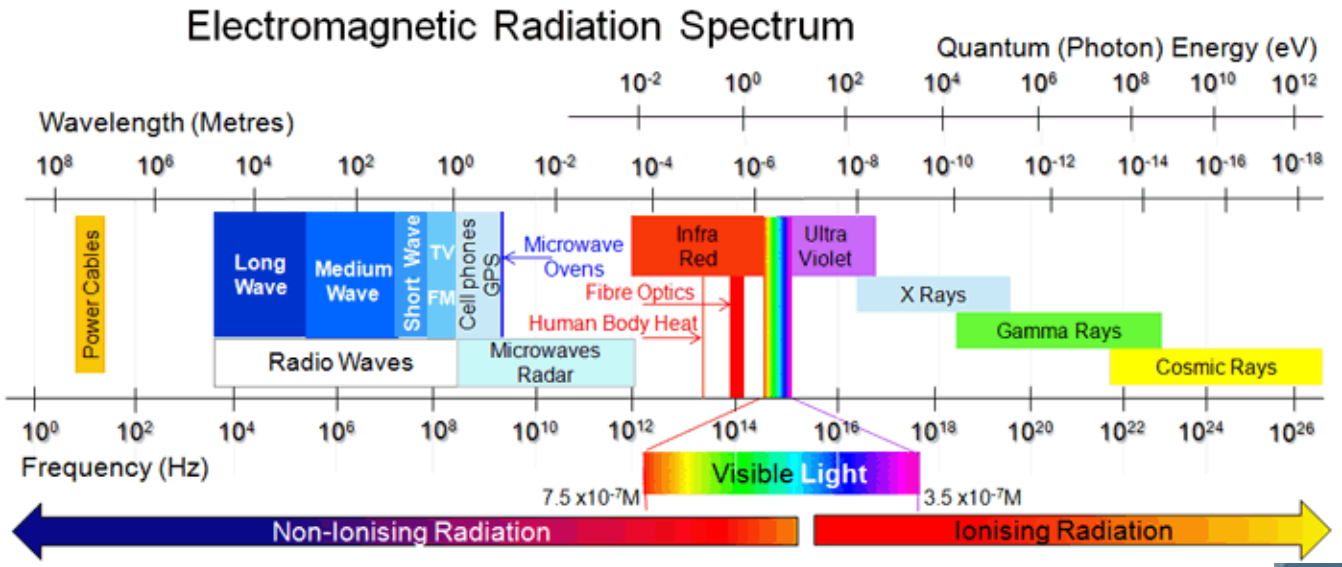
Photoreception

BIOS01C2, 2019

Light



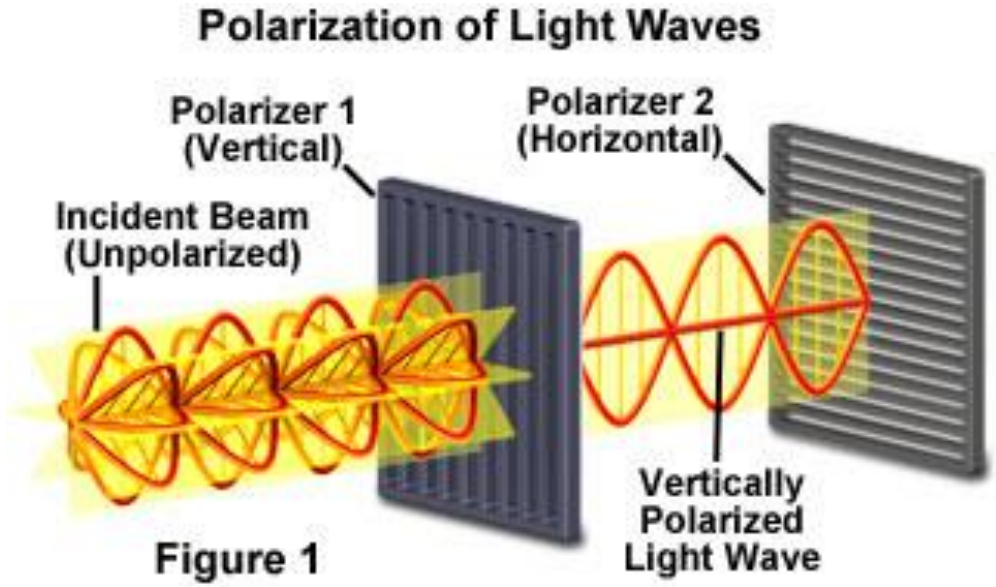
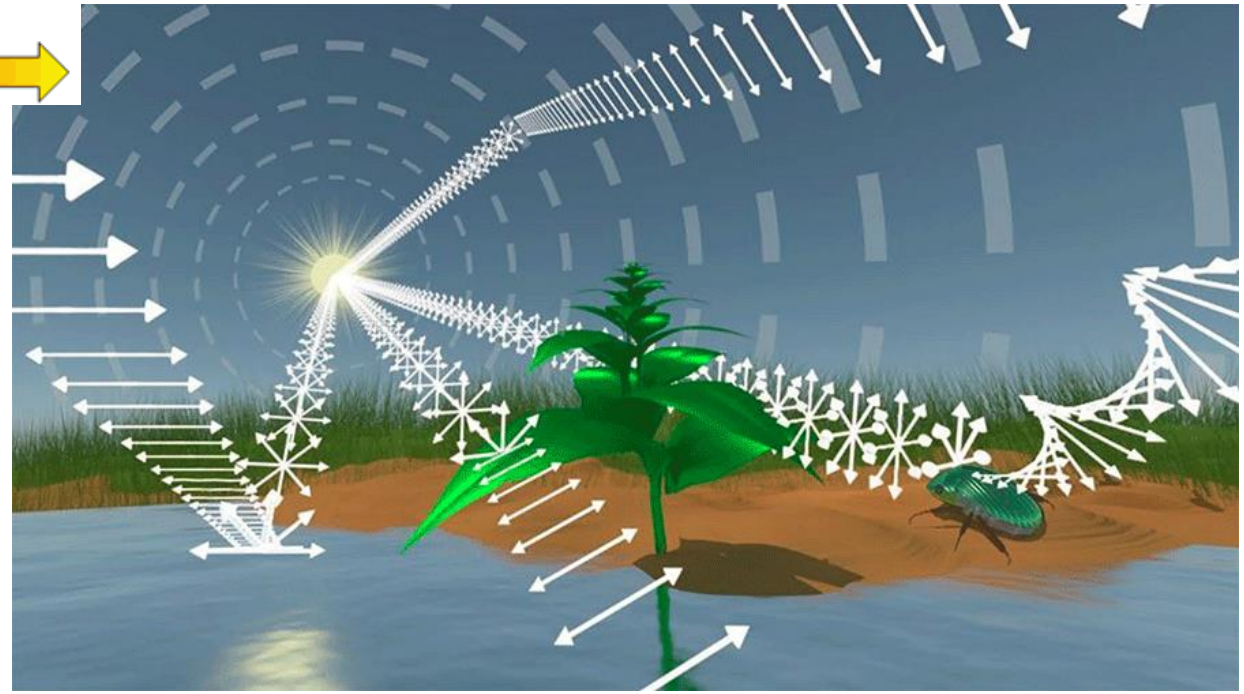
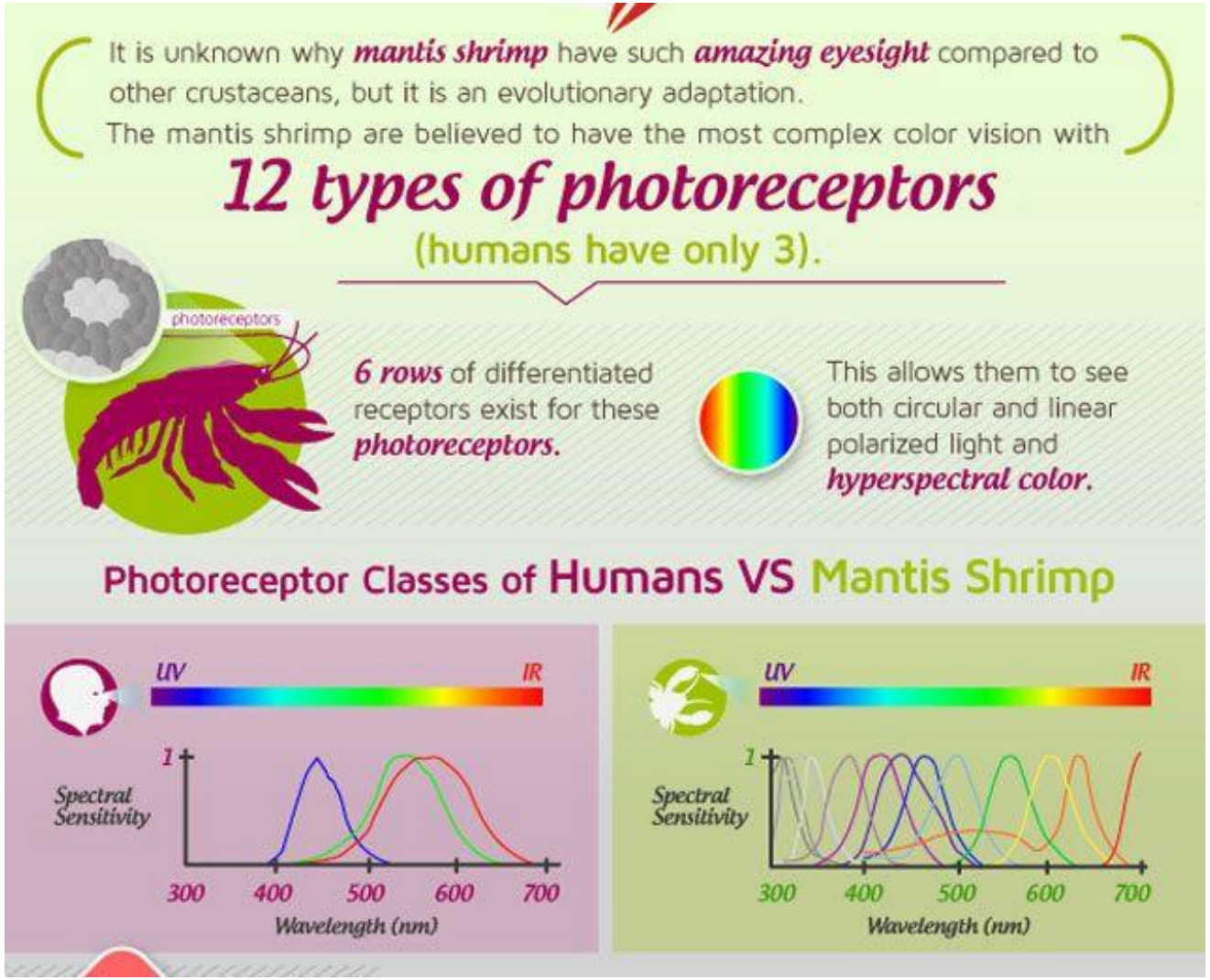
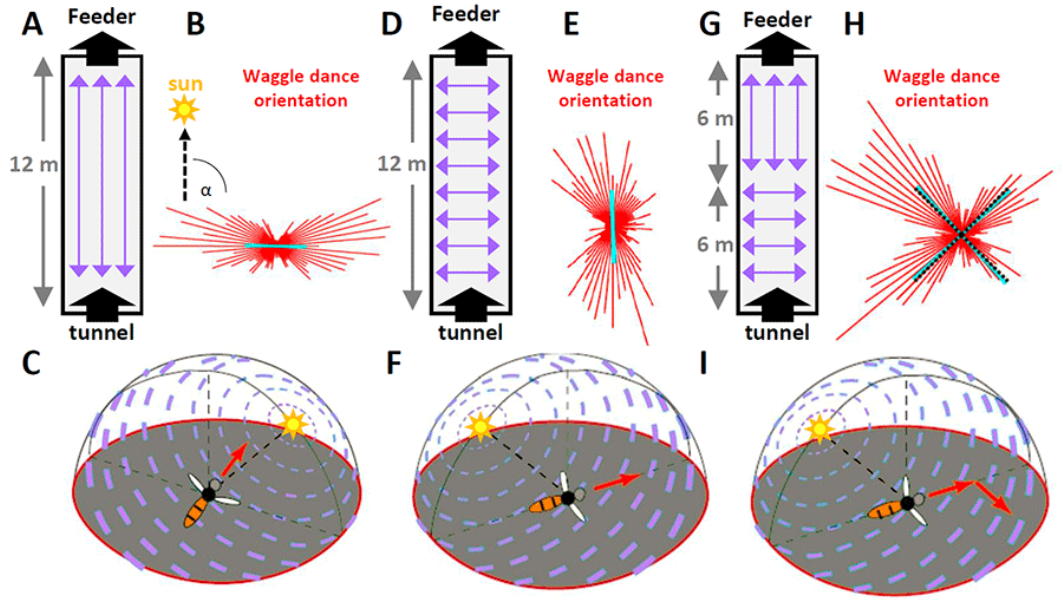


Figure 1



Can we see what there is to see?

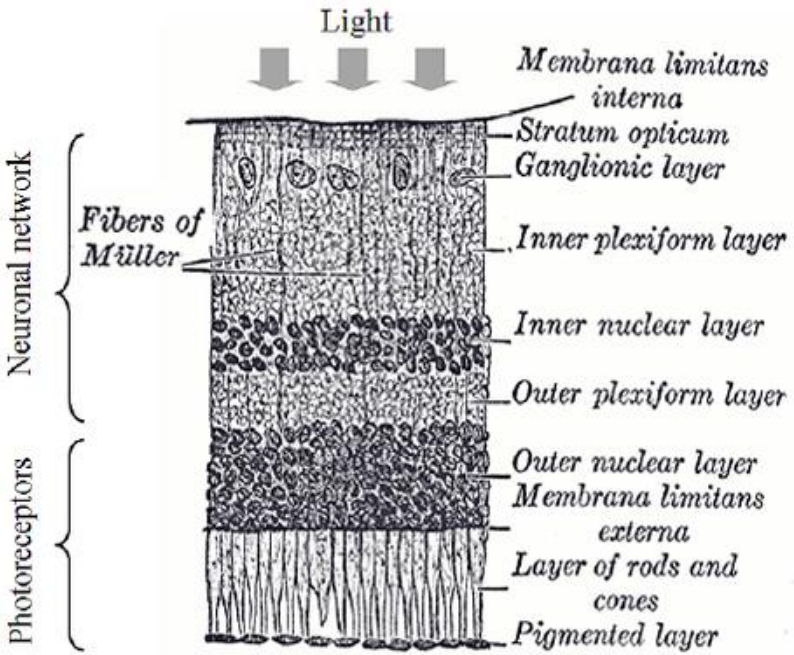




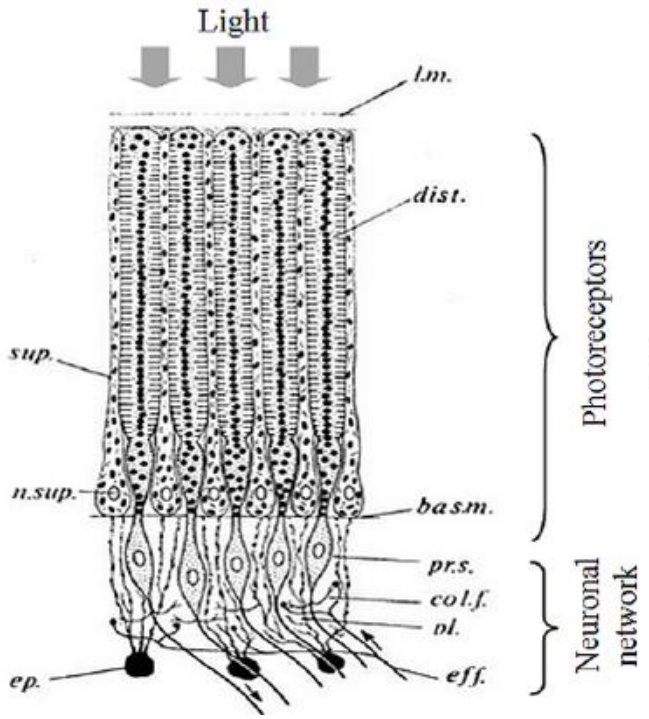
https://youtu.be/glOsvm9t7ec

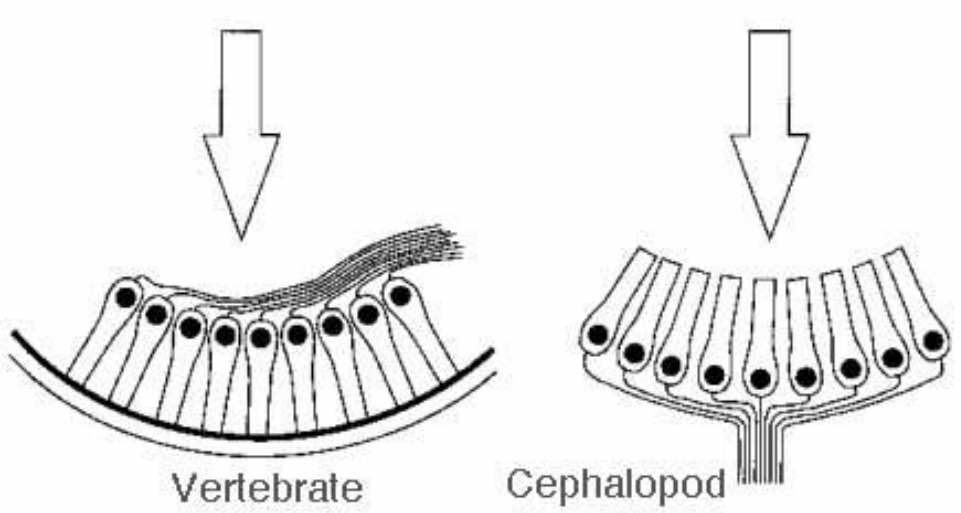
Inverse vs Converse eyes

(a) Retina structure of vertebrates

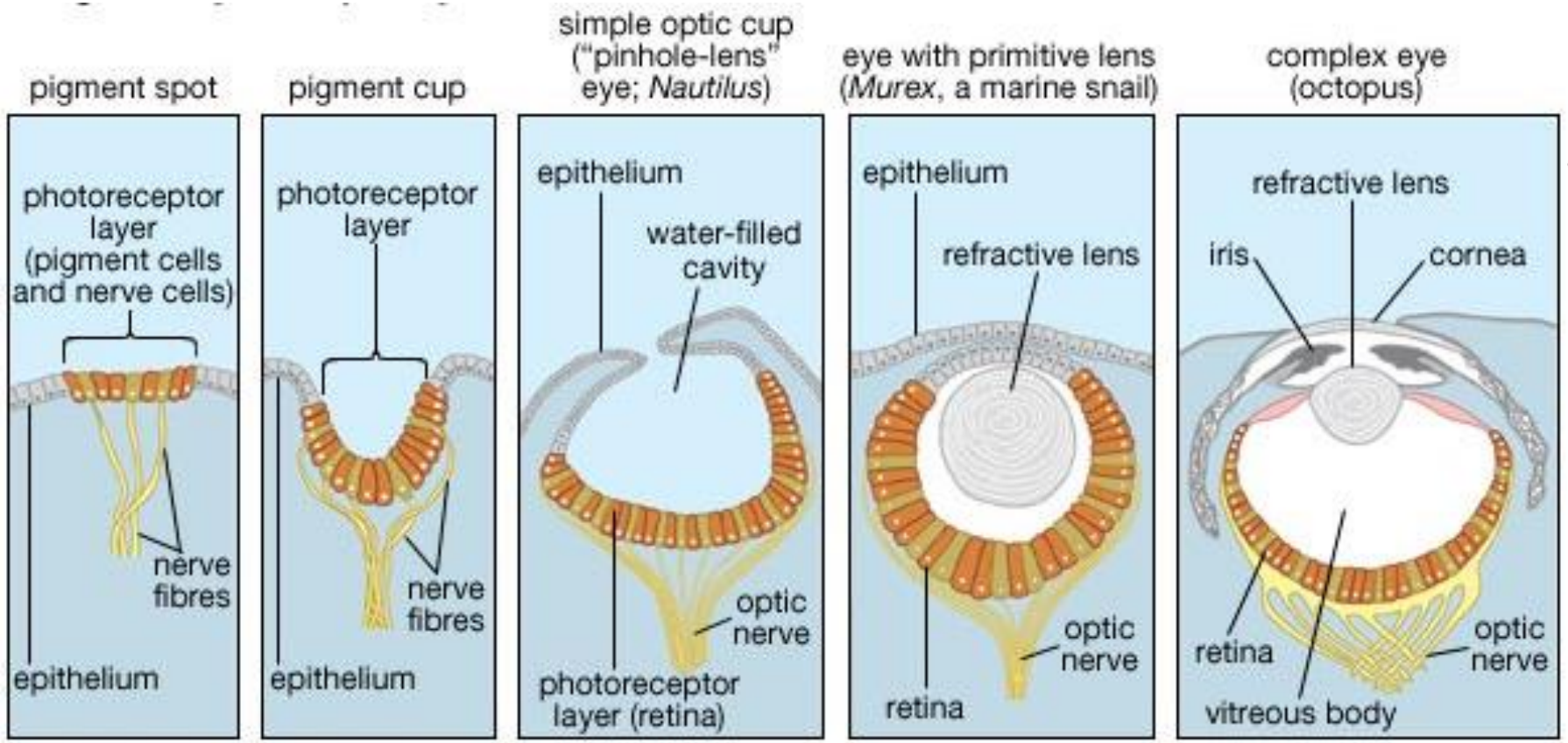


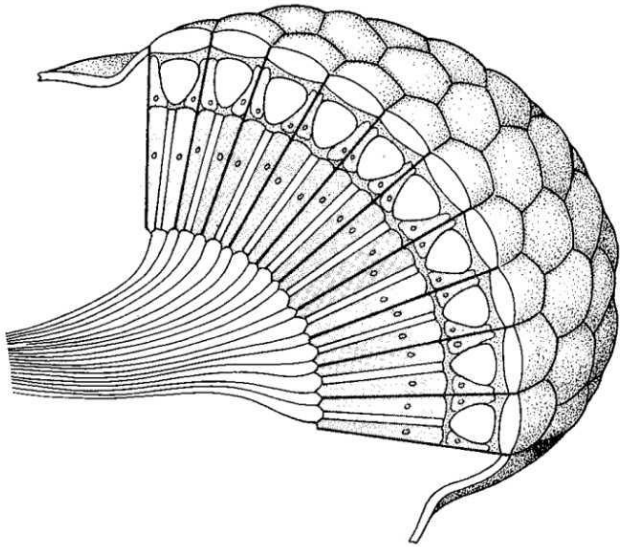
(b) Retina structure of octopus





Basic types of eyes

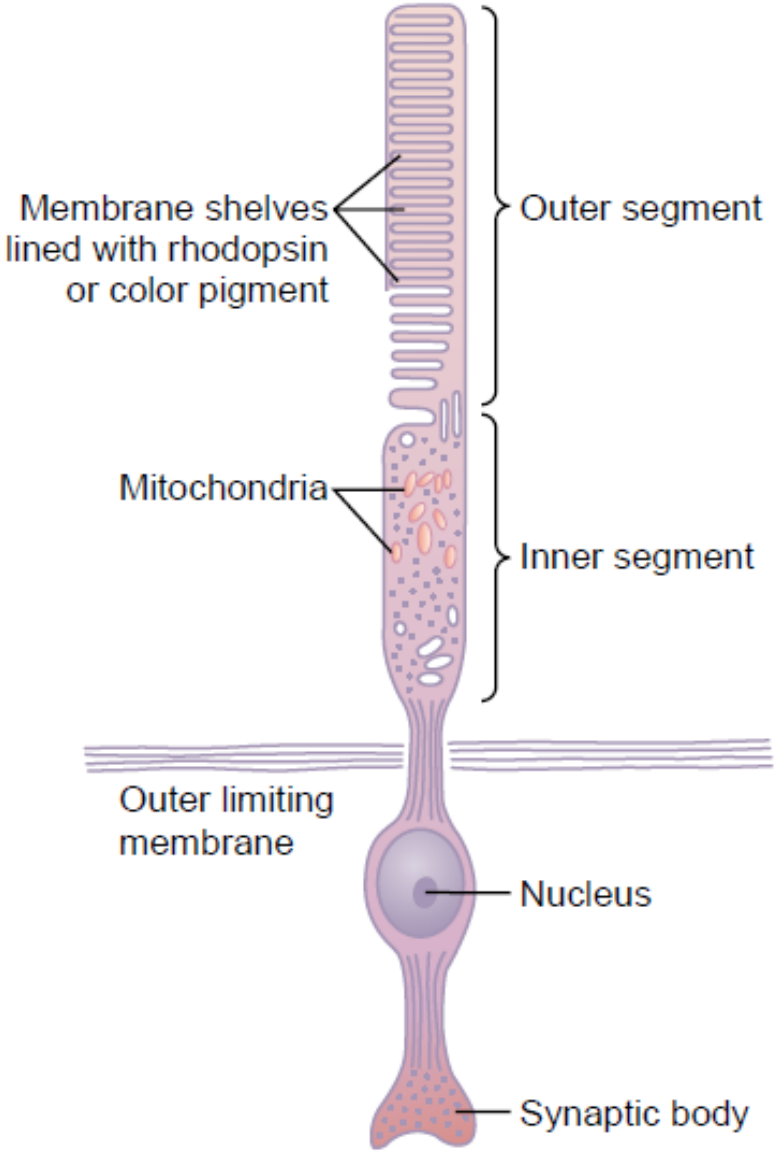




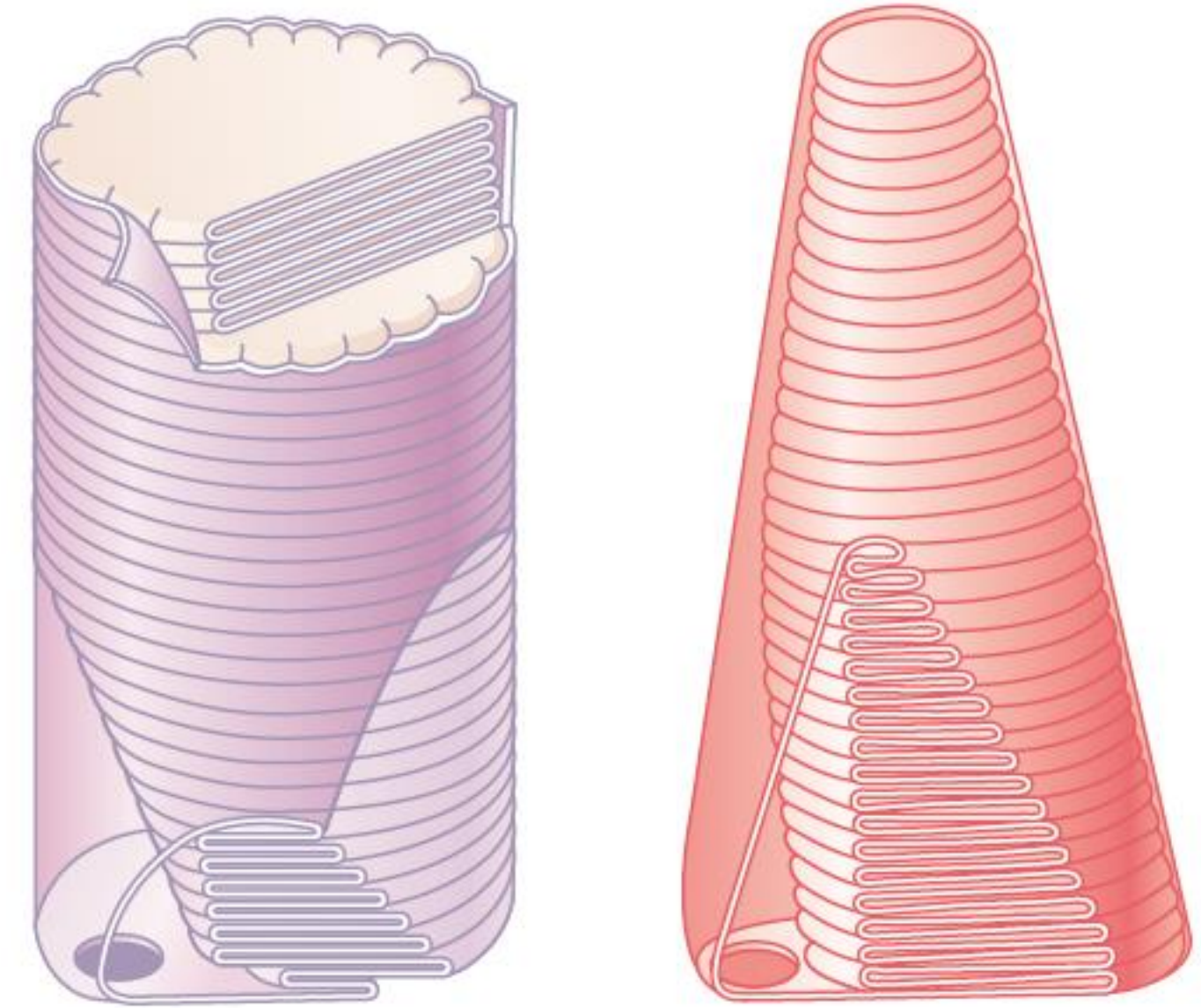
Flat Cup Vesicular Convex

Pineal or Median or Parietal eye

Photoreceptors in mammals



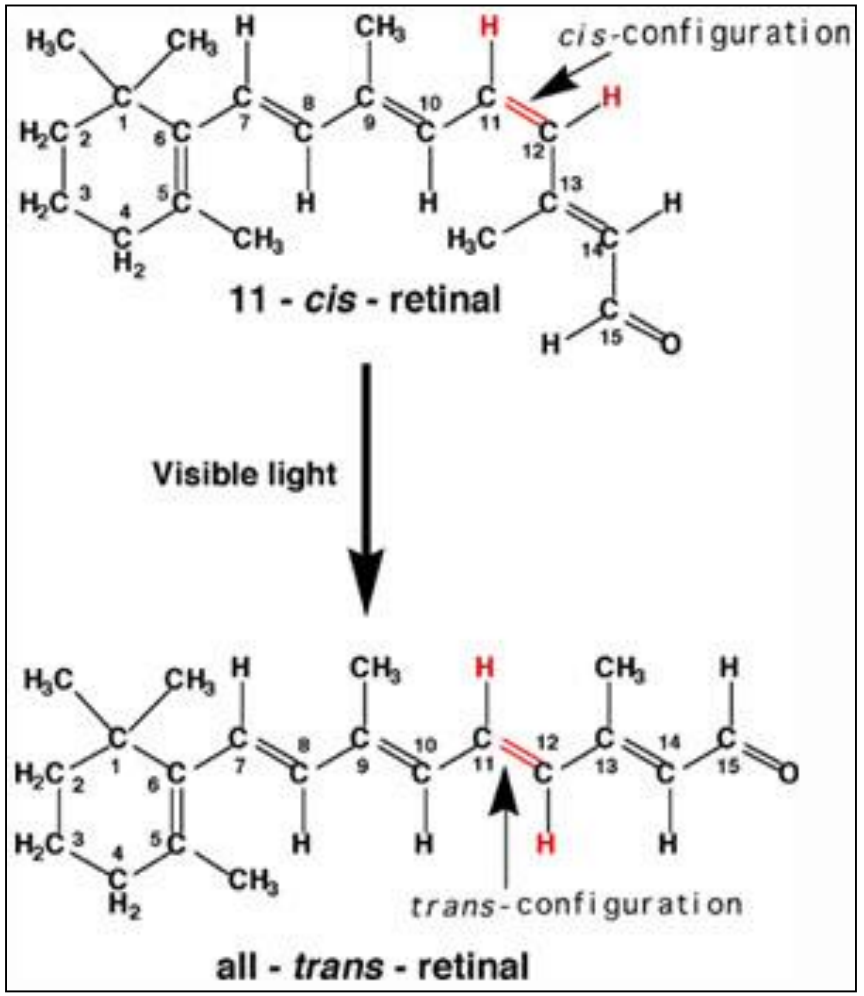
Rod & Cone



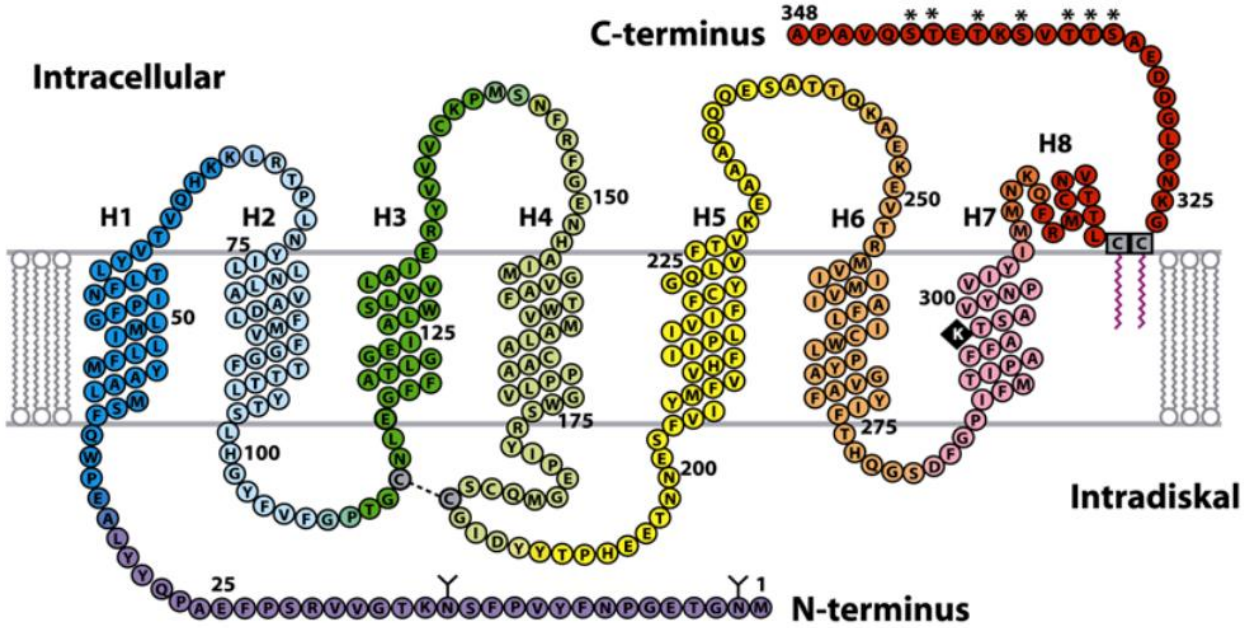
Photochemistry

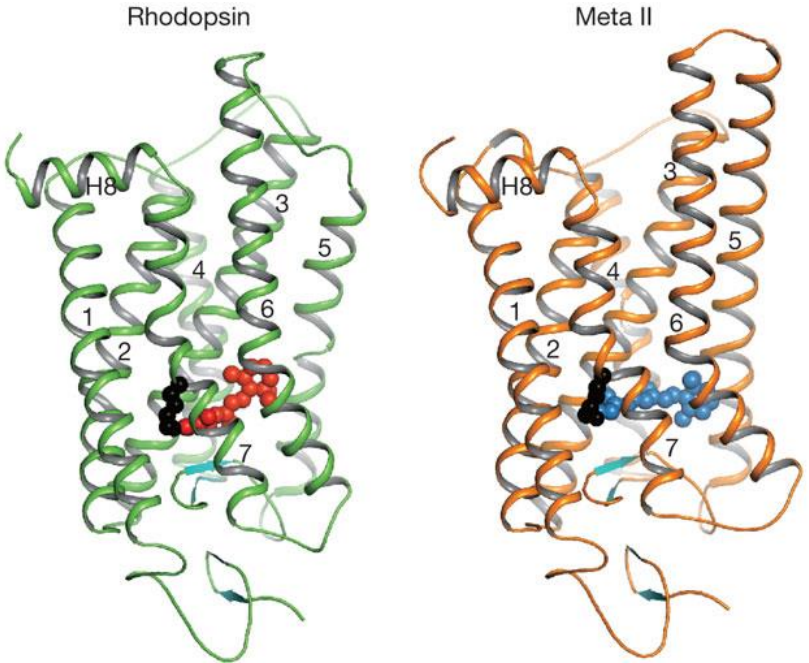
- The light-sensitive proteins in the rods is called rhodopsin
- The light sensitive proteins in the cones, called cone pigments or color pigments
- They are not same but very similar in structure and function

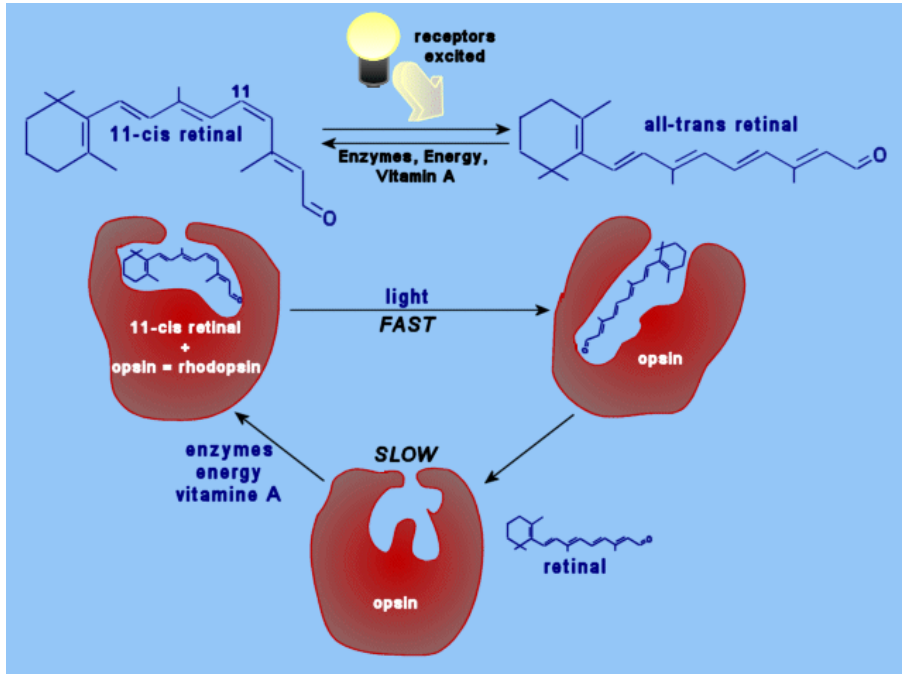
- The outer segment of the rod has a concentration of about 40 per cent rhodopsin which is protein opsin and the carotenoid pigment retinal (also called “retinene”); together called rhodopsin or visual purple
- The retinal is a particular type called 11-*cis* retinal, important because this is the only form that can bind to opsin
- 11-*cis* retinal bound Rhodopsin is called R



Opsin & Retinal







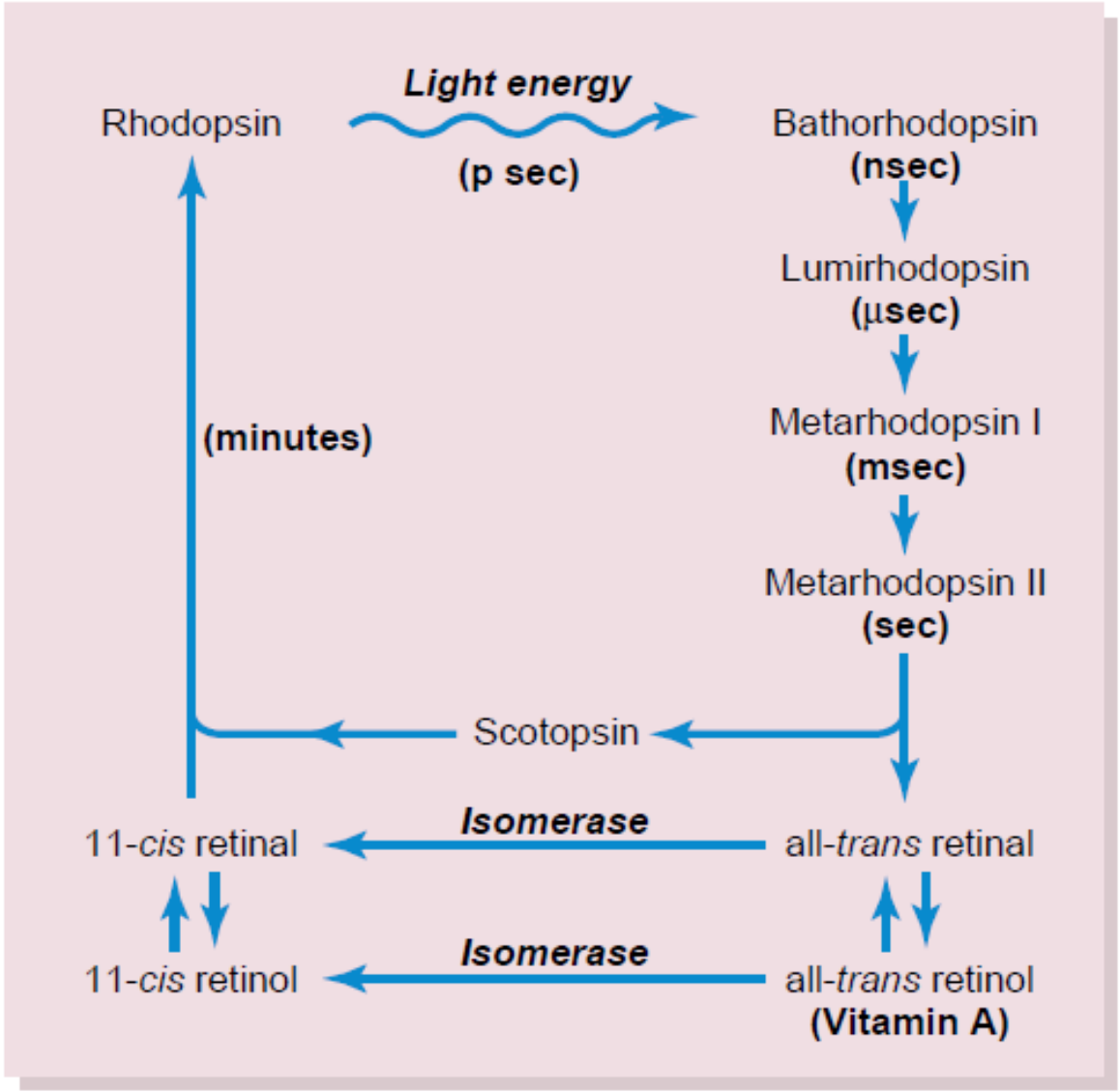
Photochemistry- continued

- Light decompose rhodopsin within a very small fraction of a second
- Because of change of the *cis* form of retinal into an all-*trans* (R*) form
- All-*trans* retinal begins to pull away from the opsin because the fit is not perfect anymore, thus producing bathorhodopsin, a partially split combination of the all-trans retinal and opsin
- Unstable bathorhodopsin immediately decays into lumirhodopsin
- That to metarhodopsin I
- Then to metarhodopsin II
  - Also called activated rhodopsin, that excites electrical changes in the rods and sends a visual signal
- And finally opsin and retinal

Photochemistry- continued

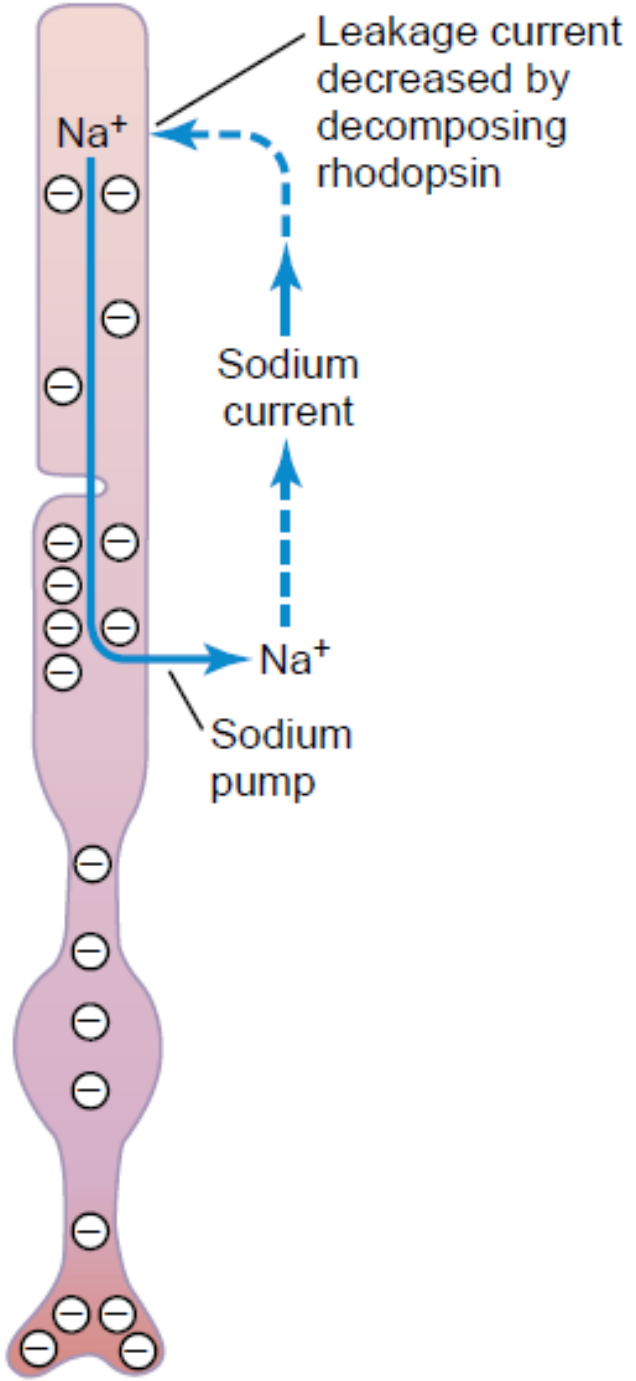
- Re-formation:
  - First, convert all-*trans* retinal into 11-*cis* retinal
  - Catalyzed by retinal isomerase
  - Once converted 11-*cis* retinal then again binds with opsin
- Role of vitamin A:
  - Another route to make 11-*cis* retinal is through retinol (one form of vitamin A)
  - First, all-*trans* retinal into all-*trans* retinol
  - Then, all-*trans* retinol into 11-*cis* retinol by isomerase
  - Finally, 11-*cis* retinol into 11-*cis* retinal
- There is an excess of vitamin A in the cytoplasm of rod cells

The biochemistry



Theoretical basis of hyperpolarisation

- Unlike other cells rod cells hyperpolarize, not depolarize
- When rhodopsin decomposes, it decreases the rod membrane conductance for sodium ions in the outer segment of the rod; hence hyperpolarization
- Inner segment pumps Na^+ out
- The outer segment lets Na^+ in
- Membrane potential -40mV
- With light excitation outer segment stops Na^+ entry creating -70 to -80mV



Guyton, mostly