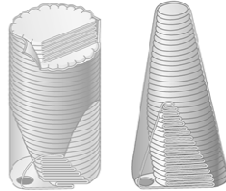


**LECTURE 3**

**PHOTO TRANSDUCTION IN  
LIGHT AND DARK**



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**OBJECTIVES**

**At the end of this lecture you should be able to:**

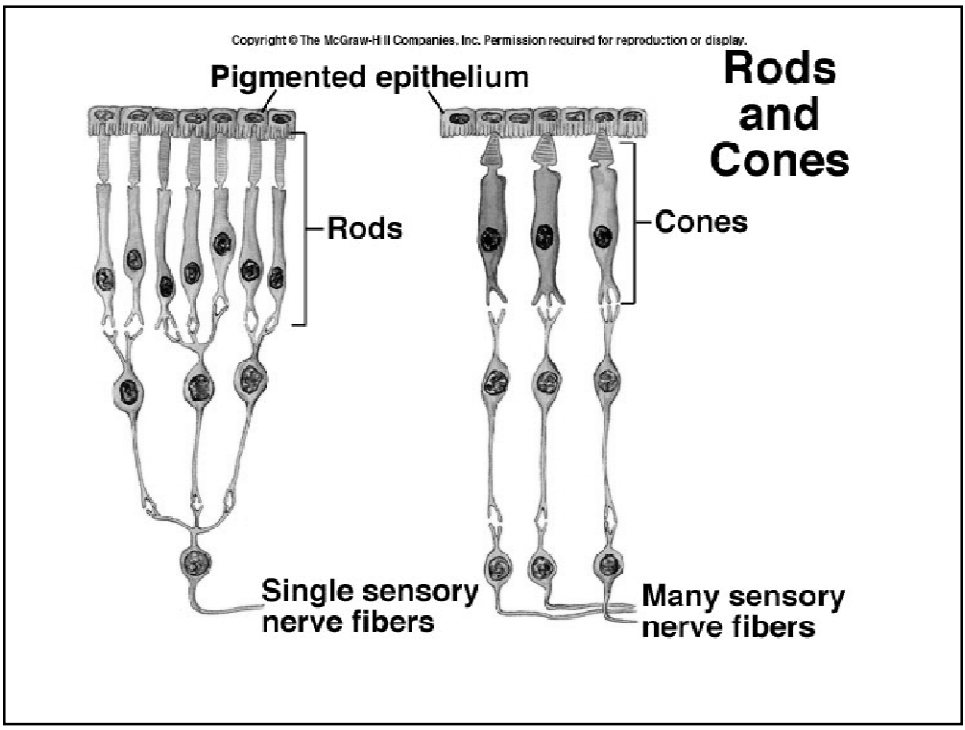
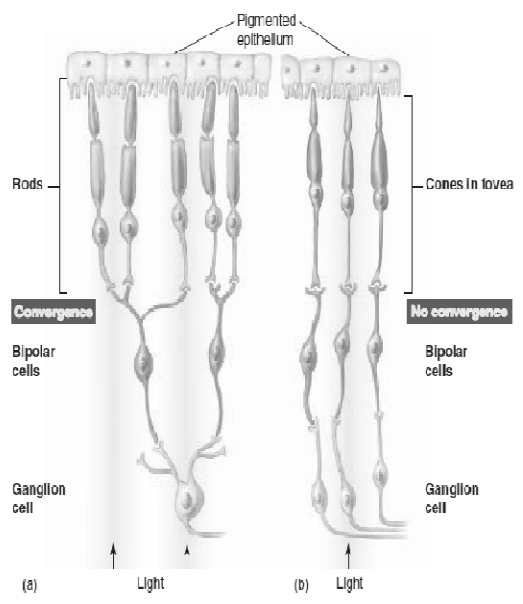
- Explain functional properties of rods and cones in scotopic and photopic vision**
- Know the convergence and its value**
- Describe phototransduction process for rods and cones in light and dark and the ionic basis of these responses**
- Enumerate Synaptic mediators at retina**
- Describe Rhodopsin regeneration**
- Define nyctalopia, dark and light adaptation**



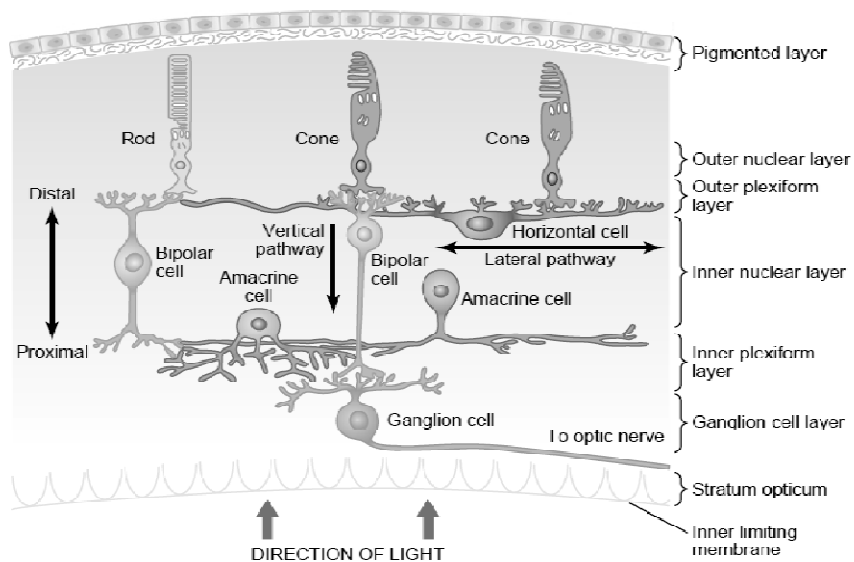
**Low convergenc in cones:**  
**cones synapse with**  
**→one bipolar cell →one**  
**ganglion cell**

**It increases visual**  
**acuity & decreases**  
**sensitivity to light**

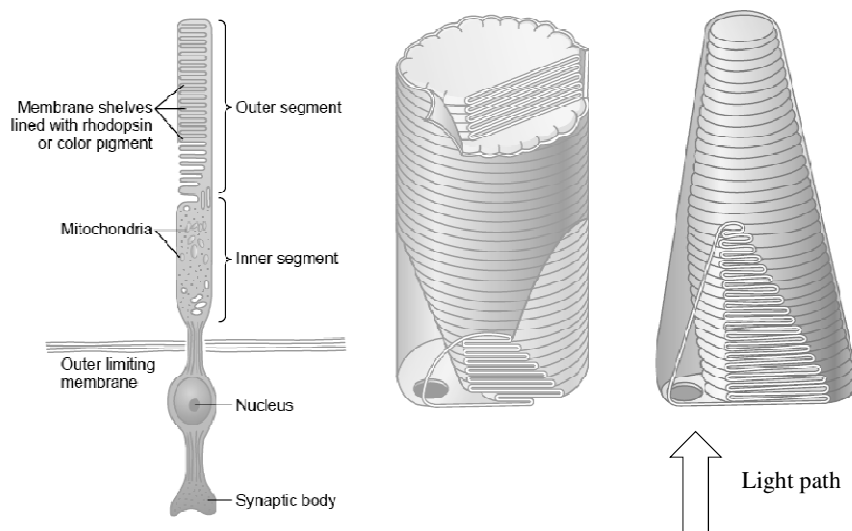
**High convergence of**  
**rods: 300:1-**  
**It decreases visual**  
**acuity & increases**  
**sensitivity to light**



## 9 Layers of retina



## Schematic drawing of the functional parts of the rods and cones



## Receptors of vision (Rods&cones)

- Outer segment (modified cilia) has disks full of photosensitive pigment (rhodopsin) react with light to initiate action potential
- -In cones is conical , small and contain 3 types of rhodopsin
- - in rods it is big, rod like and contain one type of rhodopsin
- -There are Na channels in the outer segment
- Inner segment full of mitochondria ( source of energy for Na-K pump), it is thick in cones
- There is Na-K pump in inner segment

## Comparison of Rods and Cones

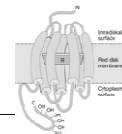
### Rods

- Abundant in the periphery of the retina
- About 120 million
- Contain Scotopsin
- Best for low light conditions
- See black/white and shades of gray

### Cones

- Abundant in fovea
- About 6 million
- Contain Photopsin (3Types)
- Best for bright light conditions
- See all colors

## Photochemistry of Vision



**1-In Rods: it is rhodopsin:**

**[Scotopsin protein (opsin) + retinal (retinene 1 = Vit A)]**

• **Called visual purple (Rhodopsin of the rods most strongly absorbs green-blue light and, therefore, appears reddish-purple**

**2- In cones there are 3 types of Photopsins (I,II & III) :**

**[Photopsin protein (opsin) + retinal (retinene 1 = Vit A)]**

- It is stored in disks of rods at outer segment

- It forms (90% of its protein )

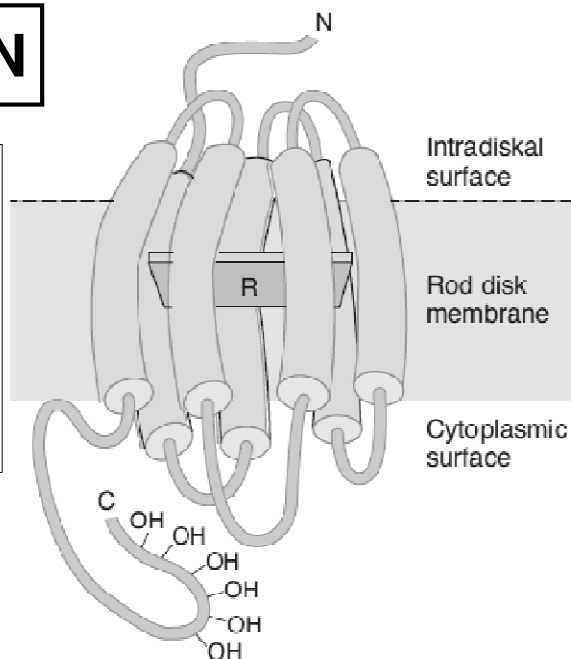
-In dark rhodopsin is in 11-cisretinal form (INACTIVE) It is light sensitive form which increase sensitivity of rods to light

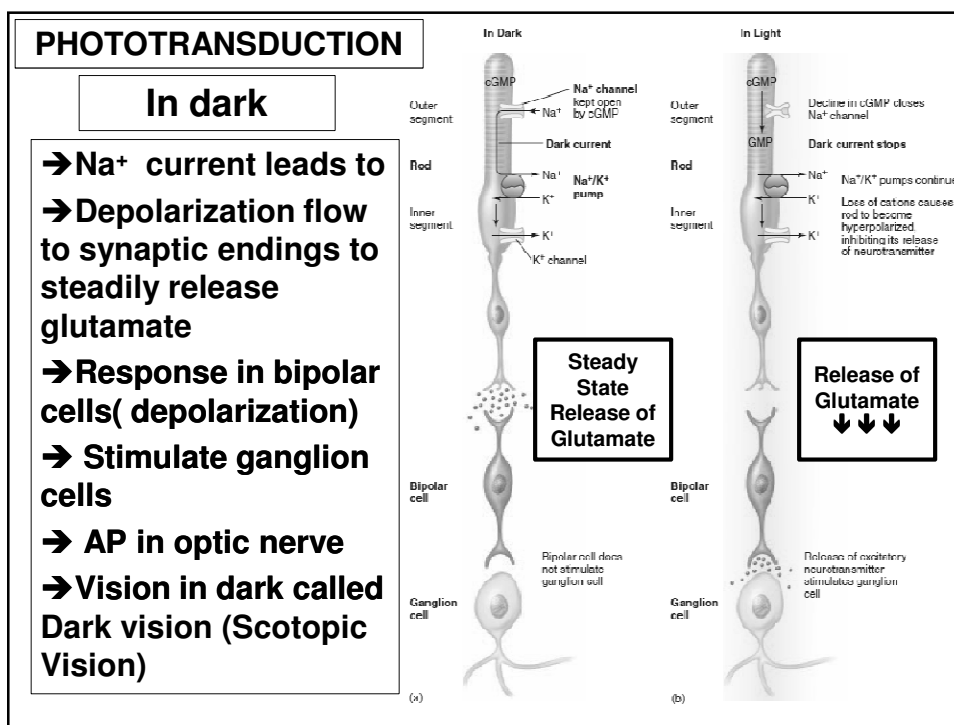
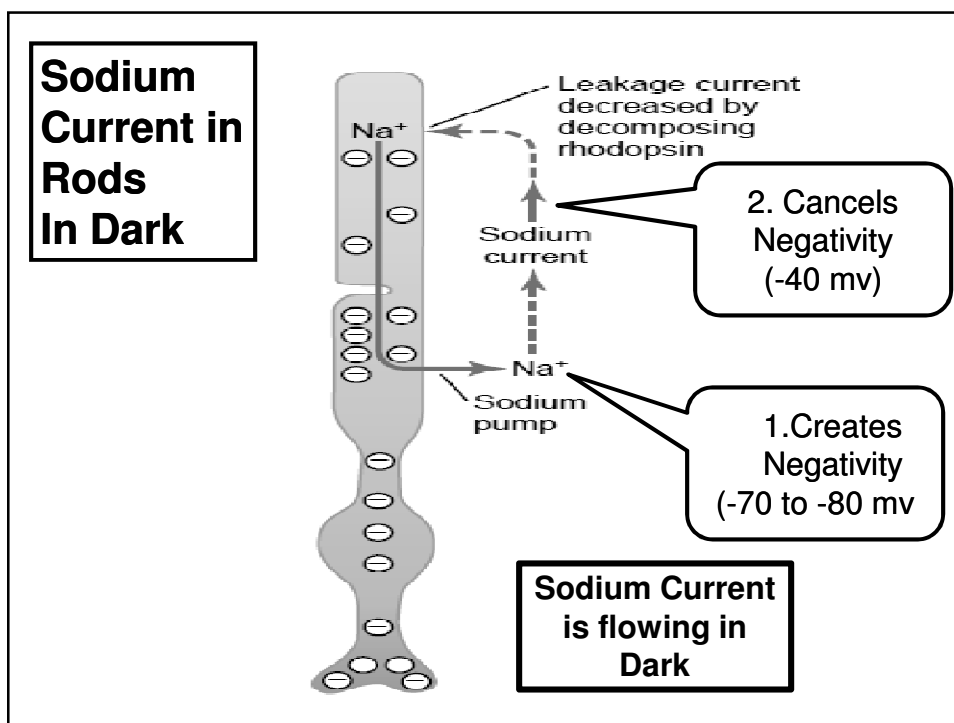
## RHODOPSIN

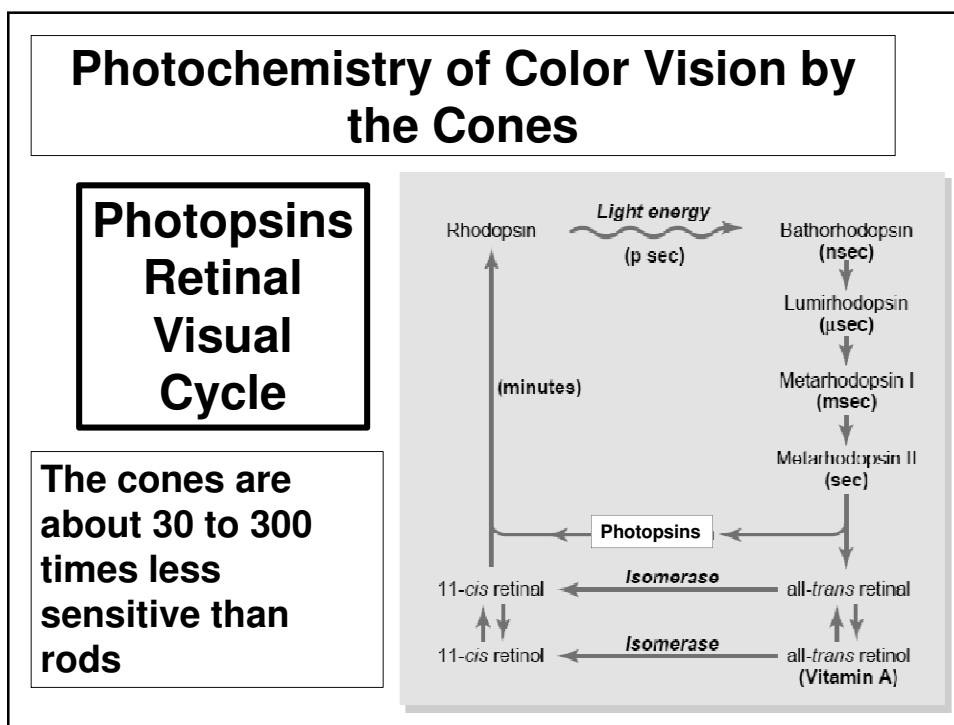
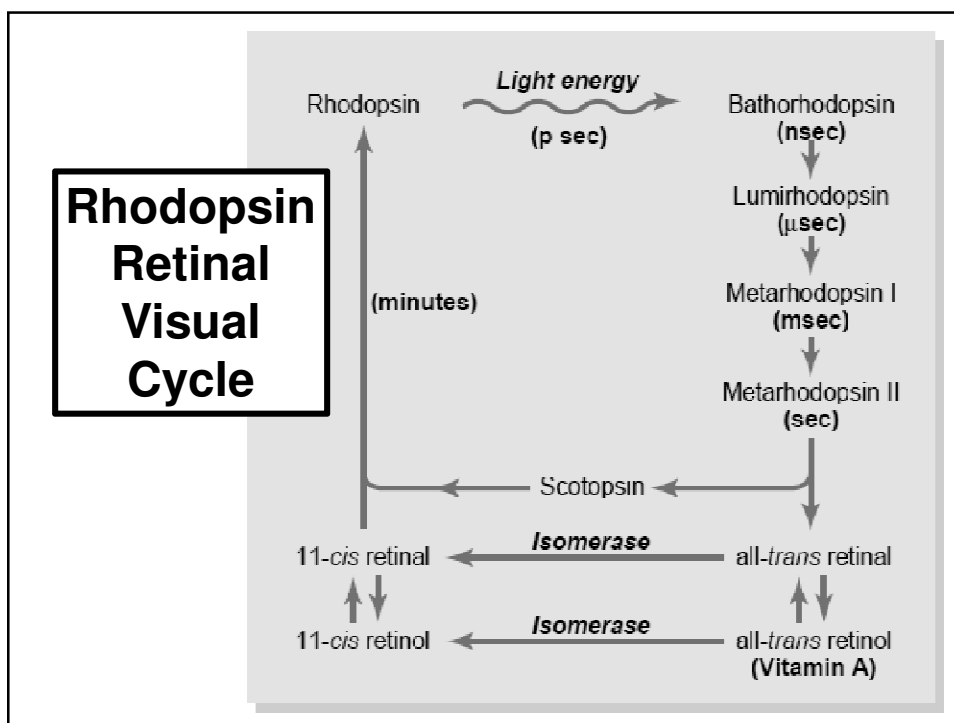
### NYCTALOPIA (night blindness)

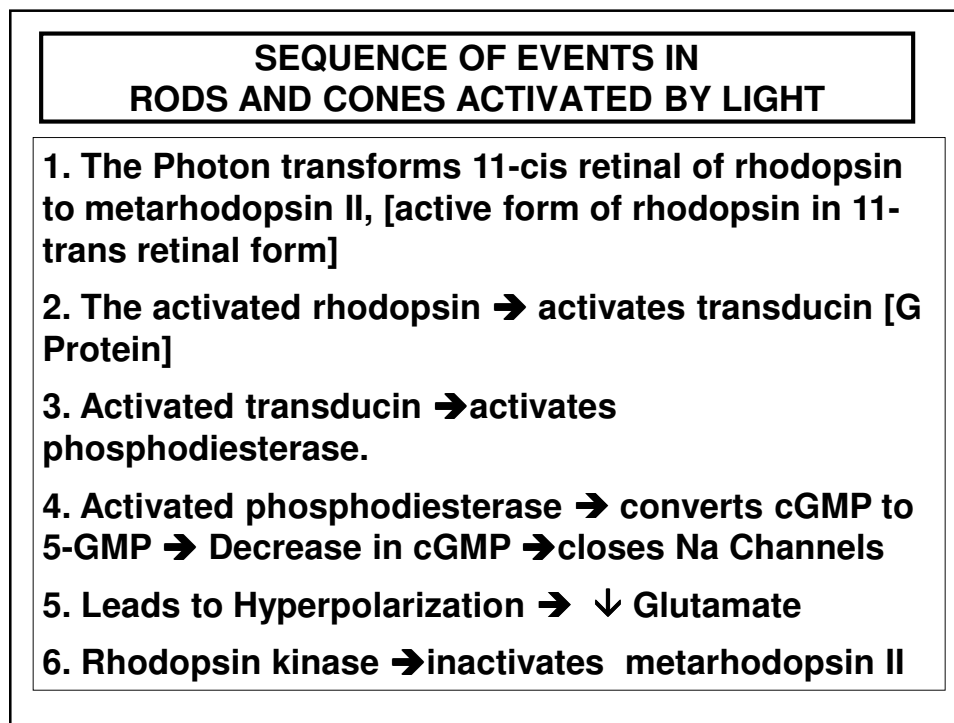
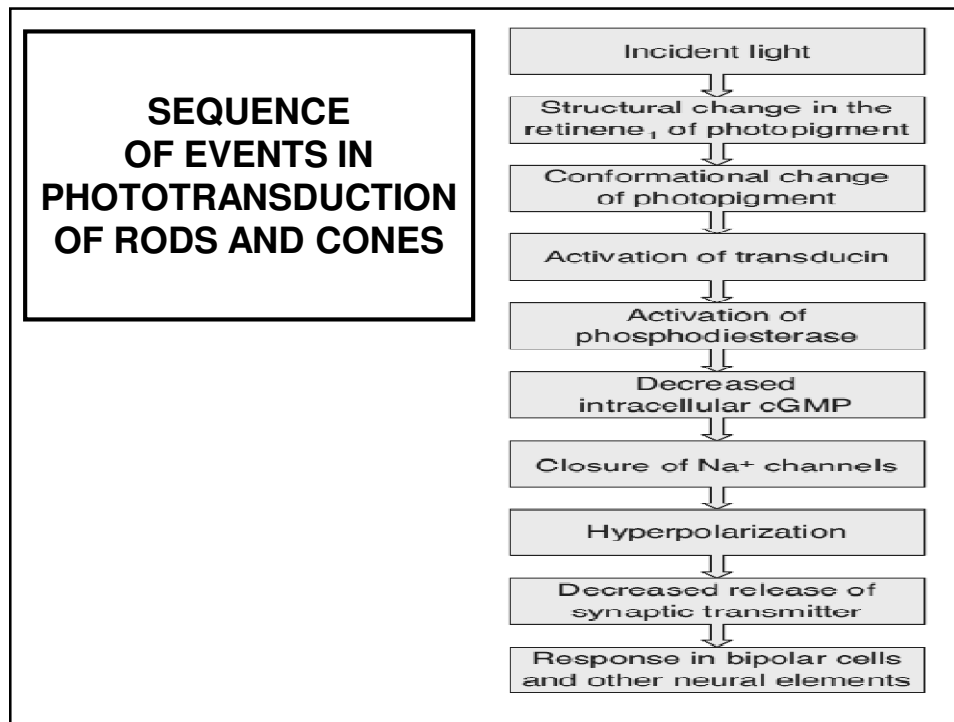
Deficiency of Vitamine A (main source of retinal of rhodopsin) cause ↓ rods pigments

Also causes xerophthamia (Dry Eyes)

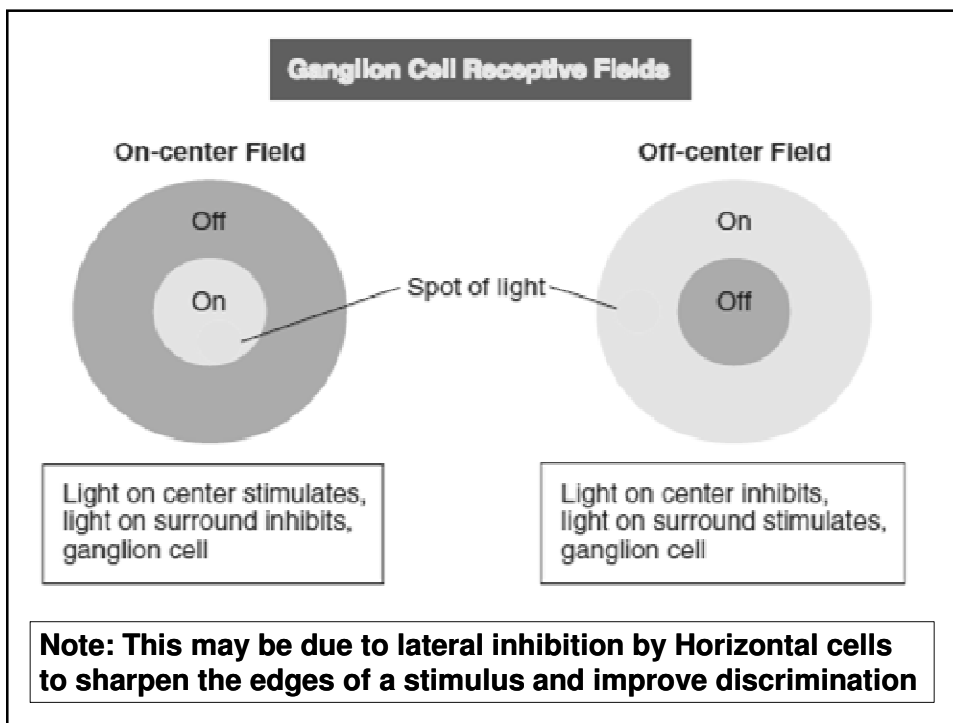
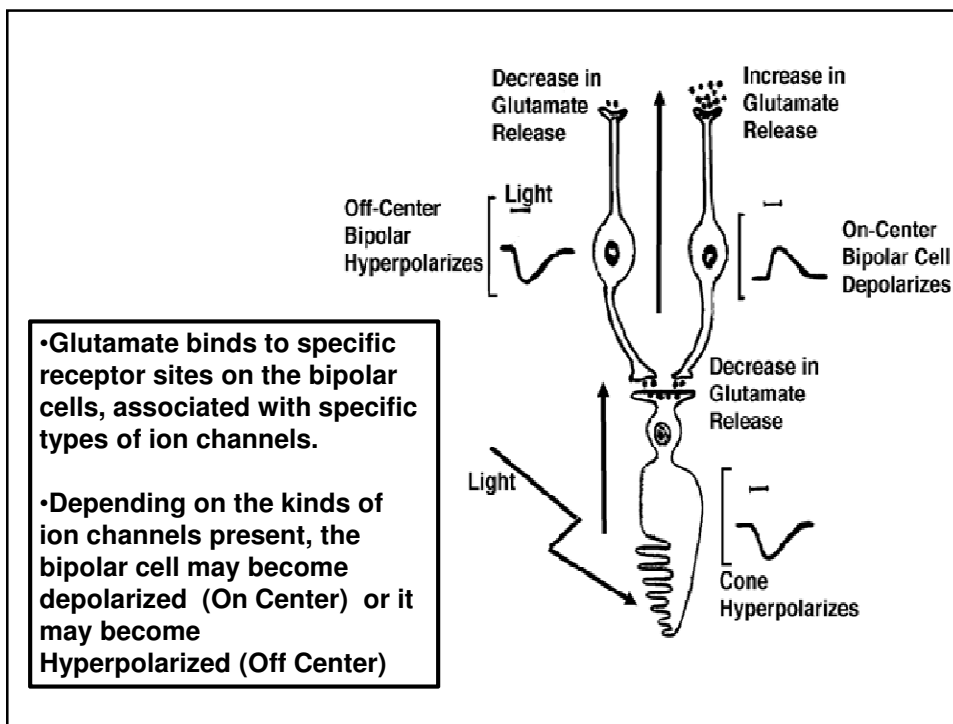


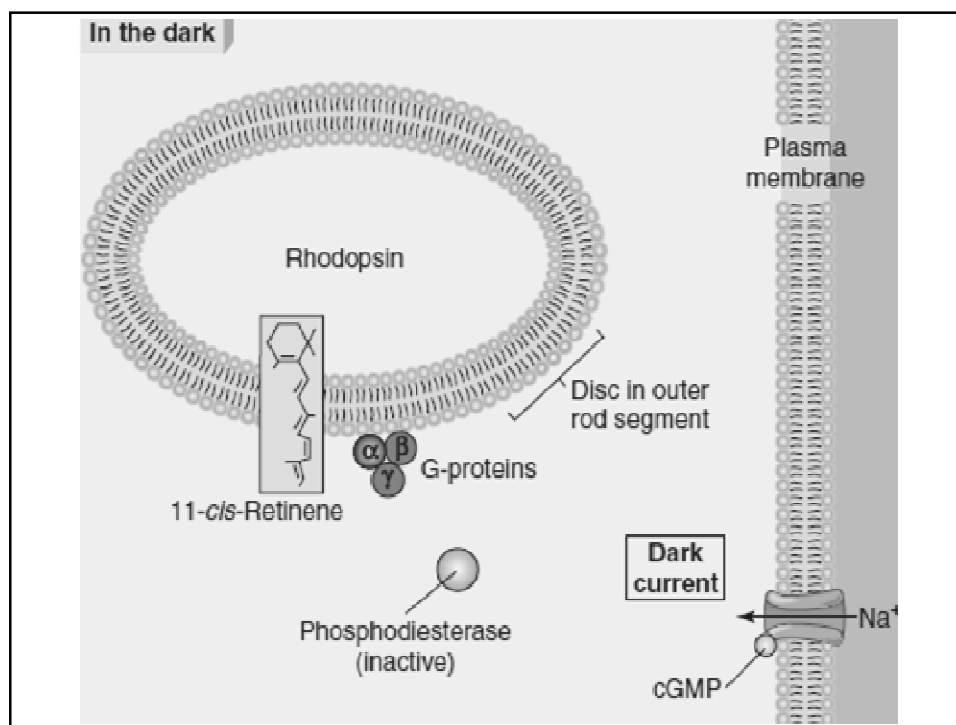
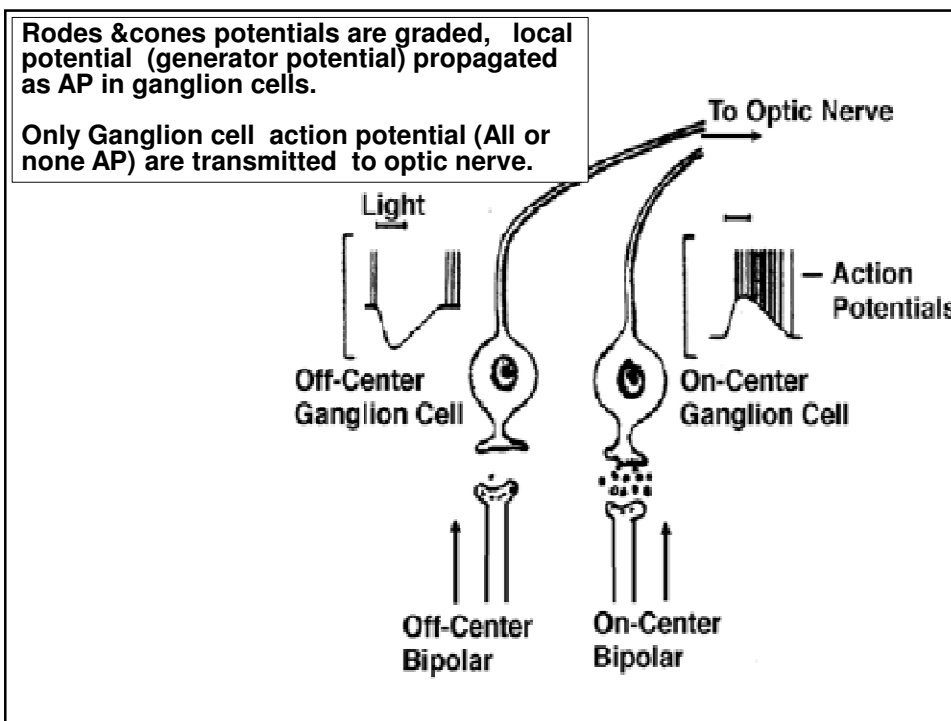


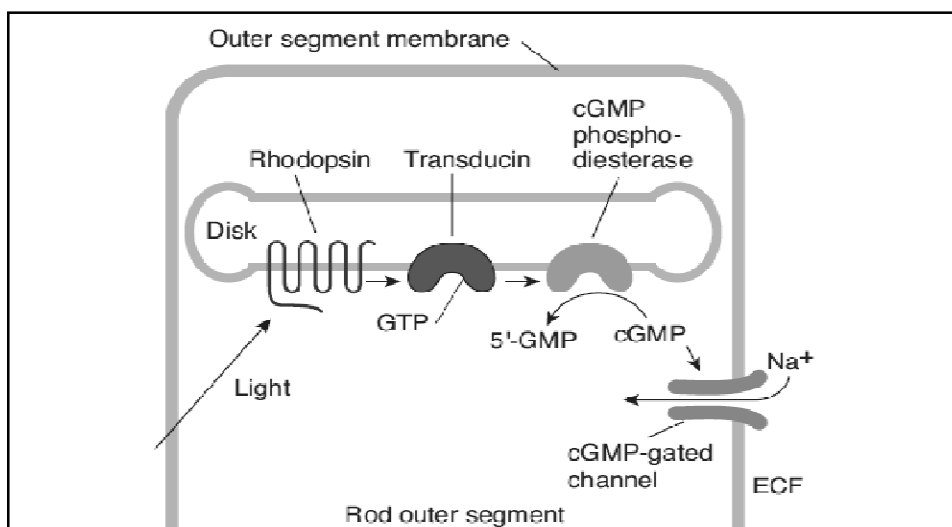
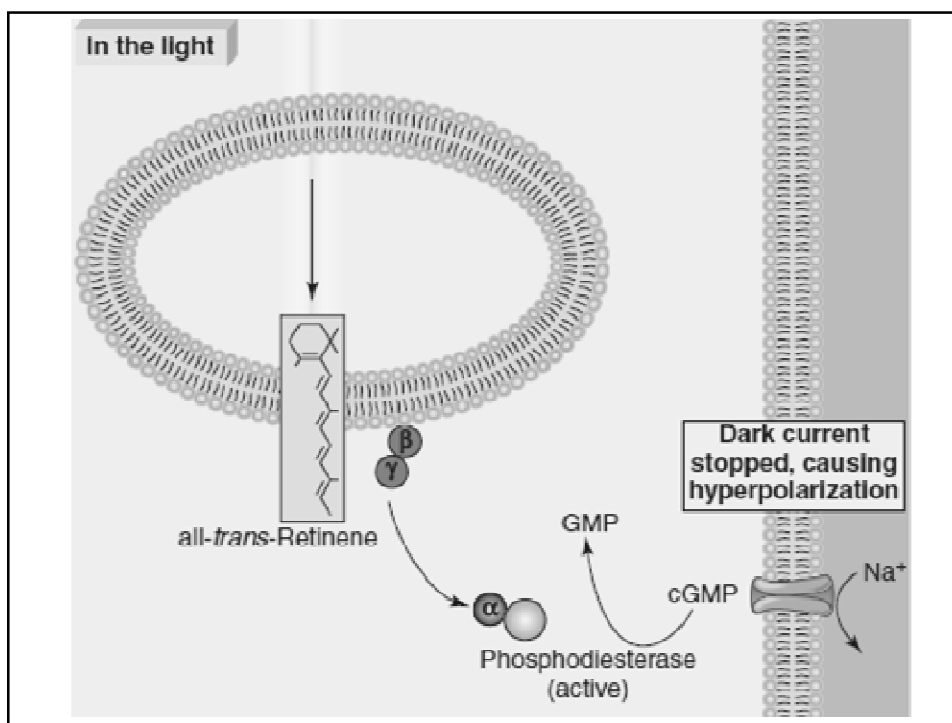




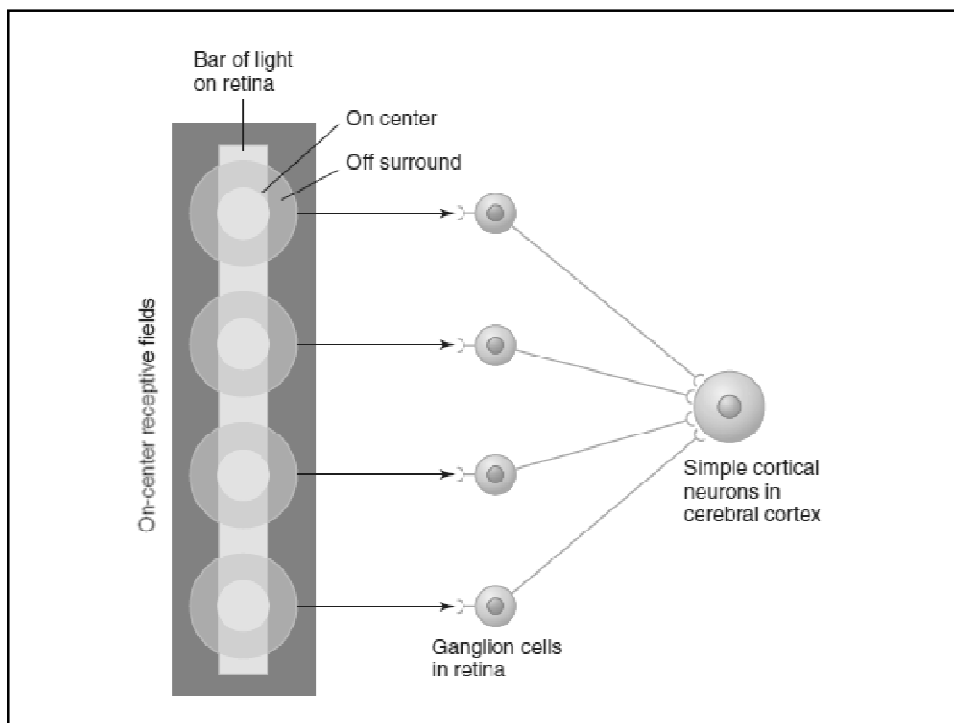
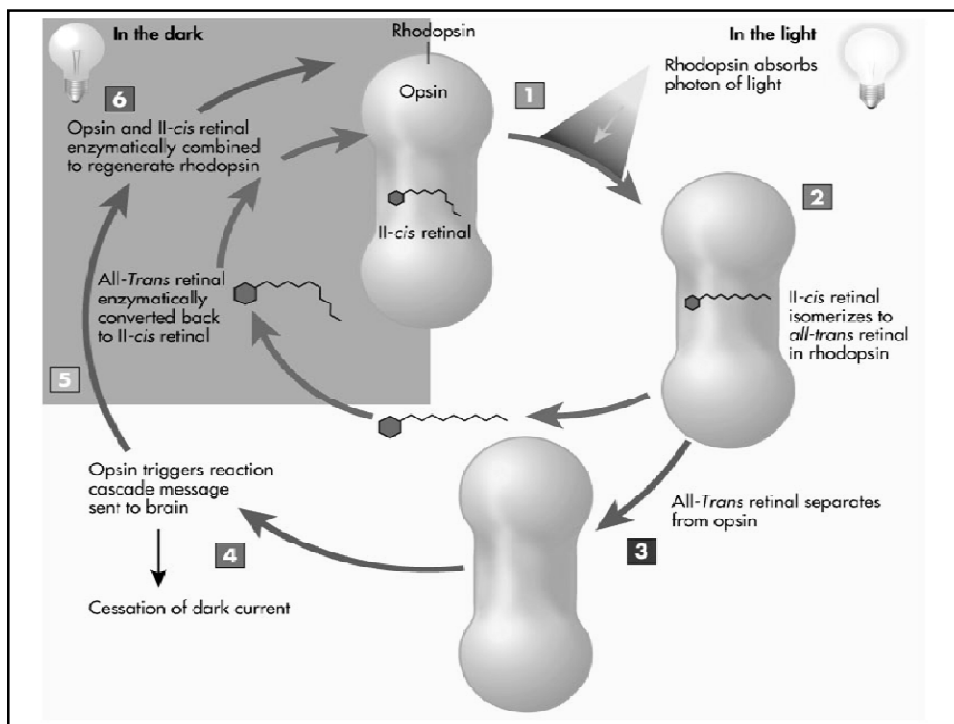








**FIGURE 12-14 Initial steps in phototransduction in rods.** Light activates rhodopsin, which activates transducin to bind GTP. This activates phosphodiesterase, which catalyzes the conversion of cGMP to 5'-GMP. The resulting decrease in the cytoplasmic cGMP concentration causes cGMP-gated ion channels to close.



## DARK ADAPTATION

If a person moves from brightly lighted surroundings to a dim lighted area the retinas slowly become more sensitive to light as the individual becomes “accustomed to the dark” [20 min] for dark vision (only gross features but no details or colors)

Rapid (5 minutes) due to adaptation of cones in fovea (sensitivity of cones to light increases)

Less rapid (20 min) due to adaptation of rodes in the peripheral retina (sensitivity of rodes to light increases)

- More light sensitive pigments
- ↓ In Visual threshold
- ↑ In Visual sensitivity
- Na channels remain open
- Na current continues

## LIGHT ADAPTATION

If a person moves from dim to enlightened area light seems intensely and even uncomfortably bright until the eyes adapt to the increased illumination and the visual threshold rises in 5 minutes.

- Less light sensitive pigments
- ↑ In Visual threshold
- ↓ In Visual sensitivity
- Na channels remain close
- Na current decreases

**Why radiologists & aircraft pilots wear red goggles in bright light?**

Red light mainly stimulates the cones & rods to some extent, so red goggles for rods act as dimlight, so with it rods are adapted to darkness & form large amounts of rhodopsin while the person is in bright light & when person enters a dark place he can see well & do not have to wait for 20 minutes for dark adaptation.