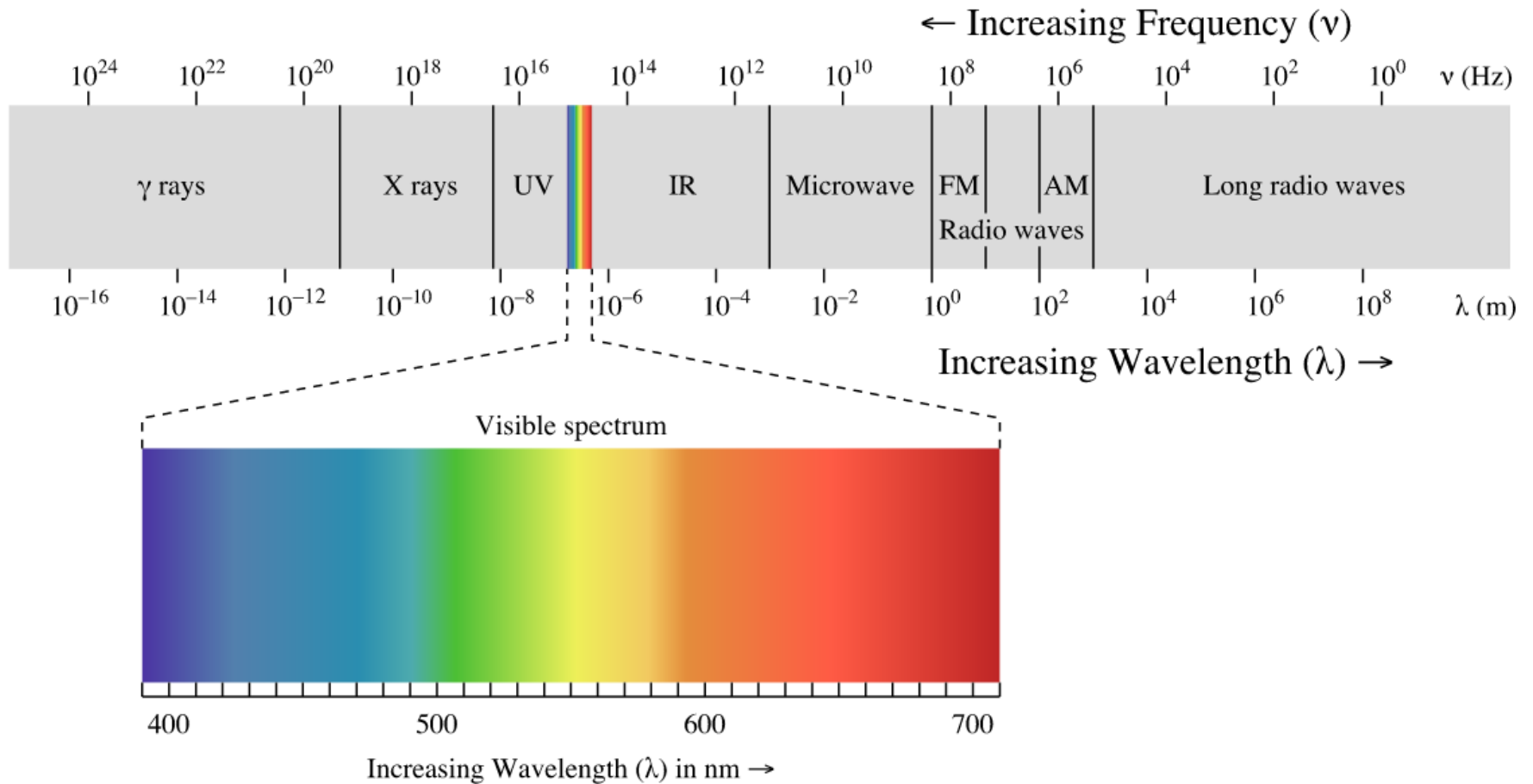


10

Vision I

Light

Electromagnetic radiation with wavelengths in range of 400 – 700 nm



Color mixing

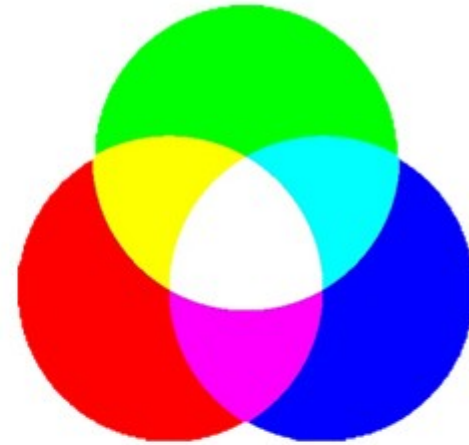
RGB

Additive
Color



mixing light

RED GREEN BLUE



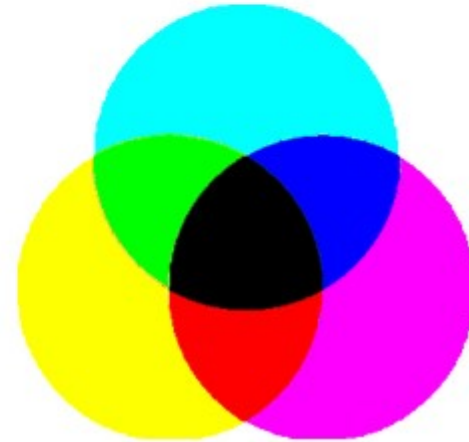
CMYK

Subtractive
Color



mixing ink

CYAN MAGENTA YELLOW



Photoreceptive organ

✓ Light detection

✓ Image formation

Light detection

- Circadian activity
 - Both prokaryotes and eukaryotes
 - Day/night cycle is the most influential and the most stable biorhythm

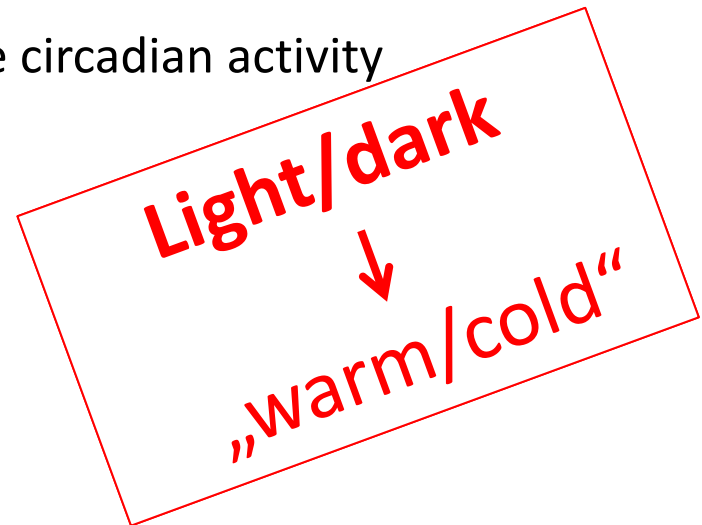
Light detection

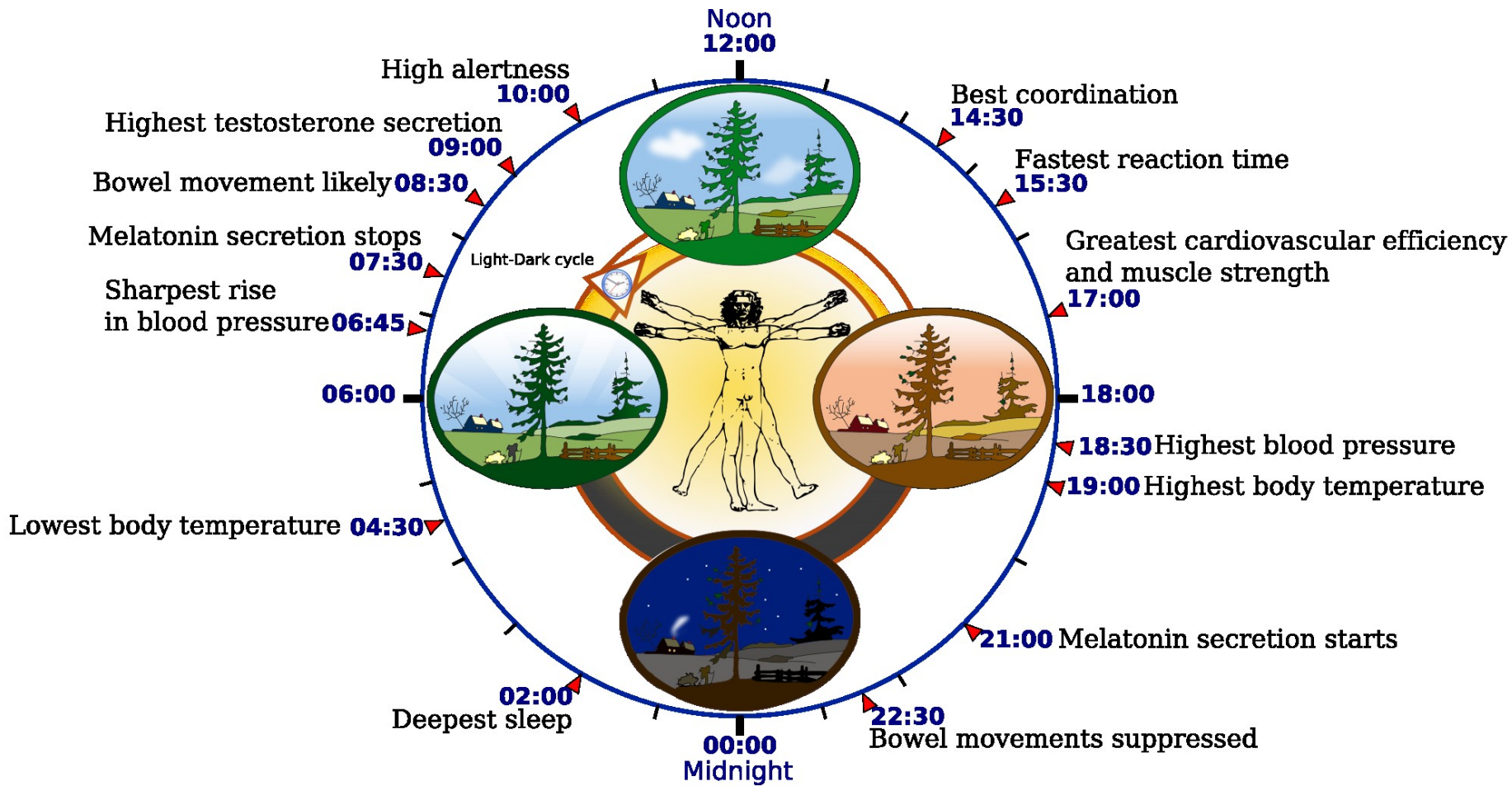
- Circadian activity
 - Both prokaryotes and eukaryotes
 - Day/night cycle is the most influential and the most stable biorhythm



Light detection

- Circadian activity
 - Both prokaryotes and eukaryotes
 - Day/night cycle is the most influential and the most stable biorhythm
 - Oscillation with a period of aprox. 24 hours even without signals from environment
 - Environmental signals synchronize circadian activity
- Season activity





Biological clock

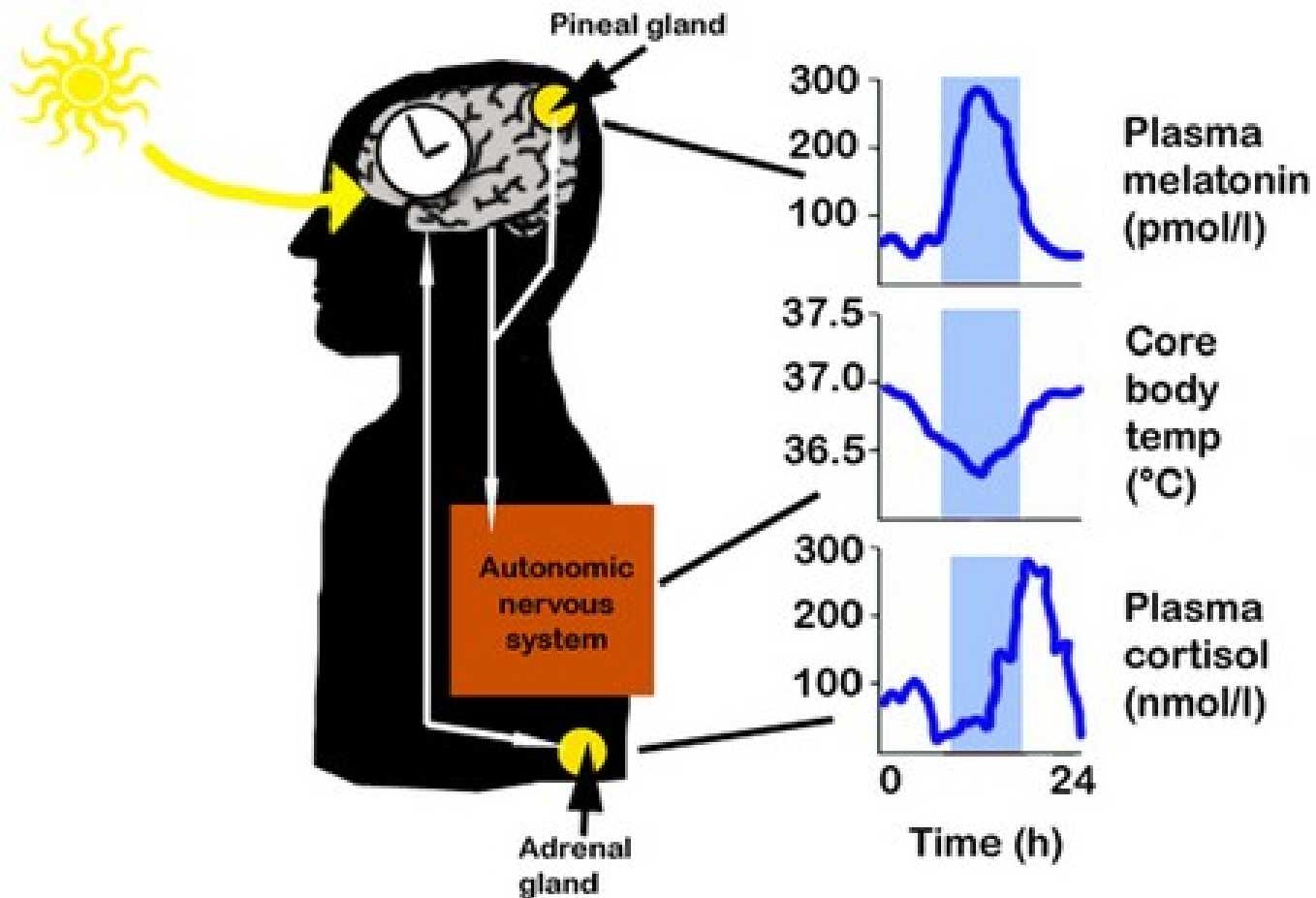
- Cellular level
 - Group of proteins rhythmically expressed creating interconnected feedback loops (about 24hours)

Biological clock

- Cellular level
 - Group of proteins rhythmically expressed creating interconnected feedback loops (about 24hours)
- Tissue level
 - Peripheral oscillators
 - Adrenal gland, lung, liver, pancreas, skin
 - Influenced by neurohumoral factors and also by light

Biological clock

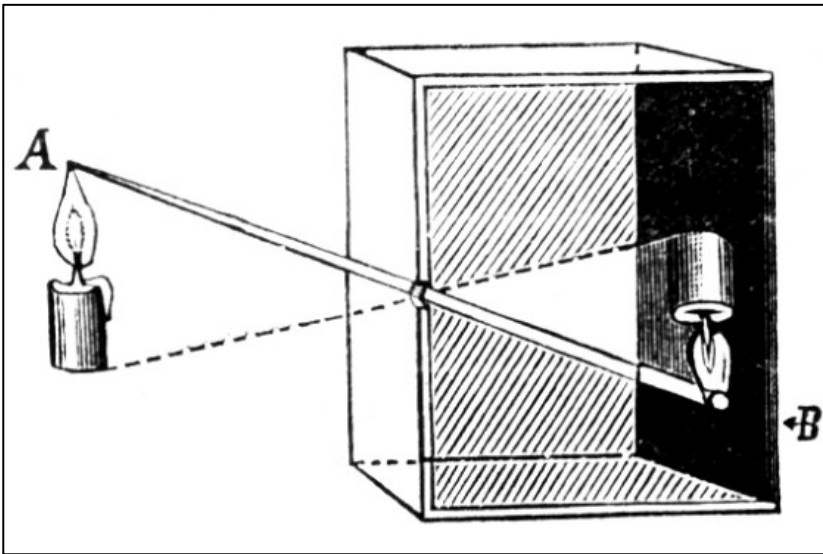
- Cellular level
 - Group of proteins rhythmically expressed creating interconnected feedback loops (about 24hours)
- Tissue level
 - Peripheral oscillators
 - Adrenal gland, lung, liver, pancreas, skin
 - Influenced by neurohumoral factors and also by light
- Central pacemaker
 - Hypothalamus (nucleus suprachiasmaticus)
 - Clock protein expression
 - Information about illumination from retina (specialized ganglion cells)
 - synchronization of central pacemaker
 - Pineal gland - melatonin
 - Autonomic nervous system – adrenal gland - cortisol



A.J. Hesse, G.E. Duffield

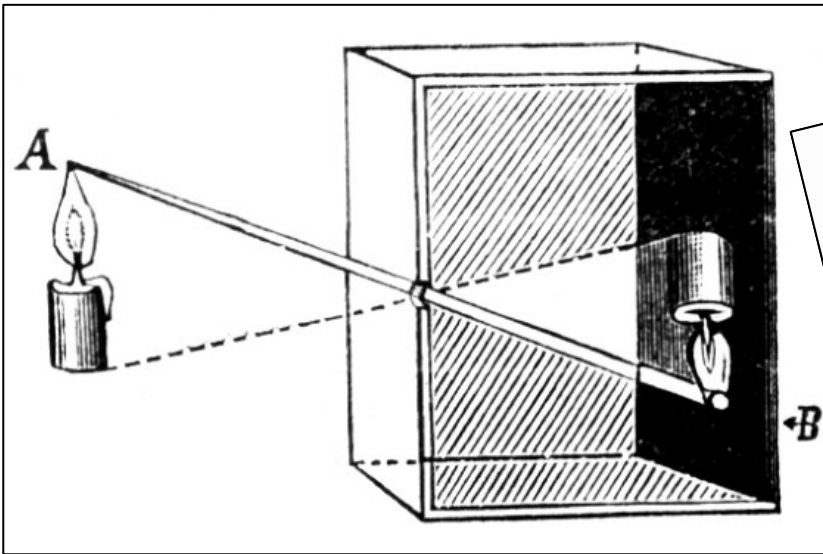
adapted from Hastings, M. BMJ 1998;317:1704-1707

Image formation

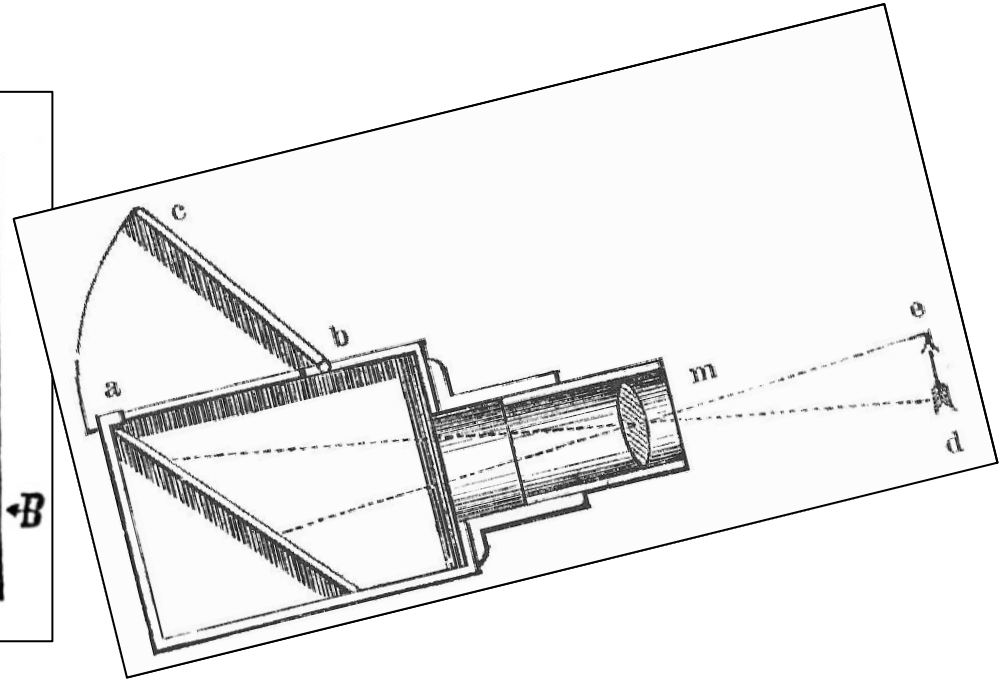


https://www.fotoskoda.cz/images/manufacturers/camera_obscura.png

Image formation



https://www.fotoskoda.cz/images/manufacturers/camera_obscura.png



<http://de.academic.ru/pictures/meyers/large/030717c.jpg>

Image formation

- Shape
- Color
- Localization
- Movement
- Image interpretation

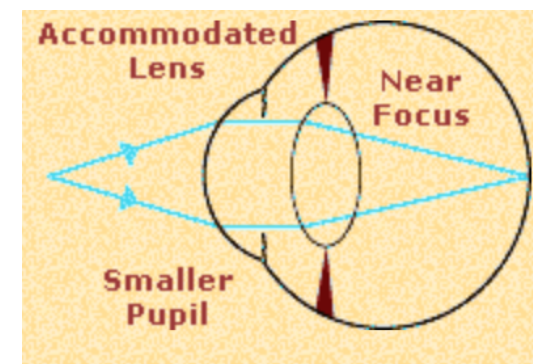
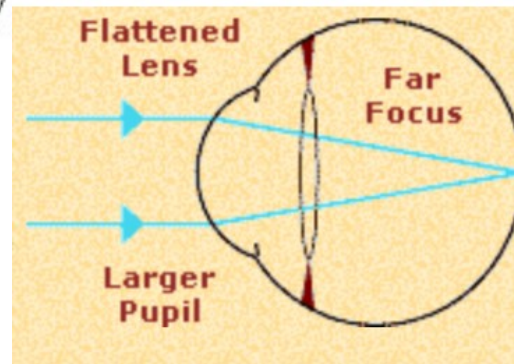
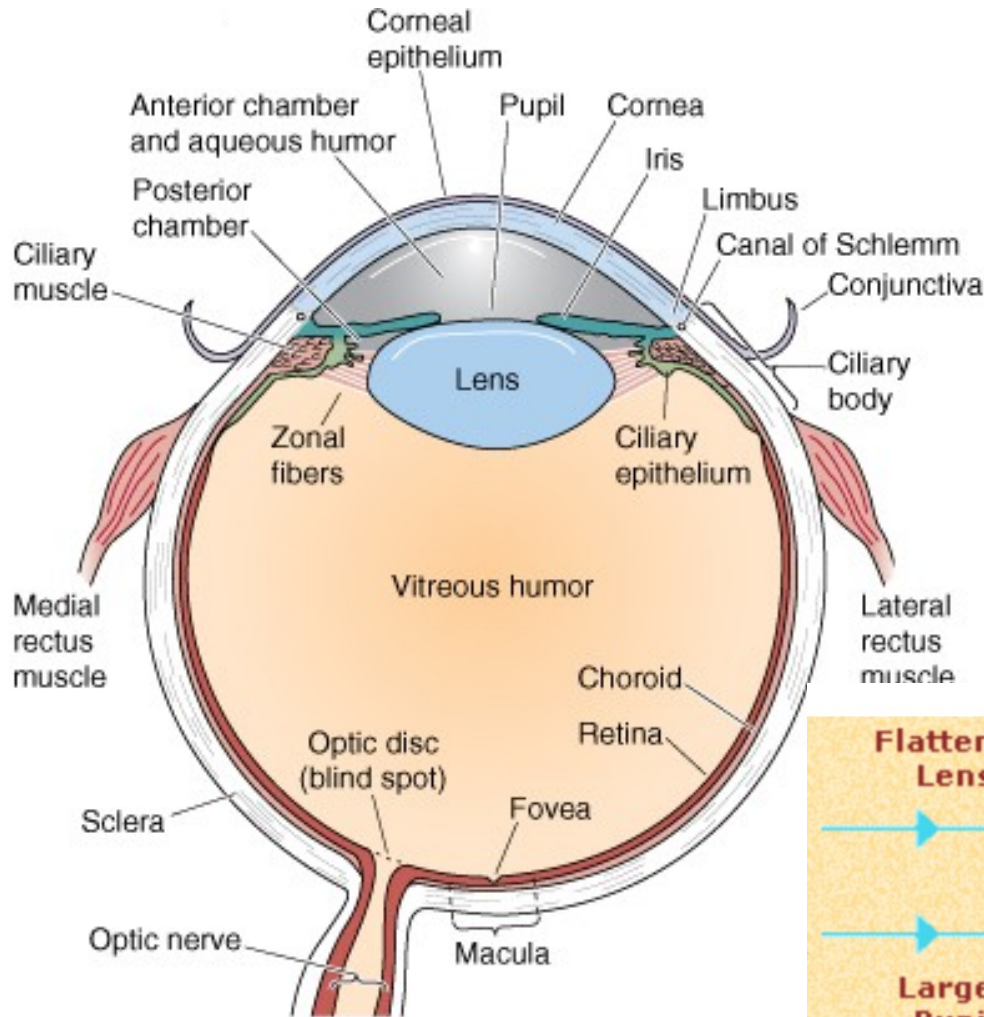


Image formation

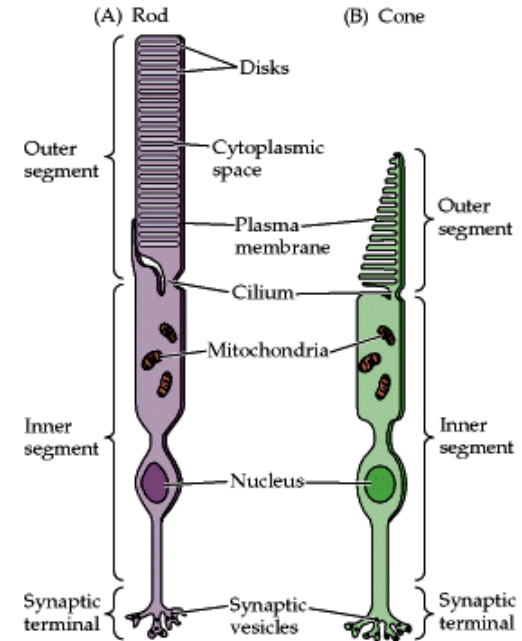
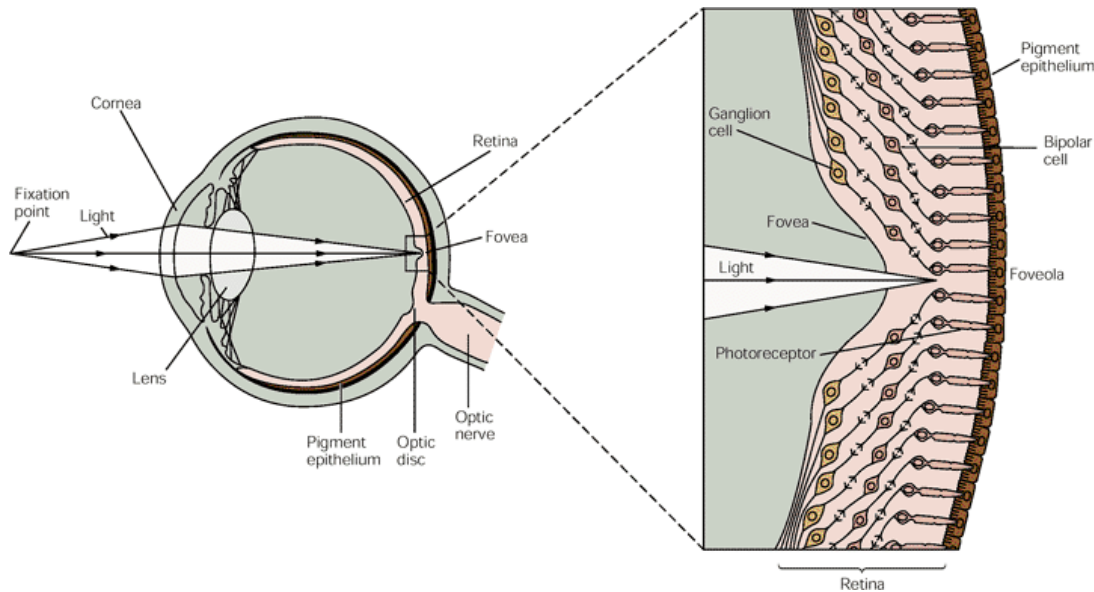


Table 26-1 Differences Between Rods and Cones and Their Neural Systems

Rods

High sensitivity to light, specialized for night vision
 More photopigment, capture more light
 High amplification, single photon detection
 Low temporal resolution: slow response, long integration time
 More sensitive to scattered light

Rod system

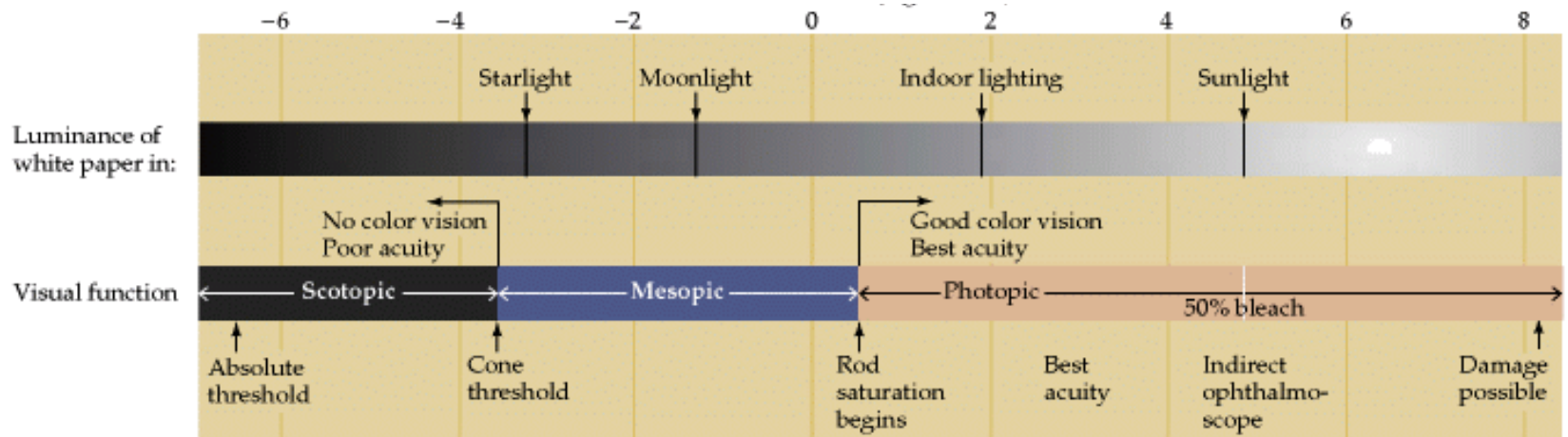
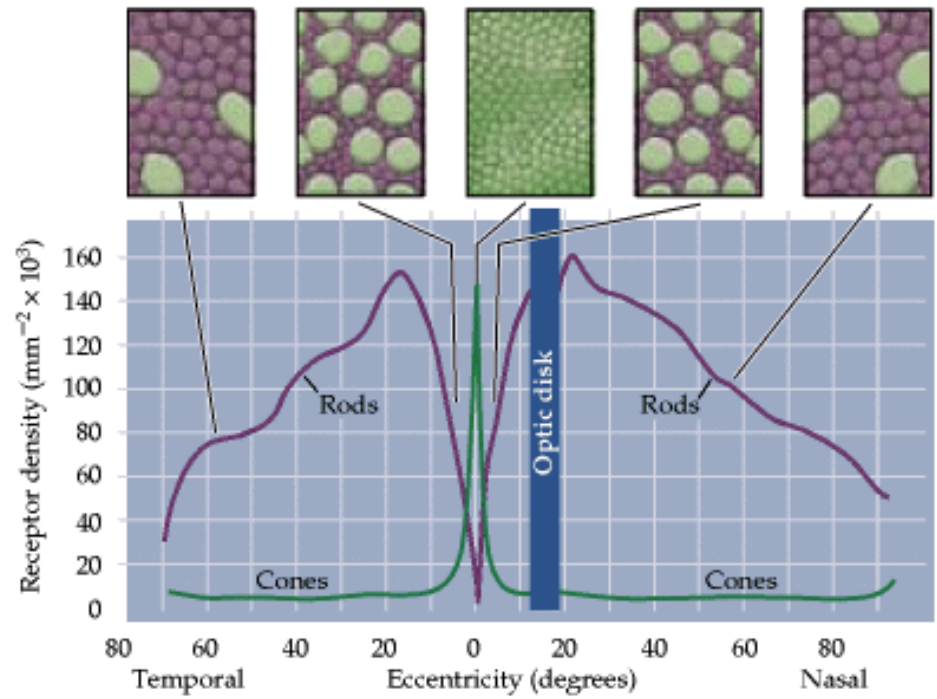
Low acuity: not present in central fovea, highly convergent retinal pathways
 Achromatic: one type of rod pigment

Cones

Lower sensitivity, specialized for day vision
 Less photopigment
 Lower amplification
 High temporal resolution: fast response, short integration time
 Most sensitive to direct axial rays

Cone system

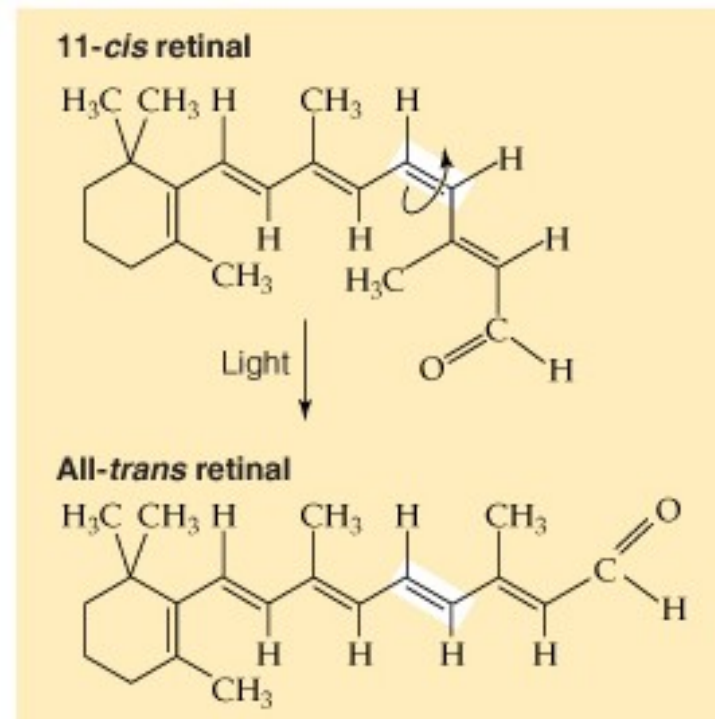
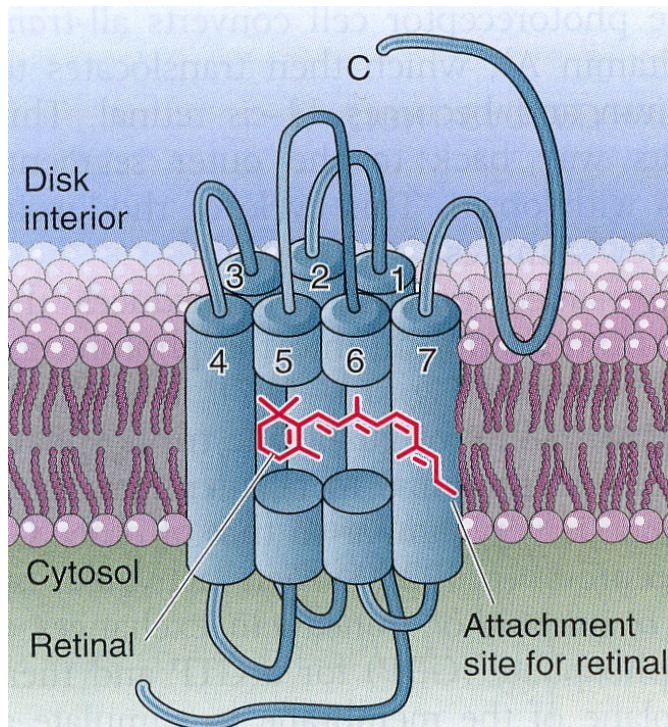
High acuity: concentrated in fovea, dispersed retinal pathways
 Chromatic: three types of cones, each with a distinct pigment that is most sensitive to a different part of the visible light spectrum



Photopigment of rods

Rhodopsin

- Opsin
 - G – protein
- Retinal
 - Aldehyd retinolu (vit. A)



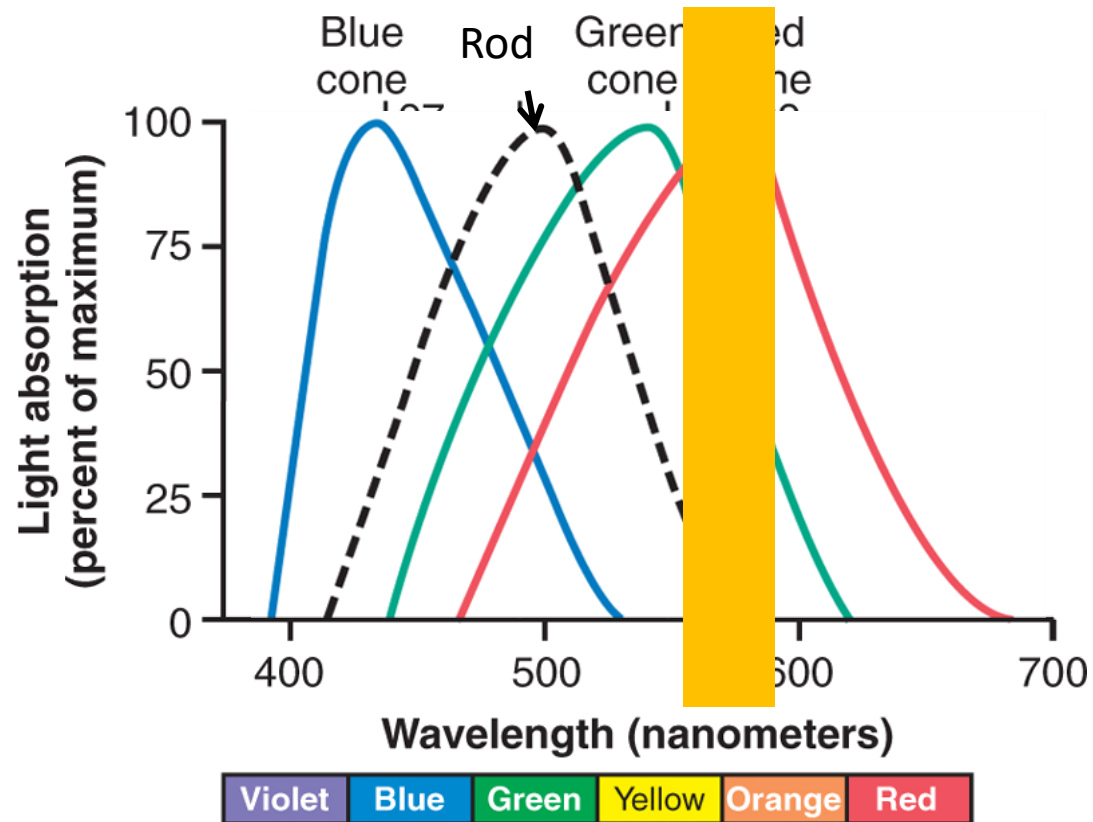
Photopigments of cones

- 3 types of cones - 3 types of photopigment

- Blue(420nm)
- Green (530nm)
- Red (560nm)

- Color is interpreted by ratio of cone stimulation

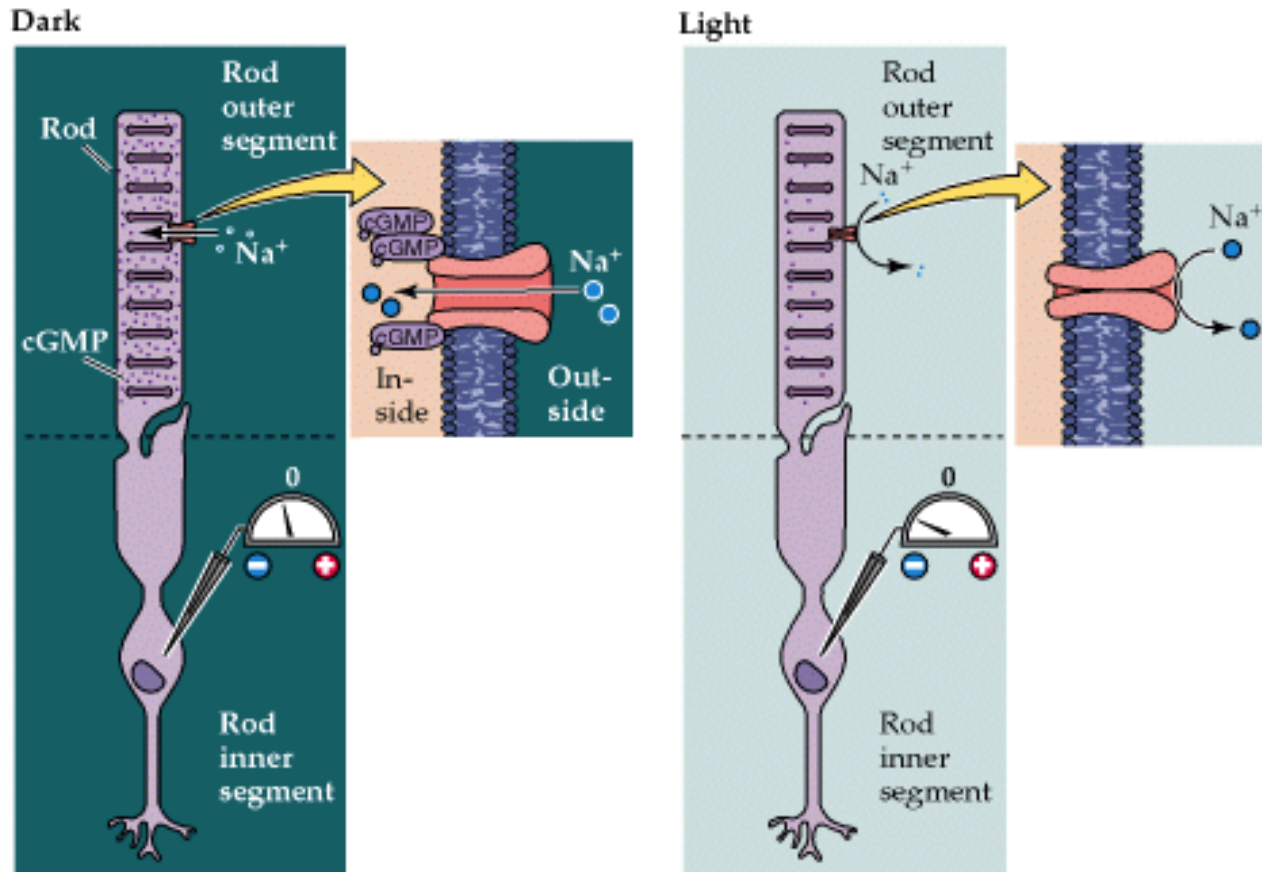
- Orange (580nm)
 - Blue: 0%
 - Green: 42%
 - Red:99%



Hall: Guyton and Hall Textbook of Medical Physiology, 12th Edition
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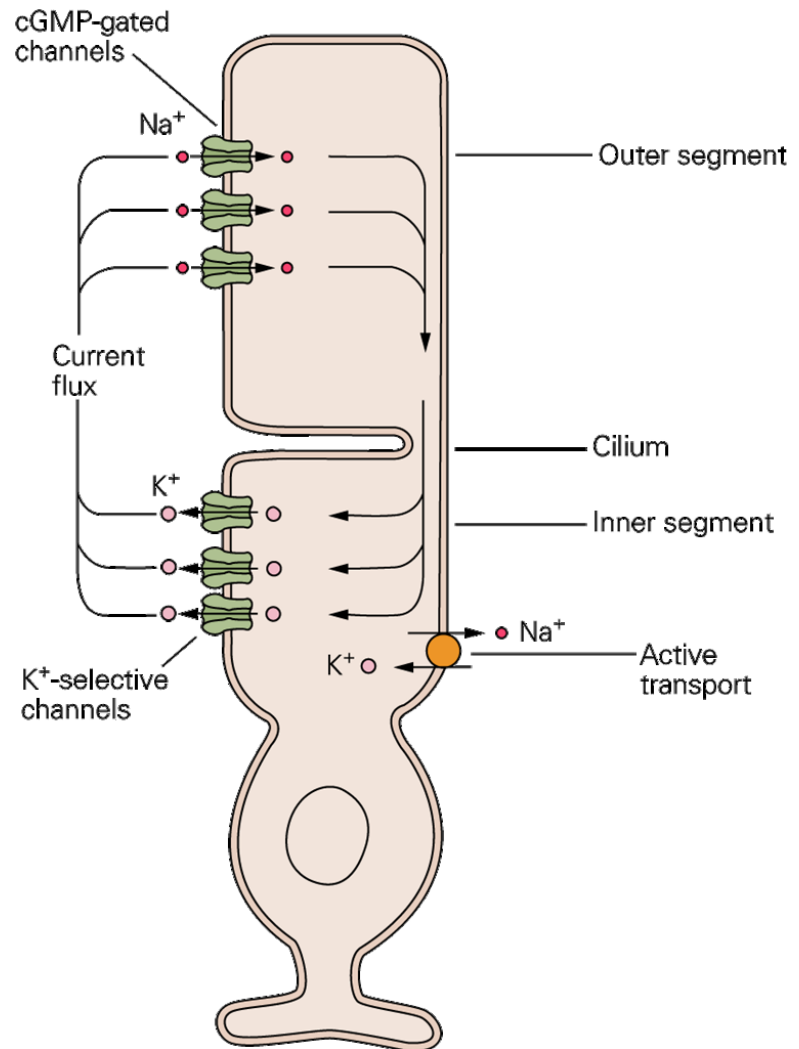
Phototransduction

- Photoreceptors continuously release neurotransmitter (glutamate) in darkness
- In response to the light, the membrane **hyperpolarizes** and release less neurotransmitter



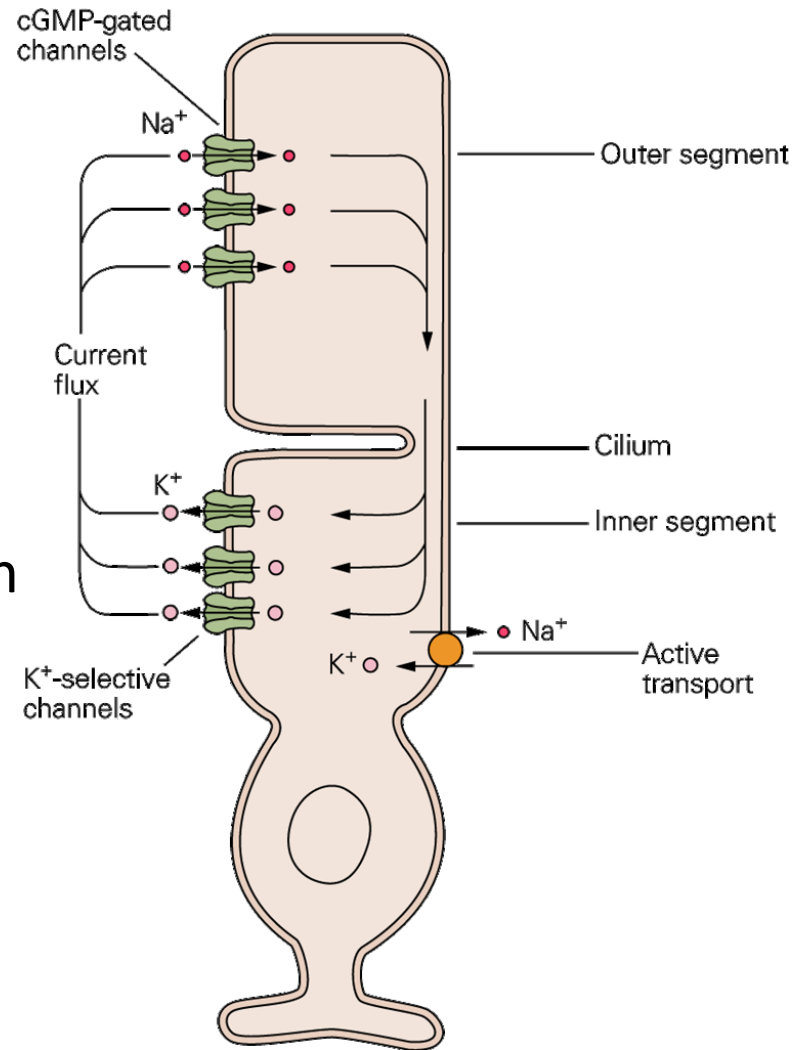
Phototransduction - darkness

- Guanylyl cykles
– cGMP
- cGMP-gated Na^+ channels
– Na^+ influx
- Voltage gated Ca^{2+} channels
– Release of glutamate
- The balance is kept by
– K^+ efflux
– Na^+/K^+ exchanger
- Resting membrane potential: -40mV



Phototransduction - light

- Photon is absorbed by photopigment
- Isomerization of retinal
- Cascade of reactions result in cGMP phosphodiesterase
 - cGMP levels decreased
- Deactivation of cGMP gated Na^+ channel
- K^+ efflux continues
- Membrane hyperpolarization
 - Deactivation of voltage Ca^{2+} channels
 - Decrease in glutamate release



Adaptation to the light/darkness

- **Optic adaptation**
 - Constriction of pupils
- **Photoreceptor adaptation**
 - Ca^{2+} inhibits guanylyl cyclase
 - Light
 - Ca^{2+} decreased - cGMP increa
 - Darkness
 - Ca^{2+} increased – cGMP decreased
 - cGMP gated Na^+ channels...

