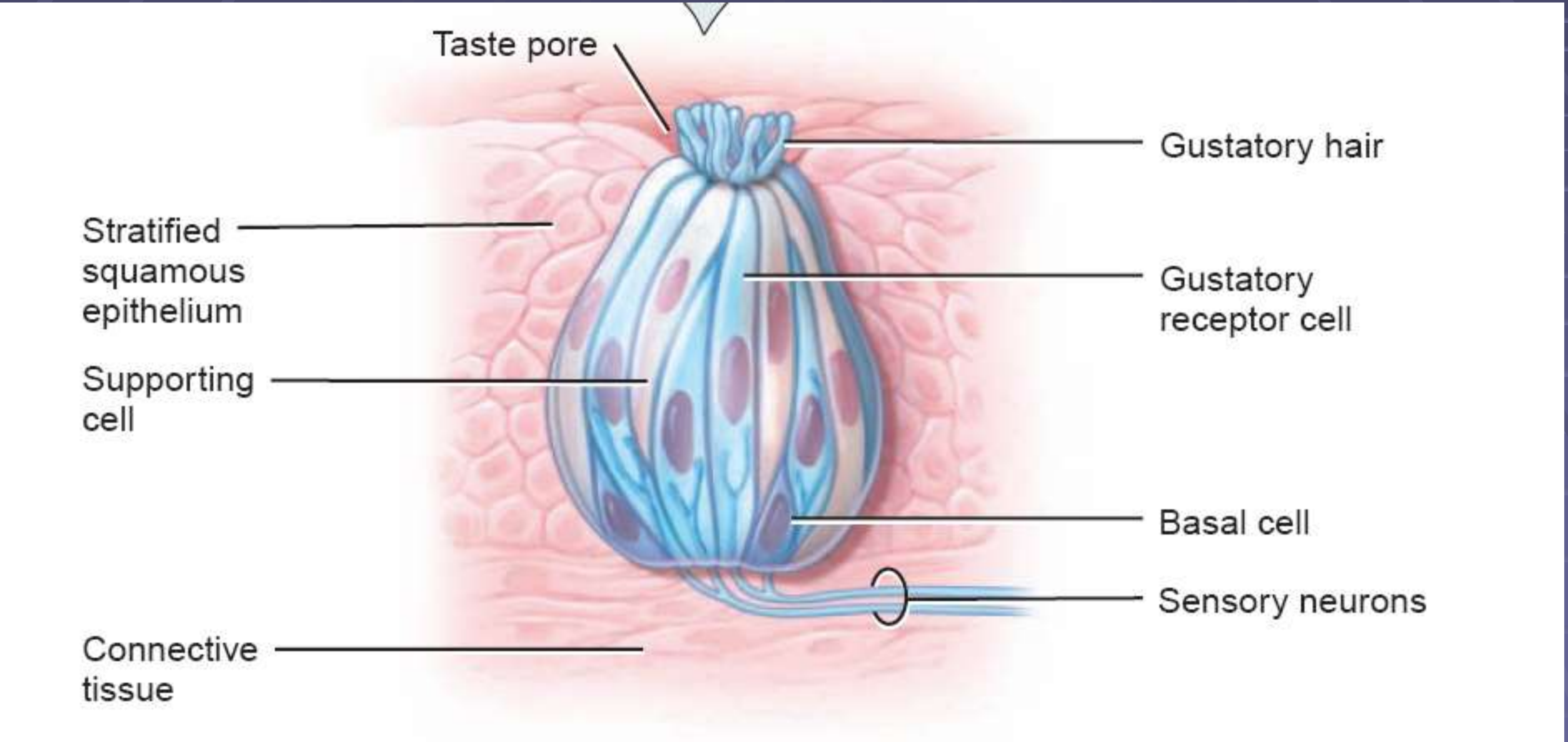
The Gustatory System

Taste receptors (taste buds)



(c) Structure of a taste bud

Receptor Cells and Taste Buds

Receptor cells found in taste buds

Taste buds: most obvious on tongue

1 bud contains= 40-60 receptor cells

Microvilli found on apical end of receptor cells and extend into taste pore

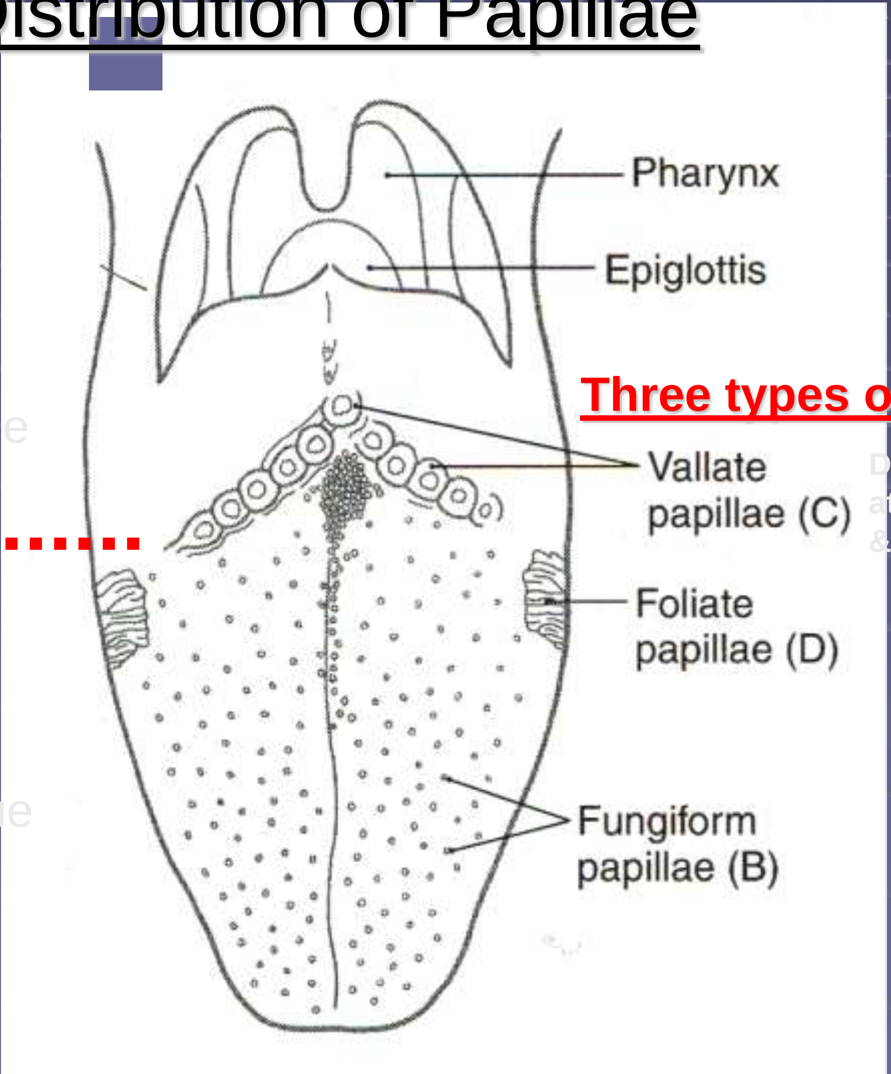
Taste receptor cell life span: 10-14d

On the tongue, taste buds are found exclusively in papillae

Distribution of Papillae

Posterior 1/3 of tongue

Anterior 2/3 of tongue

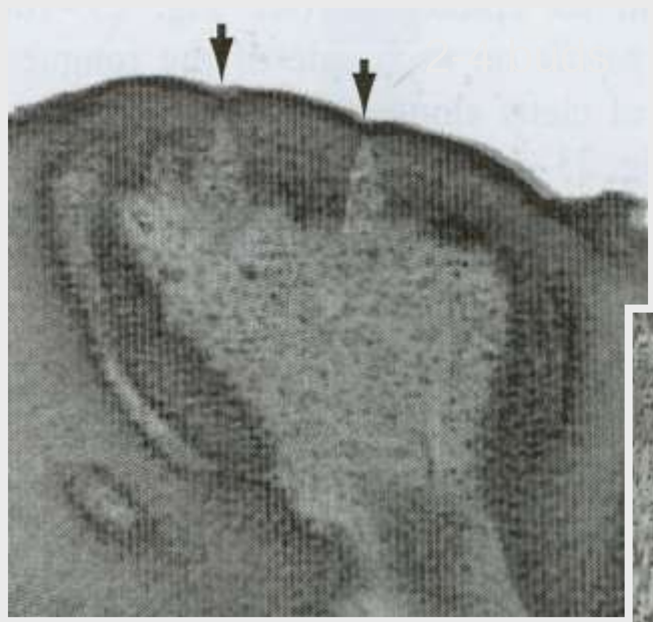


Three types of papillae

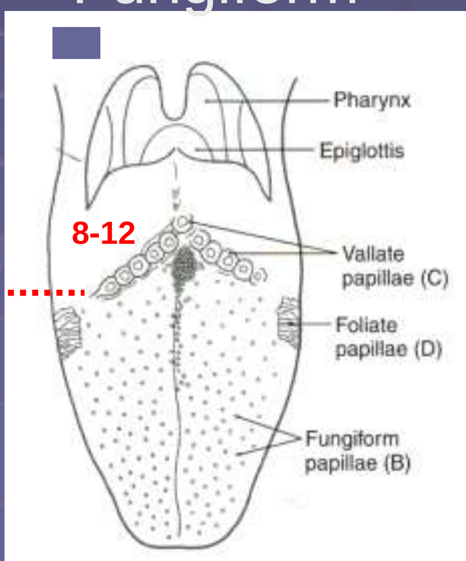
Dorsal surface of tongue at the junction of the oral & pharyngeal cavities

Subtypes of Papillae

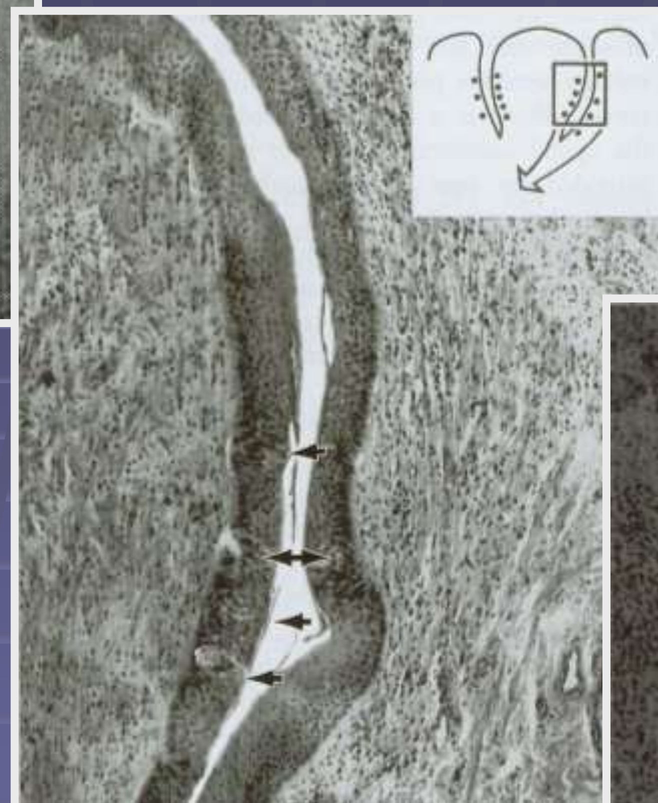
Text Fig. 23-11



Fungiform



Von Ebner salivary glands: drain into papillar clefts & influence local microenvironment

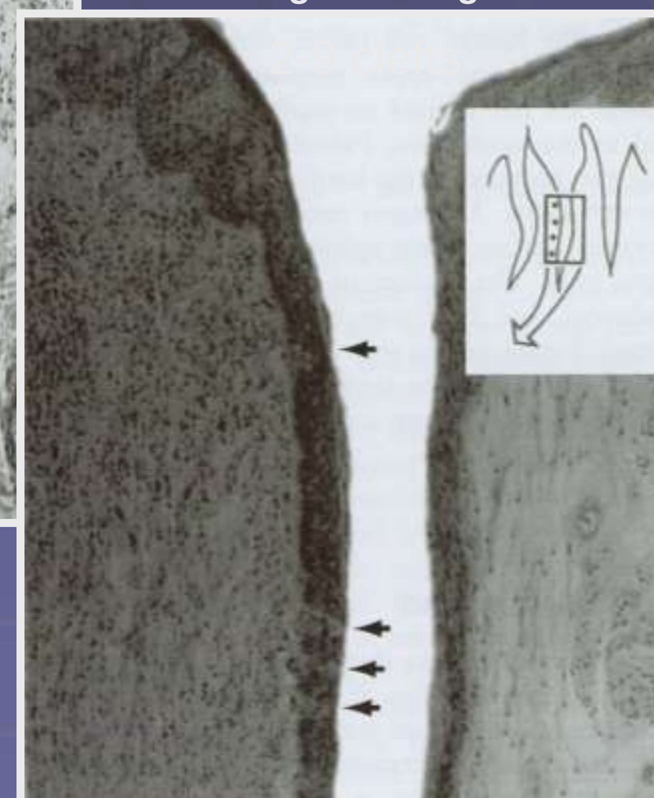


Vallate

Central papilla surrounded by a cleft containing taste buds in epithelium

Foliate

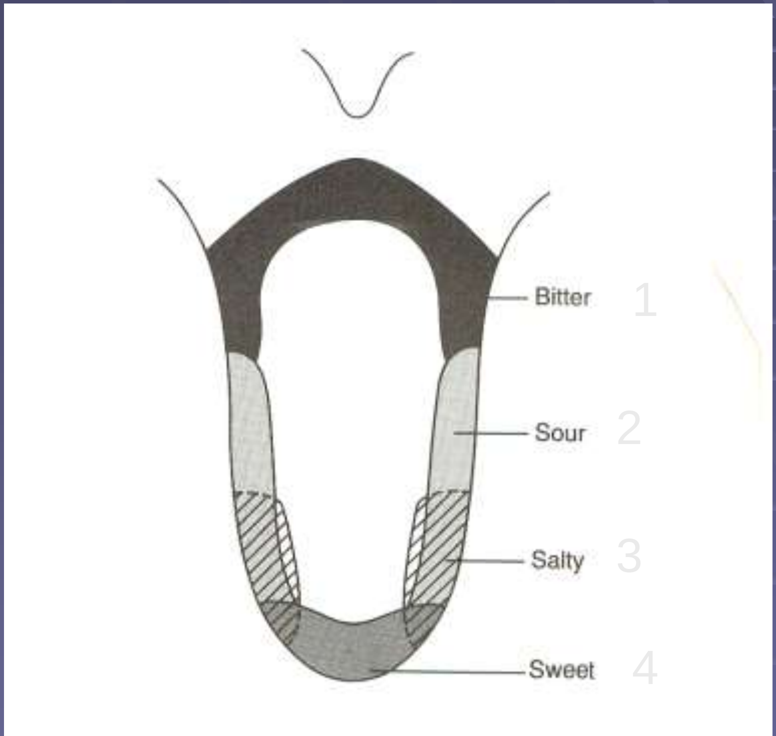
Series of clefts along lateral margin of tongue



Regional Specialization for the Detection of Different Taste Qualities ?

5

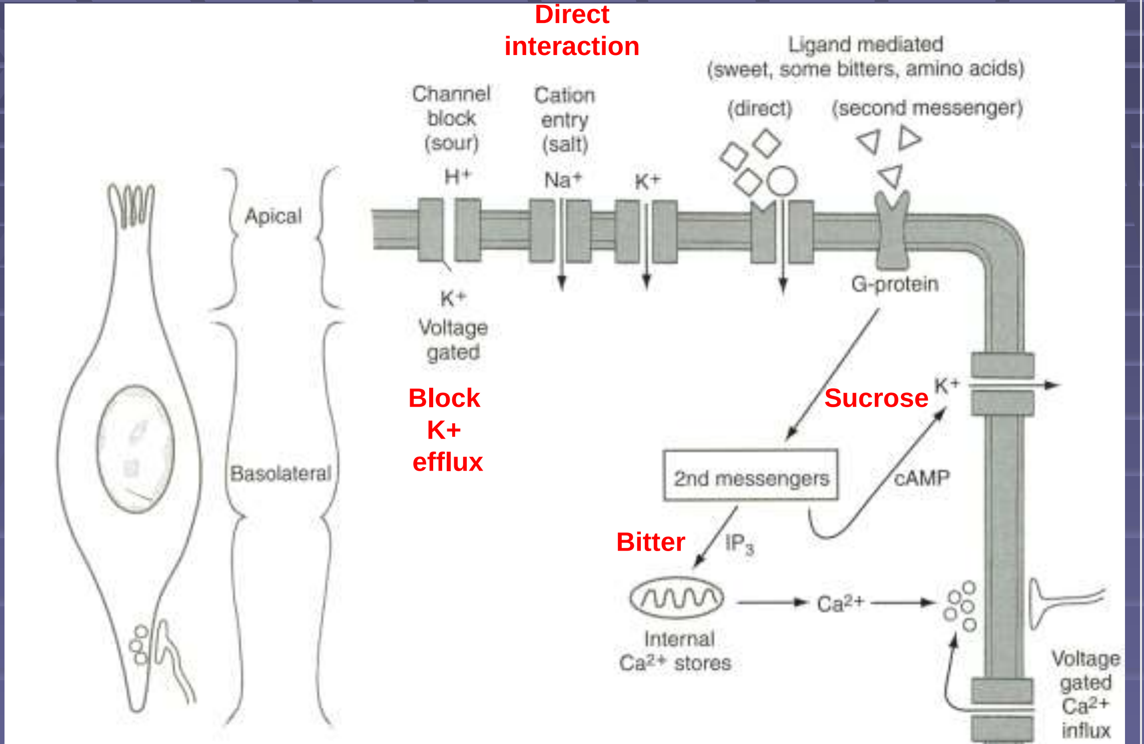
- **Umami: a recently described taste sensation for meaty sensation, that exemplifies the taste of monosodium glutamate & is important in the identification of amino acids.**



(Kandel, Schwartz & Jessup: Principles of Neural Science 3rd ed. Fig. 34-8)

All taste qualities are detected in all regions of the tongue, although sensitivity to the different taste qualities may vary by region

Pathways of Transduction in Taste Receptors



Text Fig. 23-12

•Begins when a soluble chemical interacts with taste receptors

•Results in a depolarization or hyperpolarization of the receptor cell microvilli

•Sufficiently large depolarizations will result in action potential generation

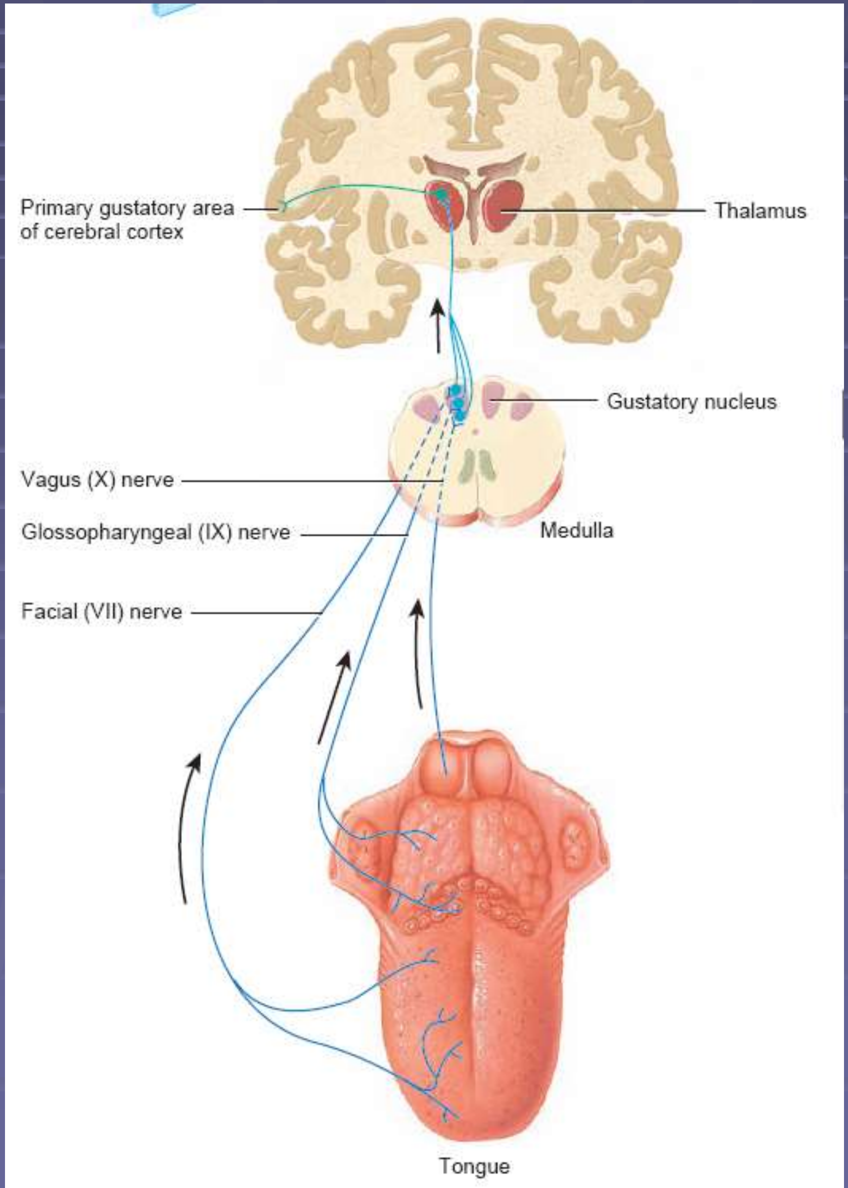
•Produce an increase in intra-cellular Ca++ either by release from internal stores or by activation of voltage gated Ca++ channels.

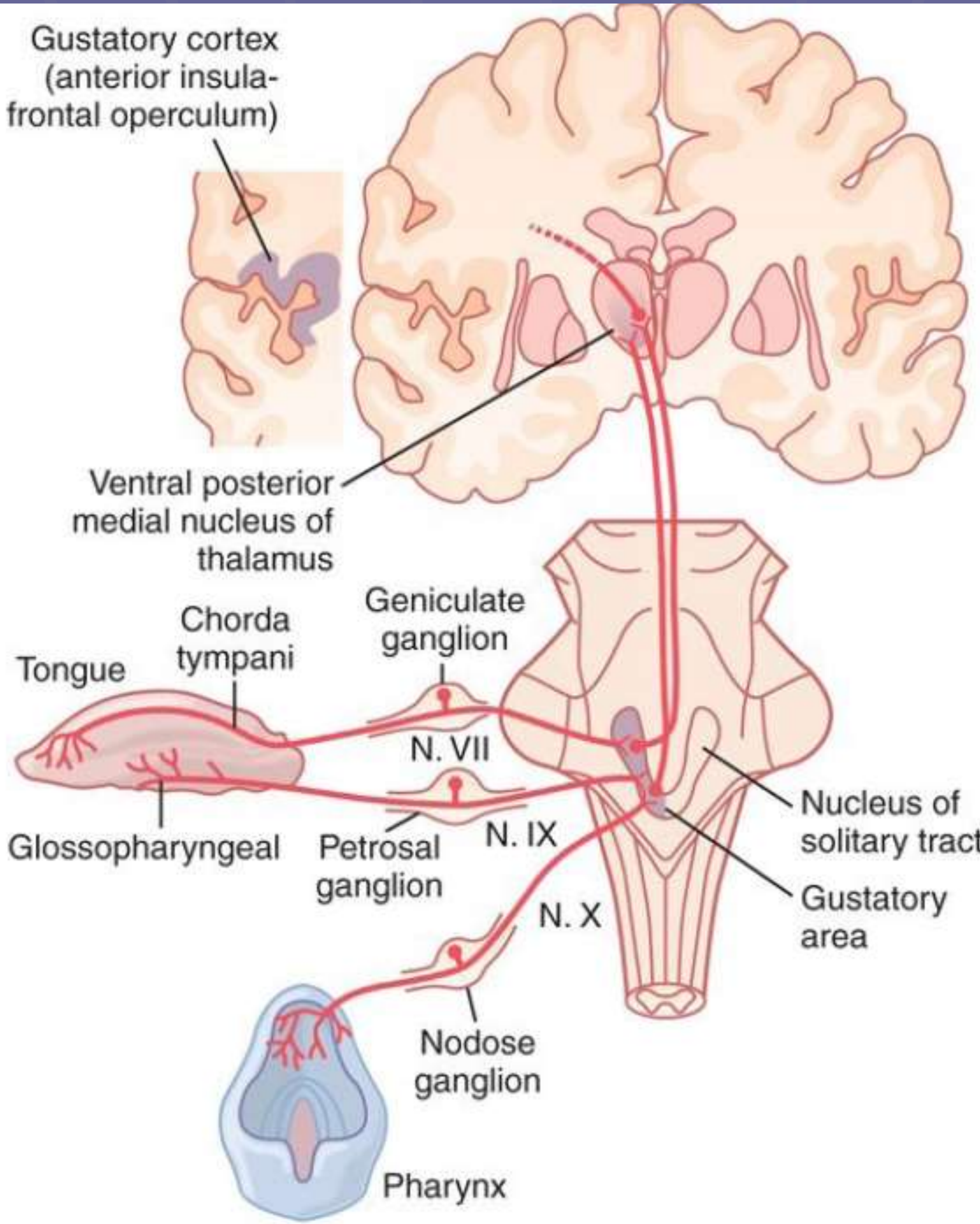
•Ca++ release results in the liberation of chemical transmitters at the afferent synapse, which in turn leads to an action potential in the afferent fiber.

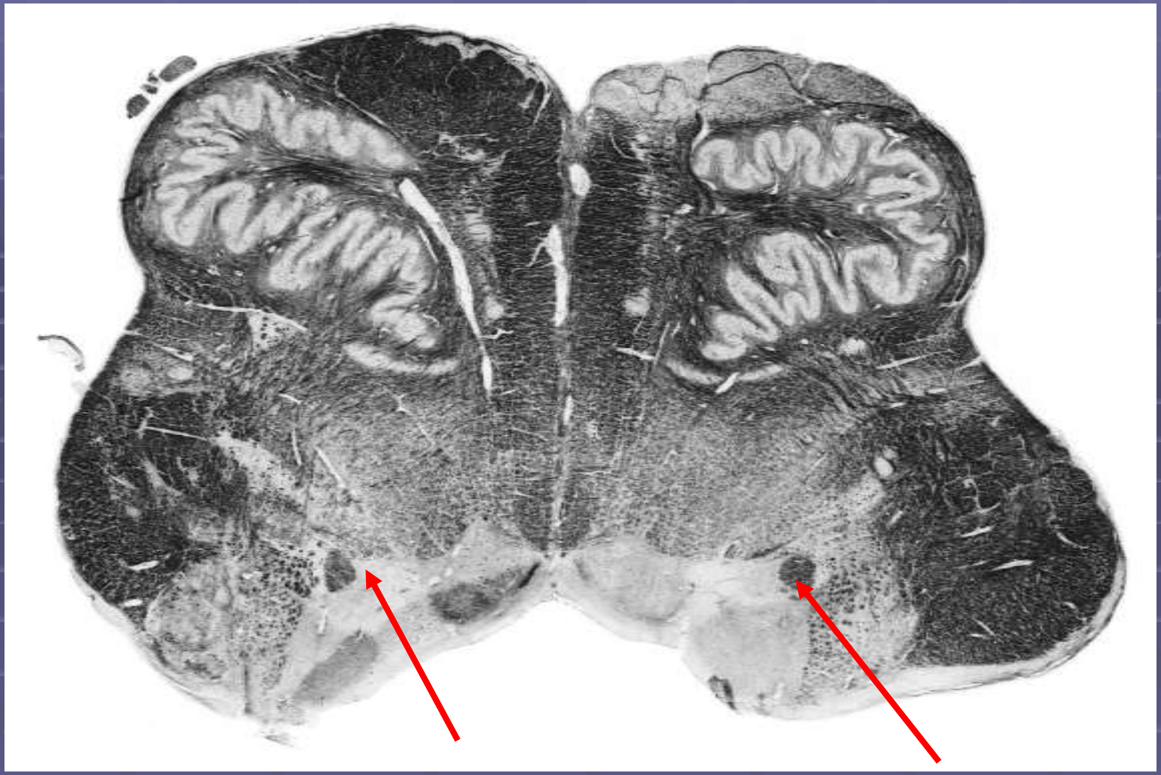
Umami:

Transduced: via a G-protein linked glutamate receptor that stimulates phosphodiesterase → reduction in intracellular cAMP

Taste pathway

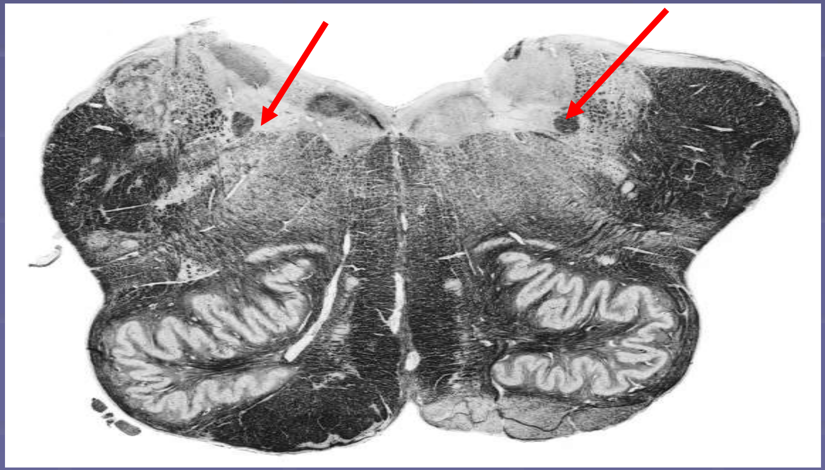



Gustatory cortex
(anterior insula-
frontal operculum)
Ventral posterior
medial nucleus of
thalamus
Geniculate
ganglion
Chorda
tympani
Tongue
N. VII
Glossopharyngeal
Petrosal
ganglion
N. IX
N. X
Nucleus of
solitary tract
Gustatory
area
Nodose
ganglion
Pharynx

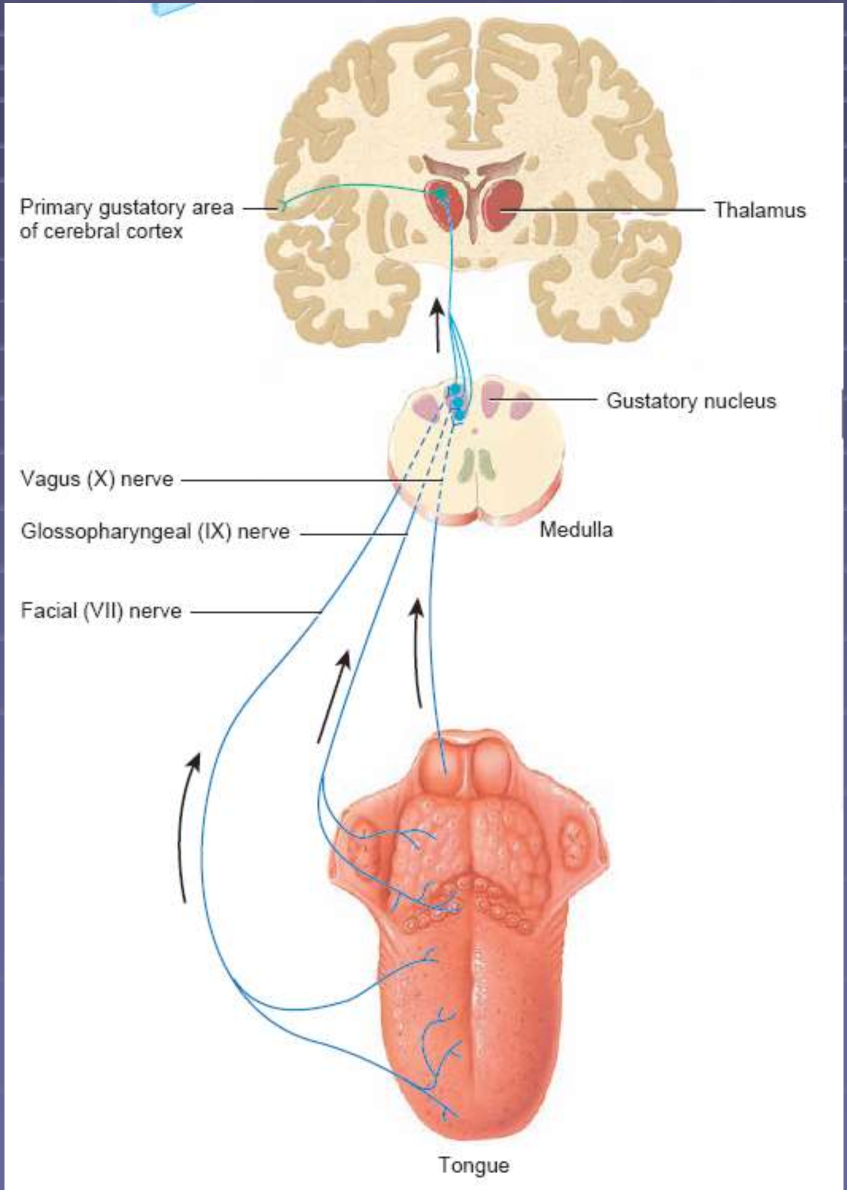


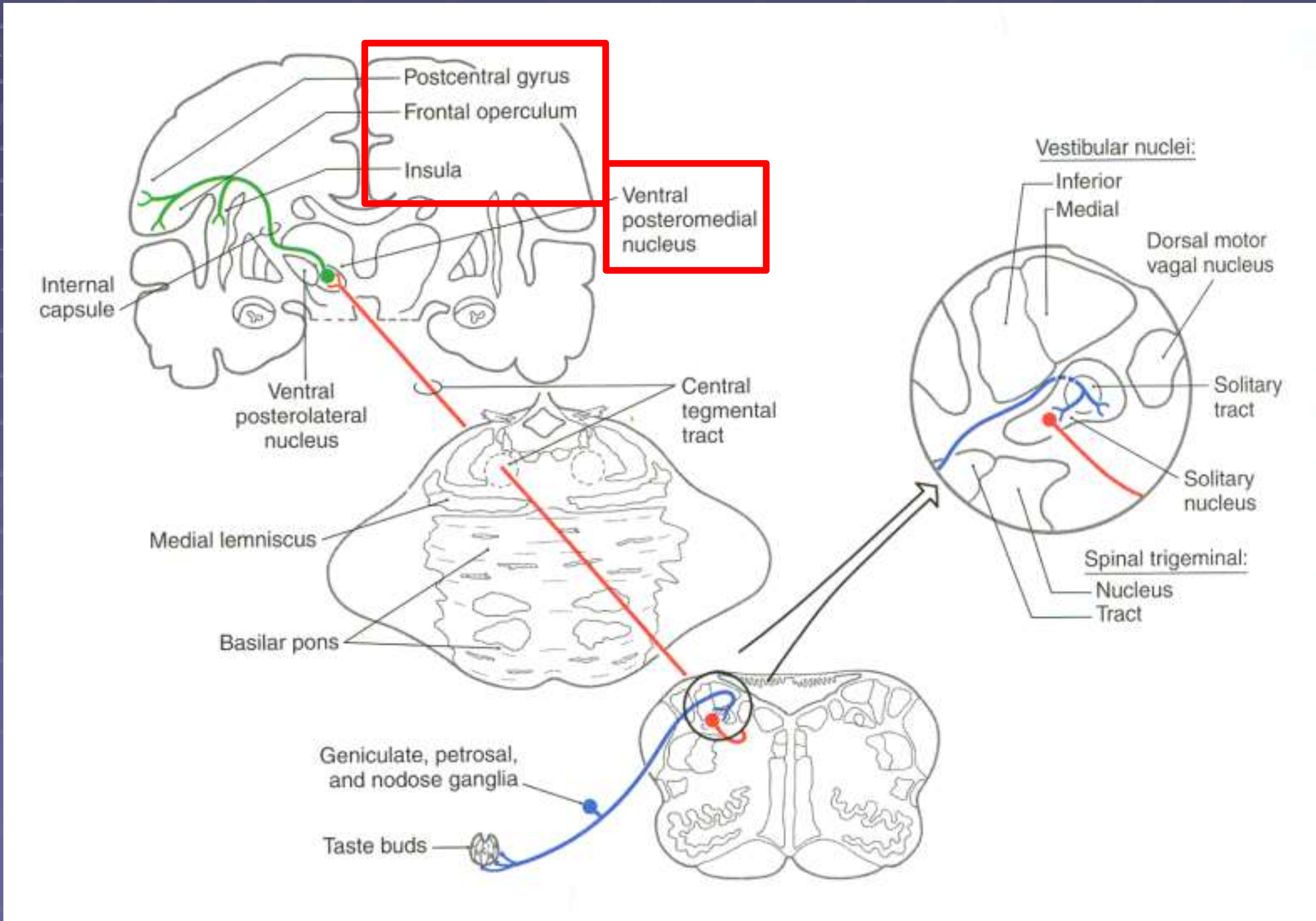
Nucleus of the Solitary tract

Solitary Tract



Taste pathway





Postcentral gyrus
Frontal operculum
Insula
Ventral posteromedial nucleus
Internal capsule
Ventral posterolateral nucleus
Central tegmental tract
Medial lemniscus
Basilar pons
Geniculate, petrosal, and nodose ganglia
Taste buds
Vestibular nuclei:
Inferior
Medial
Dorsal motor vagal nucleus
Solitary tract
Solitary nucleus
Spinal trigeminal:
Nucleus
Tract

Disorders of Taste

- Ageusia: Complete loss of taste.
- Hypoageusia: Decreased taste sensitivity.
- Examples:
  - Cancer patients undergoing radiation or chemotherapy.
  - Medications.
  - Progressive loss of taste in diabetic patients.




Aromas & Flavors

Almond
Apple
Apricot
Asparagus
Banana
Biscuit
Blackberry
Black currant bread
Brioche
Bubble gum
Butter
Cat's pee
Cedarwood
Cherry
Chestnut
Chocolate
Clove
Coffee beans
Cream
Currant leaf
Earth/gravel/stone

Eucalyptus
Flint
Floral
Game
Gasoline
Gooseberry
Grape
Grapefruit
Grass
Herbaceous
Honey
Lanolin
Leather
Lemon
Licorice
Lychee
Melon
Mineral
Mint
Nivea
Nut

Oak
Olive
Orange
Peach
Pear
Pepper
Plum
Quince
Raisin
Raspberry
Rose
Salt
Smoke
Spice
Strawberry
Tar
Toast
Tobacco
Turkish delight
Vanilla
Yeast




Taste smell interaction

- Although anatomically distinct systems, the modalities of taste and smell work well together

- Flavor:
  - Incorrectly mistaken as taste
  - A sensory experience which results from the combination of olfactory and taste cues.

Olfaction >>>>> taste

potent

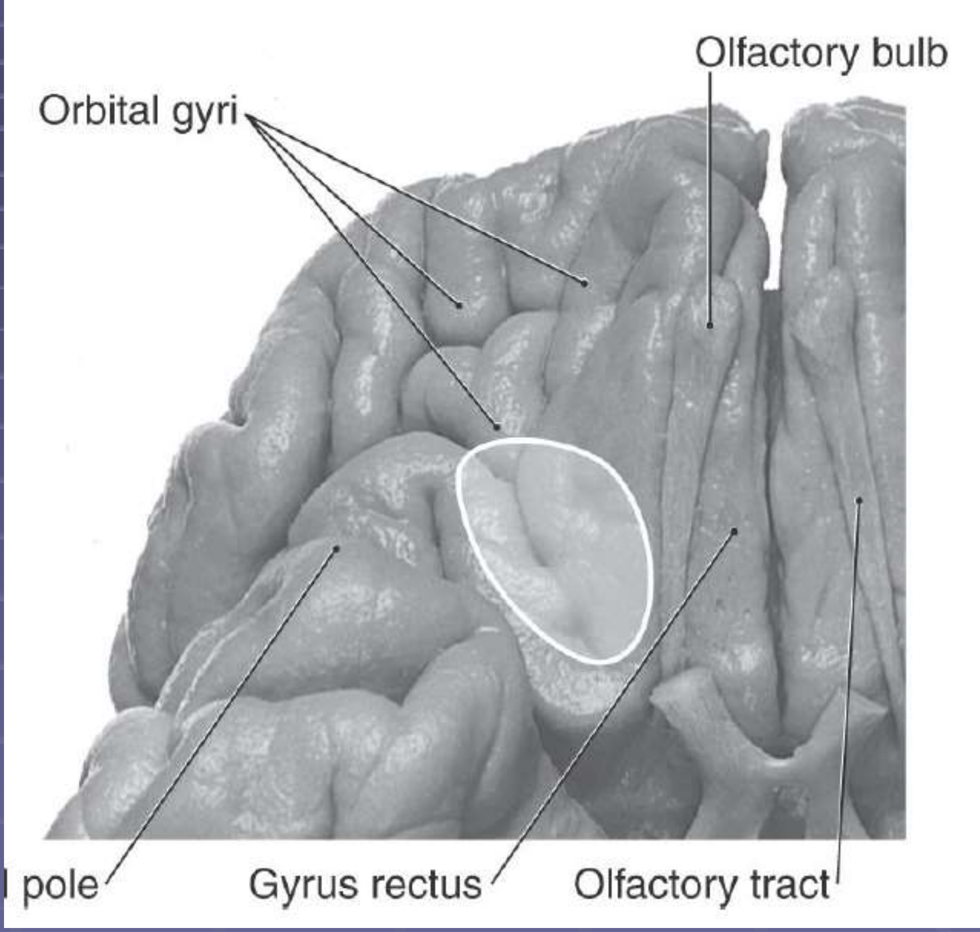
insular cortex and orbitofrontal cortex

- The **medial orbitofrontal cortex**

&

lateral posterior orbitofrontal cortex

play an important role in integrating olfactory, taste, and other food-related cues that produce the experience of flavor

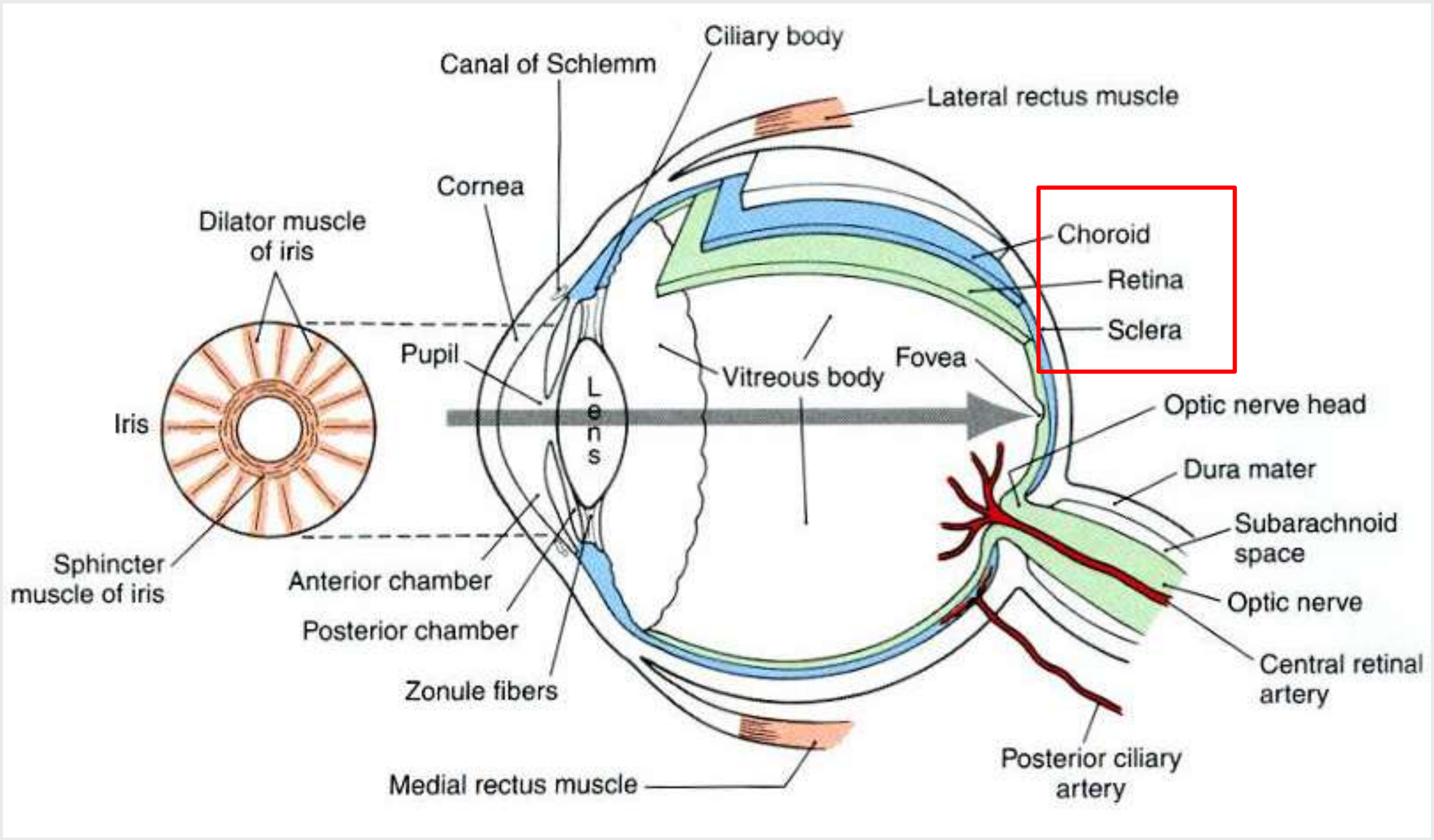


- ***Disorders of the Olfactory System (page 704-707)***

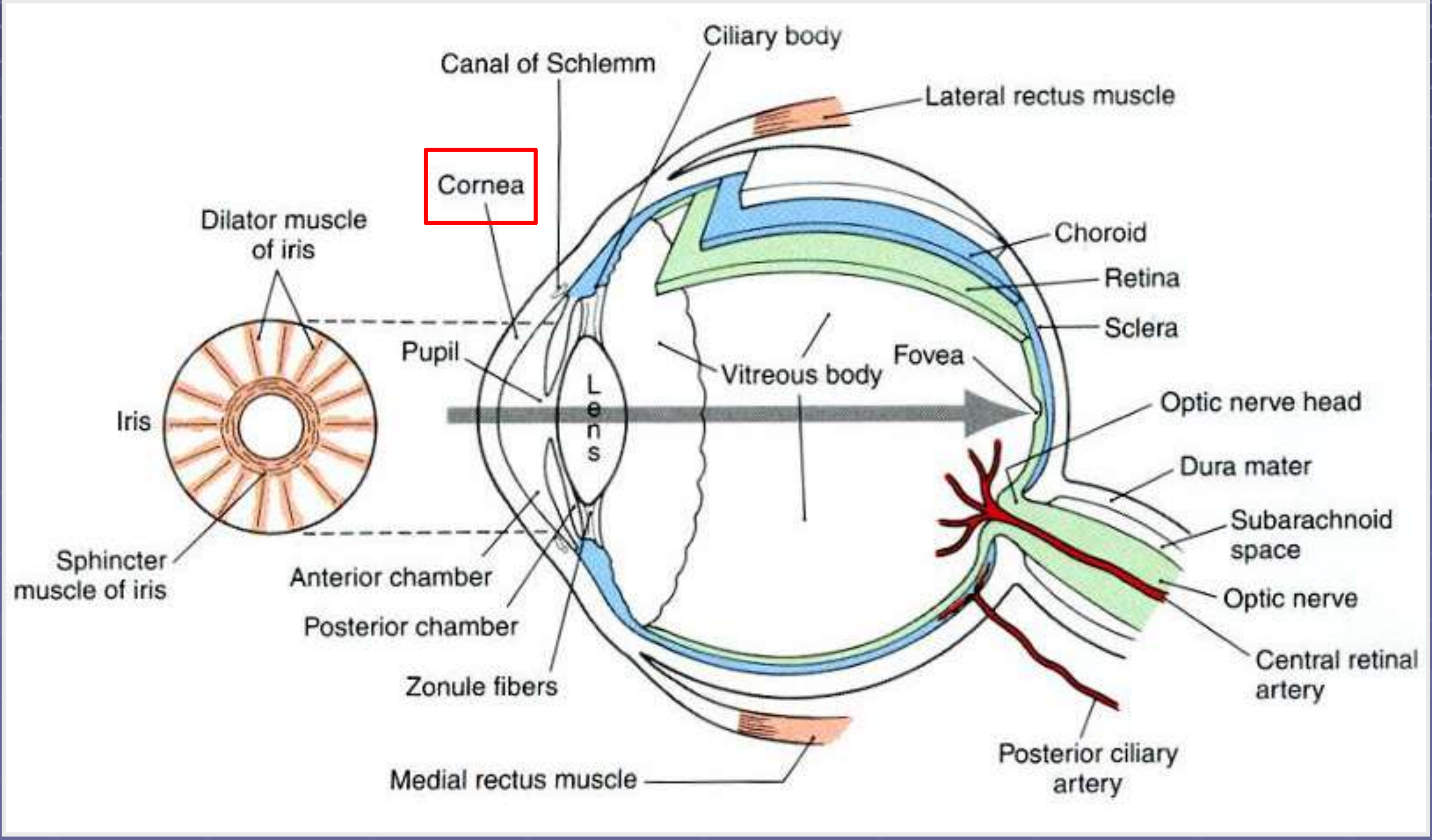
- ***Disorders of the Gustatory System*** (page 716)

The Visual System

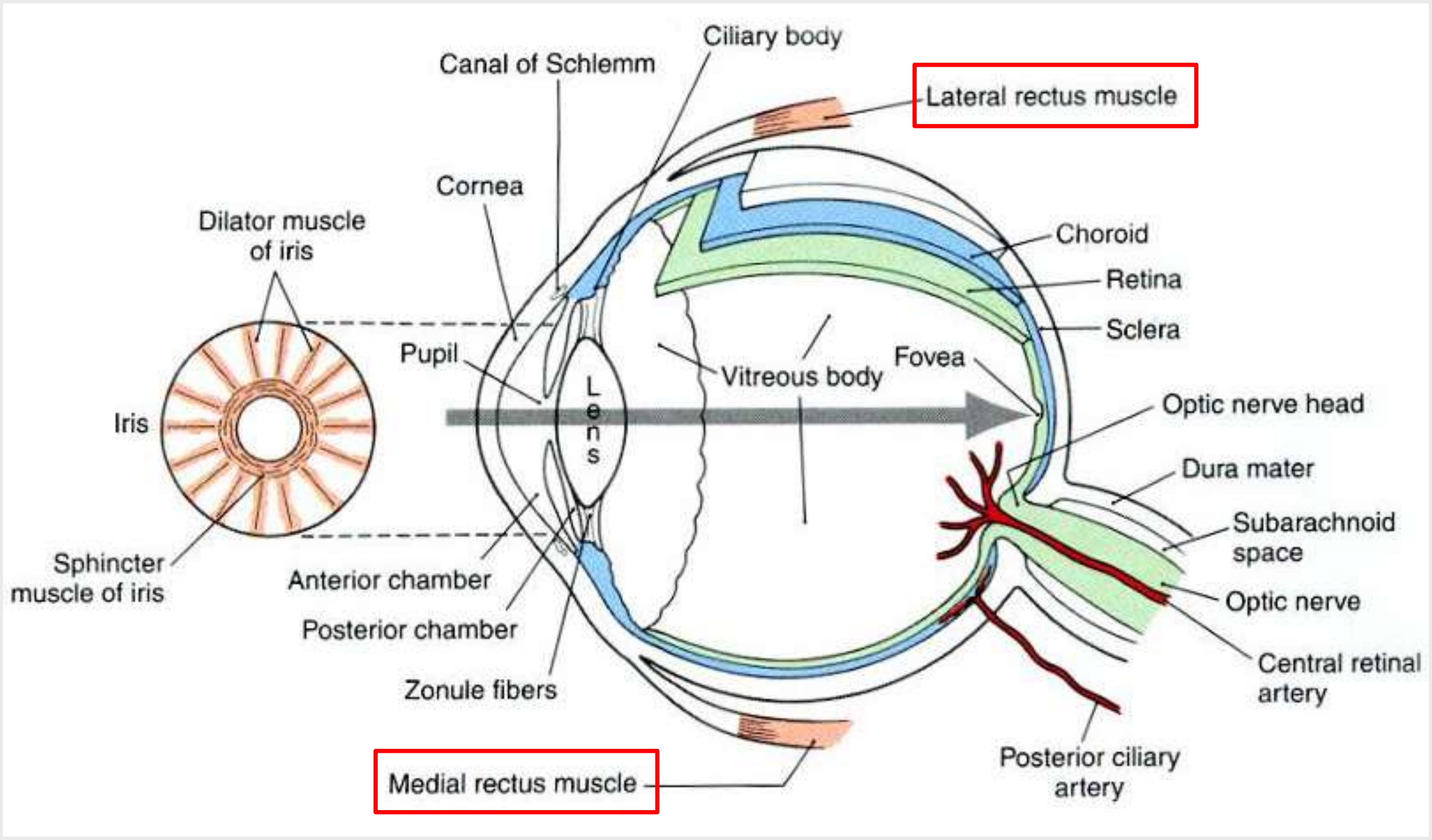
Anatomy of the eye



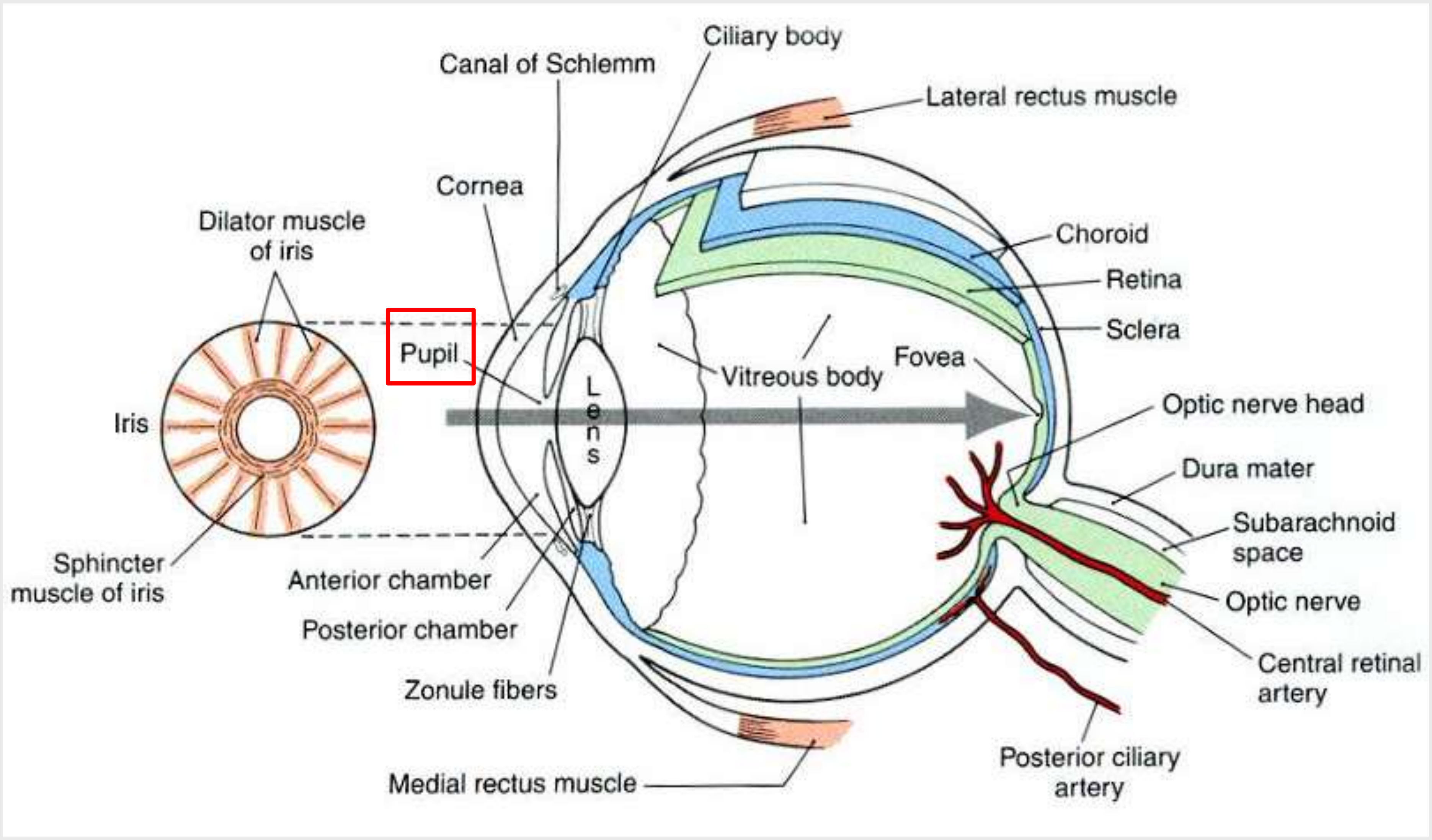
Anatomy of the eye



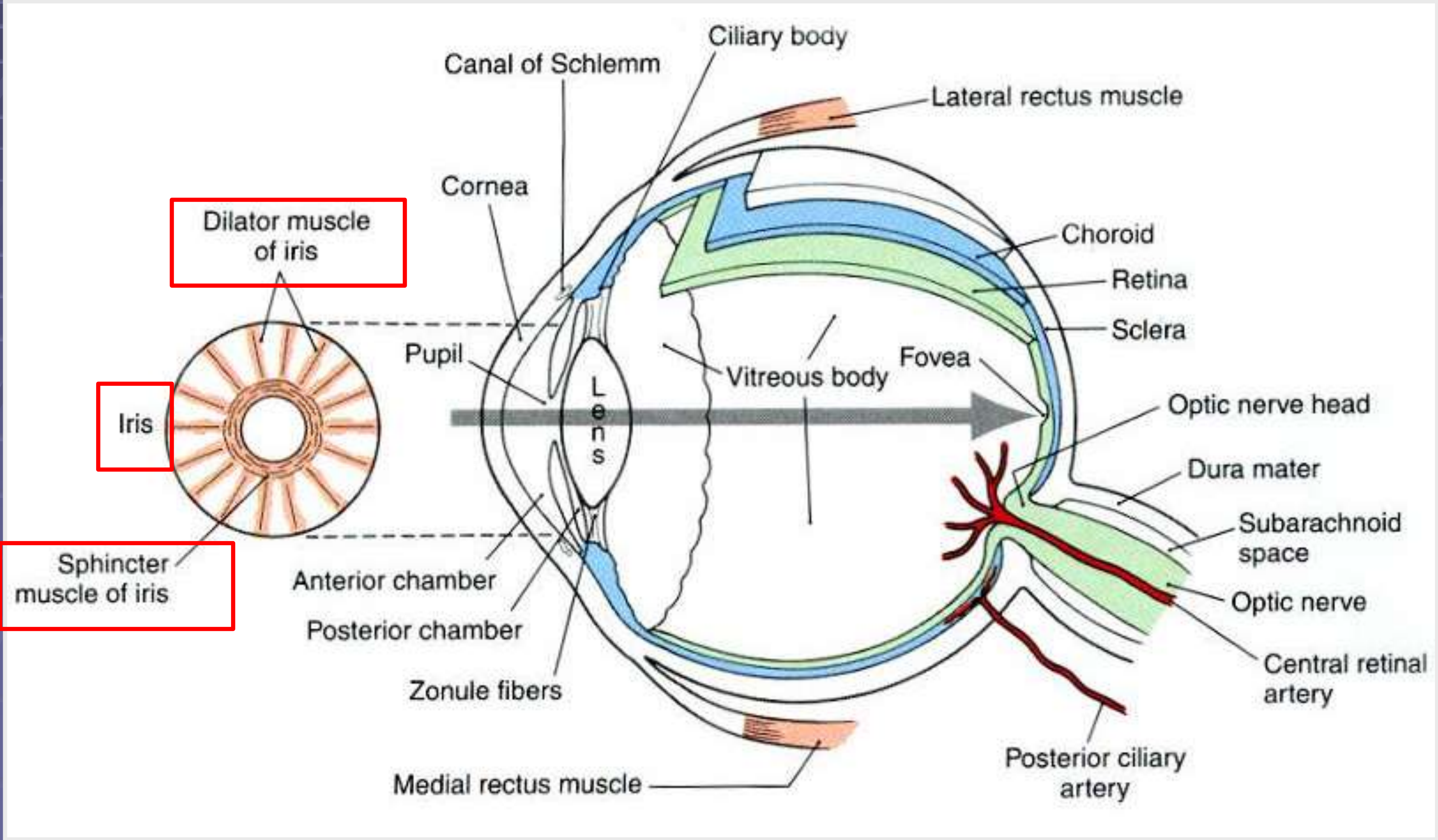
Anatomy of the eye



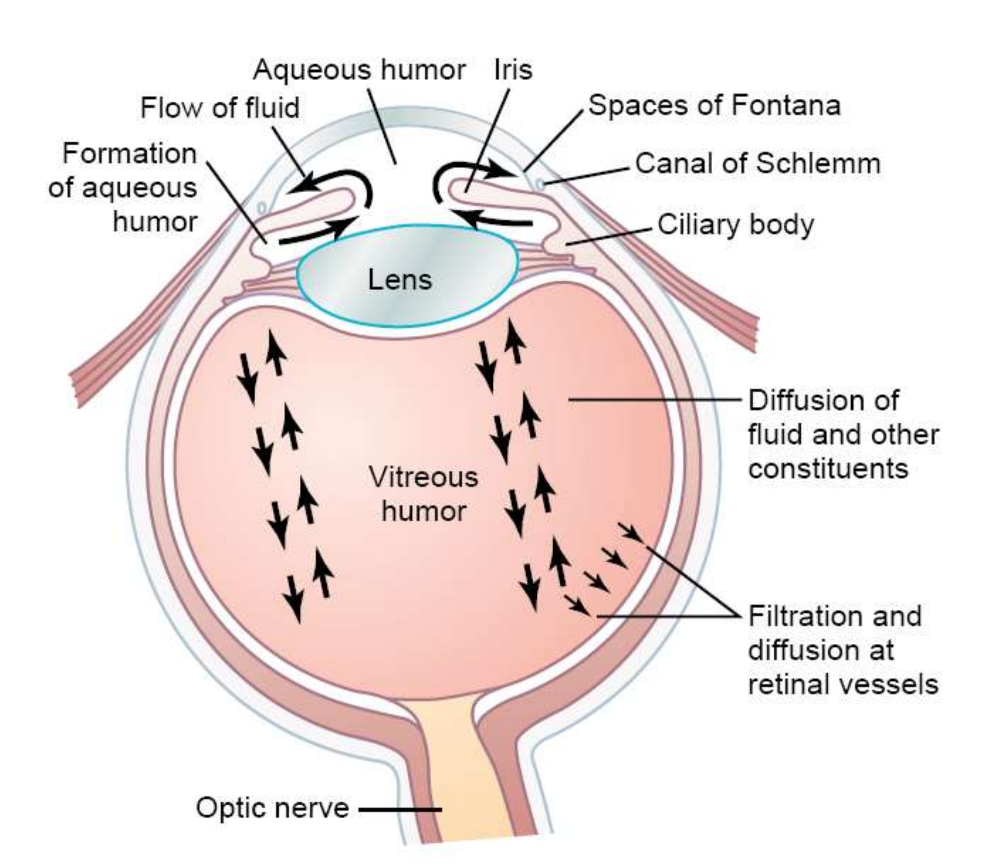
Anatomy of the eye



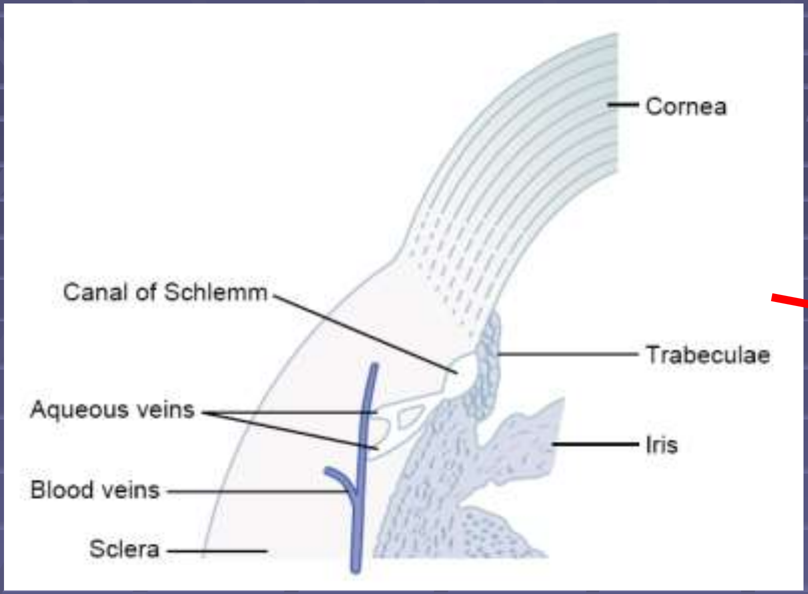
Anatomy of the eye

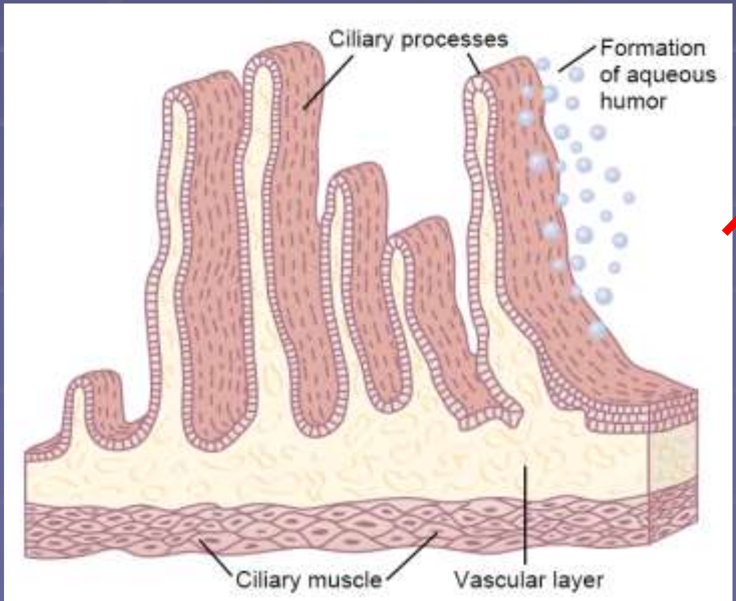


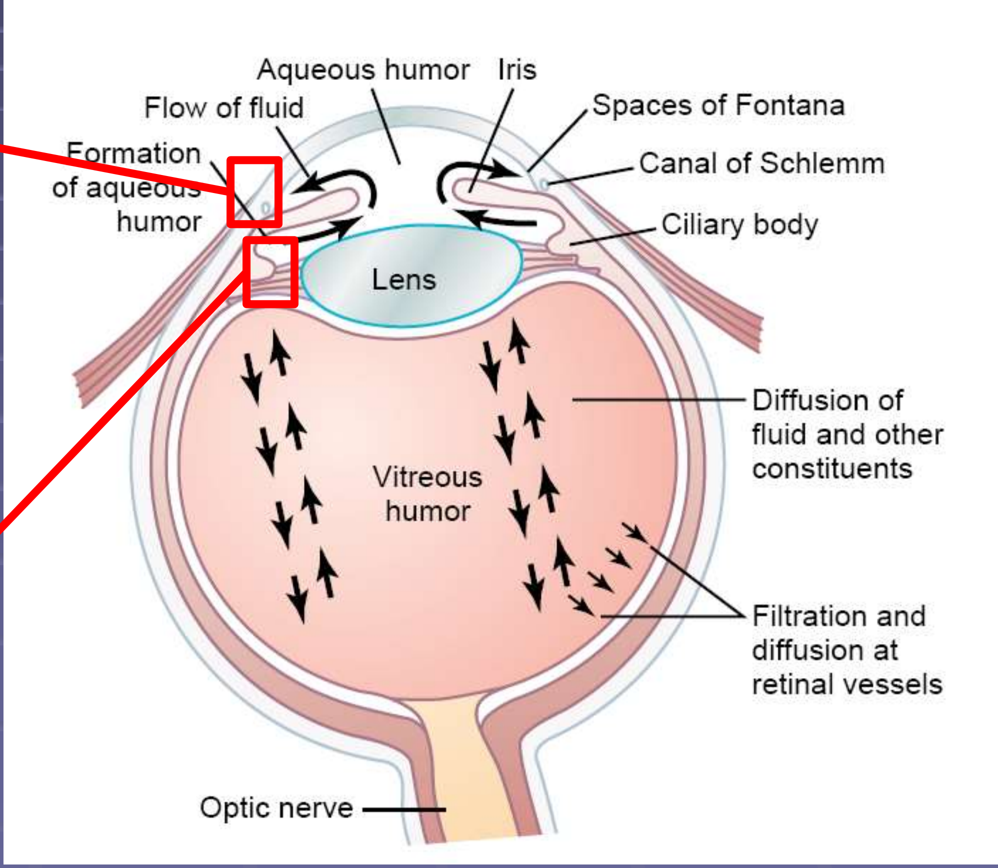
Intraocular Fluid



Intraocular Fluid



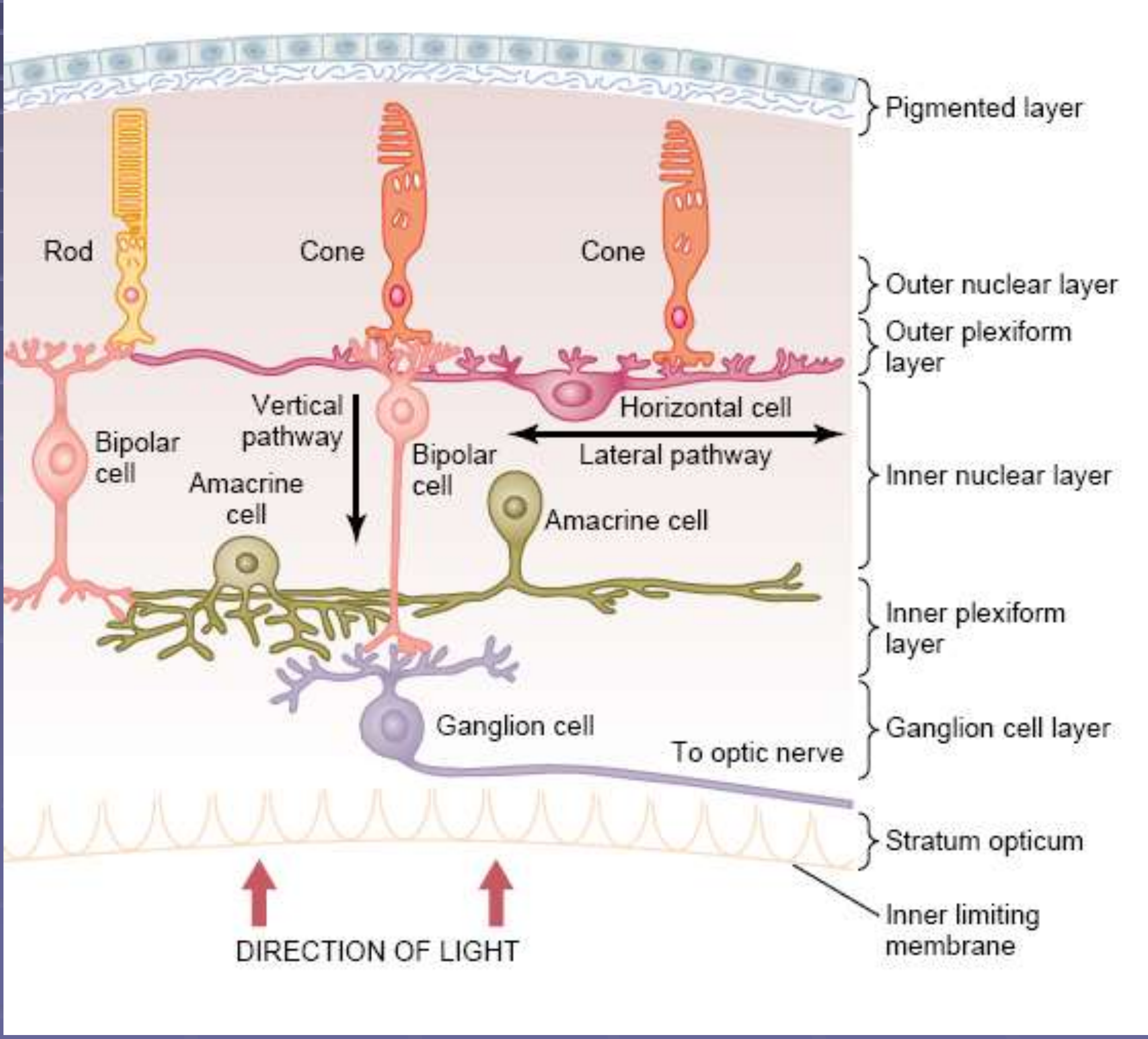




Glaucoma

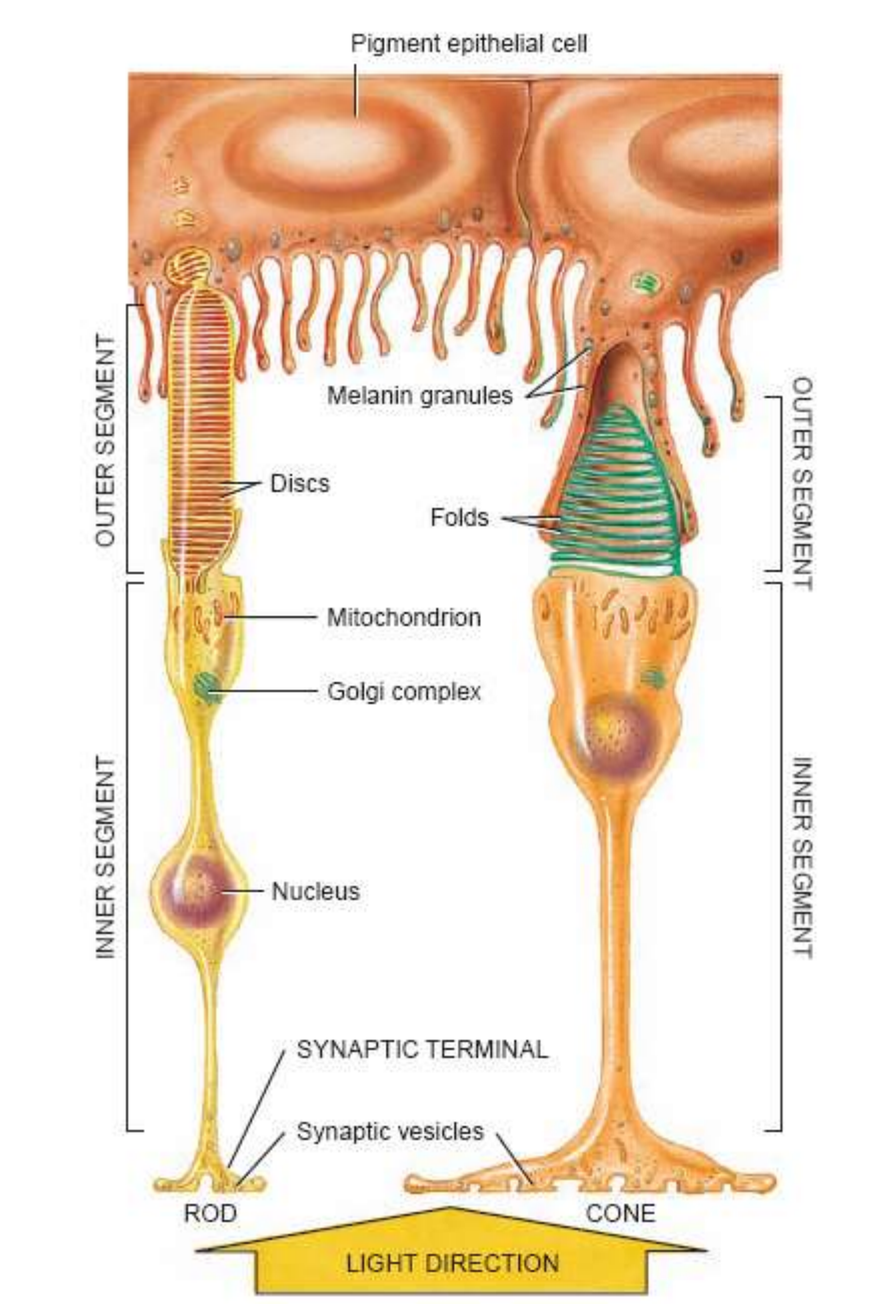
Retina

- Pigmented layer
- Photoreceptors
- Bipolar cells
- Ganglion cells
- Horizontal cell
- Amacrine cell

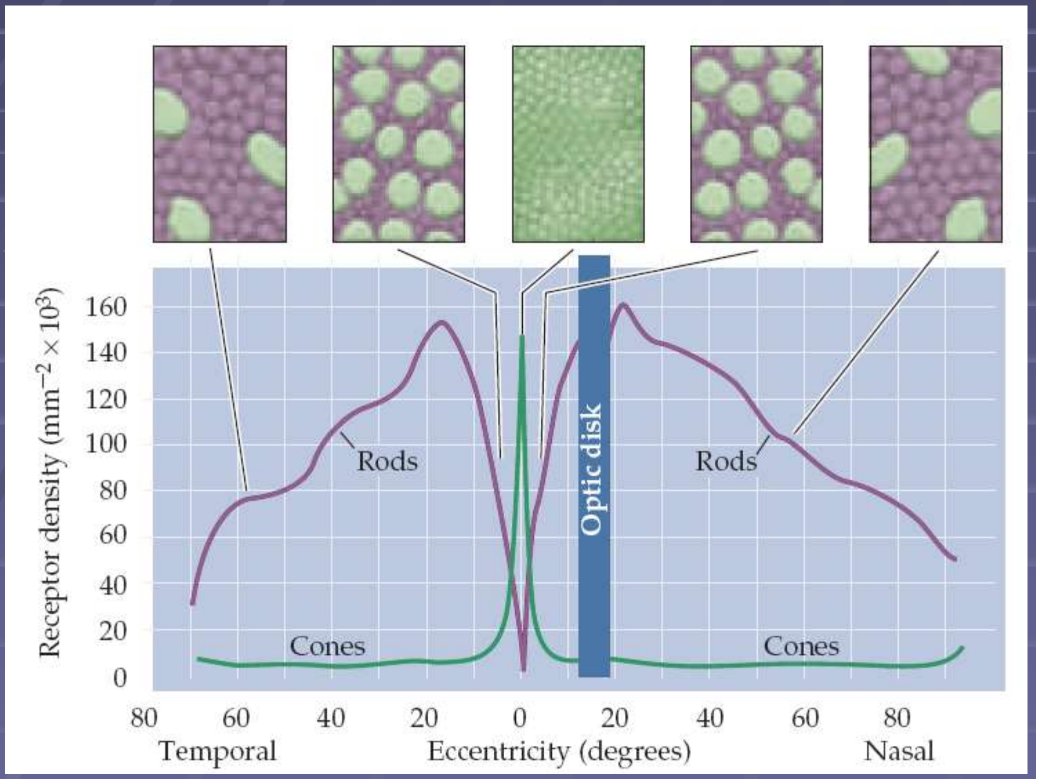


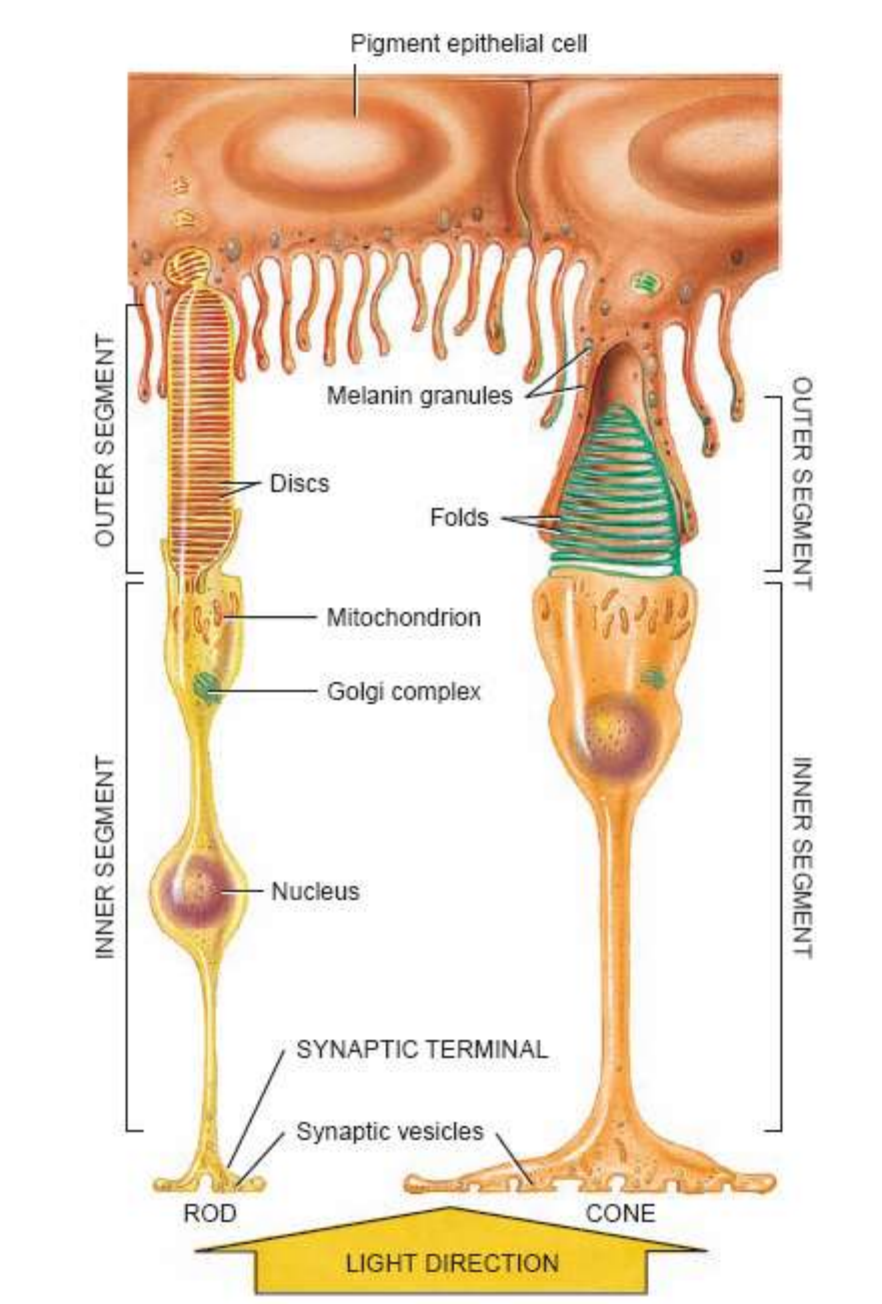
Photoreceptors

- Cones
- Rods



Photoreceptors





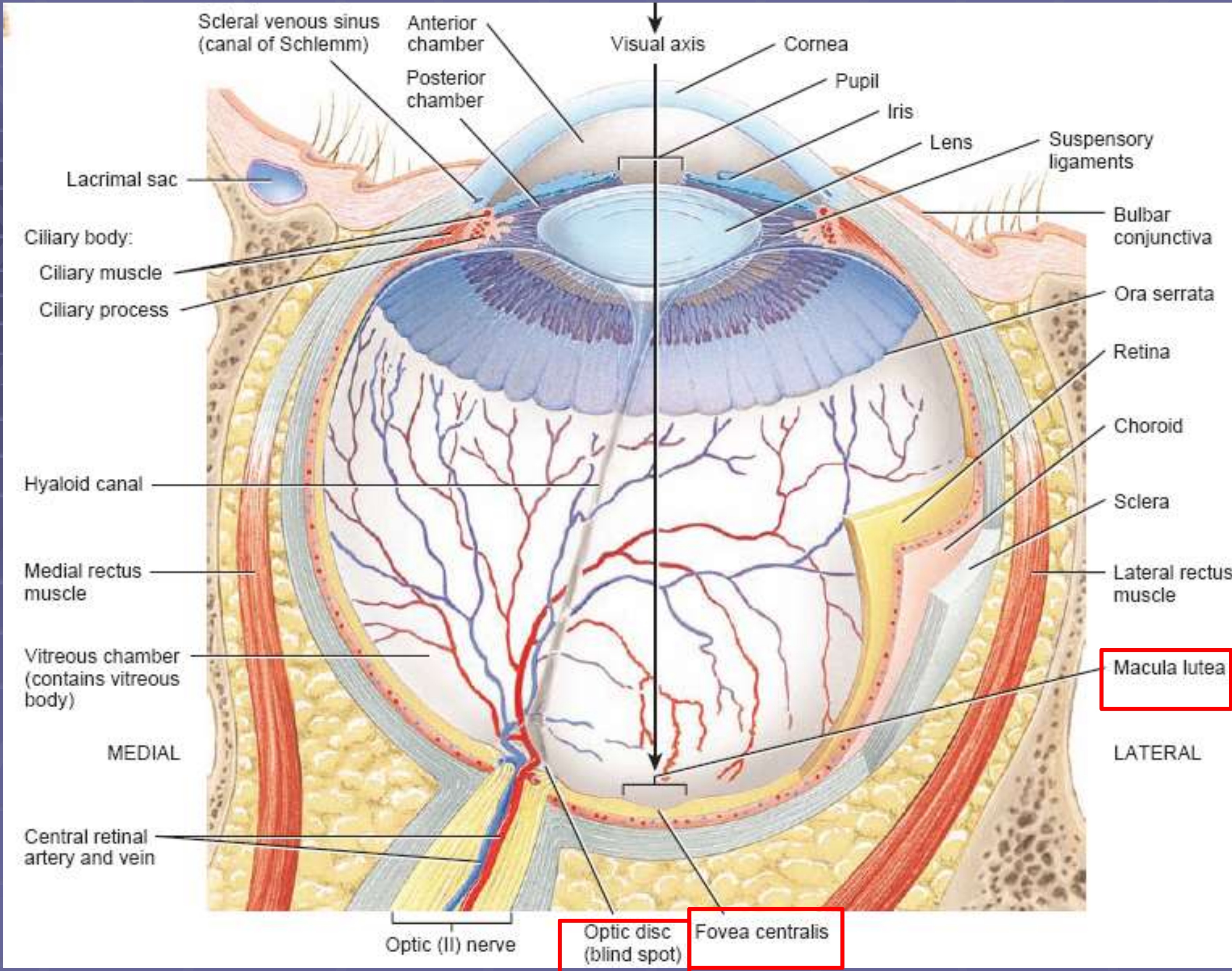
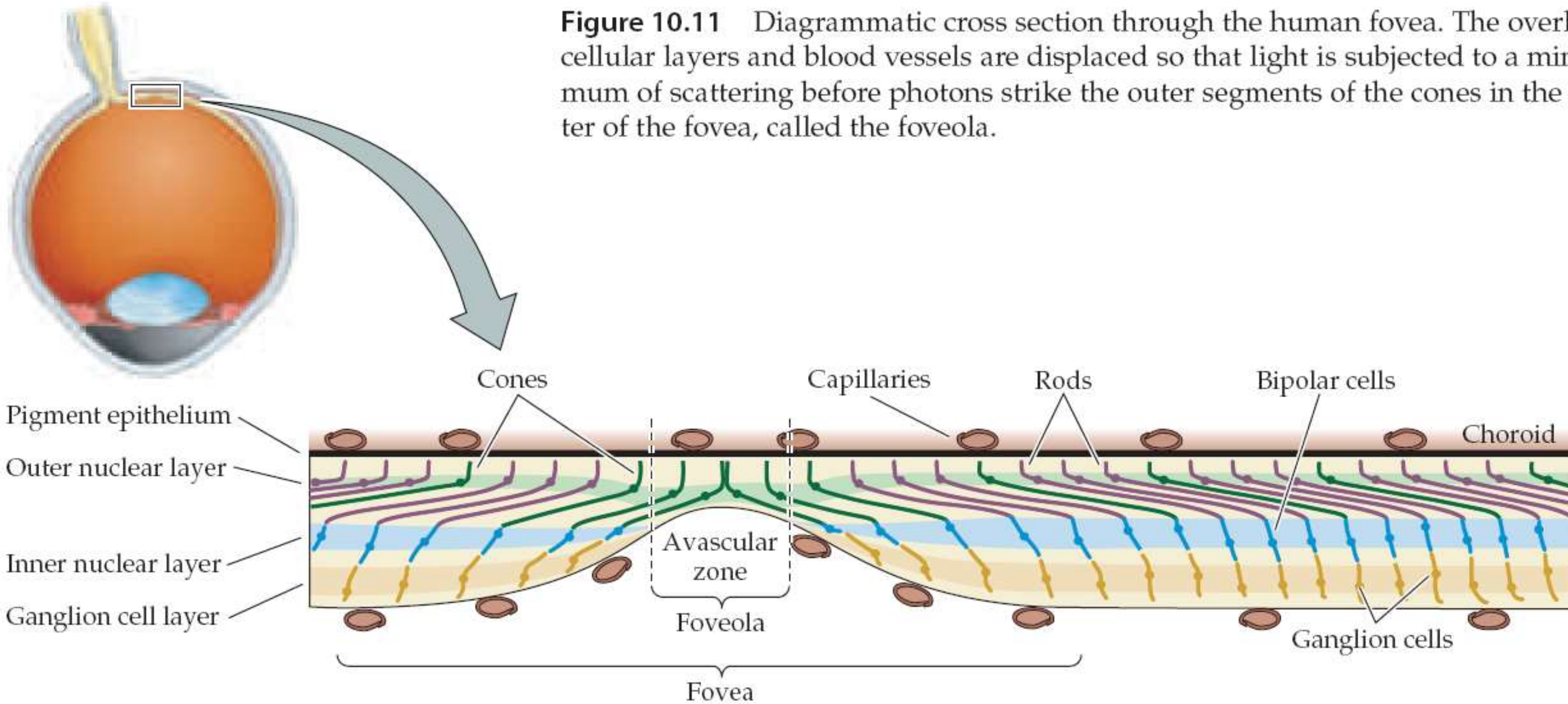
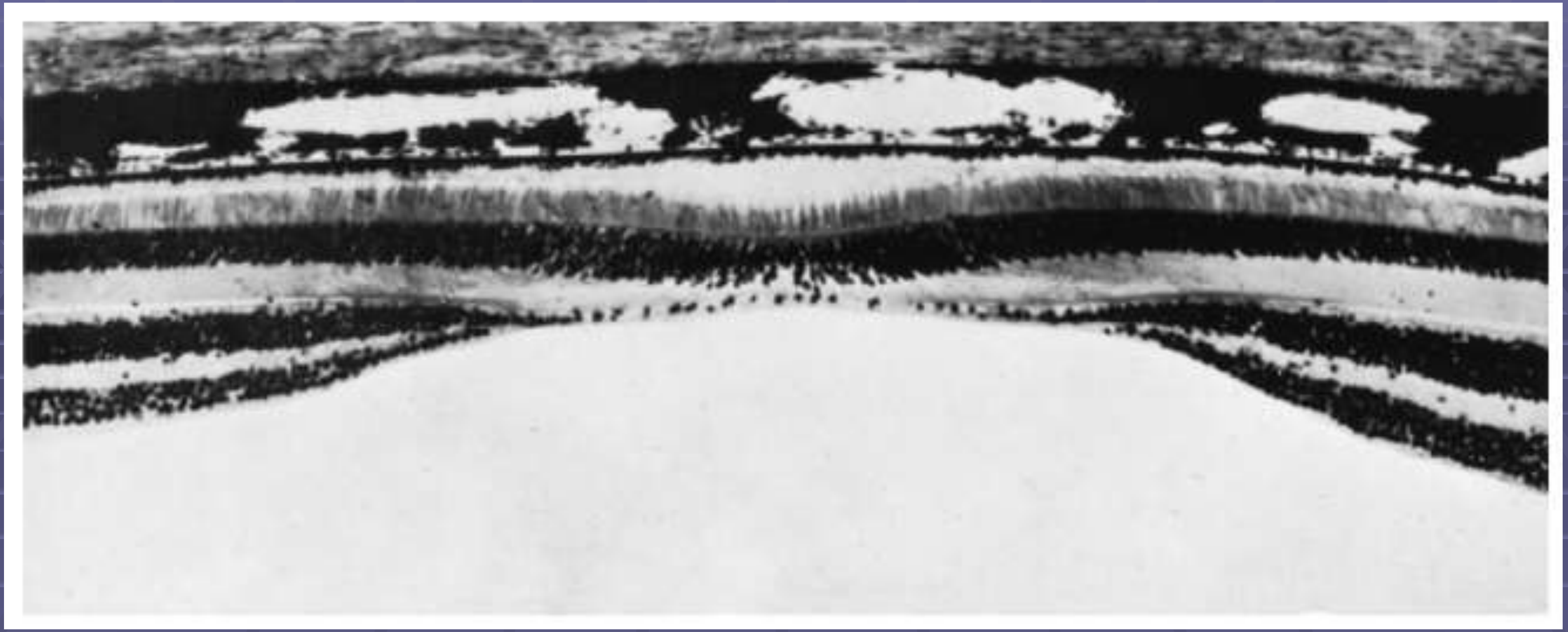

Scleral venous sinus
(canal of Schlemm)
Anterior chamber
Visual axis
Cornea
Posterior chamber
Pupil
Iris
Lens
Suspensory ligaments
Lacrimal sac
Bulbar conjunctiva
Ciliary body:
Ciliary muscle
Ciliary process
Ora serrata
Retina
Choroid
Hyaloid canal
Sclera
Medial rectus muscle
Lateral rectus muscle
Vitreous chamber
(contains vitreous body)
Macula lutea
MEDIAL
LATERAL
Central retinal artery and vein
Optic (II) nerve
Optic disc
(blind spot)
Fovea centralis

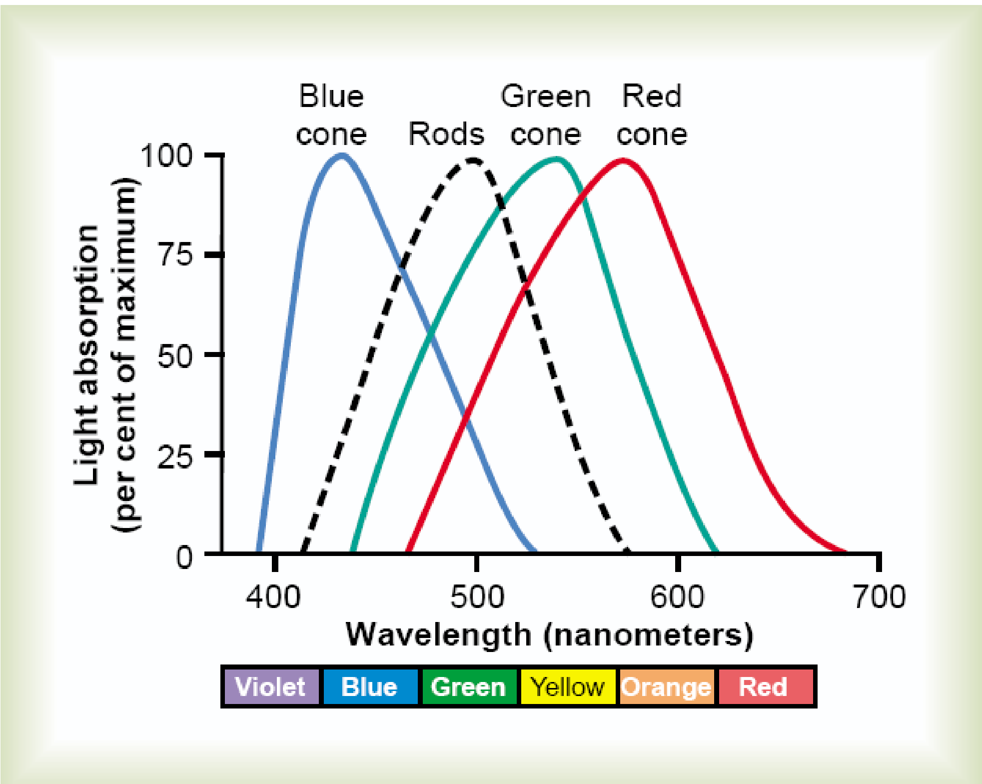
Figure 10.11 Diagrammatic cross section through the human fovea. The overlying cellular layers and blood vessels are displaced so that light is subjected to a minimum of scattering before photons strike the outer segments of the cones in the center of the fovea, called the foveola.

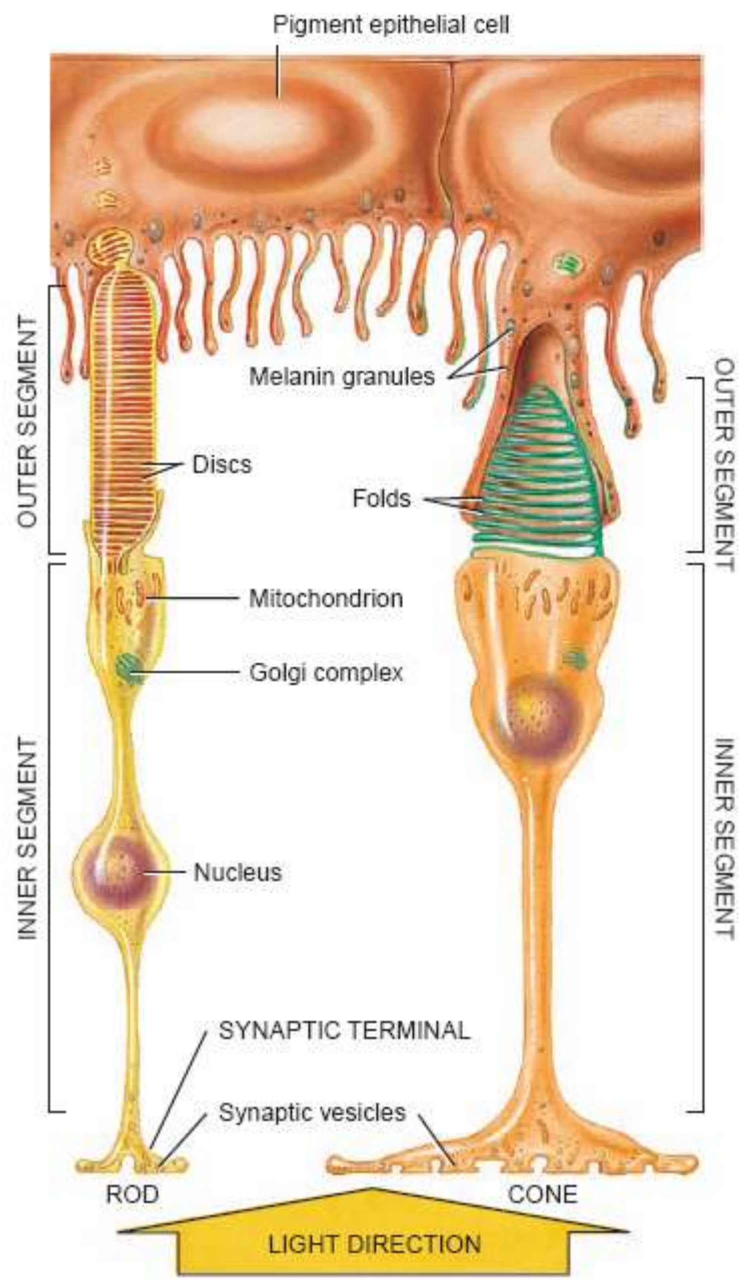




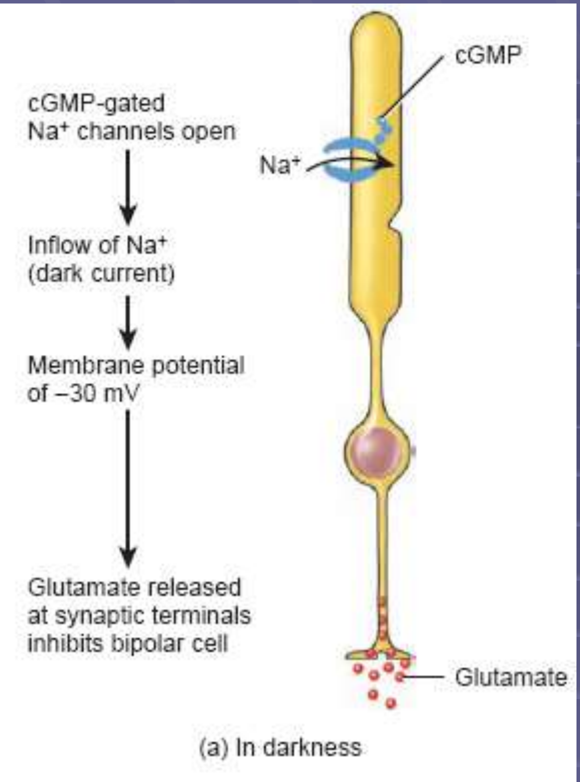
- Macular Degeneration
- age-related macular degeneration
- juvenile macular degeneration
  “Stargardt disease”

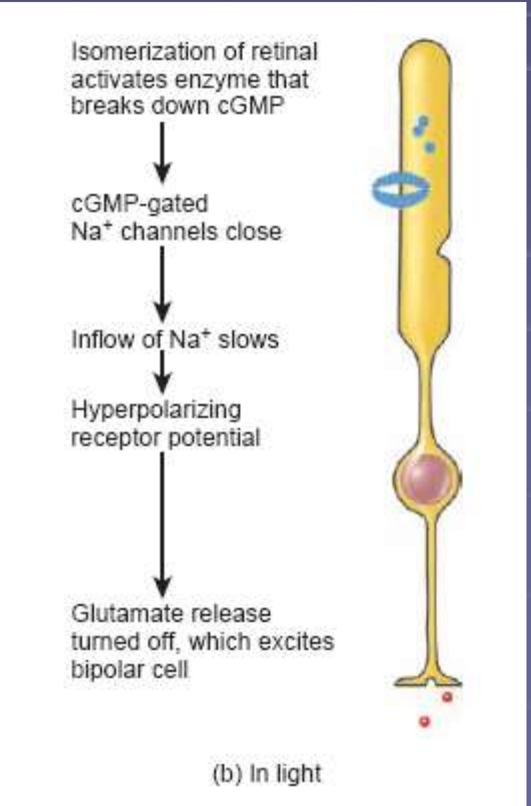
Photoreceptors

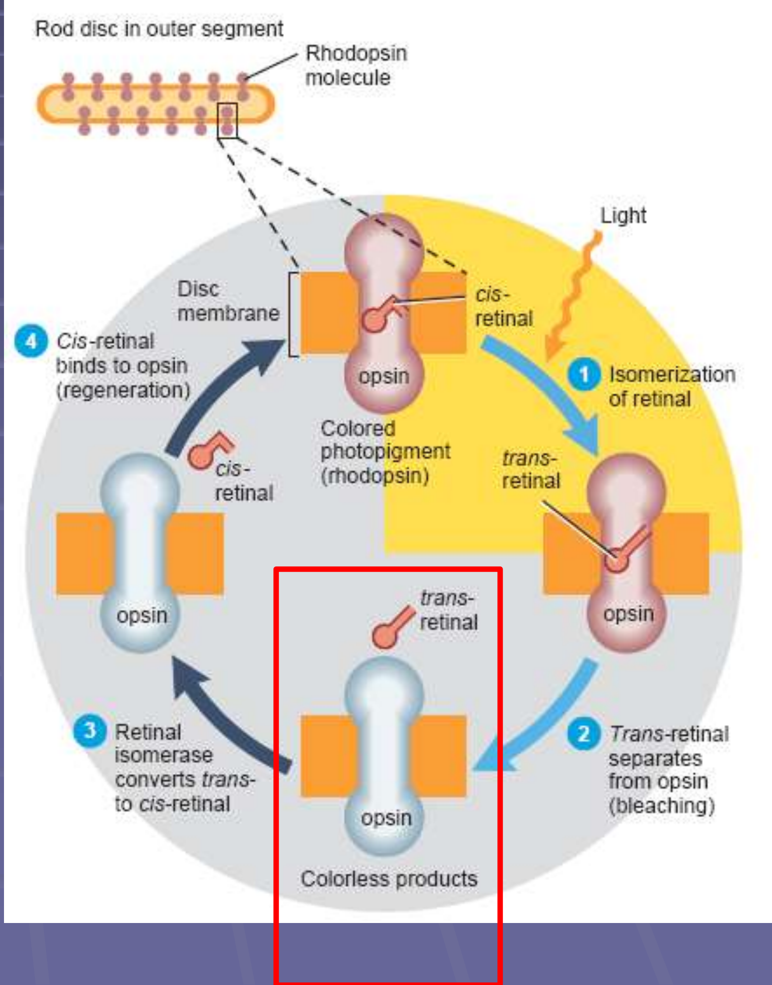


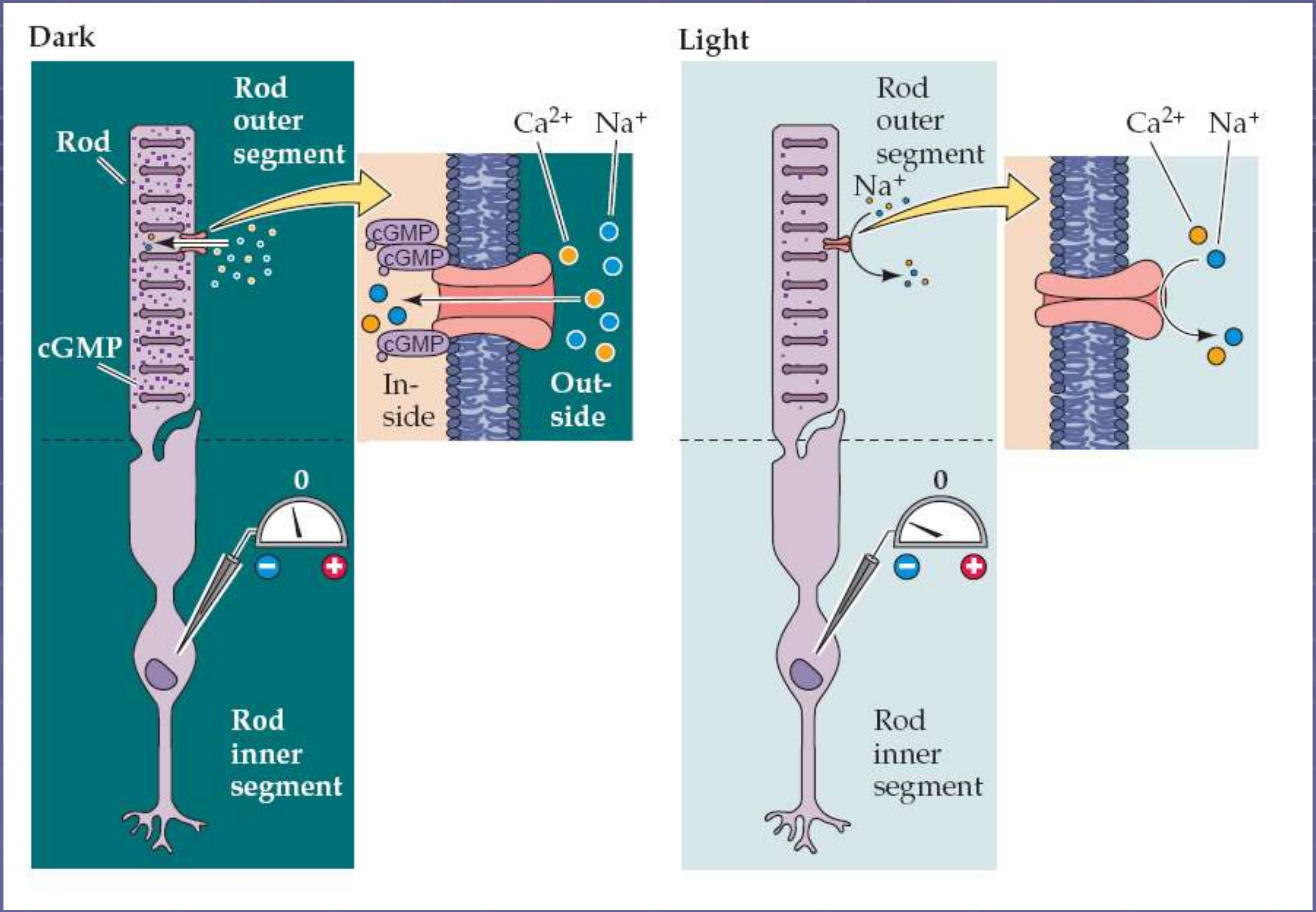


Light Detection



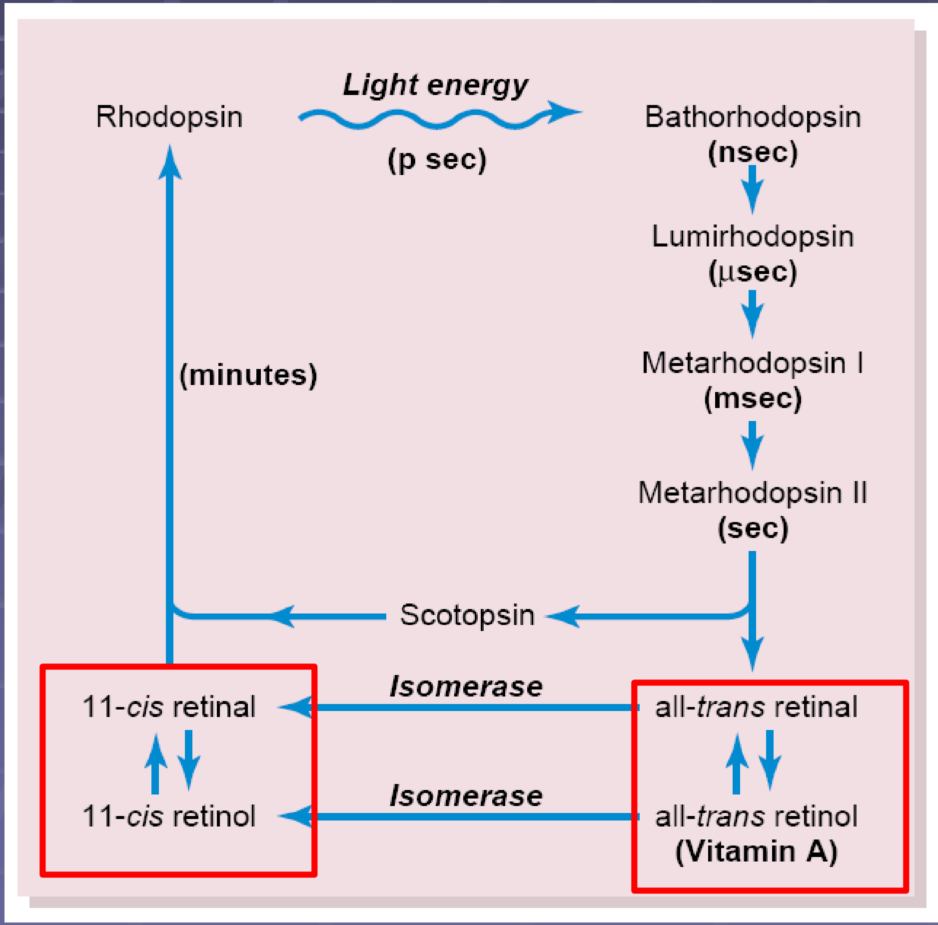


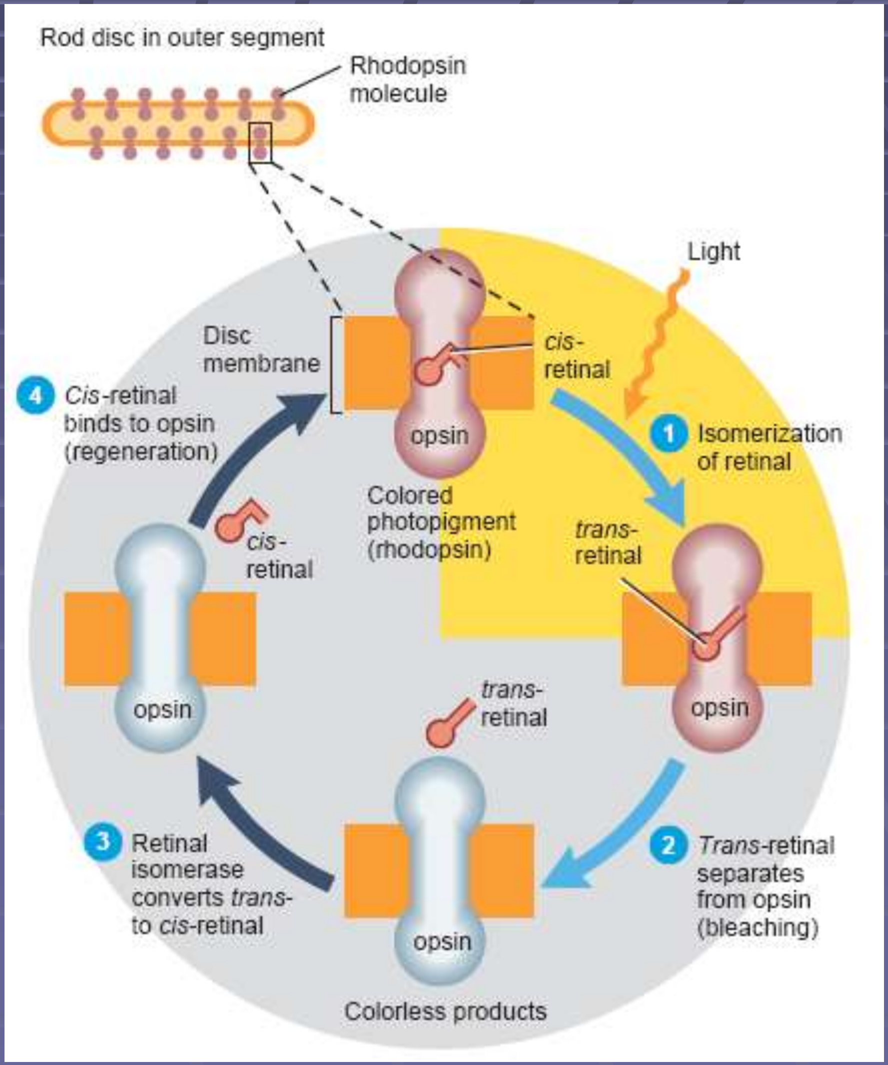




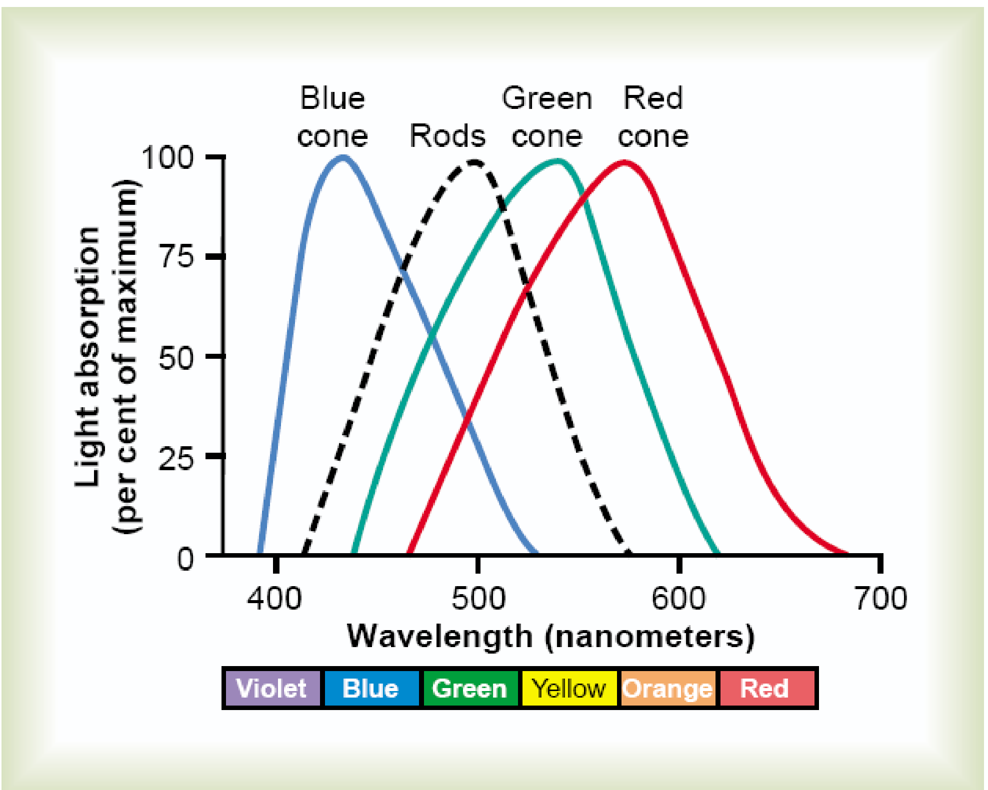
Dark
Rod
Rod outer segment
cGMP
Ca2+
Na+
cGMP
cGMP
cGMP
In-side
Out-side
0
Rod inner segment
Light
Rod outer segment
Na+
Ca2+
Na+
0
Rod inner segment

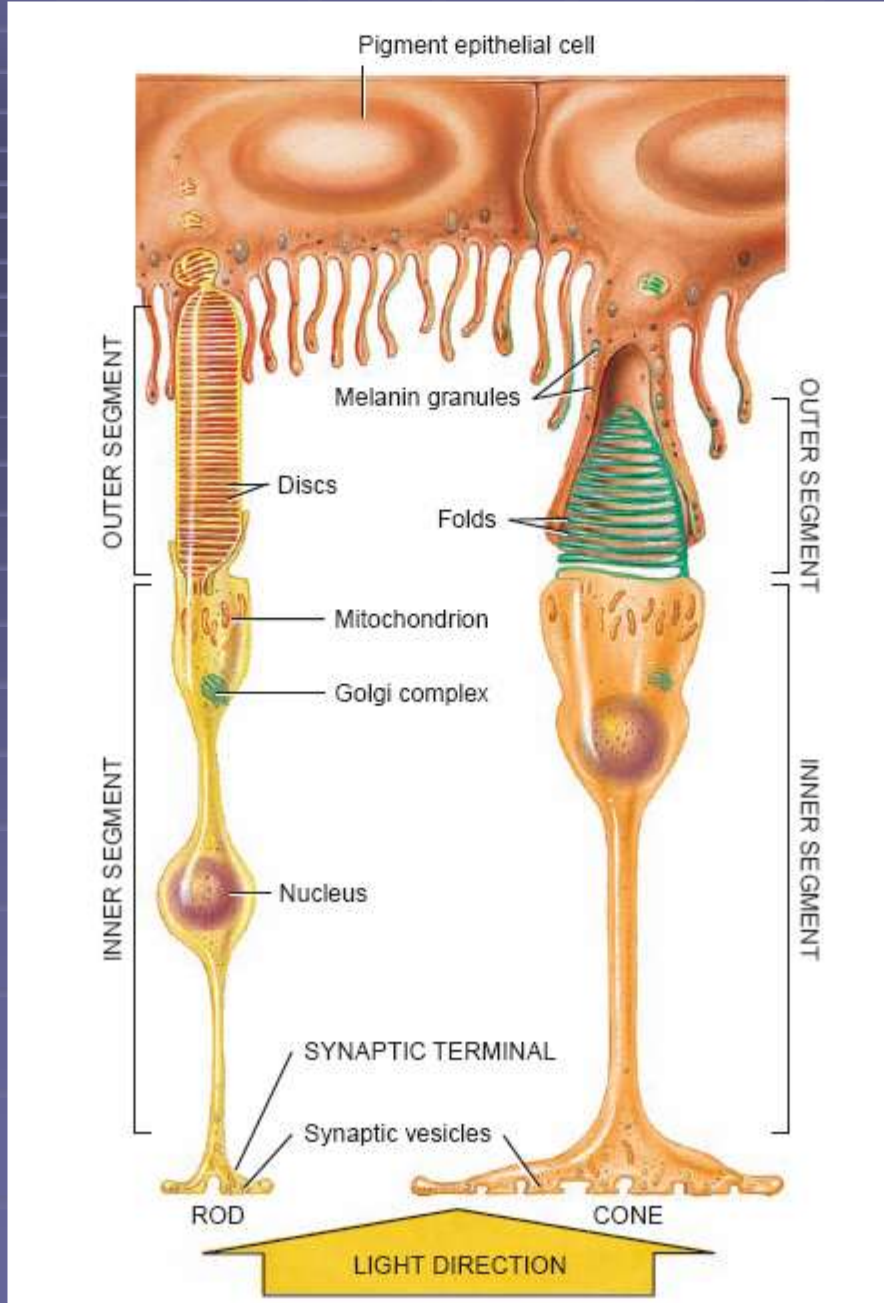
Light Detection



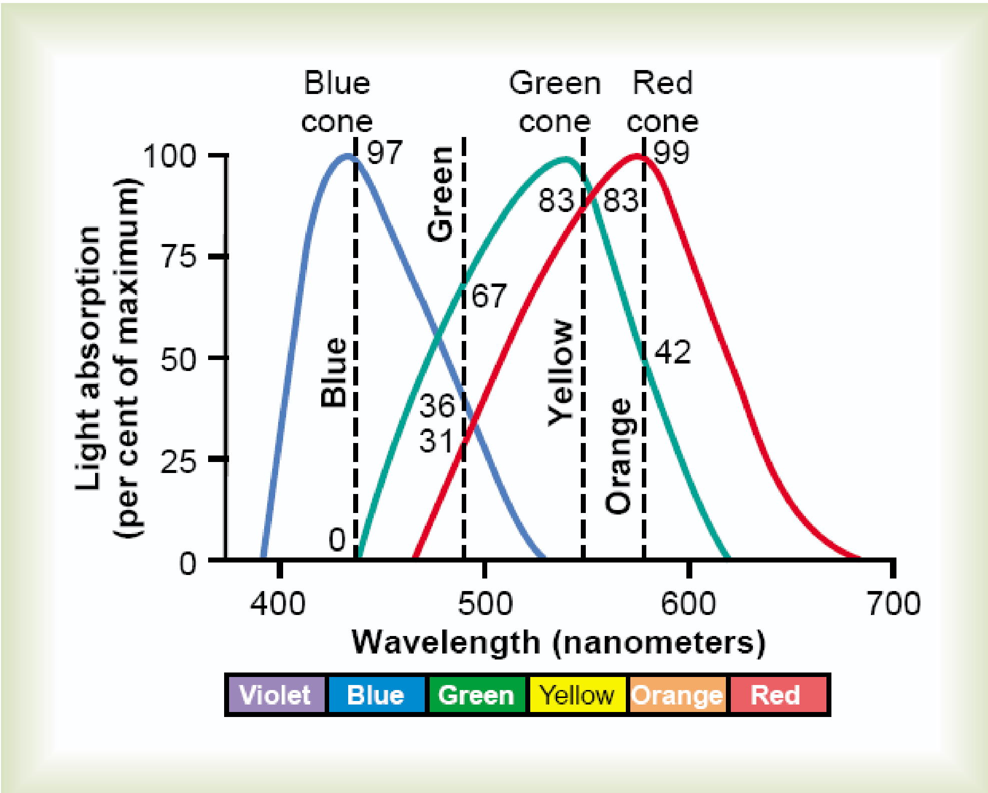


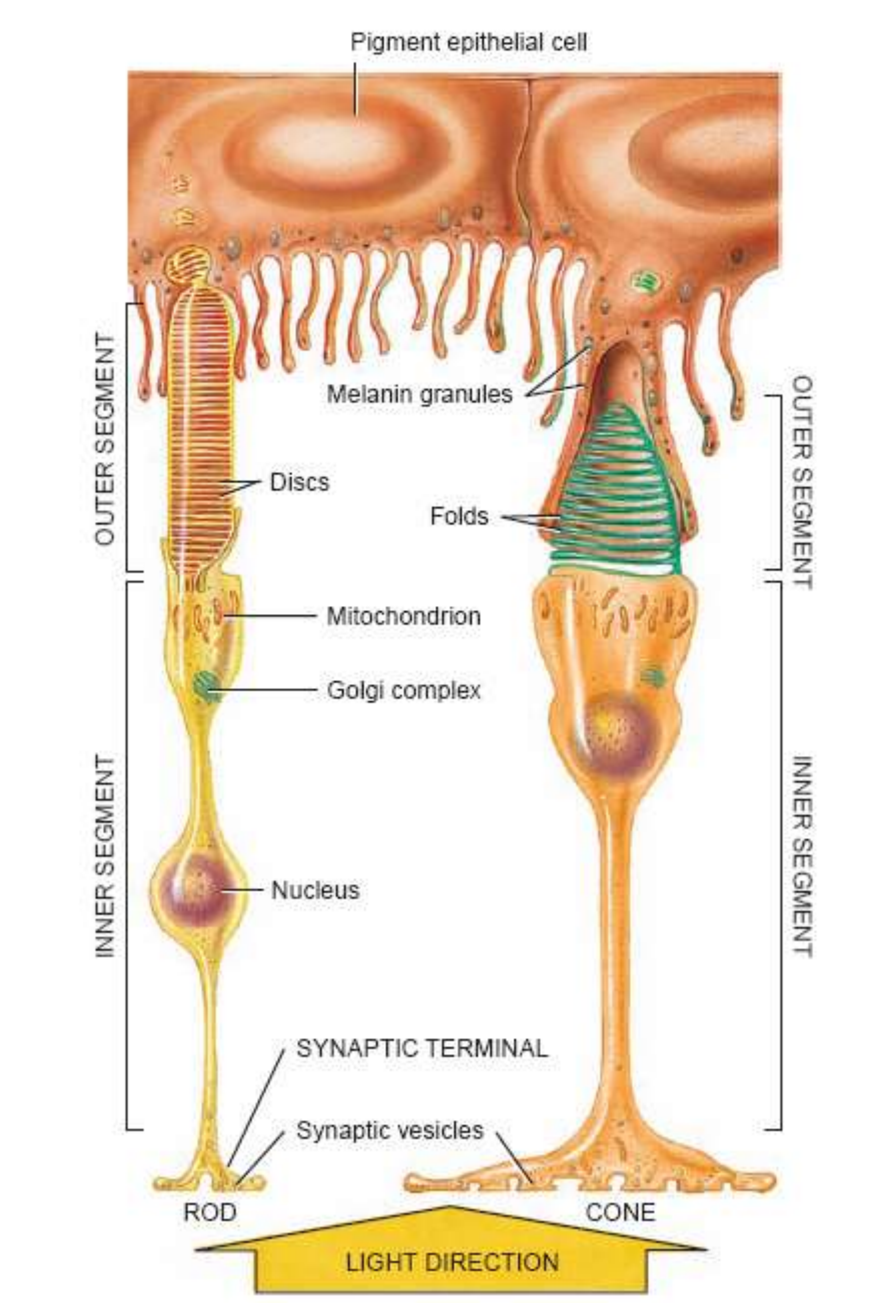
Photoreceptors





Photoreceptors



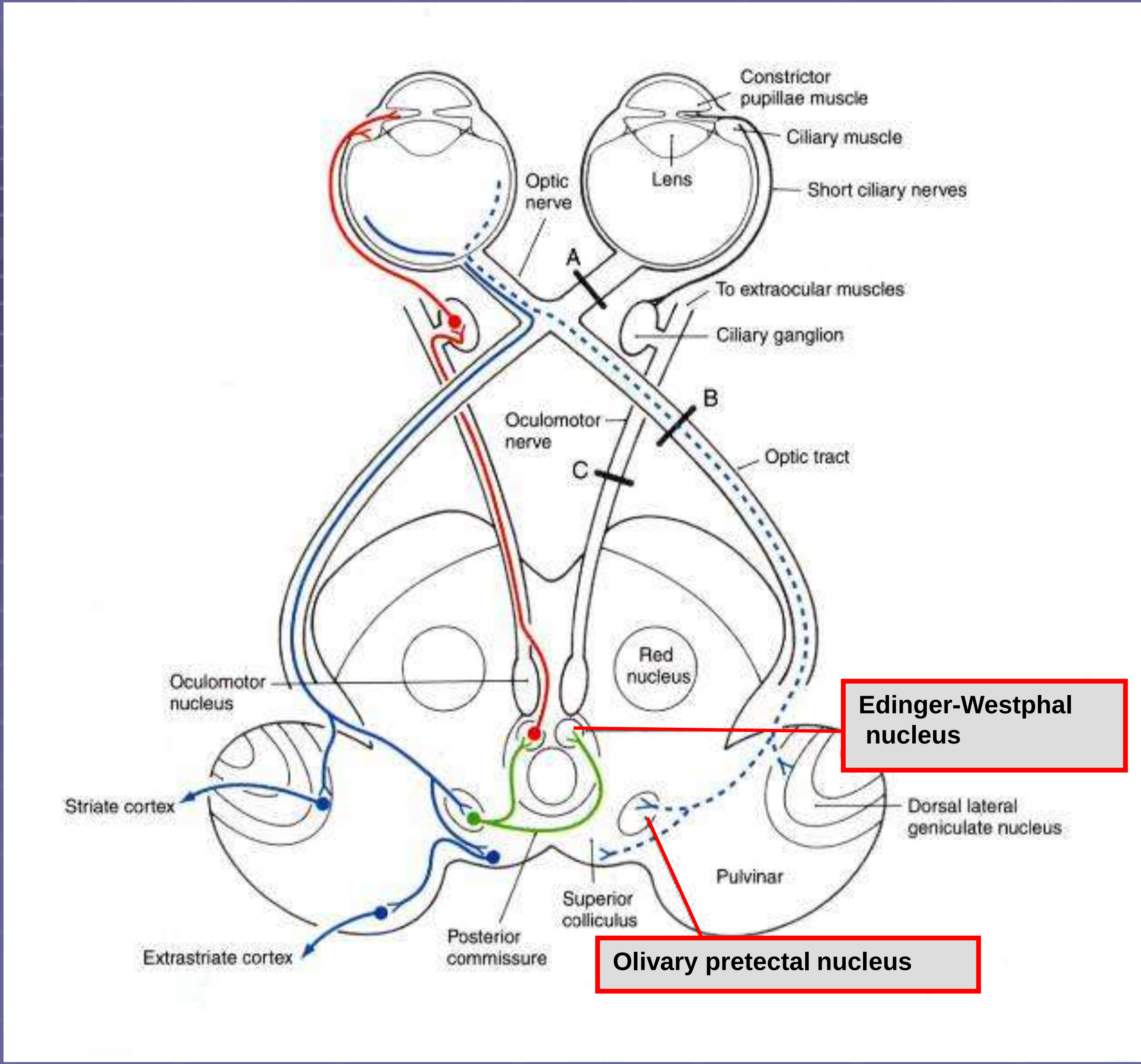


Photopsin : blue, green and red sensitive pigments

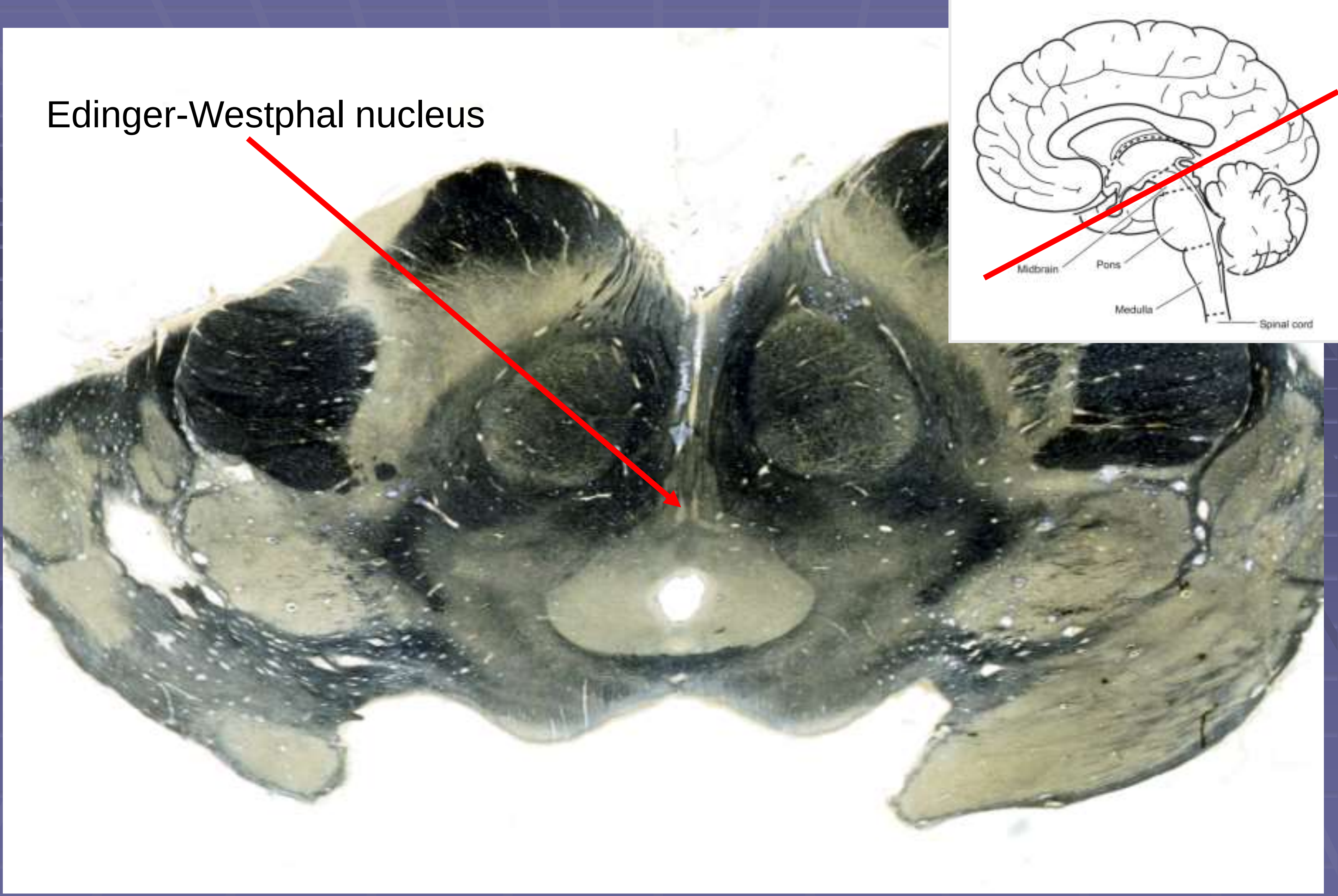
Light Adaptation

- Pupillary size

Pupillary Light Reflex


Constrictor pupillae muscle
Ciliary muscle
Short ciliary nerves
Lens
Optic nerve
A
To extraocular muscles
Ciliary ganglion
B
Oculomotor nerve
C
Optic tract
Red nucleus
Oculomotor nucleus
Edinger-Westphal nucleus
Striate cortex
Dorsal lateral geniculate nucleus
Pulvinar
Superior colliculus
Posterior commissure
Extrastriate cortex
Olivary pretectal nucleus

Edinger-Westphal nucleus

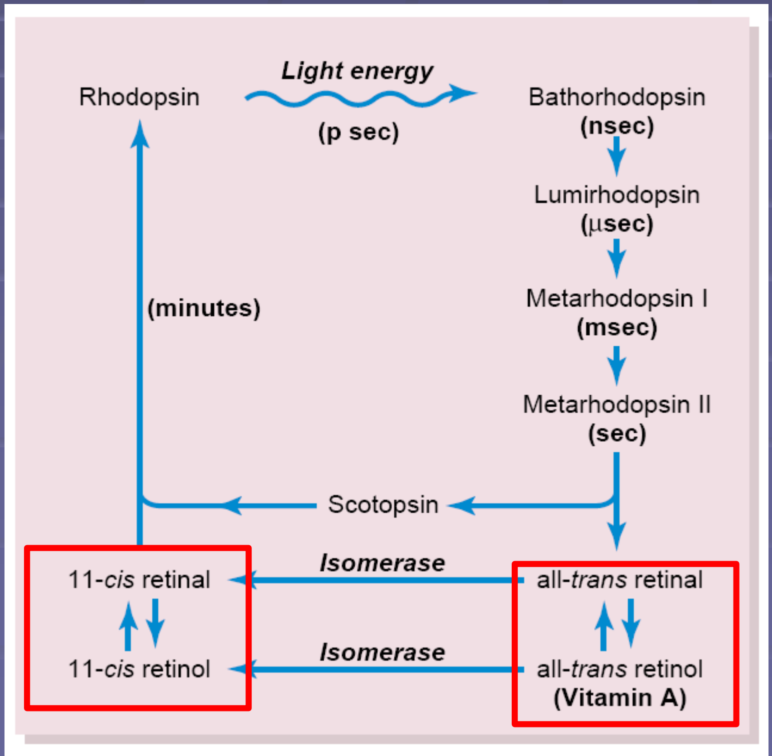


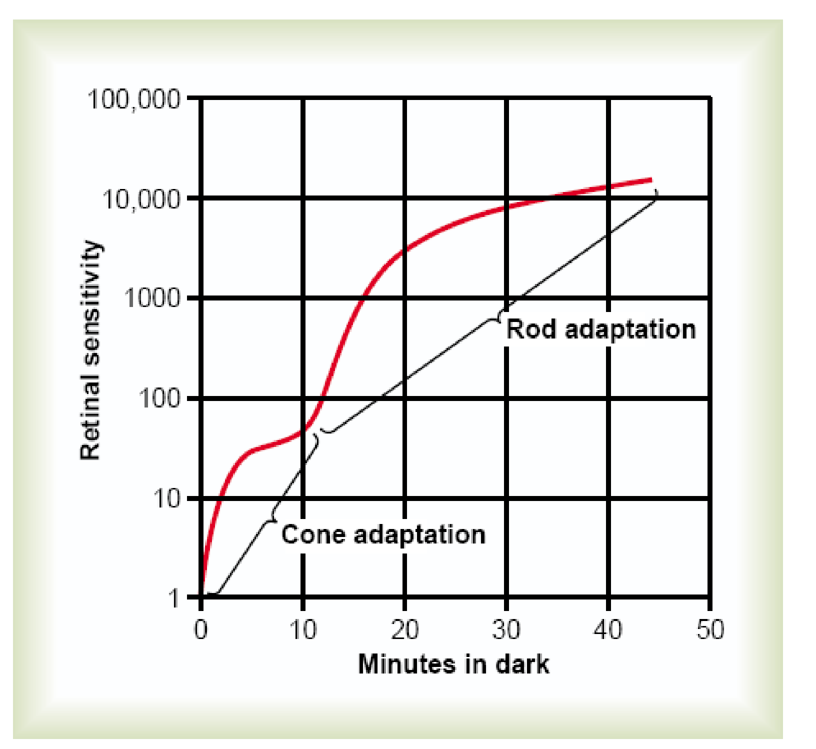
Light Adaptation

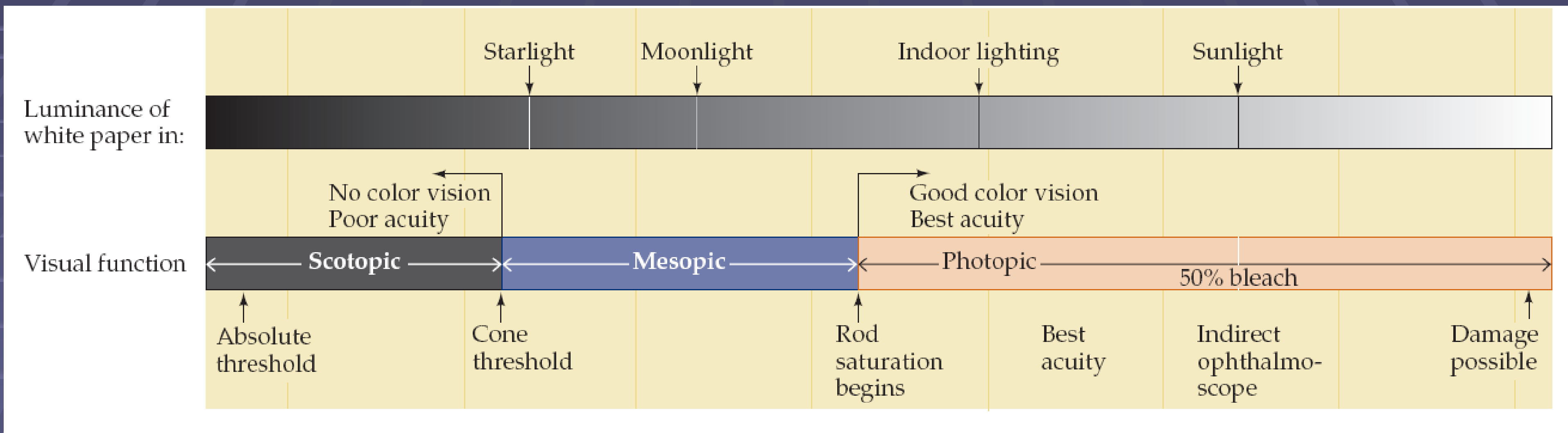
- Pupillary size
- Neural adaptation
- Photoreceptor adaptation

Light Adaptation

- Pupillary size
- Neural adaptation
- Photoreceptor adaptation







Starlight
Moonlight
Indoor lighting
Sunlight
Luminance of white paper in:
No color vision
Poor acuity
Good color vision
Best acuity
Visual function
Scotopic
Mesopic
Photopic
50% bleach
Absolute threshold
Cone threshold
Rod saturation begins
Best acuity
Indirect ophthalmo-scope
Damage possible

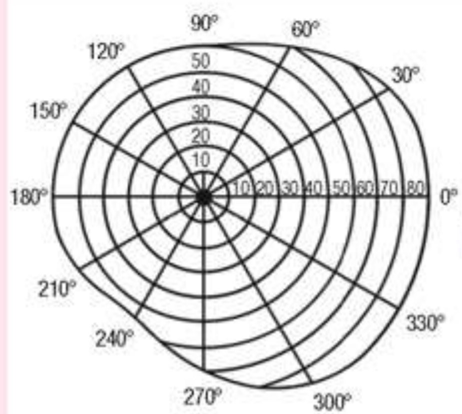
Night blindness

Retinitis pigmentosa

Comparing tunnel vision with normal vision

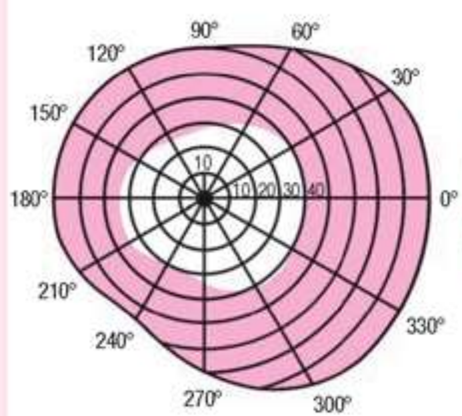
The patient with tunnel vision experiences drastic constriction of his peripheral visual field. The illustrations here convey the extent of this constriction, comparing test findings for normal and tunnel vision.

Normal field of vision in the right eye, as shown on a perimetry chart



Normal field of vision in the right eye, as shown on a perimetry chart

Tunnel vision in the right eye, as shown on a perimetry chart



Tunnel vision in the right eye, as seen in advanced glaucoma during perimeter examination