

Special senses

Vision

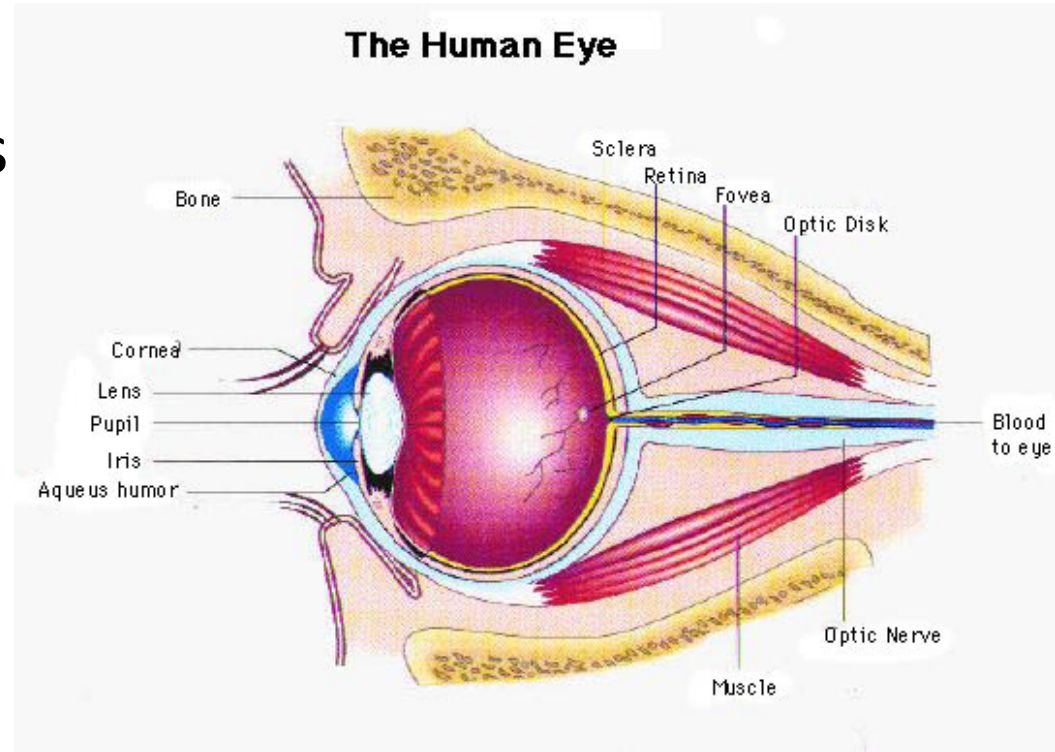
Figures in this ppt are from guyton, ganong, best & taylor, tortora, netters, gray's anatomy and google images

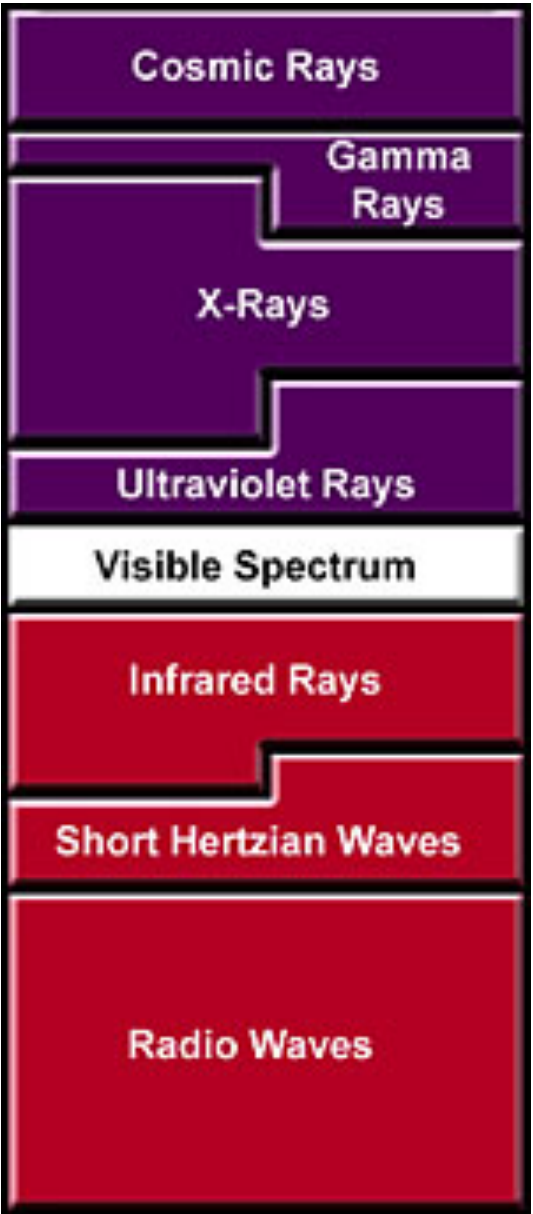
- According to proverb, **the eyes are the windows to the soul.**
- According to researchers, they might also be windows to brain disease.
- We can see microvascular changes in hypertension & diabetes mellitus.
- Even in alzheimers initially amyloid like depsoition can be noticed in retina

EYE

In its protective casing it has

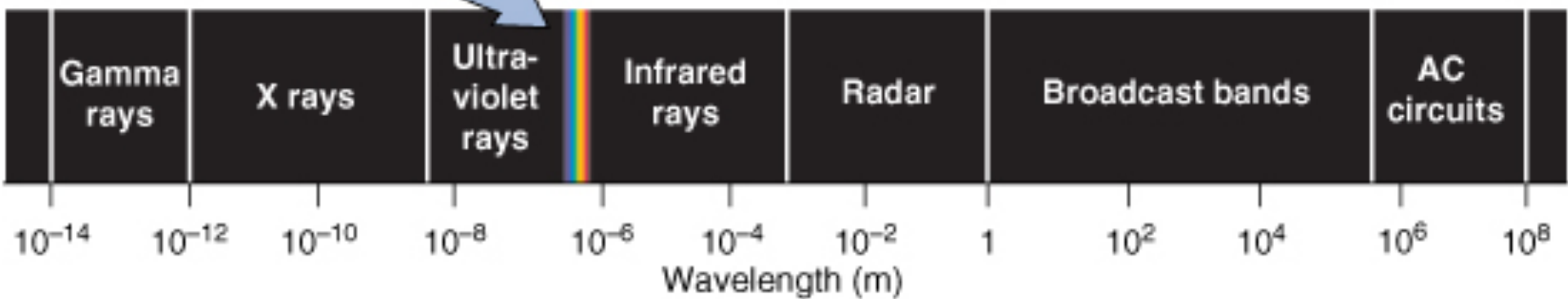
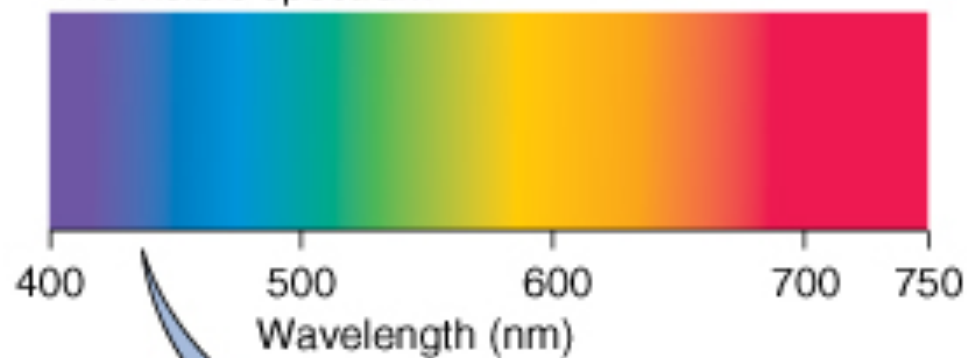
1. A layer of receptors
2. Lens system that focusses light on the receptors
3. A system of nerves that conducts impulses from receptors to CNS





Electromagnetic Waves

The visible spectrum

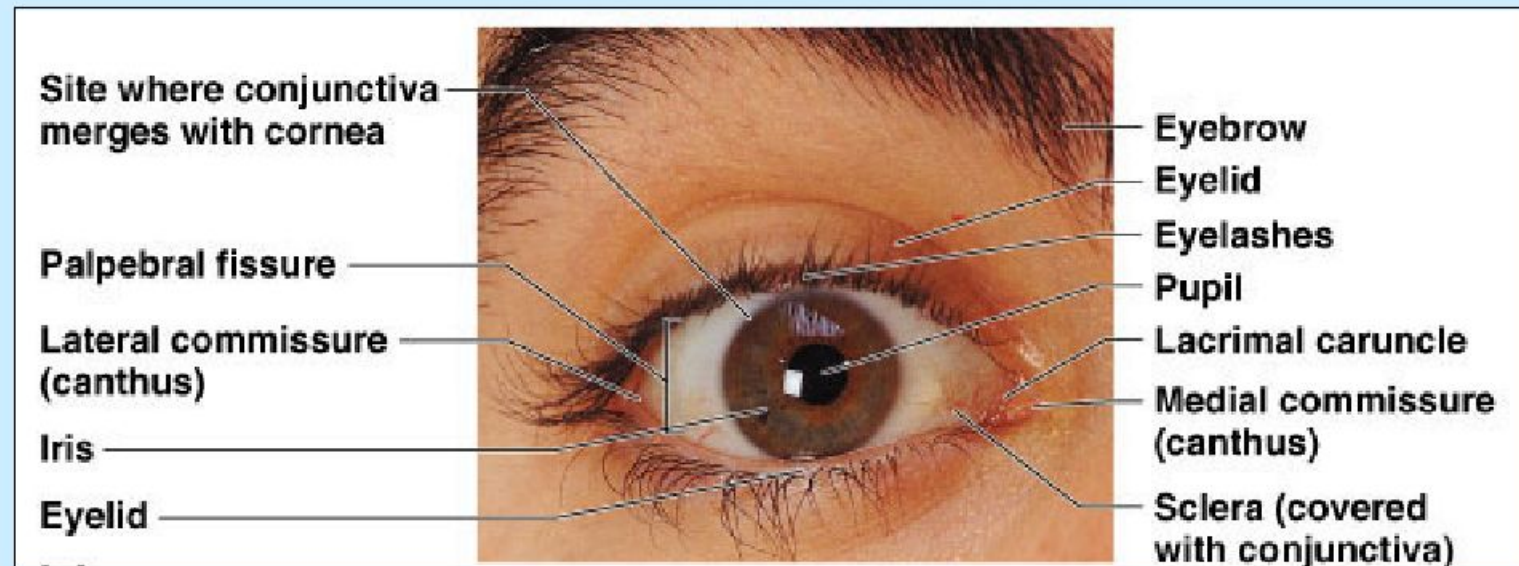


Eye and Associated Structures

70% of all sensory receptors are in the eye

Most of the eye is protected by a cushion of fat and the bony orbit

Accessory structures include eyebrows, eyelids, conjunctiva, lacrimal apparatus, extrinsic eye muscles



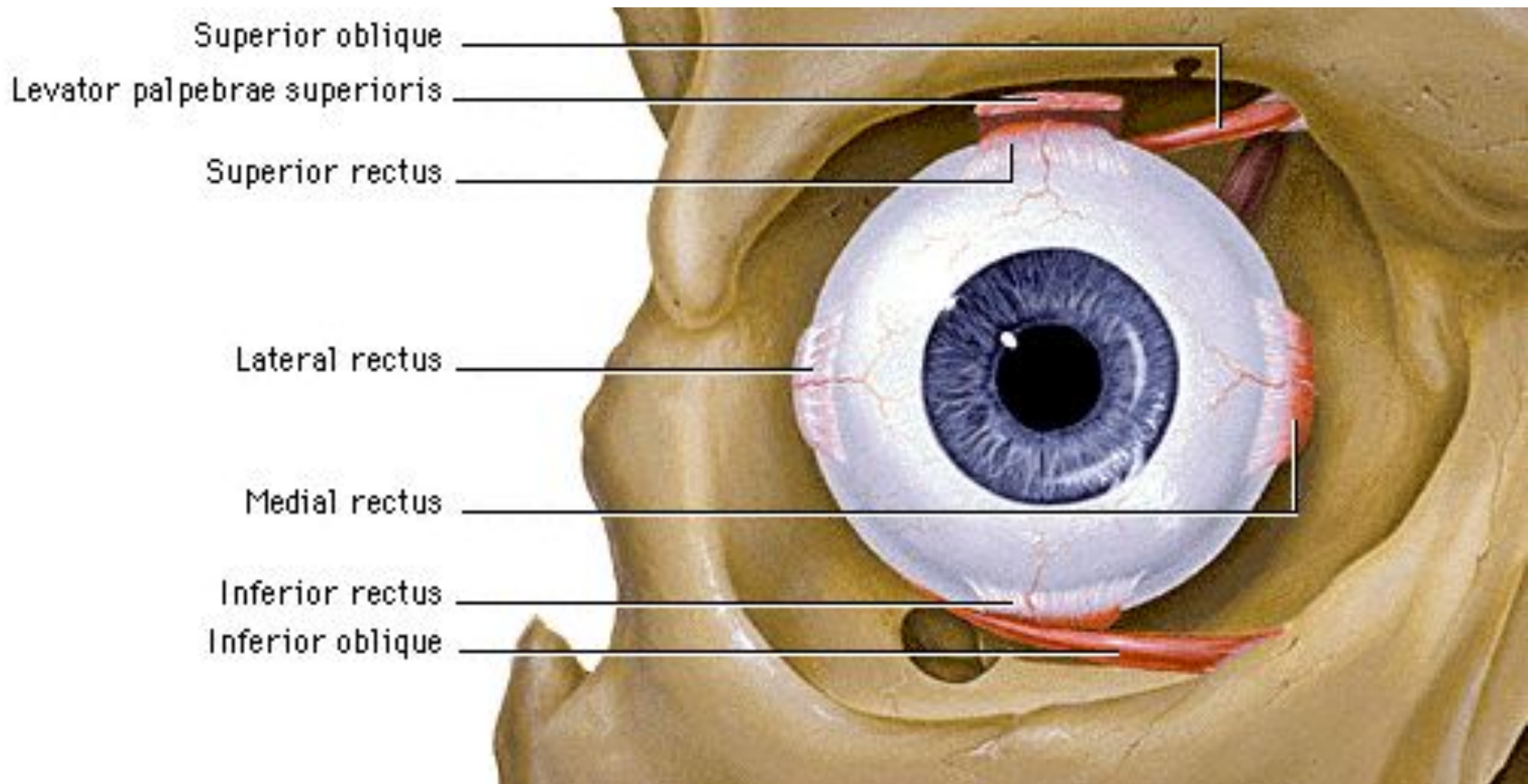
Extrinsic Eye Muscles

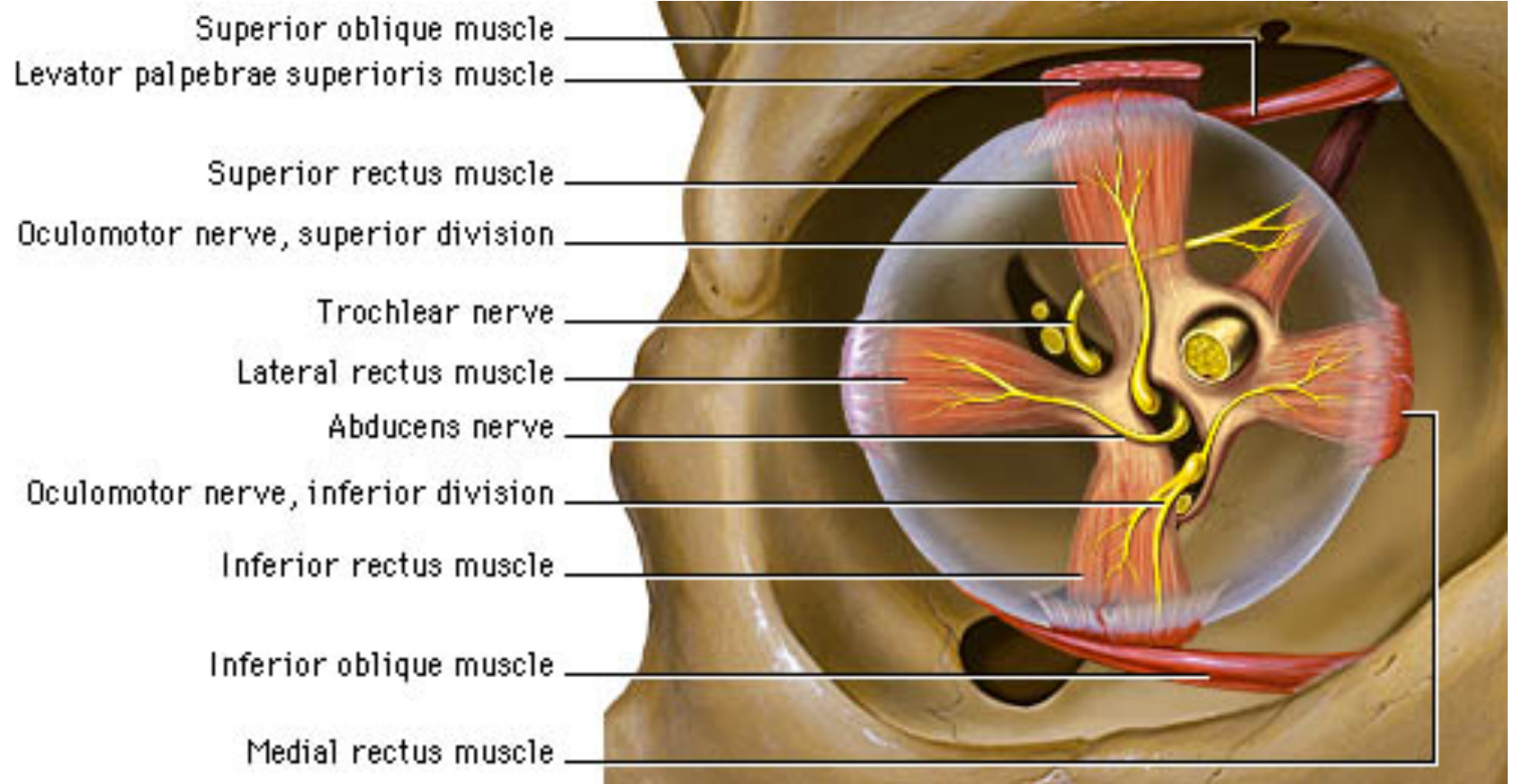
Six straplike extrinsic eye muscles, enable the eye to follow moving objects, maintain the shape of the eye

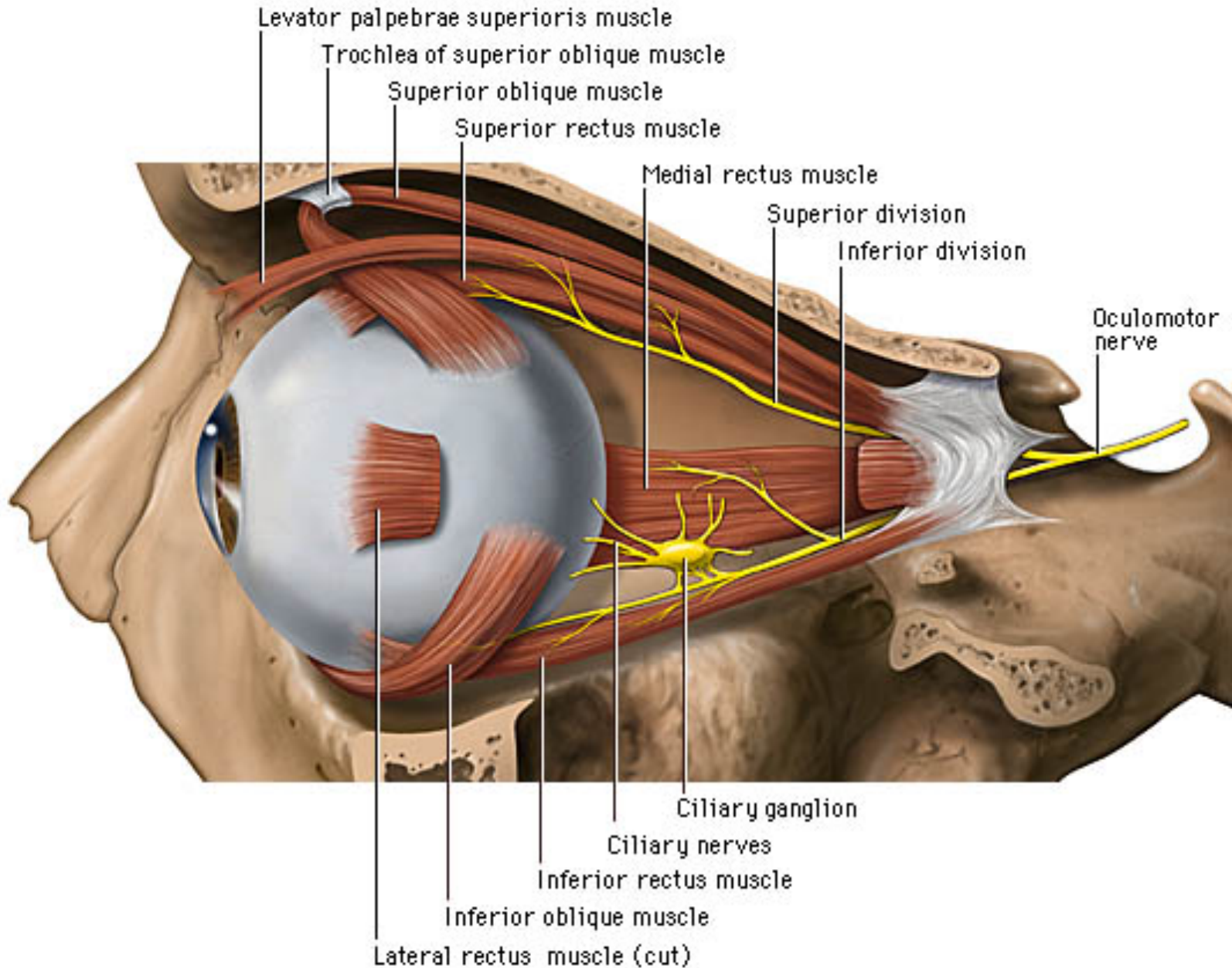
Four rectus muscles originate from a tendinous ring, the annular ring, at the back of the orbit and run straight to their insertion on the eye (superior, inferior, lateral, and medial rectus muscles)

Two oblique (superior and inferior) muscles move the eye in the vertical plane

EXTRA OCCULAR MUSCLES







Cranial Nerves and Muscle Actions

Name	Action	Controlling cranial nerve
Lateral rectus	Moves eye laterally	VI (abducens)
Medial rectus	Moves eye medially	III (oculomotor)
Superior rectus	Elevates eye	III (oculomotor)
Inferior rectus	Depresses eye	III (oculomotor)
Inferior oblique	Elevates eye and turns it laterally	III (oculomotor)
Superior oblique	Depresses eye and turns it laterally	IV (trochlear)

Precise and rapid control due to High axon-to-muscle fiber ratio (small motor units)

Eye Muscles

Diplopia – double vision due to imperfect coordination of the eye muscles

Strabismus – congenital weakness of eye muscles where the affected eye rotates medially or laterally

Eyebrows

Hairs overlying the supraorbital margins

Functions:

Shade the eye

Prevent perspiration from reaching the eye

Orbicularis oculi – depresses the eyebrows, closes the eye when it contracts

Corrugator muscles – move the eyebrows medially

Levator palpebrae superioris – raises the upper eyelid

Palpebrae (Eyelids)

Palpebral fissure – separates eyelids

Canthi (commissures) – medial and lateral angles or corners where palpebrae meet

Lacrimal caruncle at the medial canthus – contains sebaceous and sweat glands, produces an oily secretion

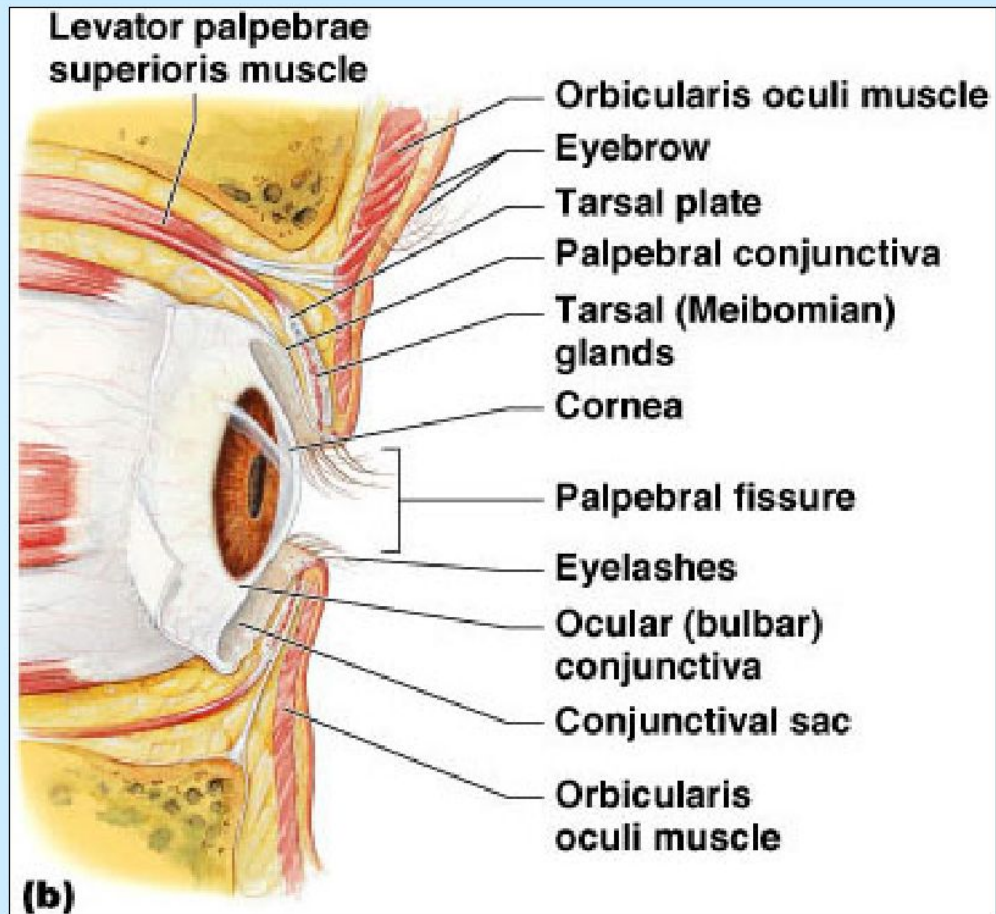
Tarsal plates of CT support the eyelids internally

Eyelashes - project from the free margin of each eyelid, initiate reflex blinking (hair follicle receptors)

Meibomian (tarsal sebaceous) glands

Ciliary glands (modified sweat glands) between the hair follicles

Palpebrae (Eyelids)



CORNEA

- The cornea has an endothelium (facing the aqueous humour) and an epithelium (facing the tear film) sandwiching the stroma (fibroblast-like cells and collagen fibrils).
- The collagen fibrils exert a high colloid osmotic swelling pressure.
- The cornea will naturally swell and as it does so become opaque.
- swelling must be counteracted by continual pumping of water out of the tissue to maintain the correct thickness and transparency

Conjunctiva

Transparent mucous membrane lining the eyelids as the palpebral conjunctiva and the anterior surface of the eye (the sclera only) as the ocular (or bulbar) conjunctiva

Thin, with blood vessels beneath it, lubricates and protects the eye

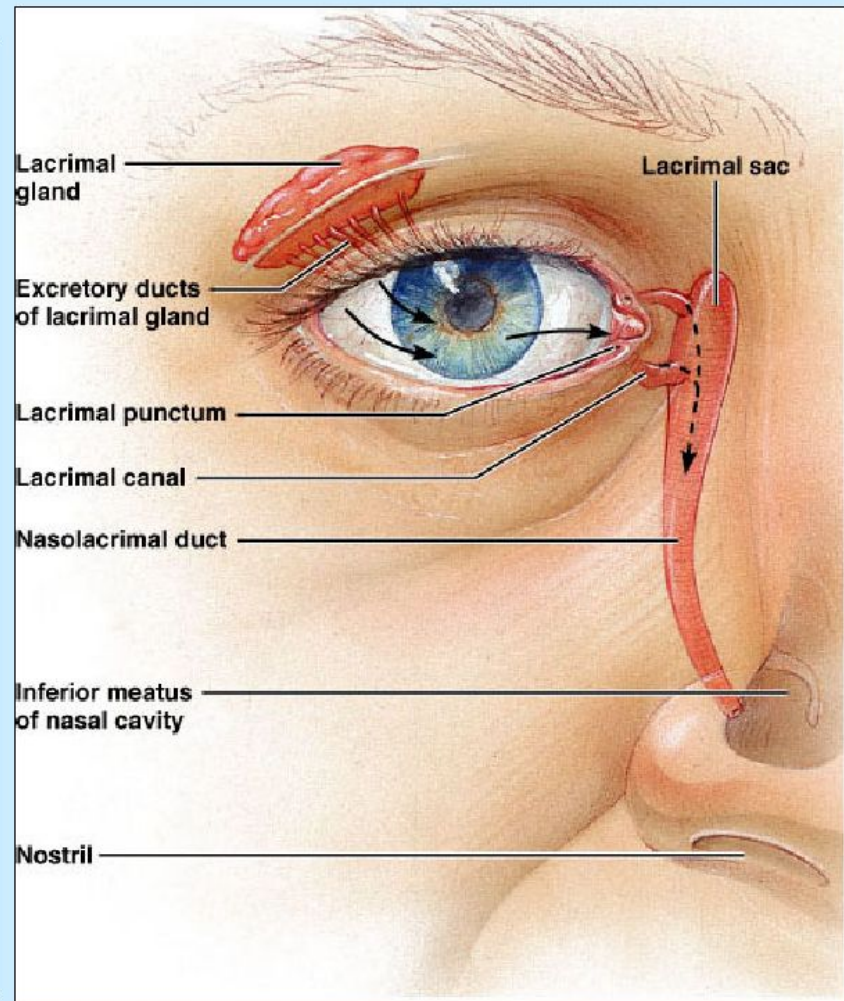
Conjunctivitis – inflammation of conjunctiva – many causes (actinic, allergic, chemical, bacterial, viral)

Lacrimal Apparatus

Consists of the lacrimal gland and ducts

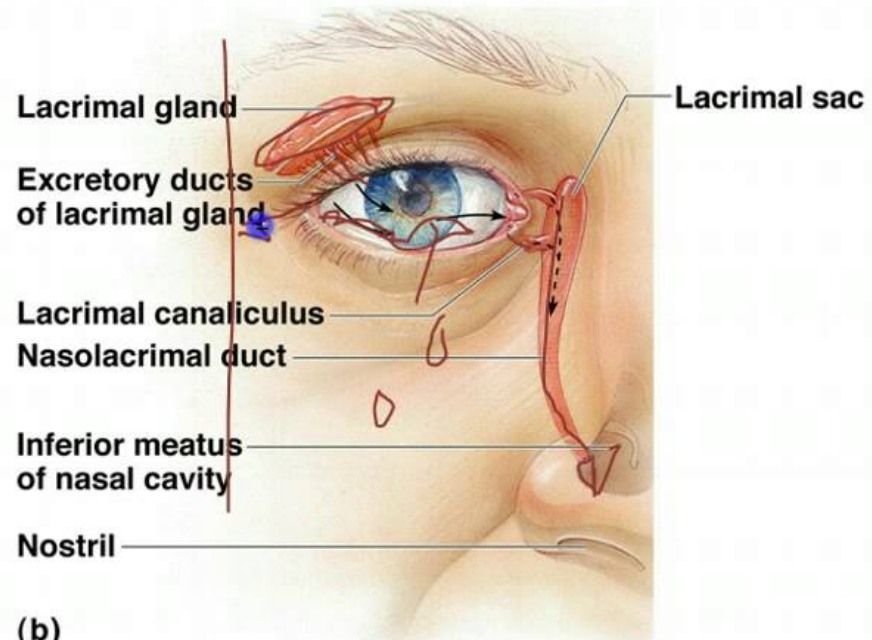
Lacrimal gland secretes tears (mucus, antibodies, and lysozyme)

Fluid enters the eye via superolateral excretory ducts and exits medially via the lacrimal puncta, then drains into the nasolacrimal duct



Accessory Structures of the Eye

- **Lacrimal apparatus (ctd)**
 - **Lacrimal sac—provides passage of lacrimal fluid towards nasal cavity**
 - **Nasolacrimal duct—empties lacrimal fluid into the nasal cavity**



Applied

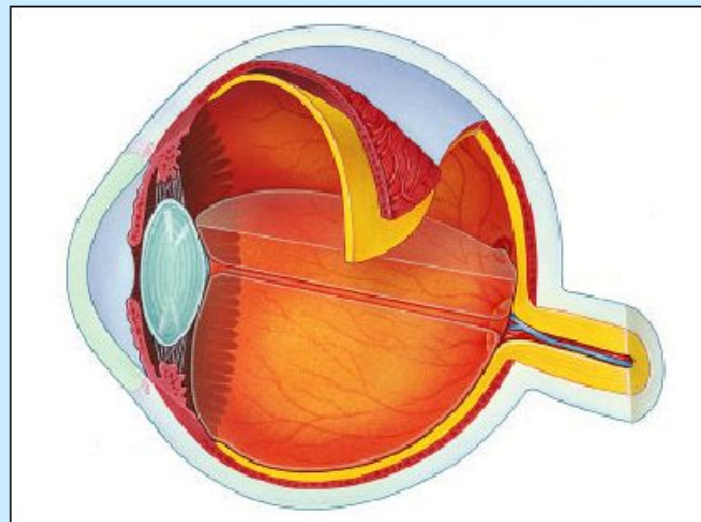
- Dry eyes –xerophthalmia.
- Stye(mebomian & sebaceous gland inflammation)
- Dacryosistitis(inflammation of lacrimal sac)

Structure of the Eye

A slightly irregular hollow sphere with anterior and posterior poles. The wall is composed of three tunics – fibrous, vascular, and sensory

The internal cavity is filled with fluids called humors

The lens separates the internal cavity into anterior and posterior segments or cavities



Structure of the Eye

Fibrous tunic

Sclera and Cornea

Vascular tunic

Choroid, Ciliary body, and Iris

Sensory tunic

Pigmented layer

Neural layer

Fibrous Tunic

Sclera and Cornea

The outermost coat of the eye is dense avascular CT

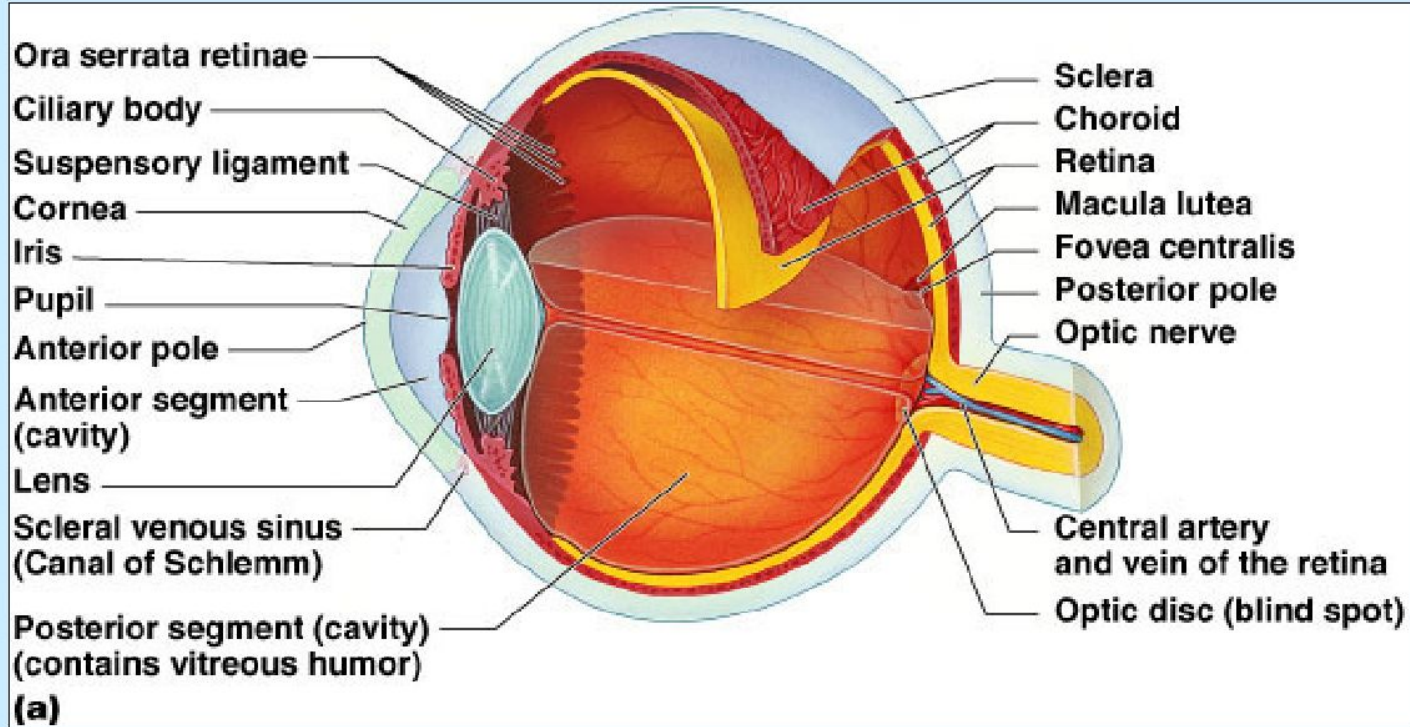
Two regions:

Opaque sclera (posterior) - protects the eye and anchors extrinsic muscles – is continuous with dura where the optic nerve enters

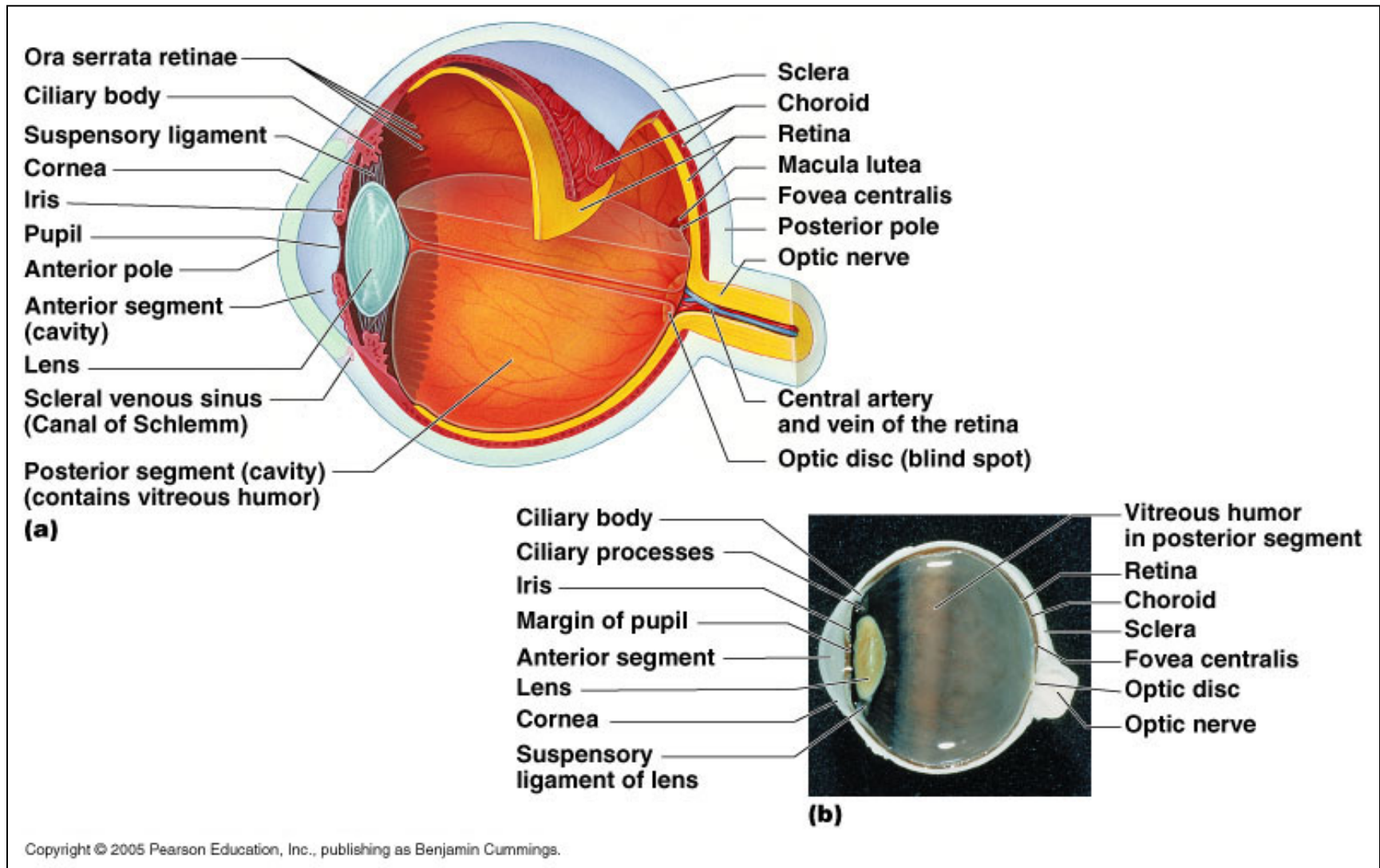
Cornea (anterior) – transparent, lets light enter the eye- many nerve endings (pain receptors)

Vascular Tunic (Uvea):

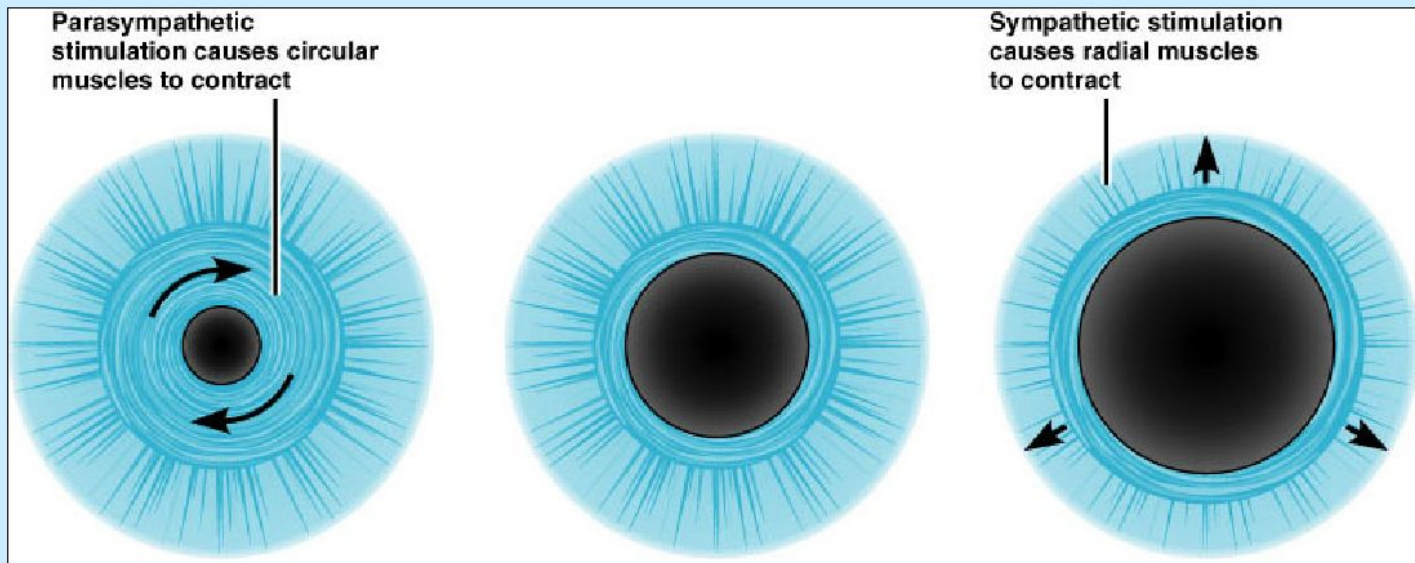
Choroid, Ciliary body, and Iris



Internal Eye Structure



Pupil Dilation and Constriction



Parasympathetic stimulation – pupil constricts

Sympathetic stimulation – pupil dilates

Internal Chambers and Fluids

The lens and suspensory ligament separates the internal eye into anterior and posterior segments

The posterior segment is filled with a clear gel called vitreous humor that:

- Transmits light

- Supports the posterior surface of the lens and holds the neural retina firmly against the pigmented layer

- Contributes to intraocular pressure

Ciliary body: Lies anterior to choroid & is formed of 3 structures.

1. **Orbicularis ciliaris:** Fibrous band of 4mm breadth encircling the eyeball in front of choroid.
2. **Ciliary process:** Project from orbicularis ciliaris to interior of the eye & surrounds the lens. Gap between lens capsule and ciliary process is filled with zonules(70).
3. **Ciliary muscles:** Meridional fibres and circular fibres (ciliary sphincter)

PUPIL: size can change from 1.5mm to 8mm. Optimum size 2mm forms sharpest image.

Functions of pupil:-

- Control the amount of light entering eye. Amount of light entering can change 5 folds
- Cuts off the peripheral rays and avoids spherical aberration and chromatic aberration.
- Color of eye is due the pigment cells in posterior epithelium & stroma of the iris.
- Size of pupil determines depth of focus.

Lens

Biconvex, transparent, flexible, avascular structure that can change shape and focus light on the retina

Two regions:

Lens epithelium – anterior cuboidal cells that differentiate into lens fibers

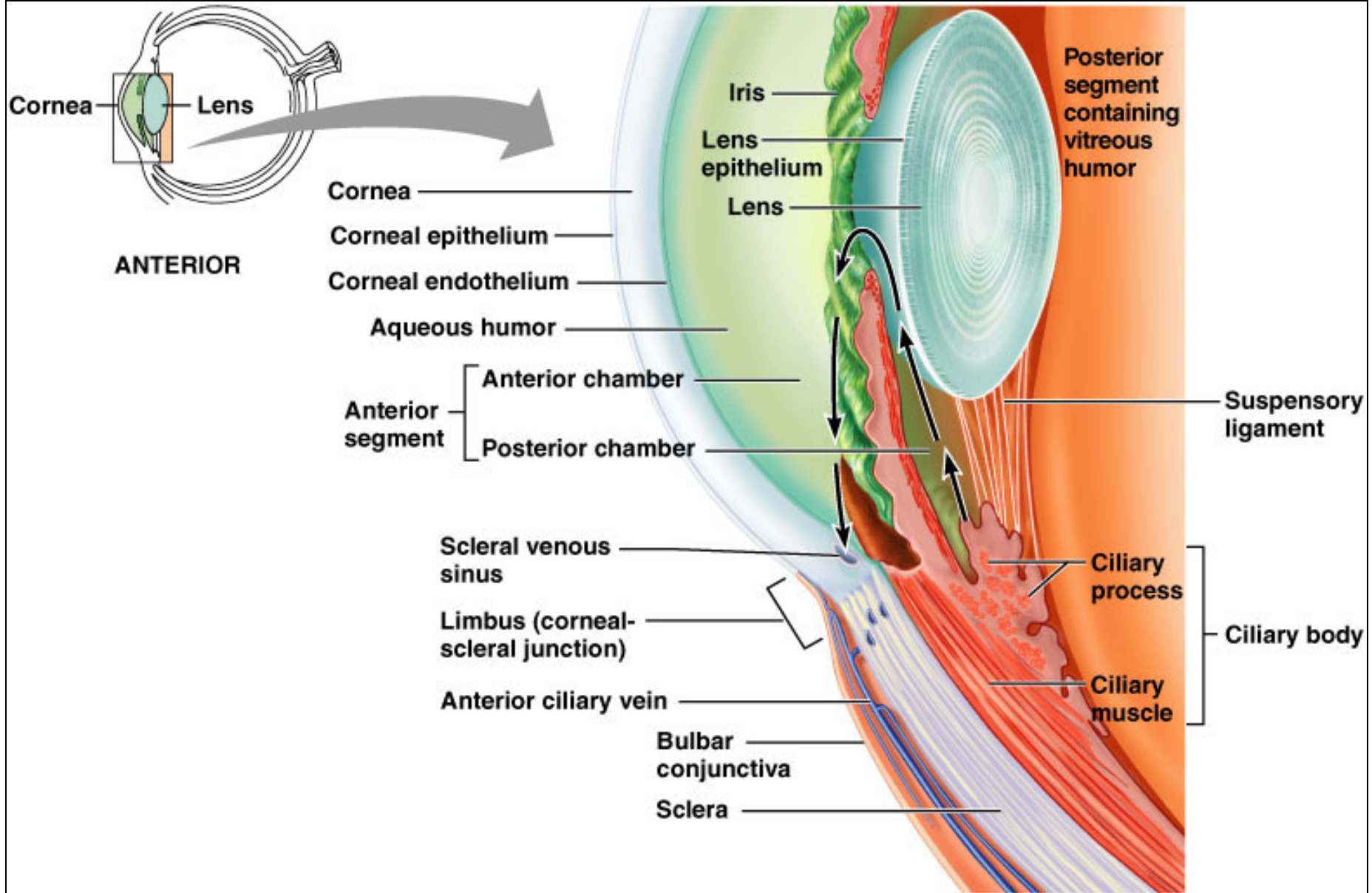
Lens fibers – cells filled with the transparent protein crystallin.

With age, the lens becomes more compact and dense and loses its elasticity

LENS

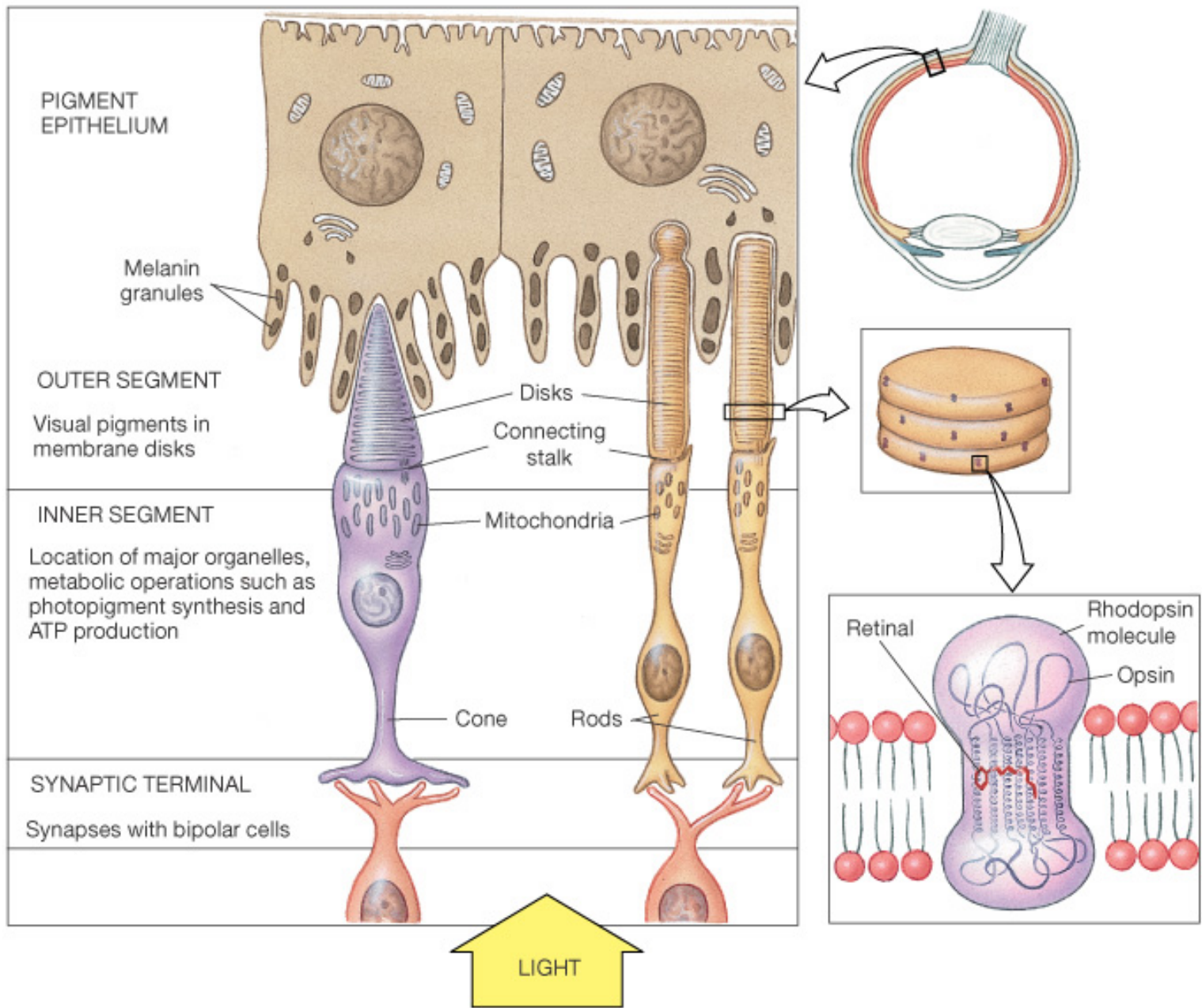
- The lens is transparent.
- It will naturally take up water and swell.
- This must be balanced by a continuous pumping of (ions and) water out of the lens.
- Anything that interferes with this process will cause the lens to swell and opacify - a condition known as *cataract*.
- There are many causes of cataract, ageing being the predominant of these - the so-called "sunlight" hypothesis for cataract is largely discredited.

Anterior Segment



Receptors in retina

- In 1 eye
- 6 million cones, 120 million rods
- 1.2 million nerve fibers in optic nerve
- Photon:-minimum quantum of light energy
- 1 photon is enough for rods stimulate it & several 100 photons required for cones



- Rhodopsin :-rod pigment made of 11 cis retinal(aldehyde of vit A) & scotopsin
- Cone pigment
- Blue cones(435)
- Green cones(535)
- Red cones(575)

Visual centers

- Area no 17 in occipital pole.

Striate cortex ,calcarine fissure(sulcus)

Angular gyrus

Visual stimuli also goes to inferior temporal cortex

Posteroinferior parietal cortex

Portions of the frontal lobe

Amygdala

Subcortical structures in addition to lateral geniculate body

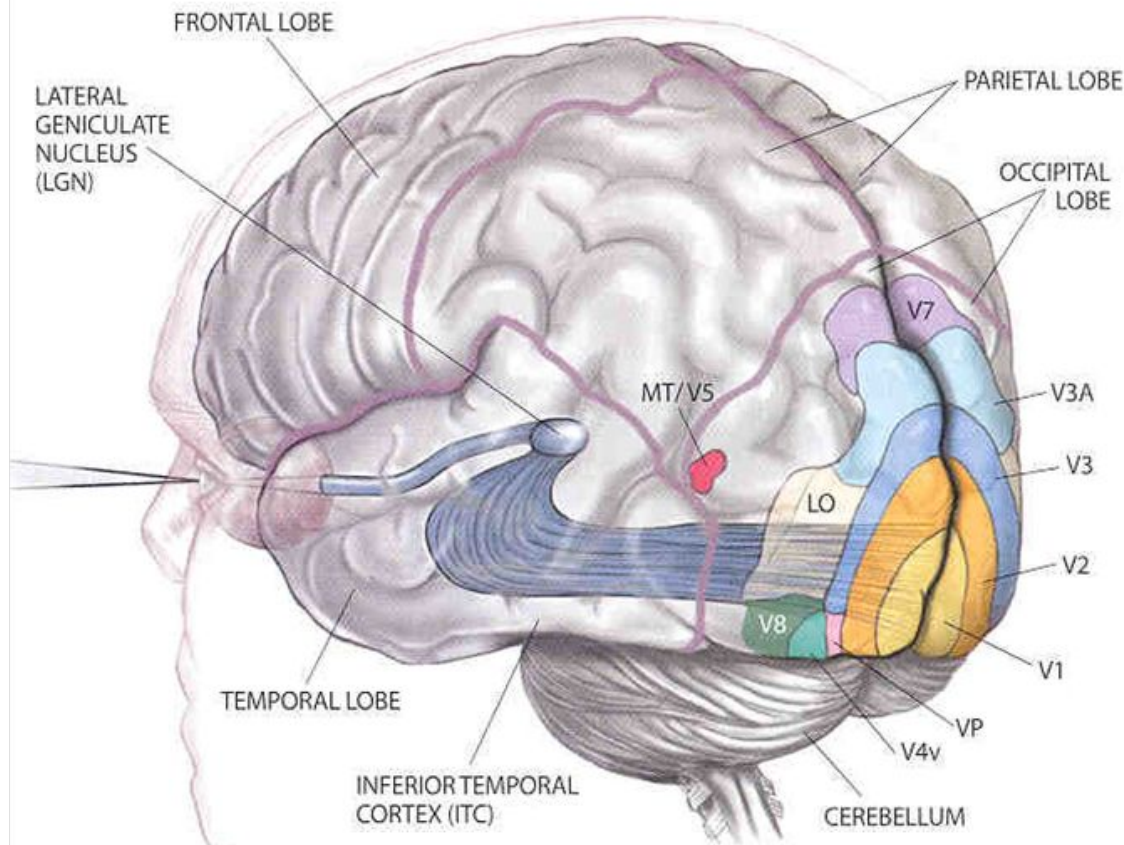
Superior colliculus,pretectal nucleus

Pulvinar

Caudate nucleus

Putamen

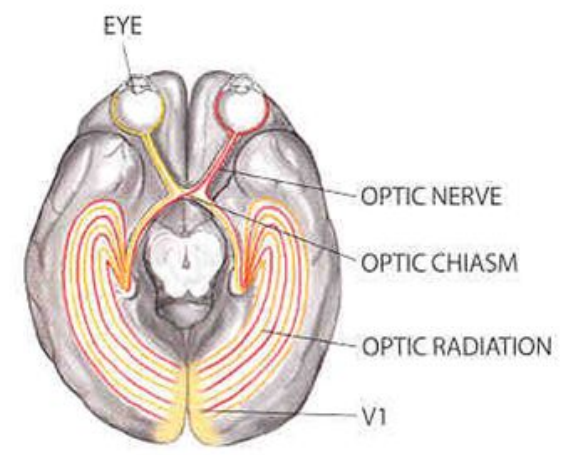
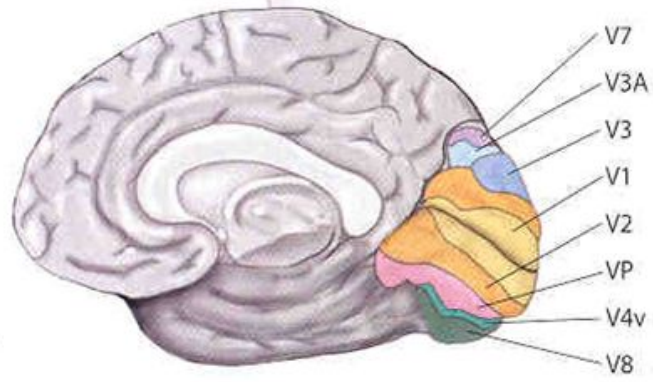
claustrum

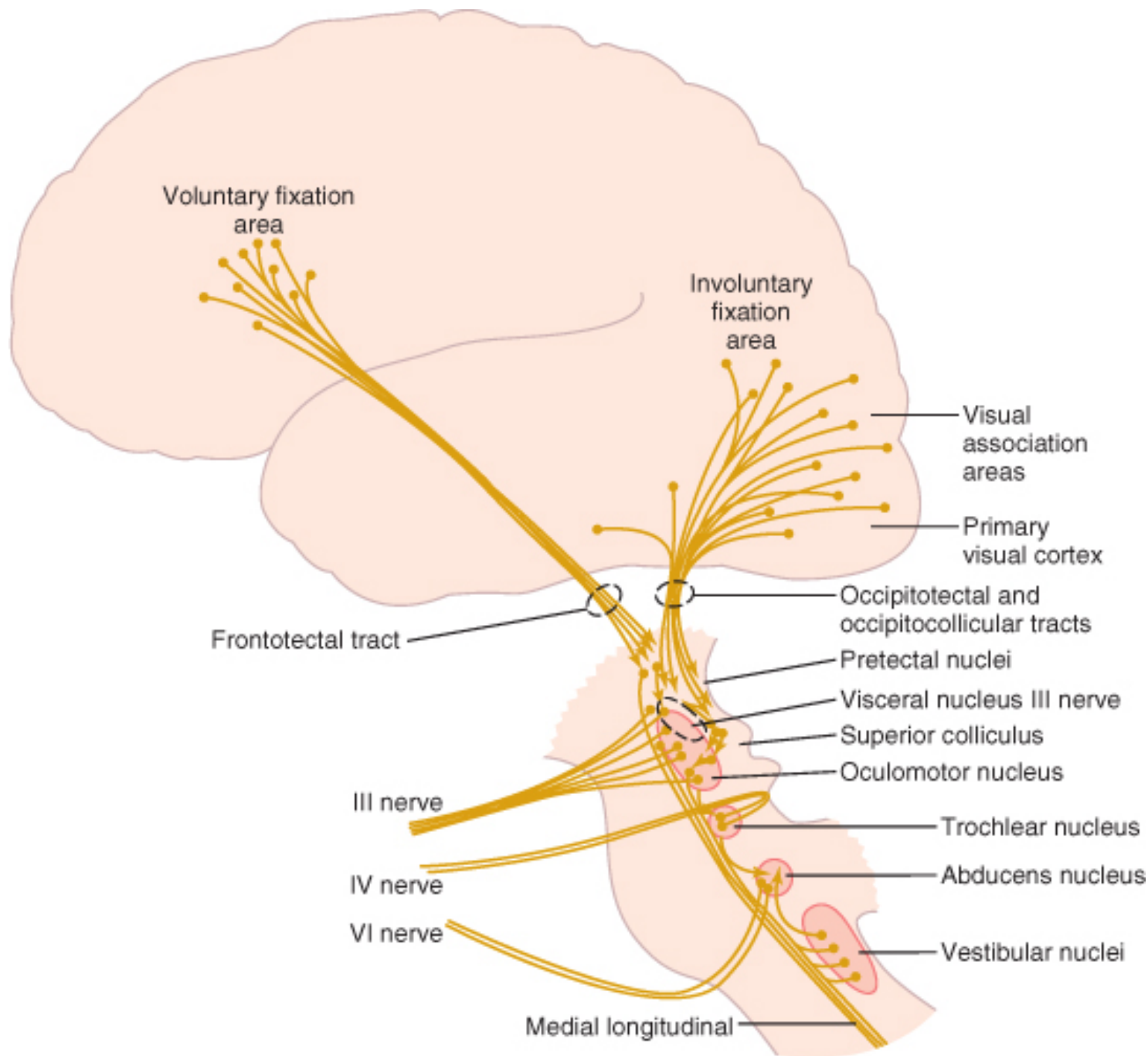


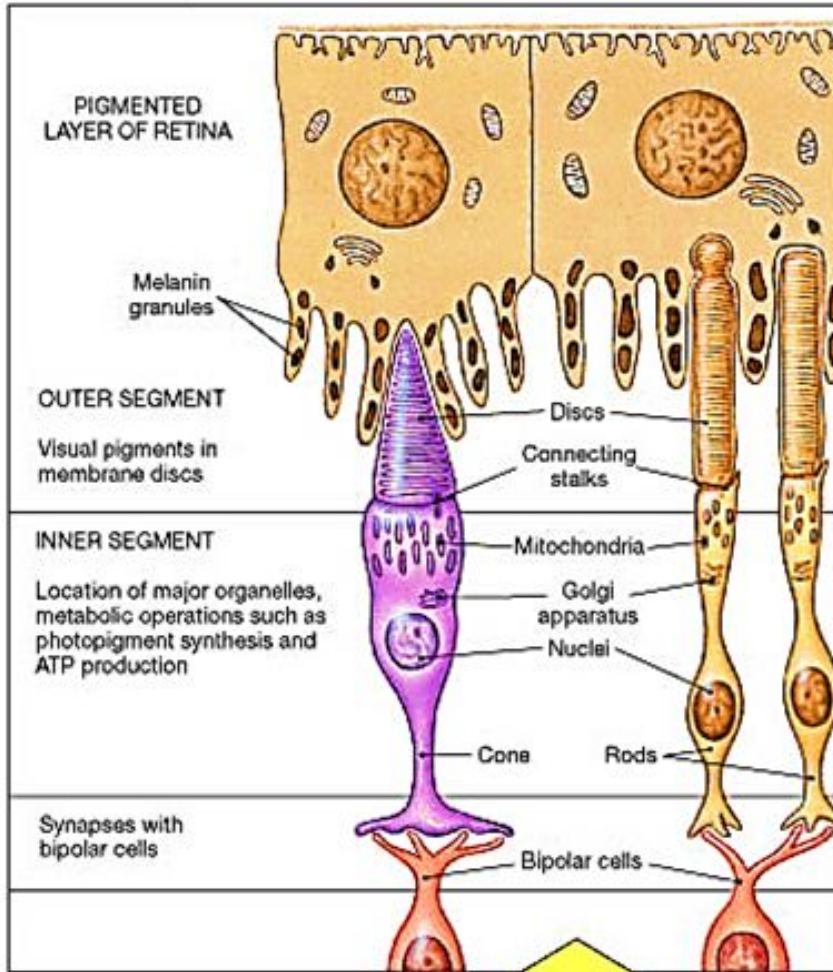
KEY TO FUNCTION

- **V1:** Primary visual cortex; receives all visual input. Begins processing of color, motion and shape. Cells in this area have the smallest receptive fields.
- **V2,** ■ **V3** and ■ **VP:** Continue processing; cells of each area have progressively larger receptive fields.
- **V3A:** Biased for perceiving motion.
- **V4v:** Function unknown.
- **MT/V5:** Detects motion.
- **V7:** Function unknown.
- **V8:** Processes color vision.
- **LO:** Plays a role in recognizing large-scale objects.

Note: A V6 region has been identified only in monkeys.







(b)

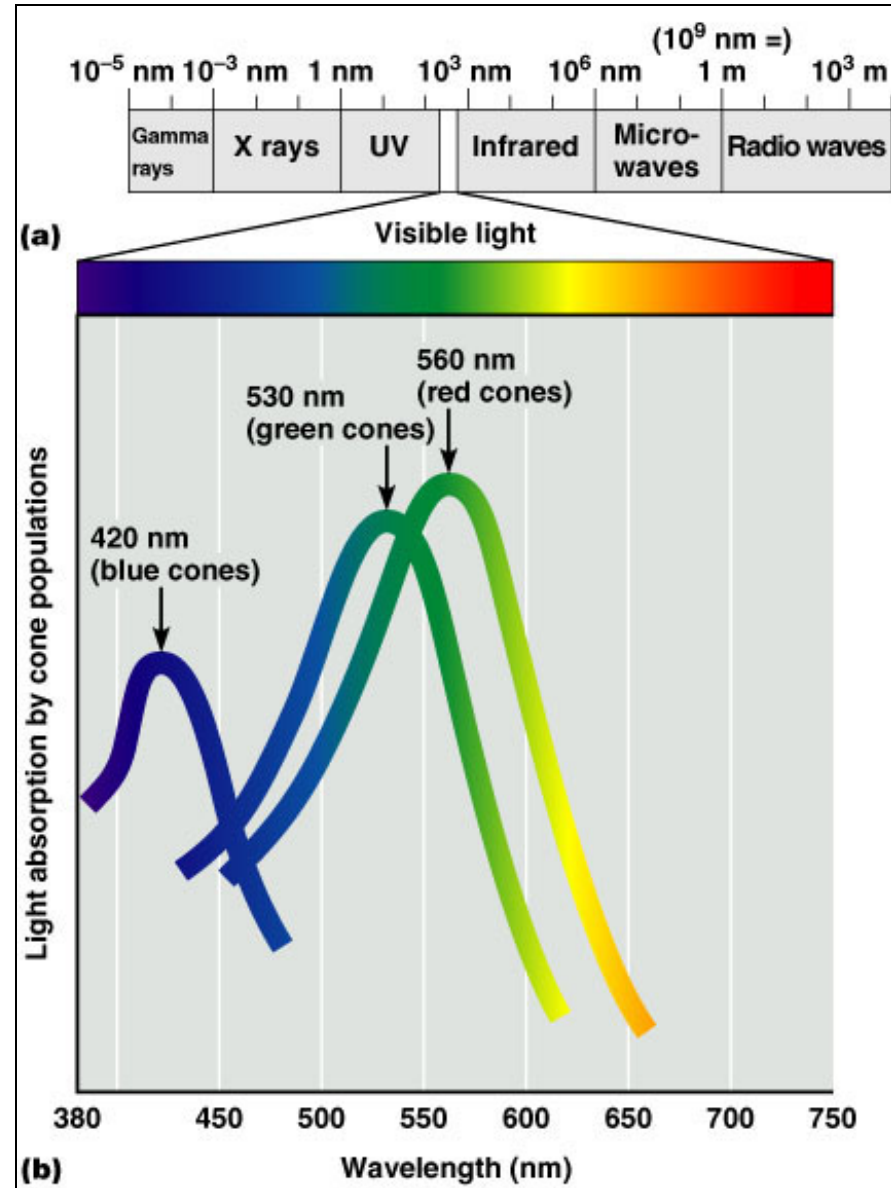


Light

Electromagnetic radiation – all energy waves from short gamma rays to long radio waves.

Our eyes respond to a small portion of this spectrum called the visible spectrum

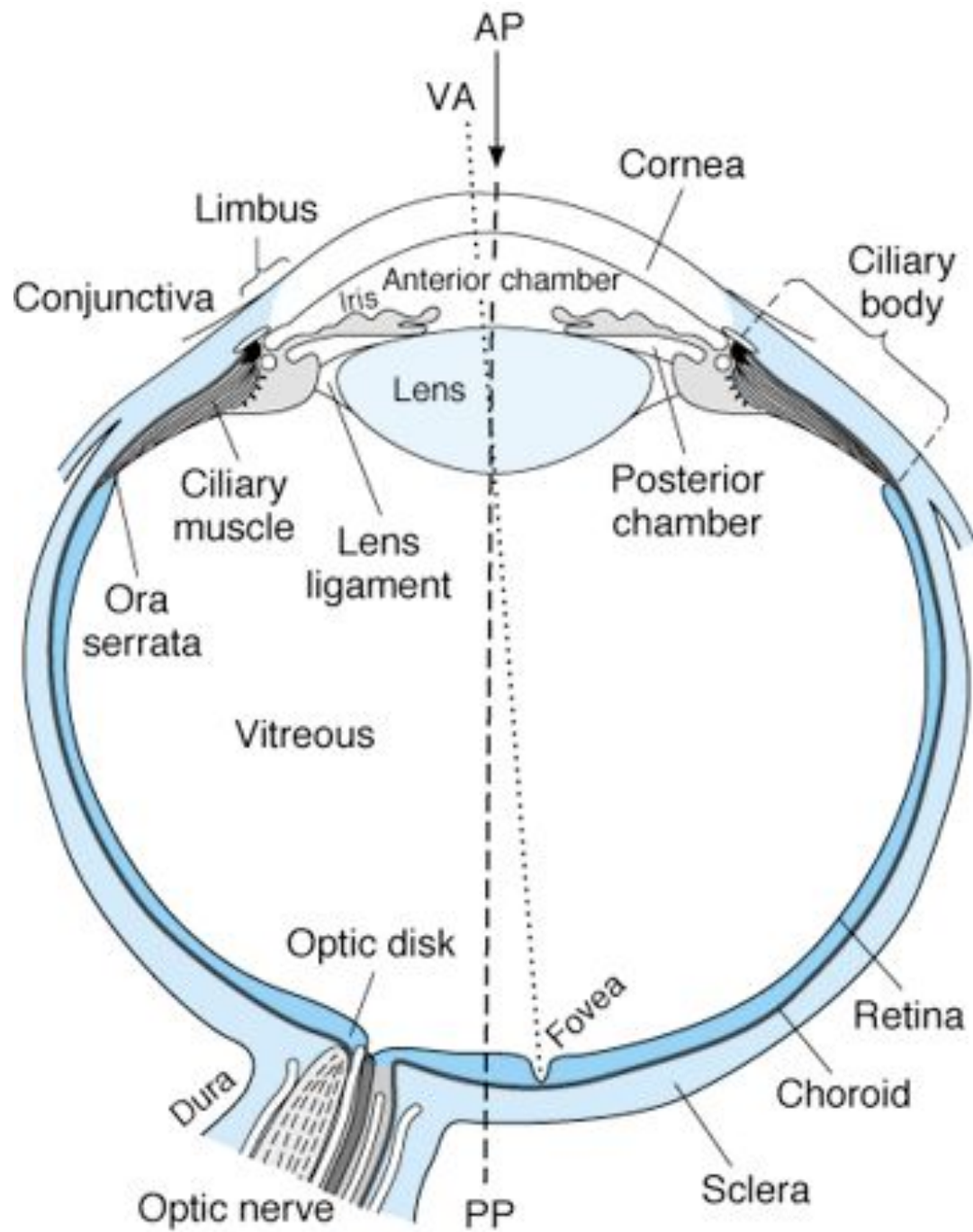
Different cones in the retina respond to different wavelengths of the visible spectrum



Light is the visible part of the electromagnetic spectrum.
We "see" because we have receptors which are excited by wavelengths between 400-700nm

OPTICS

- The light pass first through the cornea.
- The cornea and the lens represent the refractive system of the eye.
- The cornea is responsible for 70% and the lens for 30% of the refraction.
- The refractive system focuses the light upon the retina, where the photosensitive pigment lies.
- The image is inverted



Refractive index: refractive index of any transparent medium is Ratio of velocity of light in air to velocity of light in the substance

Refraction: Bending of light rays at an Angulated interface and refractive index of two medium is different

If the interface is perpendicular to light ray it will only change its velocity & wavelength (but not get refracted) if 2 medium has different refractive index.

Refractive mediums of eye with their refractive indices:

- | | |
|--------------------|------|
| 1. Cornea | 1.38 |
| 2. Aqueous humour | 1.33 |
| 3. Lens | 1.4 |
| 4. Vitreous humour | 1.34 |
| 5. AIR | 1 |

Refraction

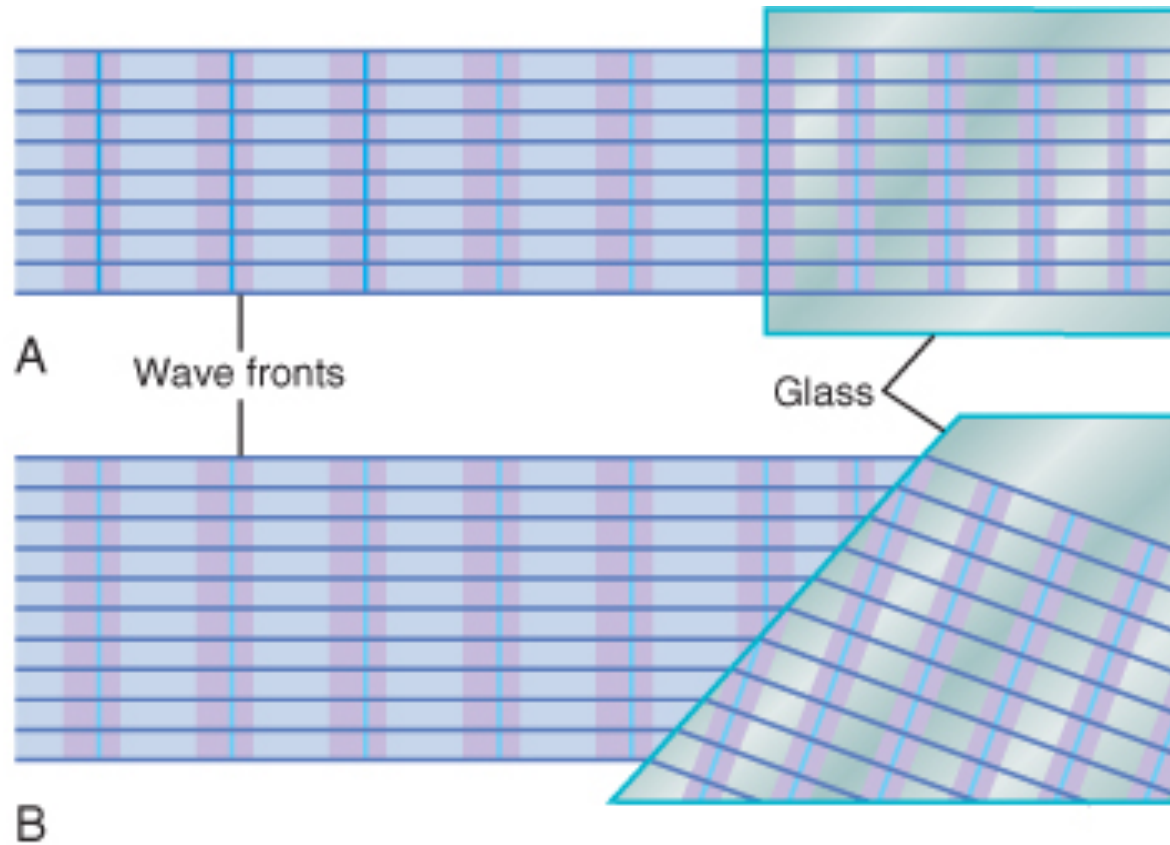
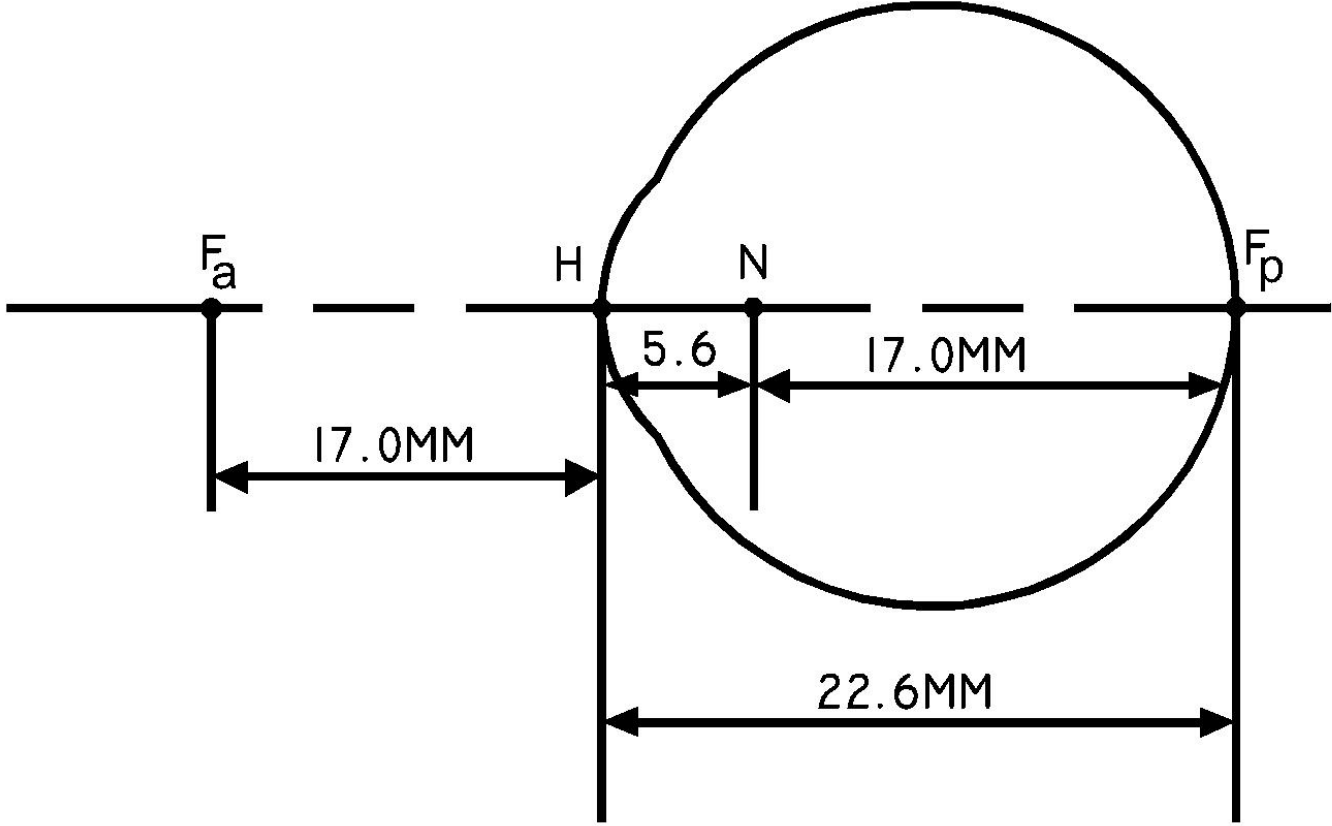


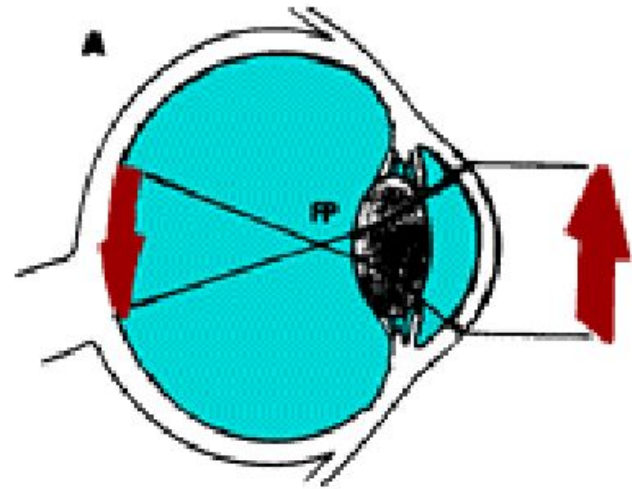
FIGURE 33



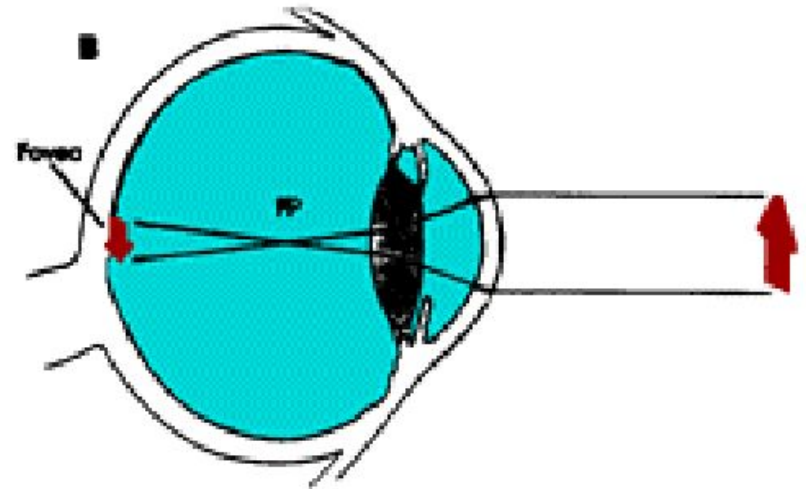
Emmetropia: Normal eye is emmetropic. It is a condition in which with ciliary muscles relaxed parallel rays coming from distant object are focussed on the retina.

Visual Acuity: Power of eye to resolve 2 stimuli separated in space. It is expressed as reciprocal of the angle subtended by 2 stimuli at the nodal point of eye .

Depth Of Focus



Near Object

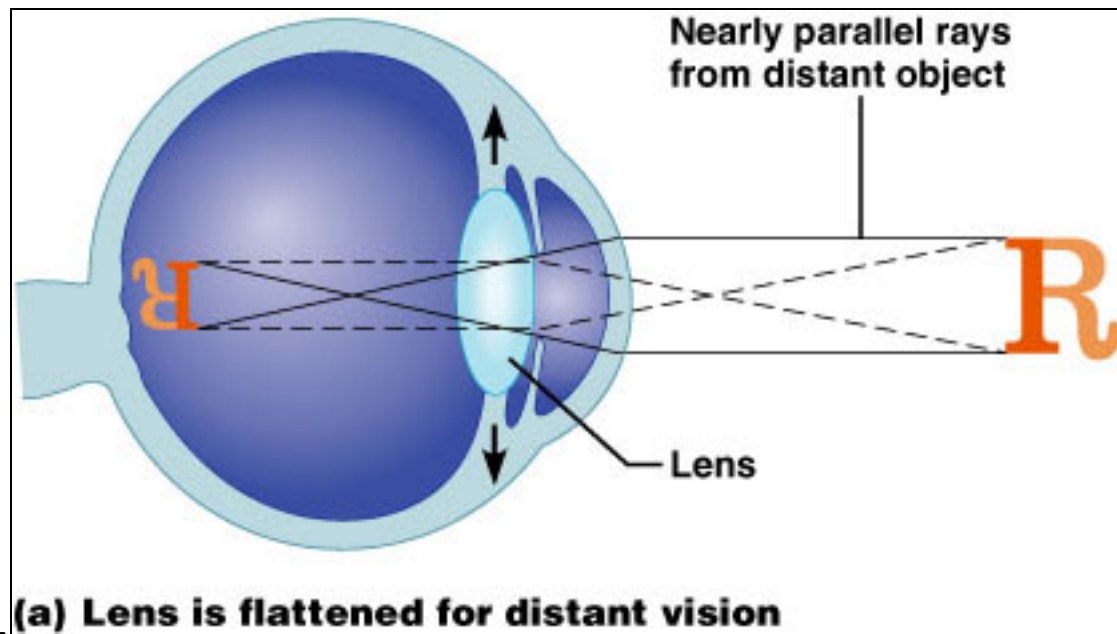


Far Object

DEPTH OF FOCUS: Is maximum distance through which object can be moved but still can be clearly focused on the retina.

Focusing for Distant Vision

Light from a distance needs little adjustment for proper focusing

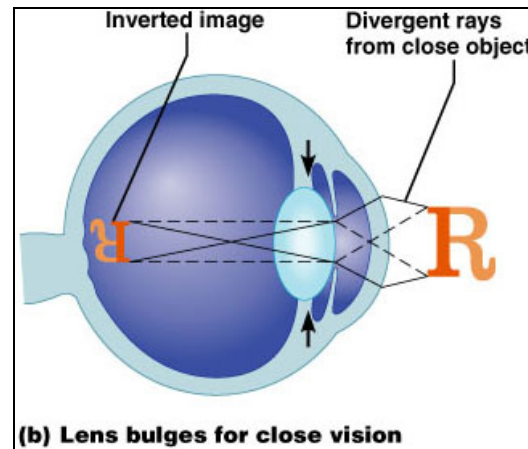


Far point of vision – the distance beyond which the lens does not need to change shape to focus (20 ft.)

Focusing for Close Vision

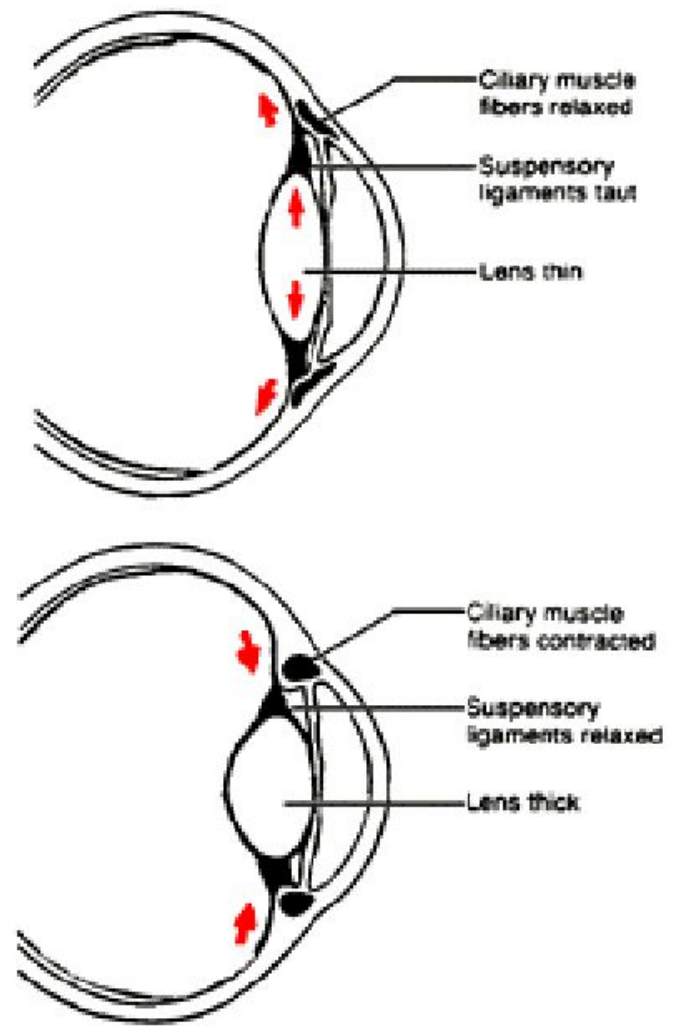
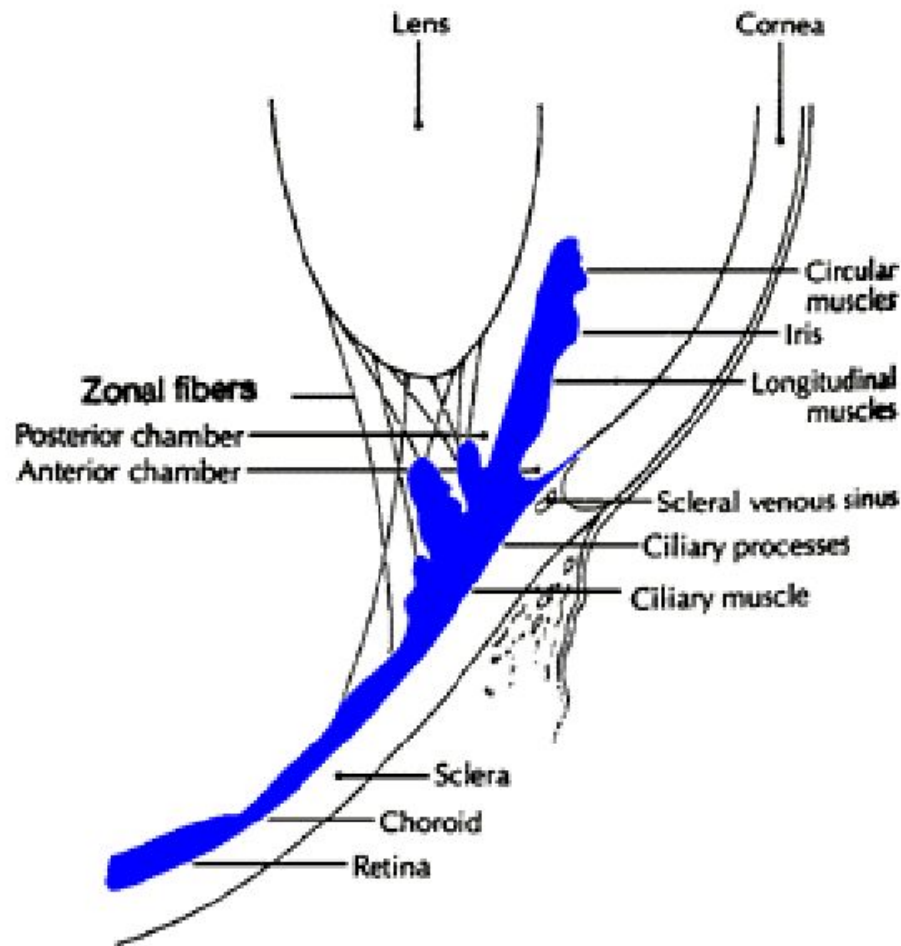
Accommodation – changing the lens shape by ciliary muscles to increase refractory power

Constriction – the pupillary reflex constricts the pupils to prevent divergent light rays from entering the eye



Convergence – medial rotation of the eyes toward the object being viewed

Accommodation

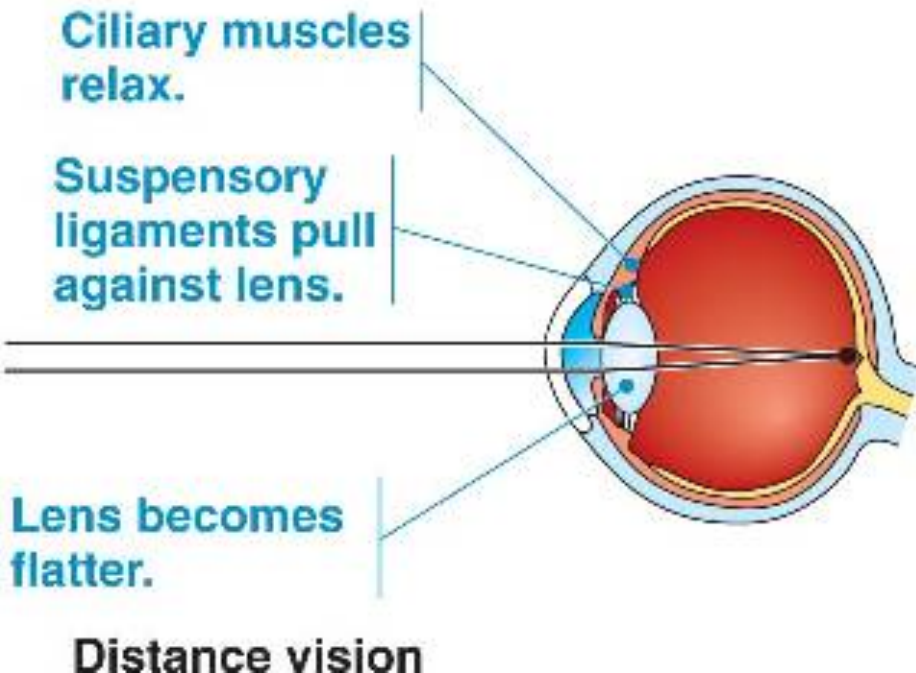
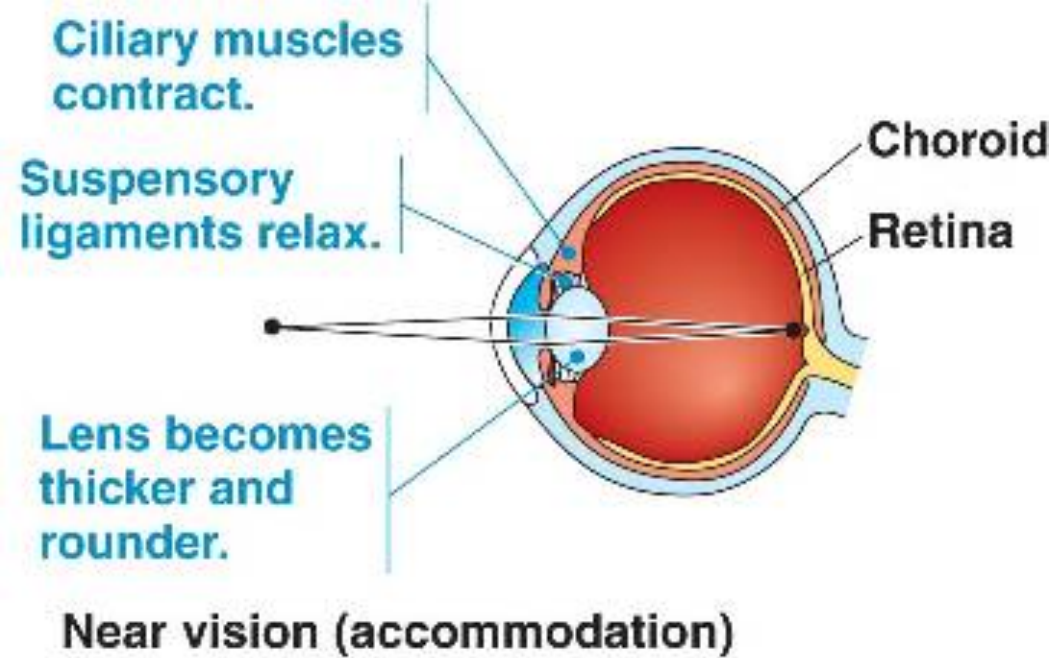


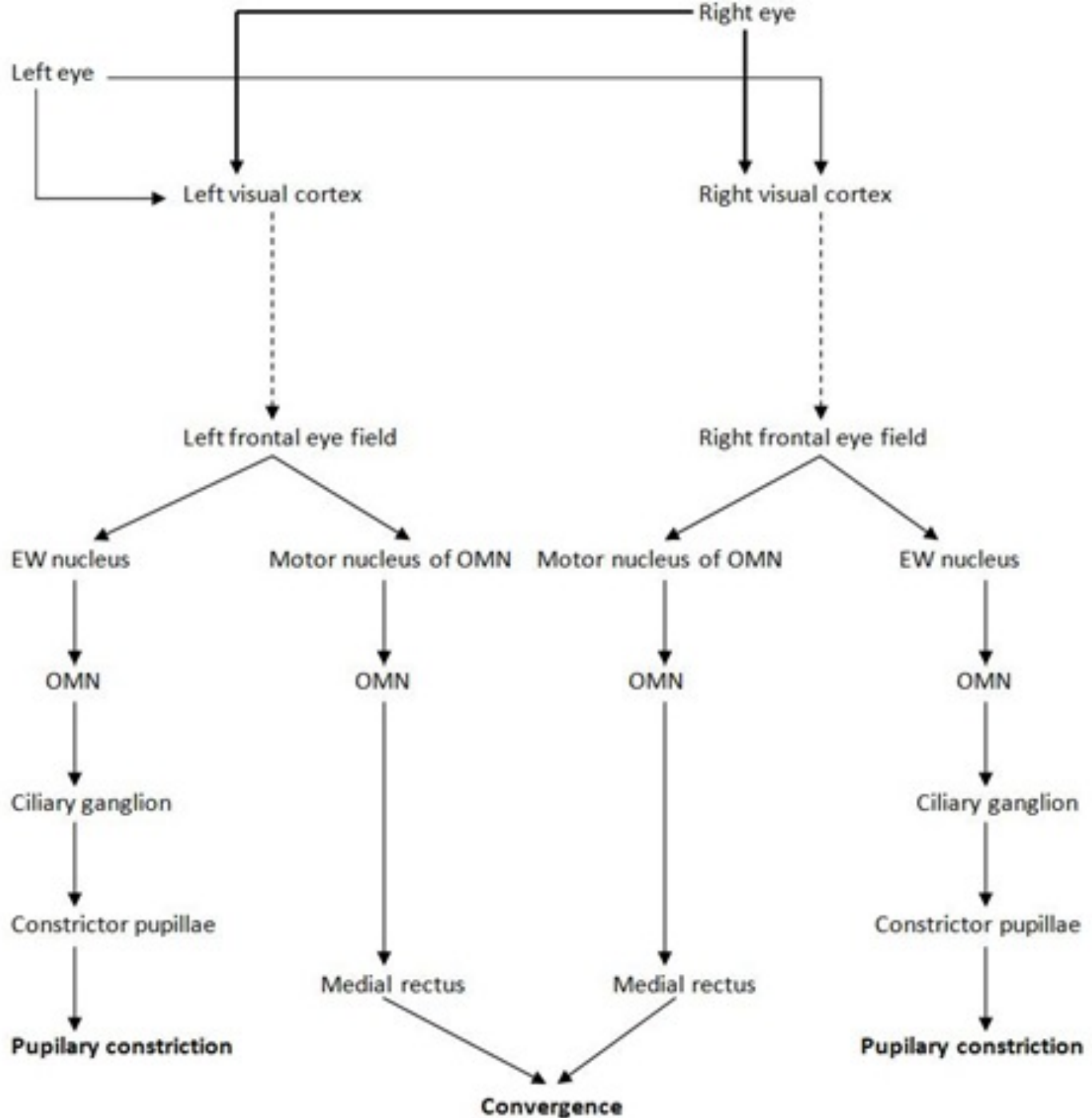
Accommodation

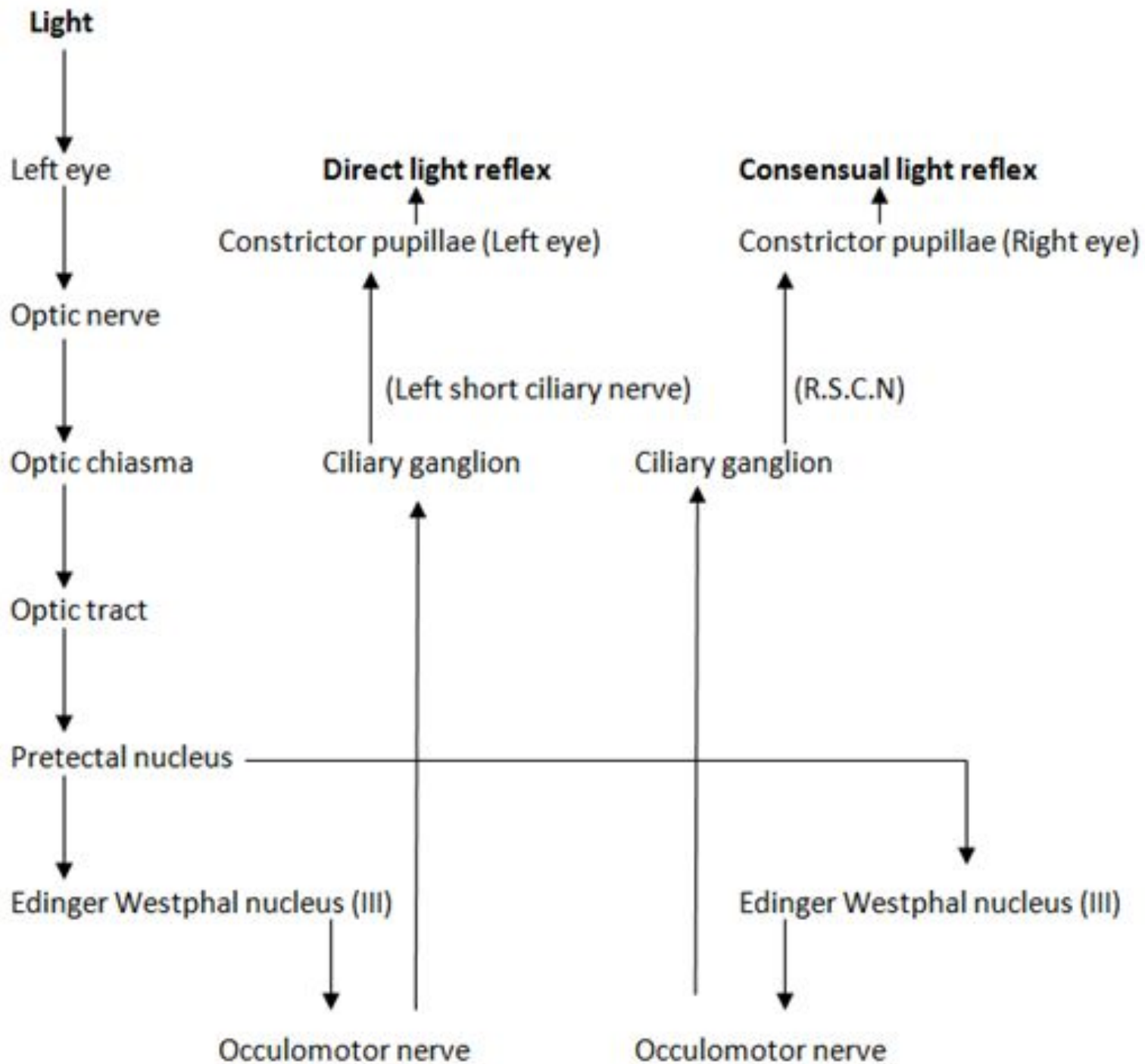
15 D - 29D

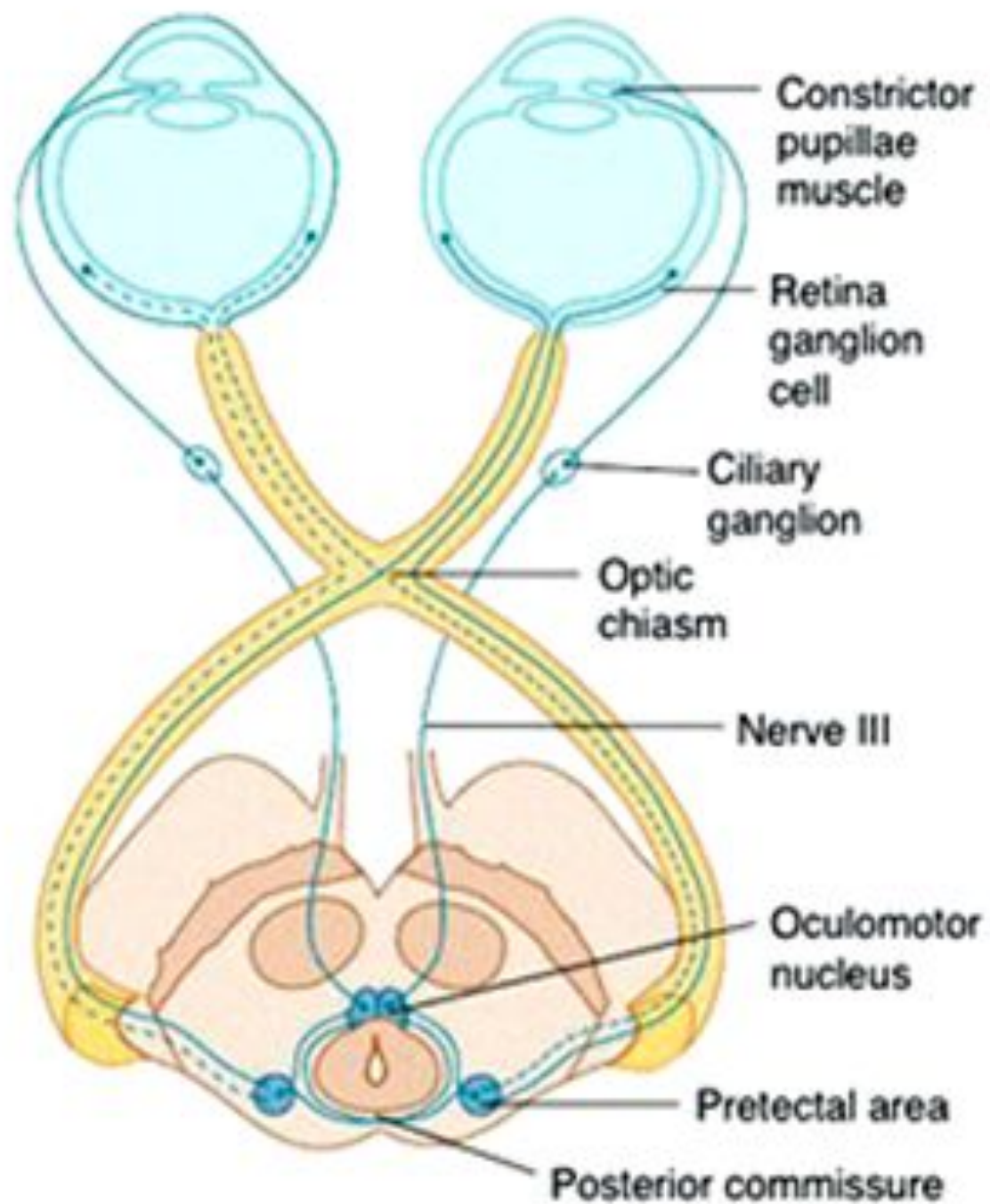
25cm

20ft or 6meters









Errors of refraction:

Physiological

&

Pathological

Spherical aberration

sightedness

Myopia or Near

Chromatic aberration

or Hyperopia or

Hypermetropia

Far

sightedness

Astigmatism

Presbyopia

MYOPIA

Definition: Parallel light rays are focussed in front of retina with ciliary muscles relaxed

Cause: 1. AXIAL; Due to increased anteroposterior diameter of eye. (common). 2. INDEX : Due to increased refractive index of lens or cornea

Pathophysiology: Far point –near & Near point –Nearer

Clinical features: Visual acuity for near vision is normal but of far vision reduced.

Diagnosis :By snellens chart and computerised. Visual acuity <6/6
Accommodation status:Comparatively less used so presbyopia late to develop

Correction:Concave spherical lens,surgical correction

Types: Simple&malignant

Complications:Vitreous degeneration,Retinal holes&Retinal detachment

HYPERMETROPIA

Definition: Parallel light rays are focussed beyond the retina with ciliary muscles relaxed.

Causes:

Axial : decrease anteroposterior diameter of eye

Index : Decrease refractive index of cornea or lens

Curvature : Due to flat cornea

Aphakia

Child hood

Pathophysiology

Far point : Normal (By Accomodation) and near point is far

Clinical Feature : visual acuity for

1, Far vision normal

2, Near vision reduced

Headache and pain in eyes.

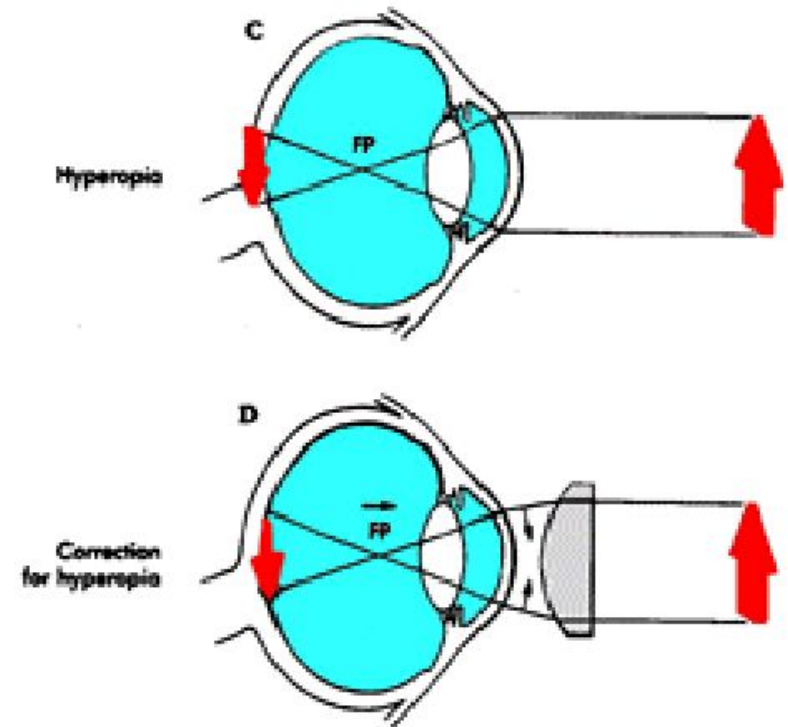
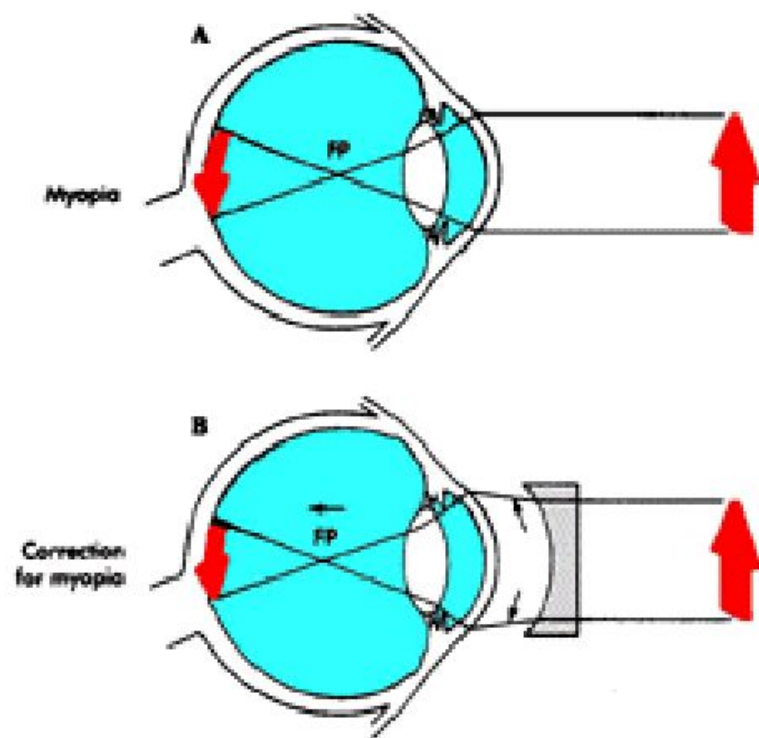
Diagnosis:

Jaeger's chart, reduced Snellen's chart.

Accomodation status: Ciliary muscle contracted even under resting condition so presbyopia early to develop.

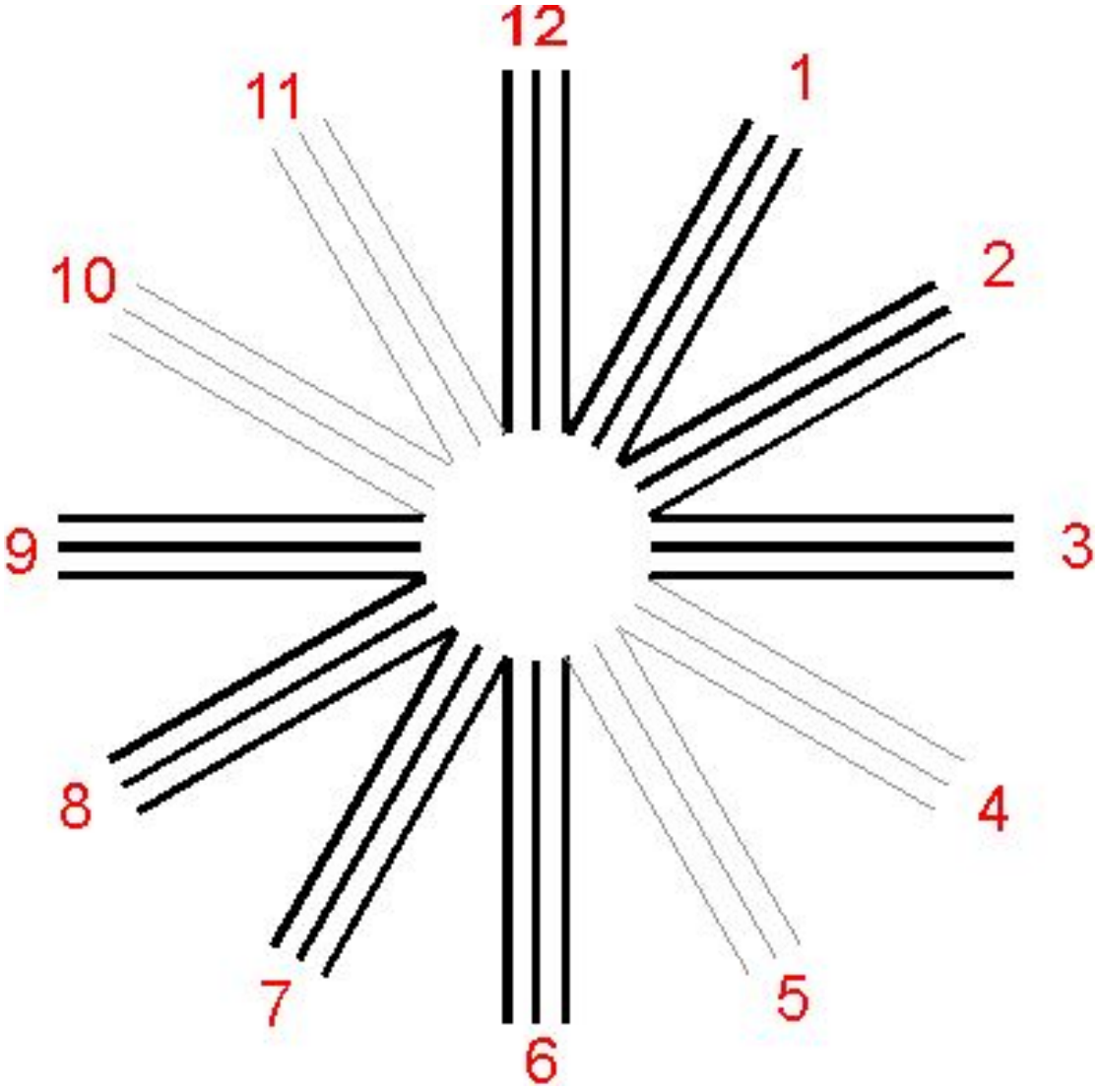
Correction : convex spherical lens, contact lens,

Errors of Refraction



- **Astigmatism**
- Ammetropic condition due to difference in curvature of cornea in different meridians.
- May be due to lens when pushed out of alignment or curvature of lens is not uniform
- **Diagnosis:** Astigmatic dial
- **Types:**
- **Regular:** Normally cornea flatter from side to side. It is curved in vertical meridian. Can be corrected by lenses if symptoms present.
- **Irregular:** Is due to irregular corneal surface. Cannot be corrected by lenses. Contact lense or Keratoplasty can be done.

ASTIGMATIC FAN



PRESBYOPIA

Is a condition where amplitude of accommodation is reduced.

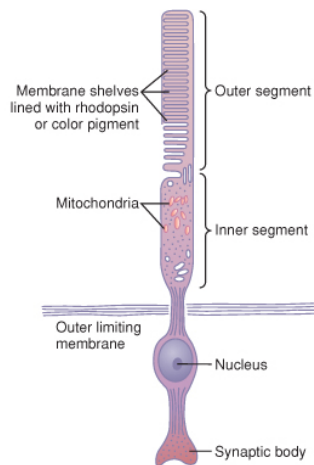
As age advances the capsule of the lens loses its elasticity and there is progressive denaturation of lens protein, so ability to change shape progressively decreases

Lens becomes non accommodative

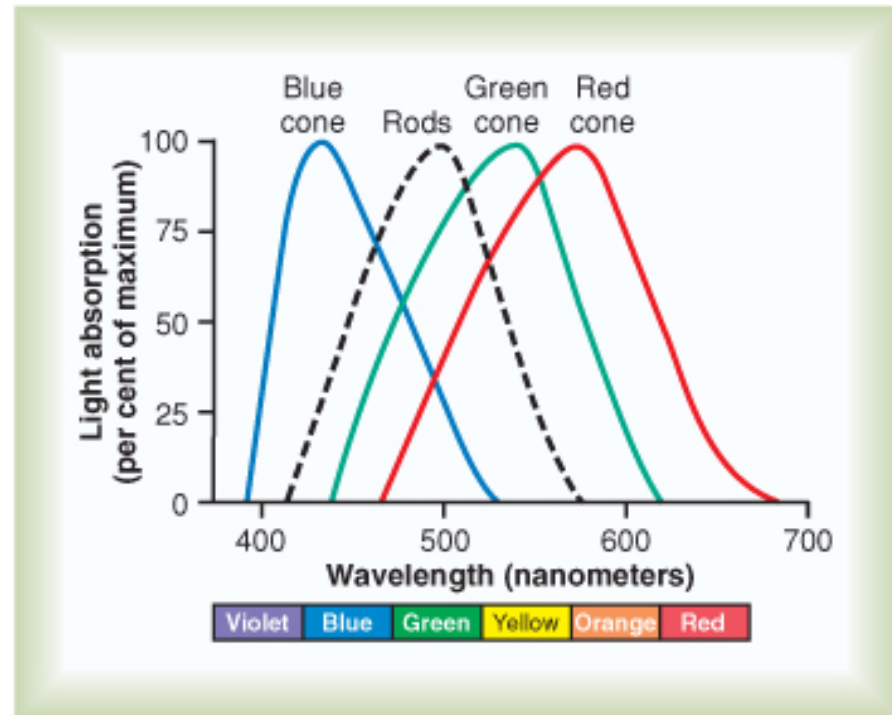
Amplitude of accommodation is reduced from 14 D to almost 2 D

TREATMENT

Bifocal glasses (Spherical) with upper segments focussed for seeing far objects and lower segments for near objects

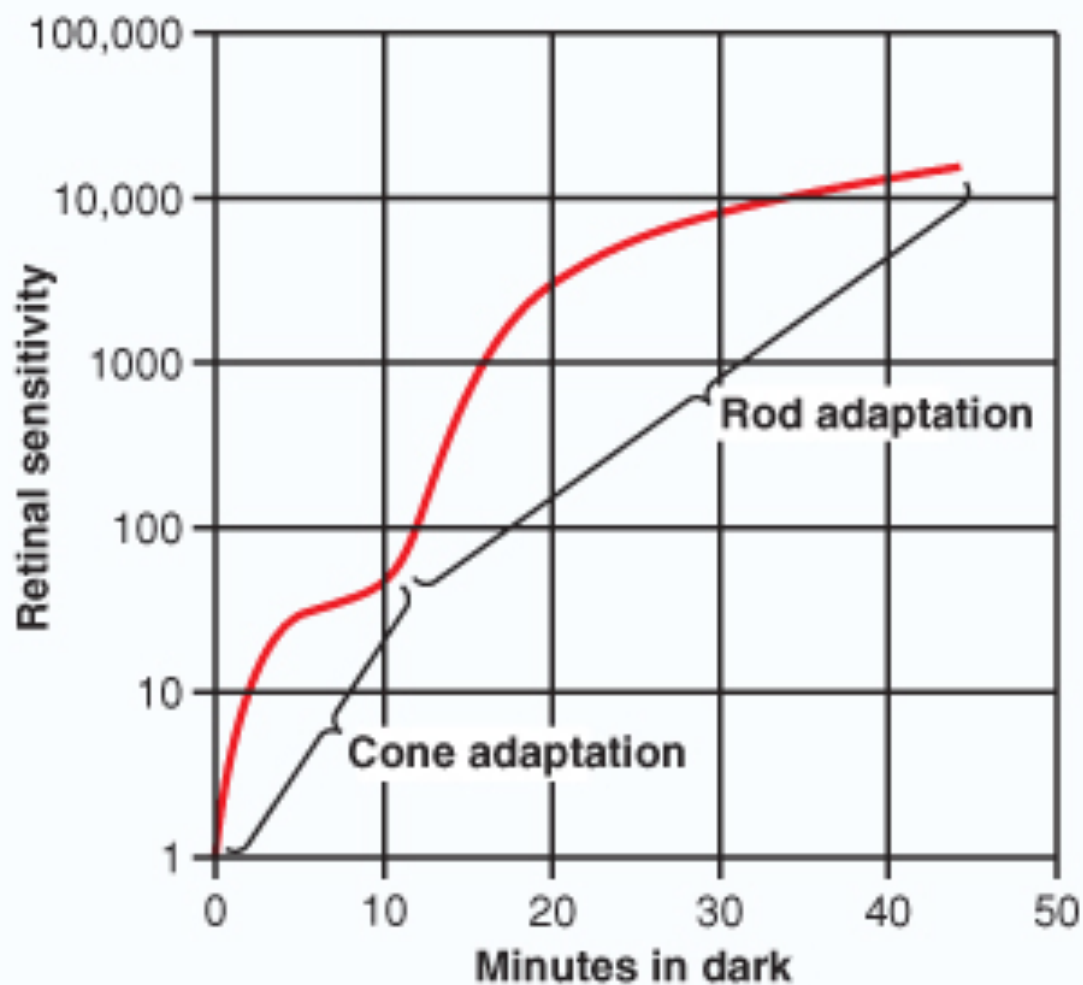


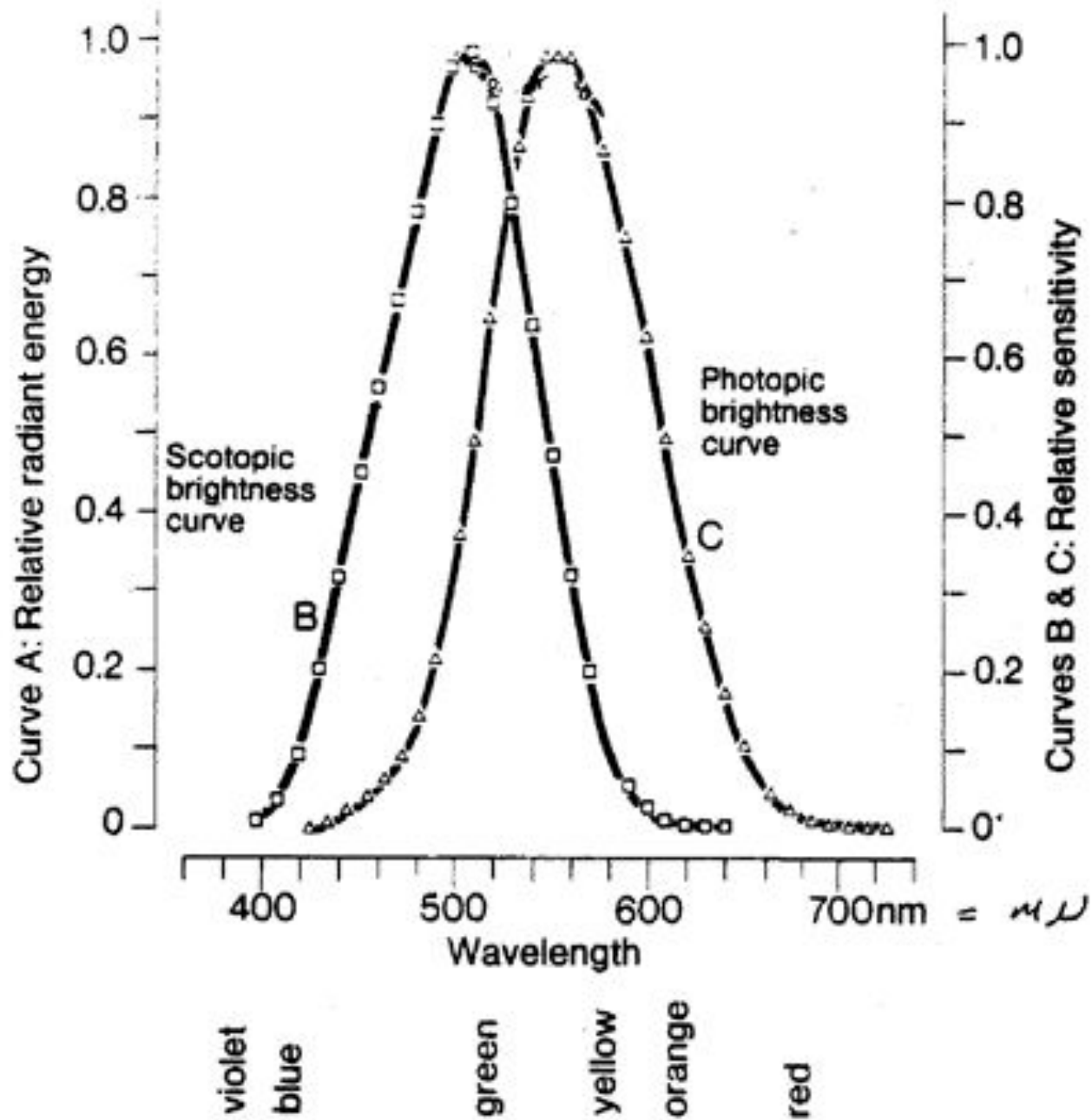
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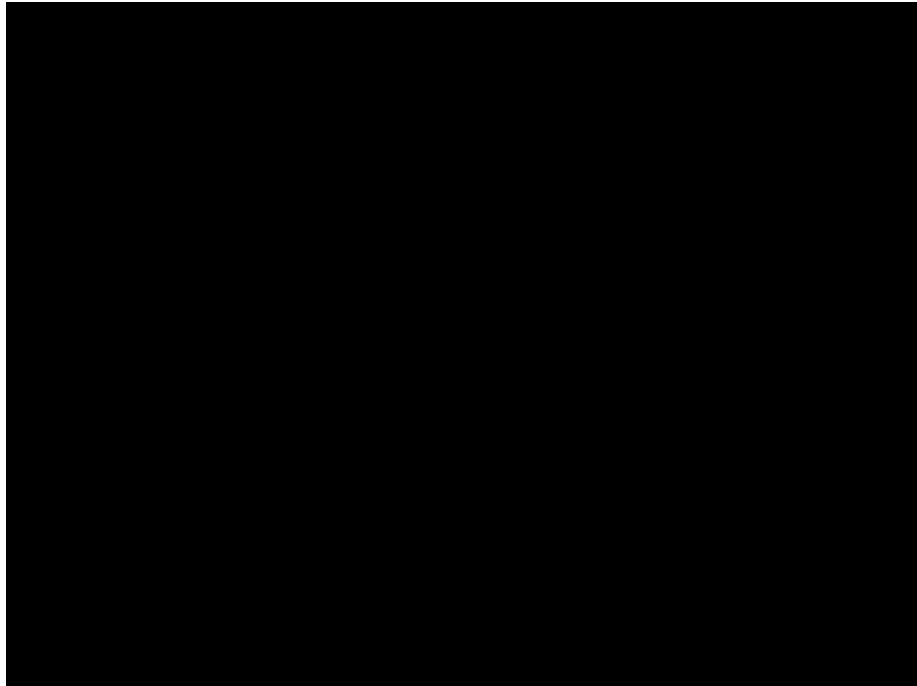


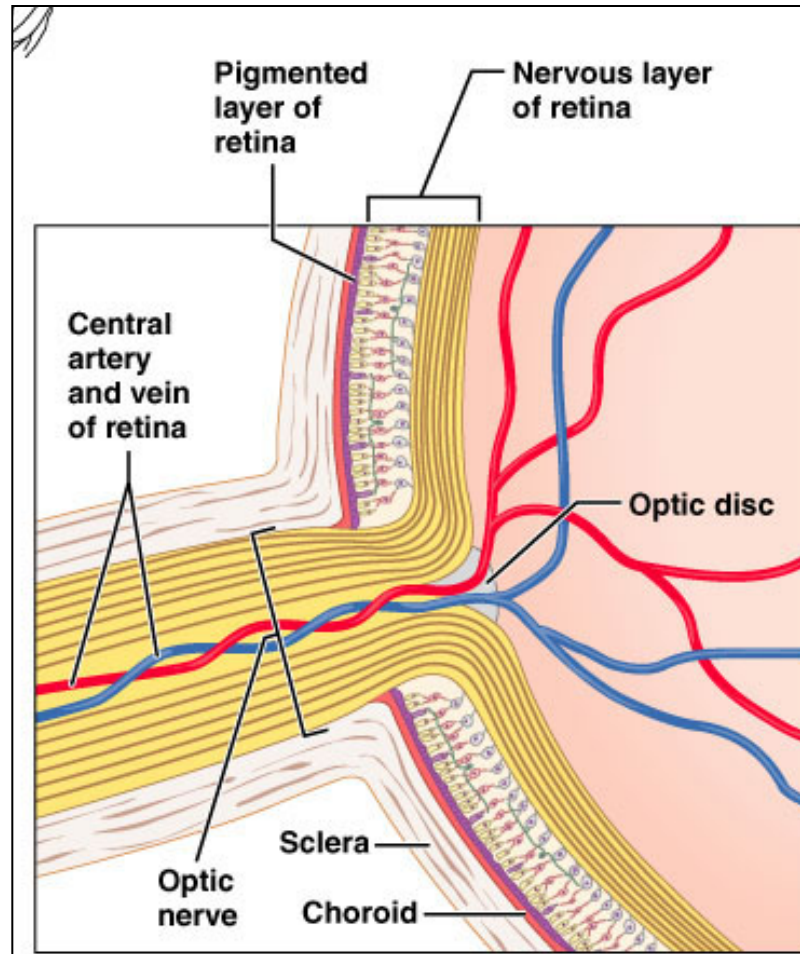
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- ERRORS OF REFRACTION
- ACCOMODATION / ACCOMODATION REFLEX OR NEAR REFLEX
- PUPILLARY REFLEXES
- DISCUSS THEORIES OF COLOR VISION
- EFFECT OF LESION IN VISUAL PATHWAY AT VARIOUS LEVEL
- PHOTOCHEMISTRY OF VISION
- DARK ADAPTATION
- WHAT IS PRESBYOPIA?
- DIFFERENCE BETWEEN PHOTOPIC & SCOTOPIC VISION.
- WHAT IS PURKINJE SHIFT?
- FLICKER FUSION FREQUENCY (CRITICAL FUSION FREQUENCY)
- STEREOPSIS

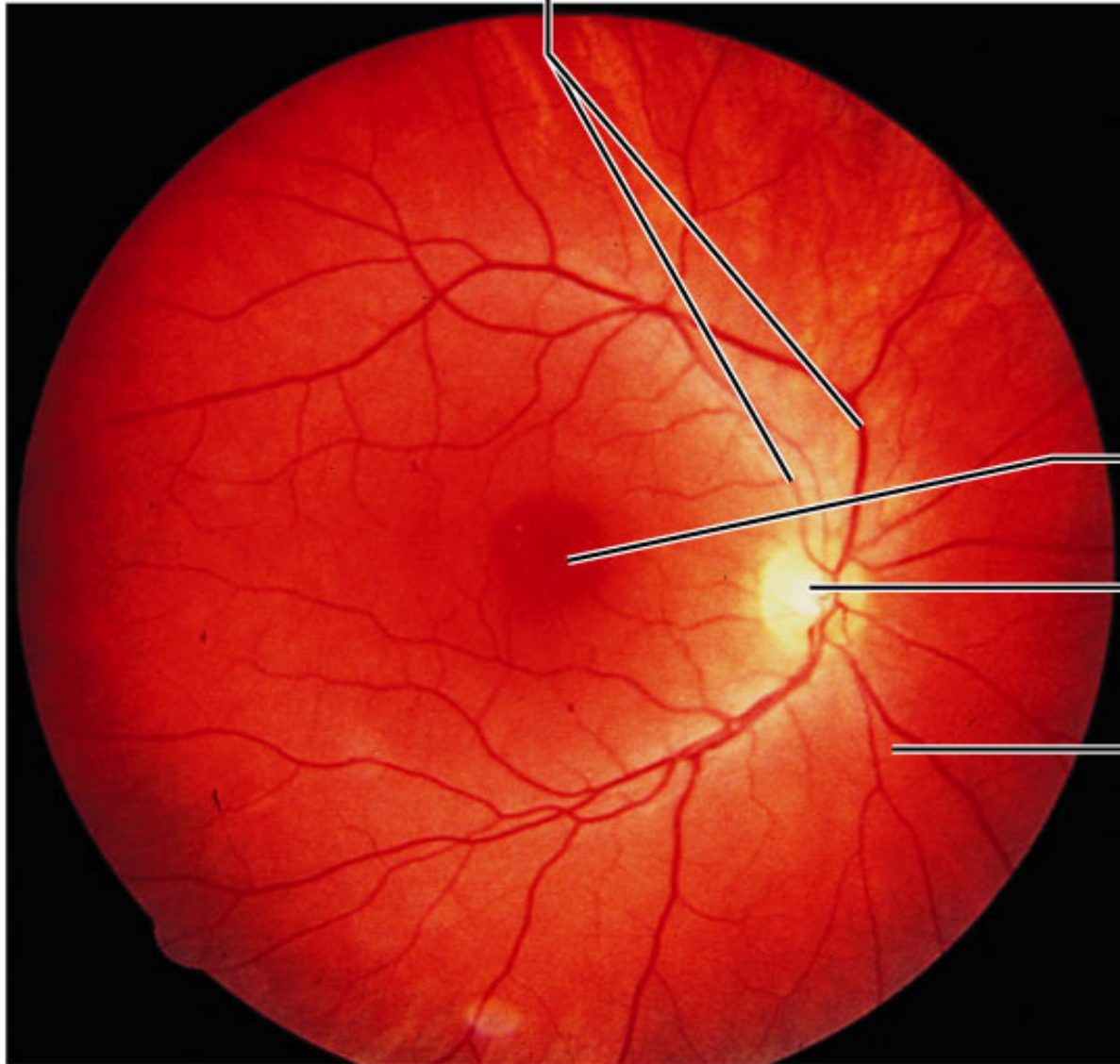








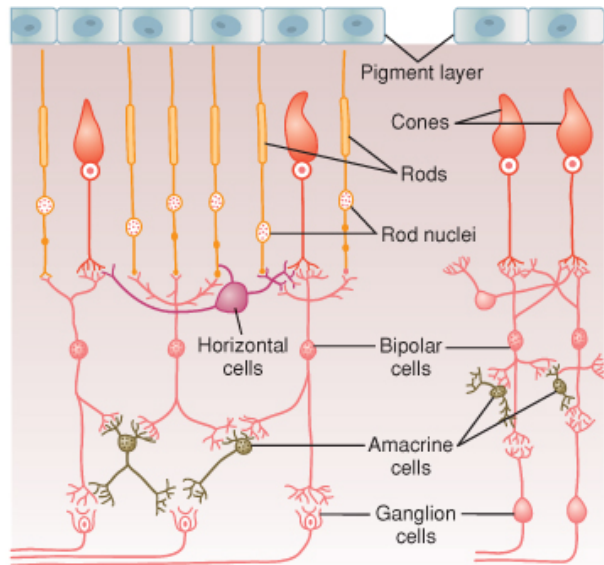
Central artery and vein
emerging from the optic disc



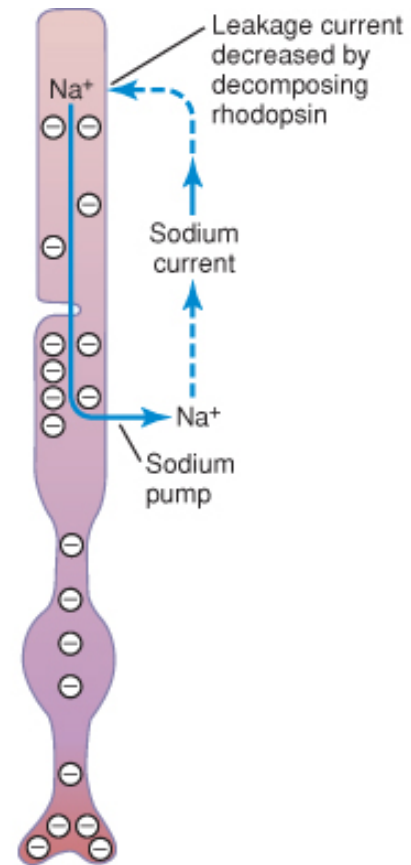
Macula
lutea

Optic
disc

Retina

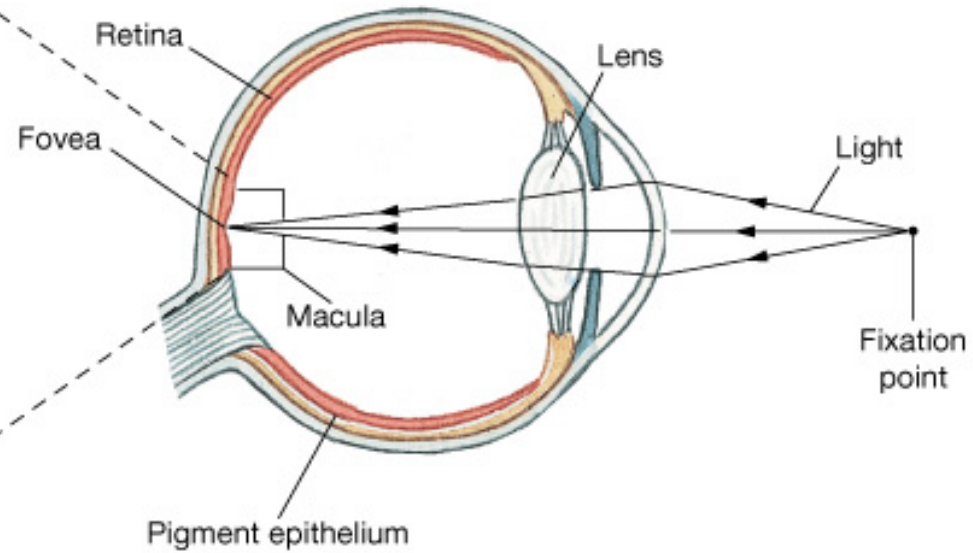
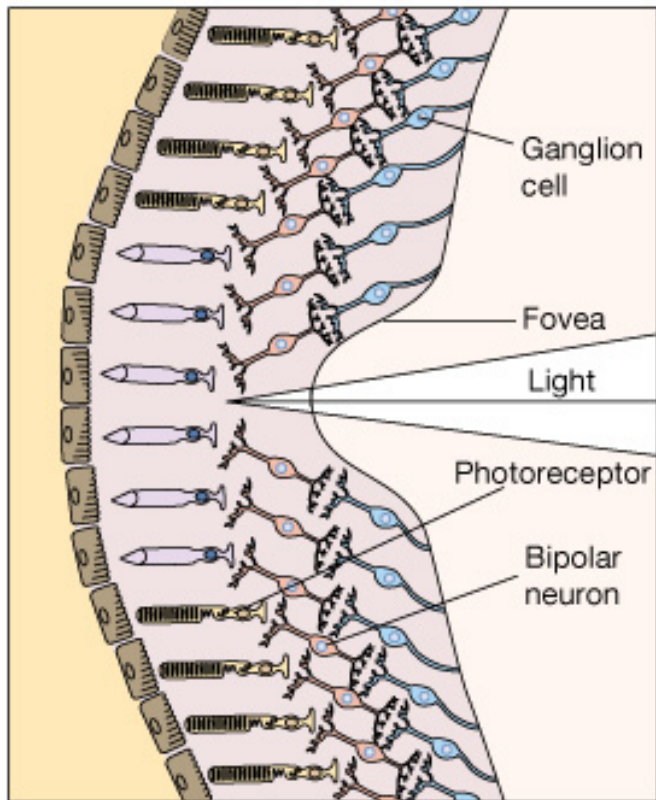


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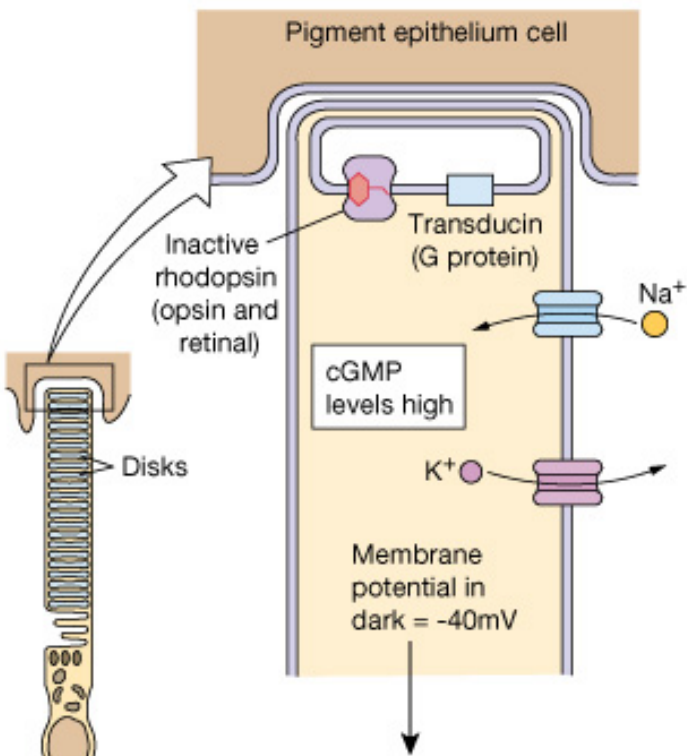
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Light strikes the photoreceptors in the fovea directly because overlying neurons are pushed aside.



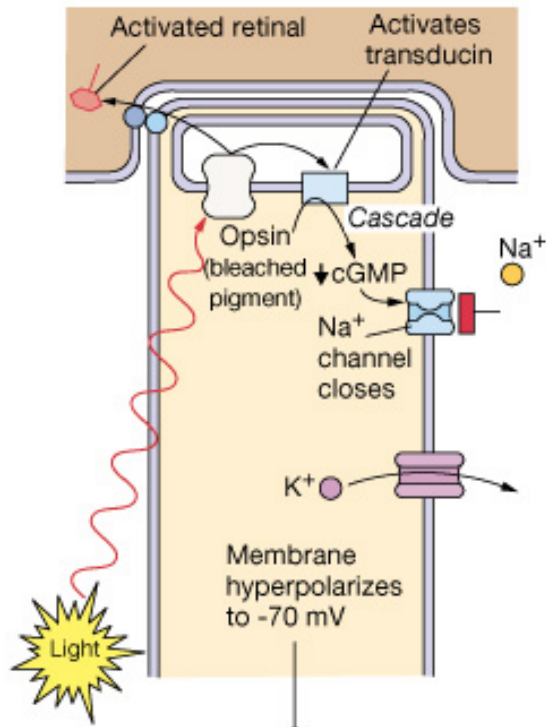
Retina

(a) In darkness, rhodopsin is inactive, cGMP is high, and ion channels are open.



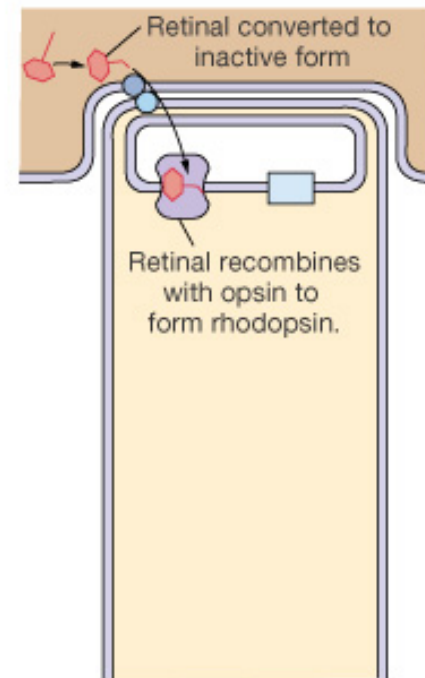
Tonic release of neurotransmitter onto bipolar neurons

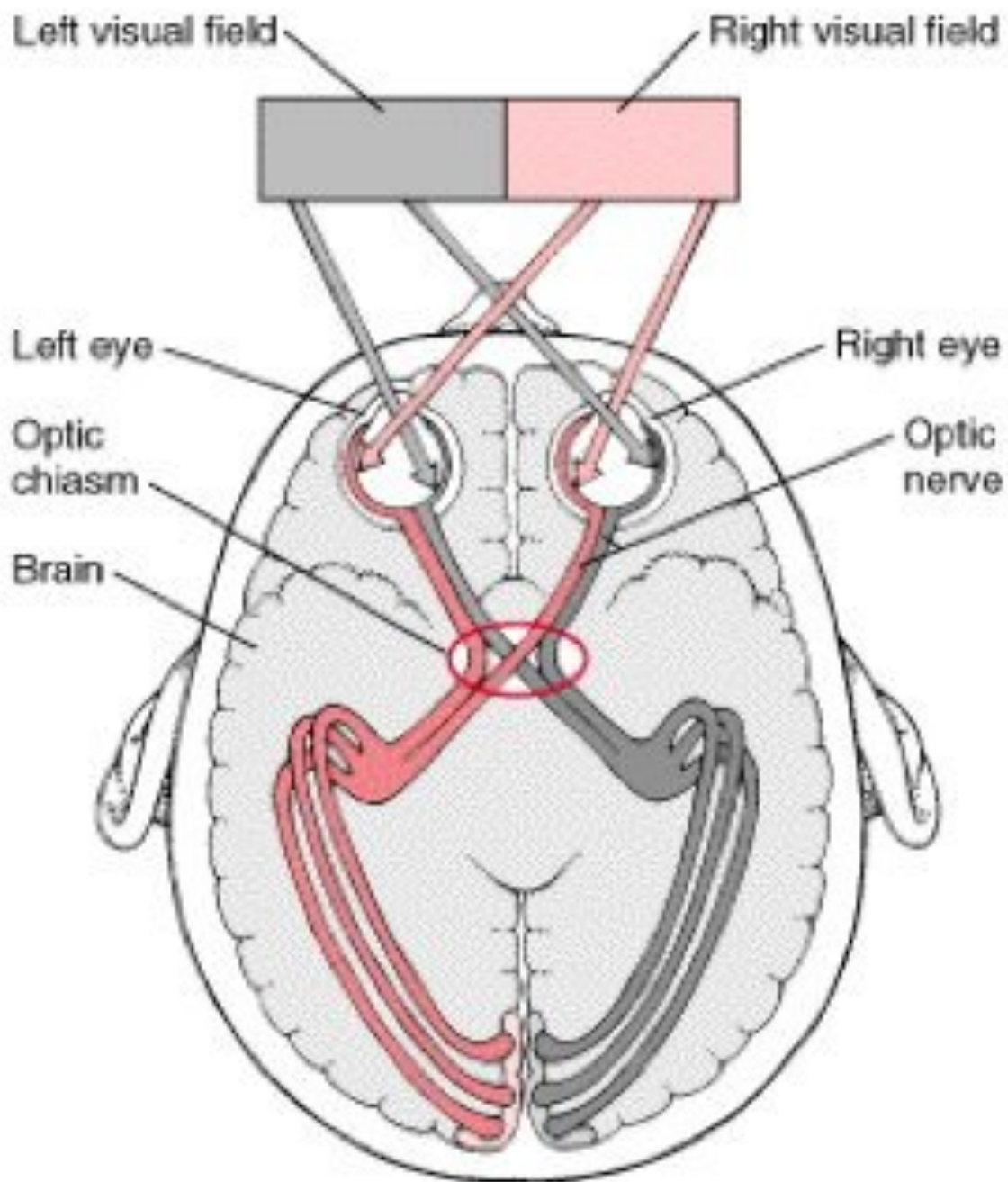
(b) Light bleaches rhodopsin. Opsin decreases cGMP, closes Na⁺ channels, and hyperpolarizes the cell.

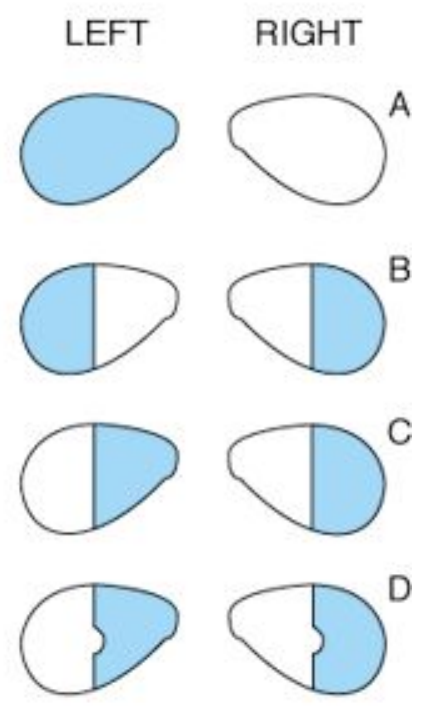
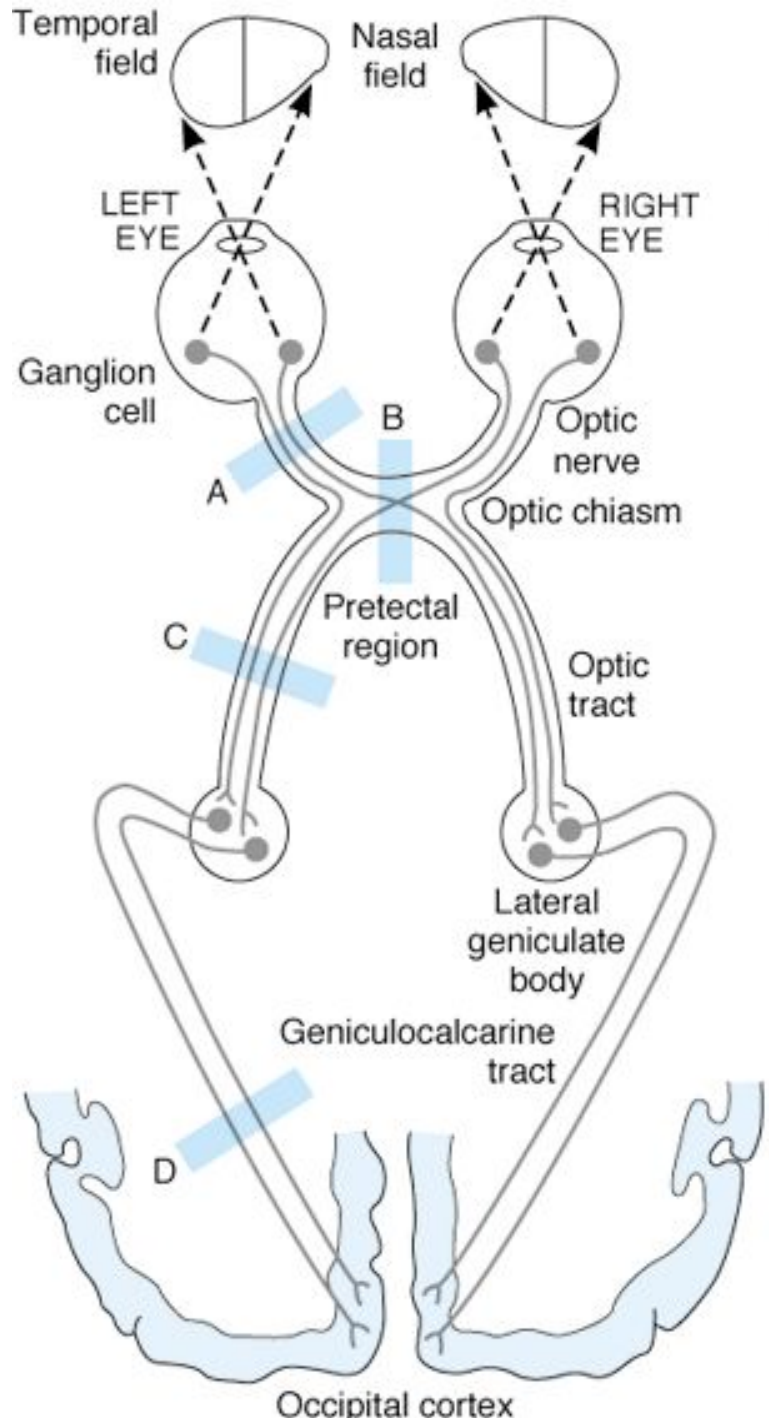


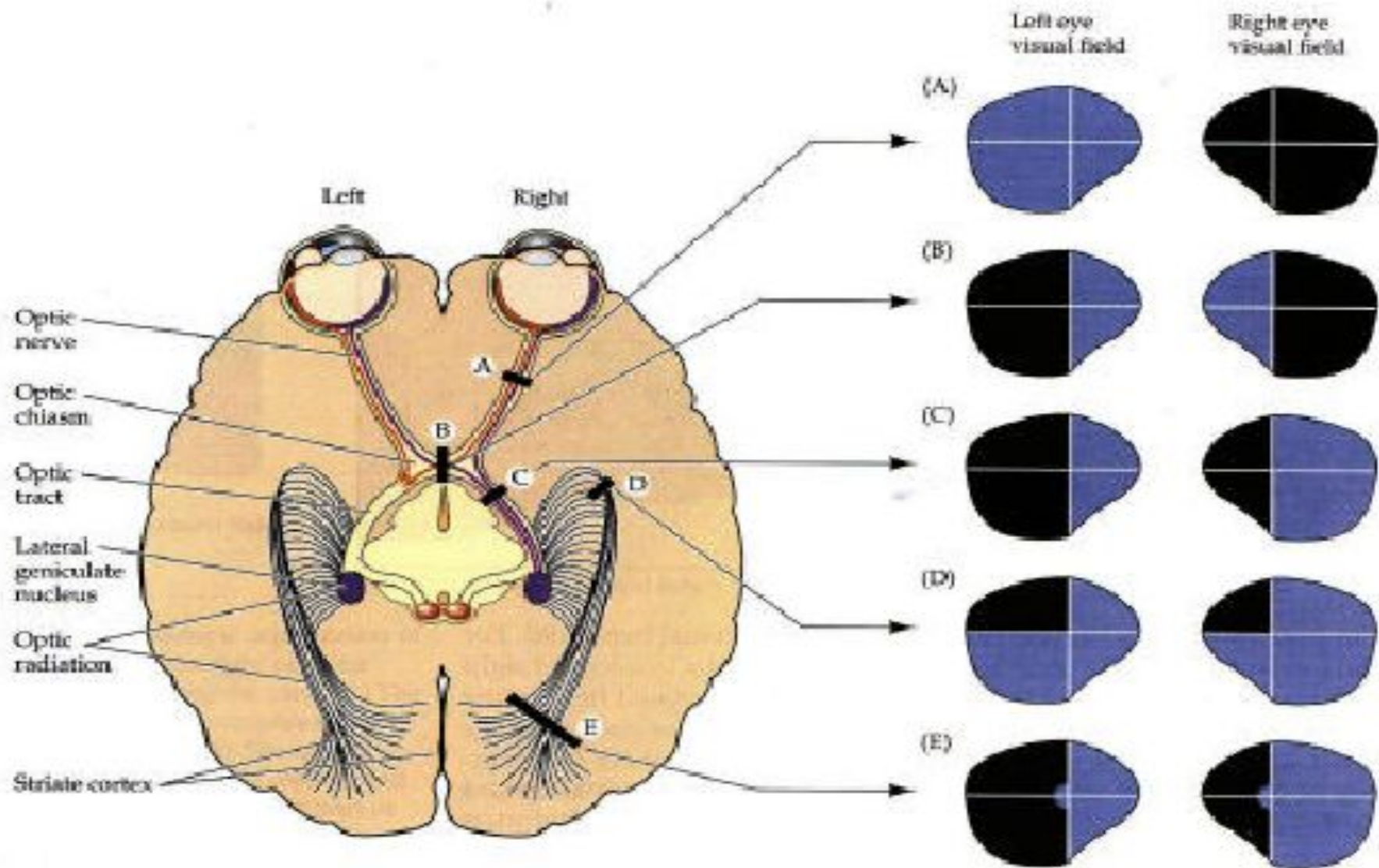
Neurotransmitter release decreases in proportion to amount of light.

(c) In the recovery phase, retinal recombines with opsin.





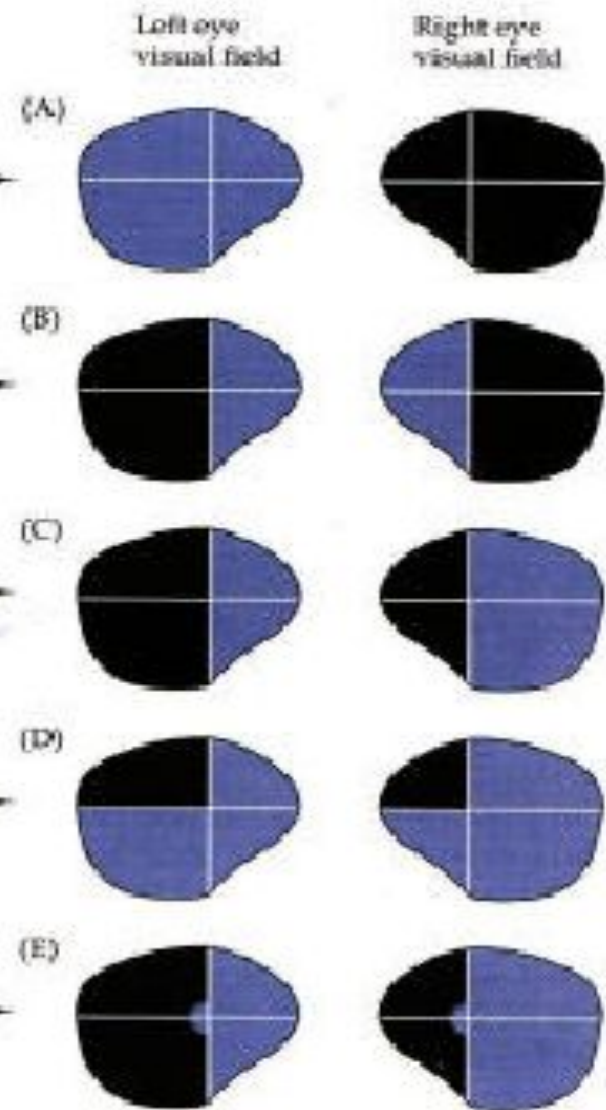




Optic nerve
Optic chiasm
Optic tract
Lateral geniculate nucleus
Optic radiation
Striate cortex

Left Right

A
B
C
D
E



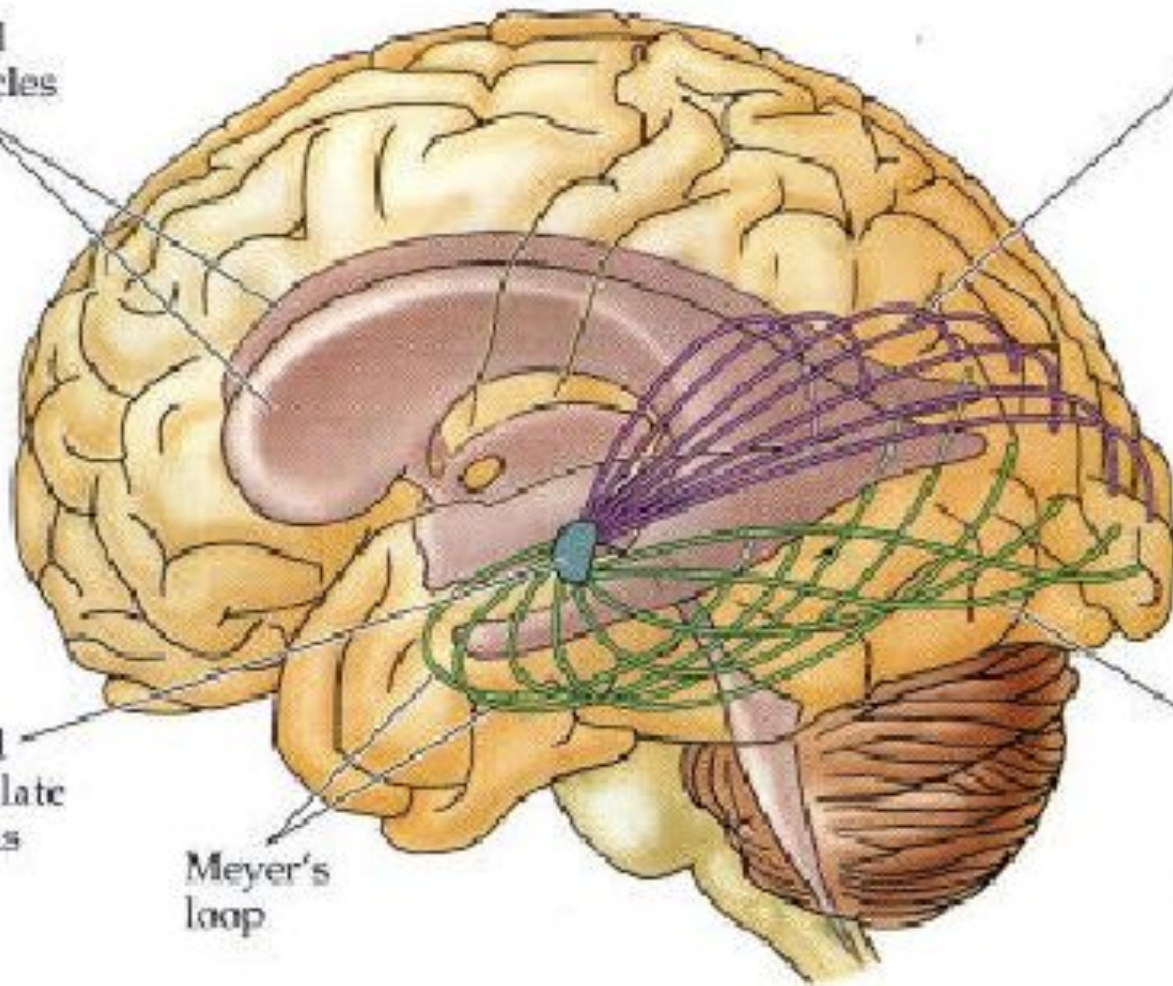
Lateral
ventricles

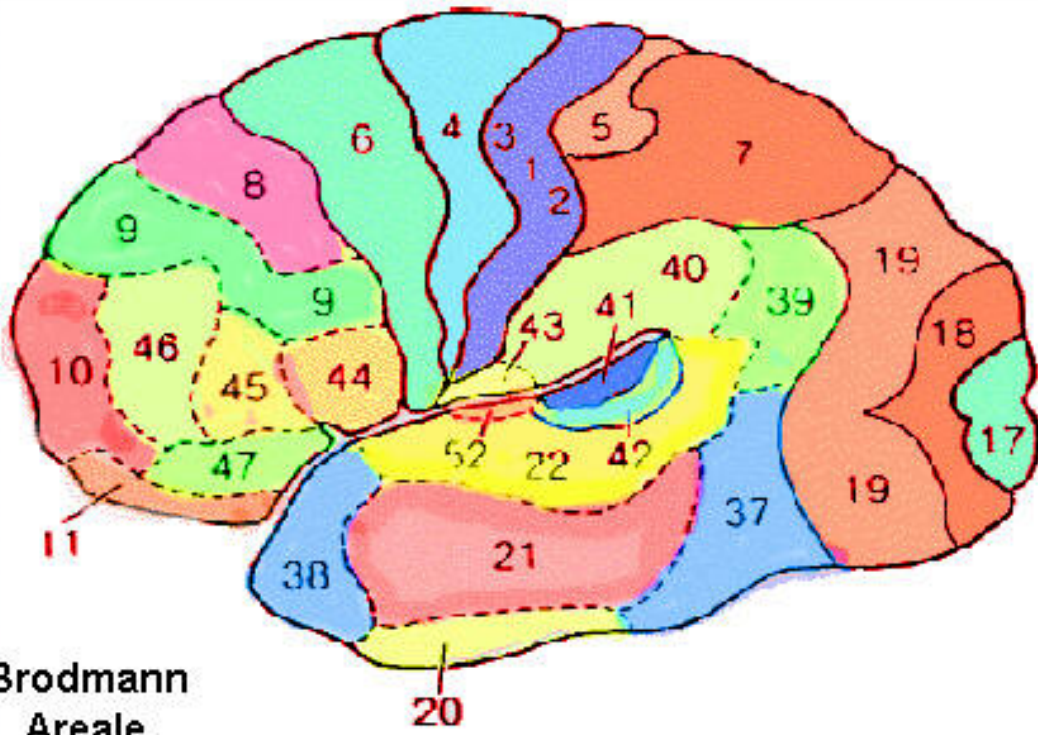
Fibers representing
superior retinal
quadrants (inferior
visual field)

Lateral
geniculate
nucleus

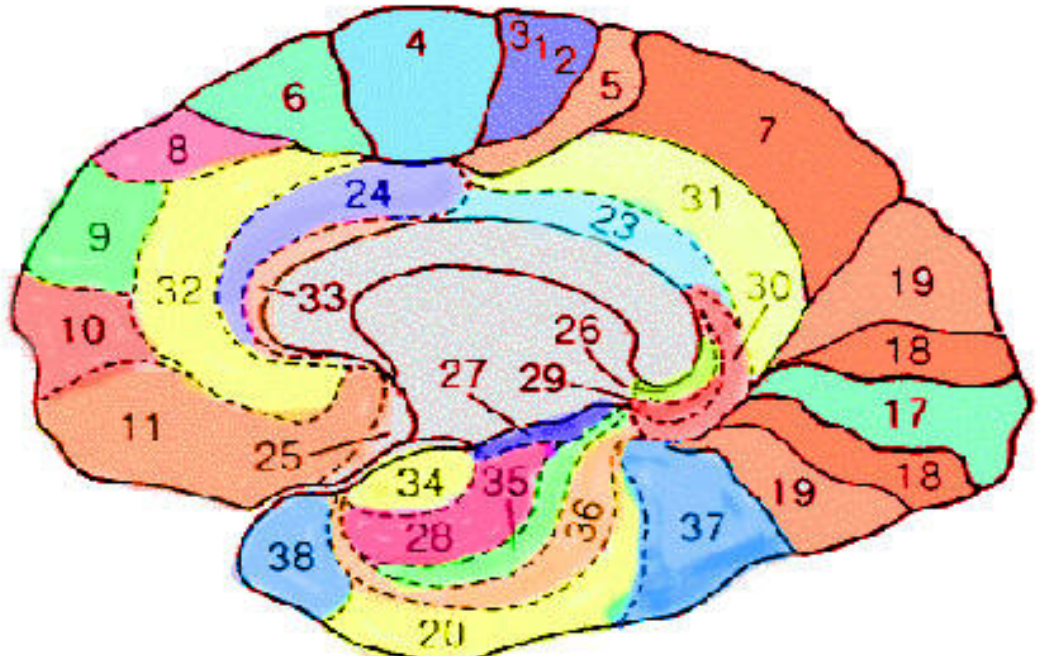
Meyer's
loop

Fibers representing
inferior retinal
quadrants (superior
visual field)

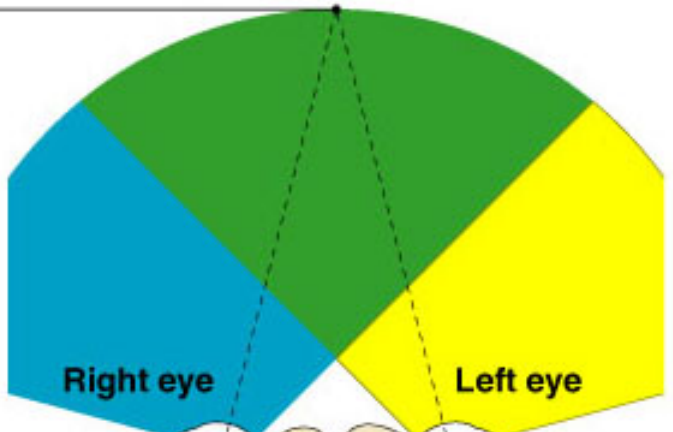




Brodman
Areal



Fixation point



Supra-chiasmatic nucleus

Pretectal nucleus

Lateral geniculate body of thalamus

Superior colliculus

Occipital lobe (visual cortex)

Optic nerve

Optic chiasma

Optic tract

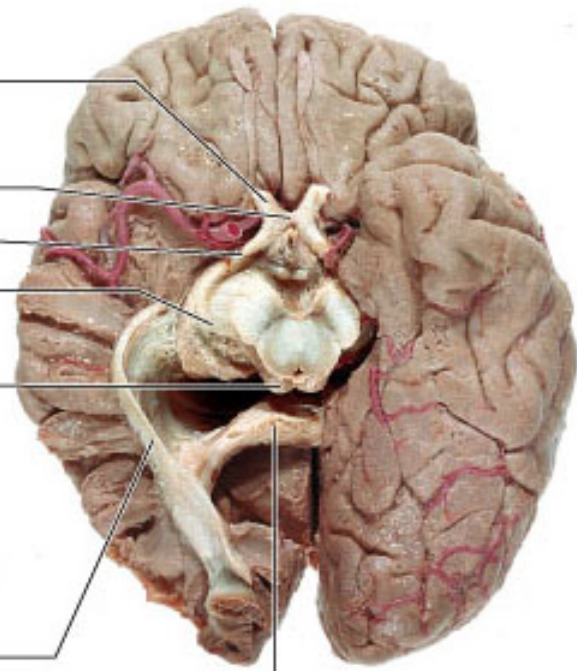
Lateral geniculate body

Superior colliculus (sectioned)

Uncrossed (ipsilateral) fiber

Crossed (contralateral) fiber

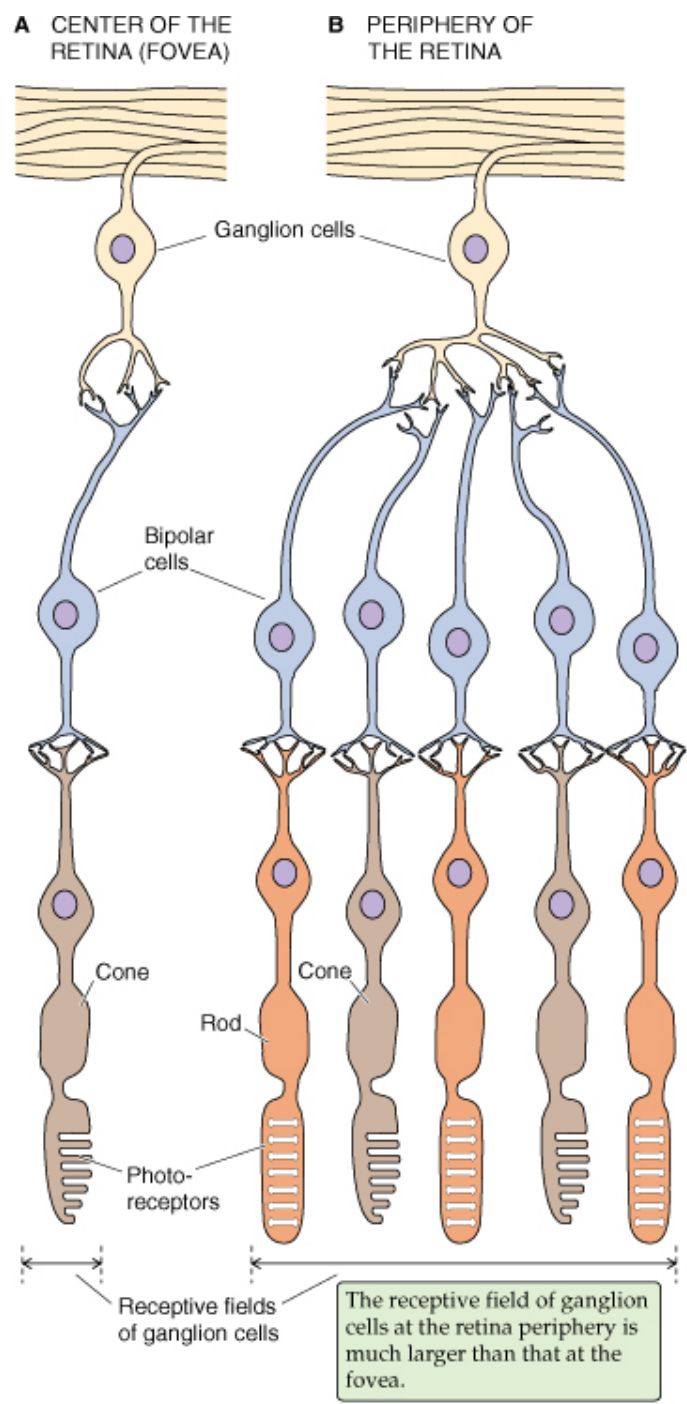
Optic radiation



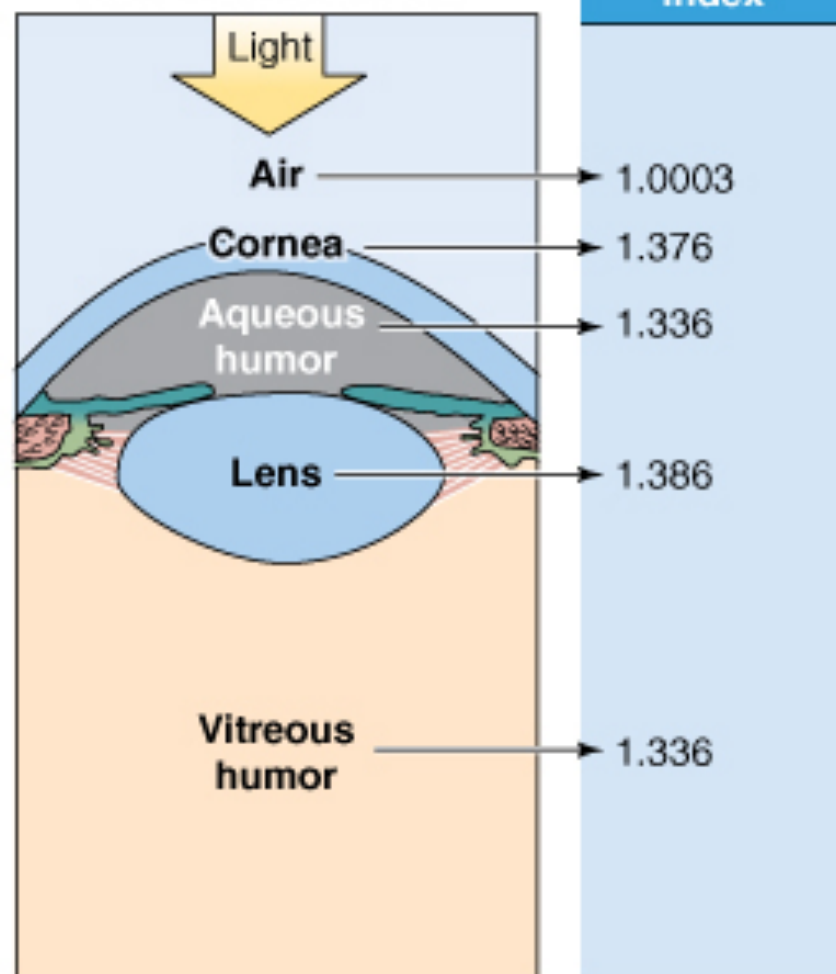
Corpus callosum

(a)

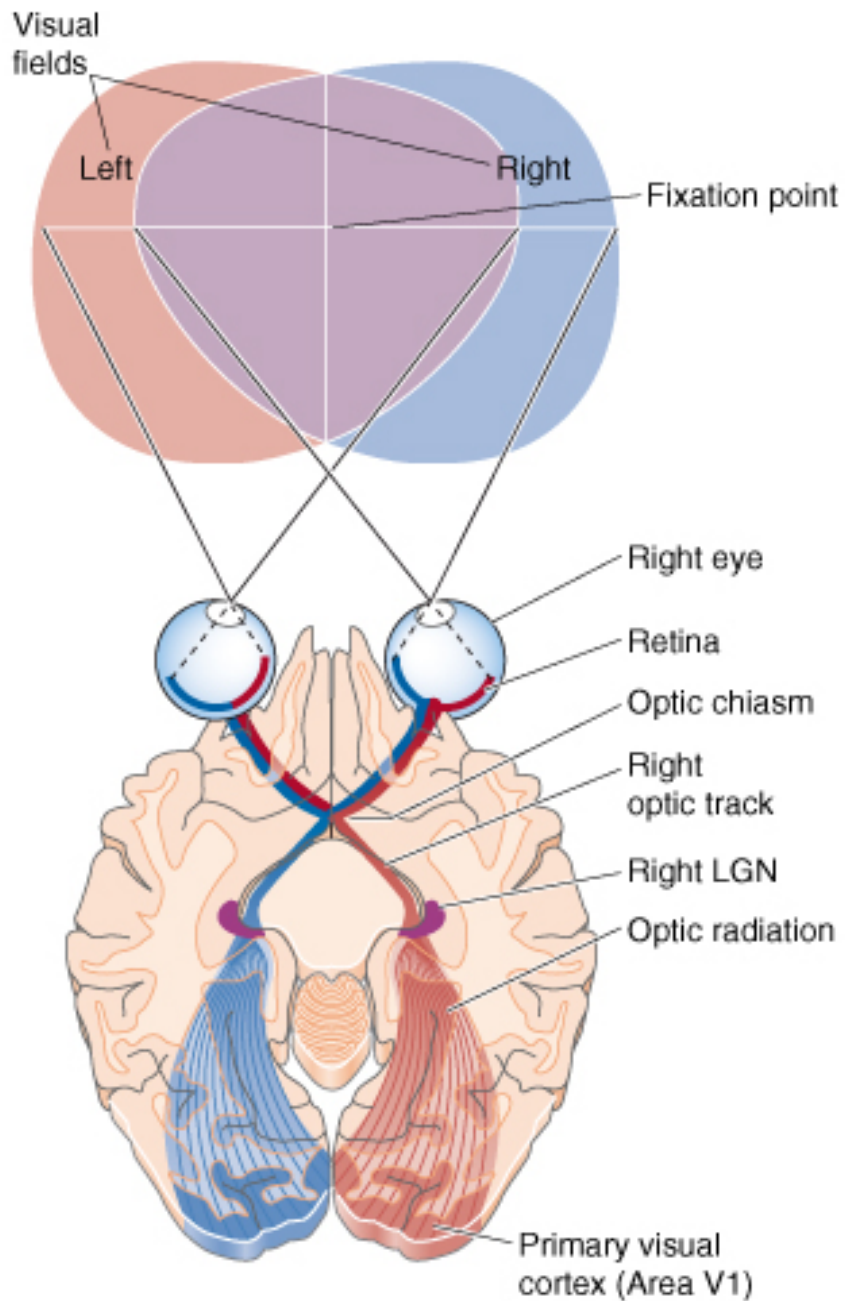
(b)



B REFRACTIVE INDEX OF EYE COMPONENTS



A VISUAL FIELDS AND THE
PRIMARY VISUAL CORTEX



Visual field of left eye

Visual field of right eye

