Vision

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Learning Objectives

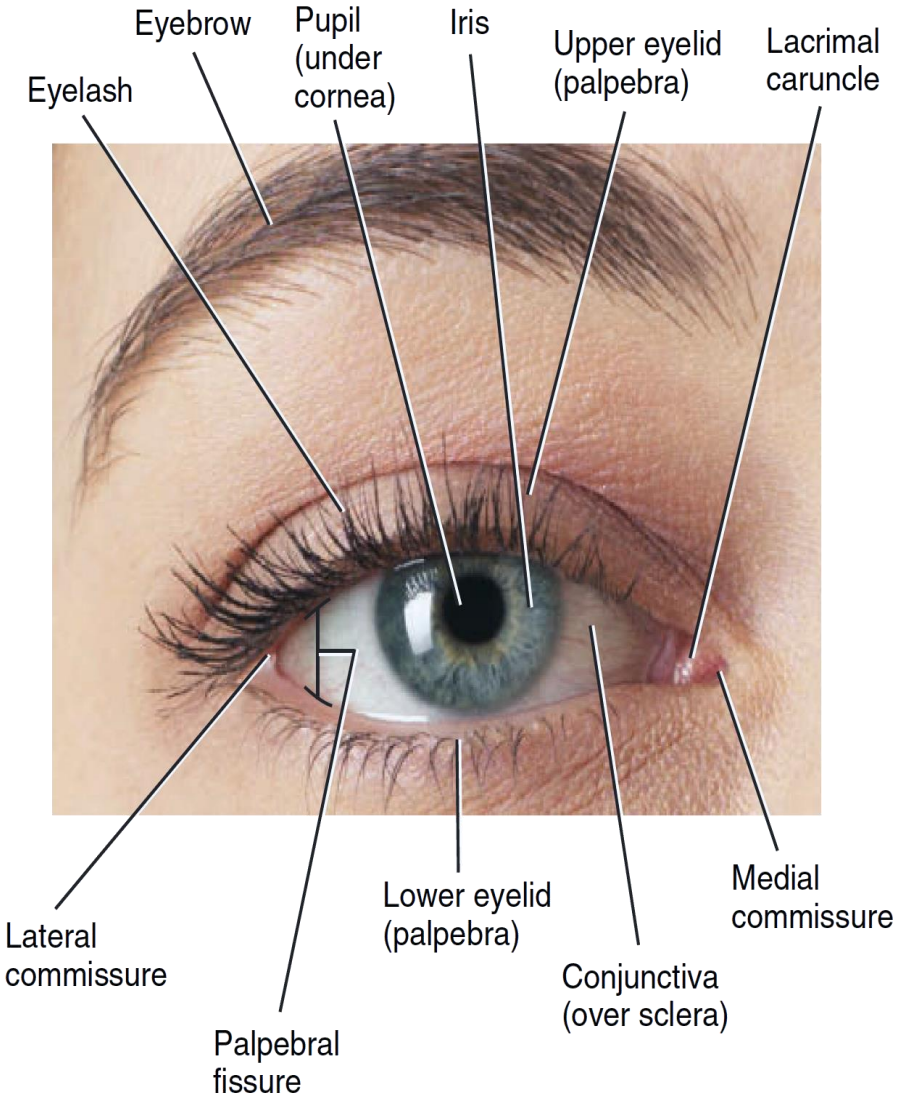
At the end of this lecture, the student should be able -:

- To Describe different components of the eye and function of each .
- Describe the refraction of light as it passes through the eye to the retina
- Identifying the refractive media of the eye
- Know fluid system of eye & glaucoma
- binocular vision .
- Know layers of retina, blind spot, and fovea
- Know principles of optics and errors of refraction

The Eye

- Human vision is one of the most complex visual systems among animals.

- The eye is a complex sensory organ, which capable of transduction physical stimuli of light rays into electrical and chemical signals that can be interpreted by the brain to construct physical images.



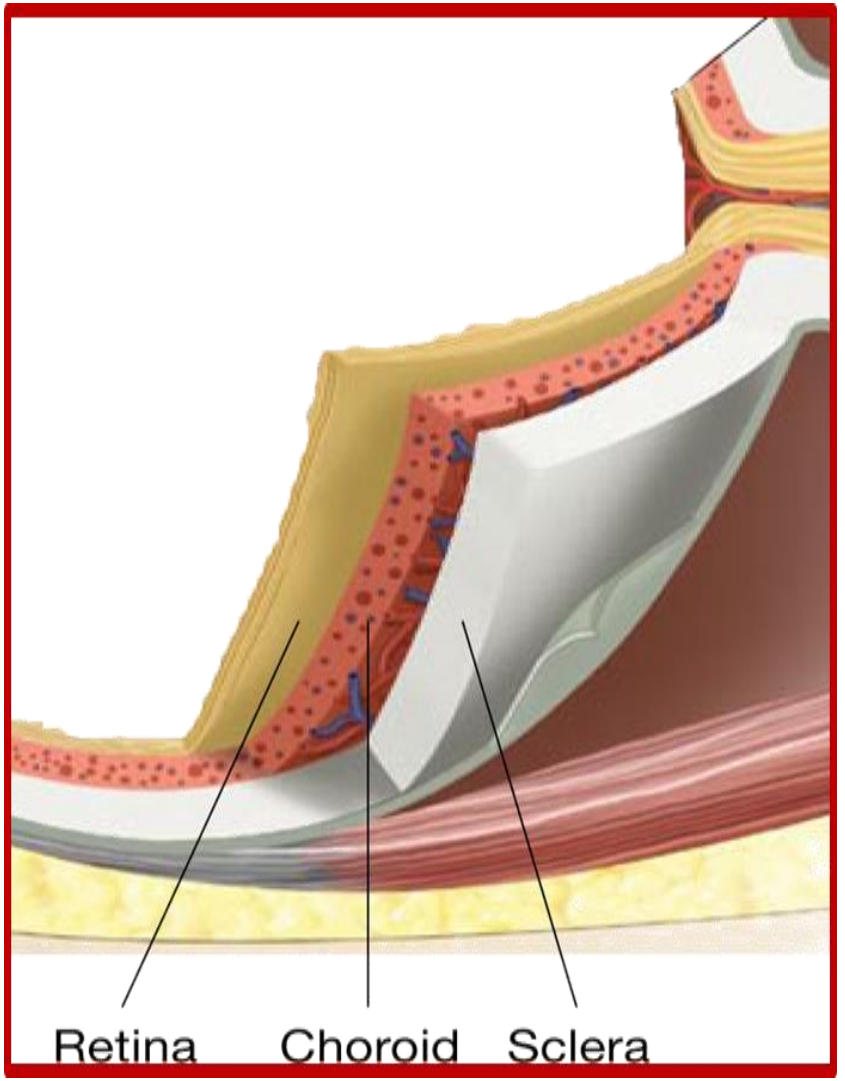
The eye consists of 3 layers :

1/ Outer fibrous layer :
consists of →

(a) Sclera

(b) Cornea

- ✓ Cornea is transparent anterior portion
- ✓ Conjunctiva lines the eyelids and covers the sclera. It is a transparent epithelium .



2. Middle Vascular Layer:

consists of →

(a) Iris:

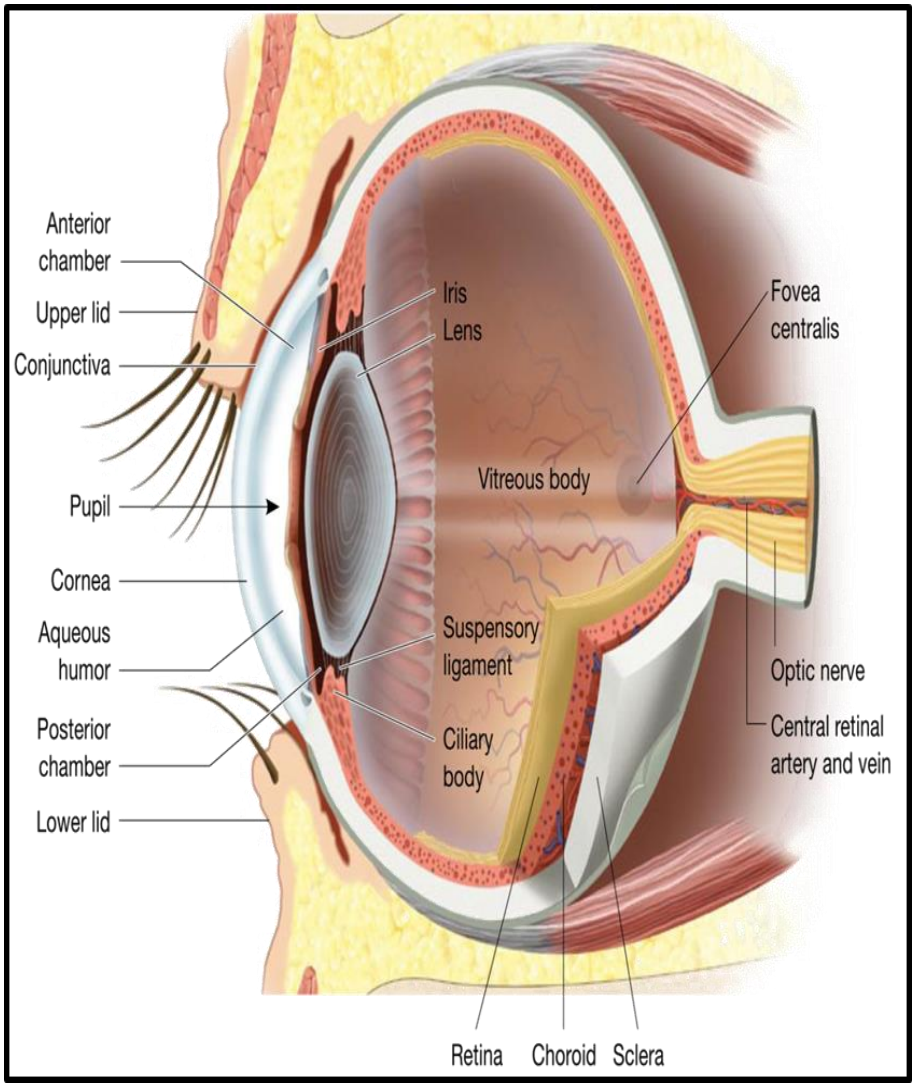
- ✓ Is the colored part of the eye
- ✓ Has aperture (pupil) control & allow light to enter the eye

(b) Ciliary body:

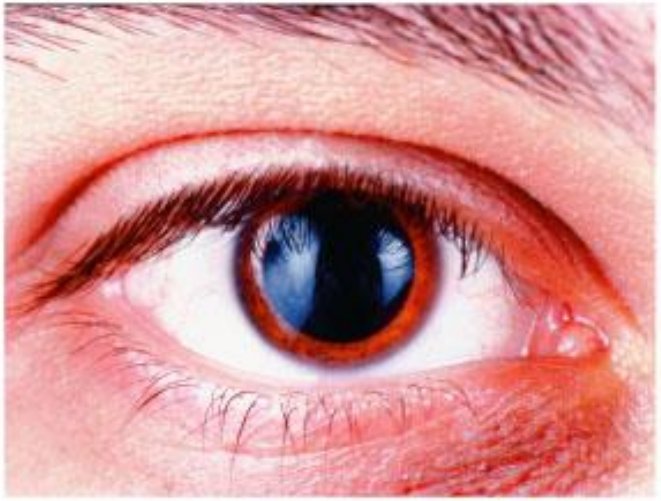
Ciliary body consists of:

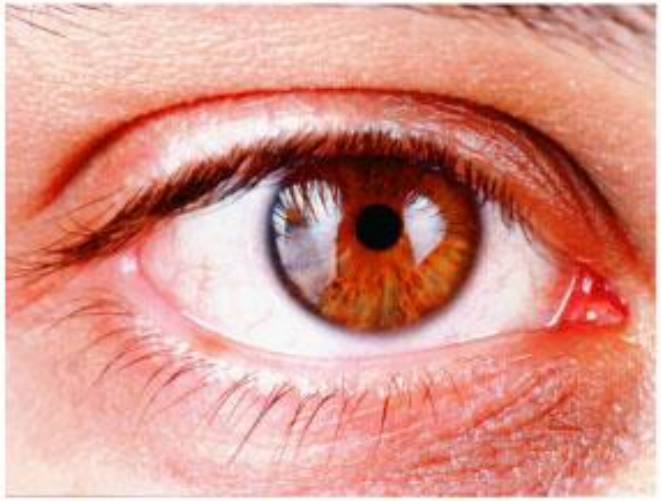
- ✓ Ciliary muscles
- ✓ Ciliary glands
- ✓ Suspensory ligaments which attached to the lens

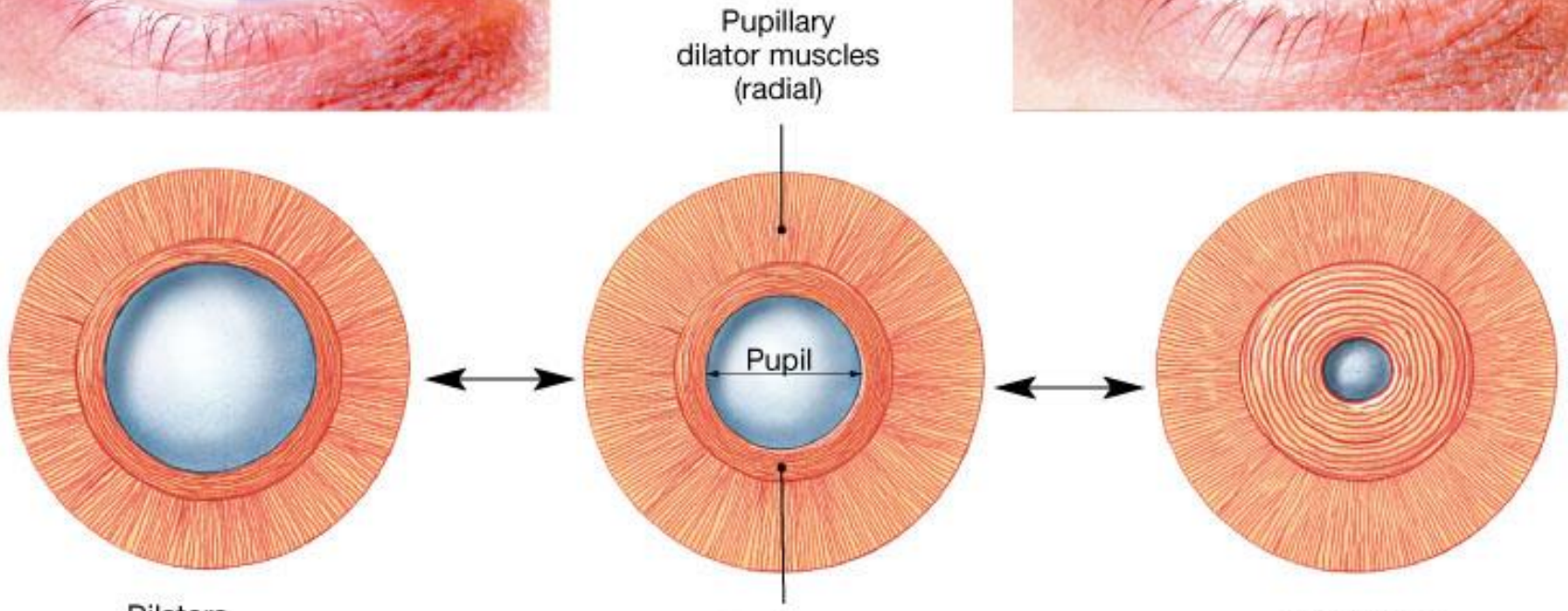
(c) Choroid



The Pupillary Muscles: consists of → Radial and Circular parts

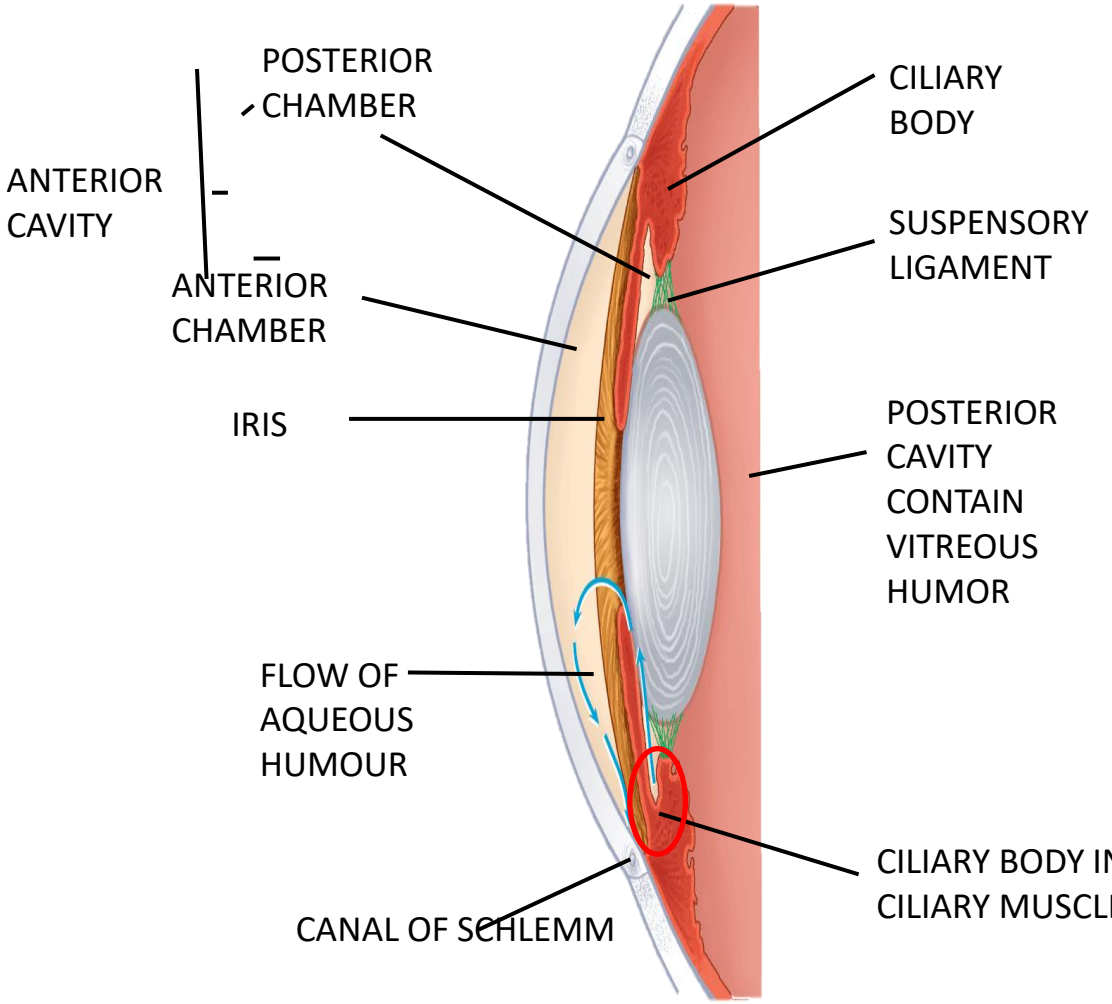




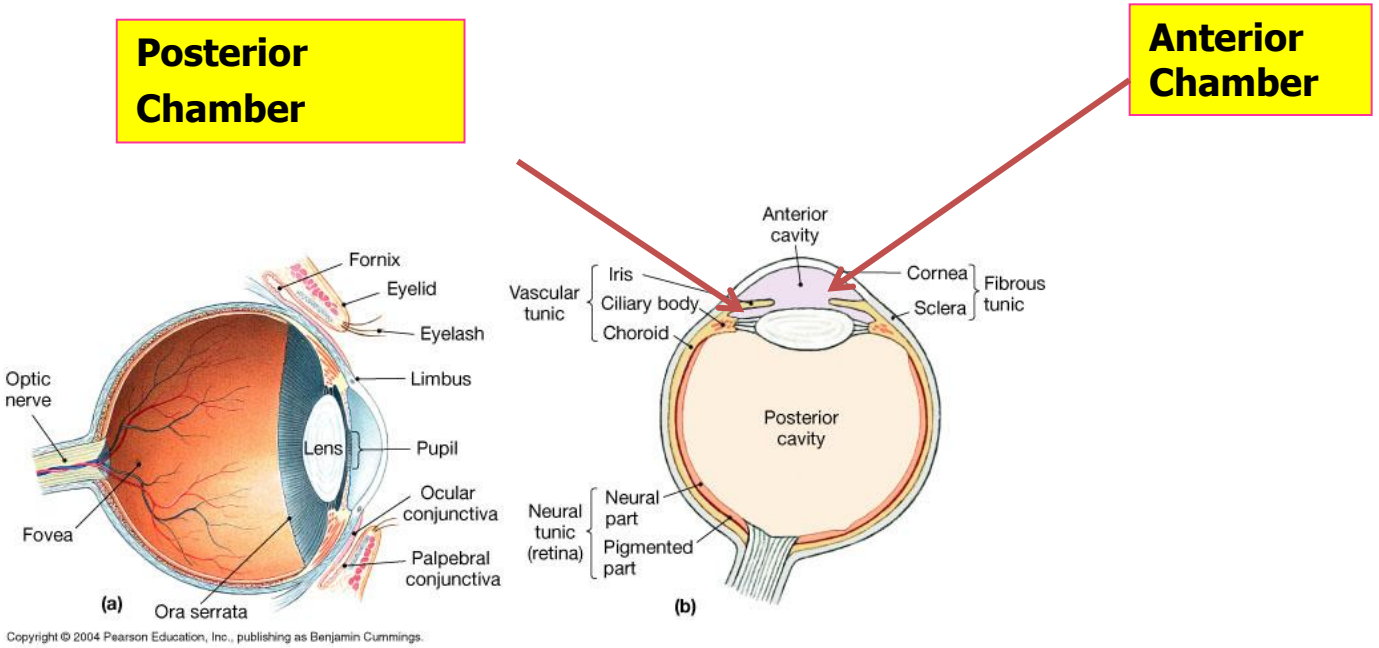


The Anterior & Posterior Cavities

- The Ciliary Body (& its suspensary ligament) and lens divide the eye into :
- (1) Anterior cavity which contains a fluid called Aqueous Humor
- (2) Posterior cavity (which contains fluid called Vitreous Humor) .



The Anterior and Posterior Chambers



- **Furthermore , the Iris further divides the anterior cavity into :**

(a) Anterior Chamber (in front of the iris) , and

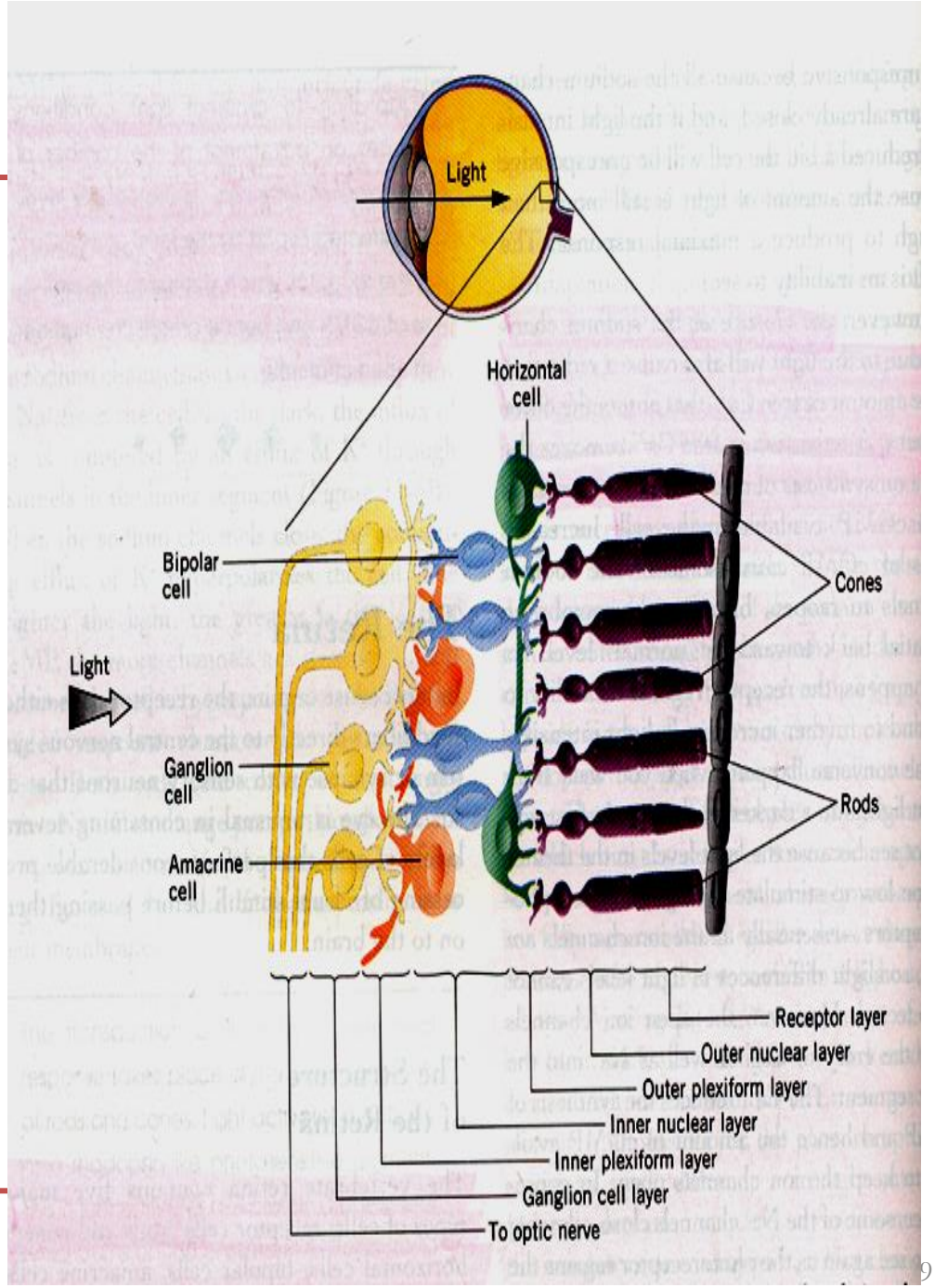
(b) Posterior Chamber (behind the iris ; between the iris and lens) .

3. The Retina:

consists of →

✓Outer pigmented portion (part)

✓Inner neural part , containing Photoreceptors called Rods and Cones .



Rods & Cones

Rods

(1) are best for vision in dim light (**scotopic vision**)

(2) are better than cones for detection of flicker (sudden movements of objects).

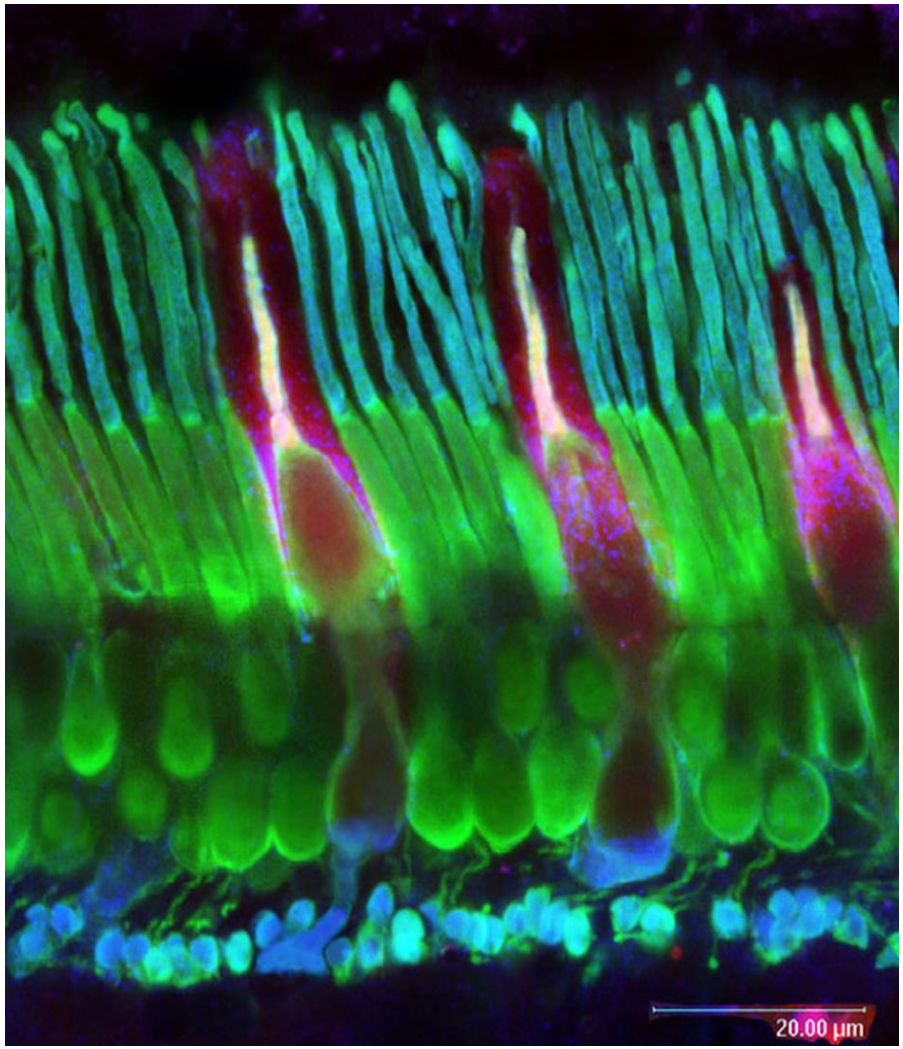
Cones

are best for

(1) vision in daylight or bright light (**photopic vision**)

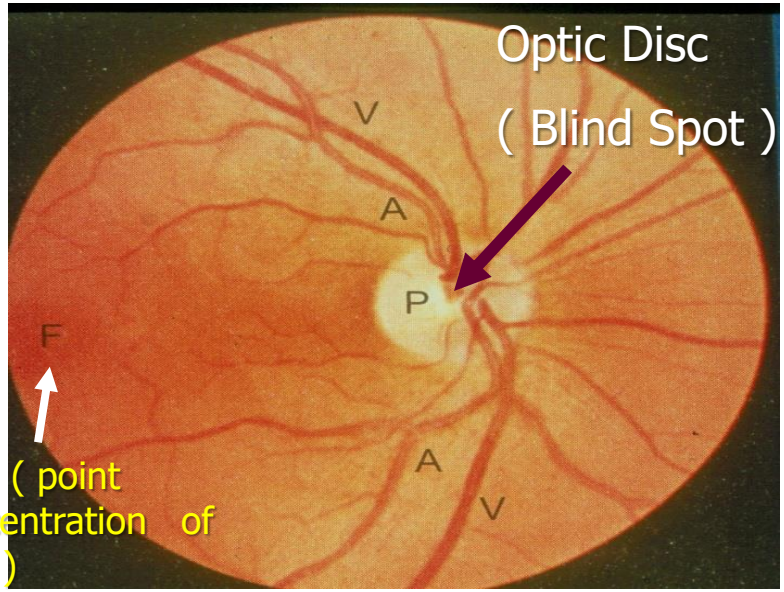
(2) Color Vision (color perception)

(3) Perception of detail (acuity of vision)

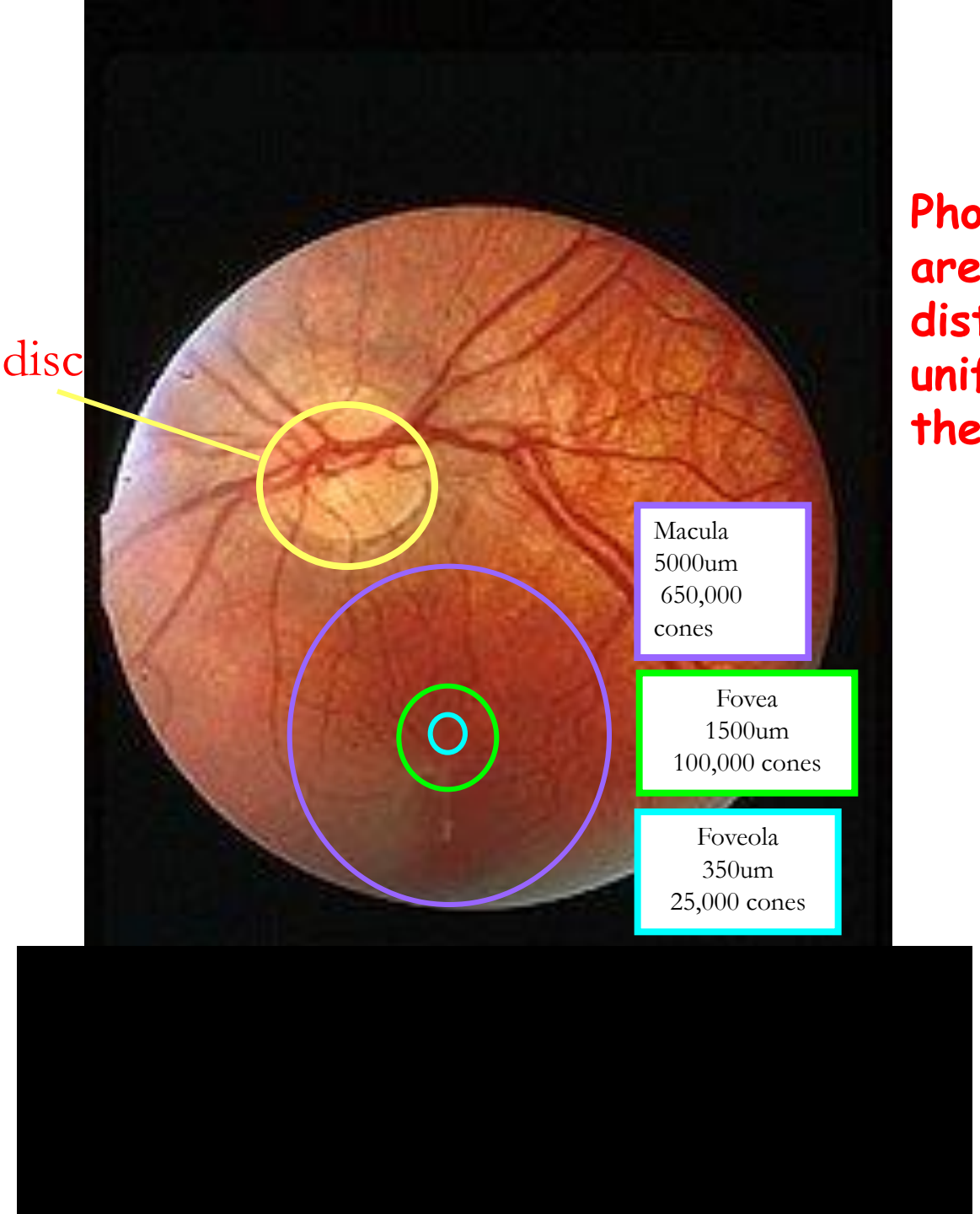


Macula & Fovea Centralis

- An important part of the retina is the Macula Lutea .
- At the center of the Macula we find the Fovea Centralis .
- In the Fovea we find the maximum concentration of cones →consequently → the Fovea is the point of maximal visual activity in the retina .
- Cones are densely packed at the Fovea .
- When you turn your eye to look at an object → you tend to place its image in the Fovea



Fovea (point ofconcentration of Cones)

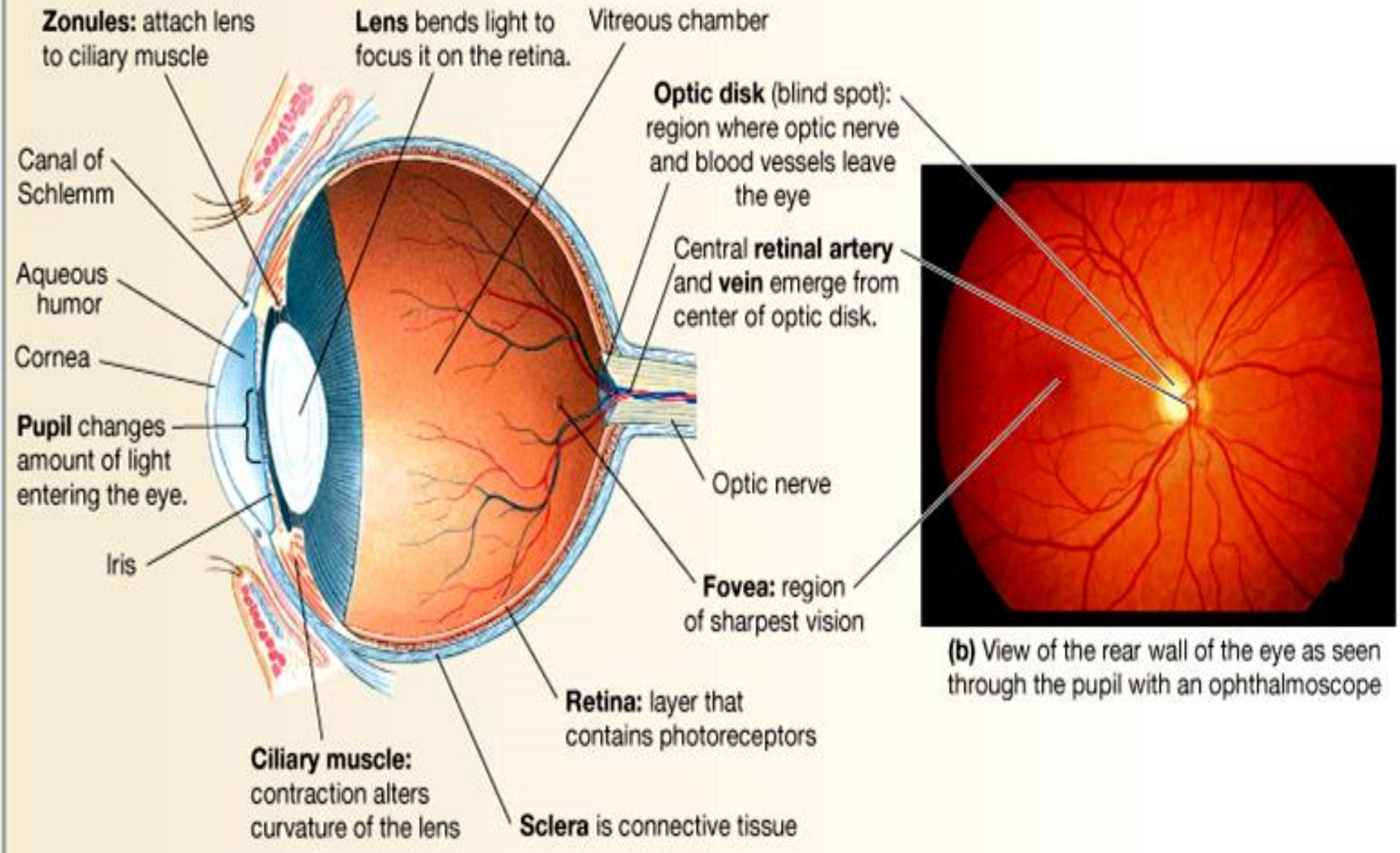


Photoreceptors are not distributed uniformly across the retina

Disorders of the Eye and Vision: Retinopathy

- Retinopathy in diabetes
  - Vessels have weak walls – causes hemorrhaging and blindness

STRUCTURE OF THE EYE



(a) Cross section of the eye

(b) View of the rear wall of the eye as seen through the pupil with an ophthalmoscope

Organization of the Retina

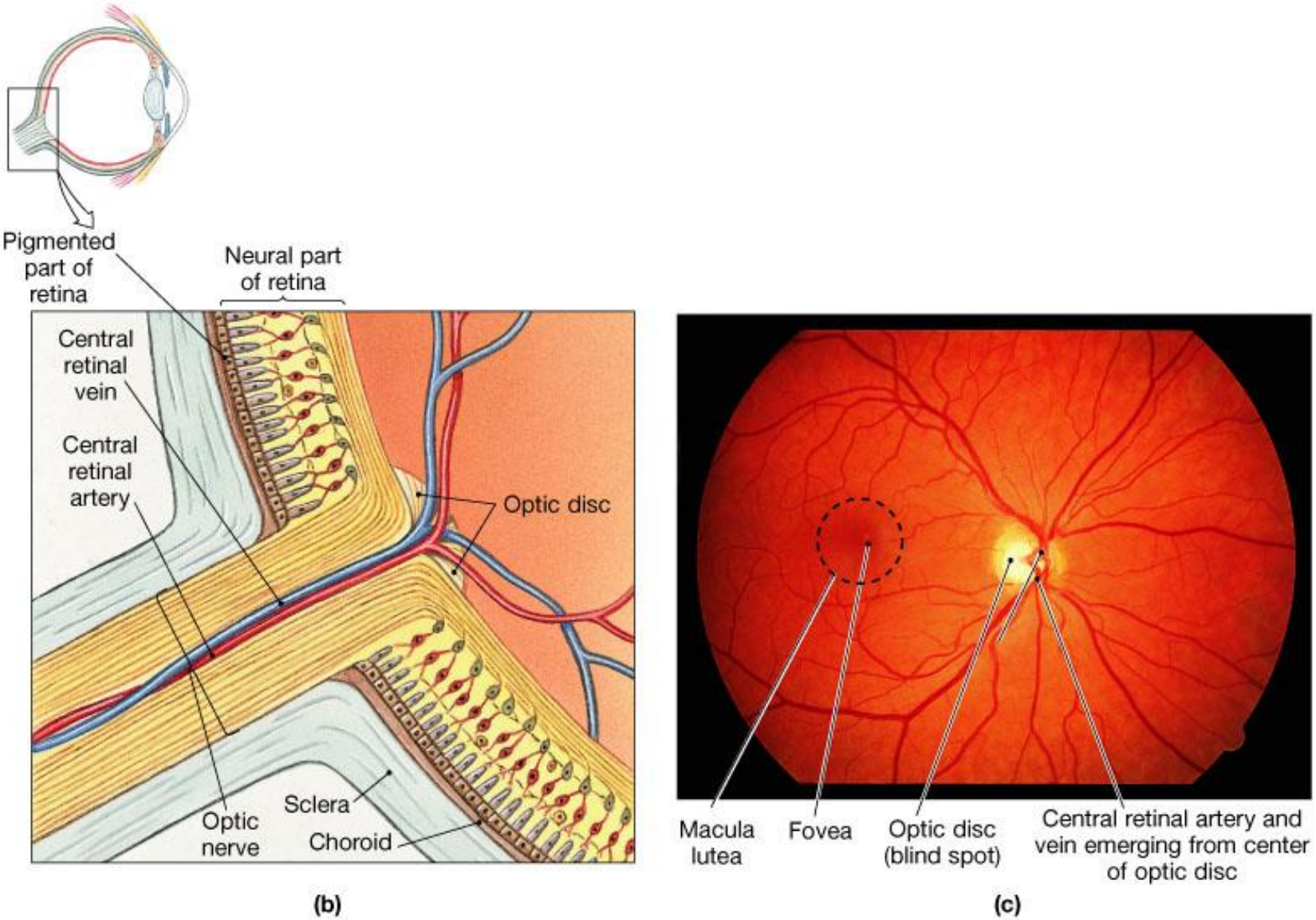


Figure 17.6b, c

External protection of the eye

1. Bony orbit
2. -Eye lids with their lashes
3. Conjunctiva
4. -Tears from lacrimal gland has antibacterial, lubricating effect ,keep cornea moist & clear & **PROVIDE NUTRITION TO THE CORNEA**

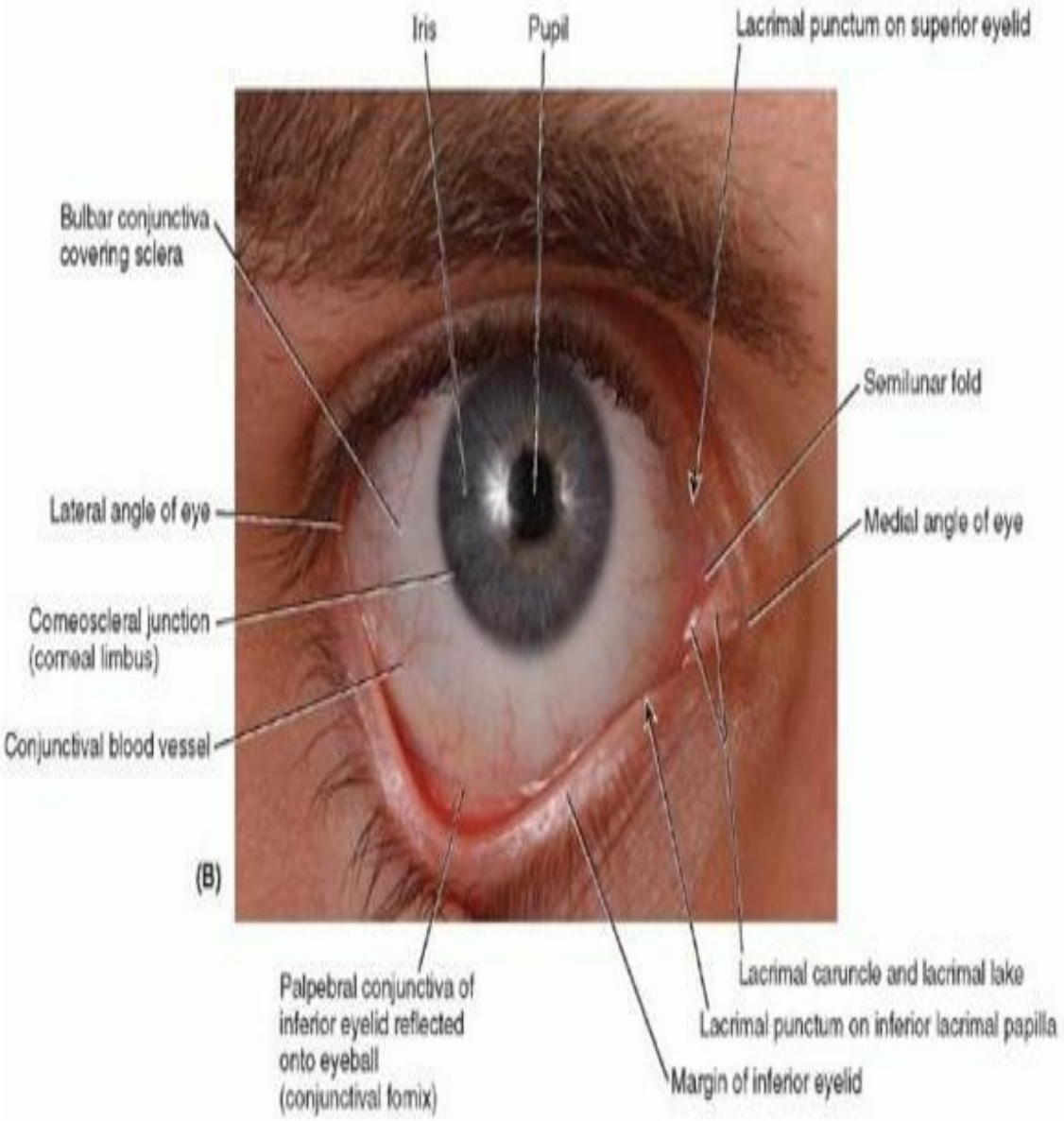
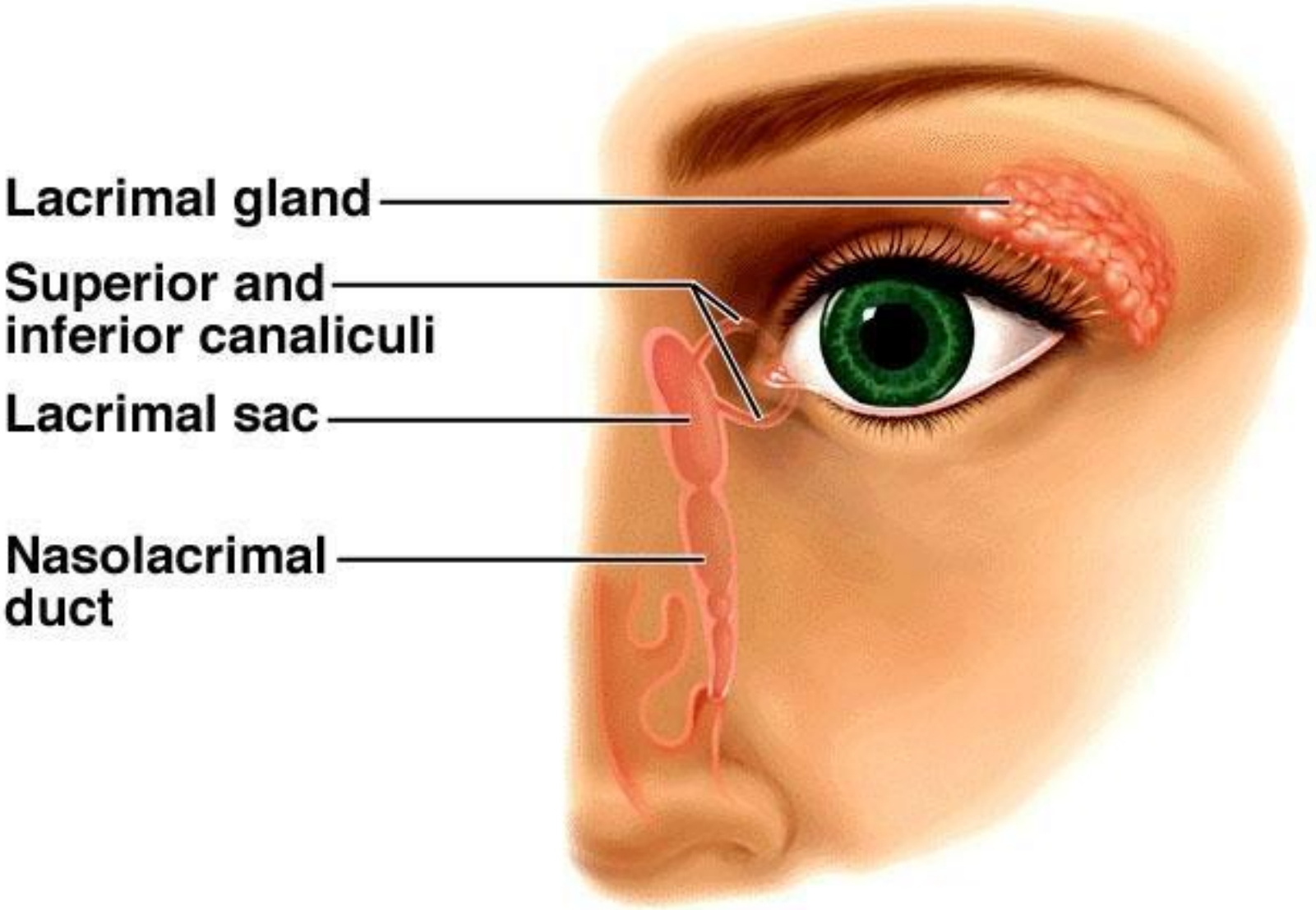


FIGURE 7.64. Surface anatomy of the eye (A) and lacrimal apparatus (B).

Lacrimal Apparatus

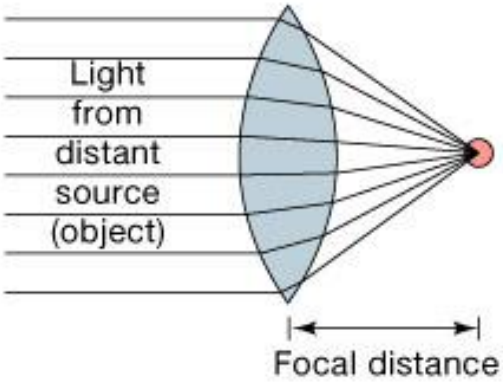


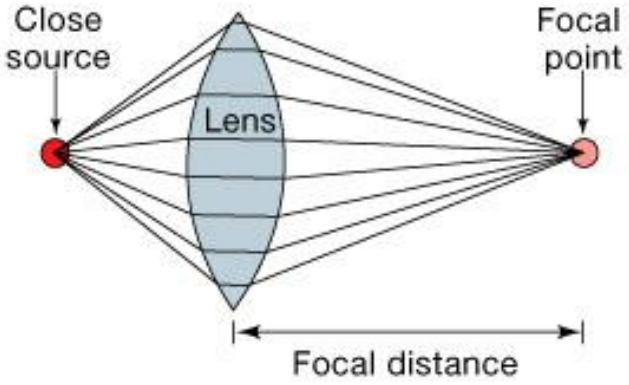
The image-forming mechanism - **Optics of the eye -**

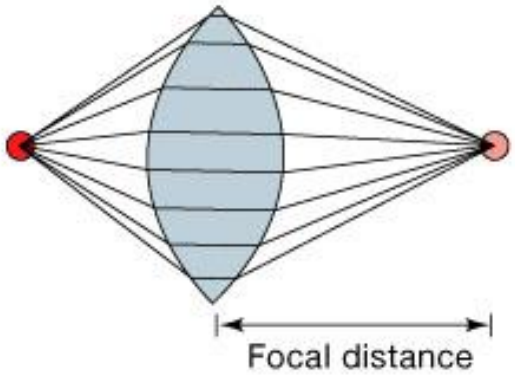
Lenses

Principles of Optics

Image Formation







(a) The closer the light source, the longer the focal distance

(b) The rounder the lens, the shorter the focal distance

Principles of Optics

principle focus:-

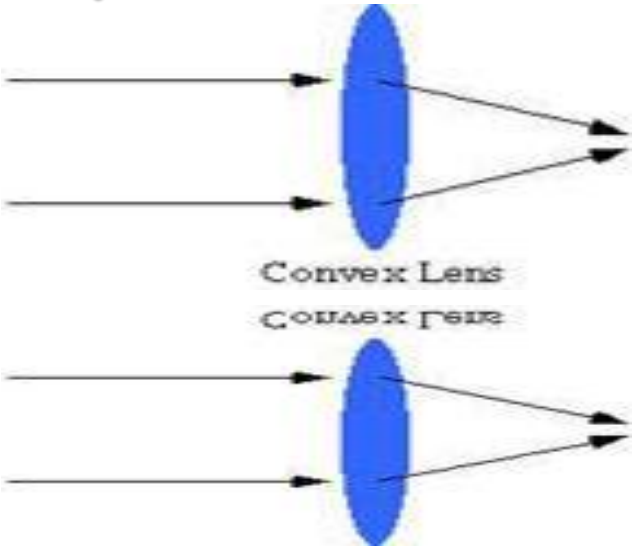
- parallel rays strike biconvex lens refracted in a point is PF.

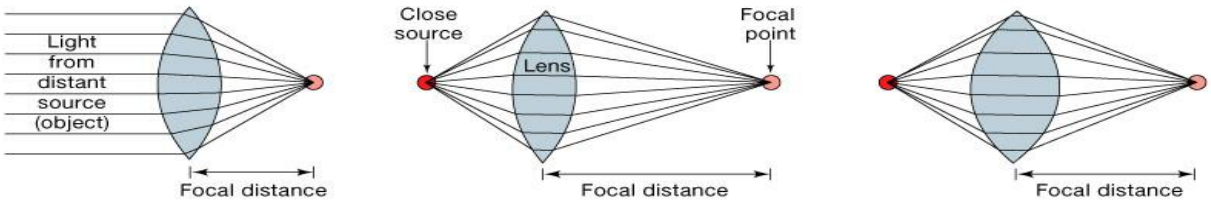
principle axis:-

- PF lies on line pass through centers of lens curvatures

Principal focal distance:-

- distance between lens & PF.
- Biconvex lens(converge) & biconcave lens(diverge)





(a) The closer the light source, the longer the focal distance

(b) The rounder the lens, the shorter the focal distance

Emmetropic: objects focused on retina (normal)

Diopter:

- Measure of refractive power) = 1 / Principal focal distance in meters

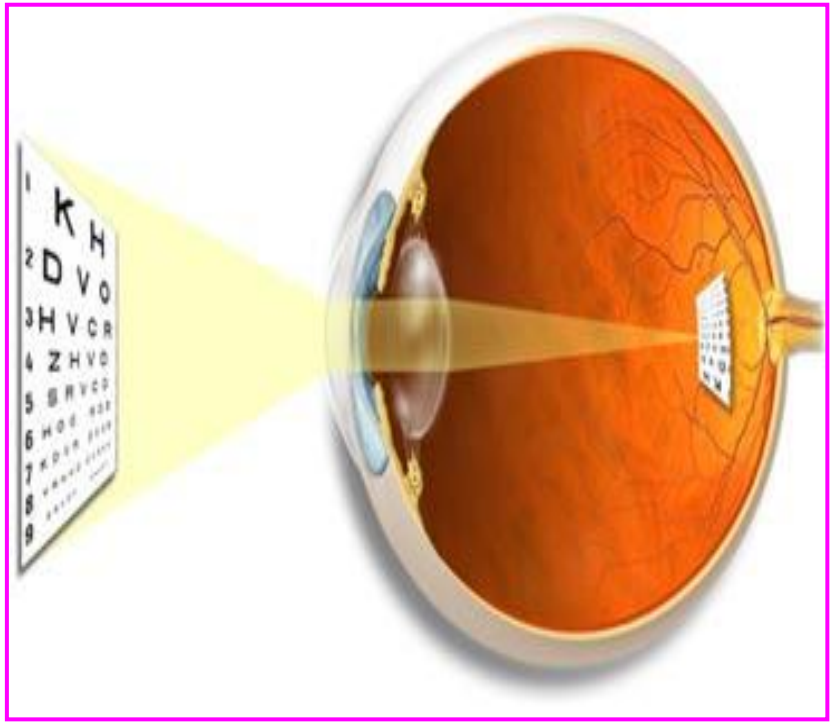
Exp/ if Principal focal distance of a lens is 25cm,so its R.P=1/ 0.25 meter = 4D

Emmetropic eye;-

✓Normal eye has image on retina , has diopteric power of 59D

✓Lens-retina distance =17mm

✓The greater the curvature of the lens, the greater the refractive power of the eye.



Refractive media of the eye

- (1)The interface between air and the anterior surface of the cornea,
- (2) The interface between the posterior surface of the cornea and the aqueous humor,
- (3) The interface between the aqueous humor and the anterior surface of the lens of the eye,
- (4) The interface between the posterior surface of the lens and *the vitreous humor.*

- *- a total refractive power of 59 diopters when the lens is accommodated for distant*

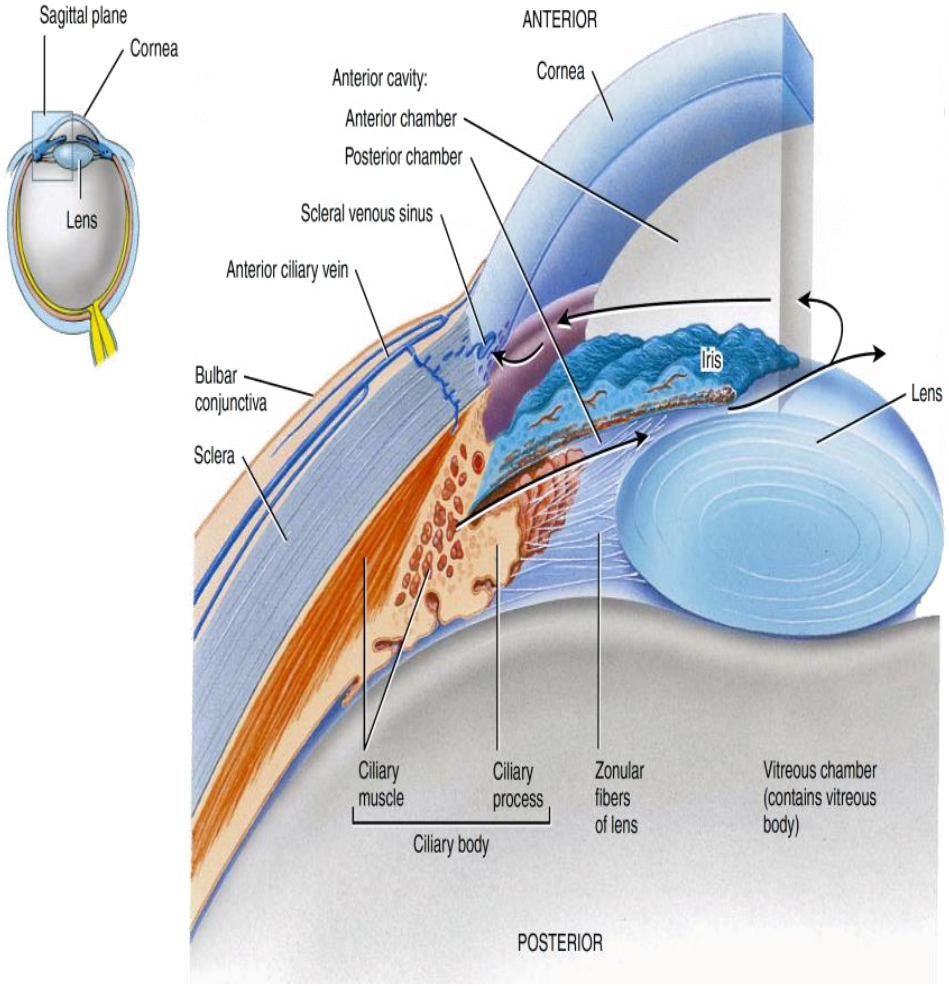
Refractive media of the eye

1. The Cornea

- Its diopteric power is 40-45 diopter at its anterior surface.
- About two thirds of the 59 diopters of refractive power of the eye is provided by the anterior surface of the cornea

-N.B/ The internal index of air is 1

- ✓ the cornea, 1.38
- ✓the aqueous humor, 1.33
- ✓ the crystalline lens 1.40
- ✓the vitreous humor 1.34.



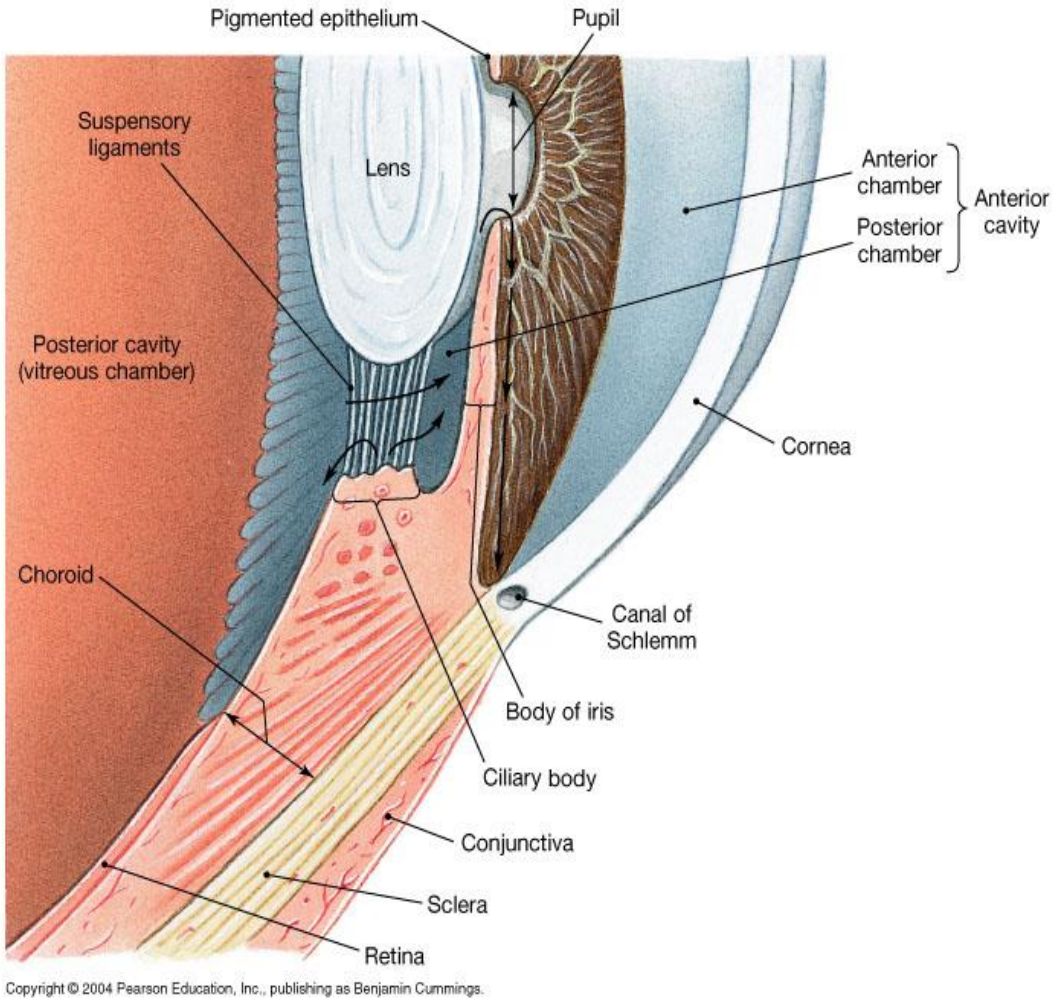
2. Aqueous humour

- Fluid produced by ciliary body ---to post chamber-----to pupil---to ant chamber----to canal of schlemm at angle of ant chamber---to veins

- Function:

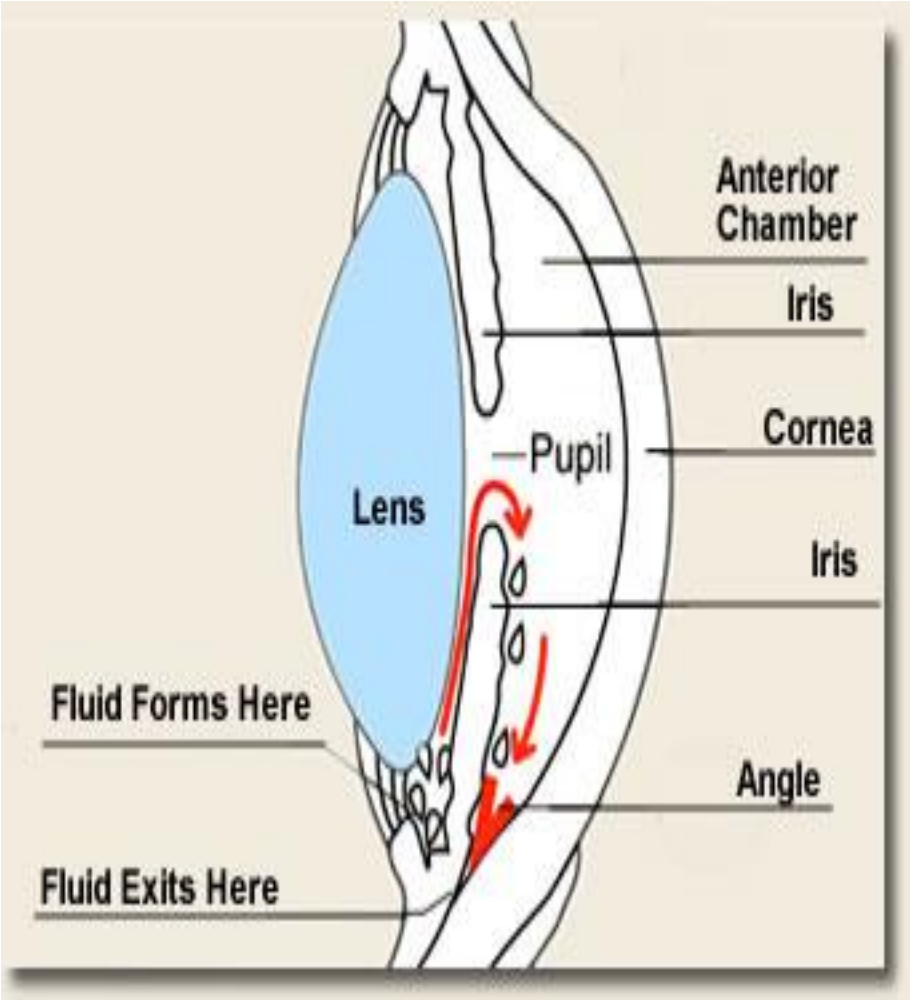
✓nourishing a vascular structures (cornea ,iris)

✓causes intraocular pressure 10-20mm Hg



Glaucoma

- Build up of Aqueous Humor Volume
- Increases pressure in eye
- Damages nerve
- Meds/surgery



Normal Vision

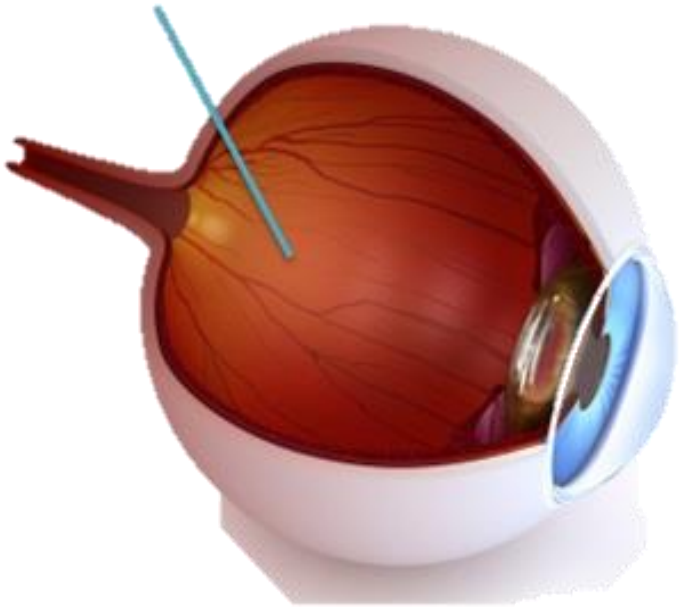
Glaucoma

Glaucoma is an eye condition that develops when too much fluid pressure builds up inside of the eye. The increased internal pressure can damage the optic nerve, which transmits images to the brain. Without treatment, glaucoma can cause blindness within a few years. Glaucoma is most often inherited, meaning it is passed from parents to children. Less common causes of glaucoma include a blunt or chemical injury to the eye, severe eye infection, blockage of blood vessels in the eye and inflammatory conditions of the eye. Glaucoma usually occurs in both eyes, but it may involve each eye to a different extent.

3. THE VITREOUS HUMOUR

- is the transparent, colorless, gelatinous mass
- It fills the vitreous chamber between the lens of the eye and the retina
- The vitreous humour is clear and allows light to pass through
- For nourishing retina & keep spheroid shape of the eye)
- Both water and dissolved substances can diffuse slowly in the vitreous humors

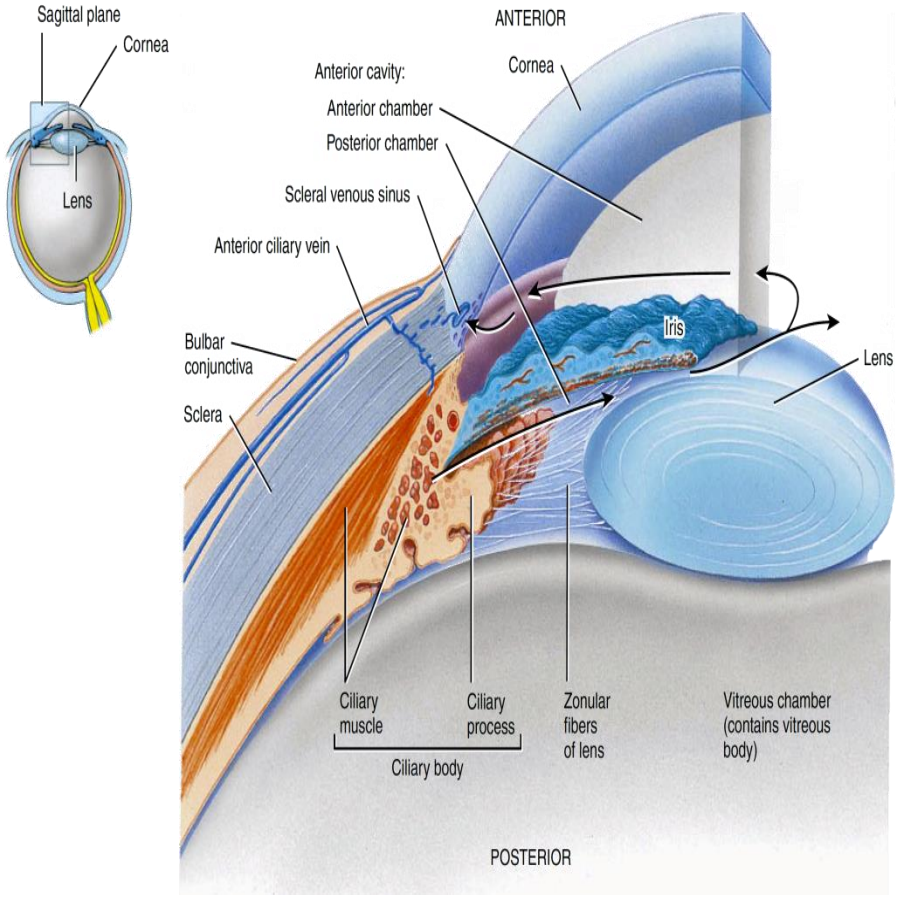
VITREOUS HUMOUR REMAINS FROM BIRTH



4. The Lens

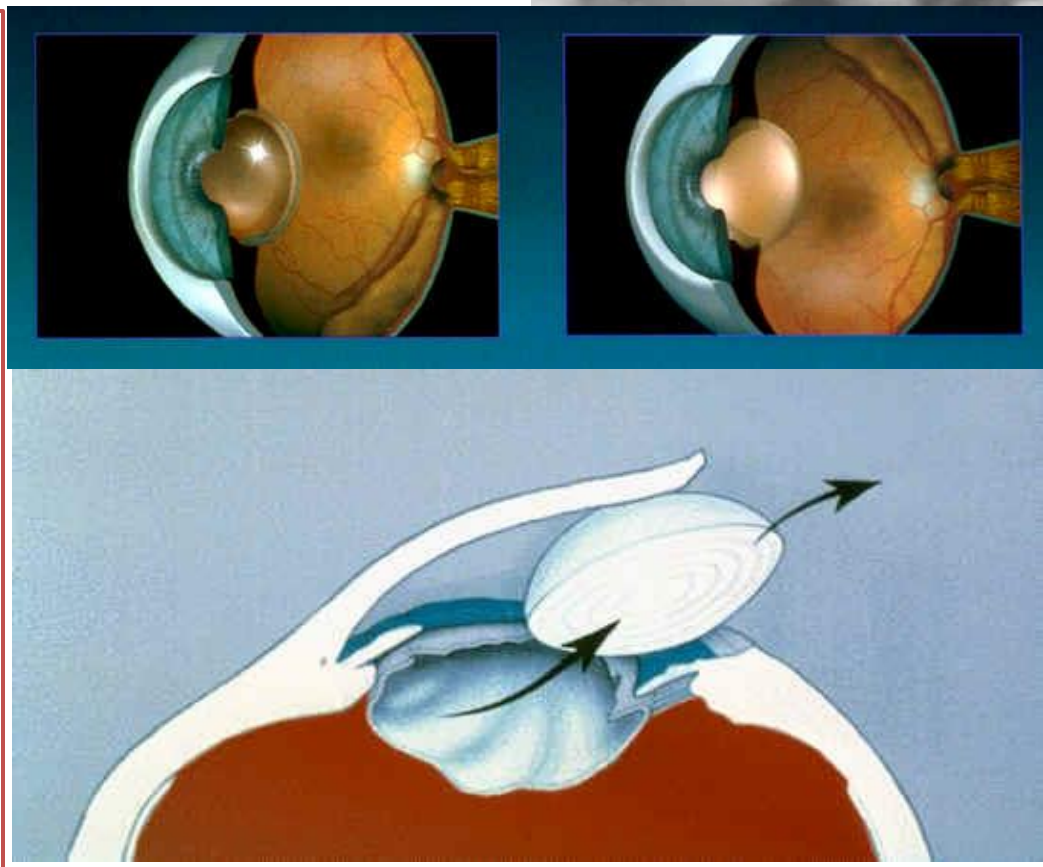
- Has diopteric power 15-20 D (1/3 refractive power of eye) , more important than cornea.

- why?
- Importance of the internal lens is that, in response to nervous signals from the brain, its curvature can be increased markedly to provide "accommodation"



Cataracts

- Lens clouds up
- Must be removed
- Typical to replace lens with implant
- Can get clouding repeated
- Laser removal

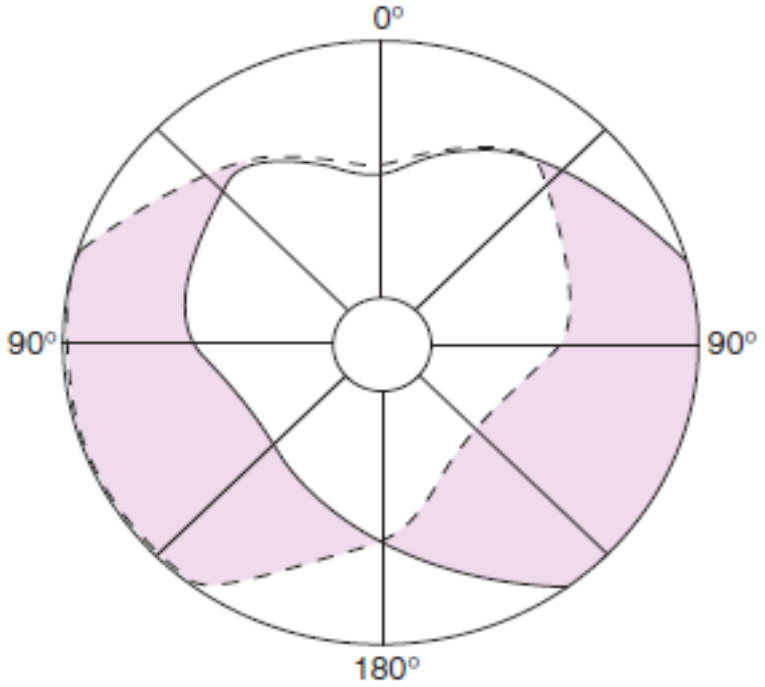


BINOCULAR VISION

▪are the areas in the centre of visual field of the two eyes in which any object in this area will be seen by both eyes.

BINOCULAR VISION for:

- 1- Large visual field
- 2- cancel the effect of blind spot
- 3- stereoscopic vision
- 4- one eye lesion does not affect vision



Monocular and binocular visual fields. -The dashed line encloses the visual field of the left eye;
-the solid line, that of the right eye. -The common area (heart-shaped in the center) is viewed with binocular vision.
-- The colored areas are viewed with monocular vision.

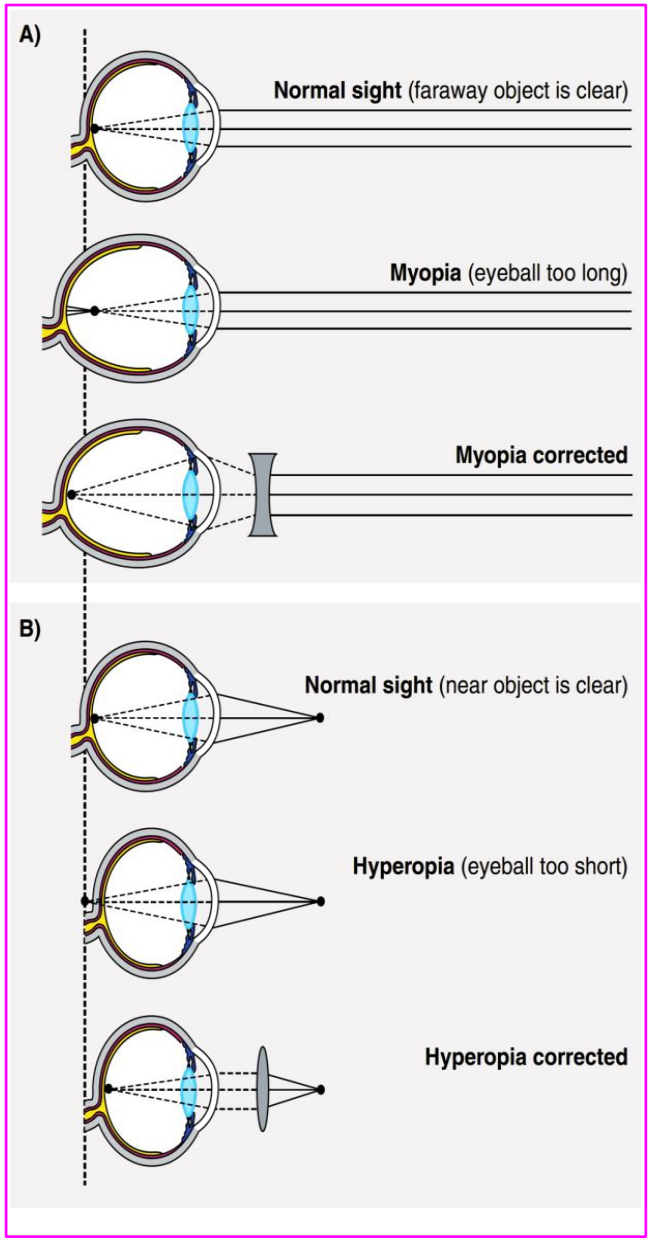
Errors of refraction

1. Hypermetropia (long sight)
2. Myopia (Short sight)
3. Astigmatism

Errors Of Refraction

1-Hypermetropia (hyperopia = far-sightedness)

- Short eyeball, focus behind retina,
- An affected individual has to use accommodation even for distant objects.
- Headache & hypertrophy of ciliary muscle
- correction by biconvex lens.



Errors Of Refraction

2-Myopia(nearsightedness):

- Genetic, large eye ball, long anteroposterior diameter, cause image to focus in front of retina

- Correction by biconcave lens to diverge rays before strike lens)

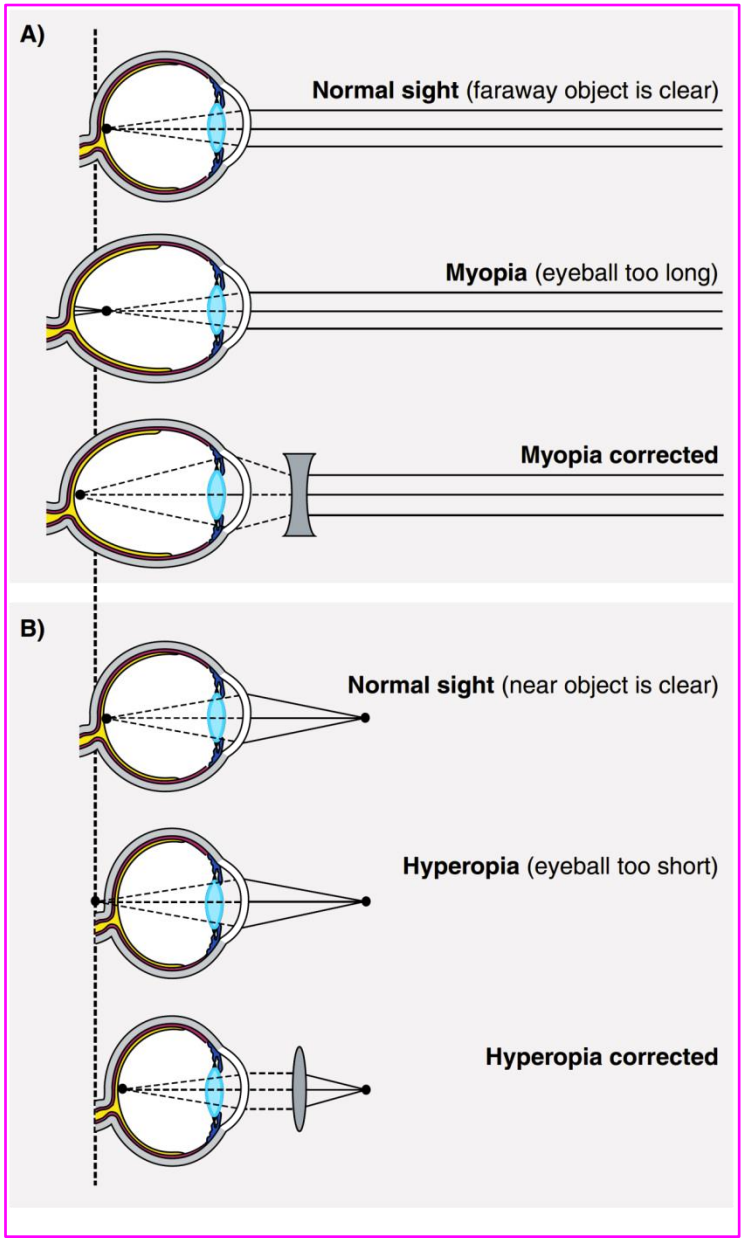
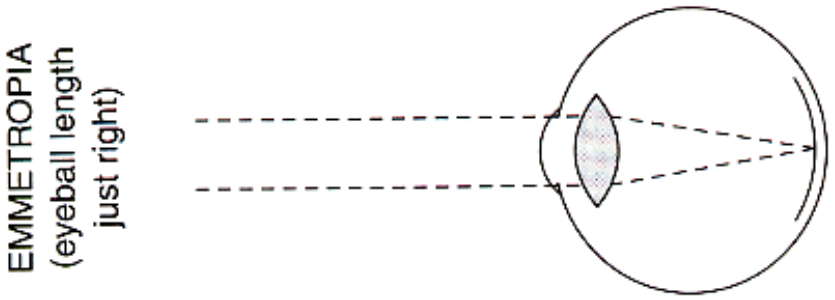


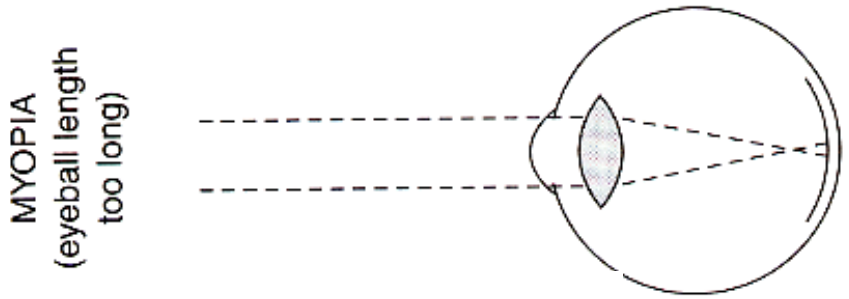
Image Focusing

Emmetropia
(normal vision)



Fully relaxed unaccommodated lens

Myopia
(Short sight)



Hyperopia
(long sight)

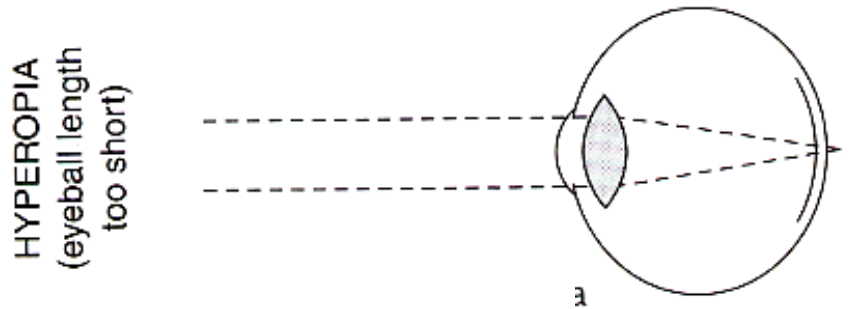
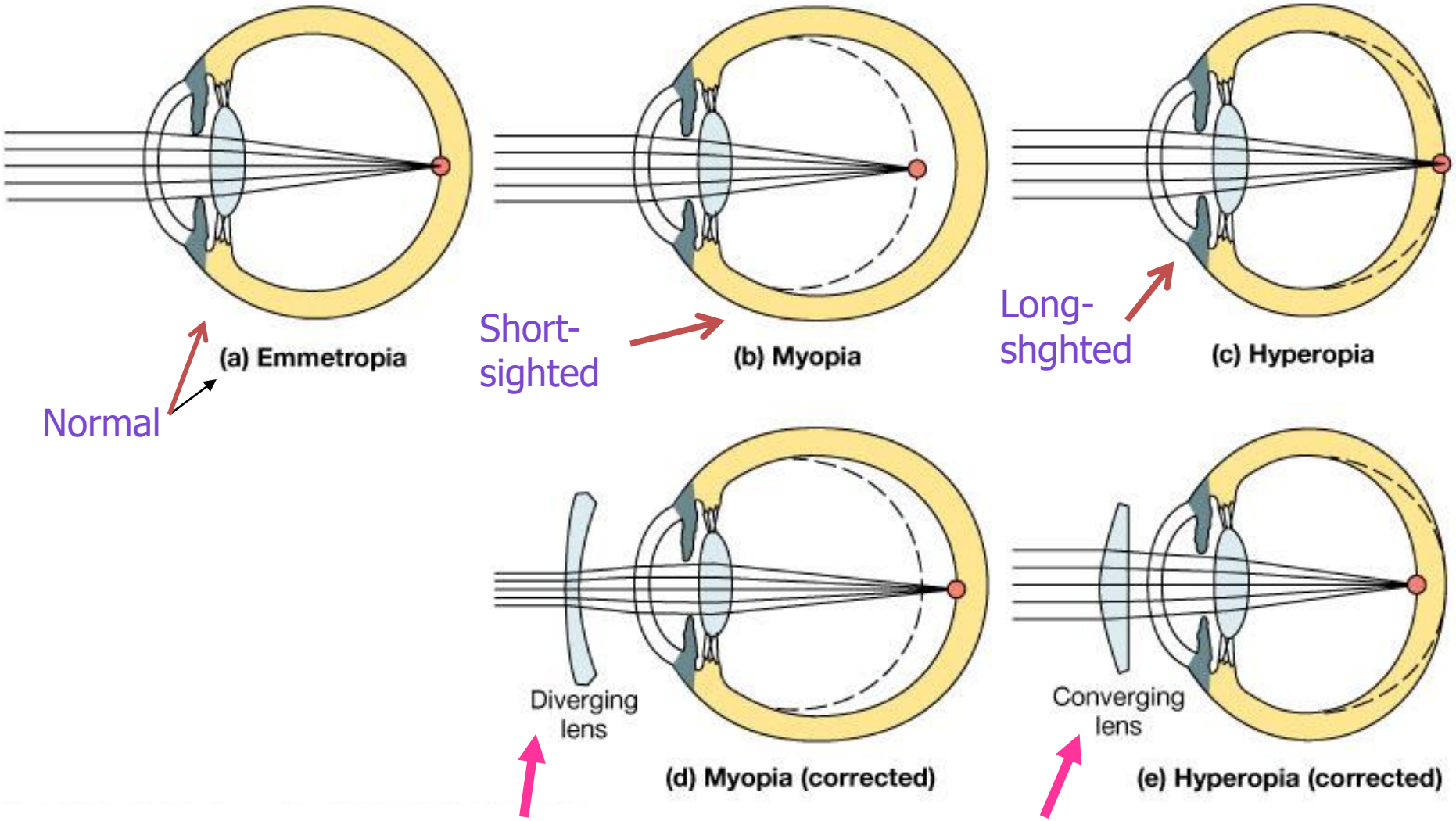


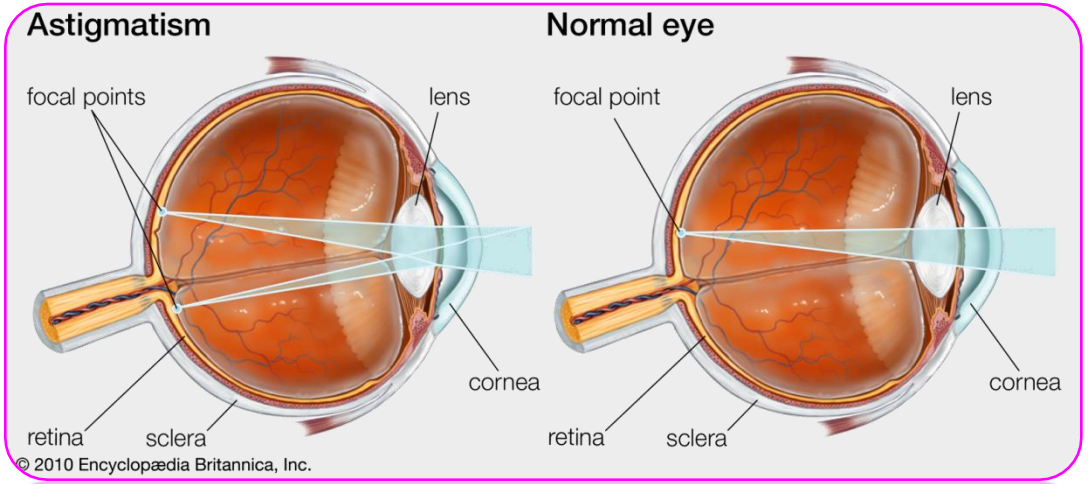
Figure 17.11 Visual Abnormalities



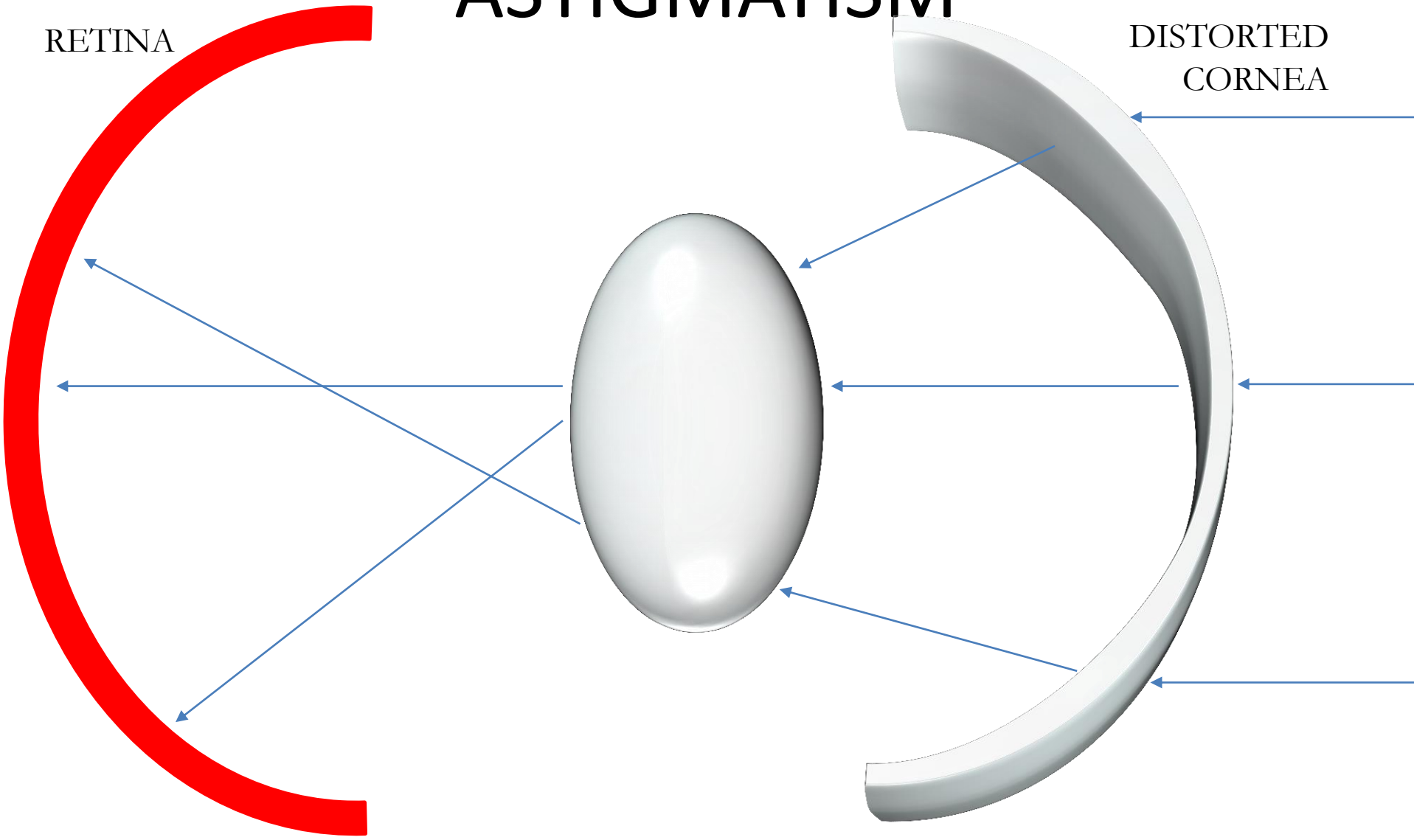
Astigmatism

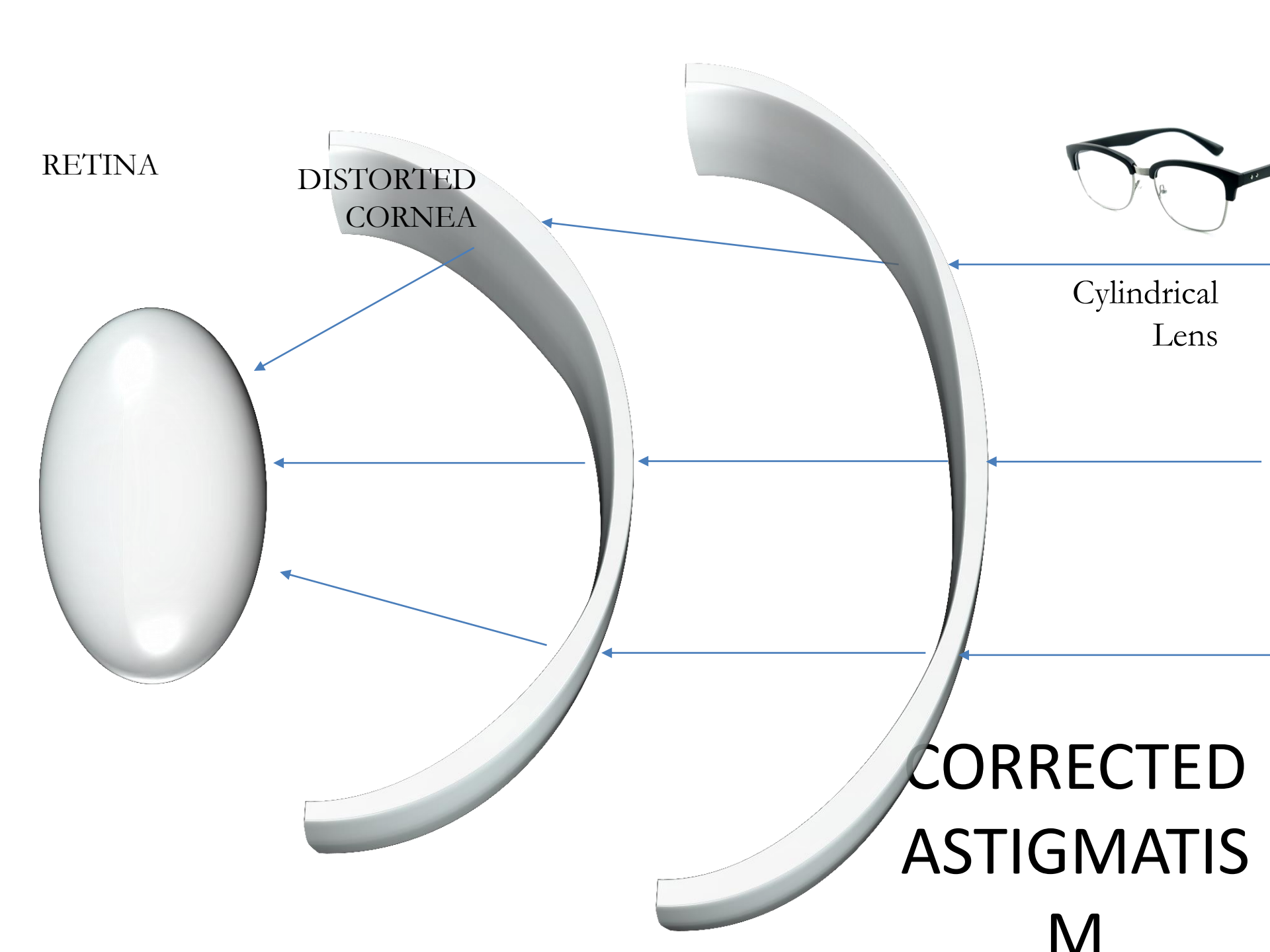
3-Astigmatism :

- Uneven & ununiformed corneal curvature, very rare ununiformed lens curvature
- Rays refracted to diff focus---------blurred vision
- Correction by cylindrical lens

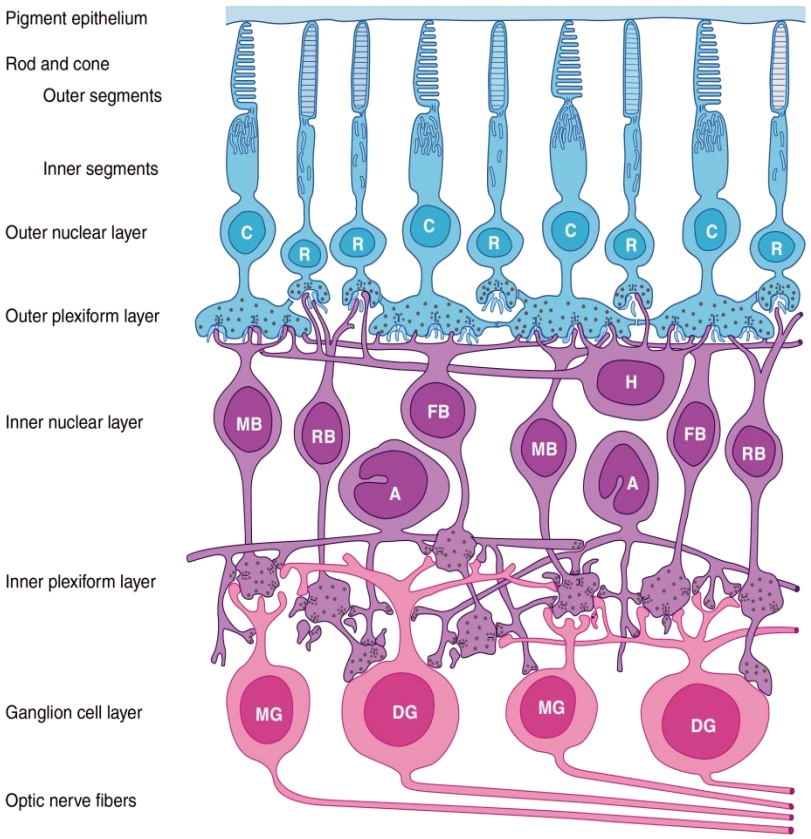


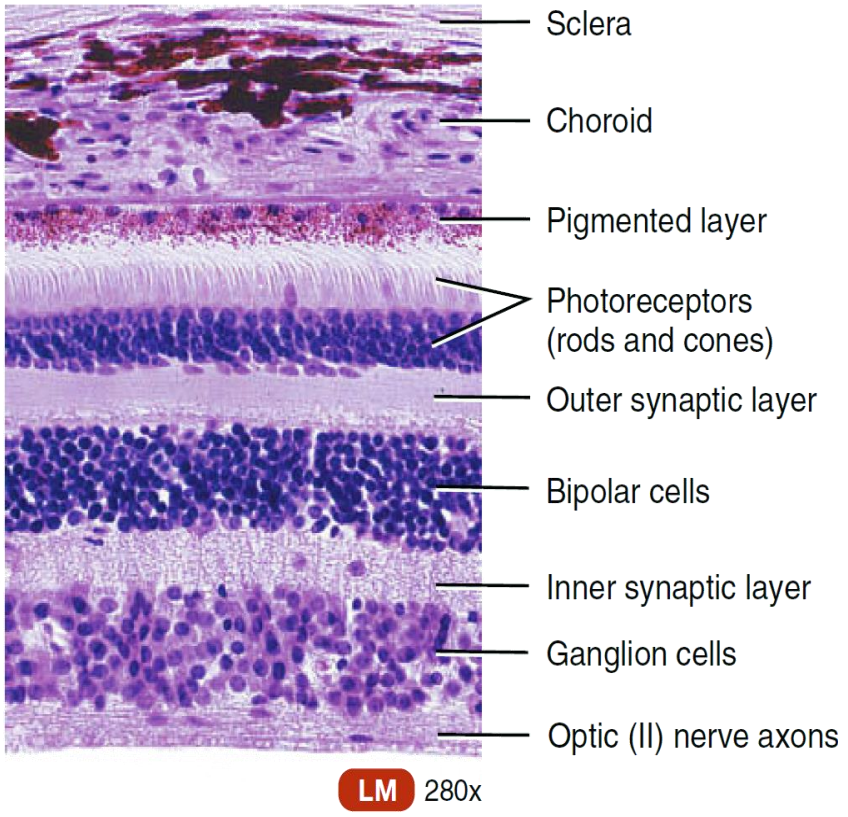
ASTIGMATISM



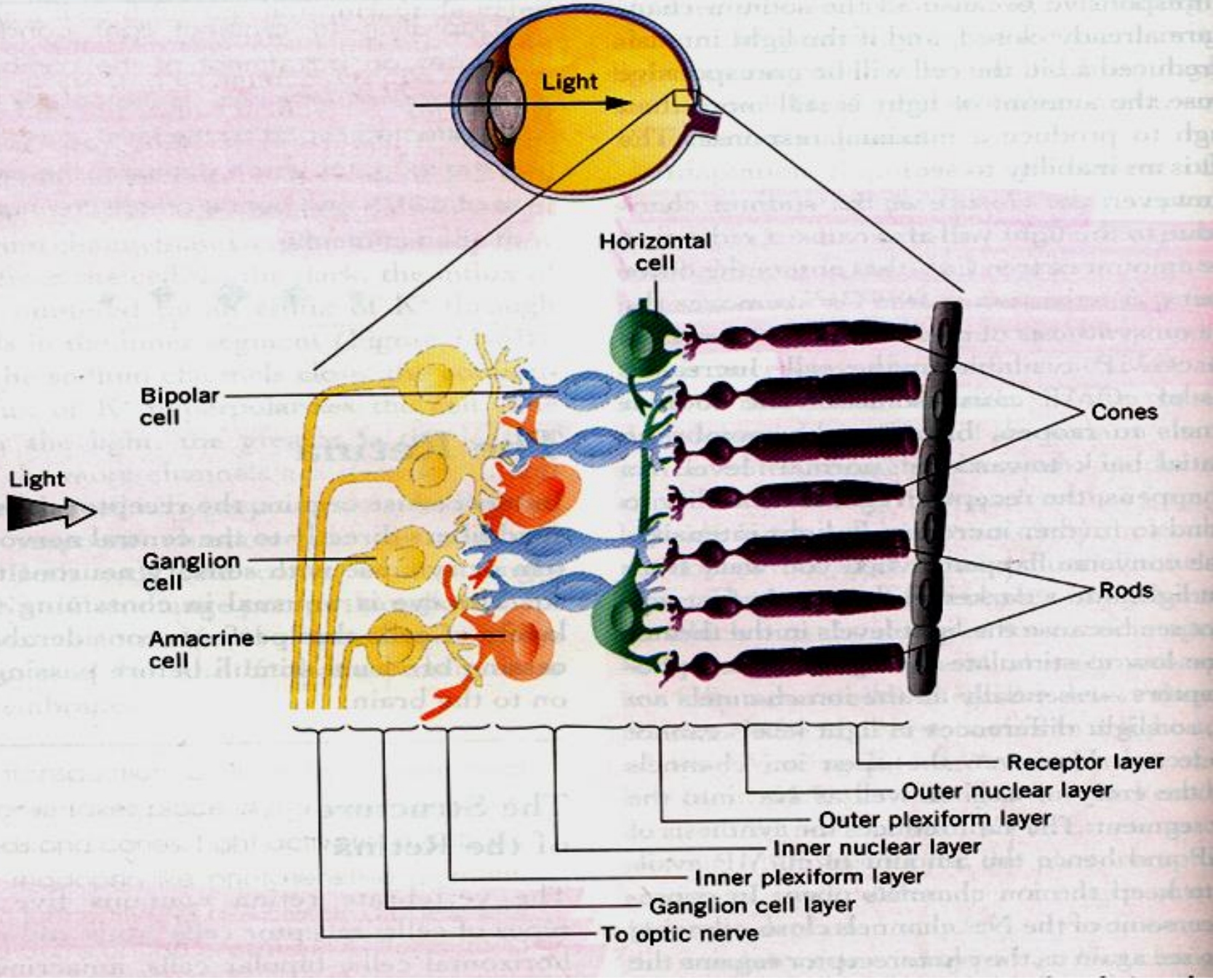

RETINA
DISTORTED CORNEA
Cylindrical Lens
CORRECTED ASTIGMATISM

Retinal Layers





(c) Histology of a portion of the retina


Light
Horizontal cell
Bipolar cell
Light
Ganglion cell
Amacrine cell
Cones
Rods
Receptor layer
Outer nuclear layer
Outer plexiform layer
Inner nuclear layer
Inner plexiform layer
Ganglion cell layer
To optic nerve

Retina: Neural Circuitry

Light hits photoreceptors, sends signal to the bipolar cells

Bipolar cells

Ganglion