



Vision

1-Physiology of the eye & Refraction

By

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OBJECTIVES:-

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

- Describe different components of the eye and function of each -understand the eye protection media

- Describe the refractive media of the eye

- Know glaucoma and binocular vision

- Know layers of retina, blind spot, and fovea centralis

- explain the different light sensitivities of the fovea, peripheral retina and optic disk

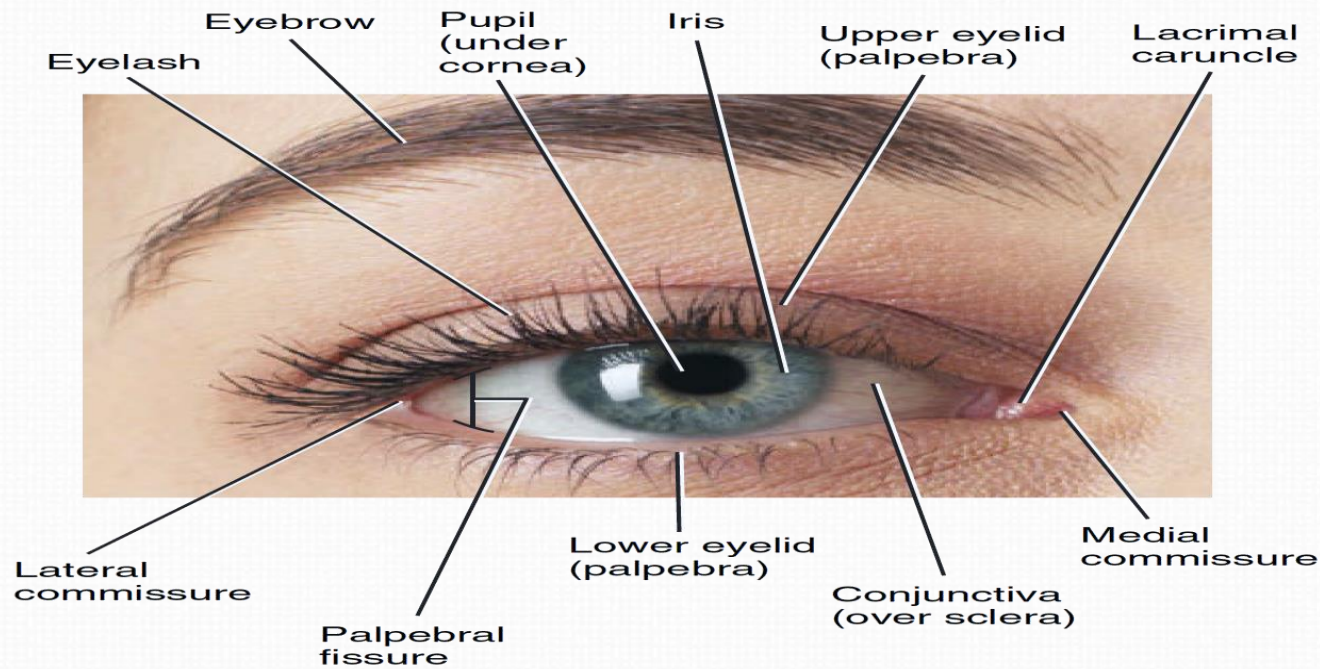
- Know principles of optics and errors of refraction

- Light pathway in the eye-

-Textbook/Guyton & Hall

Reference book/Ganong review of medical physiology

-



EYE HAS:-

1-Refracting Media

2- Coats (Sclera, Choroid and Retina)

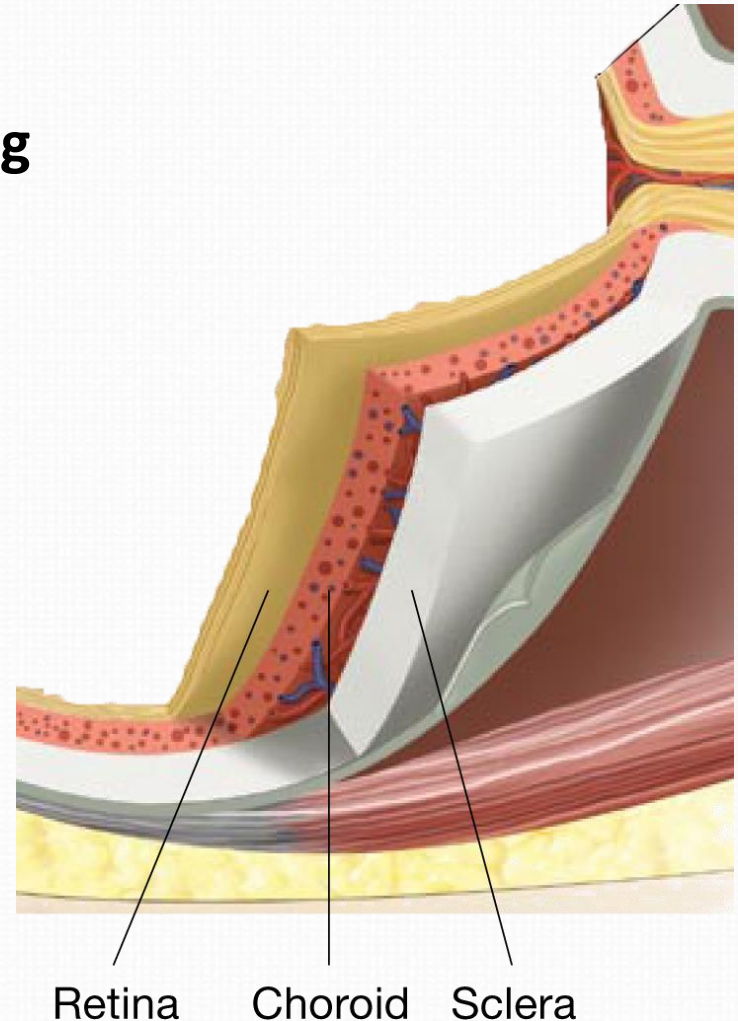


The eye is a fluid-filled sphere enclosed by three specialized tissue layers.

1-the sclera is a tough outer covering of connective tissue.

2-the middle layer is the choroid containing blood vessels.

3-the retina is the innermost layer which contains light sensitive cells



Anatomy of the eye:

1-Outer layer

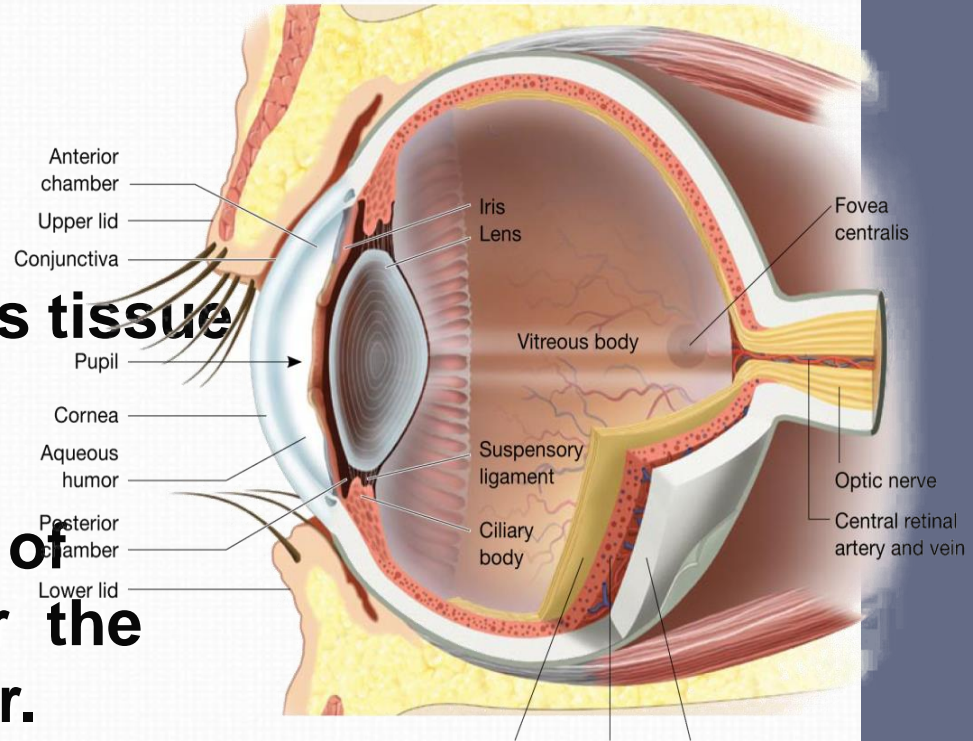
- Sclera (thick ,white fibrous tissue for protection- spherical appearance)

2- cornea (modified ant 1/6 of sclera) to allow light to enter the eyes, transparent , avascular.

Q.From where it gets its nutrition?

-A/ Tears& aqueous humor

- Refractive or dioptric power 40-45 D at its anterior surface.



Cornea





3- conjunctiva

- **Transparent membrane cover anterior surface of eye,reflected on inner surface of eye lids**
- **Covered with thin film of tears for protection,wetness, cleaning**

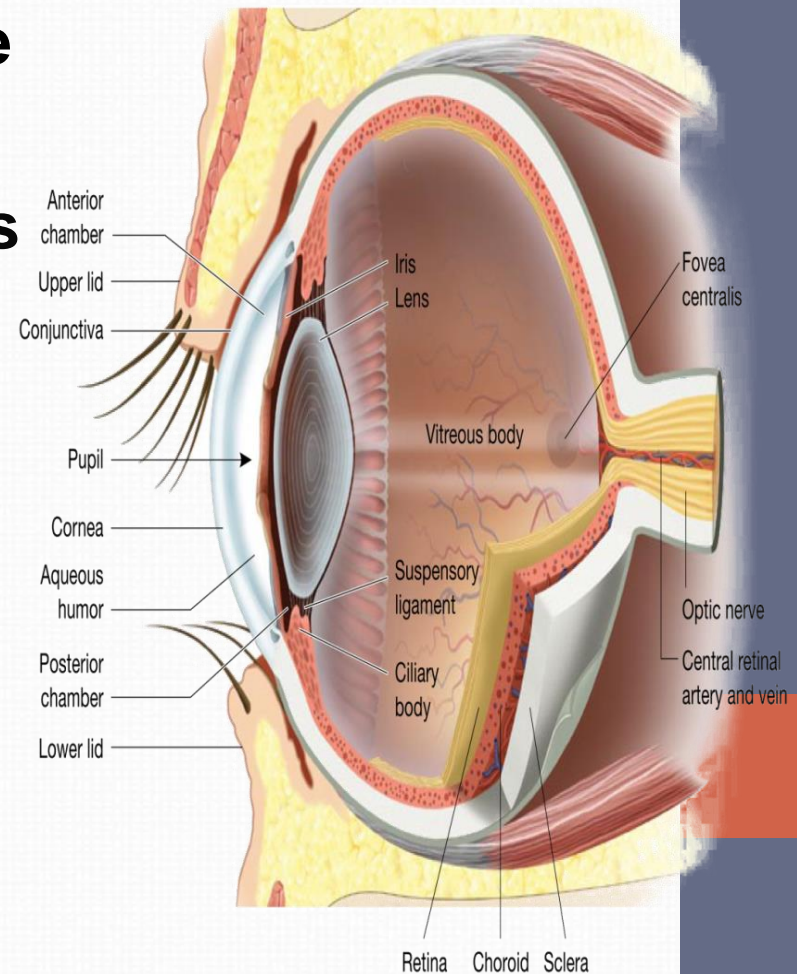
- Middle layer

- 1-Choroids

-inside sclera , highly vascular

-the capillaries in the choroid are the primary source of nourishment for retinal photoreceptors & oxygen to rods and cones

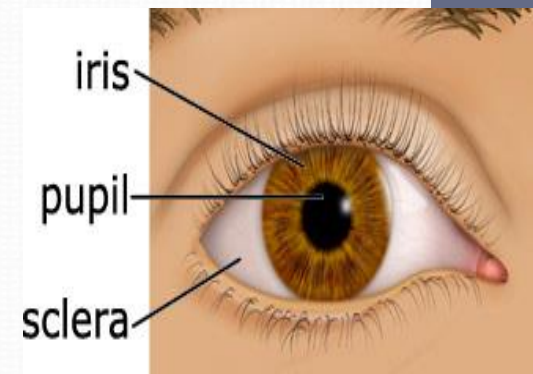
- post 2/3 of choroid has retina (innermost layer lining) -



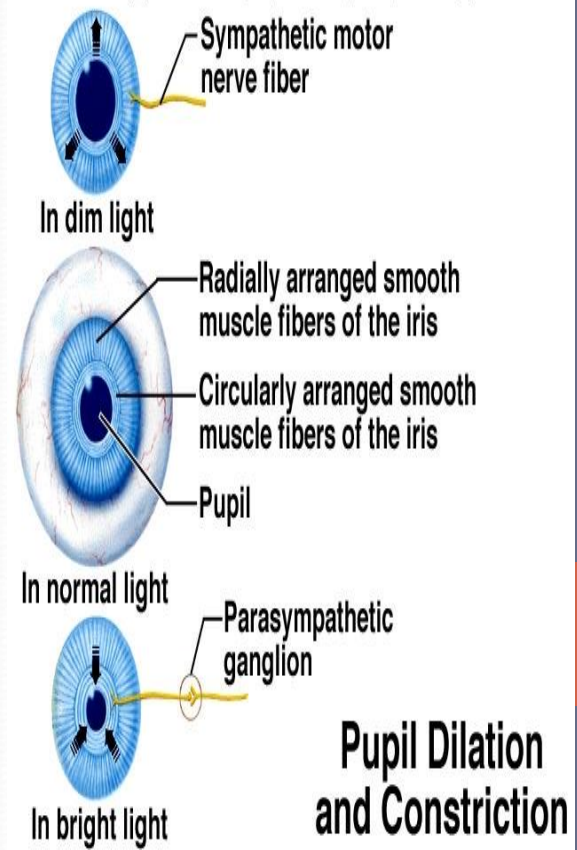
2-Iris

Colored part (has radial muscle dilates the pupil as in dimlight (supplied by sympathetic) + circular muscles constrict the pupil (by parasympathetic), as in bright light

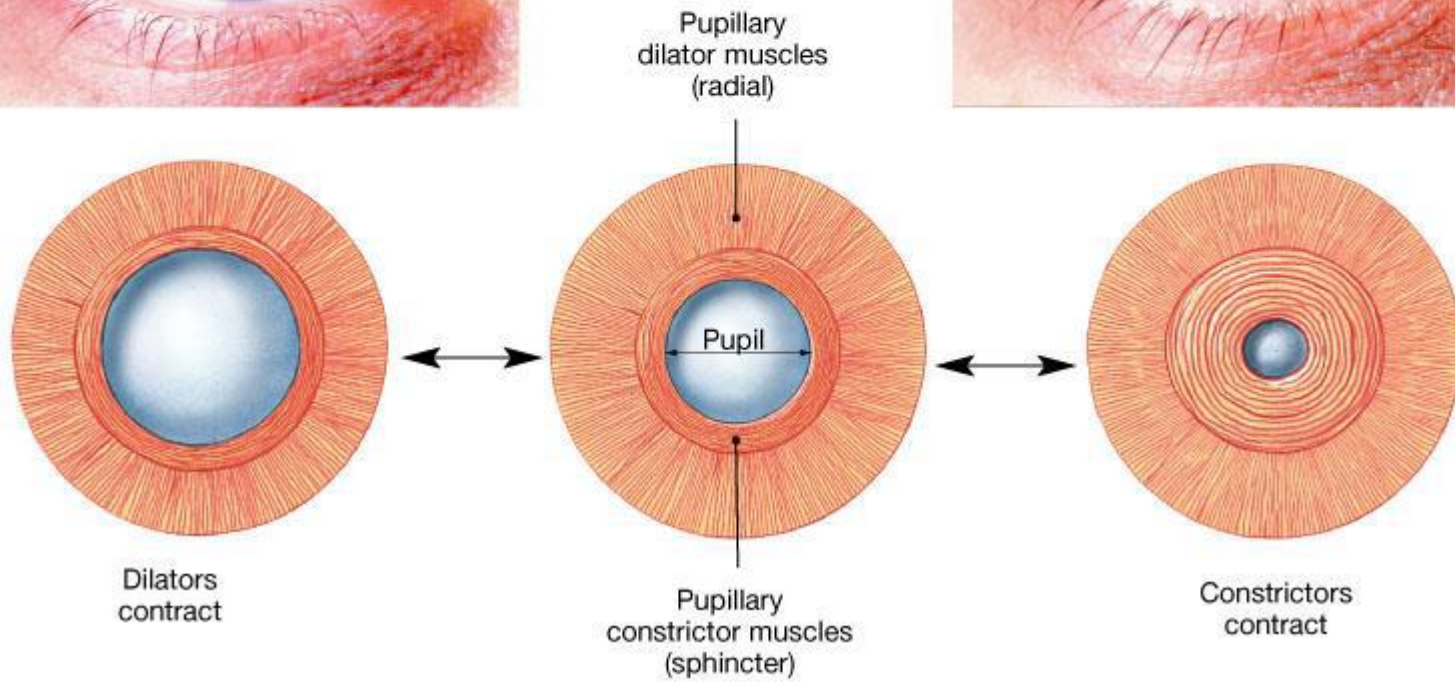
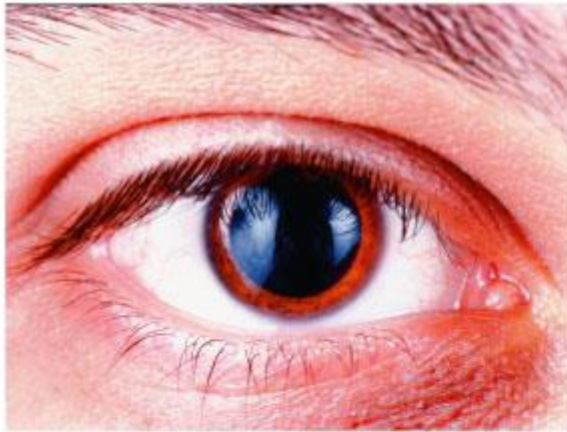
3-pupil /
behind center of cornea,
control & allow light to enter
the eye,appears black
because, as you look through
the lens, you see the heavily
pigmented back of the eye
(choroid and retina)



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The Pupillary Muscles: consists of Radial and Circular parts



-Ciliary muscles (body)

Thick ant part of choroid to which attached suspensory ligaments (zonule attached to lens)

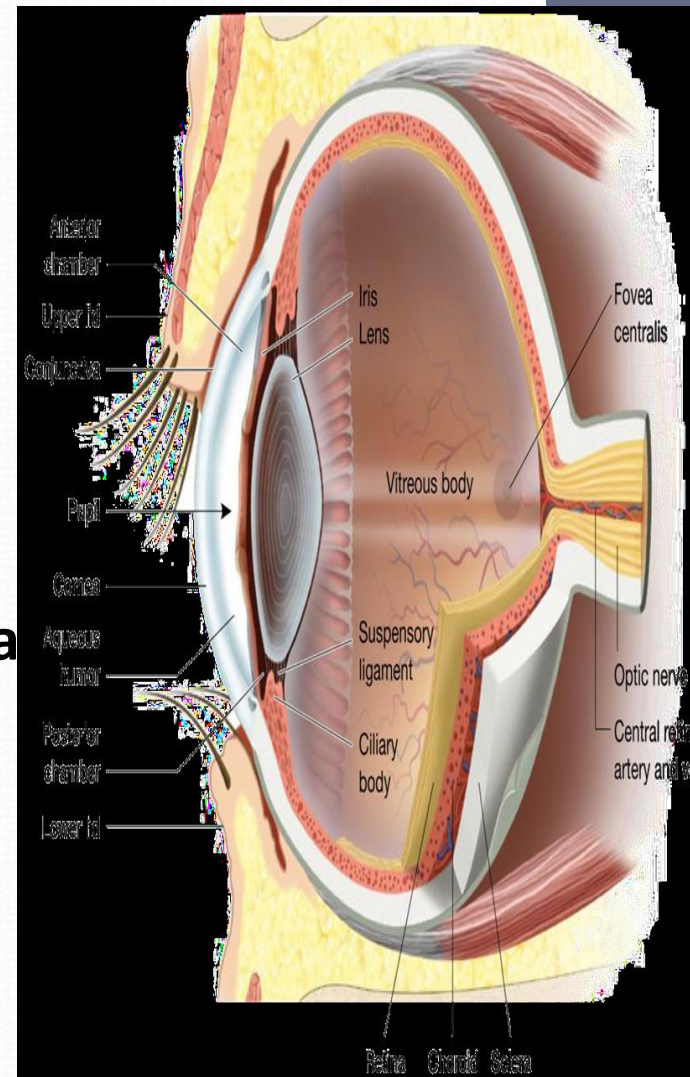
- lens

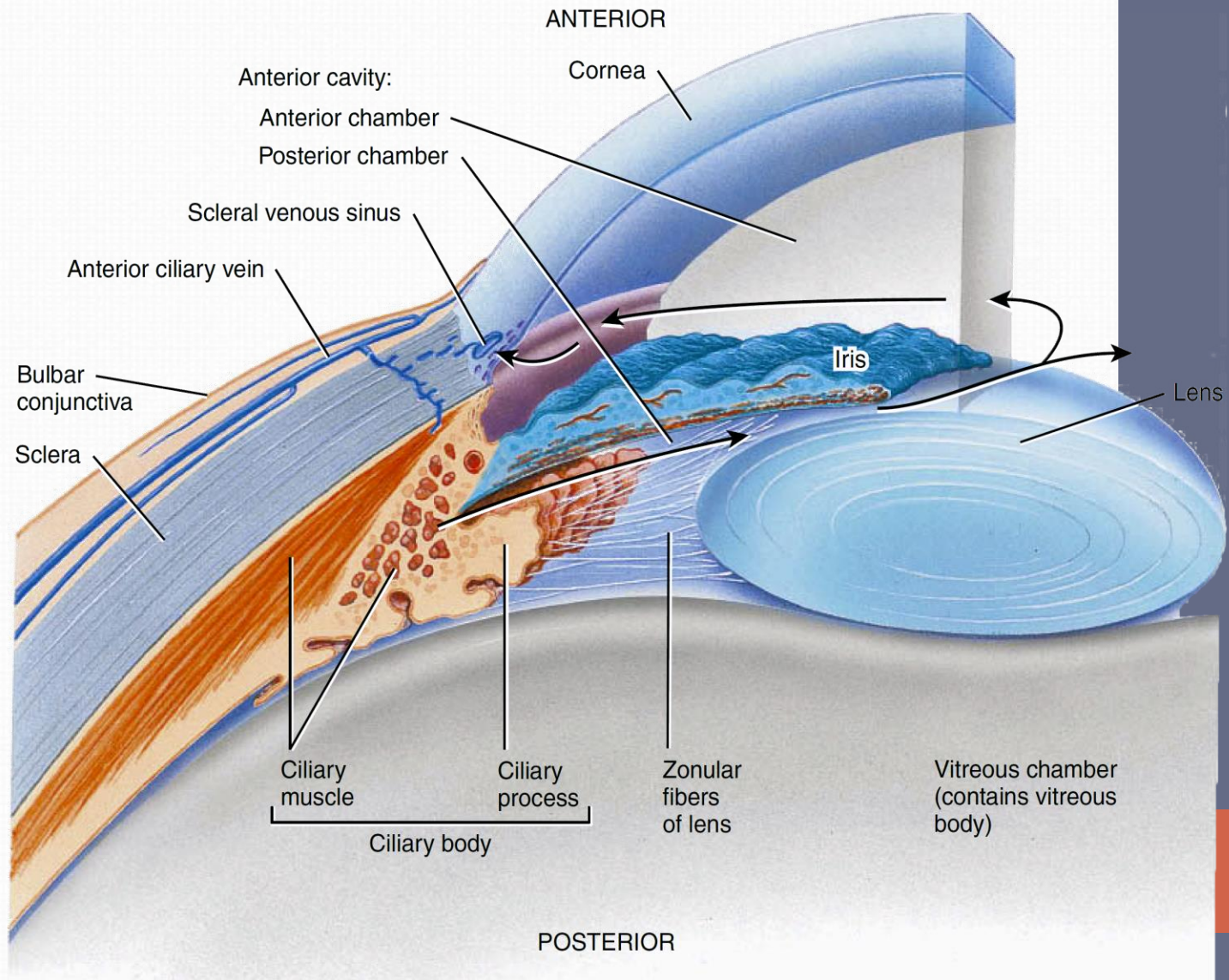
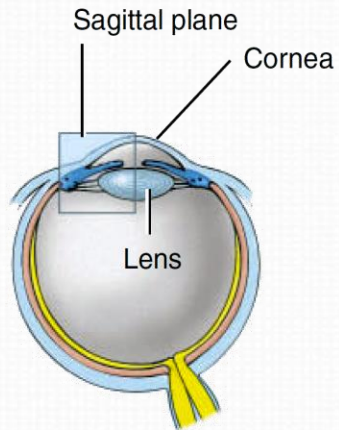
Transparent, biconvex, semisolid, dioptric power 15-20 D, held in place by zonule =lens ligament= suspensory ligament) attached to ant part of ciliary body

within the cells of the lens, proteins called crystallins are arranged like the layers of an onion,this makes up the refractive media of the lens

-the lens helps focus images on the retina to facilitate clear vision.

- Uvea = choroid + iris + ciliary muscles



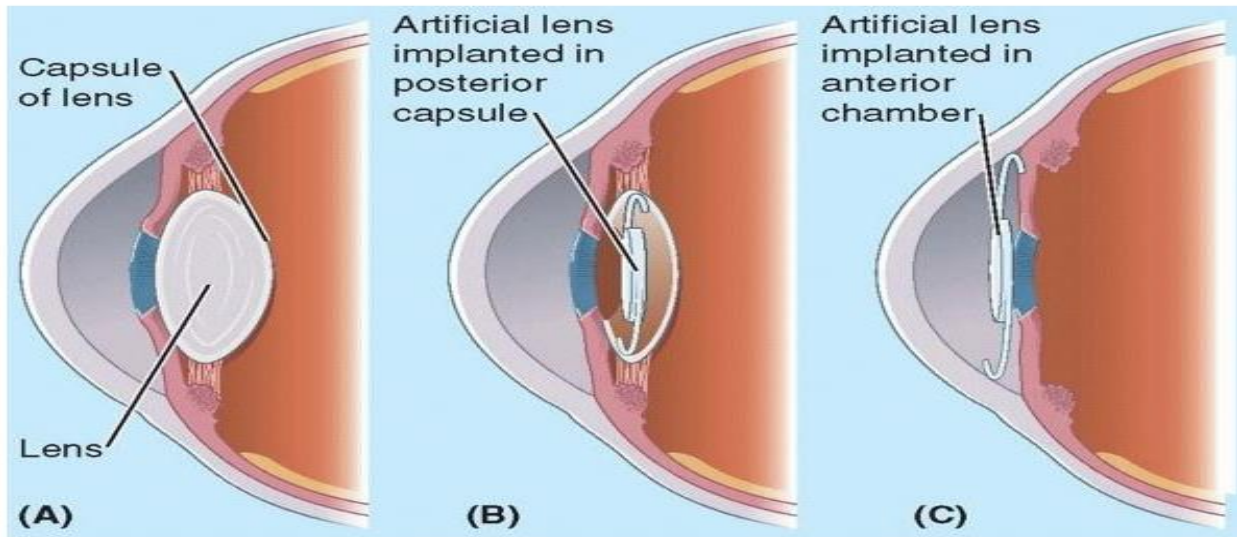


q.what is cataract?

Cataracts" occurs in older people. is a cloudy or opaque area or areas in the lens

- the proteins in some lens fibers coagulate to form opaque areas .

cataract impairs vision

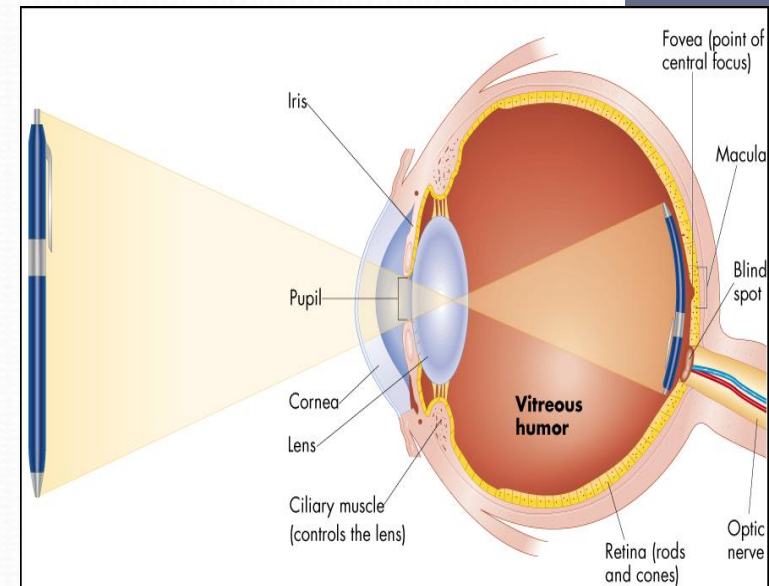


The Anterior & Posterior Cavities

- The Ciliary Body, suspensory 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)
- Anterior cavity divided by iris into 2 chambers by the iris.

Anterior chamber of the eye ✱
/Between iris & cornea.

-posterior chamber of the eye /
Between iris & ciliary muscles
- Iris between both



INNERMOST LAYER

RETINA

- Outer pigmented portion (part)
- Inner neural part , containing Photoreceptors called Rods and Cones .

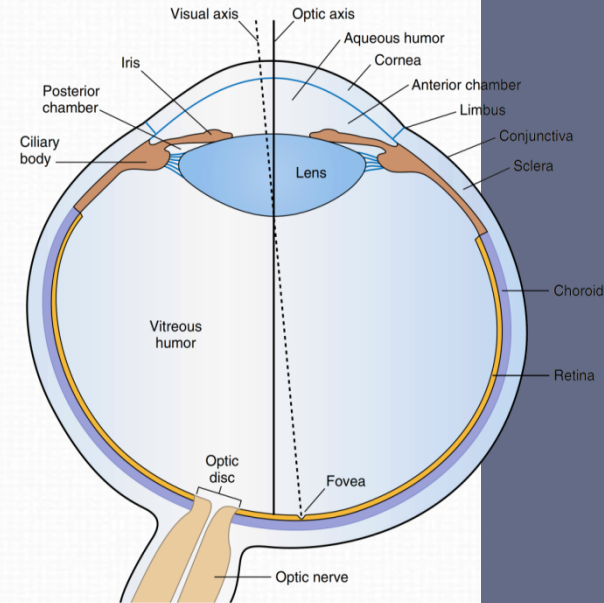
1-Photoreceptors (RODS + CONES)

2-OPTIC DISC (blind spot. Why?)

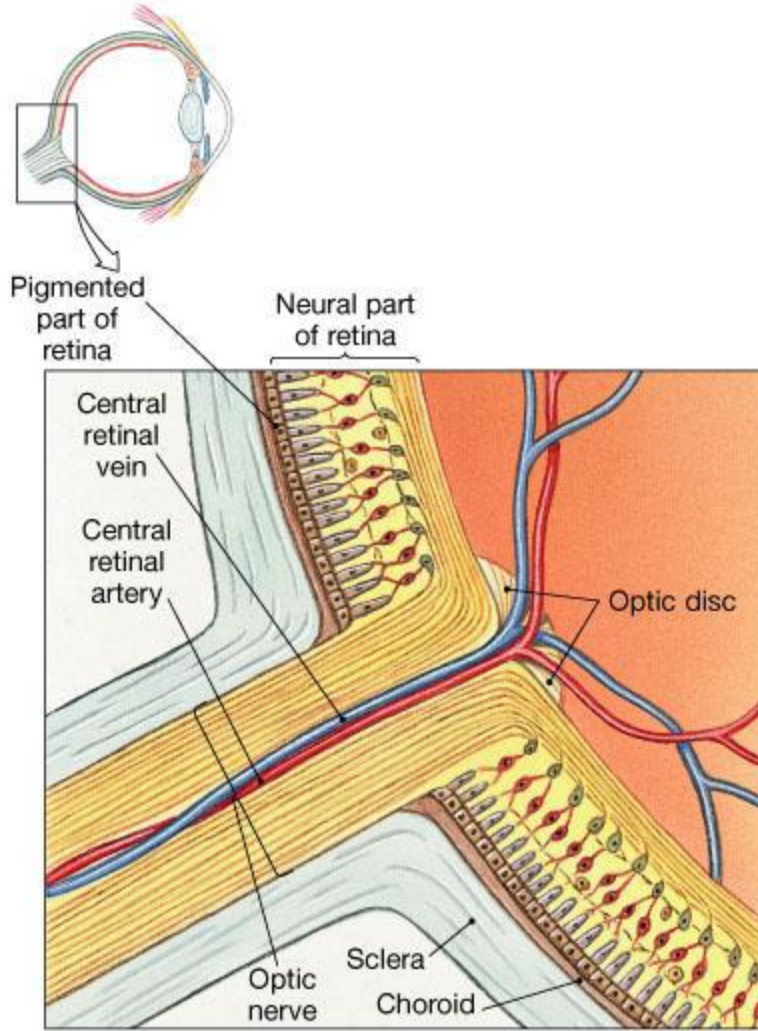
- 3mm medial & above post pole of eye
- optic nerve leave & retinal bld vessels enter
- no photoreceptors so it is blind spot)

3-FOVEA CENTRALIS :-

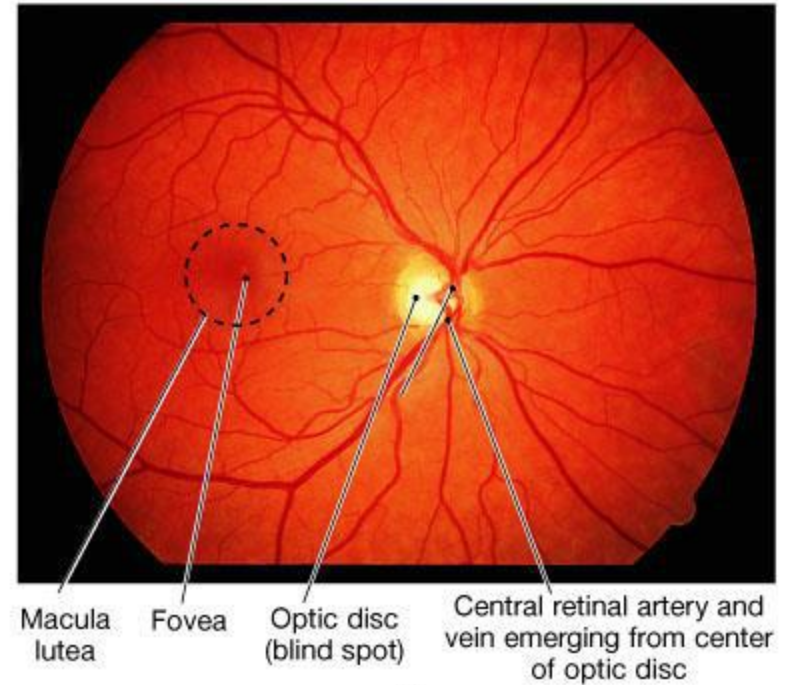
- Depression or spot inside macula lutea ,yellow pigmented at post pole of eye
 - - contains only cones
 - -high visual acuity
 - -for colors vision & details detection



Organization of the retina

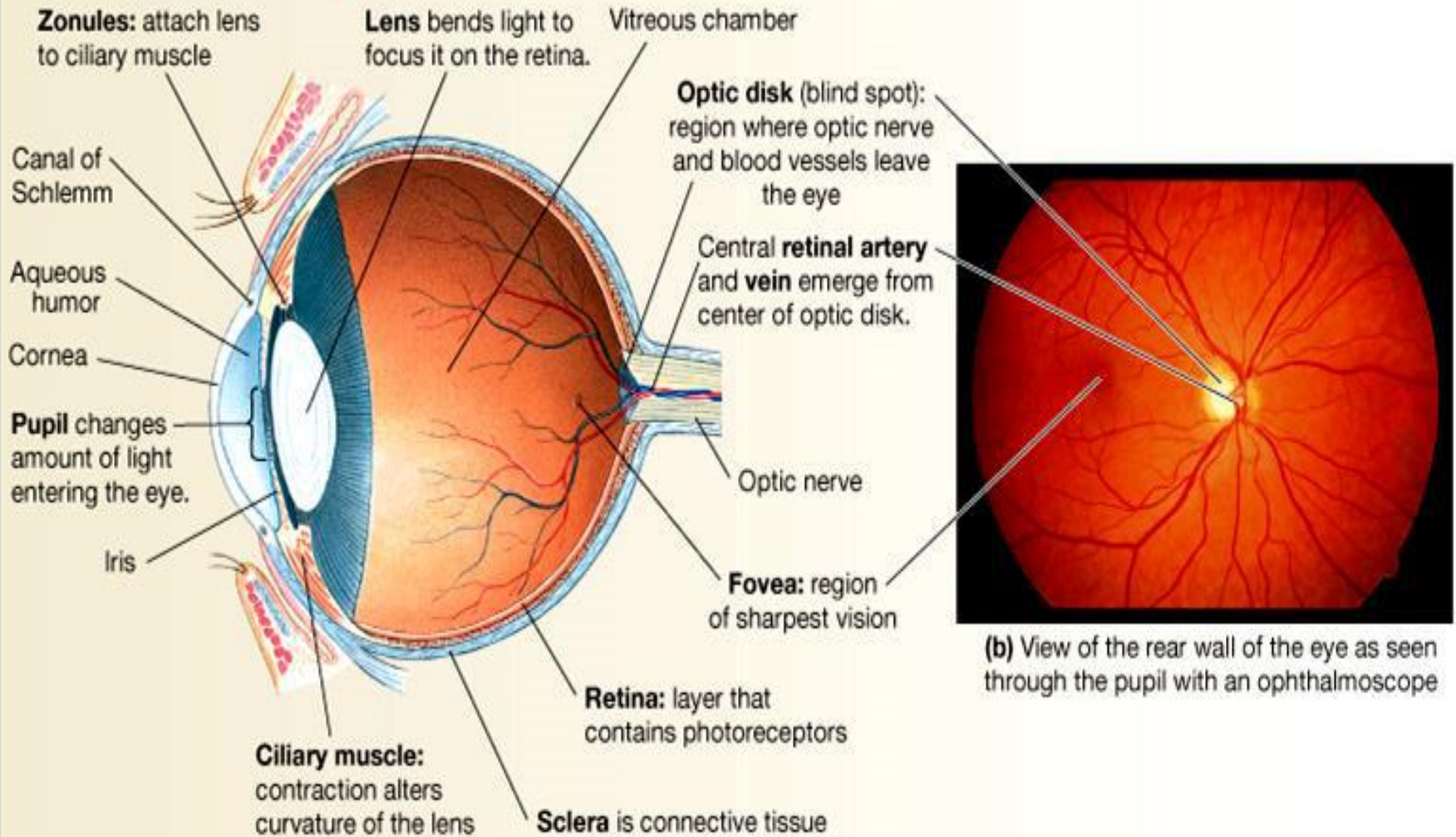


(b)



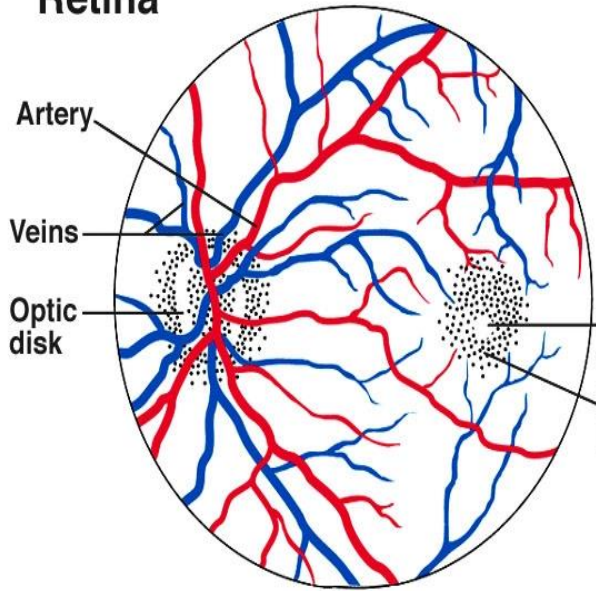
(c)

STRUCTURE OF THE EYE

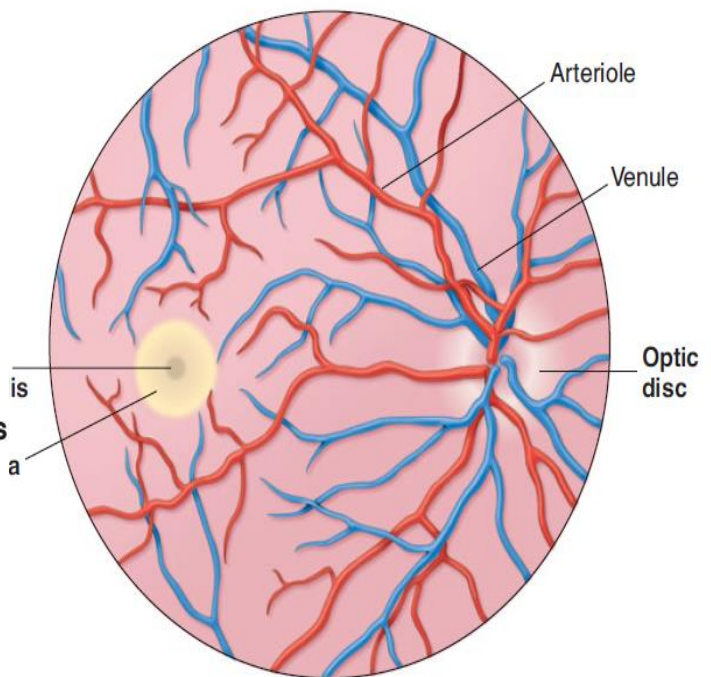


(a) Cross section of the eye

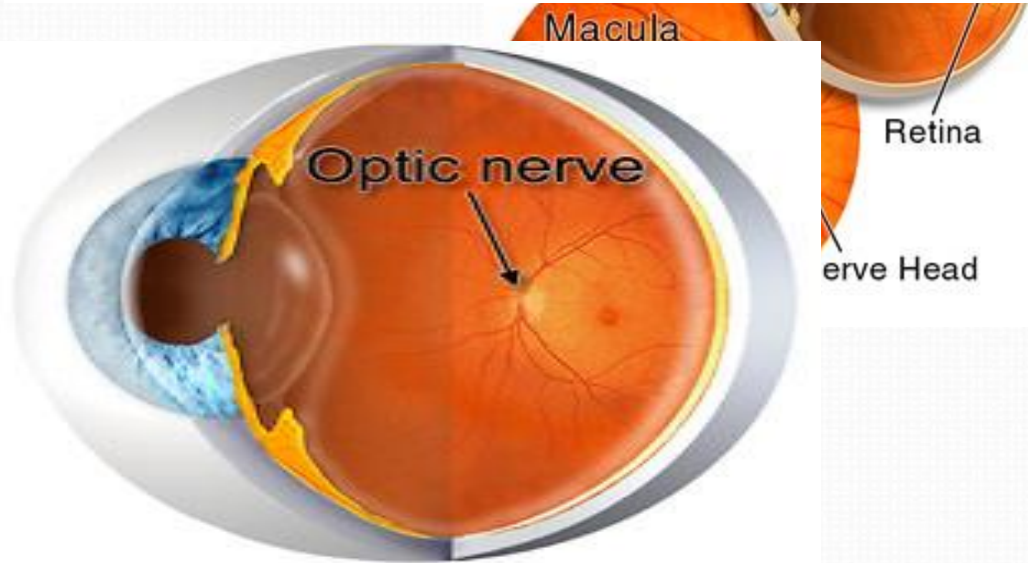
Retina



(a)



(b)



Optic nerve Head

External protection of the eye

- 1- Bony orbit
- 2- lids blinking keep cornea moist
- 3 -Conjunctiva
- 4-Tears from lacrimal gland has antibacterial, lubricating effect ,keep cornea moist & clear & provide nutrition to the cornea)

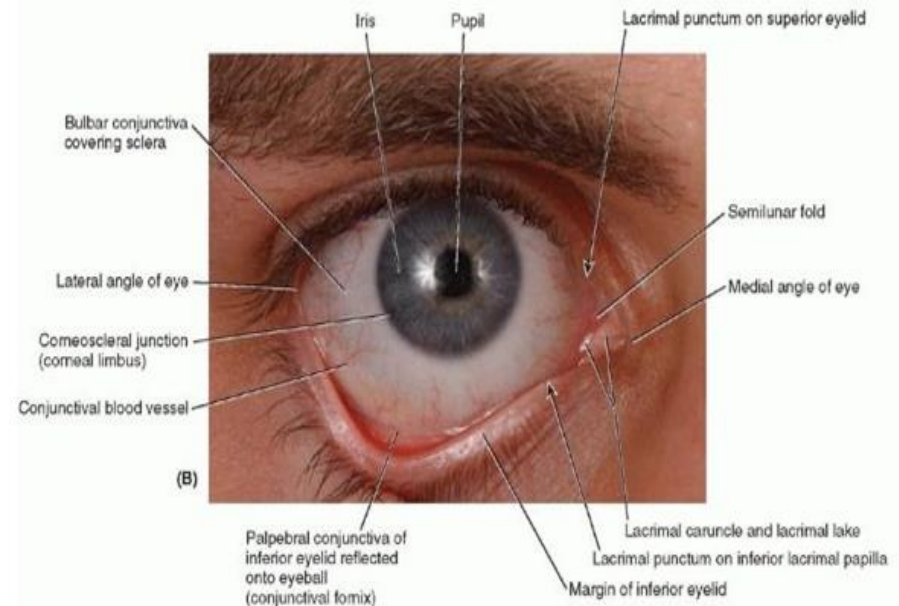


FIGURE 7.64. Surface anatomy of the eye (A) and lacrimal apparatus (B).

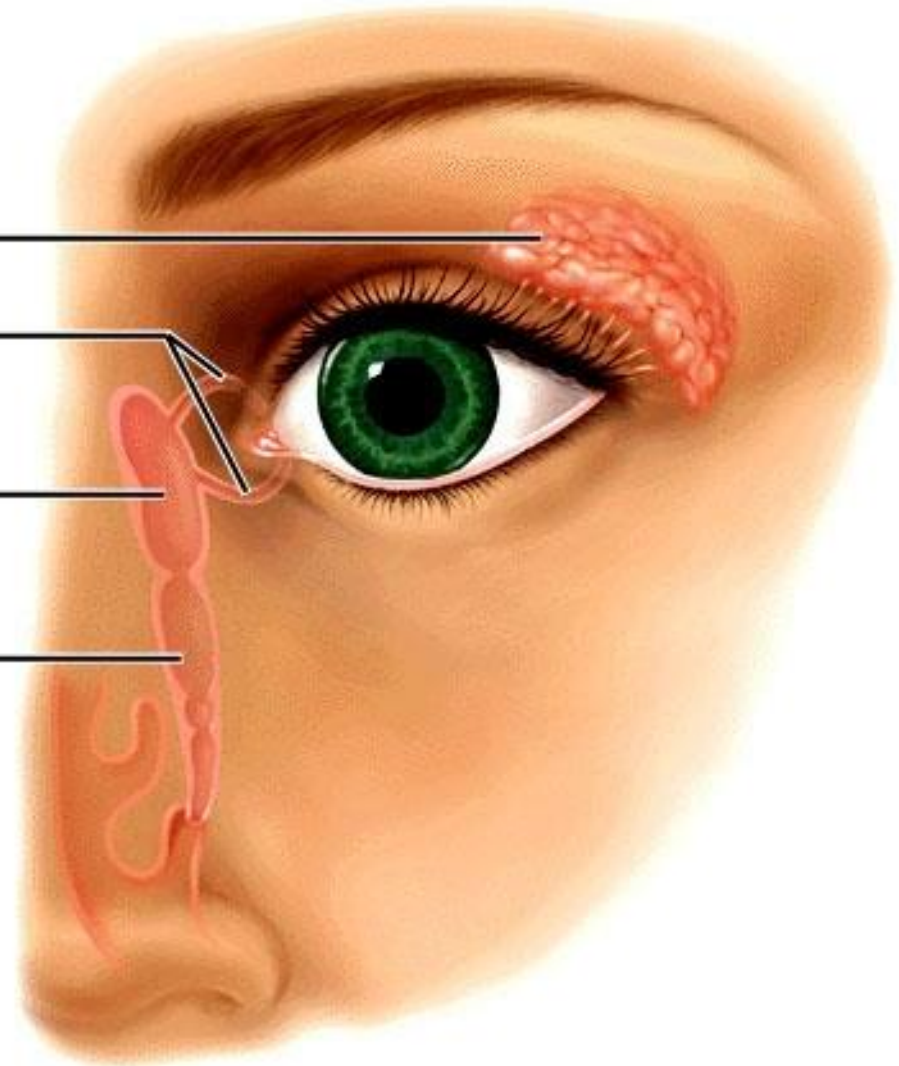
Lacrimal Apparatus

Lacrimal gland

Superior and inferior canaliculi

Lacrimal sac

Nasolacrimal duct



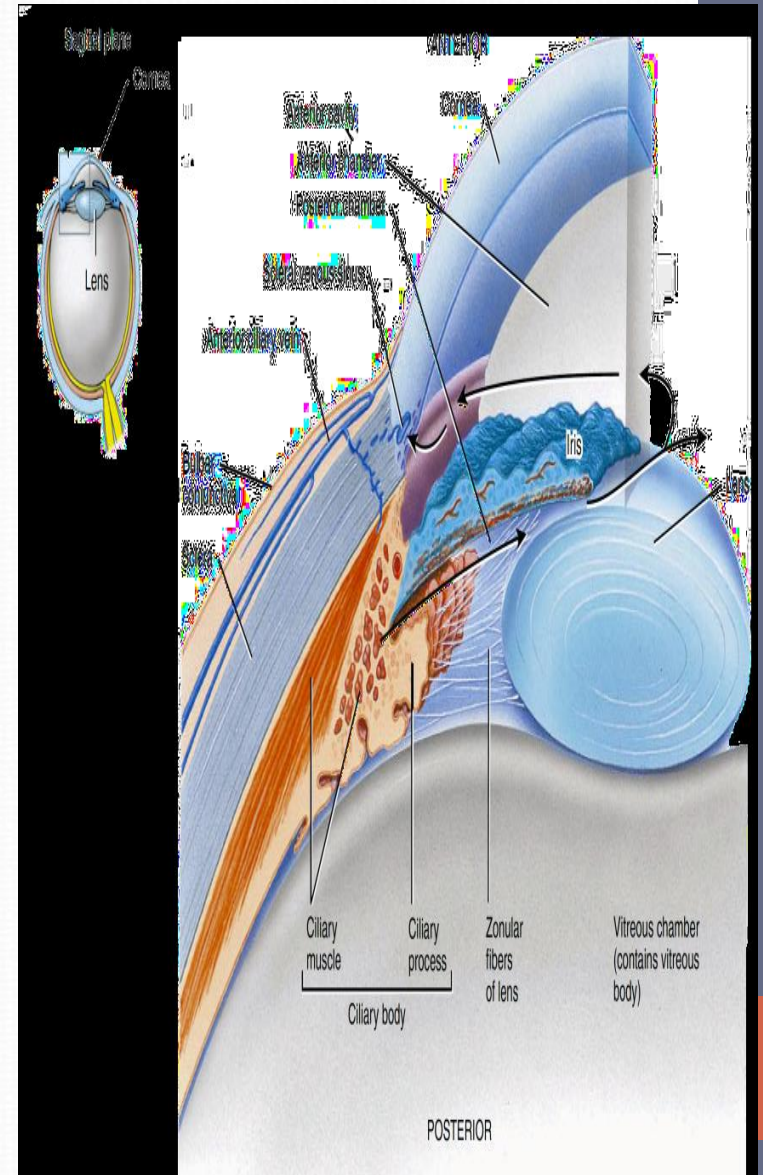
Refractive media of the eye:-

- 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 vision

Refractive media of the eye:-

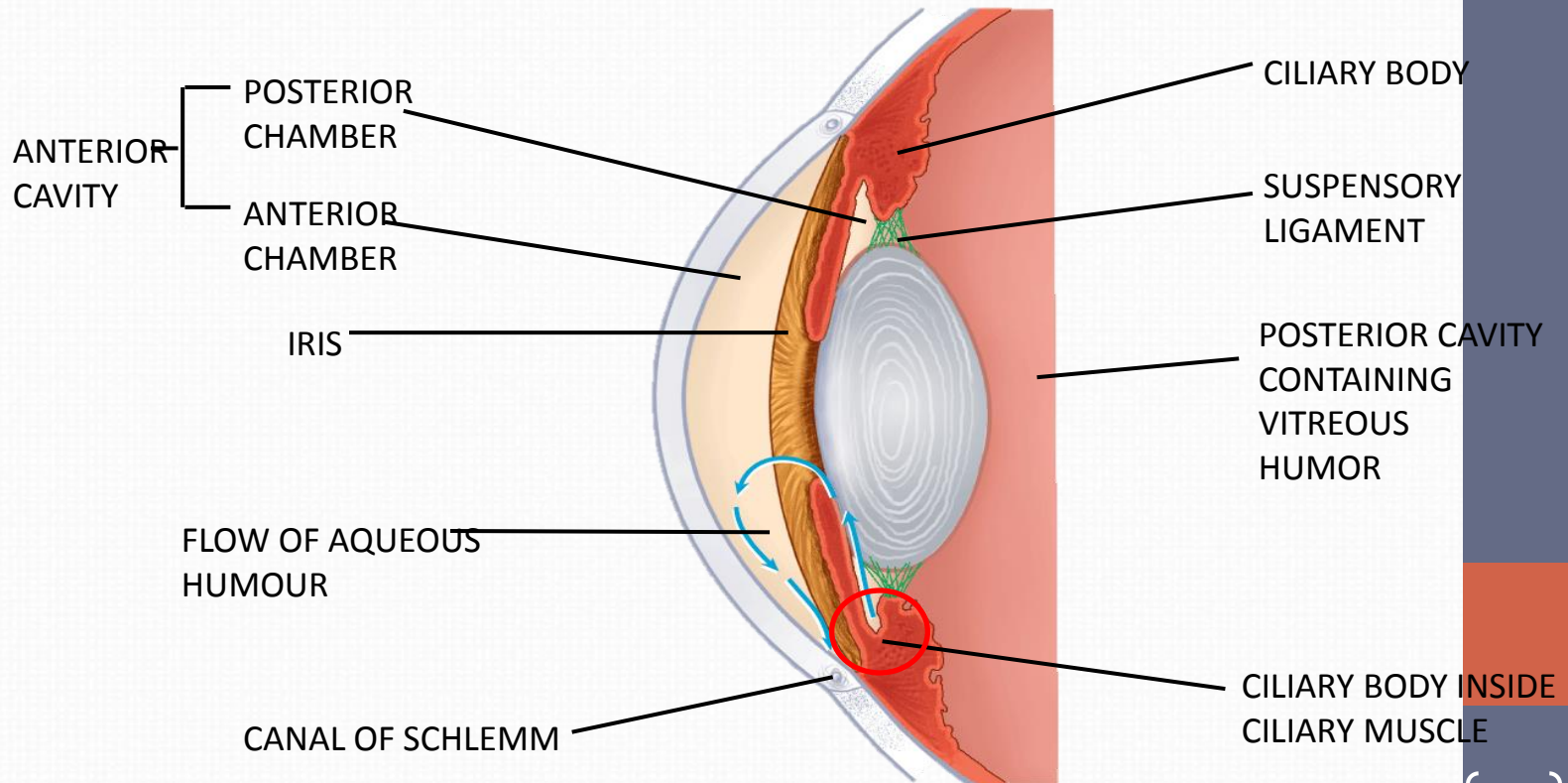
1-Cornea

- Its dioptric 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
- The principal reason for this is that the refractive index of the cornea is markedly different from that of air
- (whereas the refractive index of the eye lens is not greatly different from the indices of the aqueous humor and vitreous humor)
- 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.



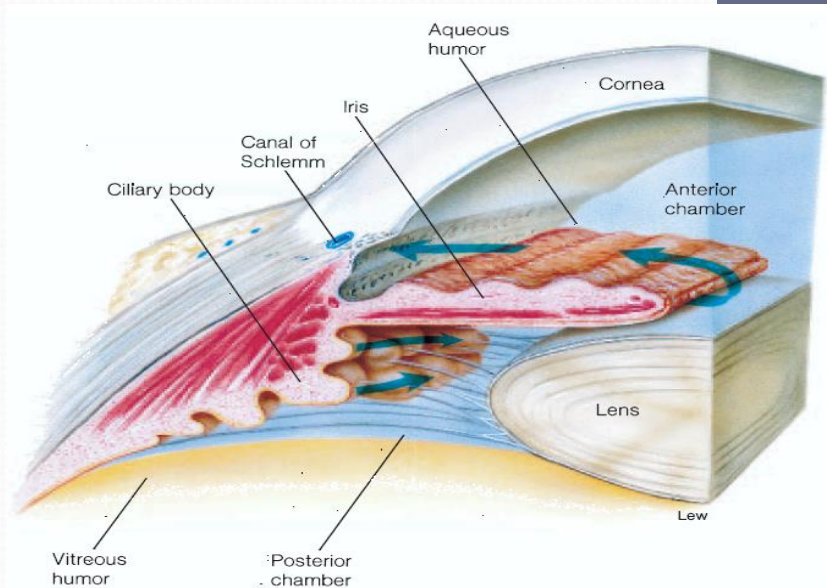
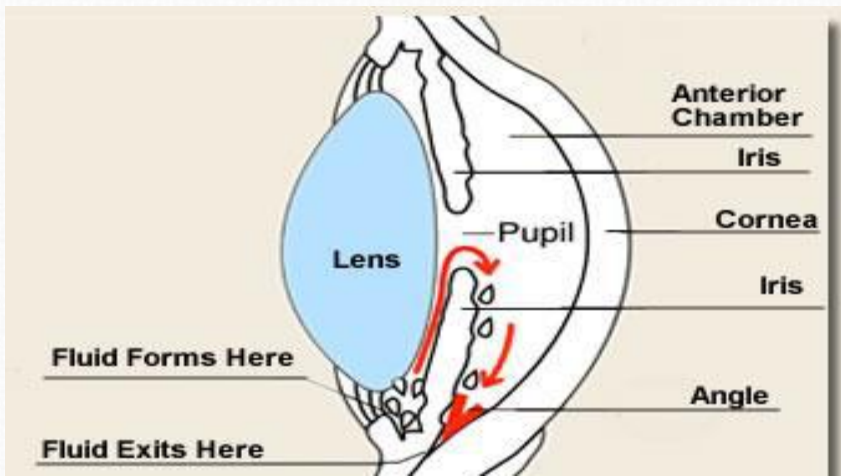
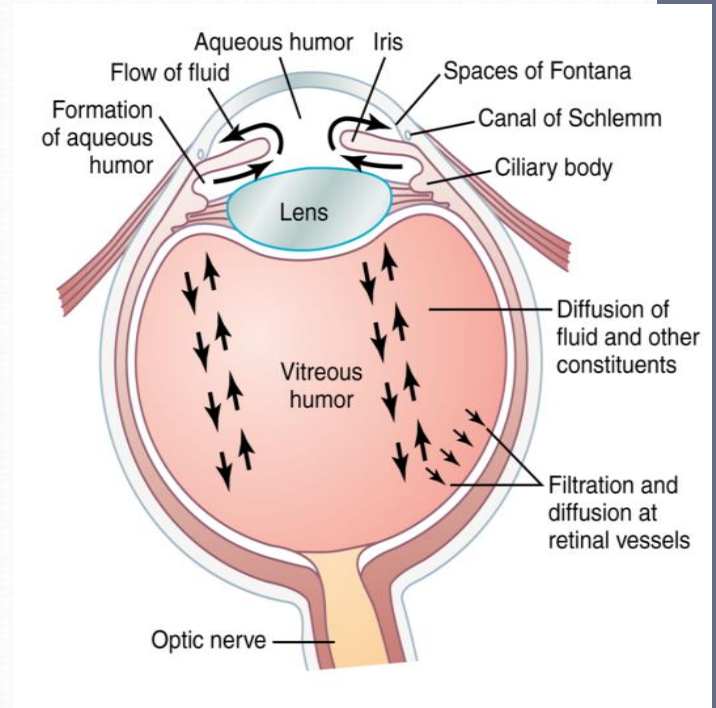
2-THE AQUEOUS HUMOUR

the aqueous humour is a transparent, slightly gelatinous (gel-like) fluid similar to plasma



-The aqueous humor

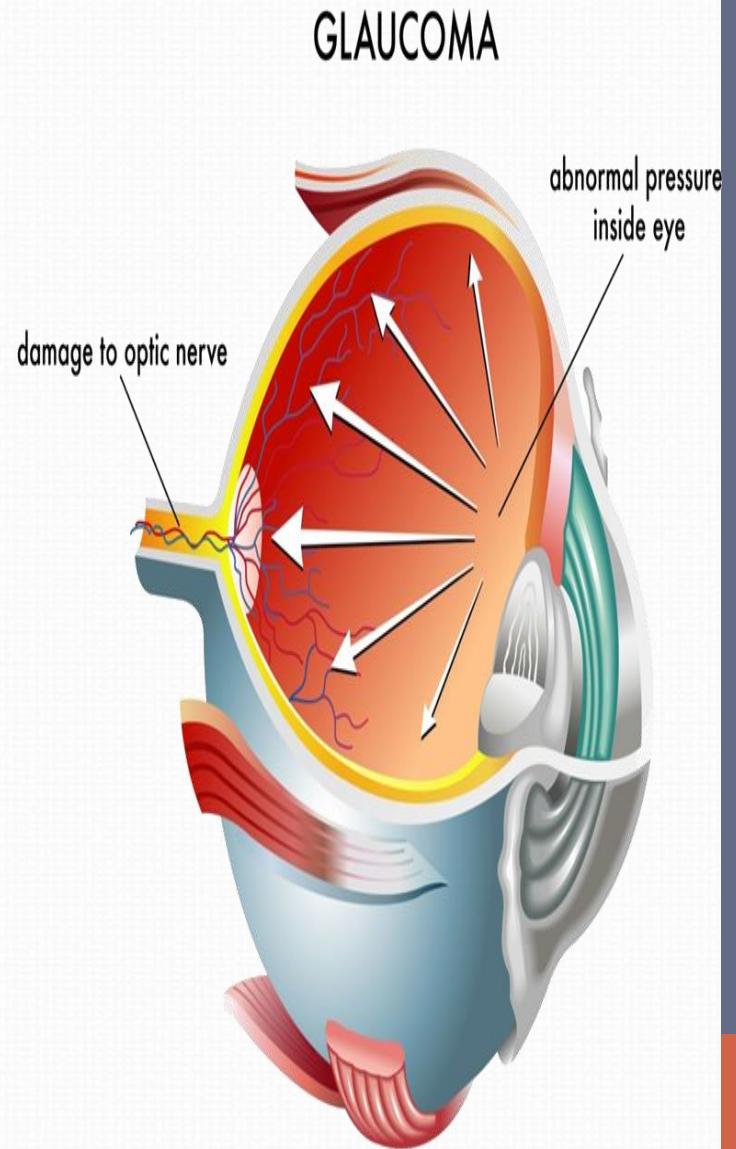
- is continually being formed and reabsorbed.
- **nourishes the cornea and iris**
- **produced in the ciliary body** by an active secretion by ciliary processes..
- GO TO → **posterior chamber** → → **pupil** → → **ant chamber** → → **drained into canal of Schlemm** in anterior chamber angle → → **into veins**
- It causes **intra-ocular pressure** 10-20 mmhg
- **Obstruction of this outlet leads to increased intraocular pressure** , a **critical risk factor for glaucoma**



What is glaucoma ?

(intraocular pressure more than 20mm Hg)

- obstruction of **Aqueous humor** outlet leads to **increased intraocular pressure**.
- pushes the lens backwards into vitreous, which pushes against the retina.
- compression causes retinal and optic nerve damage that can cause blindness



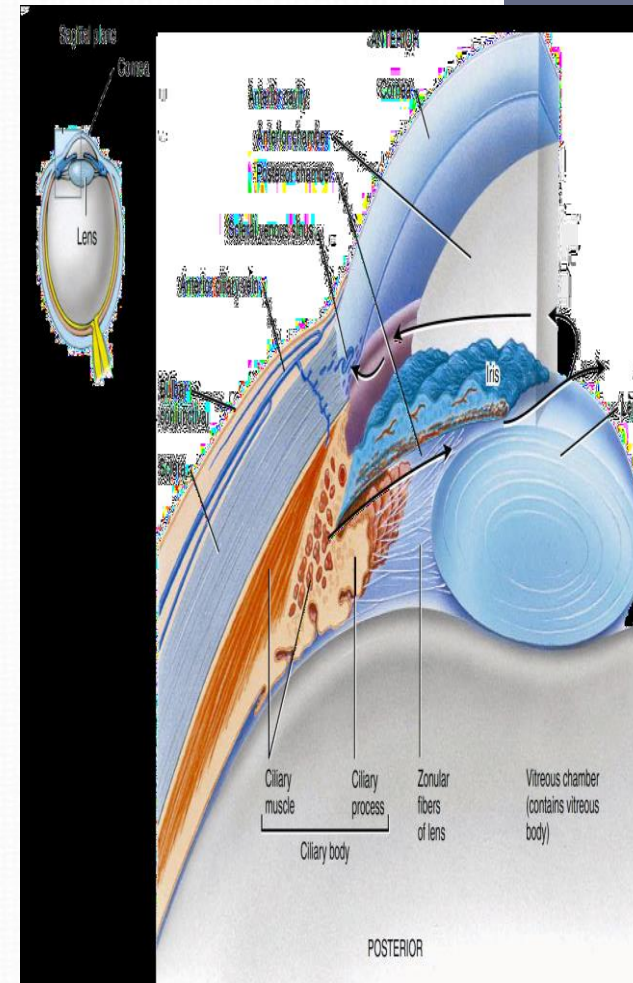
3-lens:-

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

why?

-in response to nervous signals from the brain, *its curvature can be increased* markedly to provide “accommodation,

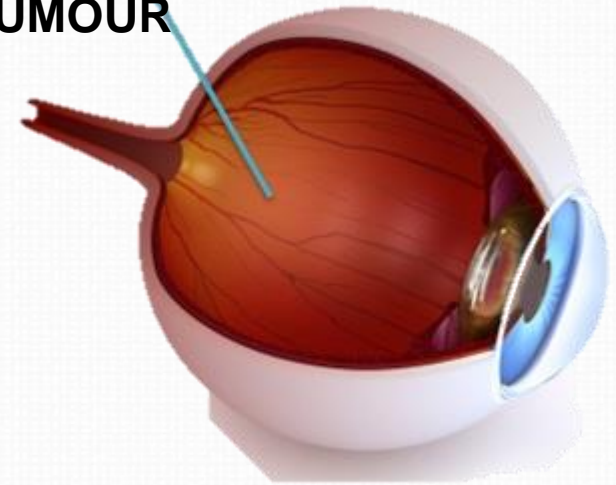
”



4-THE VITREOUS HUMOUR

- is the transparent, colourless, gelatinous mass .fills the vitreous chamber between the posterior surface of lens and the retina (for nourishing retina & keep spheroid shape of the eye)
- the vitreous humour is clear and allows light to pass through

THE VITREOUS HUMOUR



- VITREOUS HUMOUR REMAINS FROM BIRTH

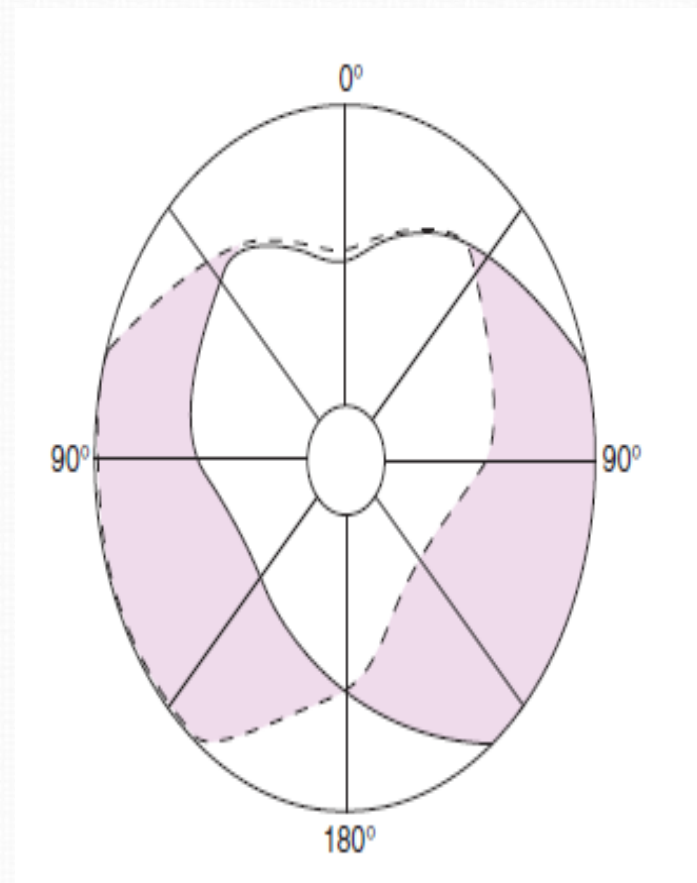


BINOCULAR VISION for :-

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

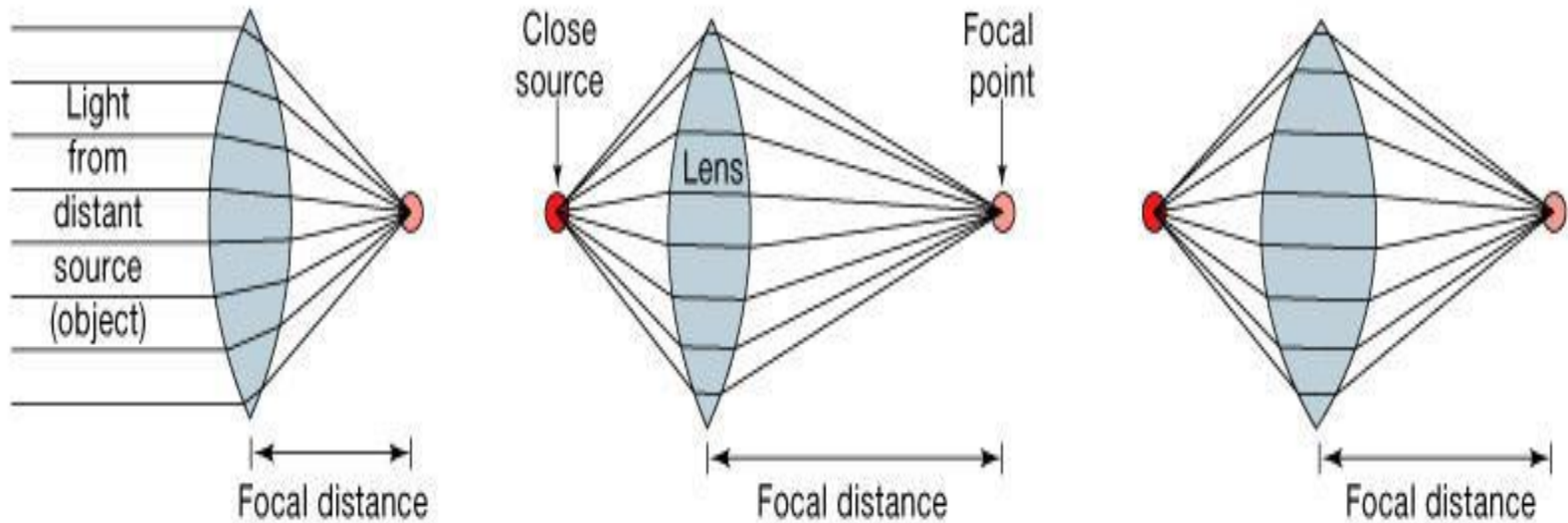
Monocular and binocular visual fields.

- 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.**



The image-forming mechanism –

O]



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

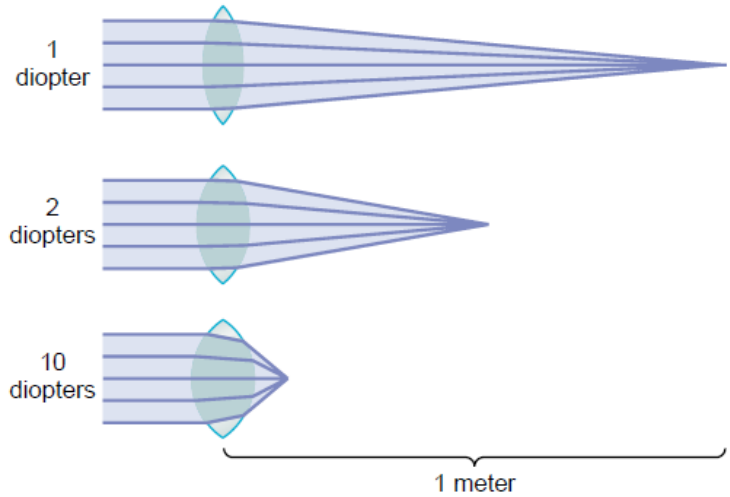
(b) The rounder the lens, the shorter the focal distance

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

-Lens-retina distance =15mm

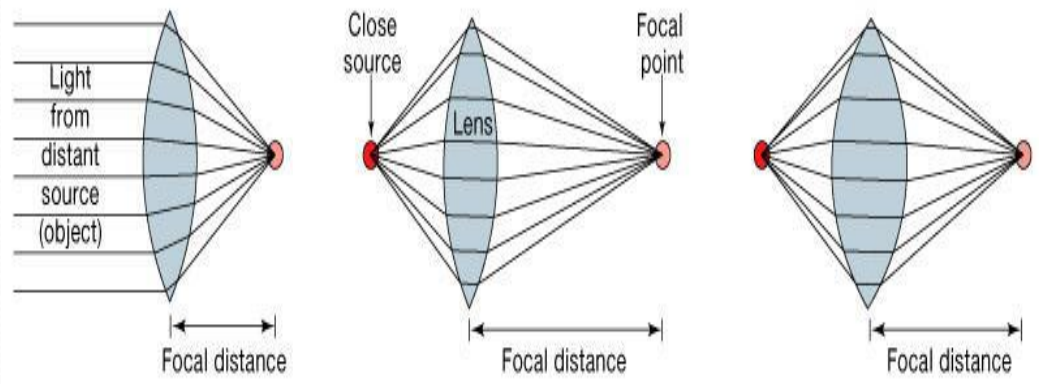
Dioptre (s) = 1 / Focal length (in meters)

Dioptric power of the eye:

Cornea40-45 D (max refraction)

Lens 15-20 D

Accomodation by lens +12 D



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

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

Principles of optics:-

--Biconvex lens(converge) & biconcave lens(diverge)

-Diopter (measure of refractive power

$R.P = 1 / \text{Principal focal distance in}$

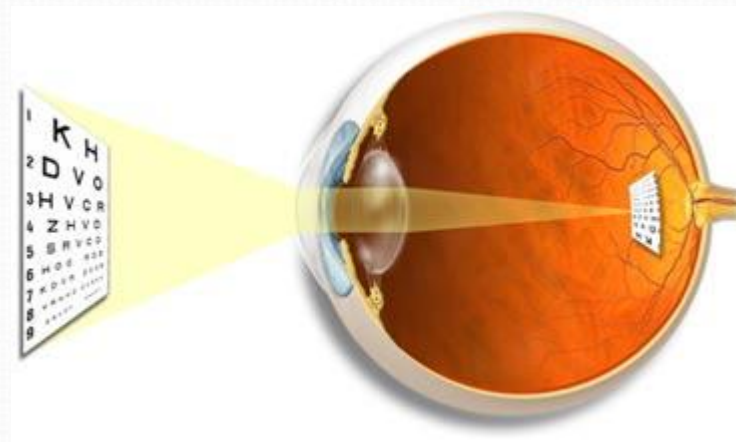
Exp/if Principal focal distance of a lens is 25cm, so its $R.P=1/0.25 \text{ meter} = 4D$

-

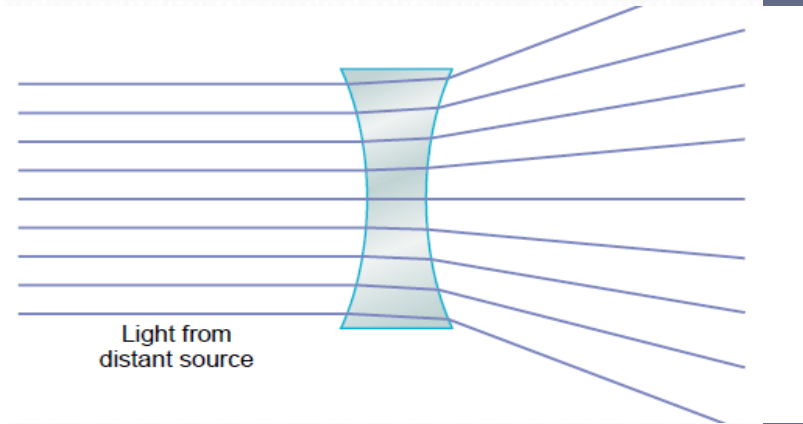
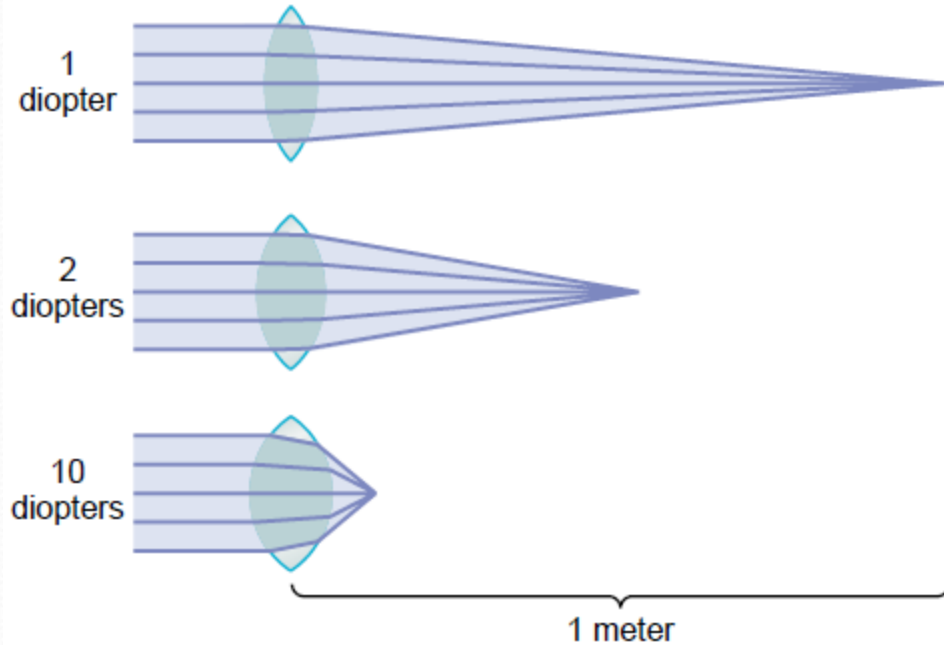
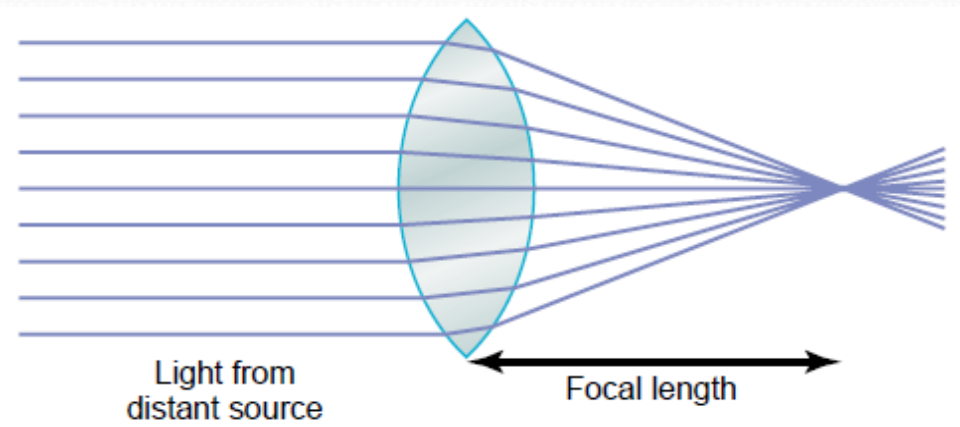
--The greater the curvature of the lens, the greater the refractive power of the eye

Emmetropic eye;- is the normal eye has image on retina, has dioptric power 59-60D

-It can see all distant objects clearly with its ciliary muscle relaxed & see close objects clearly with ciliary muscles contracted
Normal eye = Emmetropia



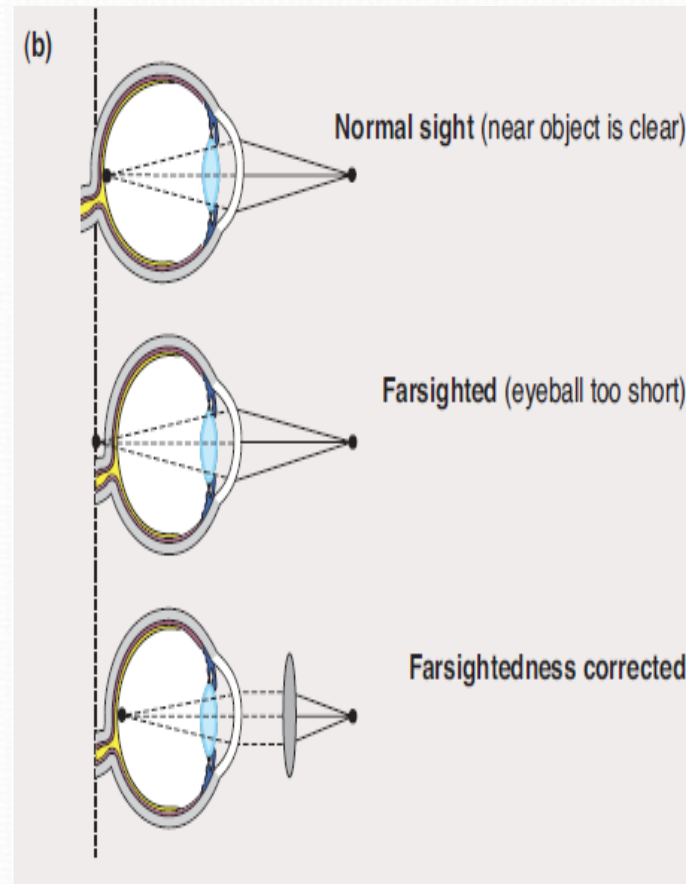
Concave lenses
“neutralize” the refractive power of convex lenses.
Thus, placing a 1-diopter concave lens immediately in front of a 1-diopter convex lens results in a lens system with zero refractive power



1-Errors of refraction

1/Hyperopia(hypermotropia-farsightedness)

- Small eye ball- weak lens system
- Focus behind retina
- Causes headache & blurred vision
- Continuous accommodation to bring image on retina causes muscular effort on ciliary muscle & prolonged convergence , this leads to headache & finally squint
- Correction by biconvex lens

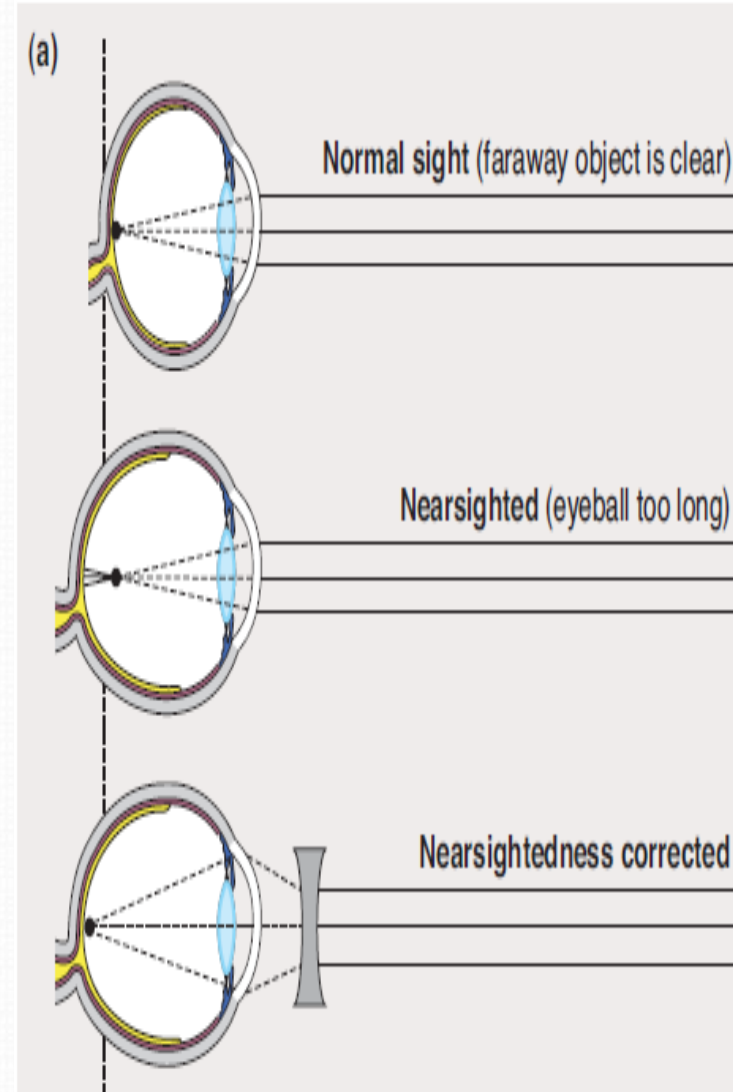


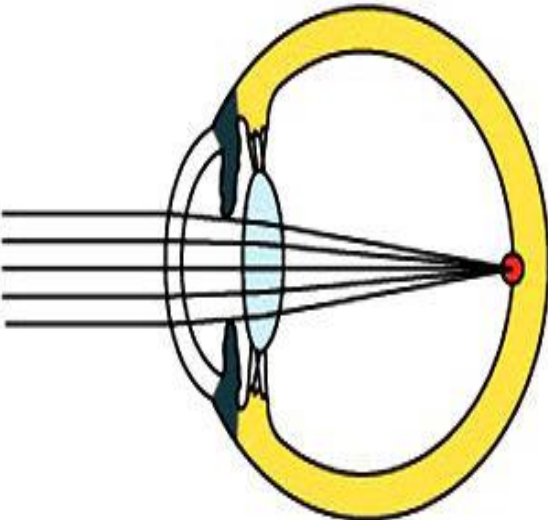
2- Myopia(near sightedness)

**-genetic large eye ball or too much refractive power of lens system or cornea due to its too curved surface-
or due to long antero-posterior diameter of the eye**

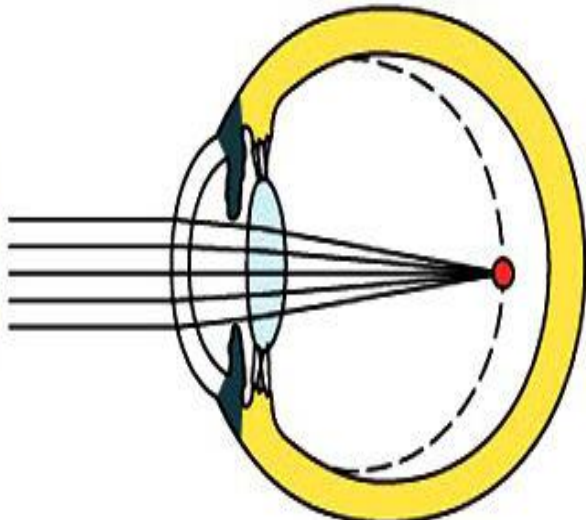
-focus in front the retina

**-correction by biconcave lens to
diverge rays before strike the lens**

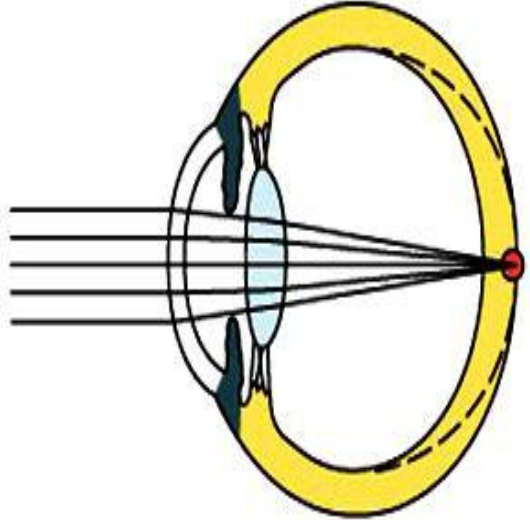




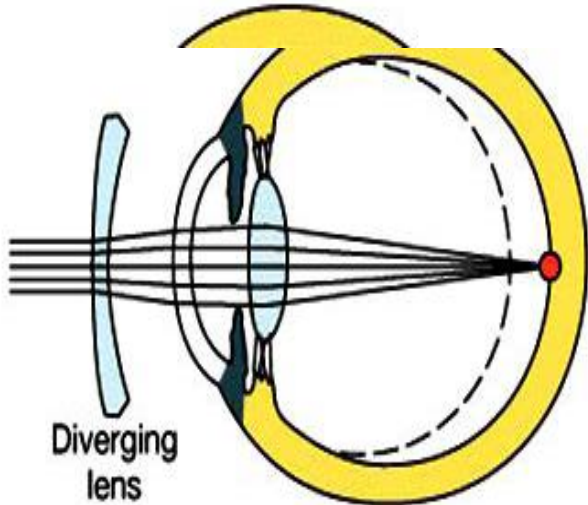
(a) Emmetropia



(b) Myopia

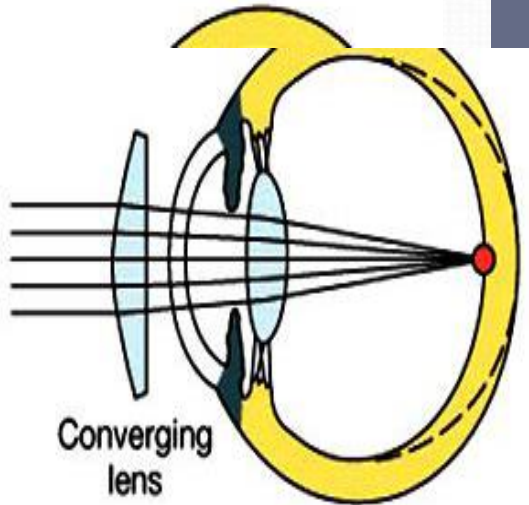


(c) Hyperopia



Diverging lens

(d) Myopia (corrected)



Converging lens

(e) Hyperopia (corrected)

3-Presbyopia

(eye near point recedes by age due to loss of accommodation)

- Focus behind retina
- correction by biconvex lens

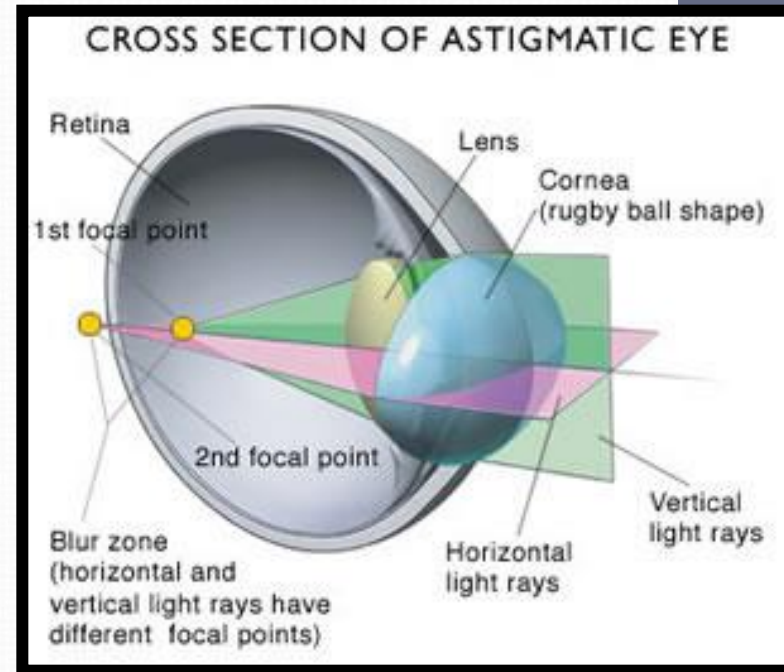
4-Astigmatism

(mainly uneven & ununiform corneal curvature and very little due to uneven lens curvature)

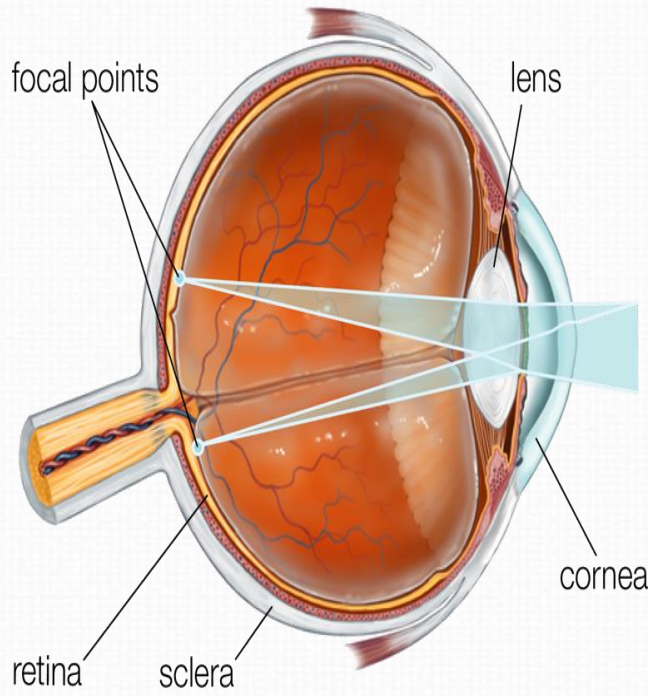
- rays refracted to different foci >>>>>> blurred vision
- correction by cylindrical lens which bends light rays in only one plane (a focal line)

Astigmatism

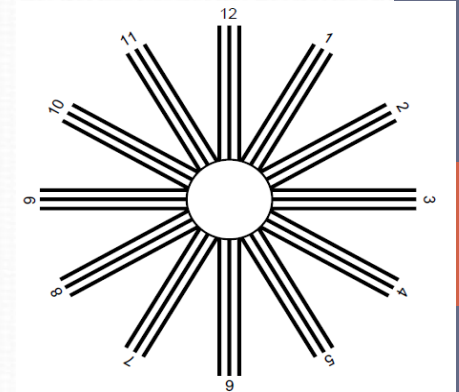
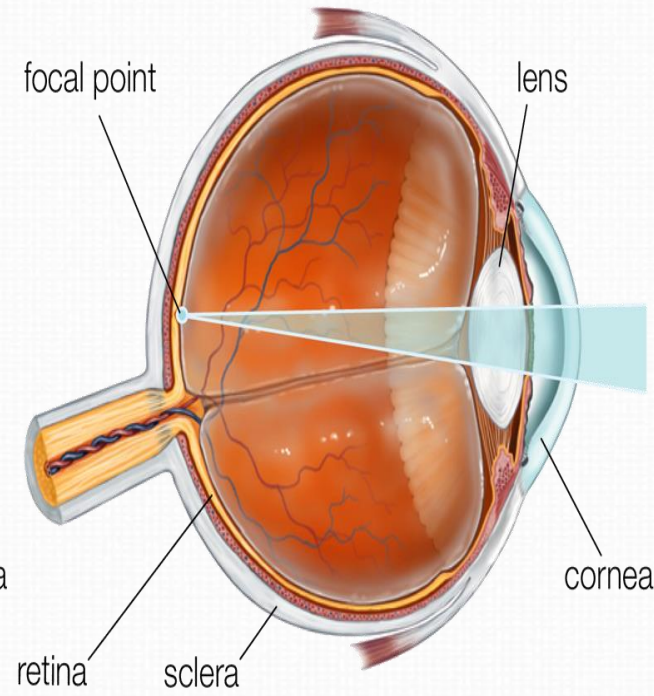
light rays focus at one focal distance in more than one focal point



Astigmatism



Normal eye



- **LAYERS OF RETINA (10 layers)**, the most important are :-

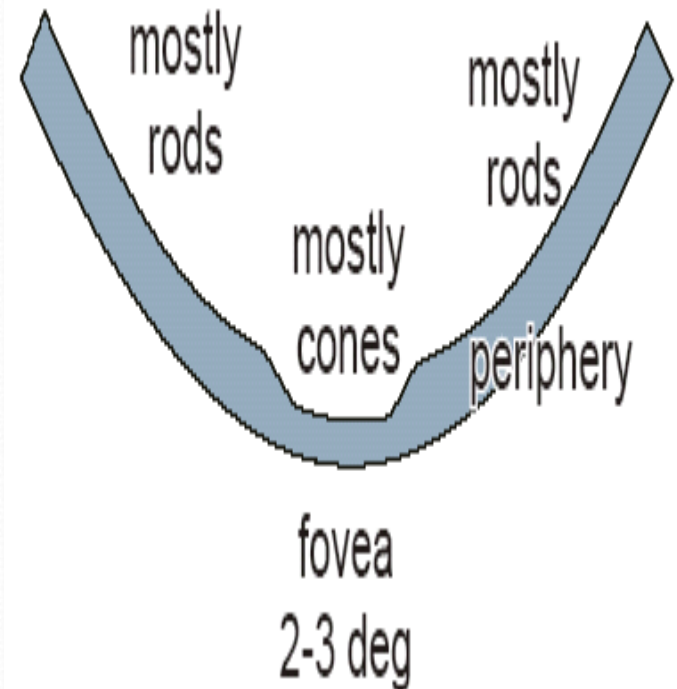
1-Pigment cell layer (vit A) (outermost layer) .what is its value? (absorb light & prevent its reflection back)
-The pigment layer also stores large quantities of *vitamin A* an important precursor of the photosensitive chemicals of the rods and cones.

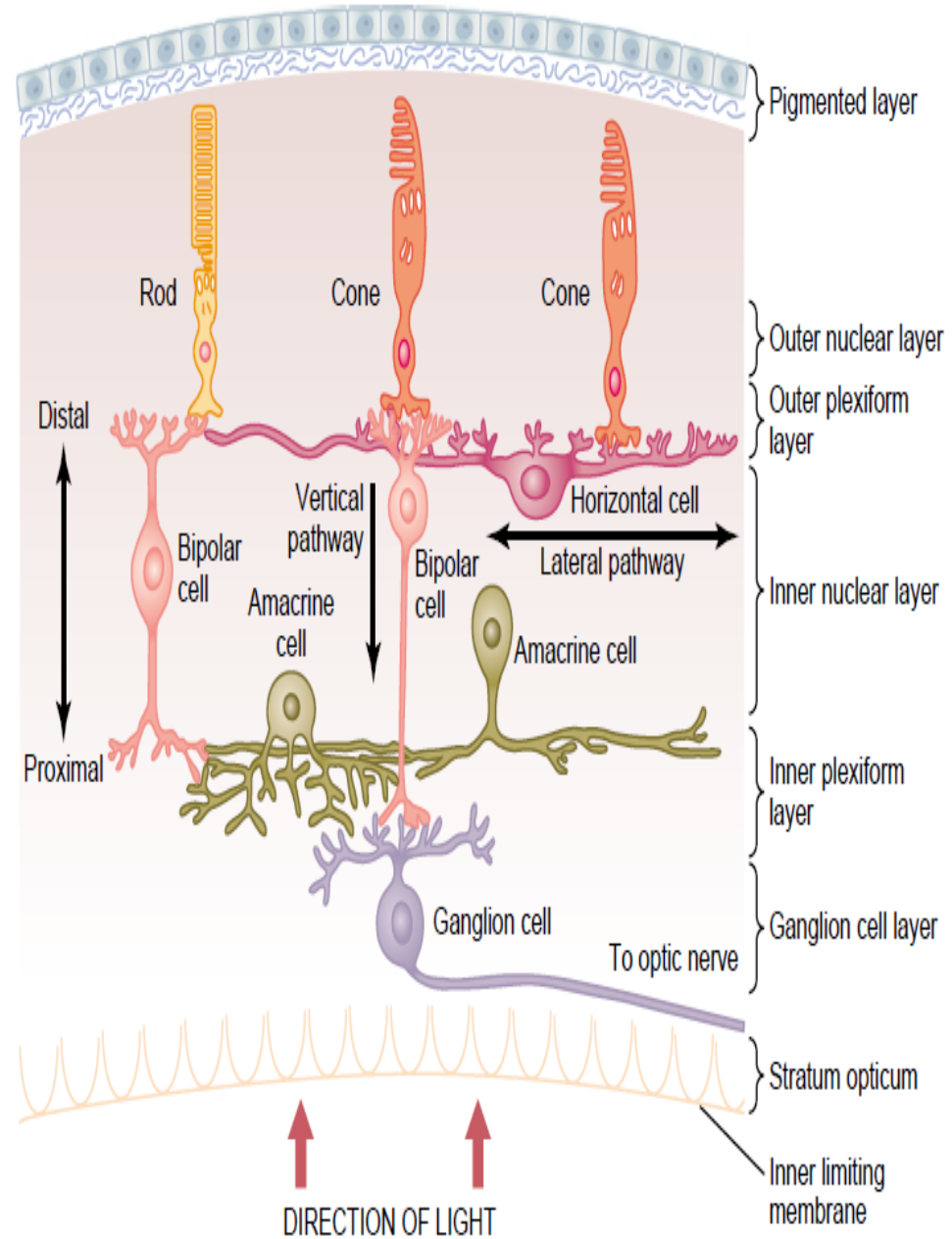
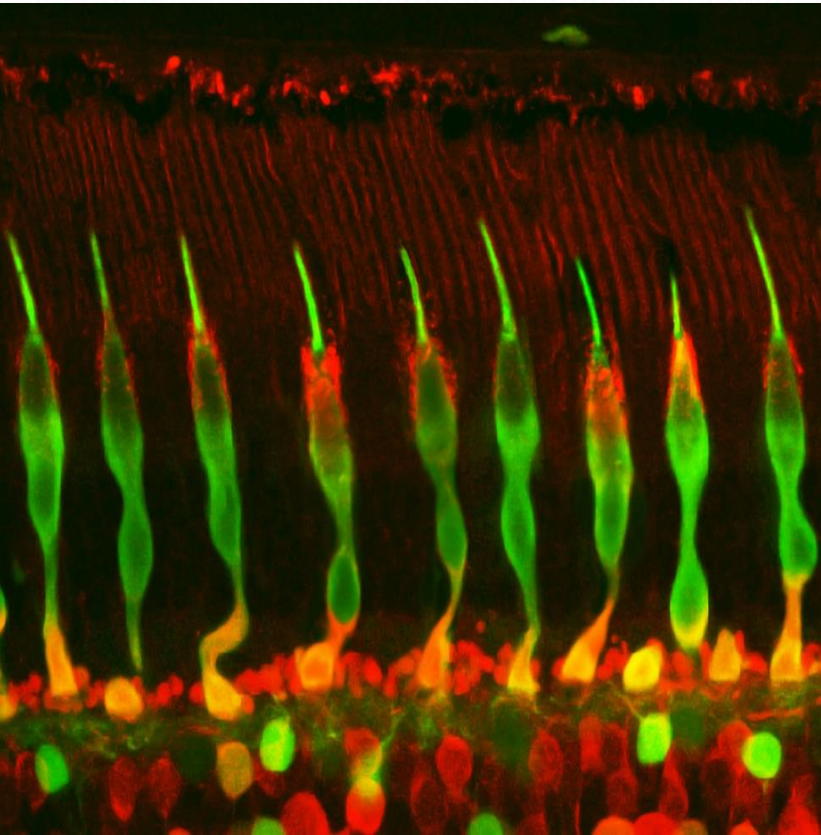
2- rods & cones

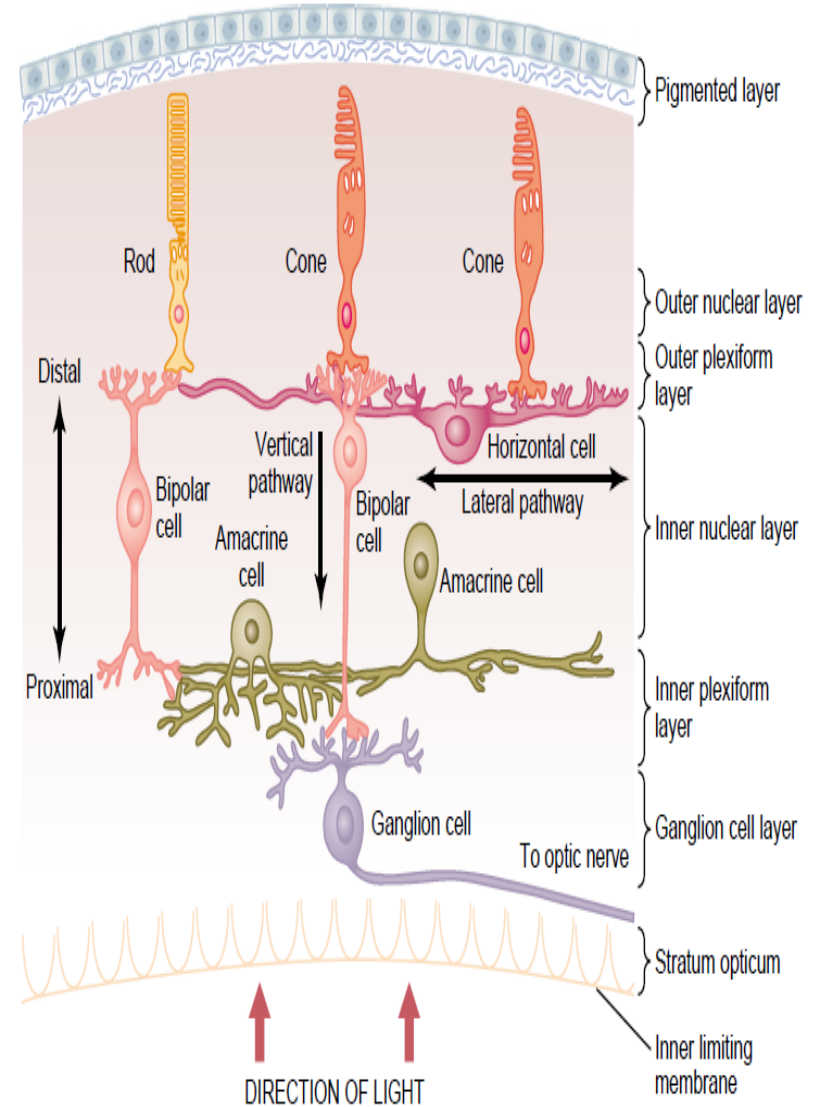
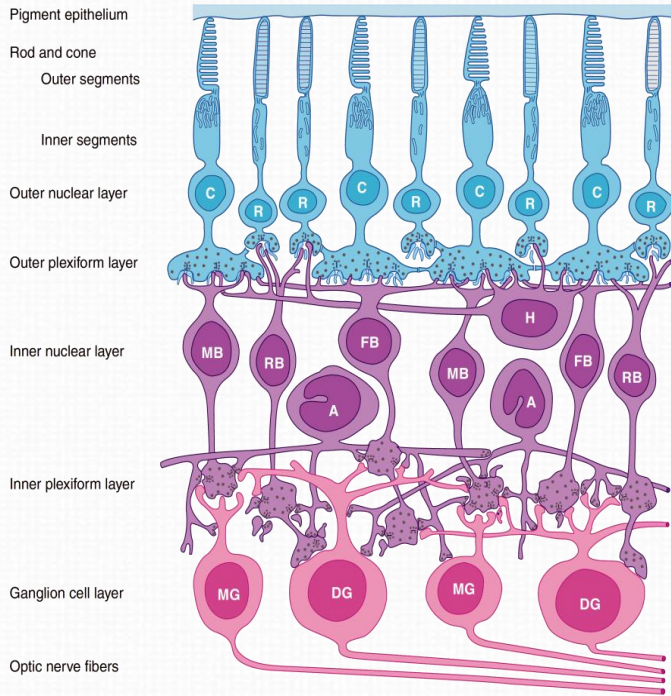
(their outer& inner segments), but not cell bodies(rods 90-120 million & cones 4.5- 6 million) - describe their distribution.

photoreceptor cells are responsible for capturing light and transforming this into generator potential to be used by the nervous system

)







RETINAL CELLS

- there are five basic classes of neurones in the retina:
 - photoreceptors,
 - bipolar cells,
 - ganglion cells,
 - horizontal cells,
 - amacrine cells.

3-Outer nuclear layer(cell bodies of rods & cones)

4-Outer plexiform layer
mainly of Horizontal cells.

5-Inner nuclear layer (bipolar cells)

6-Inner plexiform layer.

(amacrine cells) the inner plexiform layer is interposed between the inner nuclear and ganglion cell layers.)

7-Ganglion cell layer

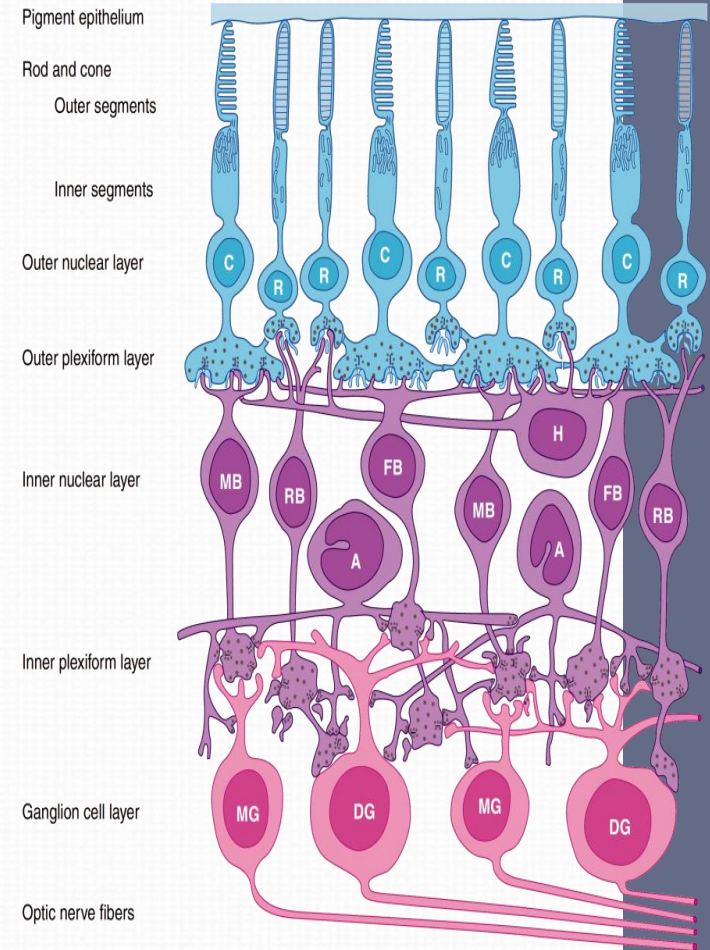
8-Optic nerve fibers (1.2 million fibers)

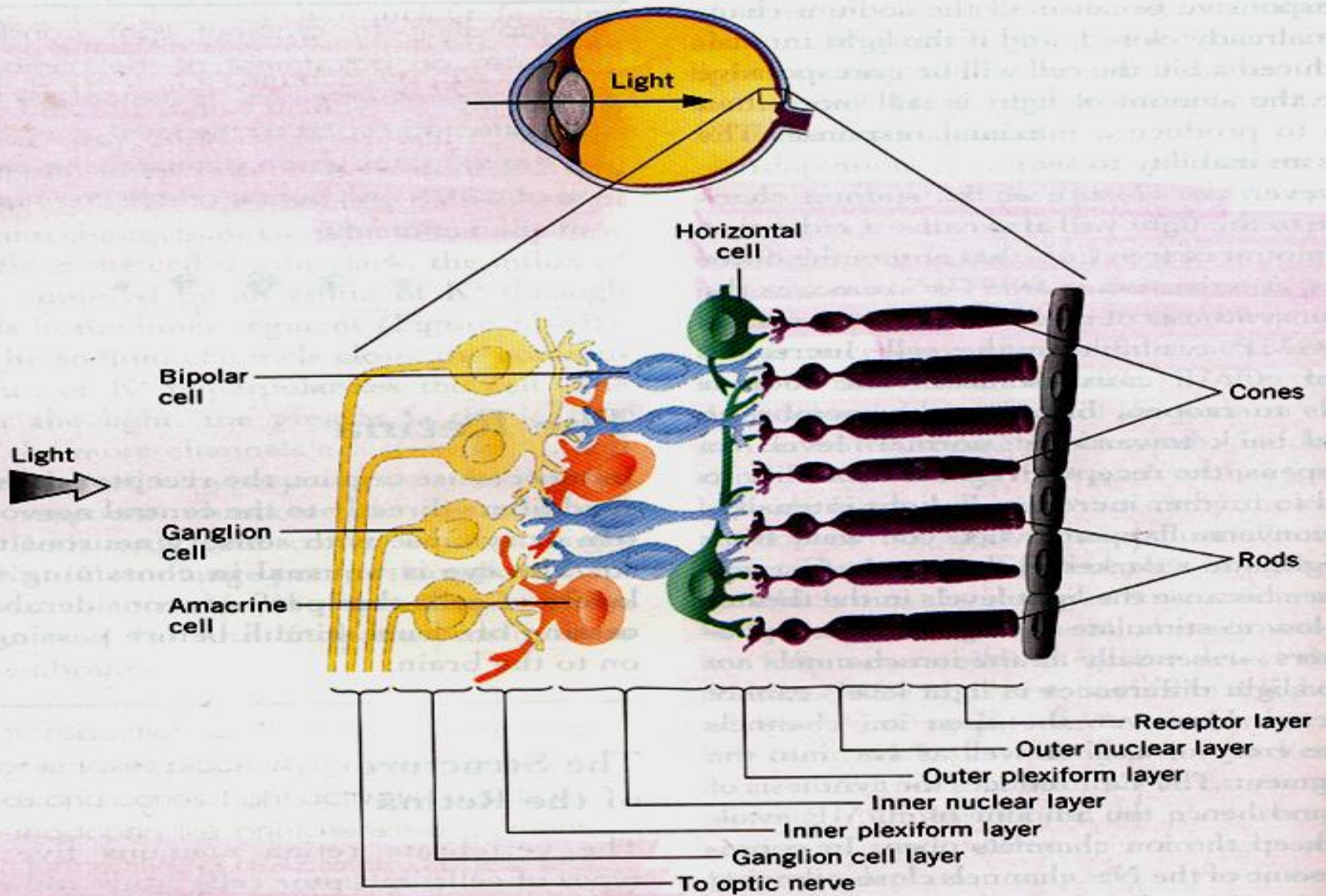
-# Horizontal cells (outer plexiform layer)

(Make synaptic connections with receptors)

Amacrine cells (inner plexiform layer)

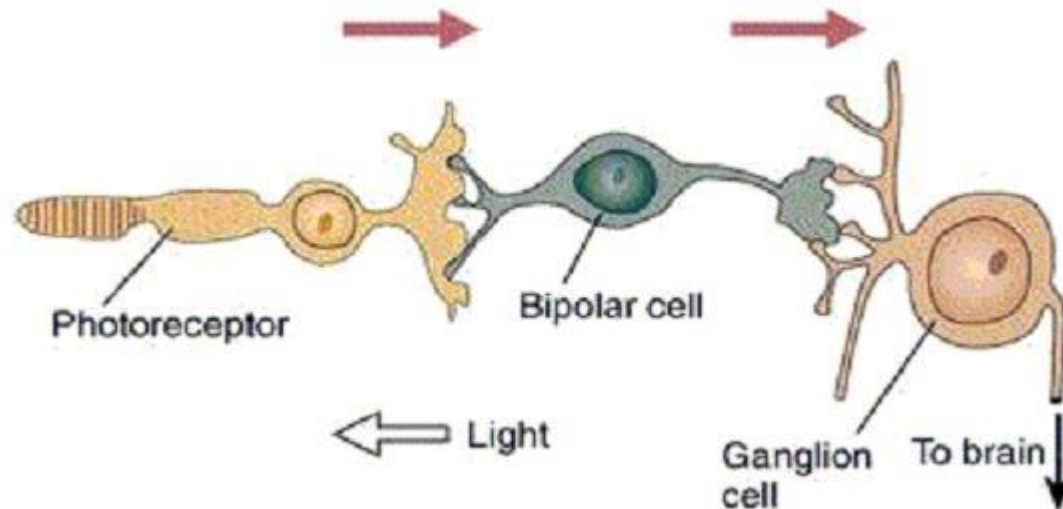
(make synaptic connections with ganglion cells)





Retinal neural circuits

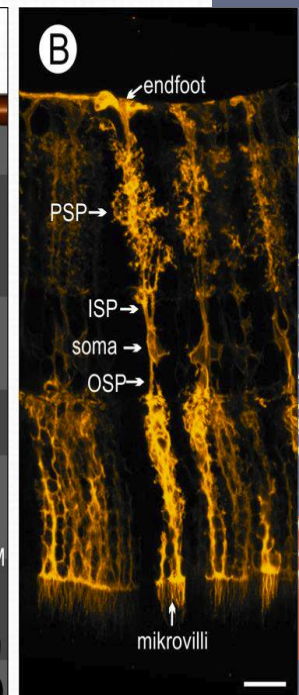
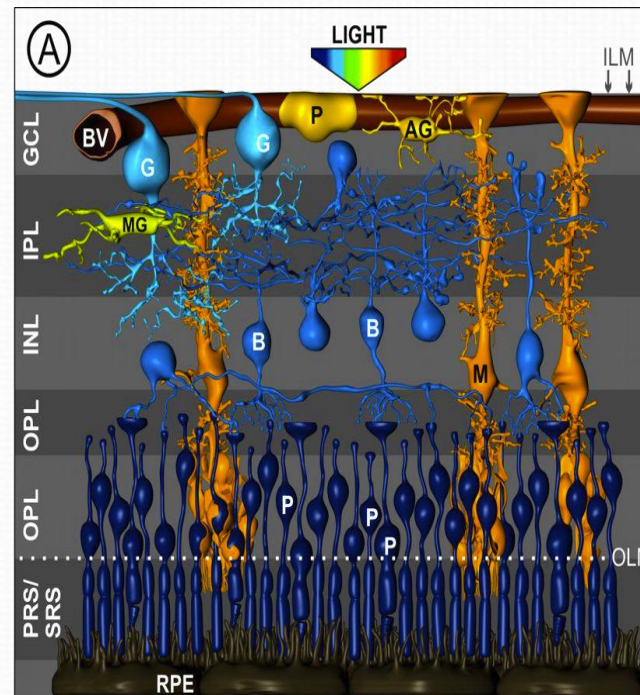
Light hits photoreceptors, sends signal to the bipolar cells then to ganglion cells



Müller cells are the major glial element of the retina.

- located in the inner nuclear layer
- providing metabolic support to retina
- maintaining synaptic levels of neurotransmitters.
- act as light conductor.

**MÜLLER CELLS ARE SHOWN
IN ORANGE**



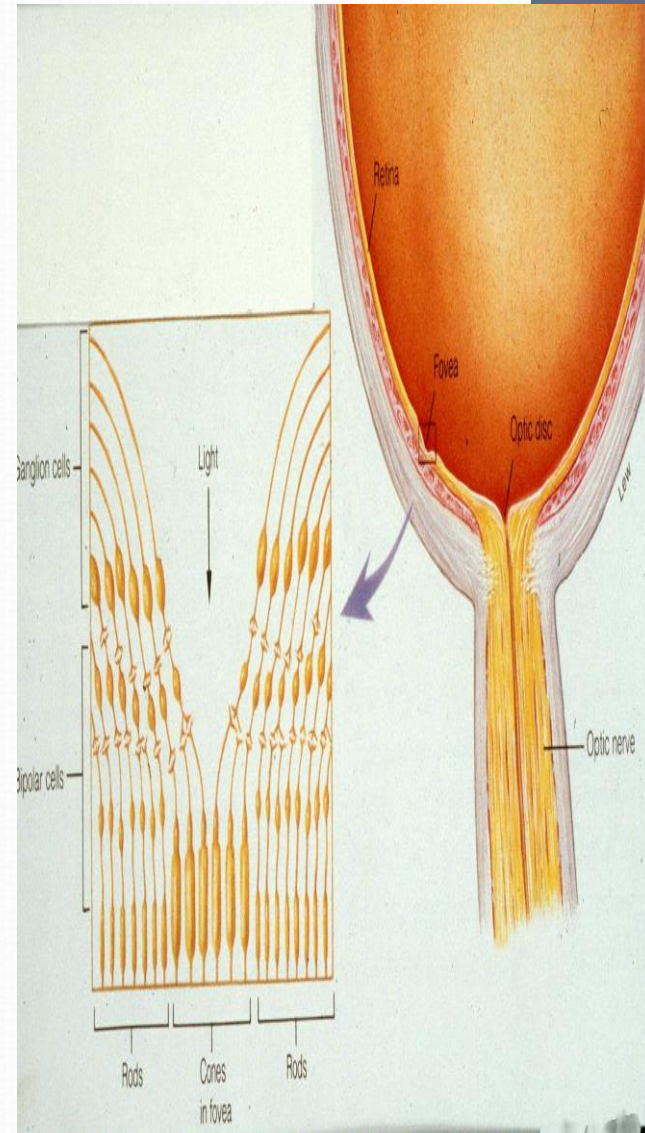
Light pathway in the eye:

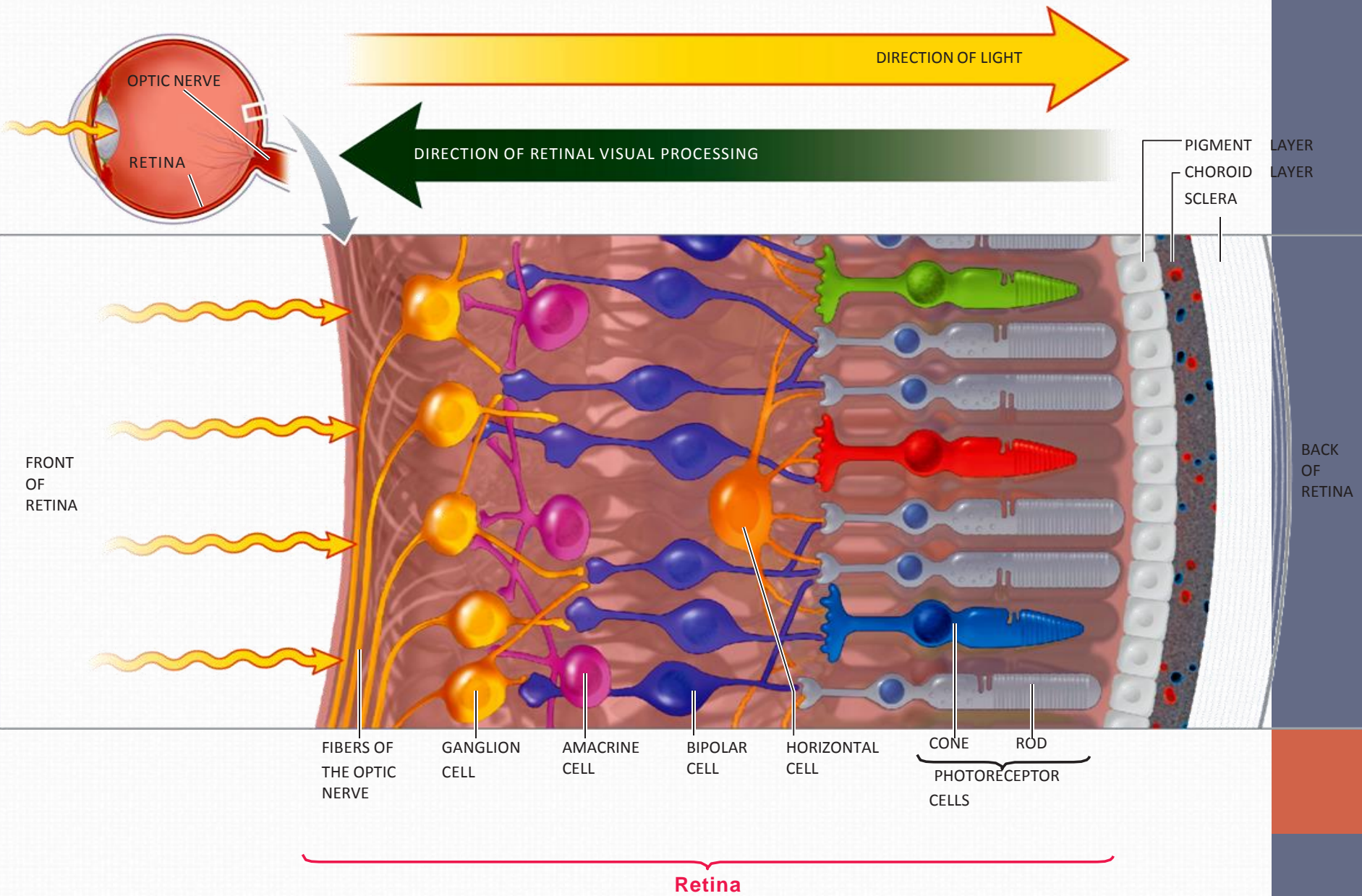
—
After light passes through the lens system of the eye and then through the vitreous humor, it enters retina

-it passes first through the ganglion cells and then through the plexiform and nuclear layers before it finally reaches the layer of rods and cones located on the outer edge of the retina

--Light absorbed by pigment cell layer contain melanin pigment

- then to rods & cones then impulses pass from them to rest of layers finally to ganglion cell layer -to optic nerve





DIRECTION OF LIGHT

DIRECTION OF RETINAL VISUAL PROCESSING

OPTIC NERVE

RETINA

PIGMENT LAYER

CHOROID

SCLERA

FRONT OF RETINA

BACK OF RETINA

FIBERS OF THE OPTIC NERVE

GANGLION CELL

AMACRINE CELL

BIPOLAR CELL

HORIZONTAL CELL

CONE

ROD

PHOTORECEPTOR CELLS

Retina

*Thank you for
listening*



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