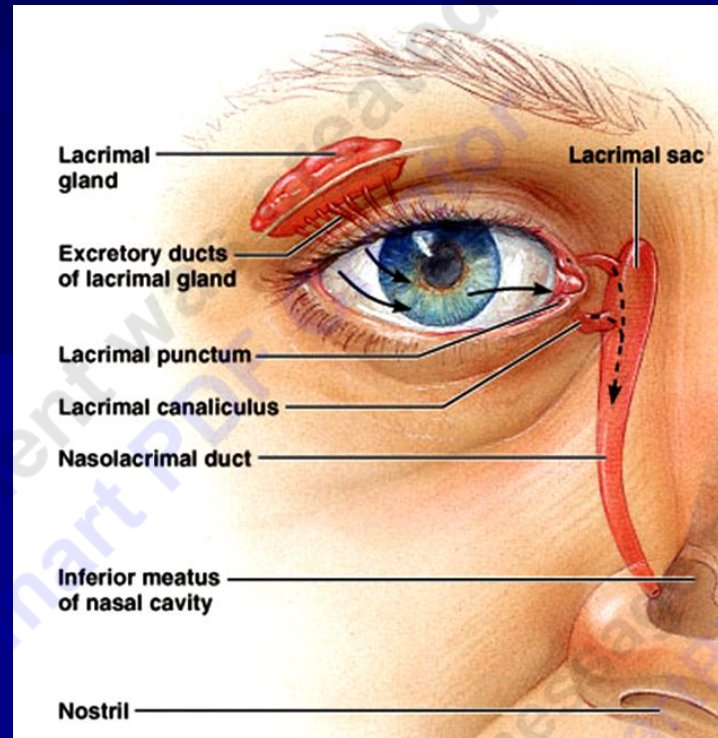


Physiology of Vision

Lecture 1

Dr Taha Sadig Ahmed
Physiology Department , College of Medicine ,
King Saud University , Riyadh

Q: What factors contribute to external protection of the eye ?



1- The bony orbit

2- Tears secreted by lacrimal gland → tears form a thin film over conjunctiva . Tears have antibacterial + lubricating effect → thereby they keep cornea moist (protect it from dryness) and clear.

3- Blinking of lids help to distribute tears over the cornea to keep it moist

4 -Conjunctiva : transparent (skin) membrane that covers the anterior surface of eye, & is reflected on the inner surface of eye lids .

- It is Covered with thin film of tears for protection, wetness, & cleaning

Q : Describe structure of the eye !

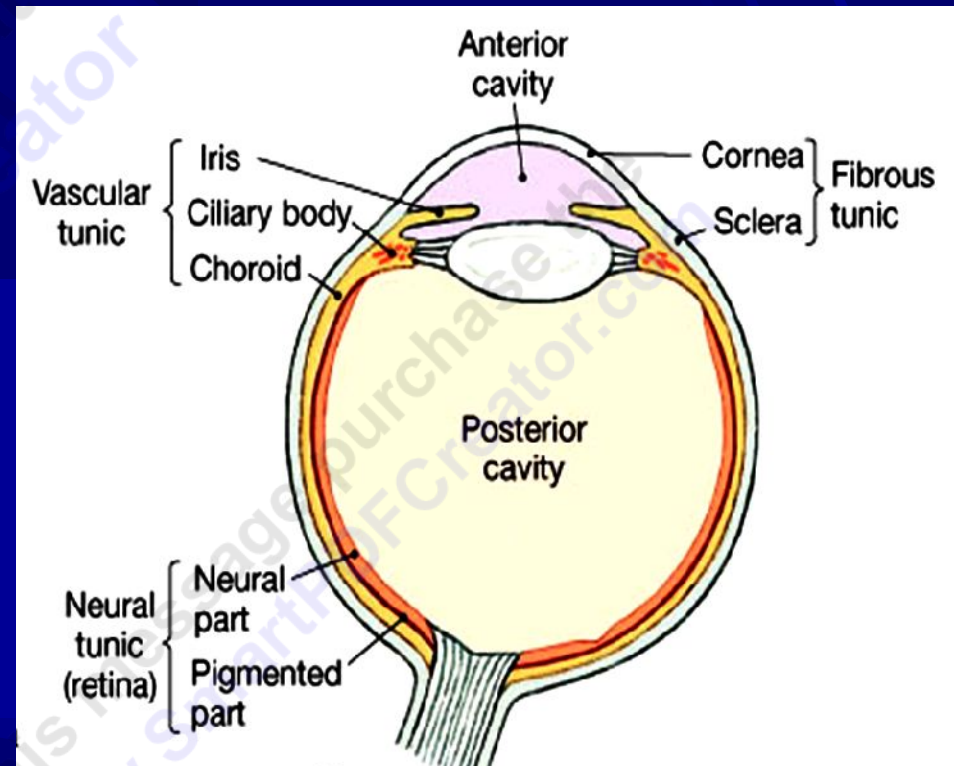
The eye consists of 3 layers :

1/ Outer fibrous coat
(tunic , layer) :

consists of →

(a) Sclera (white of the eye) , and

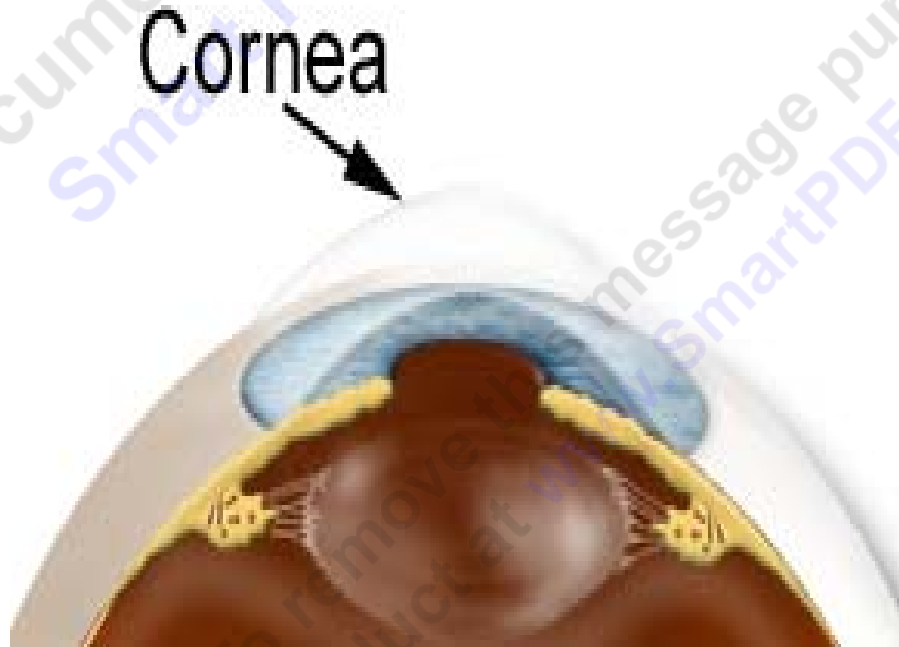
(b) Cornea



Sclera : Offers protection to the eye & maintains its spherical appearance

Cornea

- ✓ Is the transparent , avascular modified anterior part of the sclera → to allow light to enter the eyes
- ✓ Its dioptric (refractive) power = 40-45 D at its anterior surface.
- ✓ This constitute 2/3 rd of the total refractive power in the eye



Layers of the eye (contd 2)

2/ Middle vascular layer:

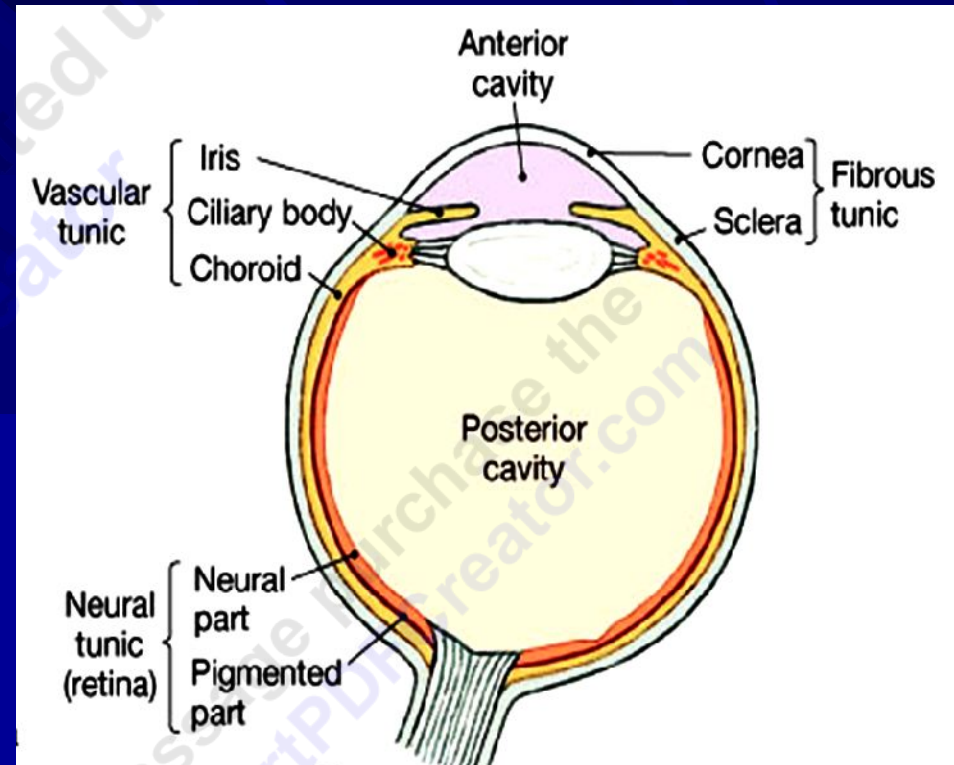
consists of 3 parts →

(1) Iris

(2) Ciliary body/muscle ,

(Actually ciliary body consists of ciliary muscles + ciliary processes coming out of the muscle . The suspensory ligament that holds the lens in place is attached to the ciliary processes)

(3) **Choroid** : lies on the inner side of the sclera .



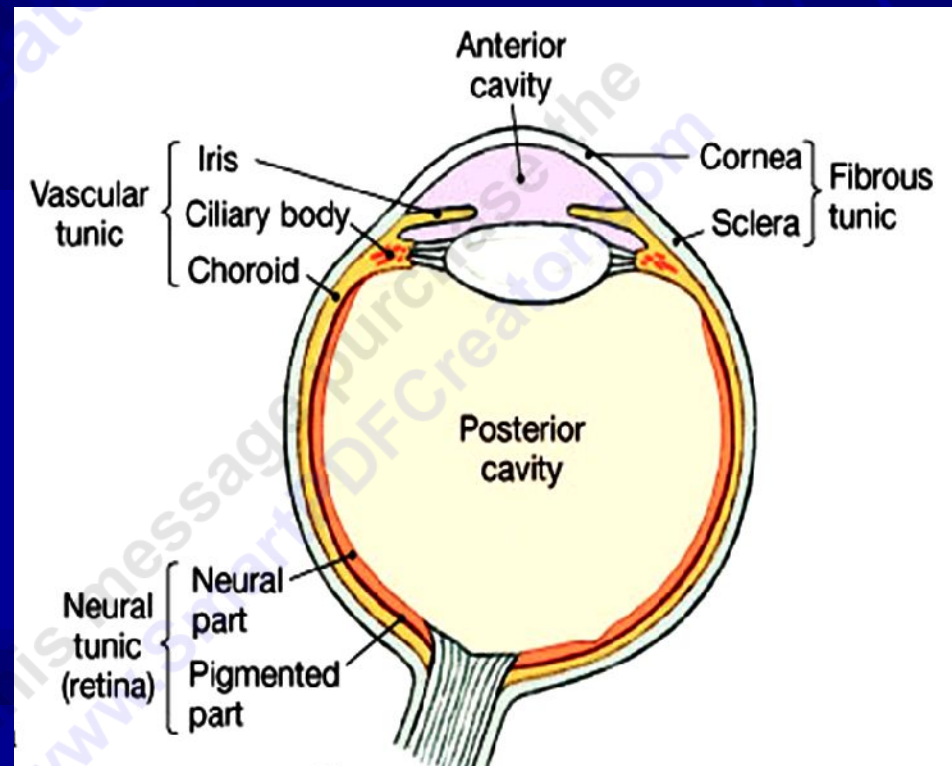
✓ The choroid contains blood vessels that supply the retina with blood .

✓ The posterior 2/3rd of the choroid has the retina lining it on the inside

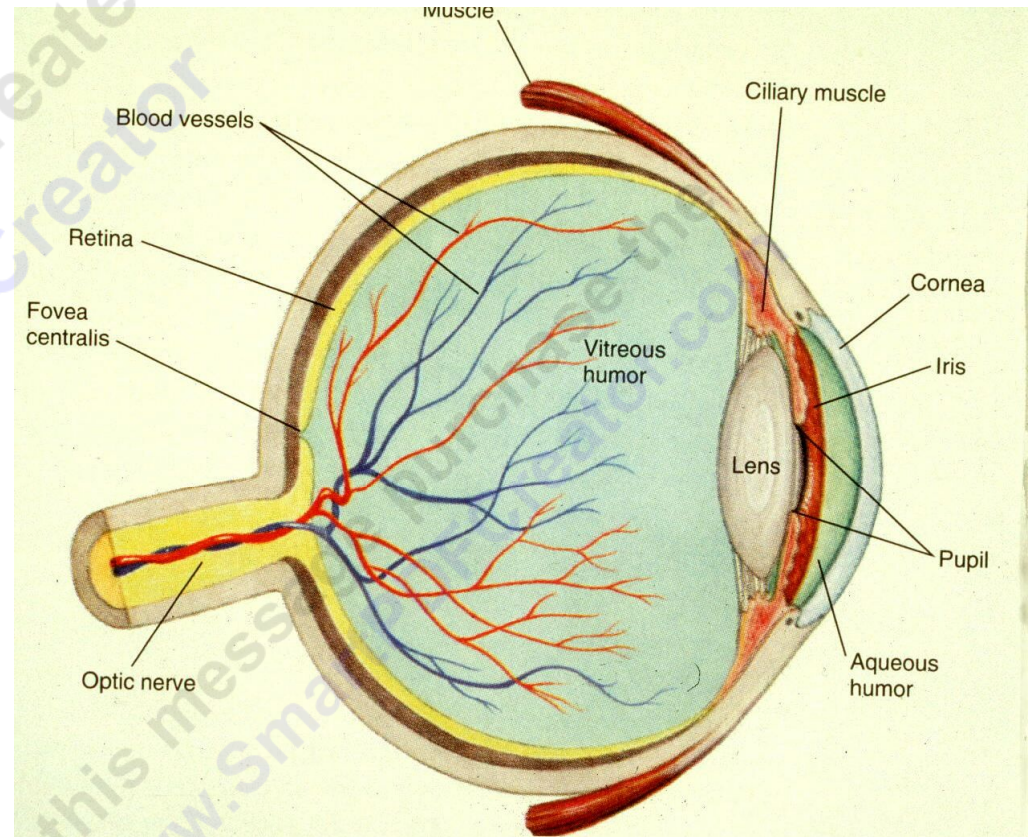
Layers of the eye (contd 3)

3/ Inner Neural (Nervous) layer called **Retina**

- It contains
Photoreceptors
which are 2 types :
Rods and **Cones** .



- **Pupil** : is the opening in the middle of the iris ; behind center of cornea
- It allows light to enter the eye
- **Iris** : colored part , has
 - (i) Radial muscle that dilates the pupil (controlled by sympathetic NS)+
 - (ii) circular muscles that constrict the pupil (controlled by parasympathetic) NS .



Ciliary muscles (body)

thick anterior part of choroid to which attached suspensory ligaments .

Lens :

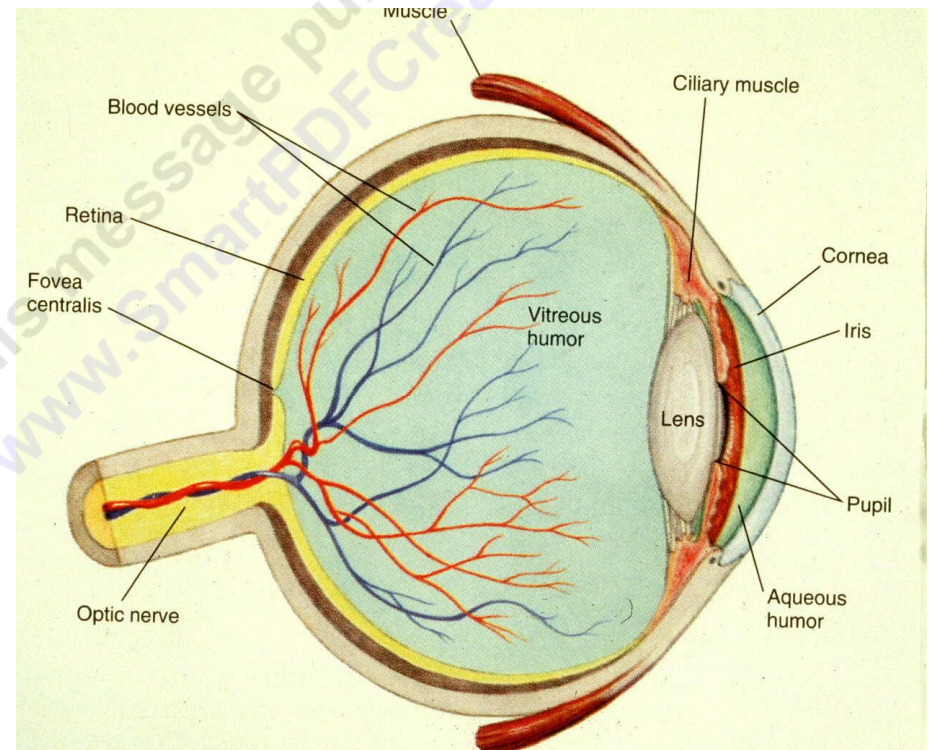
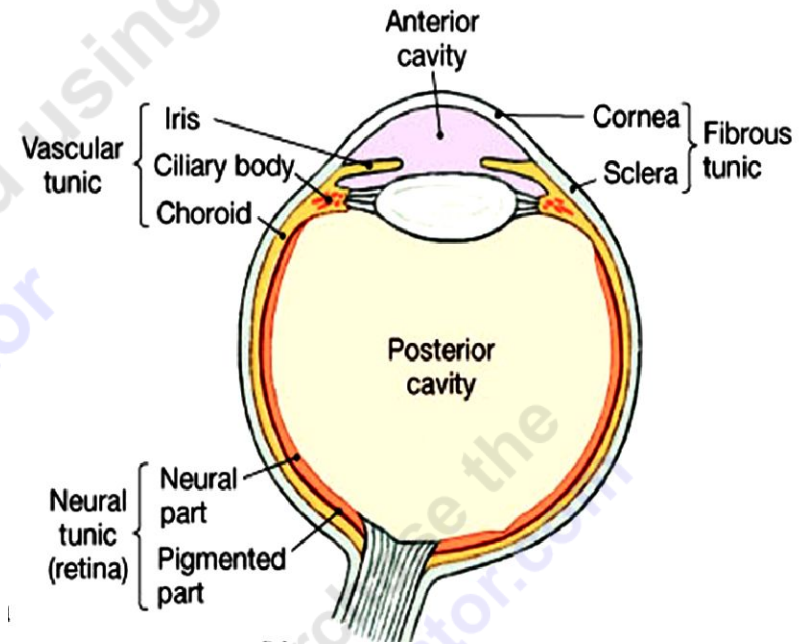
- ✓ transparent, biconvex, semisolid structure
- ✓ Dioptric (refractive) power = 15-20 D,
- ✓ Held in place by suspensory ligament that is attached to the ciliary body (which is the anterior part of the choroid)

Q.what is cataract?

Opacity of the lens

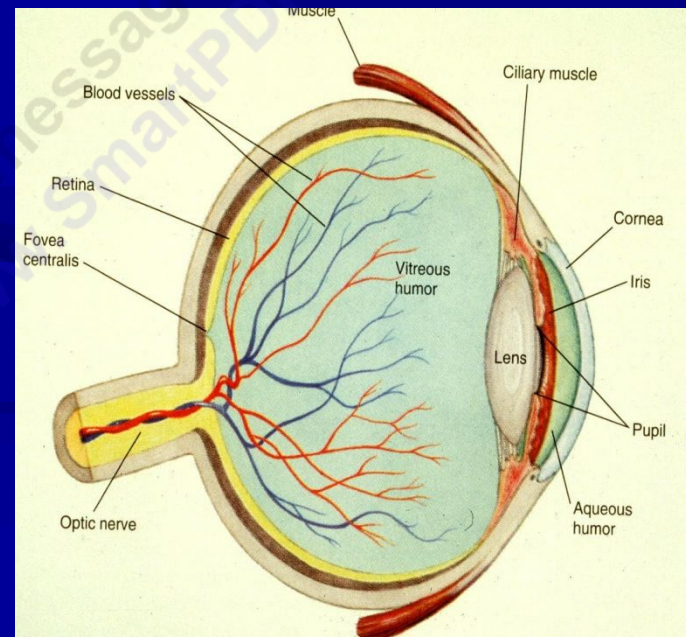
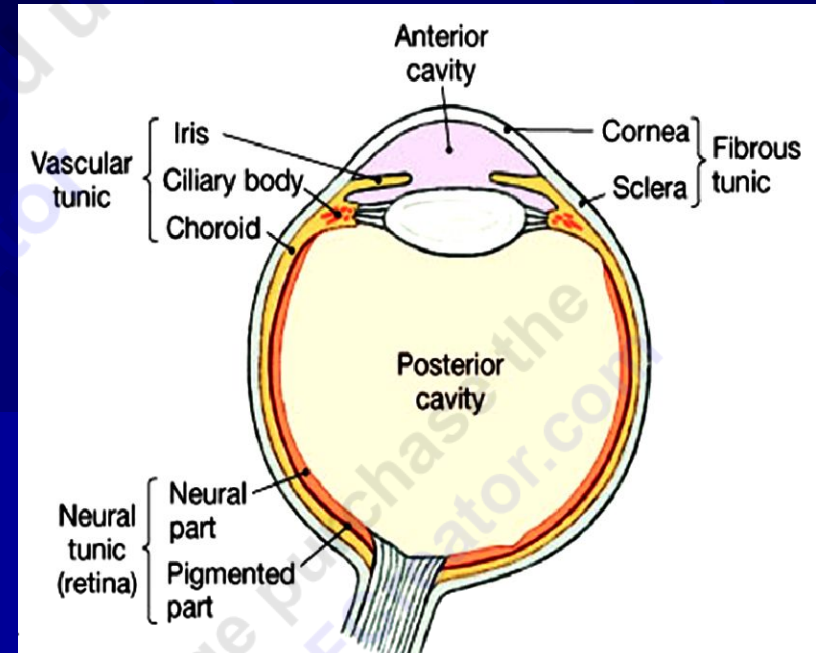
Q : What is Uvea ?

Uvea =
choroid + iris + ciliary muscles

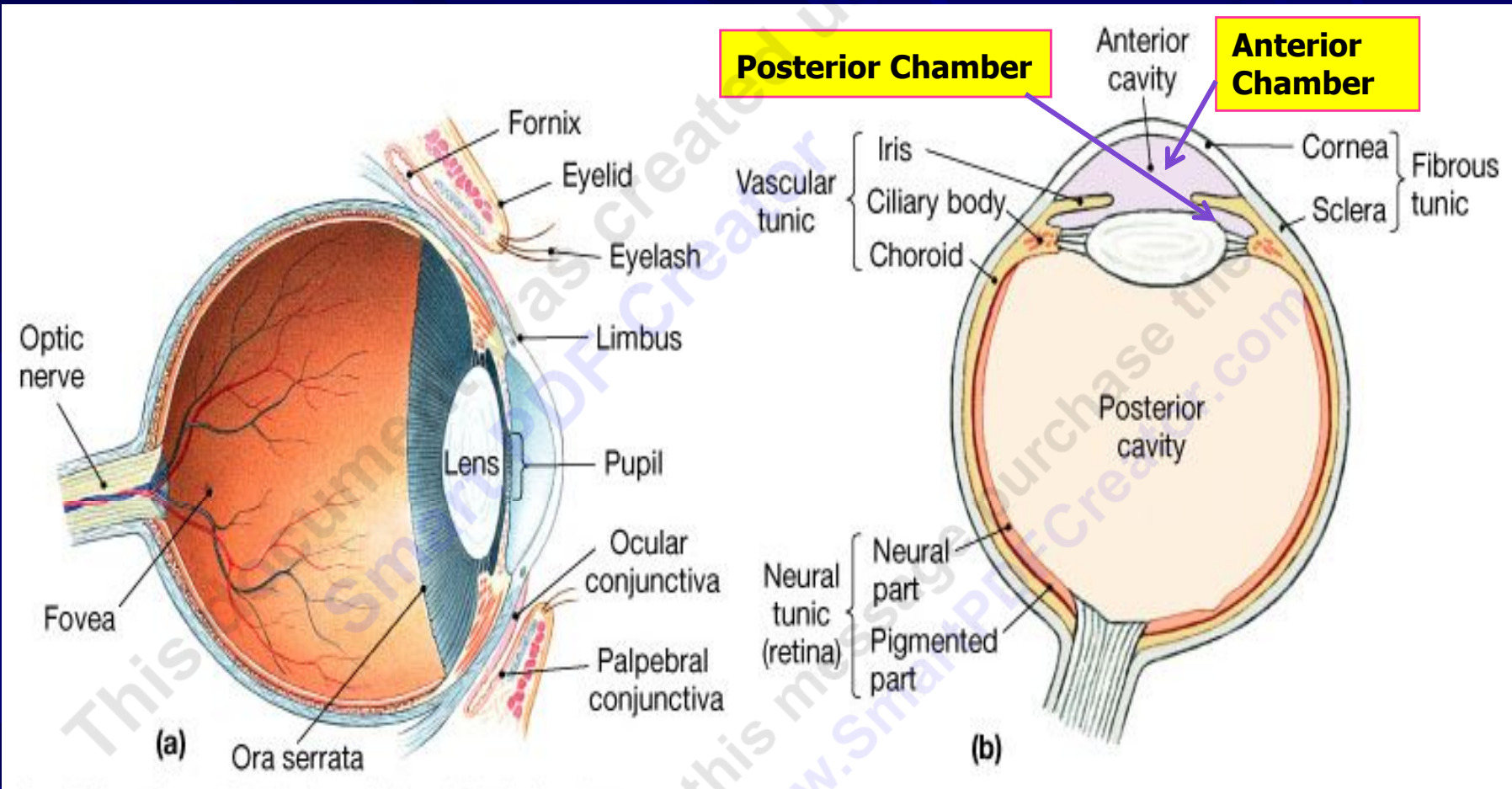


Q : What do we mean by anterior & posterior cavities ?

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



Q: What do we mean by anterior and posterior chambers of the eye ?



■ The **Iris** further divides the anterior cavity (which contains **Aqueous Humor**) into :

(a) **Anterior Chamber** (in front of the iris , between it & cornea) ,
and

(b) **Posterior Chamber** (behind the iris ; between it & lens)

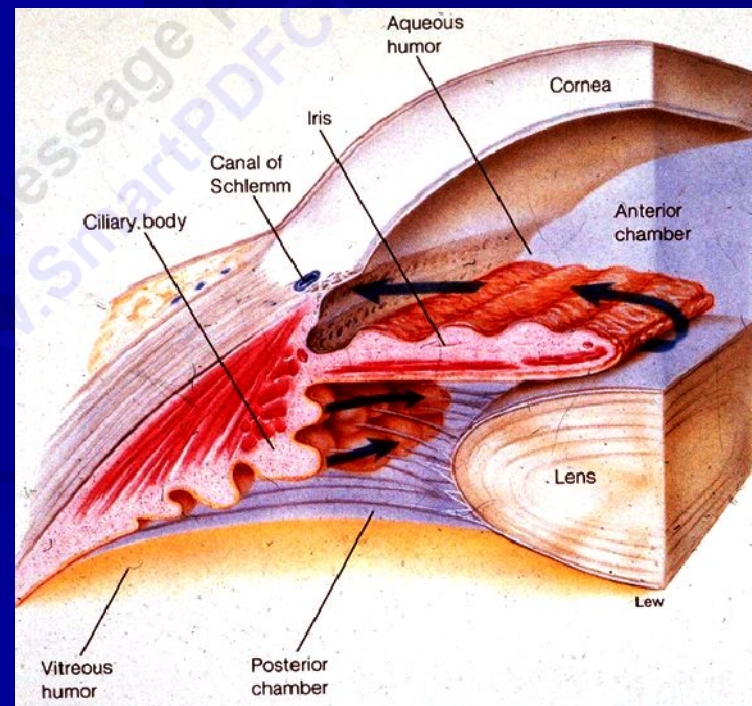
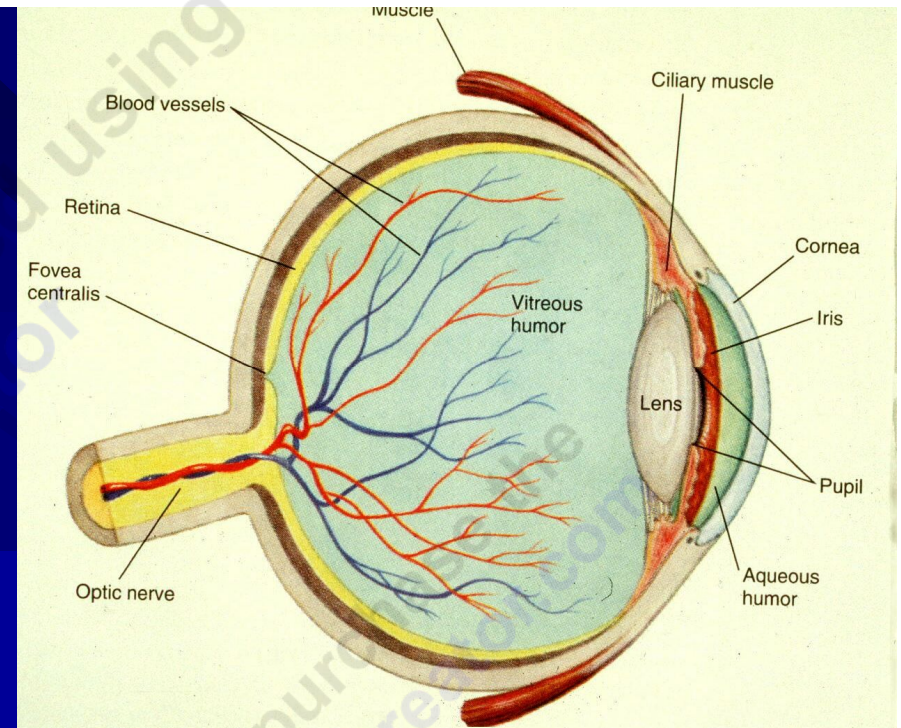
Aqueous Humor

- Fluid produced by ciliary body
→ flows into posterior chamber
→ passes through the pupil into anterior chamber
→ then goes through Canal of Schlemm

(that is present at angle of anterior chamber) → to be reabsorbed into veins
(diffuses into the venous circulation)

- Function

- ✓ nourishing the retina
- ✓ causes intraocular pressure 10-20mm Hg



- Q : What is Glucoma ?
- A: Intraocular pressure more than 20 mmHg
- It causes damage to the optic nerve .

Q: Describe the Retina
and its Receptor Cells
(Photoreceptors) ?

**Receptors in the retina are 2
types : Rods and Cones**

The Retina

- The Retina consists of →
 - Outer pigmented portion (part)
 - Inner neural part , containing **Photoreceptors** (neurons that are receptors for light) called called **Rods** and **Cones** .

- Rods :
 - (1) 120 million per retina
 - (2) increase in number as we go from center to periphery , not present in the fovea
 - (3) are best for vision in dim light (**Scotopic Vision**)
 - (4) are better than cones for detection of flicker (sudden movements of objects).

■ **Cones** : are best for

(1) 6 million per retina

(2) Increase in number as we go from periphery towards the fovea ; and are maximally concentrated in the fovea (which contains no rods) , not present in the fovea

(3) are best for vision in daylight/bright light
(**Photopic Vision**)

(4) detect colors (Color Vision)

(3) are best for perception of detail (i.e., acuity of vision)

- 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

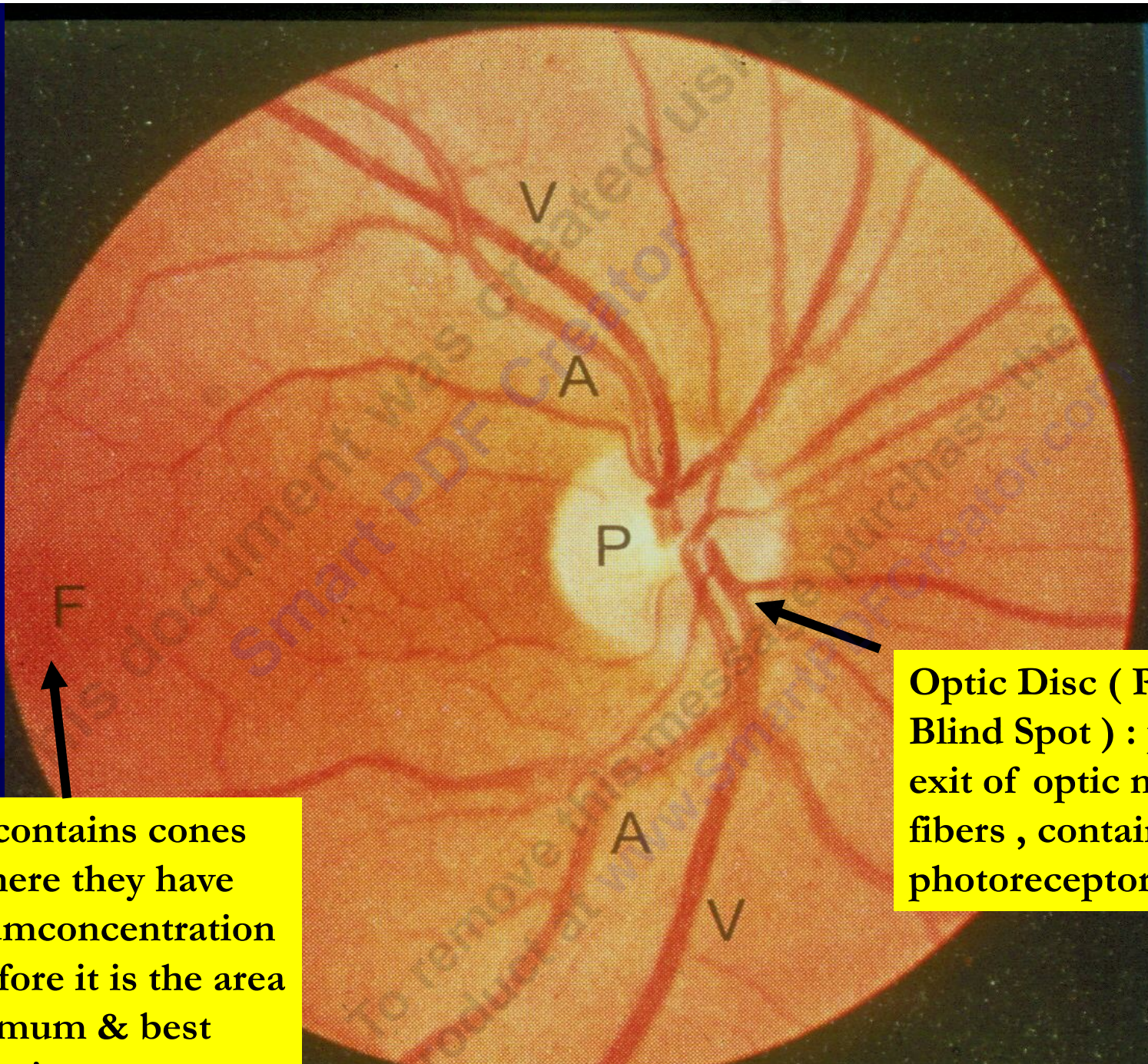
PHOTORECEPTORS

Rods

- ✓ Abundant in the periphery of the retina
- ✓ Best for low light conditions (dim)
- ✓ Detect black/white and shades of gray

Cones

- ✓ Abundant around fovea
- ✓ Best for bright light conditions
- ✓ Detect all colors

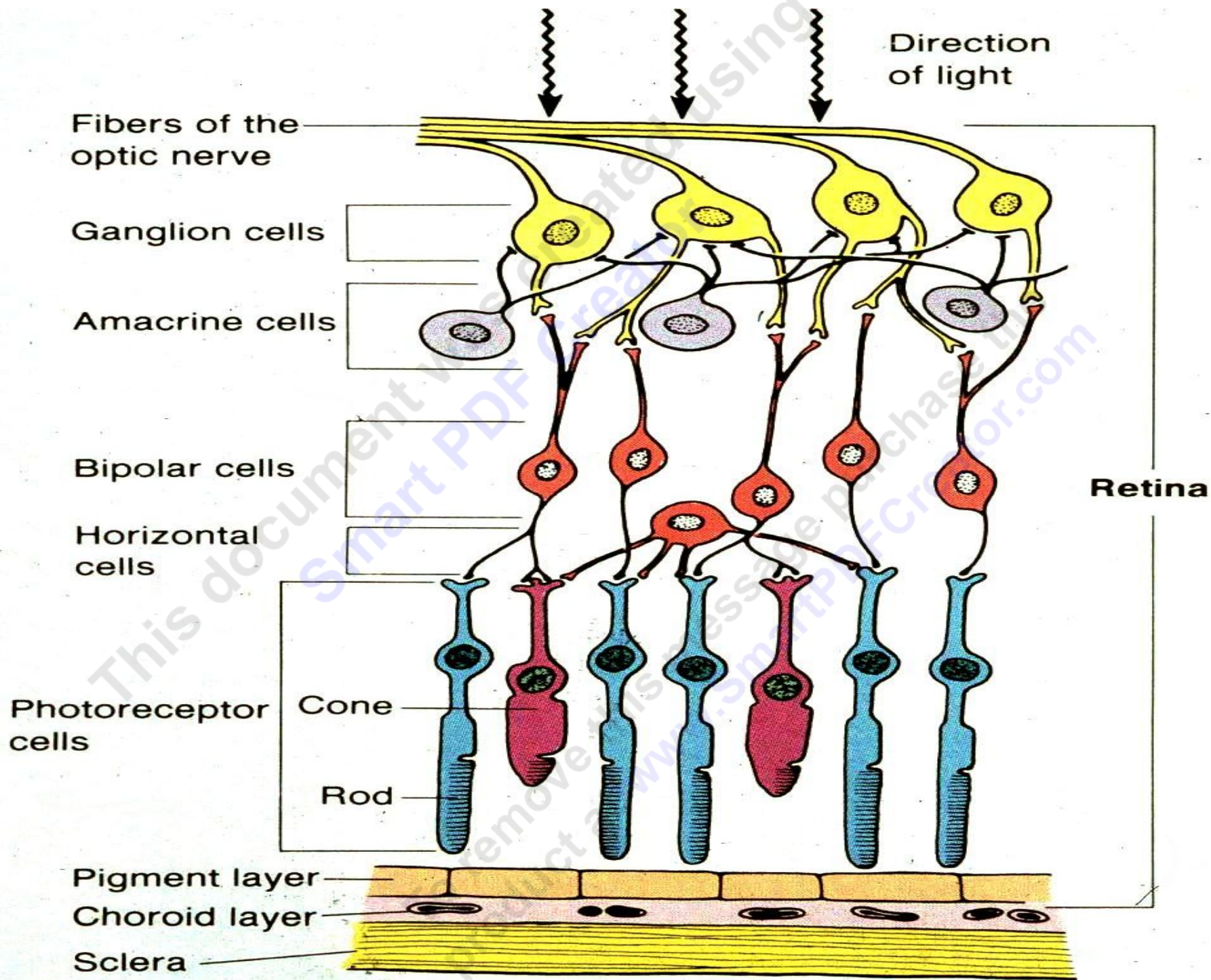


Fovea : contains cones only & here they have maximum concentration
→ therefore it is the area of maximum & best visual acuity

Optic Disc (Papilla , Blind Spot) : point of exit of optic nerve fibers , contains no photoreceptors

Layers of the Retina

- The Retina consists of →
- (1) outermost pigment cell layer (Q : what is its value ?)
- (2) inner neural part , containing the **Photoreceptors (Rods & Cones)**
- (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)
- (7) ganglion cell layer
- (8) optic nerve fibers (1.2 million fibers)



Q: What are the advantages of Binocular vision over Monocular vision ?

- 1- Large visual field
- 2- Cancels effect of blind spot
- 3- Stereoscopic vision
- 4- One eye lesion does not affect vision

Refraction in the Eye & Image Formation

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Refractive Media of the Eye

1-Cornea (**greatest refraction of light**)

- dioptric power 40-45 D at ant surface
- (2/3 refractive power of eye)

2-Aqueous humour

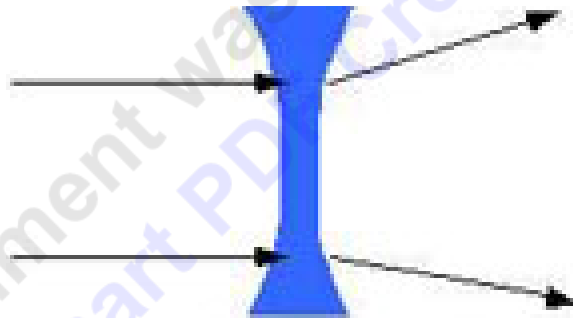
- (fluid produced by ciliary body ---to post chamber---
 - to pupil---to ant chamber----to canal of schlemm at angle of ant chamber---to veins
- Function//
- -nourishing retina
- -causes intraocular pressure 10-20mm Hg

- **3-lens:-** diopteric power 15-20 D
- **-(1/3 refractive power of eye) , more important than cornea. why?**
- **4-Vitrous humour** (between retina & lens for nourishing retina & keep spheroid shape of the eye)*

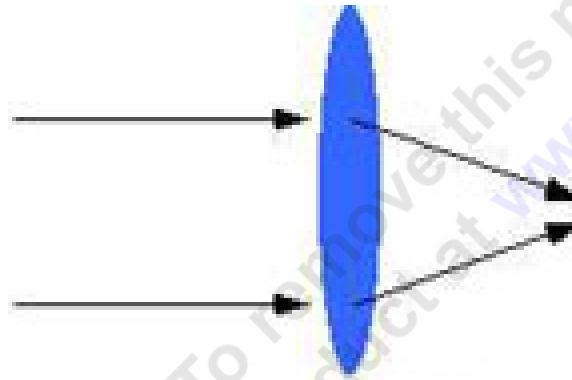
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Principles of optics:-

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



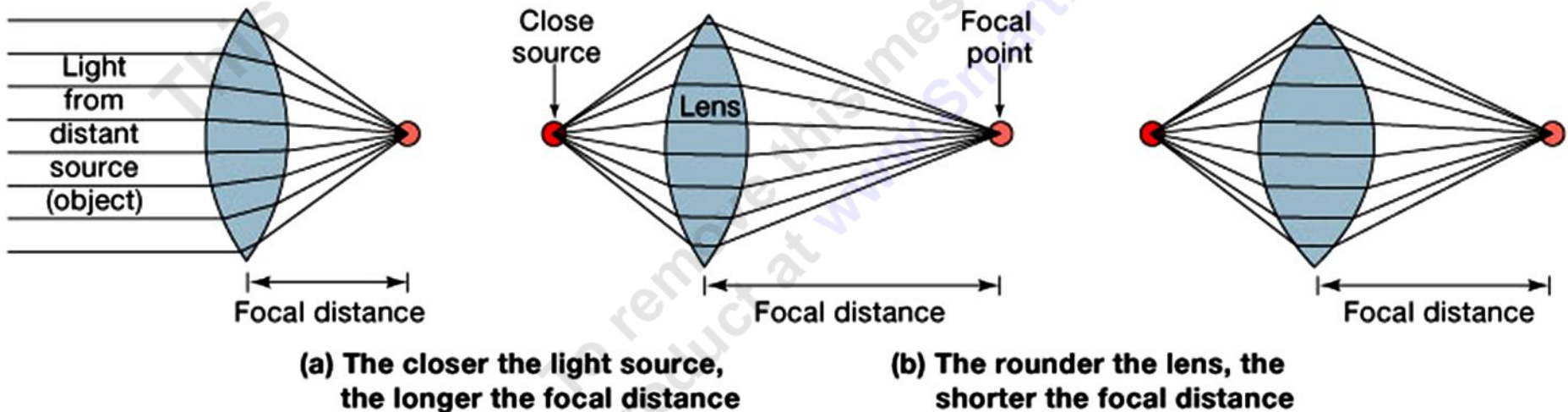
Concave lens



Convex lens

• Principles of optics

- Biconvex lens(**converge**) & biconcave lens(**diverge**)
- **Diopter** (measure of refractive power) = $1 / \text{Principal focal distance in meters}$
- Exp/ if Principal focal distance of a lens is 25cm,so its R.P= $1/0.25 \text{ meter} = 4\text{D}$
- **Emmetropic eye**;-normal eye has image on retina,has diopteric power 60D
- **Lens-retina** distance =15mm
- The greater the curvature of the lens, the greater the refractive power of the eye.

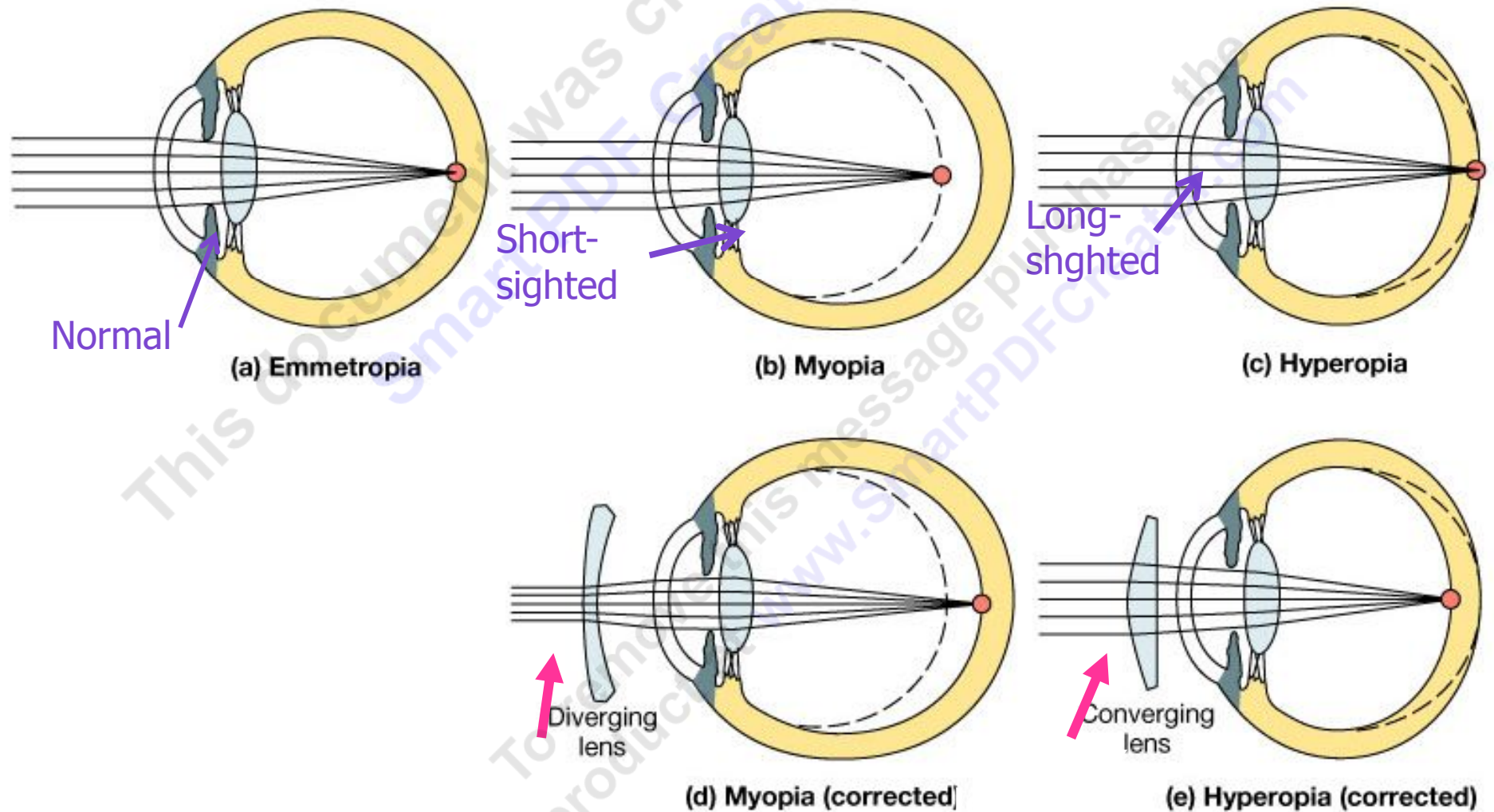


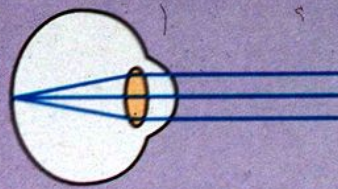
• Errors of refraction

- 1-Hypermotropia (hyperopia = farsightedness)
- (small eyeball, focus behind retina,
- headache&blurred vision
- continuous accommodation—muscular effort--- cause headache, prolonged convergence by accommodation---squint
- correction by biconvex lens)
- 2-Myopia(nearsightedness)
- (genetic,large eye ball, long anteroposterior diameter,or extensive close work as in studying----- cause focus in front of retina
- correction by biconcave lens

- **3-Presbyopia** (eye near point recedes by age due to loss of accommodation)
- - correction by biconvex lens
- **4-Astigmatism** (uneven & ununiform corneal curvature)
- -rays refracted to diff focus-----blurred vision
- -correction by cylindrical lens

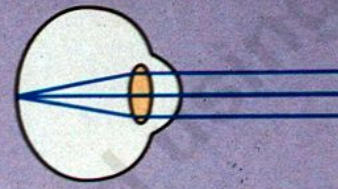
Visual Abnormalities



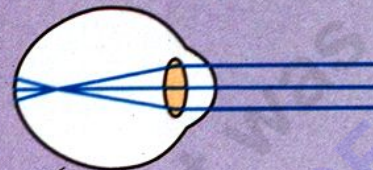


Normal sight
Rays focus on retina

(a)

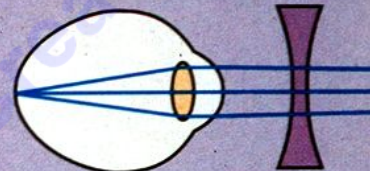


No correction necessary

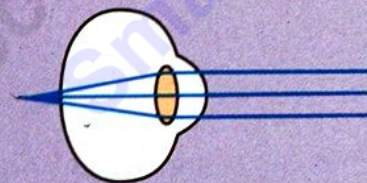


Nearsightedness
Rays focus in front of retina

(b)

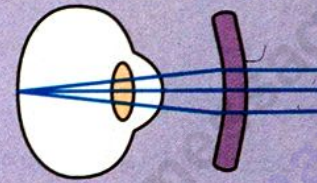


Concave lens corrects
nearsightedness

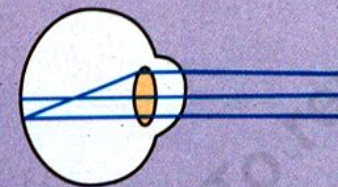


Farsightedness
Rays focus behind retina

(c)

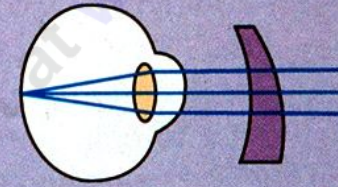


Convex lens corrects
farsightedness



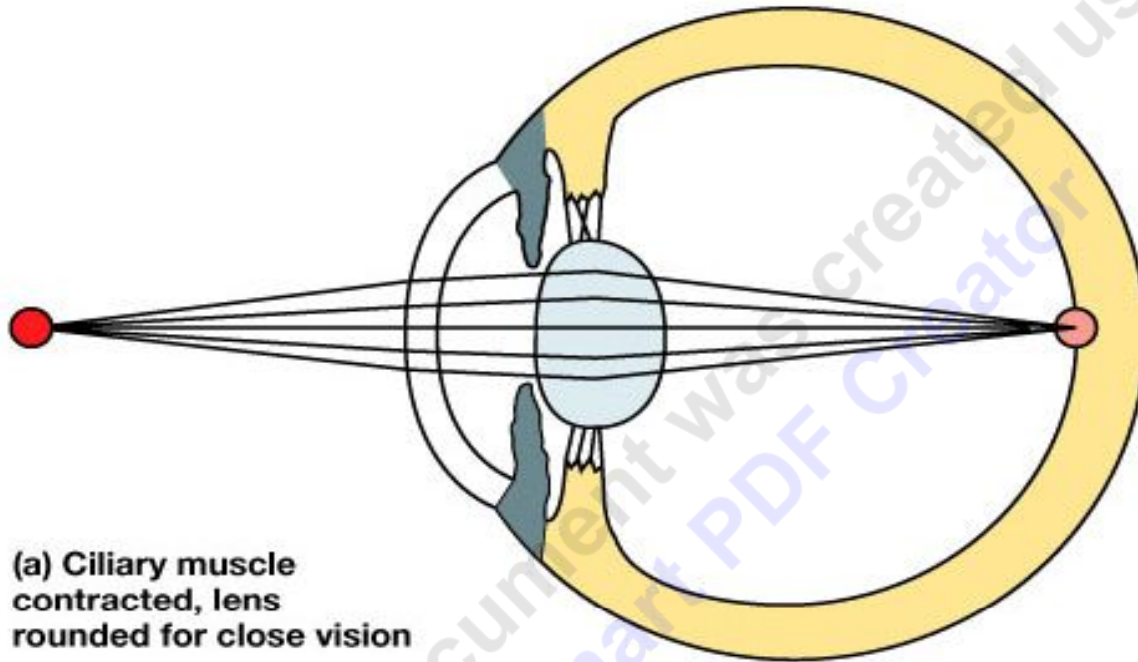
Astigmatism
Rays do not focus

(d)



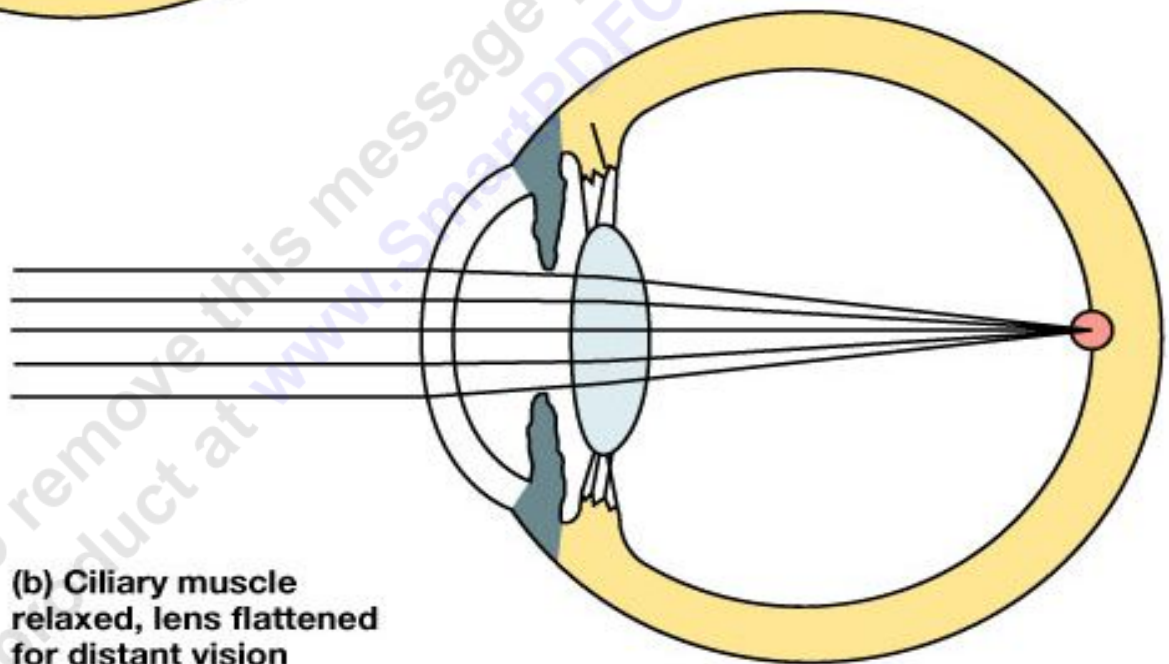
Uneven lens corrects
astigmatism

Accommodation



(a) Ciliary muscle contracted, lens rounded for close vision

(1) When you look at a distant object the ciliary muscle is relaxed and the suspensory ligament is taut, pulling on the lens and making it thinner → reducing its refractive power.



(b) Ciliary muscle relaxed, lens flattened for distant vision

(2) Once you shift your gaze from the distant object to focus on a close object, the Ciliary muscle contracts → relaxing the Suspensory ligament → allowing the lens to bulge and increase in thickness → thereby increasing its refractive power (focusing on a close object).



Thanks