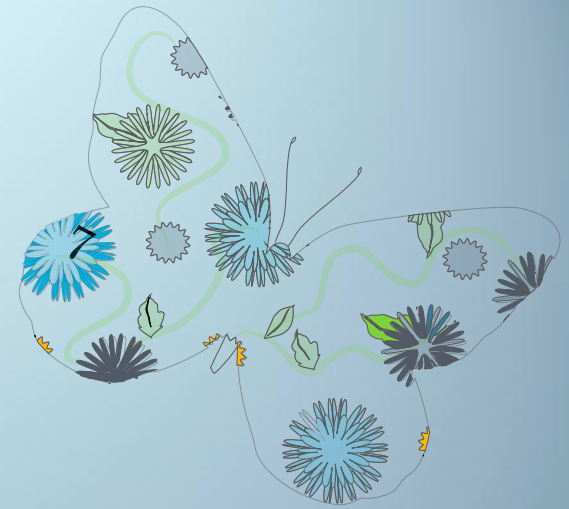


Conjunctiva



# Vision

1-Physiology of the eye & Refraction

By

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College of medicine-King Saud

University

Physiology Dept



## OBJECTIVES:-

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

to :-

- Describe different components of the eye and function of each and -understand the eye protection media
- Describe the refraction of light as it passes through the eye to the retina, identifying 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*



# FUNCTIONS OF VISION



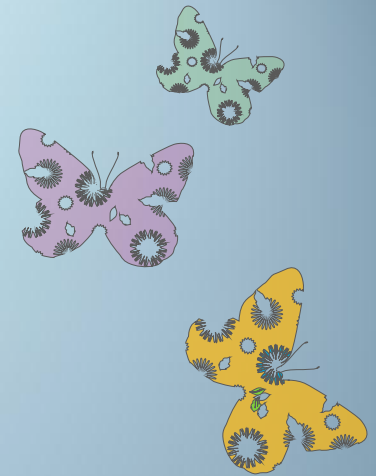
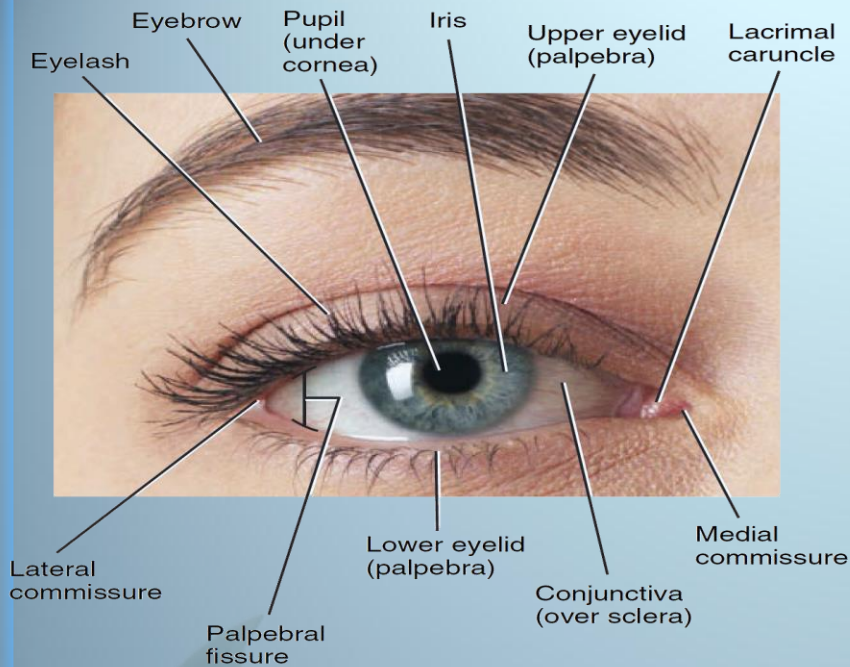
DISCRIMINATION  
– LIGHT VS.  
DARK



DETECTION OF  
MOVEMENT

DETECT COLOUR  
(ADAPTIVE  
VALUE OF  
COLOUR VISION)





# EYE HAS:-

1- Refracting Media

2- Coats (Sclera, Choroid and Retina)

3- Post 2/3 Retina, Ant 1/6 Cornea



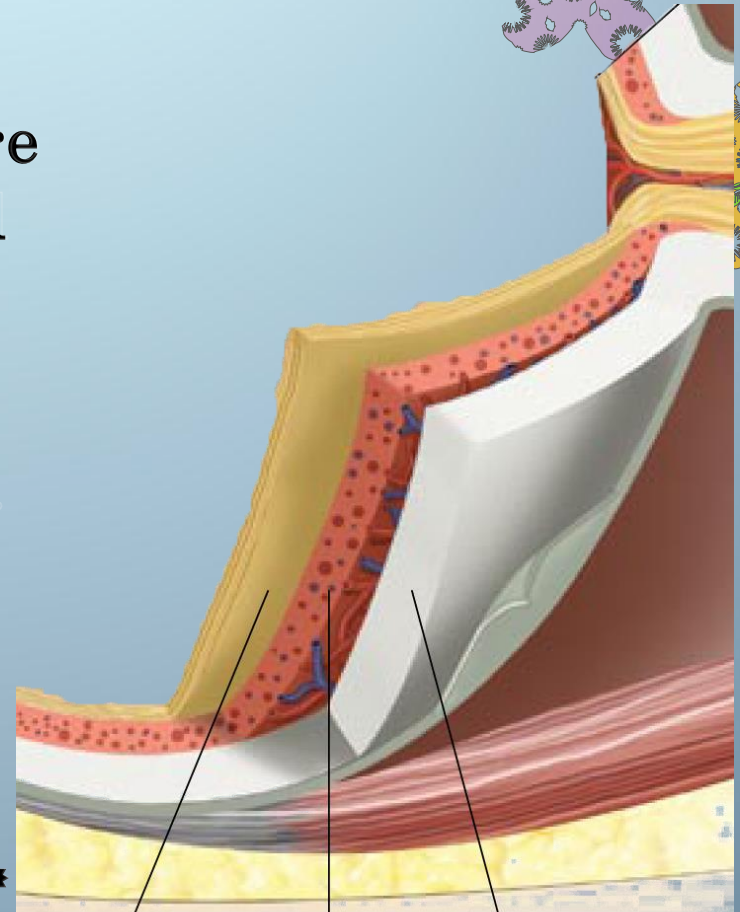
# THE EYE IS A FLUID FILLED SPHERE

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

the sclera is a tough outer \* covering of connective tissue.

the middle layer is the \* choroid containing blood vessels.

the retina is the innermost \* layer which contains light sensitive cells



Retina

Choroid

Sclera

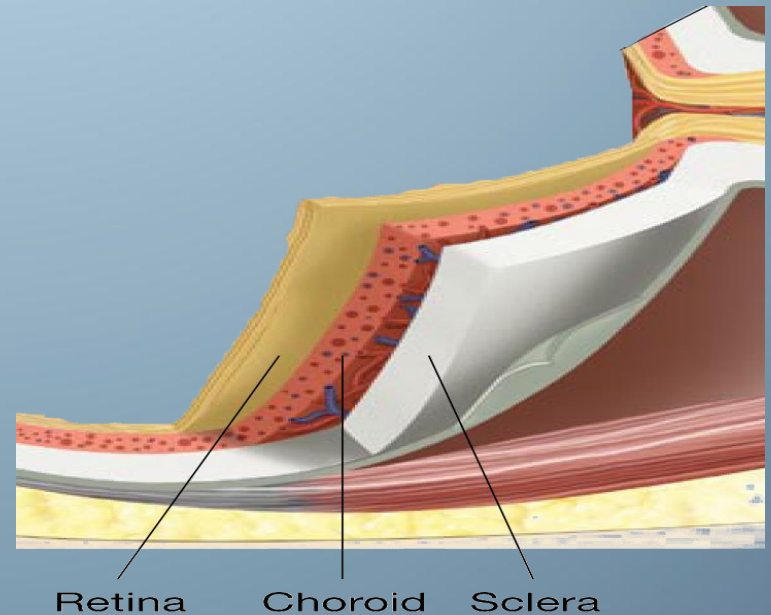
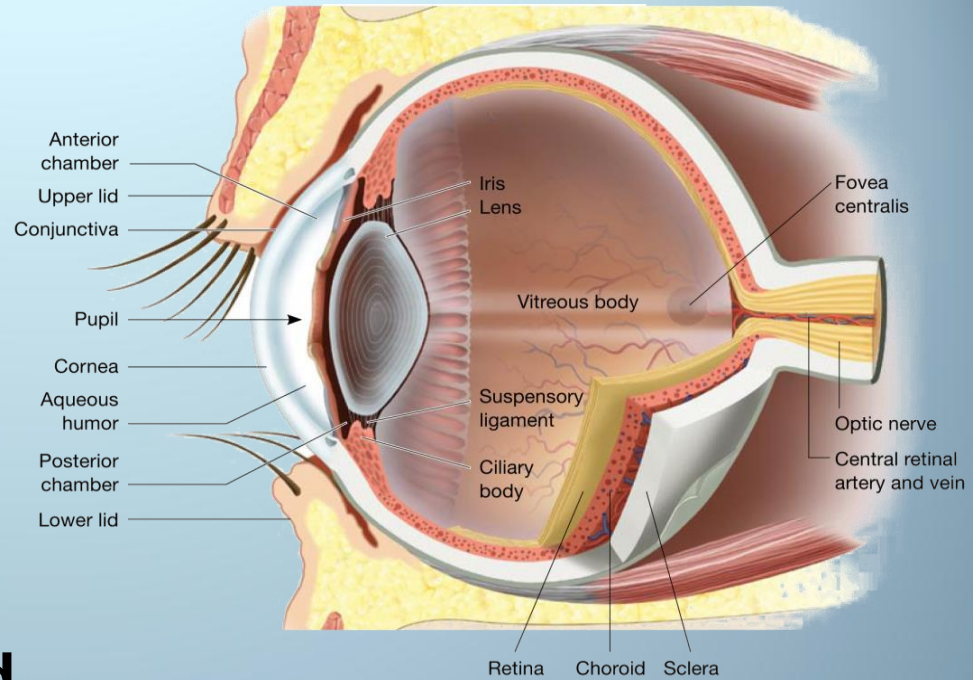
# Anatomy of the eye:

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

## **-Choroids**

**-inside sclera , highly vascular has BV to supply retina with blood**  
**-the capillaries in the choroid underlying the pigment epithelium are the primary source of nourishment for retinal photoreceptors & oxygen to rods and cones**

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

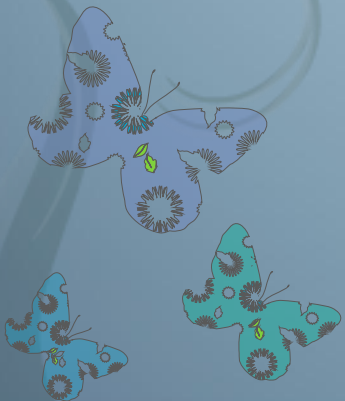
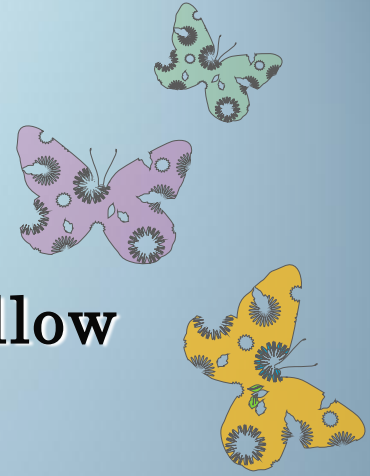
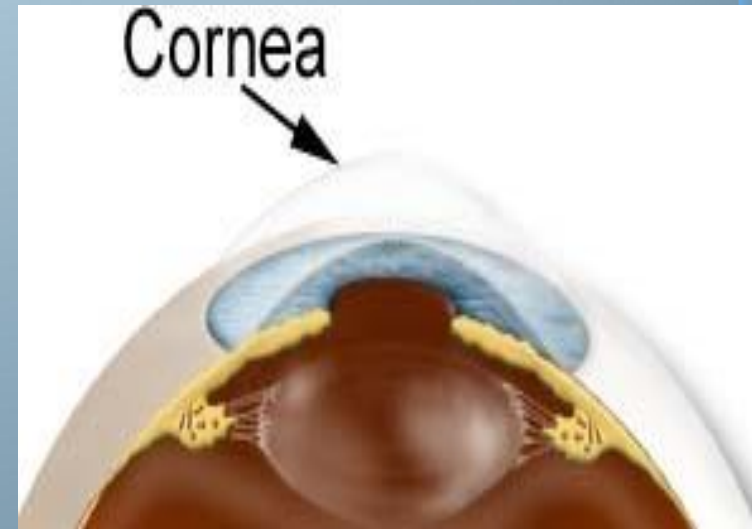


**2- cornea** ( modified ant 1/6 of sclera ) to allow light to enter the eyes, transparent , avascular.

Q.From where it gets its nutrition?

-Refractive or dioptric power

**40-45 D at its anterior surface.**

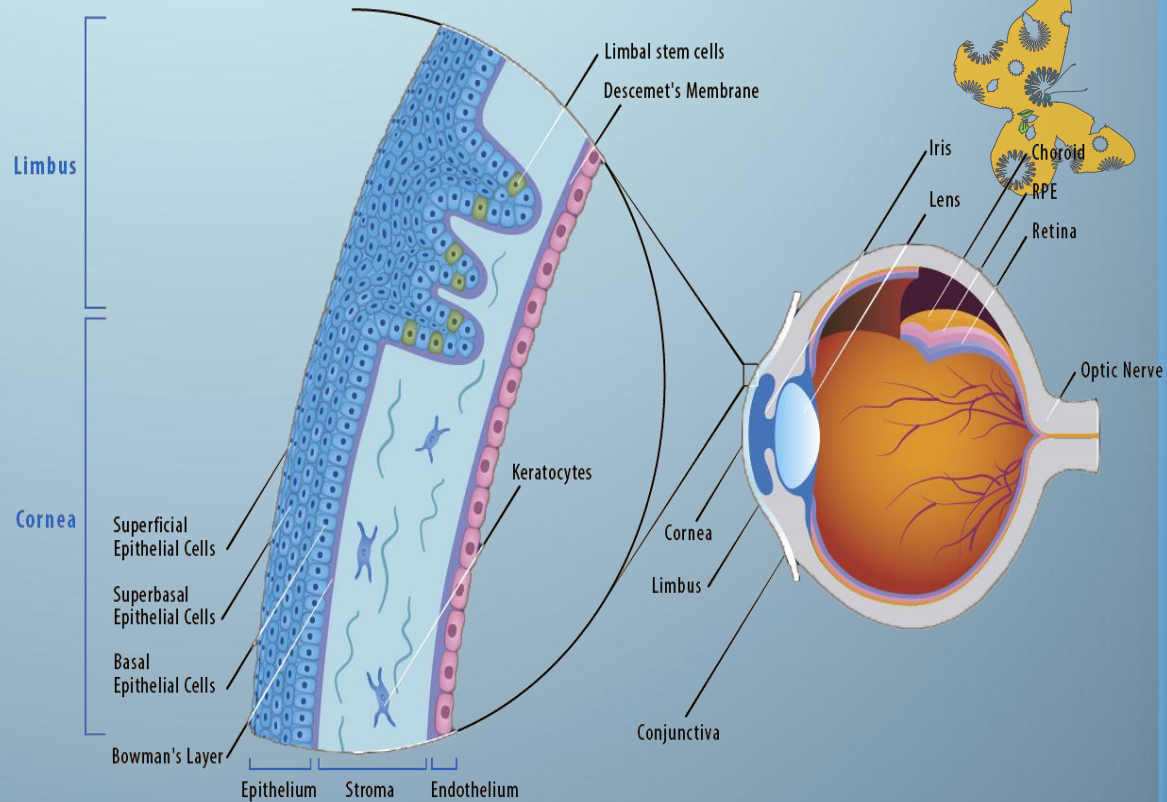


TRANSPARENCY IS OF PRIME IMPORTANCE FOR THE CORNEA AND THEREFORE IT **DOES NOT HAVE BLOOD VESSELS**

IT RECEIVES NUTRIENTS VIA DIFFUSION FROM THE TEAR FLUID THROUGH THE OUTSIDE SURFACE

AND FROM THE AQUEOUS HUMOUR THROUGH THE INSIDE SURFACE,

FROM NEUROTROPHINS SUPPLIED BY NERVE FIBRES THAT INNERVATE IT.



**YOU DON'T HAVE TO KNOW THE HISTOLOGY**

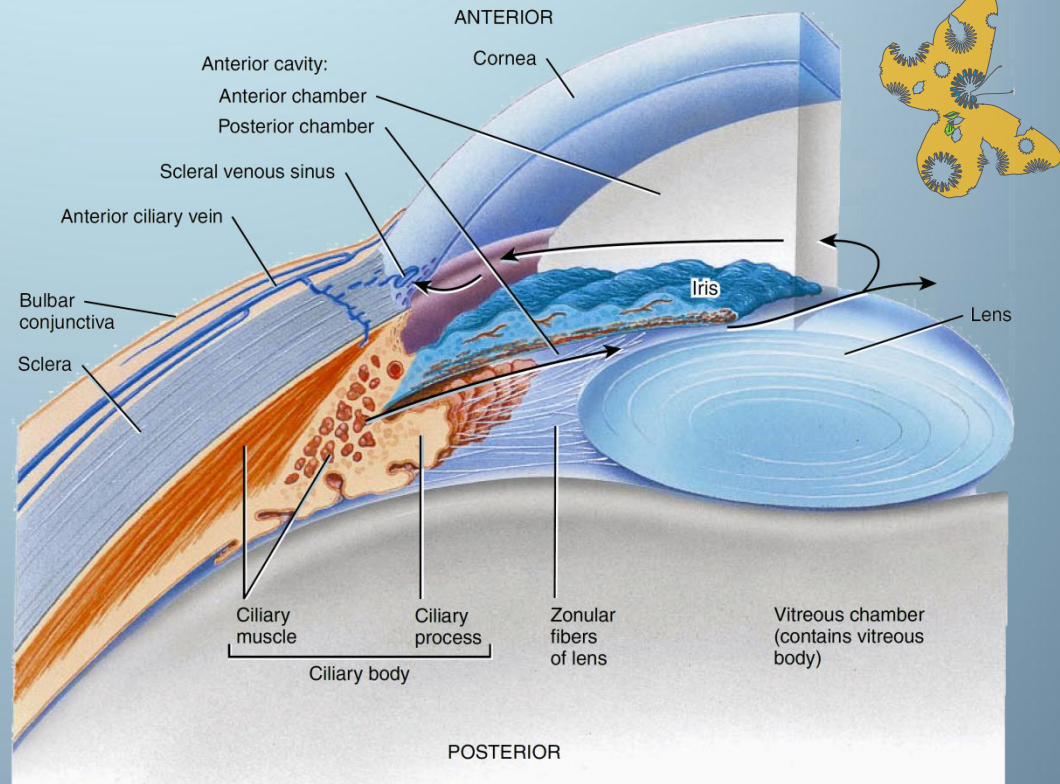
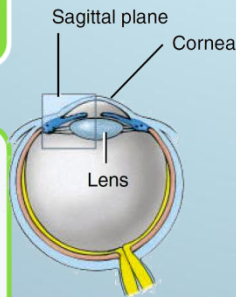


THE CORNEA HAS NO BLOOD SUPPLY; IT GETS OXYGEN DIRECTLY THROUGH THE AIR.

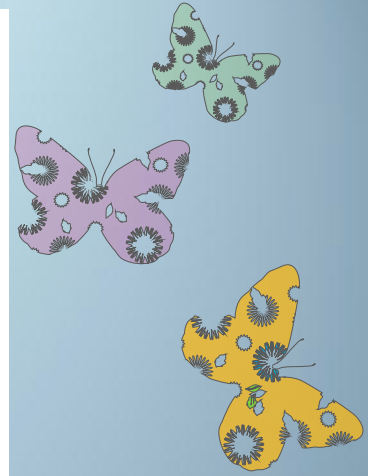
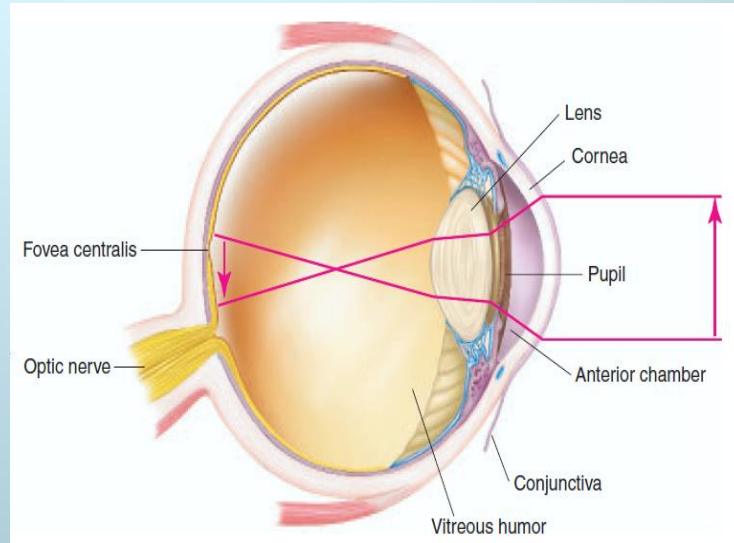
OXYGEN FIRST DISSOLVES IN THE TEARS AND THEN DIFFUSES THROUGHOUT THE CORNEA

THE ENVIRONMENT SUPPLIES ALMOST ALL OXYGEN NEEDED FOR TISSUE RESPIRATION IN THE OPEN EYE.

IN THE CLOSED EYE, ABOUT TWO THIRDS OF THE OXYGEN DEMAND IS MET BY DIFFUSION FROM THE CAPILLARIES AND THE REST FROM THE ANTERIOR CHAMBER

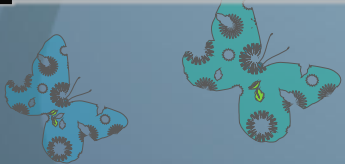


IN HUMANS, THE CORNEA HAS RESIDENT IMMUNE CELLS



### 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

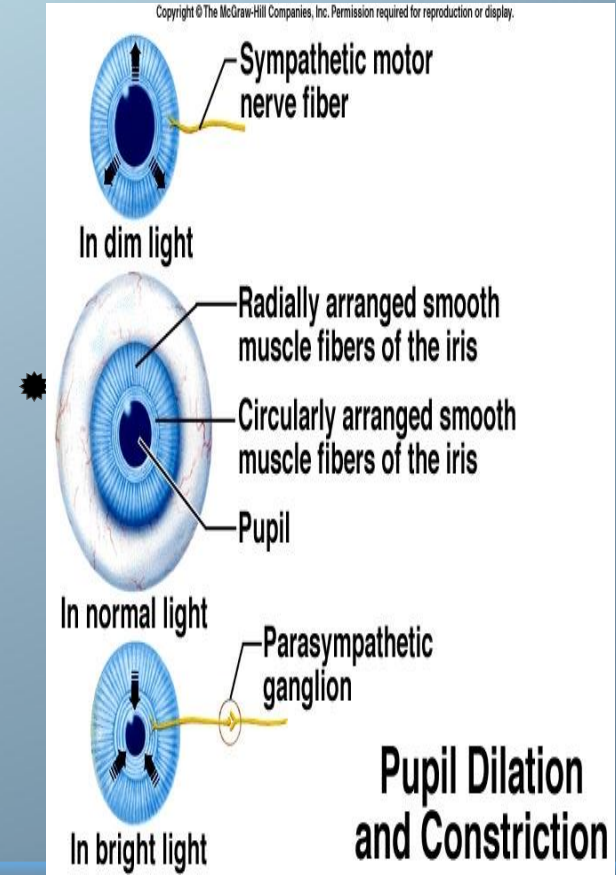
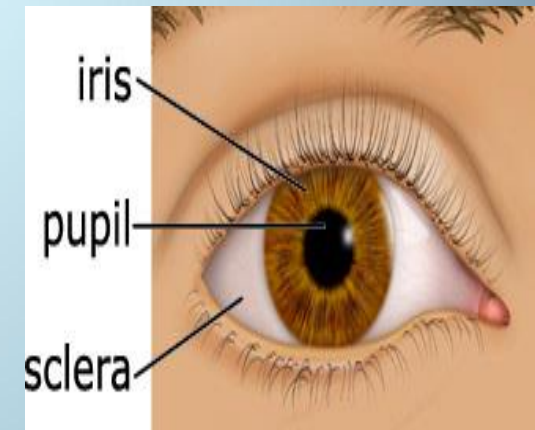


4- pupil / behind center of cornea, control & allow light to enter the eye, appears black because, as you look through the lens, you see the heavily pigmented back of the eye (choroid and retina)

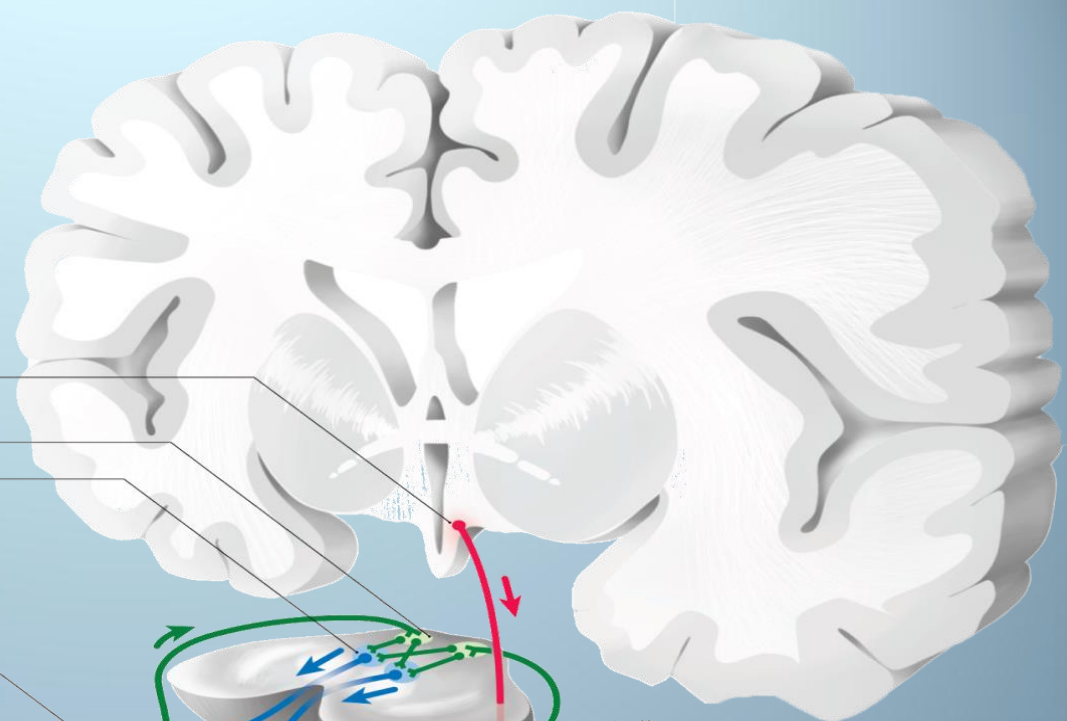
e \*

5- 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

-the eyes appear brown to black when the iris contains a large amount of melanin, and blue due to low melanin.



- **Sensory**
- **Sympathetic**
- **Parasympathetic**



Hypothalamus  
 Pretectal nucleus  
 Edinger-Westphal nucleus

Optic n. & chiasm  
 Oculomotor n.  
 Ciliary ganglion  
 Short ciliary n.

Midbrain  
 Pons  
 Trigeminal n.

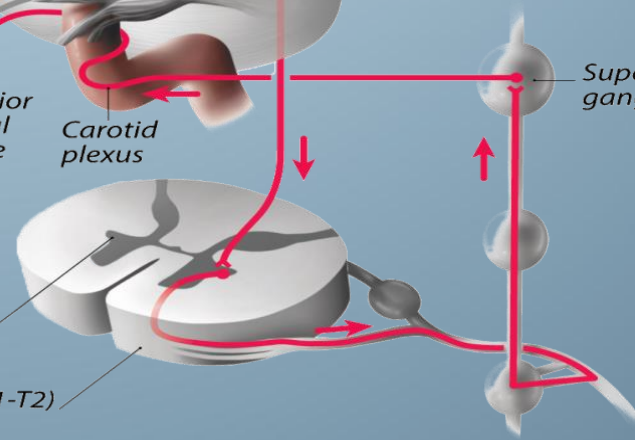


Superior orbital fissure  
 Carotid plexus

Superior cervical ganglion

Sphincter pupillae m.  
 Dilator pupillae m.  
 Long ciliary n.

Intermediolateral cell column  
 Spinal cord (T1-T2)



## 6-cilliary muscles (body)

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

## 7- lens

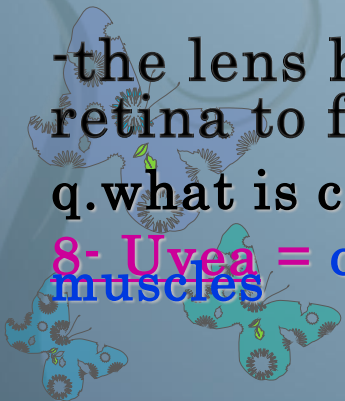
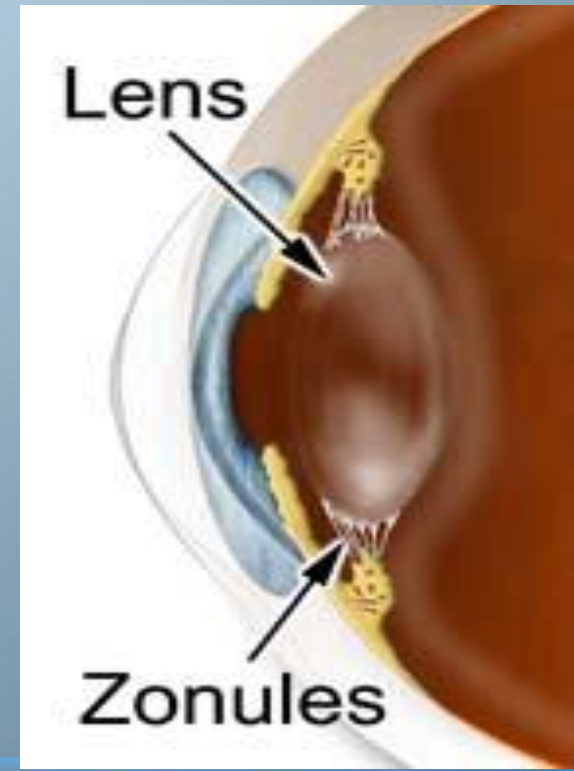
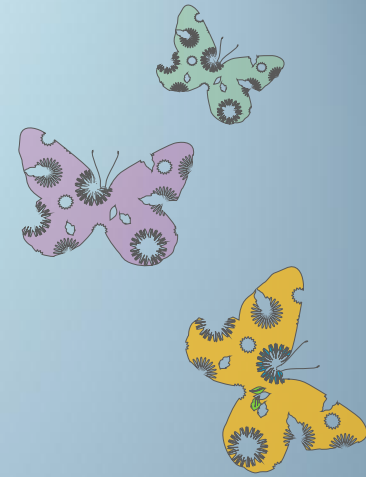
transparent, biconvex, semisolid,  
dioptric power 15-20 D,  
held in place by zonule  
(lens ligament= suspensory ligament)  
attached to ant part of cilliary body

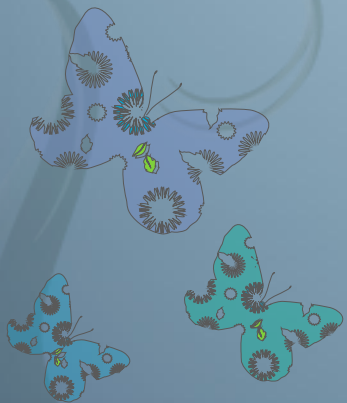
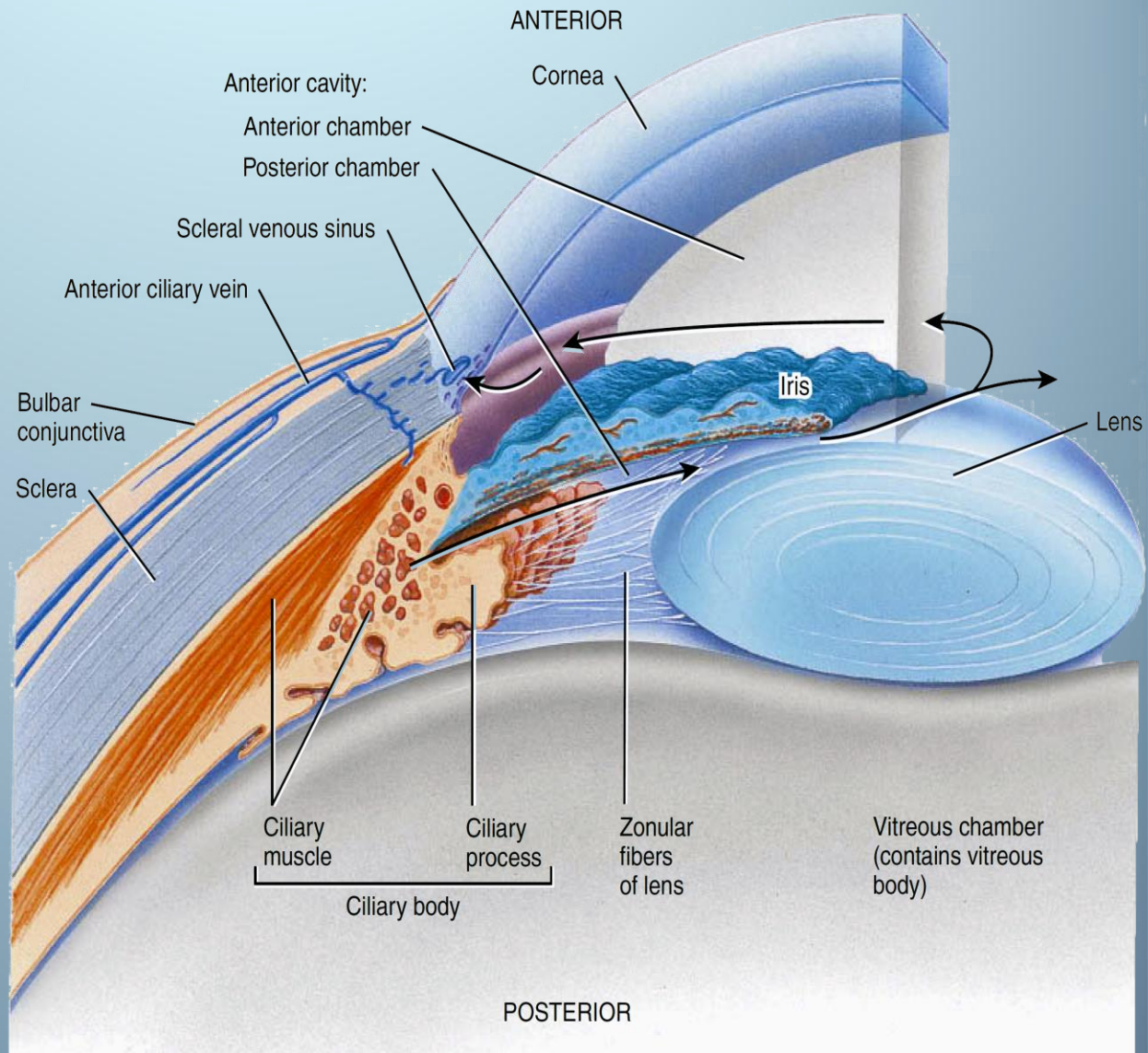
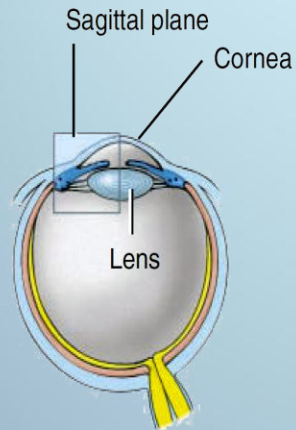
within the cells of the lens, proteins called crystallins are arranged like the layers of an onion, this makes up the refractive media of the lens

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

q.what is cataract?

8- Uvea = choroid + iris + cilliary muscles

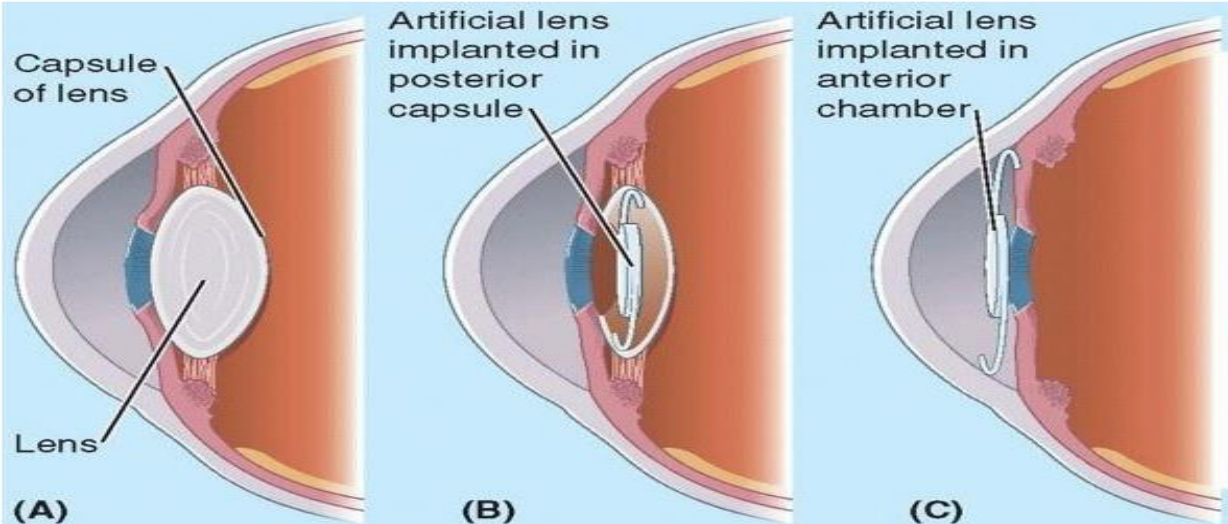




**Cataracts” occurs in older people. is a cloudy or opaque area or areas in the lens**

- the proteins in some lens fibers become denatured and coagulate to form opaque areas .**
- When a cataract has obscured light transmission so greatly that it impairs vision**

- An extracapsular cataract extraction involves removing the lens but leaving the capsule to put synthetic lens .**
- Intracapsular lens extraction removing the lens and capsule, and implanting a synthetic lens in the anterior chamber**

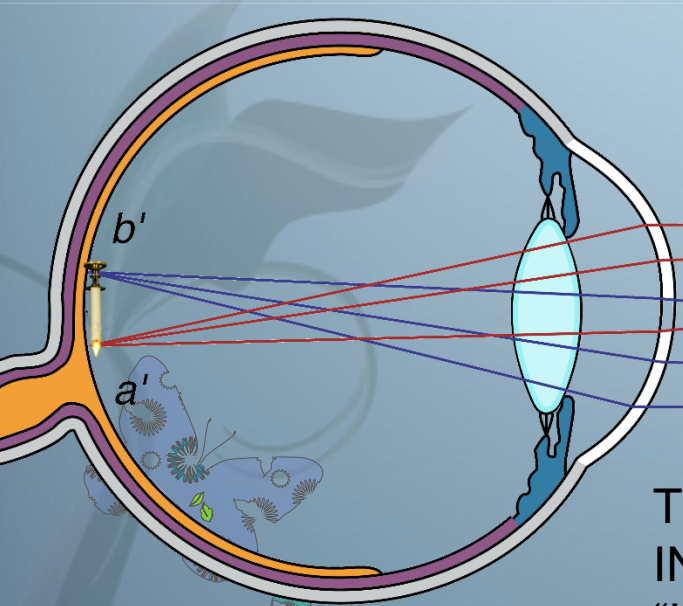
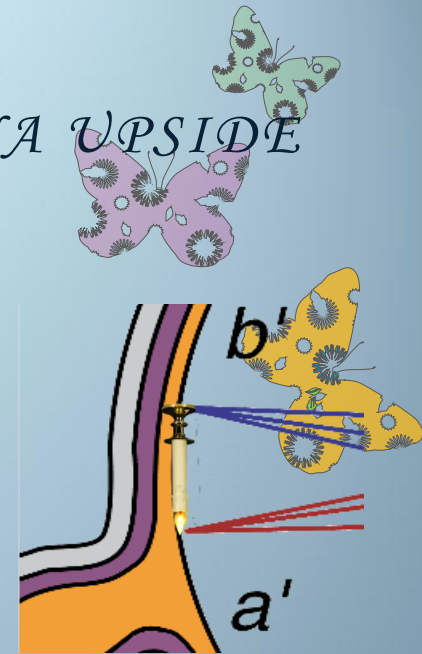


*THE IMAGE IS PROJECTED ONTO THE RETINA UPSIDE DOWN*  
*DOWN*

THE LENS SYSTEM OF THE EYE WILL FOCUS AN IMAGE ON THE RETINA UPSIDE DOWN

THE IMAGE IS INVERTED AND REVERSED WITH RESPECT TO THE OBJECT.

HOWEVER, THE BRAIN PERCEIVES OBJECTS IN THE UPRIGHT POSITION DESPITE THE UPSIDE-DOWN ORIENTATION ON THE RETINA



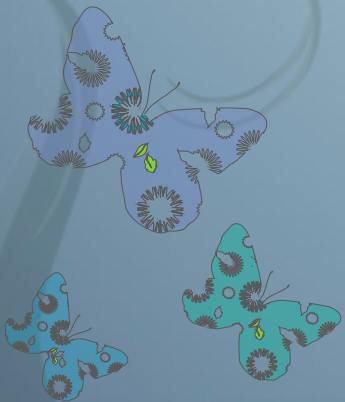
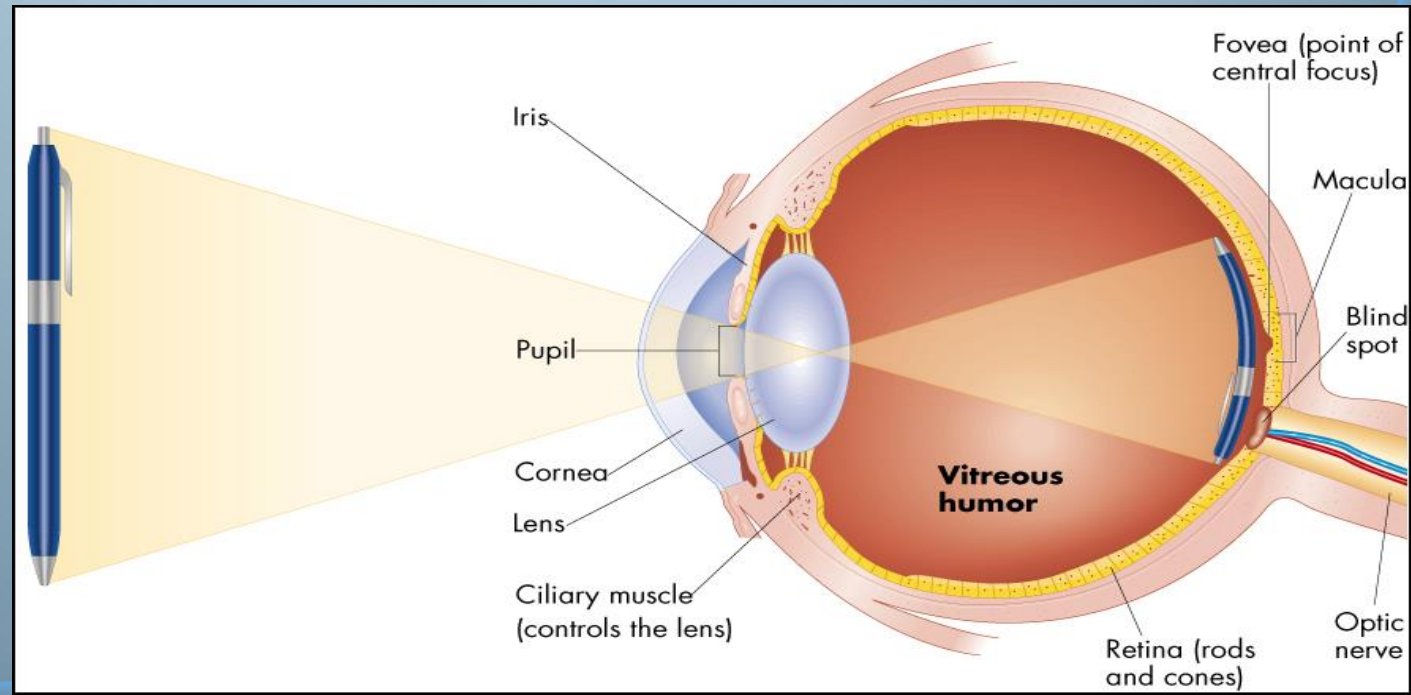
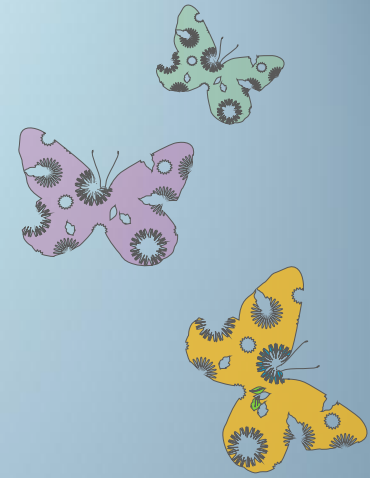
THE REASON THE WORLD DOES NOT LOOK INVERTED AND REVERSED IS THAT THE BRAIN “LEARNS” EARLY IN LIFE TO COORDINATE VISUAL IMAGES WITH THE ORIENTATIONS OF OBJECTS.





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

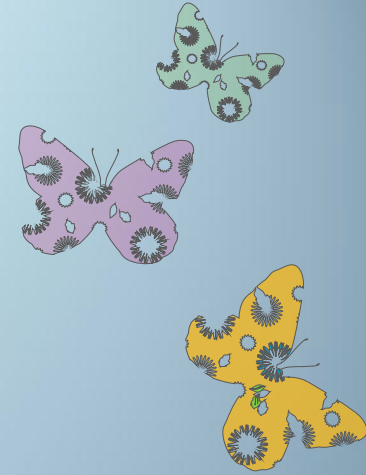
-posterior chamber of the eye /  
Between iris & ciliary muscles  
- Iris between both



# 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*



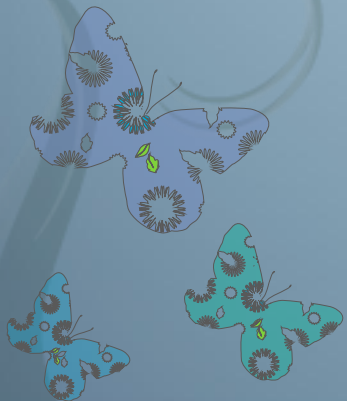
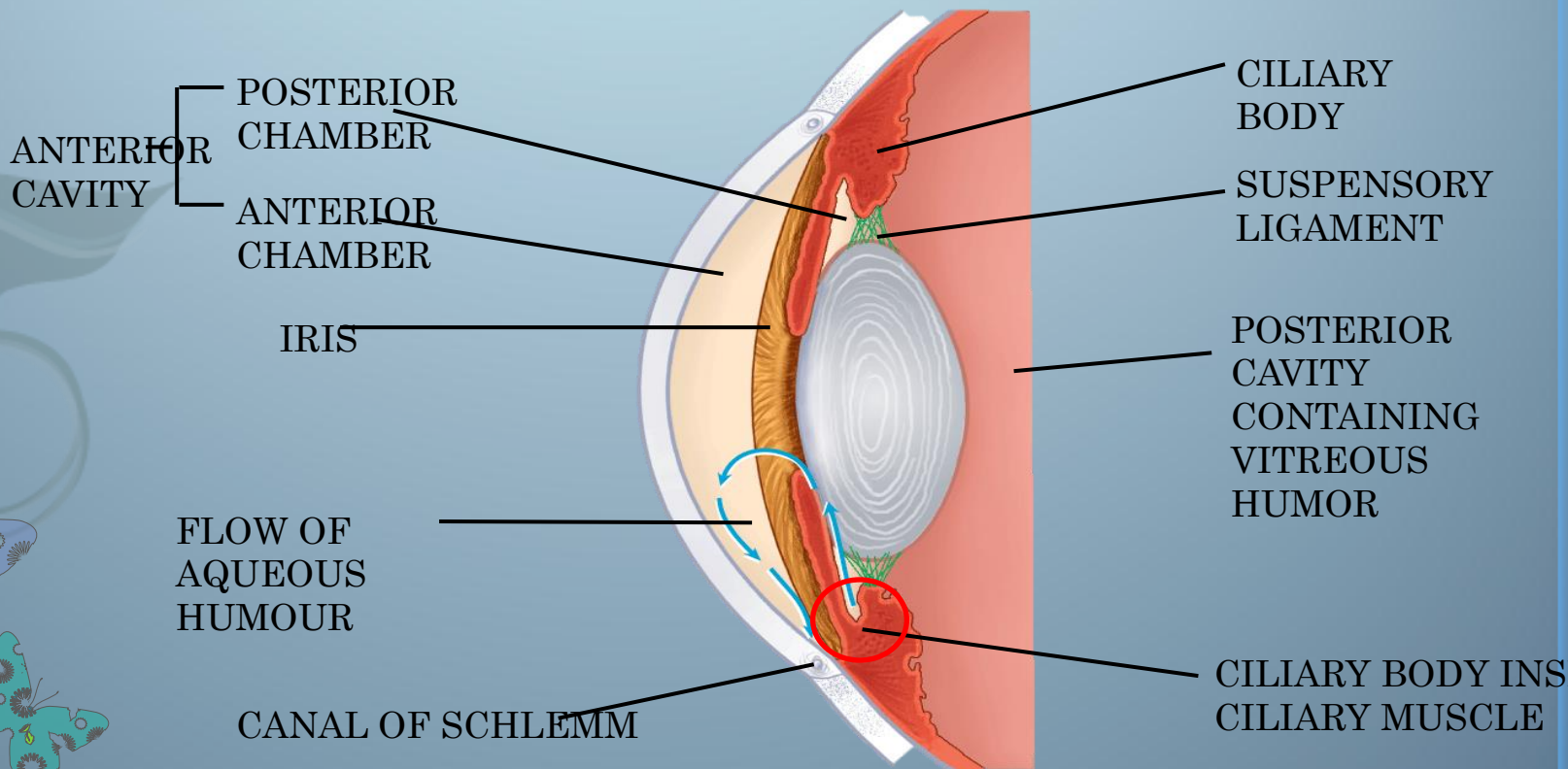
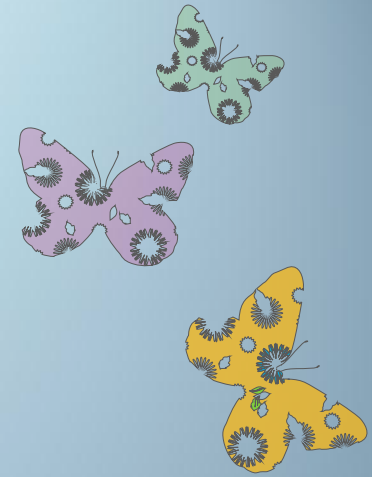
# Refractive media of the eye:-

## 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.

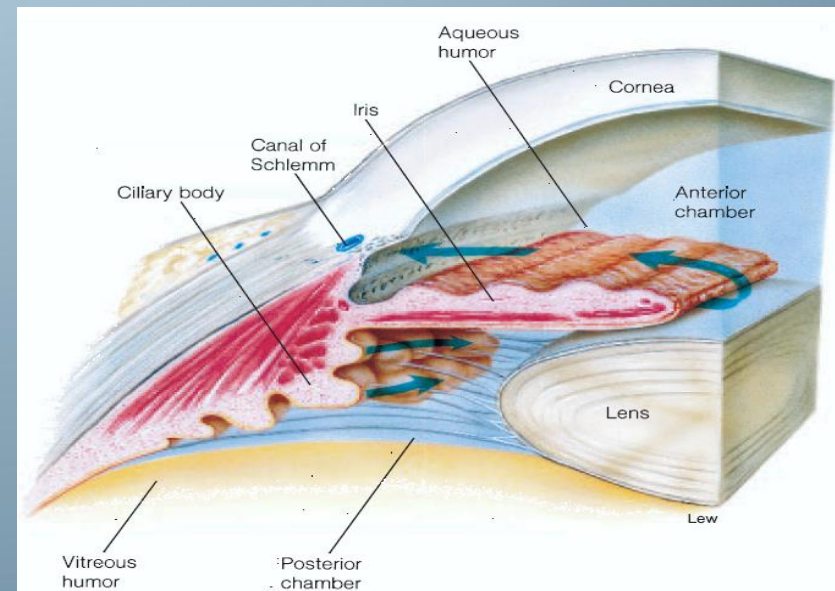
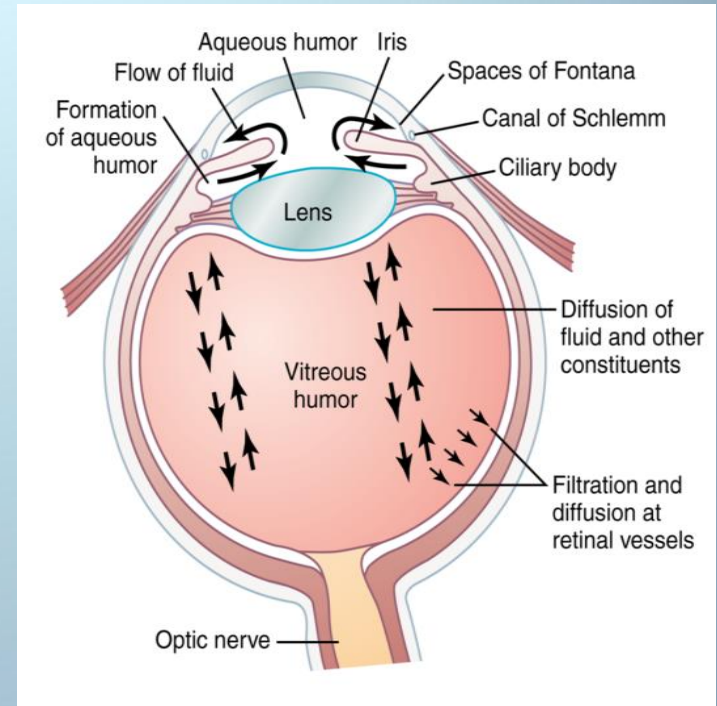
# 2-THE AQUEOUS HUMOUR

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



## -The aqueous humor

- is continually being formed and reabsorbed.
  - The balance between its formation and reabsorption regulates the total volume and pressure of the intraocular fluid
  - **nourishes the cornea and iris**
  - **produced in the ciliary body** by an active secretion by ciliary processes..
- GO TO → **posterior chamber** >>> to **pupil** >>>> **ant chamber** >>>> **drained into canal of Schlemm** in anterior chamber angle, which is a venous channel at the junction between the iris and the cornea ( anterior chamber angle ).
- 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)

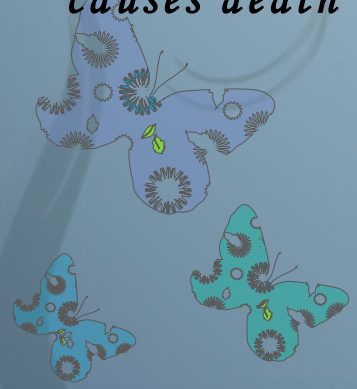
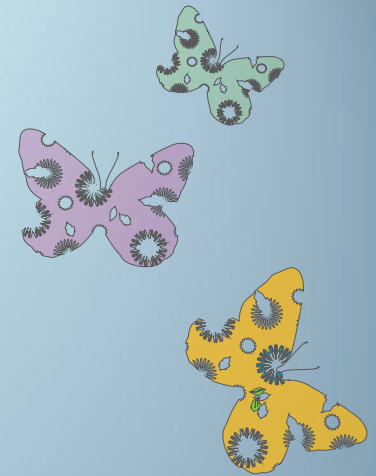
-Why it causes damage of optic nerve?

*obstruction of AQH outlet leads to increased intraocular pressure.*

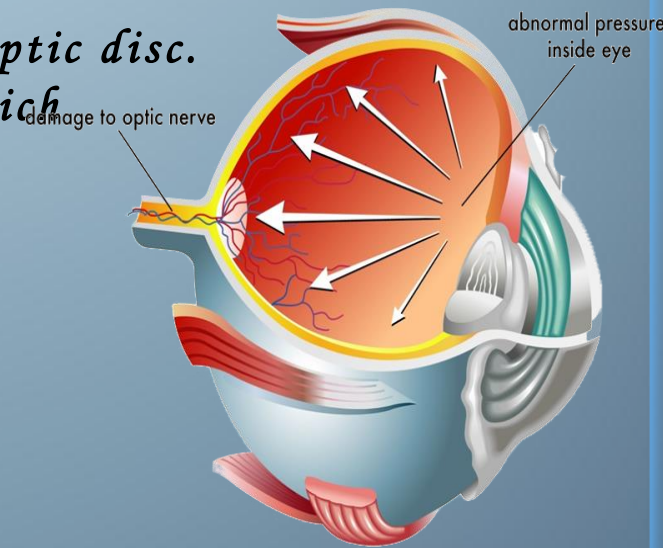
*excessive aqueous humour pushes the lens backwards into vitreous, which pushes against the retina.*

*this compression causes retinal and optic nerve damage that can cause blindness if not treated?*

*the axons of the optic nerve are compressed at the optic disc. This lack of nutrition of the optic nerve fibers, which causes death of the involved fibers & blindness*



GLAUCOMA



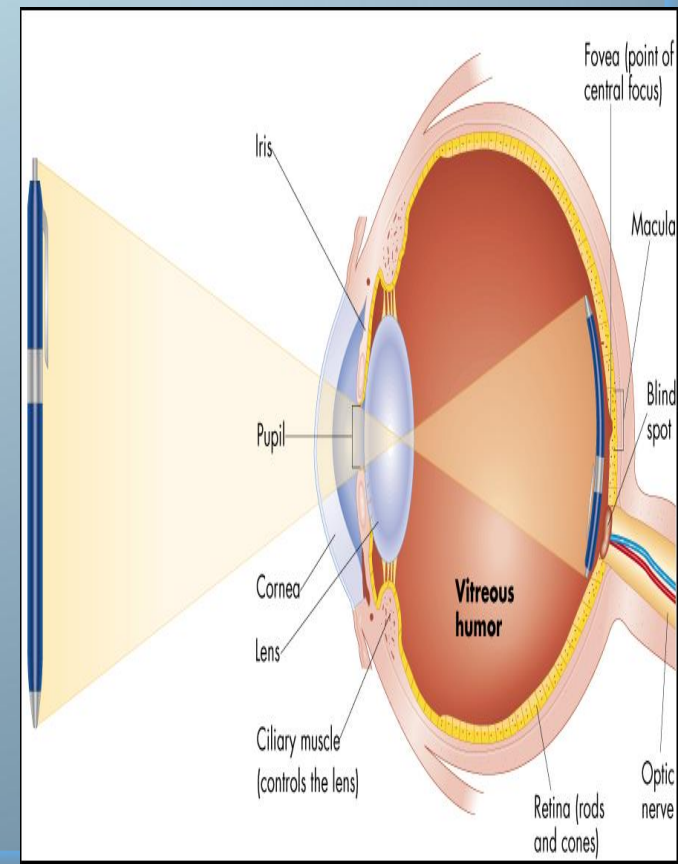
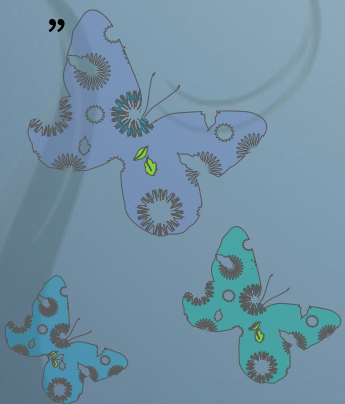
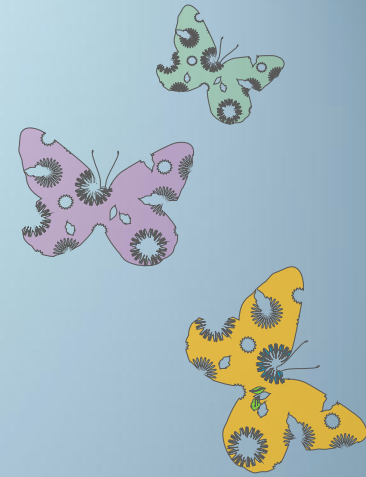
## 3-lens:-

- Has dioptric 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,

”



## 4-THE VITREOUS HUMOUR

- between the posterior surface of the lens and the retina

(for nourishing retina & keep spheroid shape of the eye)

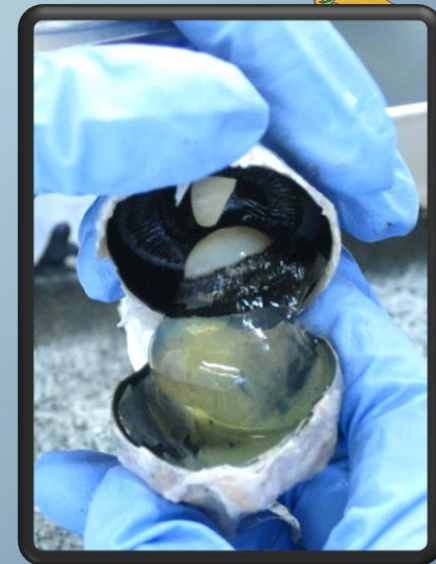
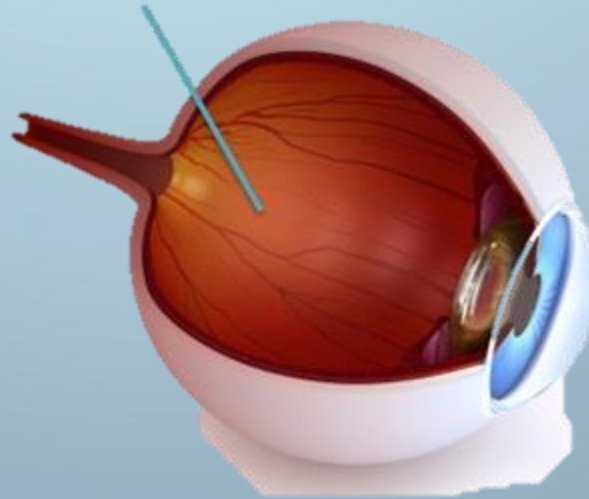
-is the transparent, colourless, gelatinous mass

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

both water and dissolved substances can diffuse slowly in the vitreous humour

### THE VITREOUS HUMOUR



● VITREOUS HUMOUR REMAINS FROM BIRTH



**Lens-retina distance =15mm**

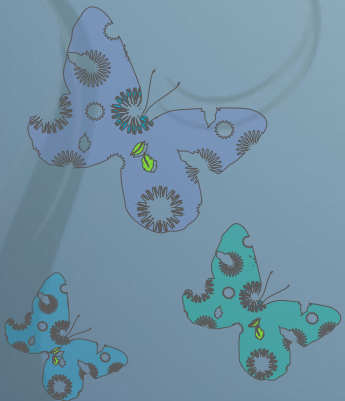
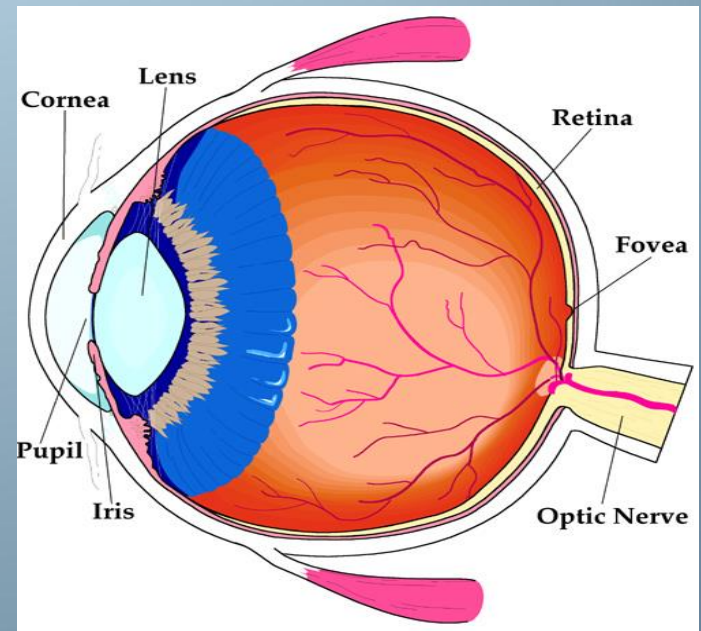
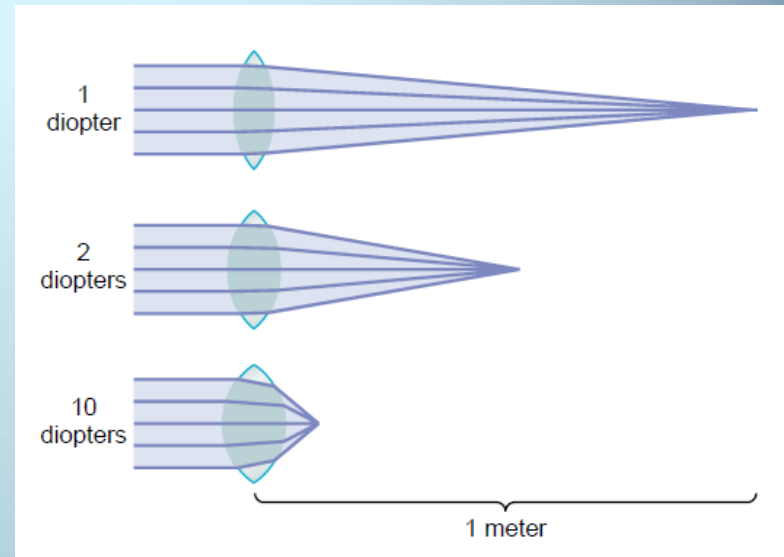
**Dioptre (s) = 1 / Focal length (in meters)**

**Dioptric power of the eye:**

**Cornea .....40-45 D (max refraction)**

**Lens ..... 15-20 D**

**Accomodation by lens .... +12 D**



# 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

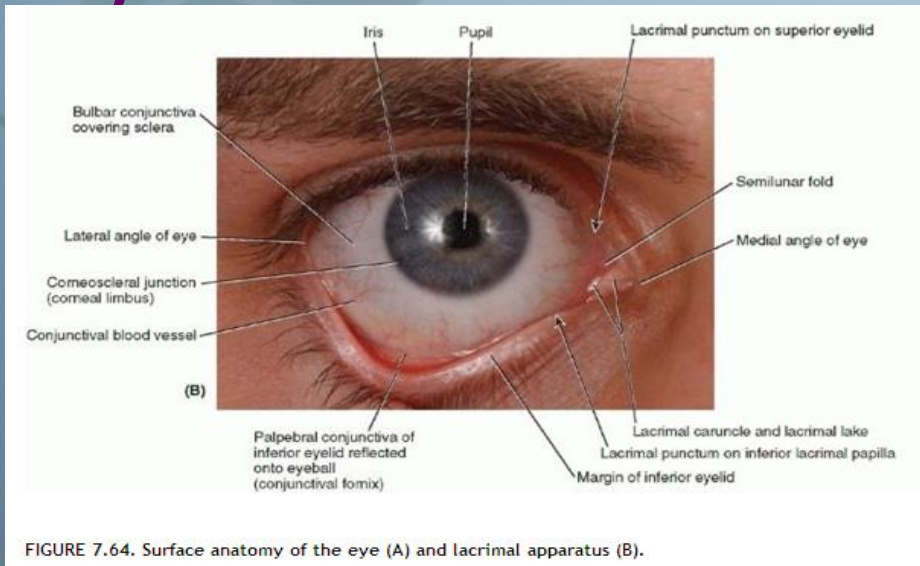
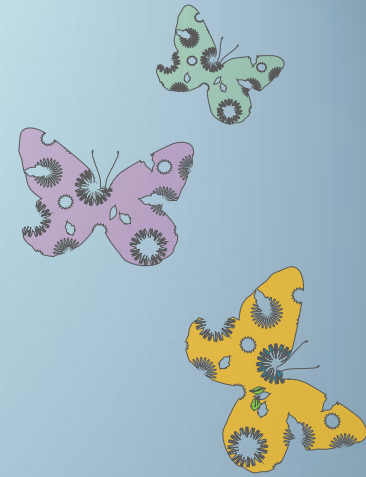
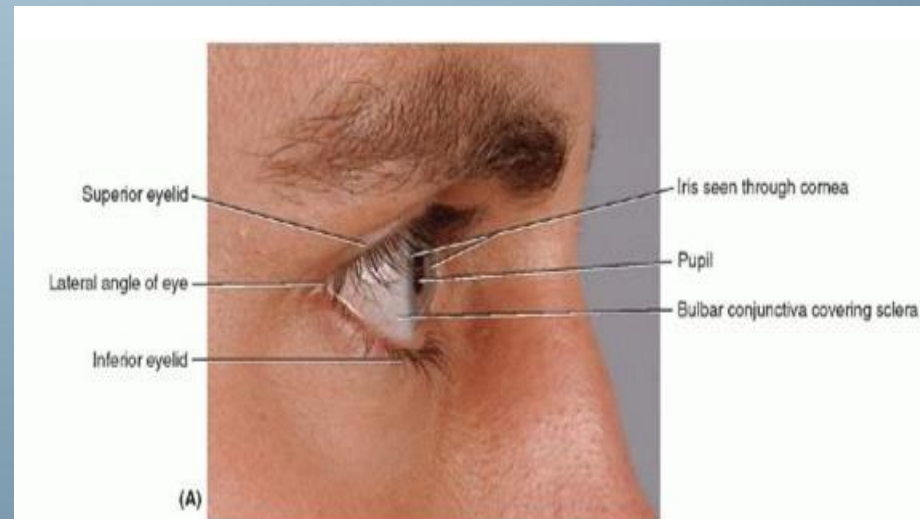


FIGURE 7.64. Surface anatomy of the eye (A) and lacrimal apparatus (B).



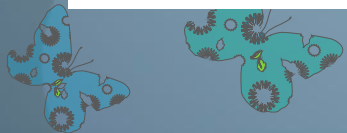
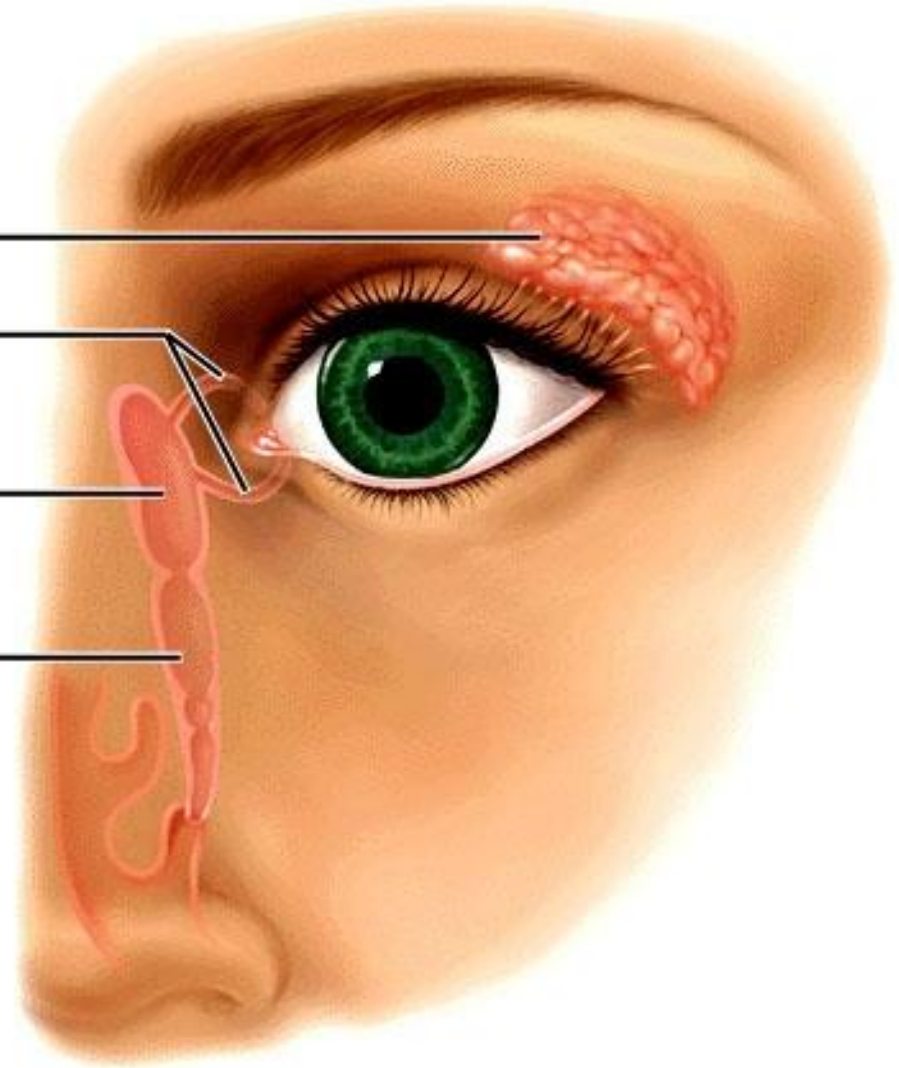
# Lacrimal Apparatus

**Lacrimal gland** —————

**Superior and inferior canaliculi** ————

**Lacrimal sac** —————

**Nasolacrimal duct** —————



# RETINA

-the one place in the body where arterioles are visible and examination by ophthalmoscope is of great value in the diagnosis of diabetes mellitus, hypertension, and other diseases that affect blood vessels

## 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)

## 3-FOVEA CENTRALIS :-depression in macula

lutea - yellow pigmented spot at post pole of eye + only cones + high visual acuity + for colors vision & details detection

when attention is attracted to or fixed on an object, the eyes are normally moved so that light rays coming from the object fall on the fovea

