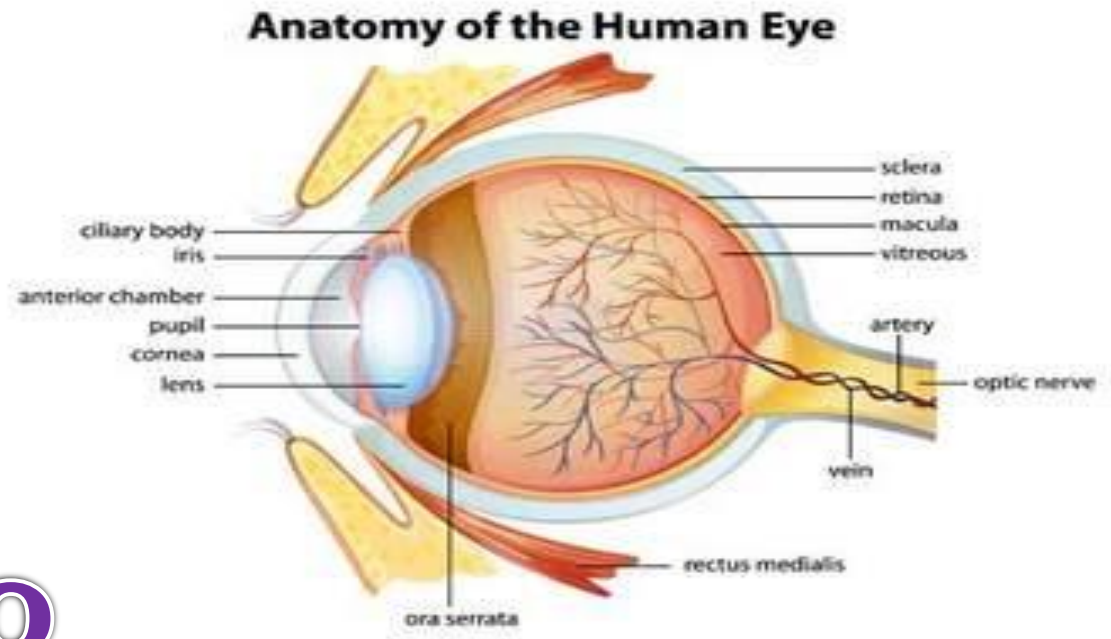
SPECIAL SENSE-VISION HUMAN EYE ANATOMY AND VISUAL PATHWAY



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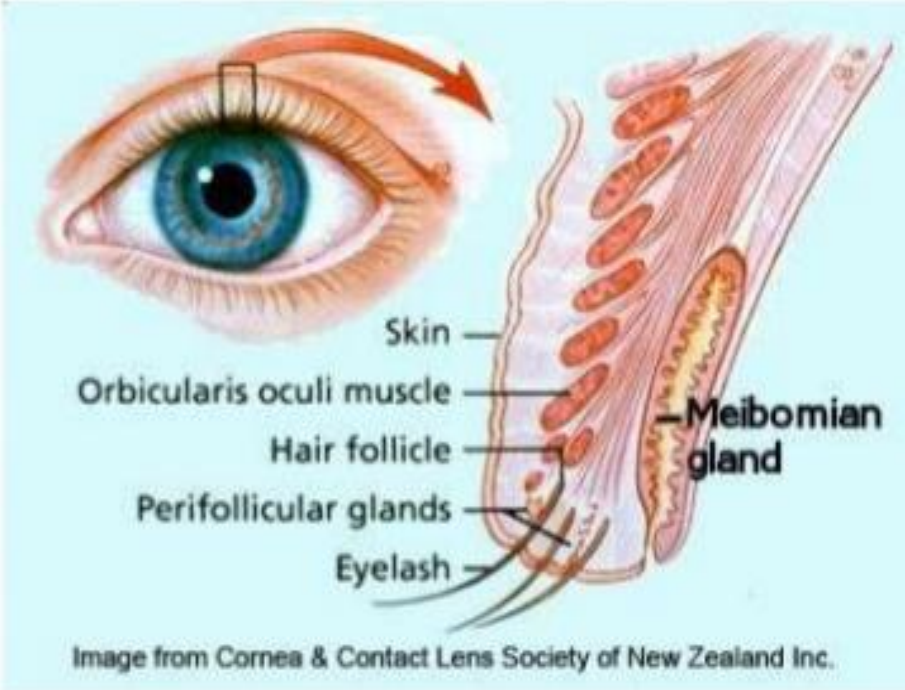
Outline

A. Anatomy of the eye:
   1. Accessory structures
   2. Eye ball structures
      1) Fibrous Tunic
      2) Vascular Tunic
      3) Nervous Tunic
   3. Interior of the ball
      1) Anterior Cavity
      2) Vitreous Chamber
      3) Lens

B. Physiology of the eye
   1. Image Formation
   2. Physiology of vision

Accessory structures: Eye lids

- Skin Layer
- Orbicularis Oculi
- Tarsal plate
- Meibomian Gland



Different Parts of Eye

Eye lids

The eyelids fulfill two main functions:

- protection of the eyeball.
- secretion, distribution and drainage of tears.

Eye lashes and Eye brows

- Hair follicles.
- They protect the eye from direct sunlight, dust, perspiration and foreign bodies.

Lacrimal Gland

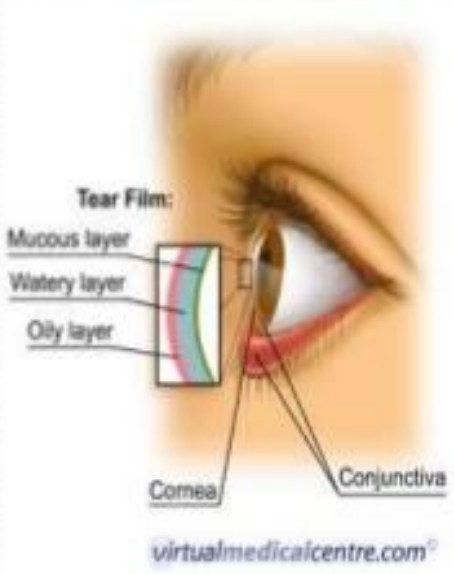
- Located in the upper, outer portion of each orbit of the eye
- Lobulated exocrine glands secreting tears

Lacrimal Ducts

- There are about 6 to 12 in number
- They dump tears on the surface of the conjunctiva of the upper lid through the palpebral part of the gland

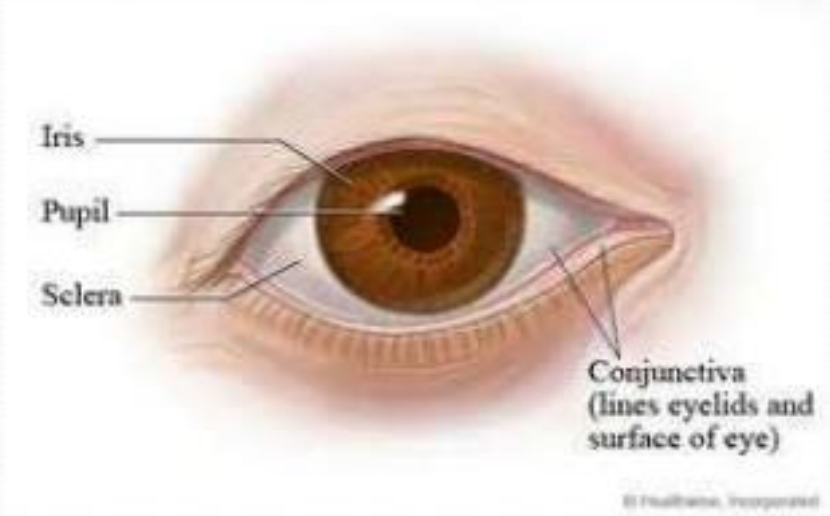
Tear Film:

- Lipid layer produced by the meibomian gland (oil)(hydrophobic)
- Aqueous layer produced by the Lacrimal gland (spreading, control of infectious agents)
- The mucous layer produced by microscopic goblet cells in the conjunctiva (coating)



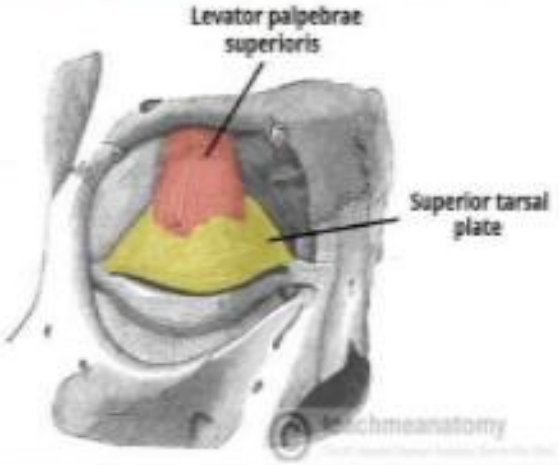
Conjunctiva

- The conjunctiva is a mucous membrane lining the eyelids and covering the anterior eyeball up to the edge of the cornea.
- Bulbar: covers the sclera
- Palpebral: lines the inside of the upper and lower lids



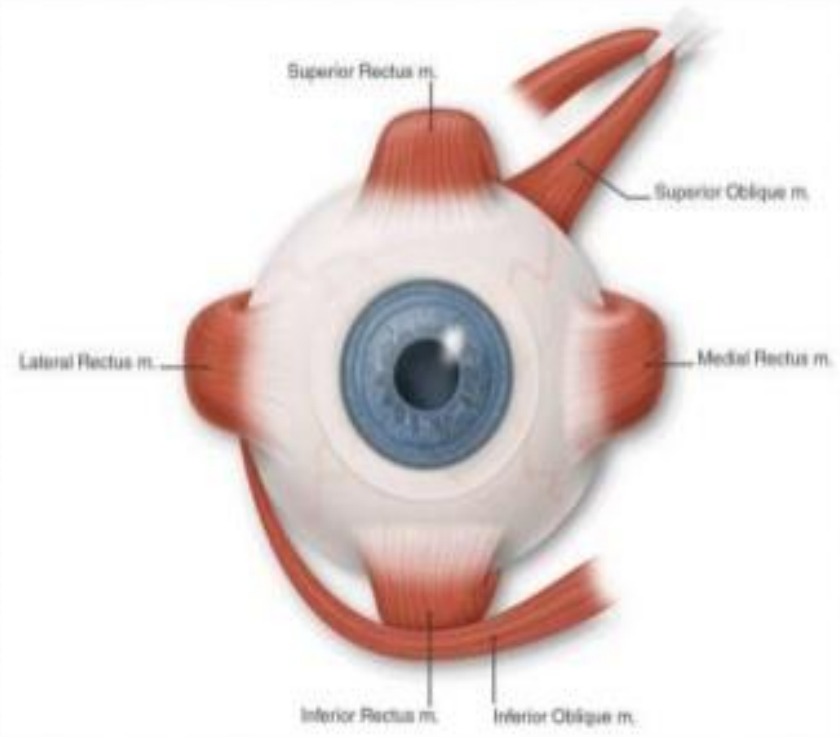
Lid retractors

- Responsible for opening the eyelids
  - levator palpebrae superioris muscle
  - Lower lid retractor
    - inferior rectus, extends with the inferior oblique and insert into the lower border of the tarsal plate



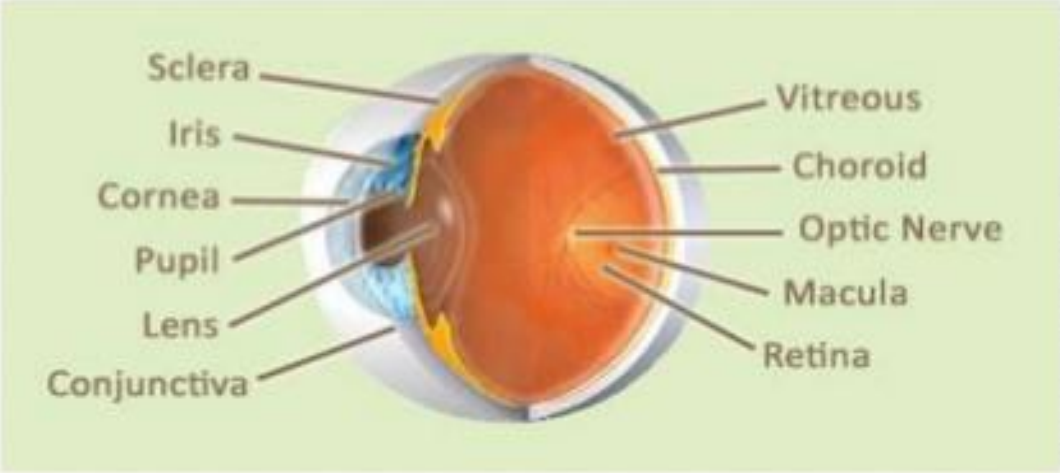
Extraocular Muscles

- Rectus Muscles
  - superior rectus
  - inferior rectus
  - medial rectus
  - lateral rectus
- Oblique Muscles
  - Superior oblique
  - Inferior oblique



Cornea and sclera

The cornea and sclera form a spherical shell which makes up the outer wall of the eyeball.



Cornea and sclera

- The sclera is :
  - principally collagenous,
  - avascular (apart from some vessels on its surface)
  - relatively acellular.

The cornea and sclera merge at the corneal edge (the limbus).

Cornea and sclera

- Refraction of light occurs because of the curved shape of the cornea and its greater refractive index compared with air.
- The cornea is transparent because of the specialized arrangement of the collagen fibrils within the stroma, which must be kept in a state of relative dehydration.

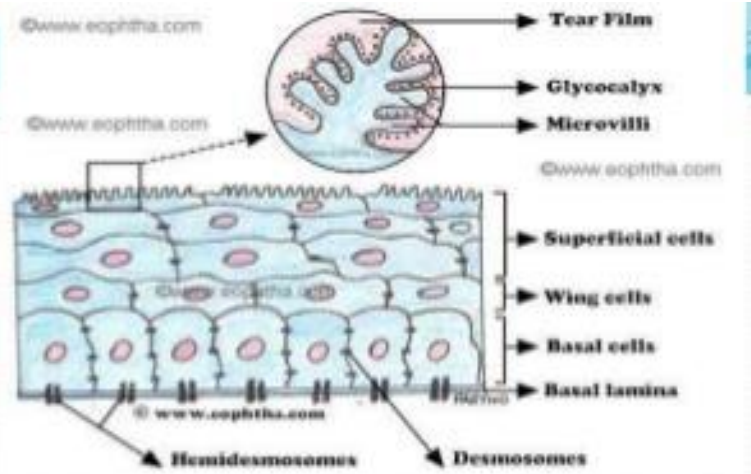
Cornea

- Epithelium
- Bowman membrane
- Stroma
- Descemet's membrane
- Endothelium

The chief functions of the cornea

- Are protection against invasion of microorganisms into the eye
- the transmission and focusing (refraction) of light.
- Screening out damaging ultraviolet (UV) wavelength in sunlight

Epithelium



- Made of epithelial cells
- A thin layer that keeps the stroma dehydrated and shields the eye while being able to provide nutrients and oxygen to the cornea
- It acts as a barrier to protect the cornea, resisting the free flow of fluids from the tears, and prevents bacteria from entering the epithelium and corneal stroma.

Epithelium

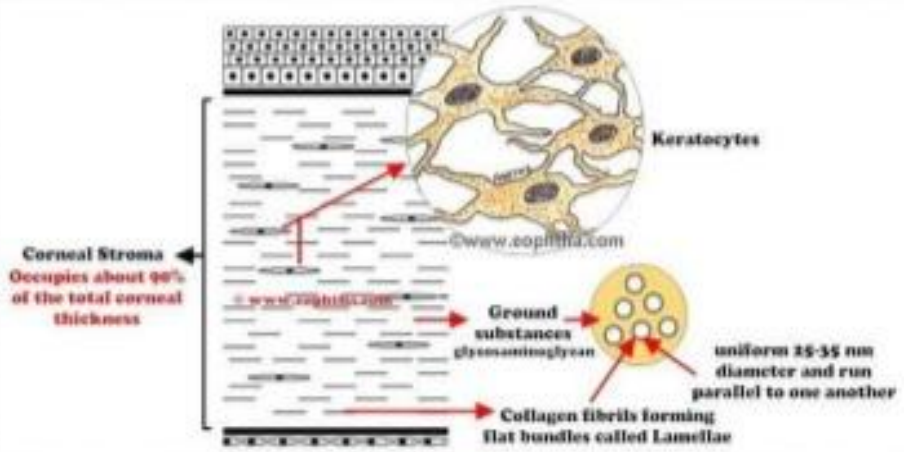
- Extremely sensitive to pain
- Can regenerate itself if damaged from disorders such as:
  - Recurrent corneal erosion: characterized by the failure of the cornea's outermost layer of epithelial cells to attach to the underlying basement membrane
  - Epithelial basement membrane dystrophy: the epithelium's basement membrane develops abnormally, causing the epithelial cells to not properly adhere to it.
  - Diabetes mellitus: poor adhesion between epithelial cells and their basement membrane

Bowman's membrane

- smooth, acellular, nonregenerating layer, located between the superficial epithelium and the stroma in the cornea of the eye.
- Is transparent, composed of collagen, cannot regenerate after damage and form scars as it heals which can lead to vision loss

Stroma

- Lies beneath Bowman's membrane
- Is composed primarily of water (78%) and collagen (16%), keratocytes
- Giving the cornea its strength, elasticity and form
- Fairly dehydrated which contributes greatly to the light-conducting transparency.



Descemet's membrane

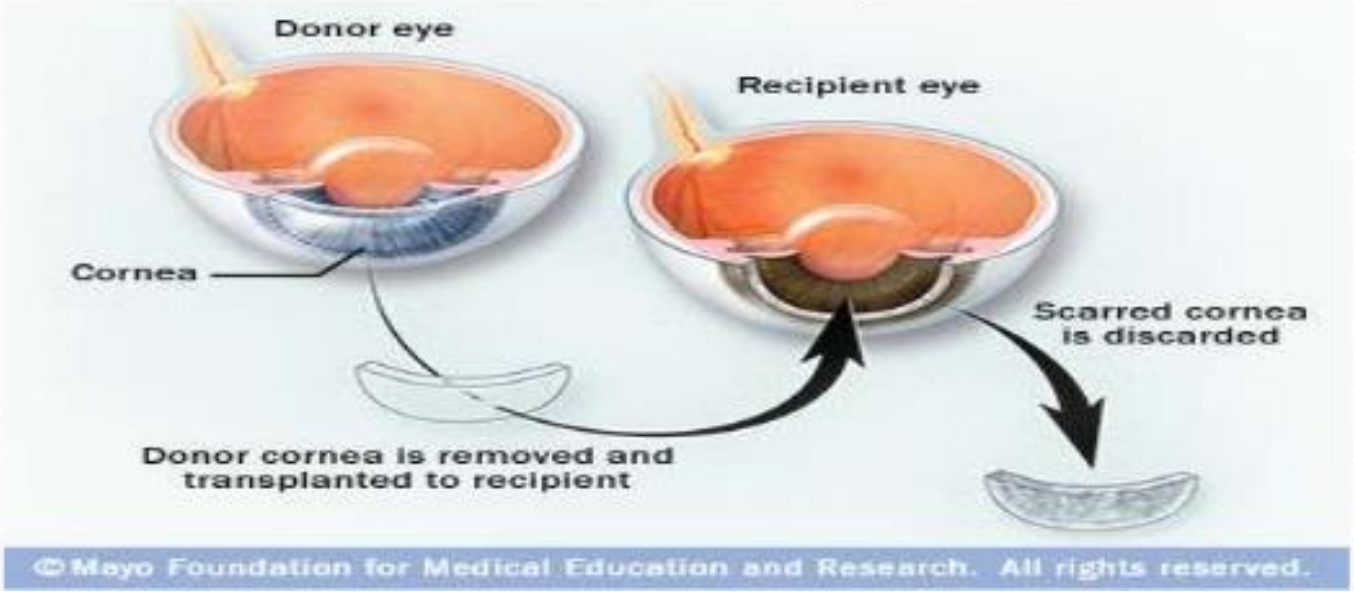
- Is a protective barrier under the Stroma
- Interiorly composed of collagen and posteriorly made of endothelial
- Can regenerate after injury

Endothelium

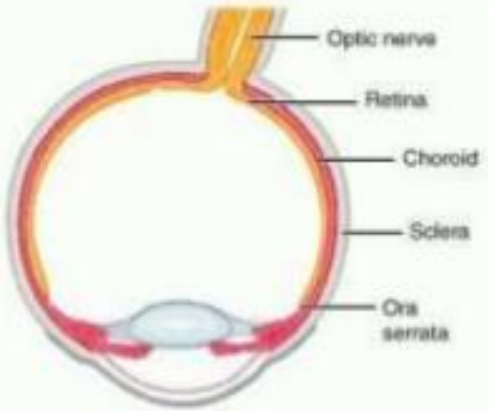
- Monolayer cells lies under the Descemet's membrane.
- Is responsible for regulating fluid and solute transport between the anterior chamber and the stroma
- The endothelial pump is an energy-dependent mechanism resulting in ion transported from the stroma to the aqueous humor, creating an osmotic gradient drawing water out of the stroma

Endothelium

- These cells don't regenerate, if they are destroyed, a corneal transplant is the only therapy. Where the defective cornea is removed and another donor cornea of similar diameter is implanted



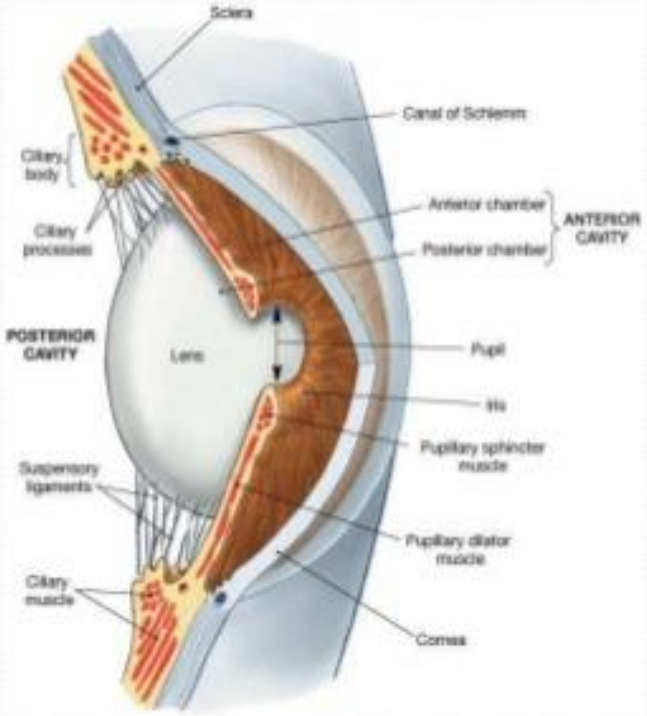
Choroid:



- Thin brown tissue
- Highly vascularized
- Provides nutrients and oxygen to the retina
- The choroid is opaque making sure no light is scattered from the sclera to the retina.

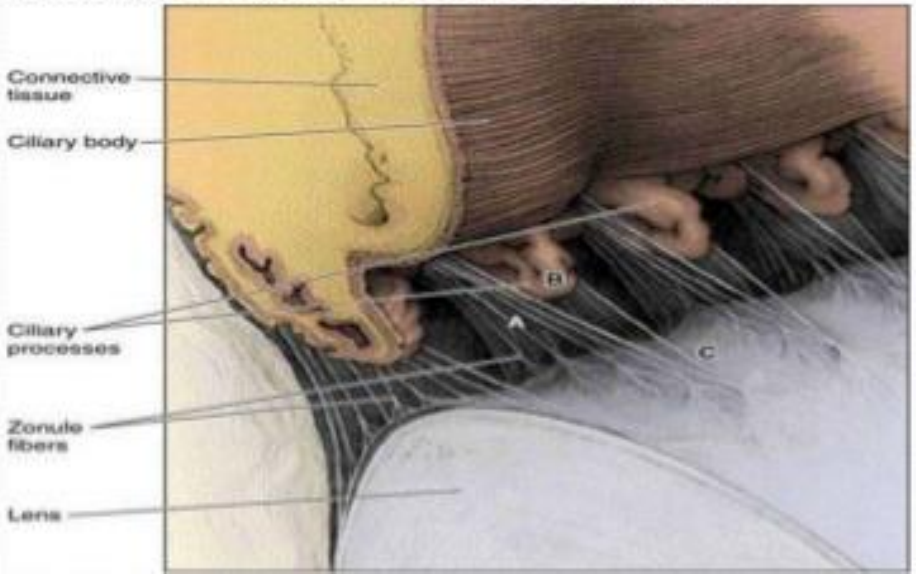
Ciliary Body

- A thick tissue inside the eye composed of ciliary processes and muscles
- Highly vascularized
- Continuous with the choroid behind and the iris in front



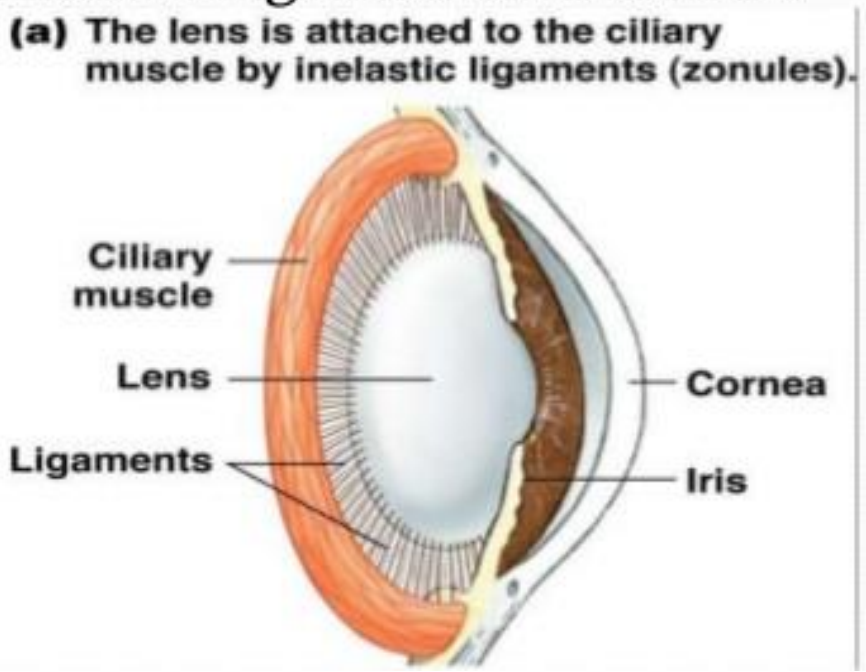
Ciliary Processes:

- Secretes the aqueous humour in the posterior chamber and from it to the anterior chamber
- The fluid nourishes and oxygenates the cornea and lens and then drains into the sclera via Schlemm canal



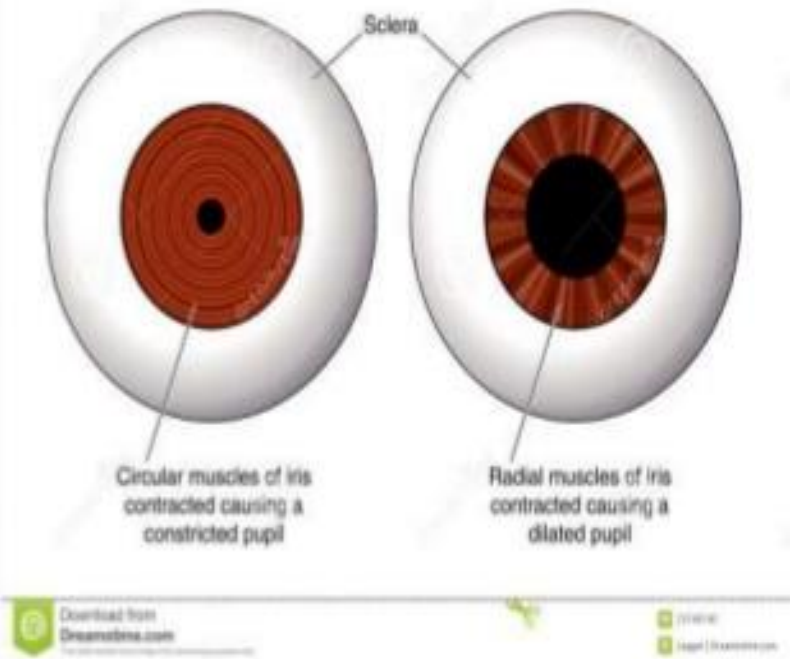
Ciliary Muscles:

- Ciliary muscles are the set of muscles (meridional, oblique, sphincteric) that affect the shape of the lens during accommodation.



Iris:

- Colored portion of the eye positioned between the cornea and the lens
- Smooth radial muscles
- The Sphincter papillae
- The Dilatator papillae



Retina

- Thin, semitransparent, multilayered sheet of neural tissue
- lines the inner aspect of the posterior two thirds of the globe
- terminates anteriorly at the ora serrata

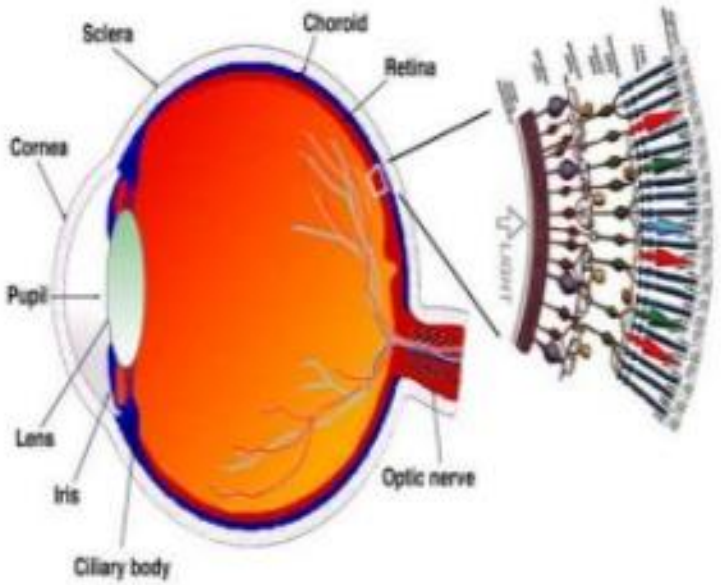
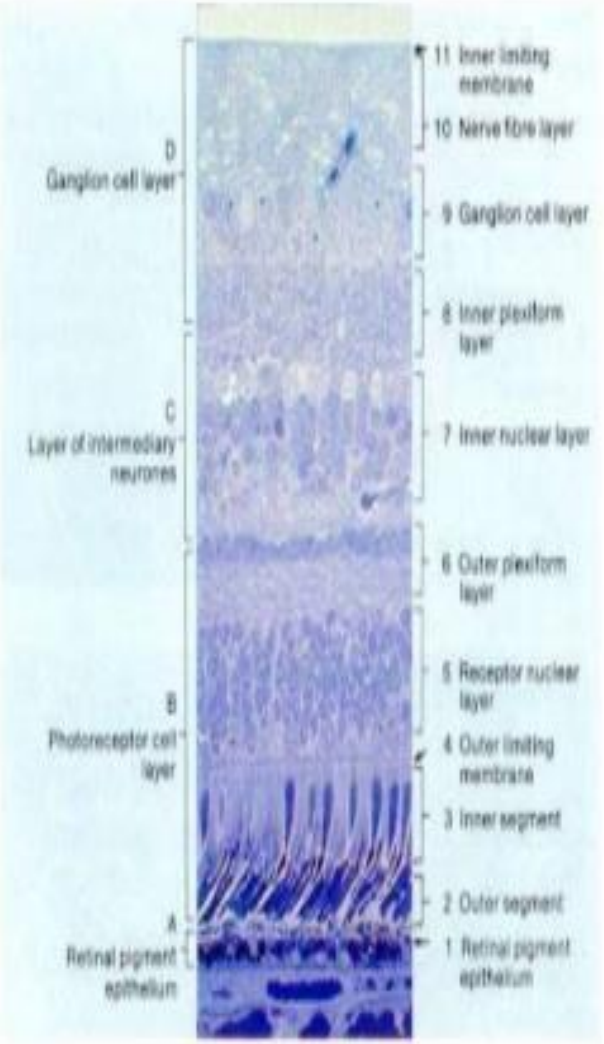


Fig. 1.1. A drawing of a section through the human eye with a schematic enlargement of the retina.

Layers of the Retina

1. Internal limiting membrane
2. Nerve fiber layer
3. Ganglion cell layer
4. Inner plexiform layer
5. Inner nuclear layer
6. Outer plexiform layer
7. Outer nuclear layer
8. External limiting membrane
9. Photoreceptor layer (rods and cones)
10. Retinal pigment epithelium



Retinal Pigment Epithelium:

- Sheet of melanin-containing epithelial cells lying between the choroid and the neural portion
- Which form a single layer extending from the periphery of the optic disc to the Ora Serrata
- epithelial cells that assist in the turnover of rods and cones and prevent the scattering of light within the eyeball due to the presence of melanin also works as a barrier between the vascular system of the choroid and the retina.

The neural portion of the retina:

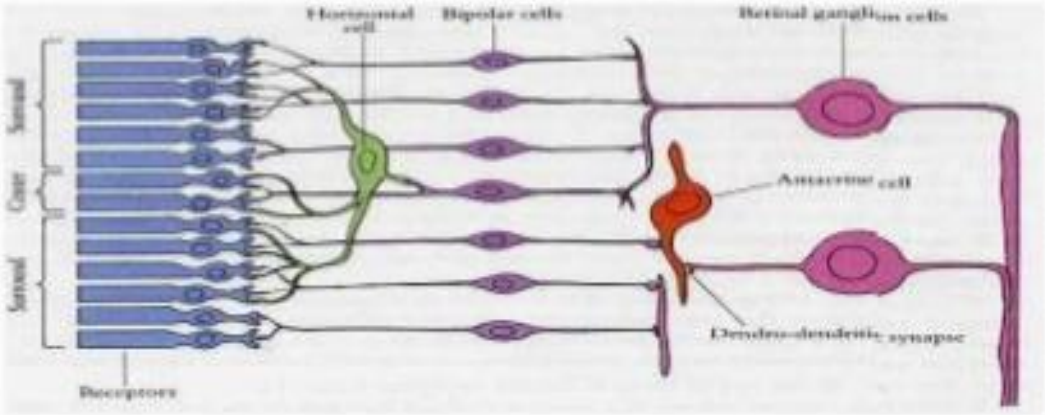
- composed of the 9 remaining layers that would convert light into electrical impulses to be transmitted to the thalamus
- The neural portion is soft, translucent and purple (due to the presence of Rhodopsin) which becomes opaque and bleached when exposed to light.
- Neurons in the retina are classified into different categories

The Ganglion cell layer:

- Transmits the visual packets received from the photoreceptors to the brain for further processing
- Highly concentrated in the Macula, less in the fovea
- Retinal ganglion cells vary significantly in terms of their size, connections, and responses to visual stimulation but they all share the defining property of having a long axon that extends into the brain. These axons form the optic nerve

The bipolar cell layer:

- Radially oriented neurons. Signal couriers between the photoreceptors that react to light stimuli and the ganglion cells, there are two types of bipolar cells Cone bipolar and rod bipolar, receiving information from their respective photoreceptors.

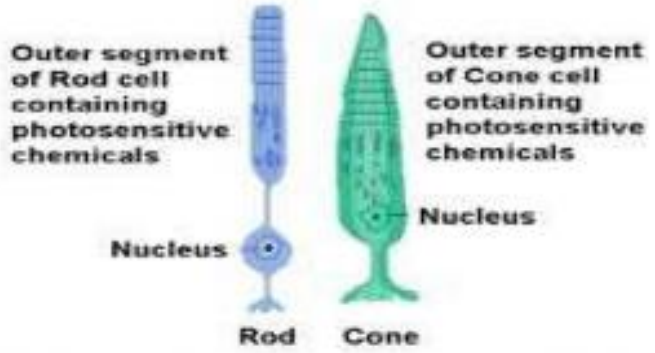


Photoreceptor layer:

- Comprised of rod and cons neurons that converts light to receptor potential.
- The rods are responsible for identification of shapes and movement and the discrimination between black and white and are dense at the peripheral of the retina.
- Cons neurons are responsible for color vision and for high visual acuity in bright light; they are highly concentrated in the fovea at the center of the macula lutea.

Photoreceptor layer:

- The photoreceptors have photopigments that when hit by light goes thru structural change and triggers the initiation of a receptor potential across the nerves.
- The cone cells have three photopigments each one interacts at different wavelength (red, green and blue),
- The rod cells they only have Rhodopsin which are essential for vision during dimmed light.



Receptor potential initiation in a rod cell

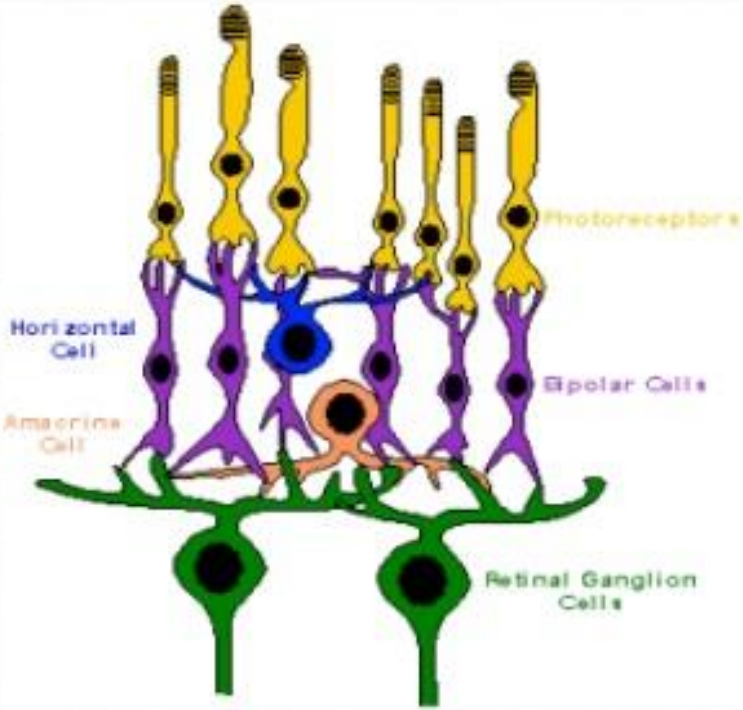
- Light isomerizes retinal, which activates Rhodopsin that in turn activates a G protein called transducin which in turn activates the enzyme phosphodiesterase (PDE), this enzyme then detaches cyclic guanosine monophosphate (cGMP) from Na^+ channels in the plasma membrane by hydrolyzing cGMP to GMP. The Na^+ channels close when cGMP detaches. The membrane's permeability to Na^+ decreases and the rod hyperpolarizes due to the added negativity in neurons. This hyperpolarization decreases the release of the neurotransmitter glutamate into the synaptic cleft between rod and the subsequent bipolar.

ON-OFF mechanism

- At dark, Neurotransmitter glutamate is maximally released and the rods are depolarized consequently the ON bipolar gets hyperpolarized and the OFF bipolar depolarized.
- In light, Neurotransmitter glutamate is minimal and the rods are hyperpolarized consequently the ON bipolar gets depolarized and the OFF bipolar hyperpolarized.
- Depolarizing bipolar cells results in the release of neurotransmitters whereas hyperpolarization stops this release.

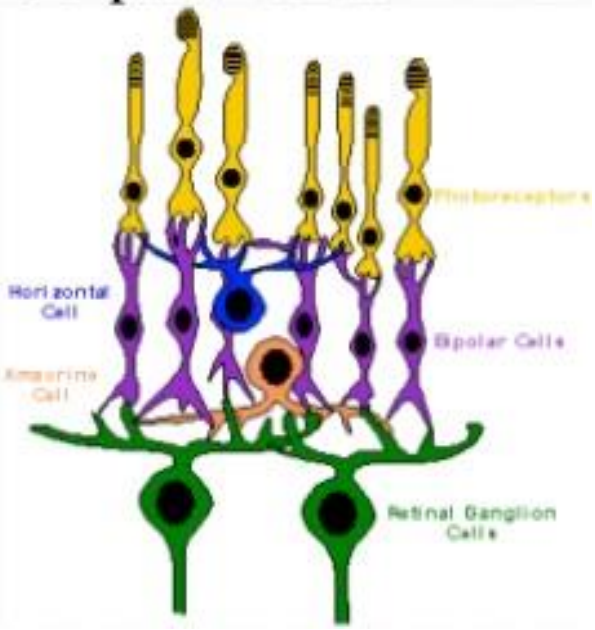
Horizontal cells:

- Inhibitory interneurons, that help integrate and regulate the input from multiple photoreceptor cells and are responsible for regulating vision under both bright and dim light.



Amacrine cells:

- Interneurons in the retina
- They are responsible for 70% of input to retinal ganglion cells. The remaining 30% are regulated by the amacrine cells but are handled by the bipolar cells.



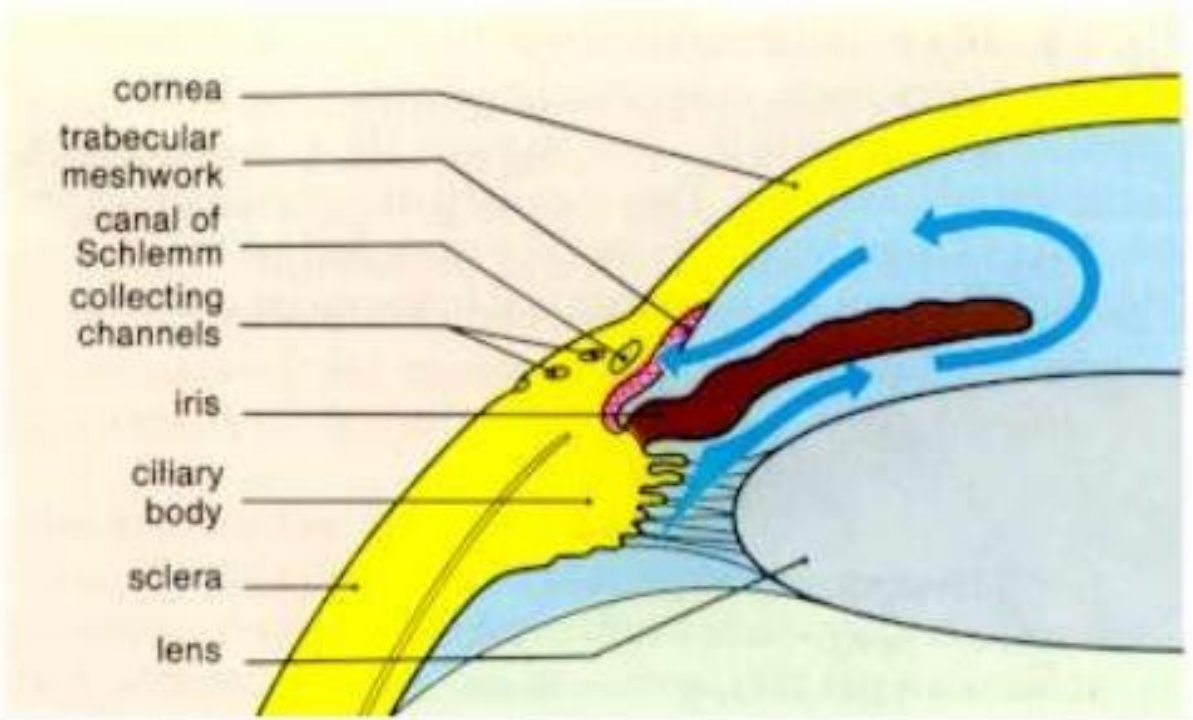
Macula

- Center of the posterior retina
- responsible for fine central vision
- has yellow pigment (xantophyll)
- histologically empty space tends to the accumulation of extracellular material that cause thickening

Anterior cavity

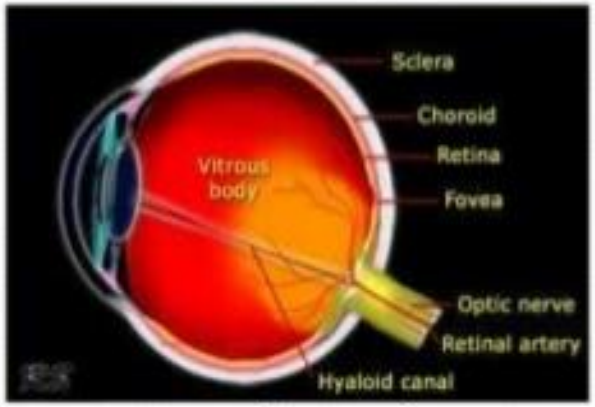
- Anterior Chamber located between the cornea and the iris
- Posterior chamber located between the lens and the iris
- Filled with aqueous humor produced by ciliary processes and rich in nutrient, and is a metabolic exchange for the vascular tissue of cornea and lens
- Increase in Intraocular Pressure leads to glaucoma

Aqueous Flow



Vitreous Body

- Clear, avascular, gelatinous body.
- comprises 2/3 of the volume of the eye.
- 99% water ; 1% hyaluronic acid and collagen.



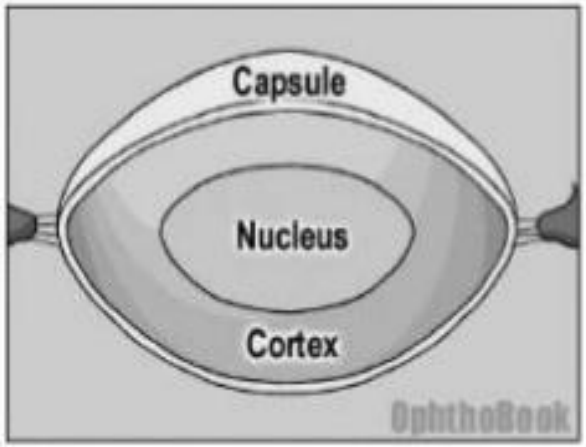
- The vitreous is adherent to the retina at certain points, particularly at the optic disc and at the ora serrata.

The Lens

- a biconvex lens with an index of refraction of 1.336 attached to the ciliary process by zonular fibers.
- Non-vascular, colorless and transparent
- The lens consists of stiff, elongated, prismatic cells known as lens fibers, very tightly packed together and divided into nucleus, cortex and capsule.

The Lens

- These fibers are rich with proteins known as crystallins which are responsible for transparency and refractive properties and elasticity

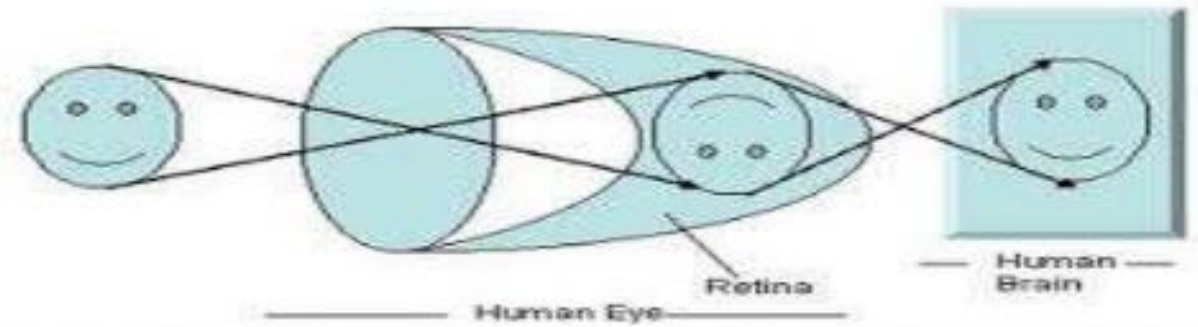


Pathway of Vision

- Pathway of vision is discussed later…

Refraction of Light:

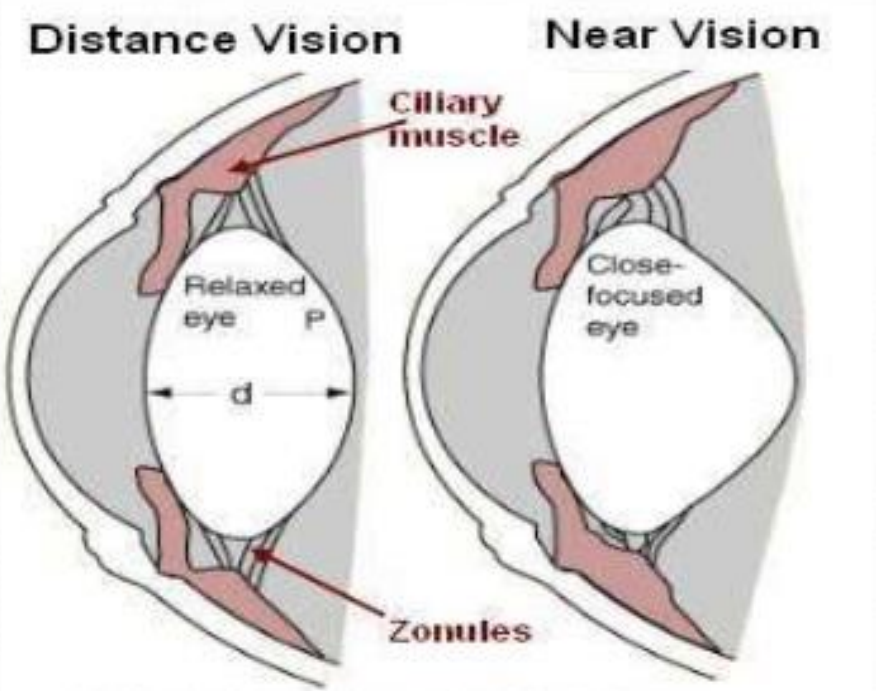
- The cornea refracts 75% of the light transmitted
- The rest is done by the lens
- Image is projected on the retina, inverted, minimized and real.



Accommodation of the Lens:

- The Lens is biconvex which intensifies the focusing power
- The lens is flexible and can change curvature to accommodate according to light and object distance
- For far away objects: the zonule fibers provide tension to the lens giving it an elongated shape
- For close objects: ciliary muscles contract, relaxes the tension of the lens leading to a rounder shape

Accommodation of the Lens:



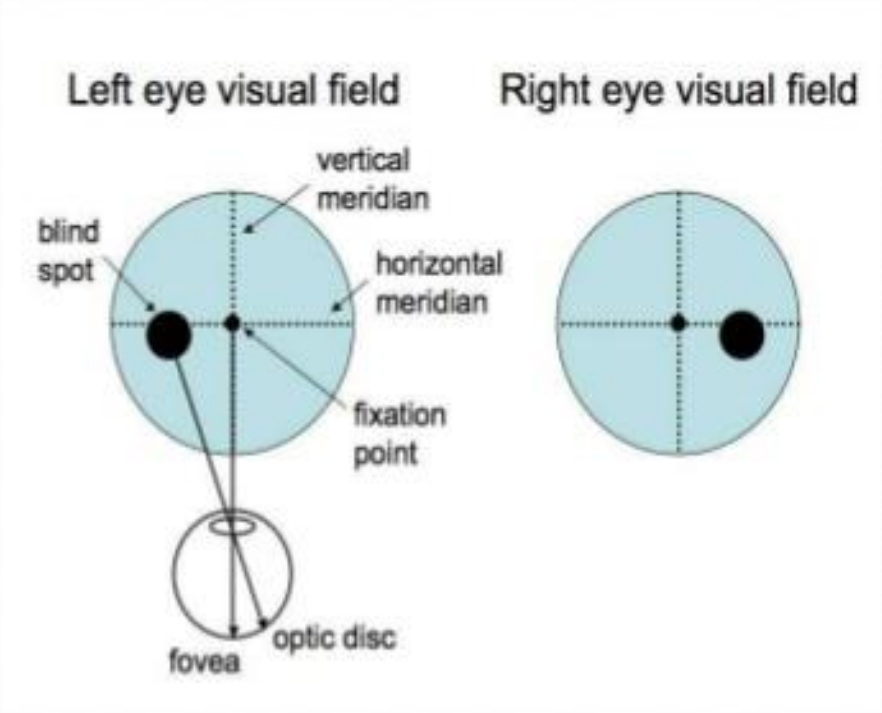
For near vision, the ciliary muscles contracts and the central lens thickness increases to increase its power.

Alignment of the Eyes:

- Binocular vision: The two eyes field of vision overlap and the image coincide creating a single impression
- This is done by synced eye movements where both eyes move simultaneously to maintain the overlap of vision.

Fixation

- Involves looking stably straight ahead toward an object in space.



Fusion:

- Is the power exerted by the eyes to keep the position of the eyes aligned so that the fovea can project the same point in space.

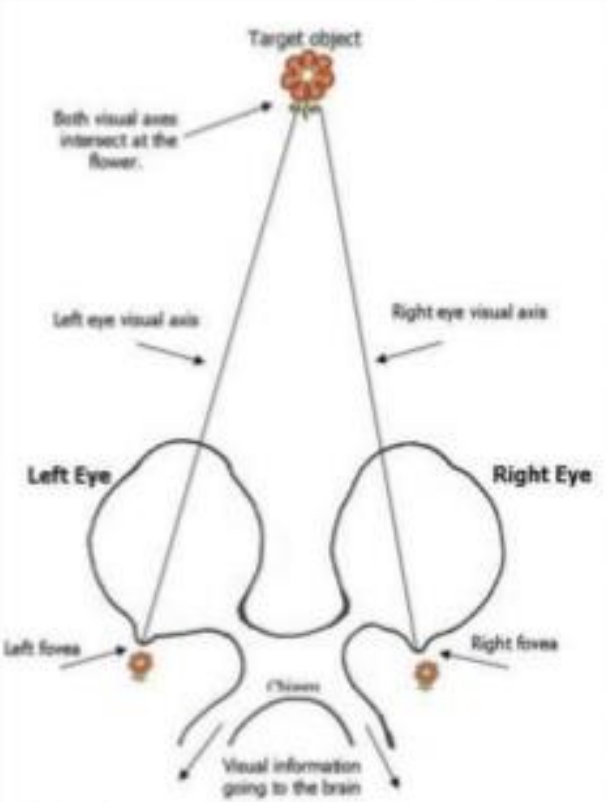
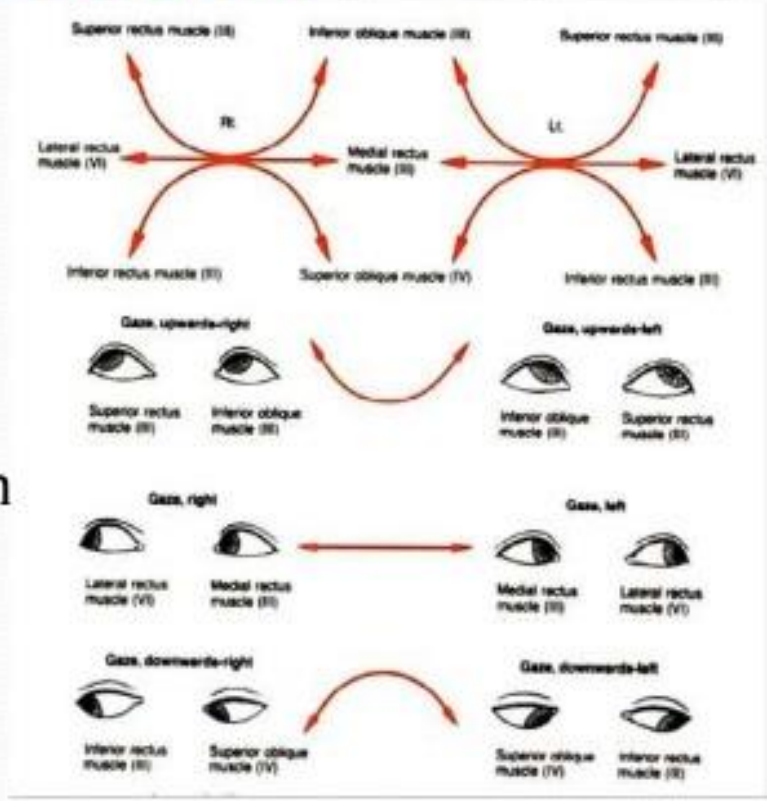


Figure 1: Our eyes, viewed as though you are standing on the top of the head, looking down. Here, the flower lands on both foveas resulting in fusion.

Eye Movement:

- Controlled by extraocular muscles
- To the left: levoversion
  To the right: dextroversion
  Upwards: sursumversion
  Downwards: deorsumversion



Range of Focus:

- For distances greater than 20 feet no accommodation is required by the lens, but as this distance shortens the lens has to accommodate and will thicken to clarify image.

REFRACTIVE ERROR OF EYE

DEFINITION

Refractive error also known as refraction error is problem with focusing of light on the retina .

Refractive error means that the shape of the eye does not bend light proper and correct resulting in a blurred image .

TYPES

- Myopia - near-sightedness also known as short – sightedness and myopia is a condition of the eye where light focuses in front of the retina instead of on the retina this causes distant objects to be blurred while close objects appear normal.

Hyperopia

Far-sightedness also known as long sightedness ....

Hyperopia is a condition of the eye in which light is focused behind the retina , instead of on the retina . Resulting in an inability to seen near objects clear . Causes abnormal shape of cornea

presbyopia

Presbyopia is a common type of vision disorder that occurs as you age . It is often referred to as the aging eye condition . Result in the inability to focus up close , a problem associated with refraction in the eye ..

ASTIGMATISM

is a condition in which an abnormal curvature of the cornea .

Astigmatisms may cause eye strain and may be combined with nearsightedness or long-sightedness .

CAUSES

- Infection adenovirus
- Injury due to optic nerve damage
- Ultraviolet radiation
- eye disease
- Inherited
- Aging (above 45year)
- Environmental factors
- Previous corneal injury
- Previous eye surgery
- Optic nerve hypoplasia

symptoms

1. Double vision
2. Haziness (unclearness)
3. Glare or halos around bright light
4. Squinting (it is a condition where the eyes do not look in the same direction)
5. Headaches
6. Eye strain fatigue pain in or around the eyes blurred vision ,headache, occasional double vision.
7. Eye irritation

PATHOPHYSIOILOGY

due to etiology factors such as infection

degenerative changes causes by gradual loss of elasticity of lens

which leads to decreased ability to accommodate

then lead to refractive errors

MEDICAL MANAGEMENT

- Identify the cause & eliminate the cause
- Lens correction – a concave lens is used to correct the problem
- Prevention foreign particles enter in eye
- Use of sunglasses
- Use of antibiotics prevention from infection

Pharmacological management

- Cycloplegic drugs are used to refraction (to paralyze the ciliary muscle in order to determine the true refractive error of eye)
- Cholinergics (Miotics): Pilocarpine, Carbachol

- It increases aqueous fluid outflow by contracting the ciliary muscles

- Beta blockers : Betaxolol, Timolol
- Decreases aqueous humor production.
-
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Thank you