Anatomy & Physiology of The Eye

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Resources: Team 433, Doctors Notes

433 Team
Important
Doctor's Notes
Explanation

Editing File

EMBRYOLOGY OF THE EYE :

This highly specialized sensory organ is derived from neural ectoderm, mesoderm and surface ectoderm.patient who get affected by atopic dermatitis*[1] could have cataract . surface ectoderm derived structures such as cornea and lenses they're the only structures in eyes that we can implant .surface ectoderm structures consider as the most painful structures in the eye because it causes epithelial defect. The eye is essentially an outgrowth from the brain (neural ectoderm). Started as *Optic vesicle* connected to the forebrain by *Optic stalk*.

DEVELOPMENT OF THE EYE AFTER BIRTH :

- At birth, the eye is relatively large in relation to the rest of the body.
- The eye reaches full size by the age of 8-13 years.Dr said by 2-3 y full size reached.
- The lens continues to enlarge throughout the life.
- The iris has a bluish color due to little or no pigment on the anterior surface.
- During early infant life, the cornea & sclera can be stretched by raised IOP → enlargement of the eye. normal axial of the eye is 21-24mm (2.4cm)
- elevated intraocular pressure with onset in the first year of life it called congenital glaucoma. eye consist of globe (eyeball, extraocular muscles) and adnexa (lacrimal gland and sac).

[1] **Atopic dermatitis** (**AD**), also known as **atopic eczema**, is a type of inflammation of the skin (dermatitis). It results in itchy, red, swollen, and cracked skin

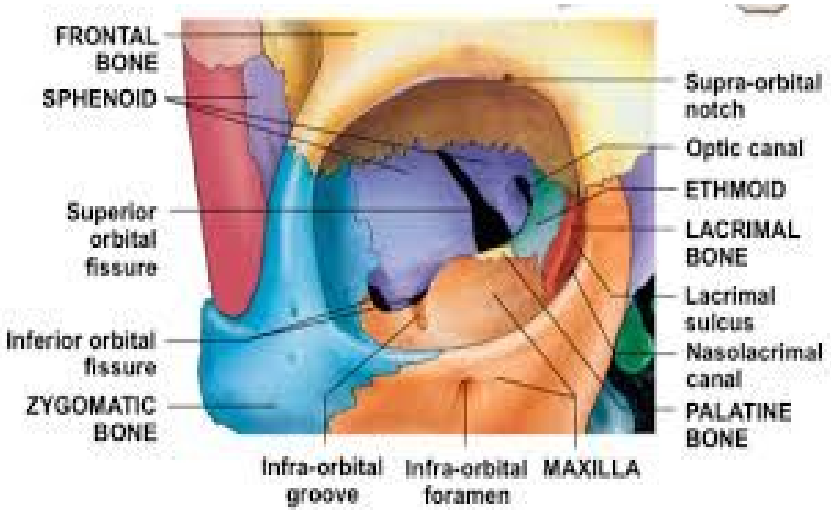
THE ORBIT :

- As a socket, contains & protect the eye.
- The weakest parts are the floor & the medial wall(weakest one - called lamina papyracea). Q. past Hx of sinusitis brought by Proptosis? that mean there is infection from the sinus to orbit through lamina papyracea.
- Floor: Formed by the orbital plate of the maxilla, which separates the orbital cavity from the maxillary sinus.
- Lateral wall: Formed by the zygomatic bone and the greater wing of sphenoid.
- Medial wall: Formed from before backwar by the frontal process of the maxilla, the lacrimal bone, the orbital plate of ethmoid (which separate the orbital cavity from the ethmoid sinuses), and the body of sphenoid.
- Seven bones contribute the bony orbit.
- Surrounded by nasal sinuses.

Important openings are:

1. Optic foramen: The structures passing through are: the optic nerve, ophthalmic artery, and central retinal vein.
2. Superior orbital fissure. The structures passing through are: III, IV and VI cranial nerves, lacrimal nerve, frontal nerve, nasociliary nerve, orbital branch of middle meningeal artery, recurrent branch of lacrimal artery, superior orbital vein, and superior ophthalmic vein.
3. Inferior orbital fissure.The structures passing through are: infraorbital nerve, zygomatic nerve, parasympathetic to lacrimalgland, infraorbital artery, infraorbital vein, inferior ophthalmic vein branch to pterygoid plexus. (traum in floor result in hyperesthesia[2] in cheek area)

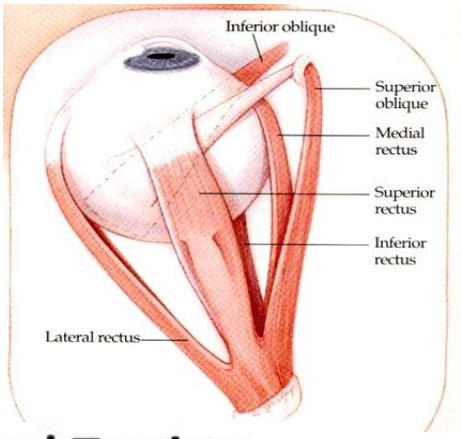
seven bones contribute to the framework of each orbit. They are the maxilla, zygomatic, frontal, ethmoid, lacrimal, sphenoid and palatine bone.



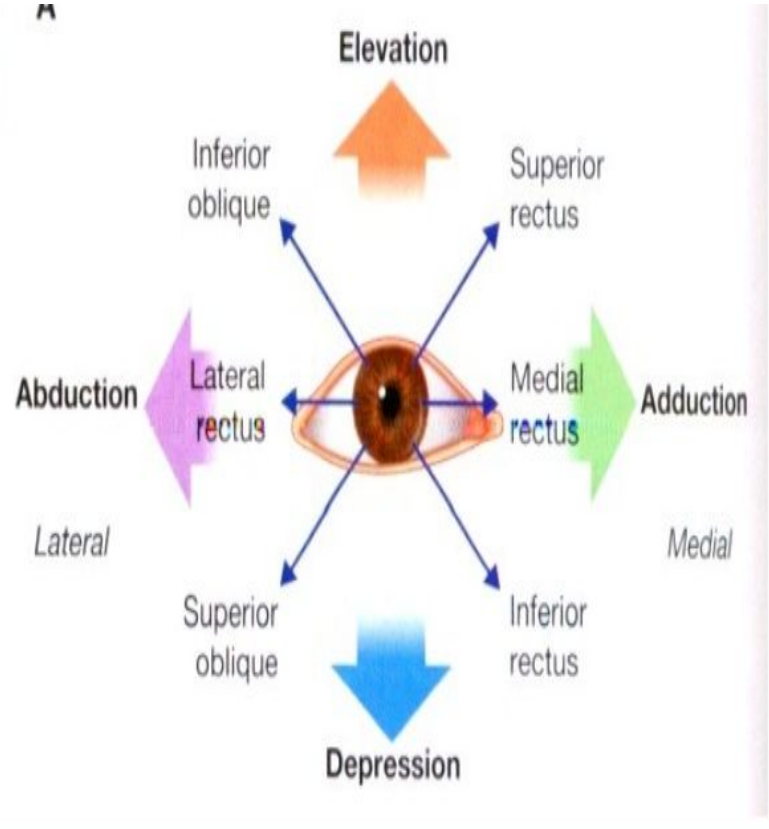
[2] **Hypesthesia definition**, an abnormally weak sense of pain, heat, cold, or touch.

THE EXTRAOCULAR MUSCLES:

- Four recti & two oblique muscles.
- All are supplied by III Oculomotor n. except superior oblique (Trochlear n.)SO4 & lateral rectus (Abducens n.)LR6 .



Field of action: the dr said this schedule enough



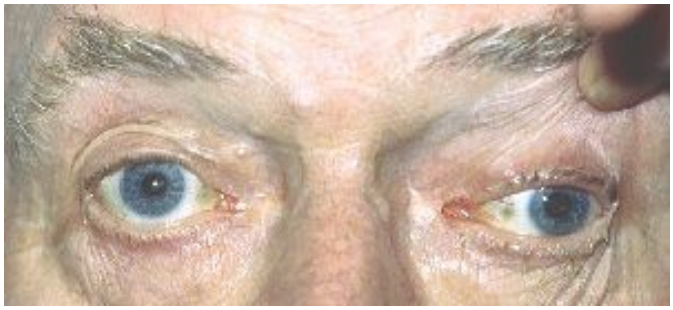
Clinical Testing

Muscle tested	Movement
SR	Looks laterally and upwards
IR	Looks laterally and downwards
LR	Looks laterally
MR	Looks medially
IO	Looks medially and upwards
SO	Looks medially and downwards

Q.Patient with a 3rd nerve palsy, how can you rule out 4th nerve palsy?

The clinical manifestations of 3rd nerve palsy:

- Ptosis.
- All muscles are paralyzed except the LR, so the eye will be abducted.
- The patient can not look downward because the IR is paralyzed.



To know if the 4th nerve is intact or not, ask the patient to look downward and if the 4th nerve is intact, then the eye will be intorted due to the action of SO muscle.

The Globe:

Coats of the Eye :

- Fibrous coat "outer protective coat - protective layer - external": Made up of a posterior opaque part, the sclera and an anterior transparent part, the cornea. Both are formed of collagenous fibers with different arrangement . Lamina cribrosa is the area of the sclera that is pierced by the nerve fibers of the optic nerve. Cornea is in contact posteriorly with the aqueous humor. "the cornea in stronger than the sclera due to her special collagenous arrangement "
- Vascular pigmented coat "middle vascular coat": Consists from behind forward, of the choroid, the ciliary body, and the iris. The choroid is composed of an outer pigmented layer and an inner, highly vascular layer. The ciliary body is continuous posteriorly with the choroid, and anteriorly, it lies behind the peripheral margin of the iris. It is composed of the ciliary ring, the ciliary processes, and the ciliary muscles. "The ciliary body has pigmented and non pigmented epithelium, the non-pigmented one secrets the aqueous which contain Vit C & glucose "
- Inner layer: composed of the optic nerve and the retina. The retina extends forward to within 6 mm of the limbus. lenses attached to ciliary body by zonular fibers about 70,000 in number. power length in cornea 42 db while in lens 18.

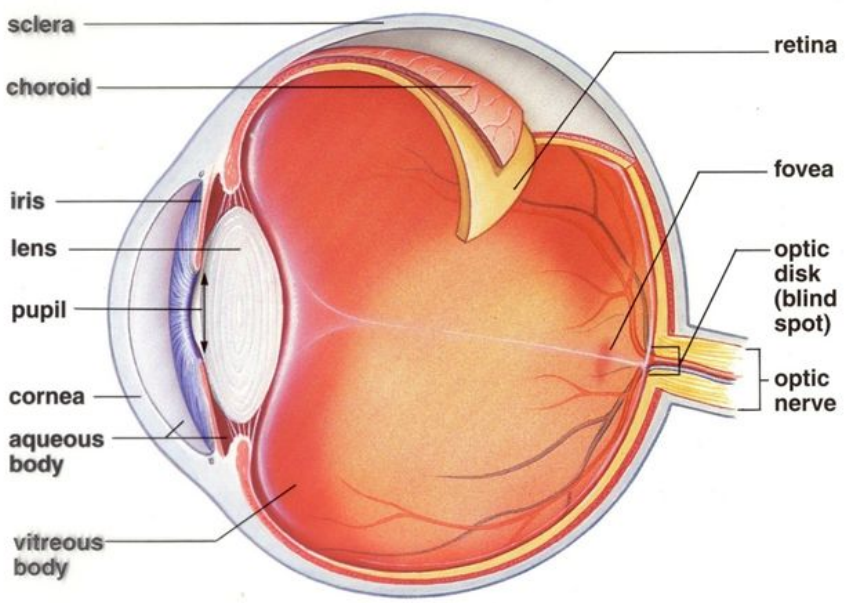
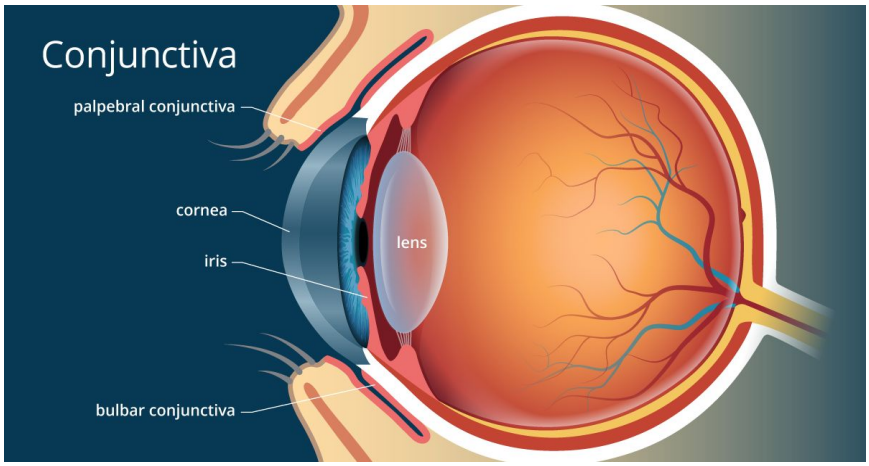


Fig. 32.30 Structure of the human eye.

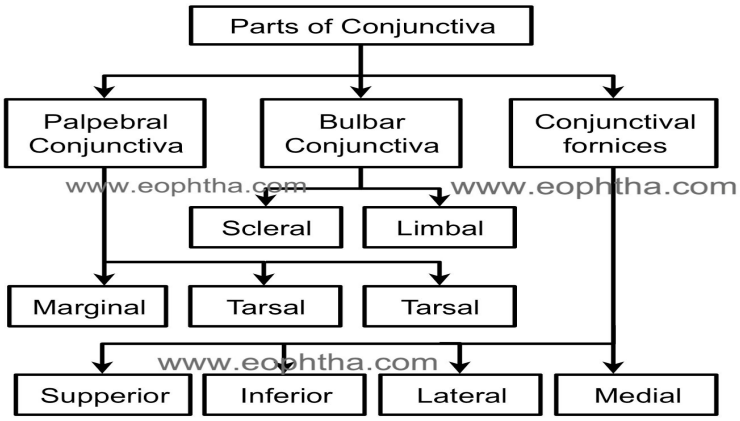
Conjunctiva: (transparent membrane covering sclera) :

1.Bulbar conjunctiva.
2.Palpebral conjunctiva (it contain accessory gland which responsible for tear secretion while lacrimal gland a reflex secretion).
3.Forniceal conjunctiva.
The stroma (no adenoid tissues until 3 months after birth) - Follicles & Papillae - Injection and chemosis.



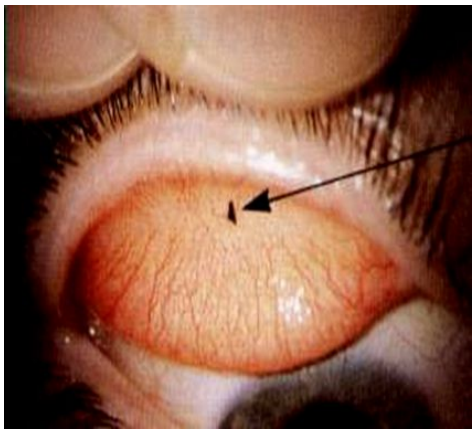
"Chemosis is the swelling of the conjunctiva due to abnormally permeable capillaries, it's a non specific sign of eye irritation and could be caused by conjunctivitis". - "Ciliary injection is peripheral hyperemia of the anterior ciliary vessels which produces a deep red or rose color of the corneal stroma"

- Causes of ciliary injection: keratitis , Uveitis & Acute glaucoma.



SAQ/Q. patient came complaining of tearing and pain when I exam the eye I found foreign body ?

- What is the diagnosis? Palpebral conjunctival foreign body - tarsal foreign body .
- What is the treatment? Removal and topical antibiotic.



Cornea:

- It has 5 layers:

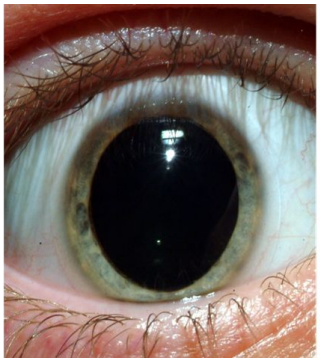
1-epithelium (painful layer we treat abrasion by covering the eye in 24hrs defect will heal never use topical anesthesia)
2-Bowman's membrane.
3-stroma
4-Descemet's membrane.
5-endothelium (it end in the angle , we have to know if it's open or closed which is about Schwalbe's Line , Trabecular Meshwork , Scleral Spur , Ciliary body and Iris if all structures are seen that mean open angle glaucoma while if all structures closed that mean closed angle).

- 500 -530 micron in thickness.
- Transparent
- Avascular
- Regularly arranged collagen fibers.

The Chambers of The Eye:

- The anterior chamber, in front of the iris
- The posterior chamber, immediately behind the iris. These two chambers which communicate through the pupil are filled with clear aqueous humour(which secreted from non-pigmented epithelium of ciliary body and circulate from posterior chamber through pupil and lens to anterior chamber drainage in angle go to Schlemm's Canal, in = out = normal IOP , glaucoma means there is obstruction not increase in secretion) .Open angle glaucoma occurs in any age. Closed angle glaucoma "caused by pupillary block by the lens and iris" occurs in patients above 40y (prodromal glaucoma: the earliest stage of angle closure glaucoma; patients may be free of symptoms or have minor attacks of varying severity, duration, and frequency for months or years before a crisis) (Intermittent Angle Closure : There are also patients who have intermittent episodes of angle closure that resolve between attacks) . we treated the attack by pupil constriction or by laser peripheral iridotomy) .
- The vitreous cavity: filled by gel-like structure.
- ANTERIOR AND POSTERIOR SEGMENT

Iris and Pupil :

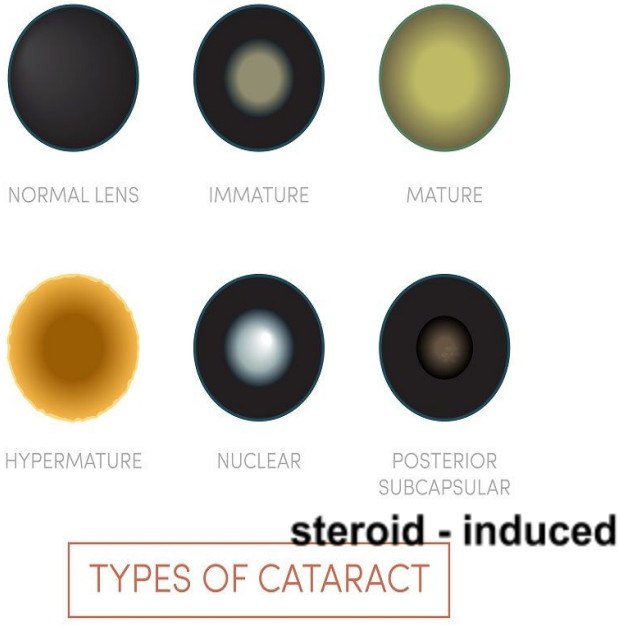


anisocoria : different size of the pupil . one supply by sympathetic and the other by parasympathetic.

The iris is a thin, contractile, pigmented diaphragm with a central aperture, the pupil. It is suspended in the aqueous humor between the cornea and the lens. The iris has **two muscles** :

1. Dilator pupillae : supplied by sympathetic fibers .
2. Sphincter pupillae: supplied by parasympathetic fibers from the oculomotor nerve.

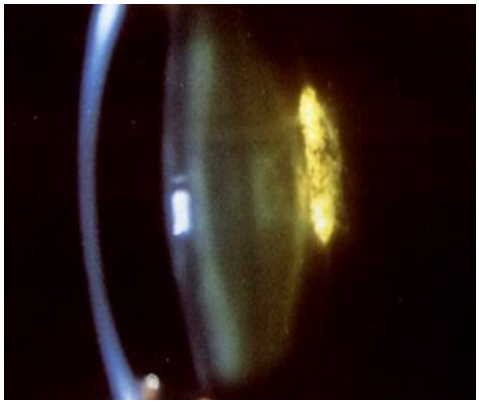
The Lens:



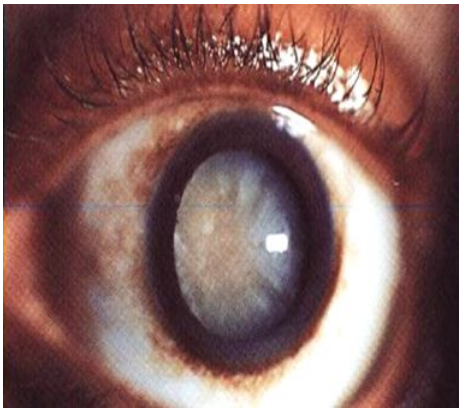
The lens is a transparent, biconvex structure enclosed in a transparent capsule. It is situated behind the iris in front of the vitreous body and is encircled by the ciliary processes. The lens consists of an elastic capsule, which envelops the structure ; a cuboidal epithelium, which is confined to the anterior surface of the lens , and lens fibers, which are formed from the cuboidal epithelium at the equator of the lens . (after age of 40 decrease in elasticity and increase refractive index and lenses could develop nuclear sclerosis which is early stage of cataract), (Crystalline lens is the only structure continuously grow throughout life.).

Lens structure:

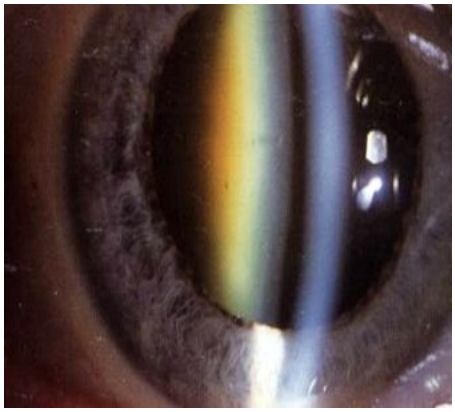
- Anterior capsule - Cortex - Nucleus - Posterior cortex - Posterior capsule.



posterior subcapsular cataract Possible causes: steroids and trauma

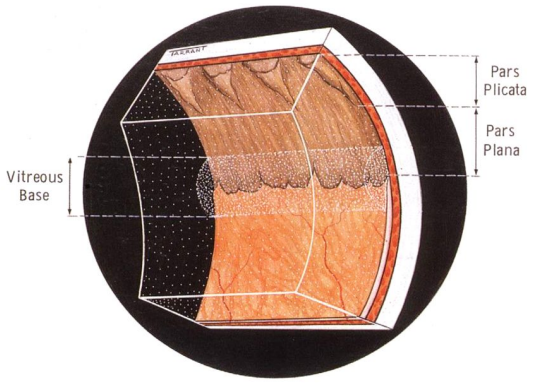


cortical cataract



this is a nuclear sclerosis representing a manifestation of early stage cataract.

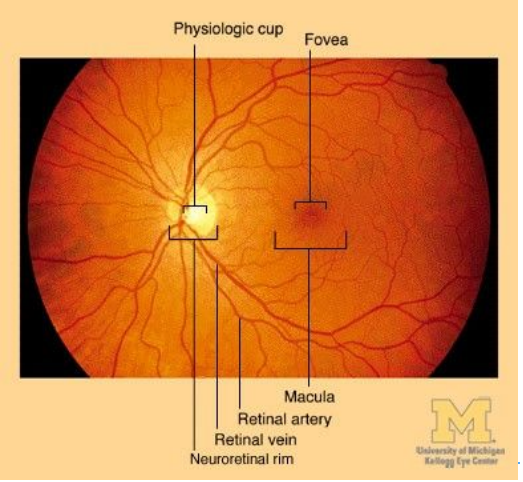
Retina and Vitreous:



- Vitreous attachment.
- Optic nerve head, macula, fovea, retinal background, Ora serrata, and retinal vasculature.
- Effect of systemic diseases.
- Retinal detachment.

At the center of the posterior part of the retina is an oval, yellowish area, the macula lutea, which is the area of the retina for the most distinct vision. It has a central depression, the fovea centralis(avascular zone).

Macula: An area of the eye near the center of the retina where visual perception is most acute. “oval yellowish area surrounding the fovea”.

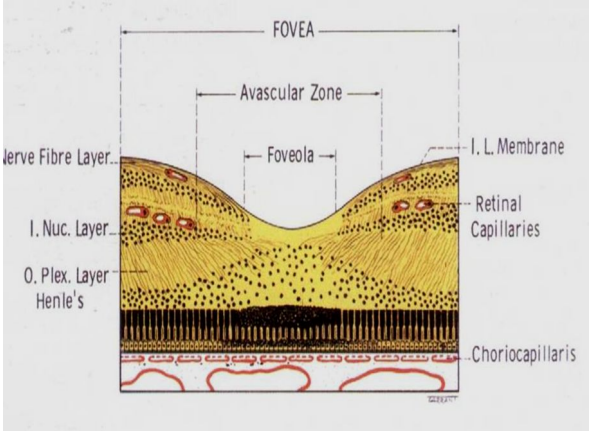


Fovea: The fovea is the region in the center back of the eye that is responsible for acute (central) vision. The fovea has a high density of cones.

The ciliary body has two portions, the pars plicata(which has part of ciliary body secreting aqueous). at the front and the pars plana at the back. Pars plicata has the ciliary processes, and the zonular lens fibers from the crystalline lens pass deep into the valleys between them. Pars plana is a relatively avascular area, so it is important surgically in the approach to vitreous space(They put 2 opening one for light and the other for vitrectomy).

Foveola is the one who responsible for 6/6 vision.

suppose patient has dysfunctional foveola ?
will decrease his vision by 50%..



Optic Nerve: (optic nerve > optic disc > rim and cup(when increase is sign of glaucoma, or could be physiological and we differentiate two types by measuring IOP and visual field)).

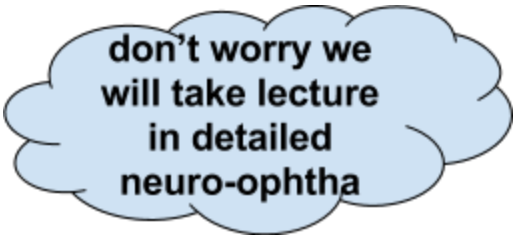
- contains around 1.2 million nerve fibers, which are axons of the retinal ganglion cells.

the length of optic nerve in these structures:

- 1 mm in the globe.
- 25 mm in the orbit.
- 9 mm in the optic canal.
- 16 mm in the cranial space
- Partial decussation occurs and about 53% of the fibers cross to form the optic tracts (if pt have carotid lesion will develop binasal hemianopia)

The optic nerve leaves the retina about 3 mm tothe medial side of the macula lutea by the optic disc. The optic disc is slightly depressed at its center, where it is pierced by the central retinal artery. At the optic disc, is a complete absence of rods and cons, so that the optic disk is insensitive to light and is referred to as the “blind spot”.

The Visual Pathway:



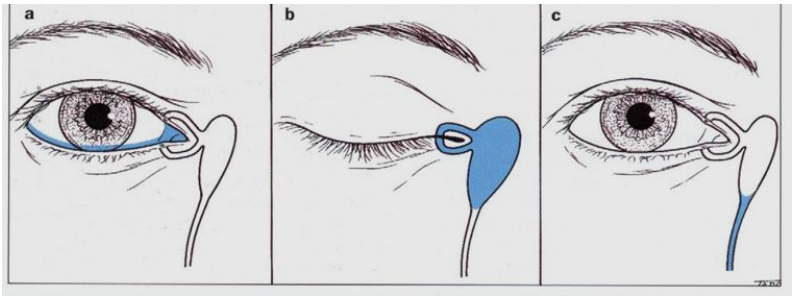
Visual Pathway: Three neurons

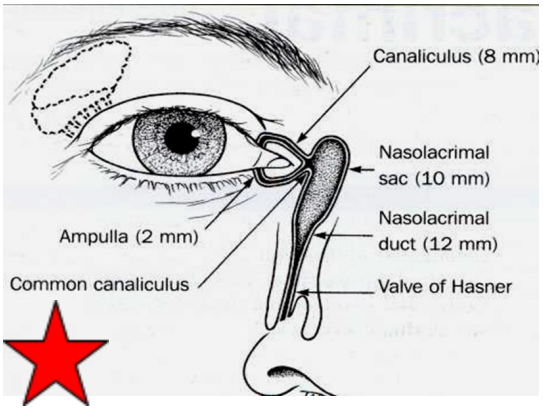
1. Bipolar cell, lies within the retina.
2. Ganglion cell, synapse in lateral geniculate body.
3. Third neuron terminates in visual cortex.

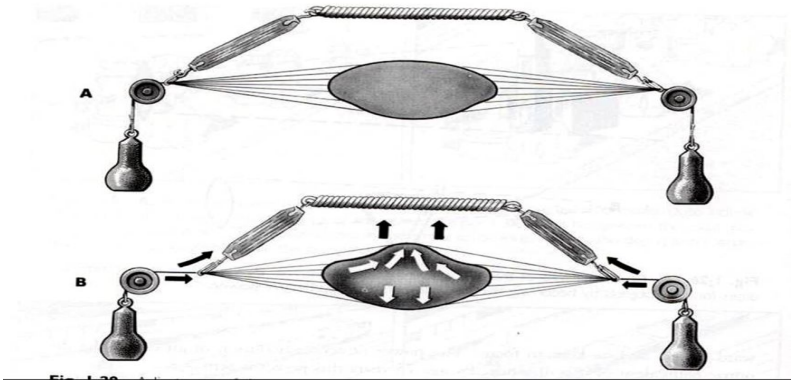
THE LACRIMAL APPARATUS- adnexa :

- Lacrimal gland secretes tears into the upper fornix of the conjunctival sac which are spread over the surface of the cornea as a tear film by blinking of the lids.
- Tears accumulate at the inner canthus and drain into the lacrimal sac via the puncta and canaliculi.
- The sac is continuous inferiorly with the nasolacrimal duct which opens into the nasal cavity just beneath the inferior turbinate.

A. Tear secretion.
B. Layers of precorneal tear film.
C. Drainage of tear.







Optics of the Eye:

The eye is like a camera. Light must have a clearly pathway to be clearly focused on the sensory receptors of the retina, i.e., Clear cornea, anterior chamber, lens and vitreous cavity.
The Refractive power of the eye is about 58 - 62 diopters.

- The cornea is the major refracting element of the eye with a power of approximately 40 diopters. If the curvature is greater in one meridian than the other→ Astigmatism.
- The refractive power of the lens is about 17-21 diopters at rest. Accommodation able to change the power of the lens markedly depends on age.(when near contraction of ciliary muscle , relaxation of zonular and bulging of the lens due to elastic lens capsule will occur while looking for far relaxation of ciliary muscle , contraction of zonular and lens will flatten) .

The Intraocular Pressure:

- The pressure within the eye is maintained at a steady level by continuous formation & drainage of aqueous.
- Aqueous is secreted by the ciliary epithelium → posterior chamber → anterior chamber (through the pupil) → drained through the anterior chamber angle.
- The intraocular pressure, (IOP), is normally 10 – 21 mmHg; increased IOP ocular hypertension .
- High IOP almost always due to an obstruction of aqueous outflow.

VISION:

The retina:
- The central retina contains yellow pigment, Xanthophyll, the so called macula lutea (yellow spot).
- It is divided into retinal pigment epithelium & neurosensory retina.
- Photoreceptors contains visual pigment which consists of a large protein (opsin) attached to retinal (vitamin A aldehyde).

- Light splits the opsin from the retinal with initiation of a graded electrical potential → Transmitted through the visual pathway to be processed in the visual cortex (occipital lobe) → vision sense.(transform chemical to electrical symptoms)
- Visual Pathway: Three neurons

1. Bipolar cell, lies within the retina.

2. Ganglion cell, synapse in lateral geniculate body.
3. Third neuron terminates in visual cortex.

senario

mother came with her baby complaining of tearing eye ?

DDx: nasolacrimal duct obstruction and congenital glaucoma , how would you know which one is the Dx?

if there is nasal secretion that mean this is congenital glaucoma.

MCQs

1. The socket that contains the eye called? ORBIT
2. the orbit is formed by. Seven Bones
3. The optic nerve pass through. Optic foramen or canal
4. The eye has …...Extraocular muscles. Six(4 Recti and 2 obliques)
5. All extraocular muscles are supplied by…… except …. and…. . Oculomotor nerve/SO4/LR6.
6. When we test a patient 4th nerve we should ask him to look ….and ….. Down/ in
7. The space that lies behind the cornea & in front of the iris called. Anterior chamber
8. The fluid that fills the chambers of the eye called. Aqueous humors
9. The cavity that lies behind the lens called. Vitreous cavity
10. The main refractive structure in the eye is….. . The cornea
11. The second refractive structure in the eye can change its power The lens
12. The structure that determines the color of the eye is… The iris
13. when the lens get opacified this condition called cataract
14. The central part of the retina called. The macula
15. The central part of the macula called Fovea
16. The central part of the fovea called foveola
17. The optic nerve lies in Nasal part of the retina
18. The percentage of the decussating fibers is 53%