Basic Anatomy and physiology

OBJECTIVES:

- Touch embryology of the eye.
- Explore anatomy of the orbit.
- Explore anatomy and physiology of EOM.
- Explore anatomy of the eyelid and conjunctiva.
- Explore anatomy of the globe.
- Explore anatomy of the visual pathway.
- Understand the physiology of vision, accommodation, pupillary reflex & tear drainage system.

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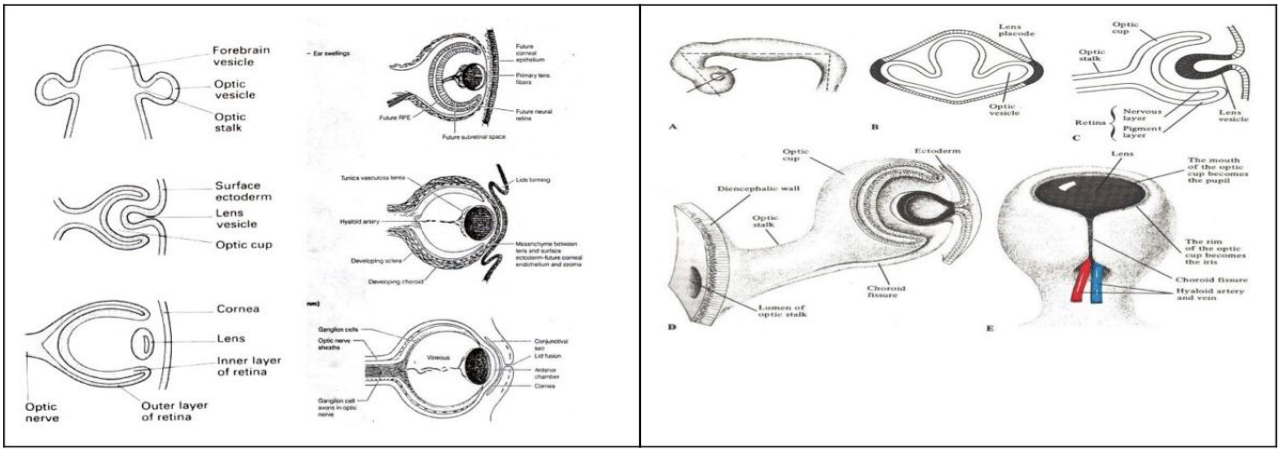
REFERENCES: lecture, 436 group A team, lecture notes book, 435 team.
Editing file

Color index: Important | Notes | Book & previous teams | Extra

Special thanks to 436 (A) teamwork.

Embryology of The Eye:

- This highly specialized sensory organ is derived from:
  - Ectoderm
    - Neural ectoderm.
    - Surface ectoderm.
  - Mesoderm.
  - ENDODERM does not contribute in eye embryogenesis.
- The eye is essentially an outgrowth from the brain (neural ectoderm).
- It started as optic vesicle connected to the forebrain by optic stalk.
- The primitive eyes come as lateral bulbs then move anteriorly.
- In embryology, the development of one organ is very important to develop the second one. The development of the eye is very crucial for the development of the orbit. If eye development is arrested, the bony orbit will not develop normally, and the child will have dysmorphic features.
- If the primitive eye develops the surface ectoderm will invaginate to form the lens. If the surface ectoderm fails to invaginate the surface epithelium won't form.
- During development of the eye, all structures of the eye are vascular (important).
- At the end of embryogenesis, the lens, vitreous & cornea **become avascular** which ensures clarity of the media for the passage of light to be focused on the retina to be able to see.
- The blood vessels invading the eyes are coming from inferio-nasal aspect, and this is the last area that become completely fused. So, if we have defective fusion of this area, it will be evident after birth as defect on the sclera, choroid, iris and lens and that's called coloboma.
  - If you have missed part of iris, missed part of retina
  - If the defect location is inferio-nasal this is a congenital anomaly. If it lateral, superior or superio-nasal this is not congenital anomaly, and you have to look for another etiology (It is important to know that the last fusion of the eye is inferio-nasal).

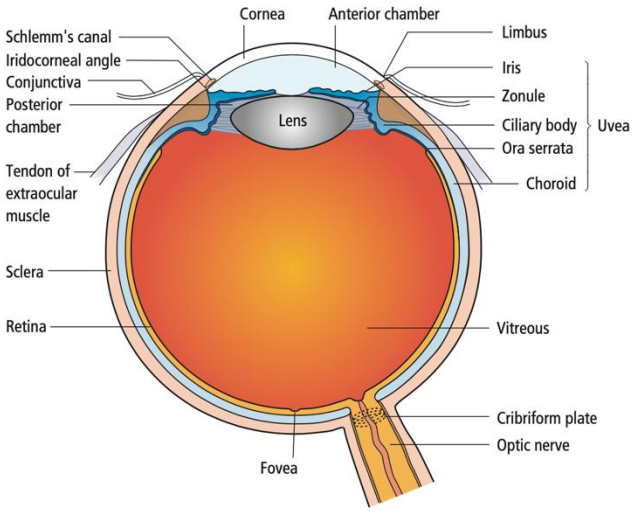


- Surface ectoderm which will form the epithelium of the eyelids, cilia, meibomian gland, lid margin, conjunctiva, bulbar conjunctiva, lens over the cornea.
- Formation of the lens will lead to invagination of the developing cup. This invagination will have 2 layers (outer & inner) and a potential space between them.
  - The outer layer of the retina will form:
    - The retinal pigment epithelium
    - The epithelium of choroid and iris
  - The inner layer of retina will form all layers of neurosensory retina starting from photoreceptors going inward up to the internal limiting membrane.
  - From embryological point of view, there is a potential space between inner & outer layers of retina.
    - Later in life, if for example trauma, traction (as in diabetic retinopathy), or tear happened & gave access inside, this potential space will be re-created causing separation of the retina (retinal detachment).
    - That's why retinal detachment occurs exactly between retinal pigment epithelium and photoreceptors.

- Hyaloid vessels vascularize the cornea and lens and then at the end of embryogenesis it starts to regress (dissolve), they are no longer needed because of the clarity of the media.
  - **If the vessels do not disappear this is called persistent hyperplastic primary vitreous** which results in absence of red reflex (also called dim red reflex, white red reflex, cat eye).
  - Leukocoria = absence of red reflex in pediatrics.
  - Other ddx of absence red reflex: most common is congenital cataract, most dangerous is retinoblastoma.

Brief gross anatomy: recommended video

- The eye consists of 3 layers:
  - A tough outer coat which is transparent anteriorly (the cornea) and opaque posteriorly (the sclera). The extraocular muscles attach to the outer sclera while the optic nerve leaves the globe posteriorly.
  - A middle rich vascular coat (the uvea) forms the choroid posteriorly and the ciliary body and iris anteriorly. The choroid lines the retina, to which it is firmly attached and nourishes its outer two-thirds.



  - The ciliary body contains the smooth ciliary muscle, which is responsible for changes in lens thickness and curvature during accommodation. The zonular fibers supporting the lens are under tension during distant viewing, giving the lens a flattened profile. Contraction of the muscle relaxes the zonule and permits the elasticity of the lens to increase its curvature and hence its refractive power.
  - The ciliary epithelium secretes aqueous humor and maintains the ocular pressure. The ciliary body provides attachment for the iris, which forms the pupillary diaphragm.
  - The lens lies behind the iris, supported by the zonular fibrils, which run from the lens equator to the ciliary body.
  - The cornea anteriorly and the iris and central lens posteriorly form the anterior chamber, whose periphery is the iridocorneal angle or drainage angle; the angle is lined by trabecular meshwork.
  - Between the iris, lens and ciliary body lies the posterior chamber, a narrow space distinct from the vitreous body. Both the anterior and posterior chambers are filled with aqueous humor. Between the lens and the retina lies the vitreous body, occupying most of the posterior segment of the eye.
  - The iris forms the pupil at its center, the aperture of which can be varied by the circular sphincter and radial dilator muscles to control the amount of light entering the eye.
    - The sphincter muscle is innervated by the parasympathetic system; The smooth dilator muscle is innervated by the sympathetic system.
  - The eye receives its blood supply from the ophthalmic artery via the retinal artery, ciliary arteries & muscular arteries.
    - The central retinal artery and vein enter the eye in the center of the optic nerve.

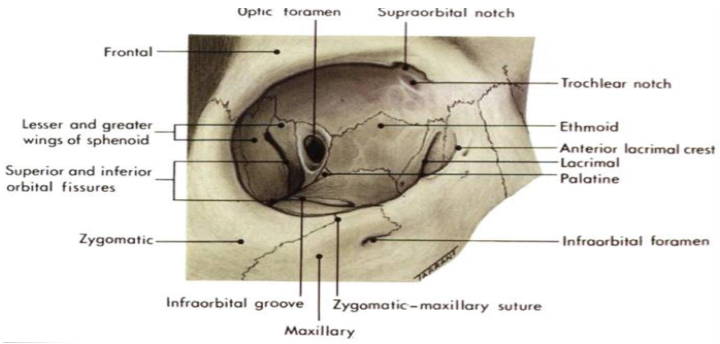
Development of the Eye After Birth:

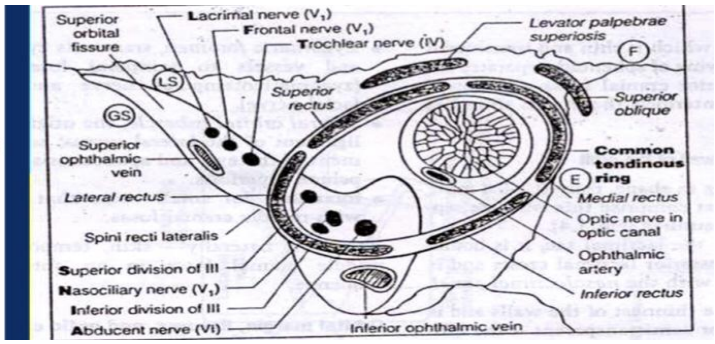
- At birth, the eye is relatively large in relation to the rest of the body.
- The iris has a bluish color due to little or no pigment on the anterior surface.
- During early infant life, the cornea & sclera can be stretched by raised IOP → enlargement of the eye.
    - In adult, increased IOP will **not** distend the eye. However, in pediatrics it can distend because the sclera is still soft.
- The eye reaches full size by the age of 8 years. This is important for the clarity of vision.
    - In pediatrics, the eye is slightly shorter than adults; thus, **it's normal** to have an infant with slight hypermetropia. As the baby grows will become emmetropic.
    - If a baby is emmetrope, with time will become myopic.
- **The lens continues to enlarge throughout the life.**
- If a pt has a large cornea, large bluish-colored sclera, large globe, on myopic side = you have to think about congenital glaucoma.

The Orbit:

- As a socket, contains & protect the eye.
- It has the shape of a 4-sided pyramid, with its base in-front & its apex behind.
- Seven bones contribute to the bony orbit. (frontal, zygomatic, maxillary, sphenoid, ethmoid, palatine & lacrimal).
    - The zygomatic bone is the strongest as it is more prone to trauma.
- The lateral aspect is the strongest wall of the orbit as well as the anterior aspect (rim).
    - If a pt presents w/ a fracture in the lateral orbital wall, he is most likely to have other fractured walls.
- the lateral aspects (walls) are 45 degrees.
- The smallest part is the orbital apex; therefore, any lesion in the apex is very dangerous because it presses on the vessels & nerves that pass through it.
- The weakest parts are the floor & the medial wall.
- The medial orbital wall & ethmoid sinus are separated by a very thin straight bone called (**lamina papyracea).** Being thin makes it a very common source of infection; thus
    - The most common site of infection is the medial wall.
        - A patient with sinusitis commonly presents with orbital cellulitis.
    - The medial orbital wall **is the thinnest** wall but not the weakest because it is a **straight bone**.

- The floor is slightly thicker but **is weaker** because it is curved.
    - The most common fracture of the orbital wall is the orbital floor **(blow out fracture)** due to blunt trauma & it causes high IOP.
        - The patient will complain of diplopia (vertical diplopia)
- From 435, MCQ: the infra-orbital nerve supplies the skin of the lower lid, so when you get a scenario saying a patient present with paresthesia of the lower lid, what nerve is affected? Infra-orbital nerve.
- Surrounded by nasal sinuses.
- Important openings are:
    1. Optic foramen.
    2. Superior orbital fissure.
    3. Inferior orbital fissure.



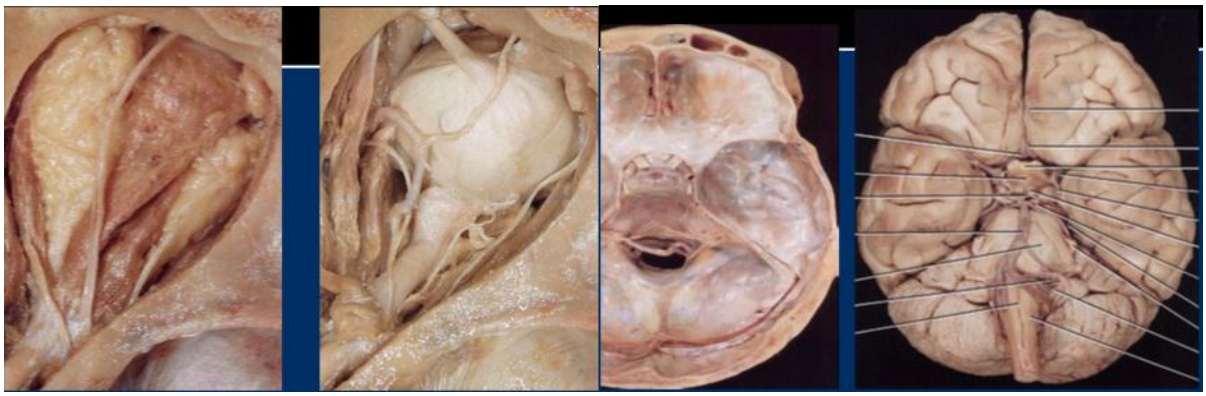


♦ Openings in the orbit (Important)

Optic foramen	Superior orbital fissure	Inferior orbital fissure (22 mins)
1. Optic nerve. 2. Ophthalmic artery.	ANY STRUCTURE NOT MENTIONED IN OTHER OPENINGS. 1. III, IV, and VI cranial nerves. 2. Lacrimal nerve. 3. Naso-ciliary nerve. 4. Superior ophthalmic vein. 5. Inferior ophthalmic vein.	1. Infraorbital nerve. 2. Infraorbital vessels.

- **If I mentioned something you don't know, say it passes through the superior orbital fissure.**

- The bone is covered with periorbita (periosteum) which is loosely adherent to the orbital walls. Thus, it can accumulate pus, sub-periosteal abscess or hemorrhage.
- The orbital septum prevents bulging of the globe. The periorbita is very resistant to infection; therefore, we divide the infections into 2 groups:
  - Anterior to the orbital septum (pre-septum).
    - Any infection that develops anterior to the orbital septum can be treated as outpatient by either oral or systemic antibiotics.
  - Posterior to the septum (orbital).
    - Any infection behind the orbital septum is very dangerous as it can easily get access to the cavernous sinus through the ophthalmic vein & induce cavernous sinus thrombosis which is fetal.
    - Orbital cellulitis should be treated aggressively as in-patient.



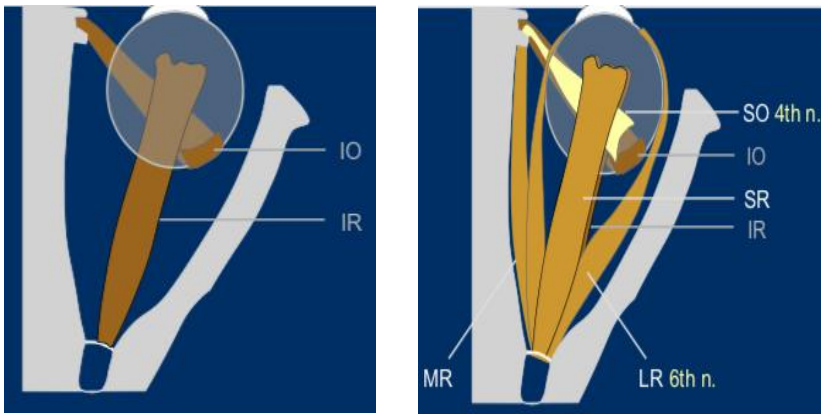
- Annulus of zinn (other names: common tendinous ring, annular tendon) is a fibrous band surrounds the optic nerve and gives origin to the extraocular muscles (lateral, medial, superior, inferior recti muscles)
- Extraocular muscles pass in angulated way except the medial rectus which comes straight & the lateral rectus which comes exactly bisecting the globe. That's why medial and lateral recti can do only one movement.
  - ADduction for the medical recti.
  - ABduction for the lateral recti.

The extraocular muscles:

- Four recti & two oblique muscles.
- **All are supplied by oculomotor n. except superior oblique (trochlear n.) & lateral rectus (abducent n.).**
- The intraocular muscles include the ciliary muscles and the pupillary muscles (sphincter pupillae and dilator pupillae).

- The levator muscles are also supplied by the oculomotor.
- Structures passing within the cavernous sinus: abducent n. & internal carotid artery (if a pt has carotid-cavernous fistula, the first structure to be affected is the abducent nerve).
- The 2 optic nerves are connected together at the optic chiasma below the pituitary gland.
    - The pituitary adenoma patient presents first to an ophthalmologist, complaining of decreased peripheral visual field “I had a car accident”.
- Why do we have two eyes? To see 3-dimensional image“stereopsis” to appreciate distance, different angulations translated in the brain as distance.
    - This is why pediatrics with uncorrected strabismus won’t develop the ability to have 3-d image will not develop properly.
- Why do we have the optic chiasm “decussation”? Because looking at a specific object doesn’t limit your visual field you can still see the surroundings although there’re not very clear, so seeing part of the image from the right nasal and the other from the left temporal will be confusing for the visual cortex without decussation and we will see double.
- The brain is taking the information from one side of this eye and the corresponding side from the other eye and they’re corresponding to one field of vision to a certain visual cortex.

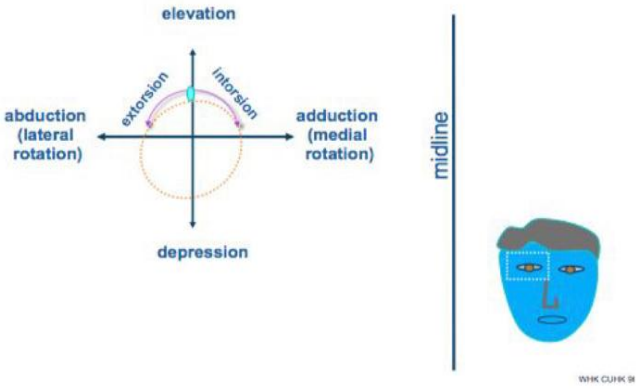
Attachment of eye muscles



♦ Innervation & action of eye muscles:

Muscle	Actions (1 primary & 2 secondary)
Superior rectus	Primary: elevation. Secondary: - Adduction. - Intorsion.
Inferior rectus	Primary: depression. Secondary: - Adduction. - Extortion.
Medial rectus	Primary: adduction (**ONLY 1 action**).
Lateral rectus	Primary: abduction (**ONLY 1 action**).
Superior oblique	Primary: intorsion. Secondary: - Depression. - Abduction.
Inferior oblique	Primary: extortion Secondary: - Elevation - Abduction

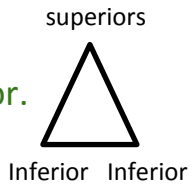
Hence for clinical test	Direction to look • SO Down and in • IO Up and in • SR Up and out • IR Down and out [R=O, O=I]



Helpful video Helpful video extra-video

- The anatomical axis of the globe is parallel to the medial aspect of the orbit.
- The anatomical axis of the muscles is not parallel to the anatomical axis of the globe (except the medial rectus).
- Equator means the largest diameter of the globe.
    - If the muscle is attached anterior to the equator the superior muscle will cause elevation of the eye.
    - If the muscle is attached behind the equator the superior muscle will cause depression of the eye.
    - The insertion of the oblique muscles is **behind the equator** that's why superior oblique depresses the eye & inferior oblique elevates the eye; unlike the recti which are inserted anterior to the equator.
- If the anatomical axis of the globe is parallel to the anatomical axis of the muscle, **the muscle can do one action only.**
- If the anatomical axis of the globe **is perpendicular to the anatomical axis of the muscle no action will happen**, because the only action that can happen here is retraction of the eye and this does not happen because the globe has fixed position by strong fibers.
- So, if I can bring the eye perpendicular to the anatomical axis of the muscle as if I'm completely obstructing the action of this muscle.
- For example,
    - if I look medially: the axis of the eye become perpendicular to the lateral rectus, so its action is blocked, while the axis is parallel to the oblique so the only elevator of the eye in this position is inferior oblique & the only depressor is superior oblique.
    - If I look laterally: the axis of the eye become parallel to the superior & inferior recti. So, the only elevator of the eye in this position is superior rectus & the only depressor is inferior rectus.
    - **When talking about extraocular muscles ALWAYES remember to mention which eye are you testing.**
    - The muscle of reading is superior oblique.
- Both superior rectus & inferior oblique elevate the eye, so how to test each muscle separately?
    - For superior rectus, let patient look laterally then up.
    - For superior oblique, let patient look medially then up.
    - Same concept for inferior rectus & superior oblique.

- General roles to help you memorize:
    - All recti are adductors EXCEPT lateral rectus which is abductor.
    - All obliques are abductors.
    - So, three muscles are adductors & three are abductors.



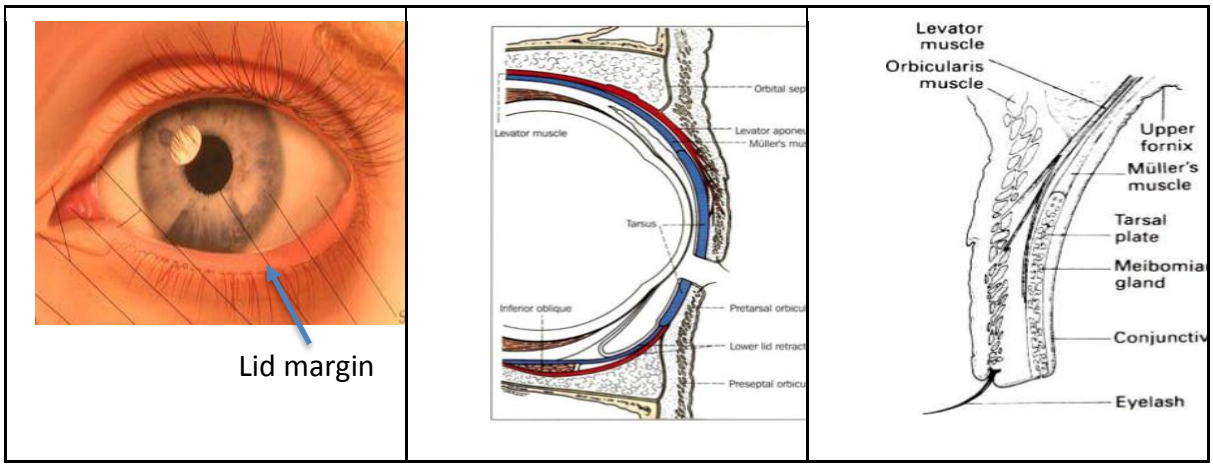
- All superiors are intortors (intorsion) (In/ الأغنياء منغلقين على نفسهم).
- All inferior are extortors (extorsion) (Ex/ عامة الناس اجتماعيين أكثر).

- Why we have intorsion & extortion movements? For compensatory movement with our head.
- Tricky thing in MCQs:
    - Superior oblique depresses the eye ON adduction (so the adductor here is another muscle).

The Eyelids:

- They provide a protective covering for the eye.
- They spread the precorneal tear film in a regular smooth way over the ocular surface. The precorneal tear film is a very thin fluid layer over the corneal surface.
- Cilia is for protection of the eye from dust.
- They comprise:
    - An anterior layer of skin.
    - The orbicularis muscle is innervated by the seventh nerve.
    - A tough collagenous layer (the tarsal plate) which houses the oil glands.
    - An epithelial lining, the tarsal conjunctiva, which is reflected onto the globe via the fornices.
- The lids are:
    - Closed by orbicularis oculi muscle (innervated by facial n.)
    - The orbicularis oculi muscle is composed of three parts: the orbital part, the palpebral part, and the lacrimal part. The palpebral part composed of pre-septal & pretarsal.
    - We have three types of closures:
        - Involuntary closure, by pretarsal part of orbicularis.
        - Voluntary closure, by pre-septal part of orbicularis.
        - Forceful closure, by orbital part.
            - Contraction of the peripheral fibers of the orbicularis muscle results in a protective forced closure while the inner palpebral muscle fibers results in blinking.
    - The lacrimal part of orbicularis is responsible for suctioning the tears (when eye closes this muscle contracts and the lacrimal sac will expand. As a result, there will be negative pressure inside which sucks the tear, so this is how the tears are drained from the eye).
    - The lids are opened with Levator palpebrae muscle (innervated by oculomotor n.), Muller's muscle (sympathetic supply) & Lower lid retractors.

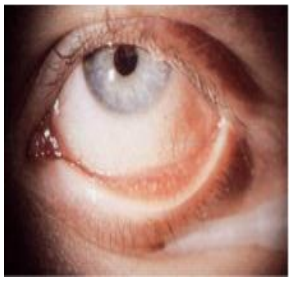
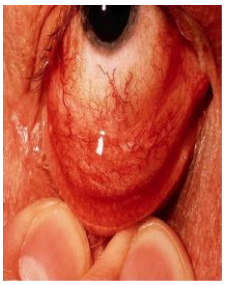
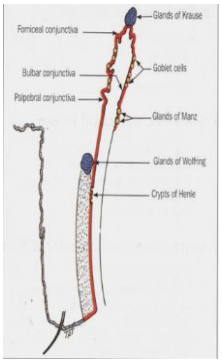
- The sympathetic supply will be affected in pts w/ Horner syndrome in which they have miosis, partial ptosis, anhidrosis & enophthalmos (Mnemonic: MAPLE).
- The difference between ptosis due to parasympathetic & sympathetic injury is that:
    - In third nerve palsy (para-sympathetic injury) ptosis occurs due to levator palpebrae muscle paralysis & is associated with lateral deviation of the eye; while, in sympathetic nerve injury the Muller's muscle will be paralyzed & patient will have ptosis as in Horner's syndrome.

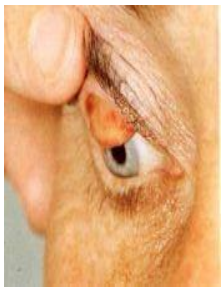
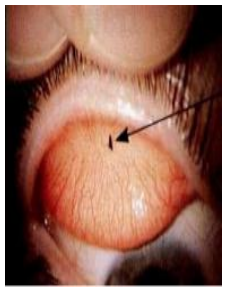


- **Tarsus** is a thick fibrous tissue that acts as a skeleton to the lid.
- **Meibomian gland** produces meibum, an oily substance that prevents evaporation of the eye's tear film.
- **Entropion** is when the lid margin folds inward.
- **Ectropion** is when the lid margin turns outward.
- Inflammation of the lid margin is called blepharitis.
- **Lagophthalmos** is the inability to close the eyelids completely.

The Conjunctiva:

- Is a thin membrane covering the sclera & has three parts:
    1. Bulbar conjunctiva covering the sclera.
    2. Palpebral conjunctiva we have to invert the eyelids to see the palpebral conjunctiva.
    3. Forniceal conjunctiva.
- Limbus.
- The stroma (no adenoid tissues until 3 months after birth).
- Follicles & Papillae.
- Injection and chemosis.

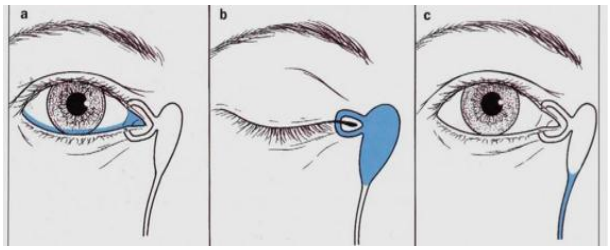




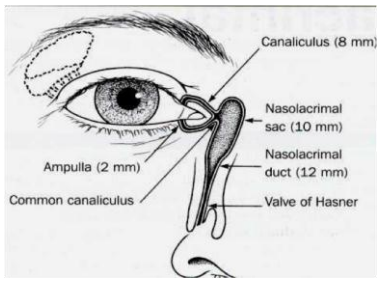
- **The Lacrimal apparatus:**
  - The lacrimal gland lies anteriorly in the superior-temporal (superiolateral) aspect of the orbit.
    - You can't palpate the lacrimal gland, if you palpate it this is a diseased gland.
  - On the anterior medial wall lies the fossa for the lacrimal sac.
  - Tear production & secretion (it works by reflex tearing).
  - Tears drain from superior & inferior puncta to upper & lower canalicului >> lacrimal sac >> nasolacrimal duct which opens into inferior meatus.
    - Failure of the distal part of the nasolacrimal duct to fully canalize at birth is the usual cause of a watering, sticky eye in an infant.
  - Valve of Rosenmuller, separates the common canaliculus from the lacrimal sac. This separation prevents reflux through the lacrimal system.
  - Valve of hasner prevents nasal secretion from going up. Valve of hasner is located at the lower end of the nasolacrimal duct (at the meatus). If well developed, it prevents air from being blown back from the nose into the lacrimal sac.

  - Drainage of tear.
    - If there is secretion with no drainage, there will be persistent tearing.
  - Layers of precorneal tear film.
    - A mucin gel layer produced by the conjunctival goblet cells, in contact with the ocular surface.
    - An aqueous layer produced by the lacrimal gland.
    - A surface oil layer produced by the meibomian glands and delivered to the lid margins.

- This is a hot topic in the exam, we can put an arrow and ask you what is the name of a certain structure?

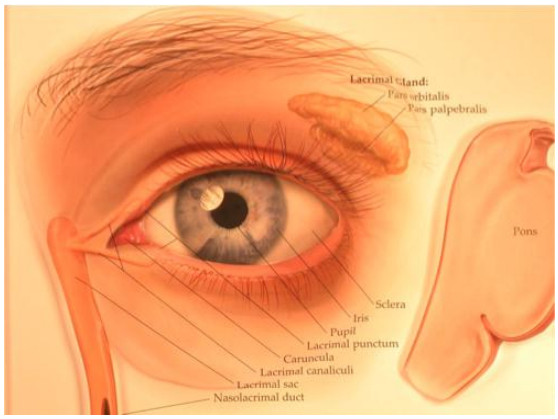


- Fluorescein test is done for pediatrics & adults.
- We put fluorescein stain in the eye.
- Normally it goes away after 15 mins, but if it doesn't it indicates obstruction of the nasolacrimal duct.



From 436 (A), you need to memorize the lengths.

- Babies born with teary eyes have a problem with the nasolacrimal duct (blocked).
- If closed by bony part: nothing to do.
- Closed by membranous part: observe for 1 year > goes spontaneously> persists > syringe & probing.



• The eye (Globe):

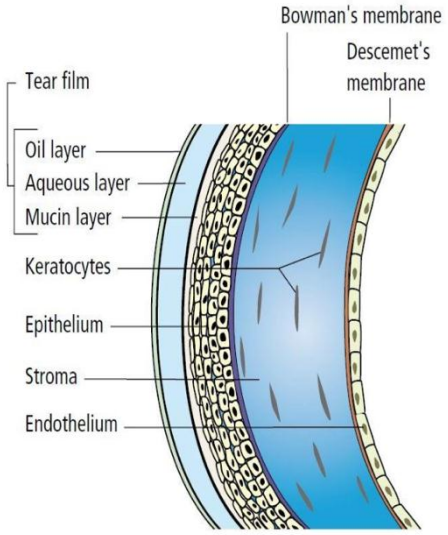
- Two spheres with different radii:
  - Cornea, window of the eye.
  - Sclera, opaque shell.
- The eye measures approximately 24 mm in all its main diameters.
- 2/3 of the refractive power of the eye is from the cornea while 1/3 is from the lens.

♦ The cornea

- It consists of five layers: epithelium, bowman's layer "called anterior limiting membrane", corneal stroma, descemet's layer "called posterior limiting membrane", and corneal endothelium.
- It is avascular & has regularly arranged collagen fibers; thus, it is transparent.
- From 436 (A) you need to know the layers.

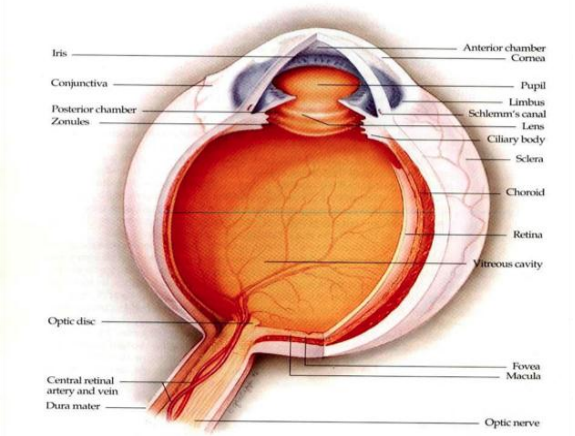
It has 5 layers

Layer (anterior to posterior)		condition
Epithelium	➢ continuation of the bulbar conjunctiva ➢ ectodermal origin	Abrasion. Treatment by covering the eye for 24hrs and defect will heal without scarring. Never use topical anesthesia in this case.
Bowman's membrane	clear **acellular** layer	Abrasion. Risk of scarring
Stroma	contains collagen fibrils that accounts for around 90% thickness	
Descemet's membrane		Disturbance of this layer is common in congenital glaucoma. Management is surgical via keratoplasty
Endothelium	Single layer	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**.



♦ The coats of the eye:

- Three layers:
  - The outer: inelastic coat, transparent cornea and opaque sclera.
  - The middle, vascular coat, the uvea: choroid, ciliary body and iris.
  - The inner: the retina, extends forwards to within 6 mm of the limbus.



♦ The choroid

- The choroid is formed of arterioles, venules and a dense, fenestrated capillary network.
- It has a remarkably high blood flow.

The eye chambers:

- Three optically clear spaces:
  - 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 humor.
  - The vitreous cavity: filled by gel-like structure, the vitreous.
- The lens and cornea are avascular, so they obtain oxygen & nutrients from surrounding fluids (aqueous humor).
- Aqueous humor is produced by the epithelium of the ciliary body.
  - The ciliary body has pigmented & non-pigmented epithelium; the aqueous humor is secreted from the non-pigmented.
- It is secreted into the posterior chamber, from which it flows through the pupil to enter the anterior chamber, then it is drained into the canal of Schlemm through the trabecular meshwork and finally the episcleral venous pressure.
- Aqueous humor production is continuous & is **not** pressure gradient. So, if IOP raised its production will not stop.
- Inflammation of the ciliary body (uveitis) causes atrophy of the eye.
- Abnormal blood collection in the anterior chamber is known as hyphema & is mainly due to trauma.
- Pus collection in the anterior chamber is known as hypopyon.

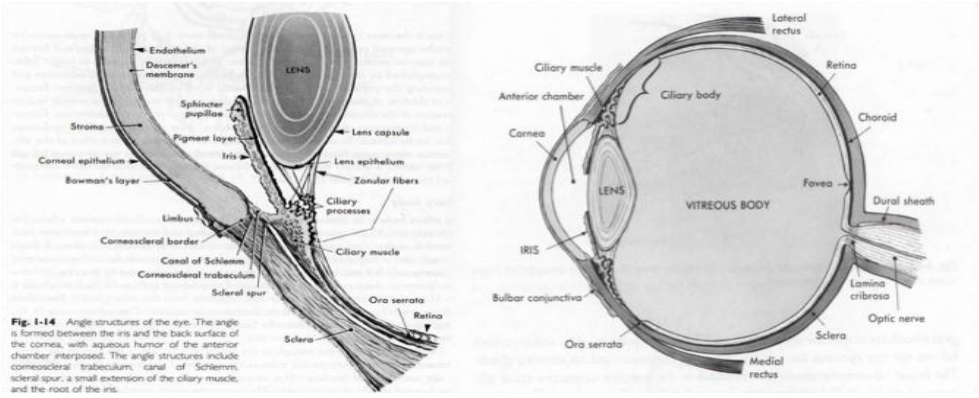


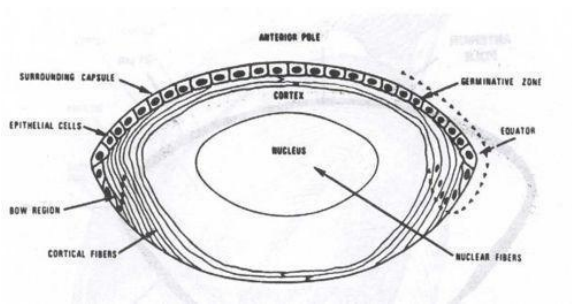
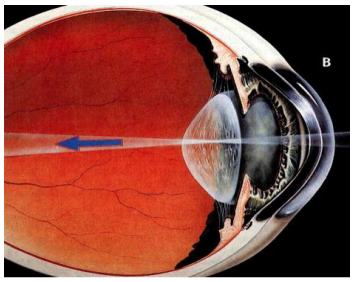
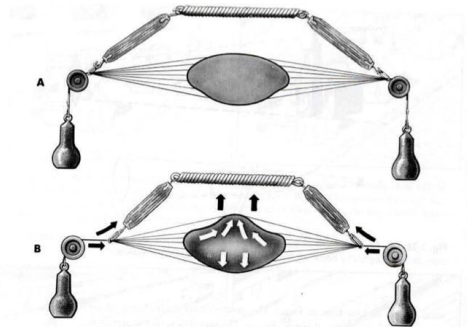
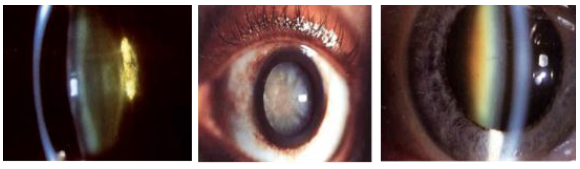
Fig. 1-14 Angle structures of the eye. The angle is formed between the iris and the back surface of the cornea, with aqueous humor of the anterior chamber interposed. The angle structures include corneoscleral trabeculum, canal of Schlemm, scleral spur, a small extension of the ciliary muscle, and the root of the iris.

The Intraocular pressure (IOP):

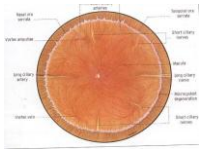
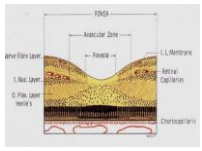
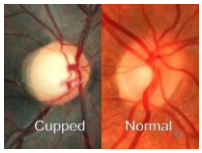
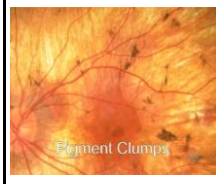
- The pressure within the eye is maintained at a steady level by continuous formation & drainage of aqueous.
- Aqueous is secreted by the ciliary epithelium → posterior chamber → anterior chamber (through the pupil) → drained through the anterior chamber angle.
- The intraocular pressure (IOP) **is normally 10 – 21 mmHg**; increased IOP called Glaucoma (glaucoma is a triad of high IOP enough to induce optic n. damage manifested by visual field defect).
  - The most important is to know the baseline. If someone's IOP baseline is 12 and know is 20, this is considered high & should be investigated.
- High IOP almost always due to an obstruction of aqueous outflow.

- **The Lens:**
  - The crystalline lens is the only structure continuously growing throughout the life.
  - Capsule (anterior & posterior), epithelium and lens fibers.
  - In pediatrics the lens is soft & the power of accommodation is very high. With time the lens becomes harder, so the ability of the lens to change its shape is decreasing.
  - Normally, by the age of 45 the accommodation is decreasing significantly, a condition known as presbyopia.
  - Presbyopia a is a physiological condition not a pathology.

    - **Diseases of the lens:**
      - Cataract
        - any opacity in the lens called cataract.
      - Congenital anomalies and effect of systemic diseases.

Structures of the lens	Changeable refractive media
	
Zonules contraction & relaxation	**Cataract**
	

- **The Retina and the vitreous:**
  - Optic nerve head, macula, fovea, retinal background, Ora serrata, and retinal vasculature.
  - Vitreous attachment.
  - Retinal detachment.
  - Effect of systemic diseases.
  - Collapse of the vitreous gel (vitreous detachment), which is common in later life, puts traction on points of attachment and may occasionally lead to a peripheral retinal break or hole, where the vitreous pulls off a flap of the underlying retina.

 Pic-1: - Normal fundus photograph by indirect ophthalmoscopy (with indirect we can see a wide field while with direct we will see the optic nerve only) **See below for more info regarding pic 1 & 3**	 Pic-2:	 Pic-3:	 Pic-4: - You see this ring because of the slopping edge	 Pic-5: - You can see the edge here (normal) but you cannot draw it with a pencil. When you can draw it like this (pale) and the color is getting more pale this is a pale optic nerve and optic atrophy
 Pic-6: - When it is become more and more blurred this is swollen optic nerve. - If it's bilateral we call it papilledema.	 Pic-7: - Sometimes the cup is enlarging in the area which is pale, and center becomes more and more enlarged and this is diagnostic for glaucoma **See below for more**	 Pic-8: - These are abnormal blood vessels we call it new-vascularization which is diagnostic for ischemic status of the retina due to many causes, the most common cause is diabetes.	 Pic-9: - We see it in retinitis pigmentosa.	 Macular degeneration

- **More info regarding pic 1 & 3**

  1) Optic nerve head:
     - The first thing we look at is the optic nerve. It has a lot of diseases that you have to comment in the OSCE and determine any abnormality.
     - You can identify the optic nerve head clearly, but you cannot draw it with a pencil.
     - We call the central pale part the optic cup. It does not have any nerve fiber layer, and the normal disc to cup ratio is almost 0.3 (1/3). This is important because if we have any edema or any compression it won't be affected directly it gives time for the edema not to strangulate the optic nerve.

  2) Macula and Fovea centralis:
     - Fovea centralis is responsible for the highest visual acuity.
       - It has very condensed photoreceptors and no blood vessels (avascular). So, it takes its blood supply from the choroid behind it. Because if it has blood vessels, it will obstruct the passage of the light.
       - It is also sloppy, so the light will hit directly on the photoreceptors. You will see the slopping part as a ring in the fundus when you look at a normal fovea.
       - Since this part is thinner it will look darker, because it is highlighting the underlying choroid melanin pigment.

  3) Artery. 4) Vein.
     - The artery is brighter and thinner than the vein.

  More info regarding pic 5&7:
  - Difference between cupped and pale:
    - The cupped is one degree of pale optic nerve but the cupped there is an area that is still viable while in pale the whole optic disc is gone.

  More info regarding pic 8:
  - The normal blood vessels on the retina are directed to a certain area not polarizing with the ring. This is to differentiate it from new vessels (abnormal blood vessels on the retina in case of diabetes).

Processes of vision:

- Function of the eyes:
  - Receive the image and change it into language that the brain can understand (action potential). So, it receives the photon power cascade of the action then changing it into action potential so the brain can understand.
- The retina:
  - It is divided into retinal pigment epithelium (outermost) & neurosensory retina (innermost).

- The neurosensory retina consists of the photoreceptors (rods and cones), the bipolar nerve layer (and horizontal nerve cells) and the ganglion cell layer, whose axons give rise to the innermost, nerve fiber layer.
    - These nerve fibers converge to the optic nerve head, where they form the optic nerve.
- The retina has 10 layers: (1) the inner limiting membrane (2) the nerve fiber layer (3) the ganglion cell layer (4) the inner plexiform layer (5) the inner nuclear layer (6) the outer plexiform layer (7) the outer nuclear layer (8) the outer limiting membrane (9) the photoreceptor layer and (10) the retinal pigmented epithelium.
- Photoreceptors contains visual pigment (11-cis-retinal) that changes into Rhodopsin upon light stimulation (electrical stimulation).
    - The photoreceptor layer is responsible for converting light into electrical signals.
        - Cones are responsible for daylight and color vision They are concentrated at the fovea where they provide high resolution and the detailed vision required to read.
        - Rods are responsible for night vision.
    - The optic disc is slightly depressed at its center, where it is pierced by the central retinal artery. At the optic disc, there is a complete absence of rods and cons, so that the optic disc is insensitive to light and is referred to as the "blind spot".
    - Light splits the opsin from the retina with initiation of a graded electrical potential →Transmitted through the visual pathway to be processed in the visual cortex (occipital lobe) → vision sense.
    - Macula: an area of the eye near the center of the retina which is the area of the retina for the most distinct vision. It has a central depression, the fovea centralis.
    - 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. (while periphery of retina has higher density of rods).
    - Optic disc: the terminal part of the optic nerve where ganglion cells fibers leaves the eye.
    - Optic cup: a central depression within the optic disc.
    - The normally cup-disc ratio is 3/10 (0.3). The measurement is crucial to diagnose certain diseases like glaucoma.

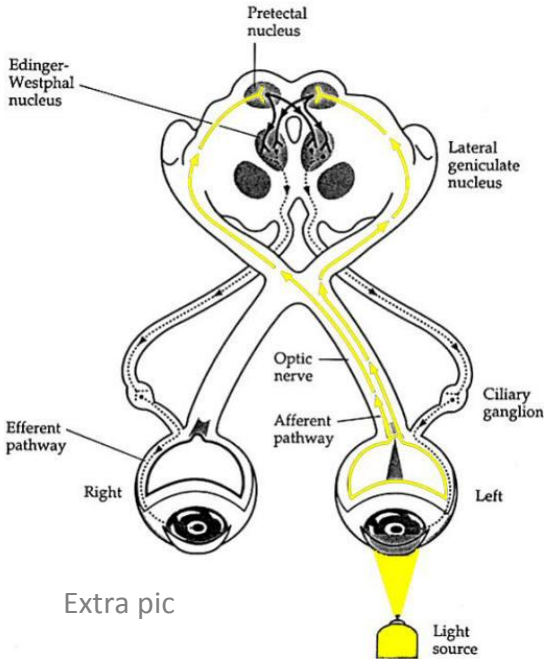
♦ Where are the leaking points for information transmission throughout the visual pathway? Answer: gab junctions.

- Visual pathway: ganglion cell in the retina >> optic nerve >> optic chiasm >> optic tract >> lateral geniculate body (one of the leaking points) >> optic radiation >> visual cortex.
- From ganglion to lateral geniculate body is one single cell. So, if we have pressure on the optic nerve, optic tract, optic chiasm it will be manifested by pale optic disc because we are dealing with the same cell.
    - This is why we have the cup, because the cup gives space so if we have any strangulation the cell doesn't die.

The visual Pathway

helpful video

- 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.



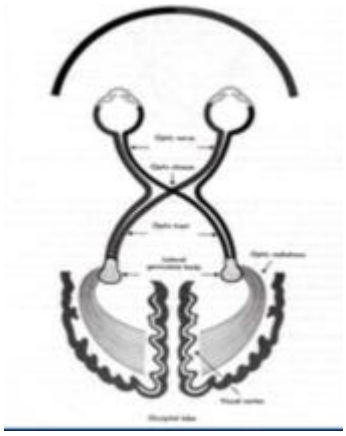
Extra pic

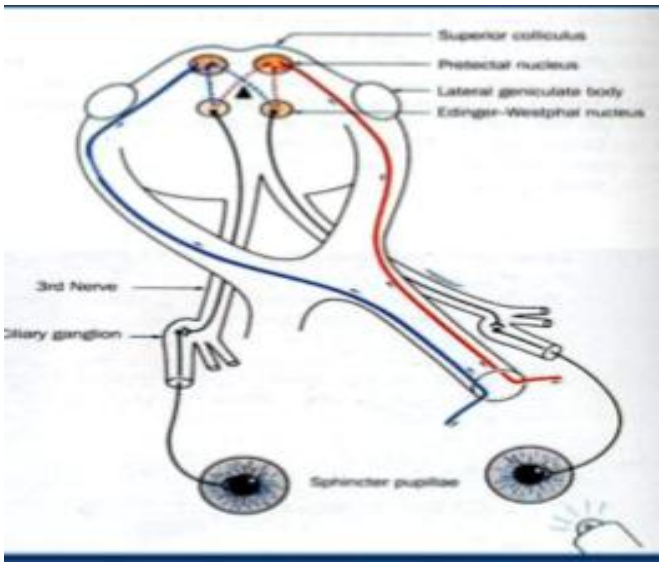
- Why do we have decussation?
    - We have decussation so the right or left visual field from both eyes are processed in one visual cortex.

The Pupillary Light Reflex

- The fibers responsible for pupillary reaction will go from lateral geniculate body to pretectal nucleus >> edinger-westphal nuclei >> third nerve >>pupils.
- One pretectal nucleus supplies both edinger-westphal nuclei, that's why when we stimulate one side both are responded.
- In the optic nerve, the fiber responsible for pupillary reaction is located on the outer part of the nerve. This is why if we have any light pressure on the nerve, the pupillary reaction will be affected directly. Absence of pupillary reaction can be an early sign of optic nerve compression. (Afferent by optic, efferent by oculomotor)
- The central part of the fiber is supplied with dual arterial supply from inside & outside. This is why when we have medical diseases, the optic nerve itself will not be affected much but the peripheral fibers which are supplied by only the peripheral will be affected early.

- For example, the left visual field from both eyes get processed in the right visual cortex only, not right & left cortex.





Doctor's questions:

1. Regarding embryology & development of the eye which statement is True:
   A. The eye is derived from endoderm, mesoderm, and surface ectoderm.
   B. The iris coloboma has to be superior-temporal in location.
   C. The eye reaches its full size at puberty.
   D. The lens continues to enlarge throughout the life.
   E. During early infant life, the cornea and sclera cannot be stretched by raised IOP.

2. Regarding anatomy of the orbit, which statement is false:
   A. The thinnest wall is the medial wall.
   B. The weakest wall is the floor.
   C. The ophthalmic artery passes through optic canal.
   D. The superior division of oculomotor nerve passes through the superior orbital fissure.
   E. The inferior division of oculomotor nerve passes through the inferior orbital fissure.

3. Regarding extra-ocular muscles, which statement if false:
   A. All are supplied with oculomotor nerve except the lateral rectus.
   B. The superior rectus elevates the eye on abduction.
   C. The inferior rectus depresses the eye on abduction.
   D. Superior oblique depresses the eye on adduction.
   E. Inferior oblique elevates the eye on adduction.

4. Regarding eyelid & conjunctiva, which statement if false:
    A. The lids are closed by orbicularis oculi (facial n.).
    B. The lids are opened with levator palpebrae muscle (oculomotor n.) and Muller's muscle (para-sympthatic supply).
    C. The tarsus is the skeleton of the eyelid.
    D. The orbital septum is a strong barrier against infection.
    E. The conjunctiva has 3 parts: bulbar, palpebral and Forniceal conjunctiva.

5. Regarding lacrimal apparatus, which statement is true:
    A. Lacrimal gland is located at the inferio-nasal aspect of the orbit.
    B. The lacrimal gland is the only source of tears.
    C. The tears are spread over the surface of the cornea as a tear film by blinking of the lids.
    D. Tears drain into the lacrimal sac via the puncta & naso-lacrimal duct.
    E. The facial nerve has no role in tear drainage.

6. According to the anatomy of the retina which statement is false: (from 436 group A team)
    A. The anterior & posterior chambers are filled with clear aqueous humor.
    B. The anterior chamber angle examination is essential in glaucoma.
    C. The optic cup/disc ratio is normally 0.3.
    D. The fovea is highly vascularized.

Answers:

1. D 2. E 3. A 4. B 5. D 6. D

Questions:

1. The eye reaches full size by which age?
    A. 18
    B. 8
    C. 15
    D. 5

2. Which of the following passes through the superior orbital fissure?
    A. Central retinal vein
    B. Lacrimal nerve
    C. Optic nerve
    D. Ophthalmic artery

3. The anterior chamber is between the cornea and zonules:
    A. True
    B. False

4. Which of the following structures responsible for tears spreading?
    A. Eye lids
    B. Cornea
    C. Sclera
    D. Eye lashes

5. What is the function of the iris?
    A. Carries visual messages from the retina to the brain
    B. Regulates the amount of light entering the eye
    C. Converts light into electrical impulses
    D. Gives central vision

6. Light first enters the eye through the iris.
    A. True
    B. Flase

7. Normal intraocular pressure is between ___ mmHg
    A. 12-10
    B. 10-21
    C. 19-100
    D. 10-22

8. The orbit is formed by ___ bones
    A. 6
    B. 7
    C. 8
    D. 9

9. The optic nerve lies in ___ part of the retina.
    A. Nasal
    B. Temporal
    C. Anterior
    D. Posterior

Answers: 1:B 2:B 3:A 4:A 5:B 6:B 7:D 8:B 9:A

Good Luck!