



MED437  
KING SAUD UNIVERSITY



# Cranial Nerves II, III, IV & VI (Optic, Oculomotor, Trochlear, & Abducens)

Lecture (13)

Please check our [Editing File](#)

هذا العمل مبني بشكل أساسي على عمل دفعة ٤٣٦ مع المراجعة  
والتدقيق وإضافة الملاحظات ولا يغني عن المصدر الأساسي للمذاكرة

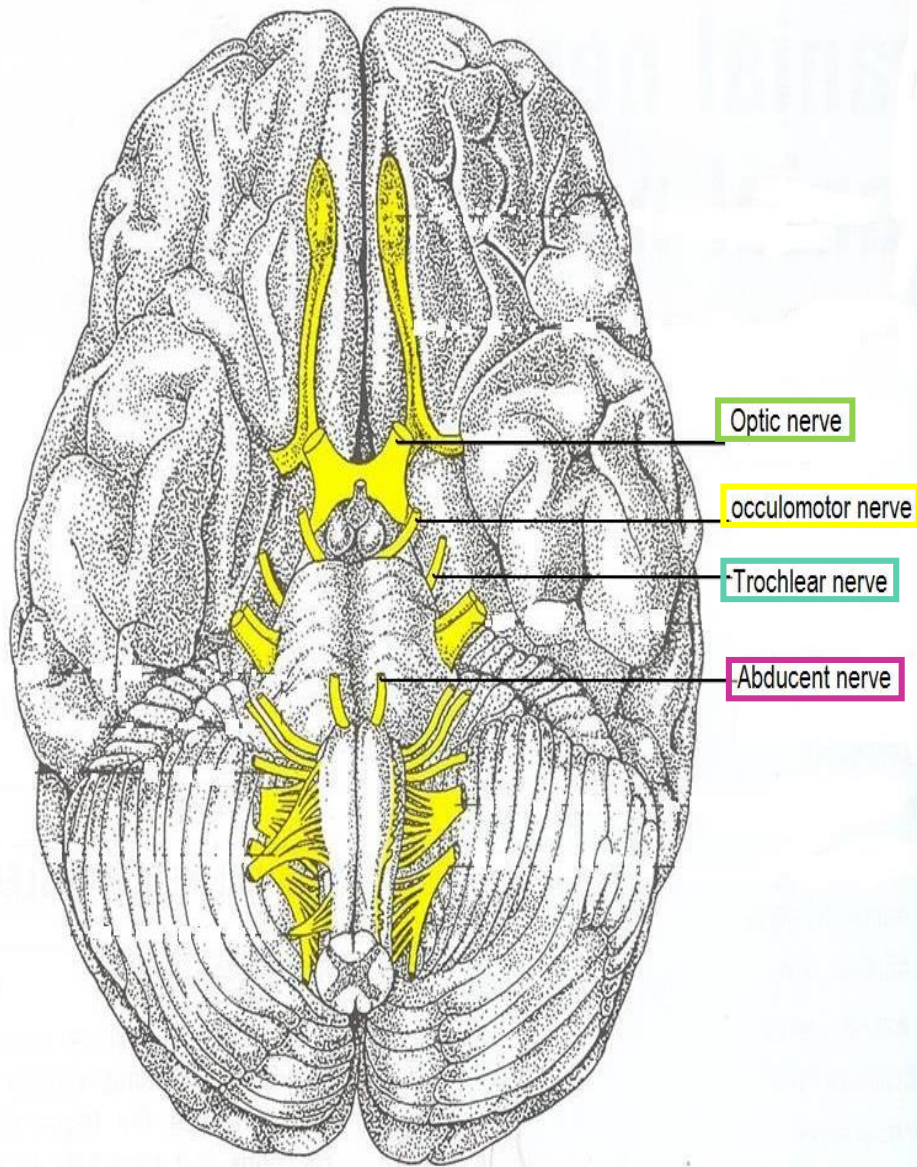
- **Important**
- **Doctors Notes**
- Notes/Extra explanation

{وَمَنْ يَتَوَكَّلْ عَلَى اللَّهِ فَهُوَ حَسْبُهُ}

# ■ Objectives

**At the end of the lecture, students should be able to:**

- ✓ List the cranial nuclei related to oculomotor, trochlear, and abducent nerves in the brain stem.
- ✓ Describe the type and site of each nucleus.
- ✓ Describe the site of emergence and course of these 3 nerves.
- ✓ Describe the important relations of oculomotor, trochlear, and abducent nerves in the orbit
- ✓ List the orbital muscles supplied by each of these 3 nerves.
- ✓ Describe the effect of lesion of each of these 3 nerves.
- ✓ Describe the optic nerve and visual pathway.



**Brain (Ventral view)**

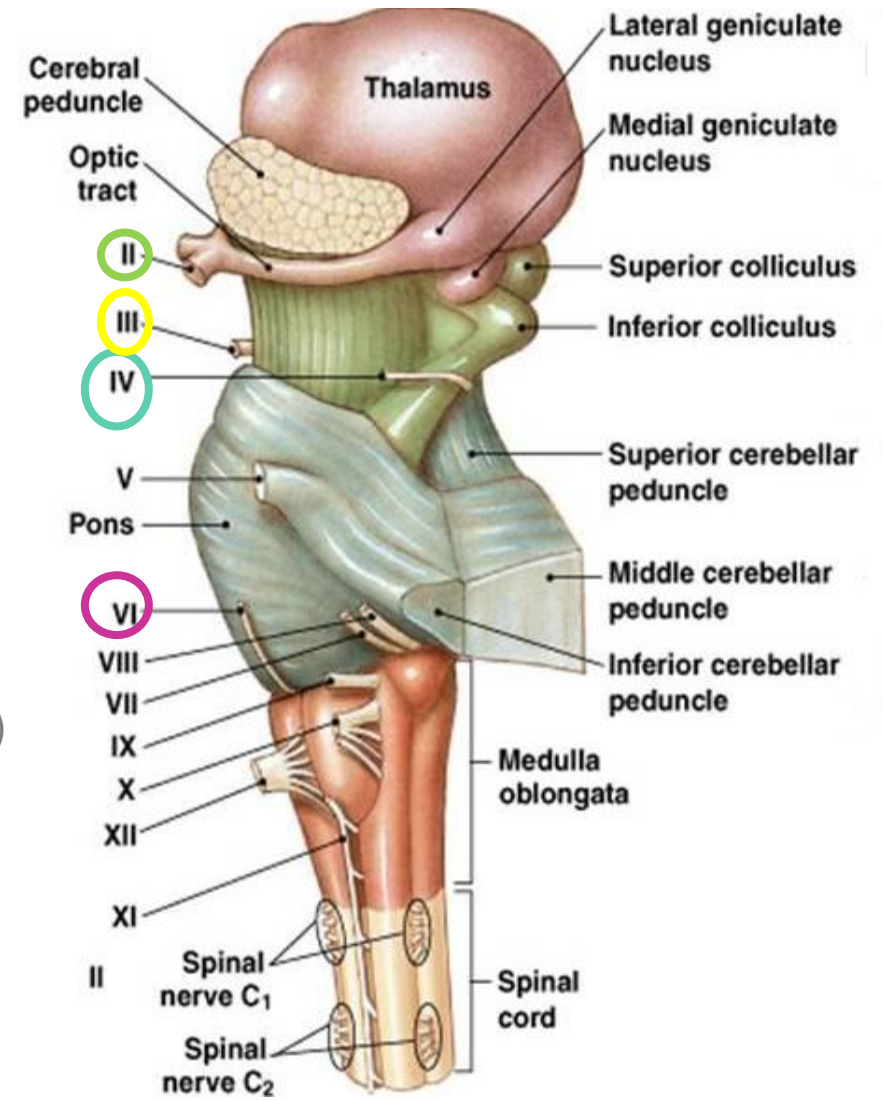
Recall the how these nerves exit from the brain stem:

**Optic** (does not exit from brain stem)

**Oculomotor:** ventral midbrain (medial aspect of crus cerebri)

**Trochlear:** dorsal midbrain (caudal to inferior colliculus)

**Abducent:** ventral Pons (junction b/w pons & pyramid)



**Brain stem (Lateral view)**

# Extra-Ocular Muscles

7 muscles:

1- Levator palpebrae superioris. (ترفع جفن العين)

(4) Recti muscles: Origin: from the roof of the orbit

2- Superior rectus (upward and medially)

3- Inferior rectus (downward and medially)

4- Medial rectus (medial)

5- Lateral rectus (lateral)

(2) Oblique muscles: -اسمها عكس وظيفتها-

6- Superior oblique (downward and laterally)

7- Inferior oblique (upward and laterally)

Origin: from the anterior floor

**NB. All muscles of the eye are supplied by the oculomotor nerve, EXCEPT SO4 superior oblique (by trochlear) and LR6 lateral rectus (by abducens)C★**

\*Rectus:

ماشي على

الصراط

المستقيم

(medial)

فحركته

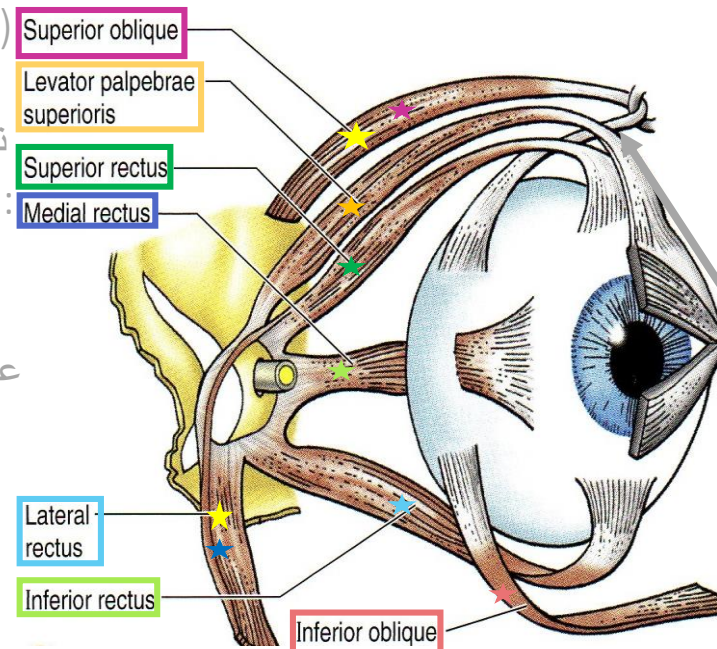
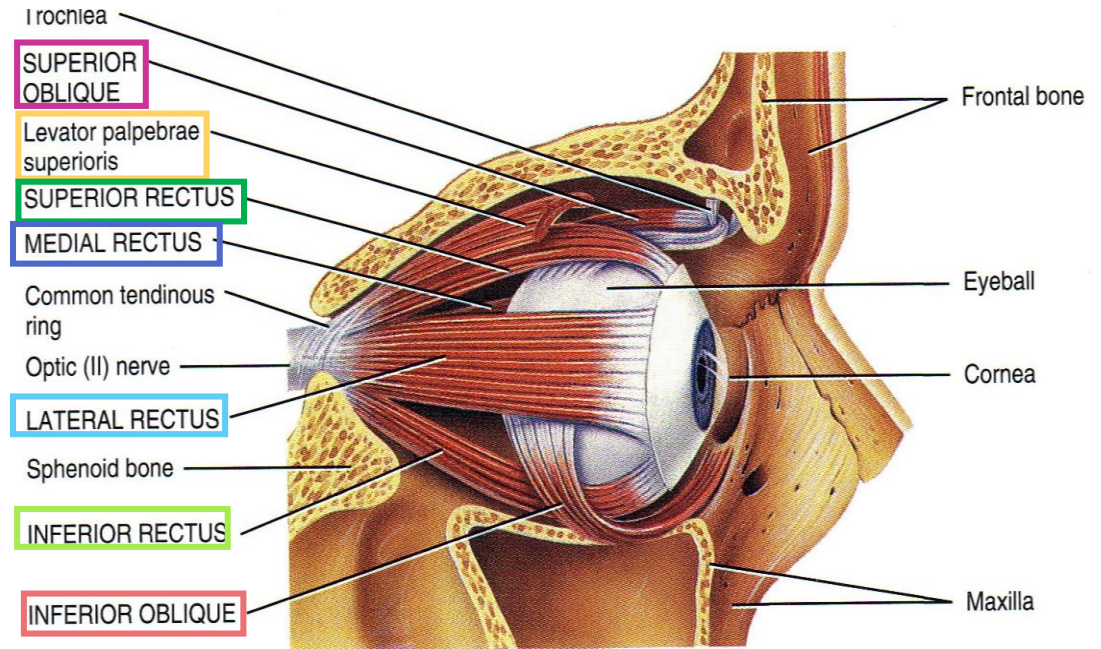
نفس اسمه

Oblique:

منحرف

يمشي

عكس كلامه

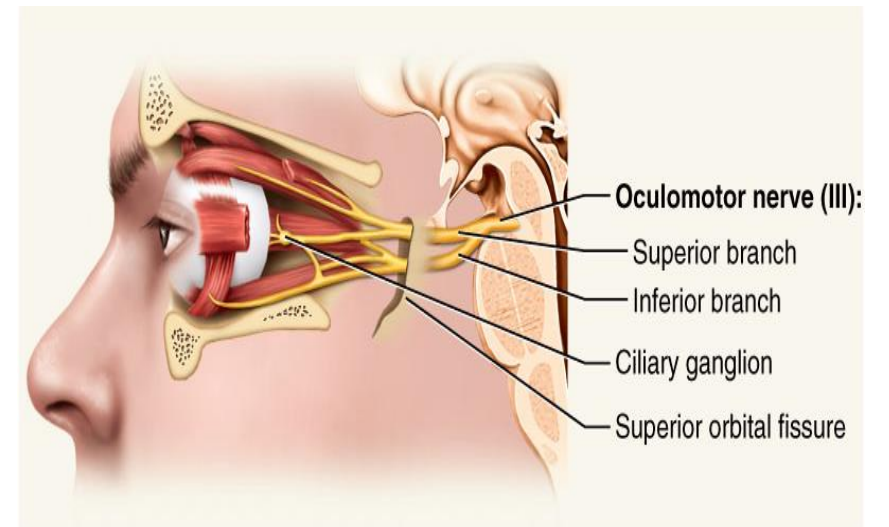
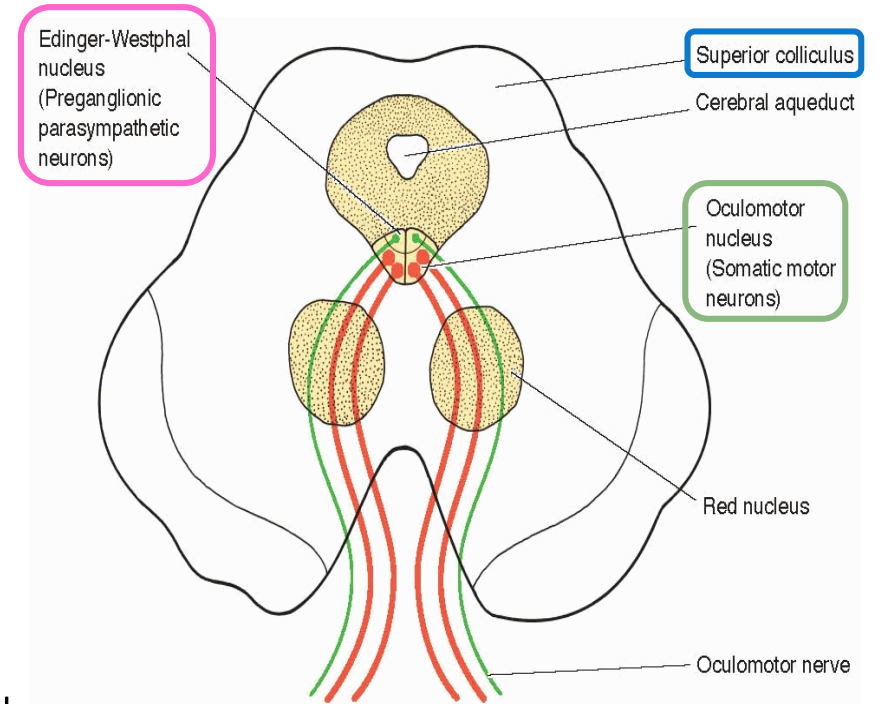


How to remember the 2 muscles not supplied by CN3?  
 1- Superior oblique goes up (superior) and turns around (oblique) a notch or pulley and its supply is trochlear which in latin means pulley (بكرة)  
 2- Lateral rectus function: abduction and is supplied by abducens

# Occulomotor

## (III) 3rd Cranial Nerve

- **Motor** for most of extraocular muscles.
- Also carries preganglionic **parasympathetic** fibers to the pupillary constrictor and ciliary muscles.
- **Has two nuclei:**
  - 1- Main oculomotor nucleus;
    - Lies in the mid brain (posterior part of the tegmentum), at the level of superior colliculus located in the periaqueductal grey matter.
  - 2- Accessory nucleus (Edinger-Westphal nucleus);
    - Lies dorsal to the main motor nucleus.
    - Its cells are **preganglionic parasympathetic neurons**.
    - It receives; **Corticonuclear fibers** for (1) accommodation reflex, and from the **pretectal nucleus** for the direct and consensual (2) pupillary reflexes.

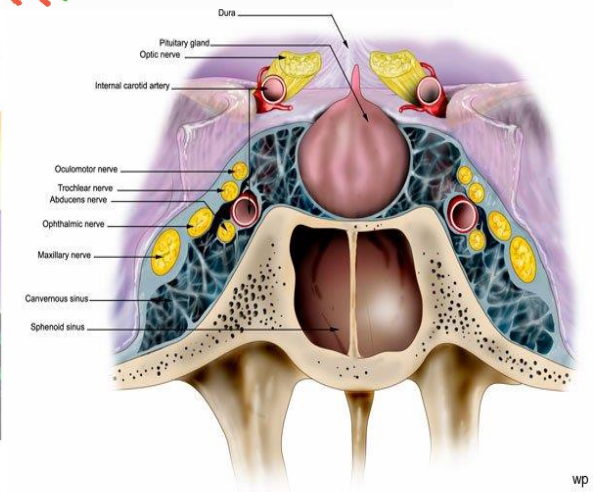
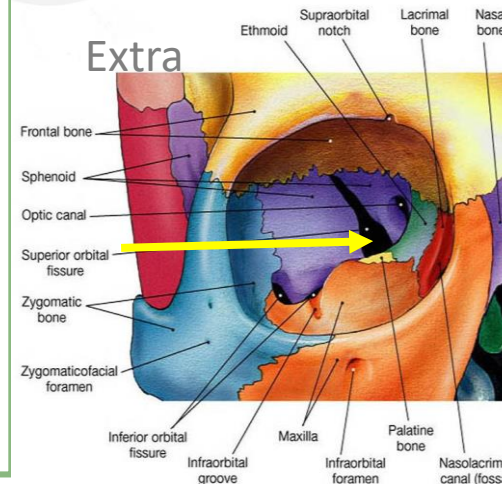
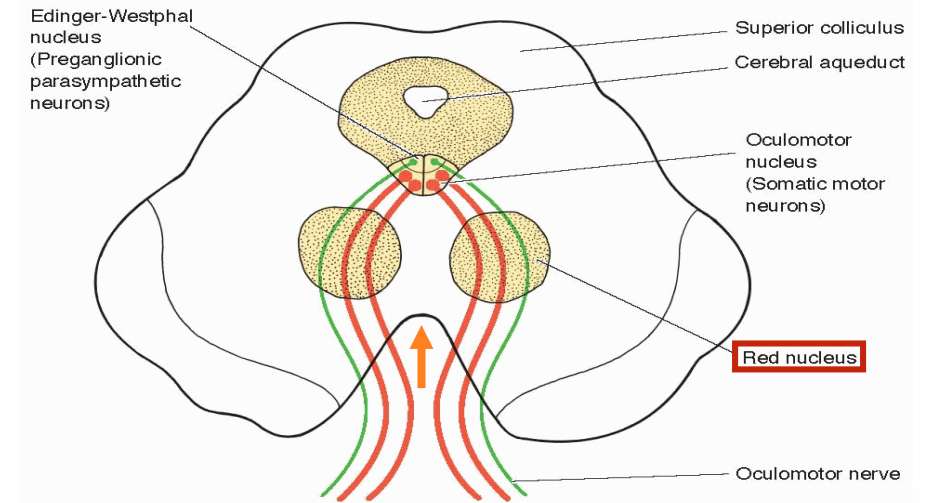


# Oculomotor

## (III) 3rd Cranial Nerve

- **Axons** from the oculomotor nucleus curve ventrally through the **tegmentum\*** and the **red nucleus** in the midbrain.
- The nerve emerges on the anterior surface of the midbrain in the interpeduncular fossa **medial to crus cerebri/cerebral peduncle**.
- Then it passes forward **between** posterior cerebral and superior cerebellar arteries.
- In the **middle cranial fossa** it runs in the lateral wall of the cavernous sinus\*\*, then it divides into superior and inferior divisions which pass to the orbit through the superior orbital fissure.

\*Recall: the midbrain is divided into a dorsal part (Tectum) and a ventral part (Tegmentum)

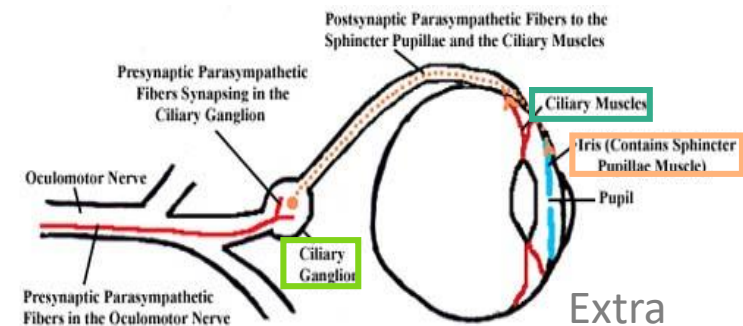
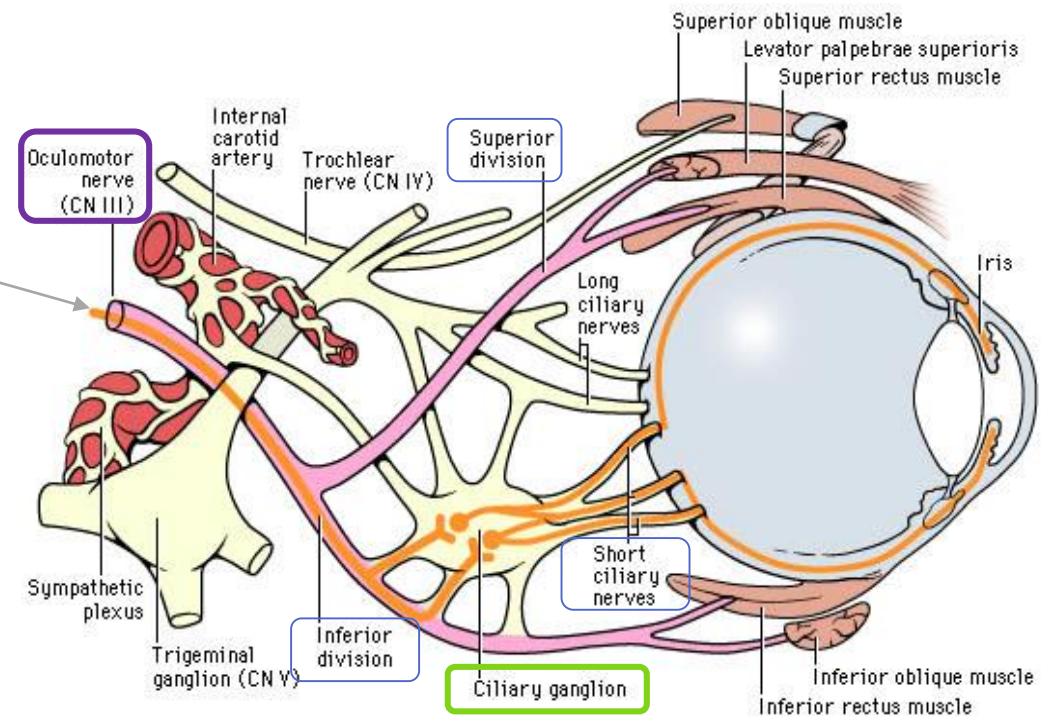


\*\*Cavernous sinus: one of the **Dural Venous sinuses**, trochlear & oculomotor run in the lateral wall and abducent runs in the floor

# Occulomotor

## (III) 3rd Cranial Nerve

- Axons from the **Edinger-Westphal nucleus** accompany the oculomotor nerve fibers to the **orbit**, where they terminate in the ciliary ganglion (one of the parasympathetic ganglion of the head & neck)
- Postganglionic fibers pass through the short ciliary nerves to the eyeball, where they supply:
  - Constrictor pupillae muscle of the iris
  - Ciliary muscle.



# Occulomotor

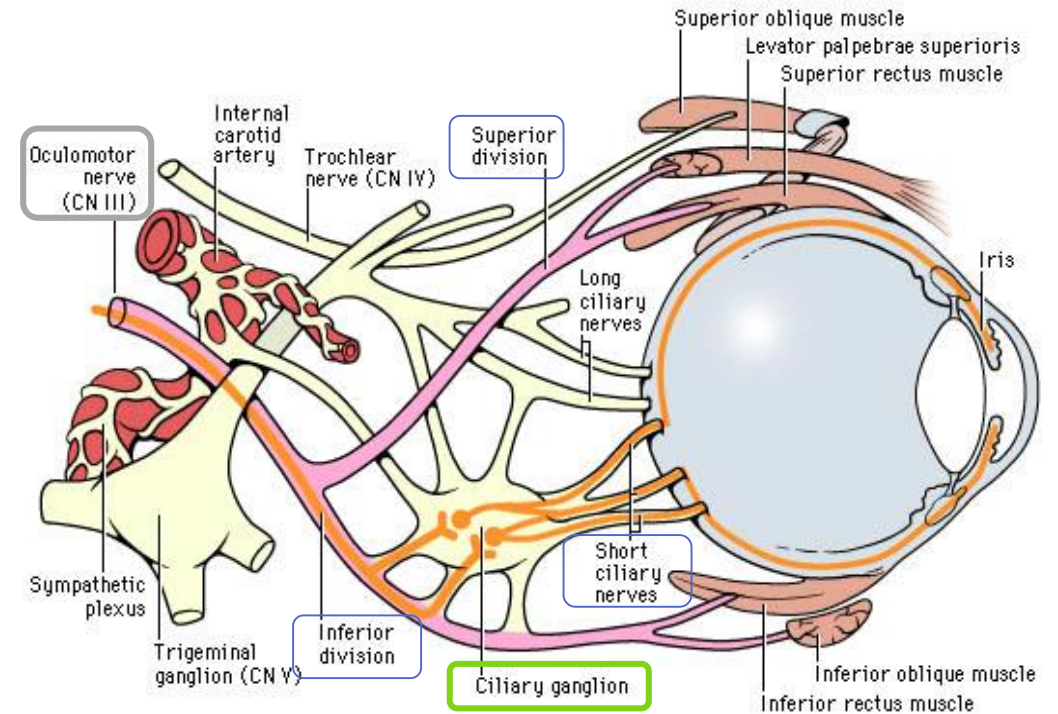
## (III) 3rd Cranial Nerve

### Occulomotor nerve supplies:

- Motor to:
  1. Levator palpebrae superioris
  2. Superior rectus muscle
  3. Medial rectus muscle
  4. Inferior rectus muscle
  5. Inferior oblique muscle
- Parasympathetic fibers to:
  1. Constrictor pupillae
  2. Ciliary muscles

### It is responsible for;

- **Elevation** of upper eyelid (open the eye) (by **levator palpebrae superioris**).
- **Turning** the eyeball upward, downwards and medially.
- **Constriction** of the pupil (pupillary reflex)
- Accommodating **reflex** of the eyes.





# Occulomotor

## (III) 3rd Cranial Nerve

### Lesion results in:

1. **Lateral squint.** (since medial is affected and only lateral is working)
2. Ptosis (drooping of the eyelid).
3. Diplopia (double vision). **Diplopia always accompanies squint**
4. Pupillary dilatation.
5. Loss of accommodation.
6. The eyeball is fully abducted and depressed (down and out) because of the unopposed activity of lateral rectus and superior oblique.

The preganglionic parasympathetic fibers run superficially in the nerve and are therefore the first axons to suffer when a nerve is affected by external pressure. Consequently, the first sign of compression of the oculomotor nerve is ipsilateral slowness of the pupillary response to light.



Normal eye alignment



Lateral squint

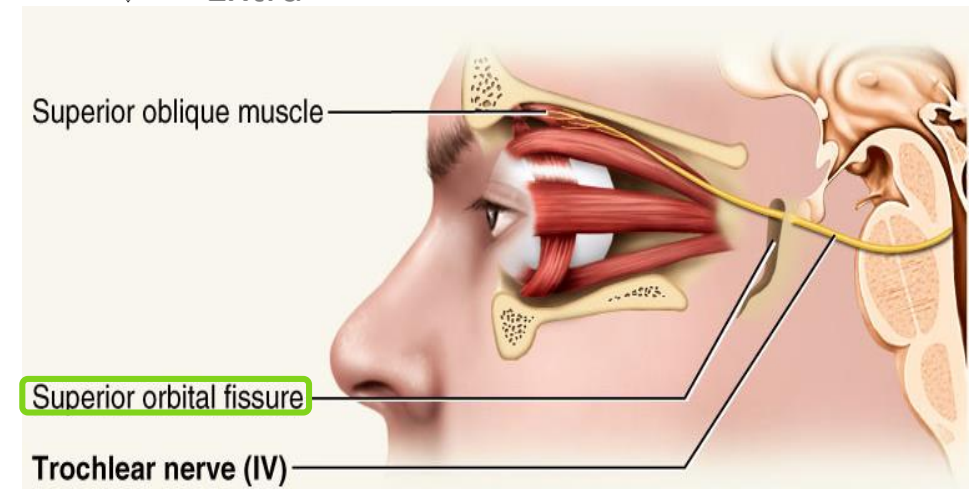
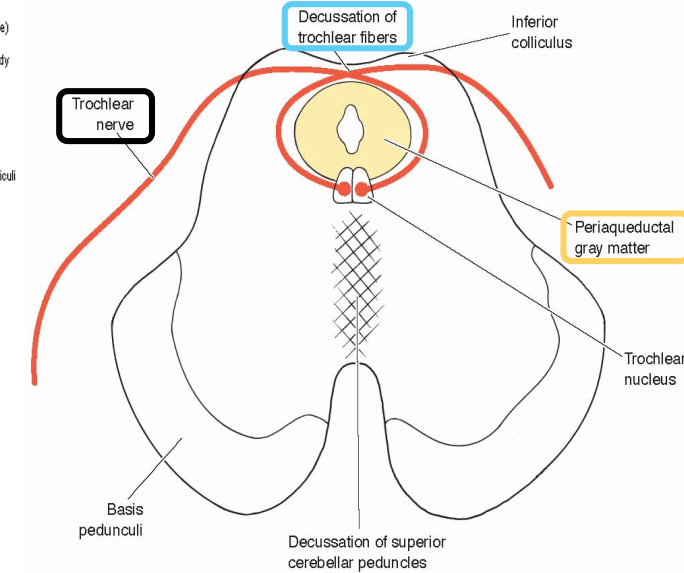
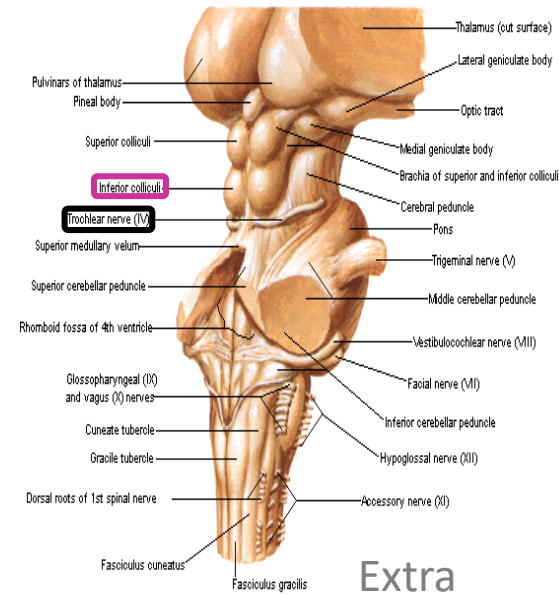


Ptosis (drooping of the eyelid)

# Trochlear

## (IV) 4th Cranial Nerve

- Type: motor
- Small motor nucleus located in the periaqueductal grey matter at the level of inferior colliculus of the midbrain.
- Fibers curve backwards and decussate.
- The nerve emerges immediately caudal to the inferior colliculus, on the **dorsal** surface of brain stem. (recall it is the only cranial nerve to emerge from the dorsal surface).
- It passes forward through **middle cranial fossa** in the lateral wall of the **cavernous sinus\*** **below the 3<sup>rd</sup> cranial nerve**
- The nerve then enters the orbit through the superior orbital fissure (with oculomotor).

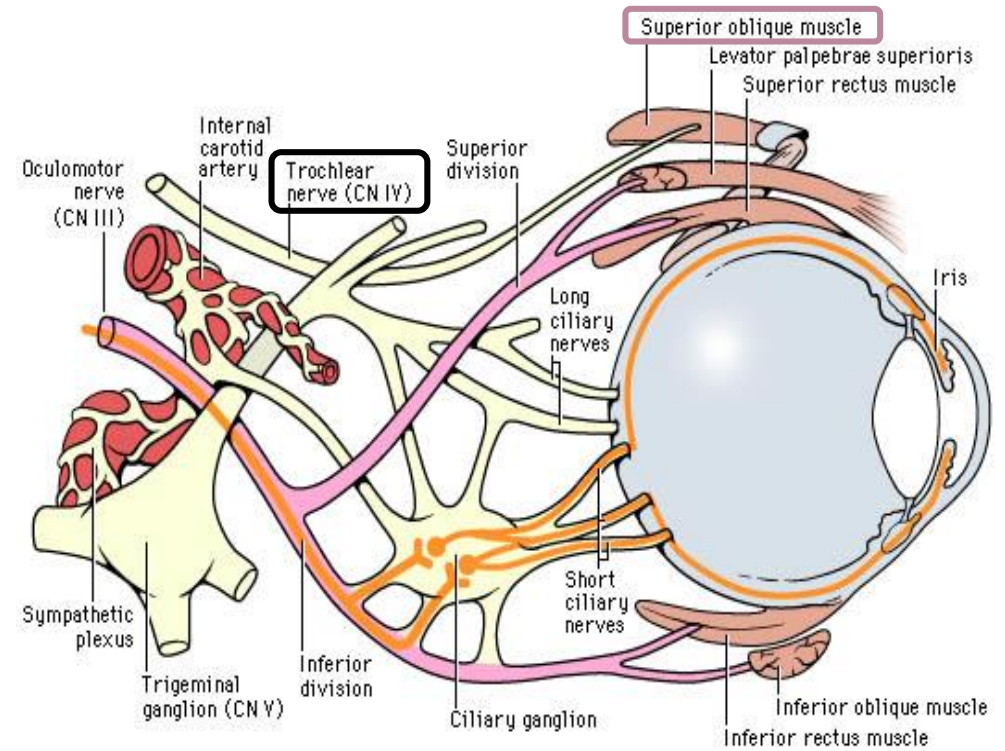


\*\*Cavernous sinus: one of the **Dural Venous sinuses**, trochlear & oculomotor run in the lateral wall and abducent runs in the floor

# Trochlear

## (IV) 4th Cranial Nerve

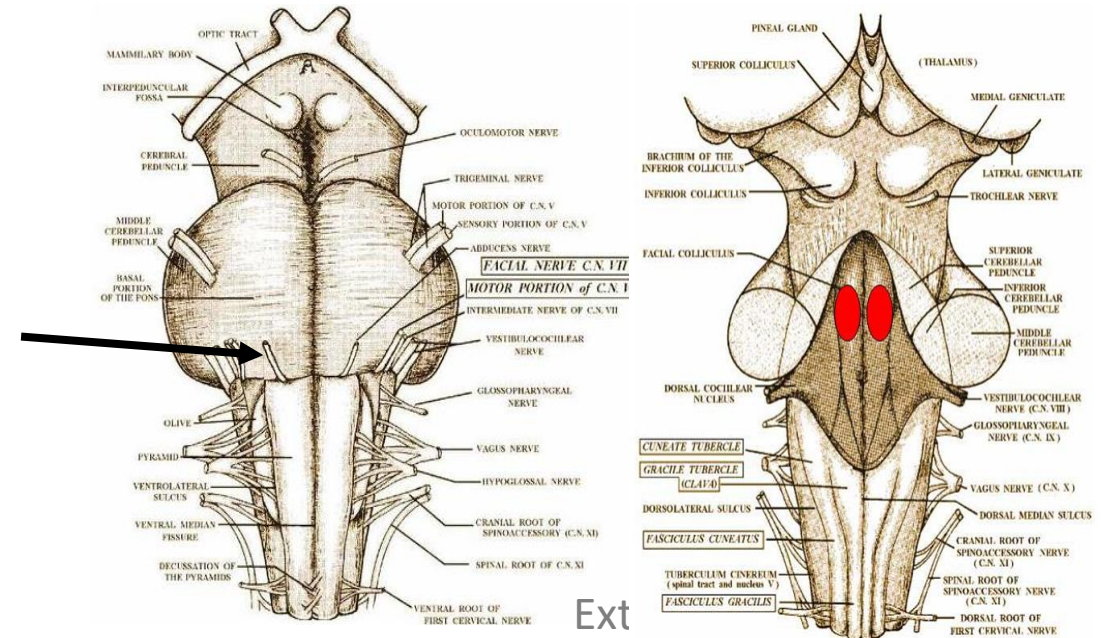
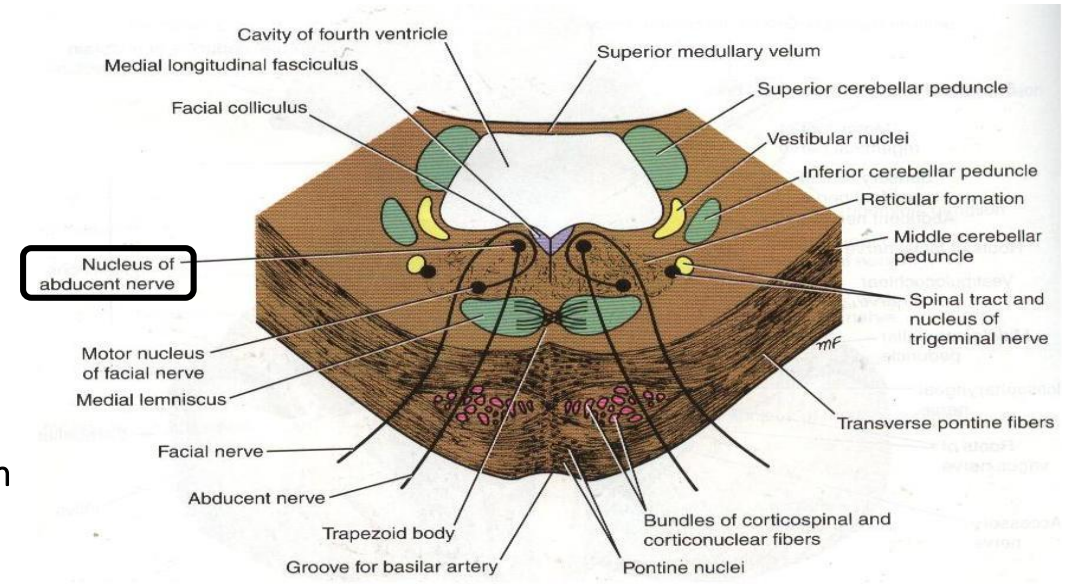
- It supplies;  
**Superior oblique muscle**, (only one muscle).
- Its function;  
Rotates the eye ball downwards and laterally.
- Lesion of trochlear nerve results in
  - **diplopia** (double vision) &
  - Inability to rotate the eyeball **infero-laterally**.
- So, the eye deviates; **upward** and slightly **inward (medially)**.
- This person has **difficulty in walking downstairs**



\*Trochlear → بكرة → عجلة → كرتسي متحرك → كرسى متحرك → مايتحرك فبالتالي مايقدر ينزل من الدرج → كرسى متحرك → عجلة → بكرة

# Abducent (VI) 6th Cranial Nerve

- Only one motor nucleus.
- Lies in caudal pons in the floor of the 4<sup>th</sup> ventricle.
- Lies close to the middle line, in a line with 3<sup>rd</sup>, 4<sup>th</sup> & 12<sup>th</sup> nerves (All motor).
- Fibers of facial nerve looping around the abducent nucleus forms the facial colliculus. (recall from anatomy of brainstem: The abducent nucleus lies medially, and below it is the fiber of the facial nerve which goes above and around it and forms the facial colliculus)
- **It emerges** from the ventral aspect of brainstem, at the junction of the pons and the pyramid of the medulla oblongata.



Ext

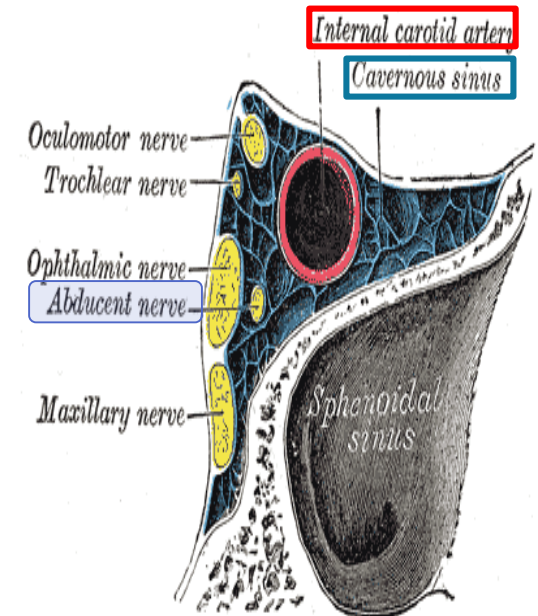
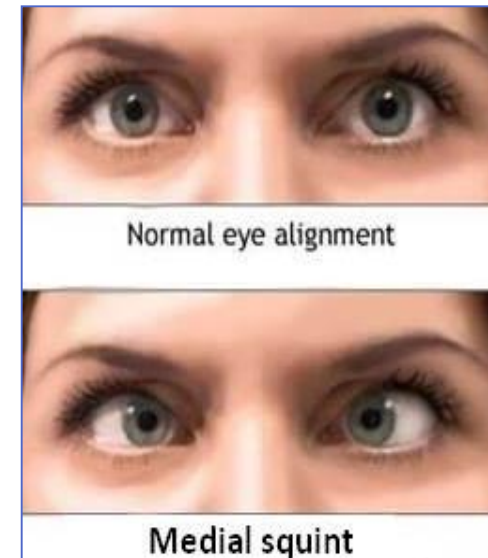
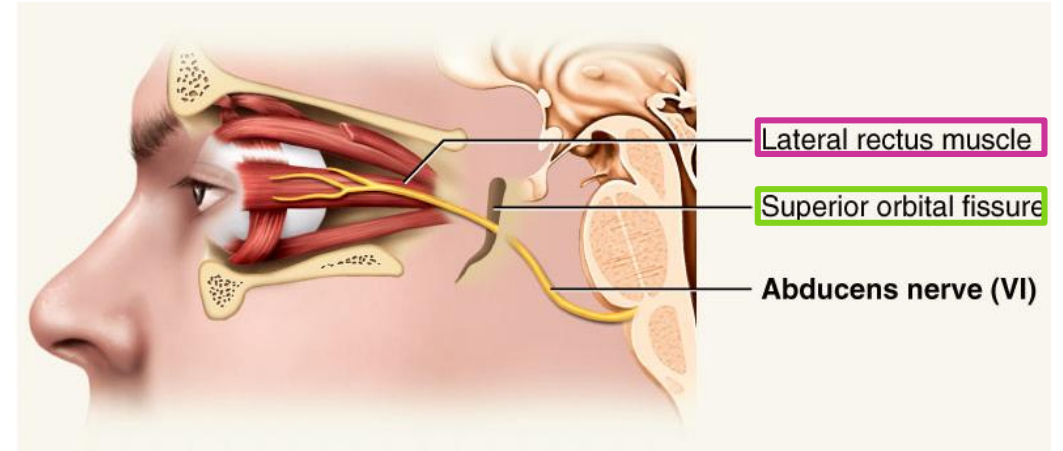
# Abducent

## (VI) 6th Cranial Nerve

- It passes through **the floor of cavernous sinus**, lying below and lateral to the **internal carotid artery**\*\*
- Then it enters the orbit through the **superior orbital fissure**.
- It supplies;  
the **lateral rectus muscle** which rotates the eye ball laterally ; (abduction).
- **Lesion results in:**
- Inability to direct the affected eye laterally, so it result in (**medial squint\***).
- A nuclear lesion may also involve the nearby nucleus or axons of the **facial nerve**, causing paralysis of all facial muscles in the ipsilateral side.

\*Oculomotor → lateral squint | Abducent → medial squint

\*\* لو حصل Aneurysm راح يتأثر هذا النيرف  
\*\*\*لأنه يمشي مسافة طويلة فهو اكثر نيرف معرض ان يحصل له مشكلة



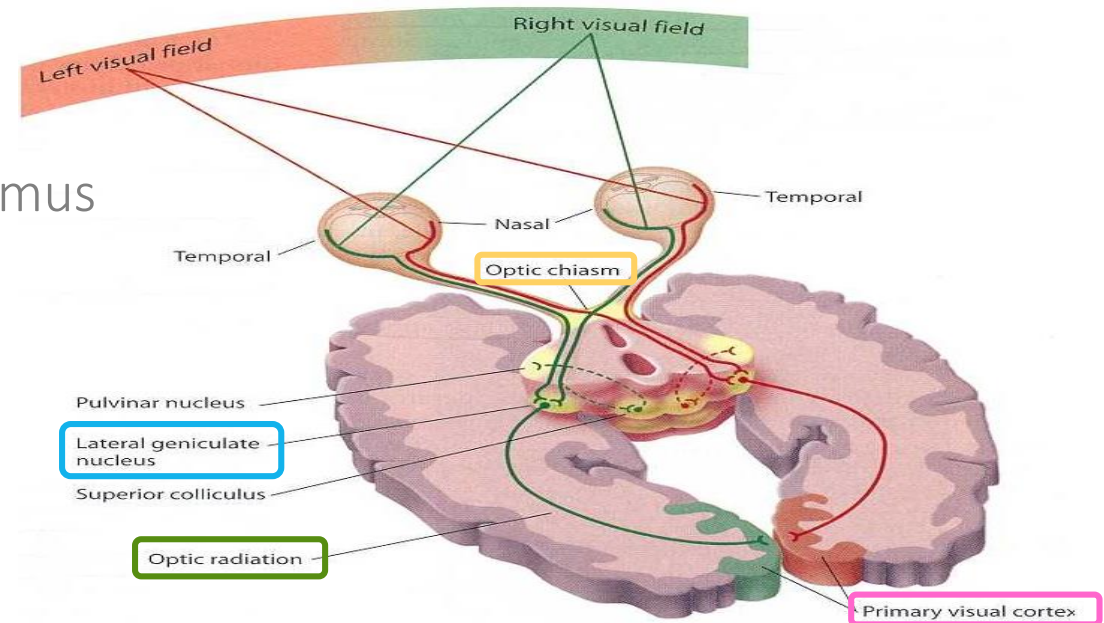
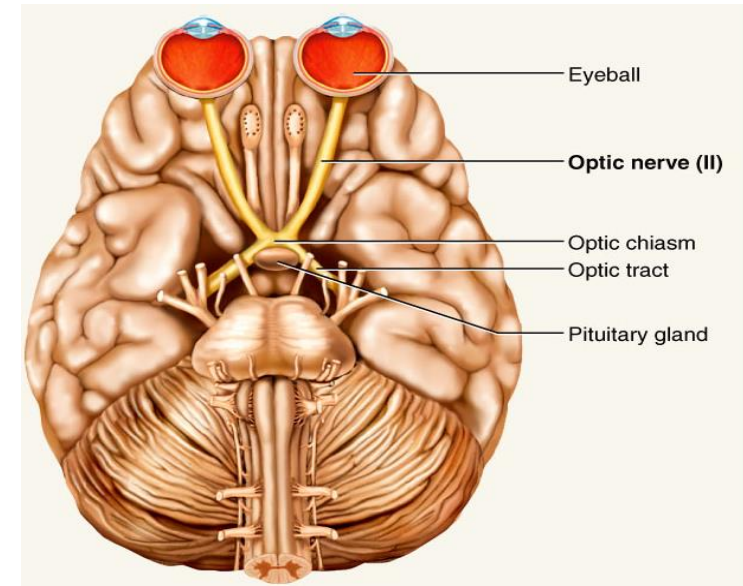
# Optic

## (II) 2nd Cranial Nerve

- Type: **Special sensory N.**
- Function: **Vision**
- Lesion results in: visual field defects and loss of visual acuity, a defect of vision is called **anopsia**.

### Visual Pathway

1. Optic nerve.
2. Optic chiasm.
3. Optic tract.
4. Lateral geniculate body (nucleus). In thalamus
5. Optic radiation.
6. Visual cortex.



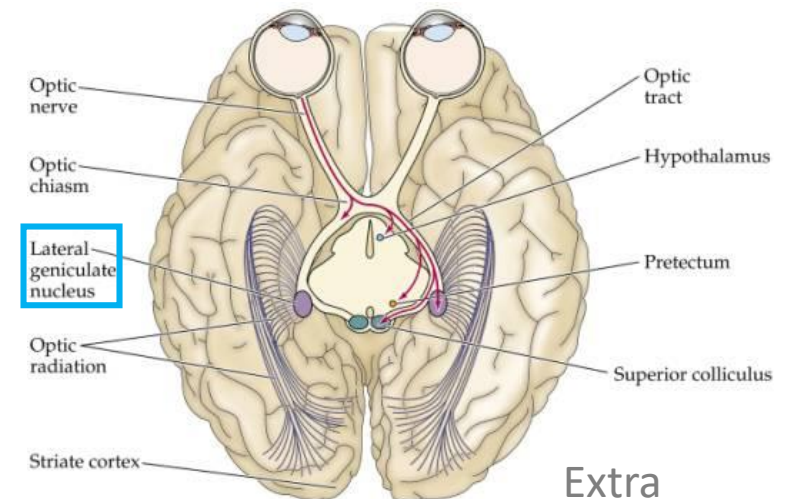
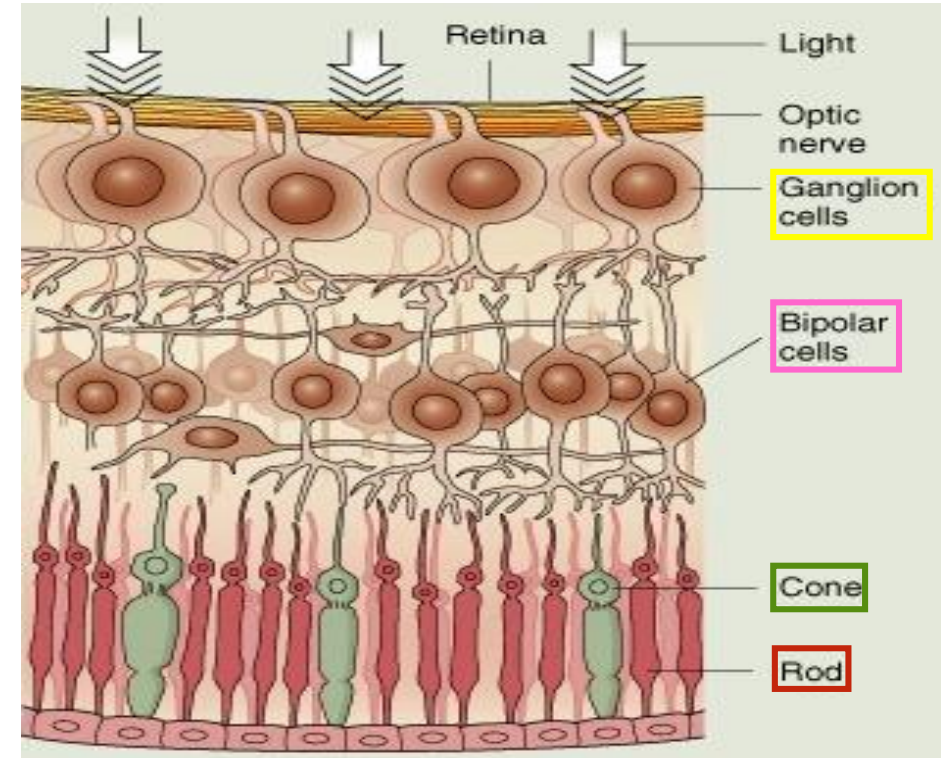
# Visual Pathway

- Photoreceptors:  
Rods & Cones of the retina
- Three neurons pathway

1<sup>st</sup> order neurons:  
**Bipolar** cells of retina

2<sup>nd</sup> order neurons:  
**Ganglion** cells of retina.  
Their axons form the optic nerve

3<sup>rd</sup> order neurons:  
Neurons in the **lateral geniculate body**.  
Their axons terminate in **primary visual cortex**.



# Visual Pathway

## Optic nerve

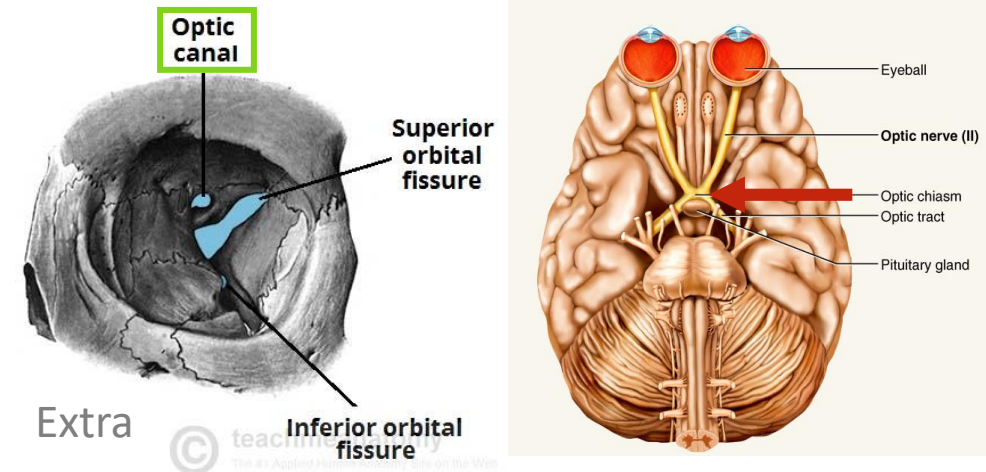
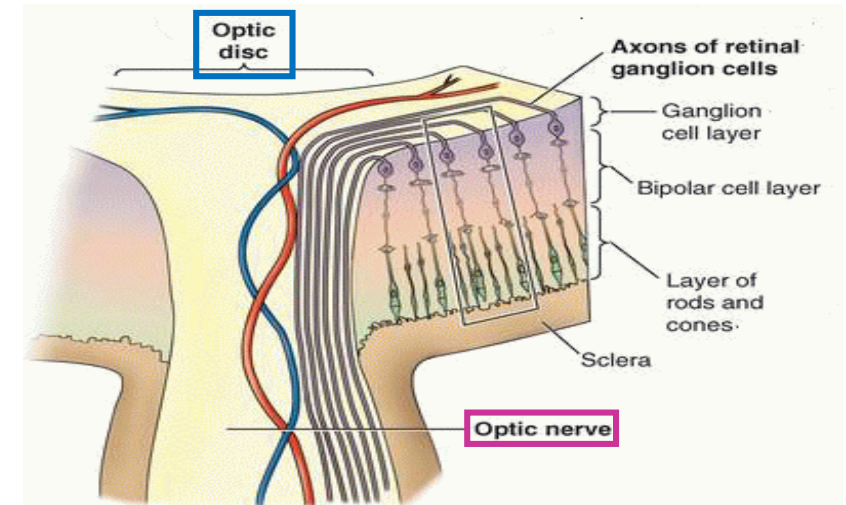
- **Axons of retinal ganglion cells** converge at the **optic disc** and pass as the **optic nerve**.



- Then the nerve **passes** posteromedially **in the orbit**.



- Then exits through the **optic canal** (optic nerve & ophthalmic artery pass through it) to enter the **middle cranial fossa** to form the **optic chiasma**.





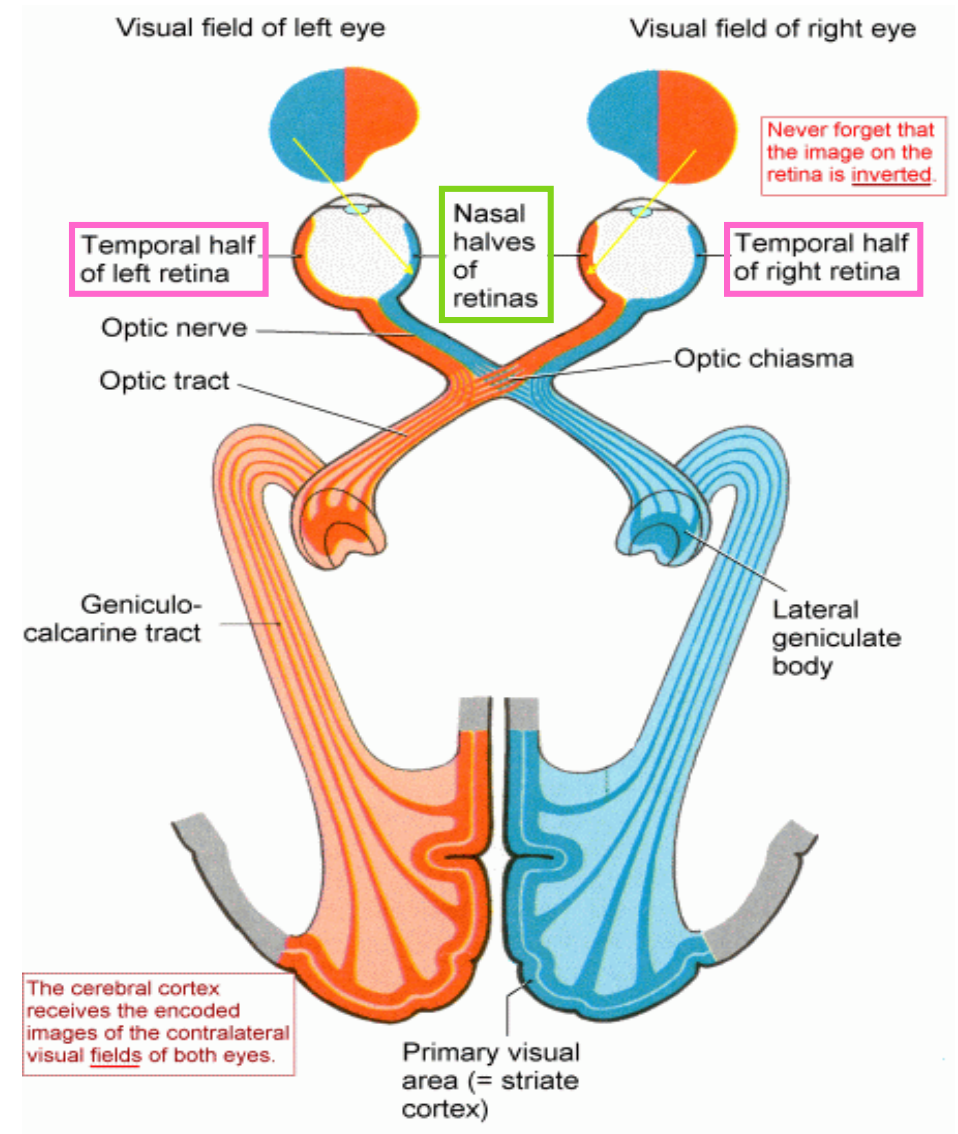
# Visual Pathway

## Optic Chiasma

- Fibers from the nasal (medial) half of retina decussate in the chiasm and join uncrossed fibers from the temporal (lateral) half of the retina to form the optic tract.
- The decussation of nerve fibers in the chiasm results in the right optic tract conveying impulses from the left visual field and vice versa.
- The partial crossing of optic nerve fibers in the optic chiasma is a requirement for **binocular** vision.

Which retinal fibres are present in the left optic tract?

Fibers from left temporal and right nasal.



# Visual Pathway

## Optic Tract

### Fibers in the optic tracts:

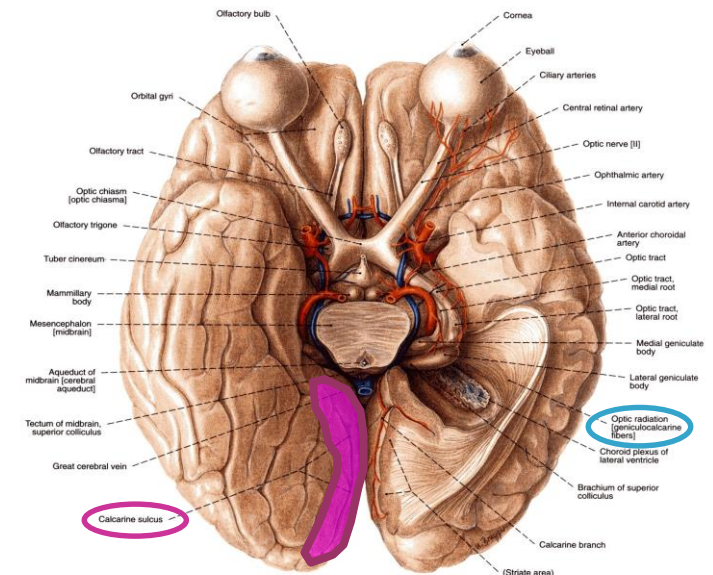
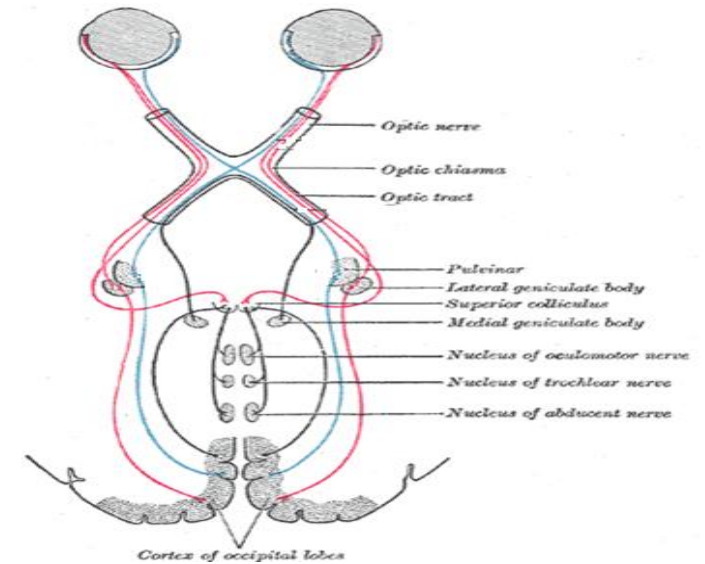
- A few fibers terminate in **pretectal area** and **superior colliculus**.
- These fibers are related to **light reflexes**.

- Mainly terminate in the (LGB), **lateral geniculate body** of the thalamus (**3<sup>rd</sup> order neuron**).

- From the lateral geniculate nucleus (third-order neuron), **thalamocortical fibres** project through the retrolenticular part of the posterior limb of the internal capsule as the **optic radiation**,

- which terminates in the **primary visual cortex** of the **occipital lobe**.

- The primary visual cortex is located predominantly on the medial surface of the hemisphere in the region above and below the **calcarine sulcus**.



# Visual Pathway

## Visual Cortex

- The **primary visual cortex** (area 17\* of Brodmann's) occupies the upper and lower lips of the **calcarine sulcus** on the medial surface of the cerebral hemisphere.
- The **visual association cortex** (area 18) is extensive, including the whole of the occipital lobe, the adjacent posterior part of the parietal lobe. This cortex is involved in interpretation and recognition of objects and perception of color, depth, motion, and other aspects of vision.

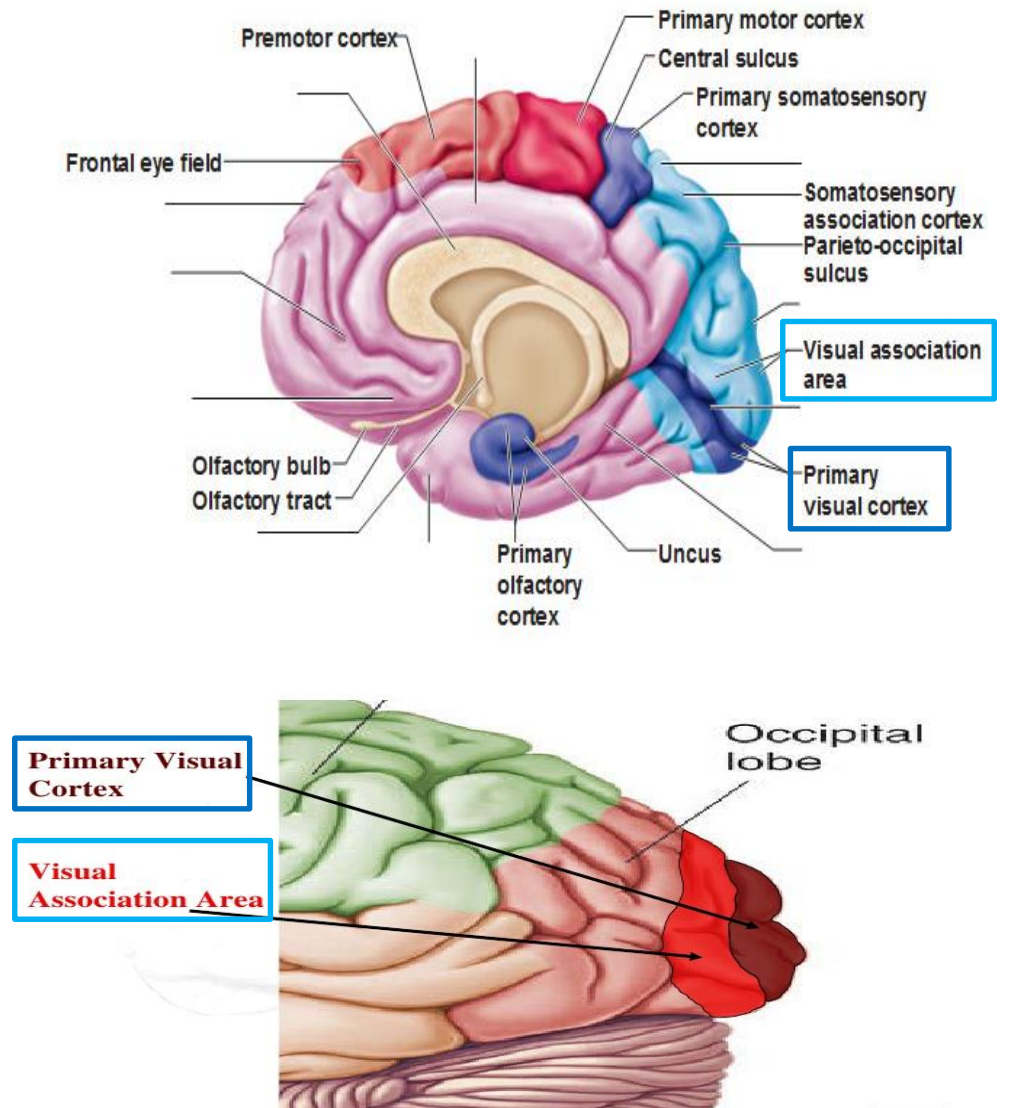
\*The primary cortex: I saw something (مجرد رؤية)

Association: what did I see (recognition & interpretation)

Note: each primary cortex has an association cortex

\* بالعربي تشبهه ١٧ → visual VI

(b) Parasagittal view, right hemisphere



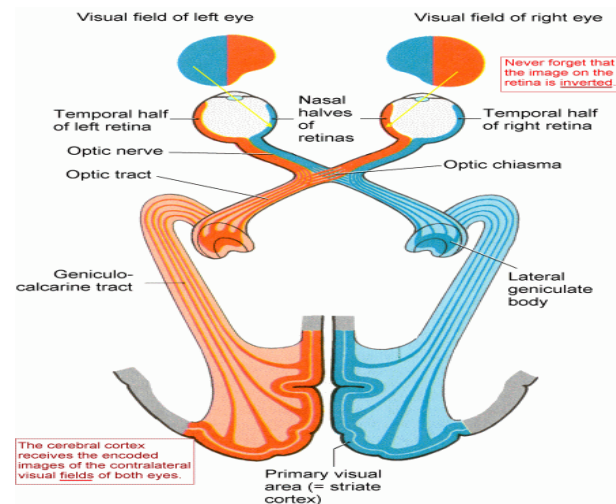
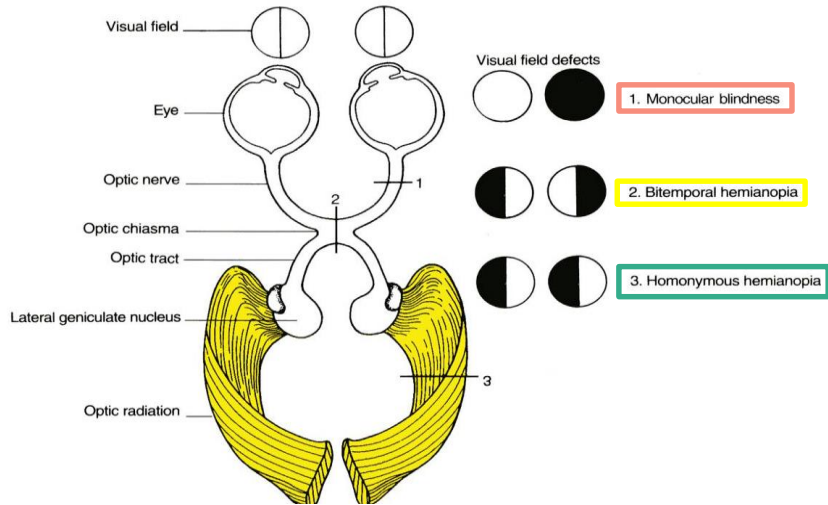
# Visual Defects

1. Disease of the **eyeball** (cataract, intraocular hemorrhage, retinal detachment, glaucoma & methyl alcohol poisoning) and disease of the **optic nerve** (multiple sclerosis, optic nerve tumors) lead to : **loss of vision** in the affected eye (**monocular blindness**).
2. Compression of the **optic chiasm** by an adjacent pituitary tumor leads to: **bitemporal hemianopia**.
3. Vascular and neoplastic lesions of the **optic tract, optic radiation** or **occipital cortex** produce: **contralateral homonymous hemianopia**.

JUST READING (EXTRA)

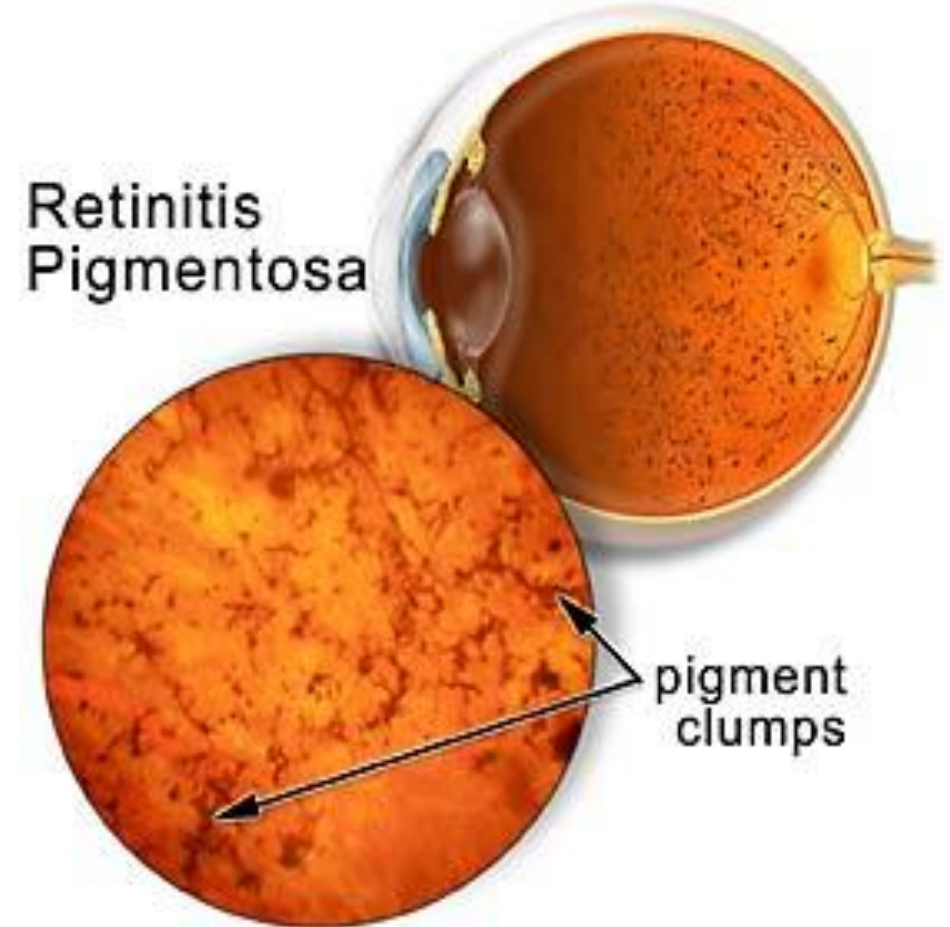
## For you: Visual field deficits

- A person may not be able to see objects on their right or left sides (**homonymous hemianopsia**) if the optic tract or radiation or visual cortex is affected.
- Or may have difficulty seeing objects on their outer visual fields (**bitemporal hemianopsia**) if the optic chiasm is involved.
- The pretectal area, or **pretectum**, is a midbrain structure composed of seven nuclei and comprises part of the subcortical visual system. Pretectal nuclei are bilateral group of highly interconnected nuclei located near the junction of the midbrain and forebrain.



# Retinitis Pigmentosa

- **Retinitis pigmentosa** is an inherited metabolic disorder of the photoreceptor and retinal pigment epithelial cells.
- It is due to mutation of a key protein in the retinal photoreceptors.
- Which protein?  
**Rhodopsin.**
- There is:
  - **Progressive night blindness**
  - **Peripheral visual field constriction**
  - **Pigmentation of the retina visible on ophthalmoscopy.**
- Which type of photoreceptor is affected?  
**Rods.**



## OPTIC

- \*Special **sensory** N.
- \*Function: Vision.
- \*Lesion results in: visual field defects and loss of visual acuity, **anopsia**.

### \*Visual Pathway

1. Optic nerve.
2. Optic chiasm.
3. Optic tract.
4. Lateral geniculate body (nucleus).
5. Optic radiation.
6. Visual cortex

## OCCULOMOTOR

### \***Motor** to:

1. Levator palpebrae superioris
2. Superior rectus muscle
3. Medial rectus muscle
4. Inferior rectus muscle
5. Inferior oblique muscle.

\***Parasympathetic fibers** to: 1- Constrictor pupillae and 2- Ciliary muscles.

### \***Lesions:**

1. Lateral squint.
2. Ptosis.
3. Diplopia.
4. Pupillary dilatation.
5. Loss of accommodation.
6. The eyeball is fully abducted and depressed.

## TROCHLEAR

- \***Motor** to Superior oblique muscle.
- \*Its function; Rotates the eye ball downwards and laterally.

\***Lesion** of trochlear nerve results in

- diplopia (double vision)
- Inability to rotate the eyeball inferolaterally. So, the eye deviates; upward and slightly inward (medially).

This person has difficulty in walking downstairs

## ABDUCENT

- \*Only one **motor** nucleus.
- \*It forms the facial colliculus.
- \*It supplies; the lateral rectus muscle which rotates the eye ball laterally ; (abduction).

\*Lesion:

- Inability to direct the affected eye laterally, so it result in (medial squint\*).
- A nuclear lesion may also involve the nearby nucleus or axons of the facial nerve, causing paralysis of all facial muscles in the ipsilateral side.

\*Oculomotor → lateral squint | Abducent → medial squint

# MCQs

## (1) The oculomotor nerve has?

- A) Motor fibers
- B) Sensory fibers
- C) Sympathetic fibers
- D) Parasympathetic fibers

## (2) The edinger-westphal nucleus receives fibers from corticonuclear fibers for?

- A) Stretch reflex
- B) Pupillary reflex
- C) Accommodation reflex
- D) Non of them

## (3) Lesion of trochlear nerve results in?

- A) Lateral squint
- B) Loss of accommodation
- C) Inability to rotate the eyeball infero-laterally
- D) Non of them

## (4) First order neurons of optic nerve are?

- A) Bipolar cells of retina
- B) Ganglion cells of retina
- C) lateral geniculate body
- D) Medial geniculate body

## (5) The primary visual cortex occupies the upper and lower lips of the?

- A) Calcarine sulcus on the medial surface of the cerebral hemisphere
- B) Calcarine sulcus on the lateral surface of the cerebral hemisphere
- C) Parieto-occipital sulcus on the lateral surface of the cerebral hemisphere
- D) Parieto-occipital sulcus on the medial surface of the cerebral hemisphere

## (6) Abducens nerves supplies?

- A) Inferior oblique muscle
- B) Inferior oblique muscle
- C) Lateral rectus muscle
- D) All of the above

## (7) Compression of the optic chiasm leads to?

- A) monocular blindness
- B) bitemporal hemianopia
- C) contralateral homonymous hemianopia
- D)

## (8) Which of the following nerves runs in the floor of the cavernous sinus?

- A) III
- B) IV
- C) VI
- D) V

## (9) Which retinal fibers are present in the left optic tract?

- A) Left temporal and left nasal fibers
- B) Left temporal and right nasal fibers
- C) Right temporal and left nasal fibers
- D) Right temporal and right nasal Fibers

## (10) Abducent nerve together with facial nerve forms?

- A) Inferior colliculus
- B) Superior colliculus
- C) Facial colliculus
- D) Lateral collicullus

# Answers

(1) A&D

(6) C

(2) C

(7) B

(3) C

(8) C

(4) A

(9) B

(5) A

(10) C



# SAQ

Name all muscles supplies by the nerves below and what movement is lost due the their injury.

## Occulomotor:

### (A) Muscles:

1. Levator palpebrae superioris
2. Superior rectus muscle
3. Medial rectus muscle
4. Inferior rectus muscle &
5. Inferior oblique muscle

### (B) Lesion:

1. Lateral squint
2. Ptosis
3. Diplopia
4. Pupillary dilatation
5. Loss of accommodation
6. The eyeball is fully abducted and depressed (down and out) because of the unopposed activity of lateral rectus and superior oblique

## (2) Trochlear:

**(A) Muscles:** Superior oblique muscle

**(B) Lesion:** Diplopia & Inability to rotate the eyeball infero-laterally

## (3) Abducent:

**(A) Muscles:** lateral rectus muscle

**(B) Lesion:** Inability to direct the affected eye laterally, so it result in (medial squint).



Good luck  
Special thank for team436 ❤️

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