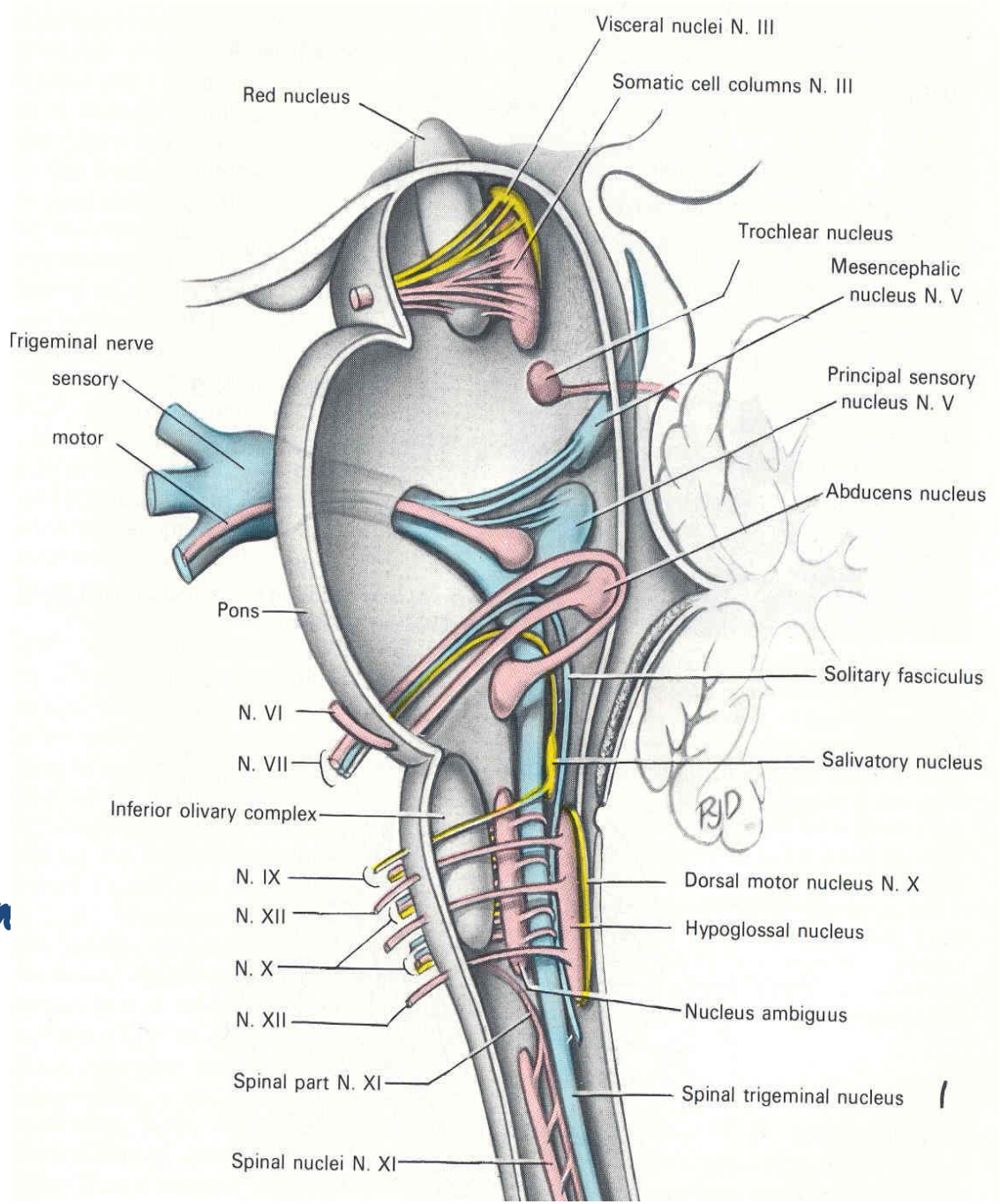
THE CRANIAL NERVES

2, 3,4,6

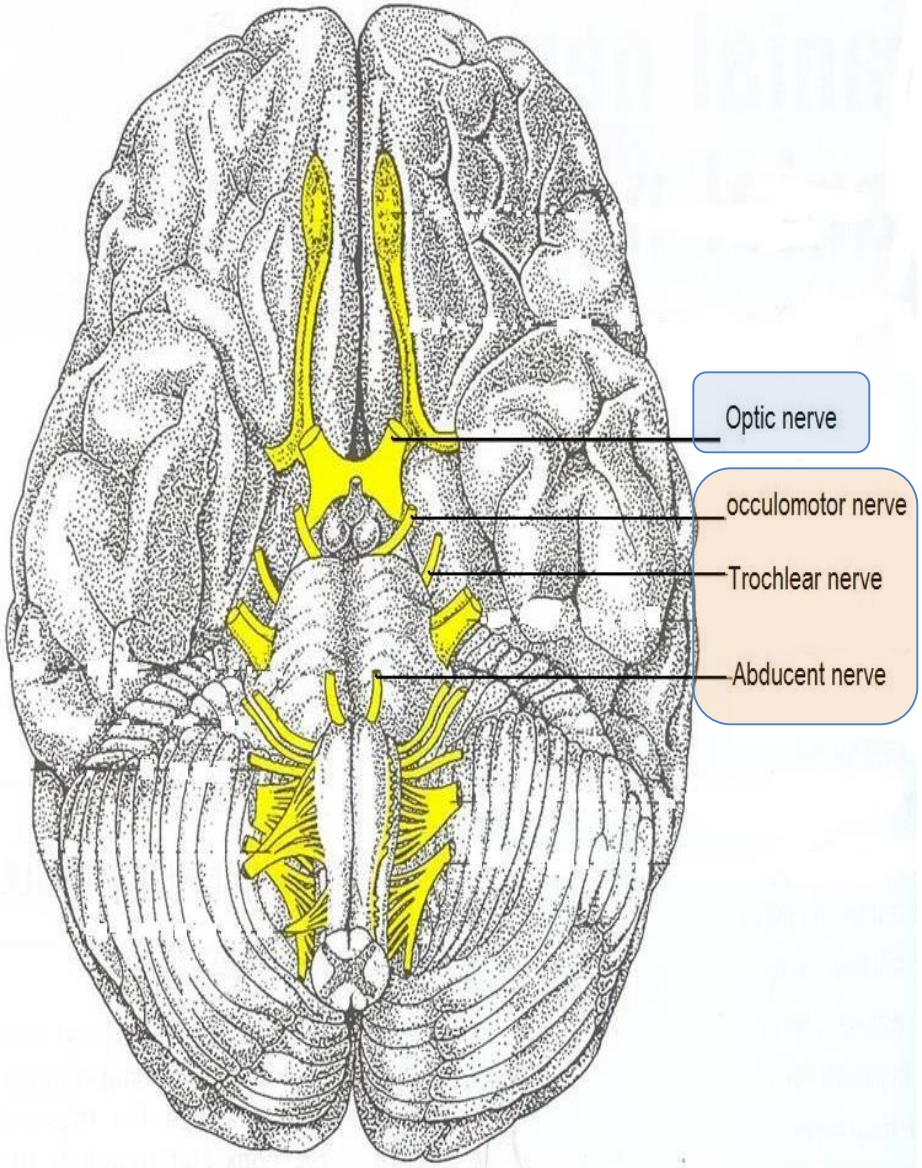
Prof. Saeed Abuel Makarem

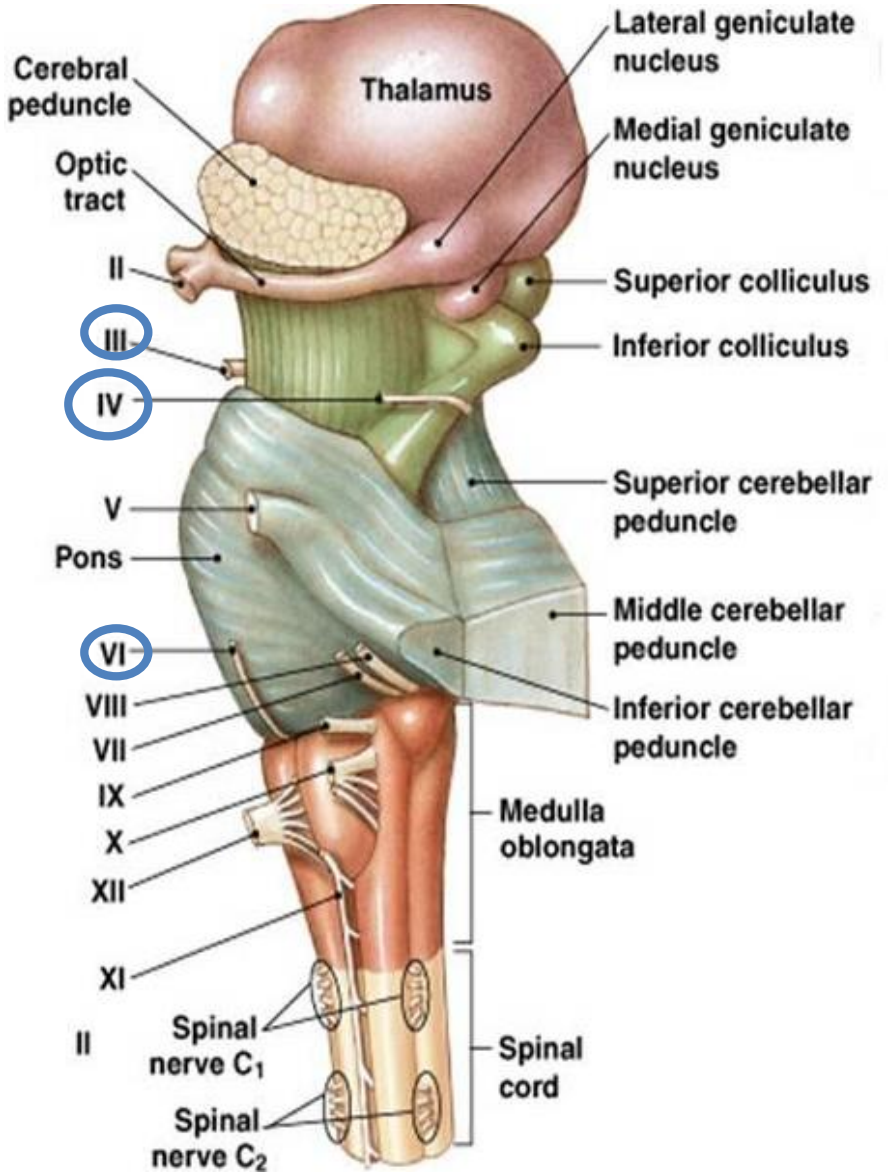


Objectives

By the end of the lecture, you should be able to:

- List the cranial nuclei of the **occulomotor, trochlear**, and **abducent** nerves in the brain stem.
- Describe the site and type of each nucleus.
- Describe the site of emergence and main points in the course of these 3 nerves.
- List the orbital muscles supplied by each of these **3** nerves.
- **Describe the effect of lesion** of each of these 3 nerves.
- Describe briefly the optic nerve and visual pathway.





Brain Base
(Ventral View)

Brain stem
(Lateral view)

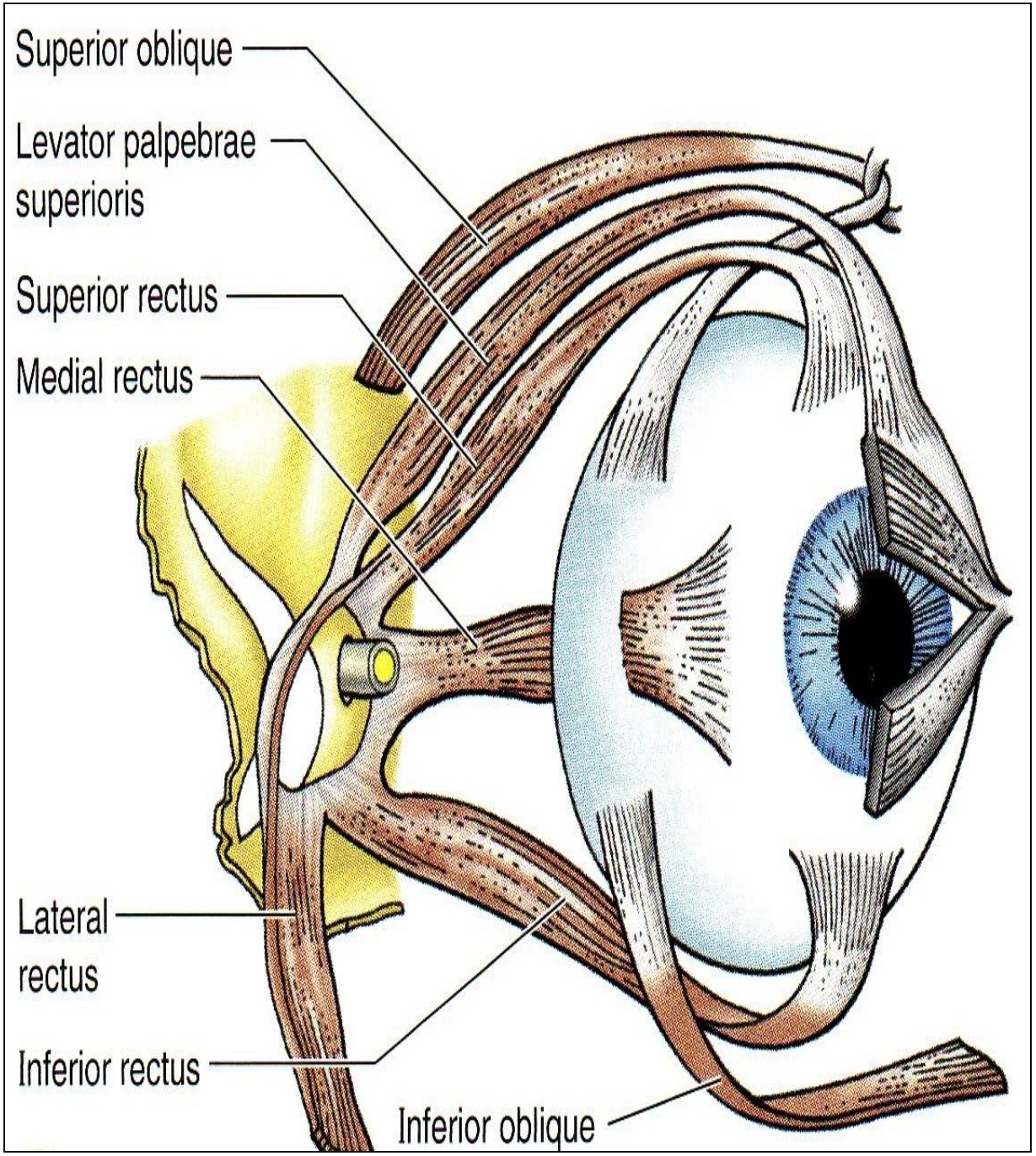
- **EXTRA-OCULAR MUSCES (7 muscles).**
- **Levator palpebrae superioris.**
- **4 Recti muscles:**

1. Medial rectus,
2. Lateral rectus,
3. Superior rectus,
4. Inferior rectus.

- **2 Oblique muscles:**

1. Superior oblique,
2. Inferior oblique.

- *NB. **All muscles of the eye are supplied by the oculomotor nerve, EXCEPT LR6 + SO4.***



Oculomotor Nerve

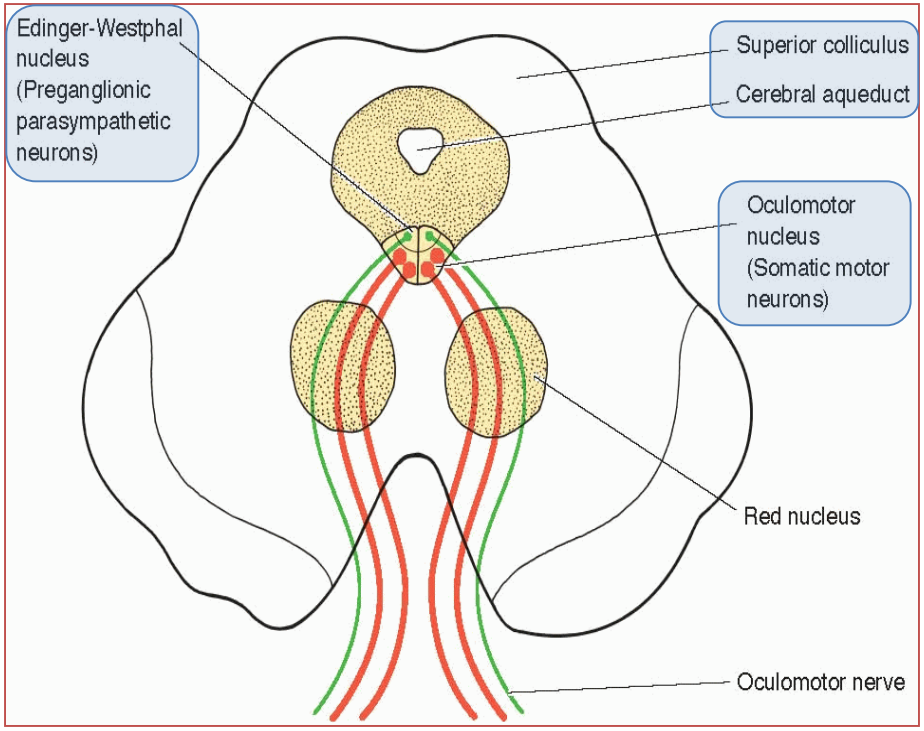
- **Motor** for most of extraocular muscles.
- Also carries preganglionic **parasympathetic** fibers to the pupillary constrictor and ciliary muscles.
- **Has two nuclei:**

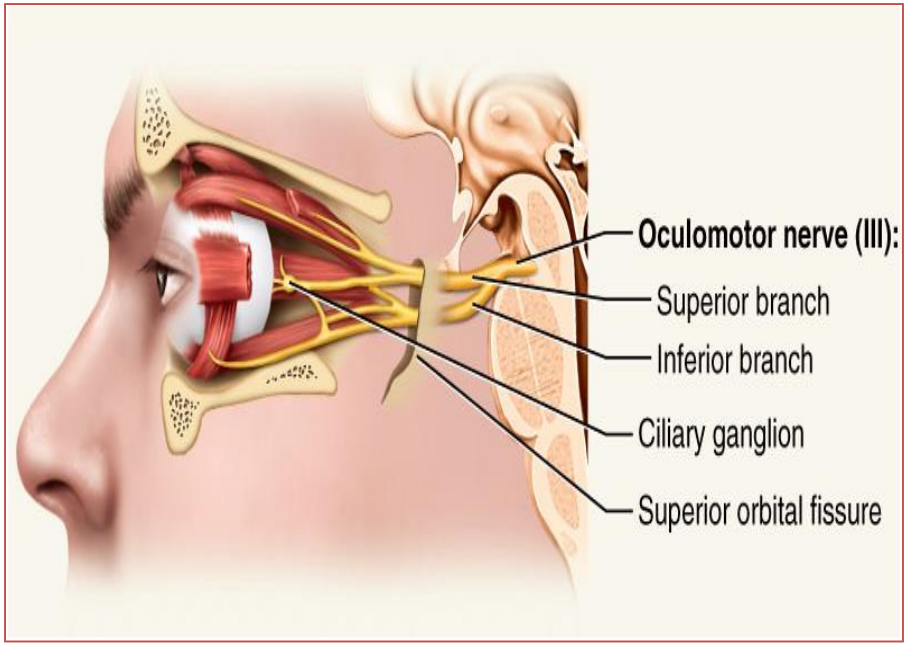
1- **Main oculomotor nucleus;**

- Lies in the mid brain, at the level of **superior colliculus.**

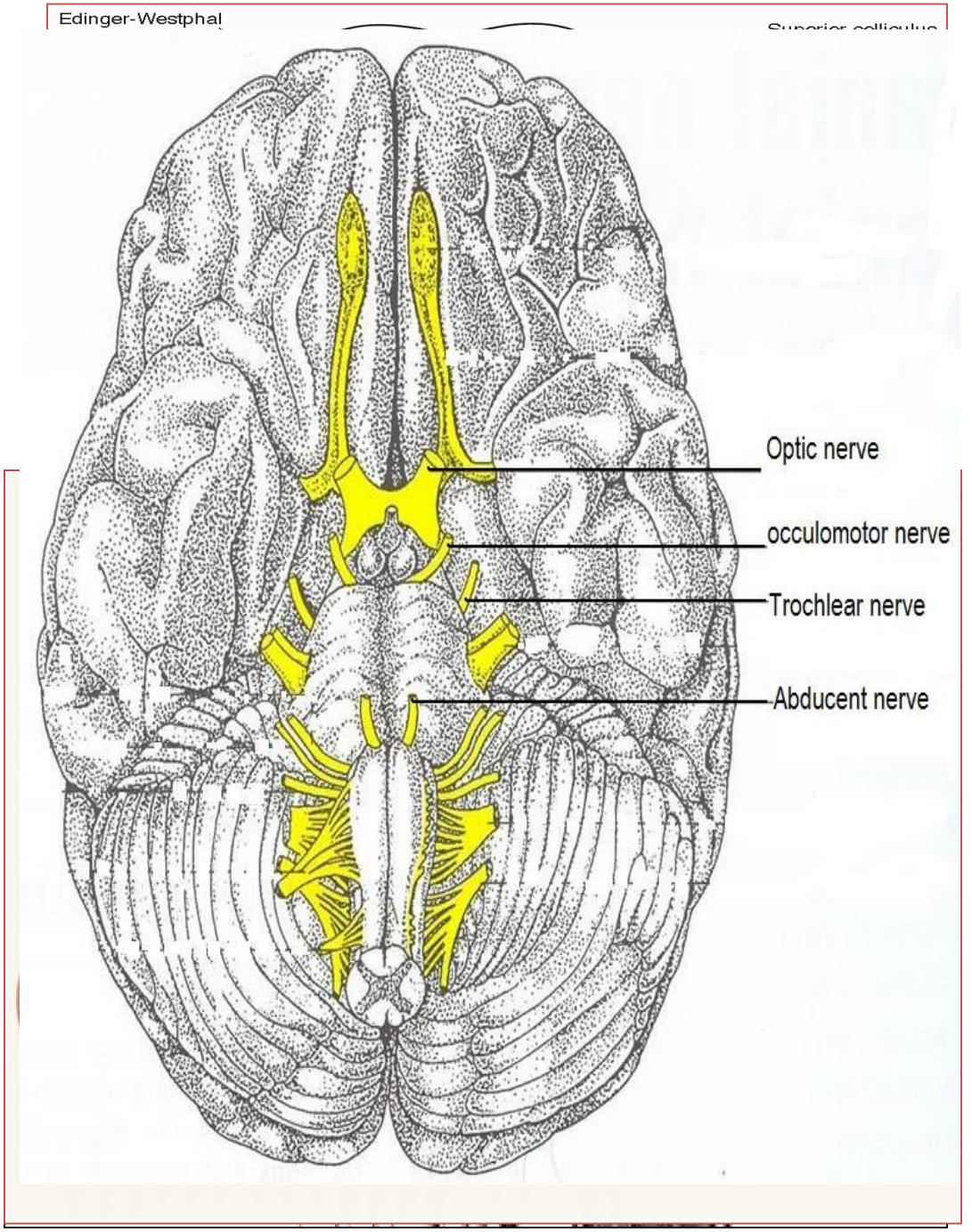
2- **Accessory nucleus (Edinger-Westphal nucleus);**

- Lies dorsal **to the main motor nucleus**,
- Its cells are preganglionic parasympathetic neurons to the ciliary ganglion.
- It **receives;** Corticonuclear fibers for the accommodation reflex,
- Also it receives fibers from **pretectal** nucleus for direct and consensual pupillary reflexes.

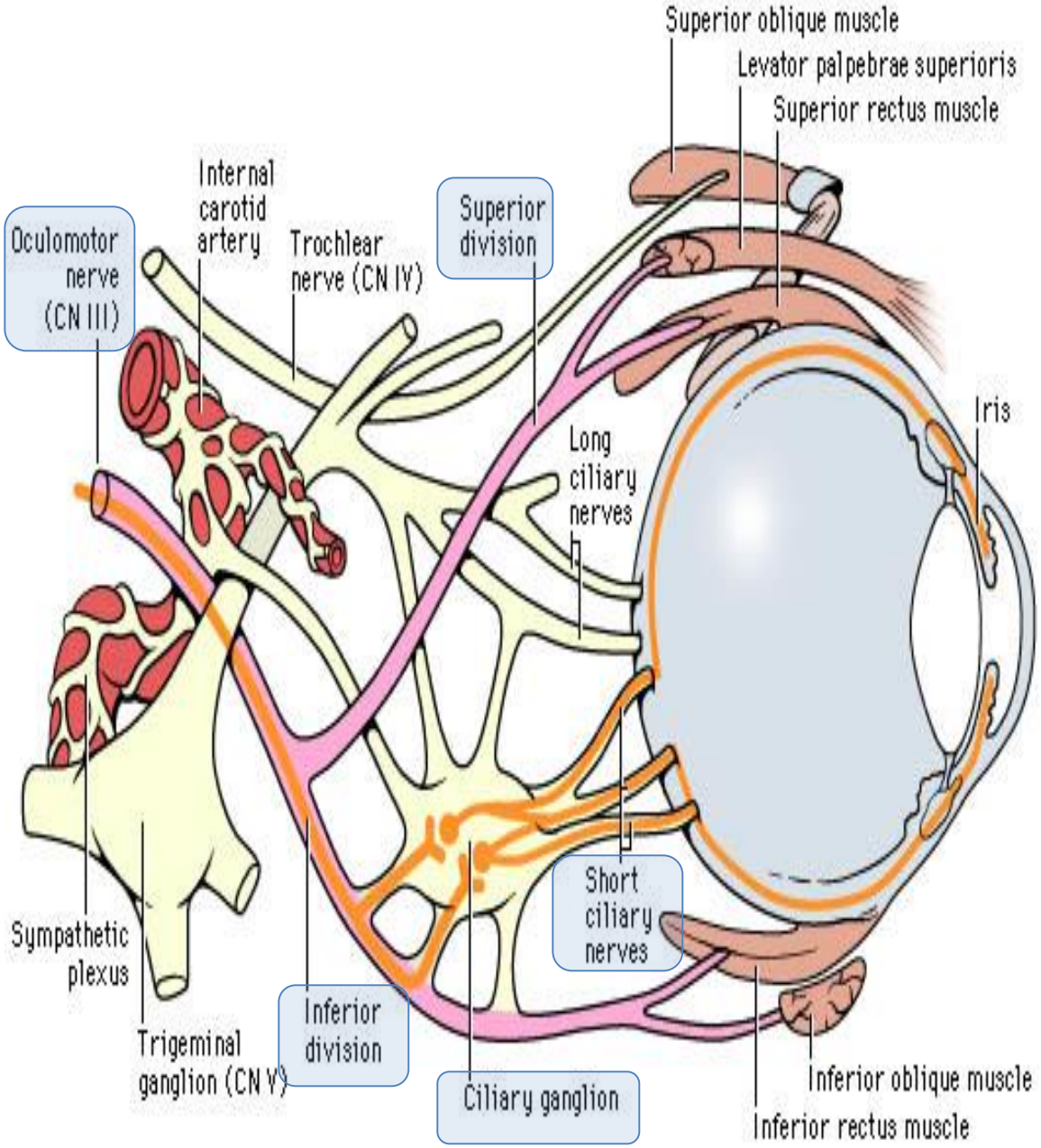




- Axons from the oculomotor nucleus **curve ventrally** through the tegmentum and the **red nucleus** in the midbrain.
- **The nerve emerges** on the anterior surface of the midbrain in **interpeduncular fossa**.
- Then it passes forward between **2 arteries:**
- **Posterior cerebral artery,**
- **Superior cerebellar artery.**
- 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 through the **superior orbital fis**sure to the orbit .



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



Occulomotor nerve supplies**:**

- **Motor to:**

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

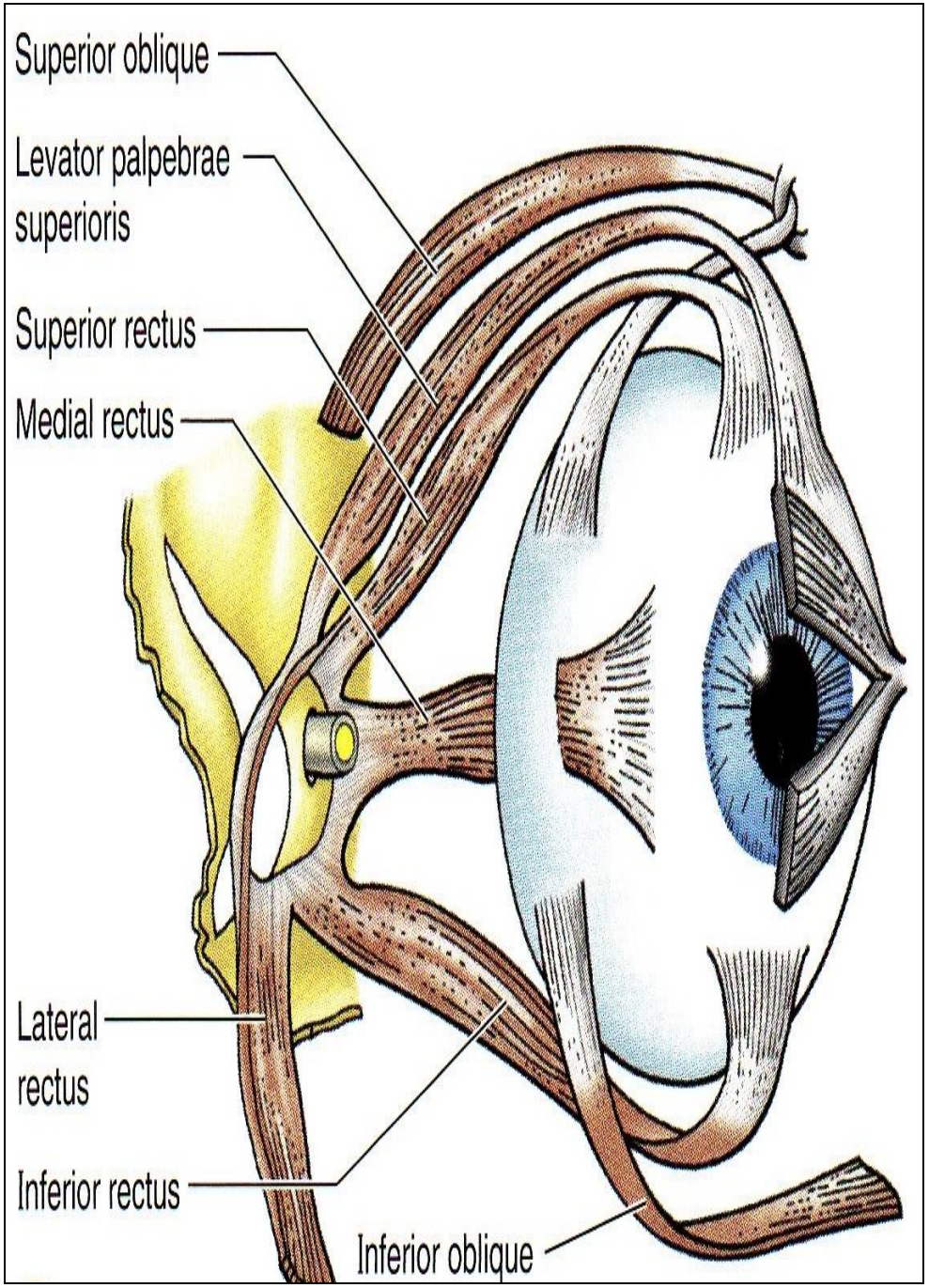
- Parasympathetic fibers to

6- Constrictor pupillae muscle.

7- Ciliary muscle.

It is responsible for;

- Elevation of upper eyelid (open the eye).
- Turning the eye upward, downwards and medially,
- Constriction of the pupil.
- Accommodating reflex.



Occulomotor Nerve Lesion

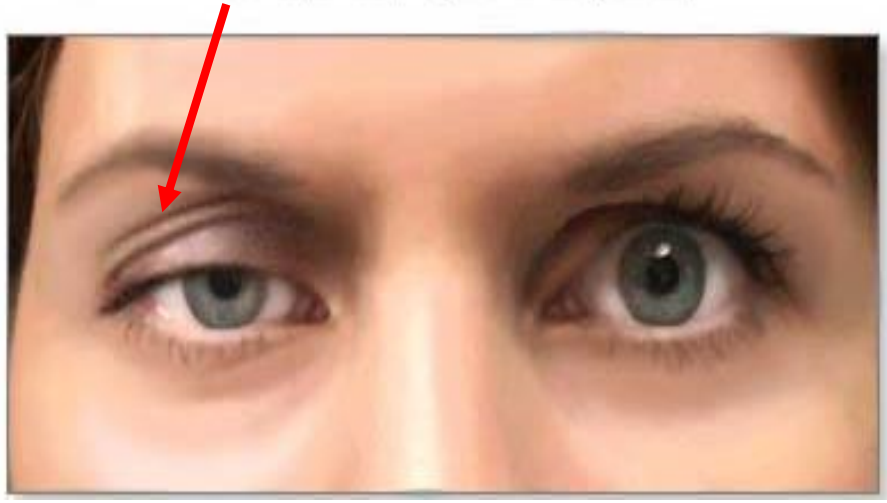
- **Lesion** results in**:**
  - Lateral squint.
  - Ptosis.
  - Diplopia.
  - Pupillary dilatation.
  - Loss of accommodation.
  - The eye is fully abducted and depressed (down and out) because of the unopposed activity of the lateral rectus and superior oblique muscles.

NB. The preganglionic parasympathetic fibers run superficially in the nerve so they are the **first axons to suffer** when the nerve is compressed by external pressure. **Consequently,** the first sign of compression of the occulomotor nerve is ipsilateral slowness of the pupillary response to light, **(sluggish pupil).**

Normal eye alignment

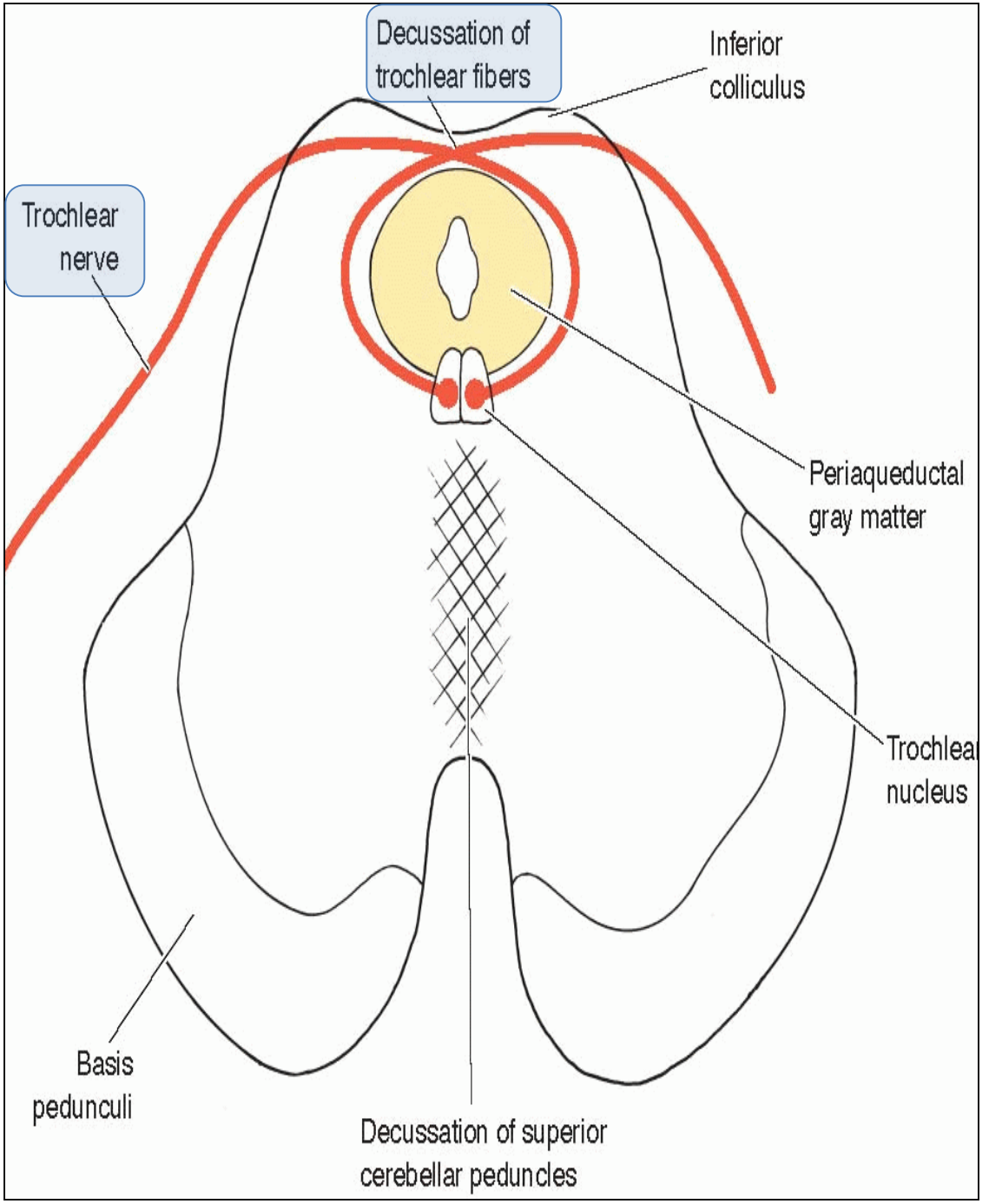
Lateral squint

Ptosis (drooping of the eyelid)

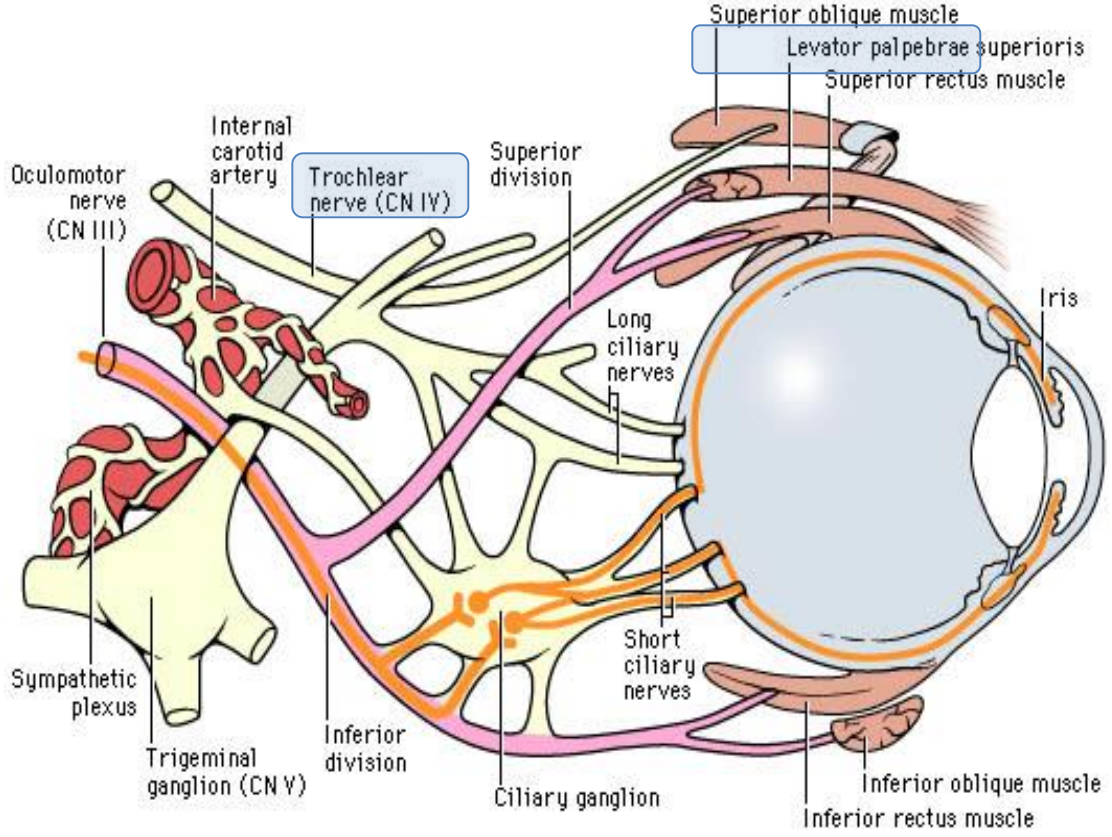


Trochlear Nerve

- **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.**
- NB. **The only cranial nerve which emerges from back of the brain stem.**



- It passes forward through middle cranial fossa in the lateral wall of the cavernous sinus below the oculomotor nerve.
- The nerve then enters the orbit through the superior orbital fissure.

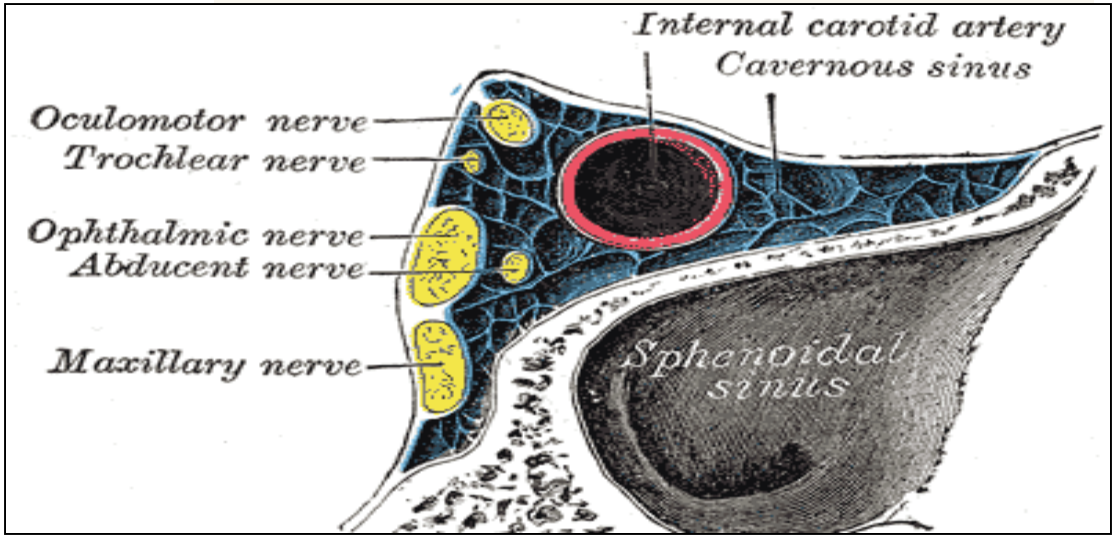


It supplies;

- Superior oblique muscle, (only one muscle).

Its function;

- Rotates the eye ball downwards and laterally.

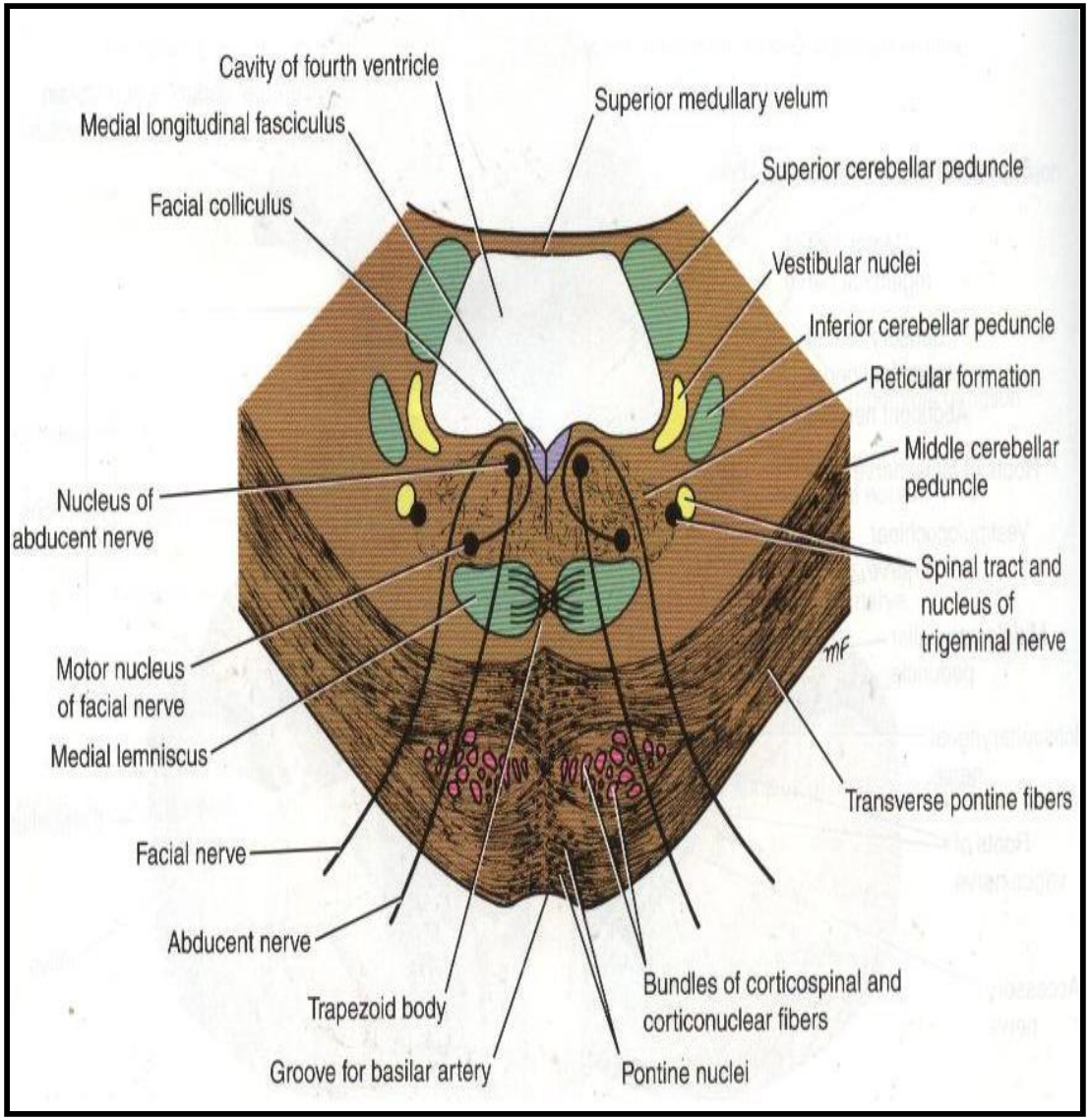


Trochlear Nerve Lesion

- Lesion results in **diplopia** (double vision) &
- Inability to rotate the eye **inferolaterally**.
- So, the **eye deviates; upward** and slightly **inward.**
- This person has difficulty in walking downstairs.

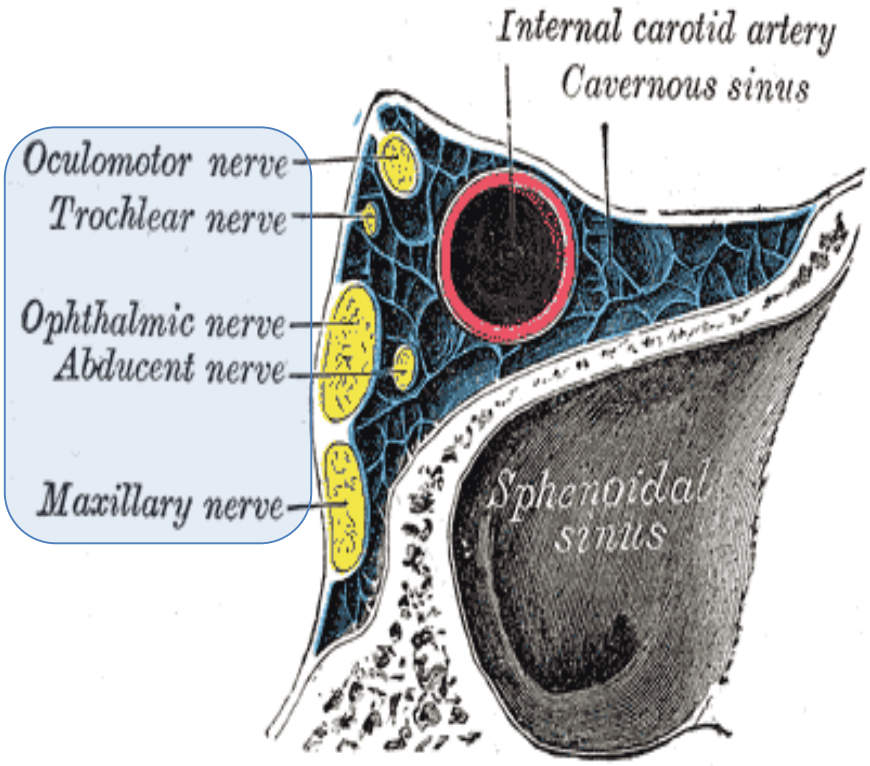
Abducent Nerve

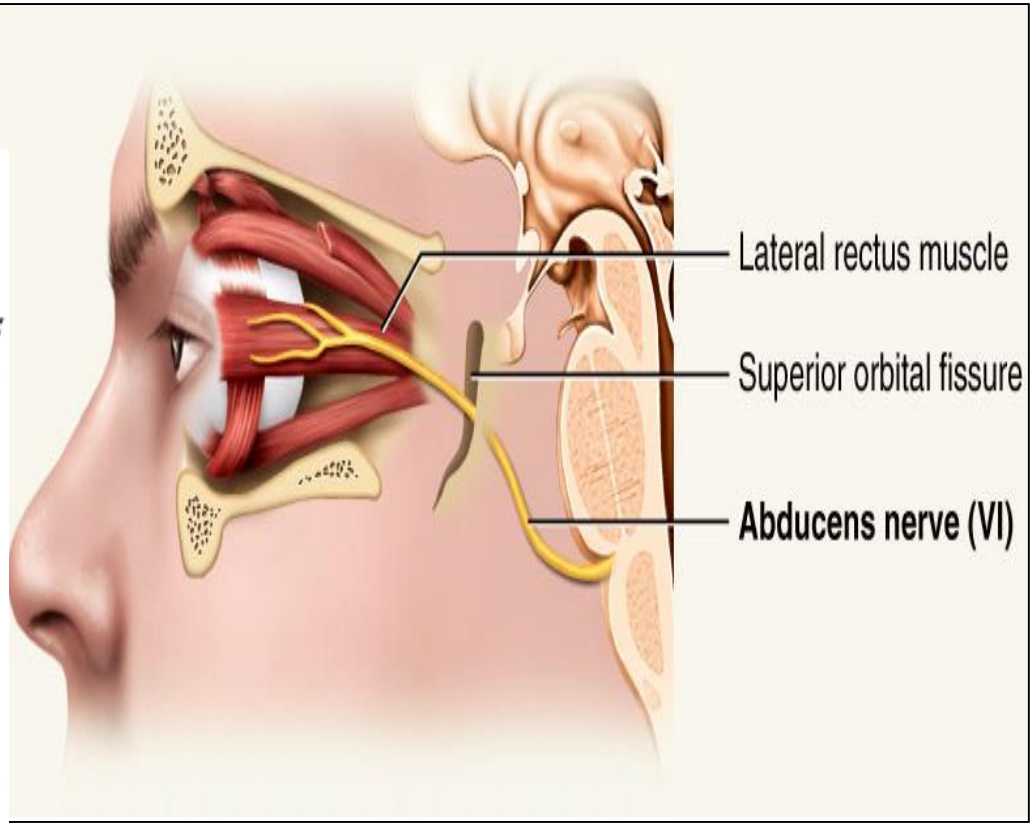
- Only one **motor** nucleus.
- Lies in **caudal pons** in the floor of the **4th ventricle**.
- Lies close to the middle line, in a line with **3rd, 4th & 12th** nerves.
- Fibers of facial nerve looping around the **Abducent nucleus**, forms the facial colliculus.
- It emerges from the ventral aspect of the brain stem at the junction of the pons and the pyramid of the medulla oblongata.
- It has the longest course to reach the orbit.



Abducent Nerve

- It passes through 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** (only one muscle), which rotates the eye ball laterally; (abduction).

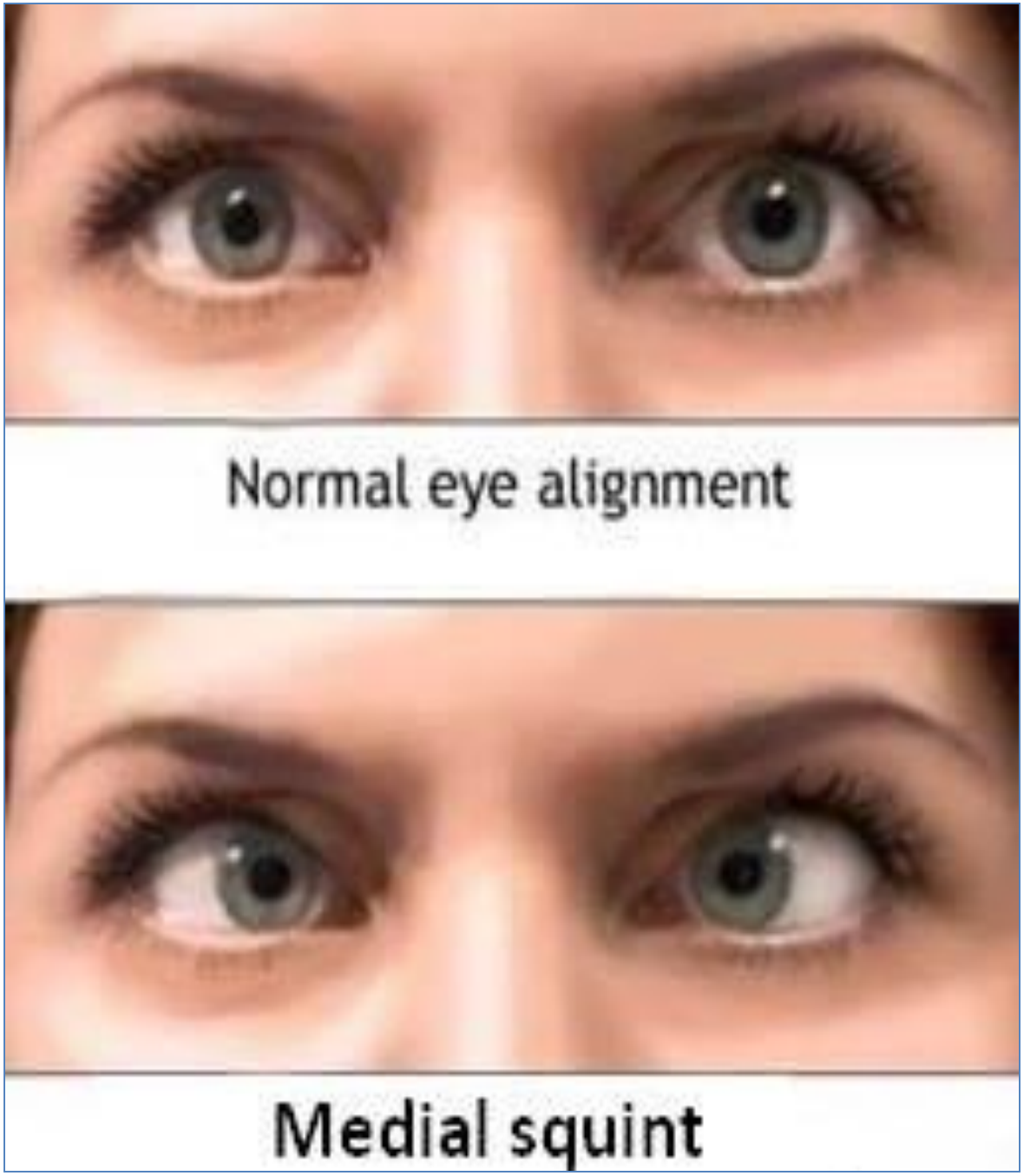




Abducent Nerve Lesion

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.



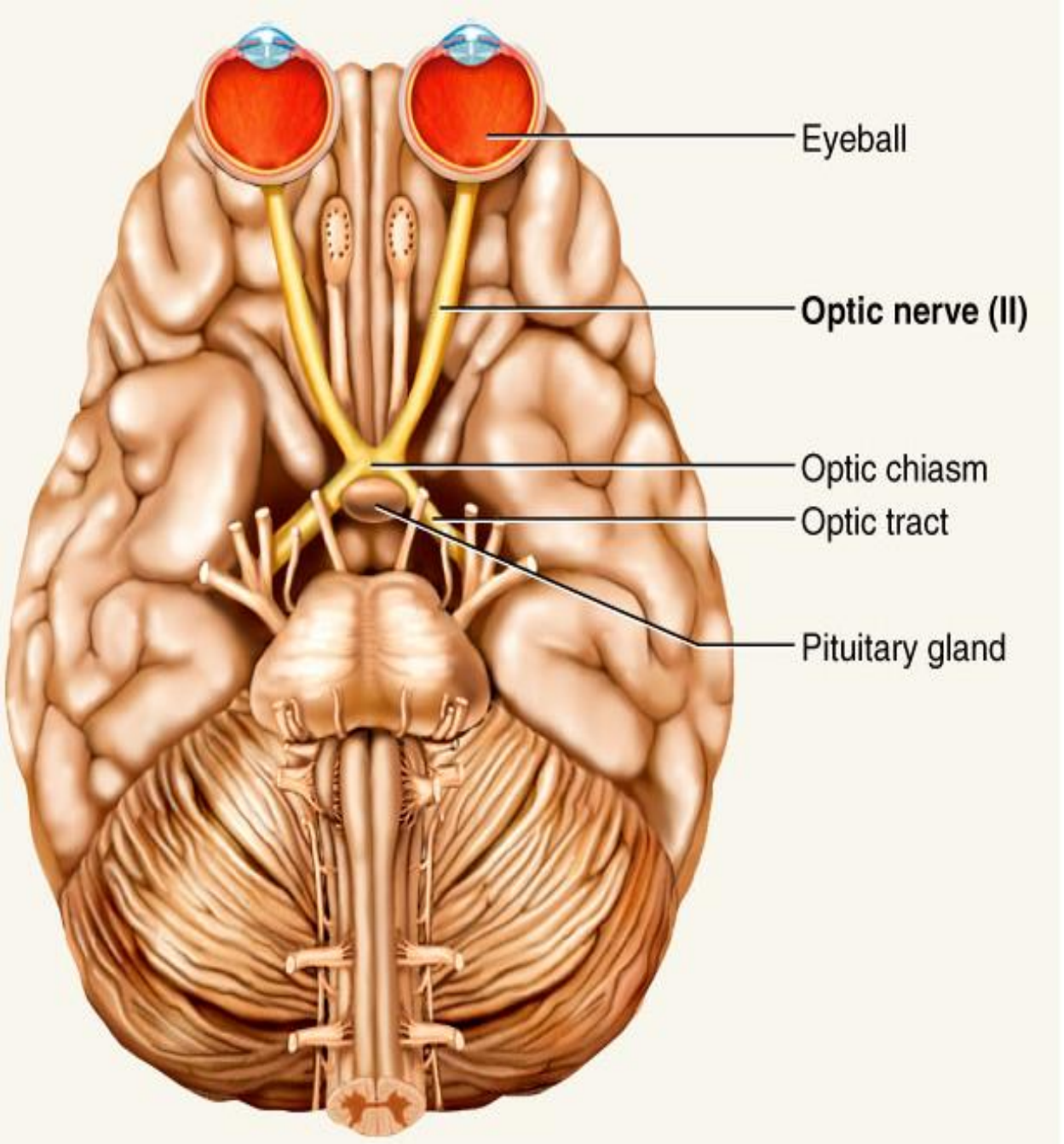
Optic Nerve

Type: Special sensory.

Function: **Vision.**

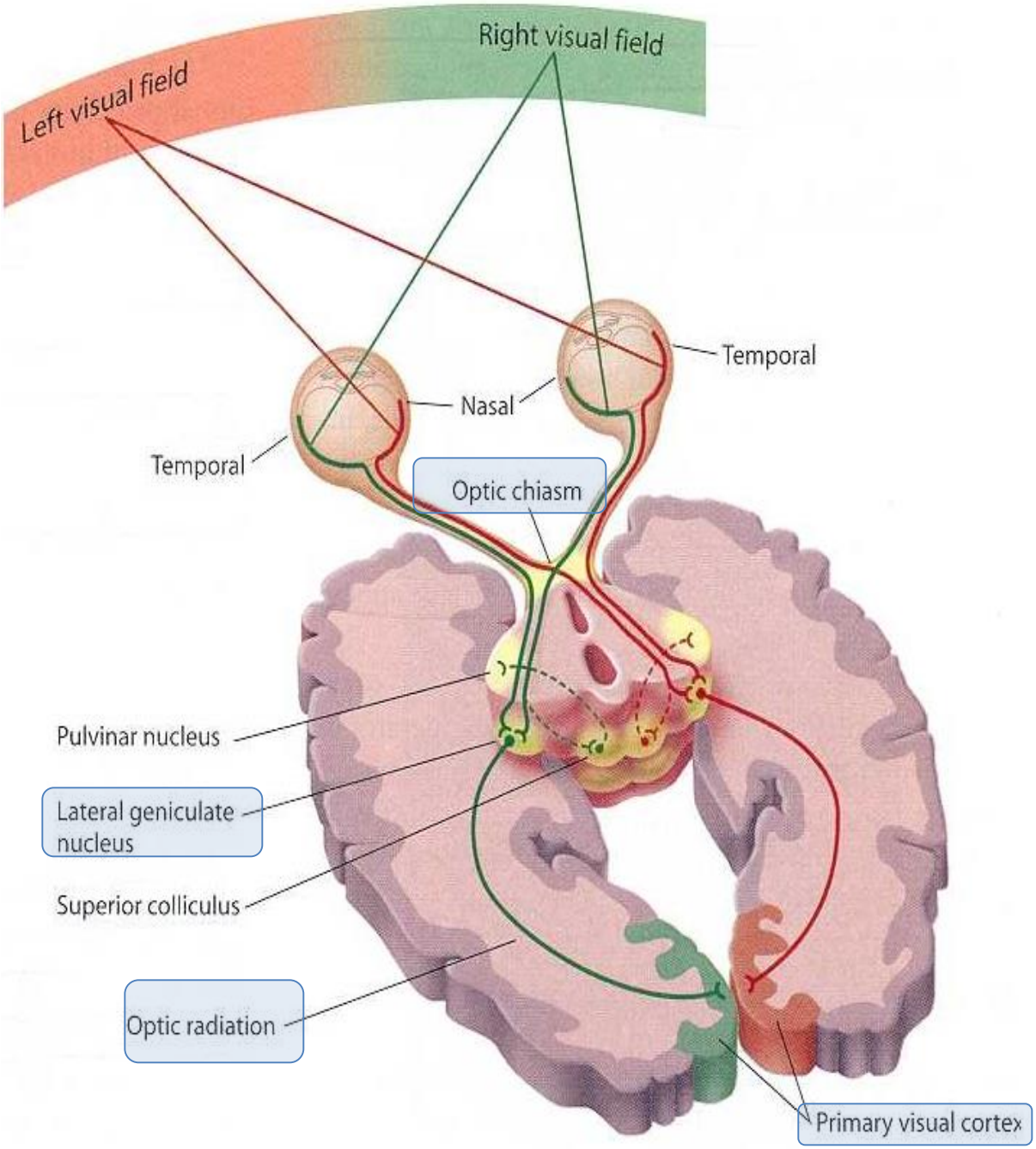
<u>Lesion results in:</u>

visual field defects & 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).
5. Optic radiation.
6. Visual cortex.



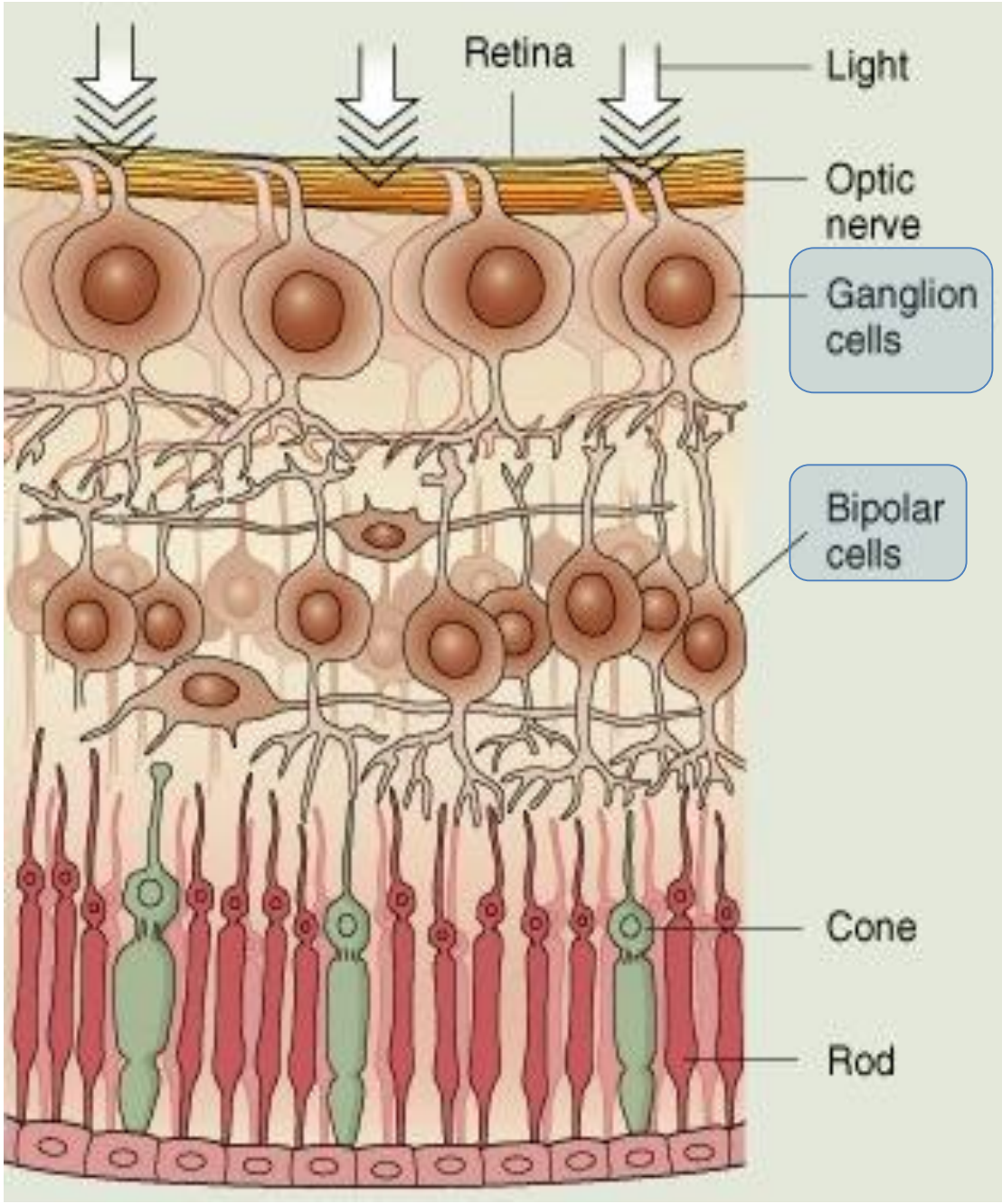
Visual Pathway

- Photoreceptors:
  Rods & **Cones** of the retina.
- **Three** neurons pathway
  - **1st order neurons:**
    Bipolar cells of retina
  - **2nd order neurons:**
    Ganglion cells of retina.

  Their axons form the optic nerve
  - **3rd order neurons:**

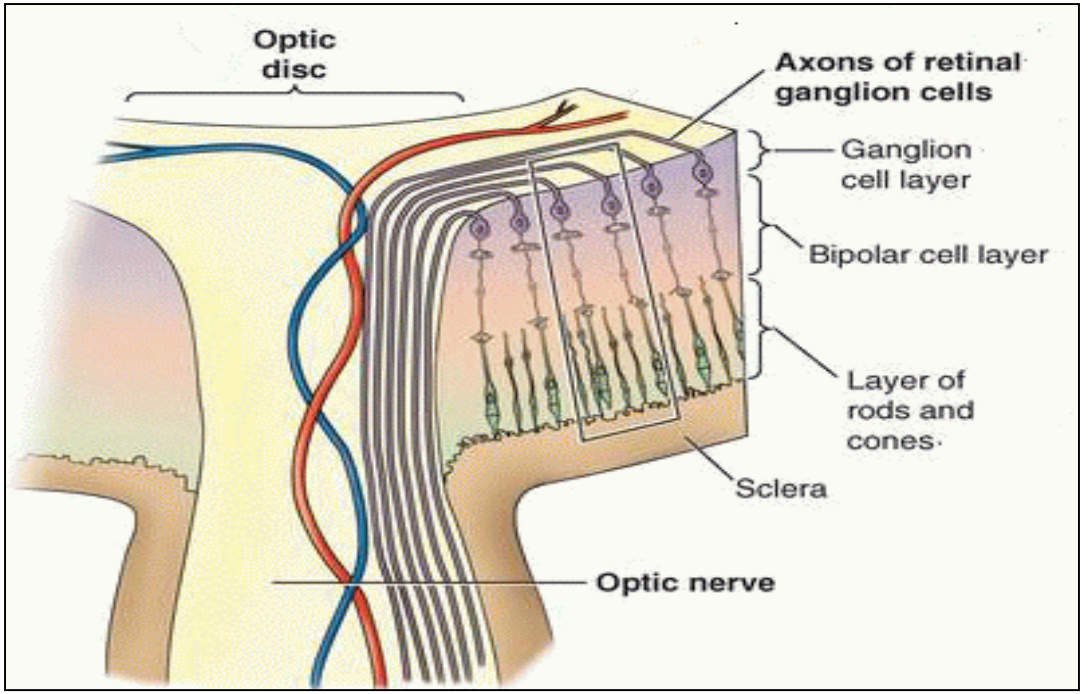
  Neurons in the lateral geniculate body.

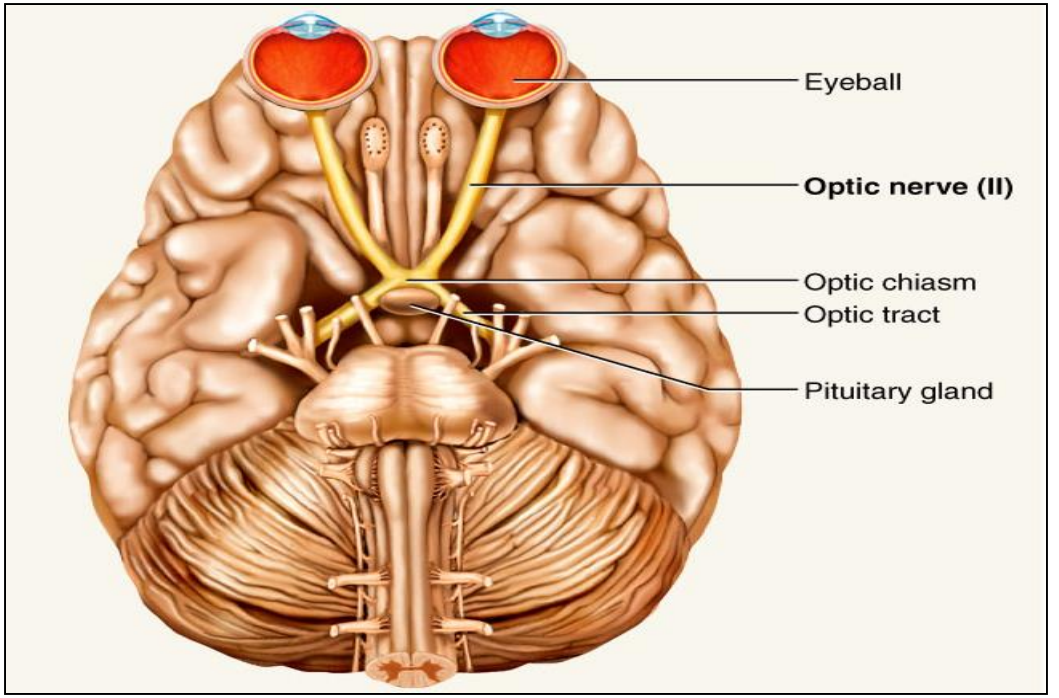
  Their axons terminate in primary visual cortex.



Optic Nerve

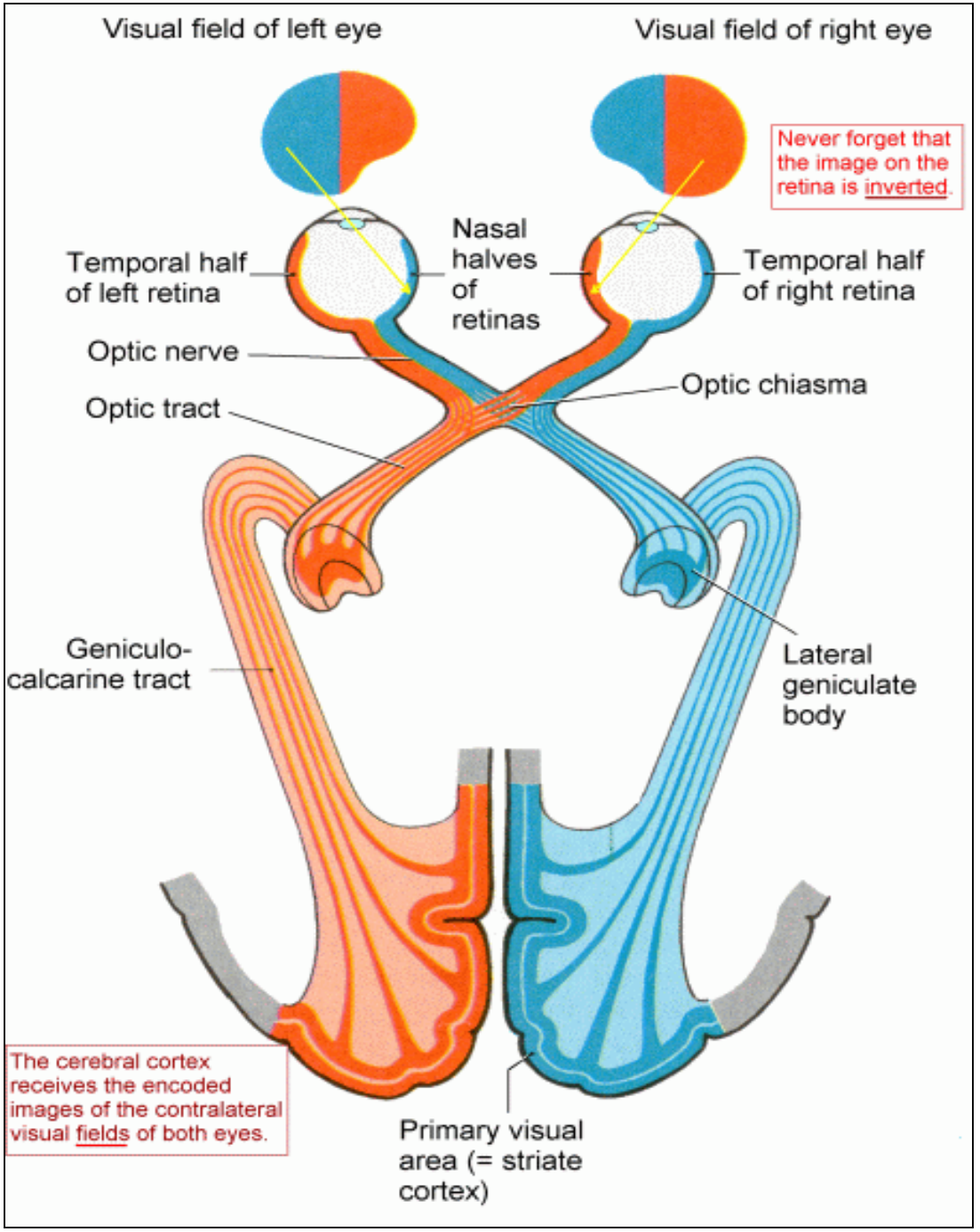
- Axons of retinal ganglion cells converge at the **optic disc** and pass as the **optic nerve.**
- Then the nerve passes posteromedially in the orbit.
- Then exits through the **optic canal accompanied by the ophthalmic artery.**
- Then it enters the middle cranial fossa to joins the**.** **optic chiasma.**





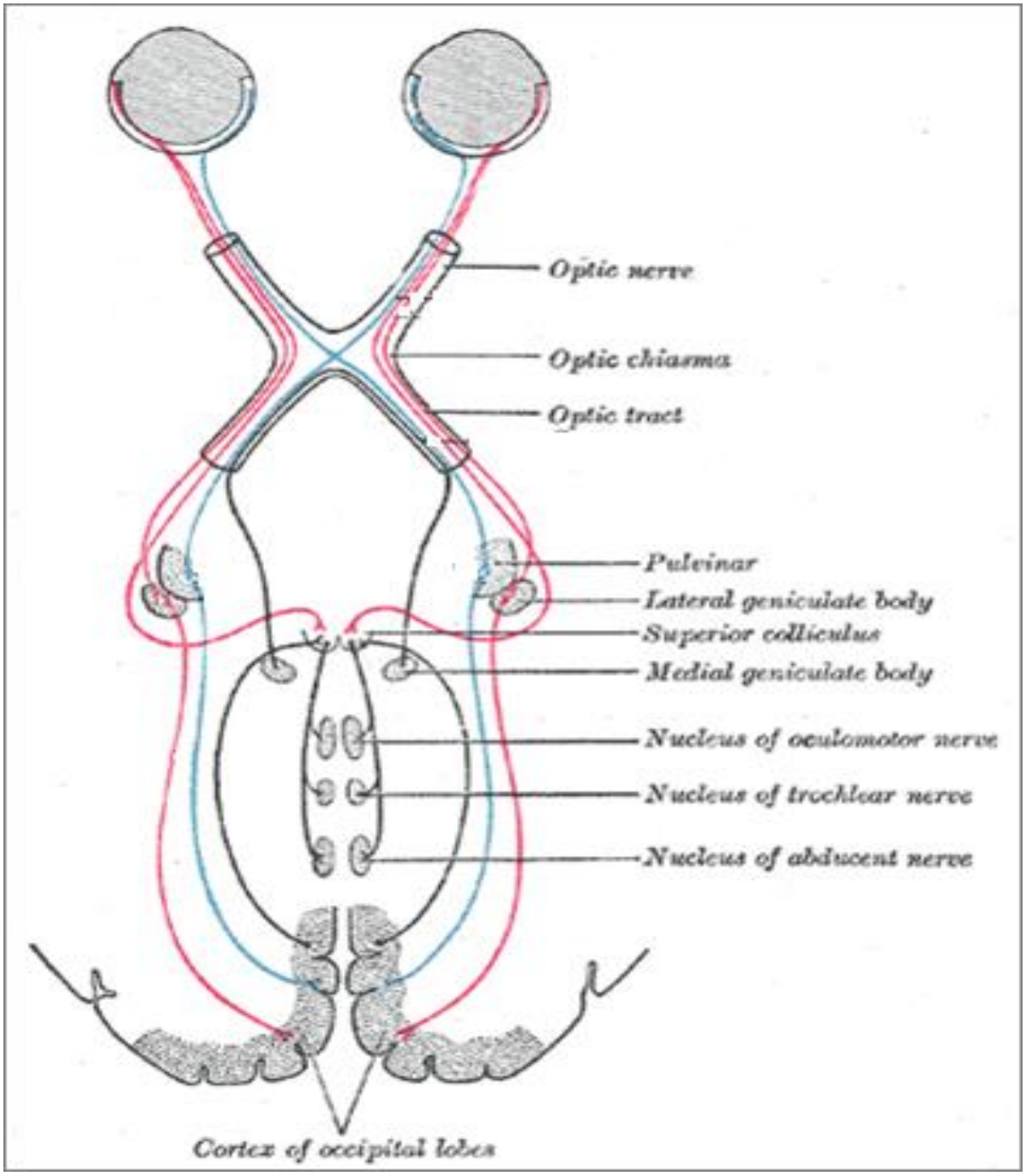
Optic Chiasma

- Fibers of **nasal (medial)** half of the **retina decussate** in the chiasm and **join uncrossed fibers of the opposite side 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 eye field** and vice versa.
- The crossing of optic nerve fibers in the optic chiasma is a requirement for **binocular vision**.

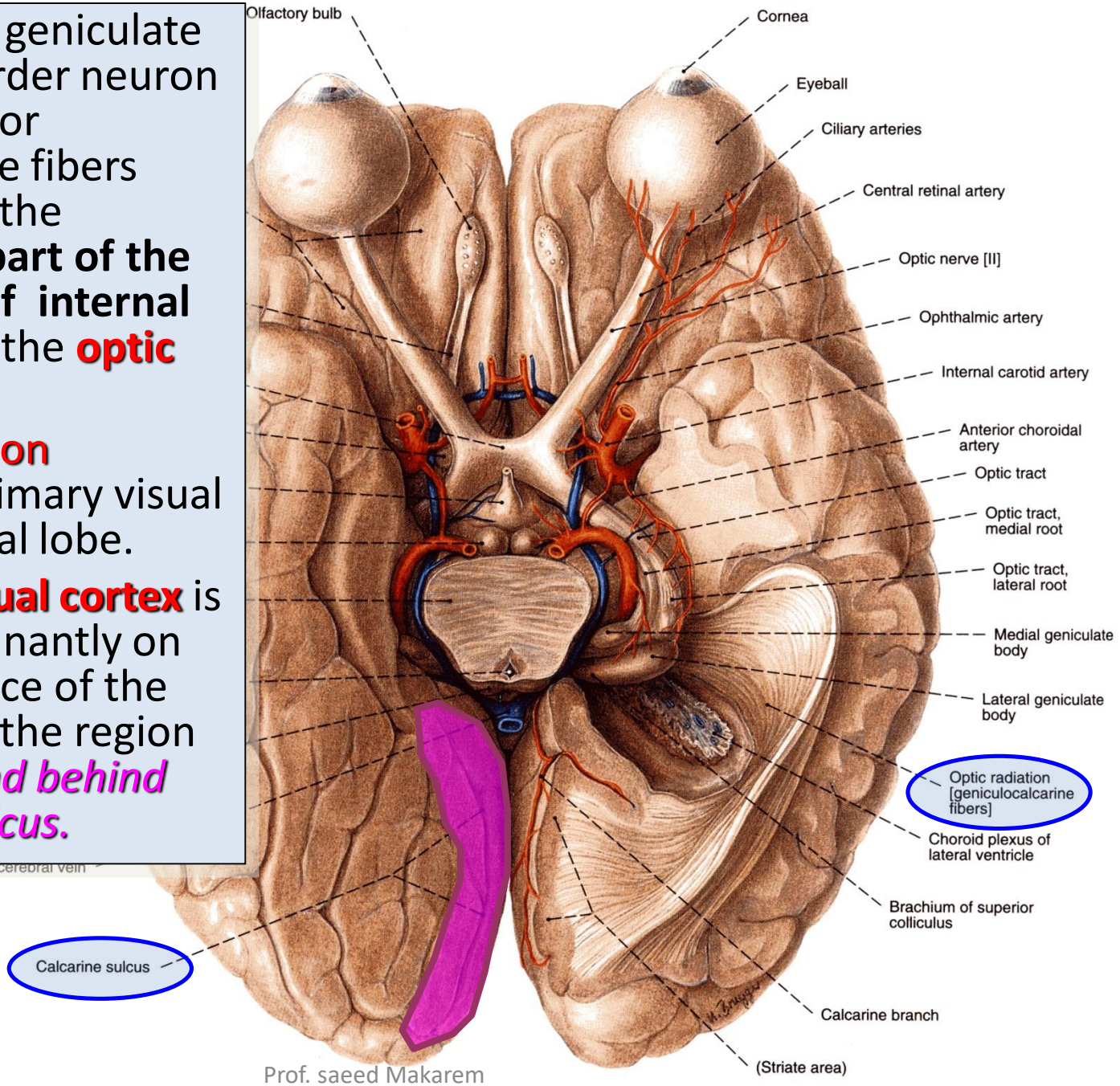


Optic Tracts

- Fibers in the optic tracts:
  - Mainly terminate in the (LGB), lateral geniculate body of the thalamus (3rd order neuron).
  - A few fibers terminate in pretectal area and superior colliculus.
  - These fibers are related to light reflexes.



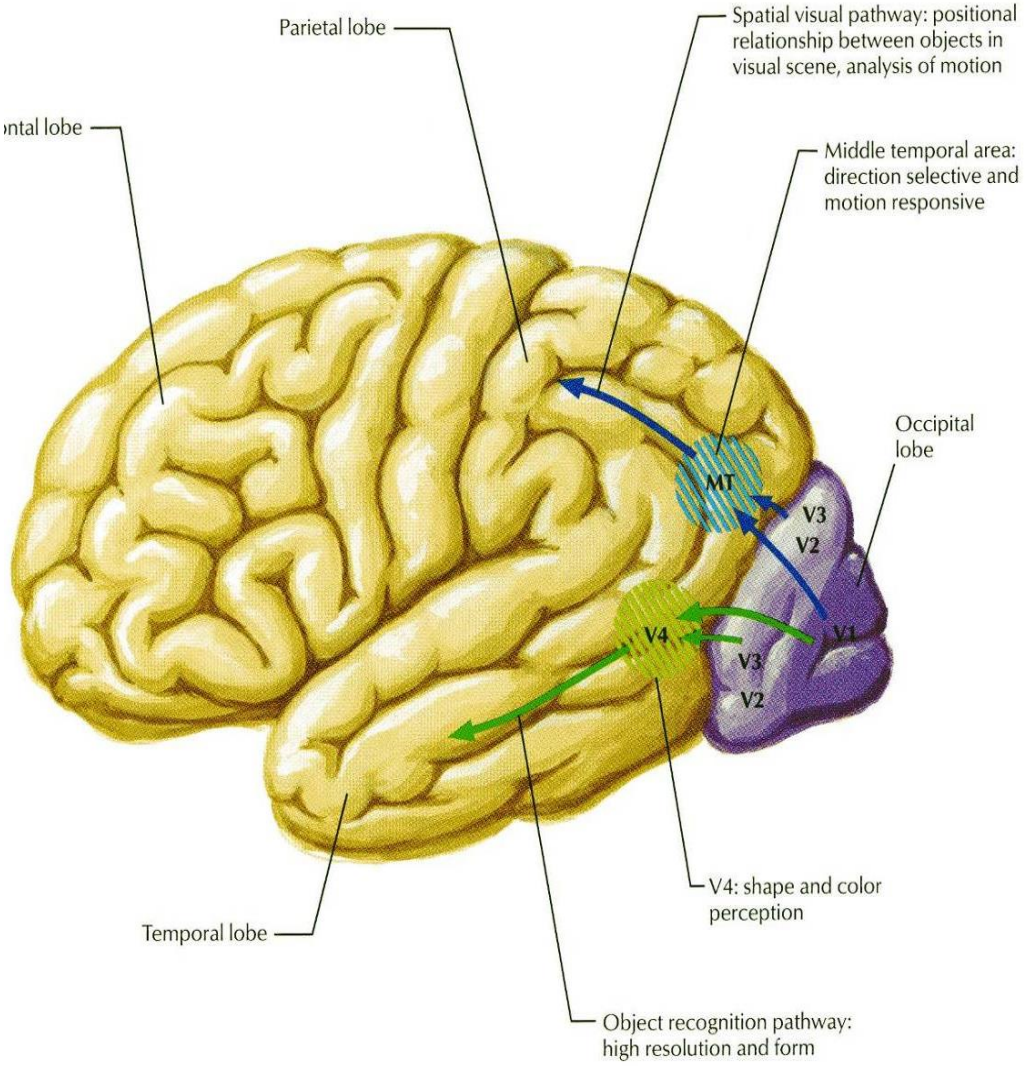
- From the lateral geniculate nucleus, third-order neuron thalamocortical or geniculocalcarine fibers project through the **retrolenticular part of the posterior limb of internal capsule** to form the **optic radiation.**
- **The optic radiation** terminates in primary visual cortex of occipital lobe.
- The **primary visual cortex** is located predominantly on the medial surface of the occipital lobe in the region *above, below and behind the calcarine sulcus.*



Visual Cortex

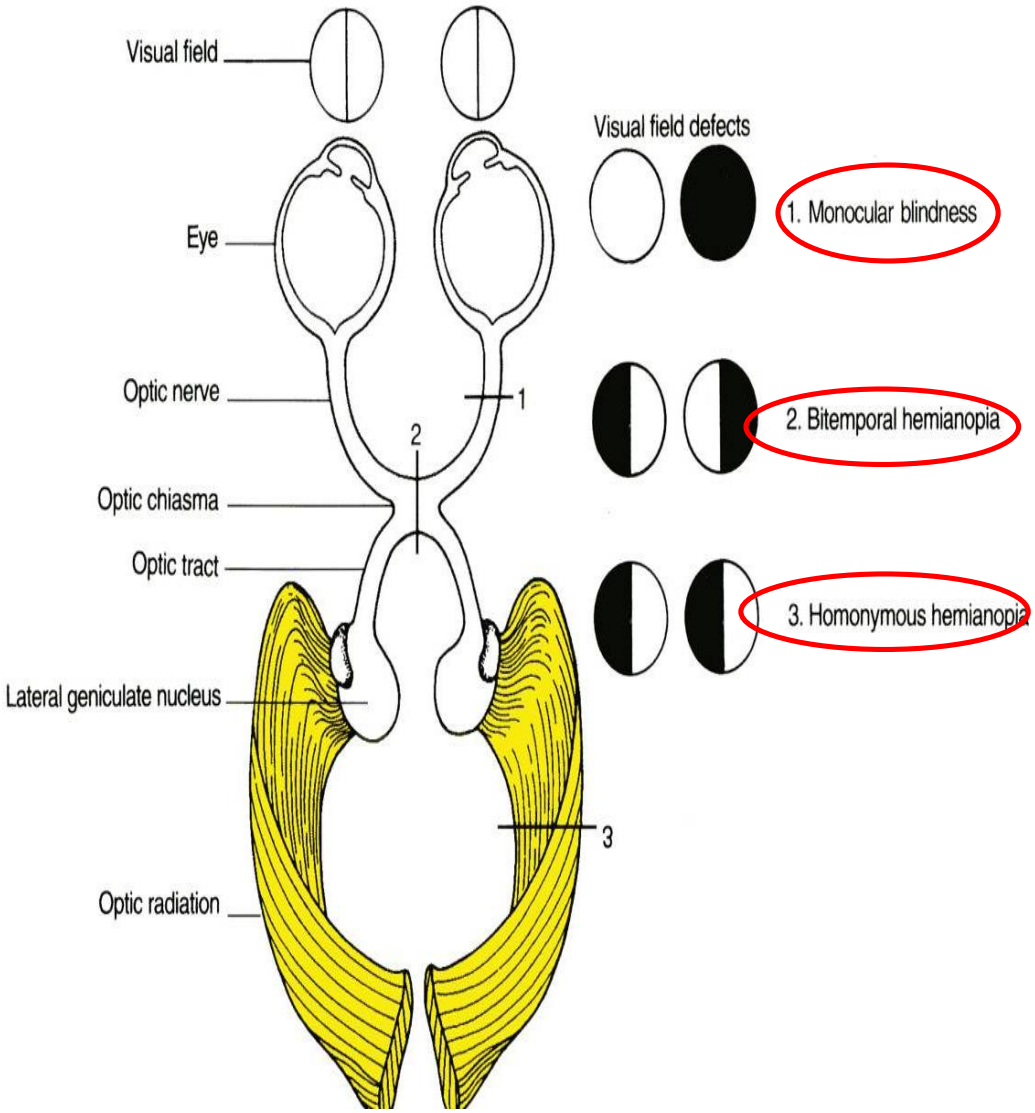
- The **primary visual cortex** (area 17 of Brodmann's classification) occupies the upper and lower lips of the calcarine sulcus on the medial surface of occipital lobe.

The **visual association cortex 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.



Visual field deficits

1. Disease of the eyeball as: Cataract, Intraocular haemorrhage, Retinal detachment, Disease of optic nerve, **MS,** (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 tumour leads to **Bitemporal hemianopia.**
3. Vascular and neoplastic lesions of the optic tract, or optic radiation produce a **Homonymous hemianopia, (Contralateral).**

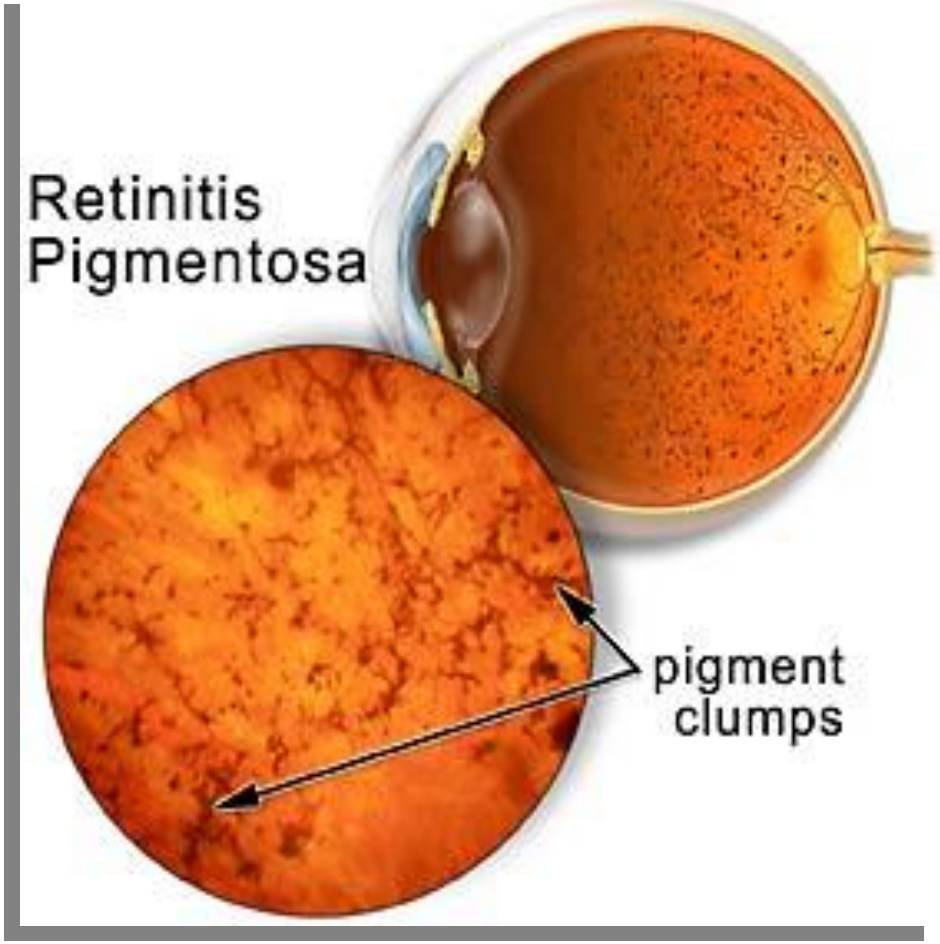



THANK YOU

WHICH DISEASE IS THIS?

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:
- **P**rogressive night blindness.
- **P**eripheral visual field constriction.
- **P**igmentation of the retina visible by ophthalmoscop.
- *Which type of photoreceptor is affected?*
- **Rods.**

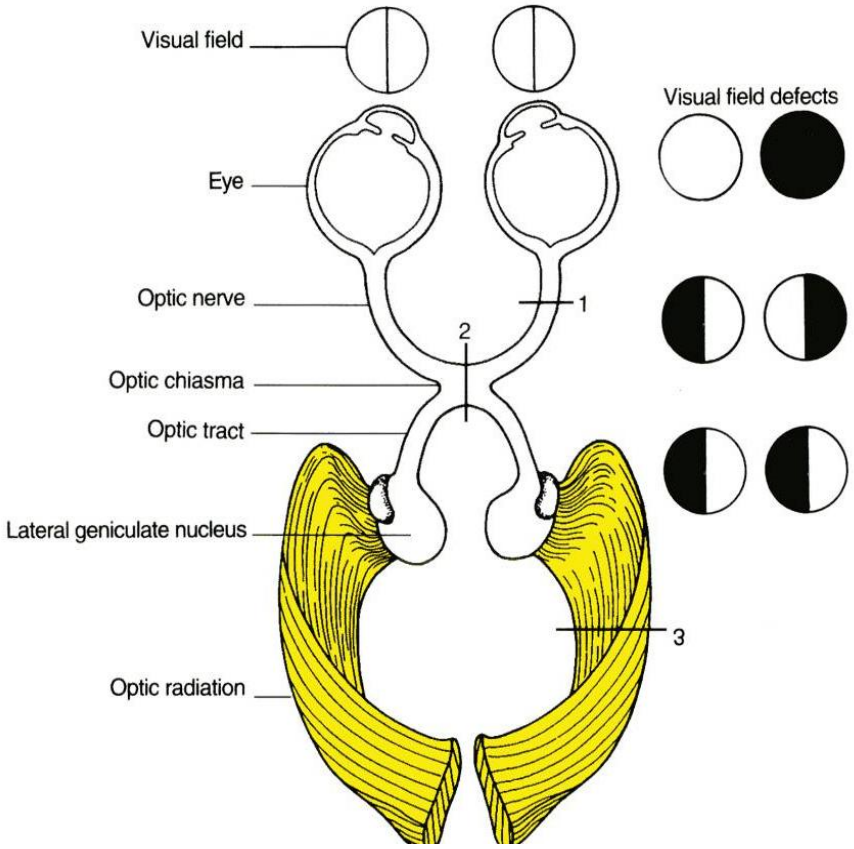


Test your self?

- If a patient is recently diagnosed with **Bitemporal hemianopia**.

Where is the most likely site of lesion?

- a. Right optic tract.
- b. Optic chiasma.
- c. Left eye.
- d. Left optic radiation.

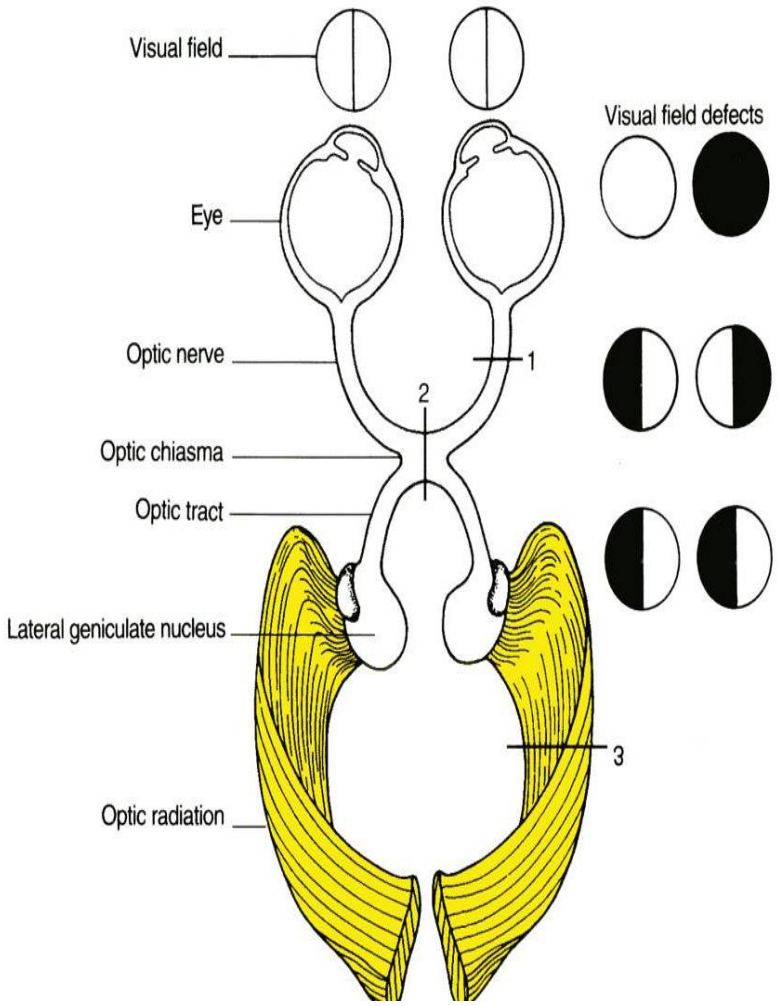


Test your self?

- If a patient is recently diagnosed as **left homonymous hemianopia**.

Where is the most likely site of lesion?

- a. Right optic tract..
- b. Optic chiasma.
- c. Left optic nerve.
- d. Left occipital cortex.



THANK YOU
AND
GOOD LUCK