

Lecture: 8

Anatomy and Physiology of the Cranial Nerves 1, 2, 3, 4 & 6

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الرجاء تحويل الجوال إلى وضع
الصامت مع
الشكر



The Cranial Nerves

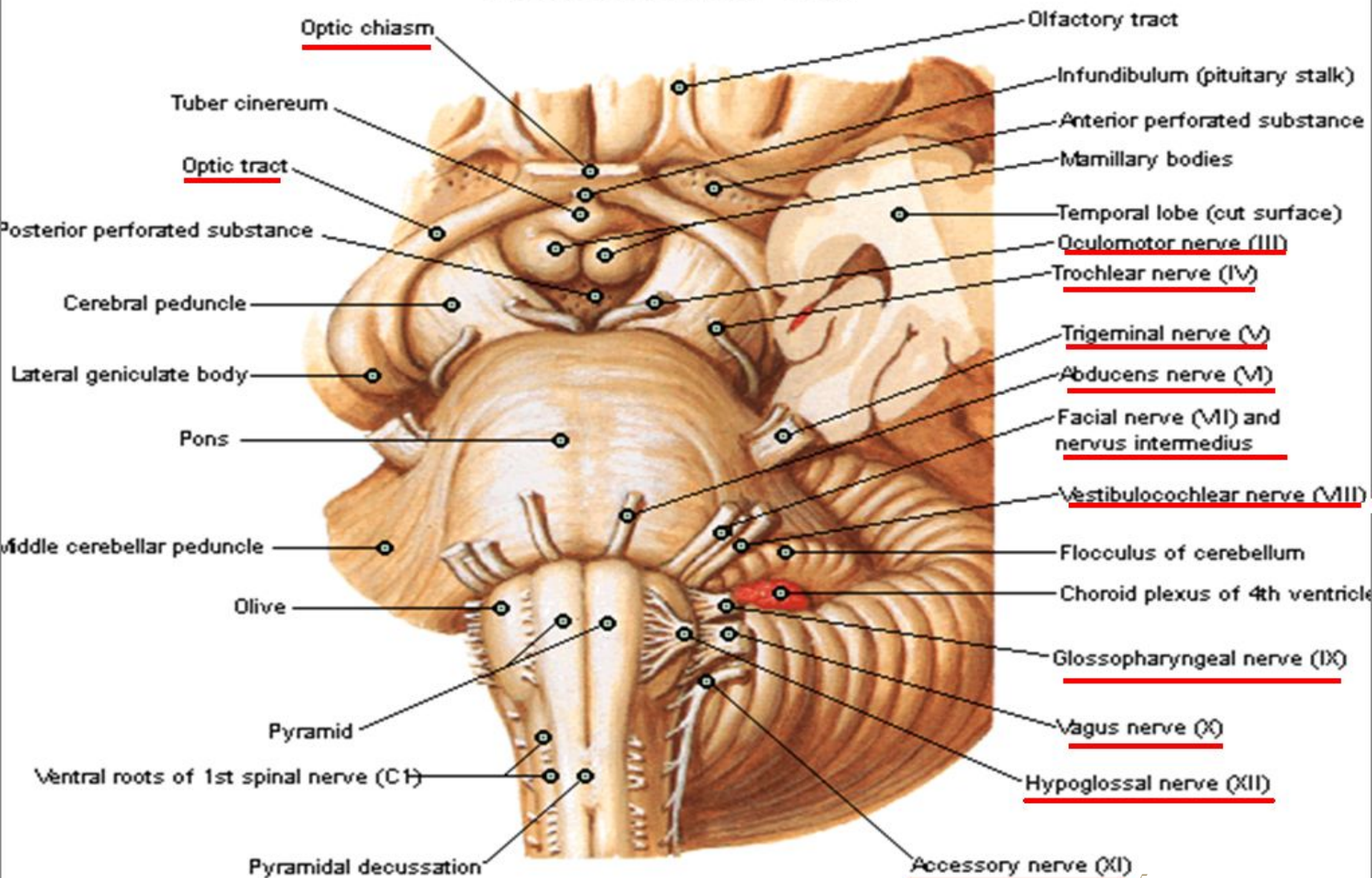
- The cranial nerves consist of 12 pairs of nerves that arise from the brain.
- They exit/enter the cranium through openings in the skull.
- The olfactory, optic and vestibulocochlear nerves are purely sensory nerves “special sensory” **(128)**.
- The oculomotor, trochlear, abducent, accessory and hypoglossal nerves are purely motor nerves.
- The trigeminal, facial, glossopharyngeal and vagus nerves are mixed nerves **(10975)**.

Classification of the Cranial Nerves

No	Name	Function	Site of nucleus	Opening in the skull
1	Olfactory	Smell	Temporal Lobe	Cribriform plate
2	Optic	Vision	Occipital lobe	Optic canal
3	Oculomotor	Motor	Midbrain	Superior orbital fissure
4	Trochlear	Motor	Midbrain	Superior orbital fissure
5	Trigeminal: Ophthalmic Maxillary Mandibular	Sensory Sensory Mixed	Midbrain, Pons Pons Medulla oblongata Upper C. spinal cord	Superior orbital fissure Foramen rotundum Foramen ovale
6	Abducent	Motor	Pons	Superior orbital fissure
7	Facial	Mixed	Pons	Internal acoustic meatus, Facial canal, Stylomastoid foramen
8	Vestibulo-cochlear	Hearing and balance	Pons	Internal acoustic meatus
9	Glossopharyngeal	Mixed	Medulla oblongata	Jugular foramen
10	Vagus	Mixed	Medulla oblongata	Jugular foramen
11	Accessory	Motor	Medulla oblongata C1-C4 AHC of SC	Jugular foramen
12	Hypoglossal	Motor	Medulla oblongata	Hypoglossal canal ⁴

Brainstem

Anterioinferior View



I. The Olfactory Nerve

- **Olfactory Nerve:** (Latin for "to smell").
- **Function:** Special sensory nerve (smell).
- **Olfactory tract** located in the anterior cranial fossa and attached to the inferior surface of frontal lobe.



The Sense of Smell

The smell sensation is a special sense, which is important:

1. It determines the flavors of food (together with taste, touch and thermal sense).
2. It essential for gastrointestinal functions.
3. It is necessary for avoiding dangerous liquids or substance.

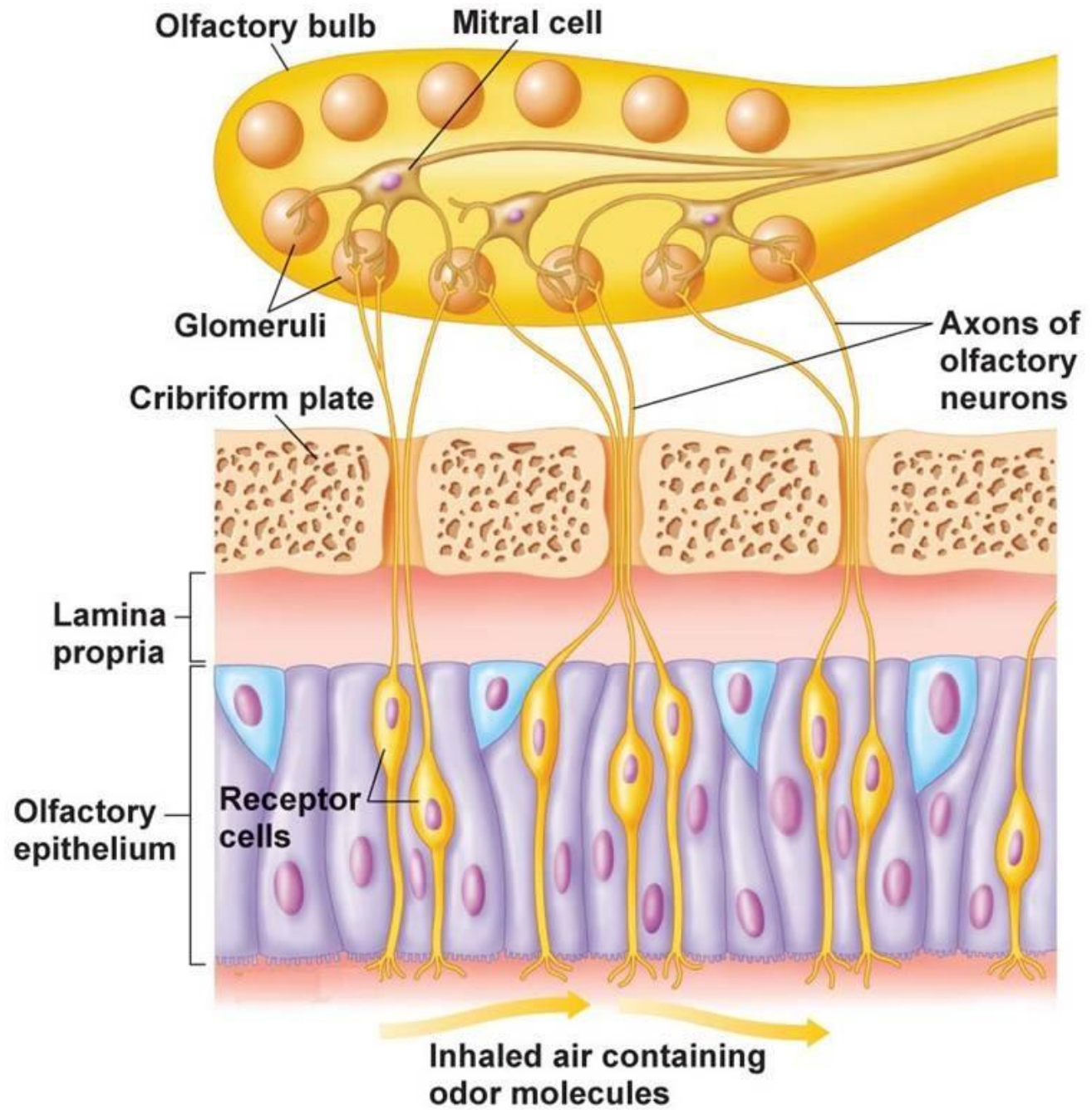
Properties of Olfactory Receptors

1. **Sensitivity:** the olfactory receptors are chemoreceptors.
2. **Discrimination of odorants:** the olfactory system can discriminate about 10,000 odors.
3. **Discrimination of odorants intensity.**
4. **Adaptation:** the **olfactory receptors** and **smell center** are adapt rabidly with continuous exposure to an odorant.

Note: Replacement of receptor cells (about 60 days).

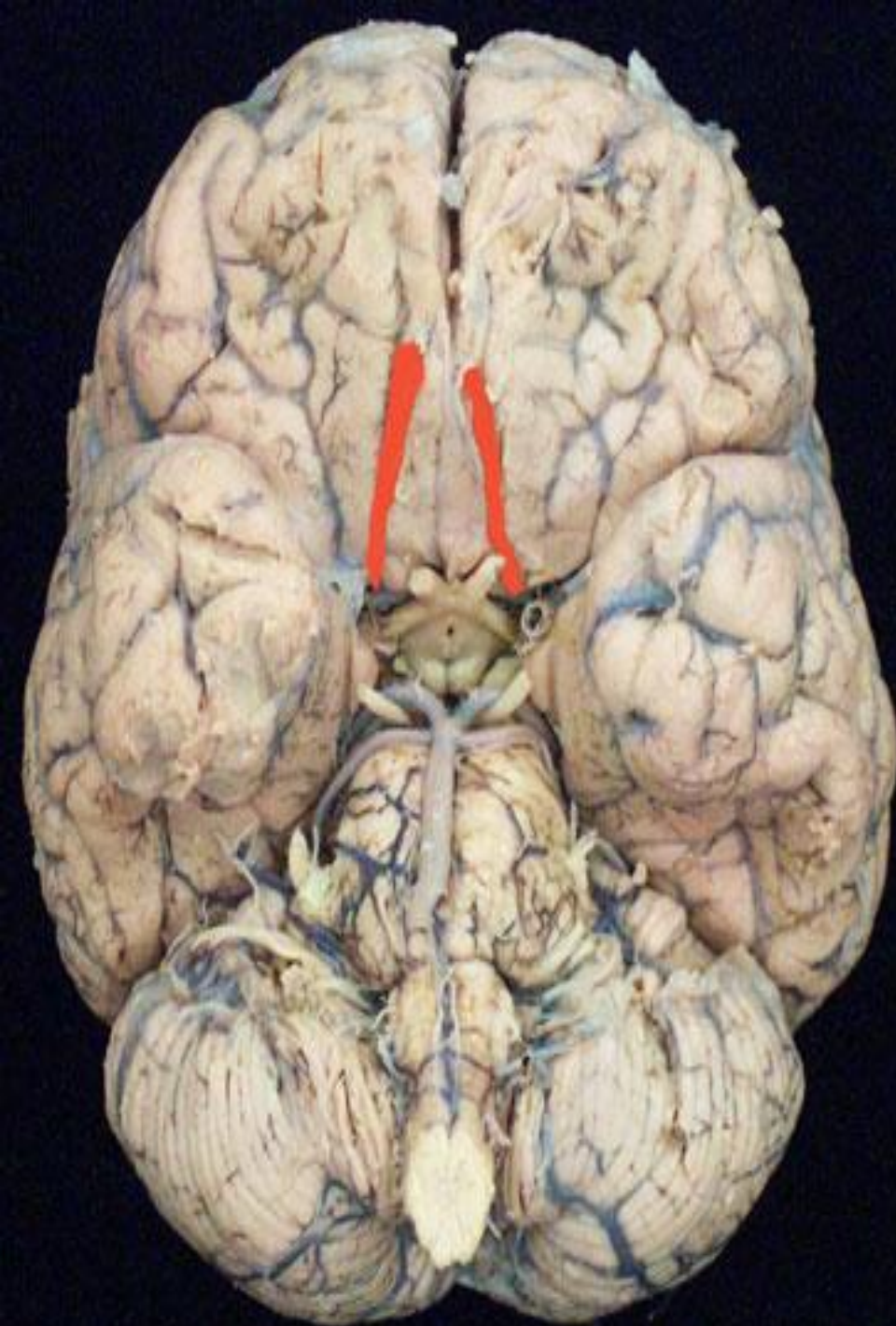
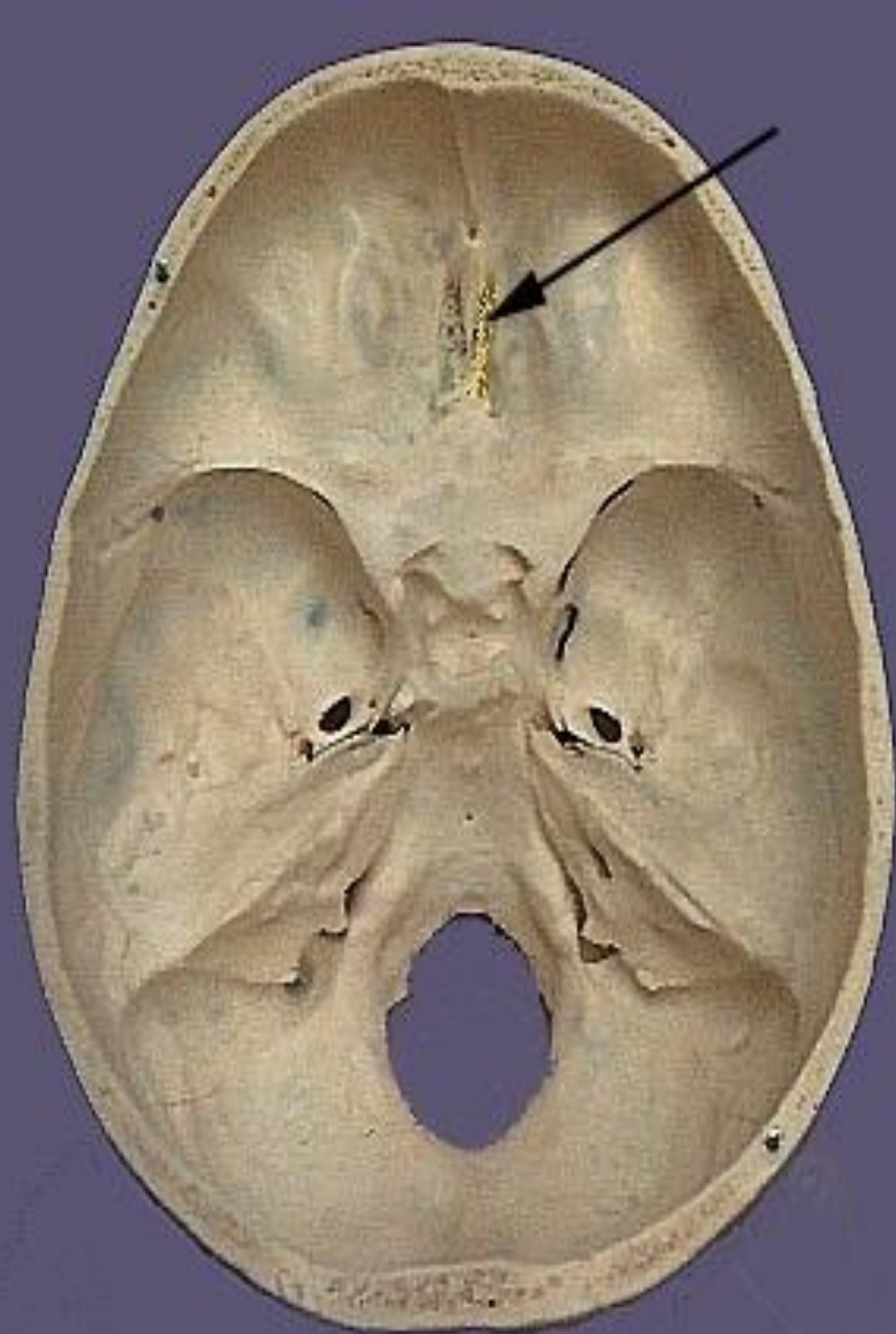
Pathway of Smell Sensation

- I. First Neuron: Bipolar cells (receptors) in the olfactory mucous membranes of the superior nasal cavity → fibers of **olfactory nerve** (consist of about 20 small filaments on each side) → the cribriform plate of the ethmoid bone → olfactory groove → **olfactory bulb** where they relay in **the mitral cells**.



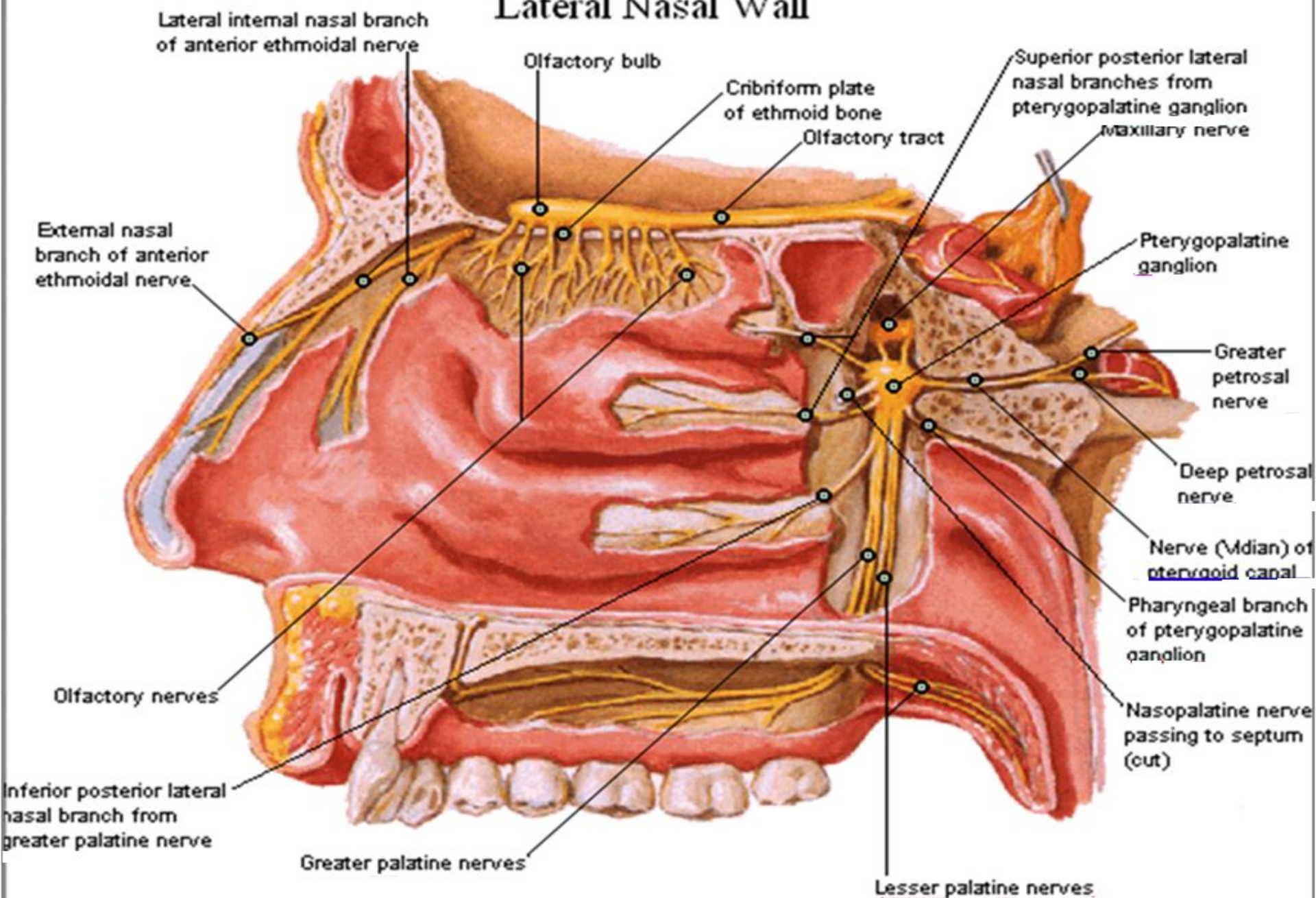
2. Second Neuron:

- The olfactory nerve fibers “axon of the first order neuron” makes synapse with the dendrites of the **mitral cells (second order neuron)** of olfactory bulb, the synapse called **olfactory glomeruli** → olfactory tract → ends in the temporal lobe of both cerebral hemisphere.
- **Note:** Unilateral lesion of temporal lobe does not cause of anosmia as the sense of smell is bilaterally represented.



Nerves of Nasal Cavity

Lateral Nasal Wall



Lesion of the Smell Pathway

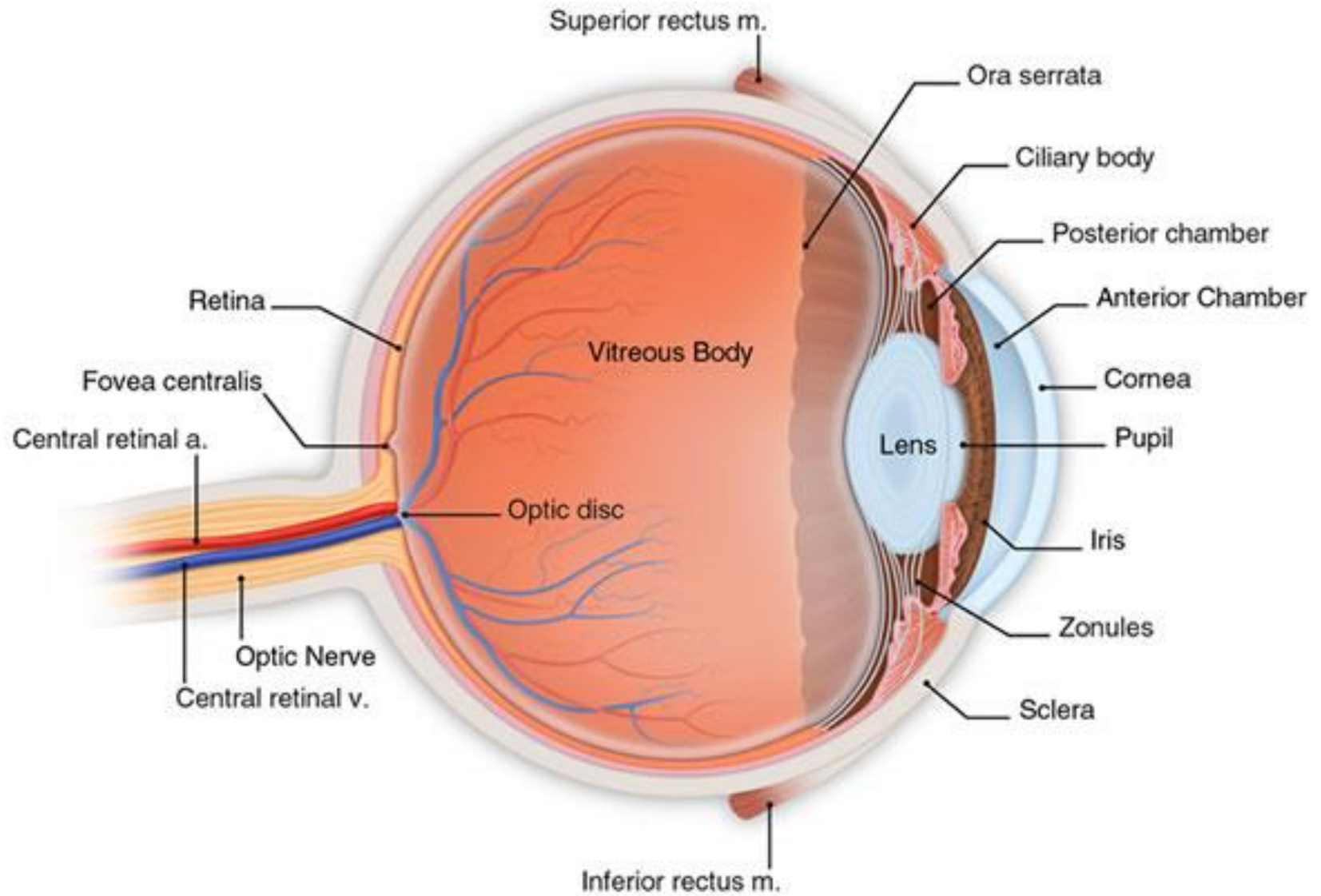
1. Unilateral hyposmia or anosmia.
2. Bilateral hyposmia or anosmia.
3. Parosmia (Smell hallucination)
4. Cacosmia (bad smell in chronic sinusitis)
5. Olfactory agnosia

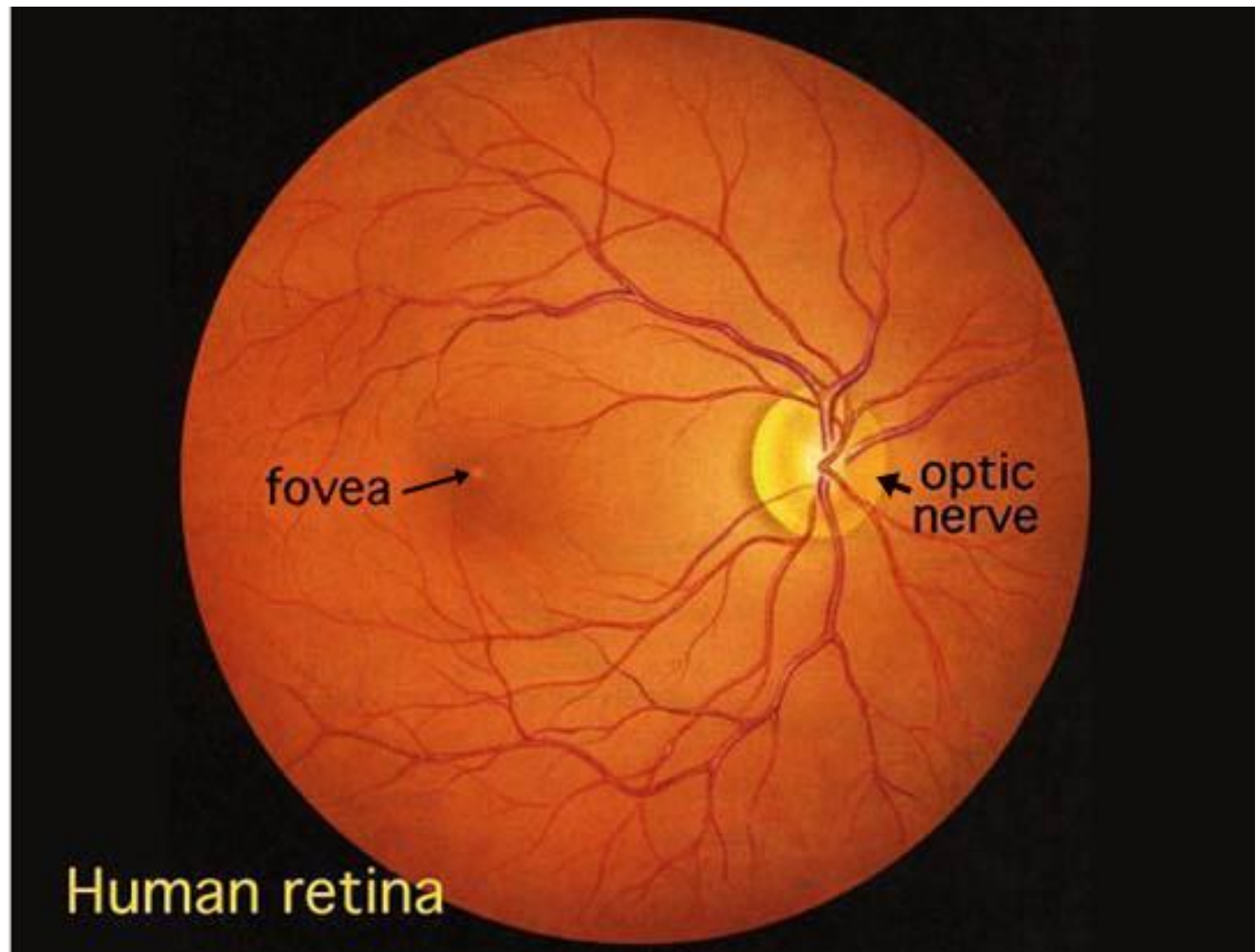
II. The Optic Nerve

❖ **Optic Nerve:** (Latin for "to see").

- A bundle of 1 million nerve fibers.
- Responsible for transmitting nerve signals from the retina to the brain.
- The optic disc is the front surface of the optic nerve.

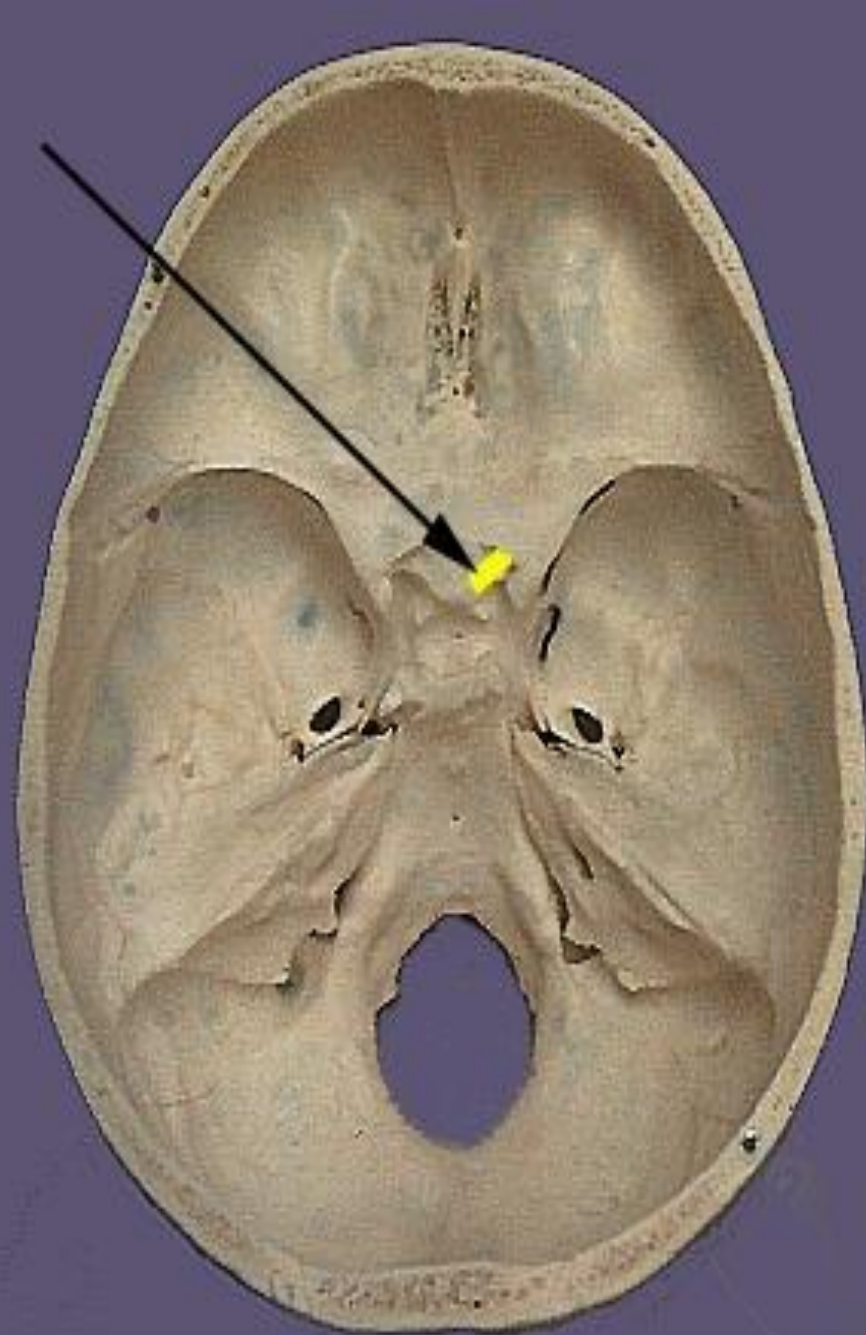
❖ **Function:** Special sensory nerve (Sense of vision).

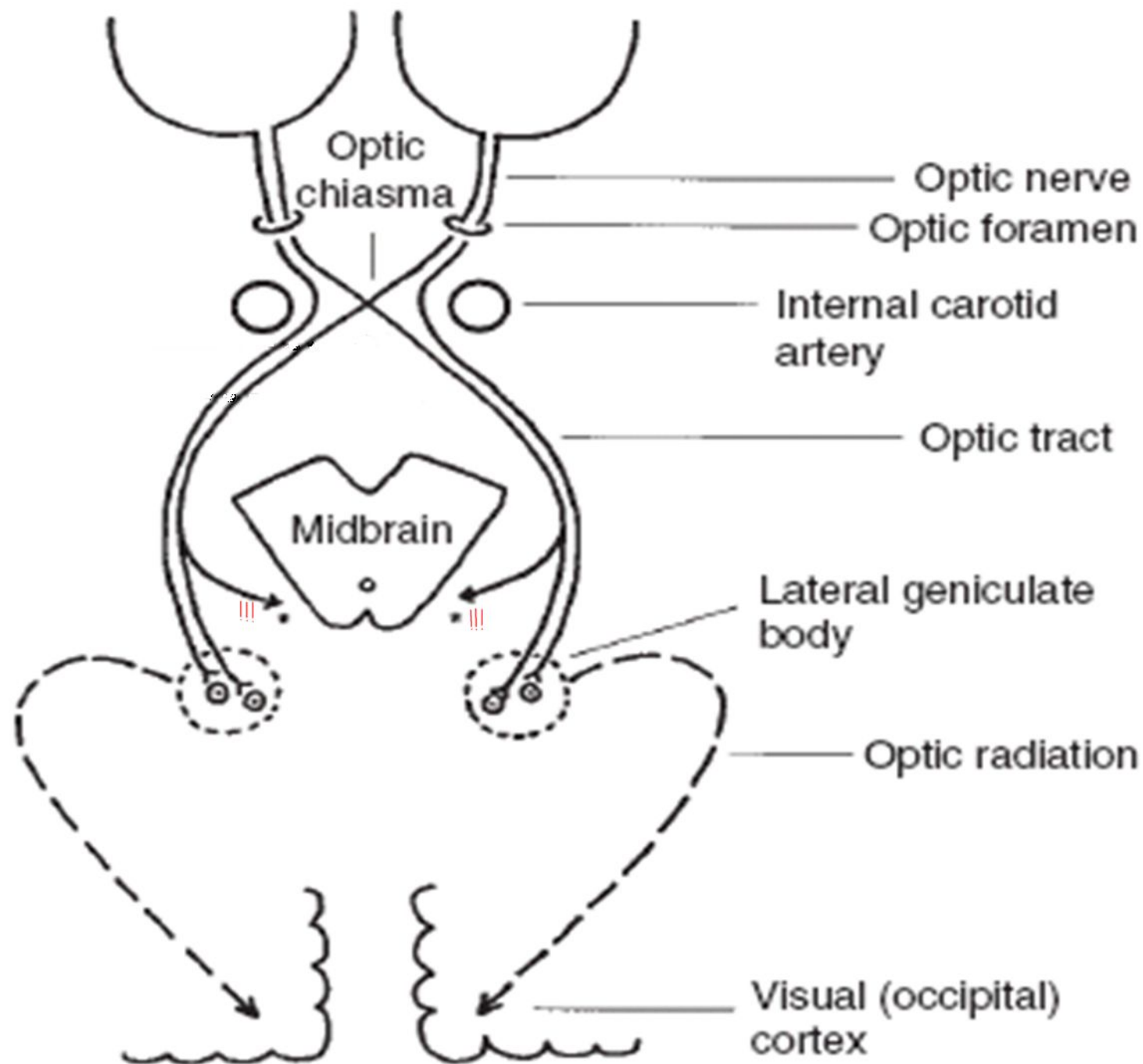




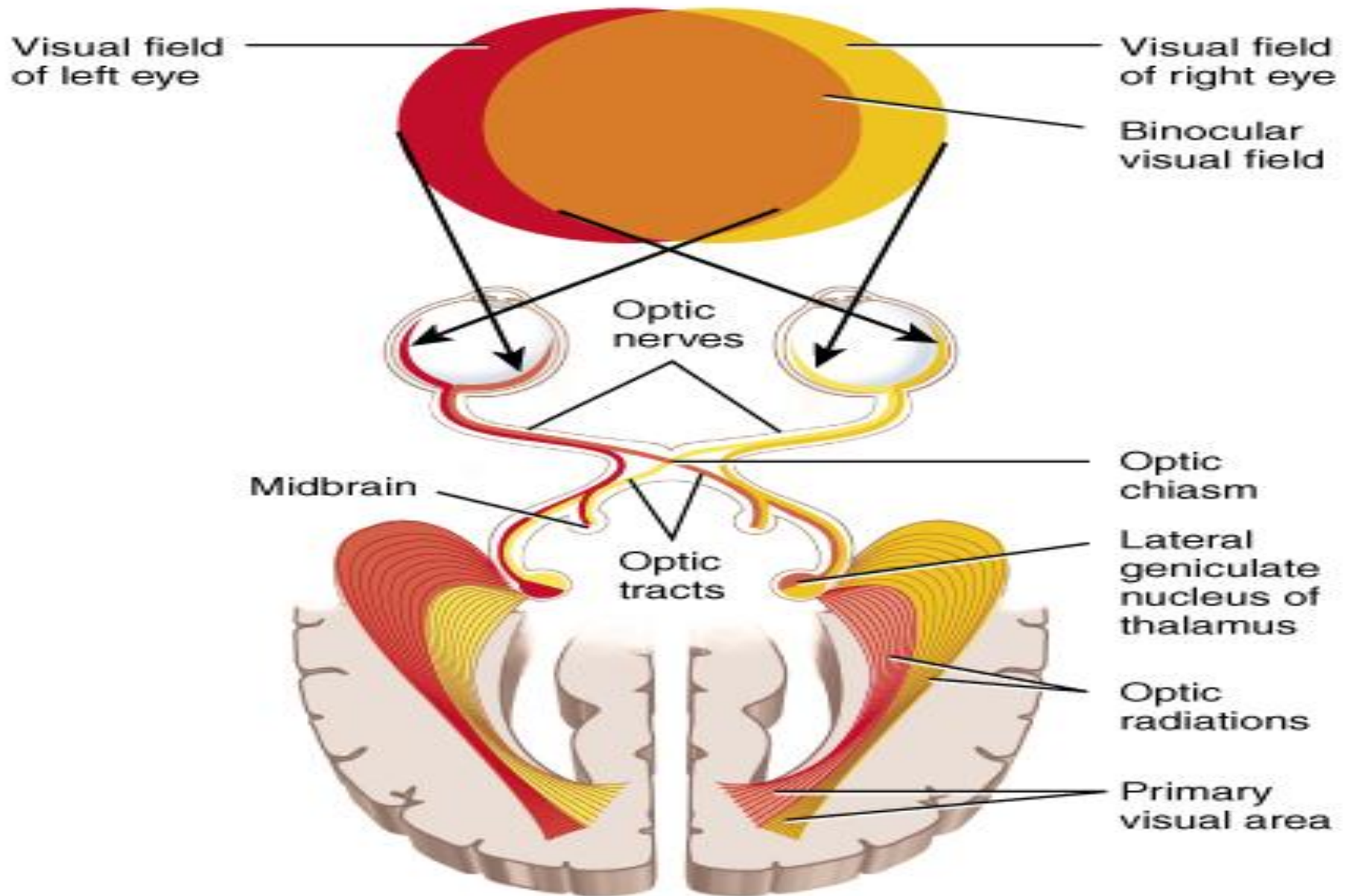
Pathway of the Vision

Receptors of light are **rods and cones of retina** → **optic nerve** → optic canal of the sphenoid bone → **optic chiasma** (the medial fibers decussate to the opposite optic tract, while the lateral fibers continue in the same optic tract) → **optic tract** (gives fibers to **Edinger-Westphale nucleus in midbrain for light reflex**) → relay in the lateral geniculate body → posterior limb of internal capsule → optic radiation → end in areas **17, 18, 19 of occipital lobes.**

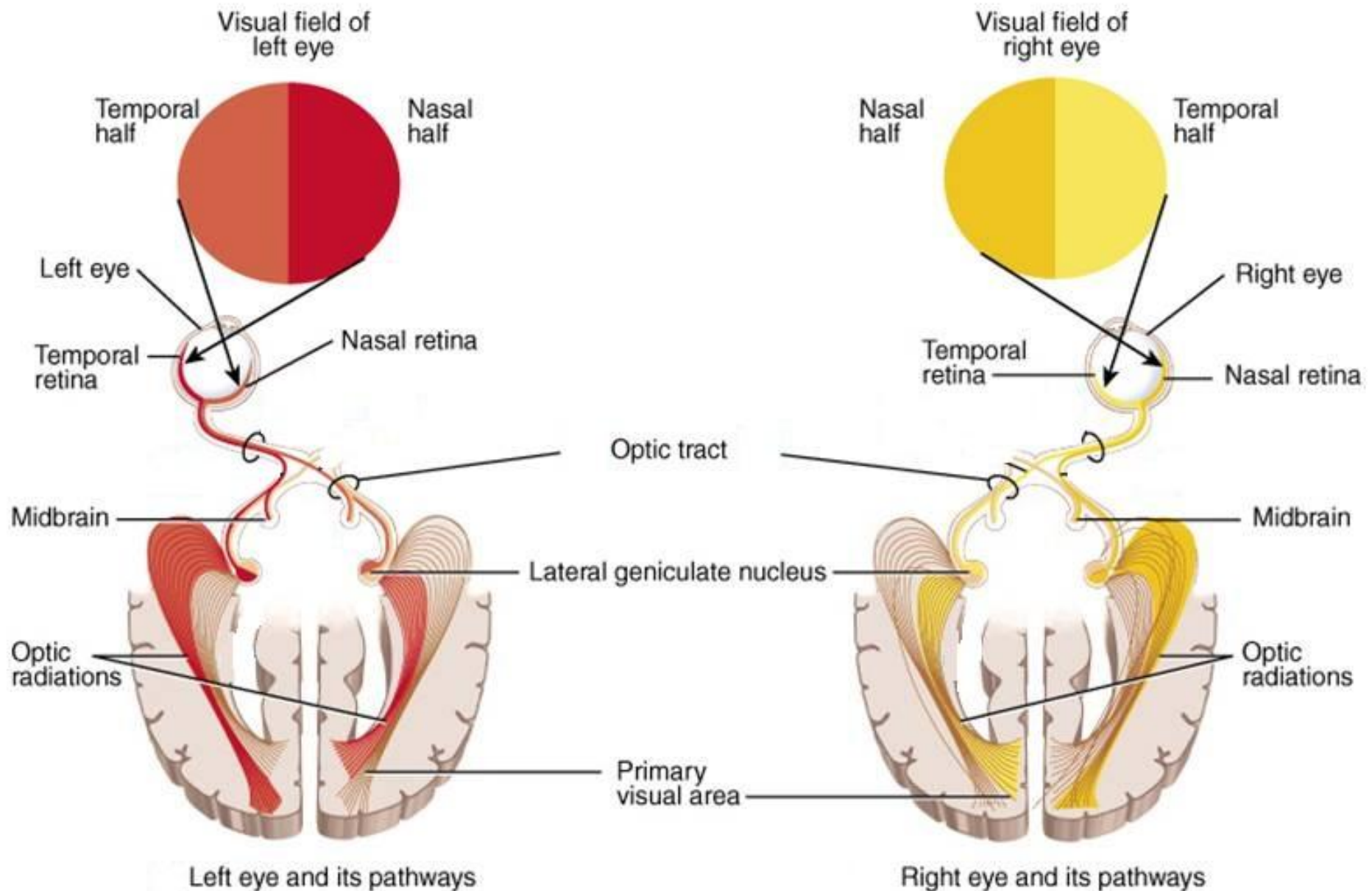




The Visual Pathway



The Visual Pathway



Lesions

- [illegible]

The ocular Nerves (III, IV, VI)

1. Oculomotor nerve: *(Latin for "eye" and "moving")*.

Function:

1. **Motor function:** movement of the eye ball.

2. **Autonomic (parasympathetic):** pupillary reaction.

2. Trochlear nerve:

Function: motor function → supplies the superior oblique muscles.

3. Abducent nerve: *(Latin for "abduction")*.

Function: motor function → abducts (laterally) the eye ball → supplies the lateral rectus muscle.

The oculomotor Nerve (III)

Oculomotor nerve: *(Latin for "eye" and "moving")*.

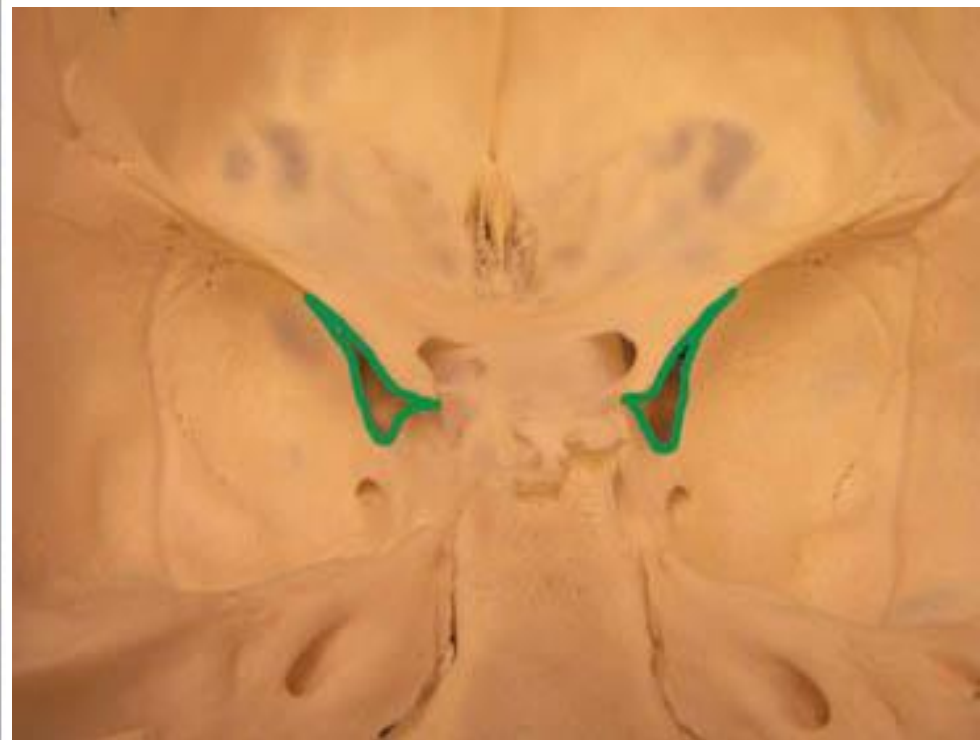
Function:

- 1. Motor function:** movement of the eye ball.
- 2. Autonomic (parasympathetic):** pupillary reaction.

Site of nucleus: it lies in the tegmentum of midbrain.

The Oculomotor Nerve

- The Oculomotor nerve is purely a motor nerve.
- Emerges from the anterior surface of the midbrain.
- The oculomotor nerve travels in **the upper lateral wall of the cavernous sinus** and then enters the orbit via the **superior orbital fissure (SOF)** of the sphenoid bone.





The oculomotor N. supplies all of the intra- and extraocular muscles except:

1. **Superior oblique muscle** → from the trochlear nerve – IV.
2. **Lateral rectus muscle** → from the abducent nerve – VI.
3. **Dilator pupillae muscle** → from the sympathetic fibers.
4. **Muller's muscle** → from the sympathetic fibers.

Structure of Oculomotor Nuclei

1. **The Edinger-Westphal nucleus:** parasympathetic function which supplies two intraocular muscles:
 - a. **Constrictor pupillae muscle** → Miosis.
 - b. **Ciliary muscle** → Responsible for light and accommodation reflexes.
2. **The lateral cell mass (motor function):** supplies five extra ocular muscles:
 - a. **Levator palpebrae superior muscle.**
 - b. **Superior rectus muscle.**
 - c. **Medial rectus muscle.**
 - d. **Inferior oblique muscle.**
 - e. **Inferior rectus muscle.**
3. **The central nucleus of Perlia:** motor function which supplies **the medial recti muscles of the two eyes** allowing to contract together when both eyes converge to look to a near object.

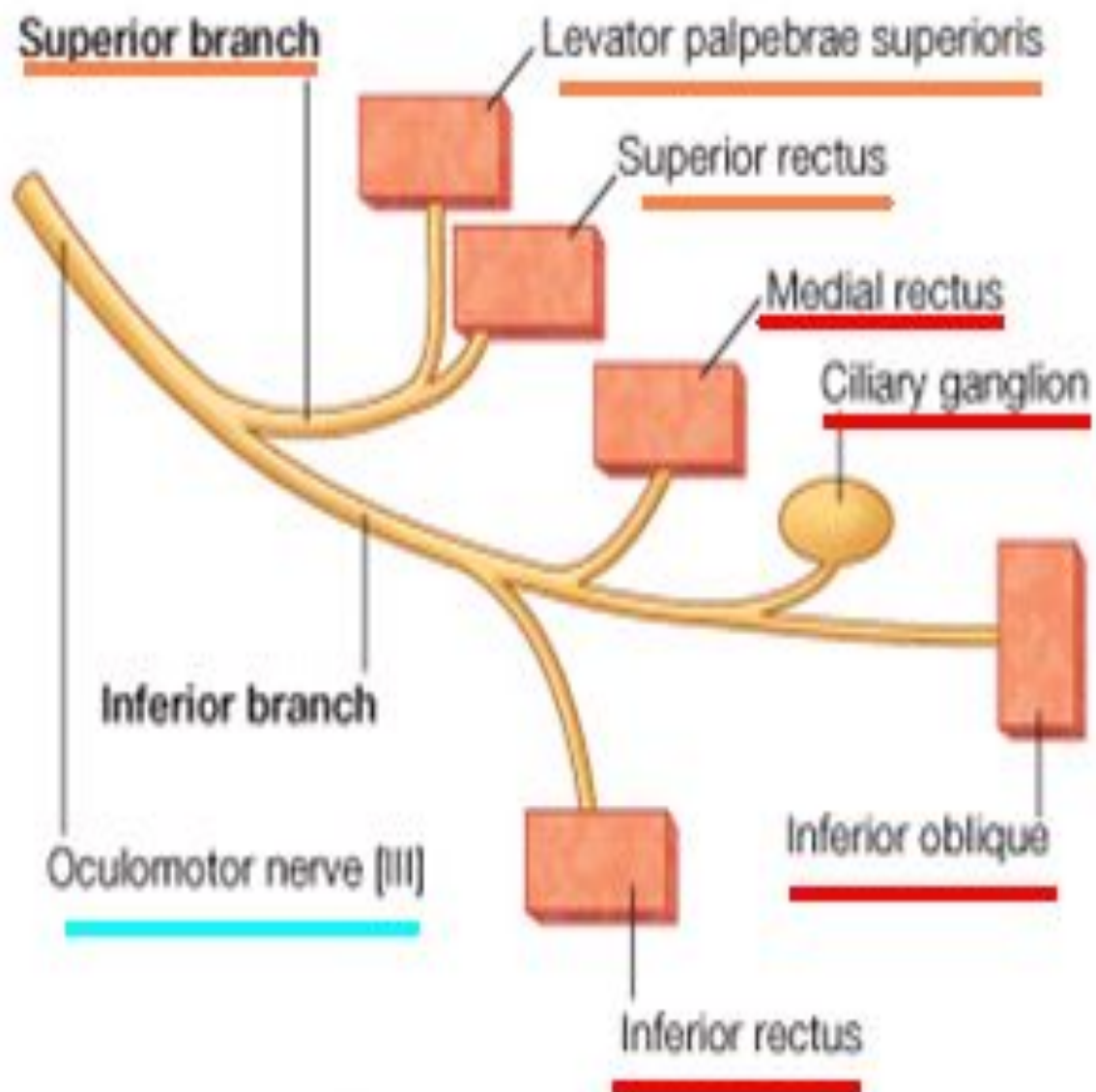
Branches of the Oculomotor Nerve

1. Superior division: which supplies the:

- a. Levator palpebrae superior muscle.
- b. Superior rectus muscle.

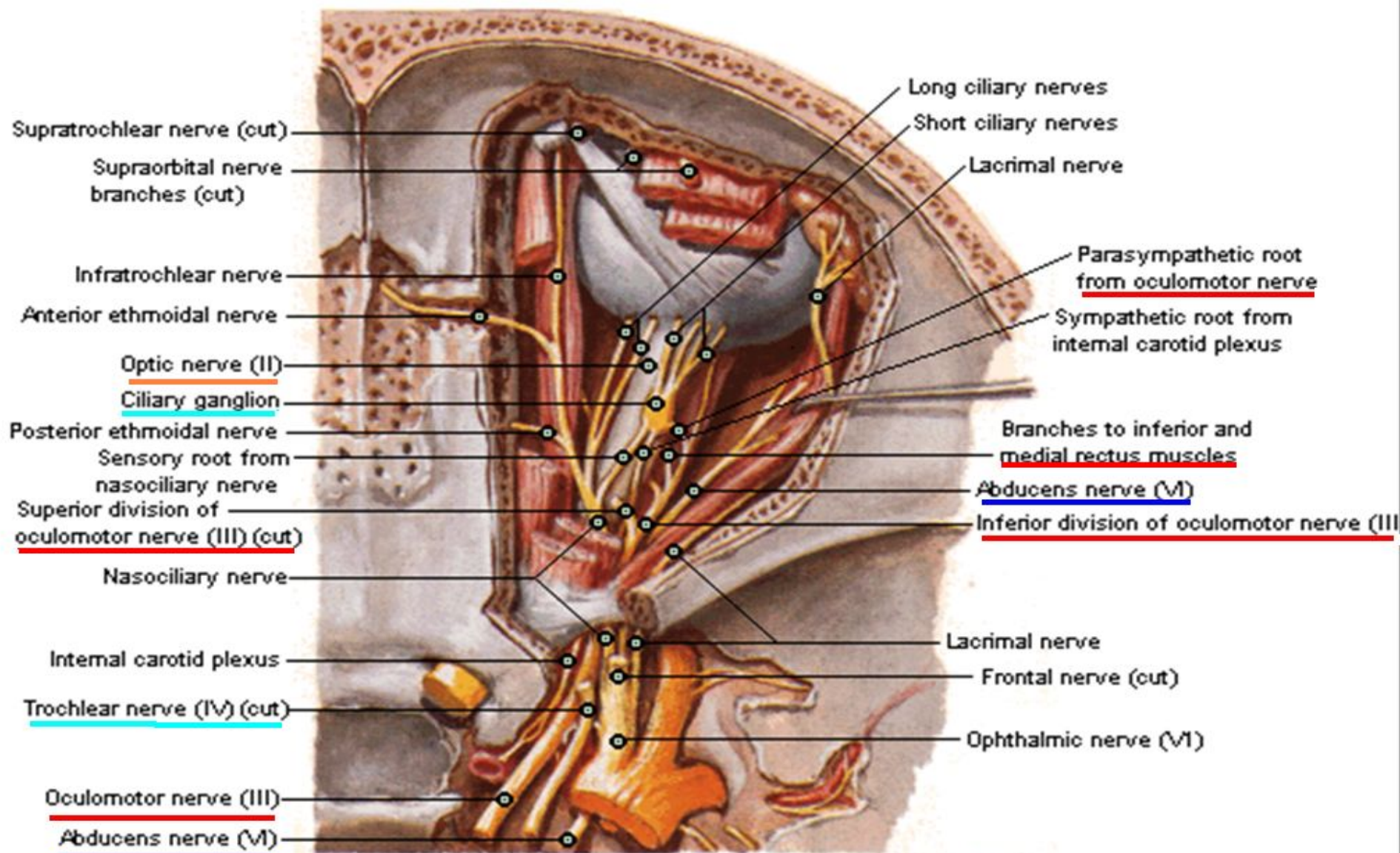
2. Inferior division: which supplies the:

- a. Medial rectus muscle.
- b. Inferior rectus muscle.
- c. Inferior oblique muscle.
- d. Constrictor pupillae muscle (via ciliary ganglion).
- e. Ciliary muscle (via ciliary ganglion).



Nerves of Orbit - Muscles Partially Cut Away

Superior View

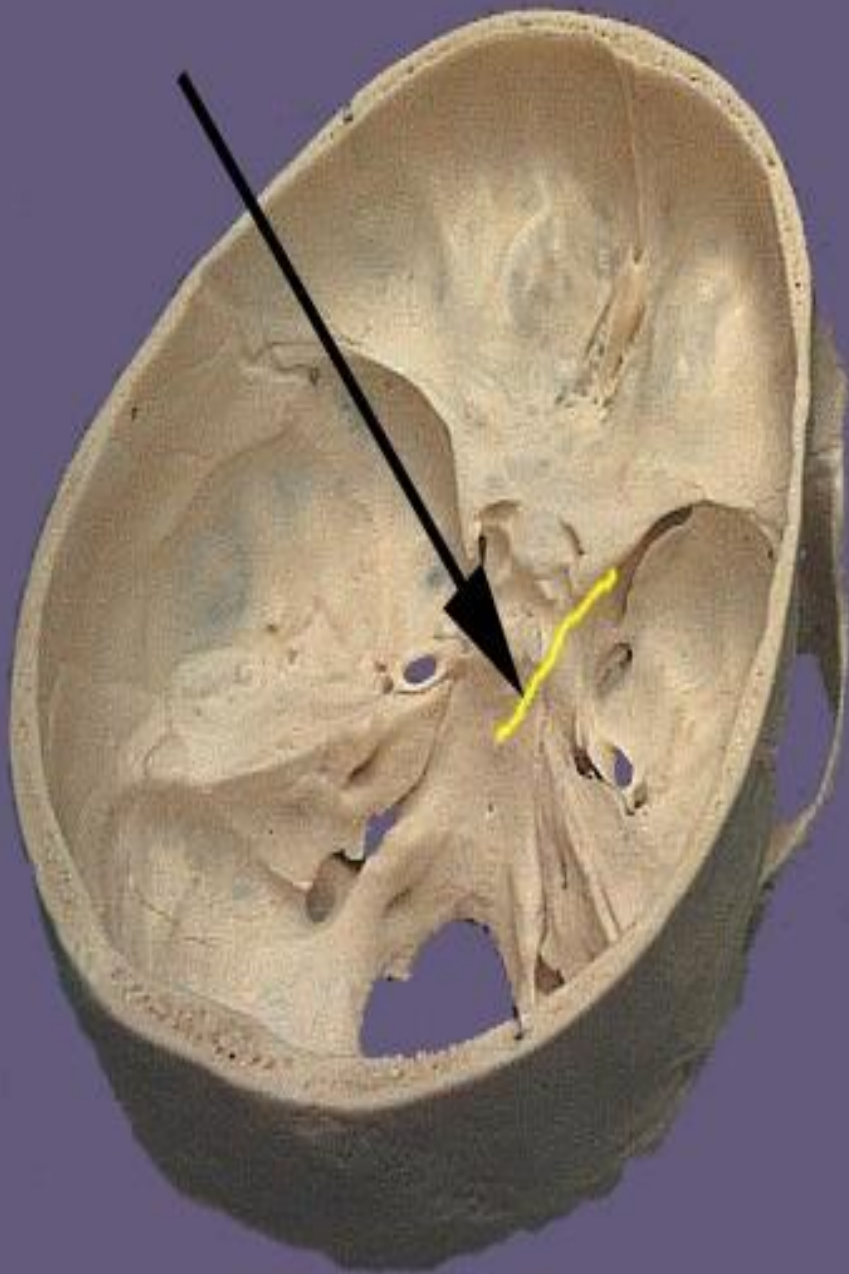


The Trochlear Nerve (IV)

- It is purely a motor nerve and the smallest cranial nerve.
- **Function:** motor nerve → supplies the superior oblique muscles.
- **Site of the nucleus:** it lies in the tegmentum of the midbrain.
- Emerges from the posterior surface of the midbrain.
- Travels in the upper lateral wall of the cavernous sinus and then enters the orbit via the superior orbital fissure “SOF” of the sphenoid bone.

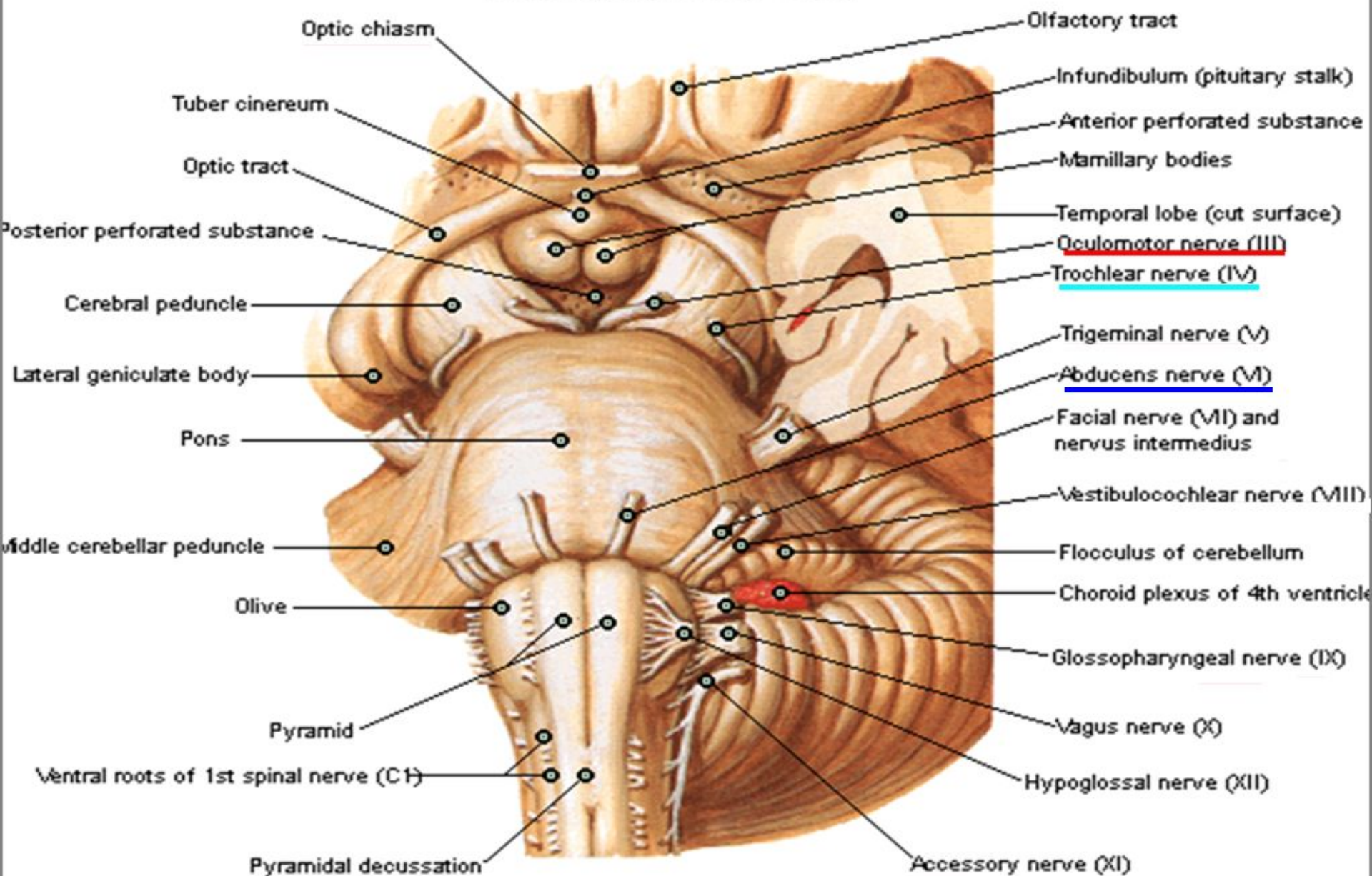
The Abducent Nerve (VI)

- **Abducent nerve:** *(Latin for "abduction")*.
- **Site of the nucleus:** it lies in the lower part of the ventral surface of pons.
- **Function:** purely motor nerve → supplies the lateral rectus muscle (abduction).
- The abducent nerve emerges from the lower border of the pons (between the pons and medulla oblongata).
- The abducent nerve travels **the medial wall of the cavernous sinus** and then enters the orbit via the **SOF** of the sphenoid bone.



Brainstem

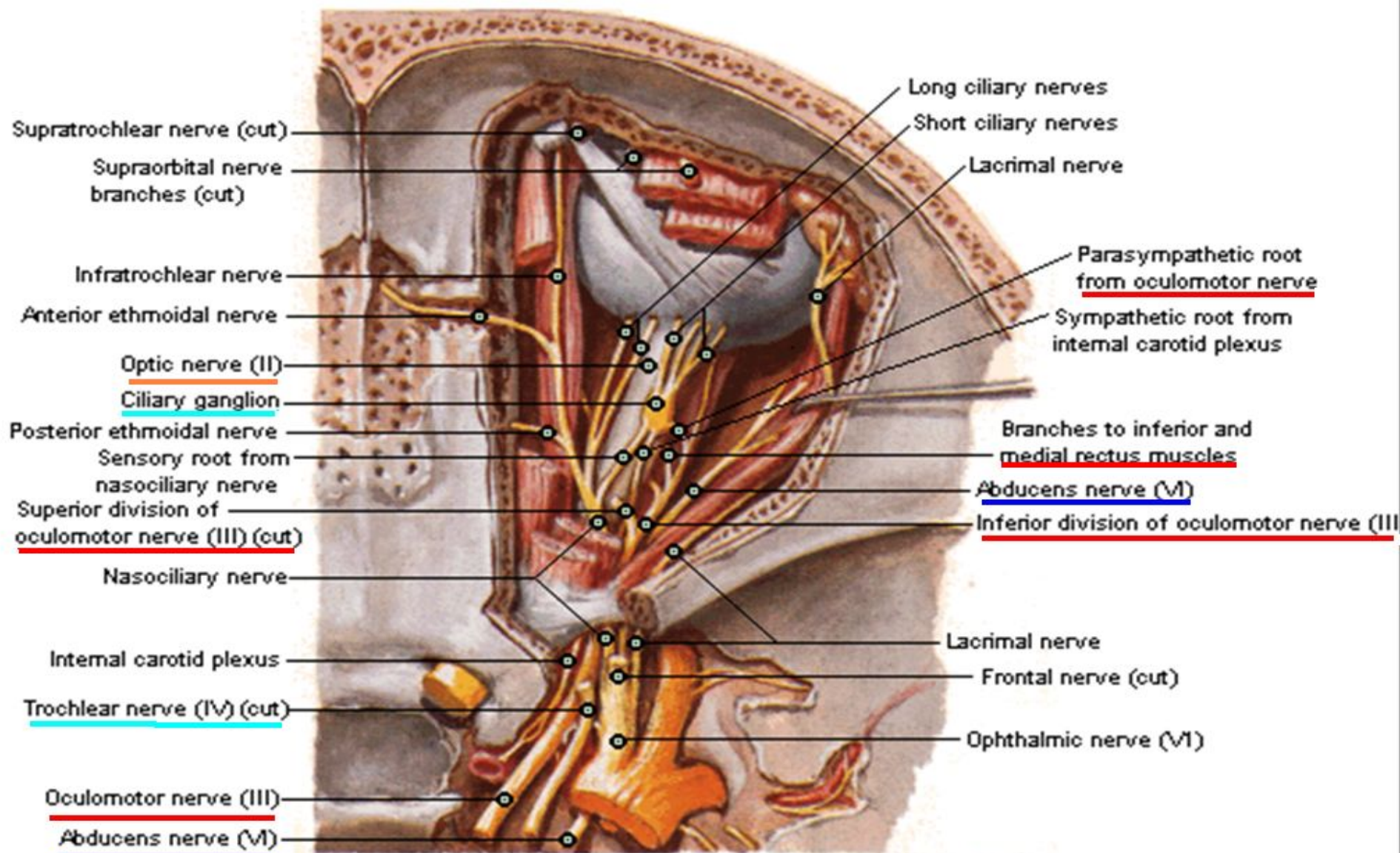
Anterioinferior View





Nerves of Orbit - Muscles Partially Cut Away

Superior View

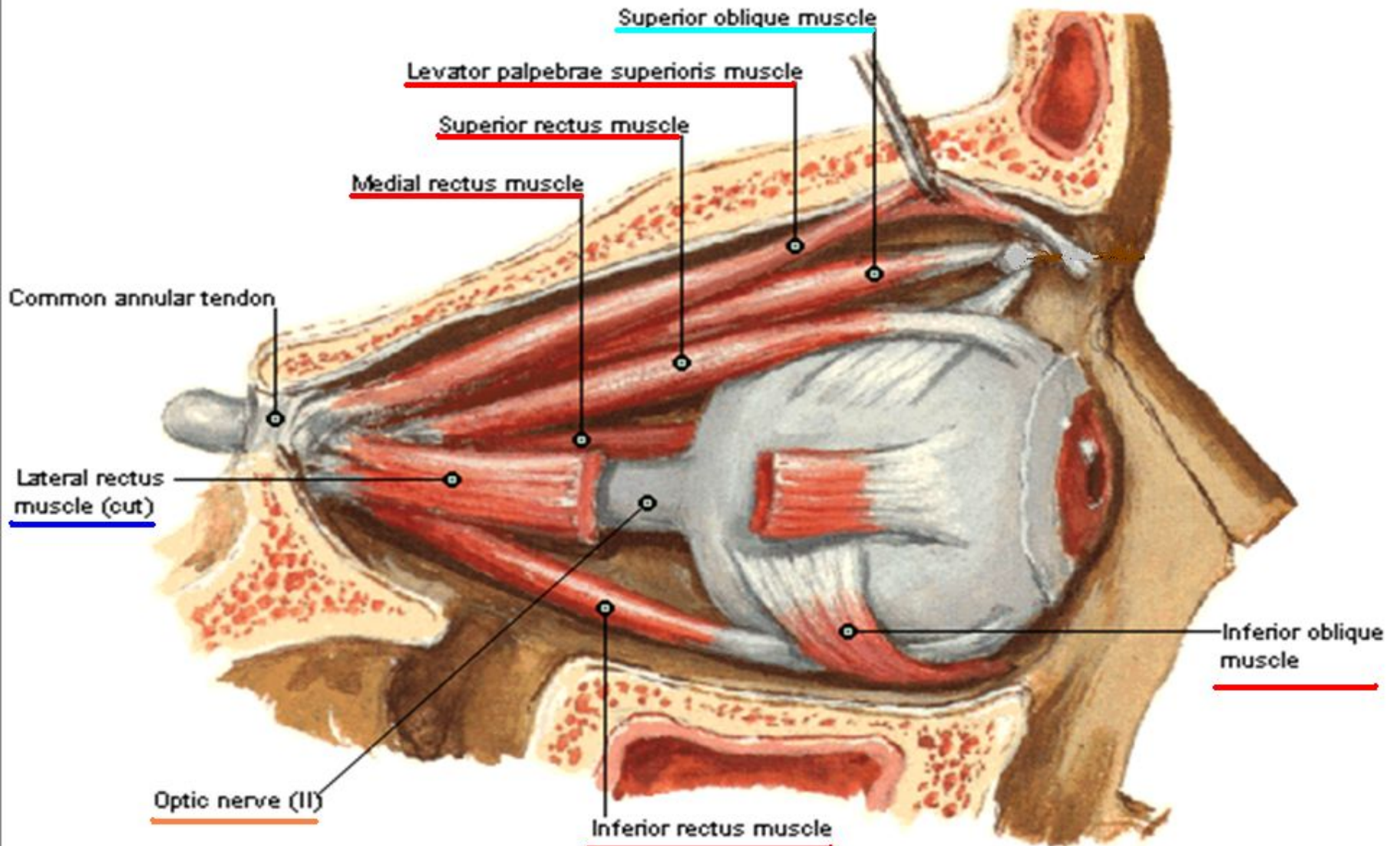


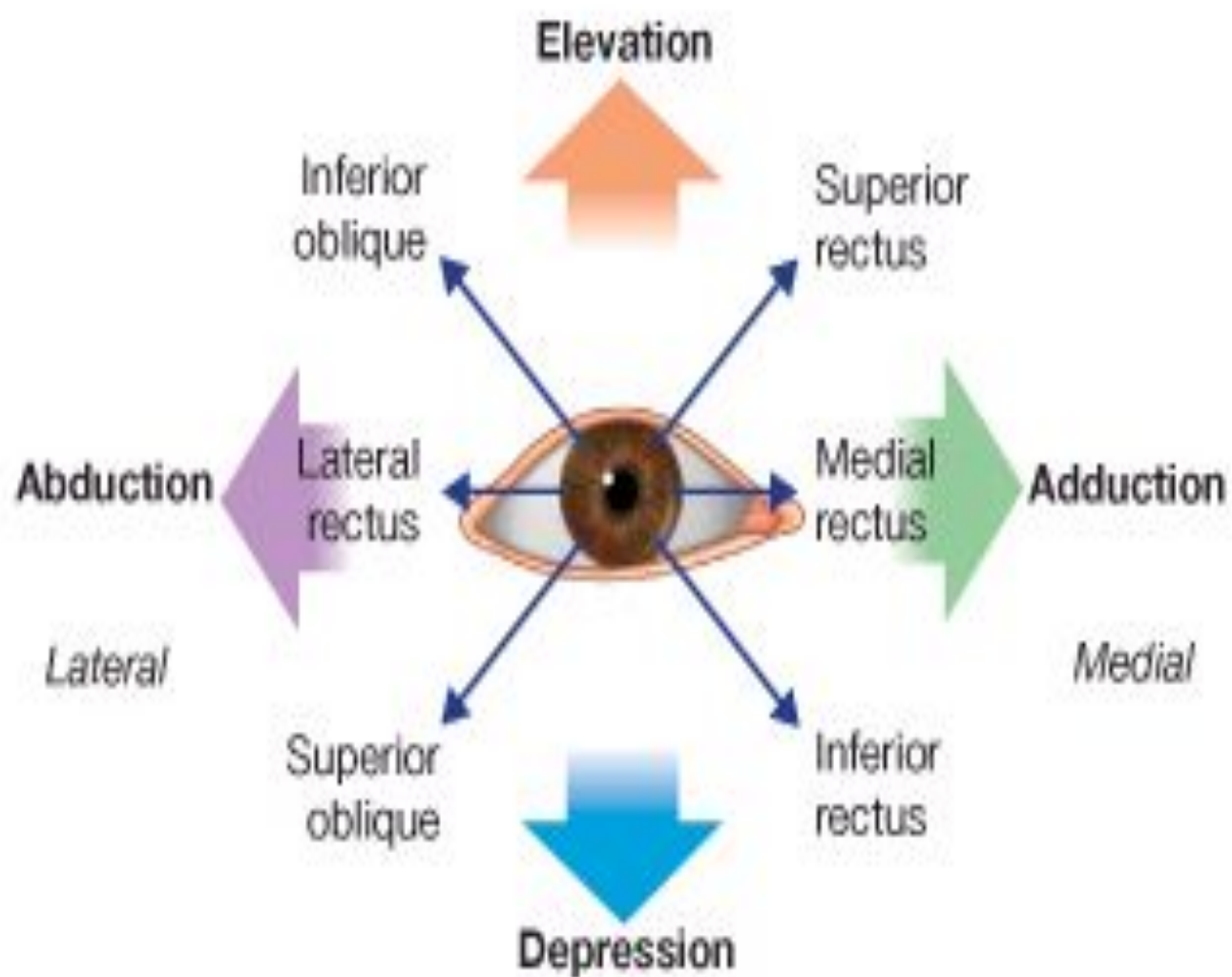
The Actions of the Ocular Muscles

1. **Lateral Rectus Muscle:** abducts (laterally) the eye ball.
2. **Medial Rectus Muscle:** adducts (medially) the eye ball.
3. **Superior Rectus Muscle:** elevates, **adducts** and rotates medially.
4. **Inferior Rectus Muscle:** depresses, **adducts** and rotates medially.
5. **Superior Oblique Muscle:** depresses, **abducts** and rotates laterally.
6. **Inferior Oblique Muscle:** elevates, **abducts** and rotates laterally.

Extrinsic Eye Muscles

Right Lateral View





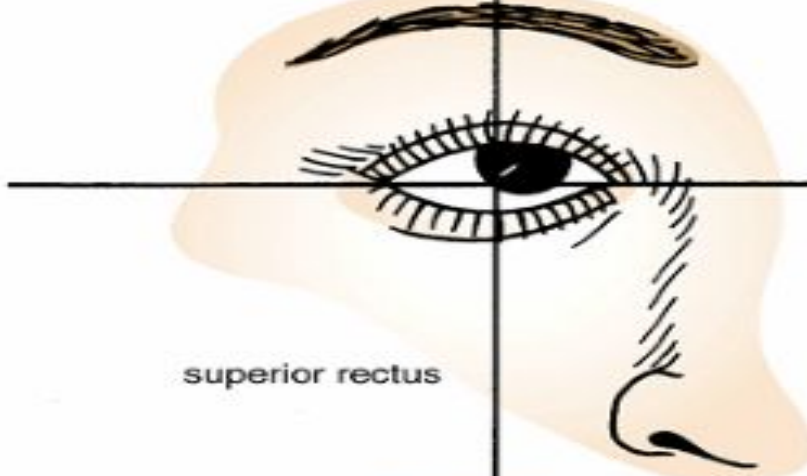


Diagram of the right eye showing the superior rectus muscle contracted, elevating the eye. A horizontal line and a vertical line intersect at the center of the eye. The superior rectus muscle is shown as a thickened band originating from the upper eyelid and extending towards the top of the eye.

superior rectus

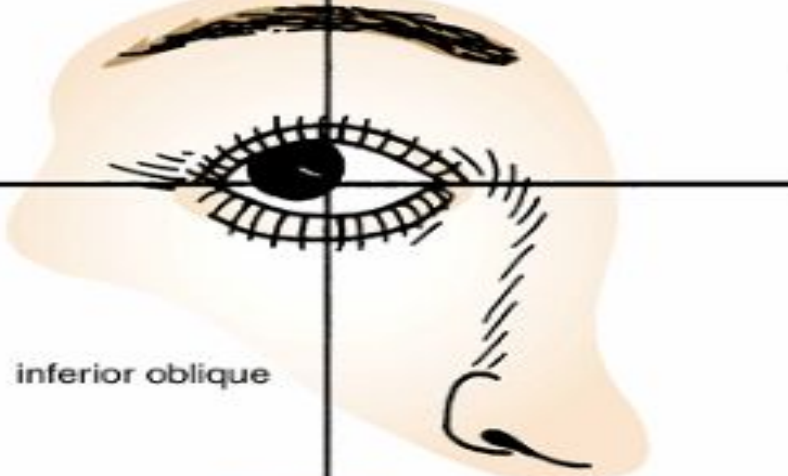


Diagram of the right eye showing the inferior oblique muscle contracted, elevating and abducting the eye. A horizontal line and a vertical line intersect at the center of the eye. The inferior oblique muscle is shown as a thickened band originating from the lower eyelid and extending towards the bottom-right of the eye.

inferior oblique

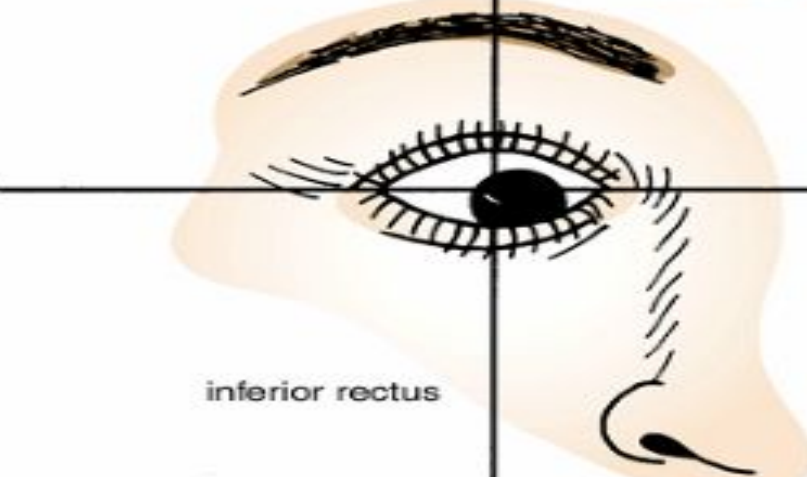


Diagram of the right eye showing the inferior rectus muscle contracted, depressing the eye. A horizontal line and a vertical line intersect at the center of the eye. The inferior rectus muscle is shown as a thickened band originating from the lower eyelid and extending towards the bottom of the eye.

inferior rectus

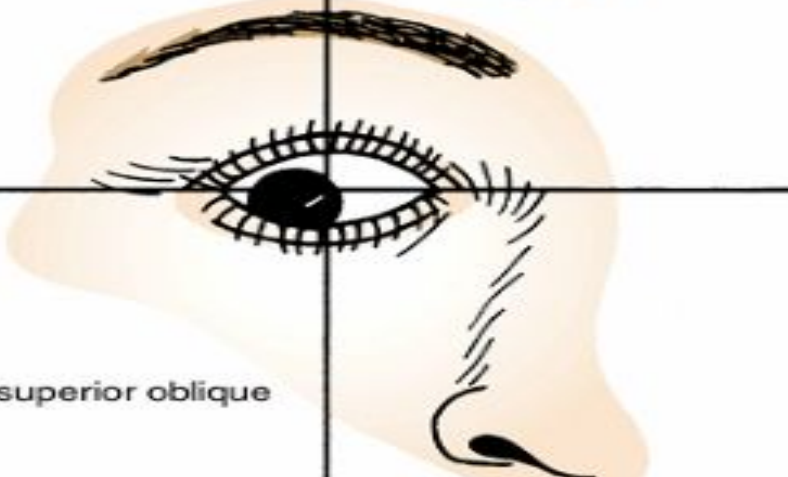


Diagram of the right eye showing the superior oblique muscle contracted, depressing and abducting the eye. A horizontal line and a vertical line intersect at the center of the eye. The superior oblique muscle is shown as a thickened band originating from the upper eyelid and extending towards the top-left of the eye.

superior oblique

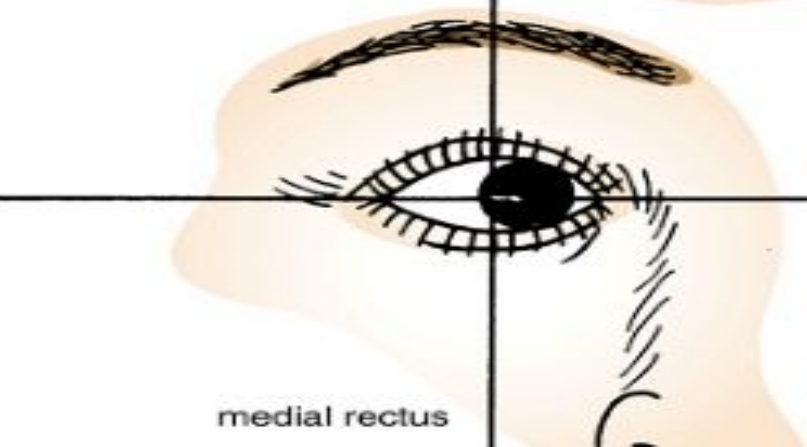


Diagram of the right eye showing the medial rectus muscle contracted, adducting the eye. A horizontal line and a vertical line intersect at the center of the eye. The medial rectus muscle is shown as a thickened band originating from the inner corner of the eye and extending towards the center of the eye.

medial rectus

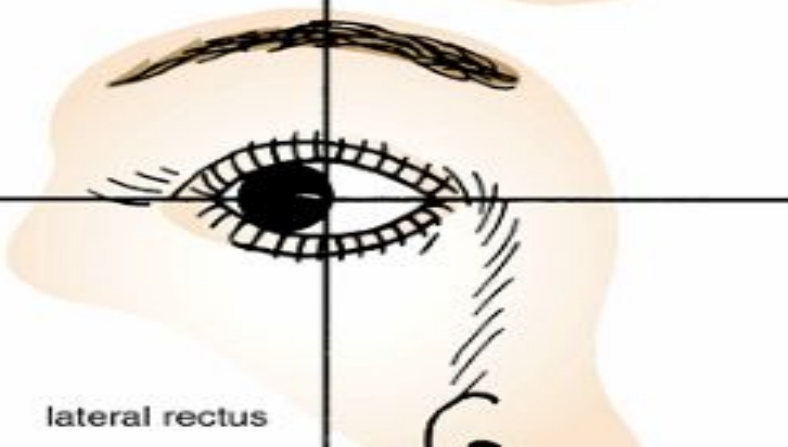


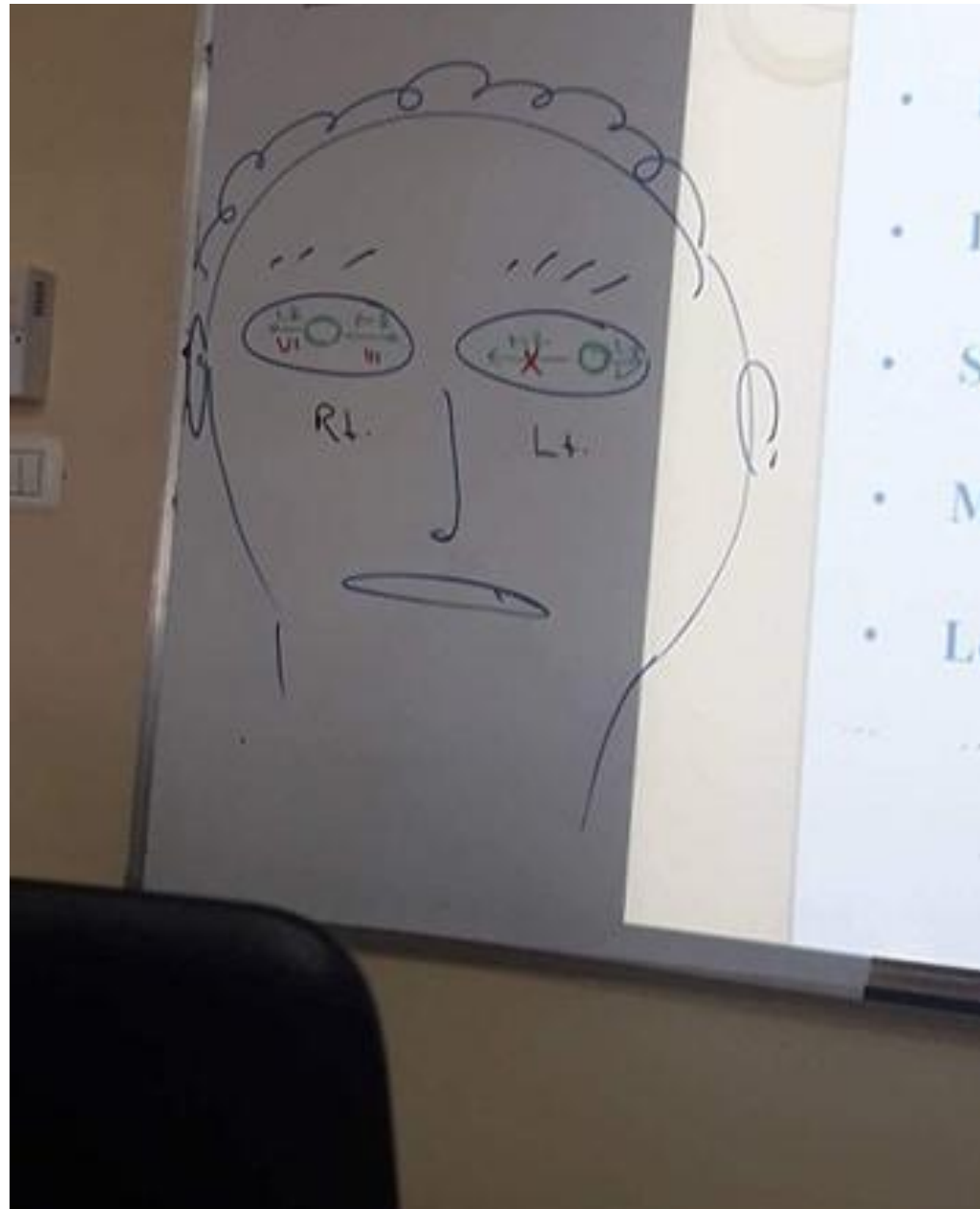
Diagram of the right eye showing the lateral rectus muscle contracted, abducting the eye. A horizontal line and a vertical line intersect at the center of the eye. The lateral rectus muscle is shown as a thickened band originating from the outer corner of the eye and extending towards the center of the eye.

lateral rectus

Lesion of the Oculomotor Nerve

- **Ptosis:** paresis of the levator palpebrae superior muscle.
- **Diplopia:** occurs only on elevation of eye lid.
- **Squint:** divergent paralytic.
- **Mydriasis:** dilated fixed pupil.
- **Loss of light and accommodation reflexes.**

Lesion of the Oculomotor Nerve



Lesion of the Trochlear Nerve

1. Diplopia on looking down and out.
2. Limitation of movement during examination for eye movement down and out.

Lesion of the Abducent Nerve

1. Diplopia on looking out wards.
2. Limitation during examination of eye movement in the outward direction.
3. Convergent paralytic squint.

Causes of the Ocular Nerves Lesion

1. Lesions of the III, IV, and VI cranial nerves or nuclei.
2. Disorders of the neuromuscular junction (e.g. myasthenia gravis, Botulism).
3. Disorder of the ocular muscles (e.g. myopathy).
4. Injury of the ocular muscle.
5. Orbital lesion (mass, inflammation).

Complete External Ophthalmoplegia

Describes the immobile eye when the III, IV, and VI nerves are paralysed by:

1. Orbital tumor or inflammation.

2. Cavernous sinus thrombosis.

3. Tolosa-Hunt syndrome: is characterized by painful ophthalmoplegia (weakness of the eye muscles) and is caused by an idiopathic granulomatous inflammation of the cavernous sinus.

Light Reflex

- **Direct Light Reflex:** Light in one eye leads to constriction (miosis) of the same eye
- **Indirect Light Reflex :** Light in one eye leads to constriction (miosis) of the opposite eye.

Pathway of Light Reflex

Fibers from rods and cones of retina → optic nerve → optic chiasma → optic tract → before reaching the lateral geniculate body → they pass to the third cranial (oculomotor) nerve nucleus (Edinger-Westphal nucleus) in midbrain of both side → through oculomotor nerve → ciliary ganglion → supply the constrictor pupillae muscle

Thank You

