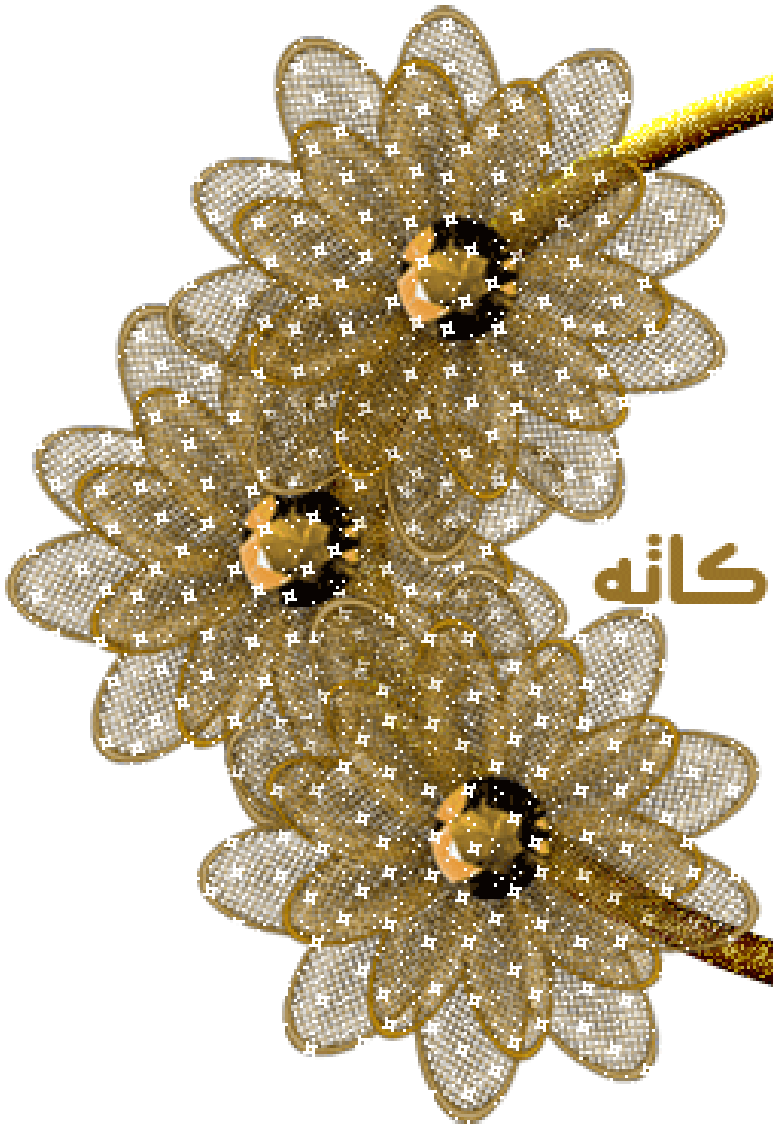


بسم الله الرحمن الرحيم

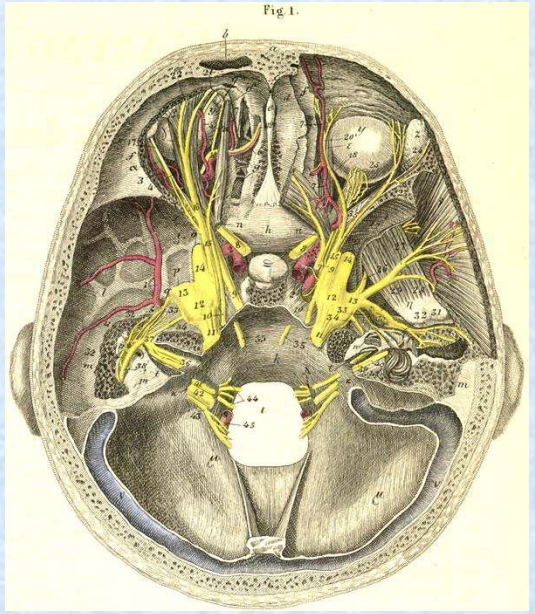
السلام عليكم ورحمه الله وبركاته

Cranial Nerves
PART I

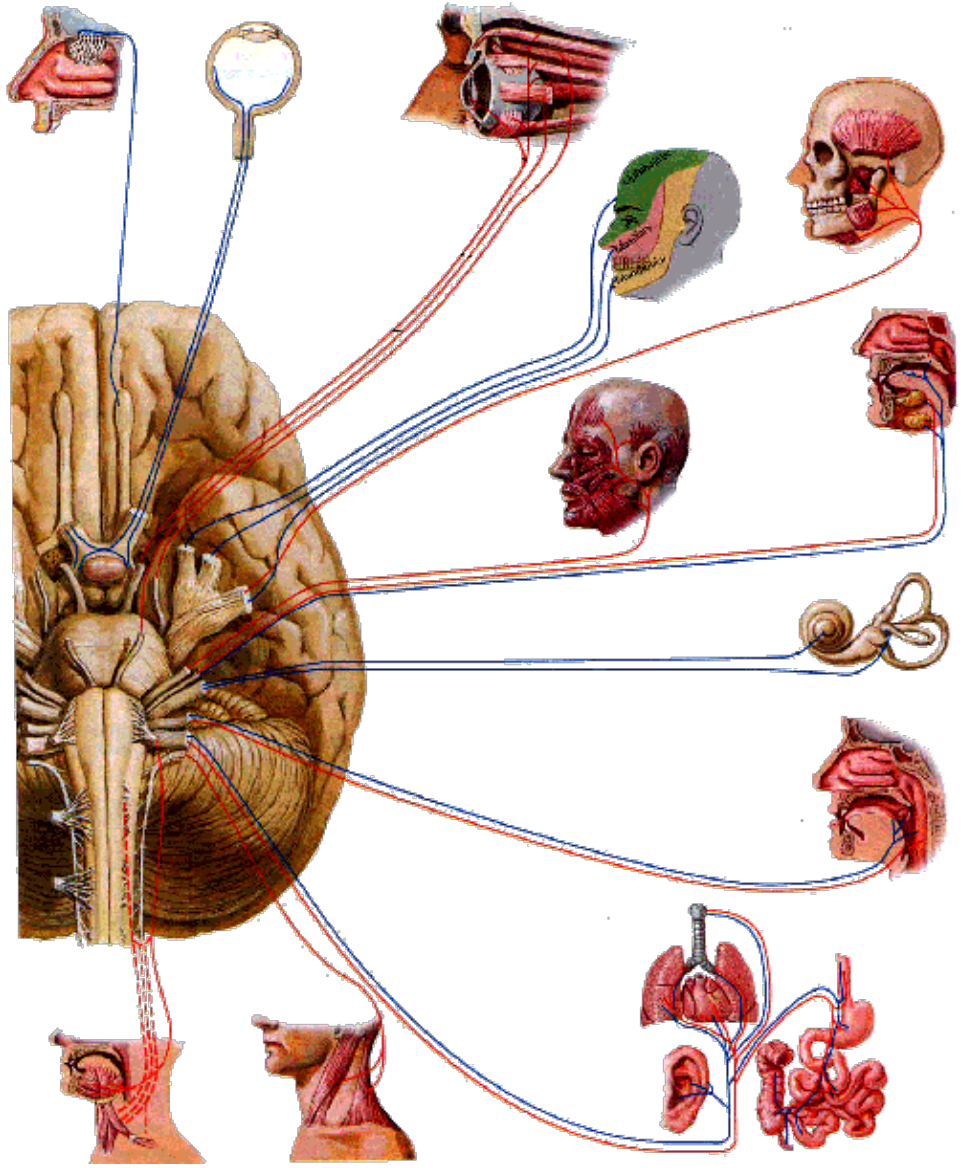
Department of human Anatomy and Embryology
Faculty of Medicine
Mansoura National University, Egypt

Study of the cranial nerves

1. Deep Origin (Nuclei)
2. Exit point from brain stem
3. Intracranial course
4. Exit Foramen from the skull
5. Extracranial course
6. Distribution



1. Olfactory nerve
2. Optic nerve
3. Oculomotor nerve
4. Trochlear nerve
5. Trigeminal nerve
6. Abducent nerve
7. Facial nerve
8. Vestibulocochlear nerve
9. Glossopharyngeal nerve
10. Vagus nerve
11. Accessory nerve
12. Hypoglossal nerve

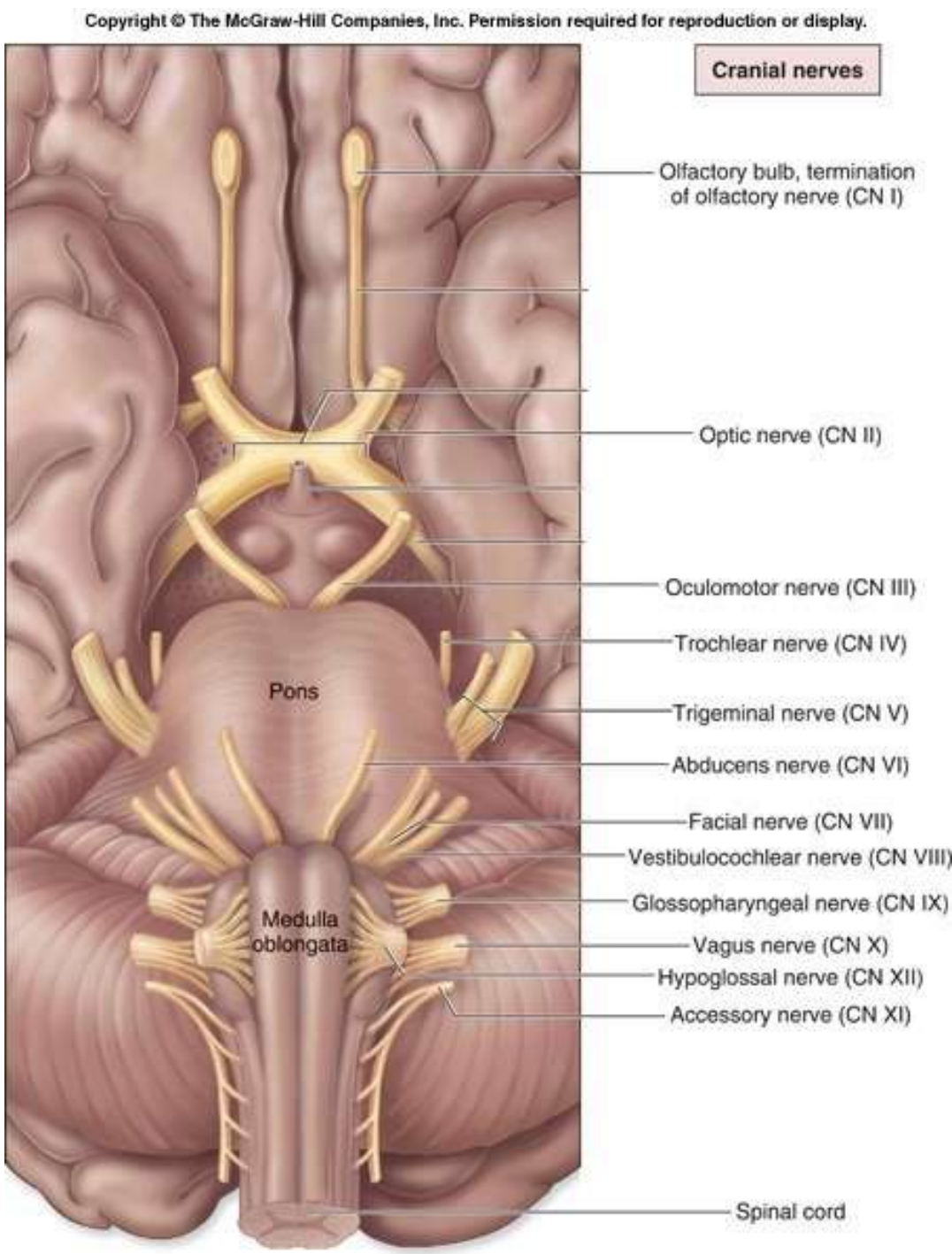


Cranial nerves

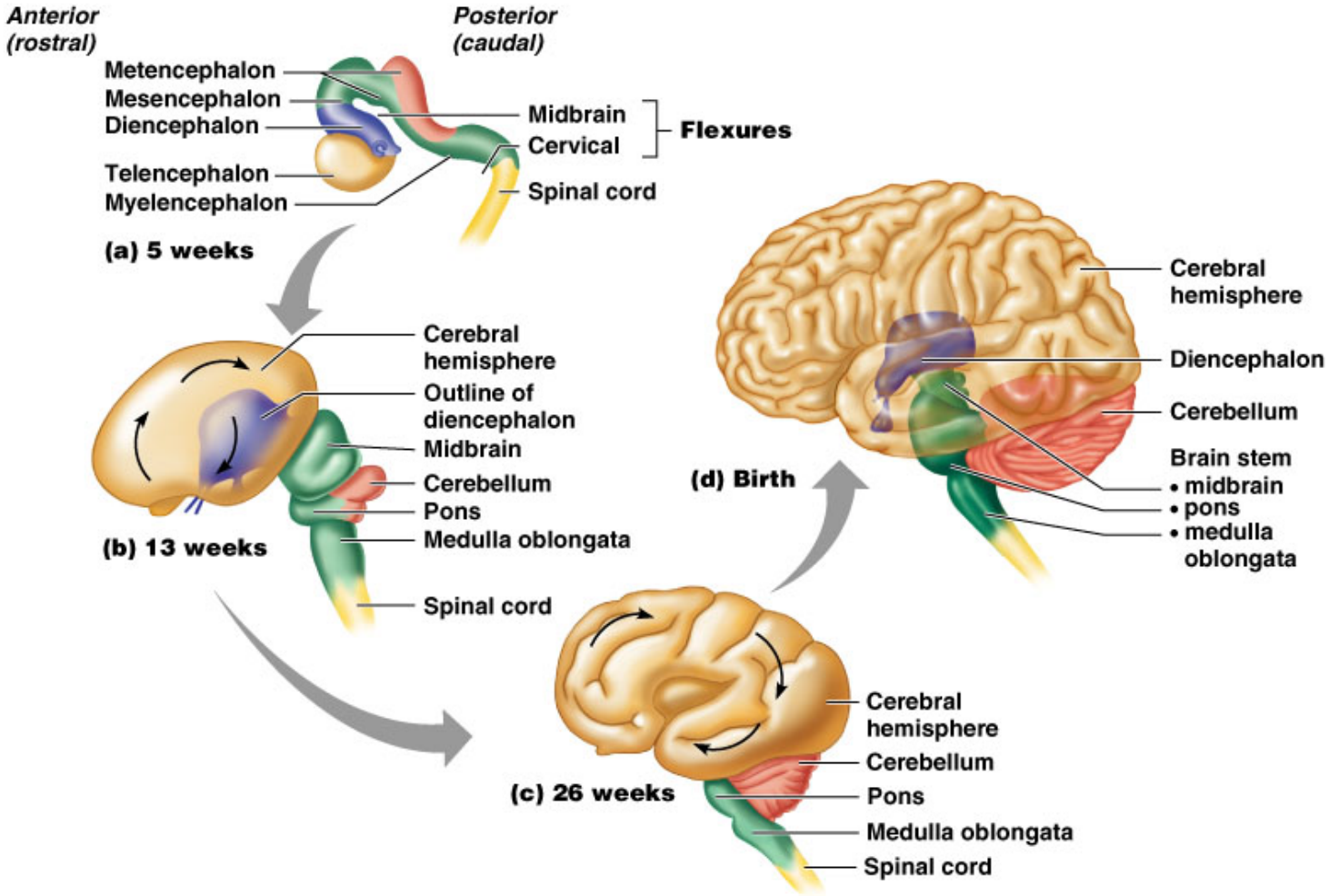
Origin of the Cranial Nerves

- There are twelve cranial nerves in total.
- The olfactory nerve (CN I) and optic nerve (CN II) originate from the **cerebrum**.
- Cranial nerves III – XII arise from the ventral surface of **brain stem** .

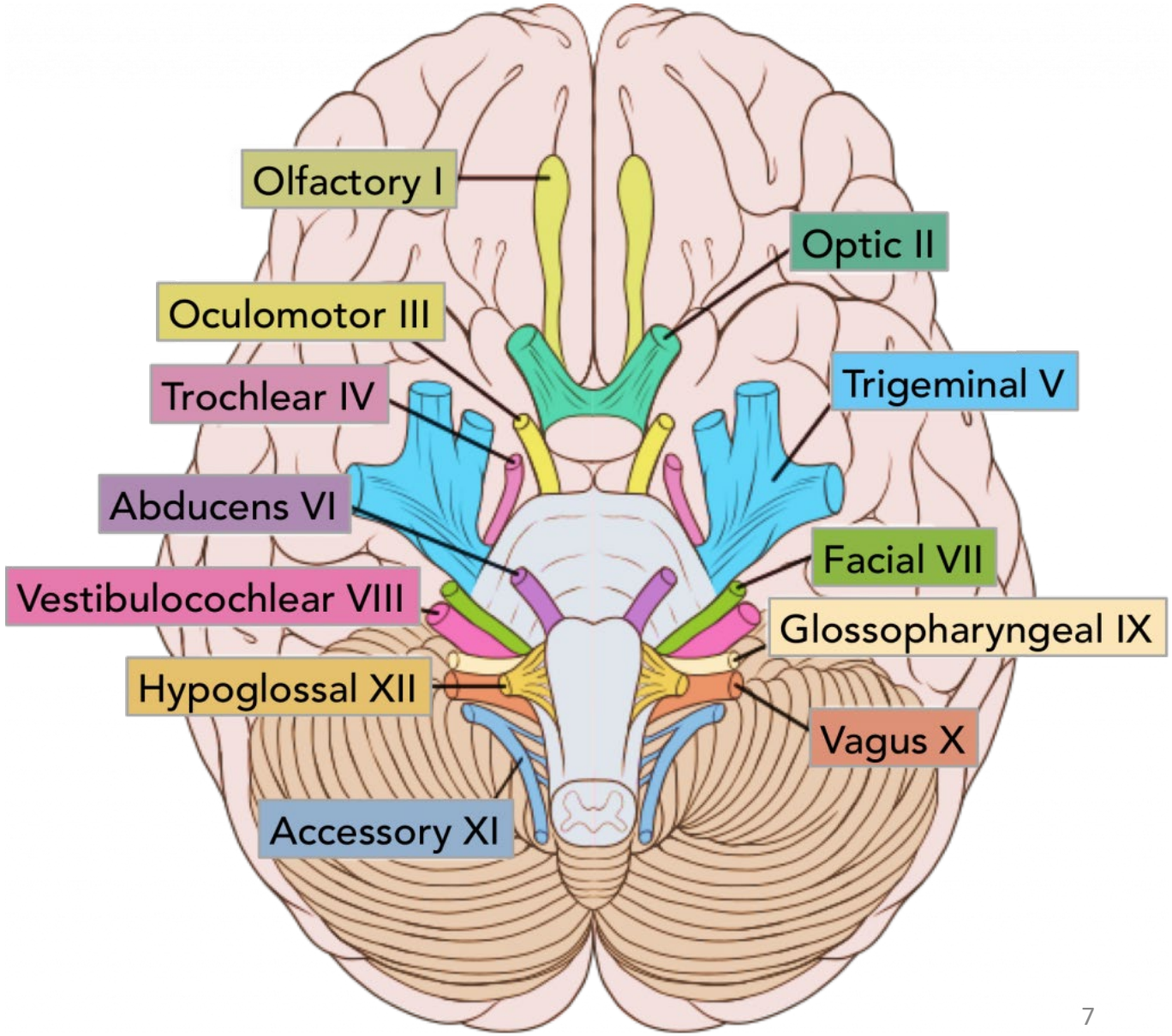
➢ **Except,** the trochlear nerve (IV) comes from the posterior side of the midbrain.



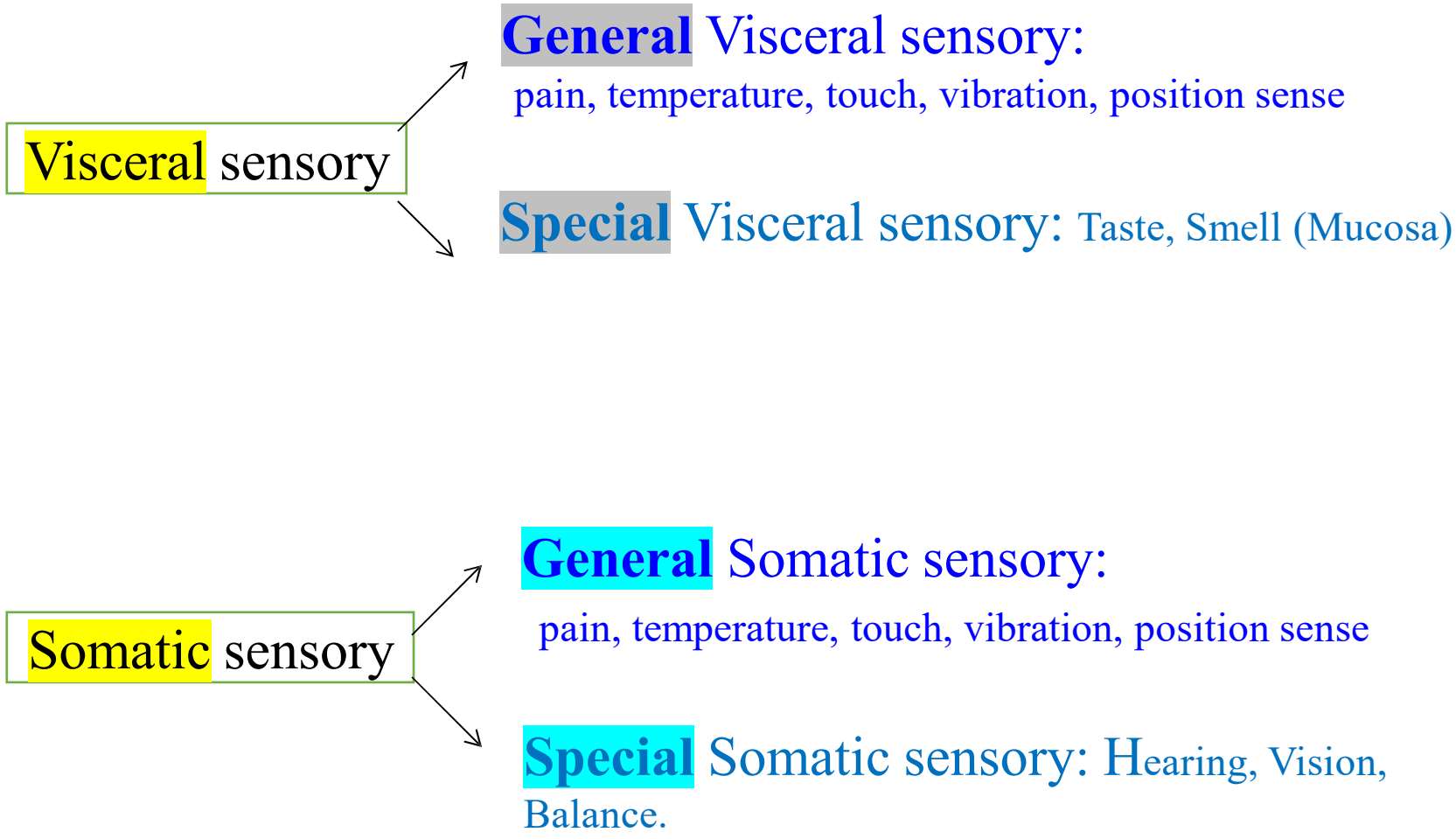
- **Olfactory nerve (I)**: is developing as an early part of the primitive telencephalon
- **Optic nerve (II):** is developing as an outpouching from the diencephalon
- **Carnial nerves III to XII:**
  - ❖ Originate from the **brain stem**



Cranial nerves and the brain



Types of sensations



Functional Components of Peripheral Nerves

Spinal Nerves

- General somatic afferents (GSA)
- General somatic efferent (GSE)
- General visceral afferents (GVA)
- General visceral efferent (GVE)

[All spinal nerves carry all the four components]

Cranial Nerves

- GSA
- GSE
- GVA
- GVE

- Special somatic afferents (SSA)
- Special visceral afferents (SVA)
- Special visceral efferent (SVE)

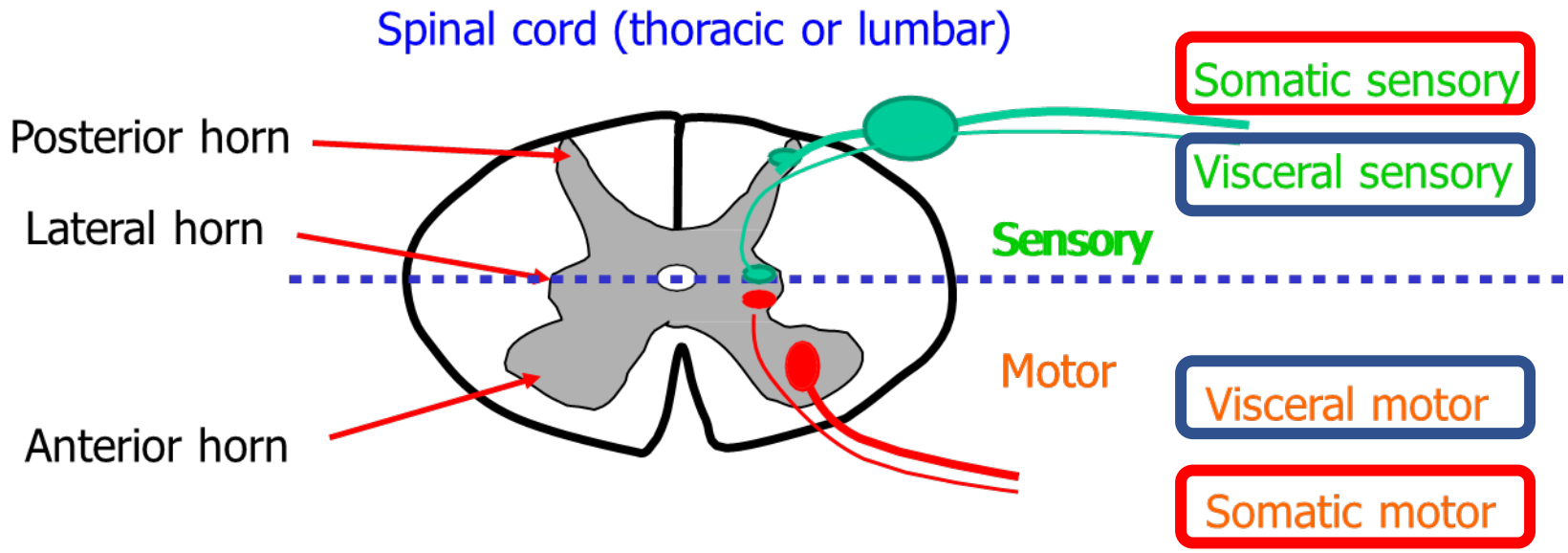
[NOT all cranial nerves carry all these components]

Visceral

- In relation to internal organs
  - Heart
  - Lung
  - Intestines

Somatic

- In relation to:
  - Skin (Sensory)
  - Muscles (Motor)



Cranial nerves

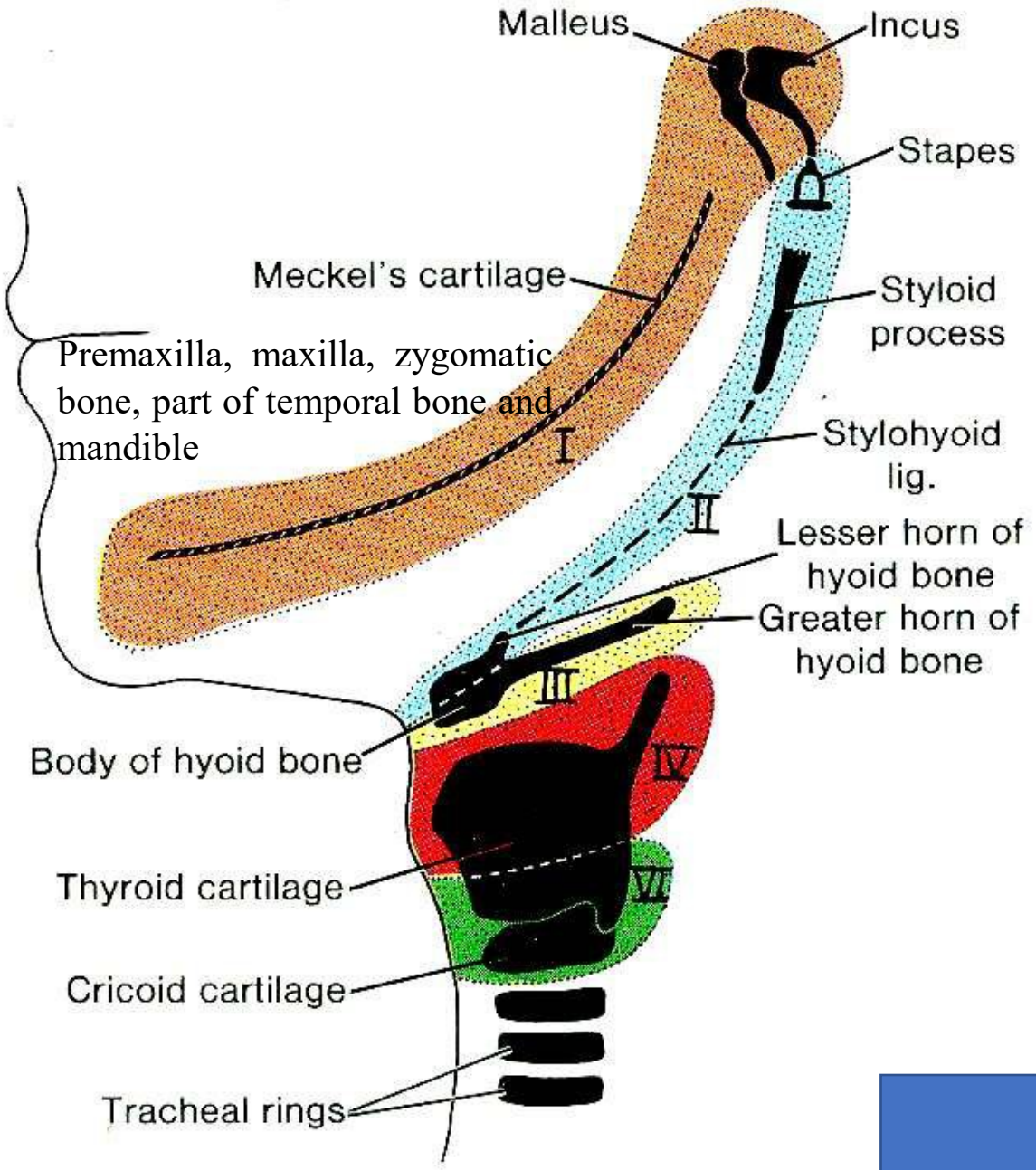
Sensory (afferent) Modalities:

- General somatic sensory (GSA) – general sensation from ectoderm (skin).
- General visceral sensory (GVA) – general sensation from endoderm (viscera).
- **Special** somatic sensory (SSA) – Special senses derived from ectoderm (e.g. vision, sound, balance).
- **Special** visceral sensory (SVA) – Special senses derived from endoderm (e.g. taste, smell).

Cranial nerves

Motor (efferent) Modalities:

- General somatic motor (GSE) – skeletal muscles.
- General visceral motor (GVE) – smooth muscles of gut and **autonomic**.
- **Special** visceral motor (SVE) – muscles derived from **pharyngeal arches**.



Mandibular branch of trigeminal nerve (V) — 1

Facial nerve (VII) — 2

Pharyngeal and laryngeal muscles (Nucleus ambiguus via IX, X, XI nerves)

Glossopharyngeal nerve (IX) — 3

Superior laryngeal branch of vagus nerve (X) — 4 &

Recurrent laryngeal branch of vagus nerve (X) — 6

1975

Classification of cranial nerves

- **Sensory cranial nerves**: contain only afferent (sensory) fibers
  - **I Olfactory nerve**
  - **II Optic nerve**
  - **VIII Vestibulocochlear nerve**
- **Motor cranial nerves**: contain only efferent (motor) fibers
  - **III Oculomotor nerve**
  - **IV Trochlear nerve**
  - **VI Abducent nerve**
  - **XI Accessory nerve**
  - **XII Hypoglossal nerve**
- **Mixed nerves**: contain sensory, motor and parasympathetic fibers
  - **V Trigeminal nerve,**
  - **VII Facial nerve,**
  - **IX Glossopharyngeal nerve**
  - **X Vagus nerve**

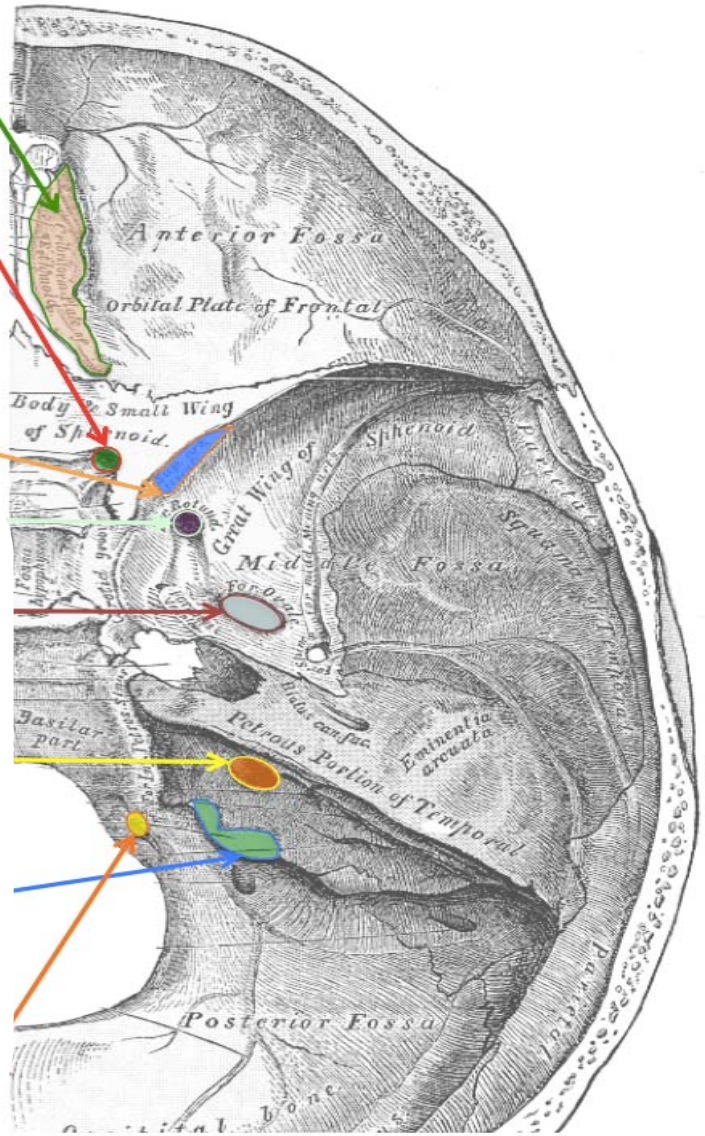
1975

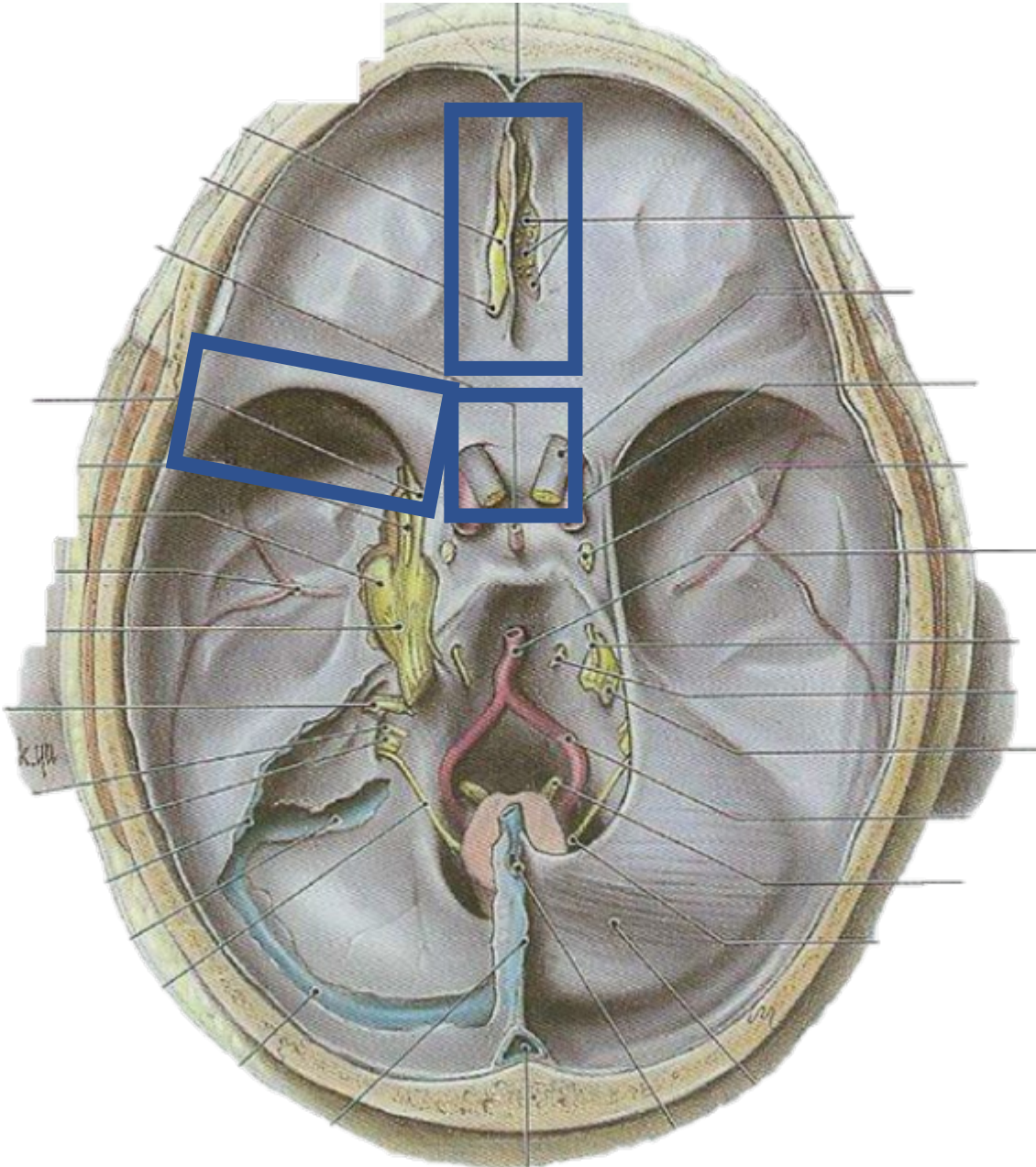
Exit of Cranial nerves

Cribriform plate
Olfactory n (CNI)

Optic canal
Optic n (CNII)

Superior orbital fissure
Oculomotor n (CNIII)
Trochlear n (CNIV)
Ophthalmic n (CNV_1)
Abducens n (CNVI)

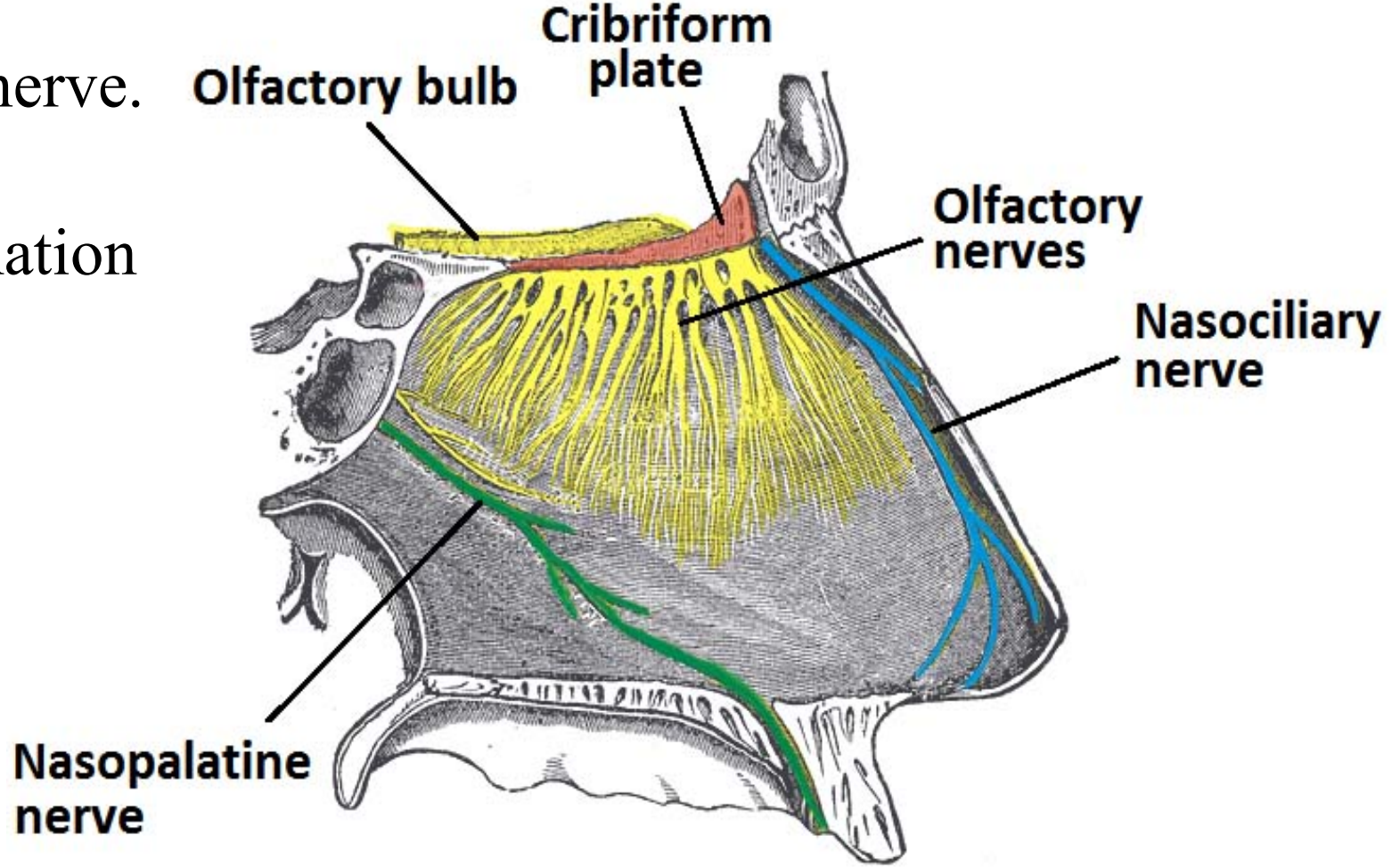




Cranial nerves – CN I

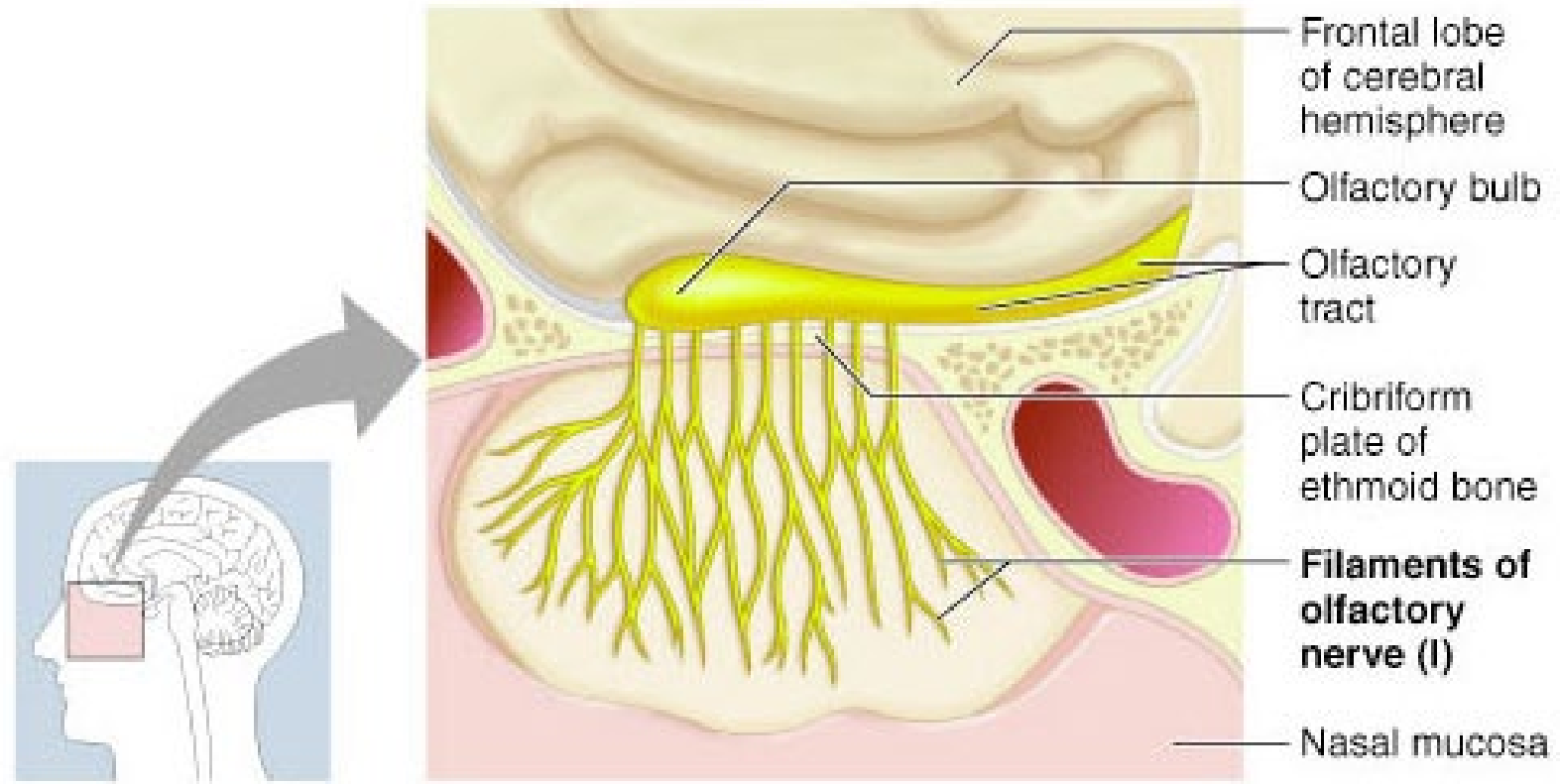
The olfactory nerve (CN I)

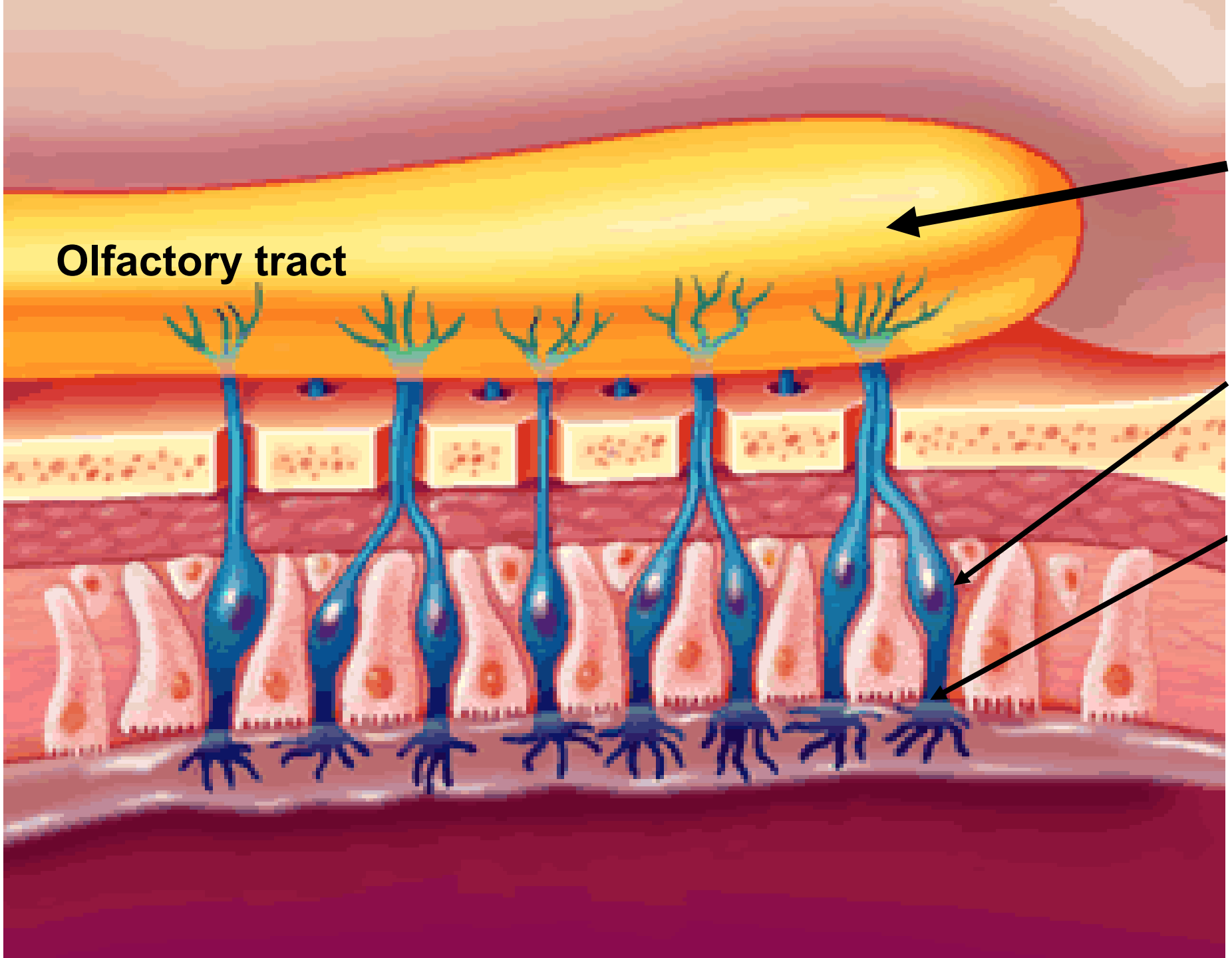
- The first and shortest cranial nerve.
- It is a special visceral afferent nerve, which transmits information related to **smell**.



Cranial nerves – CN I

- Arises from the olfactory epithelium.
- Passes through the cribriform plate of the ethmoid bone.
- Fibers run through the olfactory bulb and terminate in the primary olfactory cortex.
- Function: Smell.

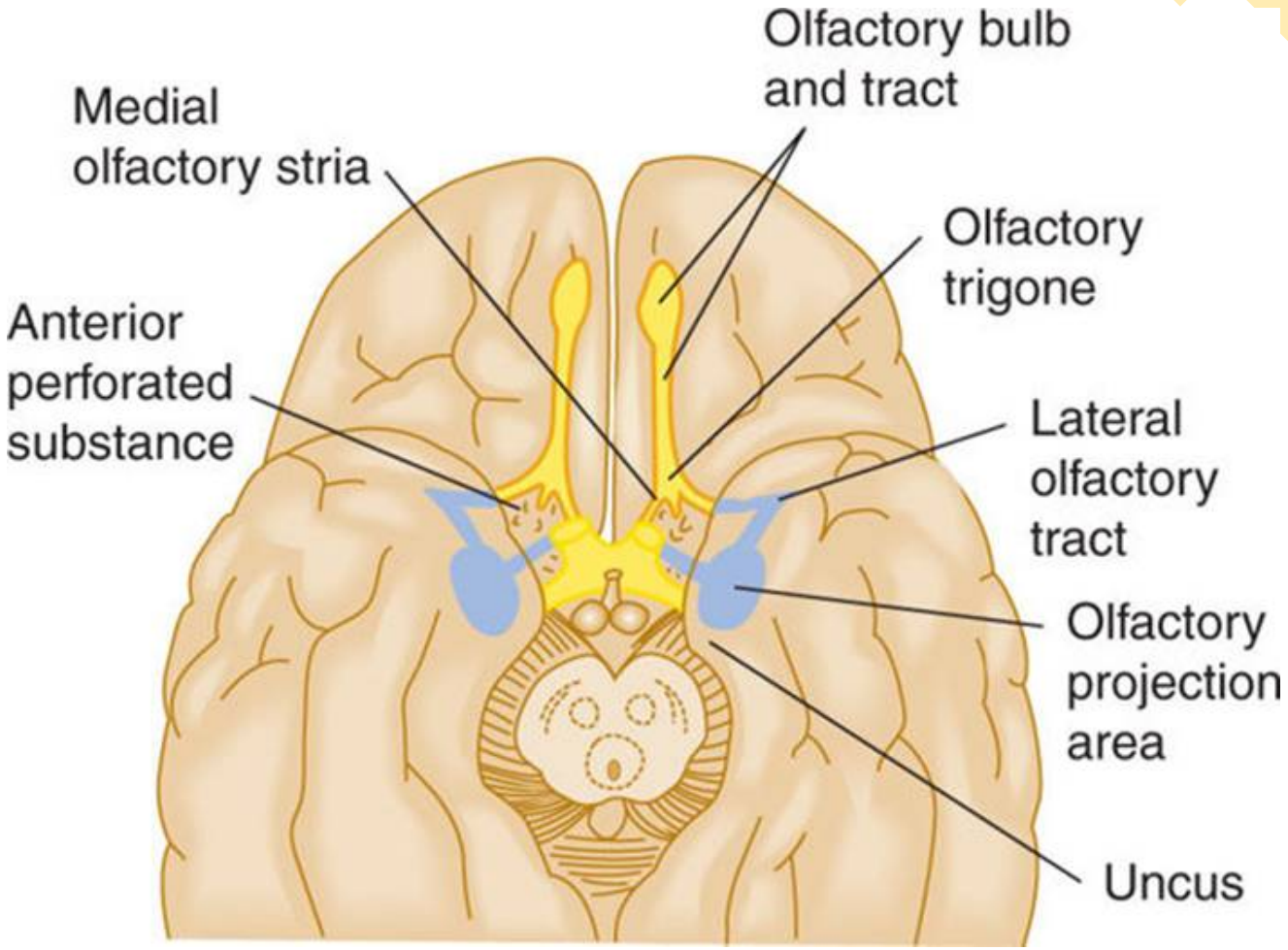


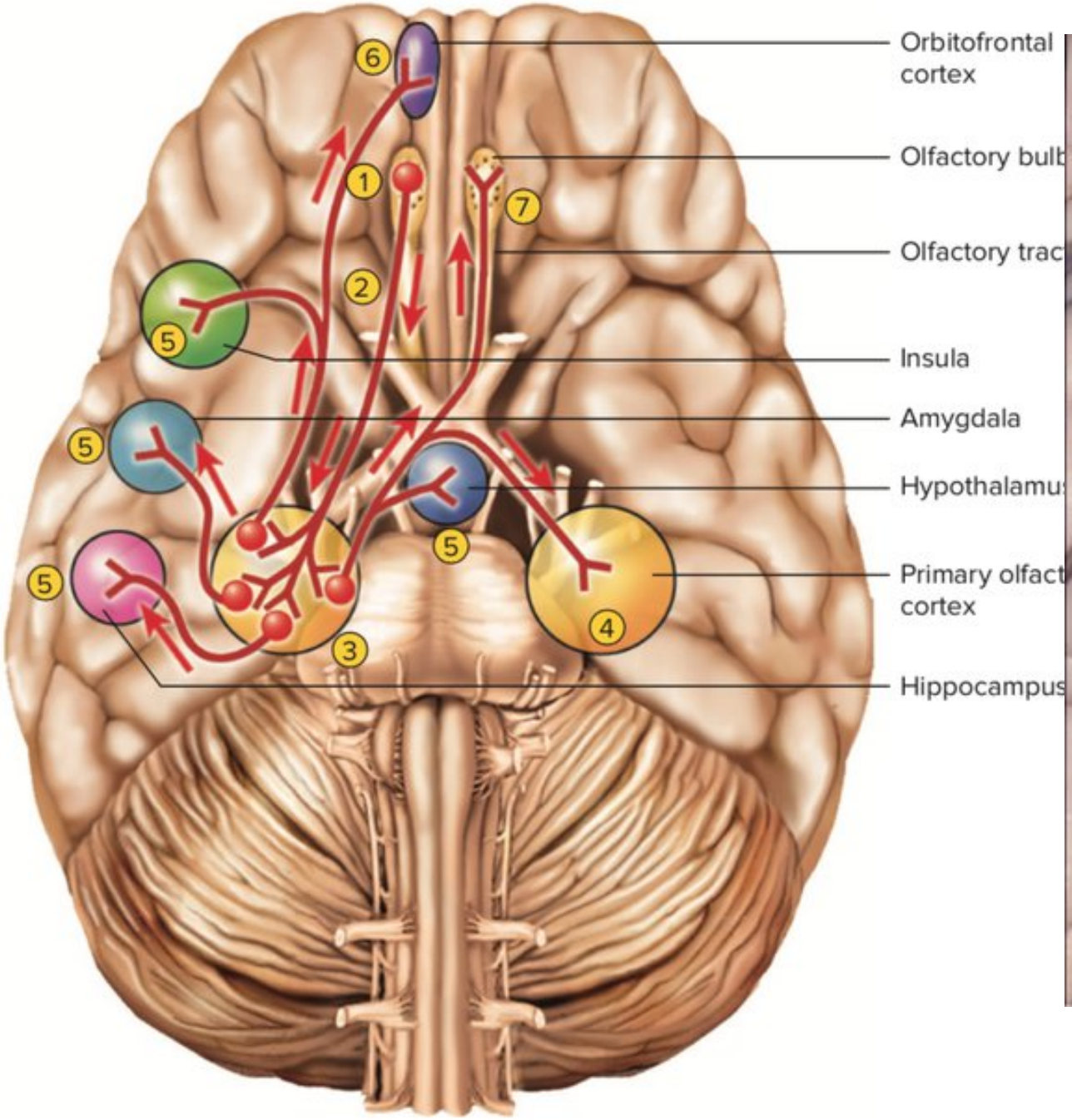

Olfactory tract
Olfactory bulb
Olfactory nerve
Olfactory receptor cell

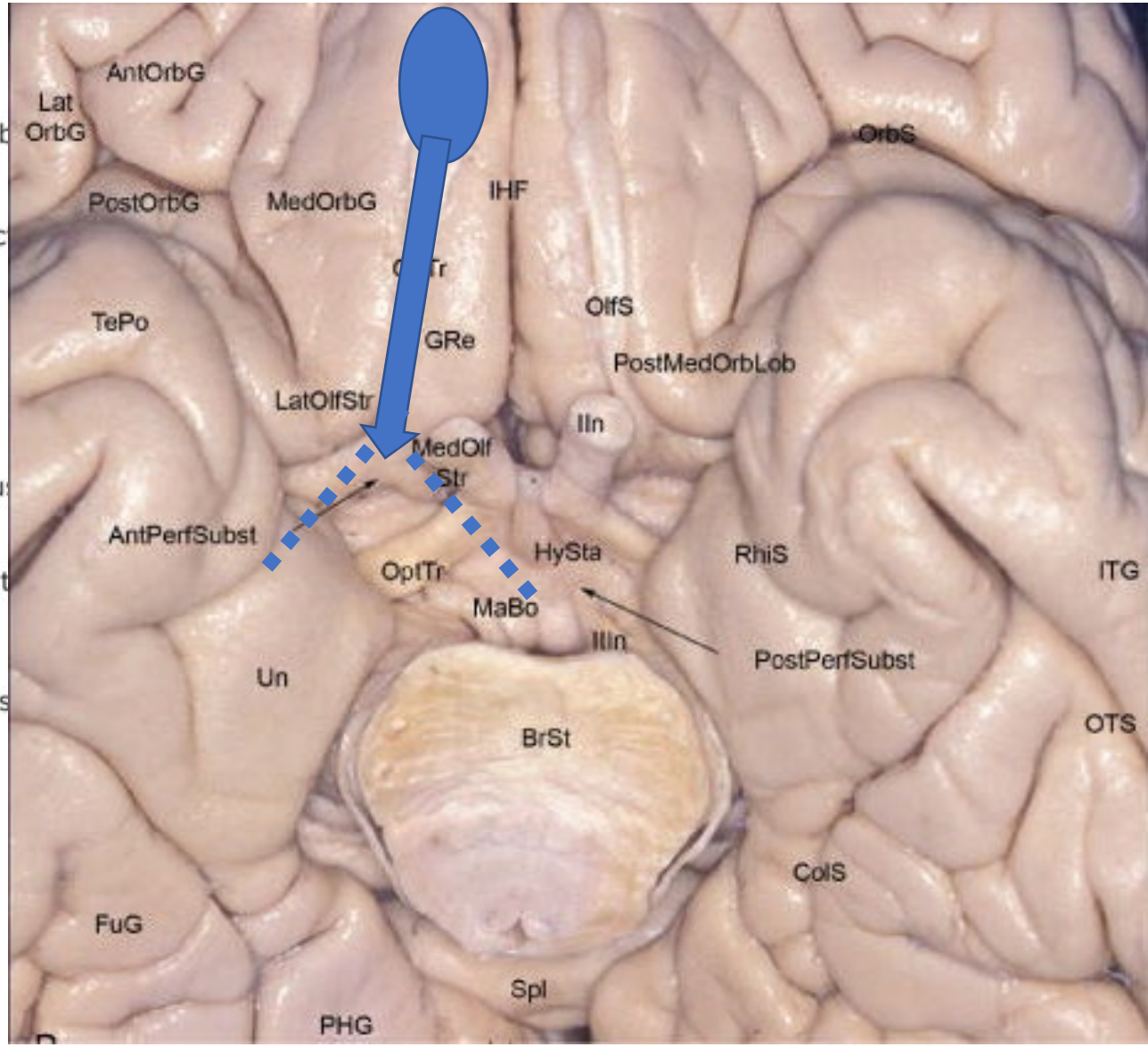
Cranial nerves – CN I

Olfactory Tract

- As the tract reaches the anterior perforated substance (an area at the level of the optic chiasma) it divides into medial and lateral stria**:**
- **Lateral stria** – to the primary olfactory cortex, located within the uncus of temporal lobe.
- **Medial stria** – cross the median plane, where they meet the olfactory bulb of the opposite side.



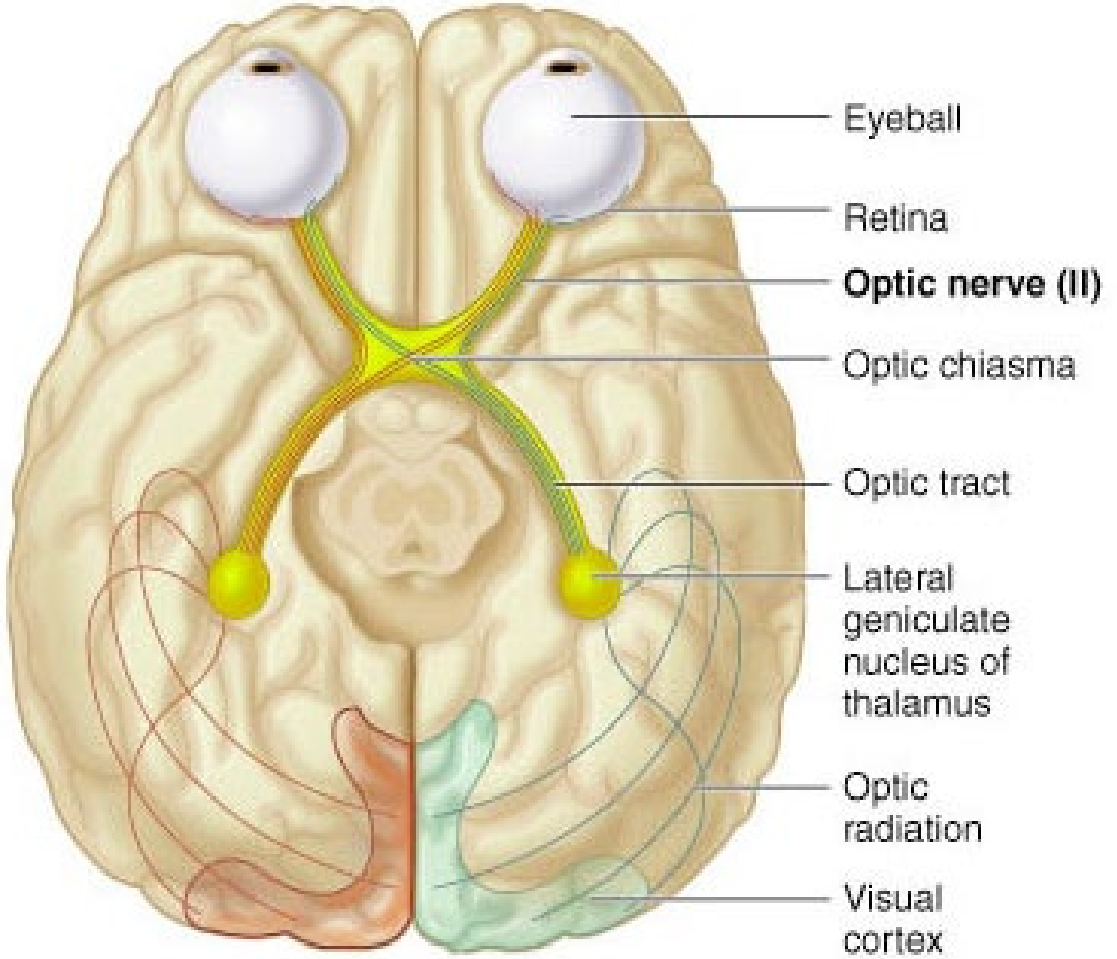

Orbitofrontal cortex
Olfactory bulb
Olfactory tract
Insula
Amygdala
Hypothalamus
Primary olfactory cortex
Hippocampus
1
2
3
4
5
6
7


AntOrbG
Lat OrbG
OrbS
PostOrbG
MedOrbG
IHF
TePo
OlfS
GRe
PostMedOrbLob
LatOlfStr
IIn
MedOlf Str
AntPerfSubst
HySta
RhiS
ITG
OptTr
MaBo
IIIn
PostPerfSubst
Un
BrSt
OTS
ColS
FuG
Spl
PHG

Cranial nerves – CN II

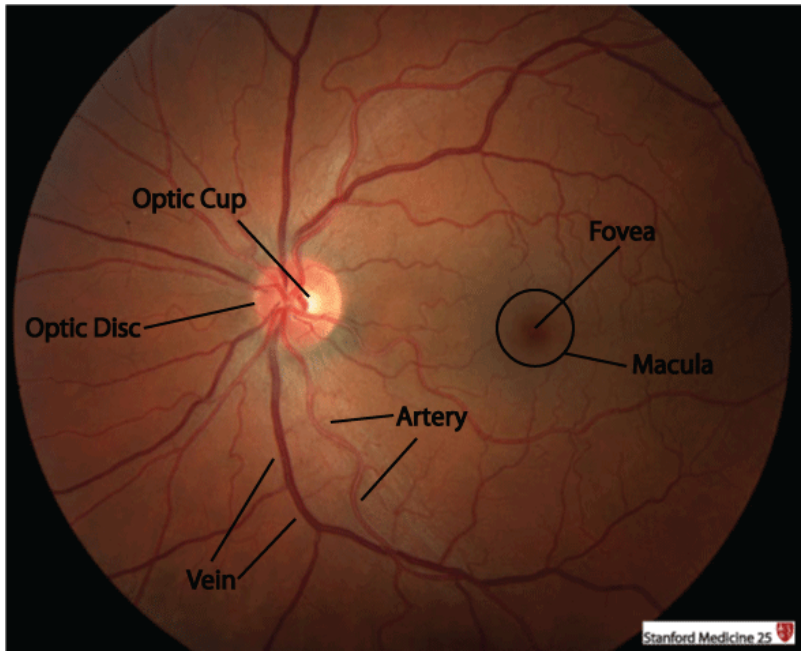
The optic nerve (CN II)

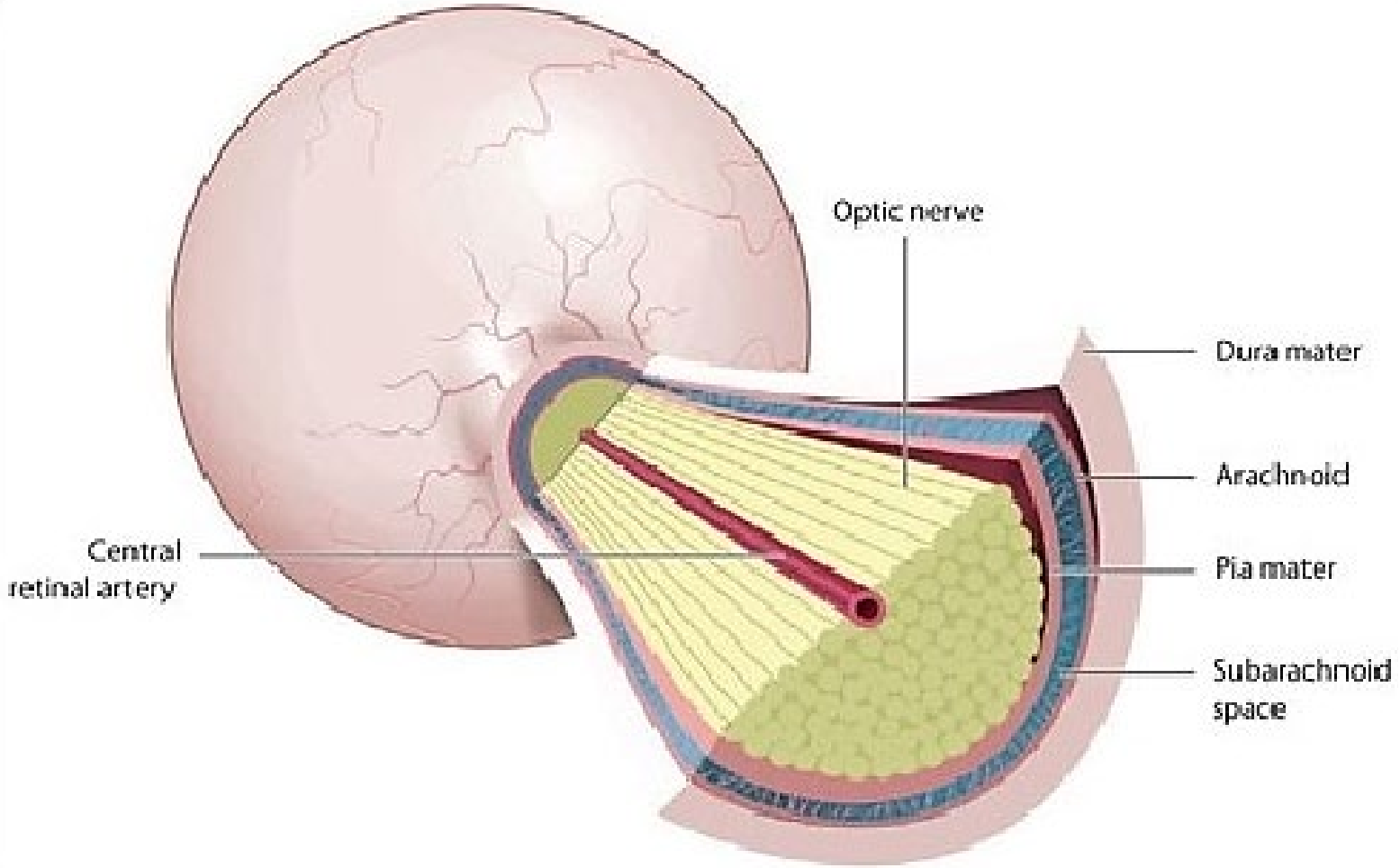
- It is responsible for transmitting the special sensory information for **vision**.
- The optic nerve is considered a part of the central nervous system and examination of the nerve enables an assessment of intracranial health.



Cranial nerves – CN II

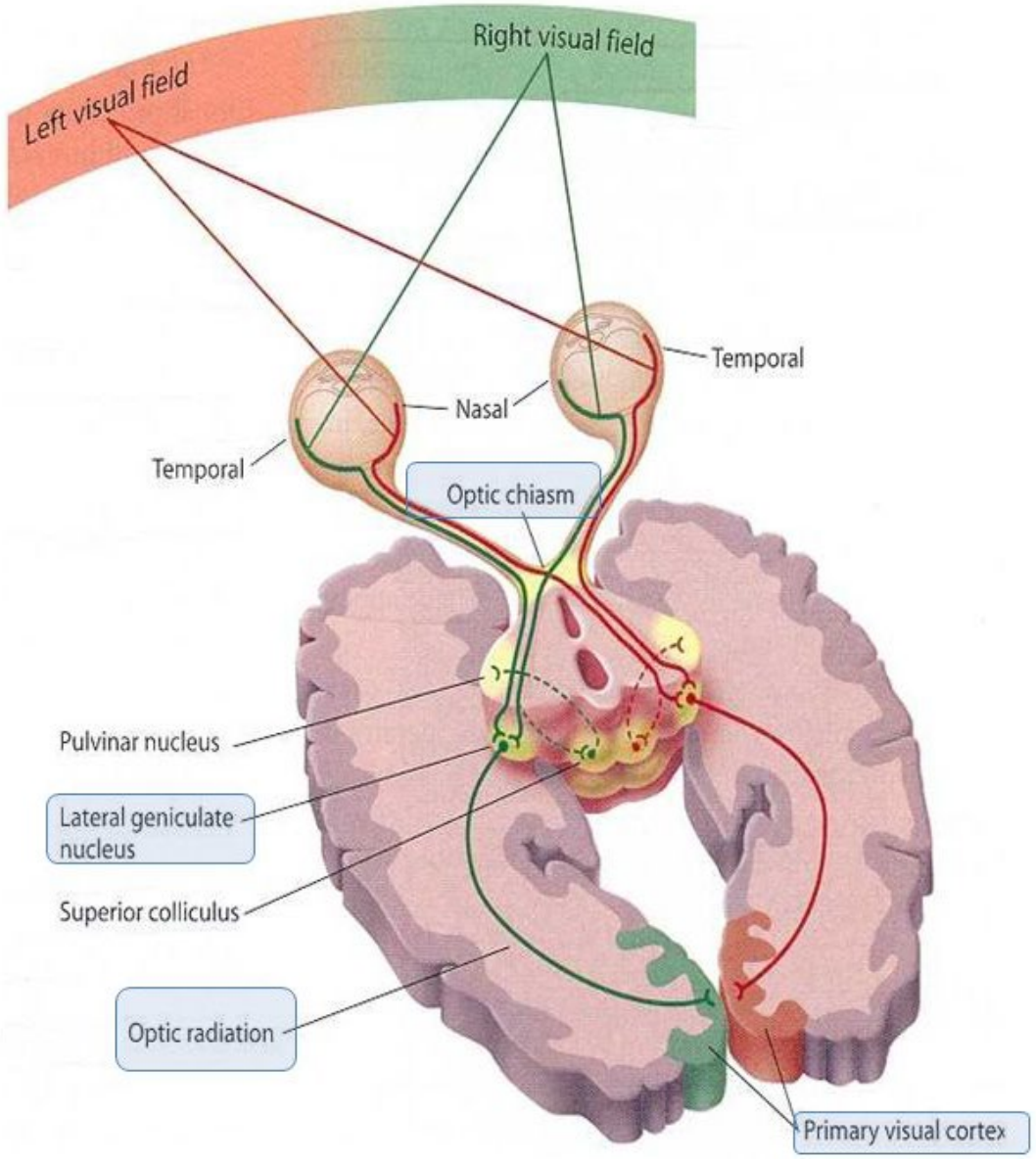
- Due to its unique anatomical relation to the brain, the optic nerve is surrounded by the **cranial meninges**.





Cranial nerves – CN II

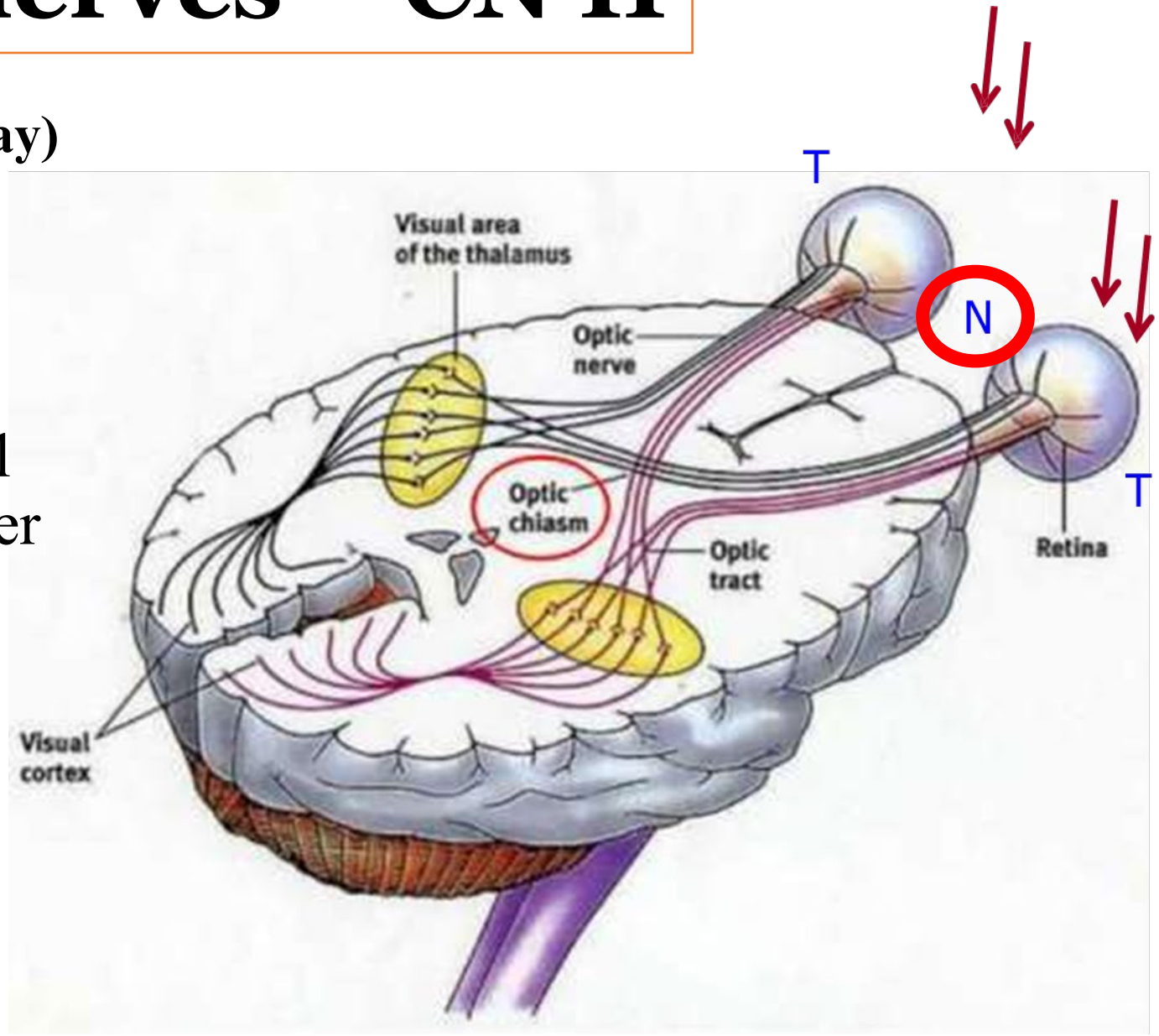
- Arises from the **retinal ganglion cells** of the eye.
- Optic nerves pass through the **optic canals** and converge at the optic **chiasma** (close to the pituitary gland).
- They continue as Optic **tract** to the thalamus (**LGB**) where they synapse.
- Then, the optic **radiation** fibers run to the visual **cortex**.
- Function: Vision.



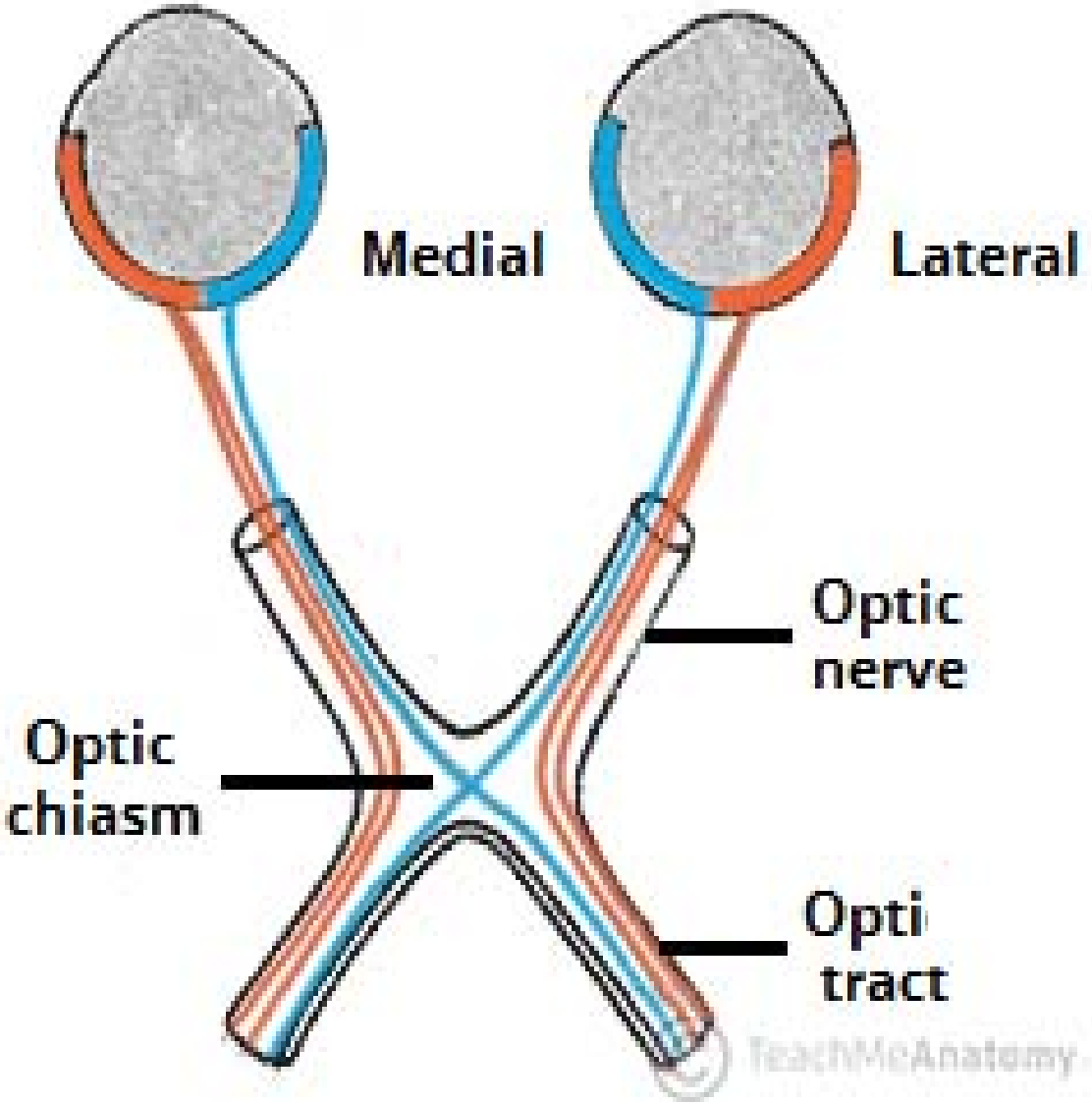
Cranial nerves – CN II

Intracranial course: (The Visual Pathway)

- Within the middle cranial fossa, the optic nerves from each eye unite to form the **optic chiasma**.
- At the chiasma, fibers from the nasal (medial) half of each retina cross over to the contralateral optic tract, while fibers from the temporal (lateral) halves remain ipsilateral.



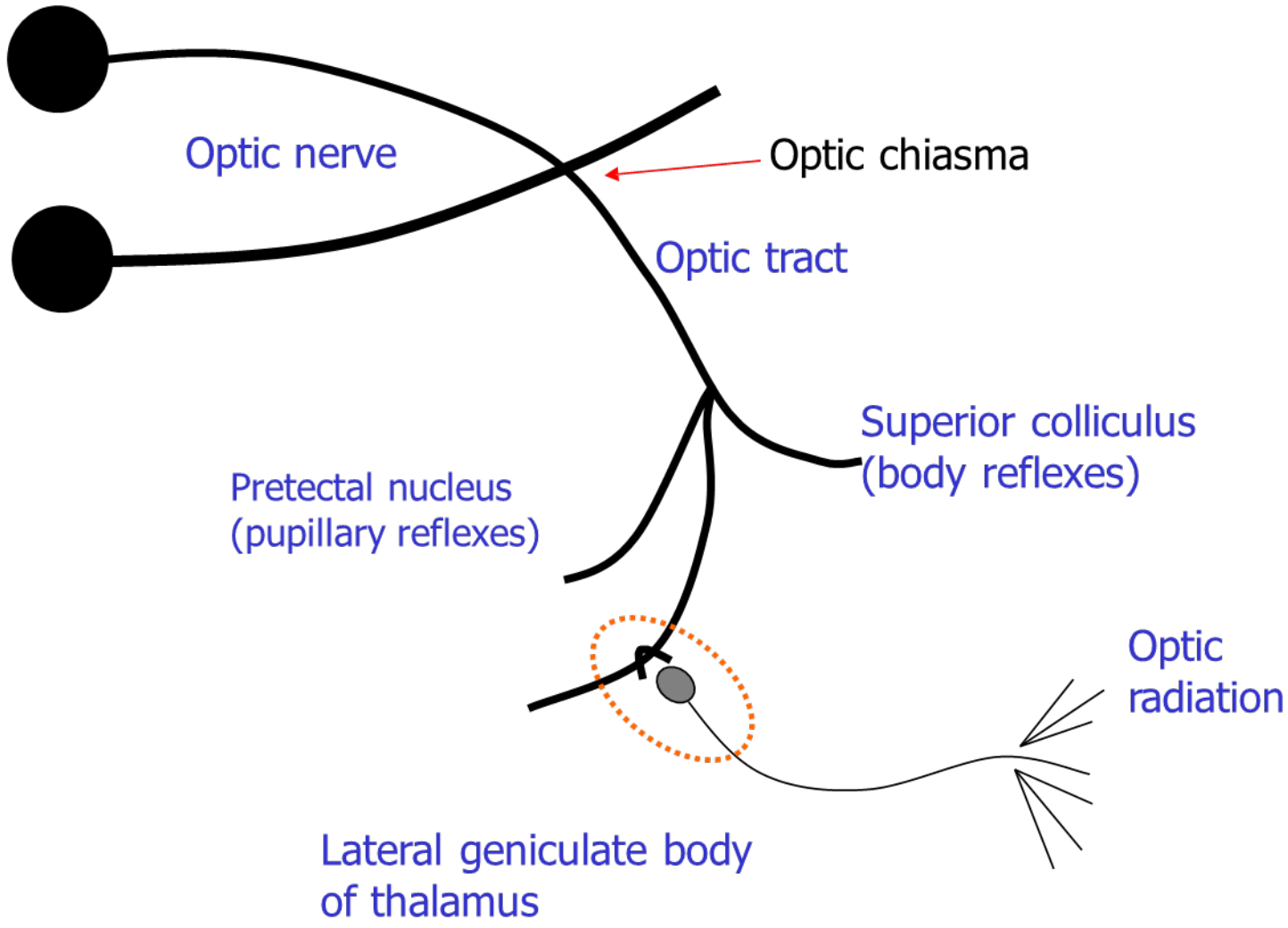
Cranial nerves – CN II



- **Left optic tract** – contains fibers from the left temporal (lateral) retina, and the right nasal (medial) retina.
- **Right optic tract** – contains fibers from the right temporal retina, and the left nasal retina.

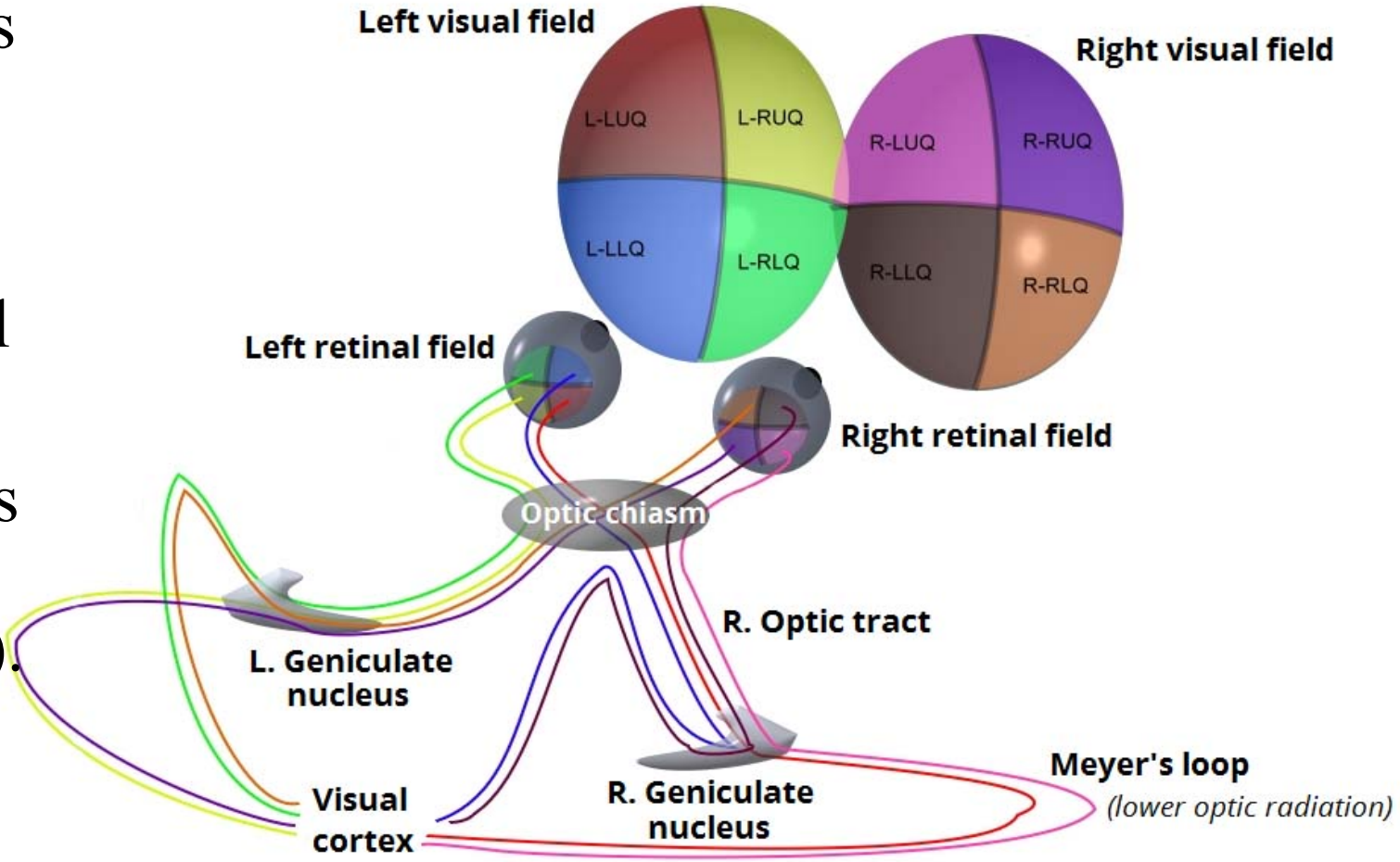
Cranial nerves – CN II

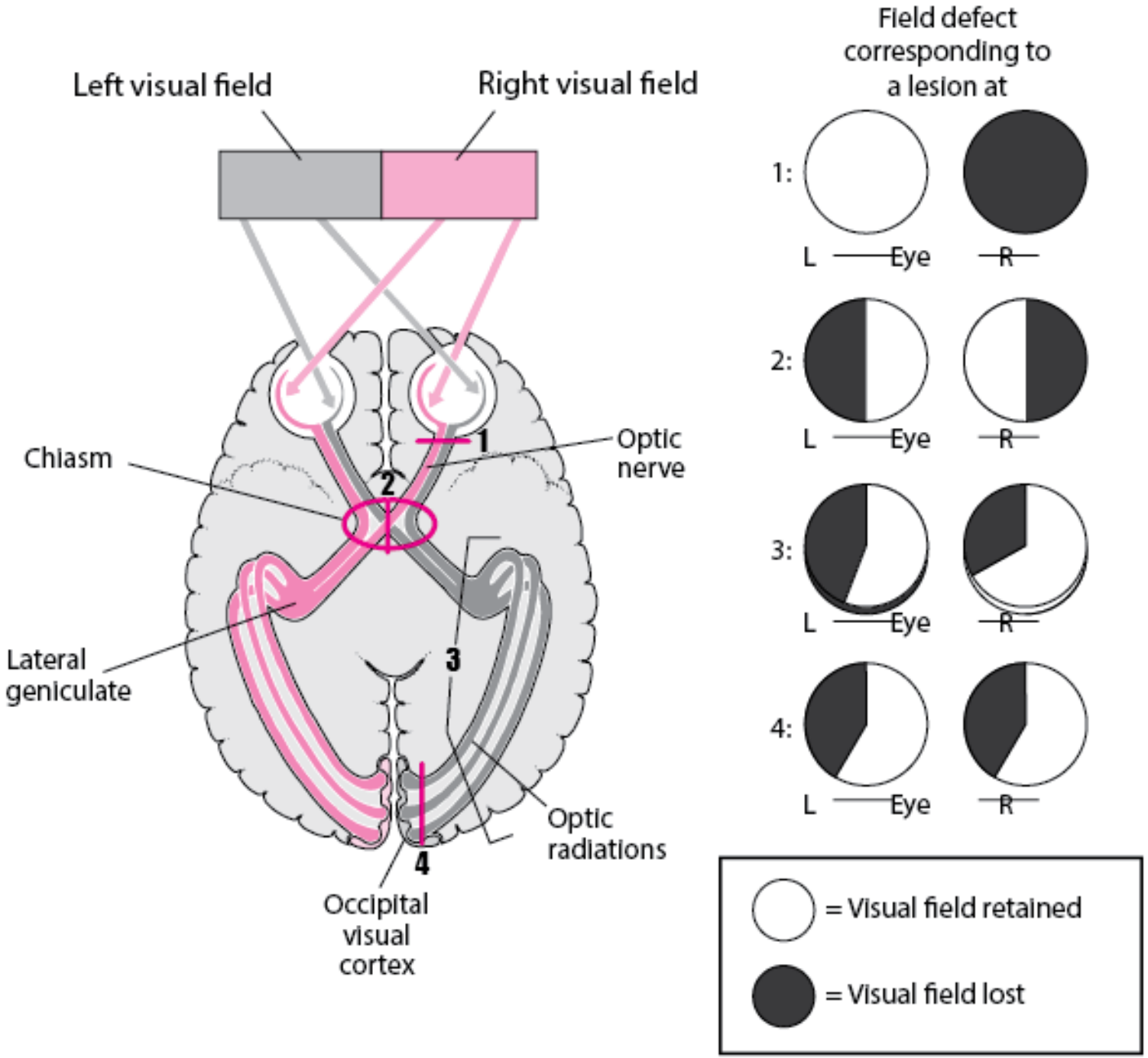
- Each optic tract travels to its corresponding cerebral hemisphere to reach the **lateral geniculate nucleus (LGN)**, a relay system located in the thalamus.
- Axons from the LGN then carry visual information via a pathway known as the **optic radiation**.



Cranial nerves – CN II

- **Upper optic radiation** – carries fibers from the superior retinal quadrants (inferior visual field). It travels through the **parietal** lobe to reach the visual cortex.
- **Lower optic radiation** – carries fibers from the inferior retinal quadrants (superior visual field). It travels through the **temporal** lobe to reach the visual cortex.

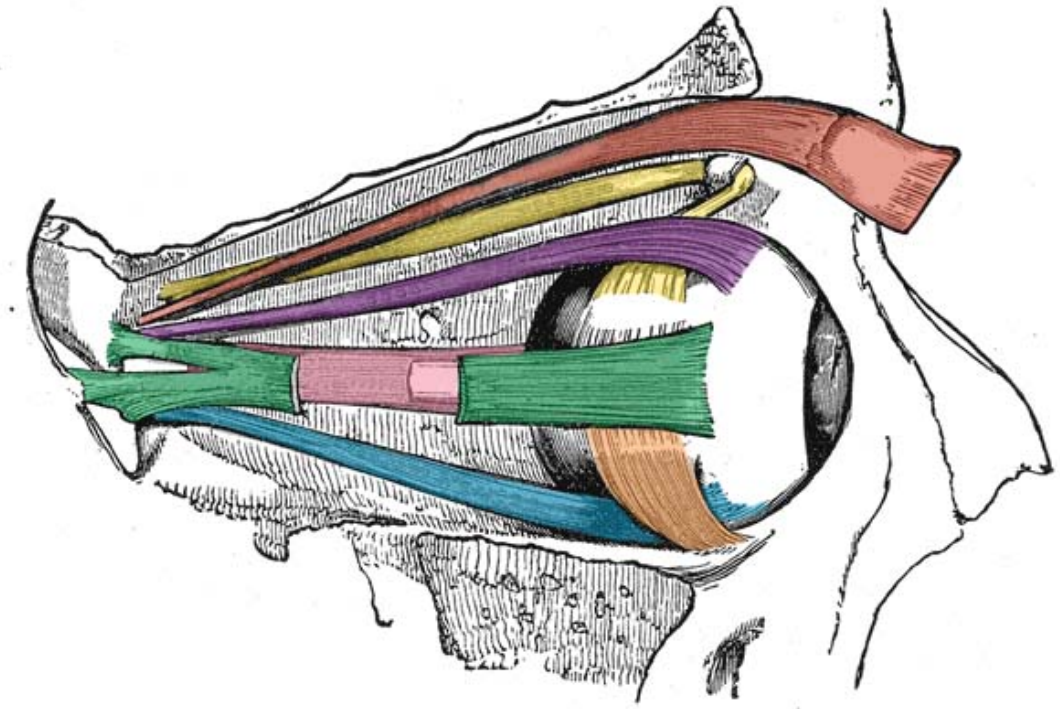


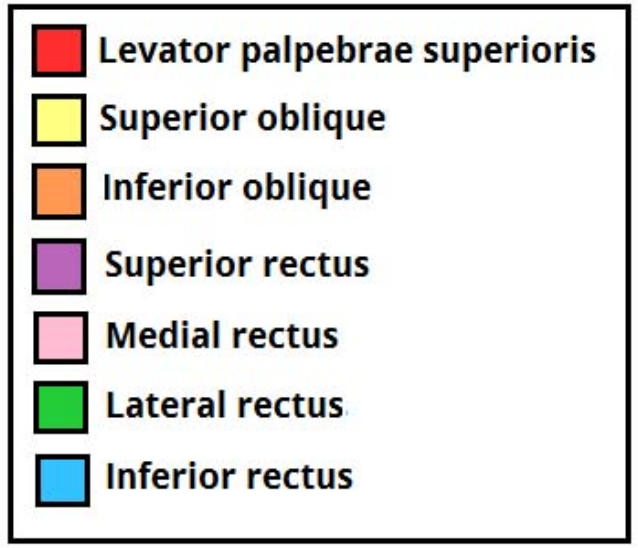

Left visual field
Right visual field
Chiasm
Optic nerve
Lateral geniculate
Optic radiations
Occipital visual cortex
1
2
3
4
Field defect corresponding to a lesion at
1:
2:
3:
4:
L
Eye
R
= Visual field retained
= Visual field lost

Cranial nerves – CN III

The oculomotor nerve (CN III)

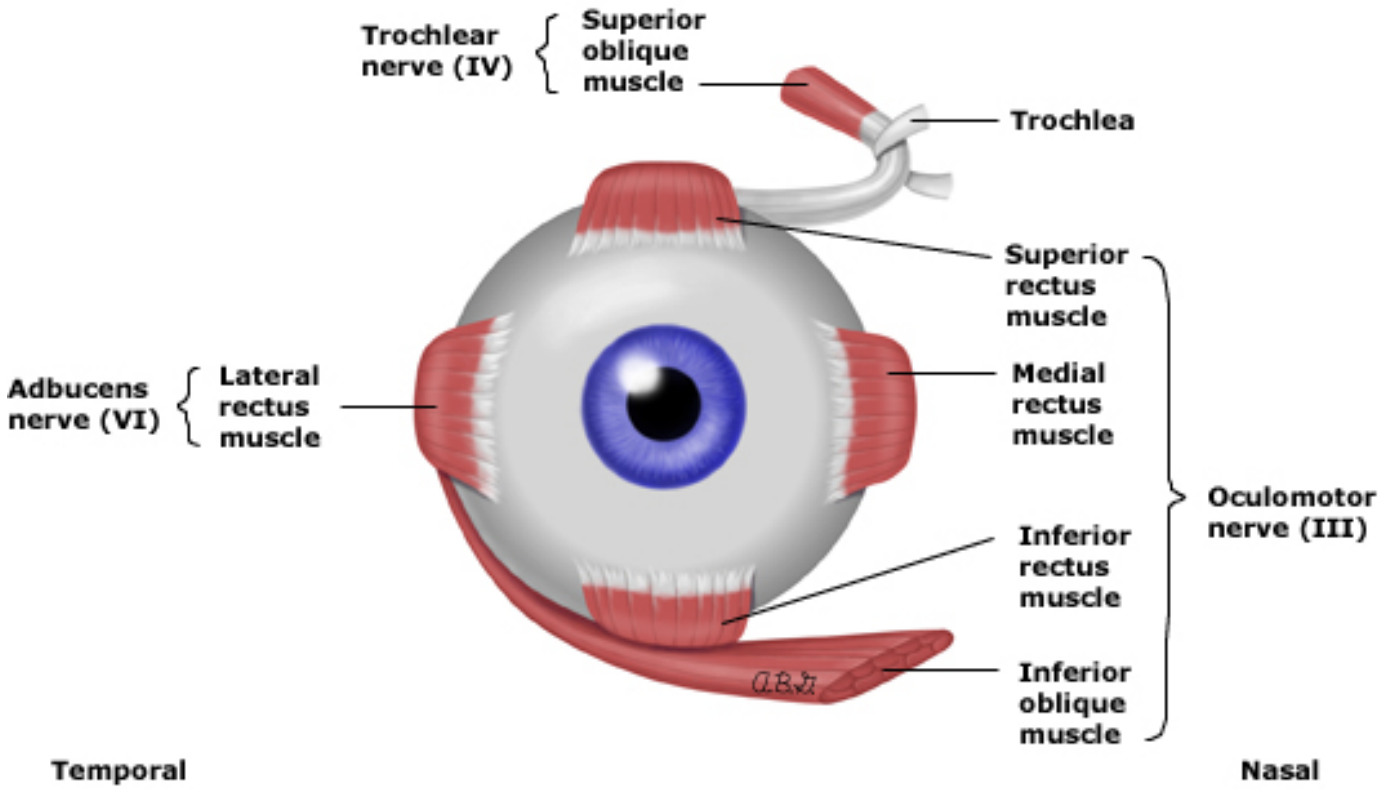
- The third cranial nerve (CN III). It provides motor and parasympathetic innervation to some of the structures within the bony orbit.

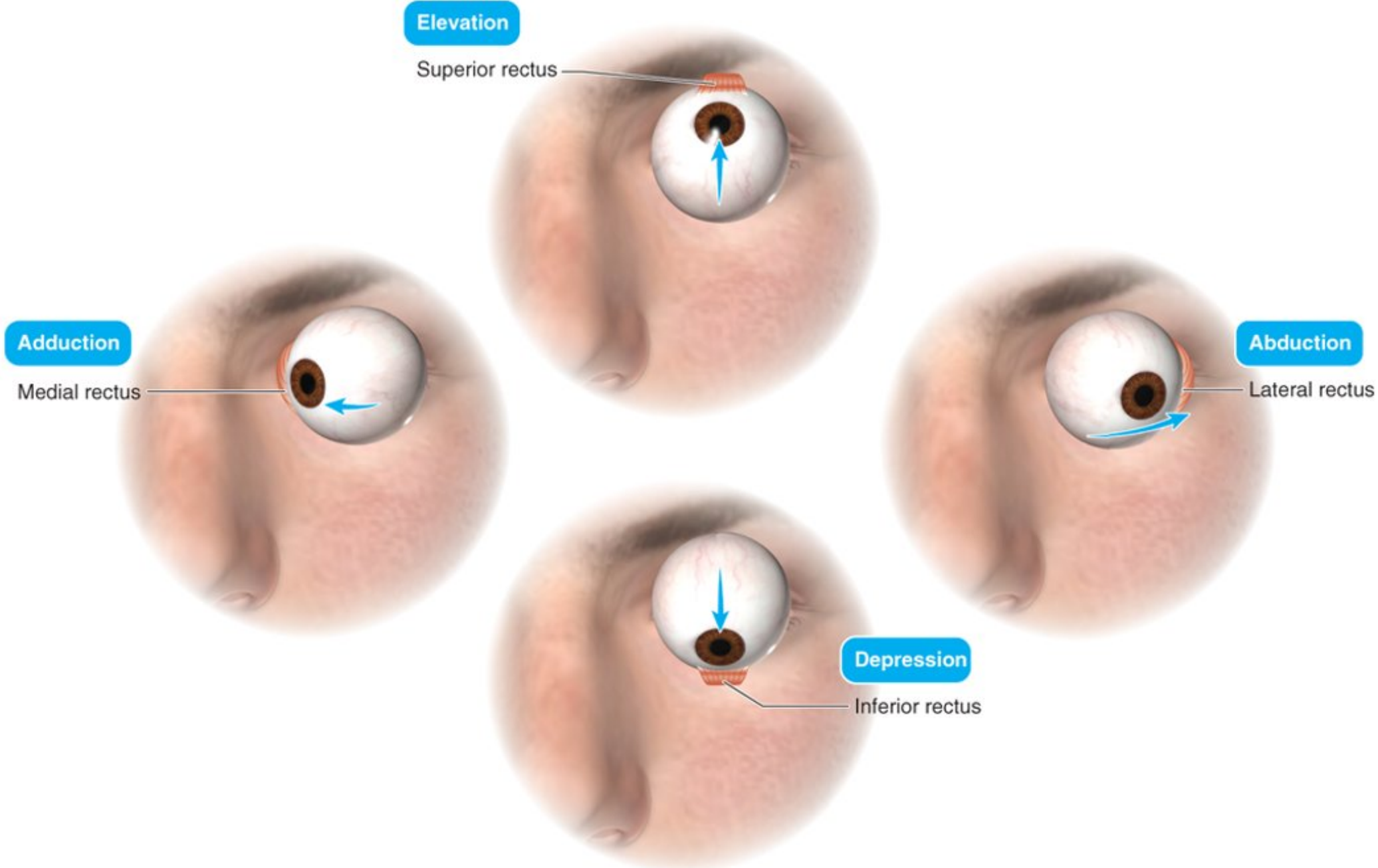




Cranial nerves – CN III

- **Motor** – Innervates the majority of the **extraocular muscles** (laevator palpebrae superioris, superior rectus, inferior rectus, medial rectus and inferior oblique).
- **Parasympathetic** – Supplies the sphincter pupillae and the ciliary muscles of the eye.

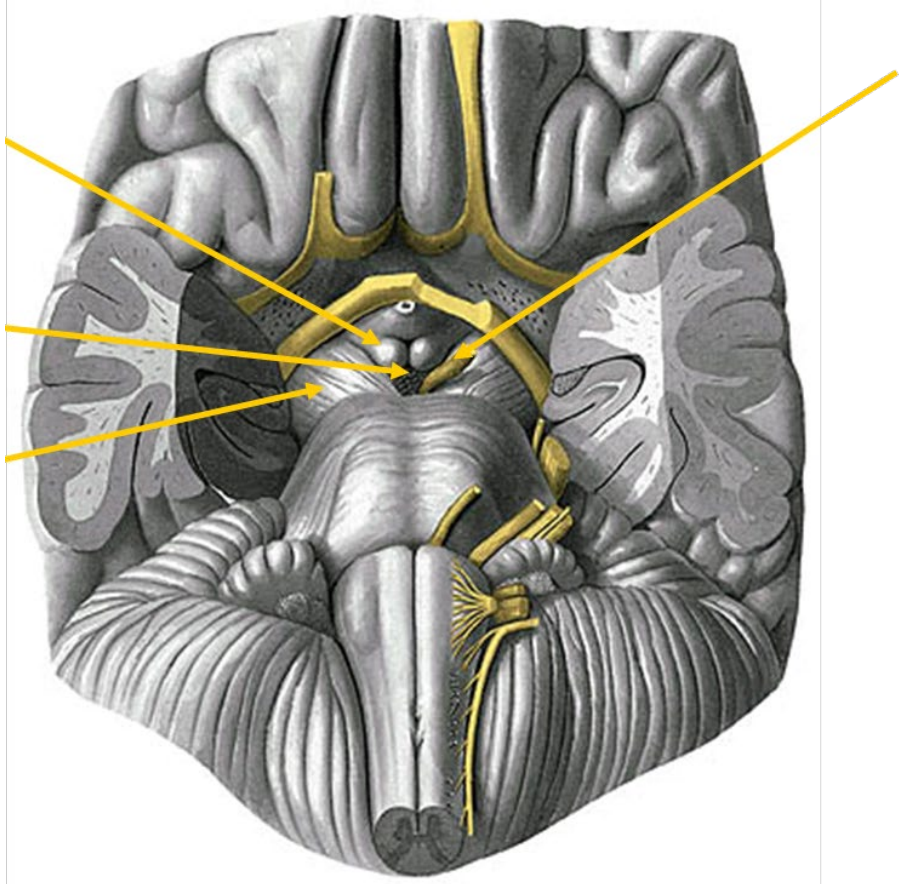


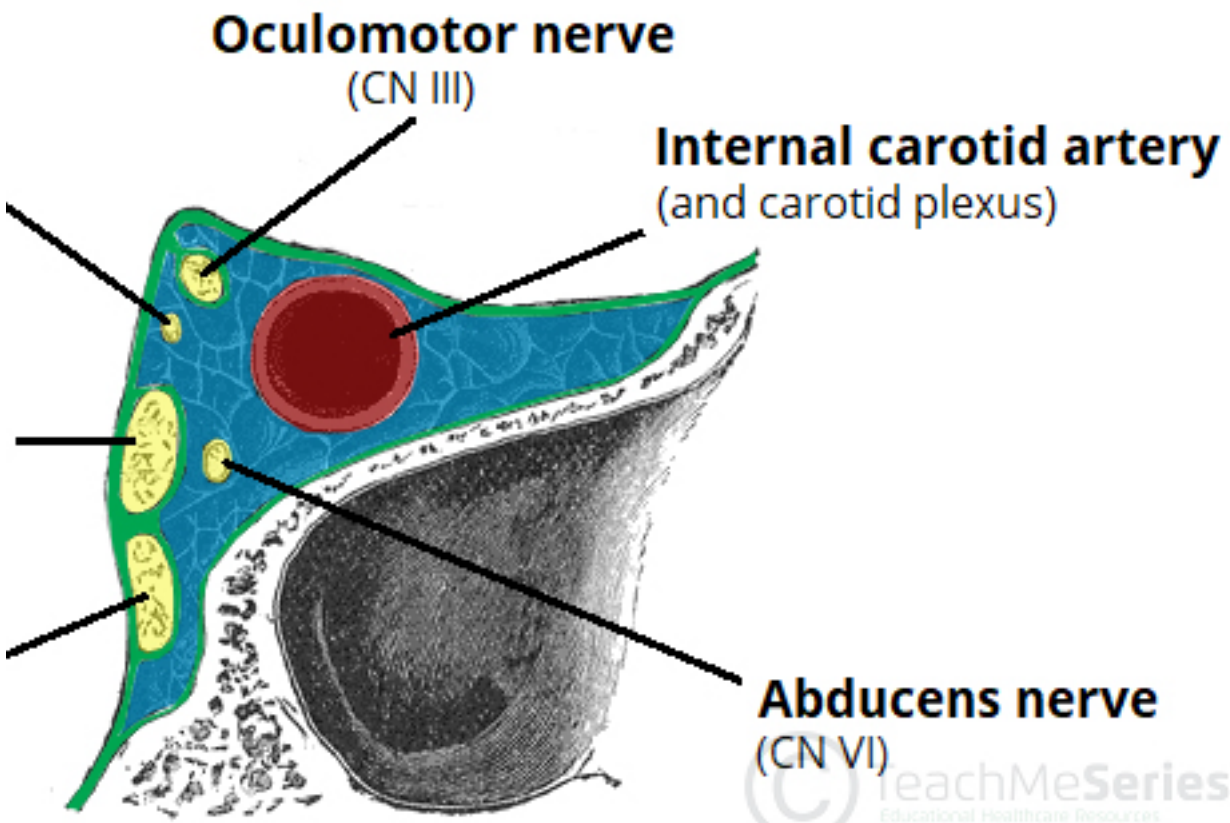


Source: Aaron L. Berkowitz:
Clinical Neurology & Neuroanatomy: A Localization-Based Approach, 2e

Cranial nerves – CN III

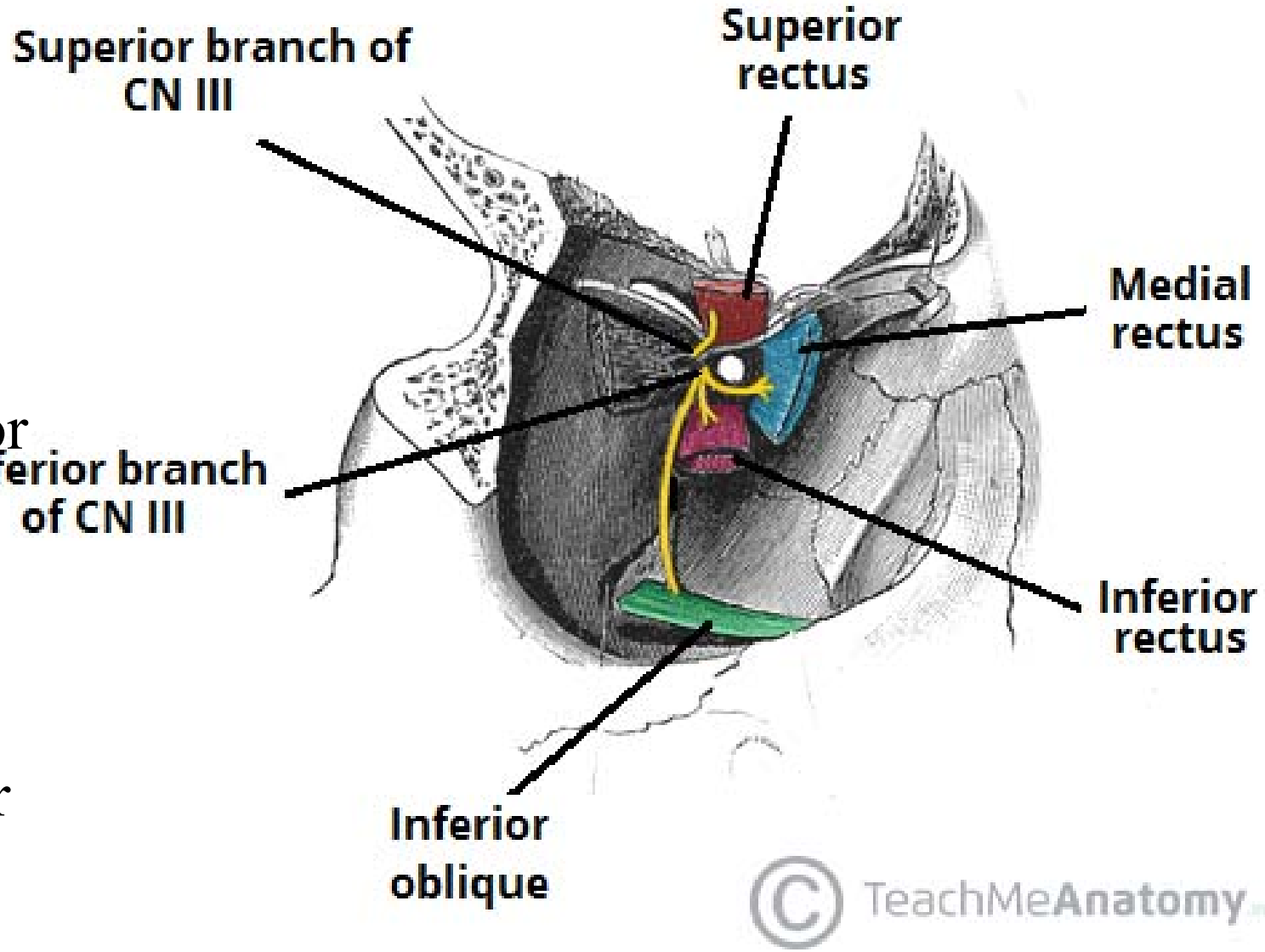
- The **oculomotor nerve** originates from the oculomotor nucleus – located within the midbrain.
- The nerve then pierces the dura mater and enters the lateral wall of the **cavernous sinus**.



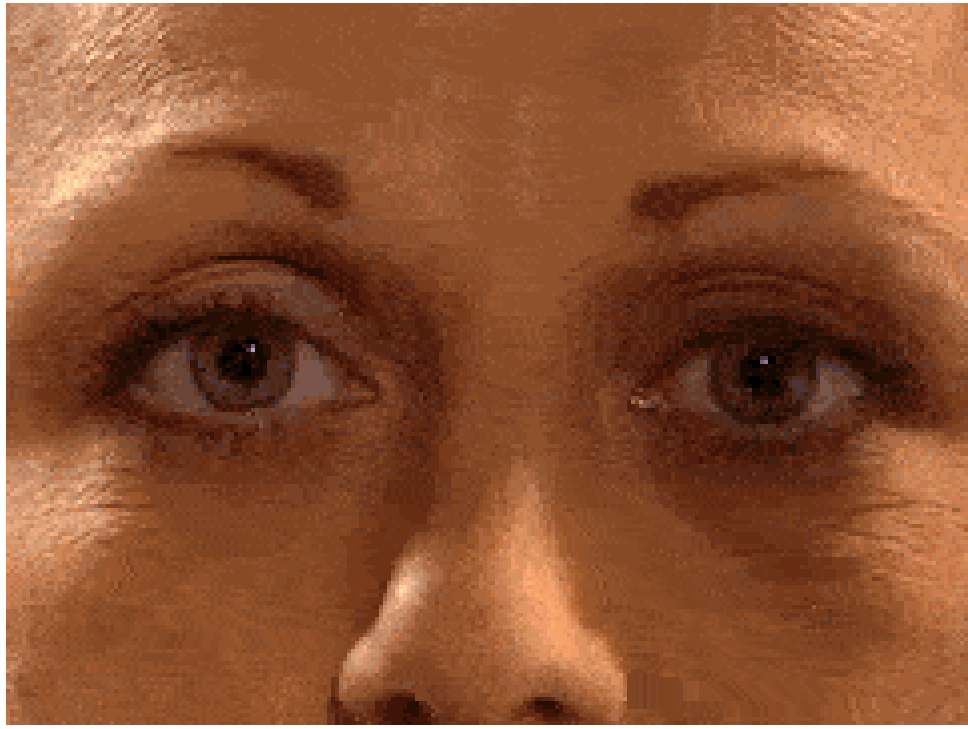


Cranial nerves – CN III

- The nerve leaves the cranial cavity via the **superior orbital fissure**. At this point, it divides into superior and inferior branches:
- **Superior branch** – provides motor innervation to the superior rectusand levator palpabrae superioris.
- **Inferior branch** – provides motor innervation to the inferior rectus, medial rectus and inferior oblique.



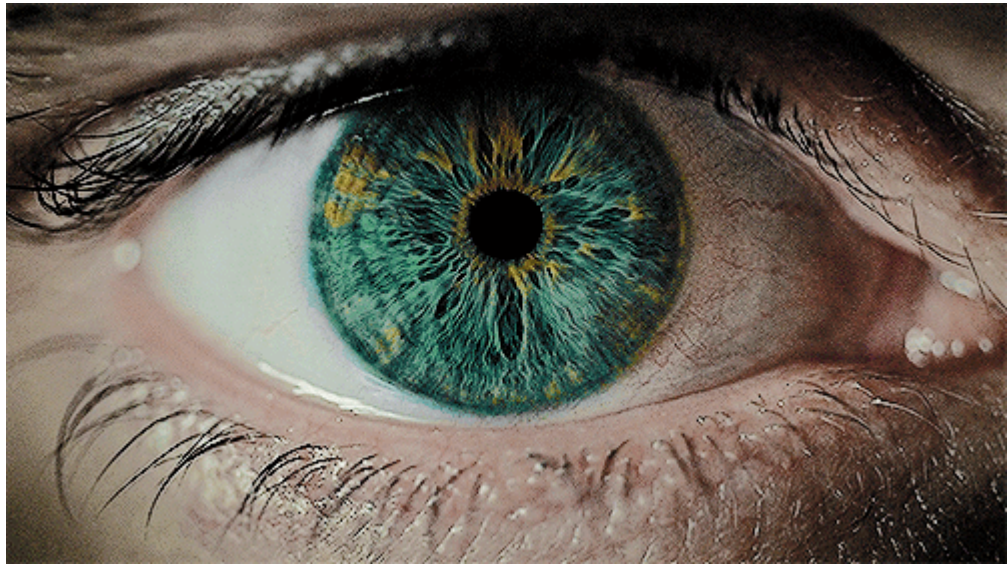
Cranial nerves – CN III



Parasympathetic Functions

There are two structures in the eye that receive parasympathetic innervation from the oculomotor nerve:

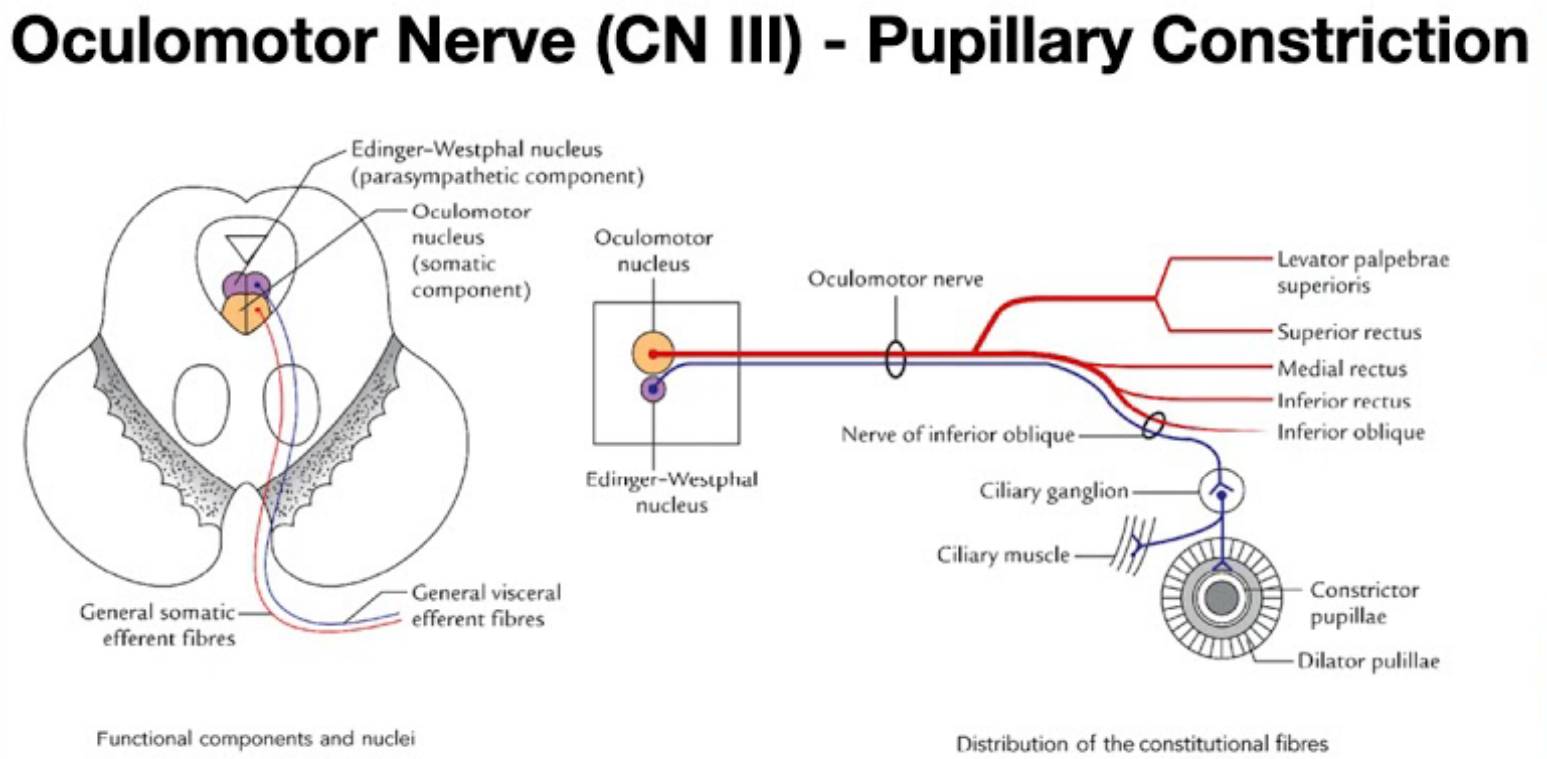
- **Sphincter pupillae** – constricts the pupil, reducing the amount of light entering the eye.
- **Ciliary muscles** – contracts, causes the lens to become more spherical, and thus more adapted to short range vision. [Accommodation]



Cranial nerves – CN III

Parasympathetic Functions

- The pre-ganglionic parasympathetic fibers travel in the inferior branch of the oculomotor nerve. Within the orbit, they branch off and synapse in the **ciliary ganglion**. The post-ganglionic fibers are carried to the eye via the short ciliary nerves.

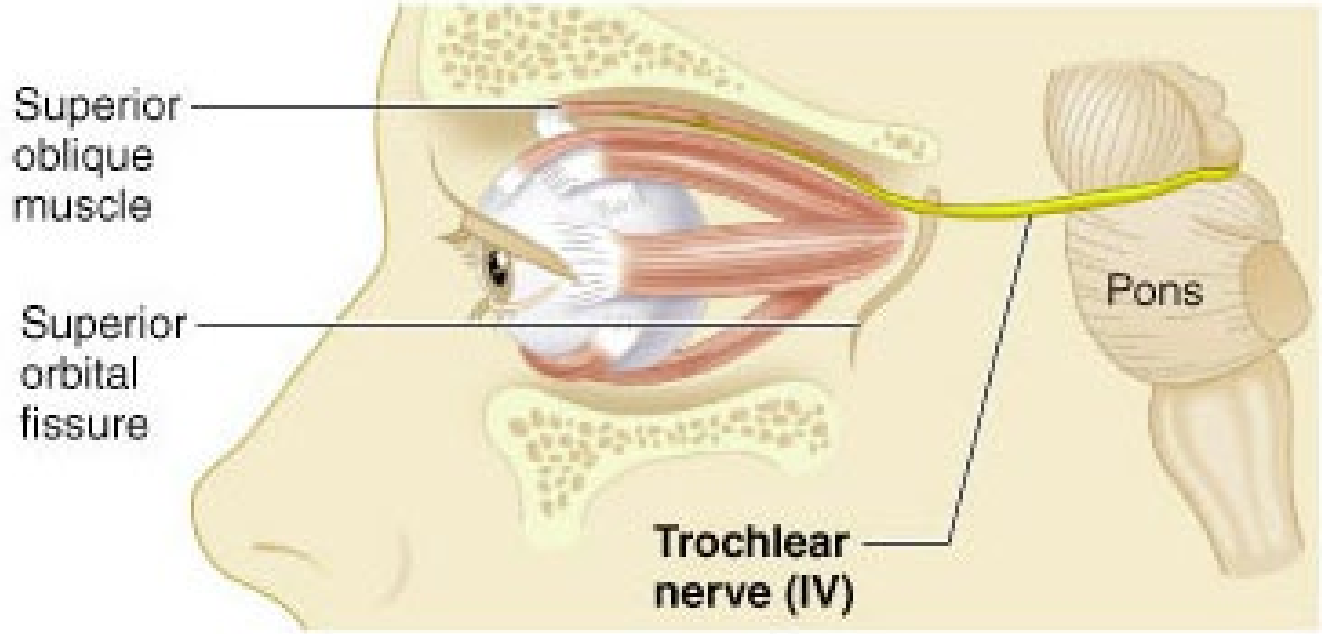


Oculomotor paralysis

Cranial nerves – CN IV

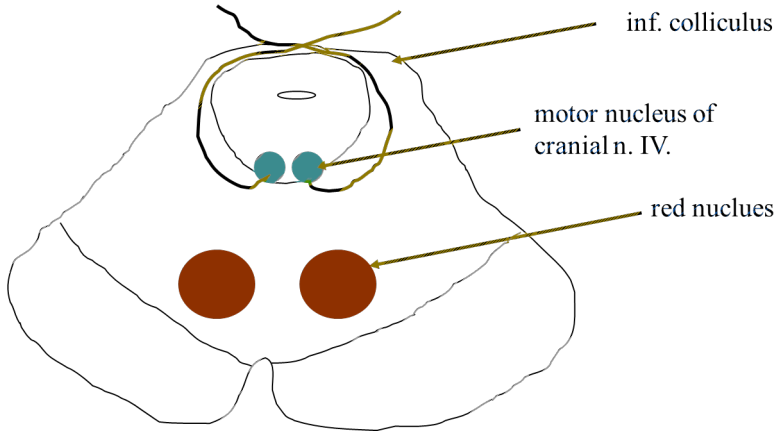
The trochlear nerve (CN IV)

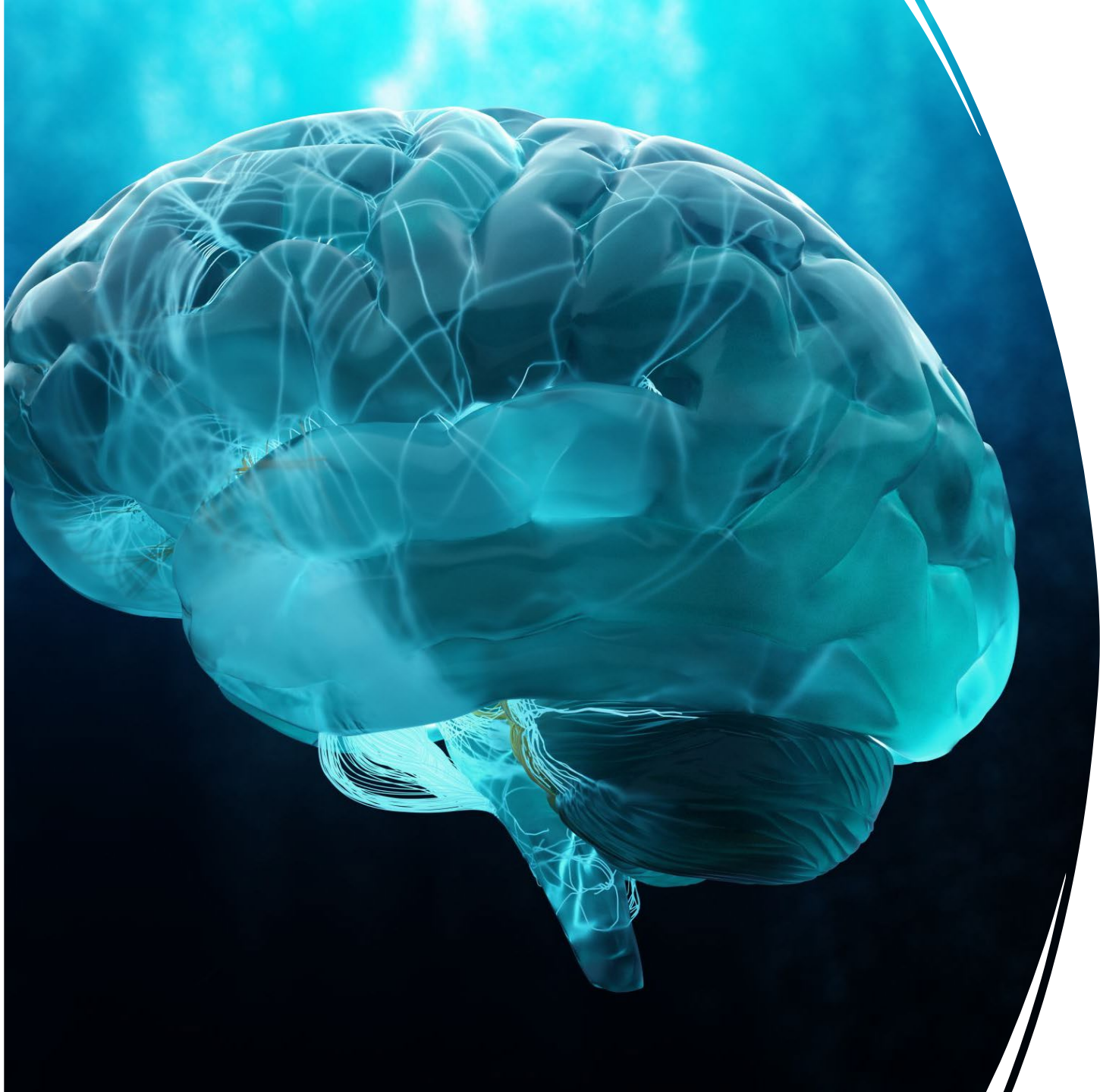
- The fourth cranial nerve.
- It has the longest intracranial course.
- It has a purely somatic motor function.



Cranial nerves – CN IV

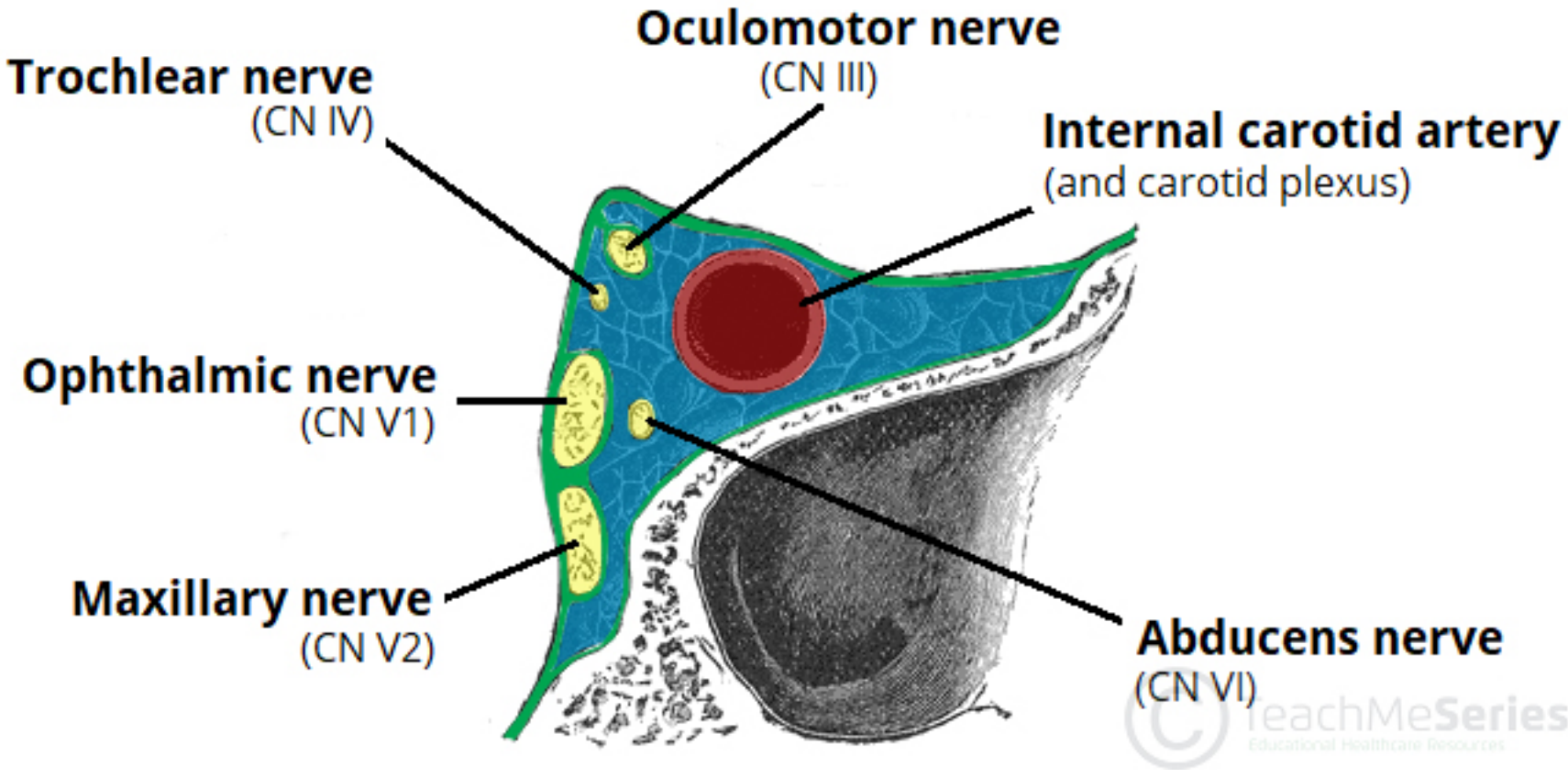
- The trochlear nerve arises from the **trochlear nucleus** of the brain, emerging from the posterior aspect of the midbrain
- It is the only cranial nerve to exit from the posterior midbrain.





Cranial nerves – CN IV

- The trochlear nerve then moves along the lateral wall of the **cavernous sinus** before entering the orbit of the eye via the **superior orbital fissure**.



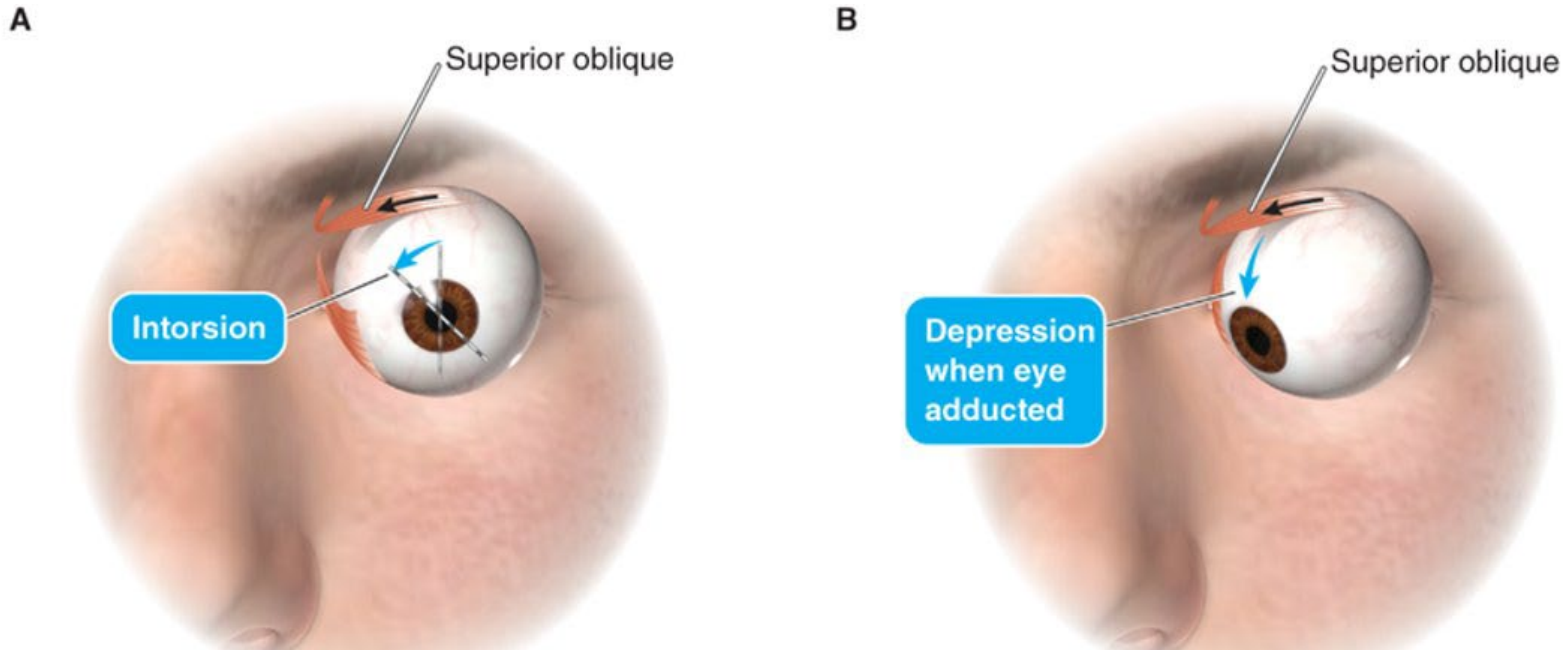
Cranial nerves – CN IV

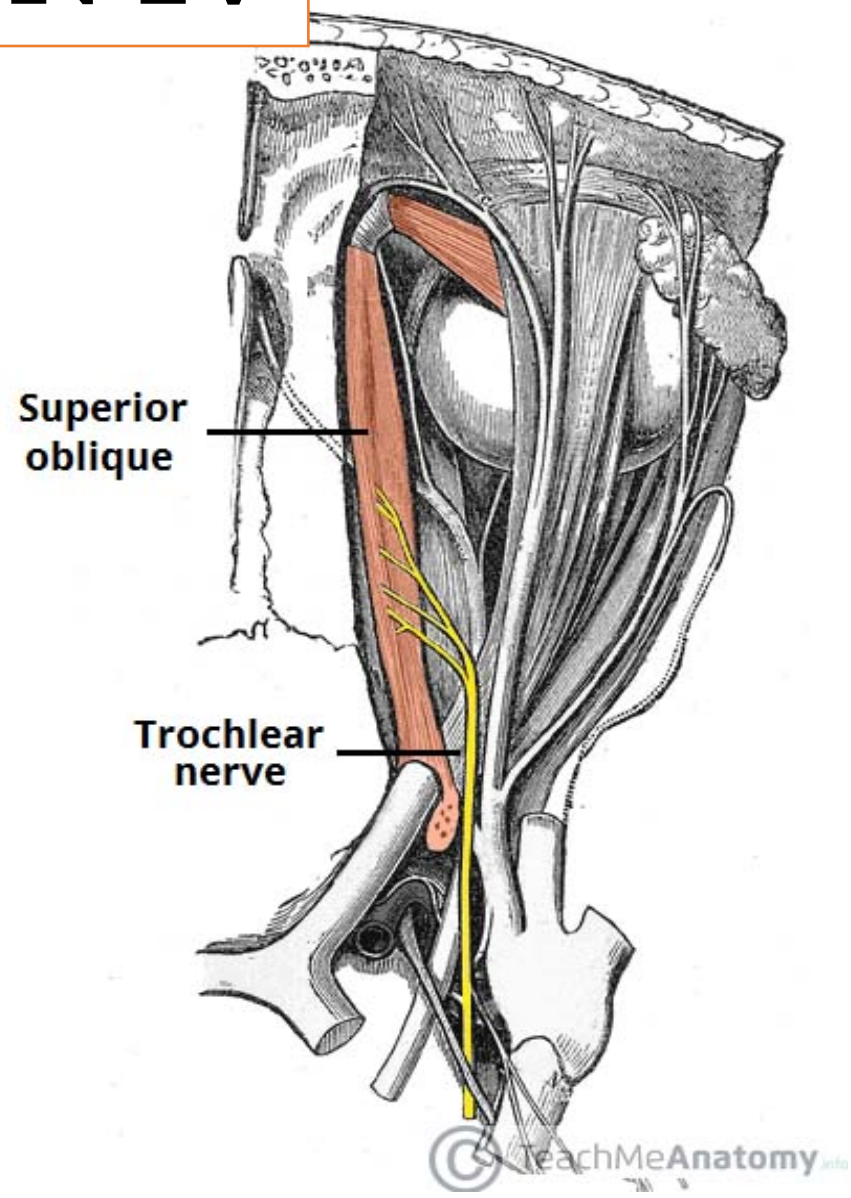
Motor Function

- The trochlear nerve innervates the **contralateral** superior oblique.

SO4

- The action of the superior oblique is to depress and intort the eyeball.



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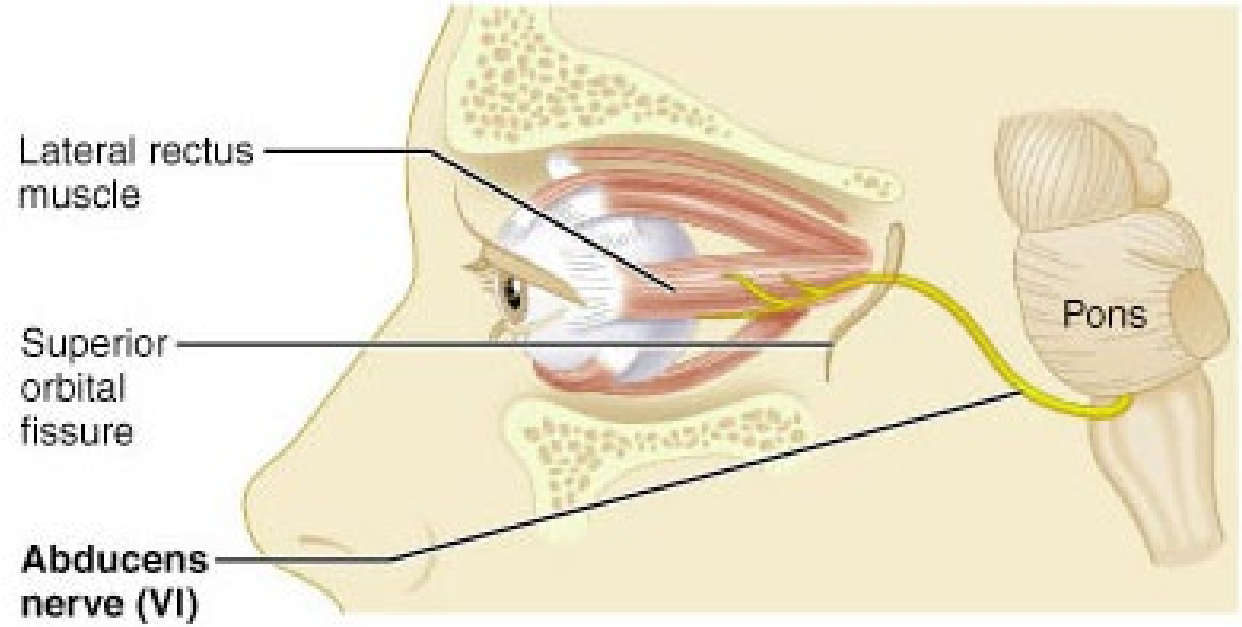
Cranial nerves – CN VI

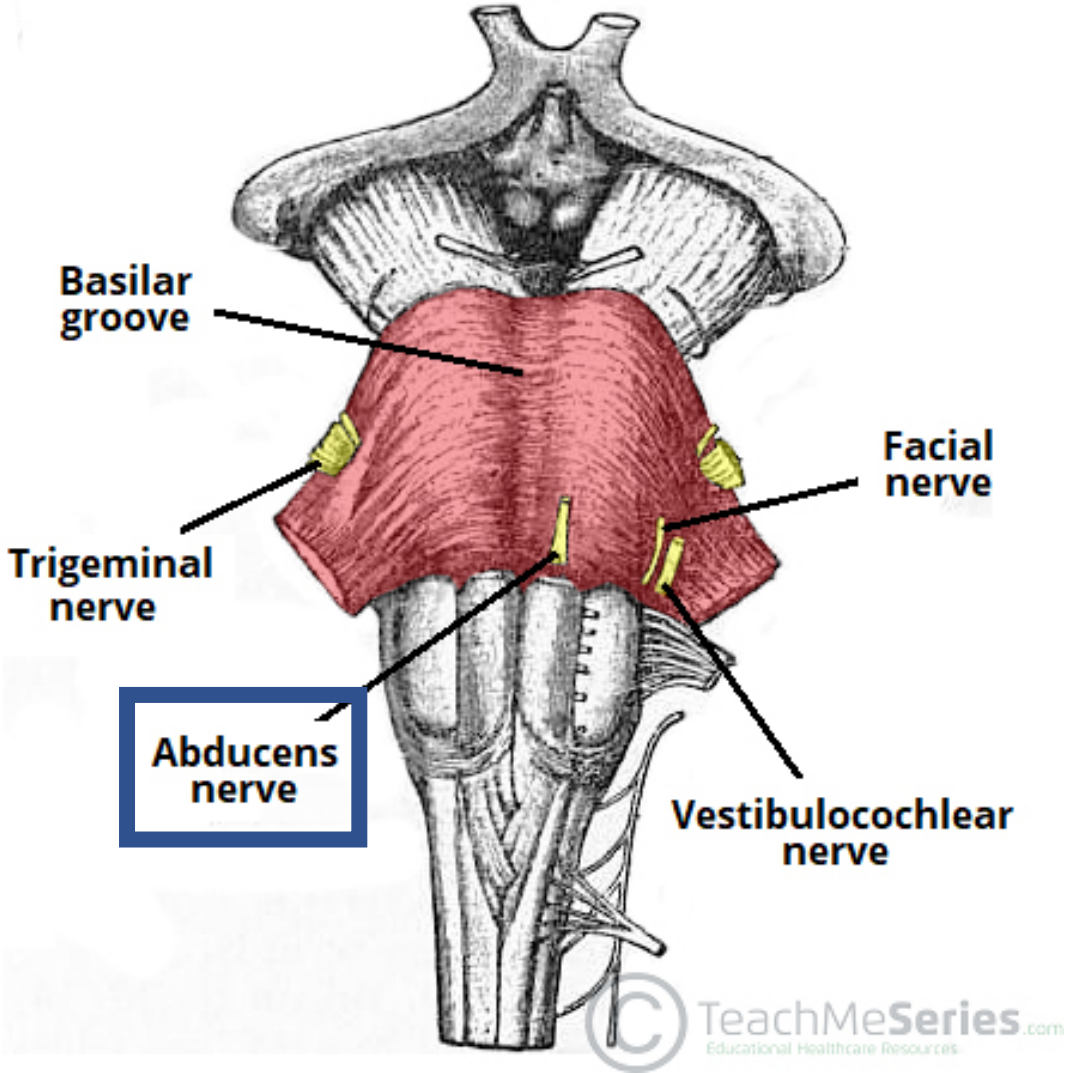
The abducent nerve (CN VI)

- The sixth cranial nerve.
- It has a purely somatic motor function.



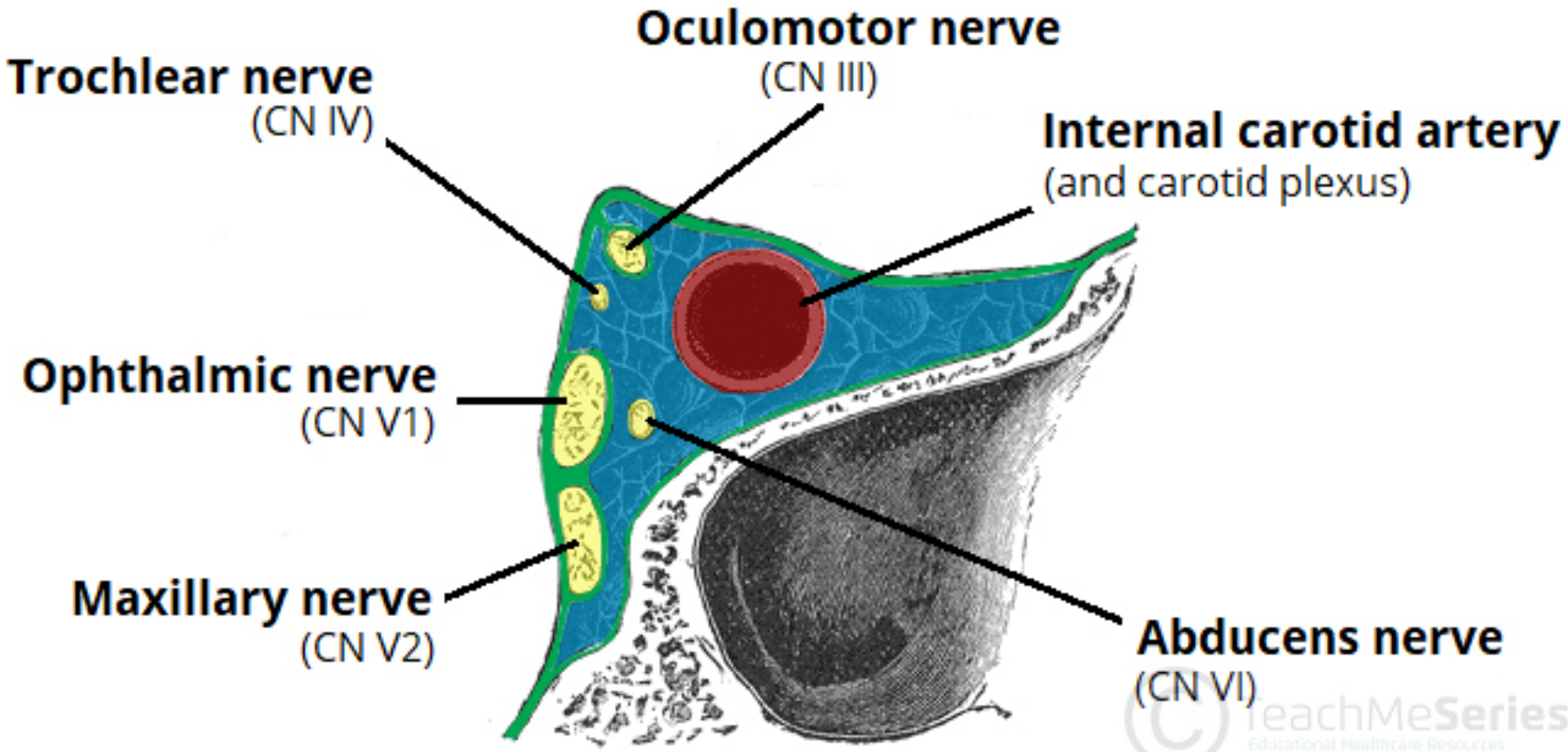
Cranial nerves – CN VI

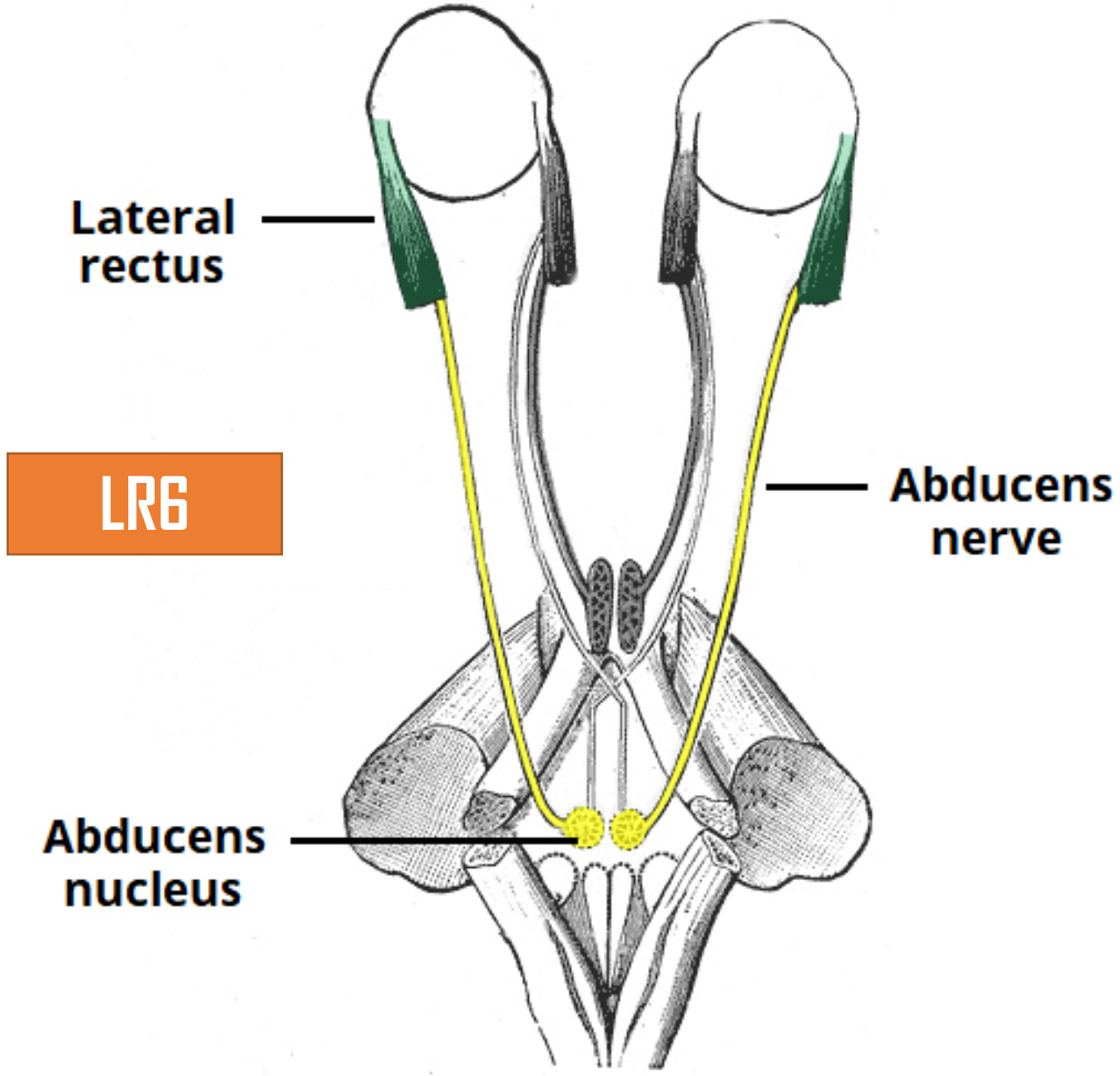
- The abducens nerve arises from the abducens nucleus in the **pons** of the brainstem.



Cranial nerves – CN VI

- Enters the **cavernous sinus**. It travels through the cavernous sinus and enters the bony orbit via the **superior orbital fissure**.
- Within the bony orbit, the abducens nerve terminates by innervating the **lateral rectus** muscle.




Lateral rectus
LR6
Abducens nerve
Abducens nucleus

Abducens nerve injury

Oculomotor N (III)

Ventral midbrain

Trochlear N (IV)

Dorsal midbrain

Abducent N (VI)

Between Pons & pyramid of medulla

occulomotor n.

trochlear n.

abducens n.

↓

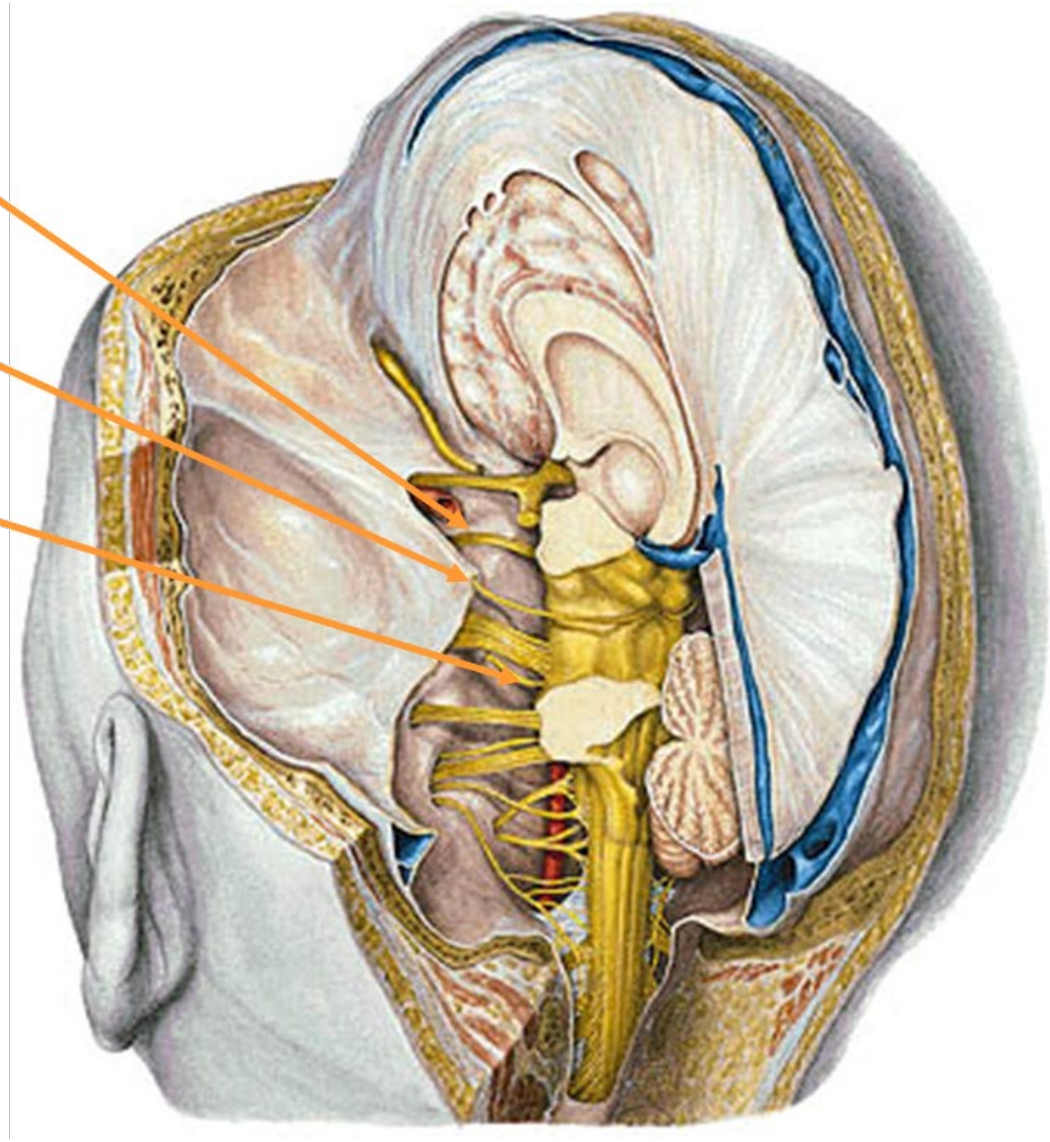
cavernous sinus

↓

sup. orbital fissure

↓

orbit



SUMMARY TABLE

Number	Name	Exit	Modality	Function
1 (CNI)	Olfactory	Cribriform plate	Sensory (SVA)	Smell
2 (CNII)	Optic	Optic canal	Sensory (SSA)	Vision
3 (CNIII)	Oculomotor	Superior orbital fissure	Motor (GSE & GVE)	GSM: 4 extrinsic eye muscles and levator palpebrae superioris. GVM: pupillary sphincter
4 (CNIV)	Trochlear	Superior orbital fissure	Motor (GSE)	Superior oblique
6 (CNVI)	Abducent	Superior orbital fissure	Motor (GSE)	Lateral rectus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