بسم الله الرحمن الرحيم

Brain Stem (pt.3)

MID | Lecture 8

﴿إِنِّي تَوَكَّلْتُ عَلَى اللَّهِ رَبِّي وَرَبِّكُمْ ۚ مَّا مِن دَابَّةٍ إِلَّا هُوَ آخِذٌ بِنَاصِيَتِهَا ۚ إِنَّ رَبِّي عَلَىٰ صِرَاطٍ مُّسْتَقِيمٍ﴾

Written by: Sara Masadeh
Hala Al-Turman

ANATOMY

رحلة اليقين مع سورة يس

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

وَٱلشَّمْسُ تَجْرِي لِمُسْتَقَرٍّ لَّهَا ۚ ذَٰلِكَ تَقْدِيرُ ٱلْعَزِيزِ ٱلْعَلِيمِ (٣٨) وَٱلْقَمَرَ قَدَّرْنَٰهُ مَنَازِلَ حَتَّىٰ عَادَ كَٱلْعُرْجُونِ ٱلْقَدِيمِ (٣٩)

{ وَالشَّمْسُ تَجْرِي لِمُسْتَقَرٍّ لَهَا } أي: دائما تجري لمستقر لها قدره الله لها، لا تتعداه، ولا تقصر عنه، وليس لها تصرف في نفسها، ولا استعصاء على قدرة الله تعالى. { ذَلِكَ تَقْدِيرُ الْعَزِيزِ } الذي بعزته دبر هذه المخلوقات العظيمة، بأكمل تدبير، وأحسن نظام. { الْعَلِيمُ } الذي بعلمه، جعلها مصالح لعباده، ومنافع في دينهم ودنياهم، { وَالْقَمَرَ قَدَّرْنَاهُ مَنَازِلَ } ينزل بها، كل ليلة ينزل منها واحدة، { حَتَّى } يصغر جدا، فيعود { كَالْعُرْجُونِ الْقَدِيمِ } أي: عرجون النخلة، الذي من قدمه نش وصغر حجمه وانحنى، ثم بعد ذلك، ما زال يزيد شيئا فشيئا، حتى يتم [نوره] ويتسق ضياؤه.

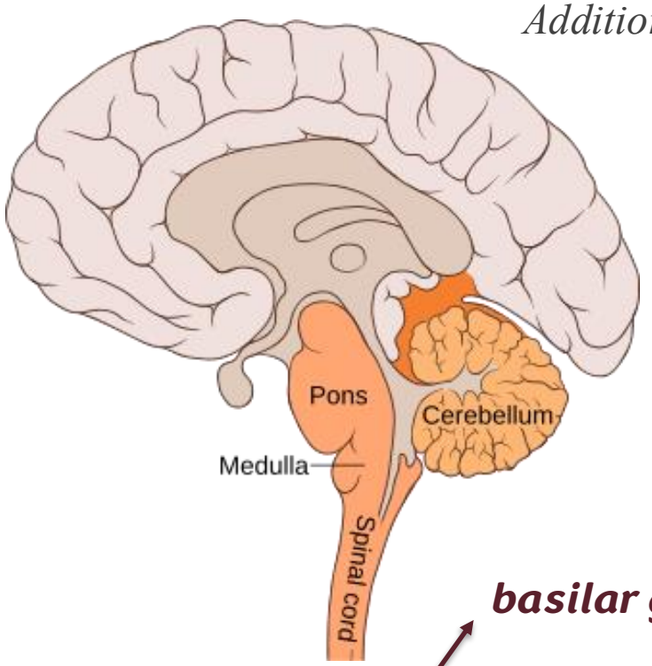
Pons

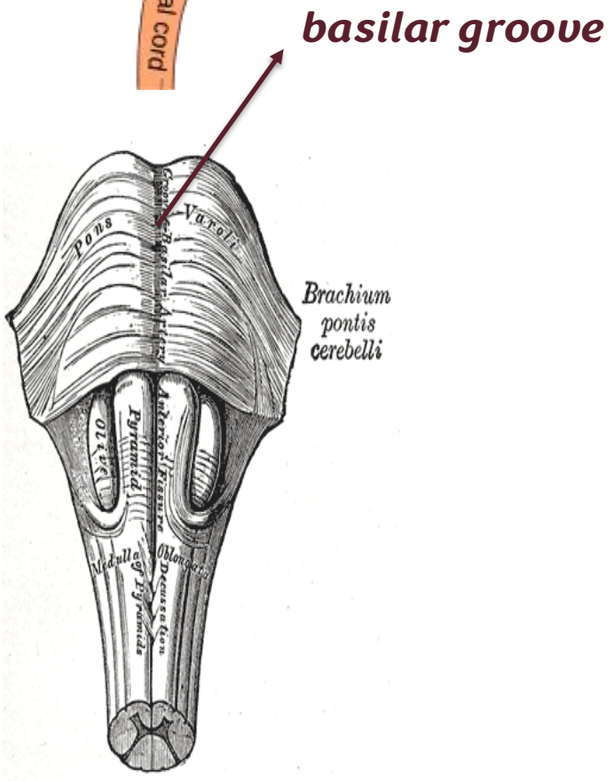
- The pons is a component of the brainstem located superior to the medulla oblongata and is located anterior to cerebellum
- 1 inch long
- Anterior surface is convex & shows transverse fibers

that converge on each side to form middle cerebellar peduncle

- Located between the midbrain and medulla oblongata
- Contains the nuclei of cranial nerves V, VI, VII and VIII

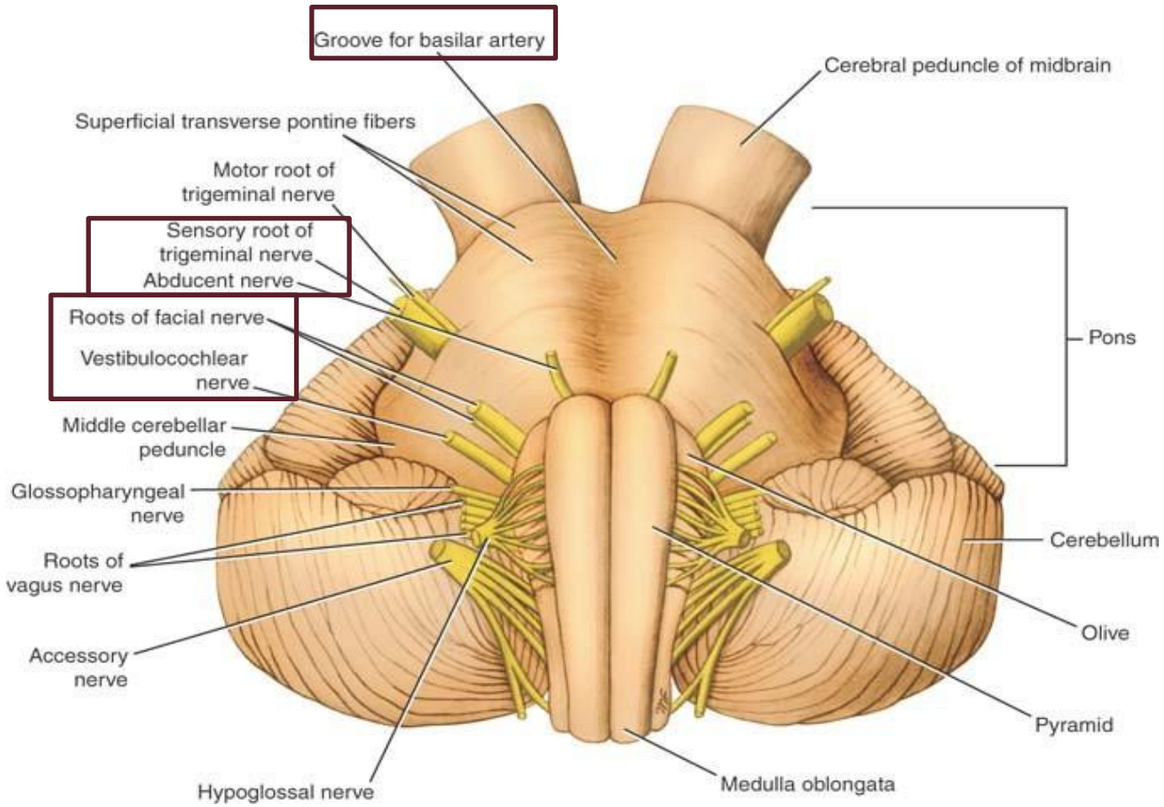
Additional figure





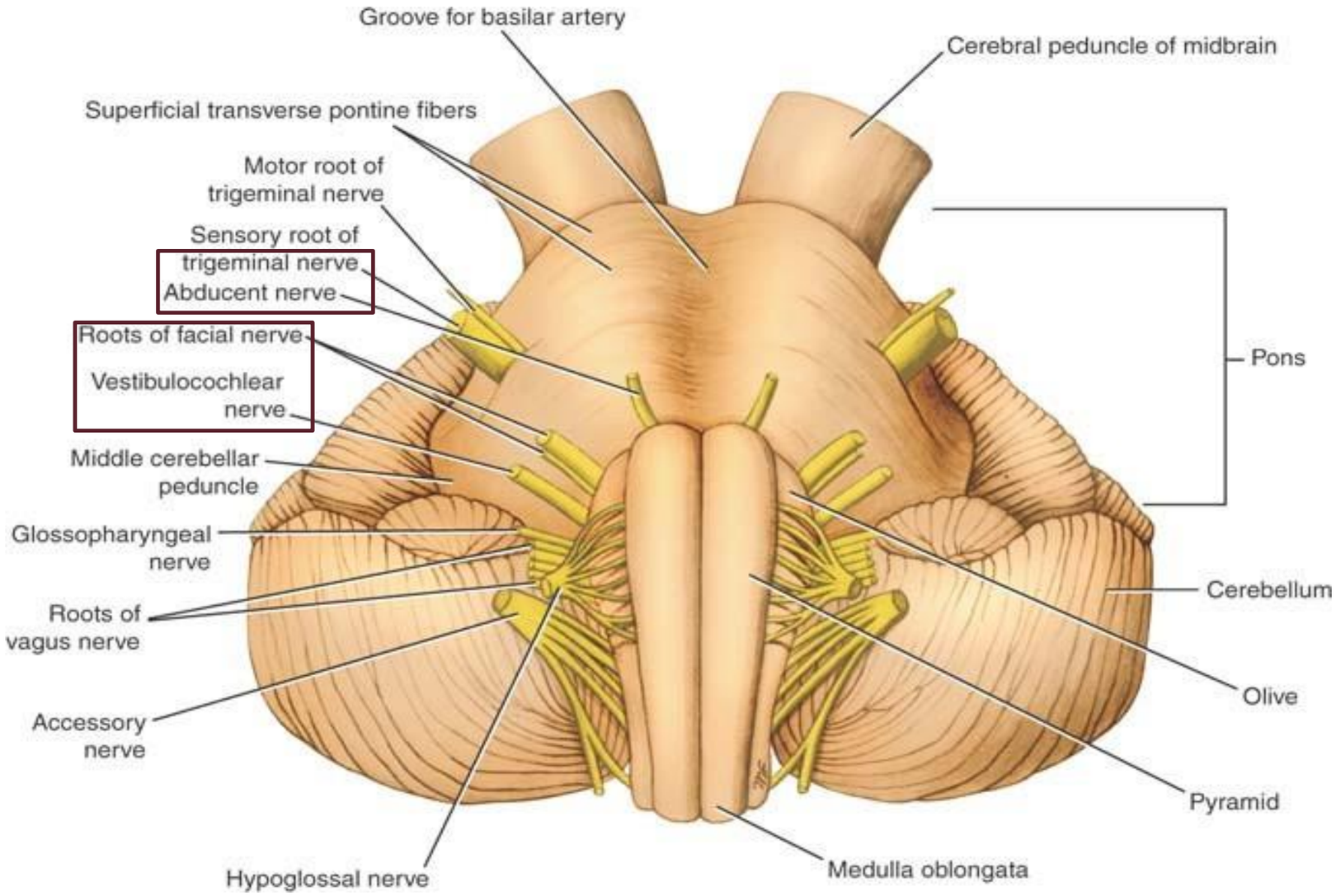
Gross appearance of pons (anterior surface)

- **Basilar groove** (midline). Contains basilar artery (important blood supply for the brain)
- The *trigeminal nerve* (cranial nerve **V**) emerges from the **mid-pontine** area.
- At the **pontomedullary junction,** which is the junction between the pons and the medulla oblongata, the *abducent* (cranial nerve **VI**), *facial* (cranial nerve **VII**), and *vestibulocochlear* (cranial nerve **VIII**) nerves emerge. (from medial to lateral).



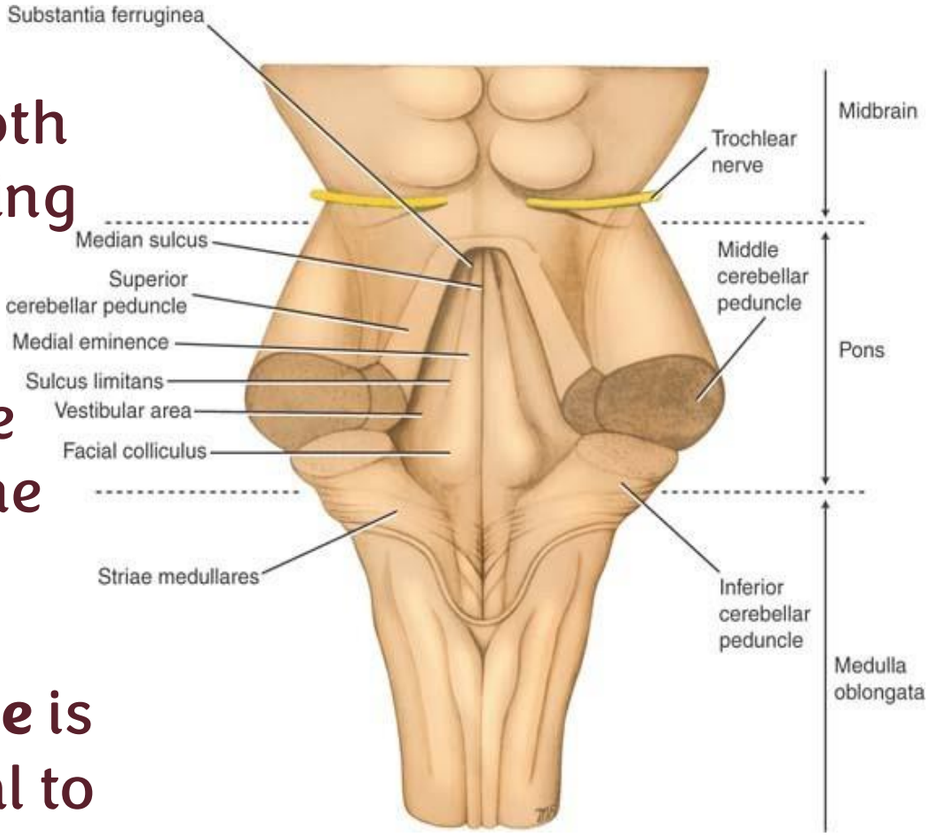
Gross appearance of pons (anterior surface)

- Basilar groove (midline)..lodges basilar artery
- 5th nerve emerges from anterolateral surface (small motor (medial) and large sensory (lateral)
- 6th 7th & 8th emerges at pontomedullary junction M→L



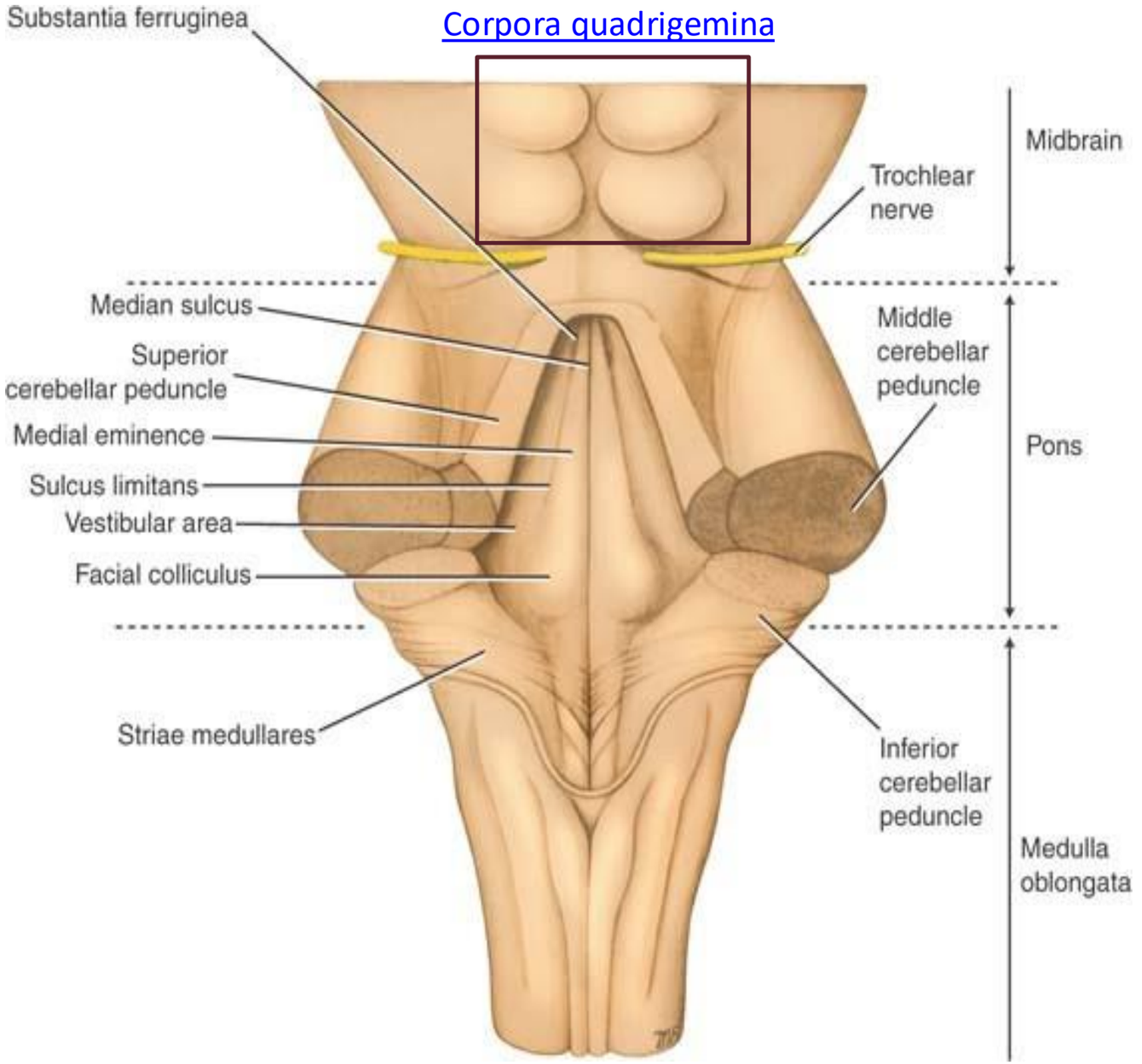
Gross appearance of the posterior surface of pons (cerebellum removed)

- The **floor of the fourth ventricle** is visible and has a rhomboid shape, as it is formed by structures from both the **pons and the medulla oblongata**. When considering only the pons, the portion of the floor it forms corresponds to the upper half, which is triangular in shape. Thus, the upper triangular pontine part and the lower triangular medullary part together constitute the **rhomboid fossa**, which forms the floor of the fourth ventricle
- In the 4th ventricle floor (rhomboid fossa), the **midline** is made by a sulcus known as the **median sulcus**. Lateral to the midline, another sulcus can be seen, which is called the **sulcus limitans**. Between the median sulcus and the sulcus limitans is the median eminence, which forms the **facial colliculus** inferiorly.
- **Vestibular area** (lateral to sulcus limitans).



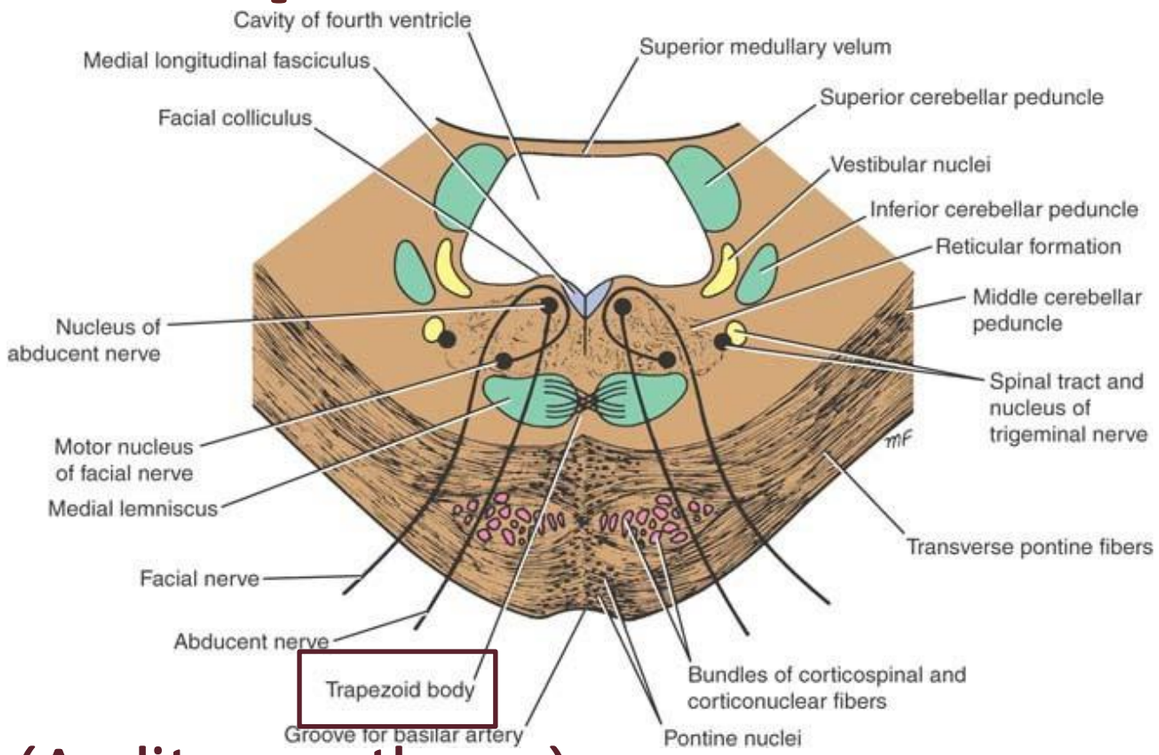
Gross appearance of the posterior surface of pons

- Its hidden by from view by cerebellum
- Forms the upper half of floor of 4th ventricle
- Triangular in shape
- Median sulcus
- Medial eminence
- Sulcus limitans
- Facialcolliculus (inf end of medial eminence)
- Area vestibuli (Lateral to sulcus limitans)
- In studying the internal structure of the pons, we will divide it to **2 levels** . The first level will be **“level of facial colliculus (caudal)”** and the second level will be **“level of trigeminal nuclei (cranial)”**



Internal structure of pons

- In the pons, there is the trapezoid body, which divides the cranial and caudal levels into anterior and posterior parts
- Anterior to the trapezoid body is the basilar part, which has the basilar groove most anteriorly. (contains basilar artery)
- Posterior to the trapezoid body is collectively known as the tegmentum.



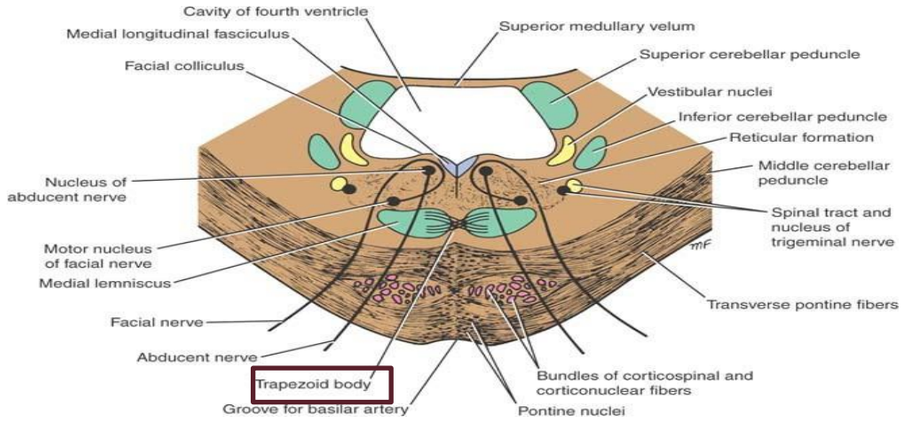
What is the trapezoid body?

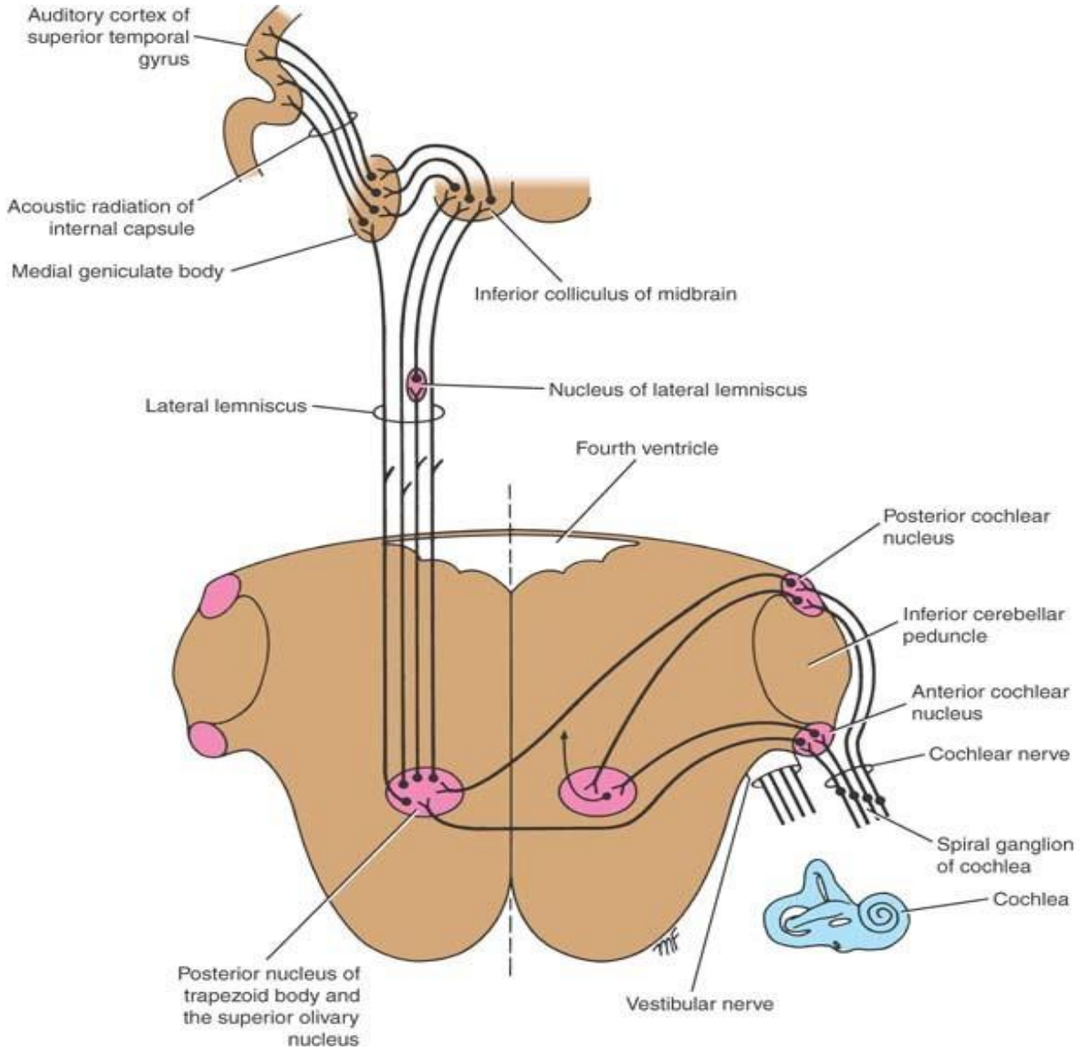
Trapezoid body is part of the acoustic pathway (Auditory pathway)

The acoustic pathway starts from the cochlea in inner ear, from which the cochlear nerve (part of vestibulocochlear nerve) which has its cell body in the spiral ganglion of Cochlea, goes to the brainstem (it pass through pontomedullary junction) to reach the anterior and posterior cochlear nuclei. Where synapse with 2nd order neuron occurs. Most of the 2nd order neurons decussates at the midline (contralateral) (some stay ipsilateral) These fibers that cross the midline are known as the trapezoid body.

Internal structure of pons

- From the trapezoid body, these fibers ascend in what is known as the **lateral lemniscus**. These fibers will reach the **inferior colliculus** -recall it controls the auditory reflexes- (In posterior aspect of midbrain/part of tectum), then they will go to **the medial geniculate body** (one of the thalamic nuclei) within the thalamus, and finally they will project to **the primary auditory cortex** (of the temporal lobe).





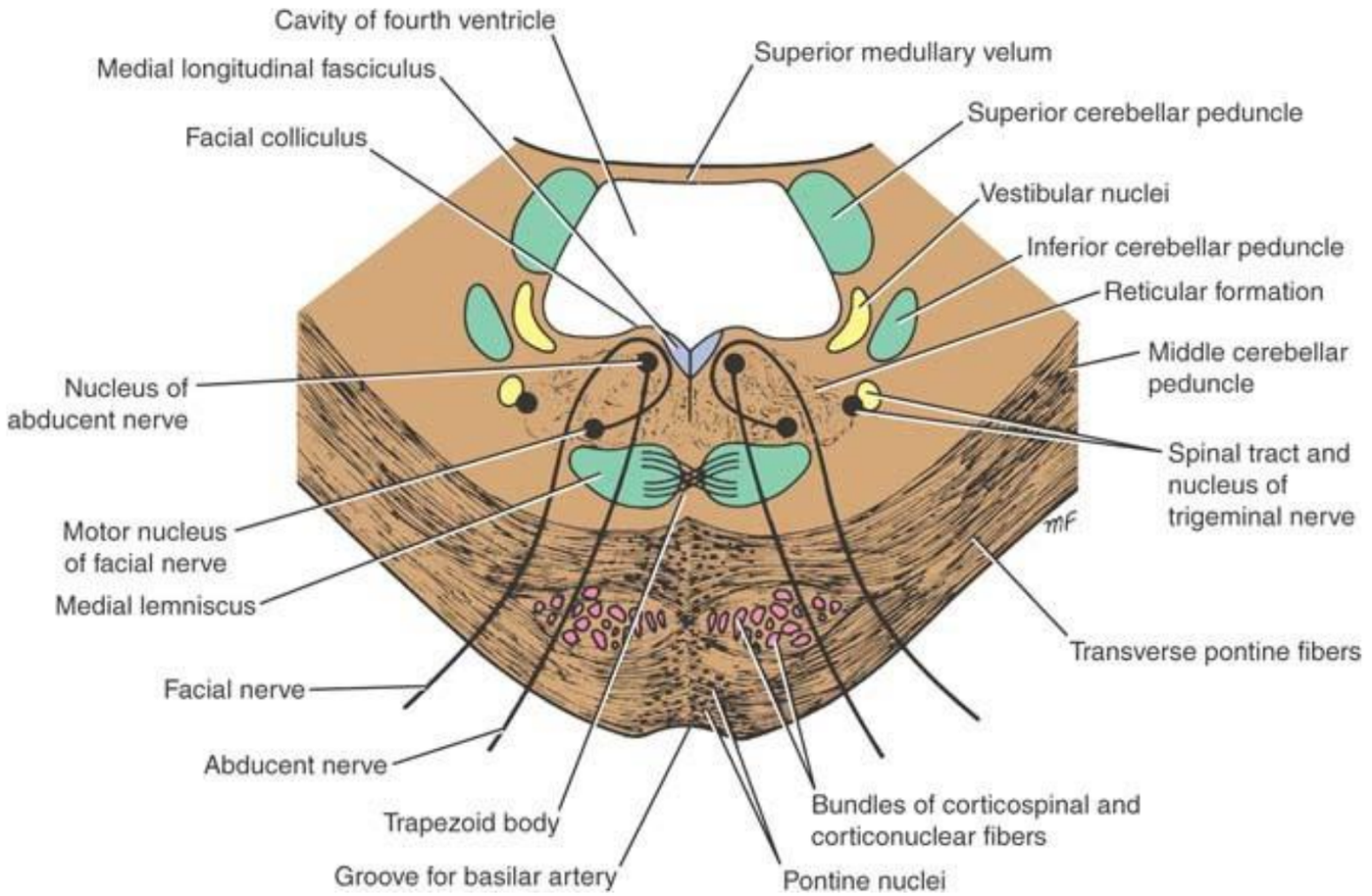
Internal structure of pons

- Its divided by transversely running fibers of trapezoid body into:

1. Tegmentum (post part)
2. Basal part (ant part)

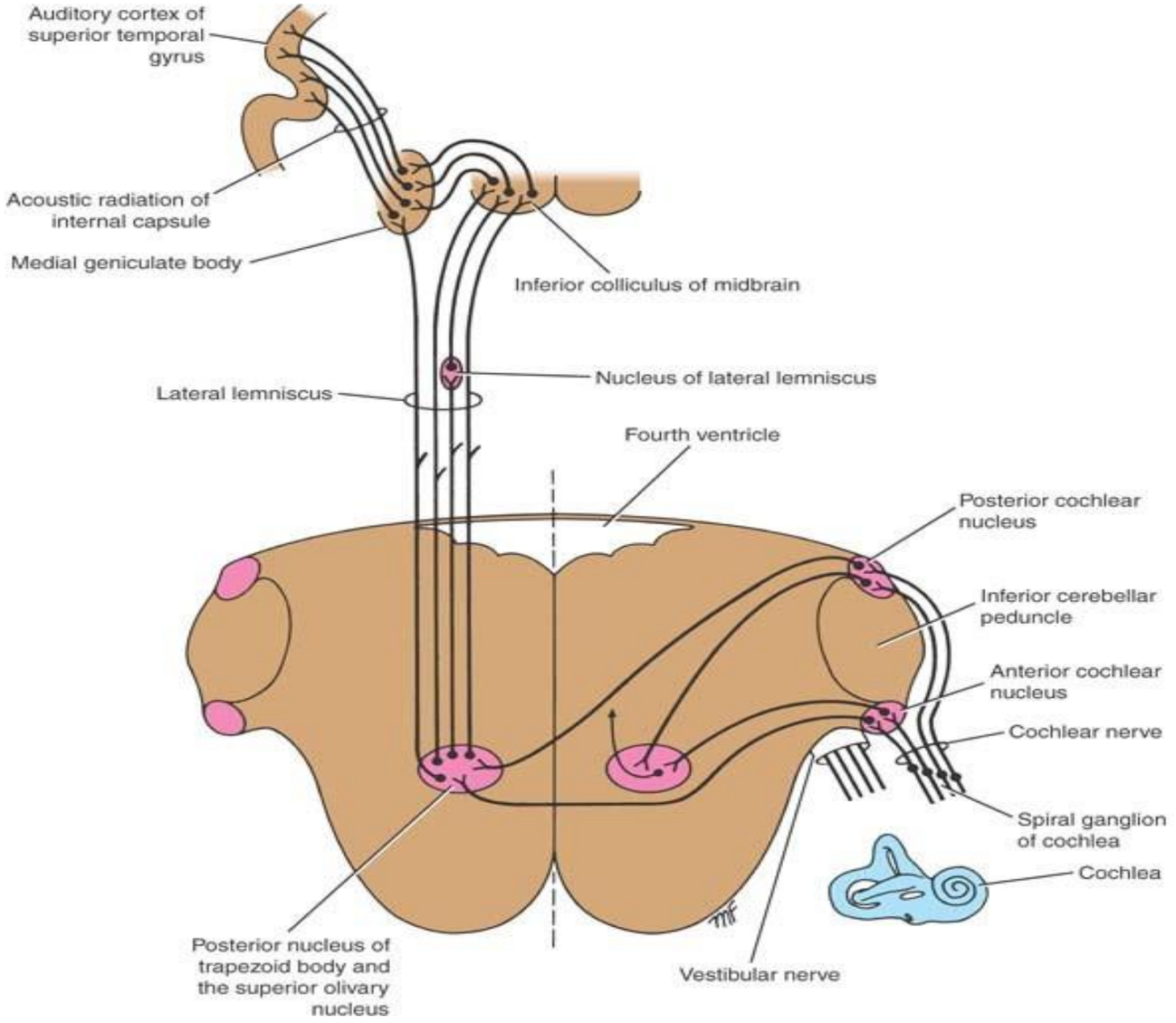
levels

- Level through caudal part (facial colliculus)
- Level through cranial part (trigeminal nuclei)



The trapezoid body

- is part of the acoustic pathway
- Made up of fibers derived from cochlear nuclei
- **lateral lemniscus**: tract of axons in the brainstem that carries information about sound from the cochlear nucleus to the contralateral inferior colliculus of the midbrain
- Cochlear nuclei---- trapezoid body---- lateral lemniscus---- inf colliculus-----medial geniculate body----- auditory cortex

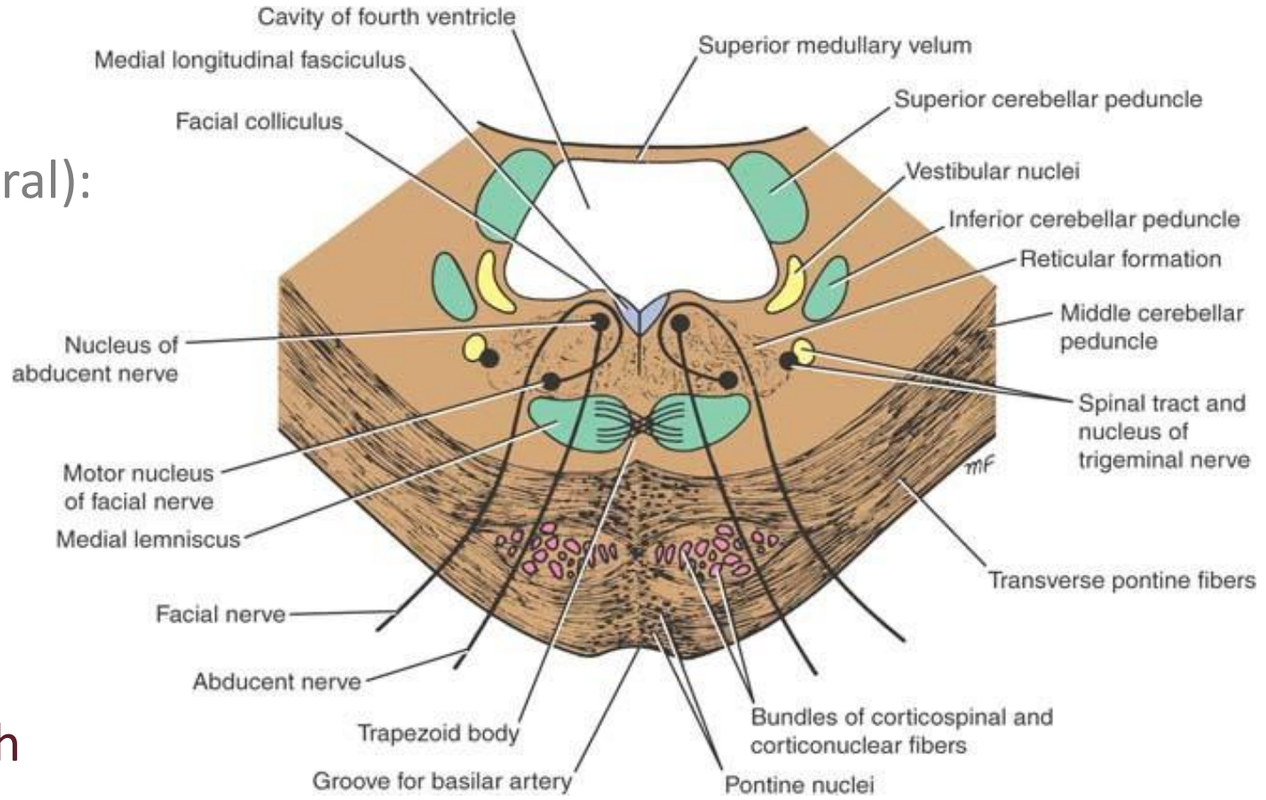


Level through caudal part (facial colliculus)

- Cavity seen in the section is the 4th ventricle.

1. The Tegmentum (everything posterior to the trapezoid body) (from medial to lateral):

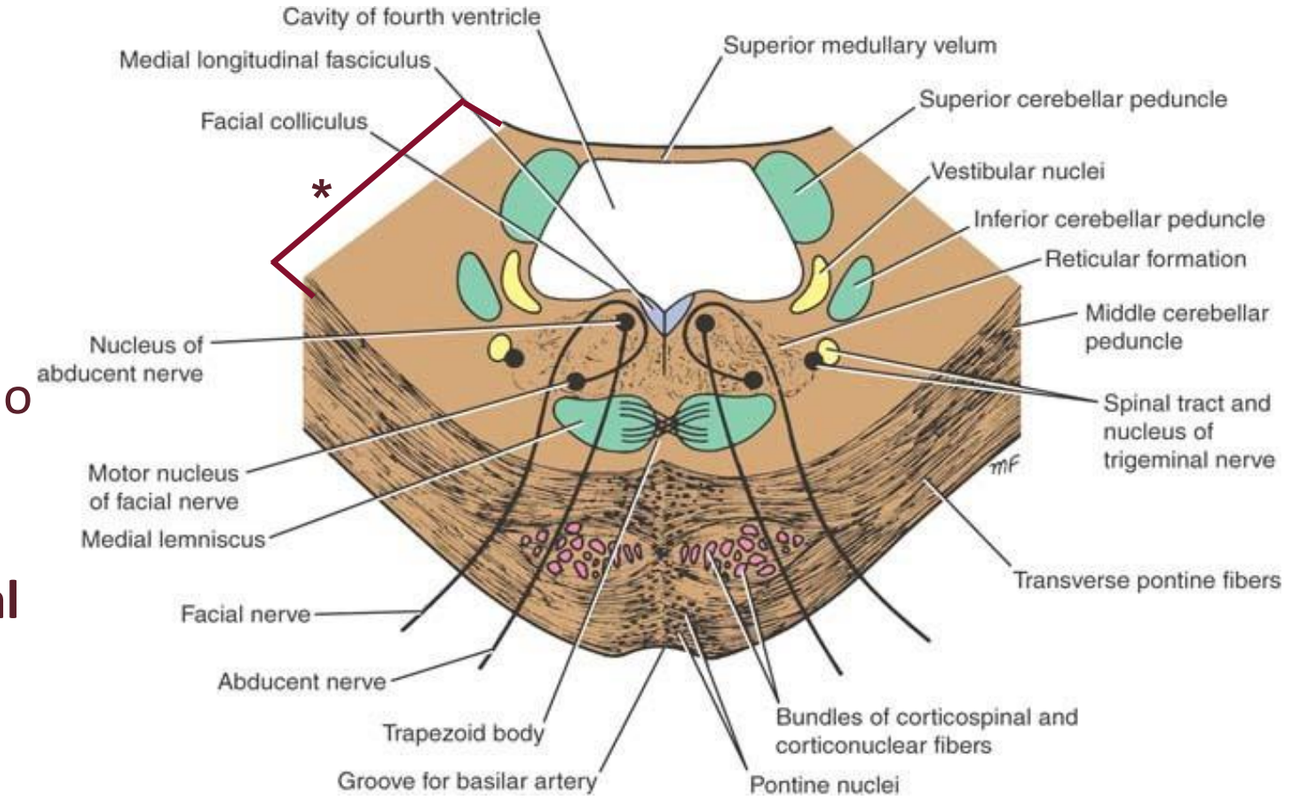
- Trapezoid body (at the midline)
- **Medial lemniscus** most anterior part of the tegmentum, long axis running transversely
- Note that the **lateral lemniscus** is not visible yet, since its formed by the trapezoid body itself.
- **MLF**: beneath the floor of the fourth ventricle on either side of the midline, it connects the motor nuclei of the third, forth and six cranial nerves with the vestibular nuclei and the upper cervical segments.



- **Abducent nucleus:** beneath the floor of the upper part of the fourth, supplies the lateral rectus muscle, the fibers arise anteriorly, passing through the basilar part then through the pontomedullary junction.
- **Spinal nucleus** of trigeminal and its tract: anteromedial aspect of ICP
- **Medial vestibular nucleus:** lateral to the abducent nucleus

Level through caudal part (facial colliculus)

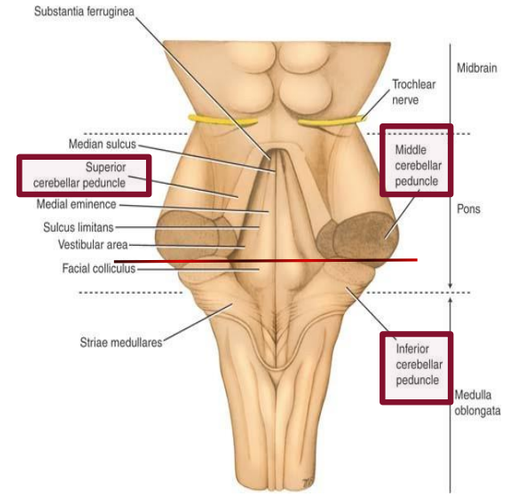
- **Facial nucleus** posterior to the lateral part of the medial lemniscus. The motor facial nuclei are found directly posterior to the medial lemniscus, relatively far away from the fourth ventricle. The fibers of the motor facial nuclei have an unusual pathway. The fibers move posteriorly and turn (do a U-turn) around the abducent nuclei, then they emerge from the ponto-medullary junction. **This turn is responsible for the formation of the facial colliculus distinct shape.**



- Note there are 3 cerebellar peduncles

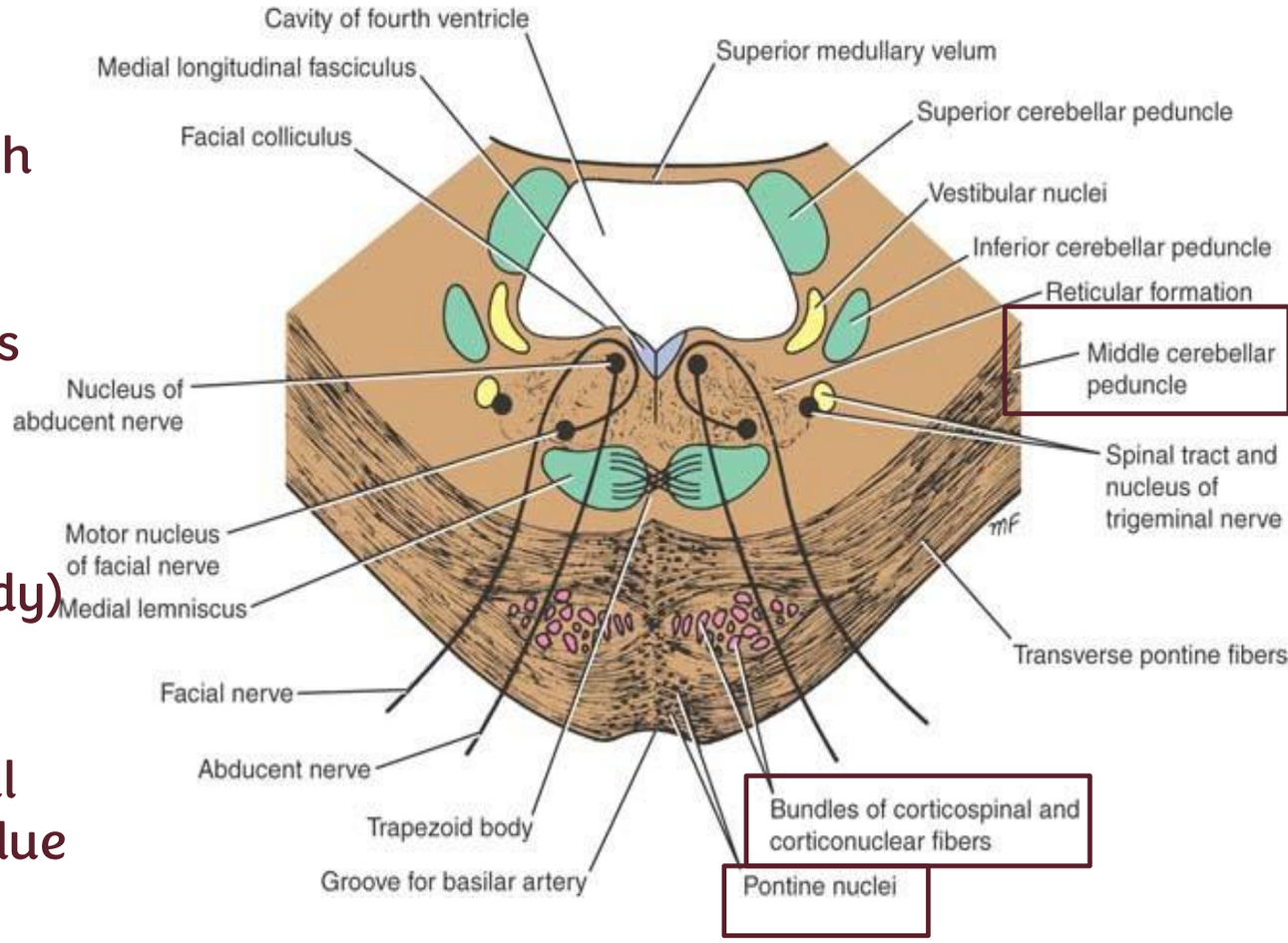
1. Inferior cerebellar peduncle (connect medulla oblongata and cerebellum)
2. Middle cerebellar peduncle* (connect pons and cerebellum)
3. Superior cerebellar peduncle (connect Midbrain and cerebellum)

Middle cerebellar peduncle is found on the outside, whereas the superior and inferior cerebellar peduncles are found to the inside. That is why all three can be found in the same section.



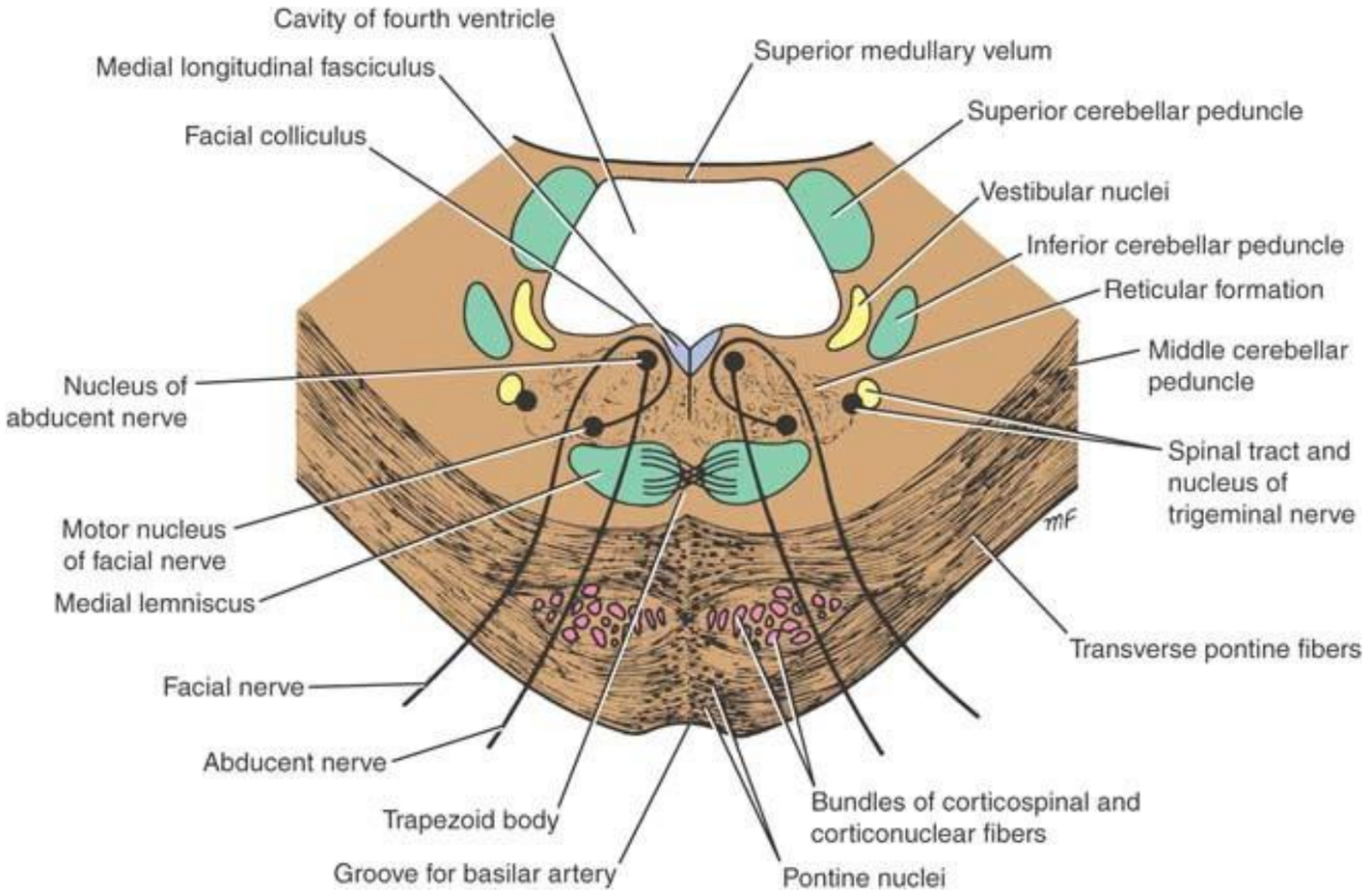
Level through caudal part (facial colliculus)

- 2. The basilar part (anterior to the trapezoid body)
- Notice the basilar groove most anteriorly.
- Note the **pontine nuclei** (group of cell bodies)
- Transverse fibers, known as transverse pontine fibers, **form the middle cerebellar peduncle** which will reach the cerebellum posteriorly.
- This pathway is known as the **cerebro-ponto-cerebellar pathway**, which means that it connects the cerebrum with the cerebellum.
- This pathway is very important because the **cerebellum receives information** from the spinal cord about the muscle-joint sense (position of body) and because the cerebellum must also receive information **about the intended movement.**
- Bundles of **corticospinal tract** fibers descend until they reach this section where they get **scattered** due to the presence of the pontine nuclei.
- The descending **corticospinal tract** fibers and the **cerebro-ponto-cerebellar pathway** transverse fibers intersect at this point .



Level through caudal part (facial colliculus)

- Basilar part of pons contain small masses of nerve cells called pontine nuclei
- Corticopontine fibers terminate in pontine nuclei
- Axons of these cells give origin to transverse fibers of the pons which cross the midline and intersect the corticospinal & corticonuclear tracts, breaking them into small bundles
- Transverse fibers enter MCP to cerebellum
- This connection is the main pathway linking cerebellum to cerebral cortex



Facial Nerve Nuclei

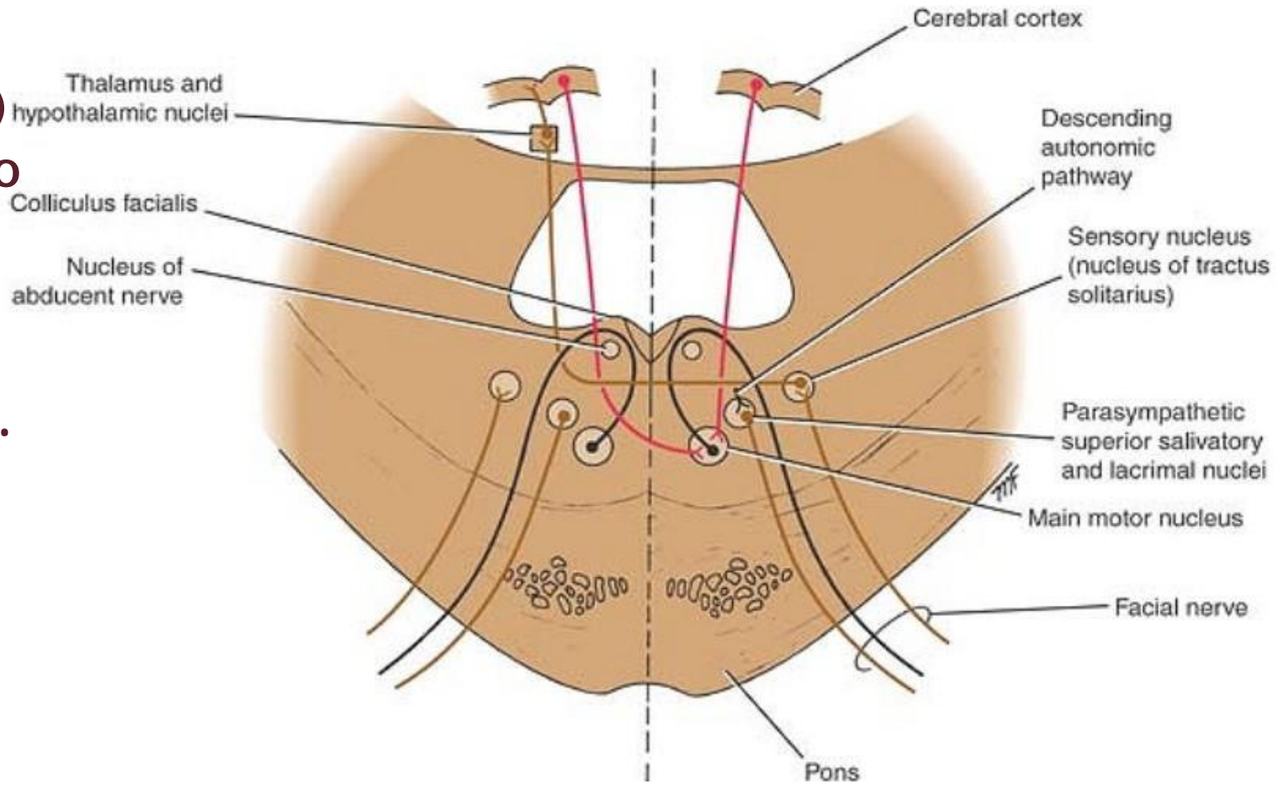
1. **Superior salivatory nucleus/ Salivatory lacrimatory nucleus (Parasympathetic nuclei)**

- It gives preganglionic parasympathetic supply to the **submandibular** and **sublingual** glands (salivatory) but NOT parotid gland. Parotid by Glossopharyngeal nerve.
- It also supplies the **lacrimal gland** (lacrimatory).
- These preganglionic fibers will synapse in an autonomic ganglia before supplying the glands
- It is located posterolateral to the main motor nucleus. (discussed before)

2. Part of the nucleus of tractus solitarius (sensory nucleus of facial nerve)

Located posterolateral to the parasympathetic nucleus of facial nerve.

It receives taste sensation from the anterior 2/3 of the tongue.



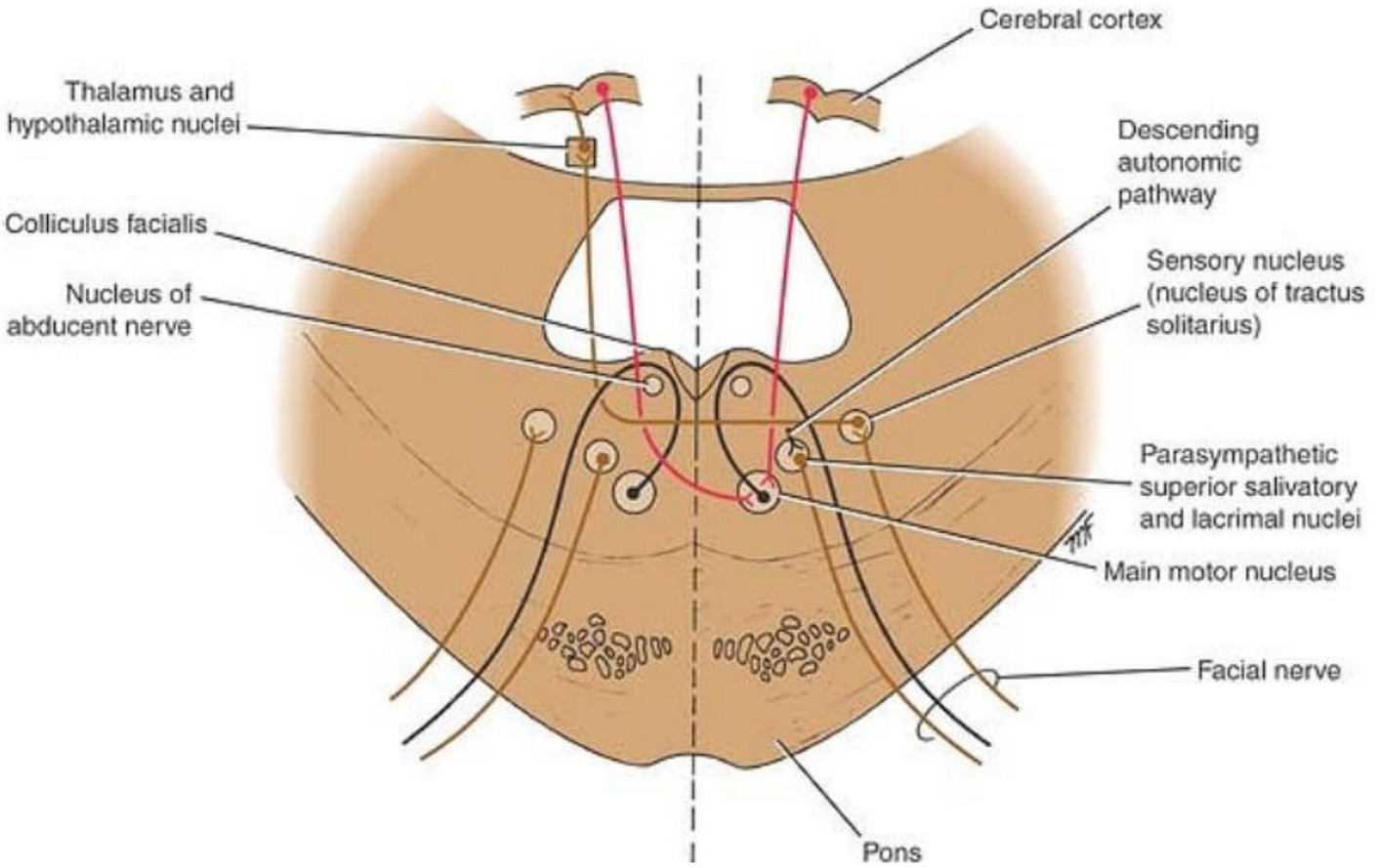
Facial Nerve Nuclei

Parasympathetic Nuclei:

- **Location**: Posterolateral to the main motor nucleus

- **superior salivatory:** receives from the hypothalamus

- **Lacrimal nucleus:** receives from
  - hypothalamus (Emotional)
  - sensory nuclei of the trigeminal (reflex)



Level through cranial part (trigeminal nuclei)

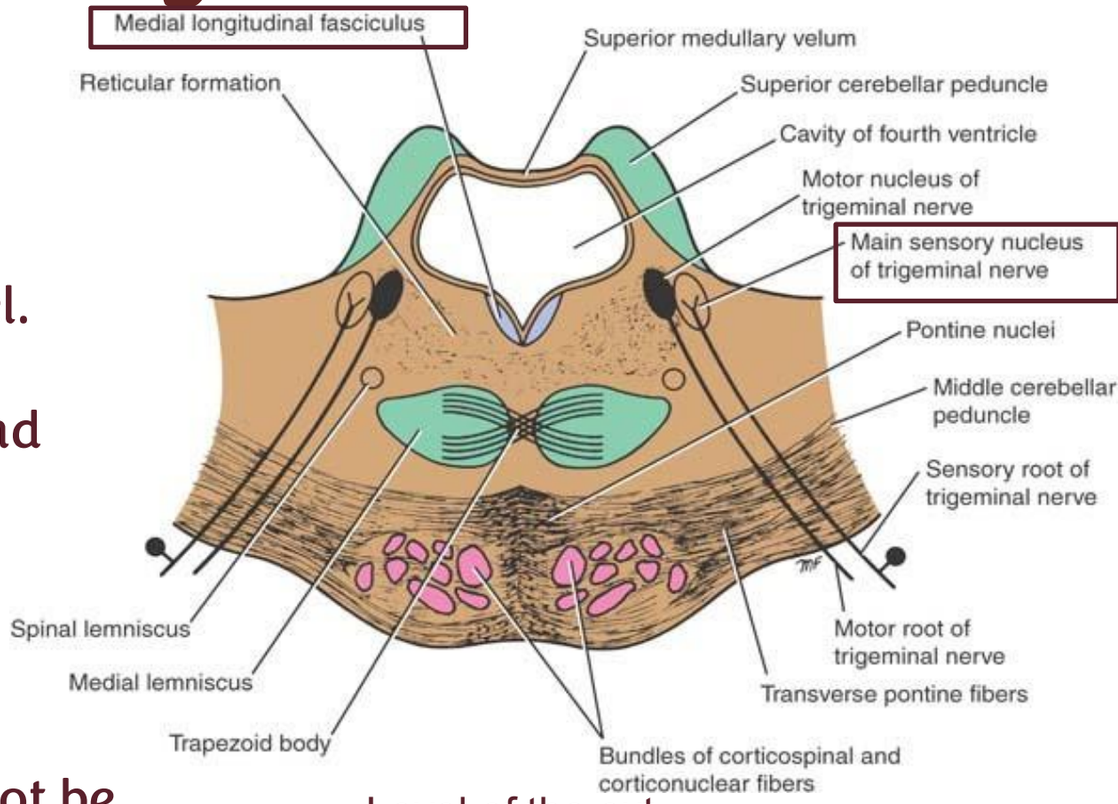
- This is the **midpontine area,** which means that only the **trigeminal nuclei** will be seen.
- Cavity seen in this section is the 4th ventricle.

1. The basilar part

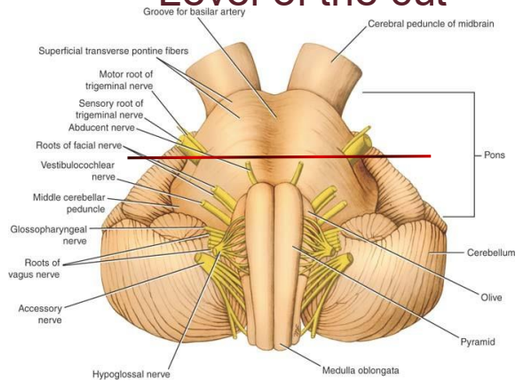
Similar to the previous level. No change from previous level.

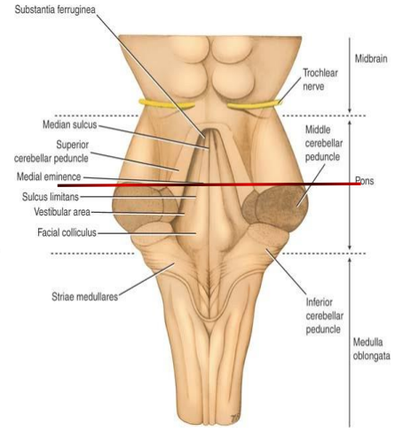
2. The tegmentum

- Inferior cerebellar peduncle not visible. Only superior and middle cerebellar peduncles can be seen.
- The **spinal lemniscus & medial lemniscus** can be seen, while the lateral is still forming.
- **Motor nucleus** of trigeminal nerve can be seen.
- Lateral to it is the **main/principle sensory nucleus.**
- Notice that the **spinal nucleus of trigeminal nerve** cannot be seen in this section. It is located inferiorly. Extending from the cervical region -lowest part of medulla oblongata- all the way to just below the cranial part of the pons (the caudal part of pons). At the level of the cranial part of pons, the spinal nucleus of trigeminal nerve cannot be seen. Since it's replaced by the principle/main sensory nucleus of trigeminal.



Level of the cut





Trigeminal Nerve Nuclei

Recall that the trigeminal has 3 sensory nuclei (from down to up they are arranged):

1. Spinal Nucleus of the Trigeminal Nerve

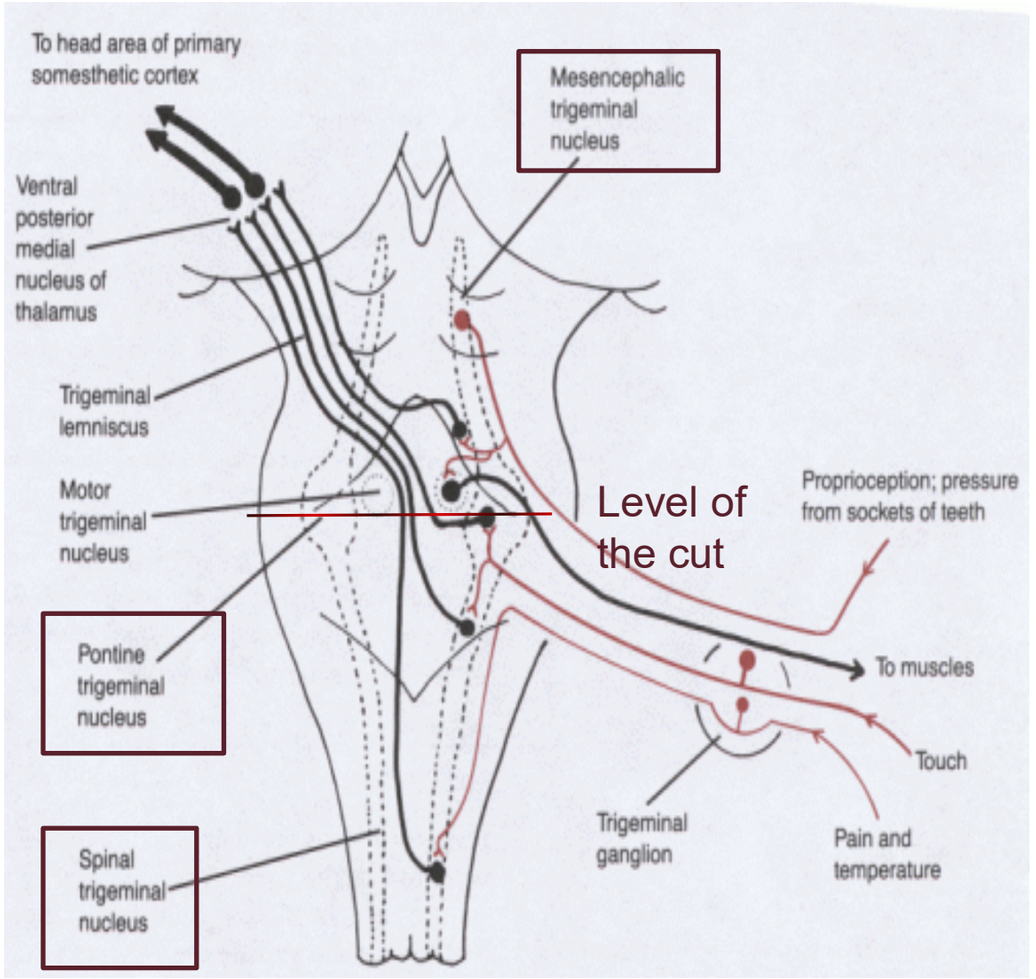
- Functionally similar to the Anterior Lateral Spinothalamic Tract (ALST).
- Carries pain, temperature, and crude touch from the head and neck.
- Can't be seen at the cranial level.

2. Main (Principal) Sensory Nucleus of the Trigeminal Nerve

- Functionally similar to the Dorsal Column–Medial Lemniscus Pathway (DCMLT).
- Receives: Discriminative touch, Vibration and Proprioception.

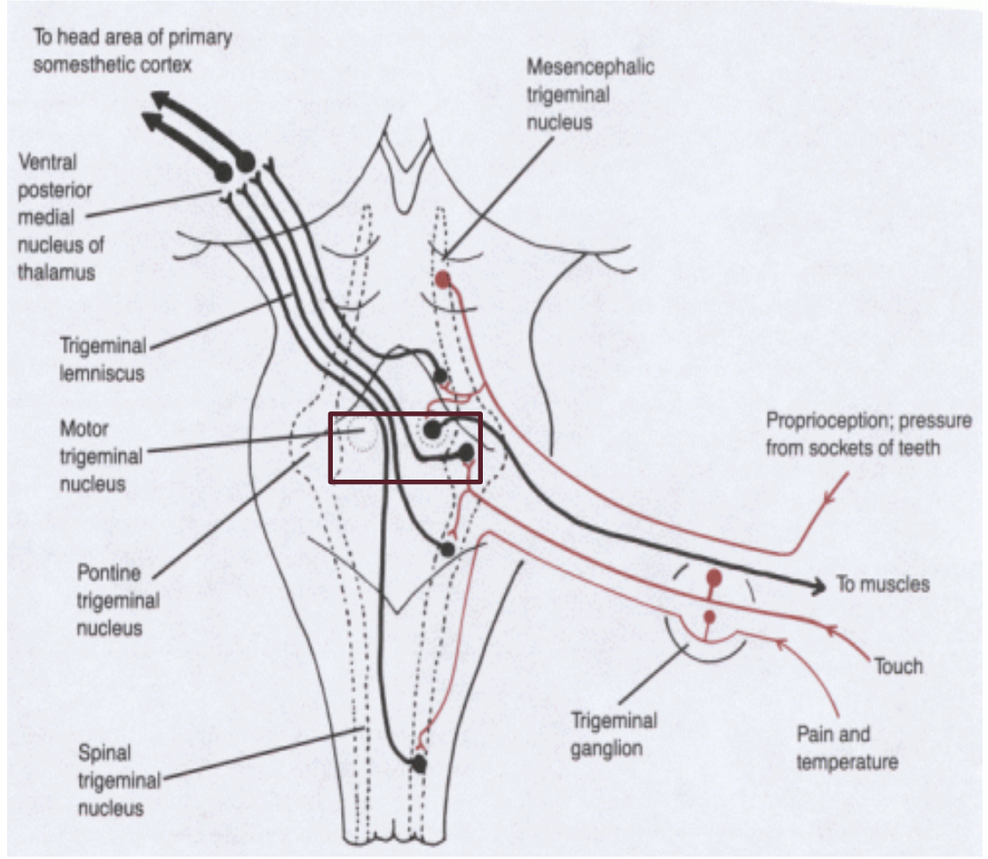
3. Mesencephalic Trigeminal Nucleus (midbrain-related)

- Reflexes (Jaw Reflex)
- Proprioception (muscle joint sense) from muscles of mastication and dental sockets.



Trigeminal Nerve Nuclei

- Sensory 1st-order neurons of the trigeminal nerve have their cell bodies in the trigeminal ganglion (resembling Dorsal root ganglion).
- The 1st-order neurons synapse in the main (principal) sensory nucleus, the spinal nucleus, or the mesencephalic trigeminal nucleus.
- The 2nd-order neurons, arising after synapsis with the nuclei, cross the midline.
- After crossing, they form the trigeminal lemniscus, which ascends to the Thalamus and synapses in the Ventroposteromedial Nucleus (VPM) .
- 3rd-order neurons: arise from the VPM of the thalamus and project to the primary somatosensory cortex (postcentral gyrus) for perception of facial sensation.



4. Motor Nucleus of the Trigeminal Nerve

- Located medial to the sensory nuclei
- Supplies the:

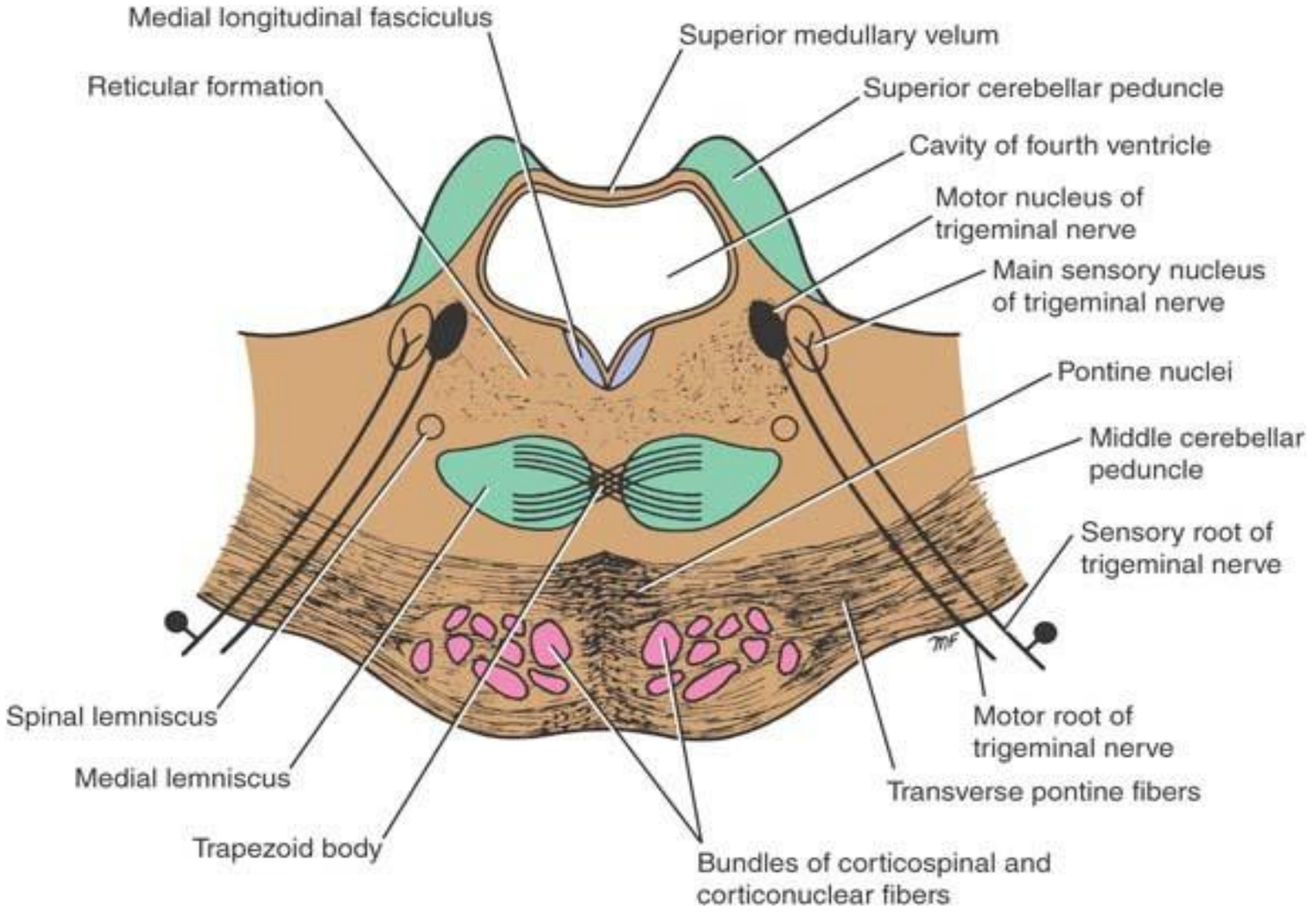
a. muscles of mastication:

1)Masseter 2)Temporalis 3)Medial Pterygoid Muscle 4) Lateral Pterygoid Muscle

a. Tensor tympani
b. Tensor veli palatini
c. Mylohyoid
d. Anterior belly of the digastric muscle

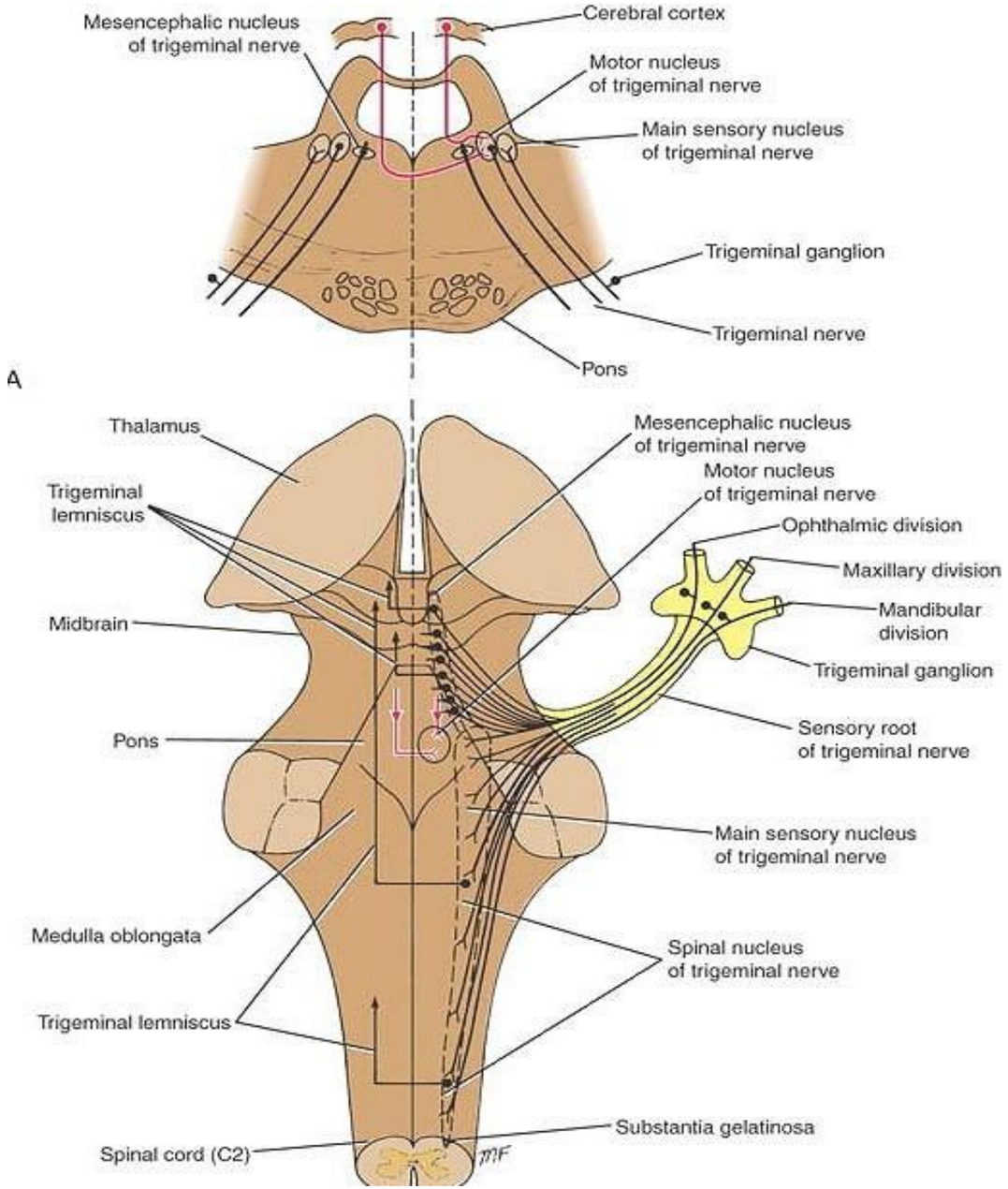
Level through cranial part (trigeminal nuclei)

- **Motor nucleus** of trigeminal n: beneath the lateral part of thefourth ventricle within the reticular formation
- **Main Sensory** nucleus of trigeminal n (*lateral*)
- **SCP:** posterolateral to the motor nucleus of V
- **Trapezoid body**
- **Medial leminiscus**
- **Lateral leminiscus, Spinal leminiscus**: lateral extremity of the medial lemniscus



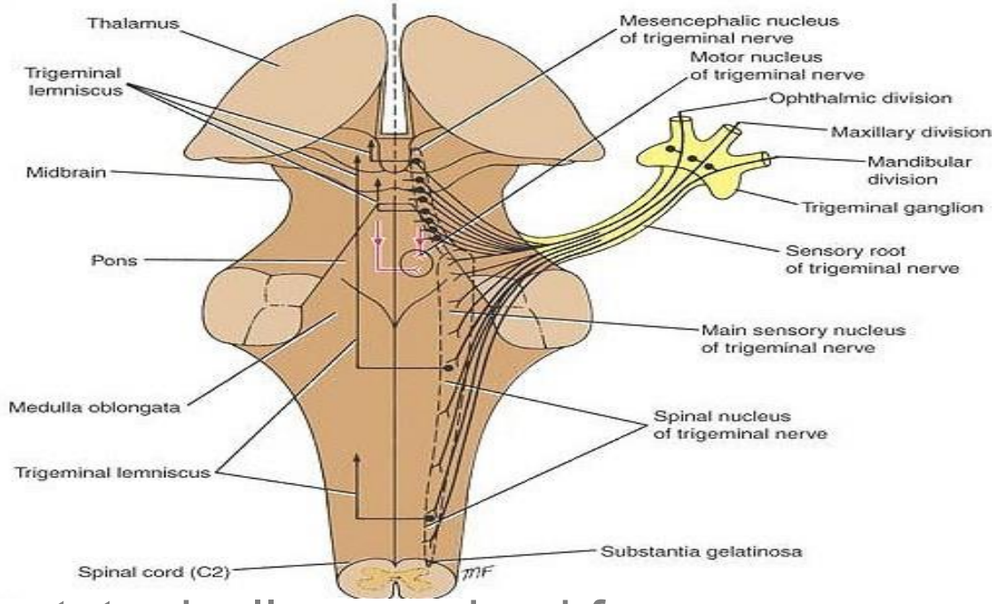
Trigeminal Nerve Nuclei

- **Main sensory nucleus**
  - Posterior part of the pons (lateral)
- **Motor nucleus**
  - Posterior part of the pons (Medial)
- **Spinal nucleus**
  - Superiorly: main sensory nucleus
  - Inferiorly: C2 segment
- **Mesencephalic nucleus**
  - Lateral part of the gray matter around the cerebral aqueduct
  - Inferiorly main sensory nucleus



Sensory Components

- Trigeminal sensory ganglion: (Cell bodies)
- Ascending branches: main sensory nucleus
- Descending branches: spinal nucleus
- Division:
  - ophthalmic inferior part of SN
  - Maxillary: middle part of SN
  - Mandibular: superior part of SN
  - The spinal nucleus (SN) of the trigeminal nerve is somatotopically organized from superior to inferior: mandibular (V3) fibers from the jaw enter the superior SN, maxillary (V2) fibers from the cheek enter the middle SN, and ophthalmic (V1) fibers from the forehead/eye enter the inferior SN.



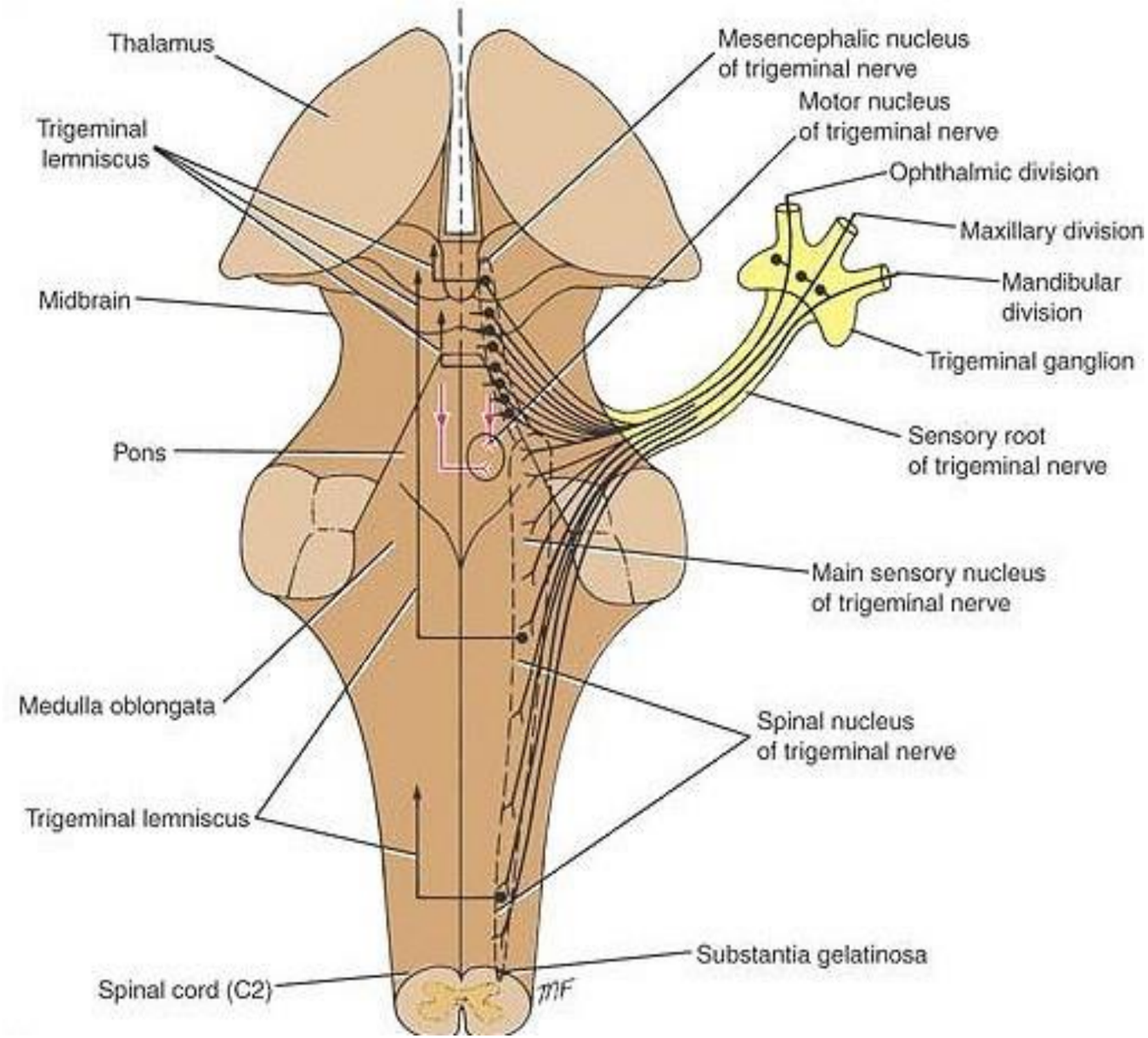
- Main sensory nucleus: discriminative and light touch of the face as well as conscious proprioception, (similar to PCML)
- Spinal nucleus: crude touch, pain, and temperature (similar to ALS)
- Mesencephalic nucleus: reflex proprioception of the periodontal ligament and of the muscles of mastication in the jaw

Motor Components

- Motor nucleus receives
  - Corticonuclear fibers
  - Red nucleus
  - Reticular formation
  - Tectum

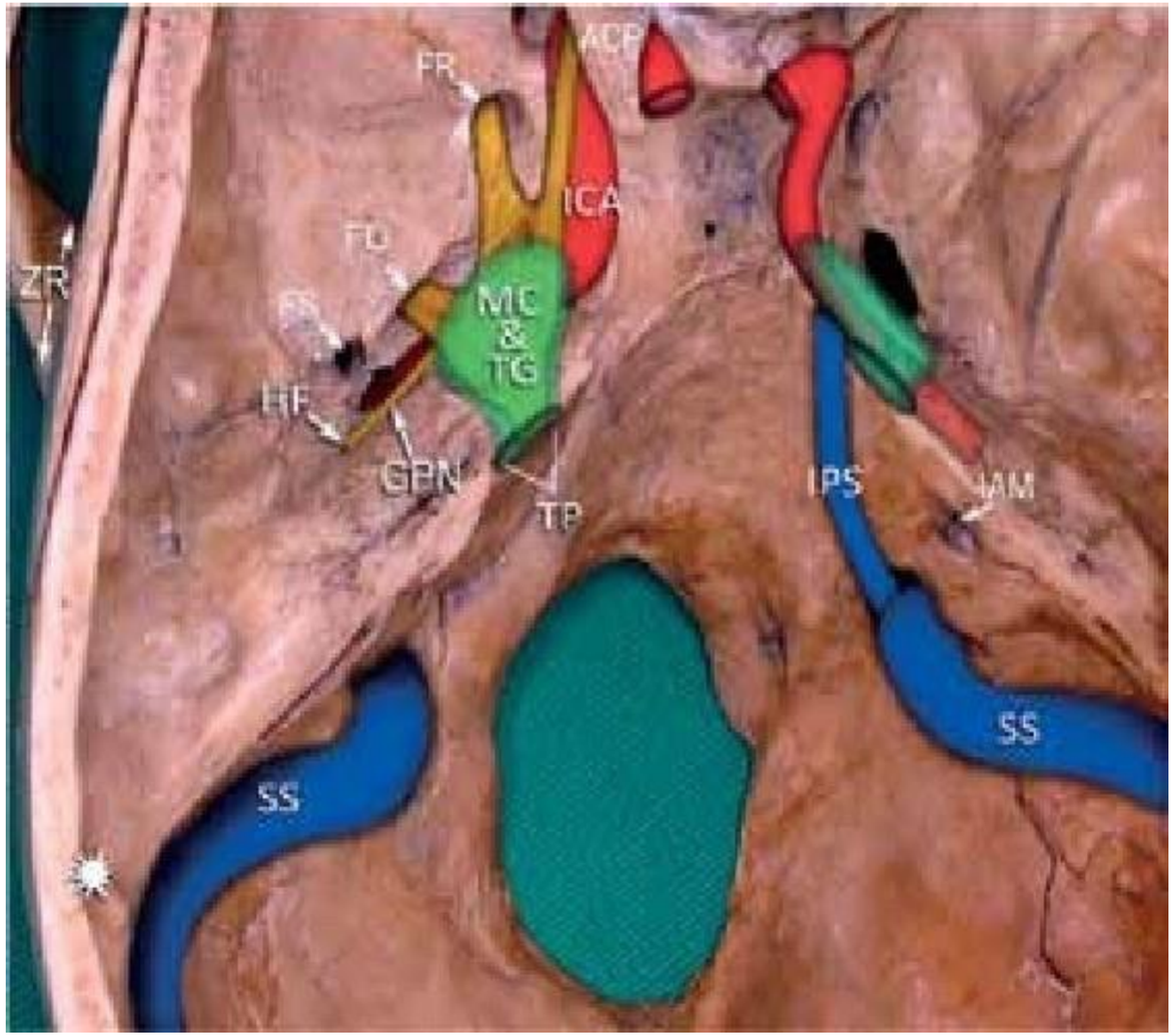
- Supplies
  - Muscles of mastication
  - Tensor tympani

- Tensor veli palatini
- Mylohyoid
- Anterior belly of the digastric muscle

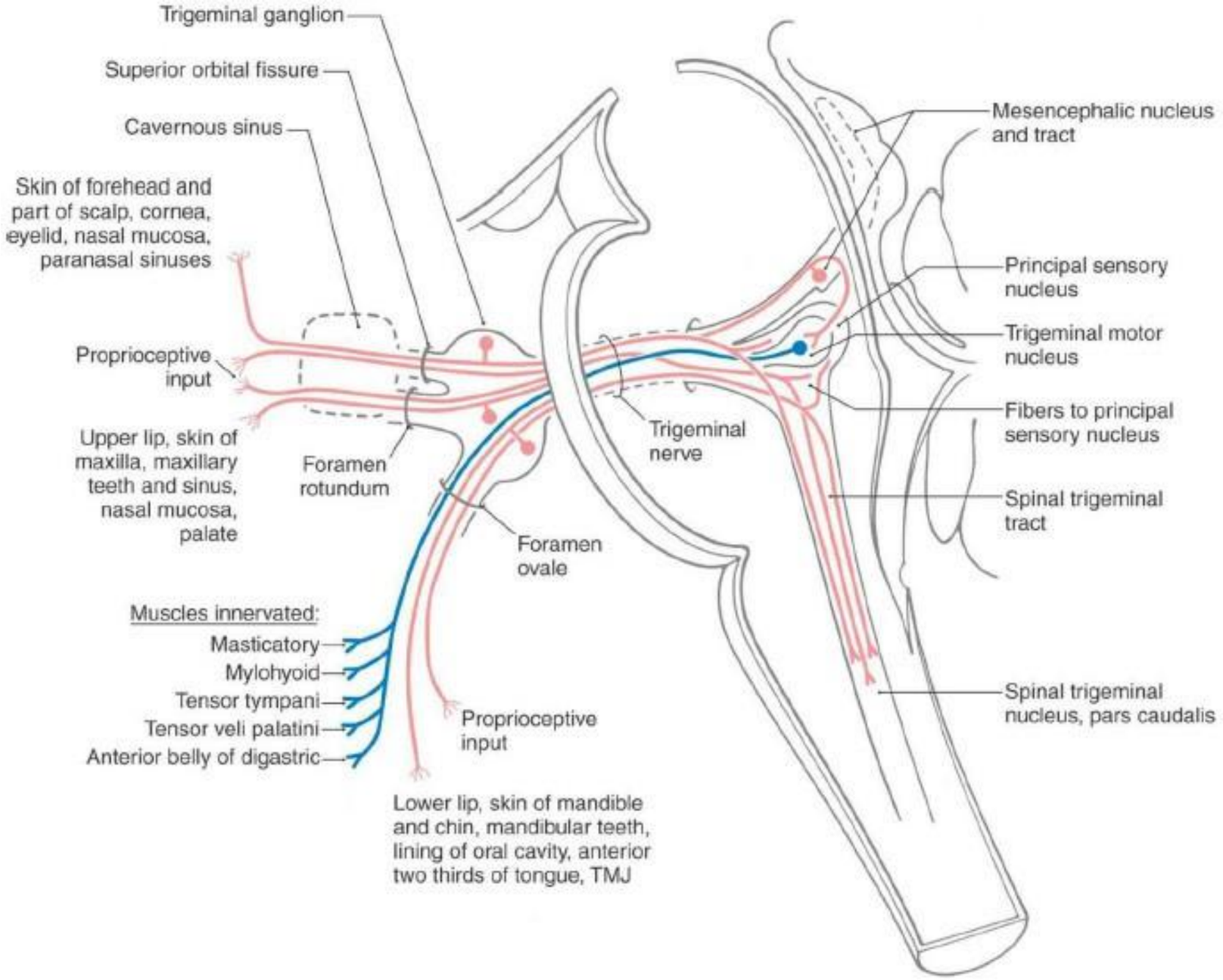


Course of V

- Anterior aspect of the pons
- Upper surface of the apex of the petrous bone
- Trigeminal ganglion: in **Meckel cave:** pouch of dura mater
- Divisions:
  - Ophthalmic: superior orbital fissure
  - Maxillary: foramen rotundum
  - Mandibular: foramen ovale

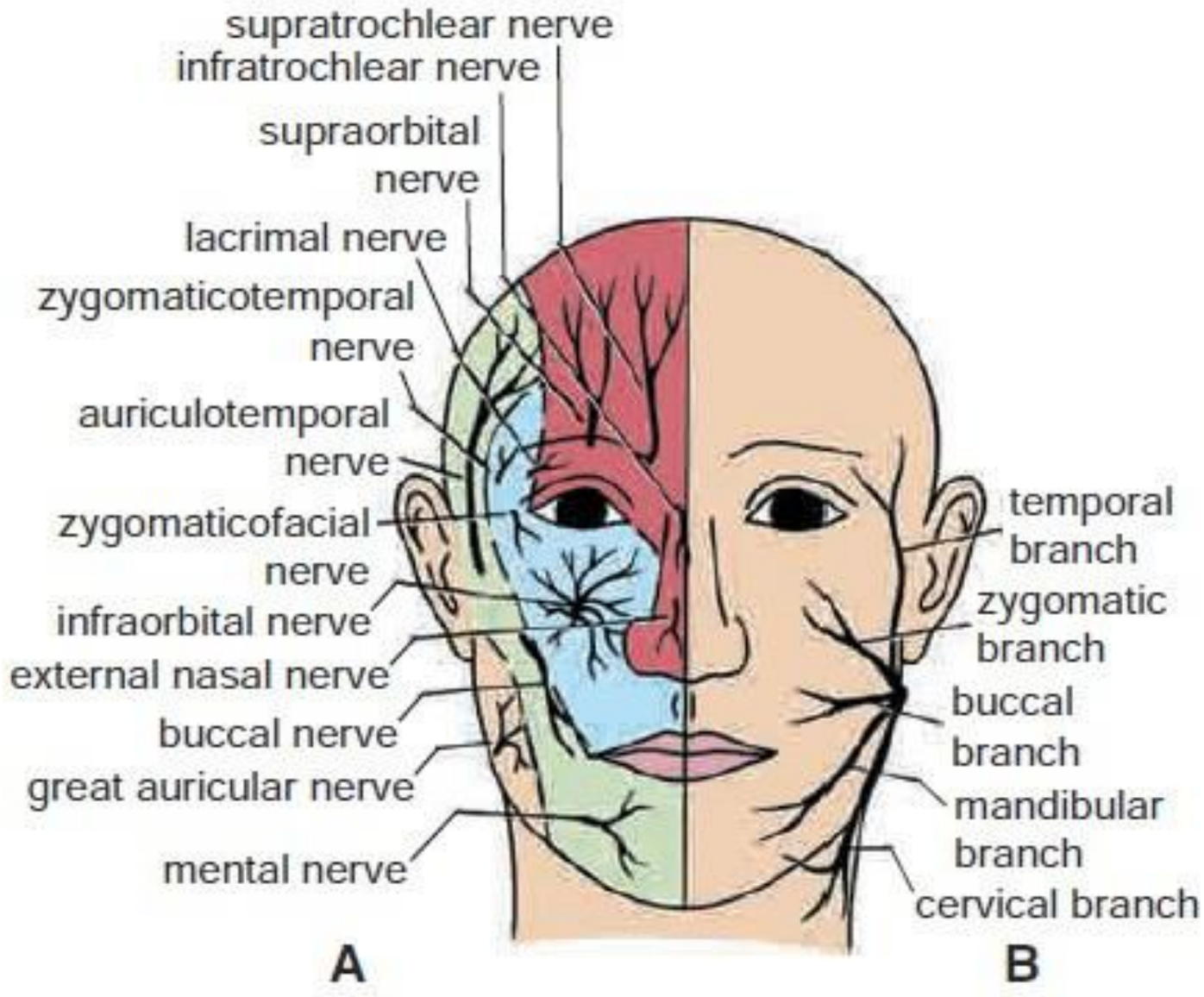


Course of V


Trigeminal ganglion
Superior orbital fissure
Cavernous sinus
Skin of forehead and part of scalp, cornea, eyelid, nasal mucosa, paranasal sinuses
Proprioceptive input
Upper lip, skin of maxilla, maxillary teeth and sinus, nasal mucosa, palate
Foramen rotundum
Trigeminal nerve
Foramen ovale
Muscles innervated:
Masticatory
Mylohyoid
Tensor tympani
Tensor veli palatini
Anterior belly of digastric
Proprioceptive input
Lower lip, skin of mandible and chin, mandibular teeth, lining of oral cavity, anterior two thirds of tongue, TMJ
Mesencephalic nucleus and tract
Principal sensory nucleus
Trigeminal motor nucleus
Fibers to principal sensory nucleus
Spinal trigeminal tract
Spinal trigeminal nucleus, pars caudalis

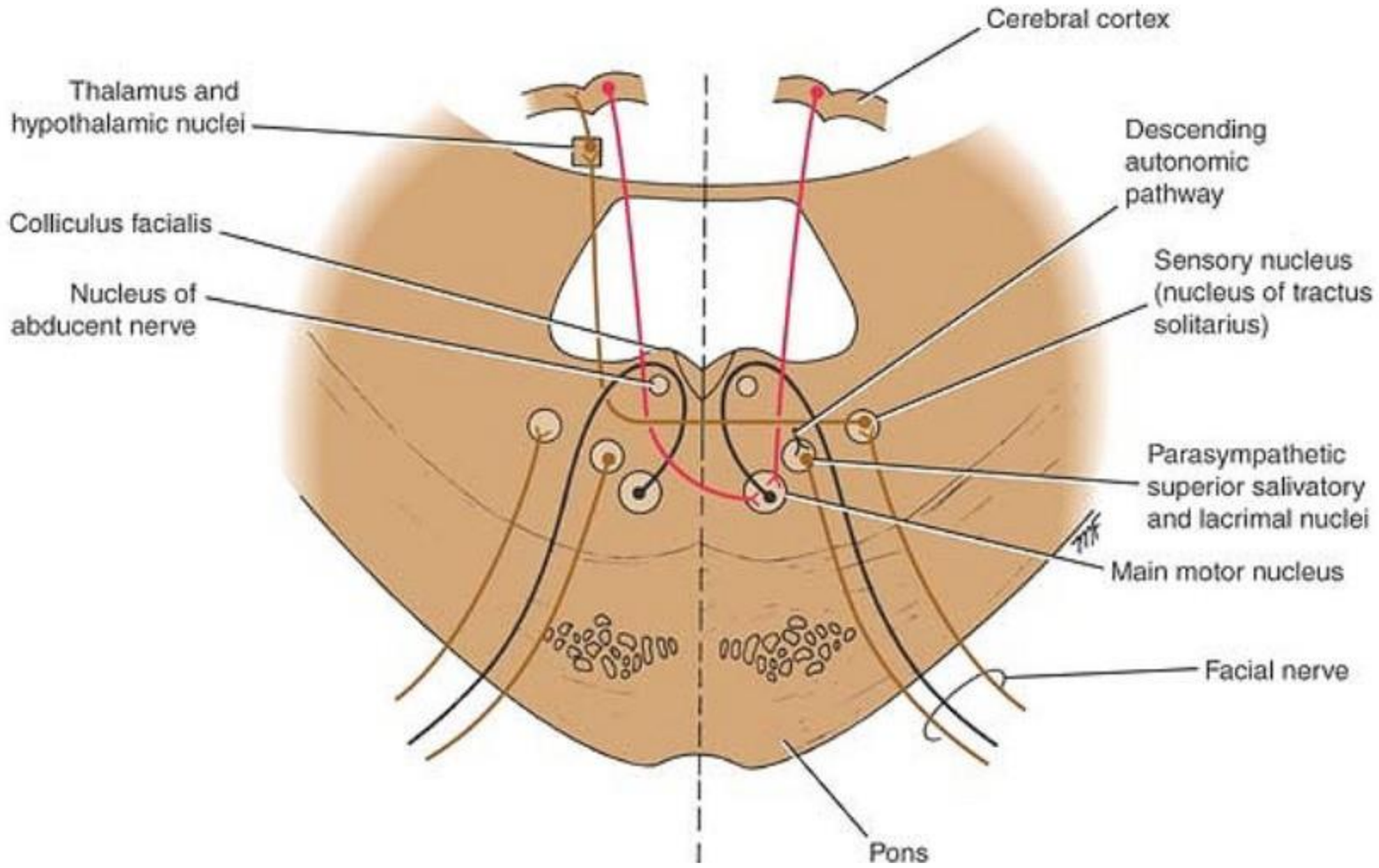
Trigeminal sensory map

- The whole face is supplied by the trigeminal nerve in terms of sensory supply, with one exception.
- **The facial angle receives sensory innervation from the great auricular nerve, which arises from C2 of the cervical plexus.**
- Note the specific supply for each division of the trigeminal.



Facial Nerve Nuclei

- **Main Motor Nucleus**
- Deep in the reticular formation of the lower part of the pons
- The part of the nucleus that supplies
  - **Upper part** of the face receives corticonuclear fibers from **both** hemispheres. (Bilateral supply)
  - **lower part** of the face receives only corticonuclear fibers from the **opposite** cerebral hemisphere (contralateral supply)



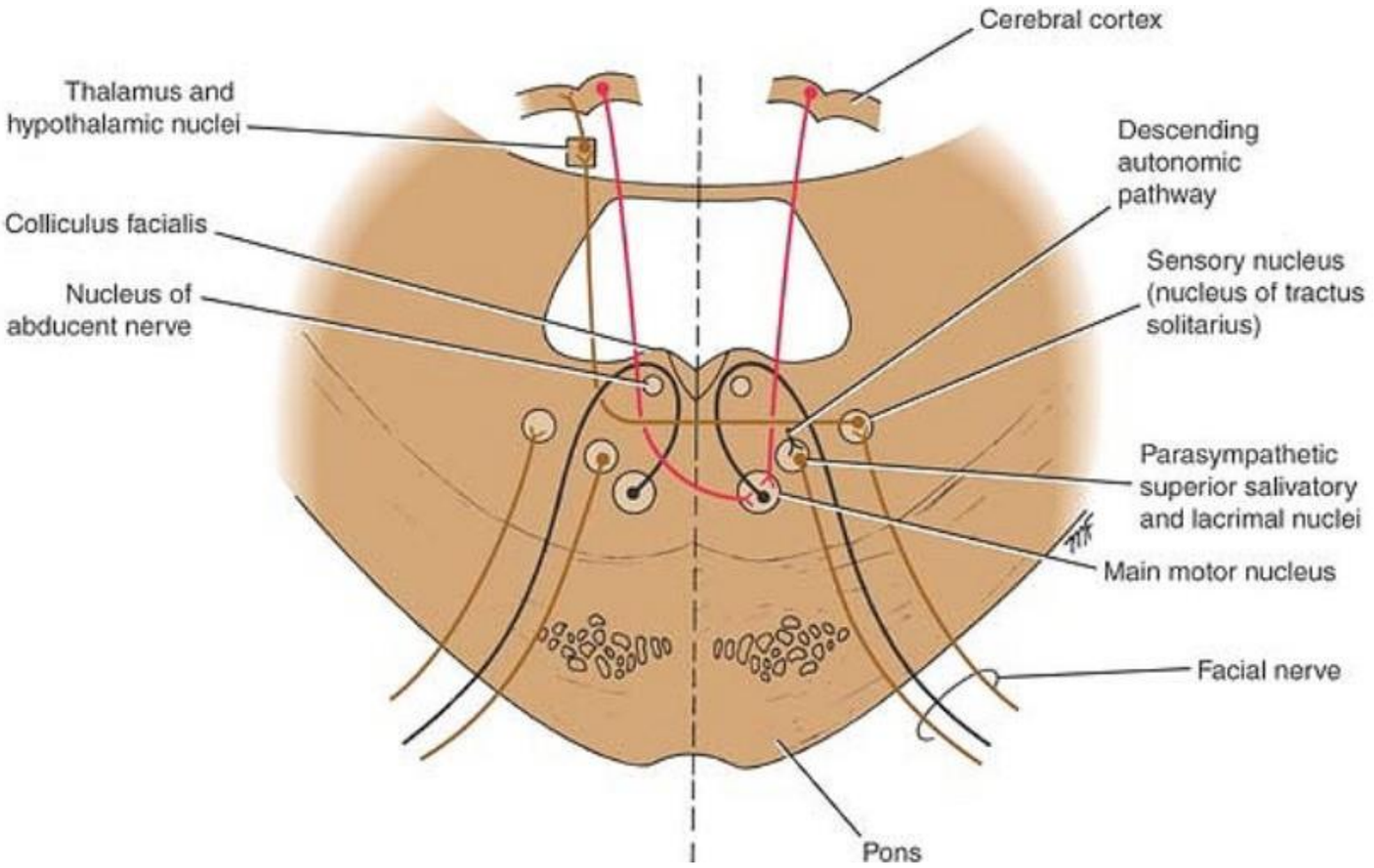
Facial Nerve Nuclei

Parasympathetic Nuclei:

- **Location**: Posterolateral to the main motor nucleus

- **superior salivatory:** receives from the hypothalamus

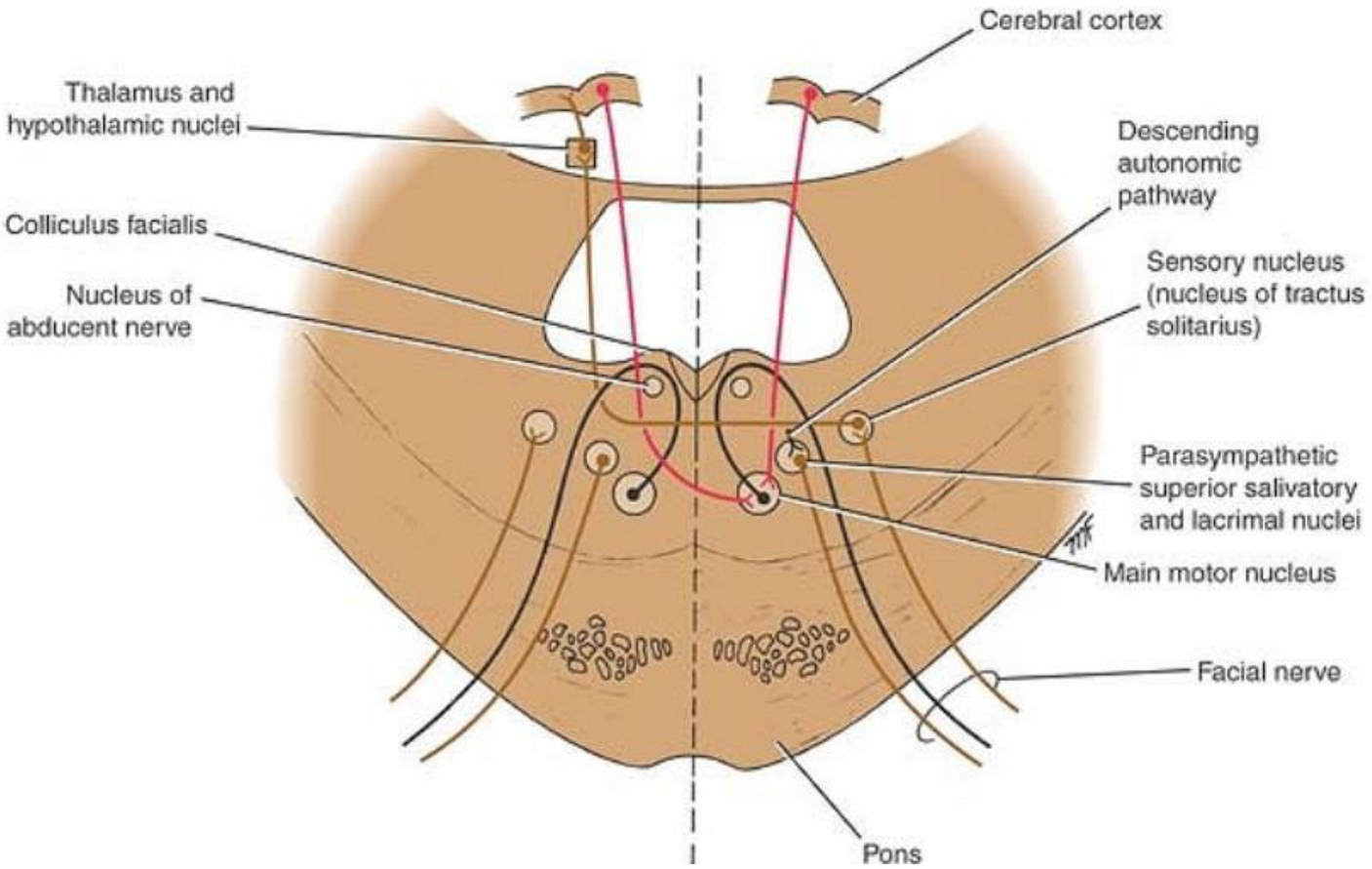
- **Lacrimal nucleus:** receives from
  - hypothalamus (Emotional)
  - sensory nuclei of the trigeminal (reflex)



Facial Nerve Nuclei

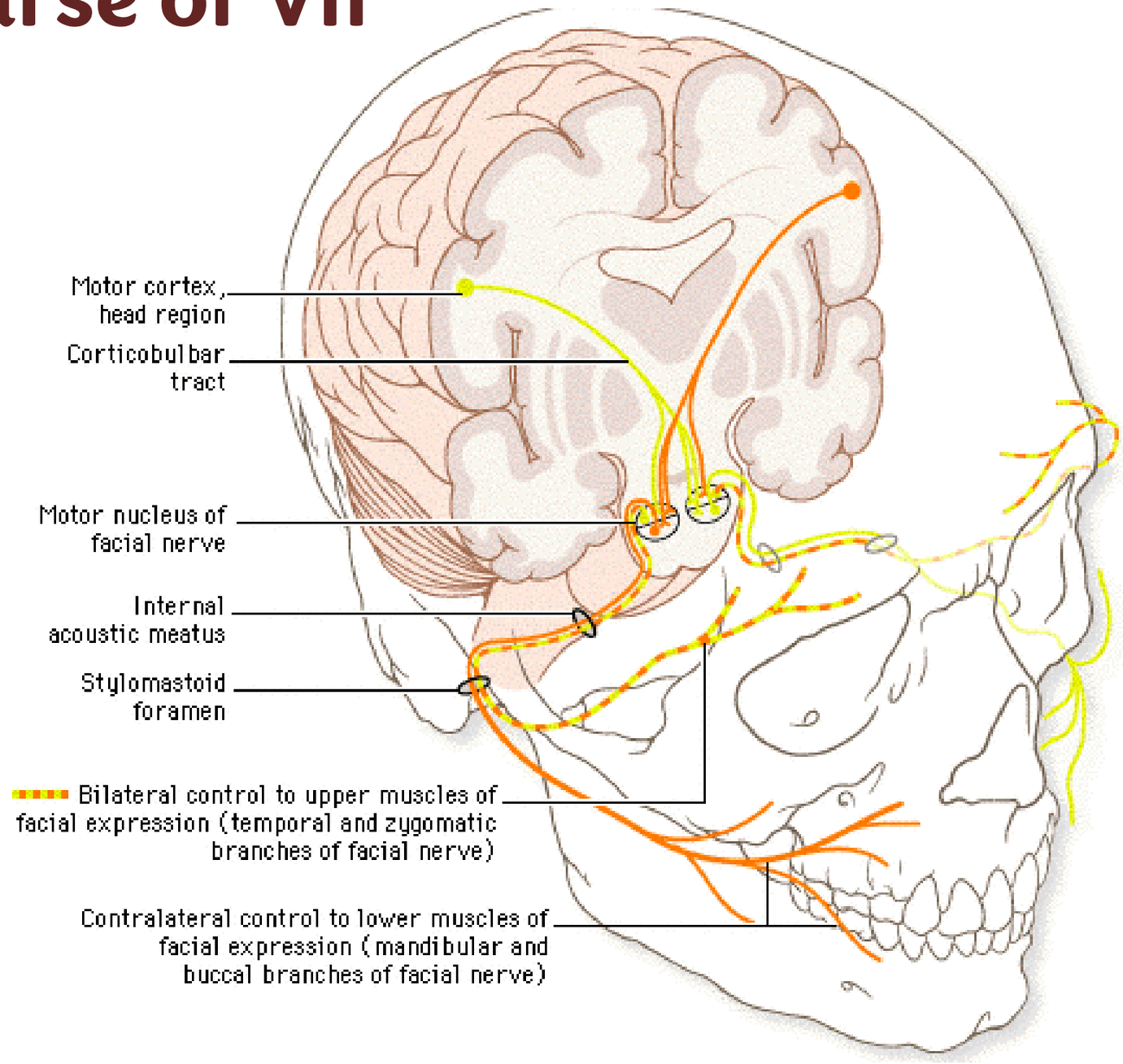
Sensory Nucleus: Taste, by chorda tympani, a branch of the facial nerve, responsible for the taste in the anterior 2/3 of the tongue.

- **Location**: upper part of the nucleus of the tractus solitarius
- Sensations of taste
  - Cell bodies in **geniculate ganglion**
  - Sensory Nucleus
  - VPM
  - Primary gustatory cortex (area 43)



Course of VII

- Anterior surface between the pons and the medulla oblongata
- Internal acoustic meatus
- facial canal then laterally through the inner ear



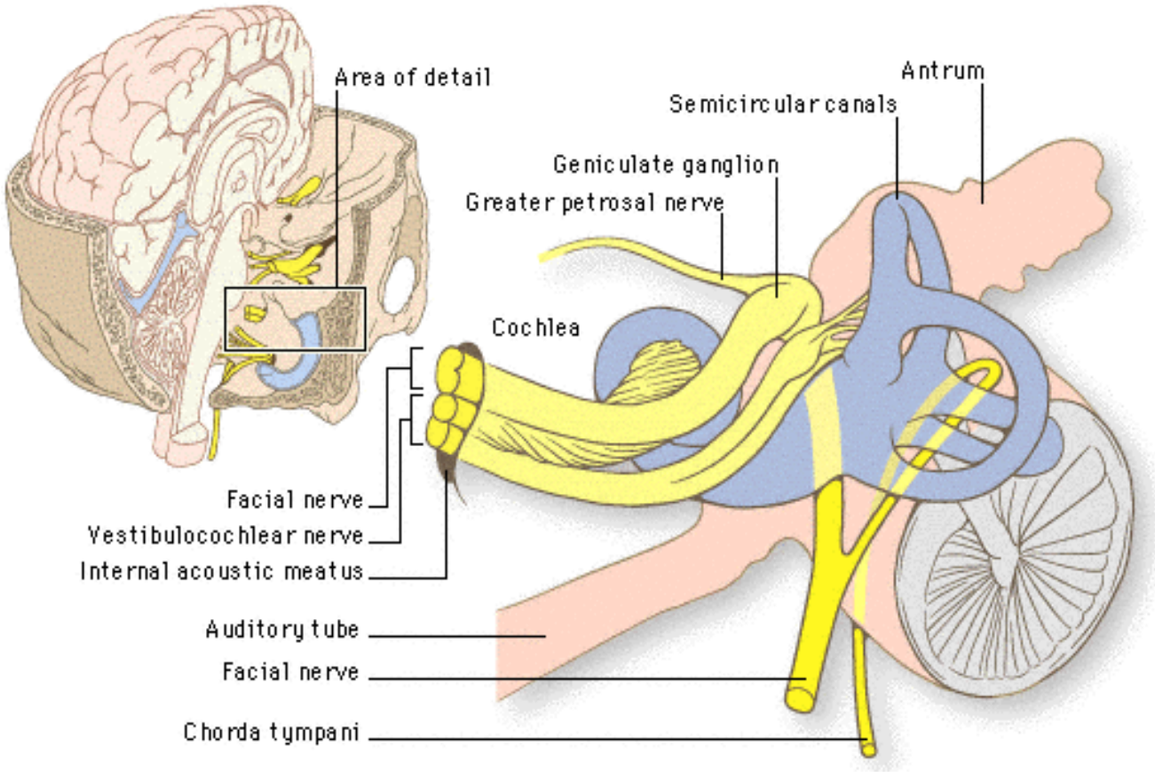
Course of VII

- Medial wall of the tympanic cavity **geniculate ganglion**
- Posterior wall of the tympanic cavity
- Emerges from the stylomastoid foramen.

1. Origin
- Emerges from the pontomedullary junction (between pons and medulla).

2. Intracranial Course
- Enters the **internal acoustic meatus** along with the vestibulocochlear nerve (CN VIII).
- Travels through the **facial canal** (fallopian canal) inside the temporal bone.
- Forms the **geniculate ganglion** (curve) along its course.

3. Extracranial Course
- Exits the skull via the **stylomastoid foramen**



Function
- **Motor:** muscles of facial expression, stapedius, posterior belly of digastric, stylohyoid.
- **Sensory:** taste from anterior 2/3 of tongue (chorda tympani).
- **Parasympathetic:** lacrimal, submandibular, and sublingual glands.

Course of VII

Taste Pathway via the Facial Nerve (CN VII)

1. Origin

•Taste fibers arise from taste receptors in the anterior 2/3 of the tongue.

•Cell bodies of 1st-order neurons are in the geniculate ganglion (formed along the facial nerve in the temporal bone).

2. Intracranial Course

•Fibers travel with the chorda tympani and join the facial nerve in the facial canal (fallopian canal).

•The geniculate ganglion houses the sensory cell bodies.

3. Brainstem Entry & Synapse

•Taste fibers enter the brainstem at the pontomedullary junction.

•They synapse in the rostral part of the solitary nucleus aka **Nucleus Tractus solitarias** (gustatory nucleus).

4. Central Pathway

•2nd-order neurons project to the **ventroposteromedial (VPM)** nucleus of the **thalamus**.

•3rd-order neurons ascend to the primary gustatory **cortex** in the insula and frontal operculum for conscious perception of taste.

Parasympathetic Pathway of the Facial Nerve (CN VII)

It has 2 components, the chorda tympni and the greater petrosal

1) Submandibular and Sublingual Glands

1. **Preganglionic neurons**: in the **superior salivatory nucleus** (same nucleus).
2. Fibers travel via the **chorda tympani**.
3. Join the **lingual nerve (branch of V3)**.
4. Synapse in the **submandibular ganglion**.
5. **Postganglionic fibers** innervate:

· **Submandibular gland** → saliva
· **Sublingual gland** → saliva

2) Lacrimal and Nasal Glands

1. Preganglionic fibers

Originate from the superior salivatory nucleus in the pons.
Travel in the greater petrosal nerve.

2. Temporal bone & middle cranial fossa

Exit the temporal bone via the hiatus of the greater petrosal nerve.
Enter the middle cranial fossa.

3. Formation of the nerve of the pterygoid canal

Greater petrosal nerve joins the deep petrosal nerve (sympathetic fibers from internal carotid plexus).
Together, they form the nerve of the pterygoid canal (Vidian nerve).
Pass through the foramen lacerum into the pterygopalatine fossa.

4. Synapse

Fibers synapse in the Pterygopalatine Ganglion.

5. Postganglionic fibers

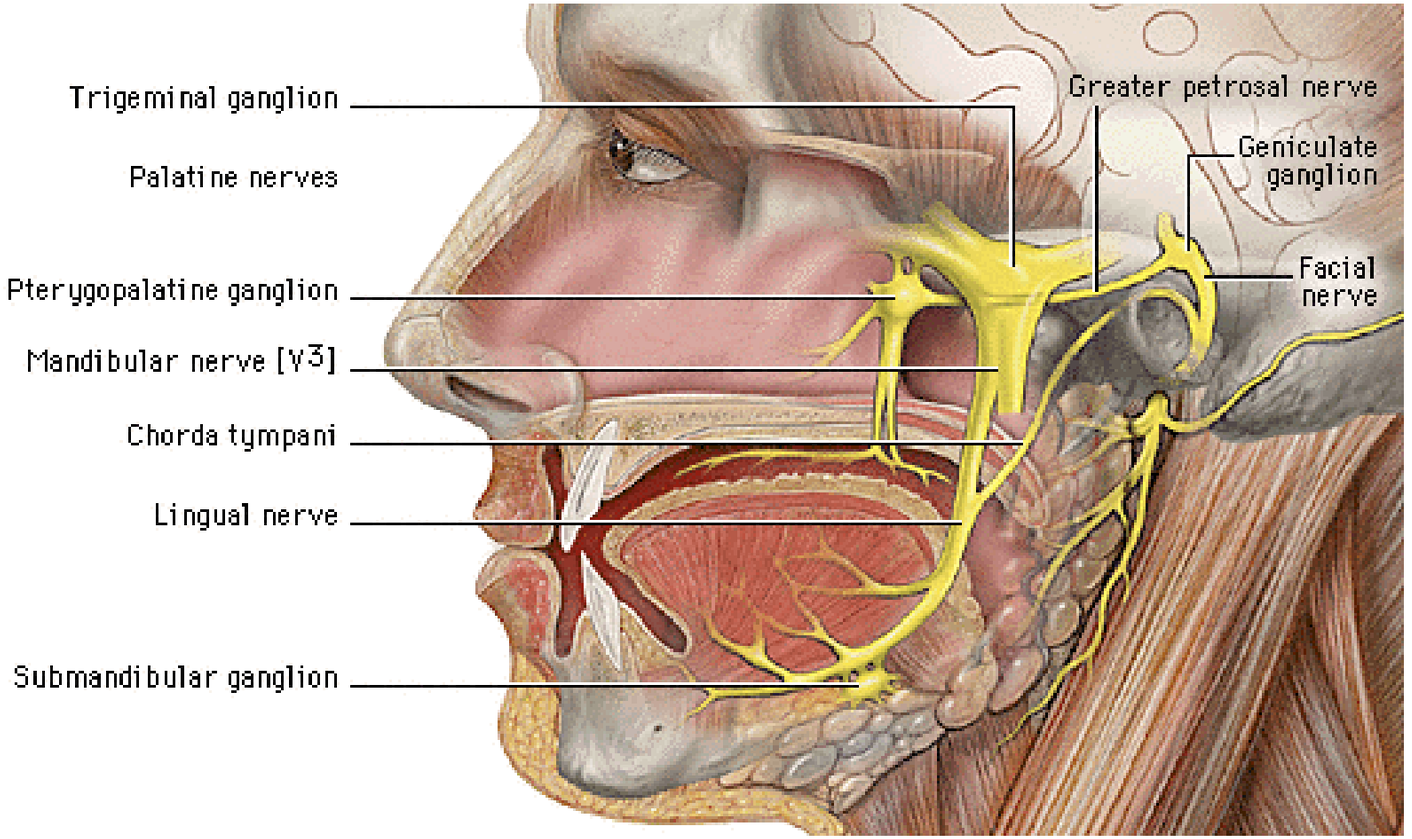
Travel with branches of the Maxillary Nerve (V2):
Zygomatic nerve → zygomaticotemporal branch → lacrimal gland
Other V2 branches → nasal and palatine gland

6. Target organs

Lacrimal gland → tears
Nasal mucosa and palatine glands → mucus secretion

greater petrosal nerve

- Middle cranial fossa through the **greater petrosal foramen**
- Passes over **Foramen lacerum**, where it joins deep **petrosal nerve** to form the nerve to pterygoid canal
- Pterygoid canal
- Pterygopalatine gangilion
- Maxillary nerve

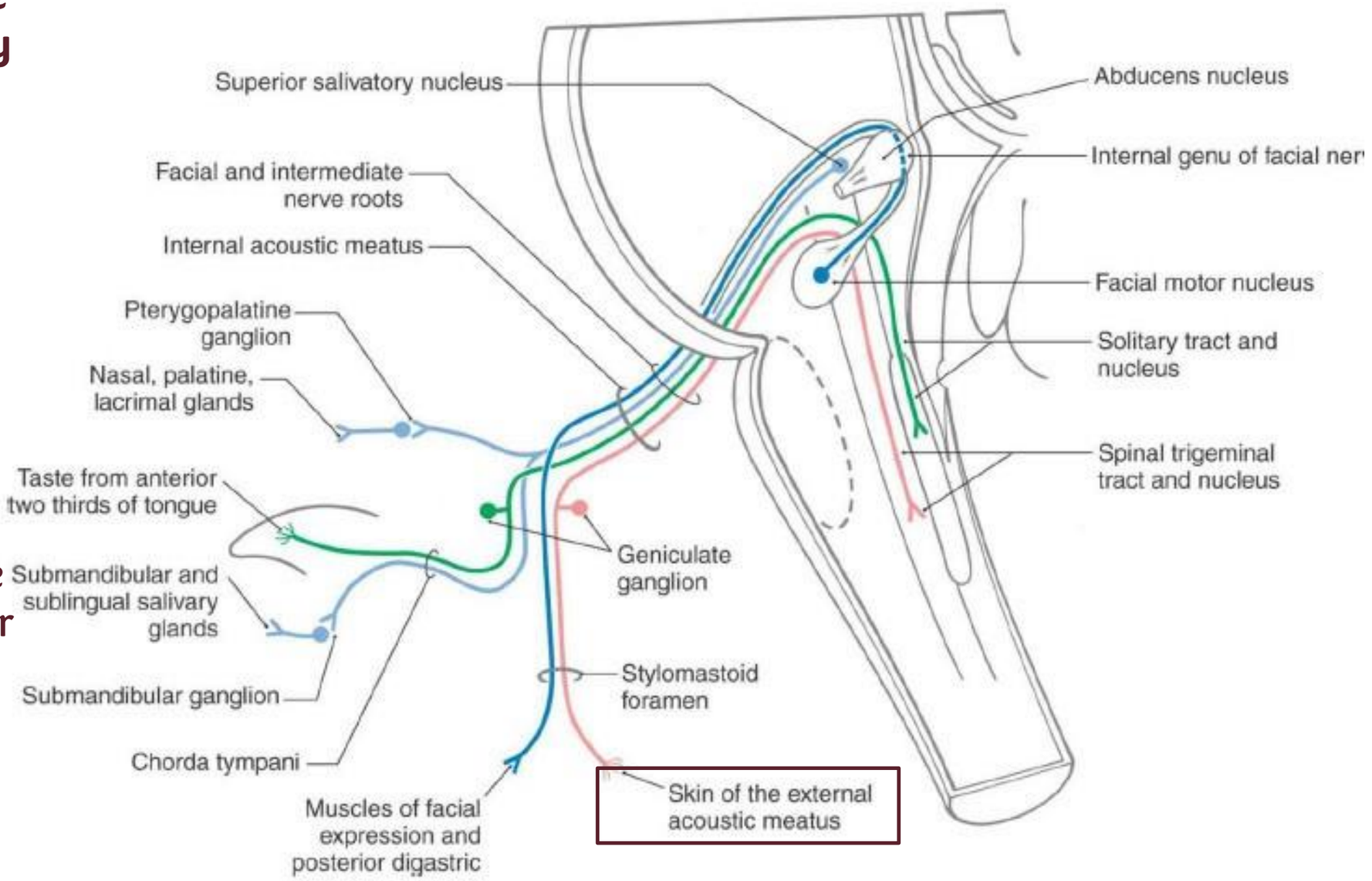


The chorda tympani nerve

- continues through the petrotympanic fissure after which it emerges from the skull into the infratemporal fossa. It soon combines with the larger lingual nerve (Taste Anterior 2/3 of tongue)

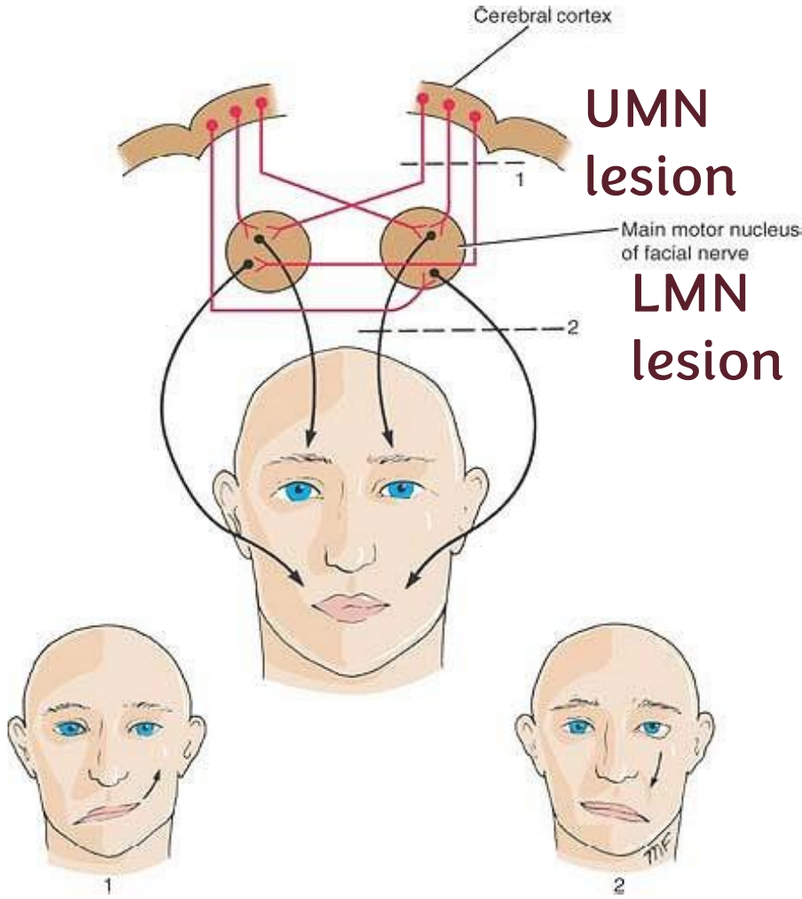
Course of VII

The **facial nerve (CN VII) sensory component** carries **general sensation** from the **skin of the external acoustic meatus**, with 1st-order neurons in the **geniculate ganglion**. These fibers then enter the brainstem and descend to the **spinal nucleus of the trigeminal nerve**.



Facial Nerve injury

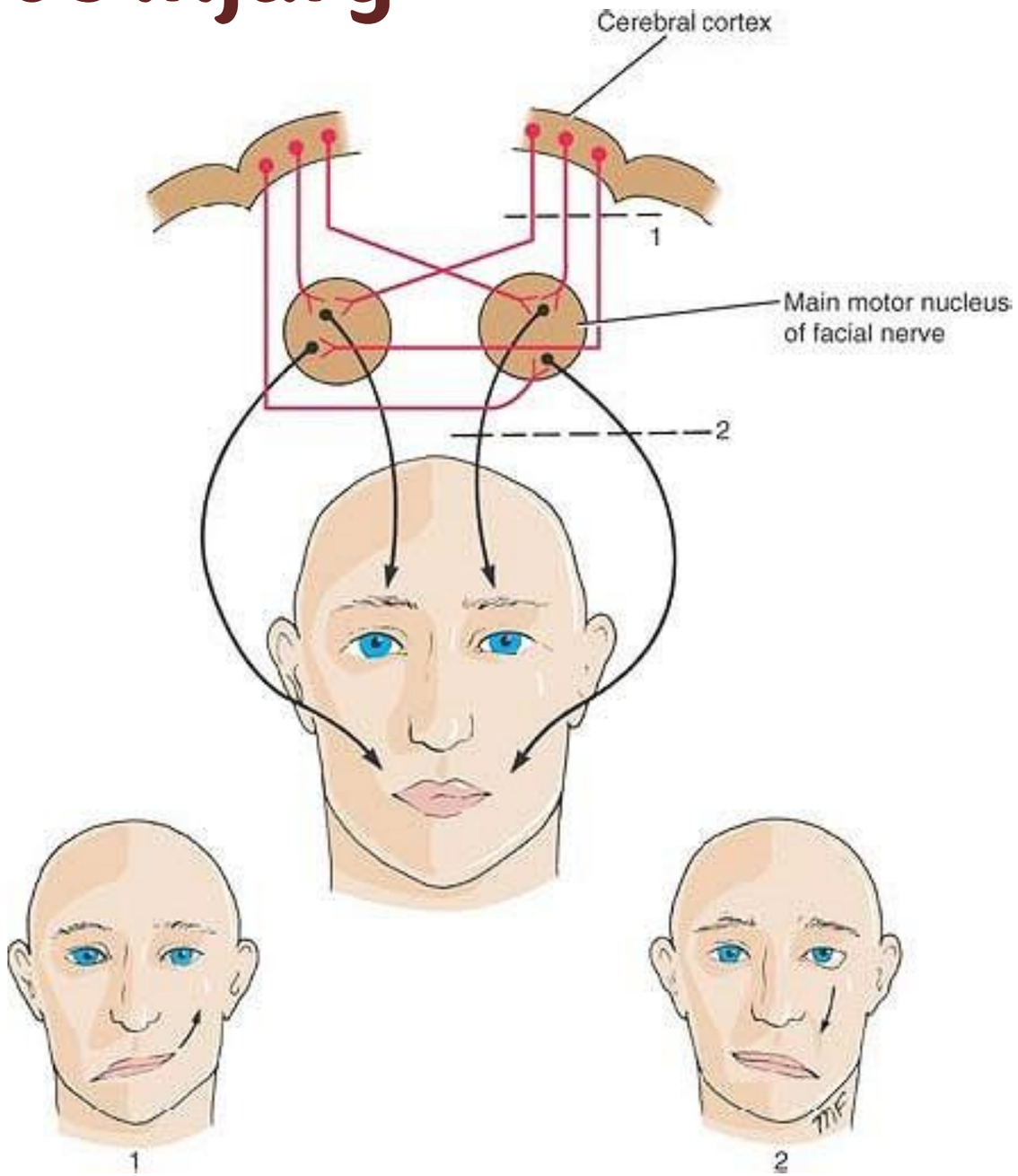
1) An **upper motor neuron (UMN) lesion** affecting the Facial Nerve occurs **above the facial nucleus** (usually in the corticobulbar pathway). It causes **weakness of the contralateral lower half of the face**, while the **forehead (upper half of the face) muscles remain functional** because the upper facial muscles receive **bilateral cortical innervation (so the other side compensates).** Therefore, the patient can still **wrinkle the forehead and close the eyes**, but the **mouth deviates to the normal side.**



2) A **lower motor neuron (LMN) lesion** (e.g. iatrogenic injury of the parotid gland) occurs **at the facial nucleus or along the facial nerve after it exits the brainstem**. It produces **ipsilateral paralysis of the entire half of the face**, affecting both **upper and lower facial muscles**. As a result, the patient **cannot wrinkle the forehead, close the eye, or move the mouth** on the affected side, and the mouth deviates **toward the normal side**. A common example is Bell's Palsy

Facial Nerve injury

- Location of the lesion:
  - Abducent and the facial nerves are not functioning: lesion in the **pons:**
  - Vestibulocochlear and the facial nerves are not functioning: lesion in the **internal acoustic meatus**
  - Loss of taste over the anterior two-thirds: damaged to the **chorda tympani** branch
- Upper vs lower motor neuron injury

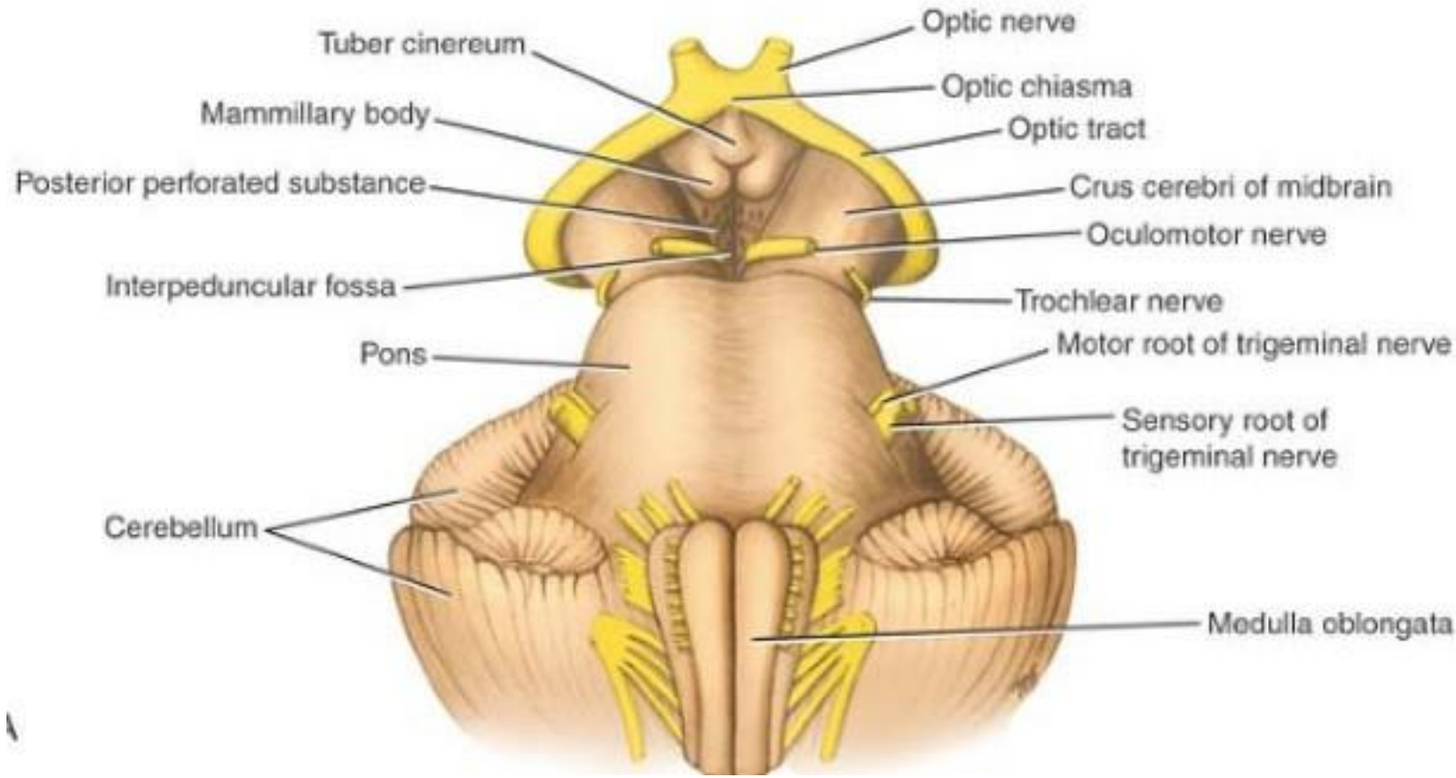


Bell's Palsy شلل العصب السابع

- Usually unilateral
- Lower motor neuron type of facial paralysis.
- Cause is not known,
  - Exposure of the face to a cold draft?
  - Complication of diabetes?
  - Can occur as a result of tumors or AIDS?

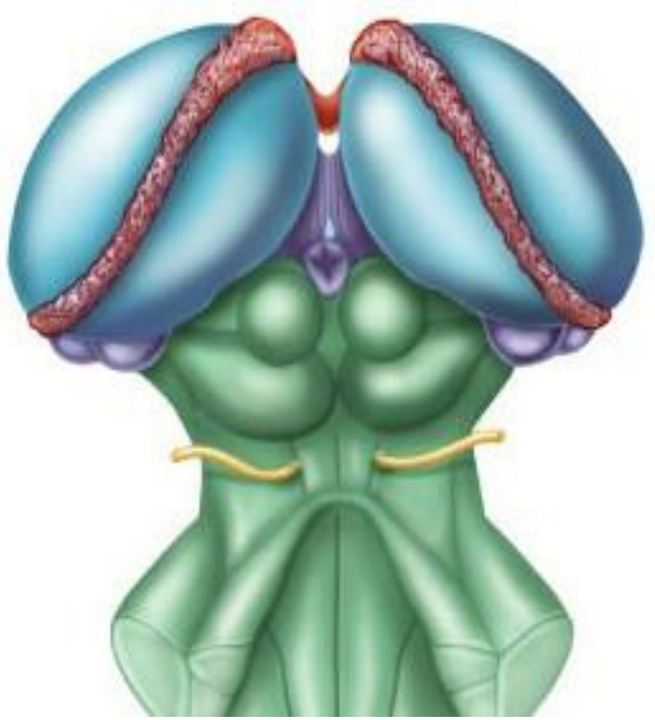
Midbrain ant. View

- Interpeduncular fossa
- Crus cerebri
- 3rd nerve emerges from medial side of crus cerebri in the interpeduncular fossa



- There are 2 peduncles (**white matter**) called **cerebral peduncles** (**NOT** cerebellar).
- Between the two cerebral peduncles there is the **interpeduncular fossa** (**Oculomotor** nerve **3rd** cranial nerve originate from this fossa)

The Midbrain-posterior view

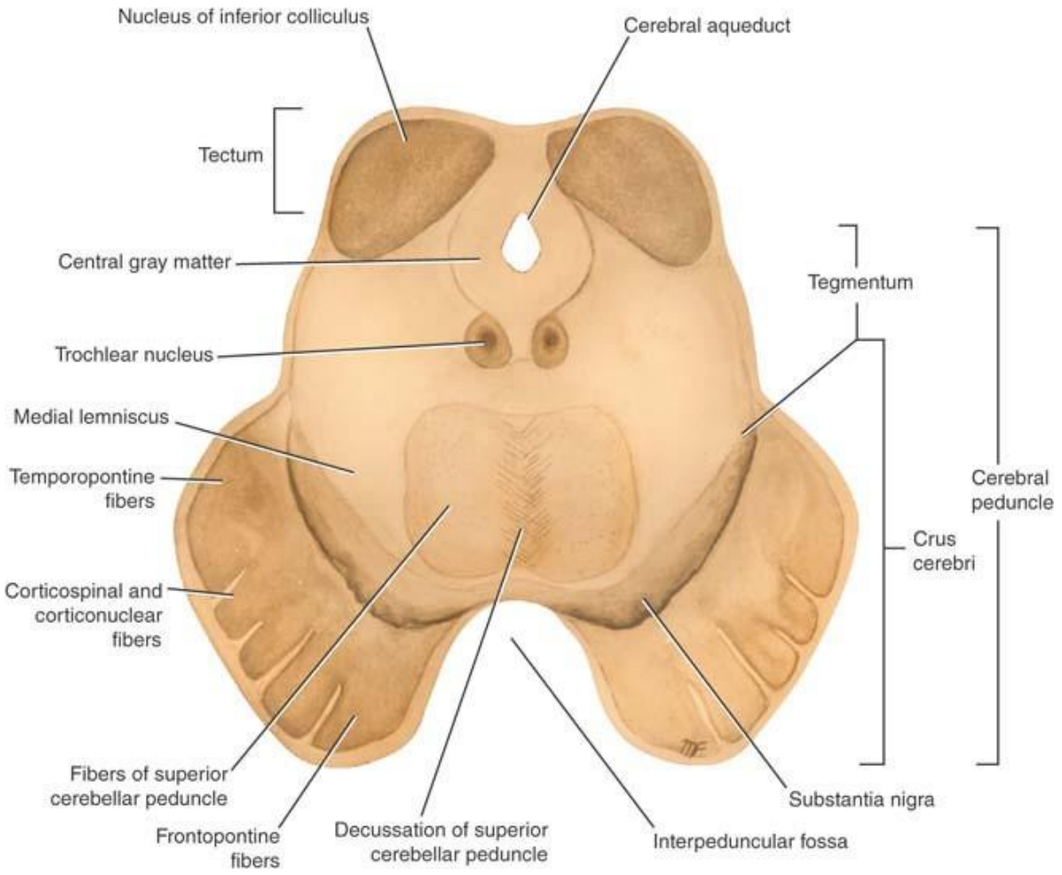


- Corpora quadrigemina – the largest nuclei
  - Divided into the superior and inferior colliculi
    - Superior colliculi – nuclei that act in visual reflexes
    - Inferior colliculi – nuclei that act in auditory reflexes
- Trochlear nerve emerges below the level of inf. Colliculus (from posterior surface)
- Occulomotor nerve emerges at the level of sup. colliculus
- Sup.brachium (to lateral geniculate body)
- Inf. Brachium (to medial geniculate body)
- 4th emerges

- Thee **4** colliculi of the **tectum** can be seen. Called corpora quadrigemina
- The **trochlear nerve (CN4)** is the **Only** cranial nerve that arises **posteriorly**. It arises from the posterior aspect of the midbrain. Supplies **superior oblique muscle of the eye**.
- In the figure on the right, the two thalami can be seen. They are divided into right and left thalami by the 3rd ventricle. Third ventricle is connected to the fourth ventricle by **cerebral aqueduct**.
- The thalami are egg-shaped and contain multiple nuclei. **It contains the medial geniculate body** (part of the auditory pathway) and **lateral geniculate body** (part of the visual pathway).
- **Superior brachium** connects the **superior colliculus** with the **lateral geniculate body**. (connecting the visual with visual)
- **Inferior brachium** connects the **inferior colliculus** with the **medial geniculate body.**

The Brain Stem – The Midbrain

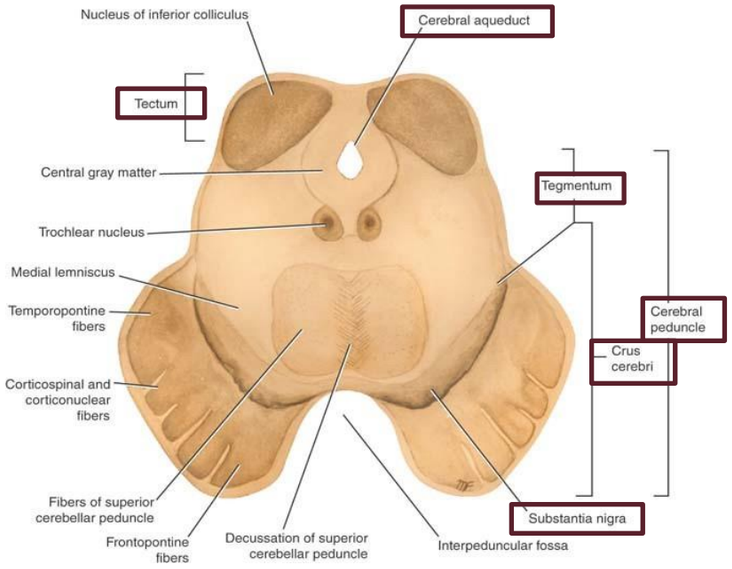
- Lies between the diencephalon and the pons
- Central cavity – the **cerebral aqueduct**
- Cerebral peduncles located on the ventral surface of the brain divided by the **substantia nigra** into**:**
- **Crus cerebri: Anterior**
- **Tegmentum: Posterior**
  - Contain pyramidal (corticospinal) tracts
- Superior cerebellar peduncles
  - Connect midbrain to the cerebellum



- Cerebral peduncle is divided into crus cerebri (ant) & tegmentum (post)
- Tectum is post to cerebral aqueduct

See next slide

Midbrain



- The figure shown here represents an **anteroposterior** view.
- As can be seen, the central opening is the **cerebral aqueduct** (**NOT** the central canal). The cerebral aqueduct connects the **fourth ventricle** (the cavity of the **hindbrain**) **inferiorly** with the **third ventricle** (the cavity of the **diencephalon**) **superiorly**.

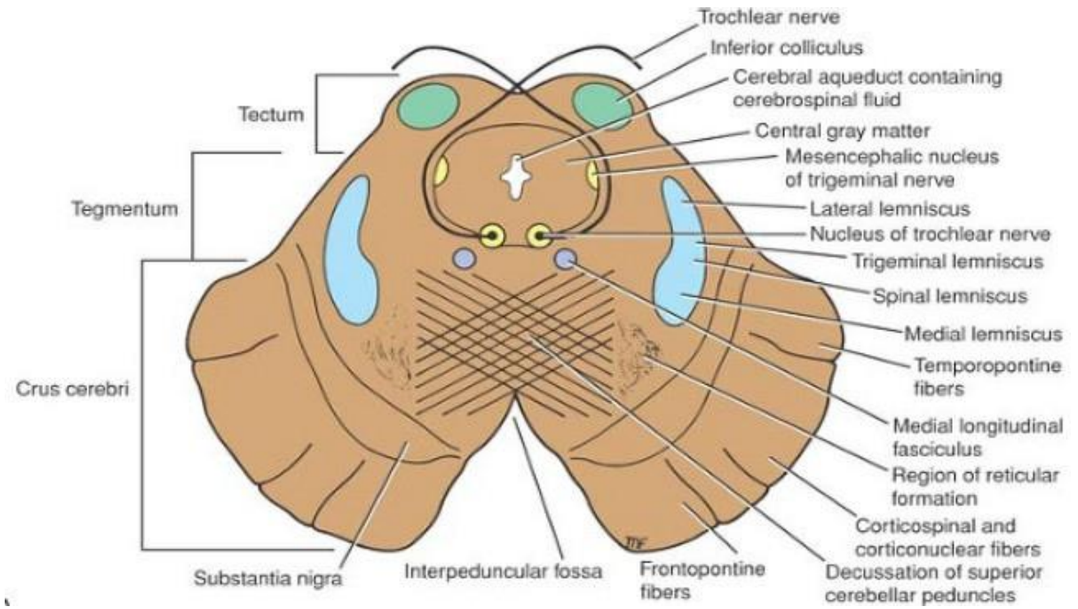
- Whether at the level of the superior colliculi or the inferior colliculi, the structure located **posterior to the cerebral aqueduct is the tectum**, while the structure **anterior to it is the cerebral peduncle**.

- The cerebral peduncle can be subdivided into the **tegmentum and the crus cerebri**.
- These two parts are **separated by a band of tissue called the substantia nigra**, which is clinically significant because it is **associated with Parkinson's disease**.

Level of inf. colliculus

- Trochlear nucleus lies close to midline in the central gray matter (posterior to MLF =medial longitudinal nucleus)
- Trochlear nerves(decussate in the superior medullary velum

- Decussation of sup. cerebellar peduncles (central part of the tegmentum anterior to the cerebral aqueduct)
  - RF is lateral to decussation
  - Medial, spinal ,trigeminal & lateral leminisci (Posterior to Substantia nigra)



- Substantia nigra
- Crus cerebri
- Mesencephalic (midbrain) nucleus of trigeminal *(lateral to cerebral aqueduct)*
- MLF

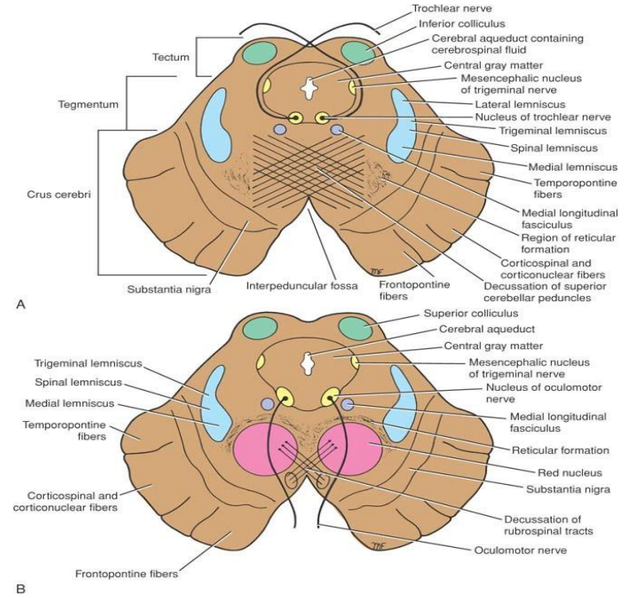
Next slides

Level of inf. colliculus

We can see at this level:

- **Cerebral aqueduct** and **inferior colliculus**. How to distinguish between superior and inferior colliculi?

  Answer: The presence of the **red nucleus and the decussation of the superior cerebellar peduncle.**
  When the **red nucleus is present, the section corresponds to the level of the superior colliculus**. In contrast, the **presence of the decussation of the superior cerebellar peduncle indicates the level of the inferior colliculus.**



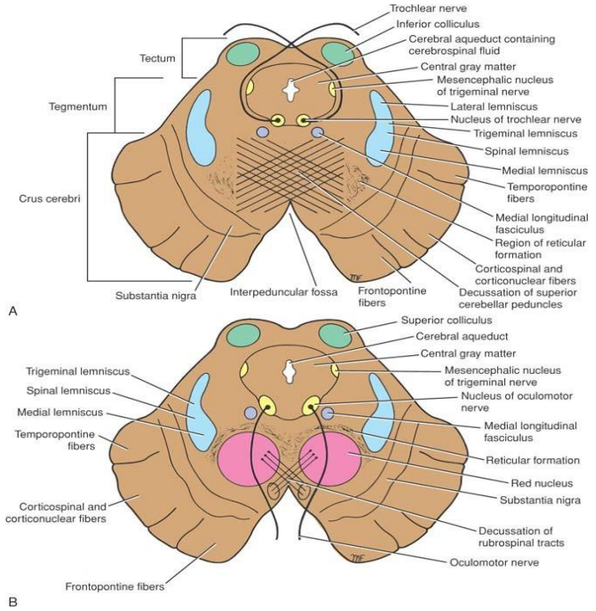
- **Mesencephalic (midbrain) nucleus** lies lateral to the cerebral aqueduct. It is a **longitudinal nucleus** that can also be observed at the level of the **superior colliculus**.

- The **trochlear nucleus** lies close to the **midline** within the central gray matter. It is located **posterior to the medial longitudinal fasciculus (MLF) and anterior to the cerebral aqueduct**. The MLF connects the trochlear nucleus with the oculomotor nucleus superiorly and with other nuclei inferiorly.

- The trochlear nerve is a **purely motor** nerve that supplies the **superior oblique muscle of the eyeball**. Its fibers decussate in the superior medullary velum.

  - The trochlear nerve has a **unique** pathway: the lower motor neuron fibers **curve around the cerebral aqueduct and mesencephalic trigeminal nucleus** to exit from the **posterior aspect of the midbrain**, where they decussate, and then **turn again to reach the orbital cavity anteriorly through the superior orbital fissure.**

Level of inf. colliculus



We can see at this level:

- **Decussation of superior cerebellar peduncle**
  - There are four deep cerebellar nuclei arranged from medial to lateral: fastigial, globose, emboliform, and dentate. One important pathway occurring at a **higher** level connects the cerebellum to the red nucleus. This pathway is the globose-emboliform rubral pathway, which also decussates together with the superior cerebellar peduncle.

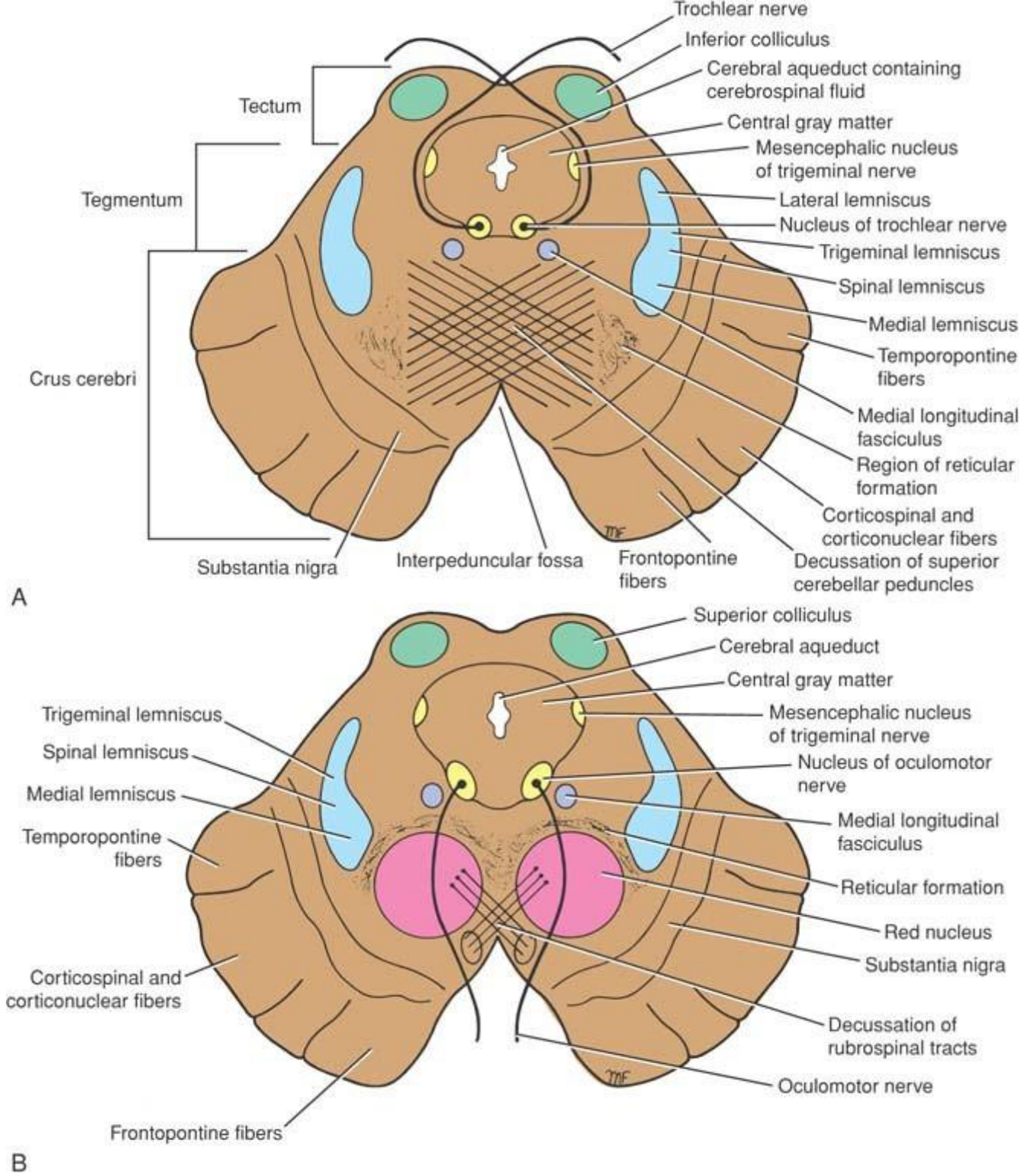
- **Substantia nigra** which is **anatomically** located in the **midbrain**, but **functionally** it is considered part of the **basal nuclei**, which are involved in **motor control**. Specifically, the substantia nigra plays a key role in the **initiation of movement**. **Degeneration in this region results in akinesia or bradykinesia, as seen in Parkinson's disease**.

- **Crus cerebri** is composed of **white matter**. Its middle three-fifths contain the corticospinal tract, the medial fifth contains the frontopontine fibers, and the lateral fifth contains the temporopontine fibers.

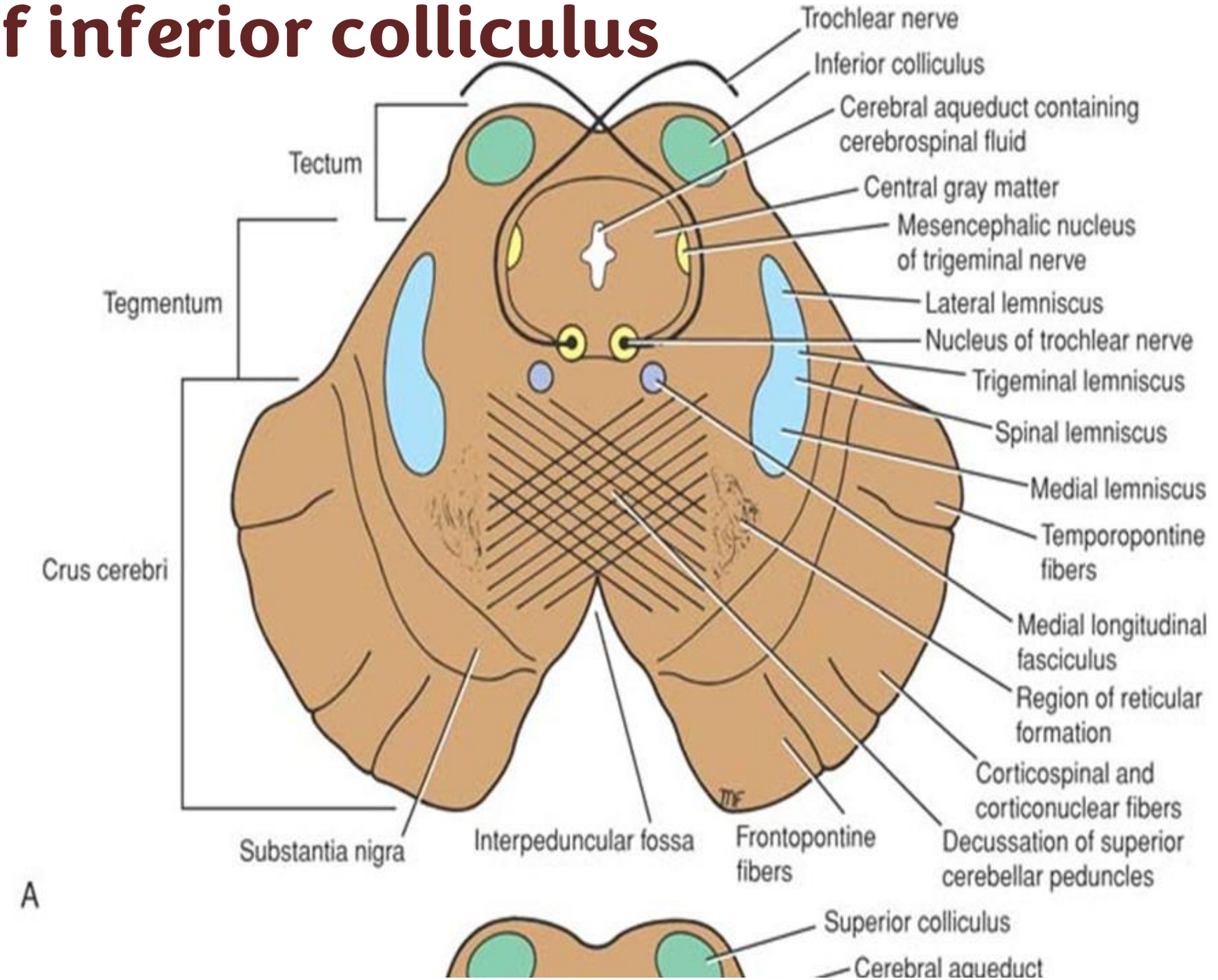
- **Posterior to the substantia nigra**, there is a band of white matter tracts known as the **lemnisci**. These tracts are arranged from **medial to lateral** as follows: medial lemniscus, spinal lemniscus, trigeminal lemniscus, and lateral lemniscus (**auditory pathway**).

Substantia nigra

- Large motor nucleus
- is a brain structure located in the midbrain
- plays an important role in reward, addiction, and movement.
- *Substantia nigra* is Latin for "black substance" due to high levels of melanin
- has connections with basal ganglia ,cerebral cortex
- Concerned with muscle tone
- Parkinson's disease is caused by the death of neurons in the substantia nigra

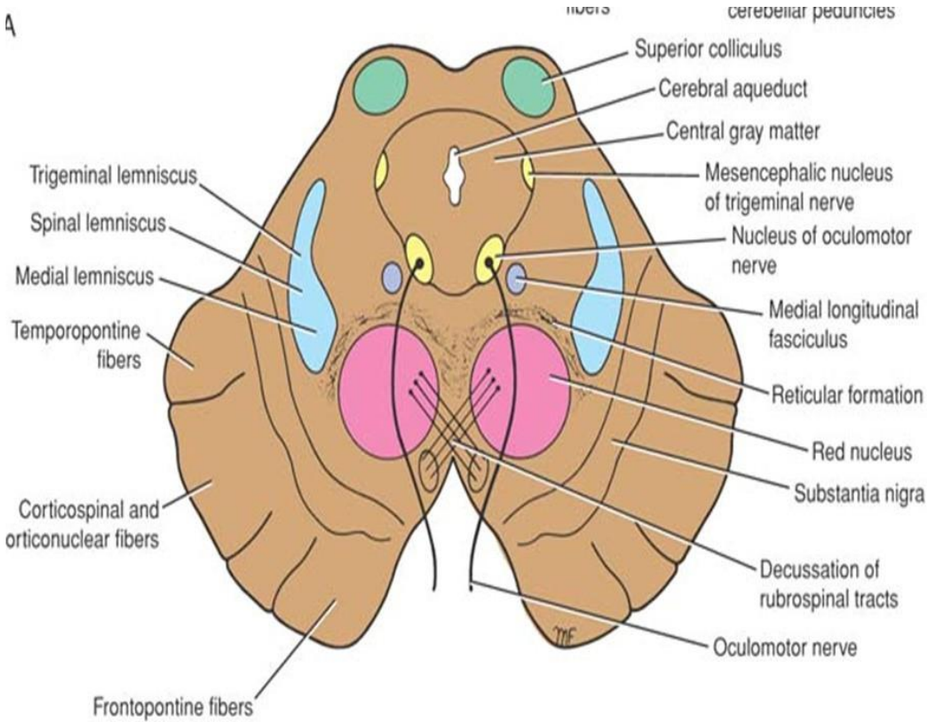


Level of inferior colliculus



Level at superior colliculus

- Superior colliculus
- Occulomotor nucleus (posterior to MLF)
- Occulomotor n emerges through red nucleus
- Edinger-Westphal nucleus
- **pretectal nucleus:** close to the lateral part of the superior colliculus.
- MLF
- Medial , trigeminal, spinal leminiscus (**no** lateral leminiscus)
- Red nucleus
- Substantia nigra
- Crus cerebri
- RF

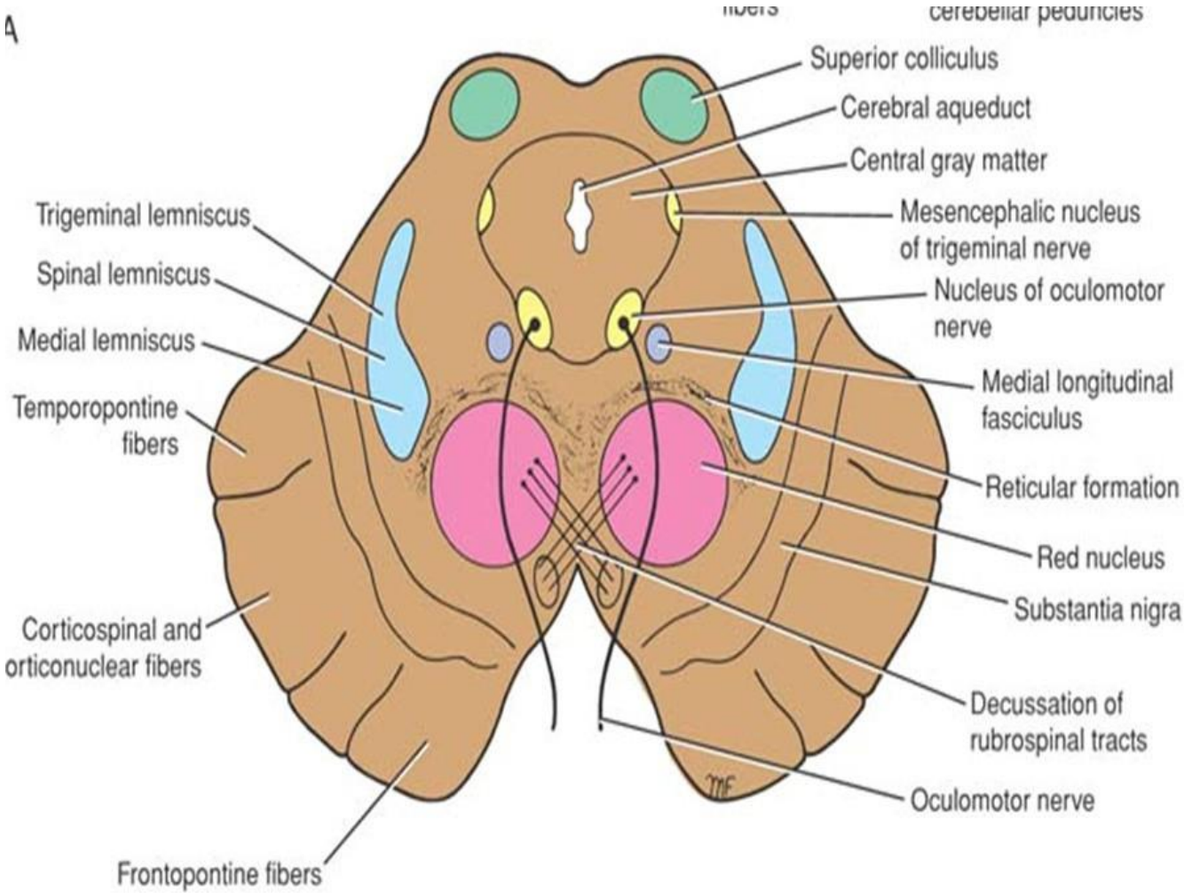


❑ At this level, most structures are similar to those observed at the level of the inferior colliculus; however, several key **differences** are present:

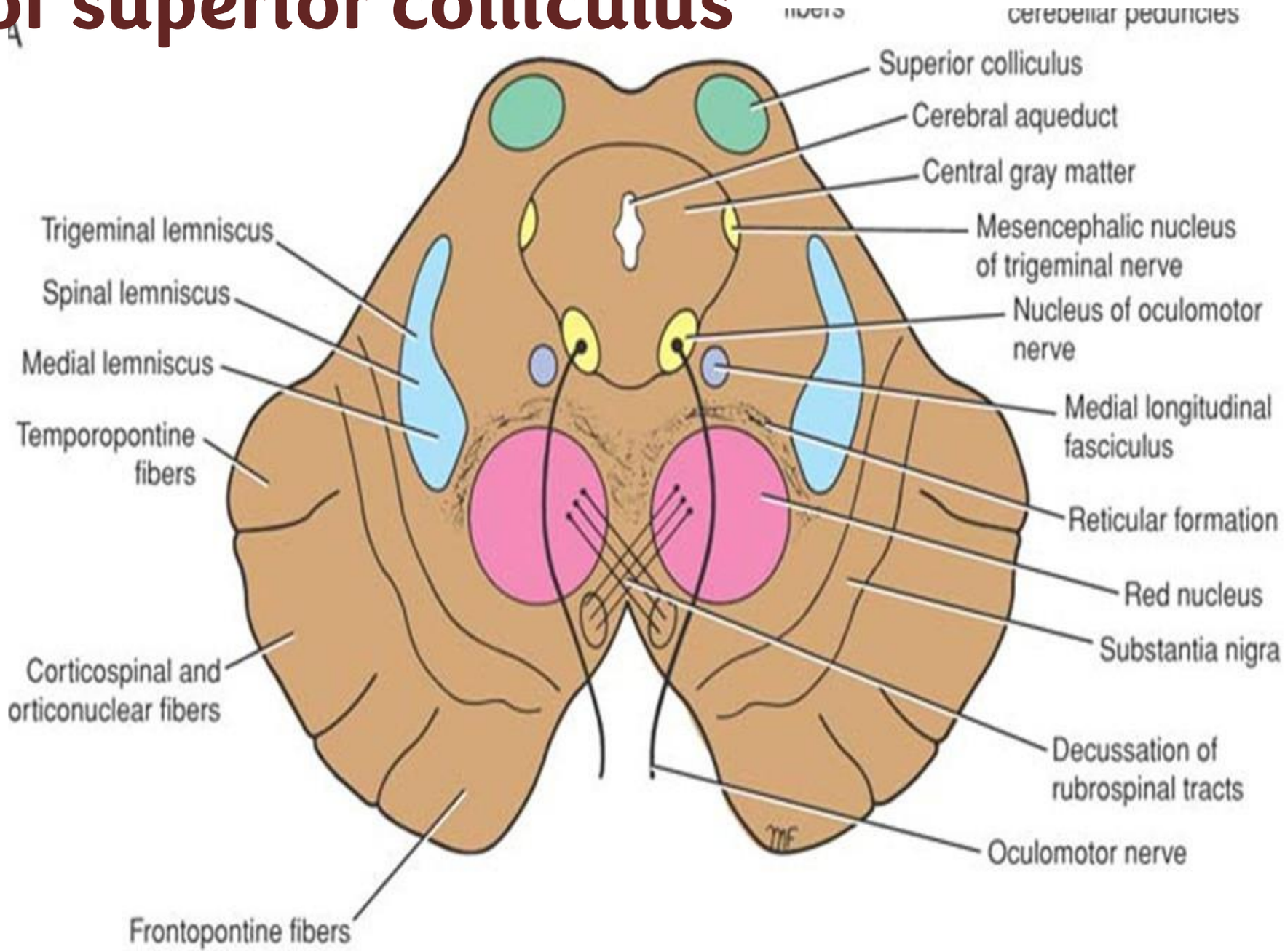
- **Red nucleus**: It is named for its **reddish appearance, which results from the presence of iron-containing pigments. The decussation of the rubrospinal tract occurs at this level.**
- **Lemnisci**: The lateral lemniscus is **Not** present at this level.
- **Motor nucleus of the oculomotor nerve**: This nucleus **replaces the trochlear nucleus at this level**. The oculomotor nerve innervates all extraocular muscles of the eyeball except the lateral rectus (supplied by the abducent nerve) and the superior oblique (supplied by the trochlear nerve). It also contains a **parasympathetic** component that supplies smooth muscles of the eye. The **parasympathetic nucleus is located posterolateral to the somatic motor nucleus.**

Red nucleus

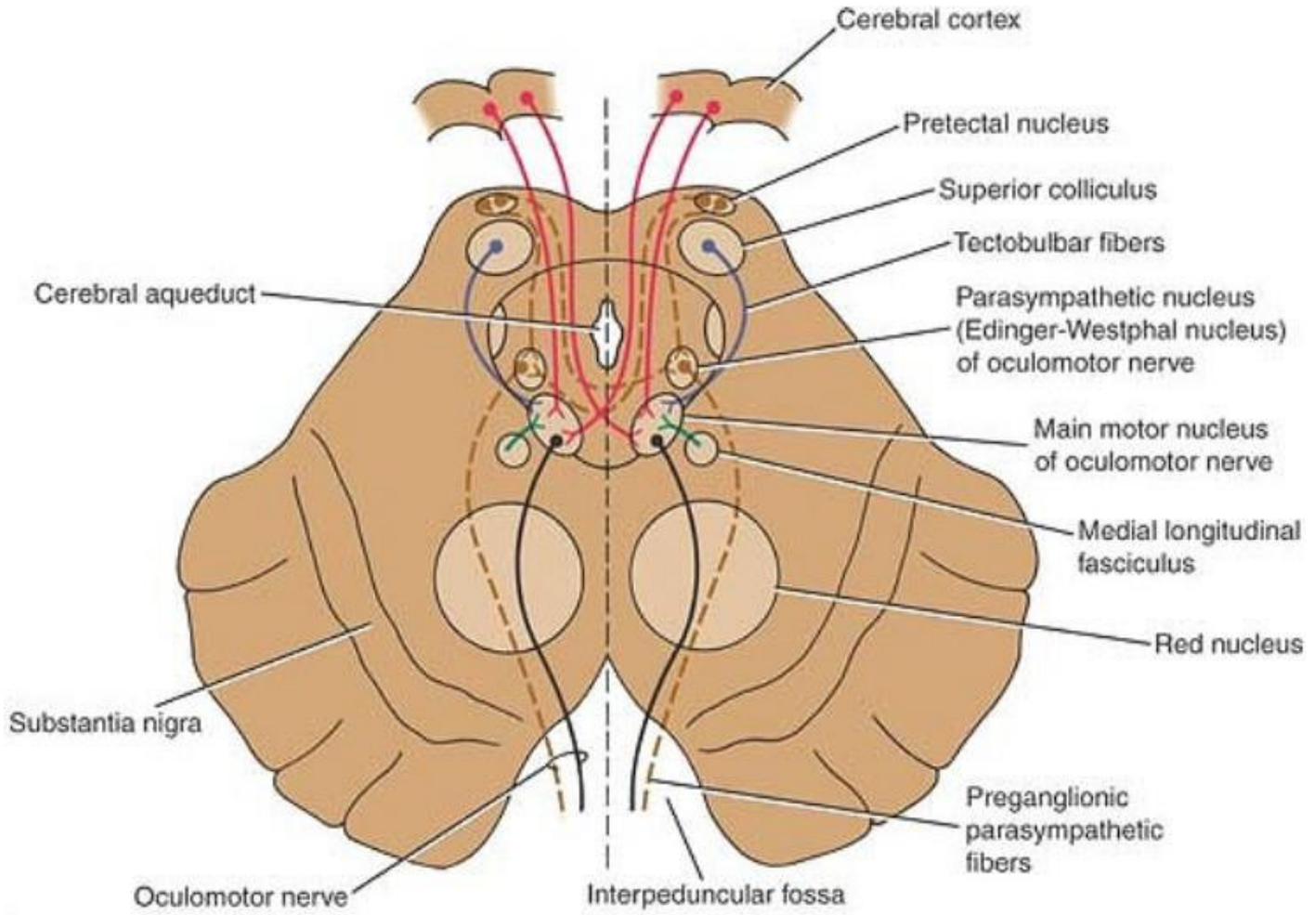
- Rounded mass of gray matter
- Situated bt cerebral aqueduct and substantia nigra
- Reddish blue(vascularity & iron containing pigment)
- Afferents from: cerebral cortex,cerebellum,substa ntia nigra, thalamic nuclei, spinal cord
- Efferent to: spinal cord, reticular formation. thalamus and substantia nigra
- involved in motor coordination.

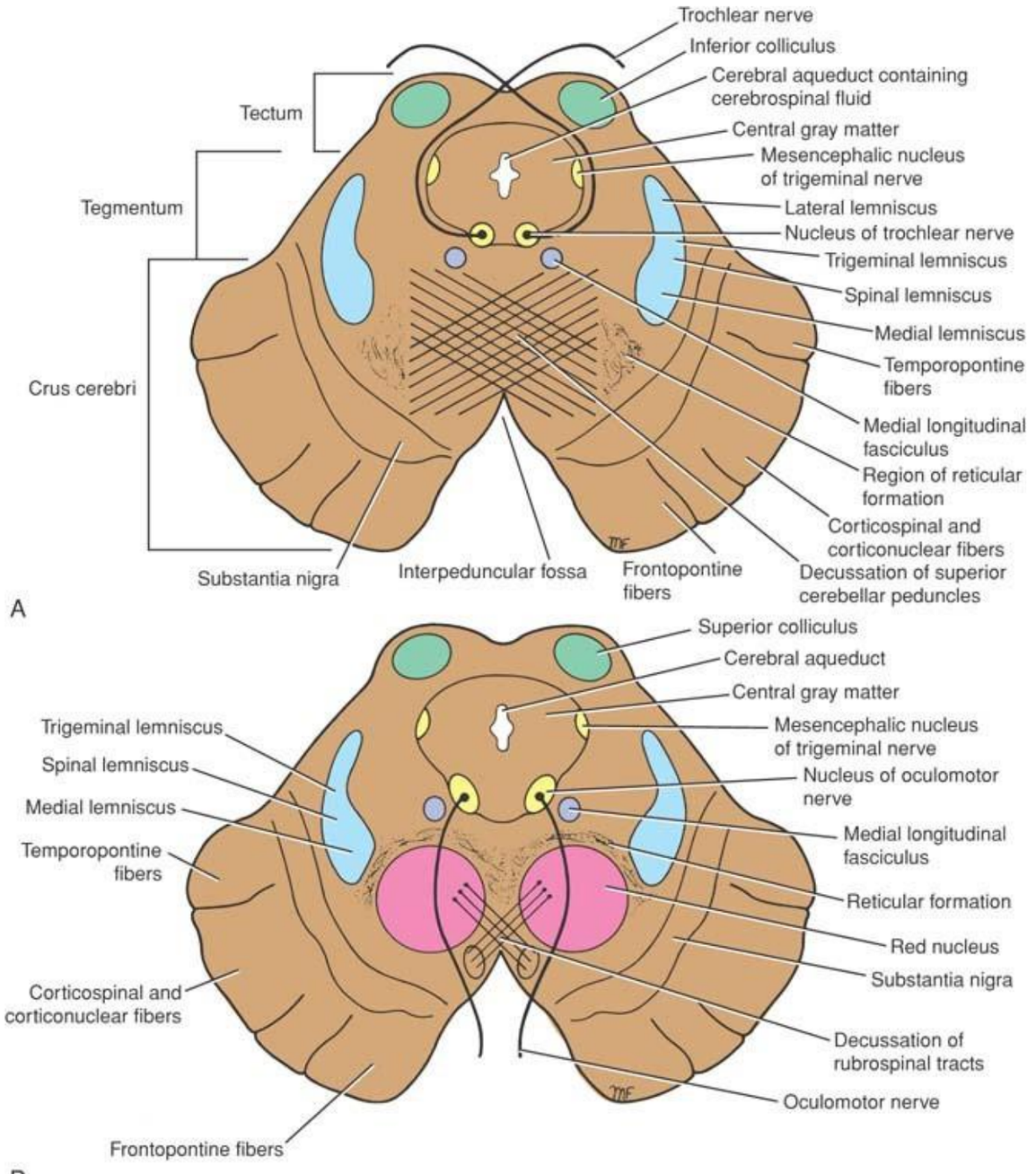


Level of superior colliculus



- Edinger- Westphal nucleus
- **pretectal nucleus:** close to the lateral part of the superior colliculus.

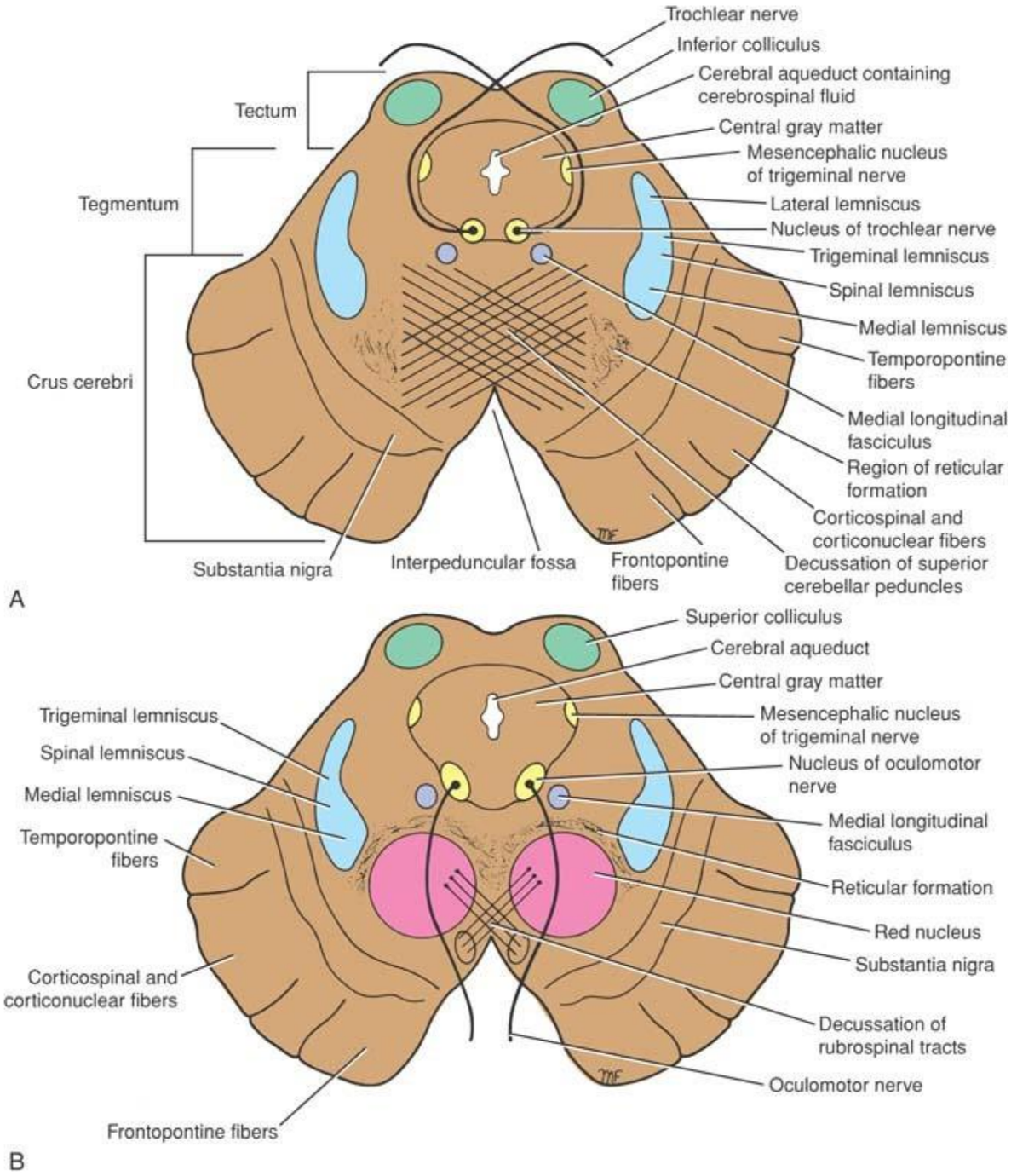



Trochlear nerve
Inferior colliculus
Cerebral aqueduct containing cerebrospinal fluid
Tectum
Central gray matter
Mesencephalic nucleus of trigeminal nerve
Tegmentum
Lateral lemniscus
Nucleus of trochlear nerve
Trigeminal lemniscus
Spinal lemniscus
Medial lemniscus
Temporopontine fibers
Crus cerebri
Medial longitudinal fasciculus
Region of reticular formation
Corticospinal and corticonuclear fibers
Decussation of superior cerebellar peduncles
Substantia nigra
Interpeduncular fossa
Frontopontine fibers
A
Superior colliculus
Cerebral aqueduct
Central gray matter
Trigeminal lemniscus
Mesencephalic nucleus of trigeminal nerve
Spinal lemniscus
Nucleus of oculomotor nerve
Medial lemniscus
Medial longitudinal fasciculus
Temporopontine fibers
Reticular formation
Red nucleus
Substantia nigra
Corticospinal and corticonuclear fibers
Decussation of rubrospinal tracts
Oculomotor nerve
Frontopontine fibers
B

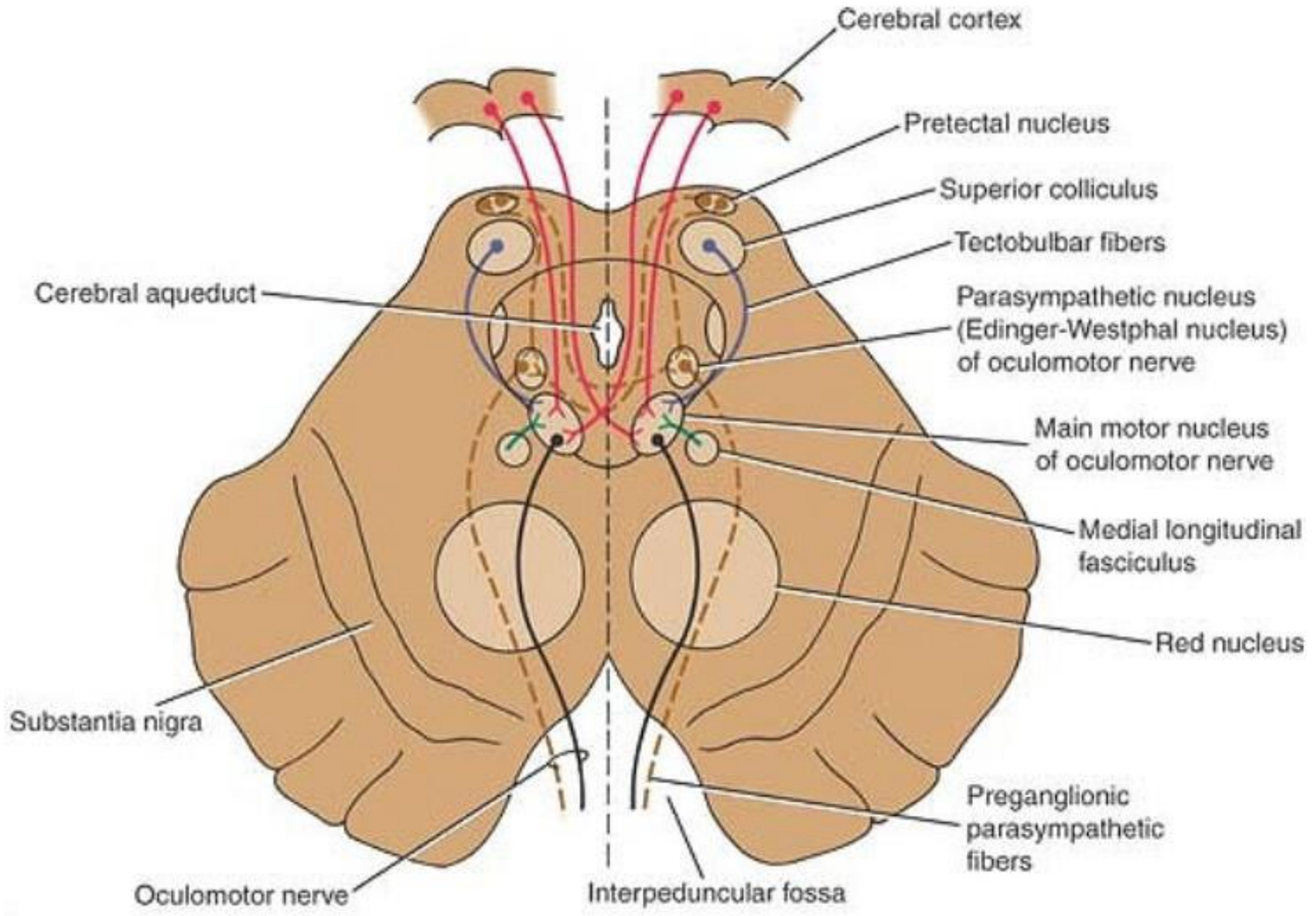
Crus cerebri

- Corticospinal & corticonuclear fibers (middle)
- Frontopontine fibers (medial)
- Temporopontine fibers (lateral)

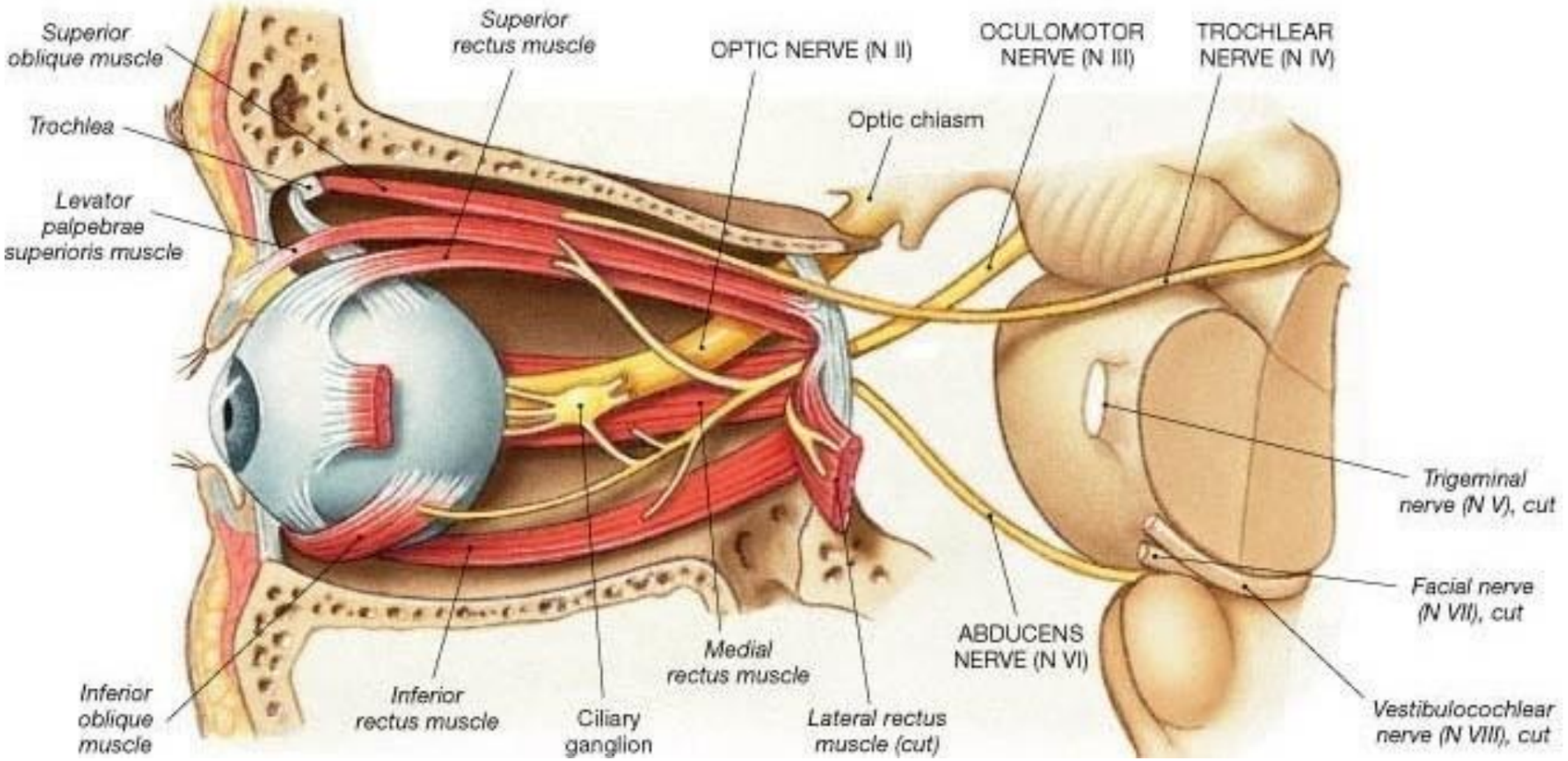
these descending tracts connect the cerebral cortex with spinal cord, cranial nerves nuclei, pons & cerebellum



Oculomotor Nerve (III)



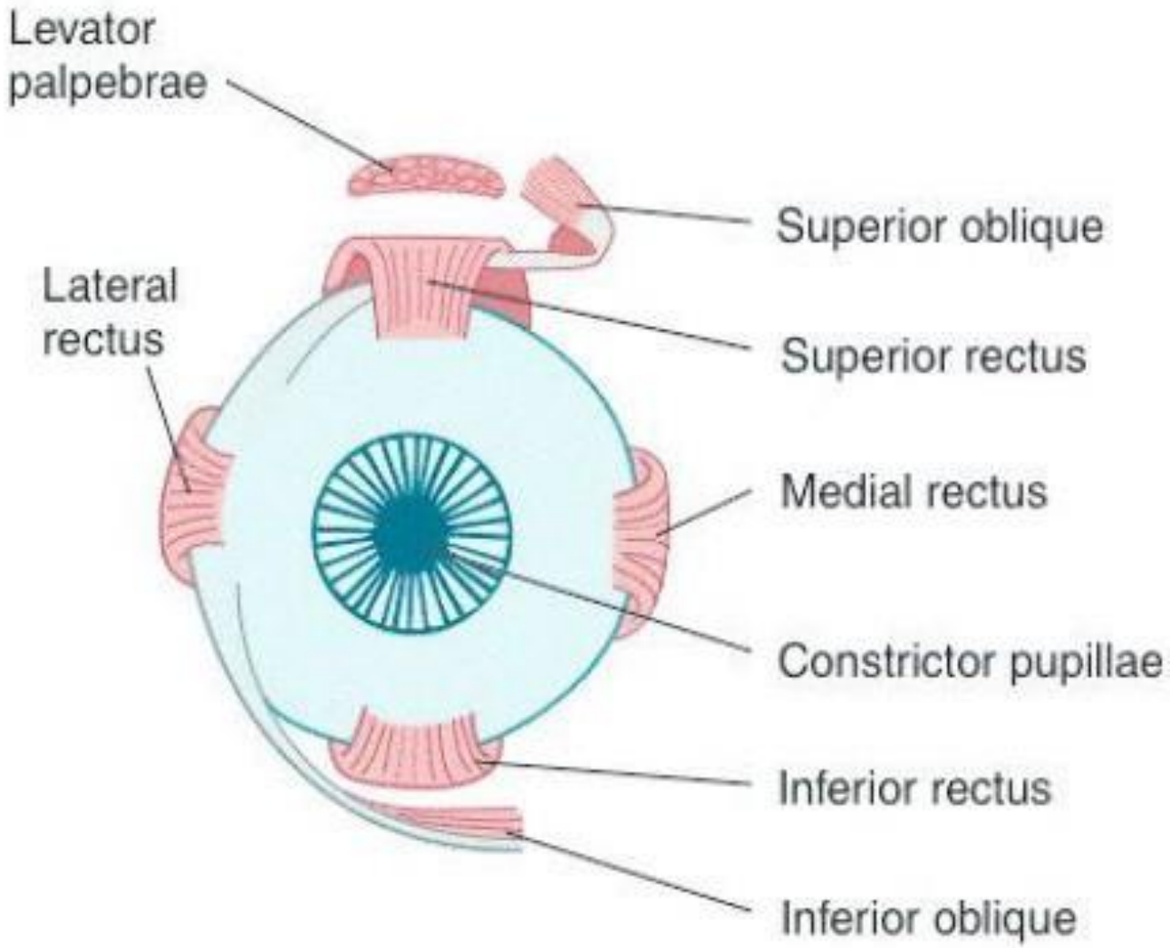
- **Main oculomotor nucleus**
- **Accessory parasympathetic nucleus (Edinger-Westphal nucleus)**



Course of occulomotor nerve

- Fibers pass anteriorly through Red nucleus **WITHOUT synapse**
- Emergence in Interpeduncular fossa
- Middle cranial fossa in the lateral wall of the cavernous sinus (on either sides of sella torsica) (Two rami)
- superior orbital fissure

Oculomotor Nerve (III)



- **Extrinsic muscles:**
  - The levator palpebrae superioris, superior rectus, medial rectus, inferior rectus, and inferior oblique
- **Intrinsic muscles (smooth muscles):**
  - The constrictor pupillae of the iris and ciliary muscles
  - **Preganglionic** fibers from **edinger westphal nucleus**, synapse in ciliary ganglia, and **postganglionic** fibers supply these muscles

- **Action:**
  - Lifting the upper eyelid; turning the eye upward, downward, and medially; constricting the pupil; and accommodating the eye

Oculomotor Nerve injury

- **Complete lesion**
  - All of the muscles are paralyzed except lateral rectus and superior oblique

- Symptoms:
  - External strabismus) العين لبرة **medial rectus paralysis**)
  - Diplopia
  - Ptosis: drooping of the upper eyelid (**levater palpebrae superioris paralysis**)
  - The pupil is widely dilated and nonreactive to light (**parasympathetic**)
  - Accommodation of the eye is paralyzed (**parasympathetic**)

Double Vision

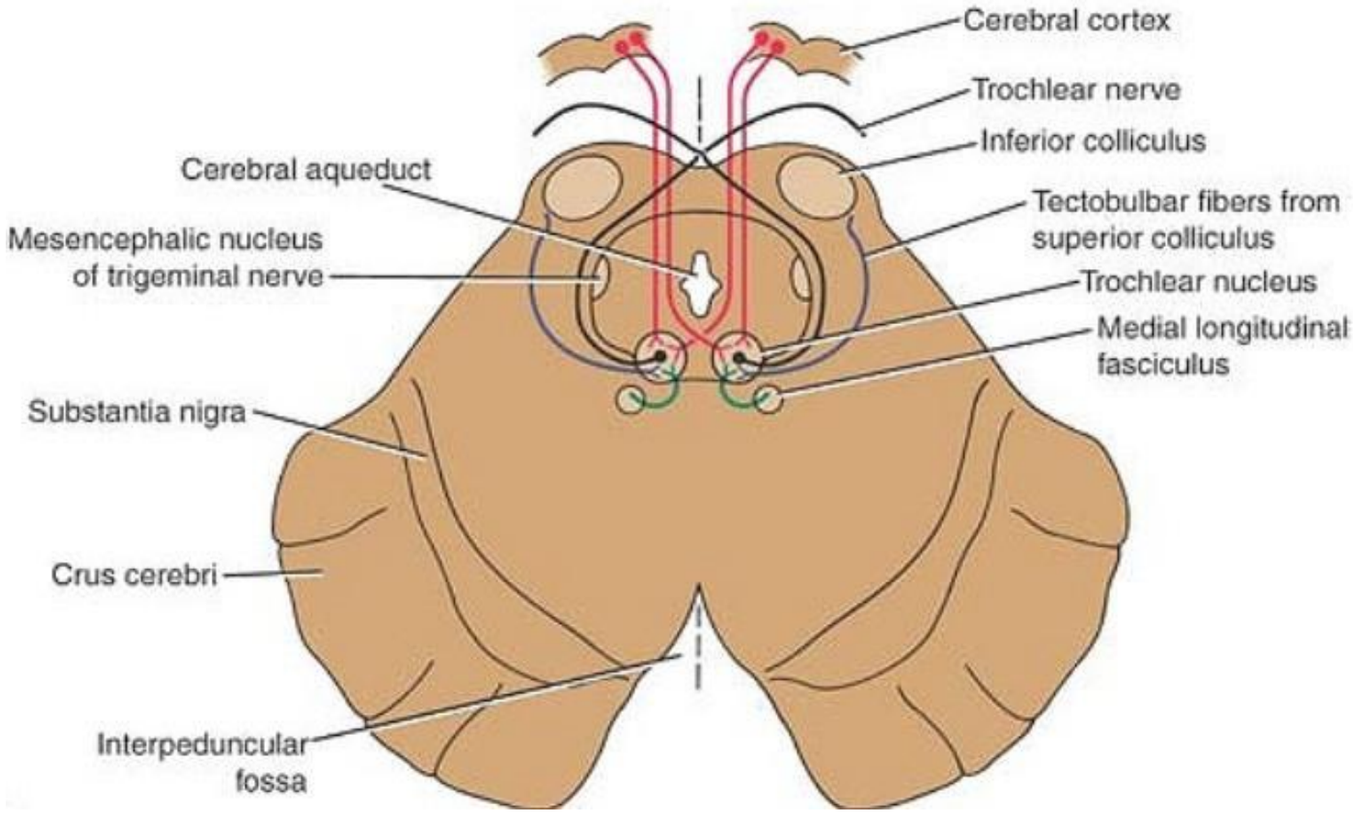
- **Incomplete lesions:**
  - **Internal ophthalmoplegia:** loss of the autonomic innervation of the sphincter pupillae and ciliary muscle
  - **External ophthalmoplegia.:** paralysis of the extraocular muscles

In cases of (diabetic neuropathy), the autonomic fibers are unaffected, whereas the nerves to the extraocular muscles are paralyzed.

Trochlear Nerve

Nucleus

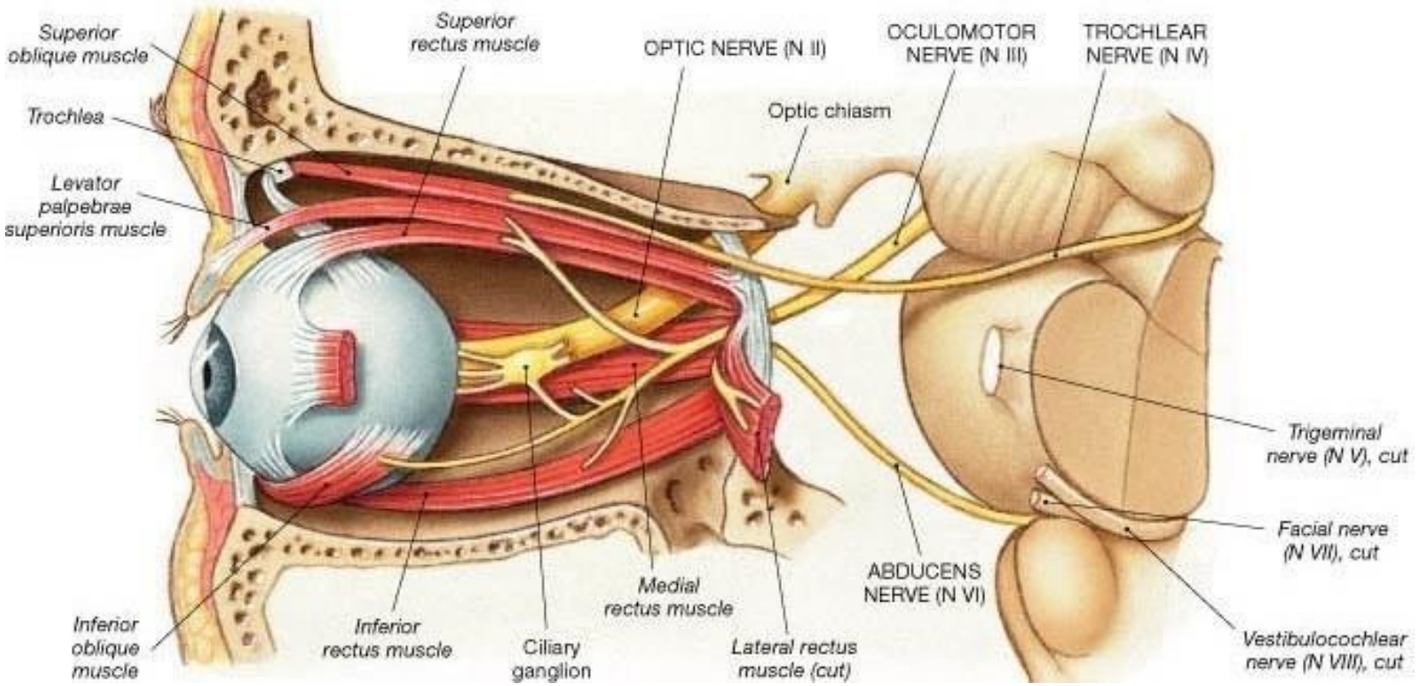
- **Location**

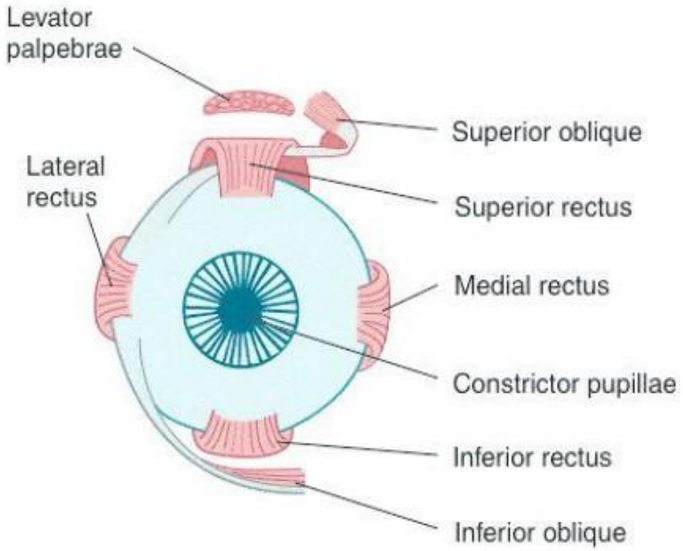


- One motor nucleus, one muscle, bicortical.
- Its pathway was mentioned before.

- Pass **posteriorly** around the central gray matter
- Immediately decussates

Trochlear Nerve





- **Supplies**: superior oblique muscle
- **Action:** turning the eye downward and laterally

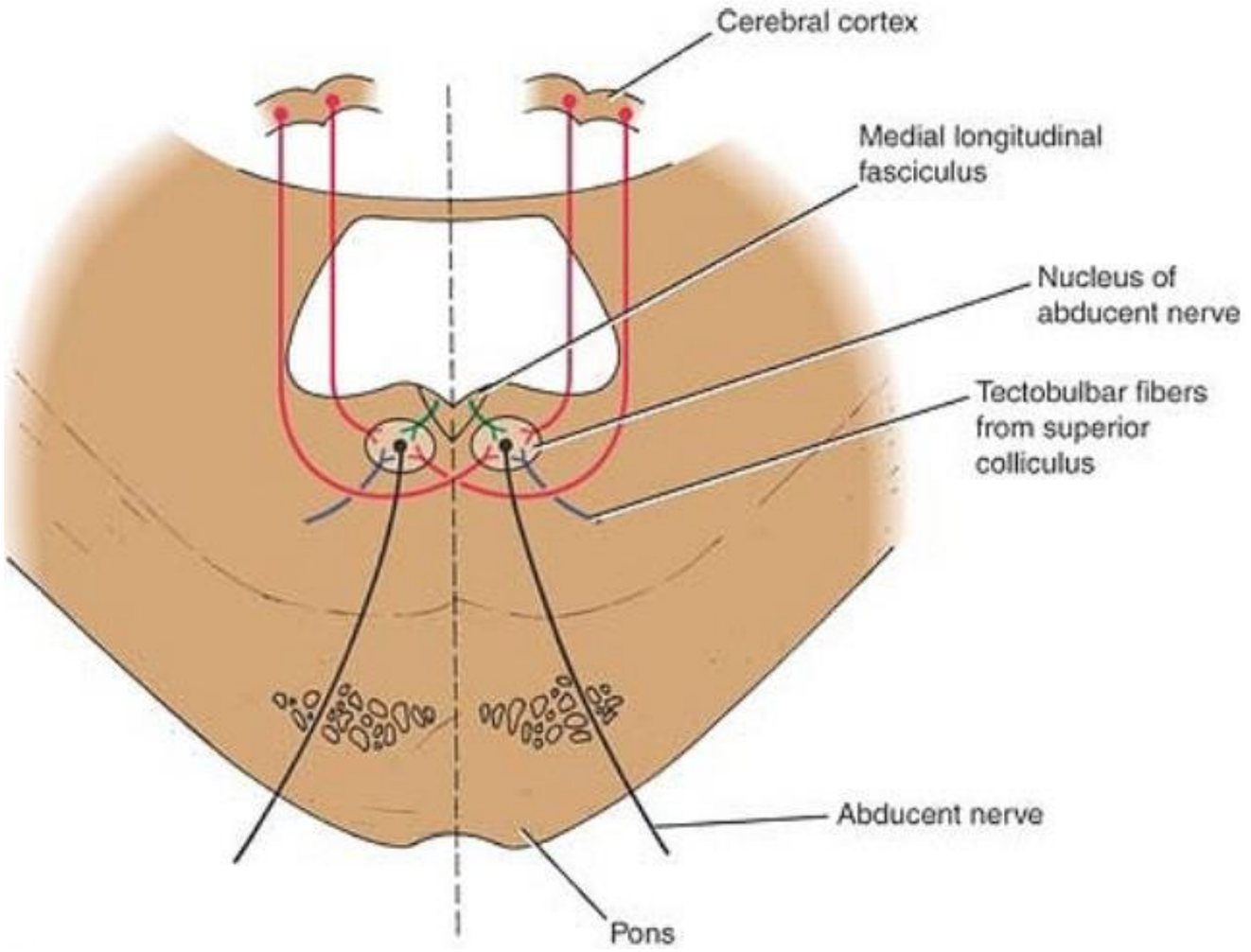
Trochlear Nerve injury

- Symptoms:
  - Diplopia
  - Difficulty in turning the eye downward and laterally.
  - Difficulty in descending stairs, we normally see stairs by moving our **eyeball downward**, but people with injury of trochlear nerve need to move their **head downward** to see stairs
  - Head tilt to the side opposite the paralsied eye (compensatory adjustment)

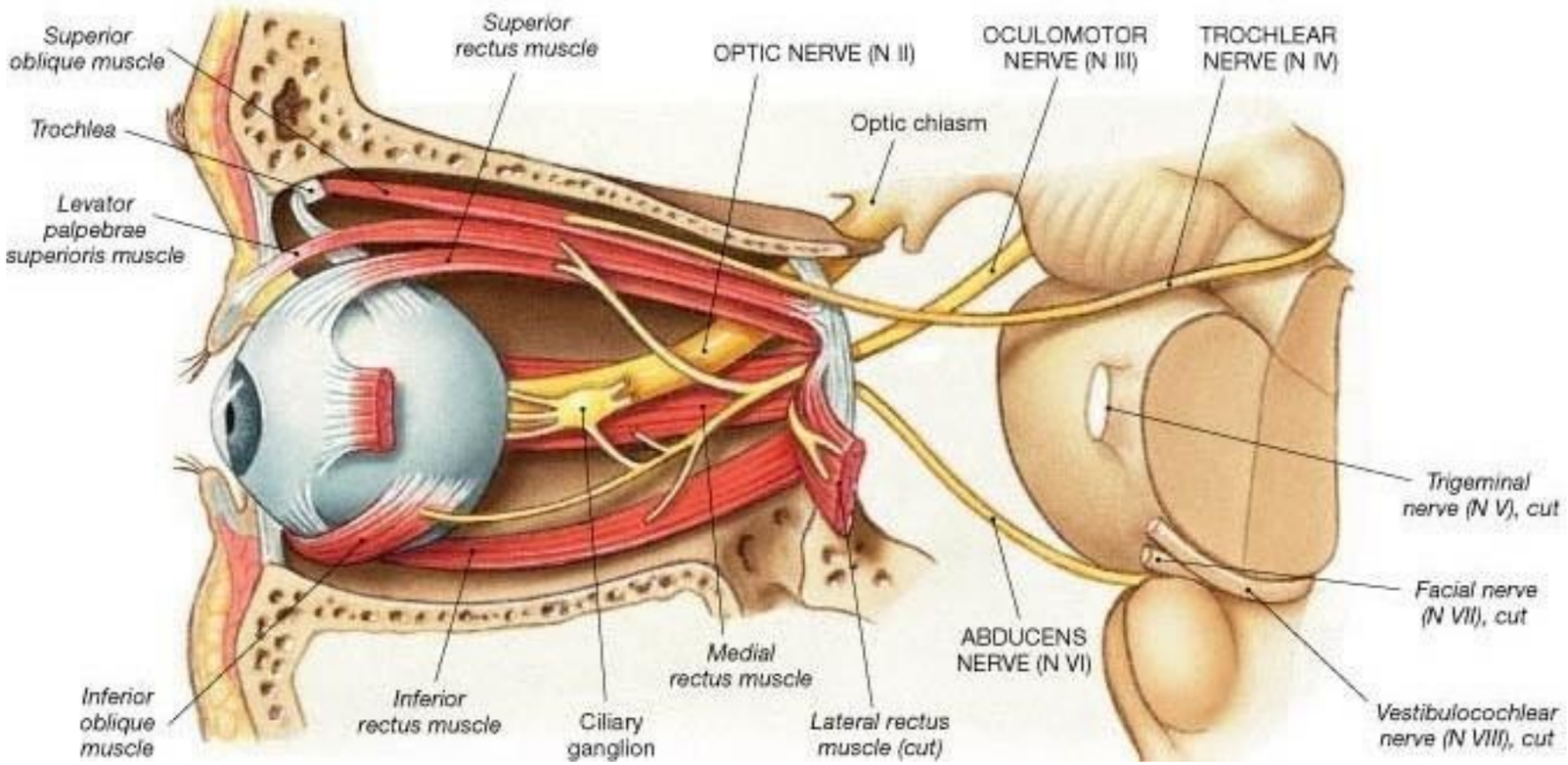
Abducent Nerve

Nucleus

- **Location:** beneath the floor of the upper part of the fourth ventricle, caudal part of pons close to the midline, pass anteriorly



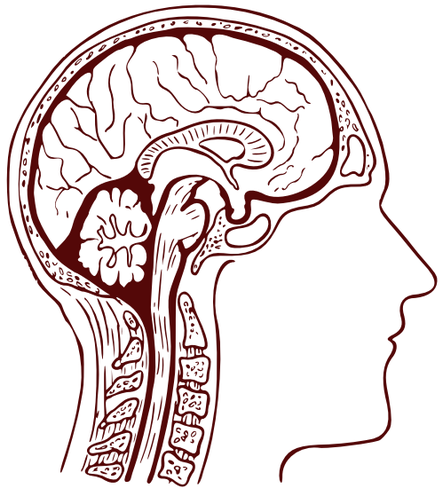
Course of Abducent nerve

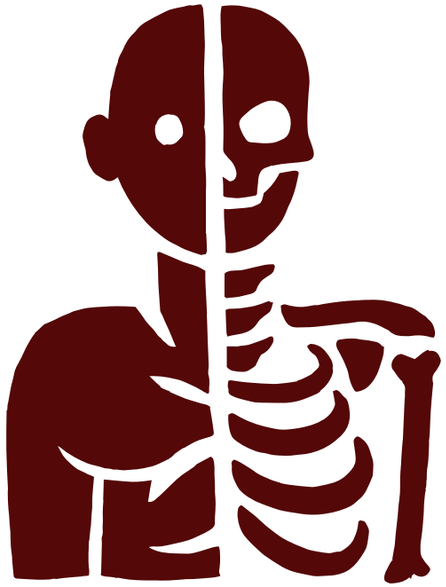


- Passes anteriorly: groove between the lower border of the pons and the medulla oblongata
- Through the cavernous sinus, below and lateral to the internal carotid artery
- Superior orbital fissure
- Supplies the lateral rectus: turning the eye laterally

Abducent Nerve injury

- Symptoms:
  - Diplopia
  - Difficulty in turning the eye laterally.
  - **internal strabismus.** unopposed medial rectus pulls the eyeball medially





ANATOMY QUIZ LECTURE 8

External Resources

رسالة من الفريق العلمي

اللهم إن عمر عطية في ذمتك وحبل جوارك، فقِه من فتنة القبر وعذاب النار،
أنت أهل الوفاء والحق، فاغفر له وارحمه إنك أنت الغفور الرحيم.

Ninja Nerd Cranial Nerves
(very very useful and recommended)

Writing this modified was very exhausting, please remember us in your prayers ❤️

For any feedback, scan the code or click on it.

Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1	27	Great auriculotemporal nerve	Great auricular nerve
V1 → V2			