MED437
KING SAUD UNIVERSITY

ANATOMY
Team 437

Internal Structures of the Brainstem

Lecture (6)

- Important
- Doctors Notes
- Notes/Extra explanation

Please check our Editing File

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

{وَمَنْ يَتَوَكَّلْ عَلَى اللَّهِ فَهُوَ حَسْبُهُ}

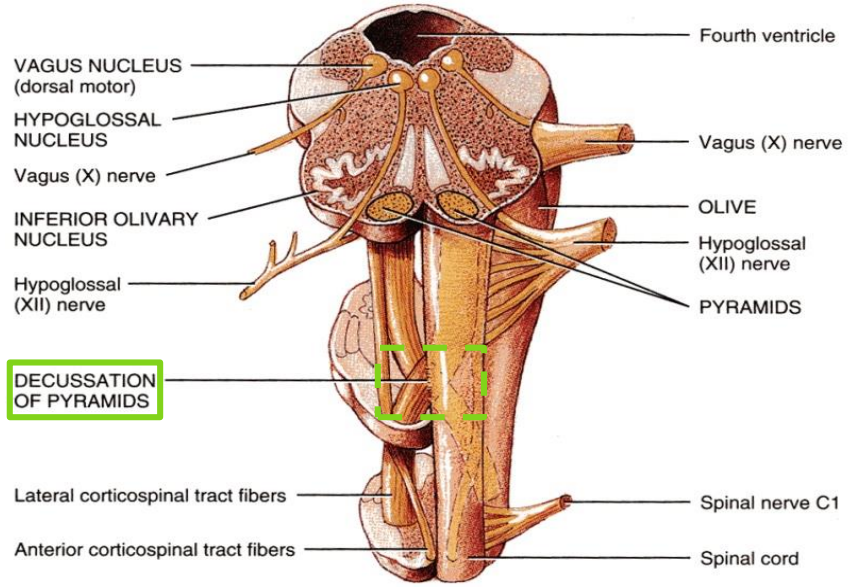
Objectives

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

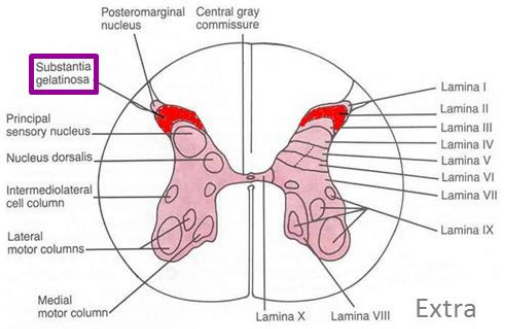
- ✓ Distinguish the internal structure of the components of the brain stem in different levels and the specific criteria of each level.
  1- Medulla oblongata (closed, mid and open medulla)
  2- Pons (caudal, mid “Trigeminal level” and rostral).
  3- Mid brain (superior and inferior colliculi).

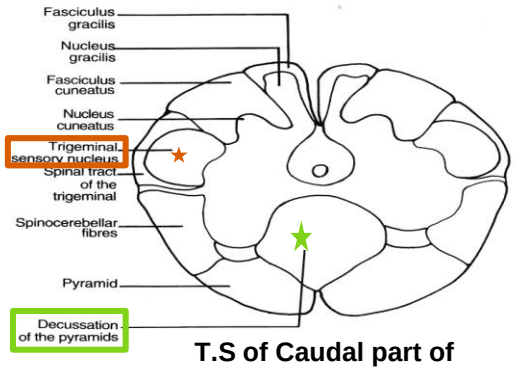
Medulla (Closed)
Caudal surface

- Traversed* by the Central Canal.
- Motor Decussation**.
- Spinal Nucleus of Trigeminal nerve (Trigeminal sensory nucleus):
  - It is a larger sensory nucleus.
  - It is the brain stem continuation of the Substantia Gelatinosa of spinal cord.



Transverse section and anterior surface of medulla oblongata





T.S of Caudal part of M.O.

* Traversed = travel across or through

**Decuss- = crossing

Doctor's note: the major thing we see in the closed Medulla is The Motor Decussation.

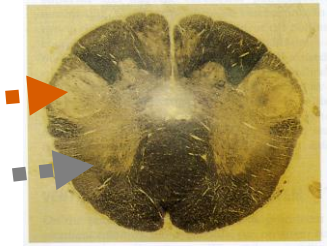
Medulla (Closed)
Caudal surface

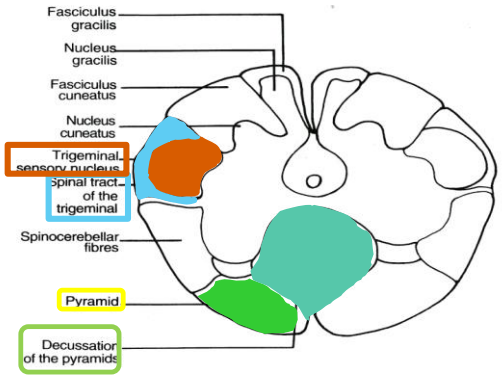
Trigeminal Sensory Nucleus & Tract

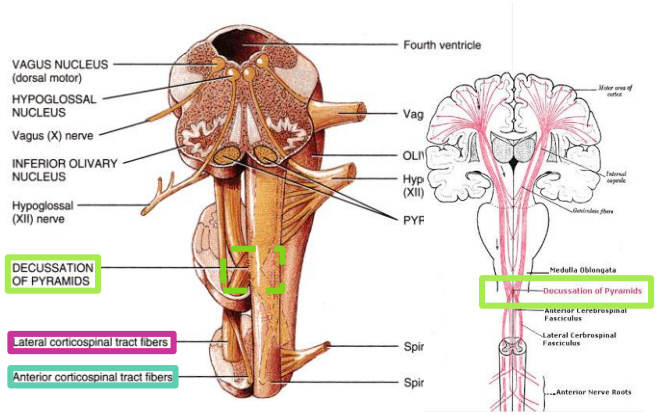
- The Nucleus Extends :

Through the whole length of the brain stem and into upper segments of spinal cord.

- It lies in all levels of medulla oblongata, **medial** to the spinal tract of the trigeminal.
- It receives **pain** and **temperature** from face and forehead Its tract present in all levels of M.O. is formed of ascending fibers that terminate in the trigeminal nucleus.







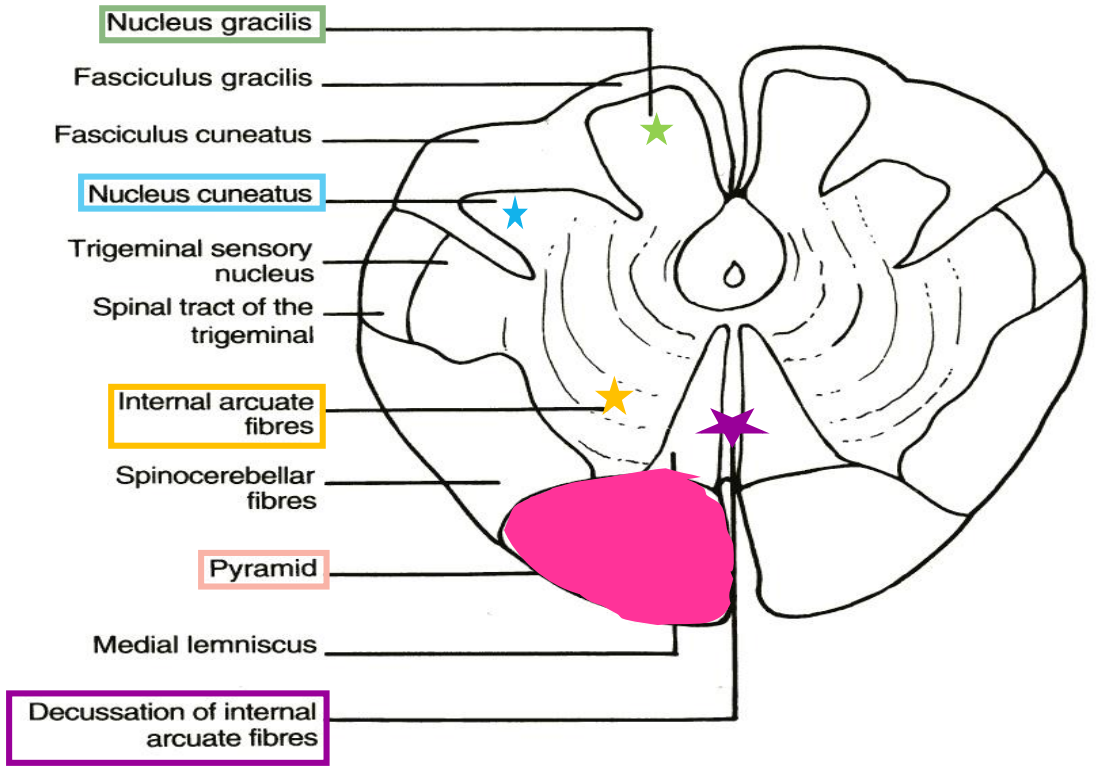
Pyramidal Decussation

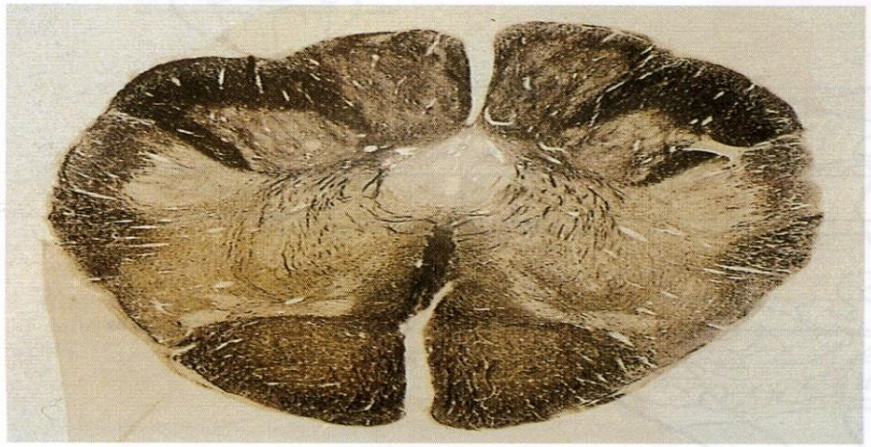
- **Pyramidal decussation** is Motor Decussation Formed by pyramidal fibers, (75-90%) cross to the opposite side
- They descend in the lateral white column of the spinal cord as the **lateral corticospinal tract.**
- The uncrossed fibers form the **ventral corticospinal tract.**

*Decuss- = crossing

Medulla
Mid medulla

- Traversed by **Central Canal**.
- Larger size **Gracile** & **Cuneate nuclei**, concerned with proprioceptive (knowing the normal body position) deep sensations of the body.
- Axons of Gracile & Cuneate nuclei form the **internal arcuate fibers**; Sensory Decussation.*
- **Pyramids** are prominent ventrally.





Motor decussation (pyramids): Closed/Caudal Medulla
Sensory decussation (internal arcuate fibers): Mid Medulla

Medulla
Mid medulla

Sensory Decussation

- Formed by the crossed **internal arcuate fibers.**
- **Medial Leminiscus***:
  - Composed of the ascending internal arcuate fibers **after** their crossing.
  - Lies adjacent to the middle line ventral to the central canal
  - Terminates in thalamus.
  - Concerned with proprioceptive deep sensation.

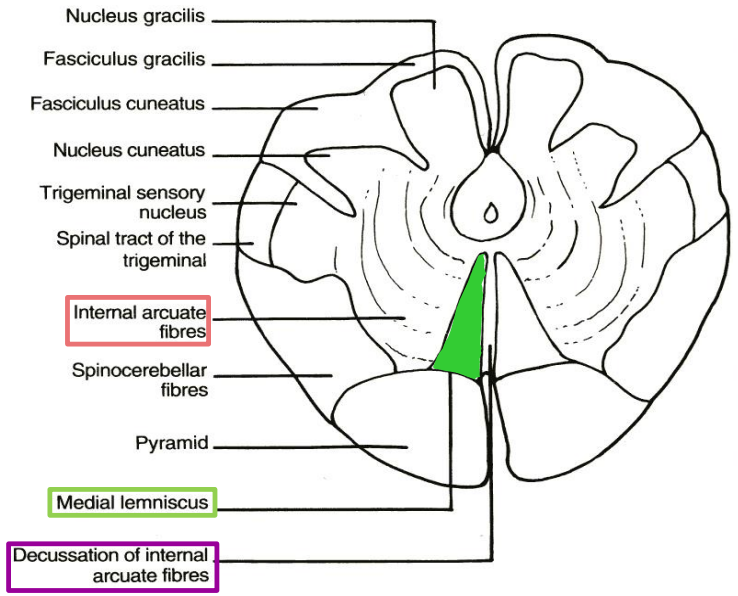
*lemniscus = ribbon

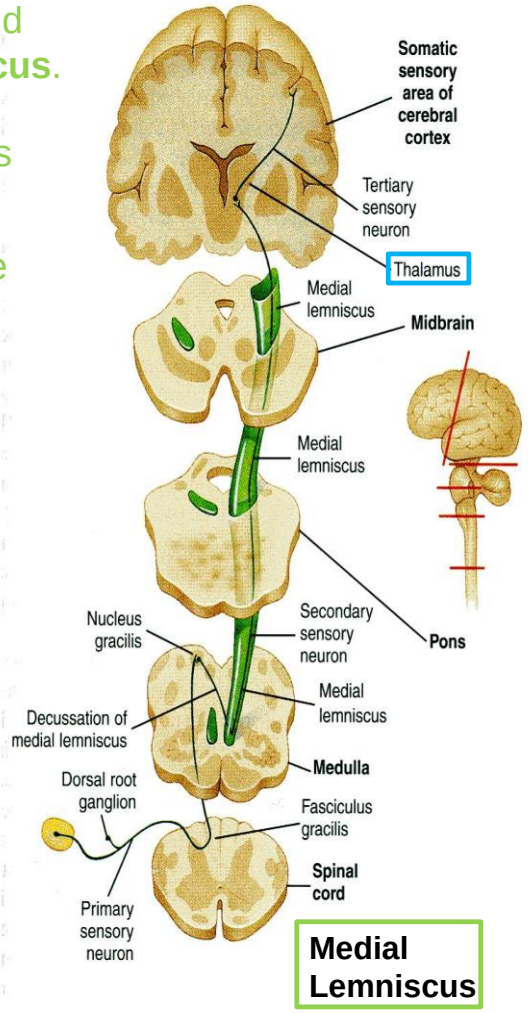
Doctor's note: don't be confused about Tracts , Fasciculus , Leminiscus . They are all tracts with different locations and shapes.

After crossing and they ascend and form the **medial leminsicus**.

At the level of the crossing it is called **sensory decussation**

Before they cross they are the **internal arcuate fibers** from gracile and cuneate nuclei





Medulla (Open)
Rostral Part

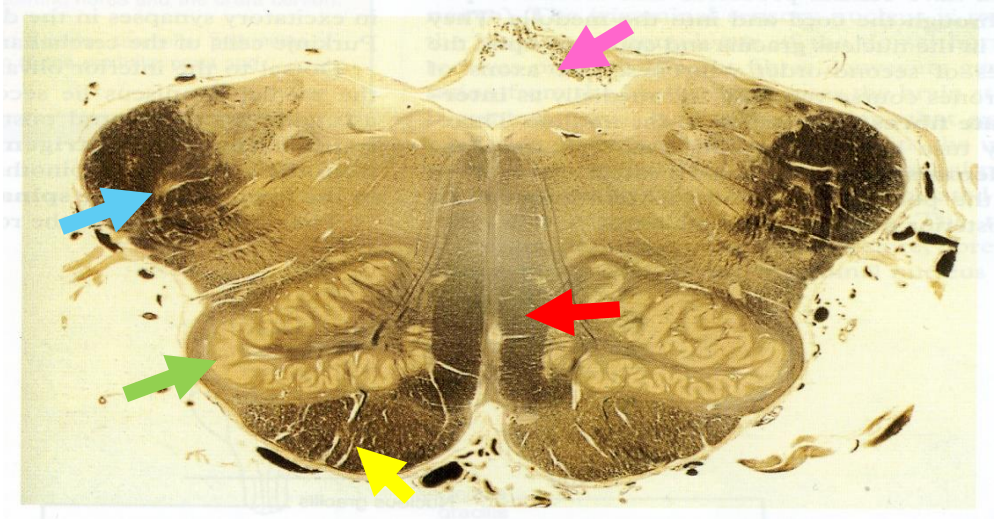
On the **ventral** aspect :

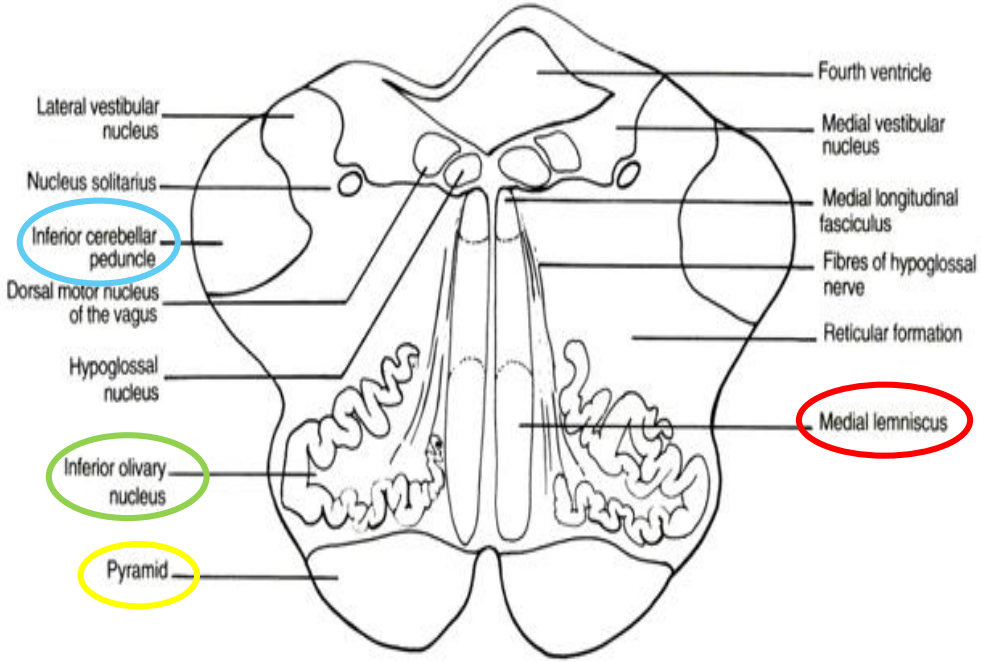
- The pyramid is clear, with **medial lemniscus** on either sides of middle line dorsal to the pyramid
- **Inferior Olivary Nucleus**:
  - A convoluted mass of gray matter., lies posterolateral to the pyramids & lateral to the medial leminiscus.
  - It is concerned with the control of movement. The fibers in here will come from the cerebellum.

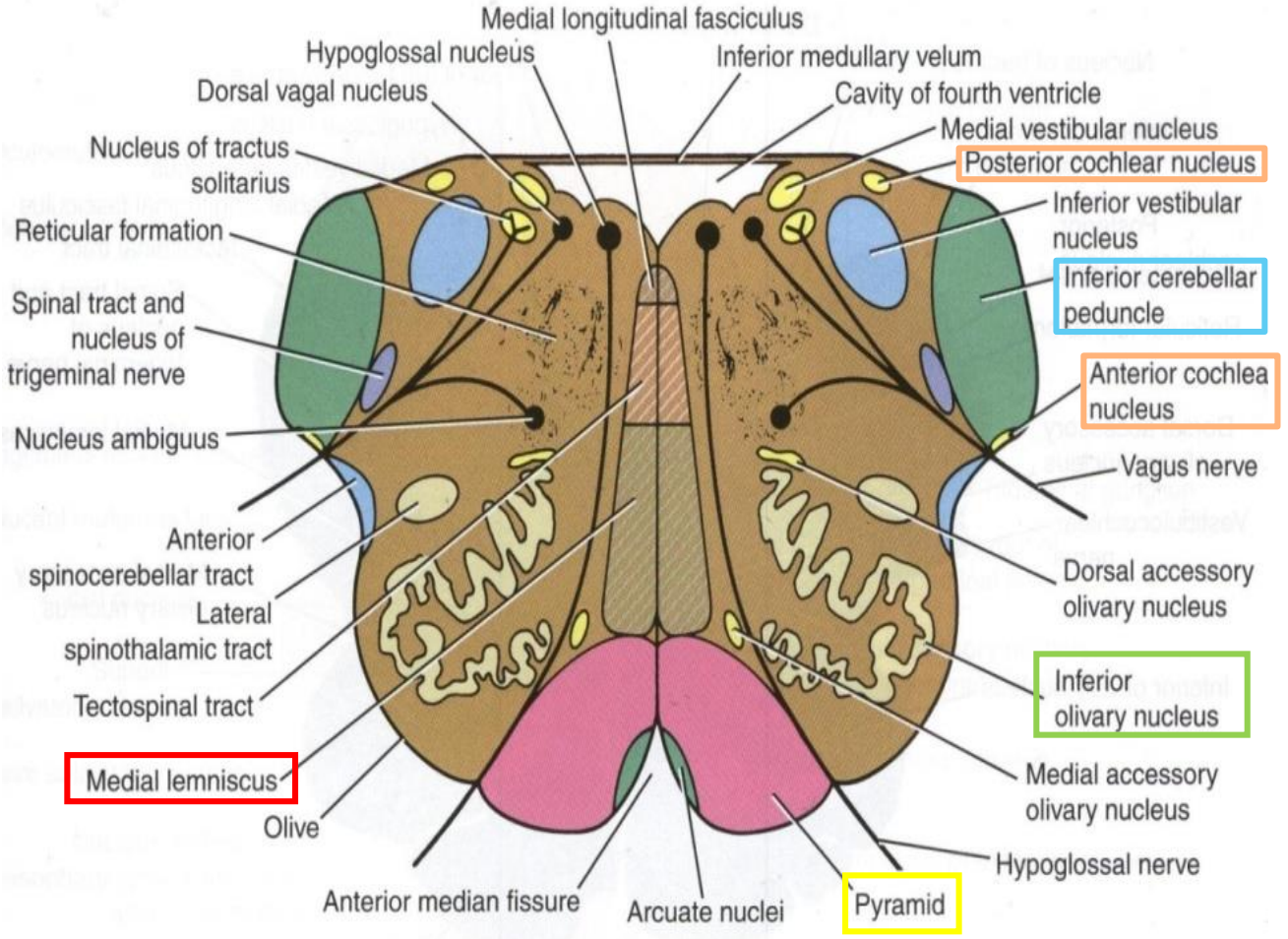
On the **dorsal** aspect:

- Lower part of the floor of the **4th ventricle**.
- The **Inferior** Cerebellar Peduncle is, connecting Medulla Oblongata with cerebellum.
- Dorsal and lateral to the Inferior cerebellar peduncle lie the **Cochlear nuclei** (dorsal and ventral).

Doctor's Note: we call it open medulla because the central canal will open at this level into the 4th ventricle.




Fourth ventricle
Lateral vestibular nucleus
Medial vestibular nucleus
Nucleus solitarius
Medial longitudinal fasciculus
Inferior cerebellar peduncle
Fibres of hypoglossal nerve
Dorsal motor nucleus of the vagus
Reticular formation
Hypoglossal nucleus
Medial lemniscus
Inferior olivary nucleus
Pyramid


Medial longitudinal fasciculus
Hypoglossal nucleus
Inferior medullary velum
Dorsal vagal nucleus
Cavity of fourth ventricle
Medial vestibular nucleus
Nucleus of tractus solitarius
Posterior cochlear nucleus
Inferior vestibular nucleus
Reticular formation
Inferior cerebellar peduncle
Spinal tract and nucleus of trigeminal nerve
Anterior cochlea nucleus
Nucleus ambiguus
Vagus nerve
Anterior spinocerebellar tract
Dorsal accessory olivary nucleus
Lateral spinothalamic tract
Inferior olivary nucleus
Tectospinal tract
Medial lemniscus
Medial accessory olivary nucleus
Olive
Hypoglossal nerve
Anterior median fissure
Arcuate nuclei
Pyramid

Medulla (Open)
Rostral Part

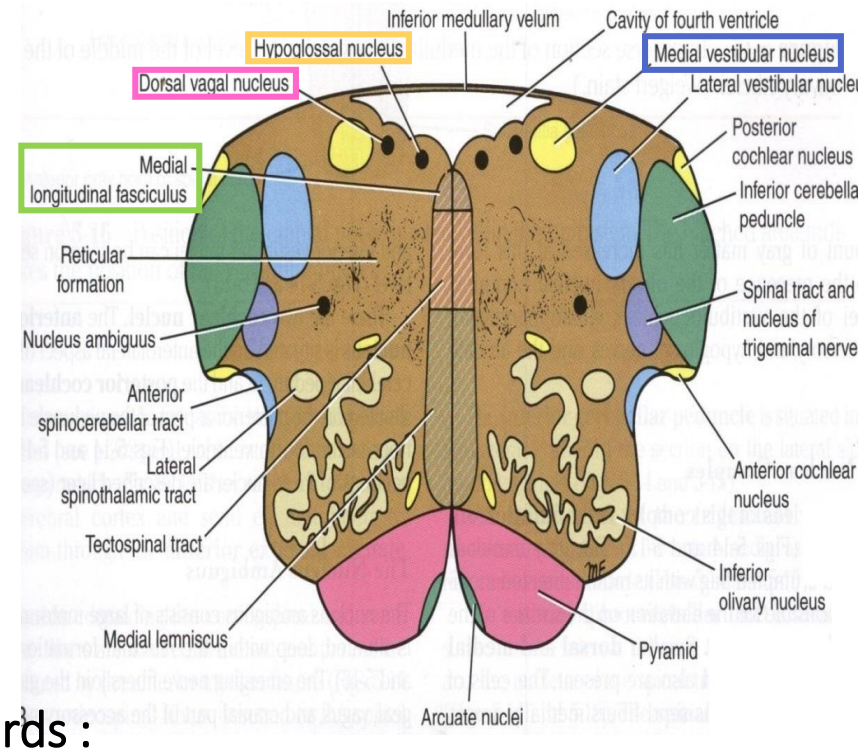
Beneath the floor of 4th ventricle lie :

1. Hypoglossal Nucleus.
2. Dorsal Nucleus of Vagus
   lateral to the hypoglossal nucleus, contains preganglionic parasympathetic fibers.
3. Medial longitudinal fasciculus, it is **important** association tract, lies close to the midline, ventromedial to the hypoglossal nucleus.

Function:

Upwards :
It links the vestibular nuclei with **nuclei of extraocular muscles (**in CN **3,4&6)** as (vestibulo-ocular tract) to help coordination of eye movements with head movements.

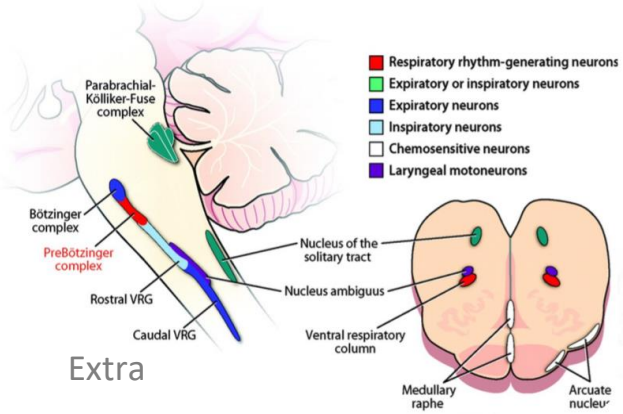
4. Vestibular nuclei complex **:** concerned with equilibrium.



Downwards :
It links vestibular nuclei with **anterior horn cells** of spinal cord **(cervical & upper thoracic segments)** as (vestibulo-spinal tract) so, the neck & trunk move with head movements

Medulla (Open)
Rostral Part

5. Nucleus Ambiguus: (motor nucleus) : lies dorsal to **olivary nucleus** gives motor fibers along glossopharyngeal N. & vagus N. to motor supply of the constrictors of the pharynx, intrinsic muscles of the larynx & palate.
6. Solitary nucleus (sensory nucleus) : lies ventrolateral to dorsal nucleus of vagus, receive **taste sensation** from the tongue along the facial (VII), glossopharyngeal (IX) and vagus (X).
7. Tectospinal tract : between tectum of midbrain and spinal cord (involved in head movements during visual and auditory tracking).



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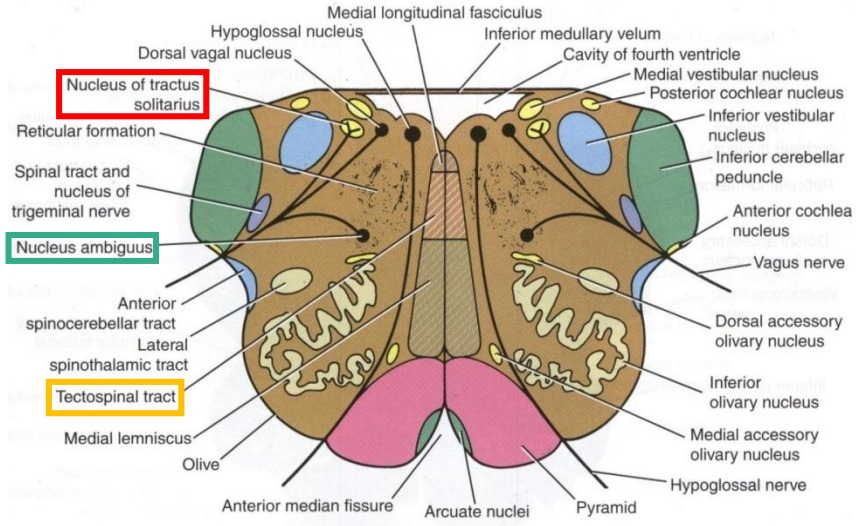
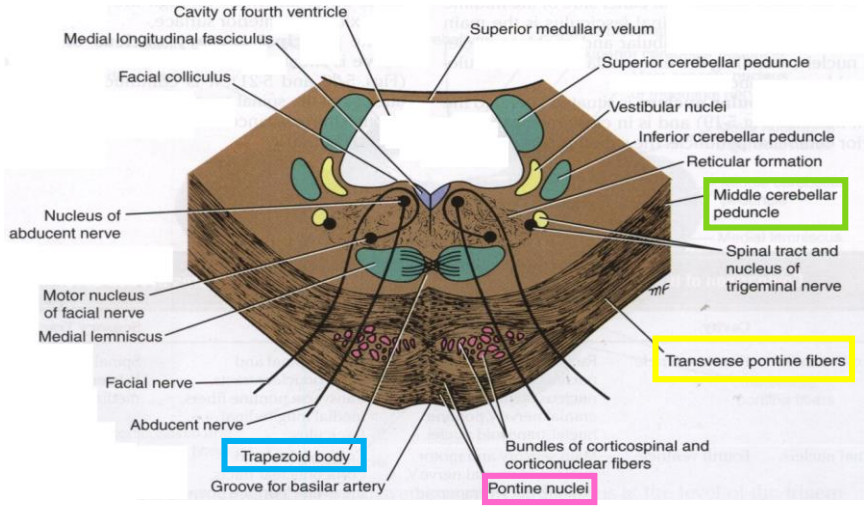


Pons

- Divided into an anterior part (**basis pontis**) & a posterior part (**Tegmentum**) by the **Trapezoid Body.***
- The trapezoid body consists of acoustic fibres from **cochlear nuclei** to ascend into midbrain as lateral lemniscus and terminate in inferior colliculus.
- The ventral (anterior) portion is marked by numerous transversely oriented fascicles of **pontocerebellar fibres** that originate from scattered cell groups, the **pontine nuclei** and that pass to the contralateral side of the cerebellum through the massive **middle cerebellar peduncle.**

*Trapezoid body between basepoints & tegmentum

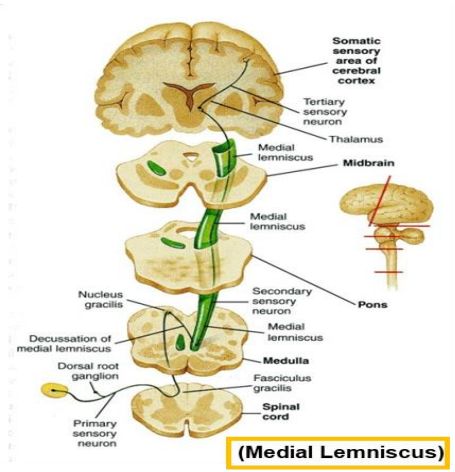


Compare:

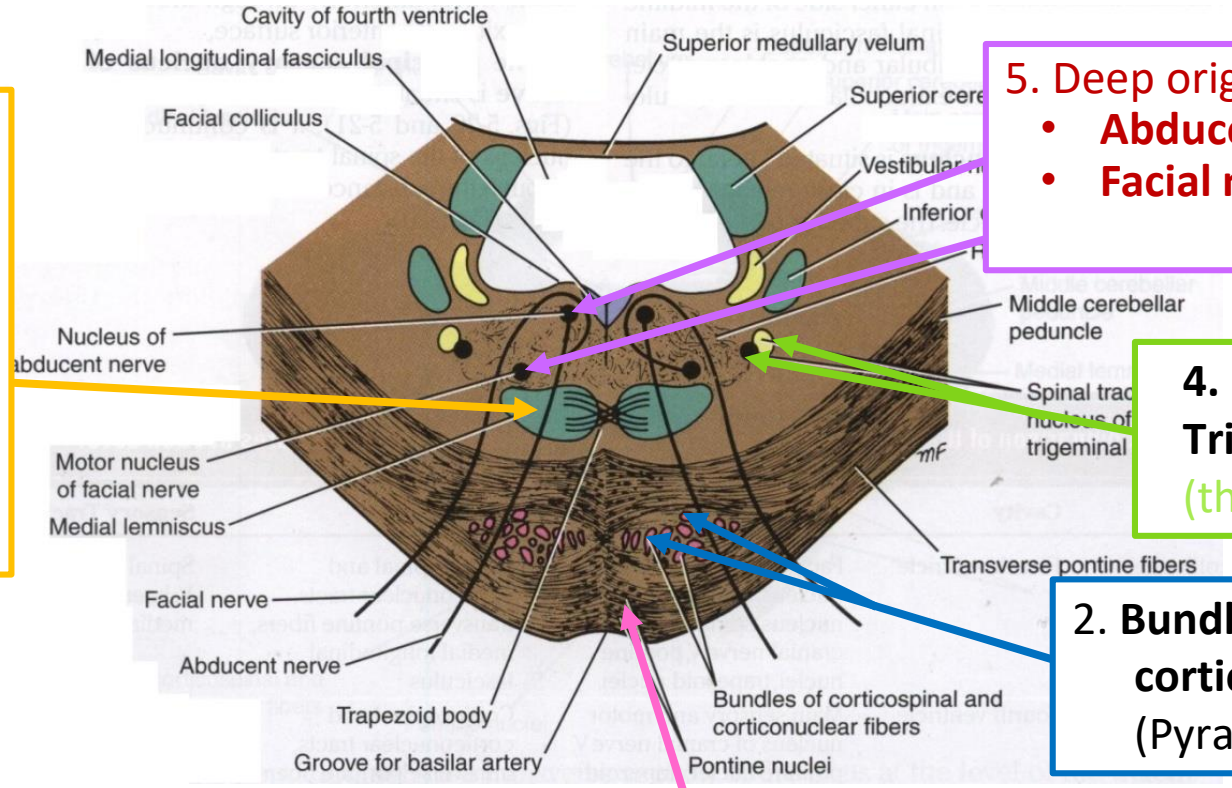
Medial lemniscus	Lateral lemniscus
Ascending internal arcuate fibers	Acoustic fibres from cochlear nuclei
Terminates in thalamus	Terminate in inferior colliculus

Pons
Caudal Part

3. The ascending fibres of the **medial lemniscus**
- become separated from the pyramid and displaced dorsally.
- The Medial Lemniscus rotates 90 degrees and lies almost horizontally.



(Medial Lemniscus)



5. Deep origin of cranial nerve nuclei :
- **Abducent nucleus**
- **Facial motor nucleus**

4. Spinal tract & nucleus of Trigeminal.
(they become smaller)

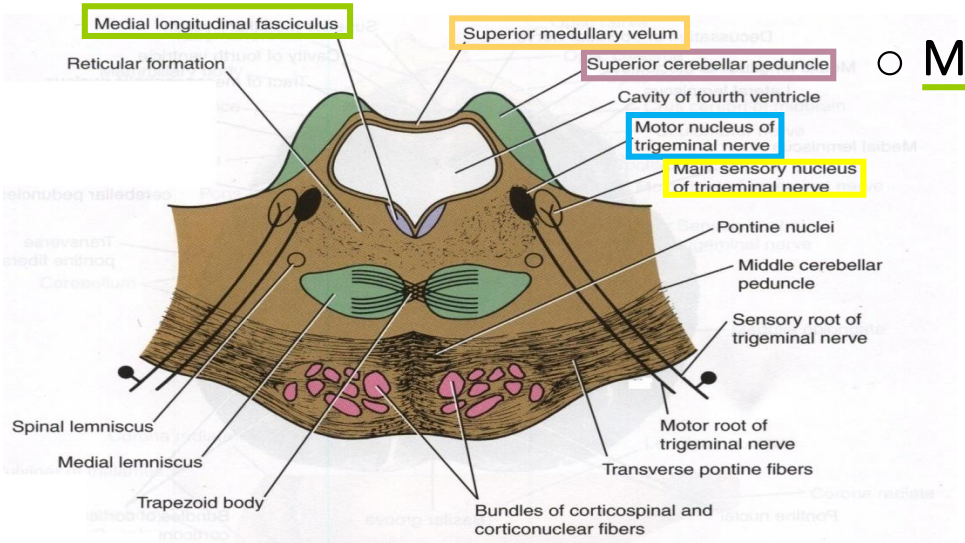
2. **Bundles of corticospinal** & **corticonuclear fibres** (Pyramidal fibres)

1. Pontine Nuclei: are small masses of nerve cells, receive corticopontine fibers (involved in motor activity)
Their axons form the **transverse pontocerebellar fibers** which pass to the contralateral side of the cerebellum through **Middle Cerebellar peduncles**.

Pons

Level of Trigeminal Nerve (Mid Pons)

- Motor nucleus of the trigeminal nerve: Lies in the lateral part of the floor of the 4th ventricle.
- Main sensory nucleus of the trigeminal nerve: Reaches its maximum extent in the pons and it lies lateral to the motor nucleus.



Transverse section through the pons at the level of the trigeminal

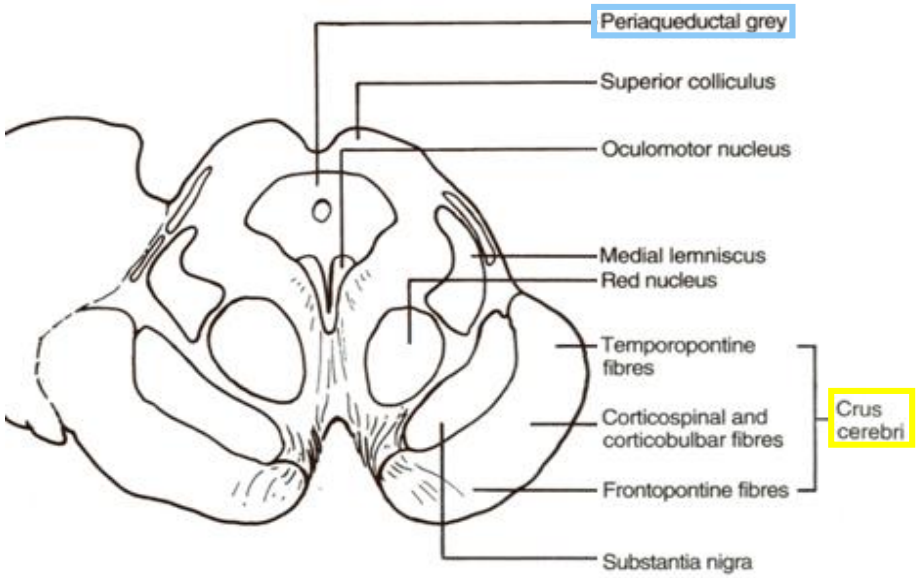
Rostral Part

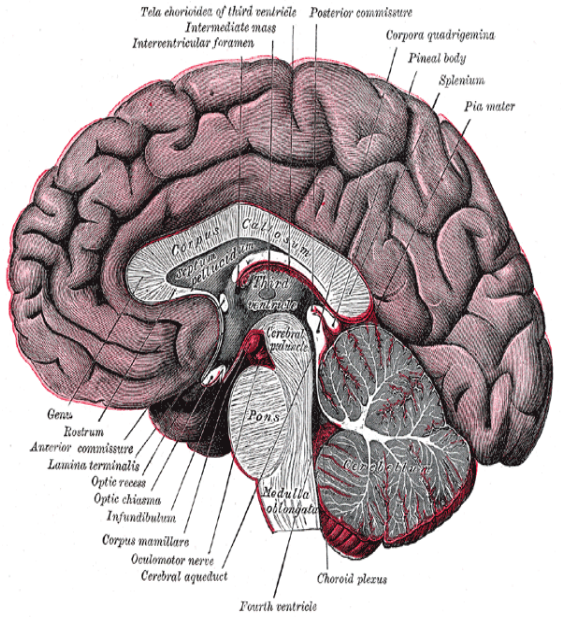
- **Superior cerebellar peduncles** :
  - form the lateral boundary of the 4th ventricle.
- Superior Medullary Velum:
  - Passes between the two peduncles & forms the roof of the 4th ventricle.
- Medial longitudinal fasciculus:
  - Lies close to the midline *beneath* the floor of the 4th ventricle.

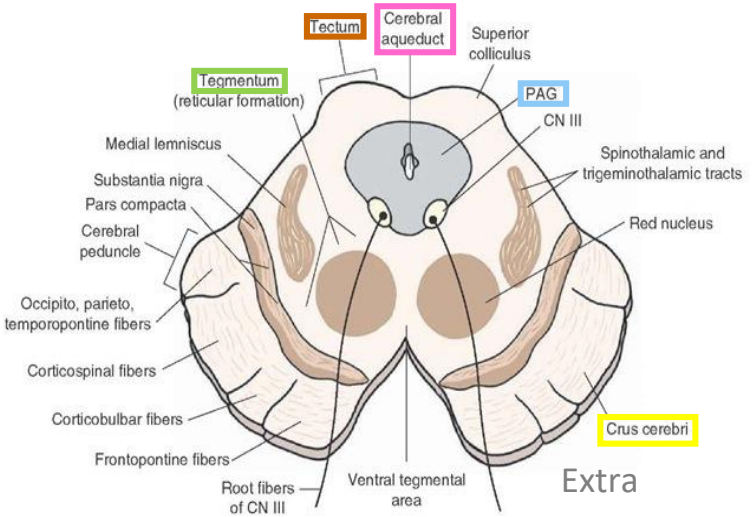
Midbrain

- It is divided at the level of the cerebral aqueduct into :
  - a dorsal part (**Tectum**) and
  - a ventral part (**Tegmentum**)

    In pons it will be the opposite.
- The **cerebral aqueduct** is surrounded by a pear shaped periaqueductal (central) gray matter.
- The most ventral part of the tegmentum is the massive fibrous mass (**Crus Cerebri**).





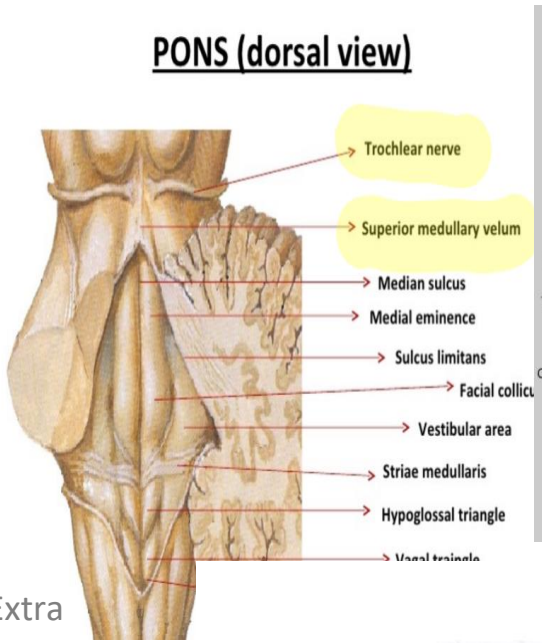


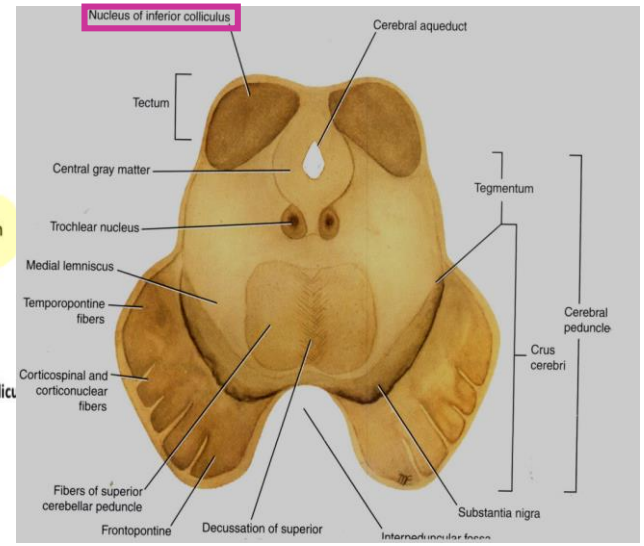
Extra

Midbrain
Inferior Colliculus Level

- **Inferior colliculus** is a large nucleus of gray matter that lies beneath a corresponding surface elevation.
- It is part of the auditory pathway.
- It receives fibers from the lateral lemniscus.
- Its efferent fibers pass to the thalamus.

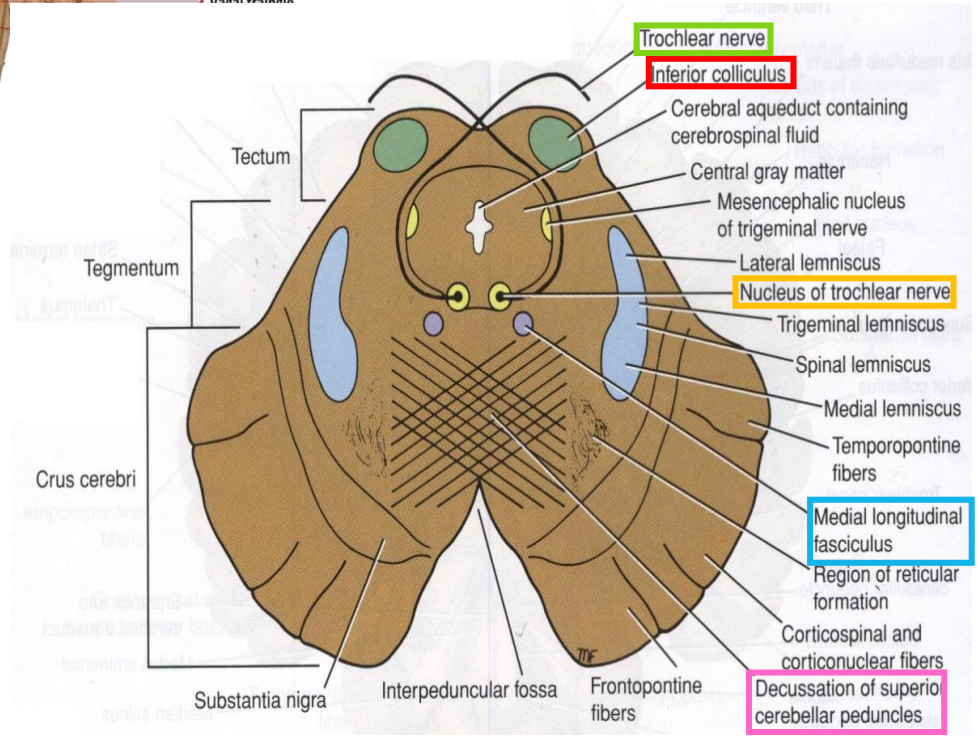
Extra



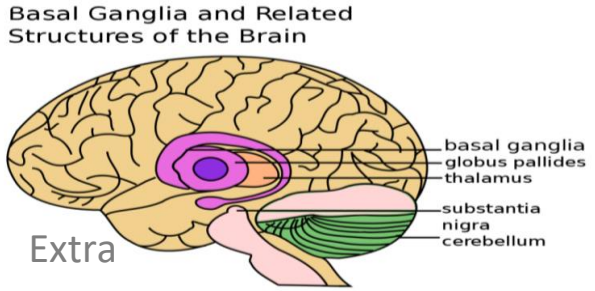


Structures:

1. **Trochlear nucleus**:
   - lies in the central gray matter close to the median plane just posterior to the medial longitudinal bundle.
   - The fibers of the trochlear nerve decussate in the superior medullary velum.
2. **Decussation of the superior cerebellar peduncles** in the mid line.



Midbrain
Inferior Colliculus Level



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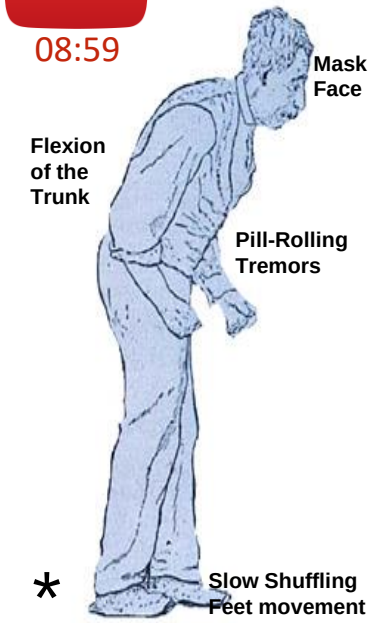
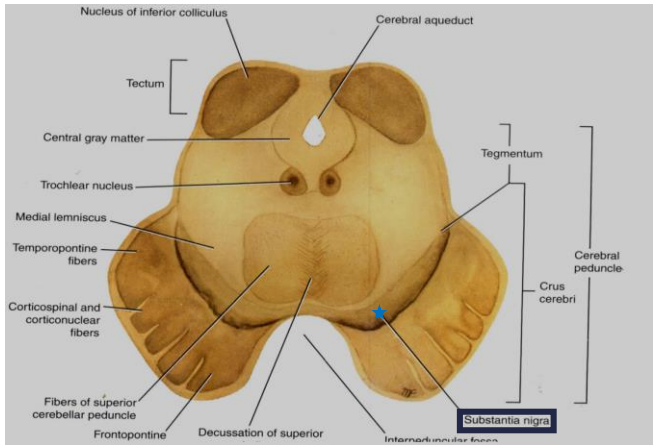
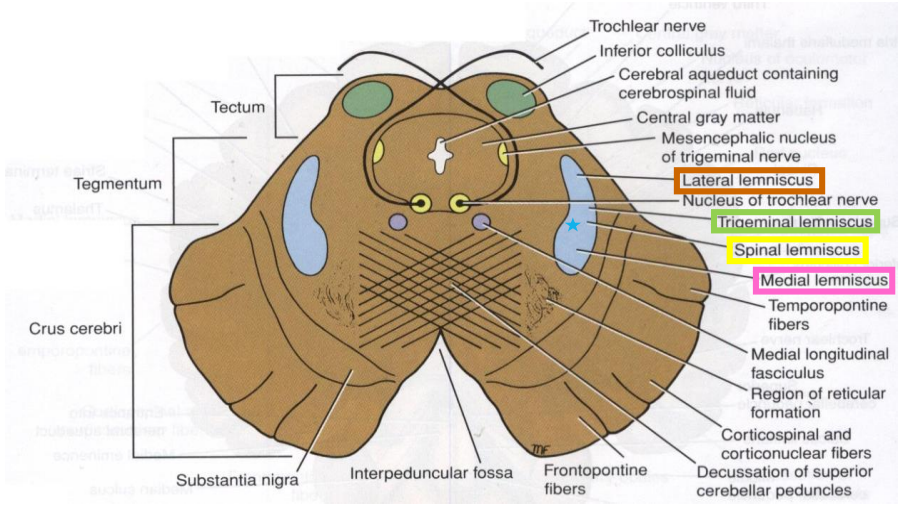


3. <u>Substantia nigra</u> :
   - Occupies the most <u>ventral</u> part of the tegmentum.
   - It consists of pigmented, melanin containing neurones.
   - It projects to the basal ganglia. Its degeneration is associated with Parkinson's disease*.

     Tone of the muscle will be lost.

4. <u>Ascending Leminisci</u>:
   - Composed Of:
     - <u>Medial lemniscus.</u>
     - <u>Spinal</u> (Lateral & anterior spinothalamic tracts)
     - <u>Trigeminal</u> (Lateral & medial).
     - <u>Lateral lemniscus.</u>

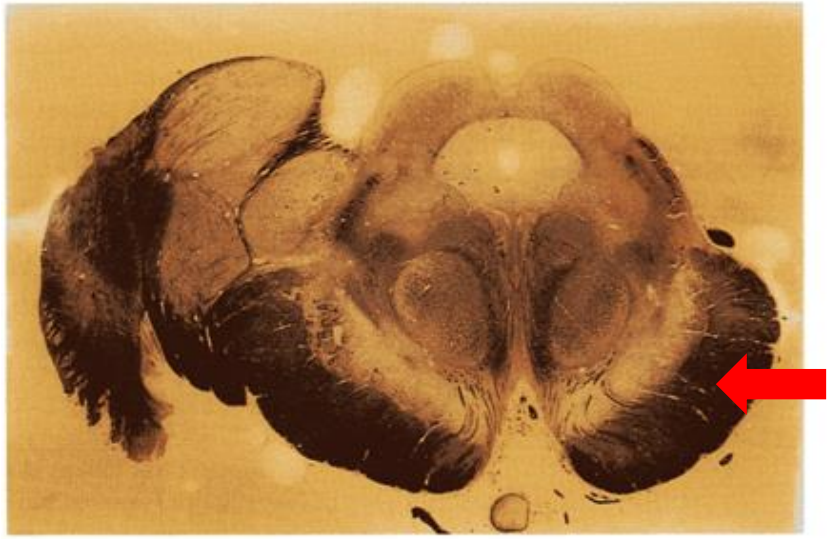


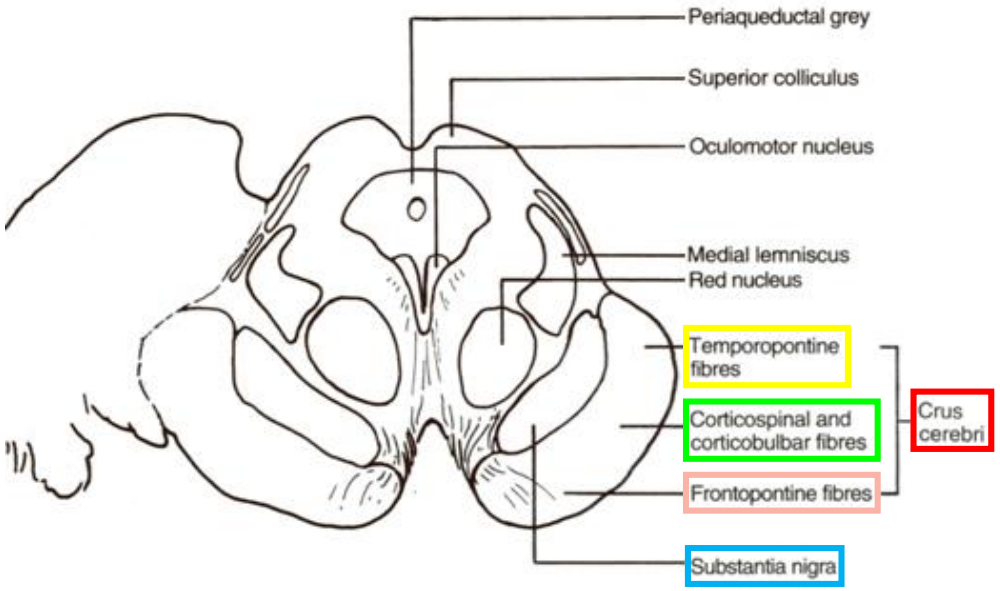


3. Midbrain

Crus Cerebri

- It is a massive mass ventral to the **substantia nigra**.
- It consists entirely of **descending cortical efferent fibers** (Frontopontine, Corticospinal & corticobulbar and Temporopontine Fibres) to the motor cranial nerve nuclei and to anterior horn cells.
- Involved in the **coordination of movement.**
- Present in both levels of colliculi (inferior and superior).

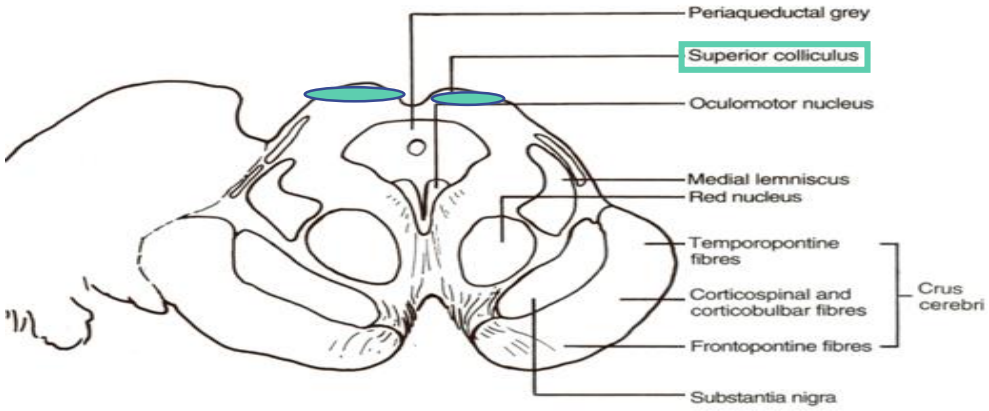


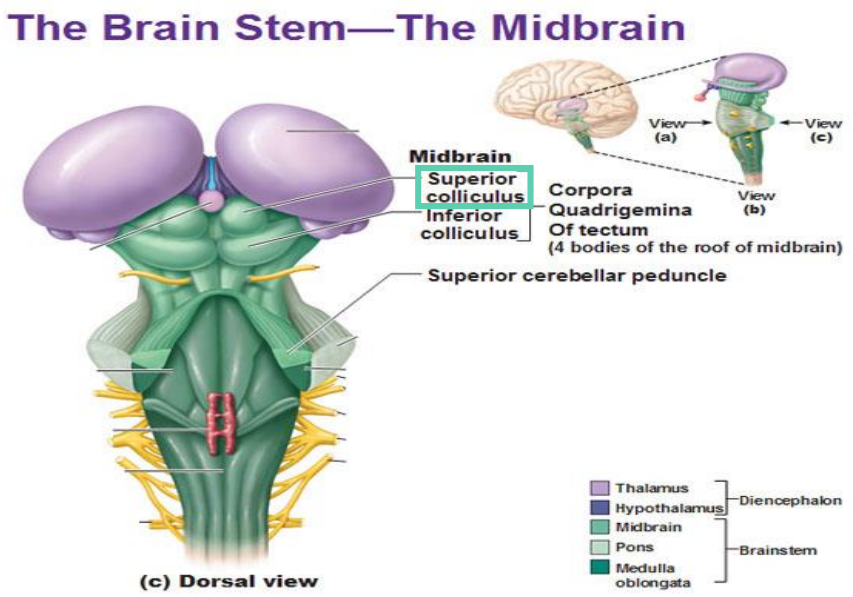


Midbrain
Superior colliculus level

- A large nucleus of gray matter that lies beneath corresponding elevation.
- It forms part of the visual reflexes*.
- Its efferent fibers go to the **anterior horn cells** & to **cranial nuclei 3, 4, 6, 7 & 11**.
- It is responsible for the reflex movements of the eyes, head and neck in response to visual stimuli, as in following a moving object or altering the direction of the gaze.

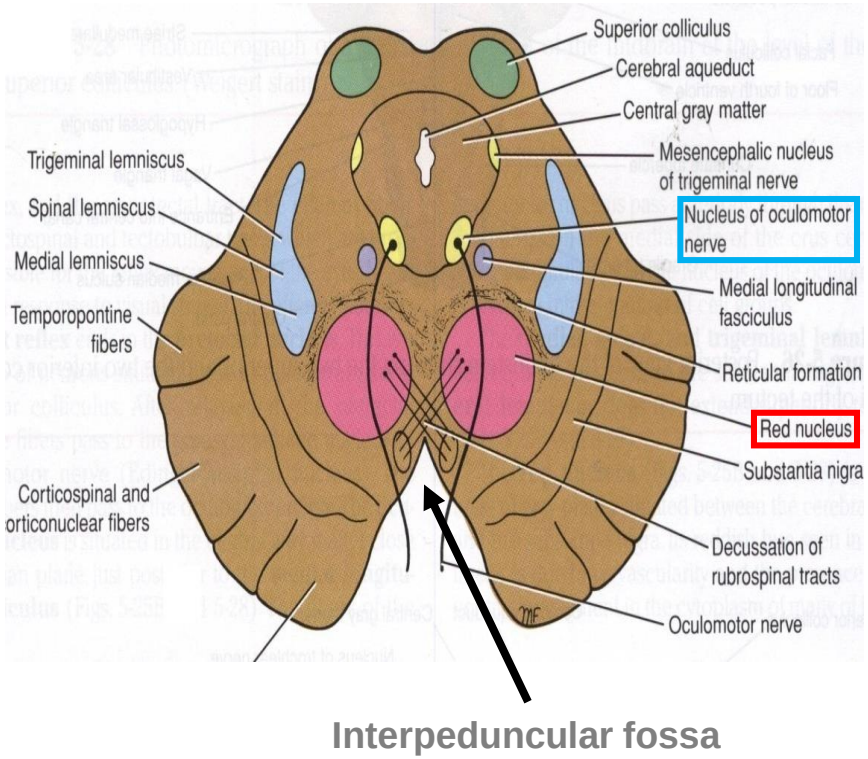
*to remember:
The eyes are on top so the superior colliculus → visual





Midbrain
Superior colliculus level

1. Oculomotor nucleus:
   - Situated in the central gray matter close to the median plane.
   - The fibers of the oculomotor nerve passes anteriorly through the red nucleus to emerge on the **medial side of the crus cerebri**.
2. Red nucleus :
   - A rounded mass of gray matter that lies in the central portion of the tegmentum.
   - Its red coloration is due to its vascularity and the presence of an iron containing pigment in the cytoplasm of its neurons. (Important)
   - It is involved in **motor control**.



Summary of levels and structures:

Medulla	Caudal / Closed	1. Traversed by central canal 2. Motor decussation 3. Trigmenial sensory nucleus
	Mid	1. Traversed by central canal 2. Gracile and cuneate nuclei 3. Internal arcuate fibers 4. Sensory decussation 5. Medial leminiscus
	Rostral / Open	1. Dorsal surface forms lower part of floor of 4th ventricle 2. Cochlear nuclei (dorsal and ventral) 3. Hypoglossal nucleus 4. Dorsal nucleus of vagus 5. Medial longitudinal fasciculus 6. Vestibular nuclei complex 7. Nucleus ambiguus 8. Solitary nucleus 9. Tectospinal tract

Pons	Caudal	1. Trapezoid body (divides it into basis pontis and tegmentum) 2. Transverse pontocerebellar fibers 3. Pontine nuclei 4. Bundles of corticospinal & corticonuclear fibers. 5. Medial lemniscus 6. Spinal tract & nucleus of trigeminal 7. Deep origin of CN 6 & 7
	Mid (level of trigeminal)	1. Motor nucleus of trigeminal 2. Main sensory nucleus of the trigeminal 3. Superior cerebellar peduncle (forms lateral boundary of 4th ventricle)
	Rostral	1. Superior medullary velum 2. Medial longitudinal fasciculus
Midbrain	Inferior colliculi (auditory)	1. Trochlear nucleus 2. Decussation of cerebellar peduncle sin the midline 3. Substantia nigra (parkinsons) 4. Ascending lemnisci
	Crus cerebri	1. Descending cortical efferent fibers (present in superior and inferior colliculi)
	Superior colliculi (visual)	1. Occulomotor nucleus 2. Red nucleus

MCQs

(1) Most axons of cochlear nuclei cross the midline of pons forming?

A) The medial lemniscus B) The red nucleus
C) Trapezoid body D) The medial longitudinal fasciculus

(2) The axons of the cochlear nuclei are represented in?

A) Trapezoid body B) Medial longitudinal bundle
C) Tectospinal tract D) Spinal lemniscus

(3) Which of the following lies in the tegmentum of the midbrain?

A) Oculomotor nuclei B) Trochlear nucleus
C) Red nucleus D) Fascial nucleus

(4) Parkinsons disease results from degeneration of?

A) Red nucleus B) Substantia nigra
C) Inferior olivary nucleus D) Non of them

(5) Which of the following bands carry corticopontine fibers?

A) Crus cerebri B) Medial eminence
C) Medullary Pyramid D) Basis pontis

(6) The caudal pons give have deep nuclei of which nerve?

A) Vagus B) Facial
C) Trigeminal D) Basilar

(7) Which nerve fibers emerge on the medial side of the crus?

A) Cerebri B) Occulomotor
C) Opthalmic D) Vestibulocochlear

(8) A rounded mass of gray matter that lies in the central portion of the tegmentum?

A) Oculomotor nucleus B) Raphe nuclei
C) Red nucleus D) Locus Ceruleus

(9) The fibers of the oculomotor nerve passes_____ through the red nucleus to emerge on the _____ side of the crus cerebri?

A) Anteriorly , medial B) Anteriorly , lateral
C) Posteriorly , medial D) Posteriorly , lateral

(10) Solitary nucleus is responsible for which of the following?

A) Hearing B) Taste sensation
C) Vision D) Fine touch

Answers

(1) C
(2) A
(3) C
(4) B
(5) A
(6) B
(7) A
(8) C
(9) A
(10) B

SAQ

(1) Ascending Leminisci Composed Of?

- Medial lemniscus.
- Spinal (Lateral & anterior spinothalamic tracts)
- Trigeminal (Lateral & medial).
- Lateral lemniscus.

(2) The Descending cortical efferent fibers that form the crus cerebri are ?

Frontopontine, Corticospinal &corticobulbar andTemporopontine Fibres.

(3) Name 4 things that lie Beneath the floor of 4th ventricle in the open medulla?

1.Hypoglossal Nucleus.
2. Dorsal Nucleus of Vagus
3. Medial longitudinal fasciculus.
4. Vestibular nuclei complex.
5. Nucleus Ambiguus.
6. Solitary nucleus.
7. Tectospinal tract.

Good luck
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Team Leaders:

Faisal Fahad Alsaif
Rawan Mohammad Alharbi

Team Members:

Abdulaziz Aldukhayel
Abdulrahman Alduhayyim
Rinad Alghoraiby
Rawan Mishal

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Twitter.com/Anatomy437

Anatomyteam.437@gmail.com