INTERNAL STRUCTURE OF THE BRAIN STEM

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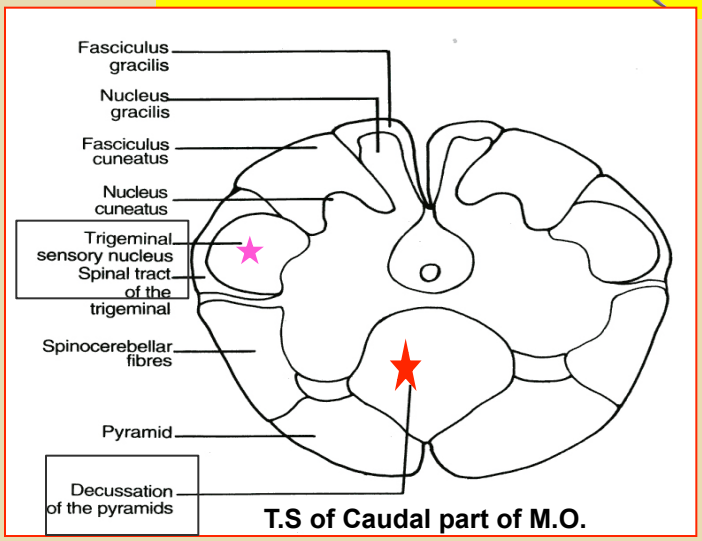
OBJECTIVES

By the end of the lecture, students will be able to :

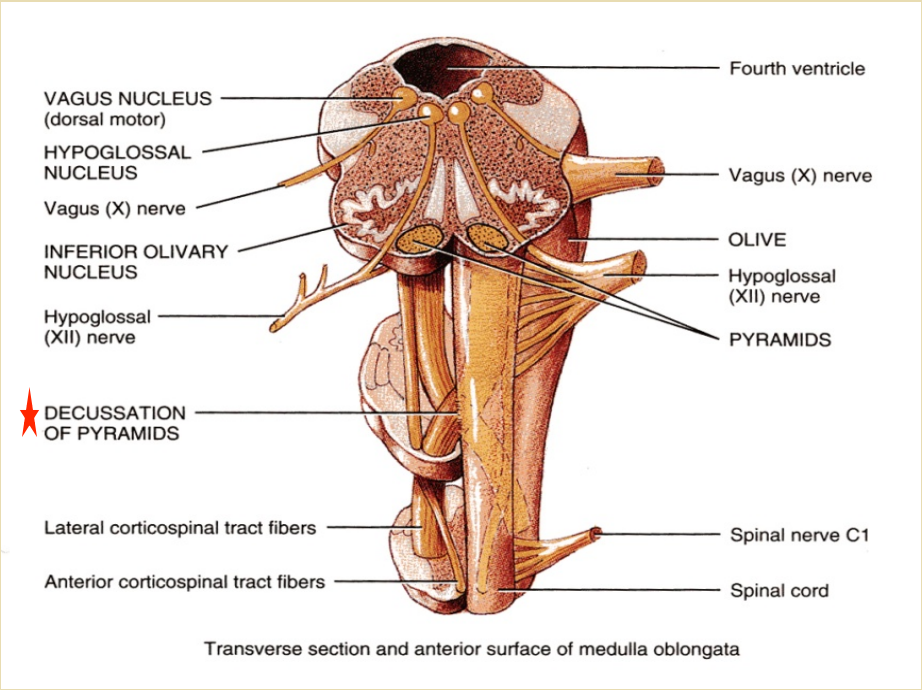
- *Distinguish the internal structure of the components of the brain stem in different levels and the specific criteria of each level.*
- *1. Medulla oblongata (closed, mid and open medulla)*
- *2. Pons (caudal, mid "Trigeminal level" and rostral).*
- *3. Mid brain (superior and inferior colliculi).*
- *Describe the Reticular formation (structure, function and pathway) being an important content of the brain stem.*

CAUDAL (closed) MEDULLA



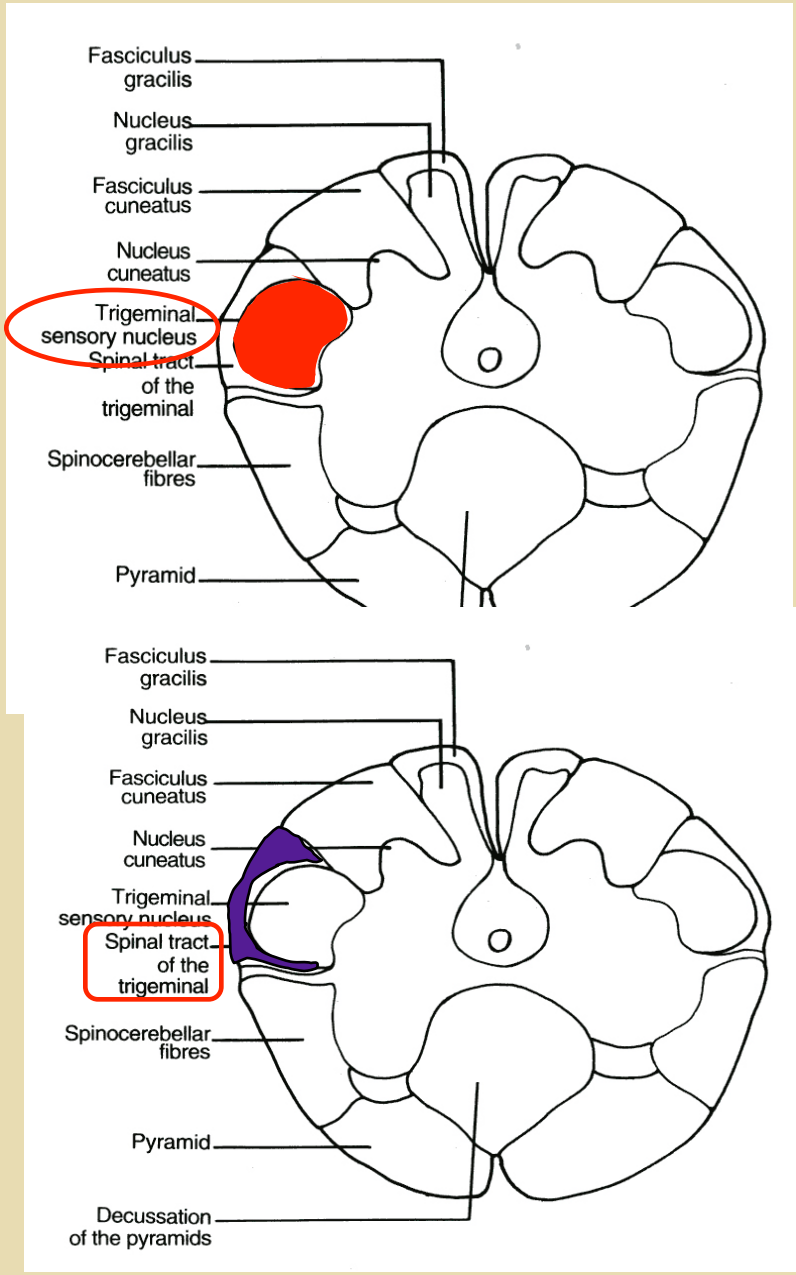
T.S of Caudal part of M.O.

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



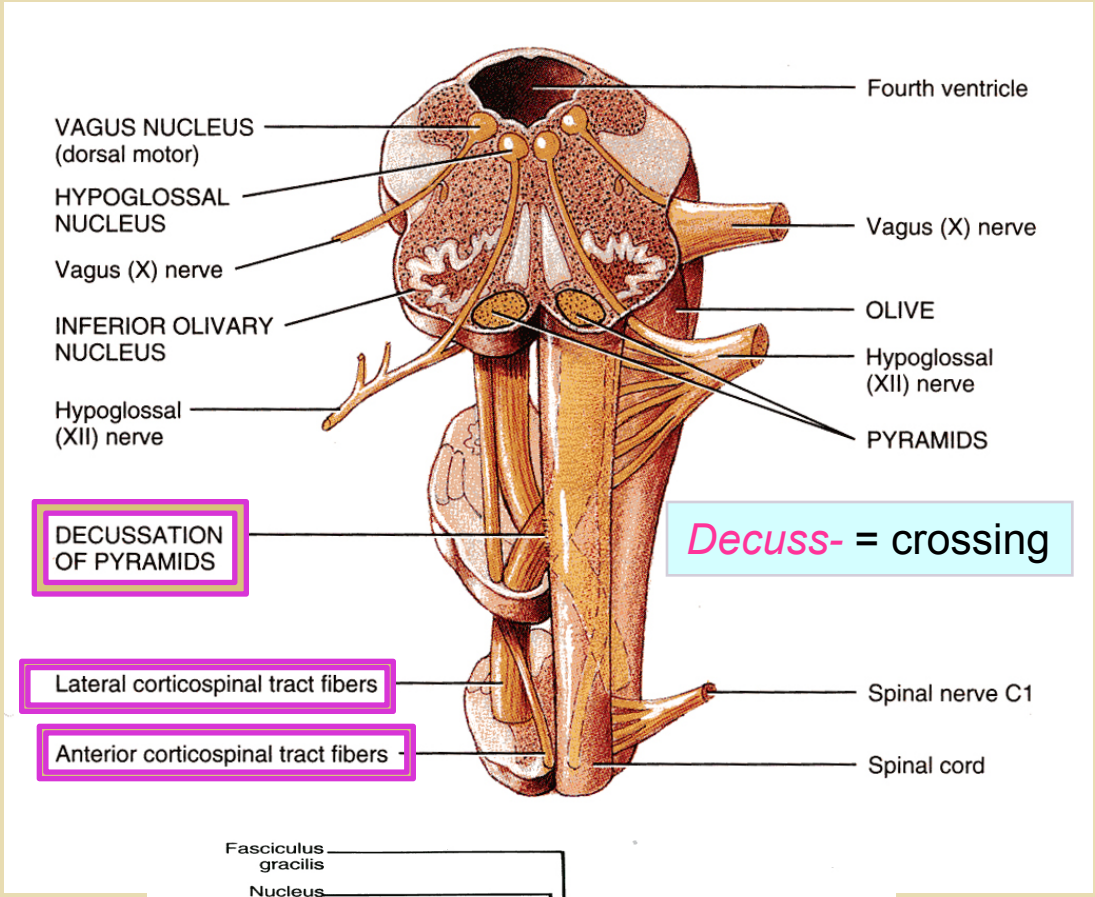
Transverse section and anterior surface of medulla oblongata

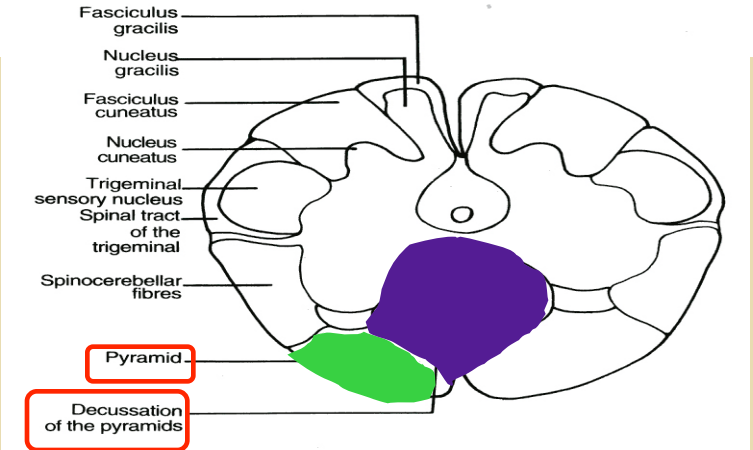
TRIGEMINAL SENSORY NUCLEUS & TRACT



- ***The Nucleus Extends :***
- *Through the whole length of the brain stem and into upper segments of spinal cord.*
- *It lies in all levels of M.O, medial to the spinal tract of the trigeminal.*
- *It receives pain and temperature from face, forehead.*
- *Its tract present in all levels of M.O. is formed of descending fibers that terminate in the trigeminal nucleus.*

PYRAMIDAL DECUSSATION

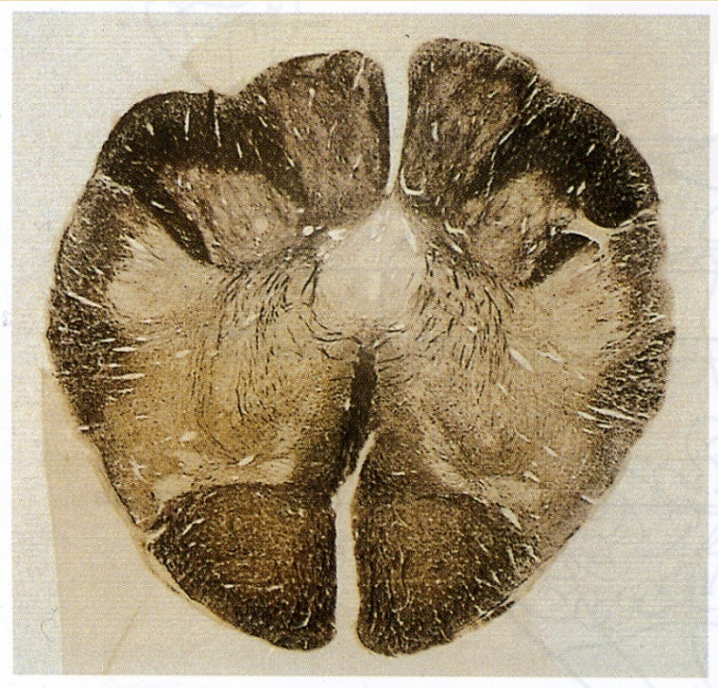


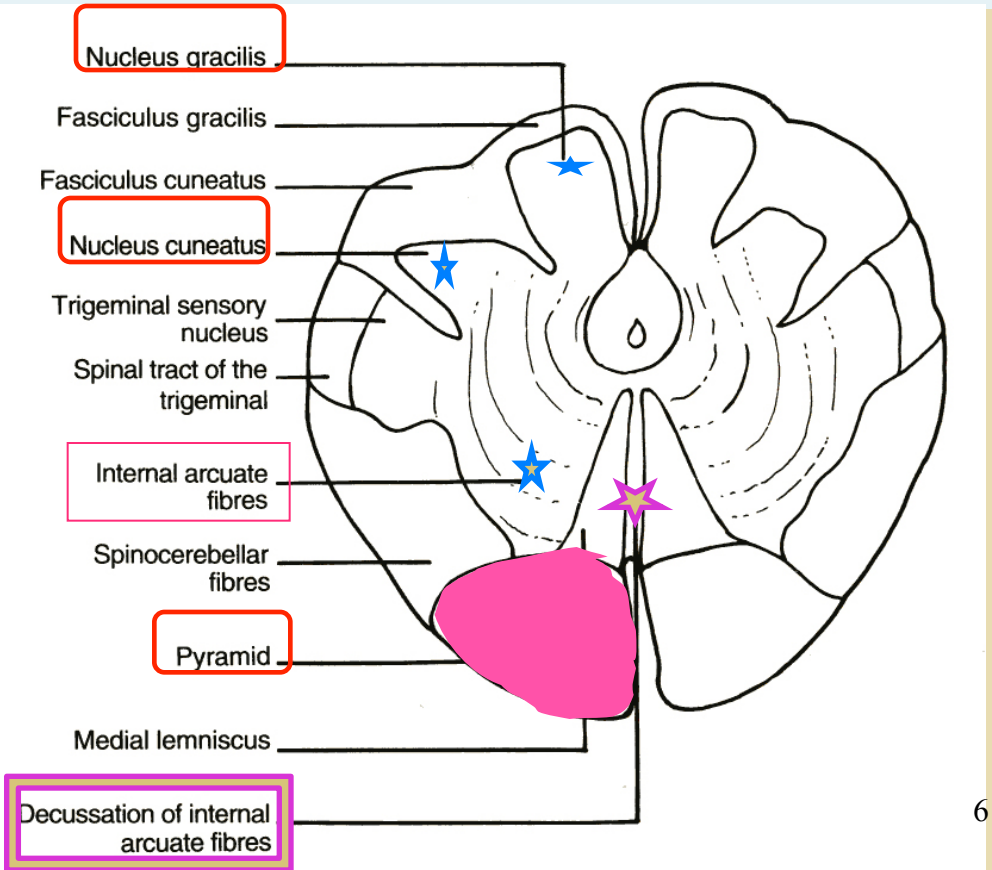


- *It is Motor Decussation.*
- *Formed by pyramidal fibers, (75-90%) cross to the opposite side*
- *They descend in the lateral white column of the spinal cord as the lateral corticospinal tract.*
- *The uncrossed fibers form the ventral corticospinal tract.*

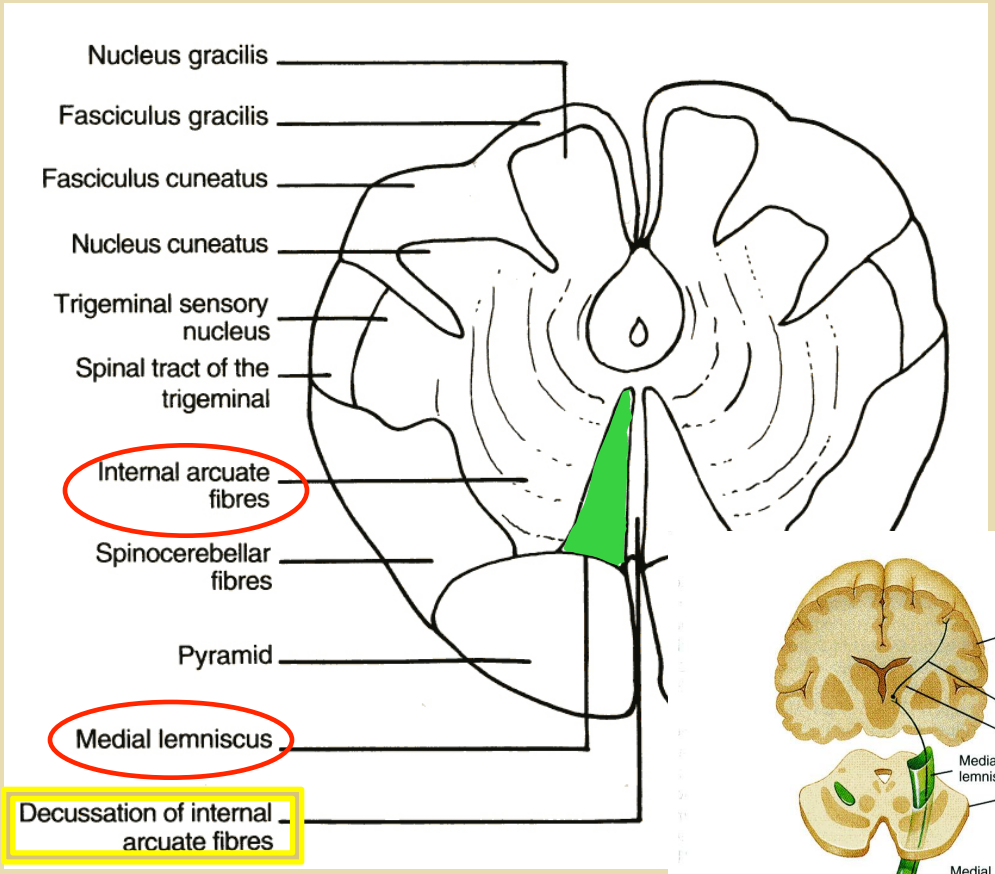
MID MEDULLA

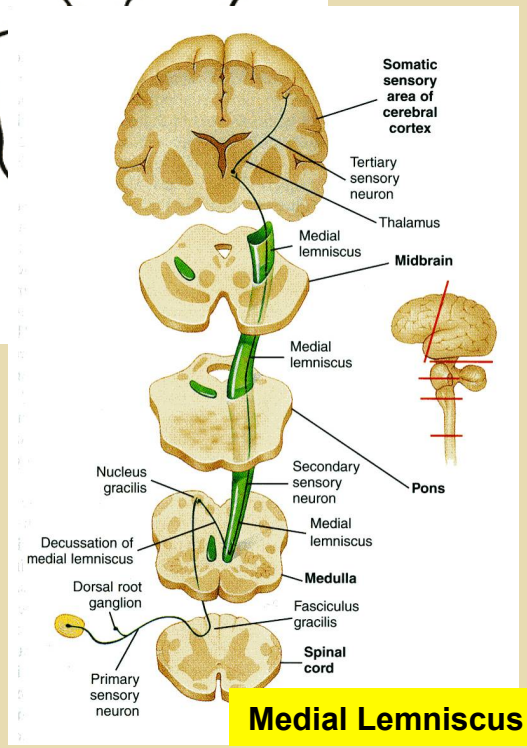
- *Traversed by Central Canal.*
- *Larger size Gracile & Cuneate nuclei, concerned with proprioceptive deep sensations of the body.*
- *Axons of Gracile & Cuneate nuclei form the internal arcuate fibers; decussating forming Sensory Decussation.*
- *Pyramids are prominent ventrally.*





SENSORY DECUSSATION

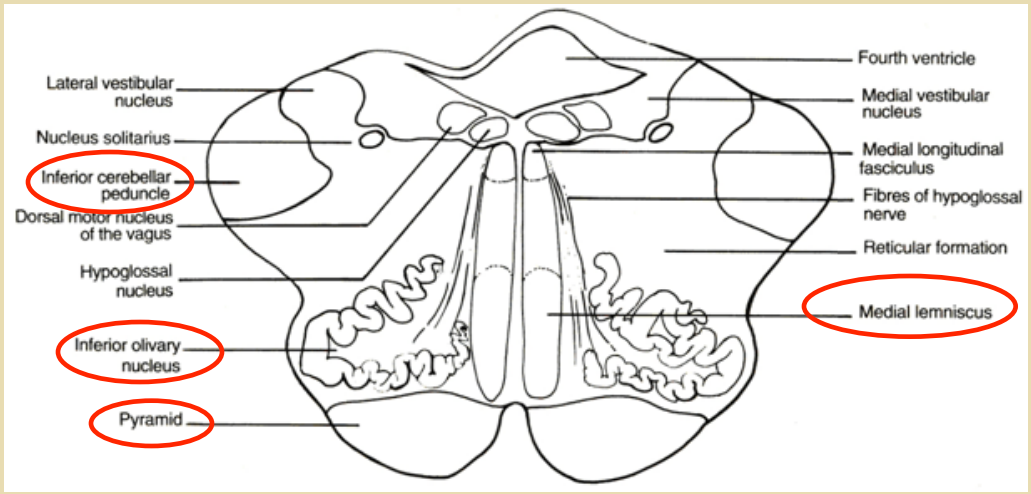


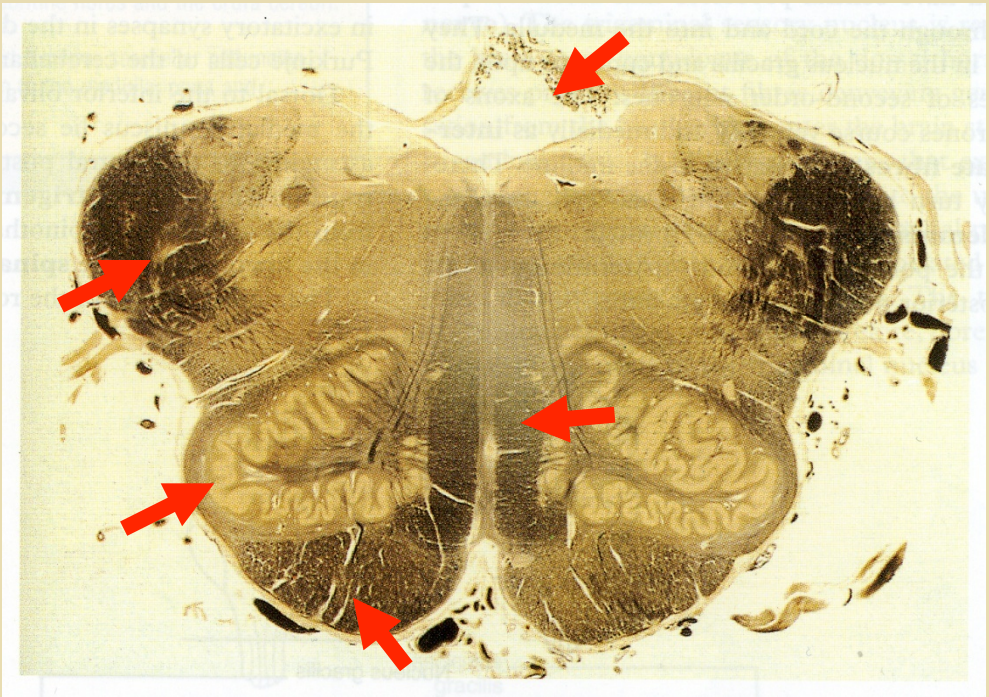


Medial Lemniscus

- *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.*

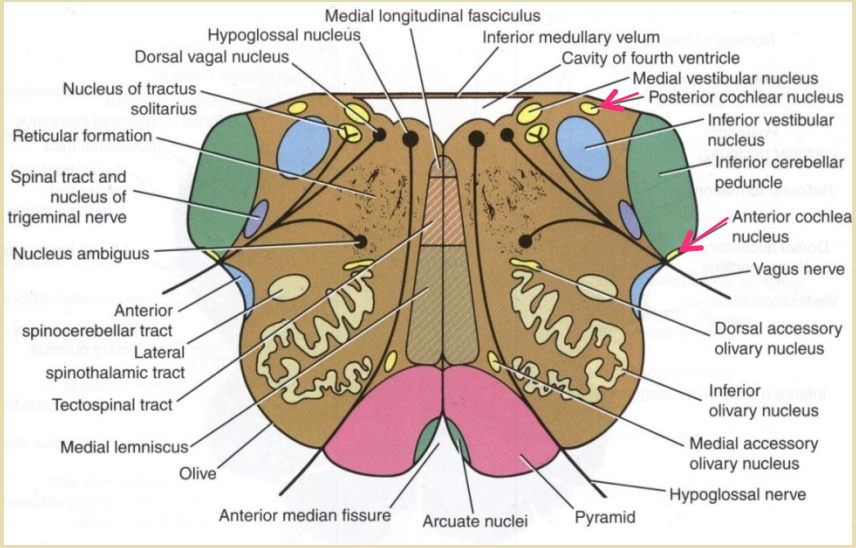
ROSTRAL (open) MEDULLA





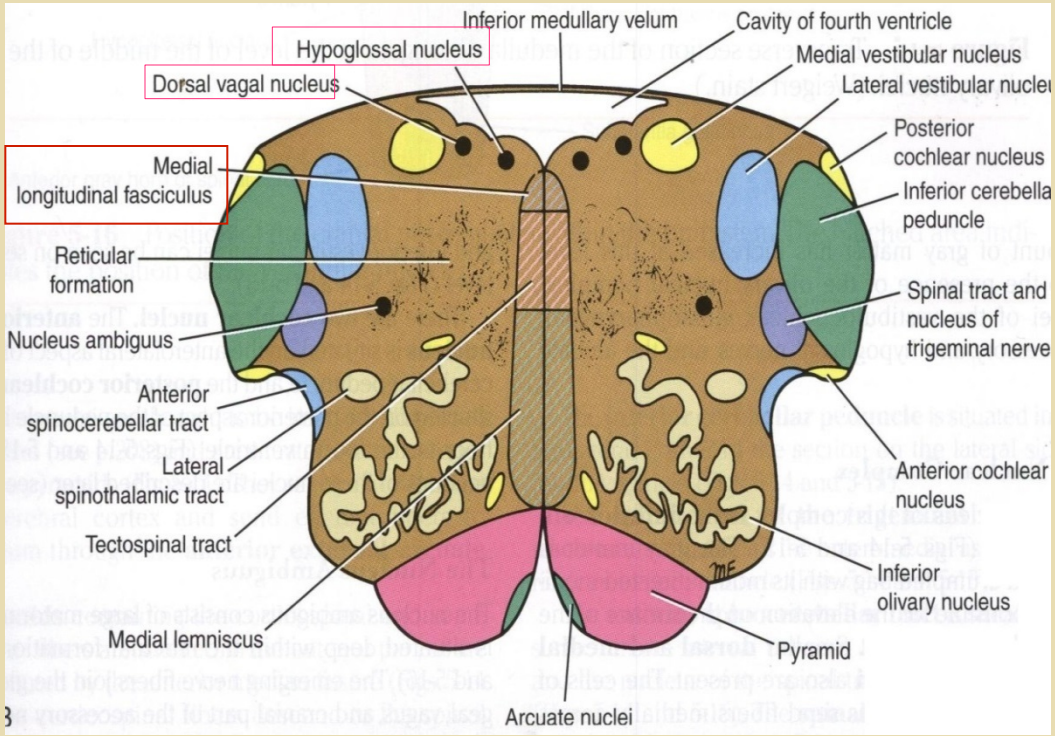
- **On the ventral aspect :**
- The pyramid is clear, with medial lemniscus on either sides of middle line dorsal to the pyramid
- Inferior Olivary Nucleus:
  - A convoluted mass of gray matter., lies posterolateral to the pyramids & lateral to the medial leminiscus.
  - It is concerned with the control of movement.

ROSTRAL (open) MEDULLA



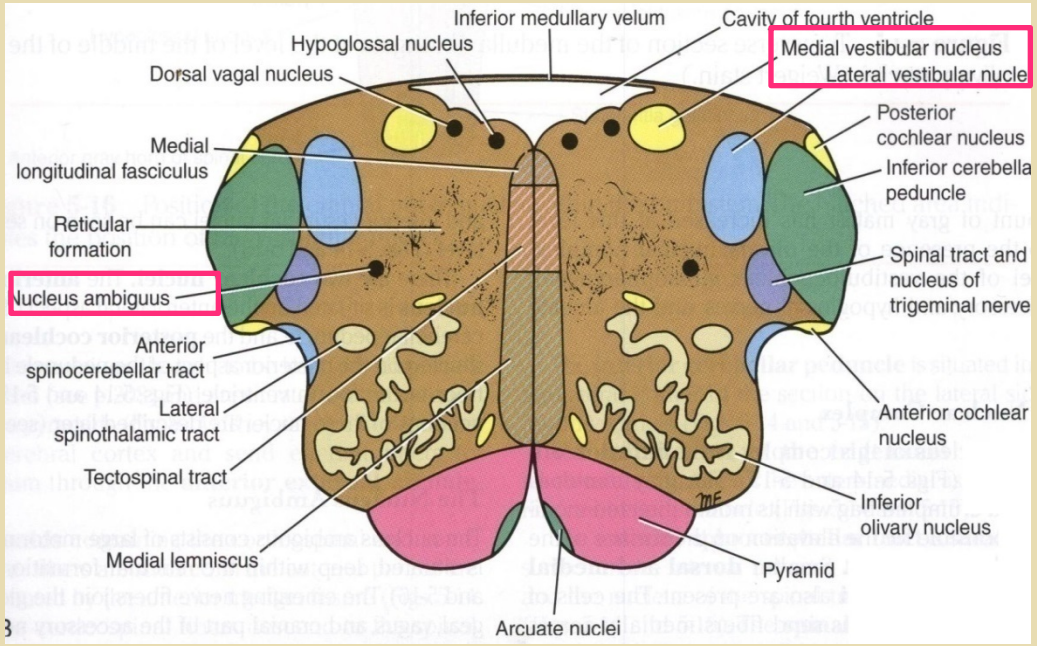
- **Its dorsal surface forms:**
  - **Lower part of the floor of the 4th ventricle.**
- **The Inferior Cerebellar Peduncle is, connecting M.O. with cerebellum.**
- **dorsal and lateral to the Inferior cerebellar peduncle lie the Cochlear nuclei (dorsal and ventral).**

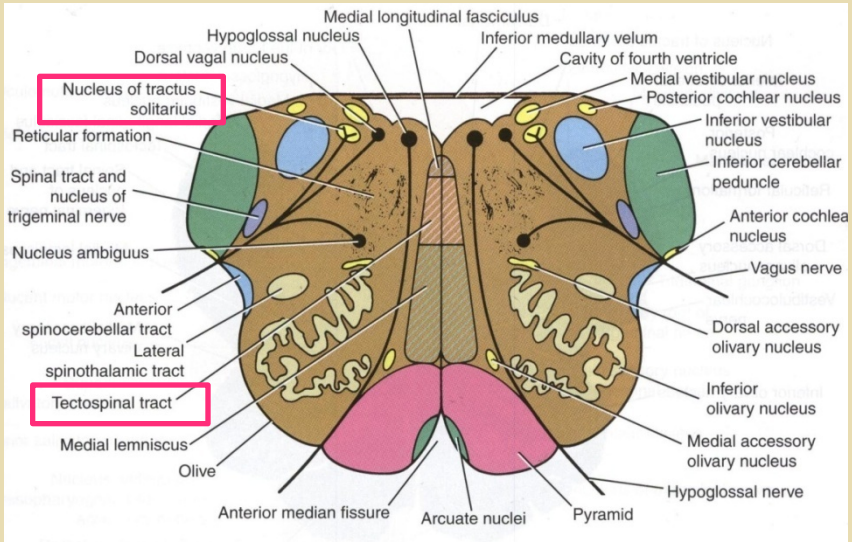
ROSTRAL (open) MEDULLA



- **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.*
- *Upwards :*
- *It links the vestibular nuclei with nuclei of extraocular ms.(3,4&6) as (vestibulo-ocular tract)to help coordination of eye movements with head movements.*
- *Downwards :*
- *It links vestibular nuclei with anterior horne cells of spinal cord (cervical & upper thoracic segments) as (vestibulo-spinal tract)---so, the neck & trunk move with head movements.*

ROSTRAL (open) MEDULLA

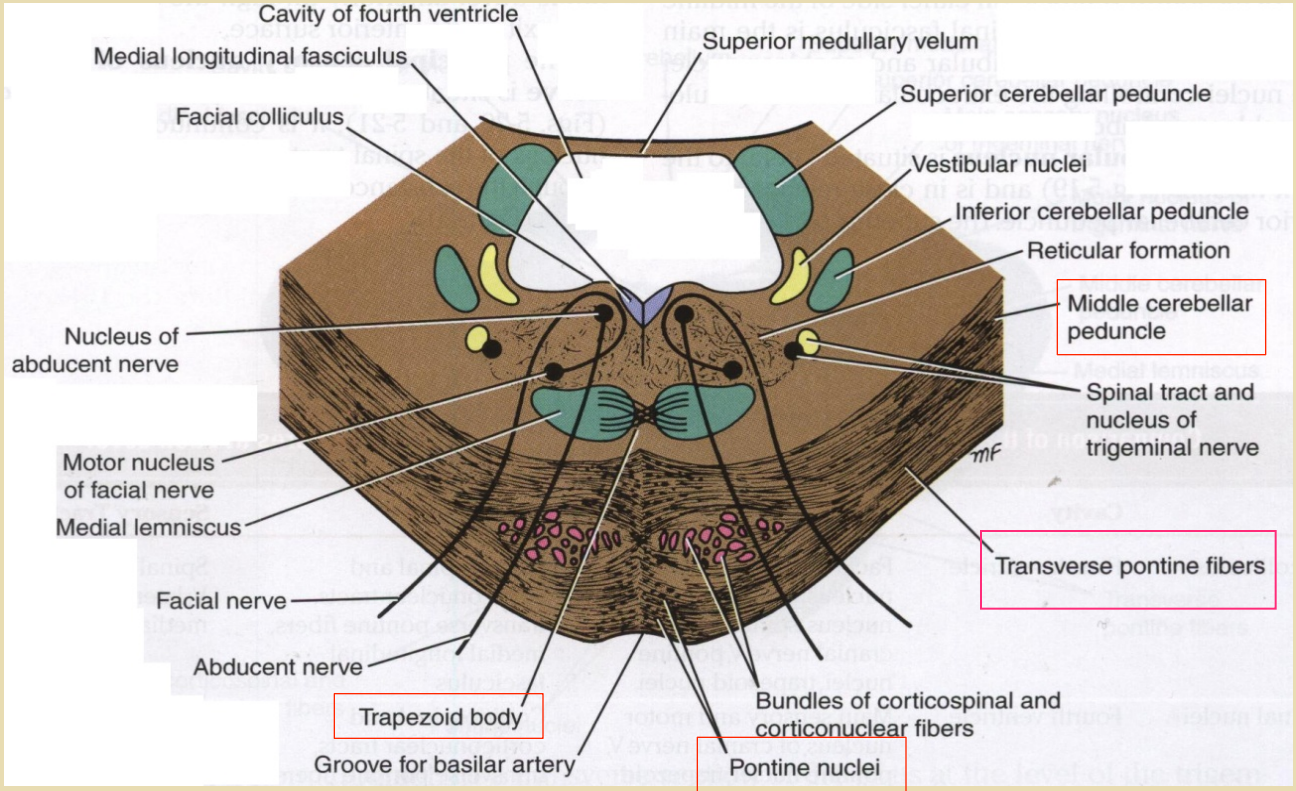




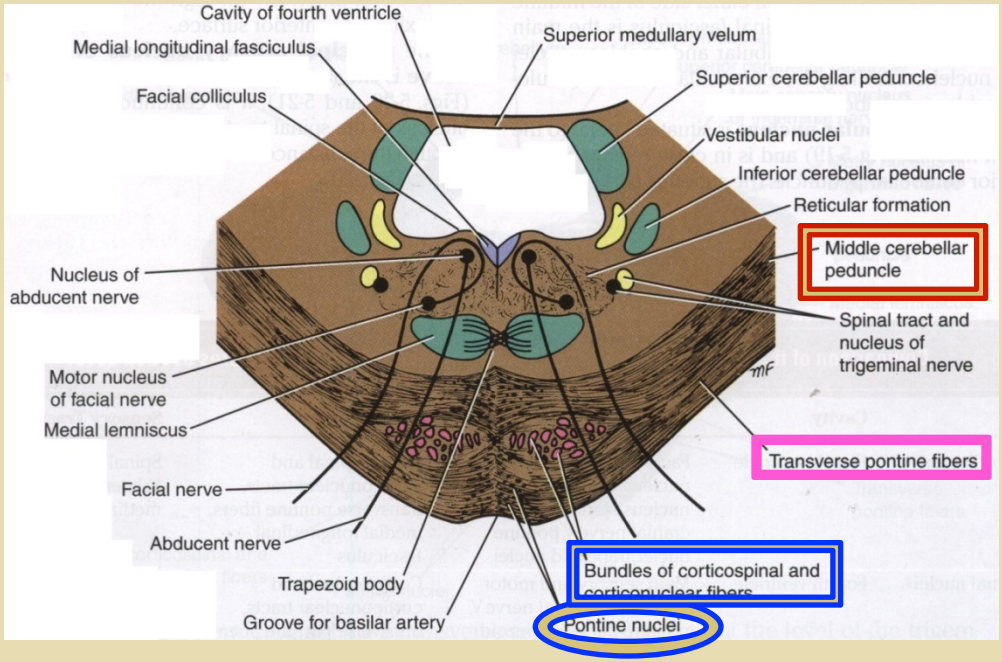
- ***4. Vestibular nuclei complex : concerned with equilibrium.***
- ***5. Nucleus Ambiguus: (motor nucleus) : lies dorsal to olivary nucleus gives motor fibers along glossopharyngeal N. & vagus N. to Ms. of the pharynx, larynx & palate.***
- ***6. Solitary nucleus (sensory nucleus) : lies ventrolateral 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).

CAUDAL PART OF THE PONS

- **Divided into an anterior part (Basis Pontis) & a posterior part (Tegmentum) by the Trapezoid Body (consists of acoustic fibres from cochlear nuclei to ascend into midbrain as lateral lemniscus and terminate in inferior colliculus).**
- **The ventral 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.**

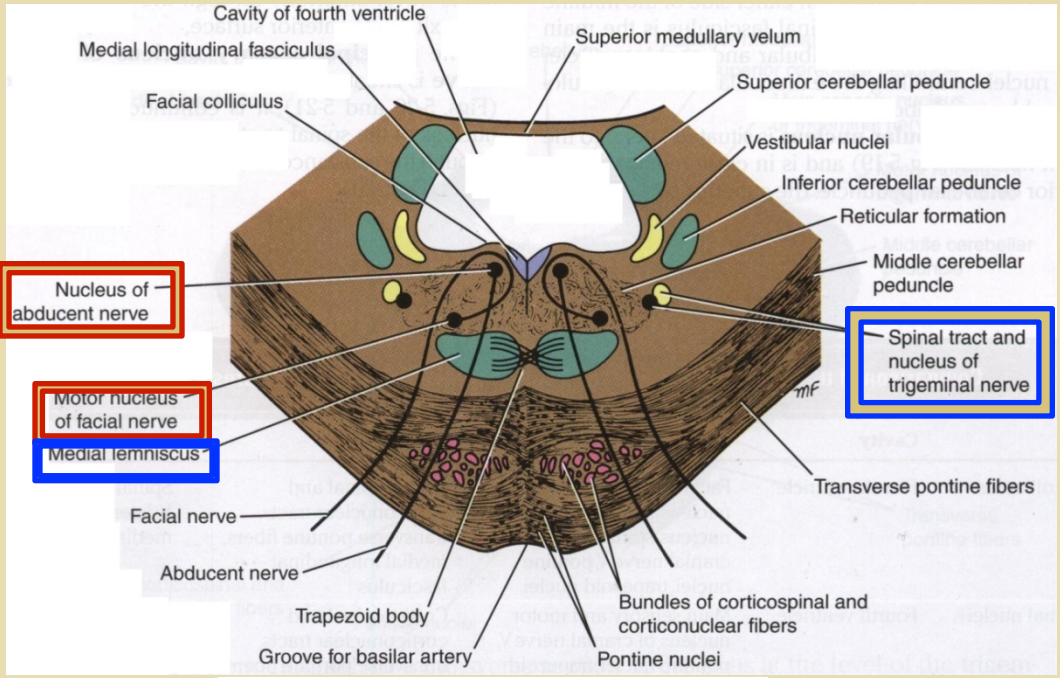


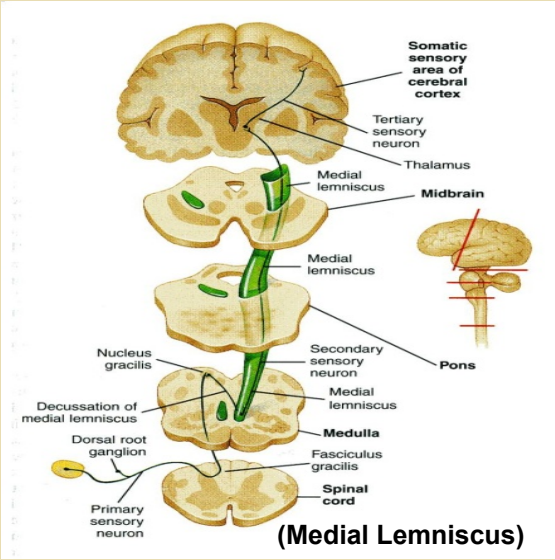
CAUDAL PART OF THE PONS



1. ***Pontine Nuclei:***
   - ***Are small masses of nerve cells, receive cortico pontine fibers. Their axons form the transverse pontocerebellar fibers which pass to the contralateral side of the cerebellum through Middle Cerebellar peduncles.***
2. ***Bundles of corticospinal & corticonuclear fibres (Pyramidal fibres)***

CAUDAL PART OF THE PONS





(Medial Lemniscus)

3. The ascending fibres of the medial lemniscus

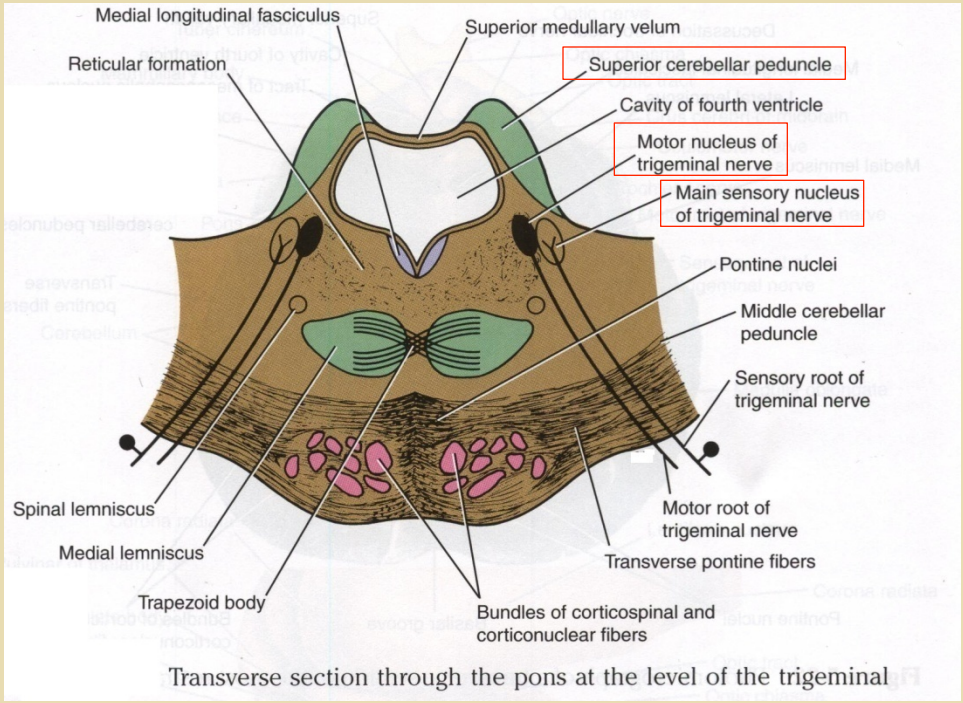
- become separated from the pyramid and displaced dorsally.
- *The Medial Lemniscus rotates 90 degrees and lies almost horizontally.*

4. Spinal tract & nucleus of Trigeminal.

5. *Deep origin of* ***cranial nerve nuclei :***

- *Abducent nucleus*
- *Facial motor nucleus*

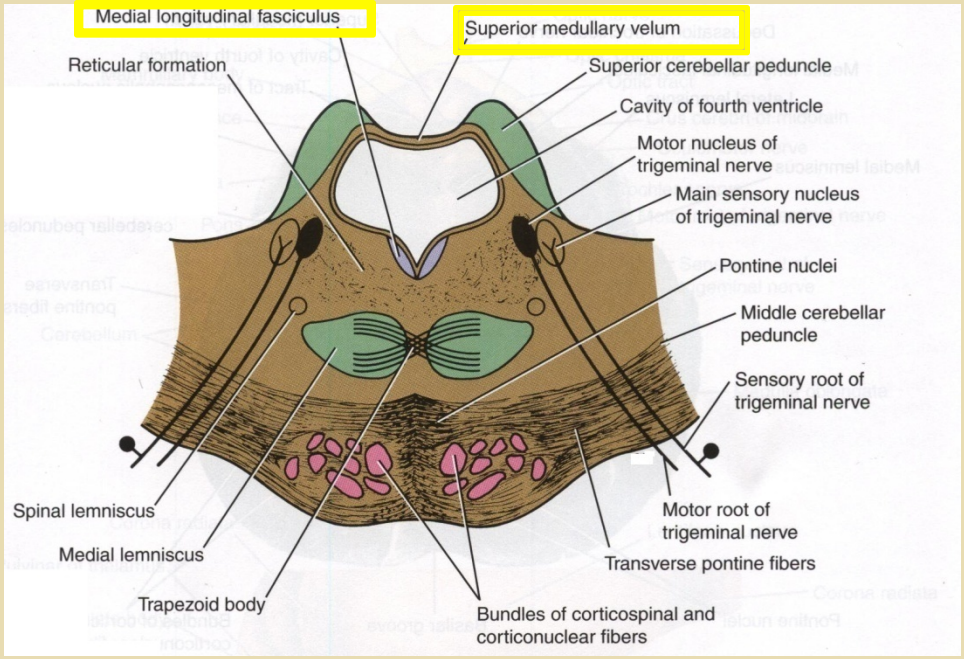
AT THE LEVEL OF THE TRIGEMINAL NERVE



Transverse section through the pons at the level of the trigeminal

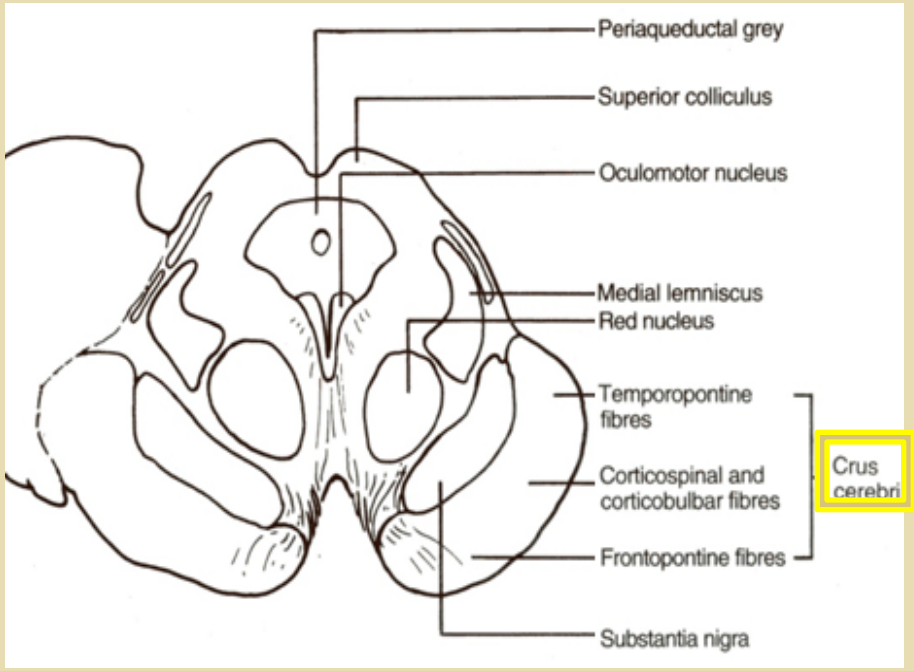
- ***Motor nucleus of the trigeminal nerve:*** ***Lies in the lateral part of the floor of the 4th ventricle.***
- ***Main sensory nucleus of the trigeminal nerve:*** ***Reaches its maximum extent in the pons and it lies lateral to the motor nucleus.***
- ***Superior cerebellar peduncles*** ***form the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

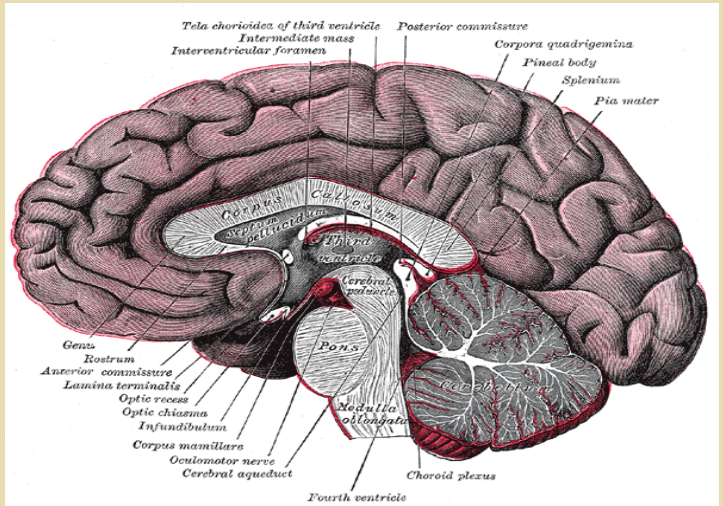
ROSTRAL PONS



- ***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

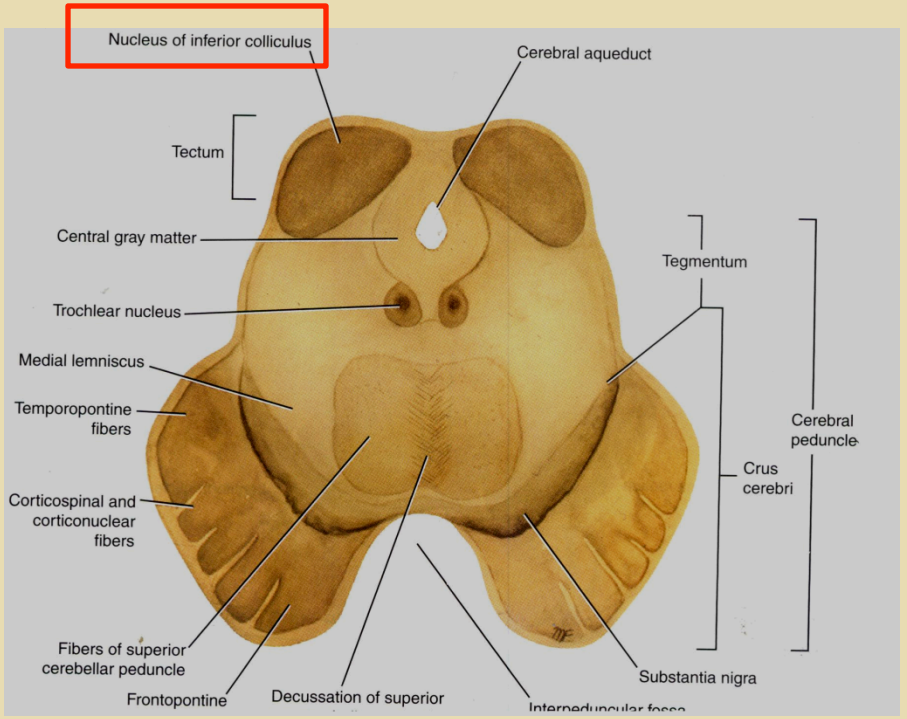




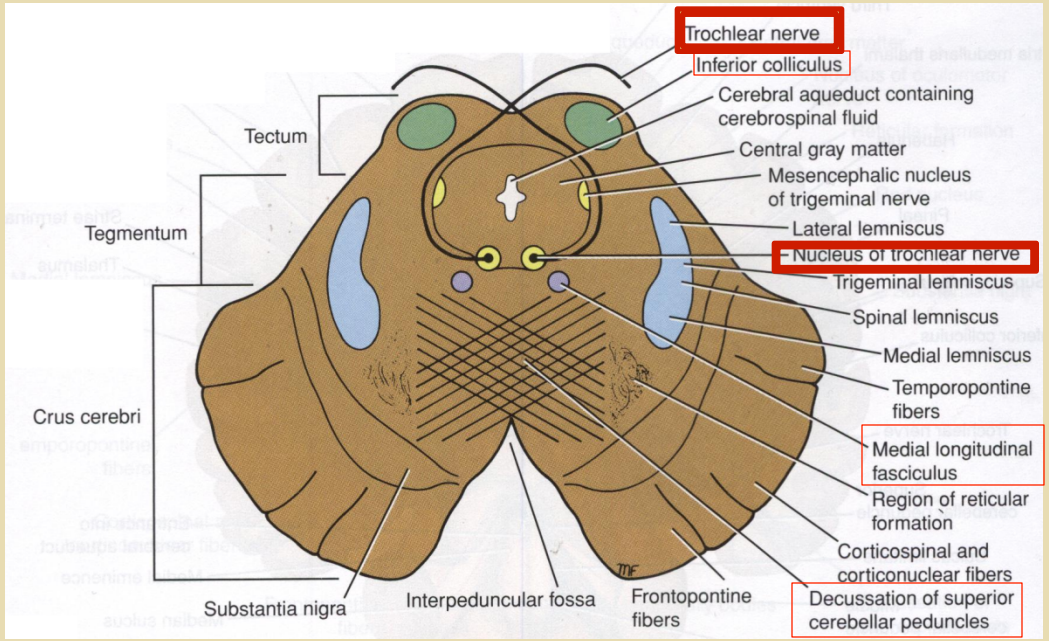
- *It is divided into :*
- *a <u>dorsal part</u> (Tectum) and*
- *a <u>ventral part</u> (Tegmentum) at the level of the <u>cerebral aqueduct.</u>*
- *The cerebral aqueduct is surrounded by a pear shaped periaqueductal (central) gray matter.*
- *The <u>most ventral part</u> of the <u>tegmentum</u> is the massive fibrous mass (Crus Cerebri).*

INFERIOR COLLICULUS Level

- *Inferior colleculus 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*

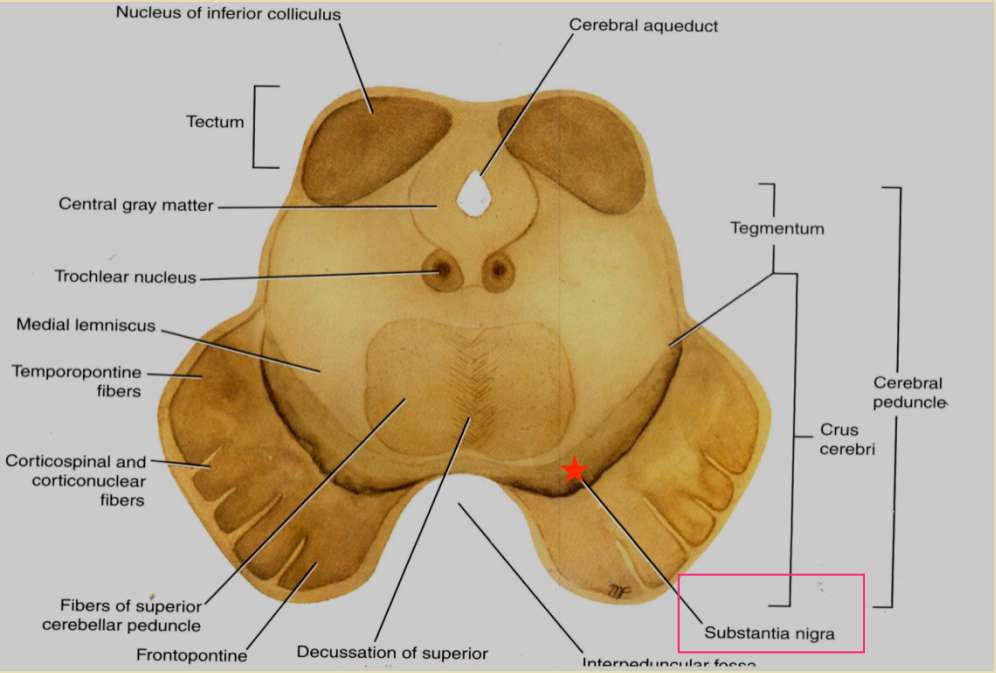


INFERIOR COLLICULUS Level



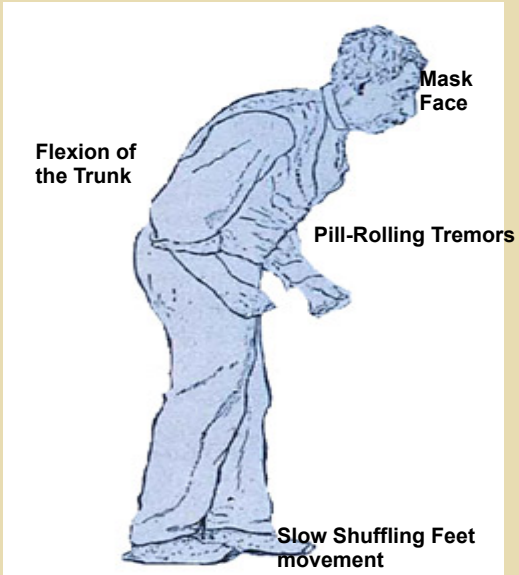
1. *Trochlear nucleus:*
   - *lies in the central gray matter close to the median plane just posterior to the medial longitudinal bundle.*
   - *The fibers of the trochlear nerve decussate in the superior medullary velum.*
2. *Decussation of the superior cerebellar peduncles in the mid line.*

INFERIOR COLLICULUS Level

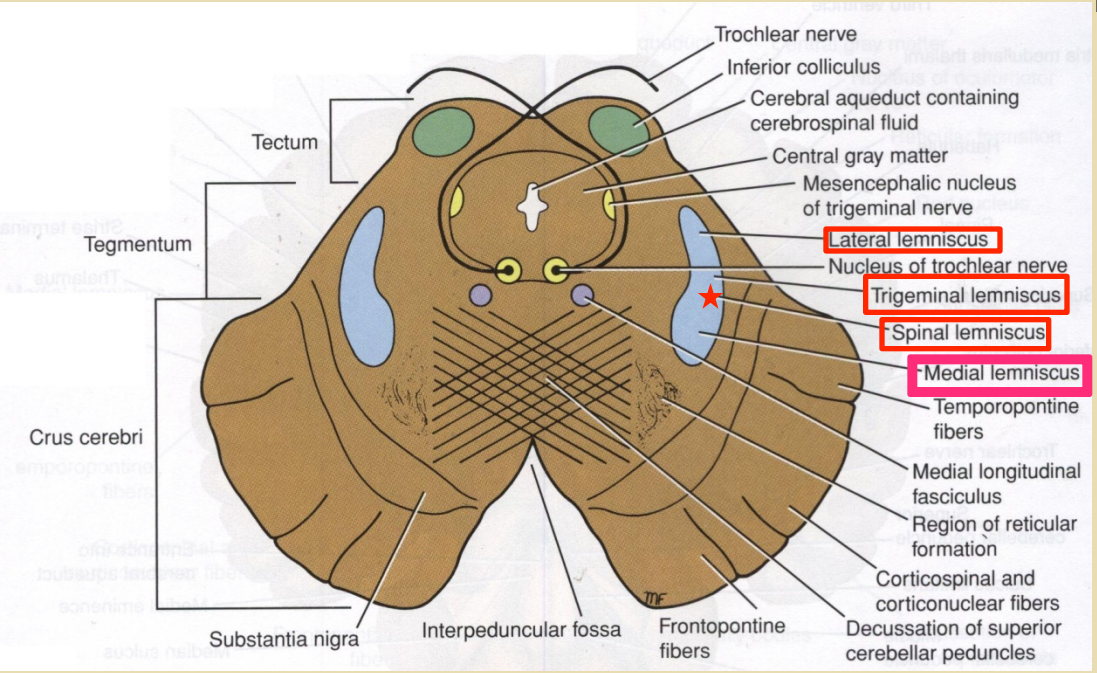


3. Substantia nigra★:

- *Occupies the most ventral 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.***

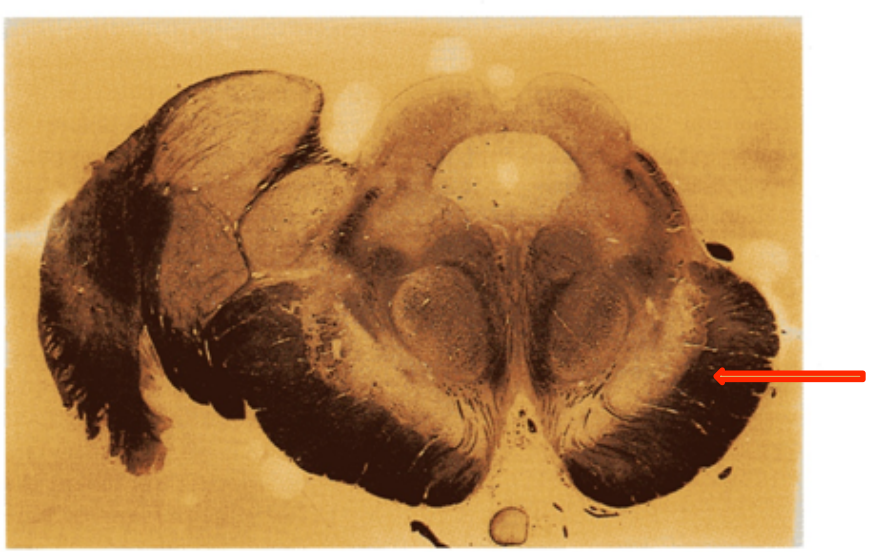


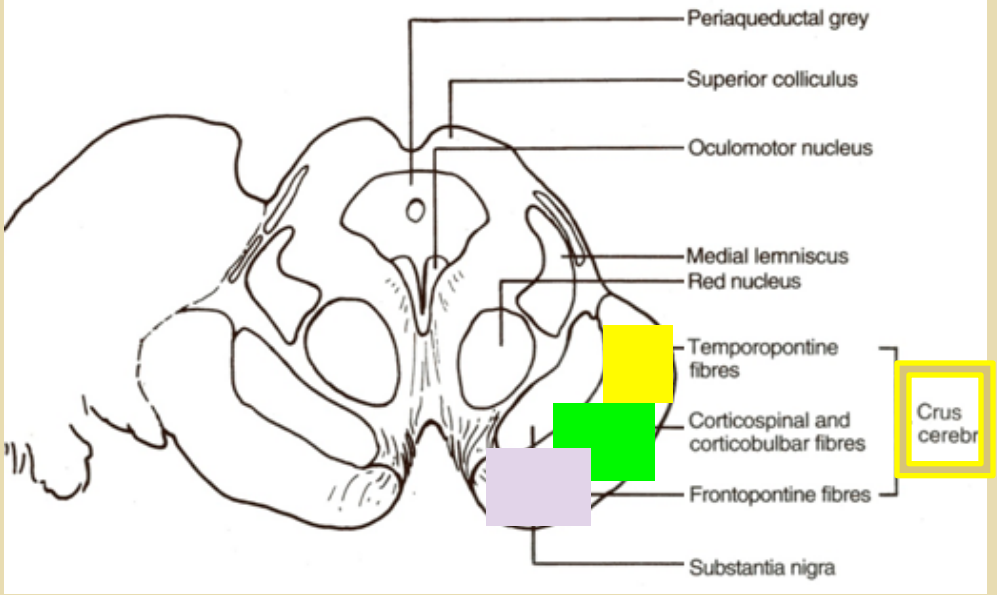
4. ASCENDING LEMINISCI :



- ***Composed Of:***
  - ***Medial lemniscus.***
  - ***Spinal* (Lateral & anterior spinothalamic tracts)**
  - ***Trigeminal* (Lateral & medial).**
  - ***Lateral lemniscus.***

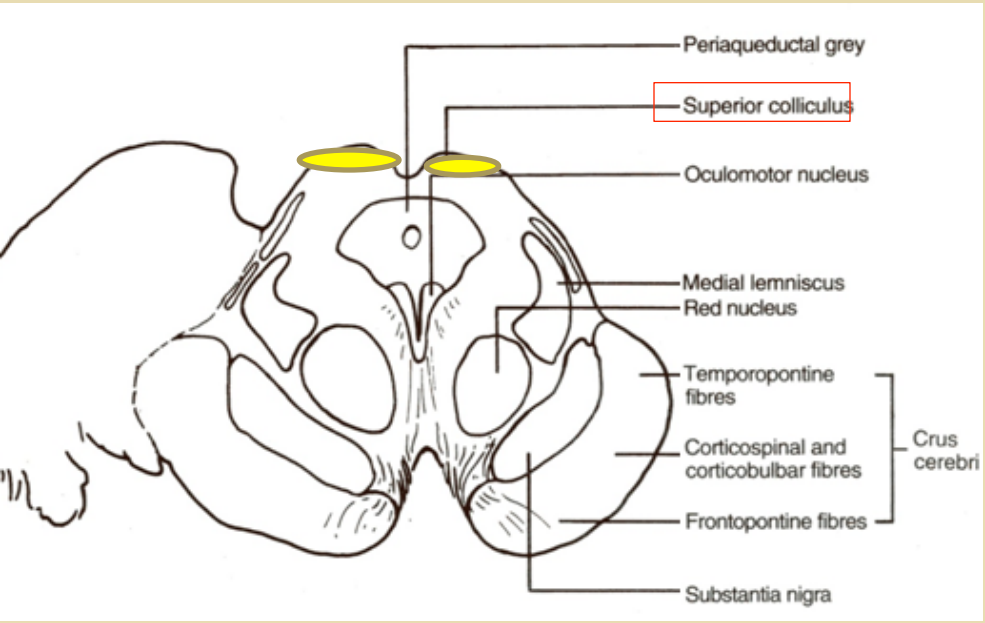
CRUS CEREBRI





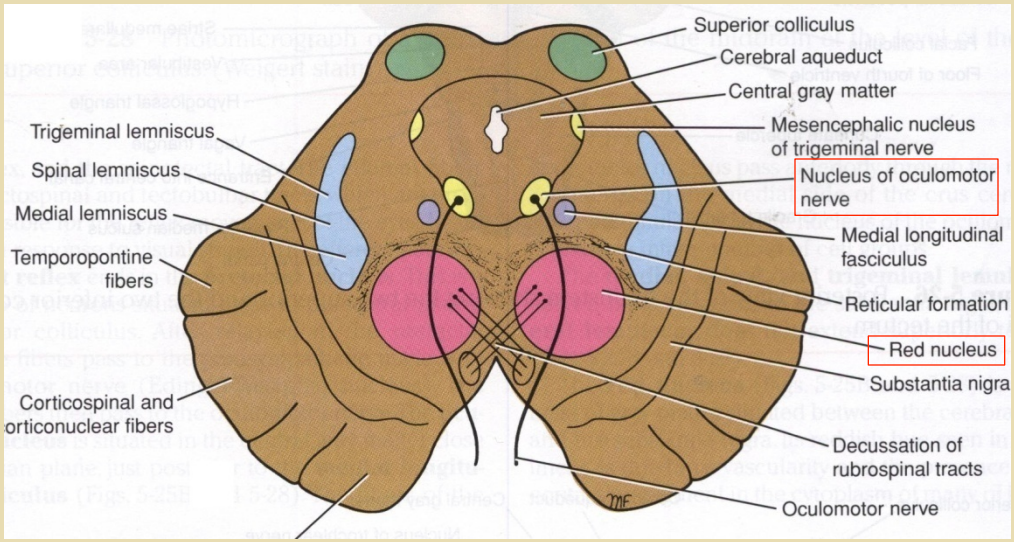
- It is a massive mass ventral to the substantia nigra.
- It consists entirely of descending cortical efferent fibers (Frontopontine, Corticospinal & corticobulbar and Temporopontine Fibres) to the motor cranial nerve nuclei and to anterior horn cells.
- Involved in the coordination of movement.
- Present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

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.

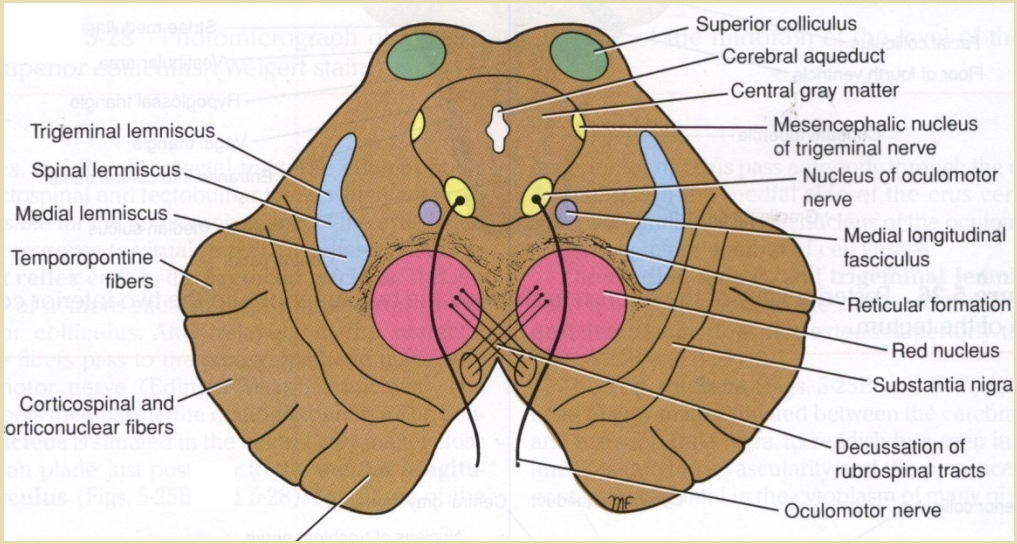
SUPERIOR COLLICULUS Level



1. Oculomotor nucleus:

- *Situated in the central gray matter close to the median plane.*
- *The fibers of the oculmotor nerve passes anteriorly through the red nucleus to emerge on the medial side of the crus cerebri.*

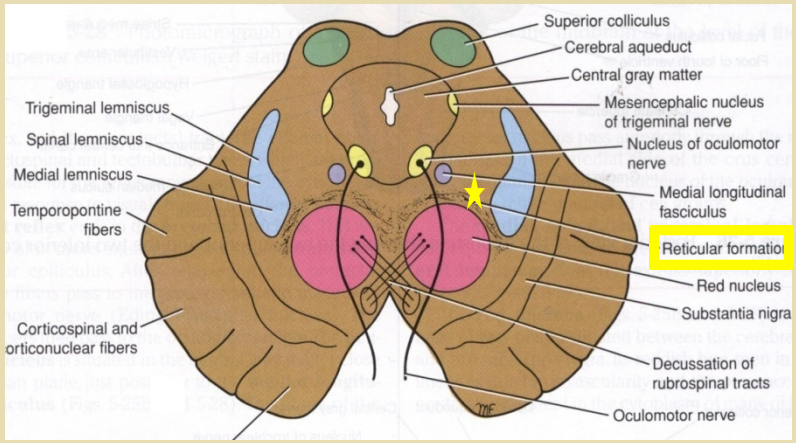
SUPERIOR COLLICULUS Level

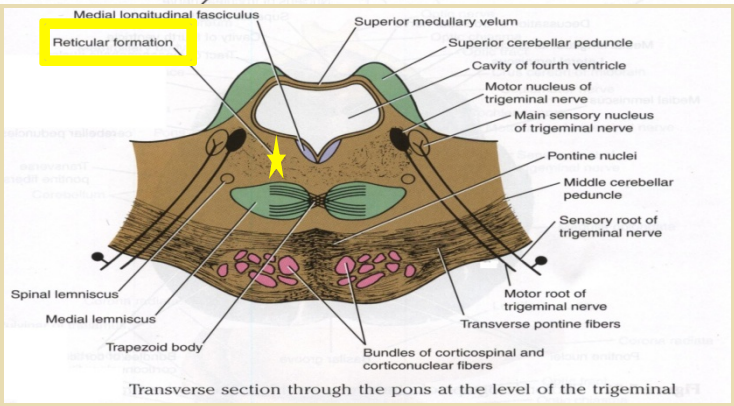


2. Red nucleus :

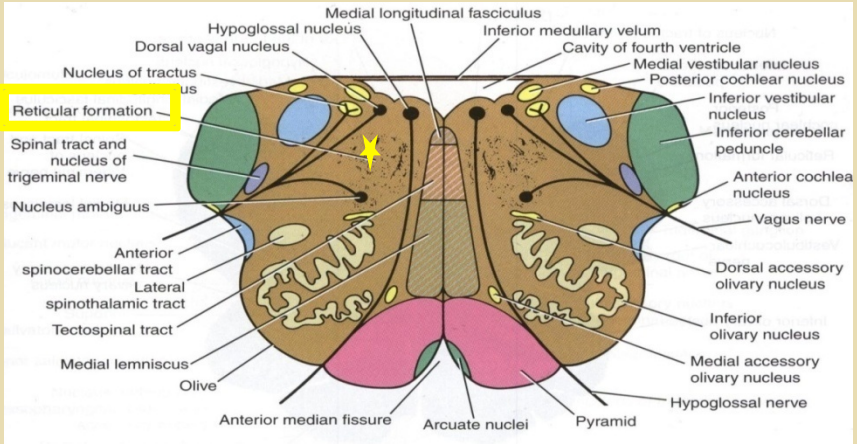
- A rounded mass of gray matter that lies in the central portion of the tegmentum.
- Its red coloration is due to its vascularity and the presence of an iron containing pigment in the cytoplasm of its neurons.
- It is involved in motor control.

RETICULAR FORMATION



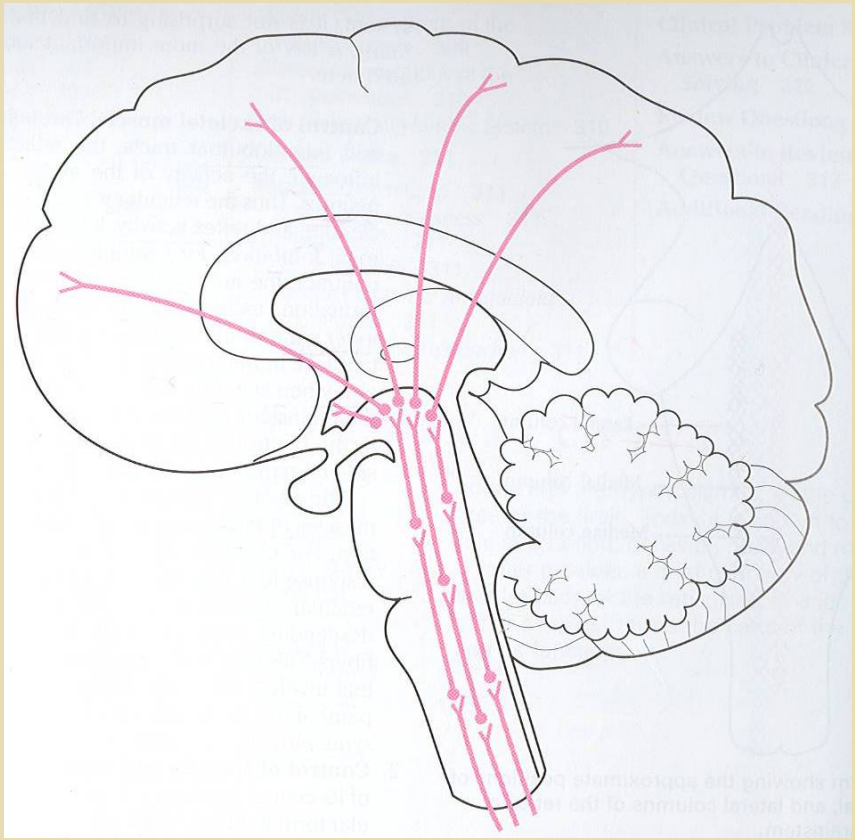


Transverse section through the pons at the level of the trigeminal



- It is a complex matrix of nerve fibers & small groups of nerve cells that extends throughout the brain stem.
- It has a number of important functions i.e. Respiratory and Cardio-vascular centers are located in the medullary and caudal pontine reticular formation.

RETICULAR TRACTS



- **Reticulo spinal tracts:**
  - **Influence a muscle tone & posture**
- **Reticular Activating system:**
  - **Formed of some of the ascending fibers of the reticular formation.**
  - **They activate the cerebral cortex through the thalamus.**

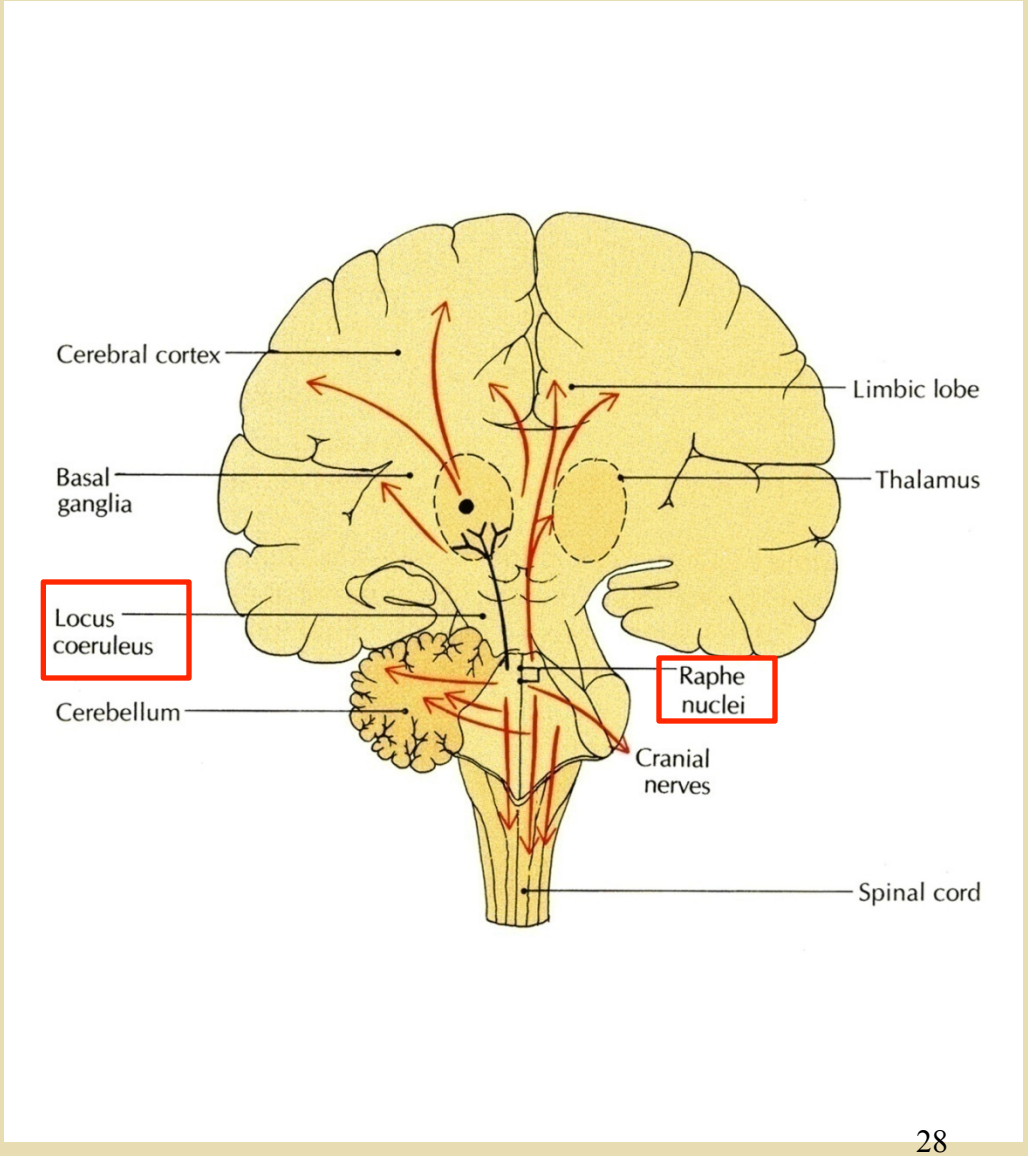
RETICULAR NEURONES

Raphe Nuclei:

- Midline reticular nuclei.
- They are serotonergic.
- Its ascending fibers to the cerebral cortex are involved in the mechanisms of sleep.
- Its descending fibers to the spinal cord are involved in the modulation of Pain.

Locus Ceruleus:

- Pigmented neurons that lie in the tegmentum of the caudal midbrain & rostral pons
- It is the main noradrenergic cell group of the brain.
- Helps in arousal and sleep-wake cycles.



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