

# INTERNAL STRUCTURE OF THE BRAIN STEM

*By*

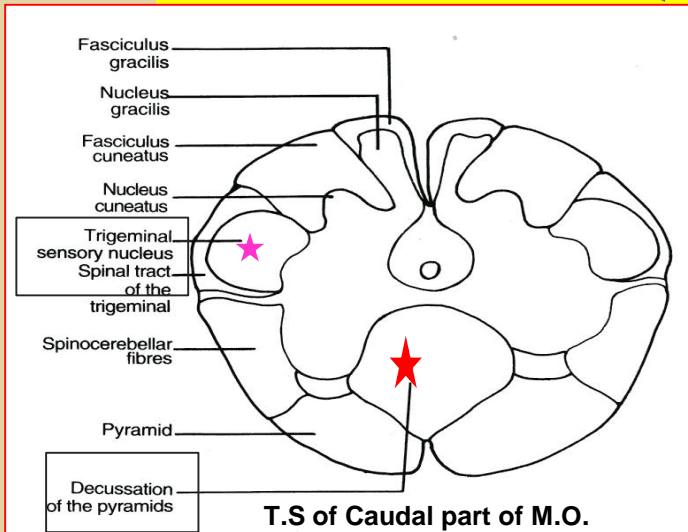
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# OBJECTIVES

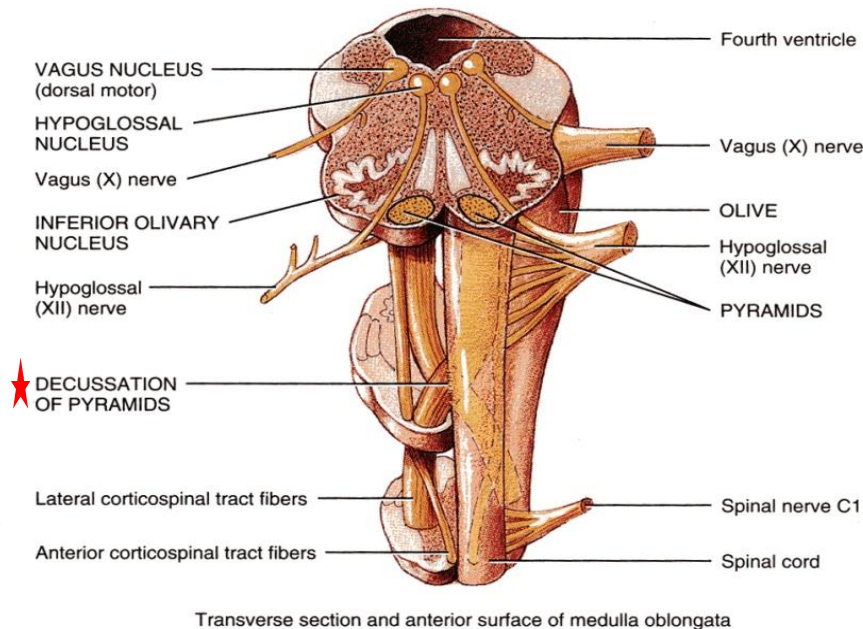
*By the end of the lecture, students will be able to :*

- ▣ *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.*

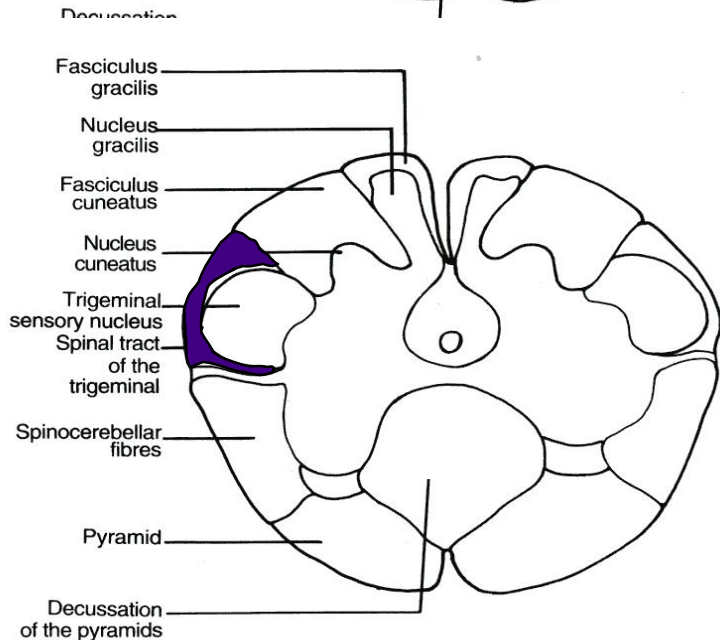
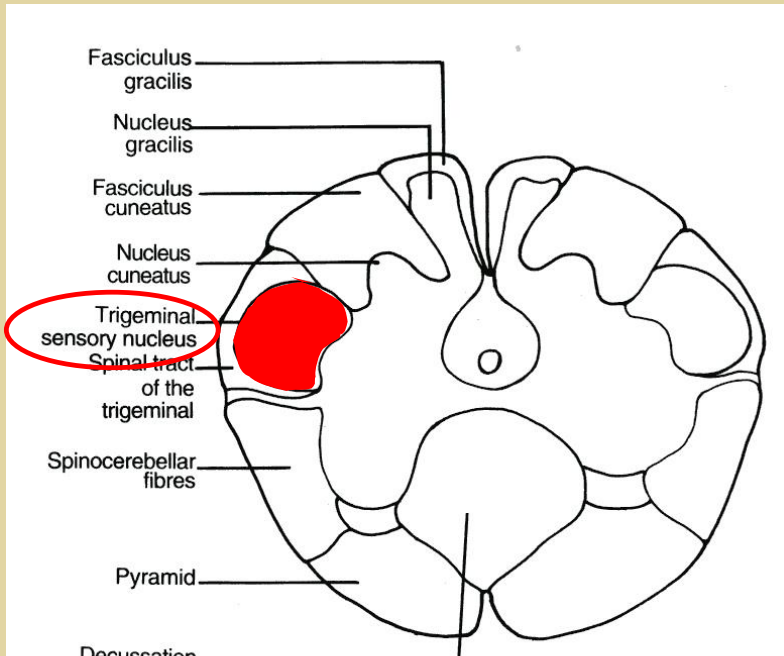
# CAUDAL (closed) MEDULLA



- ▣ 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*

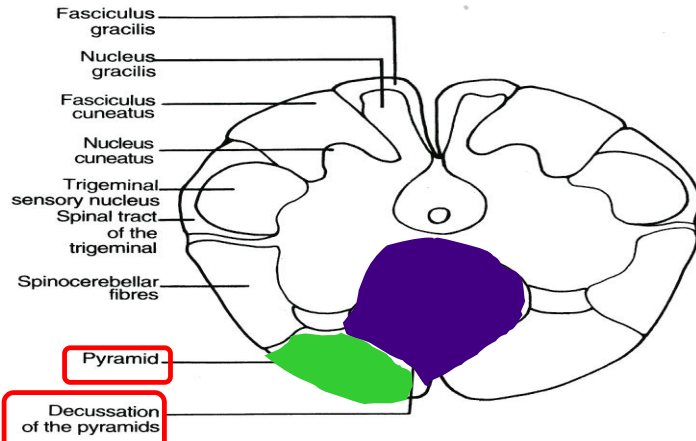
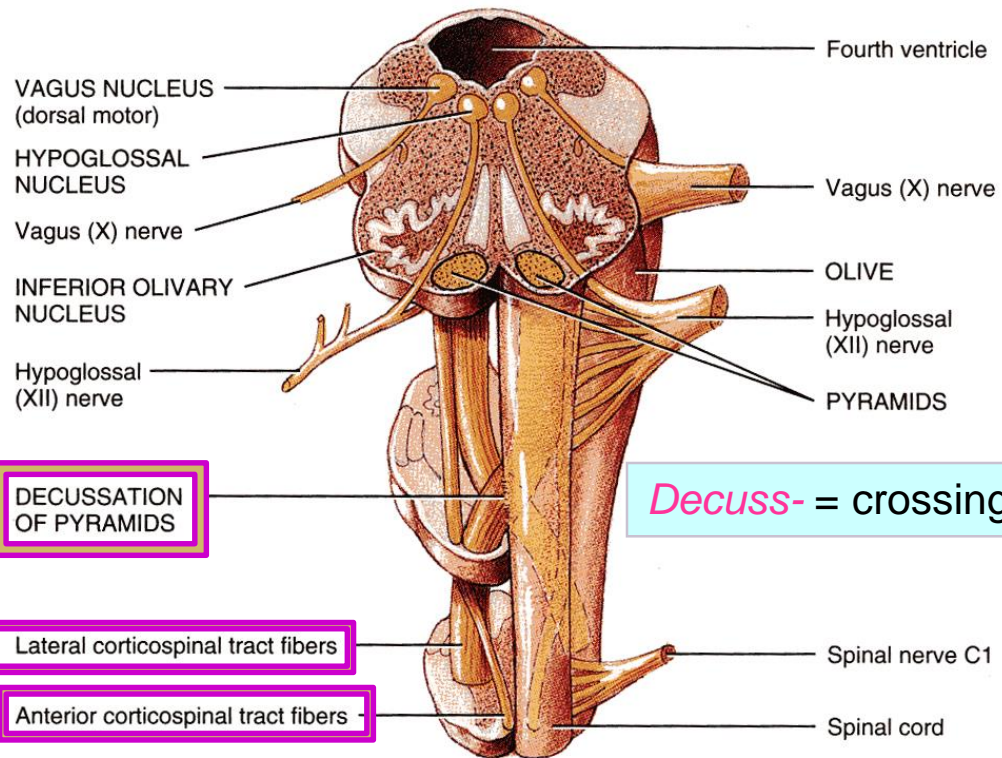


# TRIGEMINAL SENSORY NUCLEUS & TRACT



- ▣ *The Nucleus Extends :*
- ▣ *Through the whole length of the brain stem and 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

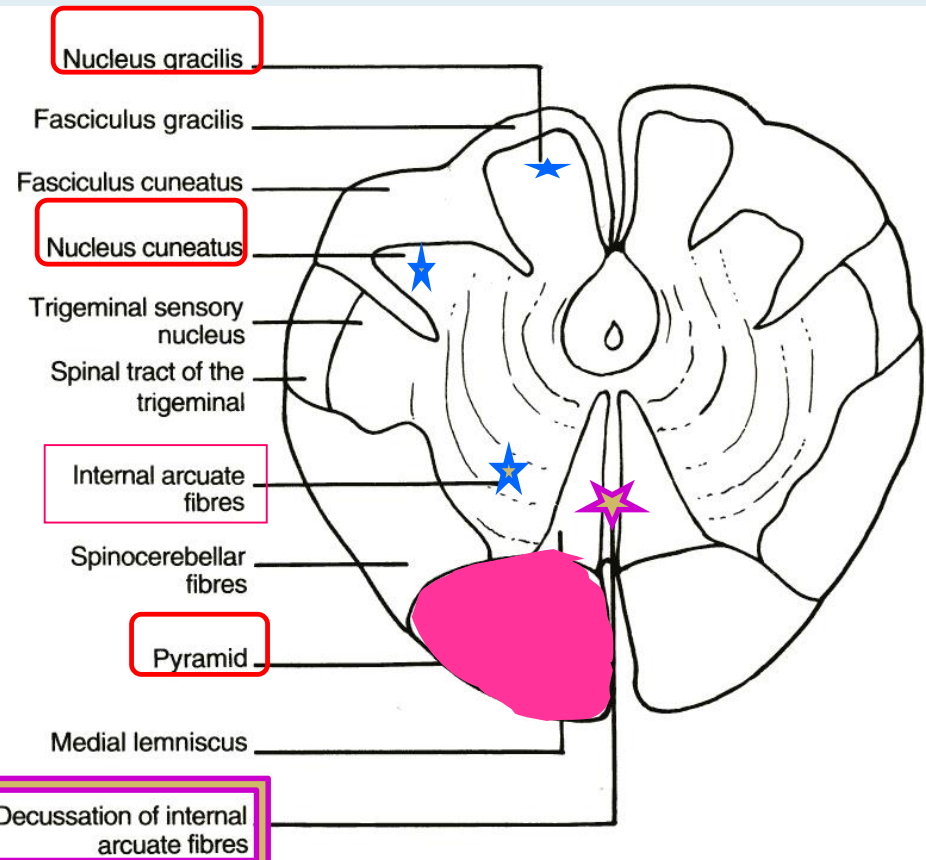
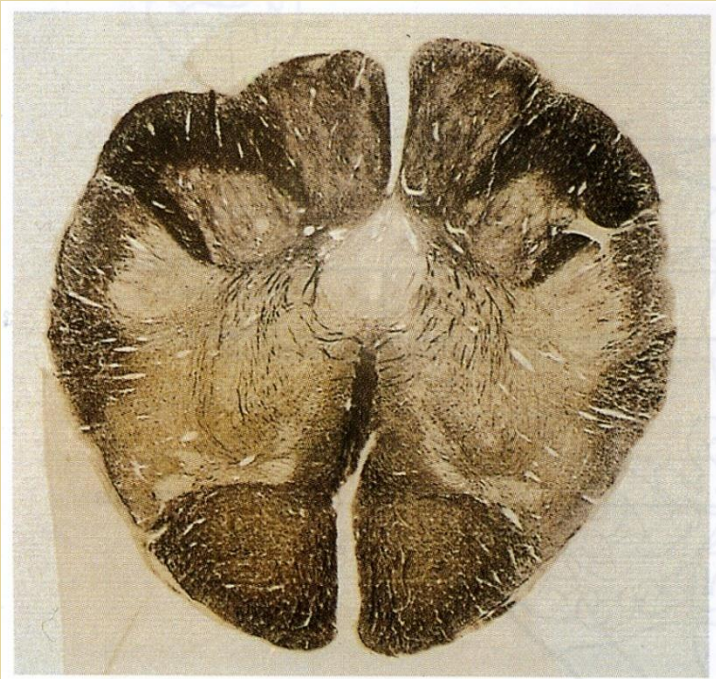


- ▣ *It is Motor Decussation.*
- ▣ *Formed by pyramidal fibers, (75-90%) cross to the opposite side*
- ▣ *They descend in the lateral white column of the spinal cord as the lateral corticospinal tract.*
- ▣ *The uncrossed fibers form the ventral corticospinal tract.*

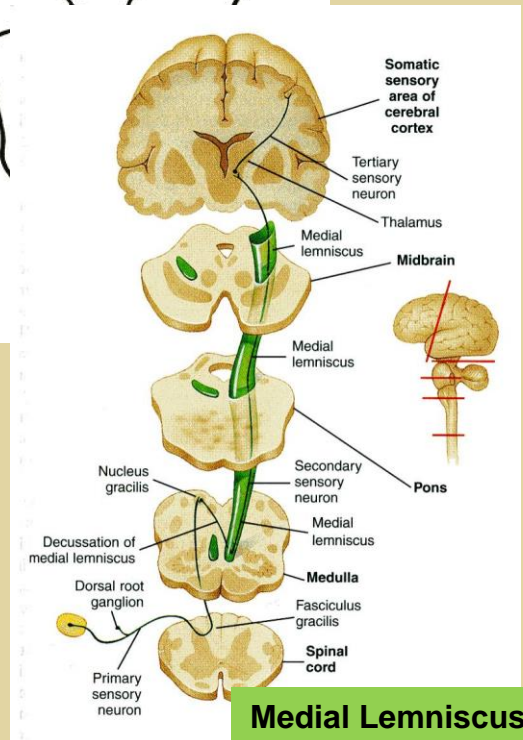
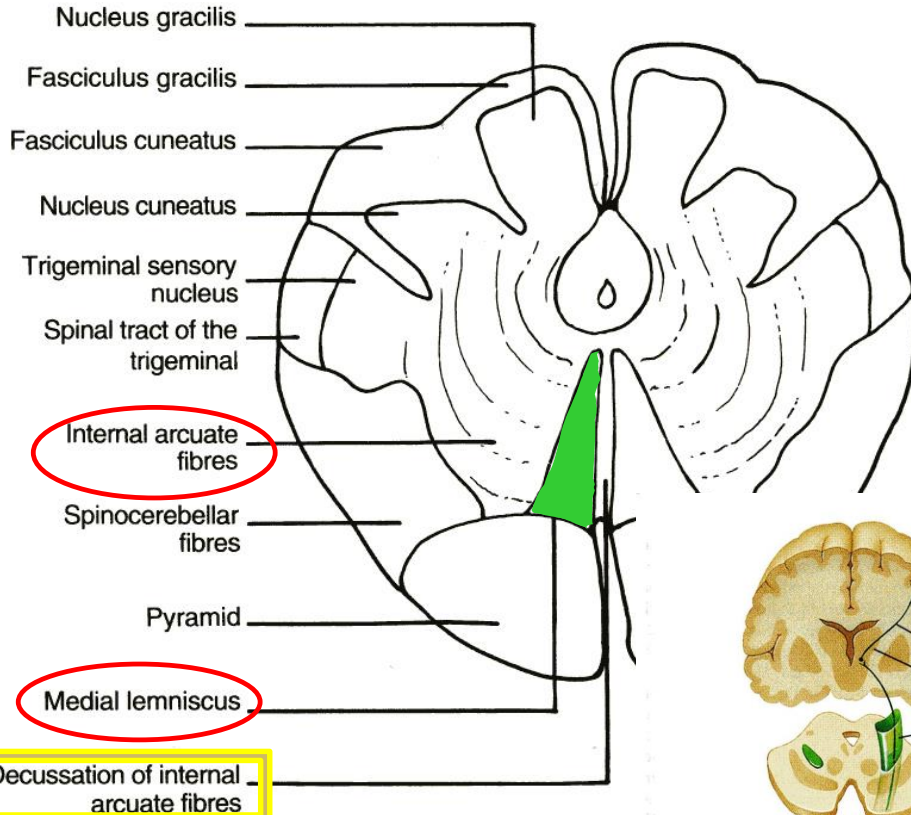


# MID MEDULLA

- ▣ *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.*



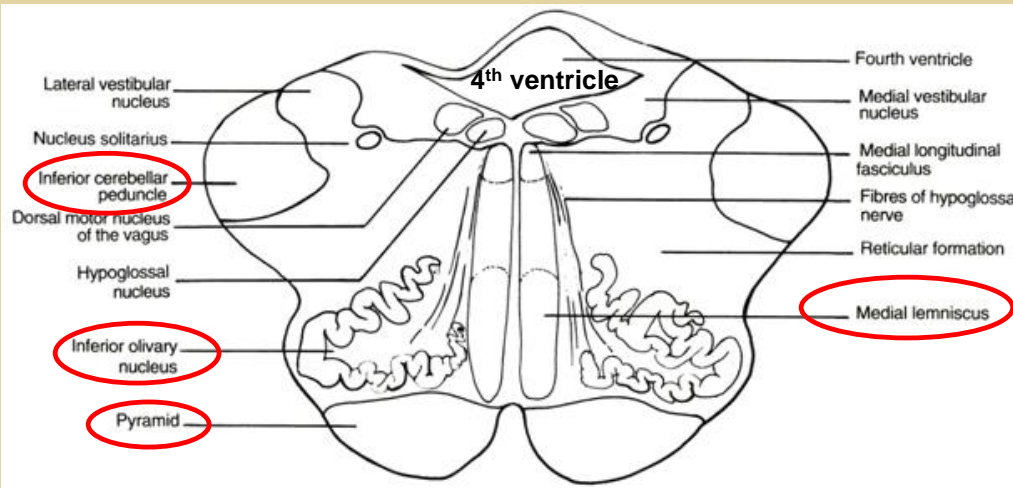
# SENSORY DECUSSATION



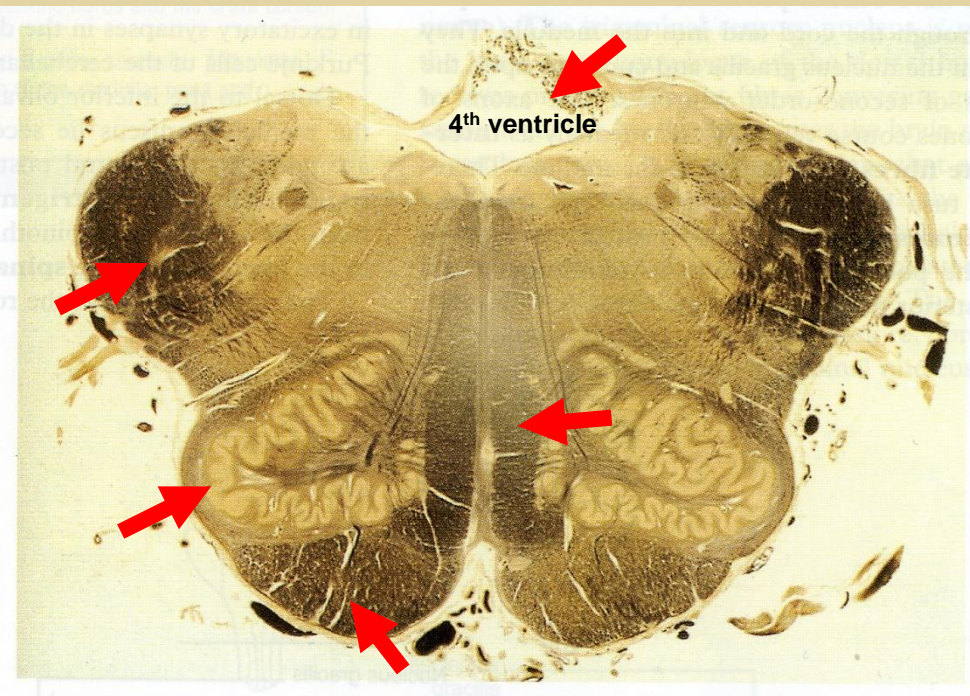
- ▣ Formed by the *crossed internal arcuate fibers*
- ▣ **Medial Lemniscus:**
  - *Composed of the ascending internal arcuate fibers after their crossing.*
  - *Lies adjacent to the middle line ventral to the central canal*
  - *Terminates in thalamus.*
  - *Concerned with proprioceptive deep sensation.*



# ROSTRAL (open) MEDULLA

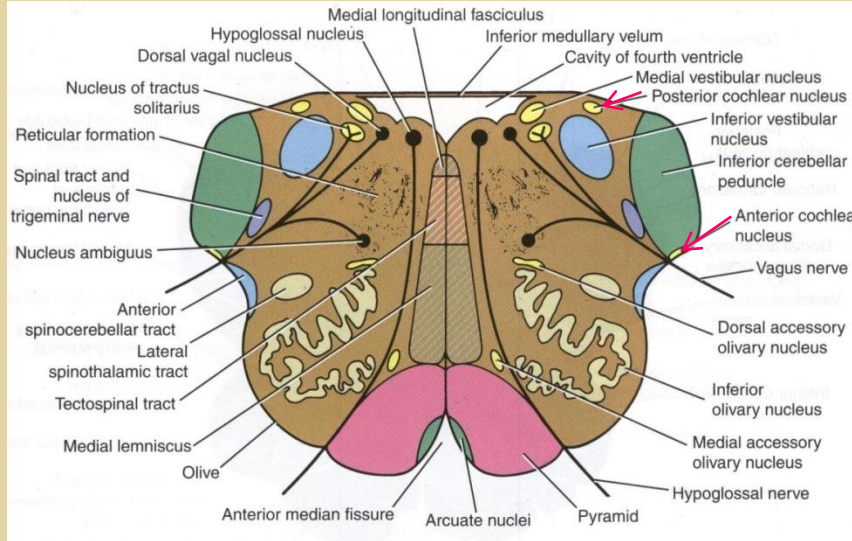


- ❑ On the ventral aspect :
- ❑ **The pyramid is clear, with medial lemniscus on either sides of middle line dorsal to the pyramid**
- ❑ **Inferior Olivary Nucleus:**
  - A convoluted mass of gray matter, lies posterolateral to the pyramids & lateral to the medial lemniscus.
  - It is concerned with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



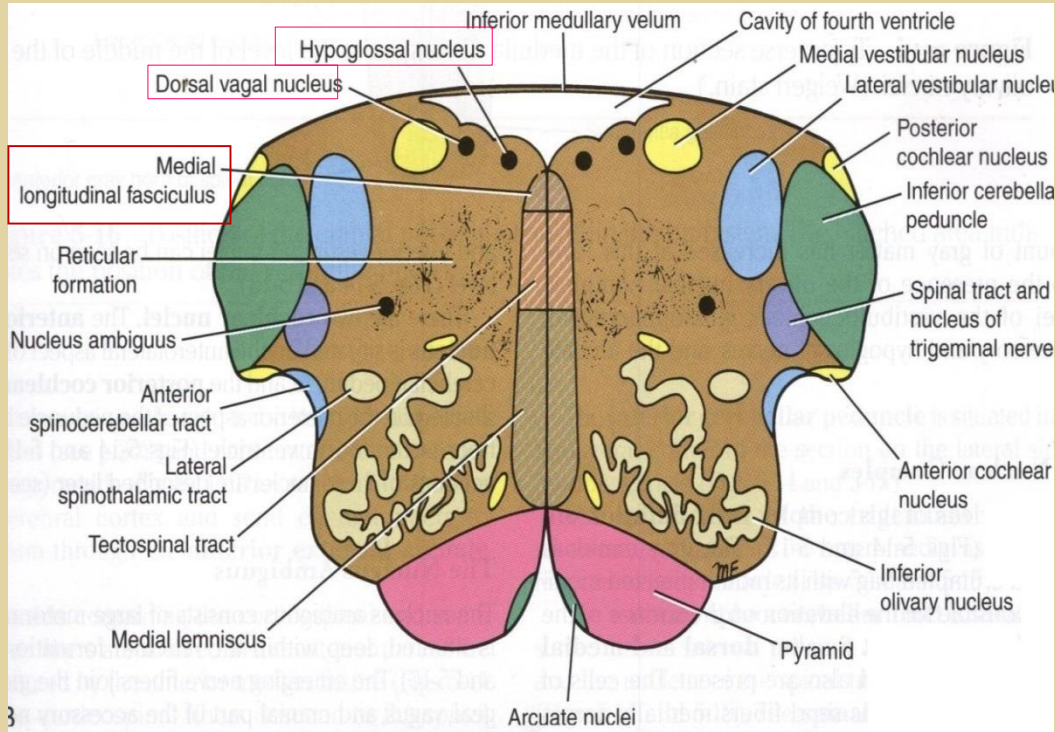


# ROSTRAL (open) MEDULLA



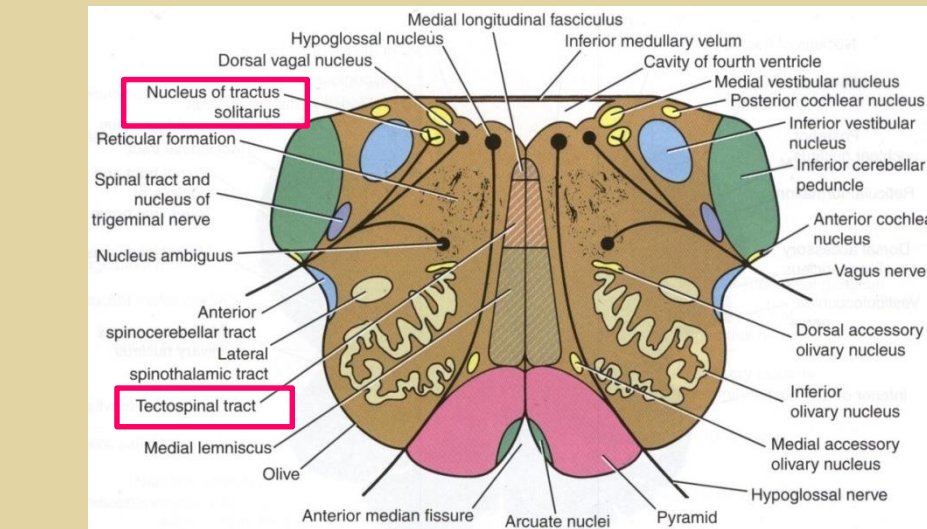
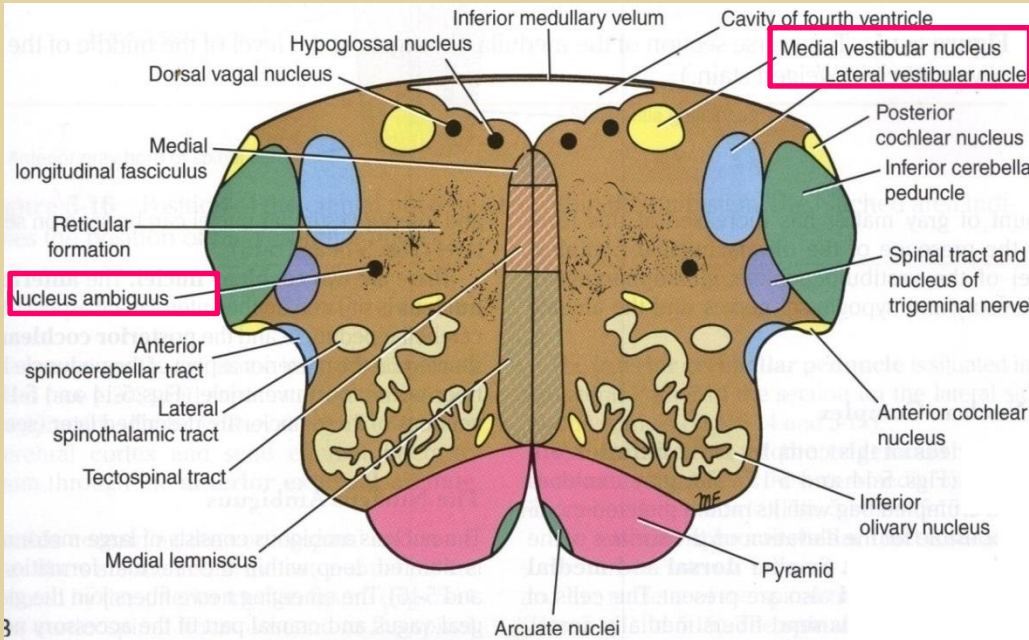
- ▣ Its dorsal surface forms:
  - ▣ Lower part of the floor of the **4<sup>th</sup> ventricle**.
- ▣ The Inferior Cerebellar Peduncle is, connecting M.O. with cerebellum.
- ▣ dorsal and ventral to the Inferior cerebellar peduncle lie the **Cochlear nuclei (dorsal and ventral)**.

# ROSTRAL (open) MEDULLA



- ▣ **Beneath the floor of 4<sup>th</sup> ventricle lie :**
  - **1. Hypoglossal Nucleus.**
  - **2. Dorsal vagal nucleus contains preganglionic parasympathetic fibers.**
  - **3. Medial longitudinal fasciculus, it 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 spinal cord (cervical & upper thoracic segments) as (vestibulo-spinal tract)---coordination of the neck & trunk movements with head movements, so maintaining balance of the body trunk and head.**

# ROSTRAL (open) MEDULLA

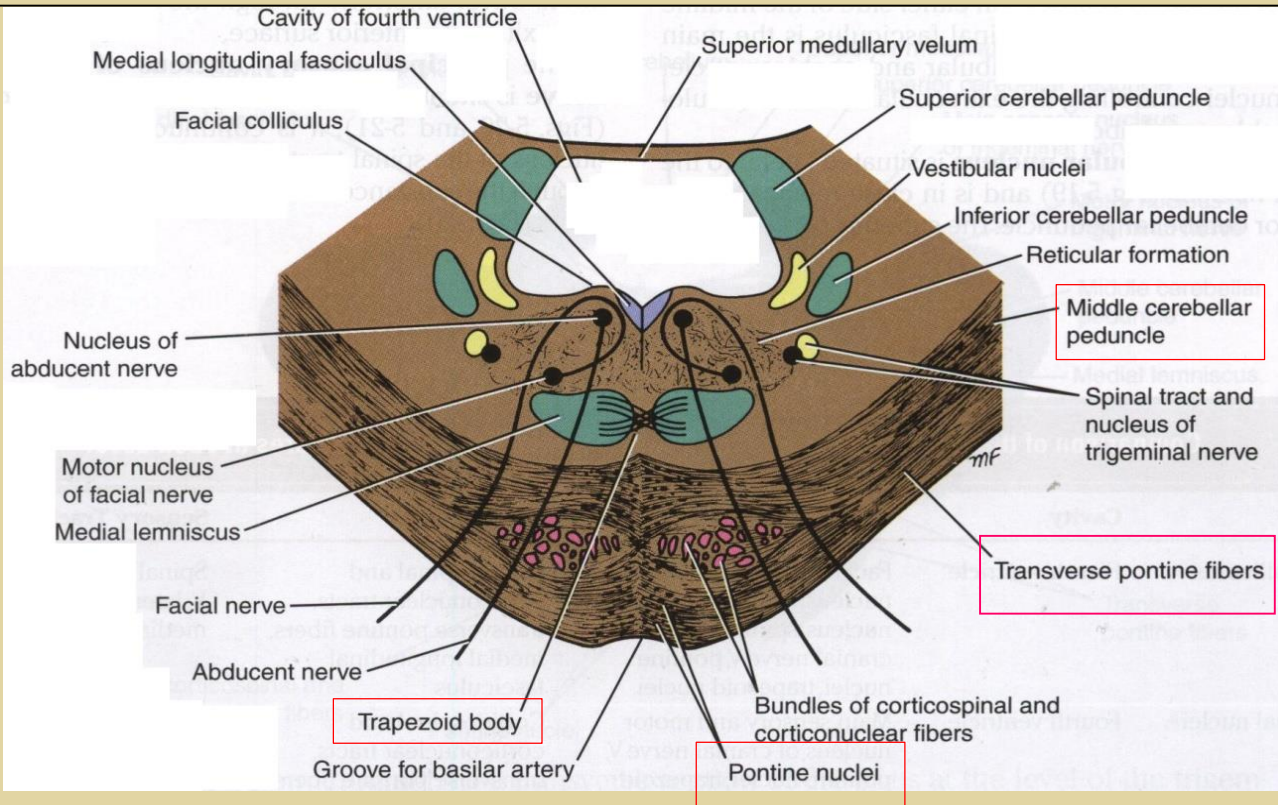


- 4. Vestibular nuclei complex : concerned with equilibrium.
- 5. Nucleus Ambiguus: (motor nucleus) : lies dorsal to olivary nucleus gives motor fibers along glossopharyngeal N. & vagus N. to Ms. of the pharynx, larynx & palate.
- 6. Solitary nucleus (sensory nucleus) ; receive taste sensation from the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



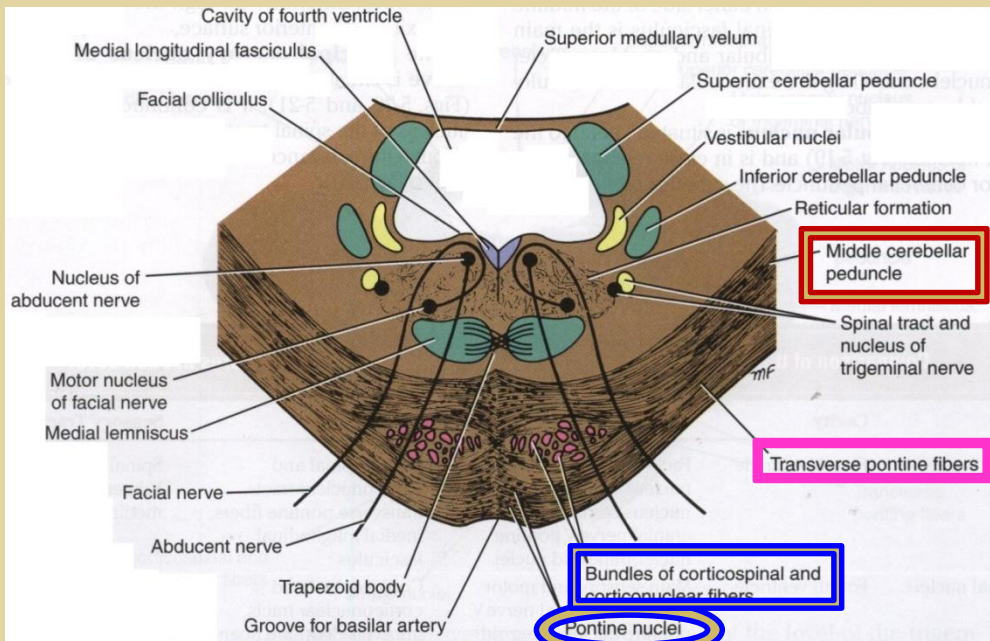
# THE PONS

- It is 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 (In all Levels of Pons) : 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 **middle cerebellar peduncle**.





# CAUDAL PART OF THE PONS

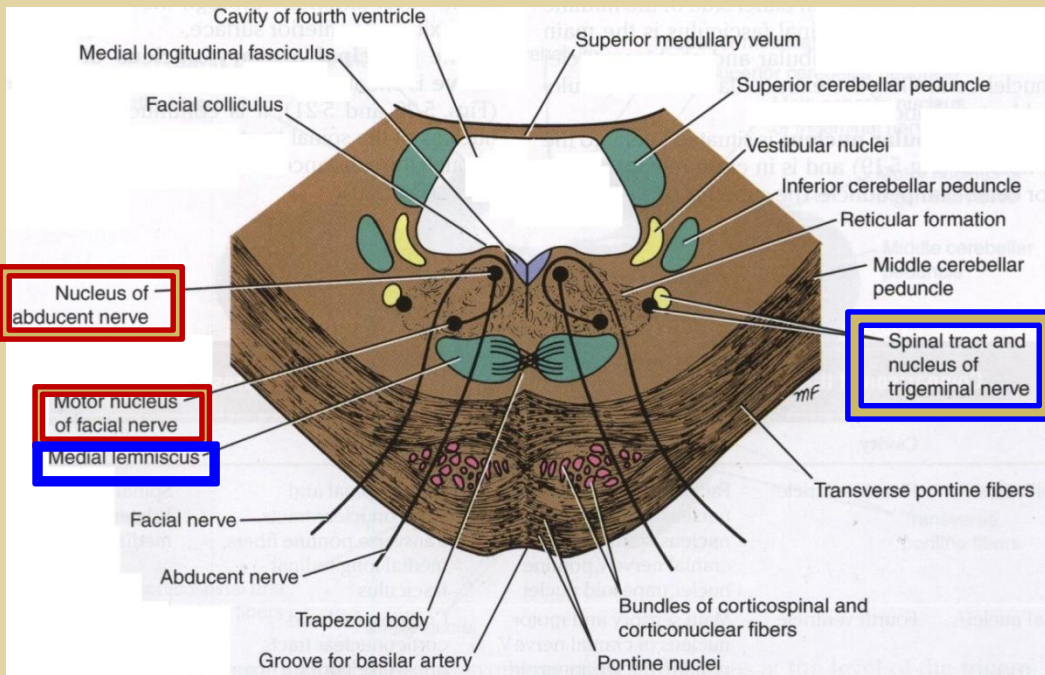


## 1. Pontine Nuclei:

- 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



## 3. The ascending fibres of the **Medial lemniscus**

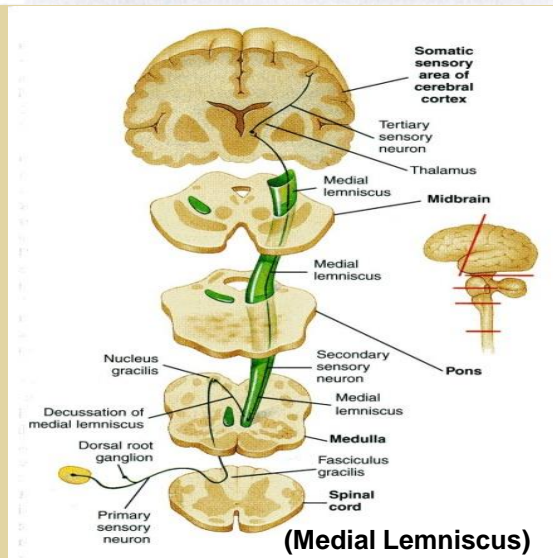
- become separated from the pyramid and displaced dorsally.

- The **Medial Lemniscus** rotates 90 degrees and lies almost horizontally.*

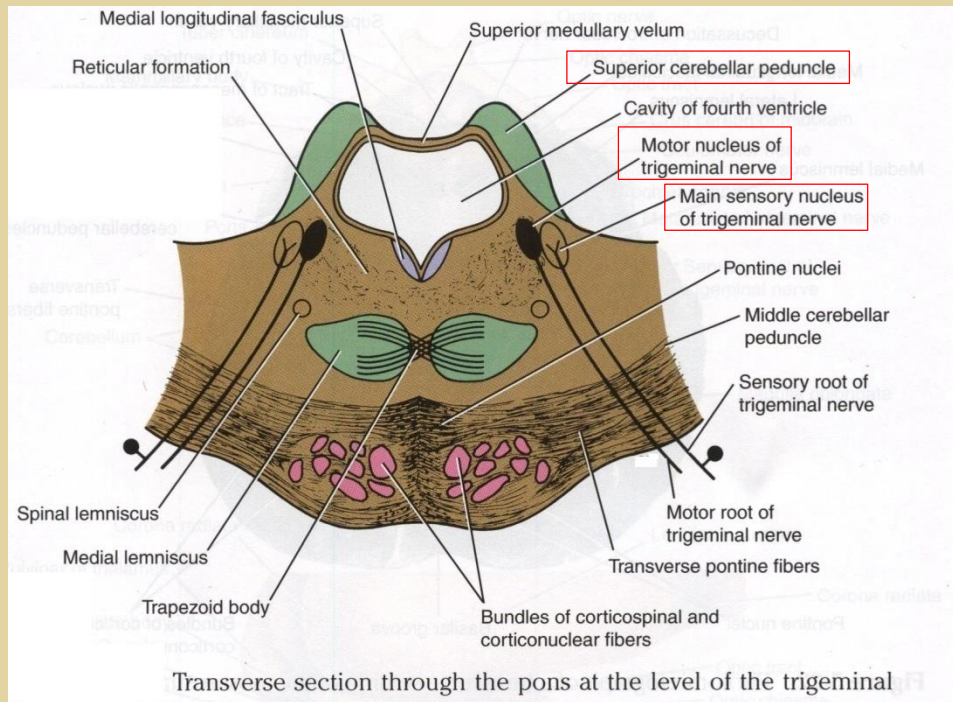
## 4. Spinal tract & nucleus of Trigeminal.

## 5. Deep origin of cranial nerve nuclei :

- Abducent nucleus**
- Facial motor nucleus**



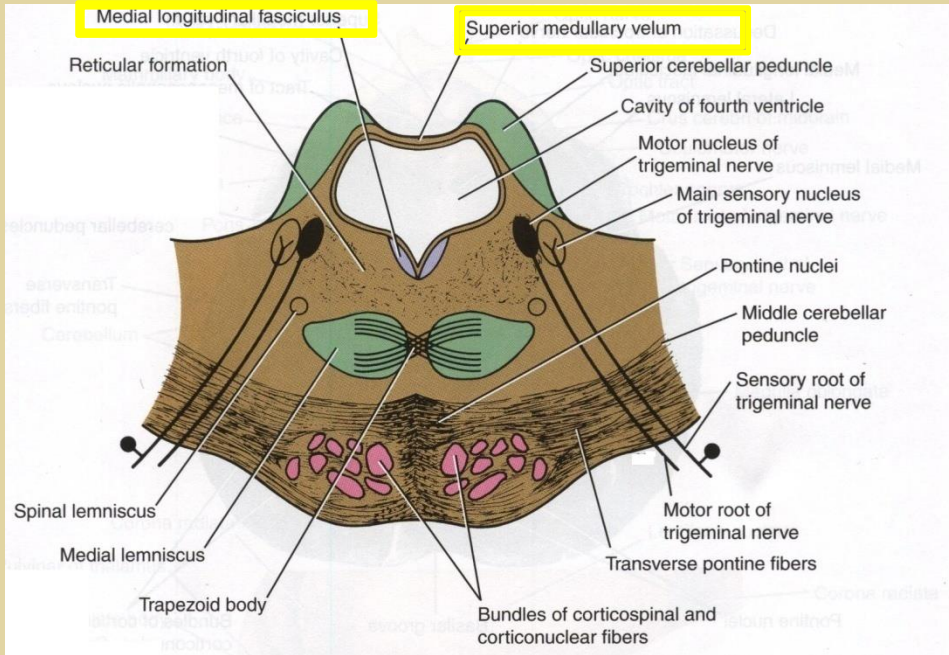
# AT THE LEVEL OF THE TRIGEMINAL NERVE



- **Motor nucleus of the trigeminal nerve:** Lies in the lateral part of the floor of the 4<sup>th</sup> ventricle.
- **Main sensory nucleus of the trigeminal nerve:** it lies lateral to the motor nucleus.
- **Superior cerebellar peduncles** form the lateral boundary of the 4<sup>th</sup> ventricle



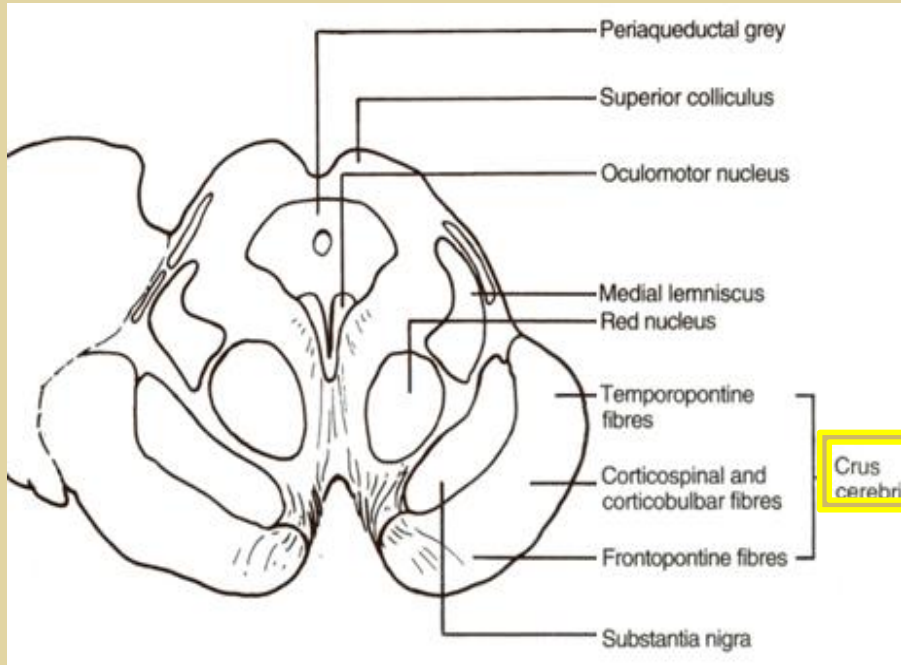
# ROSTRAL PONS



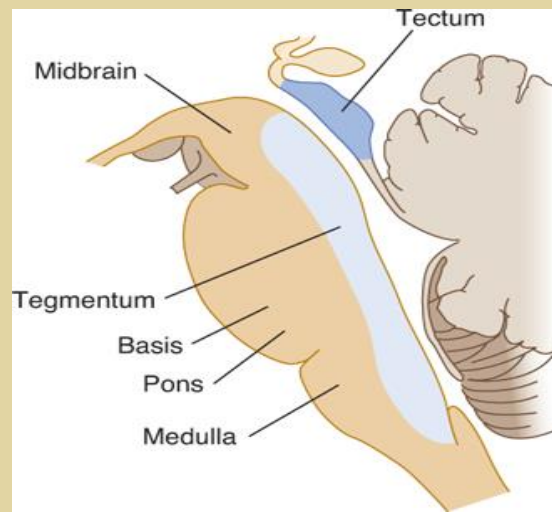
- ▣ **Superior Medullary Velum:**
  - *Passes between the two peduncles & forms the roof of the 4<sup>th</sup> ventricle.*
- ▣ **Medial longitudinal fasciculus:**
  - *Lies close to the midline beneath the floor of the 4<sup>th</sup> ventricle.*



# MIDBRAIN

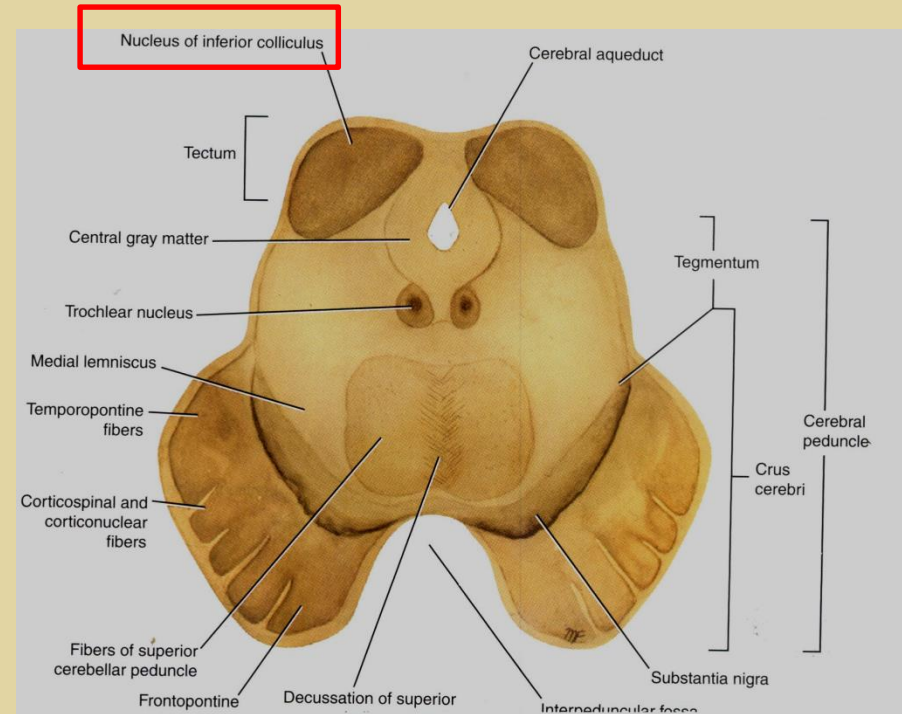


- It is divided into :
- a dorsal part (**Tectum**) of **4 colliculi**; and
- a ventral part (**Tegmentum**) at the level of the cerebral aqueduct.
- The **cerebral aqueduct** is surrounded by a pear shaped **periaqueductal (central) gray matter**.
- The most ventral part of the tegmentum is the **massive fibrous mass (Crus Cerebri)**.



# INFERIOR COLLICULUS Level

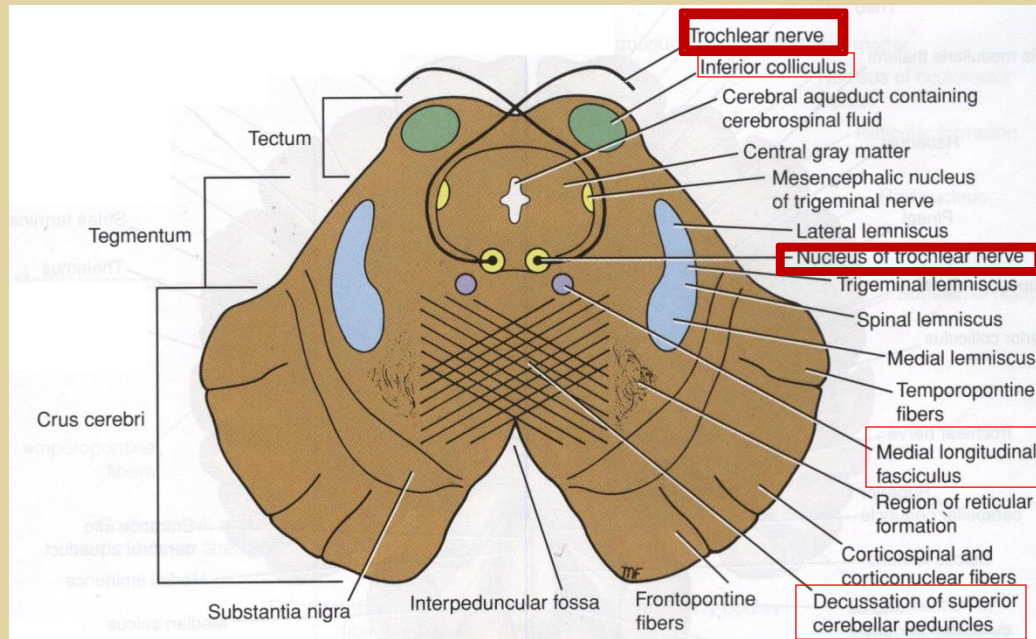
- ❑ *Inferior colliculus is a large nucleus of gray matter that lies beneath a corresponding surface elevation.*
- ❑ *It is part of the auditory pathway.*
- ❑ *It receives fibers from the lateral lemniscus.*
- ❑ *Its efferent fibers pass to the thalamus*



# INFERIOR COLLICULUS Level

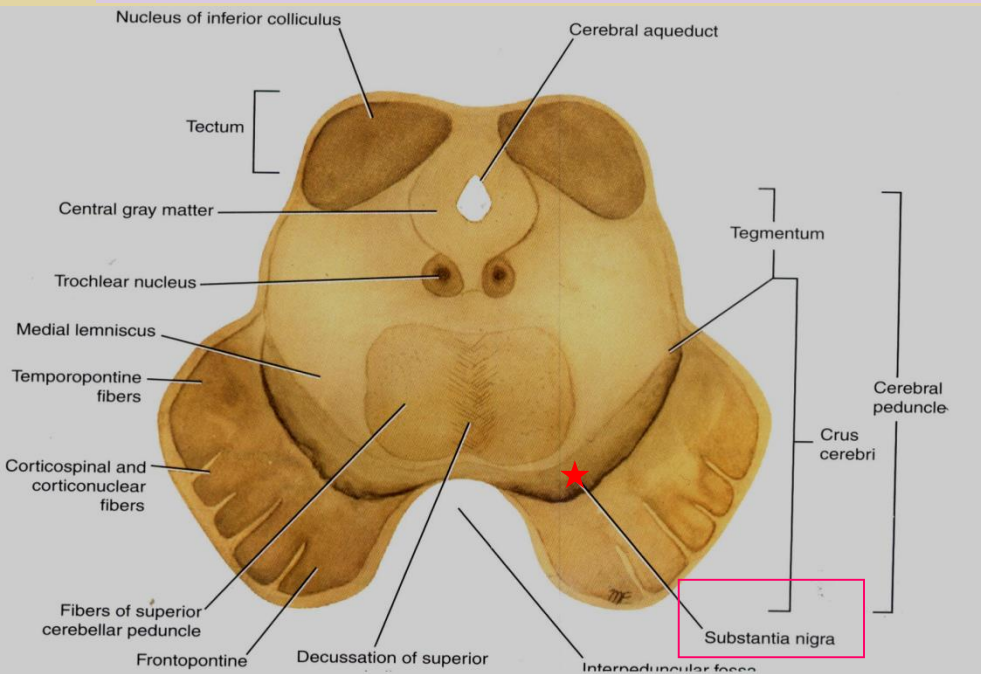
## 1. Trochlear nucleus:

- *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 and emerges from *posterior* surface of *midbrain*.



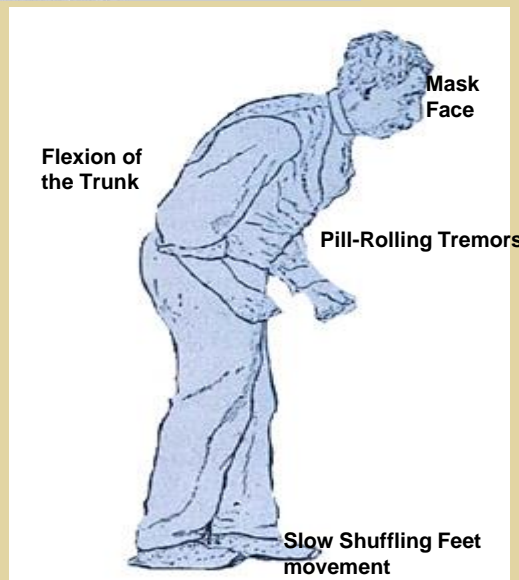
## 2. Decussation of the superior cerebellar peduncles in the mid line.

# 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.*

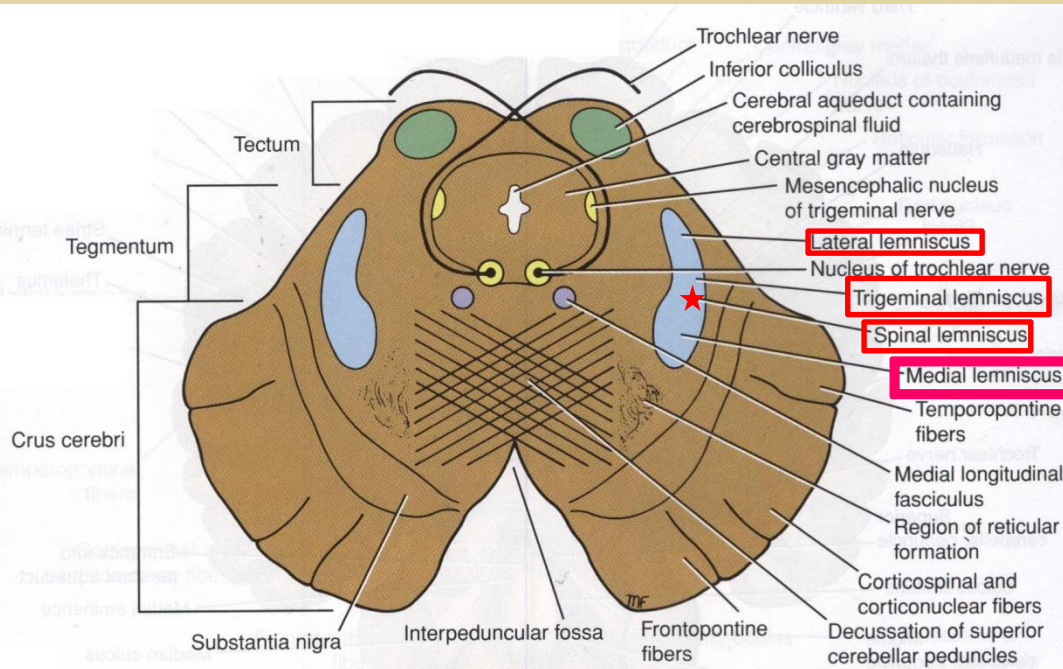




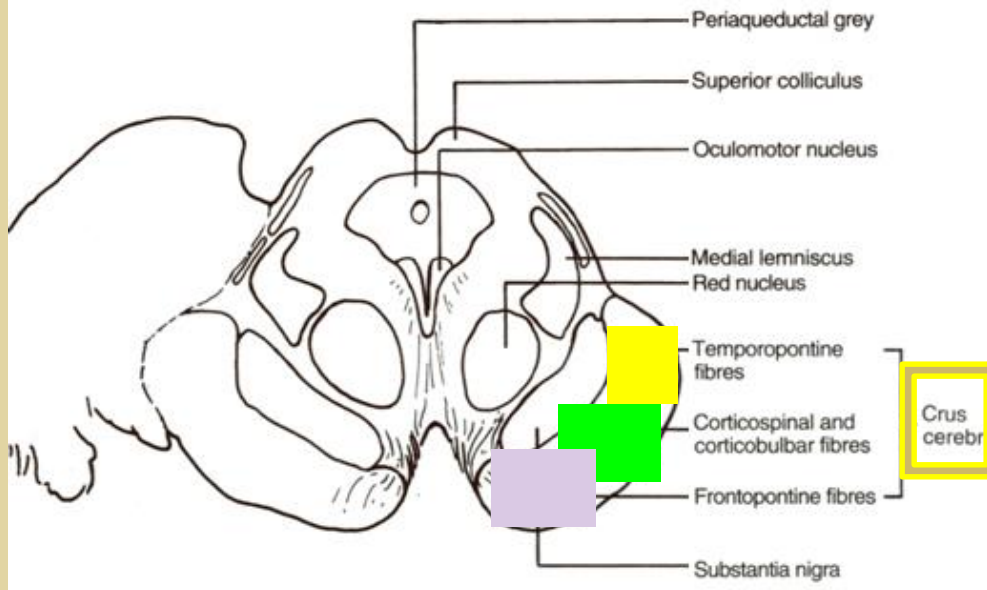
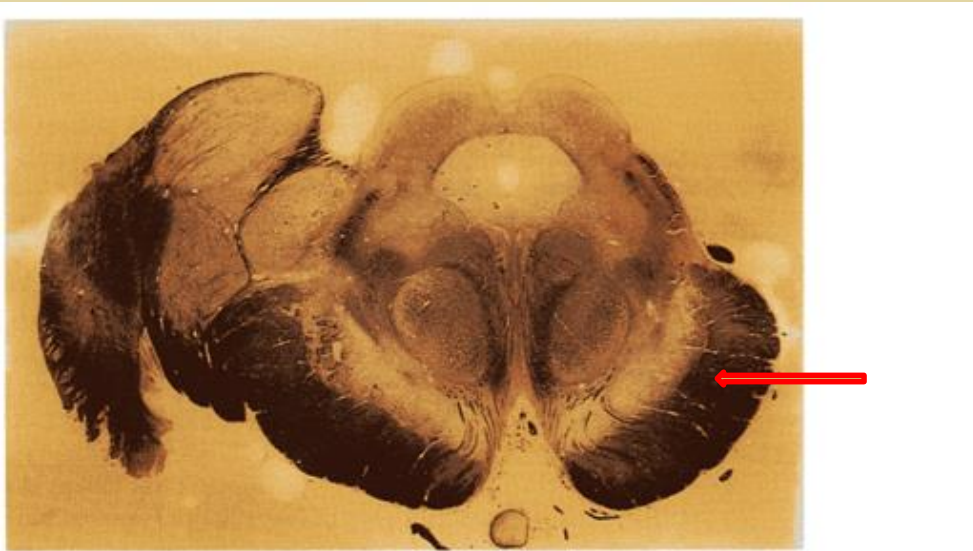
## 4. ASCENDING LEMNISCI :

### ■ *Composed Of:*

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

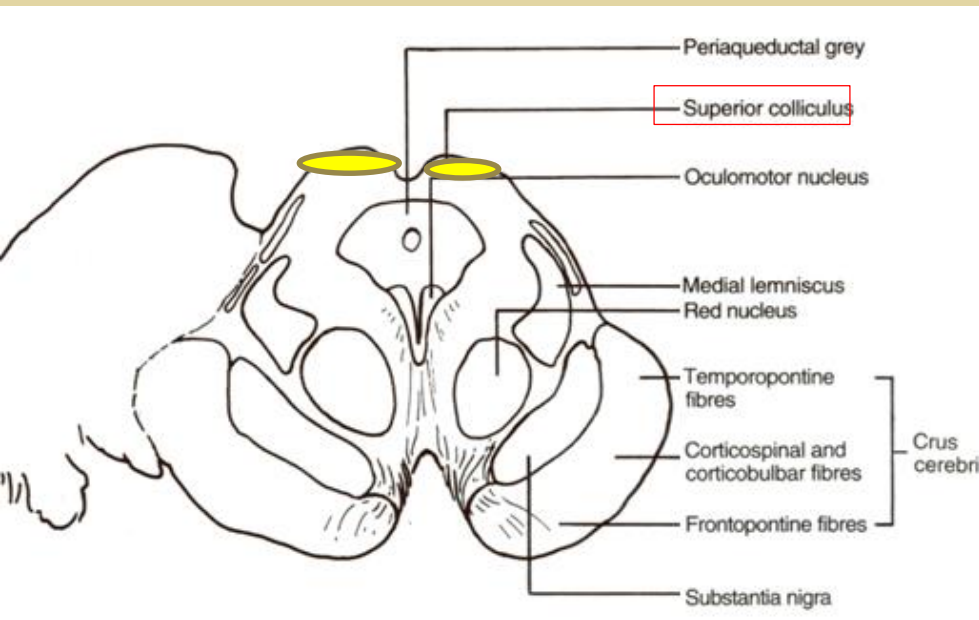


# CRUS CEREBRI



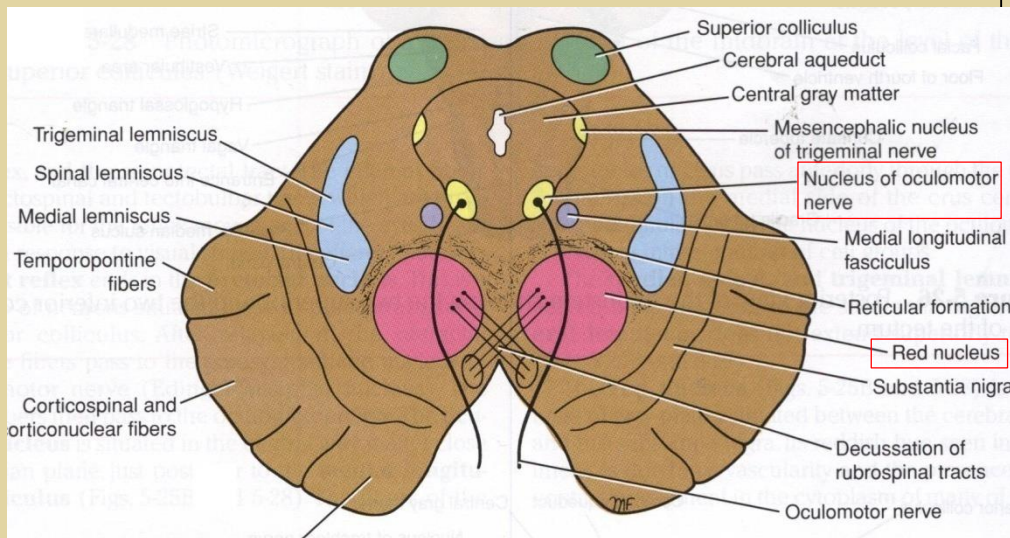
- It is a massive mass ventral to the substantia nigra.
- It consists entirely of **descending cortical efferent fibers** (Frontopontine, Corticospinal & corticobulbar and Temporopontine Fibres) to the motor cranial nerve nuclei and to anterior horn cells of spinal cord.
- Involved in the coordination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

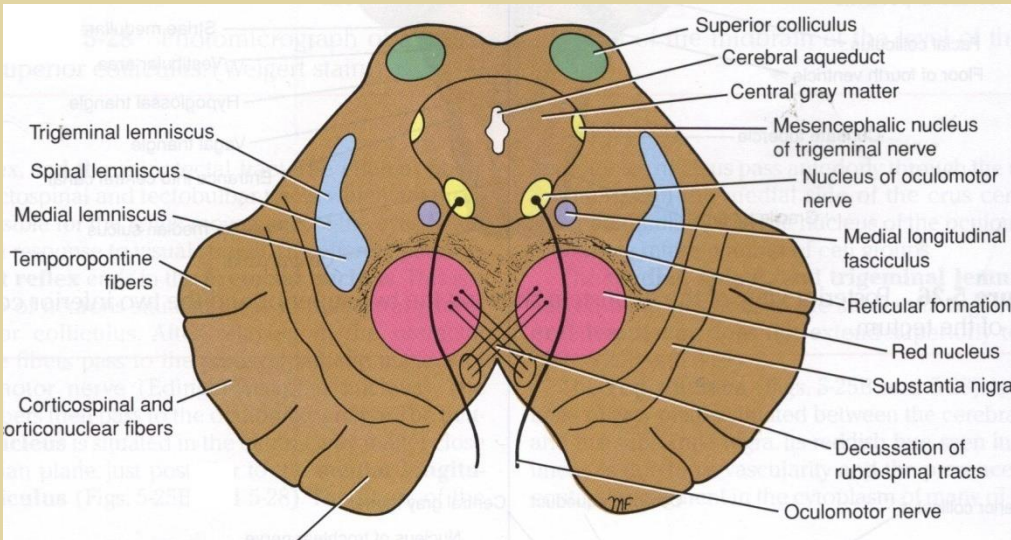


## 1. Oculomotor nucleus:

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



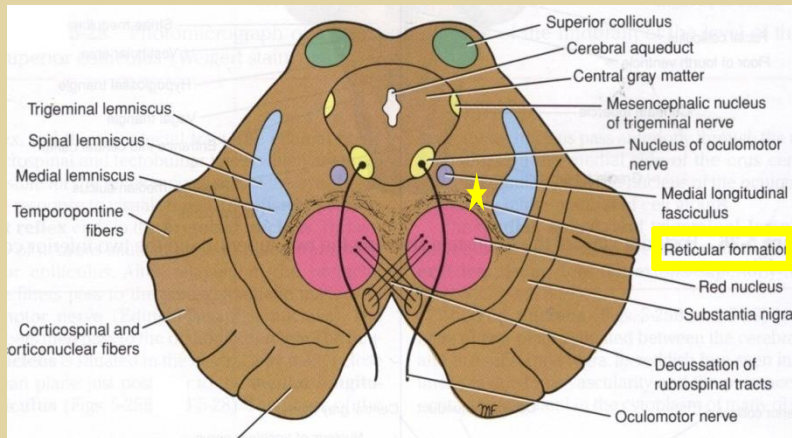
# SUPERIOR COLLICULUS Level



## 2. Red nucleus :

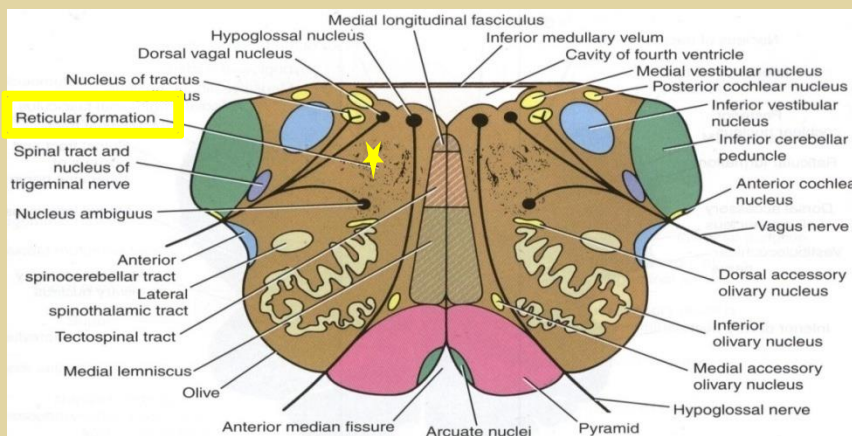
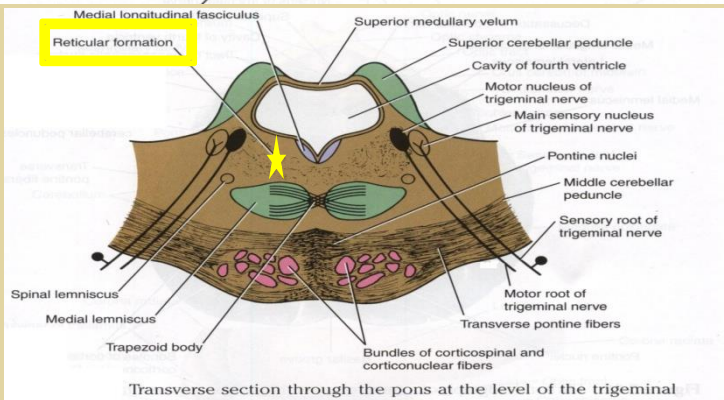
- ▣ **A rounded mass of gray matter that lies in the central portion of the tegmentum.**
- ▣ **Its red coloration is due to its vascularity and the presence of an iron containing pigment in the cytoplasm of its neurons.**
- ▣ **It is involved in motor control.**

# RETICULAR FORMATION

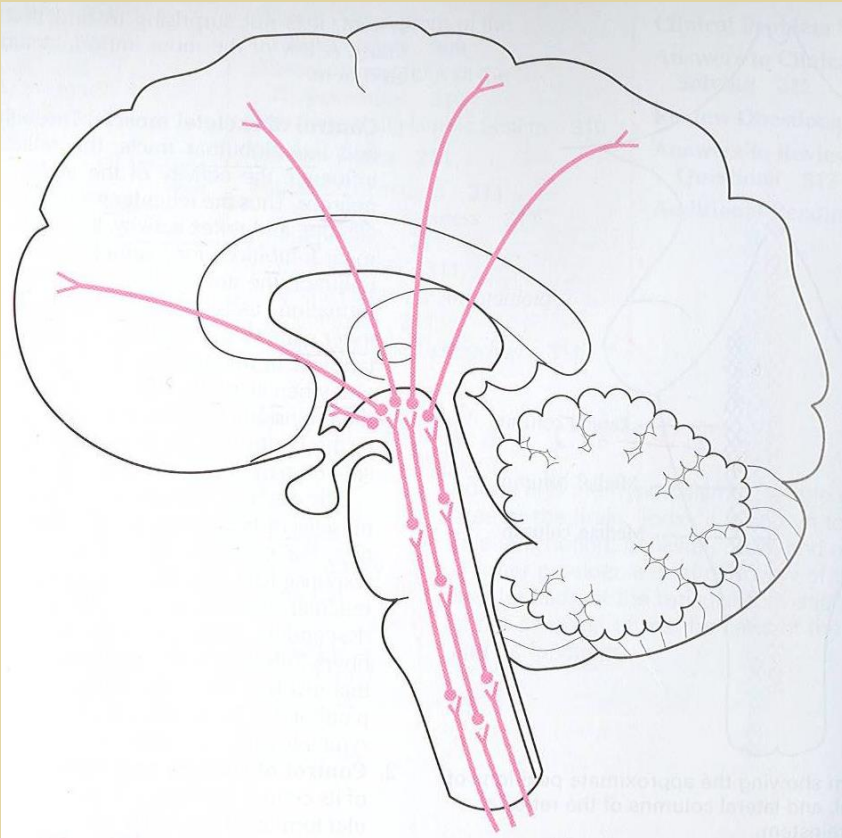


- It is a complex matrix of **nerve fibers & groups of nerve cells** that extends **throughout the brain stem**.

- 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.



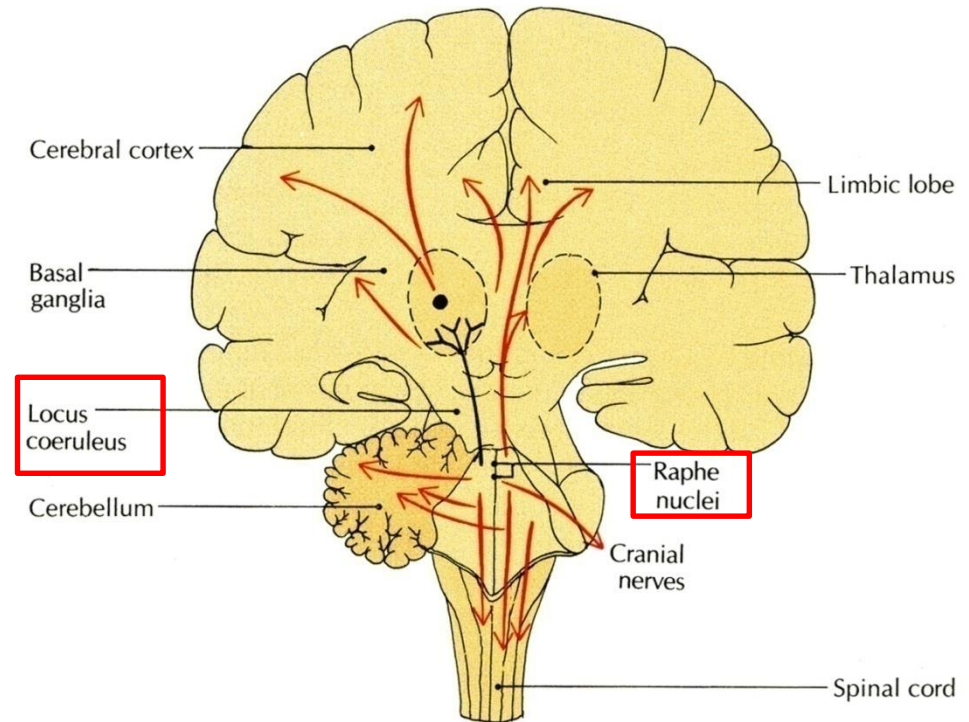
# RETICULAR NEURONES

## ▣ 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 Coeruleus:

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





THANK YOU