

# INTERNAL STRUCTURE OF THE BRAIN STEM

***By***

***Dr. Saeed Vohra***

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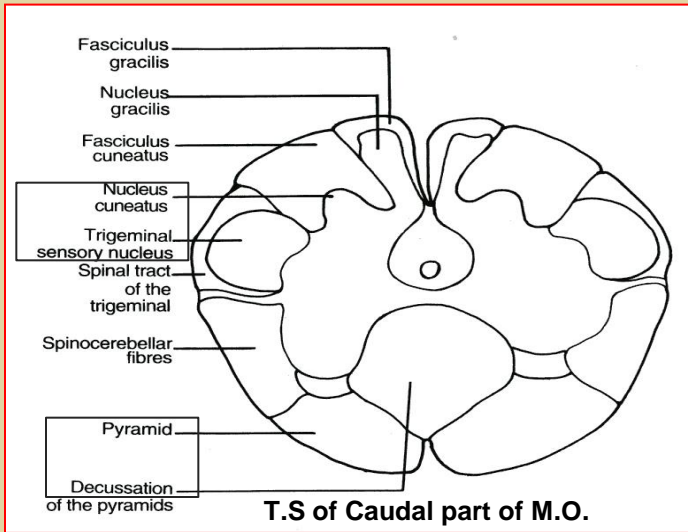
***Dr. Sanaa Alshaarawy***

# OBJECTIVES

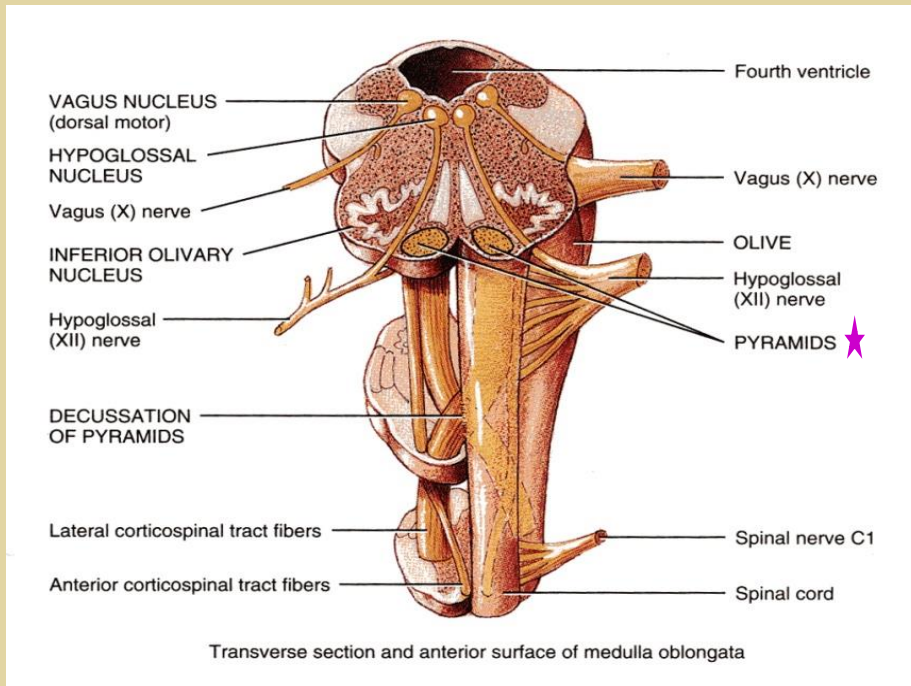
*By the end of the lecture, students will be able to :*

- ▣ *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 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.*

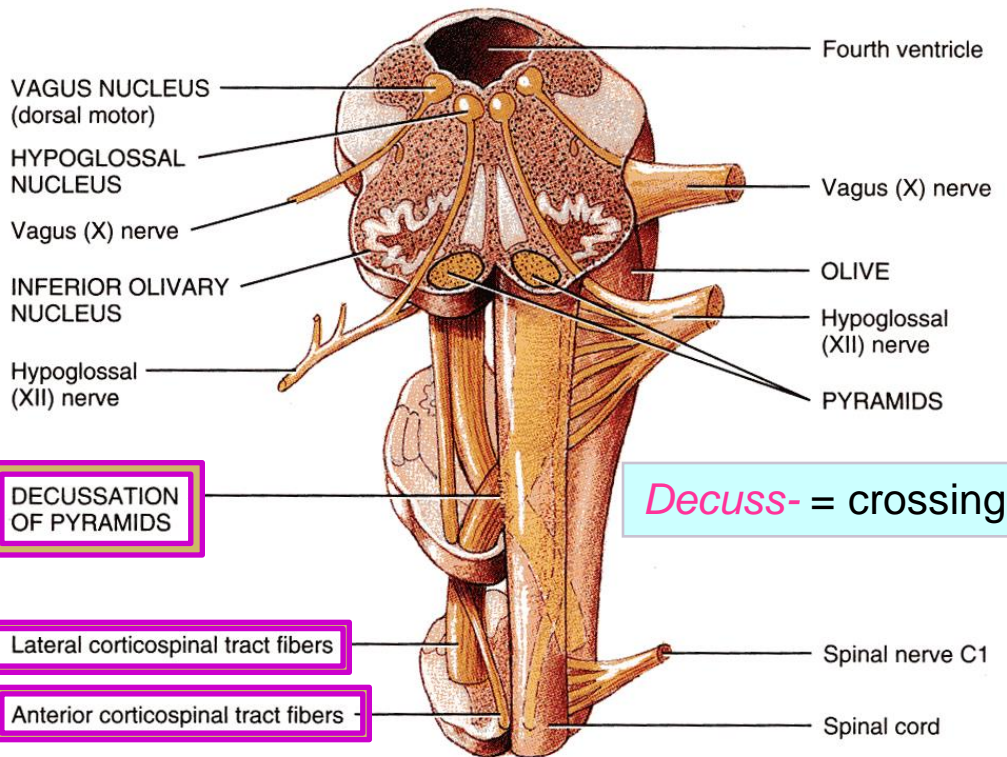
# CAUDAL (closed) MEDULLA



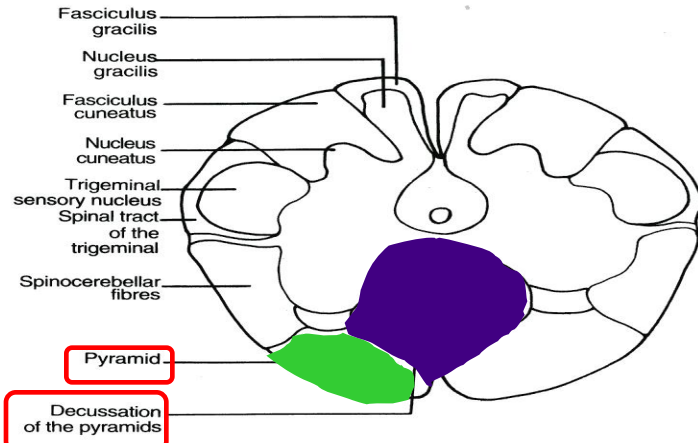
- Traversed by the *Central Canal.*
- Motor Decussation.*
- Spinal Nucleus of Trigeminal. It is a larger sensory nucleus. It is the brain stem continuation of the Substantia Gelatinosa of spinal cord.*



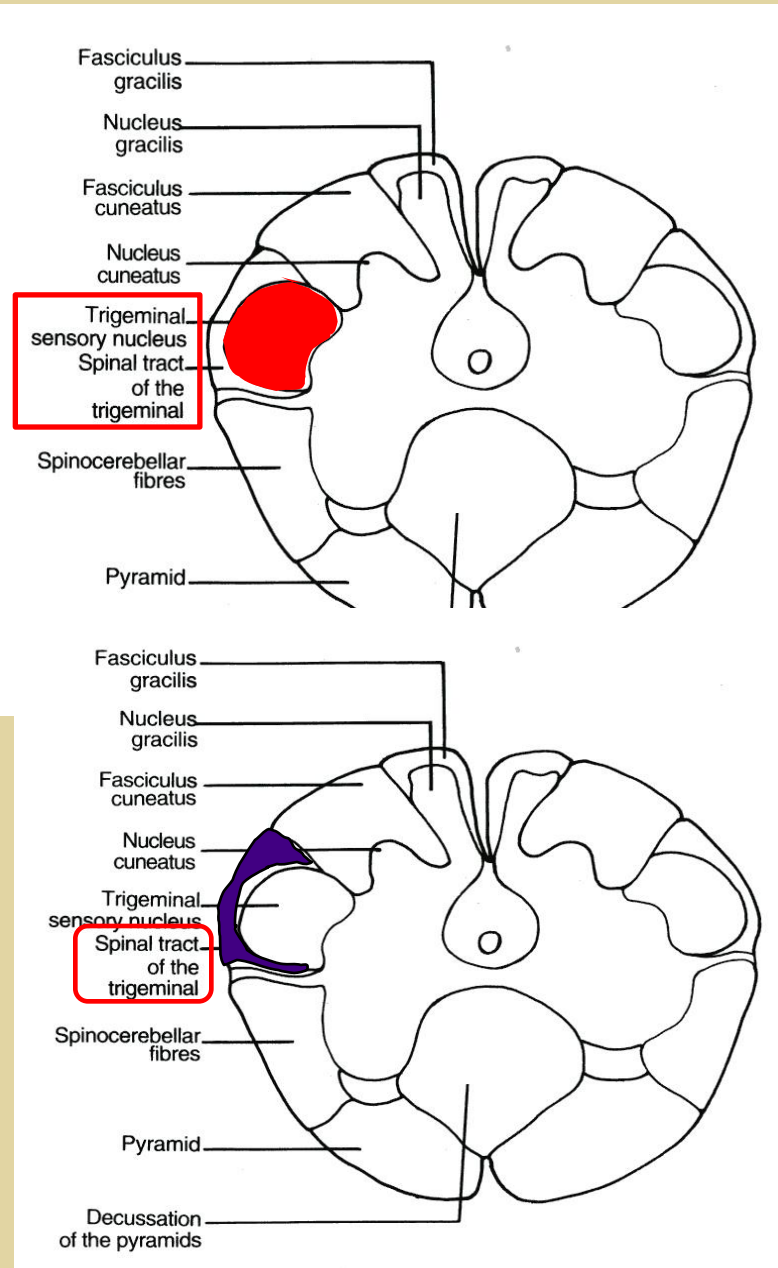
# PYRAMIDAL DECUSSATION



- ▣ *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 anterior corticospinal tract*



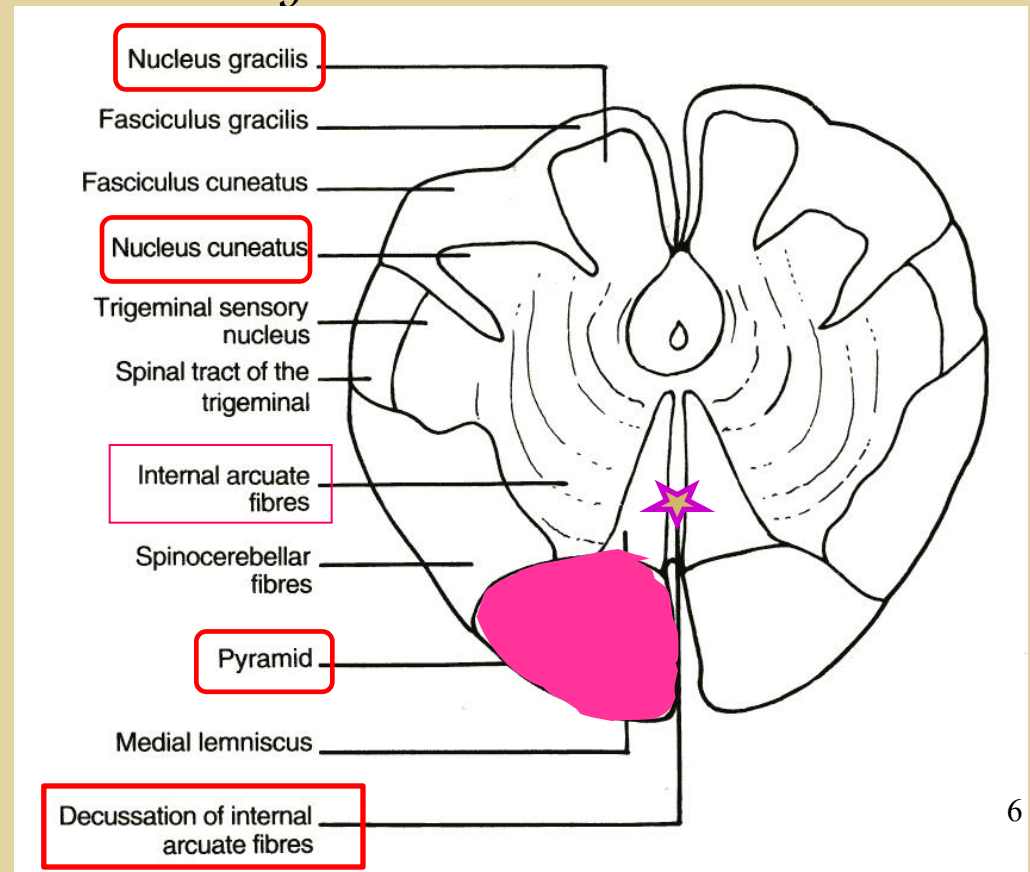
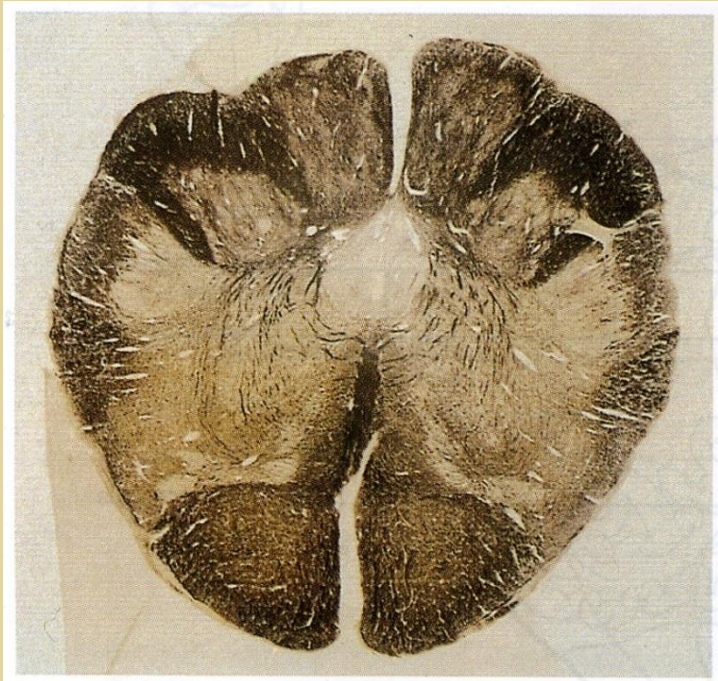
# TRIGEMINAL SENSORY NUCLEUS & TRACT



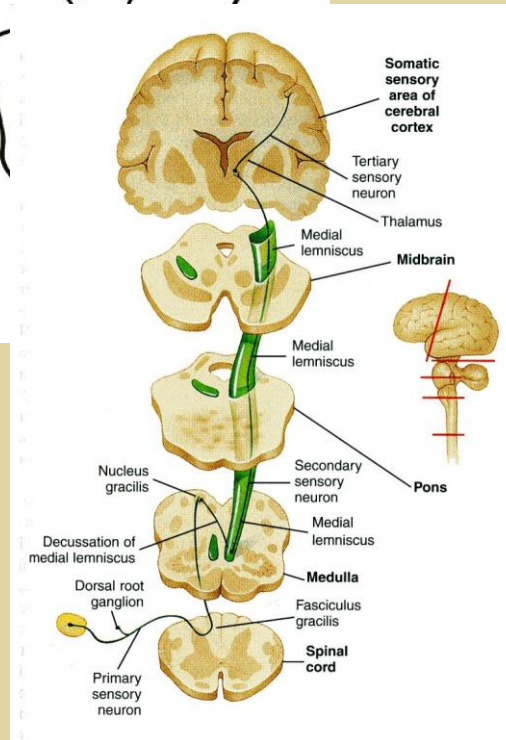
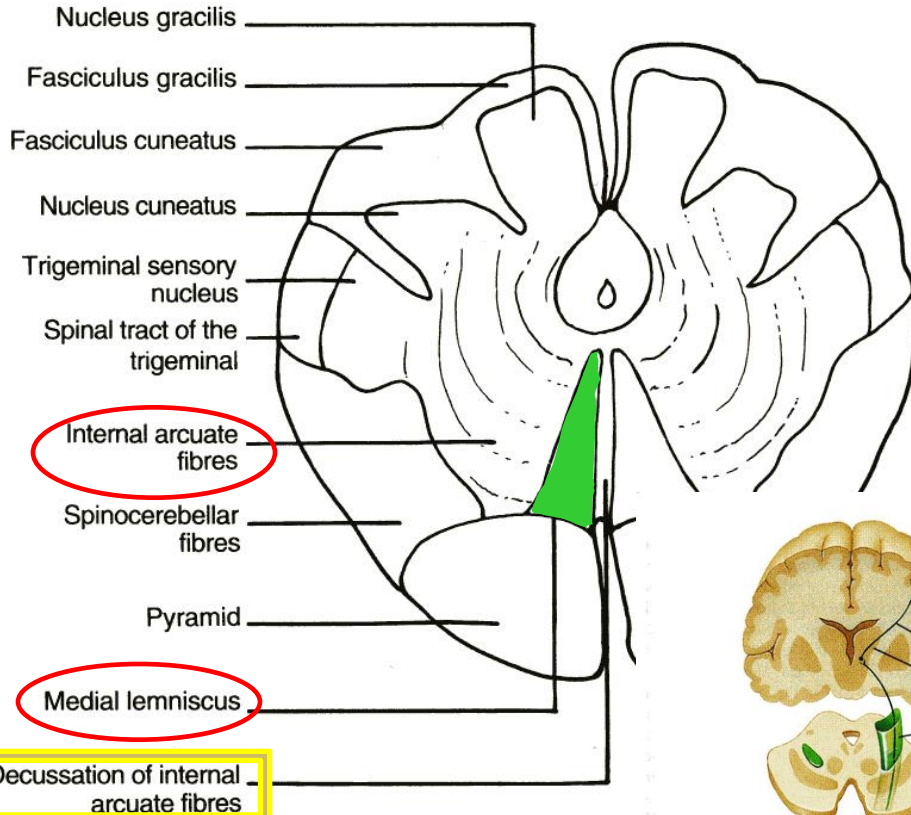
- ***The Nucleus Extends***
  - *Through the whole length of the brain stem and into upper segments of spinal cord.*
  - *It lies in all levels of medulla oblongata medial to the spinal tract of the trigeminal.*
  - *It receives **pain and temperature** from **face, forehead**.*
  - ***Its tract present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

# 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** Sensory Decussation.*
- ▣ ***Pyramids** are prominent ventrally.*

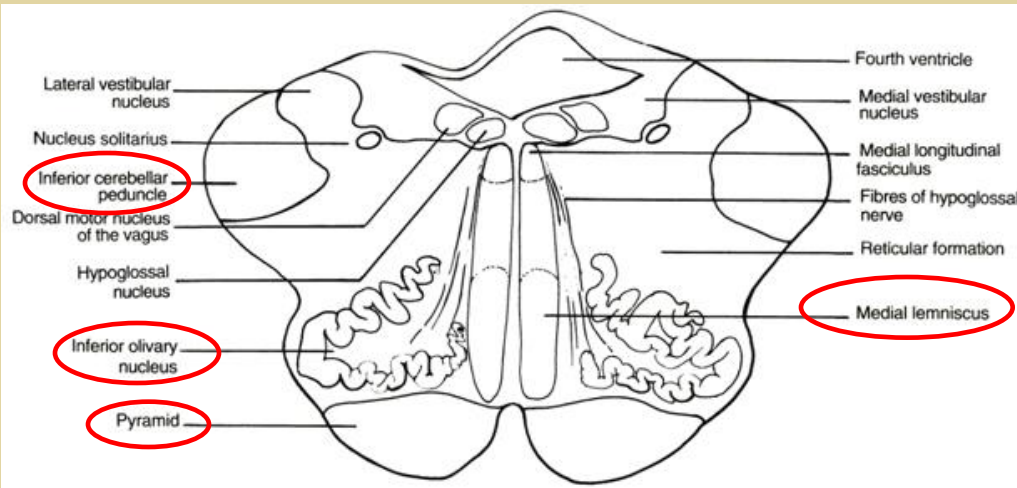


# SENSORY DECUSSATION



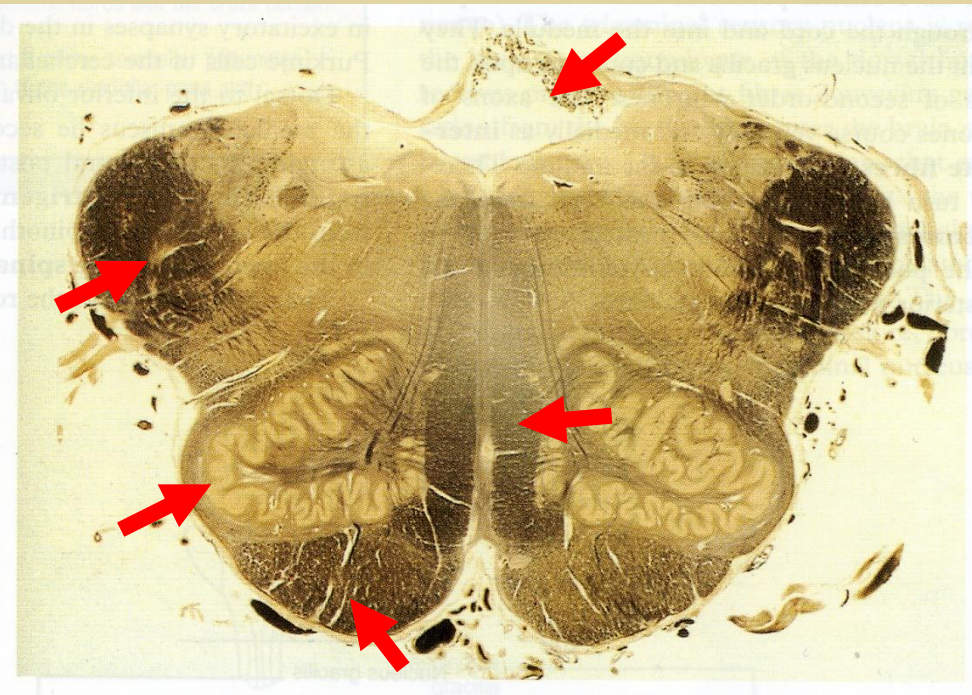
- Formed by the *crossed internal arcuate fibers*
- *Medial Lemniscus:*
  - Composed of the *ascending internal arcuate fibers* after their crossing.
  - Lies adjacent to the *middle line ventral to the central canal*
  - *Terminates in thalamus.*

# ROSTRAL (open) MEDULLA



## On the ventral aspect

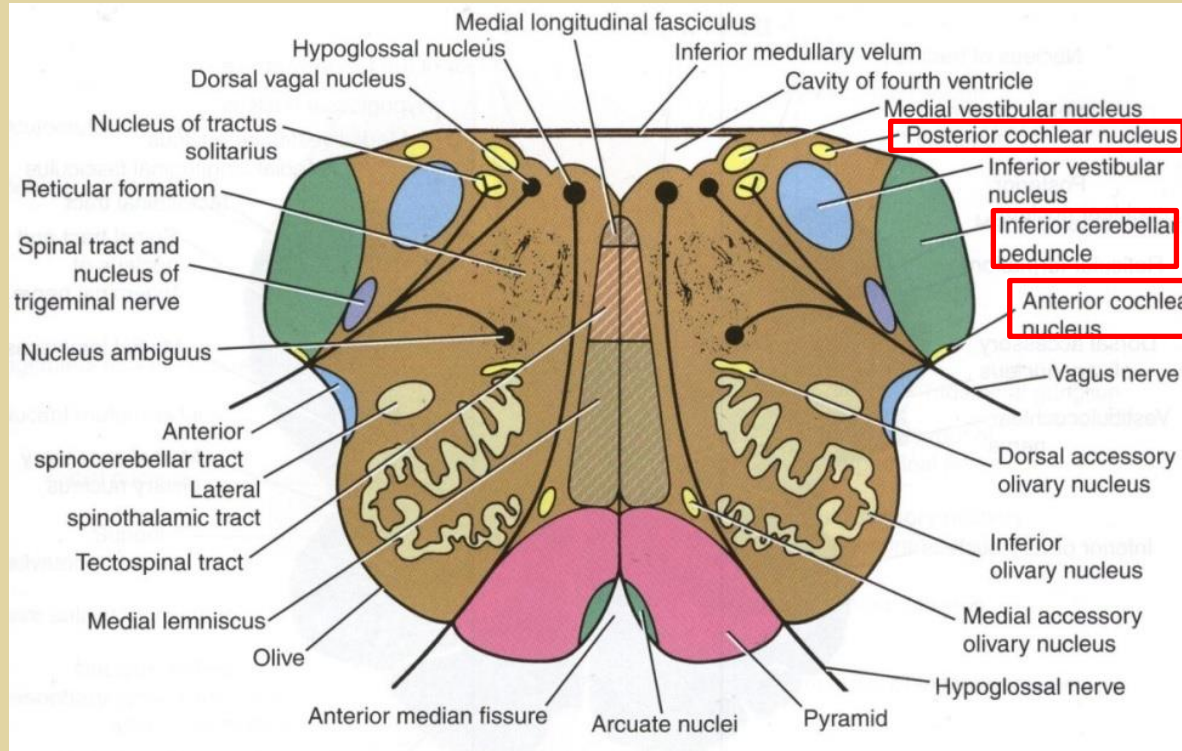
- The pyramid is clear, with medial lemniscus on either sides of middle line dorsal to the pyramid
- Inferior Olivary Nucleus
  - A convoluted mass of gray matter lies posterolateral to the pyramids & lateral to the medial lemniscus.
  - It is concerned with the control of movement.





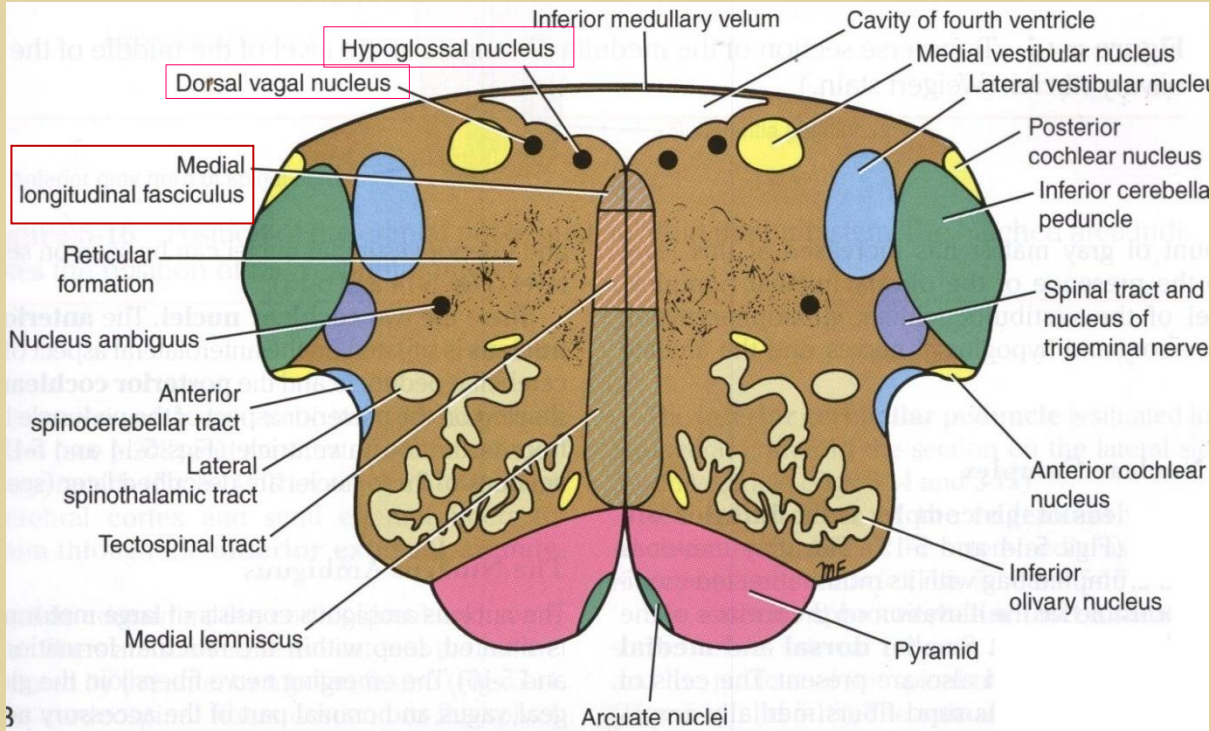
# ROSTRAL (open) MEDULLA

## On the dorsal aspect



- Lower part of the floor of the 4<sup>th</sup> 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).

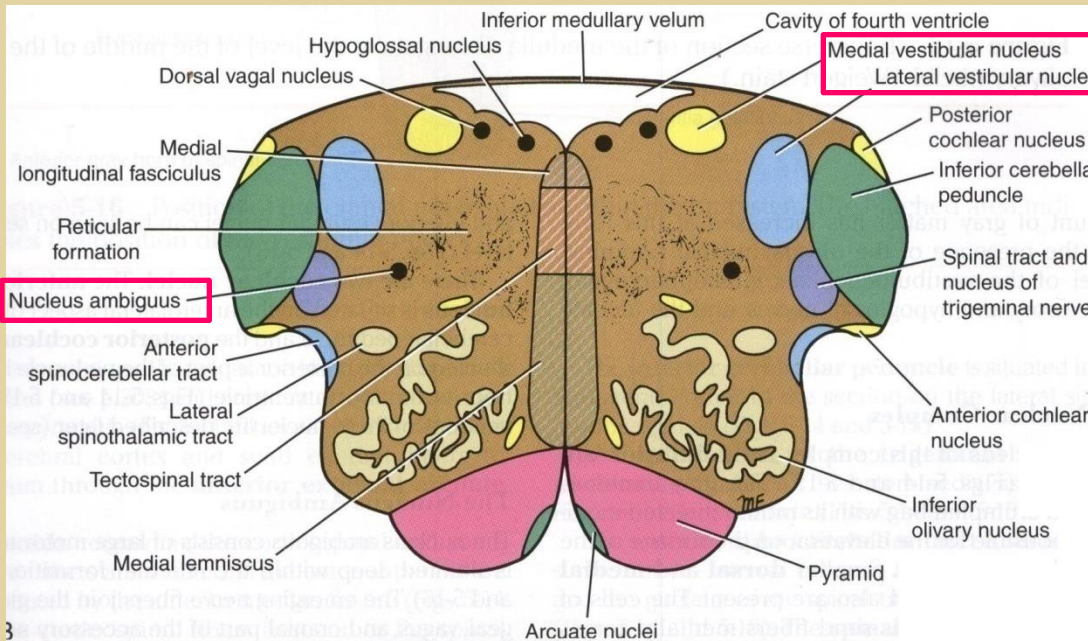
# ROSTRAL (open) MEDULLA



▣ **Beneath the floor of 4<sup>th</sup> ventricle lie:**

- **1. Hypoglossal Nucleus.**
- **2. Dorsal Nucleus of Vagus** lateral to the hypoglossal nucleus, contains preganglionic parasympathetic fibers.
- **3. Medial longitudinal fasciculus** lies close to the midline, ventromedial to the hypoglossal nucleus, dorsal to the medial lemniscus. It links the vestibular nuclei with nuclei of extraocular ms. (3, 4 & 6 nerves) to help coordination of head & eye movements

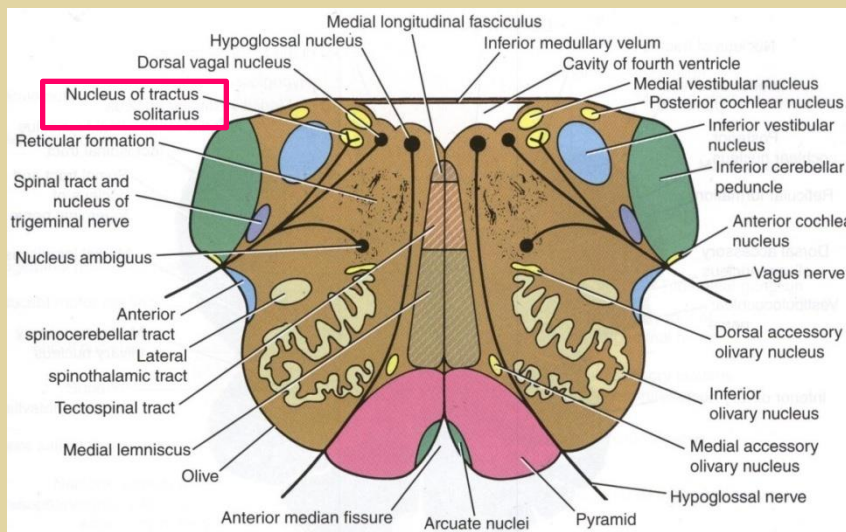
# ROSTRAL (open) MEDULLA



**Vestibular nuclei complex**  
**Concerned with equilibrium**

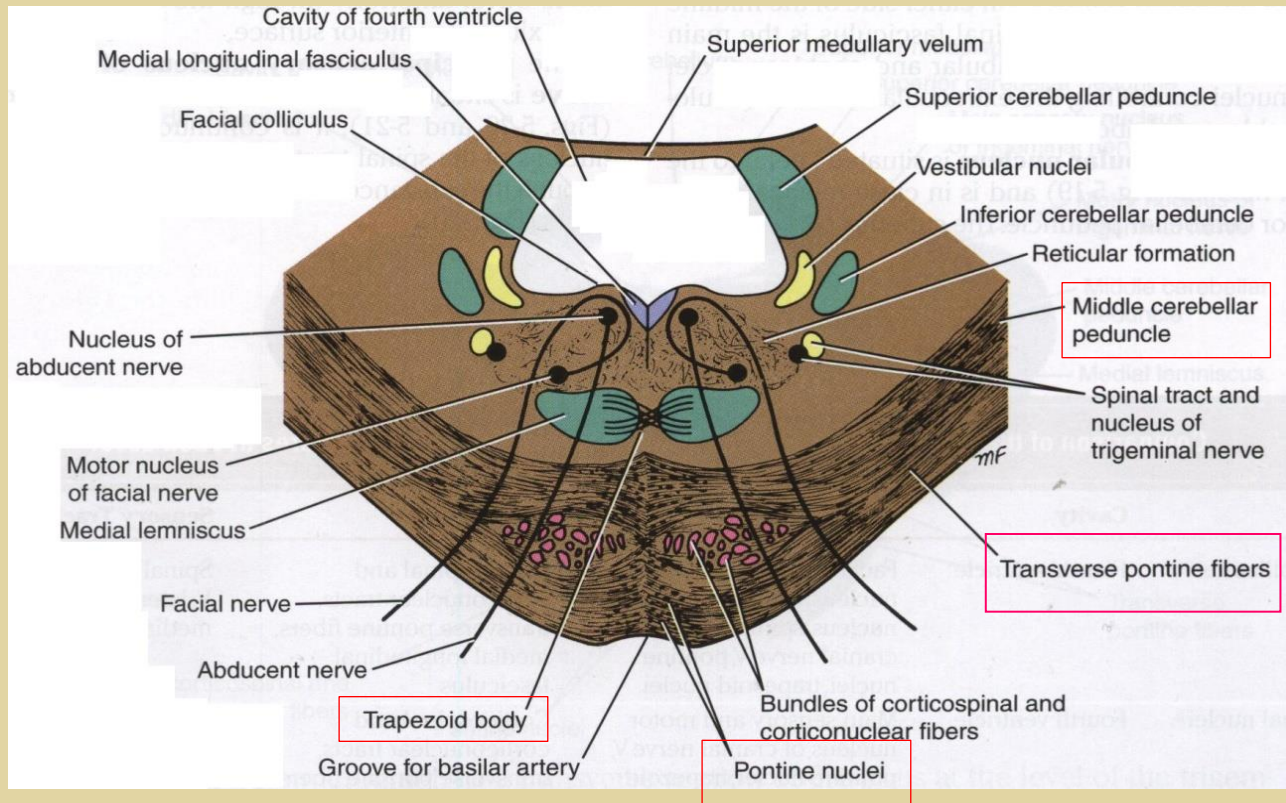
**Nucleus Ambiguus**  
 lies dorsal to olivary nucleus  
 gives motor fibers to  
 constrictors of the pharynx &  
 intrinsic muscles of the larynx

**Solitary nucleus**  
 lies ventrolateral to dorsal  
nucleus of vagus, receive  
taste sensation from the  
 tongue along the facial (VII),  
glossopharyngeal (IX) and  
vagus (X) nerves

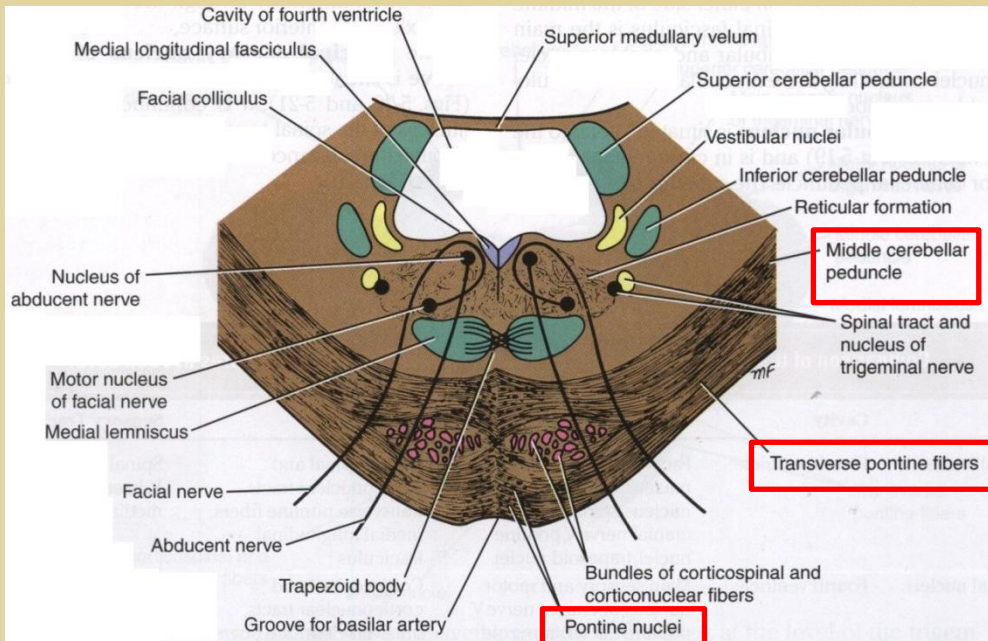


# CAUDAL PART OF THE PONS

- 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**.



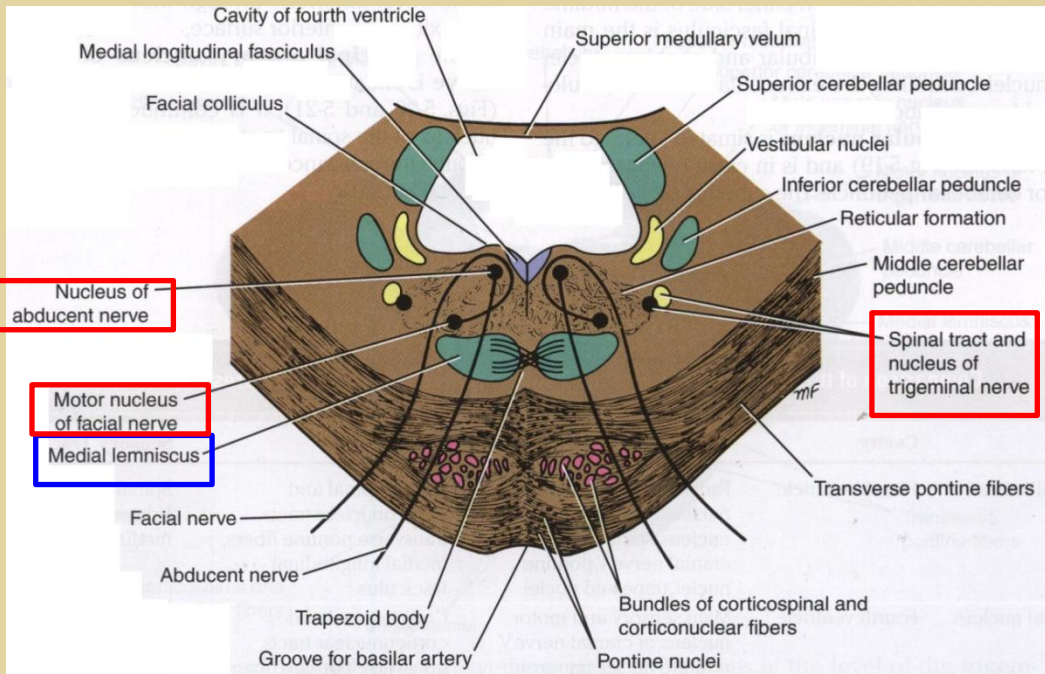
# CAUDAL PART OF THE PONS



## *Pontine Nuclei*

- Are small masses of nerve cells, receive **cortico pontine fibers** (*involved in motor activity*)
- Their axons form the **transverse pontocerebellar fibers** which pass to the contra lateral side of the cerebellum through **middle cerebellar peduncles**

# CAUDAL PONS



- The ascending fibres of the **medial lemniscus** become separated from the pyramid and displaced dorsally.

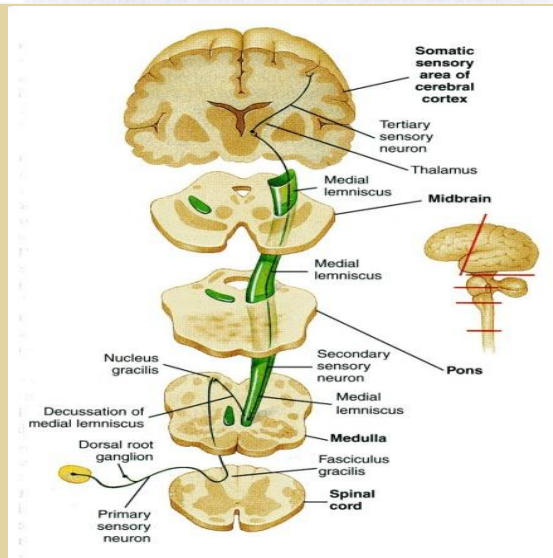
- *The **Medial Lemniscus** rotates 90 degrees and lies almost horizontally*

- It contains **spinal nucleus & tract of Trigeminal**.

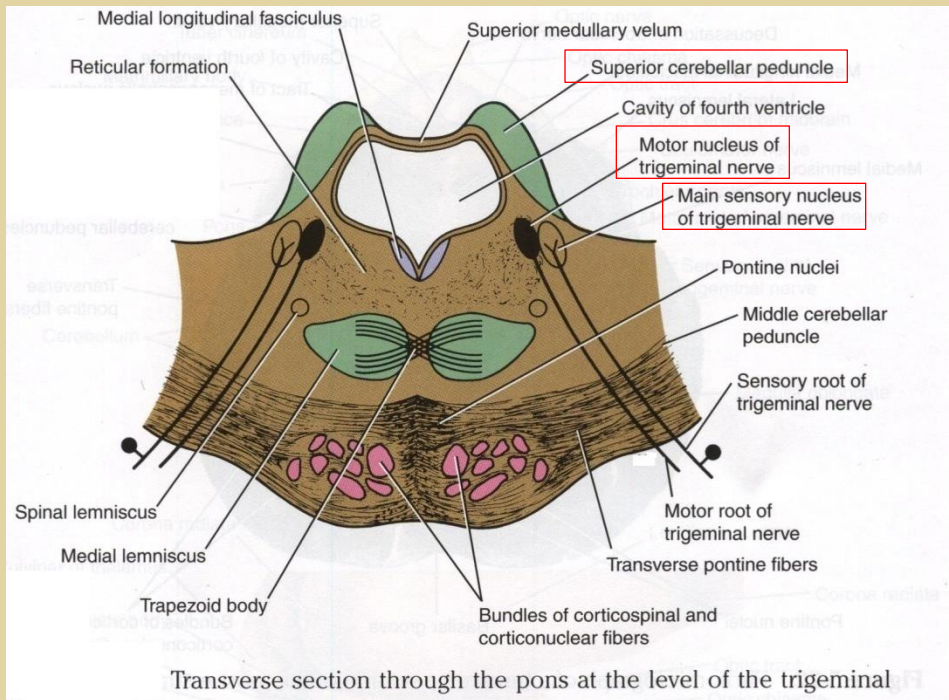
- *Deep origin of cranial nerve nuclei:*

- *Abducent nucleus*

- *Facial motor nucleus*

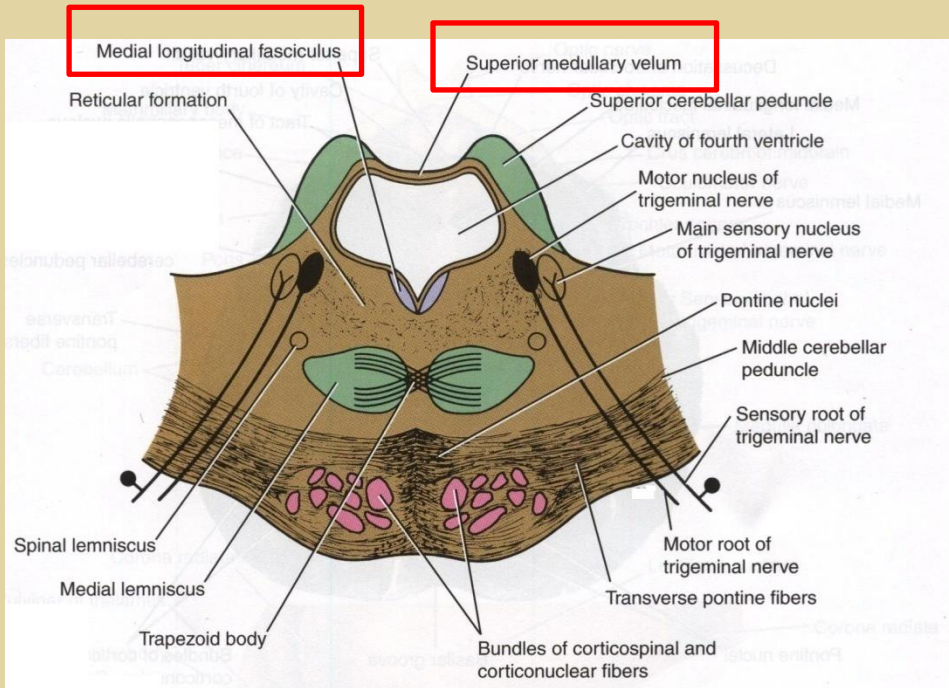


# AT THE LEVEL OF THE TRIGEMINAL NERVE



- **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:** Reaches its maximum extent in the pons and it lies lateral to the motor nucleus.
- **Superior cerebellar peduncles** form the lateral boundary of the 4<sup>th</sup> ventricle

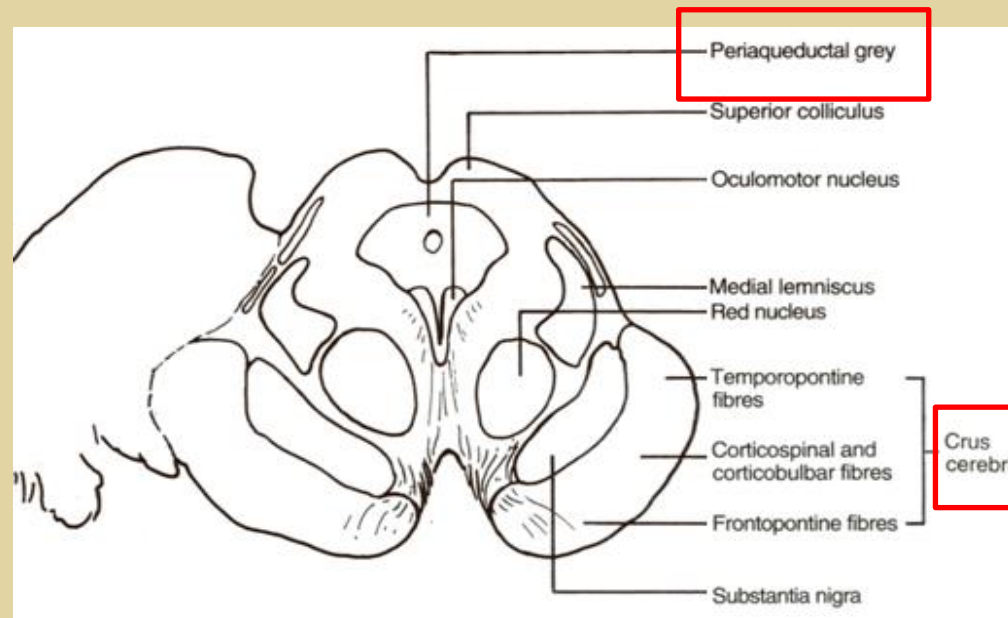
# ROSTRAL PONS



- ***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.*
  - It carries information about the direction that the eyes should move
  - It connects the cranial nerve nuclei Oculomotor nerve, Trochlear nerve and Abducent nerve together



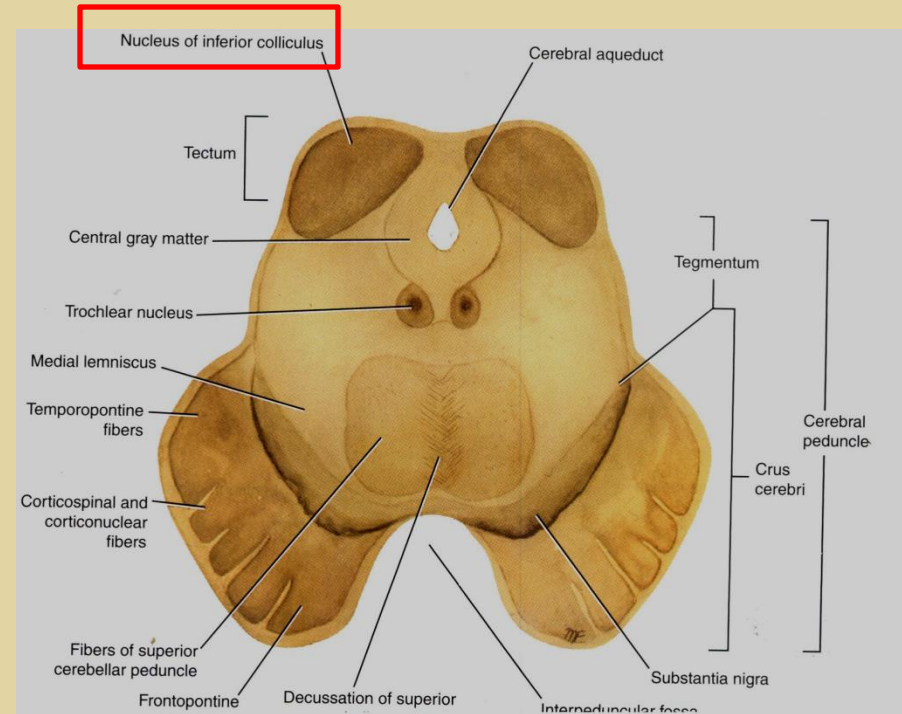
# MIDBRAIN



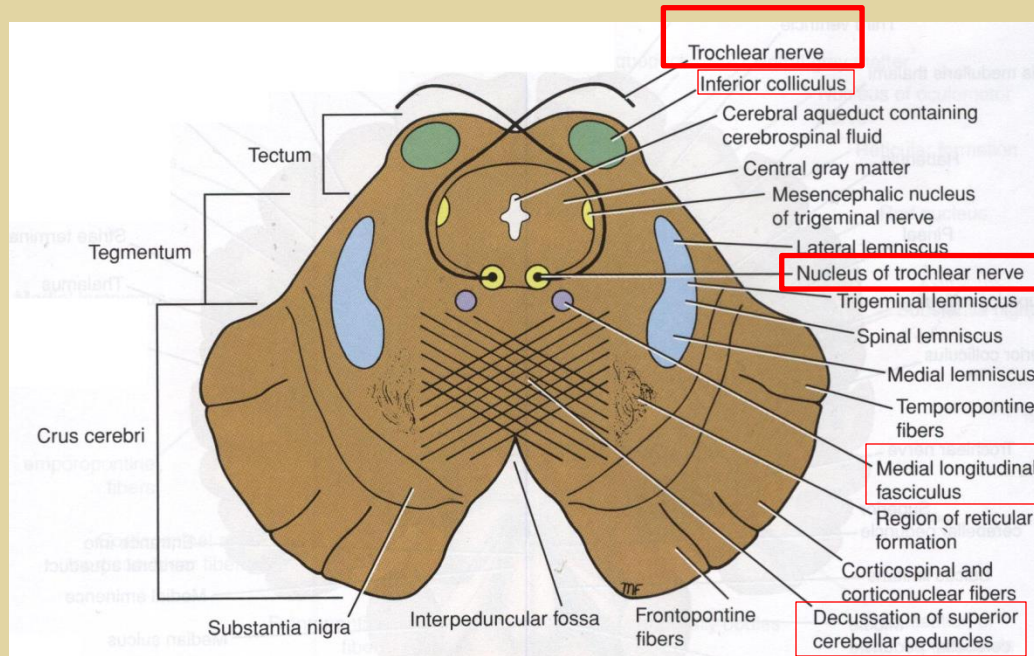
- It is divided into a dorsal part (**Tectum**) and a ventral part (**Tegmentum**) at the level of the cerebral aqueduct
- The **cerebral aqueduct** is surrounded by a pear shaped **periaqueductal** (central) **gray matter**.
- The most ventral part of the tegmentum is the massive fibrous mass (**Crus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

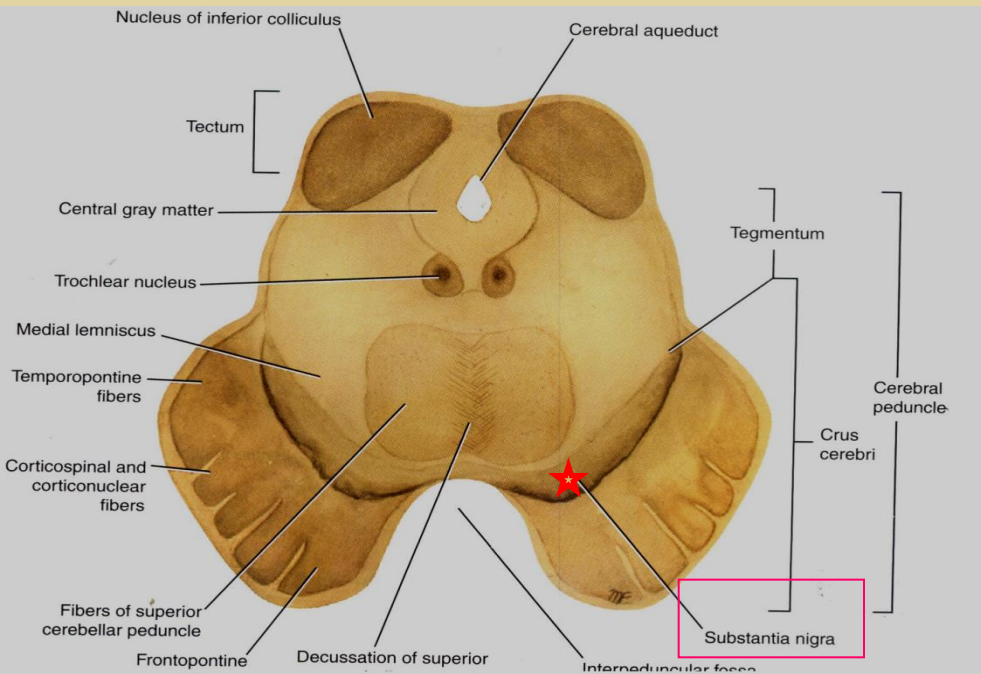


## 1. Trochlear nucleus

- 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.

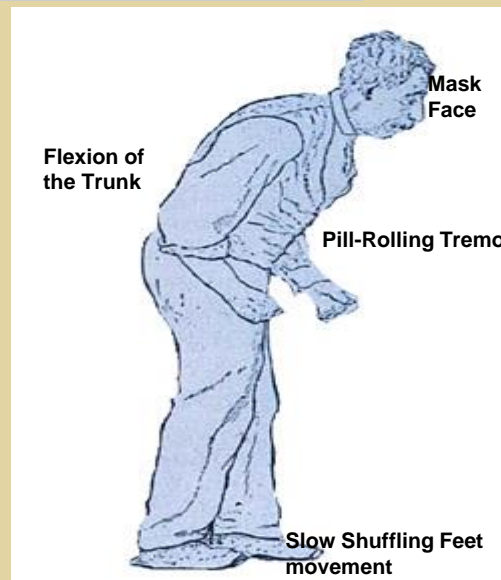
## 2. Decussation of the superior cerebellar peduncles in the mid line.

# INFERIOR COLLICULUS LEVEL

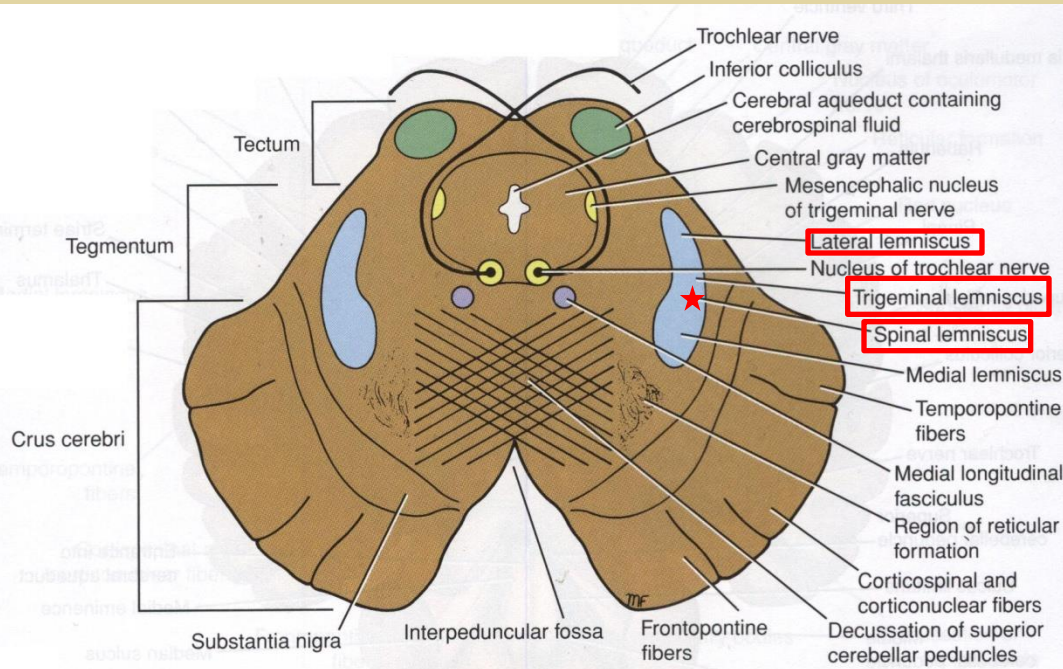


## 3. Substantia nigra:

- ❑ 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**



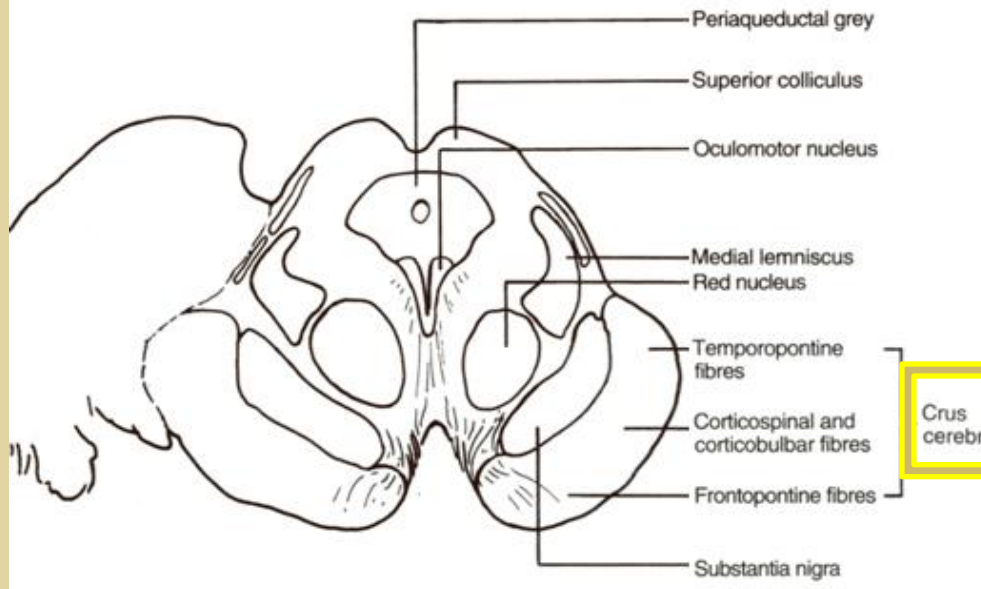
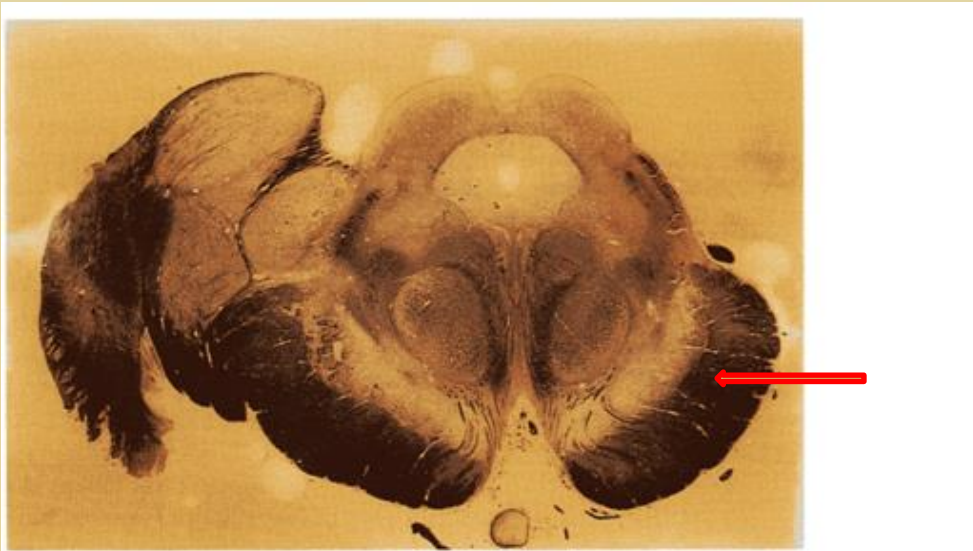
# ASCENDING LEMNISCI



## Composed of

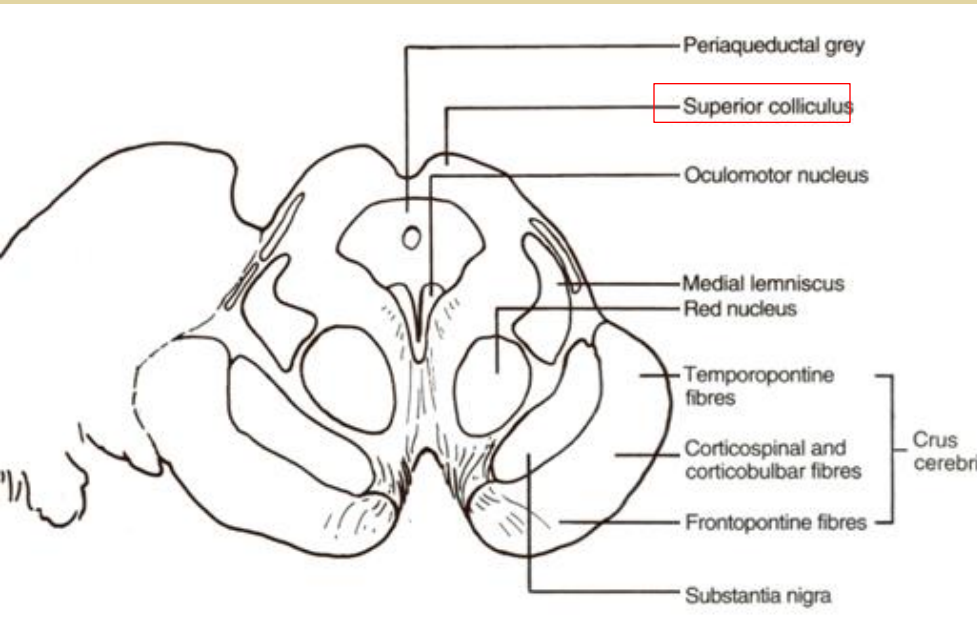
- **Spinal** (Lateral & anterior spinothalamic tracts)
- **Trigeminal** (Lateral & medial).
- **Lateral lemniscus.**
- **Medial lemniscus.**

# CRUS CEREBRI



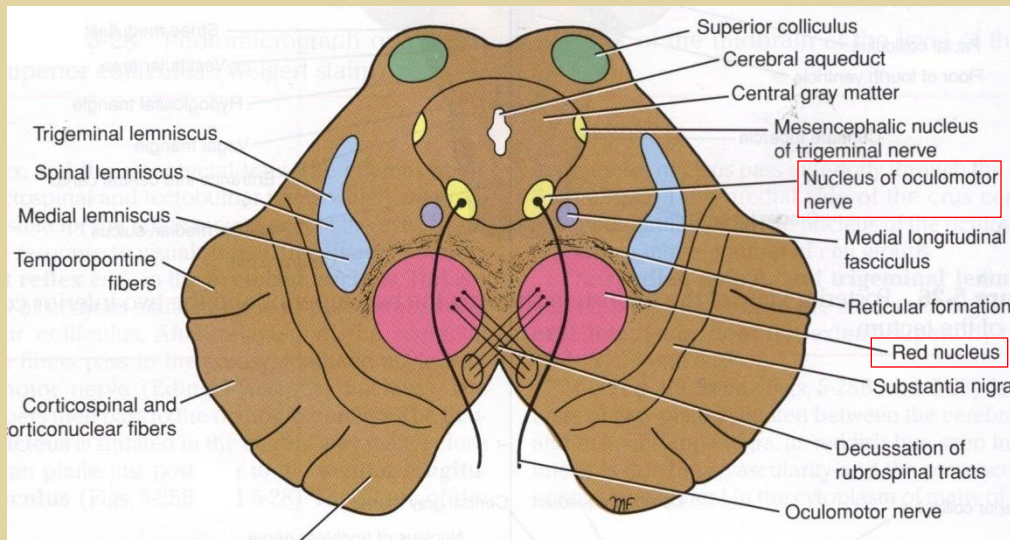
- It is a massive mass ventral to the substantia nigra.
- It consists entirely of **descending cortical efferent fibers** (Frontopontine, Corticospinal & corticobulbar and **Temporopontine Fibres**) to the motor cranial nerve nuclei and to anterior horn cells.
- Involved in the **coordination of movement**.

# 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

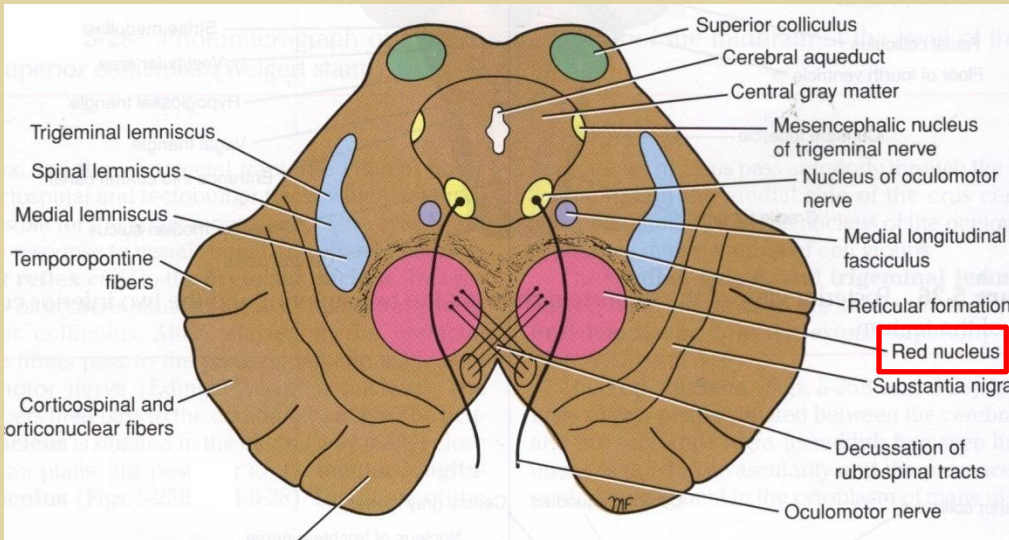


## 1. Oculomotor nucleus

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



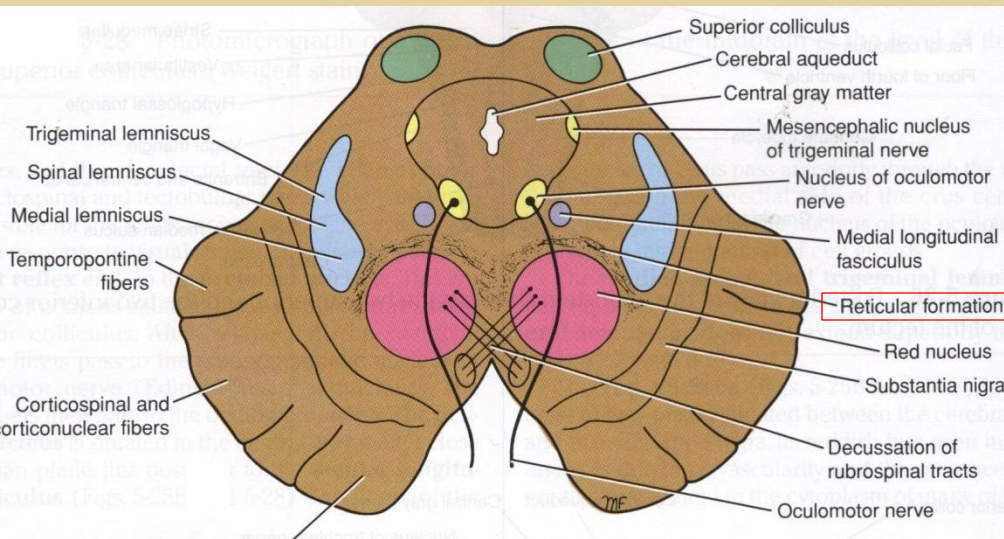
# SUPERIOR COLLICULUS LEVEL



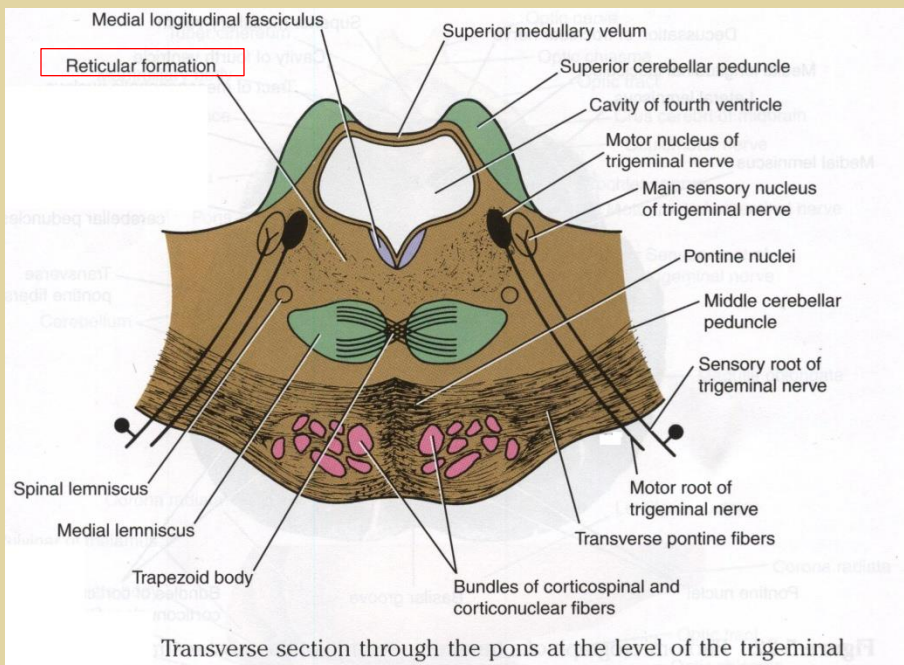
## 2. Red nucleus:

- ▣ **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**

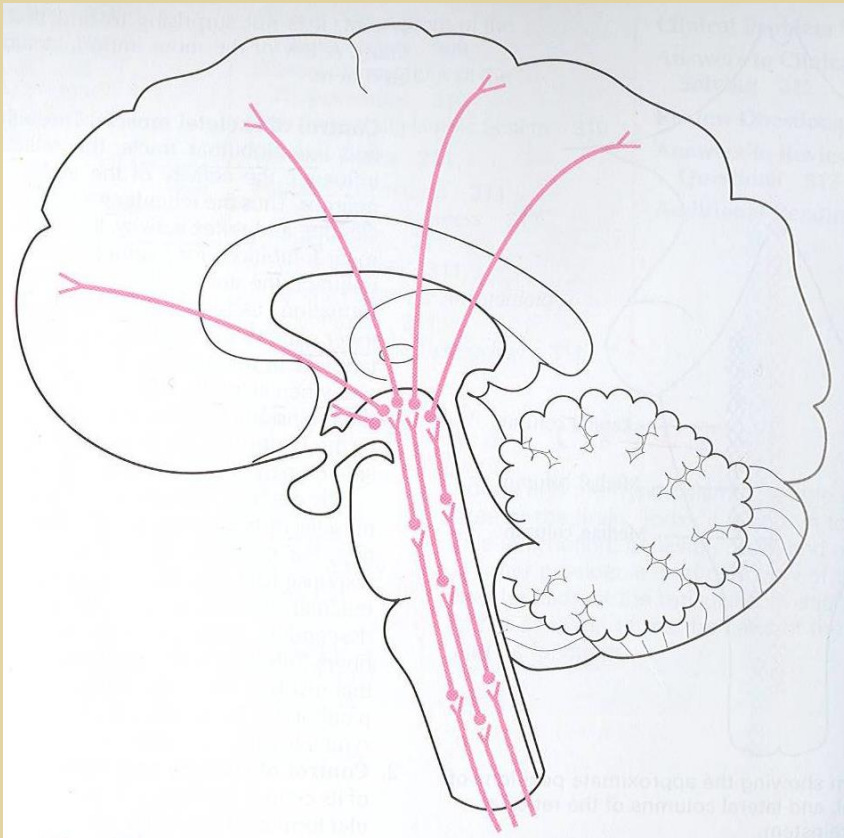
# RETICULAR FORMATION



- ▣ It is a complex matrix of **nerve fibers** & 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.



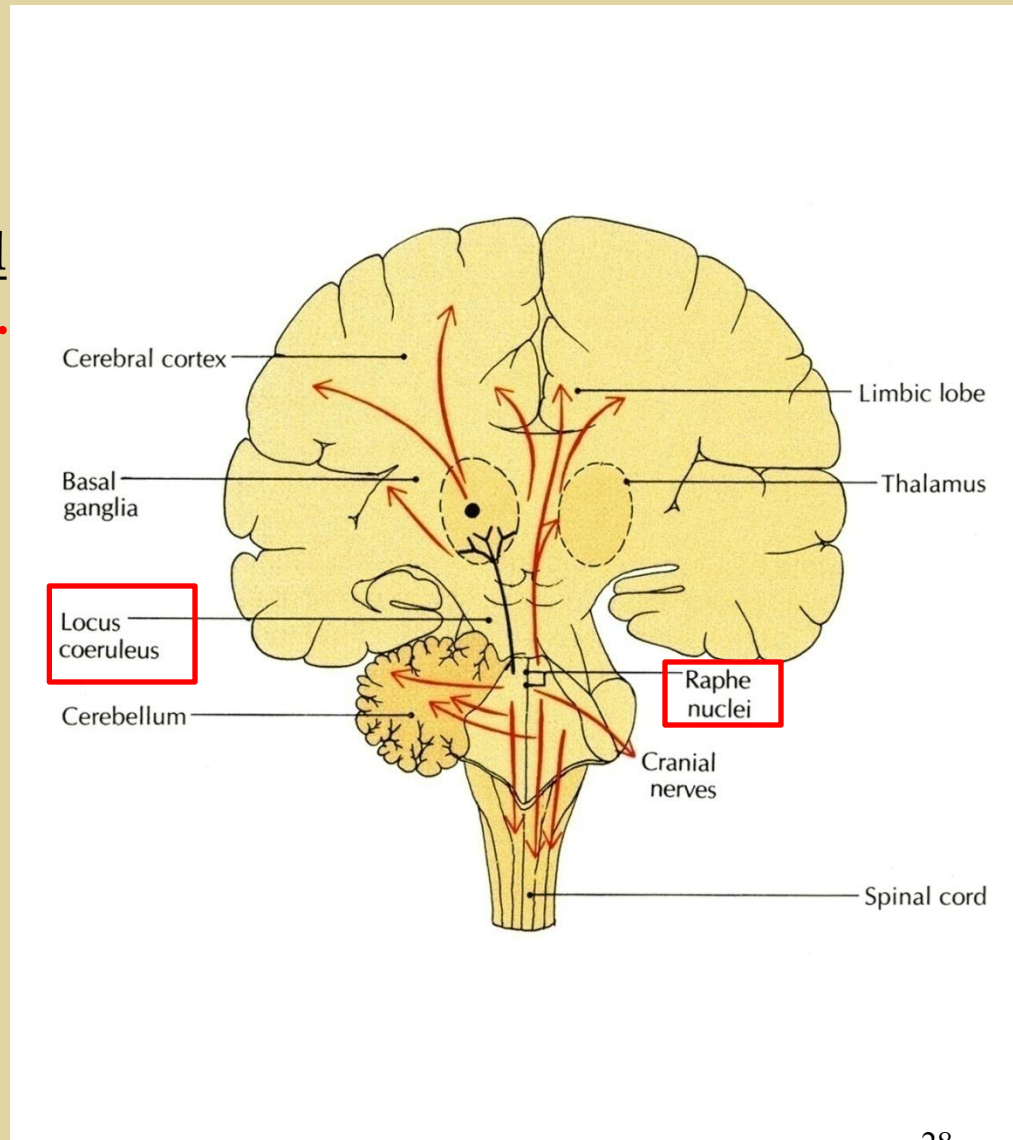
# RETICULAR TRACTS



- ▣ **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
  - 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 mid brain & rostral pons
  - It is the **main noradrenergic cell group** of the brain.



THANK YOU

**1. Most axons of cochlear nuclei cross the midline of pons forming:**

- a. The medial lemniscus.
- b. The red nucleus.
- c. The 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 one of these nuclei is lying in the tegmentum of the midbrain?**

- a. Oculomotor nucleus .
- b. Trochlear nucleus.
- c. Red nucleus.**
- e. Facial nucleus.

**4. Parkinson's disease results from degeneration of:**

- a. Red nucleus.
- b. Pyramid.
- c. Substantia nigra.**
- d. Inferior olivary nucleus.