

# 7 Brain stem

CNS



## Sources

- Male slides
- Female slides

## (تنبيه)

- سيتم إيضاح مصادر السلايدات في بداية كل محاضرة
- لن تكون هناك أسئلة نهاية كل محاضرة بل سيتم وضع أسئلة للمراجعة شاملة قبل كل اختبار بإذن الله
- ينصح بمتابعة محاضرات الدكتور نجيب لهذا البلوك

<http://www.ksums.net/files/2nd/Archive/01%20CNS%20BLOCK/Female/Physiology/Dr.%20Najeb%20lectures/>

# Objectives

1. Components of Brain stem
2. Important structures in brain stem
3. Functions of the Brain Stem
4. Signs & Symptoms of brain stem lesion
5. Brain stem function tests

## New Terms

**UMN** = Upper Motor Neuron

**LMN** = Lower Motor Neuron

## Sources

-Male slides

-Female slides

# Brain stem

The Lower part of the brain and is continuous with the **spinal cord**

## Components of brain stem

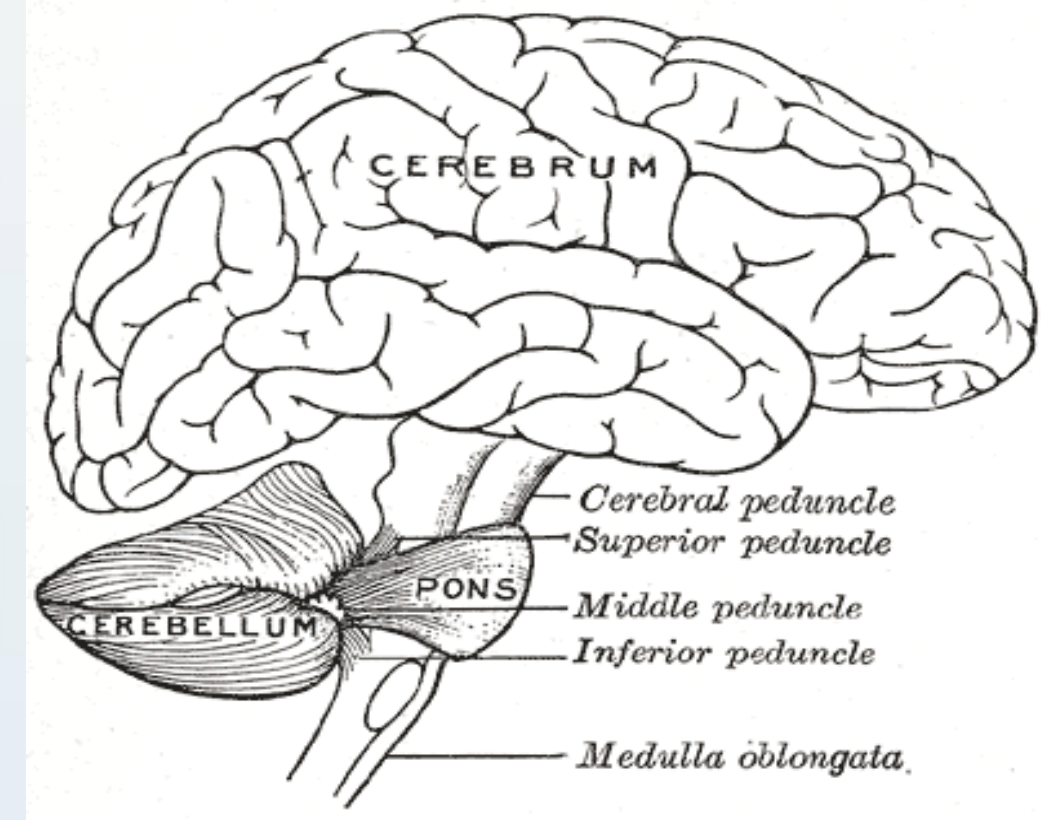
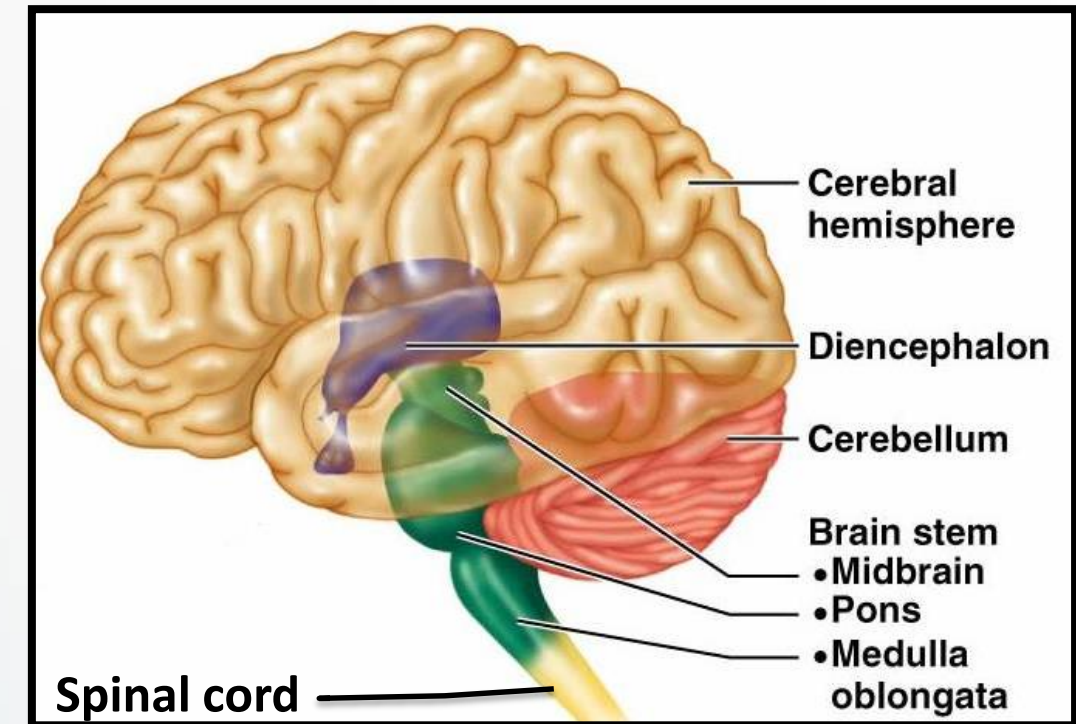
Midbrain

Pons

Medulla

\* These three parts are connected to the Cerebellum by Superior, Middle and Inferior **Peduncles** respectively

\* **Peduncle**: is a collections of white matter fibers



# Midbrain

## Tectum

includes:

1-superior colliculus:  
Concerned with vision  
and sends superior  
brachium to the lateral  
geniculate body of  
Thalamus

2- Inferior colliculus:  
Concerned with hearing  
and sends inferior  
brachium to the medial  
side of the thalamus

## Tegmentum

Ventral to the  
aqueduct

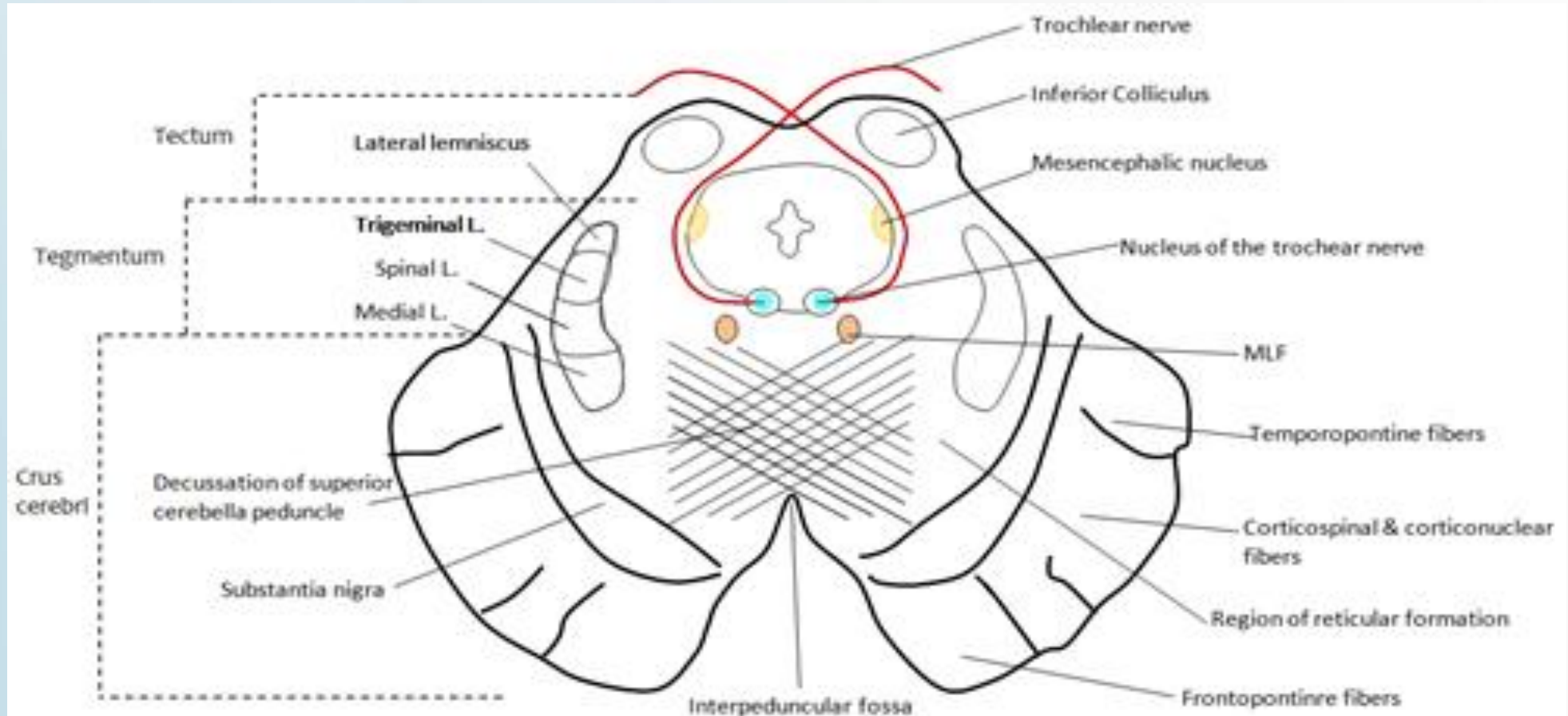
Contains:  
Several nuclei, tracts  
and reticular formation

## Cerebral peduncles

The ventral side is  
comprised of paired  
cerebral peduncles

These peduncles  
transmit axons of UMN

\*The cerebral aqueduct runs  
through the midbrain beneath the  
colloculi



# Midbrain internal structures

## Periaqueductal grey

- Around the cerebral aqueduct, contain neurons involved in **pain desensitization** (analgesia) pathway.

## Oculomotor nerve

- Nucleus of the 3<sup>rd</sup>(III) cranial nerve.

## Trochlear nerve

- Nucleus of the 4<sup>th</sup> (IV) cranial nerve.

## Red nucleus

- A motor nucleus that sends a **descending tract** to the LMN.

## Substantia nigra

- A concentration of neurons in the ventral portion of the midbrain, involved in motor function. (Degeneration of Substantia Nigra is associated with Parkinson's disease).

## Central tegmental tract

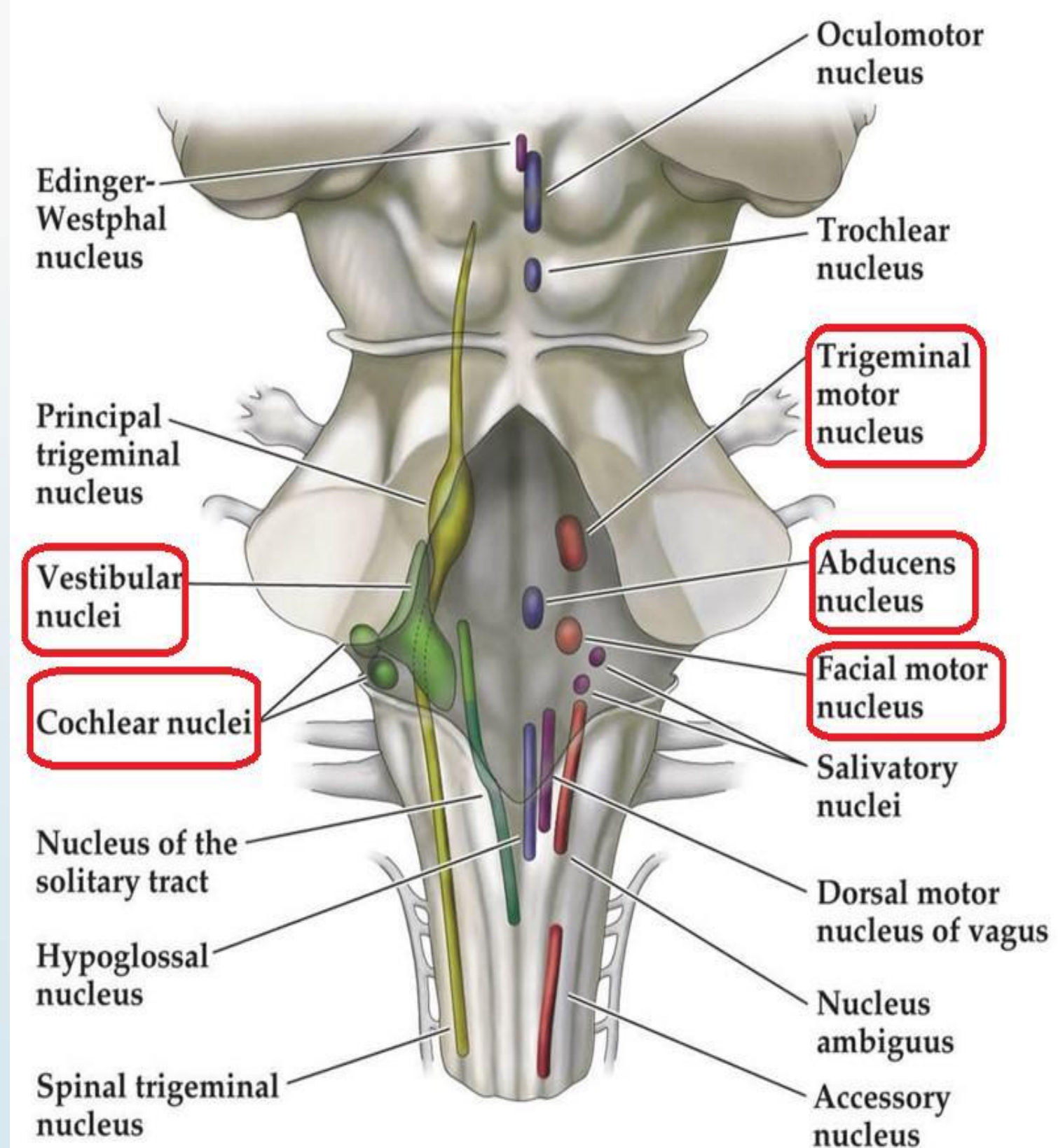
- Anterior to the floor of the fourth ventricle.
- A pathway for many tracts projecting up to the cortex and down to the spinal cord.

## Reticular formation

- A large area that is involved in various important functions of the midbrain.
- Contains LMN and locus ceruleus which is involved in intensive alertness modulation and in autonomic reflexes.
- Involved in the pain desensitization Pathway, arousal and consciousness systems.

# Pons

- At the level of the midpons, the large trigeminal nerve (CN V) emerges.
- cranial nerve 6 (abducens), 7 (facial) & 8 (vestibulo-cochlear), emerge between the basal pons



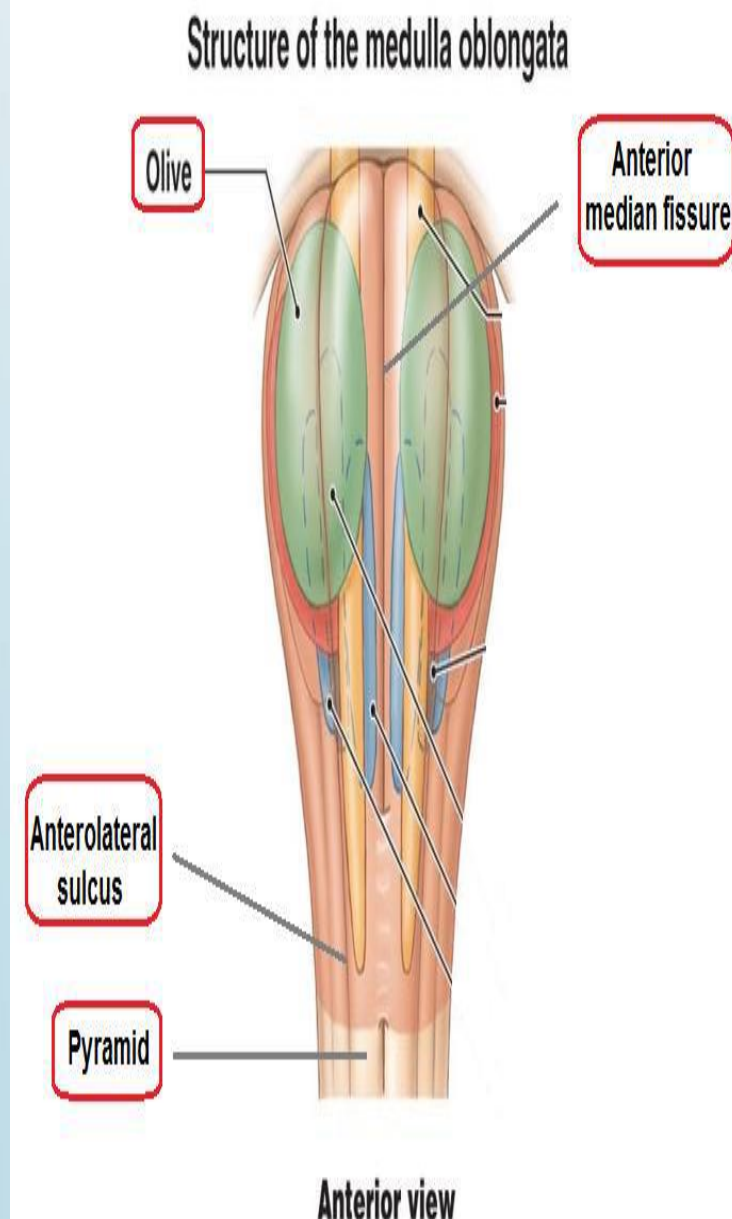
# Medulla

## Ventral view

- The most medial part is the anterior median fissure
- Lateral to it on each side, lies the pyramids<sup>1</sup>
- Lateral to the pyramids you can find the Anterolateral sulci where the roots of the 12<sup>th</sup> cranial nerve emerges.
- Lateral to the sulci are the olives<sup>2</sup>
- Lateral and dorsal to the olives are the rootlets of 9<sup>th</sup> and 10<sup>th</sup> cranial nerves.

(1) Pyramids contains fibers that carry voluntary motor message from cerebrum to spinal cord and these fibers are called : corticospinal tracts

(2) Olives are swelling in the medulla containing various olivary nuclei and afferent fibers (the olivary nucleus is closely associated with the cerebellum , meaning that it is involved in control and coordination of movements)

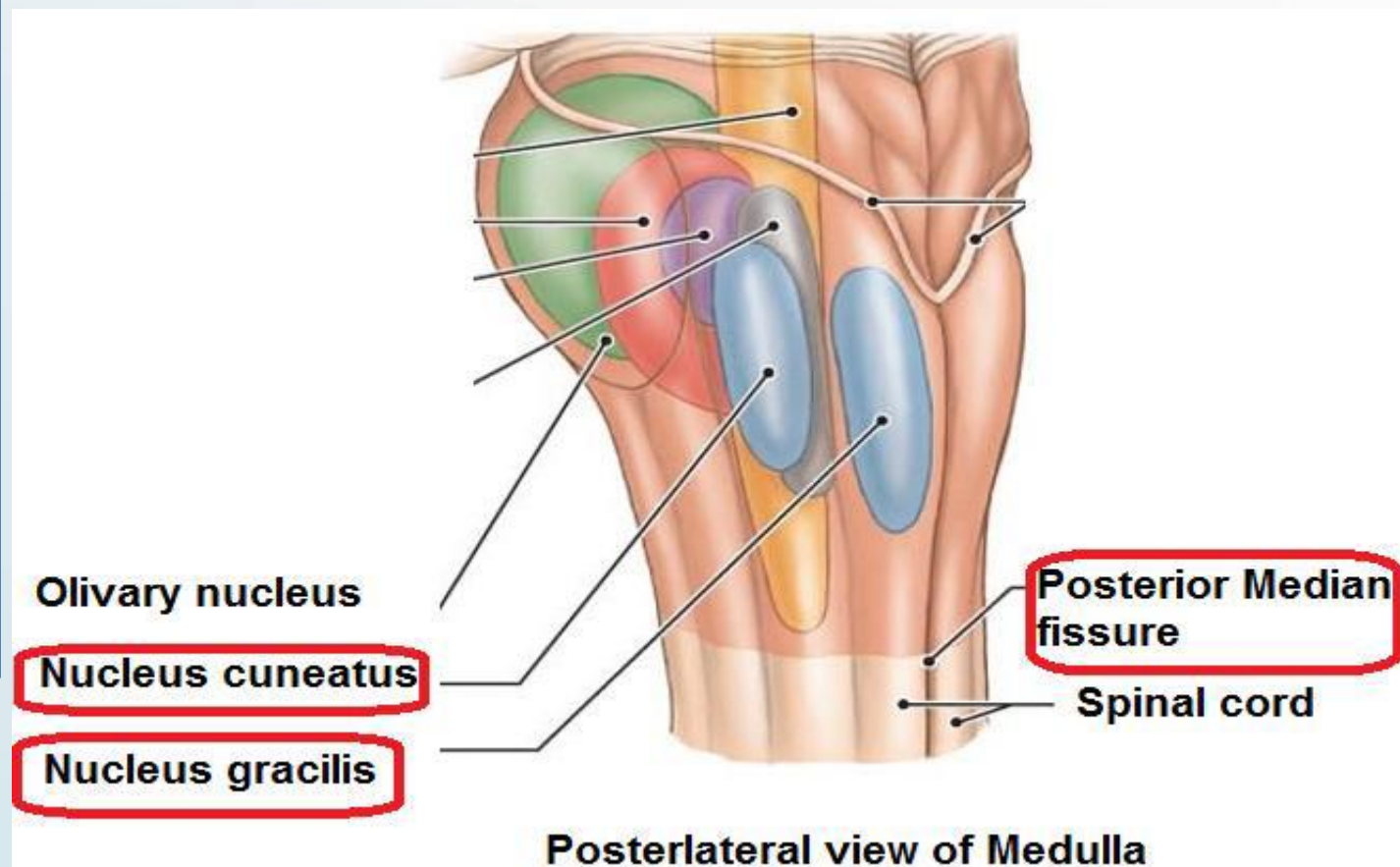


## Dorsal view

- The most medial part is the posterior median fissure
- Lateral to it on each side, lies the fasciculus gracilis
- Lateral to fasciculus gracilis is fasciculus cuneatus

Superior to each of these are the gracile and cuneate tubercles respectively. Underlying them are their respective nuclei.

In the midline is the vagal trigone and superior to that is the hypoglossal trigone. Underlying each of these are motor nuclei for the respective cranial nerves.





# Function of brain stem

## 1-Conduction function

All information between body, cereberum and cerebellum must cross brain stem.

### Ascending sensory pathway:

**A:** The spinothalamic tract for Pain and temperature.

**B:** dorsal column , fasiculus gracilis and cuneatus for touch and propioceptive and pressure sensation.

### Descending tract:

**A:** The corticospinal tract (UMN): runs through the crus cerebri and 70-90 % of fibers cross in the pyramidal decussation to form the lateral corticospinal tract, which synapse on LMN in the ventral horn of the spinal cord.

**B:** Upper motor neurons that originate in the brain stem's vestibular, red, and reticular nuclei, which also descend and synapse in the spinal cord.

## 2-Integrative functions

- It controls consciousness & sleep cycle (alertness and arousal) through reticular formation.
- It has got center for cardiovascular, respiratory & autonomic nervous system.
- It has centers for cough, gag, swallow, and vomit.
- Sense of body balance (Vestibular functions) Substantia which is a part of the basal ganglia is present in midbrain and is involved in control of movement.
- Midbrain also contain red nucleus which regulate the motor activity through cerebellum.
- Inferior and superior colliculi are situated on the dorsal surface of the midbrain and is involved in auditory & visual processing required for head movements.
- Pain sensitivity control: Periaqueductal grey matter of mesencephalon is an area which is rich in endogenous opioid and is important in modulation of painful stimuli.

### 3-Conjugate eye movement

It refers to motor coordination of the eyes that allows for bilateral fixation on a single object.

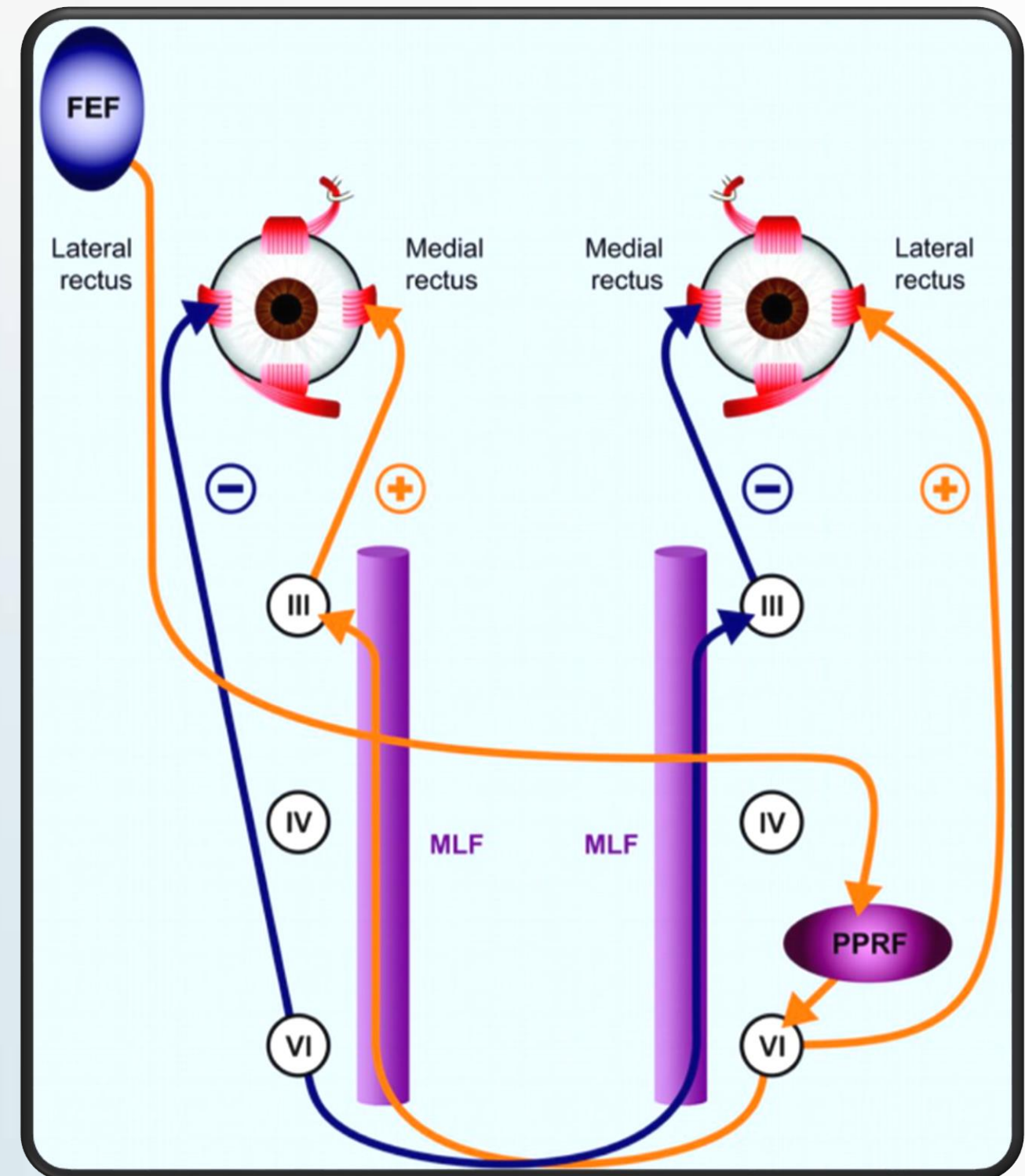
**The** frontal eye field (FEF) projects to the opposite side at the midbrain-pontine junction, and then innervates the paramedian pontine reticular formation (PPRF).

**From there**, projections directly innervate the lateral rectus (contralateral to FEF) and the medial rectus muscle (ipsilateral to FEF).

**The left FEF** command to trigger a saccade culminates in conjugate eye movements to the right.

### 4- Innervation of face and neck

- The brain stem provides the main motor and sensory innervation to the face and neck via the cranial nerves (CN III-XII) .
- The fibers of cranial nerve nuclei except for olfactory & optic nerve either originate from, or terminate in, the cranial nerve nuclei in brain stem.



# Origin and function of cranial nerves

Origin	Cranial nerve	Function
Midbrain	CN III oculomotor	Both Move eyes CN III constricts the pupils and accomodates
	CN IV Trochlear	
PONS	CN V trigeminal	Chews and feels front of the head
	CN VI Abducens	Moves eyes
	CN VII facial	Moves face, Tastes, salivates, cries
	CN VIII Acoustic (vestibulocochlear)	Hears and regulates balance
Medulla	CN IX Glossopharyngeal	Tastes, salivates, swallows, monitors carotid body and sinus.
	CN X Vagus	Tastes, swallows, lifts palate, talks, communication to and from thoraco-abdominal viscera.
	CN XI Accessory	Turns the head and lifts the shoulder
	CN XII Hypoglossal	Moves Tongue

## Sensory nerves

- CN I (1<sup>ST</sup>)
- CN II (2<sup>nd</sup>)
- CN VIII (8<sup>th</sup>)

## Motor nerves

- CN III (3<sup>rd</sup>)
- CN IV (4<sup>th</sup>)
- CN VI (6<sup>th</sup>)
- CN XI (11<sup>th</sup>)
- CN XII (12<sup>th</sup>)

## Mixed nerves

- CN V (5<sup>th</sup>)
- CN VII (7<sup>th</sup>)
- CN IX (9<sup>th</sup> I)
- CN X (10<sup>th</sup>)

# Functional Organization of the brain stem

- Ventral layer of brainstem is motor in function.
- Middle layer is sensory in function & contains medial lemniscus which conveys sensory information from dorsal column.

## Function of midbrain

- Nerve pathway to cerebral hemispheres.
- Auditory and Visual reflex centers.

### **Symptoms and signs of midbrain lesion:**

- CN Deficits: Ipsilateral CN III, CN IV palsy and ptosis (drooping).
- Pupils:  
Size: Midposition to dilated.  
Reactivity: Sluggish to fixed.
- Movement: Abnormal extensor.
- Respiratory: Hyperventilating.
- Loss of consciousness (LOC): Varies

## Function of pons

- Respiratory center

## Function of Medulla

- Crossing of motor tracts.
- Cardiac Center.
- Respiratory Center.
- Vasomotor Center (nerves having muscular control of the blood vessel walls)
- Centers for cough, gag, swallow, and vomit.

## Symptoms and signs of pons lesion:

- Pupils size: Pinpoint
- LOC: Semi-coma (a partial coma, which person roused by a stimulus).
- Movement: Abnormal extensor.
- Respiratory:
  - Apneustic (Abnormal respiration marked by sustained inhalation).
  - Hyperventilation.
- CN Deficits: CN V, CN VI, CN VII, CN VIII.

## Symptoms and signs of medulla lesion:

- Movement: Ipsilateral paralysis.
- Pupils:
  - Size: Dilated.
  - Reactivity: Fixed.
- Respiratory: Abnormal breathing patterns
- CN Palsies: Inability to control movement. Absent cough, gag.
- LOC: Comatose.

# Brain stem function test

## To test brainstem reflexes:

- Pupillary and corneal reflexes.
- Vestibulo-ocular reflex: Injection of iced water into the ear will produce eyes movement.
- Oculo-cephalic reflex: Eyes will be fixed when head is moved in one or another directions.
- Gag reflex.
- Cough reflex

## To test reticular formation:

Alertness, Consciousness & Sleep.

## Corticospinal tract:

Motor power, reflexes

## Pain response:

Facial grimacing on firm pressure over the supra orbital ridge.

## To test cardiovascular center

Look for normal circulatory function

## To test respiratory center:

look for the normal pattern of respiration

# Summary

**What is the name of the structure connect brain stem to the cerebellum?**

**Superior, middle and inferior peduncles**

**What is the function of the cerebral peduncles:**

**Transmit axons of UMN**

**What are medullary olives?**

**The are swelling in the medulla containing various olivary nuclei and afferent fibers.**

**What are the functions of brainstem:**

**1-Conduction 2- Integration 3- conjugate eye movement 4-innervates face and neck**

**What are the cranial nerves that neither originate nor terminate in brain stem?**

**1- Olfactory 2- Optic**

**Which cranial nerve constricts the pupils?**

**CN III trochlear**

**What do you expect to see in the movement of someone having Medullary lesion?**

**Ipsilateral paralysis**

**What do you test for in case you suspect reticular formation abnormalities?**

**Alertness, consciousness and sleep**

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