Lecture : 8

Physiology of the Brain Stem

Done By: Rawan Al-Taleb
Reviewed By: Abdulrahman Boggis

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OBJECTIVES

At the end of this lecture, student should be able to describe:

- *Components of Brain stem*
- *Midbrain internal structures*
- *Pons*
- *Ventral view of Medulla*
- *Dorsalal view of Medulla*
- *Functions of the Brain Stem*
- *Brain stem function tests*

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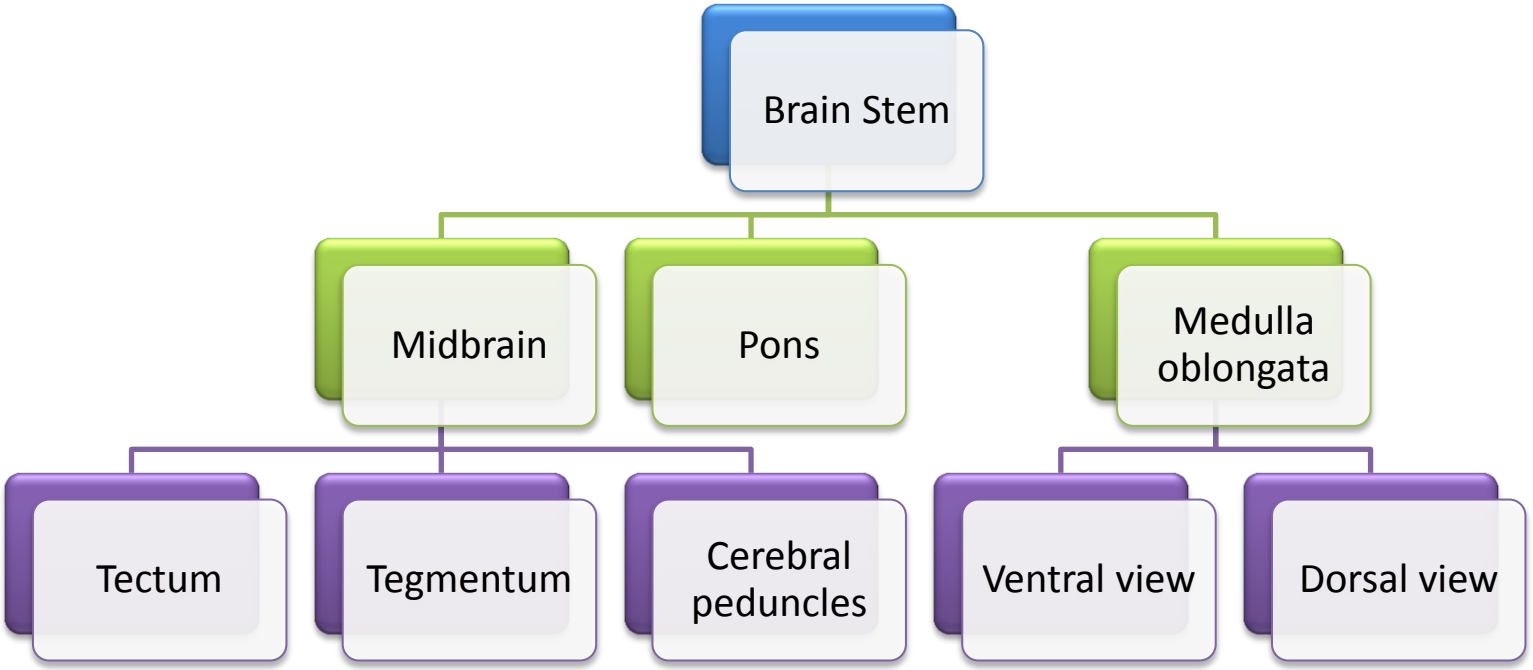
MIND MAP



Function of Brain Stem

- Conduct function
- Provides the main motor & sensory innervation to the face & neck
- Conjugate eye movement
- Integrative function

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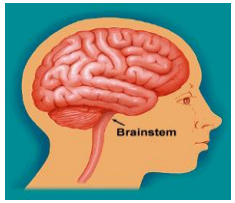
Brain Stem

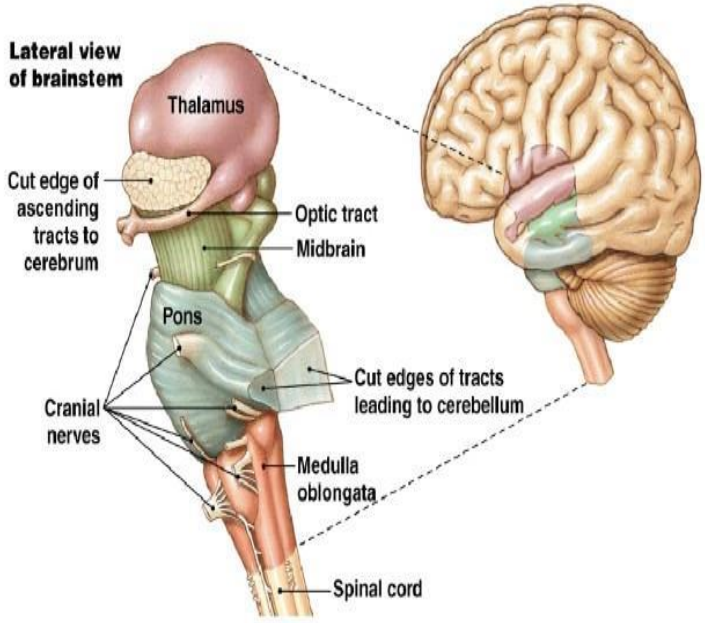
- The brain stem is the lower part of the brain, adjoining and structurally continuous with the spinal cord. **Cerebellum is located in the dorsal surface of brain stem**



Component of brain stem

- Mid Brain
- Pons
- Medulla Oblongata

The superior, middle and inferior peduncles connect the cerebellum to the midbrain, pons and medulla respectively



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Mid Brain

Tectum ("roof" in latin) includes		Tegmentum	Cerebral peduncle
Superior colliculus	**Inferior colliculus**	Ventral to the **cerebral aqueduct**. Several nuclei, tracts and the reticular formation are contained here.	The ventral side is comprised of paired cerebral peduncles These **transmit axons of UMN**.
It is involved in the special sense of vision and sends its superior **brachium** to the lateral geniculate body of the thalamus.	It is involved in the special sense of hearing & sends its inferior brachium to the medial geniculate body of the thalamus. The **cerebral aqueduct** runs through the midbrain, beneath the colloculi.		

Brachium means fibers

The midbrain is the smallest part of brain stem

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Midbrain internal structures

1.Periaqueductal gray	**Around the cerebral aqueduct, contains neurons involved in the pain desensitization pathway (pain modulation by decreasing the pain sensation)**
2.Occulomotor nerve (cn III) nucleus	
3.Trochlear nerve (cn IV) nucleus	
4.Red nucleus	This is a motor nuclues that **sends a descending tract to the lower motor neurons.**
5.substantia nigra:	This is a concentration of neurons in the ventral portion of the midbrain that is involved in **motor function**. **Associated with basal ganglia. Impairment at any one of them result in Parkinson's disease.** **(located in ventral aspect of midbrain)**
6.Central tegmental tract	Directly anterior to the floor of the 4th ventricle, this is a **pathway** by which **many tracts project up to the cortex and down to the spinal cord.**
7.Reticular formation	See the Next slide ☺

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Reticular formation:

(located in the core of midbrain)

A large area that is involved in various important functions of the midbrain pathway:

1. It contains **LMN**
2. It is involved in the **pain desensitization**
3. It is involved in the **arousal and consciousness systems**
4. It contains the **locus ceruleus**, which is involved in intensive alertness modulation and in autonomic reflexes.

Reticular activation system for arousal and conciseness
*second order neuron start at dorsal column medulla ,gracile and cuneate

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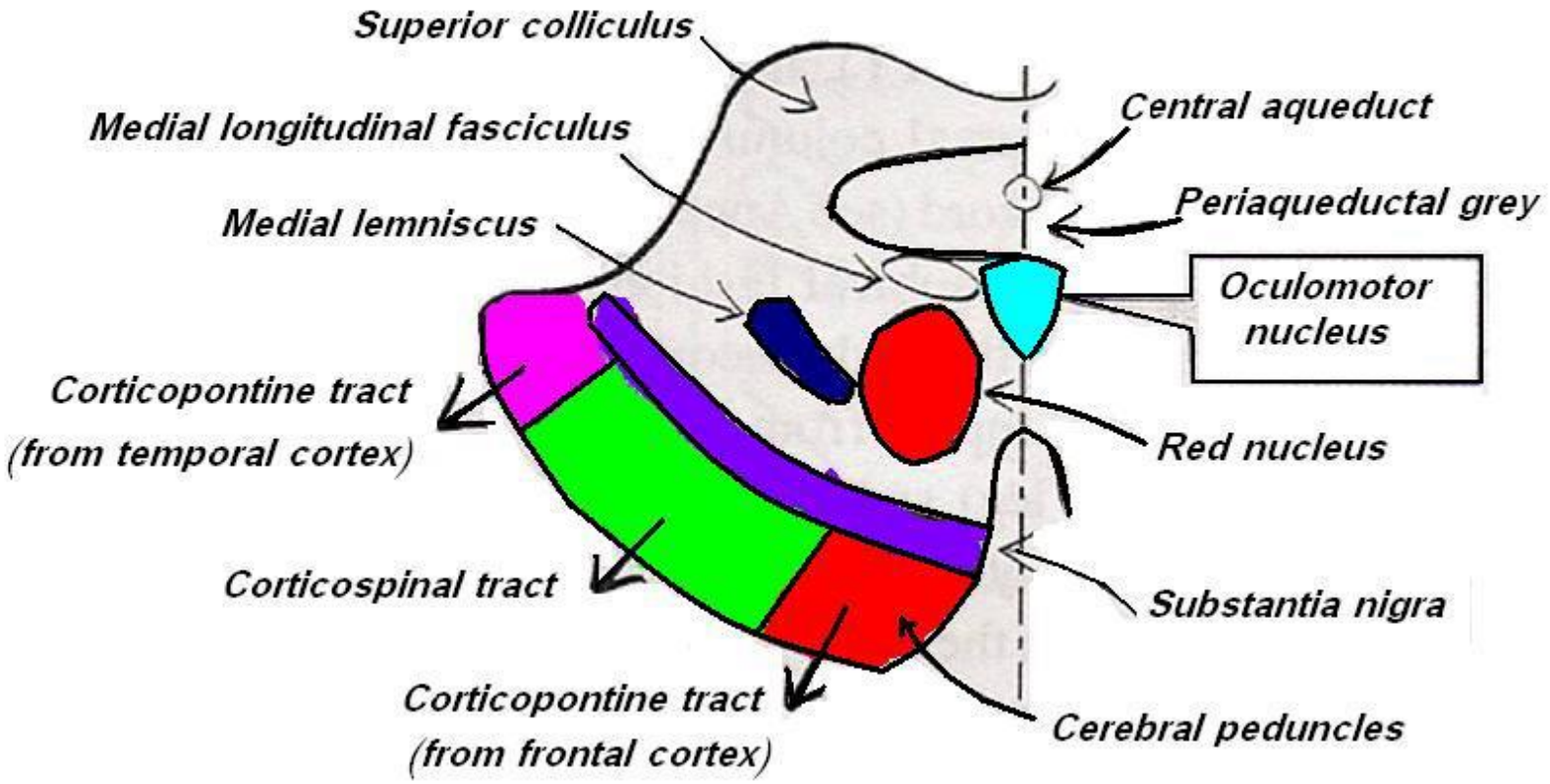
Cross section of the upper midbrain



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Pons

- **At the level of the midpons:**

the large trigeminal nerve **5** (CN V) emerges.

- **Between the basal pons:**

cranial nerve **6** (abducens), **7** (facial) & **8** (vestibulo-cochlear) emerge (**medial to lateral**).

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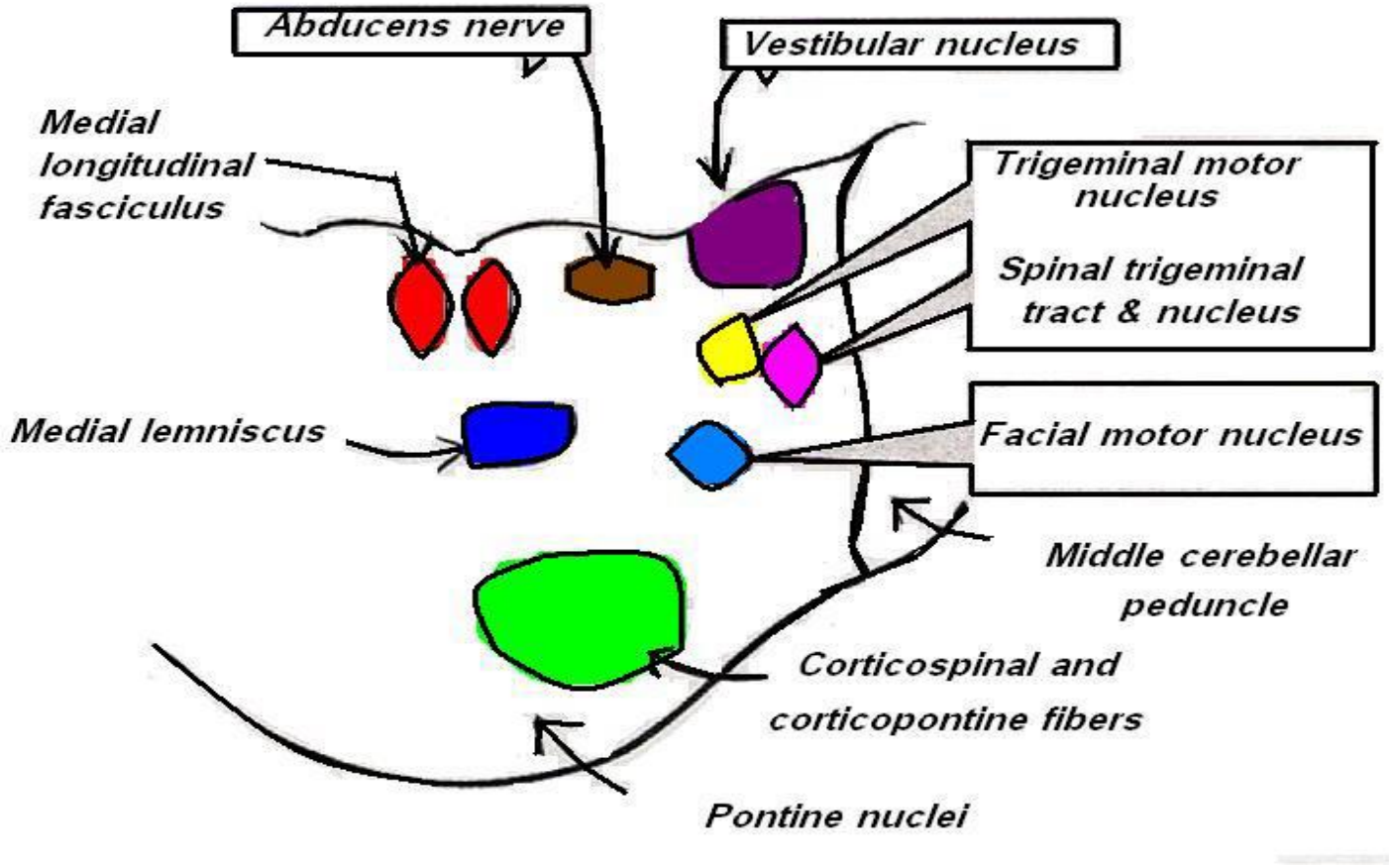
Cross section of the midpons



Medulla

Ventral view	Dorsal view
• The most medial part of the medulla is the **anterior median fissure.** • Moving laterally on each side are the **pyramids**. They contain the fibers of the **corticospinal (pyramidal) tract** as they head inferiorly to synapse on lower motor neuronal cell bodies within the ventral horn of the spinal cord. • The **anterolateral sulcus** is lateral to the pyramids. • **Emerging** from the anterolateral sulci are **the hypoglossal nerve -12 (CN XII)** rootlets. • Lateral to these rootlets and the anterolateral sulci are the **olives.** They are swellings in the medulla containing underlying inferior olivary nuclei (containing various nuclei and afferent fibers). • Lateral (and dorsal) to the olives are the rootlets for **glossopharyngeal 9** (IX) & **vagus 10** (X) cranial nerves.	• The **most medial** part of the medulla is the **posterior median fissure.** • Moving laterally on each side is the **fasciculus gracilis**. • Lateral to that is the **fasciculus cuneatus.** • Superior to each of these, are the **gracile and cuneate tubercles**, respectively. Underlying these 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.

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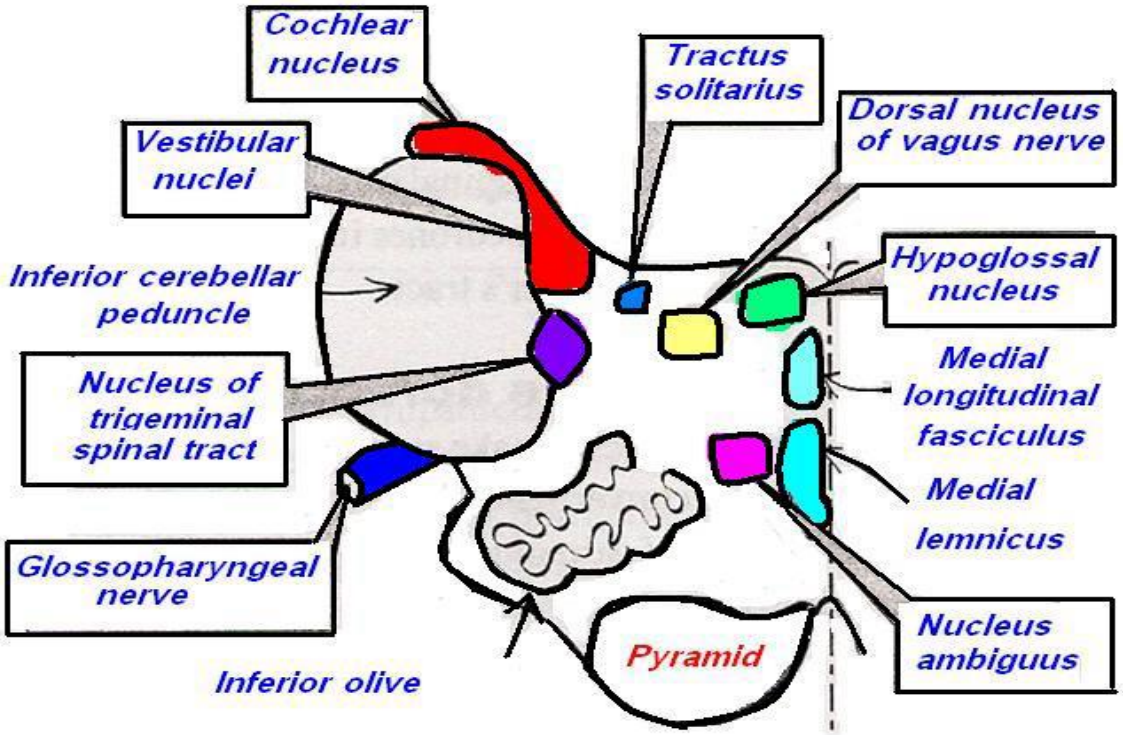
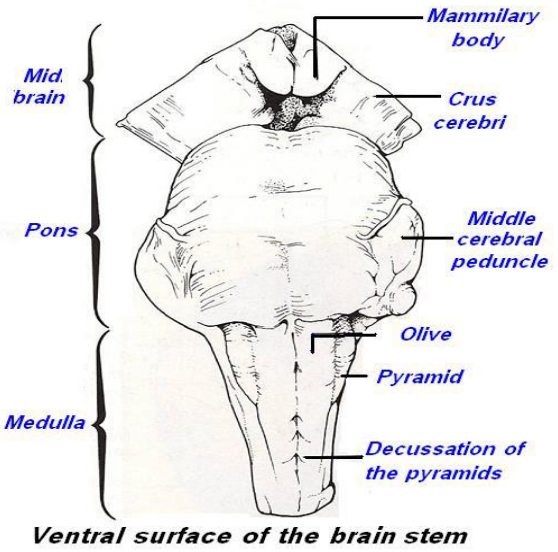
Cross section of the upper medulla





Ventral surface of the brain stem

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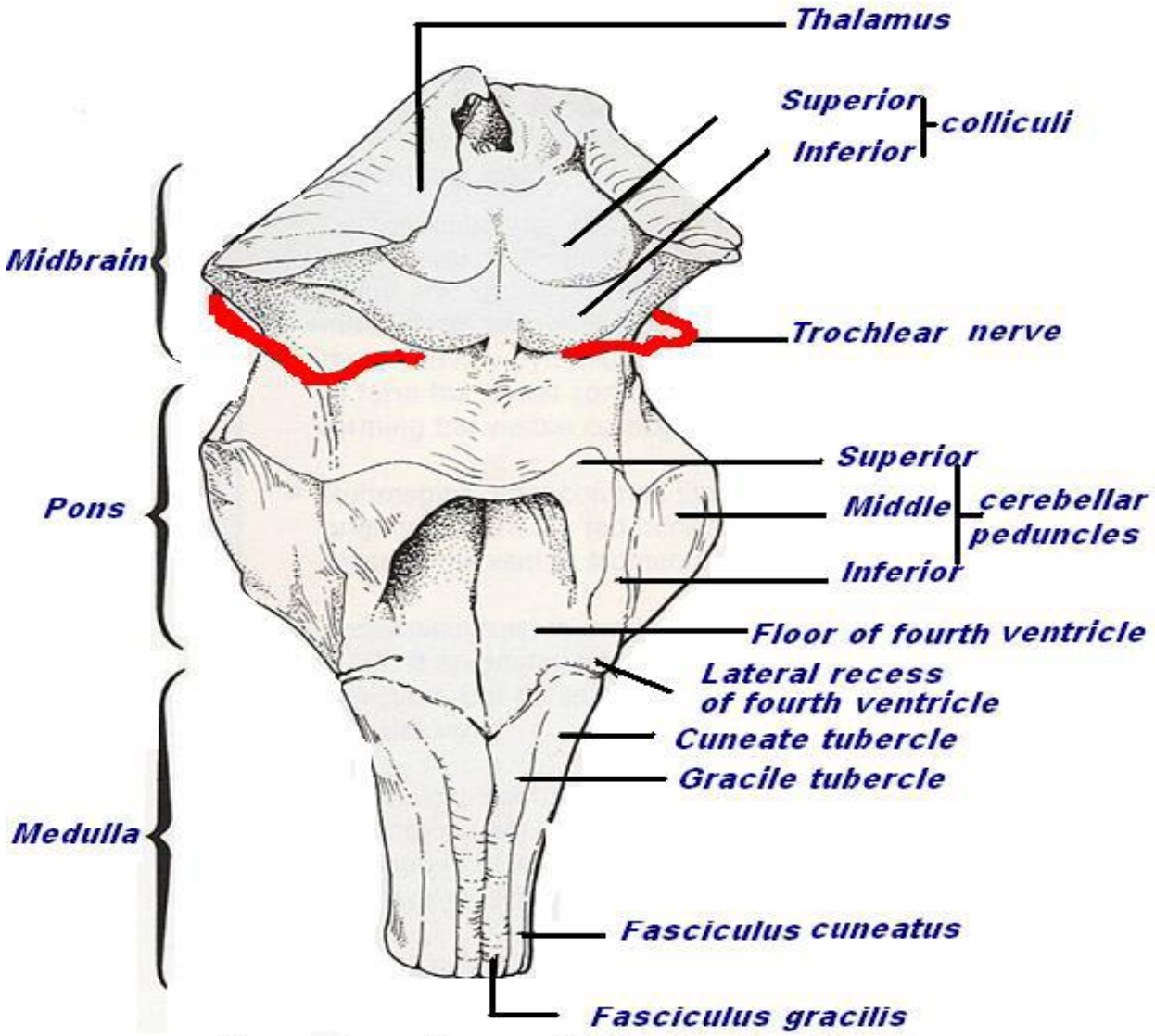

Dorsal surface of the brain stem

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Function of the brain stem

- **Though small, the brain stem is an extremely important part of the brain:**

1. Conduct functions.
2. Provides the origin of the cranial nerves (CN III-XII).
3. Conjugate eye movement.
4. Integrative functions.

Function of the brain stem

1. Conductive Function

All information related from the body to the cerebrum and cerebellum and vice versa, must traverse the brain stem.

a) The ascending sensory pathways coming from the body to the brain includes:

- The spinothalamin tract for pain and temperature sensation.
- The dorsal column, fasciculus gracilis, and cuneatus for touch, proprioceptive and pressure sensation.

b) Descending tracts

- **The corticospinal tract (UMN):** runs through the crus cerebri, the basal part of the pons and the medullary pyramids; 70-90 % of fibers cross in the pyramidal decussation to form the **lateral corticospinal tract,** destined to synapse on **lower motor neurons** in the ventral horn of the spinal cord.
- **Upper motor neurons** that originate in the brain stem's (**vestibular, red, and reticular nuclei**), which also descend and synapse in the spinal cord & synapse on lower motor neurons in the ventral horn of the spinal cord.

2. main motor and sensory innervations

to the face and neck via the cranial nerve(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

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3-conjugate eye movement

- Refers to motor coordination of the eyes that allows for bilateral fixation on a single object
- **Lateral rectus for deviation to lateral side**

- Pontine reticular formation_ right eye medial rectus (occulomotor) , left eye lateral rectus(abducent)

- The frontal eye field (**2FEF, one on each side**) 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 right FEF command to trigger a saccade culminates in conjugate eye movements to the left.

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

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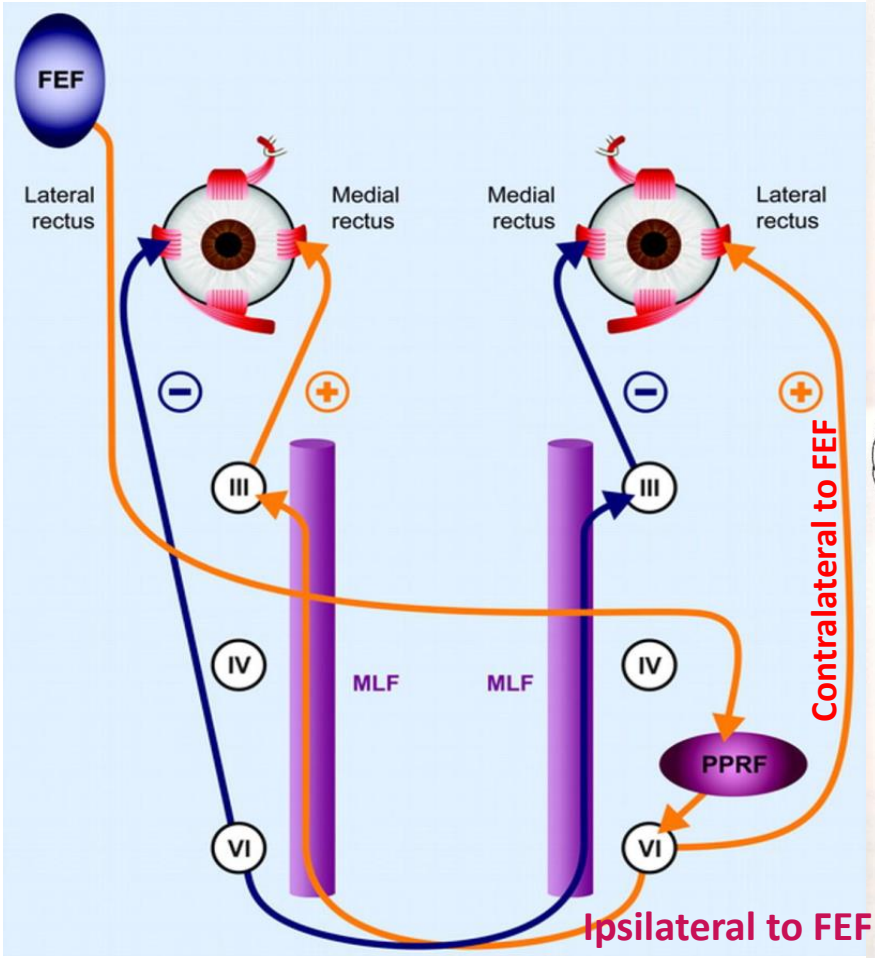
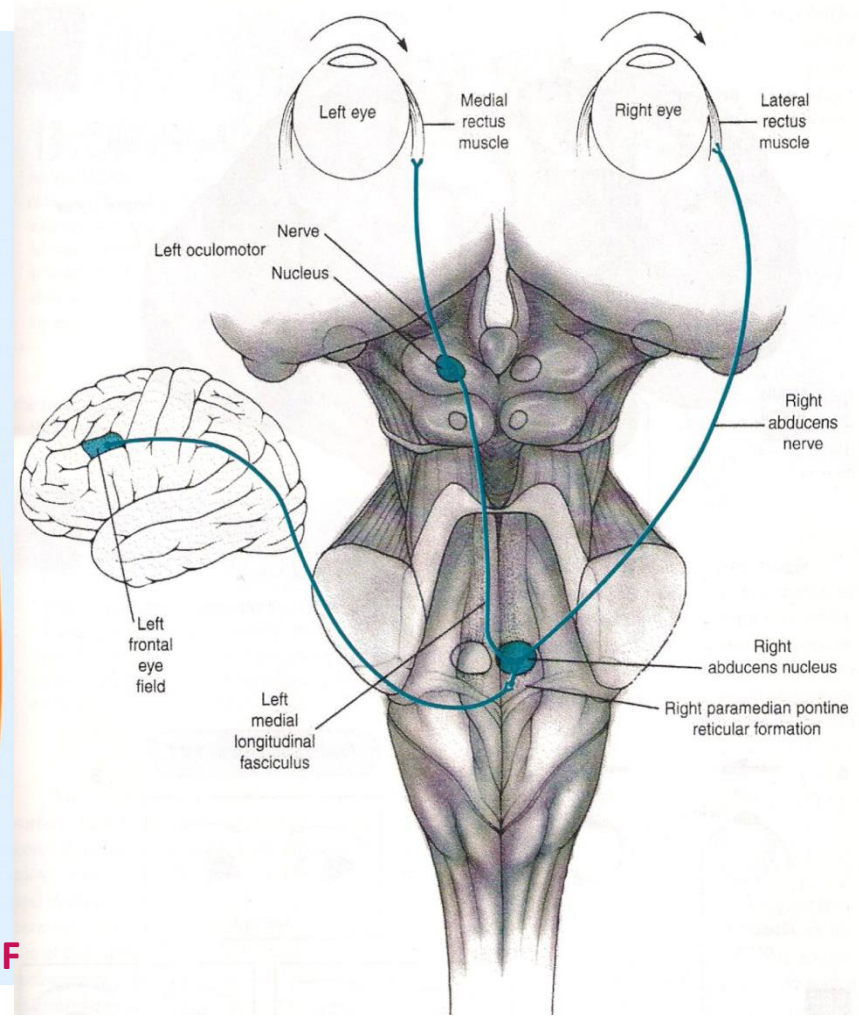
conjugate movement





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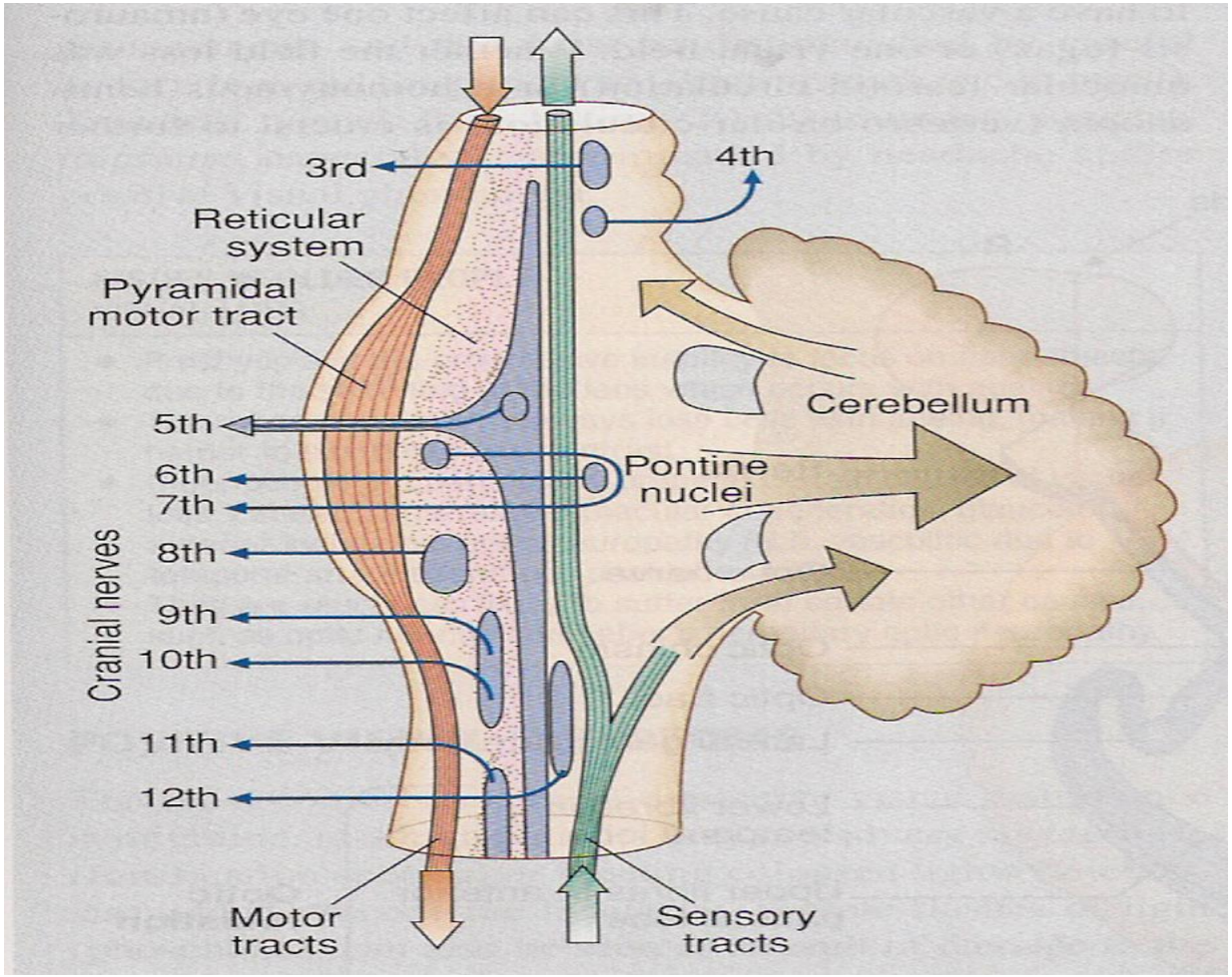
Integrative functions



Origin & functions of cranial nerves

Mid brain	pons	Medulla
• **CN III** (oculomotor) Involved in the movment of eye • **CN IV** (trochlear) **Both move eyes; CN III contsricts the pupils, accommodates.**	• **CN V** (trigeminal): Chews and feels front of the head. • **CN VI** (abducens): Moves eyes. • **CN VII** (facial): Moves the face, tastes, salivates, cries. • **CN VIII** (acoustic): Hears, regulates balance. **(equilibrium)**	• **CN IX** (glossopharyngeal): Taste, salivation, 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 head, lifts shoulder. • **CN XII** (hypoglossal): Moves tongue.

Sensory CN I, CN II, CN VIII
Motor CN III, CN IV, CN VI, CN XI, CN XII
Mixed CN V, CN VII, CN IX, CN X

Brain Stem function tests

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To test reticular formation	Alertness, Consciousness & Sleep.
To test corticospinal tract	Motor power, reflexes
To test Pain response	facial grimacing on firm pressure over the supra orbital ridge.
To test respiratory center	Look for the normal pattern of respiration
To test cardiovascular center	Look for normal circulatory function
To test brainstem reflexes	➢**Pupilary 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**

Supraorbital ridge >the surgeon do it to wake up the patient after anesthesia

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SUMMARY

- **THE BRAIN STEM IS COMPOSED** (from above downwards) of: **midbrain, pons & medulla oblongata**
- **THE BRAINSTEM PROVIDES THE MAIN MOTOR AND SENSORY INNERVATION** to the **face and neck** via the **cranial nerves**
- **AN EXTREMELY IMPORTANT PART OF THE BRAIN** as the nerve connections of the motor and sensory systems from the main part of the brain to the rest of the body pass through the brainstem e.g. **corticospinal tract (motor), spinothalamic tract** (pain, temperature, itch and crude touch)
- **THE BRAINSTEM ALSO PLAYS AN IMPORTANT ROLE IN THE** regulation of **cardiac and respiratory function**
- **PIVOTAL IN MAINTAINING** **consciousness** and regulating the **sleep cycle**.

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QUESTIONS

Q1: A
Q2: D
Q3: C

Q1. At which level of the brain stem is the Red nuleus occure?

A. Midbrain
B. Pons
C. Medulla

Q2. Which one of the following Cranial Nerves is Sensory ?

A. Abducents
B. Accessory
C. Trochlear
D. Olfactory

Q3. Which of the following is rich in endogenous opioid?

A. Substantia nigra
B. Red nucleus
C. Periaqueductal Grey

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THE END

If there are any Problems or Suggestions,
Feel free to contact:

Physiology Team Leaders

Mohammed Jameel & Shaimaa Al-Refaie

432100187@student.ksu.edu.sa
432200643@student.ksu.edu.sa

THANK YOU