

PHYSIOLOGY OF BRAIN STEM

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Learning Objectives:

- At the end of the lectures students, should be able to know:
- The different components of the brain stem
- The main functions of the brain stem
- Brain stem function tests in normal subject and if there is brain death.

The Brain Stem

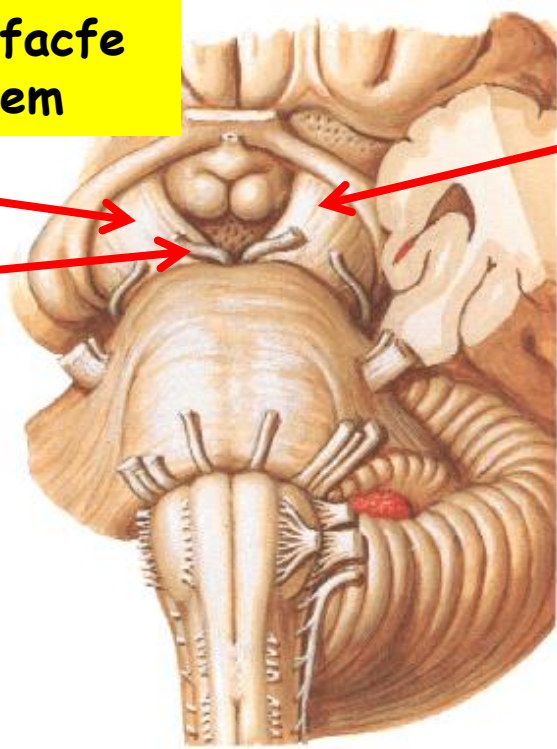
- The brain stem is the lower portion of the brain that connects the cerebrum with spinal cord.
- It provides a pathway for nerve fibers between the brain and spinal cord.

Anterior Surface of Brainstem

Cerebral Peduncles

Cerebral Peduncle

Oculomotor Nerve

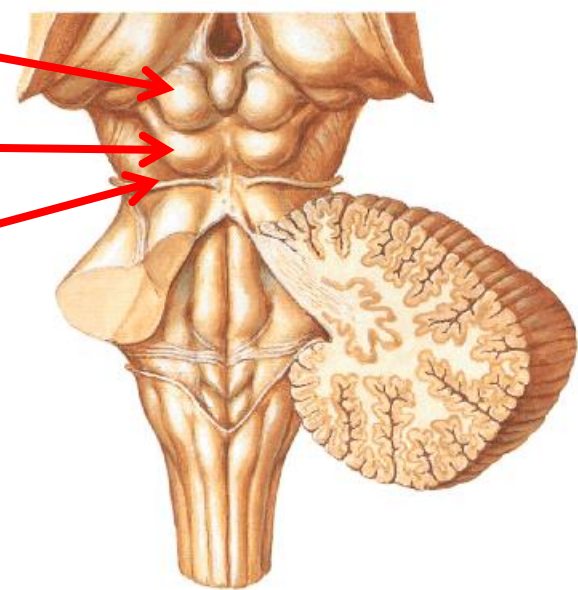


Superior Colliculus

Inferior Colliculus

Trochlear Nerve

Posterior Surface of Brainstem



Components of Brain stem

- Midbrain
- Pons
- Medulla Oblongata
- The superior, middle and inferior cerebellar peduncles connect the cerebellum to the midbrain, pons and medulla respectively

Mid brain

Tectum:

has two structures:

- 1) The superior colliculus.
- 2) The inferior colliculus.

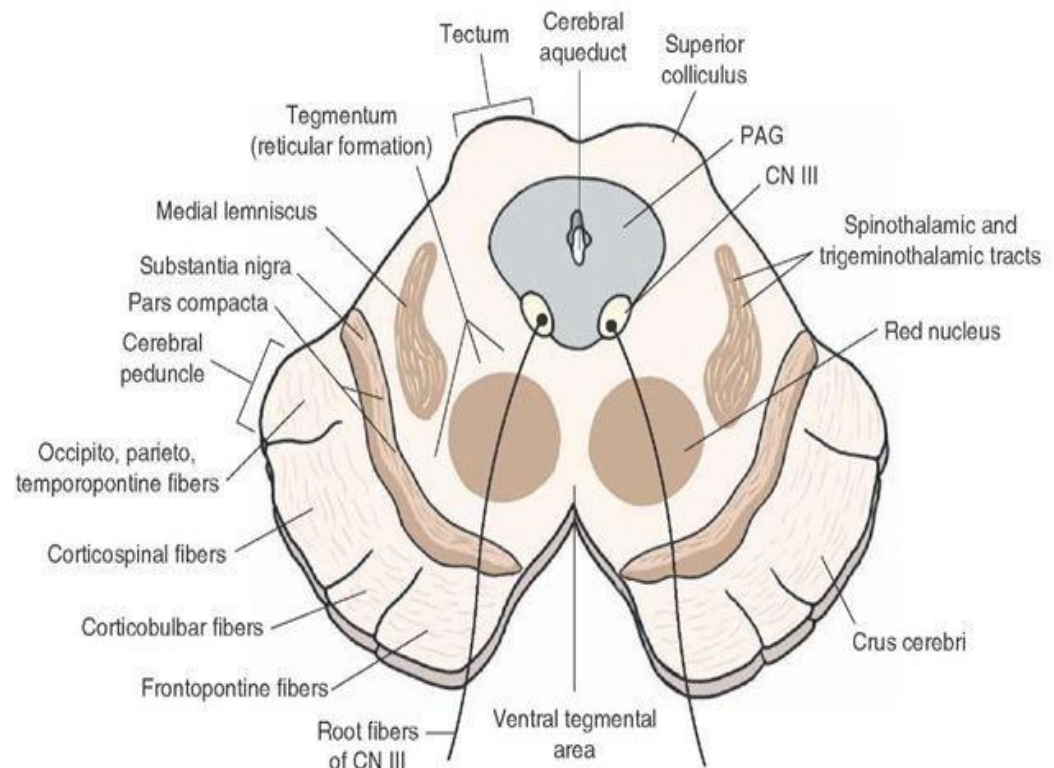
Tegmentum:

lies ventral to the cerebral aqueduct. Several nuclei, tracts and the reticular formation is contained here.

The Cerebral peduncles (Crus cerebri) transmits axons of upper motor neuron

Mid brain is divided into **Three** segments :

- 1) Tectum (most posterior)
- 2) Tegmentum (in between)
- 3) Cerebral peduncle (Crus cerebri)

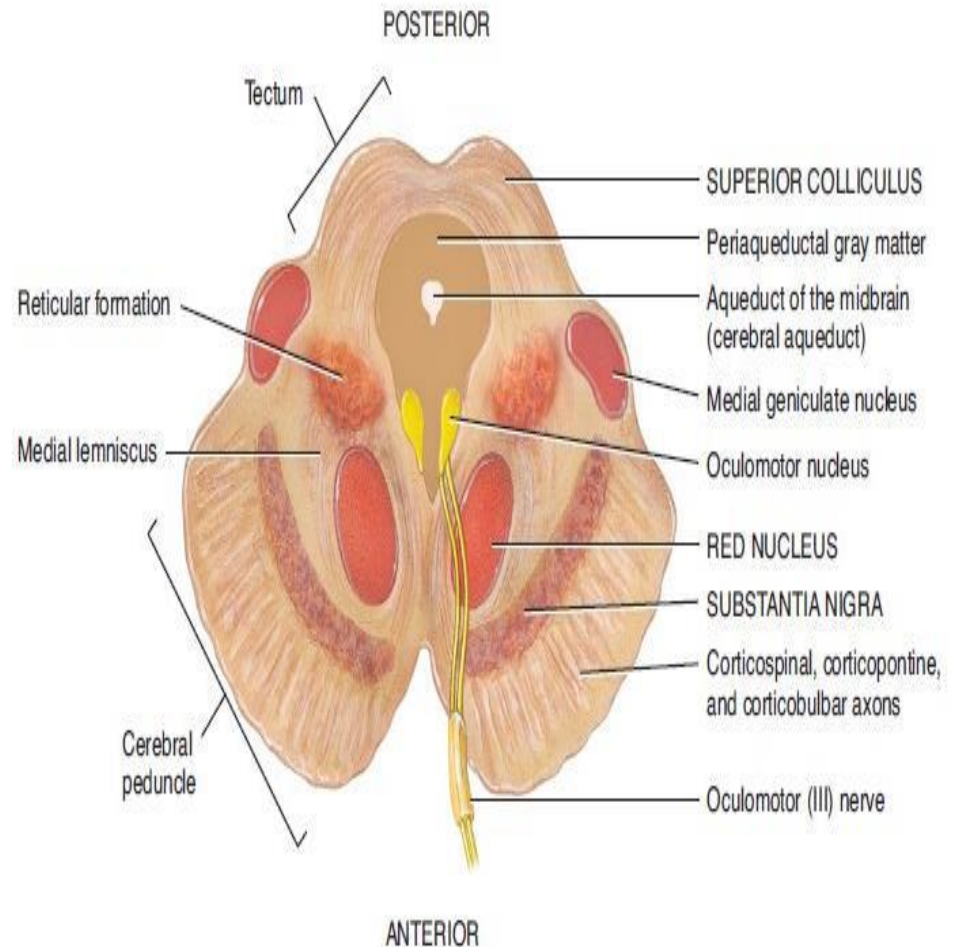


Midbrain internal structures

Periaqueductal Gray:

Around the cerebral aqueduct, contains neurons involved in analgesia & pain modulation/desensitization .

- Oculomotor nerve (CN III) nucleus
- Trochlear nerve (CN IV) nucleus
- Red Nucleus: gives out Rubrospinal



(b) Transverse section of midbrain

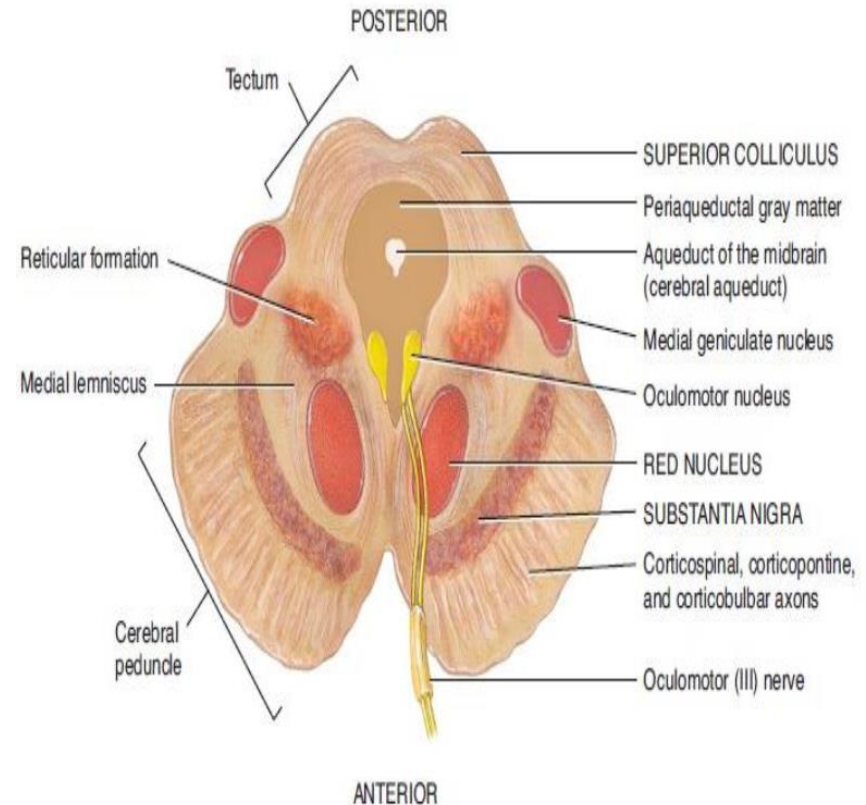
-Substantia Nigra: They secrete Dopamine. Degeneration of Substantia Nigra is associated with Parkinson's disease

-Central Tegmental tract:

This is a pathway by which many tracts project up to the cortex and down to the spinal cord

7- Reticular formation

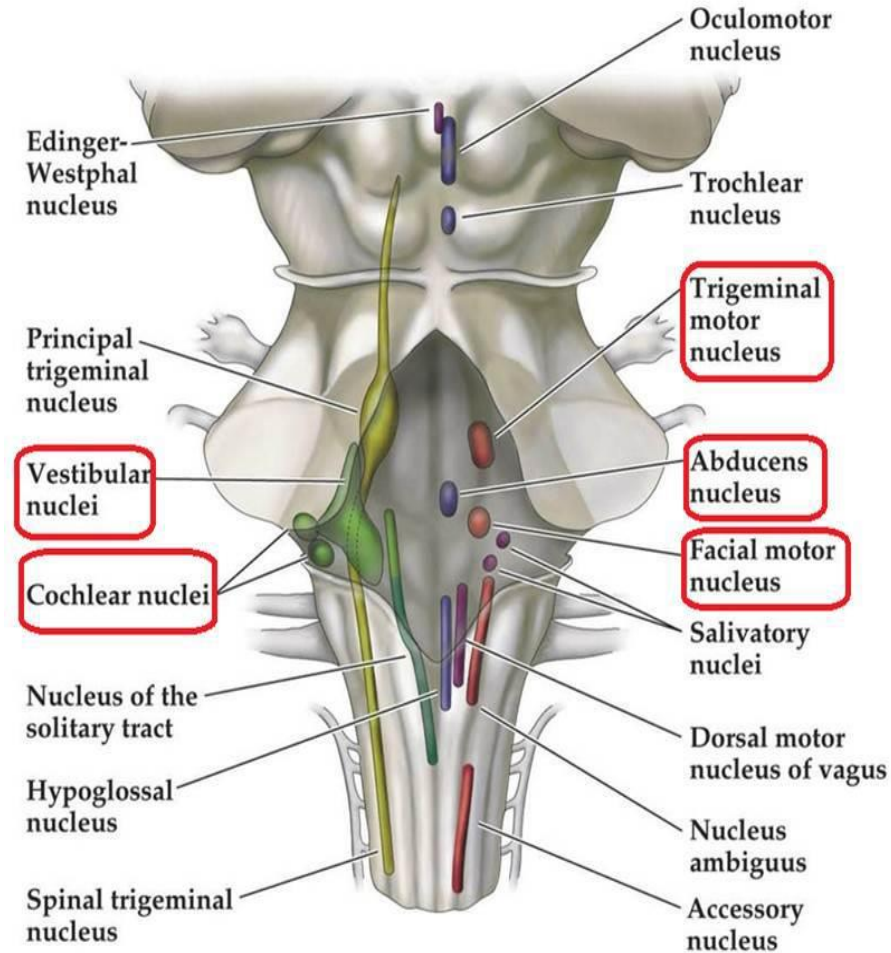
- ✓ It contains LMN
- ✓ It is involved in the pain desensitization pathway
- ✓ It is involved in the arousal and consciousness systems
- ✓ It contains the locus ceruleus, which is involved in intensive alertness modulation and in autonomic reflexes.



(b) Transverse section of midbrain

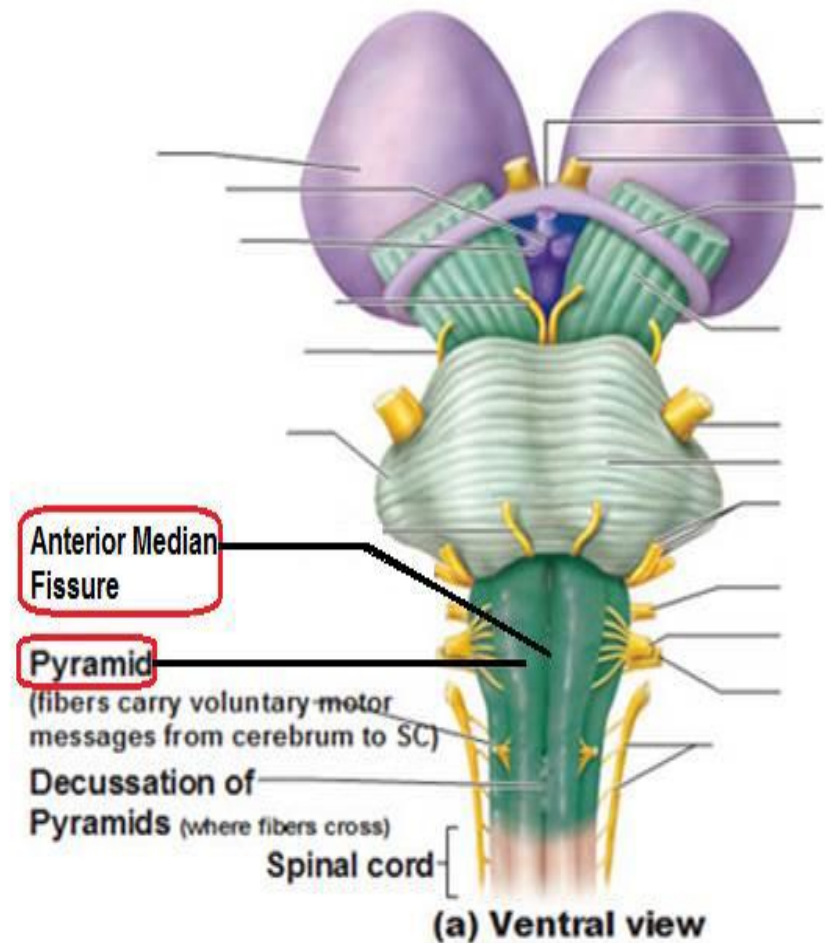
Pons

- Is the middle portion of the brain stem
- At the level of the midpons, the large trigeminal nerve (CN V) emerges.
- Between the basal pons, cranial nerve 6 (abducens), 7 (facial) & 8 (vestibulo-cochlear) emerge (medial to lateral).



Medulla Oblongata

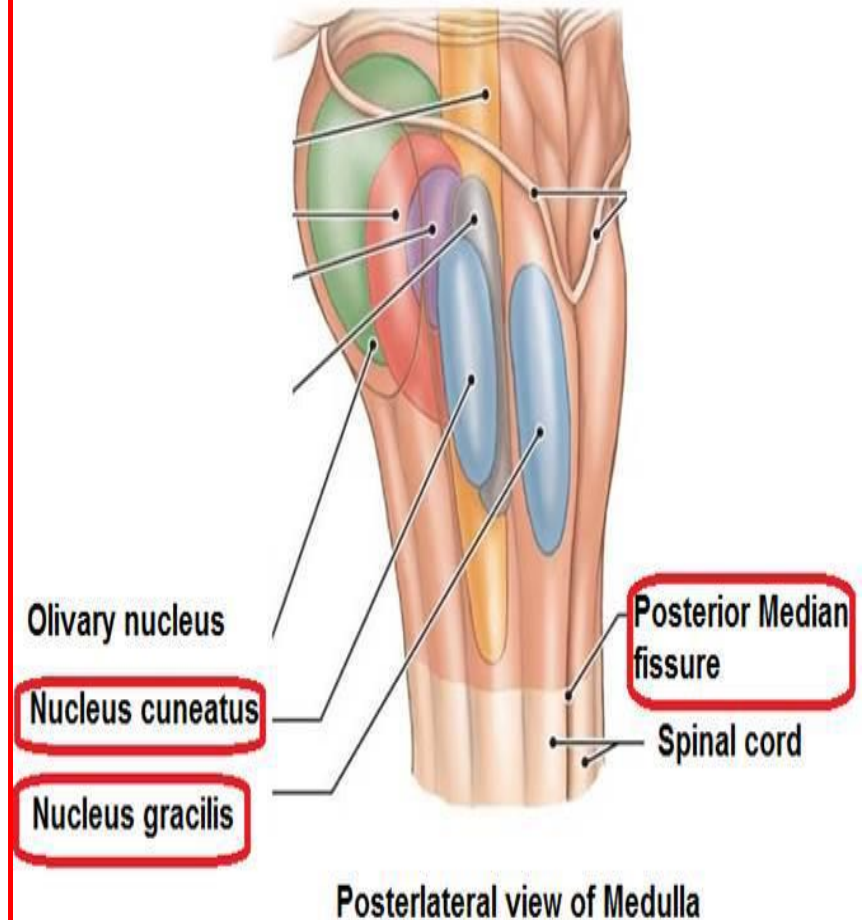
- Is the lowermost portion of the brain stem
- ❑ Ventral view;
- Pyramids which contain the fibers of the corticospinal (pyramidal)
- Just lateral to pyramids in the upper medulla are the olives, containing inferior olivary nuclei
- ✓ Emerging from the anterolateral sulci are the hypoglossal nerve (CN XII) rootlets.
- ✓ Lateral (and dorsal) to the olives are the rootlets for glossopharyngeal (IX) & vagus (X) cranial nerves.



Medulla Oblongata

❑ Dorsal view;

- The posterior median fissure.
- 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 are the motor nuclei for vagus and hypoglossal cranial nerves.



Functions of the brain stem

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

1. It has conduct functions.

2. Provides the origin of the cranial nerves (CN III-XII).

3. Conjugate eye movement.

4. Integrative functions.

1. Conduct Functions of the Brainstem

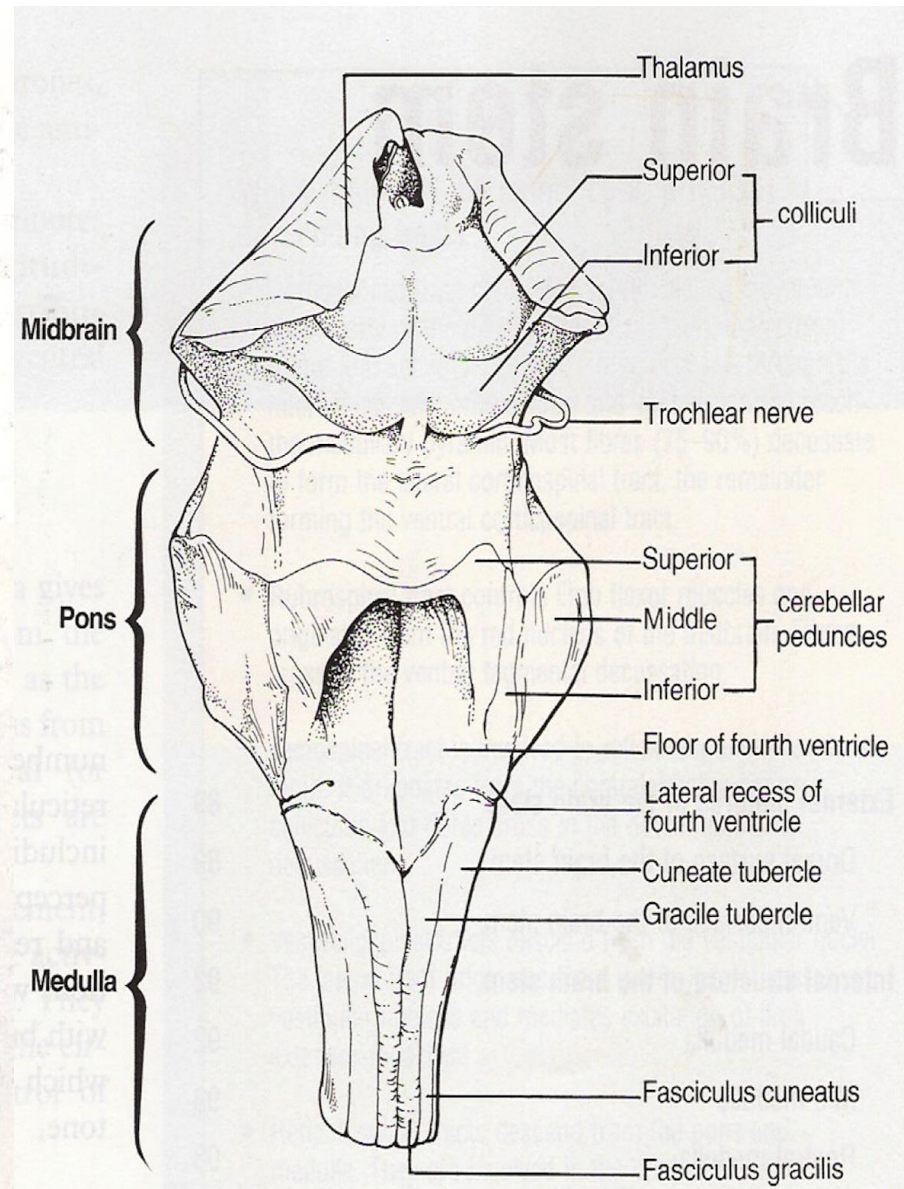
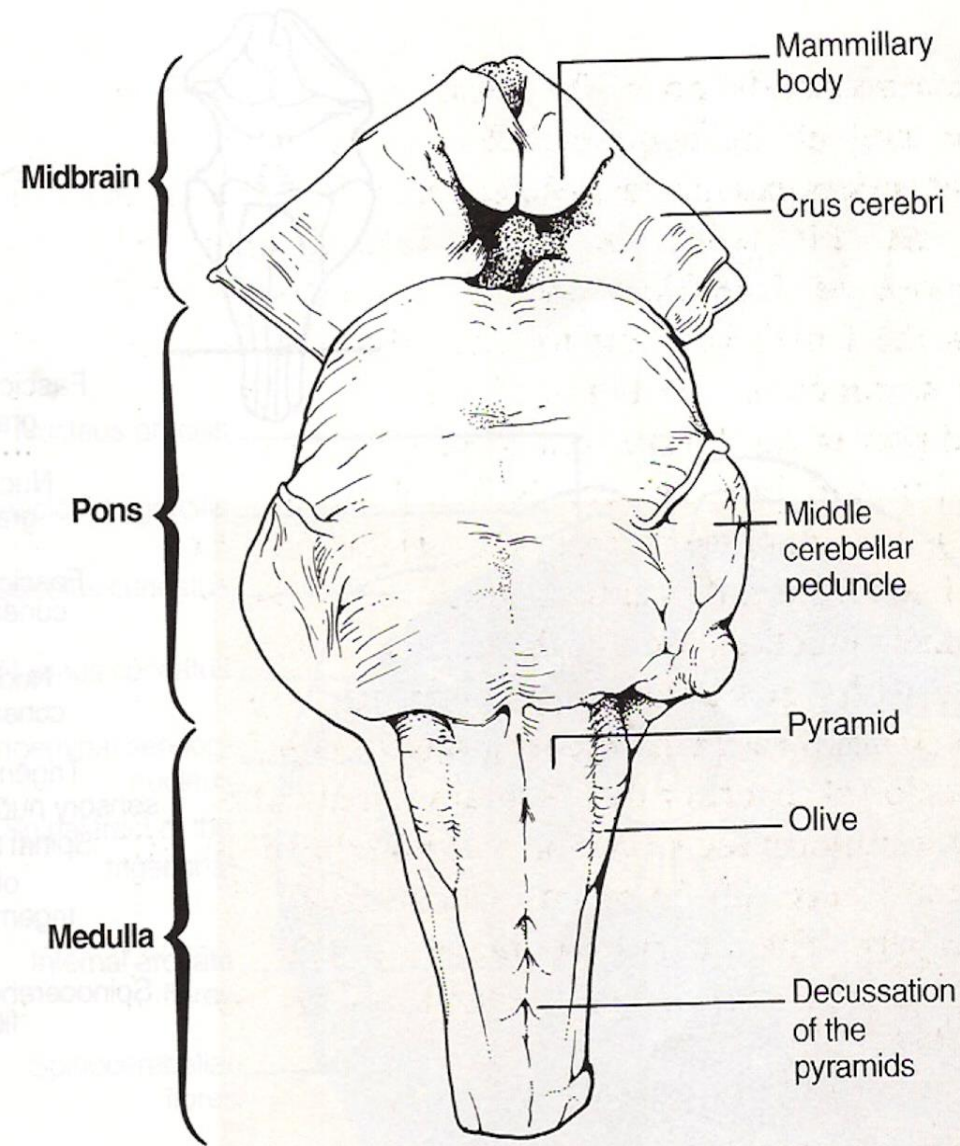
- All information related from the body to the cerebrum and cerebellum and vice versa, must traverse the brain stem

A- Ascending (sensory) tracts coming from the body to the brain include

- (1) Spinothalamic tract for pain and temperature sensation.
- (2) Dorsal column tracts , fasciculus Gracilis, and fasciculus Cuneatus for touch , & Proprioceptive and Pressure sensation.

Ventral Surface

Dorsal Surface



B- Descending (MOTOR) tracts are

- The Corticospinal (UMN) tract that originates in the cerebral cortex .
- other UMNs that originate in the Brainstem → from → (1) vestibular nucleus , (2) Red nucleus , and (3) Reticular nuclei, also descend and synapse in the spinal cord

2. The brain stem provides the main motor and sensory innervation to the face and neck via the cranial nerves (CN III-XII).

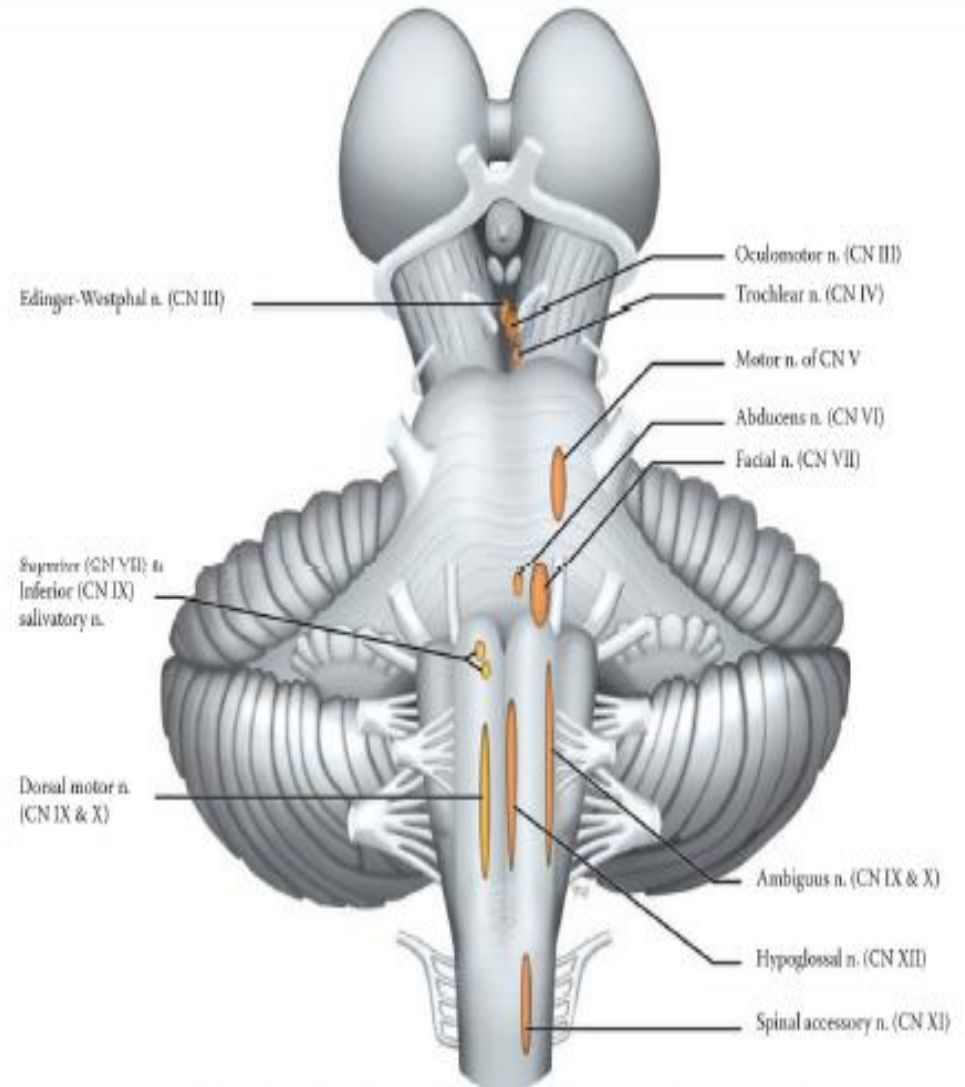


FIGURE 8A: Brainstem 3 — Cranial Nerves Nuclei — Motor

Origin & functions of the cranial nerves

From midbrain

- CN III (oculomotor)
- CN IV (trochlear)

Both moves eyes; CN III constricts the pupils, accommodates.

From pons

- 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.

From 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 head, lifts shoulder.
- CN XII (hypoglossal): Moves tongue.

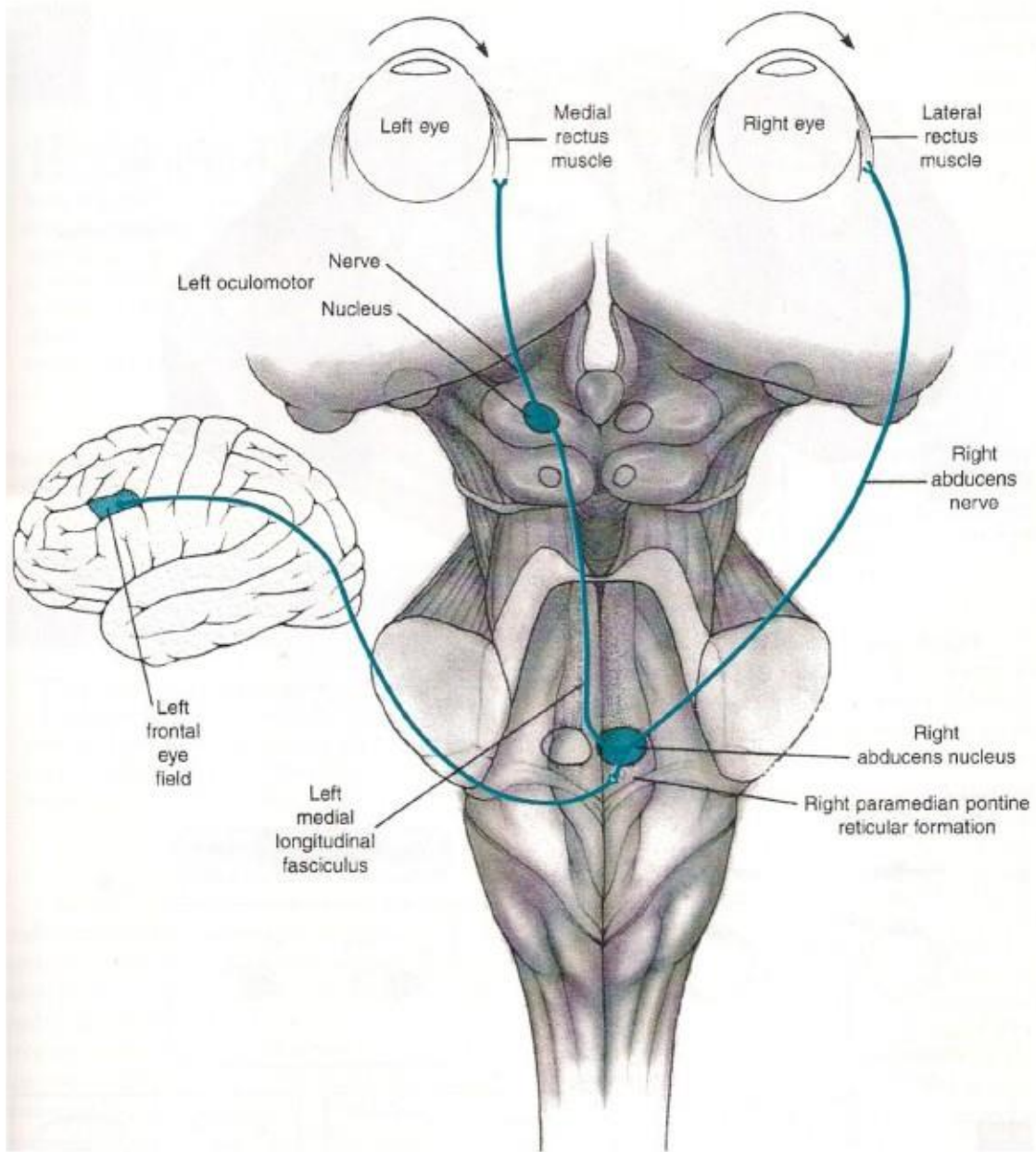
3. Integrative Functions of Brainstem

- (1) It controls consciousness & sleep cycle (alertness and arousal) through reticular formation (RAS).
- (2) It has got center for cardiovascular, respiratory & autonomic regulation .
- (3) It has centers for Brainstem Reflexes , such as cough reflex , gag reflex , swallowing , and vomiting ; + visual & auditory orientation reflexes (required for head movements).
- (4) Contributes to maintenance of body balance → through the vestibular nuclei
- (5) Plays role in motor control →
 - (i) Substantia Nigra →(which is a part of the basal ganglia) is involved in control of movement.
 - (ii) Midbrain also contain Red nucleus which regulate the motor activity through cerebellum
- (6) 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

4. Control of Conjugate Eye Movements

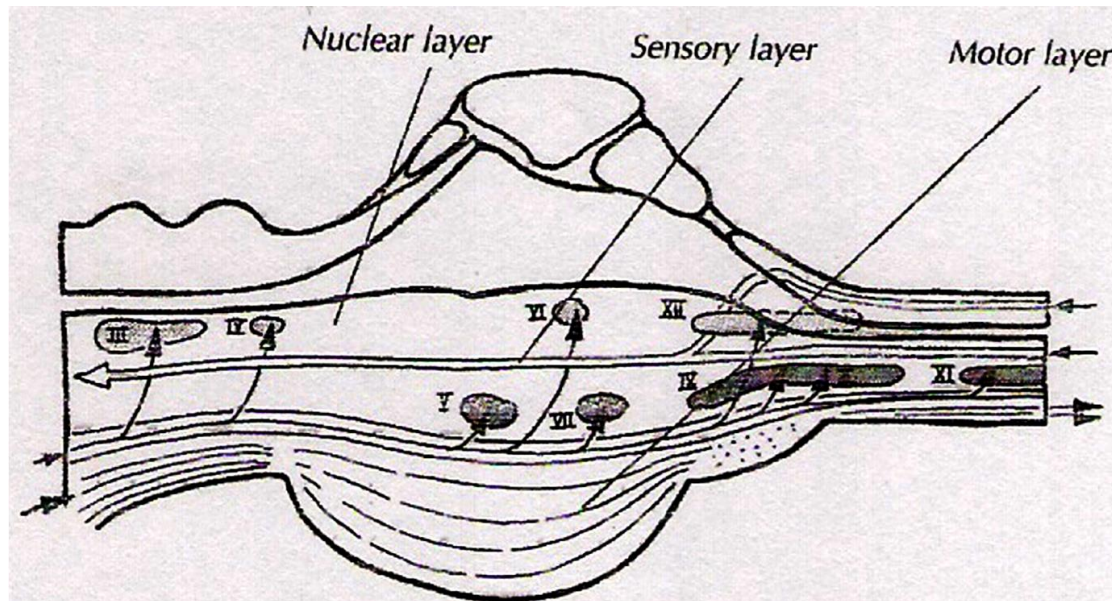
Conjugate eye movement refers to motor coordination of the eyes that allows for bilateral fixation on a single object.

- Several centers in the brainstem are involved.
- Horizontal conjugate gaze is controlled by →
 - (1) the nuclei of 3rd and 6th Cranial nerves ,
 - (2) the Paramedian Pontine Reticular Formation, and
 - (3) the nucleus prepositus hypoglossi-medial vestibular nucleus.
- Vertical conjugate gaze is controlled by the nuclei of 3rd and 4th Cranial nerves



- Layers of Brainstem

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



Brain stem, gross internal structure.

Brain Stem Function Tests

(A) To test reticular formation

(1) Alertness, Consciousness & Sleep.

(2) Corticospinal tract :

✓ Motor power, reflexes

(3) Pain response → Facial grimacing on firm pressure over the supra orbital ridge.

(B) To test respiratory center

look for the normal pattern of respiration

Brain Stem Function Tests Cont.

(C)To test cardiovascular center

_Look for normal circulatory function

(D)To test brainstem reflexes:

- Pupillary and corneal reflexes.
- Vestibulo-ocular reflex:
 - ✓ Injection of iced water into the ear will produce eyes movement.
 - ✓ No eye movement :
 - Brainstem injury / death

Brain Stem Function Tests Cont

- Oculo-cephalic reflex:
 - Rapidly turn the head 90° on both sides
 - Normal response = deviation of the eyes to the opposite side of head turning
 - Brain death = oculocephalic reflexes are absent (no Doll's eyes) = no eye movement in response to head movement
- Gag reflex.
 - Absent in brain death
- Cough reflex
 - Absent in brain death

