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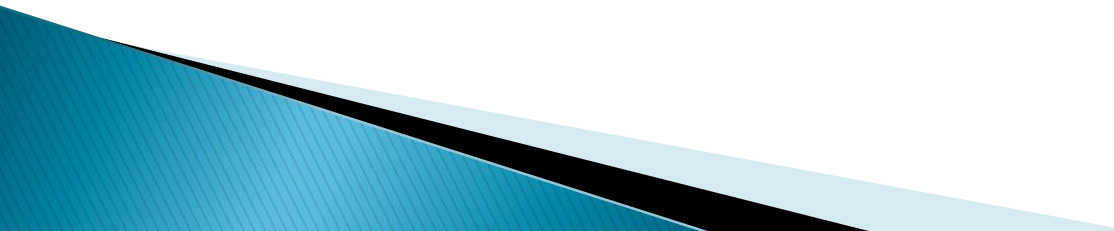
السَّلَامُ عَلَیْكُمْ

وَرَحْمَةُ اللّٰهِ وَبَرَكَاتُهُ

PHYSIOLOGY OF BRAIN STEM

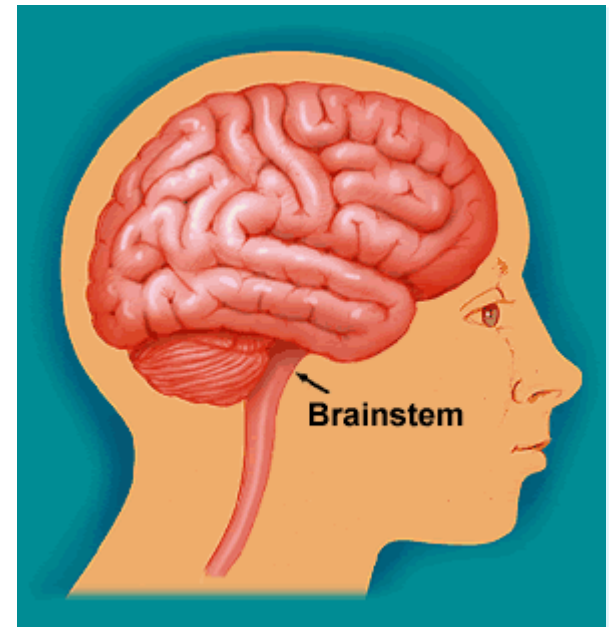
*Dr. Hayam Gad
Associate Professor of
Physiology*

Learning Objectives

- *Components of Brain stem*
 - *Midbrain internal structures*
 - *Pons*
 - *Ventral view of Medulla*
 - *Dorsal view of Medulla*
 - *Functions of the Brain Stem*
 - *Brain stem function tests*
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THE BRAIN STEM

The brain stem is the lower part of the brain, adjoining and structurally continuous with the spinal cord.

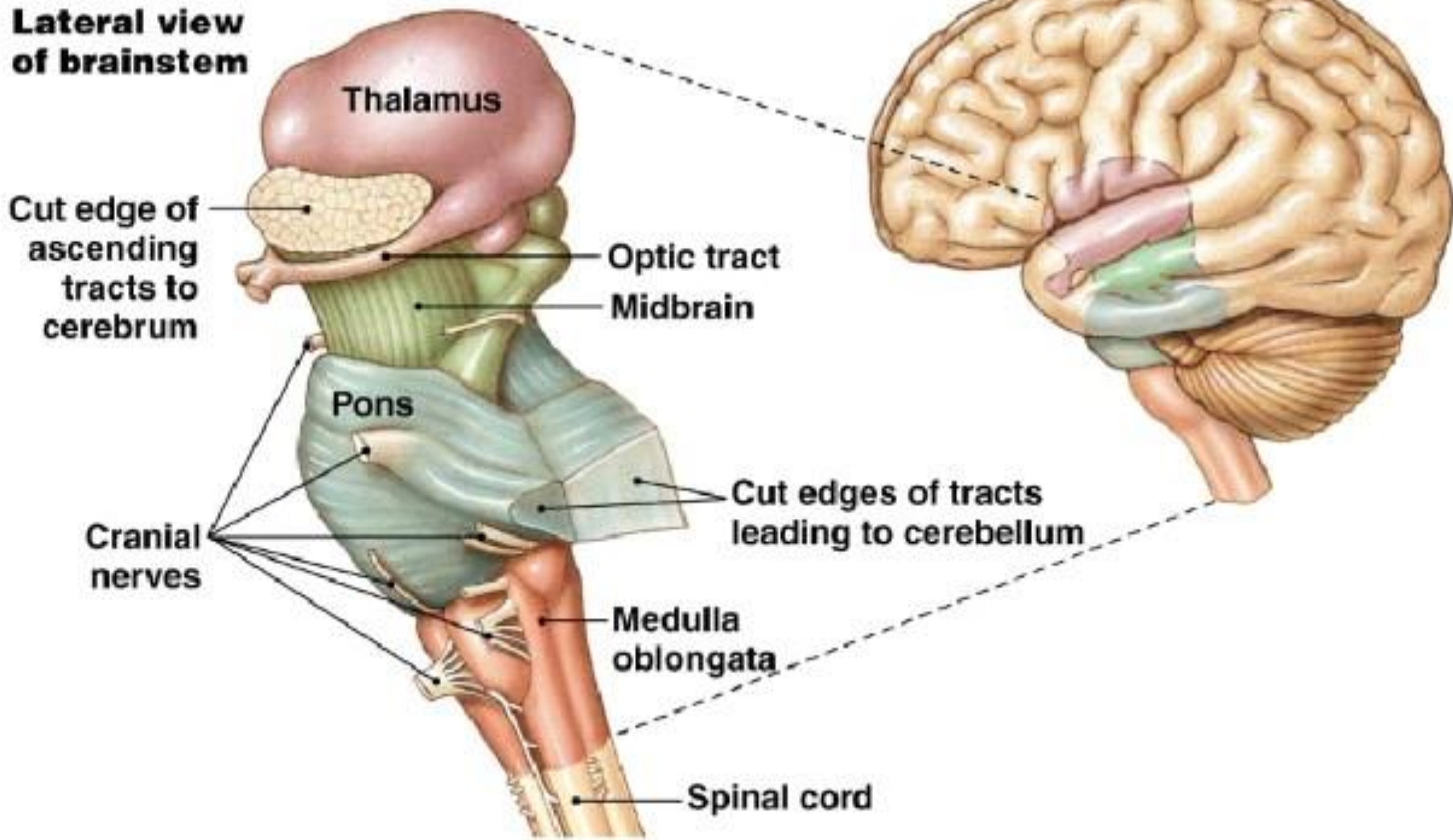


Components of Brain stem

- Mid Brain
- Pons
- Medulla Oblongata

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

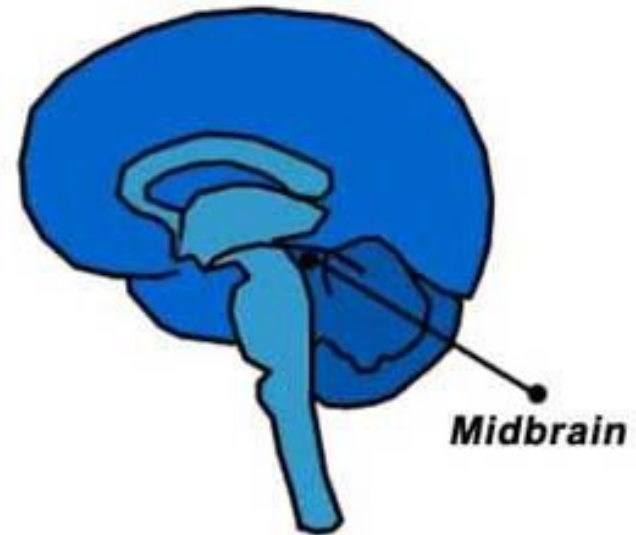
**Lateral view
of brainstem**



Midbrain

The midbrain is divided into three parts:

- 1- The Tectum
- 2- The Tegmentum
- 3- Cerebral Peduncles



1- **The Tectum** ("roof" in latin) includes:

a) **The superior colliculus**

It is involved in the special sense of vision and sends its superior brachium to the lateral geniculate body of the thalamus.

b) The inferior colliculus

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 colliculi.

2- The Tegmentum

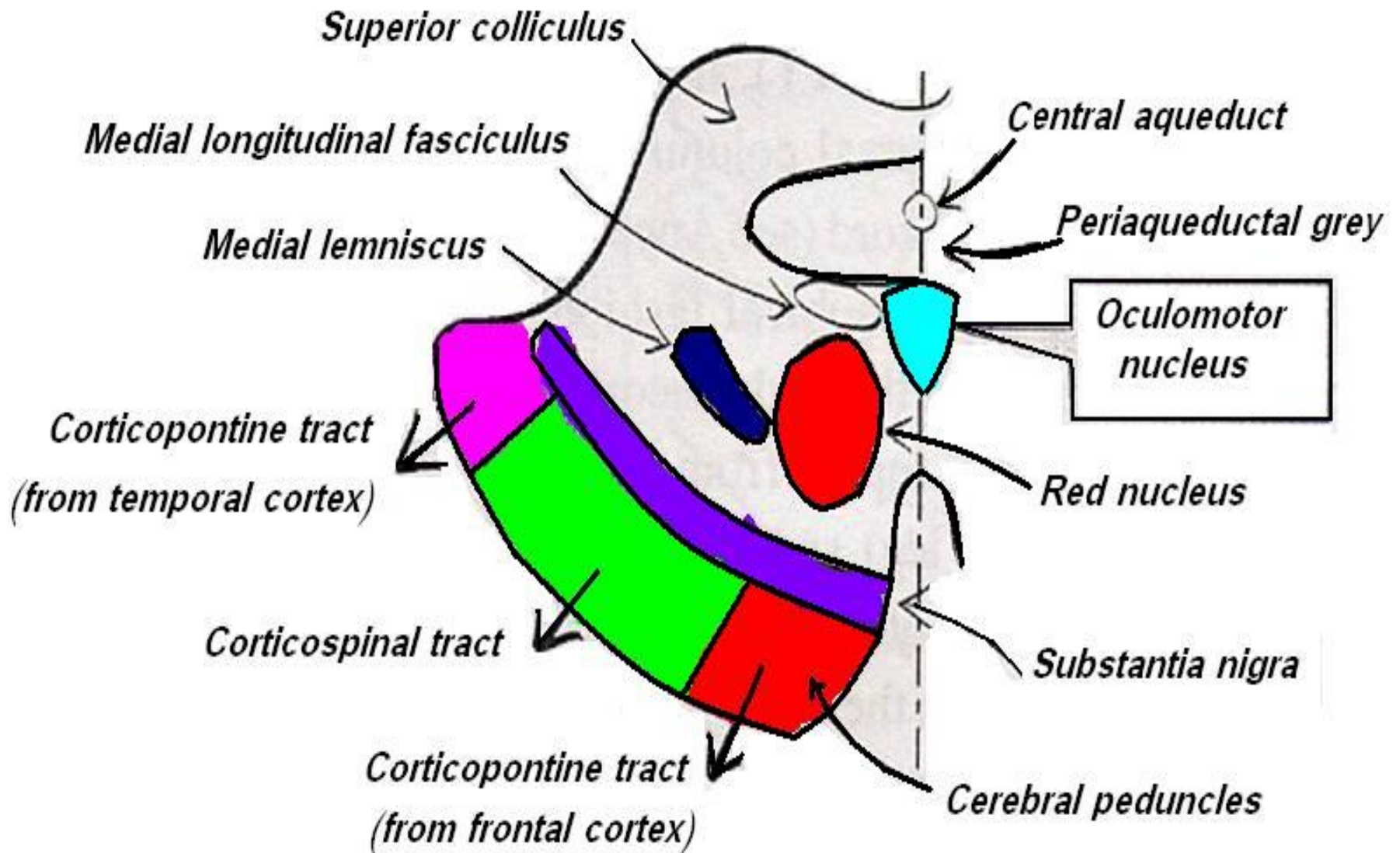
Ventral to the cerebral aqueduct. Several nuclei, tracts and the reticular formation is contained here.

3- The ventral side is comprised of paired Cerebral Peduncles. These transmit axons of UMN.

Midbrain internal structures

∞ **Periaqueductal Gray:** Around the cerebral aqueduct, contains neurons involved in the **pain desensitization** pathway.

Cross section of the upper midbrain



∞ **Oculomotor Nerve** (CN III) nucleus.

∞ **Trochlear Nerve** (CN IV) nucleus.

∞ **Red Nucleus:** This is a motor nucleus that sends a **descending tract** to the lower motor neurons.

- ❧ **Substantia Nigra:** This is a concentration of neurons in the ventral portion of the midbrain that is involved in motor function.
- ❧ **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.

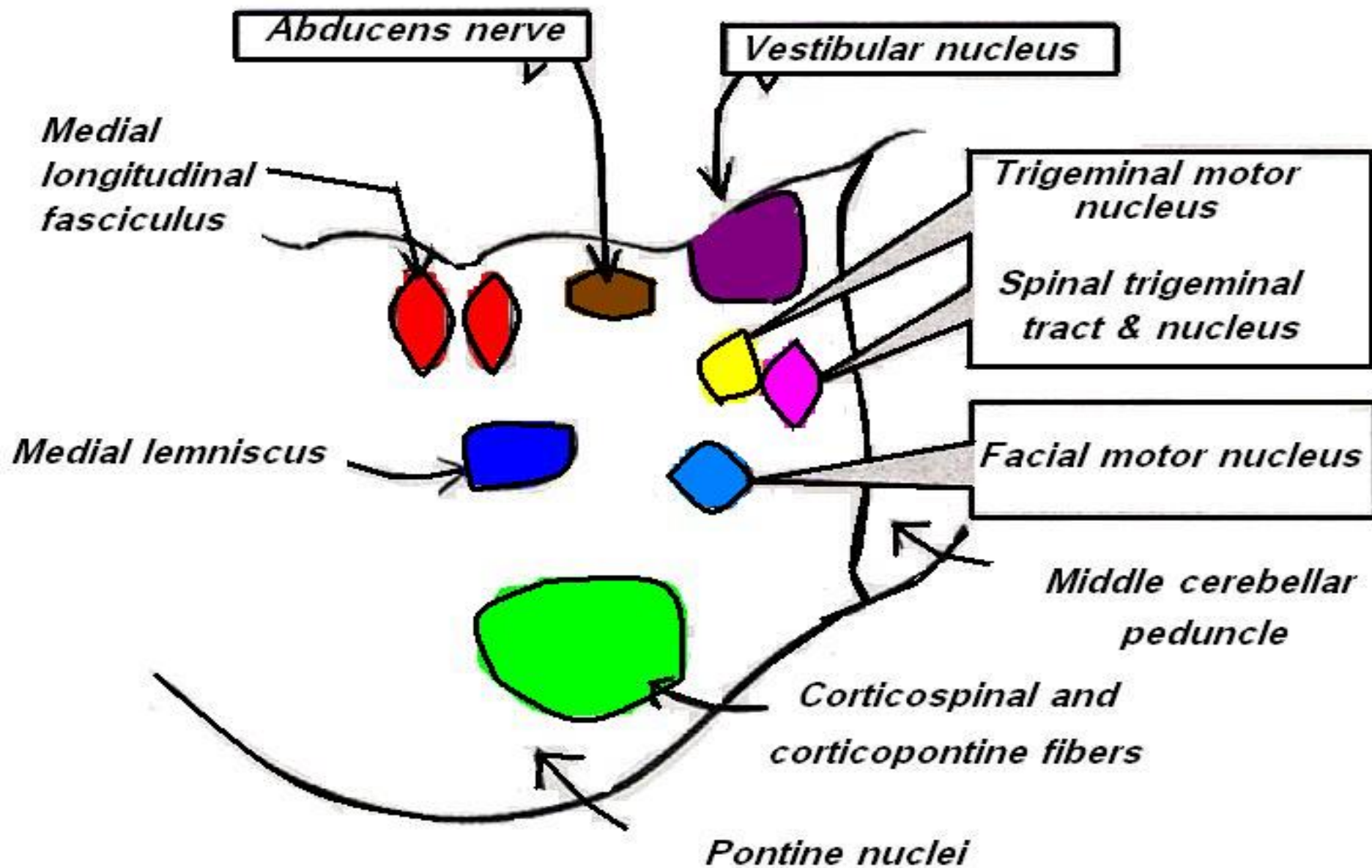
∞ **Reticular Formation:** A large area that is involved in various important functions of the midbrain:

- ☑ 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.

Pons

- 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).

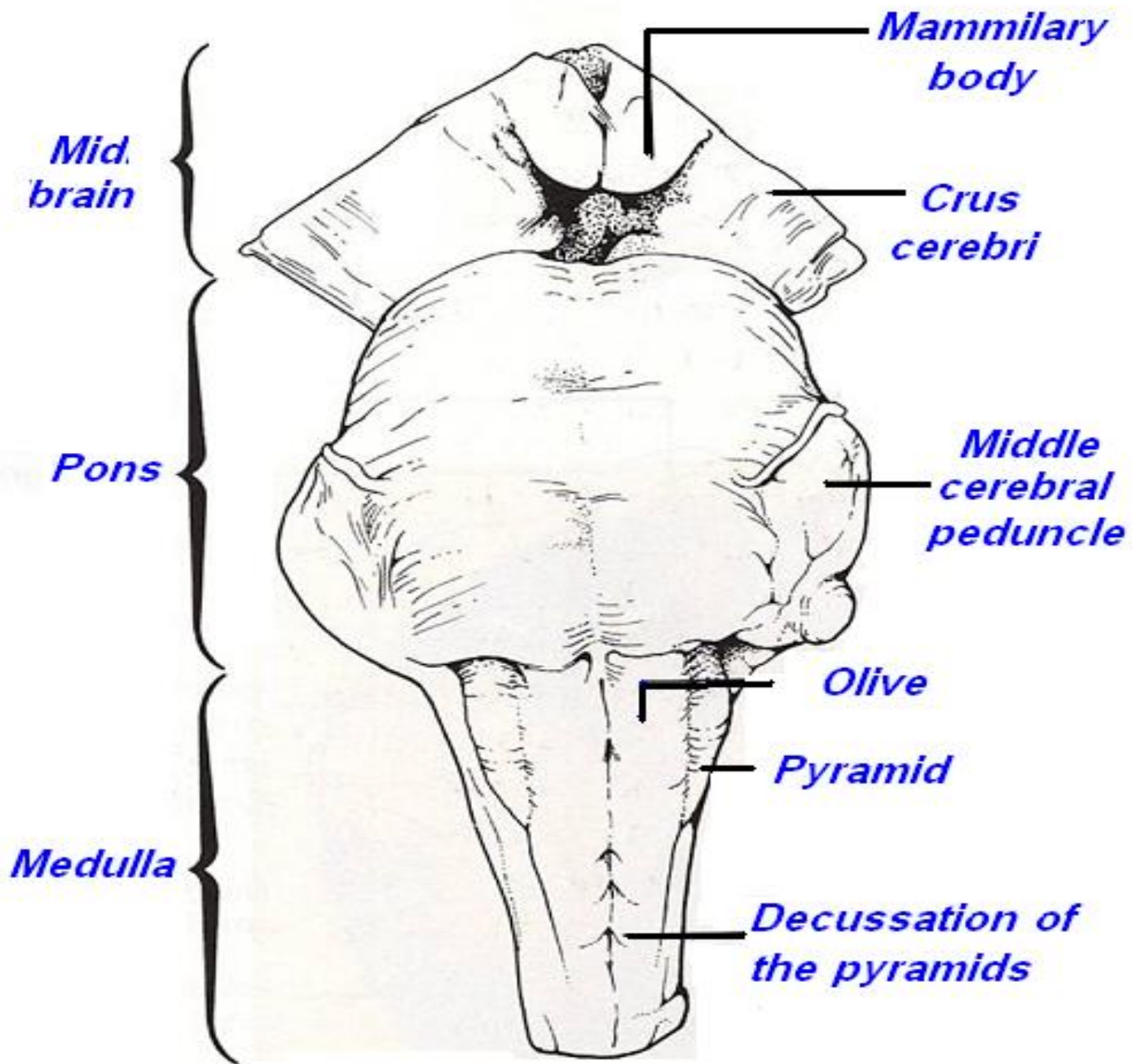
Cross section of the midpons



Medulla

Ventral view

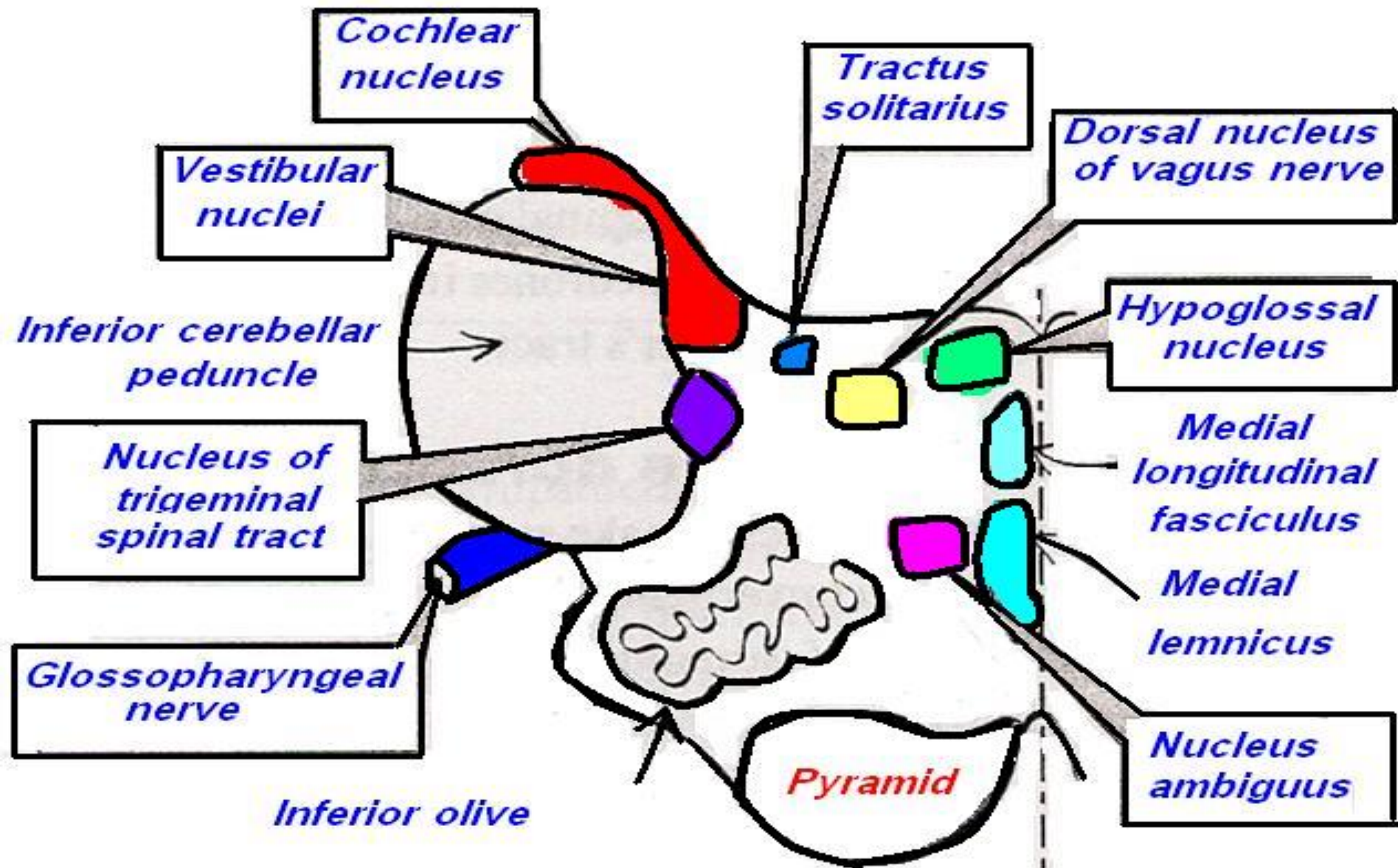
- The most medial part of the medulla is the anterior median fissure.
- Moving laterally on each side are the pyramids. They contain the fibers of the **corticospinal (pyramidal) tract** as they head inferiorly to synapse on lower motor neuronal cell bodies within the ventral horn of the spinal cord.



Ventral surface of the brain stem

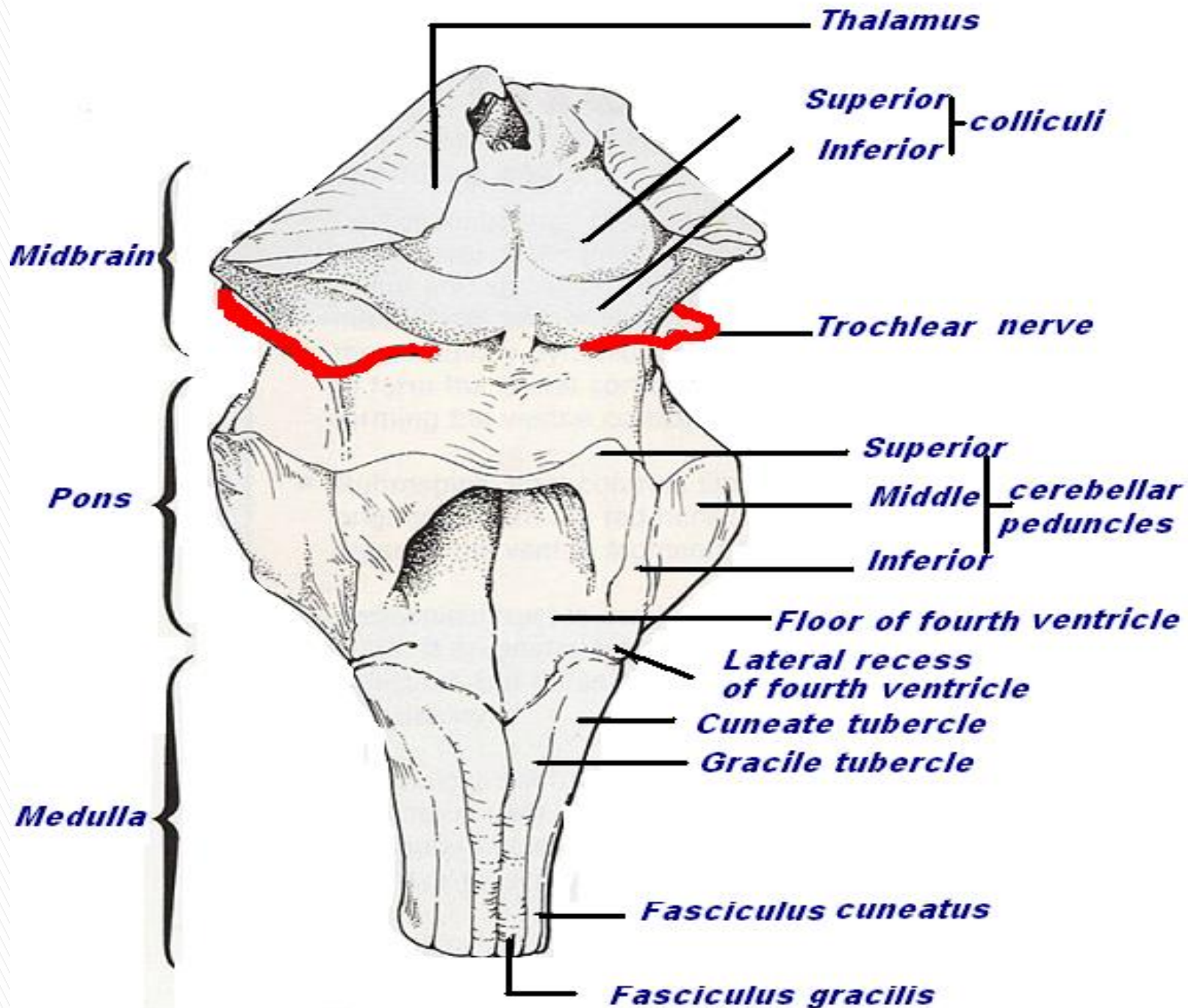
- The anterolateral sulcus is lateral to the pyramids.
- Emerging from the anterolateral sulci are the **hypoglossal nerve** (CN XII) rootlets.
- Lateral to these rootlets and the anterolateral sulci are the **olives**. They are swellings in the medulla containing underlying inferior olivary nuclei (containing various nuclei and afferent fibers).
- Lateral (and dorsal) to the olives are the rootlets for **glossopharyngeal** (IX) & **vagus** (X) cranial nerves.

Cross section of the upper medulla



Dorsal view

- ❖ 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.

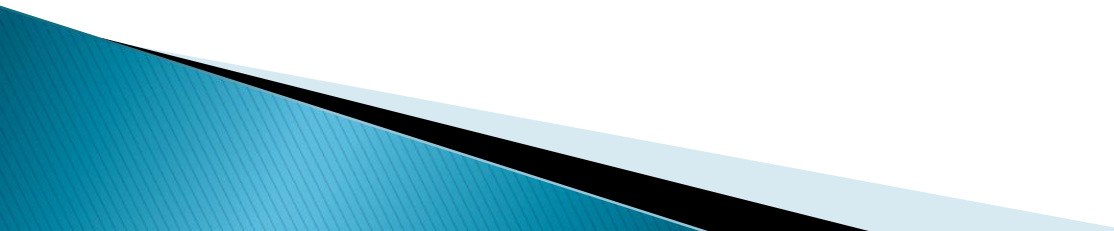


Dorsal surface of the brain stem

- ❖ 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.

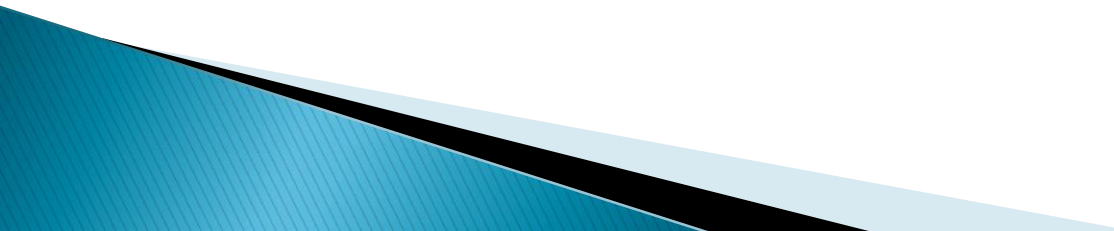
Functions of the Brain Stem

Though small, 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.
- 

1. Conduct functions

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.
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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.

2. 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 originating from, or terminating in, the cranial nerve nuclei in brain stem.

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.

▶ **Sensory**

CN I, CN II, CN VIII

▶ **Motor**

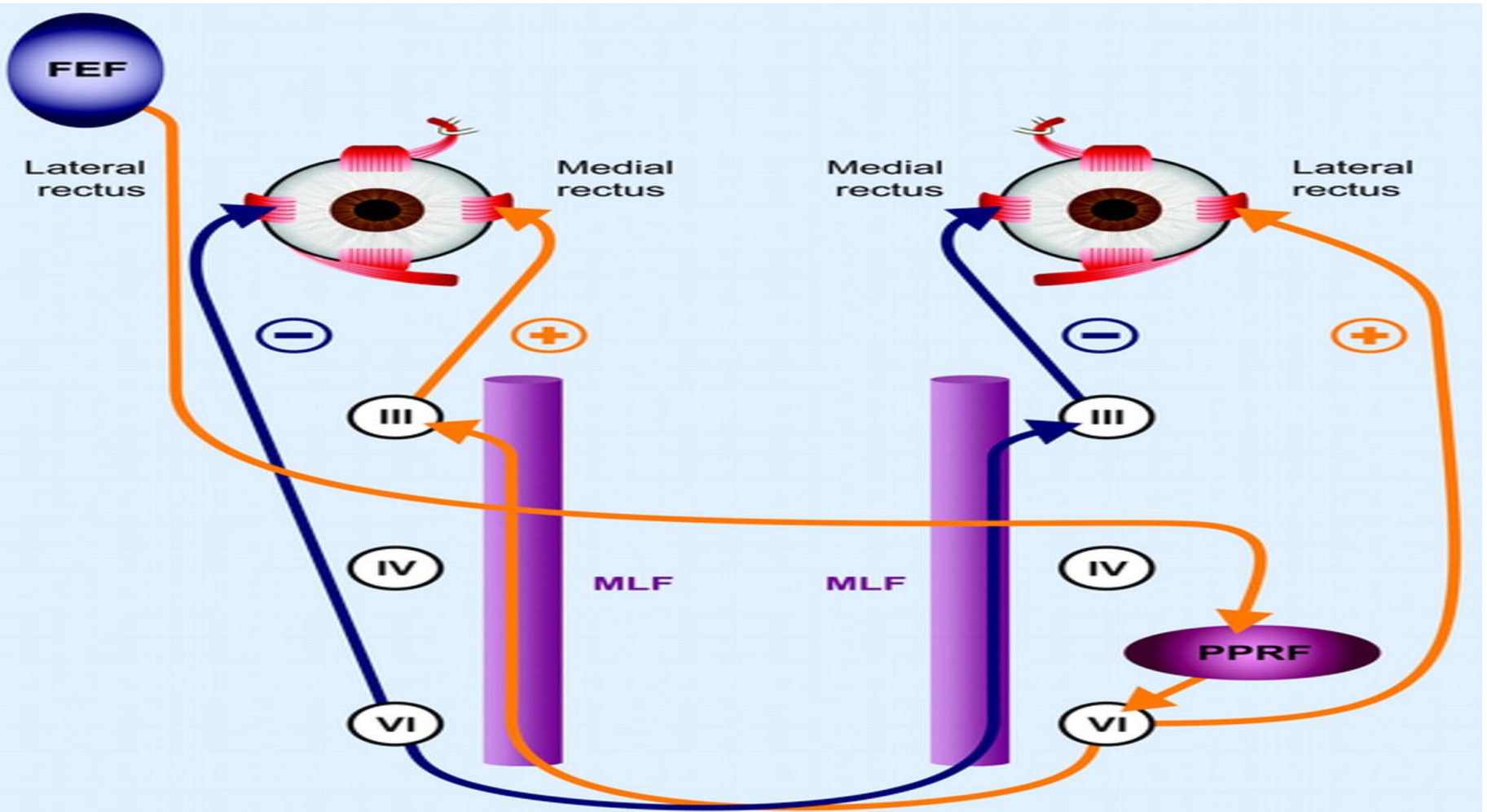
CN III, CN IV, CN VI, CN XI, CN XII

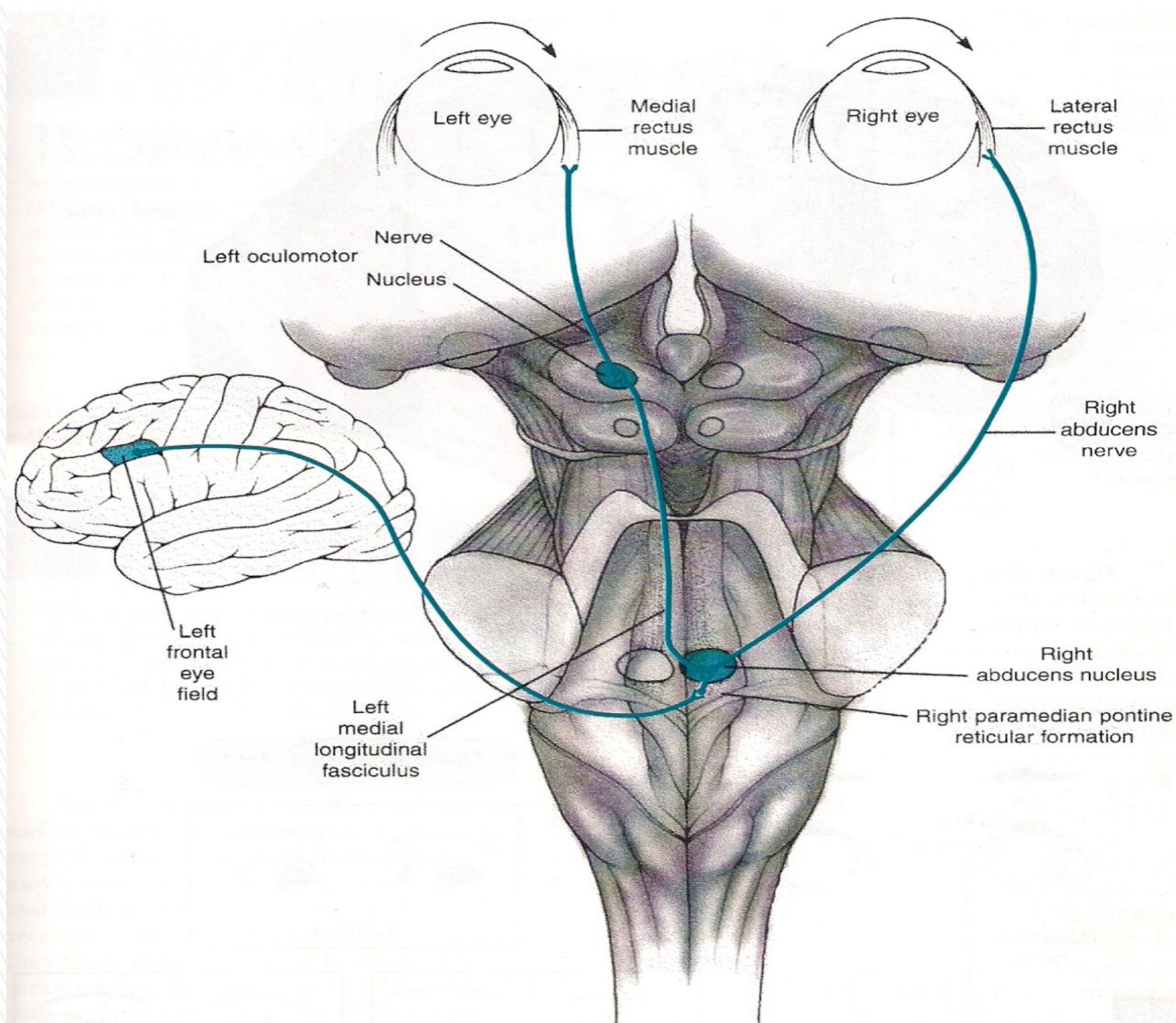
▶ **Mixed**

CN V, CN VII, CN IX, CN X

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

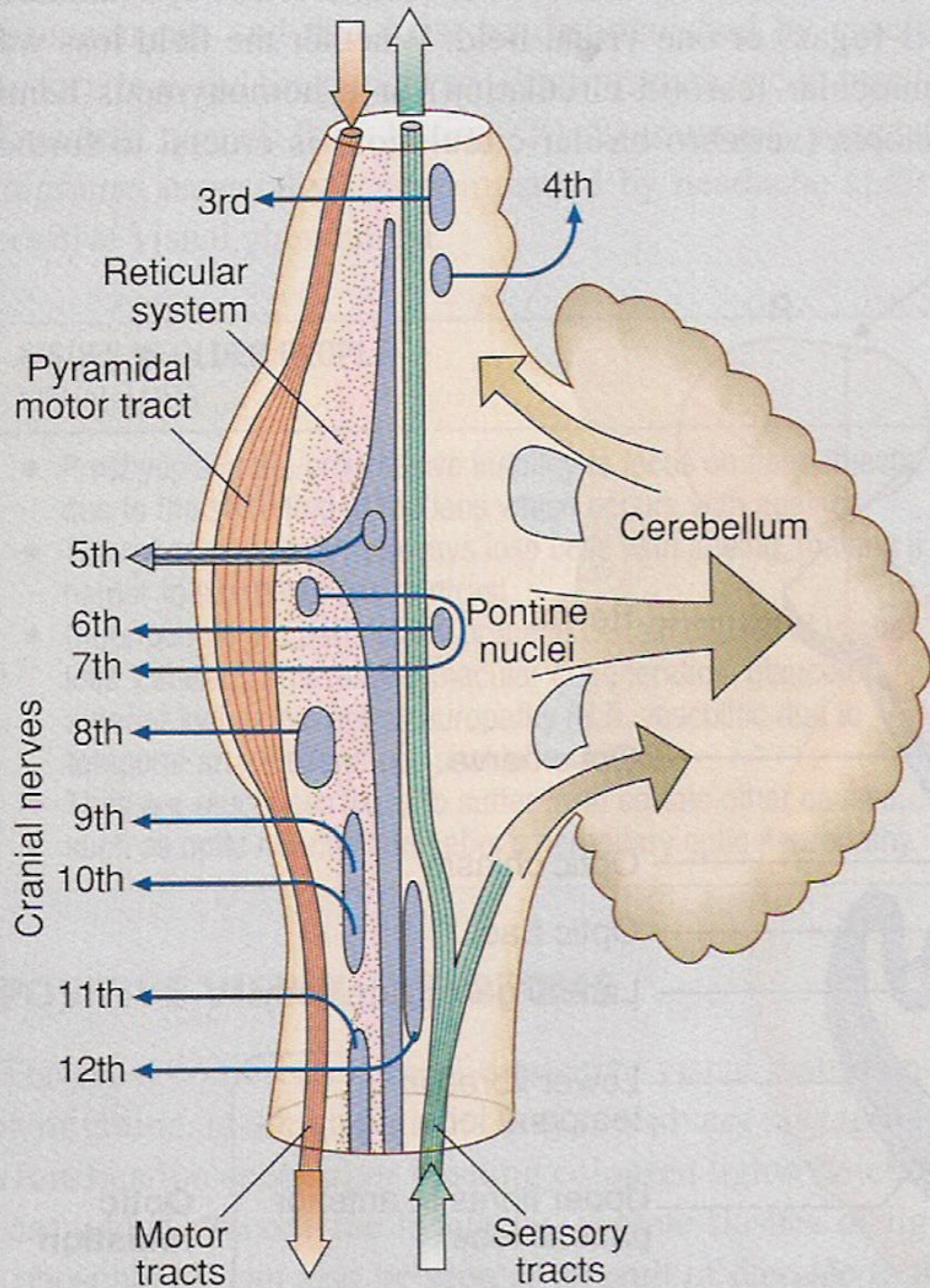
4. Integrative functions

- 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** 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.

- 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 Function Tests

☞ **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 respiratory center**

look for the normal pattern of respiration

☞ **To test cardiovascular center**

Look for normal circulatory function

☞ **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



Thank
You