بسم الله الرحمن الرحيم

السلام عليكم ورحمة الله وبركاته

PHYSIOLOHY OF BRAIN STEM

DR HAYAM GAD
Associate Professor of Physiology

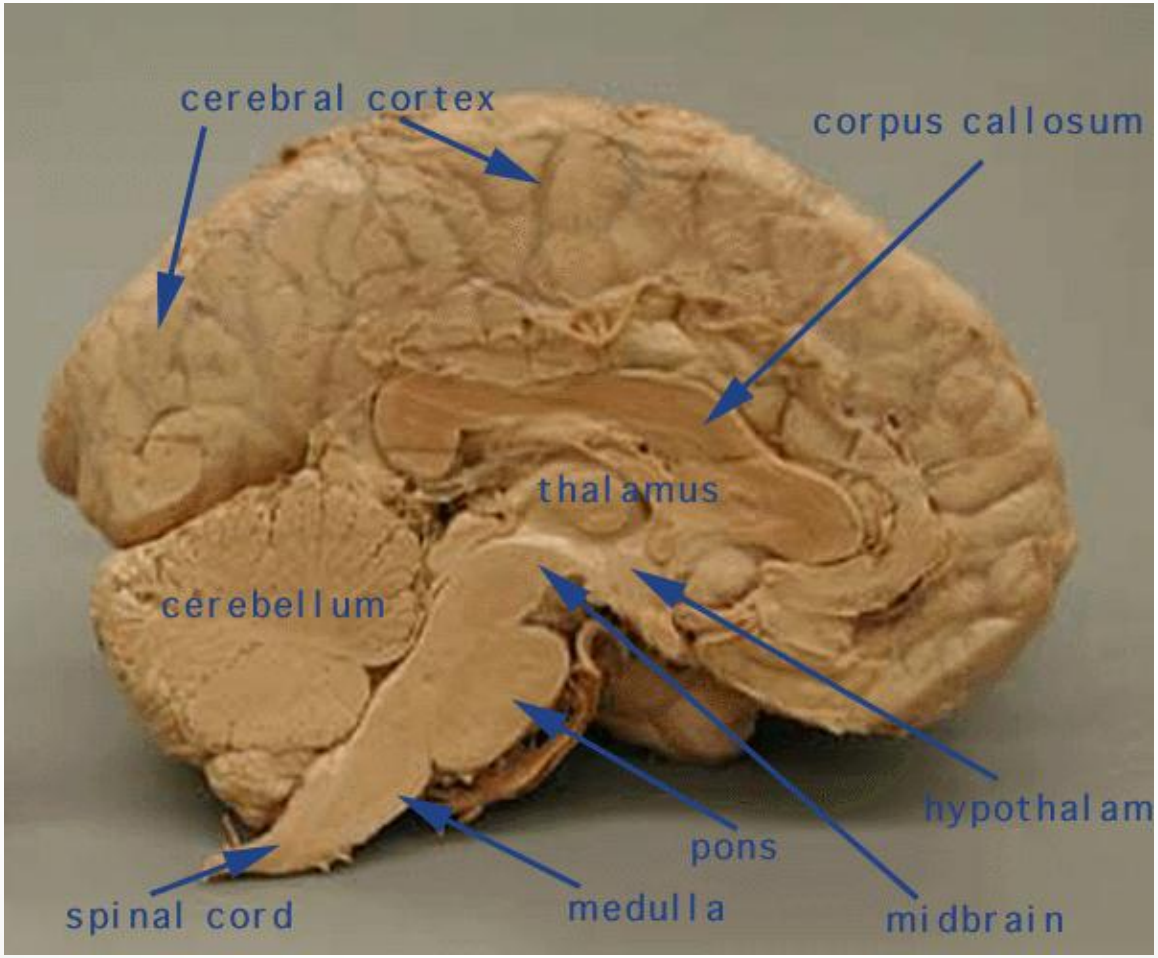
THE BRAIN STEM

- 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.


cerebral cortex
corpus callosum
thalamus
cerebellum
hypothalam
pons
spinal cord
medulla
midbrain

Midbrain

- The midbrain is divided into three parts:
- 1- The tectum ("roof" in Latin). It 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, is involved in the special sense of hearing & sends its inferior brachium to the medial geniculate body of the thalamus.

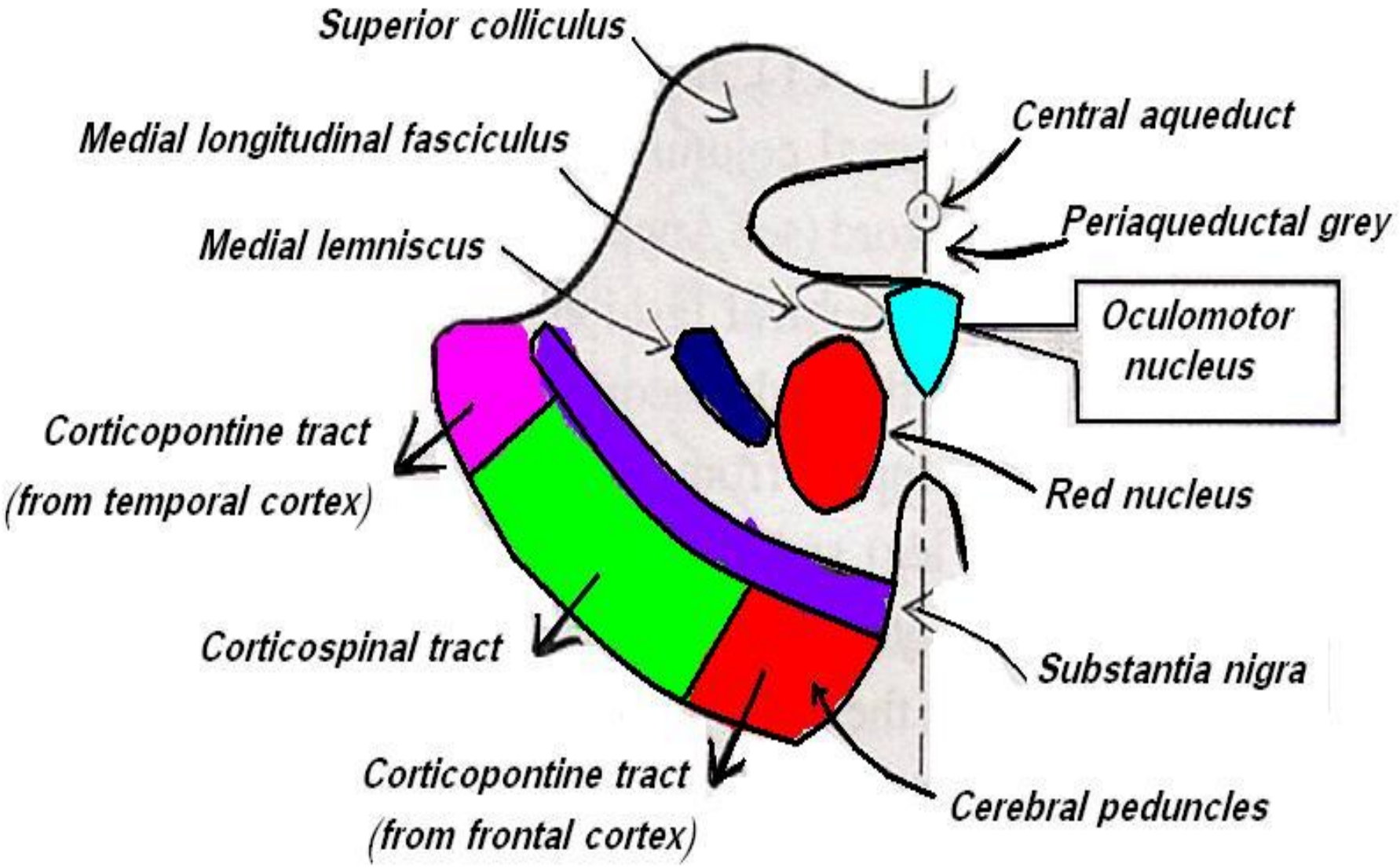
The cerebral aqueduct runs through the midbrain, beneath the colloculi.

- 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.

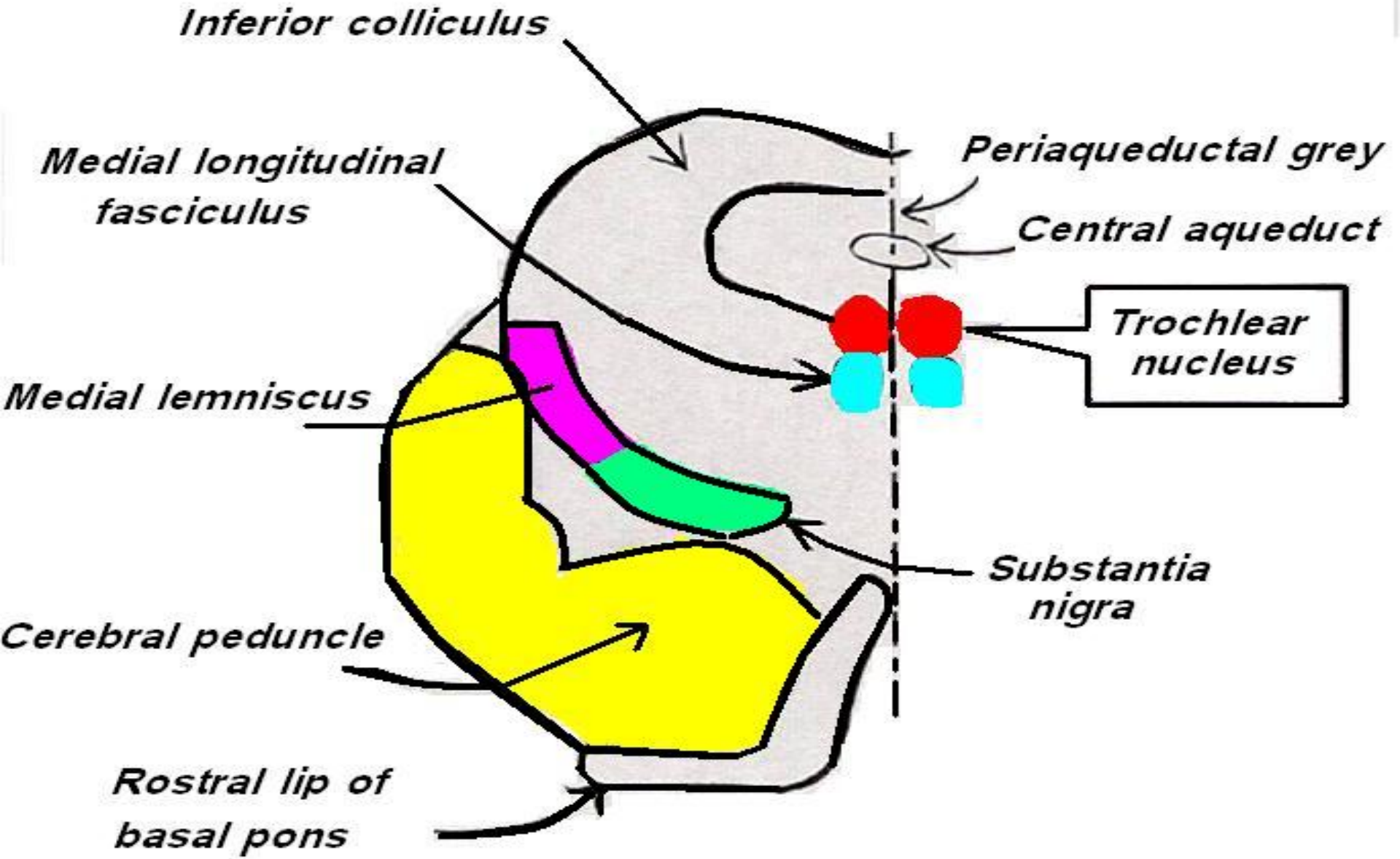
Midbrain internal structures

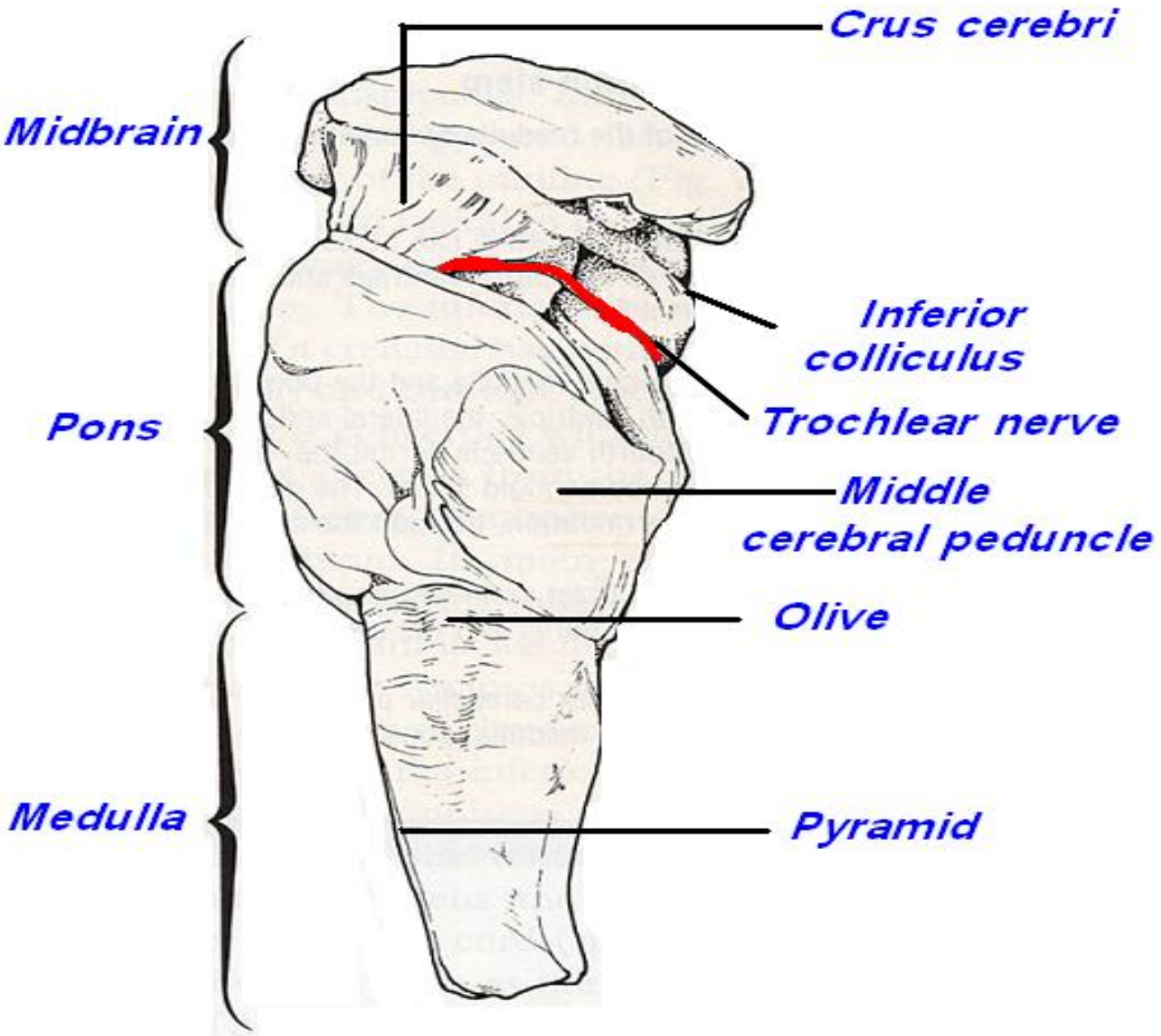
- Periaqueductal gray: Around the cerebral aqueduct, contains neurons involved in the pain desensitization pathway.

Cross section of the upper midbrain



Cross section of the lower midbrain





Lateral surface of the brain stem

- Occulomotor 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.

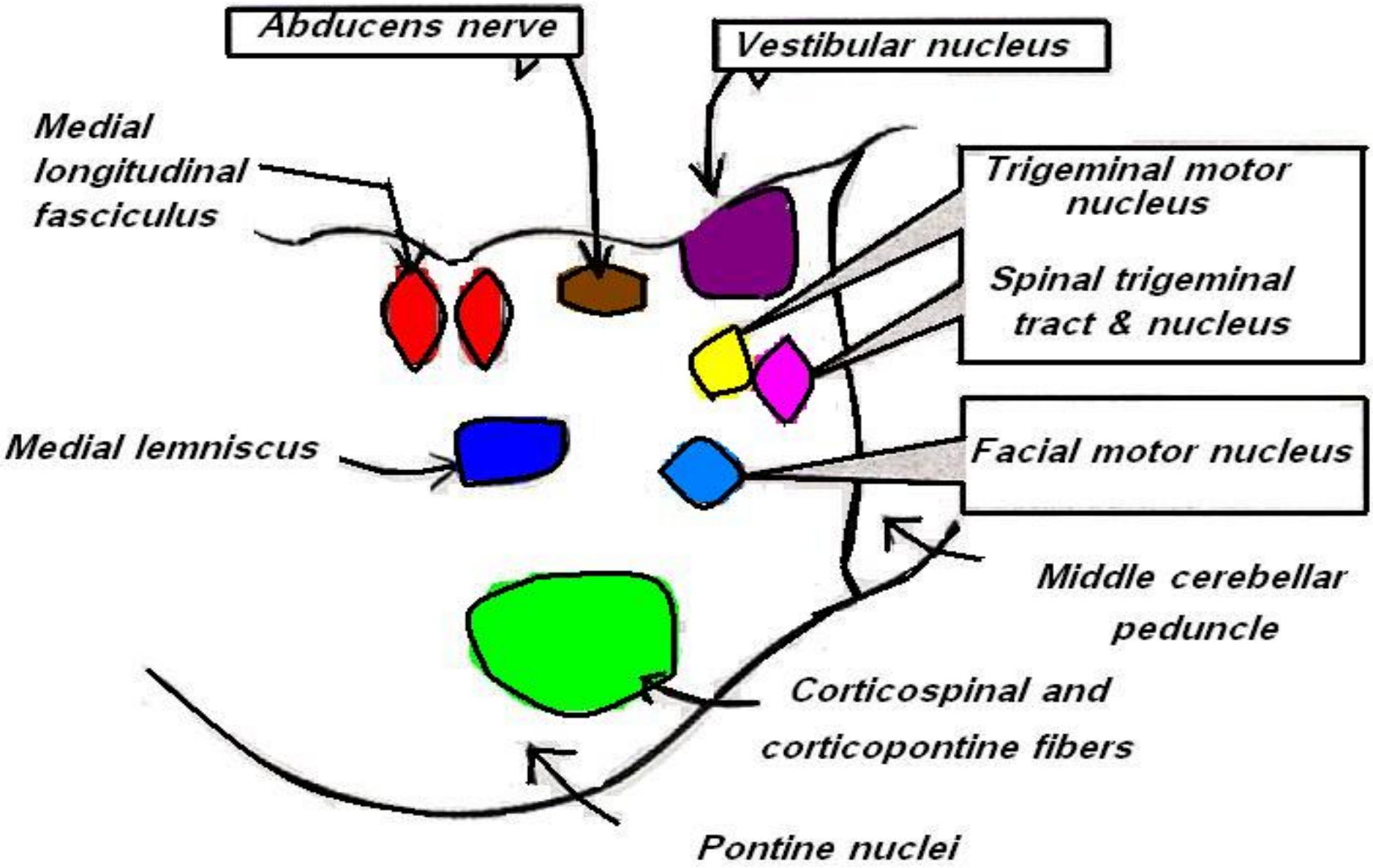
Reticular formation: A large area that is involved in various important functions of the midbrain:

- 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.

Ventral view of the pons

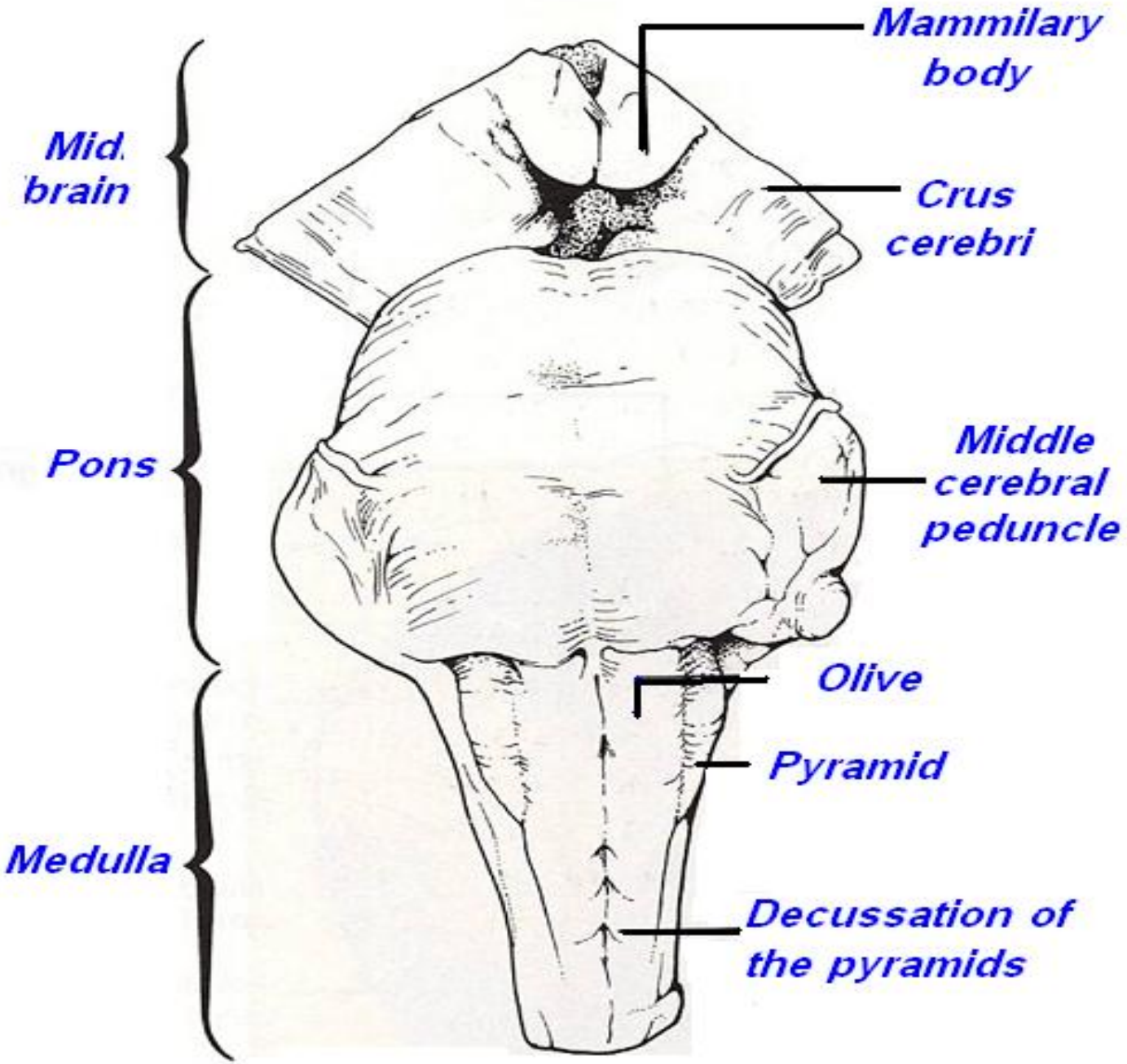
- Between the basal pons, cranial nerve 6 (abducens), 7 (facial) and 8 (vestibulocochlear) emerge (medial to lateral).
- At the level of the midpons, the large trigeminal nerve, CN V, emerges.

Cross section of the midpons



Ventral view of the medulla

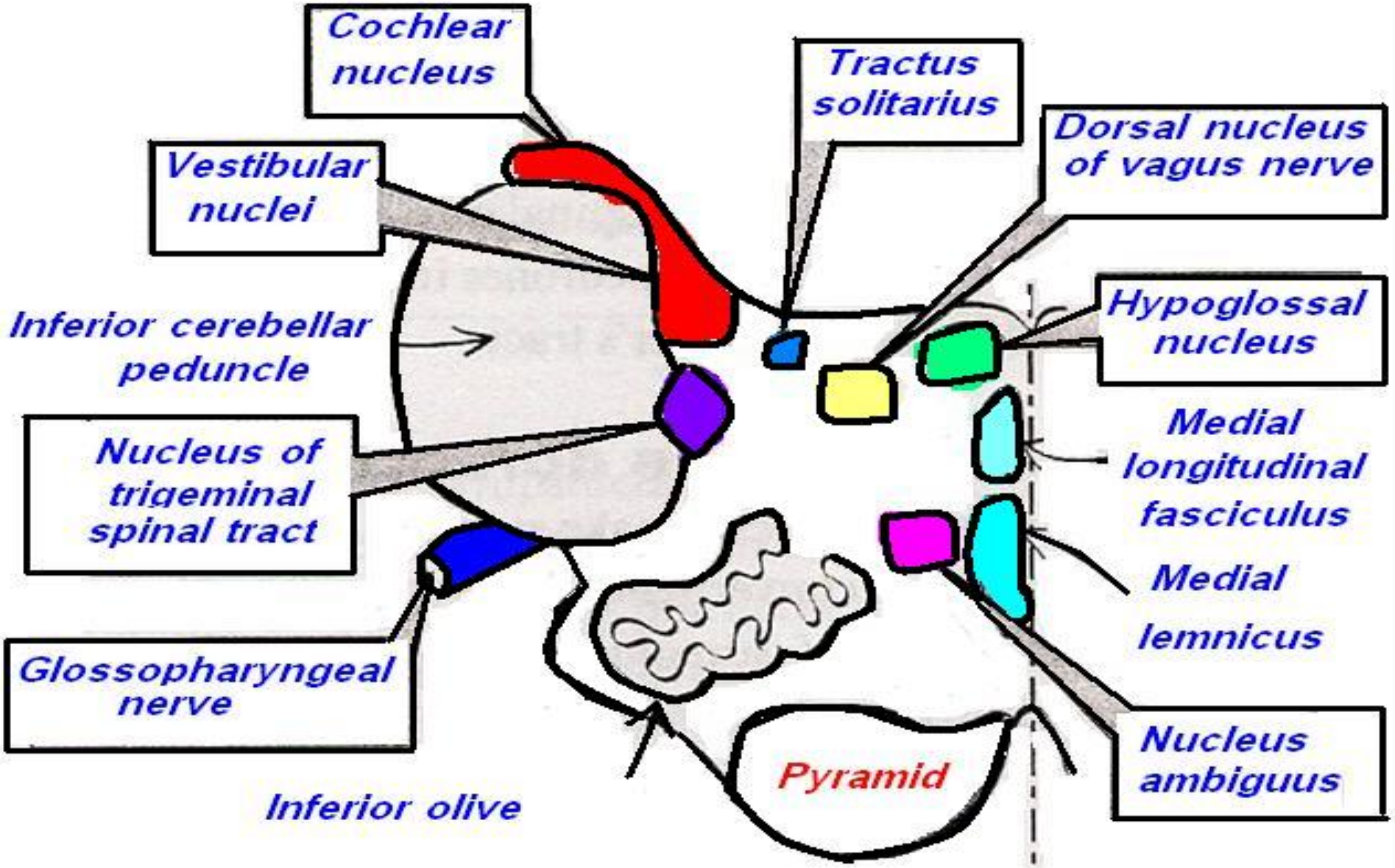
- The most medial part of the medulla is the anterior median fissure. Moving laterally on each side are the pyramids. The pyramids contain the fibers of the corticospinal (pyramidal) tract as they head inferiorly to synapse on lower motor neuronal cell bodies within the ventral horn of the spinal cord.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



Ventral surface of the brain stem

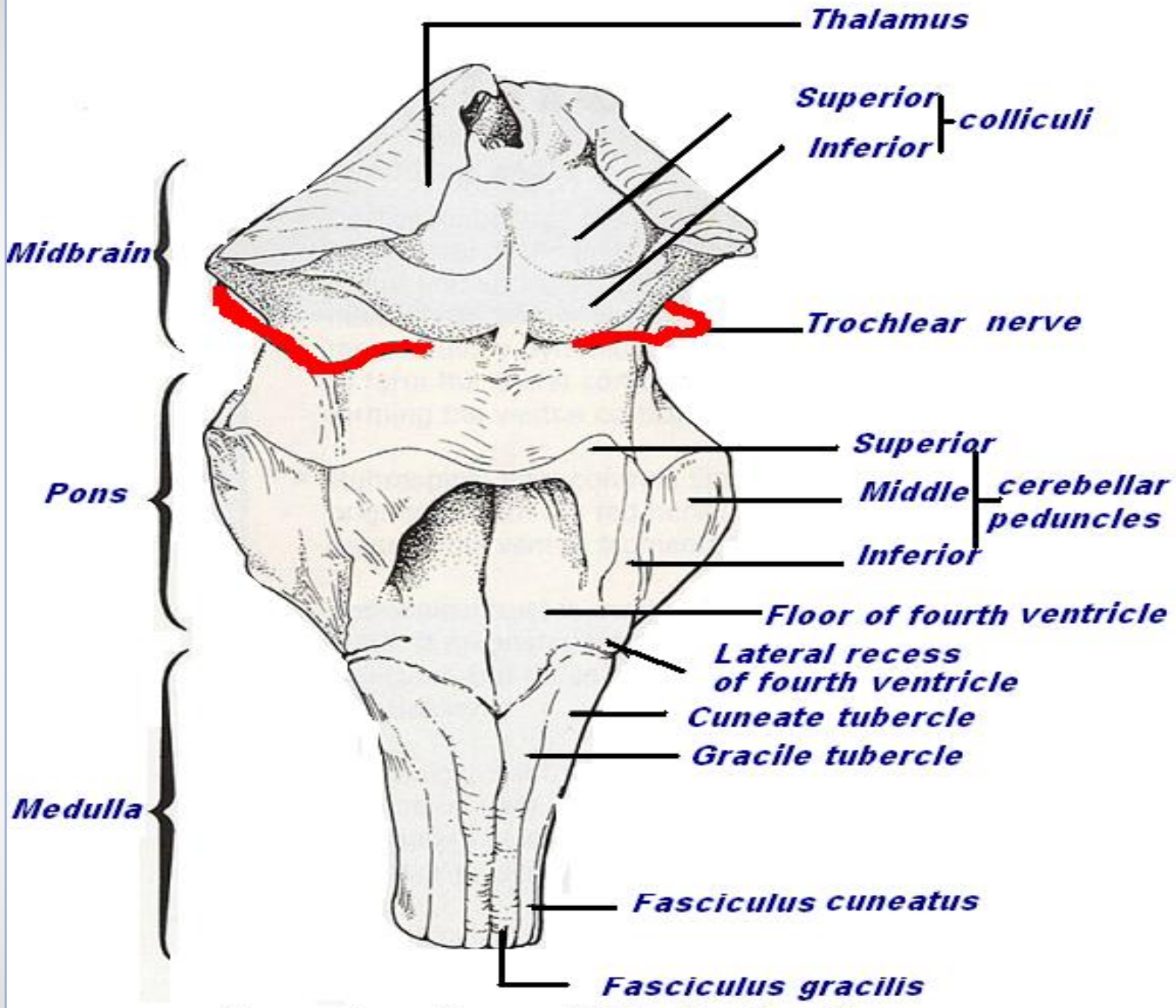
- Emerging from the anterolateral sulci are the hypoglossal nerve (CN XII) rootlets. Lateral to these rootlets and the anterolateral sulci are the olives. The olives are swellings in the medulla containing underlying inferior olivary nuclei (containing various nuclei and afferent fibers). Lateral (and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

Cross section of the upper medulla



Dorsal view of the medulla

- The most medial part of the medulla is the posterior median fissure. Moving laterally on each side is the fasciculus gracilis, and 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.

Functions of the brain stem

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 include

* The spinothalamic tract for pain and temperature sensation.

* The dorsal column, fasciculus gracilis, and cuneatus for touch.

proprioceptive and pressure sensation.

B- Descending tracts are

* 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 contsricts 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.

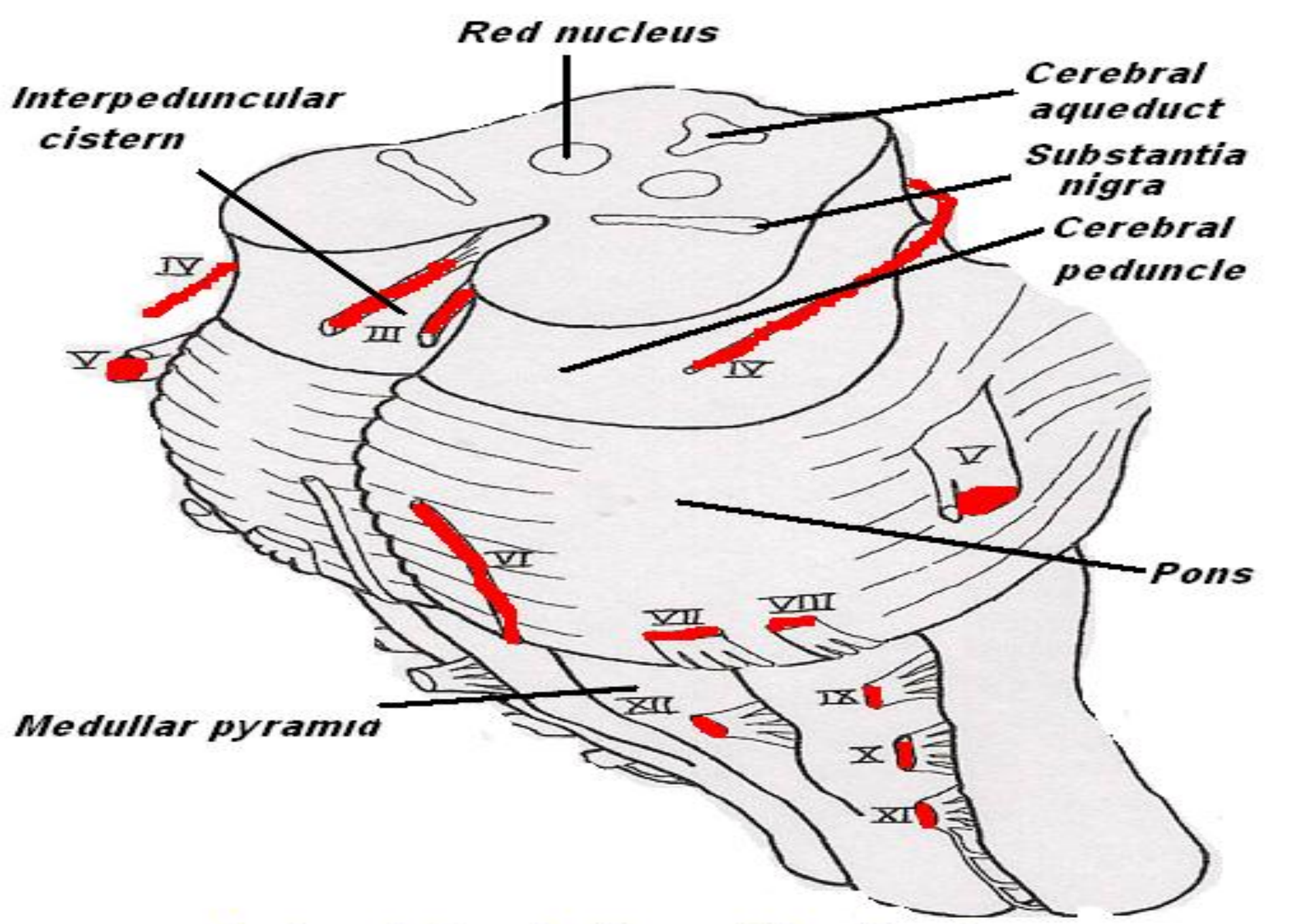
CN XII (hypoglossal): Moves tongue.

- 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



Anterolateral view of brain stem

3. Conjugate eye movement.

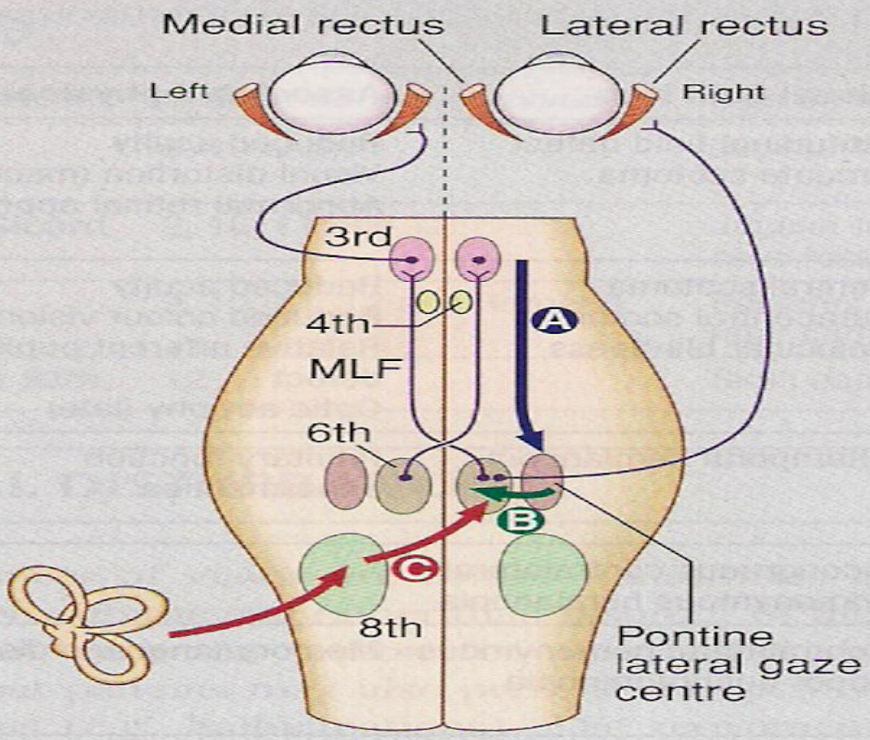
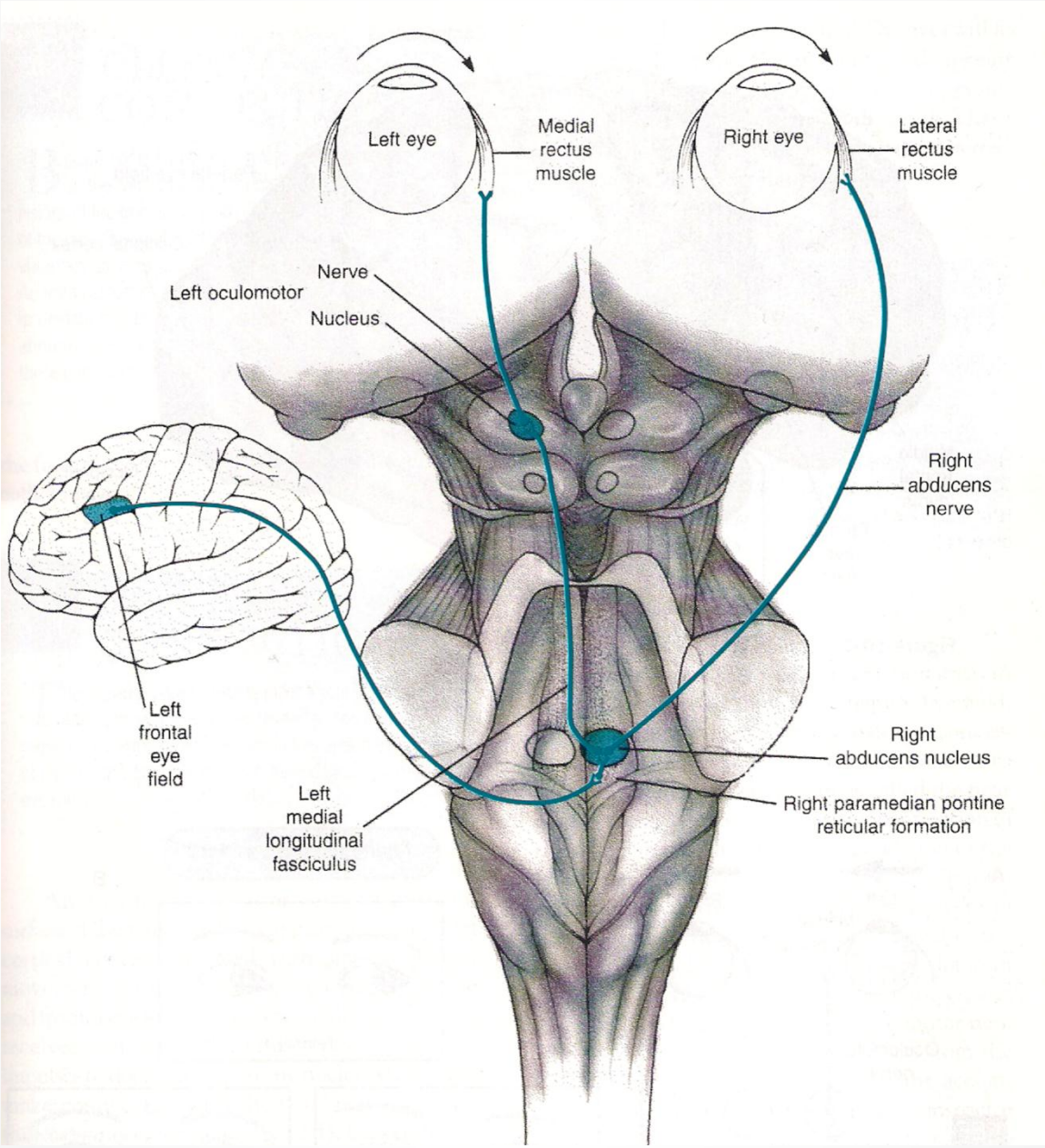


Fig. 22.23 Control of conjugate eye movements. Downward projections from the cortex to pontine lateral gaze centre (A). Pontine gaze centre projects to the 6th cranial nerve nucleus, which innervates the ipsilateral lateral rectus and projects to the contralateral 3rd nerve nucleus (and hence medial rectus) via the medial longitudinal fasciculus (MLF) (B). Tonic inputs from the vestibular apparatus via the vestibular nuclei project to the contralateral 6th nerve nucleus (C).


Left eye
Medial rectus muscle
Right eye
Lateral rectus muscle
Nerve
Left oculomotor
Nucleus
Right abducens nerve
Left frontal eye field
Right abducens nucleus
Left medial longitudinal fasciculus
Right paramedian pontine reticular formation

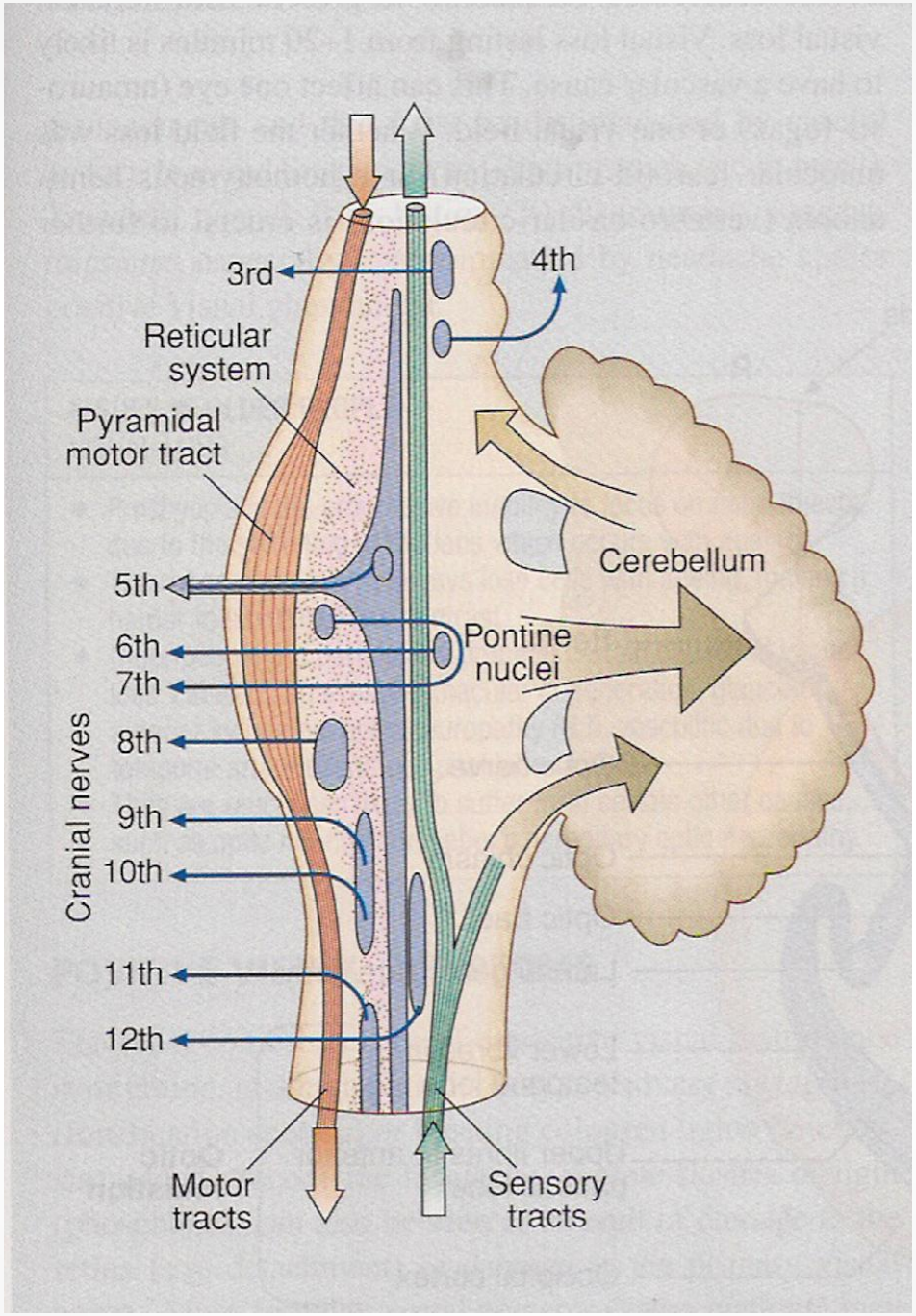
4. The brain stem has integrative functions:-

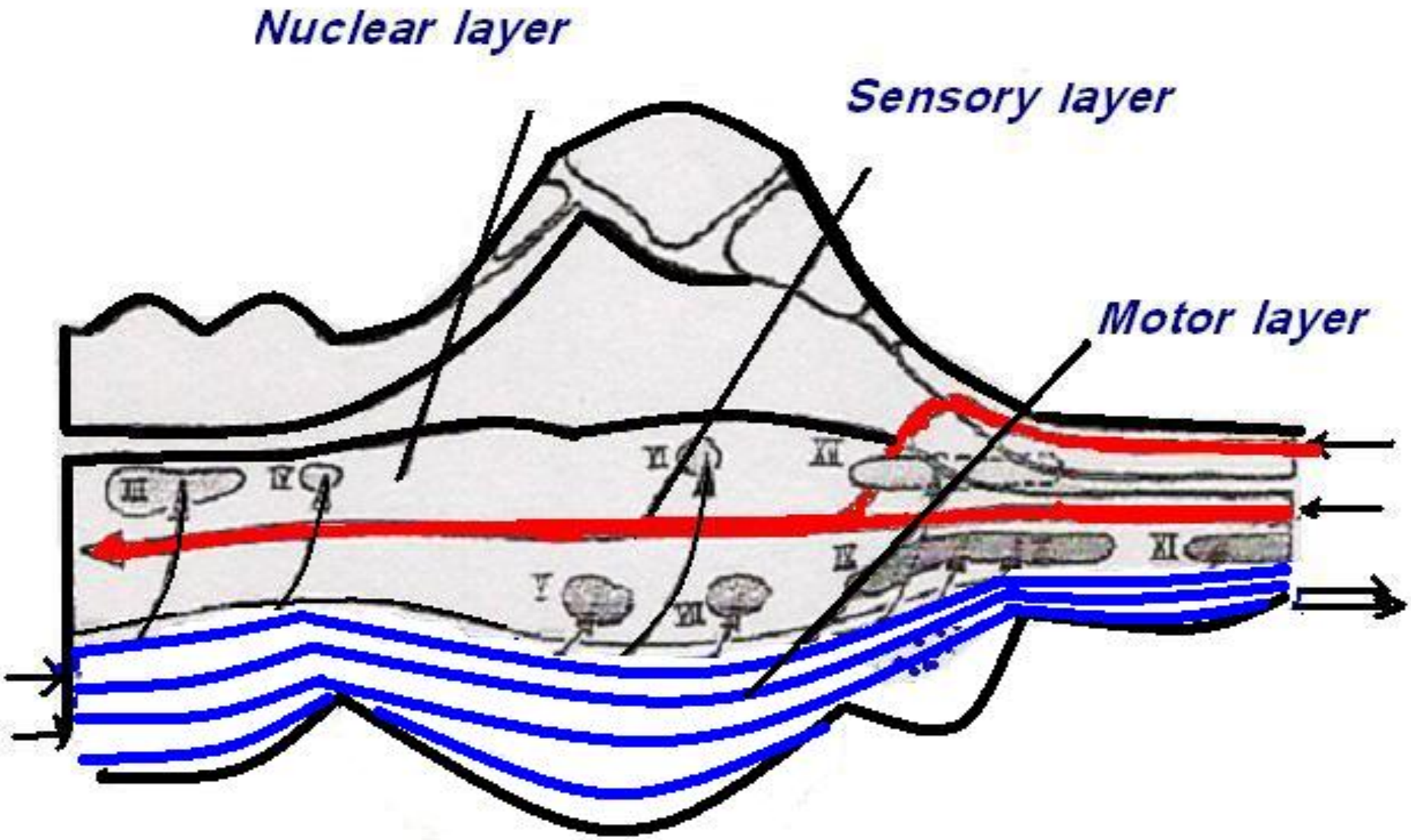
* It controls consciousness & sleep cycle (alertness and arousal) through reticular formation.
* It has got center for cardiovascular, respiratory & autonomic nervous system.
* It has centers for cough, gag, swallow, and vomit.
* Sense of body balance (Vestibular functions)

- 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.


3rd
4th
Reticular system
Pyramidal motor tract
Cerebellum
5th
Pontine nuclei
6th
7th
8th
Cranial nerves
9th
10th
11th
12th
Motor tracts
Sensory tracts



Gross internal structure of the brain stem

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

Brain Stem Function Tests

- 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


Thank
You
SoulCityGraphics