MEDICINE
KING SAUD UNIVERSITY

436

تمت المراجعة
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Physiology Team 436

CNS PHYSIOLOGY

- Text
- Important
- Formulas
- Numbers
- Doctor notes
- Notes and explanation

Lecture No.6

"Don't Follow The Majority, Follow The Right way"

We recommended you to study the anatomy of brainstem, the ascending and descending tracts lectures first.
We recommended you to read this lecture from neuroanatomy book.You can find the book on the team drive, page 91-101

Physiology of Brainstem

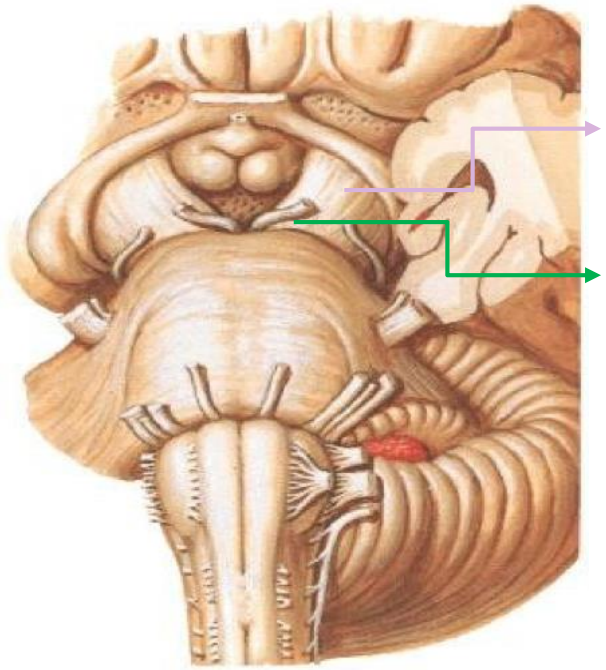
Objectives:

1. Know what is brainstem.
2. What are its internal structures.
3. What are its functions.
4. What will happen if damaged e.g brain death.

The brainstem

- 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



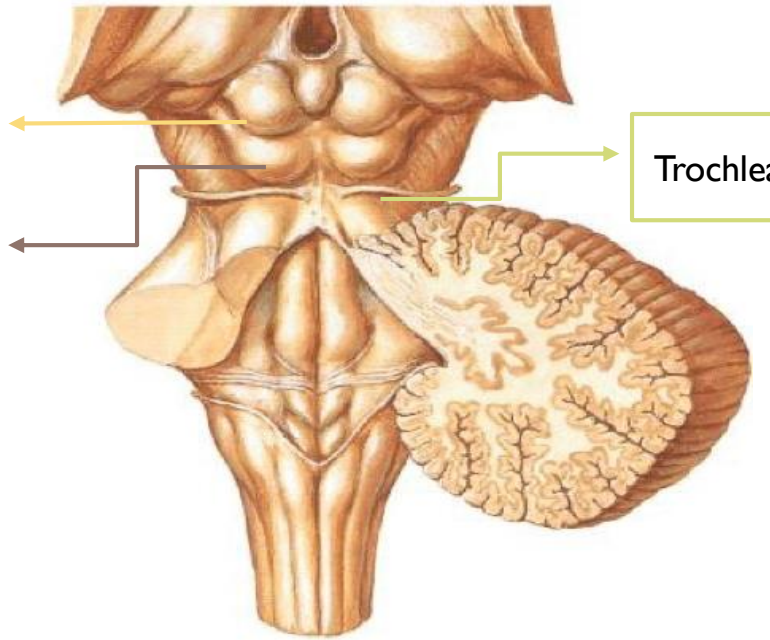
Cerebral Peduncles

Oculomotor nerve

Posterior surface of brainstem

Superior colliculus

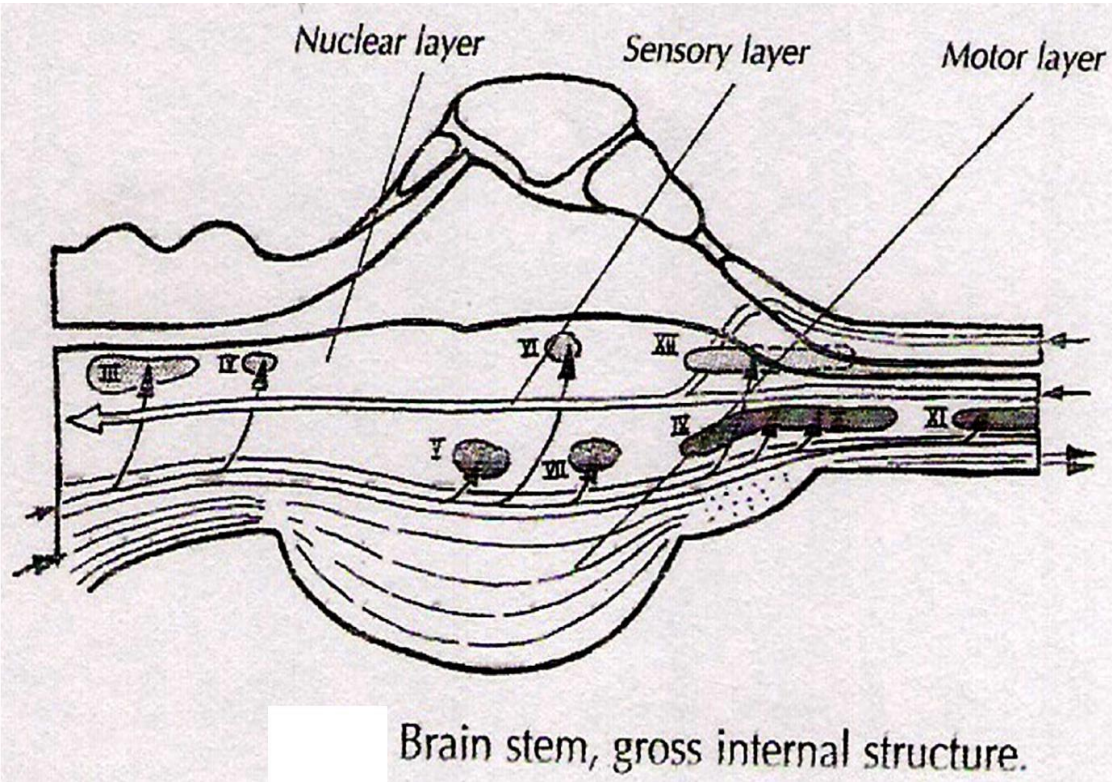
Inferior colliculus



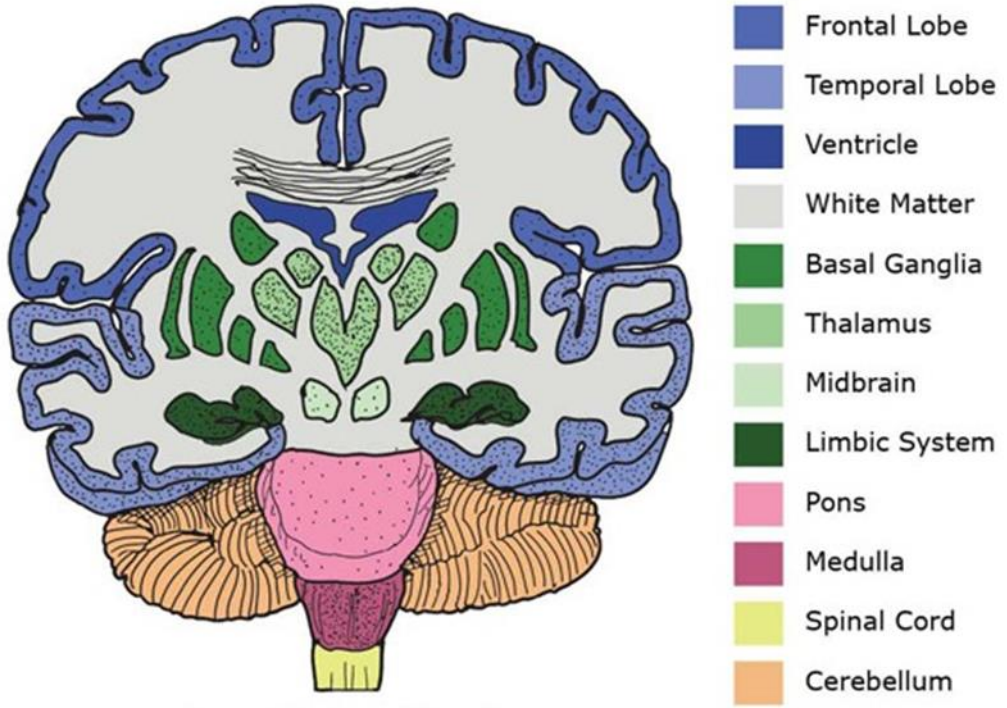
Trochlear nerve

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.



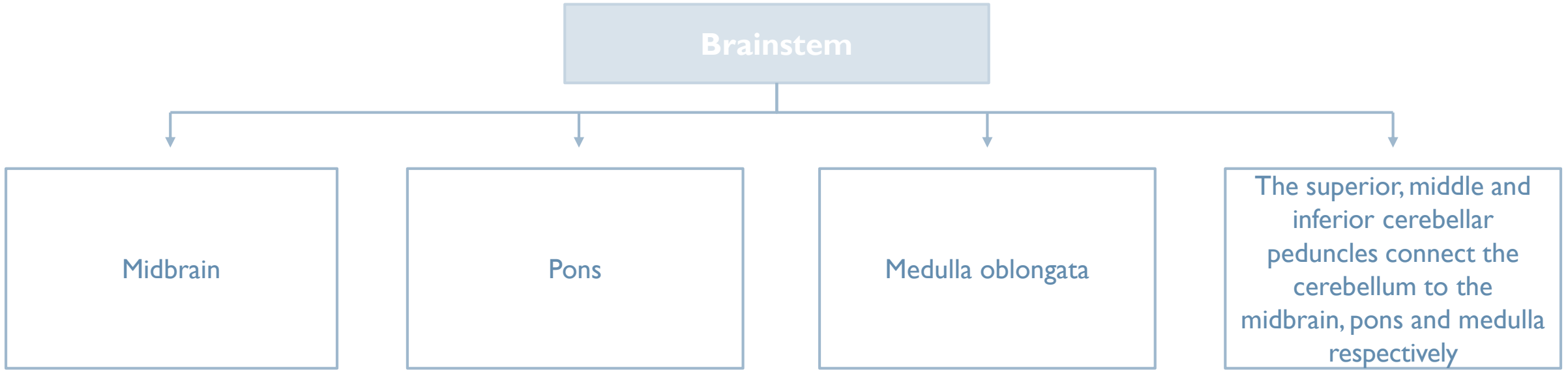
Extra picture for understanding

Components of brainstem

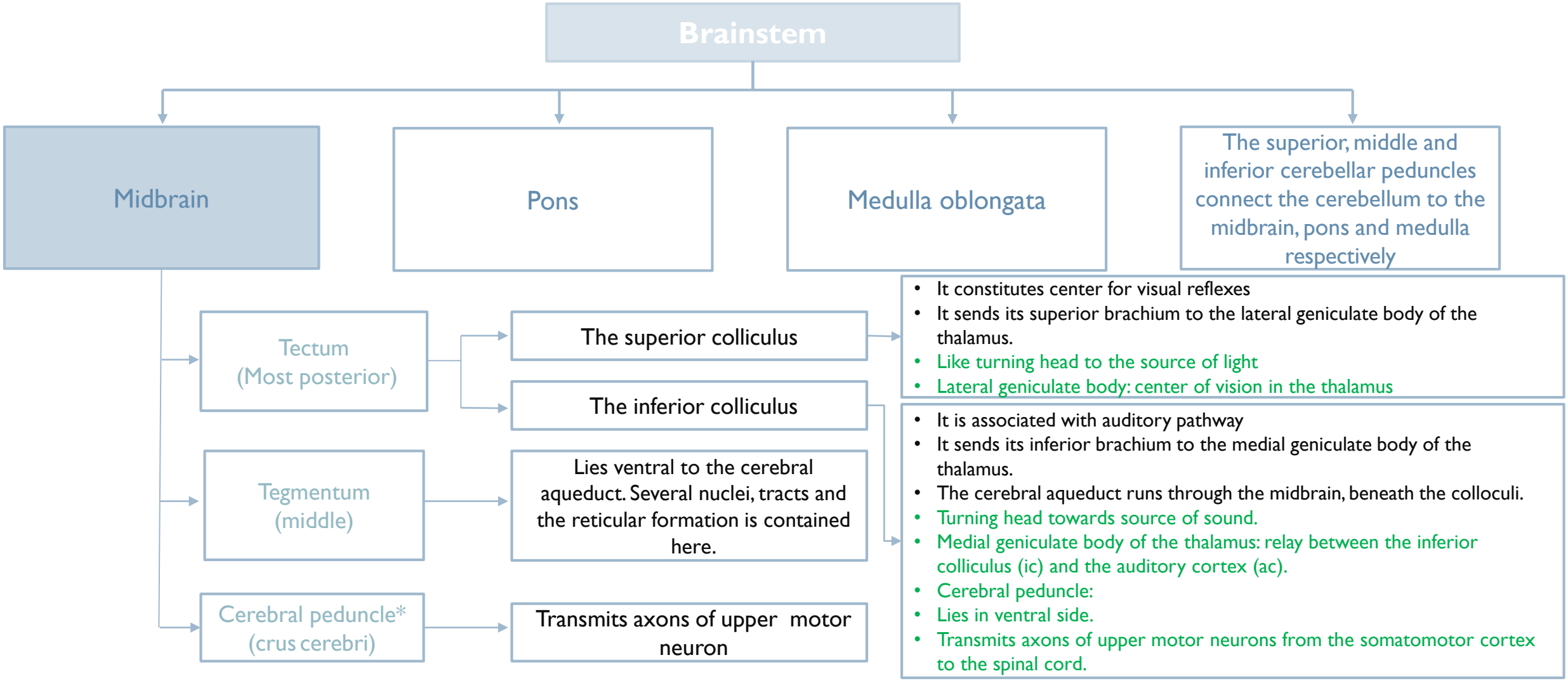
- Brainstem where 1 cm tumor can lead to death.

Basic structure of brain stem:

1. Roof plate
2. Tegmentum
3. Basal portion



Components of midbrain



*cerebral NOT Cerebellar, don't confuse between the CerebeLLar and cerebral. CerebeLLar peduncles connect the brainstem to the cerebellum.

Internal structure of Midbrain

Midbrain
"Internal structures"

Periaqueductal Gray

- Around the cerebral aqueduct
- contains neurons involved in analgesia and pain modulation/desensitization

1.Occulomotor nerve (CN III) nucleus
2.Trochlear nerve (CN IV) nucleus
3.Red Nucleus: gives out Rubrospinal (motor nucleus that sends a descending tract to the lower motor neurons)

Substantia Nigra

- Nigra means black and it is black due to melanin pigments.
- Involved in control of motor function
- Part of basal ganglia
- A concentration of neurons in the ventral portion of midbrain
- It is involved in motor function
- They secrete Dopamine.
- Degeneration of Substantia Nigra is associated with Parkinson's disease.

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

- Contains neurons that form the core 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.

Components of Pons, Medulla oblongata

Brainstem

- **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**
  - Continuous with the spinal cord. Fasiculus gracilis and Fasiculus cuneatus: They carry sensation for fine touch, pressure and proprioception.
  - 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.
    - **Dorsal view**
      - Moving lateral on each side is the fasciculus gracilis.
      - The posterior median fissure.
      - 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.
- The superior, middle and inferior cerebellar peduncles connect the cerebellum to the midbrain, pons and medulla respectively

Brain stem motor functions

- Brain stem serves as a way station for "command signals" from higher neural centers.
- The autonomic nervous system is activated mainly by centers located in the spinal cord, brain stem, and hypothalamus (cardiovascular gastrointestinal autonomic reflexes).
- Functions of brain stem nuclei in controlling subconscious, stereotyped movements (anencephaly) motor branch of the fifth cranial nerve, and the chewing process is controlled by nuclei in the brain stem and also swallowing, salivary secretion, vomiting (chemoreceptor trigger zone).
- The actual mechanics of feeding are controlled by centers in the brain stem.
- Vasomotor center for cv control (baroreceptors) in medulla.
- Many of the behavioral functions elicited from the hypothalamus and other limbic structures are also mediated through the reticular nuclei in the brain stem and their associated nuclei.
- Accommodation is controlled by parasympathetic nerves by 3rd cn.
- Brain stem neurohormonal systems in the human brain for activating four neurohormonal systems.
- Although the micturition reflex is an autonomic spinal cord reflex, it can also be inhibited or facilitated by centers in the cerebral cortex or brain stem in pons.
- Neural pathways for control of eye movements. Also shows brain stem nuclei for the third, fourth, and sixth cranial nerves by medial longitudinal fasciculus.
- Auditory nervous pathways → superior olivary nucleus.
- Nucleus of tractus solitarious→ taste pathway→sup & inf salivatory nuclei.
- Bulboreticular facilitatory area of brain stem for gamma efferent system (stabilizes joints).
- Control of cerebral activity by continuous excitatory signals from the brain stem (reticular excitatory area of the brain stem→bulboreticular facilitory area→it is the same brain stem reticular area that transmits facilitorysignals downward to the spinal cord to maintain tone in the antigravity muscles and to control levels of activity of the spinal cord reflexes.

ONLY IN MALES' SLIDES

Neurohormonal systems in the brain

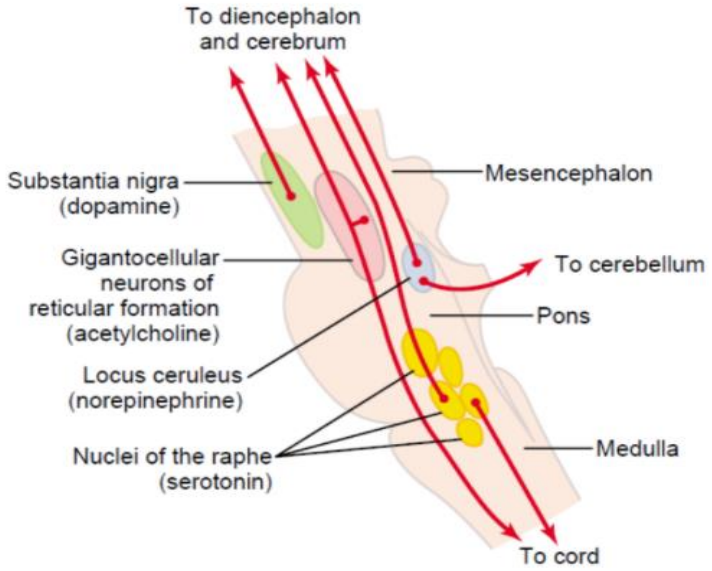
Brain stem areas in the human brain for activating four neurohormonal systems:-

1. The locus ceruleus and the norepinephrine system. Important role in causing dreaming, thus leading to a type of sleep called rapid eye movement sleep (REM sleep).

2. The substantia nigra and the dopamine system.

3. The raphe nuclei and the serotonin system. At cord suppress pain and in higher centers cause normal sleep.

4. The giganto-cellular neurons of the reticular excitatory area and the acetylcholine system. Activation of these acetylcholine neurons leads to an acutely awake and excited nervous system.

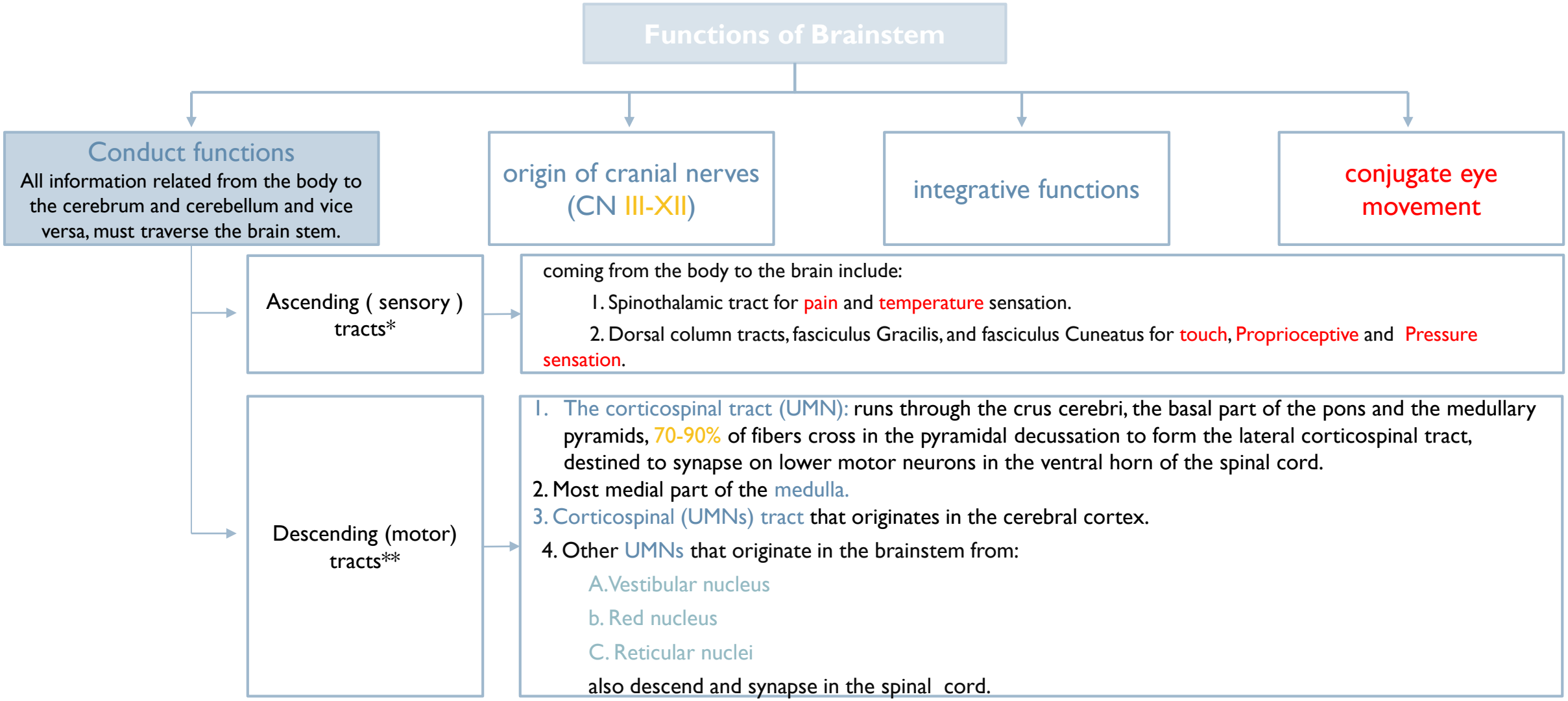


Role of the brain stem in controlling motor functions

Role of the brain stem in controlling motor functions

- 1. Control of respiration
- 2. Control of the cardiovascular system
- 3. Partial control of gastrointestinal function
- 4. Control of many stereotyped movements of the body
- 5. Control of equilibrium
- 6. Control of eye movements

Functions of brainstem



* Spinothalamic also called anterolateral system.

**Descending tracts includes: pyramidal, corticospinal and extra-pyramidal.

Origin and function of cranial nerves

- 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 and Function of Cranial Nerves

Midbrain (eye movement)

- CN III (oculomotor): constrict pupils. Responsible for near vision and accommodation
- CN IV (trochlear).

Pons

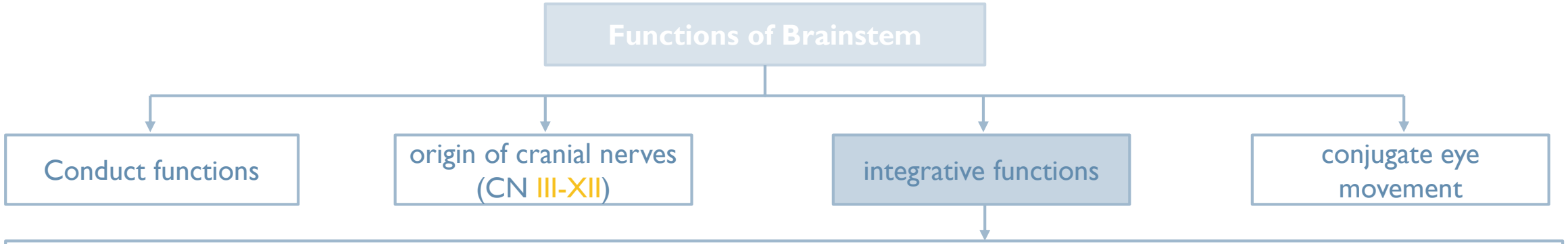
- CN V (trigeminal): chewing and sensation front of the head.
- CN VI (abducens): eye movement.
- CN VII (facial): moves face, taste, salivates, cries.
- CN VIII (acoustic): hearing regulates balance.

Medulla

- CN IX (glossopharyngeal): tastes, salivates, swallows, monitors carotid and sinus bodies).
- CN X (vagus): tastes, swallows, lifts palate, talking, communication to and from thoraco-abdominal viscera.
- CN XI (accessory): turns head, lifts shoulder.
- CN XII (hypoglossal): moves tongue.

Sensory (1-2-8)	Motor (3-4-6-11-12)	Mixed (5-7-9-10)
CN I, CN II, CN VIII	CN III, CN IV, CN VI, CN XI, CN XII	CN V, CN VII, CN IX, CN X

Functions of brainstem, integrative functions



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:
   a. Substantia Nigra (which is a part of the basal ganglia) is involved in control of movement.
   b. 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

• Inferior and superior colliculi are situated on the dorsal surface of the midbrain and is involved in auditory & visual processing required for head movements.

Functions of brainstem, conjugate eye movement

Functions of Brainstem

- Conduct functions
- origin of cranial nerves (CN III-XII)
- integrative functions
- conjugate eye movement

ONLY IN FEMALES' SLIDES

- 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 conjugate eye movements to the right.

- 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

Brainstem

Part	Function	Cranial Nerves	Signs and symptoms of lesion
Midbrain	• Nerve pathway to cerebral hemispheres. • Auditory and Visual reflex centers.	1. CN III - Oculomotor (motor) (Related to eye movement). 2. CN IV - Trochlear (motor) (Superior oblique muscle of the eye which rotates the eye down and out)	• Cranial Nerve (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
Pons	Respiratory Center	1. CN V - Trigeminal (motor and sensory). (Skin of face, tongue, teeth, muscle of mastication). 2. CN VI - Abducens (motor). (Lateral rectus muscle of eye which rotates eye outward). 3. CN VII - Facial (motor and sensory). (Muscles of facial expression). 4. CN VIII – Acoustic (sensory). (Hearing).	• Pupils size: Pinpoint • LOC: Semi-coma • Movement: Abnormal extensor. • Respiratory: - Apneustic (Abnormal respiration marked by sustained inhalation). - Hyperventilation. • CN Deficits: CN V, CN VI, CN VII, CN VIII.
Medulla Oblingata	• 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.	1. CN IX - Glossopharyneal (mixed). (Muscles & mucous membranes of pharynx, the constricted openings from the mouth & the oral pharynx and the posterior third of tongue). 2. CN X - Vagus (mixed). (Pharynx, larynx, heart, lungs, stomach). 3. CN XI - Accessory (motor). (Rotation of the head and shoulder). 4. CN XII - Hypoglossal (motor). (Intrinsic muscles of the tongue).	• Movement: Ipsilateral paralysis. • Pupils: - Size: Dilated. - Reactivity: Fixed. • Respiratory: Abnormal breathing patterns • CN Palsies: Inability to control movement. Absent cough, gag. • LOC: Comatose. • damage of medulla can lead to serious condition because it has the most important centers such as respiratory and cardiac centers..

- Midbrain lesion: Source of light applied to the eye causes constriction which signifies occulomotor nerve intact.
- Pay attention to function of each nerve because you can be asked about specific nerve lesions.

Brainstem function tests

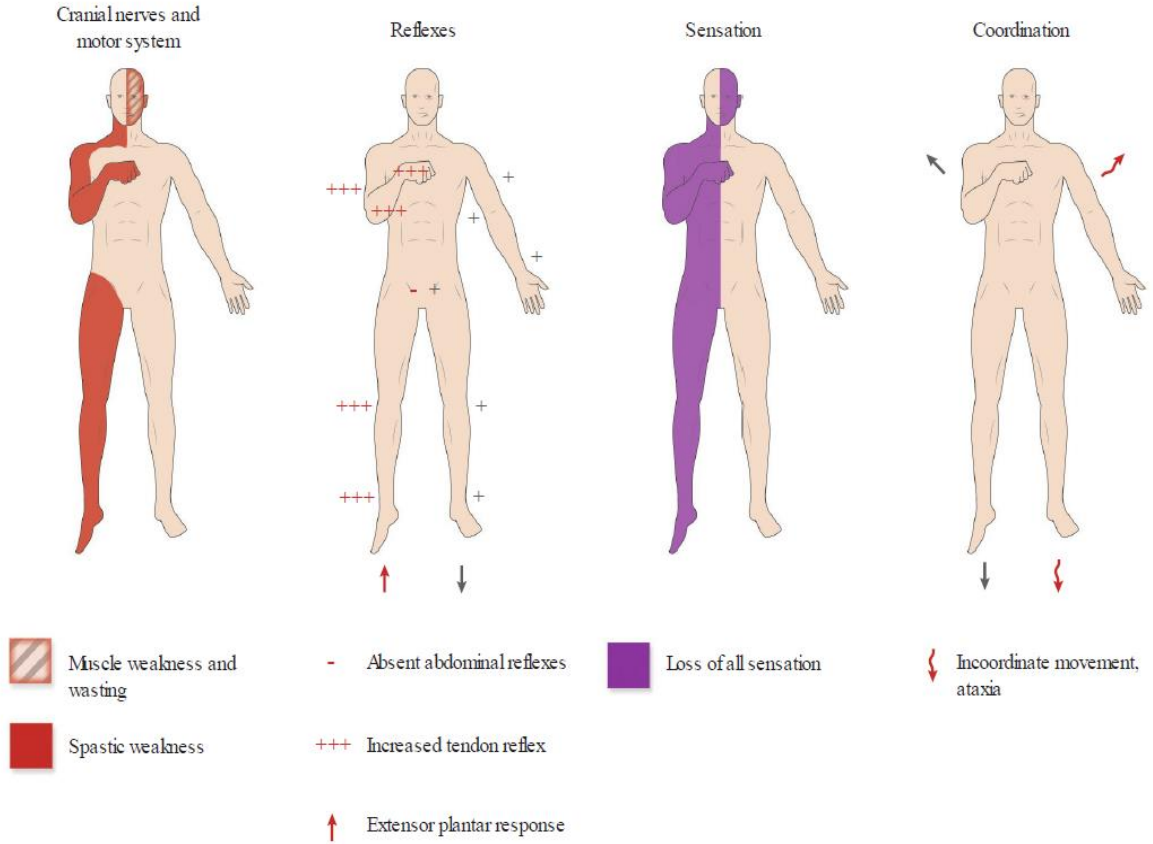
To test:	Look for, Ask about:
reticular formation	a) Alertness, Consciousness & Sleep. b) Corticospinal tract: Motor power, reflexes c) Pain response ex. Facial grimacing on firm pressure over the supra orbital ridge
respiratory center	look for the normal pattern of respiration
cardiovascular center	Look for normal circulatory function
brainstem reflexes	a) Pupilary and corneal reflexes. b) Vestibulo-ocular reflex: Injection of iced water into the ear will produce eyes movement. No eye movement > Brainstem injury / death
Oculo-cephalic reflex	a) Rapidly turn the head 90° on both sides b) Normal response = deviation of the eyes to the opposite side of head turning c) 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

Neuroanatomy corner

We recommended you to read this lecture from Neuroanatomy bock. You can find the bock on the team drive, page 91-101

Brainstem lesions:

- unilateral brain stem lesion caused by stroke, tumour or multiple sclerosis causes ipsilateral cranial nerve dysunction, contralateral spastic hemiparesis, hyperreexia and an extensor plantar response (upper motor neurone lesion), contralateral hemisensory loss and ipsilateral incoordination.
- A bilateral lesion destroys the 'vital centres' that control breathing and the circulation, leading to coma and death .



Thank you!

اعمل لترسم بسمة، اعمل لتمسح دمعة، اعمل و أنت تعلم أن الله لا يضيع أجر من أحسن عملا.

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QUIZ

اقتراحات وشكاوي

References:

- Females and Males slides.
- Neuroanatomy An Illustrated Colors Text 5th.