

Pathway of Pyramidal Tract

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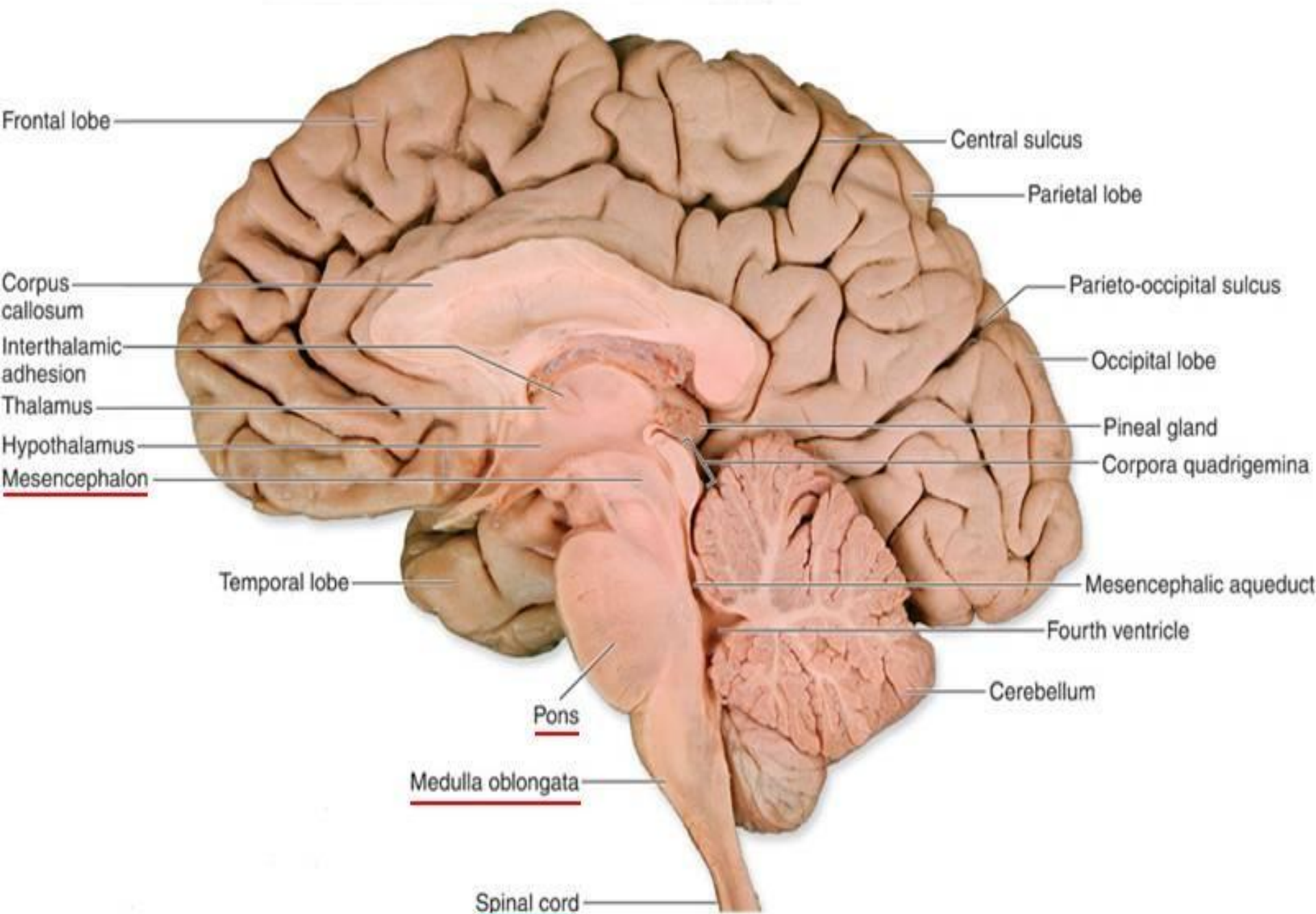
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الرجاء تحويل الجوال إلى وضع
الصامت مع الشكر



Brain Stem

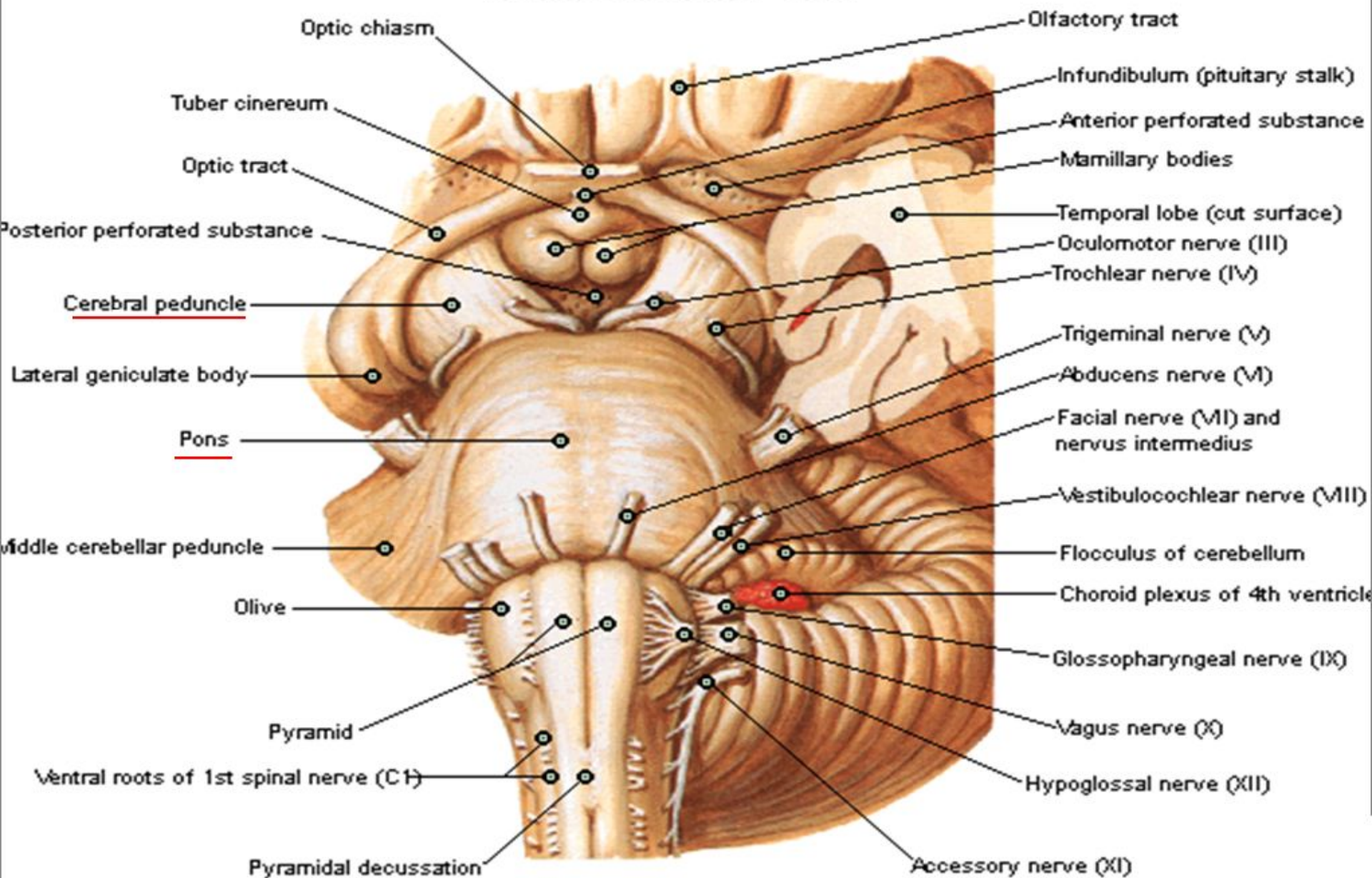
- The brain stem consists of:
 1. Medulla oblongata.
 2. Pons.
 3. Midbrain.
- It contains the complex structure known as **the reticular formation.**
- The brain stem contains the cranial nerves nuclei.



Midsagittal view

Brainstem

Anterioinferior View



Function of the Brain Stem

- Cardiovascular center.
- Respiratory and cough center.
- Swallowing and vomiting center.
- Sleep center.
- Center for eye movement.
- Reticular formation functions..
- Alertness and consciousness
- Vestibular function.
- Conduction function.
- It contains the important nuclei of cranial nerves III through XII.
- Important as extrapyramidal function (substantia nigra).

The Reticular Formation

- The reticular formation is complex structures (a network of neurons) located in the brain stem, extended to the diencephalon and downwards to the upper part of spinal cord.
- Some reticular formation neurons are clustered together, forming the brain stem nuclei and integrating centers.
- It divided into:
 1. **Sensory part.**
 2. **Motor part.**

The Sensory Part of RF

- This consists of **small neurons** that have multiple interconnections with each others.
- **It receives sensory (afferent) fibers from:**
 1. All ascending lemnisci.
 2. The olfactory, visual and auditory nervous pathways.
 3. The basal nuclei.
 4. The cerebellum.
 5. The cerebral cortex.
 6. The vestibular center.
 7. The hypothalamus.

The Motor Part of RF

- This consists of **large neurons** which receive signal from the sensory part and give the efferent (motor) fibers.
- **It contains:**

I. Excitatory (Facilitatory) reticular formation:

- Located mainly in the pons.
- The axons of its neurons divide into 2 branches:
 - a. Ascending branch to the cortex:** Ascending Reticular Activating System (ARAS).
 - b. Descending branch:** **ventral (medial) reticulospinal** tract which activates the spinal gamma motor neurons.

II. Inhibitory reticular formation:

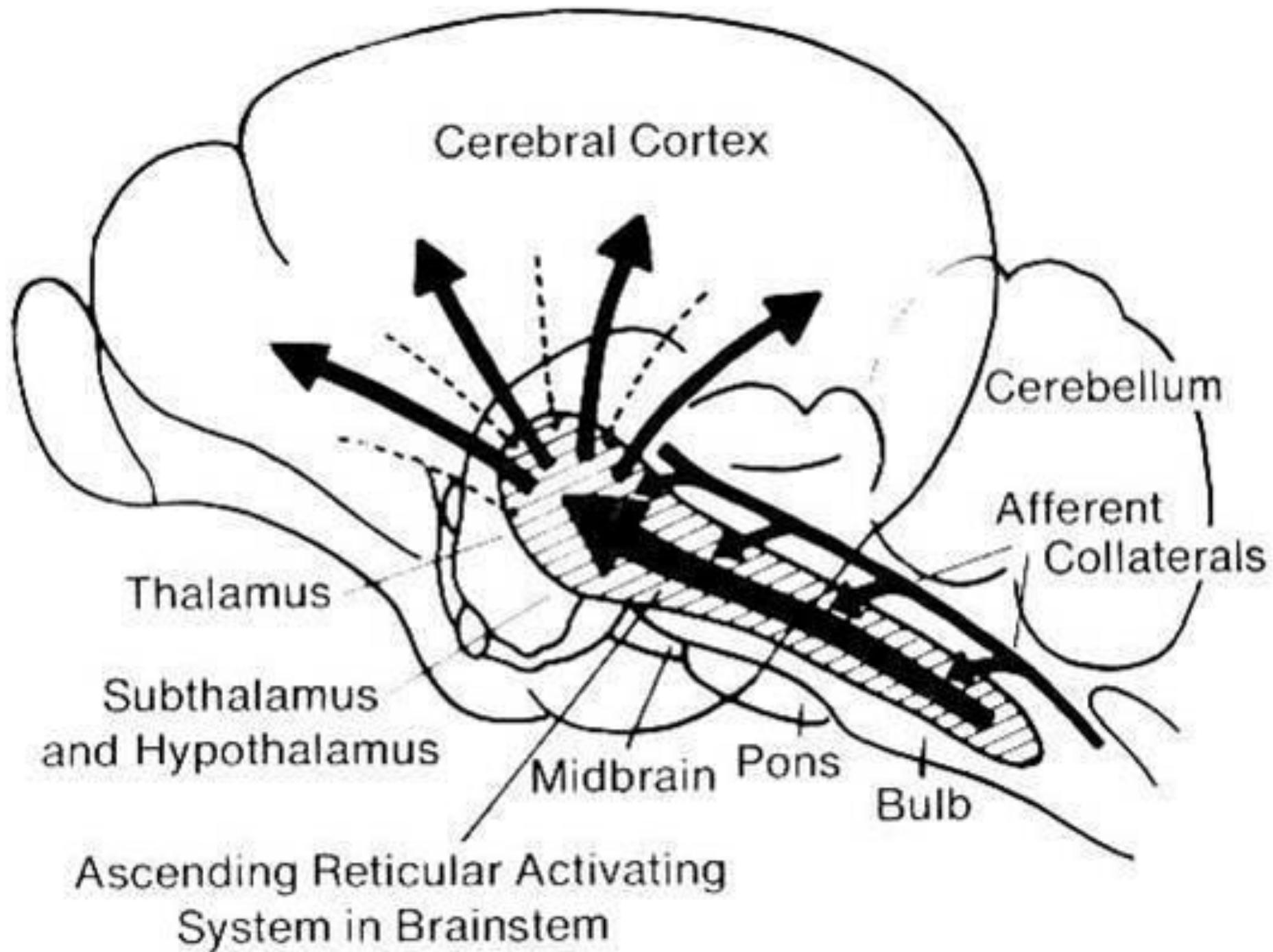
- Located mainly in the medulla oblongata.
- Its axons descend as **the lateral reticulospinal tract**, which inhibits the spinal gamma motor neurons.

Functions of the Reticular Formation

1. Control the level of consciousness (wakefulness) through the ARAS.
2. Regulation of the stretch reflexes and muscle tone through the reticulospinal tract.
3. Pain inhibition.
4. Control of sleep.
5. Control visceral functions (e.g. heart rate, BP, respiration, salivation, swallowing and vomiting).
6. Serotonin production.

Ascending Reticular Activating System (ARAS or RAS)

- This multineuronal system of nerve fibers that originate from **motor excitatory part of reticular formation.**
- Its fibers extend upwards in diencephalon, then some project directly to the cerebral cortex.
- The majority relay first at **the thalamus**, from which other fibers arise and project diffusely to almost all parts of the cerebral cortex through **the reticulo-thalamo-cortical pathway.**



Functions of the ARAS

The ARAS controls:

- The electric activity of the cerebral cortex.
- Consciousness and production of the alert response (reduction of its activity leads to sleep).

Factors that Increase the ARAS Activity

1. Sensory signal (specially pain).
2. Signal from cerebral cortex which increase alertness and decrease signal to sleep (e.g. during emotions and voluntary movements).
3. Certain drugs called **the analeptic drugs** (e.g. catecholamine and caffeine).

Factors that Decrease the ARAS Activity

1. Reduction of signals from the sensory pathway or the cerebral cortex.
2. Stimulation of the sleep centers.
3. Severe damage of the ARAS (e.g. tumor, inflammation stroke).
4. General anesthetic and sedative drugs: by inhibiting the synaptic transmission between its neurons.

Conduction Function

The brain stem plays important role for conduction (afferent and efferent pathway).

The Four Lemnisci:

1. **Medial Lemniscus:** for deep sensation and fine touch below the head. Started from Gracile and Cuneate nuclei “after decussation” and ends in the thalamus
2. **Lateral Lemniscus:** for auditory sensation.
3. **Trigeminal Lemniscus:** started from trigeminal and solitary nuclei “after decussation” and ends in the thalamus.
4. **Spinal Lemniscus:** ventral and lateral spinothalamic tract ends in the thalamus.

Medial Longitudinal Bundle

Origin: midbrain.

Function: rotational movement of the head and eyes:

- Coordinates movement of the medial and lateral recti muscles of both eyes.
- Coordinates movements of the head and eyes in response to cochlear stimuli.
- Coordinates movement of the facial muscles (lips), tongue, and soft palate.

Breathing Center

The respiratory neurons are located bilaterally in the medulla oblongata and divided into two group:

- 1. Posterior respiratory group:** modulate respiratory patterns.
- 2. Anterior respiratory group:** coordinates the innervation of both inspiratory and expiratory muscles.

Postural Reflexes

- Posture is defined as the active muscular resistance to displacement body by gravity.

There are two types of postural reflexes:

1. **Static Reflexes:** maintain the balance during rest.
2. **Statokinetic Reflexes:** maintain the balance during movement.



Center for Cranial Nerves

Nuclei of the Oculomotor Nerve

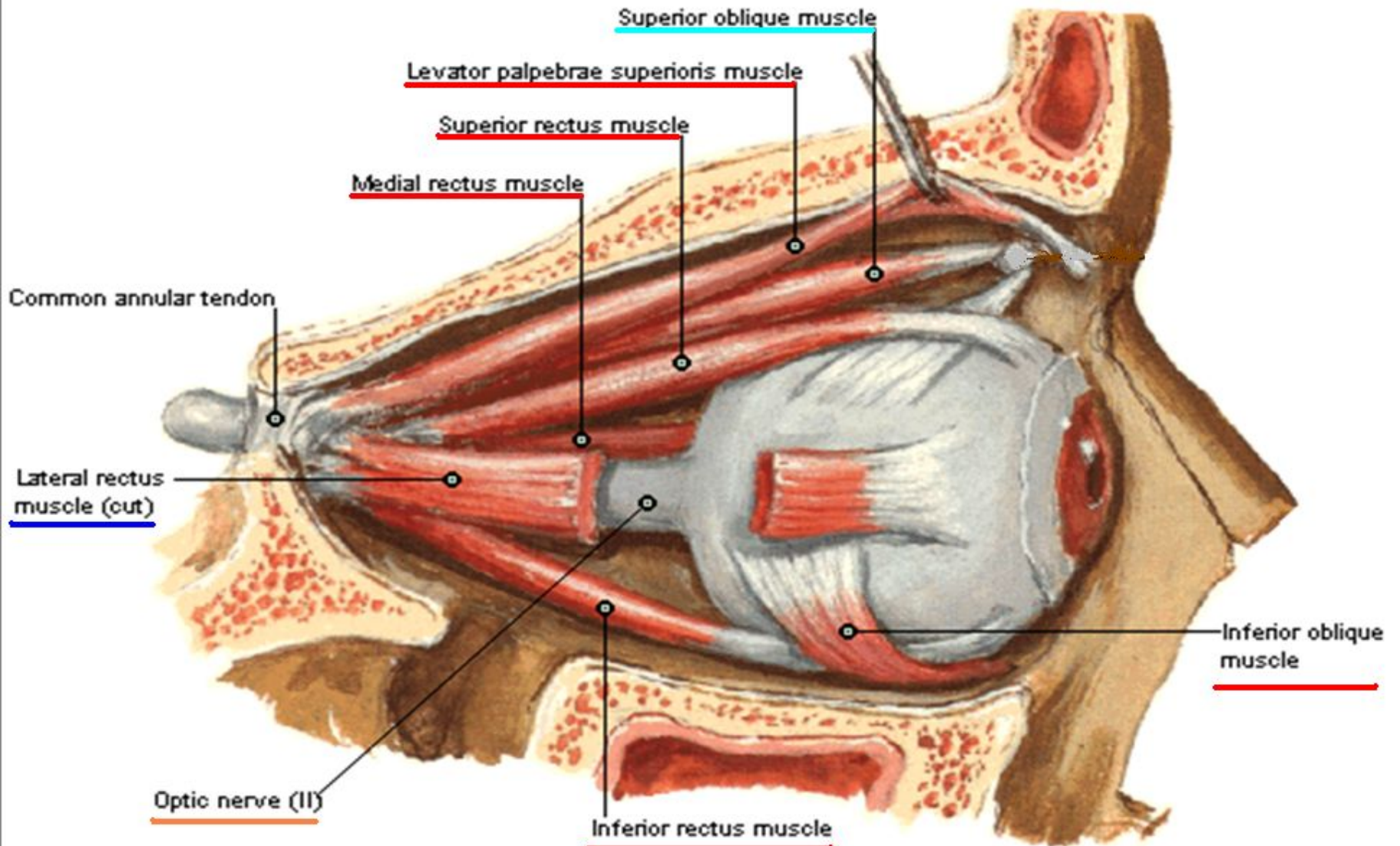
1. **The Edinger-Westphal nucleus:** parasympathetic function which supplies two intraocular muscles:
 - a. Constrictor pupillae muscle → Miosis.
 - b. Ciliary muscle → Responsible for light and accommodation reflexes.
2. **The lateral cell mass (motor function):** which is divided into five parts which supplies five extra ocular muscles which are from above downwards:
 - a. Levator palpebrae superior muscle.
 - b. Superior rectus muscle.
 - c. Medial rectus muscle.
 - d. Inferior oblique muscle.
 - e. Inferior rectus muscle.
3. **The central nucleus of Perlia:** motor function which supplies the medial recti muscles of the two eyes allowing to contract together when both eyes converge to look to a near object.

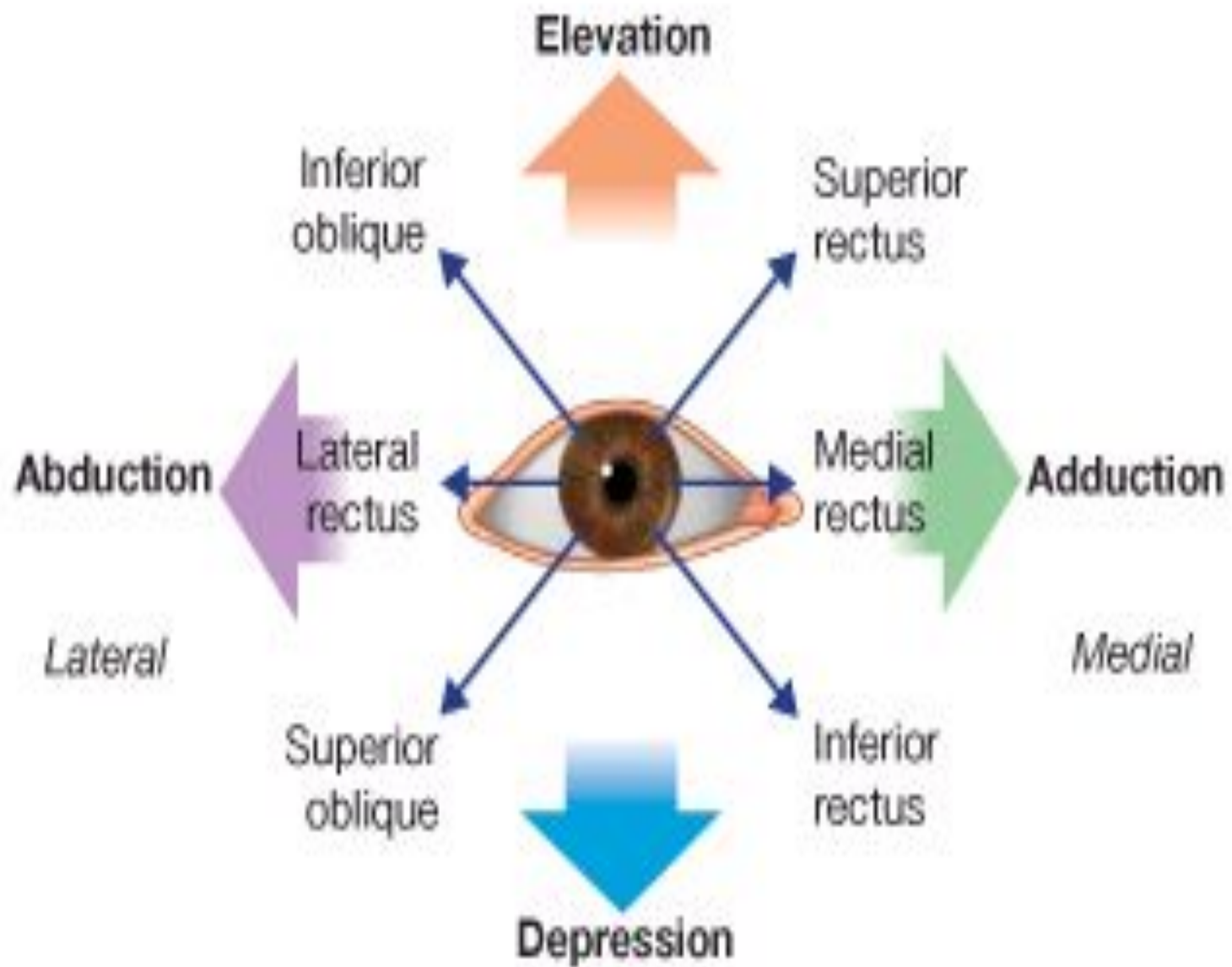
Nuclei of the Trochlear and Abducent Nerves

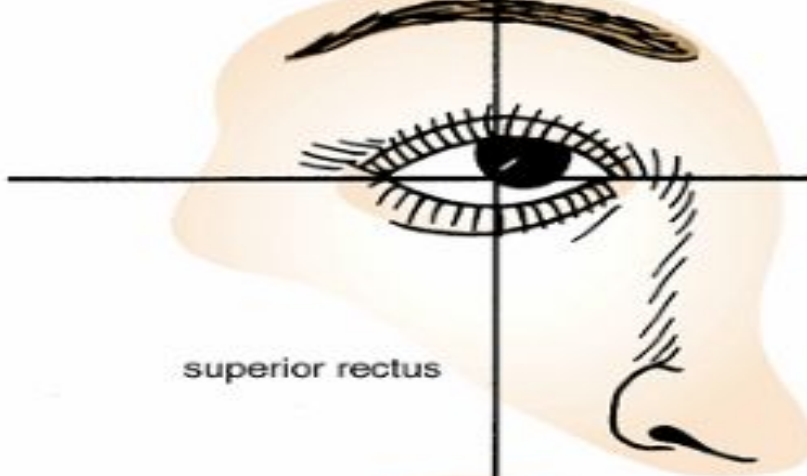
1. **The trochlear nucleus (in midbrain):** supplies the superior oblique muscle.
2. **The abducent nucleus (in pons):** supplies the lateral rectus muscle.

Extrinsic Eye Muscles

Right Lateral View

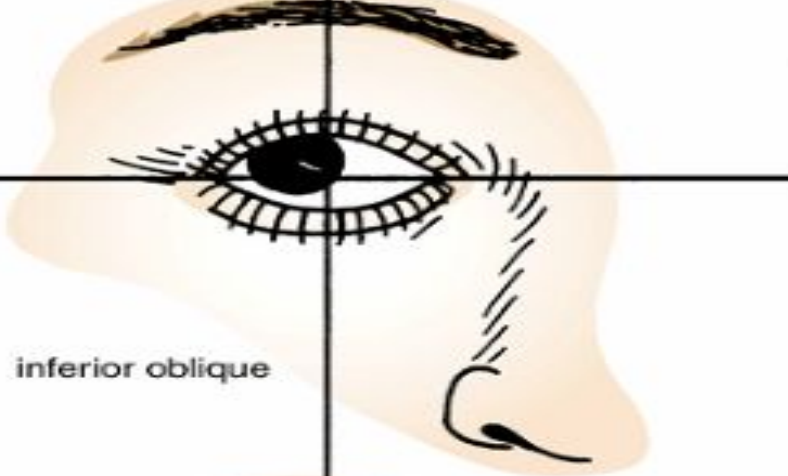






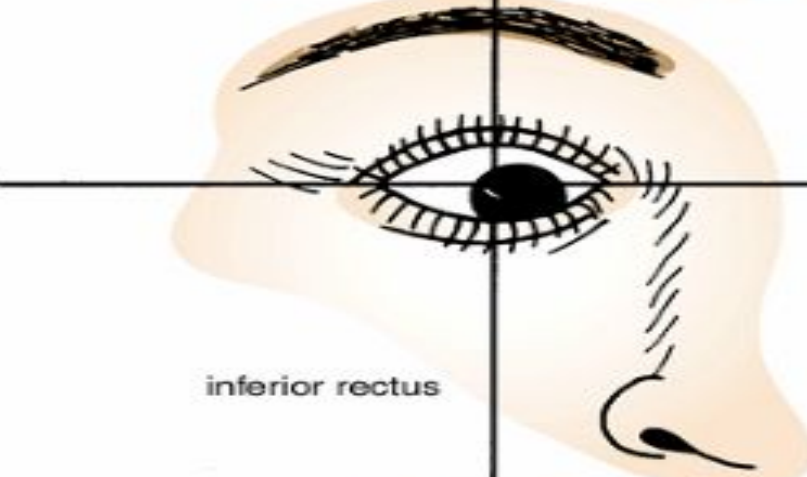
superior rectus

This diagram shows a lateral view of a human head with the right eye looking straight ahead. A horizontal line passes through the center of the eye. A vertical line is drawn through the eye, and a horizontal line is drawn through the pupil. The superior rectus muscle is highlighted in black, showing its origin from the superior orbital foramen and its insertion into the sclera of the eye.



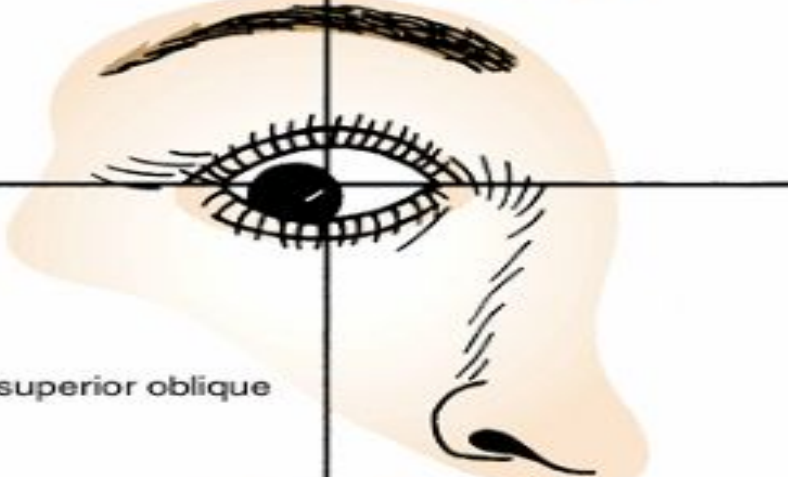
inferior oblique

This diagram shows a lateral view of a human head with the right eye looking straight ahead. A horizontal line passes through the center of the eye. A vertical line is drawn through the eye, and a horizontal line is drawn through the pupil. The inferior oblique muscle is highlighted in black, showing its origin from the anterior process of the inferior orbital foramen and its insertion into the sclera of the eye.



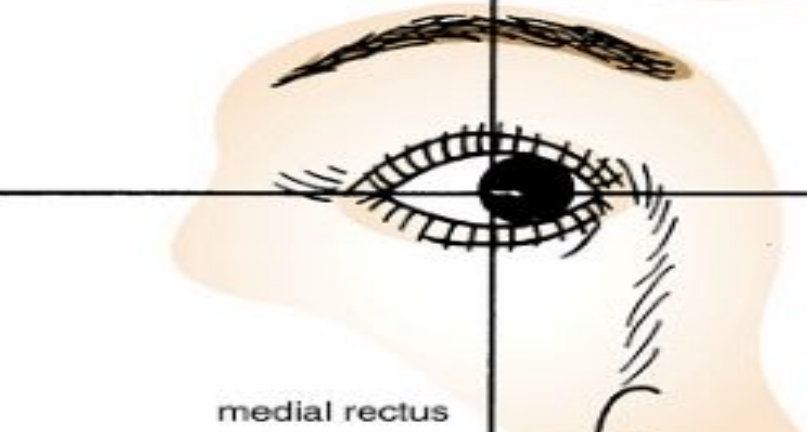
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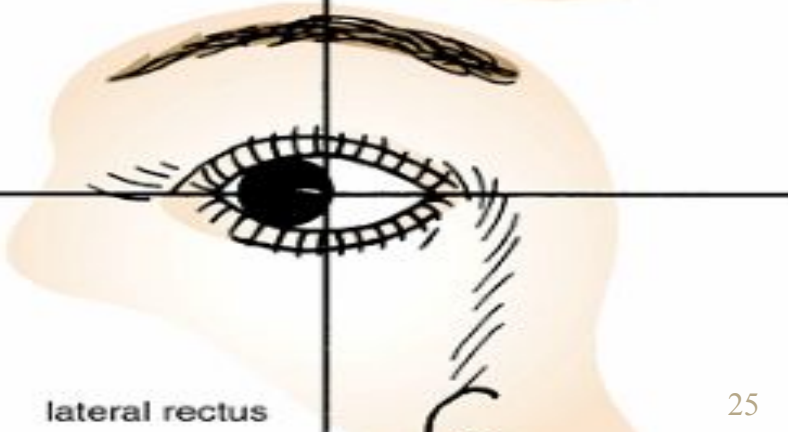
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medial rectus

This diagram shows a lateral view of a human head with the right eye looking straight ahead. A horizontal line passes through the center of the eye. A vertical line is drawn through the eye, and a horizontal line is drawn through the pupil. The medial rectus muscle is highlighted in black, showing its origin from the anterior process of the inferior orbital foramen and its insertion into the sclera of the eye.

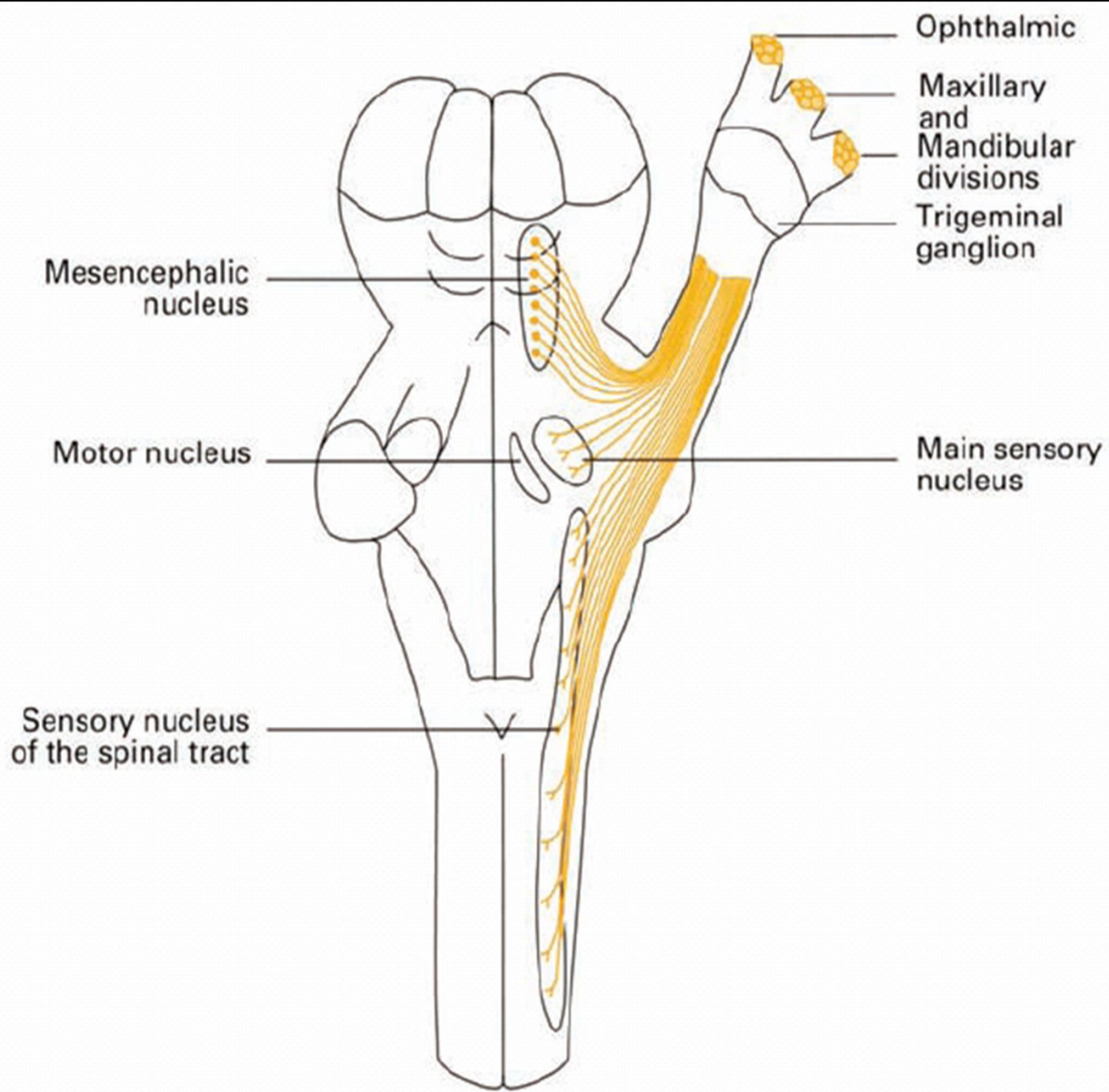


lateral rectus

This diagram shows a lateral view of a human head with the right eye looking straight ahead. A horizontal line passes through the center of the eye. A vertical line is drawn through the eye, and a horizontal line is drawn through the pupil. The lateral rectus muscle is highlighted in black, showing its origin from the anterior process of the inferior orbital foramen and its insertion into the sclera of the eye.

Nuclei of the Trigeminal Nerve

1. **Main Sensory Nucleus:** lies in the middle part of the pons (for touch sensation).
2. **Spinal (Descending) Nucleus:** lies in the medulla and extends upwards to the lower part of the pons and downwards to the upper cervical spinal cord (for pain and temperature sensation).
3. **Mesencephalic Nucleus:** lies in the midbrain and upper part of the pons (proprioception or deep sensation).
4. **Motor Nucleus:** lies in the middle of the pons. It give motor fibers which forms the motor root of trigeminal nerve that joins with the mandibular nerve for the muscle of mastication.

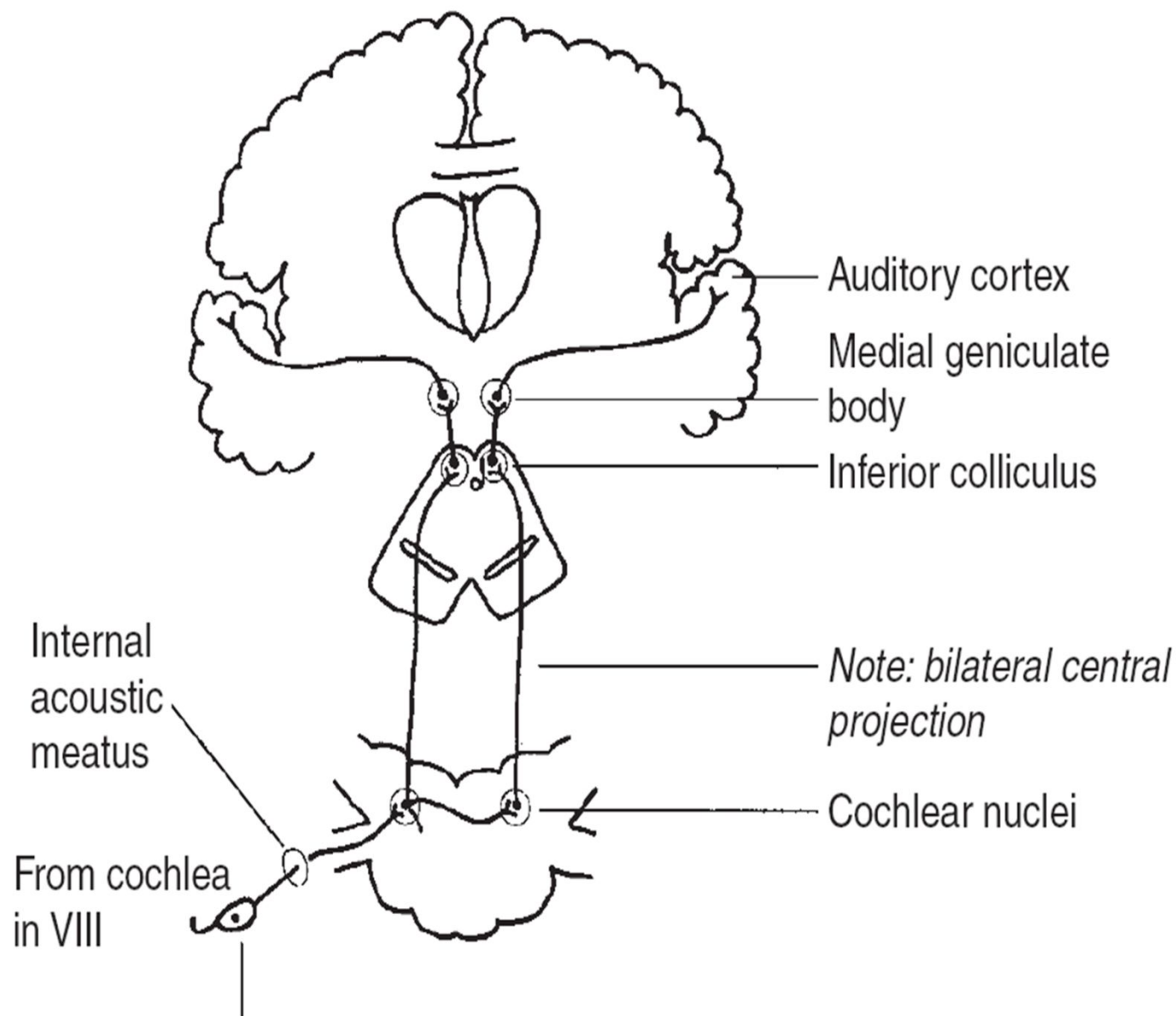


Nuclei of the Facial Nerve

1. **Facial motor nucleus:** lies in the lower part of pons and gives rise to the fibers of facial nerve which supplies the facial muscles.
2. **Superior salivary nucleus:** lies in the pons (secretomotor parasympathetic function) for:
 - a. Submandibular salivary, and sublingual (*Chorda tympani nerve*).
 - b. Glands of the palate, nose, lacrimal glands and nasopharynx (*Greater superior petrosal nerve*).
3. **Solitary nucleus:** lies in the medulla. It receives taste sensations from the anterior 2/3 of the tongue and general sensation for skin of the external auricle and tympanic membrane.

Nuclei of the Cochlear Nerve

Ventral and dorsal cochlear nucleus in pons →
inferior colliculus → medial geniculate body →
auditory sensory area in temporal lobe (area 41, 42)
where hearing is bilaterally represented.



Nuclei of the Vestibular Nerve

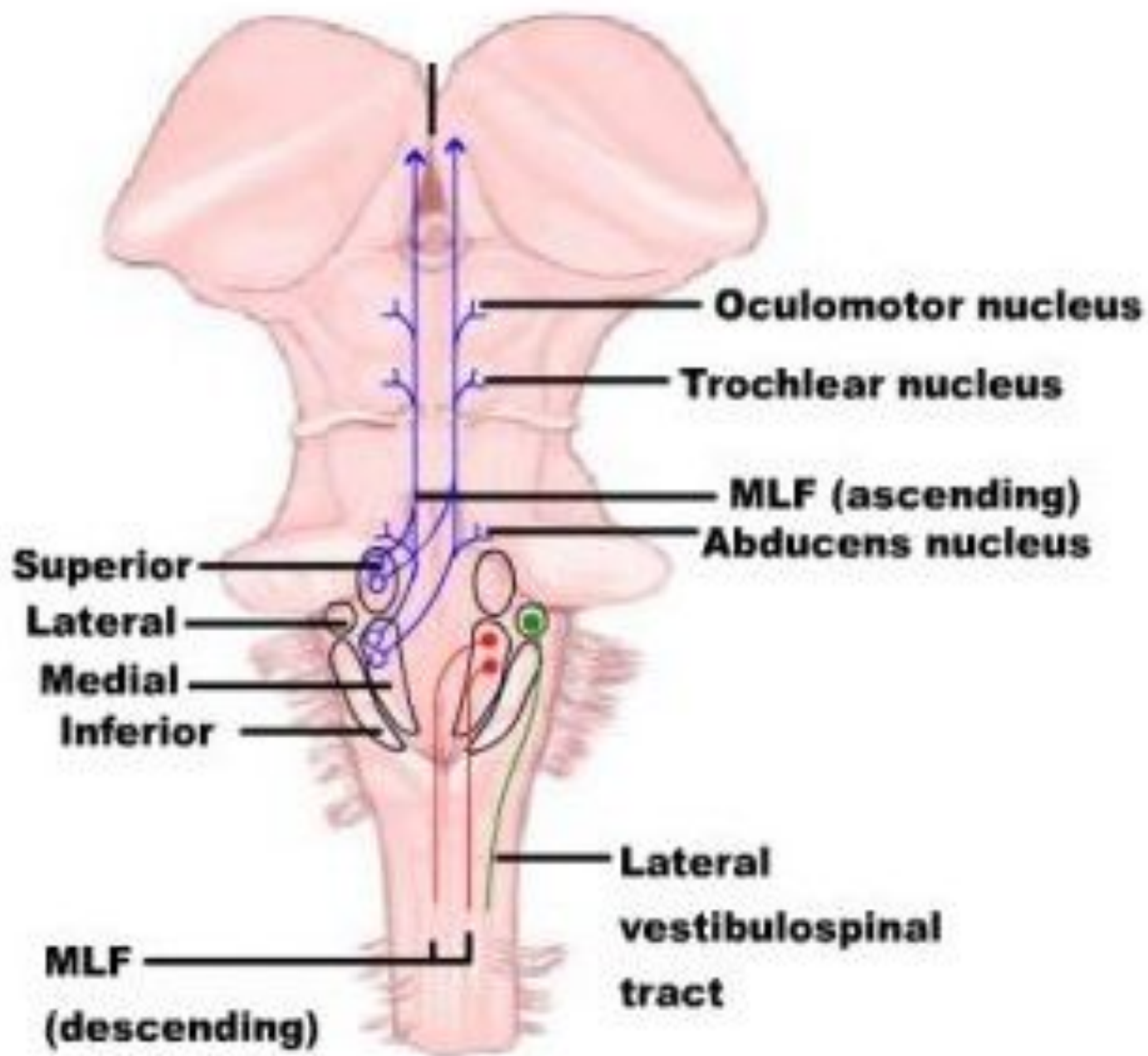
The vestibular nuclei are important for maintenance of equilibrium.

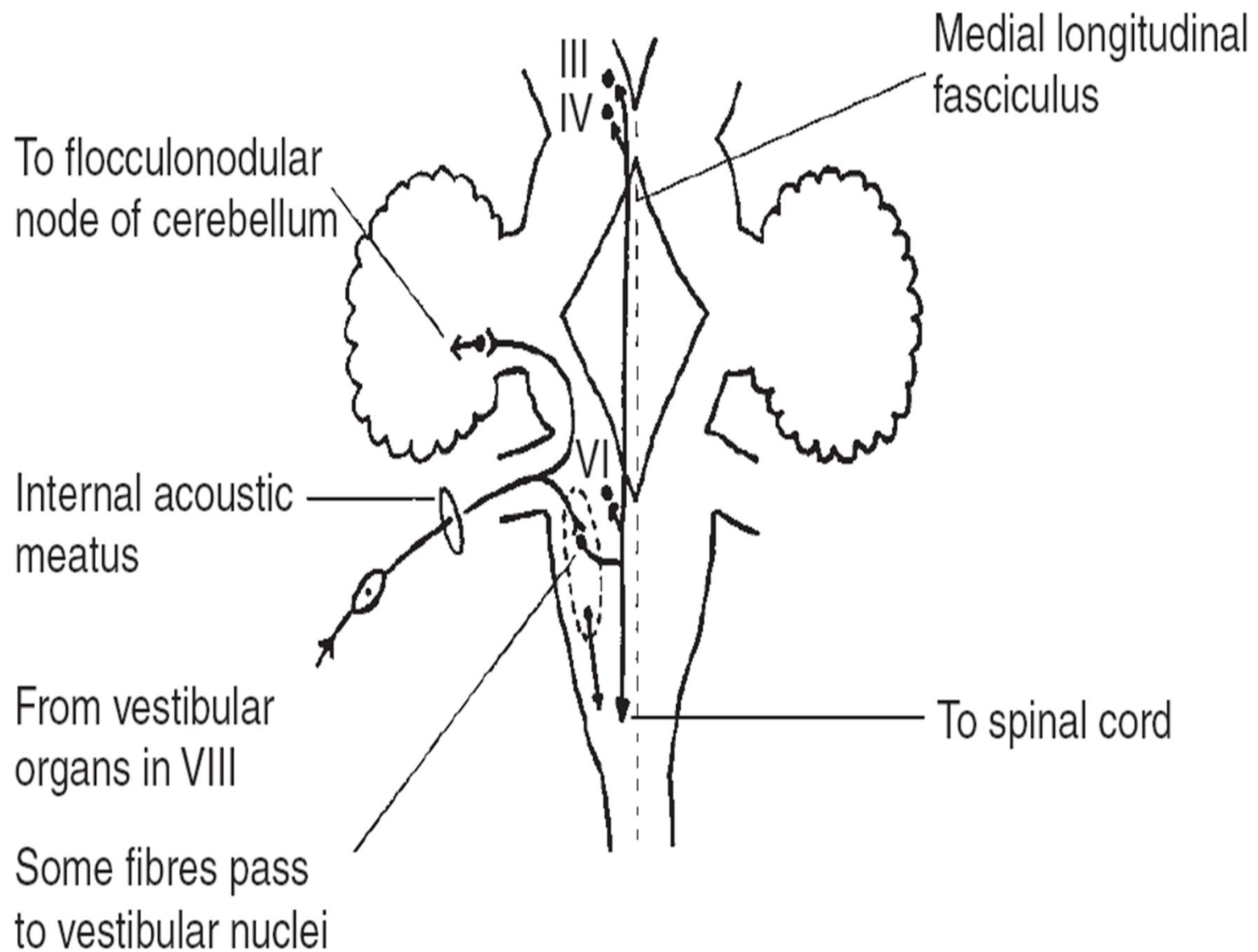
1. **The superior vestibular nucleus:** located completely in the pons.
2. **The lateral vestibular nucleus:** located in upper part of the medulla oblongata and lower part of the pons.
3. **The inferior vestibular nucleus:** located completely in the medulla oblongato.
4. **The medial vestibular nucleus:** located in the medulla oblongata “floor of the fourth ventricle”.

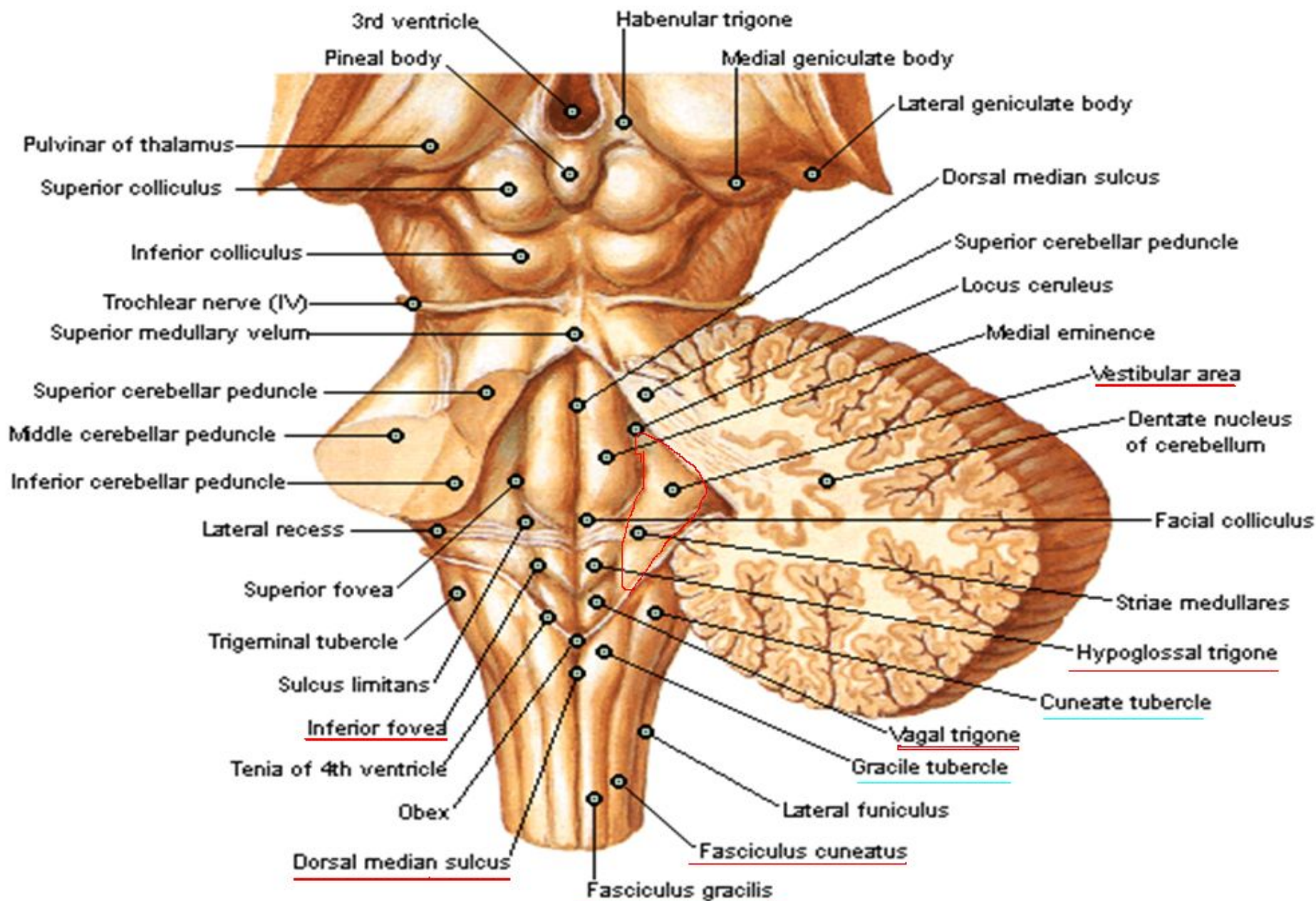
Nuclei of the Vestibular Nerve

The nuclei of the vestibular nerve send efferent fibers to:

1. Cerebellum (vestibulo-cerebellar).
2. Medial longitudinal bundle: concerned with synchronous movement of eyes, head and neck.
3. Spinal cord.
4. Cerebral cortex.



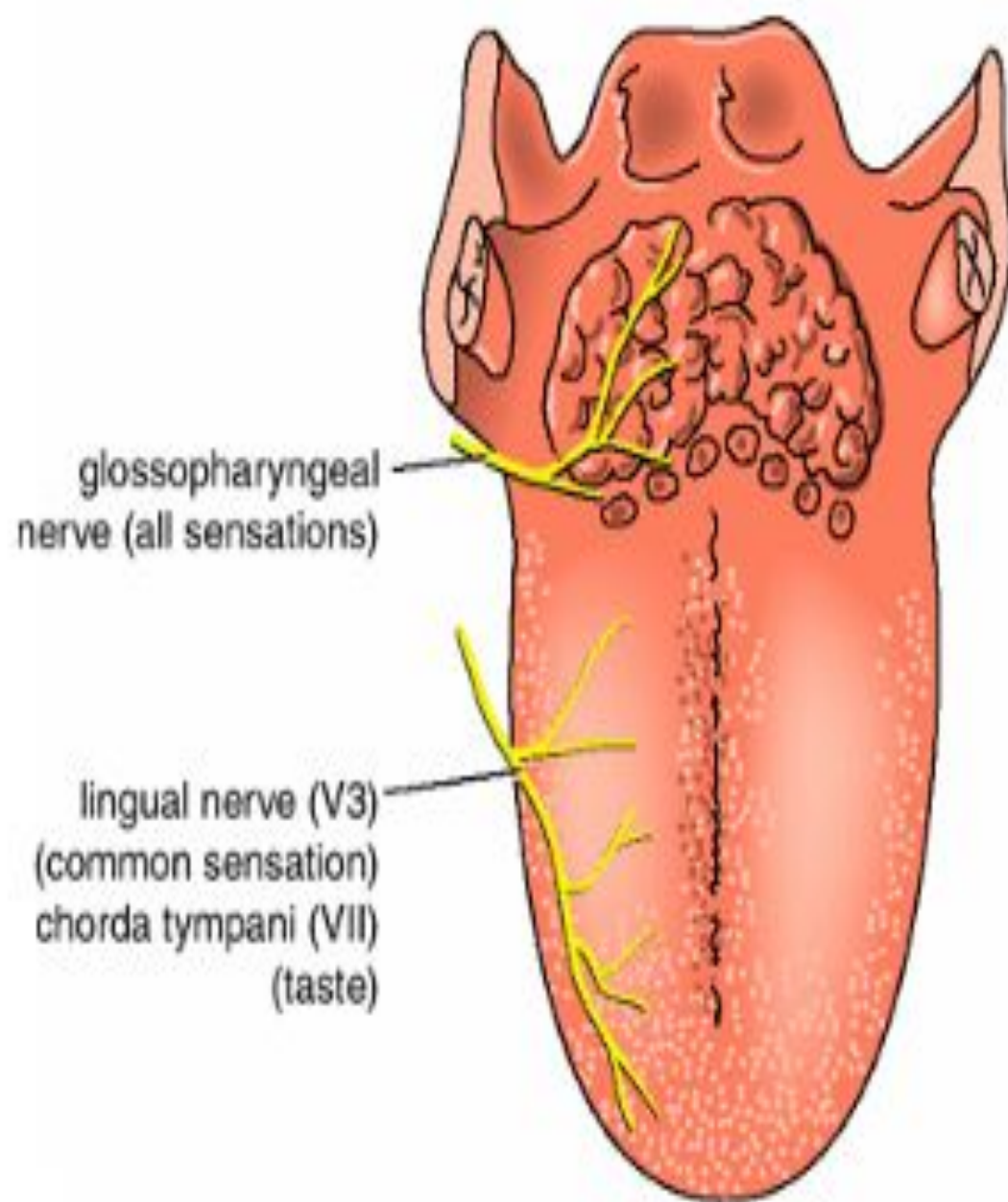




Nuclei of the Glossopharyngeal Nerve

It has three nuclei:

- 1. The upper part of nucleus ambiguous:** it lies in the medulla (motor function).
- 2. The inferior salivary nucleus:** it lies in the medulla (parasympathetic function).
- 3. The solitary nucleus:** it lies in the medulla (sensory function).



Nuclei of the Vagus Nerve

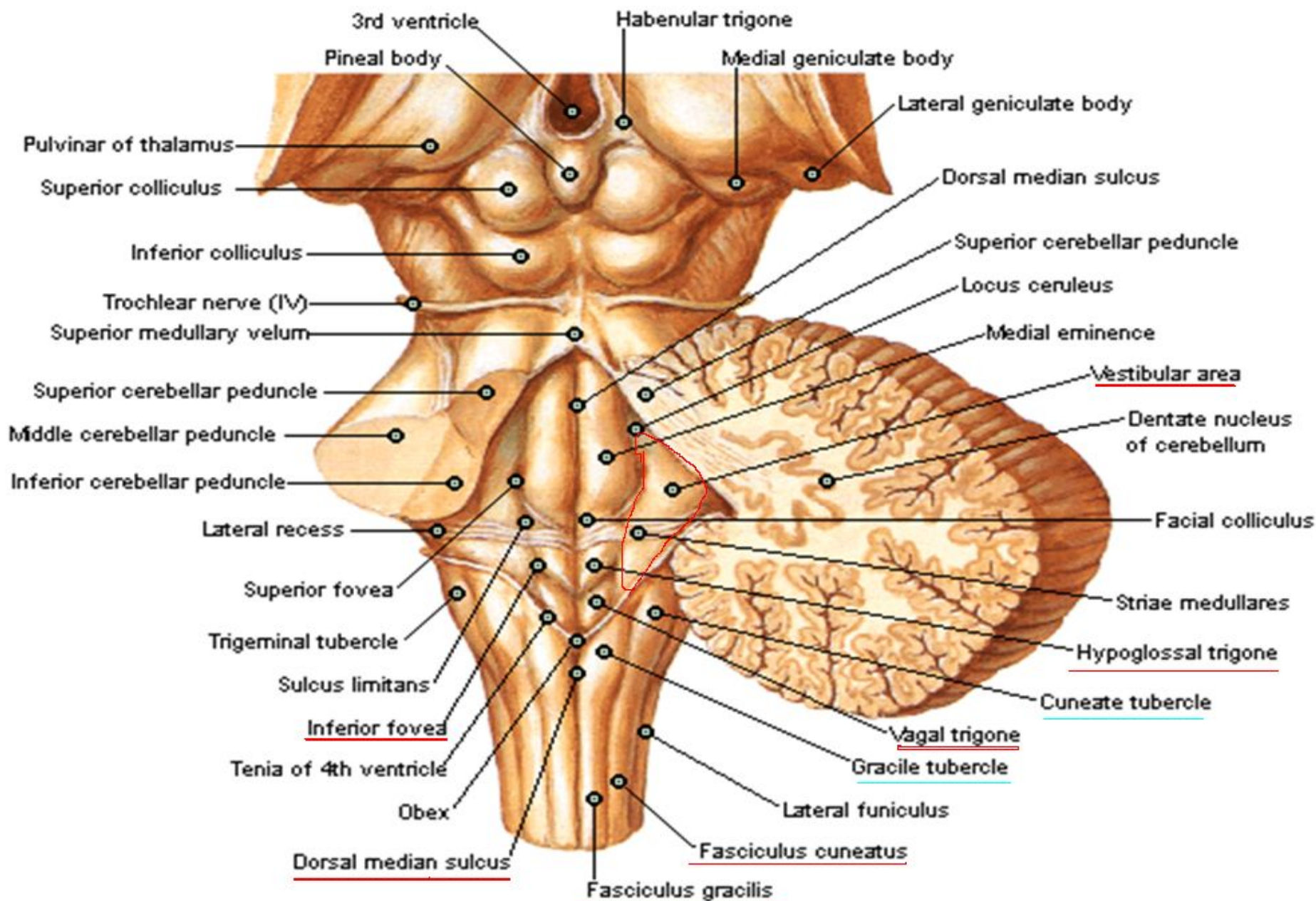
1. **Dorsal motor nucleus of vagus:** gives parasympathetic fibers to respiratory system, digestive tract and the heart.
2. **Main part of nucleus ambiguus:** gives motor fibers to the muscles of the larynx, pharynx and palate.
3. **Solitary nucleus:** receives:
 - Taste and general sensation from the epiglottis and general sensation from the larynx.
 - Skin of the back of the auricle, external auditory meatus, lower and posterior part of the tympanic membrane.
 - Meninges of the posterior cranial fossa.
 - General sensation from the areas supplied by the parasympathetic fibers.

Nucleus of the Cranial Accessory Nerve

The lower part of nucleus ambiguus located in the lateral part of medulla gives fibers for cranial accessory nerve (motor function) .

Nucleus of the Hypoglossal Nerve

- **The hypoglossal nucleus** in the posterior part of medulla oblongata.
- Supplies the muscle of the tongue.





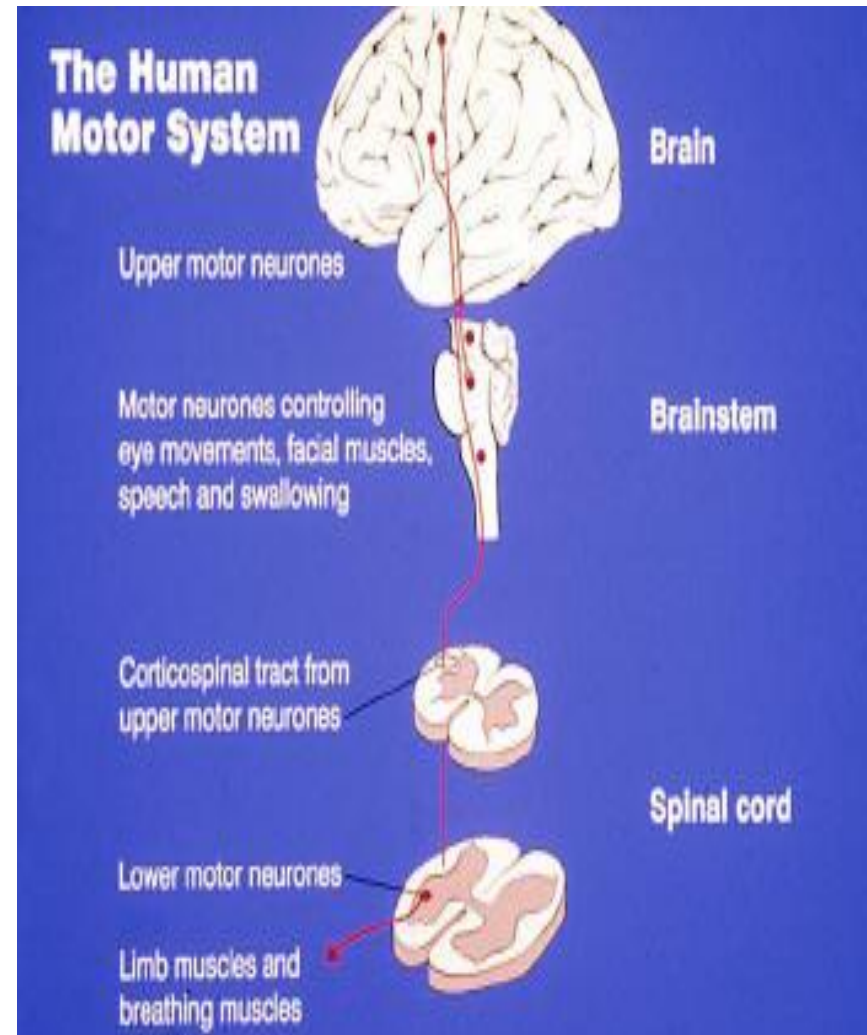
Pyramidal Tract

The Motor System

- The motor system includes the brain, brain stem, spinal cord motor pathways, all the motor nerves and muscles of the body.
- The primary somatic motor area is present in the precentral gyrus of the frontal lobe.

Components of the Motor System

1. Pyramidal (upper motor neuron) system.
2. Lower motor neuron system.
3. Extrapyramidal system.
4. Cerebellar system.



Pyramidal Tract

Corticospinal Tract

90% Lateral C.S.T.

↓
crossed to the opposite side in the lateral column for muscles of the U.L.S and L.L.S.

10% Ventral C.S.T.

↓
Passes direct to the ventral column. Supplies AHCs for chest and Abd. muscles Bilateral

Corticobulbar "corticobulbar" tract

Lateral C.N.T.

↓
to Motor nuclei of V, Dorsal VII, IX, X and XI from both C.H.s and Ventral VII and X nuclei from opposite C.H. only

Medial C.N.T.

↓
to III, IV and VI cranial nuclei From both C.H.s

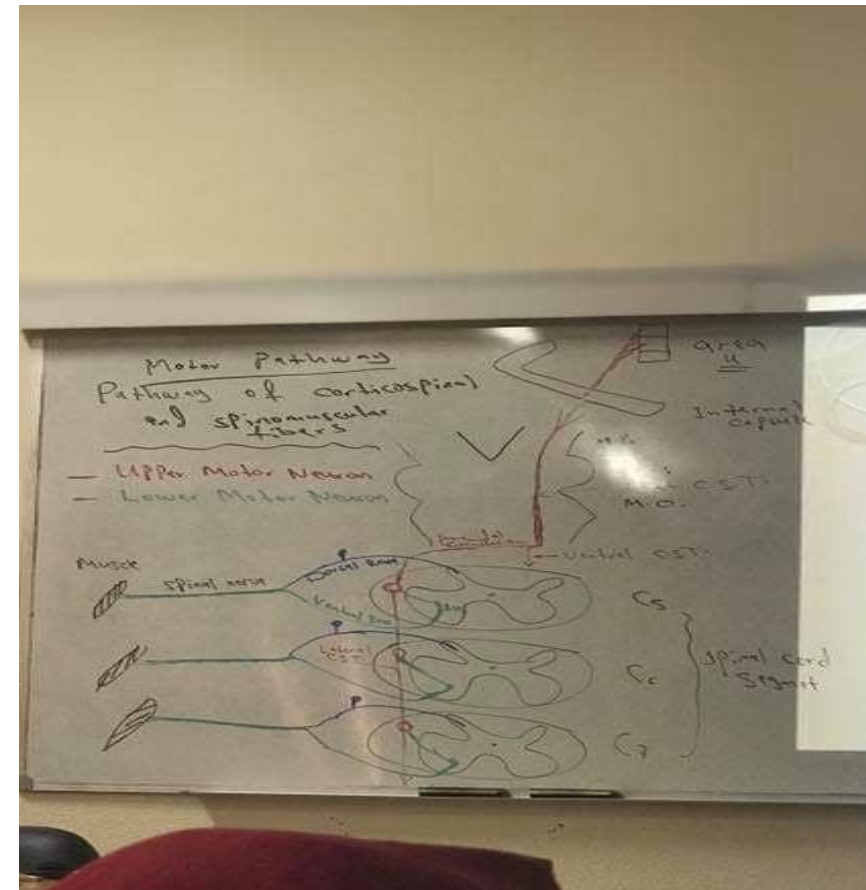
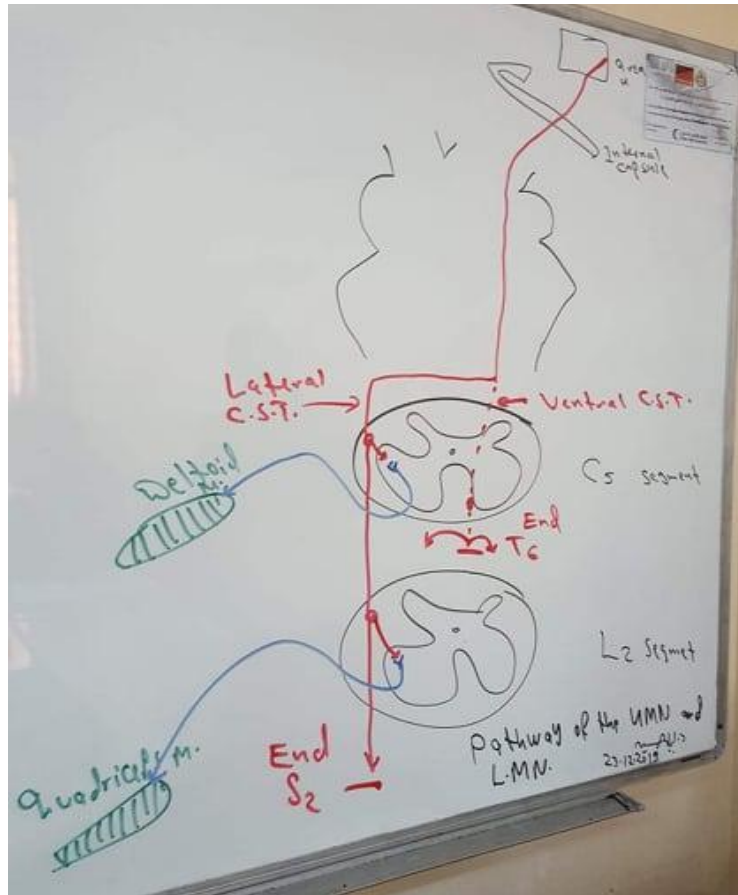
The Pyramidal Tract

- The pyramidal tract is a bundle of motor nerve fibers.
- It begins in the cerebral cortex and ends in:
 - a. **Anterior horn cells of the spinal cord**
(corticospinal tract).
 - b. **Motor nuclei of the cranial nerves** in the brain stem (corticonuclear or corticobulbar tract).
- The pyramidal tract consists of:
 1. Corticospinal tracts (lateral & ventral).
 2. Corticonuclear or corticobulbar tracts (Lateral & Medial).

The Upper Motor Neuron System (Corticospinal Tract)

:Function

1. Initiation and control of voluntary motor activity.
2. Inhibition of muscles tone.
3. Inhibition of deep reflexes.

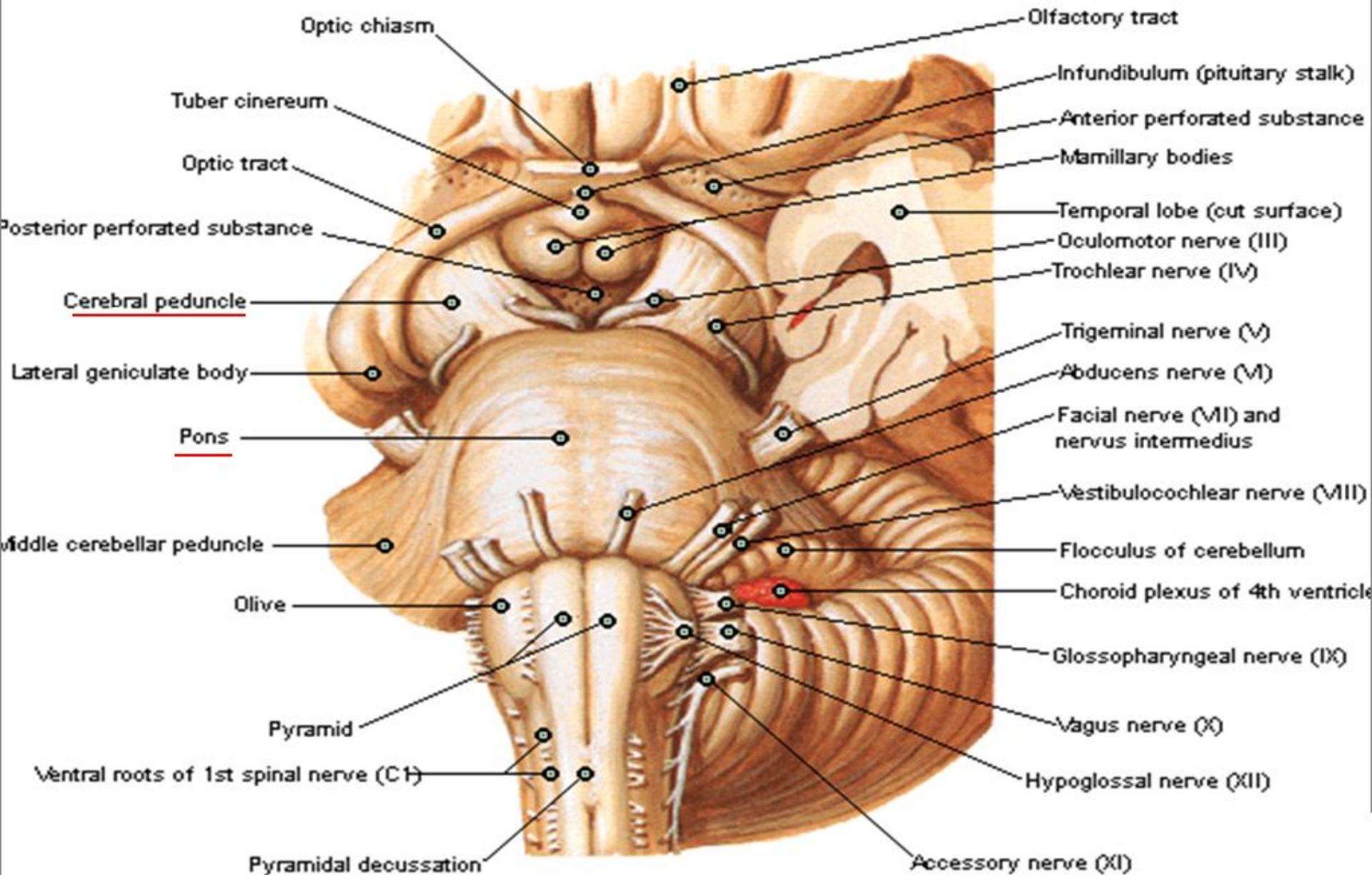


Pathway of the Upper Motor Neuron (Pyramidal or Corticospinal tract)

- ❖ From Betz cells in motor area 4 (in the upper 2/3 precentral gyrus of frontal lobe) → descends in the corona radiata → pass in the posterior limb of the internal capsule → descends in midbrain, pons and medulla oblongata.
- ❖ In the medulla the pyramidal fibers collect to form the pyramid → **pyramidal decussation.**

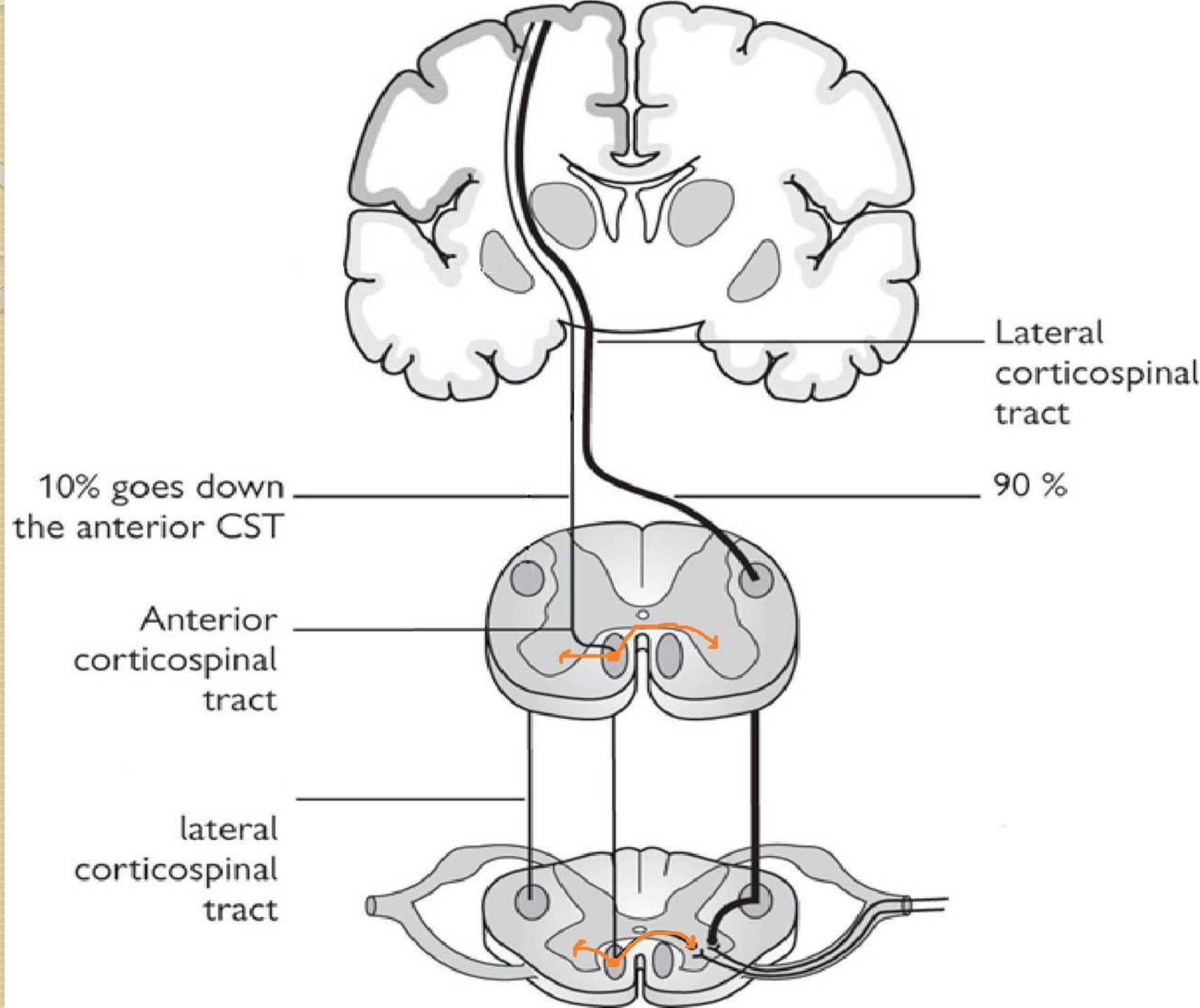
Brainstem

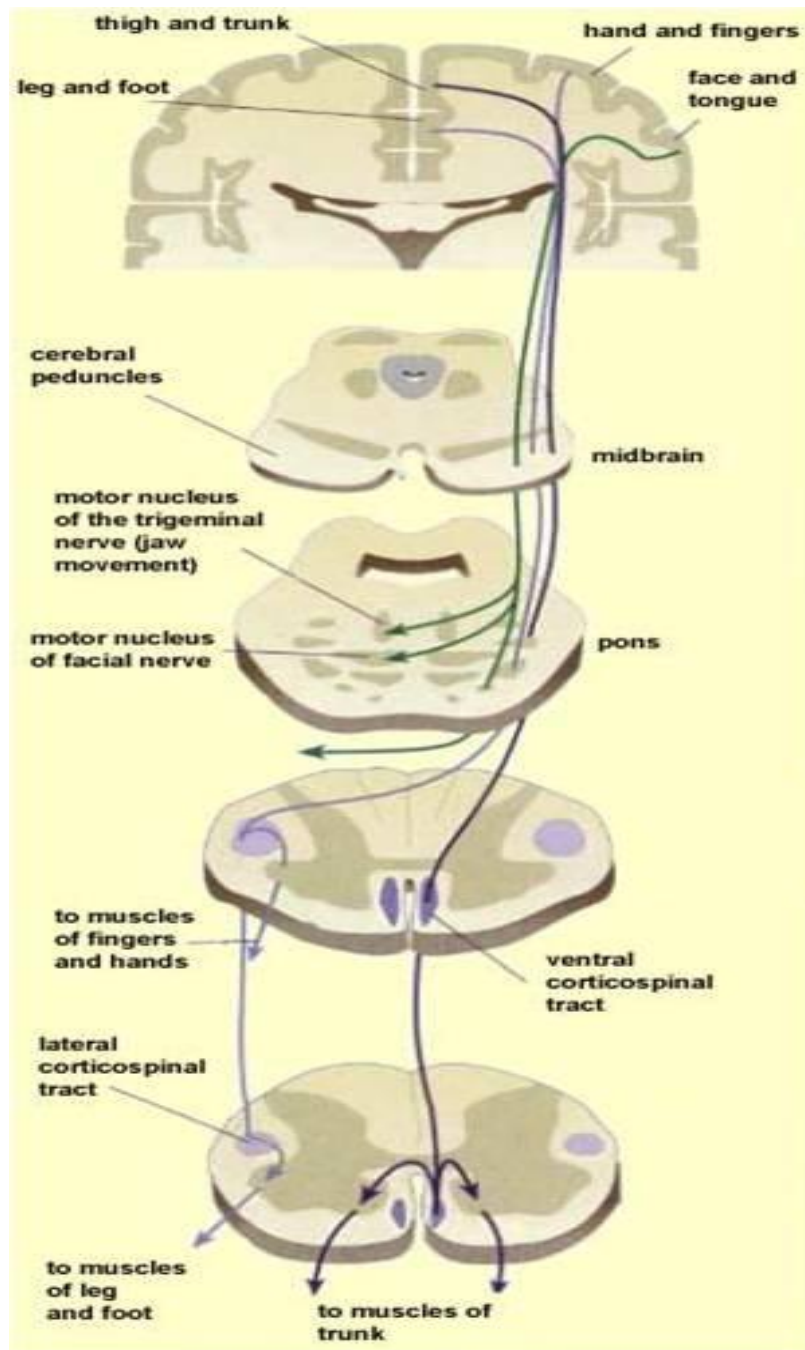
Anterioinferior View



□ In the lower medulla:

- a. 85 - 90% of fibers decussate to descends → in the lateral column of the opposite side of the spinal cord (**indirect or lateral crossed corticospinal tract**). The tract gradually diminishes in size and ends about the level of S3 or S4 segment of the SC. **For regulation of voluntary movement.**
- b. 10 - 15% of fibers descend directly → in the anterior column of the same side (**direct or anterior corticospinal tract**) then gives fibers for AHCs at the segmental level in **both side**. They descend in the spinal cord until they disappear in **the midthoracic region**.





The Corticospinal Tract

- The motor area of one side of cerebral hemisphere is responsible for movement of the muscles of the opposite $\frac{1}{2}$ of the body (mainly the limbs).
- Anterior or direct corticospinal tract end in both AHCs to supply the trunk and respiratory muscles.
- The muscles of respiration are received fibers from both cerebral hemispheres. This explain the absence of respiratory paralysis in hemiplegic person.

The Lower Motor Neuron System

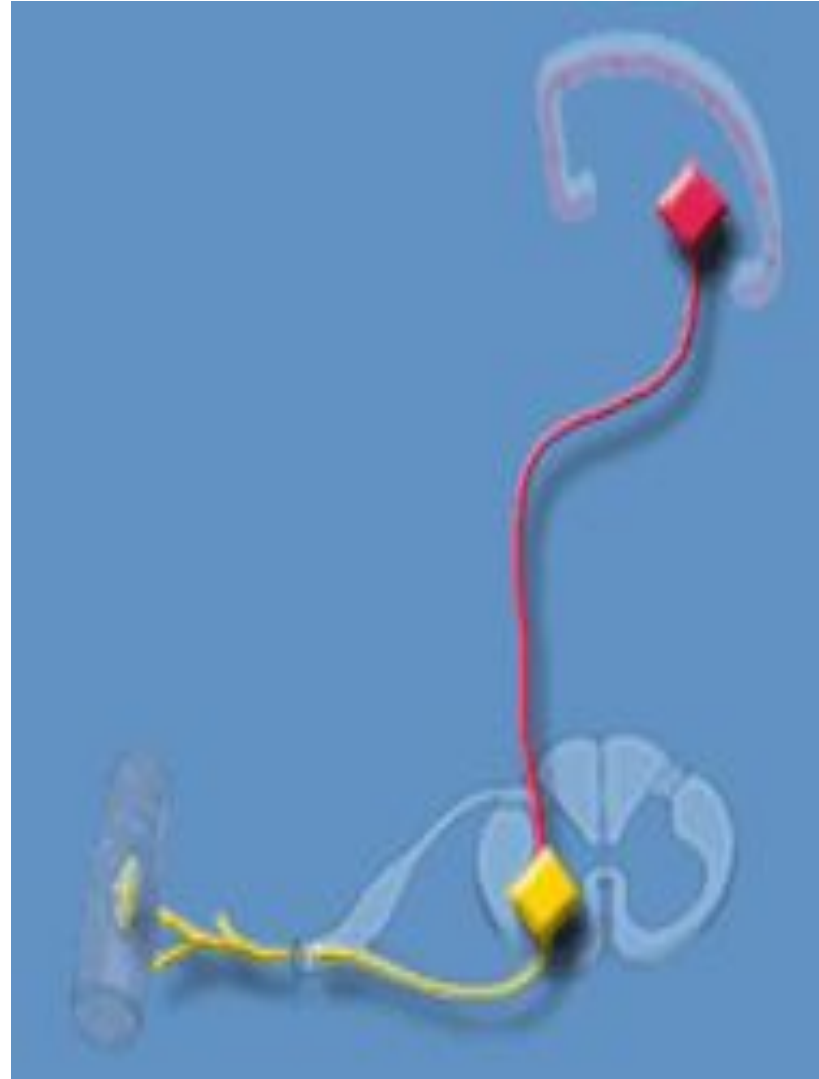
(Spinomuscular Fibers)

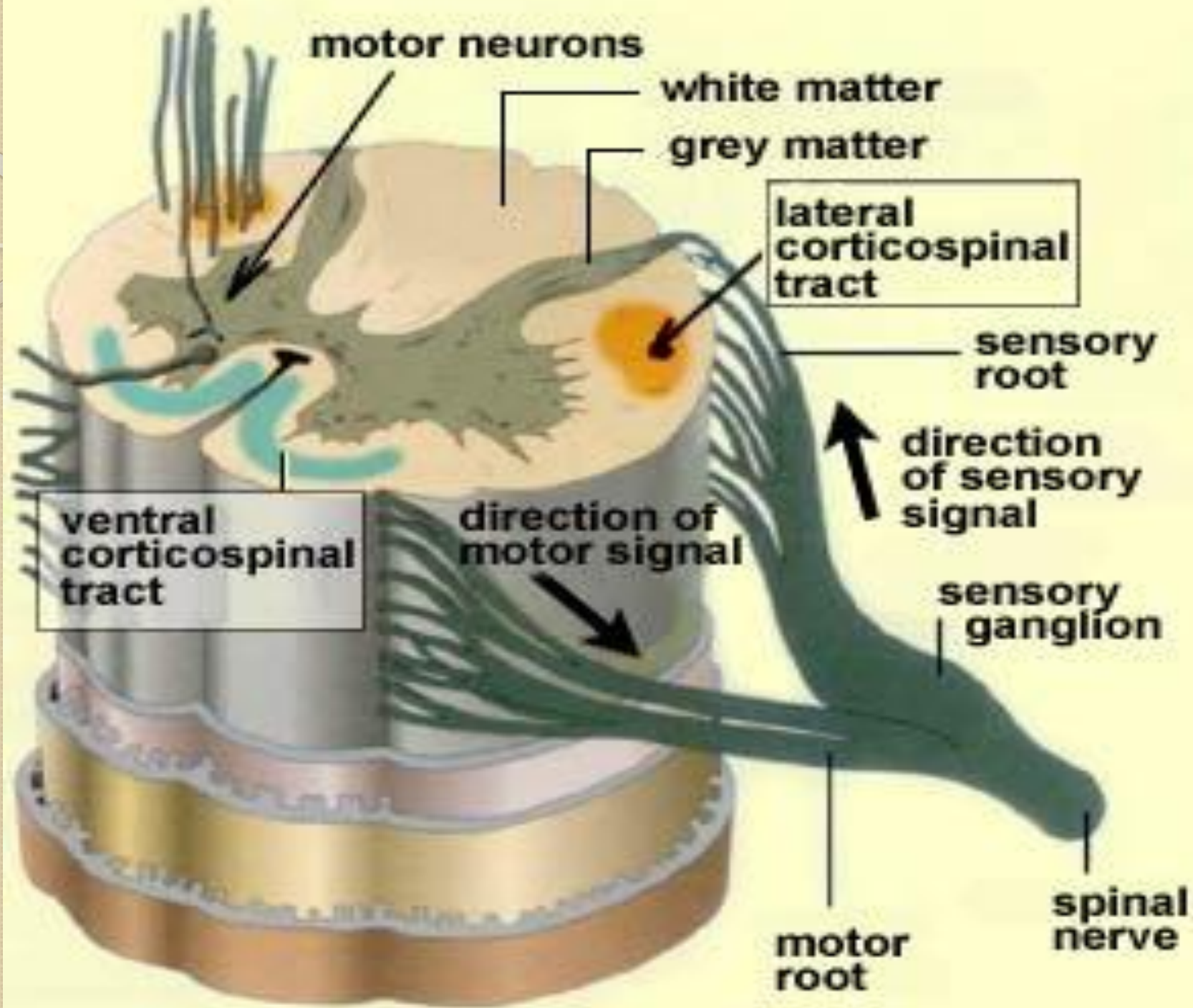
Function:

1. Stimulation of voluntary motor at the level of the same side.
2. Stimulation of muscles tone at the level of the same side.
3. Stimulation of deep reflexes at the level of the same side.

Pathway of the Lower Motor Neuron System (Spinomuscular fibers)

From AHCs of the spinal cord
→ fibers exit from the spinal
cord as the anterior roots of
the same side → peripheral
nerves → motor end plate →
.voluntary muscles





The Lateral and Medial Corticonuclear (Corticobulbar) Tract

Medial C.B.T. → give fibers
to ocular motor nuclei
in the brain stem from
both C.H. "Bilateral
C.H. supply".

Lateral C.B.T. → give fibers
to motor nuclei of cranial nerves

- V - nucleus
- Dorsal nucleus of VII nerve
- IX - nucleus
- X - nucleus
- X - nucleus

and

→ Ventral nucleus of VII nerve only from opposite side.

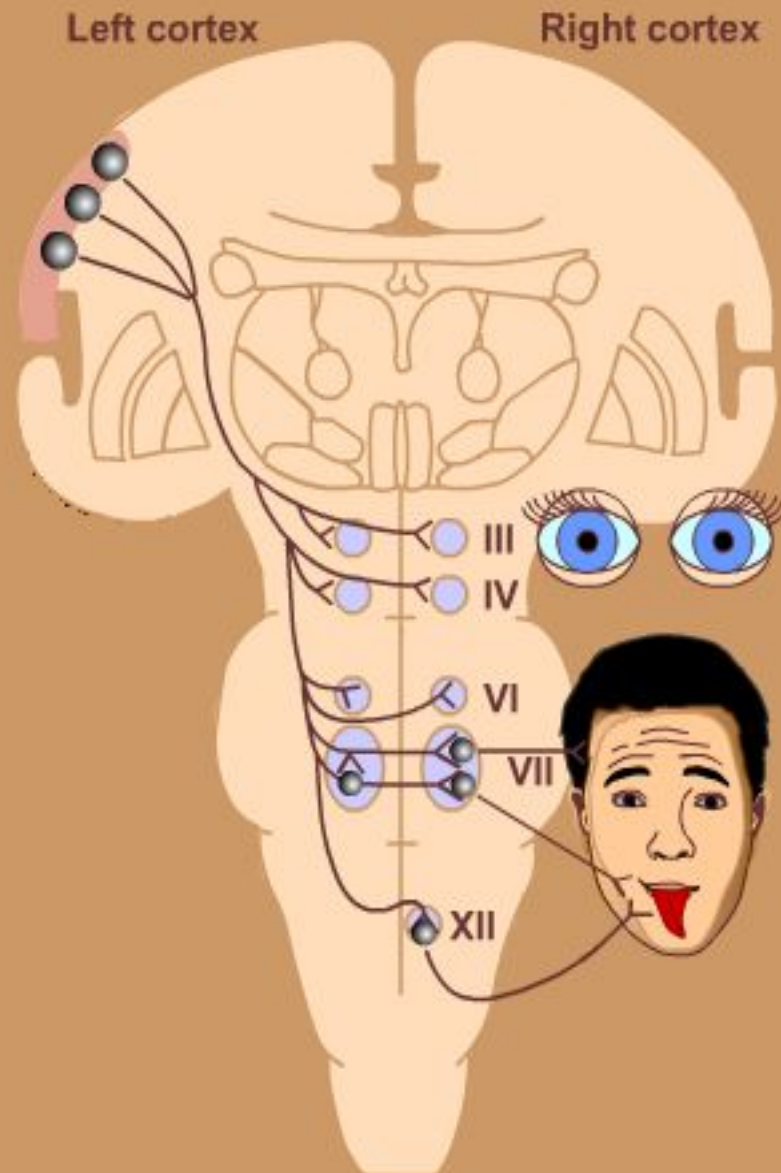
from both cerebral hemisphere "Bilateral"

The Lateral Corticonuclear (Corticobulbar) Tract

- ❖ From Betz cells in motor area 4 (in the lower 1/3 of precentral gyrus of frontal lobe – the face region) → descends in the corona radiata → pass in the genu (apex) of the internal capsule → descends in midbrain, pons → some fibers end around the motor nuclei of V and VII cranial nerves → give fibers for motor nuclei of IX, X, XI and XII cranial nerves in the medulla oblongata.
- ❖ **Termination:** the fibers of corticonuclear tract end in the motor nuclei of V, dorsal VII, IX, X and XI cranial nerves of both side except the motor nuclei of ventral VII and XII cranial nerves are receive fibers only from the opposite side.
- ❖ **Function:** Motor control of the head and neck.

The Medial Corticonuclear (Corticobulbar) Tract

- ❖ From motor cells present in area 8 of the cerebral cortex (frontal eye conjugate center) → descends in the corona radiata → pass in the genu (apex) of the internal capsule → descends in midbrain → some fibers end around motor nuclei of III and IV cranial nerves of both side → the remaining fibers descend to reach the pons and end around motor nucleus of the VI cranial nerve of both side.
- ❖ **Function:** responsible for the movement of both eyes.



Classification of the Motor Neuron Lesion

I. According to the location of the lesion:

1. Upper motor neuron lesion (spastic or central paralysis).
2. Lower motor neuron lesion (flaccid or peripheral paralysis).

II. According to the affected limbs:

1. Monoplegia (Rt. UL or LL, Lt. UL or LL): paralysis of one limb.
2. Hemiplegia (Rt. or Lt. sided): paralysis of one side of the body.
3. Paraplegia: paralysis of both limbs.
4. Triplegia: paralysis of three limbs (one upper and two lower limbs).
5. Quadriplegia (tetraplegia): paralysis of four limbs.
6. Bilateral hemiplegia.

Differential between the UMNL & LMNL

	U.M.N. LESION	L.M.N. LESION
1. Location of lesion	From area 4 until AHCs	From AHCs until muscles
2. Location of paralysis	Below the level of lesion: Contralateral (above decussation) and ipsilateral (below decussation)	Ipsilateral at the level of lesion
3. Paralysis	Spastic or central	Flaccid or peripheral
I. MUSCLES		
1. State of the muscles	Wasting occurs very late due to disuse	Wasting occurs early (hypotrophy)
2. Muscle tone	Hypertonia (spasticity)	Hypotonia (flaccidity)
Muscle fasciculation .3 (spontaneous contraction of muscles group).	Absent	May be present in the irritative lesions of AHCs
II. REFLEXES		
1. Deep reflexes	Hyperreflexia	Hyporeflexia or areflexia
2. Clonus (Rhythmical series of contraction in response to sudden stretch of muscle tendon).	May be present	Absent
3. Pathological reflexes (Babinski reflex)	+ve (dorsiflexion of big toe + fanning of other toes)	Absent
4. Superficial reflexes	Lost if the lesion is above segmental supply of the reflex	Lost if lesion involve the segmental supply of the reflex



Thank You