BAU-Medicine

Sheet no. 13
Lecture Date:
Lecture Title: Motor pathway 1
Written by: Ammar Sameeh Amro
Edited by: Safa al-Husseini & Hiyam aljammal

If you come by any mistake (whether it be spelling, grammatical or scientific) while browsing this sheet, kindly report it to the Academic team Facebook account.

اللهم إن رشيد في ذمتك و حبل جوارك فقه من فتنة القبر و عذاب النار و أنت أهل الوفاء و الحق فاغفر له و ارحمه إنك أنت الغفور الرحيم

Motor Pathways I

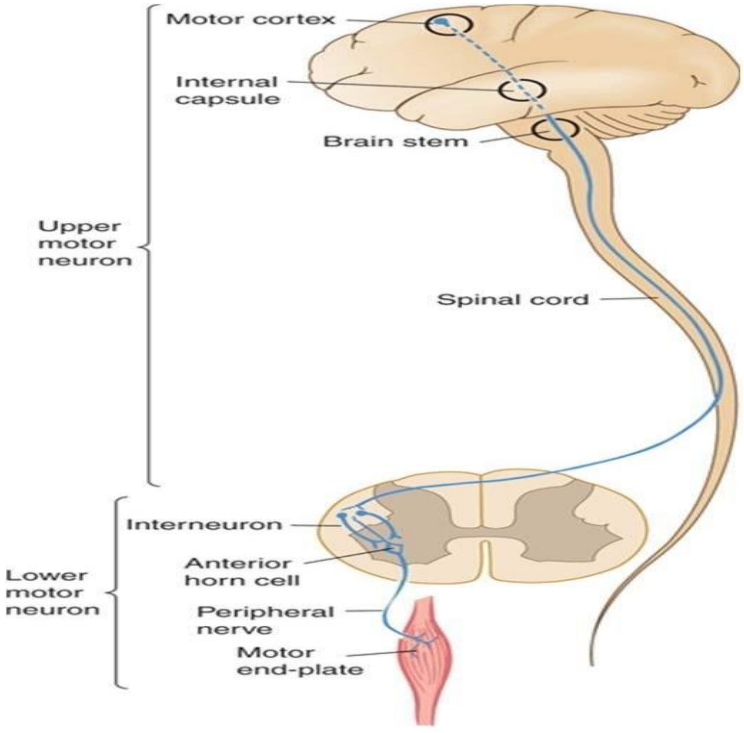
- **Motor System Hierarchy:** (Pay attention for the colors, since same colors indicates same structures)

Control system → Initiator → Executers → Lower motor neuron → Muscle.

Basal Ganglia, Cerebellum → Cortex → Upper motor neurons → Lower motor neuron → Muscle.

  - Basal nuclei + cerebellum = control systems, and their function is to monitor all processes.
  - The control systems give the initiator (cortex) the orders.
  - Any order in our body will be controlled before it goes to the initiator.
  - The cerebral cortex contains the cell bodies of upper motor neurons that their axons will form the projection fibers (descending tracts which will not leave the CNS).

- **Upper and Lower Motor Neurons:**
  - Upper motor neurons will deliver the orders to the **lower motor neurons** through interneurons or directly. (this connection is controlled either locally or supraspinal)
  - We found the Lower motor neurons in the **anterior horn of the gray matter of spinal cord**or **in the brainstem in the cranial nerves of motor nuclei**, and their axons will go toward the muscles, forming a circle , since muscle contraction will be translated as feedback sensory information to the motor system, so control system will be able to send another muscle contraction orders .



• Lower Motor Neurons:

- Neurons innervates muscles:
  - **1- Alpha motor neurons** → it responsible about real contraction of muscles.
    Innervates normal fibers
  - **2- Gamma motor neurons** → it responsible about reflexes that protect the muscle and contribute in stretch reflex and the protection of the muscle from the over stretching.
    Innervates fibers in muscle spindle
- Present in:
  - **Spinal cord**
  - **Brainstem (in the cranial nerves nuclei)**

• Muscle tone:

- Determined by the level of activity in the lower motor neurons
- Tone refers to the resistance of a muscle to passive stretch
- Primary determinant of muscle tone is the level of activity in the stretch reflex
- Muscle tone → it has a mechanism to protect the muscle and make it stand by.

• Upper motor neuron:

- **Project to LMN (lower motor neuron)**
- **Innervate α and γ motor neurons and inhibitory interneurons**
- **Location of UMN (upper motor neuron)**
  - **Reticular formation:** reticulospinal tract → modulation to the reflex.
  - **Vestibular nuclei**: vestibulospinal tract → responsible for maintaining balance.
    Sensory information from this nuclei is important for the motor system since coordination of motor actions depends on balance. (infection in middle ear→affects vestibulocochlear nerve→imbalance→affects motor activity→ يترنح بالمشي وبوقع)
  - **Superior colliculus:** tectospinal tract → responsible for the head movementthat is related to visual stimuli.
  - **Red nucleus:** rubrospinal tract → closely related to the corticospinal tract
  - **Motor cortex**: corticospinal & corticobulbar tracts (+ corticorubral & corticoreticular).

Corticobulbar tracts :
From the cortex to the brainstem
(motor nuclei of cranial nerves)

• Descending Tracts Classification:

- **Classical classification:**
  - **Pyramidal system**
    - Axons traverse the pyramids in medulla
    - Corticospinal axons
  - **Extrapyramidal system**
    - Other descending tracts
    - Basal ganglia and their connections with motor region

- **Functional classification:**
    - **Medial system**
        - Innervate medial motor nucleus (Trunk, posture, supporting)
    - **Lateral system**
        - Innervate lateral motor nucleus (Limbs, real movement, voluntary)

- **The functional classification helps us to know and determine the site that is affected from injury.**

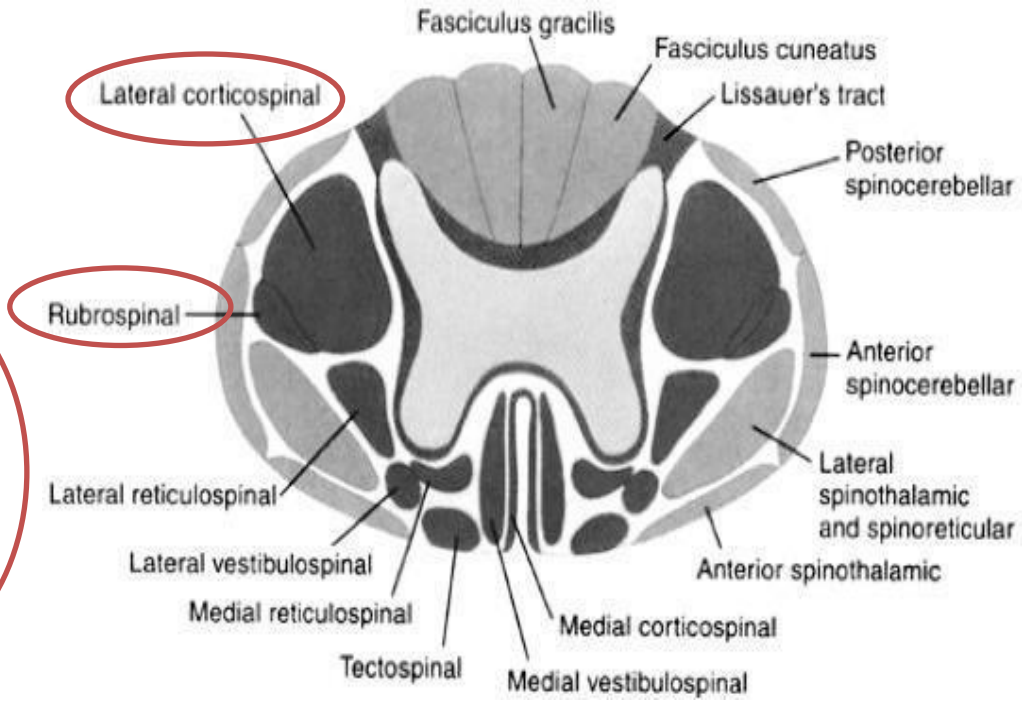
- **DESCENDING TRACTS:**

- **LATERAL PATHWAYS**
    - Located in the lateral white column.
    - Terminate laterally in the ventral horn.
    - Crossed → the left side will control the right side and vice versa.
    - Involved in movements of the distal limbs (initiation & fine movement)
    - Damage – weakness (partial) or paralysis (complete)
    - Contains
        - Lateral corticospinal tract
        - Rubrospinal tract

        Both tracts work together

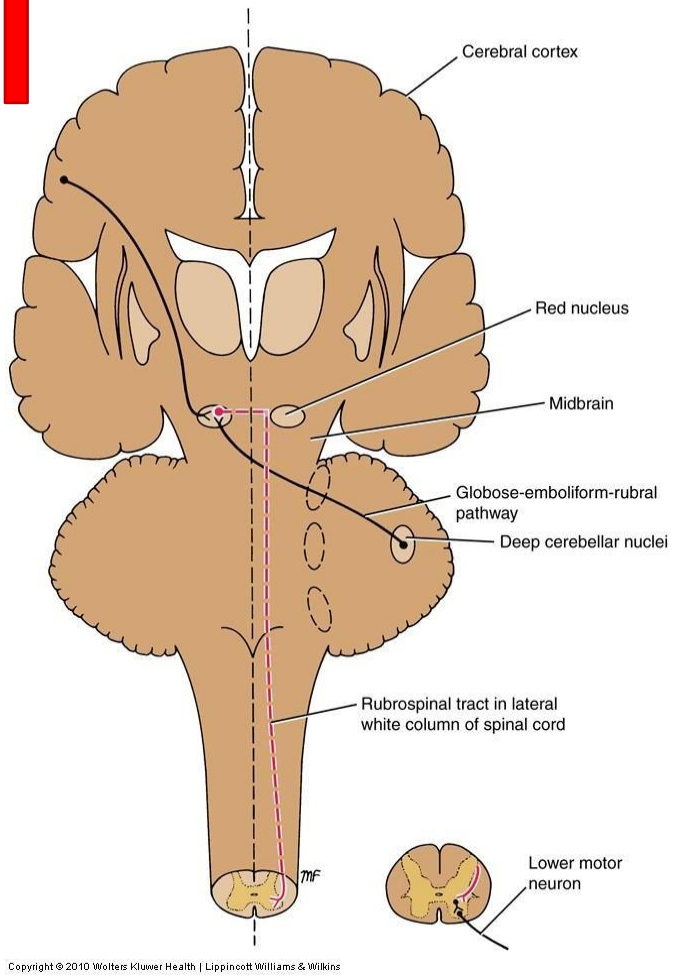
Notice that they are attached to each other

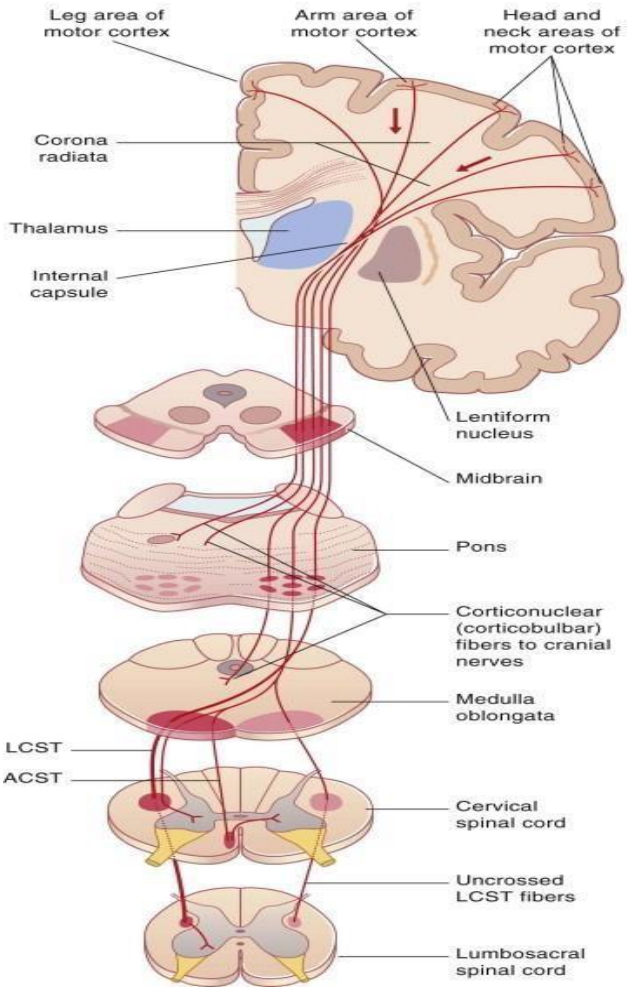
Notice that they don't reach the edges since there are another tracts in the edges



1. Rubrospinal tract:

- From red nucleus.
- Axons are crossed immediately after exiting the red nucleus.
- It is responsible for the fine controlling of the lateral pathway functions more than CORTICOSPINALTRACT.



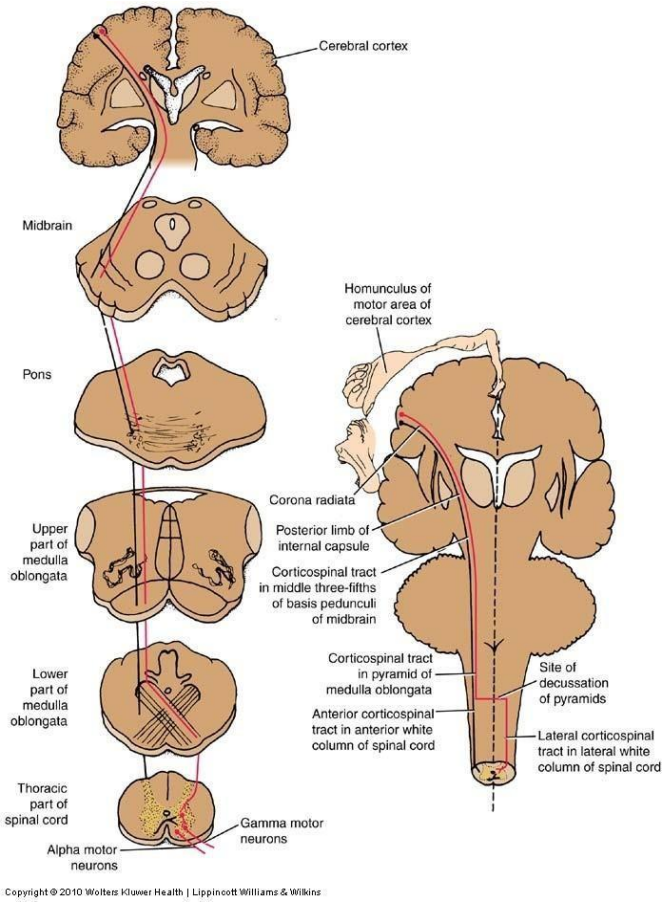


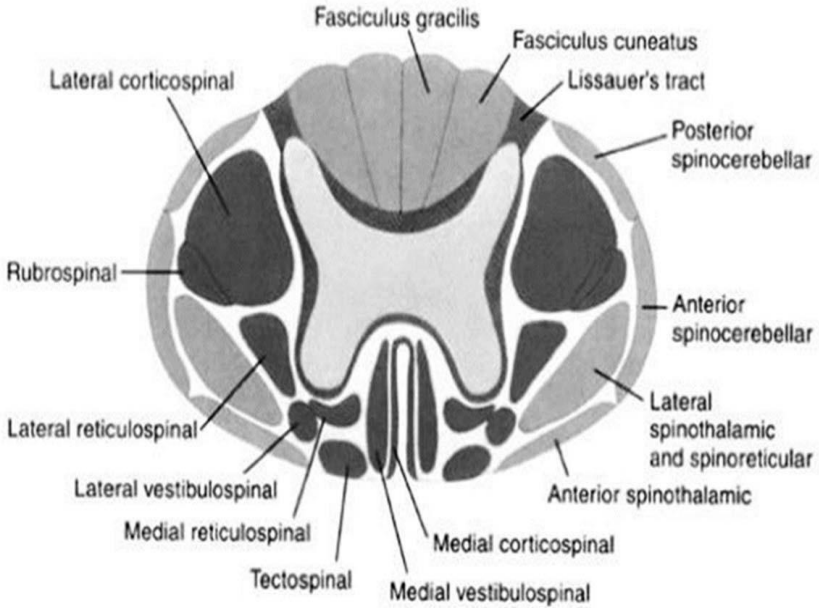
- **The Pyramidal (Corticospinal & corticobulbar) Tract:**

- **Origin – cerebral cortex**
  - ⅓ from primary motor cortex
  - ⅓ from premotor areas (Association area)
  - ⅓ from primary somatosensory cortex
    - Terminate in dorsal horn and brainstem
    - Modify processing in the somatosensory pathways

❖ Corticospinal Tract: (axons from cerebral cortex).

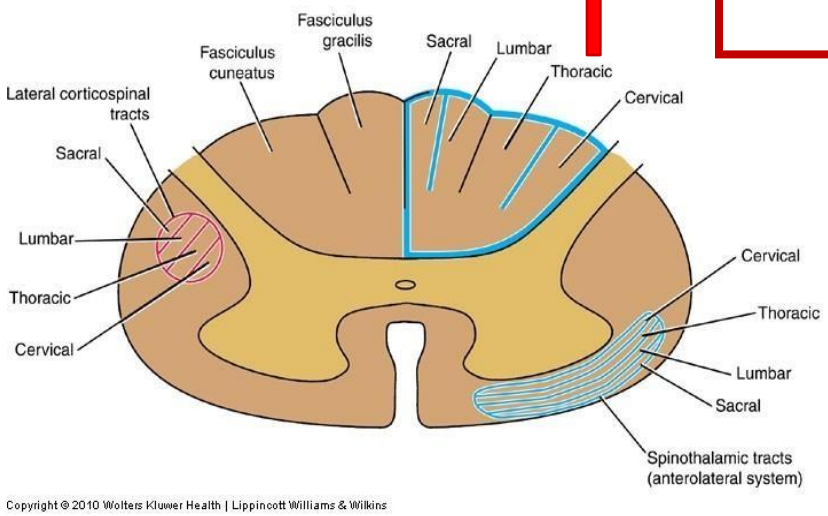
- **Axons pass through:**
    - Corona radiate.
    - Internal capsule (posterior limb).
    - Basis pedunculi – midbrain.
    - Basilar part of the pons.
    - Medullary pyramids.
        - Decussation
            - Crossed – Lateral corticospinal **90-95%**.
            - Uncrossed - Anterior corticospinal tract (medial).





1. Lateral Corticospinal Tract

Somatotopic Organization



- **The SACRAL PART** represented the most superficial part.
- Deeper to **SACRAL PART** is the **LUMBER PART.**
- Deeper to the **LUMBER PART** is the **THORACIC PART.**
- Deeper to the **THORACIC PART** is the **CERVICAL PART**, so the deepest part is the **CERVICAL PART.**

- **NOTE :**
  - The most affected part is the superficial part (sacral part).
  - The most protected part is the deepest part (cervical part).

❖ **Corticobulbar Tract:**

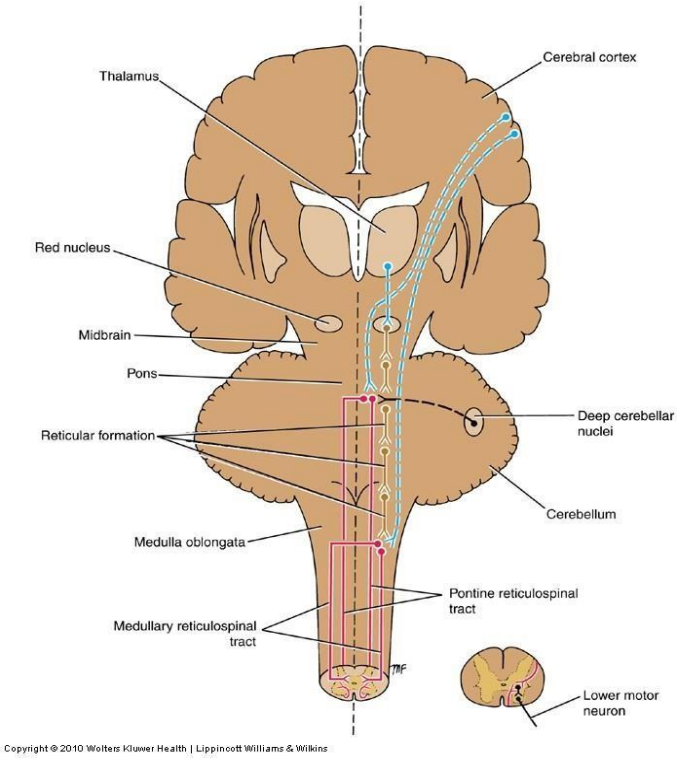
- Same origin & course as corticospinal.
- Leave tract in brainstem.
- Terminate in the **cranial nerve nuclei**
- Bilateral in general.
  - **Clinical application** :
    if the motor nucleus of trigeminal nerve is damaged in one side (that innervates mastication muscles) → ipsilateral paralysis.
    if the RIGHT upper motor neurons (which supply both trigeminal nerve nuclei) are damaged → No paralysis , since the LEFT upper motor neuron will compensate.
  - Except to facial nucleus. (part is bilateral and the another is unilateral)

- **Bilateral which means the tract that descends from the cerebral cortex from the right side will make a connection with both nuclei of cranial nerves from the right and left side, and the left tract will do the same.**

- **MEDIAL PATHWAYS → involuntary part (unconscious).**
  - Terminate Medially in the ventral horn
  - Trunk & proximal limb movements
  - Important in maintaining balance & position
  - Mostly happened unconsciously
  - Damage
    - Deficits in maintaining balance & posture
    - Changes in muscle tone
  - Contains:
    - Reticulospinal tract
    - Vestibulospinal tract
    - Tectospinal tract
    - Anterior corticospinal tract

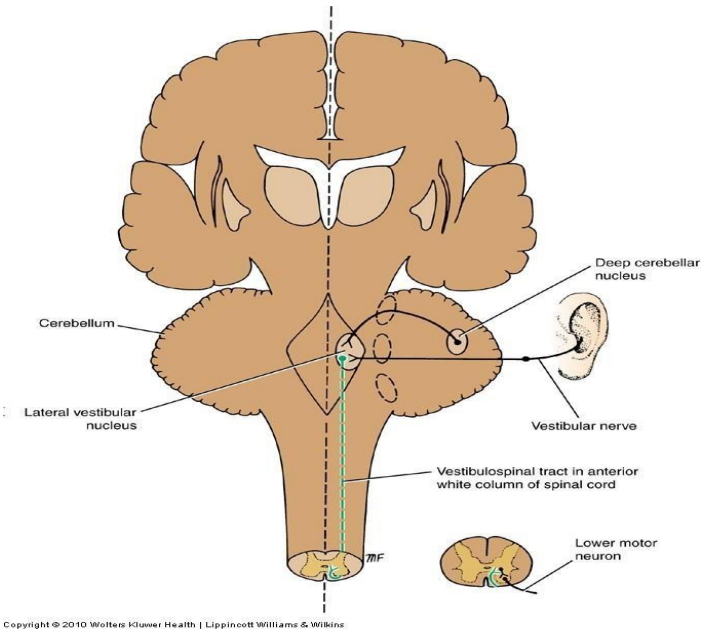
Any injury o this part won't make a paralysis BUT will affect the balance and movements of our body.

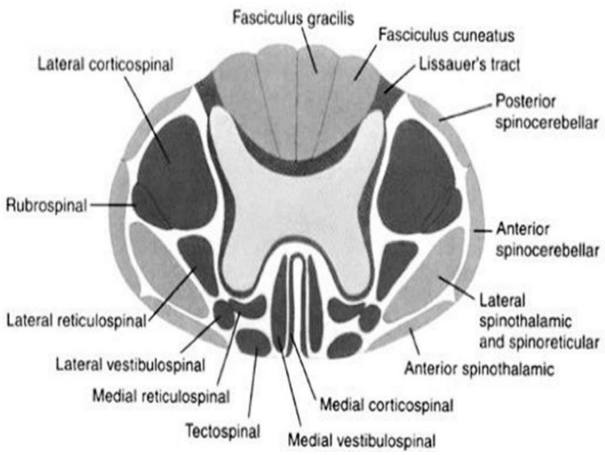
- **Reticulospinal tract:**
- From the reticular formation
- Important influence on muscle activity and reflexes
- Controlled by cortex (corticoreticular)
- Contains descending autonomic fibers – controlled by thalamus
- Crossed and uncrossed (the crossing-over will occur more than once and in more than one place).
- Two tracts
  - Lateral reticulospinal tract – from Medulla → will decrease the spinal reflexes.
  - Medial reticulospinal tract – from Pons → will increase the spinal reflexes.



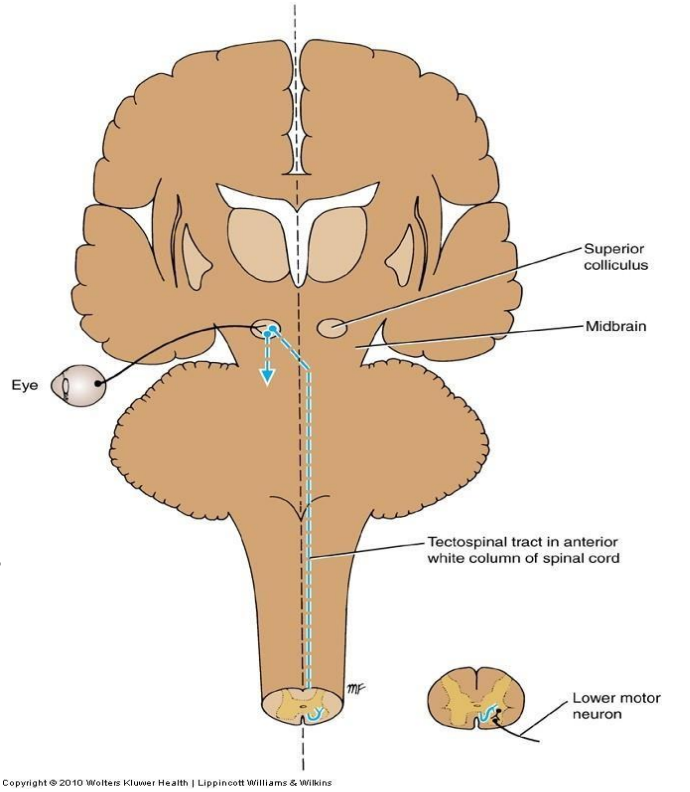
If we omit the control of the upper motor neuron on spinal reflexes it will cause hyper-reflexes, for that the net result of upper control is inhibition the spinal reflexes.

- **Vestibulospinal Tract:**
  - Importance in maintaining balance
  - Influence axial muscles
  - **Uncrossed** (works with cerebellum, which controls the ipsilateral side).
  - Medial & lateral vestibulospinal tracts

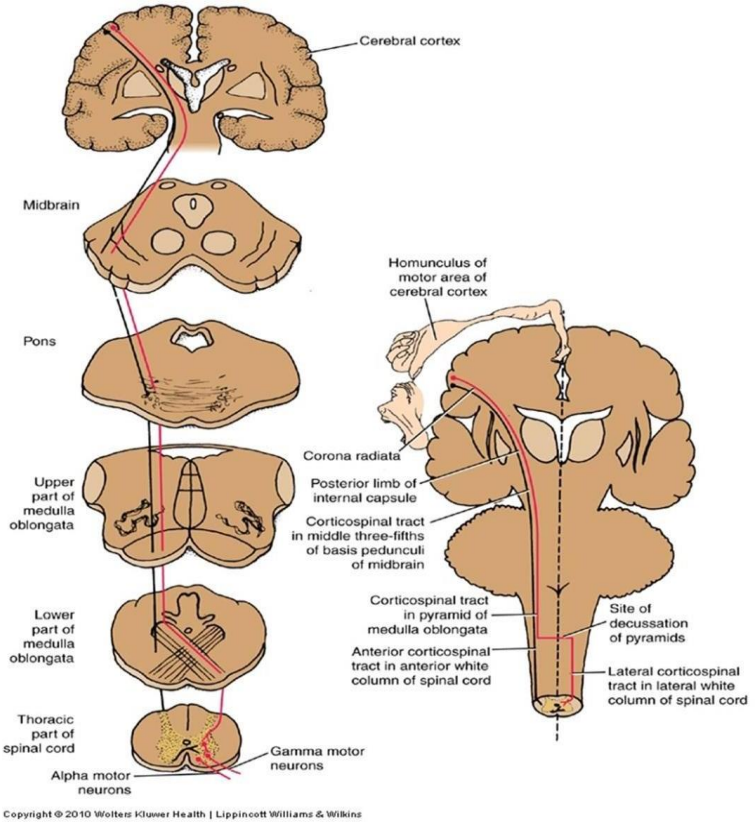




- **Tectospinal Tract:**
  - Superior colliculus.
  - Terminate in the cervical regions.
  - Head movements in response to visual stimuli.
  - Mostly crossed (functional part is crossed)



- **Anterior Corticospinal Tract:**
  - **Similar to other medial pathways**
    - Terminate in the medial motor n.
    - Except it is voluntary
  - **Do not cross in pyramidal decussation**
    - May cross before termination

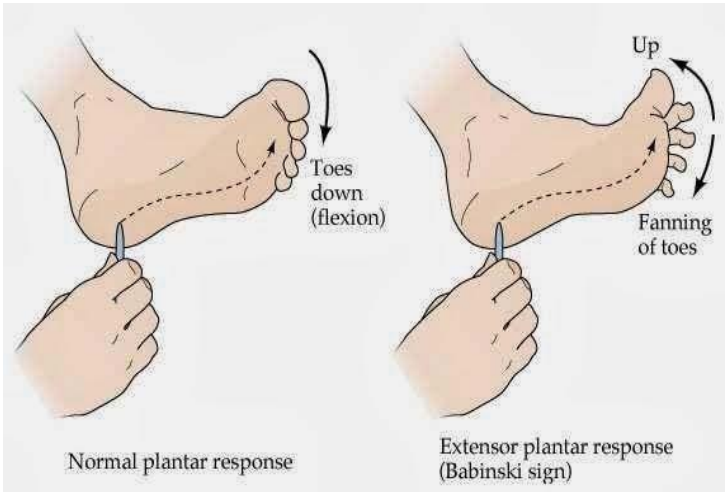


Lesions :

- **Lower Motor Neuron Lesion:**
  - **Flaccid paralysis or paresis (weakness)**
  - **Hypo- or areflexia**
  - **Decreased muscle tone**
  - **Atrophy- muscle wasting**
    - Develops over time (weeks)
  - **Fasciculation – small twitches that are visible to the eye**

- **Upper Motor Neuron Lesion:**
  - **Paralysis or paresis**
  - **Spasticity**
    - Hypertonia
    - Hyperreflexia

  And maybe:
  - **Babinski sign**
  - **Clonus**
  - **Decreased superficial reflexes**
    - Abdominal reflex & Cremasteric reflex

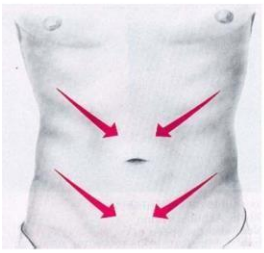


- **Babinski Sign:**
  - **Abnormal response to stroking the lateral planter surface of the foot**
    - Not useful in babies
  - **Normal response: toes planter-flex**
  - **Abnormal: dorsiflexion of big toe**
  - **Dorsal reflection** → (positive) for Babinski sign.

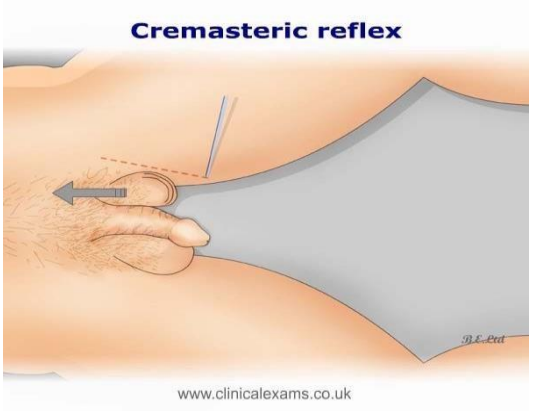
- **Clonus:**
  - **Repetitive flexion-extension of a joint in response to single flexion or extension.**

- **Superficial Reflexes:**
- **Decrease With UMN lesions**
  - Abdominal reflex; abdominal muscles contract on stroking the abdomen
  - Cremasteric reflex (useful in babies); testes elevation with stroking inside of the thigh

Abdominal Reflexes

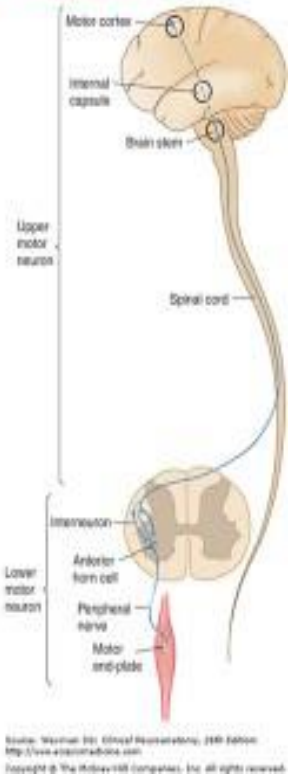


T8, T9, T10:
ABOVE umbilicus
T10, T11, T12:
BELOW umbilicus

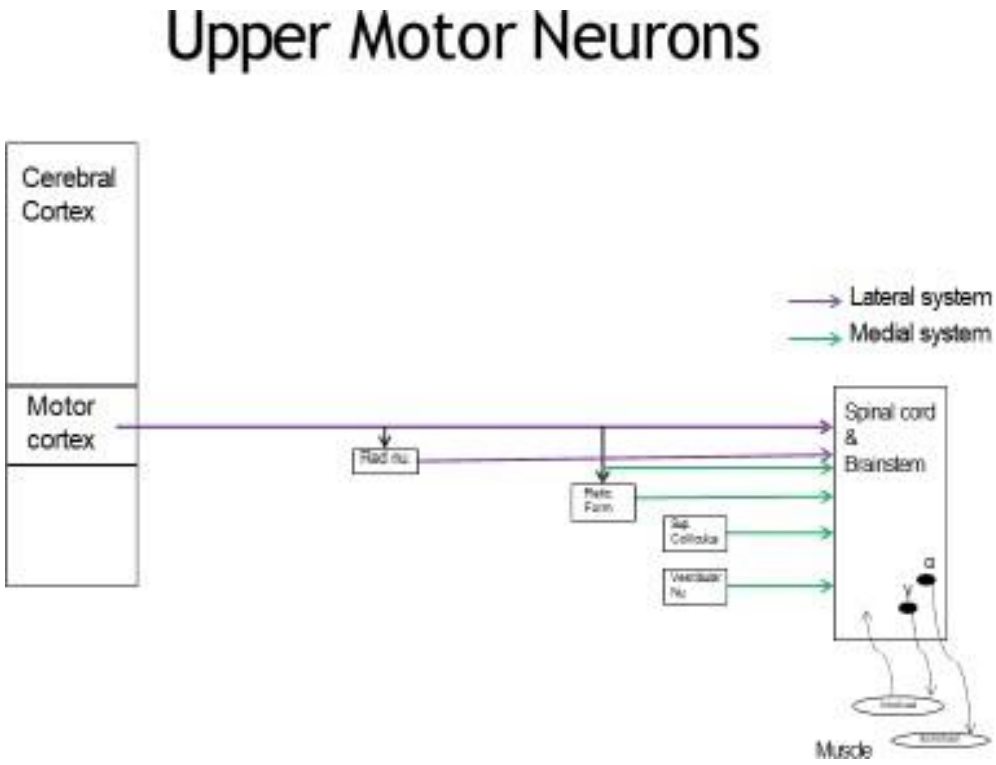


Lower-versus Upper-Motor-Neuron Lesions

Variable	Lower-Motor-Neuron Lesion	Upper-Motor-Neuron Lesion
Weakness	Flaccid paralysis	Spastic paralysis
Deep tendon reflexes	Decreased or absent	Increased
Babinski's reflex	Absent	Present
Atrophy	May be marked	Absent or resulting from disuse
Fasciculations and fibrillations	May be present	Absent



- **Spinal Shock:**
  - **Follows severe acute injury to the spinal cord**
  - **For short period (days or weeks)**
  - **Loss of all functions (motor & sensory) bellow level of injury**
    - Loss of reflexes
  - **Due to sudden loss of supraspinal inputs**
  - **Clinical application :**
    You can't determine if the injury is in the upper or lower motor neurons because of the spinal shock, since it's an acute phase caused by the injury, maybe followed by hyper reflexes (upper motor neurons injury) or persistent loss of functions (lower motor neurons injury)



وبس وهللا

وسمايل يا جماعة):