بسم الله الرحمن الرحيم

Spinal Cord (Pt.4) + Spinal Cord Lesions

MID | Lecture 5

﴿إِنِّي تَوَكَّلْتُ عَلَى اللَّهِ رَبِّي وَرَبِّكُم ۚ مَّا مِن دَابَّةٍ إِلَّا هُوَ آخِذٌ بِنَاصِيَتِهَا ۚ إِنَّ رَبِّي عَلَىٰ صِرَاطٍ مُّسْتَقِيمٍ﴾

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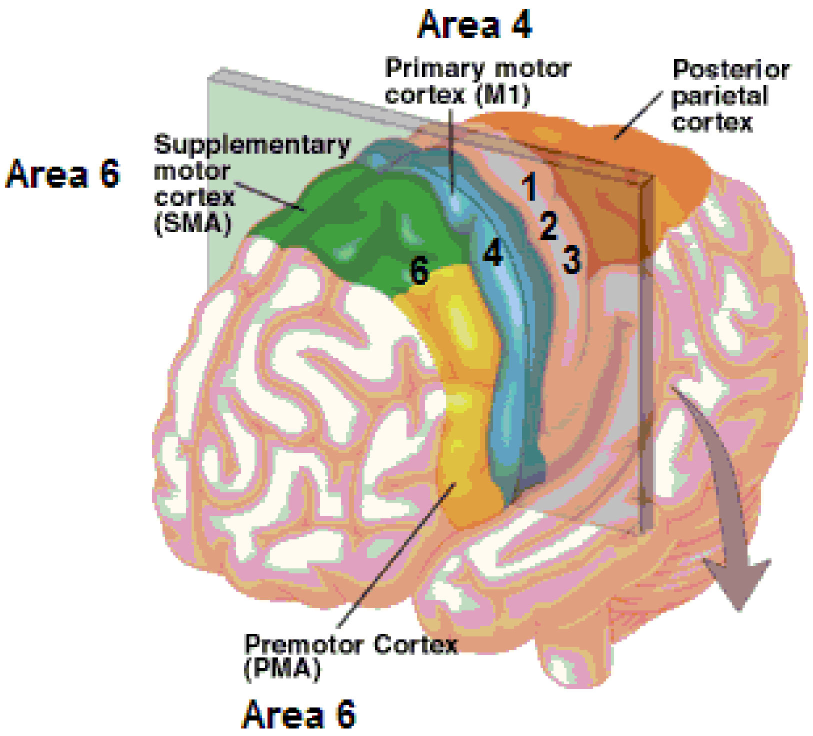
ANATOMY

Motor tracts

- ❑ Both pyramidal tracts and extrapyramidal both starts from cortex:
  - ➢ Area 4
  - ➢ Area 6
  - ➢ Area 312
- ❖ Pyramidal: mainly from area 4
- ❖ Extrapyramidal: mainly under the influence of area 6
  - ❑ area 6
  - ➢ **Premotor area:** uses external cues
  - ➢ **Suplemantary motor area:** uses internal cues



Pre-Studying Notice

- This lecture is rather long, so feel free to take at least one break in between; we recommend 2 breaks, one after slide 28, and one after slide 50.
- Wherever added full slides are present, they are positioned before their corresponding texts in the original slides, so you may read the explanation and *then* quickly take a look on the slides for consolidation and any extra details.

- تفسير سورة يس مش مكتوب لانه الملف تأخر وما بدنا نخربط الترتيب، بس اضغطوا هون.
- دعواتكم.

The Pyramidal System: Corticospinal Tracts

The **Pyramidal System** is the primary neural pathway responsible for the **conscious, voluntary control** of skeletal muscles. This system begins with **Upper Motor Neurons (UMN)** and concludes with **Lower Motor Neurons (LMN)** that directly innervate the muscles.

1. Origin and Cortical Sources

The fibers of the corticospinal tract originate primarily from the **Primary Motor Cortex (Area 4)**. However, significant contributions also come from the **Premotor and Supplementary Motor Areas (Area 6)** and the **Somatosensory Cortex (Areas 3, 1, 2)**, which provides sensory feedback for motor execution.

2. The Descending Pathway (Course)

As the fibers descend from the cortex, they follow a specific anatomical route through the brainstem:

Corona Radiata & Internal Capsule: Fibers gather in the **corona radiata** and descend through the **internal capsule**. At this point, the tract is positioned medially to the lentiform nucleus and laterally to caudate nucleus.

Midbrain: The fibers enter the **basis pedunculi (crus cerebri)**. They occupy the **middle three-fifths** of this area, located anterior to the cerebral aqueduct.

Pons: In the basal (anterior) part of the pons, the fibers become **scattered** into smaller bundles due to the presence of the **pontine nuclei**, losing the compact arrangement seen in the midbrain.

Medulla Oblongata: The fibers regroup in the medulla to form the **Pyramids**—two prominent bulges on the anterior-medial surface.

3. Pyramidal Decussation and Spinal Tracts

At the lower level of the medulla, the fibers undergo **decussation** (crossing over), splitting into two distinct tracts:

Lateral Corticospinal Tract (85%): These fibers **cross the midline** to descend contralaterally. They are highly concentrated in the **cervical segments** to support the high demand for skilled movements in the upper limbs. They terminate in the **lateral part of the anterior horn**.

Anterior Corticospinal Tract (15%): These fibers descend **ipsilaterally** (uncrossed). They eventually cross the midline only when they reach their specific spinal segment. They terminate in the **medial part of the anterior horn**.

4. Functional Organization and Clinical Correlation

The termination points in the **Anterior Horn** are organized to match muscle function:

Medial Group Neurons: Controlled by the **Anterior CST**; they manage **axial/trunk muscles** for posture and balance.

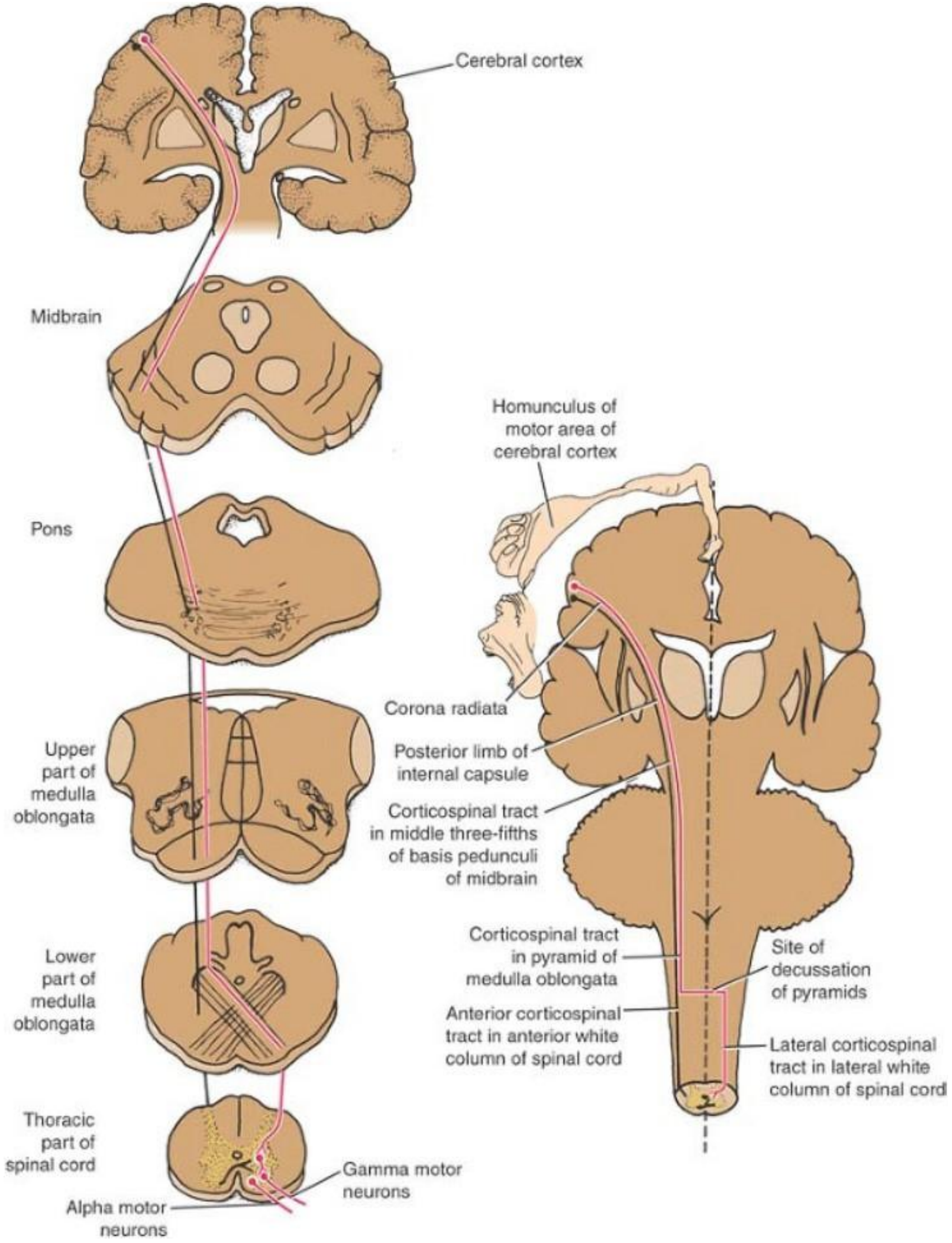
Lateral Group Neurons: Controlled by the **Lateral CST**; they manage **distal muscles** for fine, precise, and skilled movements (especially the hands and feet).

5. Motor Neuron Synapsis

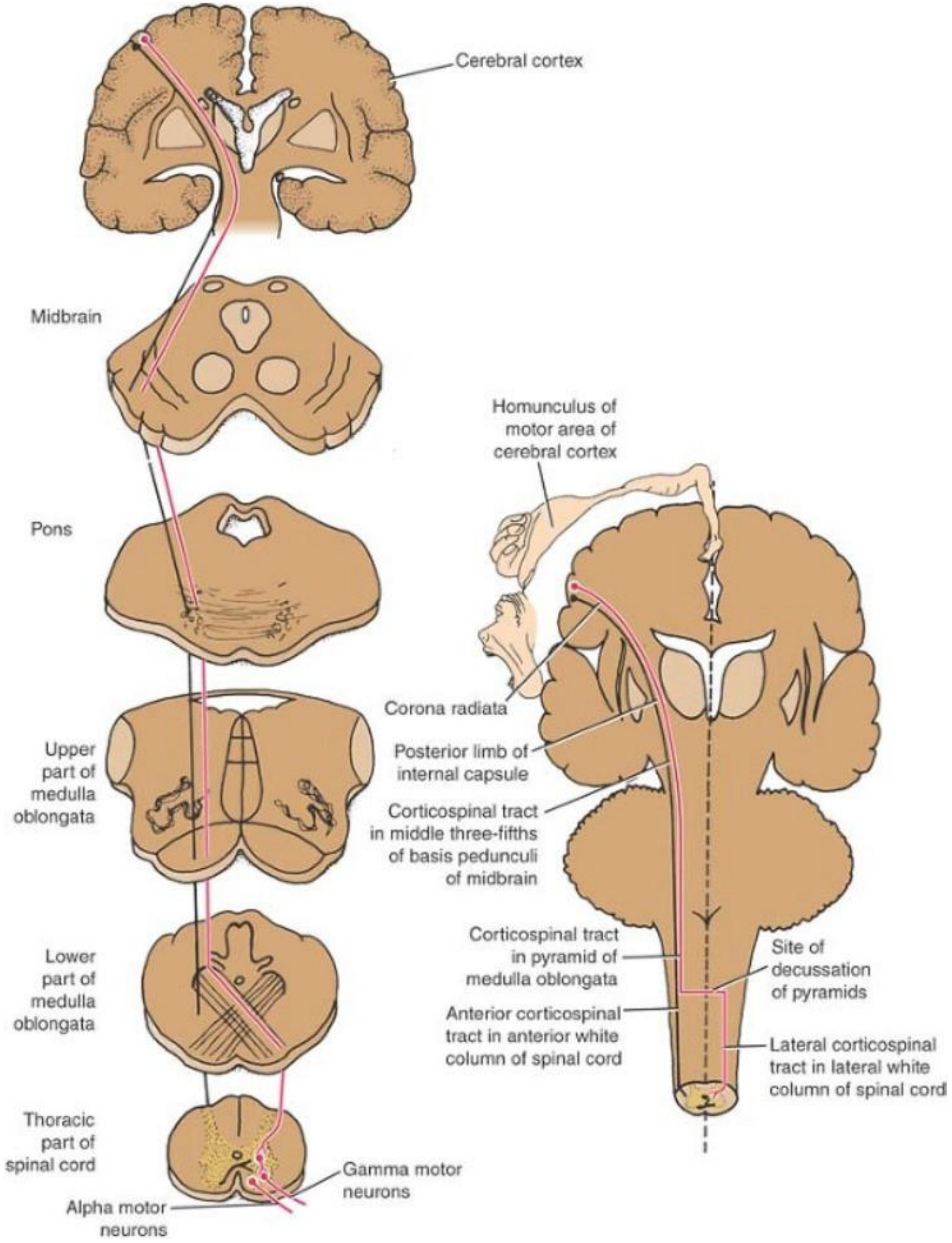
The **Upper Motor Neuron** travels from the cortex to the spinal cord. In most instances, the UMN synapses on **interneurons** before reaching the **Lower Motor Neuron** (located in the anterior horn or brainstem nuclei). However, for extremely precise movements, some UMNs synapse **directly** onto the LMN to ensure rapid and accurate signal transmission.

Lateral corticospinal tract

- The upper motor neurons of these tracts originate in the precentral gyrus of the cerebral cortex
- In midbrain: middle three- fifths of the **basis pedunculi of the midbrain**
- In medulla oblongata: pyramids
- Most of the fibers (85 percent) cross over (decussate) to the opposite side in the pyramidal decussation, where they continue to descend in the **lateral funiculus** of the spinal cord as the **lateral corticospinal tract** (LCST).

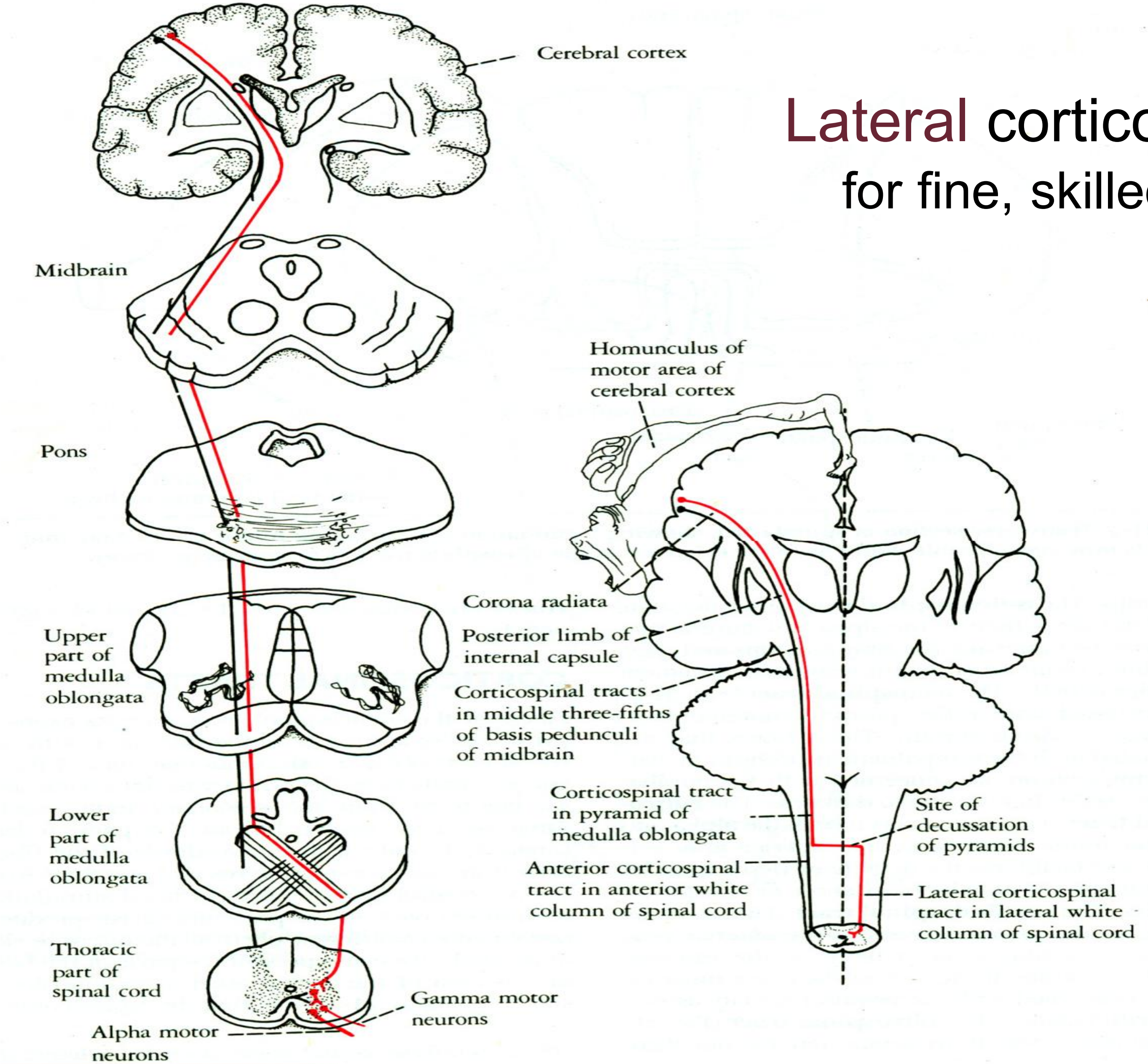


- The tract descends all the way of spinal cord with fibers continually leaving it in order to synapse on interneurons in the anterior gray horn. (Some even synapse directly on alpha and gamma motor neurons)
- *Those corticospinal fibers which do not decussate in the medulla continue descending on the same (ipsilateral) side of the cord and become the anterior corticospinal tract (ACST).*



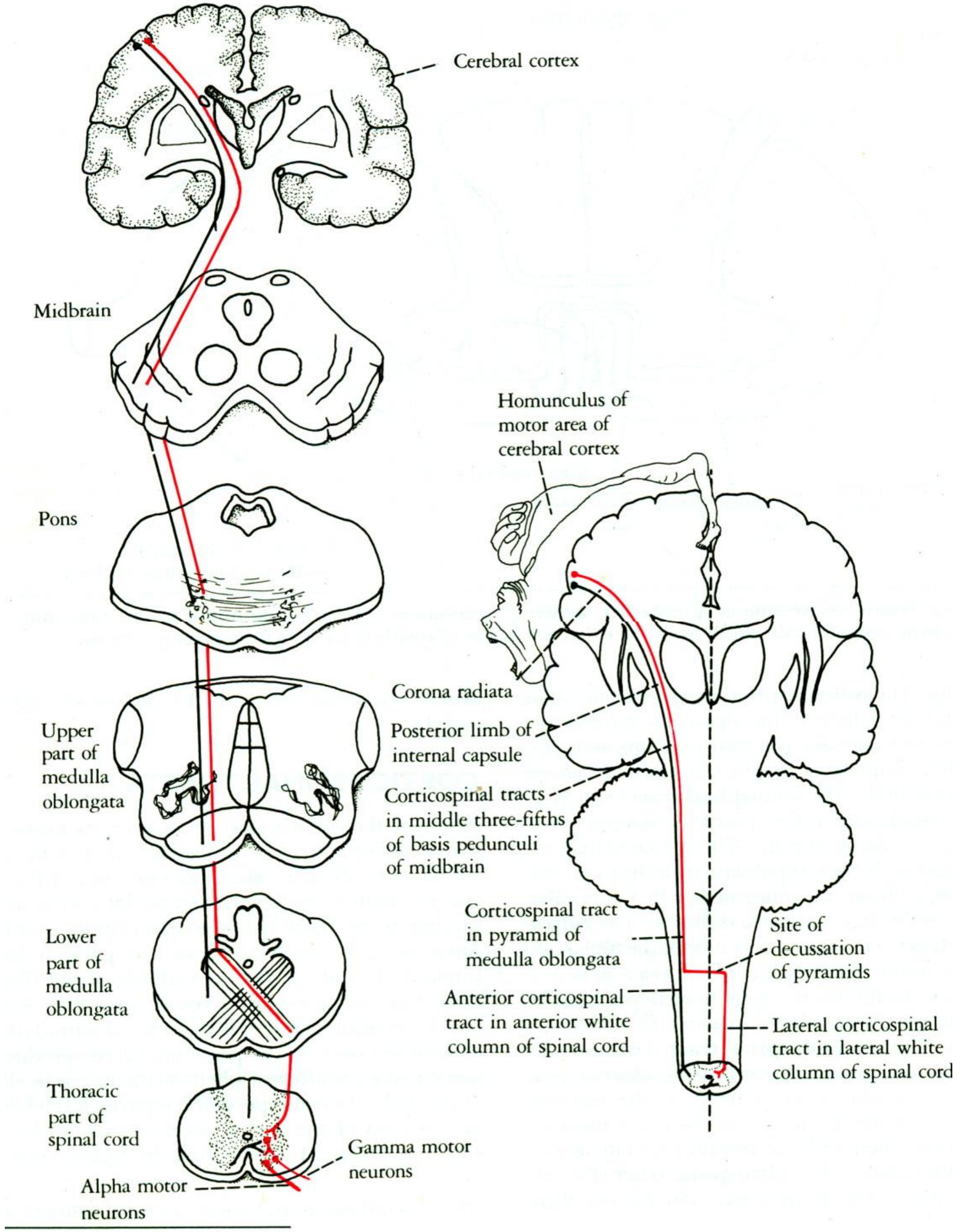
Lateral corticospinal tract

for fine, skilled movements



Corticospinal tracts.

- Lateral corticospinal tract descends the full length of the spinal cord
- LCST fibers synapse with alpha and gamma nuclei of the
    - Cervical region **(55%)** (great effect on the upper limb)
    - Thoracic 20%
    - Lumbar and Sacral 25%
- The lateral corticospinal tract synapses **mainly by interneurons** In lamine IV, V, VI, VII, VIII
- **Exception:** 3% originate from the fifth layer of area 4 (giant cells of betz) synapse directly. (Accurate movements)

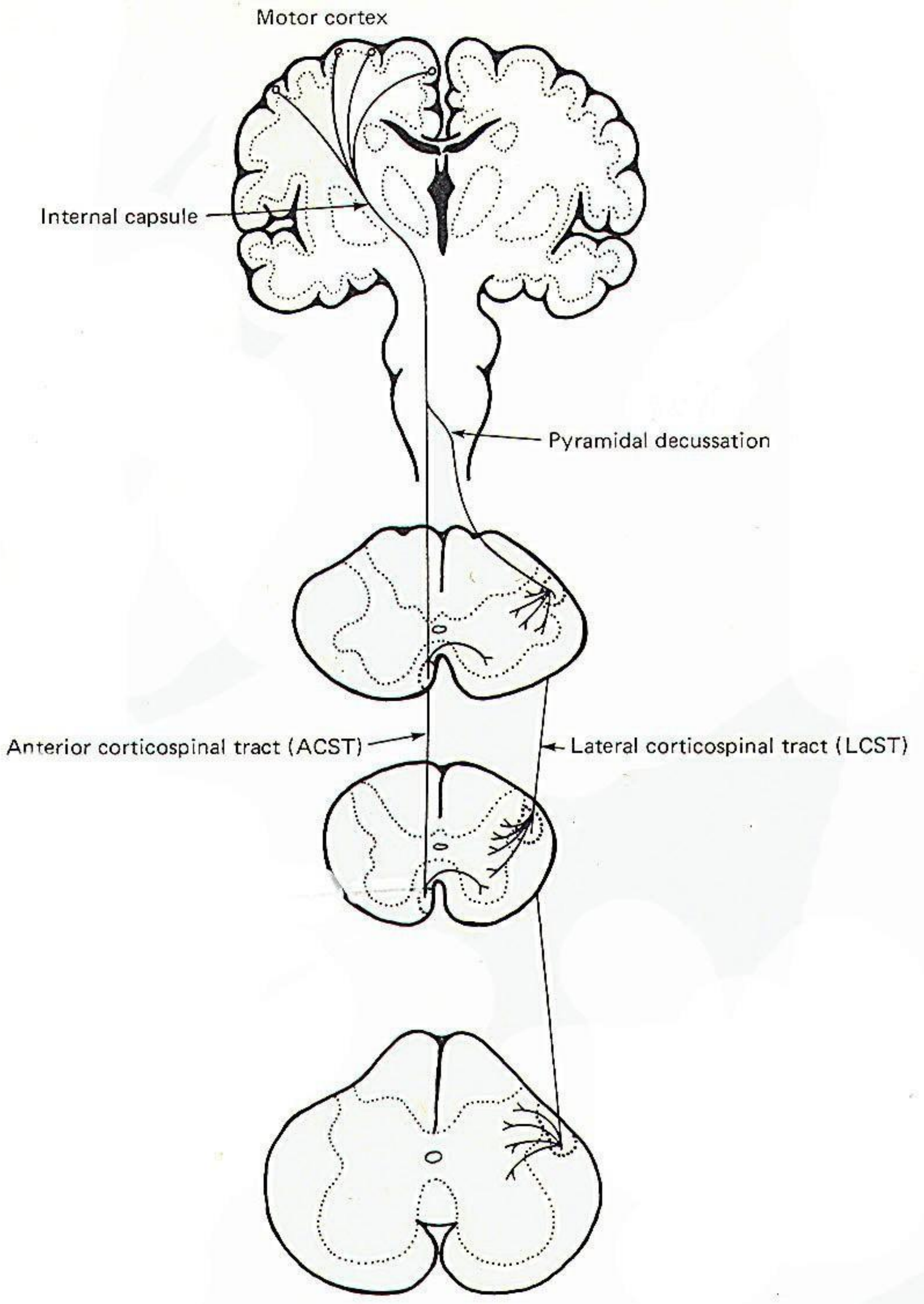


Corticospinal tracts.

The anterior corticospinal tract

- acts on the proximal muscles of upper limb (shoulder muscle) of the ipsilateral and contralateral sides

- *Fibers leave the tract at various levels to cross over in the anterior white commissure to synapse on interneurons in the anterior gray horn.*



Corticobulbar (Cortico-Nuclear) Tract

- The **motor component** of **cranial nerves** is comparable to **skeletal muscles** in terms of function, but their **organization differs** from the **spinal anterior horn**. Unlike the **anterior horn**, which has **medial and lateral groups**, **cranial motor nuclei** do not follow this **laminar arrangement**. Most **cranial motor nuclei**, **10 out of 12**, originate from the **brainstem**. However, the **brainstem lacks** the exact **structural organization** seen in the **spinal cord**.
- **Cranial motor nuclei** serve as the source of **lower motor neurons**, which innervate muscles such as those of the **face, tongue, and pharynx**. Fibers from **upper motor neurons** descend from the **cortex** to these **nuclei**. It is important to distinguish between **cortico-spinal** and **cortico-nuclear** pathways. In the **cortico-spinal tract**, the **right cortex** primarily controls the **left side** of the body through **decussation** at the **medullary or spinal level**. In contrast, the **cortico-nuclear tract** does not follow this **decussation principle**; instead, **motor nuclei** generally receive **bilateral cortical input**.
- **Bilateral cortical input** is a hallmark of most **cranial nerve motor nuclei**. For instance, the **motor nucleus of the facial nerve** (located in the **pons**) and the **motor nuclei** of the **glossopharyngeal and vagus nerves** receive fibers from **both cortical hemispheres**.
- However, there are **exceptions**:

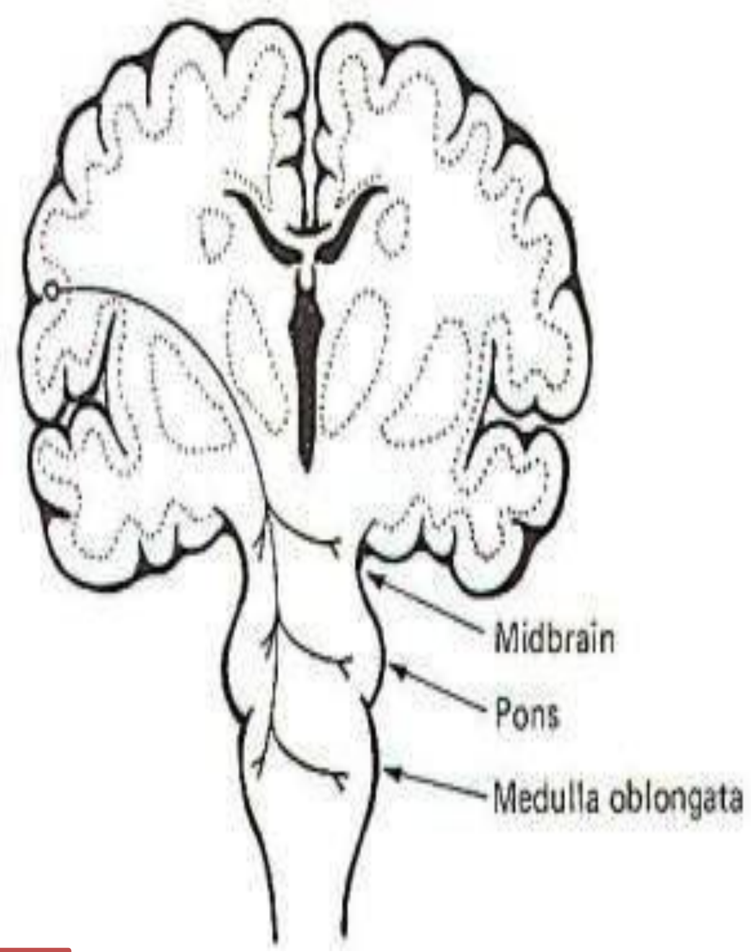
1. The **lower face region** of the **facial nerve nucleus** receives input **only from the contralateral cortex**, while the **upper face portion** maintains **bilateral input**.
2. Similarly, the part of the **hypoglossal nucleus** that innervates the **genioglossus muscle** receives **contralateral cortical input exclusively**

The Corticonuclear Tract (fibers)

➢ This tract is composed of fibers originating in the precentral gyrus of the lower quarter of the motor cortex.

➢The descending fibers terminate in the motor nuclei of cranial nerves III and IV in the midbrain; V, VI. and VII in the pons; and IX, X, XI, and XII in the medulla.

➢ The corticobulbar fibers from one side of the brain project to the motor nuclei on both sides of the brainstem (bilateral input)



The corticoneuclear input is bilateral **Except** :

1. Part of 7th (which supplies LOWER facial muscles)
2. Part of 12th (which supplies genioglossus muscle)

The Subconscious Motor Tracts

- Consists of four tracts involved in monitoring the subconscious motor control
- **Vestibulospinal tracts**
- **Tectospinal tracts**
- **Reticulospinal tracts**
- **Rubrospinal tracts**

Extrapyramidal tracts arise in the brainstem, but are under the influence of the cerebral cortex

These motor pathways are complex and multi-synaptic, and regulate:

- Axial muscles that maintain balance and posture
- Muscles controlling coarse movements of the proximal portions of limbs
- Head, neck, and eye movement

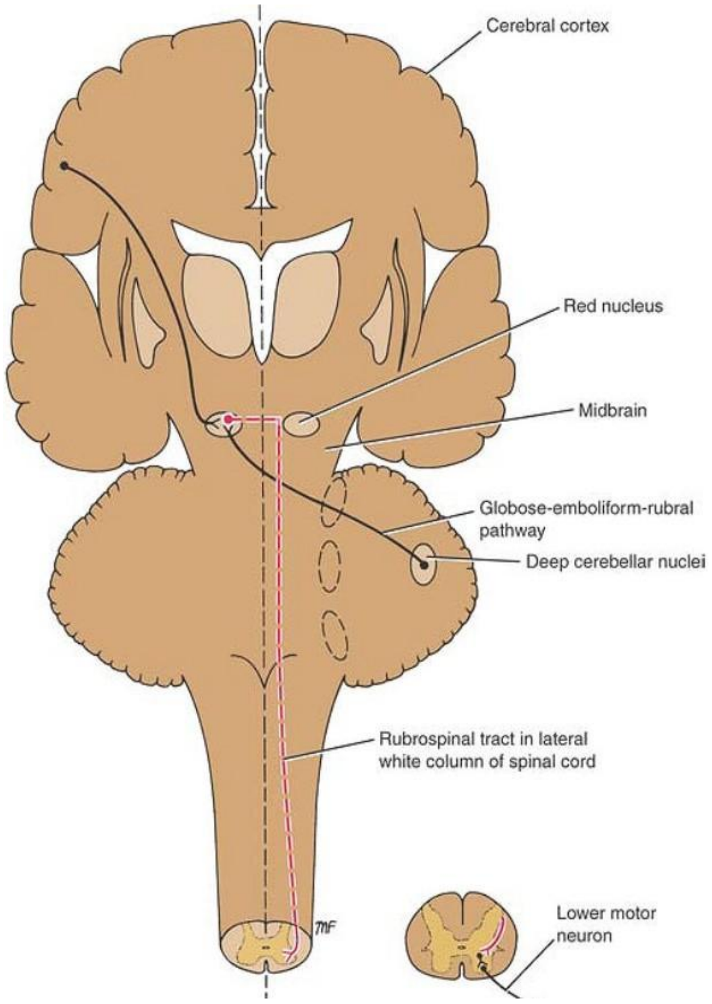
Rubrospinal Tract

- The **rubrospinal tract** originates from the **red nucleus**, which is located in the **midbrain** at the level of the **superior colliculus**. The red nucleus receives input from both the **cerebral cortex** and the **cerebellum**, forming a pathway that **integrates cortical and cerebellar signals**.
- The rubrospinal tract **crosses (decussates) immediately** at the level of the red nucleus, sending fibers to the **contralateral lateral white matter** of the spinal cord. It is **unique** among **extrapyramidal tracts** because it primarily **targets distal muscles**, especially **flexors of the hand**, facilitating **skilled movements** such as writing or typing. This makes it a part of the **lateral motor system**, functioning alongside the **lateral corticospinal tract**.

Rubrospinal tract

- **Red nucleus**
  - In the midbrain at the level of superior colliculus
  - Recieves afferent fibers from cerebral cortex and the cerebellum
- **Crossed** (at the level of the nucleus)
- Lateral white column
- **Function:**

  facilitate the activity of flexors and inhibit the activity of extensors



Rubrospinal tract

- rubrospinal tract is very close to the lateral corticospinal tract in the spinal cord. They form the **lateral motor system**
- synapses with alpha and gamma through interneurons
- Excitatory to flexors and inhibitory to extensors
- supply the distal flexors muscles mainly with little effect on the proximal muscles

(facilitate the activity of flexor muscles)

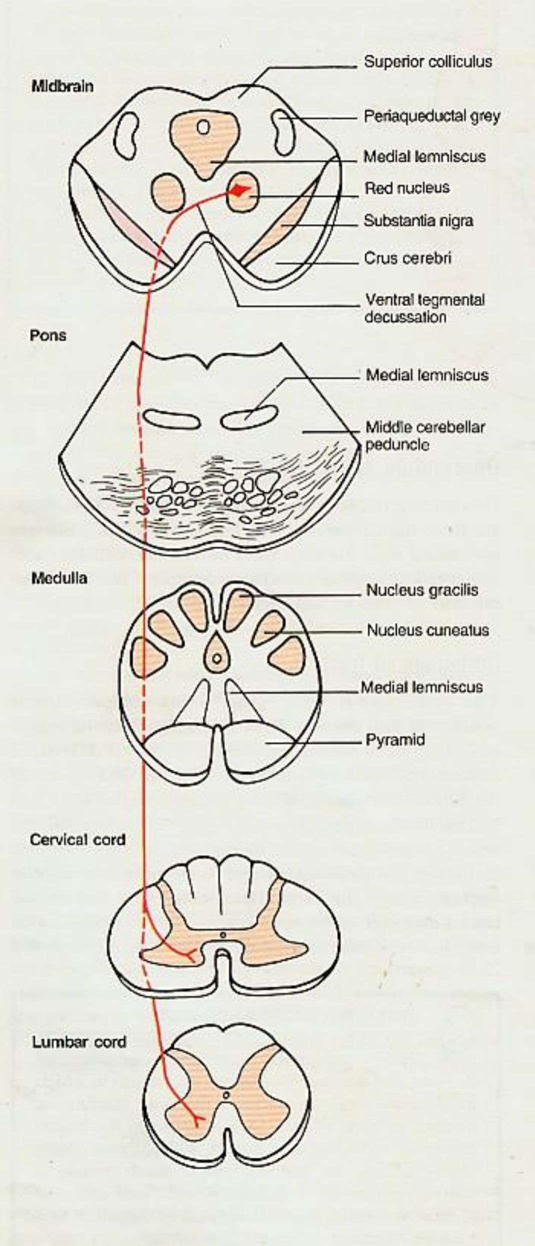


Fig. 5.17 Rubrospinal tract.

Reticulospinal Tract

The **reticulospinal tract** is divided into two parts: **pontine (medial)** and **medullary (lateral)**, based on both **anatomical location** and **functional role**.

1. Pontine Reticulospinal Tract (Medial)

Origin: Originates from the **pontine reticular formation**.

Course: Descends **uncrossed** in the **anterior white matter** of the spinal cord.

Function: It is normally **tonically active**, providing **excitatory influence** on **proximal limb extensors** to **resist gravity** and maintain **upright posture**.

Regulation: Its activity is **inhibited by the cortex**; if cortical input is lost (as in **decortication**), the tract becomes **overactive**, leading to **exaggerated extensor tone**.

2. Medullary Reticulospinal Tract (Lateral)

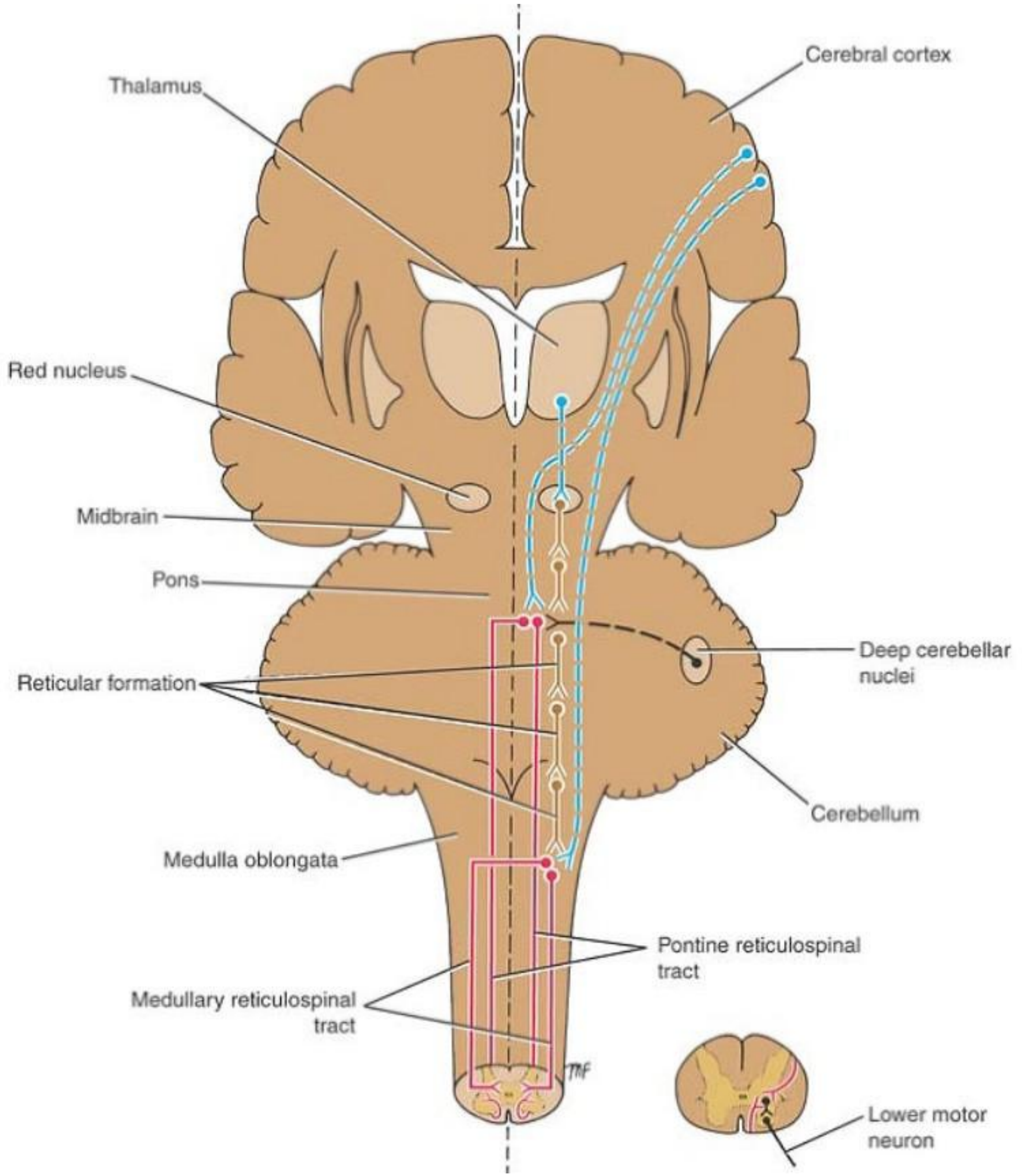
Course: Descends **uncrossed** as well, but its role is **functionally opposite** to the pontine tract.

Function: It **inhibits axial and proximal extensors** to allow **flexion and coordinated movement**.

Coordination: This ensures that during **full flexion of a limb**, the **flexors and extensors** of opposing sides are **balanced**, permitting **smooth and controlled movements**.

Pontine reticulospinal tract

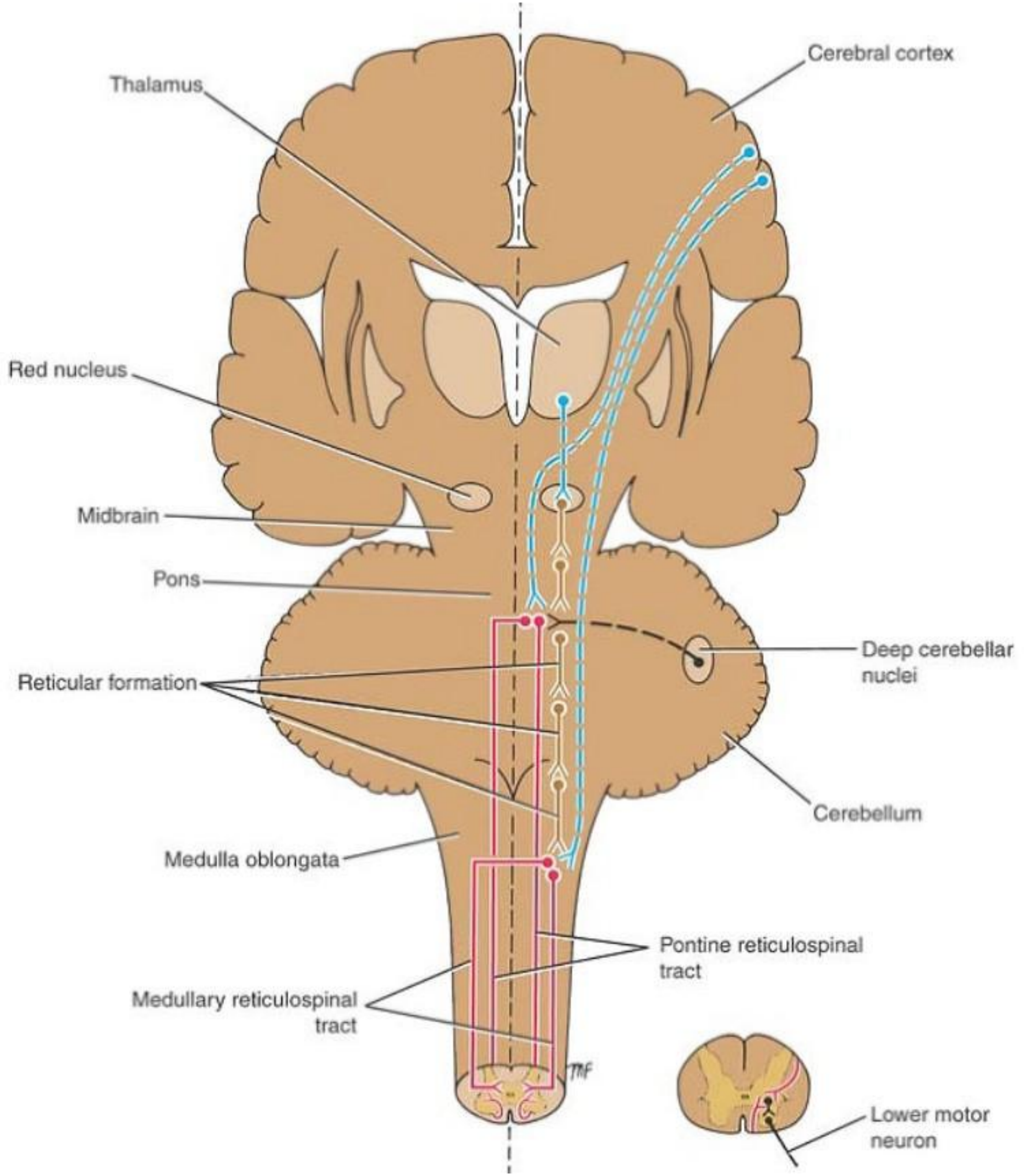
- From pons:
- axons of RF neurons descend **uncrossed** into the spinal cord
- Anterior white column
- medial reticulospinal tract (MRST)
- **tonically active**
- normally under **inhibition from cortex**
- **Function:**
- activate the axial and proximal limb extensors



Medullary reticulospinal tract

- From medulla
- axons of RF neurons descend **crossed and uncrossed** into the spinal cord
- Lateral white column
- Lateral reticulospinal tract (LRST)
- NOT tonically active
- normally under **stimulation**
- **Function:**

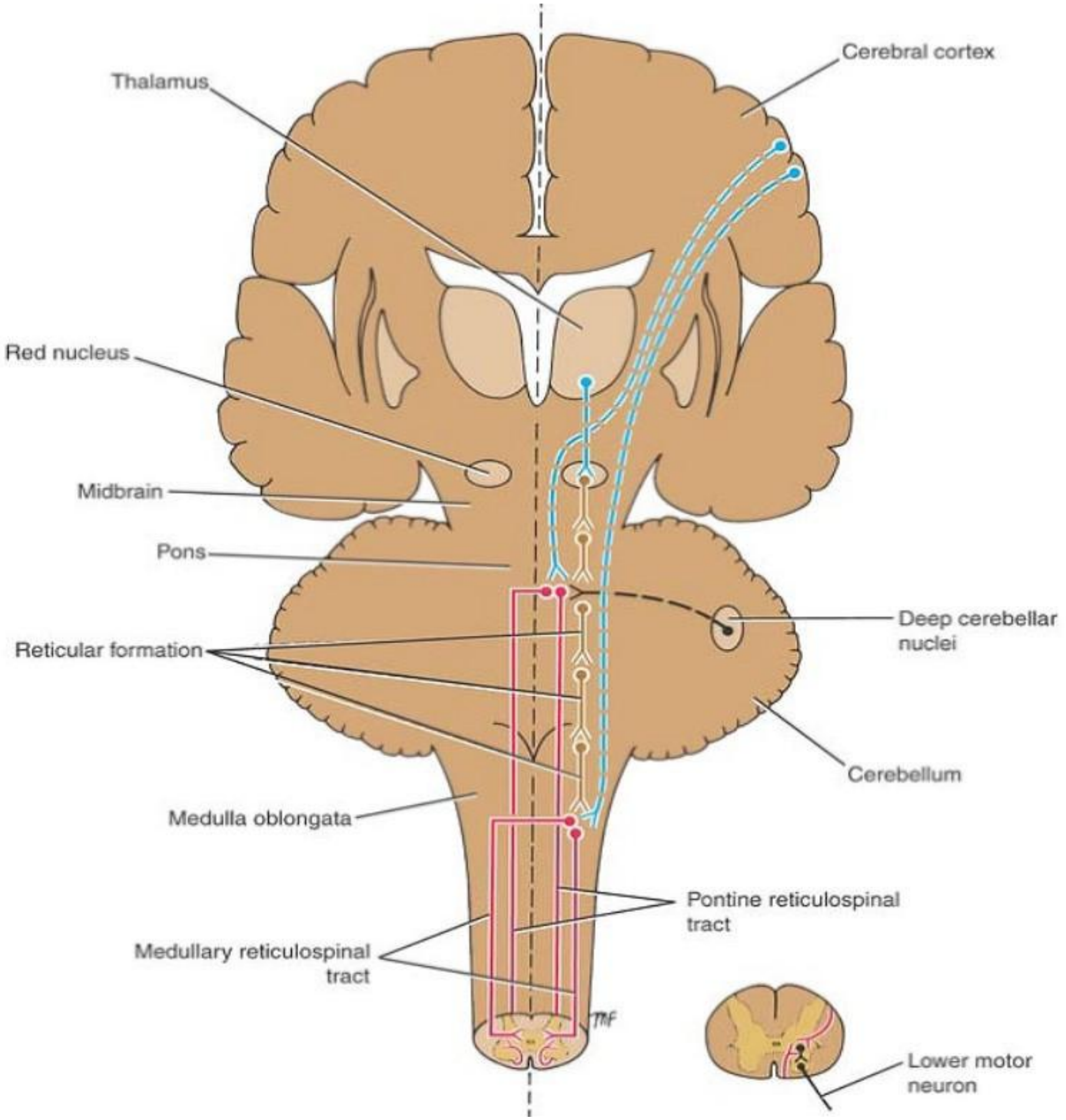
Inhibit the axial and proximal limb extensors



Reticulospinal tracts

- **Some fibers of the reticulospinal tract are autonomic, descending to specific segments of the spinal cord ipsilaterally to modulate autonomic activity.**
- **This has nothing to do with the direct motor function of the reticulospinal, extrapyramidal tract.**

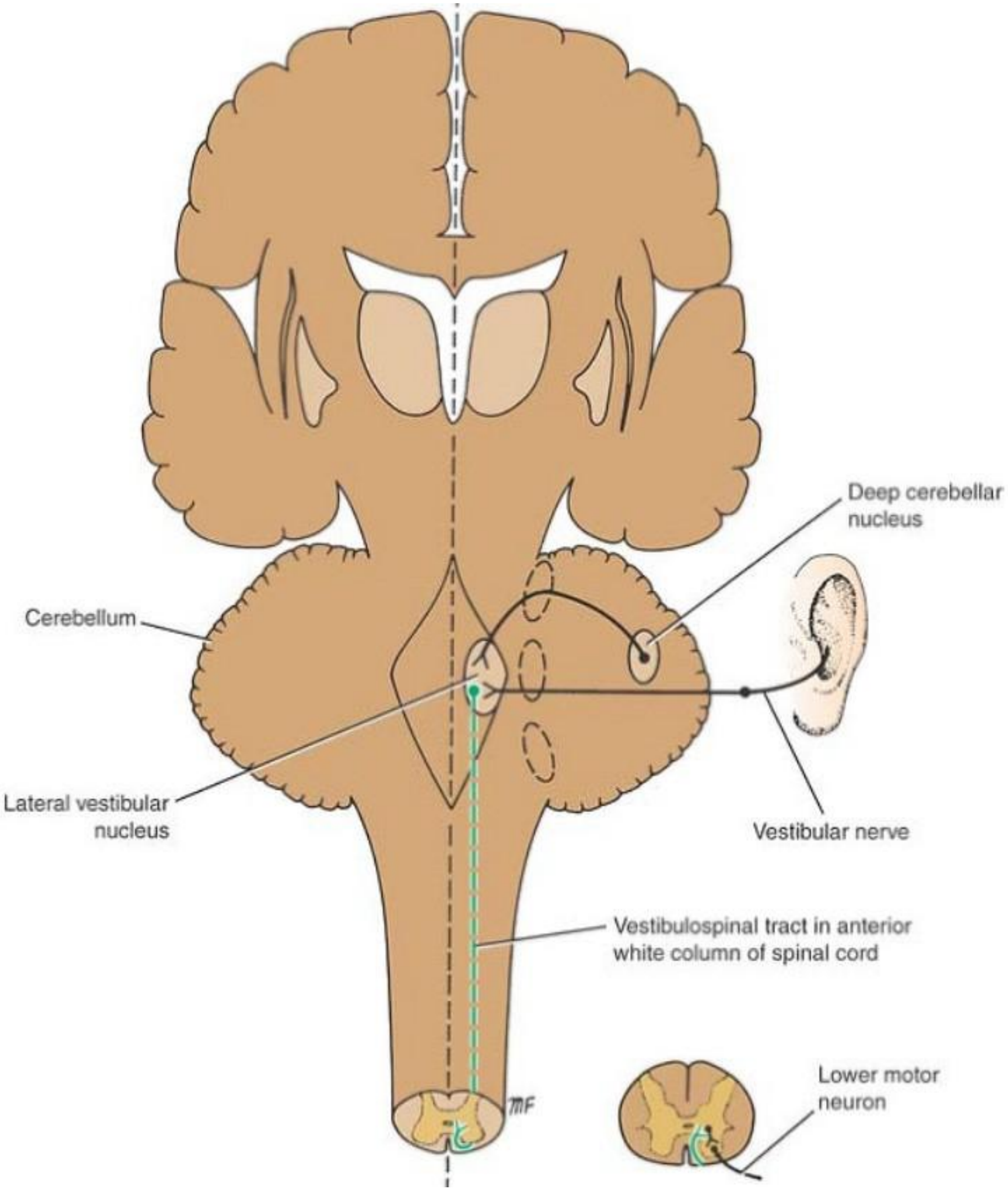
- Has also descending autonomic fibers providing a pathway by which the hypothalamus can control the sympathetic and sacral parasympathetic outflow.
- Most of these fibers are derived from *the lateral reticulospinal tract*



Vestibulospinal Tract

- **Vestibular nuclei**
  - in the pons and medulla beneath the floor of 4th ventricle
  - Recieves afferent fibers from the inner ear through the vestibular nerve and from the cerebellum
- **Uncrossed**
- Anterior white column
- **Function:**

  facilitate the activity of extensor muscles and inhibit the activity of flexor muscles in association with the maintenance of balance



Vestibulospinal Tract

- nerve cells in vestibular nucleus (in the pons and medulla oblongata
  - received afferents from inner ear and cerebellum
- axons descend <u>uncrossed</u>
  - through medulla and through the length of spinal cord
- synapse with neuron in the anterior gray column of the spinal cord

(balance by facilitate the activity of the extensor muscles)

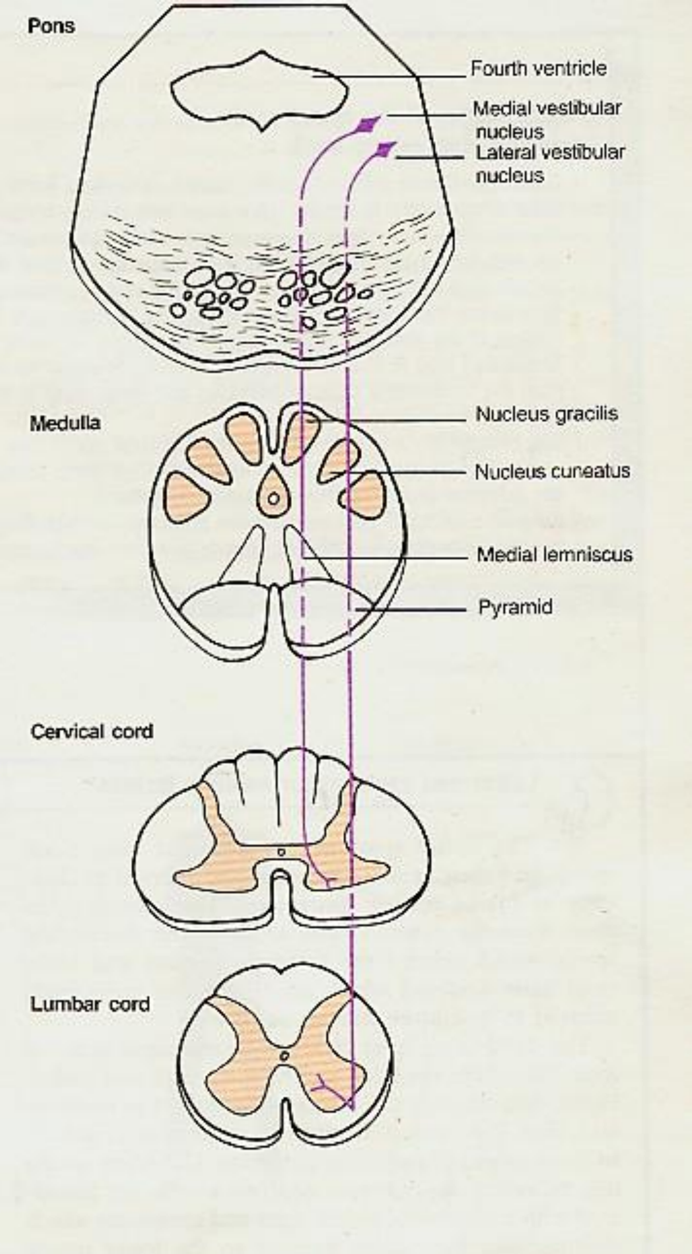
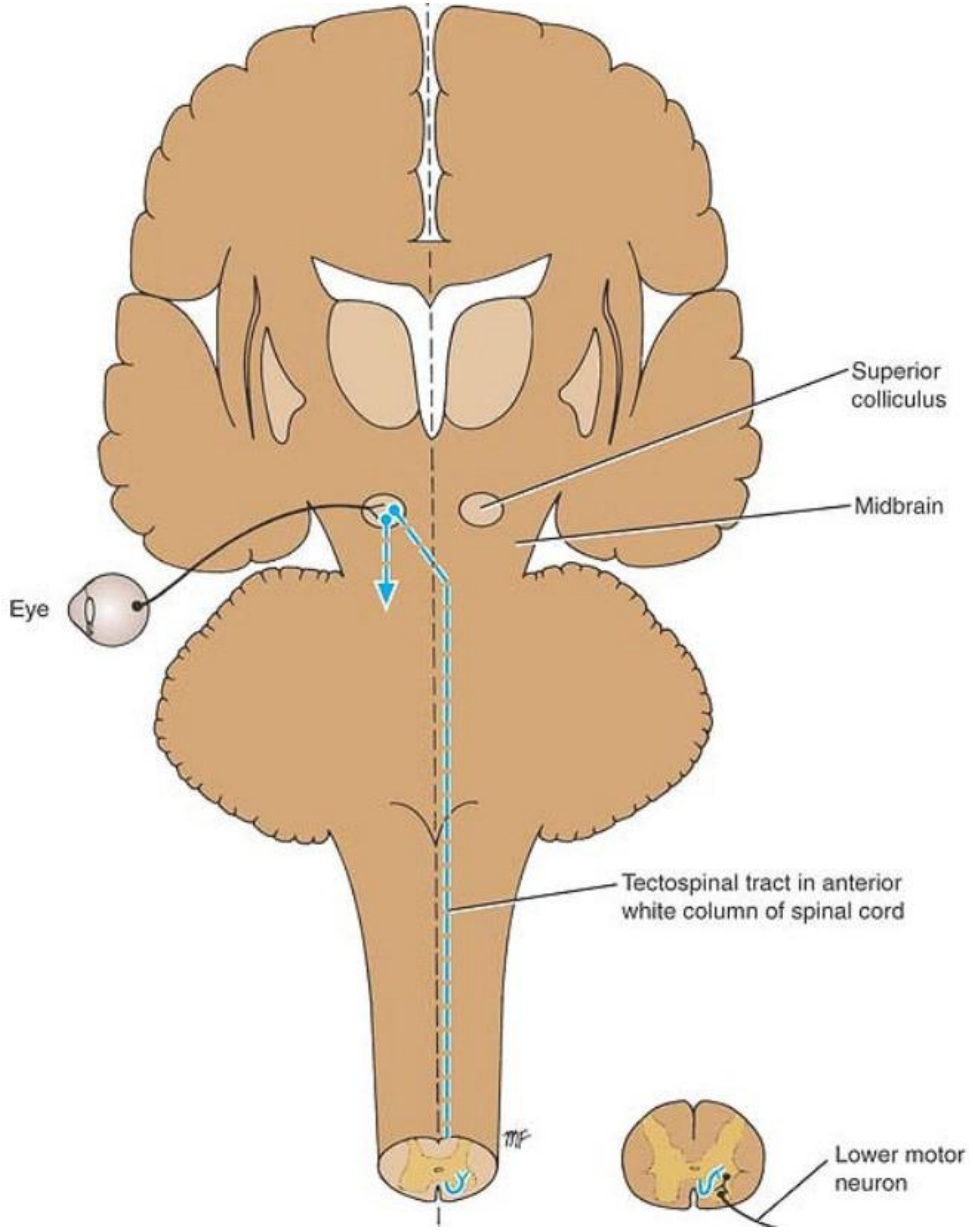


Fig. 5.19 Vestibulospinal tracts.

Tectospinal tract

- nerve cells in superior colliculus of the midbrain
- **Crossed**
- The tract descends in the anterior white column close to Anterior median fissure
- Majority of fibers terminate in the anterior gray column of upper cervical segments of spinal cord

(responsible for reflex movement of head & neck in response to visual stimuli)

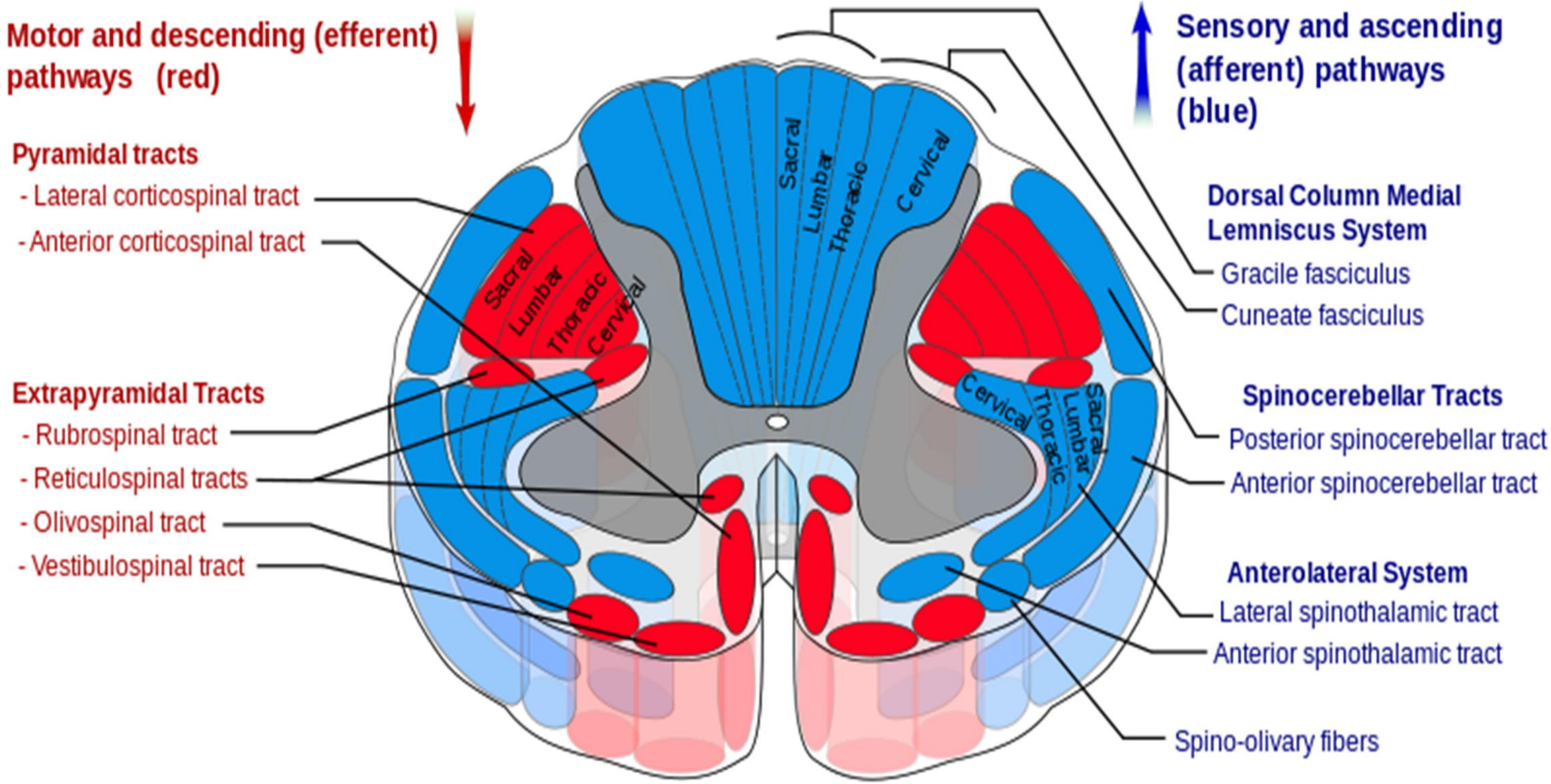


Visuospinal Reflexes

- Previously, we discussed the **spinotectal tract**, which mediates **spino-visual reflexes**. In this pathway, **afferent input** originates from the **spinal cord** in response to stimuli such as **stepping on a nail**, triggering an **automatic withdrawal reflex** while simultaneously **directing the head and eyes** toward the **source of injury**.
- In contrast, now we focus on **tectospinal reflexes** (sometimes called **visuospinal reflexes**), which are **motor responses** guided primarily by **visual input**. Here, the **afferent input** comes from the **visual system**, processed by the **superior colliculus**, and then transmitted via **descending tracts** to the **neck, trunk**, and sometimes **proximal limb muscles**.
- For example, imagine walking when a **ball is suddenly thrown** toward you. The **tectospinal reflex** allows **rapid movement** of your **head and neck**, as well as **adjustments of your body position**, to avoid injury.
- Thus, these reflexes are **complementary** to **spino-visual reflexes**: while **spino-visual reflexes** direct the head and eyes toward a **somatosensory stimulus**, **tectospinal reflexes** coordinate **protective movements** of the **head, neck, and body** in response to **unexpected visual stimuli**.

The motor pathways are classified into

- ❑ **Medial Motor system**: axial & proximal muscles. Medial Motor system include:
  - ➢ Anterior corticospinal tract.
  - ➢ Extrapyramidal pathway in general
- ❑ **Lateral Motor system**: distal muscles mainly, lateral Motor system include
  - ➢ lateral corticospinal tract
  - ➢ Rubrospinal tract distal muscles mainly (and proximal).


Motor and descending (efferent) pathways (red)
Pyramidal tracts
- Lateral corticospinal tract
- Anterior corticospinal tract
Extrapyramidal Tracts
- Rubrospinal tract
- Reticulospinal tracts
- Olivospinal tract
- Vestibulospinal tract
Sensory and ascending (afferent) pathways (blue)
Dorsal Column Medial Lemniscus System
Gracile fasciculus
Cuneate fasciculus
Spinocerebellar Tracts
Posterior spinocerebellar tract
Anterior spinocerebellar tract
Anterolateral System
Lateral spinothalamic tract
Anterior spinothalamic tract
Spino-olivary fibers
Sacral
Lumbar
Thoracic
Cervical

COMPARISON BETWEEN UMN AND LMN

Features	Upper motor neuron lesions(UMN)	Lower motor neuron lesion(LMN)
	UMN starts from motor cortex to the cranial nerve nuclei in brain and anterior horn cells in spinal cord	LMN is the motor pathway from anterior horn cell(or Cranial nerve nucleus)via peripheral nerve to the motor end plate
Bulk of muscles	No wasting	Wasting of the affected muscles (atrophy)
Tone of muscles	Tone increases (Hypertonia)	Tone decreases (Hypotonia)
Power of muscles	Paralysis affects movements of group of muscles Spastic/ clasp knife	Individual muscles is paralyzed Flaccid (flaccid paralysis)
Reflexes	Exaggerated. (Hyperreflexia)	diminished or absent. (Hyporeflexia)
Fasciculation	Absent	Present
Babinski sign	Present	Absent
clasp-knife reaction	Present	Absent
Clonus	Present	Absent

hypertonia and hyperreflexia, is the result of an increase in gamma motor neurons activity

Upper vs Lower Motor Neuron Lesions and Reflexes

1. Upper Motor Neuron (UMN) Lesions

- In **UMN lesions**, removing the **inhibitory influence of the cortex** leads to **hyperreflexia**, as spinal reflexes become **exaggerated**. Patients typically develop **spastic paralysis**, characterized by:
- **Increased muscle tone (hypertonia).**

Hyperactive reflexes.

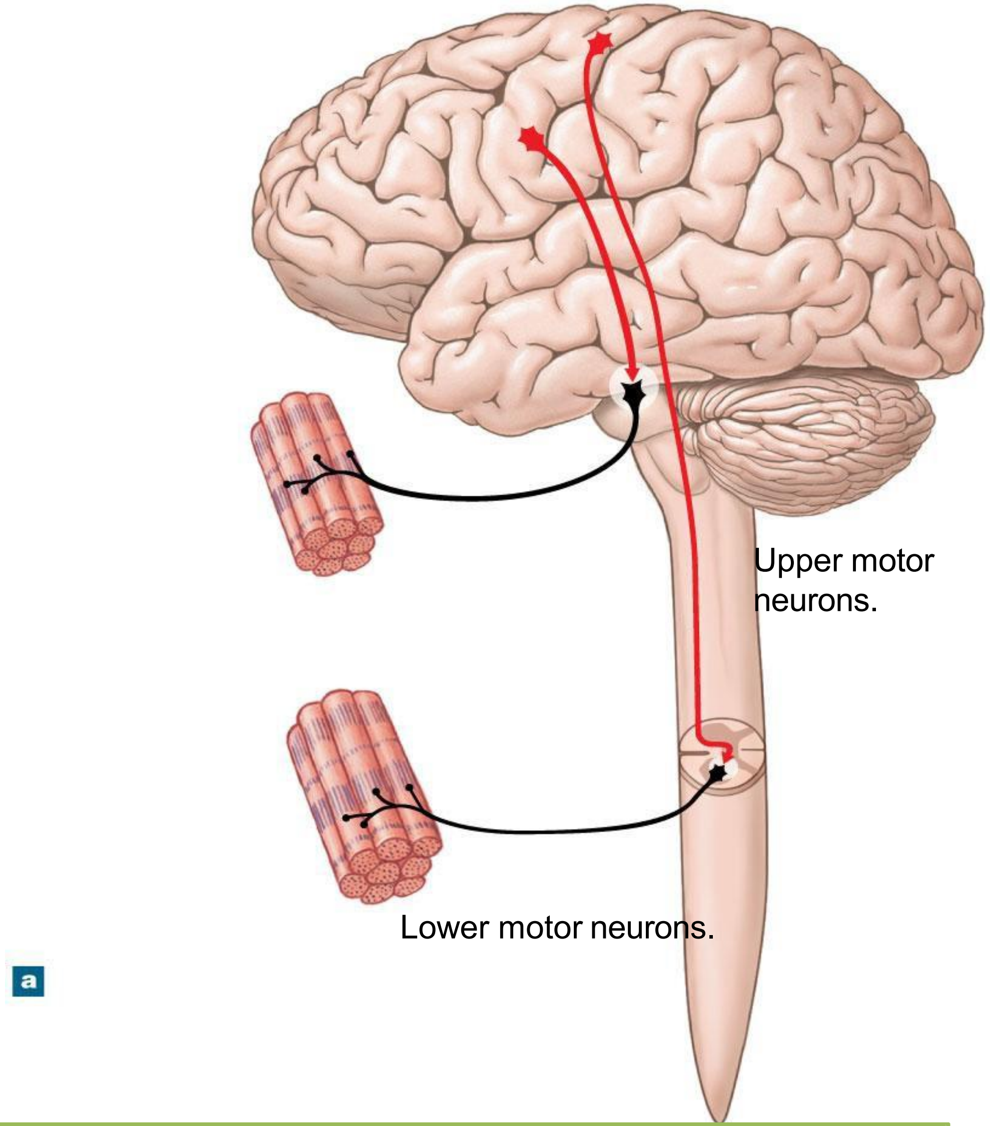
- **Rigidity/Spasticity.**
- Notably, **muscle wasting (atrophy) does not occur** immediately because the **lower motor neurons remain intact** and continue to provide trophic support to the muscles.

2. Lower Motor Neuron (LMN) Lesions

- In contrast, **LMN lesions** affect the neurons that **directly innervate muscles**. This results in **flaccid paralysis**, characterized by:
- **Muscle wasting (atrophy).**
- **Reduced muscle tone (hypotonia).**
- **Hyporeflexia or areflexia** (loss of reflexe)

Motor tracts

- ❑ There are two major descending tracts
- ➢ **Pyramidal tracts** (Corticospinal) : Conscious control of skeletal muscles
- ➢ **Extrapyramidal:** Subconscious regulation of balance, muscle tone, eye, hand, and upper limb position:
- ❖ **Vestibulospinal tracts**
- ❖ **Reticulospinal tracts**
- ❖ **Rubrospinal tracts**
- ❖ **Tectospinal tracts**



Extrapyramidal tracts arise in the brainstem, but are under the influence of the cerebral cortex

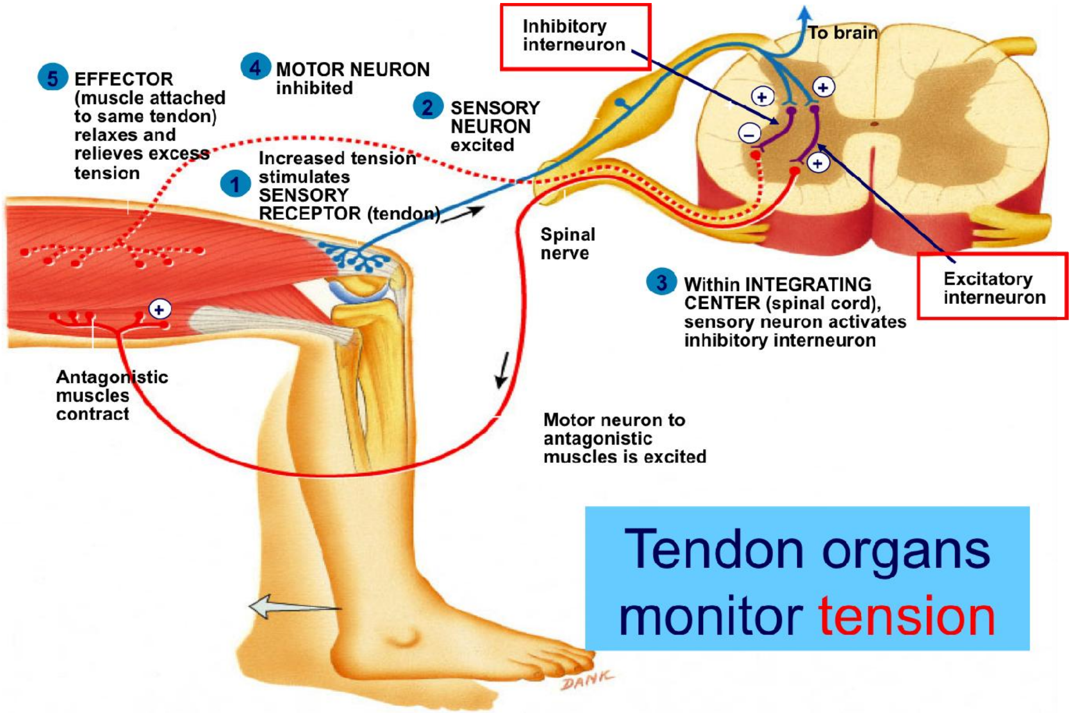
See next slides

Clasp knife reaction

- Overactivity of the pointine excitatory system (spasticity)
- **Initial resistance:** Exaggerated stretch reflex
- **Sudden release:** After applying pressure, the tension in the muscle will increase and will be enough to activate the **Golgi tendon organs** which will cause the relaxation

Tendon reflex:

- **Polysynaptic reflex arc**
- **law of reciprocal innervation**



Clasp-Knife Reaction

- The **Clasp-knife reaction** is a classic diagnostic sign seen **exclusively in UMN lesions**. It mimics the behavior of a mechanical folding knife (clasp-knife), where there is intense initial resistance followed by a sudden "snap" or release.

Clinical Example:

- In a patient with a **spastic upper limb**, the elbow is typically fixed in **flexion**. When an examiner attempts to forcibly extend the elbow:
- **Initial Resistance:** The examiner feels a strong push-back from the muscle.
- **Sudden Release:** At a specific point of tension, the resistance vanishes, and the forearm **suddenly extends**.

Physiological Mechanism:

- This reaction is a battle between two different spinal reflexes:
- **The "Resistance" (Stretch Reflex):** When the examiner stretches the muscle, the **muscle spindles** trigger an exaggerated **stretch reflex**. This causes the muscle to contract and resist the movement.
- **The "Release" (Inverse Stretch Reflex):** As the tension builds up, the **Golgi Tendon Organs (GTOs)** are activated. These receptors sense that the tension is reaching dangerous levels.
- **Result:** The GTOs send inhibitory signals that shut down the **lower motor neurons** of the contracting muscle.This causes the muscle to suddenly relax, allowing the limb to snap into position.

The Balance of Movement: Stretch Reflex vs. Golgi Tendon Reflex

1. The Stretch Reflex (The "Resistor")

- The **stretch reflex** is a **monosynaptic reflex** designed to maintain muscle length and resist over-stretching.
- **Receptor:** The **muscle spindle** (detects changes in muscle length).
- **Mechanism:** If a muscle (e.g., the **quadriceps**) is stretched, the spindle sends an **afferent signal** directly to the spinal cord.
- **Action:** It synapses directly with the **Lower Motor Neuron (LMN)** of the same muscle, causing it to **contract**.
- **Net Effect:** The muscle **resists the stretch** to maintain its original length.

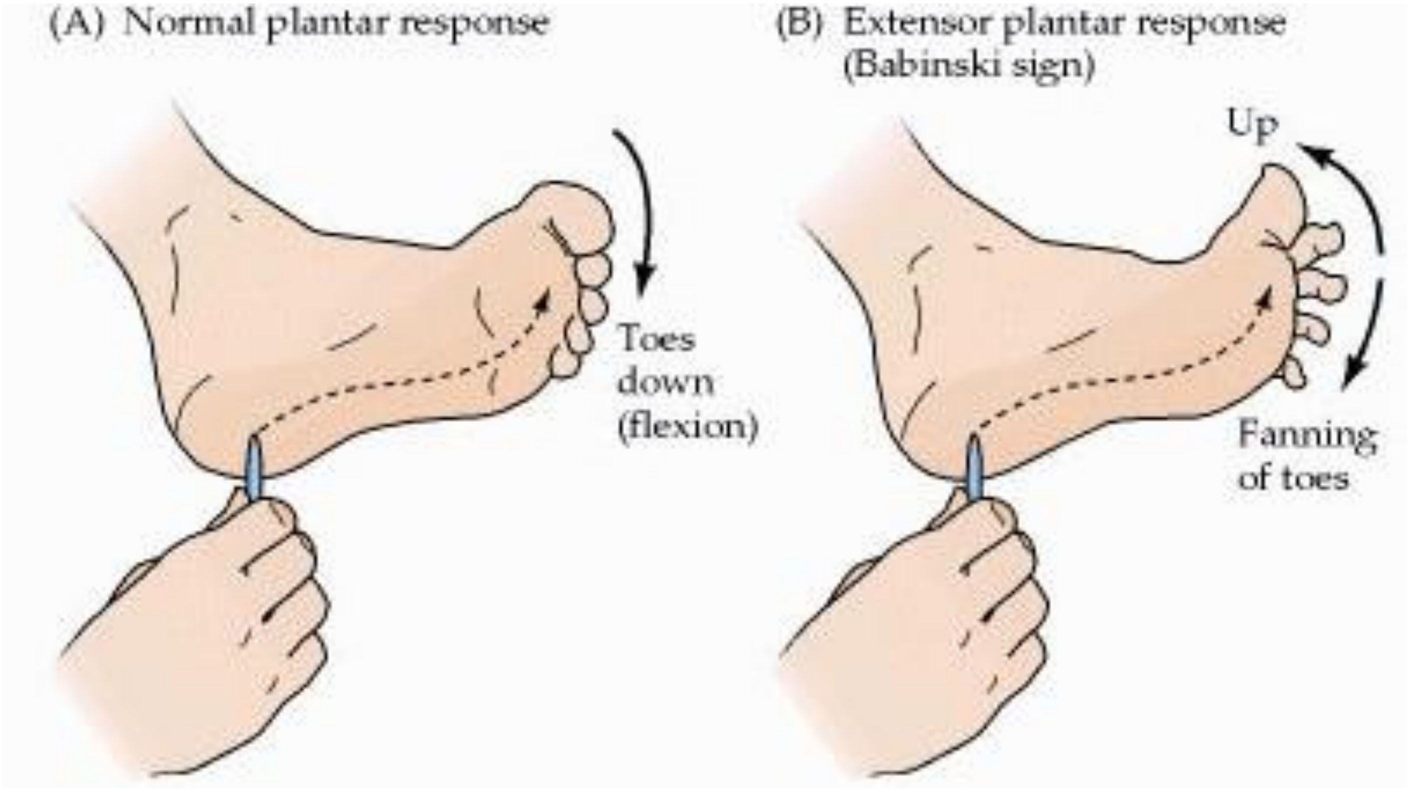
2. The Golgi Tendon Reflex (The "Release")

- Also known as the **Inverse Stretch Reflex**, this reflex protects the muscle from excessive tension during contraction. Unlike the stretch reflex, it is **polysynaptic** in nature.
- **Receptor:** The **Golgi Tendon Organ (GTO)**, located in the tendon (detects changes in muscle tension).
- **Mechanism:** When a muscle contracts strongly, **tension** in the tendon increases. The GTO fires and sends a signal through the **dorsal root**.
- **Polysynaptic Nature (The Chain of Synapses):** The complexity of this reflex arises because **multiple synapses** are involved, following this specific sequence:
  - **Sensory Neuron → Interneuron:** The first synapse occurs where the sensory fiber meets an interneuron in the spinal cord.
  - **Interneuron → Motor Neuron:** The second synapse occurs between the interneuron and the Lower Motor Neuron (LMN).
- **The Double Action of Interneurons:** Because interneurons can be either **inhibitory** or **excitatory**, they activate two pathways simultaneously:
  - **Inhibitory Interneurons:** These **inhibit the LMNs** of the same contracting muscle (agonist), causing it to **relax**.
  - **Excitatory Interneurons:** These **activate the LMNs** of the **antagonist muscle**.causing it to **contract**.

The Law of Reciprocal Innervation

- A fundamental principle in neurophysiology is that the **contraction of an agonist** muscle is always accompanied by the **relaxation of its antagonist**, and vice versa.
- **Example:** During a full contraction of the **biceps**, the **triceps** must relax. This makes **simultaneous full contraction** of opposing muscles impossible, ensuring fluid movement.

Babinski Sign: (UMN) lesion



When the corticospinal tracts are nonfunctional, the influence of the other descending tracts on the toes becomes apparent, and a kind of withdrawal reflex takes place in response to stimulation of the sole, with the great toe being dorsally flexed and the other toes fanning out.

Take a look, then continue to the next slide, and refer back to this picture afterward...

Babinski Sign: (UMN) lesion

- When moving a sharp object along the sole of the foot; (A) represents the normal response where the toes flex downward. While (B) shows the abnormal response where the toes fan apart and upward. This is considered a positive test for Babinski sign lesion. This test only applies for people older than 1 year of age.
- Most UMN lesions affect both pyramidal and extrapyramidal areas. However, the symptoms of the table in *slide 29* are mostly due to the effect of extrapyramidal lesions. An exception to that is the Babinski Sign, where a corticospinal lesion is responsible for this symptom.
- Alluding to that is the fact that children under 1 year old have their corticospinal tract underdeveloped "they still don't walk". So, if you perform the test and see a positive Babinski Sign that is the normal response. The reaction toward dragging a sharp object along the sole is thought to be originally a withdrawal reflex early in life that changes with upright walking 'bipedalism' (about after 1 year of birth) into what we see in the test.

Ankle clonus: (UMN) lesion

- **The test is done by the doctor swiftly pushing the rigid foot into dorsiflexion position.**

- **Normally, the previously mentioned reflexes take place.**

- **An abnormal response is rhythmic contraction and relaxation of the foot.** The feet looks like it is going through a rhythmic tremor up and down on the doctor's hands.

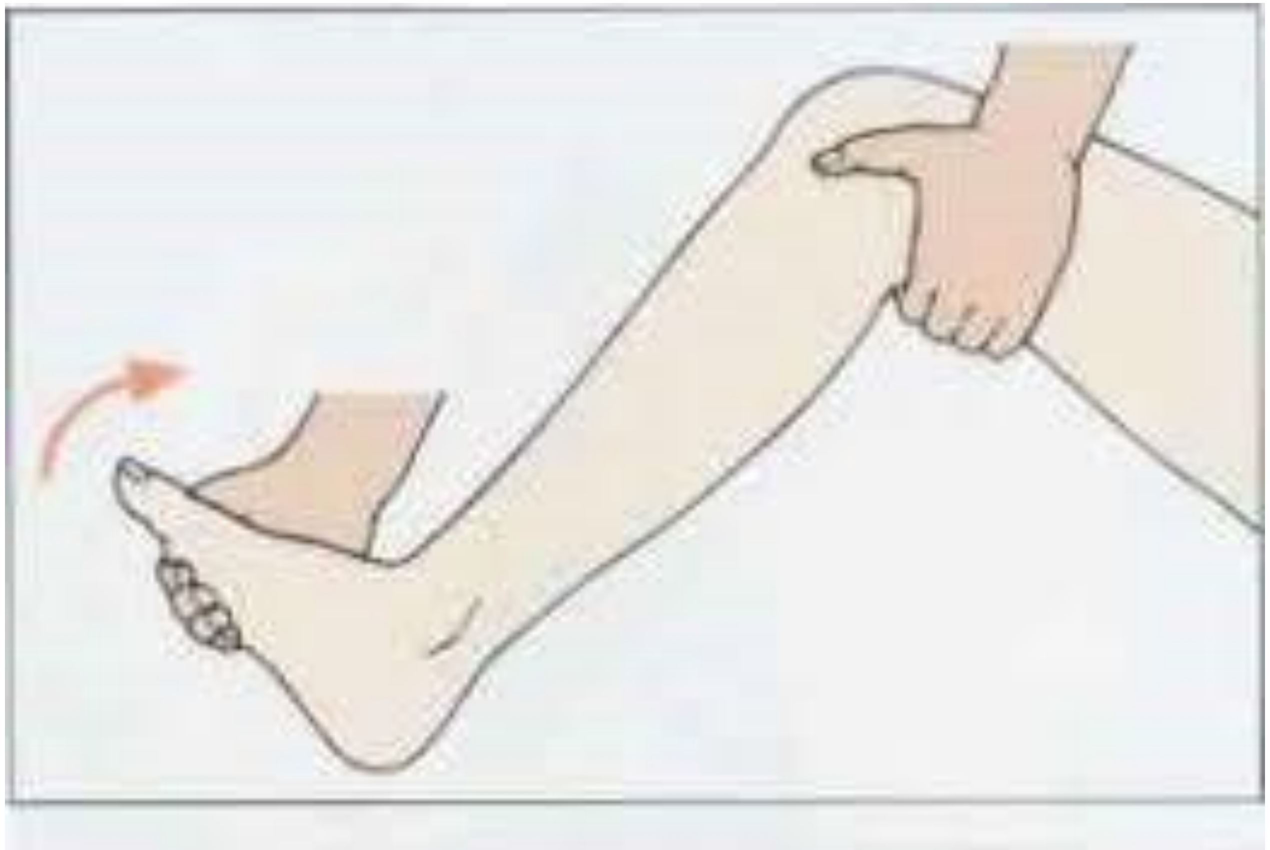


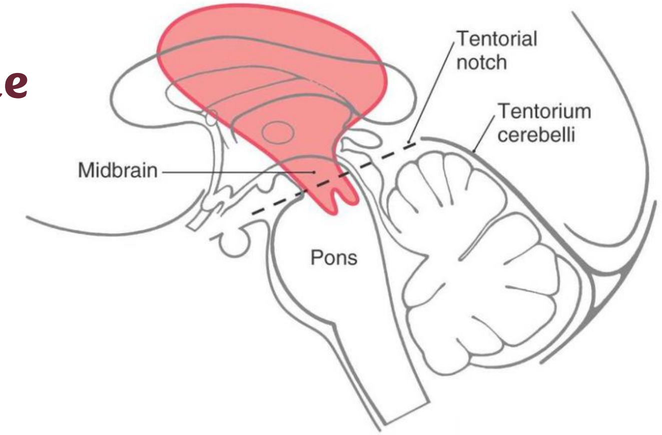
Fig. 6.29 Testing for ankle clonus.

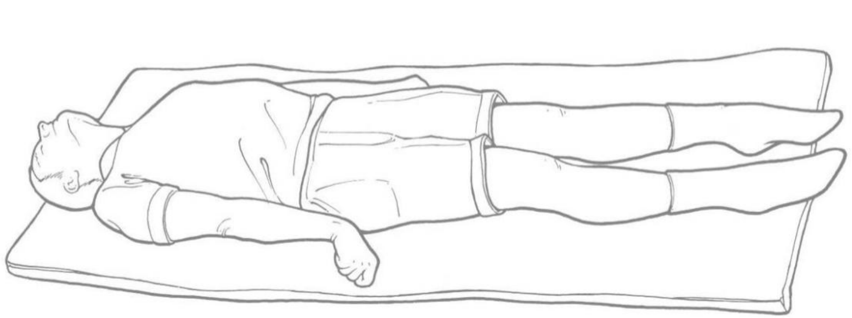
Rhythmic contractions and relaxation of muscles when they are subjected to sudden sustained stretch

More UMN lesion examples:

Decerebrate rigidity

This legion crosses the level of red nucleus in the midbrain.

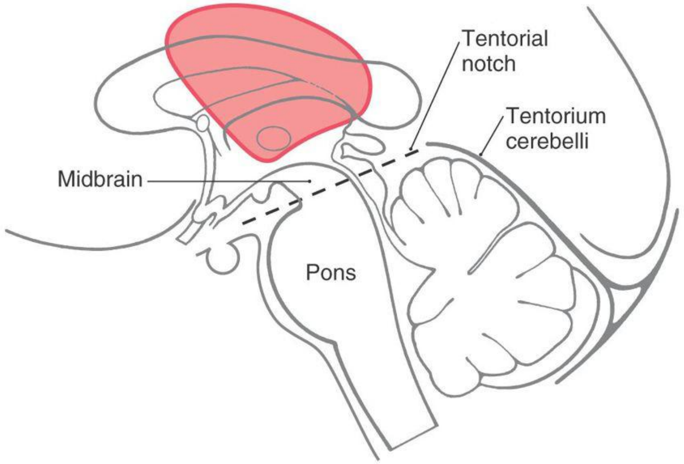


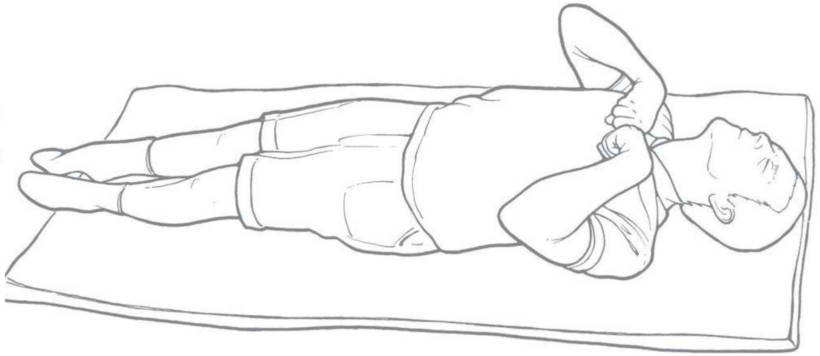


Upper and lower limbs are extended and rigid.

Decorticate rigidity

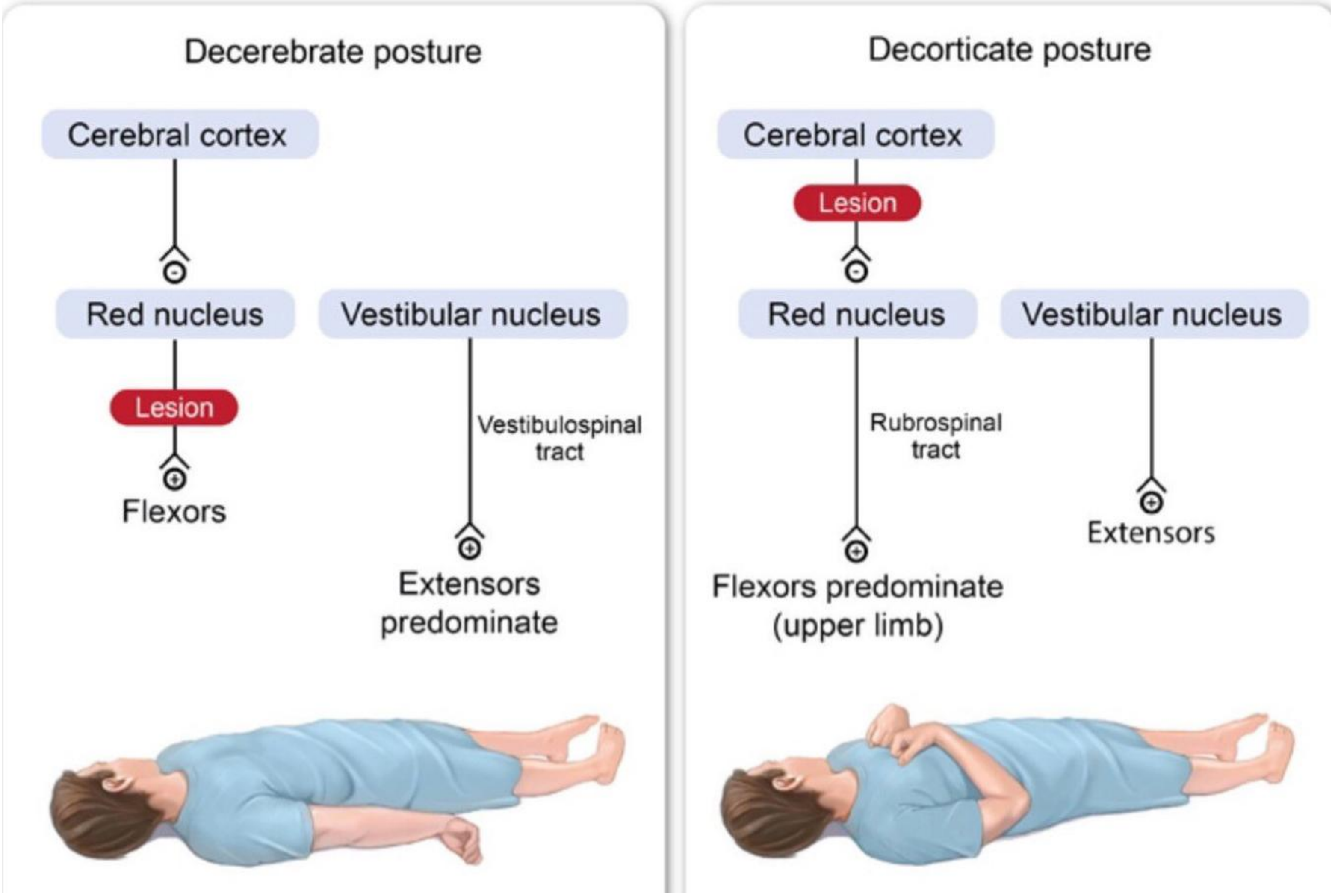
This legion doesn't cross the level of red nucleus in the midbrain.





Upper limbs are flexed, but lower are extended. Both are rigid.

Continue for explanation...



Continue for explanation...

Decerebrate and Decorticate rigidity

- These cases are also cases of extrapyramidal lesions, unlike Babinski Sign. Normally, the lower limbs and upper limbs have strong extensor and flexor pathways, respectively. Such disparity helps in daily activities and posture (i.e: strong extensor pathway in lower limbs to help standing posture or "anti-gravity" tone/activities). These pathways are rubrospinal for upper limbs [inducing flexors] and vestibulospinal (also pontine reticulospinal but not mentioned in the picture) for lower limbs [inducing extensors]. They are normally under the inhibition of the cerebral cortex to keep them from going overboard. This inhibition is lost in both rigidities.
- However, in Decerebrate rigidity the lesion crosses the level of red nucleus. That affects the rubrospinal tract negatively showing opposite symptoms to that of only Decorticate rigidity when it comes to upper limbs. Decerebrate lesion has worse prognosis and is more urgent due to the lesion's proximity to the vital centers found in inferior locations in the brain stem.

COMPARISON BETWEEN UMN AND LMN

Features	Upper motor neuron lesions(UMN)	Lower motor neuron lesion(LMN)
	UMN starts from motor cortex to the cranial nerve nuclei in brain and anterior horn cells in spinal cord	LMN is the motor pathway from anterior horn cell(or Cranial nerve nucleus) via peripheral nerve to the motor end plate
Bulk of muscles	No wasting	Wasting of the affected muscles (atrophy)
Tone of muscles	Tone increases (Hypertonia)	Tone decreases (Hypotonia)
Power of muscles	Paralysis affects movements of group of muscles Spastic/clasp knife	Individual muscles is paralyzed Flaccid (flaccid paralysis)
Reflexes	Exaggerated. (Hyperreflexia)	diminished or absent. (Hyporeflexia)
Fasciculation	Absent	Present
Babinski sign	Present	Absent
clasp-knife reaction	Present	Absent
Clonus	Present	Absent

Fasiculation: a LMN lesion typically represented with groups of muscle fibers twitching visibly under the skin. Like when your eyelids twitch.

(eyelid twitch is a benign hyper-excitability of eyelid nerves rather than an actual LMN in which LMNs are accompanied with muscle weakness and some flaccidity rather than just a few twitches).

Twitching in this LMN is due to more of a molecular situation that has to do with neurotransmitters. The prof. says just know fasciculation is a LMN issue.

The prof. said this slide is explained in the lab lecture and skipped it!

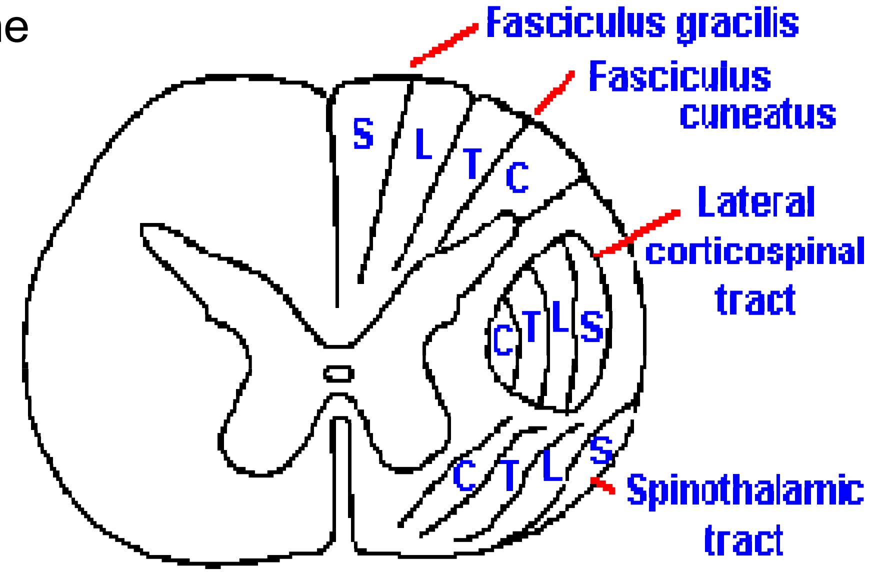
Clinical significance of lamination of the ascending tracts

- Any external pressure exerted on the spinal cord in the region of the spinothalamic tracts will first experience a loss of pain and temperature sensations in the sacral dermatome of the body
- If pressure increases the other higher segmental dermatomes will be affected

❖**Remember that in the spinothalamic tracts the cervical to sacral segments are located medial to lateral**

- **Intramedullary tumor:** affect the cervical fibers (Medial)
- **Extramedullary tumor** would affect lower limb fibers (lateral).

❑ **Sacral sparing:** Occur at intramedullary tumor



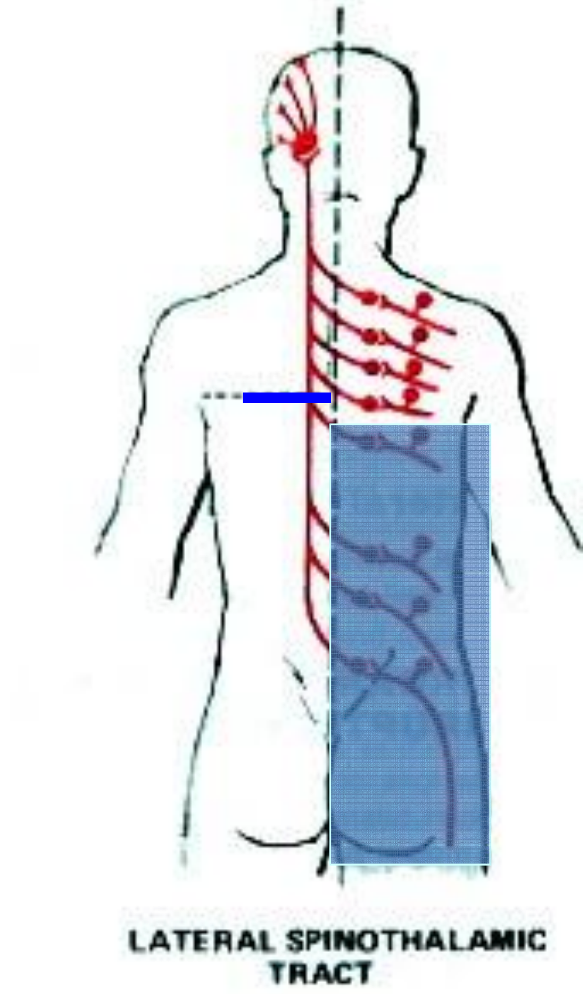
Clinical application: Destruction of LSTT

Lateral Spinothalamic Tract

- loss of
  - pain and thermal sensation
  - on the contralateral side
  - below the level of the lesion

patient will not recognize

hot and cold

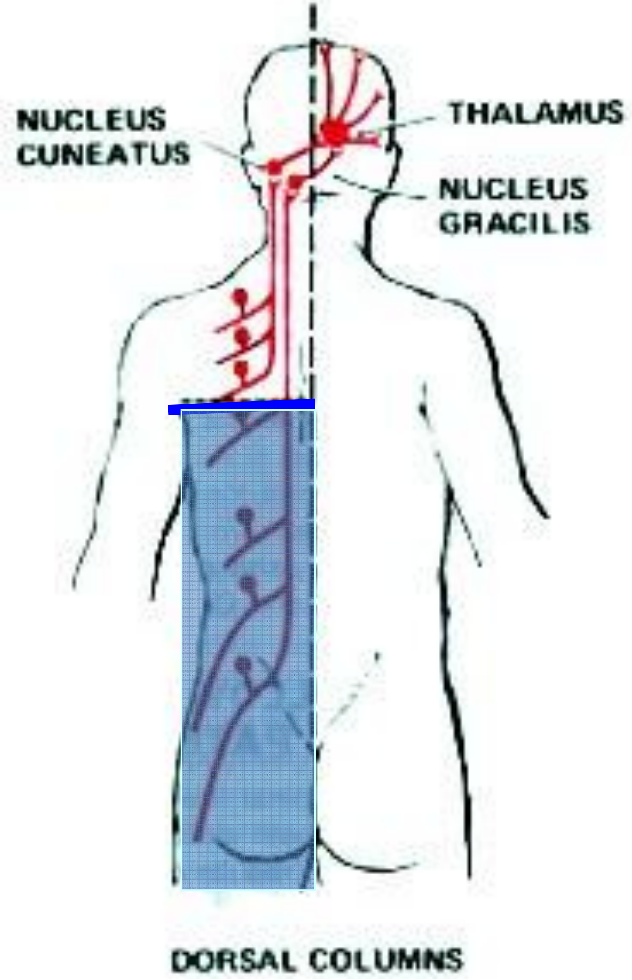


Clinical application: Destruction of fasciculus gracilia and cuneatus

(posterior column)

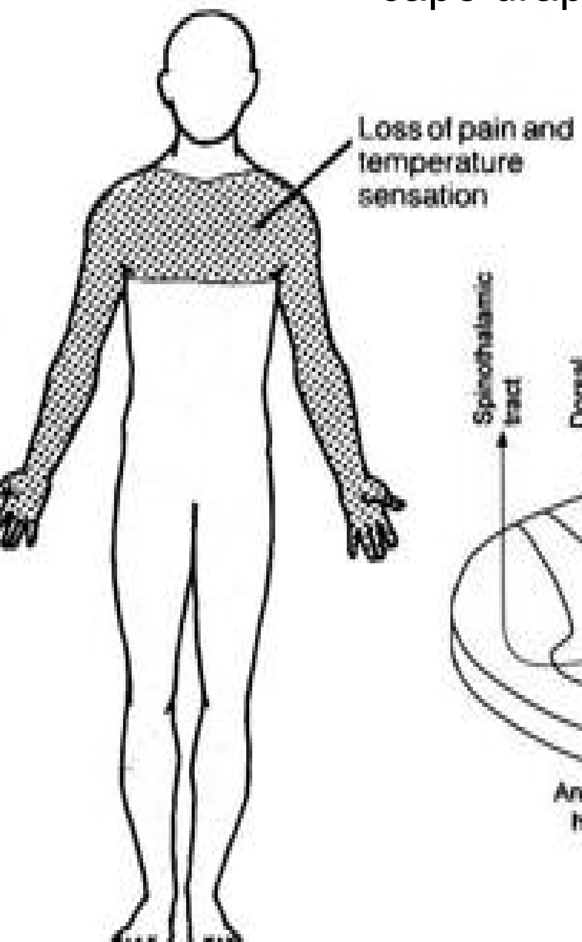
- loss of muscle joint sense, position sense, vibration sense and tactile discrimination
- <u>on the same side</u>
- below the level of the lesion

(extremely rare to have a lesion of the spinal cord to be localized as to affect one sensory tract only)

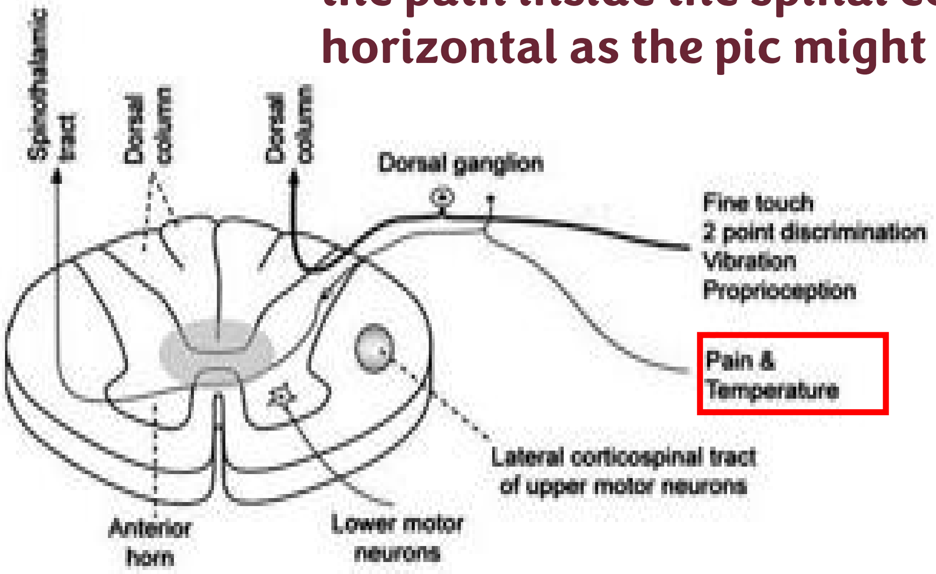


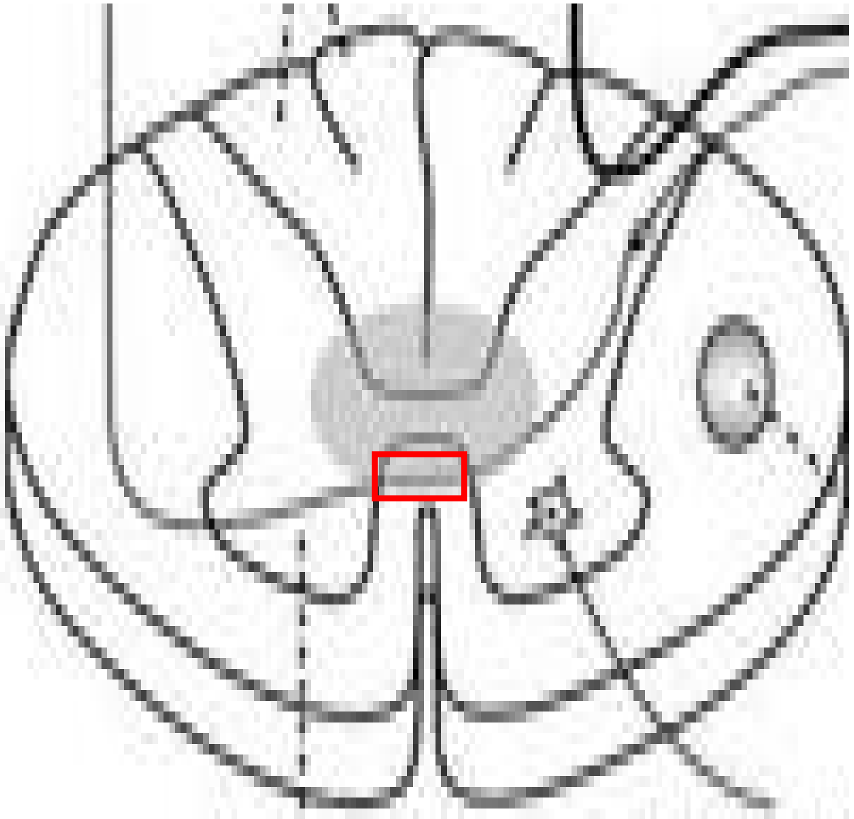
Syringomyelia

- Cavitation of the central regions of the spinal cord
- Damage to fibers crossing in the anterior white commissure in both directions; look at red boxes.
- <u>Bilateral</u> loss of pain and thermal sensations (a nerve from both sides passes there).
- When it is located at the C4 to C5 levels of the spinal cord sensory losses in the configuration of a cape draped over the shoulders and extending down to nipple level



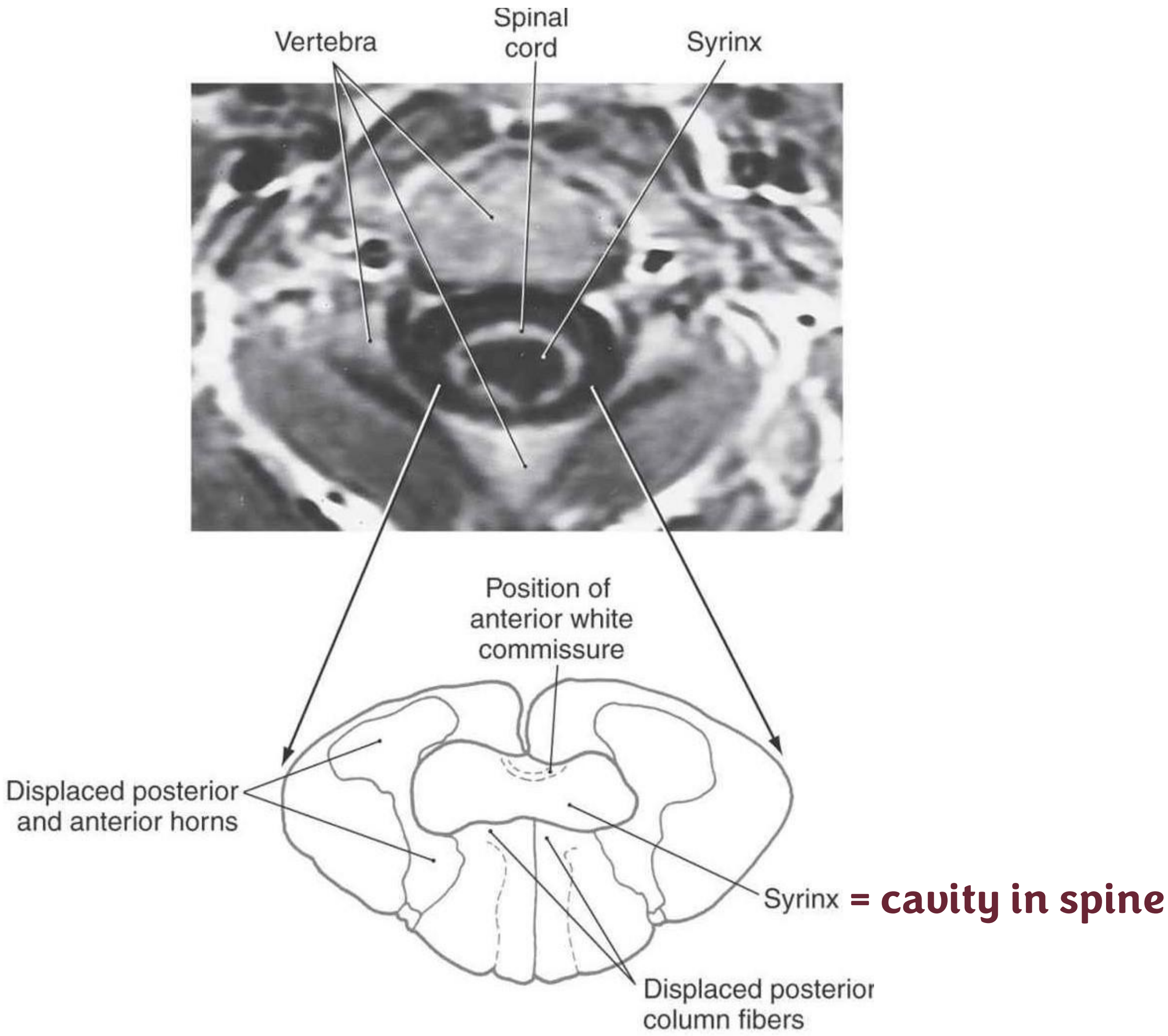
If the nerve in red box enters at C5, it will start vertical ascent at about C3, so the path inside the spinal cord is not horizontal as the pic might allude.





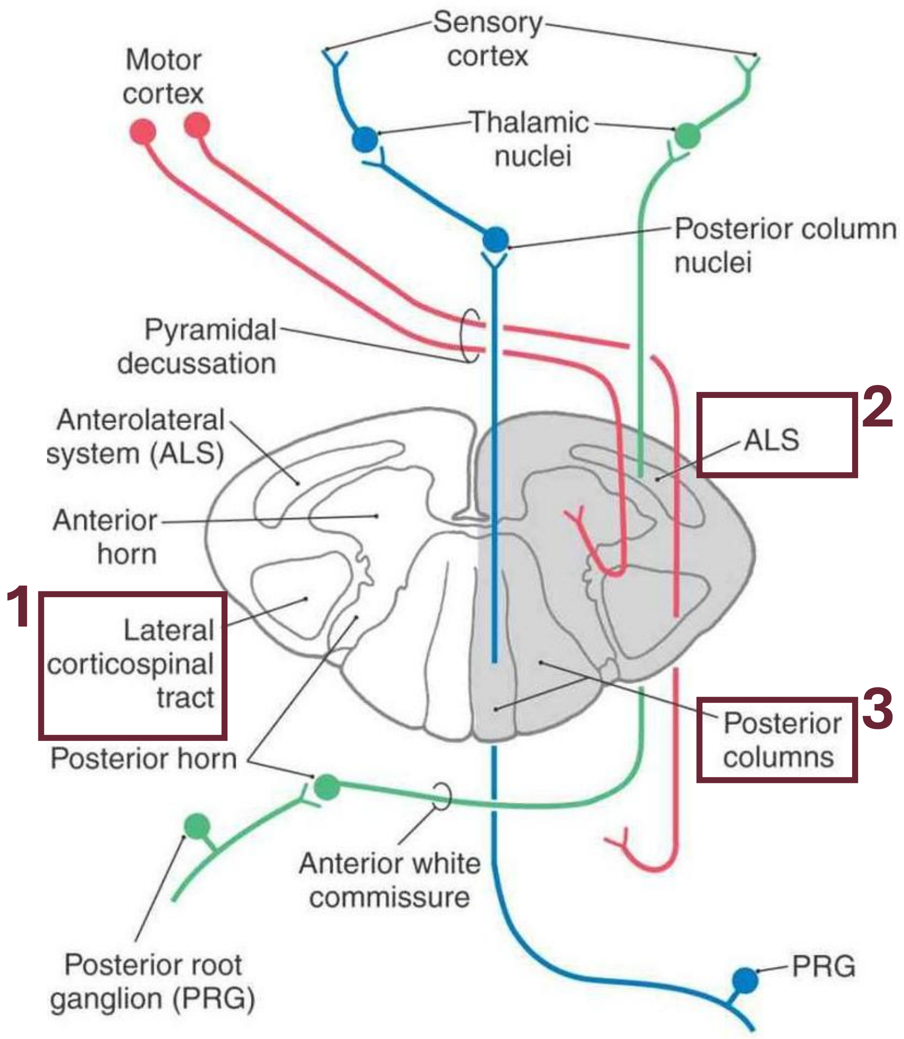
Syringomyelia

- If it **extends into** the anterior horn, it will cause:
  - bilateral sensory loss
  - weakness of the corresponding extremity:
- extension of the syrinx into one anterior horn results in an ipsilateral weakness of the upper extremity
- if both anterior horns are involved, the weakness is bilateral



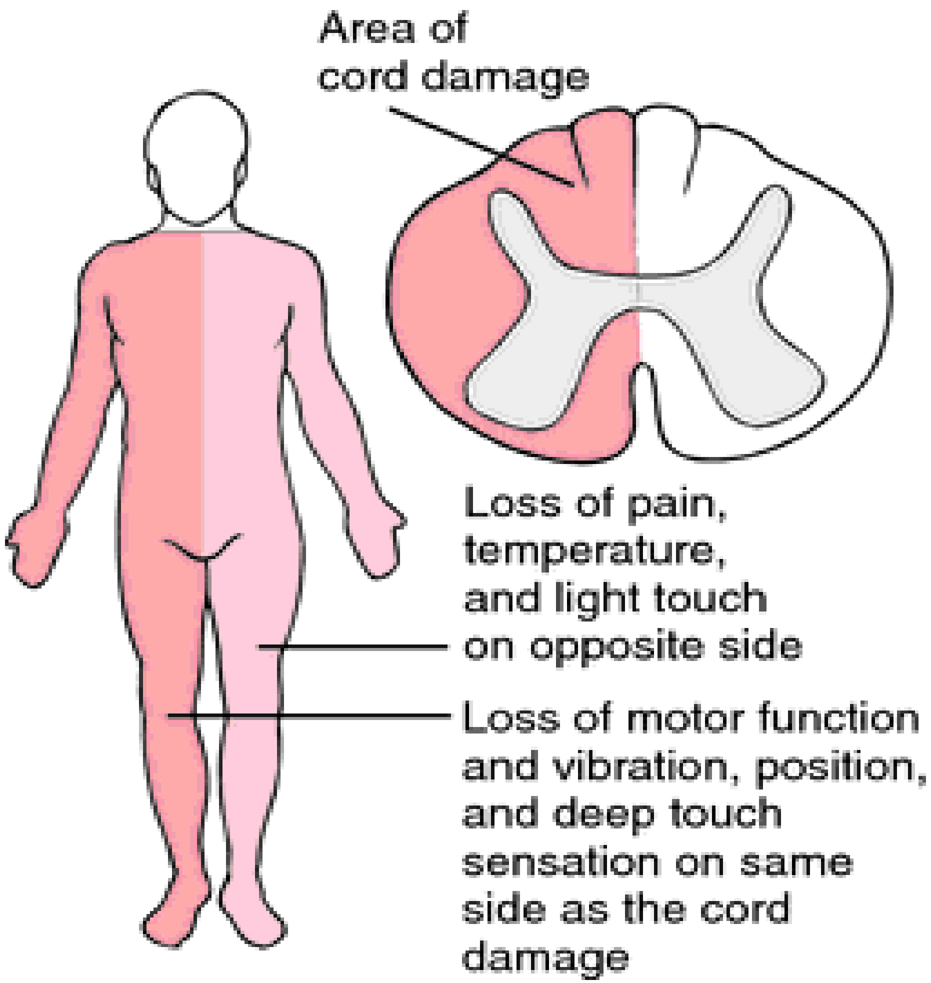
Brown-Séquard Syndrome

- Functional (hemisection = damage to one half) of the spinal cord results in:
  - damage to the lateral corticospinal tract, ALS, posterior columns
- Example: A lesion on the right at C4 to C5 will result in:
  1. muscle **weakness** or **paralysis** (hemi**paresis**, hemi**plegia**) on the right side
  2. loss of pain and thermal sensations on the left side
  3. loss of proprioception, vibratory sense, and discriminative touch on the right



Brown-Séquard Syndrome

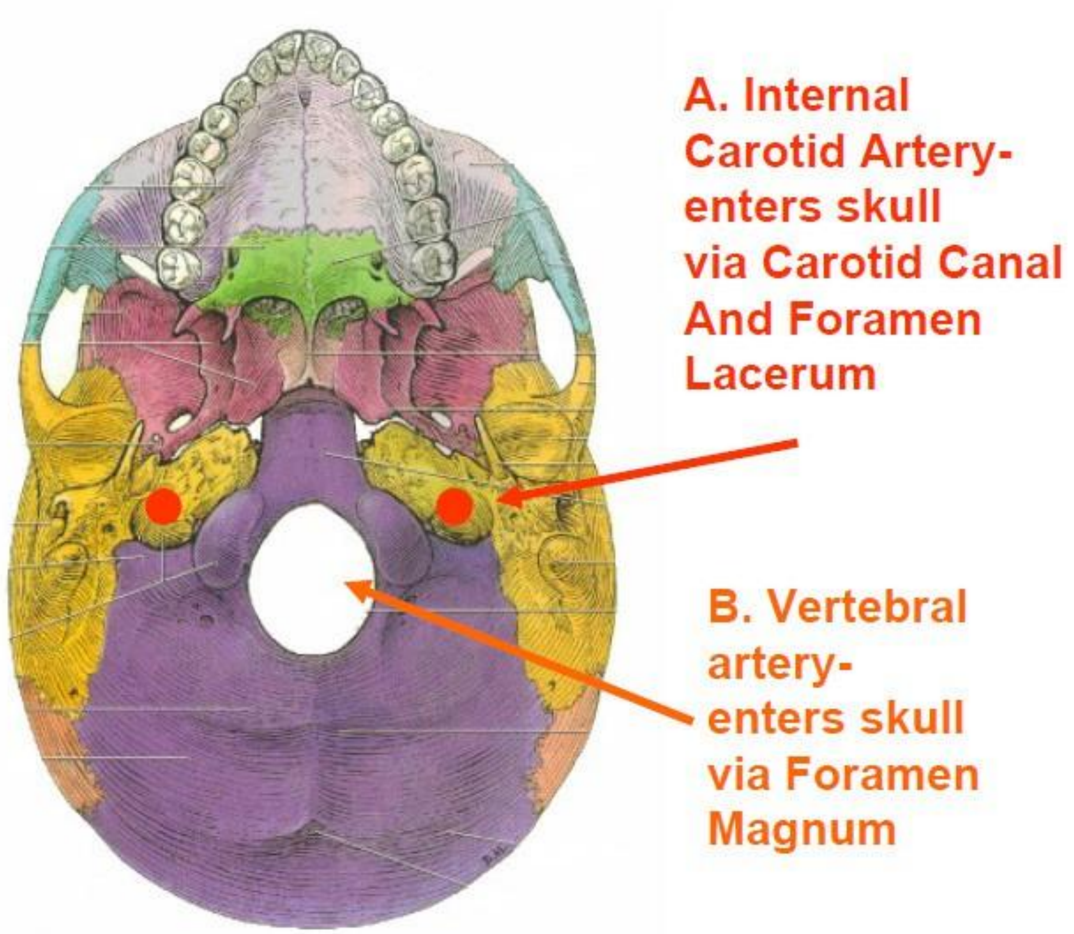
- **Contralateral** loss of nociceptive and thermal sensations over the body below the level of the lesion
- **Ipsilateral** loss of discriminative tactile, vibratory, and position sense over the body below the level of the lesion
- **Ipsilateral** paralysis of the leg or leg and arm, depending on the level of the hemisection



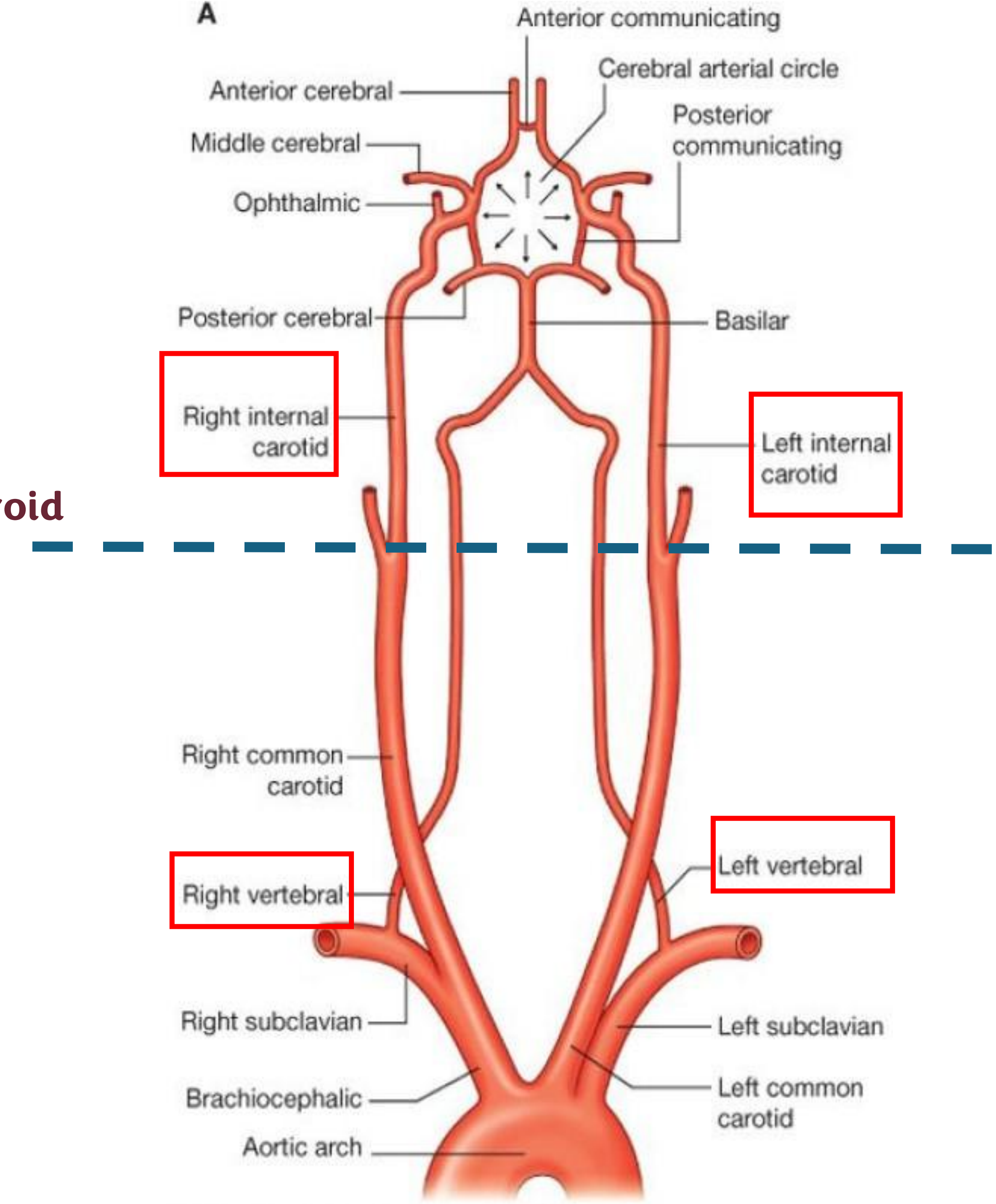
Arterial Blood Supply

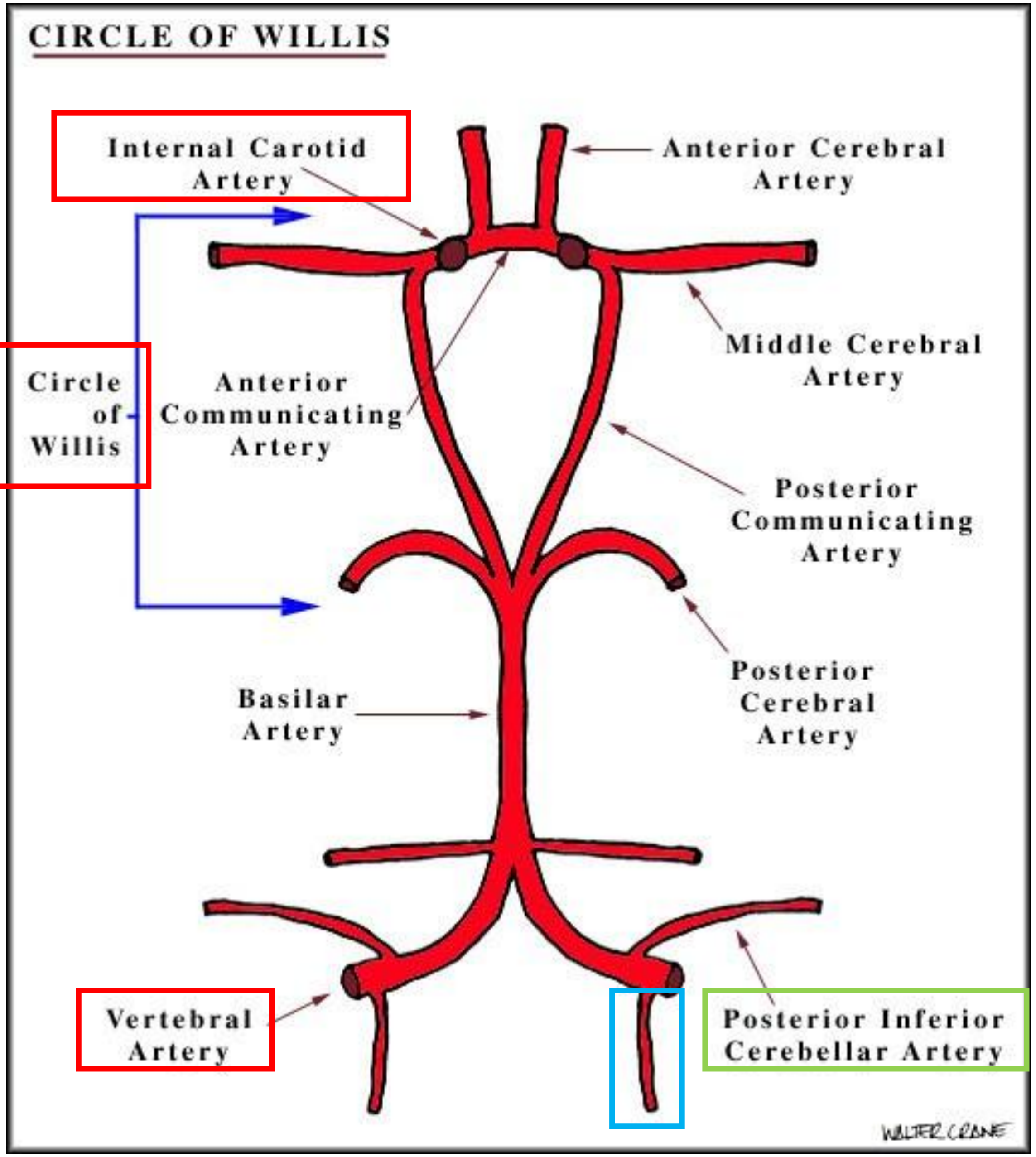
Let's recall the blood supply of the brain

- Brain is supplied by pairs of internal carotid artery and vertebral artery.
- The four arteries lie within the subarachnoid space
- Their branches anastomose on the inferior surface of the brain to form the **circle of Willis**



Level of upper border of thyroid cartilage (to help visualize).

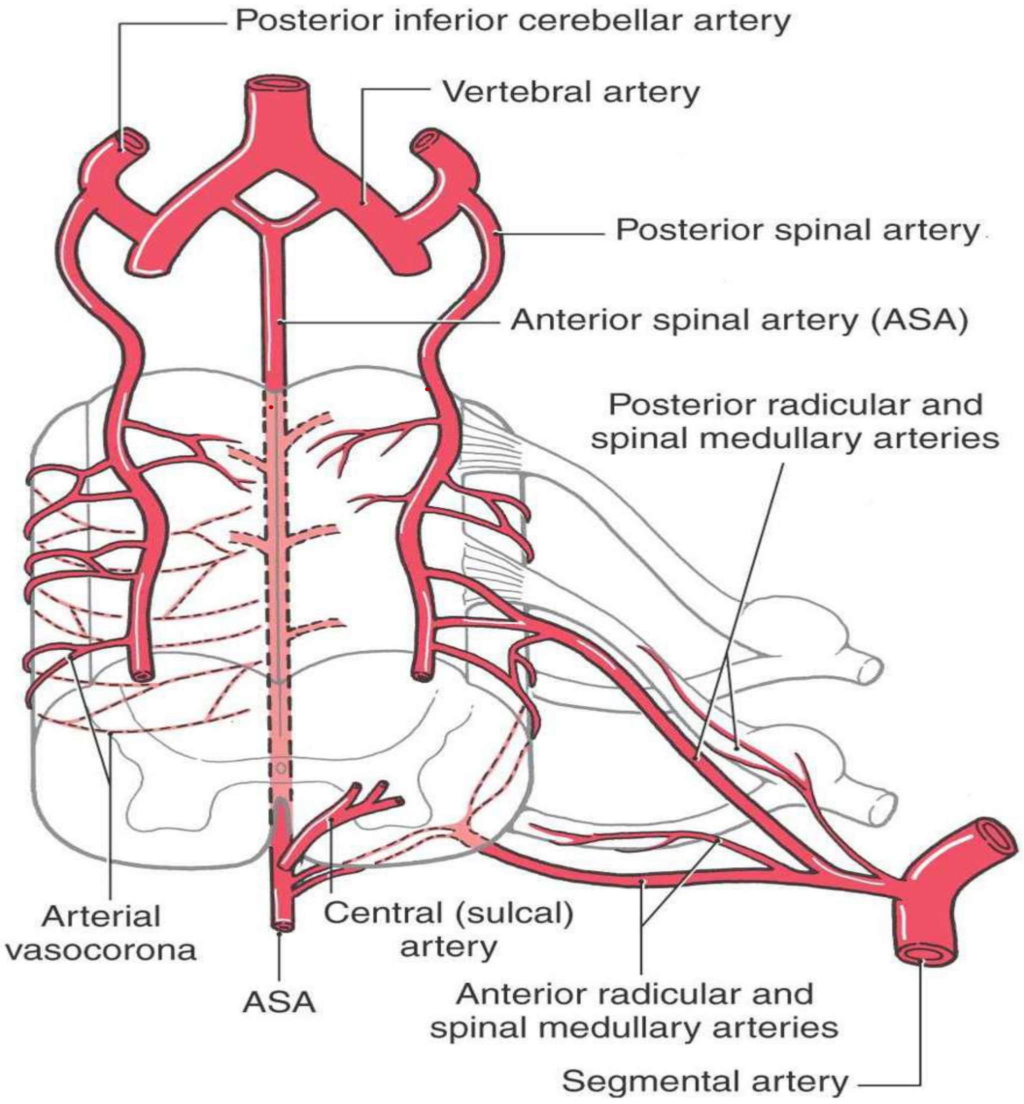


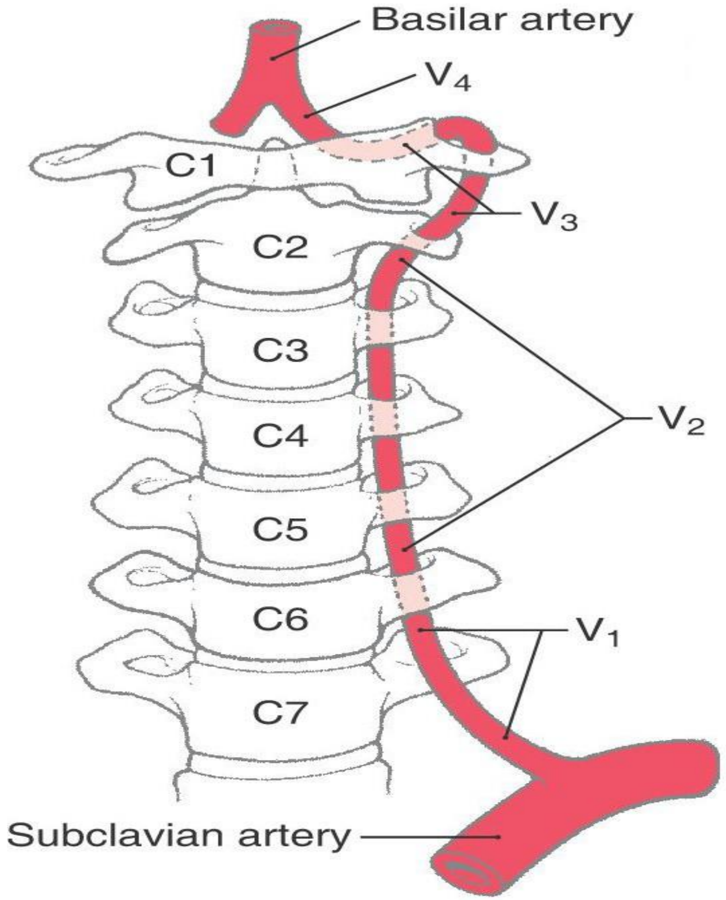


When studying the spinal cord, in this picture, we will focus on 2 branches coming from each vertebral artery:

1. posterior inferior cerebellar artery (green box).
2. anterior spinal artery (blue box).

Blood supply of spinal cord



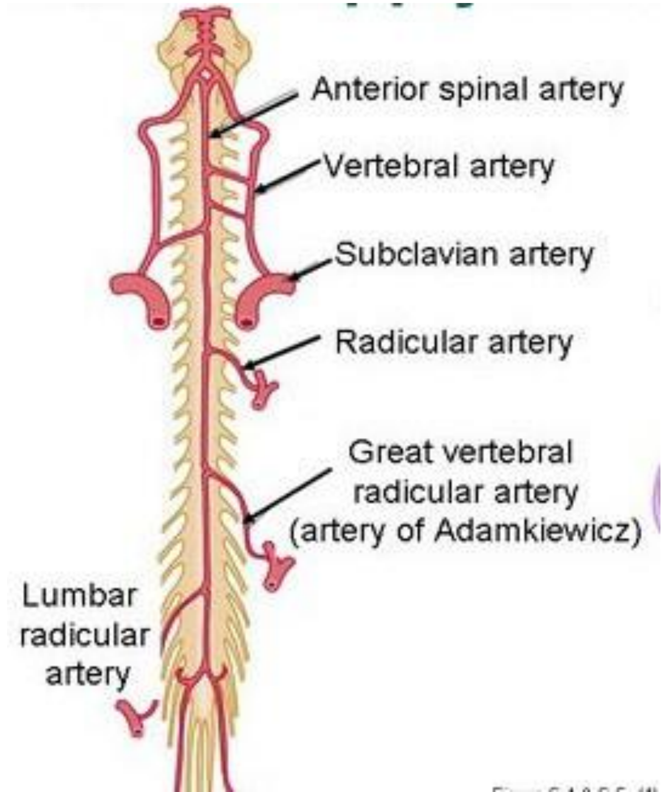


Blood supply of spinal cord

Longitudinal arteries:

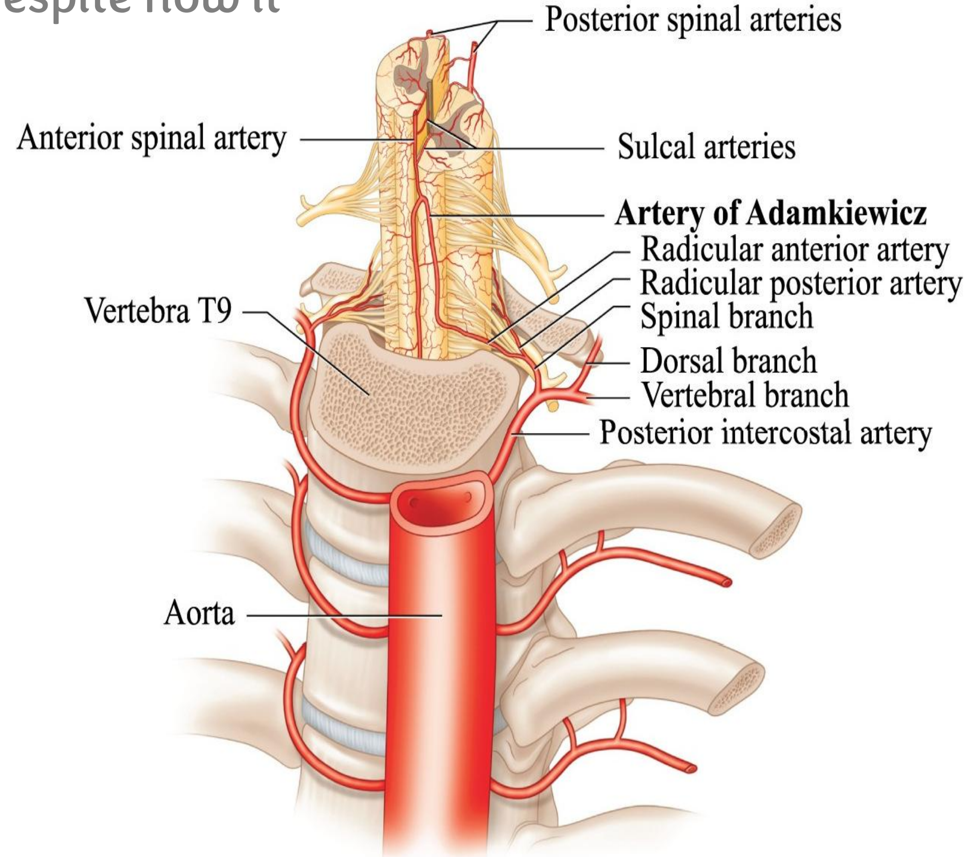
- <u>**One**</u> **anterior spinal artery**: arise from the vertebral arteries (in anterior median fissure)
- **Two posterior spinal arteries**: <u>arise from the posterior inferior cerebellar artery</u> (in the posterolateral sulcus)

In the previous slide, the blue box represents the very beginning of a branch from each side that combine into ONE median anterior spinal artery. Despite how it begins, it is referred to as a single artery.



There are 2 kinds of arteries supplying the spinal cord: longitudinal (mentioned above) and horizontal/segmental (pass through intervertebral foramen).

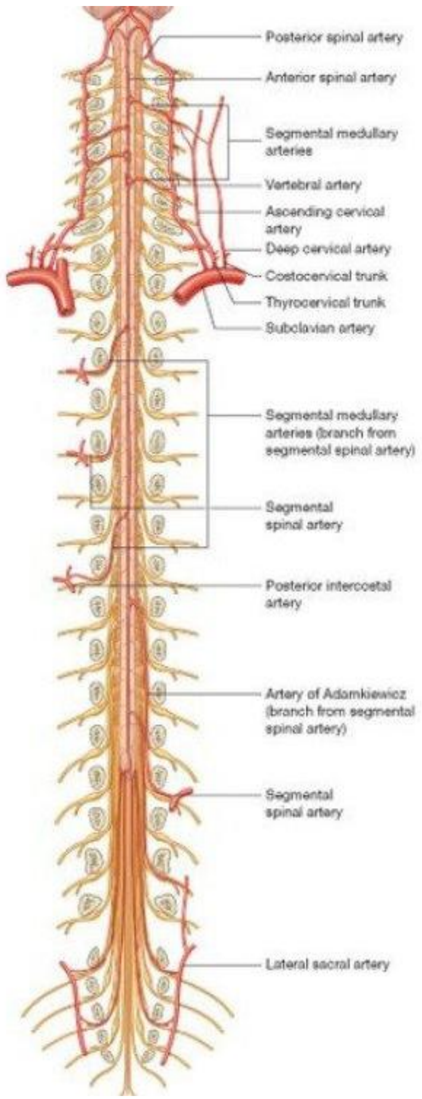
A Close-up view



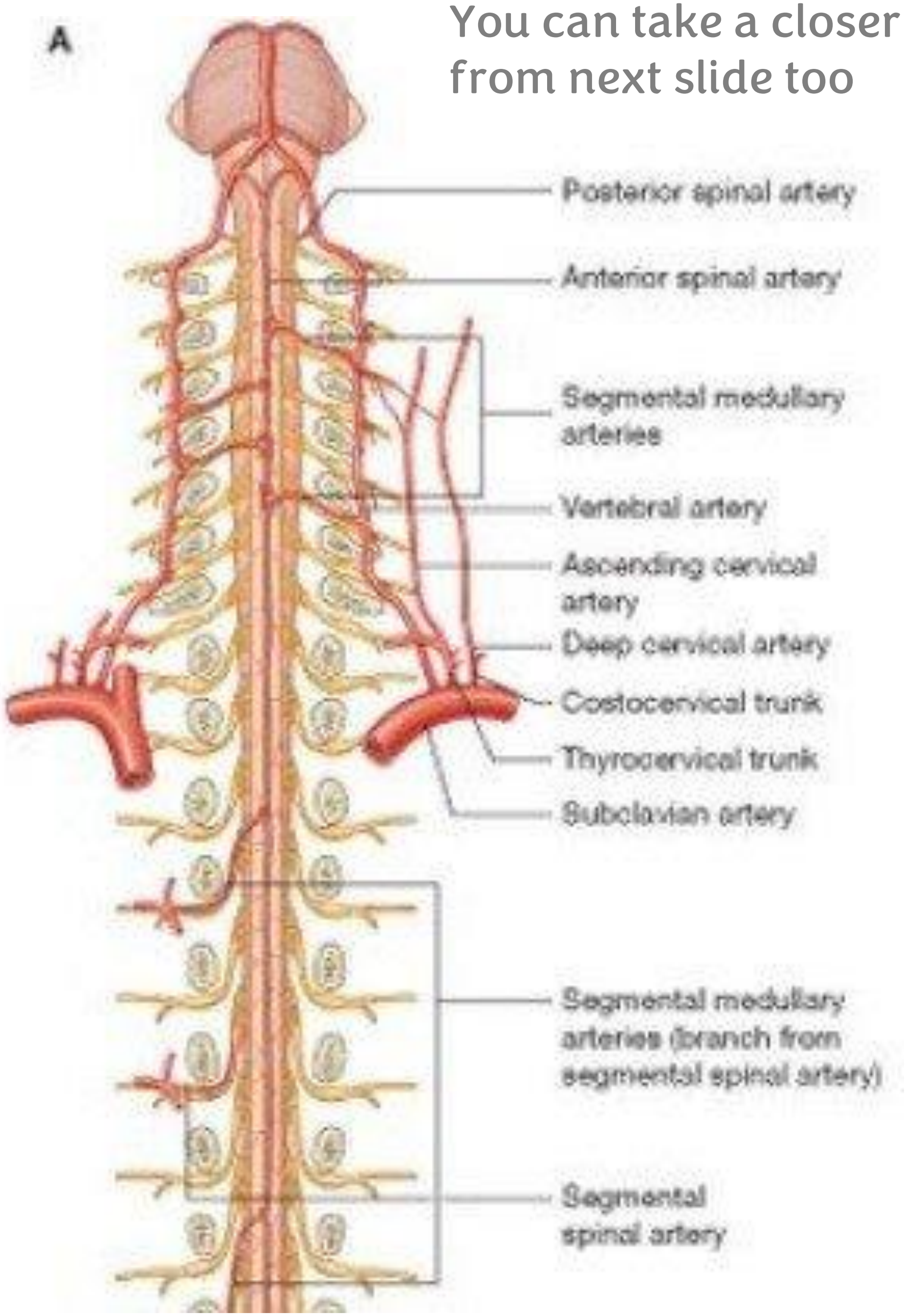
Blood supply of spinal cord

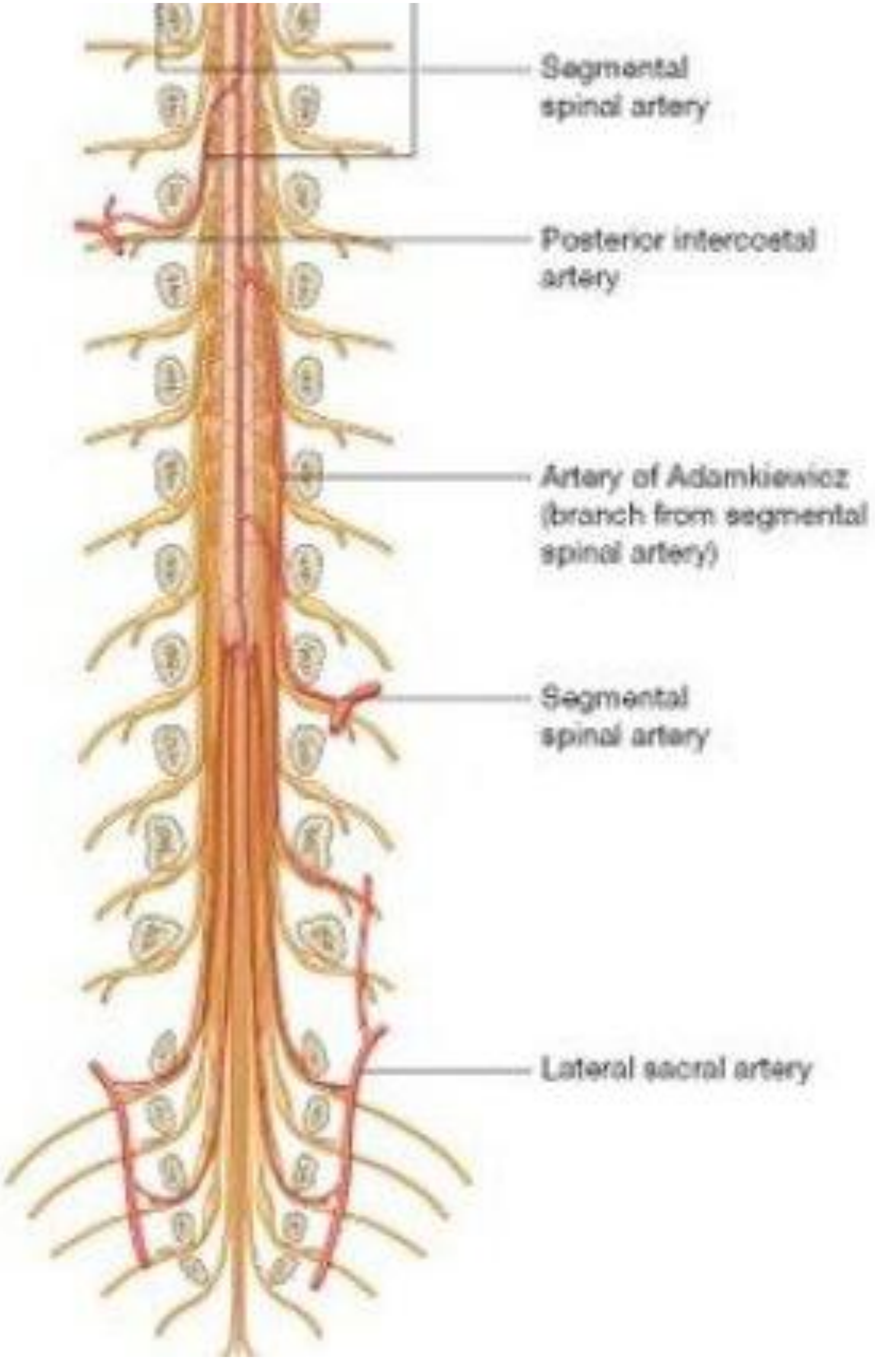
- segmental spinal arteries, arise from:
  - Vertebral arteries → **cervical region**
  - Deep cervical arteries in the neck → **cervical region**
  - Posterior intercostal arteries in the thorax → **thoracic region**
  - lumbar arteries in the abdomen → **lumbar region**
- Branches :
  - **Anterior radicular arteries**
  - **Posterior radicular arteries**
  - **Segmental medullary arteries**
- Artery of Adamkiewicz
  - usually on the left side,
  - reinforces the arterial supply to the lower portion of the spinal cord
  - From Left posterior intercostal artery at the level of the 9th to 12th intercostal artery (variations), which branches from the aorta, and supplies the lower two thirds of the spinal cord
  - Anastomose with anterior spinal artery

Refer to the figure in the next slide



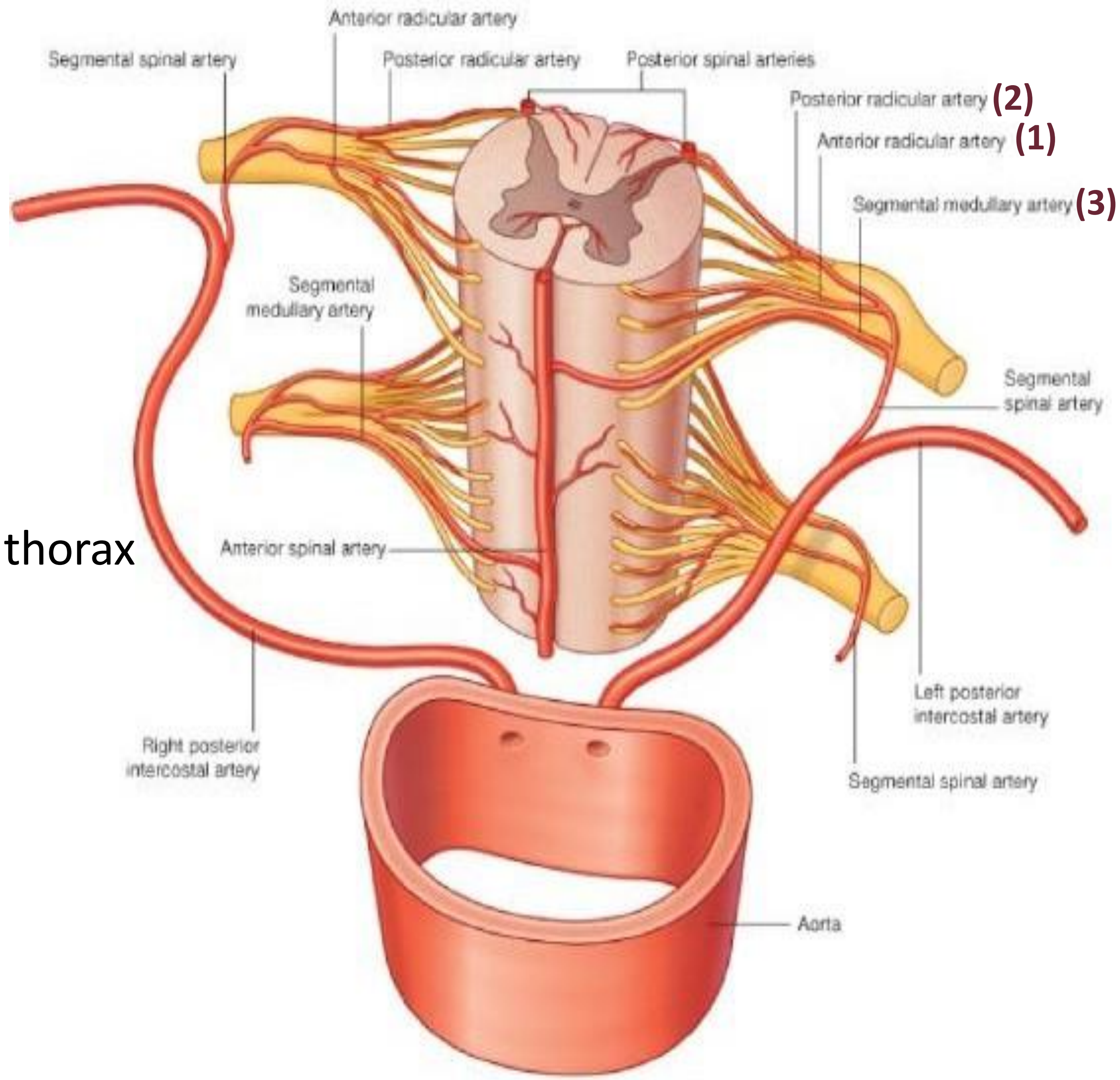
You can take a closer look from next slide too





Blood supply of spinal cord

- **segmental spinal arteries,** arise from:
  - Vertebral arteries
  - Deep cervical arteries in the neck
  - Posterior intercostal arteries in the thorax
  - lumbar arteries in the abdomen
- Branches:
  - **Anterior radicular arteries (1)**
  - **Posterior radicular arteries (2)**
  - **Segmental medullary arteries (3)**
- **Artery of Adamkiewicz**



Blood supply of spinal cord

The circle in the blue box is a cross-section of the artery

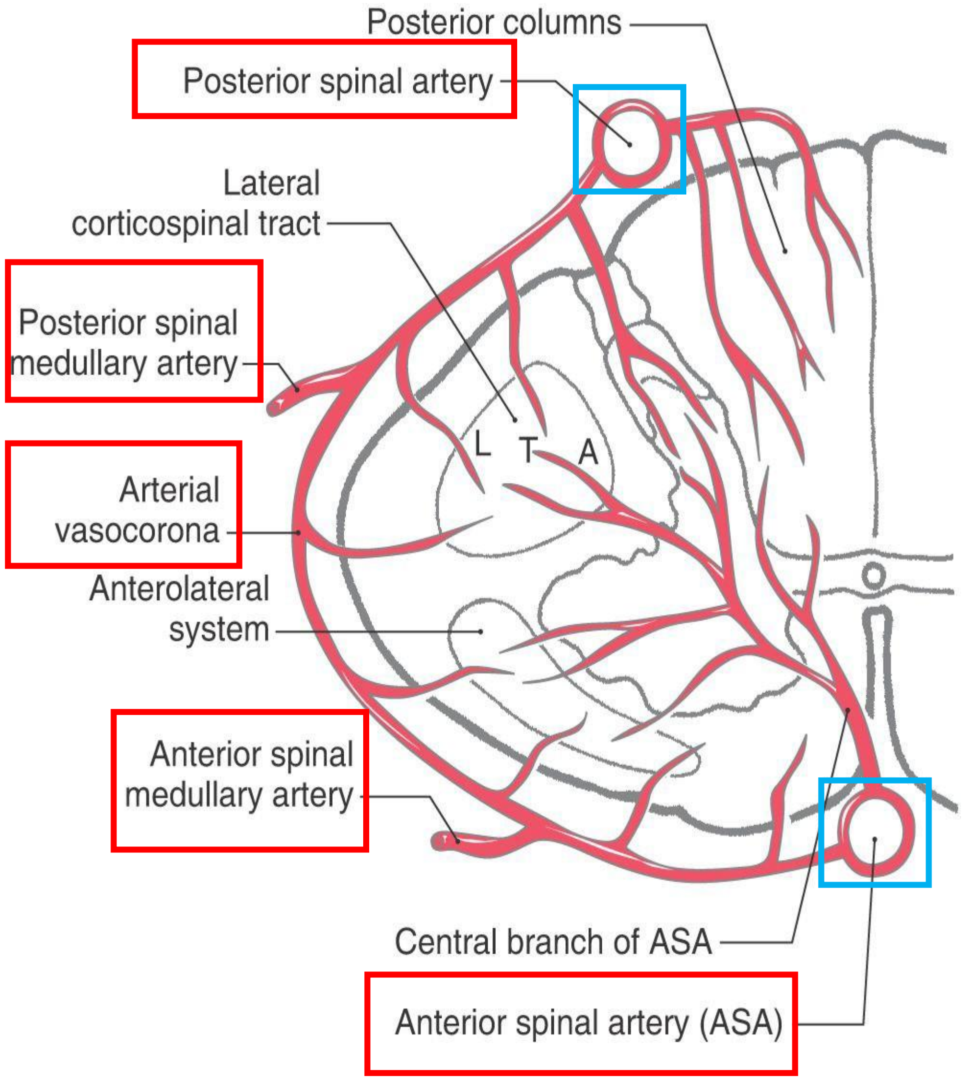
Terminal branches of the spinal medullary arteries join to form **arterial vasocorona.**

The posterior spinal arteries and arterial vasocorona:

- The posterior columns and peripheral parts of the lateral and anterior funiculi

The anterior spinal artery:

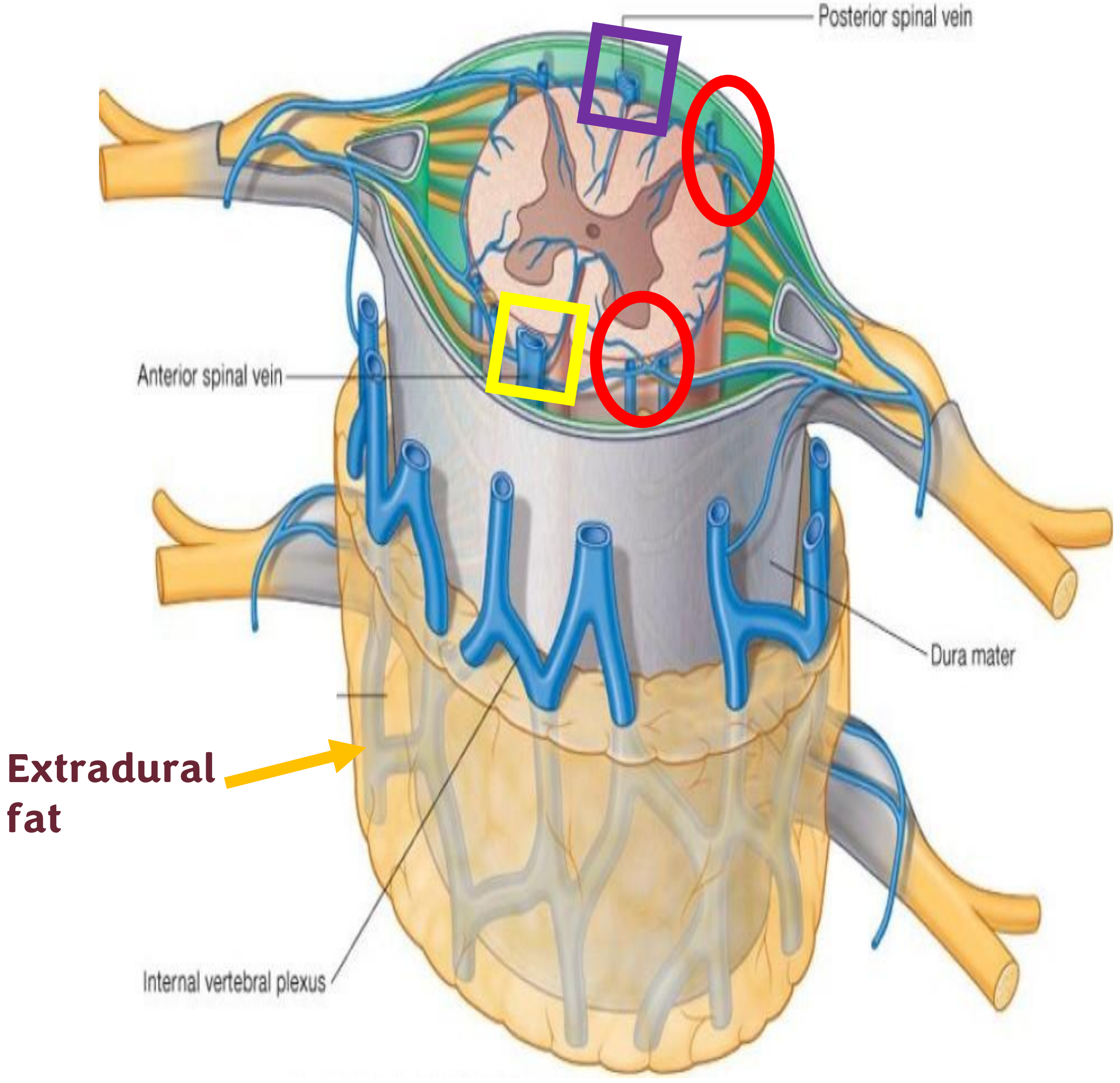
- Most of the gray matter and the adjacent parts of the white matter



Venous drainage of spinal cord

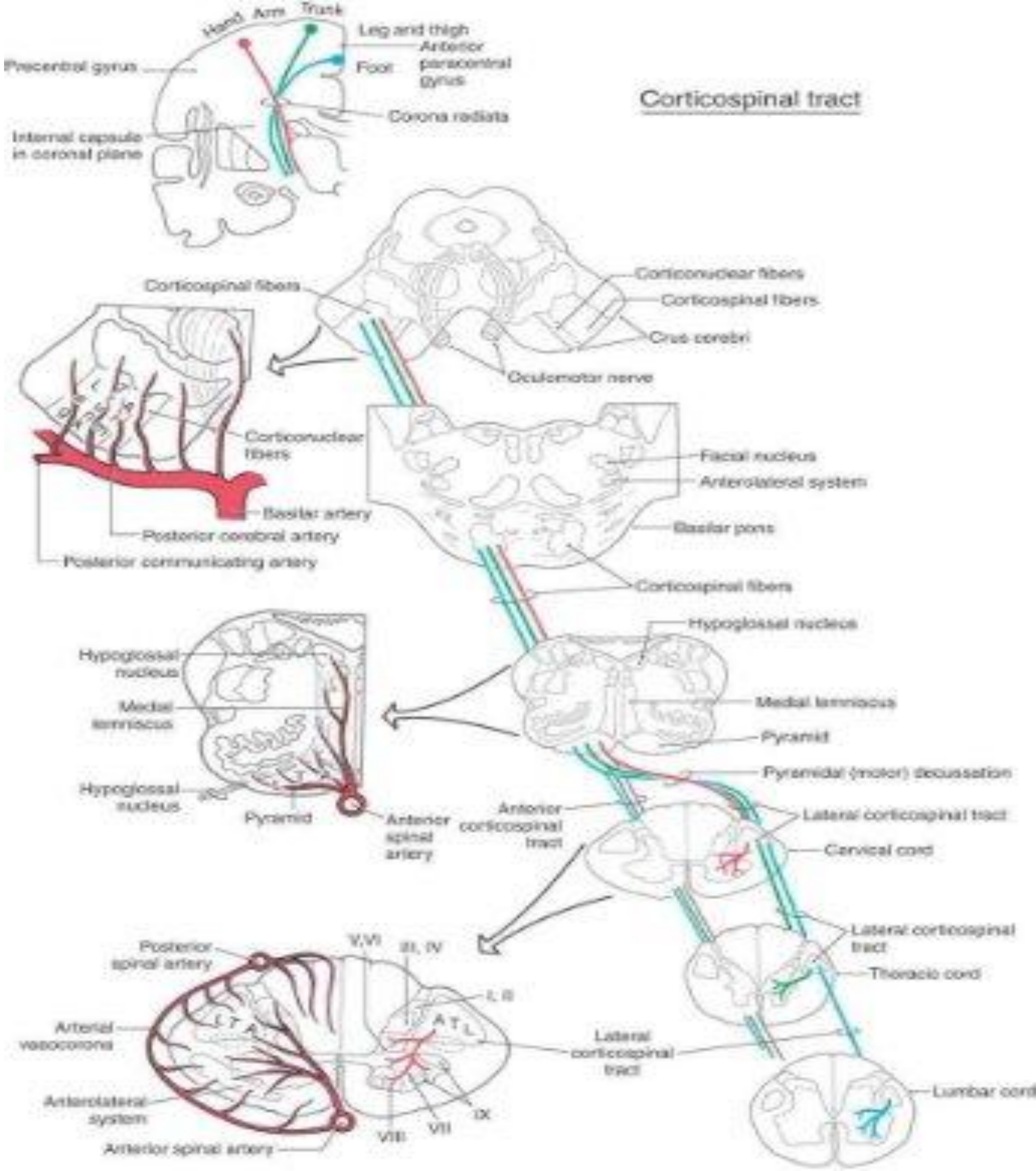
- Two pairs of veins on each side, so 4 total on each side (red ovals)
- One midline channel parallels the anterior median fissure (yellow rectangle)
- One midline channel passes along the posterior median sulcus (purple rectangle)

- These veins drain into an extensive internal vertebral plexus in the extradural (epidural) space of the vertebral canal
- Then drains into segmentally arranged vessels that connect with major systemic veins
  - Azygos system in the thorax.
  - The internal vertebral plexus
  - Intracranial veins

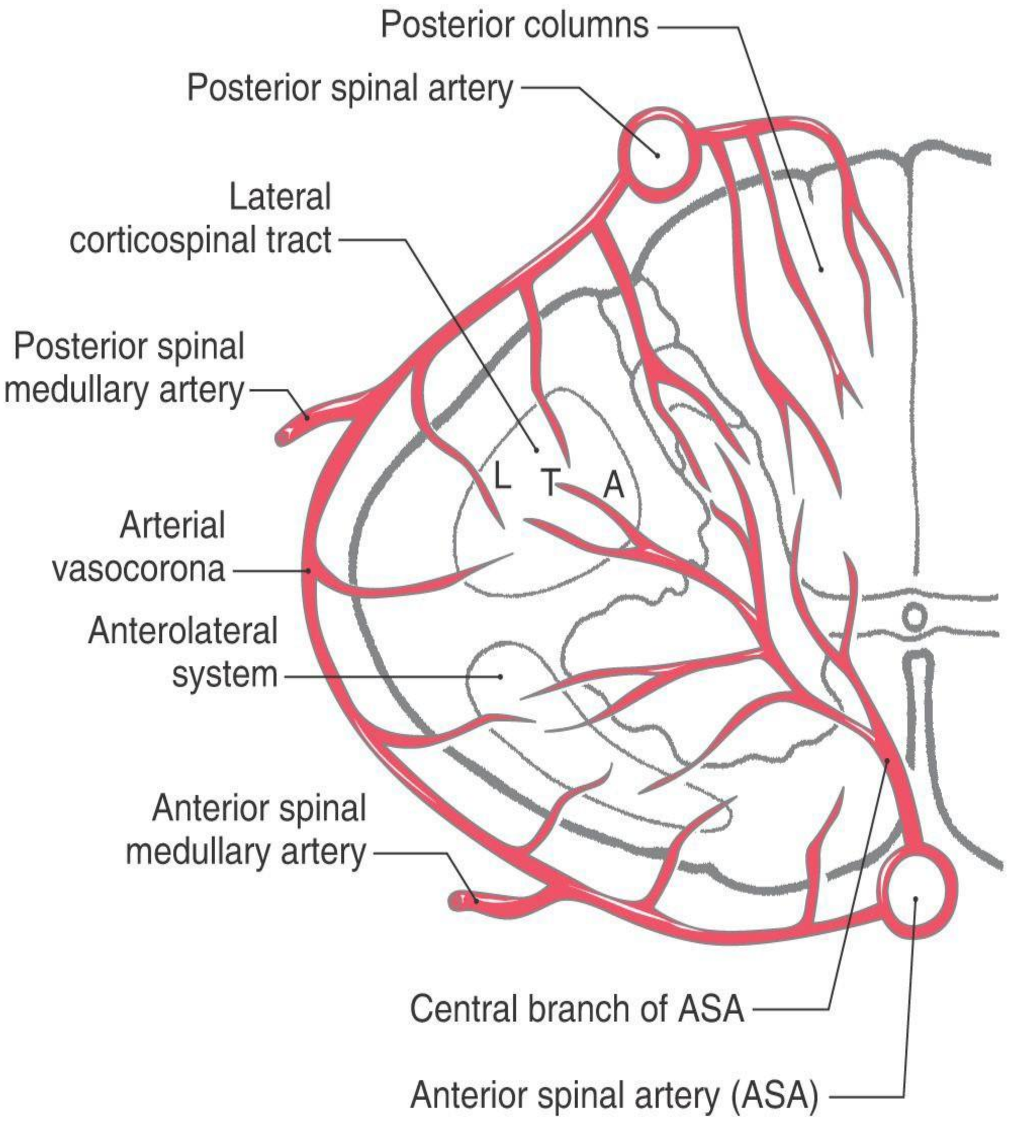


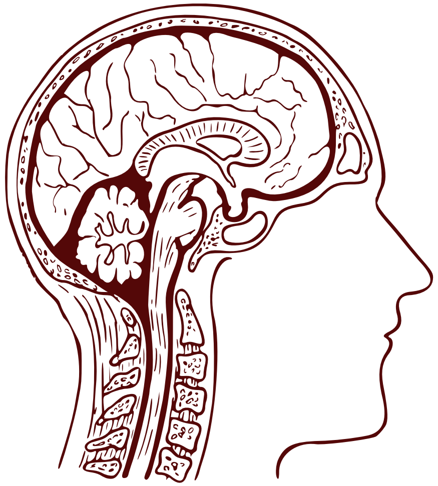
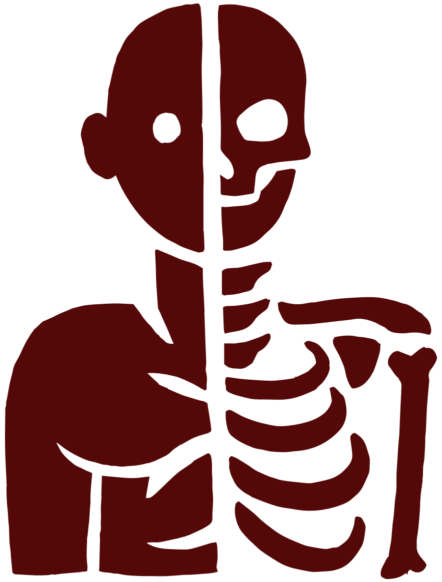
Central Cord Syndrome

- may result from hyperextension of the neck *(extension is backward)*
- Occludes blood supply to the cord via the anterior spinal artery
- Bilateral (because the anterior spinal artery is single) weakness of the extremities (more so of the upper than of the lower); lower extremities have Adamkiewicz artery that alleviates the effect.
- pain and thermal sensation loss, and bladder dysfunction (ANS)



- Compromise of blood flow in the **posterior spinal artery** results in:
- **Ipsilateral** reduction or loss of **discriminative, positional, and vibratory sensations at and below the level of the injury**



ANATOMY
QUIZ
LECTURE 5

رسالة من الفريق العلمي

اللهم إن عمر عطية في ذمتك وحبل جوارك، فقِه من فتنة القبر وعذاب النار،
أنت أهل الوفاء والحق، فاغفر له وارحمه إنك أنت الغفور الرحيم.

سَمِعْتُ النبيَّ صَلَّى اللَّهُ عليه وَسَلَّمَ يقولُ: إنَّ في اللَّيْلِ لَسَاعَةً لا يُوَافِقُهَا رَجُلٌ مُسْلِمٌ، يَسْأَلُ اللَّهَ خَيْرًا مِن أَمْرِ الدُّنْيَا وَالآخِرَةِ، إلَّا أَعْطَاهُ إيَّاهُ، وَذلكَ كُلَّ لَيْلَةٍ.
الراوي : جابر بن عبدالله | المحدث : مسلم | المصدر : صحيح مسلم

For any feedback, scan the code or click on it.

Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1	38; second point	Most UMN lesions affect both pyramidal and extra-pyramidal areas. However, the symptoms of the table in *slide 28* are mostly due to the effect of pyramidal lesions. An exception to that is the Babinski Sign, where a corticospinal lesion is responsible for this symptom.	Most UMN lesions affect both pyramidal and extrapyramidal areas. However, the symptoms of the table in *slide 29* are mostly due to the effect of extrapyramidal lesions. An exception to that is the Babinski Sign, where a corticospinal lesion is responsible for this symptom.
	42; first sentence	like Babinski Sign.	unlike Babinski Sign.