

# Lecture

## The Spinal Cord & Its Tracts

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الرجاء تقويل الجوال إلى وضع  
الصامت مع الشكر



# Anatomy of the Spinal Cord (SC)

- **Shape:** *\* located in the vertebral canal* compressed cylindrical column.
- **Number of neurons in human SC:** about 13,500,000
- **Length of human SC:** about 45 cm (male), 42 cm (female).
- **Weight of human SC:** about 35g and comprises 2% of the weight of the adult brain. *\* high protein level*
- **Diameter:** about 1 cm.
- **Location:** It is located in the spinal (vertebral) canal.  
*below the MO [downward continuation of MO]*

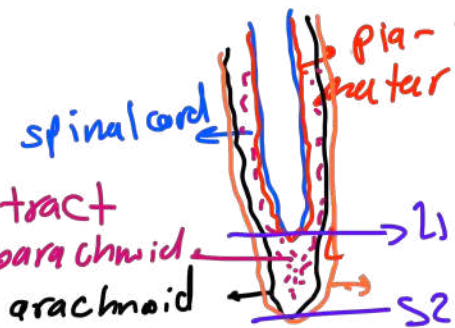
# Location of the Spinal Cord



- The spinal cord (SC) is an extracranial part of the central nervous system enclosed inside the vertebral column "Spinal Canal".
- Beginning:** the SC is continuous with the medulla oblongata at the spinomedullary junction which begin from the foramen magnum downward.

- A plane defined by three structures:**

- ✓ The foramen magnum.
- ✓ The pyramidal decussation.
- ✓ The emergence of the first cervical nerve anterior rootlets.

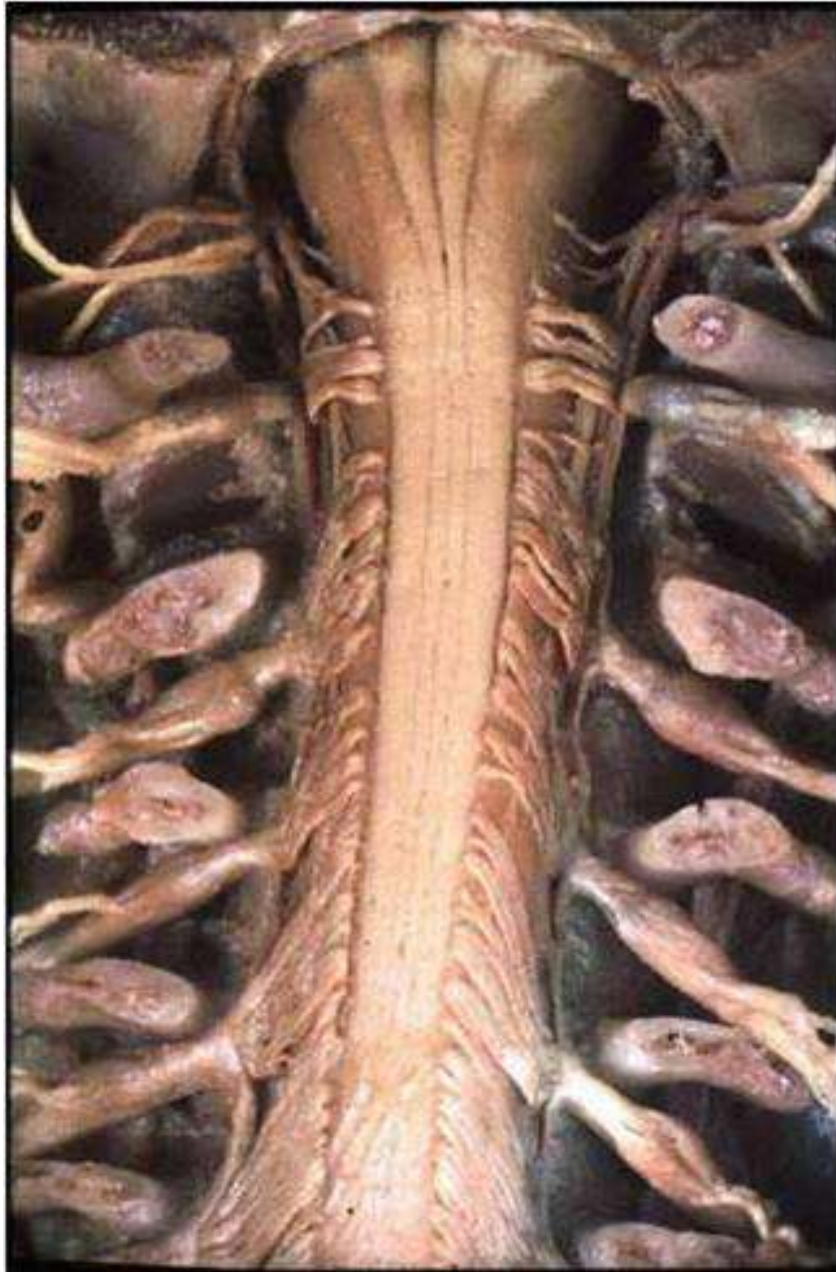
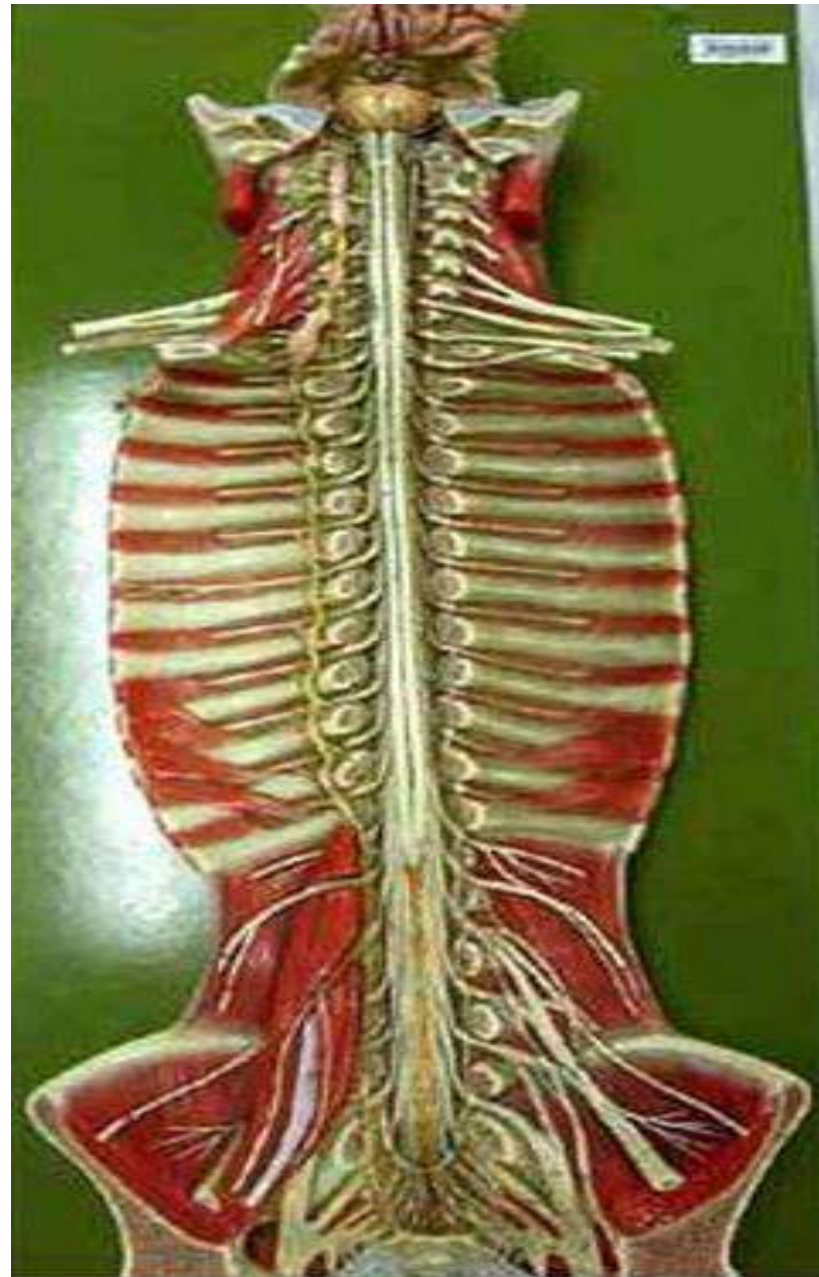


- Lies within the subarachnoid space. below arachnoid mater.

- The subarachnoid space extends caudally to the level of **the second sacral vertebra**.

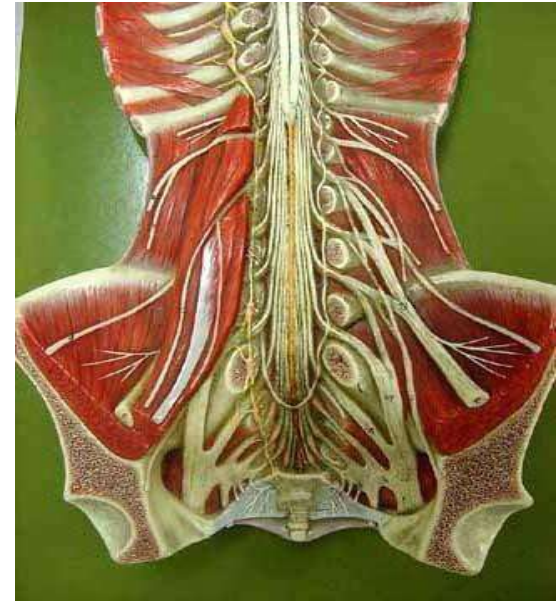
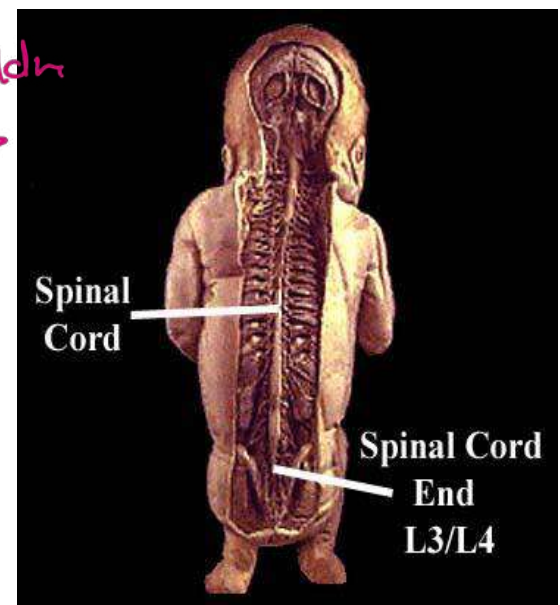
set size → weighing place of sub-arachnoid.

Spinal cord



# Termination of the Spinal Cord

- At the third month of intrauterine life the SC fills the whole spinal canal.
- At birth: it ends at the level of *in lumbar puncture in children*  
L3 vertebra. *L3 10 cm 2-3 cm 2-3 cm*  
*SC injury 2-3 cm*
- In the adult: it ends at the level of lower border of the L1 vertebra.



# Function of the Spinal Cord

1. Conduction function: from and to the brain:

→ a. **Ascending tracts**: conduct sensory impulses from the SC to the brain.

b. **Descending tracts**: conduct motor impulses from the brain to SC.

2. Reflexes center: the gray matter of the SC is the integrative area for all spinal reflexes.

\* inter neuron located in ant, post horn cell to → reflex center

# Meninges of the Spinal Cord

The spinal cord is covered by 3 membranes (meninges),

from inside to outside they are:

SC is covered

1. Pia Mater. ✓

cephalic, is

2. Arachnoid Mater. ✓

3. Dura mater. ✓

↳ outer

↳ in Brain 2 layer to form venous dura sinus.  
↳ in spinal cord one thick layer

# The Pia Mater

- Closely adherent .
- Ends at the level of SC termination (lower border of the first lumbar vertebra in adult).  
*age 21 up*
- Form the denticulate ligaments.
- It continues as the filum terminale which attached to the back of coccyx .  
*↳ fix and support the SC.*

# The Arachnoid Mater

↳ middle memb.

- The inner surface of the dura matter.
- It ends at the level of **the second sacral vertebra.**

# The Dura Mater

↳ thick, outer.

- It ends at the level of **the second sacral vertebra.**
- It is attached to:

- Margins of foramen magnum.
- Intervertebral foramina.
- Bodies of the 2<sup>nd</sup> and 3<sup>rd</sup> cervical vertebrae.

nerve ١٠٠٠ memb. layer ١٠٠٠ \* fix the SC \*  
nerve ١٠٠٠ memb. layer ١٠٠٠ \*  
nerve ١٠٠٠ memb. layer ١٠٠٠ \*

# Meningeal Spaces Of Spinal Cord

*semi liquid [fat]*  
**1. Epidural Space:** it is a potential space located between the dura matter and vertebral periosteum. It contains semiliquid fat and internal vertebral venous plexus.  
*if it injury leads to epidural, extra dural hemorrhage*

**2. Subdural Space:** it is located between the dura matter and arachnoid matter. Contains thin film of serous fluid.  
*1, 2 up to 1 cm between dura matter + arachnoid*  
*to lubrication*

**3. Subarachnoid Space:** it is located between the arachnoid and pia matter. Is a wide space contains:  
*largest*

• CSF.

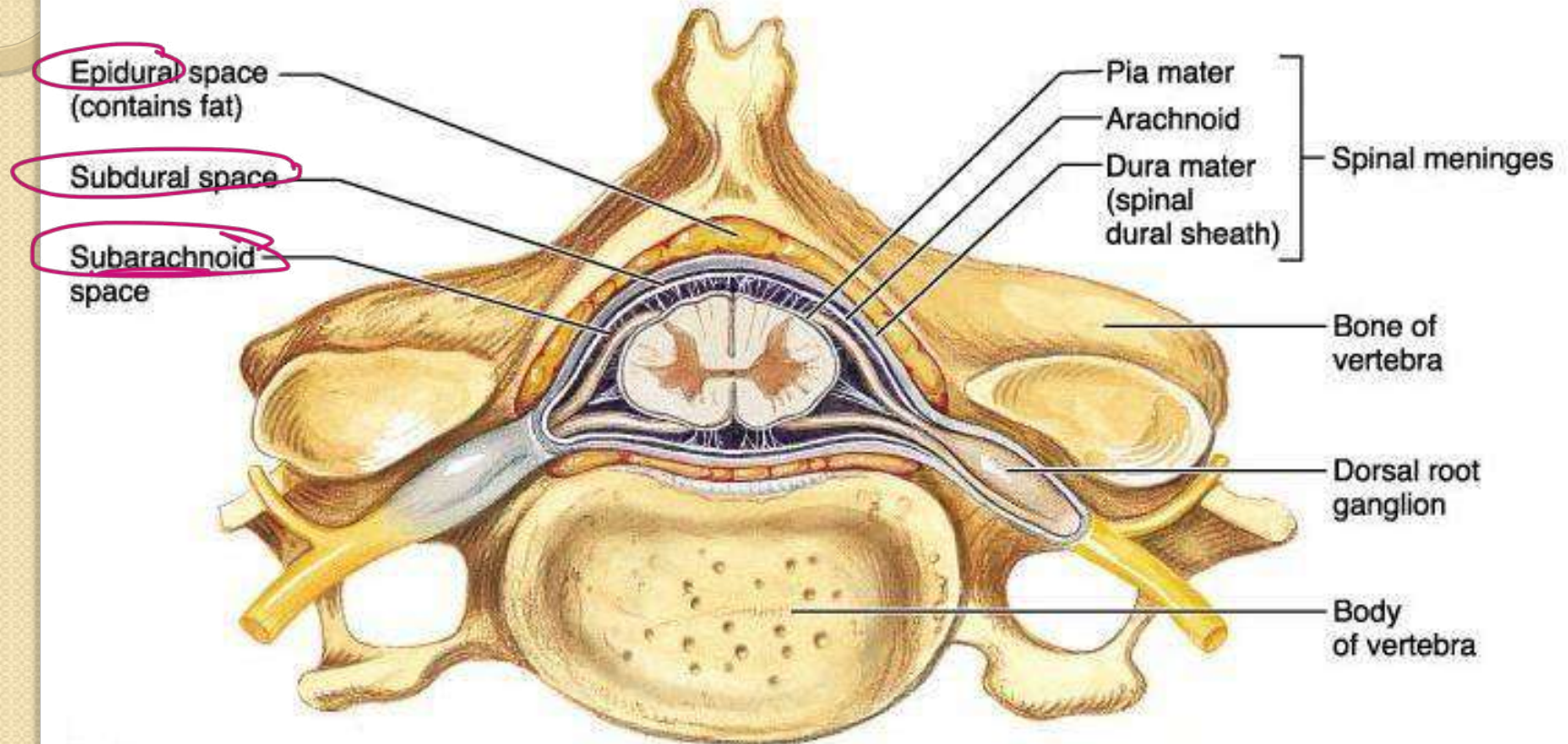
• Spinal blood vessels.

• Roots of spinal nerves.

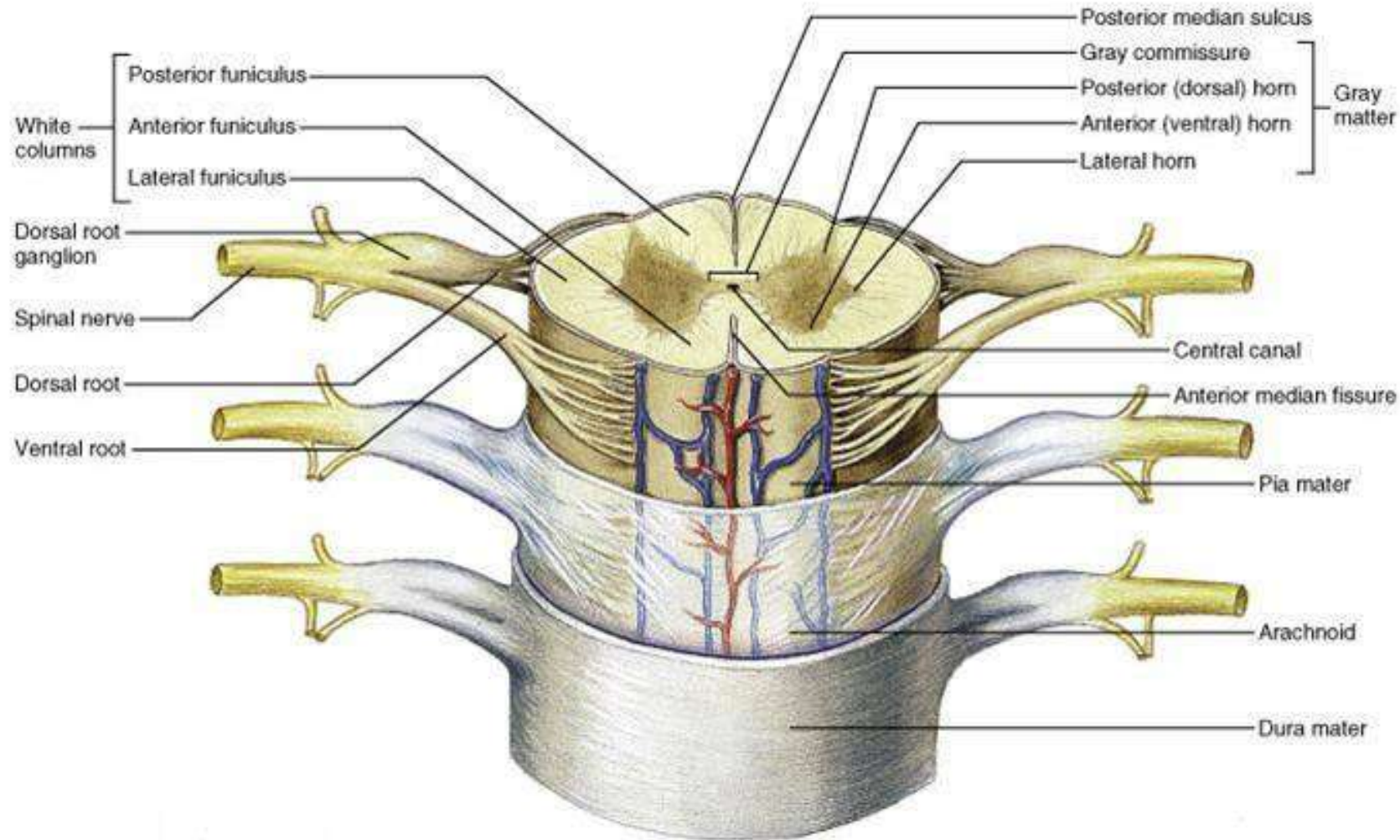
*lumbar puncture for CSF, 3rd & 4th → 3rd & 4th*  
*→ serous.*

*sub arachnoid space*

# Anatomy of the Spinal Cord



# Anatomy of the Spinal Cord



# External Structure of the Spinal Cord

- **Anterior median fissure:** the anterior spinal artery is found superficially.
- **Posterior median sulcus.**
- **Anterior lateral sulcus:** from which the anterior rootlets emerge. *↳ exist of ant. root*

- **Posterior lateral sulcus:** into which the posterior rootlets enter. *↳ exist of post. root entering.*

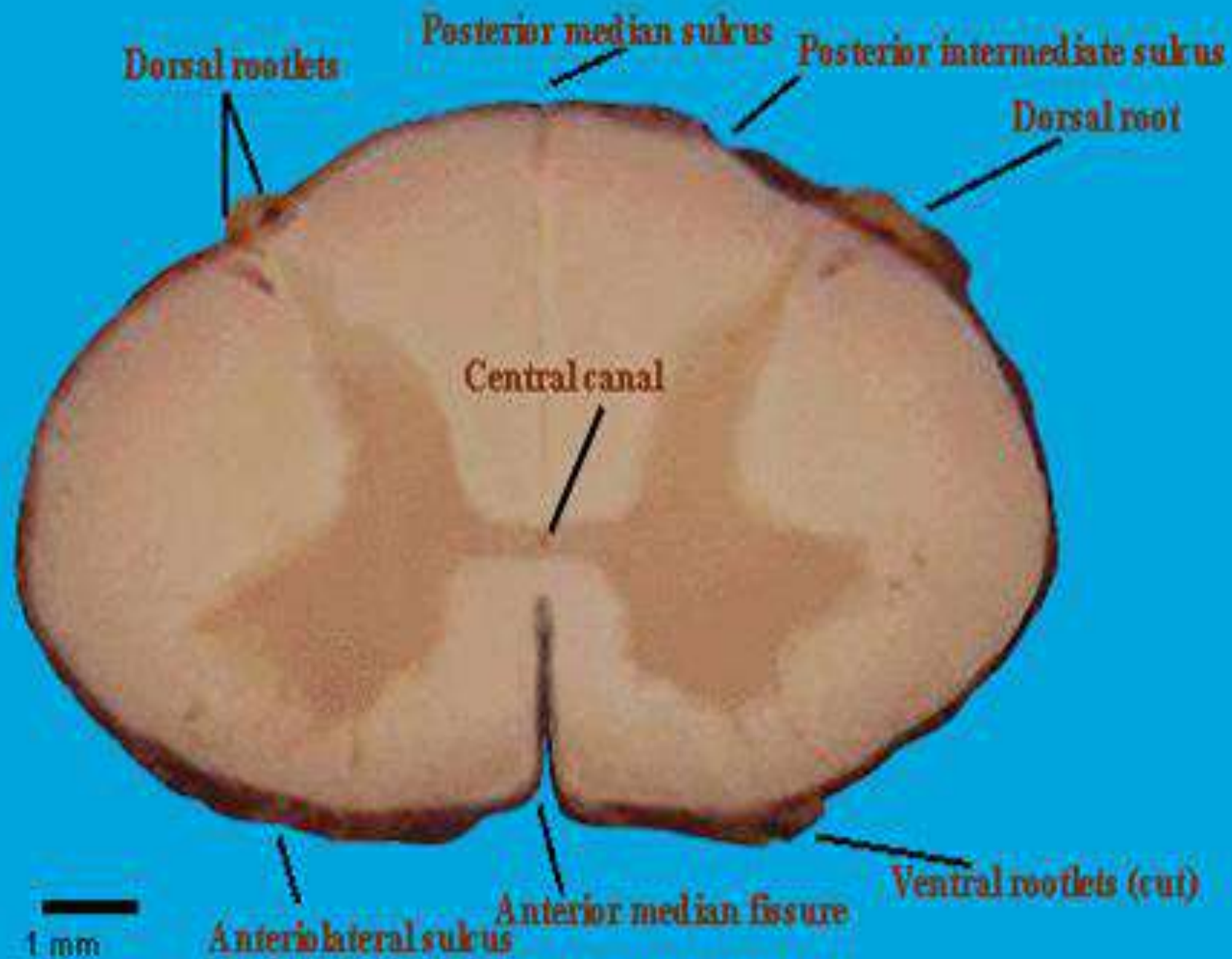
- **Posterior intermediate sulcus:** *↳ gracile and the cuneate*
  - ✓ Found between the posterior lateral and posterior median sulci but only above T6 level. *mid thoracic and ascend*

- ✓ Separates the **Gracile fasciculus** from the **Cuneate fasciculus.** *medial [UL] lateral [UL]*

*↓*  
in lower spinal cord

*بيكون في mid thoracic و فوق بيكون مع 1 Cuneate*

*بيكون في mid thoracic و فوق بيكون مع 1 spinal cord.*



# The Spinal Cord Segments

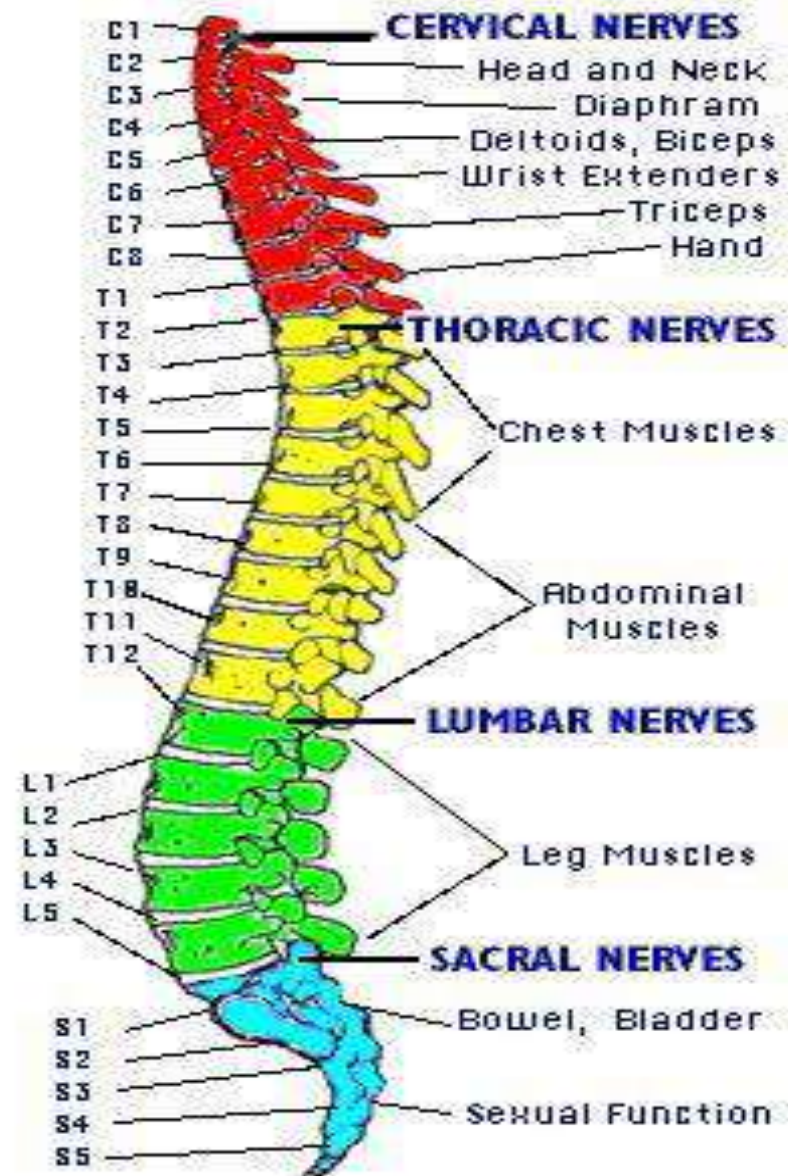
2ant  
2post } 4root

ل ٤ بجذع

forming  
Rt, Lt  
spinal nerve

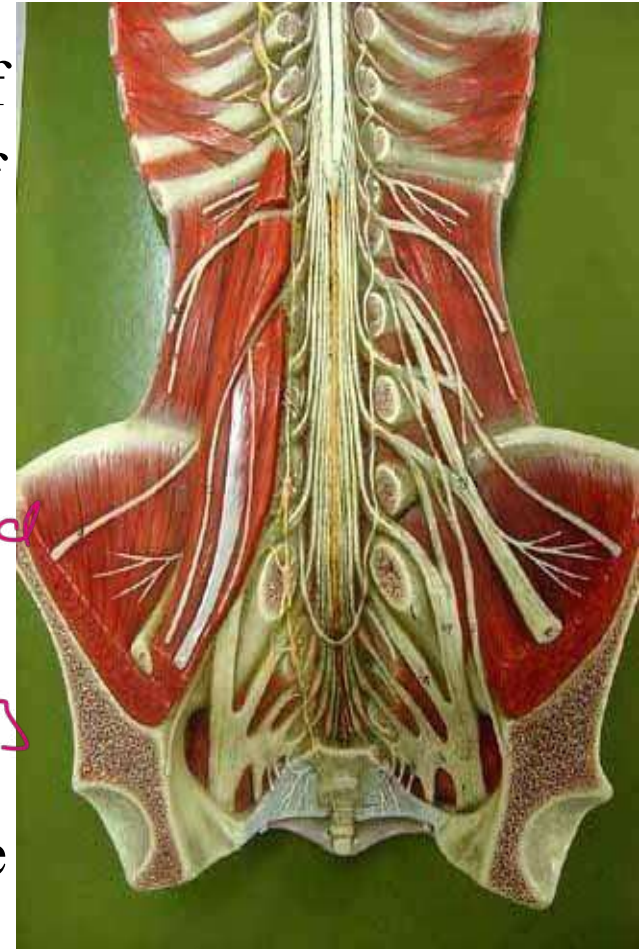
There are 31 segments:

- 8 – Cervical segments.
- 12 – Thoracic (dorsal).
- 5 – Lumbar segments.
- 5 – Sacral segments.
- 1 – Coccygeal segments.



- Epiconus: <sup>عاقيل ال Conus</sup> it is the L4, 5 and S1, 2 segments of the SC.
- Conus medularis: <sup>(end) 2 terminal part of SC</sup> the lower end of the SC. It is the S3, 4, 5 segments of the SC.
- Cauda equina: <sup>SC = spinal column</sup>
  - It is located below the lower border of the first lumbar <sup>SC end</sup> vertebra, the spinal canal is filled by the collection of lumbo-sacral roots <sup>below L1</sup> which descends in this space to their corresponding intervertebral canal. <sup>[Conus]</sup>

Called cauda equina.



\* like long cauda equina lesion.  
 ↳ lower motor neuron lesion

# Enlargement of the Spinal Cord

diameter of SC  $\rightarrow$  1cm

## 1. Cervical enlargement.

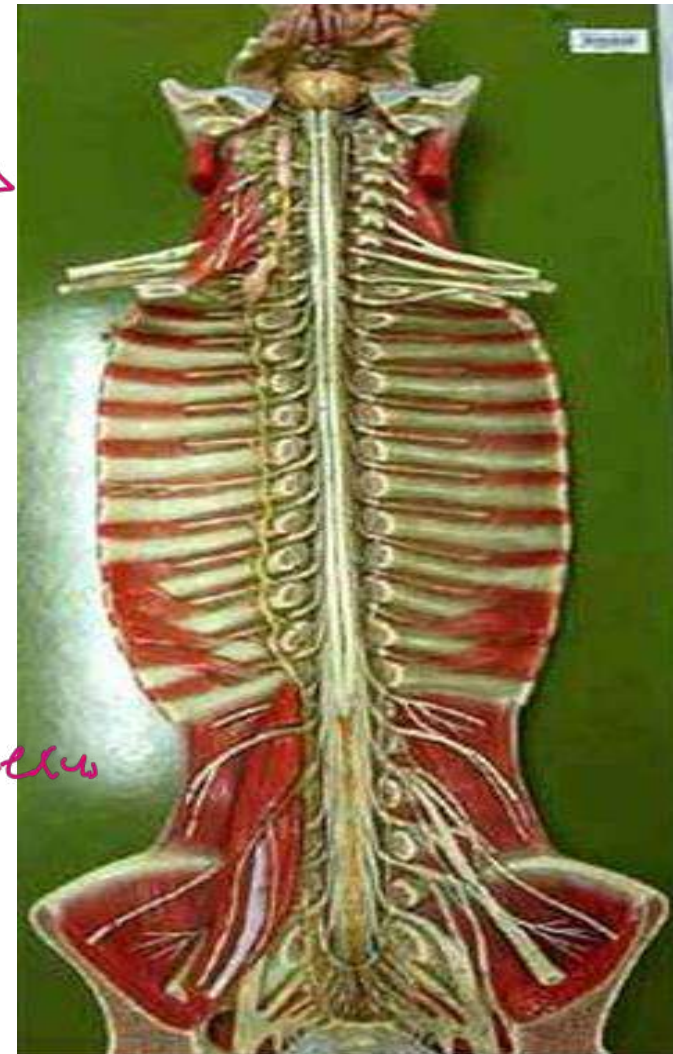
C5-T1 [ Brachial plexus ]  
to UL

origin of  
brachio plexus  
and lombo-  
sacral plexus

السبب انه ههنا الحافق يوجب  
UL  $\rightarrow$  SC  
LL

## 2. Lumbar enlargement.

L1-L5 L6-S2 lombo sacral plexus  
to LL



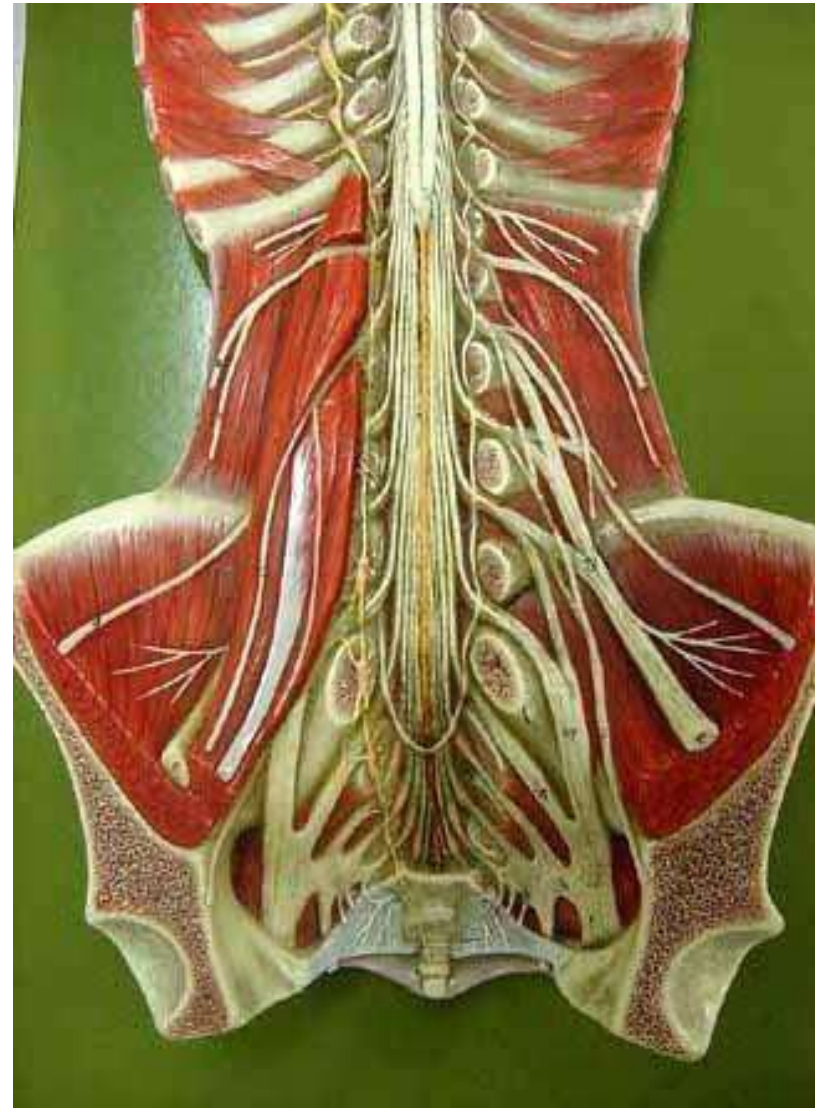
# Cervical Enlargement of the Spinal Cord

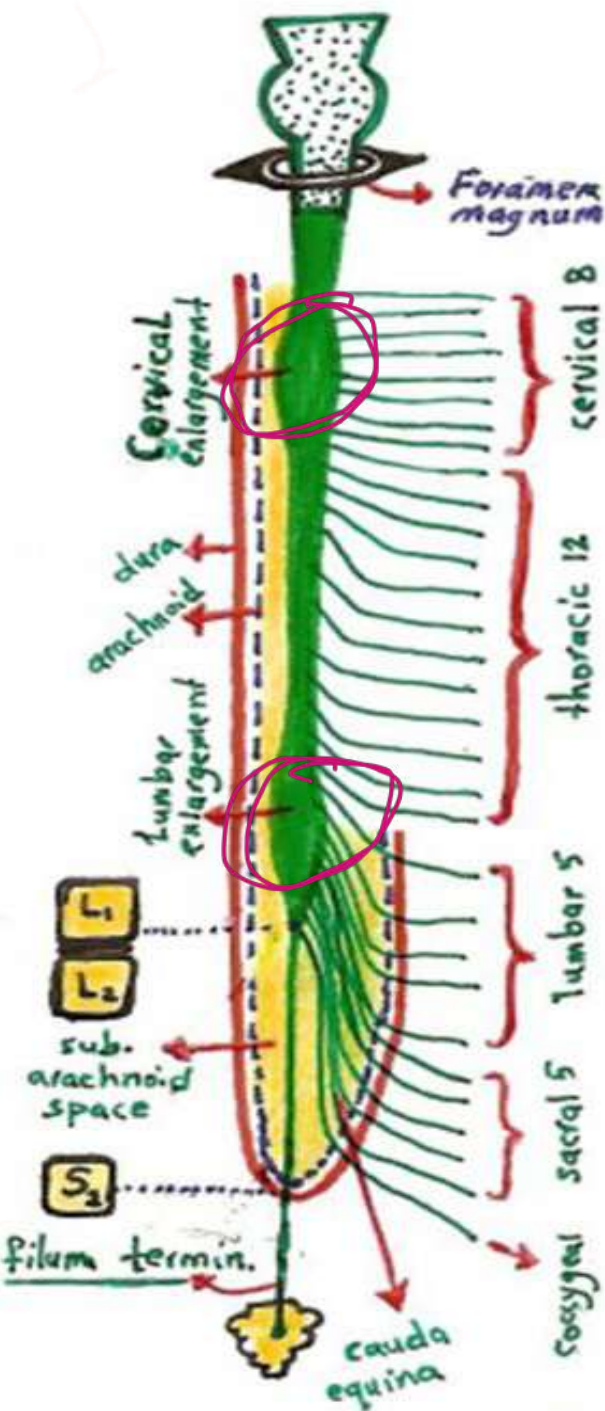
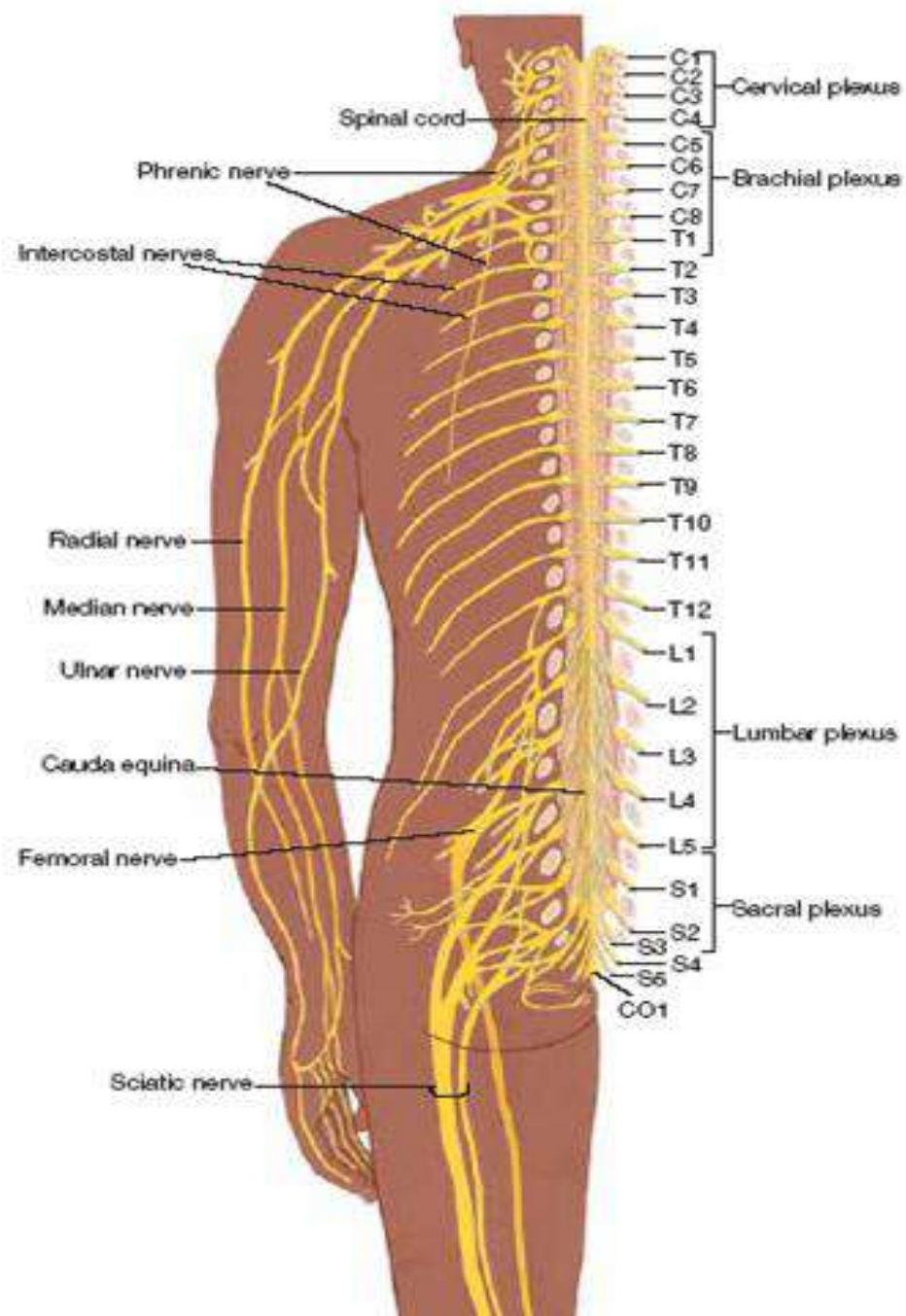
It is the **C5, 6, 7, 8 and D1 segments** of the SC, corresponding to the region from which the brachial plexus arises → give spinal nerves that supply the upper limbs.



# Lumbar Enlargement of the Spinal Cord

It is the **L1, 2, 3, 4, 5** and **S1, 2 segments** of the SC, corresponding to the region from which the lumbar and sacral plexuses arise → give spinal nerves that supply the lower limbs.





# Relationship between the Spinal Cord

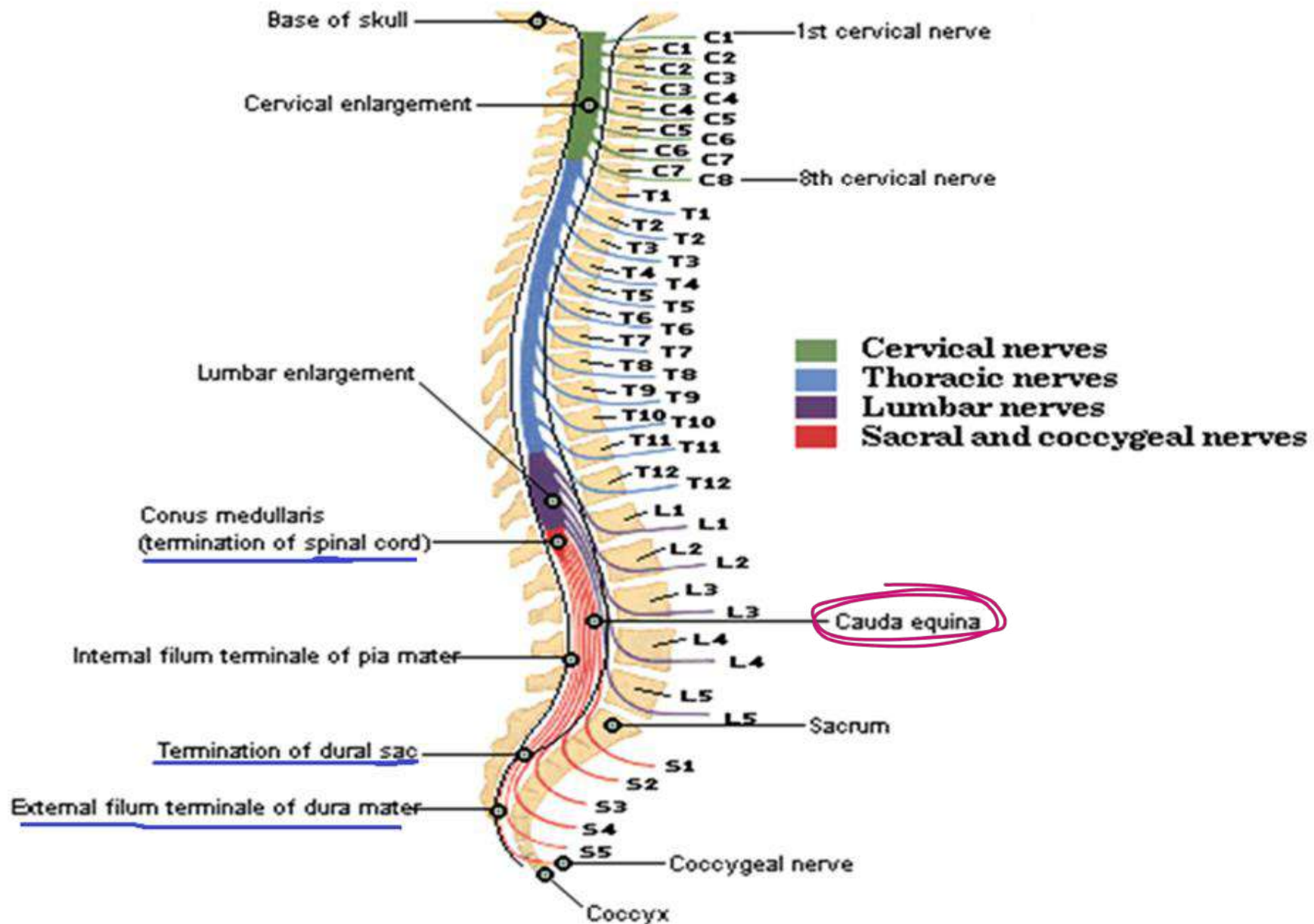
## Segment and the Vertebra

| No | Spinal Cord                                         | Vertebra                                        |
|----|-----------------------------------------------------|-------------------------------------------------|
| 1  | From <u>C<sub>1</sub> - C<sub>4</sub></u> segments  | Opposite <u>C<sub>1</sub> - C<sub>4</sub></u>   |
| 2  | From <u>C<sub>5</sub> - C<sub>8</sub></u> segments  | Subtract 1 <u>C<sub>4</sub> - C<sub>7</sub></u> |
| 3  | From <u>T<sub>1</sub> - T<sub>6</sub></u> segments  | Subtract 2 <u>C<sub>7</sub> - T<sub>4</sub></u> |
| 4  | From <u>T<sub>7</sub> - L<sub>2</sub></u> segments  | Subtract 3 <u>T<sub>4</sub> - T<sub>8</sub></u> |
| 5  | <u>L<sub>3</sub> - L<sub>4</sub></u> segments       | Opposite <u>T<sub>12</sub></u>                  |
| 6  | <u>L<sub>5</sub></u> and all <u>sacral segments</u> | Opposite <u>L<sub>1</sub></u>                   |

..T3 ✓ نظر 2 lesion ← nipple → T5 segment

lesion: T7 ✓ ← umbilicus → T10 segment

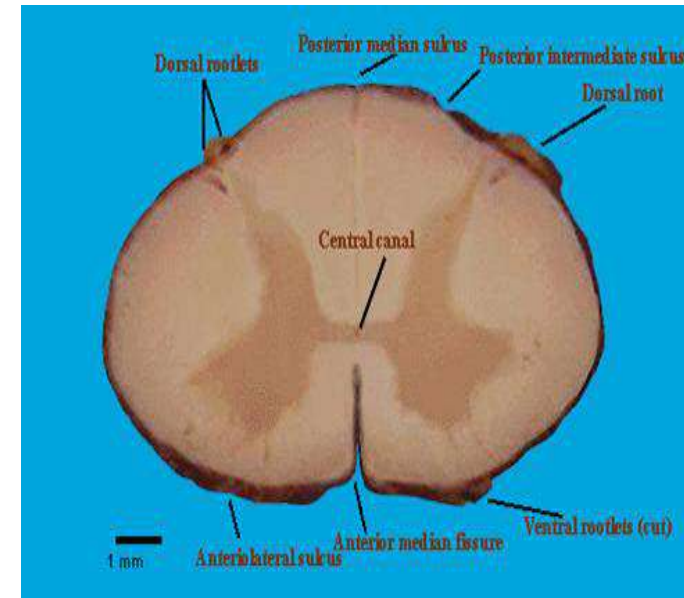
# Relation of Spinal Nerve Roots to Vertebrae



# Internal Structure of the Spinal Cord

❖ A transverse section of the SC is formed of:

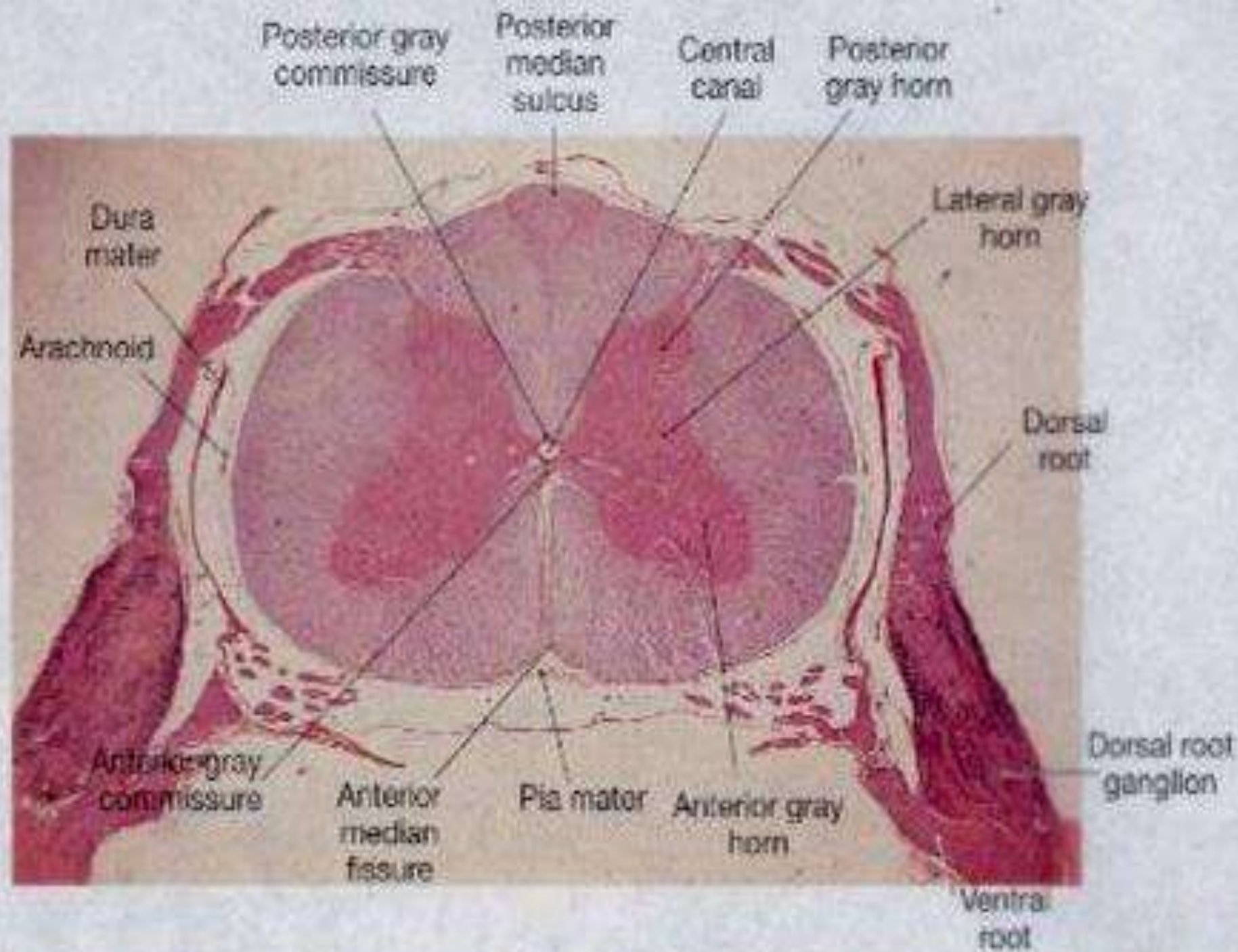
- White matter (outer or peripheral).
- Gray matter (<sup>H shape</sup> inner or central).
- Central canal (1 mm in diameter): is present in gray matter.
  - ← in the gray commissure.
  - in closed MO
  - open and fills by CS.



if there is tumor → central cord syndrome  
in central canal

# The Gray Matter of the Spinal Cord

- **Structure:** it consist of nerve cells.
- **Shape:** the grey matter resembles the letter **"H"** divided into cytoarchitectural areas called **Rexed Laminae** and formed of:
  1. **Anterior horns (right and left):** Consist of motor cells.
  2. **Posterior horns (right and left):** Consist of sensory cells.
  3. **Lateral horns (right and left):** In the thoraco-lumbar segments **"T1-L2"**. They contain sympathetic nerve cells.
  4. **Central canal:** The central canal contains C.S.F. *in the middle of gray commissure.*
  5. **Gray commissure:** anterior and posterior gray commissure.



# The Posterior (Dorsal) Horn Cells

①  
post root → post tract. [touch. sensation] حس اللمس  
[Lissauer] dorsal lateral tract ← [short tract]

- Between the dorsal horn & posterolateral sulcus there is the dorsolateral tract of Lissauer's.  
ملقحة رصير
- The posterior horn cells receives and processes sensory input and **consist of following sensory nuclei:**

### 3. Clarck's nucleus or posterior thoracic nucleus:

- Found at the medial side of the **C8-L2** segments of the spinal cord.
- Carries unconscious proprioception to dorsal spinocerebellar tract → inferior cerebellar peduncle.  
*of lower limb*  
*bind with MO*  
*pons - الأذن الوسطى middle cereb. peduncle*

### 4. Scattered nuclei:

- Found at the **L3-S2** segments of the spinal cord.
- Carries unconscious proprioception to ventral spinocerebellar tract → superior cerebellar peduncle.  
*bind with Brain Stem*

# The Posterior (Dorsal) Horn Cells

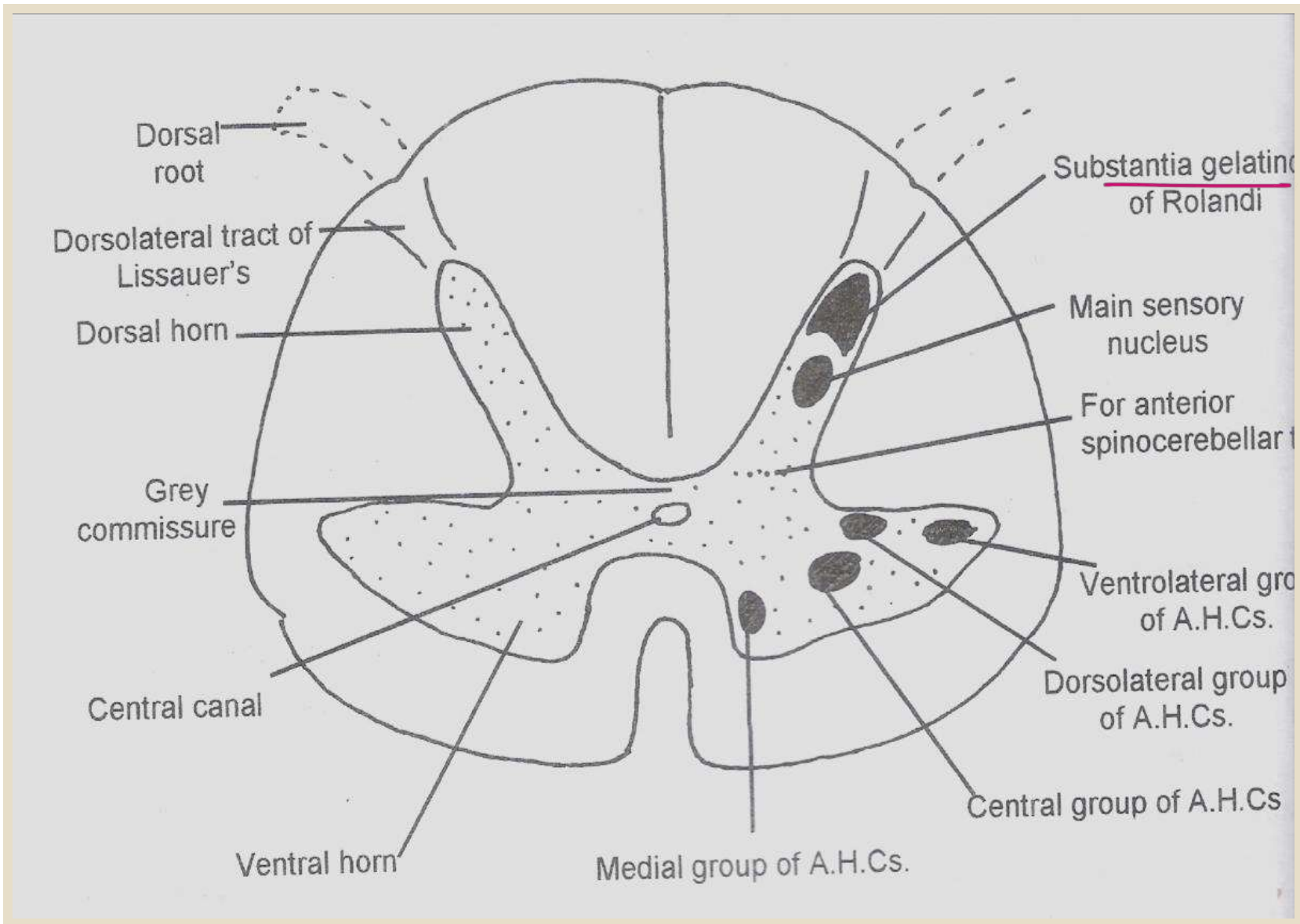
## 1. Substantia gelatinosa of Rolandi:

- Found at all cord levels.
- For pain & temperature sensations.

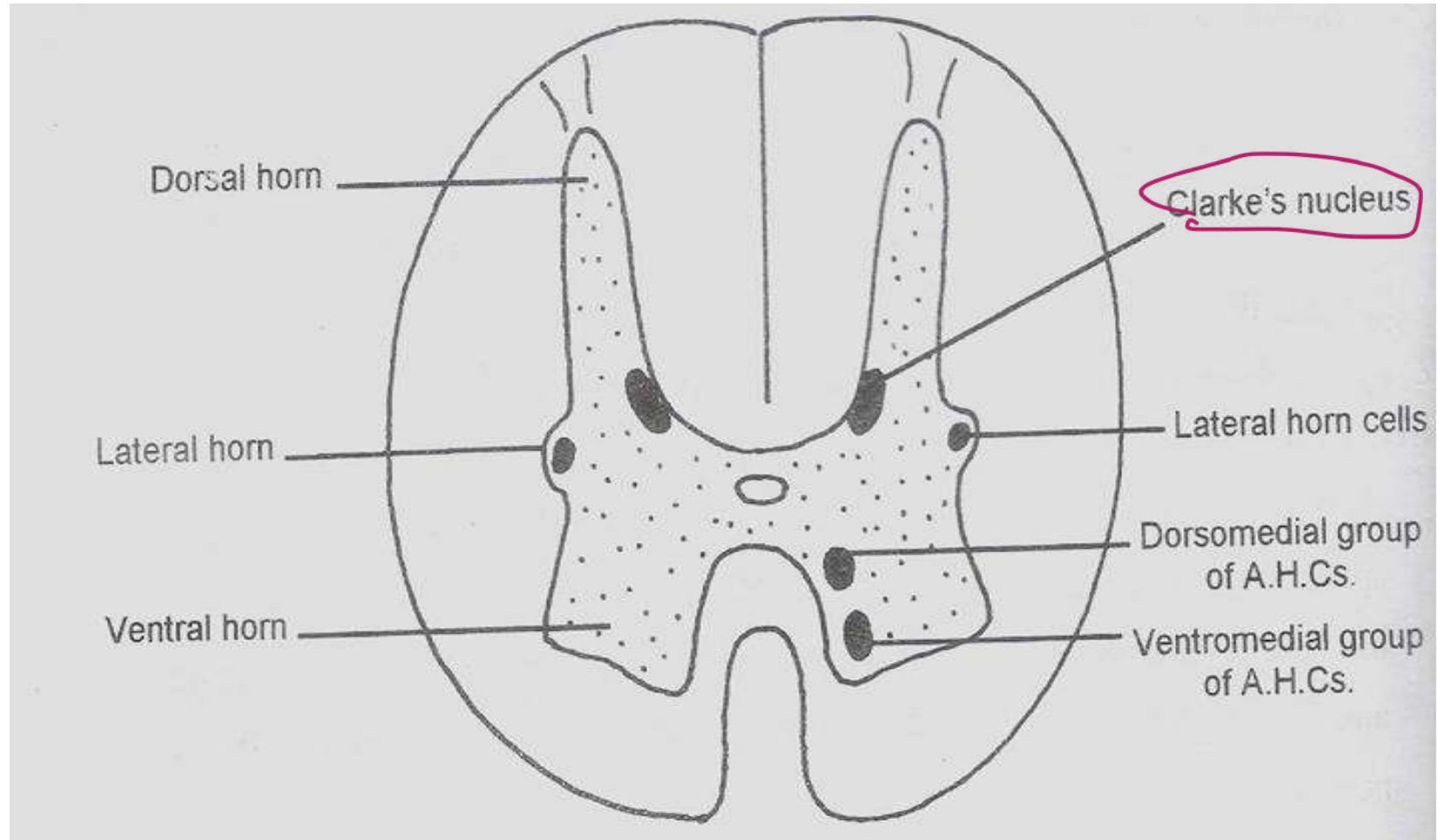
## 2. The main sensory nucleus or nucleus Proprius:

- Found at all cord levels.
- For crude “light” touch sensation.

# The Gray Matter of the Spinal Cord



# The Gray Matter of the Thoracic SC



# The Anterior (Ventral) Horn Cells

*↳ motor*

**The anterior horn cells contain the following nuclei:**

## A. Medial group:

- Lies in the whole SC.
- In the thoracic segments, divided into ventromedial and dorsomedial groups.
- **They supply muscles of the trunk.** *[motor] and abdomen.*

## B. Lateral group (ventrolateral & dorsolateral):

- Present in lower cervical, lumbar and upper 2 sacral region.
- **They supply upper and lower limb muscles.** *motor*

## C. Central group:

### 1. Spinal accessory nucleus:

- Lies in the upper cervical region "C1 - C6".
- Their axons form the spinal accessory nerve.
- Innervates the sternocleidomastoid and trapezius.

C4  
C1/C5

\* in anterior horn  
cell.

### 2. Phrenic nucleus:

- Extends from C3 to C6.
- Their axons form the phrenic nerve.
- Innervate the diaphragm.

C3/C4

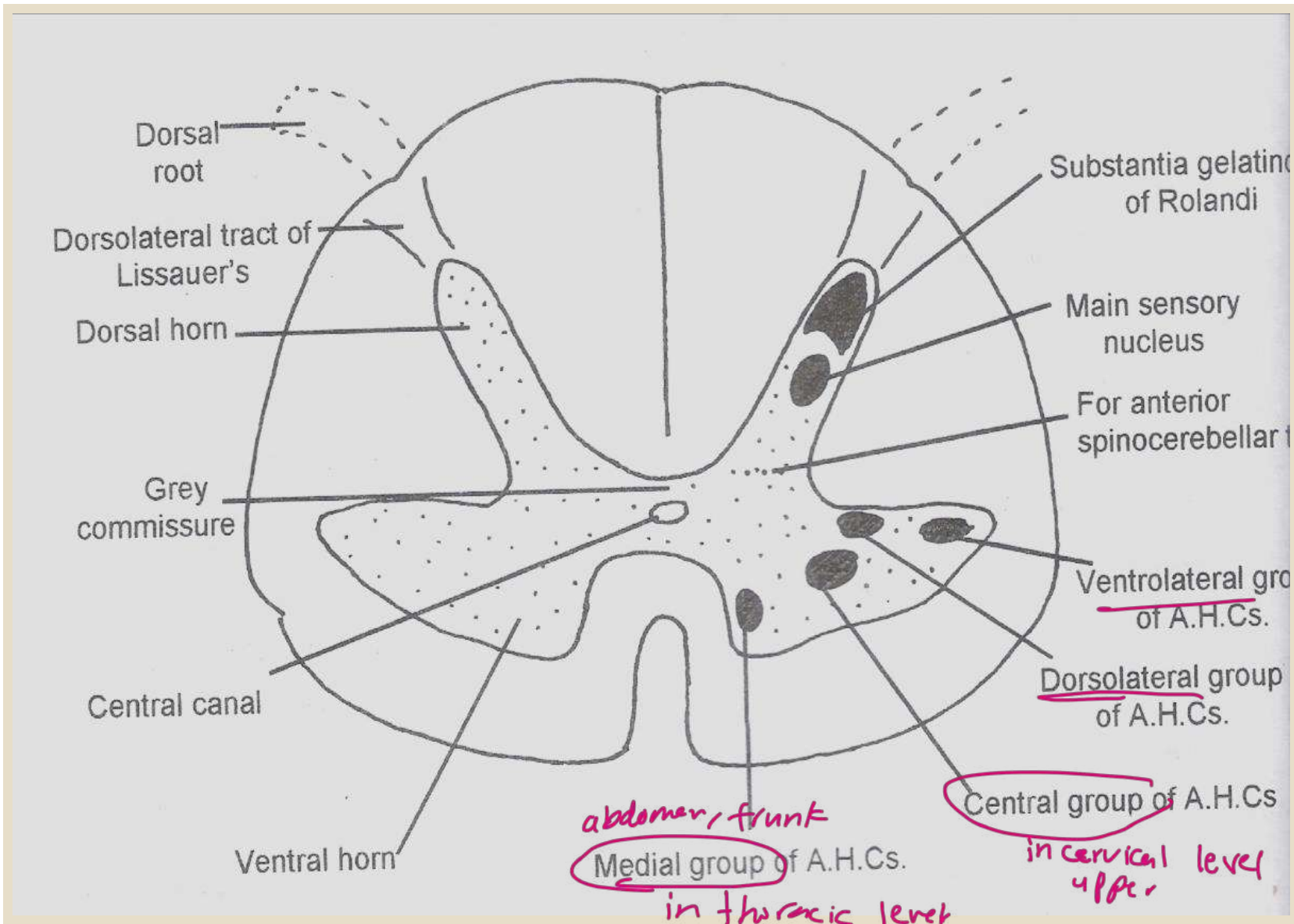
\* high level injury of SC  
[above C3/C4]  
lead to resp. failure  
and need mechanical  
ventilation

ورعق له رحت ال C4 مارا ز يوتي  
في حنط بال diaphragm

## D. Sacral parasympathetic nuclei:

- Extends from S2 to S4. [motor]
- Gives rise to preganglionic parasympathetic fibers that innervate the pelvic viscera via the pelvic splanchnic nerves

# The Gray Matter of the Cervical SC

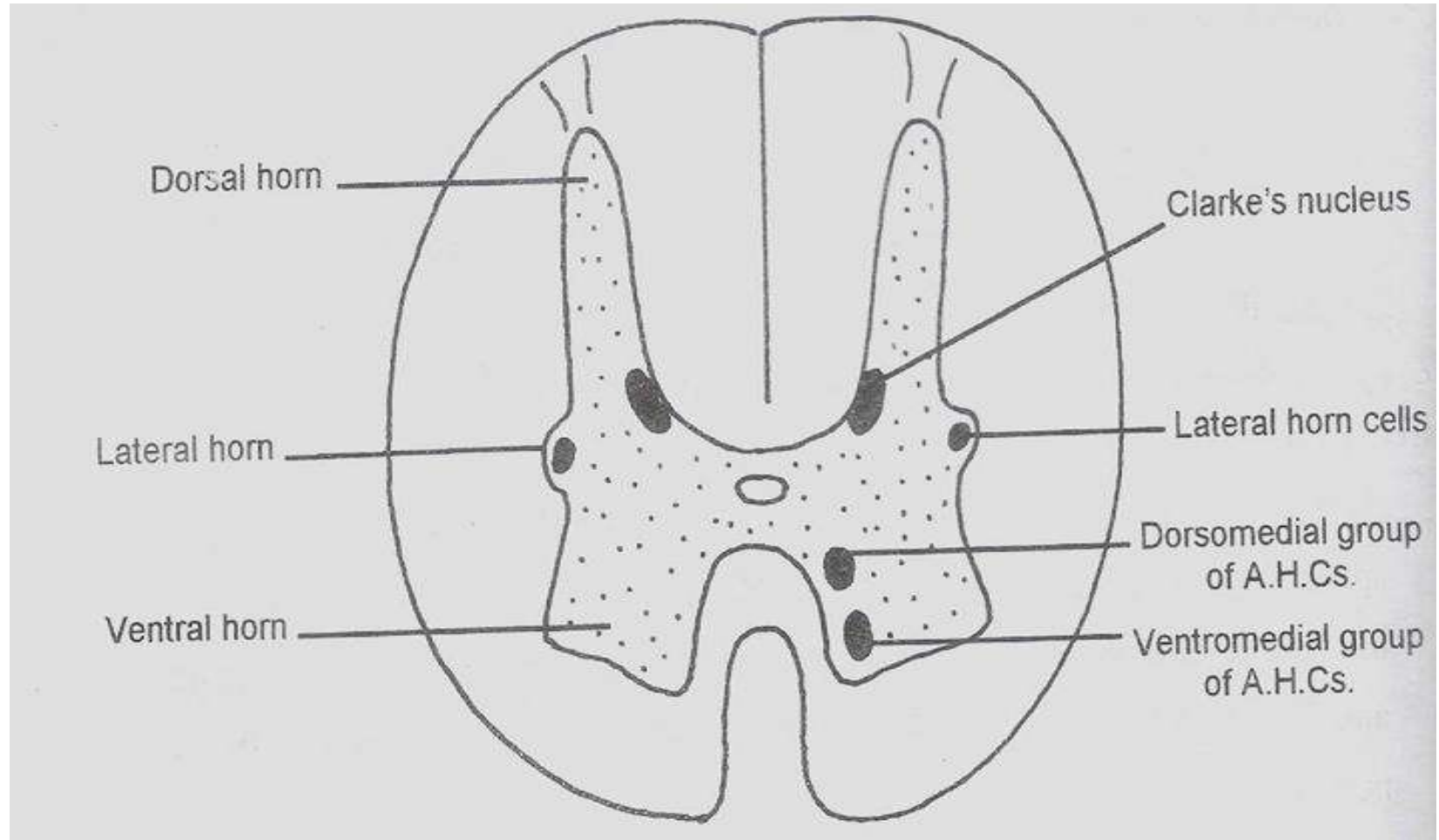


# \* The Lateral Horns

↳ first order cell of sympathetic  
(at. horn 1st 2nd 3rd)

- Receives viscerosensory input.
- Found between the posterior and anterior horns of “**T<sub>1</sub>-**”  
**L<sub>2</sub>”** segments of the spinal cord.
- Contains the intermediolateral nuclei “preganglionic sympathetic neurons”.  
relay in sympathetic..
- At “**T<sub>1</sub>-T<sub>2</sub> or C<sub>8</sub>-T<sub>2</sub>**” level located the **Cilio-spinal center of Budge** (sympathetic innervation of the eye).

# The Gray Matter of the Thoracic SC



# Neurons of the Gray Matter

A. Sensory neurons: in the posterior horns.

B. Motor neurons: in the anterior horns. *(para symp.)*  
*symp. → lateral.*

- **Alpha motor neurons**: give rise to large type A alpha  
(A $\alpha$ ) motor nerve fibers for stimulation the muscle fibers.  
*M. contraction*

- **Gamma motor neuron**: transmit impulses through much  
smaller type A gamma (A $\gamma$ ) motor nerve fibers for control  
*regulate*  
muscle tone.

C. Interneurons “Intermediate”:

- In the intermediate areas between the ventral and dorsal horns.

- **Function**: integrative functions of the SC (reflexes center).

# The White Matter of the Spinal Cord

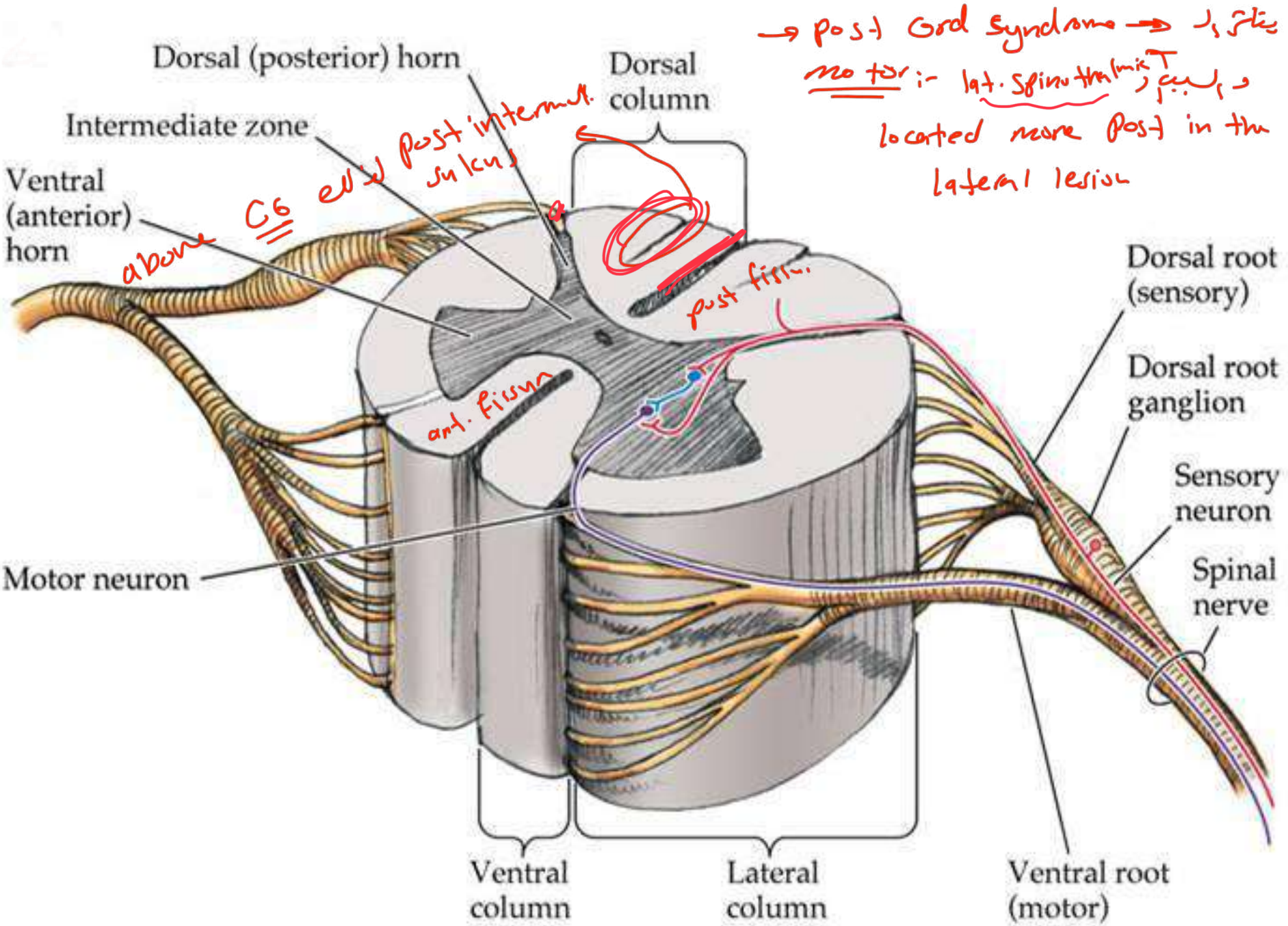
- The white matter surround the gray matter and contains ascending and descending tracts.

- It is divided into three column (fasciculus) of SC on each side:

1. <sup>ventral</sup> Anterior column (AC): lying between the anterior median fissure & the attachment of <sup>exit</sup> anterior spinal root “anterolateral sulcus”.

2. <sup>dorsal</sup> Posterior column (PC): lying between the posterior median fissure & the attachment of <sup>post</sup> dorsal spinal root <sup>enter</sup> [sensory].

3. Lateral column (LC): lying between attachment of <sup>ant</sup> anterior and posterior spinal roots. <sup>exit</sup> <sup>enter</sup> <sup>largest</sup> <sup>there is Lat. Corticospinal tract and lat. Spinothalamic tract</sup> <sup>post</sup>



→ post- horn syndrome → متلازمة القرن الخلفي  
motor: lat. Spinothalamic tract  
located more posterior in the lateral lesion

Dorsal (posterior) horn  
Intermediate zone  
Ventral (anterior) horn  
above C6

Dorsal column  
post. interm. sulcus  
ant. fissure  
post. fissure

Dorsal root (sensory)  
Dorsal root ganglion  
Sensory neuron  
Spinal nerve

Motor neuron

Ventral column  
Lateral column  
Ventral root (motor)

# Structure of White Mater

The white mater contains 3 types of nerve fibers (tract):

## 1. Ascending tracts of the SC:

Carrying sensory impulses from the SC to the brain:

e.g. Lateral Spinothalamic Tract.

## 2. Descending tracts of the SC:

Carrying motor impulses from the brain to the SC:

e.g. Corticospinal Tract.

## 3. Associative tracts:

Containing short ascending & descending fibers which coordinate the function of the different regions of spinal cord.

2 part 1 association fibers  
Rt Lt

projection  
function

**Also the tracts are divided into:**

**1. Short Tracts:**

- They begin and end in the spinal cord.
- They are found close to the gray matter.
- They are associative in function.

**2. Long Tracts:** *projection fibers*

- Ascending tracts.
- Descending tracts.

# I. Ascending Tracts

↳ Sensory.

[Continuous proprioception, touch...]

- Represent functional pathways that convey sensory information from the periphery to higher levels.
- Usually consist of a chain of **three order neurons**.
- The first-order neuron is always in **the spinal**

**ganglion.** 3 neurons :-

- ① In post. root ganglion [first order neurons]
- ② in spinal or substantia nigra [2nd order neuron]
- ③ in thalamus [3rd order neuron]

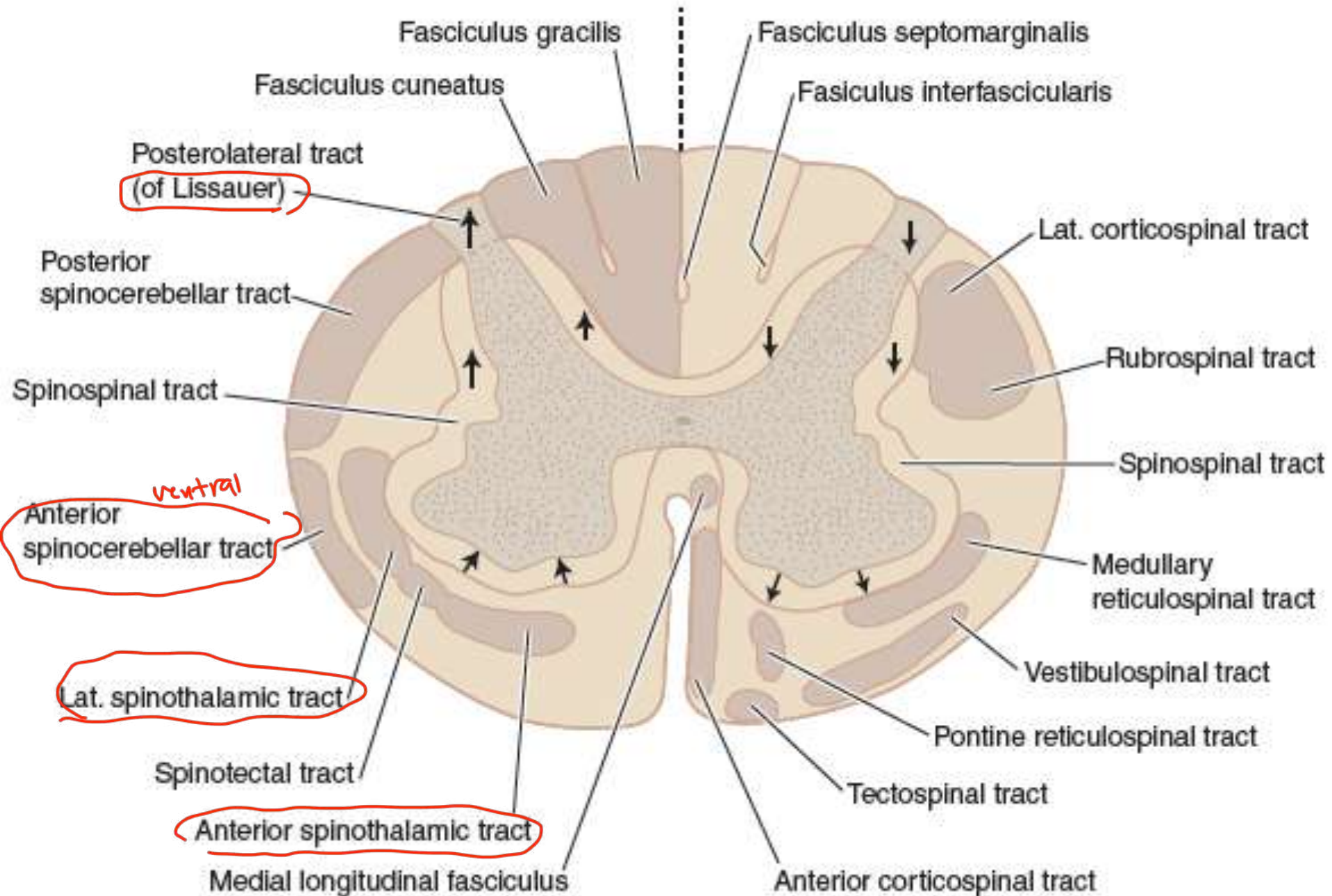
# Ascending Tracts of the Spinal Cord

1. **Gracile tract (PC)**: for proprioception & fine touch from lower half of the body.
2. **Cuneate tract (PC)**: for proprioception & fine touch from upper half of the body.
3. **Lissaurer's tract**: for pain and temperature sensation, lies between the tip of the posterior horn & posterior lateral sulcus.
4. **Dorsal spinocerebellar tract (LC)**: carries proprioceptive fibers from **Clarck's nuclei** to the inferior cerebellar peduncle.
5. **Ventral spinocerebellar tract (LC)**: carries proprioceptive fibers from **spinal border cells** to the superior cerebellar peduncle.

- 
6. **Lateral spinothalamic tract (LC)**: for pain and temperature pathway.
  7. **Ventral spinothalamic tract (AC)**: for crude touch.
  8. **Spinotectal tract (LC)**: arises from the posterior horn & ends in the superior colliculus (spinovisual reflexes).
  9. **Spino-olivary tract (LC)**: carries proprioceptive impulses to accessory olivary nuclei in the medulla.

## Ascending tracts

## Descending tracts



## Ascending tracts

Fasciculus gracilis

## DORSAL COLUMNS

Fasciculus cuneatus

Dorsal  
spinocerebellar  
tract

Fasciculus  
proprius

Ventral  
spinocerebellar  
tract

Internal

Ventral  
part

Spinothalamic tract  
& Spinoreticular tract

I am Sorry !!!!!

## Descending tracts

Medial longitudinal fasciculus

Lissauer's tract

Lateral corticospinal  
tract

Rubrospinal tract

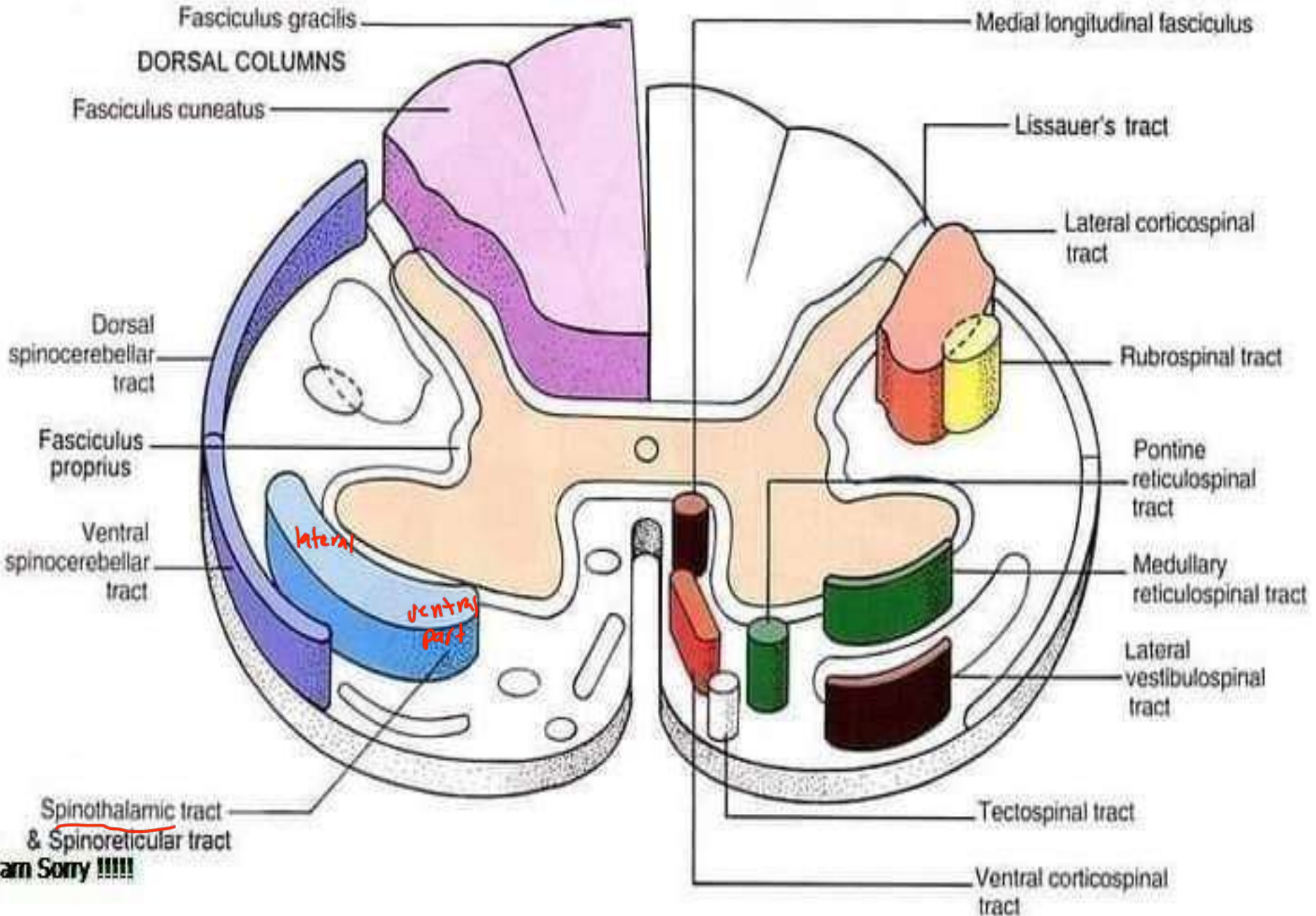
Pontine  
reticulospinal  
tract

Medullary  
reticulospinal tract

Lateral  
vestibulospinal  
tract

Tectospinal tract

Ventral corticospinal  
tract



# A. Anterolateral System

*↳ anterio lateral spinothalamic tract.*

## 1. Lateral spinothalamic tract:

- Mediates pain, and temperature sensations.
- Receives input from free nerve endings and thermal receptors.
- Receives input from A-delta and C fibers.

## 2. Anterior spinothalamic tract:

- Concerned with crude touch sensation. *non discriminating touch.*
- Receives input from free nerve endings and from Merkel tactile receptors.

# Lateral Spinothalamic Tract

## “Pathway of Pain and Temperature Sensations”

### 1. The first order neuron:

Found in **the posterior root spinal ganglion** at all levels.

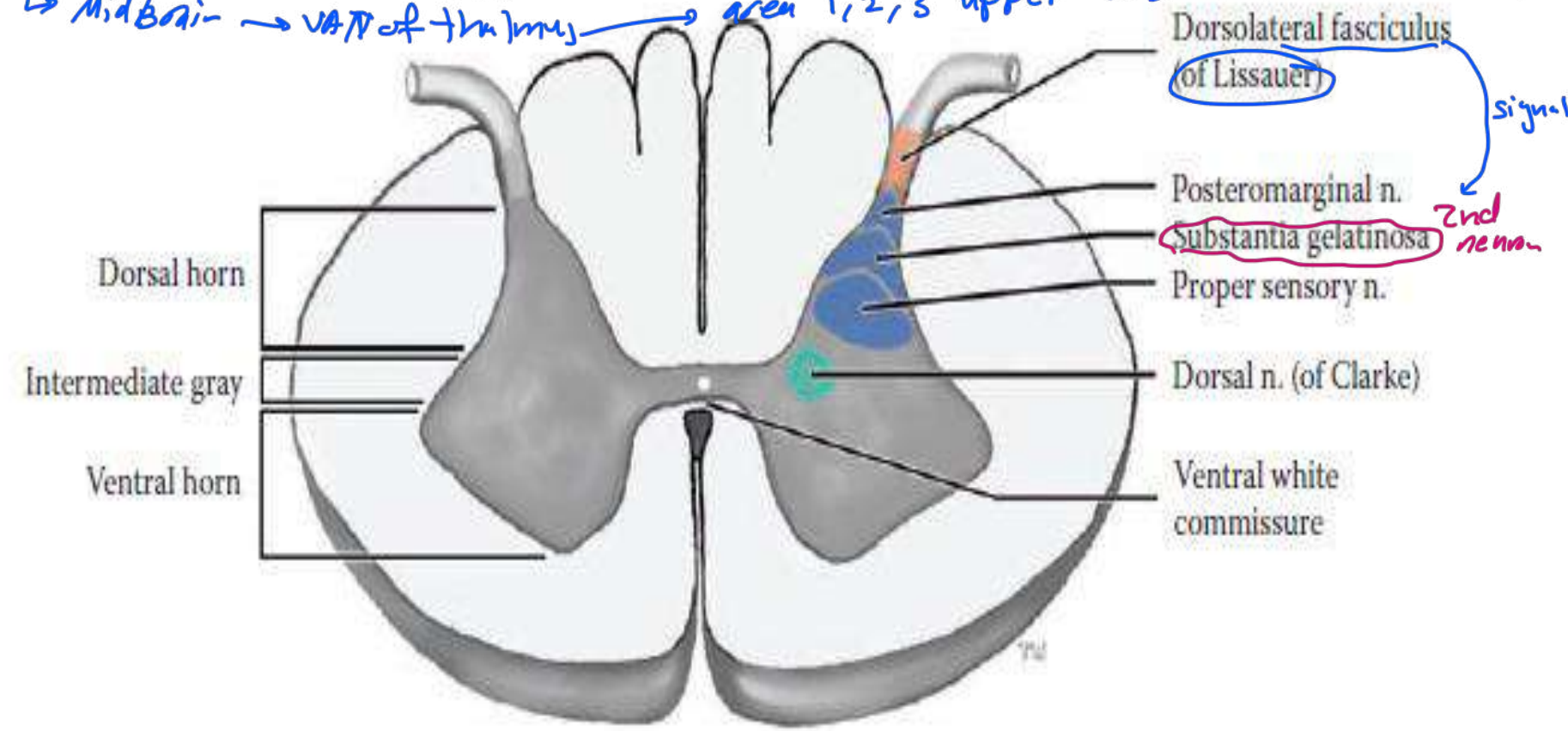
The process divided into:

- **The lateral branch (Dendrite):** goes peripherally forming the afferent sensory nerve (the ends of this nerve are receptors of the skin). *for the cell body.*
- **The medial branch (Axon):** enters the spinal cord, forming **Lissauer's tract** and make synapse with second order neurons in the **posterior horn cells** “**Substantia Gelatinosa of Rolandi**”.

first order neuron [post spinal root] → dendrite signal from R. to cell Body of first order neuron.  
 uni polar, pseudo uni polar → axon post spinal root dorsal  
 Bi polar in one process

Lissauer T. [S. G. R] 2nd neuron → signal 1st neuron

Pons → LSTT → cross to opposite side → white ventral commissure.  
 → Midbrain → more anterior → VAMP of the [unclear] → area 1, 2, 3 upper 2/3 of post lateral gyrus



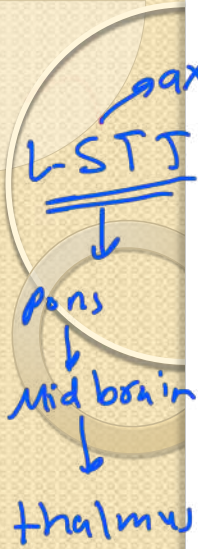
# Lateral Spinothalamic Tract

## 2. The second neuron: in post horn cell

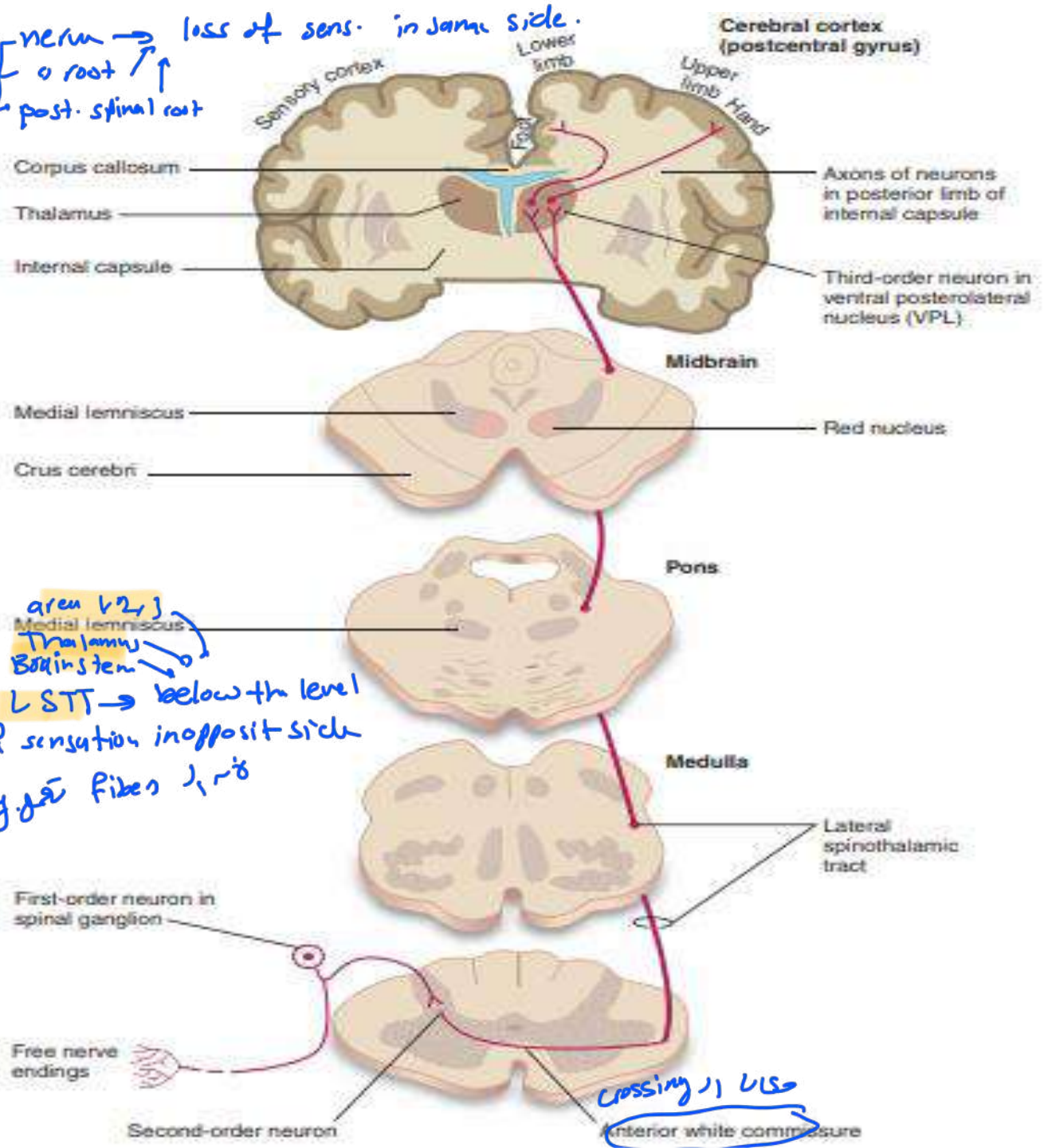
Is the cells of **Substantia Gelatinosa of Rolandi** and its axon. This axon crosses to the opposite side cross the midline in the **ventral white commissure**, usually **within two to three segments** above the level of entry of the peripheral fibers and ascends in the lateral column of the SC as the **lateral spinothalamic tract** → medulla oblongata → the pons → the mid brain → to relay the sensory impulse at the VPL nucleus of thalamus. *3rd order neuron.*

## 3. The third order neuron: thalamo cortical pathway.

Starts in the cells of **the ventral posterolateral nucleus (VPL) and intralaminar nuclei of the thalamus**, its axon ascends to pass through the posterior limb of the internal capsule conducting the impulse to the cortical **somatic sensory area (1, 2, 3)** in the upper 2/3<sup>rd</sup> of the postcentral gyrus of the parietal lobe.



→ injury of nerve → loss of sens. in same side.  
 ↳ root ↑  
 ↳ post. spinal root



area 1, 2, 3  
 Medial lemniscus  
 Thalamus  
 Brainstem  
 → injury in LSTT → below the level  
 loss of sensation in opposite side  
 crossing of fibers 1/2

5

The anterolateral tract terminates in the VPL of the thalamus. From the thalamus, fibers project through the internal capsule and corona radiata to terminate in the primary somatosensory cortex (postcentral gyrus).

4

In the pons and midbrain, the anterolateral tract lies lateral to the medial lemniscus.

3

In the rostral medulla, the anterolateral tract lies between the inferior olivary nucleus and the nucleus of the spinal tract of the trigeminal nerve.

2

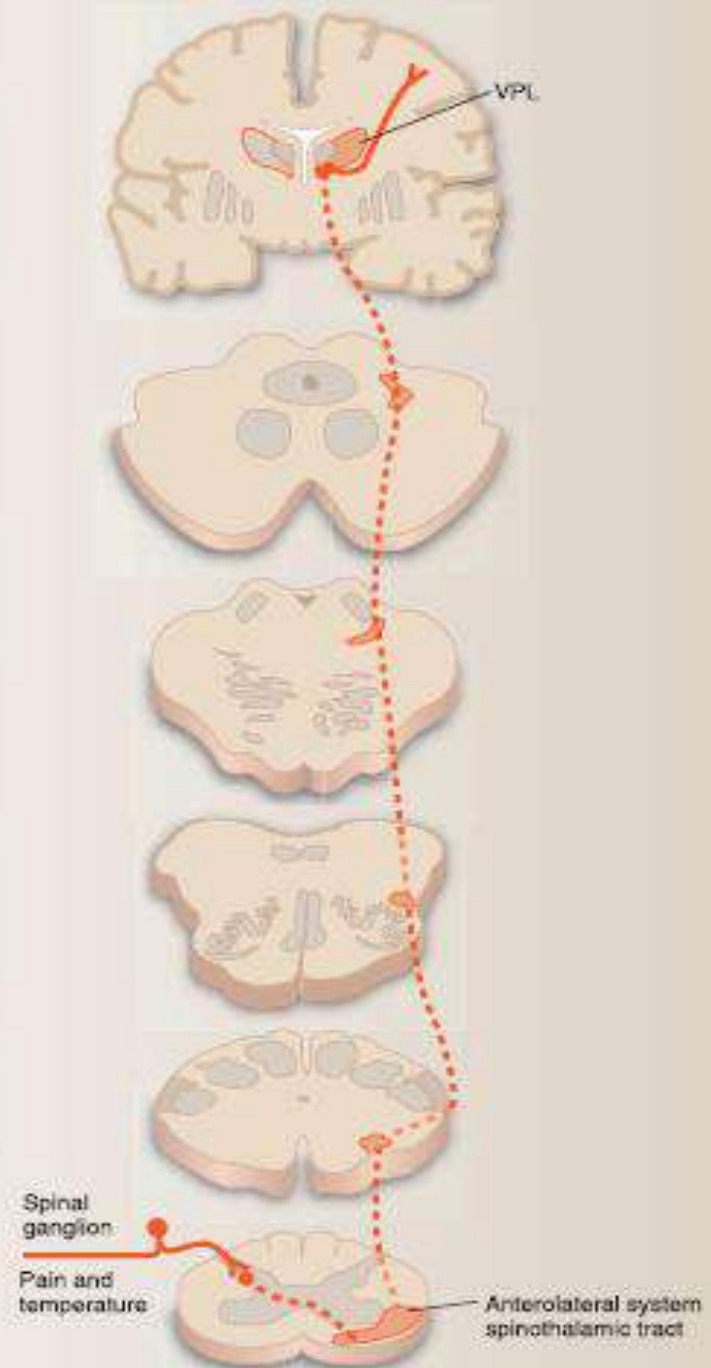
Anterolateral tract in the caudal medulla.

1

Axons enter the spinal cord from the spinal ganglia, travel up or down 1–2 segments in Lissauer tract, and then synapse in the posterior horn.

Axons of secondary neurons cross the midline in the anterior white commissure and ascend as the anterolateral tract in the spinal cord.

→ if the crossing in the Brain symptoms in the same side



# Anterior Spinothalamic Tract

## “Pathway of Crude Touch Sensation”

فصل پنج (۱) Pain حساسات استاندارد

- Has the same pathway as lateral spinothalamic tract but the second order neuron is <sup>2nd neuron</sup> **main sensory nucleus** in posterior horn cells. <sub>حس در SGR</sub>
- The axons crosses to the opposite side through the white ventral commissure and ascends in the ventral column of the spinal cord as the **Ventral Spinothalamic Tract.** <sub>حس در ۱۲+</sub>
- Found in the **VPL nucleus** of the thalamus.

in Brain stem

**N.B.** The spinal lemniscus = lateral spinothalamic tract + ventral spinothalamic tract <sub>injury loss pain [crude] sensation</sub>

# Lesions of the Anterolateral System

- **Lesions to the posterior horn cells:** Ipsilateral at the same level loss of pain and temperature, and nondiscriminative forms of touch sensations.
- **Lesions to the anterolateral spinothalamic tract:** Contralateral loss of pain and temperature, and nondiscriminative forms of touch sensations below the level of lesion.
- **Lesions thalamus and postcentral gyrus:** Contralateral loss of pain and temperature, and nondiscriminative forms of touch sensations.

## B. Posterior Column Medial Lemniscus System

- The posterior column-medial lemniscus system carries general somatic afferent (general sensory) information about **discriminative “Fine” touch, pressure, vibration and conscious proprioception**.  
*fine touch, proprioception - [conscious]*  
*حسّ دقيق، اعين على (أجزاء)*
- Receives input from Pacinian and Meissner's corpuscles, joint receptors, muscle spindles, and Golgi tendon organs.
- Transmitted through the fast-conducting large-diameter fibers **(A-Beta fibers)**.

# Pathway of Posterior Column Medial Lemniscus System

## 1. The first order neuron:

\* the signal from joint, tendon... etc  
gray matter نَبَضْ fiber ١٠

Found in **the posterior root spinal ganglion** at all levels.

The process divided into:

- **The lateral branch (Dendrite):** goes peripherally forming the afferent sensory nerve (the ends of this nerve are receptors of the tendon).
- **The medial branch (Axon):** enters the SC and ascends directly in the Gracile and Cuneate tracts "Fasciculus" within the posterior column at the same side to relay in the

[LL] medial lateral [UL]  
Gracile and Cuneate nuclei of the medulla.

crossing ٢٠ ٢٠ axon ١٠ ١٠ 2nd neuron ١٠  
↳ medial lemniscus.

[any damage  
above mo  
↓  
loss ipsilateral]

# Pathway of Deep Sensation

## 2. The second neuron:

- Is the cells of **the Gracile and Cuneate nuclei** in the medulla→ give rise to axons, **internal arcuate fibers** that decussate to the opposite side of the medulla oblongata ascends as **Medial Lemniscus through** → the pons → the mid brain → to relay in the “PLV” nucleus of thalamus.

## 3. The third order neuron:

Starts in the cells of **the posterolateral ventral nucleus (PLV) nucleus of the thalamus**, its axon ascends to pass through the posterior limb of the internal capsule conducting the impulse to the cortical somatic sensory area (1, 2, 3) in the upper 2/3<sup>rd</sup> of the postcentral gyrus of the parietal lobe.

**6**

The medial lemniscus terminates in the VPL of the thalamus. From the thalamus, fibers project through the internal capsule and corona radiata to terminate in the primary somatosensory cortex (postcentral gyrus).

**5**

As the medial lemniscus continues to ascend through the rostral pons and midbrain, it moves laterally and becomes more vertical.

**4**

In the caudal pons, the medial lemniscus flattens horizontally.

**3**

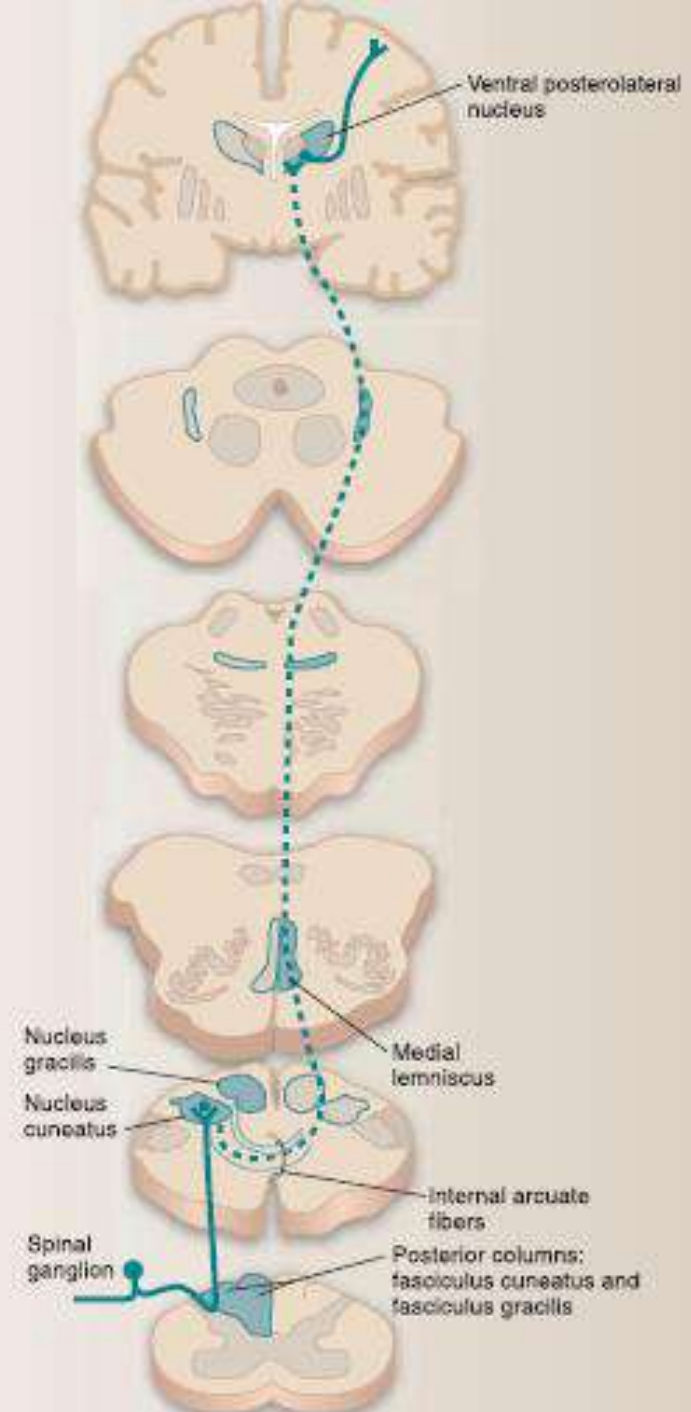
In the rostral medulla, the fibers travel as the medial lemniscus adjacent to the midline.

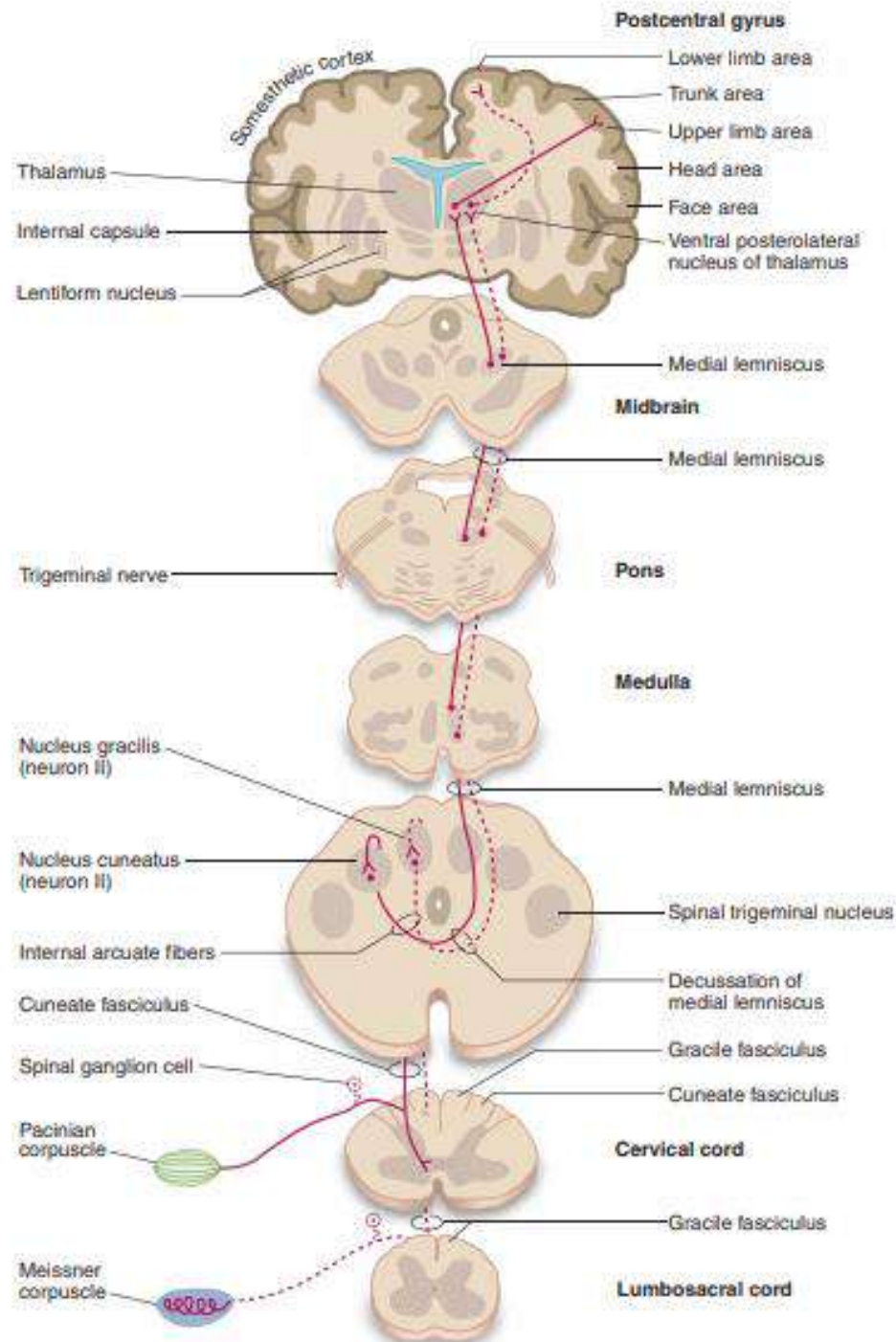
**2**

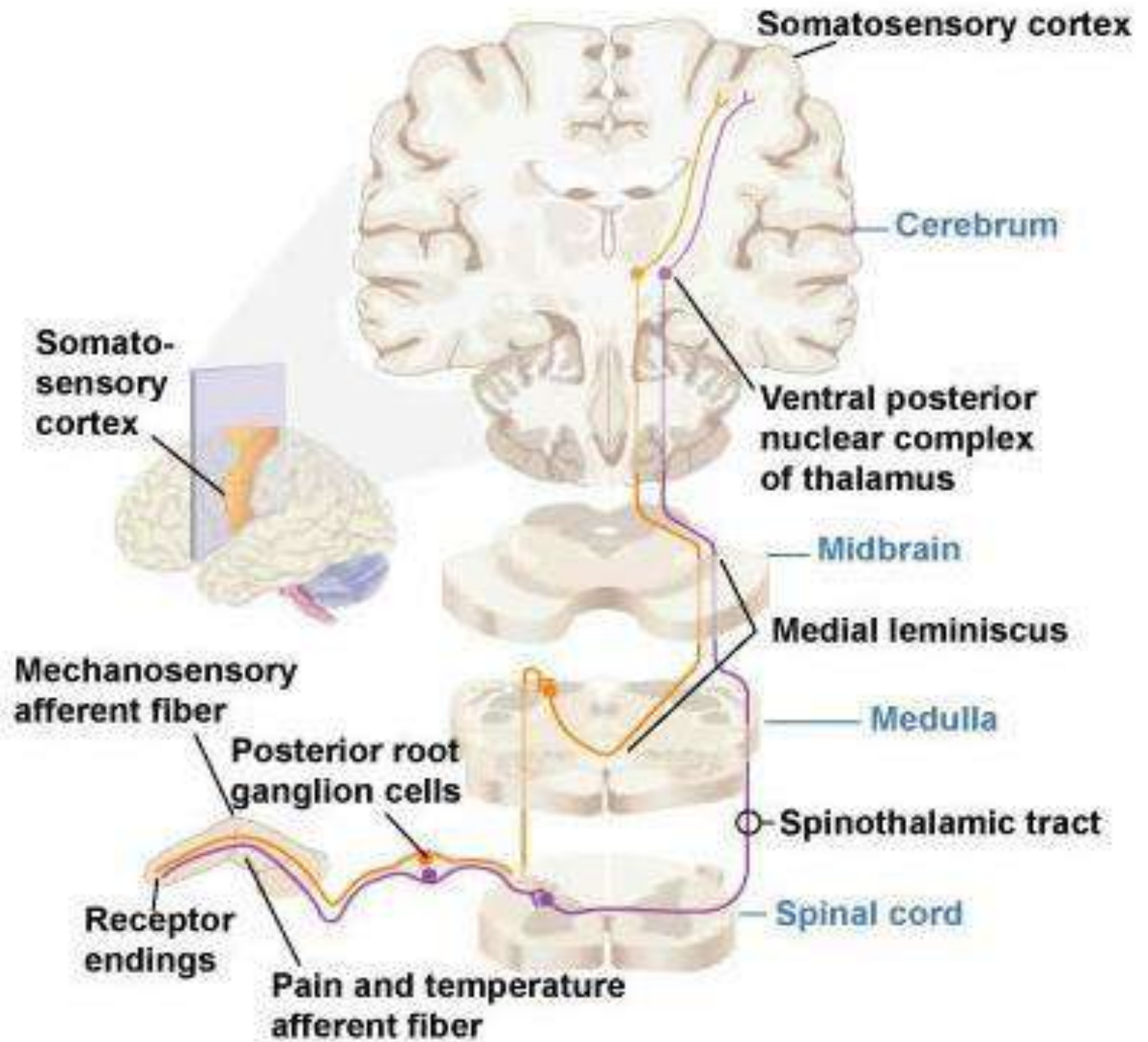
They terminate in nucleus gracilis and nucleus cuneatus. From these nuclei, axons of secondary neurons cross the midline as internal arcuate fibers and form the medial lemniscus.

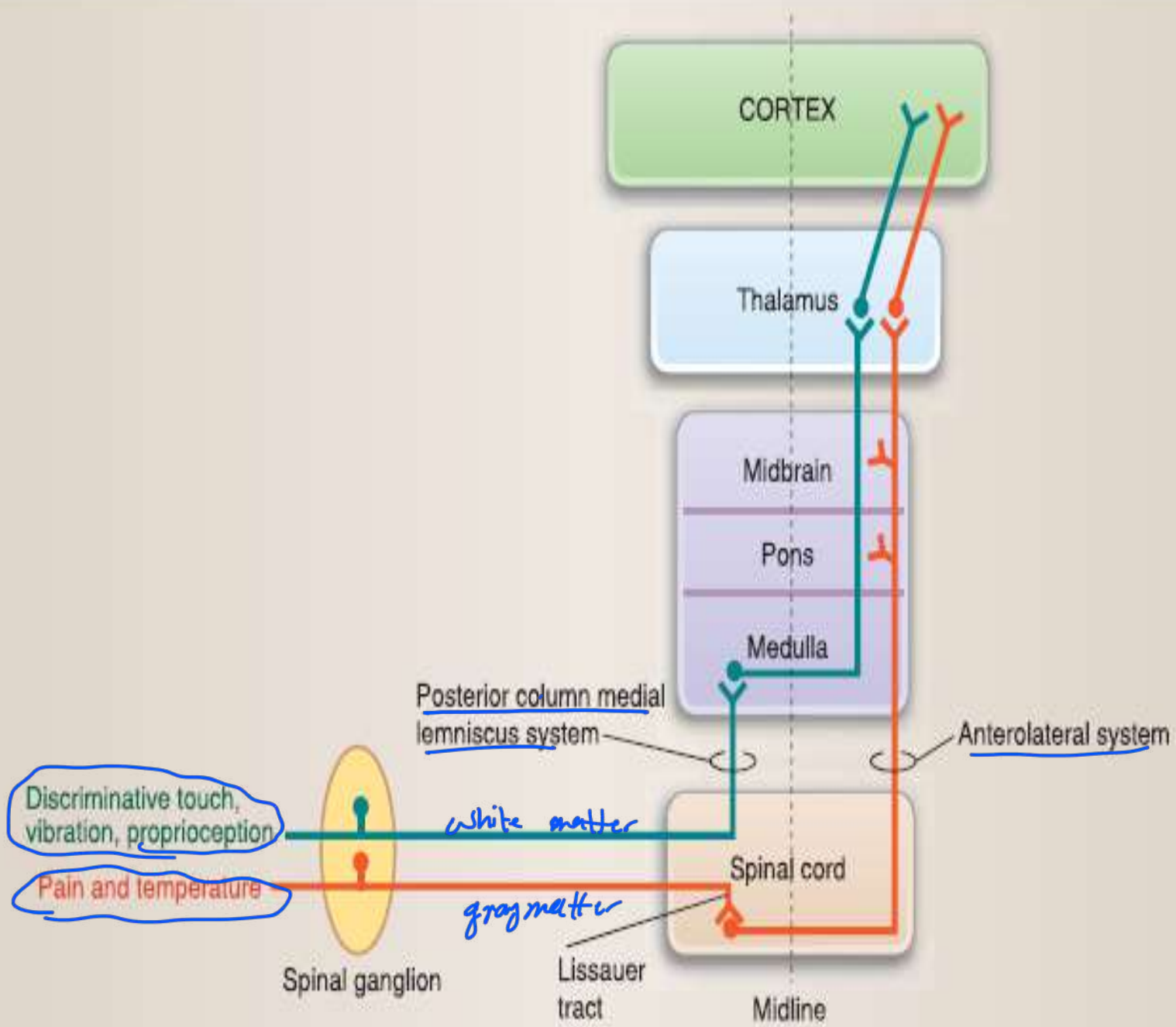
**1**

Axons enter the spinal cord from the spinal ganglia and pass directly to ipsilateral posterior column. Caudal fibers (up to and including T6) enter fasciculus gracilis (medial) and rostral fibers (above T6) enter fasciculus cuneatus to ascend.









# Lamination of the Gracile and Cuneate Tracts

- ❖ **The Gracile Tract:** *fine touch of LL / proprioception.* lies more medially and received impulses from the lower part of the body (the lower limbs and lower half of the trunk).
- ❖ **Cuneate Tract:** *UL fine touch / proprioception.* lies more laterally and received impulses from the upper part of the body (the upper limbs and upper half of the trunk).
- ❖ **From medial to lateral side:** sacral nerve fibers → lumbar nerve fibers → thoracic nerve fibers → cervical nerve fibers.

# Lesions of the Posterior Column Medial Lemniscus System

- **Lesions to the posterior columns:** Ipsilateral loss of discriminative touch, pressure, vibration and conscious proprioception “Sensitive Ataxia”.  
*neuron syphilis / spinal root syndrome / B12 deficiency* *لا يفقد عمود اليمين فقط بل يفتح مثل*
- **Lesions to the medial lemniscus, thalamus and postcentral gyrus:** Contralateral loss of discriminative touch, pressure, vibration and conscious proprioception “Sensitive Ataxia”.

*damage of R+ spinal cord → loss proprioception Rt  
↳ loss fine touch lf.*

# C. Spinocerebellar Tracts

## 1. Posterior spinocerebellar tract:

- Transmits unconscious proprioceptive information to the cerebellum.
- Receives input from muscle spindles, Golgi tendon organs, and pressure receptors.
- Carries unconscious proprioceptive information from ipsilateral lower extremity and trunk.
- An uncrossed tract.

## 2. Anterior spinocerebellar tract:

- Transmits unconscious proprioceptive information to the cerebellum.
- Carries proprioception from the lower limb to the cerebellum.
- Receives input from muscle spindles, Golgi tendon organs, and pressure receptors.

- A crossed tract.

*in spinal cord.*

*Rt → If the from cerebellum (L → Rt) double crossing. so the symptoms in the same side*

## 3. Cuneocerebellar tract:

- The upper-extremity equivalent of the posterior spinocerebellar tract.

# 1. Posterior Spinocerebellar Tract

## “Flechsig’s Tract”

### a. First-order neurons:

- Found in the **posterior spinal root ganglia**. *C8-L3*
- Project in the posterior thoracic nucleus “Clarck’s *Segm.* nucleus”. *no practical relay in thalamus.*

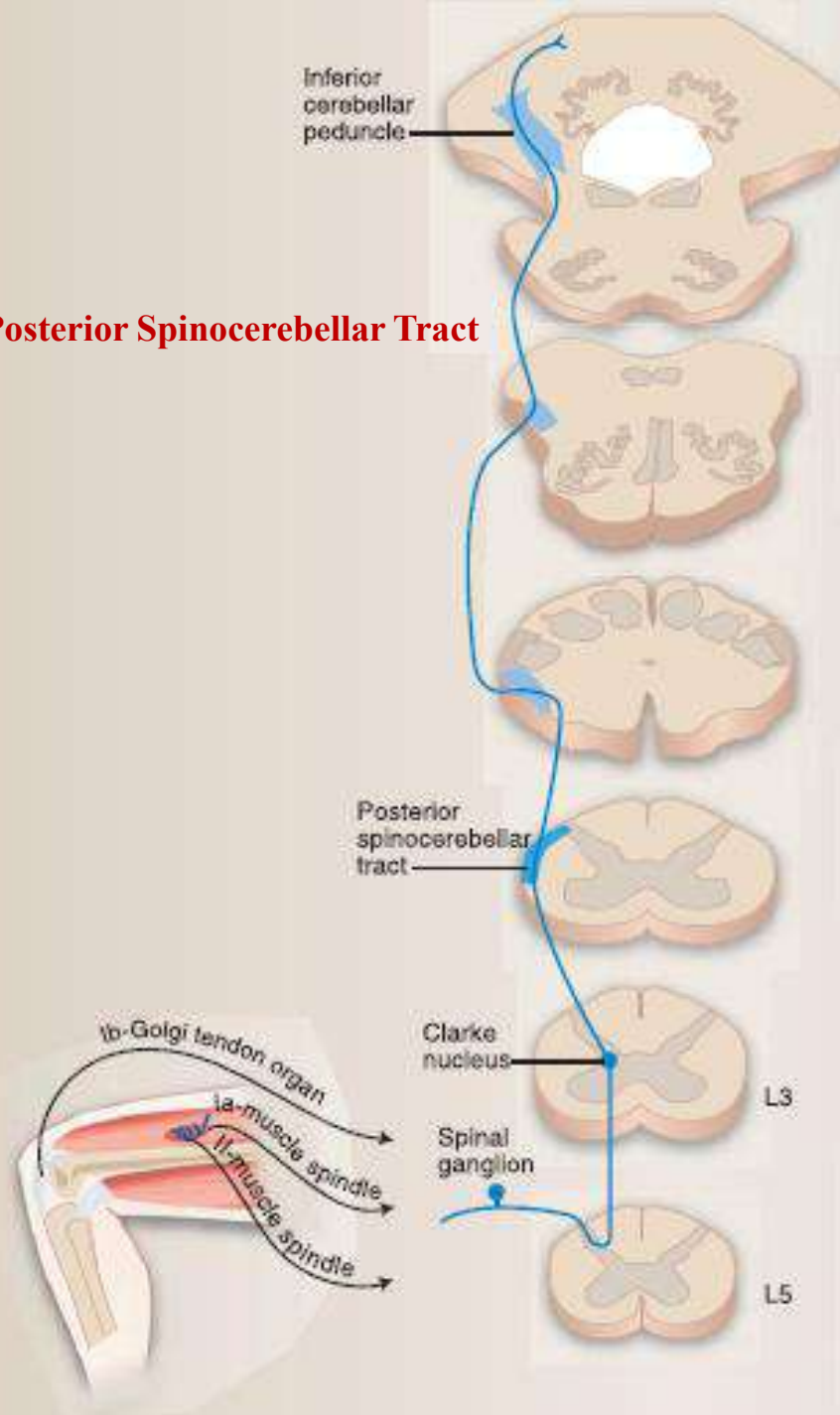
### b. Second-order neurons:

- Found in **the posterior thoracic nucleus** “Clarck’s nucleus” of (C8–L3). *segment*
- Give rise to axons that ascend in the lateral funiculus and reach the cerebellum via **the inferior cerebellar peduncle** ipsilateral. *no crossing. then to cerebellum.*

**Lesion:** Ipsilateral lower limb discoordination “Ataxia”. The patient has difficulty performing the heel-to-shin test.

unconscious proprioception

## Posterior Spinocerebellar Tract



**3**

In the rostral medulla **posterior spino-cerebellar fibers** travel through the inferior cerebellar peduncle to the ipsilateral cerebellum, mainly to the anterior lobe and the vermis.

**2**

Fibers then travel in the **posterior spino- cerebellar tract** through the spinal cord and brainstem.

**1**

Proprioceptive information from muscle spindles and Golgi tendon organs (Ia, Ib, and II fibers) and from skin enters the spinal cord. Fibers travel in the fasciculus gracilis until they reach L3 where they synapse in the Clarke nucleus. The Clarke nucleus extends from L3 to C8.

## 2. Anterior Spinocerebellar Tract

### a. First-order neurons:

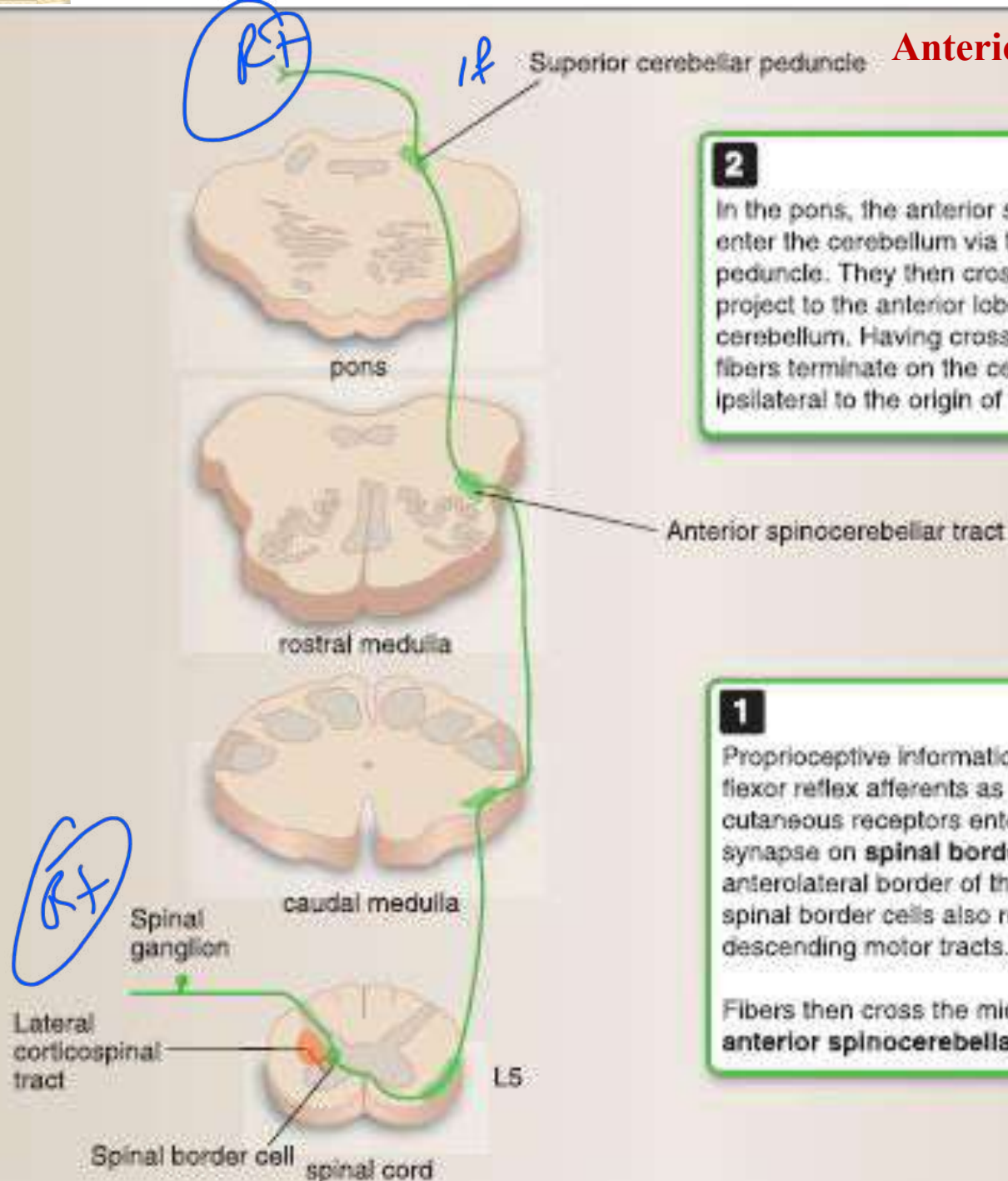
- Found in the **posterior spinal root ganglia**.
- Project in the posterior horn cells and make synapse with the spinal border cells. L1-S2

### b. Second-order neurons:

- Found in **the spinal border cells** of anterior horns (L1–S2).
- Give rise to axons that decussate in the anterior white commissure and ascend lateral to the lateral spinothalamic tract in the lateral column. *there is crossing [R+ → L-]*
- Give rise to axons that enter the cerebellum via **the superior cerebellar peduncle contralateral**. They then cross the midline again and project the anterior lobe and vermis. *Lf → Rt*

**Lesion:** Contralateral lower limb discoordination “Ataxia”. The patient has difficulty performing the heel-to-shin test. *after 1st crossing → CL  
after 2nd “ → IL*

## Anterior Spinocerebellar Tract



2

In the pons, the anterior spinocerebellar fibers enter the cerebellum via the superior cerebellar peduncle. They then cross the midline again and project to the anterior lobe and vermis of the cerebellum. Having crossed the midline twice, the fibers terminate on the cerebellar hemisphere ipsilateral to the origin of the stimulus.

1

Proprioceptive information from Ia and Ib fibers and flexor reflex afferents as well as information from cutaneous receptors enter the spinal cord and synapse on **spinal border cells** located in the anterolateral border of the anterior horn. These spinal border cells also receive information from descending motor tracts.

Fibers then cross the midline and travel as the **anterior spinocerebellar tract**.

### 3. Cuneocerebellar Tract

#### a. First-order neurons:

- Found in **the posterior spinal root ganglia** "C2 to T7".
- Project their axons via the Cuneate tract to the medulla, where they synapse in the **accessory cuneate nucleus** (similar to Posterior thoracic nucleus "Clarck's nucleus").

#### b. Second-order neurons:

- Located in **the accessory cuneate nucleus** of the medulla.
- Give rise to axons that project **ipsilaterally** to the cerebellum via **the inferior cerebellar peduncle**.

2nd neuron  
SC  
doesn't relay in the SC

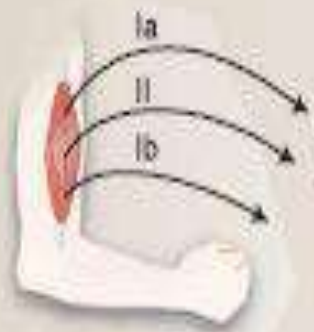
similar to post.  
C2 to T7

1st order neuron (UL)

in MD 2nd order neuron  
to UL unconscious proprioception

## Cuneocerebellar Tract

*2nd order neuron.*



Inferior cerebellar peduncle

Accessory cuneate nucleus

**2**

**Cuneocerebellar fibers** originate in the accessory cuneate nucleus in the rostral medulla and then travel through the ICP to the ipsilateral cerebellum, mainly to the anterior lobe, vermis and intermediate zone.

**1**

Ia, Ib, and II fibers as well as fibers from skin receptors enter the spinal cord above C8 and travel with the fasciculus cuneatus to the rostral medulla.

# Descending Tracts of the Spinal Cord

- A. Lateral corticospinal (LC): crossed pyramidal tract.
- B. Rubrospinal tract (LC): an extrapyramidal tract.
- C. Lateral reticulospinal tract (LC): an extrapyramidal tract.
- D. Hypothalamospinal tract (LC): the fibers arise from the <sup>begin</sup> hypothalamus & end in autonomic cells in the lateral horns.
- E. Olivospinal tract (LC): an extrapyramidal tract.

**F. Sulcomarginal tract (AC):** is very close to anterior median fissure.

**G. Anterior corticospinal tract (AC):** contains uncrossed corticospinal fibers.

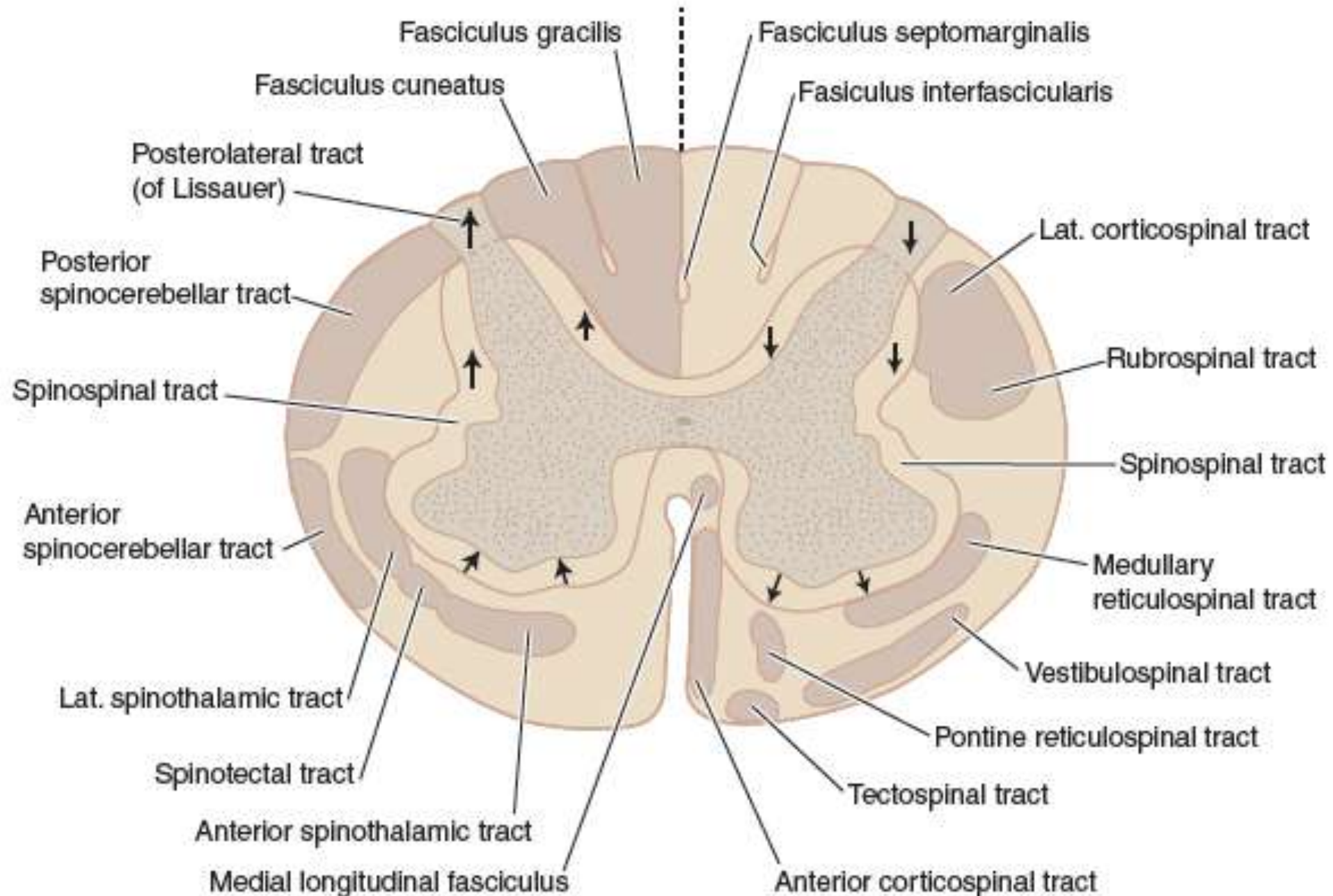
**H. Medial reticulospinal tract (AC):** an extrapyramidal tract.

**I. Tectospinal tract (AC):** arises from the superior colliculus of midbrain & the fibers end in the A.H.Cs. (spinovisual reflexes ).

**J. Vestibulospinal tract (LC):** for equilibrium arises from vestibular nuclei & ends in the A.H.Cs.

## Ascending tracts

## Descending tracts



# 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).

begin at the cortex and end at the AHC of the SC.

## b. Motor nuclei of the cranial nerves in the brain

stem (corticonuclear or corticobulbar tract).

begin at the cortex and end at the motor nuclei of brain stem

- The pyramidal tract consists of:

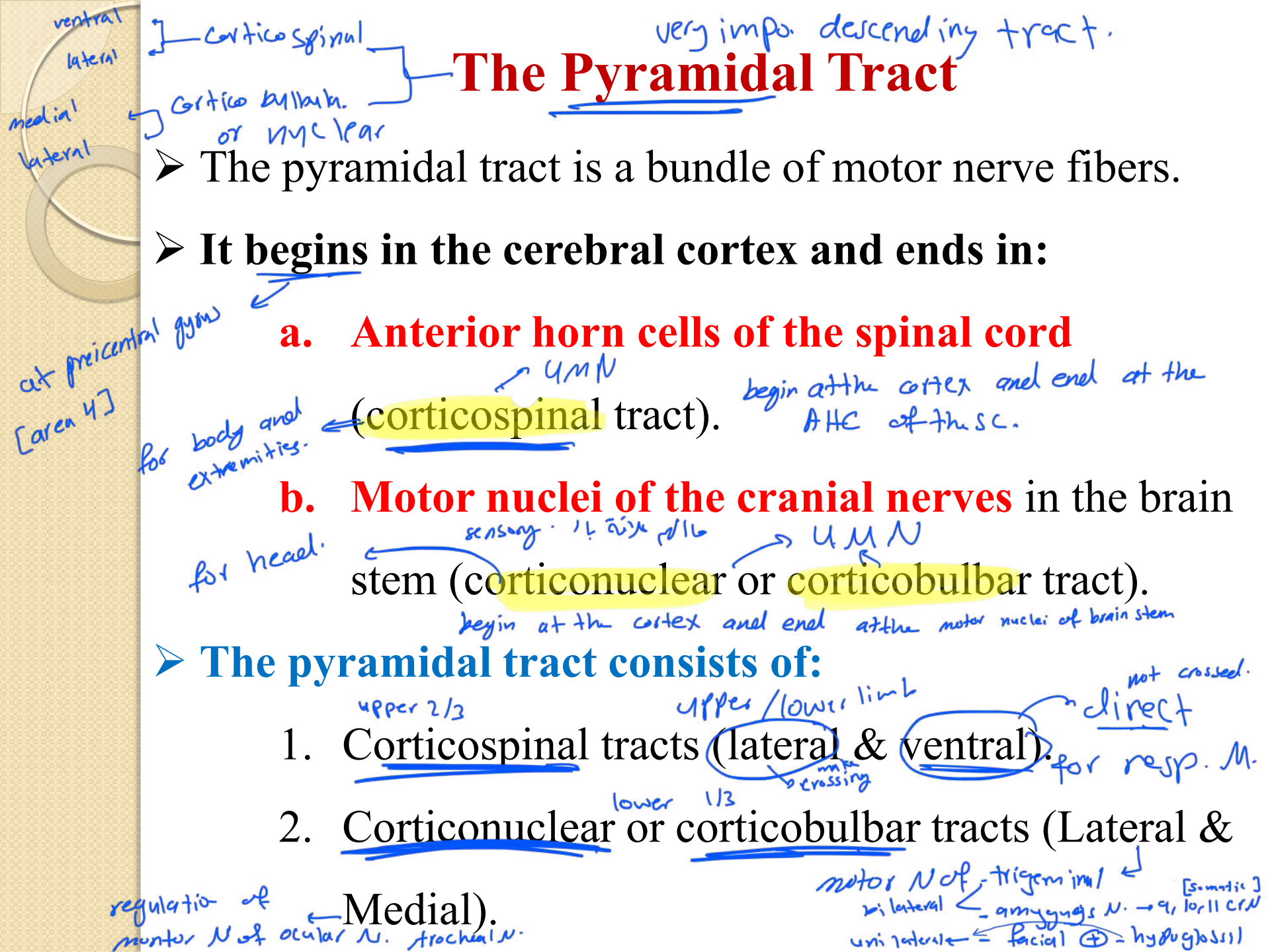
1. Corticospinal tracts (lateral & ventral).

2. Corticonuclear or corticobulbar tracts (Lateral &

Medial).

regulation of motor N of ocular N. trochlear N.

motor N of trigeminal  
bilateral - amygdala N. → 9, 10, 11 cran  
unilateral - facial ⊕ - hypoglossal



# The Upper Motor Neuron System (Corticospinal Tract)

## Function:

1. Initiation and control of voluntary motor activity.  
*if it damage lead to paralysis, above the crossing → symt opposite side [CL]  
below the crossing → IL*
2. Inhibition of muscles tone.  
*UMN damage of UMN → muscle hypertonic + spasticity after the shock stage end.*
3. Inhibition of deep reflexes.  
*damage → hyperreflexia of the deep tendon reflexes.  
spastic stage is lower*

*signs of UMN → muscle hypertonia, spasticity, paralysis, hyperreflexia of deep tendon reflexes.*

\* damage of CST → in the brain or SC [UMN] / from AHG to the muscle fibers → LMN.

## A. The Lateral Corticospinal Tract

## B. The Anterior 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.

infratentorial → LMN lesion  
supra " → UMN lesion

damage { root / anterior horn cell → LMN  
peripheral nerve, NMJ }

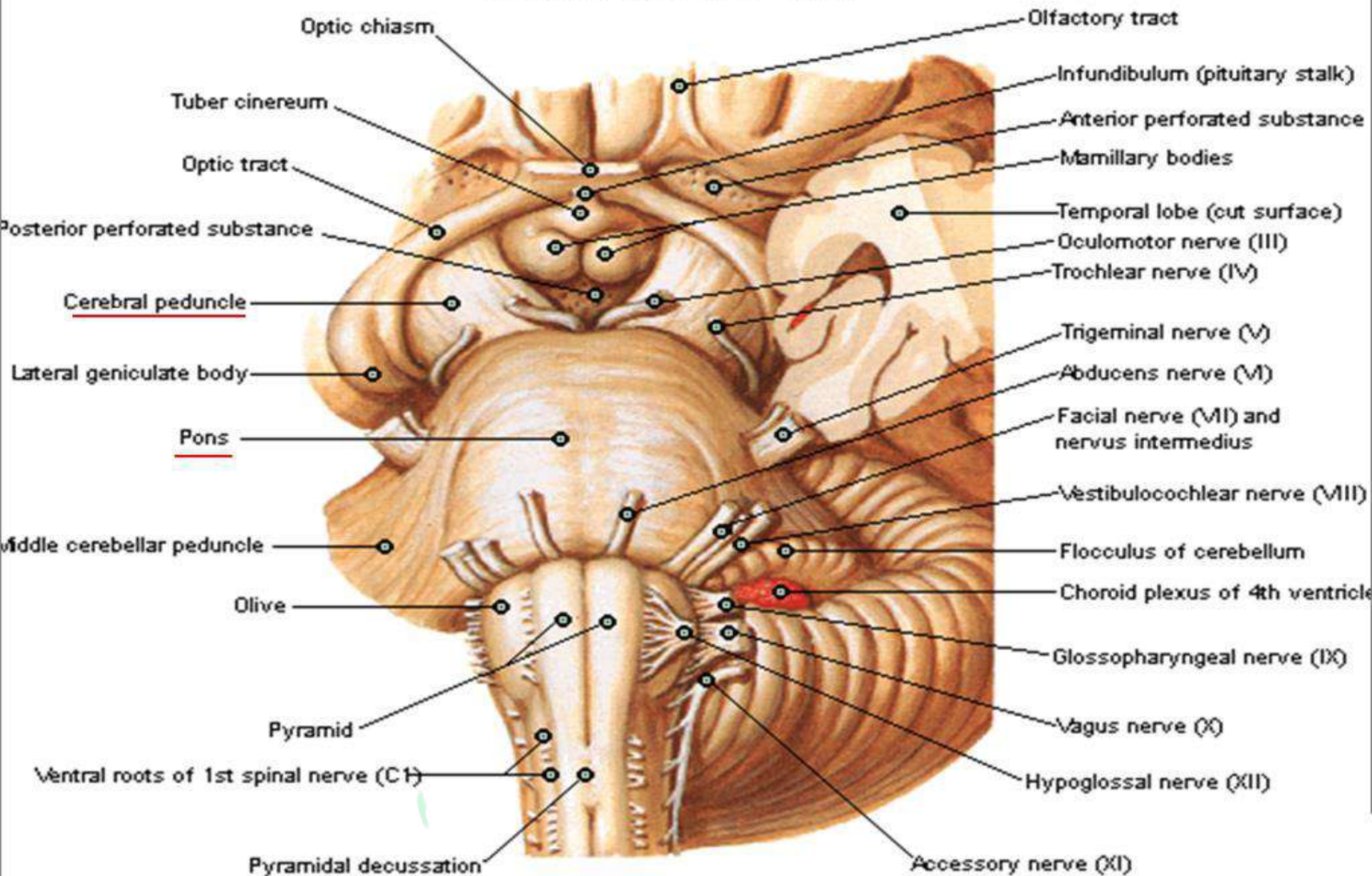
incomplete

85% of the fibers

→ between the MO and SC.  
CL side of the 12<sup>th</sup> lateral column of SC

# Brainstem

## Anterioinferior View



## ➤ In the lower medulla:

at the end of MD will happen incomplete crossing [C] incomplete for UL/LL

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.

more posteriorly in the lat. column.  
damage of post desc. cord → motor deficits esp. CST ↓ in the more post. in the column.

UL, LL fibers → AHC → segment level LMN

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.

without crossing

to resp. muscle

ventral / uncrossed

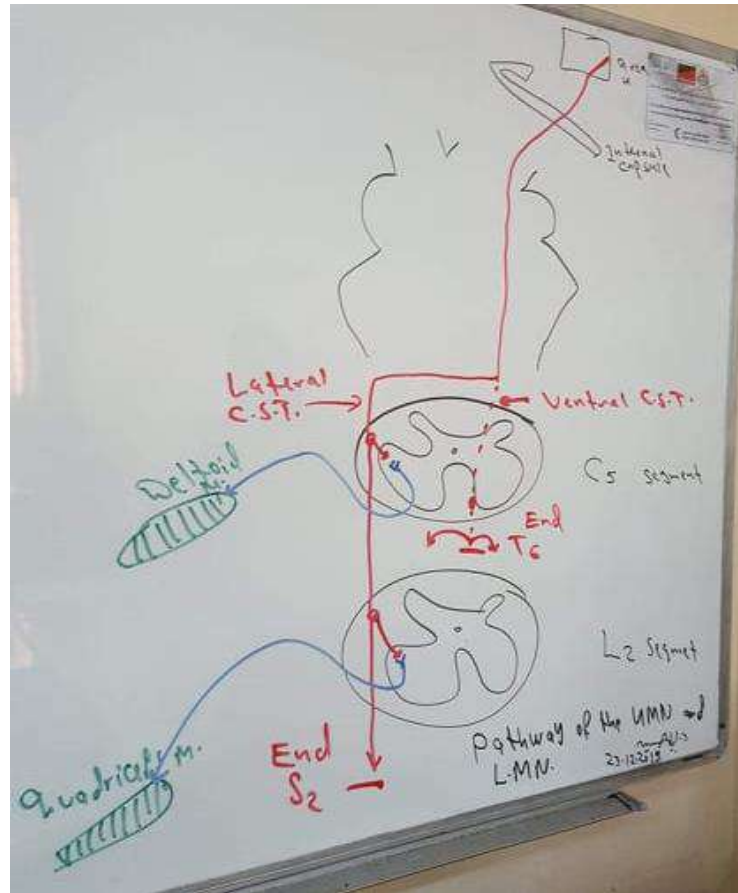
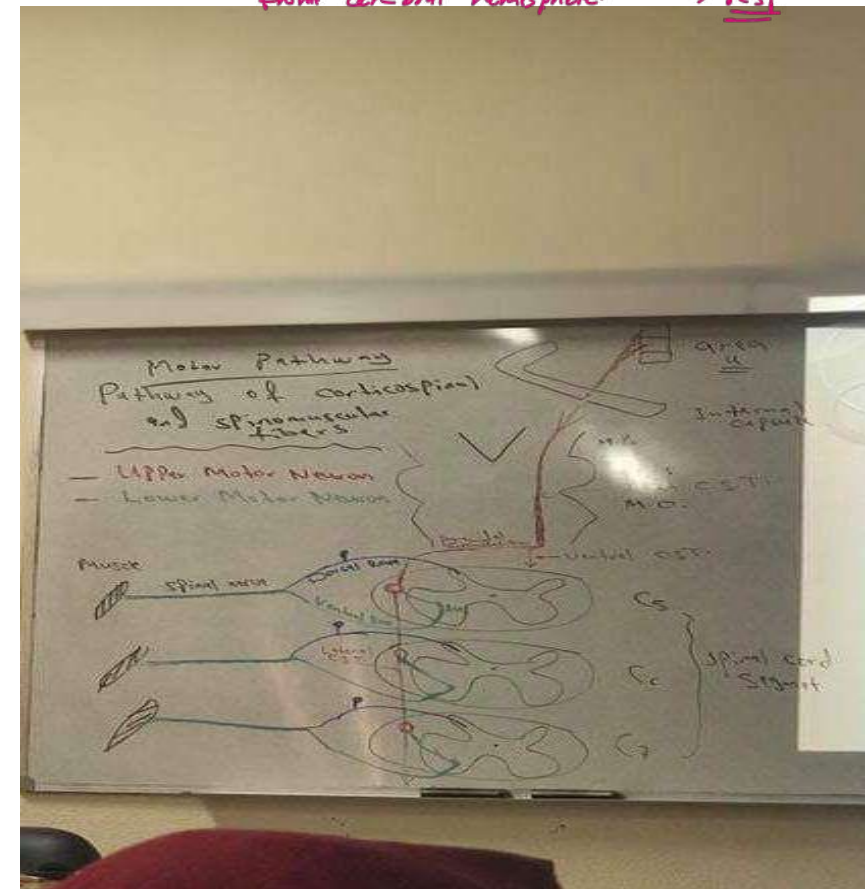
resp. + chest muscle

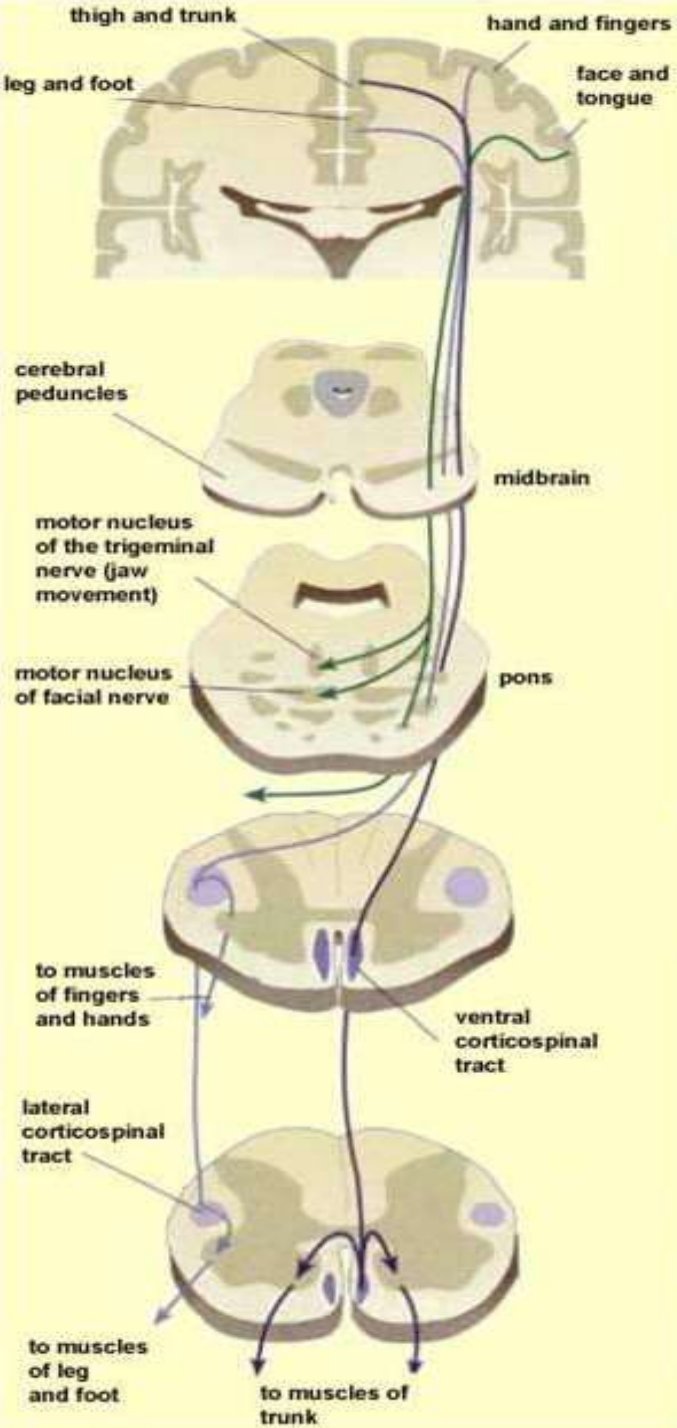
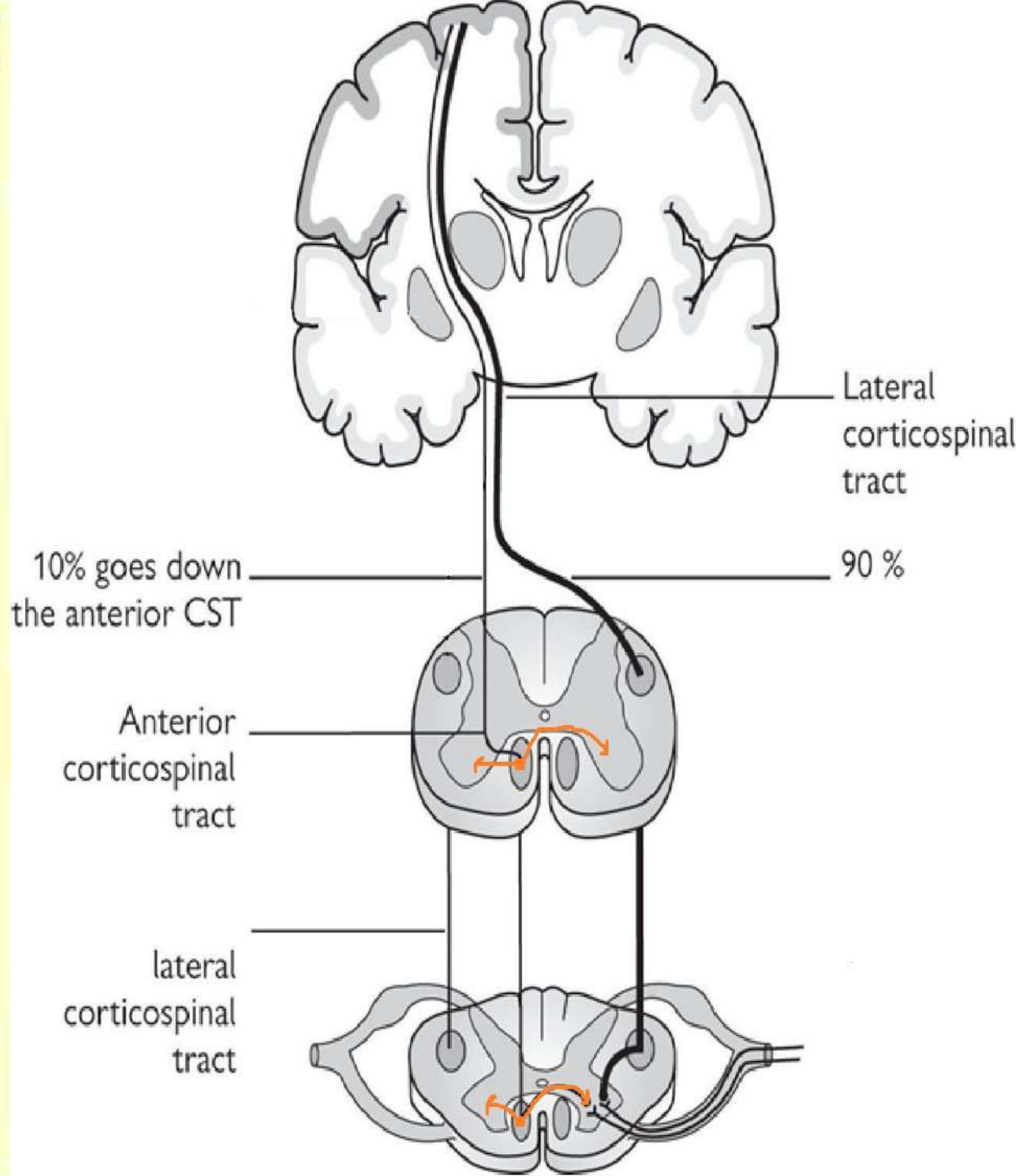
2 cerebral hemisphere  
Bilateral innervation

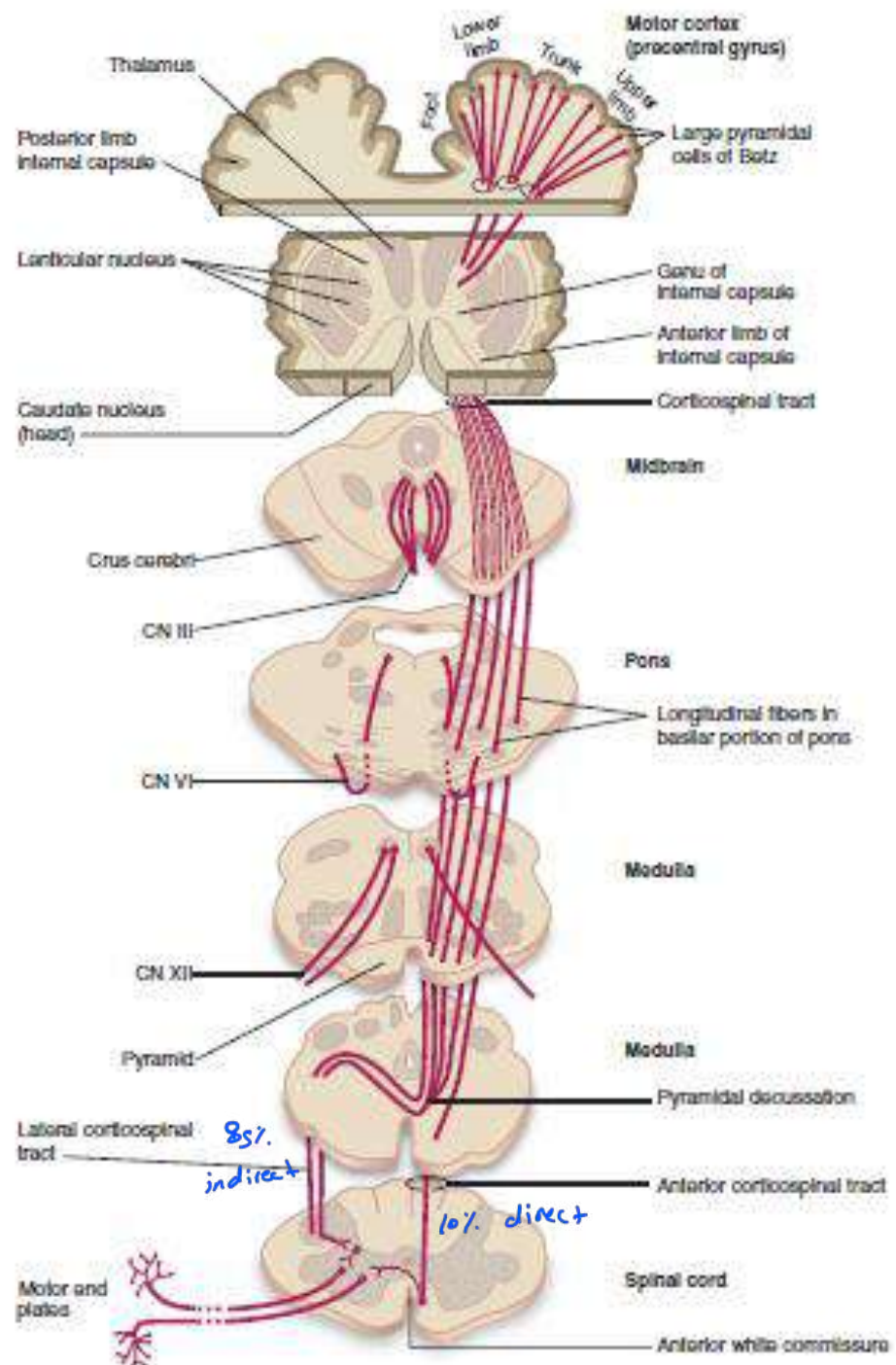
thoracic SC level

segmental level ventral, resp. muscle given AHC [UL, LL] hemiplegia in resp. failure

bilateral innervation i.e. AHC 100%  
from cerebral hemisphere.  $\rightarrow$  resp







Feb. 20

# The Corticospinal Tract

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

\* in the UMNL → symptoms lost below the level of lesion.  
above crossing CL      below crossing IL

# The Lower Motor Neuron System (Spinomuscular Fibers)

\* From the motor nucleus of CRN to the muscle → level of CRN.  
 [LML] branch to sternopharyngeal M. ← root of CR9 ← ambiguous N. upper part ← CRN9 ← CRN ← info nuclear or nuclear

**Function:** \* Affected CS segment → CS root → axillary nerve → deltoid muscle [at level of SC] → LML

1. Stimulation of voluntary motor at the level of the same side.
2. Stimulation of muscles tone at the level of the same side.  
 Rt CS → stimulate the M. to contract the Rt deltoid.
3. Stimulation of deep reflexes at the level of the same side.  
 [flaccidity] M. hypotonia / hyporeflexia ← LML

\* damage of LML ⇒ the symptoms. at the level of the damage at the same side  
 [the myotome of this segment]  
 من ضلح ← CS ← راح يتحرك ال axillary ← دبره نشيد ال Rt deltoid تحت راح يتحرك ال اليمين ...

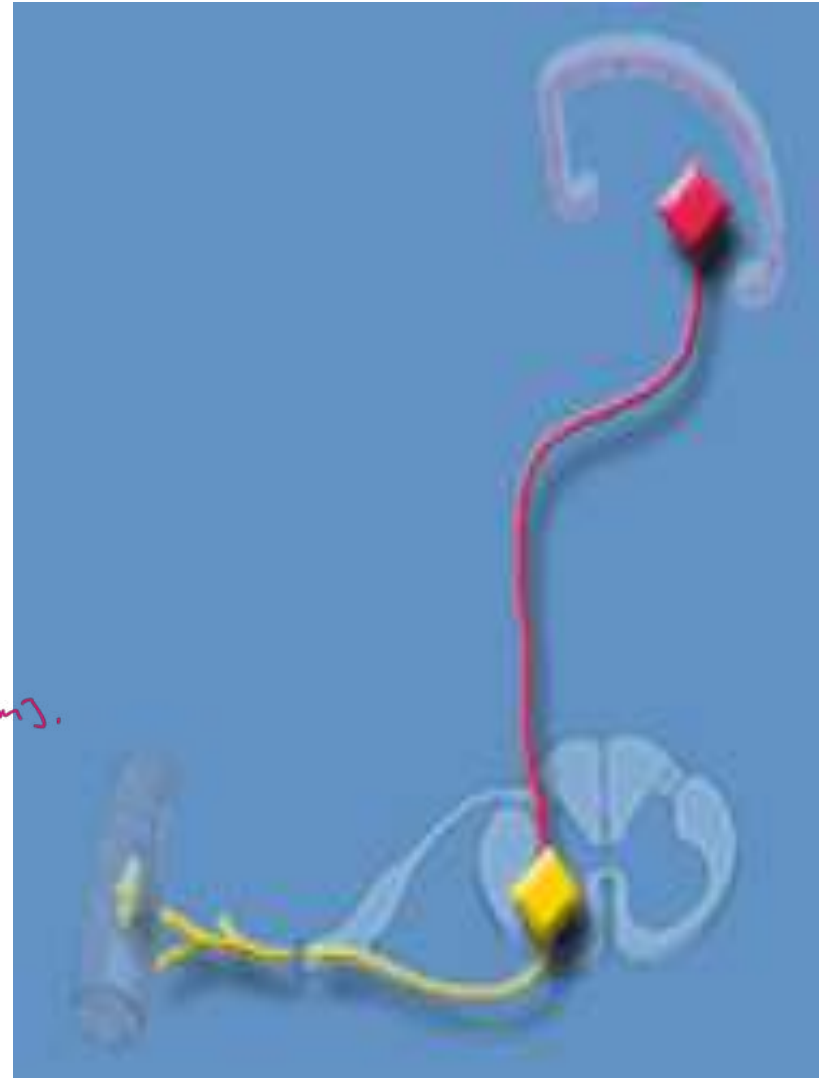
# Pathway of the Lower Motor Neuron System (Spinomuscular fibers)

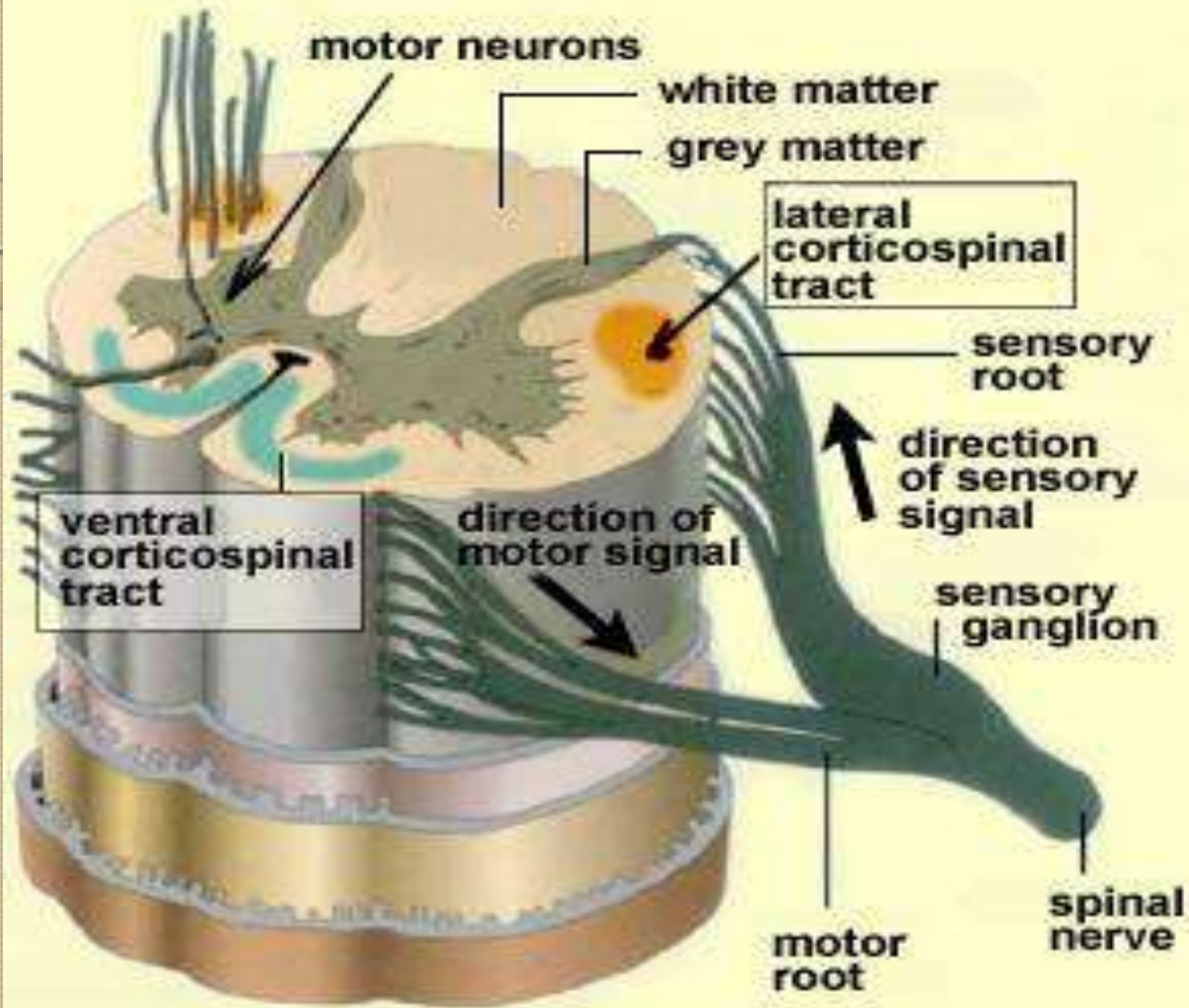
From AHCs of the spinal cord  
→ fibers exit from the spinal  
cord as the anterior roots of  
the same side → peripheral  
nerves → motor end plate →  
voluntary muscles. *skeletal M.*

*begin* ← *via spinomuscular fibers*

*fibers of CN*  
*[neuromuscular junction]*

→ damage in LMN → the symptoms appear in the  
same level and the same side.



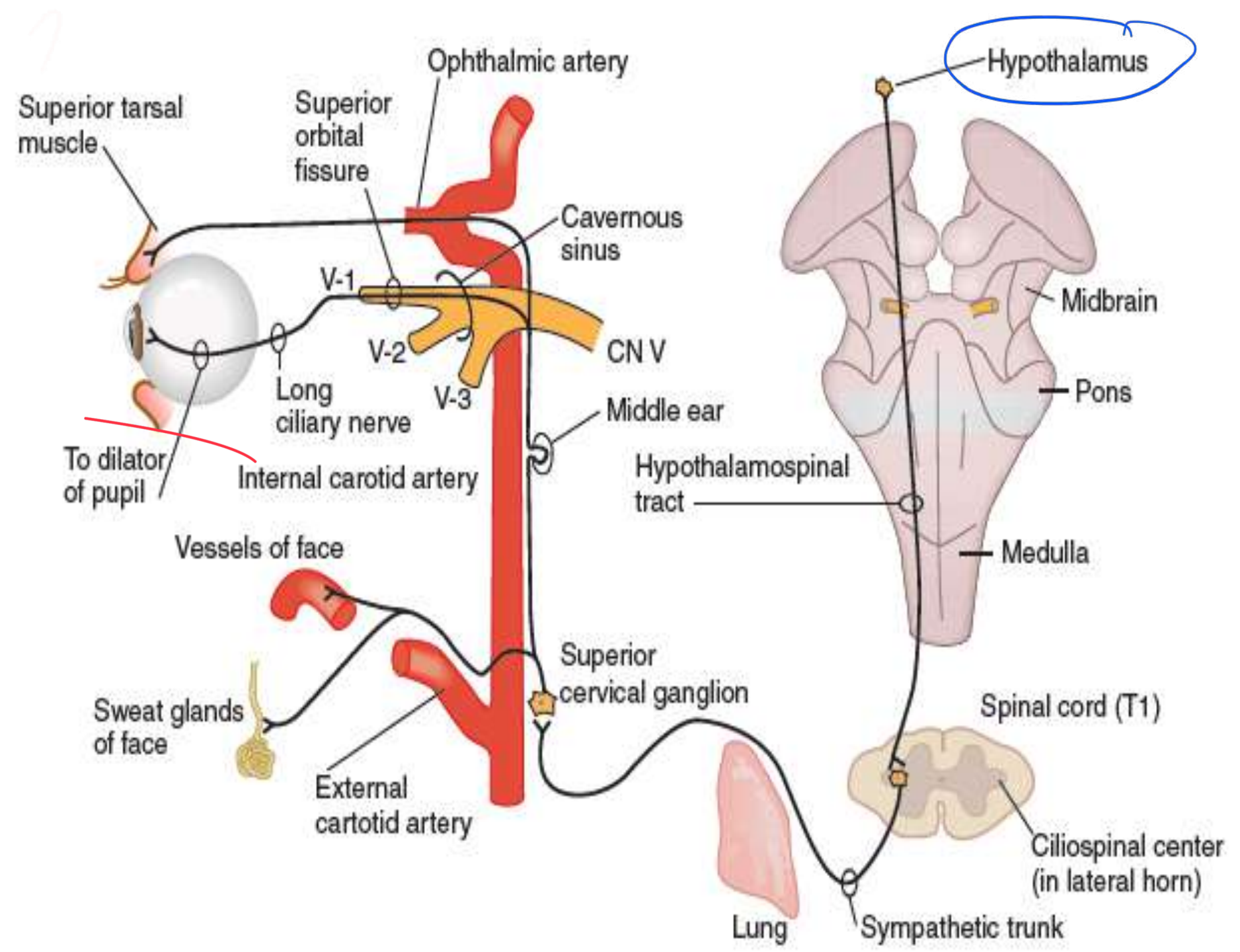


## C. Descending Autonomic Tract “Hypothalamospinal Tract”

- Project to sympathetic (T1–L2) and parasympathetic (S2–S4) centers in the spinal cord.
- Innervate the ciliospinal center (T1–T2), a pupillary center.  
*(C8–T1–T2) sympathetic.*
- Found in the posterior quadrant of the lateral column.
- **Interruption of this hypothalamospinal tract:**  
results in Horner syndrome.

\* begin at the hypothalamus then descend in the lateral part of Brainstem..  
if there is PICA occlusion → horner syndrome [HTST + 3rd eye]

parasymp. S2–S4 / symp. L2–T1 & dependent



# Horner's Syndrome

*Pupillary reaction* → Sympathetic fibers don't relay at the level of C8-T1-T2 so ascend without relay in symp. chain and relay in sup. cervical symp. ganglia then give postganglionic fiber forming plexus around ICA then give long ciliary N. mydriasis ← supply the dilator pupillary muscle

## ➤ Horner's Syndrome:

- Partial ptosis “paralysis of the Müller's <sup>damage</sup> muscle”.
- Miosis.
- Enophthalmus.
- Anhidrosis.

## ➤ Causes:

- ✓ Brain lesion: (massive ischemic stroke, brain stem lesion).  
*foramen magnum / فتحة العنق*
- ✓ Cervical cord lesion: (syringomyelia and cervical spinal cord tumor),  
*in Brain stem*
- ✓ Neck pathology: (Pancoast tumor, cervical rib, neck surgery)

# Horner's Syndrome



horner

# 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.  
*شلل نصف الجسم*
3. Paraplegia: paralysis of both limbs.
4. Triplesia: paralysis of three limbs (one upper and two lower limbs).  
*شلل ثلاثي*
5. Quadriplegia (tetraplegia): paralysis of four limbs.  
*شلل رباعي*  
*↑ same onset*
6. Bilateral hemiplegia.  
*↪ diff. onset*

## Lower Motor Neuron lesions (LMNL)

- Result from damage to motor neurons of the anterior horns or motor neurons of the cranial nerve nuclei.   
*or Brainstem or Cranial Spinal N or neuro-muscular junction*
- Result from interruption of the final common   
*↳ LMN symptoms at the level of the same side* pathway connecting the neuron via its axon with the muscle fibers it innervates (the motor unit).

# Signs of the Lower Motor Neuron lesions (LMNL)

بعض من muscle hypotonia

1. Flaccid paralysis.

السبب: AHC responsible for nutrition of muscle fibers

2. Muscle atrophy (hypotrophy).

3. Muscle hypotonia.

hyporeflexia

4. Areflexia of deep tendon and superficial reflexes.

spontaneous contraction of muscle groups [in motor neuron disease]

5. Muscle fasciculations (visible muscle twitches).

6. Muscle fibrillations (on electromyography).

وليست بالعضلة المتحركة نفسها.

myoclonus  
رعدة العضلة  
مع استرخائها

# Diseases of Lower Motor Neuron lesions

1. Anterior horn cells lesion: spinal muscular atrophy, poliomyelitis, and syringomyelia.

2. Peripheral nerve lesion: mononeuropathy, polyneuropathy.

3. Motor end plate lesion: myasthenia. or potilesim

4. Muscle disease: <sup>try disease / reversible</sup> myopathy. or muscular dystrophy...  
↳ inherited group of myopathy.  
↳ drug ↳ first in line ↳ general disease

# Upper Motor Neuron lesions (UMNL)

above crossing symptoms → CL

below " " → IL

the symptoms in the opposite side

- Lesions of the corticospinal and corticobulbar tracts

## “Pyramidal tract lesions”.

- May occur at all levels of the neuroaxis from the cerebral cortex to the spinal cord.
- When the lesion above the pyramidal decussation, the motor deficit present below the lesion, on the contralateral side.
- When the lesion below the pyramidal decussation, the motor deficit present below the lesion, on the ipsilateral side.

# Signs of the Upper Motor Neuron lesions (UMNL)

1. Spastic paralysis.

2. Hyperreflexia of deep tendon reflexes.

3. Clonus: <sup>→ severe hyperreflexia</sup> rhythmic contractions of muscles in response to

<sup>sudden stretch of achilles tendon → no reaction.</sup>  
<sup>but in the severe hyperreflexia patient →</sup> sudden, passive movements (patellar, or ankle clonus).  
<sup>of tendon.</sup>  
<sup>رhythmic contraction of muscle.</sup>

4. Loss of superficial (abdominal and cremasteric) reflexes.

5. Muscle hypertonia “Clasp-knife spasticity”: when a joint is moved briskly, resistance occurs initially and then fades.  
<sup>hyper tonia ٥١</sup>  
<sup>due to Extrapyramidal lesion</sup>  
<sup>→ spasticity - [UMNL] extension of LL, flexion of UL, circumduction gait walk.</sup>  
<sup>rigidity & plasticity ٥٢</sup>  
<sup>in parkinson disease.</sup>

6. Babinski sign: plantar reflex response that is extensor (dorsiflexion of big toe).  
<sup>Coogwheel... }</sup>  
<sup>flexion of UL, LL</sup>  
<sup>shuffling gait walk</sup>  
<sup>tremor tremor..</sup>

# Diseases of Upper Motor Neuron lesions

1. **CVA.** *cerebrovascular accident.*
2. **Multiple sclerosis.**
3. **Brain and spinal cord tumors.**
4. **Inflammatory:** encephalitis, transverse myelitis.
5. **Traumatic:** head trauma, subdural hematoma, spinal cord trauma.
6. **Congenital:** cerebral palsy, hereditary spastic paraplegia.
7. **Degenerative:** *↓ dys palsy in cervical segment → SC ١٤٣٢٦ [UMN]* vertebral spondylosis and myelopathy.
8. **Motor neuron disease.**

*note/ first weeks of stroke or SC lesion → flaccid shock stage. then spastic stage.*

# Differential between the UMNL & LMNL

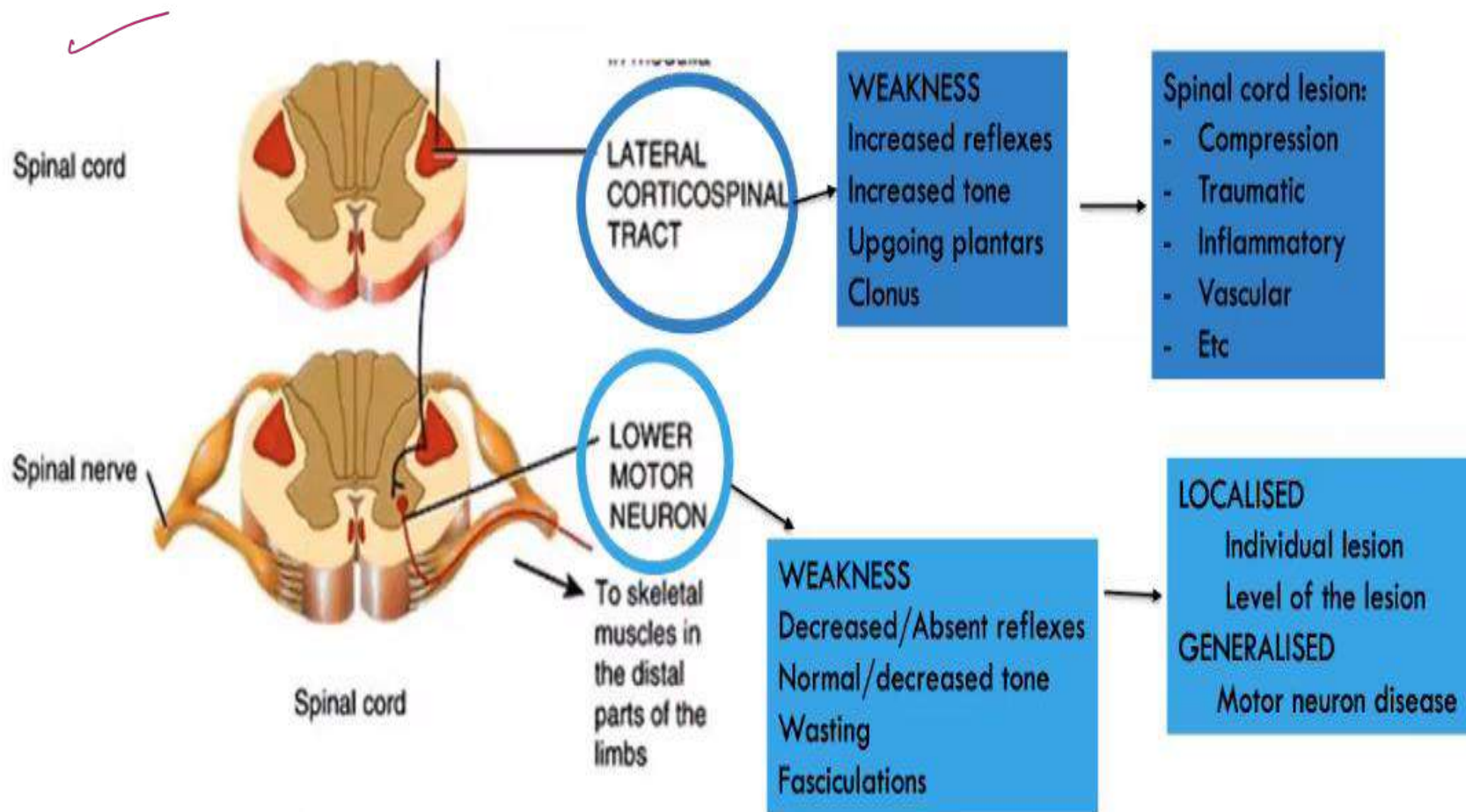
|                          | U.M.N. LESION                                                                                       | L.M.N. LESION                      |
|--------------------------|-----------------------------------------------------------------------------------------------------|------------------------------------|
| 1. Location of lesion    | From area 4 until AHCs                                                                              | From AHCs until muscles            |
| 2. Location of paralysis | Below the level of lesion:<br>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)                           |
| 3. Muscle fasciculation (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 |

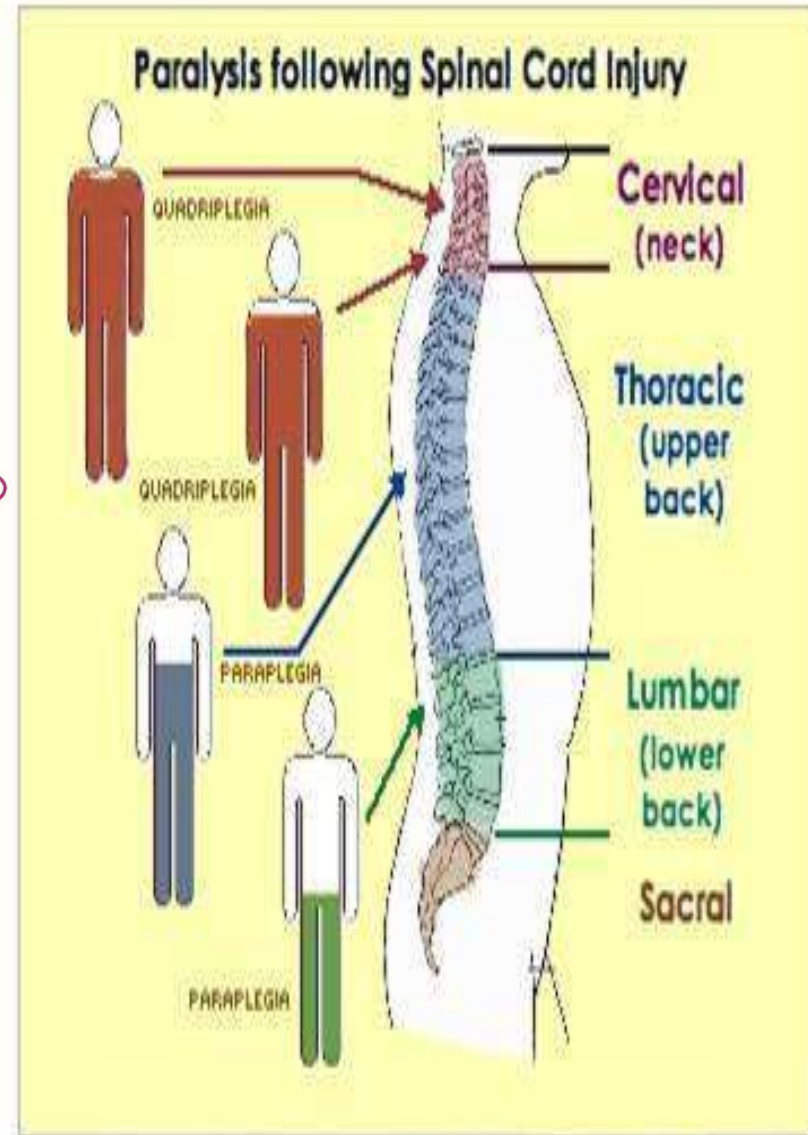


# Complete Spinal Cord Lesion

... در تمام بدن علائم وجود دارد

- Complete loss of motor power below the level of lesion.
- Complete loss of sensation (superficial and deep) below the level of lesion.
- Atonia and flaccidity with areflexia (in shock stage)
- Sphincter dysfunction.

... در مثانه و روده اختلال وجود دارد



# Spinal Shock

- **Definition:** Immediately loss of all SC functions, including the spinal reflexes after sudden transection of the SC.  
*due to :-*  
*partial* *complete*
- **Duration:** From two weeks to several months. *[Flaccid stage]*  
*... muscle contraction ... deep vein thrombosis and pulmonary embolism*
- **Mechanism:** Due to sudden withdrawal of supraspinal facilitation on the alpha motor neurons.

*المحور الحركي في النخاع الحبلي*  
*القوس الحركي*  
*cut*  
*shock stage*  
*spastic shock*  
*LMN stimulate the muscle tone and deep reflexes*  
*[hyper reflexia + hyper tonia]*

# Manifestation of the Spinal Shock

1. Quadriplegia or paraplegia (depending on the level of the lesion)
2. Loss of spinal reflex activity below the level of lesion:
  - Loss of deep and superficial reflexes.
  - Loss of muscle tone with flaccidity of the paralyzed muscles
  - Loss of erection, urination and defecation reflexes
3. Loss of all sensation below the level of lesion.
4. Vasodilatation and hypotension below the level of lesion.

# Complication of the Spinal Shock

- DVT and pulmonary embolism.
- Hypotension (specially in cases of high-level spinal cord lesion).
- Muscle wasting.
- Bed sores due to ischemia of the areas are compressed against bed.
- Urine tract infection due to urine retention and stasis.
- Sepsis. <sup>UTI</sup> UTI
- Decrease of the body temperature due to reduction of the metabolic rate after loss of the muscle tone.

# ✍ Incomplete Spinal Cord Lesion (Partial Transection)

If any form of sensation, motor power is preserved below the level of the lesion, spinal cord lesion is considered incomplete:

- **Brown Sequard syndrome (hemicord lesion).** الضربة نصفية الحادة
- **Anterior cord lesion.** الضربة الأمامية
- **Central cord lesion.** الضربة المركزية gray matter
- **Posterior cord lesion.** الضربة الخلفية

# Brown-Sequard Syndrome

## Hemisecction Lesion of the Spinal Cord

→ damage of gray matter :- symptoms at the same side.  
[LMN]  
→ AHC.

### A. At the level of :

\* but the PHC → at the level of dermatome anesthesia

②  
1. Ipsilateral zone of cutaneous anesthesia in the segment of the lesion (due to damage of afferent fibers that entered the cord (PHCs) & have not yet crossed ).

حاجب حس کان

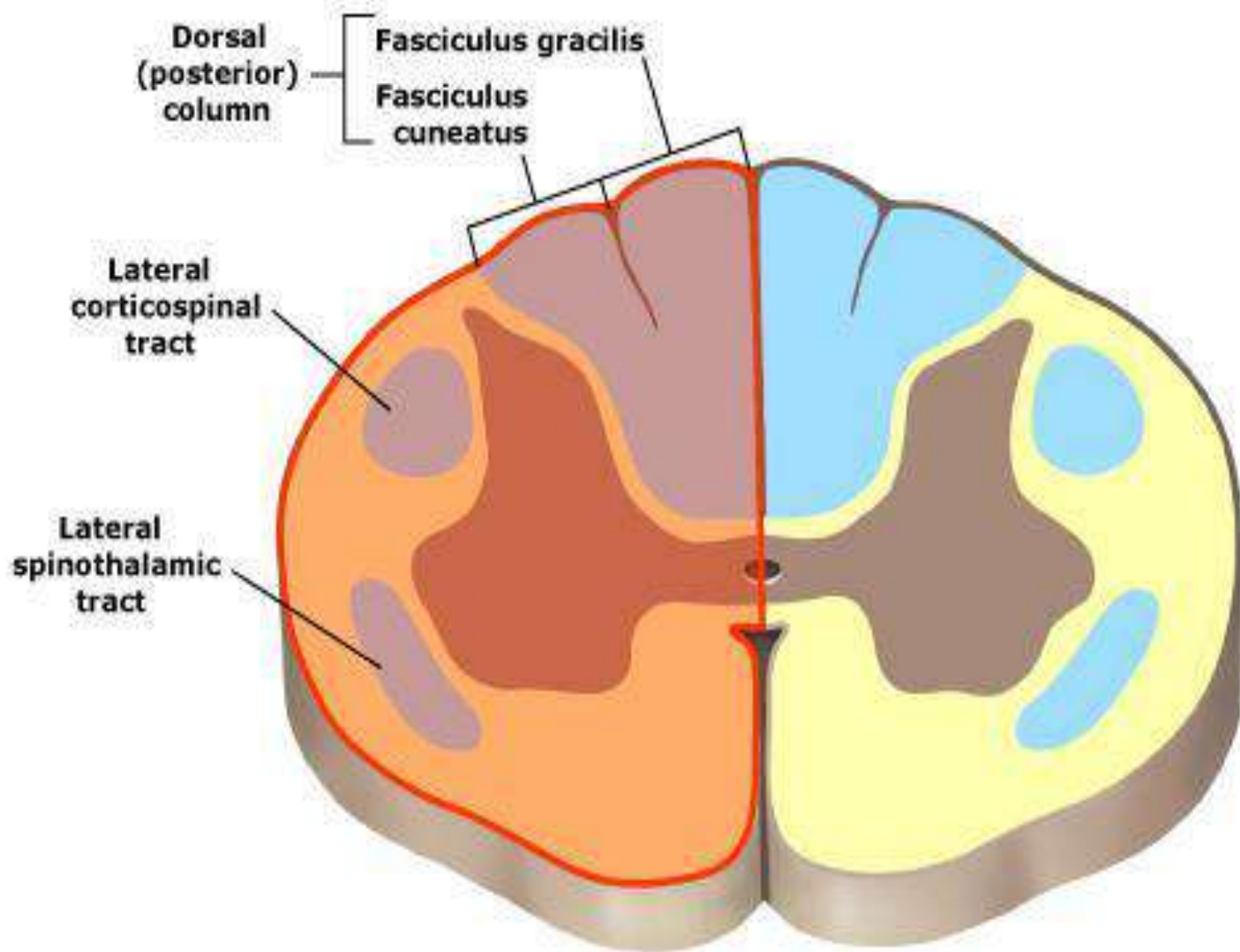
①  
2. Ipsilateral lower motor neuron paralysis in the segment of the lesion ( due to damage of the lower motor neuron in the AHCs ).

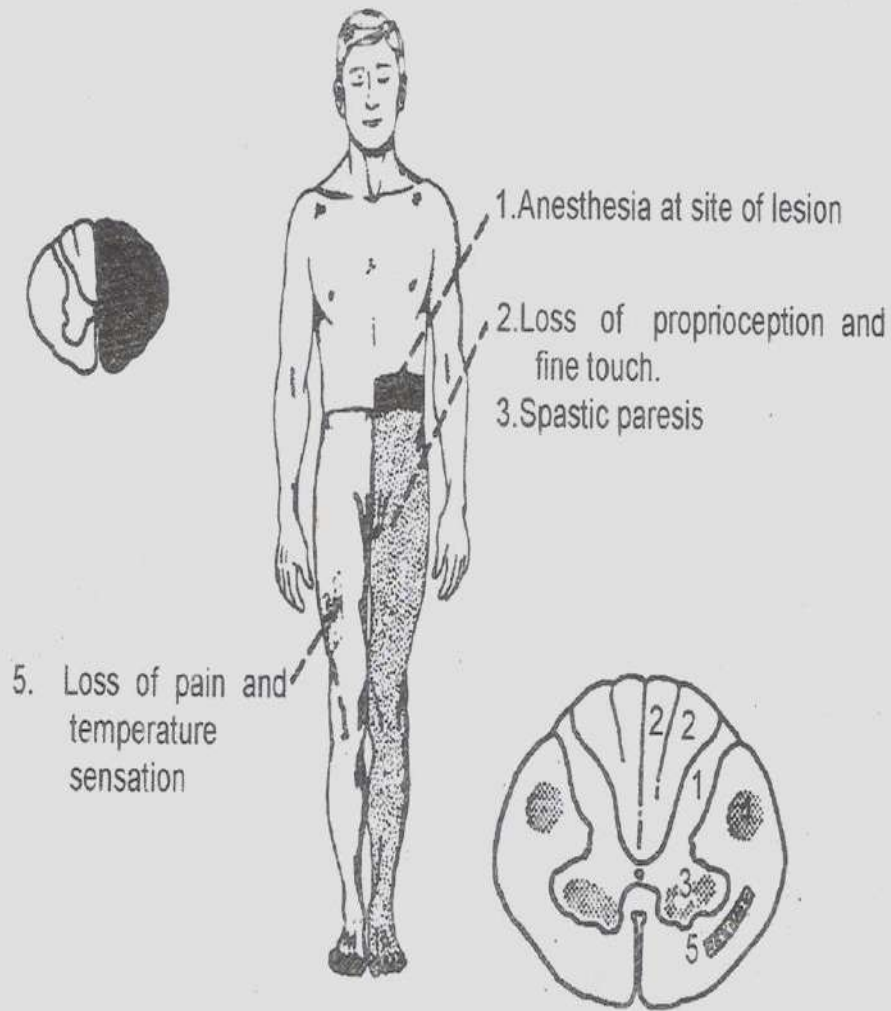
# Brown-Sequard Syndrome

## B. Below the level of lesion:

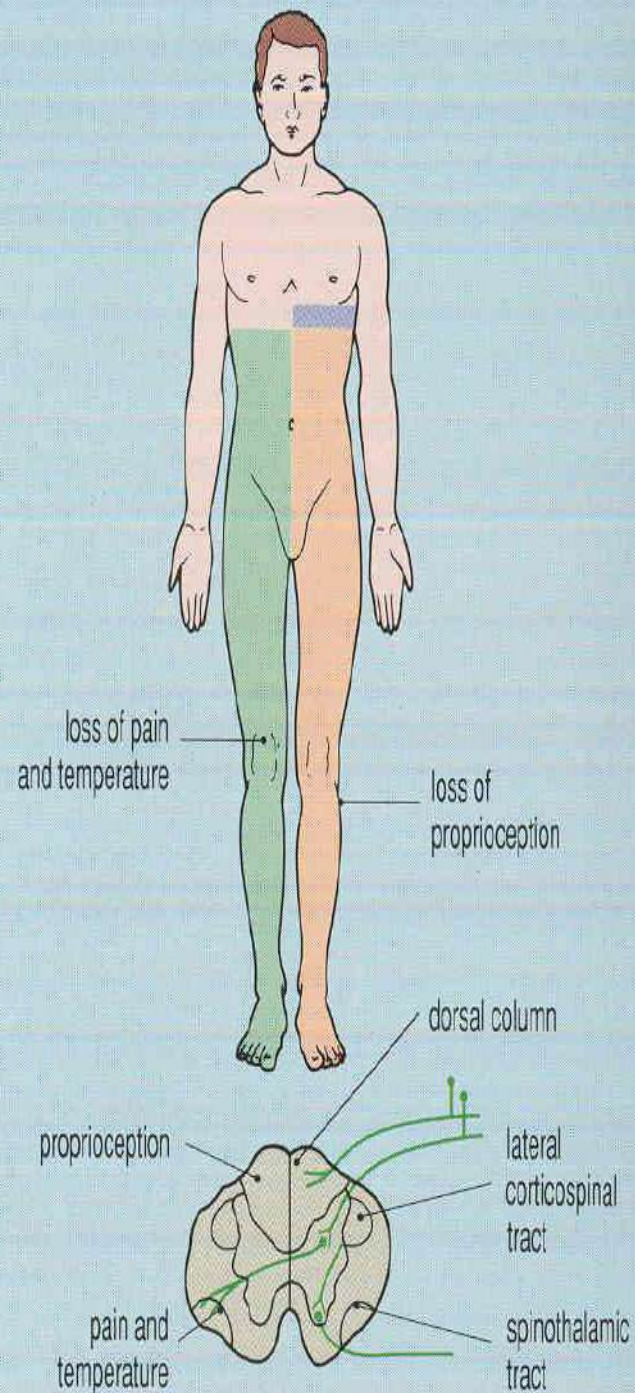
white matter damage:-  
GC damage → IL  
Corticospinal tract damage → IL  
lat., ventral S.T.T damage → CL

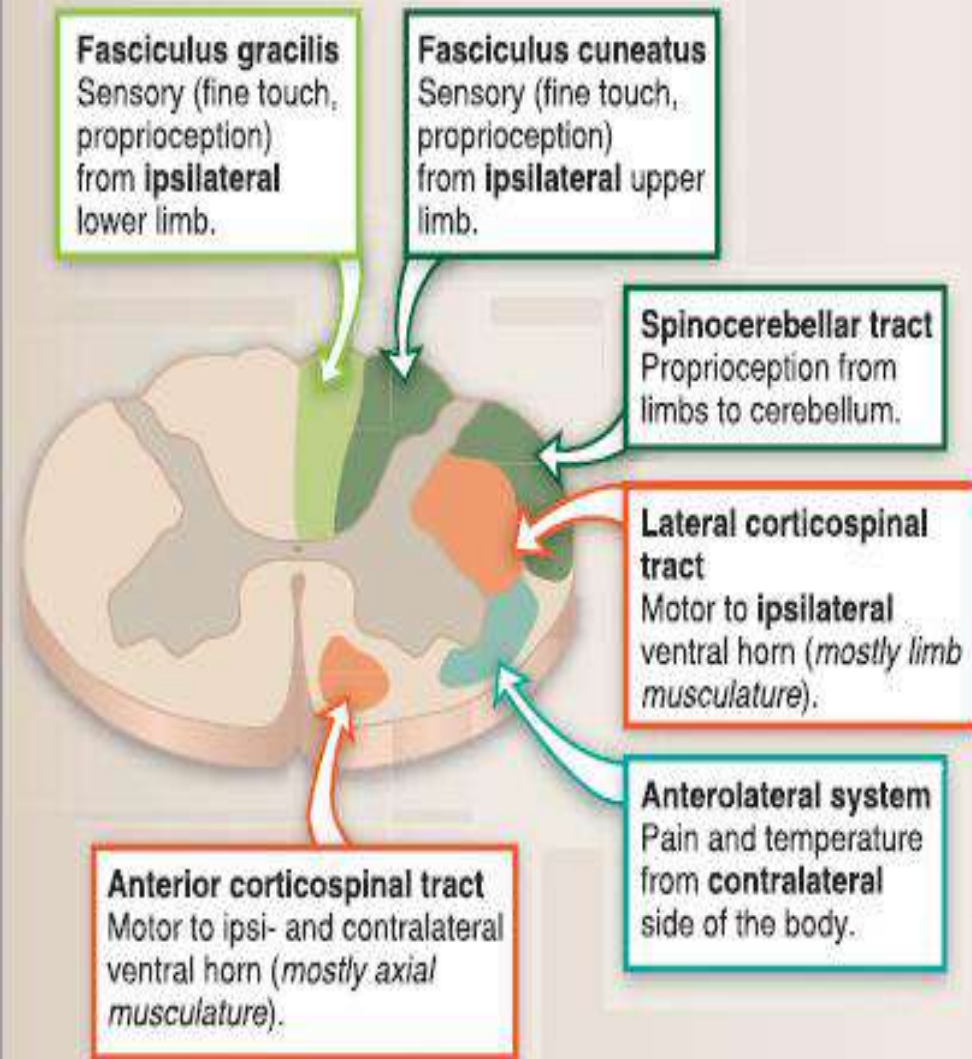
- Ipsilateral loss of proprioception & fine touch below the level of the lesion (due to damage of the dorsal column → cuneate and Gracile Tract).  
*not cross the SC*
- Ipsilateral upper motor neuron paralysis below the level of the lesion (due to damage of the lateral column → corticospinal tract).  
*crossing in Mo*      *لا يتقاطع - crossing in SC لا يتقاطع*
- Contralateral loss of pain, temperature and crude touch sensations below the level of lesion (due to damage of lateral and ventral spinothalamic tract, which has decussated).  
*direct crossing in the SC*



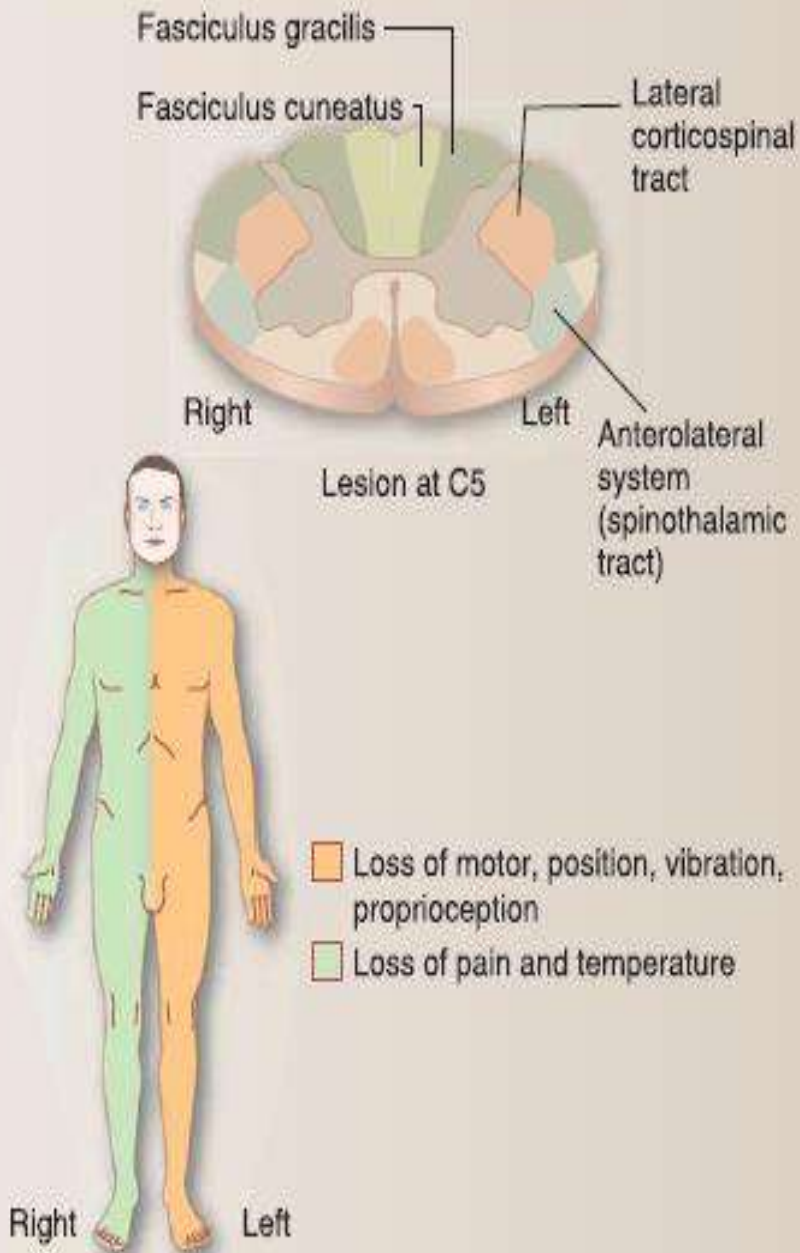


- |                                |                                                             |
|--------------------------------|-------------------------------------------------------------|
| 1. Sensory horn                | : Ipsilateral anesthesia in the segment of lesion.          |
| 2. Gracile, cuneate            | : Ipsilateral loss of proprioception below lesion.          |
| 3. A.H.Cs                      | : Ipsilateral LMN Lesion in the segment of the lesion.      |
| 4. Crossed pyramid             | : Ipsilateral UMN Lesion below the lesion.                  |
| 5. Lateral spinothalamic tract | : Contralateral loss of pain & temperature below the lesion |





## Hemisection (Brown-Séquard syndrome)



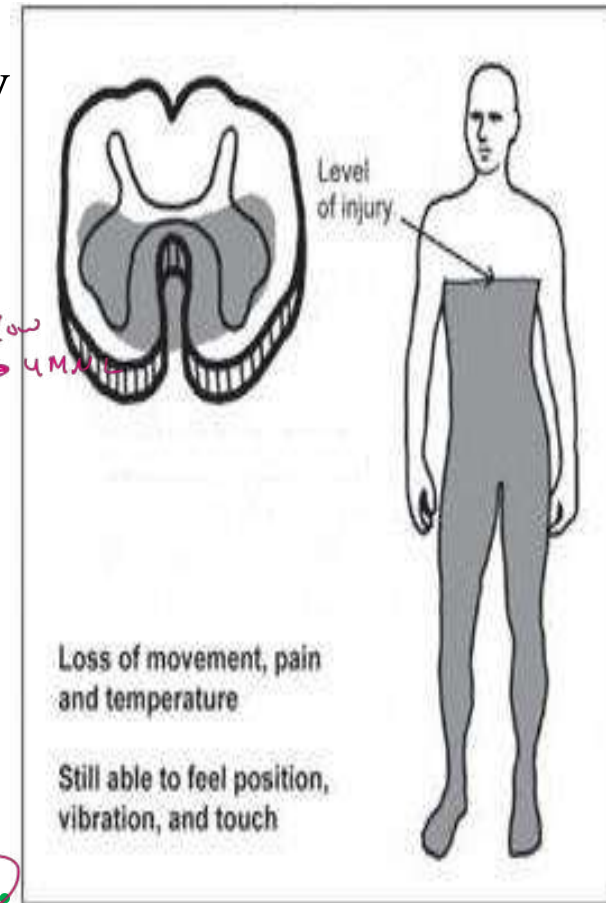
# Anterior Spinal Cord Syndrome

➤ Lesion of the anterior part of the SC, usually associated with a flexion injury and occlusion in the anterior spinal artery territory.

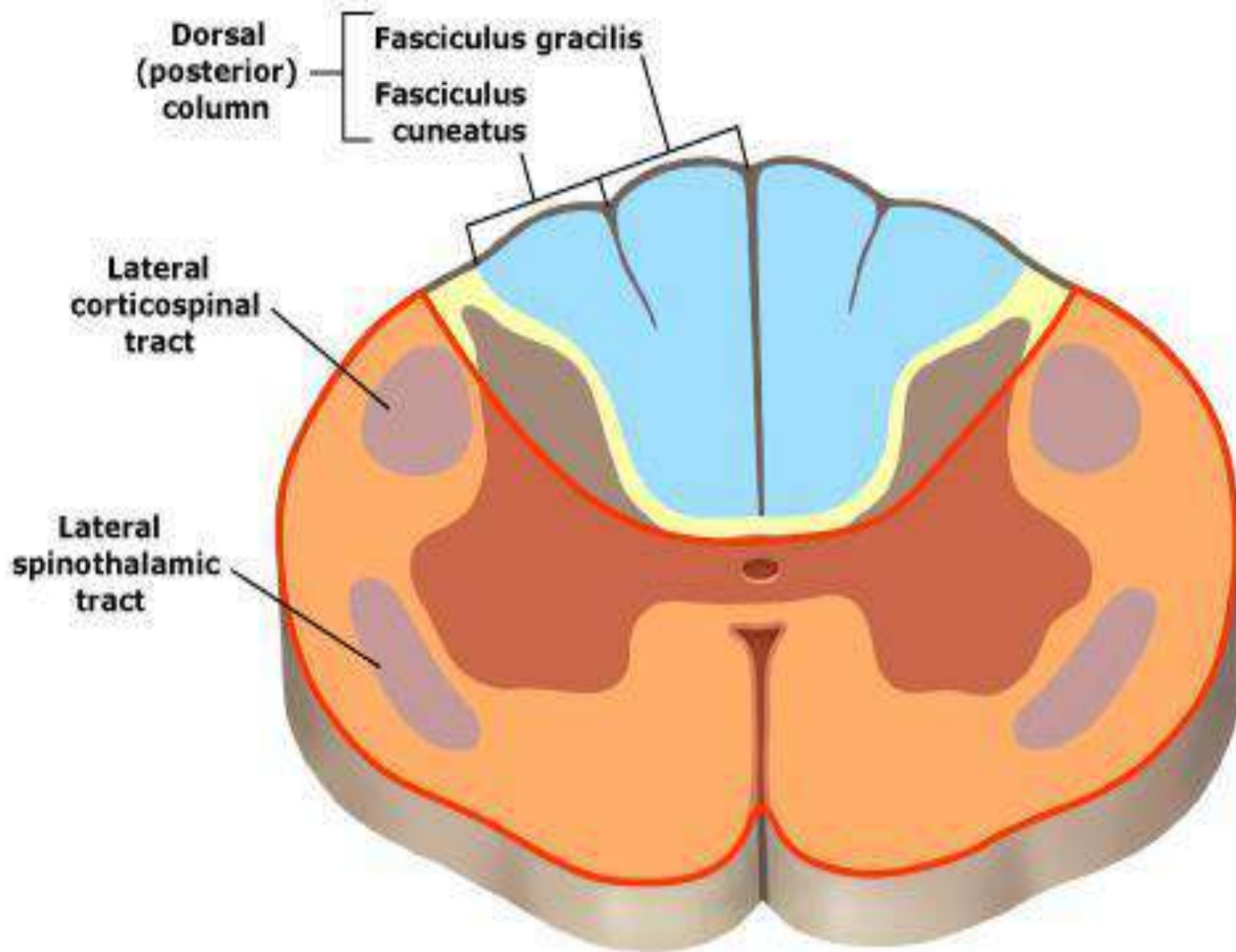
➤ Loss of motor function at lesion and below, decreased superficial sensation, including pain and loss of temperature sensation below the level of lesion.

➤ Dysfunction of sphincter tone.

➤ Deep and fine sensation is preserved.



PHC  
فقدان الحركة



# Posterior Spinal Cord Syndrome

loss of proprioception / fine touch

preserve temp., pain, crude touch → lesion of dorsal column, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

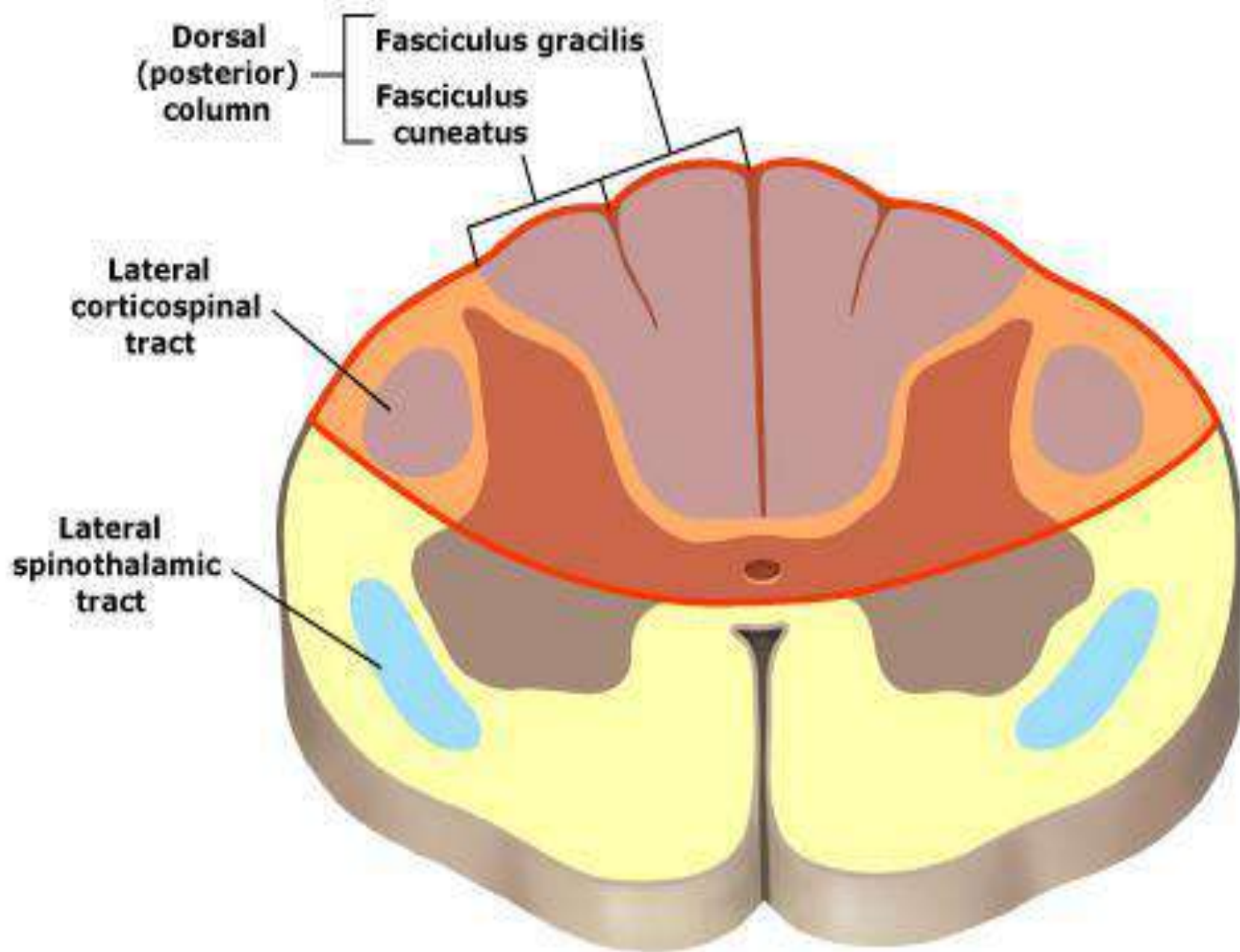
- Lesion of the posterior part of the SC, usually associated with cervical hyperextension injuries, tabes dorsalis (syphilis- tertiary stage), ischemia in the posterior spinal artery territory.
- Loss of deep sensation, fine touch, and difficulty in coordinating movement.

more post. in the lat. column → LGST 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

- Variable weakness and bladder dysfunction

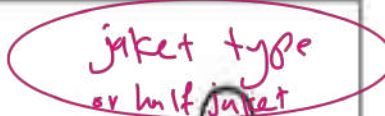
- Pain, temperature sensation intact.  
+ crude touch

below the level of lesion...  
at the level of the lesion due to the damage of the PHC

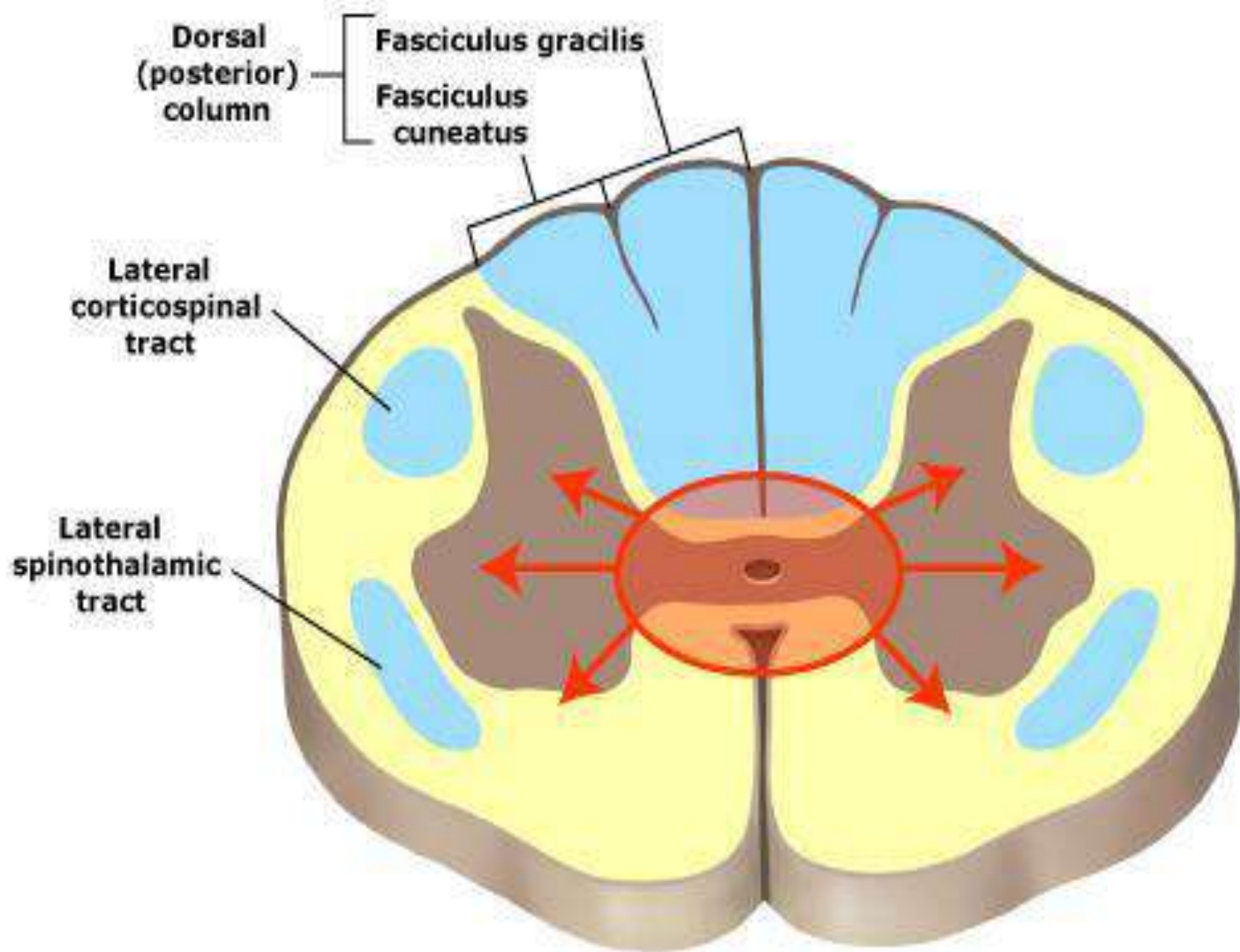


damage in the brain [gray]

- the symptoms at the level of lesion



perception, fine touch  
drag matter, 125.6  
157.5





Level  
of injury



Loss of movement  
and sensation

Incomplete loss

# Conus Medullaris Syndrome

ساخته بیعتی واکن بیعتی  
stool and urine in continence

- The lesion involves segments S3–S5.
- Results in destruction of the sacral parasympathetic  
nuclei: bladder, fecal incontinence, and impotence.  
رکتی خا ر sphincter.
- Perianogenital sensory loss in dermatomes S3–S5  
(saddle anesthesia).  
damage.
- Absence of motor deficits in the lower limbs.

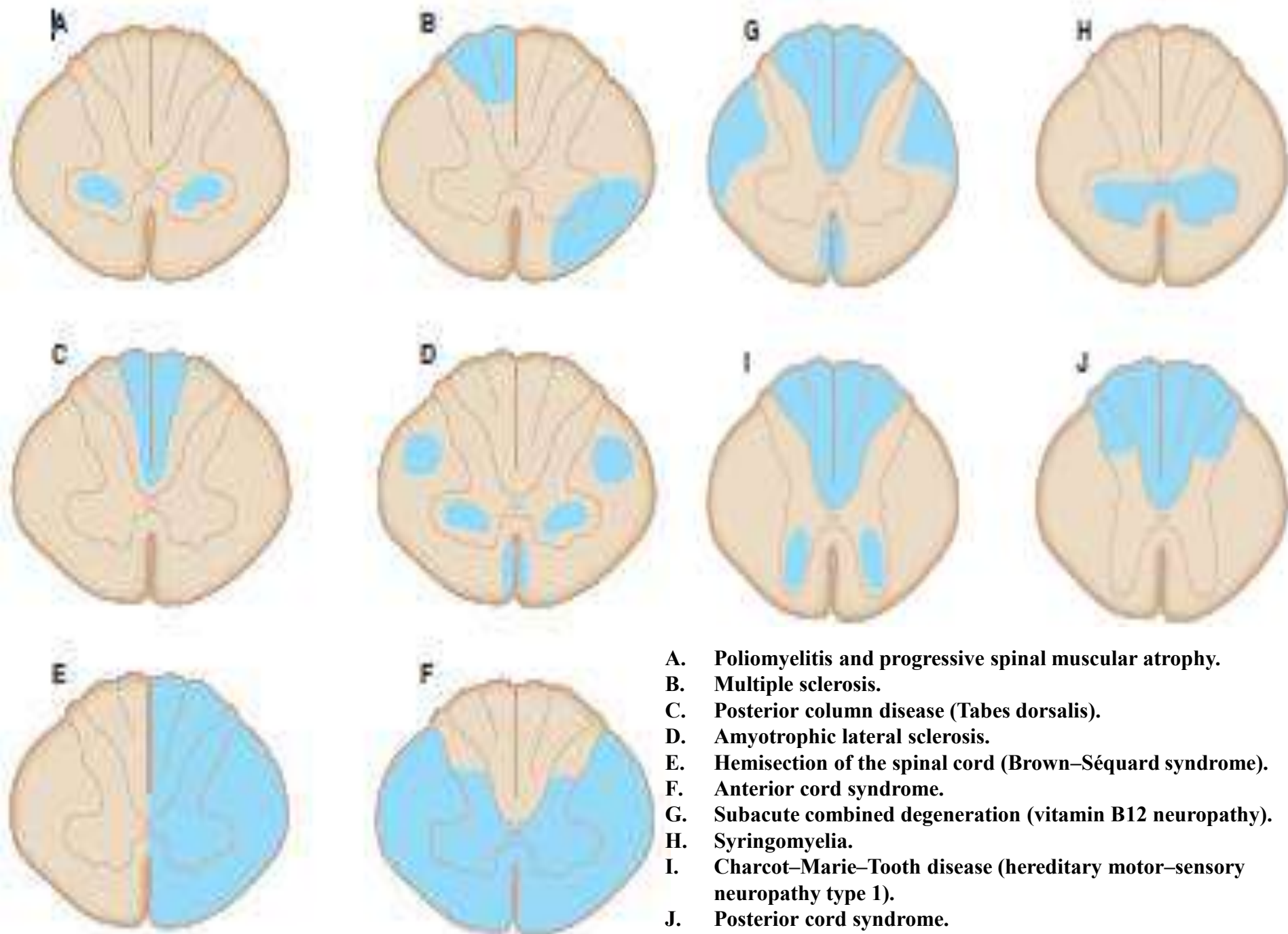
# Epiconus Syndrome

- Involves the segments L4–S2.
- Results in sphincter dysfunction.
- Loss motor and sensation <sup>U+M N</sup> below the level of lesion.
- Associated with absent achilles tendon reflex.

# Cauda Equina Syndrome

spinal root ←  
LMN

- Classically involves spinal roots L2 - S5 below the lower end of the spinal cord.
- May result from lumbo-sacral intervertebral disk herniation.
- Produces neurologic deficits similar to those seen in conus or epiconus lesions but presented radicular type loss of sensation.
- Results in signs that frequently predominate on one side or asymmetrical presentation.
- Commonly results in severe spontaneous radicular pain (pain that radiates along a dermatome).





Complete transection  
of the spinal cord



Brown-Séquard  
syndrome



Syringomyelic  
syndrome



Anterior cord syndrome  
(anterior spinal artery syndrome)



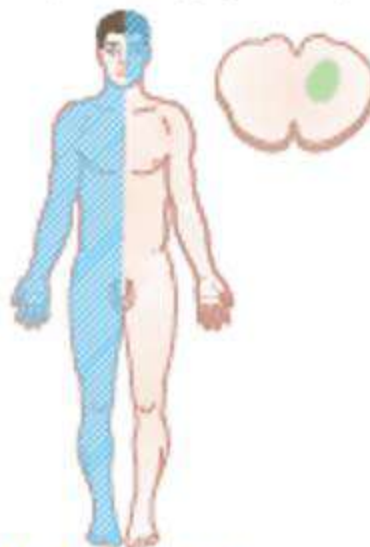
Posterior column  
syndrome



Conus medullaris  
lesion



Cauda equina  
lesion



Medulla oblongata  
lesion



Loss of pain sensation

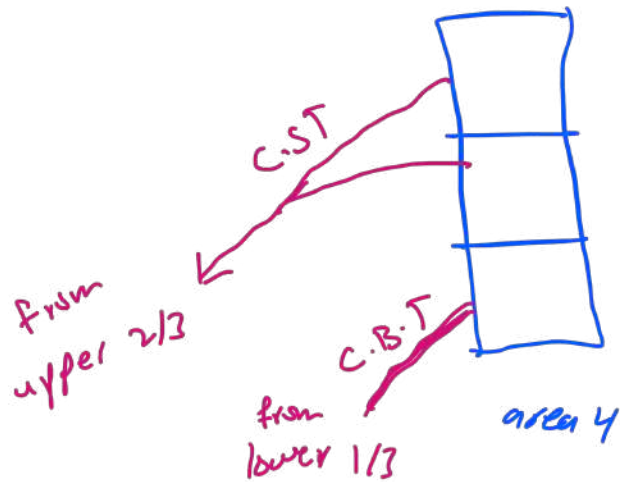


Loss of tactile or position sensation

*Thank You*  
*Thank You*



\* Slide 74:-



The upper motor neuron lesion = damage of CST or C.B.T = supra nuclear lesion damage.  
 // lower " " = damage of motor nuclei of cranial nerve, neuromuscular junction, damage of muscle fibers  
 [ infra nuclear lesion or nuclear lesion.. ]

\* example of LMNL → <sup>medial</sup> medullary stroke → damage of hypoglossal nucleus → according to the cr N it's LMNL.

\* MG affect the neuromuscular junction → LMNL.  
 or polymyositis / radiculopathy (root 11 also), neuropathy of peripheral nerves.

stroke [ R + cerebral ] ⇒ damage GNT, CST ⇒ LMNL.

\* Lateral GNT from <sup>C2-C4</sup> If → to mid brain → to pons C6 C7 C8 sensory / the trigeminal C5, C7 supply both side / facial to the dorsal  
 from medial C7 hypoglossal < IL & CL & cranial C2, C3, C4 in nucleus.

\* ventral ⇒ opposite side.

uni bi > (both) ambiguous [ 2 motor somatic nuclei ] NO   
 unilateral hypoglossal CL