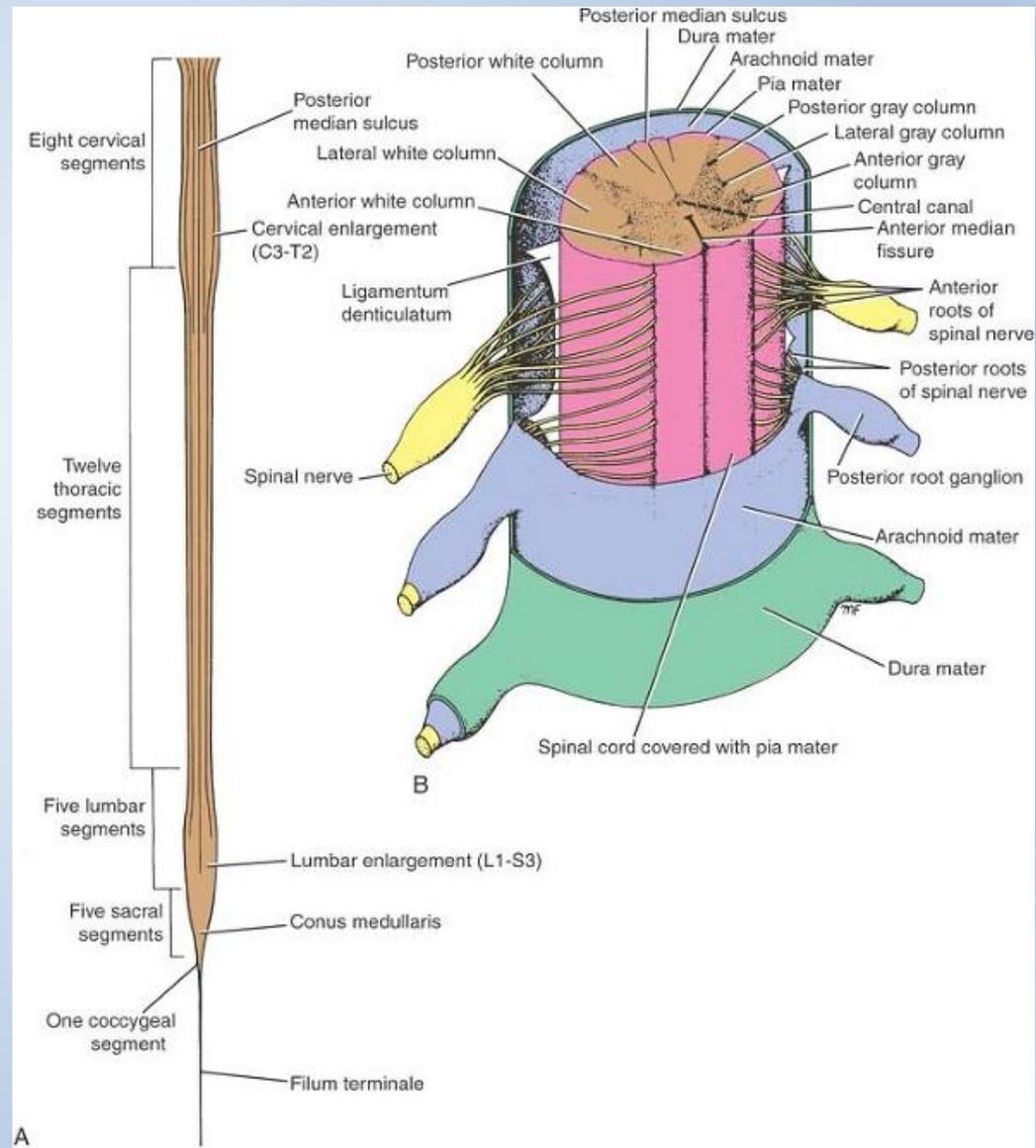


# **SPINAL CORD**

**BY DR. DALIA M. BIRAM**

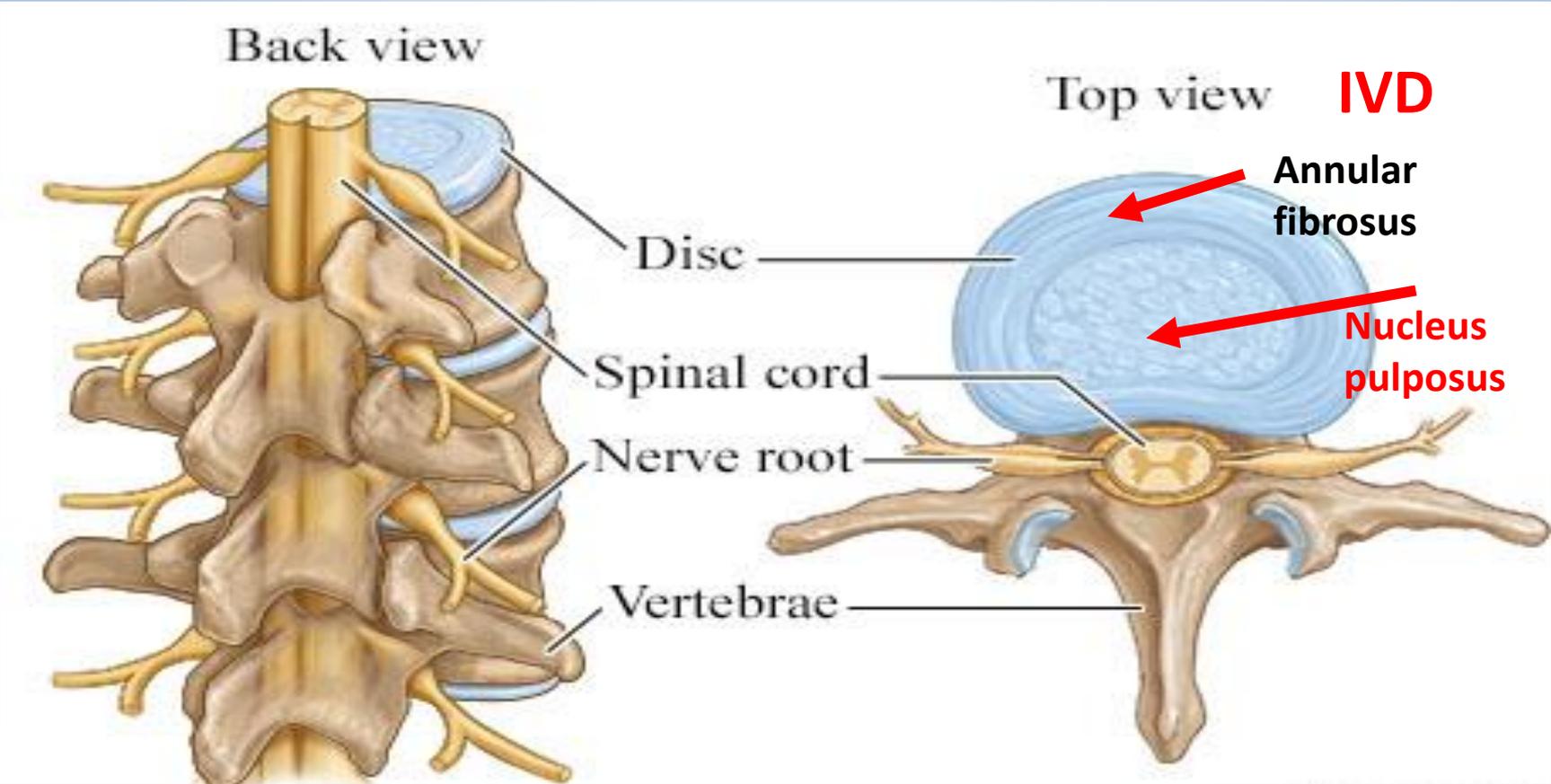
# Spinal cord

- It is an elongated cylindrical cord, about 45cm long, and occupies the upper 2/3 of the vertebral canal. It **starts** at the upper border of C1 vertebra and **ends** at the lower border of L1 vertebra.
- The spinal cord is differentiated into 31 segments: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral and 1 coccygeal.
- The spinal cord presents two enlargements:
  - **Cervical enlargement:** Which extends from C3 to T2 and corresponds to the origin of the brachial plexus.
  - **Lumbosacral enlargement:** Which extends from L1 to S3 and it corresponds to the origin of the lumbar and sacral plexuses.



# Position of the spinal cord

in the vertebral canal of the vertebral column



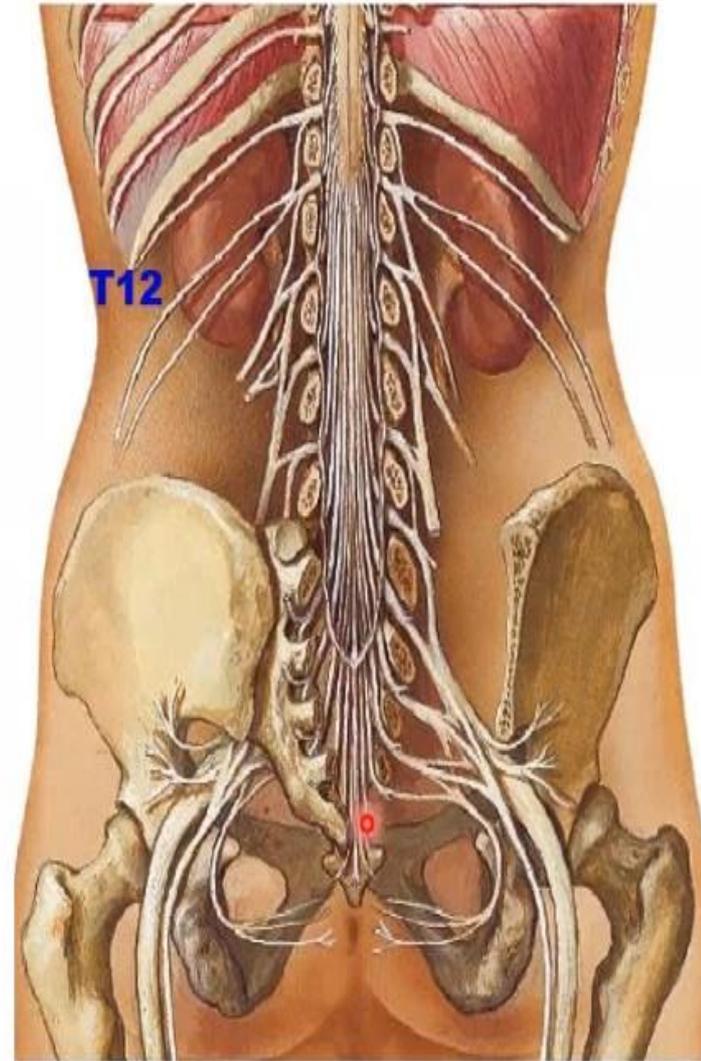
▪ **Termination of the spinal cord varies with the age:**

1- At the 3rd month of intrauterine life, **tip of coccyx**.

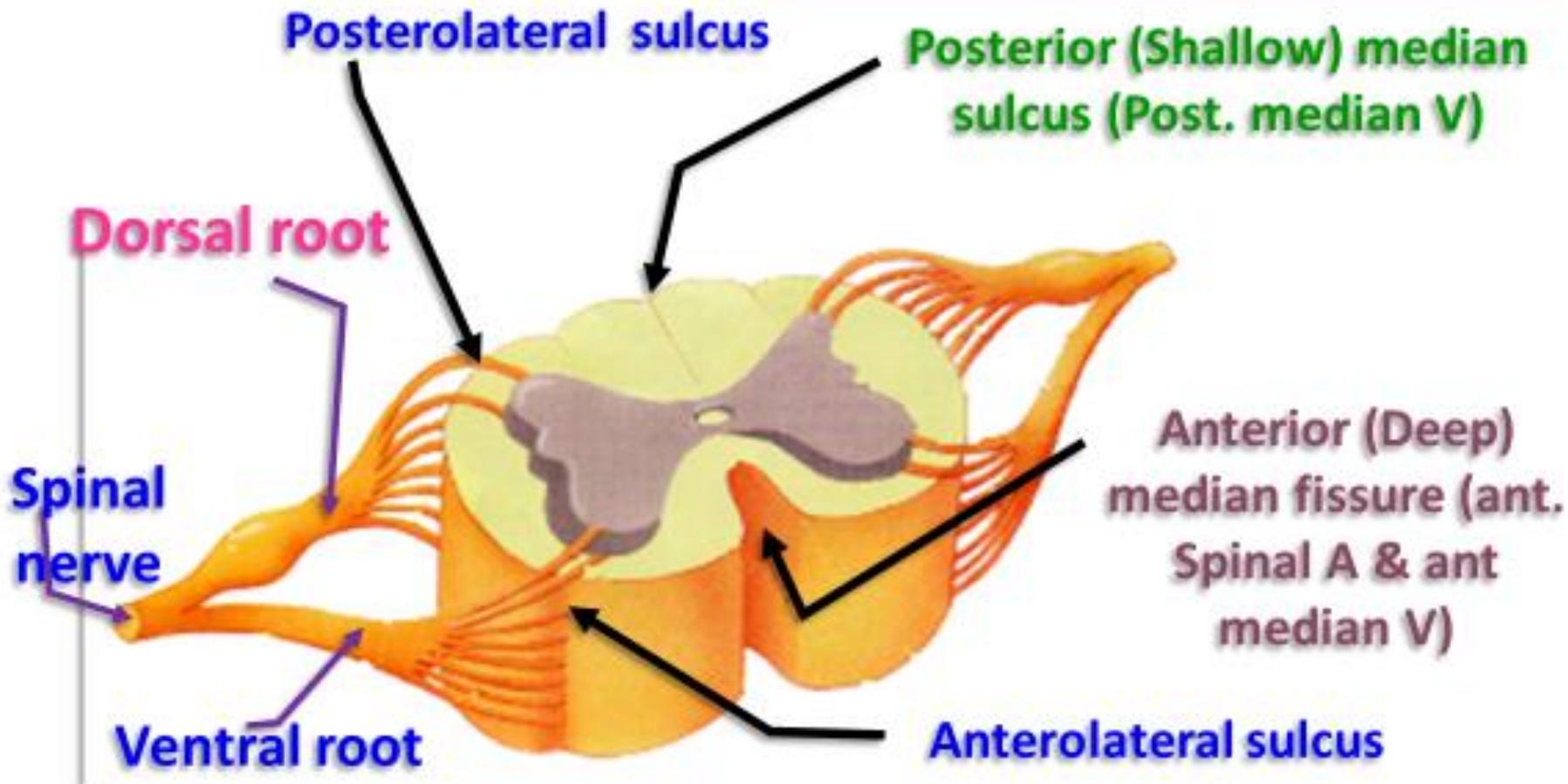
2- At birth, **intervertebral disc of L3/L4**.

3- **Adult**; at the level of **intervertebral disc of L1/L2**.

- Below this level, vertebral canal contains **roots** of lumbar, sacral, and coccygeal nerves around filum terminale which form a bundle called **Cauda Equina (L2 - C1)**
- The **lower nerve roots are longer and more oblique** because the spinal cord is shorter than the vertebral canal

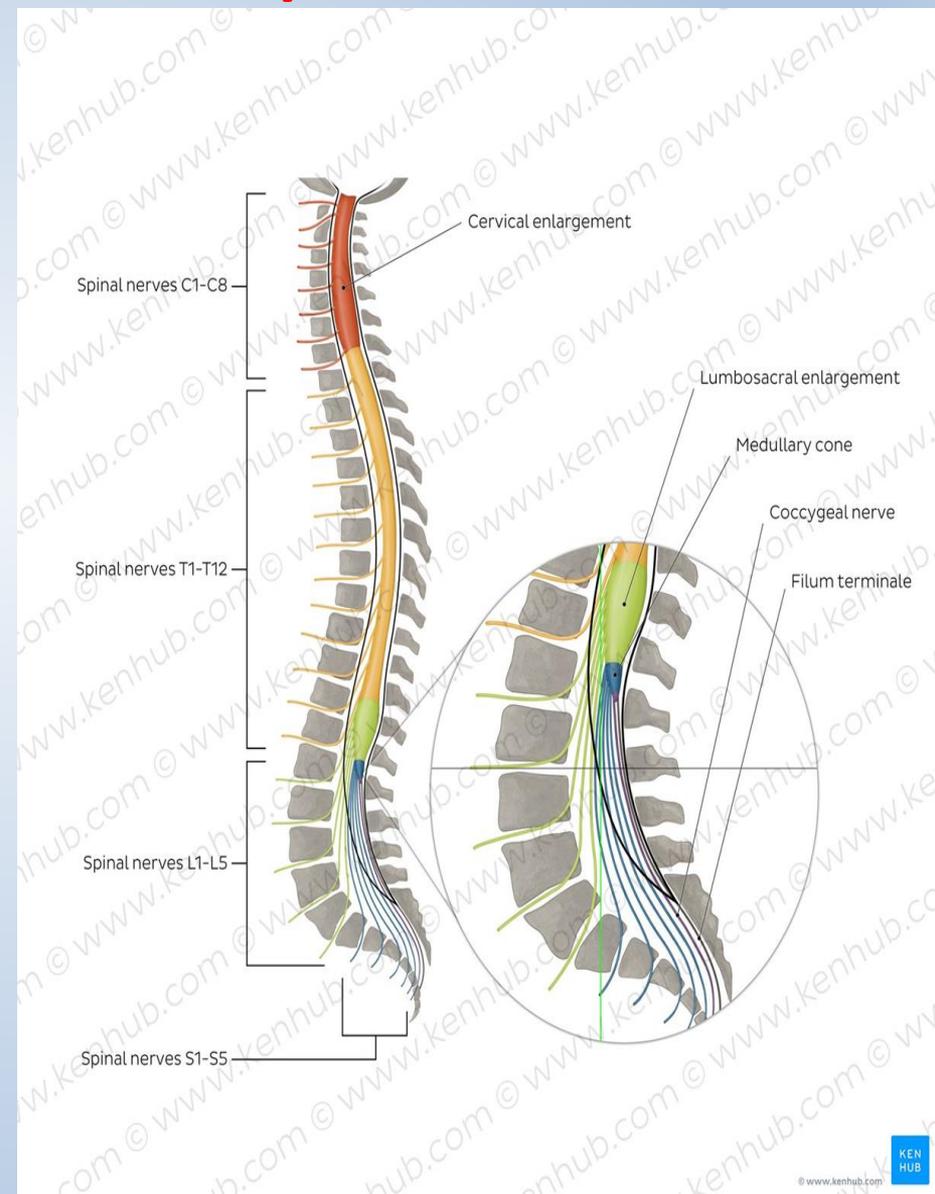


**Surface of spinal cord**



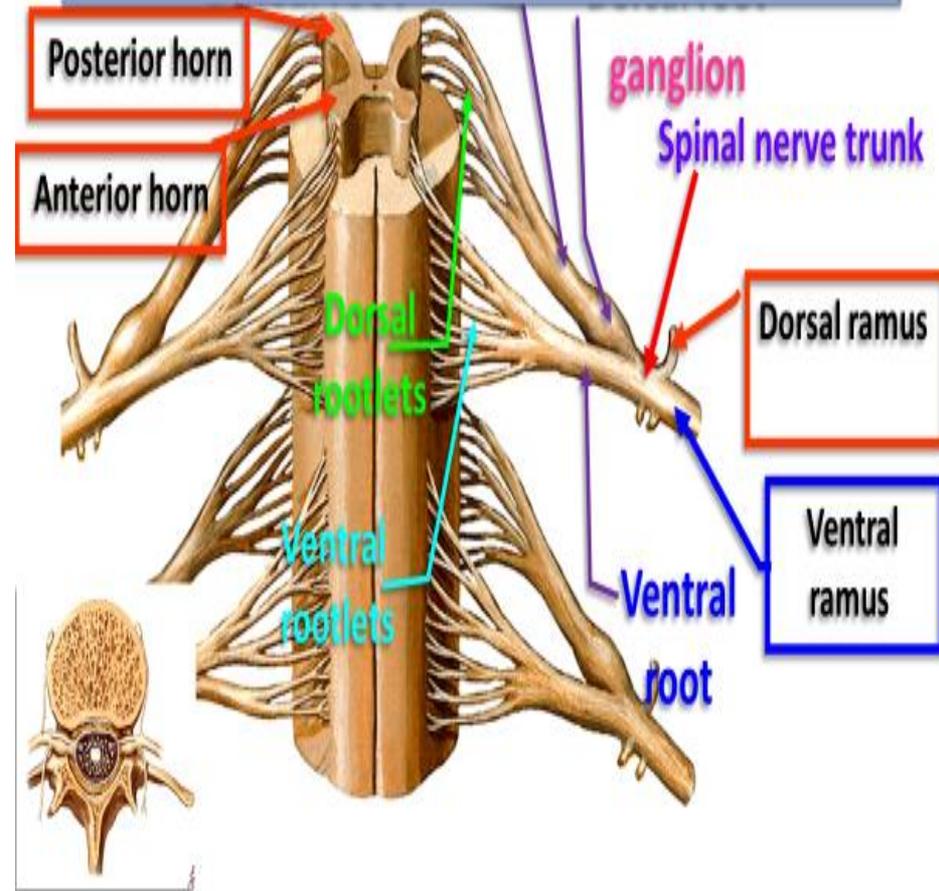
# Segmentation of the spinal cord

- It corresponds to the intrauterine period in which the spinal cord occupies the entire vertebral canal. For this reason, in adulthood, where the vertebral column is longer than the cord, **each spinal cord segment is located higher than its corresponding vertebra.** These differences become more obvious distally towards the lumbar and sacral segments of the spinal cord



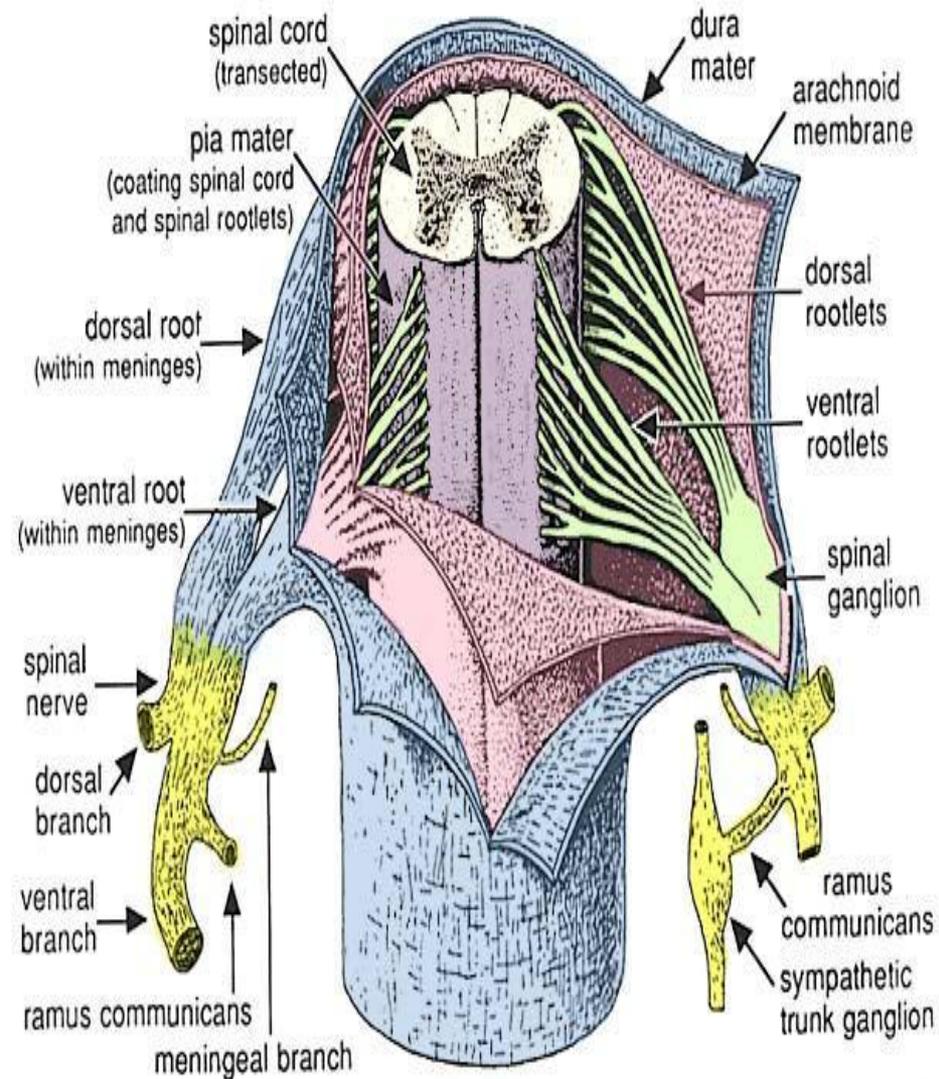
# Spinal nerves

- Each spinal nerve has an anterior and posterior root. Anterior roots transmit motor information, and they originate from the anterior horns of the gray matter and exit the spinal cord through the anterolateral sulcus. The posterior roots transmit sensory information and have sensory ganglion attached to them. They are attached to the posterior horns of gray matter and exit through the posterolateral sulcus of the spinal cord.



# Spinal nerves

- The anterior and posterior roots merge just before the intervertebral foramen and form the trunk of the spinal nerve. The trunk is very short, and soon after exiting the vertebral column, it divides into four branches: anterior ramus, posterior ramus, communicating ramus, and meningeal ramus.



- **Exit of the spinal nerves**

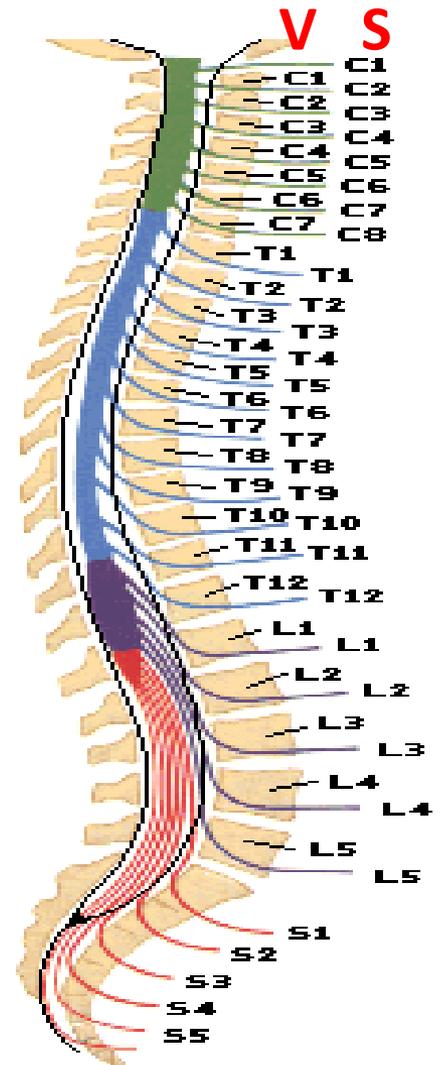
**1- Cervical nerves:** each nerve from C1-7 leaves the vertebral canal through **intervertebral foramen above** the vertebra of the same number.

- **C8 nerve** leaves **below** C7 vertebra.

**2- Thoracic and lumbar nerves;** each leaves the vertebral canal **below** the vertebra of the same number.

**3- Sacral 1- 4 nerves;** leaves the vertebral canal through the **sacral foramina**.

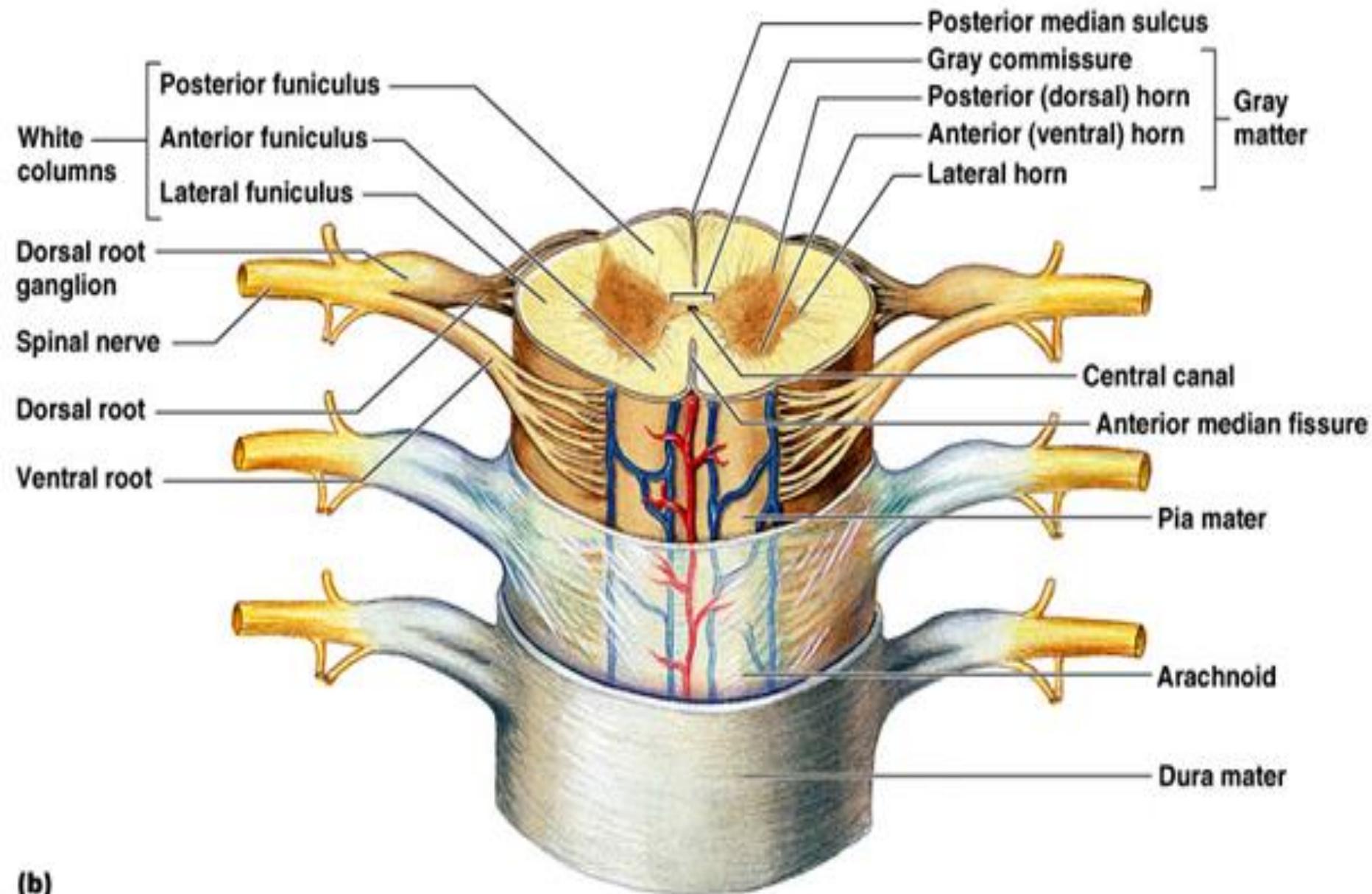
**4- The 5<sup>th</sup> sacral and coccygeal nerves** leave the canal through the **sacral hiatus**.



# Meninges of the Spinal Cord

## • A. Dura mater

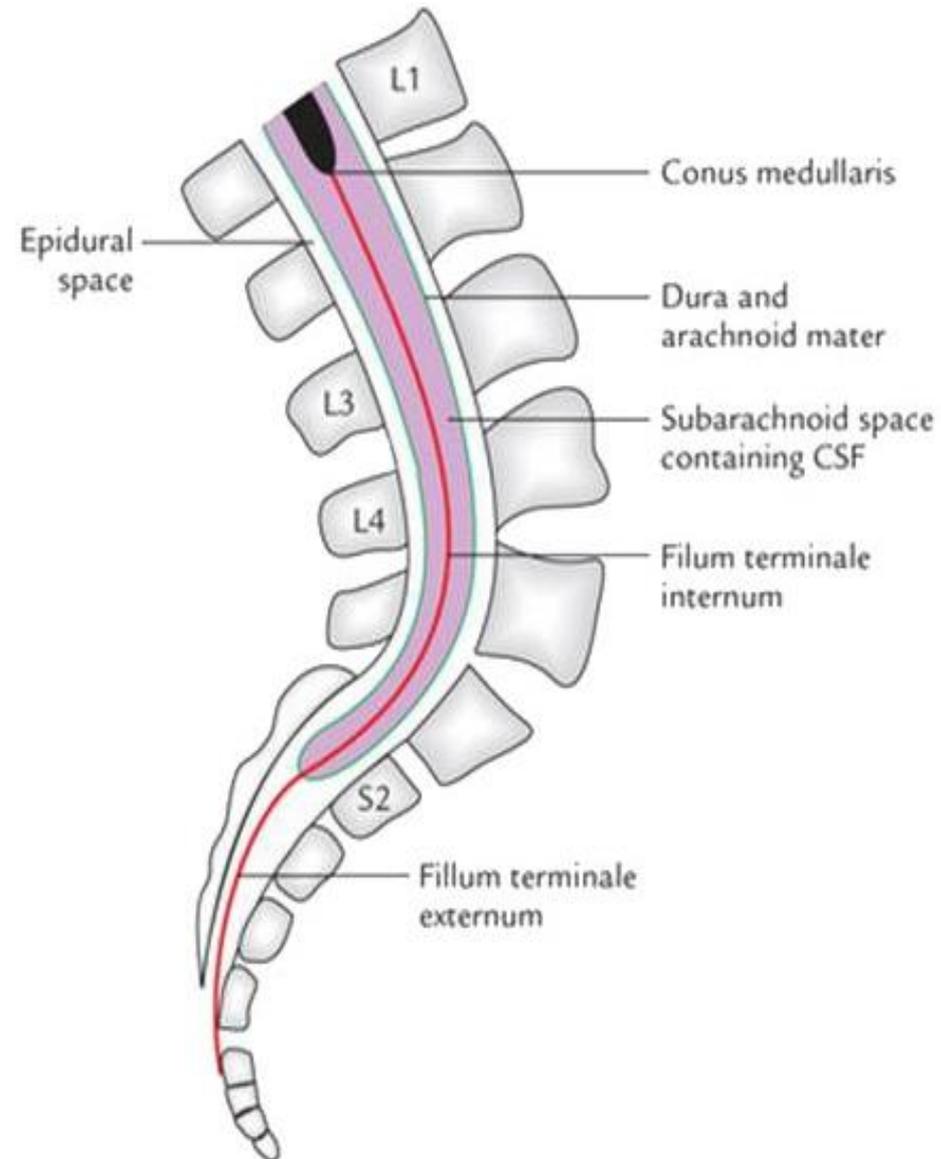
- It is the outermost coat of the three meninges. It is attached to the bones of the vertebral canal. It extends from **the foramen magnum** to **the 2nd sacral** segment. It sends out tubular sheath over the trunk of the spinal nerves as they lie in the intervertebral foramen. These dural sheaths are continuous with the epineurium of the nerves.
- The space outside the dura, between it and the periosteum of the vertebral canal, is called extradural (or epidural) space. This space contains **the internal vertebral venous plexus**.
- The space deep to the dura, between it and the arachnoid mater, is called subdural space. This space contains a thin film of serous fluid.
- **N.B.:**
  1. The spinal dura is formed of only one layer, while the cranial dura is formed of two layers.
  2. The cranial dura contains venous sinuses, while the spinal dura does not.



**(b)**  
 Copyright © 2004 Pearson Education, Inc., publishing as Benjamin Cummings.

## B. The arachnoid mater

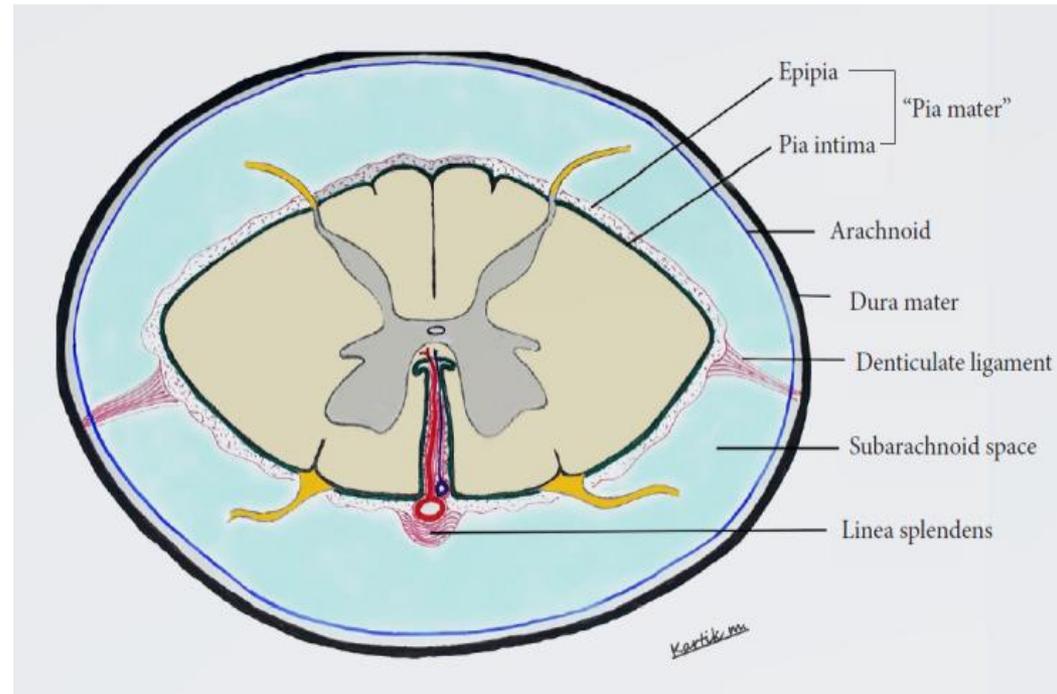
- It is a delicate tubular sheath close to the inner aspect of the dura and it also ends at the level of **second sacral vertebra**. It is separated from the pia mater by a relatively wide space called the **subarachnoid space** which is filled with the cerebrospinal fluid. The lower part of the subarachnoid space which contains the cauda equina, CSF and the filum terminale is called the **lumbar cistern**.



# C. Pia mater

- It is a delicate connective tissue sheath which is intimately adherent to the spinal cord. The pia mater springs laterally forming **21-teeth** like processes called **ligamenta denticulata**. These processes fix the spinal cord to the dura mater. The first process is attached to the margin of the foramen magnum, while the last process is at the level of first lumbar spinal segment.
- At the lower end of the spinal cord, the pia mater is prolonged to form **the filum terminale**. The filum terminale pierces the lower end of the arachnoid and dura where it extends down to be attached to tip of coccyx.

- Pia mater is thickened to form
- Posteriorly: septum posticum
- Anteriorly: linea splendens.



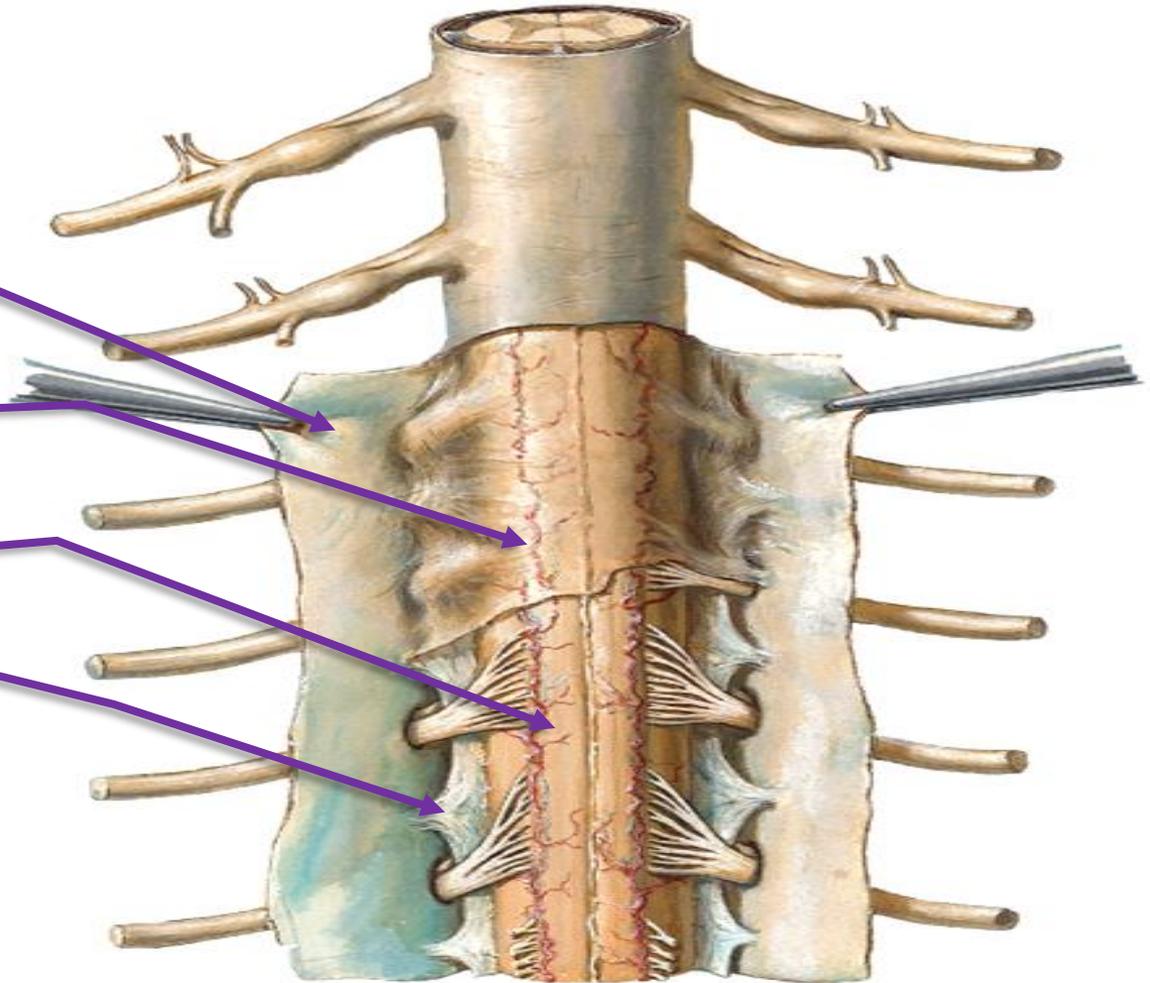
**Dura mater**

**Arachnoid mater**

**Pia mater**

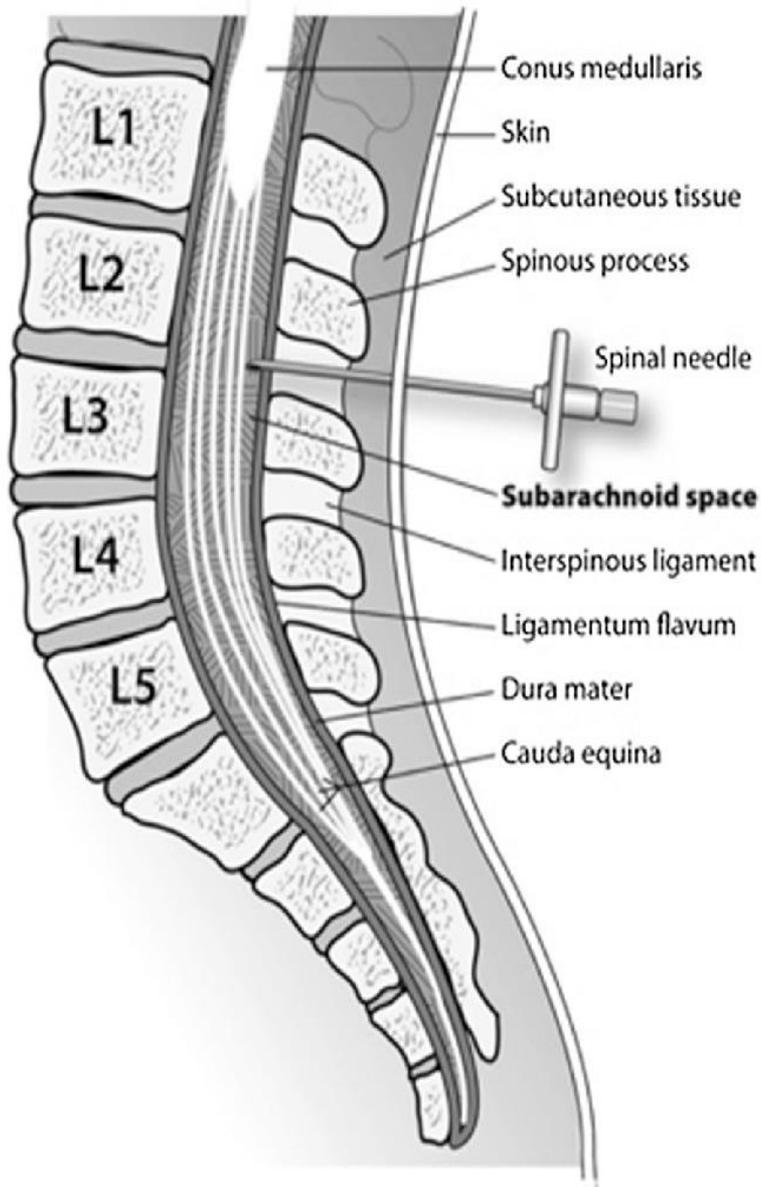
**Denticulate ligament:**

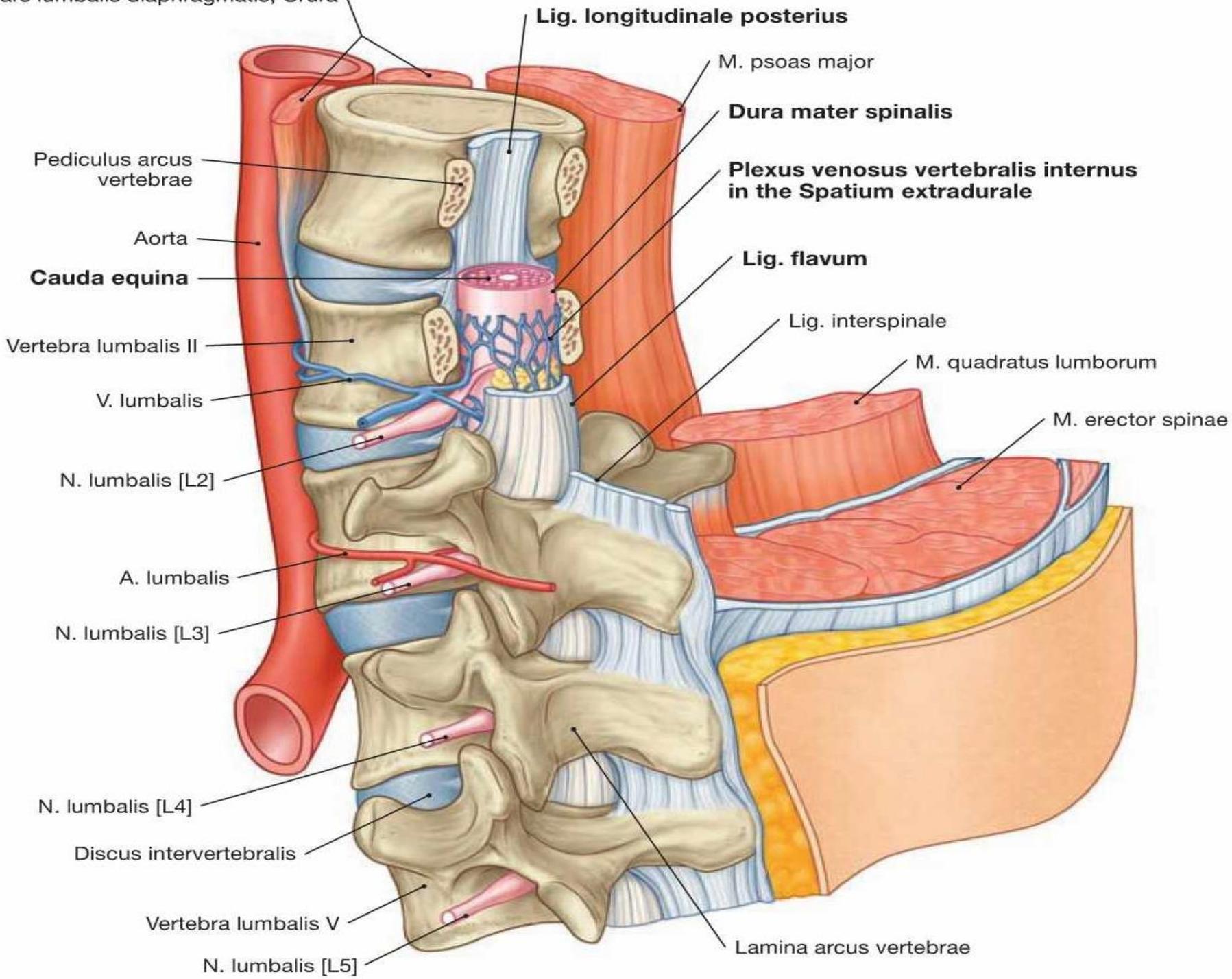
A teeth like processes from the pia matter **pierce** the arachnoid matter and **fixed** to the dura matter.



# Lumbar puncture

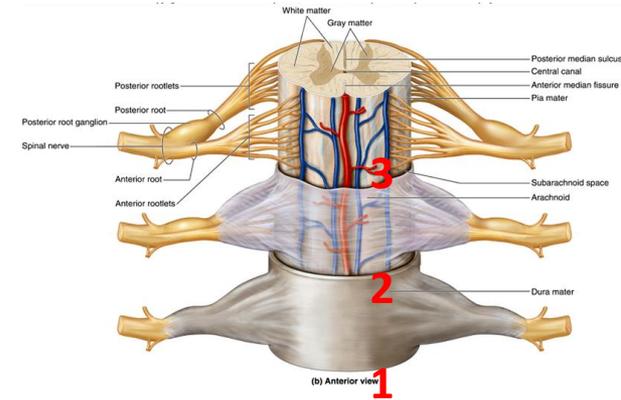
- [https://youtu.be/O\\_RjwNMZws8](https://youtu.be/O_RjwNMZws8)





# Meningeal spaces of the spinal cord

- **Epidural (extradural) space** outside dura mater, contains:
  - a- Loose areolar tissue.
  - b- Internal vertebral venous plexus.
- **Subdural space**; between dura and arachnoid matter, contains small amount of **serous fluid** to moisten the surfaces.
- **Subarachnoid space**; between arachnoid and pia matter contains;
  - 1- Cerebrospinal fluid (CSF).
  - 2- Roots of the spinal nerves
  - 3- Blood vessels of the spinal cord.
- The lower part of the subarachnoid space below L1 is dilated and called **lumbar cisterna** contains **cauda equina** (filum terminale & roots of spinal nerves) and csf.



## Fixation of the spinal cord

1- Attachment of the **filum terminale** to the tip of the coccyx.

2- Attachment of the **denticulate ligaments** to the dura matter.

Thickening of Pia mater: The ligamenta denticulata, septum posticum and linea splendens.

3- Attachment of the **dura matter** to;

a- The margin of the foramen magnum.

b- The back of S2.

c- The margin of the intervertebral foramen.

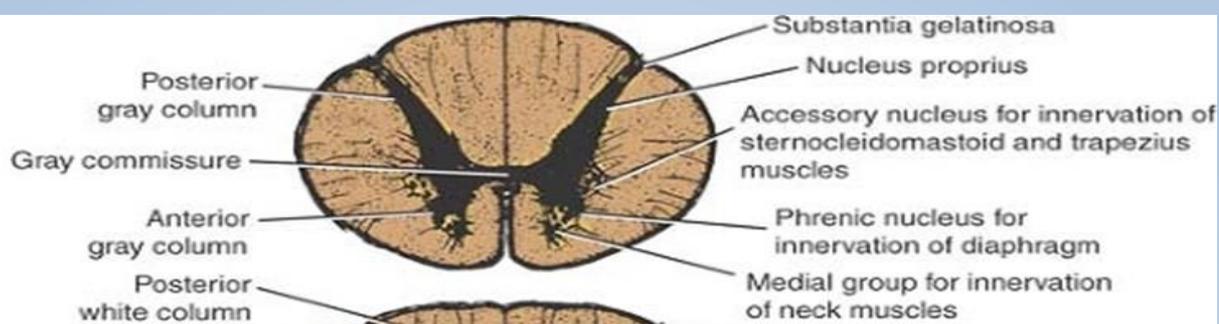
4- Attachment of the **spinal nerves and vessels** to the surface of the spinal cord.

## **Internal structure of the spinal cord:**

In transverse sections, the spinal cord appears incompletely divided into 2 symmetrical halves by the anterior median fissure and posterior median septum.

- It contains a narrow lumen called the **central canal**.
- The cord is formed of **grey** and **white matter**.
- The grey matter occupies a **central** position, while the white matter occupies a **peripheral** position.
  
- In transverse sections, the grey matter appears **H-shaped**.
- It is formed of **2 anterior horns** and **2 posterior horns** which are connected on both halves by the **grey commissures** across the median plane.
- In the **thoracic & upper lumbar** segments a **lateral grey horn** is also present.
  
- The white matter is occupied by **short** and **long ascending** and **descending** tracts.
- It is differentiated into **3 columns** on each side:
  - **Posterior white column:** between the posterior median septum and the posterior horn. In the cervical and upper thoracic regions, this column is further divided by the posterior intermediate septum into gracile tract medially and cuneate tract laterally
  - **Lateral white column:** lateral to both anterior and posterior horns
  - **Anterior white column:** between the anterior median fissure and ventral roots of spinal nerves

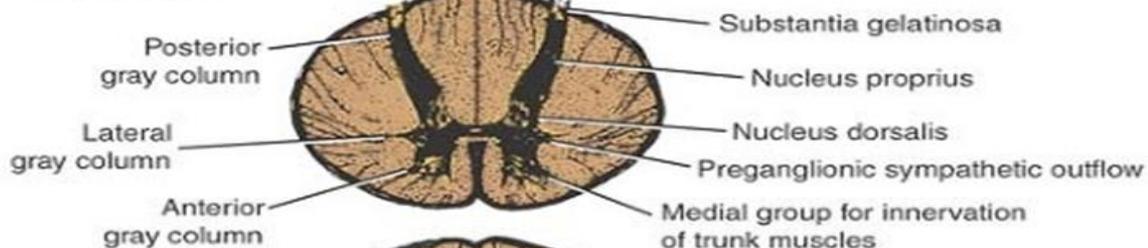
**Third cervical segment**



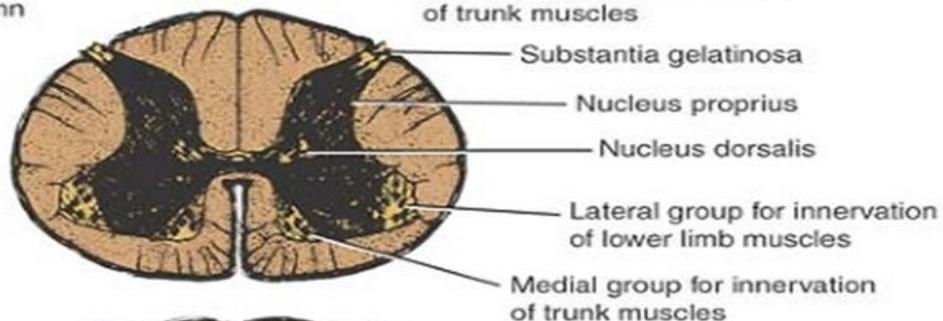
**Sixth cervical segment**



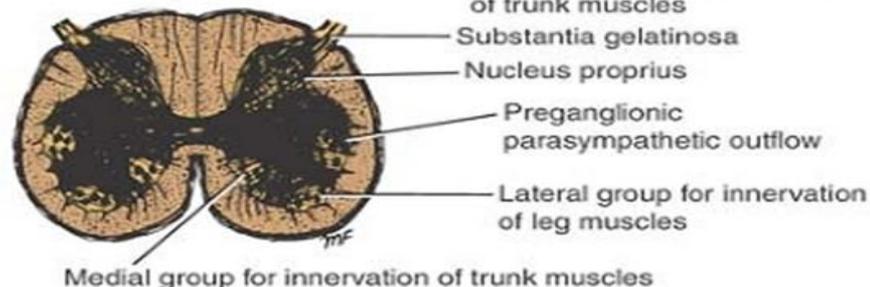
**Sixth thoracic segment**



**Third lumbar segment**



**Third sacral segment**



## **A-Nerve cell groups of the anterior grey horn:**

The ventral or anterior grey region is basically divided into three columnar groups: medial, central and lateral.

### **1. The medial group:**

It innervates the axial musculature (muscles of trunk).

### **2. The central group:**

It is present only in some cervical and lumbosacral segments.

1- In the cervical region it is present:

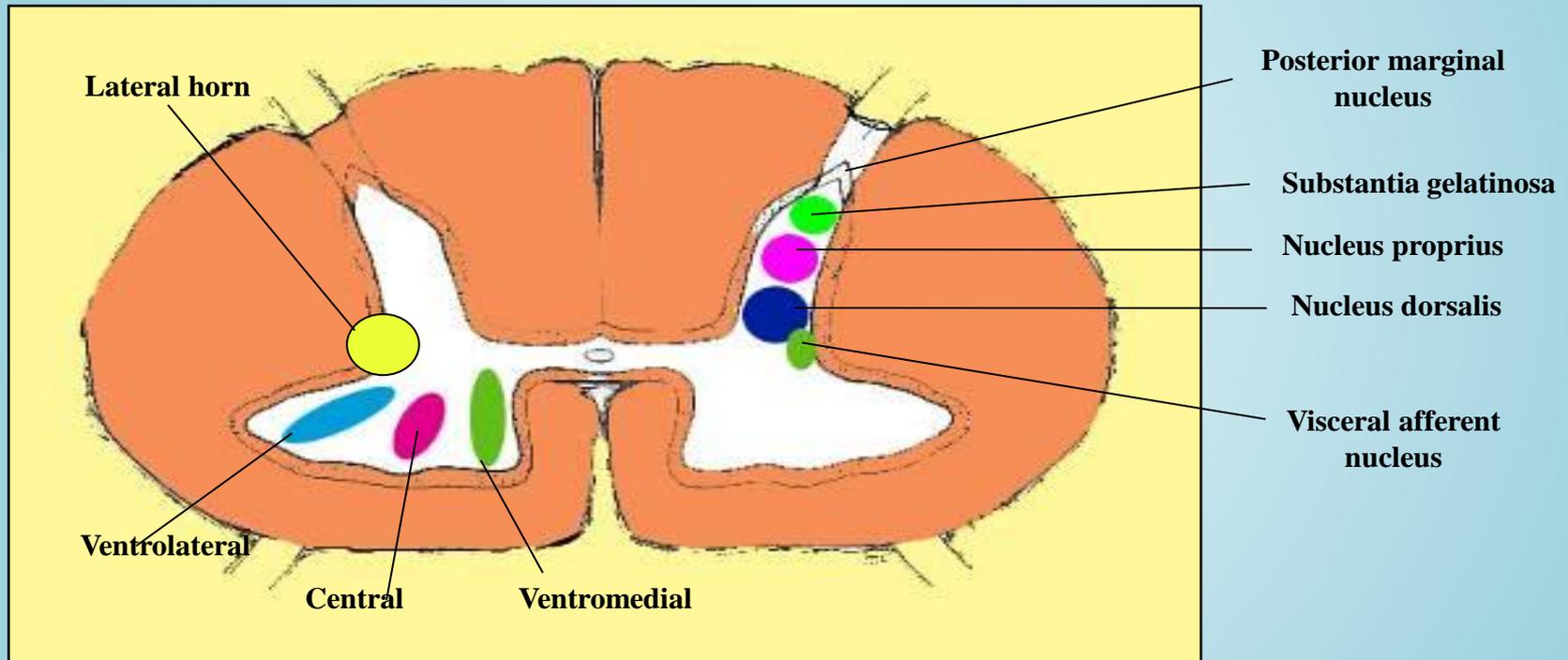
- From C1-C5 give the origin of spinal accessory nerve.

-from C3 to C5 and is termed phrenic nucleus.

### **3. The lateral group:**

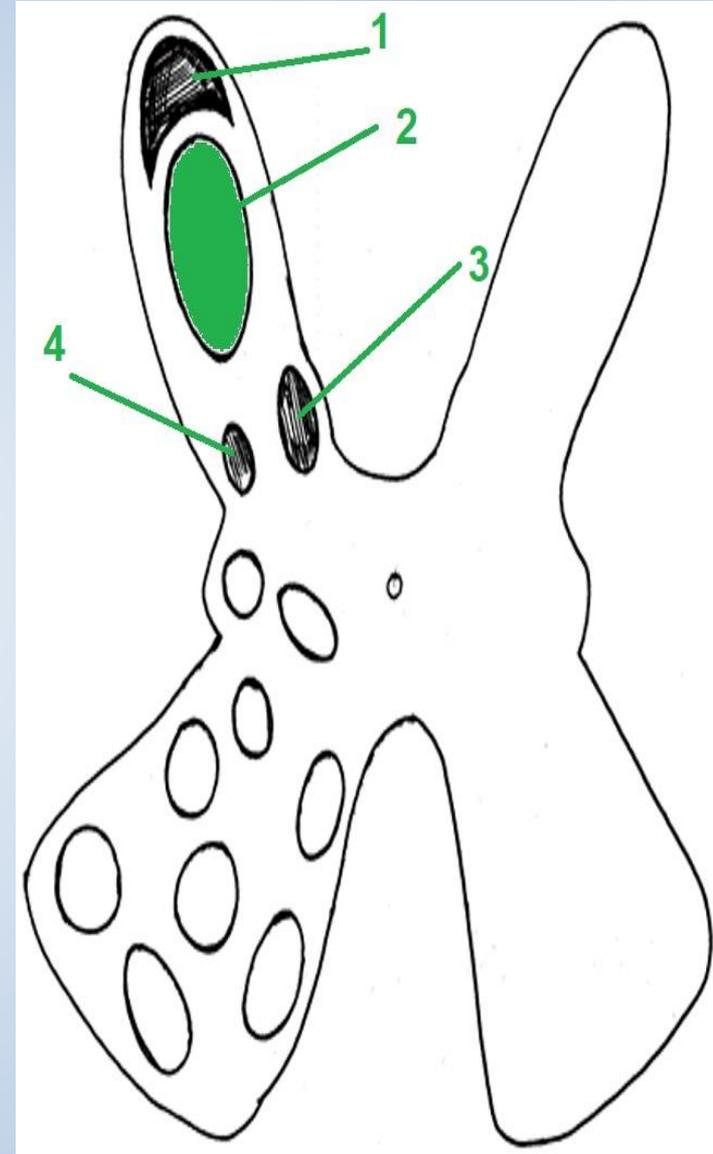
It innervates the limbs; they are present in the cervical, lumbar and sacral regions

# Nuclei of the spinal cord



## B. Nerve cell groups in the posterior grey column:

1. **Substantia gelatinosa** (of Rolando): present at all levels. It receives afferent fibers concerned with pain, temperature from the posterior root.
2. **Nucleus proprius** present at all levels. It receive pain and temperature and touch sensations
3. **Nucleus dorsalis** (or thoracis) of Clarke: it occupies the basal region of the posterior grey column. It extends from C<sub>8</sub> to L<sub>3</sub>. It is associated with proprioceptive endings (neuromuscular spindles and tendon spindles; i.e. muscle joint sense).
4. **The visceral afferent nucleus:** It is situated lateral to the nucleus dorsalis; it extends from the C8-L3. It is believed to be associated with receiving visceral afferent information.





# Blood supply of the spinal cord

## Arterial supply

The anterior and posterior spinal arteries travel in the subarachnoid space

### 1- Anterior spinal artery:

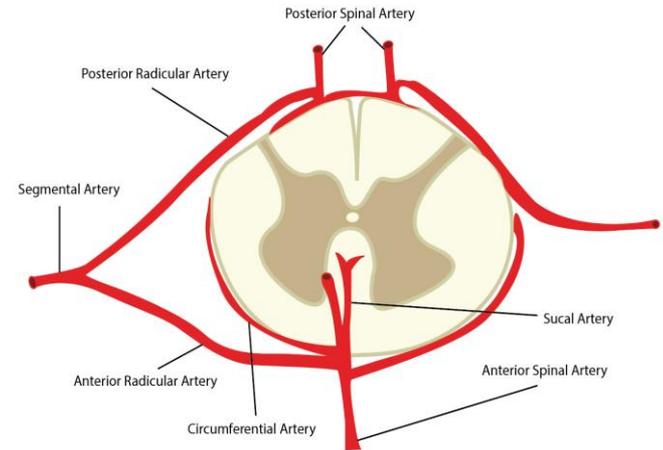
- It is branch of the **4<sup>th</sup> part of vertebral artery** (one on each side).

1. They **unit** together to form a single anterior spinal artery, descends in front of **anterior median fissure** of the spinal cord. It supplies the anterior two thirds of the spinal cord.

**2- Posterior spinal artery:** supplies **posterior 1/3** of spinal cord

- It is a branch of the **4<sup>th</sup> part of vertebral artery** (one on each side).

- Each vessel descends on the posterior surface of the spinal cord along the posterolateral sulcus.



## Arterial supply

**3- segmental arteries:** supply the lateral part of the spinal cord

- They enter vertebral canal through intervertebral foramina.

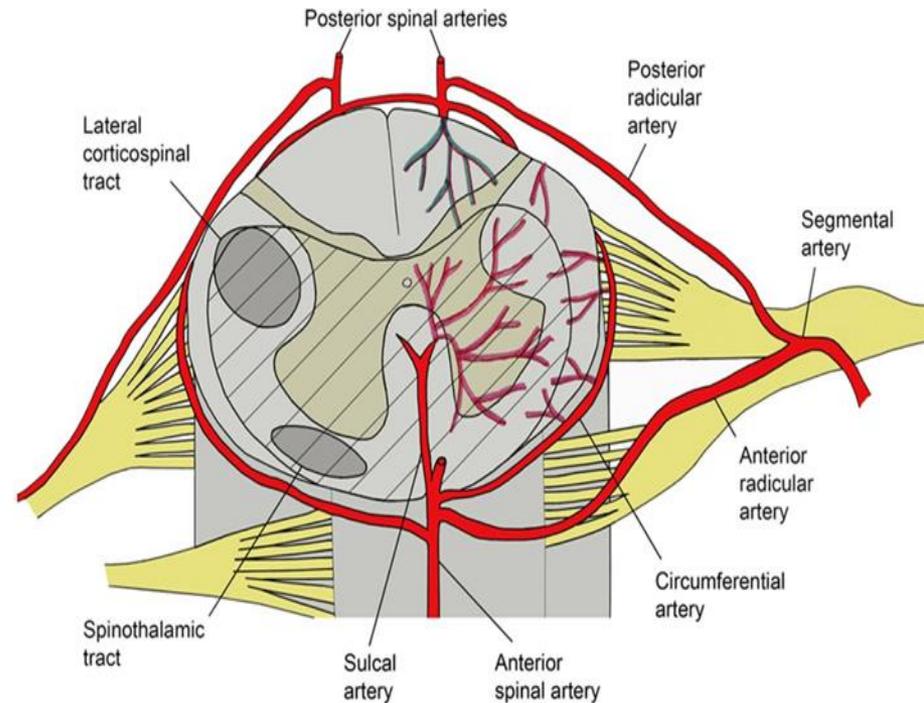
**a- Cervical region:** from the 2<sup>nd</sup> part of vertebral artery and ascending cervical artery.

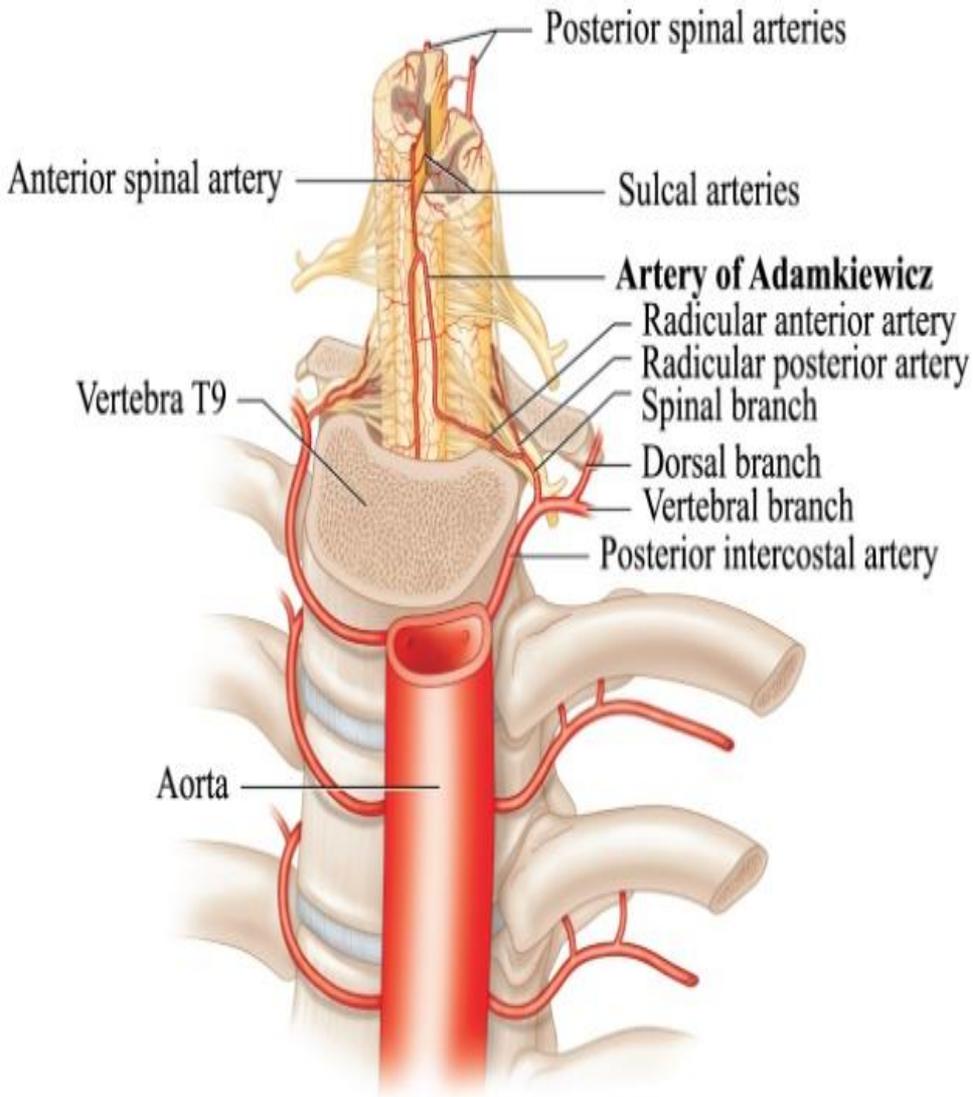
**b- Thoracic region:** from posterior intercostal and subcostal arteries.

**c- In the lumbar region:** from the lumbar arteries.

**d- In the sacral region,** the lateral sacral arteries

- In each segment, the **segmental arteries** that enter the intervertebral foramina divided into anterior & posterior radicular arteries & accompany the dorsal and **ventral & dorsal nerve roots**.
- These branches unite directly with the posterior and anterior spinal arteries to form ring of arteries (**an arterial corona**).





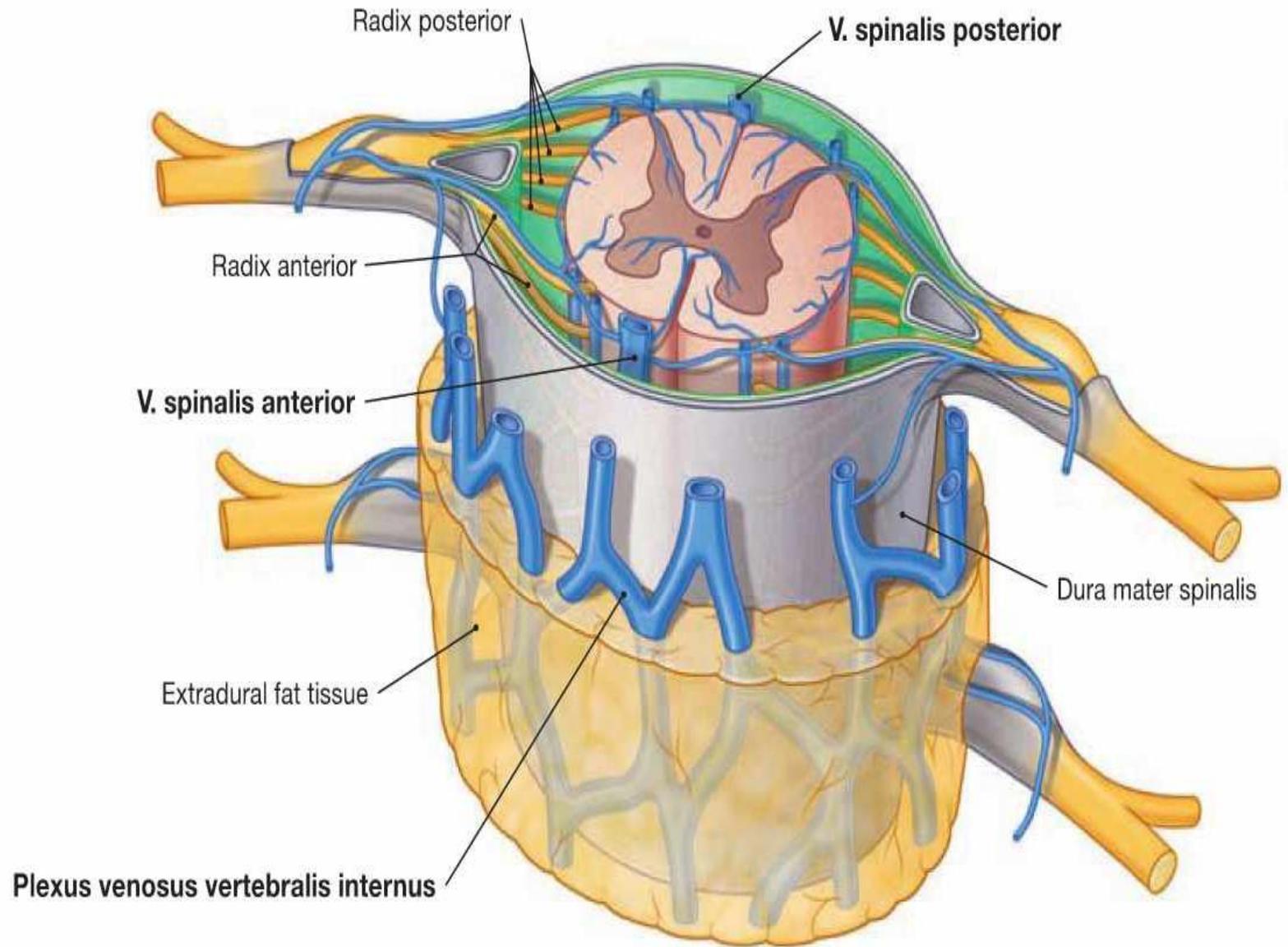
- The intermediate or midthoracic portion of the cord between T3 and T8 is poorly vascularized by intercostal arteries
- In the lower or thoracolumbosacral region, there is again a rich vascular supply through the radiculomedullary branches of the intercostal and lumbar arteries. One important artery is the great anterior radicular artery of Adamkiewicz (artery of the lumbar enlargement).

## **B. Venous drainage**

**There are six longitudinal veins which run along the spinal cord. These are:**

- 1. Anterior spinal vein: In front of the anteromedian sulcus.**
- 2. Posterior spinal vein: Behind the posteromedian septum.**
- 3. Anterolateral spinal veins (two): One on each side, lying in front the attachment of the ventral root of the spinal nerve.**
- 4. Posterolateral spinal veins (two): One on each side, lying behind of the attachment of the dorsal root of the spinal nerve.**

**These six longitudinal veins anastomose freely with each other around the spinal cord. They communicate above with the cranial venous sinuses and with the cerebellar veins. In the vertebral canal, these spinal veins communicate with the internal vertebral venous plexus and with the segmental veins outside the vertebral canal through radicular veins which run along the spinal nerves.**



*Thank You*



*Dr. Dalia M. Biram*