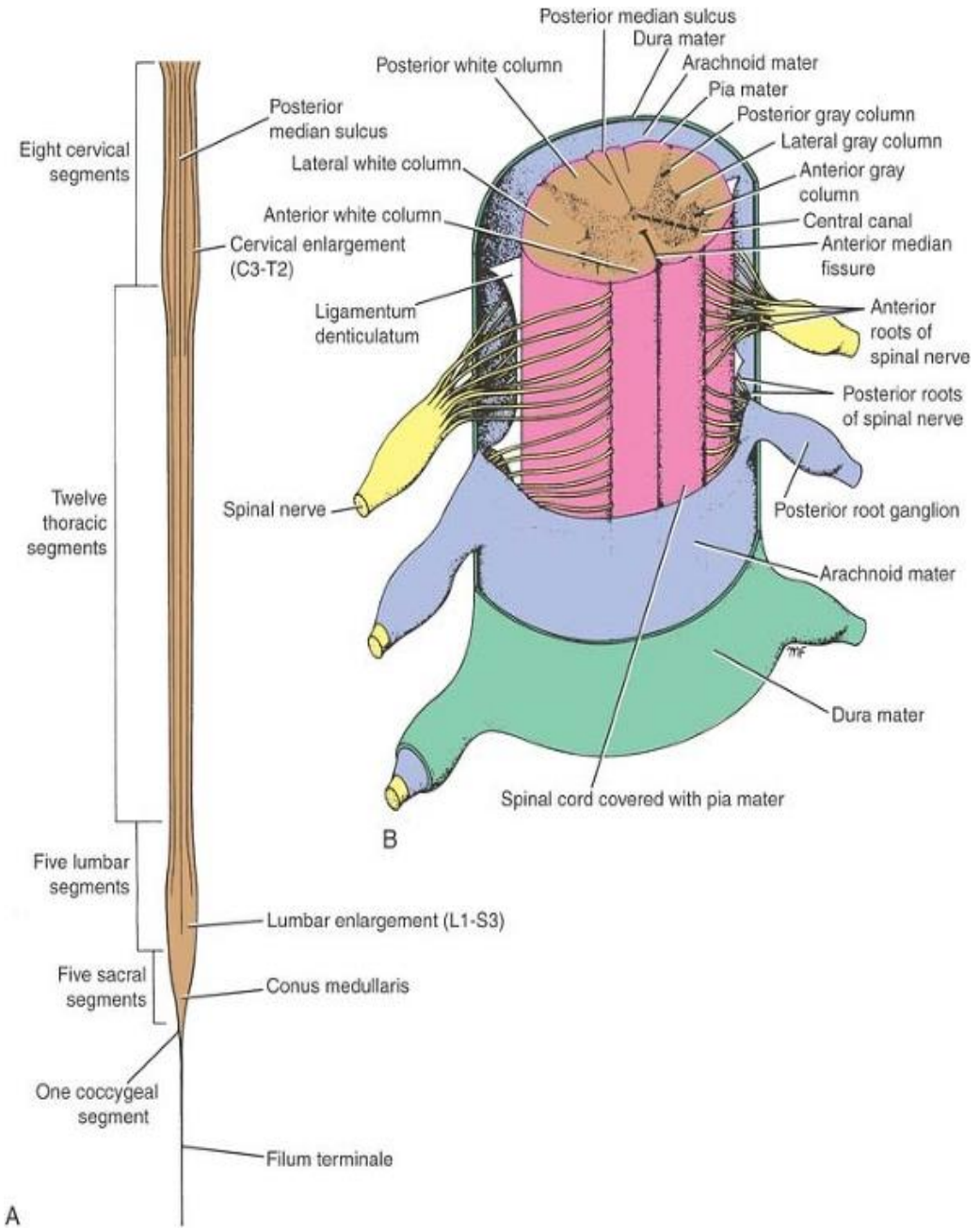
SPINAL CORD

BY DR. DALIA M. BIRAM

Spinal cord

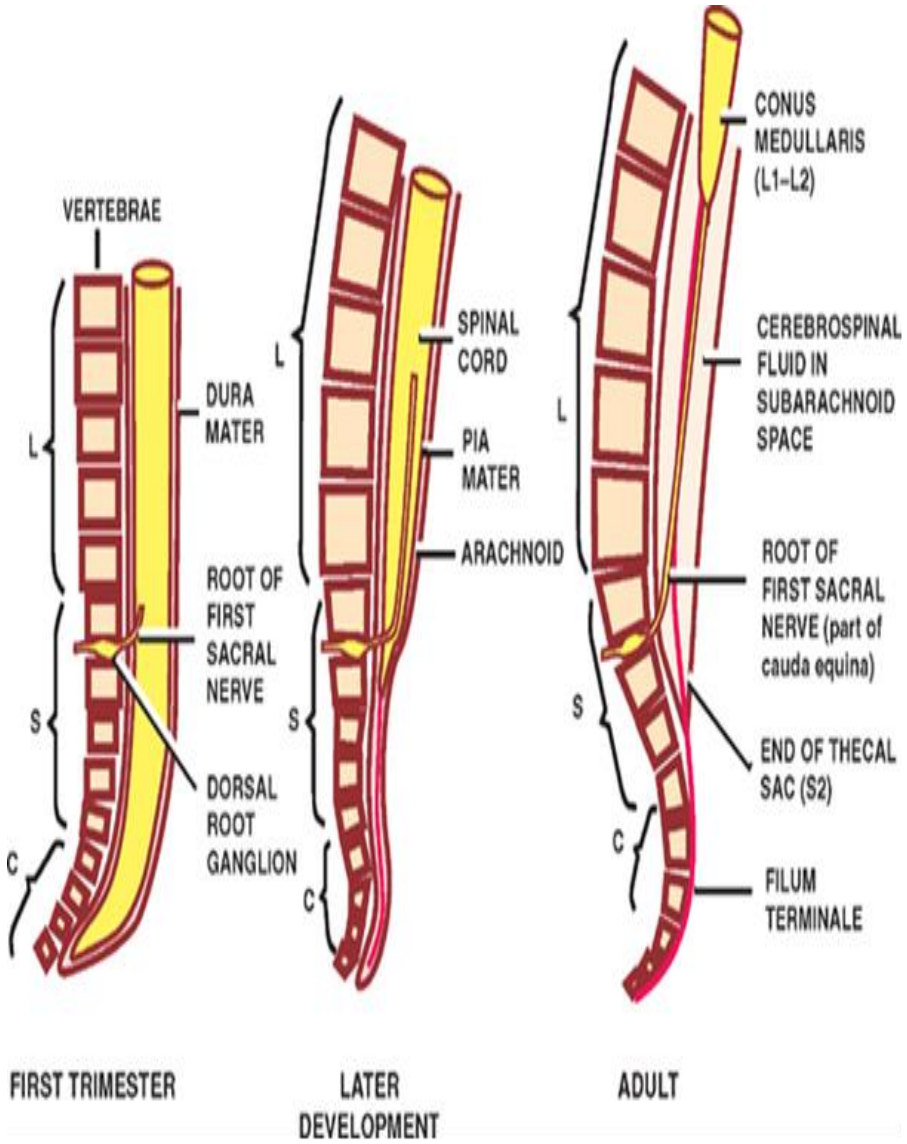
- It is an elongated cylindrical cord, about 45cm long, and occupies the upper 2/3 of the vertebral canal. It starts at the upper border of C1 vertebra and ends at the lower border of L1 vertebra as conus medullaris.
- The spinal cord is differentiated into 31 segments: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral and 1 coccygeal.
- The spinal cord presents two enlargements:
- *Cervical enlargement:* Which extends from C5 to T1 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.



Changes in the length of the spinal cord according to age:

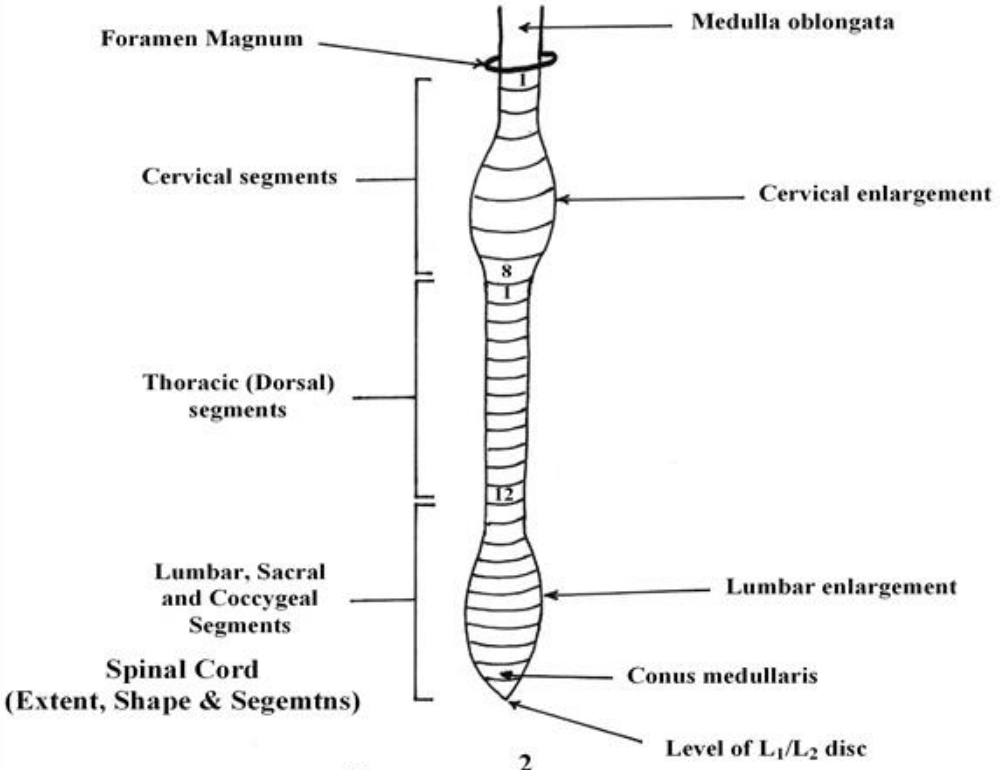
1. By the 3rd month of intra-uterine life (in the fetus), the spinal cord fills the whole vertebral canal.
2. At birth, the spinal cord ends at the level of L3 vertebra.
3. In adult, the spinal cord ends at the level of the disc between L1/2 vertebrae.

- These changes are due to the difference in the rate of growth of the spinal cord (slower) compared with that of the vertebral column (more rapid).

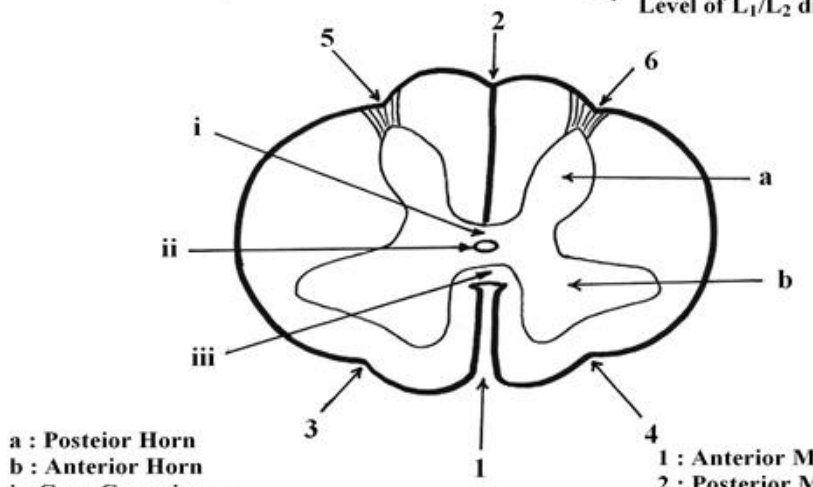


★ **External features:** The spinal cord shows **5 sulci & 1 fissure**:

- **Anterior median fissure**: is the deepest.
- **Posterior median sulcus**.
- **Two anterolateral sulci:** one on each side, along which emerge the **ventral (motor) roots** of the spinal nerves.
- **Two posterolateral sulci:** one on each side, along which enter the **dorsal (sensory) roots** of the spinal nerve.



Spinal Cord
(Extent, Shape & Segemtns)



a : Posteior Horn
b : Anterior Horn
i : Grey Commissure
ii: Central Canal
iii: White Commissure

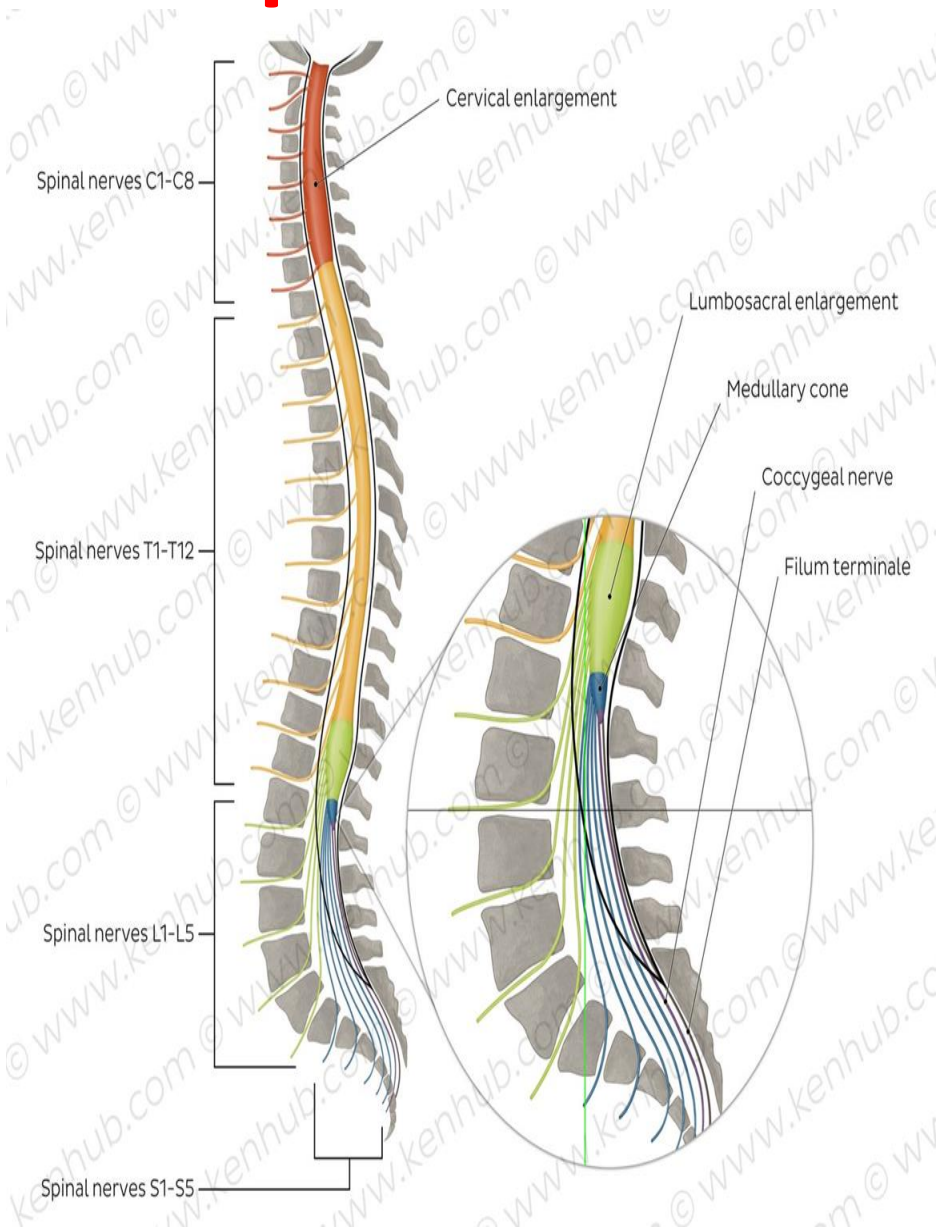
1 : Anterior Median Fissure
2 : Posterior Median Sulcus
3 & 4: Two Anterolateral Sulci
5 & 6: Two posterolateral Sulci

Spinal Cord
(External & Internal Features)

Segmentation of the spinal cord

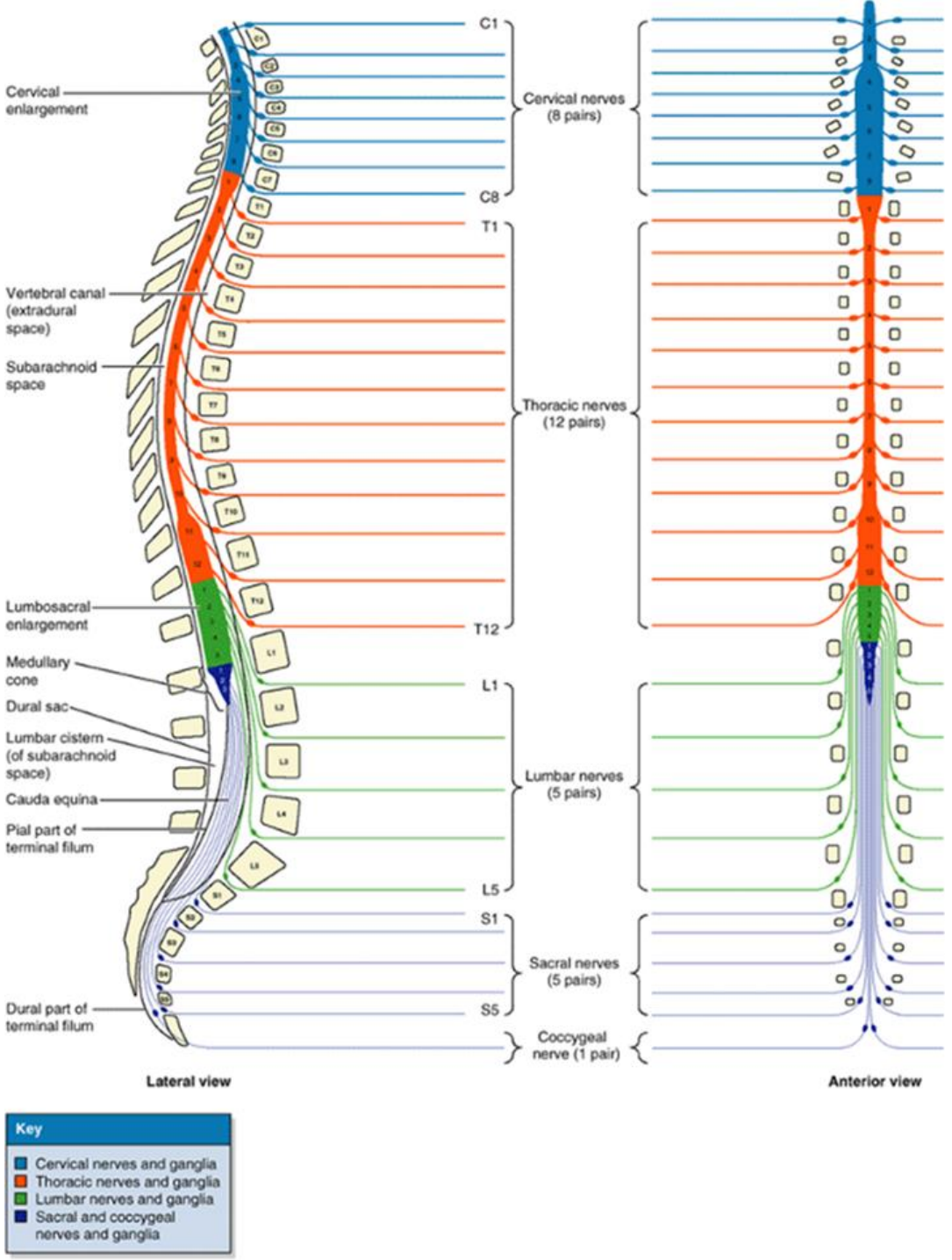
★ **Vertebral levels of the spinal cord segments:**

- Since the spinal **cord is shorter** than the vertebral column, therefore, **spinal cord segments** are present **higher** than their corresponding vertebrae
- **These differences become more obvious distally towards the lumbar and sacral segments of the spinal cord**



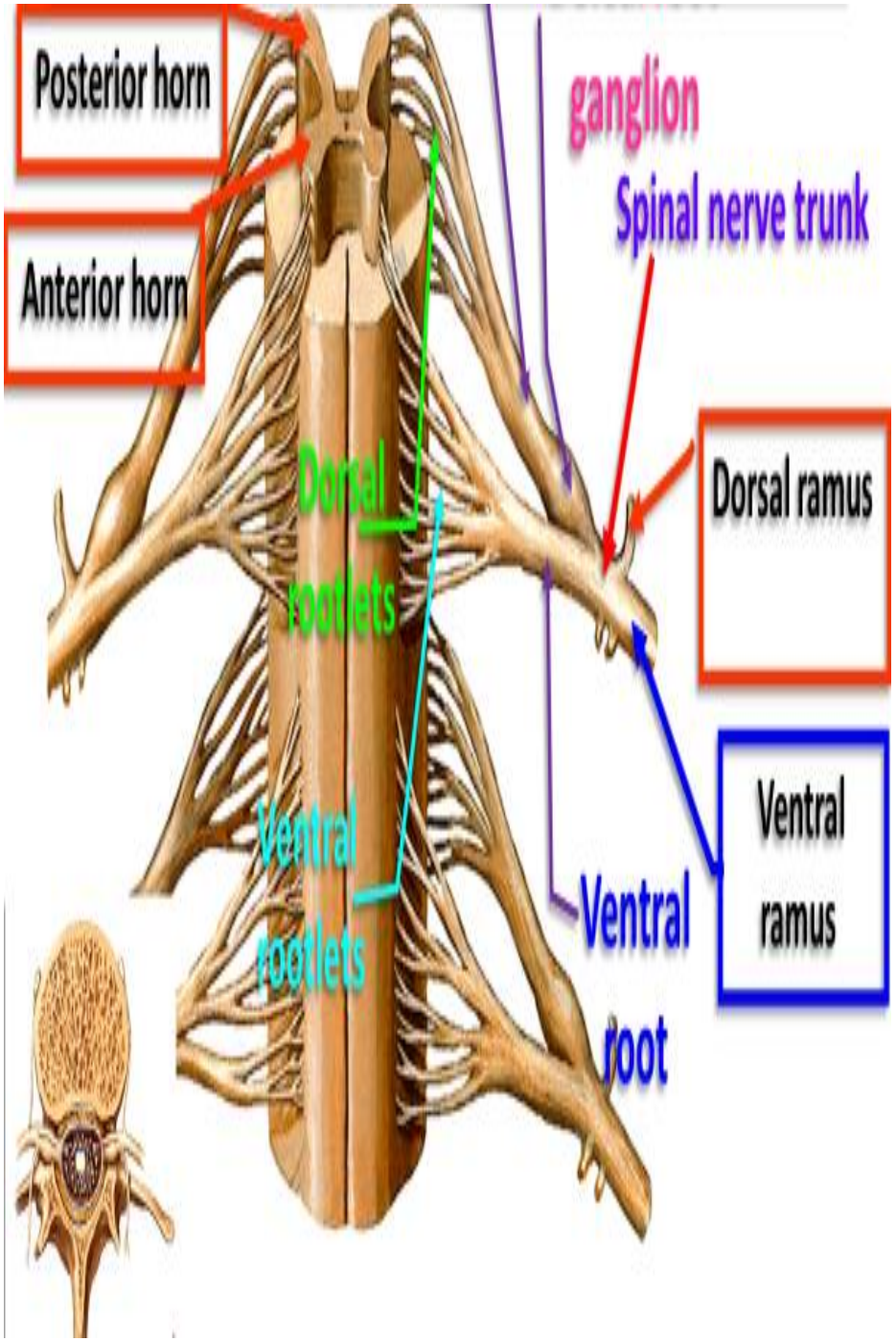
❑ Vertebral levels of the spinal cord segments:

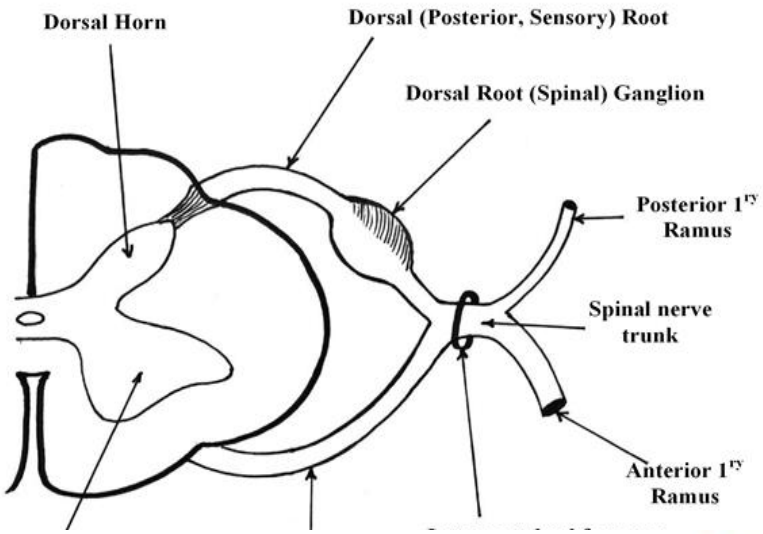
- ❑ Cervical vertebrae Add 1
- Upper thoracic vertebrae Add 2
- Lower thoracic vertebrae (7–9) -Add 3
- 10th thoracic vertebra L1 cord segments
- T11 vertebra is opposite to L2 to L5 spinal cord segments.
- T12 & L1 vertebrae are opposite to all sacral segments



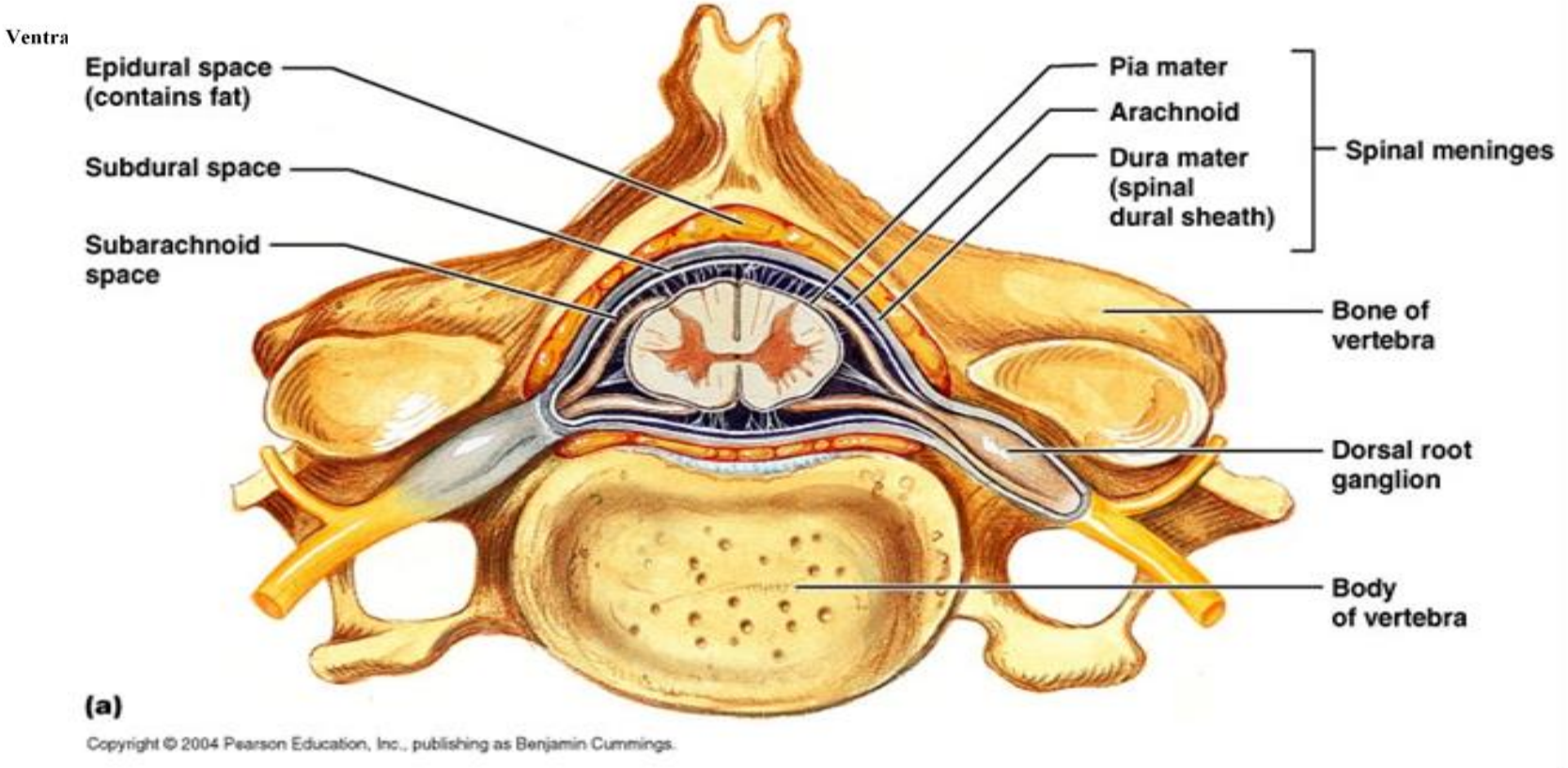
SPINAL NERVES

- Each spinal nerve has an anterior and posterior root.
- 1- 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.
- 2- The posterior roots transmit sensory information and have sensory ganglion attached to them. They are attached to the posterior horns of gray matter and pass through the posterolateral sulcus of the spinal cord.





- At the **corresponding intervertebral foramen**, the two **roots** (ventral and dorsal) **unite** together forming the **spinal nerve trunk** which is **mixed** containing both motor and sensory fibers. It leaves the vertebral canal through the **intervertebral foramen**.



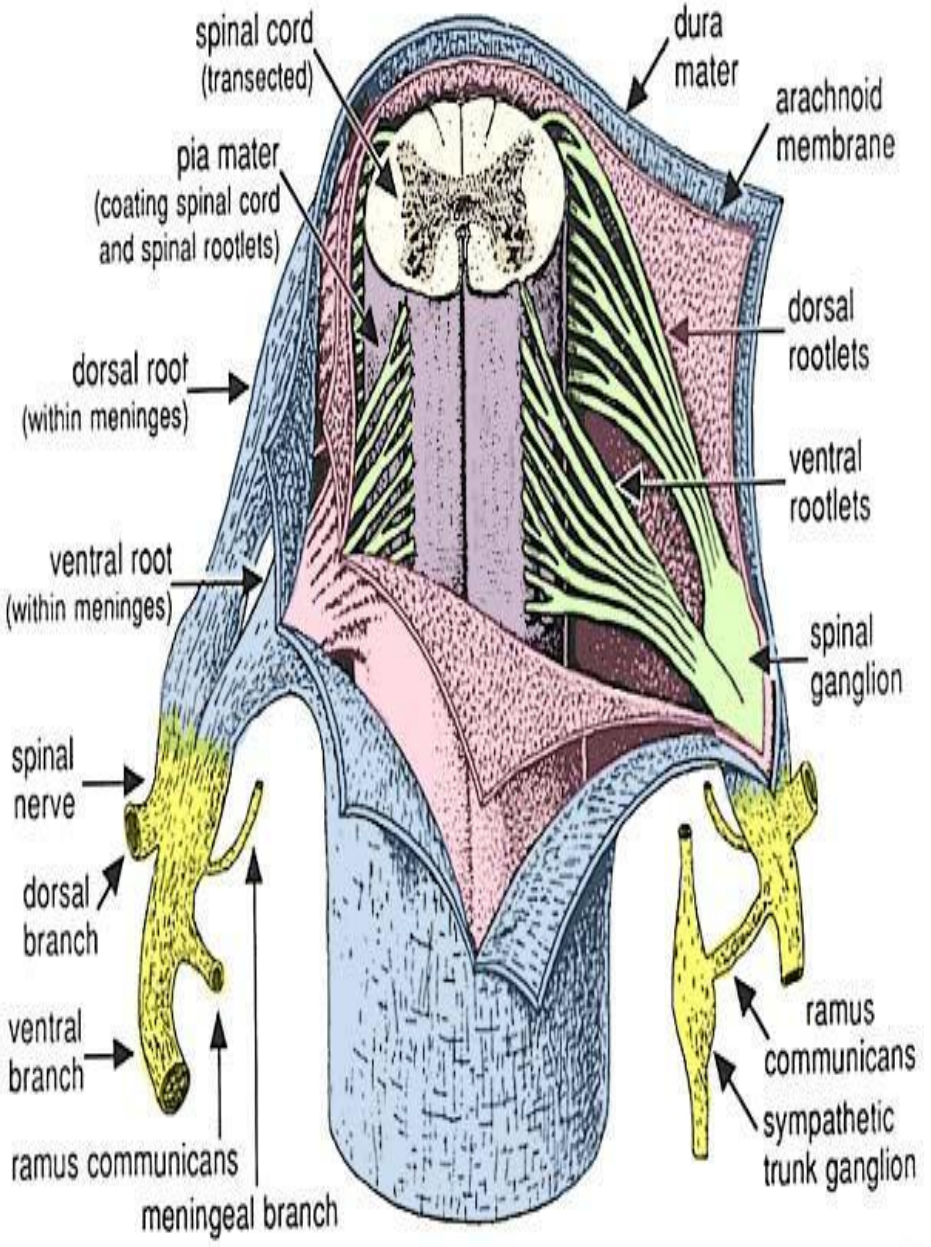
- **The trunk is very short, and soon after exiting the vertebral column, it divides into four branches:**

A. **anterior ramus**

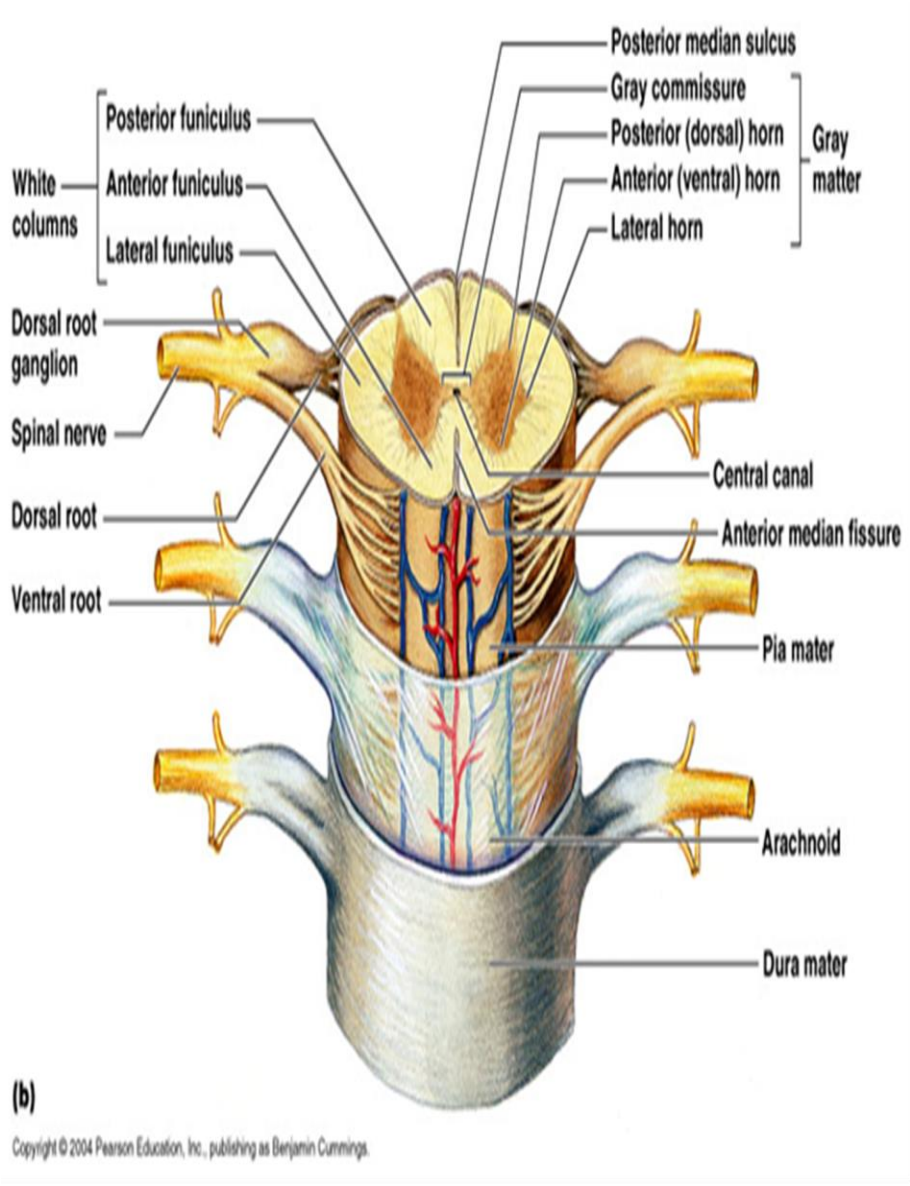
B. **posterior ramus**

C. **communicating ramus**

D. **meningeal ramus.**



- The spinal nerve trunk is very short. once it emerges from the intervertebral foramen, it divides into two primary rami (anterior and posterior). Both rami are mixed and supply the anterior and posterior aspects of the body respectively.
- Each root, during its course, acquires 3 covering (sheathes) from the pia, arachnoid and dura maters. At the intervertebral foramen, only the dural sheath continues outwards to blend with the epineurium of the nerve outside the intervertebral foramen.



Exit of the spinal nerves

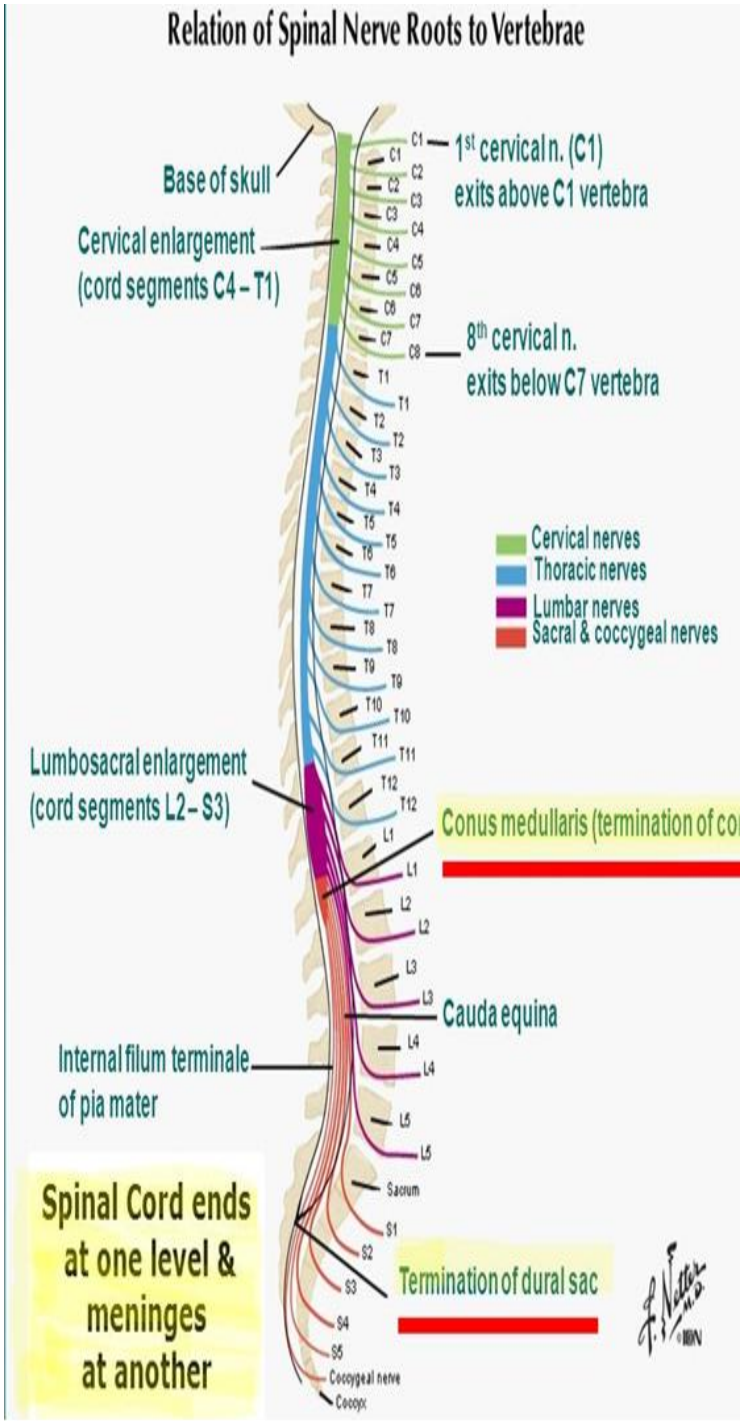
1- Cervical nerves: each nerve from C1-7 leaves the vertebral canal through **intervertebral foramen above** the vertebra of the same number.

- 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 5th sacral and coccygeal nerves leave the canal through the **sacral hiatus.**



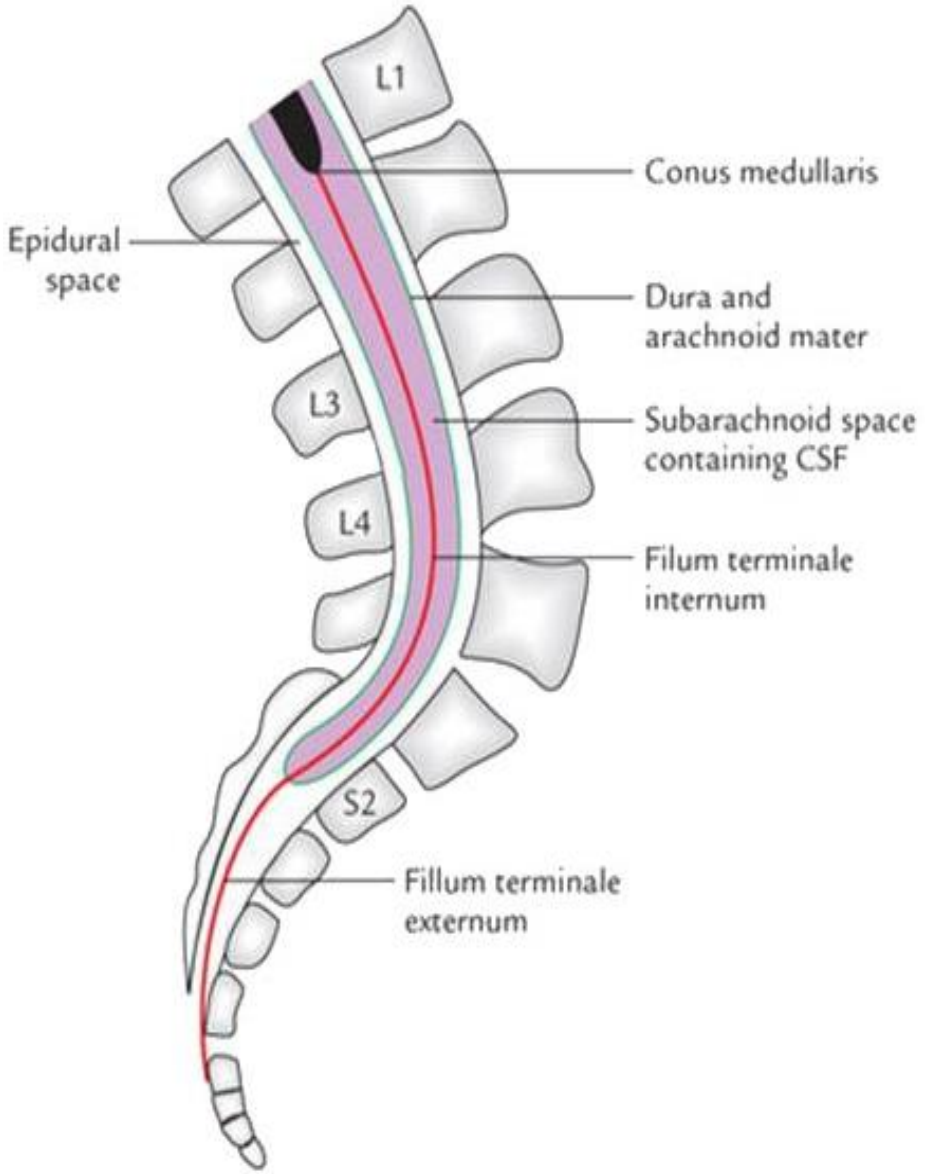
Meninges of the Spinal Cord

- **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 lies 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. The arachnoid mater

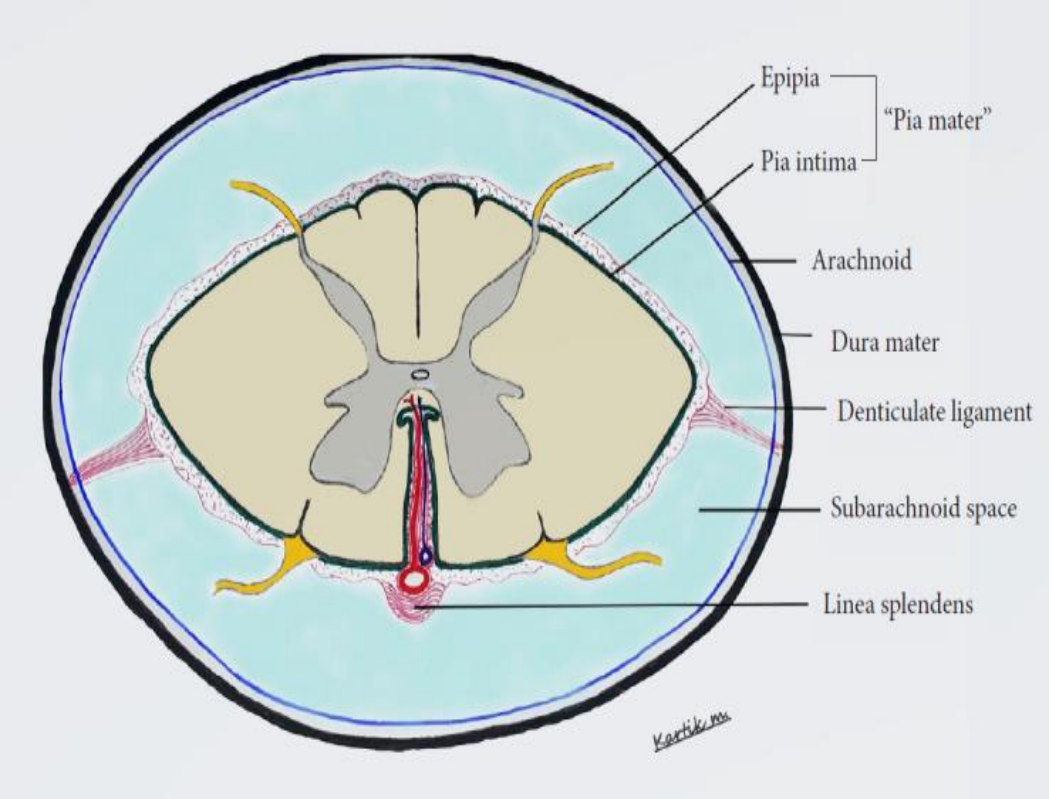
- It is a delicate tubular sheath close to the inner aspect of the dura and it also ends at the level of second sacral vertebra. It is separated from the pia mater by a relatively wide space called the subarachnoid space which is filled with the cerebrospinal fluid. The lower part of the subarachnoid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

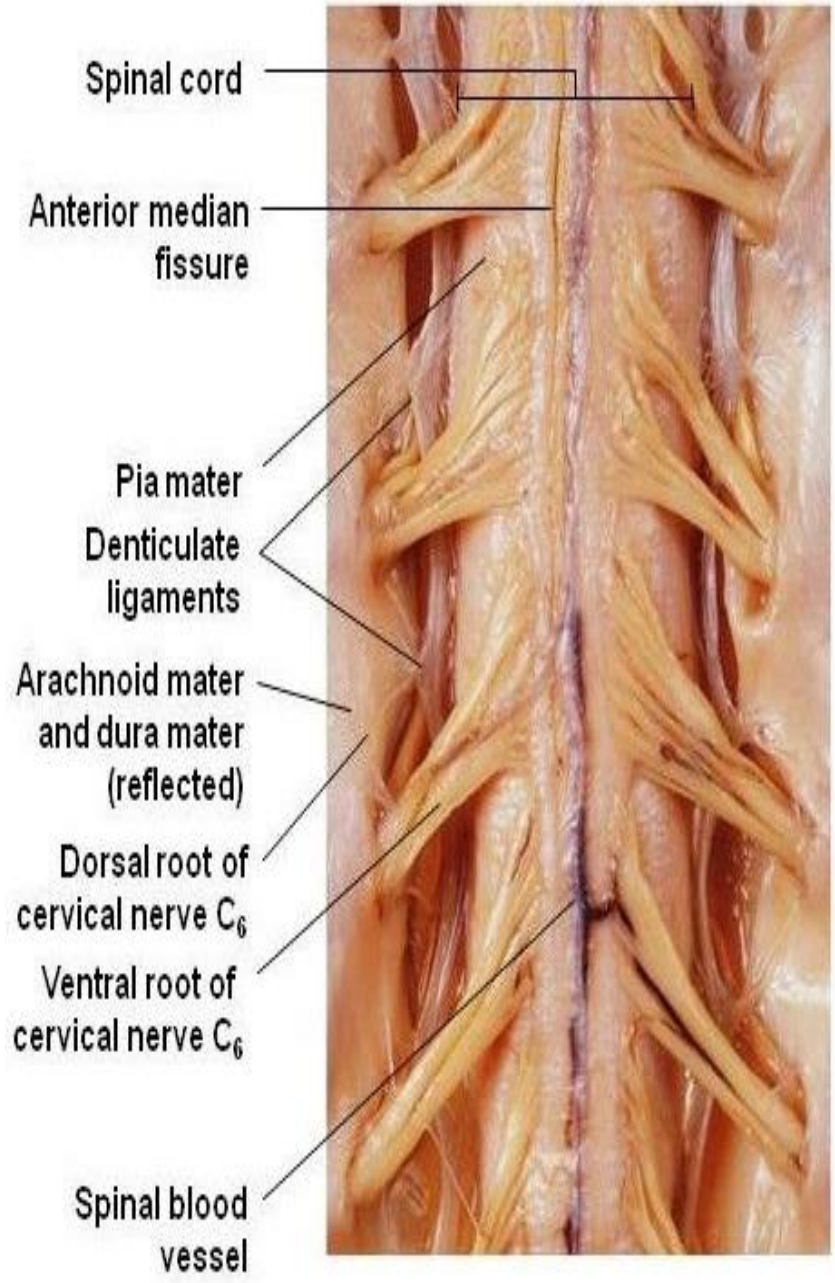


C. Pia mater

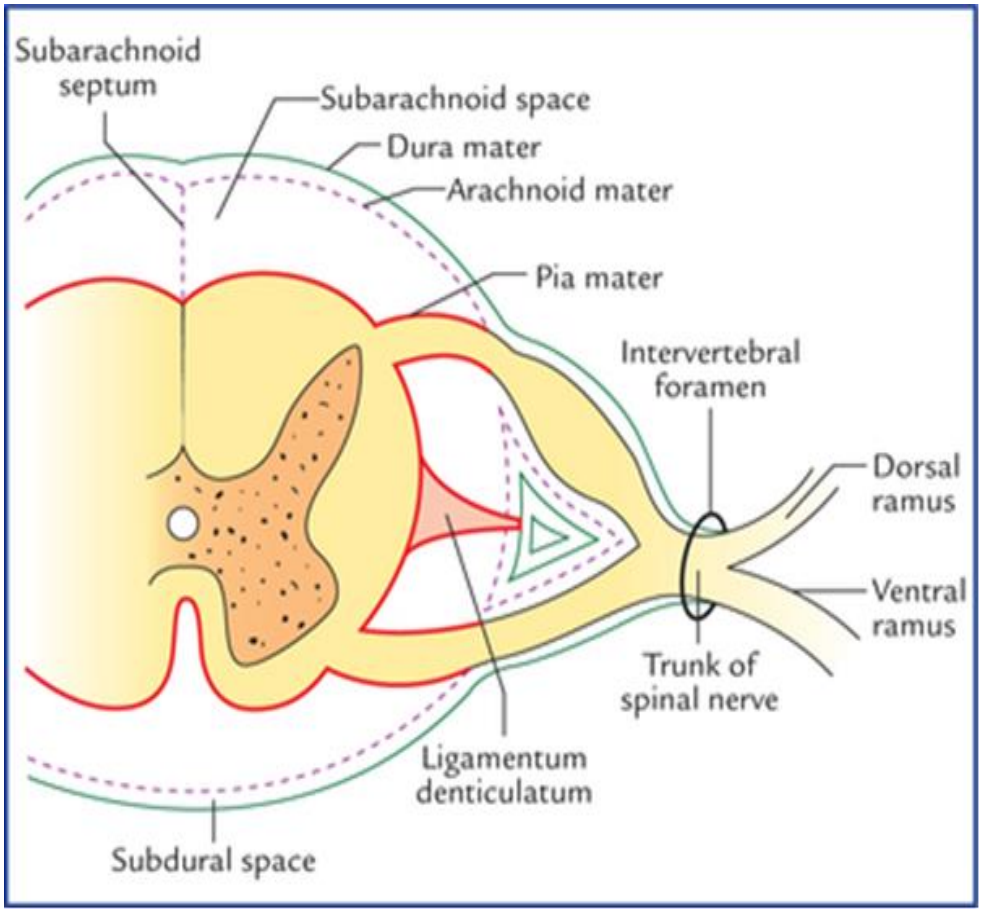
- It is a delicate connective tissue sheath which is intimately adherent to the spinal cord. The pia mater springs laterally forming 21-teeth like processes called ligamenta denticulata. These processes fix the spinal cord to the dura mater. The first process is attached to the margin of the foramen 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.



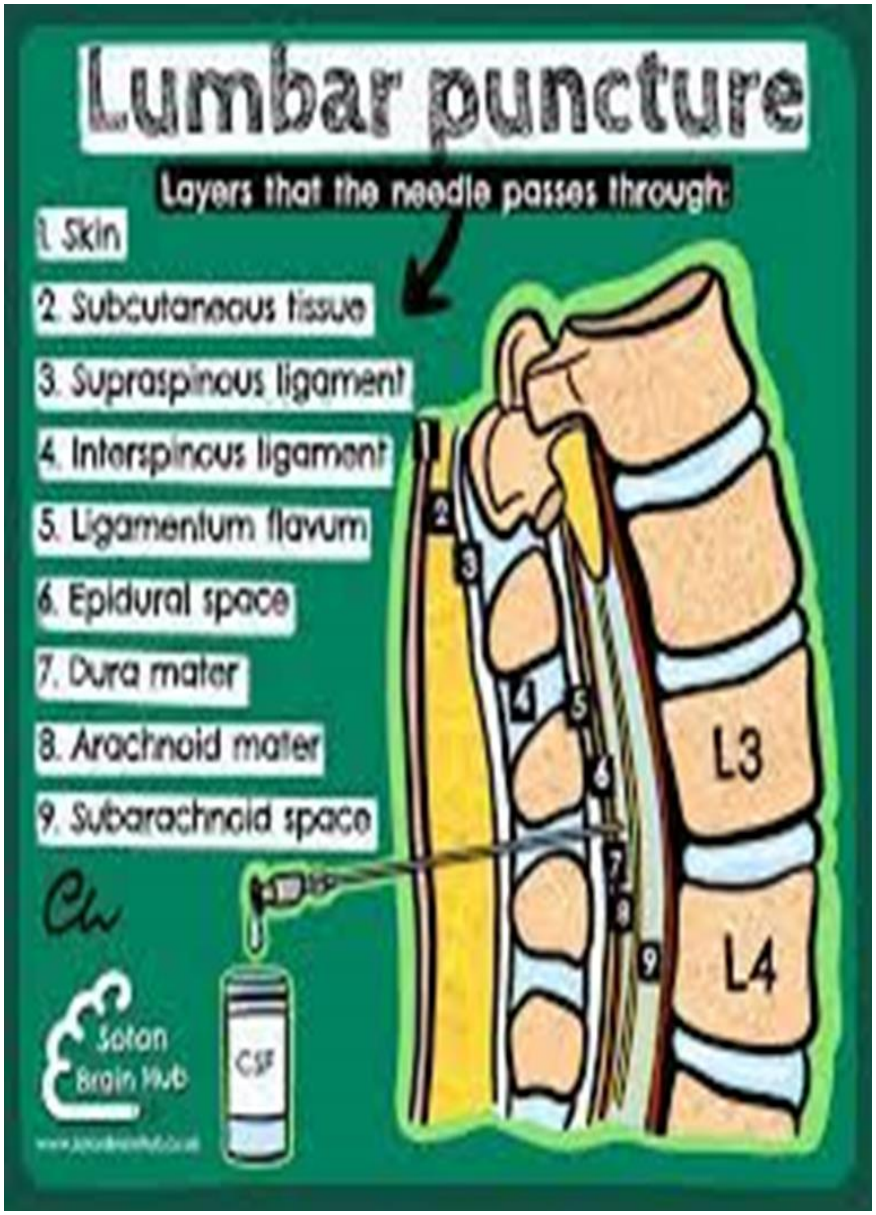


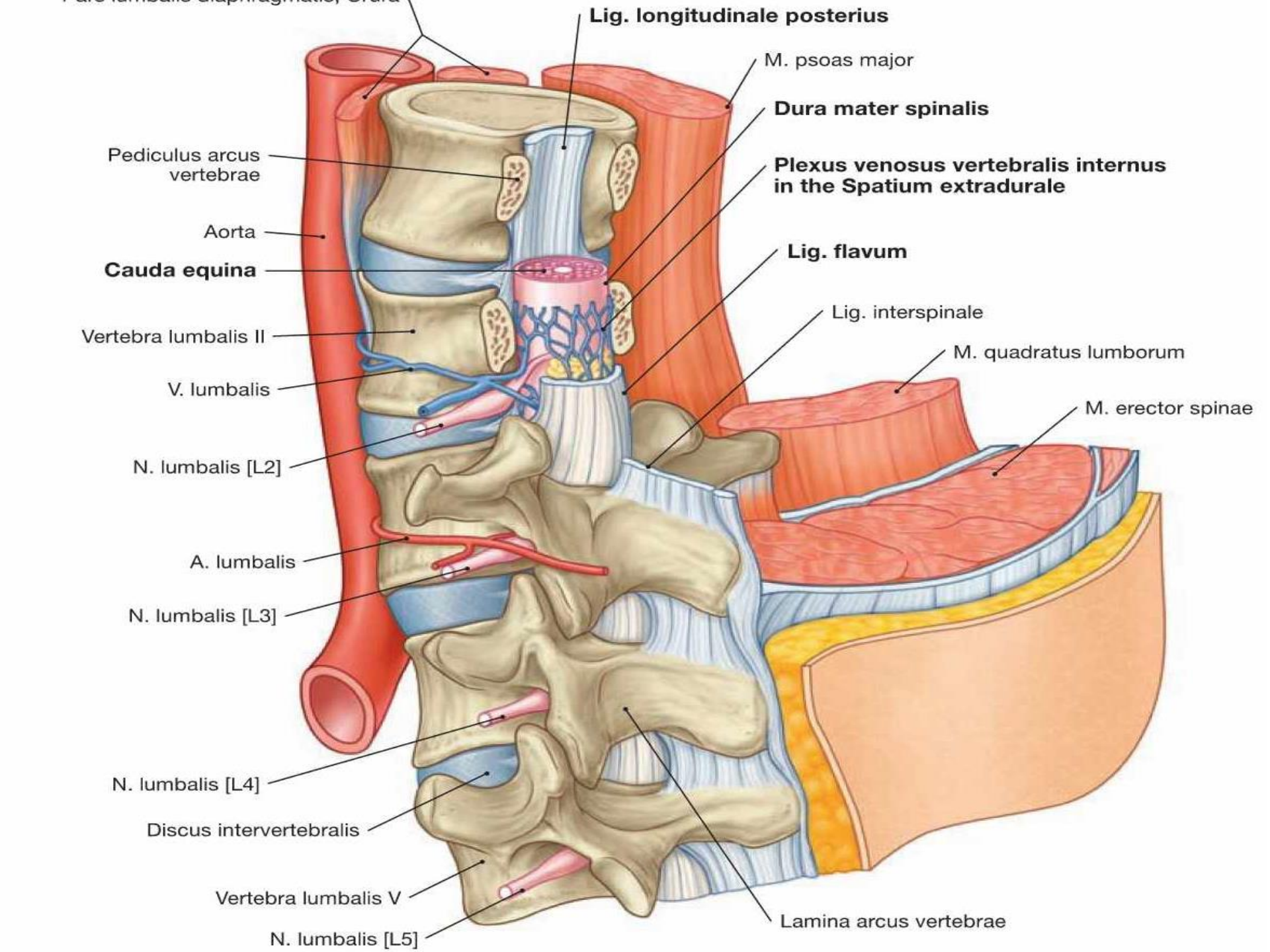
Anterior view



Applied anatomy

- **Lumbar puncture**: is done by introducing a needle into the lumbar cistern either to obtain a sample of CSF or to inject a drug. It is safe to be done **below the level of L2** vertebra (usually between L3 & L4 vertebrae) to avoid injury of the spinal cord. The nerve roots of the cauda equine, being floating in the CSF, they escape away from the lumbar puncture needle & not injured.

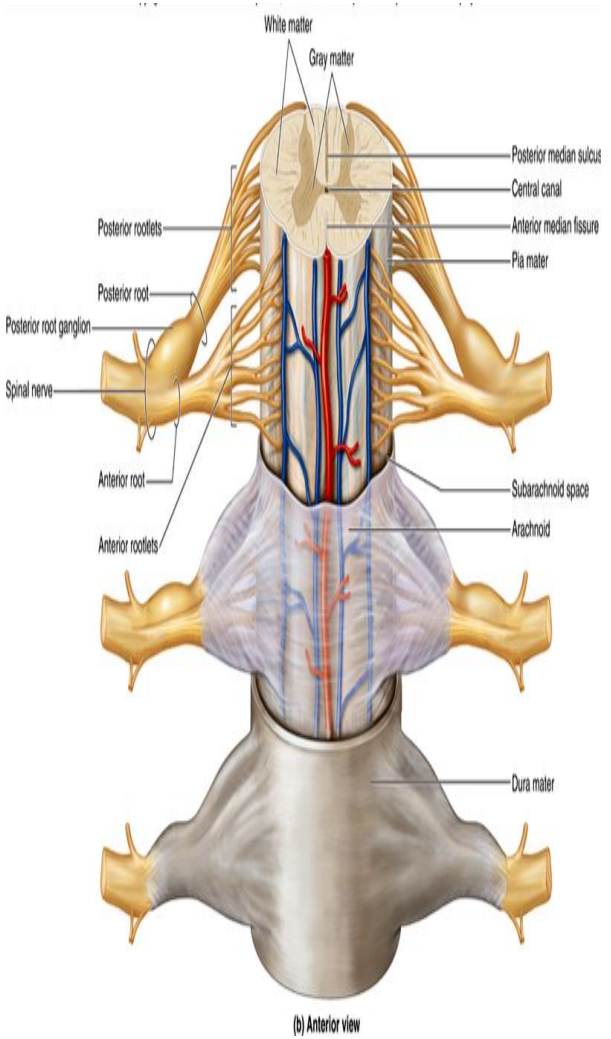



Lig. longitudinale posterius
M. psoas major
Dura mater spinalis
Pediculus arcus vertebrae
Plexus venosus vertebralis internus in the Spatium extradurale
Aorta
Lig. flavum
Cauda equina
Lig. interspinale
Vertebra lumbalis II
M. quadratus lumborum
V. lumbalis
M. erector spinae
N. lumbalis [L2]
A. lumbalis
N. lumbalis [L3]
N. lumbalis [L4]
Discus intervertebralis
Vertebra lumbalis V
Lamina arcus vertebrae
N. lumbalis [L5]

Meningeal spaces of the spinal cord

- **Epidural (extradural) space** outside dura matter**,** 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 subarachonoid 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: 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.

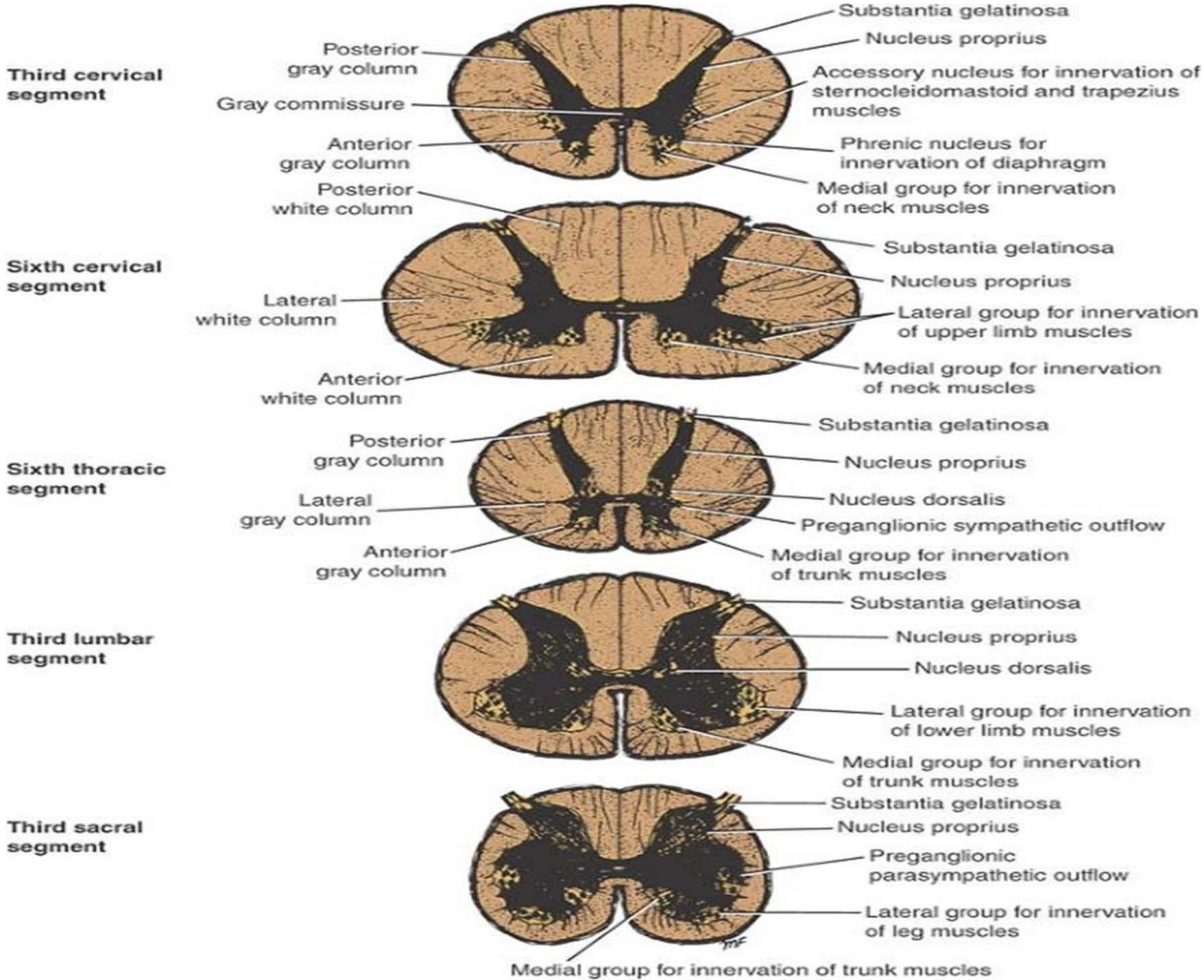
- It contains a narrow lumen called the **central canal.**
- The cord is formed of **grey** and **white matter**.
- The grey matter occupies a **central** position, while the white matter occupies a **peripheral** position.

- 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.

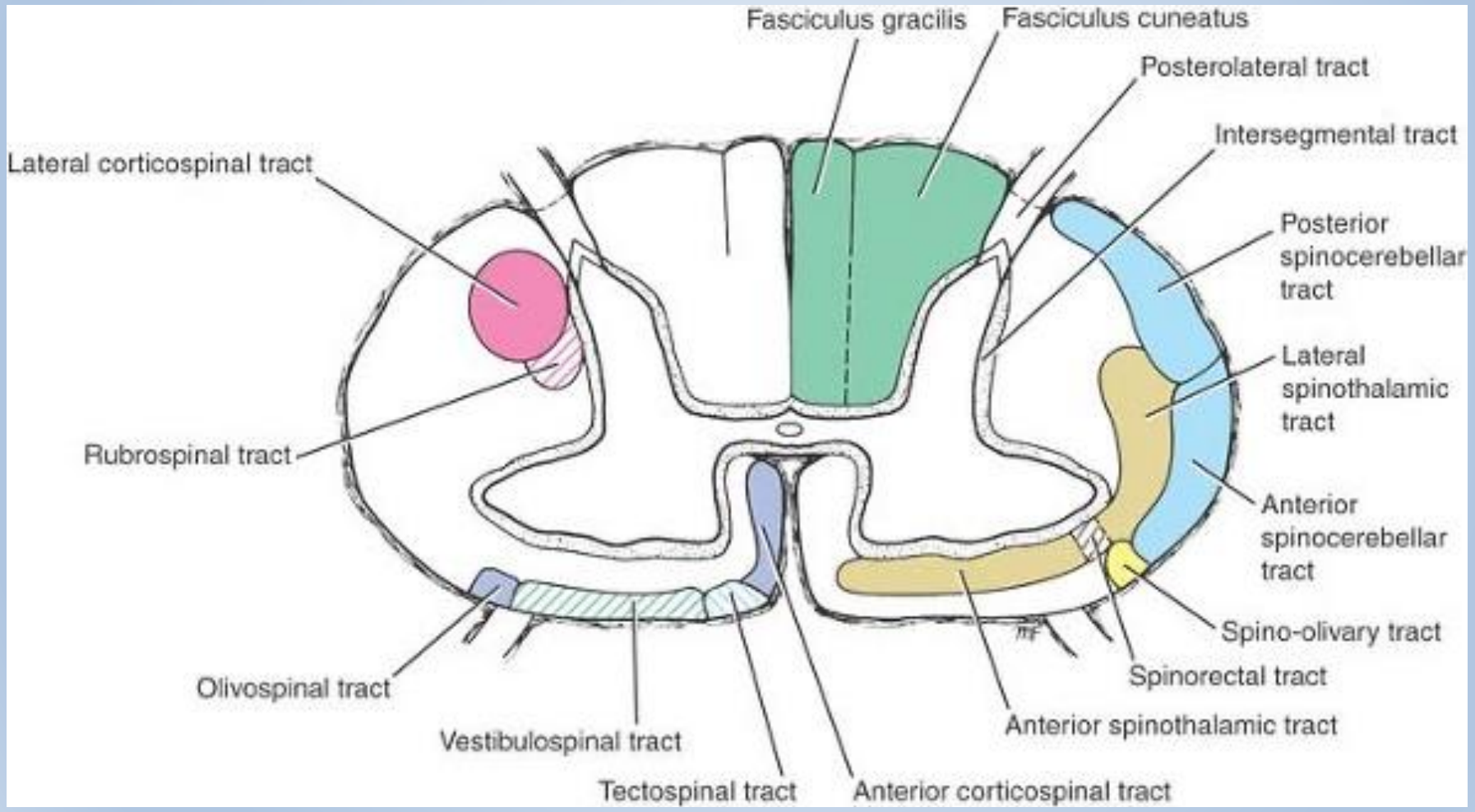
- The white matter is occupied by **short** and **long** ***ascending*** and ***descending*** tracts.
- It is differentiated into **3 columns** on each side:
- **Posterior white column**: between the posterior median septum and the posterior horn.

In the cervical and upper thoracic regions, this column is further divided by the posterior intermediate septum into gracile tract medially and cuneate tract laterall***y***

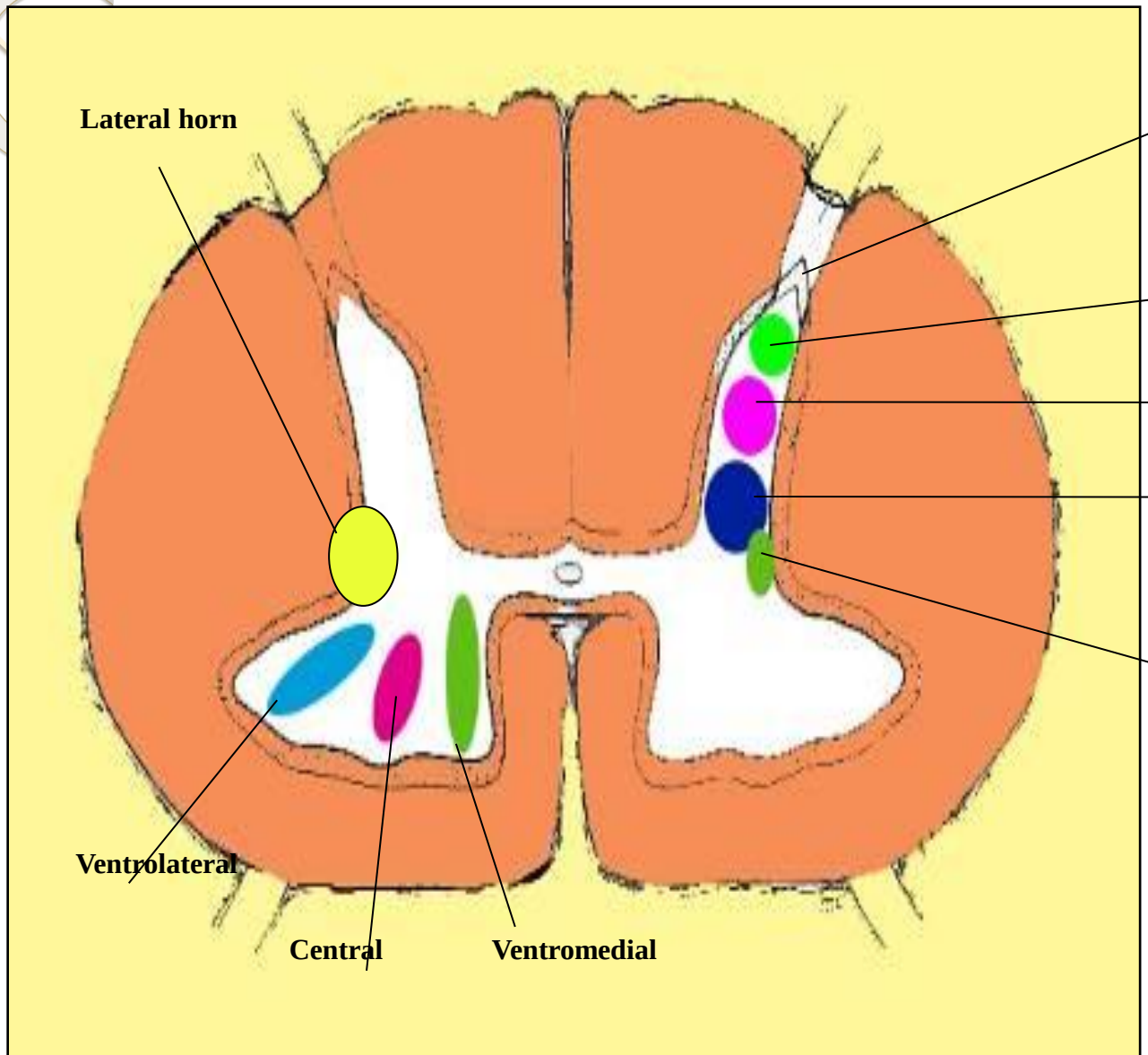
- **Lateral white column**: lateral to both anterior and posterior horns
- **Anterior white column**: between the anterior median fissure and ventral roots of spinal nerves


Third cervical segment
Posterior gray column
Gray commissure
Anterior gray column
Posterior white column
Substantia gelatinosa
Nucleus proprius
Accessory nucleus for innervation of sternocleidomastoid and trapezius muscles
Phrenic nucleus for innervation of diaphragm
Medial group for innervation of neck muscles
Sixth cervical segment
Lateral white column
Anterior white column
Substantia gelatinosa
Nucleus proprius
Lateral group for innervation of upper limb muscles
Medial group for innervation of neck muscles
Sixth thoracic segment
Posterior gray column
Lateral gray column
Anterior gray column
Substantia gelatinosa
Nucleus proprius
Nucleus dorsalis
Preganglionic sympathetic outflow
Medial group for innervation of trunk muscles
Third lumbar segment
Substantia gelatinosa
Nucleus proprius
Nucleus dorsalis
Lateral group for innervation of lower limb muscles
Medial group for innervation of trunk muscles
Third sacral segment
Substantia gelatinosa
Nucleus proprius
Preganglionic parasympathetic outflow
Lateral group for innervation of leg muscles
Medial group for innervation of trunk muscles

Transverse section for the spinal cord



Nuclei of the spinal cord



Blood supply of the spinal cord

Arterial supply

The anterior and posterior spinal arteries travel in the subarachnoid space

1- Anterior spinal artery:

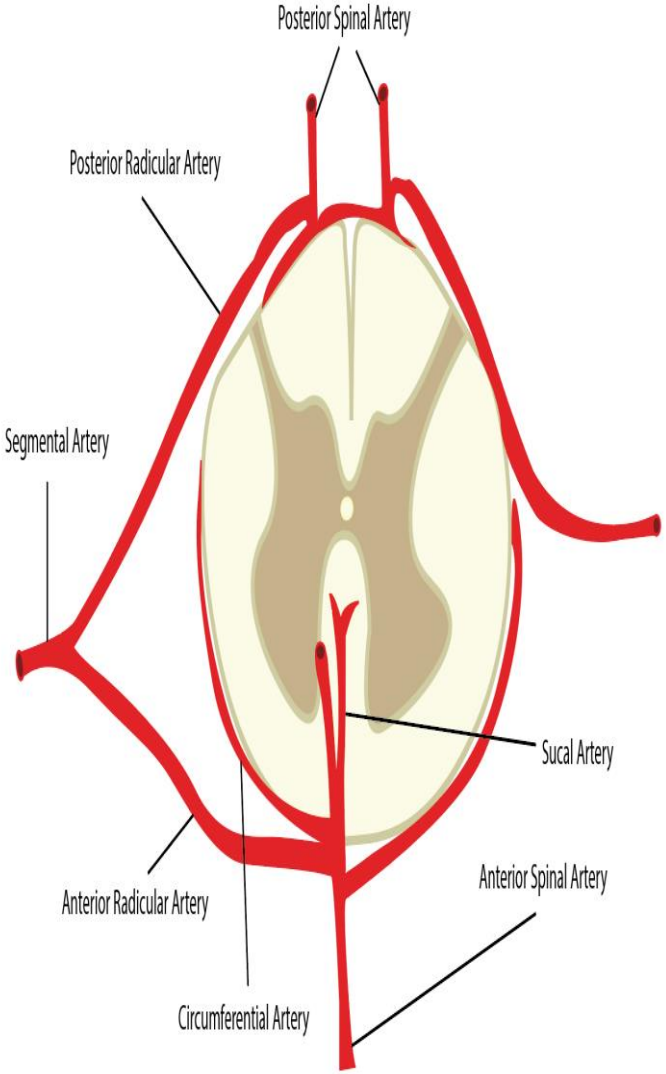
- It is branch of the 4th part of vertebral artery (one on each side).

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 4th 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.

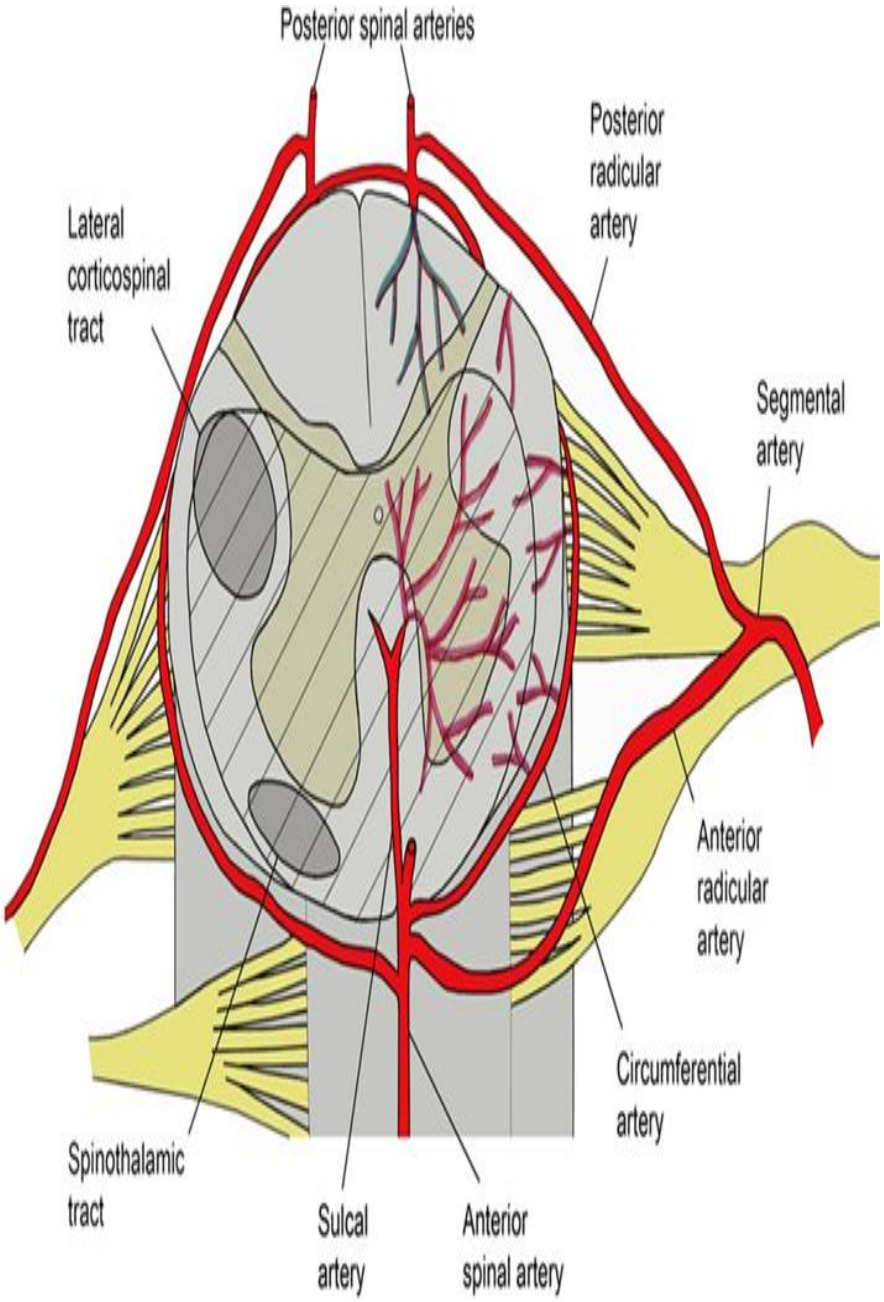
a- Cervical region: from the 2nd part of vertebral artery and ascending cervical artery.

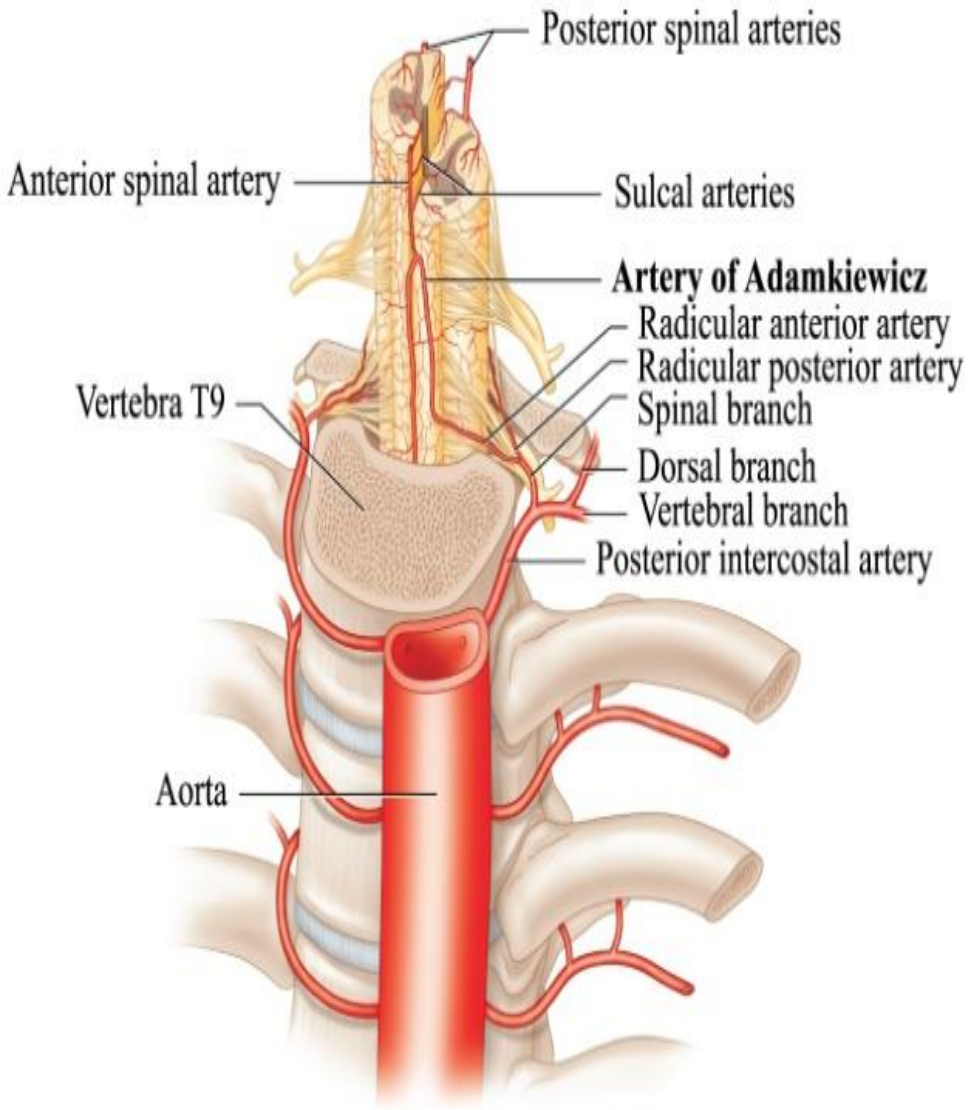
b- Thoracic region: from posterior intercostal and subcostal arteries.

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 anastomose with the posterior and anterior spinal arteries to form ring of arteries (an arterial corona).**





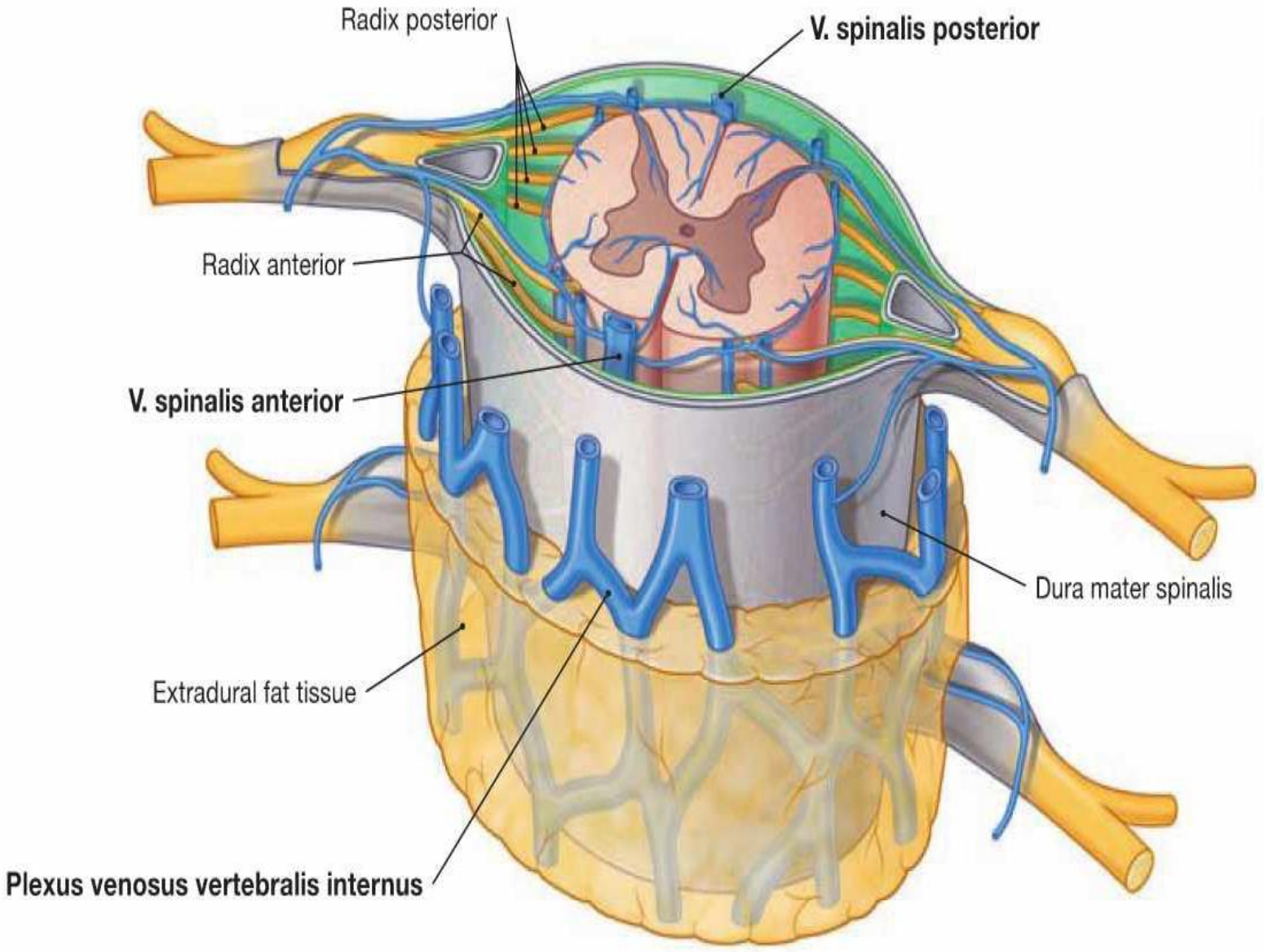
- **The intermediate or midthoracic portion of the cord between T3 and T8 is poorly vascularized by intercostal arteries**
- **In the lower region, there is again a rich vascular supply through the radicular branches of the intercostal and lumbar arteries. One important artery is the great anterior radicular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

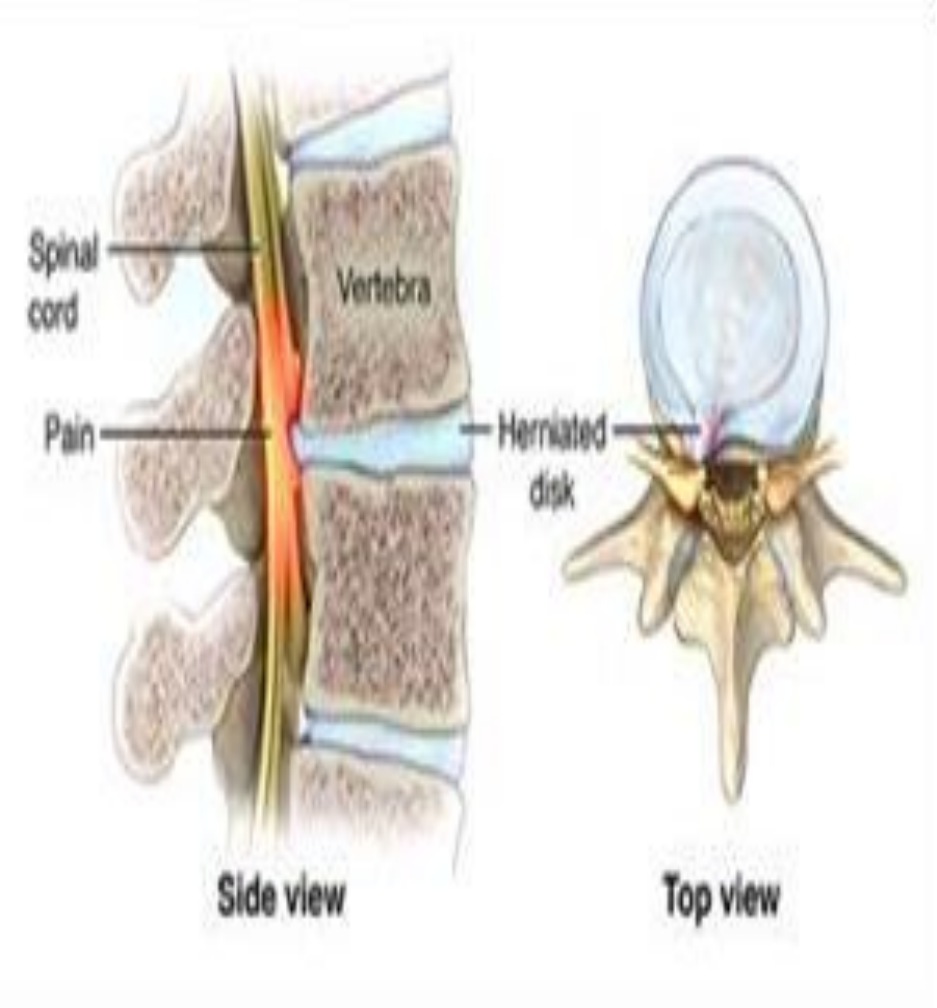
These six longitudinal veins form a network with each other around the spinal cord. They communicate above with the cranial venous sinuses and with the cerebellar veins. In the vertebral canal, these spinal veins communicate with the internal vertebral venous plexus and with the vertebral canal through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


Radix posterior
V. spinalis posterior
Radix anterior
V. spinalis anterior
Dura mater spinalis
Extradural fat tissue
Plexus venosus vertebralis internus

Applied anatomy

Spinal Cord compression:

- The commonest cause of spinal cord compression is intervertebral disc prolapse or less commonly fracture vertebrae, tumor, stenosis of spinal canal or cold abscess.



Thank You

Dr. Dalia M. Biram