
بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

GENERAL FEATURES OF BRAIN AND SPINAL CORD (EXTERNAL)

BY

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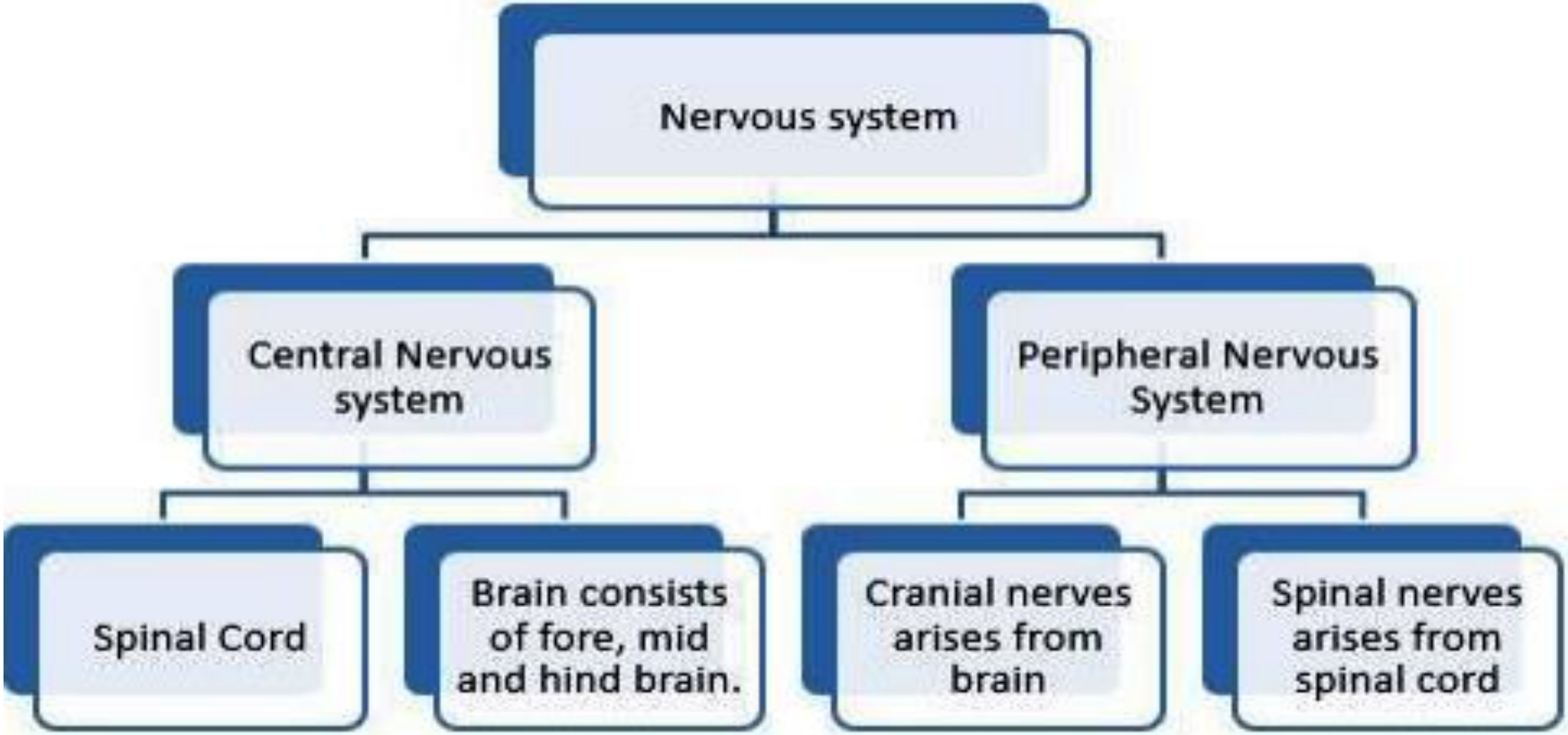
LEARNING OUTCOMES

- By the end of this lecture students will be able to know,
- Components of nervous system
- Main division of central nervous system
- Three main anatomical divisions of brain i.e., fore brain, hind brain and midbrain
- Lobes of brain
- Cerebral cortex
- Differentiate between grey and white matter

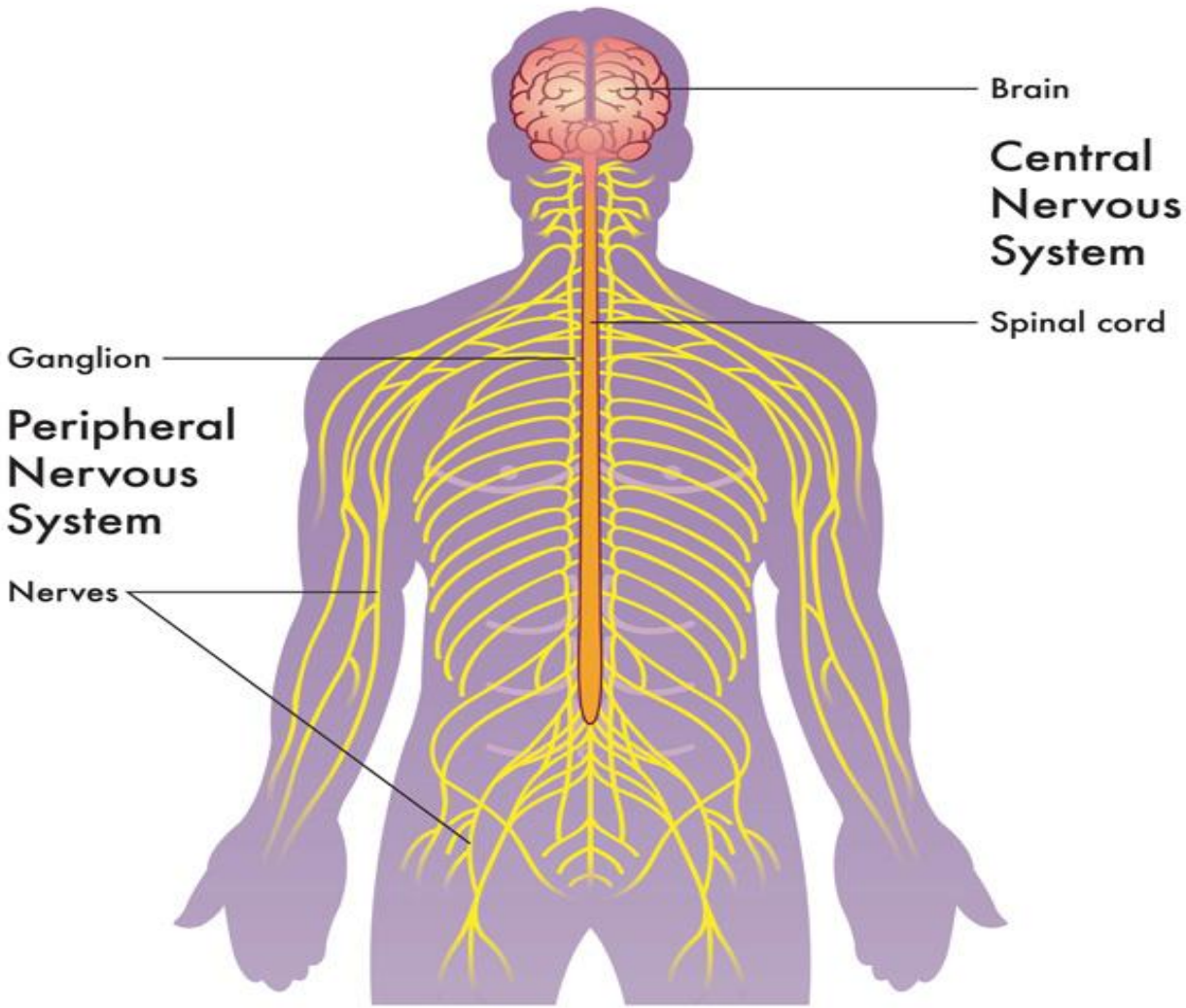
Cont…….

- **SPINAL CORD LEARNING OUTCOMES**
- Size, shape, location ,weight of spinal cord
- Segments of spinal cord
- External membranes of spinal cord
- External features of spinal cord including,
- Fissures and sulci
- Attachments of spinal nerves
- Enlargements
- Cauda equina

NERVOUS SYSTEM

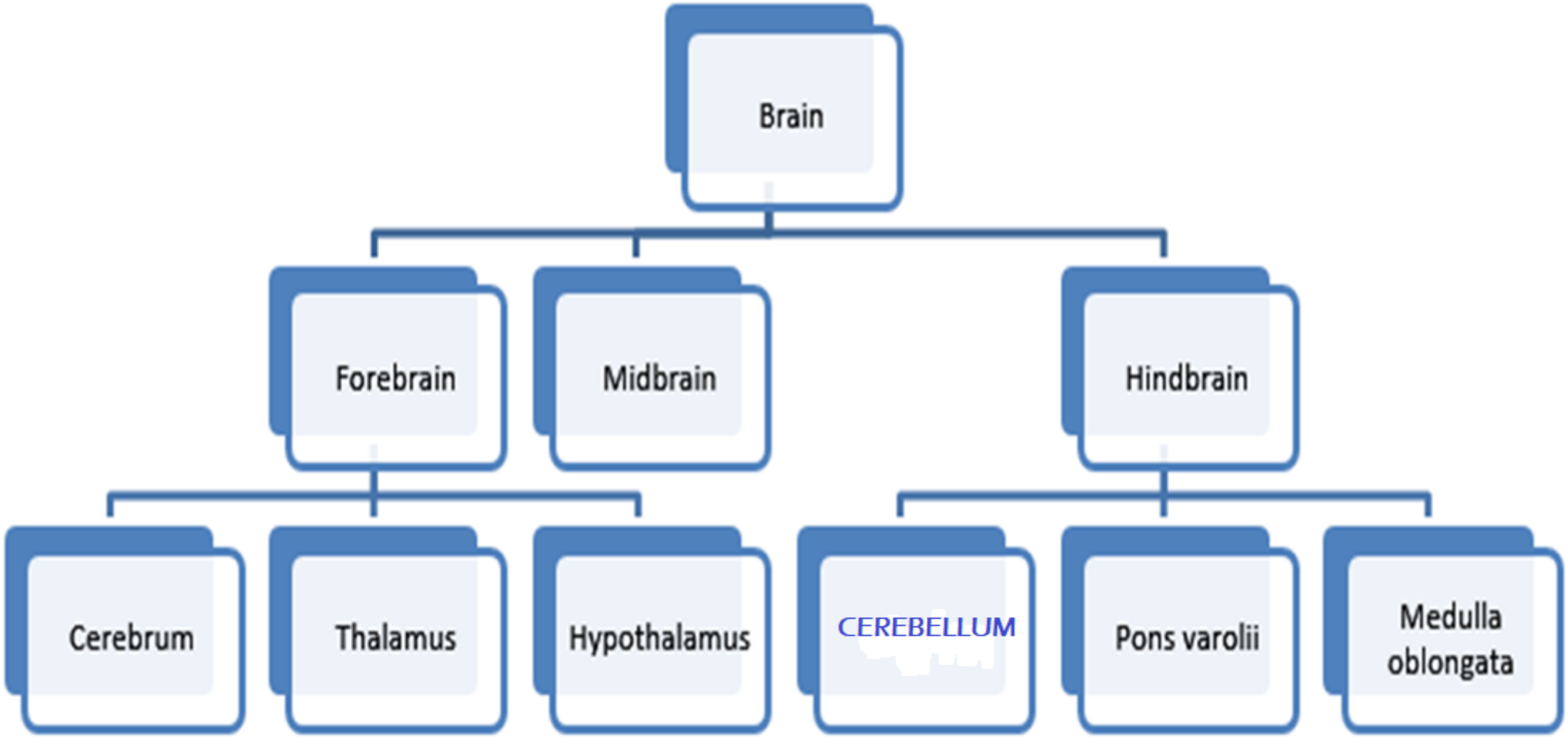


The Nervous System

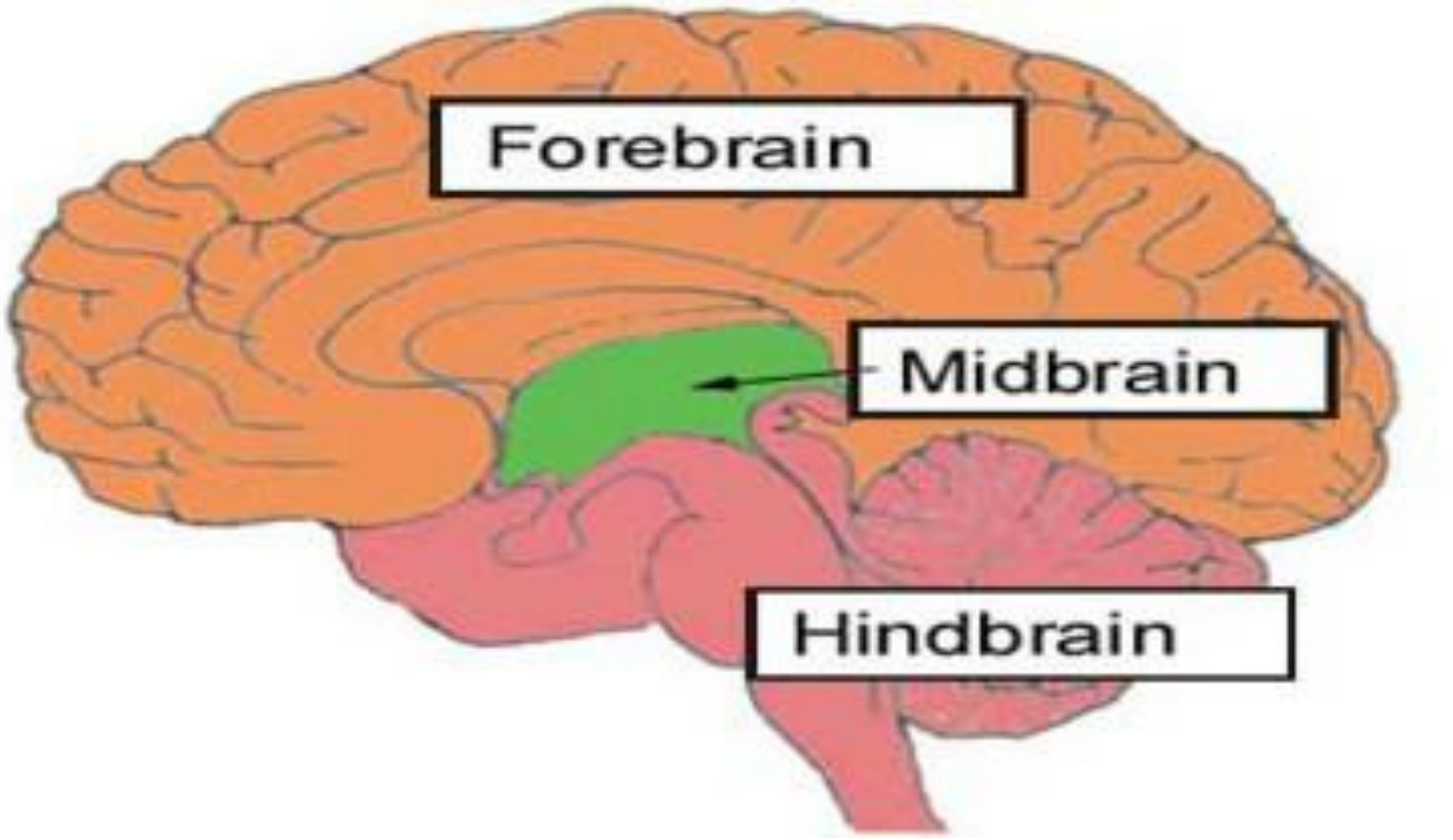


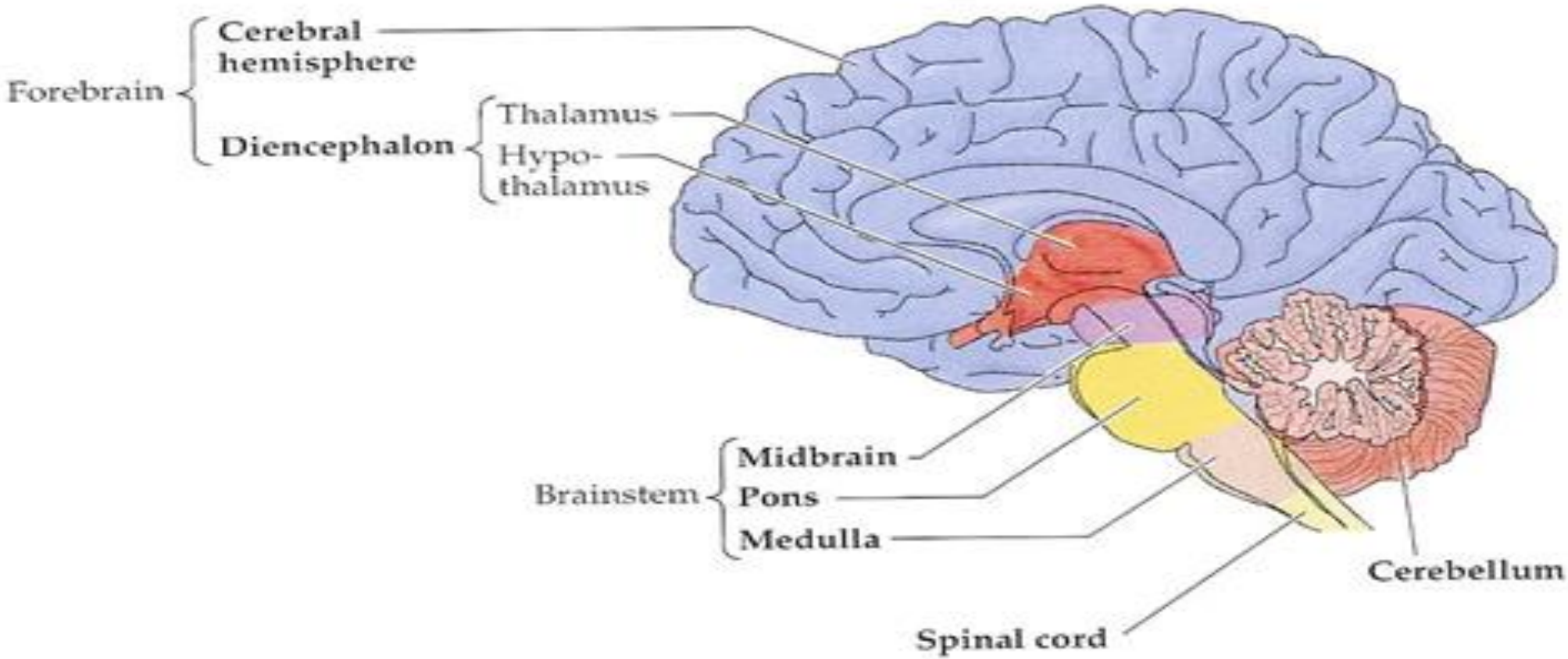
BRAIN……

- It is the main head quarter and processing unit of nervous system.
- It has three parts
- Fore brain(prosencephalon)
- Mid brain(mesencephalon)
- Hind brain(rhombencephalon)


Brain
Forebrain
Midbrain
Hindbrain
Cerebrum
Thalamus
Hypothalamus
CEREBELLUM
Pons varolii
Medulla oblongata

BRAIN

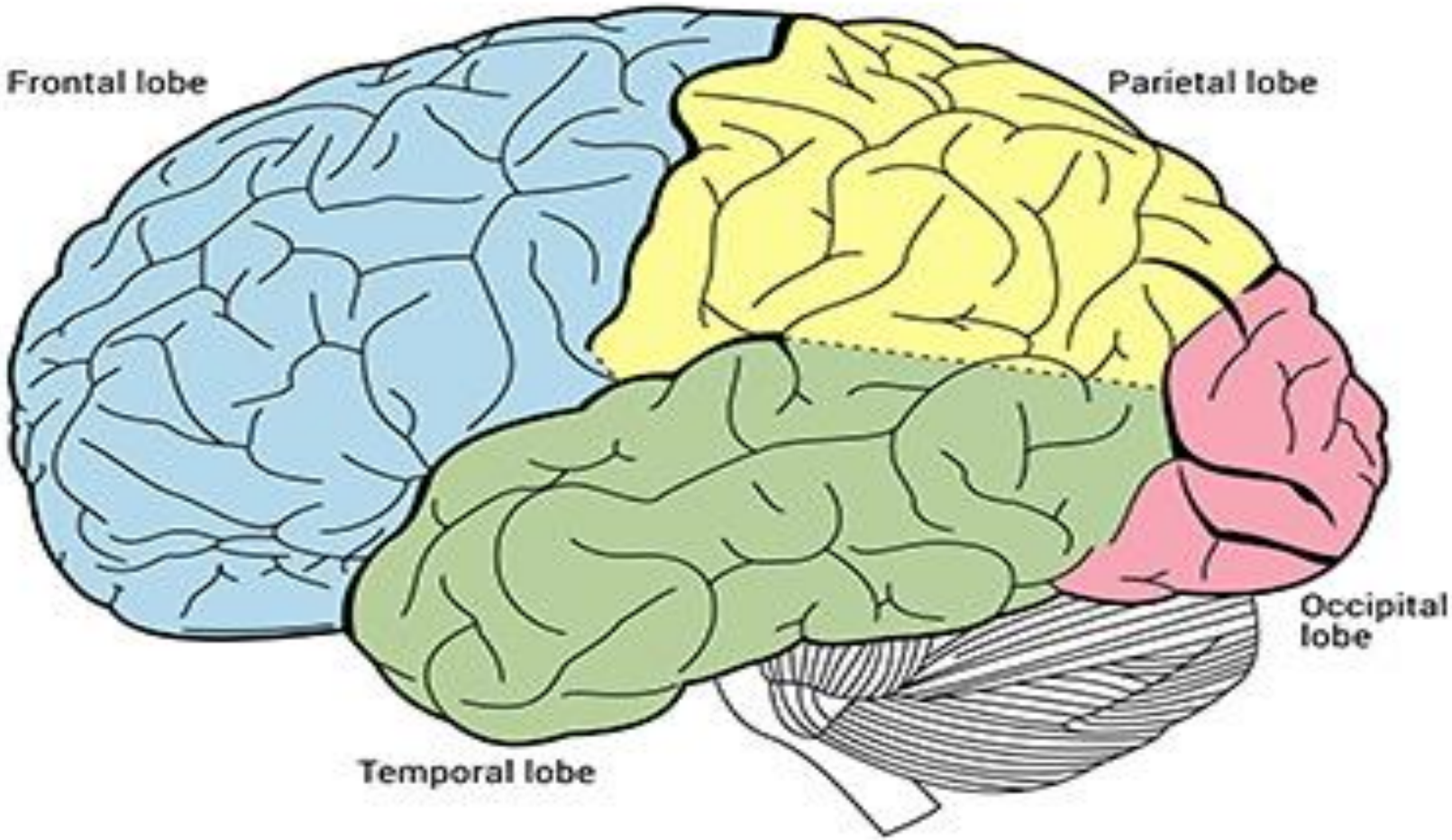


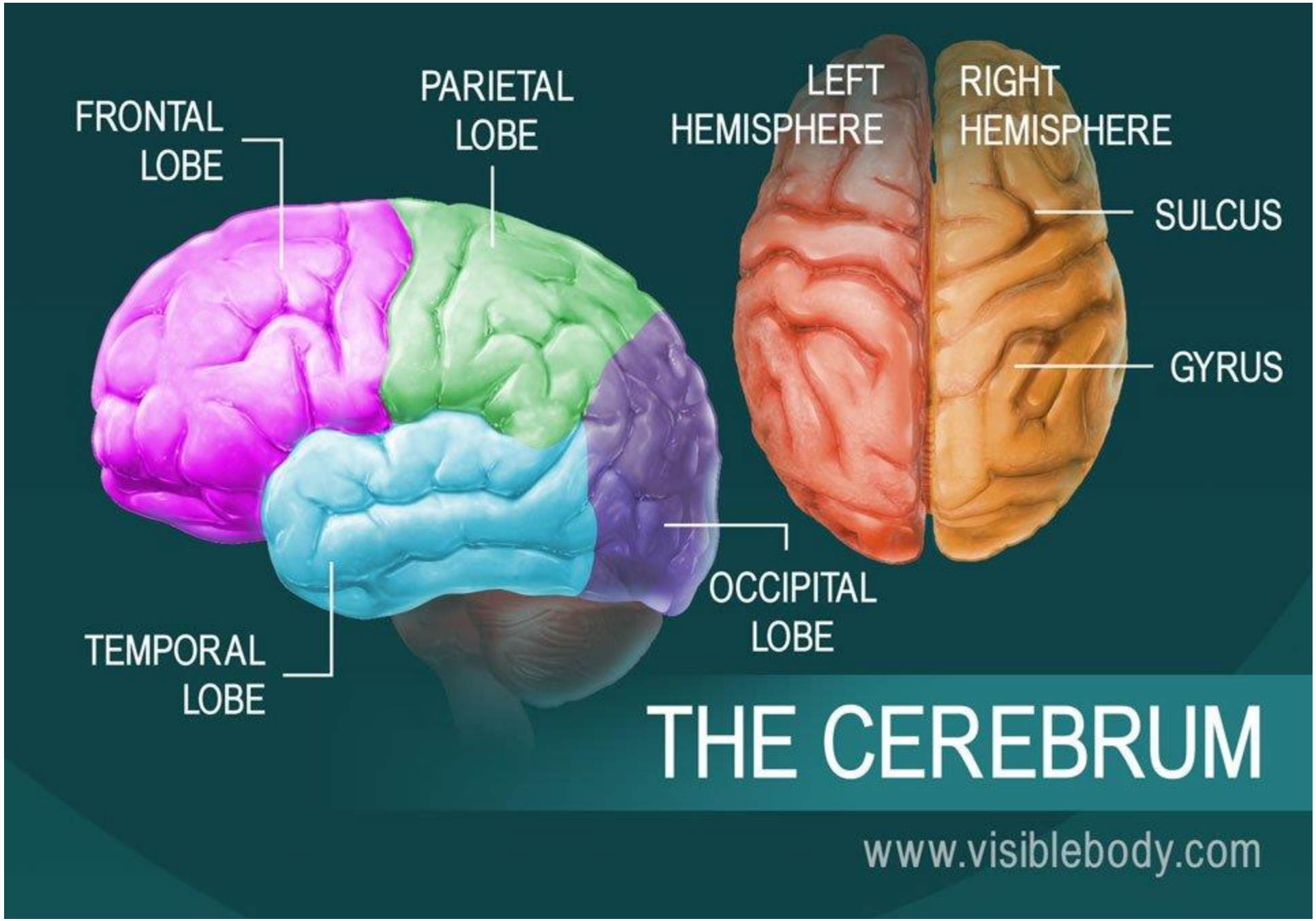

Forebrain
Cerebral hemisphere
Diencephalon
Thalamus
Hypo-thalamus
Brainstem
Midbrain
Pons
Medulla
Cerebellum
Spinal cord

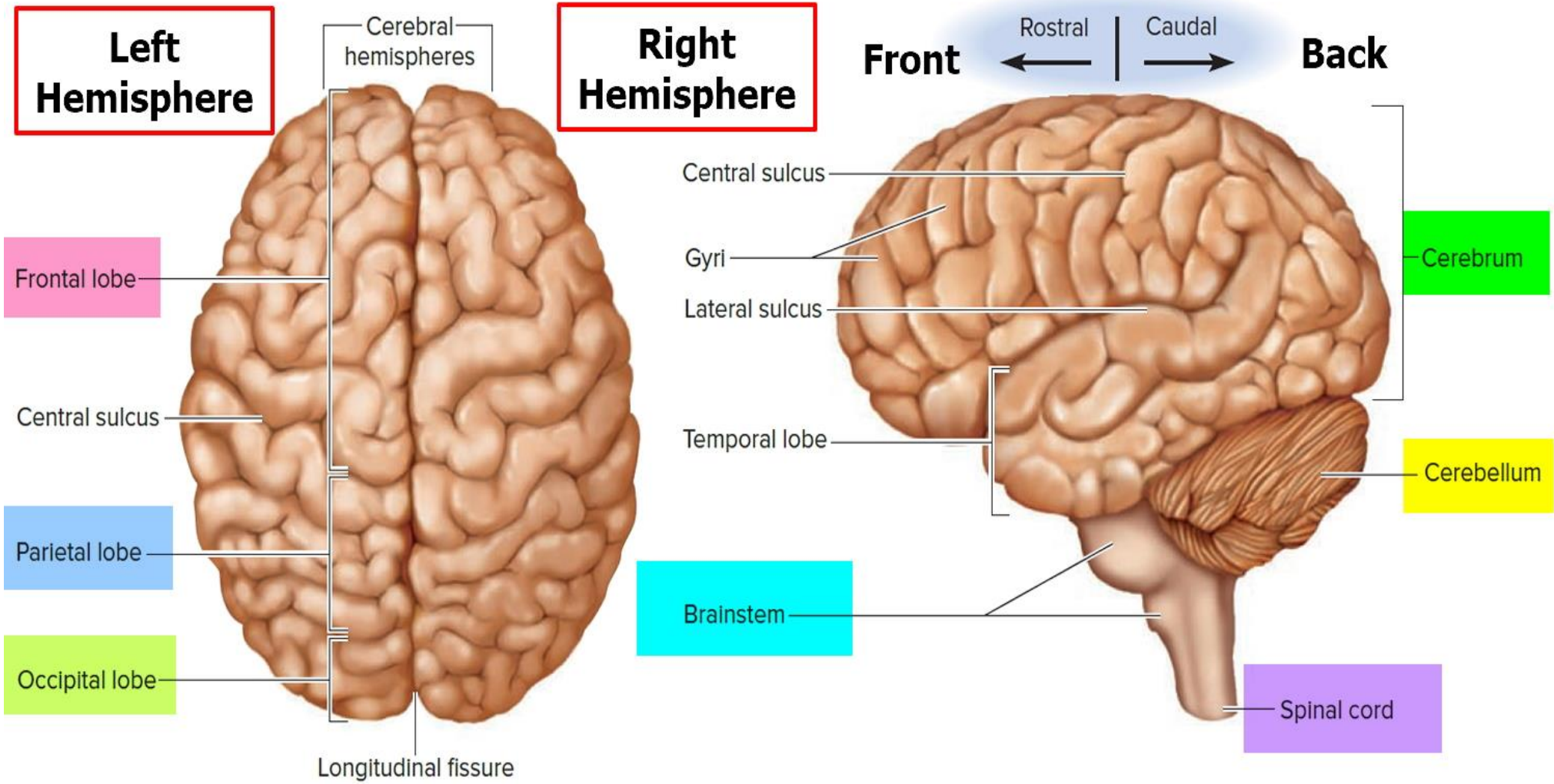
LOBES OF BRAIN

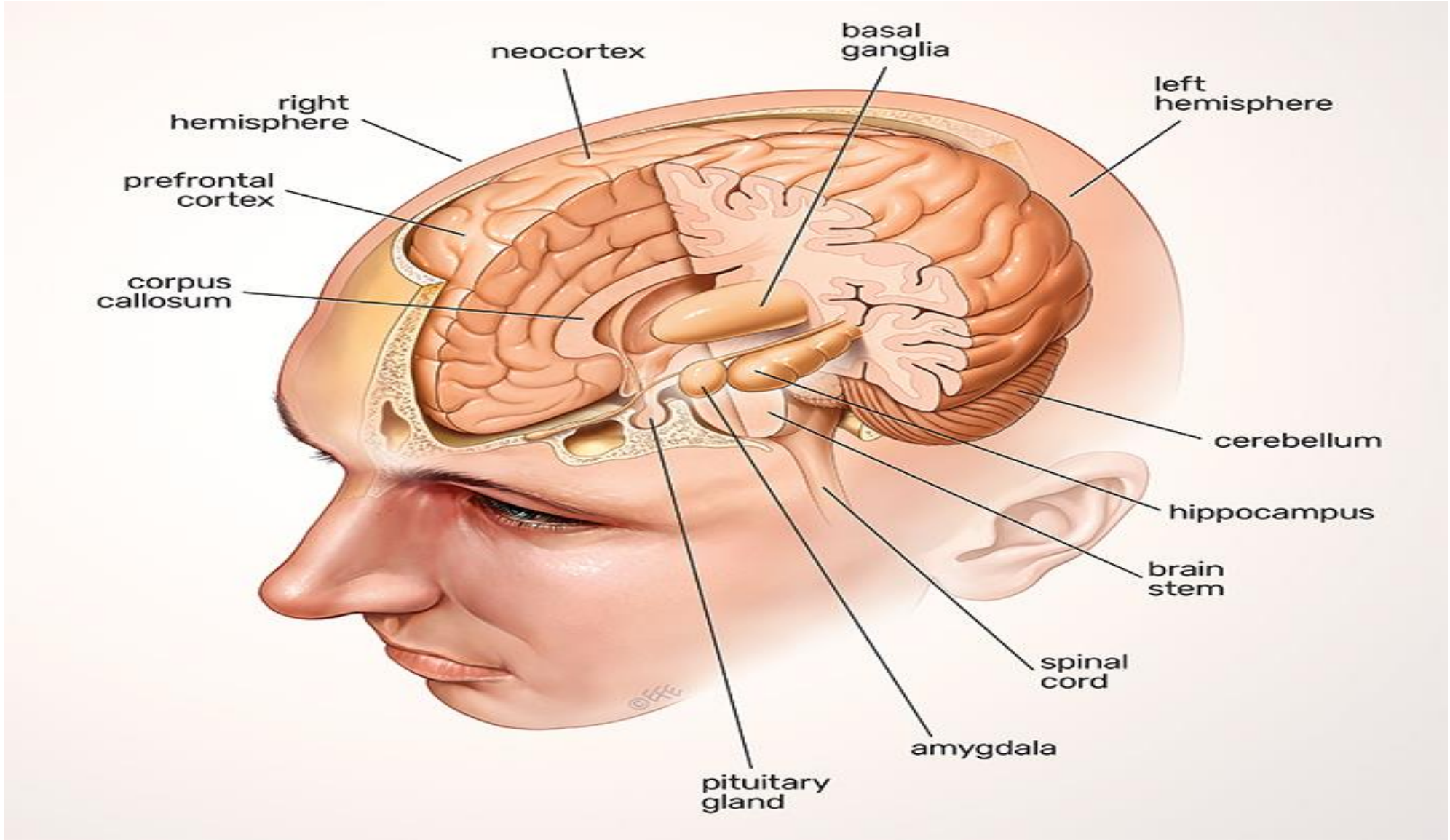
- Anatomically brain is divided into 4 lobes which are named according to the skull bones behind which it lies.
- Frontal lobe
- Parietal lobe
- Temporal lobe
- Occipital lobe

EXTERNAL FEATURES OF BRAIN



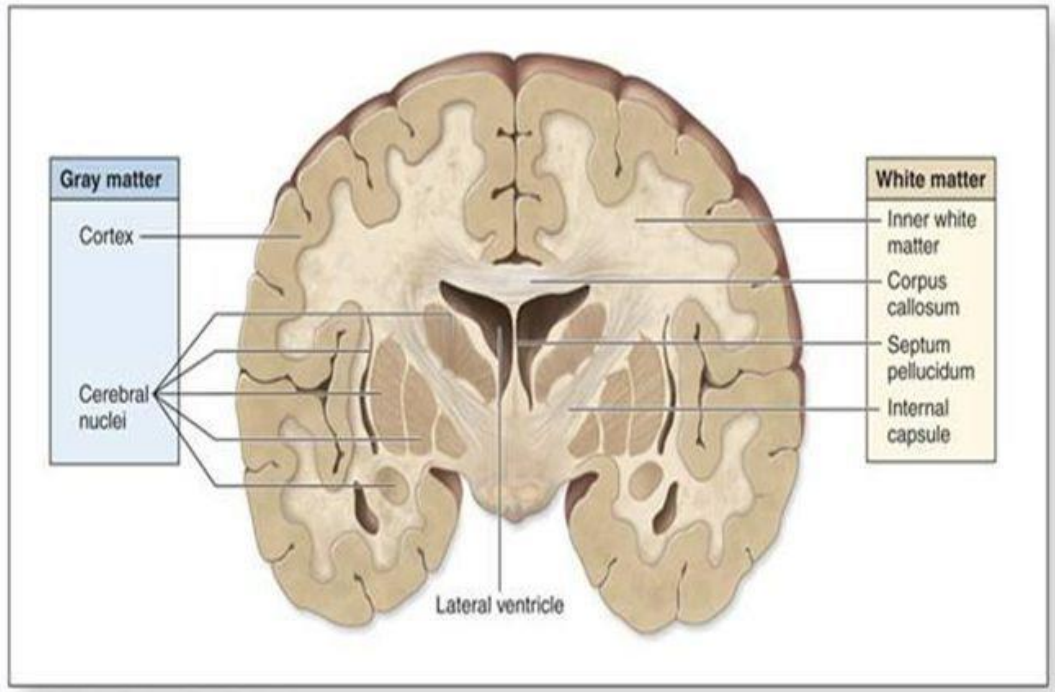

FRONTAL LOBE
PARIETAL LOBE
LEFT HEMISPHERE
RIGHT HEMISPHERE
SULCUS
GYRUS
OCCIPITAL LOBE
TEMPORAL LOBE
THE CEREBRUM
www.visiblebody.com


Left Hemisphere
Cerebral hemispheres
Frontal lobe
Central sulcus
Parietal lobe
Occipital lobe
Longitudinal fissure
Right Hemisphere
Front
Rostral
Caudal
Back
Central sulcus
Gyri
Lateral sulcus
Temporal lobe
Brainstem
Cerebrum
Cerebellum
Spinal cord


neocortex
basal ganglia
right hemisphere
left hemisphere
prefrontal cortex
corpus callosum
cerebellum
hippocampus
brain stem
spinal cord
amygdala
pituitary gland

GREY AND WHITE MATTER OF BRAIN

White vs. Grey Matter



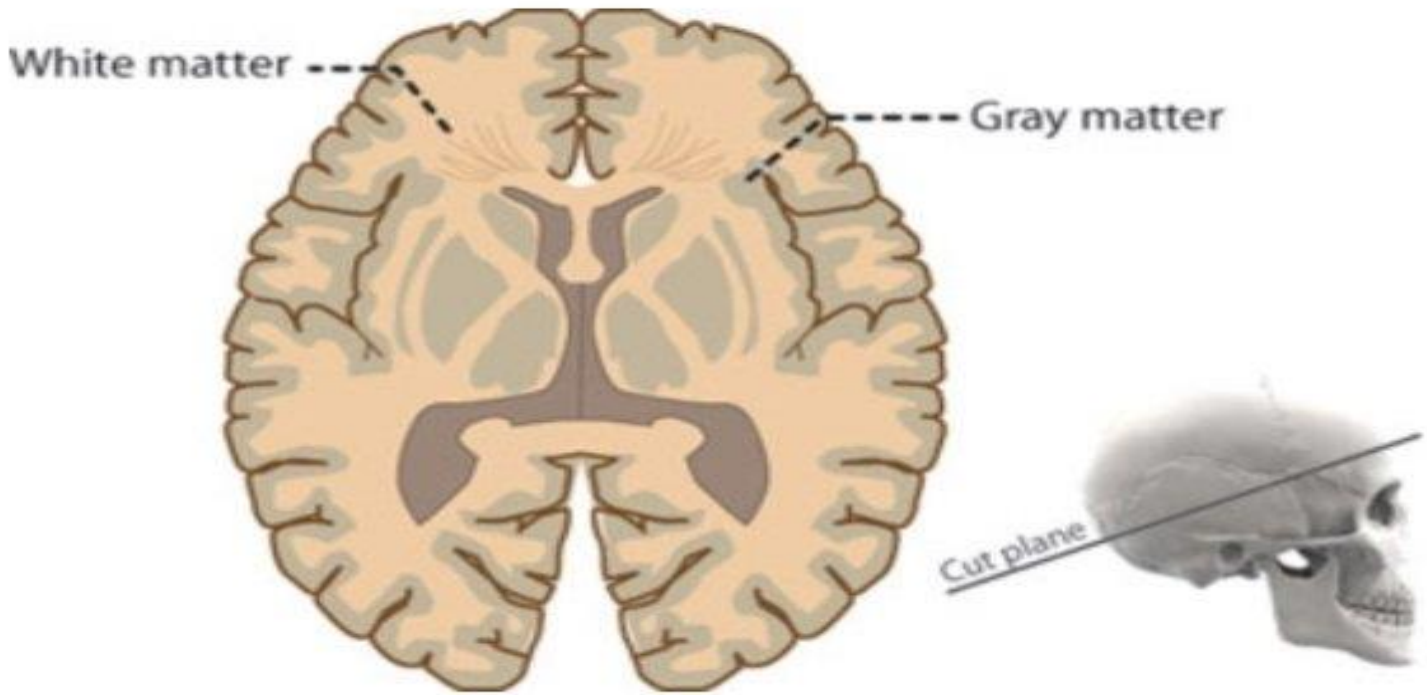
(a) Frontal section of cerebrum

- Axons with myelin sheaths are called myelinated. Axons without the sheath are called unmyelinated.
- **White matter** consists of masses of myelinated axons.
- **Grey matter** consists of masses of unmyelinated axons.

White vs Grey Matter

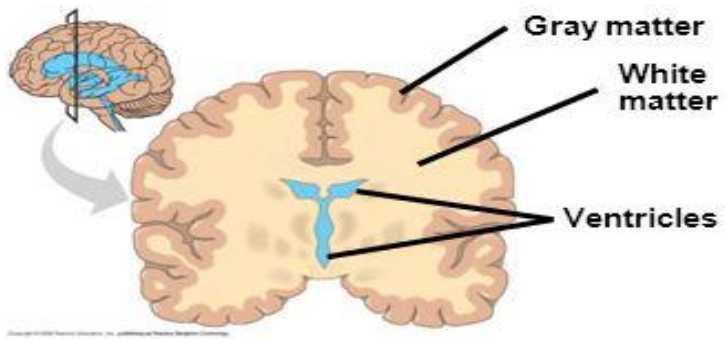
Myelinated (white matter) – myelinated axons

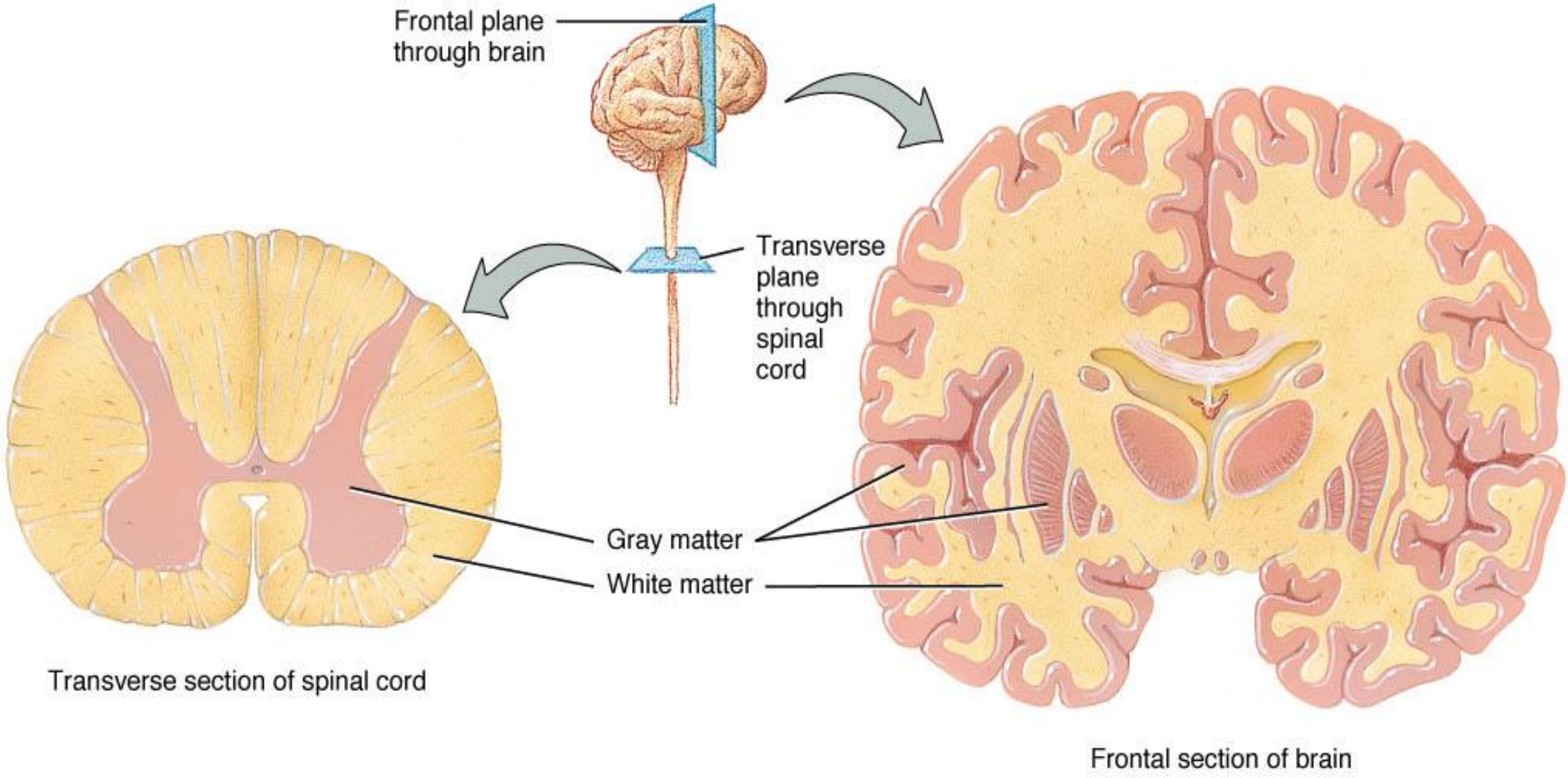
Unmyelinated (grey matter) - unmyelinated



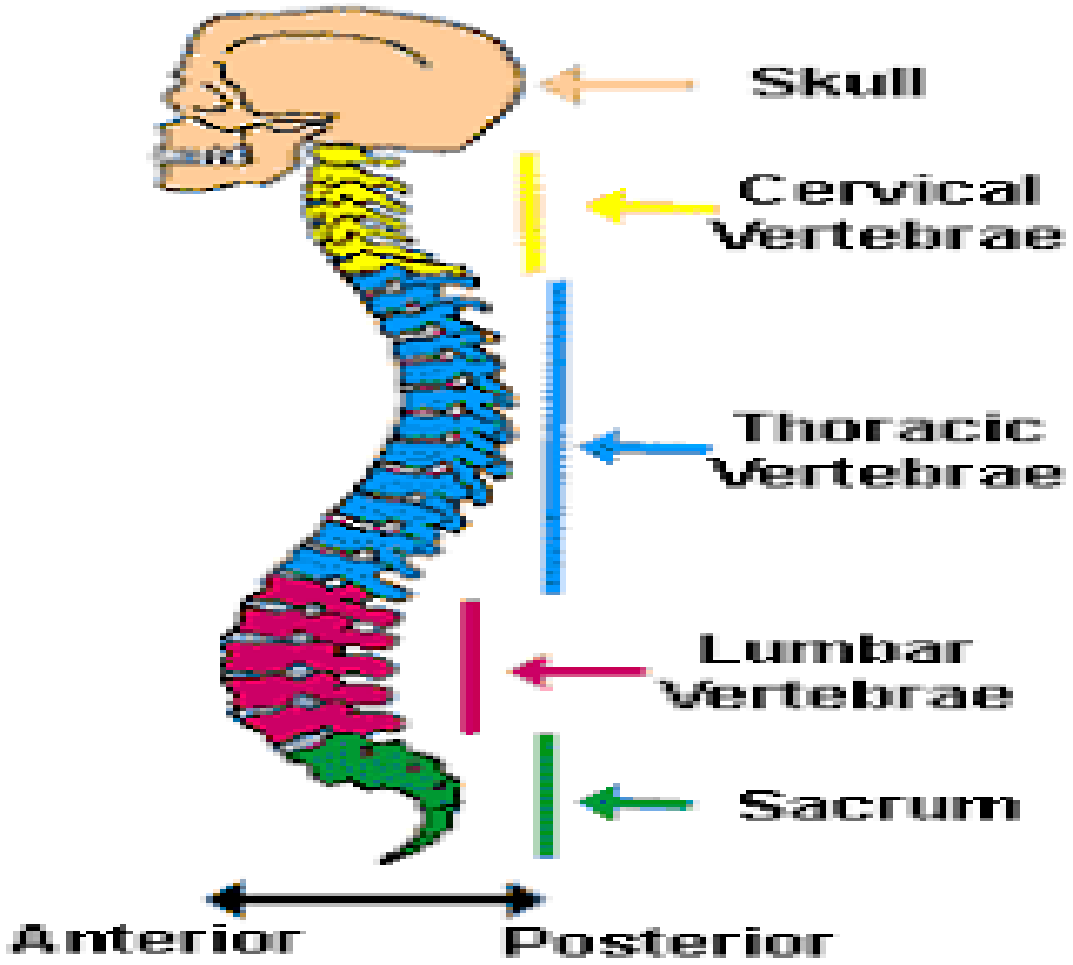
White Matter v. Gray Matter

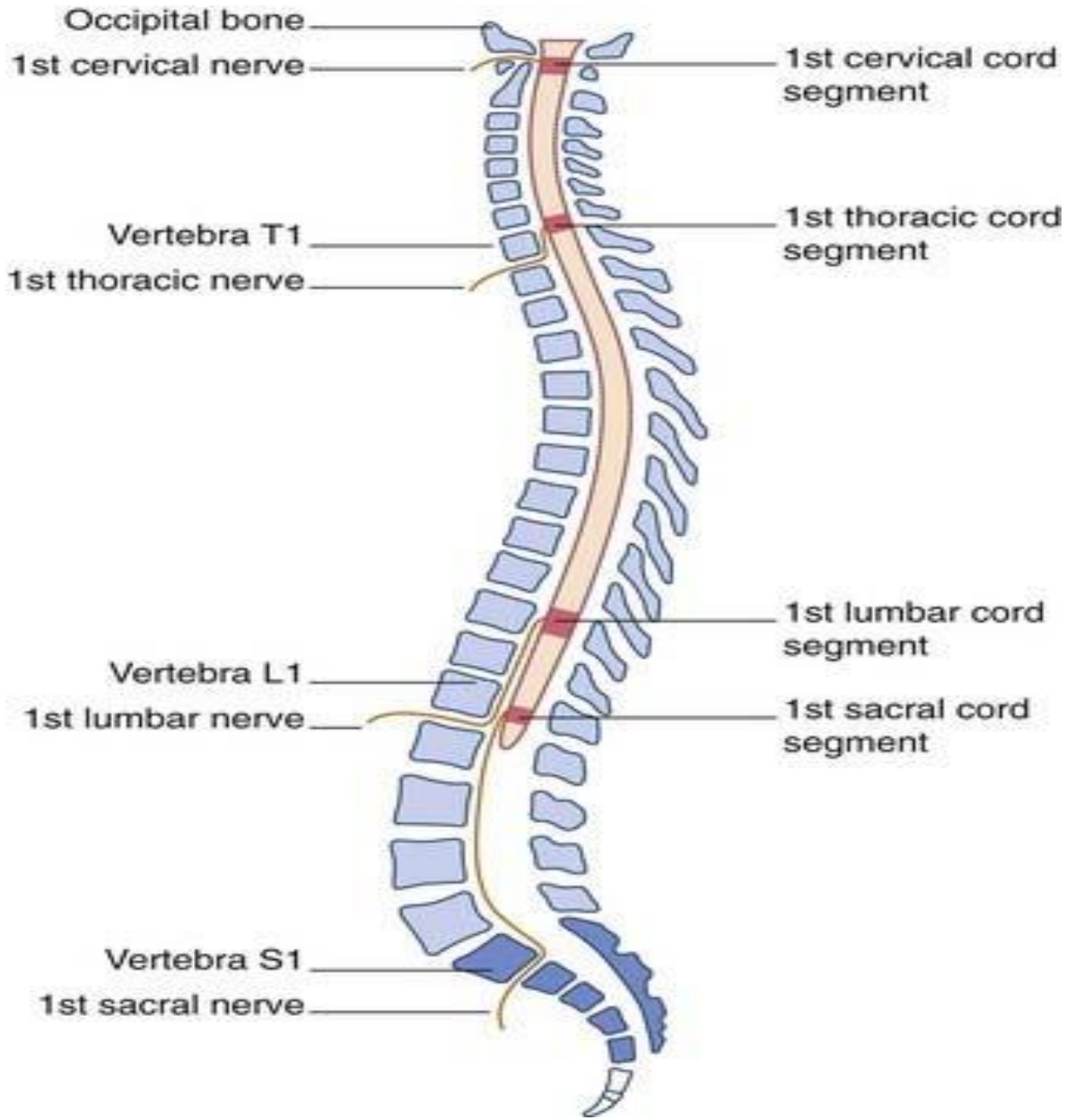
- White matter- consists of bundled axons that have myelin sheaths, which give the axons a whitish appearance
  - in the spinal cord, it lies on the outside, consistent w/ the function in linking the CNS & PNS
  - In the brain, it lies on the inside, reflecting the role of signaling between neurons of the brain in learning, feeling emotions, processing info, etc.
- Gray matter- consists mainly of neuron cell bodies, dendrites, and unmyelinated axons




Frontal plane through brain
Transverse plane through spinal cord
Gray matter
White matter
Transverse section of spinal cord
Frontal section of brain

SPINAL CORD


Skull
Cervical Vertebrae
Thoracic Vertebrae
Lumbar Vertebrae
Sacrum
Anterior
Posterior


Occipital bone
1st cervical nerve
1st cervical cord segment
Vertebra T1
1st thoracic nerve
1st thoracic cord segment
1st lumbar cord segment
Vertebra L1
1st lumbar nerve
1st sacral cord segment
Vertebra S1
1st sacral nerve

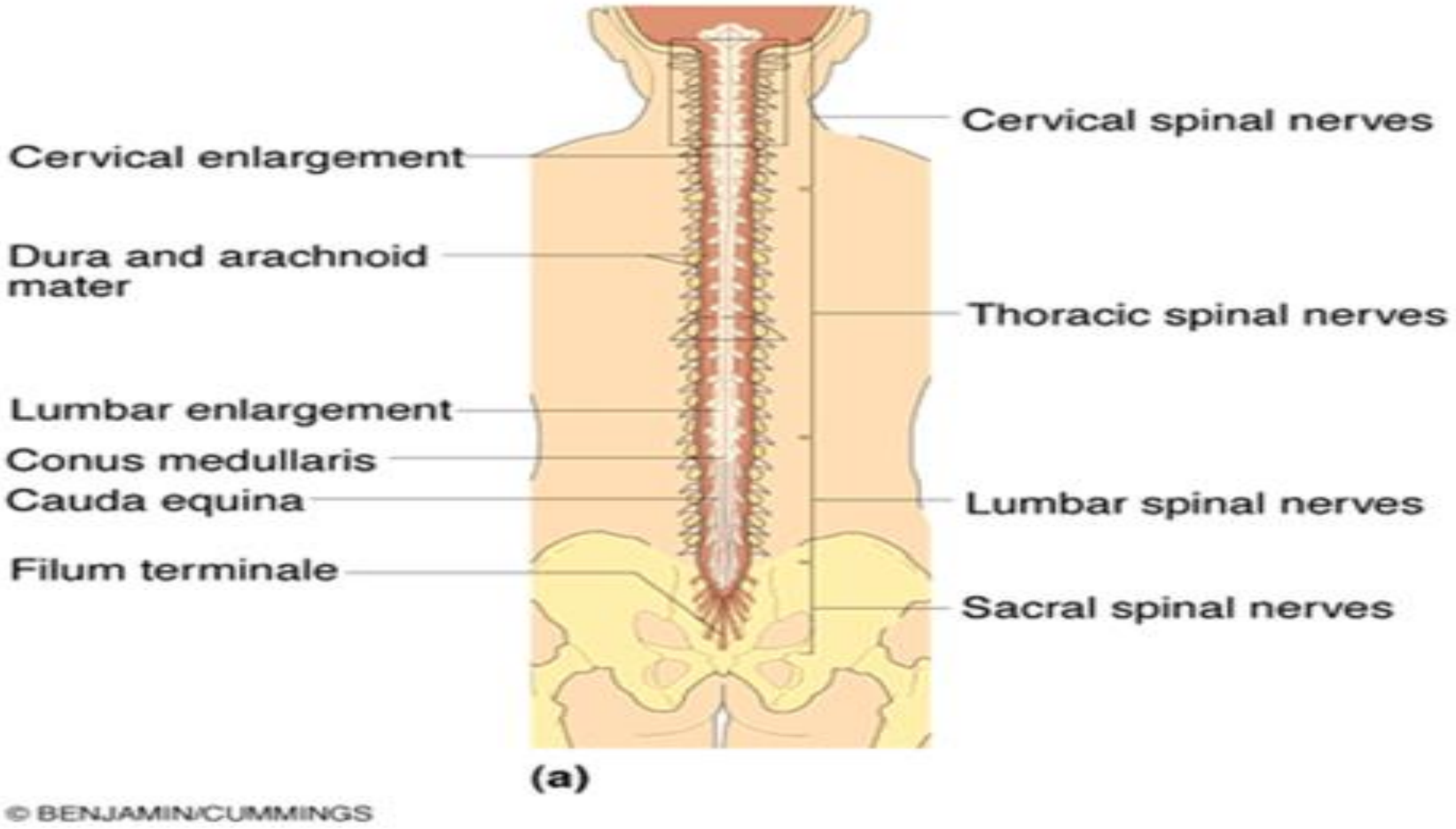
Gross Anatomy of the Spinal Cord

- The spinal cord is an elongated structure, Roughly cylindrical in shape and slightly flattened antero- posteriorly occupying the Upper 2/3rd of the vertebral column. Superiorly it is continuous with the medulla oblongata and inferiorly it has a tapering end the conus medullaris.
- Length: 45 cm (18 inches) in men
  43 cm (17 inches) in women

Gross Anatomy of the Spinal Cord

- The diameter of the spinal cord changes along its length because the amount of gray matter and white matter and the function of the cord vary in different regions. It tappers cranio-caudally except for the enlargements.
- It varies from 1-1.5 cm. being thinner in cervical and thoracic
- Region and wider in cervical and
- Lumbar enlargements.

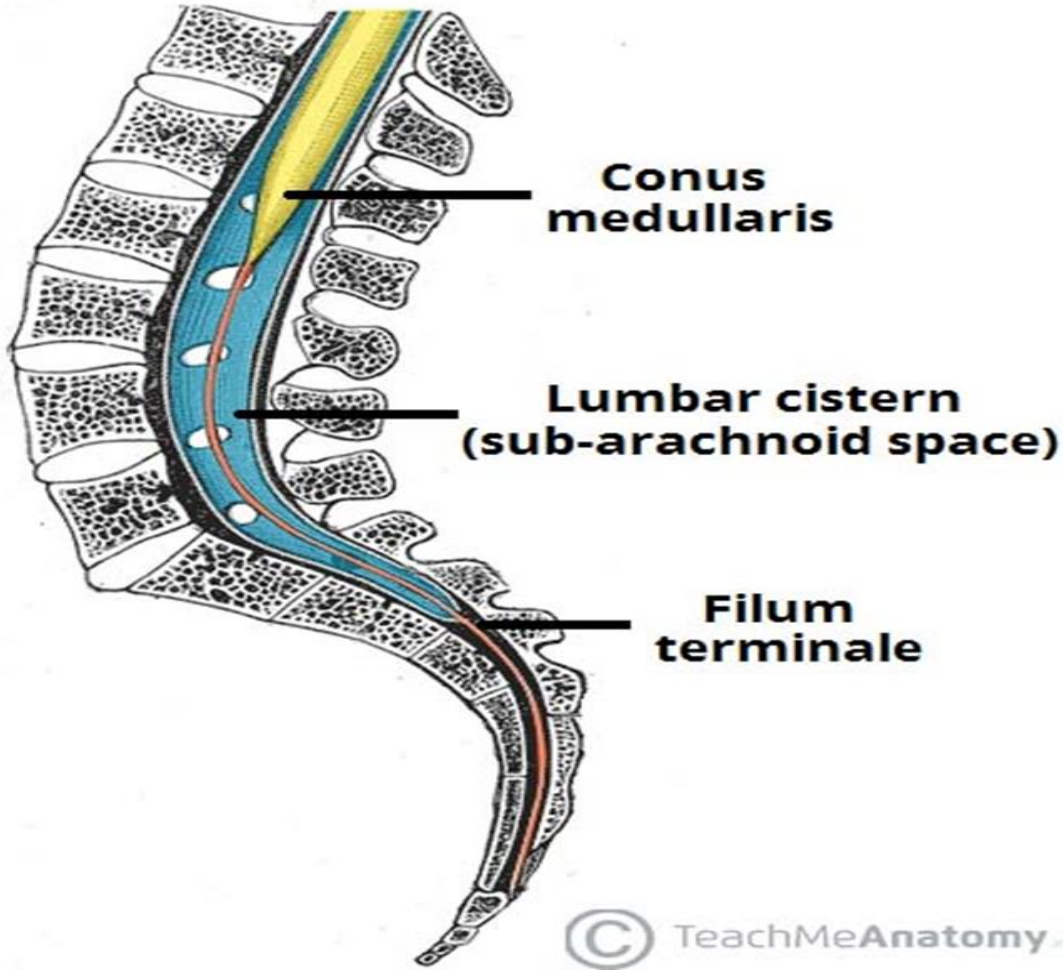
CONUS MEDULLARIS

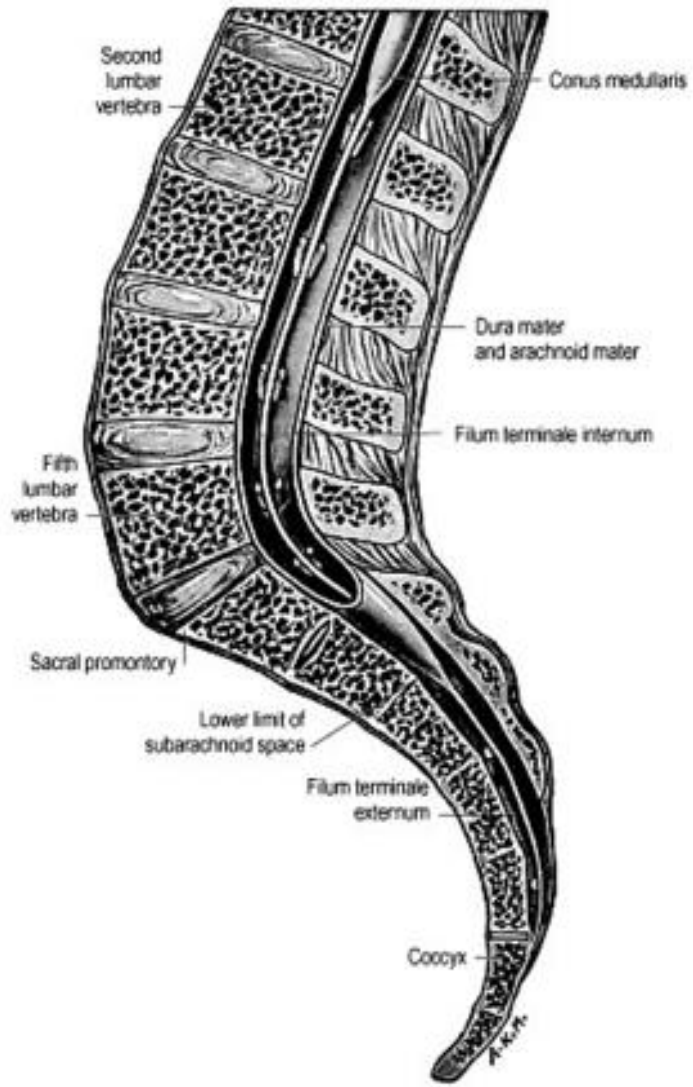


THE FILUM TERMINALE

- The filum terminale, a filament of connective tissue 20 cm long, descends from the apex of the conus medullaris. The cord tapers into a **slender filament** called the **filum terminale. It** consists of **pia mater** and **neuroglial elements**.
- A capacious part of the subarachnoid space surrounds the filum terminale internum, and is the site of election for access to the CSF (lumbar puncture).
- This lies in the midst of the **cauda equina** and has a **distinctive bluish-white colour**.
- It is a vestige of the spinal cord of the **embryonic tail**, but in the adult it has **no functional significance**.

CONT……..


Conus medullaris
Lumbar cistern (sub-arachnoid space)
Filum terminale
TeachMeAnatomy

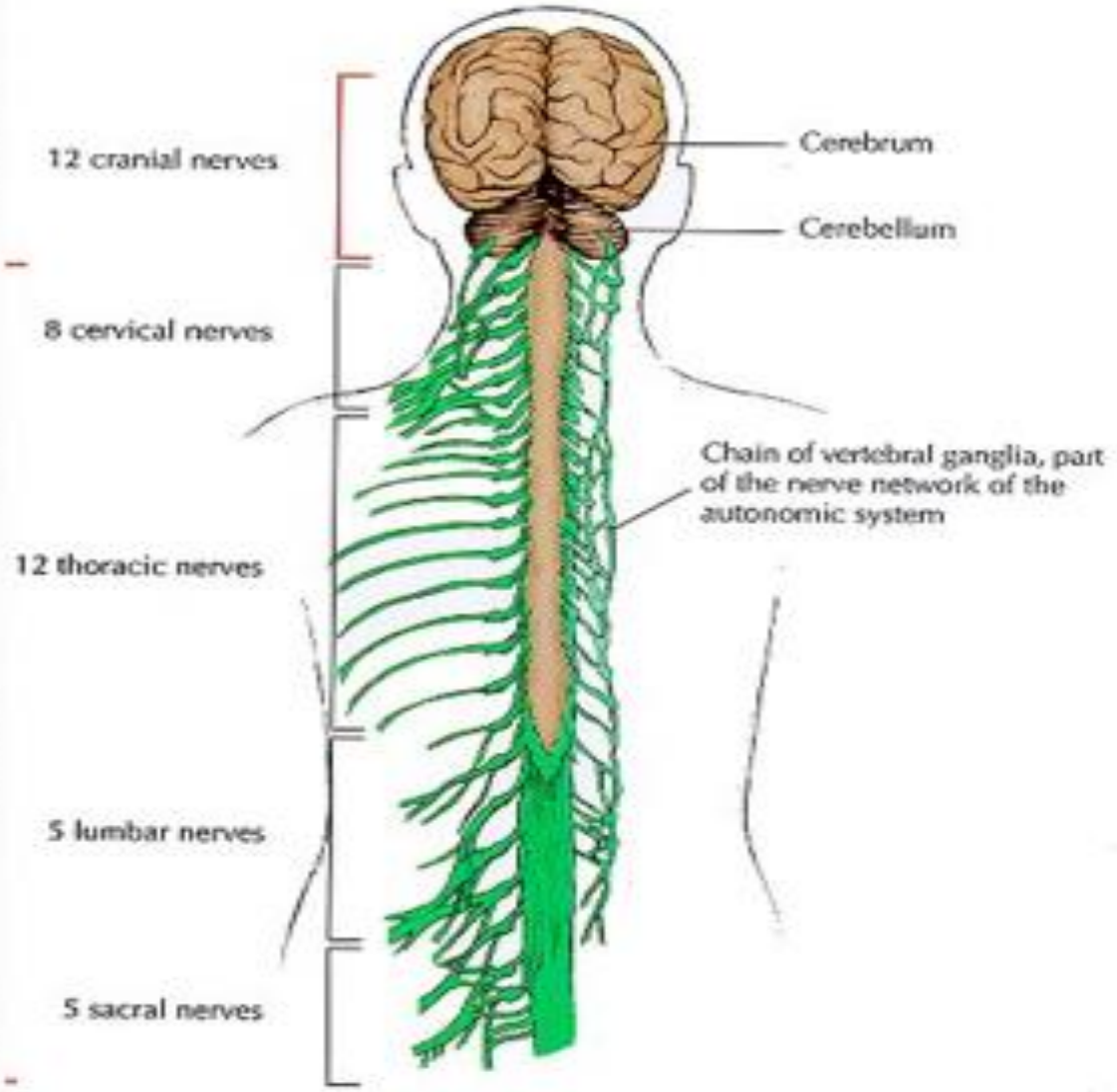


Gross Anatomy of the Spinal Cord

- The spinal cord comprises of 31 spinal segments. Each segment giving rise to a spinal nerve. Thus it is associated with thirty-one pairs of spinal nerves that connect the CNS to muscles, receptors and glands.

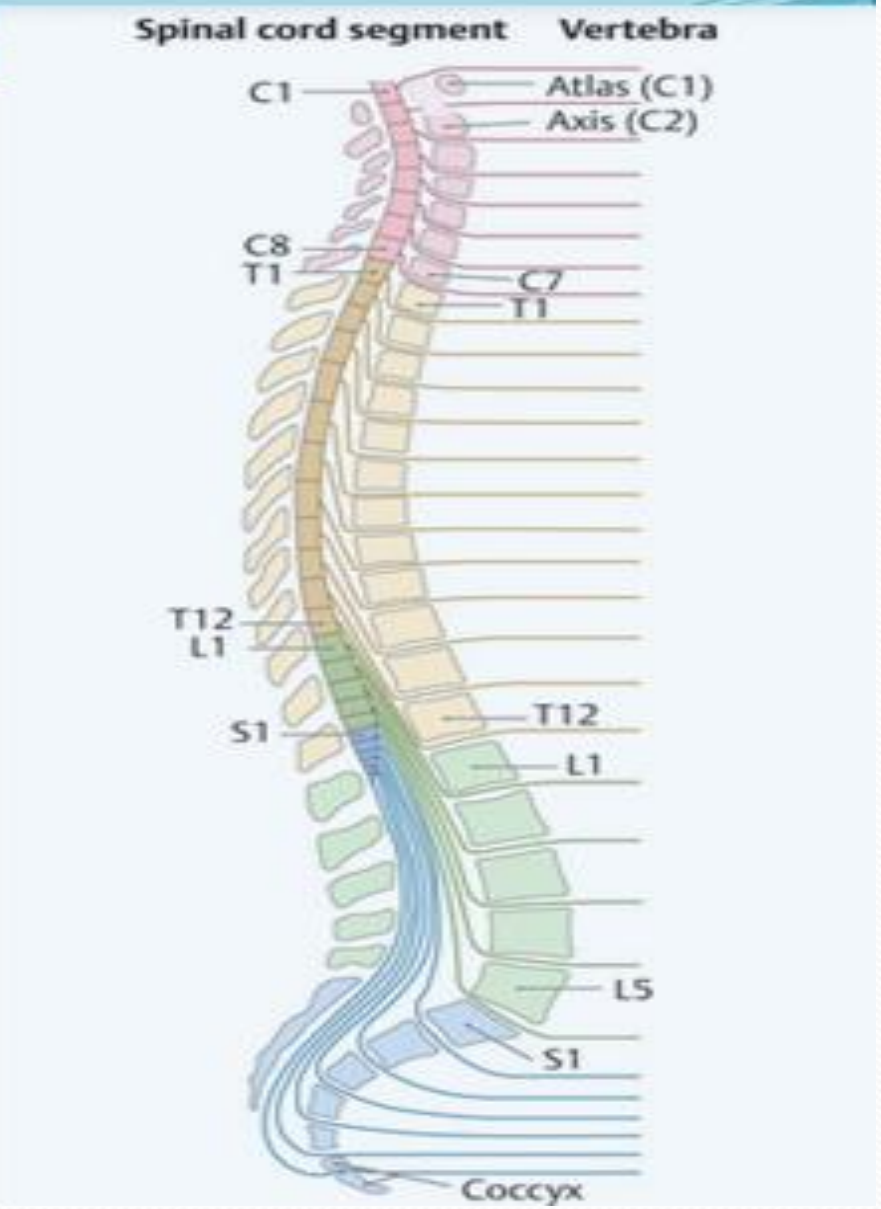
Each side contains:

- Eight cervical nerves (C1-C8).
- Twelve thoracic nerves (T1-T12).
- Five lumbar nerves (L1-L5).
- Five sacral nerves (S1-S5)
- One coccygeal nerve (Co)



Gross Anatomy of the Spinal Cord

Vertebral segments. There are 7 cervical (neck), 12 thoracic (chest), 5 lumbar (back), and 5 sacral (tail) vertebrae. The spinal cord sends roots that exit the spinal canal between vertebral bodies. Spinal cord segmental levels are defined by their roots but are not always situated at the corresponding vertebral levels. For example, the C8 cord segment is situated in the C7 vertebra while the T12 cord is situated in the T8 vertebra. The lumbar cord is situated between T9 and T11 vertebrae. The sacral cord is situated between the T12 to L2 vertebrae, as shown in figure.



Relationships of Spinal Cord Segments to Vertebral Numbers

Because the spinal cord is shorter than the vertebral column, the spinal cord segments do not correspond numerically with the vertebrae that lie at the same level. The following list helps determine which spinal segment is contiguous with a given vertebral body.

Vertebrae	**Spinal Segment**
Cervical	Add 1
Upper thoracic	Add 2
Lower thoracic (T7 to 9)	Add 3
Tenth thoracic	L1 and 2 cord segments
Eleventh thoracic	L3 and 4 cord segments
Twelfth thoracic	L5 cord segment
First lumbar	Sacral and coccygeal cord segments

CAUDA EQUINA

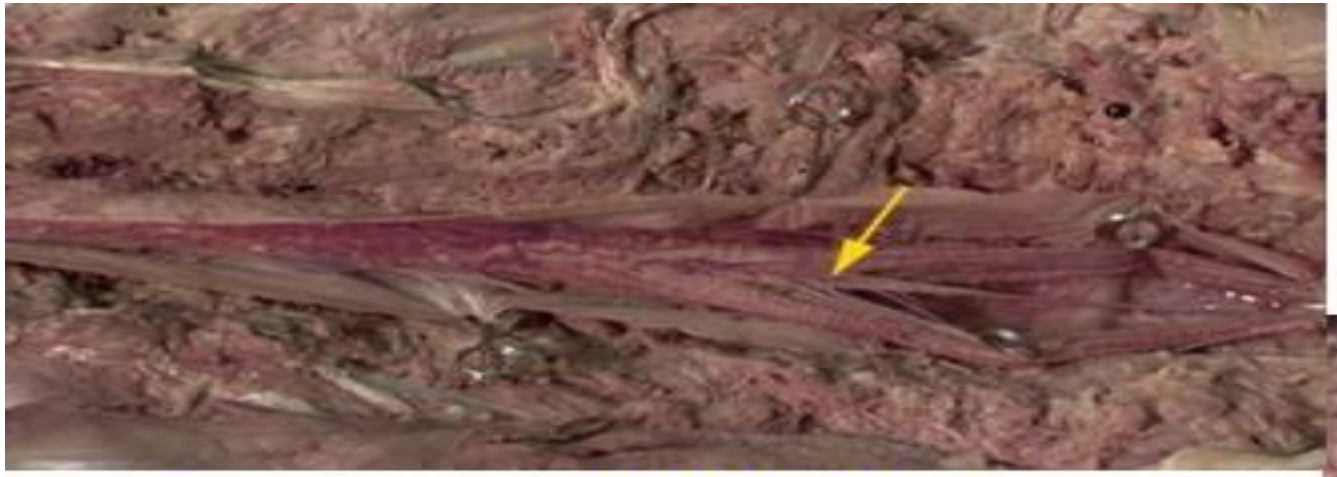
- Because of disproportionate growth in length of vertebral column during development compared with that of spinal cord ,the length of nerve roots increases progressively from above downwards to emerge through correcponding intervertebral foramin.
- In upper cervical region spinal nerve roots are shorter & run almost horizontally but roots of lumbar & sacral nerves below level of termination of cord (at lower border of L1 in adults) form a vertical leash around filum terminale. Together these nerve roots are called

  –*cauda equina*.

  Cauda=tail equina=horse

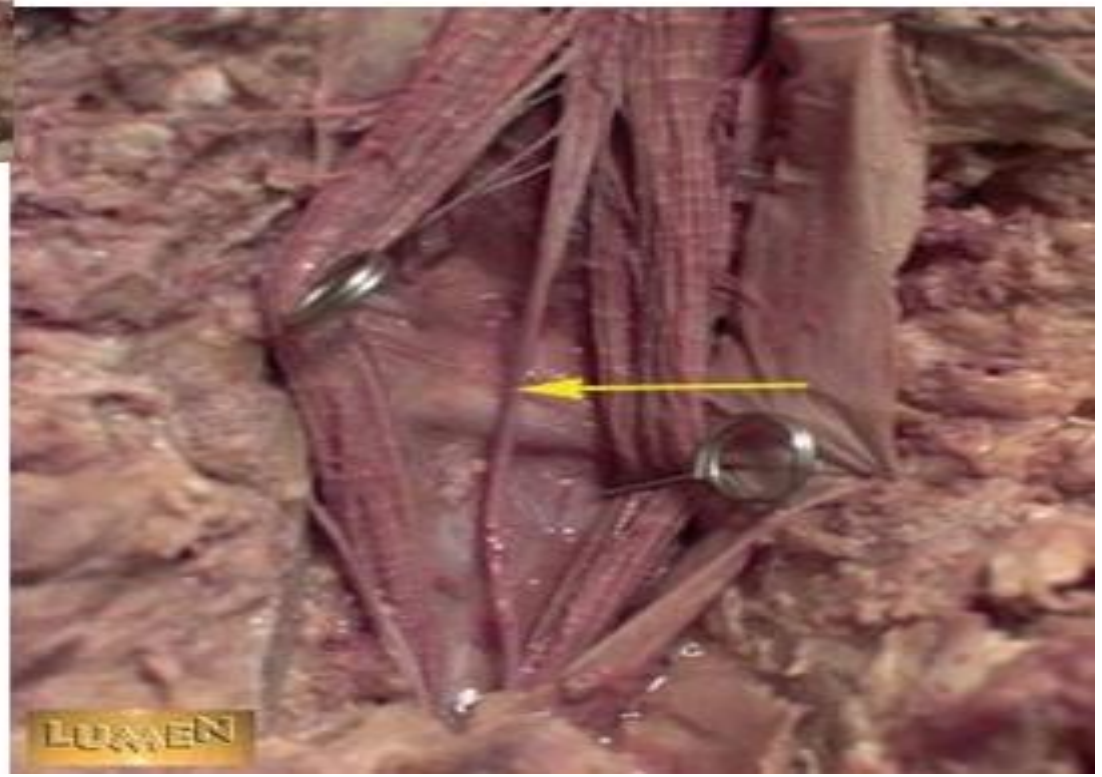
- Cauda equina consists of roots of lower 4 pairs of lumbar, 5 pairs of sacral & 1 pair of coccygeal nerves

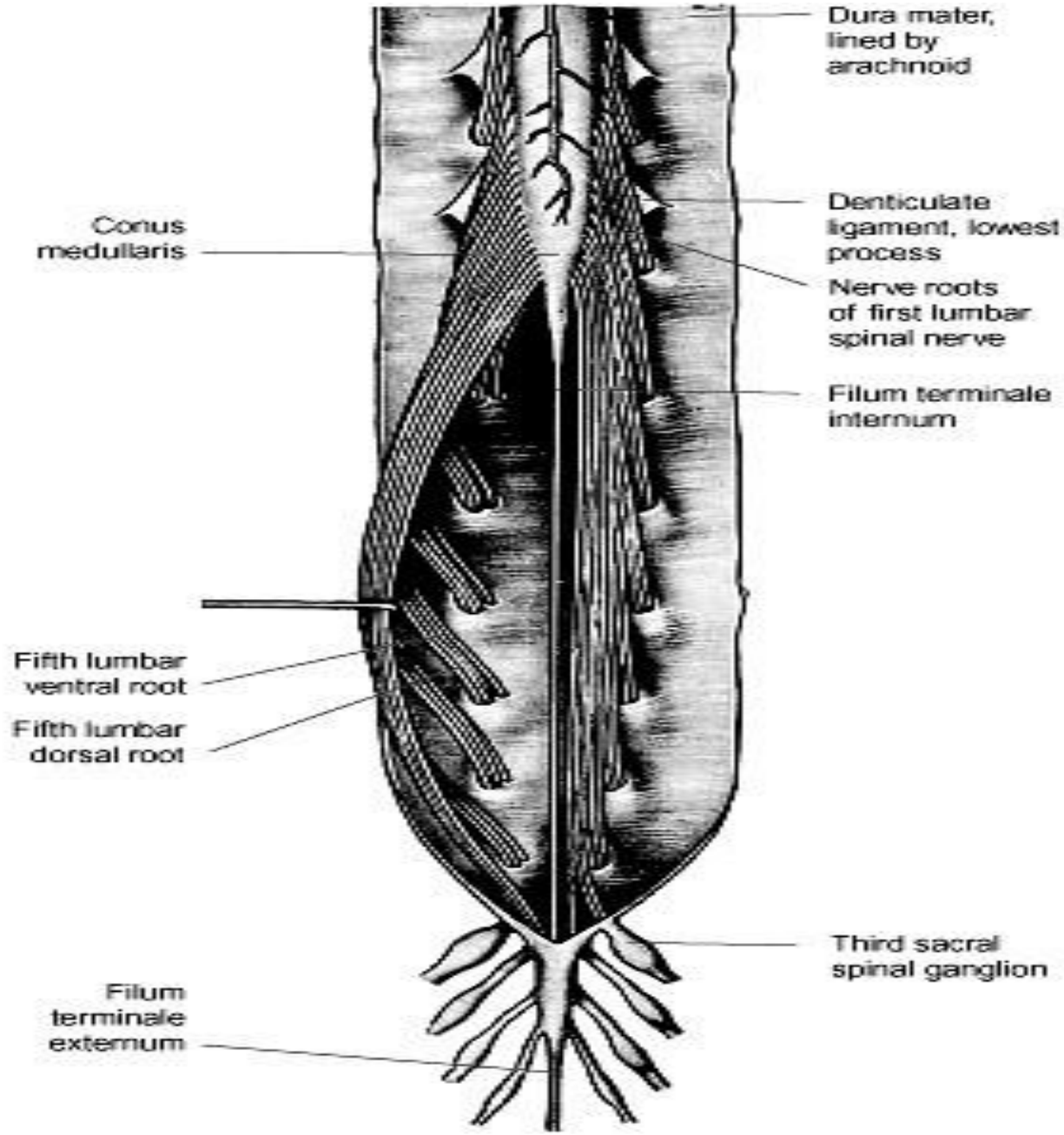
RECALL……



- **Conus medullaris** – inferior end of spinal cord proper
- **Cauda equina** – individual spinal nerves within spinal canal
- **Filum terminale** – filamentous end of meninges, "tie-down"

Inferior End of Spinal Cord





PRINCIPAL PARTS

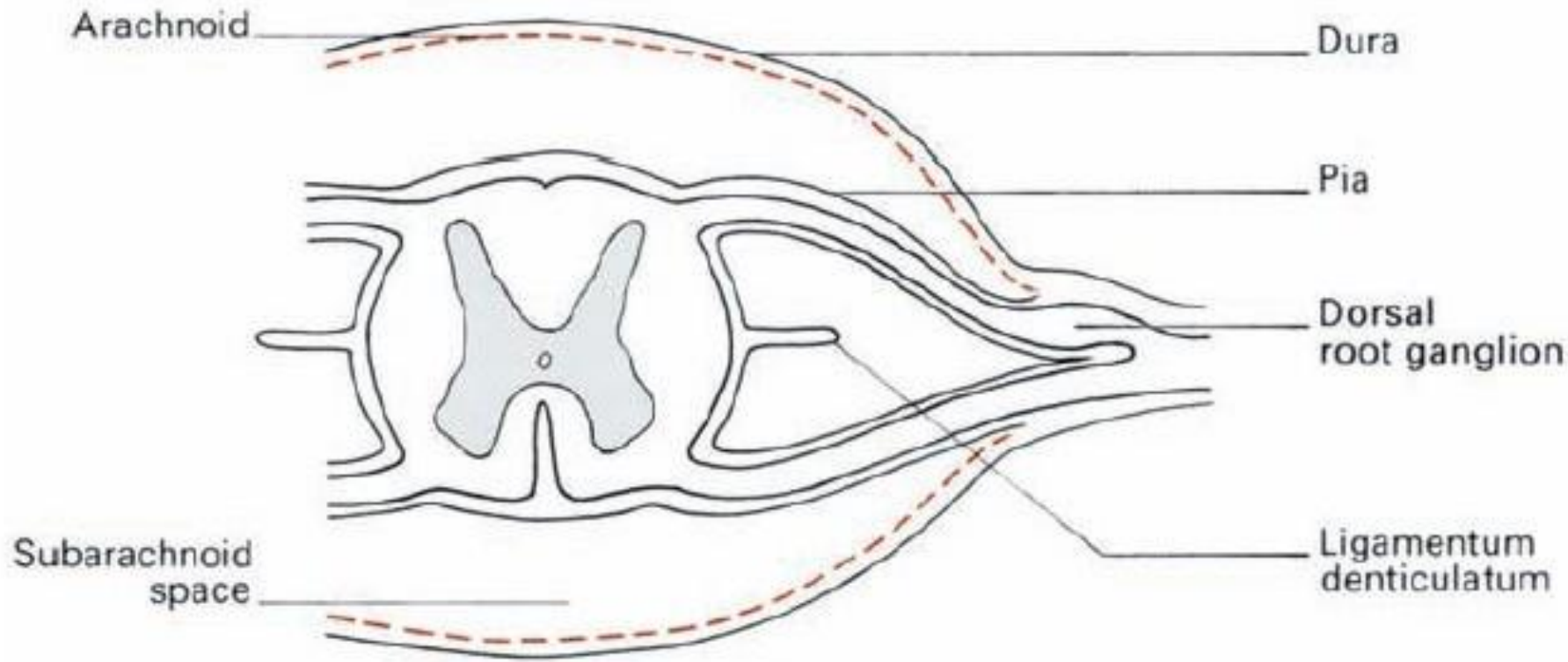
- 1. 42-45 cm in length; 2.5 cm wide
- 2. Cervical enlargement - C4-T1 supply upper limbs
- 3. Lumbar enlargement - T9-T12 supply lower limbs
- 4. Conus medullaris - tapers off to end at L1-L2
- 5. Filum terminale - pia mater anchors cord to coccyx
- 6. Cauda equina - (horse tail) nerves below L2

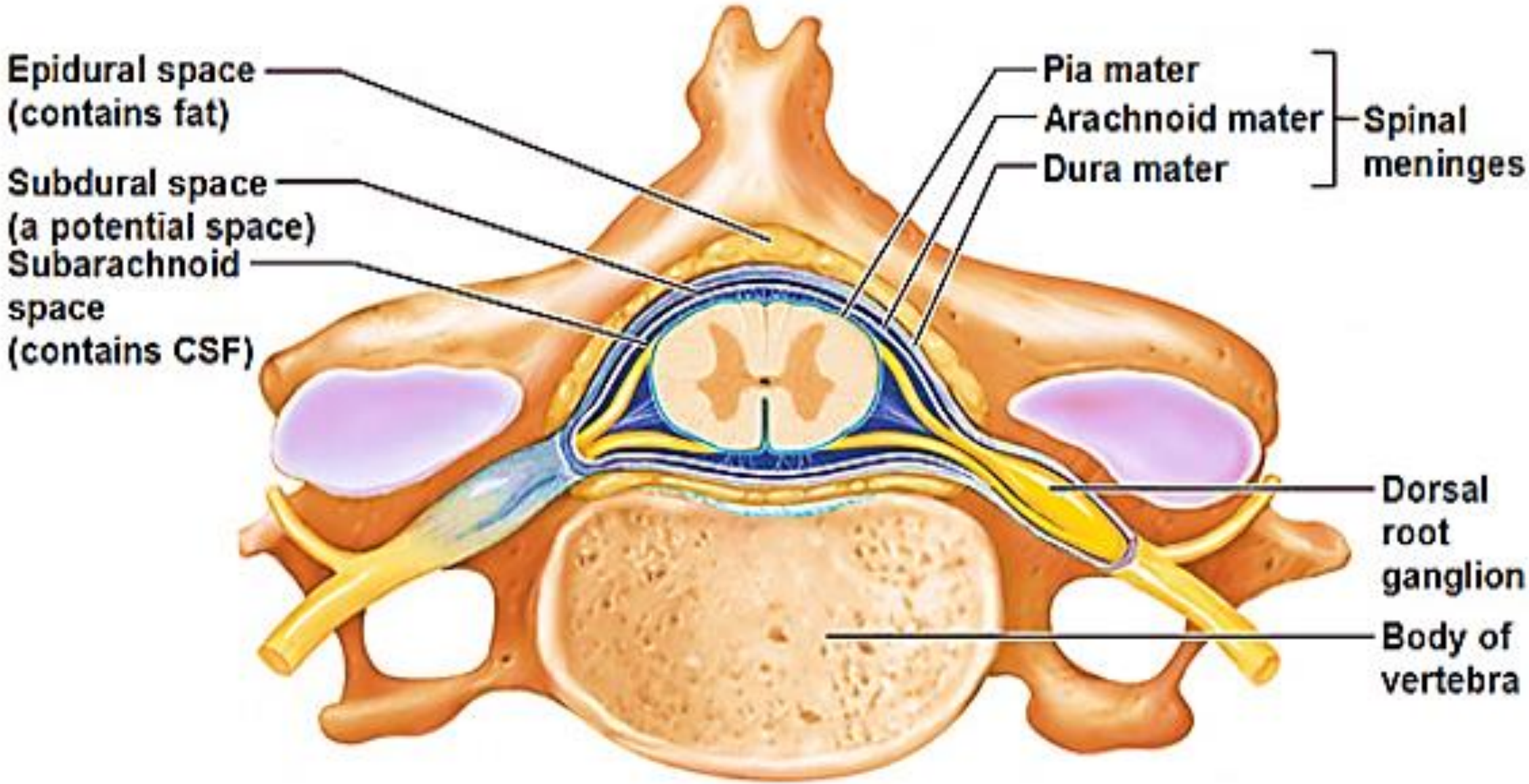
SPINAL MENINGES

- The spinal cord is enclosed in the dura, arachnoid and pia mater, separated from each other by the subdural and subarachnoid spaces respectively.
- The subdural space is a potential space.
- The subarachnoid space contains cerebrospinal fluid (CSF). .

Spinal Meninges

- Specialized membranes isolate spinal cord from surroundings
- Spinal meninges:
  - protect spinal cord
  - carry blood supply
  - continuous with cranial meninges


Arachnoid
Dura
Pia
Dorsal
root ganglion
Ligamentum
denticulatum
Subarachnoid
space


Epidural space
(contains fat)
Subdural space
(a potential space)
Subarachnoid
space
(contains CSF)
Pia mater
Arachnoid mater
Dura mater
Spinal
meninges
Dorsal
root
ganglion
Body of
vertebra

DURA MATTER

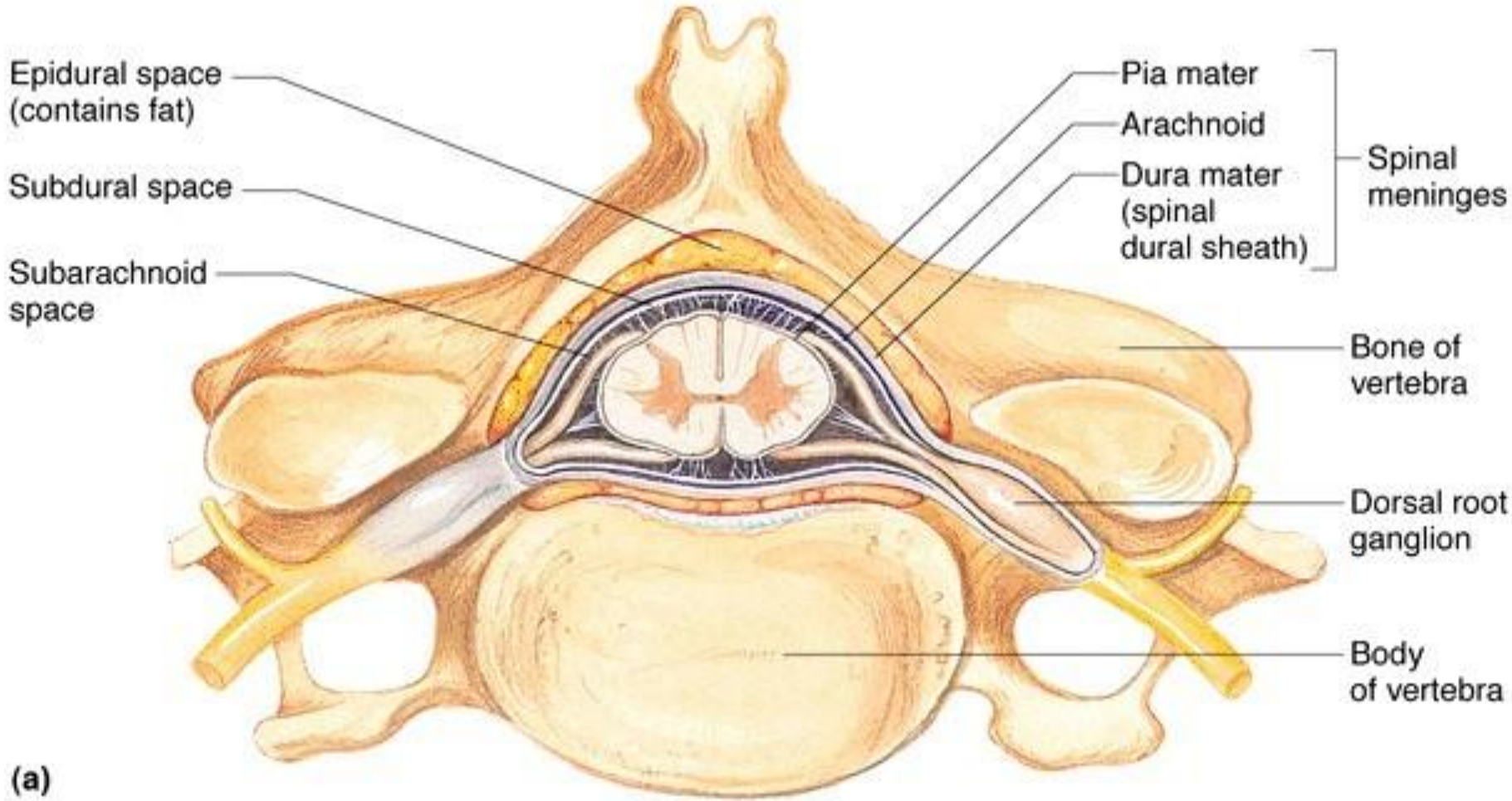
- It extends from foramen magnum to lower border of S2
- **Epidural space:**
- Space between vertebral canal and spinal dura
- It contains loose areolar tissue, vertebral plexus and fat
- **Sub Dural space**
- space between dura matter and arachnoid matter
- it is filled with capillary fluid

ARICHNOID MATTER

- Thin
- Avascular
- Transparent membrane
- Loosely investing spinal cord
- Above-------arachnoid matter of brain
- Below-------S2

PIA MATTER

- Thin
- Vascular
- Closely investing spinal cord
- Below-----filum terminale

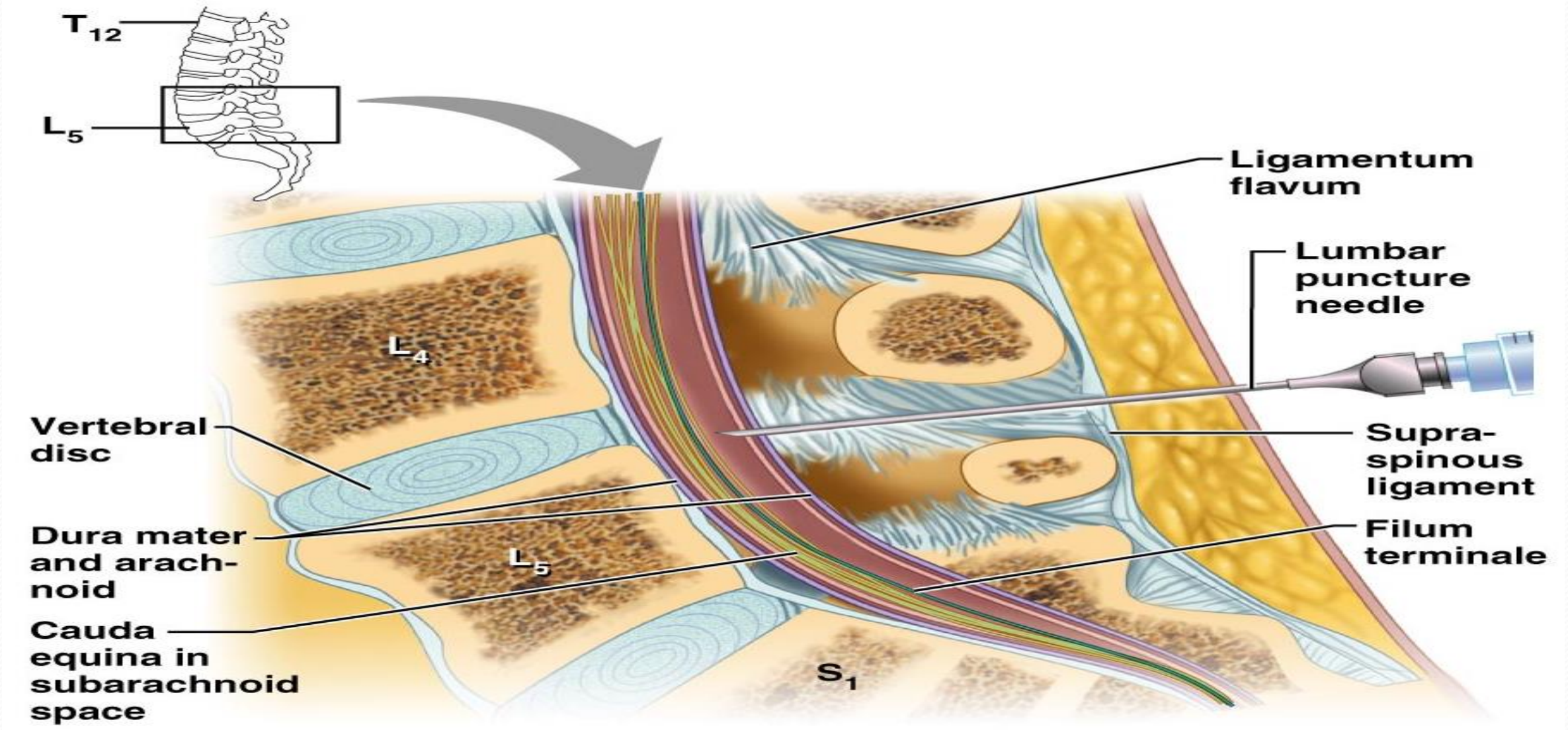


(a)

SUB ARACHNOID SPACE

- Space between pia matter and arachnoid matter which is filled with csf
- Clinical significance
- LUMBER PUNCTURE IS DONE HERE

LUMBAR TAP


T12
L5
Ligamentum flavum
Lumbar puncture needle
L4
Vertebral disc
Supra-spinous ligament
Dura mater and arach-noid
Filum terminale
L5
Cauda equina in subarachnoid space
S1

SUB ARACHINOID SEPTUM

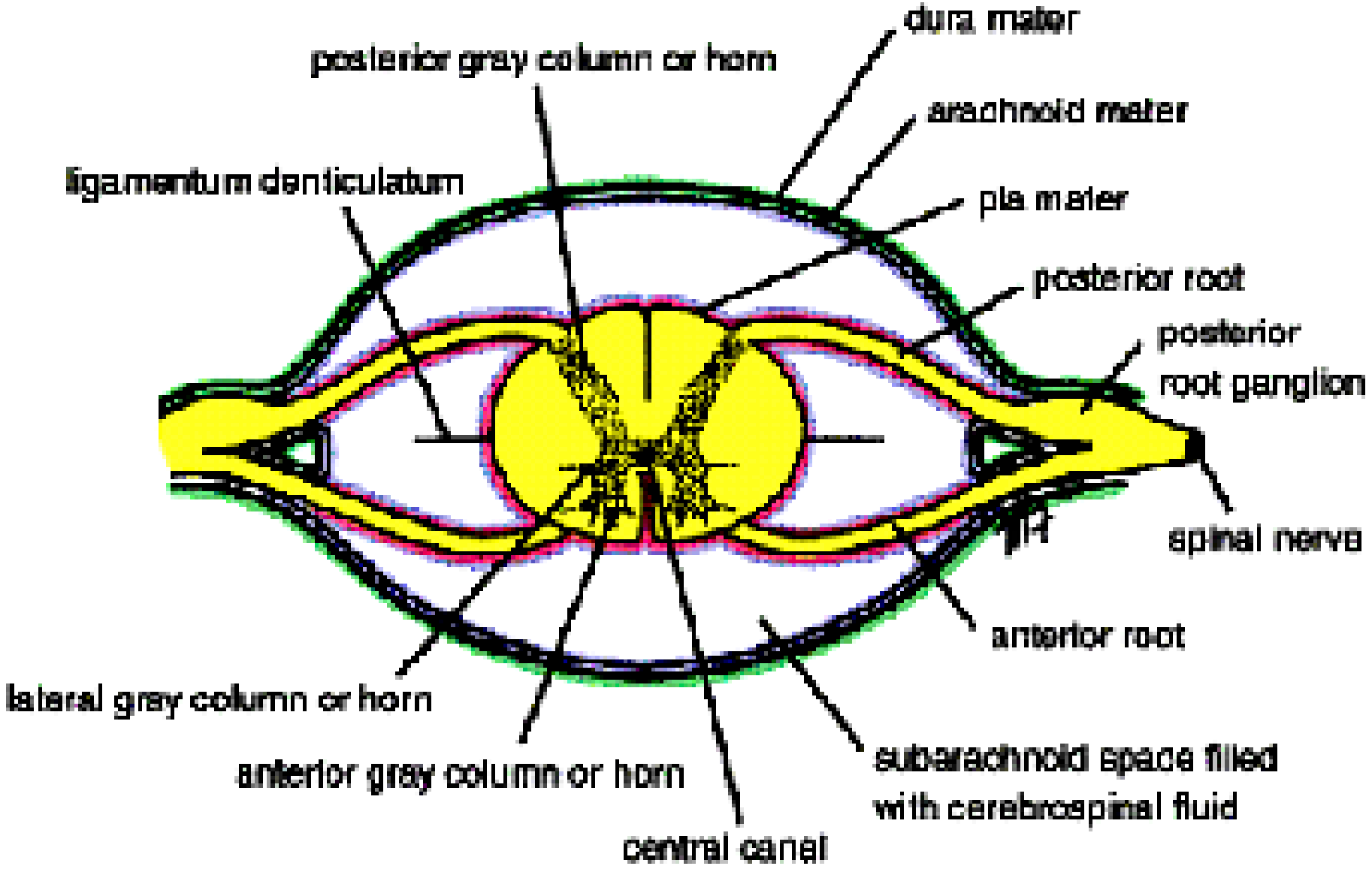
- Connects dorsal surface of spinal cord to arachnoid matter

LIGIMENTUM DENTICULATA

- Two transparent thick bands of pia matter which extends laterally to attach with inner surface of dura matter.

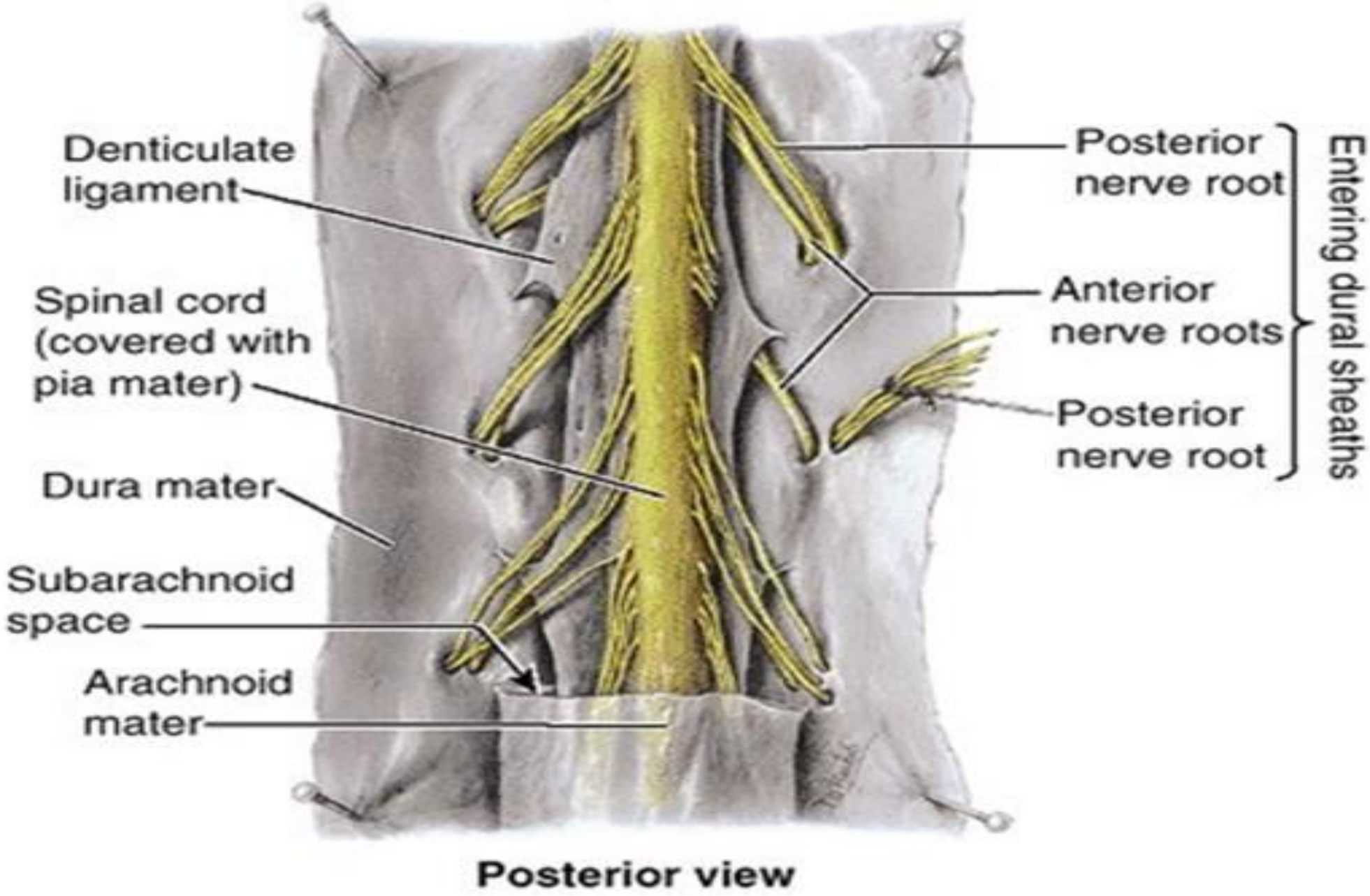
FUNCTION

- To anchor or hold spinal cord in the middle of sub arachnoid space

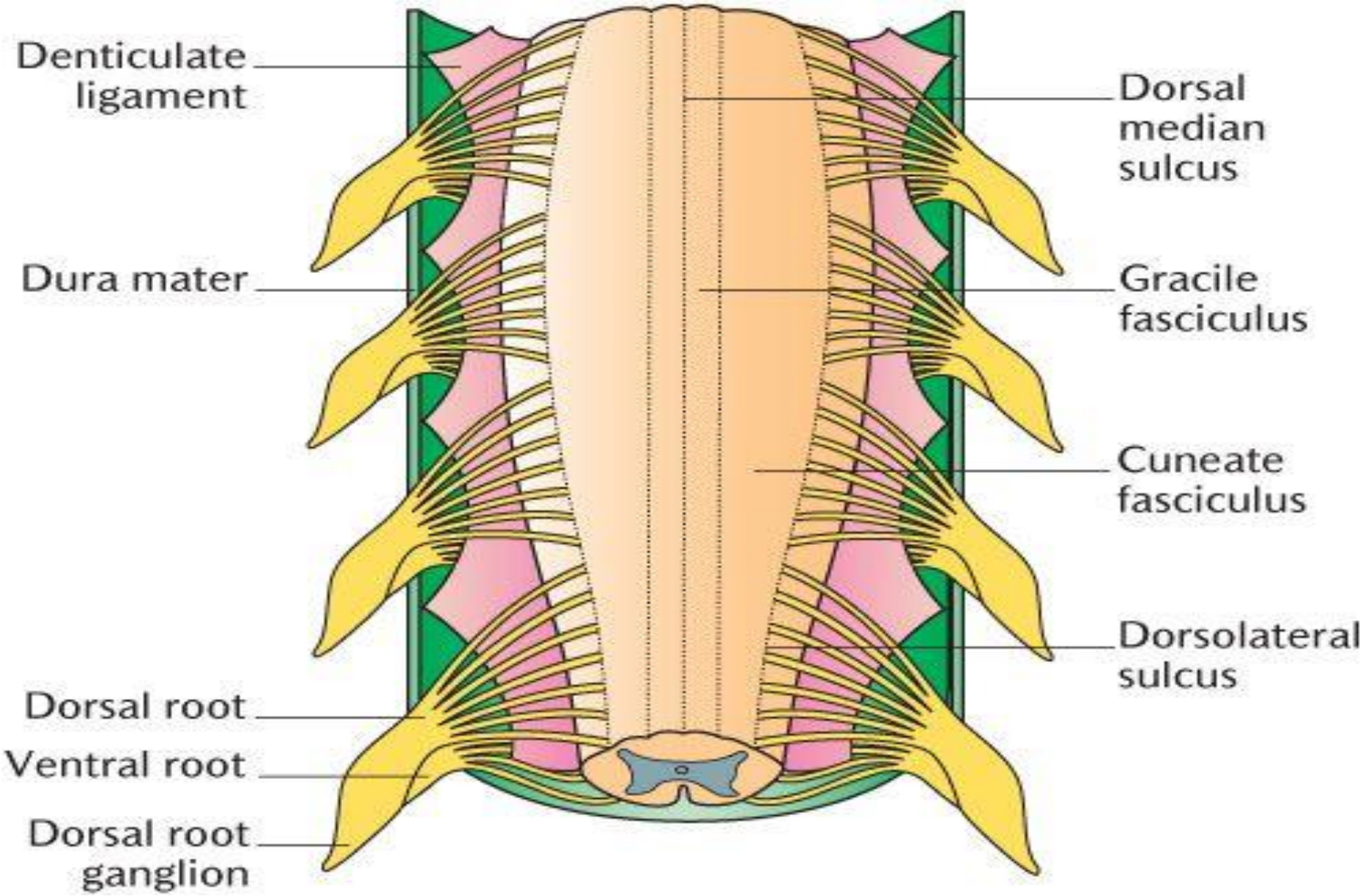

dura mater
posterior gray column or horn
arachnoid mater
ligamentum denticulatum
pia mater
posterior root
posterior
root ganglion
spinal nerve
anterior root
lateral gray column or horn
anterior gray column or horn
central canal
subarachnoid space filled
with cerebrospinal fluid

The Denticulate Ligament

- A **denticulate ligament** on each side **suspends the spinal cord** in the dural sheath.
- This ligament is in the form of a **ribbon**.
- It is attached along the **lateral surface** of the cord **midway** between the **dorsal** and **ventral roots**.
- The **lateral edge** of the denticulate ligament is **serrated**.
- **21 points** or **processes** are attached to the **dural sheath** at intervals **between** the **foramen magnum** and the level at which the dura mater is pierced by the **roots** of the **first lumbar spinal nerve**.



Posterior view


Denticulate ligament
Dura mater
Dorsal root
Ventral root
Dorsal root ganglion
Dorsal median sulcus
Gracile fasciculus
Cuneate fasciculus
Dorsolateral sulcus

FISSURES AND SULCI

Fissures and sulci extend along most of the external surface.

- An anterior median fissure and
- A posterior median sulcus and
- Septum: Almost completely separate the cord into right and left halves, but they are joined by a commissural band of nervous tissue which contains a central canal.

ANTERIOR MEDIAN FISSURE

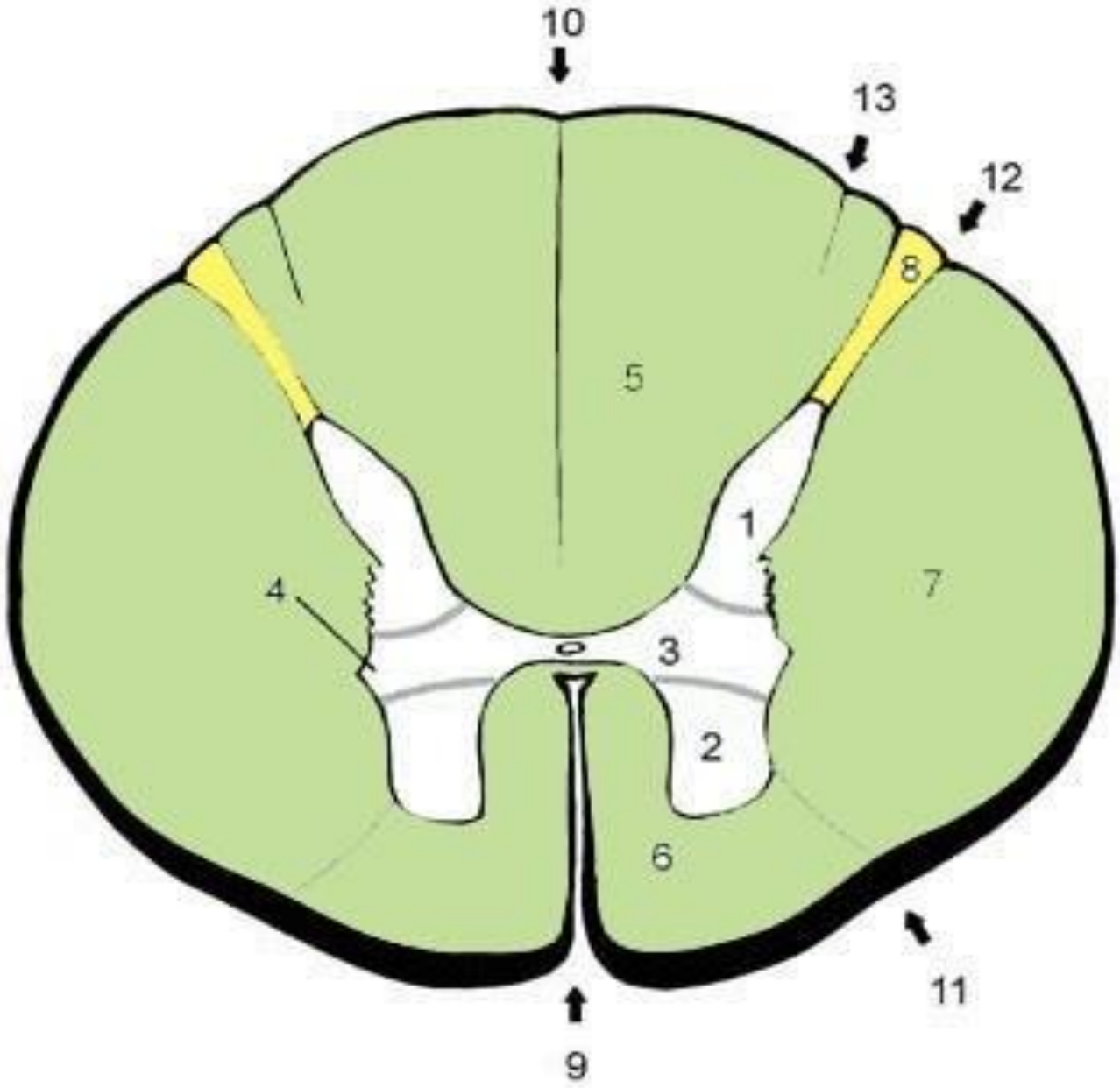
The anterior median fissure extends along the whole ventral surface with an average depth of 3 mm, although it is deeper at caudal levels.

- Perforating branches of the spinal vessels pass from the fissure to the commissure to supply the central spinal region.
- Two anterolateral sulcus

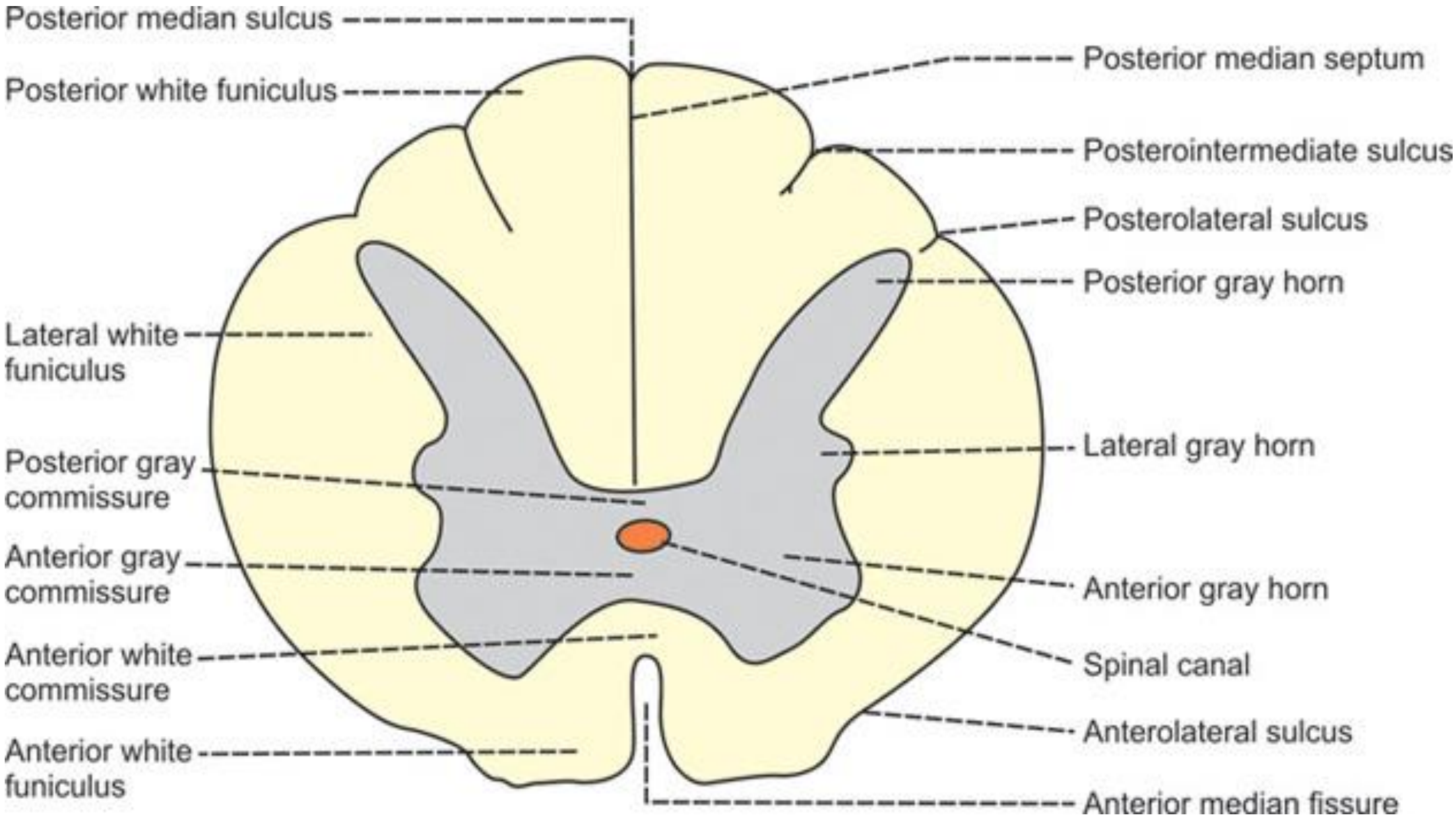
POSTERIOR MEDIAN SULCUS

- The posterior median sulcus is shallower, faint longitudinal groove and from it a posterior median septum(layer of pia) of neuroglia penetrates more than halfway into the cord, almost to the central canal. It represents the entry point of post (sensory) root.
- Laterally----Two posterolateral sulci
- Medially----Two postero intermediate sulci

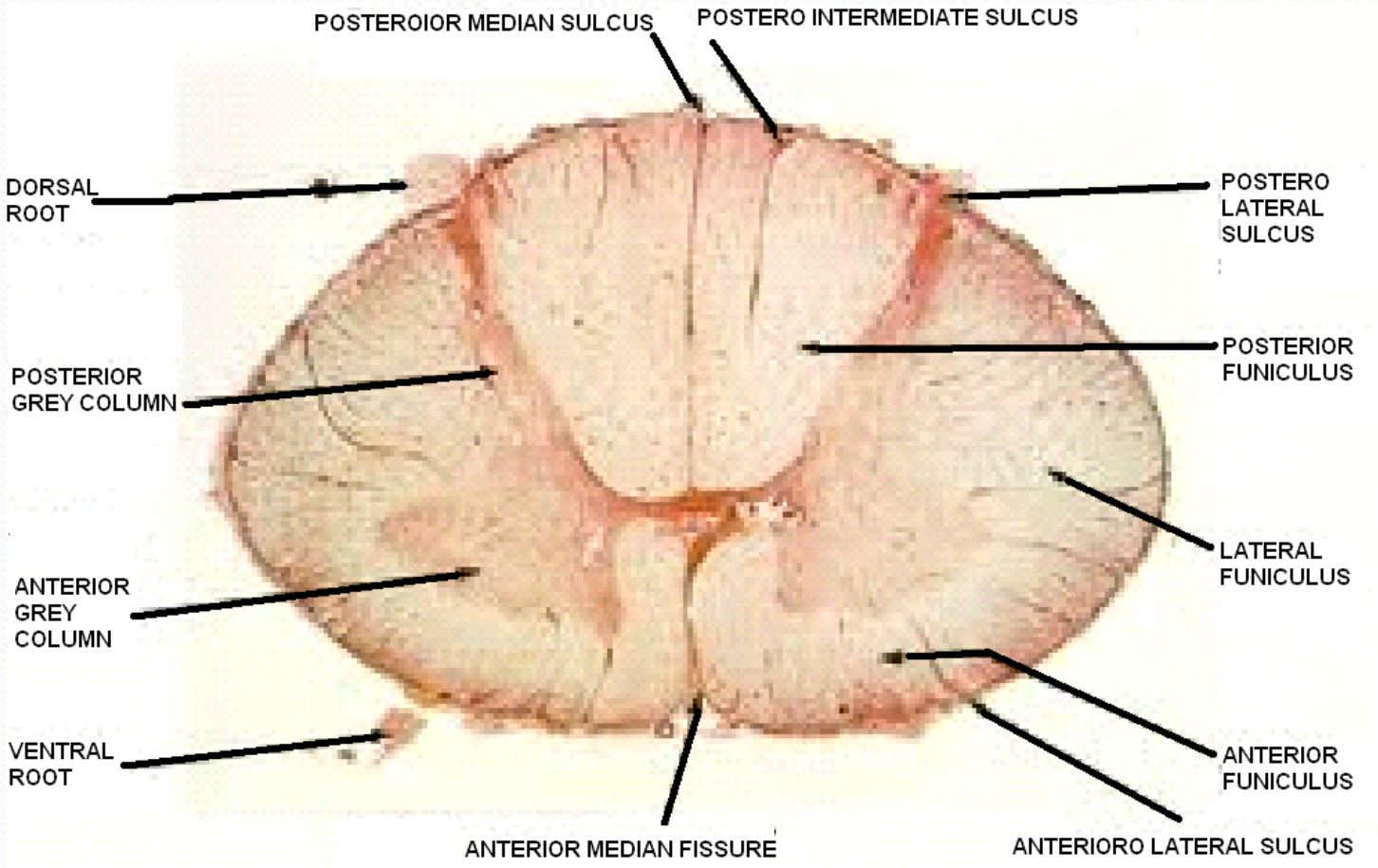
1. posterior horn
2. anterior horn
3. intermediate zone (intermediate gray)
4. lateral horn
5. posterior funiculus
6. anterior funiculus
7. lateral funiculus
8. Lissauer's tract

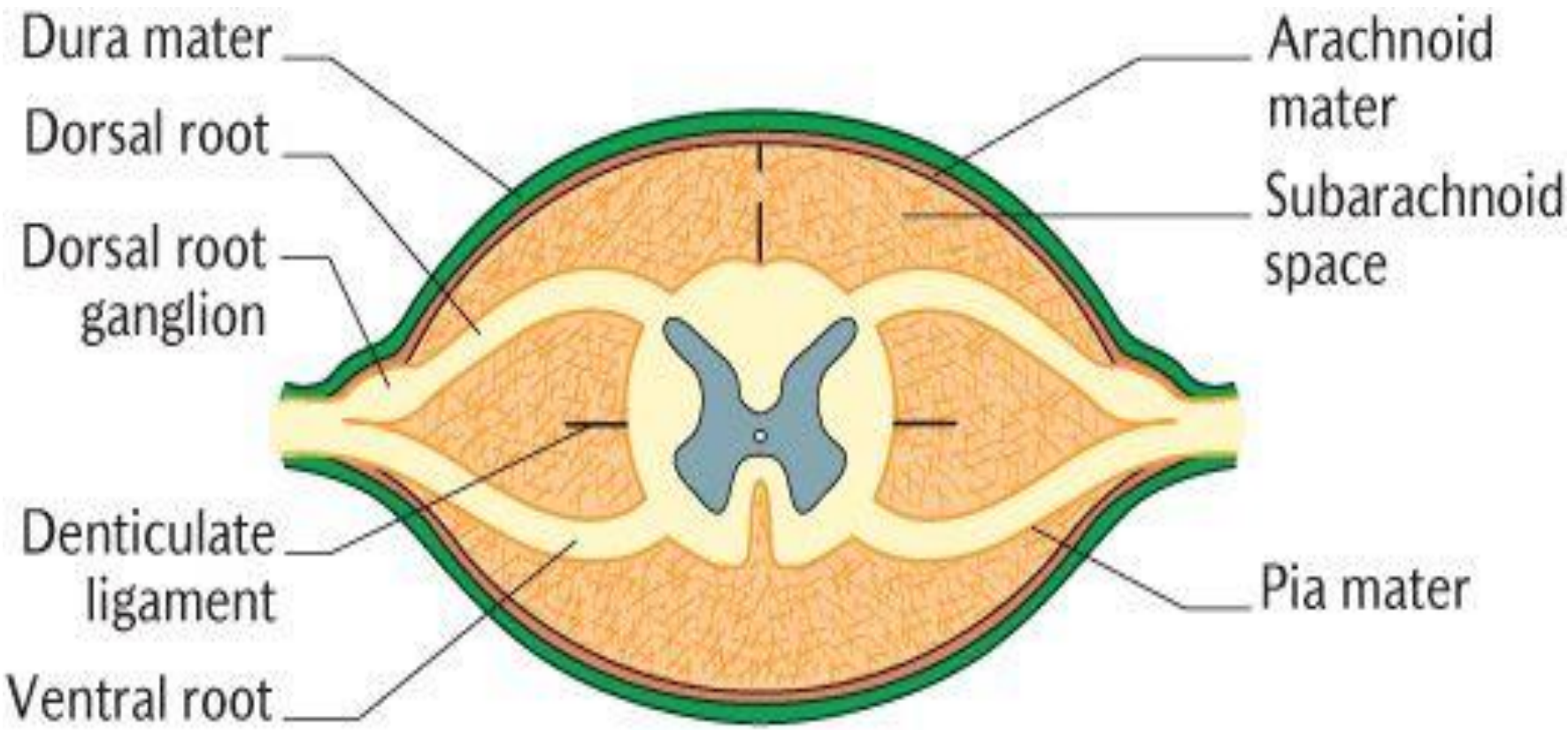


9. *anterior median fissure*
10. *posterior median sulcus*
11. *anterolateral sulcus*
12. *posterolateral sulcus*
13. *Posterior intermediate sulcus*


Posterior median sulcus
Posterior white funiculus
Lateral white funiculus
Posterior gray commissure
Anterior gray commissure
Anterior white commissure
Anterior white funiculus
Posterior median septum
Posterointermediate sulcus
Posterolateral sulcus
Posterior gray horn
Lateral gray horn
Anterior gray horn
Spinal canal
Anterolateral sulcus
Anterior median fissure

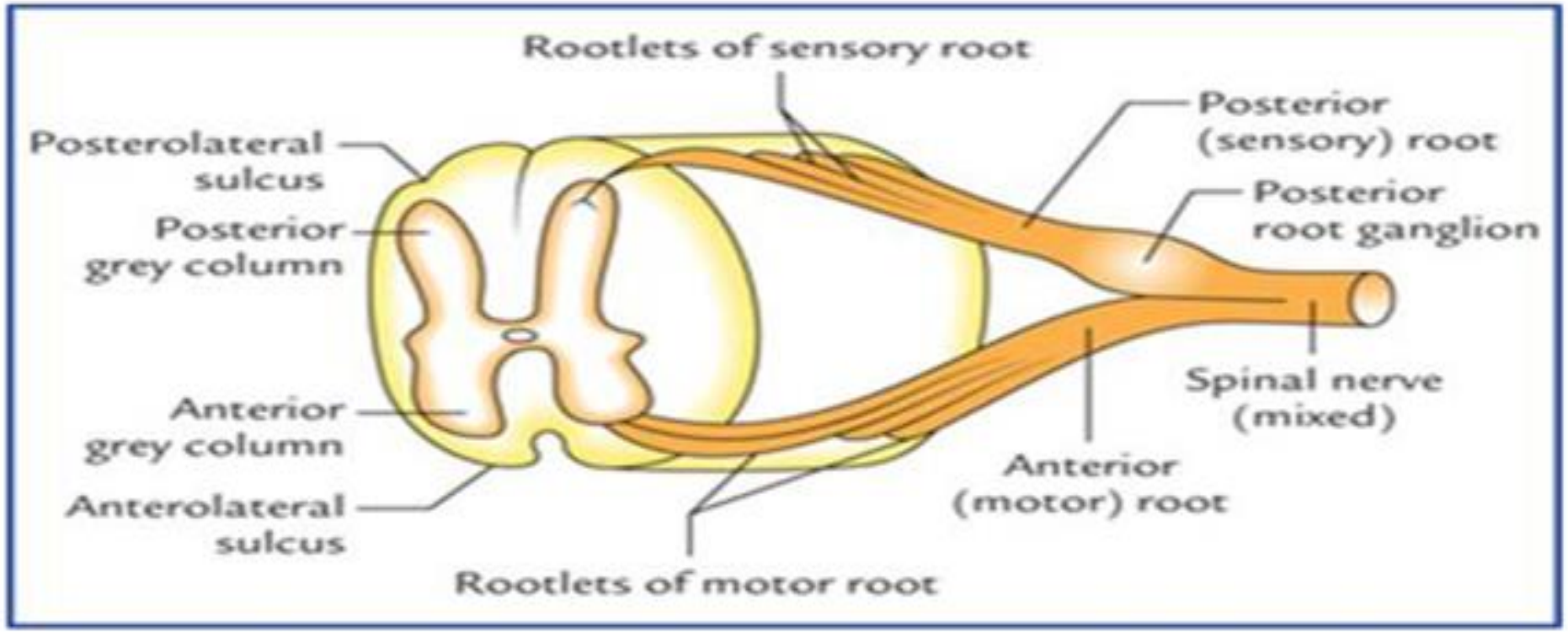
GROSS FEATURES



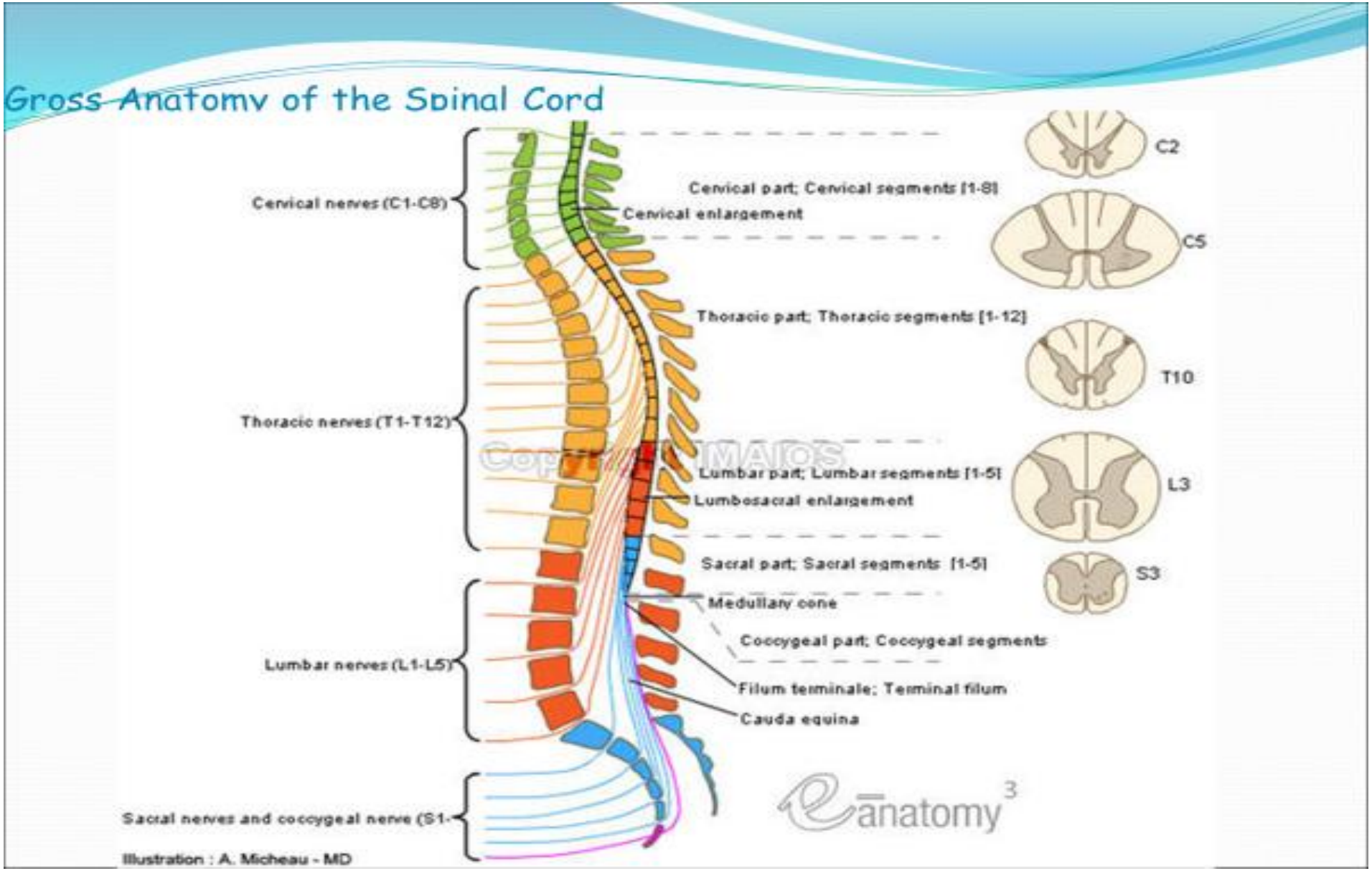

Dura mater
Dorsal root
Dorsal root ganglion
Denticulate ligament
Ventral root
Arachnoid mater
Subarachnoid space
Pia mater

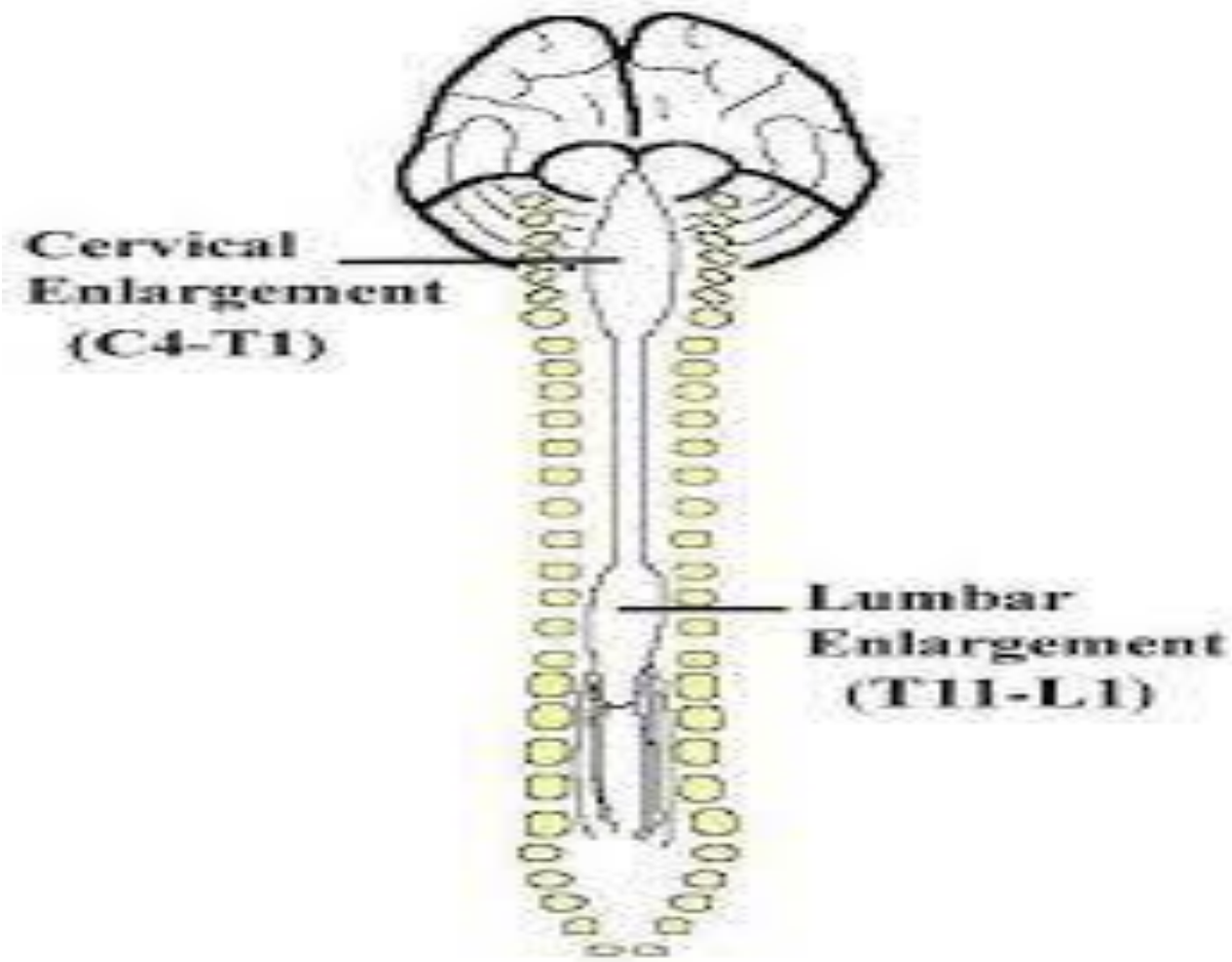
ENLARGEMENTS

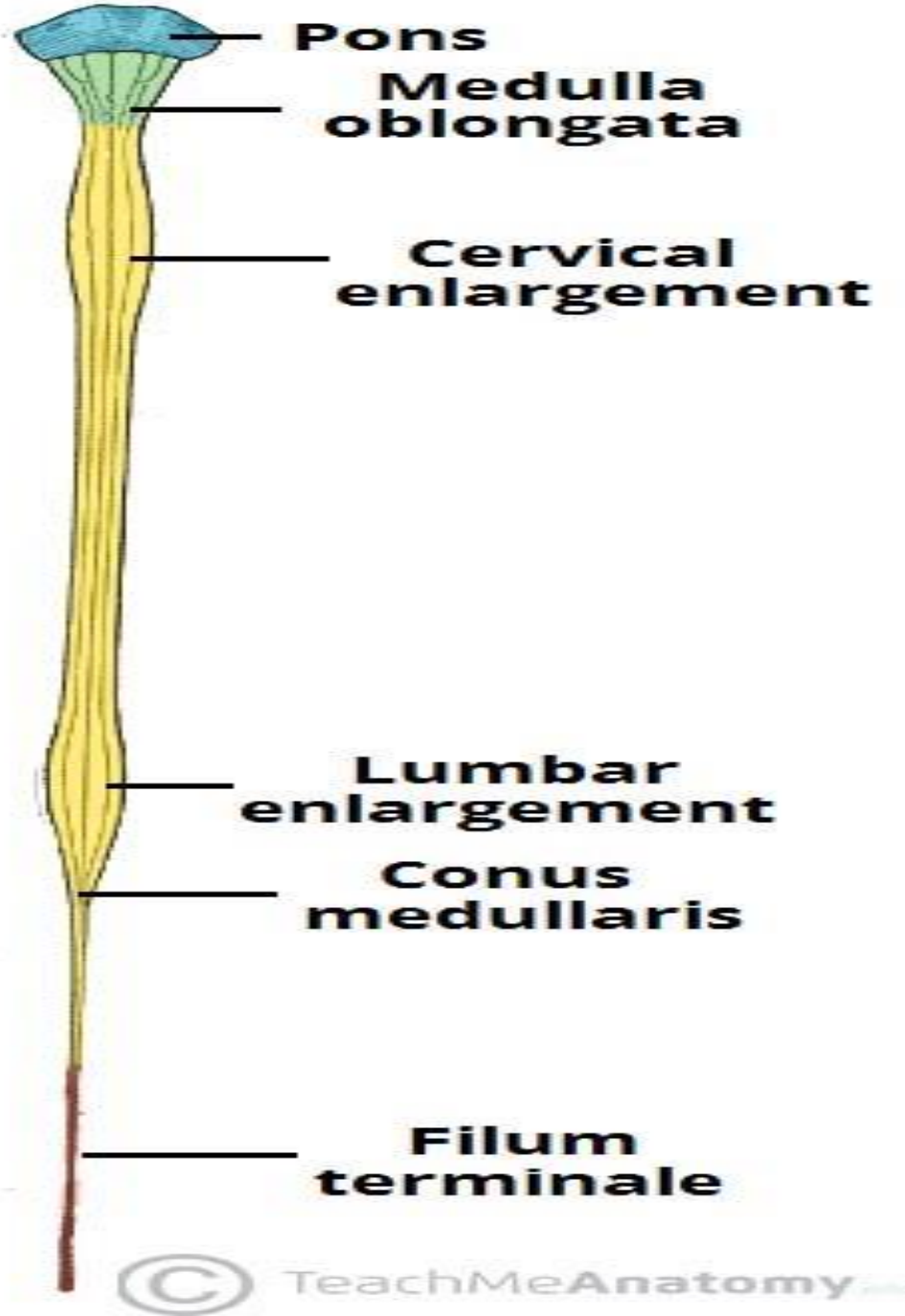
There are two fusiform swellings opposite to attachment of roots contributing to formation of brachial & lumbosacral plexuses which are cervical & lumber due to prescence of large no. of motor neurons.



ENLARGEMENTS




Cervical
Enlargement
(C4-T1)
Lumbar
Enlargement
(T11-L1)


Pons
Medulla oblongata
Cervical enlargement
Lumbar enlargement
Conus medullaris
Filum terminale
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	CERVICAL ENLARGEMENT	LUMBAR ENLARGEMENT
EXTENT	FROMC4OR 5 TO T2 OR 1 SPINAL SEGMENTS	FROM L2 TO S3 SPINAL SEGMENTS
WIDEST MM	ABOUT 38MM AT C6 CIRCUMFERENCE	ABOUT 35MM AT S1 SEGMENT
INNERVATION:	MUSCLES OF UPPER LIMB	MUSCLES OF LOWER LIMB

THANK YOU…….