

CNS Spinal cord

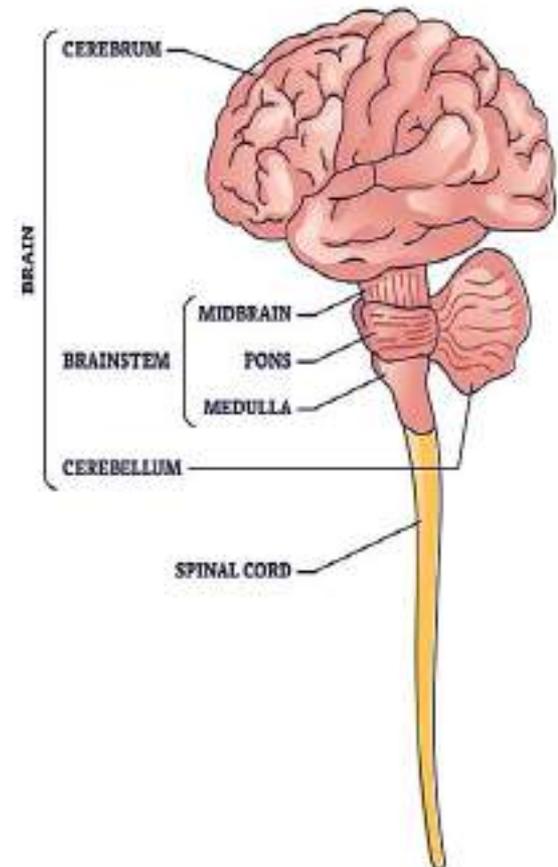
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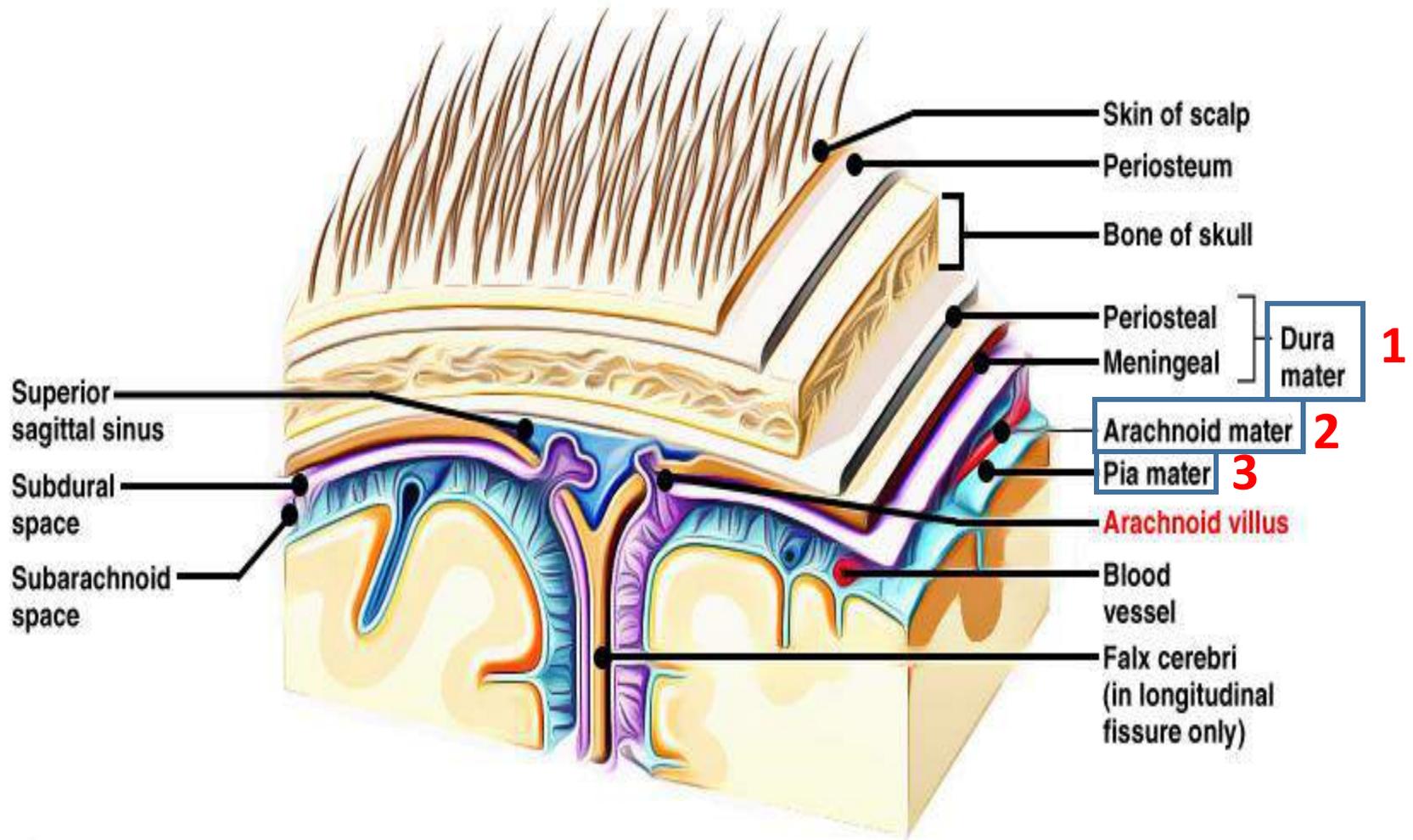
CENTRAL NERVOUS SYSTEM

- The central nervous system (CNS) includes the brain and spinal cord.
- The brain consists of the cerebrum, cerebellum, and brain stem
- The CNS is covered by three connective tissue layers, the meninges, which contains very little collagen or fibrous tissue throughout its substance, making it relatively soft and easily damaged by injuries.

CENTRAL NERVOUS SYSTEM



Meninges



Meninges

- The skull and the vertebral column protect the CNS, but between the bone and nervous tissue are membranes of connective tissue called the meninges. Three meningeal layers are distinguished: the dura, arachnoid, and pia maters.
- **Dura Mater:**
 - The thick dura mater (tough mother) consists of dense, fibro-elastic connective tissue. It contains venous sinuses which drain blood and C.S.F from the brain.
 - The internal surface of all dura mater, as well as its external surface in the spinal cord, is covered by simple squamous epithelium. external dura mater is continuous with the periosteum of the skull.

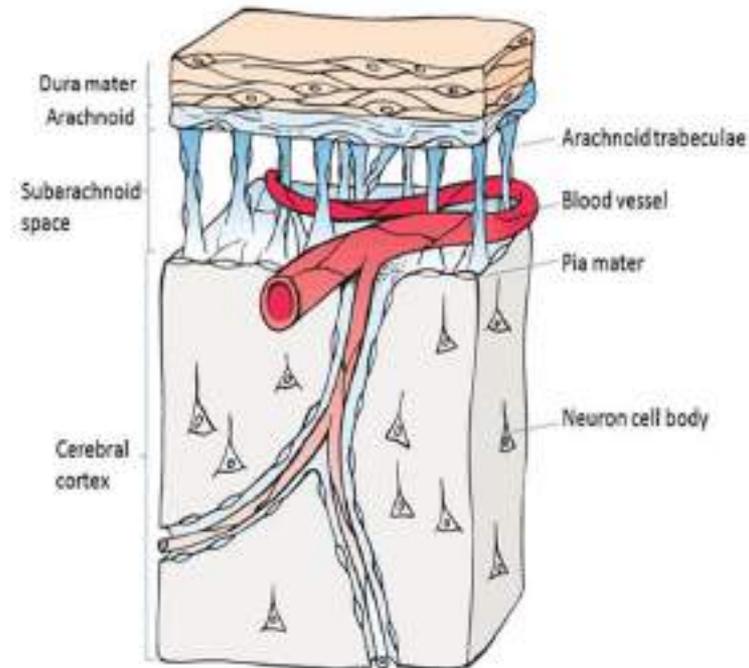
Arachnoid mater:

- The arachnoid (spider-weblike) has two components:

(1) a sheet of connective tissue in contact with the dura mater and

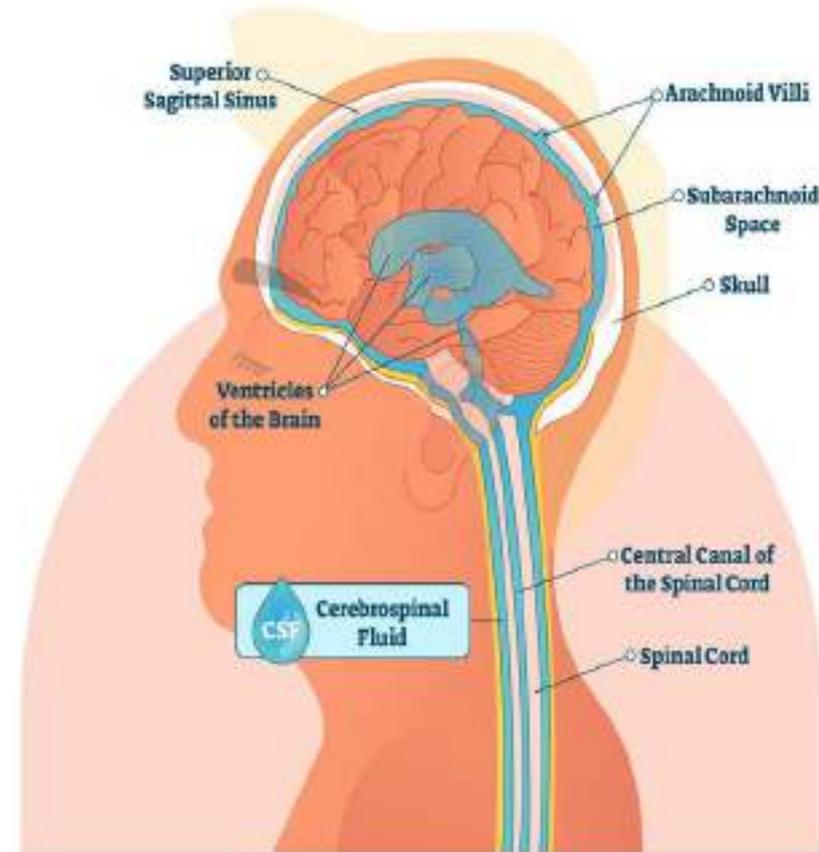
(2) a system of loosely arranged trabeculae composed of collagen and fibroblasts, continuous with the underlying pia mater layer.

- Surrounding the trabeculae is a large, sponge-like cavity, the subarachnoid space, filled with CSF communicates with the ventricles of the brain where the CSF is produced.



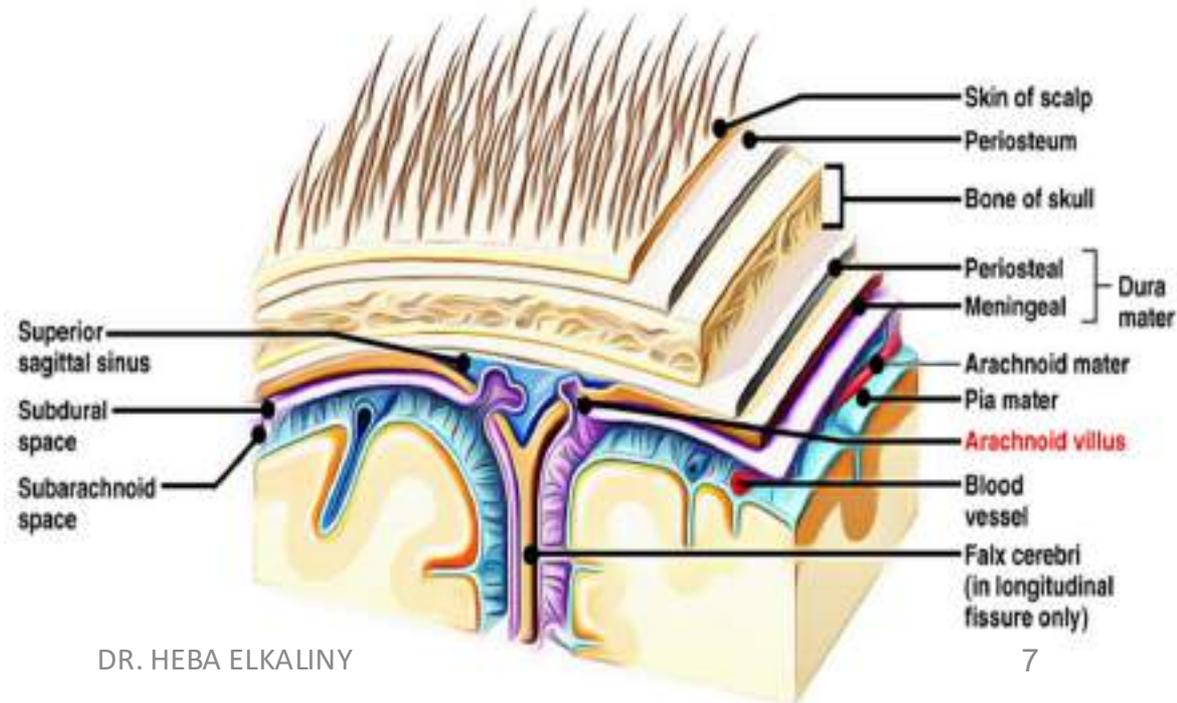
Adopted from: M.H. Ross and W. Pawlina, Histology: a text and atlas, Elsevier Saunders & Williams, 2011

- CSF, Cerebrospinal Fluid, a clear, watery liquid that surrounds and protects the brain and spinal cord, Produced in the brain's ventricles, it circulates in the central canal and the subarachnoid space. It is absorbed in venous sinuses of dura matter.



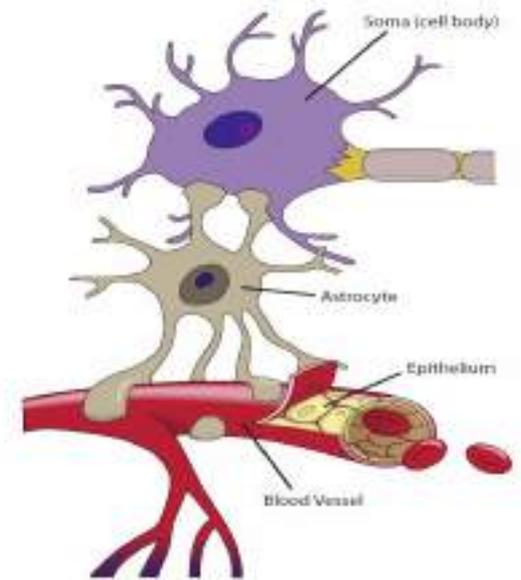
Arachnoid mater

- In some areas, the arachnoid penetrates the dura mater and protrudes into dural venous sinuses. These CSF-filled protrusions, which are covered by vascular endothelial cells as the lining of sinuses, are called arachnoid villi, which function as a site for drainage of CSF into the blood of the venous sinuses.

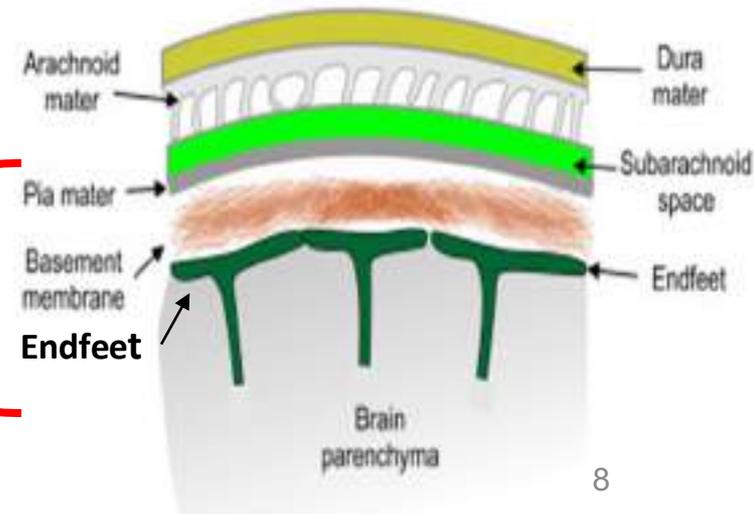


Pia Mater (tender mother) :

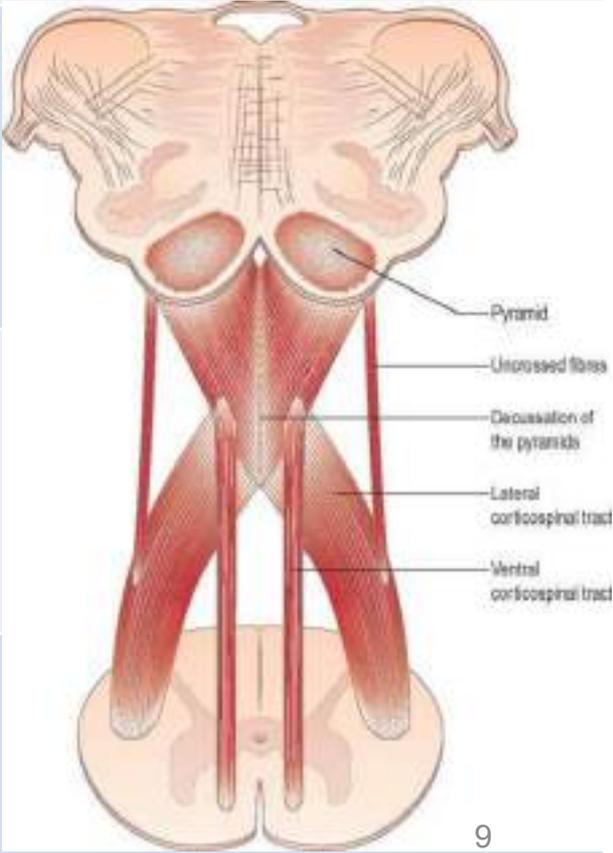
- is formed of outer layer (collagenous bundles) and the inner layer consists of flattened simple squamous cells.
- It is closely applied to the entire surface of the CNS tissue.
- The pia does not directly contact nerve cells or fibers, being separated from the neural elements by the very thin superficial layer of astrocytic processes, which adheres firmly to the pia mater.
- Together, the pia mater and the layer of astrocytic end feet with its basement membrane form a physical barrier separating CNS tissue from CSF in the subarachnoid space



Perimeningeal barrier
Glia limitans superficialis



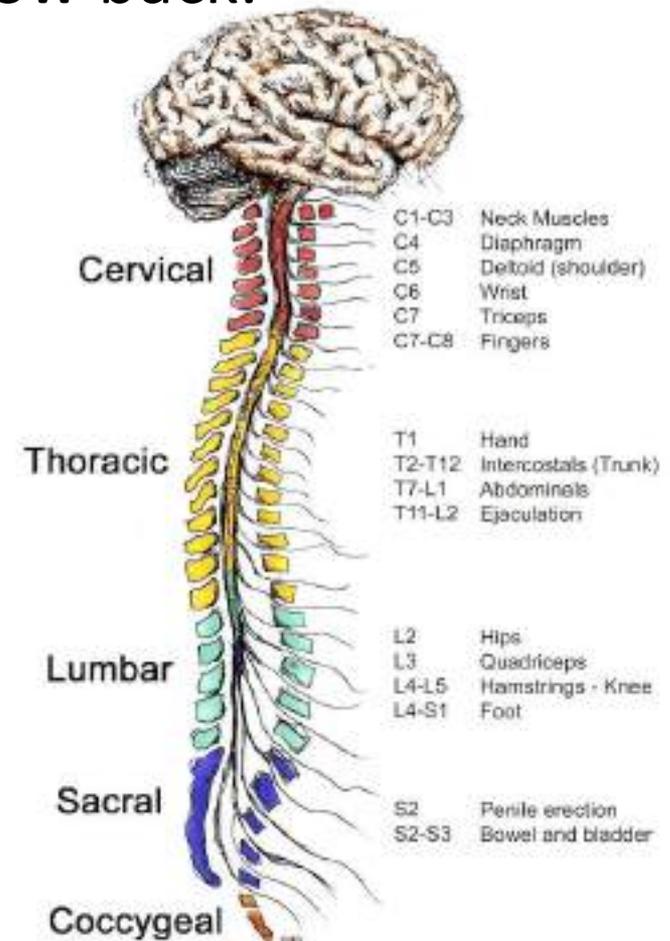
Some terms related to the C.N.S

Terms	Definition	
<p>A nucleus</p>	<p>A group of nerve cells lying very close to each other inside CNS and having the same function.</p>	
<p>A ganglia</p>	<p>A group of nerve cells lying very close to each other outside CNS</p>	
<p>A commissure</p>	<p>A band of grey or white matter connecting a part of C.N.S on one side with the same on the other side as Corpus callosum</p>	
<p>A pathway</p>	<p>It is group of neurons that transmit certain excitation from the body to CNS (sensory) or from CNS to the body (motor pathway).</p>	
<p>A decussation</p>	<p>The site of intersection of fibers of right and left identical tracts which cross the midline from both sides.</p>	

A tract	group of nerve fibers (axons) which arise from the same origin and terminate at the same site and they have the same function. It is a part of a pathway.
A fasciculus (bundle):	Group of nerve fibers, some ascending (sensory) and others descending (motor). Arise from different origins, end at different terminations and carry different function.
Grey matter	Bodies of nerve cells, dendrites, unmyelinated axons and neuroglia.
White matter	Many myelinated axons (form tracts which convey information into & out of CNS), few unmyelinated axons & neuroglia

THE SPINAL CORD

- The main sensory and motor link between brain and body. Spinal cord is a cylindrical structure that runs through the centre of spine, from brainstem to low back.



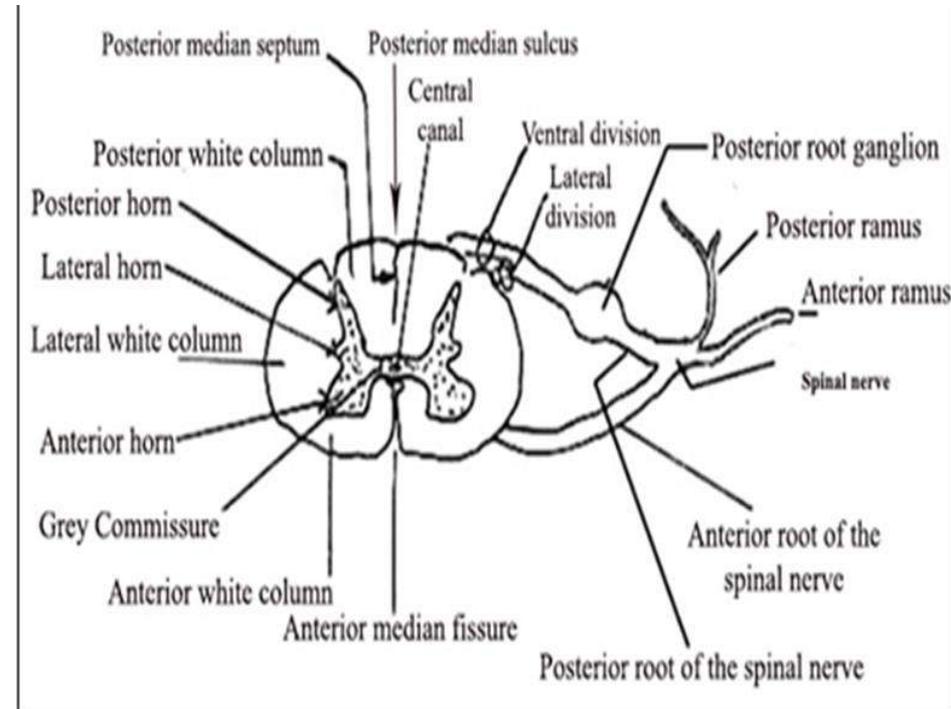
- Each spinal nerve is connected to the spinal cord by two roots:

i) Anterior or motor root (efferent) ventral

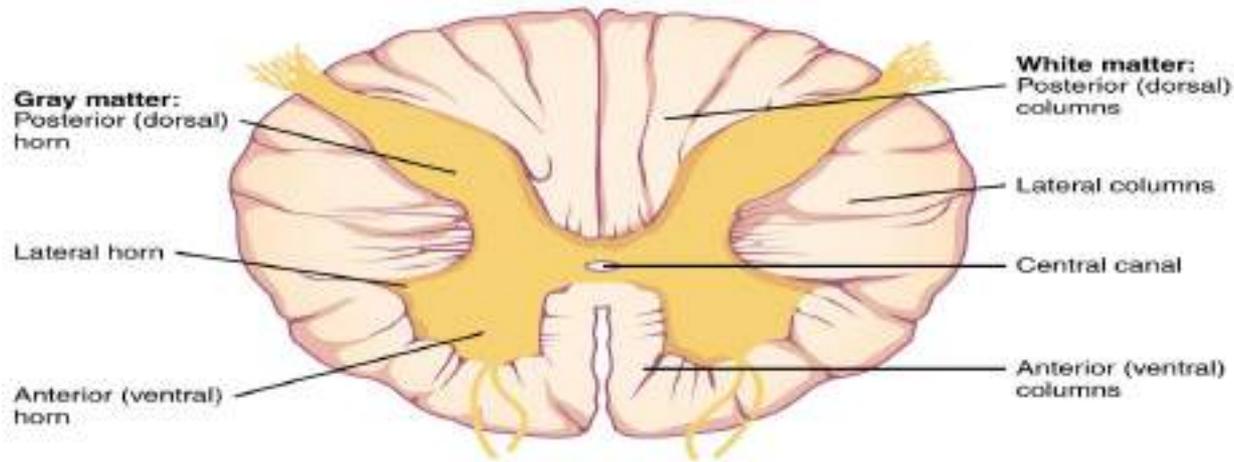
ii) Posterior or sensory root (afferent) dorsal (except 1st cervical).

- Each posterior root has a posterior or dorsal root ganglion (DRG),

-At each intervertebral foramen, anterior and posterior roots unite to form spinal nerve (31) which divides at once to anterior & posterior rami (mixed, contain sensory & motor fibers).



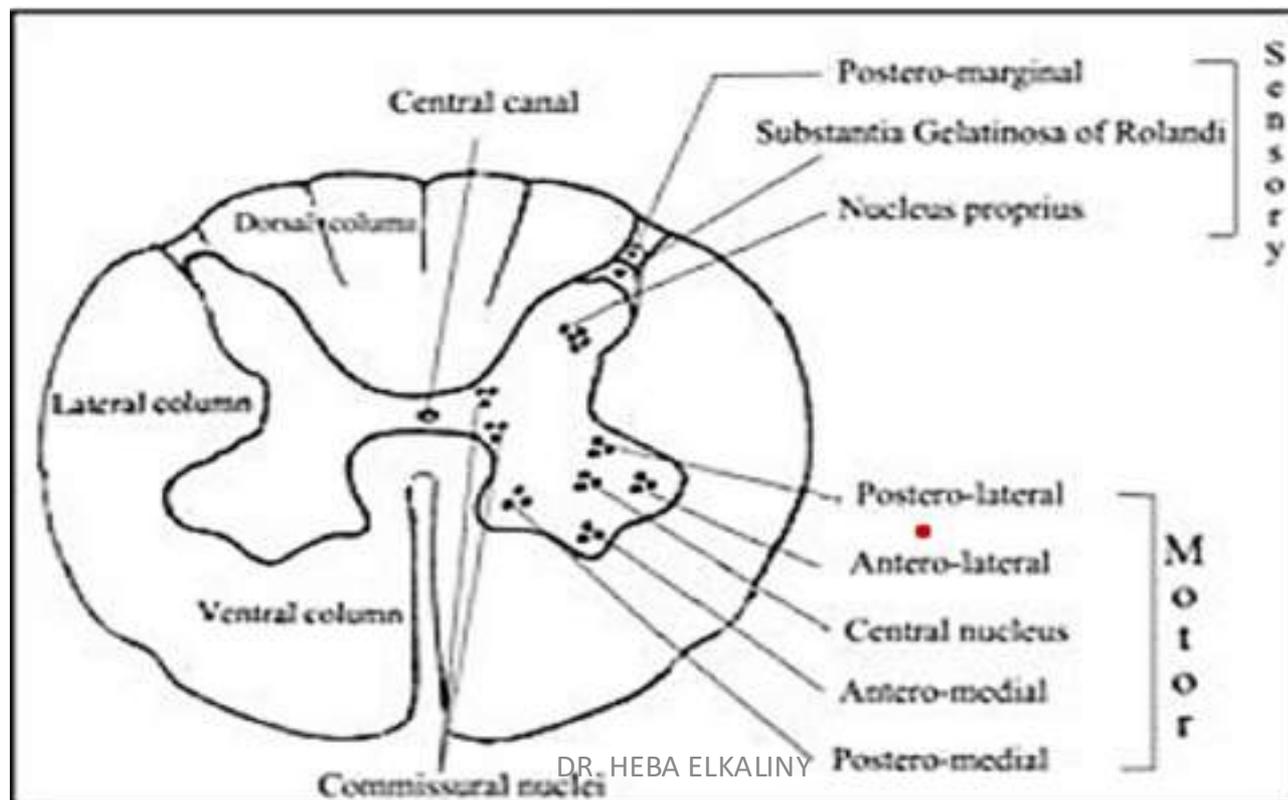
Internal structure of the spinal cord



Internal structure of the spinal cord

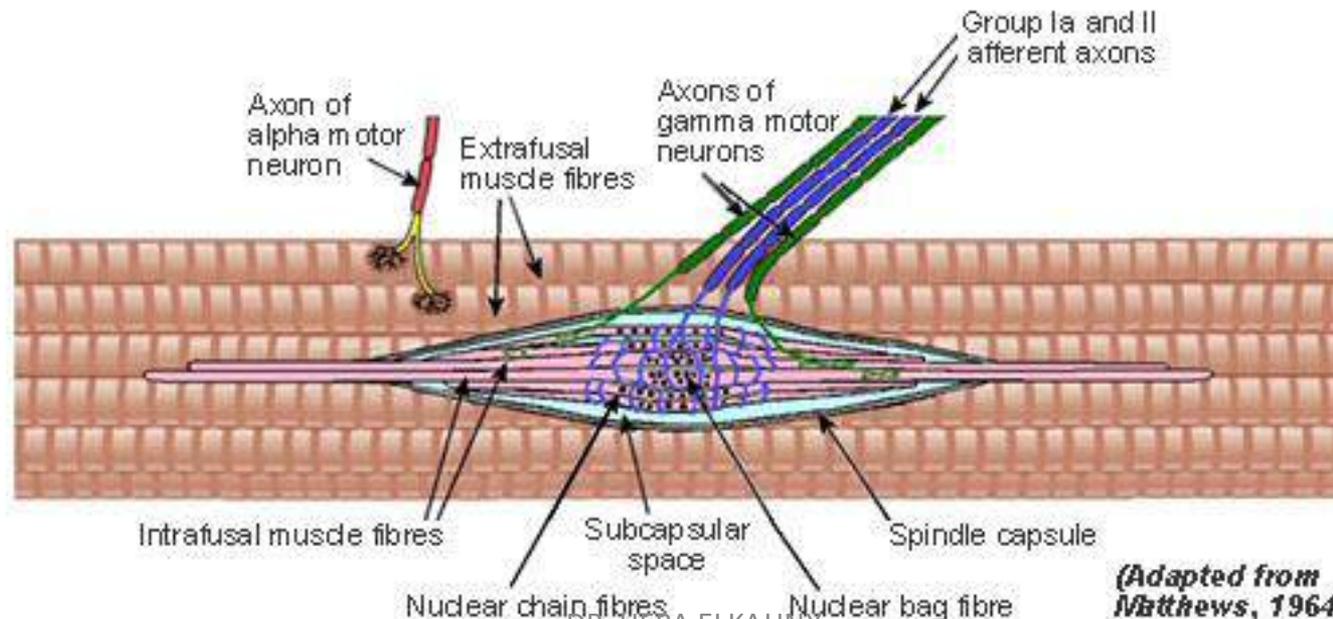
- The spinal cord contains a central canal in the middle that is surrounded by central **grey matter** and outer **white matter**. The central canal runs longitudinally through the length of the entire spinal cord and contains cerebrospinal fluid (C.S.F.)
- On cross section, the spinal cord is oval in shape. It has grey matter as **central H shaped** with two anterior and two posterior horns connected by thin grey commissure containing small central canal.
- In thoracic and upper lumbar segments two small lateral horns are seen.

- The grey matter of the spinal cord consists of multipolar nerve cells with their naked fibers (no sheaths) and dendrites, neuroglial cells and blood vessels.
- The anterior horns (contain motor nuclei), posterior horns (contain sensory nuclei), and lateral horns (contain sympathetic nuclei) while grey commissure contains anterior and posterior commissural nuclei



A) Anterior horns` nuclei (motor nuclei): - Each nucleus of anterior horn contains:

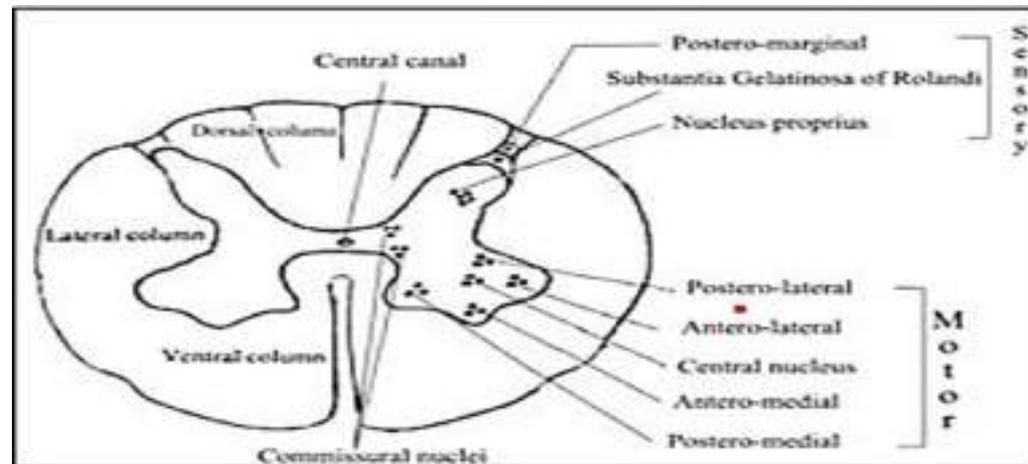
- -Large multipolar nerve cells which give α -efferents that innervate extrafusal skeletal muscle.
- -Small multipolar nerve cells which give γ -efferents which innervate contractile elements of muscle spindles (intrafusal muscle fibers of neuromuscular spindles). the 2nd order neurons of the somatic motor pathway.



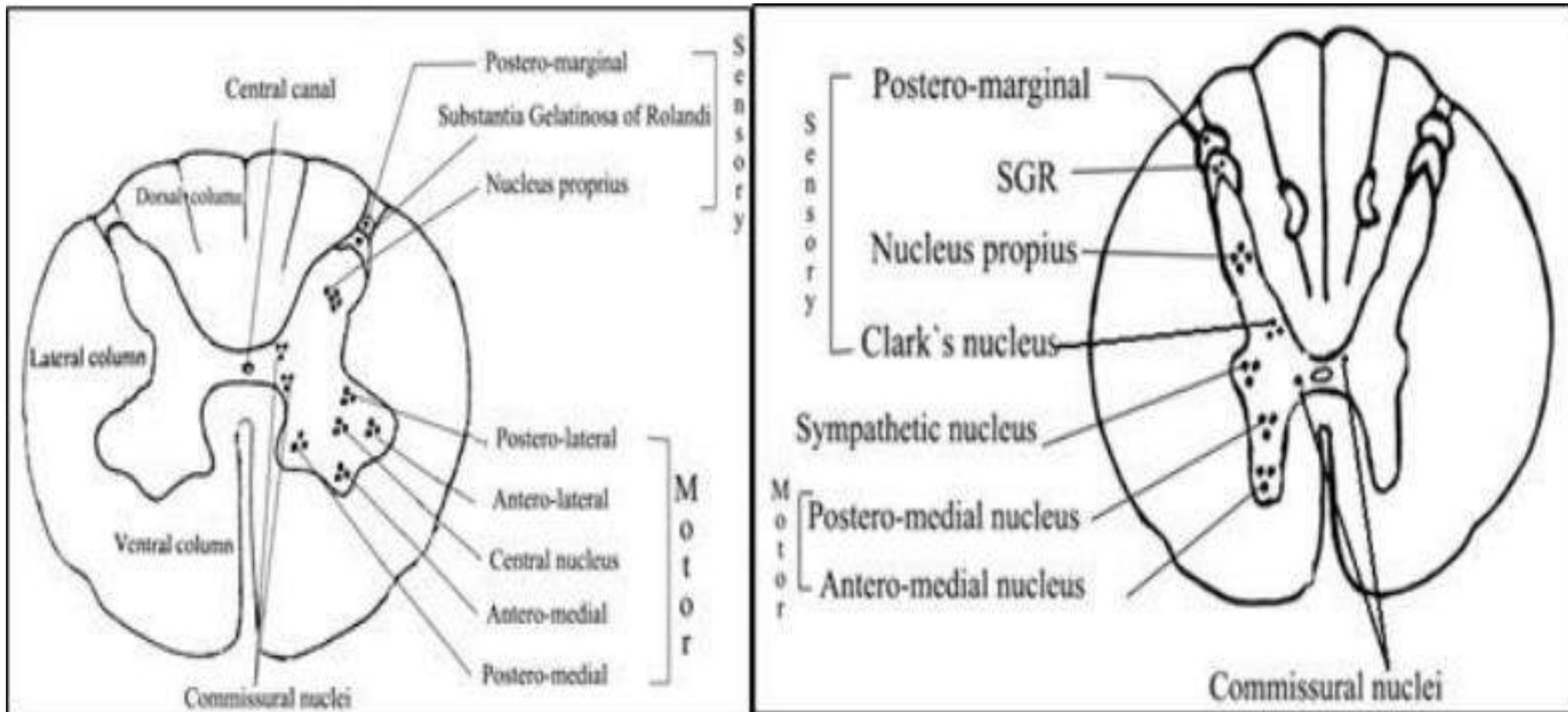
A) Anterior horns` nuclei

Three groups of nuclei are present in the anterior horns:

- (1) Medial group:** It includes: antero-medial group and postero-medial group. It is present in all segments of spinal cord. It innervates axial muscles (intercostal & abdominal).
- (2) Central group:** Present in all the segments except thoracic segments. It innervates some muscle of the neck, diaphragm & external anal and urethral sphincters.
- (3) Lateral group:** It includes antero-lateral and postero-lateral. Present in all the segments except thoracic segments It innervates the skeletal muscles of upper and lower limbs.



B) Posterior horns nuclei (sensory nuclei): They contain medium sized cells and are the 2nd order neurons of the sensory pathway.



- (1) Posteromarginal nucleus:** It covers the tip of posterior horn. In all levels of spinal segments. It mediates pain and temperature sensation.
- (2) Substantia gelatinosa of Rolandi:** Its nerve cells are present at the apex of the posterior horns beneath the posteromarginal nucleus. Present in all levels of spinal segments. Its cells form the 2nd order neurons in the pathway of pain and temperature sensations.
- (3) Main sensory nucleus (Nucleus proprius):** Its cells are present in the centre of the posterior horns. Present in all levels of spinal segments. Its cells form the 2nd order neurons in the pathway of crude (light) touch.
- (4) Clark's nucleus (nucleus dorsalis):** Its cells are present at the base of posterior horn. Present in 8th cervical and all thoracic up to 3rd lumbar (C8 – L3). Its cells form the 2nd order neurons of (unconscious proprioception).

C) Lateral horns nuclei (VII) contain: (1) Sympathetic nuclei: The thoracic and upper two lumbar segments contain intermediolateral sympathetic nuclei. (2) Parasympathetic nuclei: Present in sacral segments (S.2,3&4).

D) Commissural nuclei (X): Present in all segments of spinal cord. They surround the central canal. They act as interneurons between sensory and motor nuclei. There are anterior and posterior commissural nuclei.

N. B. Some segments contain some specific nuclei as:

- **Phrenic nucleus:** Is a part of central nucleus of anterior horn of C2- C5 for innervations of diaphragm.
- **Spinal accessory nucleus:** Is a part of central nucleus of anterior horn of C1- C5 for innervations of trapezoid and sternomastoid muscles.

Rexed Laminae

As an alternative to spinal cord nuclei, Bror Rexed (1950s) identified layers, or laminae, within the spinal cord grey matter where cells were grouped according to their structure and function, rather than location

Lamina I

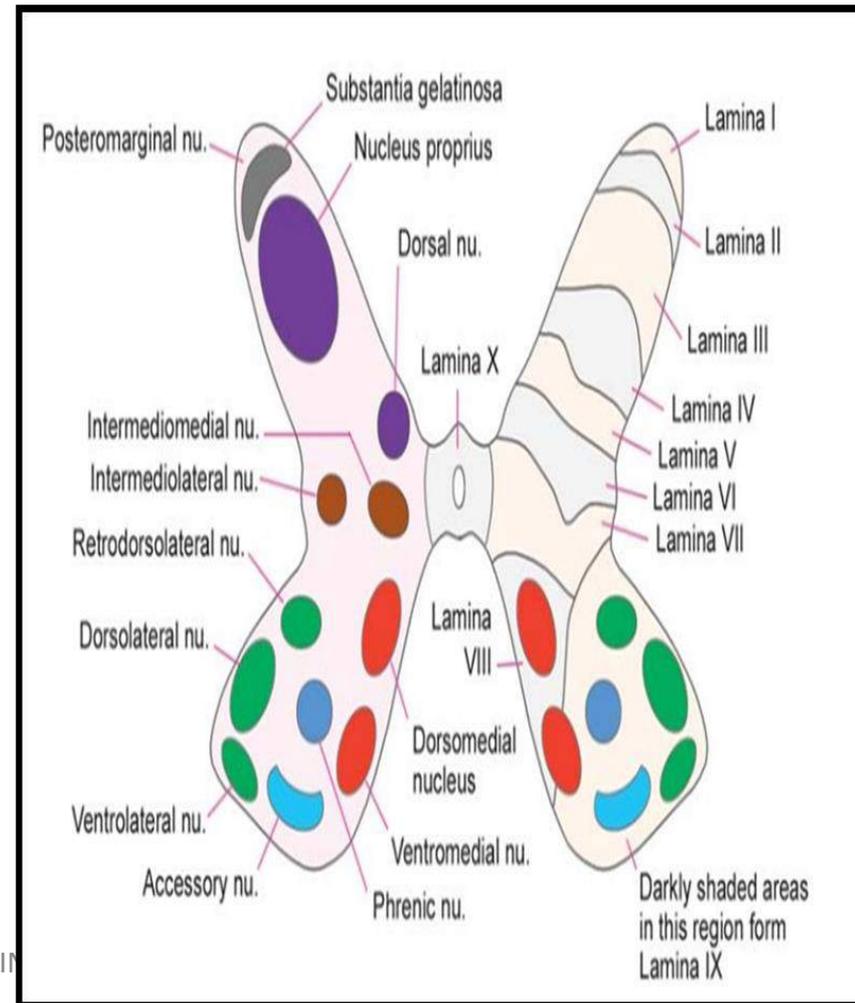
- It receives pain, temperature
- corresponds to the posteromarginal nucleus

Lamina II

- It receives pain, temperature and sexual sensation
- Corresponds to substantia gelatinosa

Lamina III

- Involved in proprioception and sensation of light touch.
- Partially corresponds to nucleus proprius



Lamina IV

- Partially corresponds to nucleus proprius

Lamina V & Lamina VI

- Correspond to Clark nucleus
- involved in proprioception

Lamina VII

- Gives rise to cells involved in the autonomic system

Lamina VIII

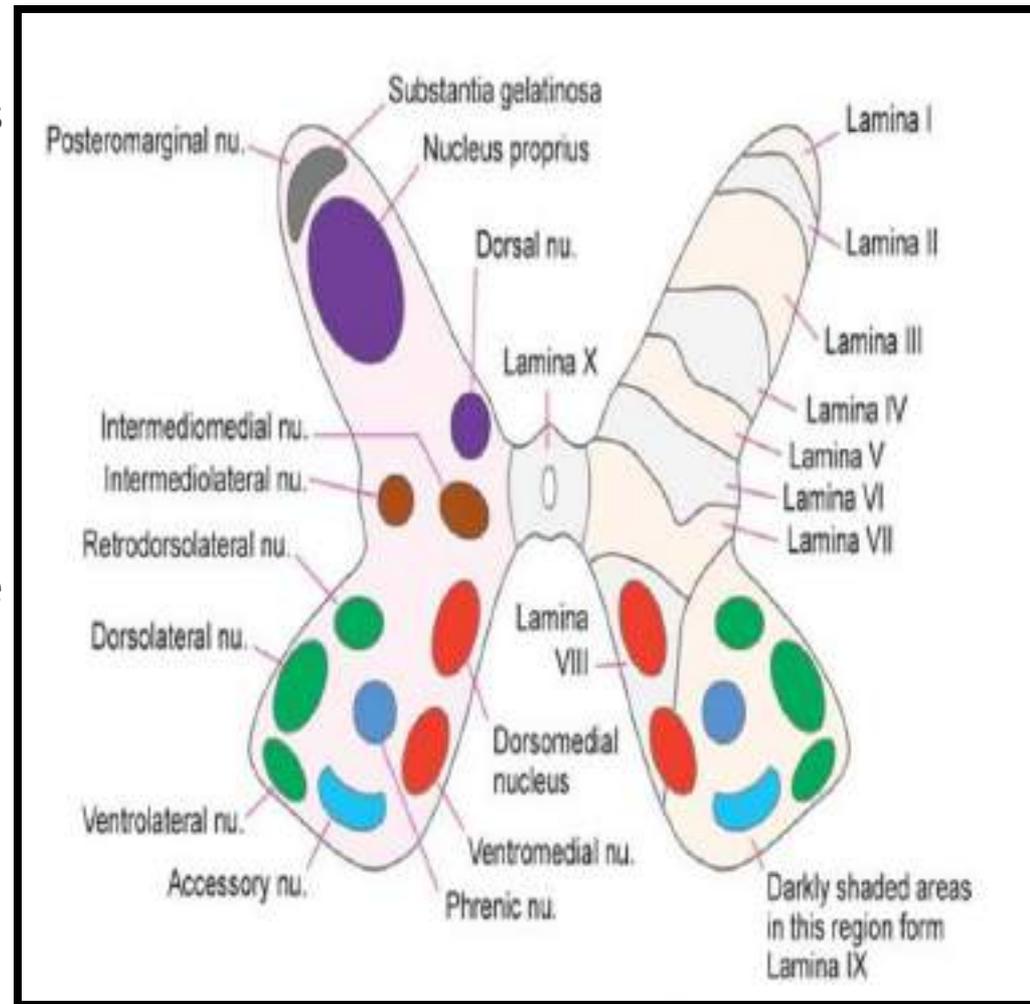
- Medial motor nuclei

Lamina IX

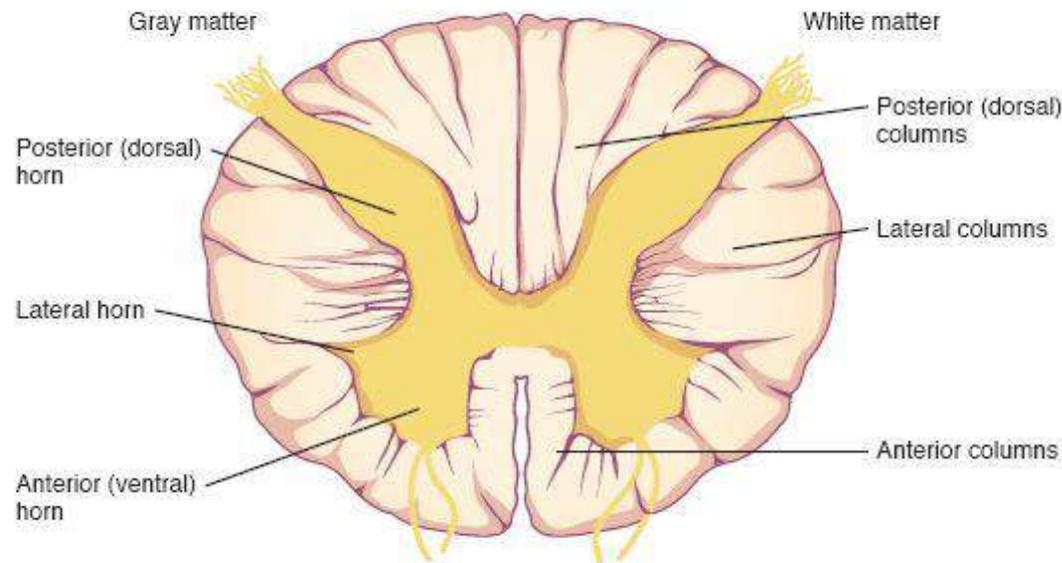
- Lateral motor nuclei

Lamina X

- Commissural nuclei



- **The white matter:** - In fresh state, it appears grossly white in colour because it contains many myelinated nerve fibers which are grouped to form tracts and few unmyelinated nerve fibers, neuroglia and few blood capillaries. - For simple description, the white matter of each half of the spinal cord is divided into three longitudinal columns (funiculi).



- The white matter:

1. Posterior column between the posterior horn of grey matter and the dorsal median septum in the midline. It contains mainly ascending tracts.

2. Anterior column between the anterior median fissure & the point of emergence of anterior nerve roots. It contains ascending & descending tracts.

3. Lateral column between the emergence of the anterior nerve roots and the entry of the posterior nerve roots. It contains ascending & descending tracts.

The tracts in white matter of spinal cord

I-Short associative tracts:

- ascending or descending tracts that begin and terminate in the spinal cord. Their functions are association and coordination of the different movements of the body with each other.
- There are four short tracts in spinal cord (Fasciculi proprii, Lissauer's, Comma shaped and Septo-marginal)

- ## II - Long tracts:
- * Long ascending tracts (sensory)
 - * Long descending tracts (motor)

Short associative tracts

Between gracile & cuneate tracts

Comma-shaped Tr

Gracil Tr
Cuneate Tr

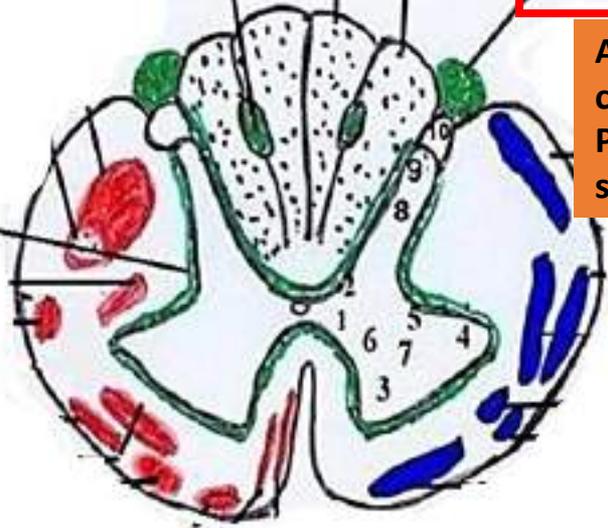
Lissauer's Tr

Axons of cells of PRG in all segments

Cervical
Upper thoracic

Fasciculi proprii

Around the grey matter of all segments

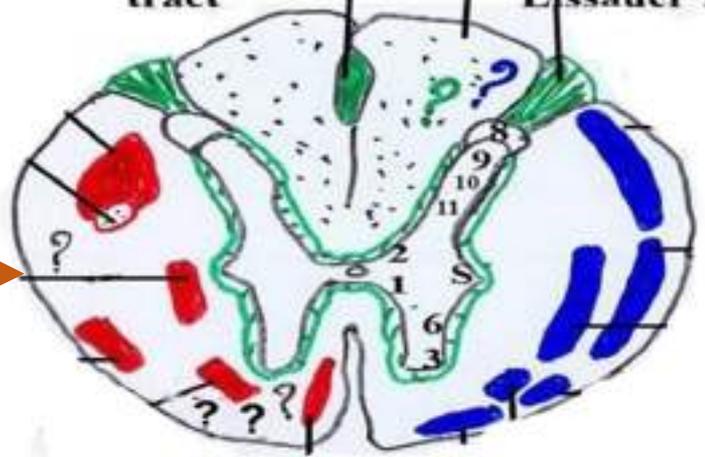


Around the posterior septum

Septomarginal tract

Gracil tract
Lissauer's tract

Lower thoracic
Lumbar
Sacral



THANK YOU