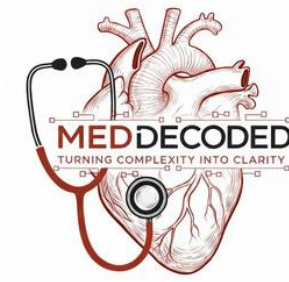


بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



ANATOMY

MID | Lecture 10

وَلَقَدْ خَلَقْنَا الْإِنْسَانَ وَنَعَلَهُمَّا تَوْسُوسًا بِهِ نَفْسُهُ وَنَحْنُ أَقْرَبُ إِلَيْهِ مِنْ حَبْلِ الْوَرِيدِ

Nervous System 3

Written by : Dareen Alhababseh
Lamar Khorma



Reviewed by : Jana Sawafta

Color coding used in the modified:



Black: the original slides



Blue: the doctor's explanation/words



Gray: additional information and explanation



Red: important information

Introduction to Anatomy



1st Year Medical Students

2025-2026

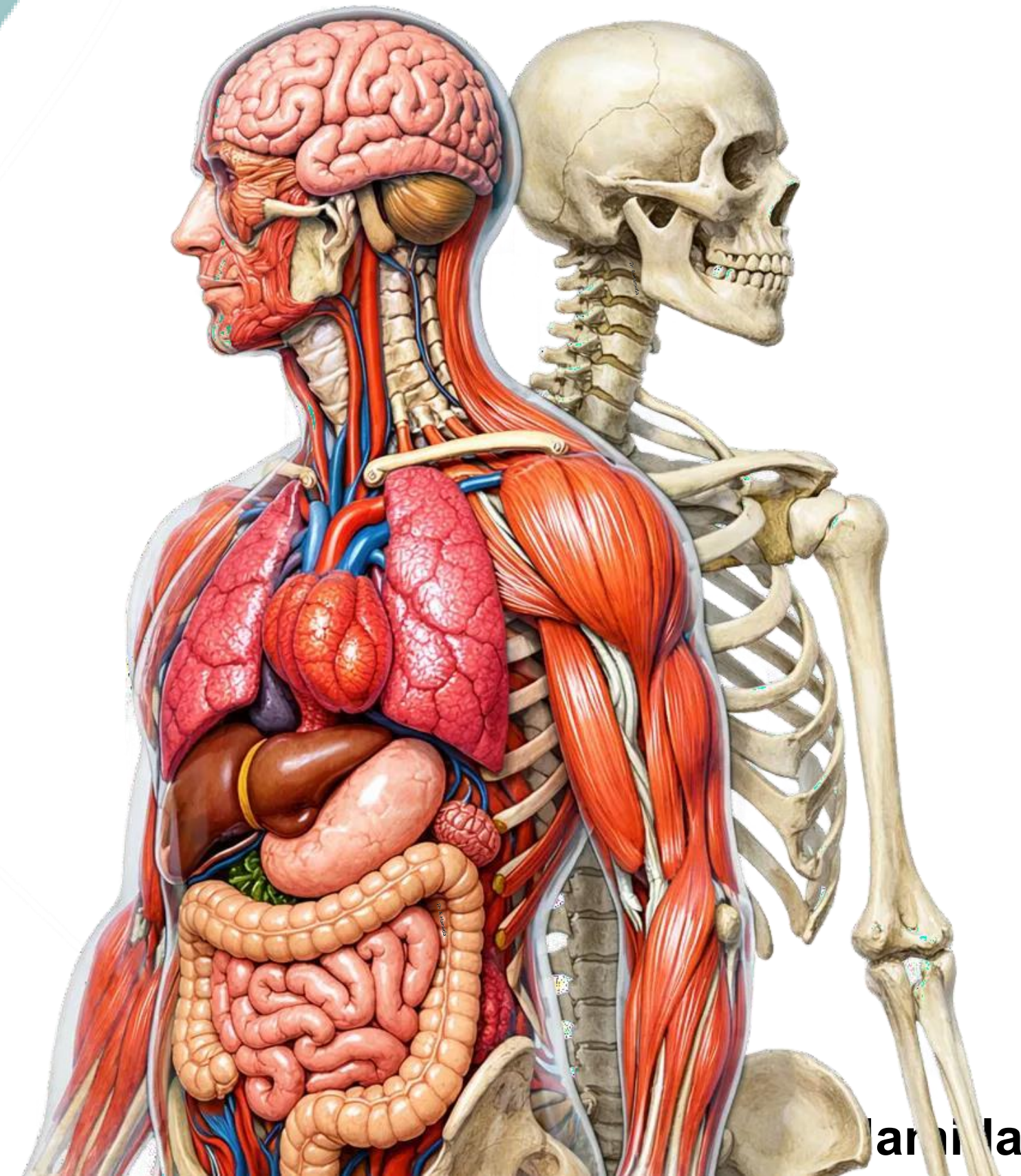
Second Semester

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Hamida

Course Outline:

1 Introduction and Terminology

2 Skeletal System

3 Cardiovascular System

4 Lymphatic System

5 Nervous System

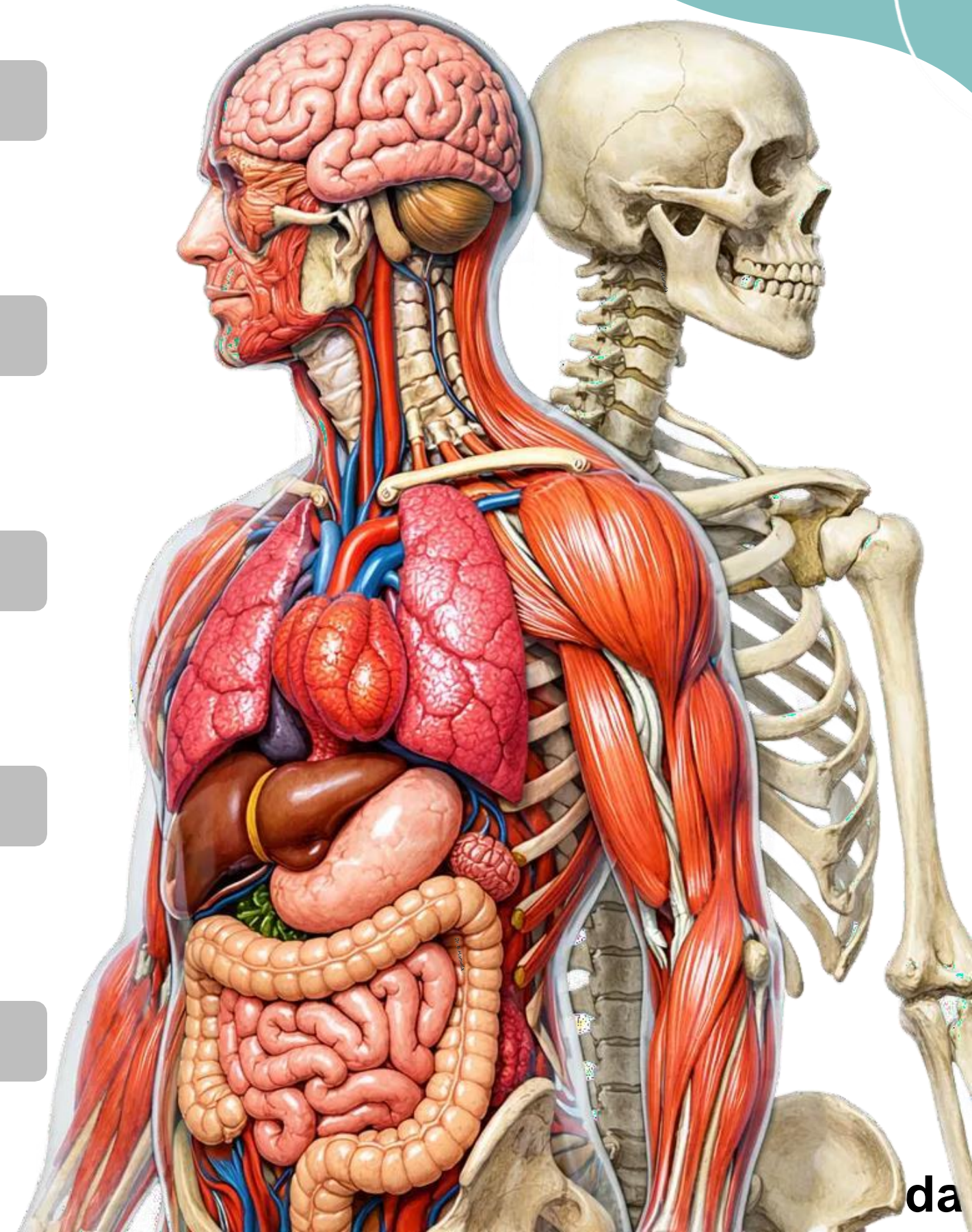
6 Muscular System

7 Respiratory System

8 Digestive System

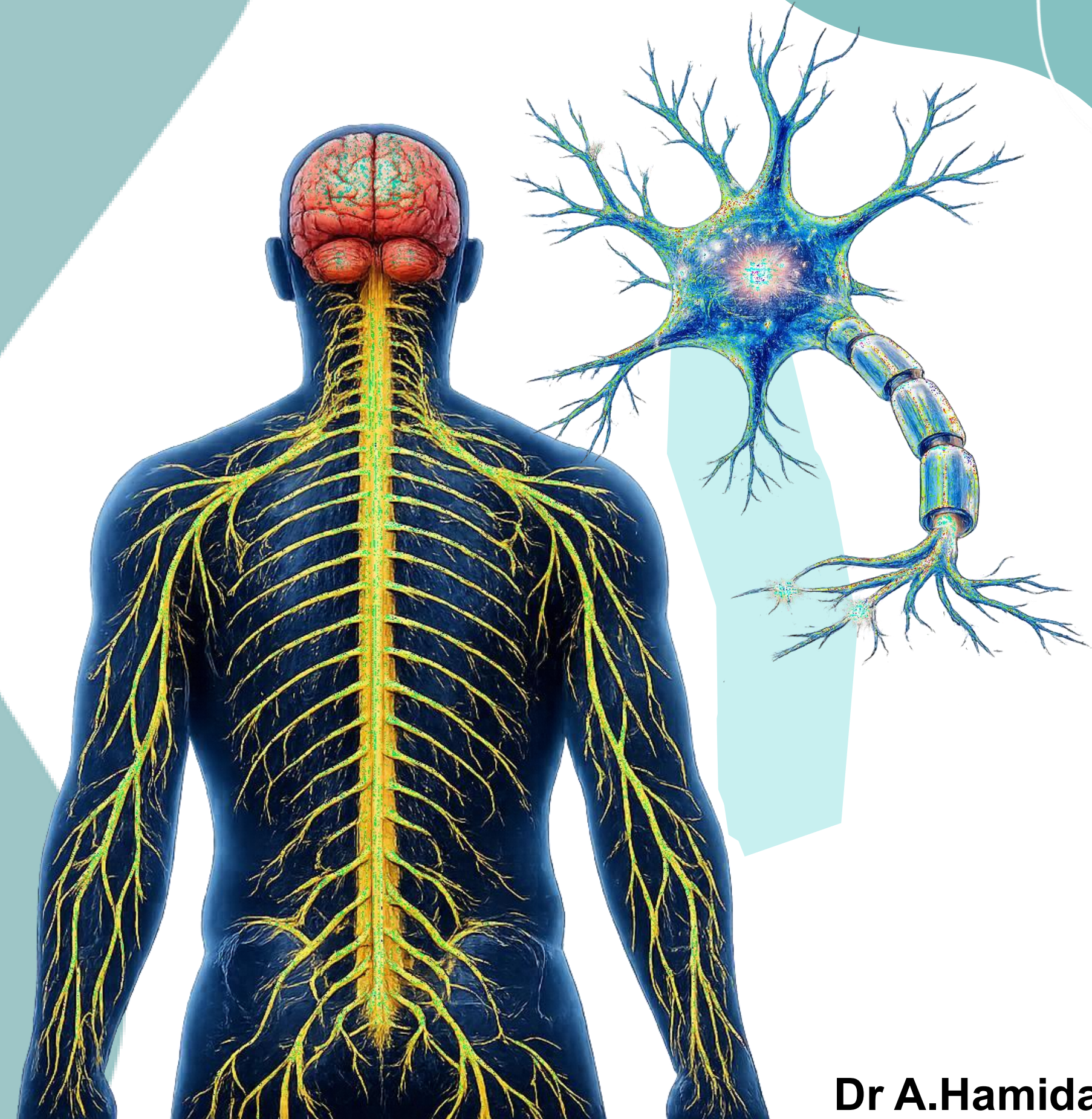
9 Urinary System

10 Endocrine System



5

Nervous System



5

Nervous System

❖ Divisions of the Nervous System

➤ Anatomically, the nervous system is divided into two parts:

1. Central Nervous System (CNS),

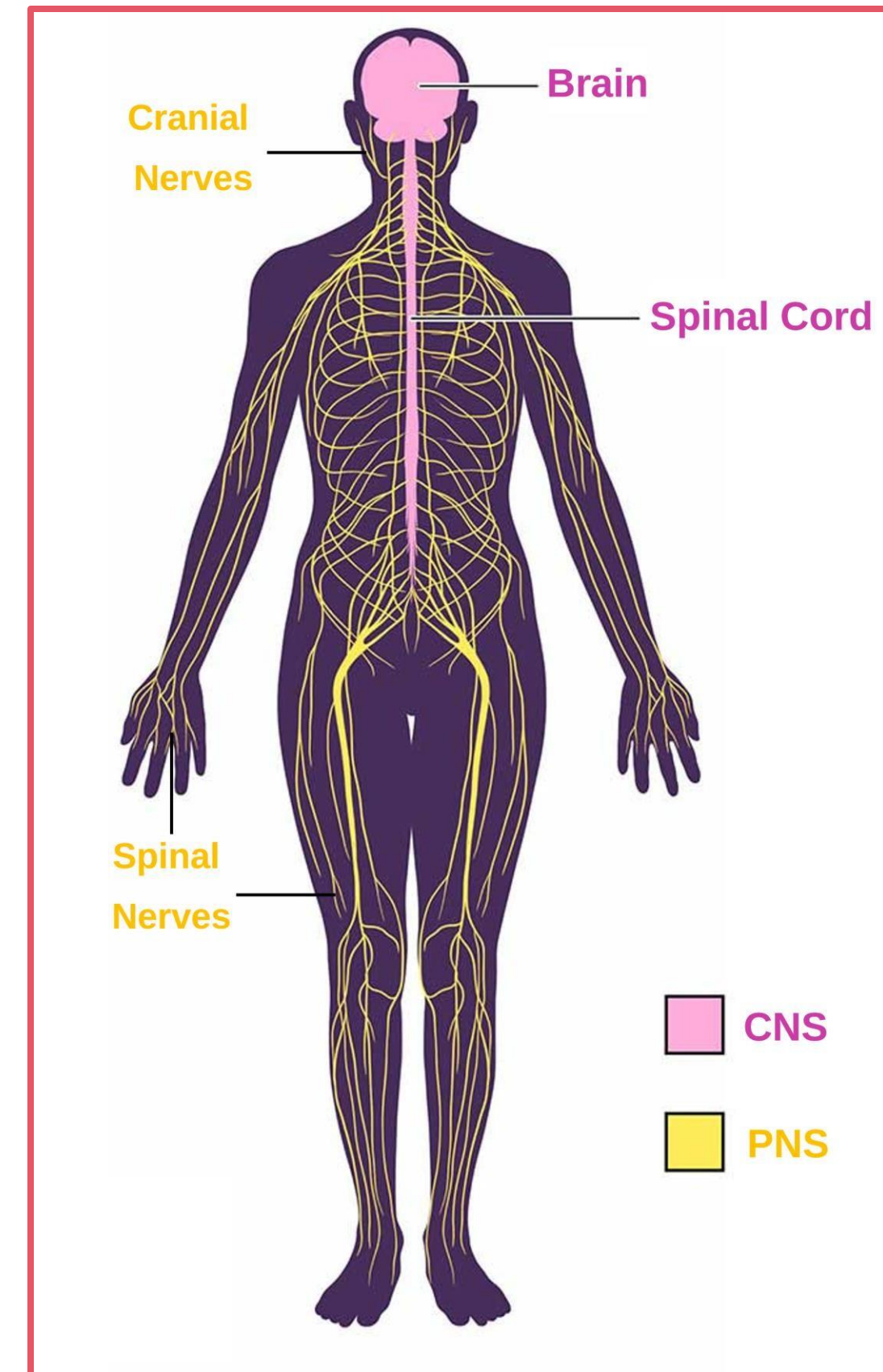
consists of:

- i. **Brain** (located in the cranial cavity)
- ii. **Spinal Cord** (located in the vertebral canal)

2. Peripheral Nervous System (PNS),

consists of nerves that exit from CNS:

- i. **Cranial nerves** (exit from the brain)
- ii. **Spinal nerves** (exit from the spinal cord)



5

Nervous System

System Outline:

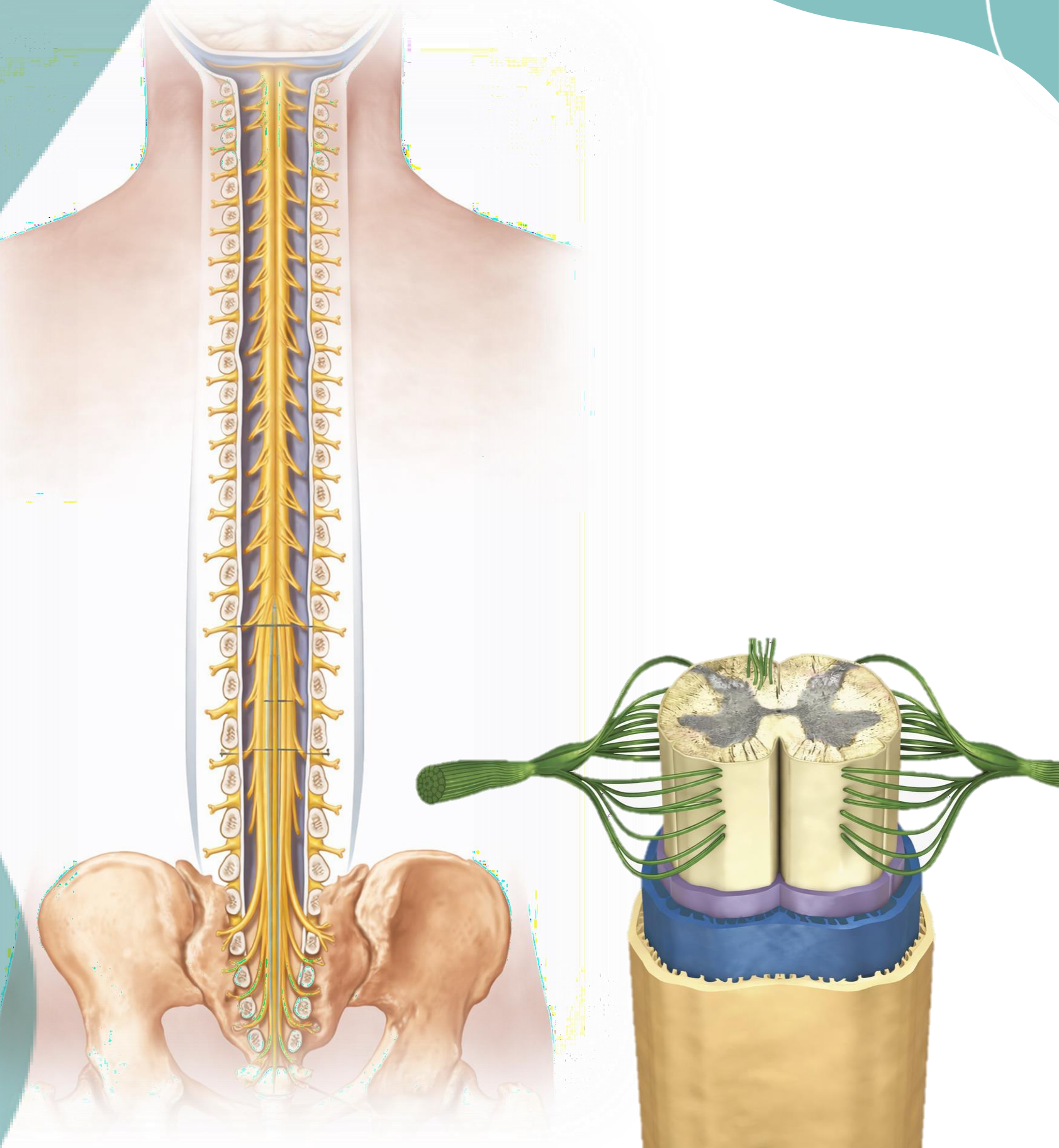
5.1 Nervous Tissue

5.2 Central Nervous System - Brain

5.3 Central Nervous System - Spinal Cord

5.4 Peripheral Nervous System

- Nervous System
- 3. CNS- Spinal Cord



5.3 Nervous System– CNS-Spinal Cord

Lecture Outline:

5.3.1

External Features of the Spinal Cord

5.3.2

Internal Features of the Spinal Cord

5

CNS-Neuronal Pathways

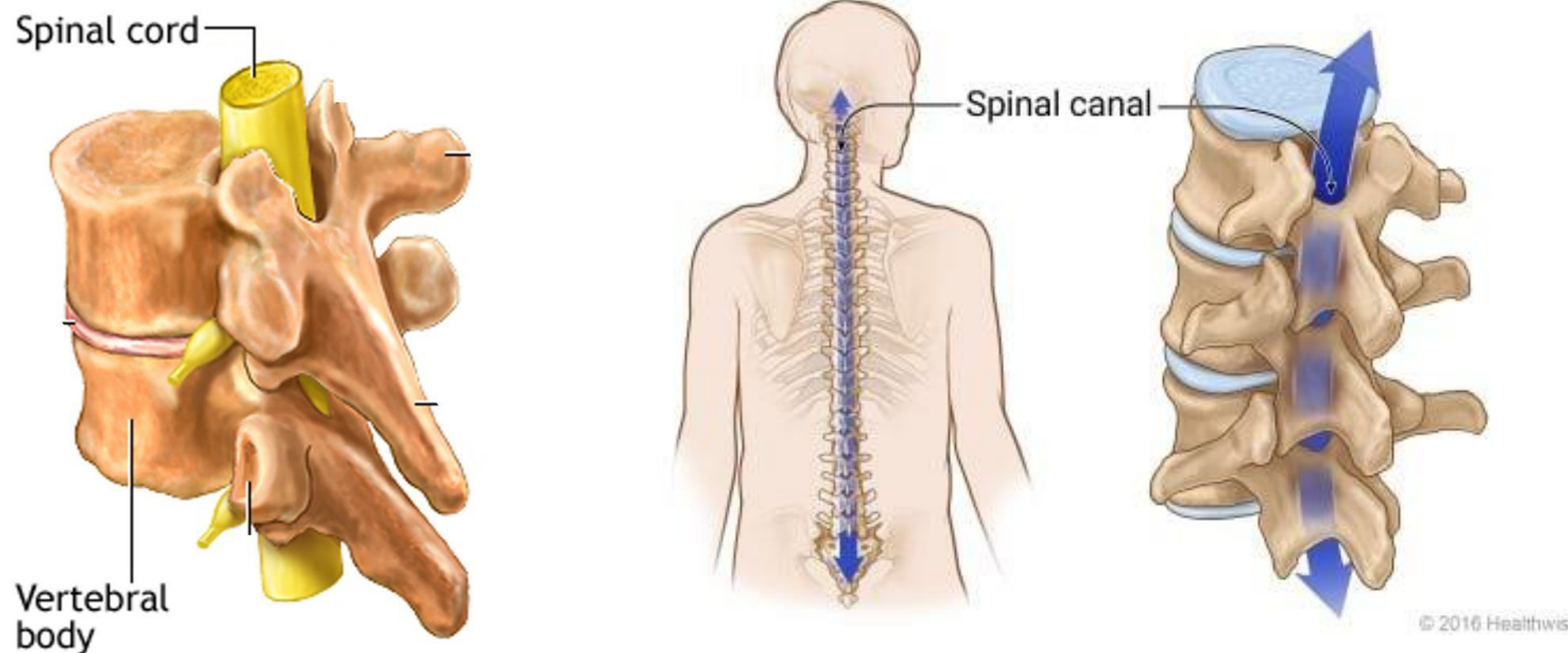
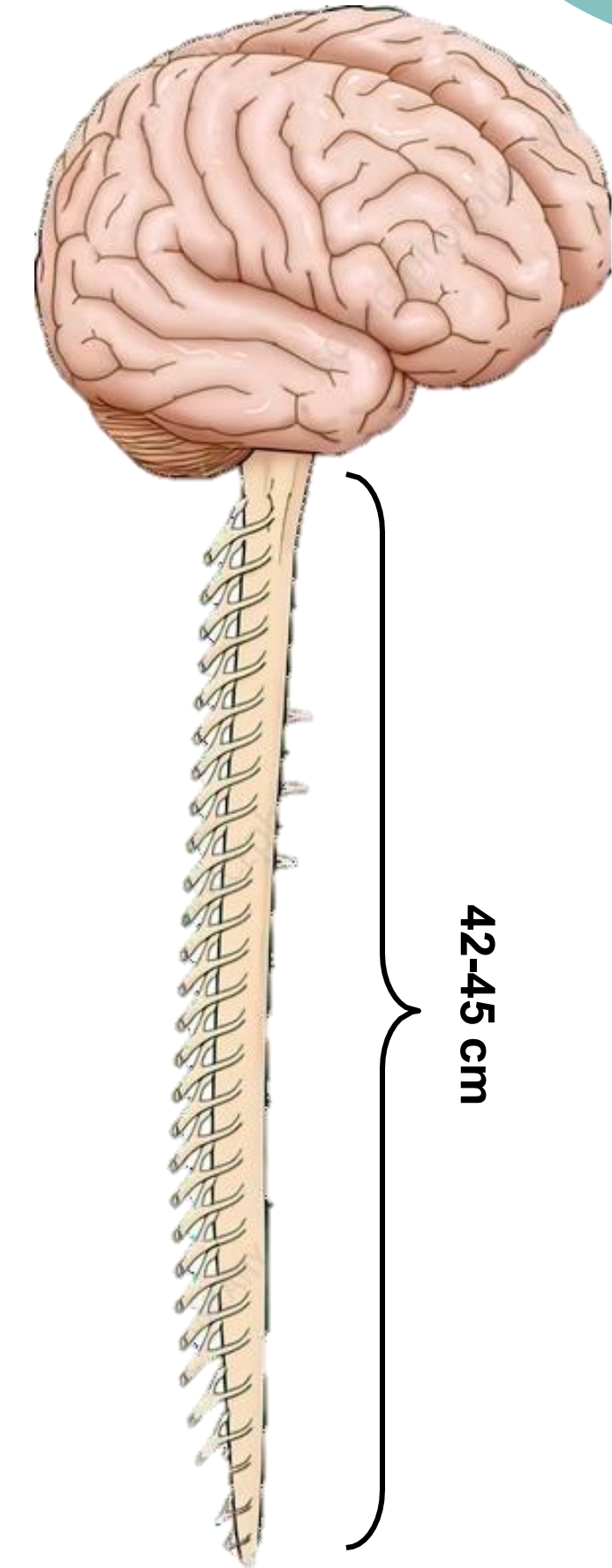
5

CNS-Meninges

5.3 Nervous System– CNS-Spinal Cord

- It is the lower elongated part of the central nervous system.
- It is cylindrical in shape located inside the vertebral canal (spinal canal).
- It measures about 42 - 45 cm in length. The length differs between males and females; in females, it is shorter than in males.

**The brain is located in the cranial cavity, and it continues as the spinal cord, which is located in the spinal canal.



The vertebral canal is formed when the vertebral foramina of the vertebrae align together, creating a canal called the spinal canal that contains the spinal cord.

External Features of the Spinal Cord

We have external and internal features of the spinal cord

❖ Anatomical Course of the Spinal Cord

- Starts at the foramen magnum at the base of the skull as a continuation of the medulla oblongata.

We know that the brain is divided into the forebrain, midbrain, and hindbrain. The hindbrain is further divided into three parts: the pons, medulla oblongata, and cerebellum. The pons and medulla oblongata are anterior, while the cerebellum is located posteriorly. The medulla oblongata ends at the level of the foramen magnum. At this point, the spinal cord begins, as it is a continuation of the medulla oblongata. The spinal cord extends downward within the vertebral (spinal) canal, but it does not reach its full length.

- Spinal cord terminates between L1 and L2 vertebrae in adults.
 - Because the spinal cord ends at L2, it occupies only about two-thirds of the vertebral canal.

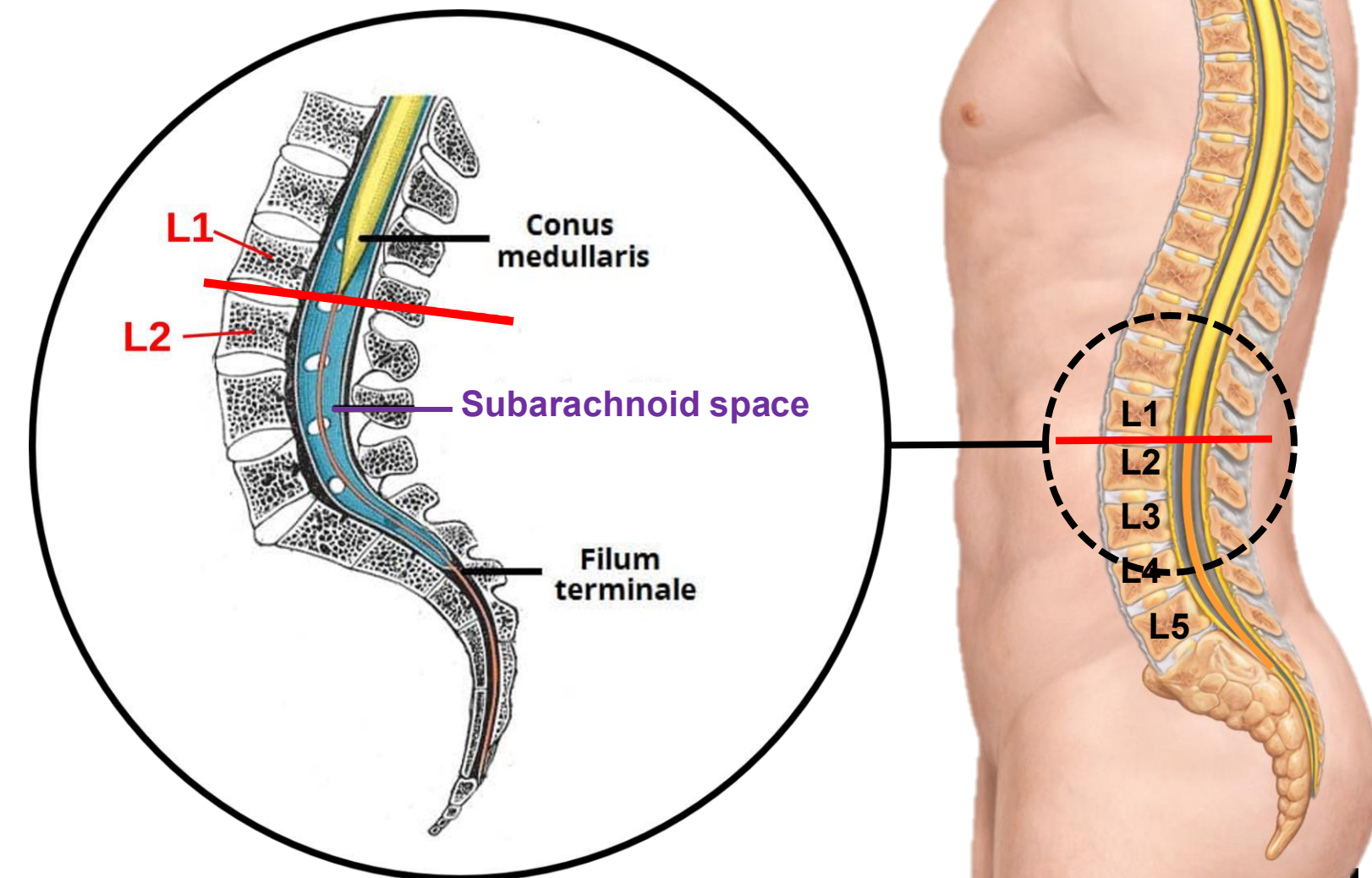
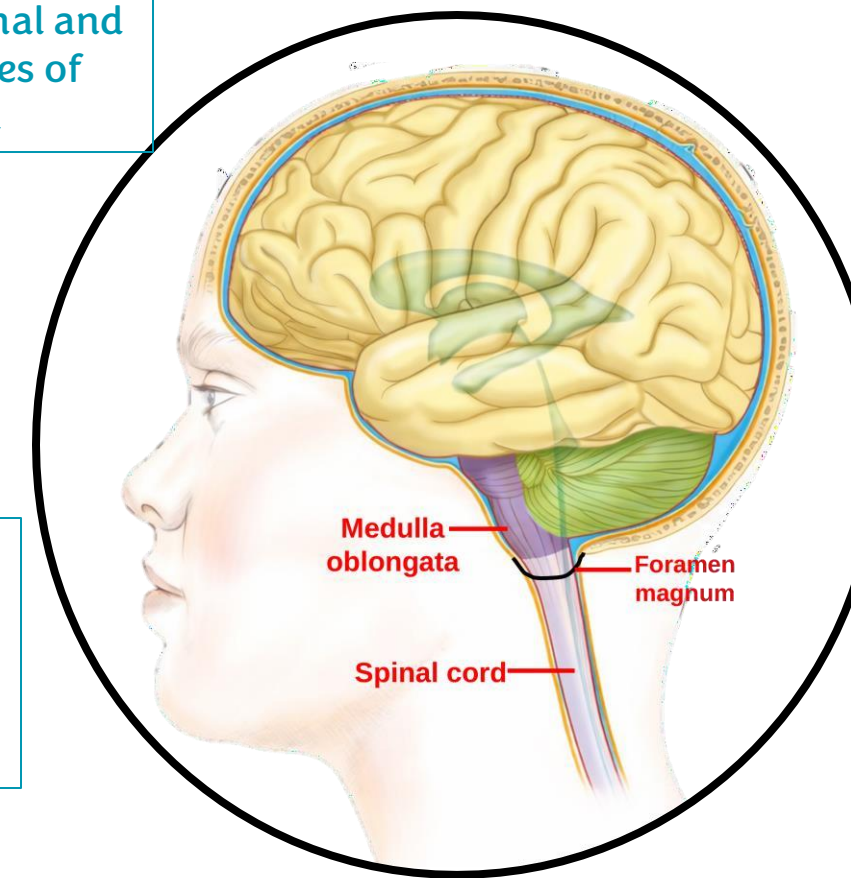
Therefore, the spinal cord is shorter than the vertebral canal (vertebral column)

- Its lower end tapers into a cone-like shape forming the conus medullaris

At its lower end, the spinal cord tapers and becomes conical in shape
شكل مخروطي

- The apex of conus medullaris continues downwards as a thin, thread-like filament called filum terminale, which attaches the end of the spinal cord to the tip of the coccyx.

The filum terminale is a thin thread-like structure that fixes the spinal cord to the coccyx.



****The brain and spinal cord are surrounded by three meninges: dura mater (outermost), arachnoid mater (middle), and pia mater (innermost, closely attached to the spinal cord).**

Between the arachnoid mater and pia mater, there is a space filled with cerebrospinal fluid (CSF) called the subarachnoid space.

This space extends along the entire spinal cord. After the spinal cord ends at the level of L1-L2, the subarachnoid space continues in the remaining part of the vertebral canal.

****The filum terminale is formed from the pia mater, which is the innermost meningeal layer covering the spinal cord.**

At the apex of the conus medullaris, the spinal cord ends, but the pia mater continues as a thin, thread-like structure called the filum terminale.

This means that the filum terminale is a continuation of the pia mater (connective tissue) that extends downward to anchor the spinal cord.

External Features of the Spinal Cord

❖ Spinal Segments

➤ Like the vertebral column, the spinal cord is also segmented

(though the segments are not visible externally)

The spinal cord is divided into segments. What do we mean by segments? They are parts of the spinal cord. Each segment is defined by the pair of spinal nerves (right and left) that arise from it. In other words, a spinal cord segment is the region from which a pair of spinal nerves emerges. Therefore, the number of spinal cord segments corresponds to the number of pairs of spinal nerves. If we take one segment of the spinal cord, we will find one spinal nerve on the right side and one on the left side arising from it.

➤ The spinal cord is made up of 31 spinal segments:

(8 cervical, 12 thoracic, 5 lumbar, 5 sacral, 1 coccygeal)

7 vertebrae
8 nerves
8 segments in
cervical region

12 vertebrae
12 nerves
12 segments in
thoracic region

5 vertebrae
5 nerves
5 segments in
lumbar region

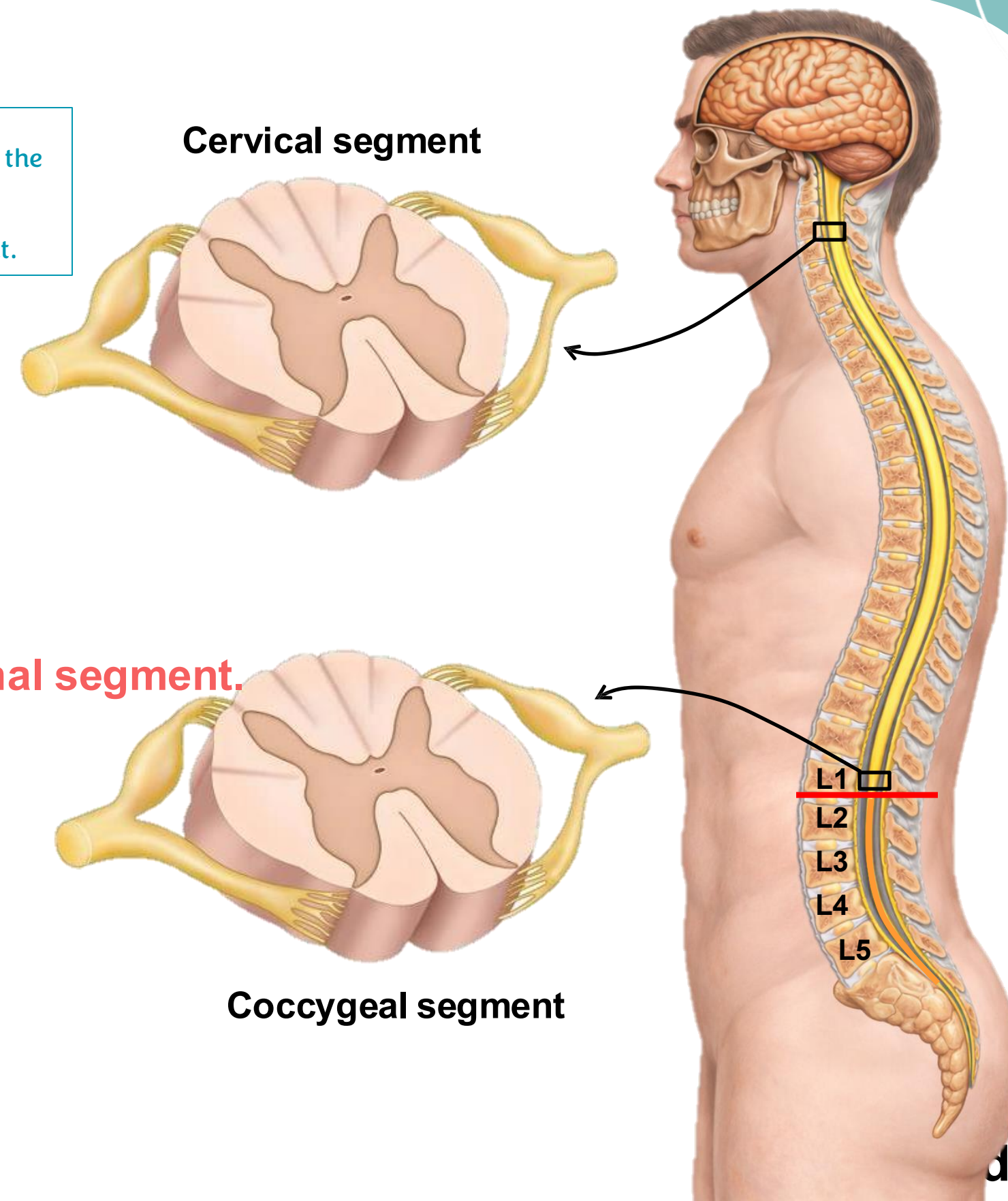
5 vertebrae
5 nerves
5 segments in
sacral region

4 vertebrae
1 nerves
1 segments in
coccygeal region

We have 31 pairs of spinal nerves, and they are named according to the region from which they emerge.

➤ Each pair of spinal nerves (right and left) is attached to the spinal segment.

➤ Due to relative shortening of the spinal cord as compared to the vertebral canal, the spinal segments lie above their corresponding vertebral level.



The vertebrae in the neck region are the cervical vertebrae, and there are seven cervical vertebrae. Normally, we expect the number of spinal nerves to match the number of vertebrae, but in the cervical region there are eight cervical spinal nerves. This is an exception. Therefore, there are eight cervical segments, each giving rise to a spinal nerve.

The spinal cord is shorter than the vertebral canal. As a result, spinal cord segments do not correspond exactly to the vertebrae in front of them. For example, the coccygeal segment at the end of the spinal cord lies roughly opposite the L1 vertebra, not the coccyx. At the top, the C1 segment is roughly opposite C1 vertebra, C2 opposite C2 vertebra, but as we go down, this alignment diverges.

Spinal nerves must exit at the level of their corresponding vertebra. For thoracic, lumbar, sacral, and coccygeal nerves, the spinal nerve forms in the spinal canal at the segment level, then descends inside the canal until it reaches the intervertebral foramen of its corresponding vertebra, and exits below the vertebra. For example, the lumbar 3 segment produces a nerve that descends inside the canal and exits below the L3 vertebra.

In the cervical region, the nerves C1–C7 exit above their corresponding vertebrae, while C8 exits below C7. From T1 to C1, nerves exit below their corresponding vertebrae.

Key point:

*Segments are not aligned with vertebrae, but spinal nerves always exit at the level of their corresponding vertebra via the intervertebral foramen.

*Any spinal nerve that forms above its vertebra descends inside the spinal canal until it reaches its correct exit point.

It stays inside the spinal canal and does not exit until it reaches its corresponding vertebra.

External Features of the Spinal Cord

Nerve Plexus: is a network of interconnected spinal nerves.

❖ Enlargements of the Spinal Cord

➤ The spinal cord is not uniform in diameter; there are two points of enlargement along its course due to origin of nerve plexuses.

➤ The two enlargements are as follows:

The course of the spinal cord isn't straight, there are regions with enlargement.

Because of the high or fine motor activity (high skilled or precise function= high complicated and specified movement), which need high number of neurons
The region in the segments which the nerves come out from it, fill with high number of neurons (high dense of neurons)

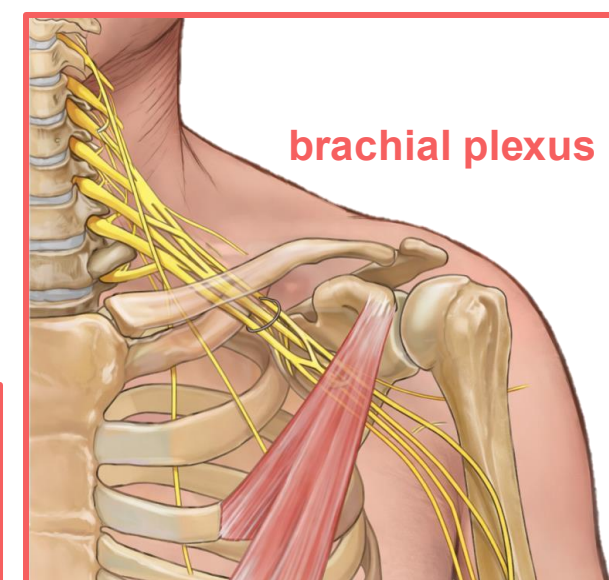
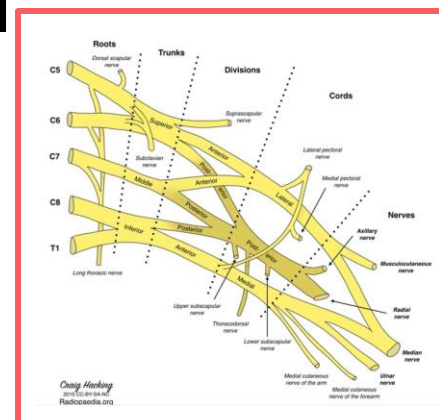
1. Cervical Enlargement:

- It represents the origin of the brachial plexus, which supplies the upper limb.
- The nerves arising from C5 to T1 spinal segments form the brachial plexus.

5 segments

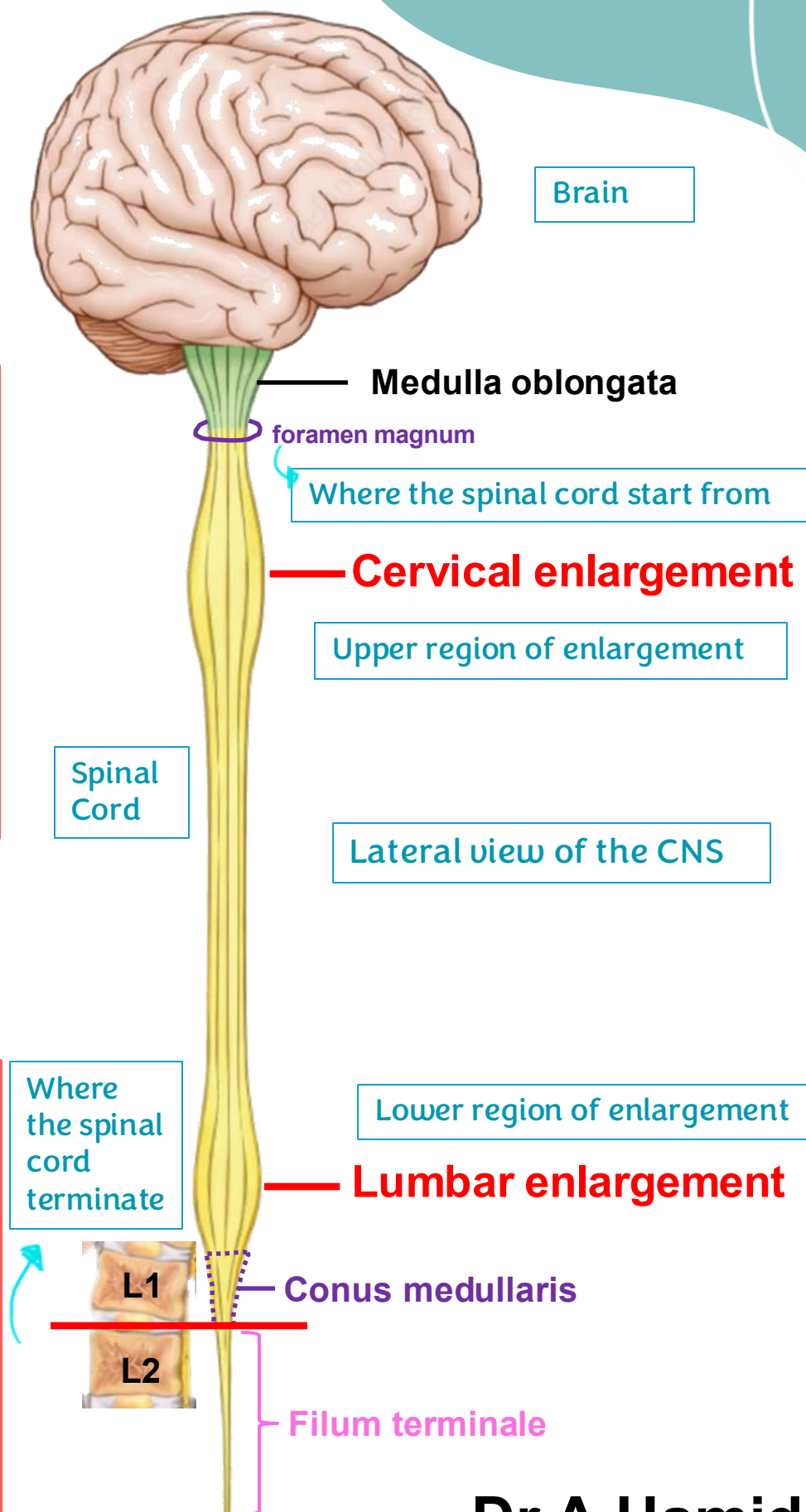
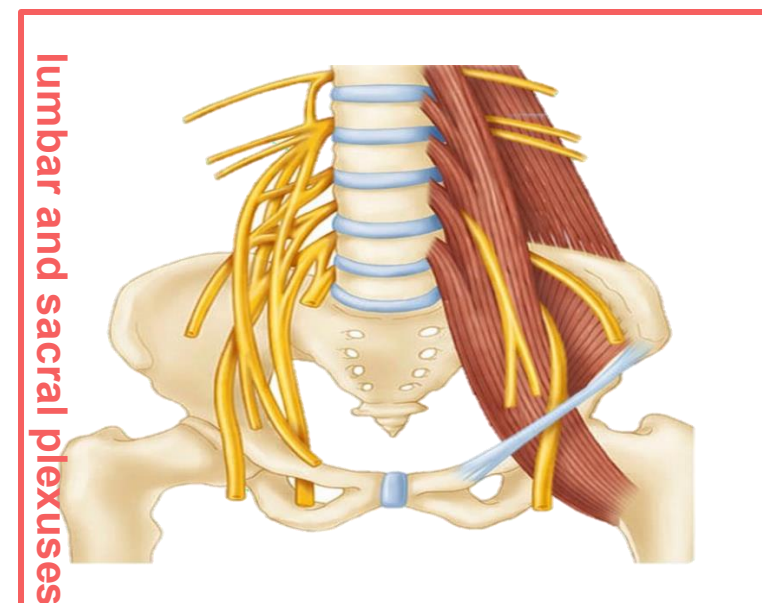
Mixing of the 5 nerve fibers, as the radial nerve has 5 types of neurons (C5, C6, C7, C8, T1), so if we have injury in one of the segments the radial remains normal and offer many sources of neurons to make perfect motor action or sensation.

This is an additional image to explain the structure of the brachial plexus.



2. Lumbar Enlargement (Lumbosacral enlargement):

- It represents the origin of the lumbar plexus and sacral plexus, which supply lower limb.
- The nerves arising from L2 to S3 spinal segments contribute to the lumbar and sacral plexuses.



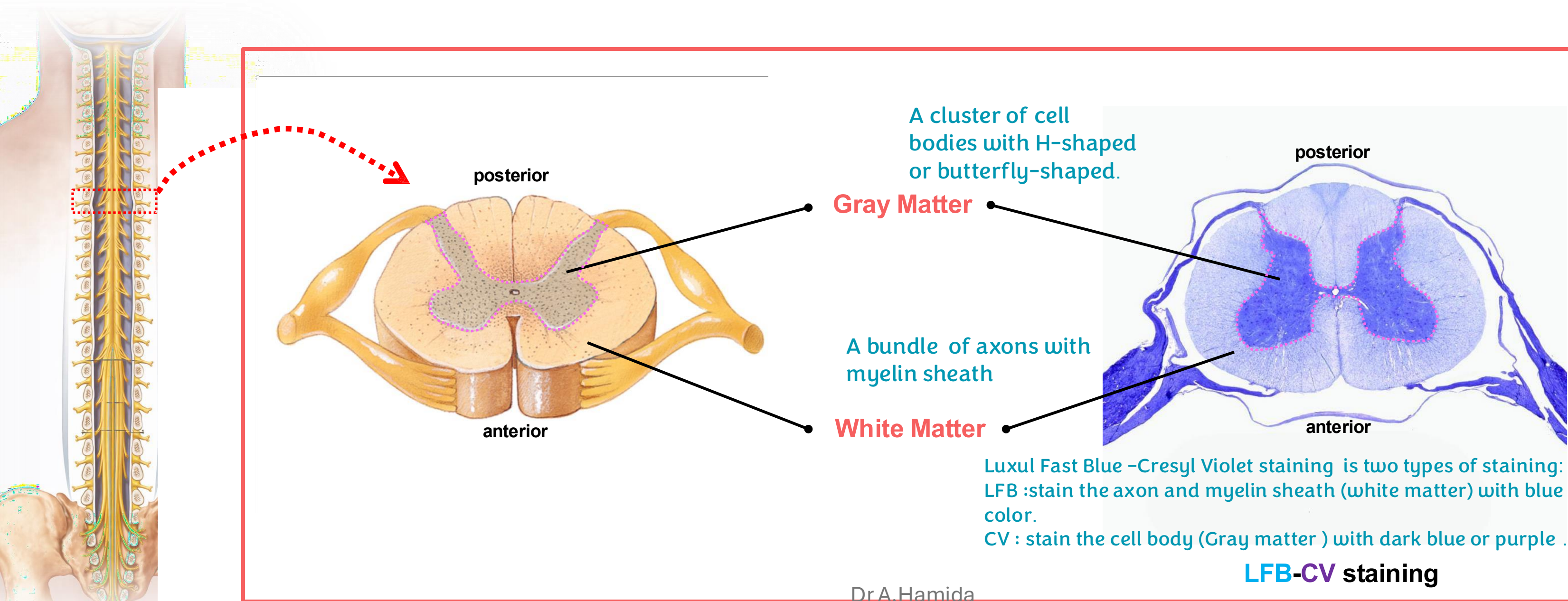
Internal Features of the Spinal Cord

➤ The cross-section of the spinal cord shows:

- Inner core of gray matter made up of cell bodies.

They are found along the spinal cord.

- Peripheral zone of white matter made up of fiber tracts.



A cluster of cell bodies with H-shaped or butterfly-shaped.

Gray Matter

A bundle of axons with myelin sheath

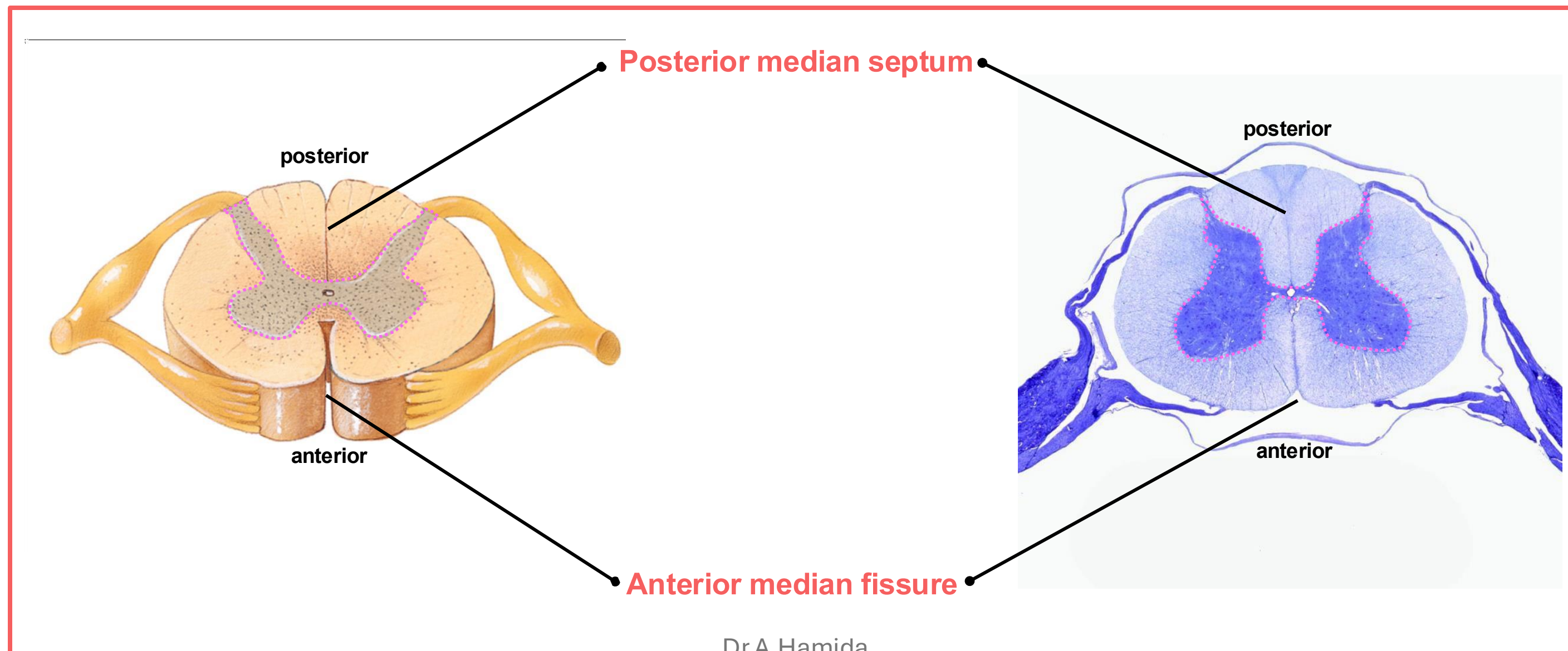
White Matter

Luxol Fast Blue -Cresyl Violet staining is two types of staining:
LFB :stain the axon and myelin sheath (white matter) with blue color.
CV : stain the cell body (Gray matter) with dark blue or purple .

LFB-CV staining

➤ The cross-section of the spinal cord shows:

- **Anterior median fissure**: a deep longitudinal groove on the anterior surface of the spinal cord, that separates the right and left halves of the anterior white column.
- **Posterior median septum**: a thin partition extending from the posterior surface of the spinal cord to the grey commissure. It partially divides the posterior white column into right and left halves.



Internal Features of the Spinal Cord

❖ Gray Matter

➤ In cross section, the gray matter is seen as an H-shaped (or butterfly-shaped) column, extending throughout the length of the spinal cord.

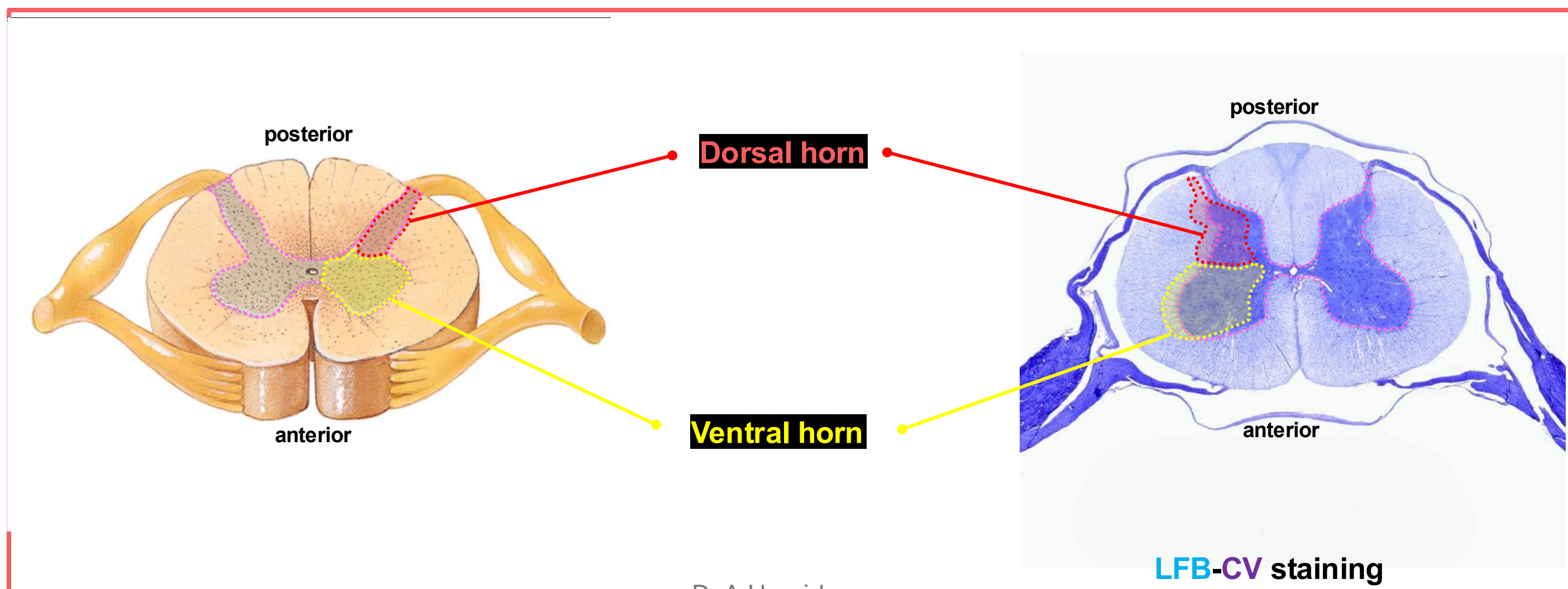
Both of them make a voluntary control

➤ It consists of two horns:

Somatic sensory neurons

1. **Posterior (dorsal) horns:** Contain neurons that receive somatic sensory input. Receiving the sensory information from PNS

2. **Anterior (ventral) horns:** Contain cell bodies of somatic motor neurons that supply skeletal muscles. Motor function



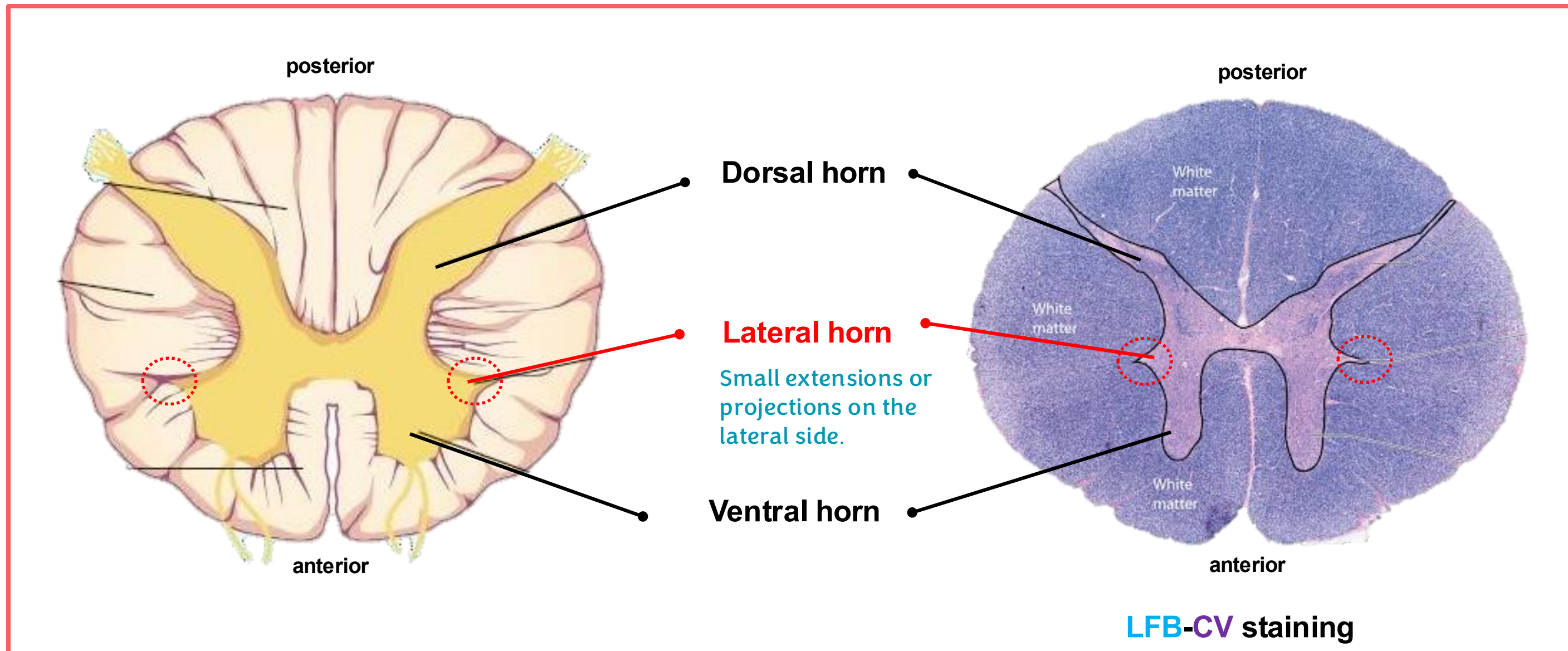
Internal Features of the Spinal Cord

❖ Gray Matter

➤ **Lateral gray horns:** present only in the thoracic and upper two lumbar segments (T1 to L2) and contain cell bodies of autonomic (sympathetic) neurons.

Involuntary and motor neurons which supply smooth, cardiac muscles and glands.

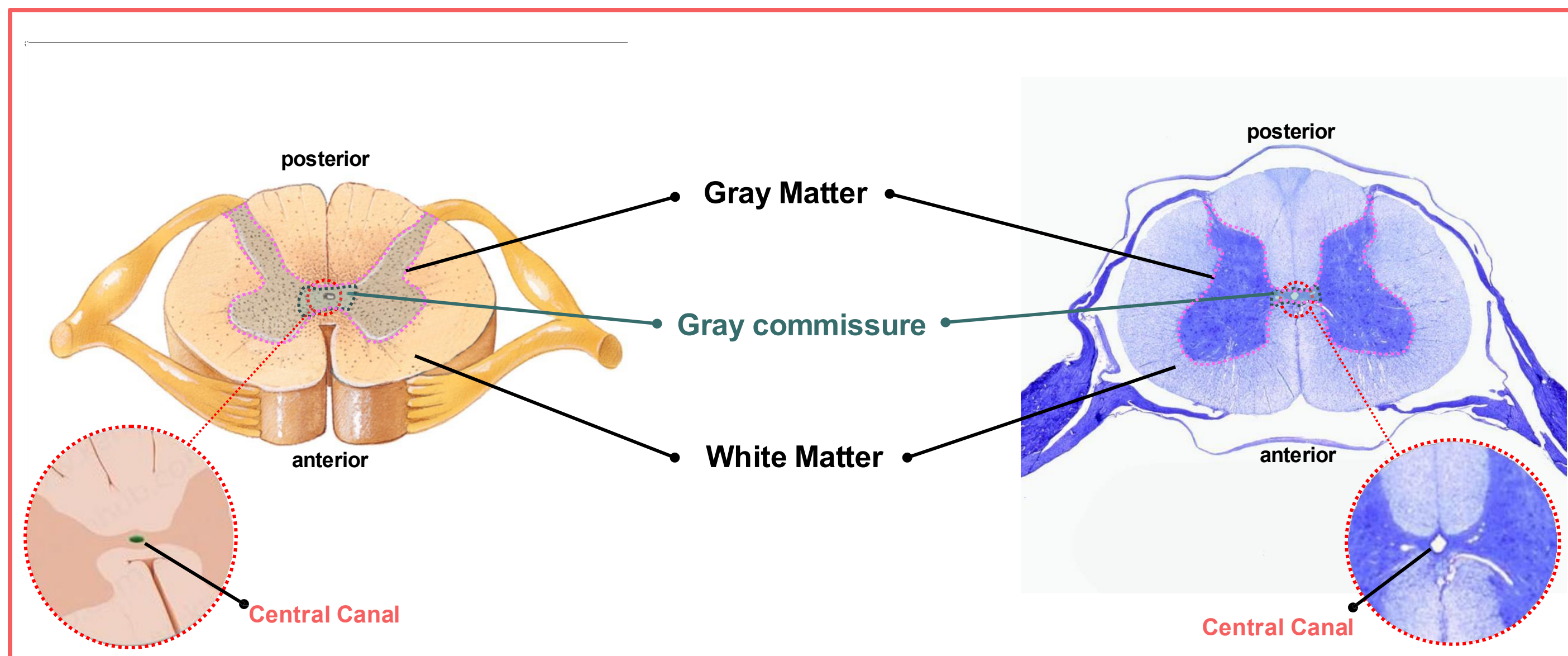
Remember:
sympathetic =
fight or flight
response
(stress
situations)



Internal Features of the Spinal Cord

❖ Gray Matter

- A narrow bridge of gray matter connecting the right and left halves of the spinal gray matter known as gray commissure, it contains the central canal. Connect the 4th ventricle with spinal cord
- **Central canal: a canal runs through the length of the spinal cord and contains the cerebrospinal fluid.**



Internal Features of the Spinal Cord

❖ White Matter There are ascending sensory tracts and descending motor tracts , and the group of tracts called column

➤ Surrounds the central H-shaped mass of gray matter and consists mainly of myelinated axon fibers, giving it a white appearance.

➤ Each half of the spinal cord contains three white columns:

1. **Anterior column:** between the anterior median fissure and the anterior horn.

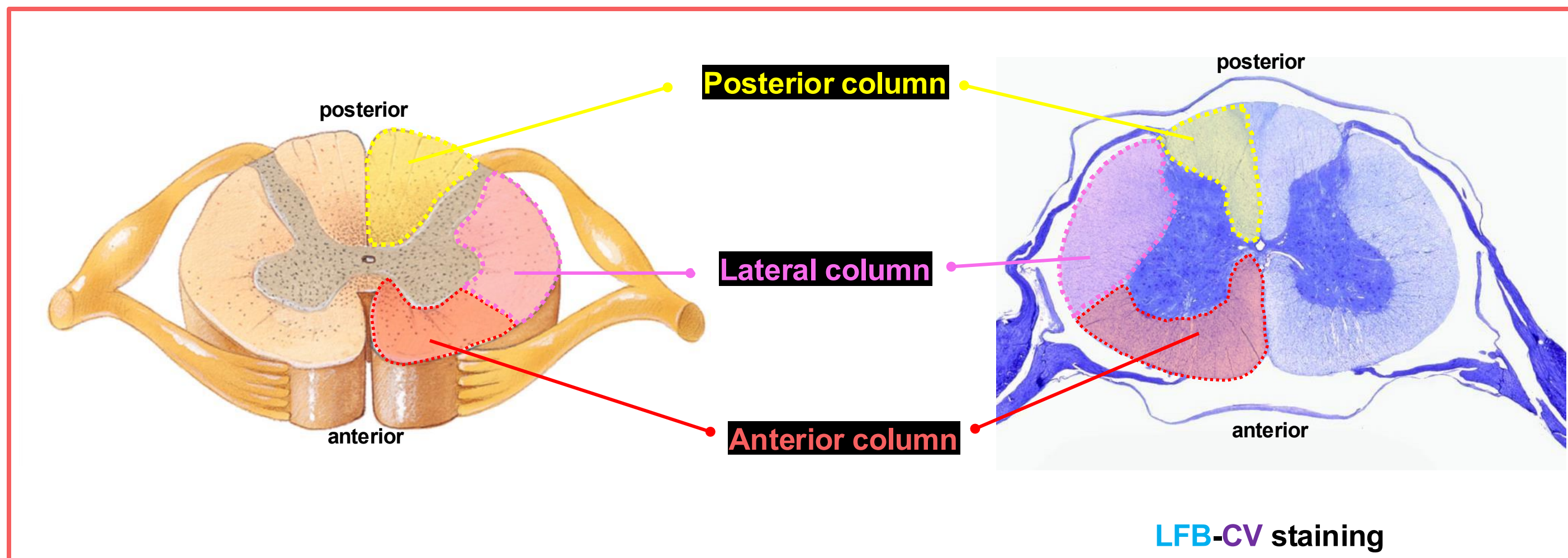
Contains descending motor tracts and ascending sensory tracts , but the major are the descending motor tracts

2. **Lateral column:** between the anterior and posterior horns.

Contains mix of descending motor tracts and ascending sensory tracts

3. **Posterior column:** between the posterior median septum and the posterior horn

Contains only ascending sensory tracts



Internal Features of the Spinal Cord

❖ White Matter

➤ Each column is made up of tracts which are either:

1. Ascending Tracts (Sensory)

- These are neural pathways that transmit sensory information (touch, pain, pressure, vibration, and proprioception) from the spinal cord (enter through peripheral nerves) to the brain.

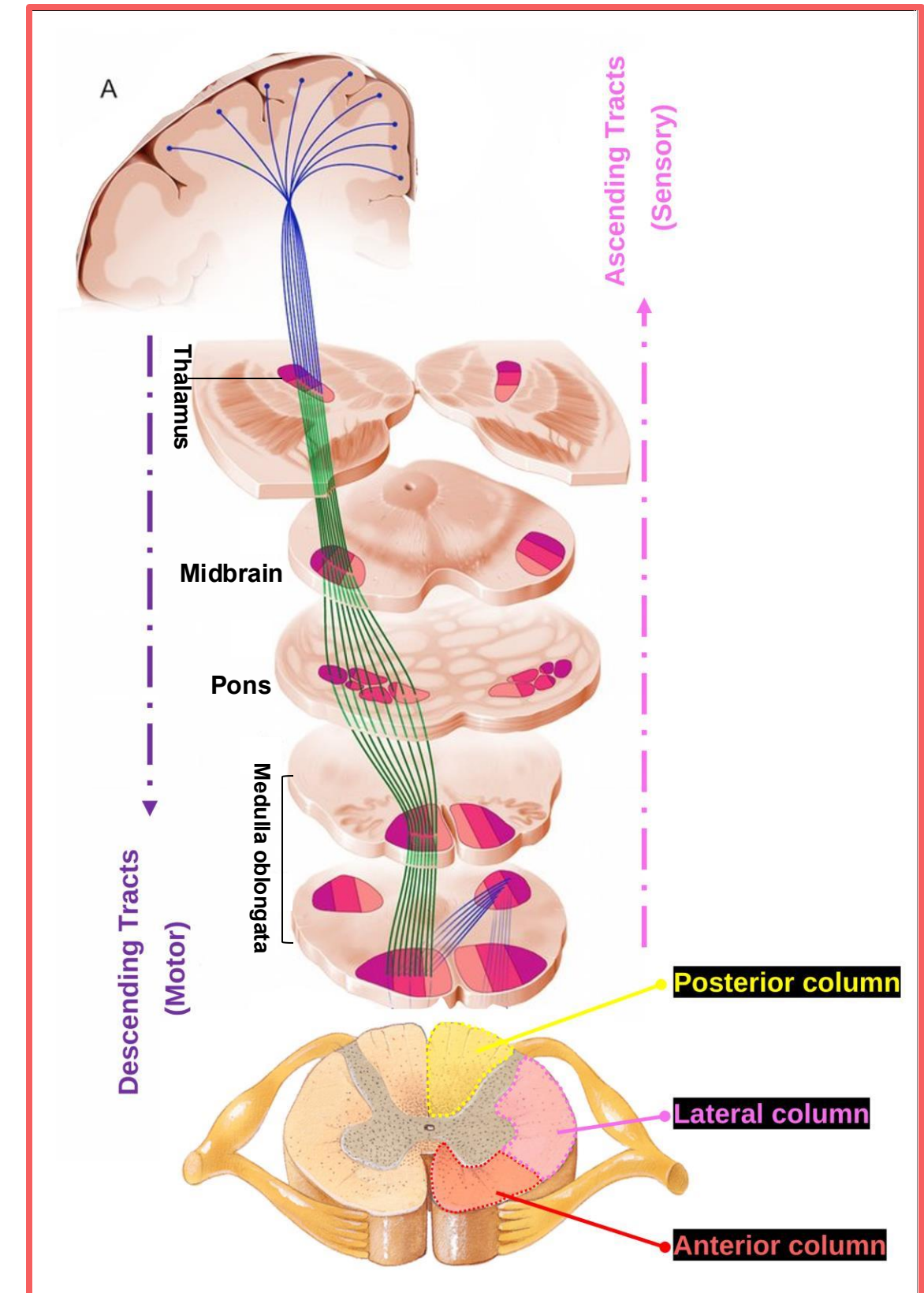
2. Descending Tracts (Motor)

- These are neural pathways that transmit motor information from the brain to the spinal cord, which then sends signals to muscles and glands.

➤ Generally

- Posterior column: mainly made up of sensory (ascending) tracts.
- Anterior column: mainly contains motor (descending) tracts but also includes some sensory tracts.
- Lateral column: contains mixed tracts (both sensory and motor).

Dr A. Hamida



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Nervous System– CNS - Neuronal Pathways

❖ Sensory Pathways (Three-Neuron Chain)

Chain = channel or unit of neurons or group of neurons side by side

➤ Each sensory signal is transmitted by three-order neurons (3 chains is needed):

1. First-order neurons

- Carry sensory signals from receptors in the skin (or other sensory organs) to the dorsal root ganglion, then their axons enter the spinal cord and synapse in the dorsal horn.

2. Second-order neurons

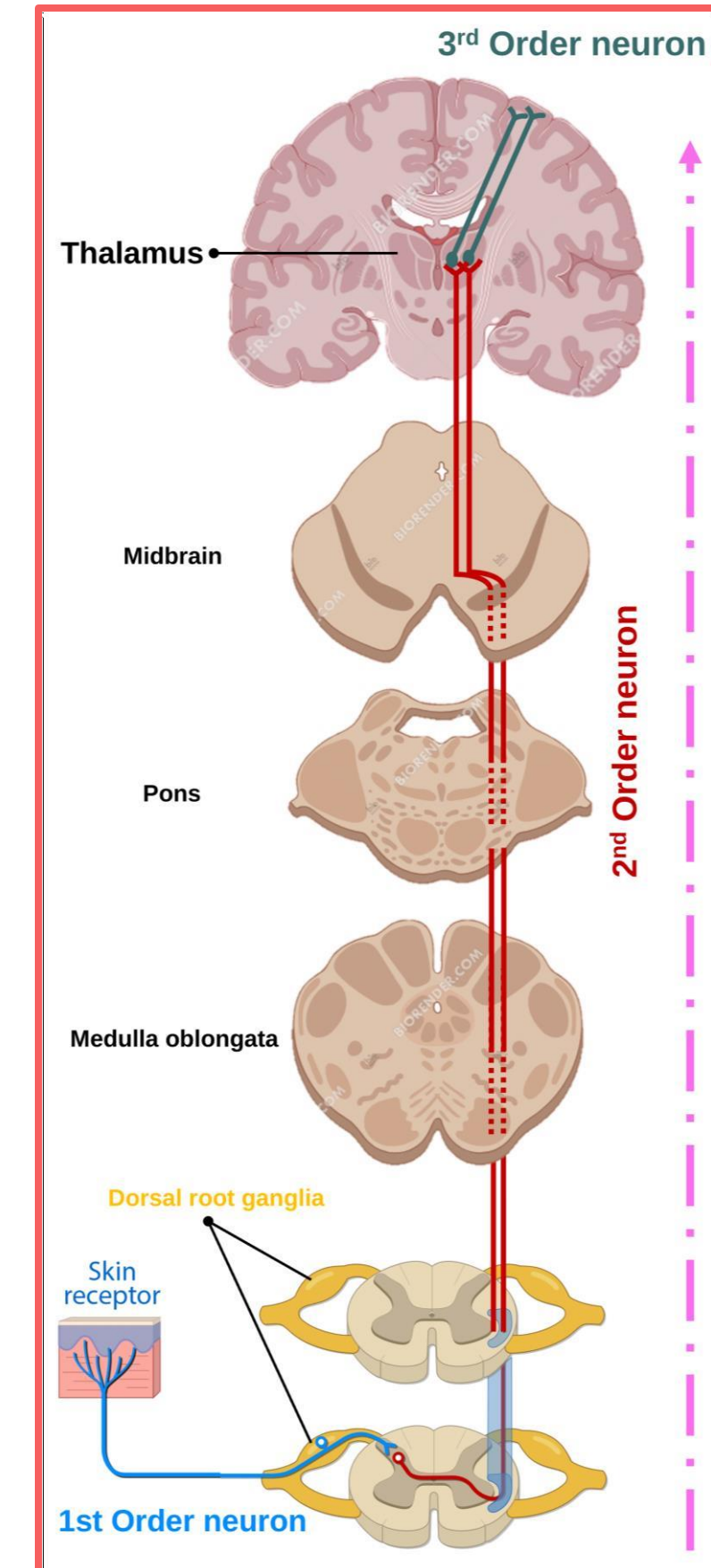
- Carry signals from the spinal cord to the thalamus.

Pass through Medulla Oblongata , Pons and Midbrain

3. Third-order neurons

- Carry signals from the thalamus to the sensory areas of the cerebral cortex (usually the primary somatosensory cortex).

In the parietal lobe



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Nervous System– CNS - Neuronal Pathways

❖ Motor Pathways (Two-Neuron Chain)

➤ Each motor signal is transmitted by two motor neurons

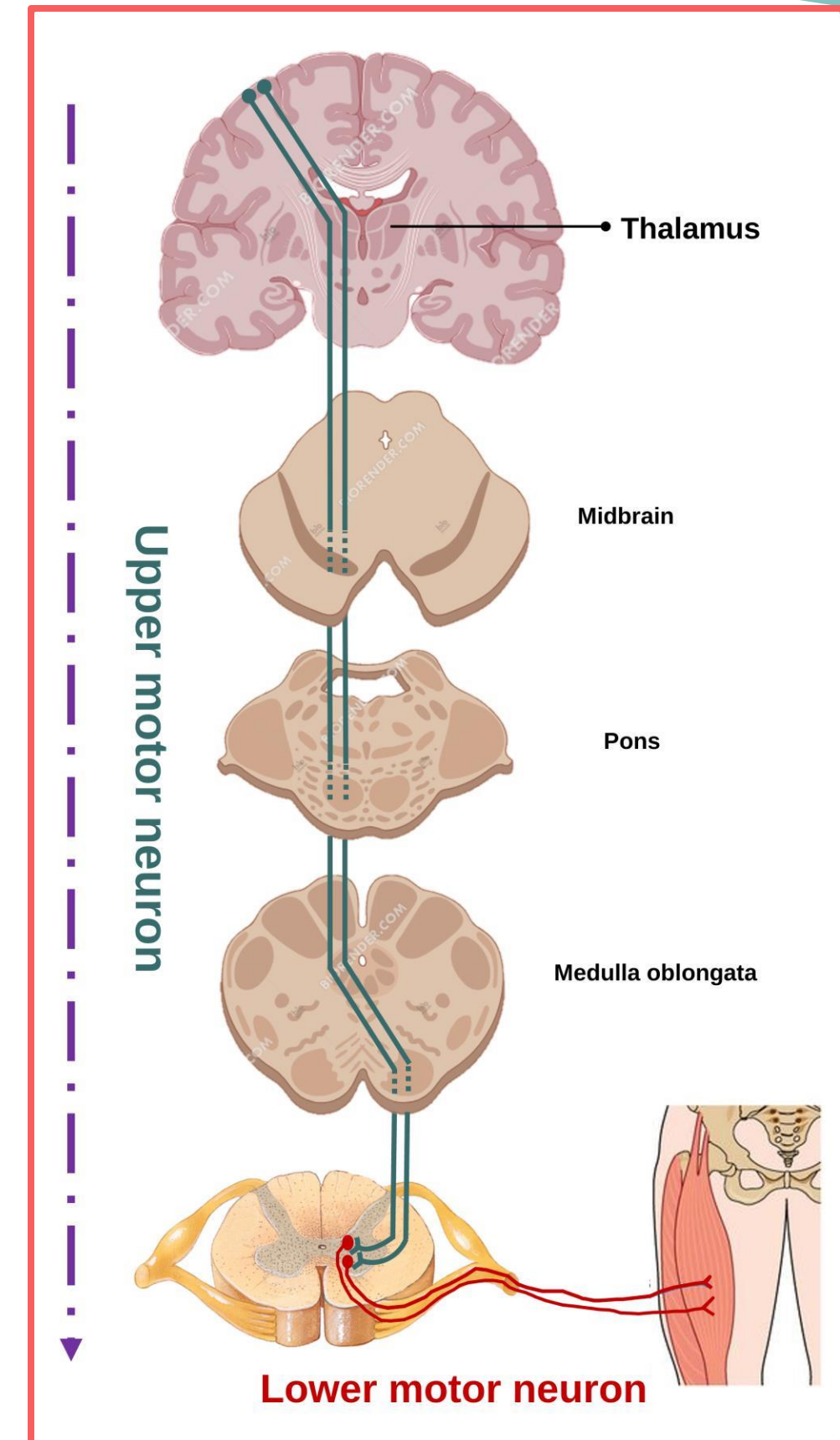
1. Upper motor neuron (UMN)

- Carries signals from the motor areas of the cerebral cortex to motor neurons in the ventral horn of the spinal cord. *In the frontal lobe*

Pass through Thalamus (just as a pathway without stopping) , Midbrain , Medulla Oblongata and Pons

2. Lower motor neuron (LMN)

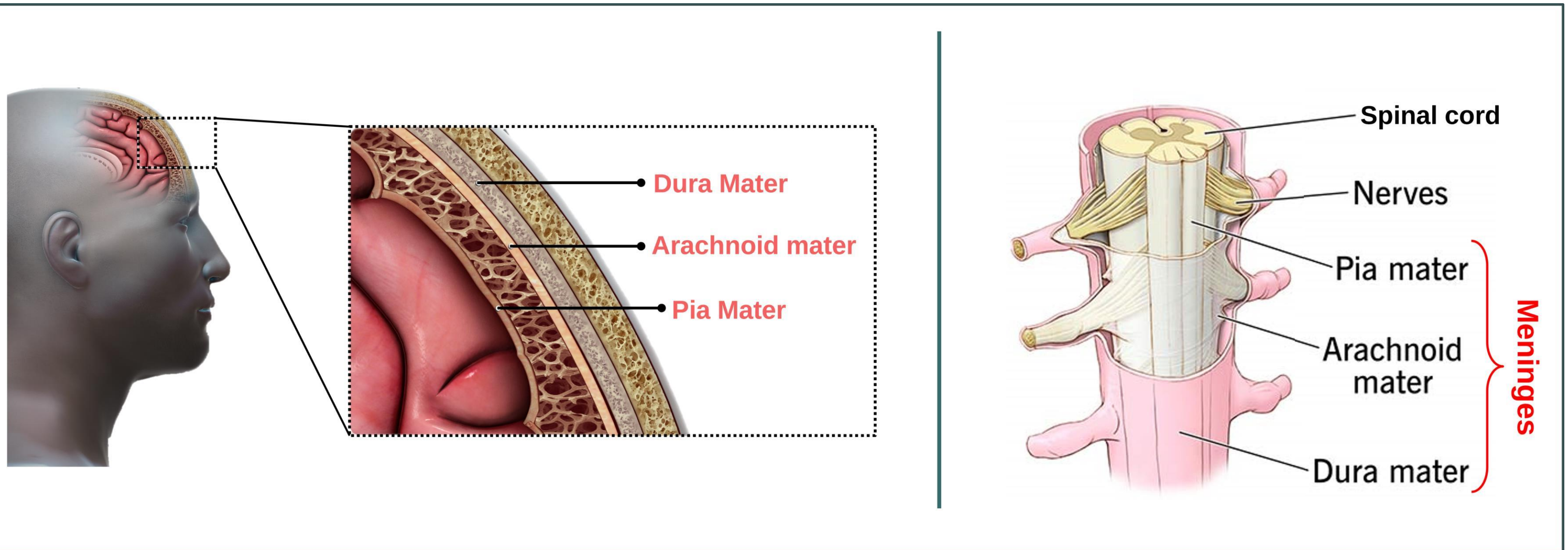
- Carries signals from the ventral horn of the spinal cord to skeletal muscles. *Under voluntary control*



5

Nervous System– CNS - Meninges

- The meninges are the membranous coverings of the brain and spinal cord.
- There are three layers of meninges, (from superficial to deep):
 1. **Dura mater:** Thick outer layer directly beneath the bones of the skull and vertebral column.
 2. **Arachnoid mater:** Middle layer lying just beneath the dura mater.
 3. **Pia mater:** Thin, transparent, vascular membrane closely adherent to the surface of the brain and spinal cord

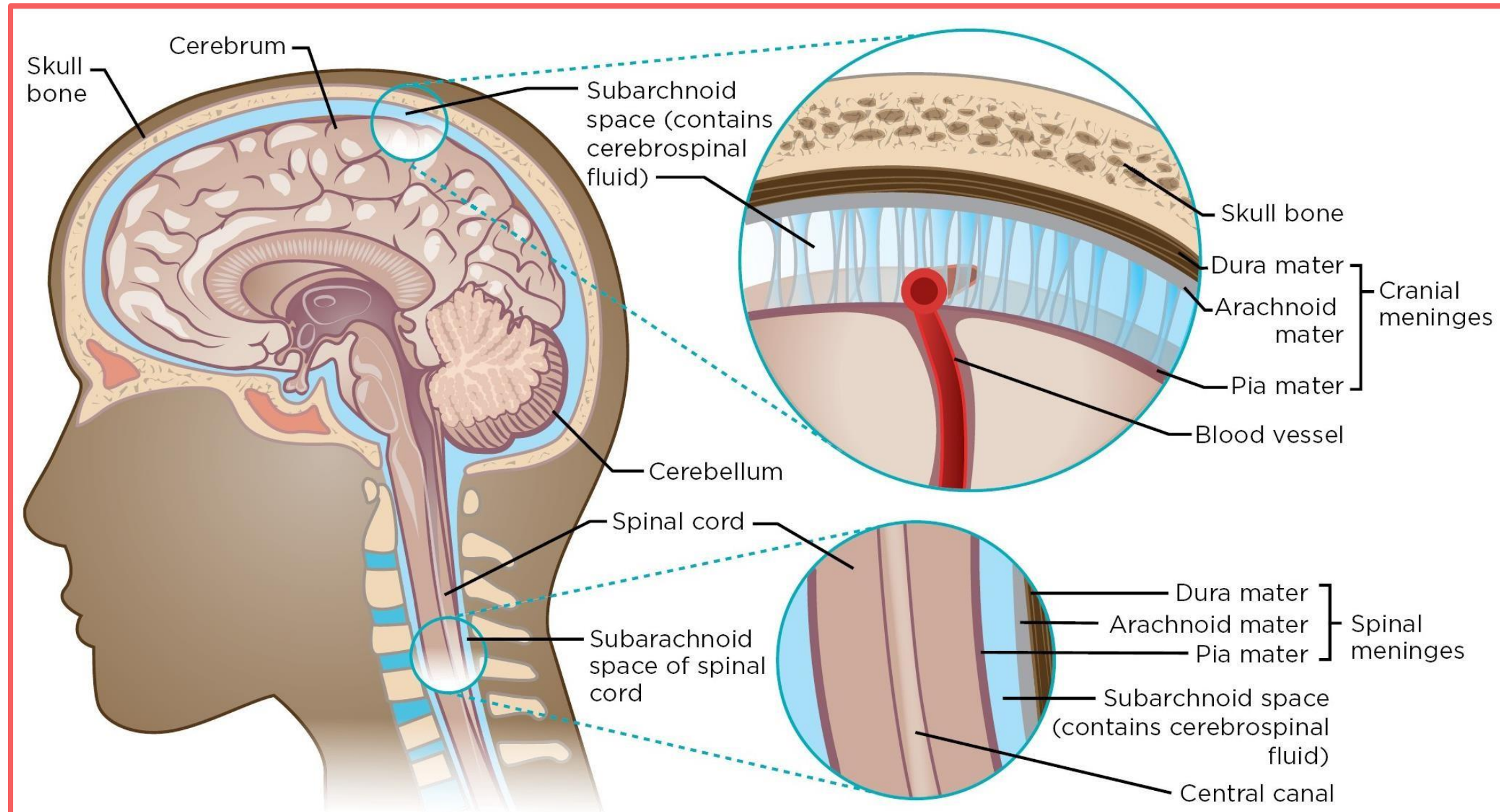


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Nervous System– CNS - Meninges

➤ Subarachnoid space

- Located between the arachnoid and pia mater.
- The subarachnoid space around the brain is continuous with that around the spinal cord.
- Filled with cerebrospinal fluid (CSF), which enters from the ventricular system.



5

Nervous System– CNS - Meninges

Clinical Correlation



Meningitis

It is an inflammation of the meninges.

Symptoms typically include fever, headache, and neck stiffness.

Most commonly caused by viral or bacterial infections.

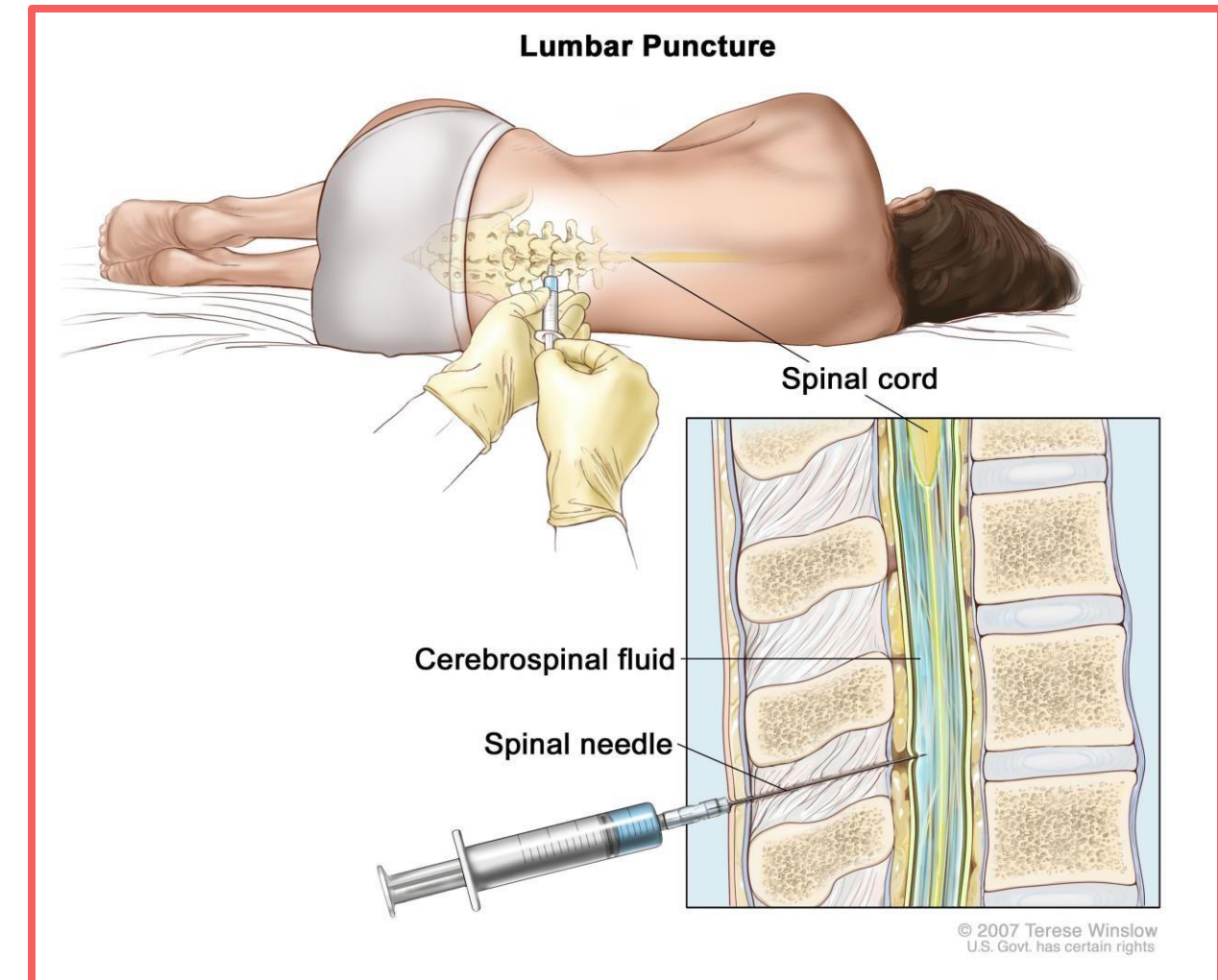
To determine the causative agent, a lumbar puncture is performed.

Lumbar Puncture

From the subarachnoid space

A medical procedure used to collect CSF by inserting a needle into the spinal canal below L2, usually between L3 and L4 or between L4 and L5

Also , we can insert the needle between L2 and L3 , but between L3 and L4 or between L4 and L5 is more safe .



Now , test yourself by this quiz:

<https://forms.gle/Lp2NjWVGJja7eW4p19>

رسالة من الفريق العلمي:



لا تنسَ احتساب أجر تعبك وقت الدراسة لله ، وتأكد أنّ الله لا يضيع تعب من سعى ، فعلينا السعي والله يتولى النتائج .

ولا تقارن نفسك بأحد ، وتوكل على الله وتأكد أن كل علامة هي رزق ومقدّر عند الله سبحانه وتعالى .
واجعل همّك في دراستك رفع الأمة وليس علامة تنالها في امتحان

قال الإمام الشافعي : «لَيْسَ الْعِلْمُ مَا حُفِظَ، إِنَّمَا الْعِلْمُ مَا نَفَعَ»

For any feedback, scan the code or click on it.



Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1			
V1 → V2			