Lecture (5): Spinal cord II (Anatomy)

Source: First aid for the basic sciences (organ systems): Chapter 6, **Page** 446 – 447
Source: Nervous System Basic science and clinical condition. Page: 60-62
Source: Kaplan neuroscience USMLE Lecture notes 2021; Pages: 262-274

Specific learning Objectives

1- Select common investigations relevant to the findings on physical examination, laboratory investigations and histopathology and in the following common clinical problems: spinal cord lesions, stroke.
2- Formulate a broad differential diagnosis for each problem, based on the clinical encounter and investigations done to date in a stable patient presenting with one of the following straight forward problems: e.g. paralysis.
3- Describe main gross anatomical features of nervous system including brain stem, spinal cord, spinal and cranial nerves and organs of special sense.

Contents:

By the end of the lecture the student will be able to:

1. **Describe** the normal anatomy of the main ascending (sensory) and descending (motor) tracts.
2. **Interpret** anatomical facts with the clinical manifestations of some vascular lesions.

NARS: (1.6.1.10, .4.1).

Tracts of the Spinal Cord

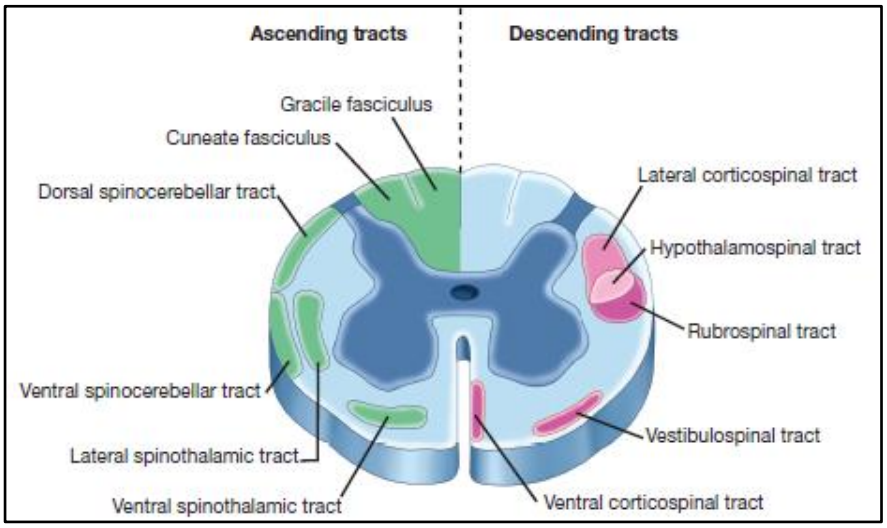

Figure 5-1: Transverse section in the spinal cord

DESCENDING (MOTOR) PATHWAYS

1-Pyramidal pathway **2-Extrapyramidal pathway**

1-Pyramidal pathway:

Includes two tracts:

a-Corticospinal tracts b-Corticobulbar tract

CORTICOSPINAL TRACTS

Include two tracts:

1-Lateral (crossed)corticospinal tract:

Origin:

■ One third from the **giant cells of Betz** in Primary motor cortex (Brodmann area 4).

■ One third from Premotor cortex and supplementary motor cortex (Brodmann area 6).

■ One third from parietal lobe (Brodmann area 3,1,2).

Course: The axons pass through (Fig.5-2).

- Corona radiata
- The posterior limb of the *internal capsule*
- In the *midbrain* pass through the **crus cerebri.**
- In *the pons* the fibers continue through the basilar part.
- In *the medulla*, forming the **"pyramids**" and decussate in the **pyramidal decussation**.

Before the decussation, the lateral and ventral corticospinal tracts run together. At the pyramids in the medulla, 85‑90% of corticospinal fibers decussate and form the ***lateral corticospinal tract;*** *the remaining 10‑15% continue as the* ***ventral corticospinal tract.***

- In the *spinal cord.* The axons travel along the corticospinal tract in the lateral funiculus.

Termination: Motor neurons in the ventral horn of the spinal cord.

2-Ventral (direct) corticospinal tract:

Course: Same as that of the lateral corticospinal tract **BUT** ☞☞

➢The ventral corticospinal tract **does not decussate** and continues ***ipsilaterally*** along the ventral white matter of the spinal cord.

Termination: On motor neurons **within the ventral horn of the spinal cord *bilaterally.*** It is only present in upper part of the spinal cord ending at midthoracic level.

CORTICOBULBAR TRACT

- ☆ It is the part of the pyramidal tract that is concerned with the voluntary movements of muscles of the head, neck, and face.
- ☆ Fibers pass through the **genu** of internal capsule and descend to the brain stem where they end on the **motor** cranial nerve nuclei.

↗↗ All motor nuclei of the cranial nerve, have a bilateral corticobulbar innervation. except those of the lower facial muscles (lower half of motor facial nucleus) and the portion of hypoglossal nerve nucleus that innervates genioglossus muscle as they receive corticobulbar fibers of the opposite side only.

⌦**Note** that muscles involved in chewing, swallowing and talking, have a bilateral innervation.

2-EXTRAPYRAMIDAL PATHWAYS:

They include tracts that originate in the brainstem, carrying motor fibres to anterior (ventral) horn cells of the spinal cord.

a-Rubrospinal tract (crossed)

Arise from red nucleus in midbrain – it lies in lateral funiculus

b-Medial (bilateral)and lateral vestibulospinal tracts

Arise from vestibular nuclei (in Medulla) it lies in the anterior funiculus.

c-Medial and lateral reticulospinal tracts

Arise from reticular formation of the pons and medulla respectively.

Medial tract lies in the anterior funiculus while lateral reticulospinal tract in the lateral funiculus.

d-Tectospinal tract

Arise from the colliculi (tectum) of midbrain of opposite side to **cervical** segment of spinal cord.

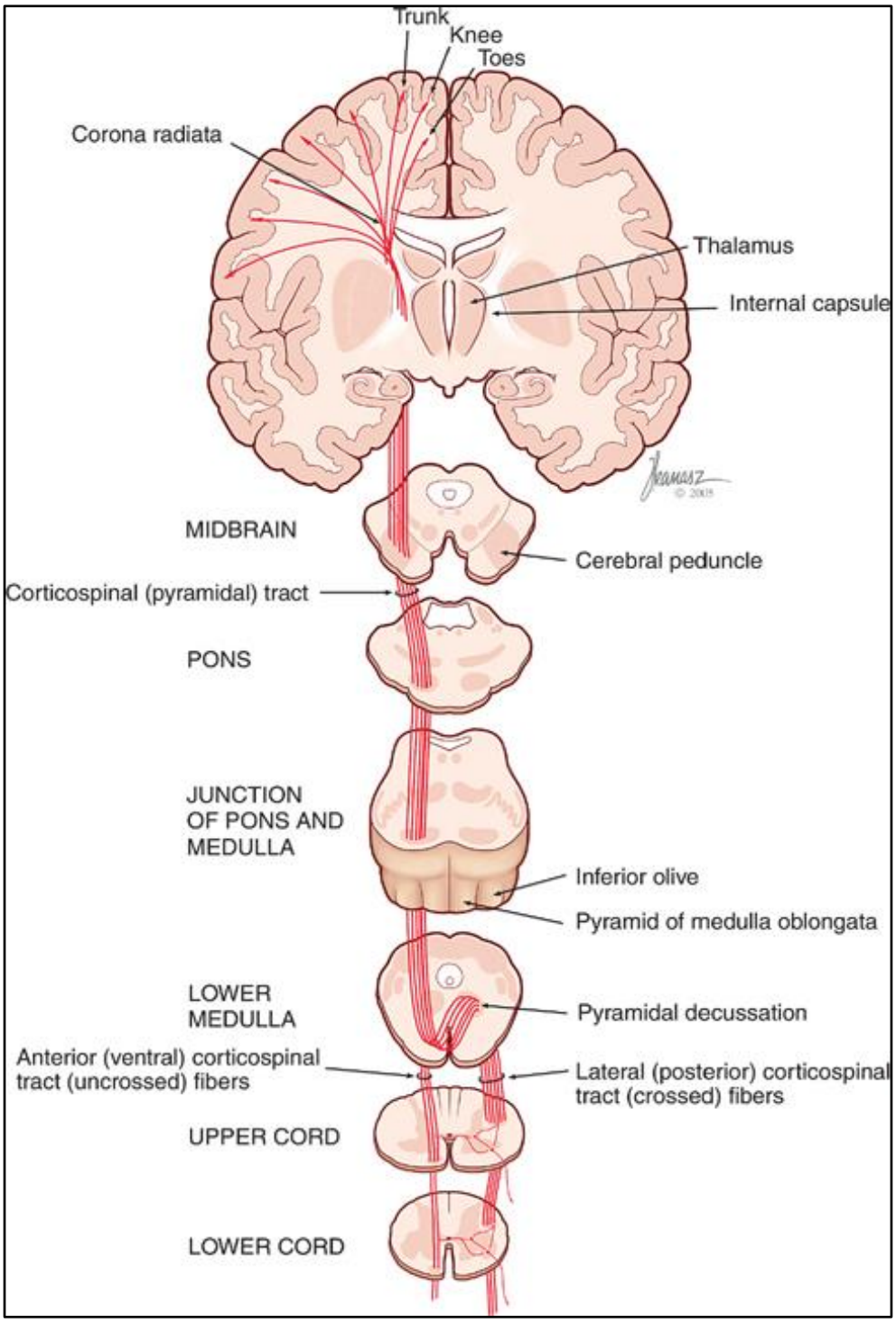

Figure 5-2: Corticospinal tracts

SENSORY PATHWAYS

I-FOR CONSCIOUS PERCEPTION:

1. Dorsal Column Medial Lemniscus pathway.
2. Spinothalamic tracts.

II-FOR UNCONSCIOUS PERCEPTION:

1. Spinocerebellar tracts
2. Spino-olivary tract
3. Spinotectal tract
4. Spinoreticular tract

Dorsal column–medial lemniscal pathway:

Mediates conscious appreciation of proprioceptive and tactile sensations

First-order neurons:

Cell bodies in the dorsal root ganglia. Axons project to the spinal cord and give rise to the following (Fig.5-3):

■ The **gracile tract** (medial) arises from sensory axons in the **lower extremities** and ascends the spinal cord and synapses on the **gracile nucleus**.

■ The **cuneate tract** (lateral) arises from sensory axons in the **upper extremity** and ascends the spinal cord and synapses on the **cuneate nucleus**.

- Since the **cuneate fasciculus** carries sensory axons from the upper extremity to the spinal cord, it does not exist **below T2 segment of the spinal cord**.

Second-order neurons:

■ Cell bodies of **gracile and cuneate nuclei** of the medulla. **Their axons** decussate in the medulla as **internal arcuate fibers(Fig.5-3).**

■ Then ascend in the **contralateral** side forming the **medial lemniscus.**

Third-order neurons:

Ventral posterolateral (VPL) nucleus of the thalamus. ⇨**posterior limb of the internal capsule** ⇨**primary somatosensory cortex** (Brodmann areas 3,1,2) in the postcentral gyrus

Anterolateral (spinothalamic tract) system

Carries pain, temperature, and crude touch sensations from the extremities and trunk.

First-order neurons:

Cell bodies in the dorsal root ganglia. Axons project to the spinal cord and ascend or descend a few levels within the tract of Lissauer.

Second-order neurons:

Substantia gelatinosa cells in the dorsal horn.

Axons ***decussate*** in the **ventral white commissure** and **ascend** in the ***contralateral*** ventral part of **lateral funiculus** forming **the spinothalamic tract.**

Third-order neurons:

Ventral posterolateral (VPL) nucleus of the thalamus ⇨**posterior limb of the internal capsule** ⇨**primary somatosensory cortex** (Brodmann areas 3,1,2) in the postcentral gyrus.

☞**Syringomyelia**

Involves enlargement of the central canal of the spinal cord, this lead to damaging the fibers of the spinothalamic tract (⇨the dicussating fibers). Syringomyelia results in a "belt like or "cape-like" loss of pain and temperature because it is most commonly localized in C8-T1 segments.

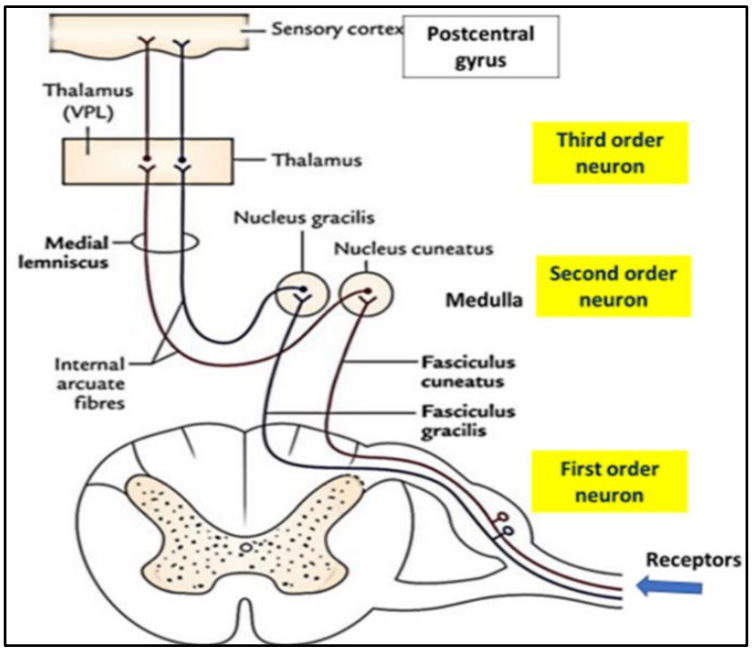

Figure 5-3: Dorsal column–medial lemniscus pathway

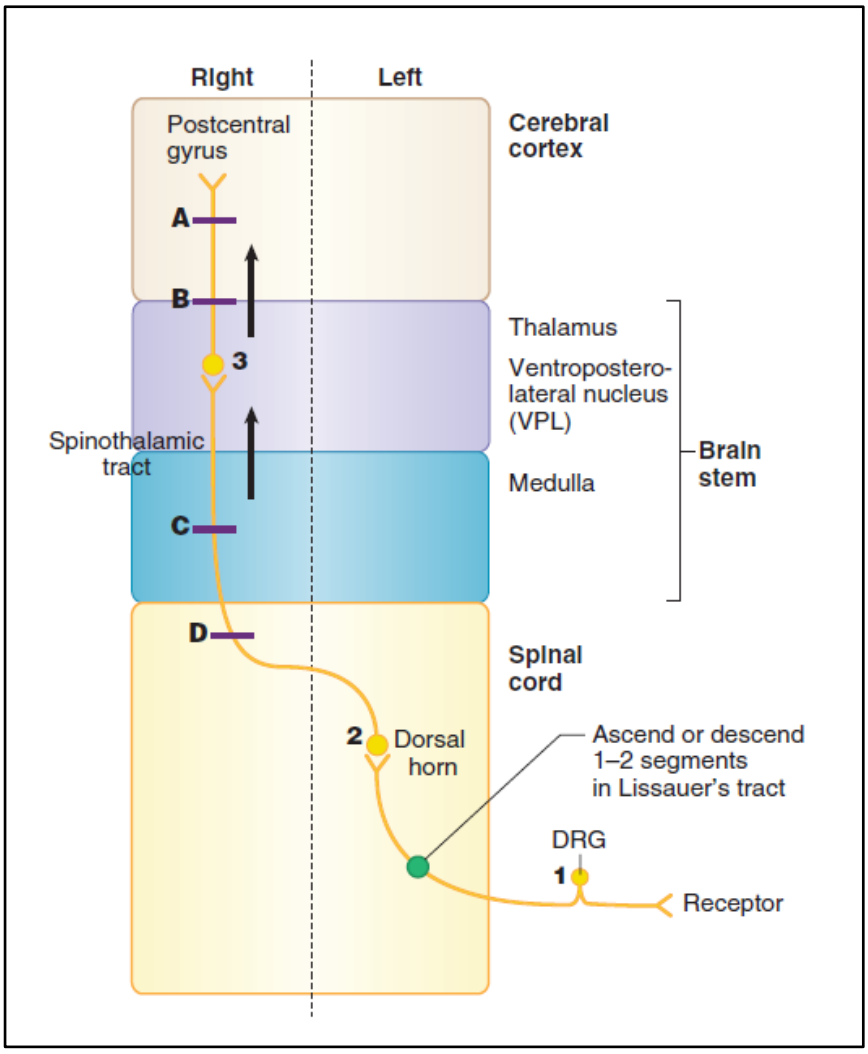

Figure 5-4: Spinothalamic tract

Sensory Pathways from head and face

Carried by trigeminal nerve ⇨Trigeminal ganglion ⇨trigeminal nerve nuclei ⇨axons from these nuclei cross to opposite side⇨form trigeminal *leminiscus* ⇨ **Ventral posteromedial (VPM) nucleus** of thalamus⇨ **primary somatosensory cortex.**

Spinocerebellar tracts (Fig.5-5).

They include:

1-The posterior spinocerebellar tract **2-The anterior spinocerebellar tract**

1-The posterior spinocerebellar tract

The first-order neuron, has its cell body in the posterior root ganglion.

The second-order neuron: nucleus dorsalis (Clarke's column) at the base of dorsal horn.

The axons of the second-order neurons enter the lateral white column on **the same side** and ascend the medulla oblongata, joins the **inferior cerebellar peduncle** and terminates in the **ipsilateral** cerebellar cortex(Fig.5-5).

2-The anterior spinocerebellar tract

The first-order neuron, has its cell body in the posterior root ganglion

The second-order neuron: cells at lamina VII in dorsal horn.

The axons of the second-order neurons enter the lateral white column on **the opposite side, ascend** through the brain stem where they **cross back before** entering the cerebellum via the superior cerebellar peduncle and terminates in the **ipsilateral** cerebellar cortex (Fig.5-5).

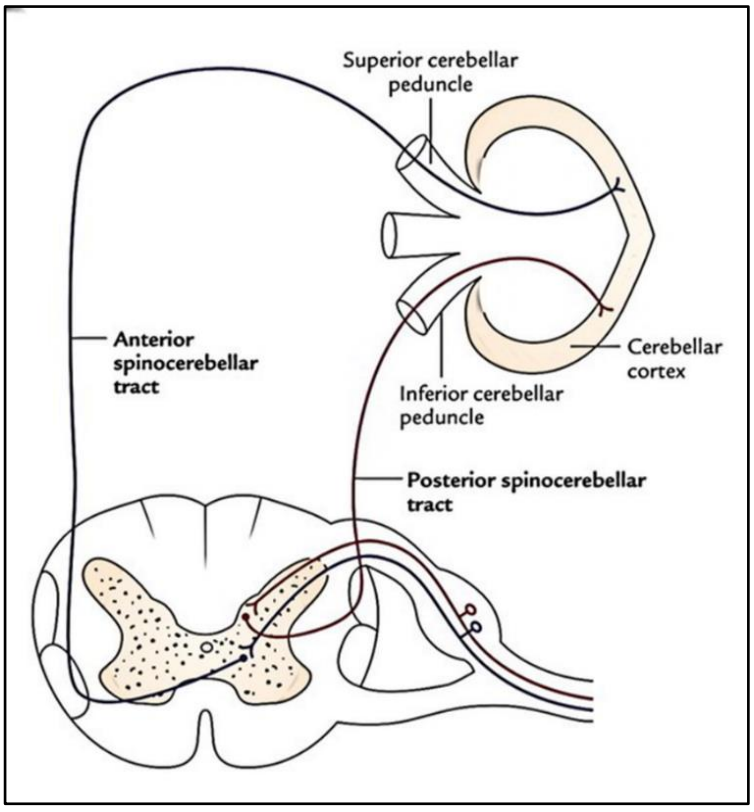

Figure 5-5: Spinocerebellar tracts

Anterior cord syndrome: caused by trauma, fracture dislocation of vertebrae, herniation of vertebral discs or occlusion of the anterior spinal artery. Presents with:

- Bilateral loss of pain and temperature that is carried by (lateral spinothalamic tract)
- Bilateral spastic paresis due to injury of corticospinal tract.
- The dorsal columns are spared