



# Central Nervous System

Sheet 4

Subject | Physiology

Done by | Tala Saleh

Correction | ...

Doctor | Loai Alzghoul



*In the previous lecture, we discussed some clinical aspects regarding the anterolateral system in general. Now, we will discuss it in more details:*

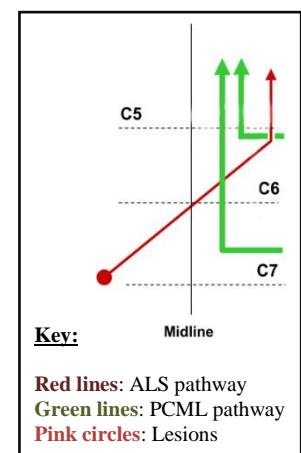
## Cont. Clinical Aspects

- In the ALS, the 1<sup>st</sup> order neurons arise from the sensory receptors in the periphery. They enter the spinal cord through the dorsal nerve root. After synapsing, 2<sup>nd</sup> order neurons ascend obliquely 2 vertebral levels as the decussate, and finally synapse in the ventral posterolateral nucleus of the thalamus.

In the PCML pathway, nerves directly enter the spinal cord and ascend in a straight line. Whereas in the ALS pathway, the pattern of '0-1-2' suggests that in the anterolateral tract:

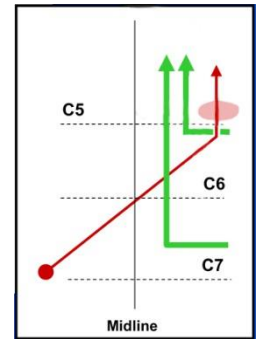
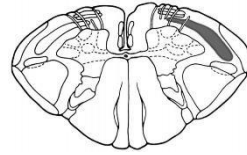
*'refer to the image'*

- ⇒ At level 0: the 1<sup>st</sup> order neurons enter the spinal cord at the level of C7 for example and synapse there.
- ⇒ At level 1: the 2<sup>nd</sup> order neurons' fibers keep ascending obliquely through the midline of C6.
- ⇒ At level 2: decussation finally ends at C5, which is 2 segments above the point of entry.



- **Example 1:** damage to the anterolateral tract of C5 segment.

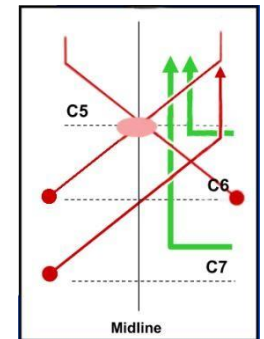
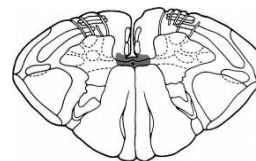
⇒ Fibers passing through the anterolateral tract at C5 will be the ascending fibers of C7 (2 levels below). This will cause loss of ALS sensations, on the contralateral side of the lesion, C7 and below.



- **Example 2:** damage to C5 at the midline.

⇒ Loss of ALS modalities of C6 on both sides.

**Note:** this represents **syringomyelia**, in which a fluid-filled cyst forms within the spinal cord. It lengthens over time and damages part of the spinal cord centrally.

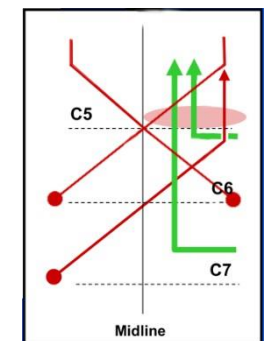
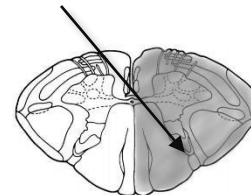


- **Example 3:** damage to the right half of the spinal cord at C5 causes:

- 1- Loss of ALS modalities on the left side, C6 and below.
- 2- Loss of PCML modalities on the right side, C5 and below.
- 3- Damage to the entry zone of 1<sup>st</sup> order neurons will cause loss to both PCML and ALS sensations at the level of C5 on the right side.

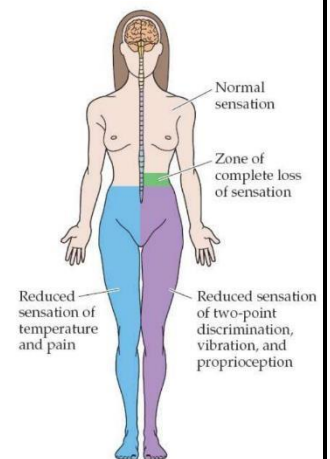
**Note 1:** This represents Brown-Séquard syndrome, which is caused by damage to one half of the spinal cord, i.e. **Hemisection** of the spinal cord.

**Note 2:** Notice that the affected central area in this example is **not fully** damaged as in example 2; only half of it is. Thus, only the fibers ascending from C6 on the left side are affected **sparing the right side** 'refer to the image'.



⇒ **Rule:** Hemisection damage to the spinal cord causes:

- 1- Complete loss of sensations at the level of the damage **ipsilaterally**.
- 2- PCML sensations loss **ipsilaterally** all the way below the damage.
- 3- ALS sensation loss **contralaterally** all the way below the damage.



# The Trigeminal System

- The general senses of somatosensation for the **face** travel through the **cranial nerves**, specifically, the **trigeminal system**.
- The trigeminal pathway carries somatosensory information from the face, head, mouth, and nasal cavity. As with the previously discussed nerve tracts, the sensory pathways of the trigeminal pathway each involve three successive neurons:

## 1- First-order neurons:

Fibers of the first-order neurons passing through the **trigeminal ganglion** enter the brain stem at the level of the **pons** (not at the level of the spinal cord as in other previously discussed systems). These axons project to the **trigeminal nuclei** to synapse with the 2<sup>nd</sup> order neurons cell bodies. There are 4 major trigeminal nuclei, we will discuss 2 of them:

a- **The spinal trigeminal nucleus** in the **medulla** receives **ALS** modalities, similar to those carried by the spinothalamic tract, such as pain and temperature sensations.

b- **The chief sensory nucleus** in the **pons** receives **PCML** modalities, similar to those carried by the dorsal tracts, such as two-points discrimination and pressure.

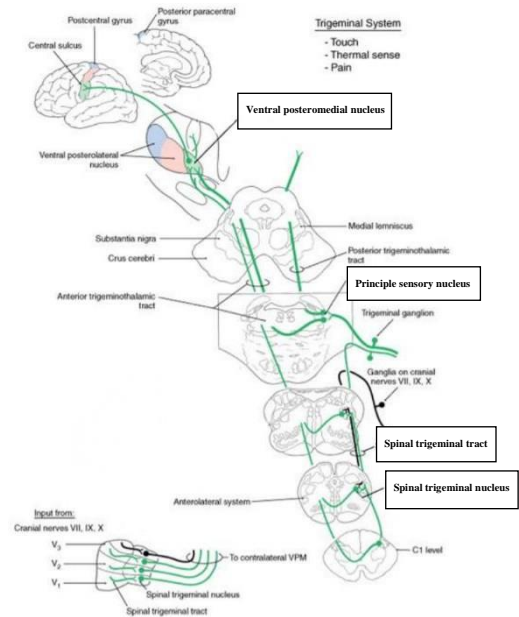
**Note:** the chief sensory nucleus is also known as the main/principle sensory nucleus.

## 2- Second-order neurons:

Axons from the second neuron leave their respective nucleus, decussate and ascend to the **thalamus** along the **trigeminothalamic tracts**. In the thalamus, each axon, in its particular pathway, synapses with the 3<sup>rd</sup> neurons cell bodies in the **ventral posteromedial nucleus** (in the PCML and ALS pathways, they synapsed in the VPLN).

## 3- Third-order neurons:

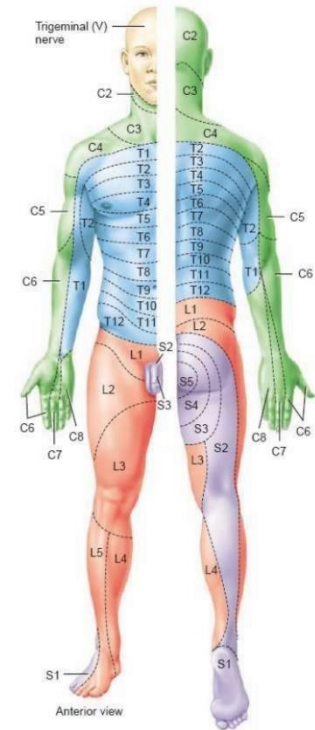
Axons from the third neuron then project from the thalamus to the **primary somatosensory cortex** of the cerebrum.



## Dermatomes

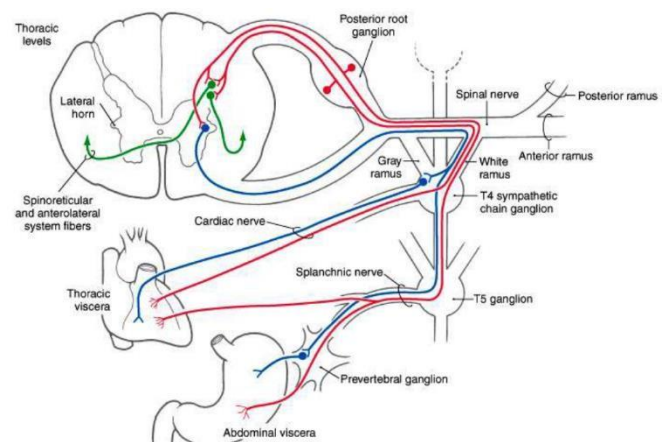
- A dermatome is the area of the skin of the human anatomy that is mainly supplied by branches of a **single spinal sensory nerve root**.
- Most important dermatomes to memorize are:

Organ	Dermatome
<b>Shoulder</b>	C5 - C6
<b>Hand</b>	(C6-C8): 6= thumb, 7= index, 8= small finger
<b>Nipple</b>	T4
<b>Umbilicus</b>	T10
<b>Inguinal region</b>	T12 - L1
<b>knee</b>	L3 - L4
<b>The big toe</b>	L4 - L5
<b>Small toe</b>	S1
<b>Genitalia and anus</b>	S4 - S5



## Visceral sensory and Referred pain

- Visceral sensory neurons transmit conscious sensations arising from the **viscera**, which can be pain, bloating, dyspnea, etc.
- Visceral pain is **referred** to other, often **remote**, locations. It is **diffuse** and **poorly** localized.
- Referred pain is presumed to occur because the information from **multiple** nociceptor afferents (body surface and visceral) usually **converges** onto individual spinothalamic tract neurons.
- The brain, therefore, interprets the information coming from visceral receptors as having arisen from receptors on the **body surface**, since this is where nociceptive stimuli originate **more** frequently.



*This picture shows how the pain from each visceral organ (color-coded) is referred to a specific area of the body's surface.*

*(memorize)*

