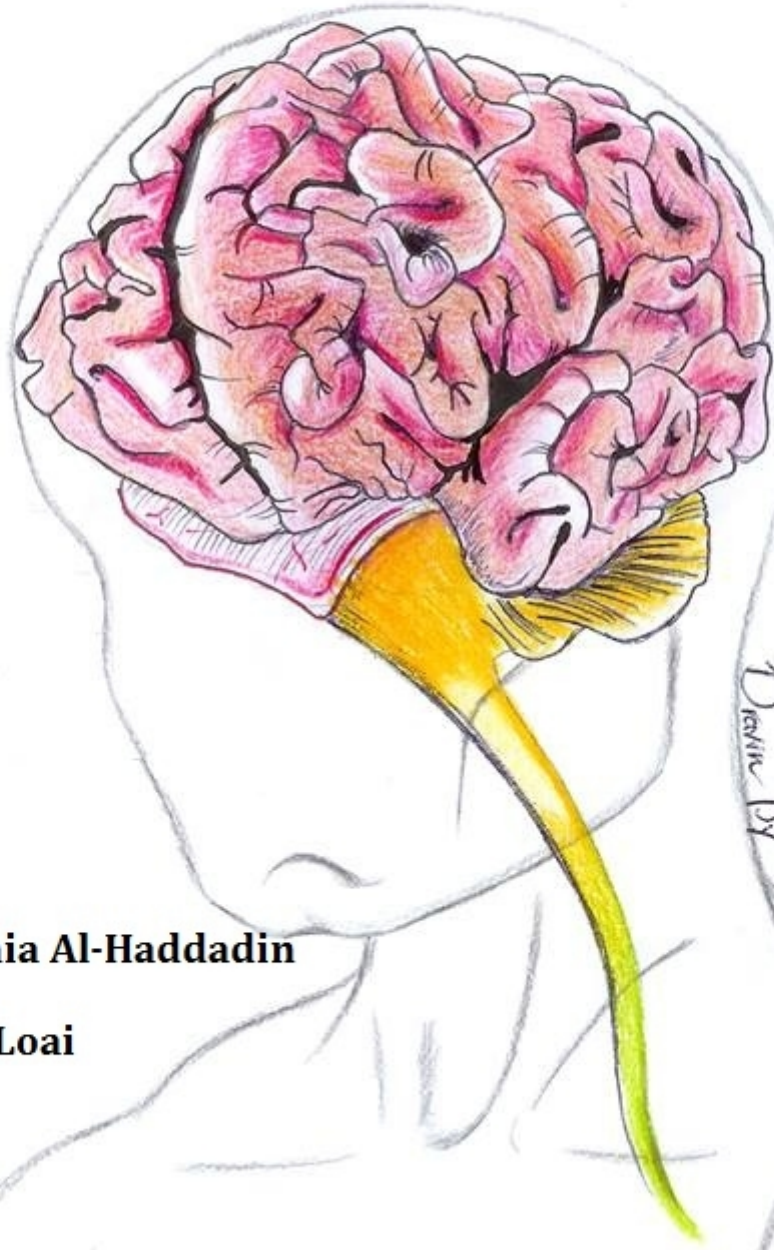


CENTRAL NERVOUS SYSTEM

- Handout
- Sheet
- Slide

- Anatomy
- Physiology
- Pathology
- Biochemistry
- Microbiology
- Pharmacology
- PBL



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Lec #: **6**



Dermatomes

This sheet should be easy the doctor only talked about three topics (Dermatomes, Referred Pain and Trigeminal System). I included some photos from the slides.

Dermatomes : An area of the body (skin) that is supplied by single spinal nerve.

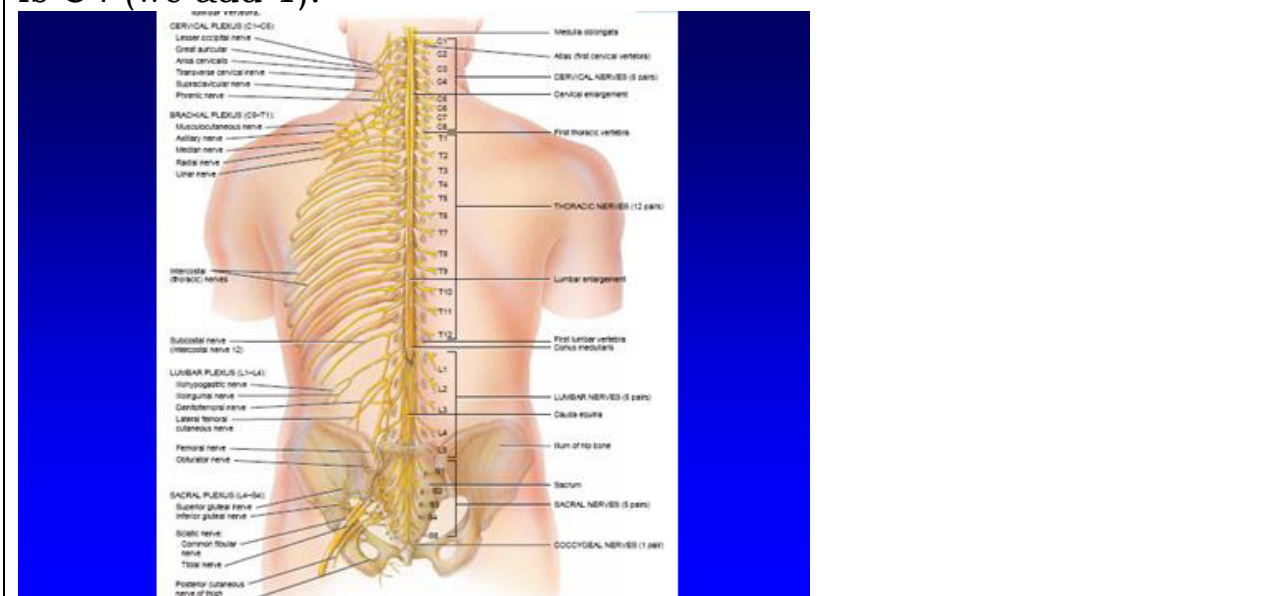
**So if a lesion happens to that specific spinal cord the patient might loss the sensation of the area that is supplied by this nerve.

Remember

The information is carried from different parts of the body to the CNS by the right and left spinal nerves that enter the spinal cord and then the impulses continue to higher levels.

The spinal nerves are named according to the vertebrae that the nerve passes near it, except in the cervical region we have extra one (7-vertebrae 8-nerves).

So the nerve under the third thoracic vertebrae is T3, under the second lumbar vertebrae L2, BUT under the third cervical vertebrae is C4 (we add 1).



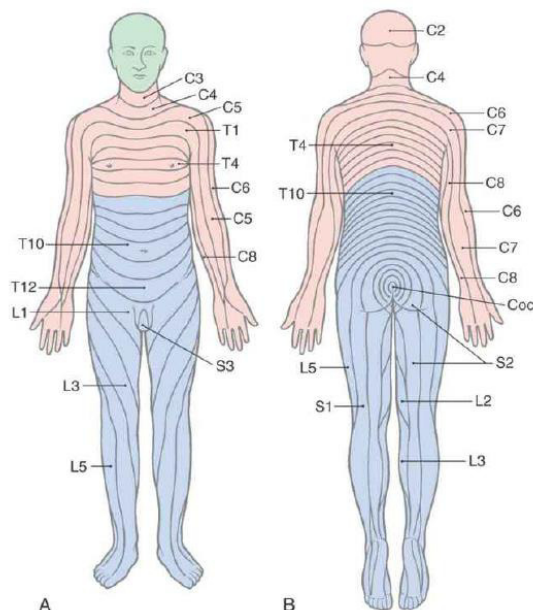


If we take one spinal nerve and follow from where it brings the sensation (which part of the body) and we draw that area, we will find that each part of the body is represented by specific spinal nerve and they are almost uniform in all humans.

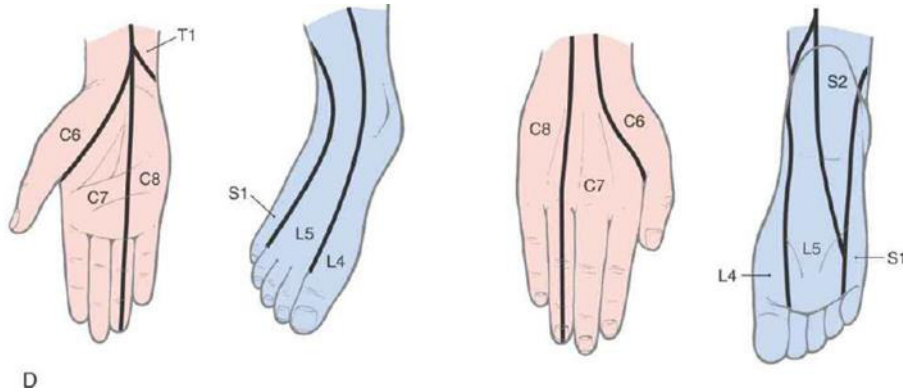
It is important to know each area to which spinal nerve is related (dermatomes): (you have to memorize them all (** the doctor mentioned them))

Dermatomes are important in the clinical aspect because they can tell you which nerve is injured and where.

- Shoulder (C5-C6)
- **Hand (C6-C8): 6= thumb the, 7= index finger, 8= small finger
- ** Nipple (T4),
- **Umbilicus (T10),
- Inguinal region (T12-L1),
- Along the pelvic rim L1
- **knee (L3, L4),
- **The big toe (L4-L5)
- The genitalia and anus (S4 and S5)



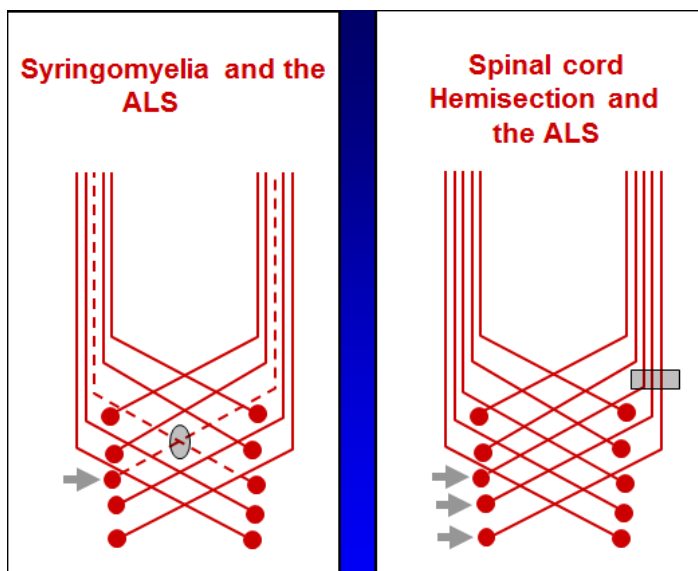
These photos from the book



(Small revision) **Anterolateral System {ALS}**

The anterolateral (spinothalamic) system transmits somatosensory information about pain, temperature, and light touch. In the anterolateral system, first-order neurons have their cell bodies in the dorsal horn (gray matter) and synapse on thermoreceptors and nociceptors in the skin. The first-order neurons synapse on second order neurons in the spinal cord. In the spinal cord, the second-order neurons cross the midline and ascend to the contralateral thalamus. In the thalamus, second order neurons synapse on third-order neurons, which ascend to the somatosensory cortex.

Axons usually ascend while crossing from one side to the other so they don't ascend in a direct way. (you can see that in the diagram below)





***So if we damage the gray area of the spinal cord at the level of the vertebrae the effect (lose of sensation) on the body would be ipsilateral but if we damage at the fiber level we will lose the sensation on the contralateral part from the damage down.

e.g the sensation of the thumb will be transmitted through C6 by the spinal nerve to the spinal cord at the level C6, by crossing the nerve we ascends so the midline (syringomyelia) won't be at C6 but a bit higher at C5, and the axon will join the fiber bundle at even higher level C4.

***There are variations between humans. Also, variation in the books so most books (the most recommended) →(0-1-2) (we call it 2 steps) (2 levels)

(0)C6 - enter spinal cord (ipsilateral)

(-1)C5- midline (crossing to the other side)

(-2)C4- joining the bundle pathway

**Other Books (only one step)(0-1)(one level) →

(0)C6 - enter spinal cord (ipsilateral)

(-1)C5- midline (crossing to the other side/ contralateral) even if after the midline by 1mm we still consider it C5.

(The doctor will stick to what we take in anatomy on this point (one level or two) so you don't have a conflict between anatomy and physiology)

Visceral sensory & referred pain

Remember the line theory in the first lectures

So the brain doesn't understand whether it's a leg or hand but from where the information is sent.

Through the development and early life, pain from the thumb → the action potential (impulses) would be sent through C6 to the brain that will connect

these impulses to what happened on the finger after a while any stimulation of C6 will be understood in the brain as pain from the thumb.

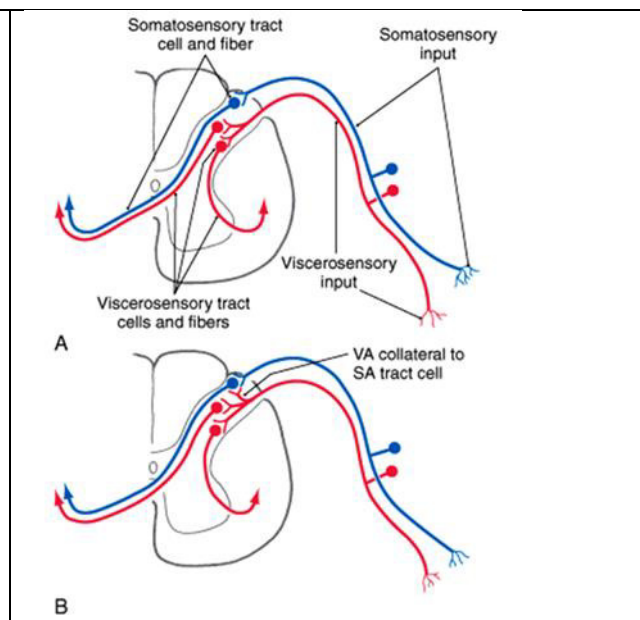
Experimentally if we stimulate C6 even if there is nothing affecting the finger the brain will interrupt the information that there is pain from the thumb. Also, if the hand is cut and we stimulated C6 → the brain will understand it as pain from the finger.

**Visceral organs will send information also to the brain (spinal nerves → spinal cord → higher levels of control)

** if we have a hypothetical visceral organ (organ X) that sends it information through the spinal nerve C6 so when we have pain in this organ its spinal nerve will be activated and the brain will understand that which organ in my body is hurting ??? → The brain will think that the thumb is hurting.

So VISCERAL Pain is usually → REFERRED Pain ... that will refer on one or more of the dermatomes depending on how strong the pain is and through which spinal nerves. (You can check page 262 on this topic)

You can see both somatosensory and viscerosensory input at the same spinal nerve.

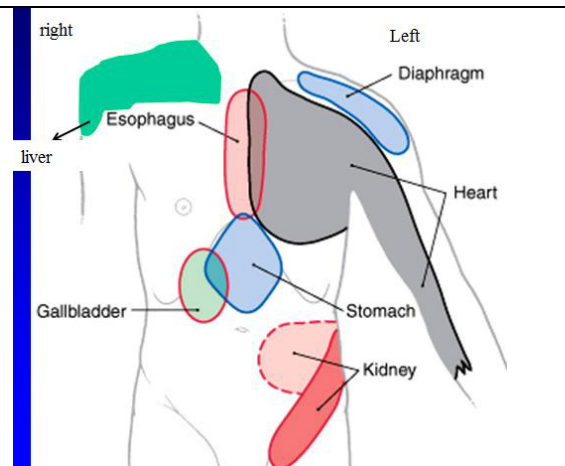


You must differentiate between “Referred pain” and “Radiated pain”:

Radiated pain is a more complex phenomenon mainly due to sensitization to more than one level of the spinal cord.(radiculitis, is pain "radiated" along the dermatome (sensory distribution) of a nerve due to inflammation or other irritation of the nerve root (radiculopathy) at its connection to the spinal column.(wiki)/ extension of pain from original site to another site with persistence of pain at original site.)

Referred pain is that the visceral organs will refer to part of the body depending on which spinal nerve they use to conduct information. (Also called reflective pain, is pain perceived at a location other than the site of the painful stimulus.(wiki))

this photo is from the book, it's very simple. Every visceral organ and where its referred pain.



If the patient has a very bad urinary tract infection (up to the kidney) the pain will refer to pain the back, so the patient might go to the pharmacy and buy pain relievers or someone will tell him your pain is due to carrying heavy things or stretching your back. Until the situation becomes WORSE and he goes to a doctor that will tell him “it’s a referred pain due to kidney infection”

Trigeminal system

(Carry all the sensation modalities from the face to the brain). The same type of sensation and modalities (pain, touch, thermal, two point discrimination,...) that happen in body happen in the face and oral cavity.



The information must be sent to cortex and higher levels of control. There is no point in making the impulses travel for a longer distant to the spinal nerves SO the nerve impulses are delivered directly to brain stem through the “cranial nerves” e.g trigeminal nerve.

**The Sensations modalities divide to more than one pathway that has different type of processing and different target and reason.

The trigeminal system in the brain stem extend to almost all parts of the brainstem and is divided to 4 parts (4 nucleus) :

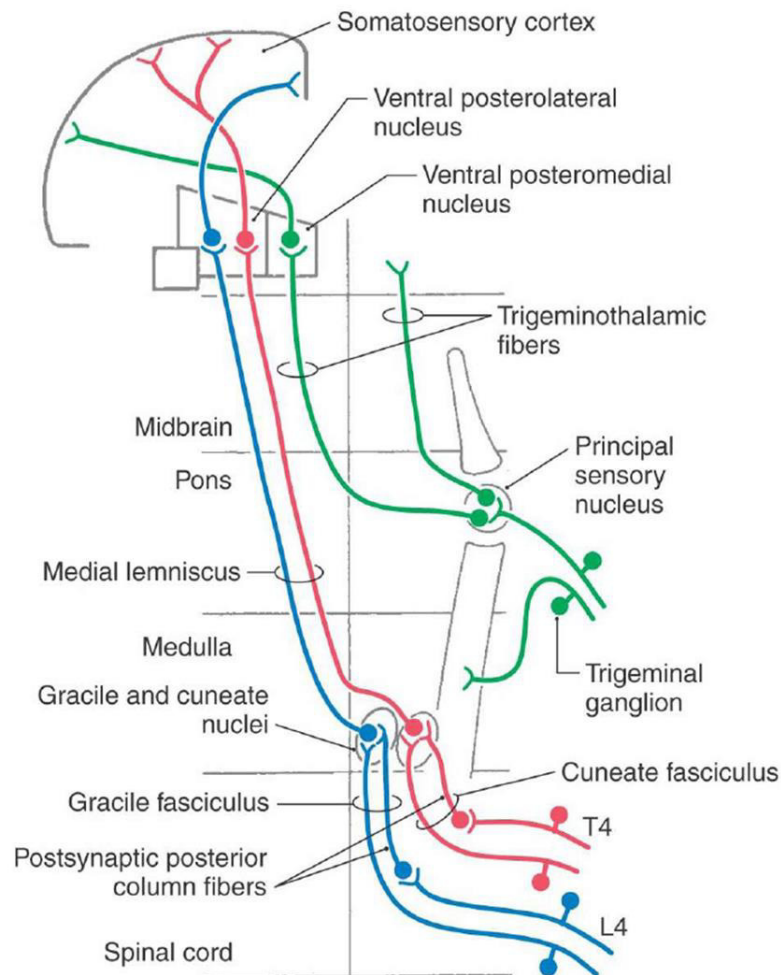
- 1- PCML
- 2- ALS
- 3- Motor nuclei (for motor function of trigeminal)
- 4- 4th nuclei is mainly for processing associated with reflexes and proprioception (like the role of the spinal cord as a part of CNS)

1) **PCML (Posterior Column-Medial lemniscus Pathway)** : -the same principle as the somatosensory-

The neurons are pseudo-unipolar neurons so the dendrites bring the information to cell body and the axon send impulses and synapses directly in the nucleus where the first order neuron synapse with the second order neuron (so it doesn't have to travel a large distance) then it ascends to the thalamus then the second ascends to synapse with the third order neuron in the somatosensory cortex.

- Function → 2-point discrimination - Vibration – Proprioception

***This nucleus is found in the middle part of the trigeminal system in the pons and is called (PRINCIPAL SENSORY NUCLEUS/ CHEF TRIGEMINAL NUCLEUS).



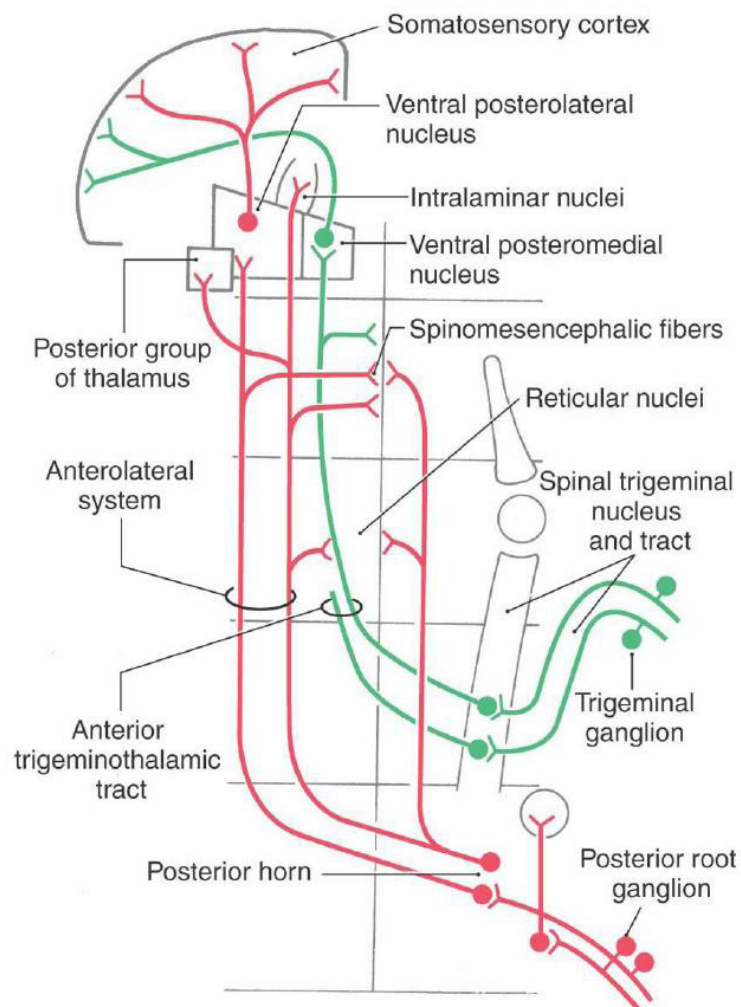
2) **ALS (Anterolateral system)** : -the same principle as the somatosensory-

The neurons are pseudo-unipolar neurons so the dendrites bring the information to cell body and the second part of the bifurcation of axons will enter the brain stem and the part responsible for them is found in lower part of the medulla, so the fibres will descend a little then synapses with the second order neuron then it crosses to the thalamus then the second ascends to synapse with the third order neuron in the somatosensory cortex.

- Function → Crud touch (itch & rub) -Temperature - Pain

***This nucleus is found in the caudal (lower) part of the trigeminal system in the medulla and is called (SPINAL TRIGEMINAL NUCLEUS AND TRACT).

**Caudal part of the medulla is formed from more than one division, somatotopic organization (then the doctor said if we did not take it in anatomy and we didn't :/ so he won't talk about it but it is found in the brain) so just know that the caudal/spinal part of the medulla are the one in charge.



In the thalamus:

*Somatosensory (body impulses) travel to → posterior part of the thalamus (ventral posterolateral nucleus).



*Face impulses travel to → more medial way in the thalamus (ventral posteromedial nucleus).

In the cortex: the same somatosensory cortex (postcentral gyrus) – feet/legs on the medial side then trunk/hands/face on the lateral.

Other two nucleuses:

3) **Motor nucleus** which is found in the pons near the Chef sensory nucleus.

4) Rostral part of the trigeminal the biggest part of the mid brain (**Mesencephalic nucleus**) responsible for the processing, reflexes and the information of proprioception (only).

* In contrast to other sensation/modalities where the ganglion and the cell bodies are found outside the brainstem but here the other part of the axons, the cell bodies of first order neuron are found in the mesencephalic nucleus and its neurons are pseudo unipolar neurons that receives sensation and send them to second order in the chef sensory nucleus neurons that follows the pathway of PCML (go to the centers related to the processing e.g. reflexes (mainly). –the only difference is that the ganglion and cell body here is found in the nucleus-

Function of proprioception: reflexes, controlling, and feedback information for motor nuclei.

So quick revision the trigeminal system is found in midbrain, pons and medulla and every part of the brain stem contain certain part of this system. **May cross to the other side or stay ipsilateral.**

*** These were the main sensory pathways but we have other small pathway but we skip them because they make the small less amount of clinical association of the pathway.. e.g. PCML while ascending gives collateral pathways and the spinal cord will send these impulses in multisynaptic pathway.



BUT if we lose the PCML (the tract get damaged) the patient will gain some sensation back after a while (6months- 1-2 years) due to the existence of these smaller pathway. → These is considered a good effect

Whereas spinalcervical thalamic tract alternative pain pathway for ALS , so if we remove the ALS the pain supposed to be gone but due to activation of these pathways the pain will retain.

YOU HAVE TO STUDY THE FOLLOWING OTHER PATHWAYS FROM THE BOOK:-

Posterior Spinocerebellar Tract

Cuneocerebellar Tract

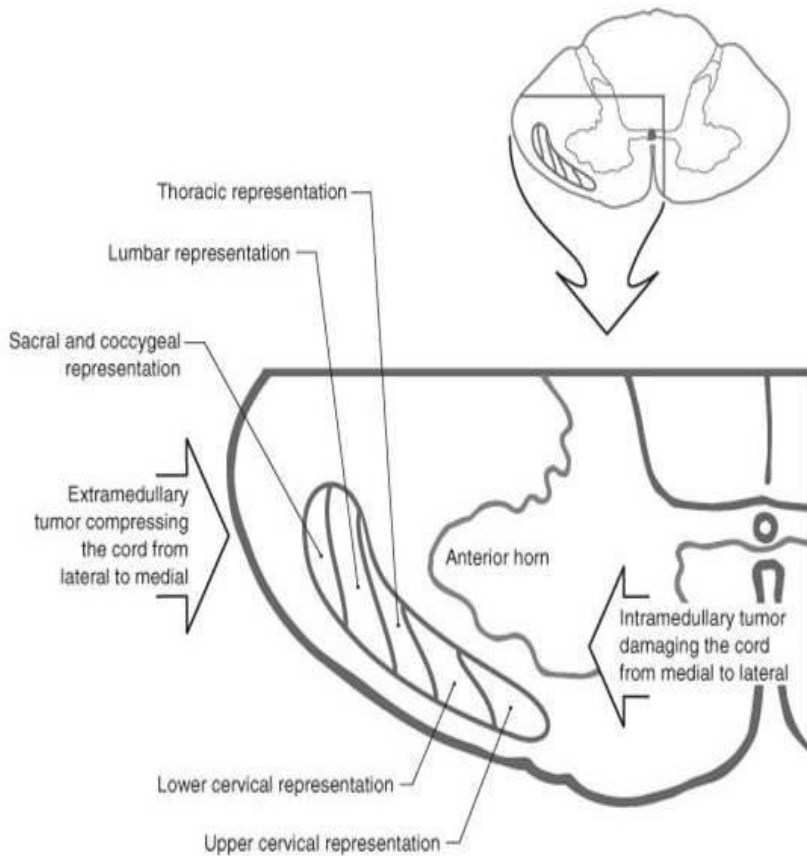
Anterior Spinocerebellar Tract

Rostral Spinocerebellar Tract

******They carry the information to the cerebellum (that takes the information from PCML/proprioception/ other modalities) (cerebellum is responsible for the analysis and coordination of the movement of motor and the movement of tracts that's targeting pain directly other than pass to the thalamus and cortex). Then main problem if these pathway where damaged is **ataxia**.

***** Somatotopic organization** (which fibers that carry impulses (bundle) are for the trunk, hand and lower limb) it can be for the cortex or ALS or PCML. (check the figure below).

Extramedullary tumor	Compress the cord from lateral to medial	Affected lower limb (lose of sensation)
intramedullary tumor	Compress the cord from medial to lateral	Affected upper limb (lose of sensation)



Slide 22 “**TERMINOLOGIE**” YOU NEED TO MEMORISE THEM.

Sorry for any mistake I tried my best to include everything the doctor said during the lecture (but you know how physiology lectures are!!)

Shout out to AlHaddadins ... MEDTEAM ... Mafia ... Duha ... Aseil <3

**Past papers:**

1. During routine neurological examination for one of your patients, you noticed that she have a defect in her jaw-jerk reflex, but no sensory problems. Which of the following parts of the trigeminal system most probably has a lesion?
 - A. The trigeminal ganglia bilaterally
 - B. The principle trigeminal nucleus bilaterally
 - C. Rostral trigeminal nucleus bilaterally
 - D. Middle trigeminal nucleus bilaterally
 - E. Caudal trigeminal nucleus bilaterally

2. After a busy weekend of painting his house, a 62 year old man experience intense pain in his arm. The pain resolves over the next few weeks and only a mild tingling sensation remains, localized to his thumb and forefinger. Which spinal nerve this localized sensation involve?

3. During a routine neurological examination of a 57 year old man, you place a quarter in his right hand wuth his eyes closed. He is able to tell you that it is a coin and is cool to the touch, but he is not able to tell you what type of coin it is (5 piasters, 10 piasters or a quarter...). This most likely indicate a lesion in which of the following?
 - A. Anterolateral system
 - B. Basilar portion of the pons
 - C. Posterior column system
 - D. Crus cerebri of the midbrain
 - E. Primary somatosensory cortex

4. A 40 year old man complains of decreased pain sensation that started eight months ago in his left foot and now it is also in his left hand. MRI shows a tumor within the vertebral canal in mid-cervical levels. Which of the following is best describing to the case?
 - A. An intra-medullary tumor located inferior (anterior) to the denticulate ligament on the left and compressing the cord from medial to lateral
 - B. An intra-medullary tumor located superior (posterior) to the denticulate ligament on the right and compressing the cord from medial to lateral
 - C. An extra-medullary tumor located inferior (anterior) to the denticulate ligament on the right and compressing the cord from lateral to medial



- D. An extra-medullary tumor located inferior (anterior) to the denticulate ligament on the left and compressing the cord from lateral to medial
5. A 92 year old woman is brought to the emergency department by her caretaker. The woman had suddenly become drowsy and confused. The examination revealed no cranial nerve deficits, age-normal motor function, but a loss of pain, thermal, vibratory and discriminative touch sensations on one side of the body excluding the head. CT shows a small infarcted area. Which of the following structures is the most likely location of this lesion?
- A. Anterolateral system
 - B. Medial geniculate nucleus
 - C. Subthalamic nucleus
 - D. Ventral posterolateral nucleus
 - E. Ventral posteromedial nucleus

Answers:

- 1. C
- 2. C6
- 3. C
- 4. D
- 5. D