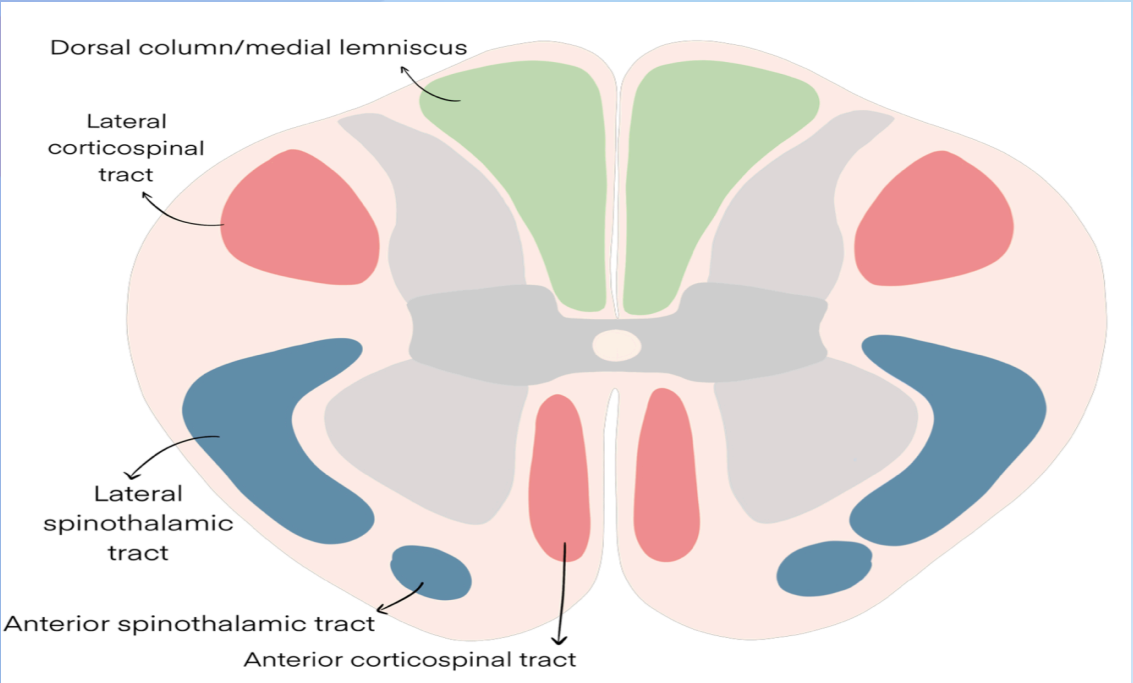


# Spinal tracts

**Nerve tract – neural pathway which consists of groups of nerve fibers carrying the information between various parts of the CNS**



# Definitions

**Ganglion** – group of the neuron cell bodies in the **PNS**

**Nucleus** – group of the neuron cell bodies in the **CNS**

**Dorsal = posterior**

**Ventral = anterior**

**Ipsilateral = on the same side**

**Contralateral = on the opposite side**

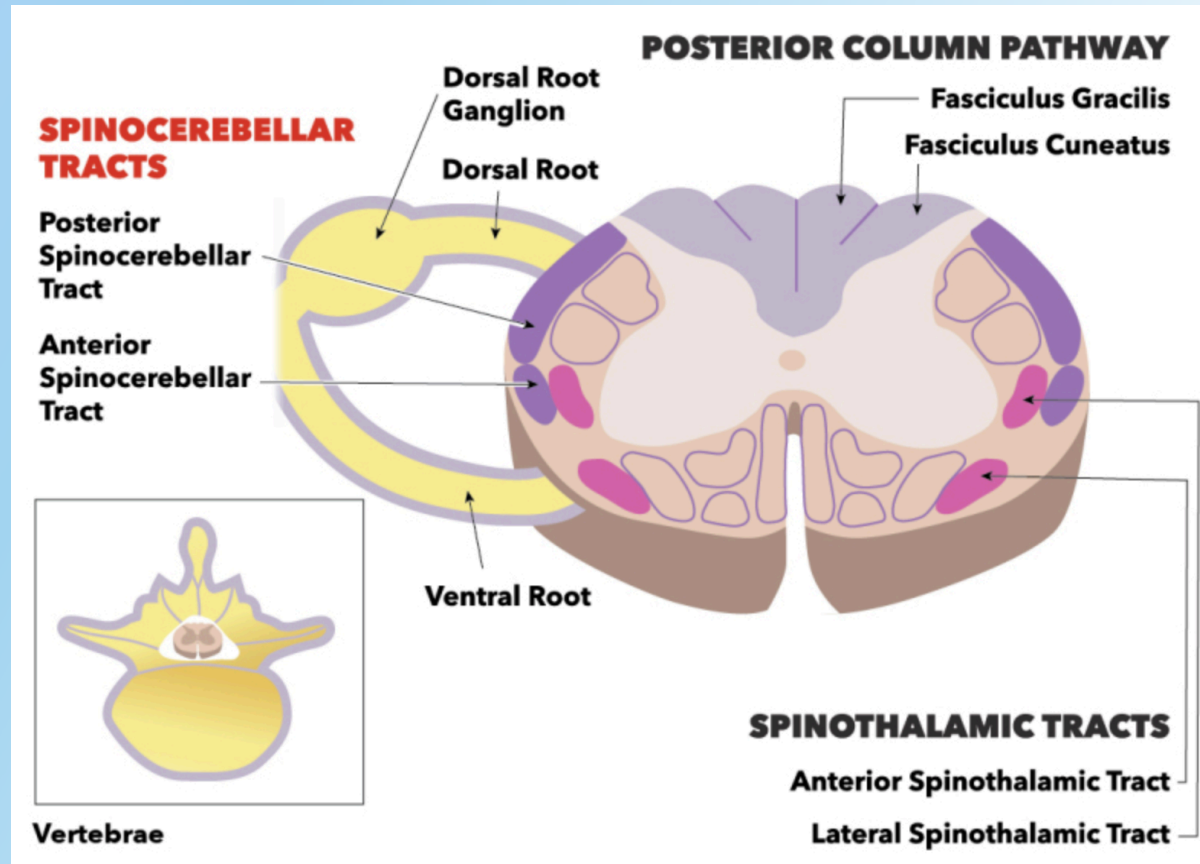
**Decussation – crossover of nerve fibers**

**! CLINICAL SIGNIFICANCE !**



# Sensory (ascending) tracts

1. Spinothalamic
2. Dorsal column-medial lemniscus
3. Spinocerebellar

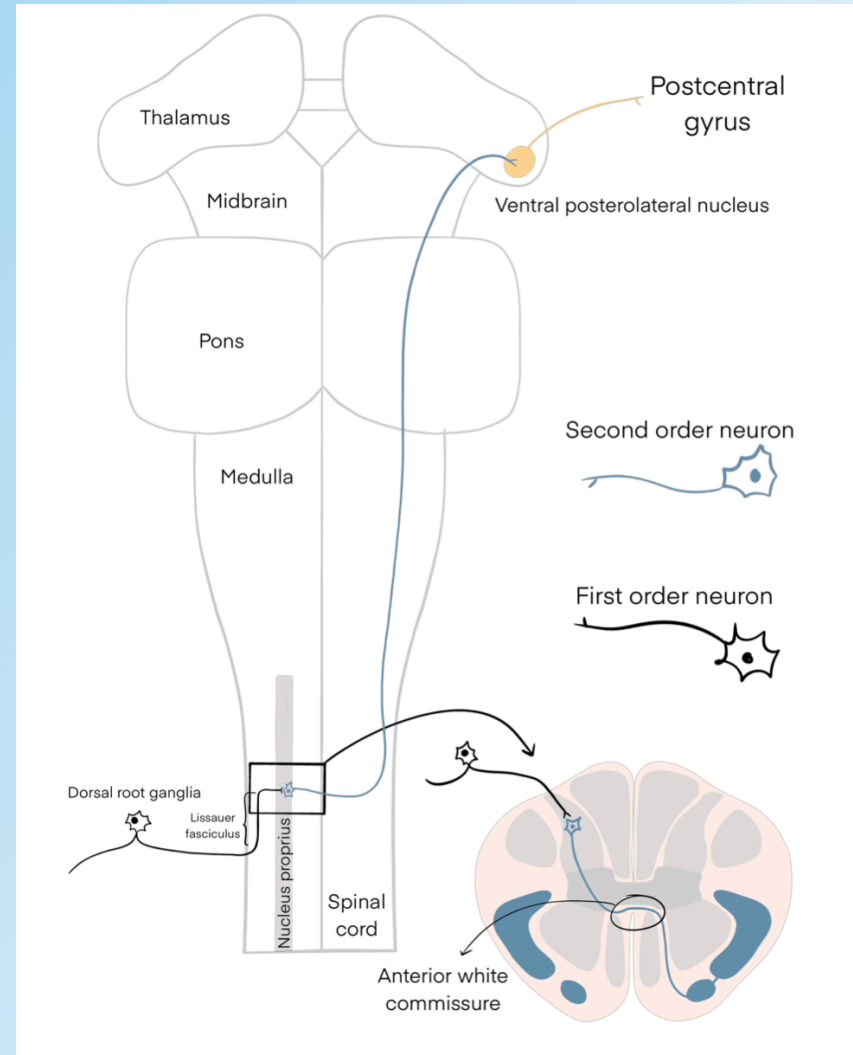


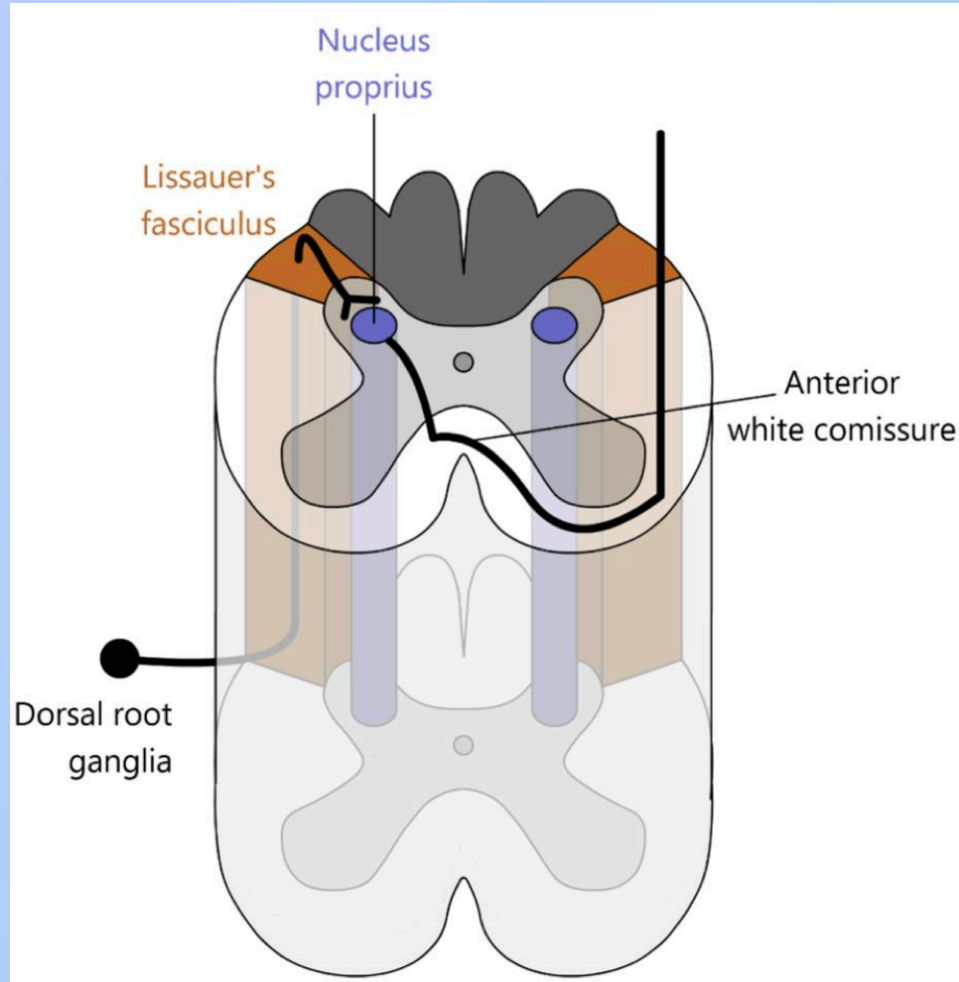
# Sensory (ascending) tracts

<b>First</b> order neuron	Dorsal root ganglion ( <b>DRT</b> )
<b>Second</b> order neuron	Medulla (DCML) OR spinal cord (spinothalamic) Axon <b>deccusates</b>
<b>Third</b> order neuron	<b>VPL</b> of the thalamus
Primary somatosensory cortex	<b>Postcentral gyrus</b> of the parietal lobe (Brodmann area 3,1, 2)

# Spinothalamic tract (anterolateral)

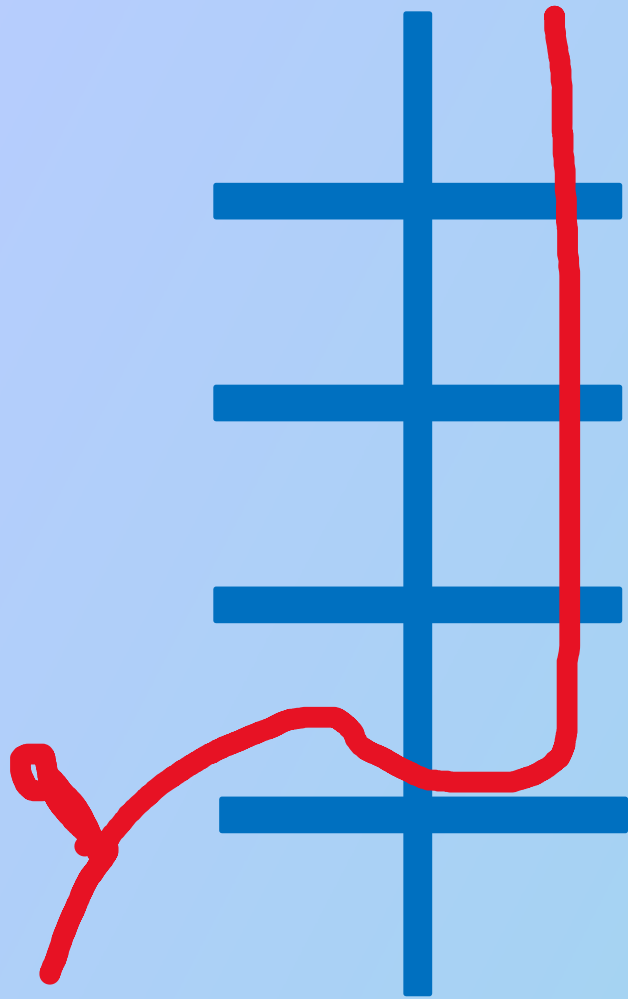
- **sPinoThalamiC tract**
- **Primitive sensation**
- **Lateral spinothalamic:**
  - Pain
  - Temperature
- **Anterior spinothalamic:**
  - Crude touch



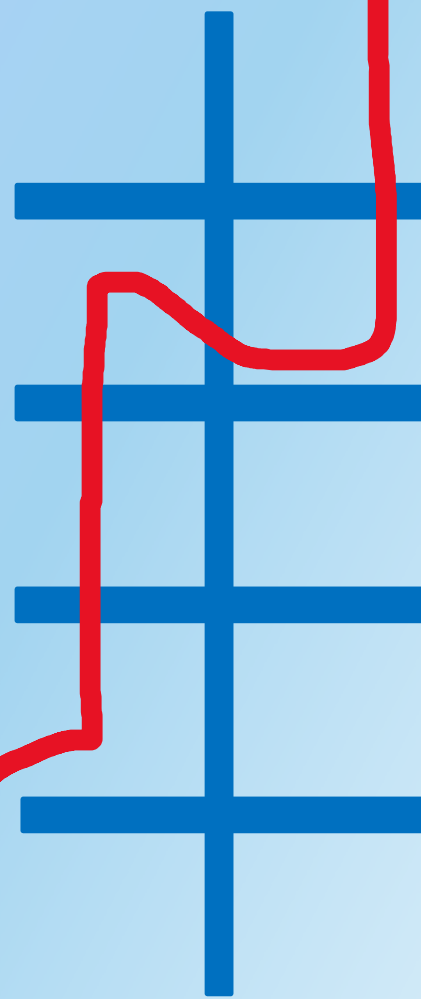


- **1<sup>st</sup> order neuron: DRG** (collects sensory information from the receptors)
- Fibers of the 1<sup>st</sup> order neuron will ascend or descend (1-2 segments) in the **Lissauer's fasciculus** (located at the tip of the grey horn)
- **2<sup>nd</sup> order neuron:** located in **posterior horn of the grey matter** (nucleus proprius or substantia gelatinosa)
- **Decussation: anterior white commissure**
- **Ascends on the contralateral side**
- **3<sup>rd</sup> order neuron:** Ventroposterolateral nucleus of the thalamus

# Lissauer's tract



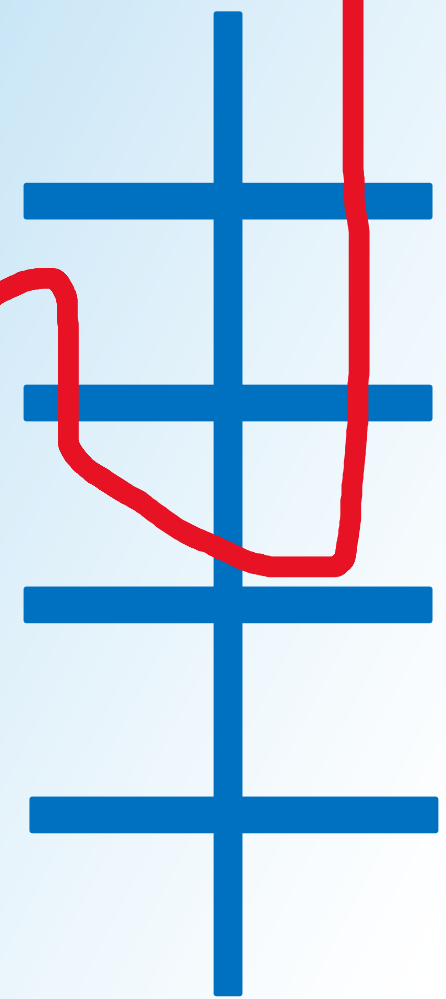
C5



C6

C7

C5



C6

C7

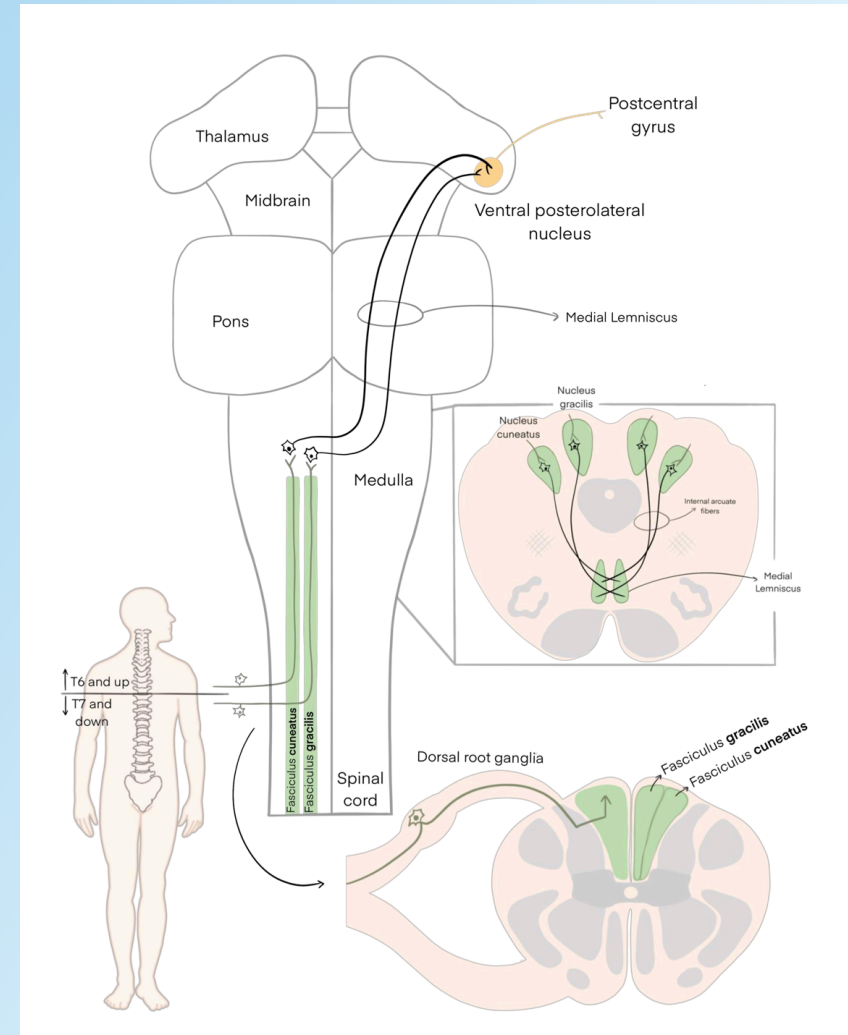


## Spinothalamic tract

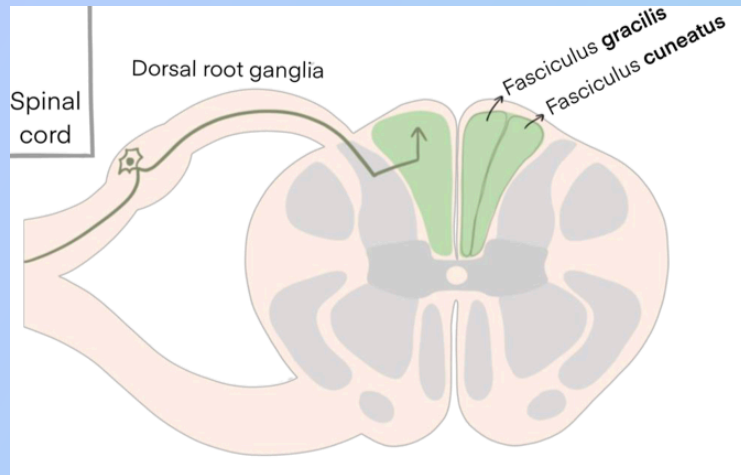
<b>Type of sensation</b>	Primitive ( <b>pain, temperature</b> , crude touch)
<b>Location of neurons</b>	1 <sup>st</sup> order neuron: DRG 2 <sup>nd</sup> order neuron: posterior horn of the grey matter (nucleus proprius and substantia gelatinosa) 3 <sup>rd</sup> order neuron: VPL
<b>Decussation</b>	Anterior white commissure
<b>Ascends</b>	<b>Contralateral side</b> (from the receptor)
<b>Destination</b>	Primary somatosensory cortex (postcentral gyrus)

# Dorsal column-medial lemniscus

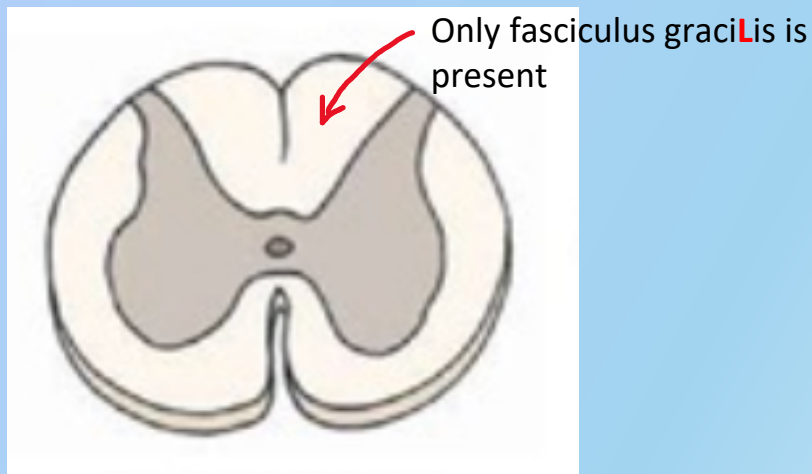
- Spinobulbothalamocortical tract
- Precise sensation
- Pressure, vibration, fine touch
- Conscious proprioception



T6 and above

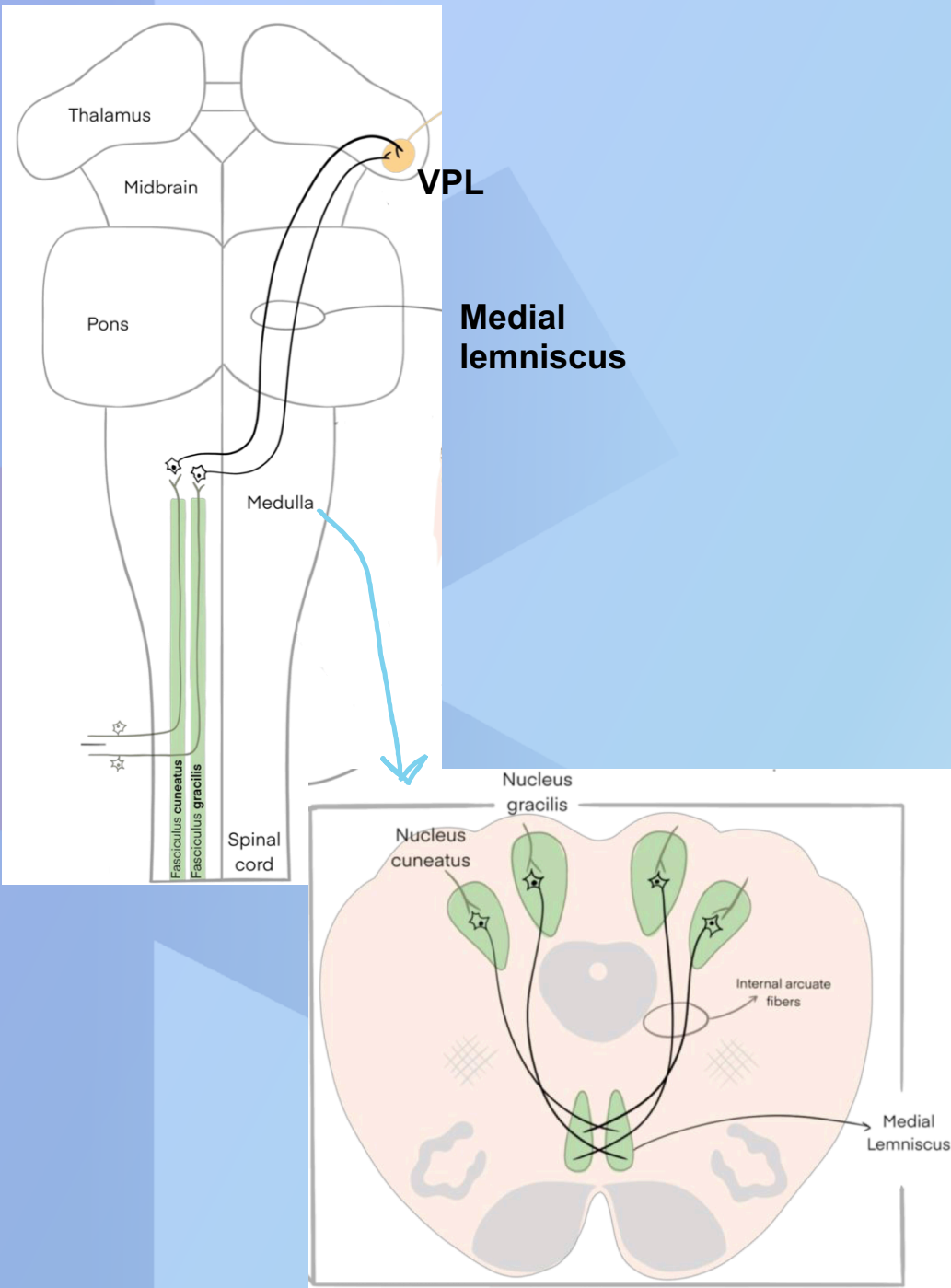


Below T6



- 1<sup>st</sup> order neuron: DRG
- Fibers of the 1<sup>st</sup> order neuron enter **dorsal column of the spinal cord**
- Ascend on the ipsilateral side as: **fasciculus gracilis (below T6)** or **fasciculus cuneatus (T6 and above)**
- Fasciculus c**U**neatus – **U**pper body
- Fasciculus graci**L**is – **L**ower body
- **L**egs inside: Graci**L**is has a medial position in the spinal cord
- **A**rms outside: Cune**A**tus has a lateral position in the spinal cord





- DCML ascend as **fasciculus gracilis** and **fasciculus cuneatus** up to the **level of medulla** where it synapses with 2<sup>nd</sup> order neuron
- 2<sup>nd</sup> order neurons are located in **nucleus gracilis** and **nucleus cuneatus**
- Axon of 2<sup>nd</sup> order neuron start **decussating** as **internal arcuate fibers**
- After decussation, those fibers are called **medial lemniscus** -> ascend on the contralateral side further
- 3<sup>rd</sup> order neuron: VPL

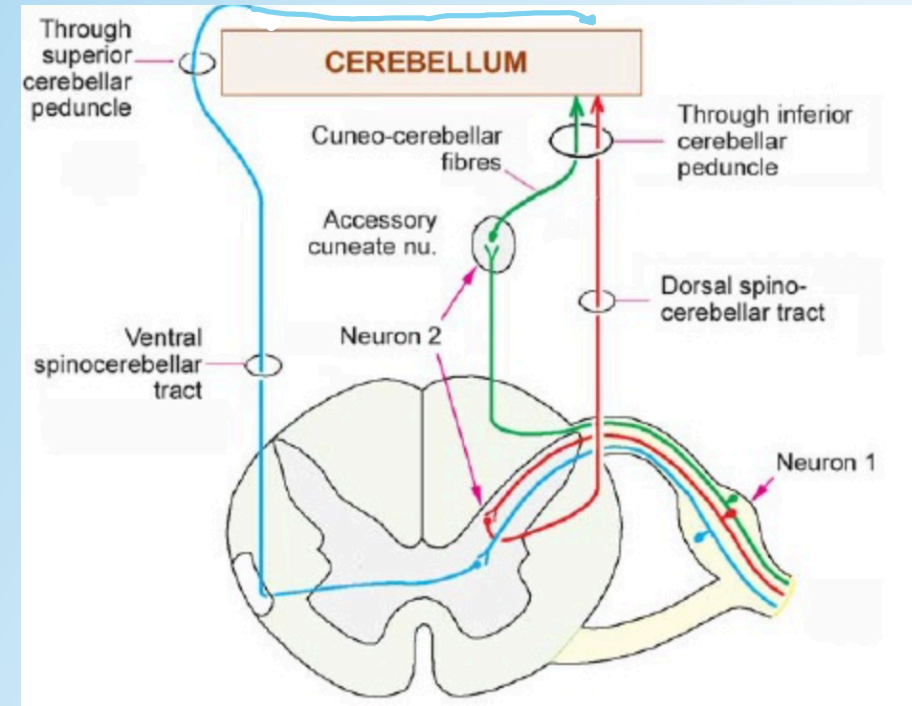
## Dorsal column-medial lemniscus

<b>Type of sensation</b>	<b>Precise sensation</b> (pressure, vibration, fine touch, conscious proprioception)
<b>Location of neurons</b>	1 <sup>st</sup> order neuron: DRG 2 <sup>nd</sup> order neuron: nucleus gracilis and nucleus cuneatus (medulla) 3 <sup>rd</sup> order neuron: VPL
<b>Decussation</b>	Medulla (as <b>internal arcuate fibers</b> )
<b>Ascends</b>	<b>Ipsilateral side</b> (as fasciculus gracilis and fasciculus cuneatus)
<b>Destination</b>	Primary somatosensory cortex (postcentral gyrus)

# Spinocerebellar tracts

- 2 neuron pathways

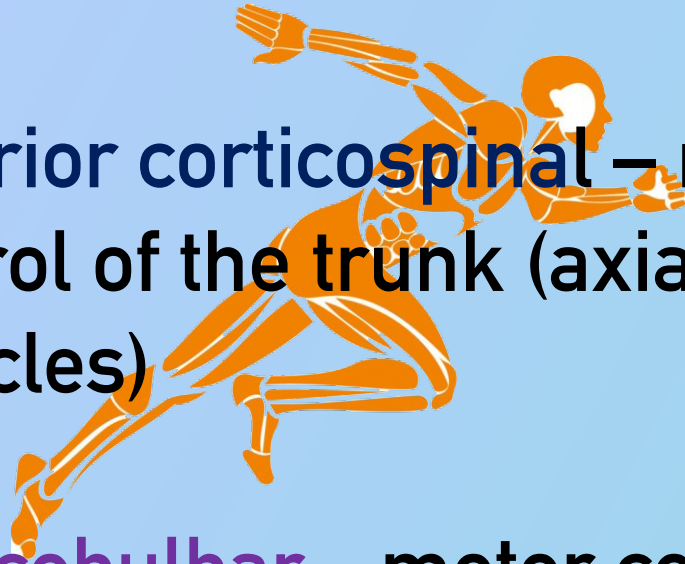
	Dorsal spinocerebellar	Ventral spinocerebellar
Function	unconscious <b>proprioception</b> , touch pressure	
Collects the information from	<b>C8-L2/L3</b> (Clark's nucleus)	<b>Below L2/L3</b>
Decussation	-	<b>Twice</b> (1 <sup>st</sup> : at level of spinal cord entrance; 2 <sup>nd</sup> : after entering the cerebellum)
Ascends	<b>Ipsilateral</b>	<b>Contralateral</b>
Cerebellum entrance	Inferior cerebellar peduncle	Superior cerebellar peduncle
Destination	Ipsilateral cerebellum	



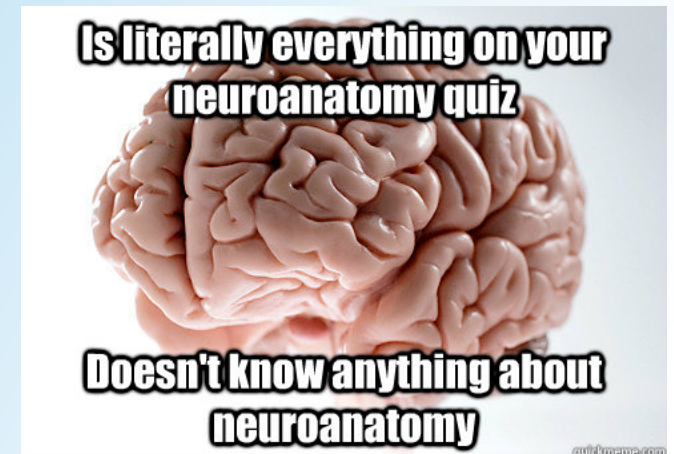
Cuneocerebellar: analog to the dorsal spinocerebellar tract for the upper limbs (above C8); 2<sup>nd</sup> order neuron is in the medulla (accessory cuneatus)

# Motor (descending) tracts

- **Lateral corticospinal** – motor control of the limbs and digits
- **Anterior corticospinal** – motor control of the trunk (axial muscles)
- **Corticobulbar** - motor control of the head neck muscle (CN innervation)

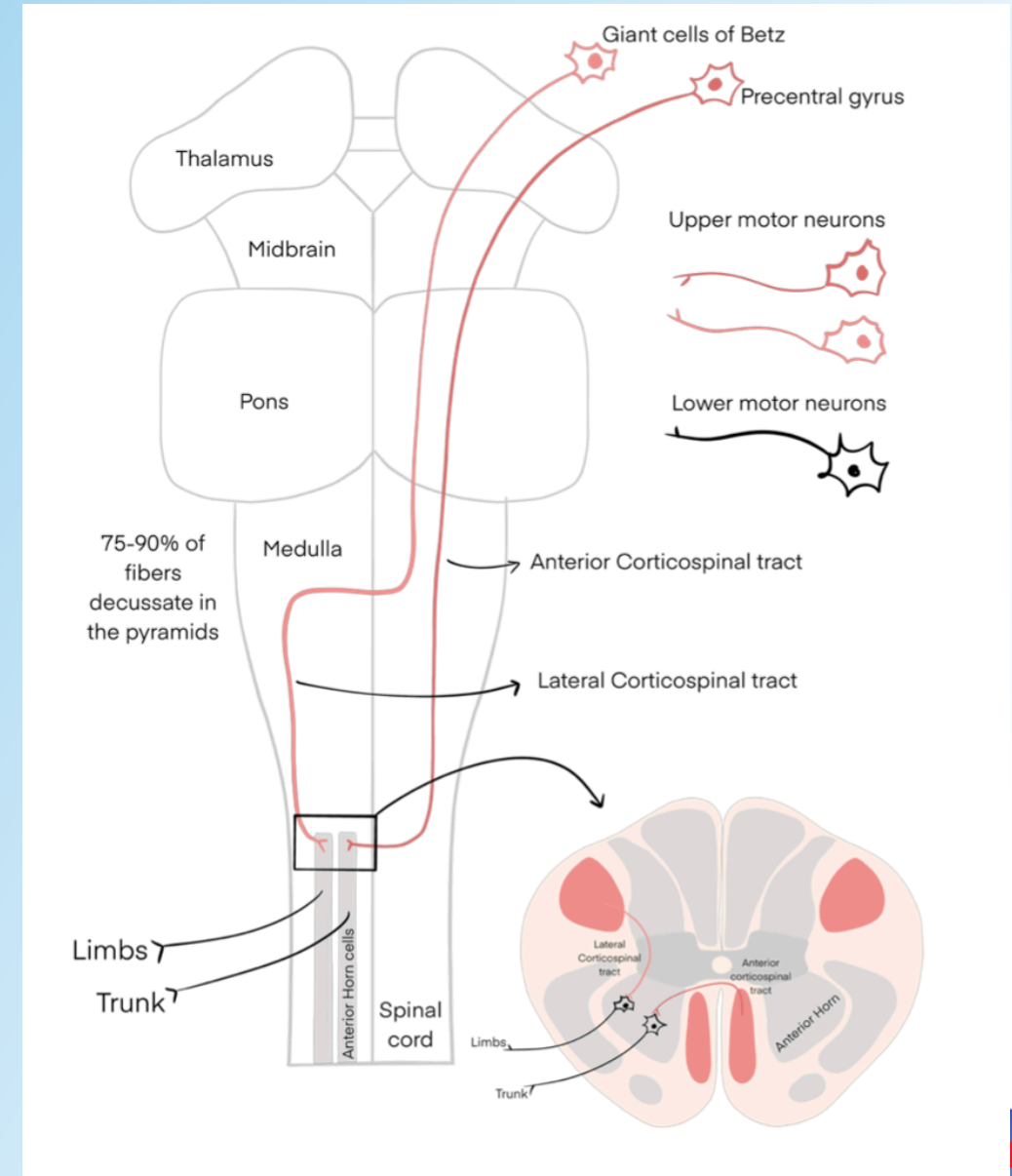


**ALL ARE PYRAMIDAL TRACTS**



# Corticospinal tract

- 2 neuron pathway: upper motor neuron (UMN) and lower motor neuron (LMN)
- **Lateral** (controls **limbs** "precise") and **Anterior** (controls trunk "gross")
- **Originates** in the **precentral gyrus** (frontal lobe)  
**UMN**: pyramidal (giant) **cells of Betz**
- Travel through the **posterior limb** of the internal capsule
- In pyramids: 1) 75-90% of fibers decussate -> descend as **lateral corticospinal** (**contralaterally**) 2) 10-25% descend as **anterior corticospinal** (**ipsilaterally**) -> decussate at the level of spinal cord
- **UMN** synapses with **LMN** in the anterior grey horn
- Axons of **LMN** travel to the muscle cells and contract them

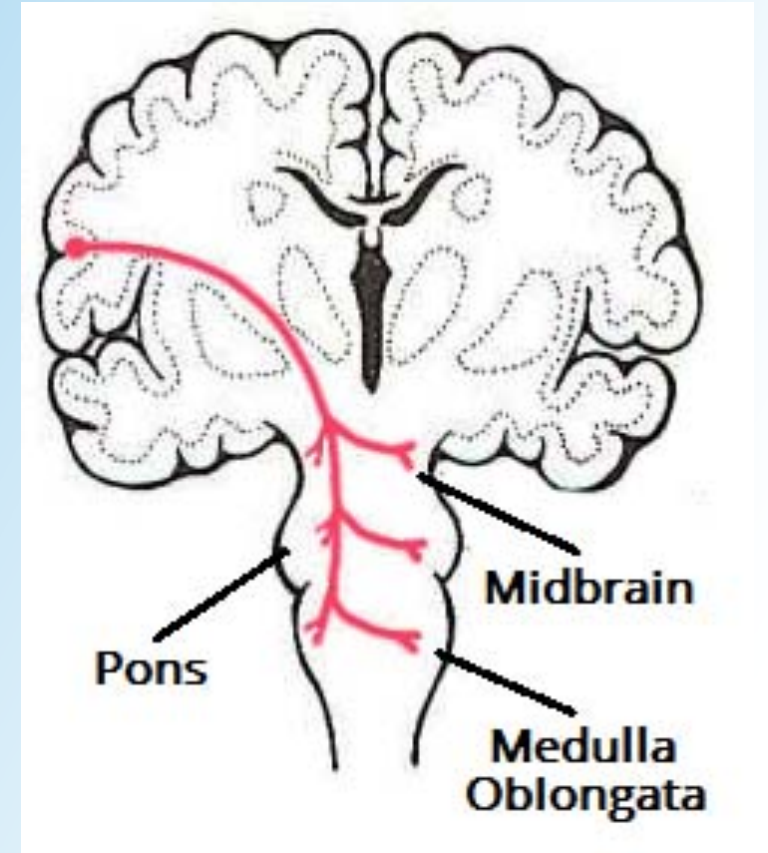




	Lateral corticospinal tract	Anterior corticospinal tract
Transmission	Motor innervation of <b>contralateral limbs</b>	Motor innervation of <b>contralateral trunk</b>
Location of neurons	UMN: precentral gyrus (Giant cells of Betz) LMN: anterior grey horn	
Decussation	<b>Pyramids</b>	<b>Anterior white commissure</b> of the spinal cord
Descends	<b>Contralaterally</b>	<b>Ipsilaterally</b>

# Corticobulbar tract

- Motor pathway responsible for the voluntary movement of the **muscles of the face, head and neck**
- **UMN** is in the **precentral gyrus**
- Descend and **synapse in the brainstem** with **LMN** which is in **cranial nerve nuclei**
- Not all the fibers decussate, for each nuclei different decussation. The majority will **synapse bilaterally**  
**Cranial nerves VII and XII are unique**

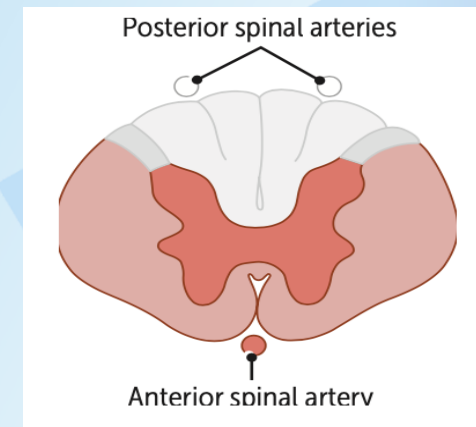
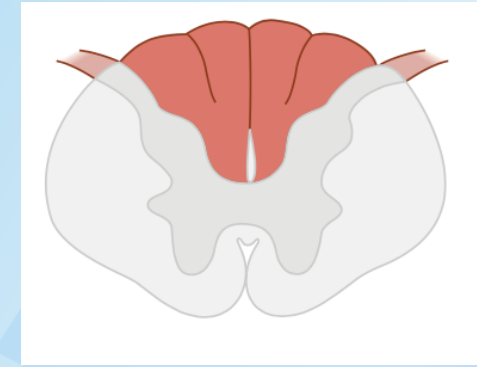


# SUMMARY

High-yield spinal tracts				
	Transmission	Synapses		Decussations
<b>Spinothalamic tract</b>	<ul style="list-style-type: none"> <li>- Pain</li> <li>- Temperature</li> <li>- Crude touch</li> </ul>	1 <sup>st</sup> order neuron	DRG	Anterior white commissure (AWC)
		2 <sup>nd</sup> order neuron	Nucleus proprius/ substantia gelatinosa	
		3 <sup>rd</sup> order neuron	VPL (thalamus)	
<b>Dorsal column-medial lemniscus</b>	<ul style="list-style-type: none"> <li>- Fine touch</li> <li>- Pressure</li> <li>- Vibration</li> <li>- Proprioception</li> </ul>	1 <sup>st</sup> order neuron	DRG	Medulla (as internal arcuate fibers)
		2 <sup>nd</sup> order neuron	Nucleus gracilis or nucleus cuneatus	
		3 <sup>rd</sup> order neuron	VPL (thalamus)	
<b>Corticospinal tract</b>	<ul style="list-style-type: none"> <li>- Motor function</li> </ul>	UMN	Giant cells of Betz	Medullary pyramids/ AWC
		LMN	Anterior horn	

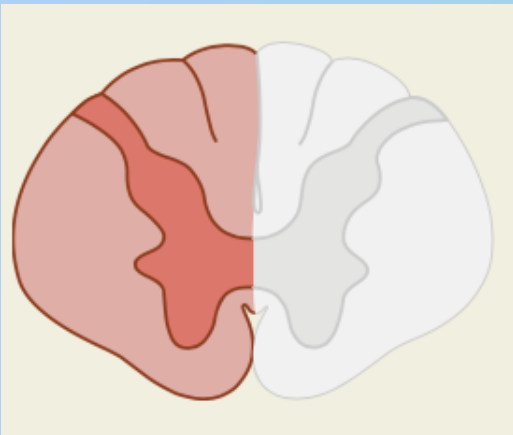
# Clinical relevance\*

- **Tabes dorsalis** – caused by tertiary syphilis. Degeneration of dorsal columns -> **DCML damage** -> impaired coordination due to loss of proprioception
- **Complete anterior spinal artery occlusion** – could be due to direct trauma, atherosclerosis, thrombosis etc. Motor paralysis and loss of pain, temperature sensation due to **damage to corticospinal and spinothalamic tracts**. **DCML is intact -> preserved proprioception**



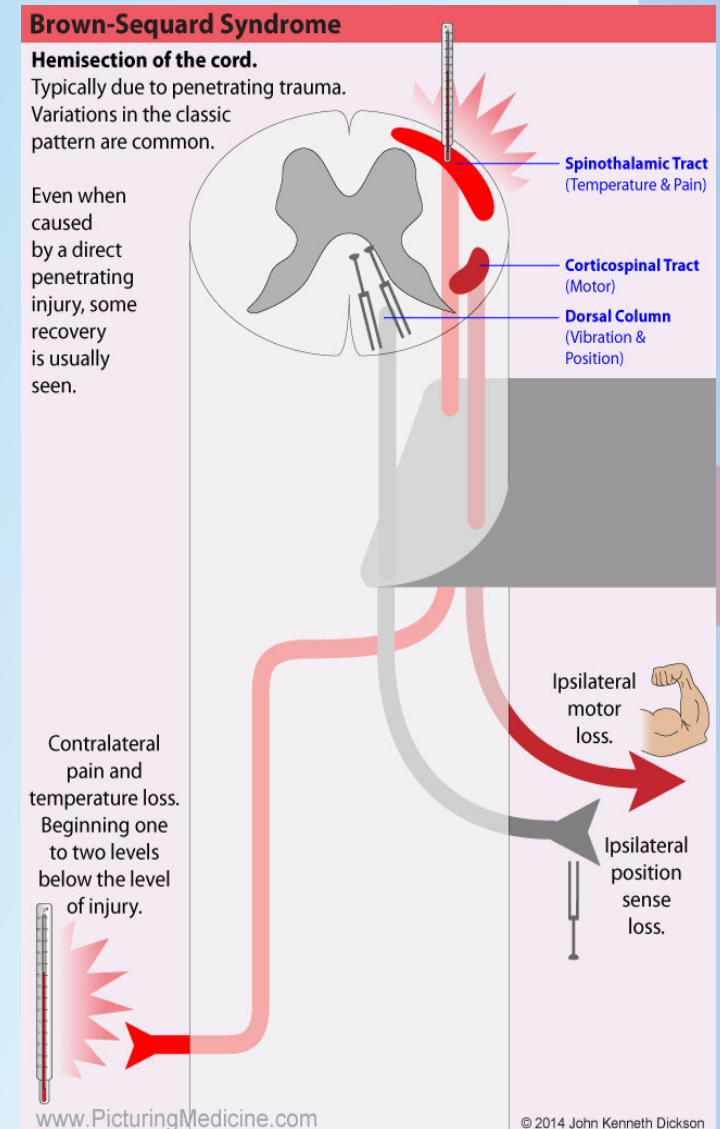
# Clinical relevance\*

- Brown-Séquard syndrome – damage to one half of the spinal cord (hemisection). Findings:
  - Ipsilateral at the level of lesions: LMN lesion + complete sensory loss
  - Ipsilateral below the level of the lesion: UMN lesion (corticospinal damage) + damaged DCML (loss of proprioception, vibration)
  - Contralateral below the level of the lesion: damaged spinothalamic tract (loss of pain and temperature)



Lesion to DCML or corticospinal = deficit on the same side

Lesion to spinothalamic tract = deficit on the opposite side



**Thank you**

