

Spinal Cord White matter (Tracts)

Ascending tracts

Descending tracts

Fasciculus gracilis

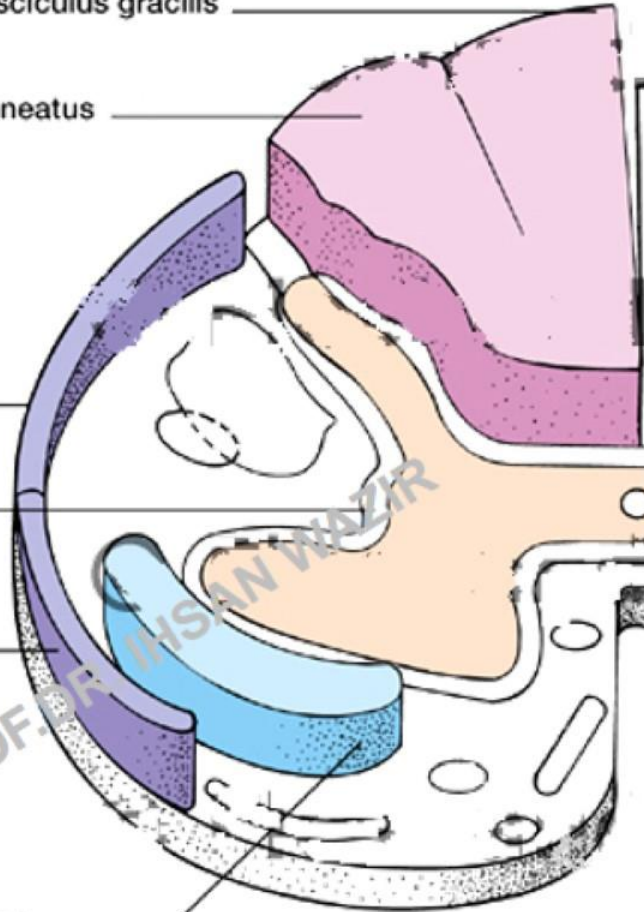
Fasciculus cuneatus

Dorsal
spinocerebellar
tract

Fasciculus
proprius

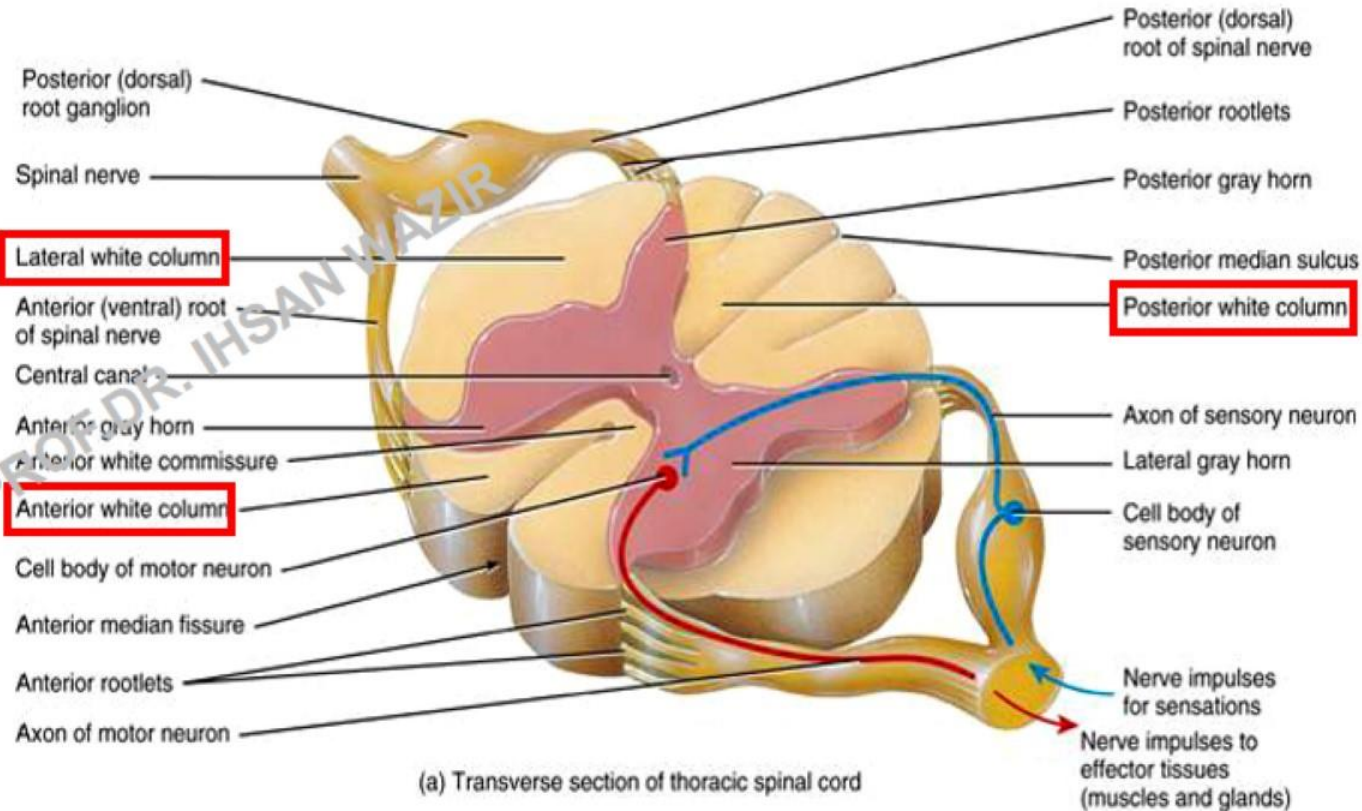
Ventral
spinocerebellar
tract

Spinothalamic tract



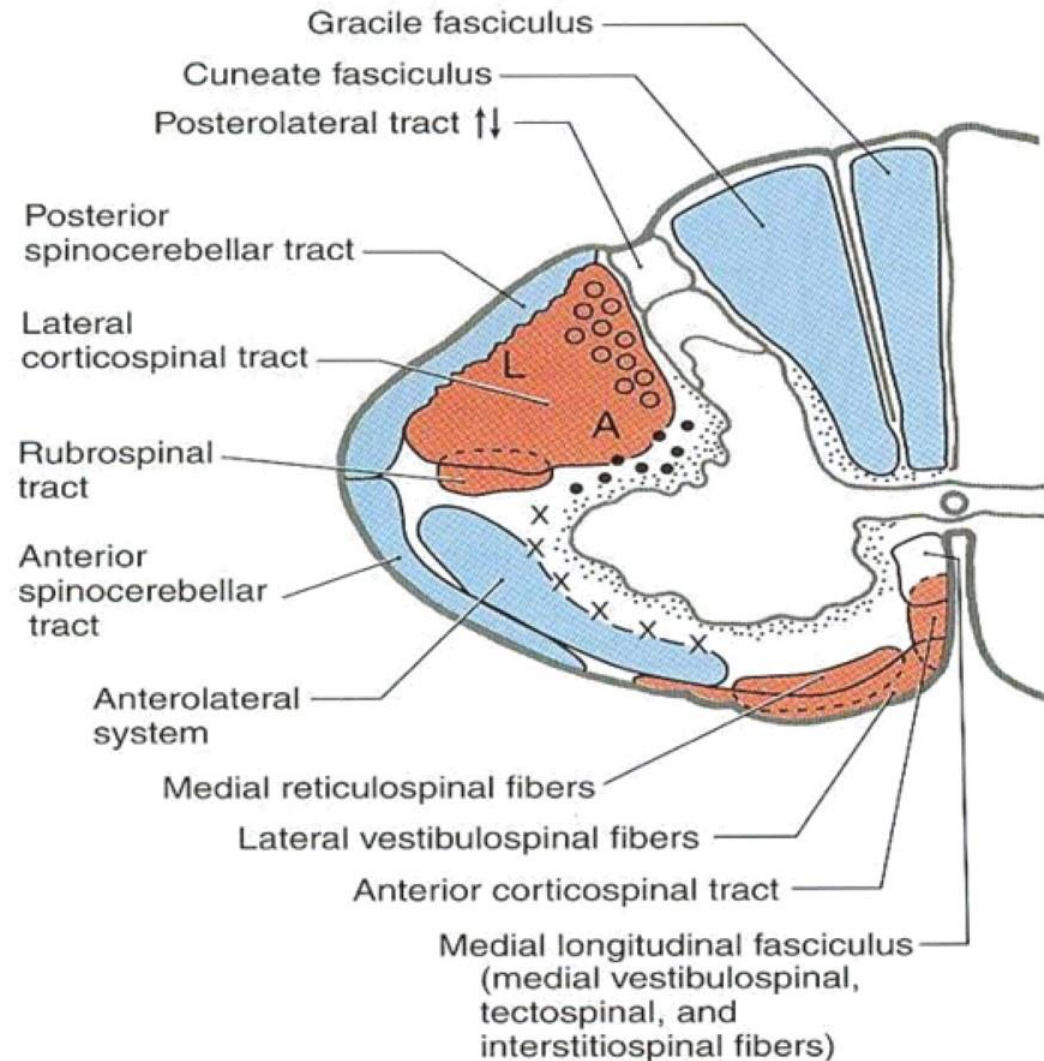
Spinal Cord White matter

- White matter is divided into three funiculi (bundles of tracts) or columns
- Posterior, lateral and anterior funiculi.
- White matter contains nerve fibers and neuroglia,
- White color is due to high proportion of myelinated nerve fibers.



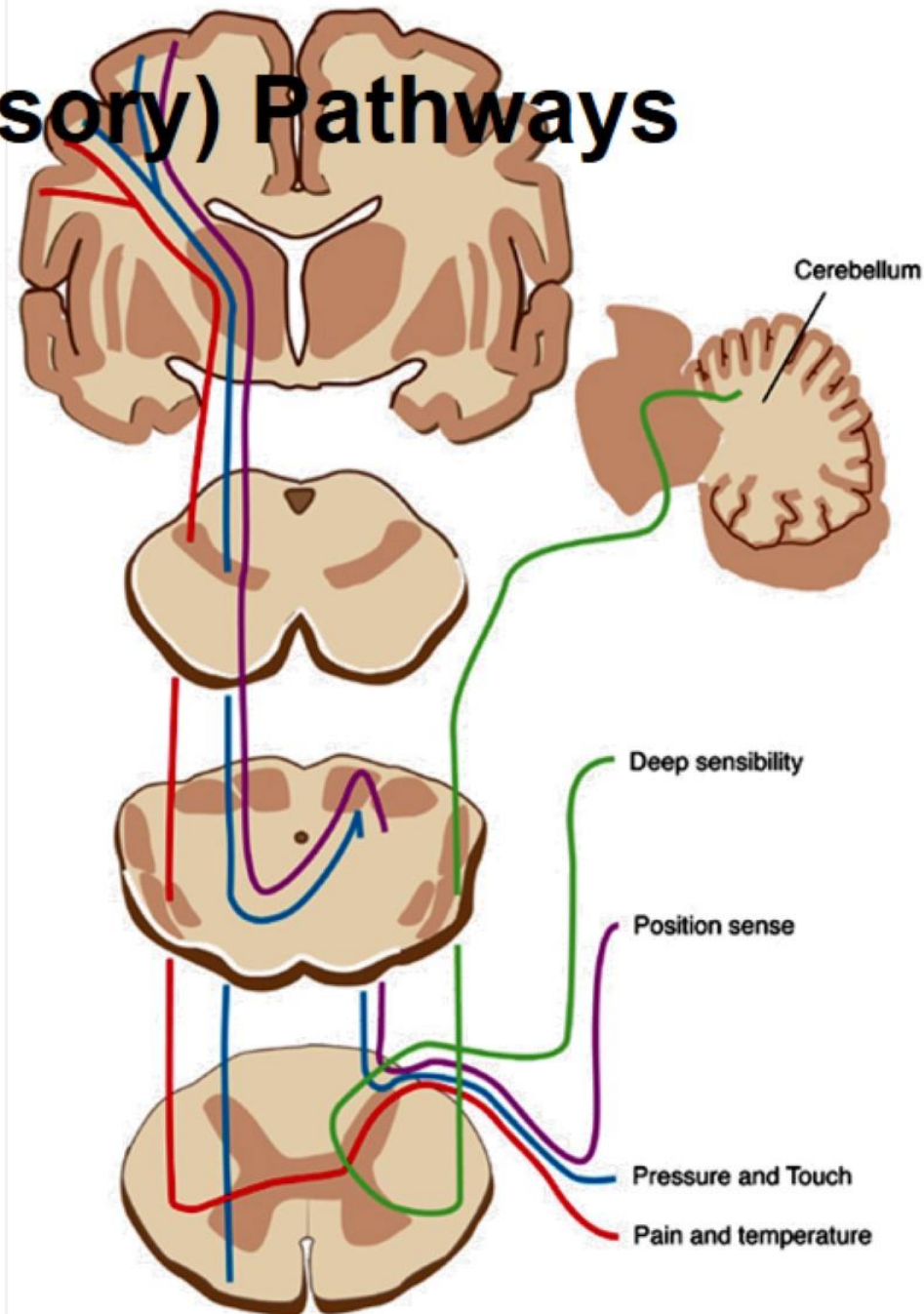
Spinal Cord Tracts

- Three types of tracts
- Ascending
- Descending
- Intersegmental

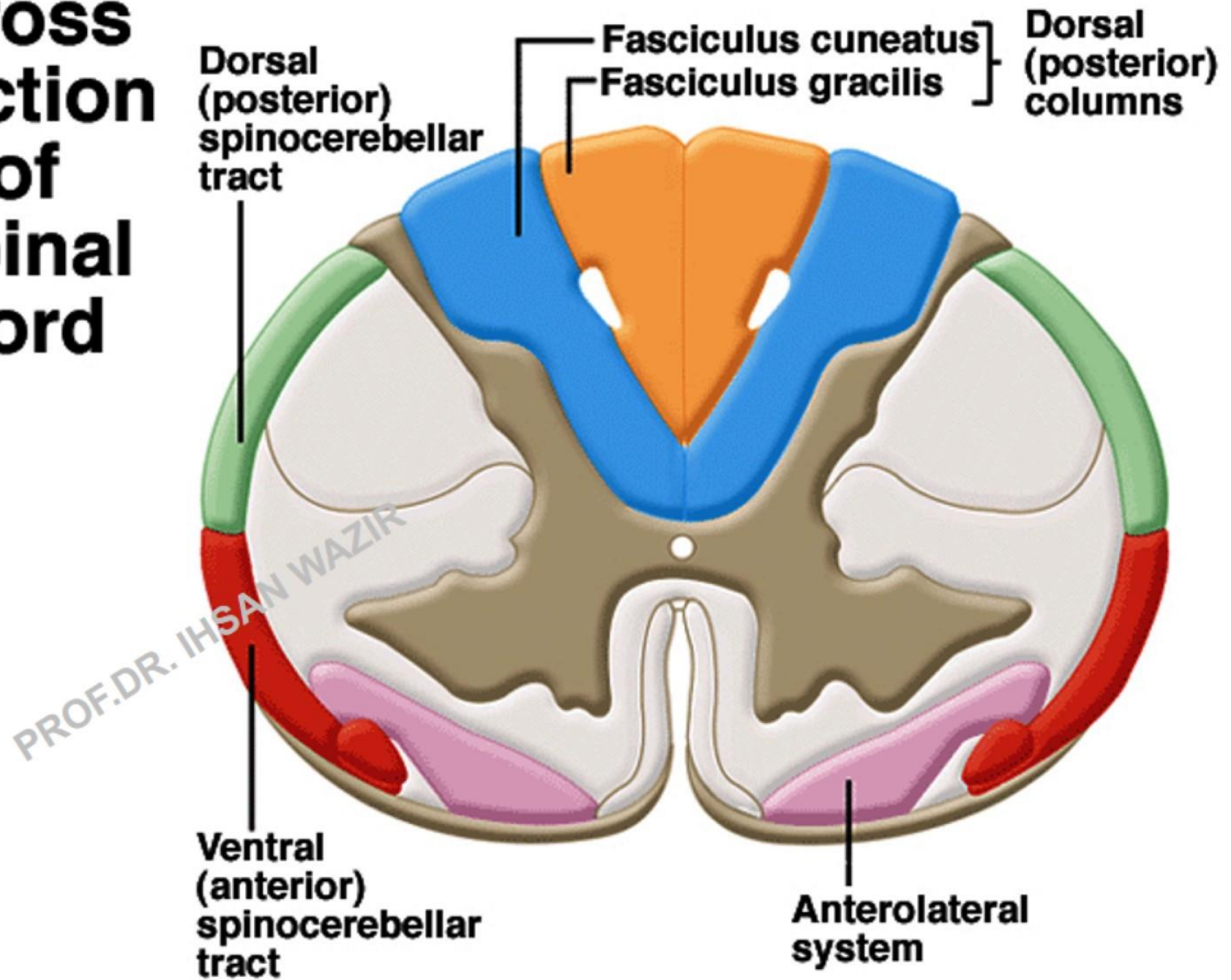


Ascending (Sensory) Pathways

- Conduct general somatic sensory impulses
- Four main ascending pathways
 - Dorsal column pathway
 - Anterolateral Spinothalamic pathway
 - Posterior spinocerebellar pathway
 - Anterior spinocerebellar pathway



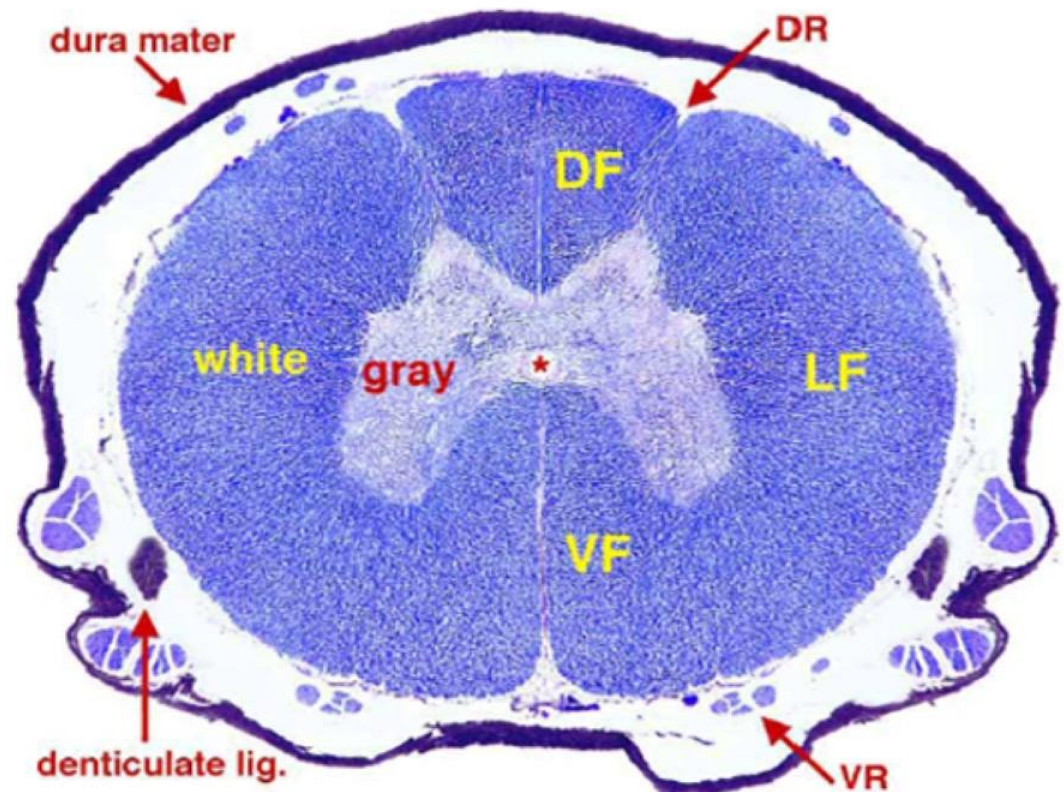
Cross section of spinal cord

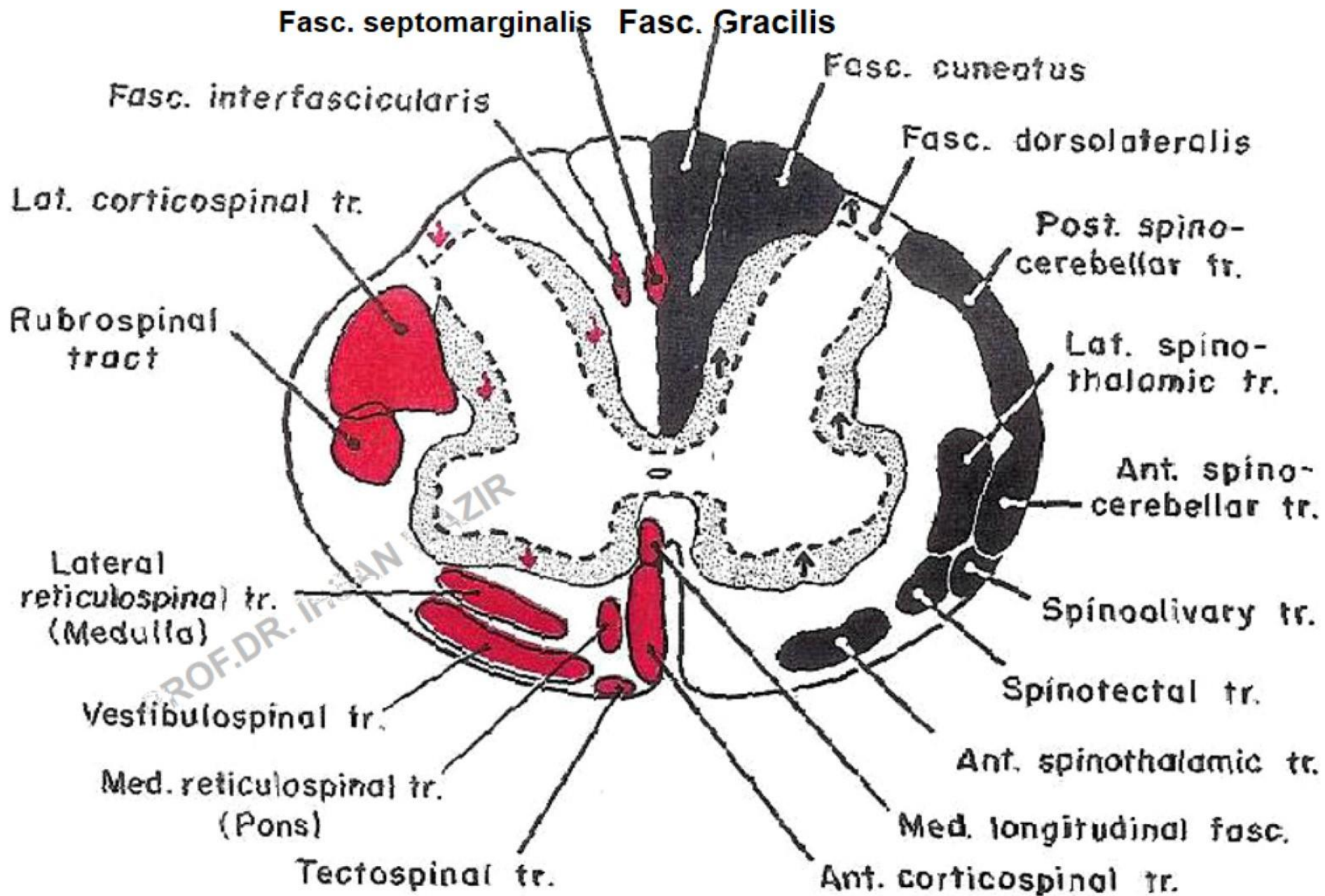


Spinal Cord Tracts

- Bundles of fibers having the same Origin, Course and Terminations are known as tracts or fasciculi. (Unidirectional)
- A funiculus contain several different tracts conducting impulses in different directions (Multidirectional)

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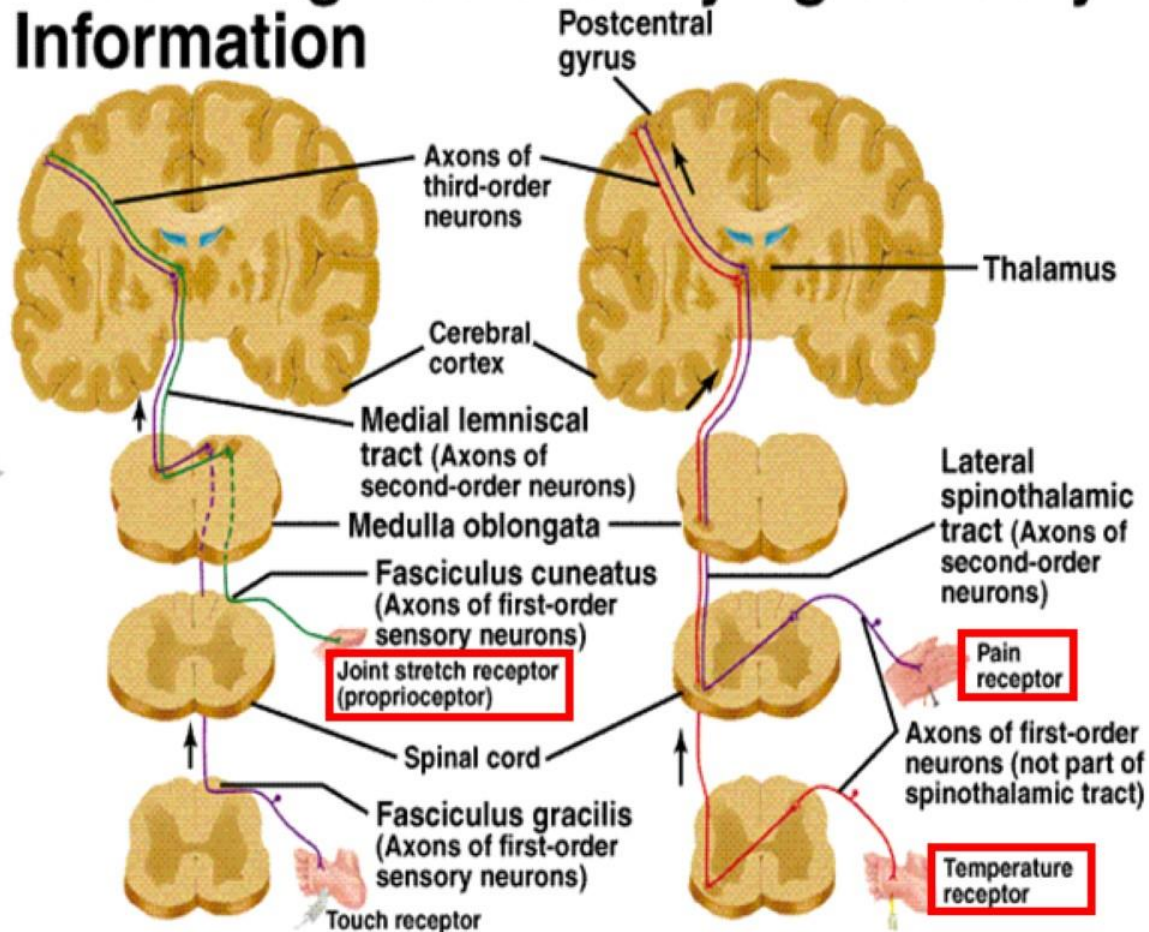


Basic structure of human brain

Spinal Cord Tracts

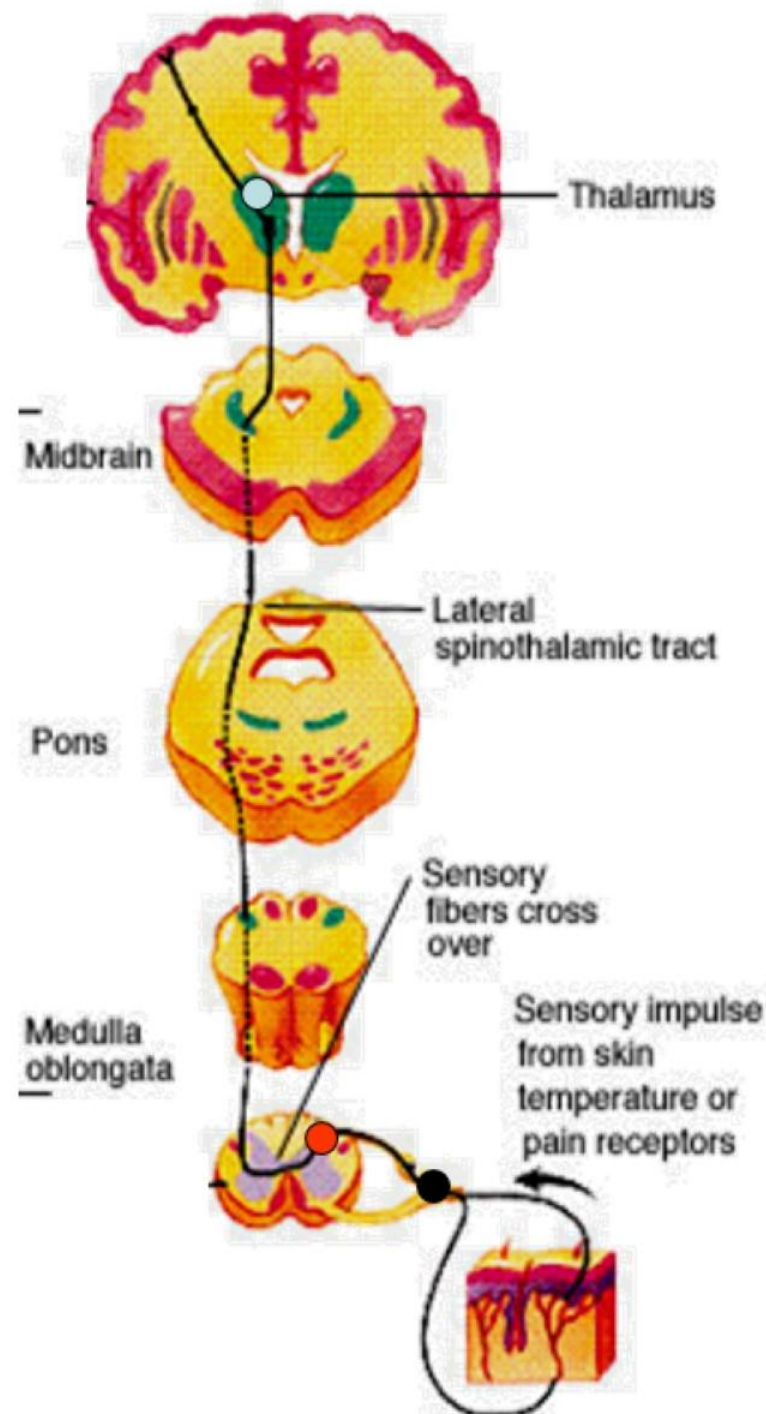
- **Ascending Tracts:**
- Conduct afferent informations which may be divided into two groups.
- **Exteroceptive:** Which originates from outside the body such as pain, temperature and touch.
- **Proprioceptive:** That is from inside the body e.g. from muscles & joints, called kinesthesia (sense of movement & position).

Ascending Tracts Carrying Sensory Information



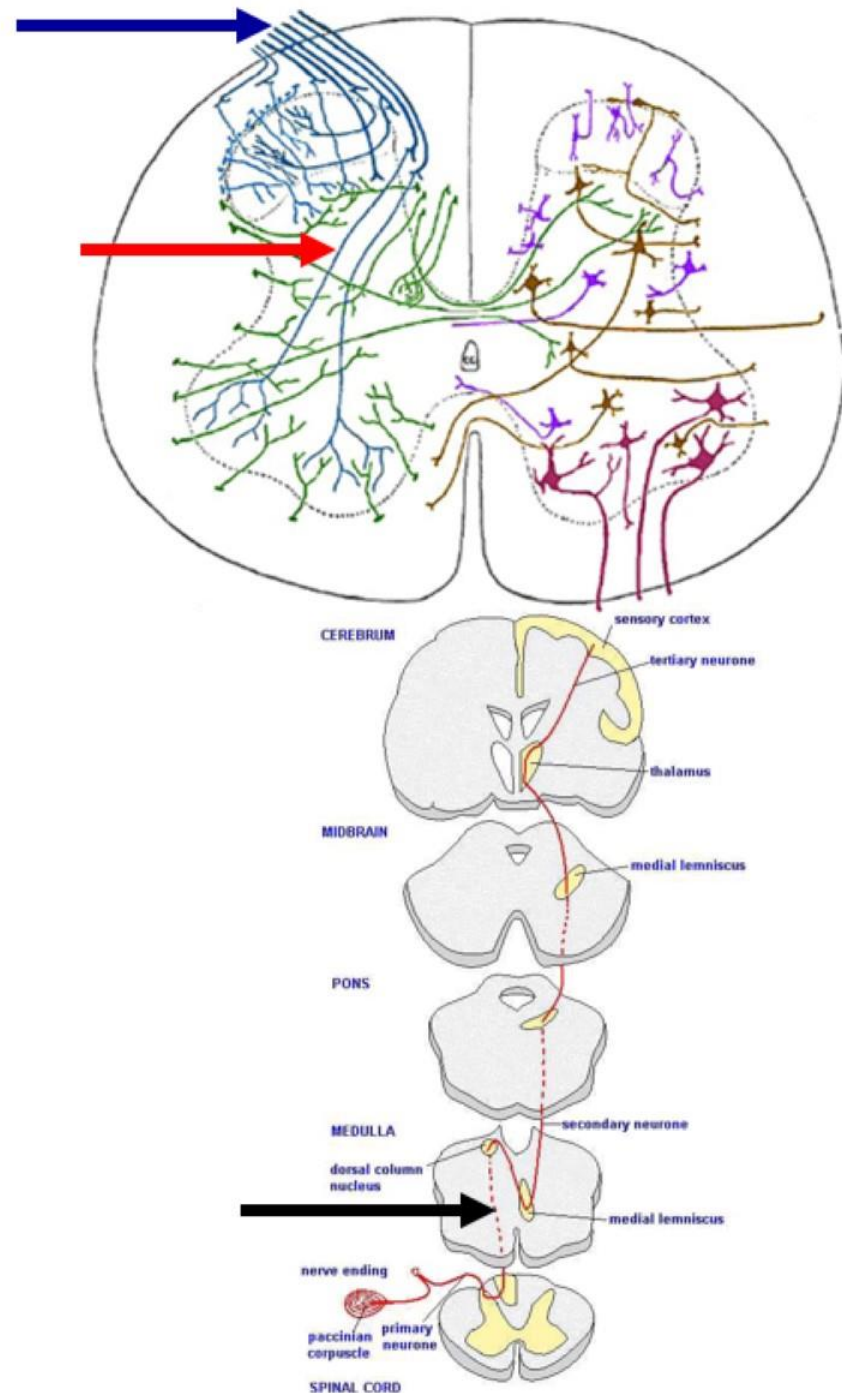
Spinal Cord Tracts

- Ascending pathway to consciousness (cerebral cortex) consist of three neurons:
- (i) First order neurons in posterior root ganglion.
- (ii) Second order neuron (in spinal grey matter or brain stem)
- (iii) Third order neuron usually in the thalamus – gives projection fibers to sensory region of cerebral cortex.

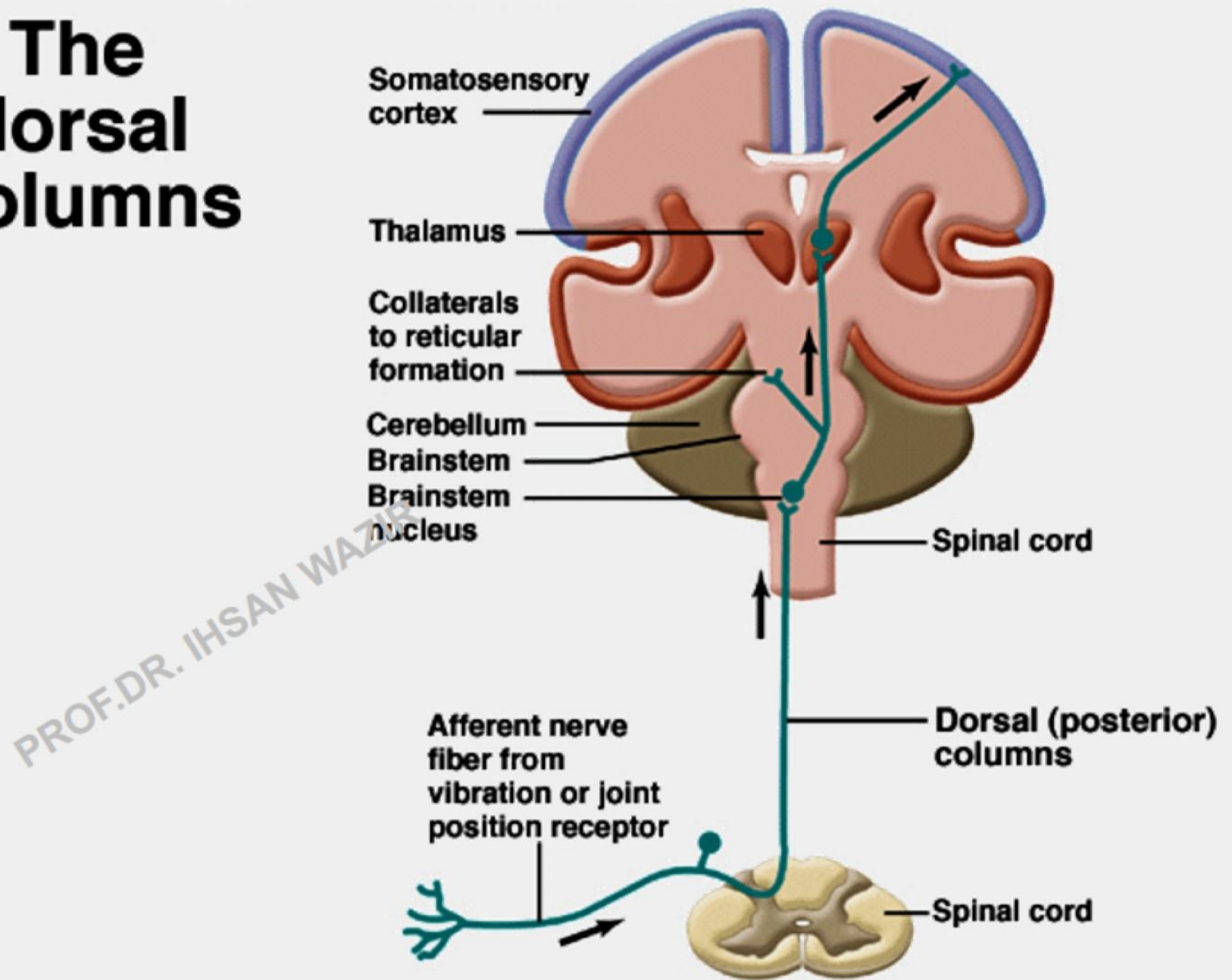


Spinal Cord Tracts

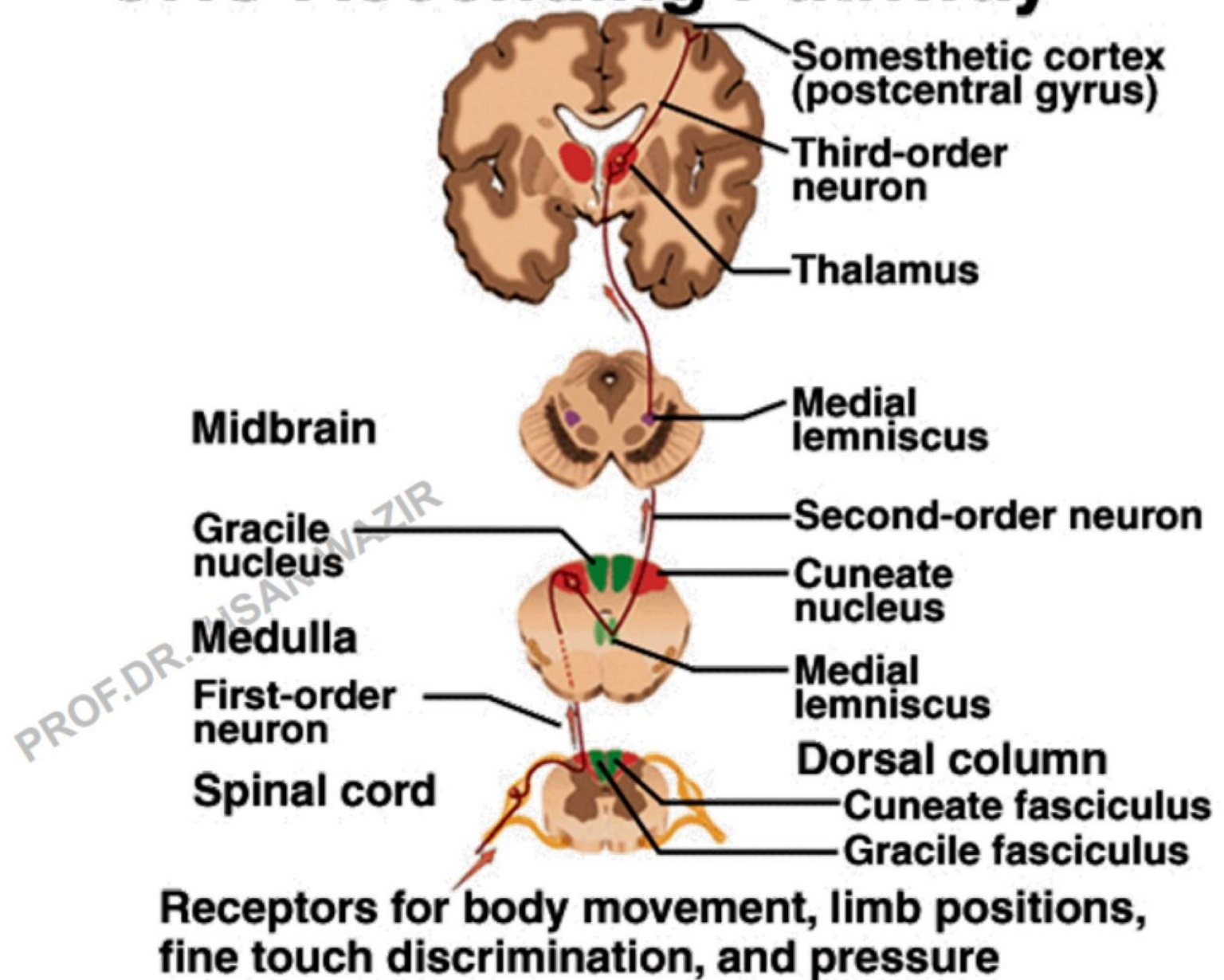
- Dorsal White Column (Funiculus)
- Axons from posterior root ganglion enters the posterior funiculus of the same side directly,
- Fibers divided into long ascending (dorsal column) and short descending branches,
- Descending branches pass down a number of segments and forms synapses with cells in the post horn, Internuncial and ant. horn cells; giving Intersegmental reflexes.



The dorsal columns

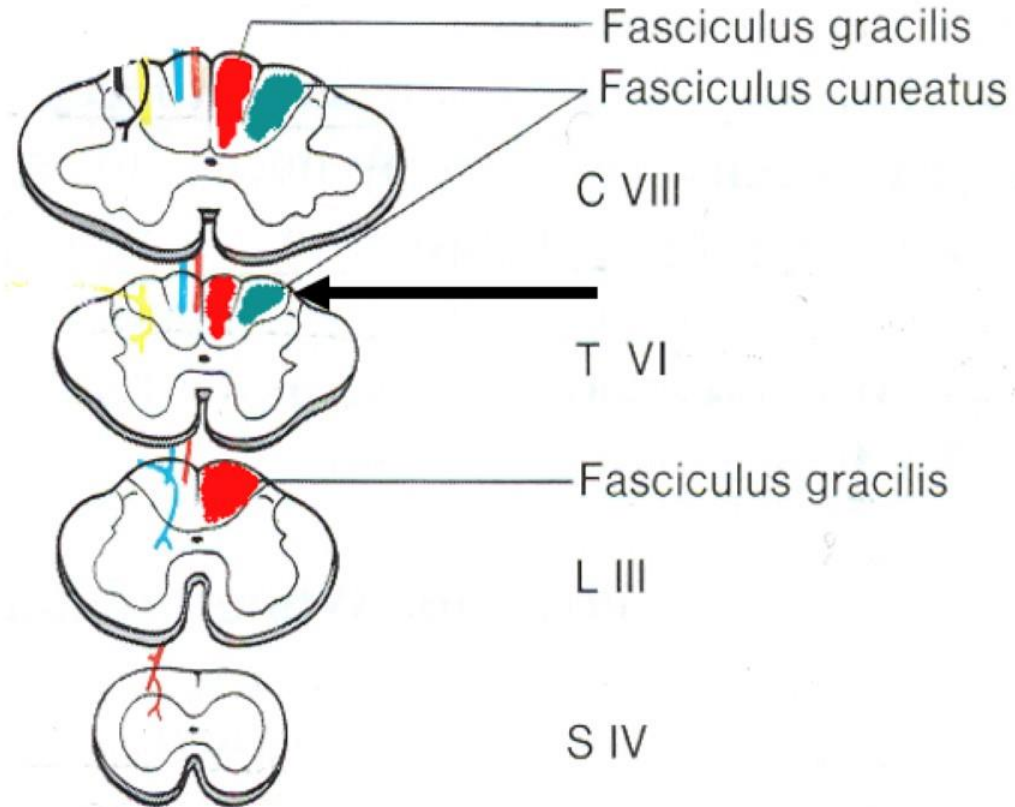


CNS Ascending Pathway



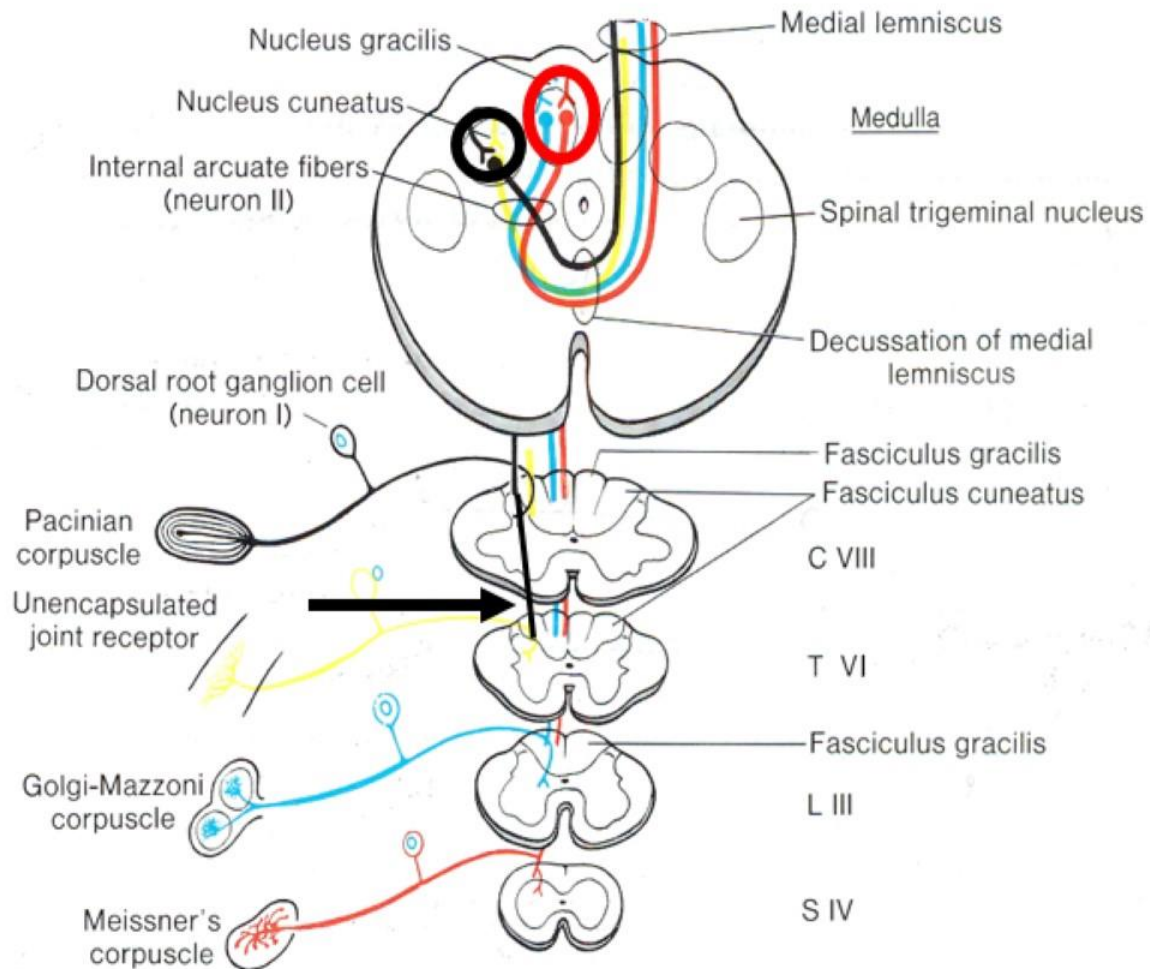
Spinal Cord Tracts

- **Post funiculus** is divided by a **posterior intermediate septum** in the upper T and C region, (T6 level)
- At T6 level it forms a medial **fasciculus gracilis** (tract of Goll) and a lateral **fasciculus cuneatus** (tract of Burdach)
- **Fasciculus gracilis** is present through out the length of spinal cord and
- Contains long ascending fibers from sacral, lumbar and lower six thoracic dorsal roots.



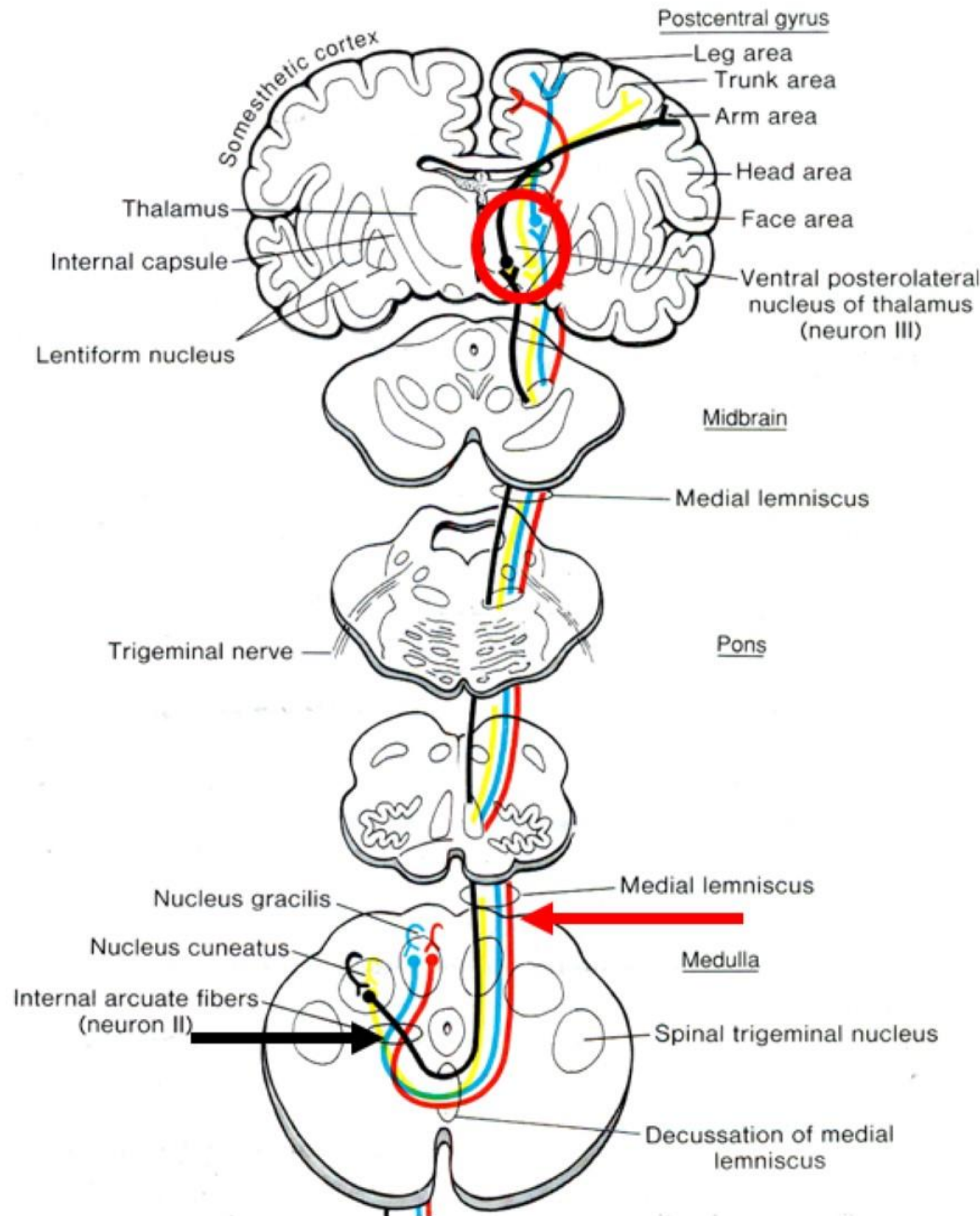
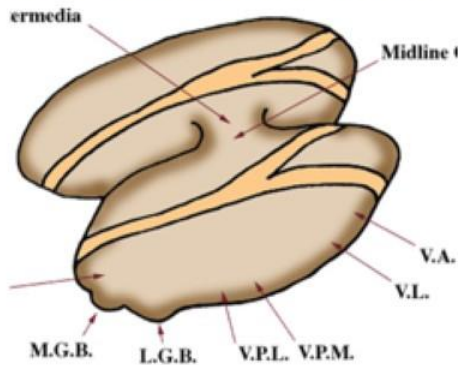
Spinal Cord Tracts

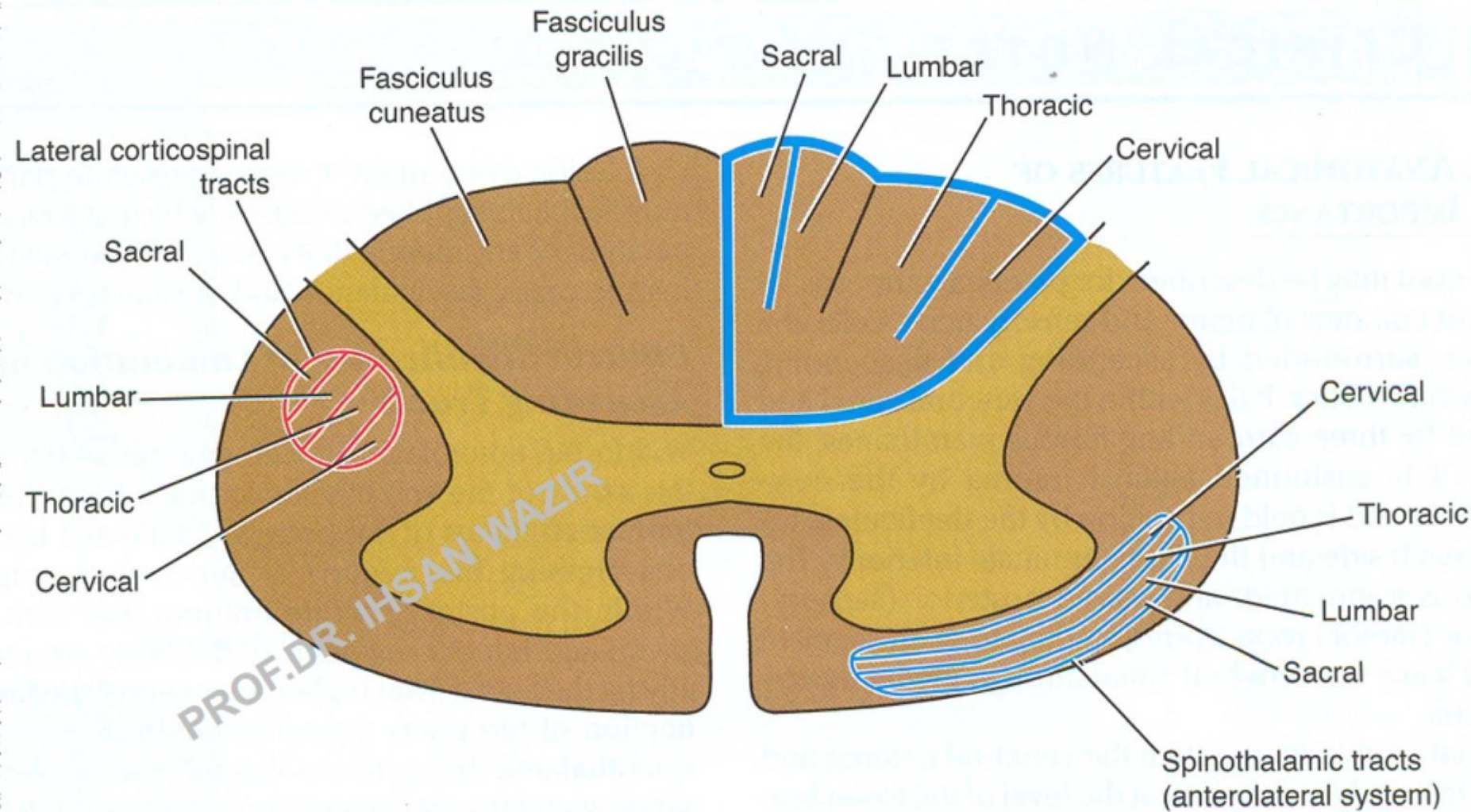
- **Fasciculus cuneatus** appears at T6 level and contains fibers from upper six thoracic and all cervical dorsal roots
- **Fibers of fasciculus cuneatus and gracilis ascend ipsilaterally and terminate on the second order neurons i.e. nucleus cuneatus and gracilis in medulla oblongata.**



Spinal Cord Tracts

- Axons of second order neurons run venteromedially forming **Internal arcuate fibers**, decussate with the corresponding fibers of opposite side and ➡
- Forms **Medial lemniscus** that ascends the medulla oblongata, pons and midbrain ➡
- Fibers terminates in the **Thalamus VPLc** (ventro posterolateral nucleus, pars caudalis).





Segmental organization of the tracts in the posterior, lateral, and anterior white columns of the spinal cord.

Somatotopic arrangement

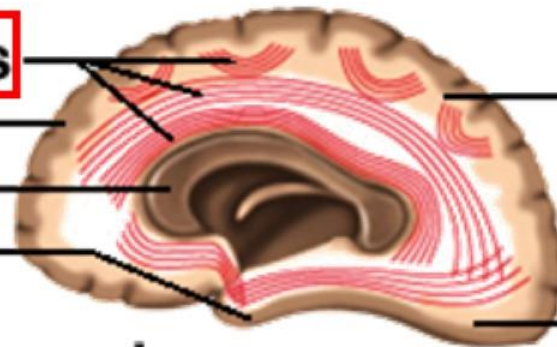
Tracts of Cerebral White Matter

Association tracts

Frontal lobe

Corpus callosum

Temporal lobe



Parietal lobe

Occipital lobe

Left lateral aspect

Longitudinal fissure

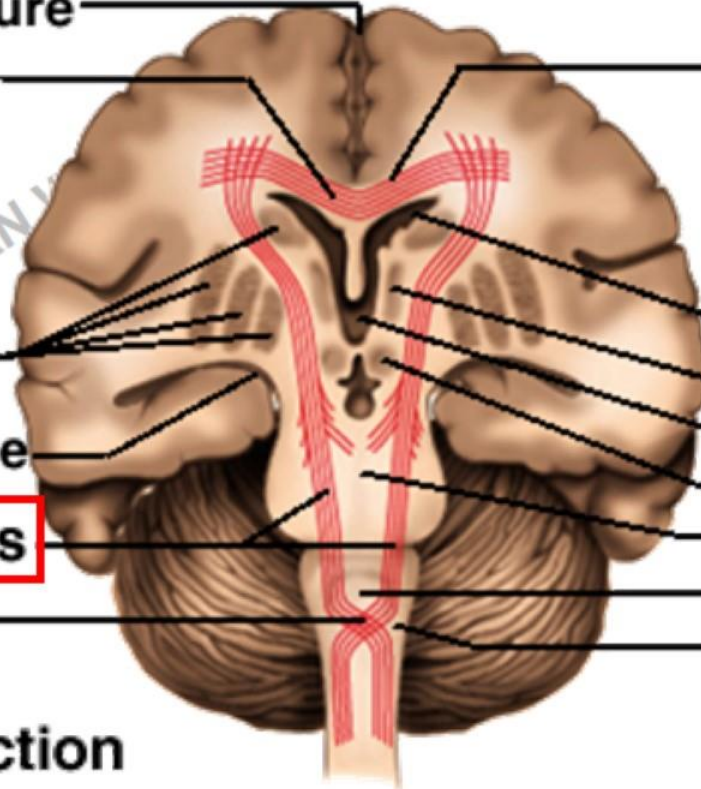
Corpus callosum

Basal nuclei

Cerebral peduncle

Projection tracts

Decussation in pyramids



Commissural tracts

Lateral ventricle

Thalamus

Third ventricle

Mamillary body

Pons

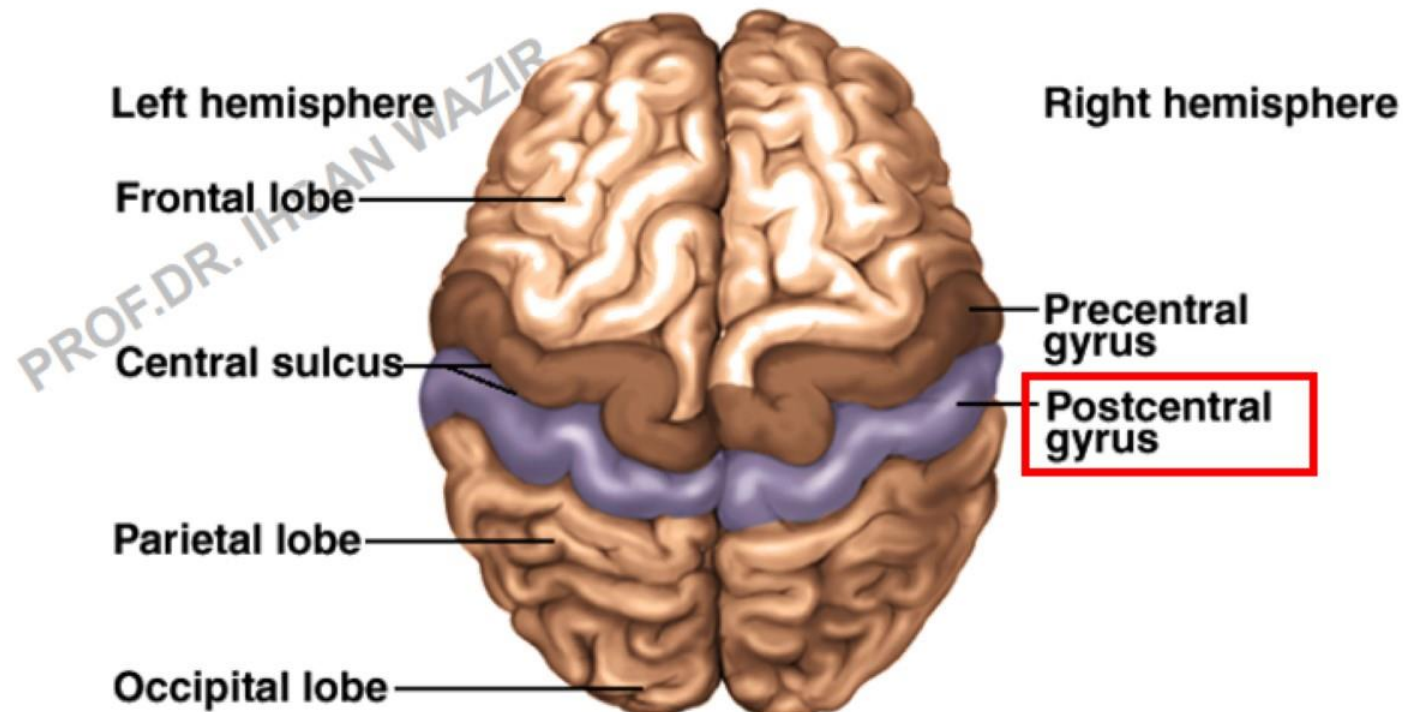
Pyramid

Medulla oblongata

Frontal section

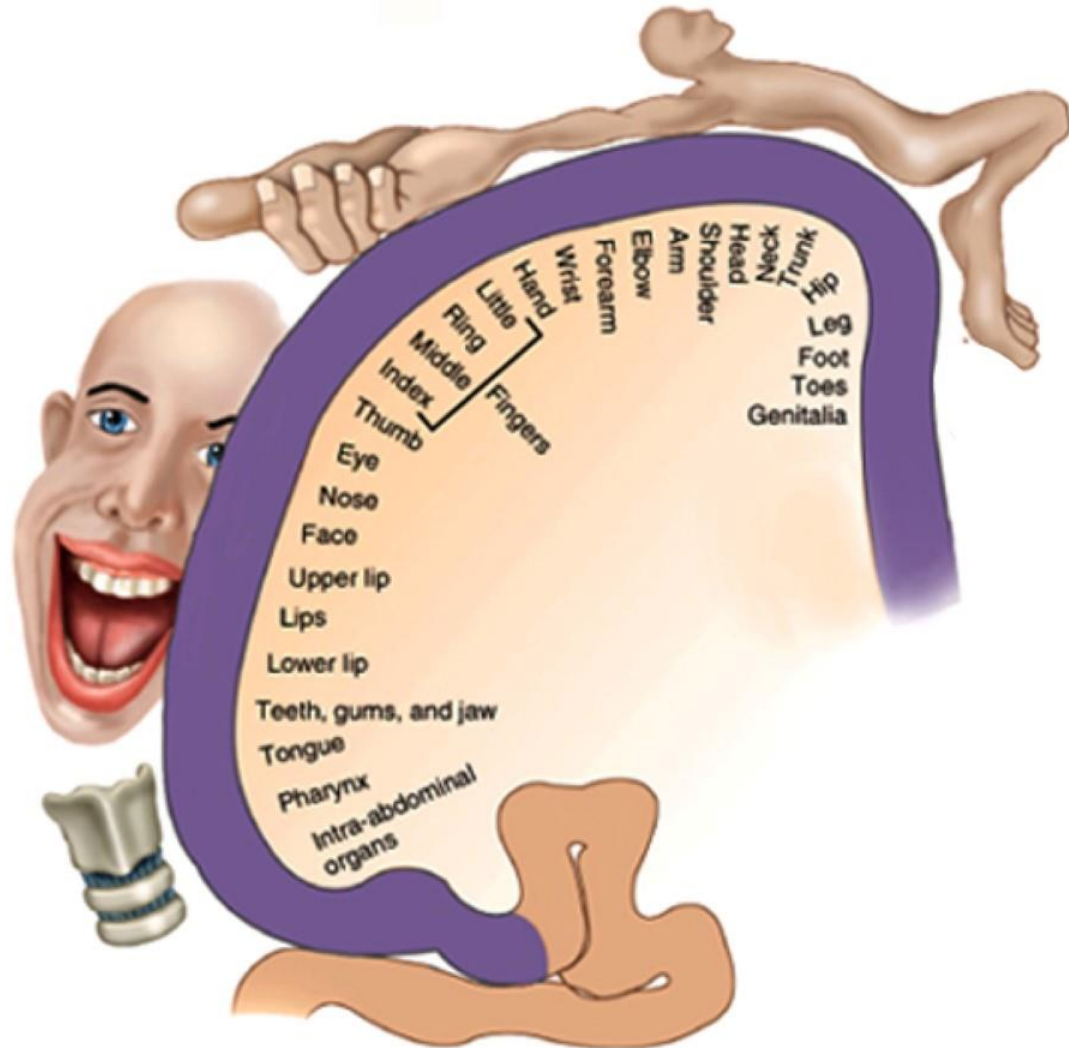
Somesthetic Sensation

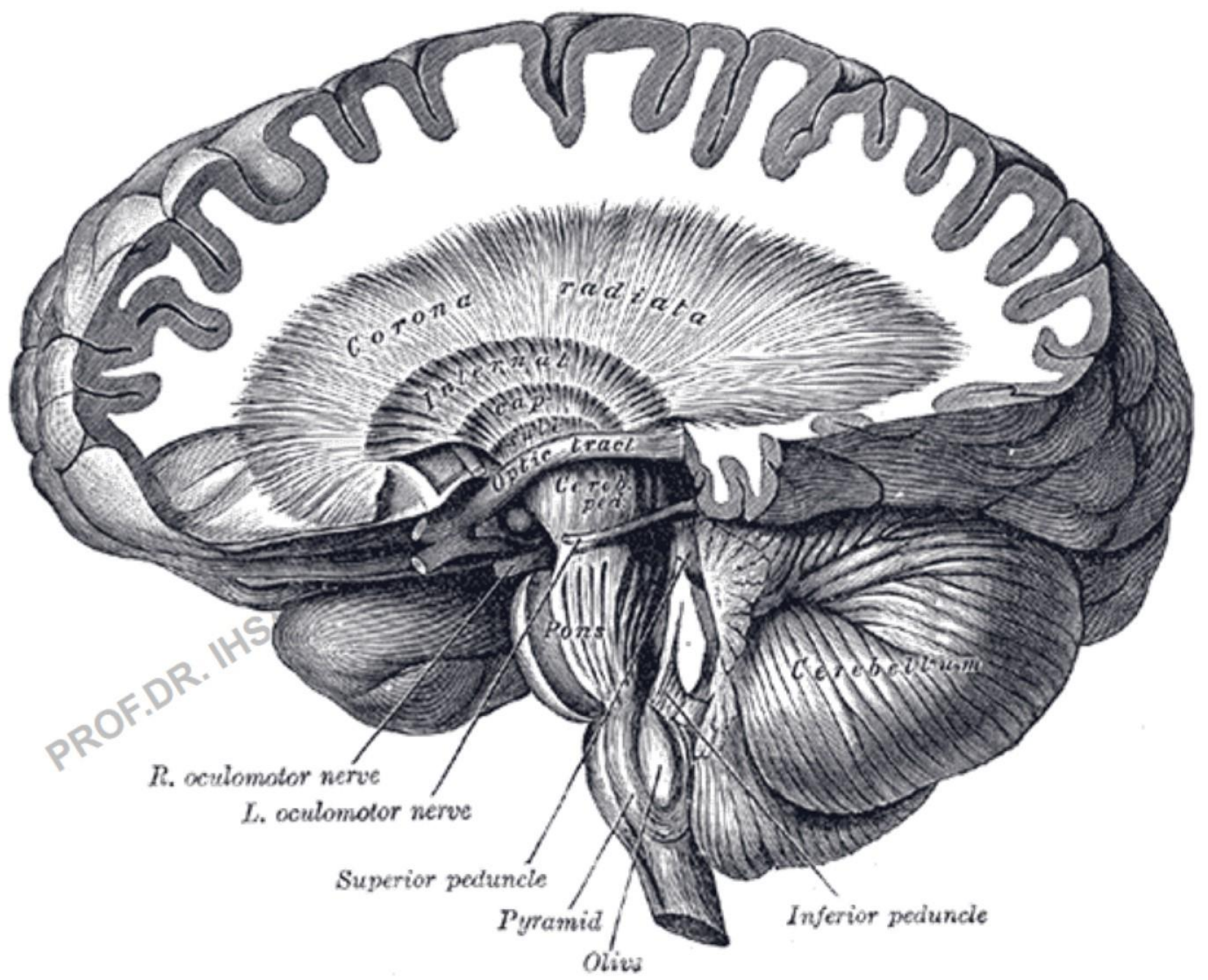
- Somesthetic signals (Somatosensory) travel up gracile and cuneate fasciculi and spinothalamic tracts of spinal cord
- Somatosensory area is postcentral gyrus



Sensory Homunculus

- **Homunculus: L– little man**
- **Shows that the area of the cortex related to sensations of various body parts is proportional to how sensitive that part of the body is.**





Corona radiata

Internal capsule

Optic tract

Cereb. ped.

Pons

Cerebellum

R. oculomotor nerve

L. oculomotor nerve

Superior peduncle

Pyramid

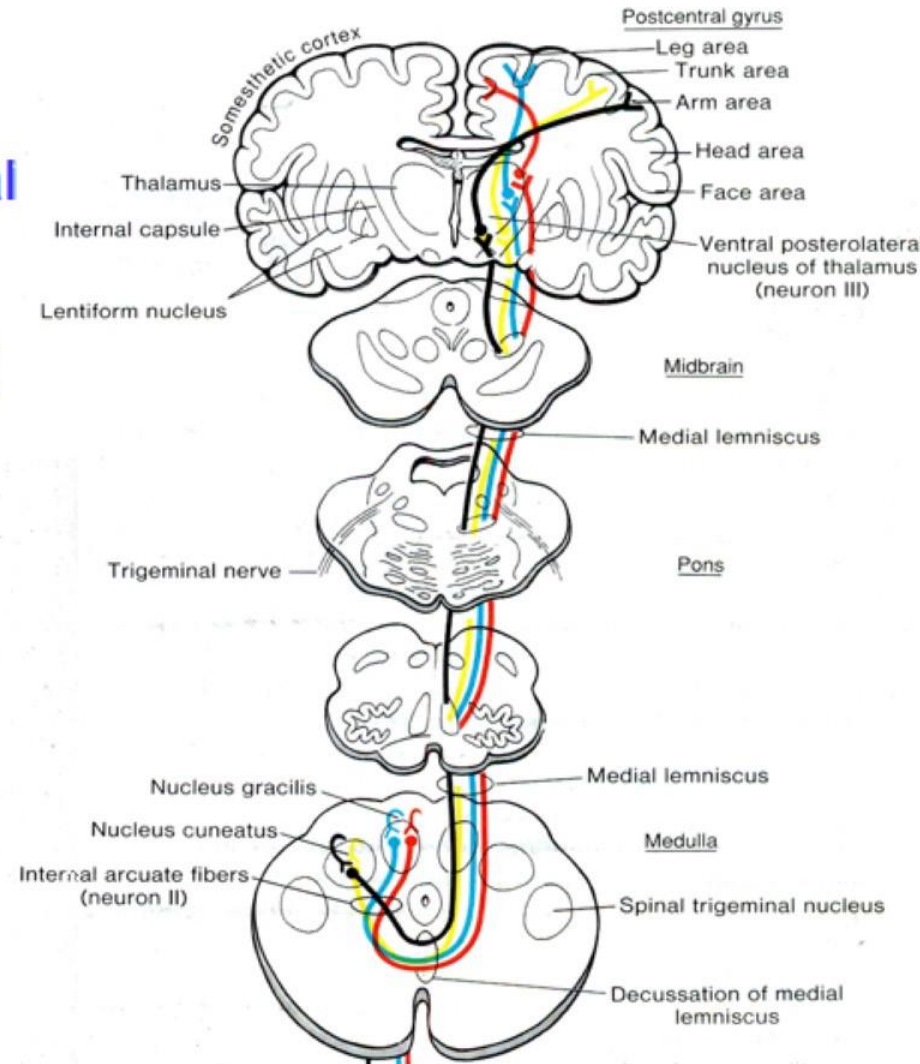
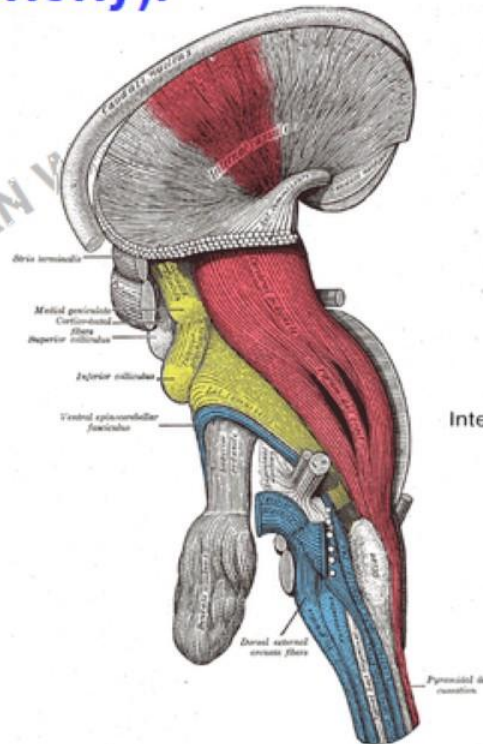
Olive

Inferior peduncle

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Spinal Cord Tracts

● Axons of third order neurons (thalamus) pass through the posterior limb of Internal capsule and Corona radiata to postero-central gyrus of cerebral cortex. (contralateral half of the body is represented inverted with hand and mouth situated inferiorly).



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Muscle Spindle (2)

Connective tissue sheath

Extrafusal fibers

Intrafusal fibers

Nuclear chain fibers

Nuclear bag fiber

Motor neurons

Gamma

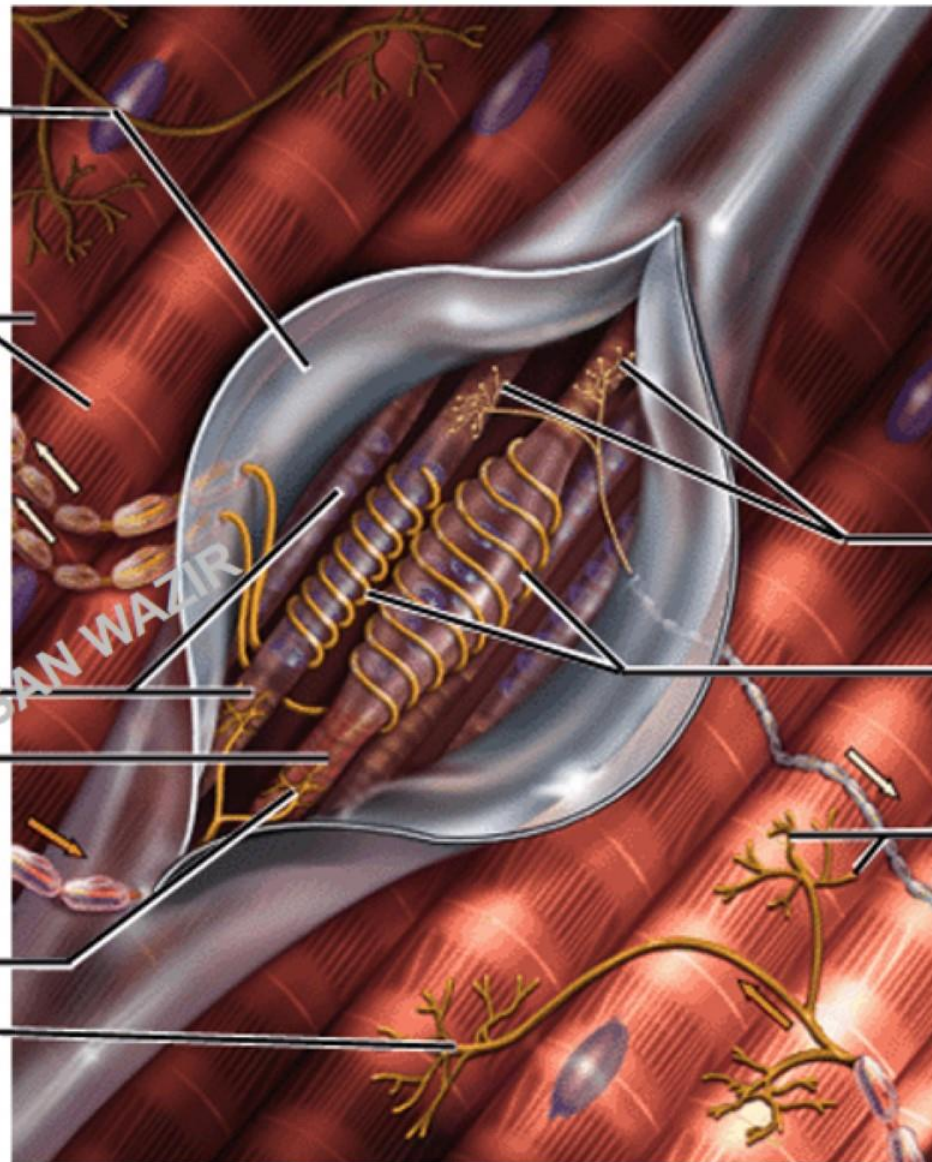
Alpha

Sensory nerve endings

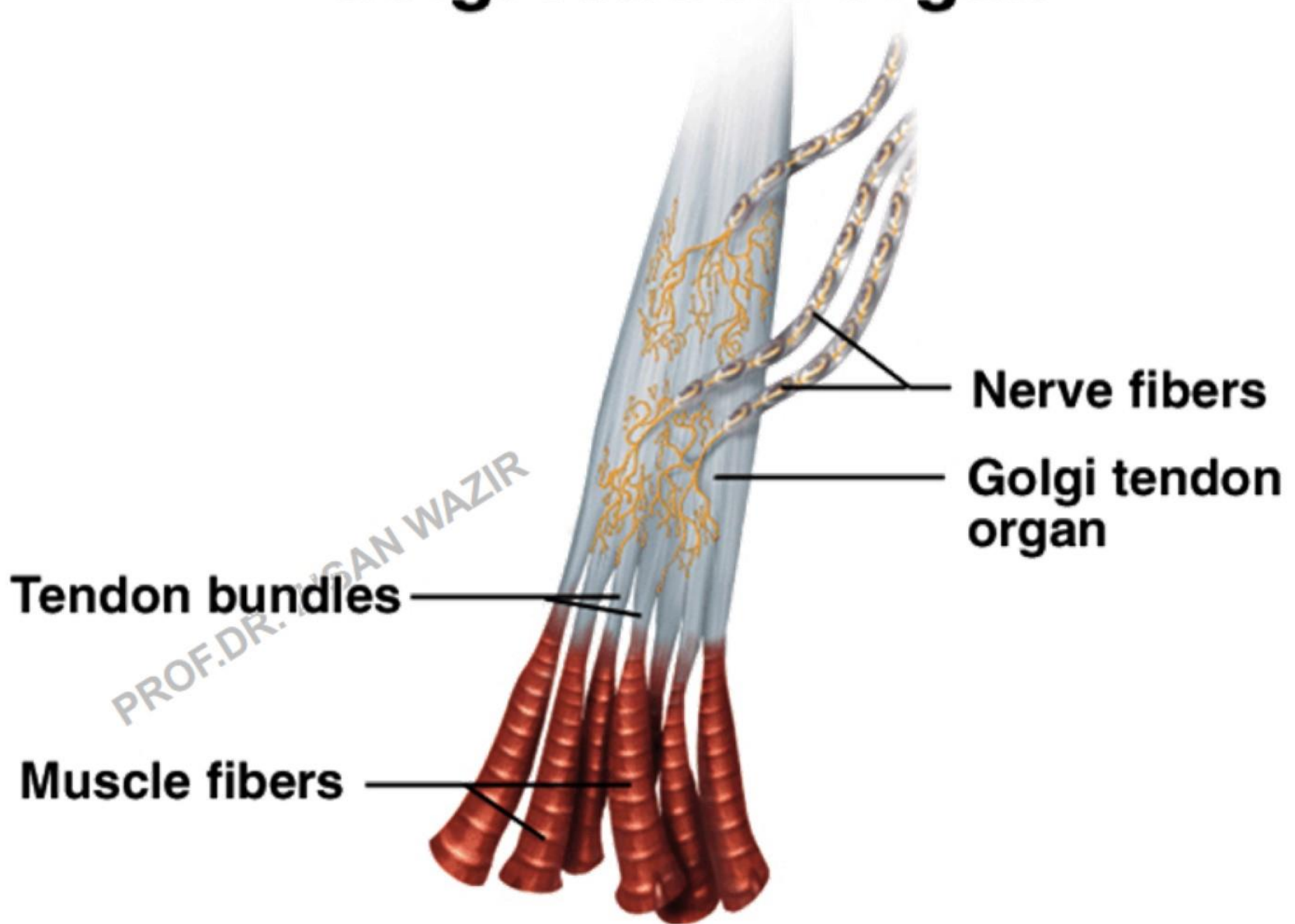
Flower-spray endings

Annulospiral endings

Motor end plates

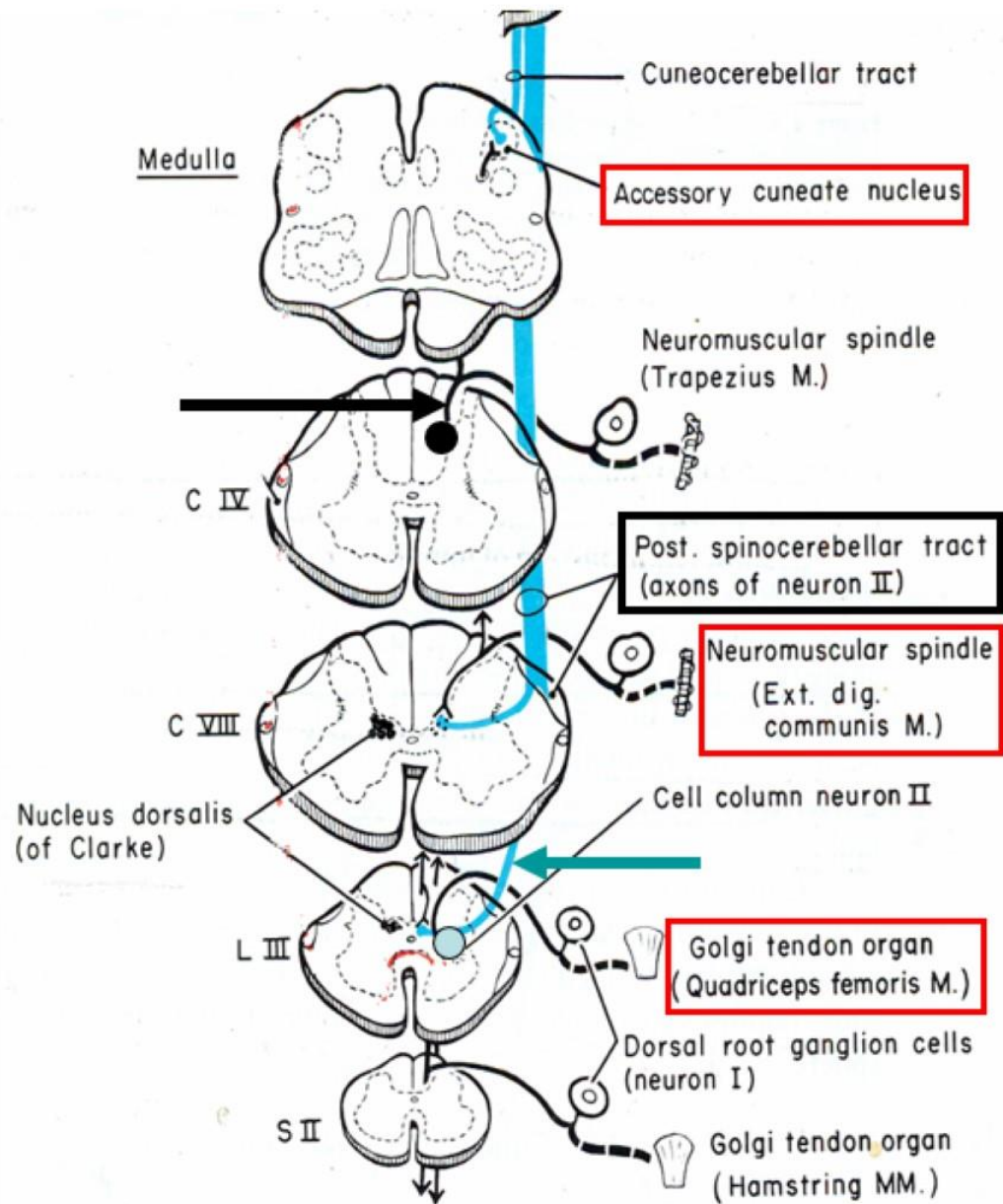


Golgi Tendon Organ



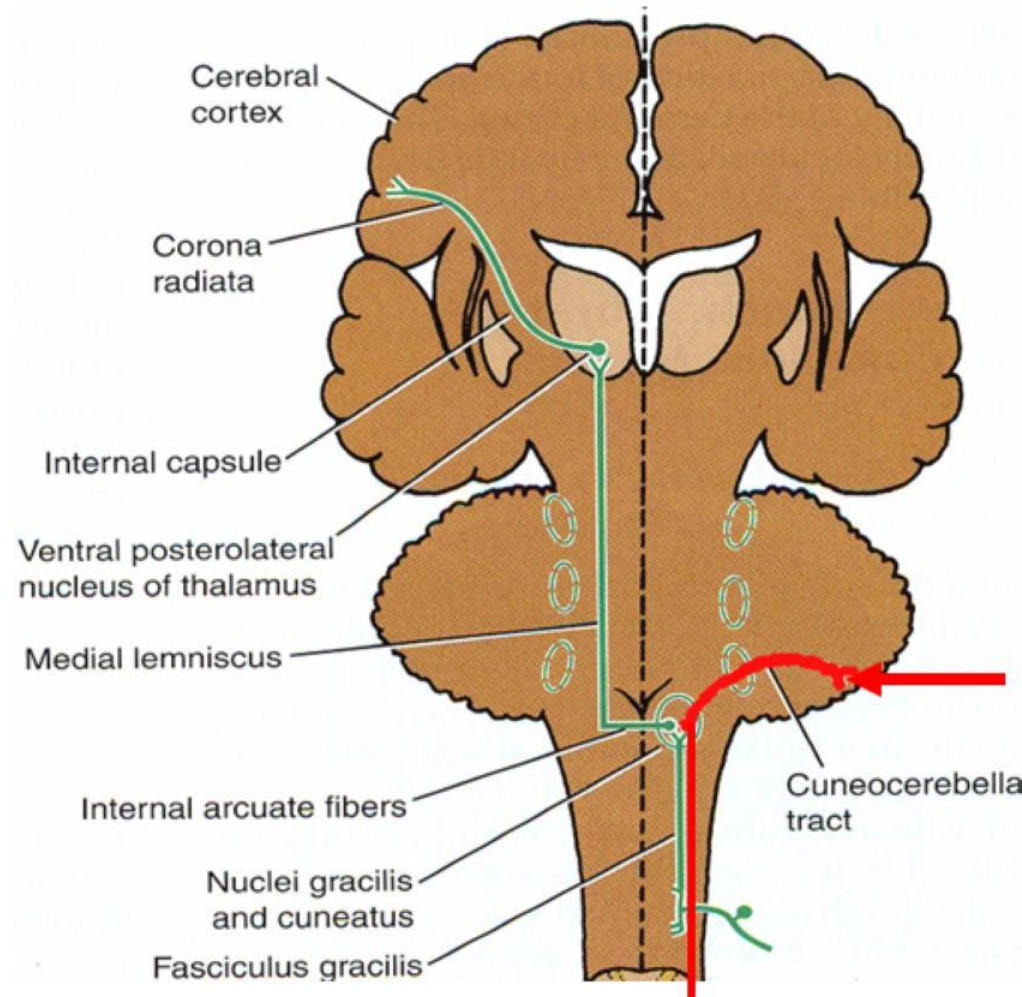
Spinal Cord Tracts

- **Muscle Joint Sense Pathways to the Cerebellum**
- **Post. Column also contains afferent impulses ascending from muscle spindles (Ia) and Golgi tendon organs (Ib) ➔**
- **From lower limb along with fasciculus gracilis reaches Clarke's nucleus (T1 – L2) at levels of L2 and above, and do not reach nucleus gracilis. (Post. Spinocerebellar tract)**
- **From upper limb fibers reaches sp. cord above nucleus of Clarke & ascend along with fasciculus cuneatus terminating on Accessory cuneate nucleus (medulla), whose cells resembles Clarke's nucleus, with eccentric nuclei.**



Spinal Cord Tracts

- Fibers from nucleus of Clarke and Acc. Cuneate nucleus (second order) enter cerebellum through Inferior cerebellar peduncle of the same side, ➡
- Fibers from Acc. Cuneate nucleus forms Cuneocerebellar tract (external arcuate fibers) –
- Impulses transmitted by these tracts to cerebellum are used in fine coordination of posture and movement of individual limb muscles.



Spinal Cord Tracts

- **FUNCTION OF POSTERIOR FIBERS COLUMN**
- Convey impulses concerned with touch & pressure, exact localization and two point discrimination (i.e. two close points touched simultaneously)
- Kinesthesia (vibratory sense) muscles and joint movement and position.
- A.A.
- Lesions in posterior columns diminish or abolish discriminating tactile & kinesthetic sense.
- Loss of position sense in lower limbs as in tubes dorsalis, impairs equilibrium and gait (post. Column ataxia)

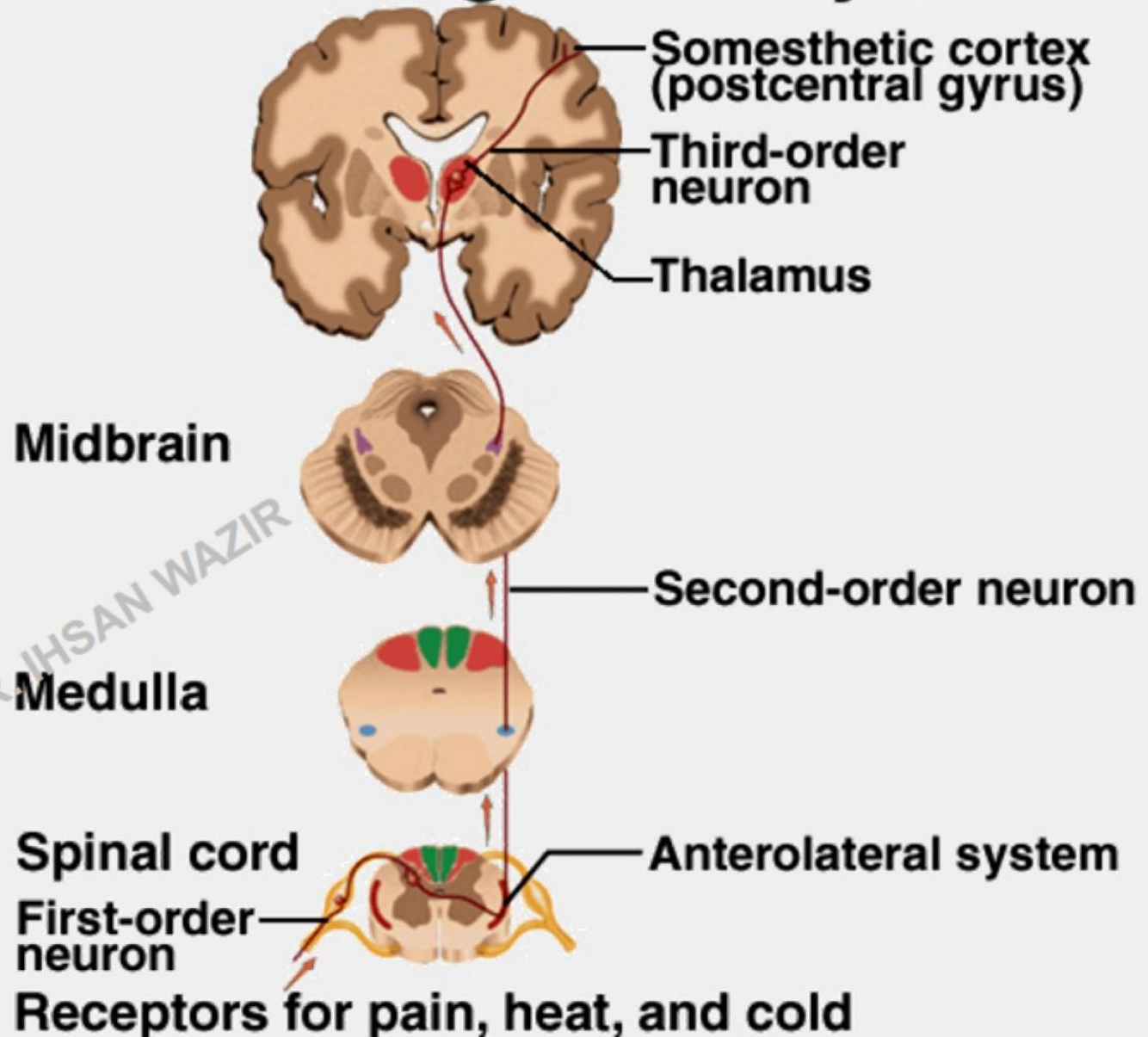
Tabes Dorsalis morphology: DORSALIS

- D**orsal column degeneration
- O**rthopedic pain (Charcot joints)
- R**eflexes decreased (deep tendon)
- S**hooting pain
- A**rgyll-Robertson pupils
- L**ocomotor ataxia
- I**mpaired proprioception
- S**yphilis

Applied Anatomy

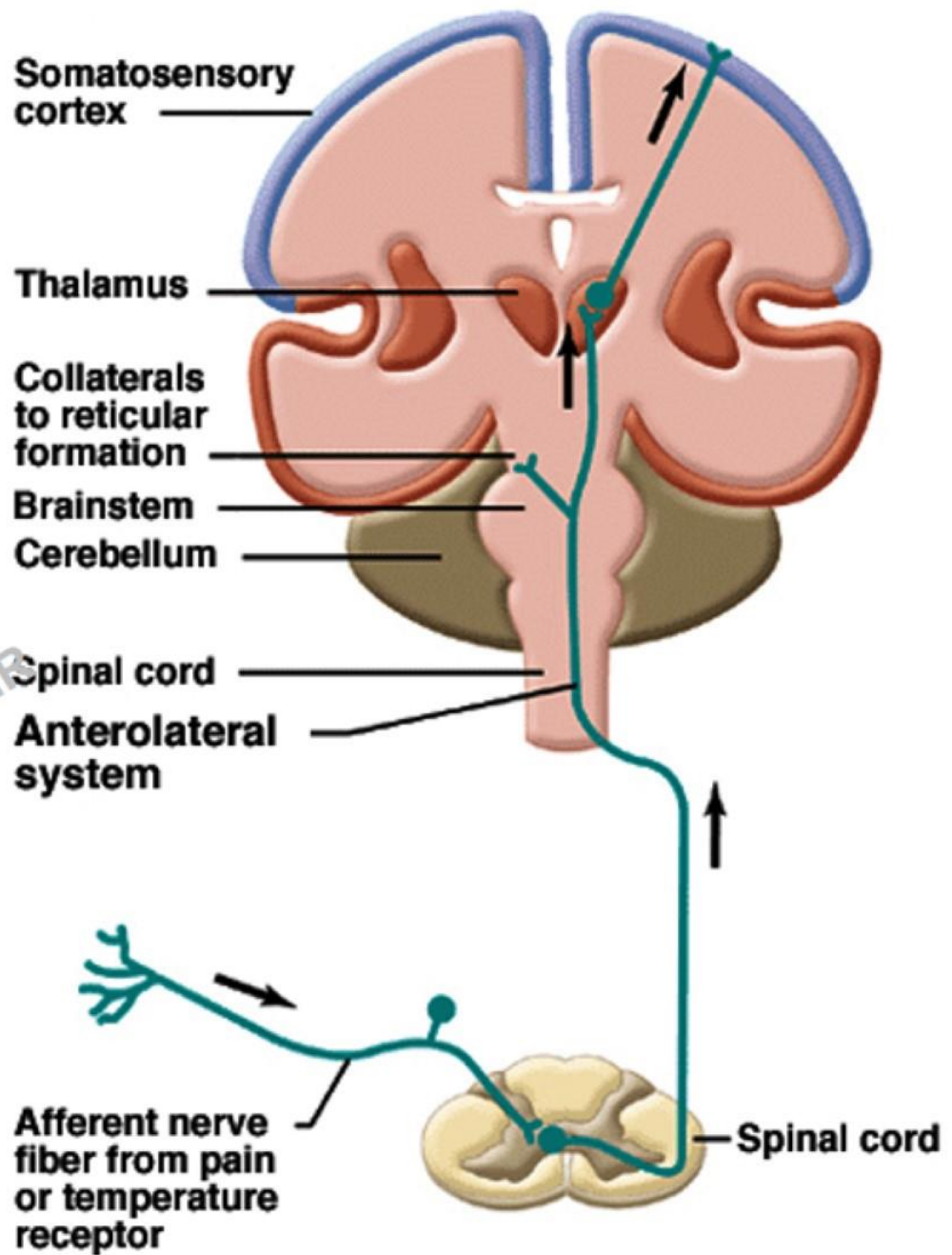
- *The pathway for proprioception gives a person the ability to localize each segment of his or her body in space.*
- *If the upper limb is in a prone horizontal position, a slight abduction of the thumb by just a few degrees will activate the receptors in the joints, muscles and tendons, and send the messages to the central nervous system so that the body is aware of the change in positioning.*
- *Fine touch is concerned with Stereognosis, which is the ability to identify forms and objects by simple touch.*
- *The tip of the fingers contains a large number of tactile receptors, mostly Meissner's corpuscles. With the help of these receptors, a person is capable of distinguishing two separate points at no more than one mm apart.*

CNS Ascending Pathway



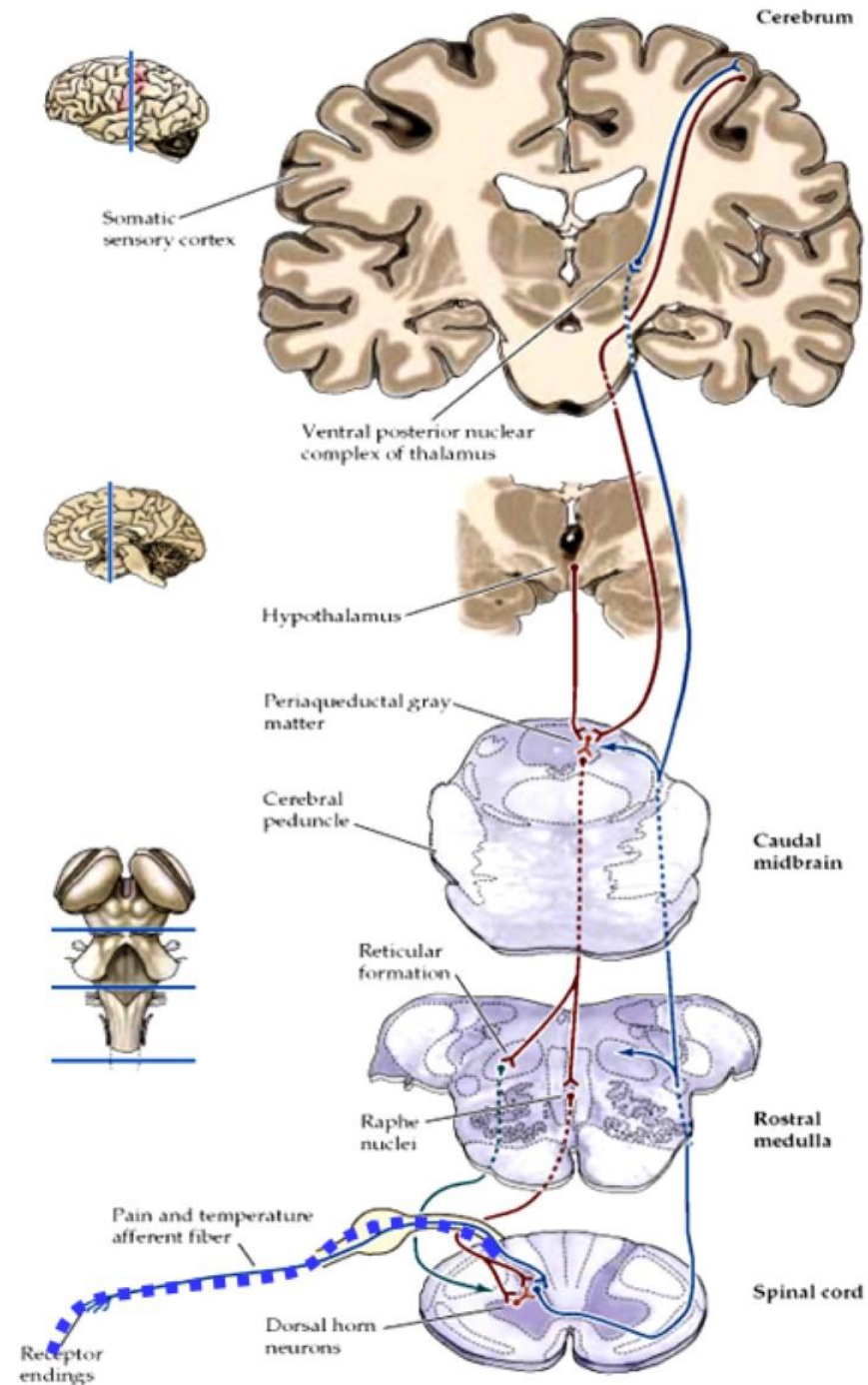
The anterolateral system

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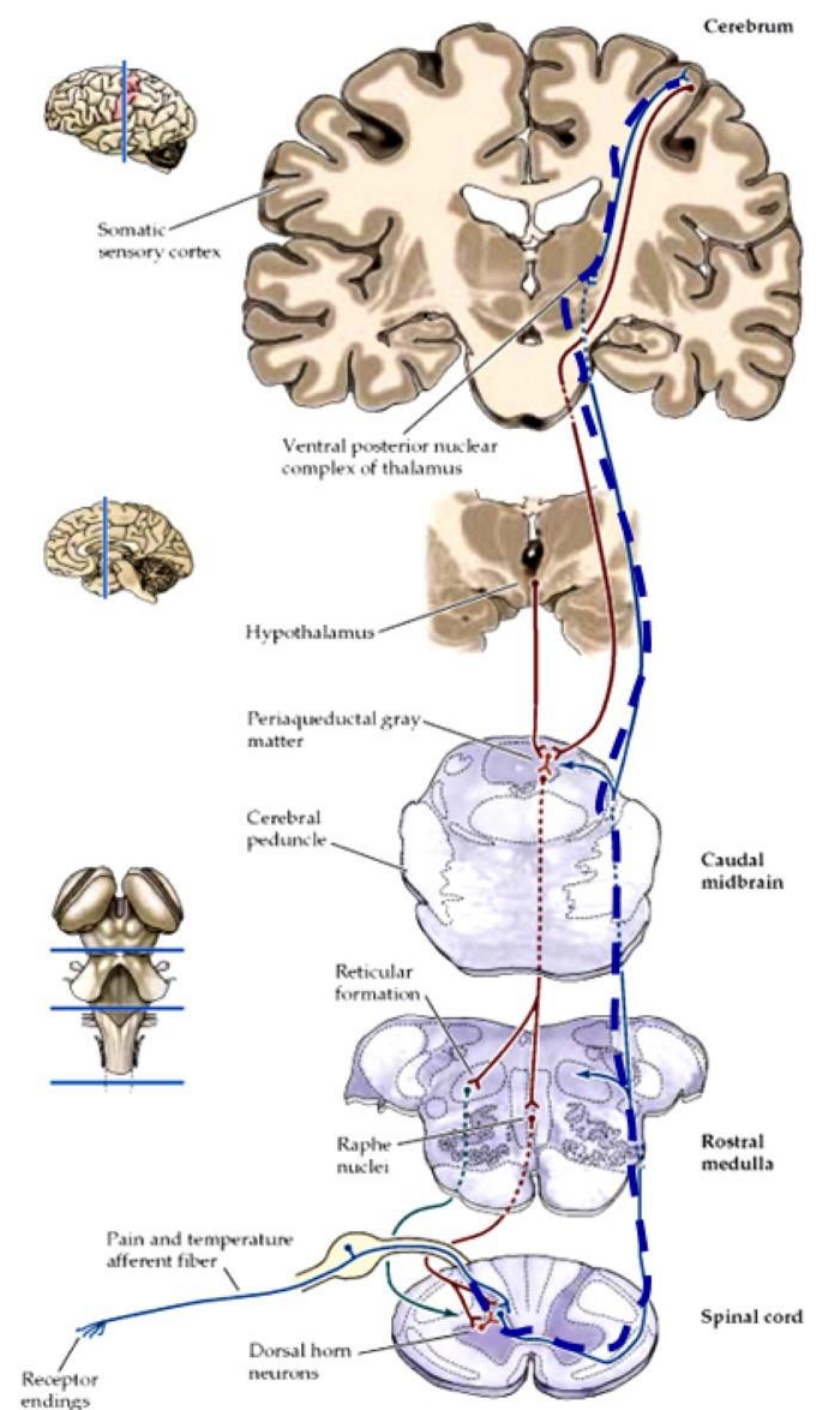
Spinothalamic Tracts

- **ANTERIOR SPINOTHALAMIC TRACT**
- Axons from DRG enters the spinal cord, divides into short ascending and descending branches which travel one or two segments and contributes to dorsolateral tract of Lissauer



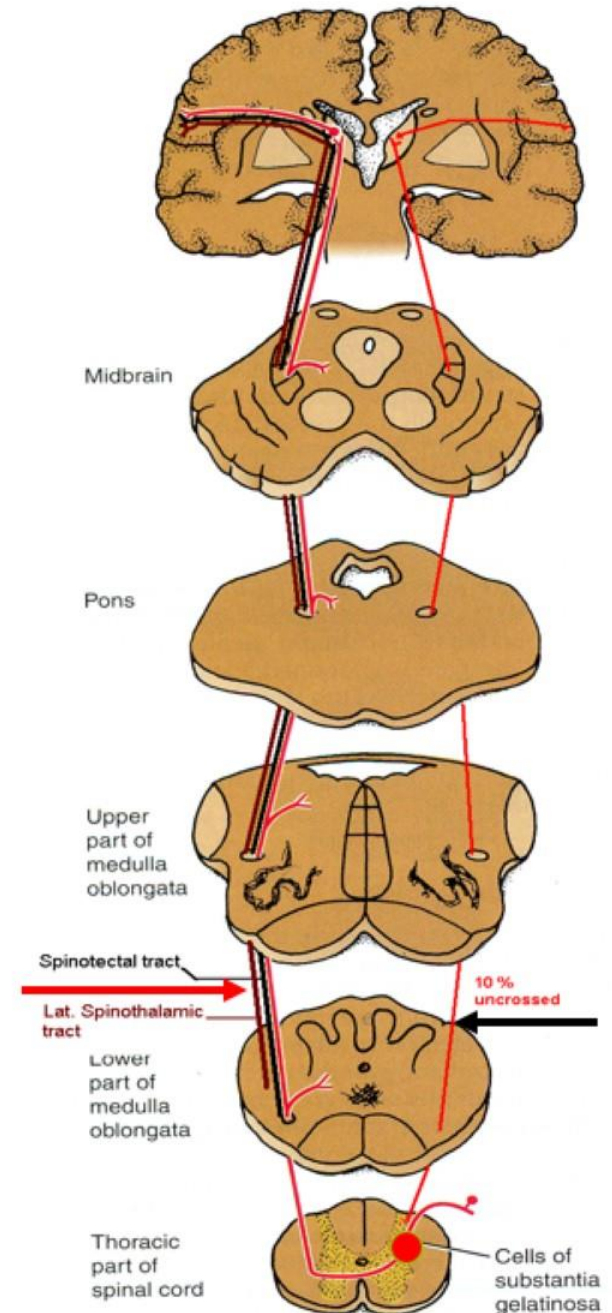
Spinothalamic Tracts

- **Fibers synapses with cells in Substantia gelatinosa, (second order neuron) ➔ axons which cross to the opposite side in the anterior grey and white commissure with in several segments and ascend contralaterally in anterior and anterolateral funiculus**



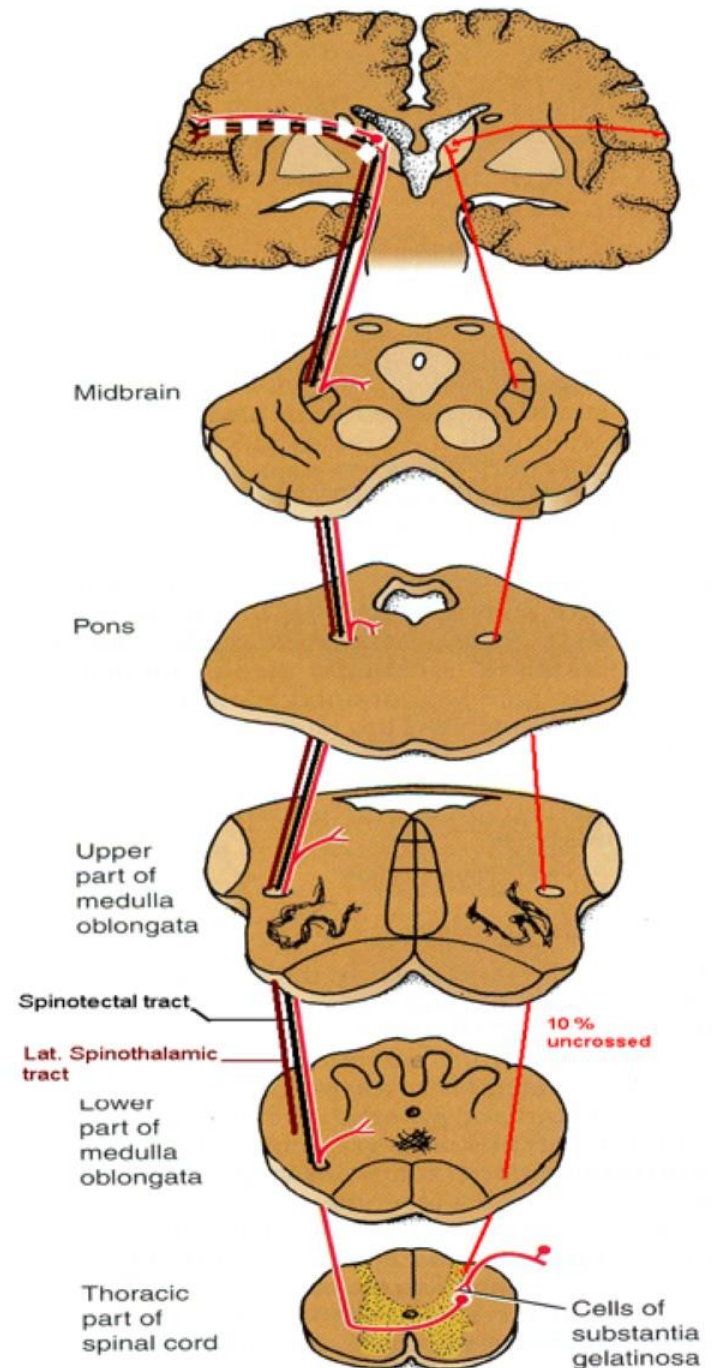
Spinothalamic Tracts

- About 10% of the fibers remains uncrossed.
- In medulla oblongata it is accompanied by lateral spinothalamic and spinotectal tract and forms spinal lemniscus ➔
- Ascend through posterior portion of pons and tegmentum of mid brain terminating in (third order neuron) ventral posterolateral nucleus VPLc (pars caudalis) of thalamus.



Spinothalamic Tracts

- From VPLc axons pass through posterior limb of internal capsule and corona radiata to posterior central gyrus.
- **Function:**
- **Light touch or Crude touch (or non-discriminative touch)**
(stroking with feather or cotton)



Spinothalamic Tracts

- **Crude touch (or non-discriminative touch) or light touch** is a sensory modality that allows the subject to sense that something has touched them, **without being able to localize where they were touched (contrasting "fine touch")**.
- **Crude (protopathic) touch**, lacks the fine discrimination and doesn't generally give enough information to the brain to enable it to recognise a familiar object by touch alone.
- **Discriminating (epicritic) fine touch** implies an awareness of an object's shape and the ability to recognise familiar objects simply by tactile manipulation.

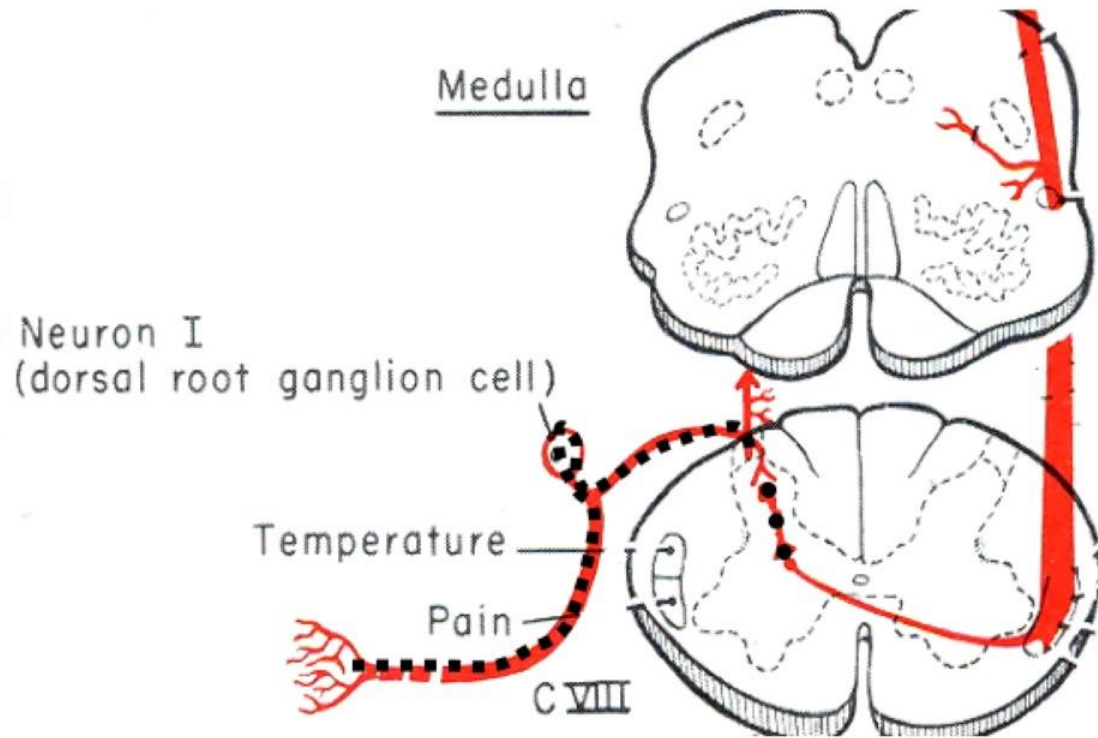
CORE TEXT OF NEUROANATOMY

Page 80

- Fibers of the **anterior spinothalamic tract** convey impulses associated with what is called "**light touch (crude)**"; this sensation is provoked by stroking skin, devoid of hair, with a feather or wisp of cotton.
- Injury to the anterior spinothalamic tract produces little, if any, disturbance because tactile sense also is conveyed by the posterior white columns

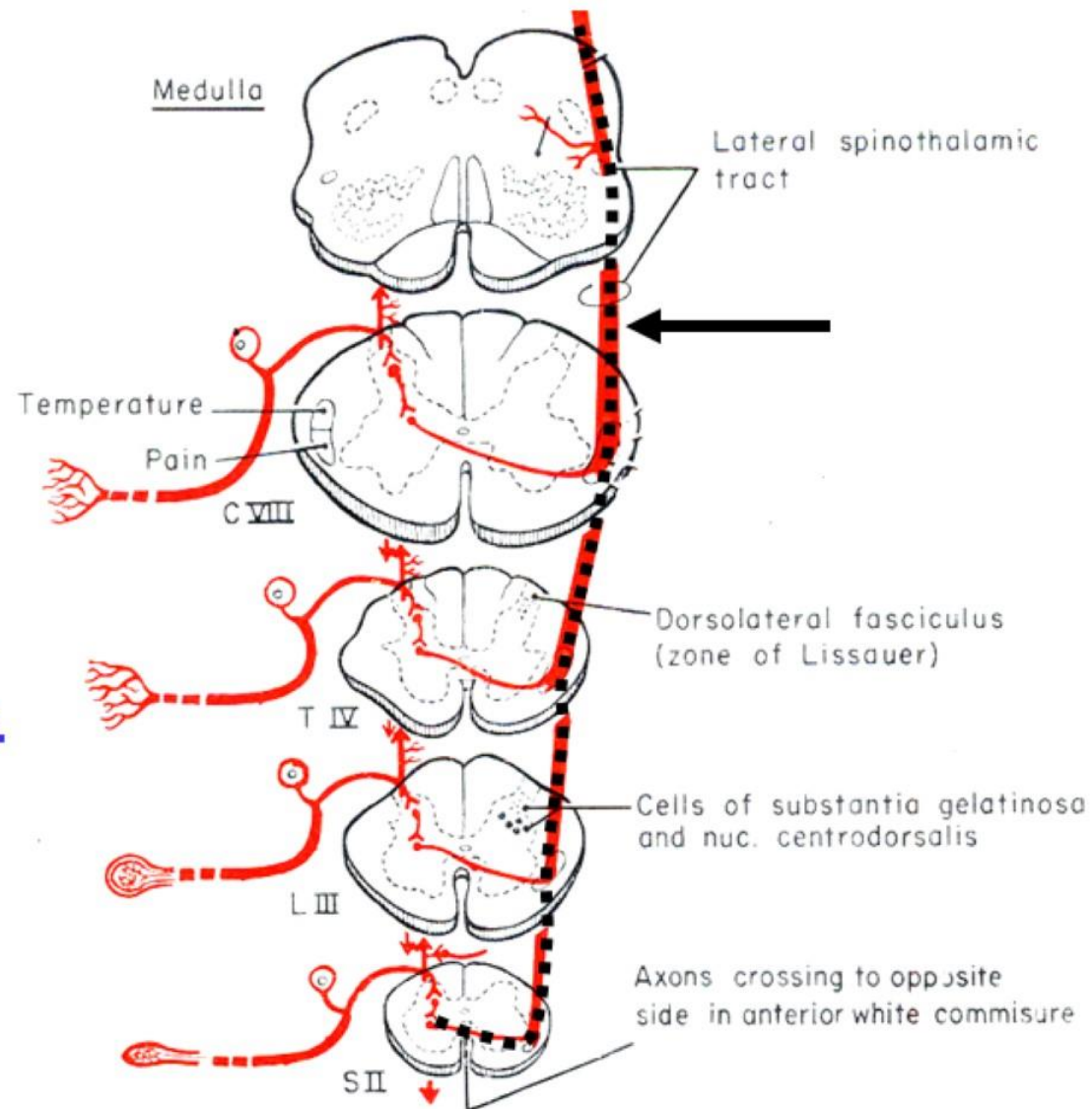
Spinothalamic Tracts

- LATERAL SPINOTHALAMIC TRACT
- Axons (1st order) enter the tip of posterior horn, divides into small ascending and descending branches in one or two spinal segments forming dorsolateral tract of Lissauer.
- These axons terminates in sub. gelatinosa (I – IV lamina) (second order neuron) (substance P, peptide is neurotransmitter)



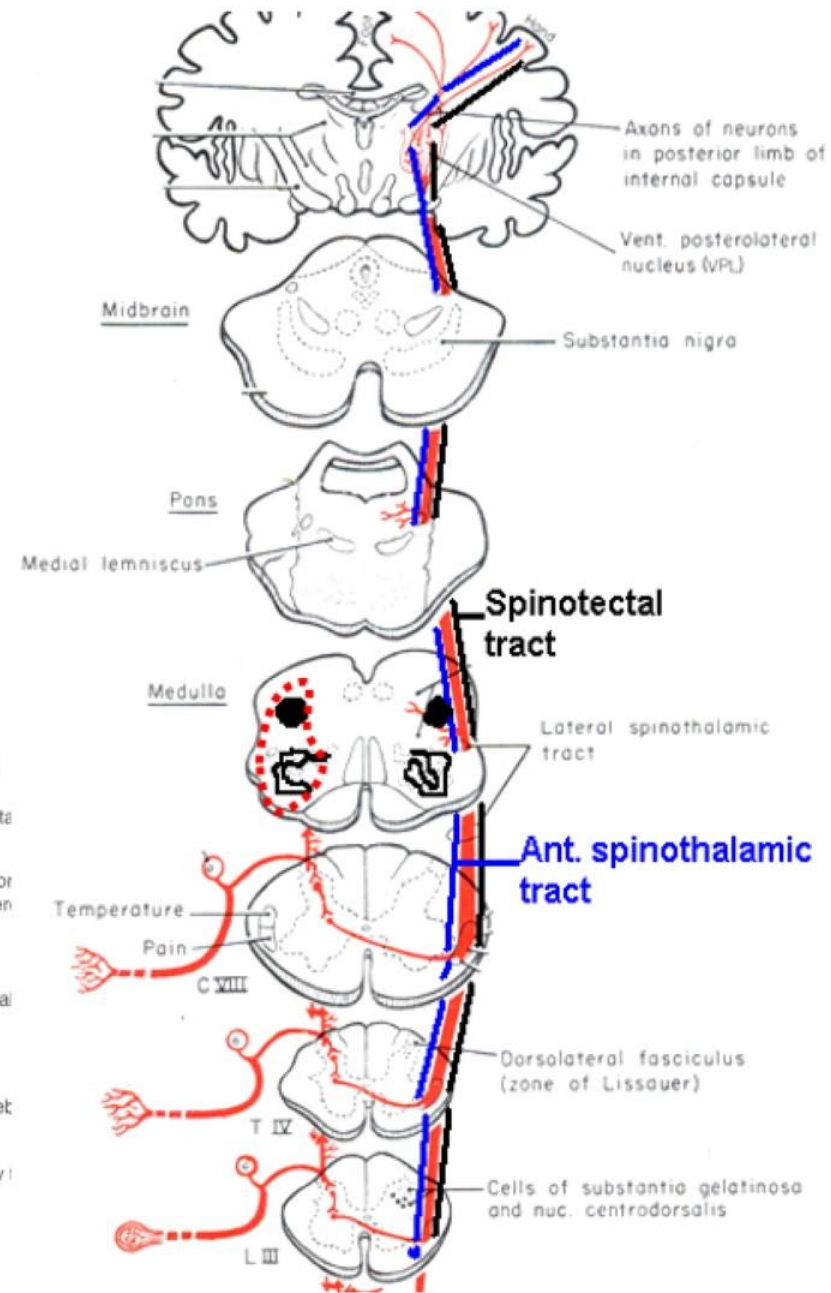
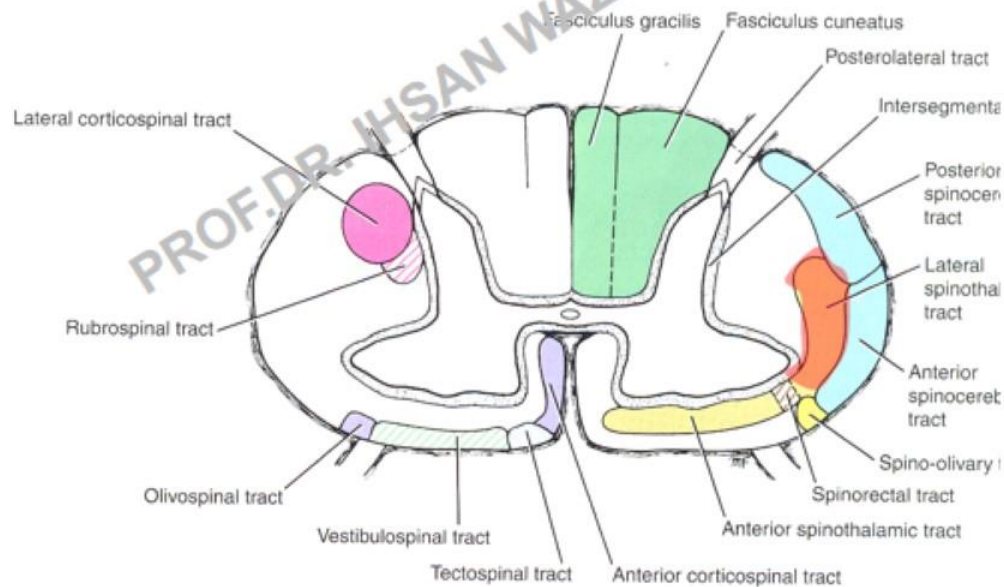
Spinothalamic Tracts

- Axon of (second order neuron) pass to opposite side in the anterior grey and white commissure remaining in one spinal segment then ascend as lateral spinothalamic tract.



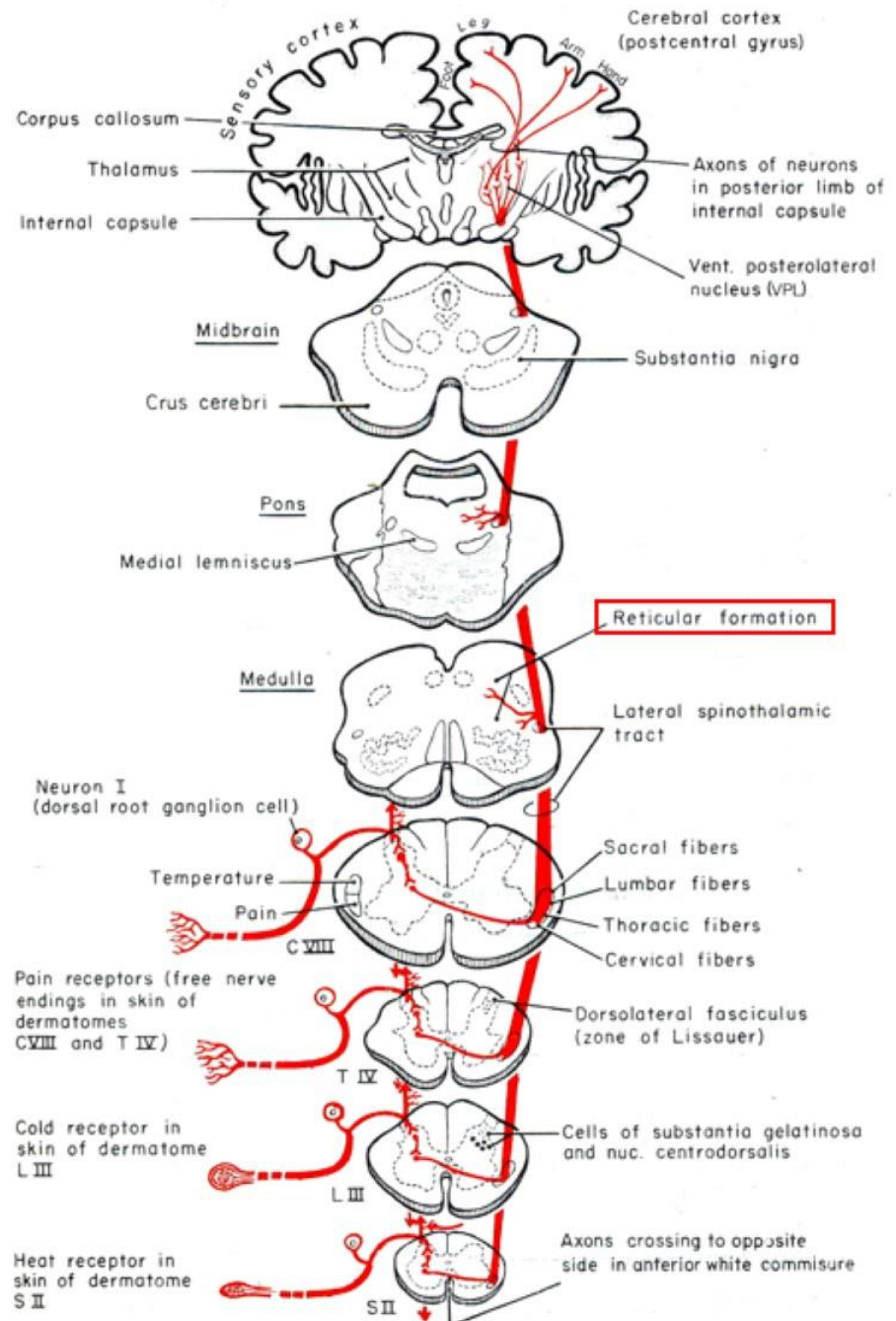
Spinothalamic Tracts

- Lie medial to anterior spinocerebellar tract in medulla.
- Lies close to the lateral surface between the inferior olivary nucleus and the nucleus of spinal tract of trigeminal nerve,
- Here it is accompanied by anterior spinothalamic and spinotectal tract forming spinal lemniscus.



Spinothalamic Tracts

- Thermal fibers lie posterior to pain conducting fibers.
- In the brain stem (medulla, pons, midbrain) it sends fibers to reticular formation,
- Terminates in the VPLc nucleus in the thalamus (third order) and through the internal capsule and corona radiata to posterior central gyrus. ➔



Spinothalamic Tracts

- Pain impulses to spinal cord are conducted either in thick delta **A type** fibers (fast) 6 – 30 m/sec or ➡
- Thin **C type** fibers (slow) 0.5 – 2 m/sec.
- Fast pain alerts the individual to danger,
- slow pain – reticular formation – the individual becomes aware of chronic, nauseas, suffering type of pain
- Lateral spinothalamic tract transmits pain and thermal impulses.

