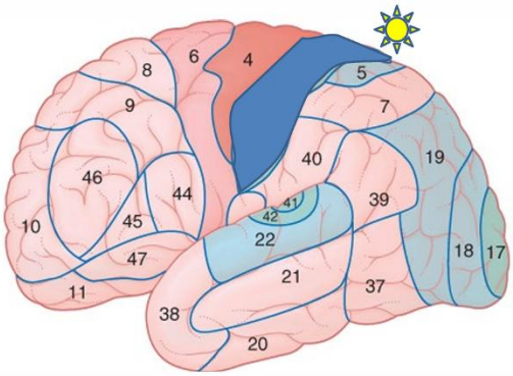
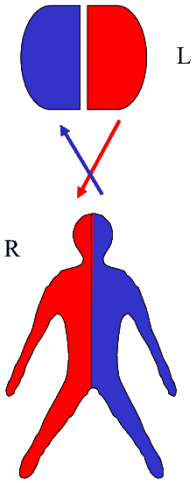
Ascending (Sensory)Tracts

- *The ascending tracts carry sensory information from the peripheries to the primary somatosensory cortex in the* ***post-central gyrus*** *of the cerebral cortex.*

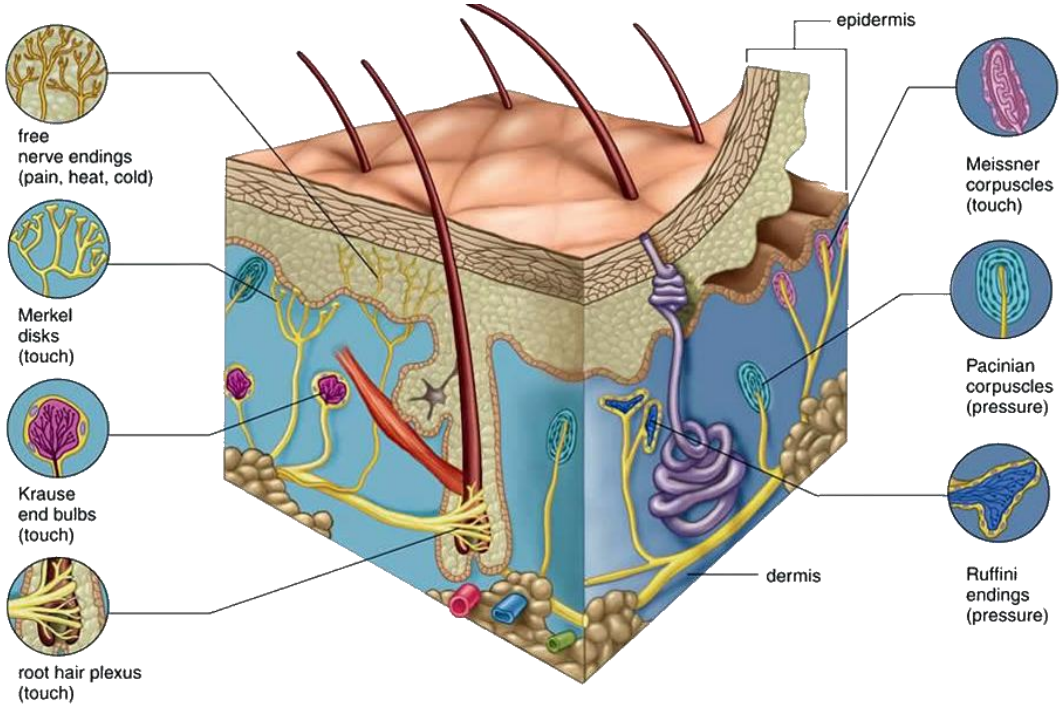


- *Control of the body by the brain:*
  - *Contralateral (opposite side) representation.*
  - ***Decussation = Crossing.***



The general senses:

General sense	Receptor
Temperature and pain	Free nerve ending
Discriminative Touch	Meissner corpuscle
Crude Touch	Ruffini ending
Deep pressure	Pacinian corpuscle

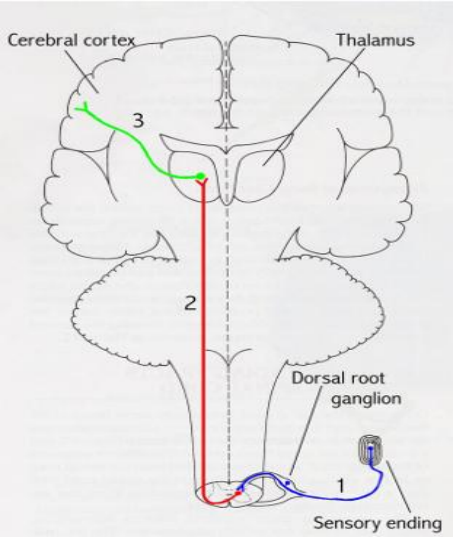


Sensation VS Perception

- *Sensation: A conscious or unconscious* **awareness** *of external or internal stimuli.*
- *Perception: The conscious* **awareness and interpretation** *of sensations.*

Neurons of the main ascending tracts

- ***3 orders*** *of neurons.*
- *1st order, 2nd order and 3rd order neurons.*

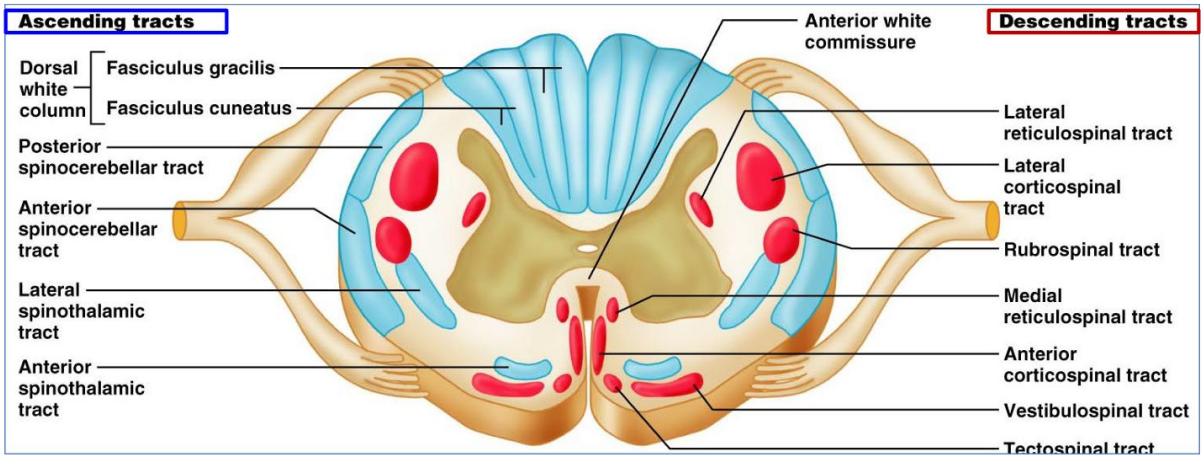


White matter tracts

- *Bundles or fasciculi of fibers have the* **same Origin, Termination and carry the same Function.**

Long tracts

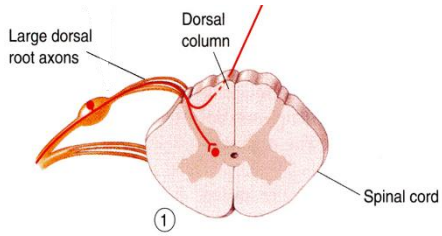
- *They are of two types:*
  - ***Ascending*** *(sensory or afferent).*
  - ***Descending*** *(motor or efferent).*
- *They serve to join the brain to the spinal cord.*



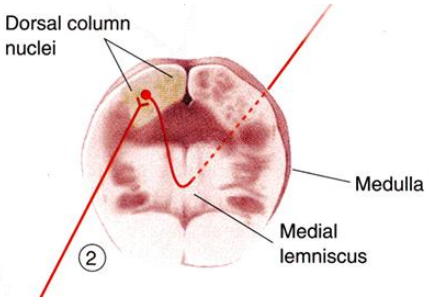
Ascending tracts

- *They carry impulses from pain, thermal, tactile, muscle and joint receptors to the brain*
- *Some of this information eventually reaches a conscious level (at the cerebral cortex), while some is destined for subconscious centers (at the cerebellum).*
- *Pathways that carry information to a conscious level share certain common characteristic:*
    - *There is a sequence of three neurons between the peripheral receptors and the cerebral cortex (1st, 2nd & 3rd order neurons).*

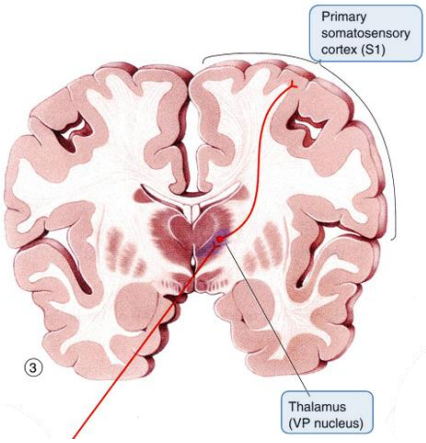
- *The axons of the first-order neuron (primary afferent neuron) enter the spinal cord through the dorsal root of a spinal nerve and its cell body lies in the dorsal root ganglion.*

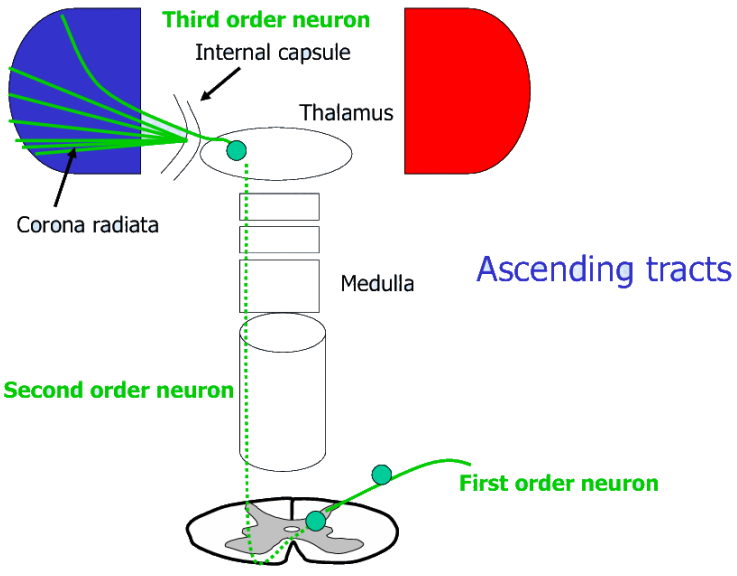


- *The main fiber remains on the ipsilateral side of the cord and terminates in synaptic contact with the second neuron which lies either in the spinal grey matter or in the medulla oblongata of the brain stem. The axon of the second order neuron decussates to the opposite side of the CNS.*



- *The third-order neuron has its cell body in the thalamus. Its axon passes to the somatosensory cortex of the parietal lobe of the cerebral hemisphere*





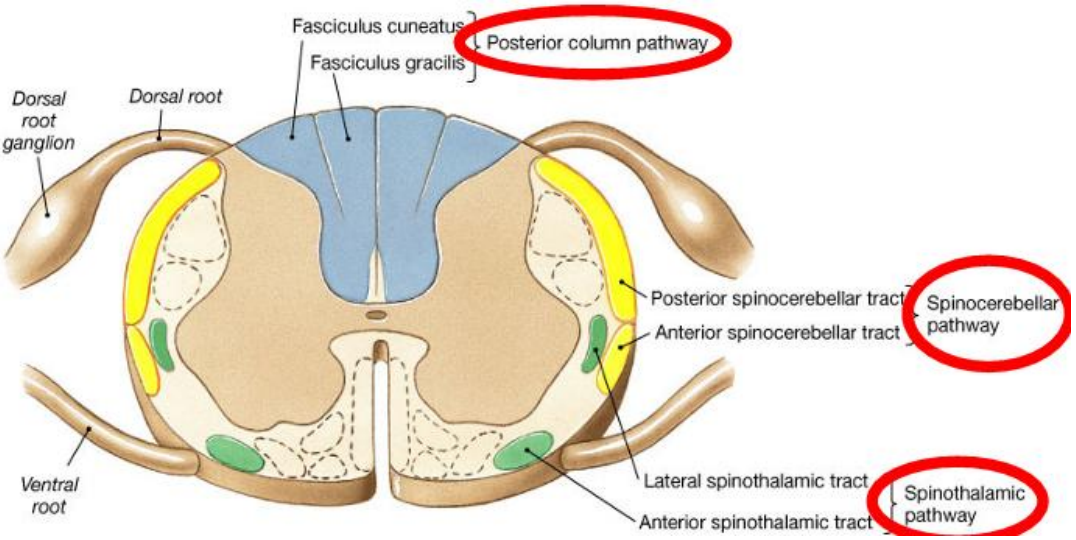
Ascending tracts

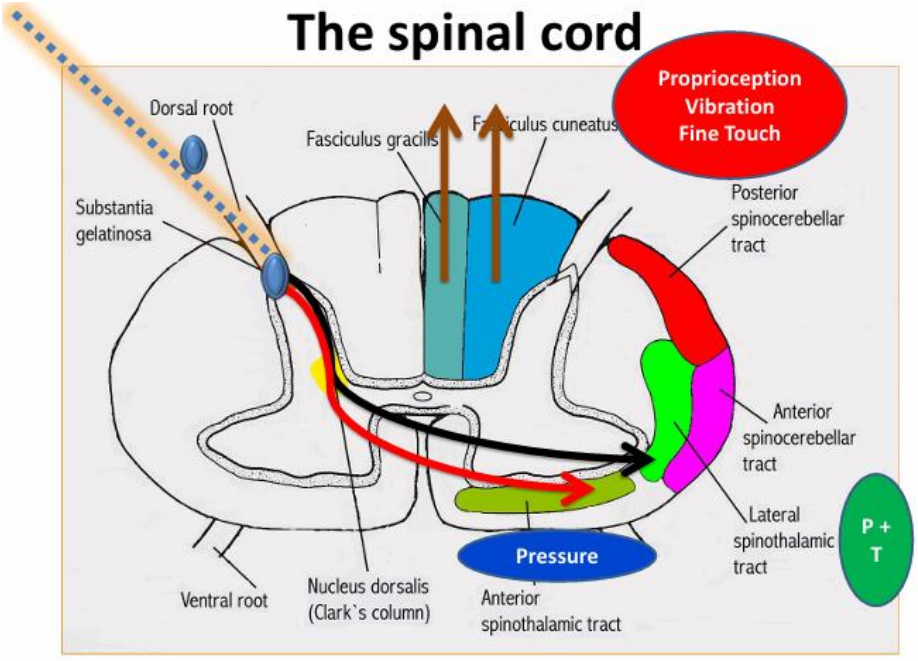
The three Major pathways of ascending tracts are:

1. Dorsal columns (Gracile & Cuneate)

2. Antero-lateral pathway (Spinothalamic tracts)

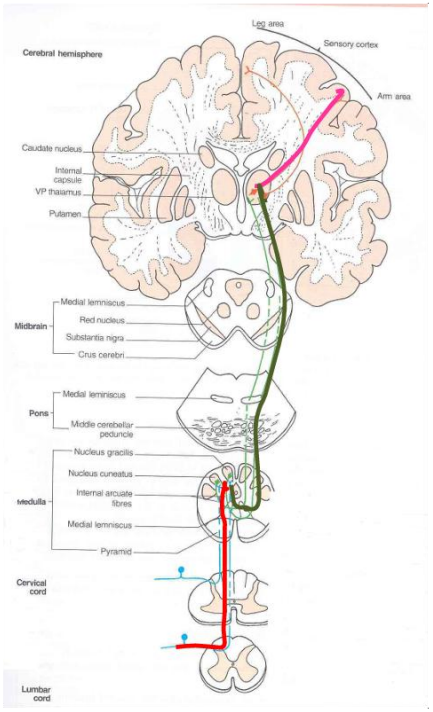
3. Spinocerebellar pathway (Ventral & Dorsal)

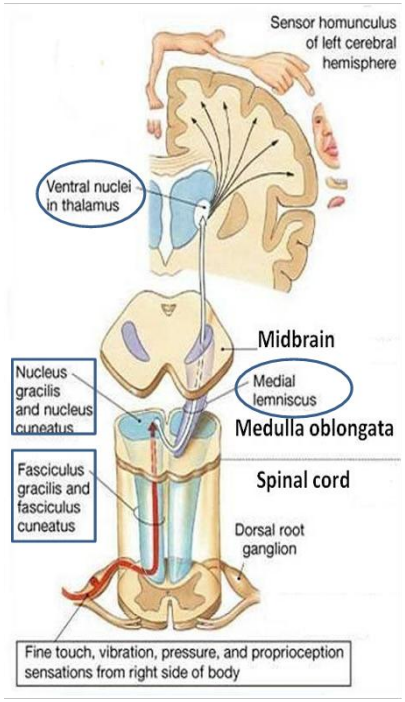


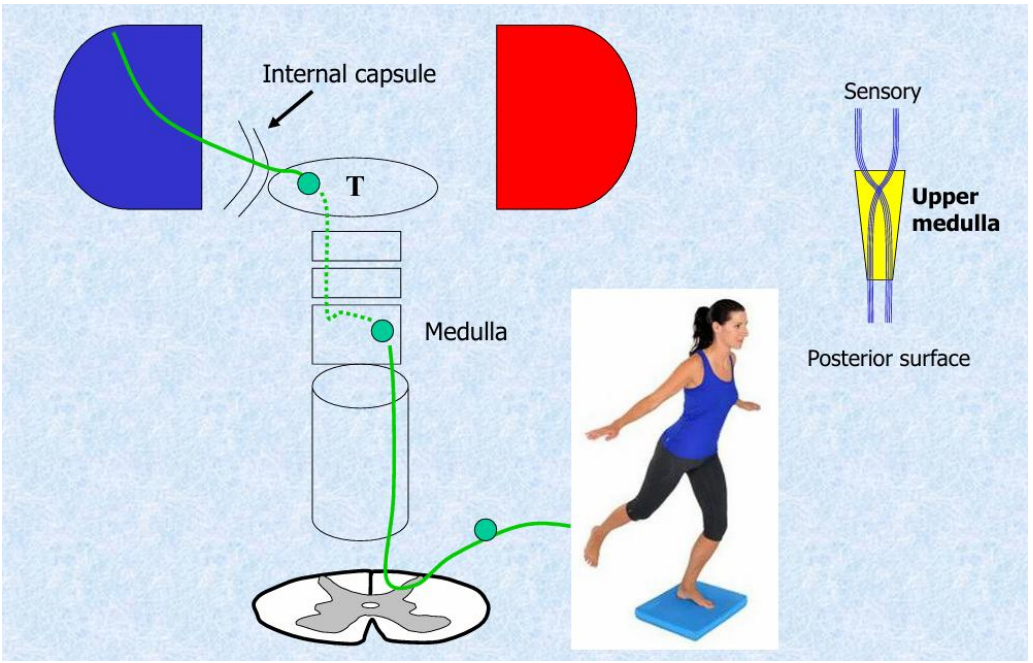


a) Dorsal (Posterior) column (Gracile & Cuneate)

1st order neuron	From **receptors** in periphery → **gracile and cuneate** tracts → ascend to **nuclei** gracile and cuneate in **medulla**.	
2nd order neuron	From nuclei gracile and cuneate in medulla → **decussate in medulla** → become **internal arcuate fibers** → **ascend** brainstem as the **medial lemniscus** → **VPL** nucleus of thalamus.	
3rd order neuron	From VP nucleus in thalamus → though posterior limb of internal capsule → cerebral cortex.	
Function	Carry impulses related to **conscious proprioception** movement and joint position & **discriminative touch**	
Tracts:	Gracile Tract	Cuneate Tract
	Contains fibers that are received at **sacral, lumbar and lower thoracic levels**.	Contains fibers that are received at **upper thoracic and cervical levels**.

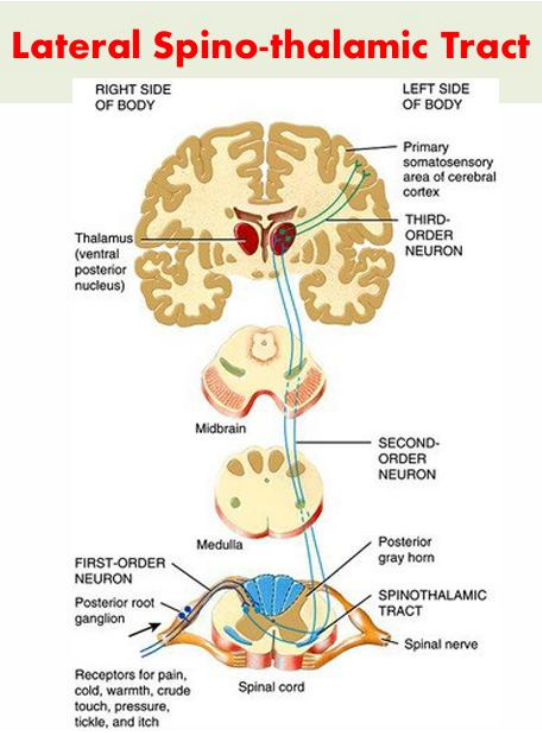


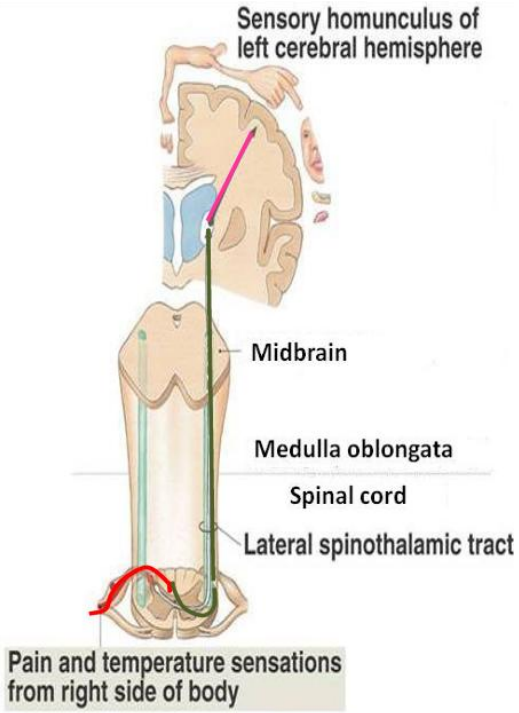


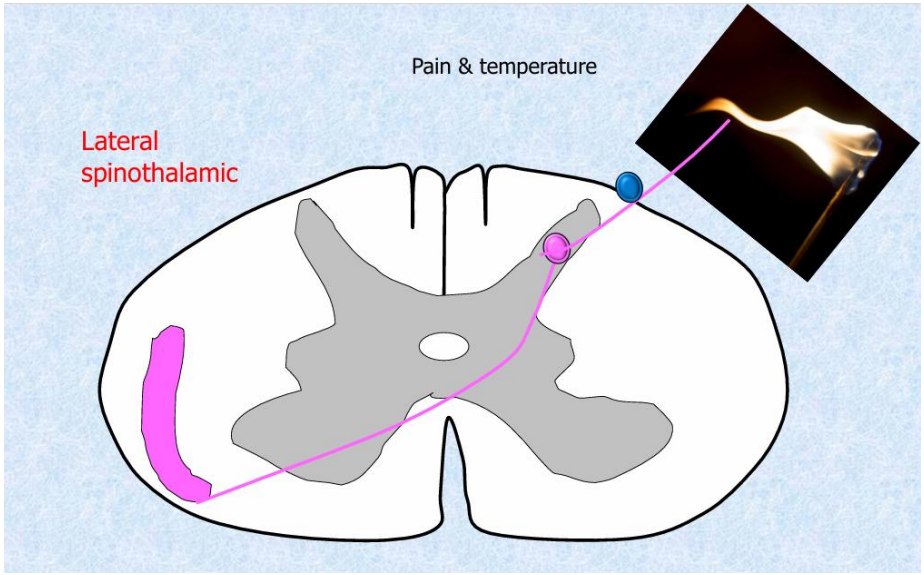


b) Lateral spinothalamic tract

1st order neuron	From **receptors** in periphery (fast (A) or slow (C) fibers) → **substantia gelatinosa** in dorsal horn.		
2nd order neuron	From substantia gelatinosa → **decussates within 1 spinal segment** and ascends in lateral Spinothalamic tract → **spinal lemniscus** in brainstem → ventral posterolateral (**VP**) nucleus in thalamus		
3rd order neuron	From VP nucleus in thalamus → though posterior limb of internal capsule → cerebral cortex.		
Function	Carries **pain & Temperature** to thalamus and sensory area of the cerebral cortex.		
Neurons	Neuron I	Neuron II	Neuron III
	Small cells in the dorsal root ganglia.	Cells of **substantia gelatinosa of Rolandi** in the posterior horn.	Cells of (**VP**) nucleus of the thalamus.

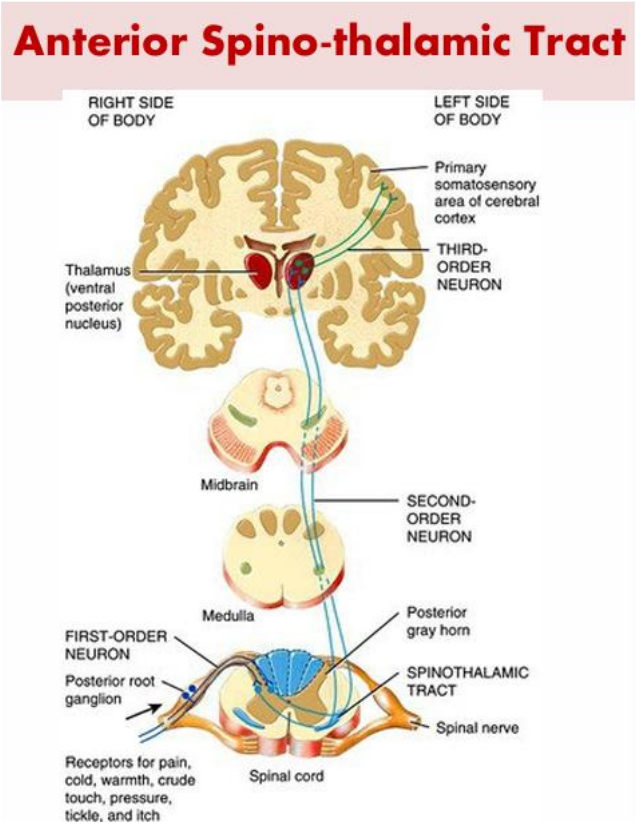


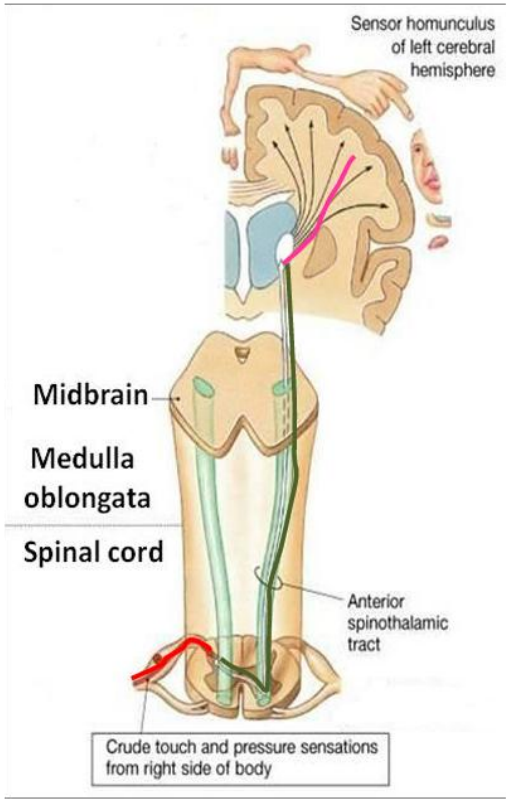


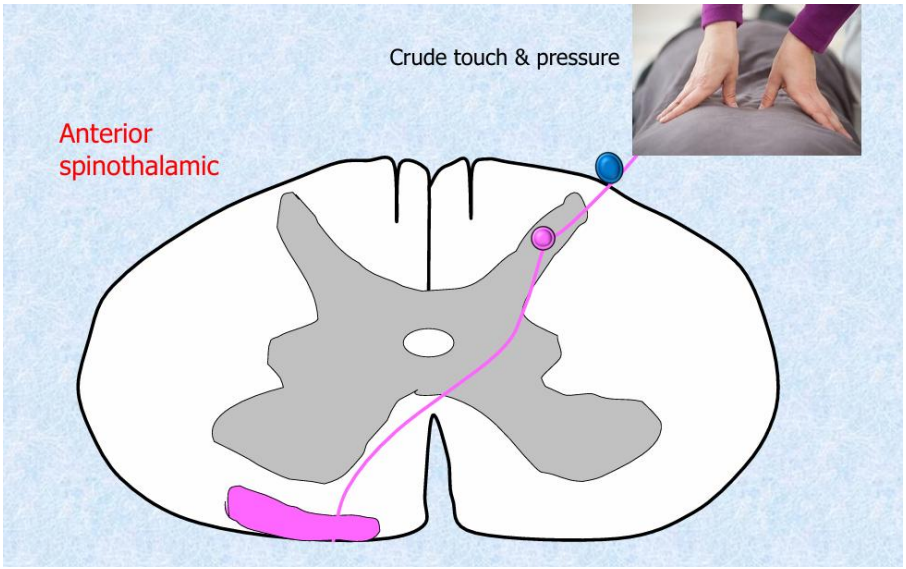


c) Anterior spinothalamic tract

1st order neuron	From various receptors in periphery → substantia gelatinosa in dorsal horn		
2nd order neuron	From substantia gelatinosa → decussates over several spinal segments and ascends in anterior Spinothalamic tract → spinal lemniscus in brainstem → ventral posterolateral (VP) nucleus in thalamus		
3rd order neuron	From VP nucleus in thalamus → though posterior limb of internal capsule → cerebral cortex		
Function	Carries crude touch (non-discriminative) & pressure to thalamus and sensory cortex.		
Neurons	Neuron I	Neuron II	Neuron III
	Medium sized cells in the dorsal root ganglia.	Cells of main sensory nucleus (nucleus proprius).	Cells of VP nucleus of thalamus.

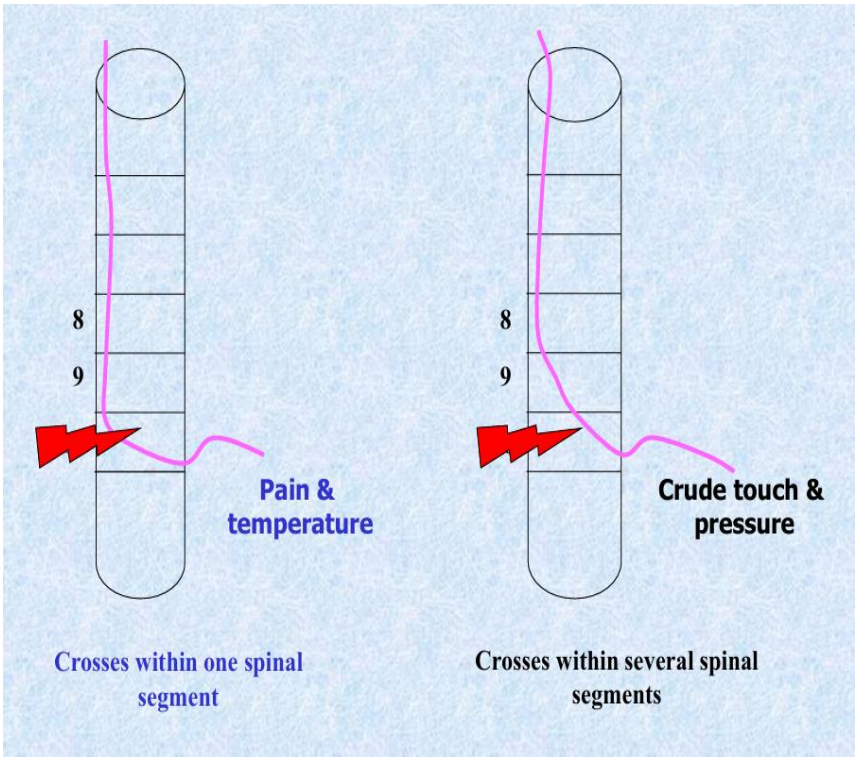


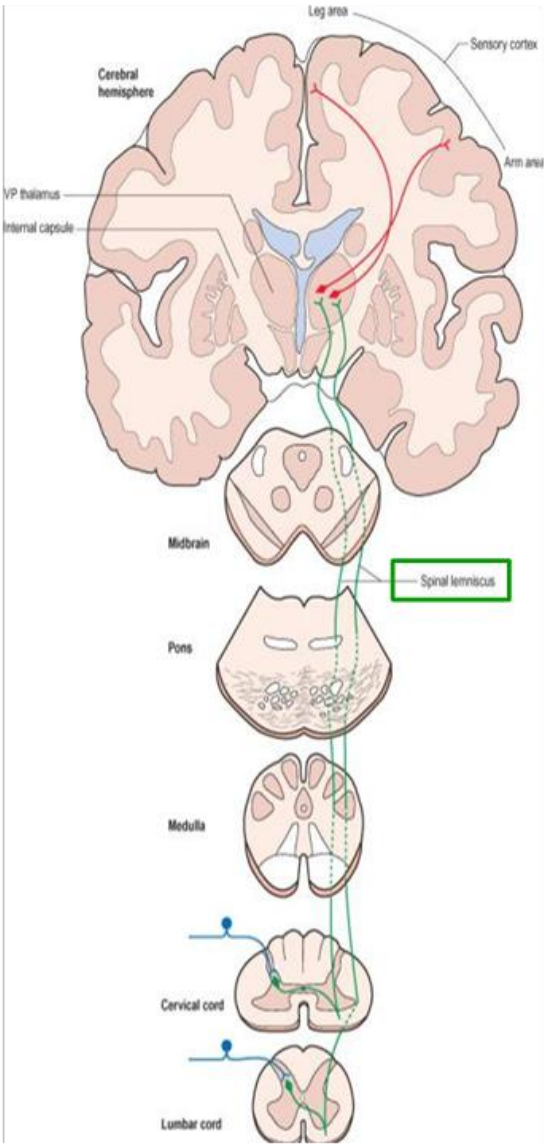




Spino-thalamic tracts:

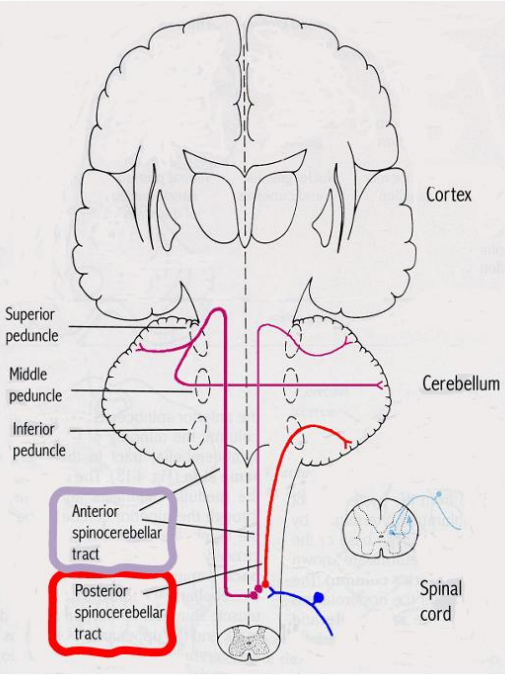
- *The spino-thalamic tracts contain* **axons of second order neurons**, *the cell bodies of which lie in the* **contralateral** *dorsal horn.*
- *Carry impulses concerned with;* **pain and thermal sensations** *(Lateral tract) and* **non-discriminative touch and pressure** *(Anterior tract), from the contralateral side.*
- *In brain stem, the two tracts constitute the Spinal Lemniscus.*
- *Information is sent to the primary sensory cortex on the opposite side of the body.*

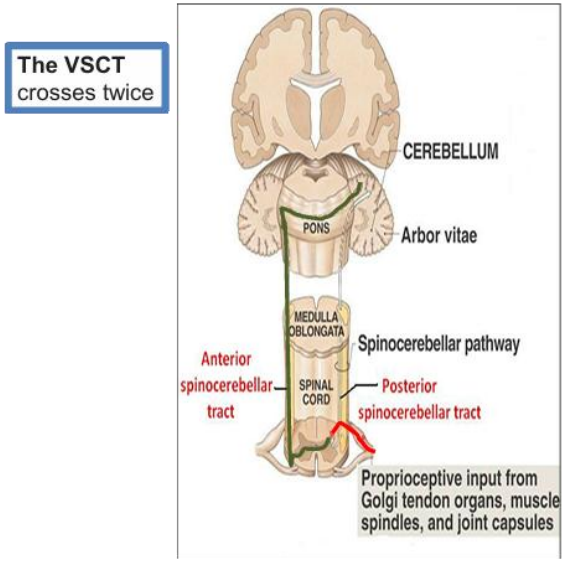


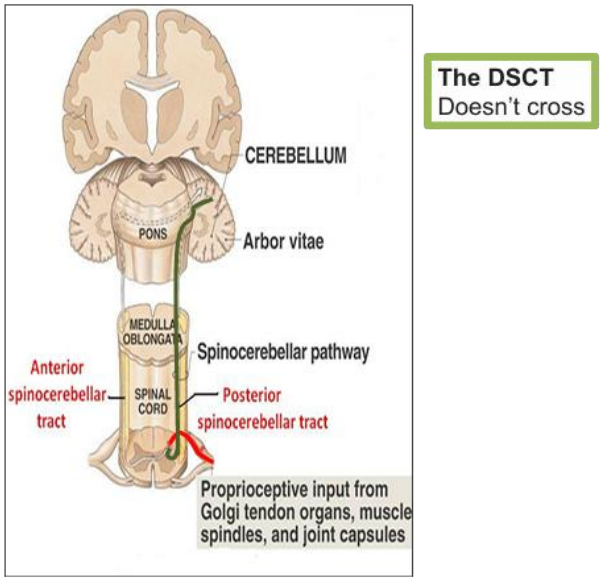


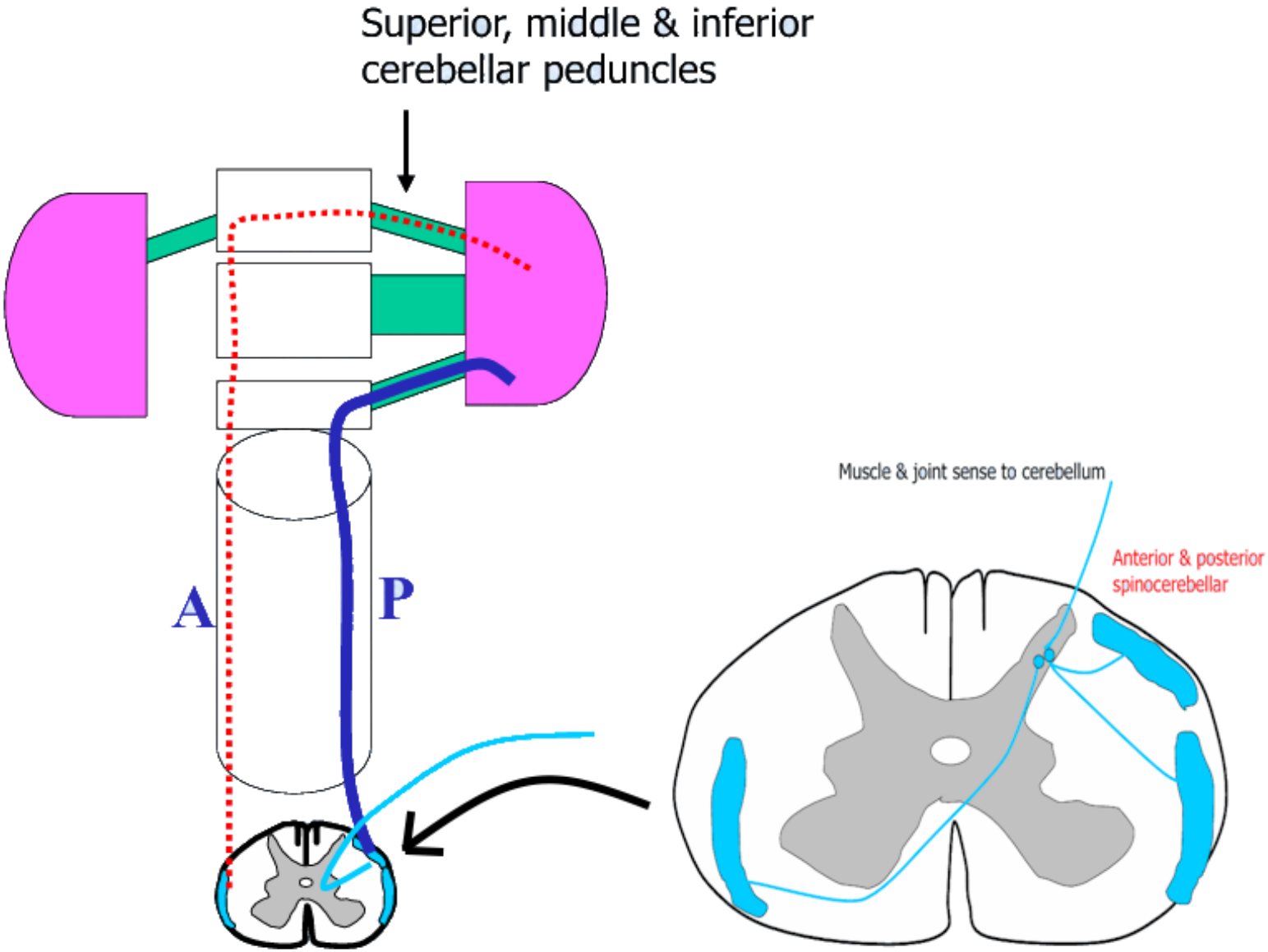
d) Spino-cerebellar tract

1st order neuron	From receptors in periphery → nucleus dorsalis	
2nd order neuron	Dorsal tract	Nucleus dorsalis → Remains uncrossed → ascend in posterior Spinocerebellar tract → inferior cerebellar peduncle in cerebellum
	Ventral tract	Nucleus dorsalis → Some fibers decussate as soon as enter spinal cord → ascend in anterior spinocerebellar tract to superior cerebellar peduncle in cerebellum
Function	Carry information derived from muscle spindles, Golgi tendon and tactile receptors to the cerebellum for the control of posture and coordination of movements (unconscious proprioception).	
N.B.	The spino-cerebellar tract doesn't contain a 3rd order neuron because it doesn't reach the cortex.	
Neurons	Neuron I	Neuron II
	Large cells of dorsal root ganglia.	Cells of the nucleus dorsalis; Clark's nucleus (column).



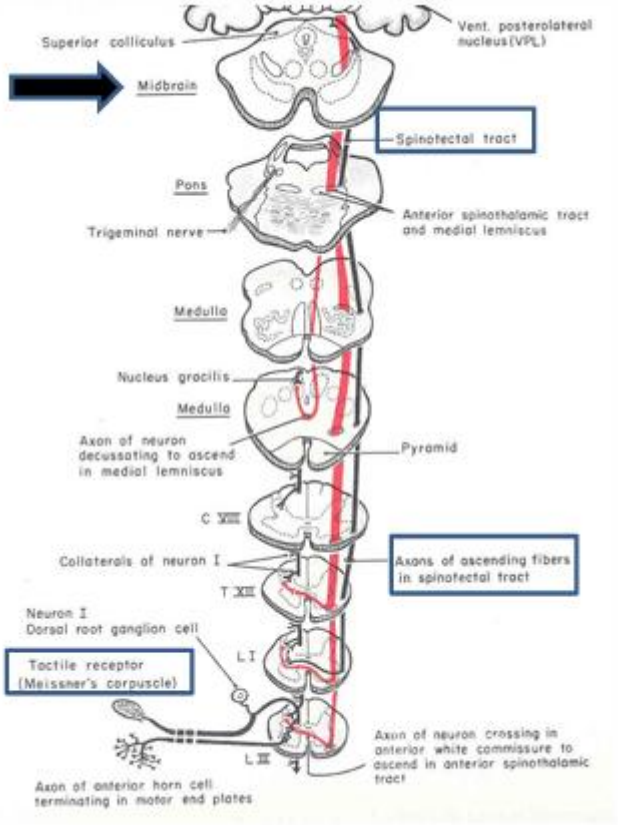


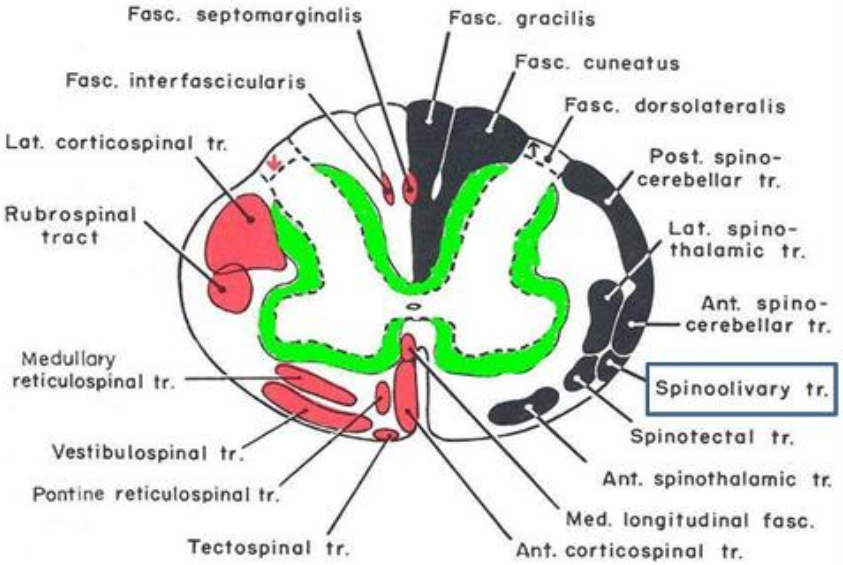


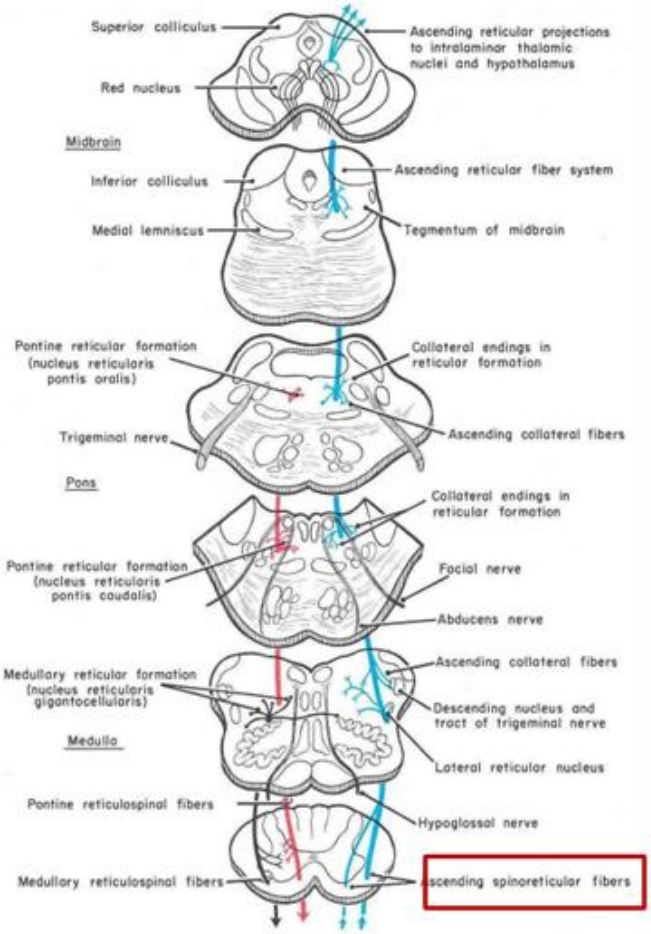

Superior, middle & inferior cerebellar peduncles
A
P
Muscle & joint sense to cerebellum
Anterior & posterior spinocerebellar

e) other tracts

Spino-tectal tract	- Primary afferents reach dorsal horn through **dorsal roots** and terminate on 2nd order neurons. - The cell bodies of 2nd order neuron lie in **base of the dorsal horn**. - Axons of 2nd order neuron **cross** to opposite side, and project to the peri-Aqueductal gray matter and superior colliculus in the midbrain. - Involved in reflexive turning of the head and eyes toward a point of cutaneous stimulation.
Spino-olivary tract	- Indirect spino-cerebellar pathway (spino-olivo-cerebellar). - Impulses from the spinal cord are relayed to the cerebellum via inferior olivary nucleus. - Conveys sensory information to the cerebellum. - Contribute to **movement coordination** associated primarily with balance.
Spino-reticular tract	- Originates in the dorsal horn and ascend in the ventrolateral region of the cord. - End in medullary reticular formation → pontine reticular formation → finally to the thalamus; that activate the cerebral cortex. - Forms part of the ascending reticular activating system (RAS). - Involved also in perception of dull aching (slow pain).


Superior colliculus
Midbrain
Vent. posterolateral nucleus (VPL)
Spinotectal tract
Pons
Trigeminal nerve
Anterior spinothalamic tract and medial lemniscus
Medulla
Nucleus gracilis
Medulla
Axon of neuron decussating to ascend in medial lemniscus
Pyramid
C VIII
Collaterals of neuron I
Axons of ascending fibers in spinotectal tract
T XII
Neuron I
Dorsal root ganglion cell
L I
Tactile receptor (Meissner's corpuscle)
L III
Axon of neuron crossing in anterior white commissure to ascend in anterior spinothalamic tract
Axon of anterior horn cell terminating in motor end plates

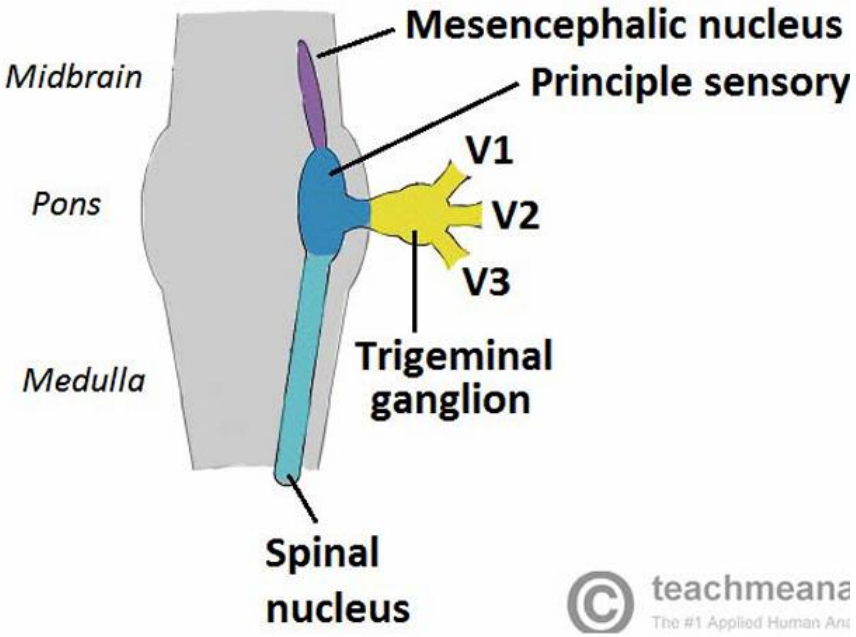

Fasc. septomarginalis
Fasc. gracilis
Fasc. cuneatus
Fasc. interfascicularis
Fasc. dorsolateralis
Lat. corticospinal tr.
Post. spino-cerebellar tr.
Rubrospinal tract
Lat. spino-thalamic tr.
Ant. spino-cerebellar tr.
Medullary reticulospinal tr.
Spinoolivary tr.
Spinotectal tr.
Vestibulospinal tr.
Ant. spinothalamic tr.
Pontine reticulospinal tr.
Med. longitudinal fasc.
Tectospinal tr.
Ant. corticospinal tr.


Superior colliculus
Ascending reticular projections to intralaminar thalamic nuclei and hypothalamus
Red nucleus
Midbrain
Inferior colliculus
Ascending reticular fiber system
Medial lemniscus
Tegmentum of midbrain
Pontine reticular formation (nucleus reticularis pontis oralis)
Collateral endings in reticular formation
Trigeminal nerve
Ascending collateral fibers
Pons
Collateral endings in reticular formation
Pontine reticular formation (nucleus reticularis pontis caudalis)
Facial nerve
Abducens nerve
Ascending collateral fibers
Medullary reticular formation (nucleus reticularis gigantocellularis)
Descending nucleus and tract of trigeminal nerve
Medulla
Lateral reticular nucleus
Pontine reticulospinal fibers
Hypoglossal nerve
Medullary reticulospinal fibers
Ascending spinoreticular fibers

Nuclei of Trigeminal Nerve (CN V)

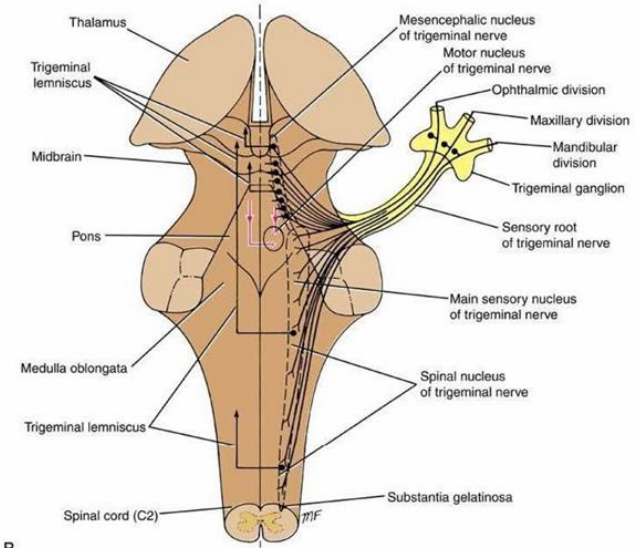
- *The trigeminal nerve got 4 nuclei:*

Mesencephalic nucleus	*In midbrain (proprioception).*
Main sensory nucleus	*In upper pons (touch & pressure).*
Spinal nucleus	*In upper pons to C2 segment (Pain & Temp).*
Motor nucleus	*In upper pons.*



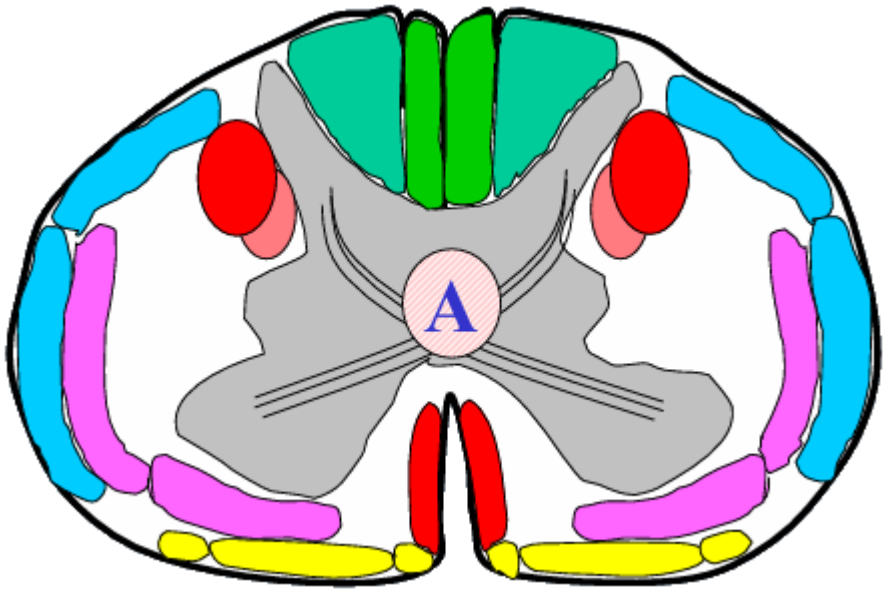
Trigeminal Nerve Sensory Nuclei

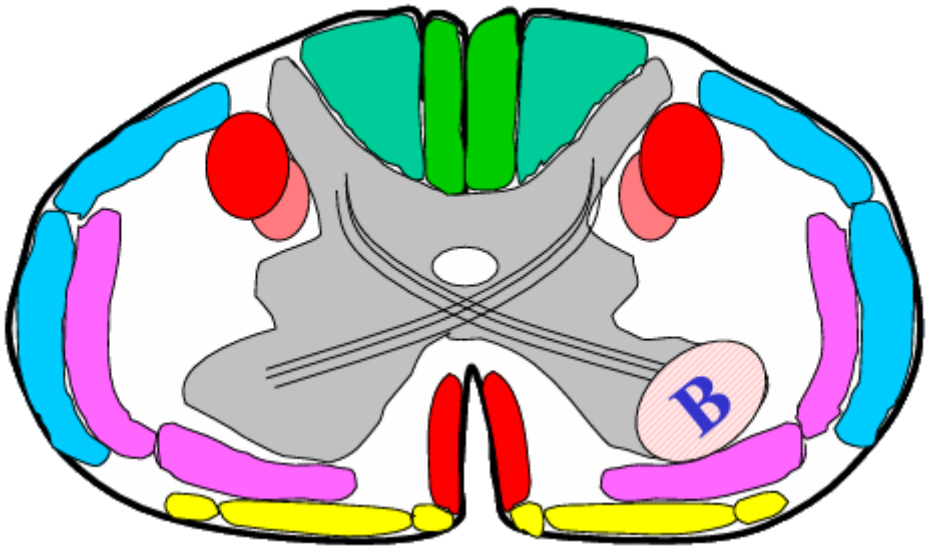
- 1st order neurons
  - Trigeminal ganglion
- 2nd order neurons
  - Trigeminal nerve sensory nuclei
  - Except mesencephalic nucleus
    - Contains 1st order neurons
  - Central axons cross midline
    - Form trigeminal lemniscus
- 3rd order neurons
  - VPM nucleus of thalamus
  - Internal capsule

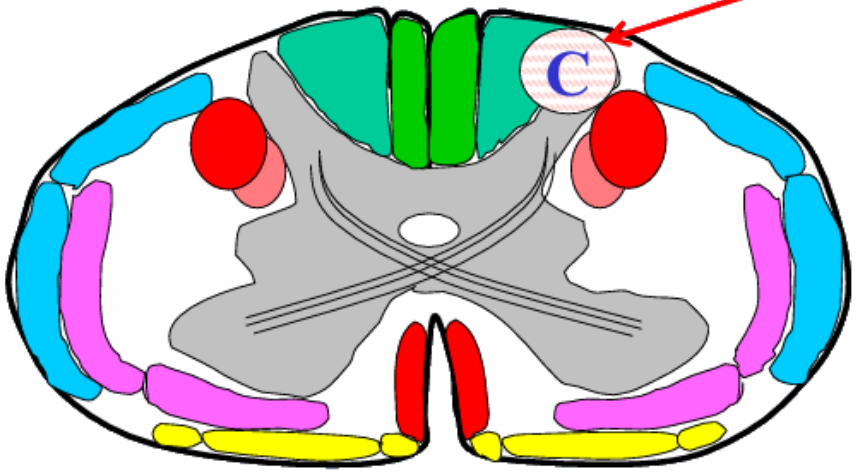


Spinal cord lesions

A) Syringomyelia	*- The central canal becomes enlarged forming a cavity compressing the adjacent nerve fibers.* *- Fibers serving pain and temperature are damaged as they decussate in the ventral white commissure close to the central canal causing selective loss of pain and temperature in the upper limbs (dissociate sensory loss)* *- Fine touch and proprioceptive sensations are retained.*
B) Poliomyelitis	
C) Tabes Dorsalis	*- A late manifestation of **syphilitic infection** on the CNS.* *- Affects the **lumbosacral dorsal spinal roots and dorsal columns of the spinal cord**.* *- Leads to **loss of proprioception** which is manifested by a high Step and unsteady gait (stamping) (Sensory Ataxia)*
D) Friedrich's ataxia (Lesion in spino-cerebellar tract)	*- An inherited degenerated disease* *- Leads to incoordination of arms, intense tremor, wide base reeling gait, ataxia. [Impaired muscle coordination]* *- It begins in childhood* *- Wheelchair is bound by 20 years of age*







Demyelination