ASCENDING TRACTS

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KGMC

TRACTS

Bundles of axons moving up and down in the CNS having common origin and termination

ASCENDING TRACTS

Bundles of axons moving up in CNS

RECEPTORS

Receptors are transducers (Certain apparatus which changes one type of energy into other type). Thus receptors are the apparatus which converts stimulus energy into electrochemical energy of action potential.

NOTE

Roots of spinal cord are pure i.e. Anterior root is purely motor and posterior root is sensory.

Trunks and Rami are mixed

It means sensory information are coming from ventral and dorsal ramus but when it enters the trunk it segregates separately as a sensory input through posterior root.

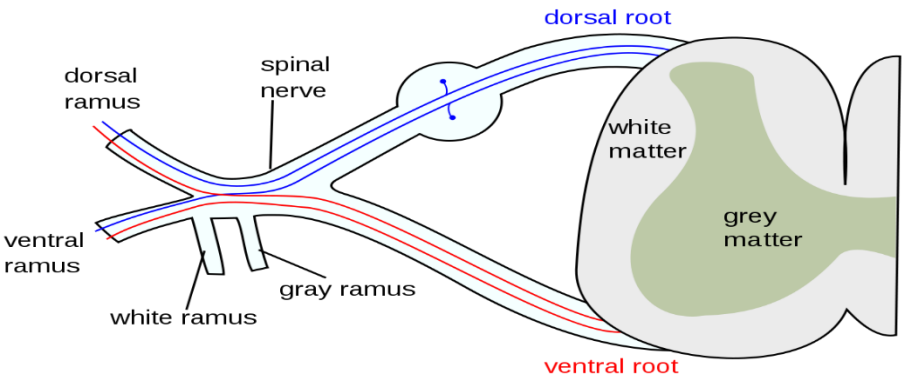
Motor output is coming from the spinal cord through ventral root but after the trunk, motor output enters through dorsal as well as ventral ramous.

WHITE MATTER OF SPINAL CORD

There are 3 columns/ funiculus of white matter i.e. dorsal, lateral and anterior

Dorsal column has only ascending tracts while lateral and ventral have both ascending and descending tract.

DORSAL COLUMN	ANTEROLATERAL COLUMN
Modern	Primitive
Purely sensory	Mixed
High velocity	Low velocity
Highly myelinated	Less myelinated
Fine touch	Crude touch
Specialized sensation	Variety of sensations
Proprioception, vibration, two-point discrimination	Temperature, pain



DORSAL COLUMN

Receptors which takes the fine stimulus to the dorsal column are:

- Meissner receptors
- Pacinian receptors
- Muscle spindles
- Golgi tendon organ

These Sensations goes to CNS through the dorsal root.

Sensations from the lower limb are added medially to the central canal of spinal cord while those of trunk and upper limb are added laterally.

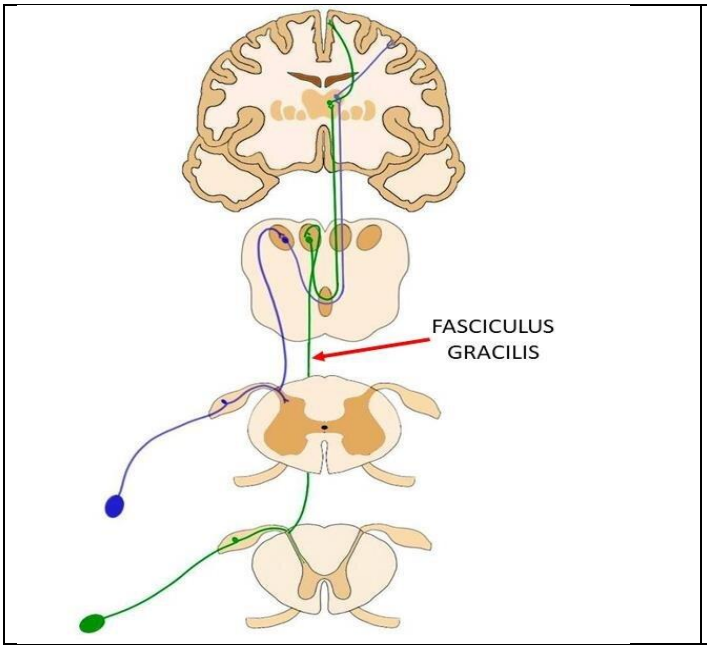
FASCICULUS GRACILIS

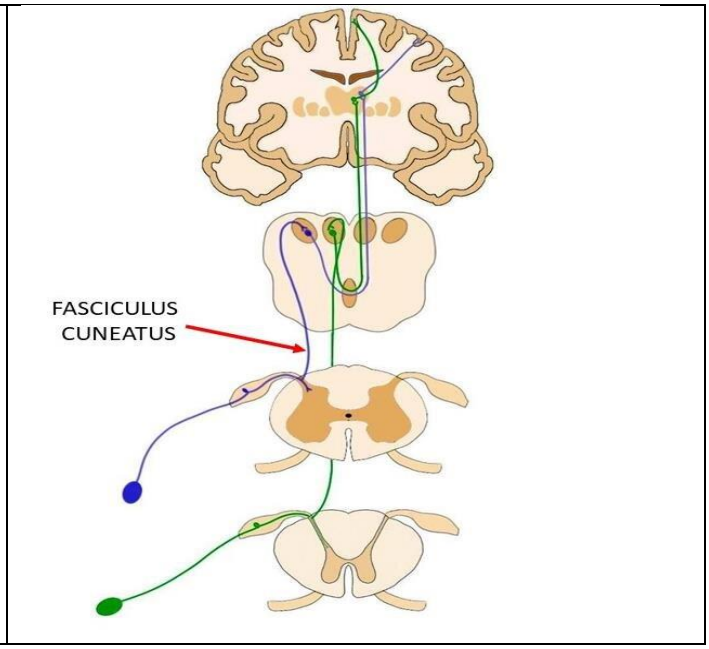
Formed by the bundles of fibers that have sensations from lower part of body and is present on the medial side of dorsal column

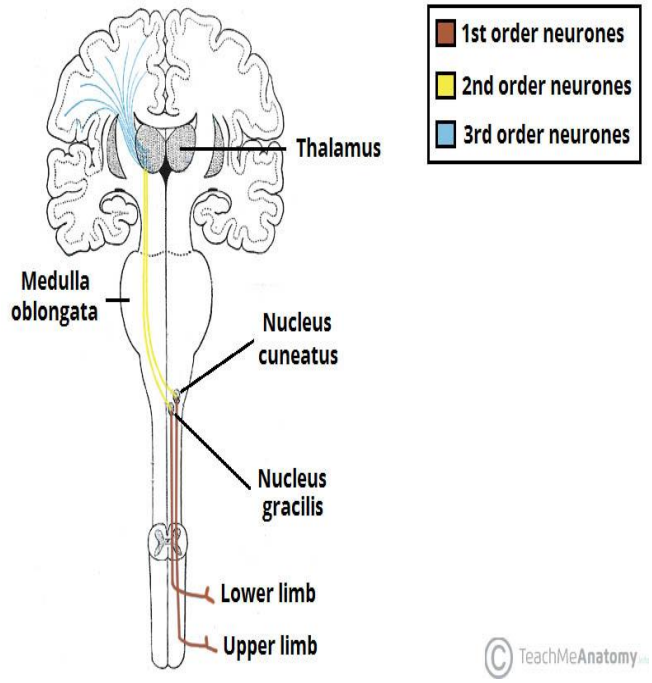
FASCICULUS CUNEATUS

Formed by the bundles of fibers that have sensations from upper part of body and is present on the lateral side of dorsal column

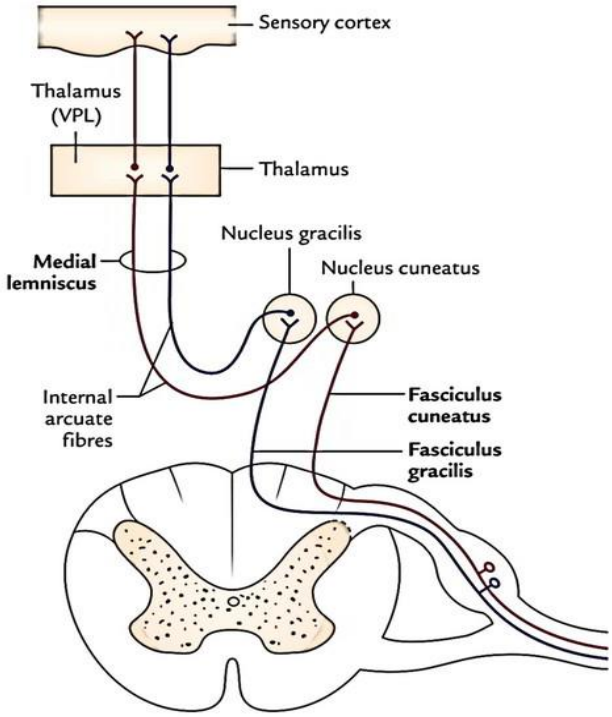
Right half of dorsal column have sensation from right side of body and left half of dorsal column receives sensations from left side of body i.e. They are uncrossed or simply they move ipsilaterally







Dorsal column pathway



Dorsal column pathway

NUCLEUS GRACILIS

Receives fibers from fasciculus gracilis

NUCLEUS CUNEATUS

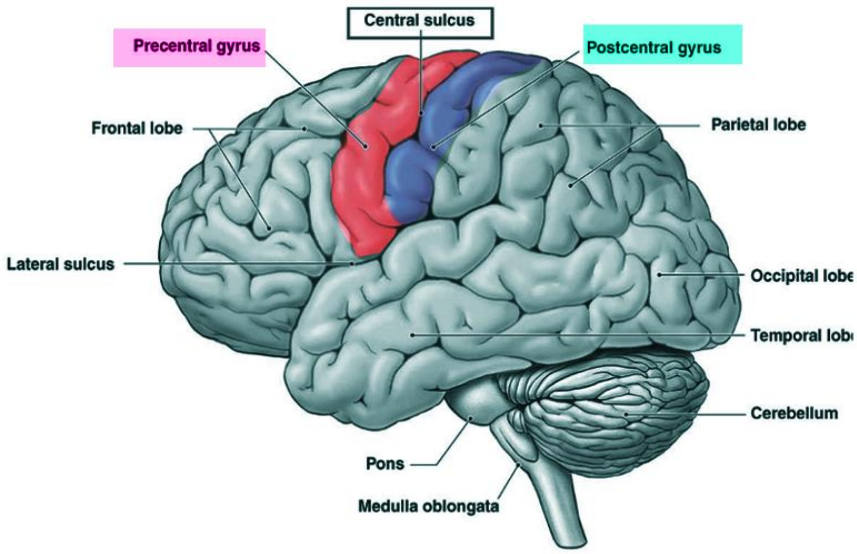
Receives Fibers from fasciculus cuneatus

The cell bodies of nucleus gracilis and cuneatus are 2nd order neuron while 1st order neuron are present in dorsal root ganglion

Then after reaching these nuclei, the fibers cross in the medulla and moves contralaterally and ascends from there. These crossing fibers are called **internal arcuate fibers.** The internal arcuate fibers ascends and are called **medial leminiscus.** That's why this system is called dorsal column medial leminiscus system.

The medial leminiscus fibers pass through pons and midbrain. The 2nd order neurons terminate in ventroposteriolateral nucleus of thalamus and from there 3rd order neurons take the signal.

The fibers of 3rd order neurons move laterally from ventroposteriolateral nucleus of the thalamus to the posterior limb of internal capsule. From there, they emerge or radiates as corona radiata and ends in cerebral cortex in the post central gyrus (also called sensory cortex)



SUMMARY

- Fibers come to spinal cord through dorsal root ganglion
- Start moving up through dorsal columns as fasciculus gracilis (from lower body) and fasciculus cuneatus (from upper body)
- Terminate in two nuclei i.e. cuneate nucleus and gracilus nucleus
- Fibers cross as internal arcuate fibers
- Go up as medial laminiscus into ventroposteriolateral nucleus of thalamus
- Eventually reach cerebral cortex

ANTEROLATERAL COLUMN

PAIN AND TEMPERATURE PATHWAY

Receptors for pain are free nerve endings and for temperature are thermal receptors

There are two pathways for pain which goes to CNS i.e.

1. A-delta pathway
2. C fibers pathway

NOTE

Peripheral nerves are divided into 3 categories namely A, B and C according to degree of myelination. A are more myelinated while C are unmyelinated.

A is further categorized into alpha, beta, gamma and delta. The A-delta which carries the fast pain are also less myelinated.

Fast pain is carried by A-delta and slow is carried by C fibers.

Fast pain is received by CNS in 0.1 sec while slow pain is received in 1 or 2 hours delay.

Fast and Slow pain both can be produced by mechanical or thermal mechanism but slow pain can also be produced by chemical phenomena for example acids

Potassium, bradykinin, histamine, acids are the chemicals present at the site of pain free nerve endings.

Prostaglandins and substance P also plays an indirect role in pain. They reduce the threshold level for above mentioned chemicals to cause pain.

Once the action potential goes to CNS, the first order neuron have their cell bodies in dorsal root ganglion similar as that in dorsal column system.

The central processes of first order neuron terminates in the area called substantia gelatinosa of the dorsal grey horn.

Second order neuron cell bodies are present within the spinal cord in the antero lateral system at the point of entry into the grey horn.

Actually the first order neuron at the point of termination gives ascending and descending branches. These branches within the spinal cord makes a local tract which is called dorsolateral tract of lissauer.

Now the second order neuron moves contralaterally. The fibers then ascend upward and the new fibers of upper side are added medially. As this tract is going towards thalamus it is called **spinothalamic tract** and it is present on the lateral side so it is called **lateral spinothalamic tract.** So lateral spinothalamic tract is concerned with pain and temperature

The peripheral part of the tract has fibers from the lower part of the body and the medial part of the tract has fibers from the upper part of the body

The pathway for the crude touch is also similar up to some extent but there is a difference that is the 2nd order neuron moves to the anterior side so it is called **anterior spinothalamic tract.**

There is another pathway which runs between the lateral and anterior part called **spinotectal tract** (running between spinal cord and tectum). It is responsible for the spinal visual reflex.

These three tracts ascends and fuses together in the medulla and runs upward as a single bundle called **spinal leminiscus**.

The anterior and lateral spinothalamic fibers from the spinal laminiscus bundle are connected to ventral posteriolateral nucleus of the thalamus and the spino tectal fibers from the spinal laminiscus bundle are connected to superior colliculus.

NOTE

The slow pain fibers also stimulate the reticular formation in its pathway and also reaches to the intralaminar nuclei of the thalamus which are present in white matter of thalamus

Reticular formation is the main switch for cerebral cortex. It is connected to intralaminar nuclei of thalamus and through that it projects to the cerebral cortex

Now the pain, temperature and crude touch pathways after reaching ventral posterior lateral nuclei leaves to go to posterior limb of internal capsule and then radiate to cerebral cortex or to sensory cortex that is postcentral gyrus. In postcentral gyrus the location and intensity of pain is analyzed. The emotional component in the pain is due to its connection with cingulate gyrus which is concerned with emotions. The autonomic response during pain is due to the connection of its fibres with insular cortex. The autonomic responses are sweating, nausea, tachycardia, fear etc

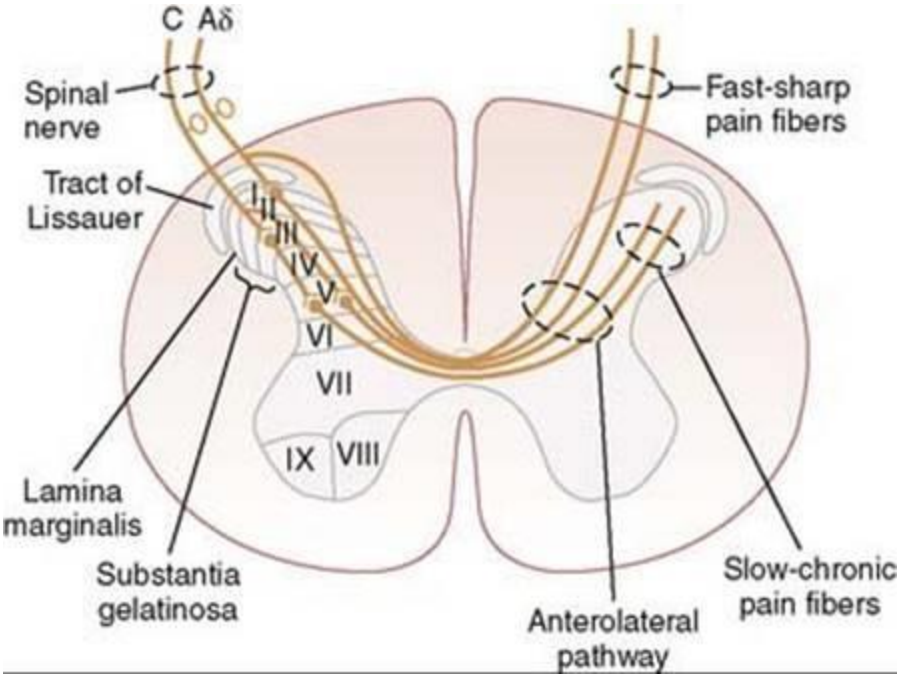
WHY SLOW PAIN IS POORLY LOCALIZED?

It is due to the fact that the neurons are fast pain are connected with few neurons in the spinal cord and move fastly to the lateral side to ascend to the main center. But the neurons of the slow pain are connected with many other neurons in the spinal cord before ascending to the main center thus it provides difficulty in its localization.

GATING THEORY

When a person has pain and we produce other stimulation which are not painful like massaging may reduce the pain through that stimulation. The action potential coming through other stimulation may stimulate the connector neurons which may produce new row inhibitory substance so that the pain pathways are inhibited.

Initially doctors were unaware of this and they thought that there might be some gates which may be closed during other stimulations, thus they called this gating theory.

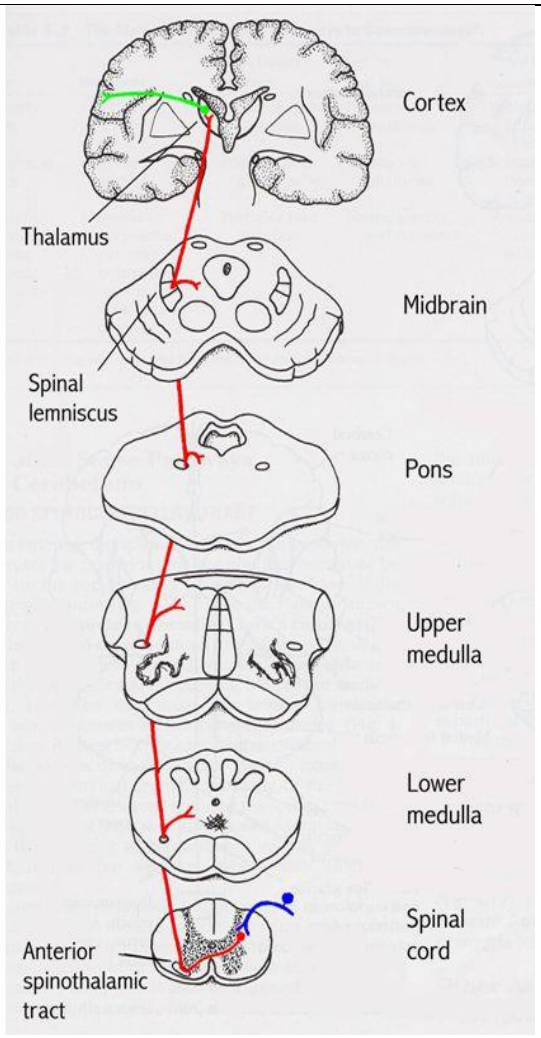


Anterior Spinothalamic Tract

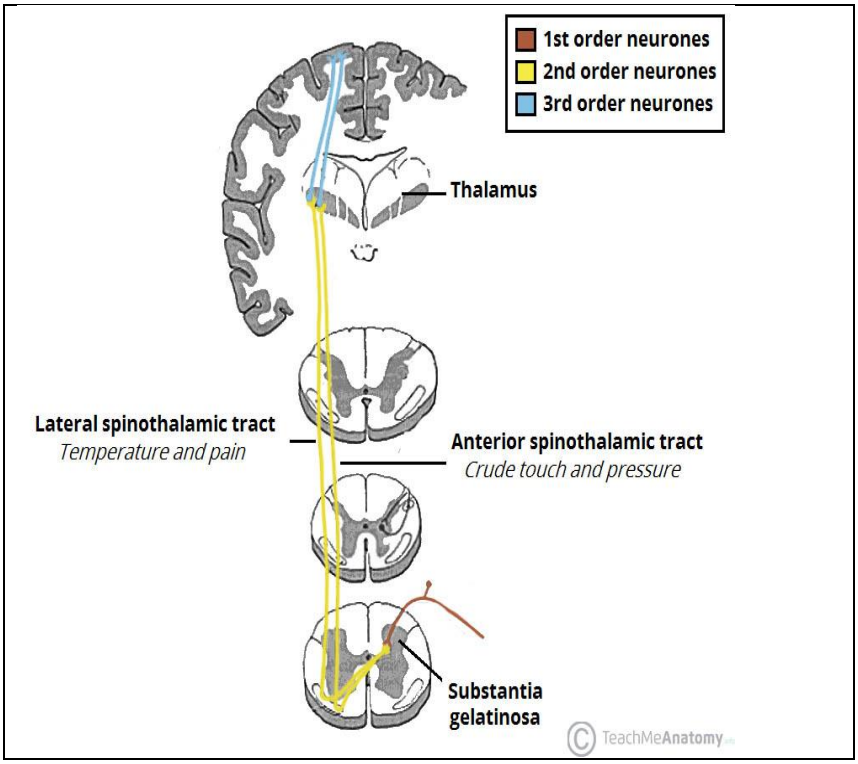
3rd order neurone:
From VP nucleus in thalamus→though posterior limb of internal capsule→ cortex

2nd order neurone:
From substantia gelatinosa→decussates over several spinal segments and ascends in ant. Spinothalamic tract→becomes lateral then spinal lemniscus in brainstem→ventral posterolateral (VP) nucleus in thalamus

1st order neurone:
From various receptors in periphery →substantia gelatinosa in dorsal horn



Anterior spinothalamic tract



PAIN REDUCTION

There is a mechanism to reduce the pain within the CNS. There are periventricular, periaqueductal and some spinal mid line grey mattrr from which neurons descend downward. The neurons of these descending pathways secrete some neurotransmitters which can block the pain pathway. They release morphine like enkephalins and endorphins. And this system is called **descending analgesic system.**

SUMMARY

Anterior spinothalamic tract takes sensation of crude touch. Lateral spinothalamic tract takes sensation of temperature and pain. Both tracts meet with spinal tectal tract in medulla to form spinal laminiscus. Spinal leminiscus Is then connected to ventral posterior lateral nucleus of thalamus. From there the fibers goes to postcentral gyrus for analysis of pain. Fiber is also moved to cingulate gyrus for emotional reaction to pain. Fiber is also moved to insulate cortex for autonomic reaction to pain. Slow pain pathways are also connected to reticular formation as well as to intra laminar nuclei of thalamus.

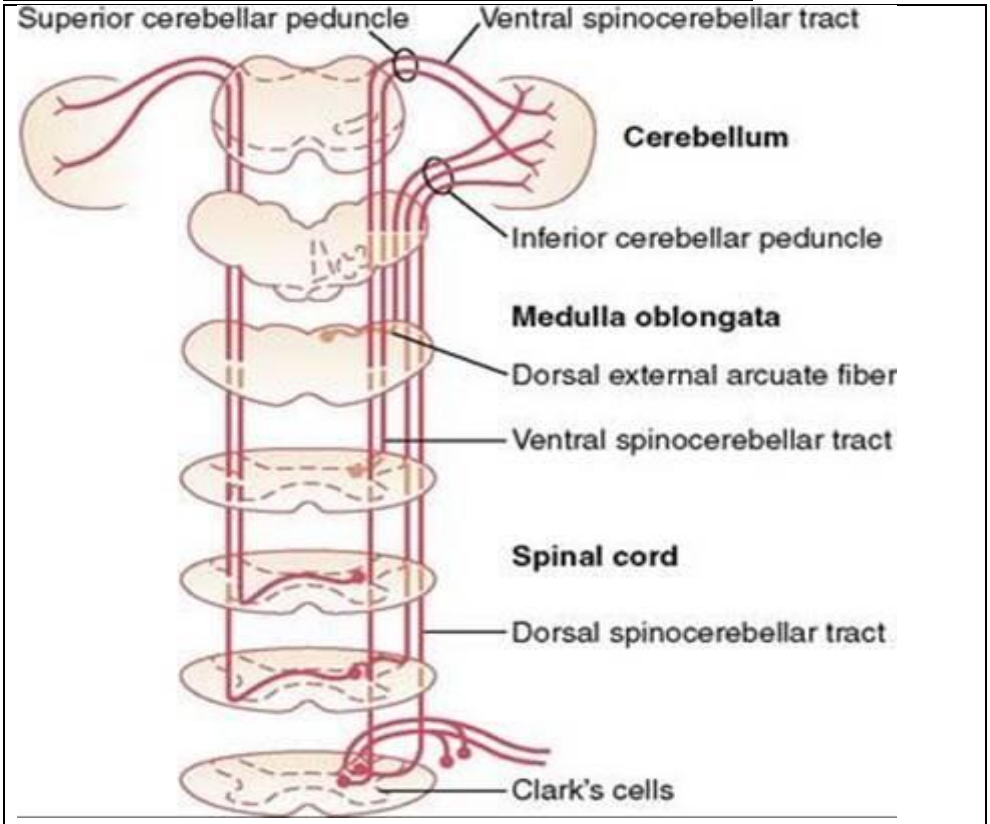
SPINO CEREBELLAR PATHWAY

Information about positioning of locomotive system reach the cerebellum from spinal called through the spino cerebellar pathway. These pathways are connected ipsilaterally to the cerebellum that is information of one side of the body will reach to the same cerebellum of that side.

There are two main spinocerebellar pathways

1. Dorsal spinocerebellar pathway
2. ventral spinocerebellar pathway

DORSAL SPINO CEREBELLAR PATHWAY



Dorsal and ventral spino cerebellar tracts

The information in this pathway comes from golgi tendon organ, muscle spindles, pressure receptors. The first order neurons goes to the dorsal grey horn and terminates there. from their second order neurons move ipsilaterally on the right white column (lateral column). The cell bodies of second order neuron makes a nucleus throughout the spinal cord and is called dorsolateral nucleus of Clarke.

NOTE

Superior peduncle connect cerebellum with midbrain

Middle peduncle connects cerebellum with pons

Inferior peduncle connect cerebellum with medula

Biden calls our bundles of white matter which connects cerebellum with brainstem

The fibres from both sides of spinal cord after descending enters the cerebellar cortex through inferior cerebellar peduncle.

As it is present on the dorsal side of the lateral white matter it is called dorsal spinocerebellar pathway

The fibers in this system can enter from C8 to S3 but the Clarks nucleus extends from C8 to L3. So the lower fibers which enters the system must ascend to reach Clark's nucleus.

CUNEOCEREBELLAR PATHWAY

In this pathway, the fibers comes from upper limb or above to the accessary cuneate nucleus instead of going to Clark's nucleus. From accessory cuneate nucleus they ascend in the same way as that of dorsal spinocerebellar pathway to reach cerebellum cortex

VENTRAL SPINO CEREBELLAR PATHWAY

Same as dorsal pathway but there are some changes of crossing.

The information is received through same receptors. The cell bodies of first order neuron terminates in the spinal cord. The fibers of second order neuron moves to contralateral side and ascends to reach superior cerebellar Peduncle. In this region it recrosses to reach the opposite cerebellum. Thus the information of one side of the body reaches the same side cerebellum. It is called ventral spinocerebellar pathway because it is present in front of dorsal pathway.

SPINO-OLIVARY PATHWAY

The information is gathered through first order neuron present in the dorsal root ganglion and after its termination the second order moves contralaterally and ascends to olives which are grey mass present in medula. From there it enters the cerebellar cortex through inferior cerebellar peduncles. This pathway is concerned with proprioception, position of body, pressure etc which is not concerned with conscious level

SPINO-RETICULAR PATHWAY

In this pathway fibers after entering spinal cord directly ascends on the same side to the reticular formation. The purpose of this pathway is simply to increase the conscious level

ASCENDING TRACTS OVERVIEW

Ascending tracts		
Major Tracts		Minor Tracts
For cerebrum ▪ Dorsal leminsicus system ▪ Anterolateral system	For cerebellum ▪ Dorsal spino cerebellar ▪ Cuneo cerebellar pathway ▪ Ventro spinal cerebellar pathway	▪ Spinotectal pathway ▪ Spino-olivary pathway ▪ Spino-reticular pathway