



**Anatomy Team**  
**MED 439**

Revised & Approved



**MED439**  
KING SAUD UNIVERSITY

# The Sensory Tract

CNS Block

Don't forget to check the [Editing File](#)

**Color index:**

**Content**

**Male slides**

**Female slides**

**Important**

**Doctors notes**

Extra information, explanation

**Contact us:**  
**Anatomy439@gmail.com**

# Objectives

At the end of the lecture, students should be able to:

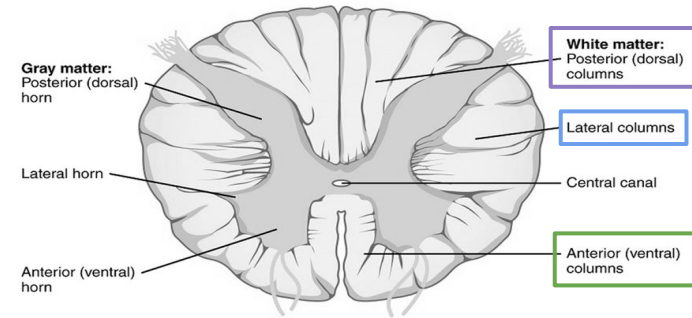
- Define the meaning of a tract
- Distinguish between the different types of tracts
- Locate the position of each
- Describe the sensory pathway
- Identify the different sensory spinal tracts and their functions
- Identify the course of each of these tracts
- Know some associated lesions regarding the main tracts

# Introduction

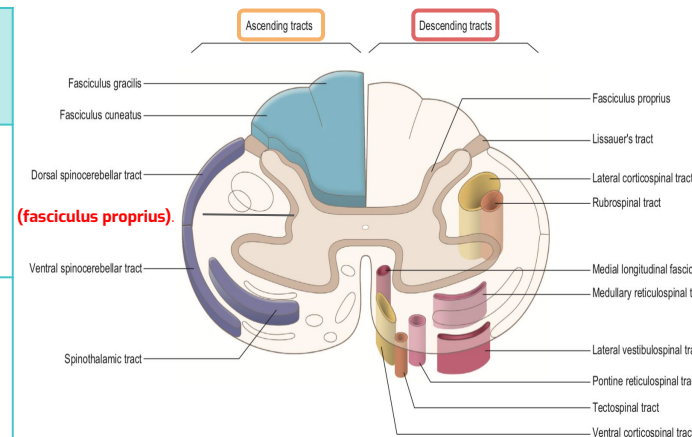
- The **grey matter** of the spinal cord is completely surrounded by the white matter
- The **White matter** of the spinal cord consists of **Ascending** and **Descending Nerve Fibers**.
- It is divided into **Dorsal**, **Lateral** & **Ventral** Columns or Funiculi.

## White Matter Tracts

- Bundles or **fasciculi of fibers** that occupy more or less definite position in the white matter.
- They have the same Origin, Termination and carry the same Function.
- **They are classified into:**



Short tracts (intersegmental or propriospinal)	Long tracts
Fibers occupy narrow band immediately peripheral to the grey matter ( <b>fasciculus proprius</b> ).	<b>Types:</b> 1. Ascending (sensory or afferent) 2. Descending (Motor or efferent)
<b>Function:</b> They interconnect adjacent or distant spinal segments And Permit <b>intersegmental coordination</b>	<b>Function:</b> They serve to join the brain to the spinal cord.

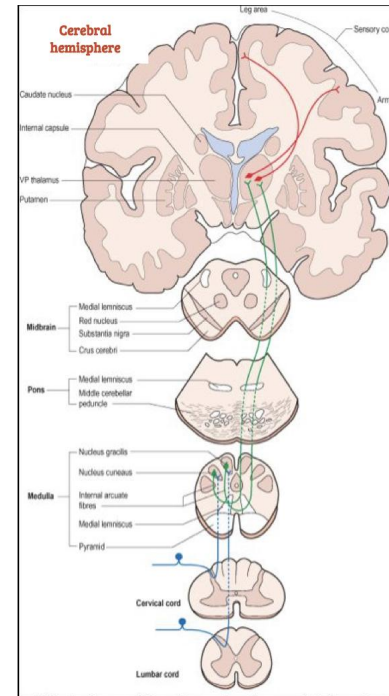


# Ascending Tracts

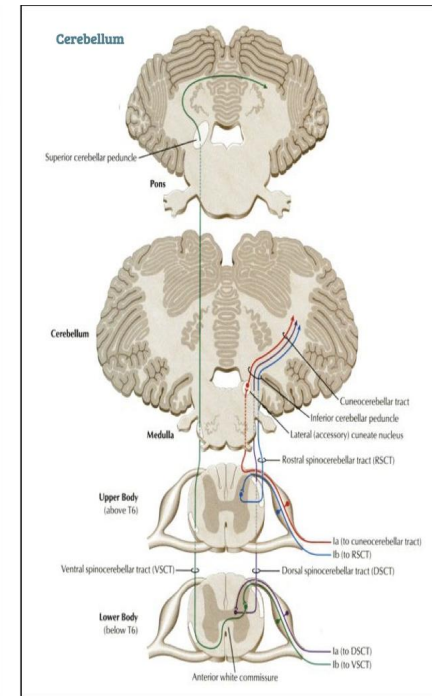
## Ascending Tracts;

- 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 (**e.g at the cerebellum**).
- Pathways that carry information to a conscious level share certain common characteristics:
- There is a sequence of Three Neurons between the peripheral receptors and the cerebral cortex.

**Dr's explosions:** ascending = Carry sensations to brain



**Conscious level**



**Subconscious level**

# Neuron

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

**Dr's note::**

قاعدة ثابتة :always first order neurons outside the spinal cord

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**.

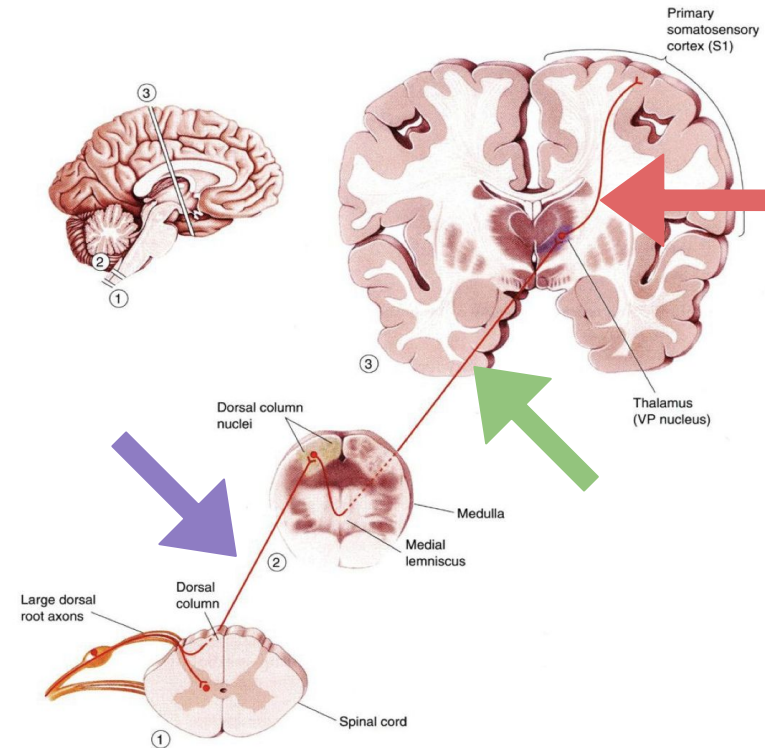
The axon of the second order neuron crosses over (decussates) to the opposite side of the CNS and ascends to the **thalamus**, where it terminates.

**Dr's note:**

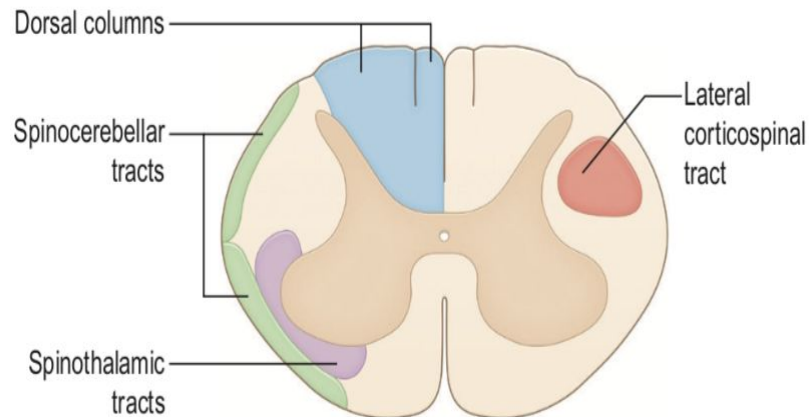
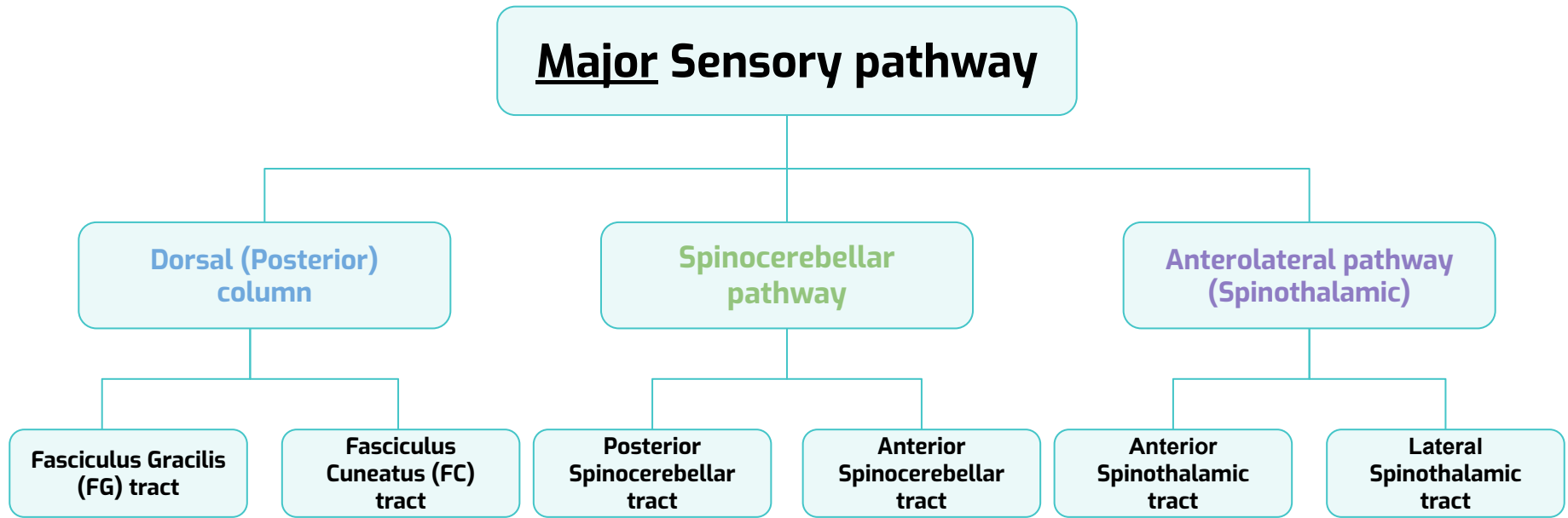
Here it's still at the same side in spinal cord or in medulla

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.



# Three major pathways carry sensory information:



# Dorsal Column

## Extra:

The dorsal columns are located between the dorsal median sulcus and the dorsal horn. The dorsal columns are comprised of two tracts, incompletely separated by a thin septum: the fasciculus gracilis, situated medially and the fasciculus cuneatus, situated laterally. The tracts carry impulses concerned with proprioception (movement and joint position sense) and discriminative (fine) touch.

## ❑ Composed of two tracts;

**Fasciculus Gracilis (FG)** & **Fasciculus Cuneatus (FC)**

❑ They Carry the axons of primary afferent neurons that have entered cord through dorsal roots of spinal nerves, from ipsilateral side of the body

## ❑ They are concerned with:

1. **Discriminative Touch:** Ability to localise accurately the area of the body touched. يعني اذا غمضت عيوني وواحد لمسني باعرف وين المكان الي لمسني فيه هذا الشخص
2. **Two Point Discrimination:** To be aware that two points are touched simultaneously even they are close together.
3. **Proprioception:** from muscles and joints for the movement & knowing the position of different parts of the body

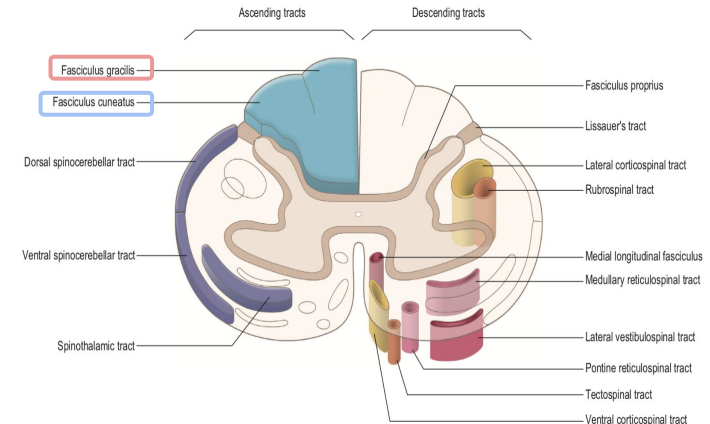
Proprioceptionي لما نطلب من شخص انه يرفع رجله وهو مغمض عينه يكون عنده القدره على انه يرجع رجله مكانها على الارض بهدوء وفي المكان صحيح وما يخلل اتزانه هو المسؤول عن تنسيق هذي الحركة

## Fasciculus Gracilis

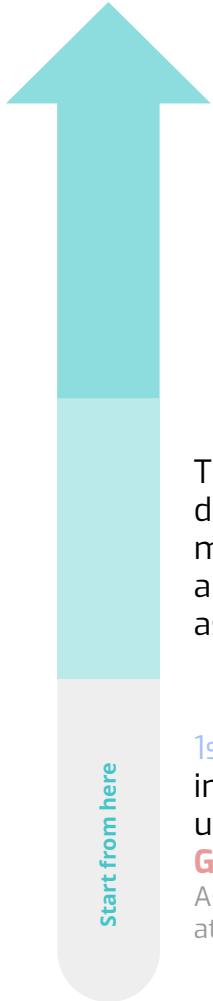
contains fibers that are received at sacral, lumbar and lower thoracic levels. thus, includes those from the lower limb.

## Fasciculus Cuneatus

contains fibers that are received at upper thoracic and cervical levels thus, include those from the upper limb.



# Dorsal Column cont.



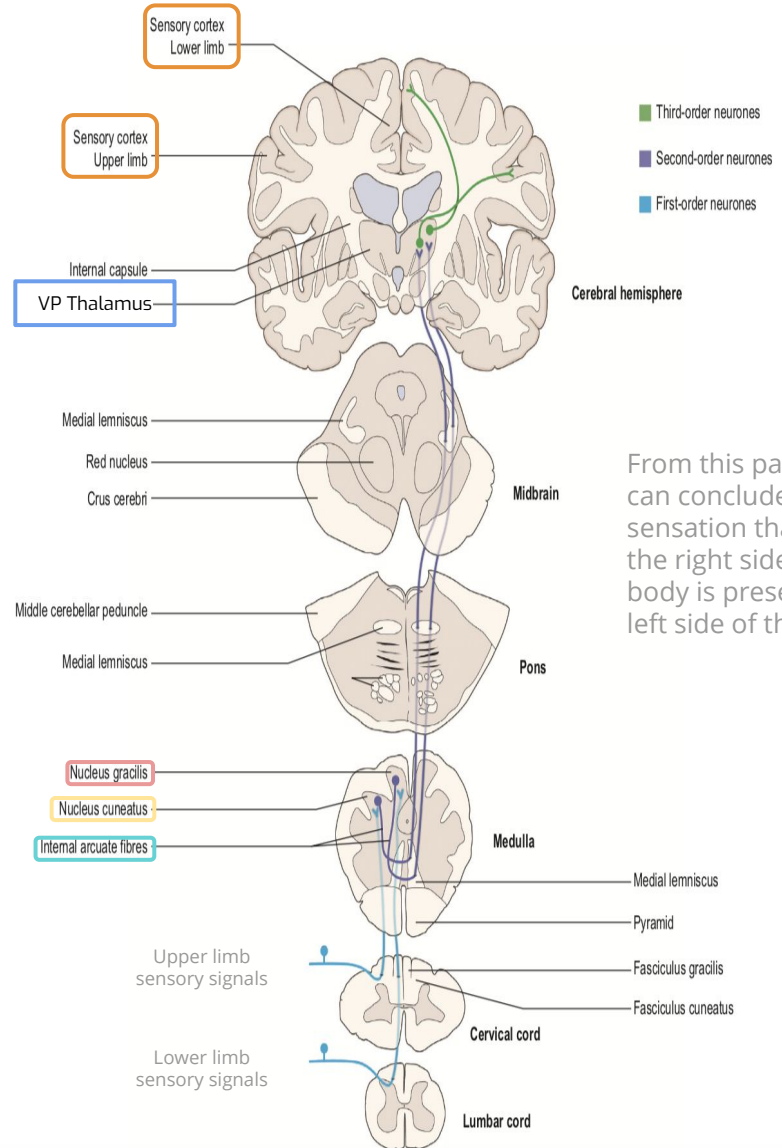
The medial lemniscus terminates in the **Ventral Posterior Nucleus of the Thalamus** (3rd order neurones), which project to the **somatosensory cortex** (thalamocortical fibers)

The axons of the 2nd order neurones decussate (cross over) in the medulla as **Internal Arcuate Fibers** and ascend through the brainstem as Medial Lemniscus.

1st order Fibers ascend without interruption where they terminate upon 2nd order neurones in **Nucleus Gracilis** and **Nucleus Cuneatus**.

As first order neurones ascend, they stay at the Ipsilateral side

**Team 438:** In the case of dorsal column, the 2nd order neuron is found in the medulla oblongata. - Whether to terminate in nucleus gracilis or cuneatus depends on which tract is ascending, each tract terminate in its corresponding nucleus (fasciculus gracilis > nucleus gracilis, fasciculus cuneatus > nucleus cuneatus).



From this pathway we can conclude that sensation that is felt on the right side of the body is presented to the left side of the brain.



# Lesions

## 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 Page and unsteady gait (**Sensory Ataxia**)

Dr note: In tabes Dorsalis patient their muscles is ok but the sensation lost

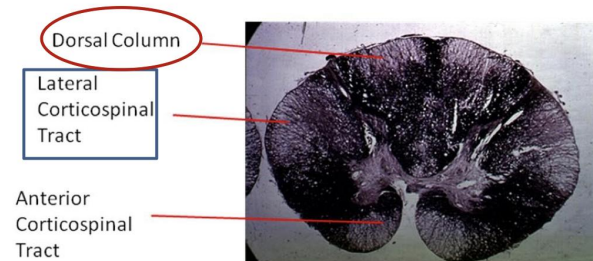


## Subacute Combined Degeneration of the spinal cord

- A systemic disease results from B12 deficiency It produces **Sensory Ataxia**. - Lateral columns are also affected (combined) causing **weak and spastic limbs** It is completely recovered by proper treatment with B12.

### Dr's explanation :

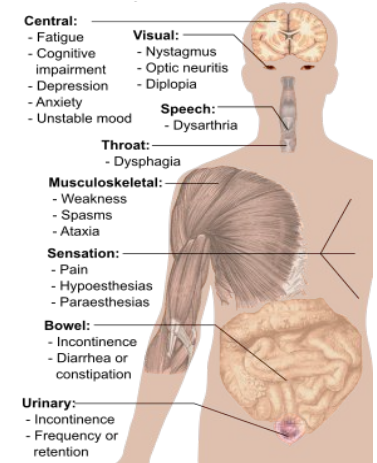
When proprioception is effected —> المريض ما يدرك مكان قدمه لو —> رفعها وهو مغمض عينه ممكن ينزلها على الارض بقوة شديده او ما ترجع بطريقة متزنه  
In the name we said combined because is effects both sensory and motor (lateral corticospinal)



## Multiple Sclerosis

- An immune disease affects specifically **fasciculus Cuneatus** (receives sensory from the upper part of body) of the cervical region. Leads to loss of proprioception in hands and fingers (**Asteriognosis**)

Dr explanation: Asteriognosis is the reverse of steriognosis steriognosis Means your ability to take certain objects when your eyes is close and identify it or like when I give you number of objects while your eyes close and ask you to identify the key you will be able to know it



# Spinothalamic Tracts

The **spinothalamic tracts** contain axons of **second-order neurons**, the cell bodies of which lie in the **contralateral dorsal horn**.

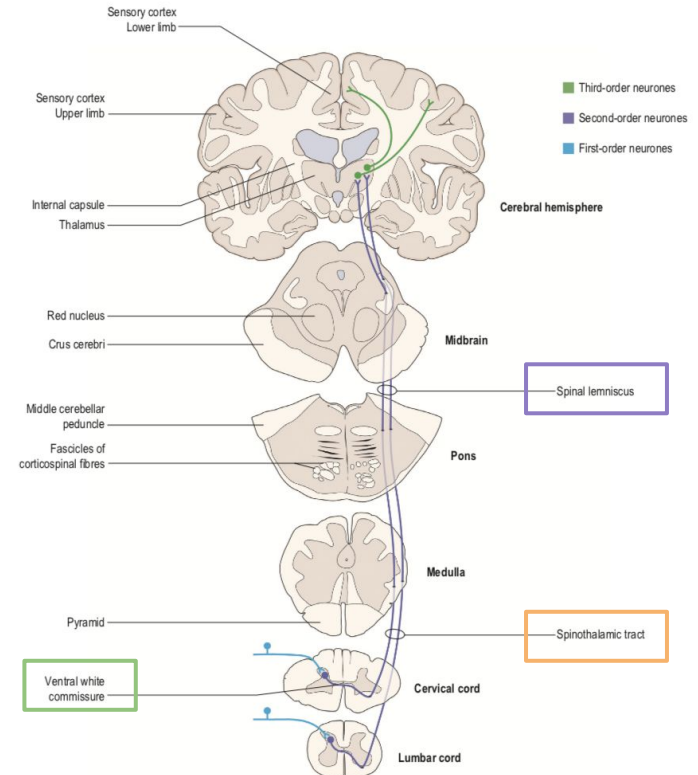
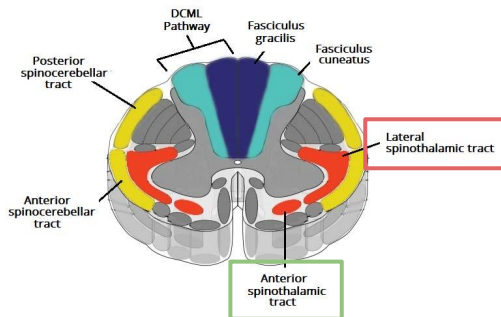
Carry impulses concerned with; pain and thermal sensations (**Lateral tract**) and Non- Discriminative touch and pressure (**Anterior tract**), from the contralateral side..

In brain stem, the two tracts constitute the **Spinal Lemniscus**.

Located lateral and ventral to the ventral horn.

**Males slide**  
Fibres decussate in the **anterior white commissure**.  
The second order neuron crossover the **anterior white commissure** and goes up

Information is sent to the primary sensory cortex on the opposite side of the body.



## Team 438:

**At the level of spinal cord:** the first order neurons terminate as soon as they enter the spinal cord in an area called Substantia Gelatinosa or Nucleus Proprius, once it terminates the second order neuron will start and they will cross through the **anterior white commissure** to the contralateral side and then ascend

**At the level of the medulla:** they fuse together forming a single bundle called **spinal lemniscus**.

**At the level of Cerebral hemisphere:** They terminate in the ventral posterior nucleus of the thalamus.

# Types of spinothalamic tracts

## Lateral spinothalamic tract

### FUNCTION:

- Carries pain & Temperature to thalamus and sensory area of the cerebral cortex.

### 3 Neurons are involved:

- Neuron I:** Small cells in the dorsal root ganglia. (First order neurons)
- Neuron II:** Cells of **substantia gelatinosa** of Rolandi in the (contralateral) posterior horn. (2nd order neurons. After 2nd order neurons the fibers decussate then ascend and are called lateral spinothalamic tract)
- Dr's note:** after it the crossing happens so when you have pain in your right side the left side of your brain receives the sensation
- Neuron III:** Cells of (VP) nucleus of the thalamus. (then continue till the somatosensory cortex of the cerebral)

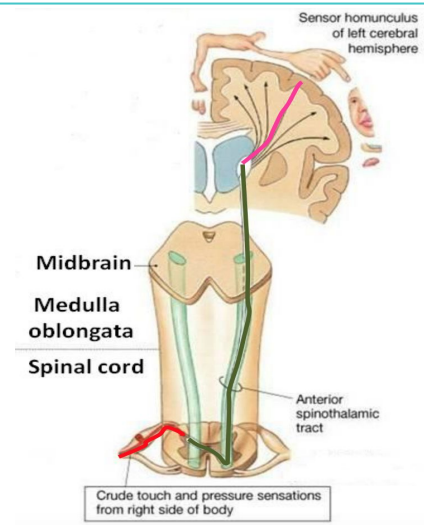
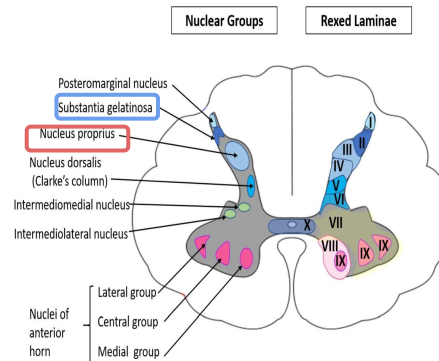
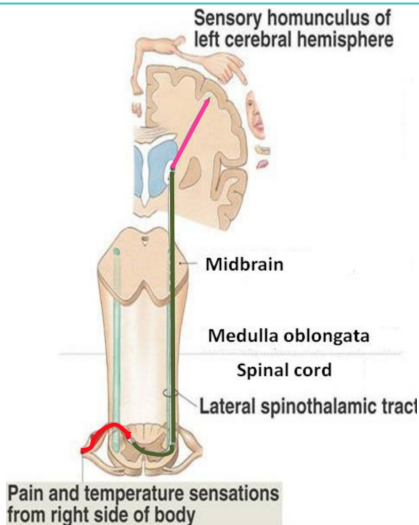
## Anterior Spinothalamic Tract

### FUNCTION:

- Carries Light, Crude Touch (non discriminative) & Pressure to thalamus and sensory cortex.

### 3 Neurons are involved:

- Neuron I:** Medium sized cells in the dorsal root ganglia. **Girls doctor:** the size of cells is not that important.
- Neuron II:** Cells of main sensory nucleus or (**Nucleus Proprius**). Fibers arising from Substantia Gelatinosa & Nucleus Proprius decussate in the Anterior White Commissure (then ascend as anterior spinothalamic tract)
- Neuron III:** Cells of VP nucleus of thalamus.



# Spinocerebellar Tracts

## Spinocerebellar Tracts

The spinocerebellar system consists of a sequence of only two neurons;

- **Neuron I:** Large cells of dorsal root ganglia.
- **Neuron II:** Cells of the **nucleus dorsalis; Clark's nucleus (column)**

### Two tracts: Dorsal & Ventral

- Located near the dorsolateral and ventrolateral surfaces of the cord
- Contain axons of the second order neurons
- Carry unconscious information derived from **muscle spindles, Golgi tendon organs, tactile receptors, joints, skin and subcutaneous tissue** to the cerebellum for the control of posture and coordination of movements.
- (Cerebellum controls the same side of the body)

**Dr's note:** There isn't a 3rd order neuron in the Hypothalamus

## Posterior Spinocerebellar Tract

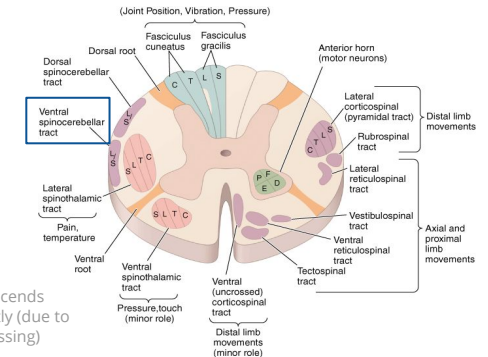
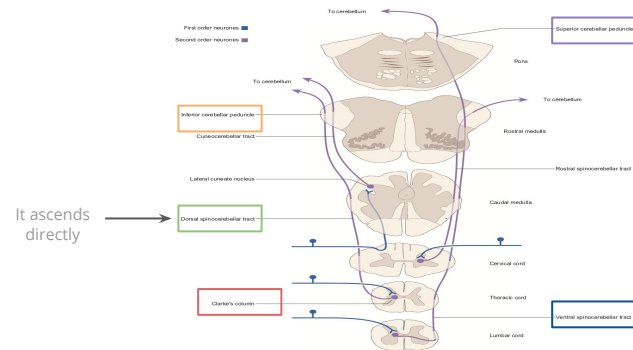
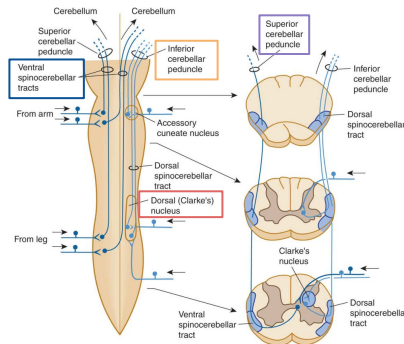
Present only above level L3

- The cell bodies of 2nd order neuron lie in **Clark's column**
- Axons of 2nd order neuron terminate **ipsilaterally** (uncrossed) in the cerebellar cortex by entering through the **inferior cerebellar peduncle**.
- **Posterior spinocerebellar tract** convey sensory information to the same side of the cerebellum

**Dr's note:** no crossing occurs

## Ventral ( Anterior ) Spinocerebellar Tract

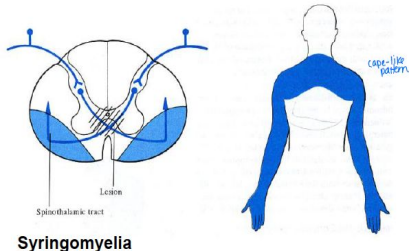
- The cell bodies of the **2nd order neuron** lies in base of the dorsal horn of the lumbosacral segments.
- Axons of the 2nd order neuron cross to opposite side, ascends as far as the midbrain the make a sharp turn caudally and enter the **superior cerebellar peduncle**.
- The fibers cross the midline for a second time within cerebellum before it terminates in the cerebellar cortex.
- So **ventral spinocerebellar tract** conveys sensory information to the same side of the cerebellum.



# Lesions

## Spinothalamic tracts lesion

Interruption of the spinothalamic (anterolateral) fibers as they cross the midline in the anterior white commissure.



The spinothalamic tract can be selectively damaged in syringomyelia, in which:

- The central canal become enlarged forming a cavity compressing the adjacent nerve fibers.
- Fibers serving pain and temperature are damaged first as they decussate in the ventral white commissure close to the central canal causing selective loss of pain and temperature in the upper limbs (dissociation sensory loss)
- Light touch and proprioceptive sensation are retained. **Why is it retained? Because the Dorsal column is intact**
- Joints of the limbs become disorganized without discomfort (Charcot's joint)

## Friedreich's ataxia

- An inherited degenerative disease
- Affecting the spinocerebellar tracts
- Leading to incoordination of arms intense tremor wide base reeling gait ataxia
- It begins in childhood
- Wheelchair is bound by 20 years of age

## Spinocerebellar tracts lesion



# Other Types Of Tracts

## Spinotectal Tract\*

Male Dr: Name & Function IMPORTANT

Ascends in the anterolateral part, in close association with spinothalamic system.

- 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 periaqueductal gray matter and **superior colliculus** in the midbrain.
- Involved in reflexive turning of the head and eyes (**spinovisual reflex**) toward a point of cutaneous stimulation

**Dr's note:** We use it when there's stimulation need the movement of head ,eyes and neck for example: loud screaming

## Spino-olivary Tract\*

Male Dr: Name & Function IMPORTANT

Indirect spinocerebellar pathway (**spino-olivo-cerebellar**) Impulses from the spinal cord are relayed to the cerebellum via inferior olivary nucleus. Conveys sensory information to the cerebellum. Fibers arise at all levels of the spinal cord. Contribute to movement coordination associated primarily with balance.

**Dr's note:** Don't go directly to cerebellum pass medulla first

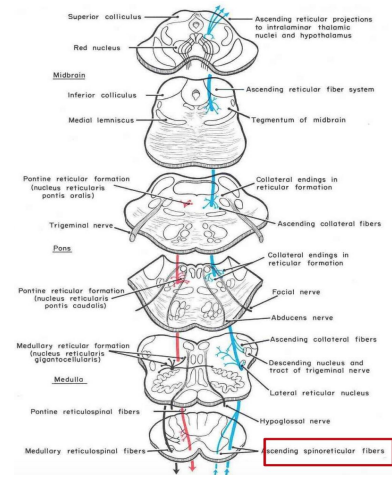
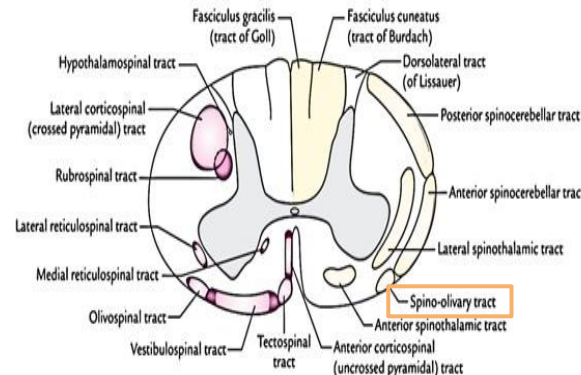
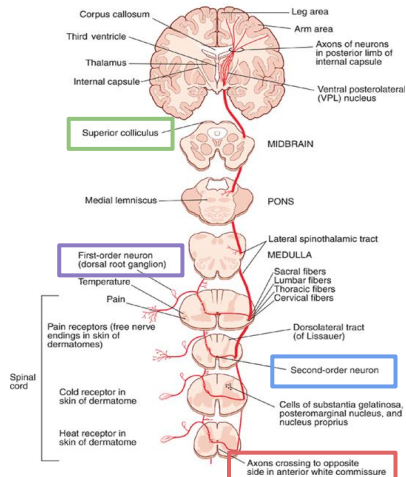
## Spinoreticular Tract\*

Male Dr: Name & Function IMPORTANT

Originates in the dorsal horn, and ascend in the ventrolateral region of the cord

- Contains uncrossed fibers that end in medullary reticular formation
- Crossed & uncrossed fibers that terminate in pontine reticular formation, **then to brain stem reticular formation** finally to the thalamus; that activate the cerebral cortex
- Forms part of the **ascending reticular activating system**.
- Involved in perception of dull aching (slow pain) الألم المحتمل

**Dr's note:** Like when someone sleeping and we touched him the Spinoreticular Tract will activated to wake him up



# MCQ

Q1: Which of the following is a short white matter tract?

A: fasciculus proprius

B: fasciculus gracilis

C: fasciculus cuneatus

D: fasciculus thalamus

Q2: Pathways that carry information to a conscious level have:

A: 1 order neurons

B: 2nd order neurons

C: 3 order neurons

D: 4 order neurons

Q3: The internal arcuate fibers ascend through the brainstem as:

A: lateral lemniscus

B: medial lemniscus

C: spinal lemniscus

D: dorsal lemniscus

Q4: Tabes dorsalis is a late manifestation of which infection?

A: Meningitis

B: Syphilis

C: Syringomyelia

D: spinal lemniscus

Q5: Multiple sclerosis affects which tract?

A: fasciculus proprius

B: fasciculus thalamus

C: fasciculus gracilis

D: fasciculus cuneatus

Q6: Spinothalamic tracts send information to primary sensory cortex on the \_\_\_\_\_ of the body :

A: Same side

B: Opposite side

C: -

D: -

Answer key:  
1 (A) , 2 (C) , 3 (B) , 4 (B) , 5 (D) , 6 (B)

# MCQ

Q7: In spinothalamic tract, both tracts (anterior and lateral) constitute the ..... In the brain stem:

A: Spinal Lemniscus

B: Medial Lemniscus

C: Fasciculus gracilis

D: Fasciculus cuneatus

Q8: In which of the following tracts crossing doesn't occur:

A: Posterior Spinocerebellar tract

B: Ventral Spinocerebellar tract

C: Lateral Spinothalamic tract

D: Anterior Spinothalamic tract

Q9: In which of the following tracts crossing occurs twice:

A: posterior Spinocerebellar tract

B: Ventral Spinocerebellar tract

C: Lateral Spinothalamic tract

D: Anterior Spinothalamic tract

Q10: People with Friedreich's ataxia are bound to wheelchair by the age of

A: 10 years

B: 15 years

C: 20 years

D: 25 years

Q11: The spinothalamic system consists of a sequence of

A: 1 neuron

B: 2 neurons

C: 3 neurons

D: 4 neurons

Q12: Which of the following tracts is involved in perception of dull aching

A: Spino-olivary tract

B: Spinotectal tract

C: Spinocerebellar tract

D: Spinoreticular Tract

Answer key:

7(A) , 8(A) , 9(B) , 10(C) , 11(C) , 12(D)



Q1: Write down the location of the three order neurons between the peripheral receptors and the cerebral cortex?

Q2: The three major pathways carry sensory information are?

Q3: An immune disease affects specifically fasciculus Cuneatus of the cervical region. Leads to Astereognosis Is ?

Q4: What is the function of anterior spinothalamic tract?

## Answers

1 : 1. First-order neuron (Delivers sensations to the CNS, The cell body is in the dorsal or cranial root ganglion)  
2. Second-order neuron ( An interneuron with the cell body in the spinal cord (grey matter) or brain stem (medulla oblongata))  
3. Third-order neuron (Transmits information from the thalamus to the cerebral cortex)

2 : 1. Dorsal (Posterior) column (divided into Gracile & Cuneate fasciculi) 2. Spinocerebellar pathway.  
3. Anterolateral pathway (Spinothalamic)

3 : Multiple Sclerosis

4: Carries Light, Crude Touch (non discriminative) & Pressure to thalamus and sensory cortex.

## Team leaders

Rayan jabaan  
Abeer Awwad

## A special thanks to Mohamed Alquhidan

### Reviser

Norah Alasheikh

### Organizer

Shaden Alsaiedan

### Note taker

Asma Alamri

## Team Members

- Alaa Assulmi
- Albandari Alanazi
- Aljoud Algazlan
- Afnan Almohsen
- Arwa Alqahtani
-  Aseel Alshehri
- Asma Alamri
- Bodoor Almubarak
- Deemah Alotaibi
- Fatimah Saad
- Ghada Alabdi
- Ghaida Alassiry
- Joud Alnujaidi
- May Barakah
- Norah Alasheikh
- Nouf Alsubaie
- Raghad Alasiri
- Raghad Soaeed
- Renad Alosaimi
- Sara Alharbi
- Sarah Almuqati
- Sarah Alqahtani
- Shaden Alsaiedan
- Shahad Almezel
- Shayma Alghanoum
- Sumo Alzeer

- Abdullah Alburikan
- Abdullah Aldosari
- Abdulaziz Alghuligah
- Abdulaziz Alkraida
- Abdulaziz Alomairy
- Abdulaziz Alrabiah
- Abdulaziz Alsuhaim
- Abdulrahman Almugren
-  Ahmed Alkhayatt
- Bader Alrayes
- Basel Fakeeha
- Fahad Alajmi
- Faisal Alotaibi
- Fayez Altabbaa
- Feras Alqaidi
- Hadi Alhemsy
- Hesham Alsqabi
- Mohammed Aldehaim
- Mohamed Alquhidan
- Mohammed Beyari
- Mubarak Alanazi
- Musab Alamri
- Nawaf Alghamdi
- Osama Alharbi
- Raed Alnutaifi
- Saad Aldohaim
- Saleh Algarni

