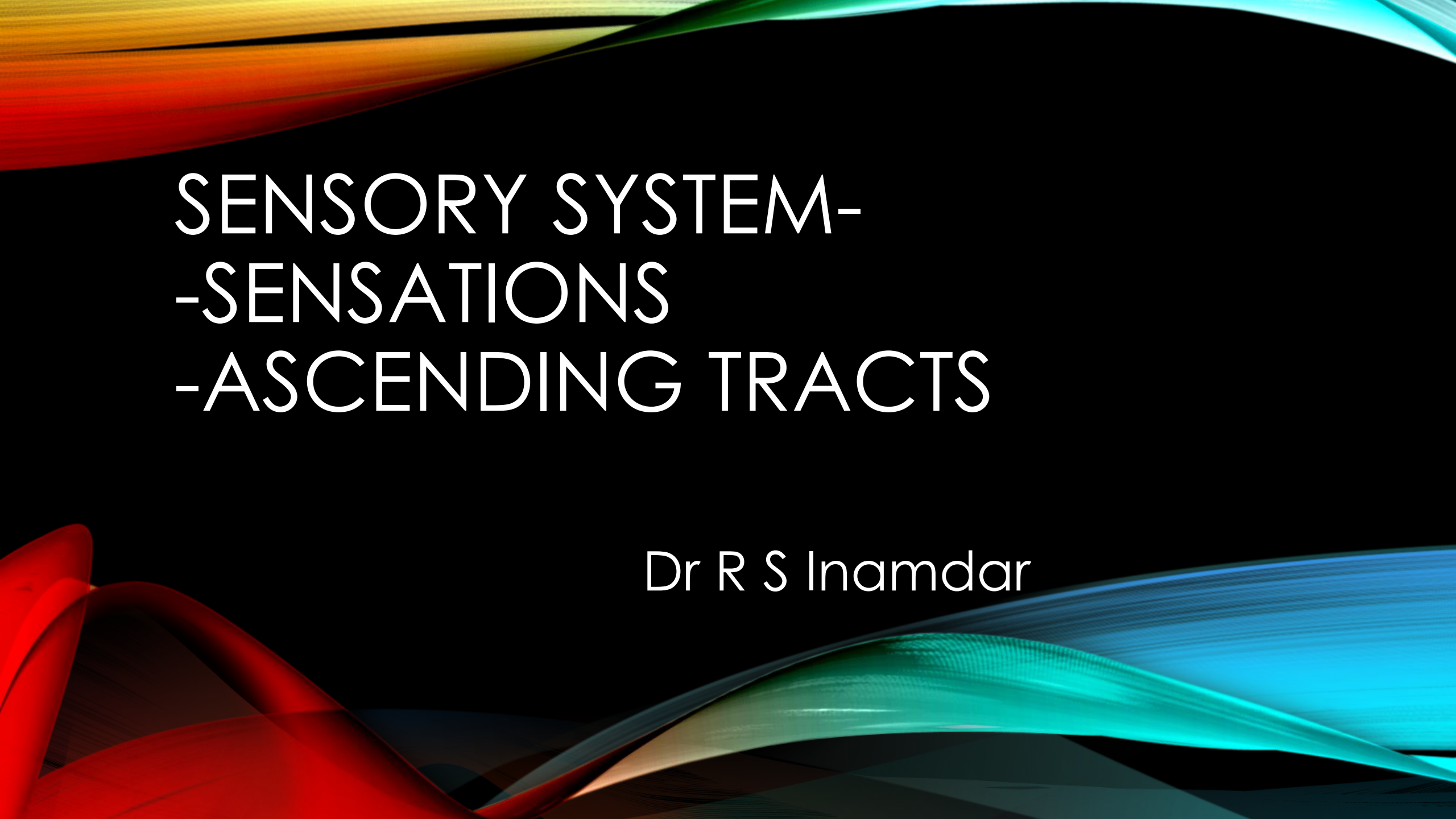




SENSORY SYSTEM- -SENSATIONS -ASCENDING TRACTS

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PY10.3

Describe and discuss

somatic sensations

&

sensory tracts

- **Sensation**: the information processed by the brain and reaches consciousness is called sensation
- **Perception**: Interpreting the meaning of sensation is called perception
- **Modality**: Each type of sensation e.g; temperature, touch, pressure is called modality of sensation.
- **Labeled line principle**: each type of nerve fibers transmitt only one modality of sensation

Sensory System

Somatic (= general) senses

- ¢ Touch
- ¢ Proprioception
- ¢ Temperature
- ¢ Nociception
- ¢ Itch

Special senses

- Vision
- Hearing
- Taste
- Smell
- Equilibrium

Conscious vs.
Unconscious

Somatic sensation

Tactile sensations: (touch, pressure vibration, itch tickle)

Transmitted by the anterolateral system

Thermal sensation:

Free nerve endings, two type cold and warm receptors

Transmitted by the anterolateral system

Pain sensation (nociception):

Carried by free nerve endings, pain receptors

Two types of pain:

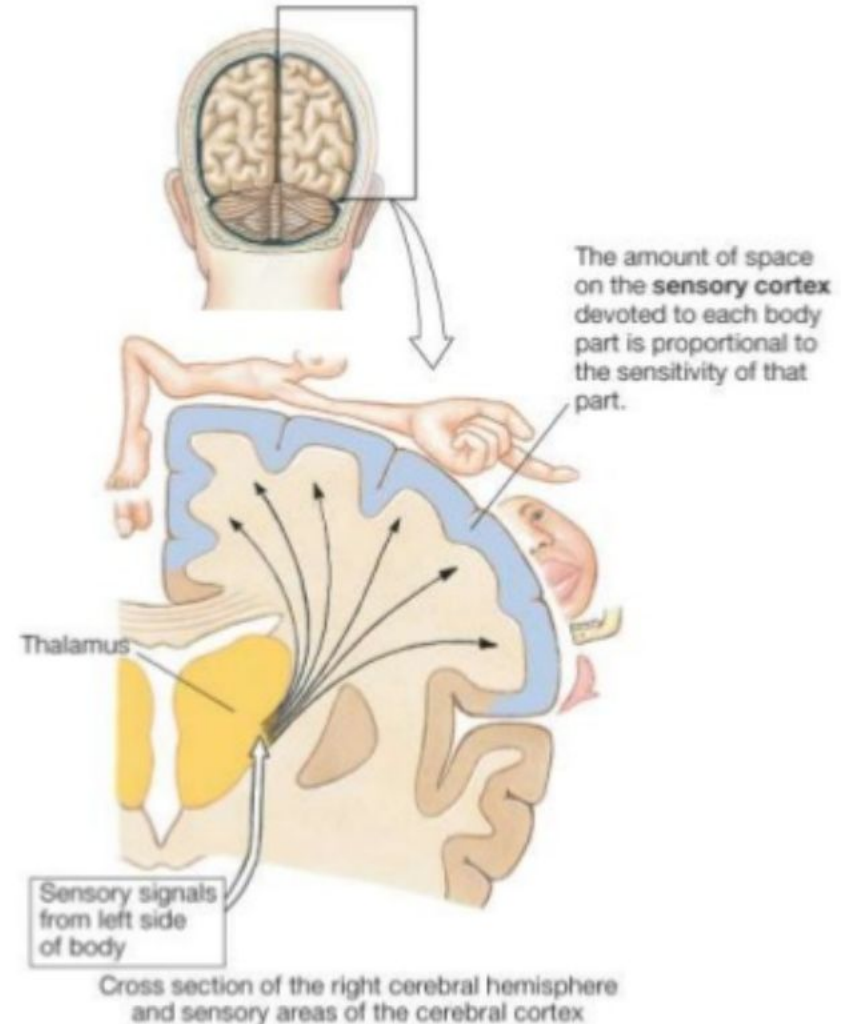
1. Fast pain (acute, pricking pain), medium diameter myelinated A fibers)
2. Slow pain(chronic, burning, aching throbbing) C fibers

Transmitted by the anterolateral system

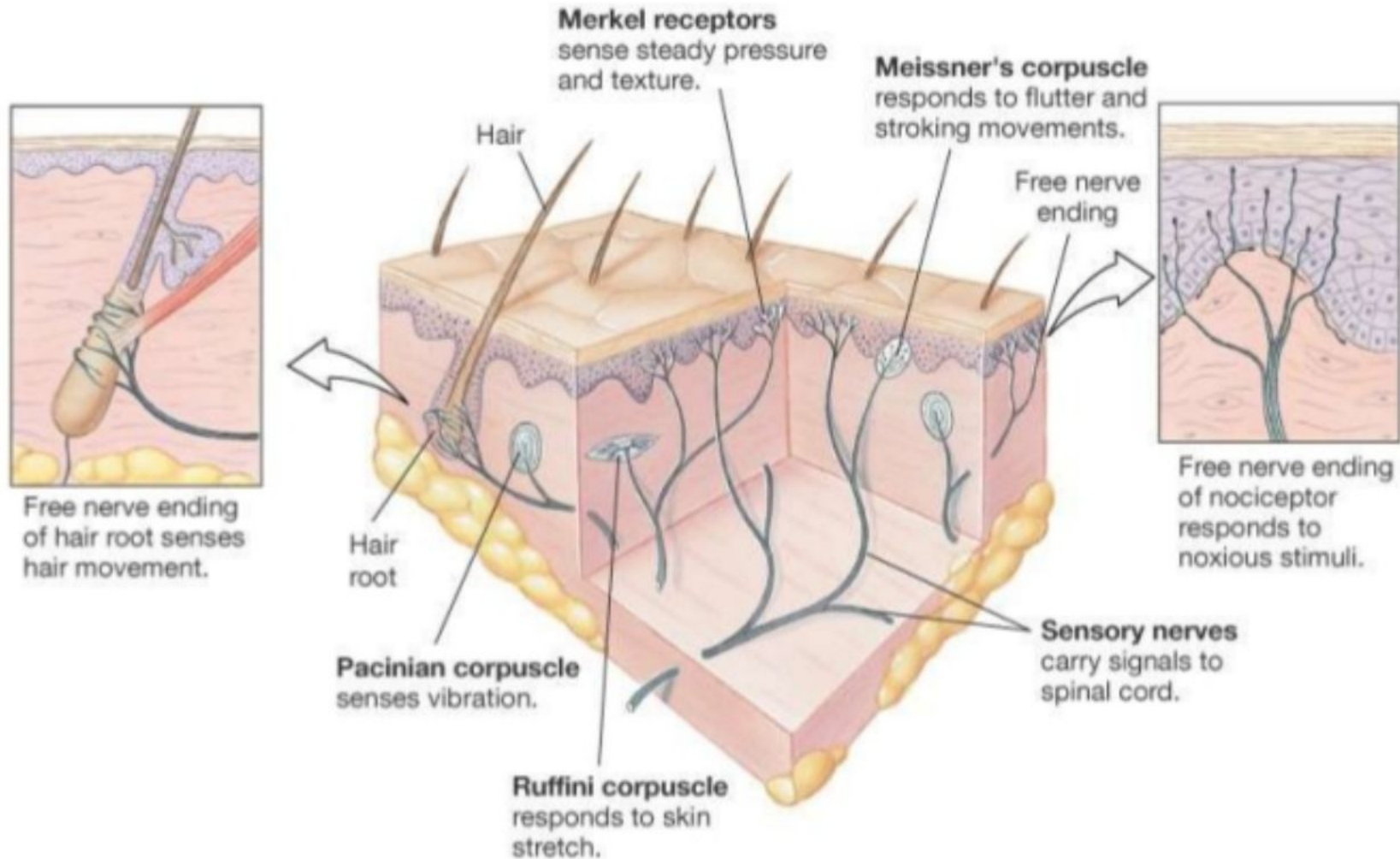
Proprioceptive sensation: sense of our position and movement

1. Muscle spindles
2. Golgi tendon bodies
3. Joint kinesthetic receptors

Transmitted by dorsal column-medial lemniscus system



Touch (pressure)



Types of touch:

1) Fine Touch:

- Enables the subject to detect the shape and texture of objects.
- Receptors are capsulated and hair end organs.
- Carried by the dorsal column-medial lemniscus system.

2) Crude Touch:

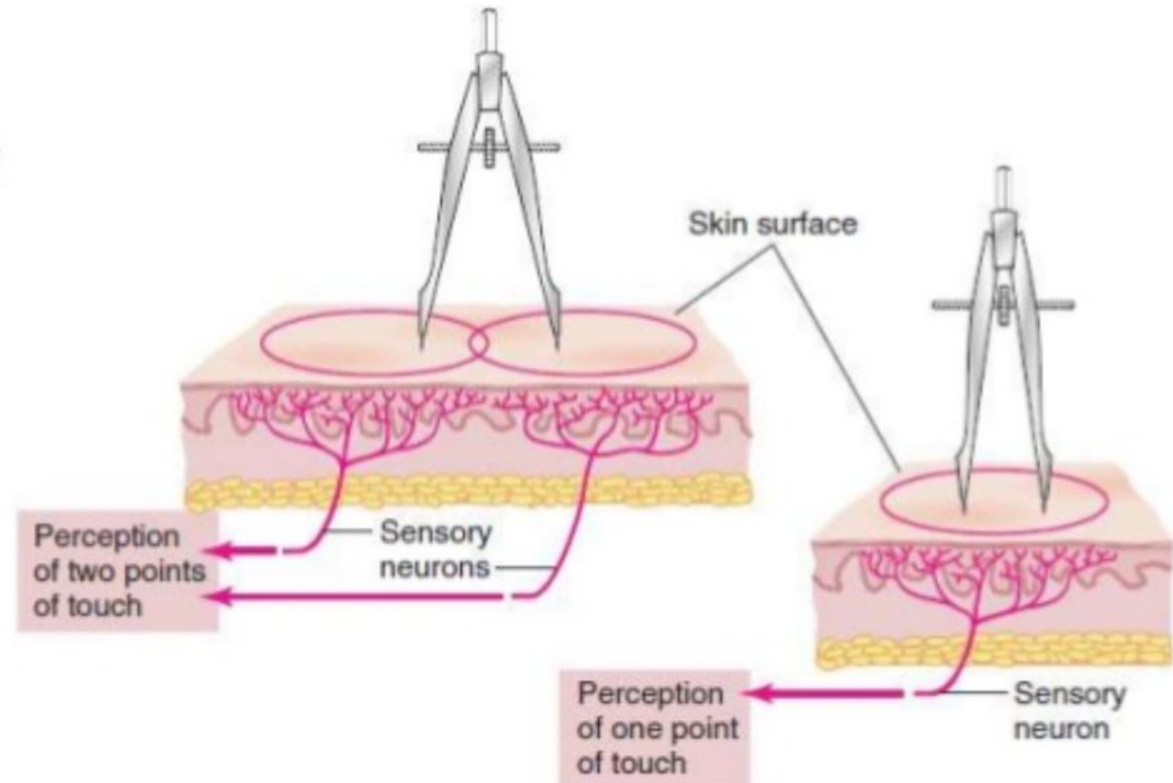
- Poorly localized sensation which needs a relatively strong stimulus.
- Emotionally important.
- Receptors are less differentiated free nerve endings,
- Carried by the anterolateral system.

Types of fine Touch:

1-Tactile Localization: the ability of the person to localize exactly the point touched with closed eyes.

2-Tactile Discrimination (Two point discrimination): the ability of the person to perceive 2 stimuli applied at the same time as two separate points provided that with closed eyes and the distance between the two points is more than the threshold distance.

- **Threshold (minimal) Distance:** it is the least distance between two points at which the person can discriminate between 2 stimuli applied at the same time.
- Factors affecting threshold distance:
 - a) Number of Receptors per unit area of the skin.
 - b) Number of afferents with minimal convergence.
 - c) Area of presentation in the cerebral cortex.
- the threshold distance is small in areas with high sensory function as **tip of the tongue 1 mm**, and **tip of the finger 3 mm**. but in the **back it is about 70 mm**.



The two-point touch threshold test. If each point touches the receptive fields of different sensory neurons, two separate points of touch will be felt.

If both caliper points touch the receptive field of one sensory neuron, only one point of touch will be felt.

Types of fine Touch:

3- Streognosis:

- The Ability of the subject to identify the name of the object with closes eyes.
- It depends on the somatic association area of the (area 5,7) of the cerebral cortex which is responsible for the understanding of the meaning somatic sensation.
- Lesion in area (5,7) → **Astreognosis.**

4- Texture of Material:

- The Ability of the subject to identify the texture of material of clothes with closed eyes.

Vibration Sense

- Definition: Certain type of Mechanoreceptive sensation in which the stimulus is rapid and receptive.
- Receptors:
 - 1- **Pacinian corpuscles**: they are stimulated up to 700 Cycle/sec.
 - 2- **Meissner's corpuscles**: they are stimulated up to 200 Cycle/sec.

Proprioceptive sensation

- Conscious perception of the position of the different parts of the body in relation to each other during rest and movement.
- This type of sensation allows our brain to identify the position of the different parts of the body during rest and movement.

- **Classification:**

1- Static position sense: Perception of the position of the body during rest

2- Movement sense (Kinesthetic sense): Provides information about the position of the body during movement

Proprioceptors

Muscle Proprioceptors

- **Muscle spindle:** detect muscle length and change in muscle length.
- **Golgi Tendon Organ:** detect muscle tension and force of contraction.
- According to their inputs the higher centers can detect position of limbs and the change in their position during movement

Joint Proprioceptors

- **Rapidly adapting:** detect the onset and offset of the movement.
- **Slowly adapting receptors:** detect the stationary position of the joint by their continuous discharge.
- Both receptors can detect the direction of the movement by changing their discharge i.e. some receptors discharge during flexion of the joint and other responds only with extension.

STEREOGNOISIS

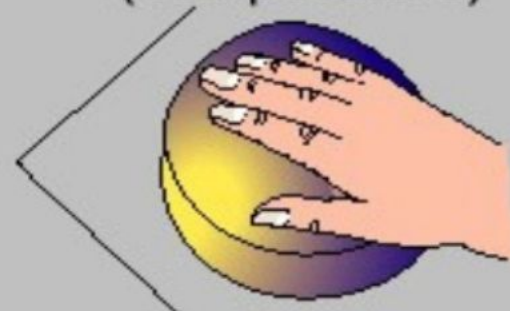
Lateral Motion
(Texture)



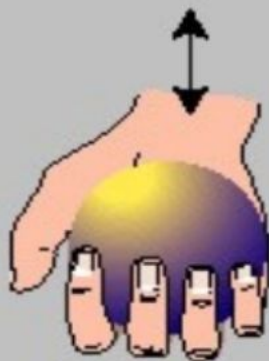
Pressure
(Hardness)



Static Contact
(Temperature)



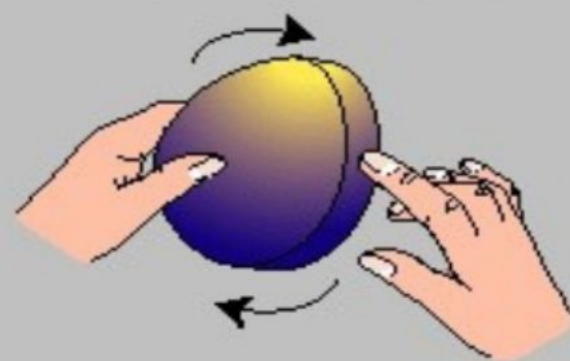
Unsupported Holding
(Weight)



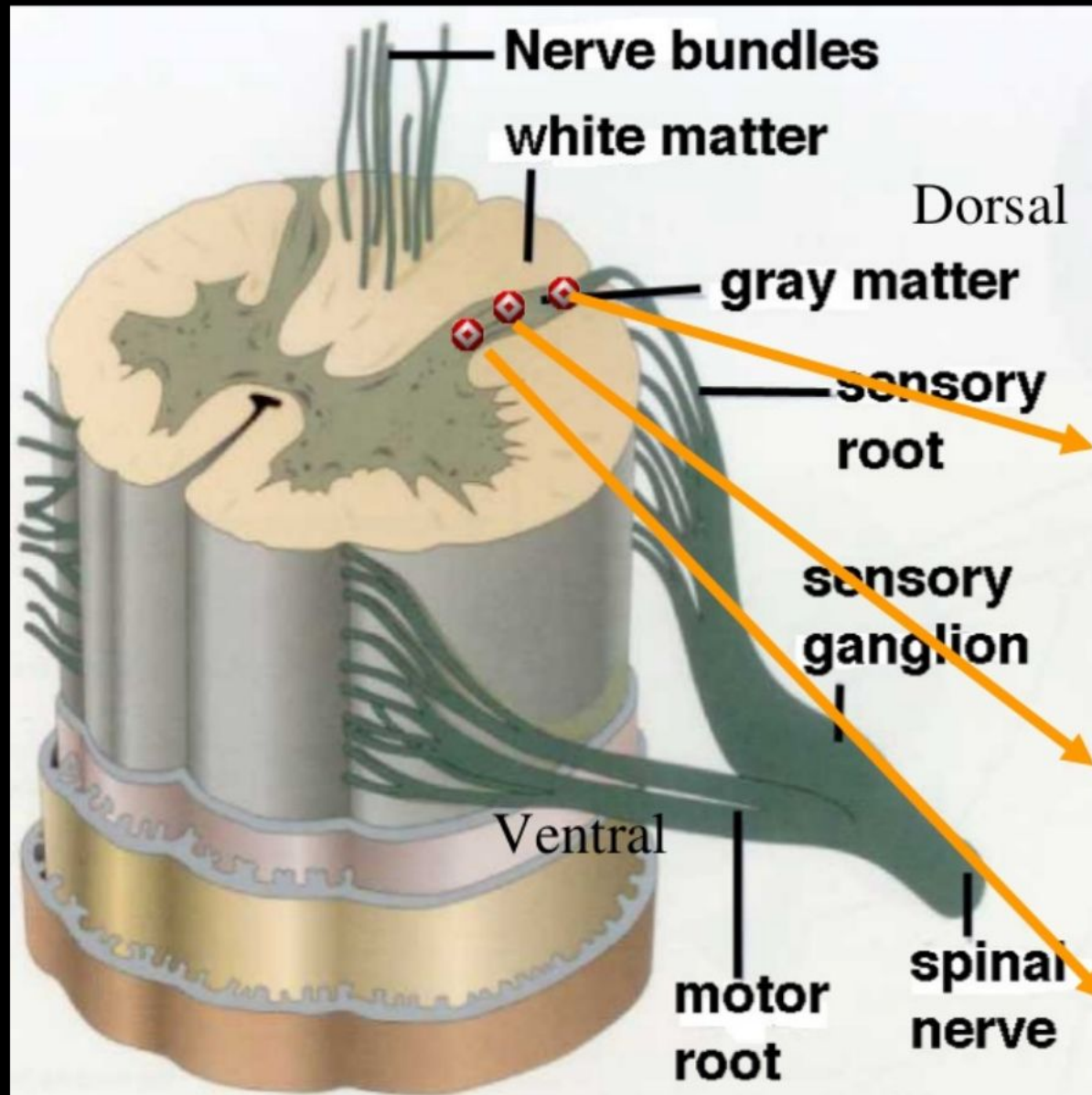
Enclosure
(Global shape)
(Volume)



Contour Following
(Global shape)
(Exact shape)



The Spinal Cord

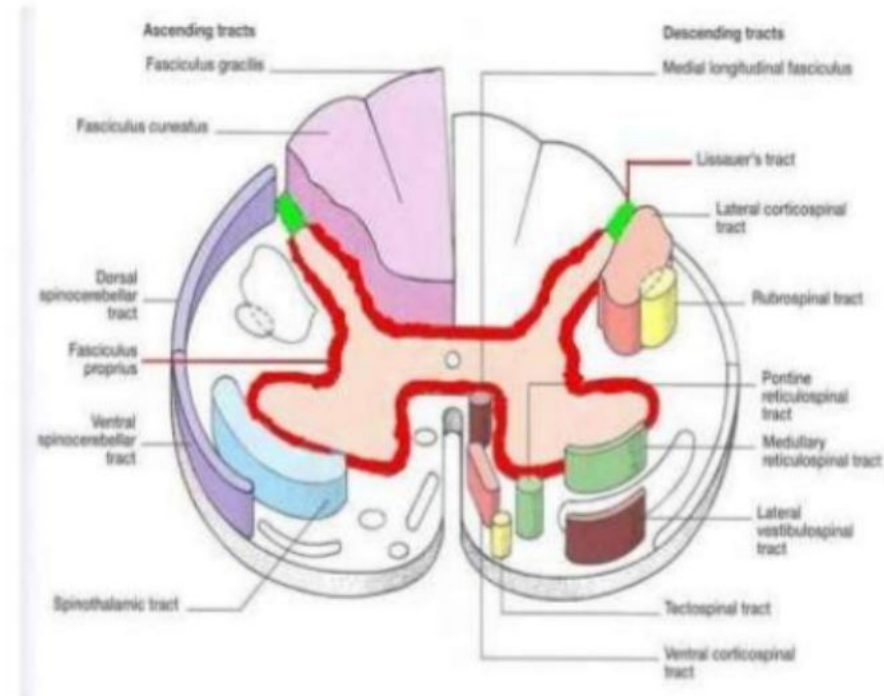


3 GROUP OF CELLS IN THE POSTERIOR HORN

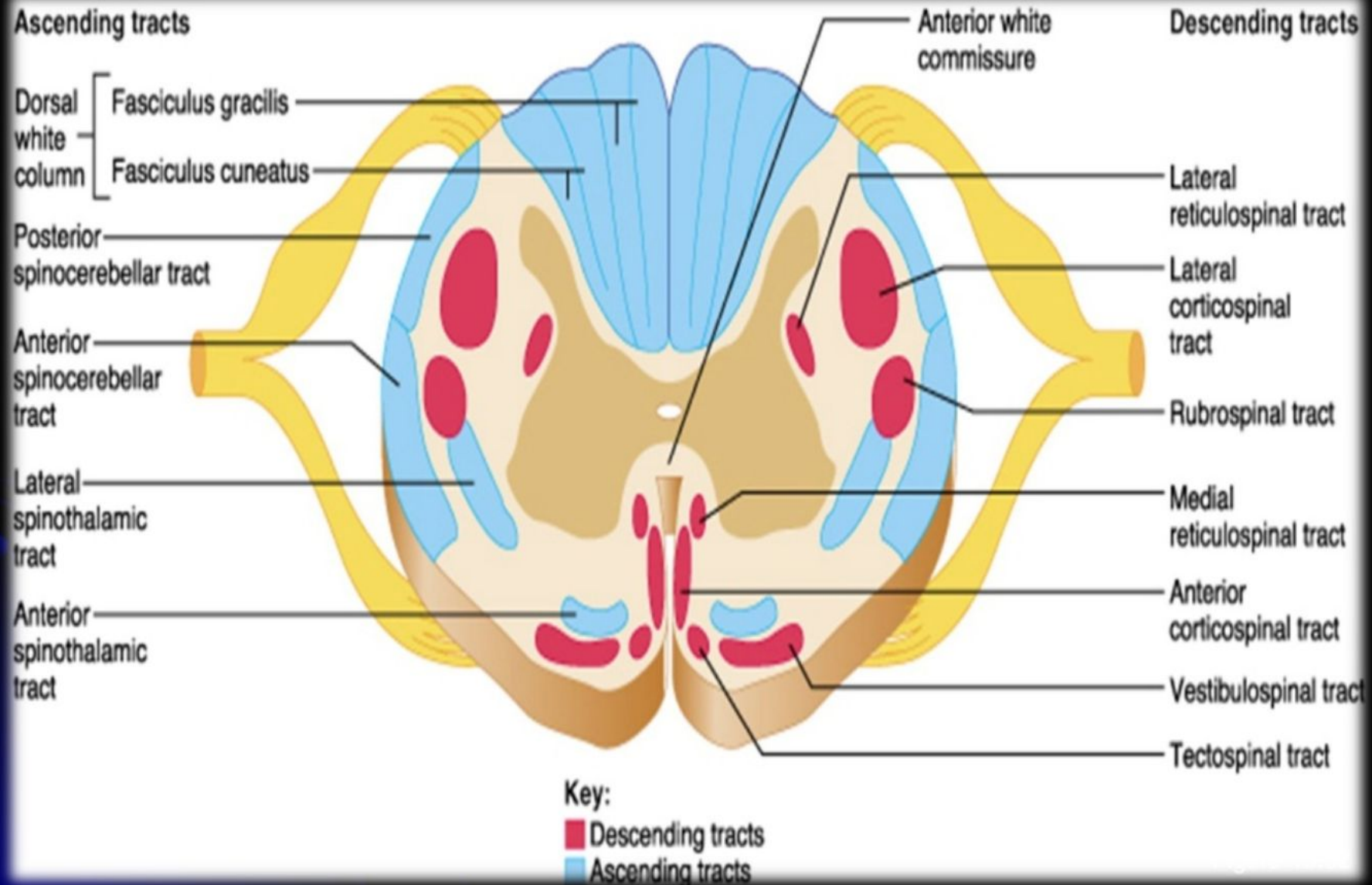
1. Substantia gelatinosa of Rolando (SGR)
2. Chief sensory nucleus
3. Clarke's

CLASSIFICATION

- 3 types
- Tracts that serve to join brain to the spinal cord
 - a) Descending
 - b) Ascending
- Fibers that interconnect adjacent or distant segments of the spinal cord
 - c) Intersegmental



Tracts of the Spinal Cord



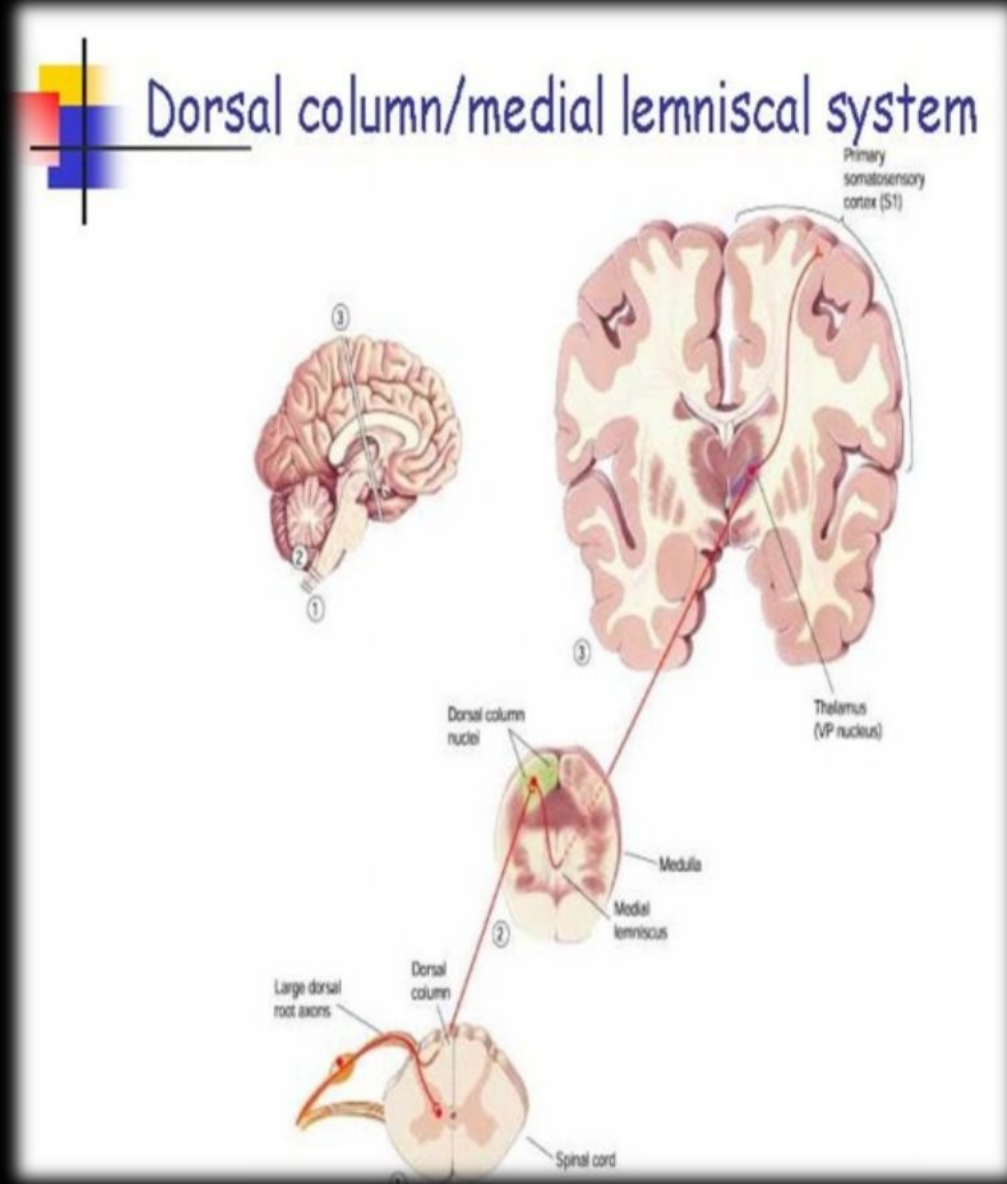
Ascending tracts

- Major

- 1) posterior column

- 2) Anterolateral system (spinothalamic)

- 3) Spino cerebellar tract



Ascending Pathways

- For conscious perception:
 - Spinothalamic system
 - Medial Lemniscal system
- For unconscious perception:
 - Spinocerebellar
 - Spino-olivary
 - Spinotectal
 - Spinoreticular

Ascending Sensory Pathway are organized
in
three neuronal chain

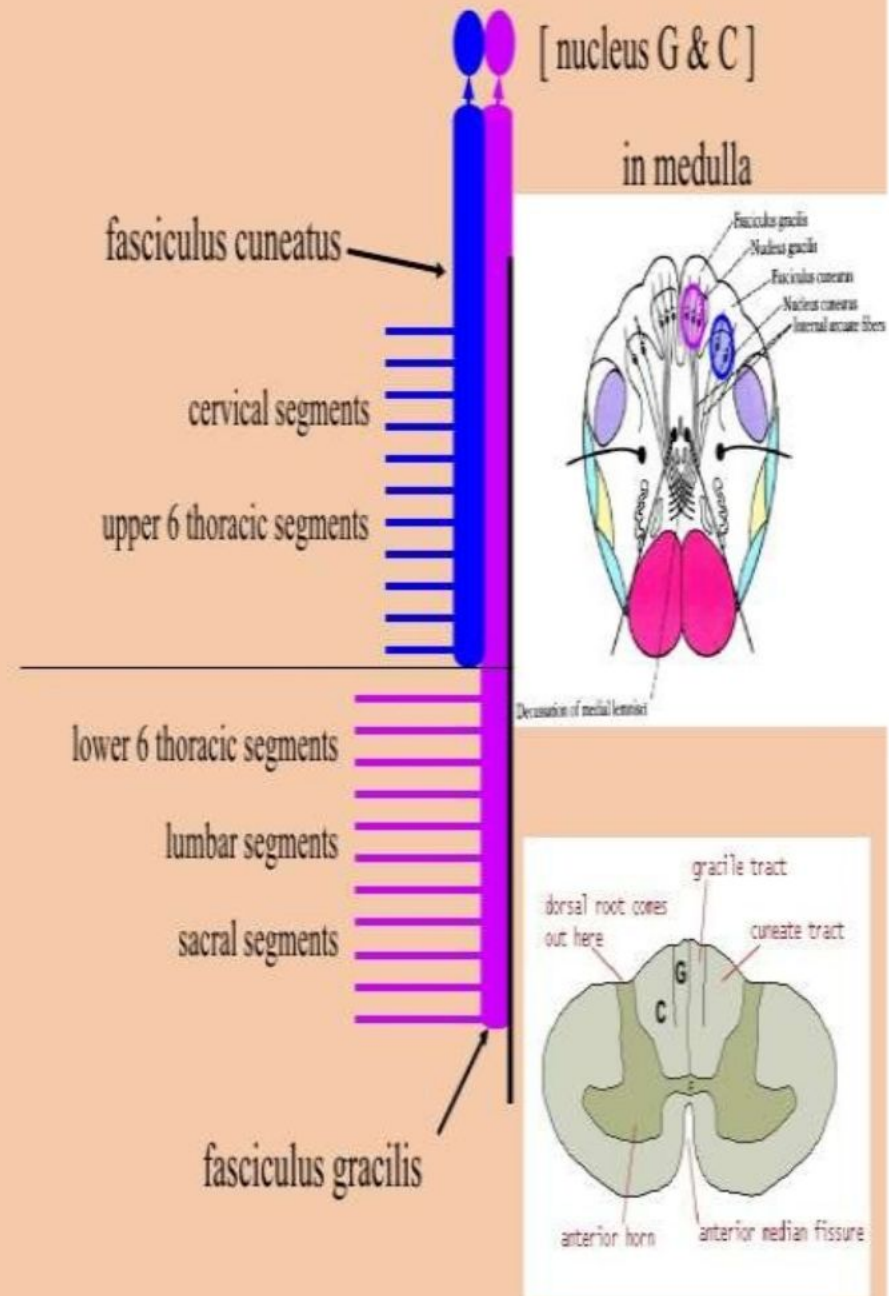
- First order neuron
- Second order neuron
- Third order neuron

FASCICULUS GRACILLIS AND FASCICULUS CUNEATUS

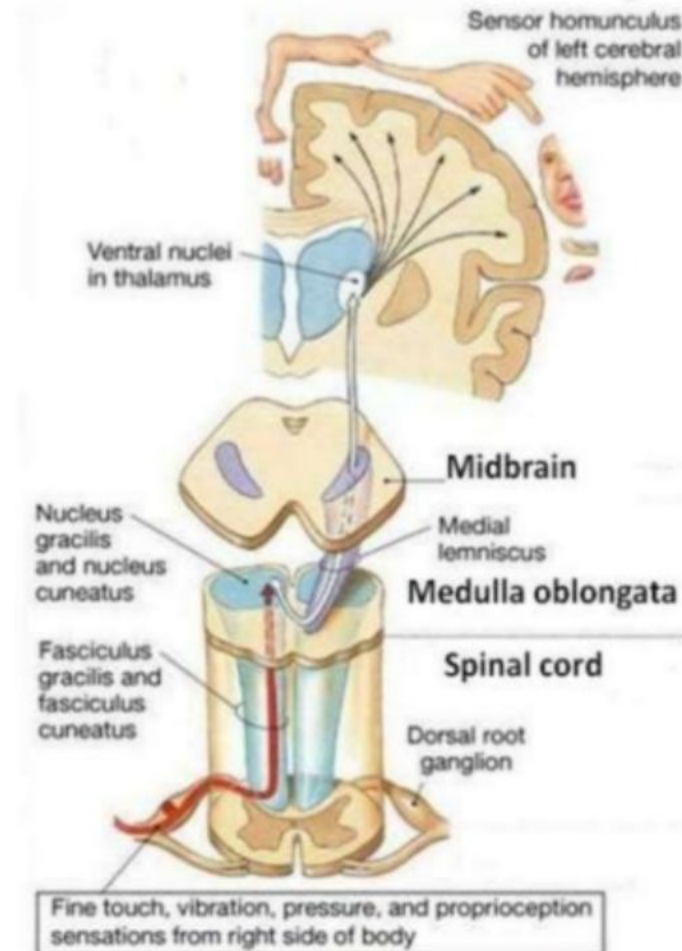
- Occupy the posterior white column of the cord
- FG being medial to FC

•FG contains fibers received at sacral, lumbar and lower thoracic levels

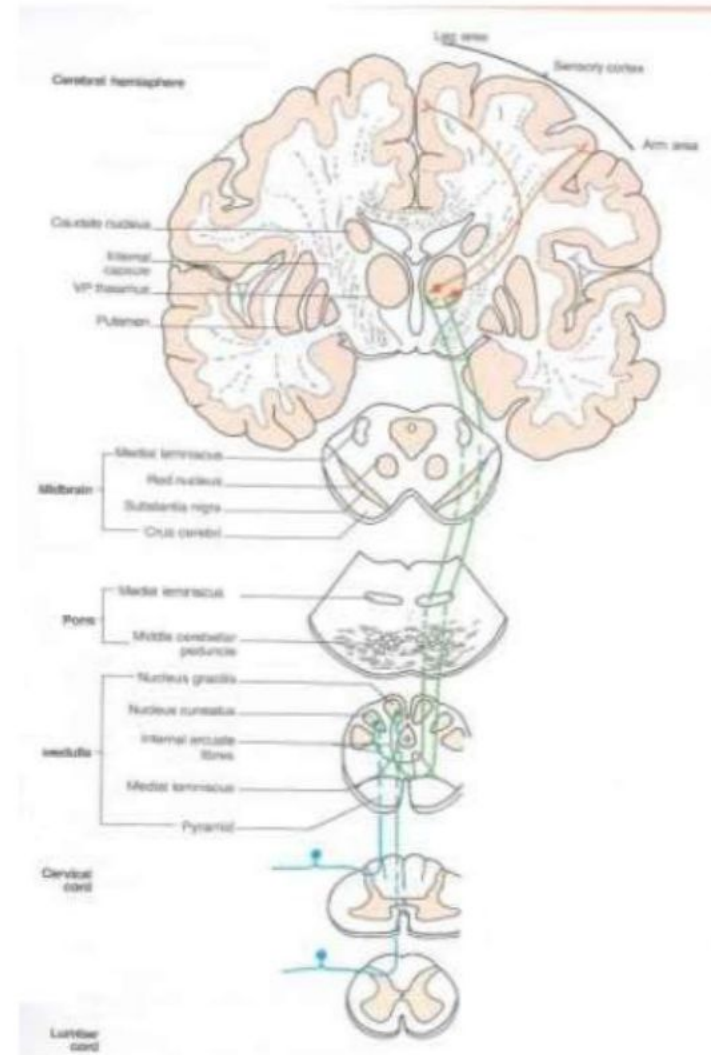
•FC contains fibers received at upper thoracic and cervical levels



- Carry impulses concerned with proprioception and discriminative touch from **ipsilateral** side of body
- Contain the axons of **primary afferent neurons** that have entered cord through dorsal roots of spinal nerves



- Fibers ascend without interruption where they terminate upon **2nd order neurons** in nucleus gracilis and nucleus cuneatus
- The axons of the 2nd order neurons **decussate** in the medulla as **internal arcuate fibers** and ascend through the brain stem as **medial lemniscus**.
- The medial lemniscus terminates in the **ventral posterior nucleus** of the **thalamus** upon **3rd order neurons**, which project to the **somatosensory cortex** (thalamocortical fibers)



Functions of posterior column
Sensations carried by Dorsal
columns:

Light touch (tactile sensation,

2. Tactile discrimination

3. Tactile localization)

4. Conscious proprioception –

5. Joint position and movement.

6. Vibration sensation

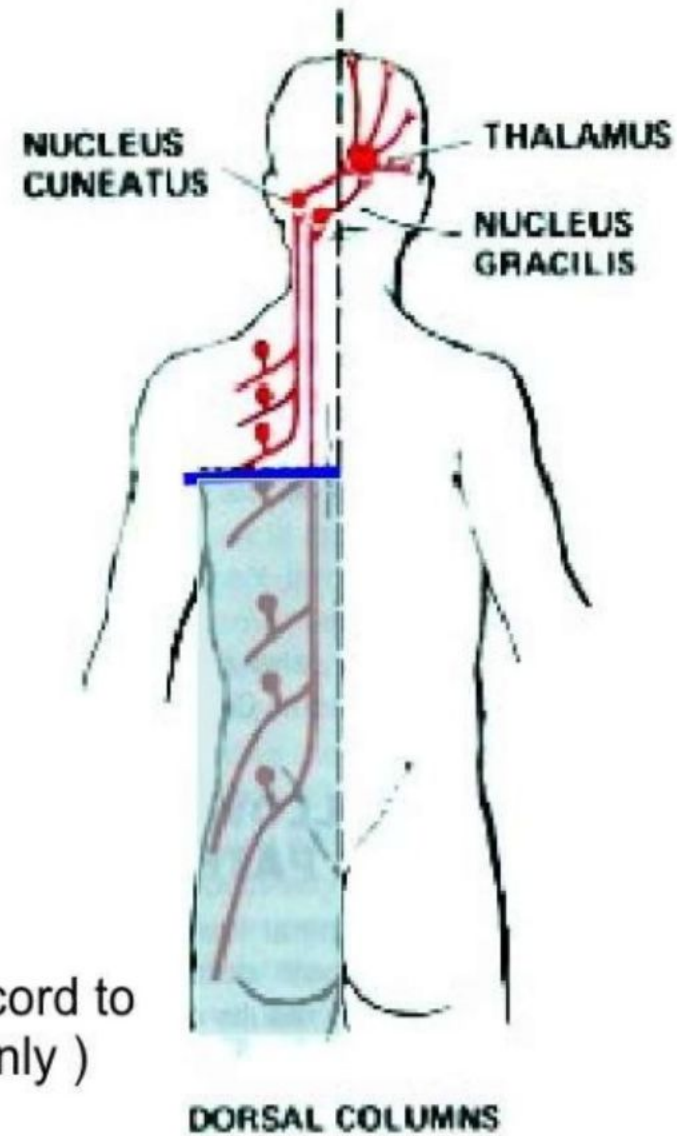
7. Stereognosis.

8. Pressure sensation with fine
gradations.

Clinical application
destruction of
fasciculus gracilis and cuneatus

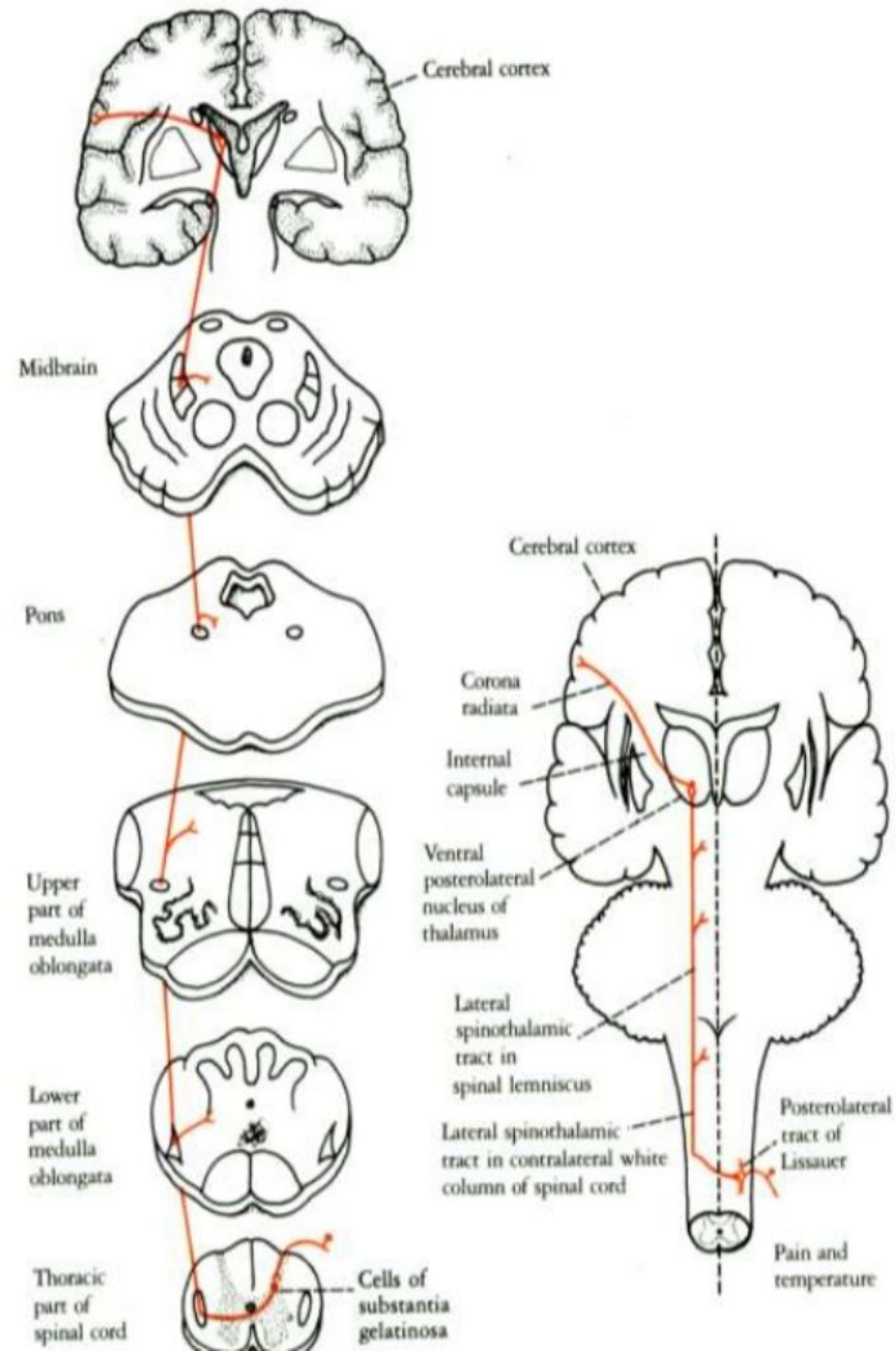
- loss of muscle joint sense, position sense, vibration sense and tactile discrimination
- on the same side
- below the level of the lesion

(extremely rare to have a lesion of the spinal cord to be localized as to affect one sensory tract only)



Lateral spinothalamic tract

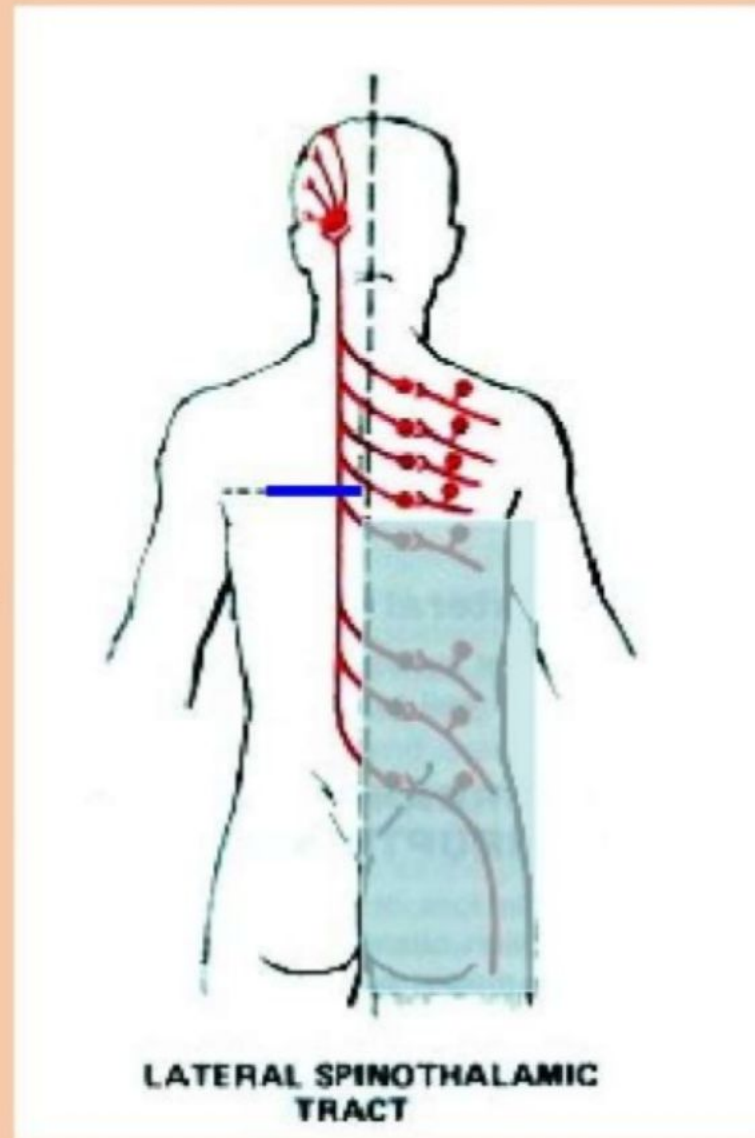
- pain and thermal impulses
(input from free nerve endings,
thermal receptors)
 - transmitted to spinal cord in
delta A and C fibres
 - central process enters the spinal
cord through posterior nerve
root, proceed to the tip of the
dorsal gray column
- **Second order neuron**
 - in the dorsal horn, cross to the
opposite side (decussate)
 - ascend in the contralateral ventral
column
 - end in VPL nucleus of thalamus
 - **Third order neuron**
 - in the VPL nucleus of thalamus
 - project to cerebral cortex (area 3,
1 and 2)



Clinical application destruction of LSTT

- loss of
 - pain and thermal sensation
 - on the contralateral side
 - below the level of the lesion

patient will not
respond to pinprick
recognize hot and cold

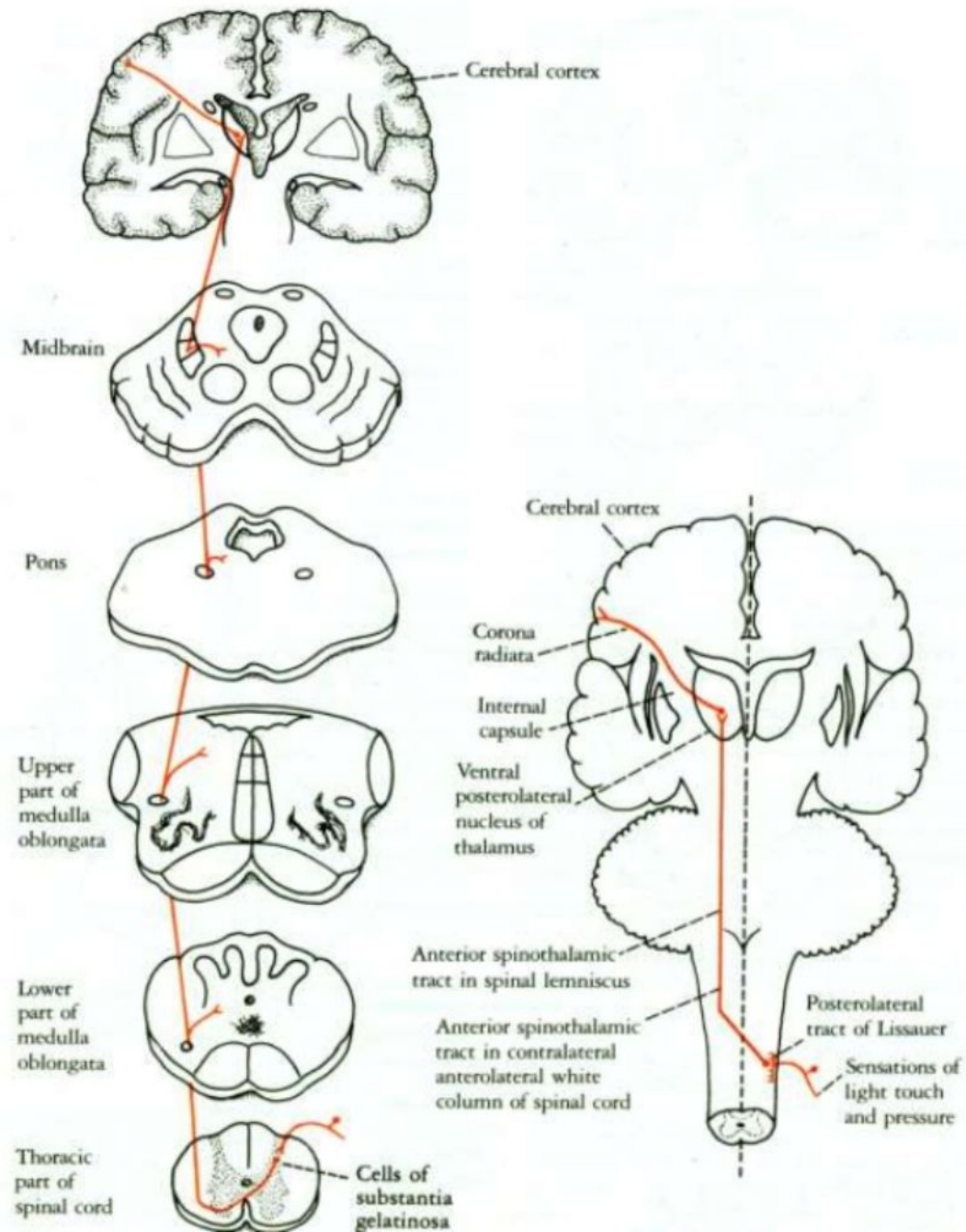


□ Anterior spinothalamic tract

light touch and pressure impulses

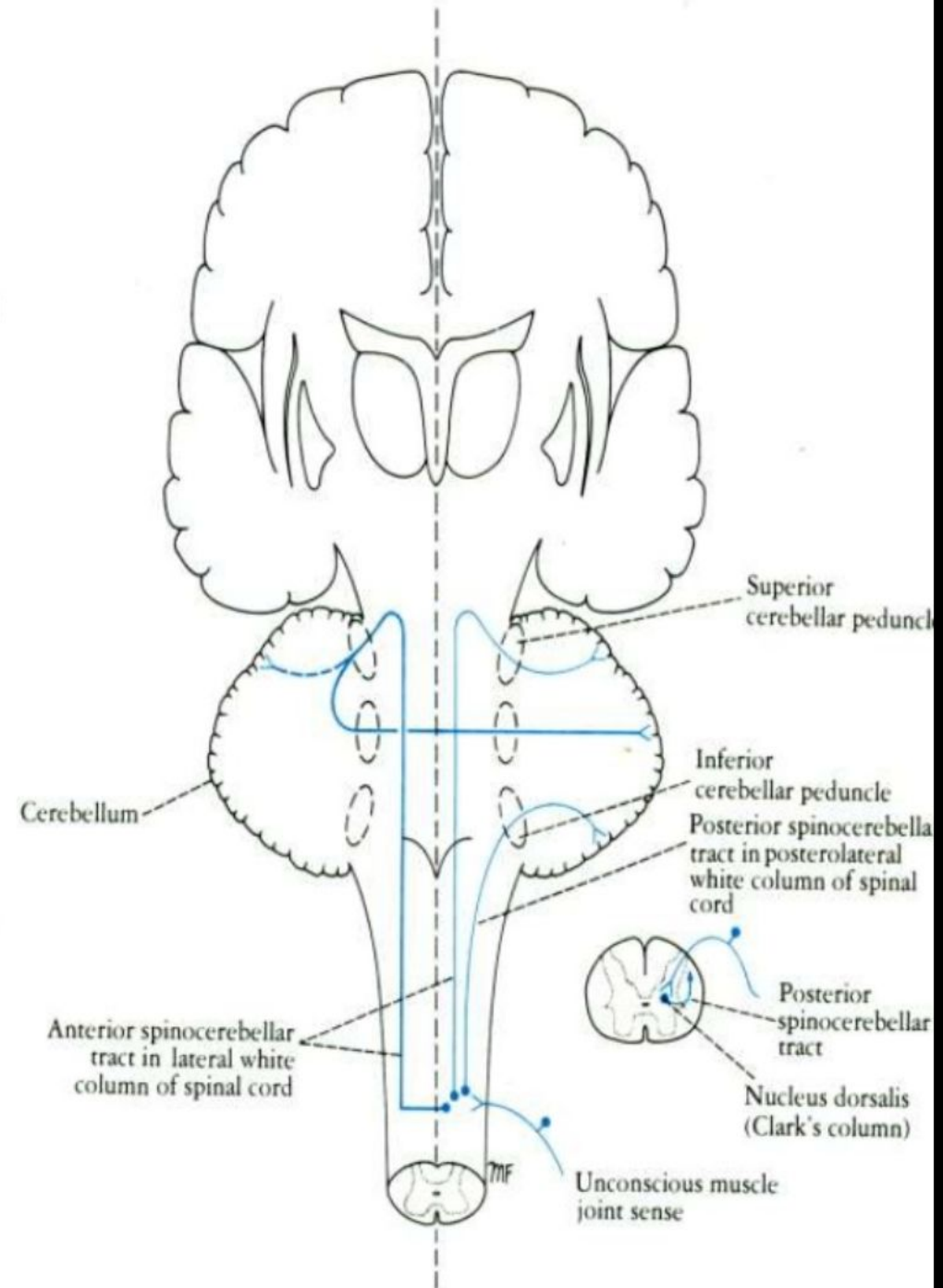
(input from free nerve endings, Merkel's tactile disks)

- **First order neuron**
 - dorsal root ganglion(all level)
- **Second order neuron**
 - in the dorsal horn, cross to the opposite side (decussate)
 - ascend in the contralateral ventral column
 - end in VPL nucleus of thalamus
- **Third order neuron**
 - in the VPL nucleus of thalamus
 - project to cerebral cortex (area 3, 1 and 2)



Posterior & anterior spinocerebellar tract

- Transmit unconscious proprioceptive information to the cerebellum
- receive input from muscle spindles, and pressure receptors
- involved in coordination of posture and movement of individual muscles of the lower limb



• Spinotectal tract

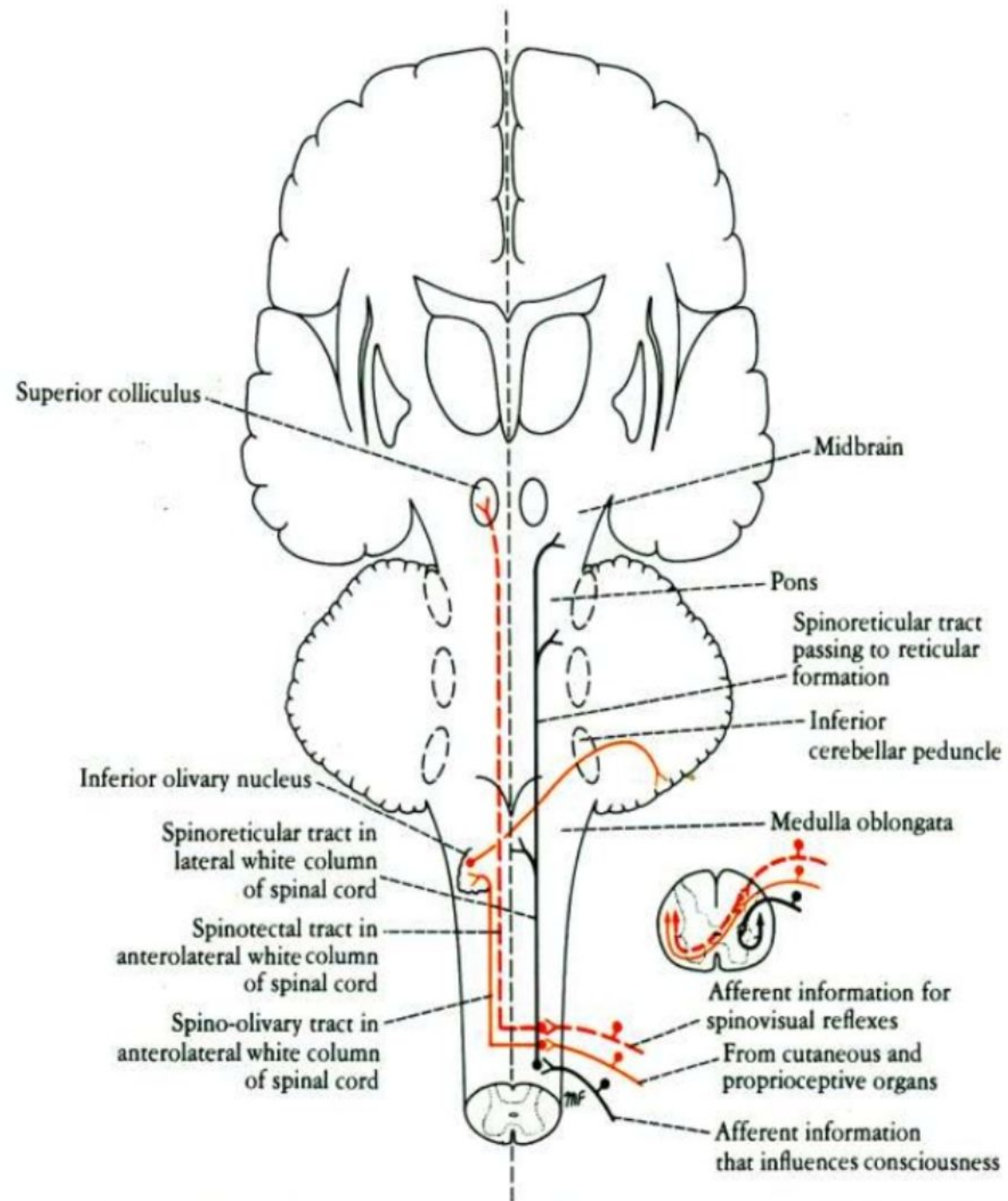
❖ passes pain, thermal, tactile information to superior colliculus for spinovisual reflexes

- cross the median plane
- synapse in the superior colliculus
- integrate visual and somatic sensory information (it brings about the movement of eye and head towards the source of information)

❖ Spinoreticular tract

- uncrossed fibres, synapse with neurones of reticular formation (important role in influencing level of consciousness)

❖ Spino-olivary tract



Sensory Homunculi

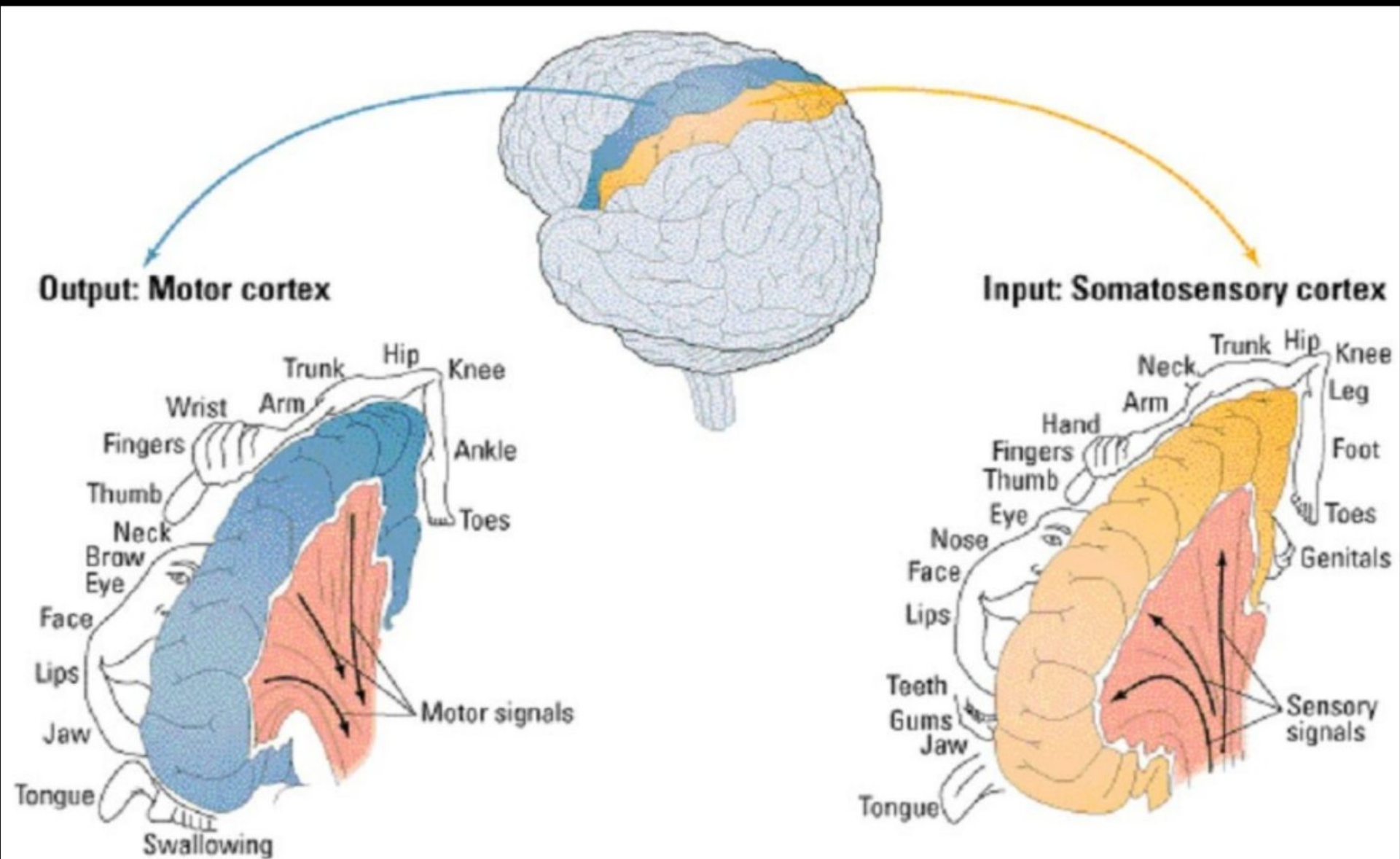
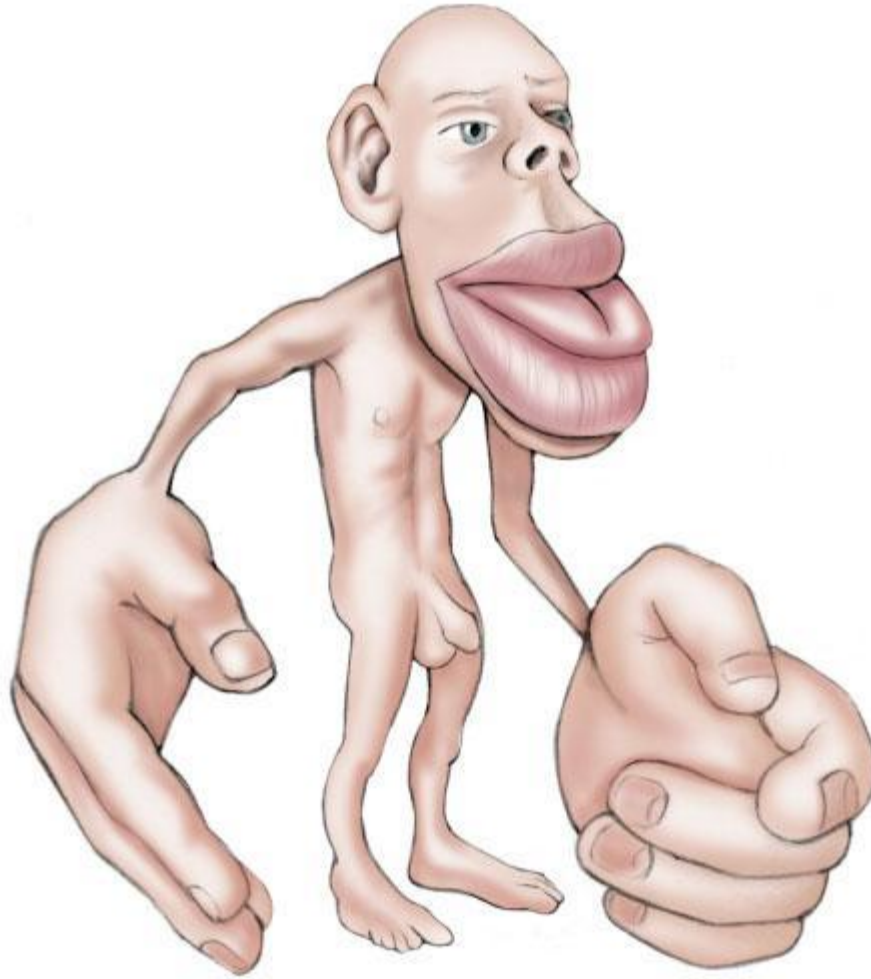
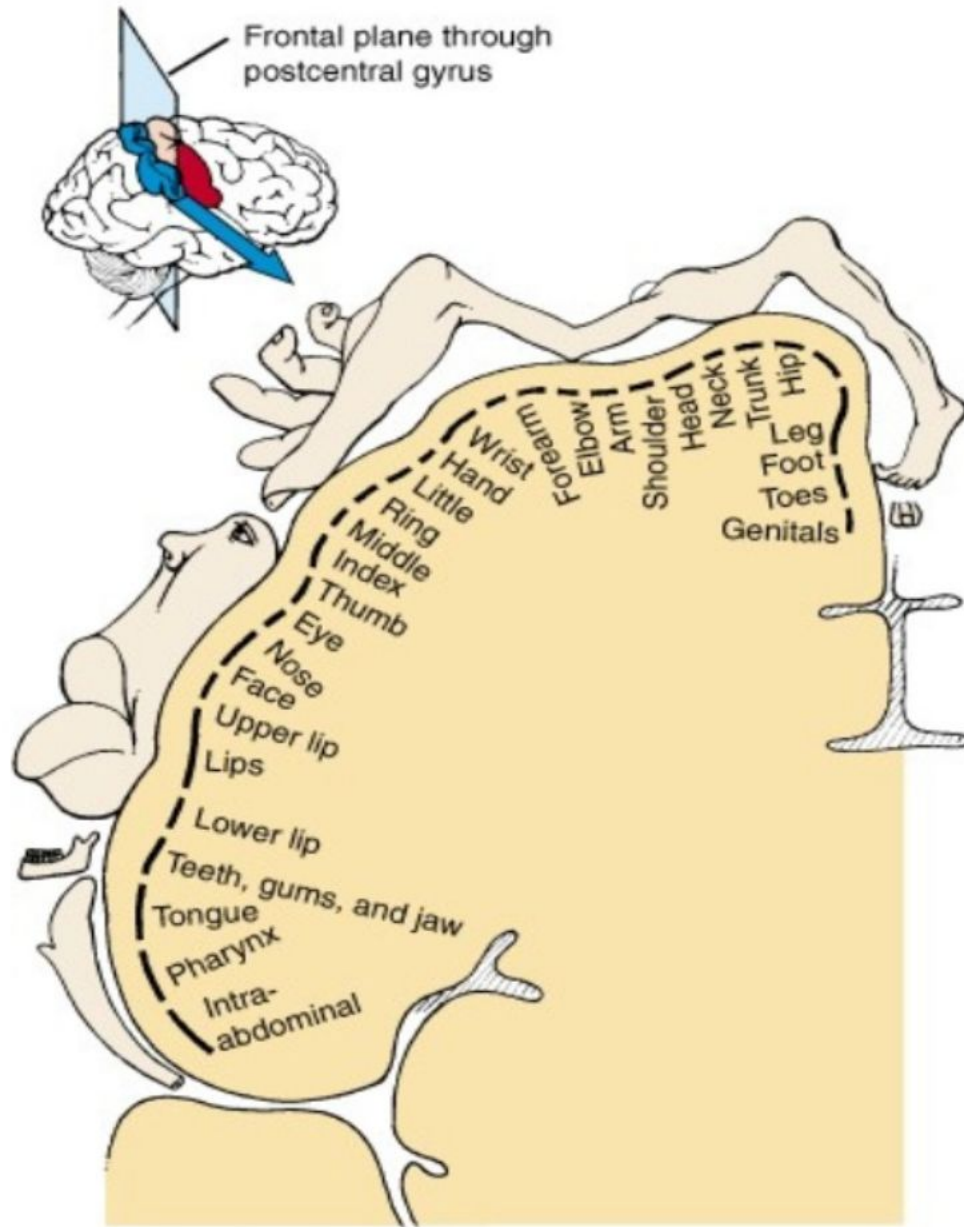


Figure 12.19
The homunculus.



Somatosensory cortex of Postcentral Gyrus



- Relative sizes of cortical areas
 - proportional to number of sensory receptors
 - proportional to the sensitivity of each part of the body
- Can be modified with learning
 - learn to read Braille & will have larger area representing fingertips

Clinical Relevance: Injury to the Ascending Tracts

DCML Pathway

A lesion of the DCML pathway causes a loss of **proprioception** and **fine touch**. However, a small number of tactile fibres travel within the anterolateral system, and so the patient is still able to perform tasks requiring tactile information processing.

If the lesion occurs in the spinal cord (which is most common), the sensory loss will be **ipsilateral** – decussation occurs in the medulla oblongata. DCML lesions can be seen in vitamin B12 deficiency and tabes dorsalis (a complication of syphilis).

Anterolateral System

Injury to the anterolateral system will produce an impairment of pain and temperature sensation. In contrast to DCML lesions, this sensory loss will be **contralateral** (the spinothalamic tracts decussate within the spinal cord).

Brown-Séquard syndrome refers to a **hemisection** (one sided lesion) of the spinal cord. This is most often due to traumatic injury, and involves both the anterolateral system and the DCML pathway:

- **DCML pathway** – ipsilateral loss of touch, vibration and proprioception.
- **Anterolateral system** – contralateral loss of pain and temperature sensation.

It will also involve the **descending motor tracts**, causing an ipsilateral hemiparesis.

Methods of sensation

examination

Position Sense

The sensation of muscle movement and joint position



Grasp the patient's big toe and hold it away from the other toes to avoid friction.

Show the patient "up" and "down."

With the patient's closed eyes ask him to identify the direction of moving the toe.

Vibration

Use a low pitch tuning fork (128 Hz).



- Place the stem of the fork over the distal interphalangeal joint of the patient's big toes.

TWO-POINT DISCRIMINATION SENSE

Use an Weber compasses to touch the patient's finger pads in two places simultaneously.

Decreased the interval between the legs of compasses.

Ask the patient to identify "one" or "two" touch feelings.

Find the minimal distance at which the patient can discriminate (or distinguish two touch feelings).



Stereognosis (three-spatial) sense

- ... is explored by object recognition with the help of touching with the closed patient's eyes.

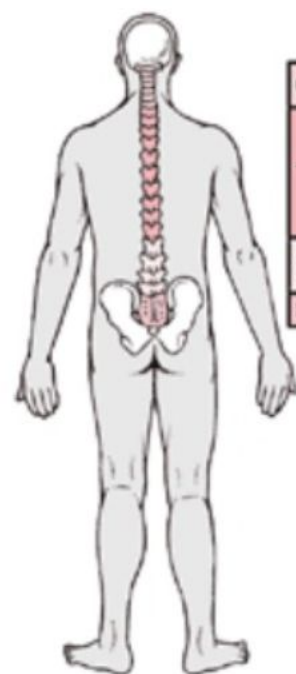


SPINAL TRAUMA



- NERVE ROOT:
- Herniated Disk/ Spondylosis
- Cervical & Lumbar
- Pain
- Paraesthesia
- Weakness & muscle wasting
- Reduced Sensation
- Loss of Reflexes

Effects of Spinal Injury



Level of Injury	Effect*
CERVICAL	C1 to C5 Paralysis of muscles used for breathing and of all arm and leg muscles; usually fatal.
	C5 to C6 Legs paralyzed; slight ability to flex arms
THORACIC	C6 to C7 Paralysis of legs and part of wrists and hands; shoulder movement and elbow bending relatively preserved
	C8 to T1 Legs and trunk paralyzed; eyelids droop; loss of sweating on the forehead (Horner's syndrome); arms relatively normal; hands paralyzed
	T2 to T4 Legs and trunk paralyzed; loss of feeling below the nipples
	T5 to T8 Legs and lower trunk paralyzed; loss of feeling below the rib cage
	T9 to T11 Legs paralyzed; loss of feeling below the umbilicus
LUMBAR	T12 to L1 Paralysis and loss of feeling below the groin
	L2 to L5 Different patterns of leg weakness and numbness
	S1 to S2 Different patterns of leg weakness and numbness
SACRAL	S3 to S5 Loss of bladder and bowel control; numbness in the perineum

*Loss of bladder and bowel control can occur with severe injury anywhere along the spinal column