16 proprioception

CNS

Sources:
Female slides

OBJECTIVES

1-Identify the major sensory pathways

Describe the components, processes and functions of the sensoty pathways

2-appreciate the dorsal column system in conscious proprioception (anatomy&functions)

3- describe the pathway of spinocerebellar tract in unconscious proprioception from muscles,tendons,and joints

4-differentiate between sensory and motor ataxia

Note: from page 3 to 6 only revision

Organization of the Nervous System

Central Nervous System

- **The brain**
- **the spinal cord**
  - The center of integration and control

Peripheral Nervous System

- **31 Spinal nerves**
  - Carry info to and from the spinal cord
- **12 Cranial nerves**
  - Carry info to and from the brain

Spinal cord

A Cross-section view of spinal cord- wider laterllay than anteroposteriorly. In the middle **on the dorsal side** is a shallow groove called the **posterior median sulcus**

and **on the ventral side** is the **anterior median fissure** (deeper).

and the center consist of gray matter shaped like a butterfly and there is an

opening at the center

Spinal cord is protected by three layers of meninges. The only difference from the brain is that the dural matter does not attach to bone. **The dural matter** is surrounded externally by a layer of cushioning fat called **epidural space**.

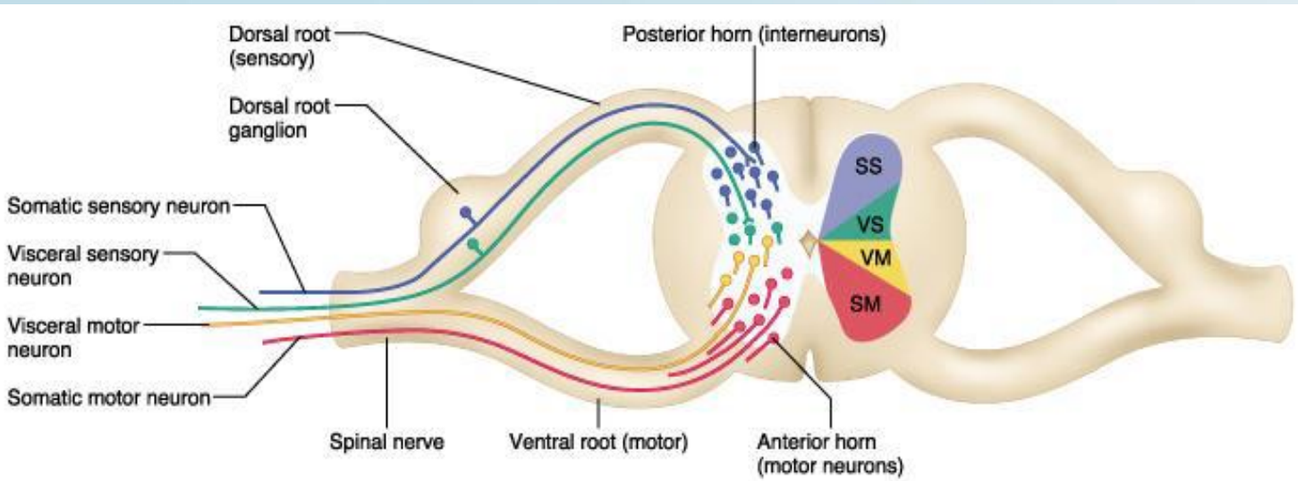
Gray Matter

Dorsal half = sensory roots and ganglia

Ventral half =motor roots

Dorsal and ventral roots fuse laterally to form spinal nerves

There are four zones are evident within the gray matter – somatic sensory (SS), visceral sensory (VS), visceral motor (VM), and somatic motor (SM)



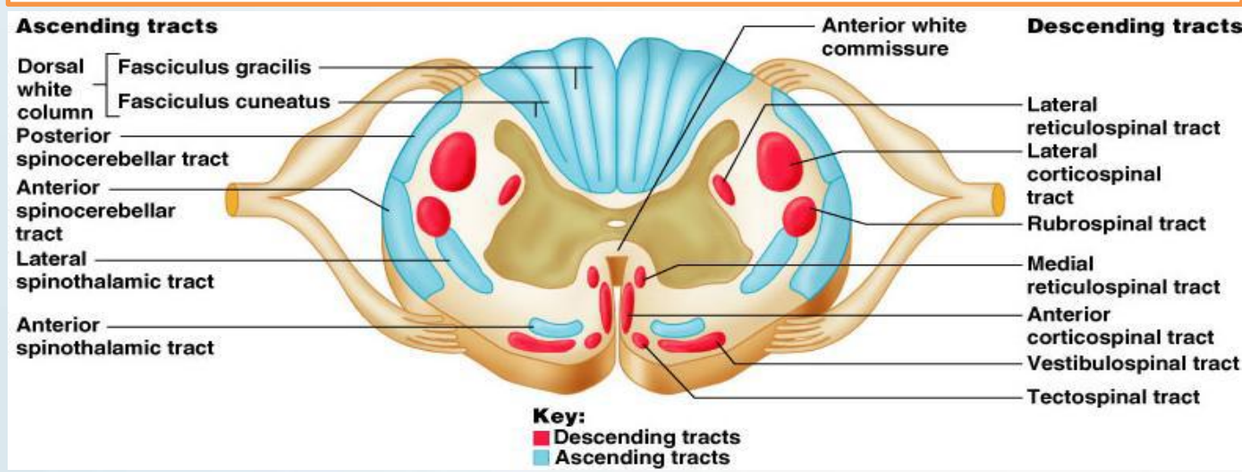
White Matter

Fibers run in three directions – ascending, descending, and transversely ,Divided into three funiculi (columns)

posterior **lateral** **anterior**

1)Fiber tract names reveal their origin and destination

2)Fiber tracts are composed of axons with similar functions



Neural pathways

Afferent pathways

Sensory information coming from the sensory receptors through peripheral nerves to the spinal cord and to the brain .

Efferent pathways

Motor commands coming from the brain and spinal cord, through peripheral nerves to effecter organs .

Sensory pathways = ascending pathways

Sensory systems allow us to detect, analyze and respond to our environment

sensory receptors

Brain, could reach to ?

Conscious: reach cerebral cortex

Unconscious: do not reach cerebral cortex

Sensations from body reach the opposite side of the brain

Peripheral Sensory Receptors

Sensory receptors classified according to:

1-Location
2-Type of stimulus detected
3-Structure

Unencapsulated Nerve Endings

Types:
*Free nerve endings of sensory neurons
*Modified free nerve endings (Merkel discs)
*Hair follicle receptors

Encapsulated Nerve Endings

*Consist of one or more end fibers of sensory neurons

*Enclosed in connective tissue

*Include four main types
1-Meissner's corpuscles
2-Pacinian corpuscles
3-Ruffini's corpuscles
4-Proprioceptors

Proprioceptors

As we said it is

*Encapsulated Nerve Endings

*Monitor stretch in locomotory organs

Three types of proprioceptors

Muscle spindles

- It is measure the changing length of a muscle
- Imbedded where ?? in the perimysium between muscle fascicles

Golgi tendon organs

- For Monitor tension within tendons
- Located where ?? near the muscle-tendon junction

Joint kinesthetic receptors

- Sensory nerve endings within the joint capsules

major sensory pathways

Spinal tracts- These are known as sensory and motor pathways consisting of multineuron pathways connecting the CNS to the PNS. At some point most pathways crossover (decussate).

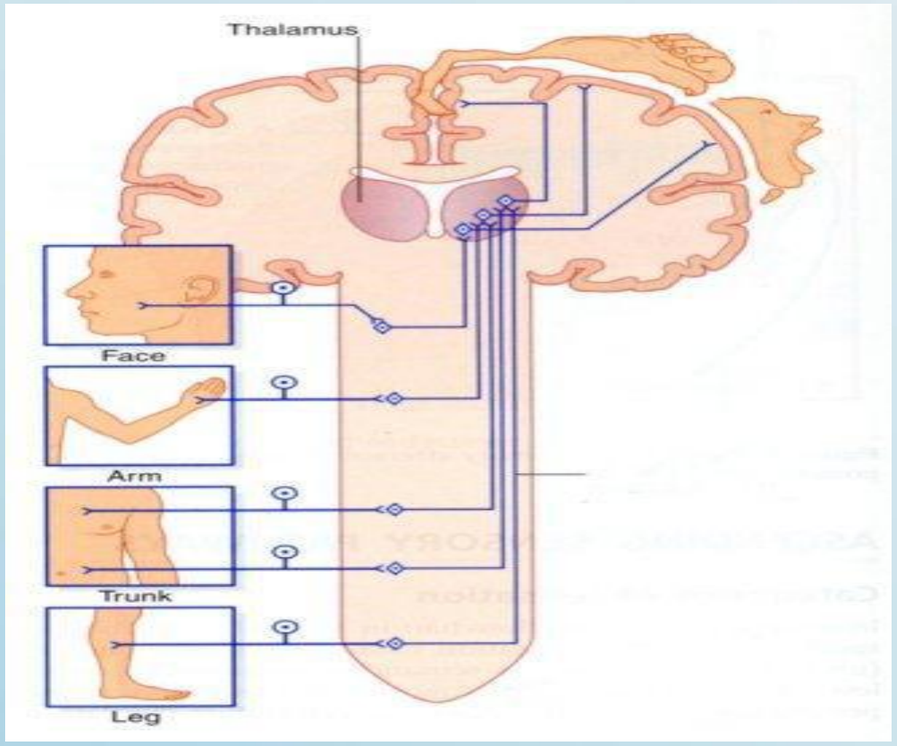
Ascending (sensory) Pathways- Four main ascending tracts that conduct afferent signals to send it to the cerebral cortex and the other two to the cerebellum.

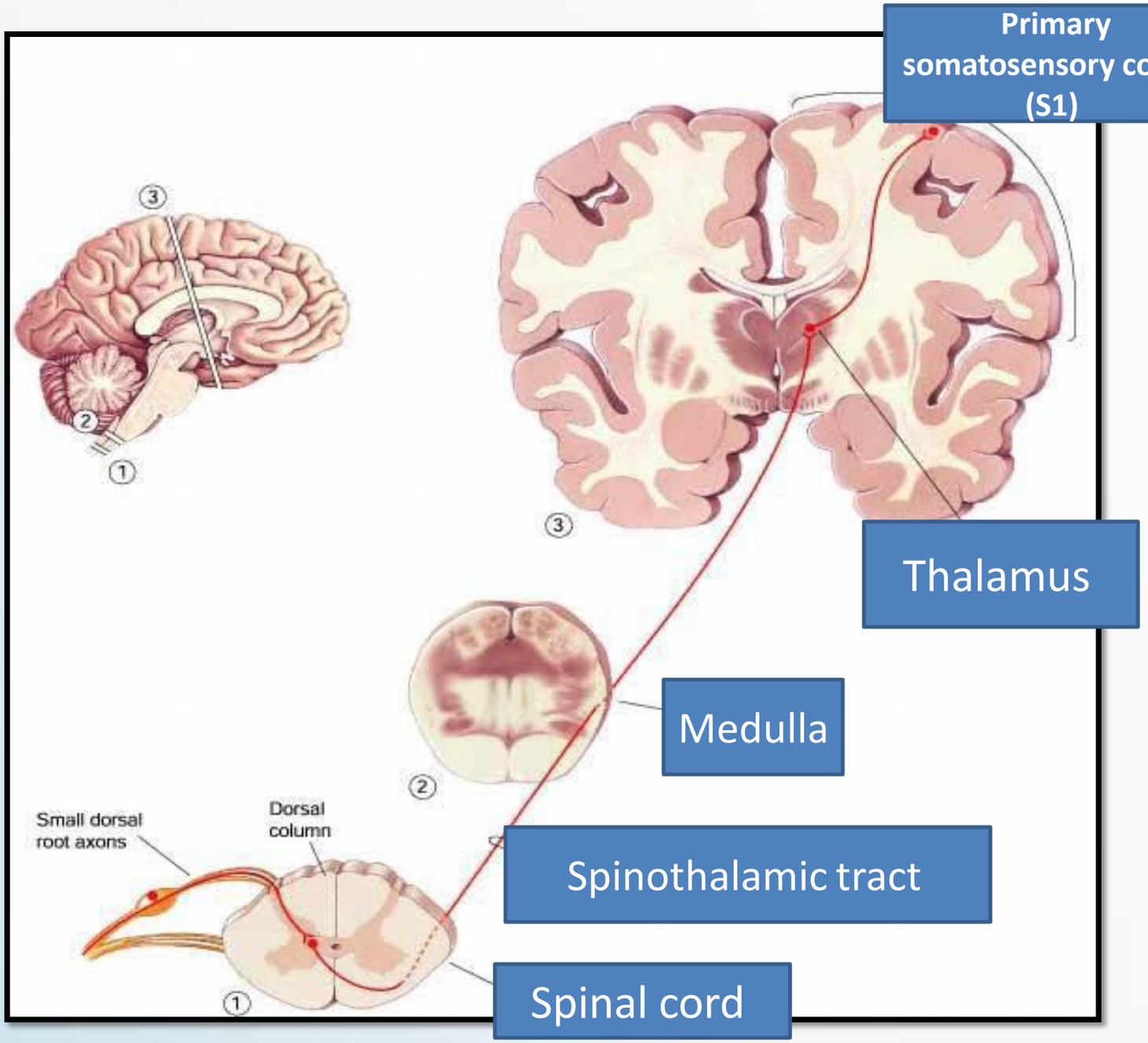
Dorsal column pathway	• carries signal of fine touch, pressure, and proprioception, ascends up dorsal white column in fasciculus gracilis or cutaneatus to medulla oblongata to the thalamus to primary somatosensory cortex (post central gyrus).
Spinothalamic pathway	• carries signals of pain, temperature, deep pressure, and course touch. From psterior gray horn decussate into lateral and anterior funiculi up to the thalamus to primary somatosensory cortex (postcentral gyrus).
Posterior and anterior spinocerebellar pathways	• carry subsconcious proprioception. Dorsal gray horn- to lateral column- to medulla oblongata- to pons – to cerebellum.

1st: enters spinal cord from periphery → 2nd: crosses over (decussates), ascends in spinal cord to thalamus → 3rd: projects to somatosensory cortex

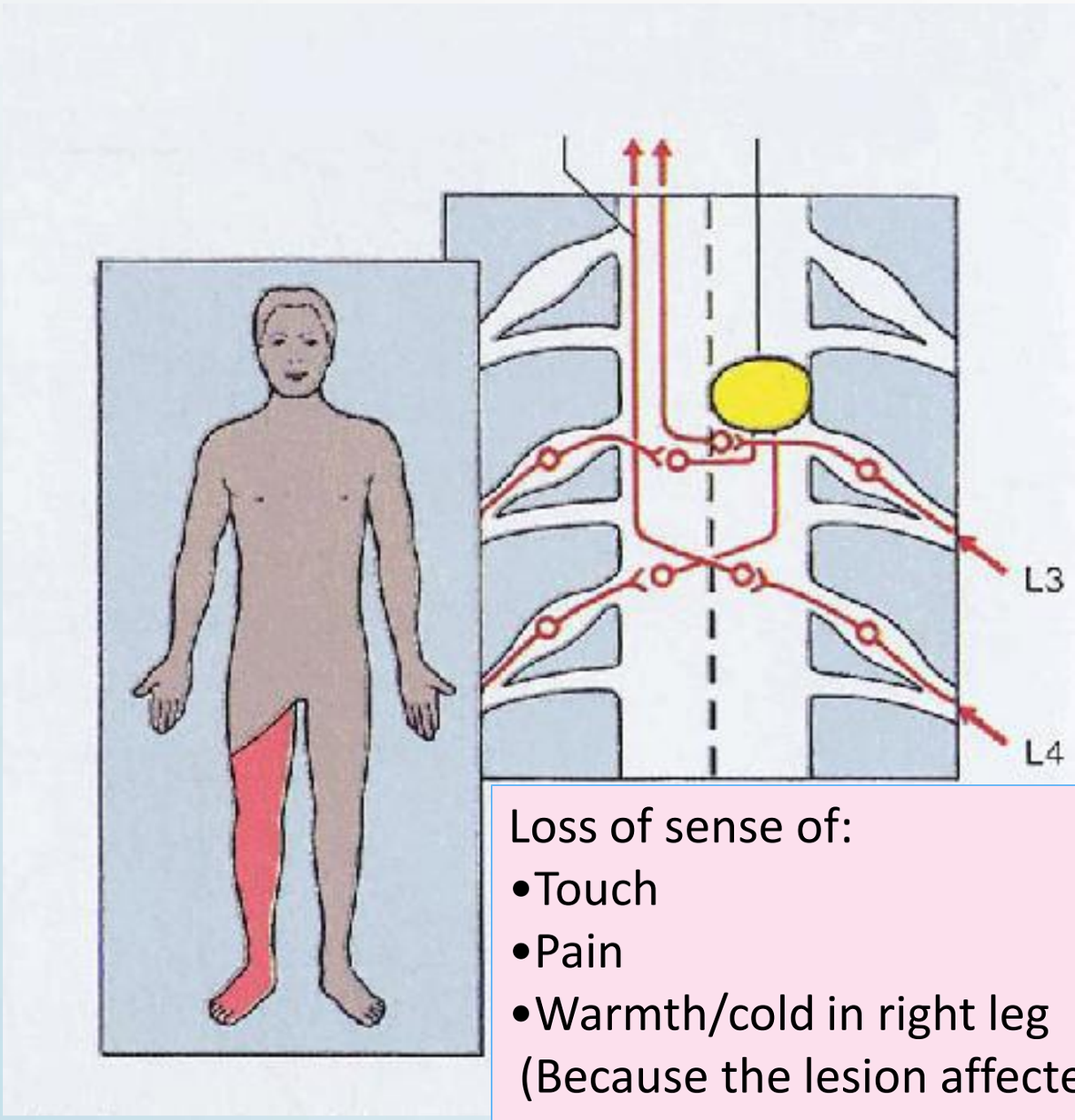
Spinothalamic pathway

- Carries pain, temperature, touch and pressure signals
- 1st neuron enters spinal cord through dorsal root
- 2nd neuron crosses over in spinal cord; ascends to thalamus
- 3rd neuron projects from thalamus to somatosensory cortex





Spinothalamic damage



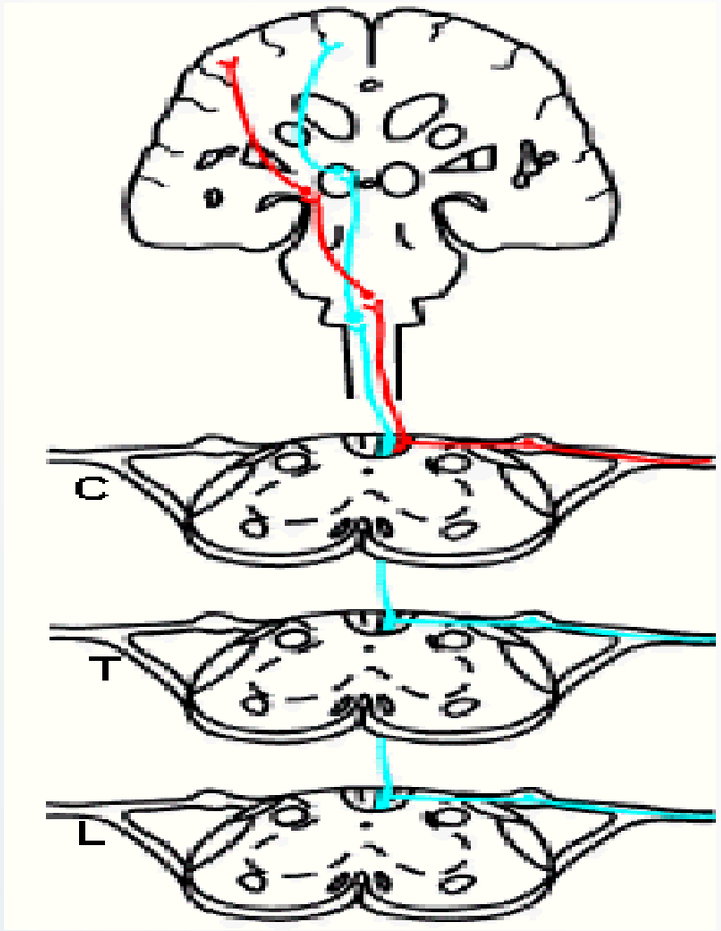
Loss of sense of:

- Touch
- Pain
- Warmth/cold in right leg

(Because the lesion affected L3&L4)

Dorsal column pathway

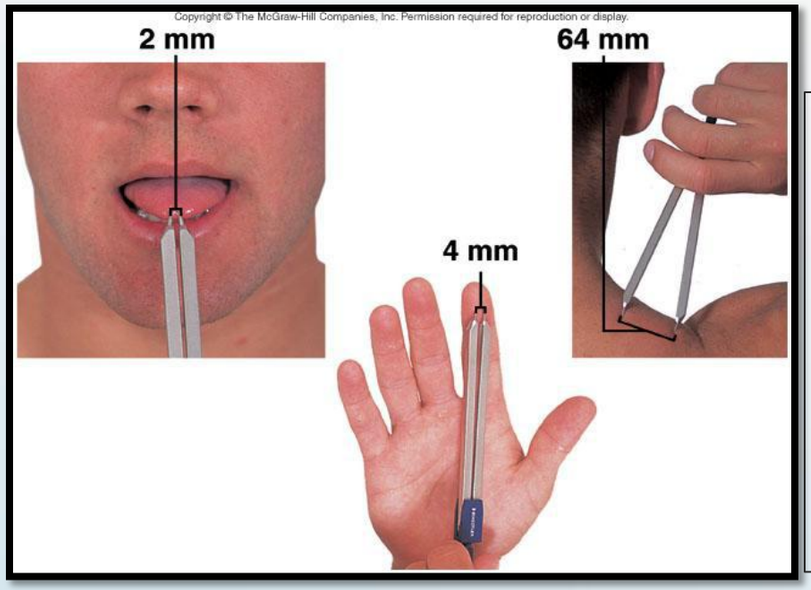
1- conscious proprioception reach the level of cerebral cortex sensory area dorsal column via medial lemniscus.
2- Unconscious proprioception reach the level of cerebellum via spinocerebellar tracts



Carries fine touch & pressuae, , Stereo gnosis, vibration and conscious proprioception signals

- 1st neuron enters spinal cord through dorsal root; ascends to medulla (brain stem)
- 2nd neuron crosses over in medulla; ascends to thalamus
- 3rd neuron projects to somatosensory cortex

Two-Point Discrimination



Highest threshold for two point discrimination present where in our body?

- **Lips (highest, remember reading Qura'an),**
- **Index, (remember al-tashahod; as the index has large portion in the somatosensory area)**

Something the Dr. mentioned : (lips have highest receptors that's why kissing is the most expressive way to convey your emotions)

Sensation depends on what?

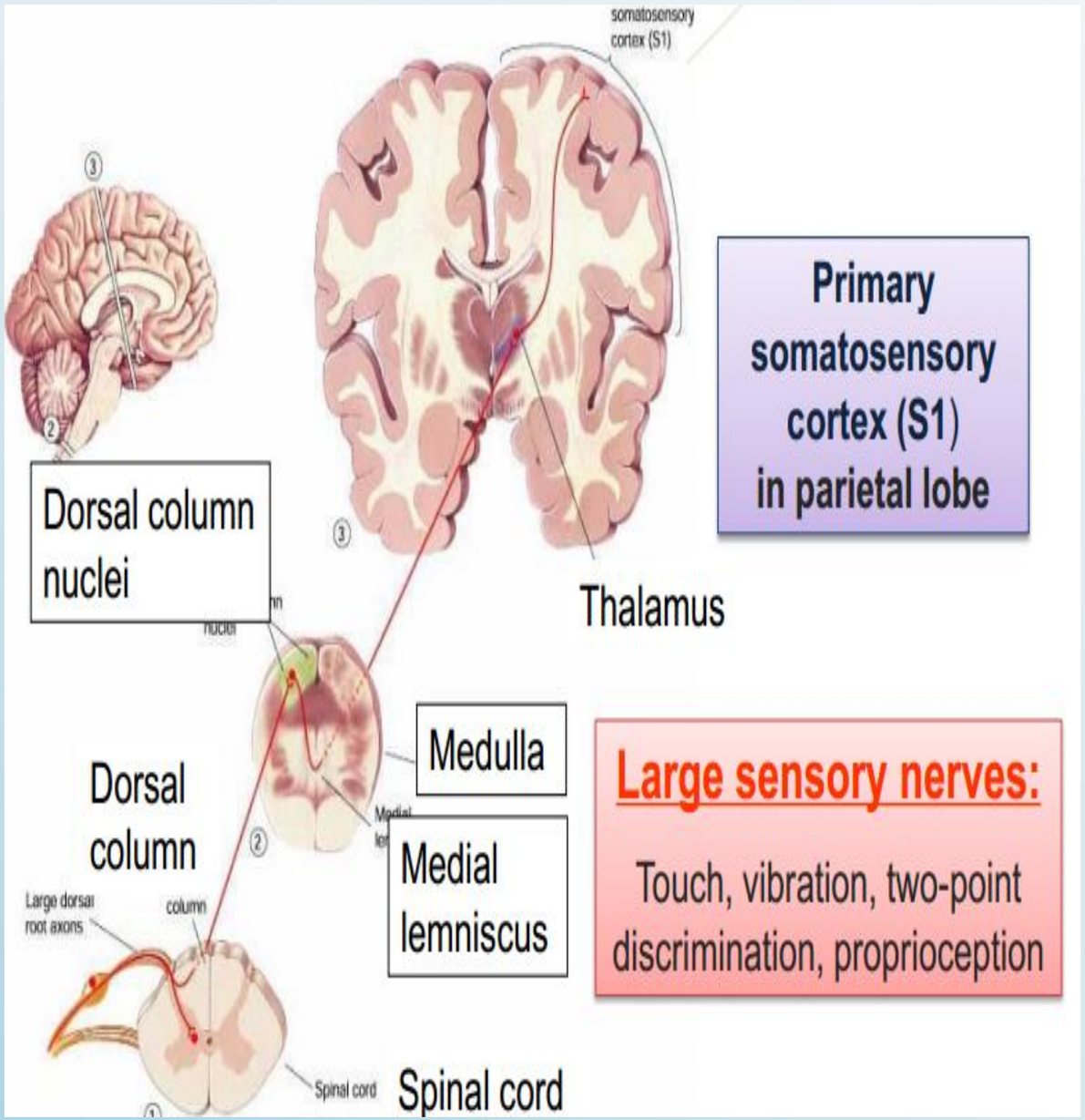
- No. of receptors.
- Representation area in brain. (Every part of the body has a portion in the somatosensory area, some have large portions others have small portions.)

Now, when you examine, the lowest distance between two point discrimination will be felt in the :

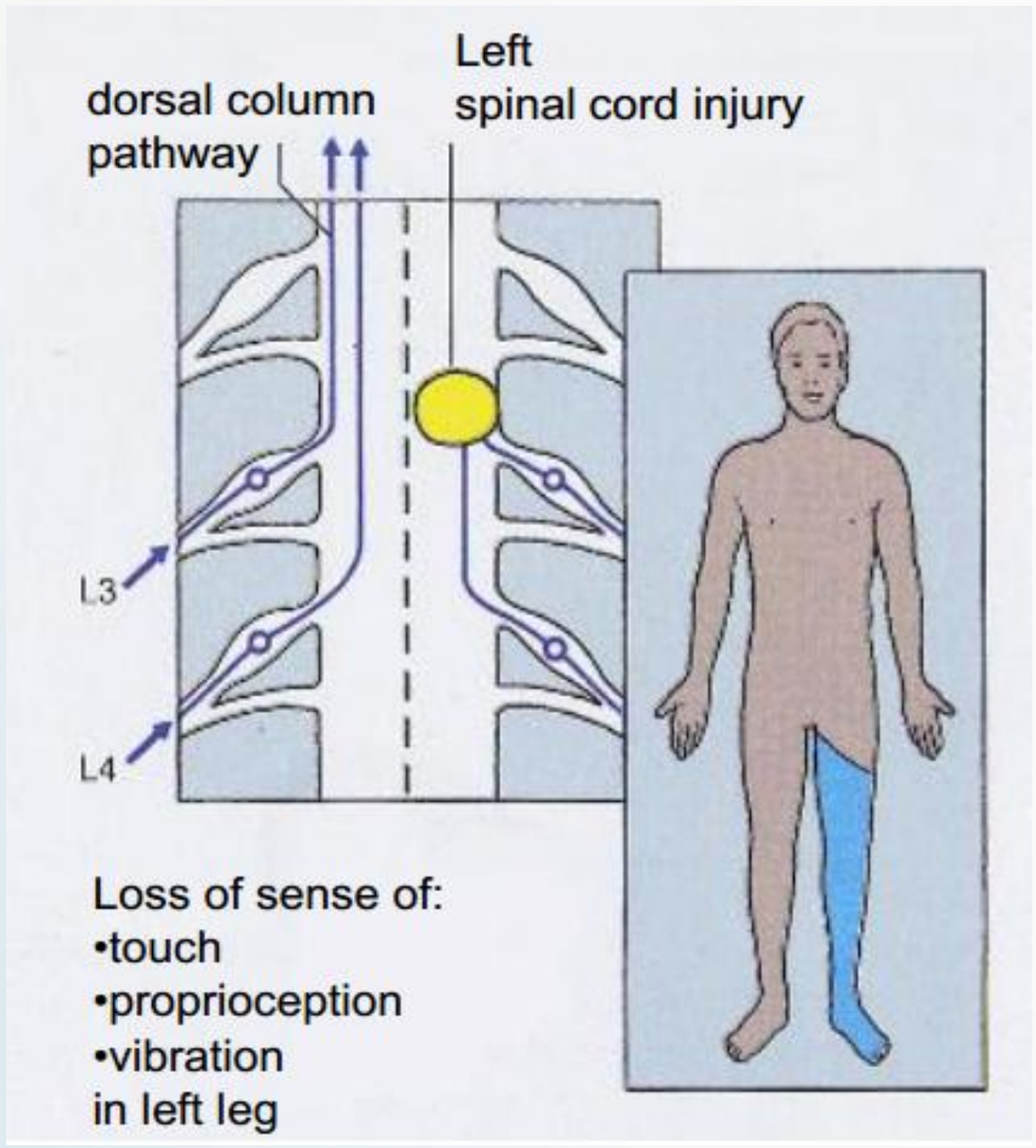
- Lips or tip of the tongue mostly (2mm distance, only)
- And also the index (4 mm).
- Other areas for example in the 3rd picture you will not feel the two point until (64 mm distance). In other words, when you decrease the distance (lower than 64) you feel the two-point as only one point!

o The lowest distance felt = the more receptor in the area = representation area is large .

Dorsal column pathway



Dorsal column Damage



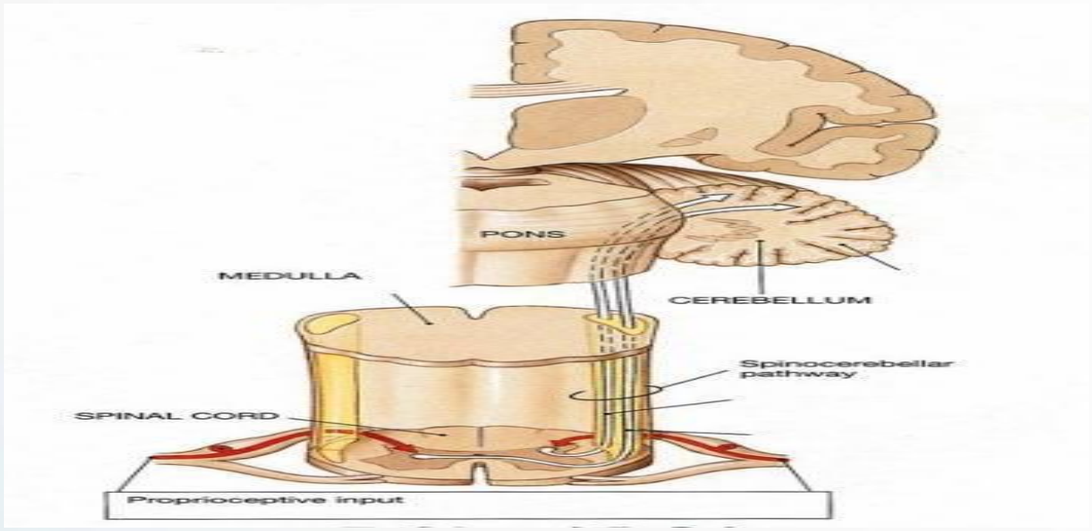
Dorsal column Damage

- ***Sensory ataxia***
- ***Patient staggers; cannot perceive position or movement of legs***
- ***Visual clues help movement***

- **The patient when he closes his eye cannot identify his position in place , (receptors are intact) but the dorsal column is damaged ; Unlike the patients who have problems**
in the cerebellum (the dorsal column in those will be intact).
- **Examination most be with aid of vision and without the aid of vision.**
- **To differentiate tell the patient to close his eye ; when you see him walking but his walk is more of a drunk walk >>> problem in the cerebellum and the dorsal column is intact**
- **But when the patient walks but he tries to locate his steps and he doesn't have the drunk walk >>> problem in the dorsal column**
- **Note that patients with damaged dorsal column when they**
open their eyes : they still tries to locate their steps and position but vision may actually help them doing that.

Spinocerebellar pathway

- Carries unconscious proprioception signals
- Receptors in muscles & joints
- 1st neuron: enters spinal cord through dorsal root
- 2nd neuron: ascends to cerebellum
- No 3rd neuron to cortex, hence unconscious



Spinocerebellar tract damage

Cerebellar ataxia or motor ataxia

- **Clumsy movements**
- **Incoordination of the limbs (intention tremor) = when he moves, there is tremor. Unlike static tremor.**
- **Wide-based, reeling gait (ataxia)**
- **Alcoholic intoxication produces similar effects!**

Additional info ;

- **Intention tremor : A tremor that occurs when a voluntary movement is made**
- **While, static tremor: irregular involuntary muscle contractions that occur when a patient makes an effort to hold the trunk or limbs in certain positions**

sensory and motor ataxia

Ataxia and Gait Disturbances

Pathophysiology

–Result from any condition that affects the central and peripheral nervous systems

–Ataxia: Types

Motor ataxia

Sensory ataxia

Motor ataxia

- Caused by cerebellar disorders
- Intact sensory receptors and afferent pathways
- Integration of proprioception is faulty
- Midline cerebellar lesions cause truncal ataxia
- Lateral cerebellar lesions cause limb ataxia
- Thalamic infarcts may cause contralateral ataxia with sensory loss

Sensory ataxia

• Failure of proprioceptive • information to the CNS •

• May be due to disorders of spinal • cord or peripheral nerves •

• Can be compensated for by visual • inputs •

Extra informations

4. **Somatosensory cortex Located in the postcentral gyrus of the human cerebral cortex.**

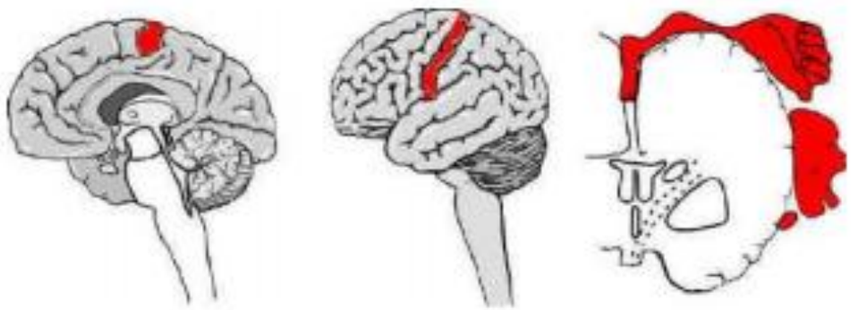
Spatial orientation of signals :

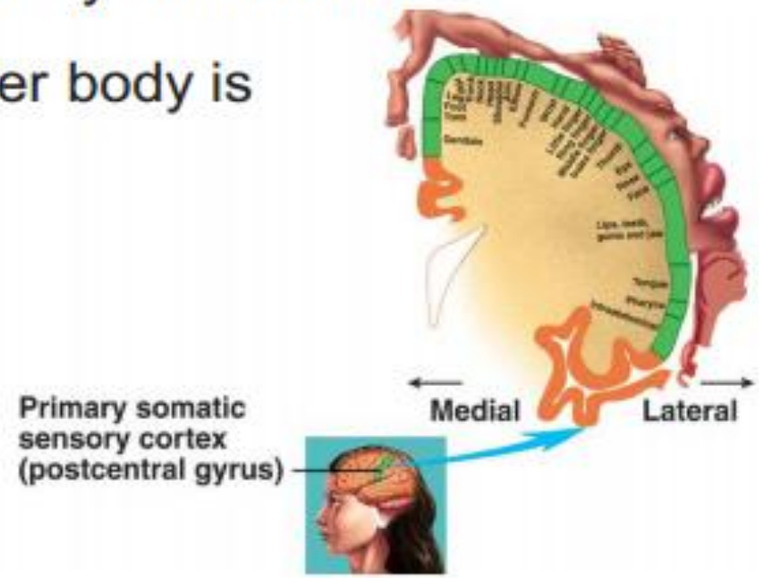
1) Each side of the cortex receives sensory information exclusively from the opposite side of the body (the exception: the same side of the face).

2)The lips, face and thumb are represented by large areas in the somatic cortex,

whereas the trunk and lower part of the body, relatively small area.

3)The head in the most lateral portion, and the lower body is presented medially





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