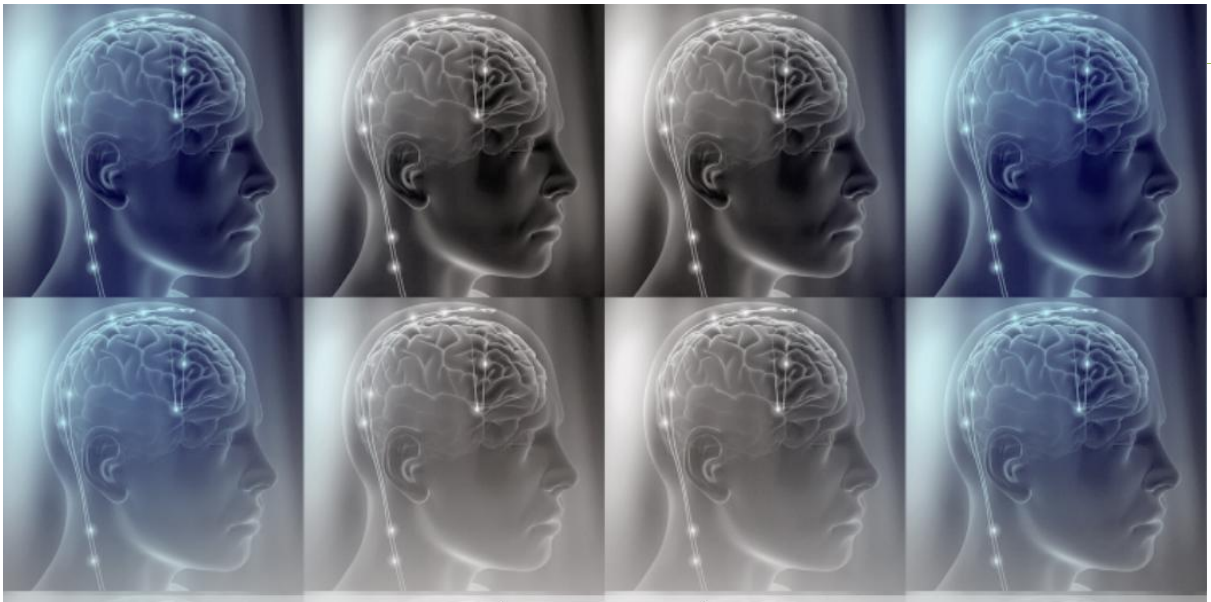

431

CNS Central Nervous System

Block

Physiology Team

Female Side Male side

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Revised By **Nour Al-Khawajah** **Mohammed Asiri**

Pathways of Proprioception

GREEN: male slides
BLUE: additional
RED: very important
GREY: not important
Other than that is just a format

- **Introduction (u can go back to the doctor's slides and read it "not included in the exam as we already took it")**
- **Sensory Receptors:**

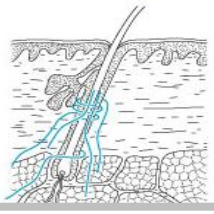
Peripheral Sensory Receptors

- Sensory receptors classified according to:
  - Location
  - Type of stimulus detected
  - Structure:

1-Unencapsulated Nerve Ending

1. **Free nerve endings of sensory neurons**
2. **Modified free nerve endings: Merkel discs**
3. **Hair follicle receptors**

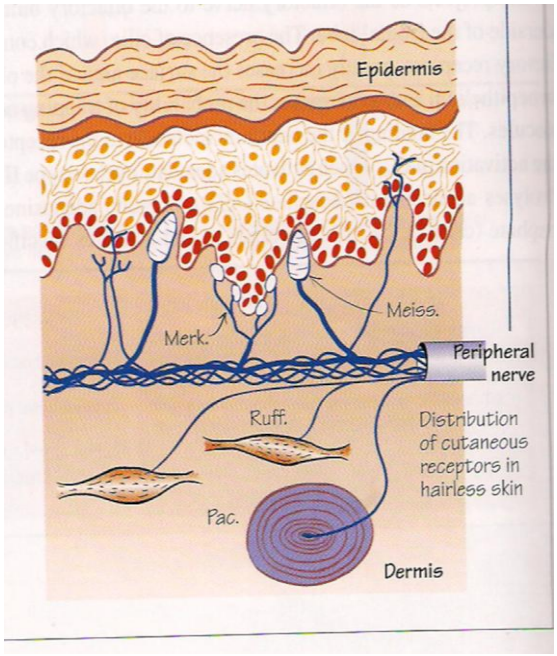
Table 14.1 General Sensory Receptors Classified by Structure and Function (1 of 3)

Anatomical Class (structure)	Illustration	Functional Class According to Location (L) and Stimulus Type (S)	Body Location
UNENCAPSULATED			
Free nerve endings of sensory neurons		L: Exteroceptors, interoceptors, and proprioceptors S: Nociceptors (pain), thermoreceptors (heat and cold), possibly mechanoreceptors (pressure)	Most body tissues; densest in connective tissues (ligaments, tendons, dermis, joint capsules, periostea) and epithelia (epidermis, cornea, mucosae, and glands)
Modified free nerve endings: Merkel discs		L: Exteroceptors S: Mechanoreceptors (light pressure)	Basal layer of epidermis
Hair follicle receptors		L: Exteroceptors S: Mechanoreceptors (hair deflection)	In and surrounding hair follicles

Not Important

2-Encapsulated Nerve Endings

- Consist of one or more end fibers of sensory neurons
- Enclosed in connective tissue
- Include four main types



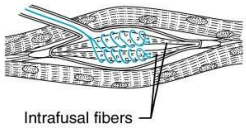
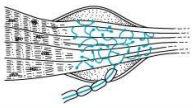
- Meissner's corpuscles : Rapidly adapting receptor. They are touch receptors with great sensitivity. They are mainly found in finger-tips (small, sharp, well defined receptive field)
- Pacinian corpuscles : Rapidly adapting receptor. mainly responsible for the sensation of vibration , deep pressure (large, poorly defined receptive field)
- Ruffini's corpuscles : slowly adapting receptor. continuous states of pressure and heavy prolonged touch. (large, poorly defined receptive field)
- Proprioceptors

- **Proprioceptors** (Provide information about position of the body in space in any given moment)

Three Types:

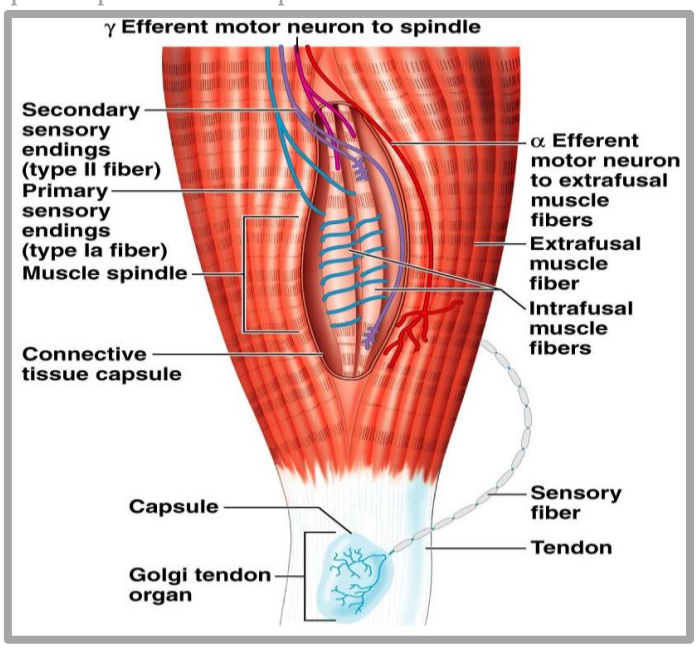
- **Muscle spindles**
  - Measure the changing length of a muscle
  - Imbedded in the perimysium between muscle fascicles
- **Golgi tendon organs**
  - Located near the muscle-tendon junction
  - Monitor tension within tendons
- **Joint kinesthetic receptors**
  - Sensory nerve endings within the joint capsules mainly pacinian C.

TABLE 14.1 General Sensory Receptors Classified by Structure and Function *(continued)*

Structural Class	Illustration	Functional Class According to Location (L) and Stimulus Type (S)	Body Location
PROPRIOCEPTORS			
Muscle spindles		L: Proprioceptors S: Mechanoreceptors (muscle stretch)	Skeletal muscles, particularly those of the extremities
Golgi tendon organs		L: Proprioceptors S: Mechanoreceptors (tendon stretch)	Tendons
Joint kinesthetic receptors (Pacinian and Ruffini endings, free nerve endings, and receptors resembling Golgi tendon organs)		L: Proprioceptors S: Mechanoreceptors and nociceptors	Joint capsules of synovial joints

Very Important

- Structure of Proprioceptors "not important"



PROPRIOCEPTION :
(Extroceptive sensations are those from the surface of the body)
Proprioceptive sensations are those having to do with the physical state of the body, including position sensations, tendon and muscle sensations and pressure sensations from the bottom of the feet.
-TYPES OF PROPRIOCEPTION :

1. ***CONSCIOUS proprioception***:

medial lemniscus pathway to the cerebral -dorsal columnCommunicated by the , conscious proprioception it is the ability to sense stimuli from within the cortexbody.
For example, if the eyes are closed a person will still know if the arm is raised above the head or hanging by the side. The person is consciously aware of the limb despite not being able to see it.

2. ***UNCONSCIOUS proprioception:***

unconscious tract to the cerebellum spinocerebellarCommunicated by the proprioception can be noted in the body's reaction once a skill has been acquired. **For example**, once a child has mastered movements required for walking, the unconscious proprioception can take over to provide a feedback system to produce the skill as required without thinking about it

Quick Overview of Sensory Pathways and the Somatic Nervous System:

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.

➢ Spinal tracts:

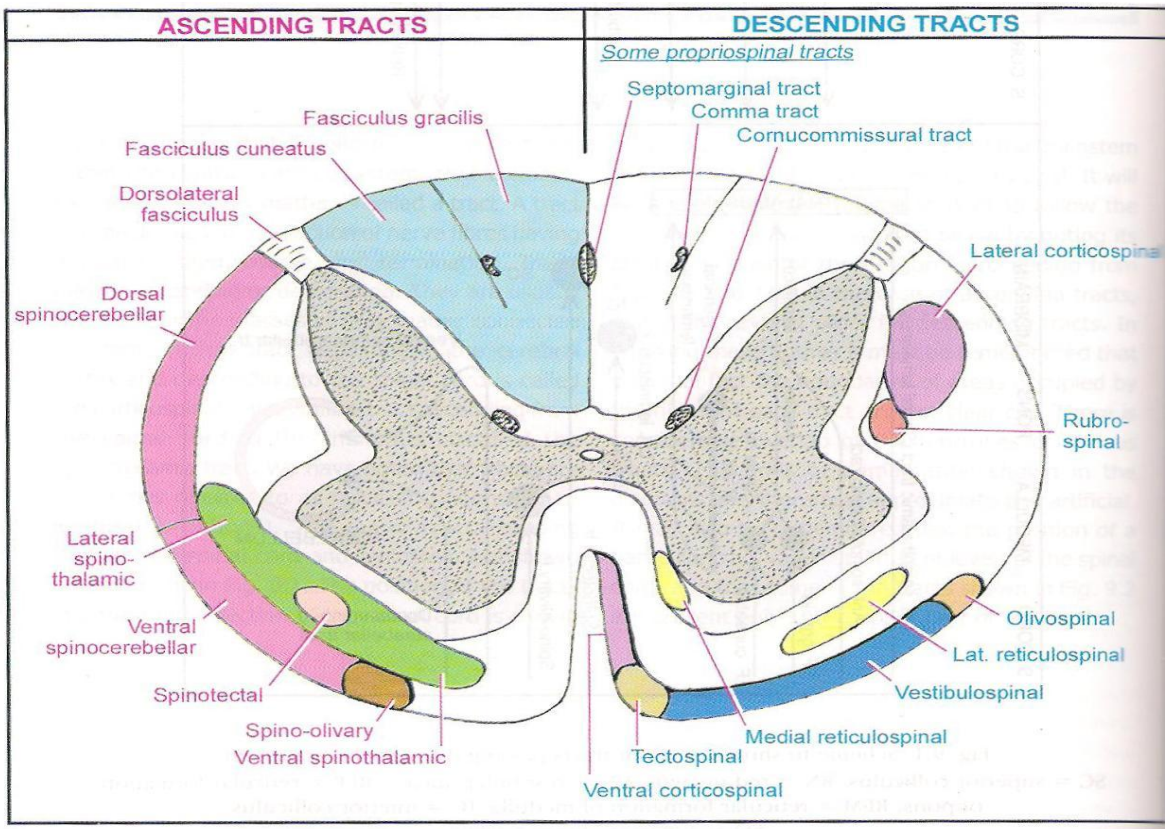
- These are known as sensory and motor pathways consisting of multineuron pathways connecting the CNS to the PNS. At some point most pathways crossover (decussate).

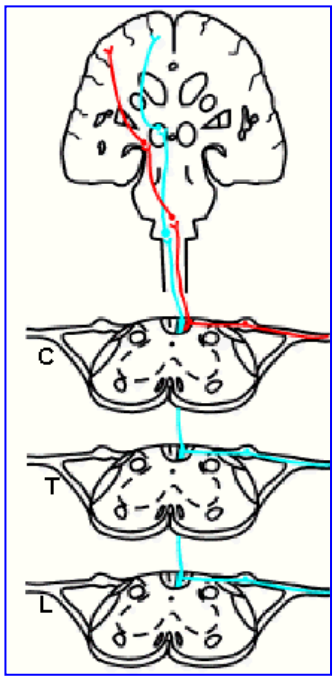
➢ Sensory pathways:

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

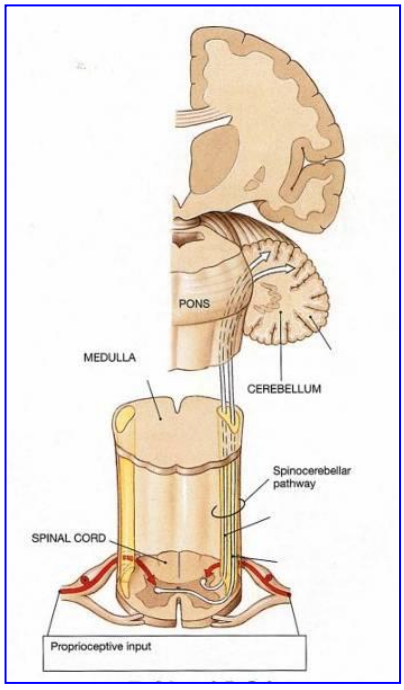
● Ascending (sensory) Pathways : -

- Carry information from sensory receptors to the brain
- Conscious: reach cerebral cortex
- Unconscious: do not reach cerebral cortex
- Sensations from body reach the opposite side of the brain





Dorsal column pathway



Posterior and anterior spinocerebellar pathways

Ascending (sensory) Pathway

	Dorsal column pathway	Posterior and anterior spinocerebellar pathways	Spinothalamic pathway
Pathway	Primary somatosensory cortex (post central gyrus) ↑ Thalamus ↑ medulla oblongata ↑ Dorsal white column in fasciculus gracilis or cutaneatus	Cerebellum ↑ Pons ↑ Medulla oblongata ↑ Lateral column ↑ Dorsal gray horn	primary somatosensory cortex (postcentral gyrus) ↑ thalamus ↑ decussate into lateral and anterior funiculi ↑ psterior gray horn
Function	carries signal of fine touch, tow point discrimination, pressure, vibration , stereognosis and conscious proprioception	Carries subsconscious proprioception signals *Receptors in muscles & joints*	carries signals of pain, temperature, deep pressure, and course touch
1st Order Neuron	Dorsal root ganglion	Dorsal root ganglion	Dorsal root ganglion
2nd Order Neuron	From DRG to either gracil or cutaneat nucleuses	From DRG terminate directly into the cerebellum	From DRG to either substantia gelatinosa or nucleus proprius
3rd Order Neuron	Projects to somatosensory cortex	No 3rd Order Neuron "subconscious"	Projects to somatosensory cortex
Injury	Sensory ataxia: Patient staggers; cannot perceive position or movement of legs *Visual clues help movement "So, if u ask him to close his eyes while walking he may fall down or the imbalance will increases"	Cerebellar "motor" ataxia: Clumsy movements Incoordination of the limbs (intention tremor) Wide-based, reeling gait (ataxia) "Alcoholic intoxication produces similar effects!"	**Loss of sense of:** **Touch** **Pain** **Warmth/cold** **in right leg**

☺ Details about sensory tracts :

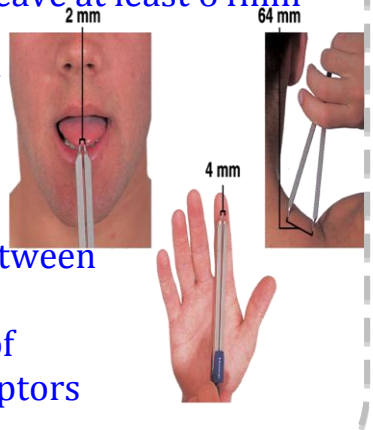
1- DORSAL COLUMN PATHWAY: CONSCIOUS PROPRIOCEPTION

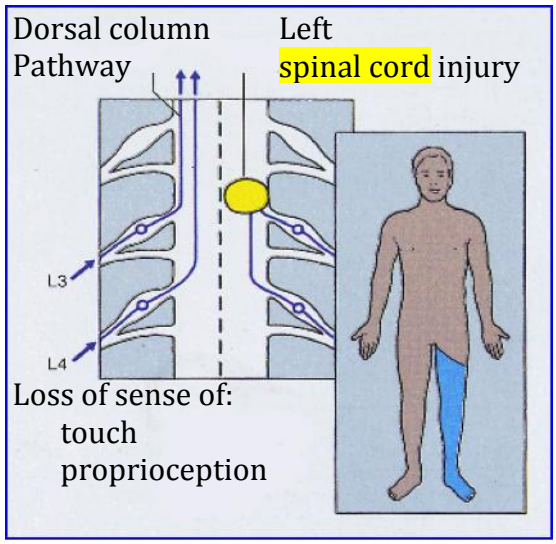
- **Pathway requires three order neurons**
- **First order neuron: starts from the receptor and enters the dorsal column pass uninterupted to medulary nucleus (Gracile and Cuneate nuclei)**
- **Second order neuron : cross immediately to opposite side and pass up through brain stem as medial leminiscus to thalamus. While passing through the brain stem it is joined by the fibers from sensory nucleus of trigeminal nerve. In thalamus the relay stops in ventro basal complex.**
- **Third order neuron: from thalamus to the post central gyrus that is somatosensory area 1 and also in sensory area 2 situated in the margin of lateral sulcus**

2- SPINOCEREBELLAR TRACT: UNCONSCIOUS PROPRIOCEPTION

- **First order neurons: enters spinal cord through dorsal root ganglia.**
- **Second order neurons: ascends to cerebellum and terminate directly there.**
  - **Posterior spinocerebellar tract :2nd order neuron axons ascend ipsilaterally to the medulla oblongata. Here, the tract joins the inferior cerebellar peduncle and terminates in cerebellar cortex.**
  - **Anterior spinocerebellar tract : 2nd order neuron axons cross to the opposite side, then they enter the cerebellum through the superior cerebellar peduncle and they cross back within cerebellum.**
- **NO 3rd neuron to cortex, hence unconscious**

Two-Point Discrimination:
For example: if u touch your back with tow stimuli u have to leave at least 64mm between them to discriminate that they are 2 stimuli, But if u did the same thing on the tongue u will only need to leave 2mm between them.
"due to the presence of larger number of receptors on the tongue"





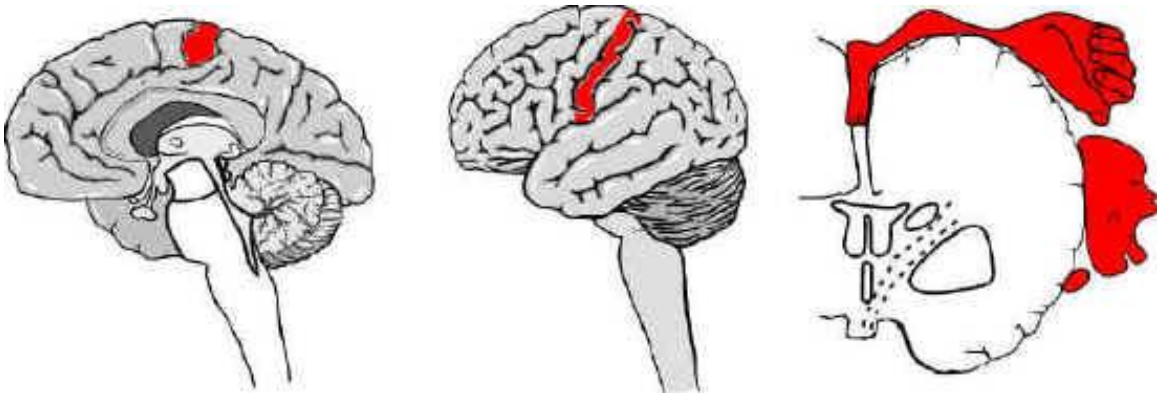
➢ Ataxia and Gait Disturbances:

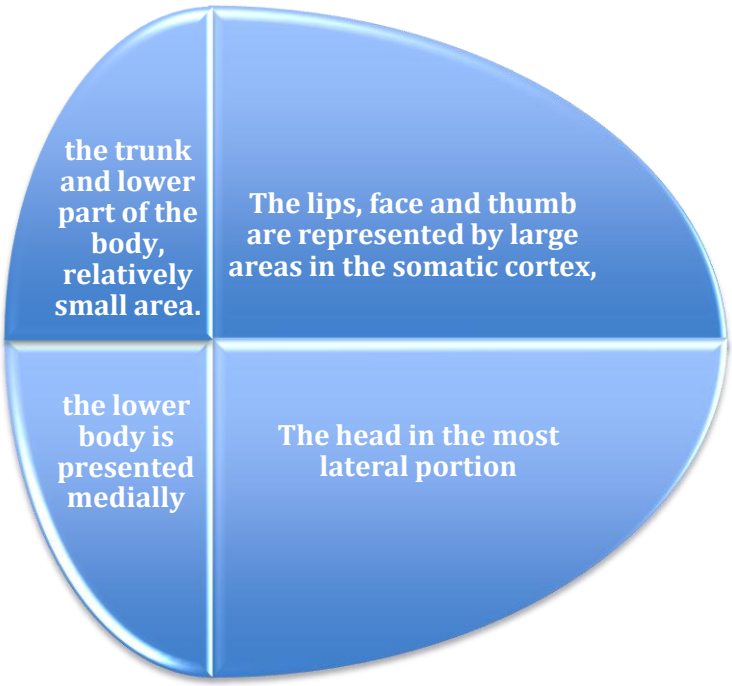
Result from any condition that affects the central and peripheral nervous systems.

Sensory ataxia	Motor ataxia
Disorders of spinal cord or peripheral nerves "Mostly dorsal column"	Cerebellar disorders
Failure of proprioceptive information to the CNS	Inability to control the coordinate movements of the muscles.
Can be compensated by visual inputs	1. Intact sensory receptors and afferent pathways 2. Integration of proprioception is faulty 3. Midline cerebellar lesions cause truncal ataxia (imbalance of the trunk) 4. Lateral cerebellar lesions cause limb ataxia 5. Thalamic infarcts may cause Contralateral ataxia with sensory loss

*Romberg's test/Rombergism: A test used to investigate the cause of ataxia. This test is performed by asking the patient to stand, feet together with eyes open, then with eyes closed. The patient with sensory ataxia will be able to stand still with eyes open because vision will compensate for the loss of position sense but will sway or fall with their eyes closed because they are unable to keep their balance. Hence, they have a positive Romberg's sign. However, patients with cerebellar ataxia will have trouble standing whether their eyes were open or closed.

<u>Somatosensory cortex :</u> located in the postcentral gyrus of the cerebral cortex.





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

QUESTIONS

1- Which of the following is not an example of proprioceptor?

A- Pacinian corpuscle.
B- Joint kinesthetic receptors.
C- a- delta nerve ending.
D- Stretch receptor (muscle spindle).

2- Sensory ataxia can be compensated by:

A- Visual inputs.
B- Audio inputs.
C- Both a & b.
D- Can not be compensated.

3- Dorsal column pathway responcibel for:

A- Conscious Proprioception.
B- Subsconscious Proprioception.
C- Both a & b.
D- Carries Signals Of Pain, Temperature Only.

4- Ahmad Abdulla is a 40 year-old-male came to the clinic complaning from imbalnce and staggering in walking. The doctor asked him to stand up and walk. He started walking with little streggering then the doctor asked him to close his eye and continue walking but suddenly- after closing his eyes- he fall down.

The probable diagnosis is:

A- Motor Ataxia.
B- Sensory Ataxia.
C- Otitis Media
D- None Of The Above.

Answers:

1-C, 2-A, 3-A, 4-B