Physiology 435 team

PHYSIOLOGY OF THE PROPRIOCEPTORS IN BALANCE

Objectives:

- Identify the major **sensory pathways**.
- Describe the **components**, processes and **functions** of the sensory pathways.
- Appreciate the **dorsal column system** in conscious proprioception (anatomy & functions).
- Describe the pathway of **spinocerebellar tract** in unconscious proprioception from muscles, tendons, and joints.
- **Differentiate** between **sensory** and **motor ataxia**.

(Girls Slides Version)

Most of this lecture is a revision for anatomy lecture: Ascending tracts

The girls slides have less information compared to the boys'. You might want to check theirs.

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★ References:

- 435 girls slides and notes.

Color index: Important - Further explanation - Doctors Notes - Numbers.

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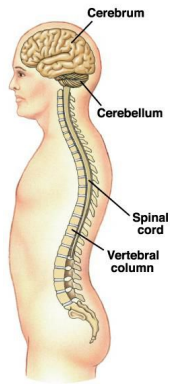
*Please check out this link before viewing the file to know if there are any additions or changes.

Organization of the Nervous System

- **The nervous system is divided into** 2 big initial divisions:



❖ Central Nervous System:

- Consists of the brain and the spinal cord.
- The center of integration and control.

❖ Peripheral Nervous System:

- The nervous system **outside** of the brain and spinal cord.
- **Consists of:**
  - 31 Spinal nerves
    - Carry info to and from the spinal cord.
  - 12 Cranial nerves
    - Carry info to and from the brain.

Peripheral Sensory Receptors

★ Sensory receptors are classified according to **location**, **type of stimulus** detected and **structure**.

❖ Unencapsulated Nerve Endings

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

❖ Encapsulated Nerve Endings[1]

- Consist of one or more end fibers of sensory neurons.
- Enclosed in connective tissue.
- **Include four main types:** "Each one responsible of some type of sensation"
  1. **Meissner's corpuscles**
  2. **Pacinian corpuscles**
  3. **Ruffini's corpuscles**
  4. **Proprioceptors**

Proprioceptors[2]

- **Proprioception:** is the sense of the relative position of neighbouring parts of the body and
- هو الإحساس العميق بوضع الجسم وحركاته مما يسمح بالتحكم بالأطراف بدون رؤيتهم مثل:قيادة السيارة تحرك رجلك ويديك بدون ما تشيل نظرك عن الطريق عشان تغير السرعة وتنعطف, عازف البيانو بعض الأحيان يعزف بدون الحاجة الى النظر الى أصابعه. هذا بسبب انه في كل عضله ومفصل يتم حساب شدة التوتر ودرجة الانقباض باستمرار ويتم إرسالها إلى cerebellum عن طريق spinal cord ليتم فيه حساب اين يجب ان يكون ال limp في الفضاء ليسمح بإتمام الأمور الأساسية(شغلك)

[1] We have two types of nerve endings: encapsulated (dendrites wrapped by glial cells or connective tissue. Most are mechanoreceptors for touch, pressure, and stretch) and unencapsulated (are dendrites not wrapped in connective tissue they found as receptors for general senses).

[2] Receptors sense the position and movements of the body or its parts. They occur in muscles, tendons and joint capsules.

- **Type:** Encapsulated nerve endings. (see the structure in the other picture)
- Monitor stretch in locomotory [3]organs.

❖ Three types of proprioceptors:

➢ Muscle spindles

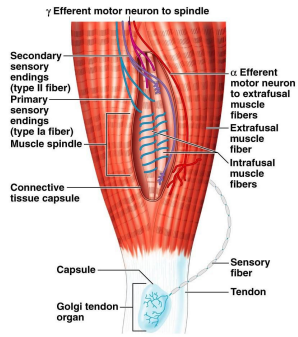
- measure the **changing length** of a muscle.
- Imbedded in the **perimysium** between muscle fascicles.

➢ Golgi tendon organs

- located near the **muscle-tendon junction**.
- Monitor **tension** within tendons.

➢ Joint kinesthetic receptors

- Sensory nerve endings within the **joint capsules**.



An Overview of Sensory Pathways and the Somatic Nervous System "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 effector organs. "**SAME:** Sensory, Afferent - Motor, Efferent."

Sensory Pathways

- Sensory systems allow us to detect, analyze and respond to our environment.
- They are "**ascending** pathways".
- Carry information from **sensory receptors** to the brain.
- Sensations from body reach the **opposite** side of the brain. (contralateral)
- **If conscious**: reach cerebral **cortex**.
- If unconscious: do **not** reach cerebral cortex.

❖ Spinal tracts

These are known as sensory and motor pathways consisting of **multi neuron pathways** connecting the CNS to the PNS. At some point most pathways crossover (decussate). Either ascending sensory or descending motor. This point of the lecture is like a revision of the anatomy lecture: Ascending tracts.

Ascending (sensory) Pathways : -

1. **Dorsal column pathway**

- carries signal of fine touch, pressure, vibration , stereognosis and **conscious proprioception**, ascends up dorsal white column in fasciculus gracilis or cutaneatus to medulla oblongata to the thalamus to primary somatosensory cortex (postcentral gyrus).

2. **Spinocerebellar pathways (Posterior and anterior)**

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[3] Capable of moving independently from place to place.

- carry **subconscious proprioception**. Dorsal gray horn- to lateral column- to medulla oblongata- to pons – to cerebellum.

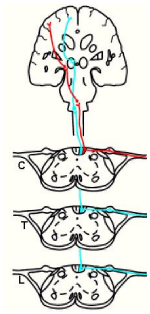
3. Spinothalamic pathway

- carries signals of pain, temperature, deep pressure, and course touch. From posterior gray horn decussate into lateral and anterior funiculi up to the thalamus to primary somatosensory cortex (postcentral gyrus).

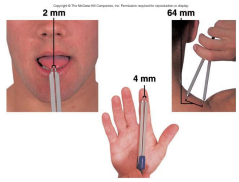
Sensory pathways: 3 neurons

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

Dorsal Column Pathway

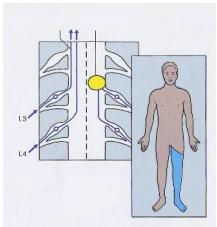


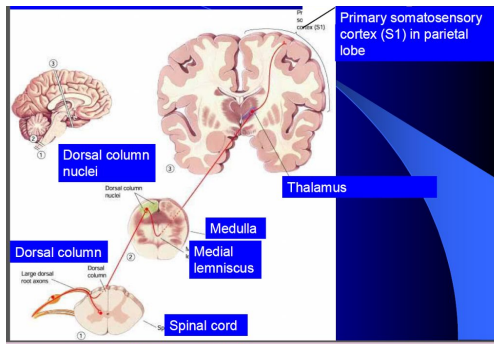
- Carries **fine** touch, two point discrimination, pressure, vibration, **stereognosis**[4] and conscious **proprioception** signals.
- **1st neuron:** enters spinal cord through dorsal root; ascends to medulla (brain stem).
- **2nd neuron:** crosses over in medulla; ascends to thalamus.
- **3rd neuron:** projects to somatosensory cortex.



❖ Dorsal Column Damage

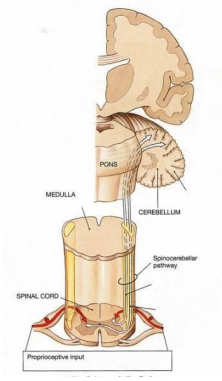
- Sensory ataxia.
- Patient staggers; cannot perceive position or movement of legs.
- Visual clues **help** movement.





Spinocerebellar Pathway

- Carries **unconscious proprioception** signals.
- Location of **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.
- Clumsy movements.
- Incoordination of the limbs (**intention** tremor).
- **Wide-based, reeling gait** (ataxia).
- **Alcoholic intoxication** produces similar effects!

[4] The ability to perceive and recognize the form of an object in the absence of visual and auditory information. Blind people use this ability in their daily lives.

Ataxia and Gait Disturbances

❖ Pathophysiology

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

❖ Ataxia: Types

1. Motor Ataxia

- Caused by **cerebellar disorders**.
- **Intact** [5]sensory receptors and afferent pathways.
- Integration of proprioception is faulty[6].
- **Midline** cerebellar lesions cause **truncal ataxia**.
- **Lateral** cerebellar lesions cause **limb ataxia**.
- Thalamic infarcts may cause contralateral ataxia with sensory loss.
- N.B cerebellar ataxia will discussed later with cerebellum lecture.

2. 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.

Spinothalamic Pathway (was on 434 slides)

- 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.

Somatosensory Cortex (Was on 434 slides)

- Each side of the cortex receives sensory information exclusively from the **opposite** side of the body
- **An exception:** the **same** side of the **face**.
- The lips, face and thumb are represented by large areas in the **somatic cortex**, whereas the trunk and lower part of the body by a relatively small area.

- The head in the most lateral portion, and the lower body is presented **medially**.

[5] Not damaged.
[6] Damaged, affected.