

Unit VIII – Problem 1 – Physiology: Introduction to Neuroanatomy



- Synaptic potential:

- Usually occurring on dendrites.
- **Can be:**
 - ✓ Excitatory: by opening Na or Ca channels leading to depolarization.
 - ✓ Inhibitory: by opening K or Cl channels leading to hyperpolarization.
- Graded (متناقص) and thus it cannot travel for long distances.
- Summated.
- If reaching 15 mV (threshold) → action potential is going to be produced.

- Action potential:

- Fixed.
- Not graded → not decreasing as it is traveling along the axon (eg. An action potential can travel for long distances).
- Once action potential is produced it cannot be prevented. For example, transmission of sensory information related to pain can only be inhibited by administrating anti-neurotransmitters in the synapses (this concept is applied in treating epilepsy).

- The central nervous system (CNS) is composed of:

- **Brain.**
- **Spinal cord: which contains:**
 - ✓ Ascending tracts: carrying information from the body to the brain.
 - ✓ Descending tracts: carrying motor actions.

Note: these tracts (bundle of axons) are forming what is known as the white matter.

- Neural cell bodies:

- ✓ **Inside the spinal cord**, they are present in the grey matter.
- ✓ **Outside the spinal cord**, they are present in dorsal root ganglia.

- Motor neurons are going to stimulate type A α nerve fibers (large diameter, heavily myelinated and ↑ conduction velocity). These fibers are connected to skeletal muscles and will cause their contraction.

Note: if the spinal cord is cut → type A α nerve fibers will still be present and contraction of muscles can occur but in an involuntary manner.

- Interneurons: they are present in the central nervous system and they provide a lot of synapses which help the brain in decision making (eg. analysis and integration of information).

- Neuroglial cells:

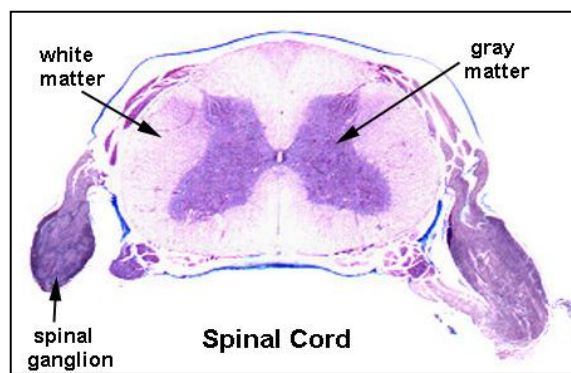
- They are found in CNS and PNS, but they are not involved in the production of action potentials.
- **Function:** protection of nerves and providing nutrition.
- **In PNS** → they are known as Schwann cells.
- **In CNS** → they are known as oligodendrocytes.

- Regeneration of nerves in CNS after injury is not possible because:

- Microglial cells and macrophages are going to form scar tissue.
- There is increased possibility of connecting wrong cells with each other because there are billions of cells present in the brain with complicated connections between them.

- Human brain has:

- A big **cerebrum** (for reasoning).





- **Cerebellum:** for motor-regulation (controlling muscles).
- **Brain stem:** containing all cranial nerves and is further subdivided to:
 - ✓ Midbrain.
 - ✓ Pons.
 - ✓ Medulla.

Note: these three are connected to the thalamus which is considered as a gate leading to the cortex. During sleeping, the thalamus keeps the brain able to come back to consciousness.
- **Reticular formation:** millions of cells arranged randomly with many synapses between them. It is stimulating the thalamus and therefore enhancing our awareness level and keeping us conscious.
- **Spinal cord:**
 - **Dorsal root ganglia and dorsal horn:** for the entry of fibers carrying sensory information.
 - **Ventral horn (motor):** for those fibers which will exit the spinal cord and cause a motor effect.
 - **Ascending tracts of the spinal cord:**
 - ✓ Dorsal column:
 - ❖ Carrying sensory information of fine touch, pressure, vibration, conscious proprioception and 2-point discrimination.
 - ❖ *In the dorsal column:*
 - ✚ **1st order neurons:** they are reaching to the medulla (terminating in n.gracilis and n.cuneatus).
 - ✚ **2nd order neurons:** crossing in the medulla (internal arcuate fibers) and ascend to terminate in the ventro-postero-lateral nucleus (VPL) of the thalamus.
 - ✚ **3rd order neurons:** from the thalamus to post-central gyrus of sensory cortex (without branching).
 - ❖ **Note:** if there is a cut above the medulla → there will be loss of all these sensations in the opposite side of the body (because the fibers crossed in the medulla).
 - ✓ Spinothalamic tract:
 - ❖ *Lateral spino-thalamic tract:* carrying sensory information of pain and temperature.
 - ❖ *Anterior spino-thalamic tract:* carrying sensory information of crude touch.
 - ❖ *In the lateral spinothalamic tract:*
 - ✚ **1st order neurons:** they terminate at the level of entry in the spinal cord.
 - ✚ **2nd order neurons:** crossing the midline of the spinal cord to reach lateral spinothalamic tract of the opposite side and ascend from there to the thalamus.
 - ✚ **3rd order neurons:** from the thalamus to the cortex.
 - ❖ **Note:** if a lesion occurs in the right side of a segment of the spinal cord, this will lead to:
 - ✚ Loss of pain and temperature in the left side of the body (why?) → because those fibers which are carrying pain and temperature are going to enter the spinal cord through the dorsal horn and then cross the midline to reach the lateral spinothalamic tract in the opposite side of the spinal cord and ascend from there to the thalamus.
 - ✚ Loss of fine touch and proprioception in the right side of the body which is the same side of the lesion (why?) → because those fibers



which are carrying fine touch and proprioception are going to enter the spinal cord through the dorsal horn reaching the dorsal column and ascend from there until they reach medulla oblongata where crossing of fibers is going to occur (there is no crossing of fibers at the level of entry).

✓ Spino-cerebellar tract (not explained in details in this note):

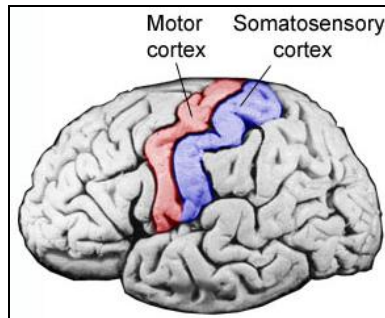
- ❖ Carrying information of unconscious proprioception.
- ❖ *It is a two-neuron-pathway:* that is the 1st order neurons are going to enter through the dorsal horn of the spinal cord and terminate in the grey matter of the cord at the level of entry. Then, 2nd order neurons are going to ascend through the spino-cerebellar pathway to reach the cerebellum.

- Proprioception: it is the information carried from muscle spindles, Golgi tendons and joint receptors informing us about the position of our body parts. Proprioception can be:

- **Conscious:** if fibers are reaching the cerebral cortex.
- **Unconscious:** if fibers are reaching the cerebellum (cerebellum aids in the coordination of movement).

- In the cerebral cortex:

- **Pre-central gyrus:** for motor activity.
- **Post-central gyrus:** for sensation.



- Lobes of the brain:

- **Frontal:** motor + thinking.
- **Parietal:** sensation.
- **Temporal:** hearing.
- **Occipital:** vision.

