PHYSIOLOGY

SHEET NO. 1

WRITER : Doctor 019

CORRECTOR : Hala Masadeh

DOCTOR : Faisal Mohammad

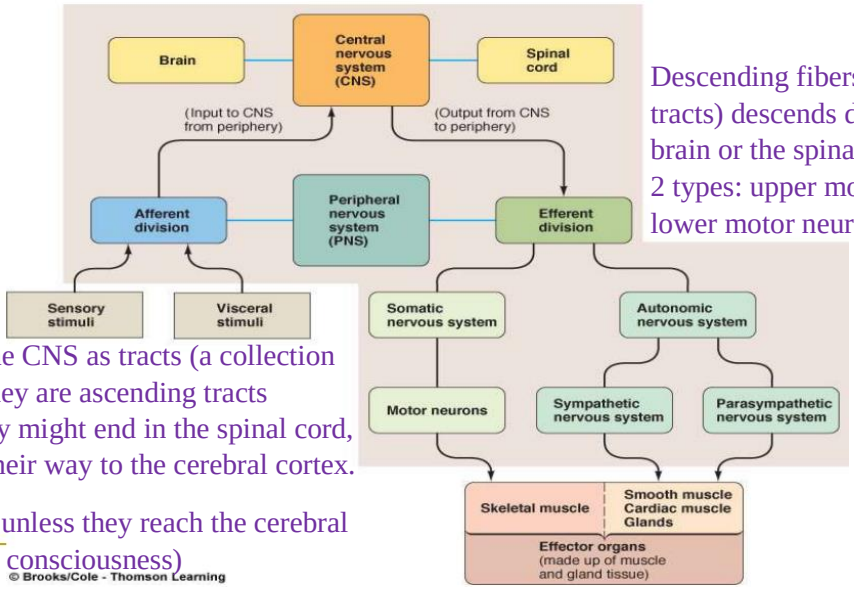
This lecture outcomes:

- State the parts of the central nervous system (brain stem & spinal cord).
- Describe the level of organization of the CNS (1- Lower level: spinal cord. 2- Middle: brain stem. 3-Higher: cerebral cortex)
- List the major functions of the CNS
- Compare the Endocrine system and nervous system
- Describe the anatomy of the functional unit of the nervous system
- Determine the area of communication in the CNS (synapse): the idea of adaptation at the level of the synapse; like when you set on a chair, at the beginning you feel the chair but then you stop feeling it because your body adapts with the "chair" sensation.

❖ Comparison between Nervous and Endocrine Control System:

- **Nervous system:**
  - is fast compared to endocrine system because it uses action potentials which travel through axons that might reach 120 m\s and even in unmyelinated neurons might reach 2 or 5m/s.
  - it has low gain: (gain= correction / error)
    for example: the normal MAP=100mmHg, if it rises to be 120 mmHg: The baroreceptors which are referred to nervous system might bring the bp to 105 for example, so the gain is equal -3 (negative feedback), correction = -15, error = 5.
  - It affects skeletal muscles and glands.
- **Endocrine system:**
  - the endocrine system is slow because it uses hormones that are going to be secreted from glands and travel in blood and then they go to the target cell to bind with the receptors that will end in hormone-receptor interactions and this process is a slow process.
  - Has a very high gain:
    In the endocrine system, the hormones try to bring blood pressure back to almost 100 mmHg with zero error; the gain will be infinite. (bring the variable almost exactly to the normal value but it will take longer time than the nervous system).
  - It affects growth, metabolism, and reproduction.

❖ organization of nervous system:



Descending fibers (motor, efferent tracts) descends down from the brain or the spinal cord and they are 2 types: upper motor neuron and lower motor neuron.

Afferent neurons enter the CNS as tracts (a collection of axons in the CNS). They are ascending tracts (afferent or sensory), they might end in the spinal cord, brain stem or complete their way to the cerebral cortex.

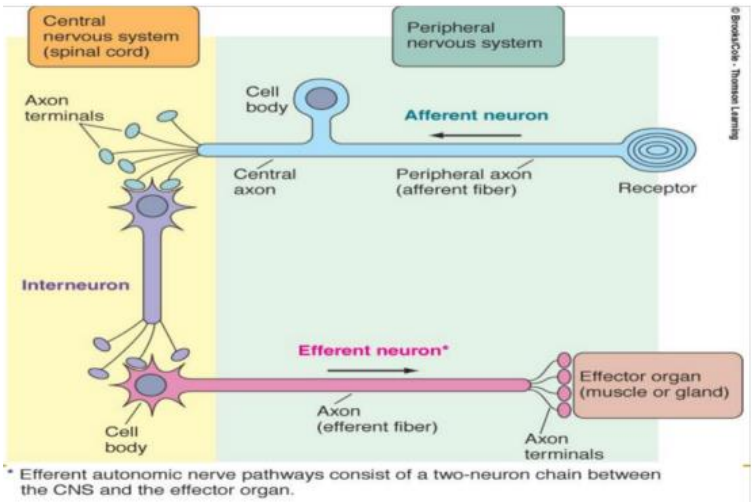
*sensations won't be felt unless they reach the cerebral cortex (reach the level of consciousness)

○ Notes:

- In the CNS, afferent is sensory, efferent is motor.
- The sensory receives its information from the sensory stimuli whether it's somatic or visceral.
- The motor part goes to somatic nervous system that supplies the skeletal muscles or autonomic nervous system the supplies smooth muscles and glands.
- Divisions:
    - Sensory Division: **general sensations:** tactile (touch and pressure), thermal, chemical sensations and pain receptors (nociceptors). **Special sensations** (not found everywhere): visual, auditory, olfactory, balance and taste.
    - Integrative Division (integrate sensory with motor): process information, creation of memory.
    - Motor Division: respond to and move about in our environment.

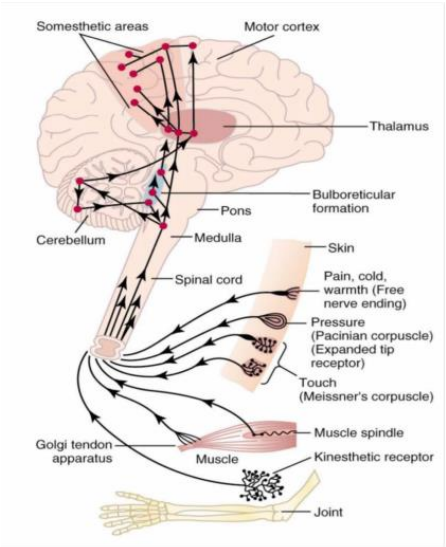
❖ Functional classes of neurons:

- The receptors sense any changes in the environment; tactile sensations are mechanical, visual are electromagnetic energy and so on.
- **The receptors are transducers; they convert any type of energy into electrical energy (action potential), they are highly specific.**
- The cell bodies of afferent neurons are found in the dorsal root ganglia, then it enters the spinal cord to synapse with interneurons.
- The interneurons connect the sensory to the motor.
- The efferent neurons go out from spinal cord to the effector organ.



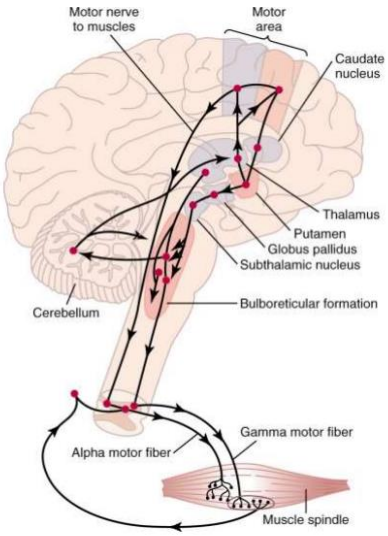
- Afferent neurons
  - Inform CNS about conditions in both the external and internal environment.
- Efferent neurons
  - Carry instructions from CNS to effector organs, muscles and glands.
- Interneurons: (connect afferent and efferent neurons)
  - Found entirely within CNS; most of neurons are interneurons.
  - Responsible for:
    - ✓ Integrating afferent information and formulating an efferent response.
    - ✓ Higher mental functions associated with the mind and memory.

❖ Somatosensory axis of the nervous system



starts with receptors (for pain, temperature, pressure, touch or receptors of the muscle) → afferent neurons (ascending tracts) carry the signals → they might stop or give diverging fibers in the brainstem → these sensations don't reach the brain directly they have to stop at the thalamus (almost all sensations except smell sensation stop at the thalamus) thalamus processes the information and may excite or inhibit the sensation → reach the cerebral cortex.

❖ Skeletal motor nerve axis of the nervous system



Descending neurons start from the cerebral cortex or certain areas of the brainstem, while descending they form motor tracts to the spinal cord → from the spinal cord, the fibers go to the muscle.

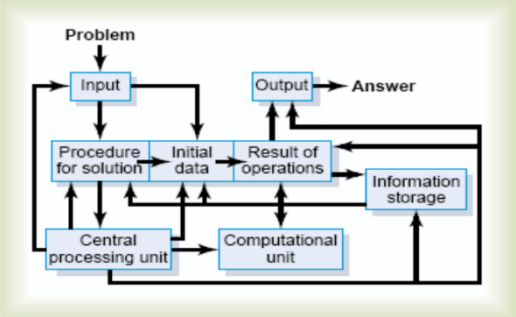
We have two motor neurons:

Upper motor neuron: from motor area of cerebral cortex/brain stem to spinal cord.

Lower motor neuron: from spinal cord to the muscle.

Central nervous system compared to computer system

- The sensation represents the input system.
- Brain represents the processing part.
- Reflexes and responses represent commands.



❖ Levels of CNS function- 3 major levels

1. **The spinal cord level:** (lowest level)

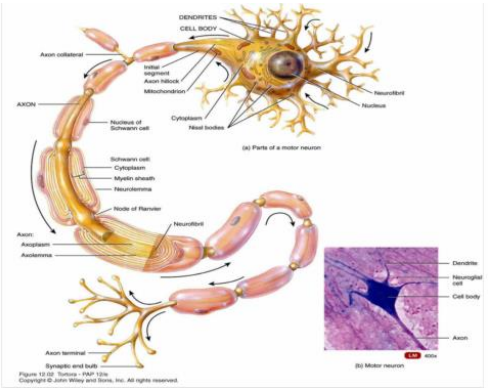
- More advanced in lower animals because they don't have cerebral cortex and brain.
- It's more than just a conduit for signals periphery of body to brain and vice versa; it contains: (one circuit may be responsible for more than one action)
    - walking circuits
    - withdrawal circuits
    - support against gravity circuits
    - circuits for reflex control of organ function

2. **The Lower Brain Level:** (middle level)

- Contains: brainstem (medulla, pons, mesencephalon), hypothalamus, thalamus, cerebellum, and basal ganglia.
- Controls subconscious body activities: arterial pressure, respiration, equilibrium, feeding reflexes, emotional patterns. (subconscious is in between consciousness and unconsciousness).

3. **The Higher Brain or Cortical Level:**
    - Cortex never functions alone, always in association with lower centers.
    - Large memory storehouse
    - Essential for thought processes
    - Each portion of the nervous system performs specific functions, but it is the cortex that opens the world up for one's mind.

❖ Anatomy of a Neuron (functional unit of the CNS)



3 major components:

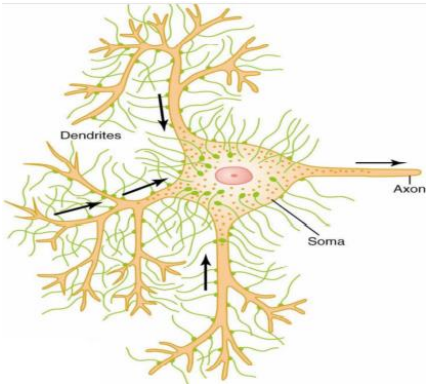
1. Soma: main body of the neuron.
2. Axon: extends from soma to the terminal
   the effector part of the neuron.
3. Dendrite: projections from the soma
   the sensory portion of the neuron.

❖ Notes:

- Dendrites have a very high resistance, they're unable to produce action potential because they have very low density of sodium voltage gated channel.

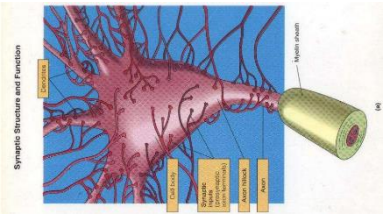
- Sometimes action potential is produced at the soma but the best area to produce action potential is the axon hillock.
- Axon hillock is the first unmyelinated area of the axon; it has the highest density of sodium voltage gated channels, so it has the lowest threshold for action potential.
- The soma contains all organelles as in other cells except the centrioles; neurons are unable to divide and regenerate (problem in CNS).
- The CNS is enclosed by bony structures for protection; the brain is enclosed by the skull and the spinal cord by vertebral column.
- CNS is also protected by meninges,3 layers of protection from outside to inside, dura mater, arachnoid mater, and pia mater.
- Some neurons are myelinated by myelin sheath that is formed from Schwann cells in PNS and from oligodendrocytes in the CNS.
- Myelin is interrupted by unmyelinated area called node of Ranvier.
- At the end we have axon terminals (buttons, knobs) that contain chemical substances (neurotransmitters) that are released upon stimulation of neurons by action potential, we have 50 types of neurotransmitters in CNS.

❖ Anterior motor neuron



It's a kind of neurons, contains many synapses:

1. Axosomatic with soma
2. Axoadendritic with dendrites
3. Axoaxonic with axons



❖ Communication between neurons

- Through release of chemical transmitters (gases, peptides) more than 50 compounds have been identified as transmitter substances.
  Example: neuropeptides formed in soma and pass to the presynaptic terminals through axonal transport; transmitted slowly through the axon so it's released in small amounts but long acting.
- General characteristics of neuronal communication: one-way conduction, always transmits signals in one direction this allows signals to be directed toward specific goal.
- **Note:** signals might go both ways in electrical synapse which isn't common in CNS.

The end