Lec1 : Introduction to Neural Engineering

Outline:

1. Physiology of the Brain and the Nervous System
2. Classification of the Nervous System
3. Biological Neuron
4. Classification of Neurons
5. Some types of neurons in the mammalian nervous system
6. General structure of a neuron

1. Physiology of the Brain and the Nervous System

The Nervous System: **A network of billions of nerve cells linked together in a highly organized fashion to form the rapid control center of the body**. The nervous system is the most complex body system which Constantly alive with electricity, the nervous system is the body's prime communication and coordination network. It is so vast and complex that, an estimate is that all the individual nerves from one body, joined end to end, could reach around the world two and a ha lf times.

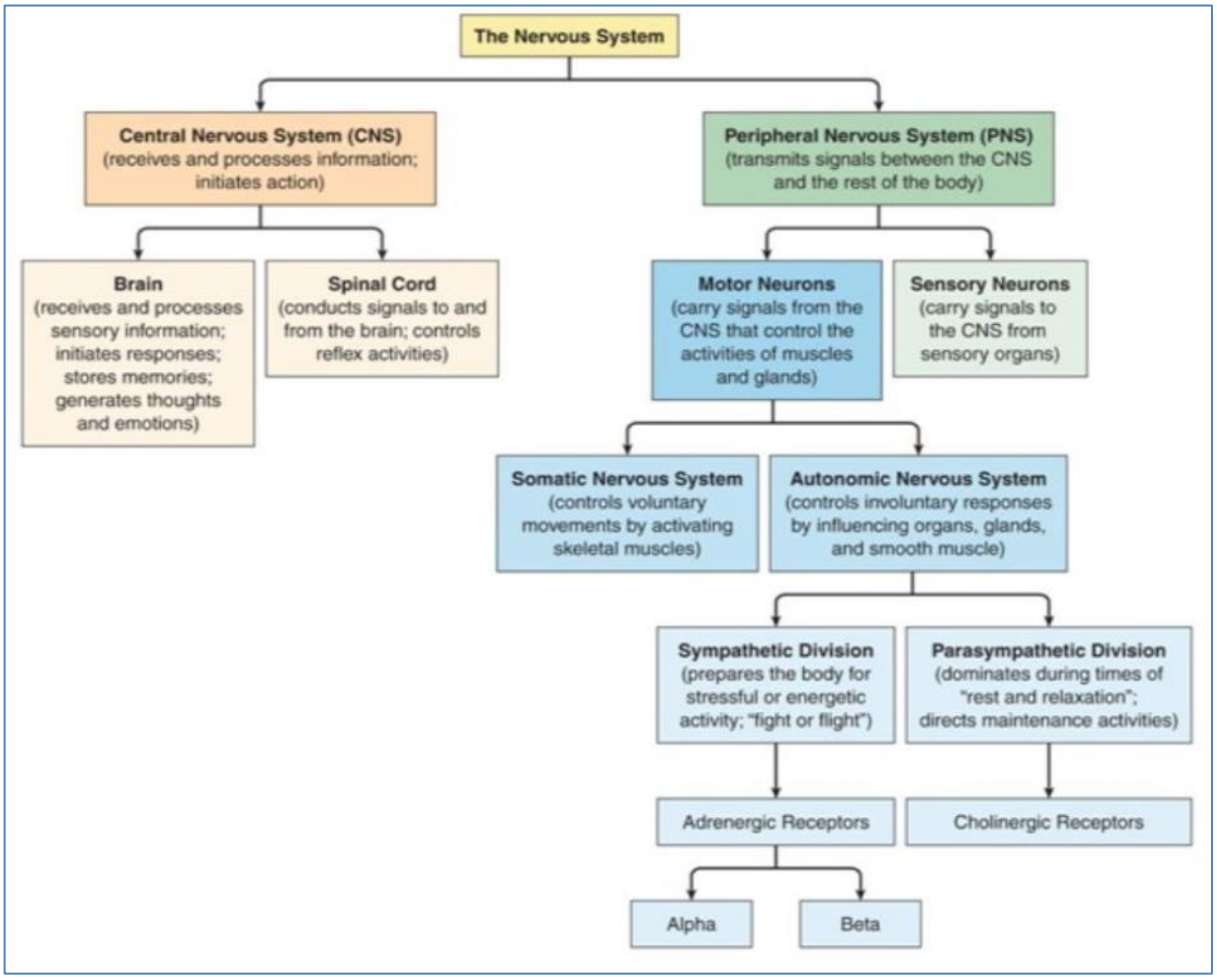

Figure 1: Nervous System classification

Note:

The Brain and Spinal Cord are the Central Nervous System System.

Nerves and Sensory Organs Make Up the Peripheral Nervous System .

The Objectives of studing the Nervous System

1. State the general functions of each division of NS.

2. Describe the general structure of a neuron and its functions.

3. Explain the classifications of neurons - in terms of structural differences and functional differences.

2. Classification of the Nervous System

It consists of 2 big initial divisions

A) Central Nervous System (CNS)

The brain + the spinal cord

The center of integration and control

B) Peripheral Nervous System (PNS)

The nervous system outside of the brain and spinal cord

PNS Consists of:

31 Spinal nerves

» Carry info to and from the spinal cord

12 Cranial nerves

» Carry info to and from the brain

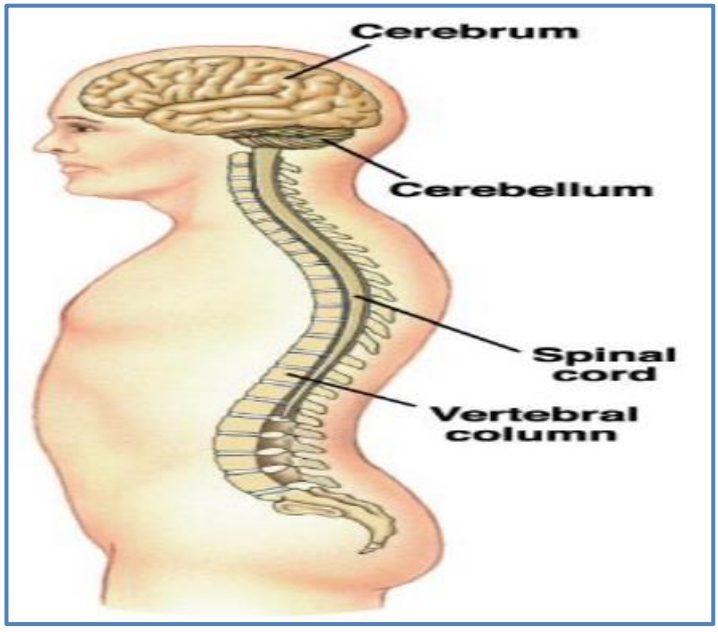

Figure 2: Brain structure

Peripheral Nervous System (PNS)

PNS Responsible for communication between the CNS and the rest of the body. It Can be divided into:

A) Sensory Division

• Afferent division

- **Conducts impulses from receptors to the CNS**
- **Informs the CNS of the state of the body interior and exterior**
- **Sensory nerve fibers can be somatic (from skin, skeletal muscles or joints) or visceral (from organs w/i the ventral body cavity**)

B) Motor Division

• Efferent division

- **Conducts impulses from CNS to effectors (muscles/glands)**
- **Motor nerve fibers**

Motor Efferent Division

It can be divided further:

1. **Somatic nervous system**

- VOLUNTARY (generally)
- Somatic nerve fibers that conduct impulses from the CNS to skeletal muscles

2. Autonomic nervous system

- INVOLUNTARY (generally)
- Conducts impulses from the CNS to smooth muscle, cardiac muscle, and glands.

3. Biological Neuron

- Neurons in the mammalian central nervous system come in many different shapes and sizes.
- Most have the same parts as the typical spinal motor neuron illustrated in the Figure .
- The cell body (soma) contains the nucleus and is the metabolic center of the neuron.

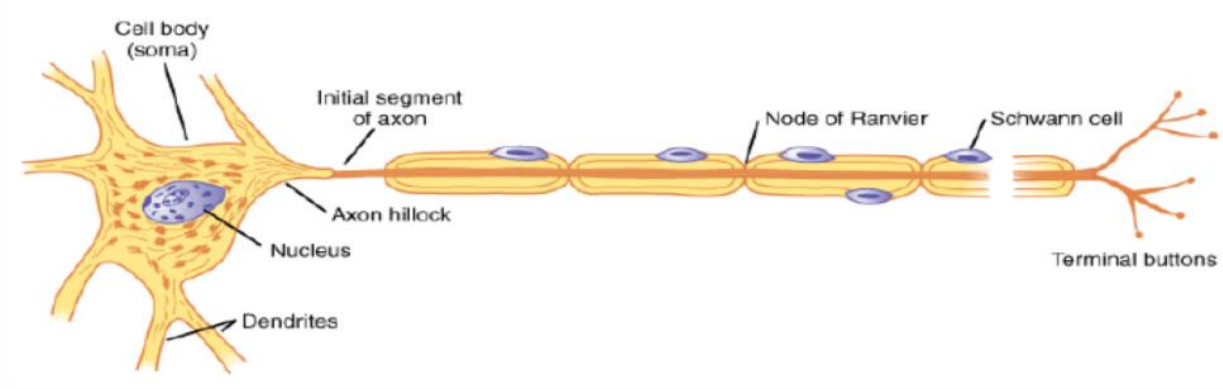

Figure 3: Biological Neuron

Types of Neurons

- Neurons 10 %
- Glial cells 90 %
- Glia from the word Glue.

4. Classification of Neurons

Based on Dendrites

Based on Connections

Based on Axon Length

Based on Neurotransmitters

Basic Neurons Types

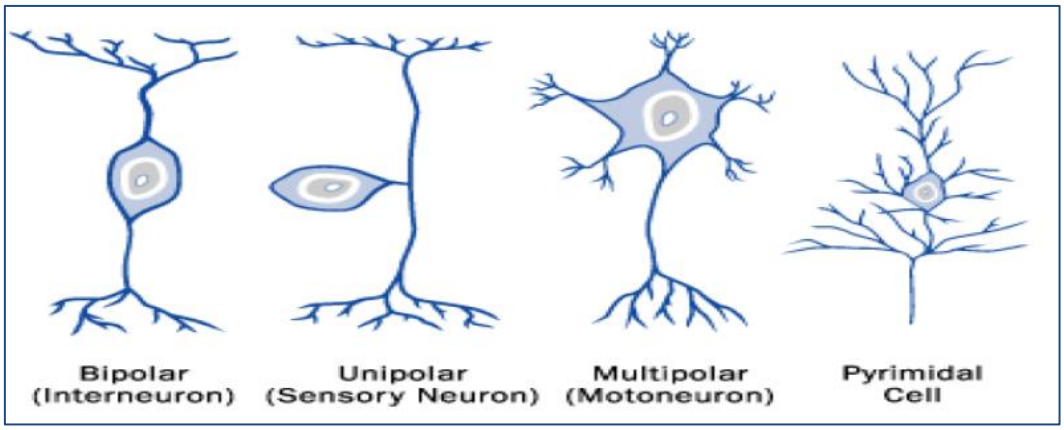

Figure 4: Neurons Types

- The cell body is about 20 μm in diameter.
- Potassium- rich solution.
- Internal structures Called organelles
- Neurons have several processes called dendrites that extend outward from the cell body and arborize extensively.
- Particularly in the cerebral and cerebellar cortex, the dendrites have small knobby projections called dendritic spines.
- A typical neuron also has a long fibrous axon that originates from a somewhat thickened area of the cell body, the axon hillock.
- The first portion of the axon is called the initial segment.

Dendrites

From the word tree Antenna of the cell. Detectors (proteins to detect the neurotransmitters)

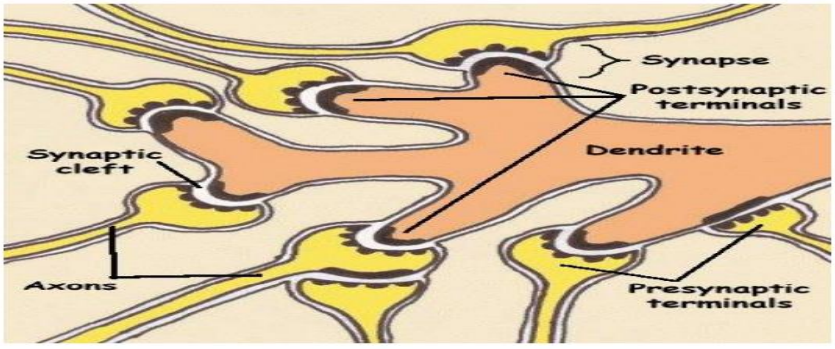

Figure 5: Dendrites structure

Axon Dendrite Synapses

Drugs used here to block the action potential. Transition through chemical signals. ELEC to CHEM

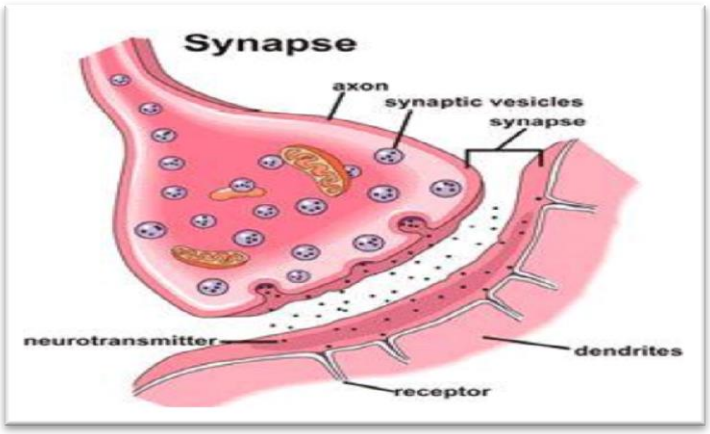

Figure 6: Axon Dendrite Synapses structure

- The axon divides into presynaptic terminals, each ending in a number of synaptic knobs which are also called terminal buttons or boutons.
- They contain granules or vesicles in which the synaptic transmitters secreted by the nerves are stored.
- Based on the number of processes that emanate from their cell body, neurons can be classified as unipolar, bipolar, and multipolar

Motor neuron with a myelinated axon

A myelin sheath forms from Schwann cells and surrounds the axon except at its ending and at the nodes of Ranvier.

- Terminal buttons (boutons) are located at the terminal endings.

5. Some types of neurons in the mammalian nervous system.

A) Unipolar neurons have one process, with different segments serving as receptive surfaces and releasing terminals.

B) Bipolar neurons have two specialized processes: a dendrite that carries information to the cell and an axon that transmits information from the cell.

C) Some sensory neurons are in a subclass of bipolar cells called pseudo-unipolar cells. As the cell develops, a single process splits into two, both of which function as axons—one going to skin or muscle and another to the spinal cord.

D) Multipolar cells have one axon and many dendrites. Examples include motor neurons, hippocampal pyramidal cells with dendrites in the apex and base, and cerebellar Purkinje cells with an extensive dendritictree in a single plane.

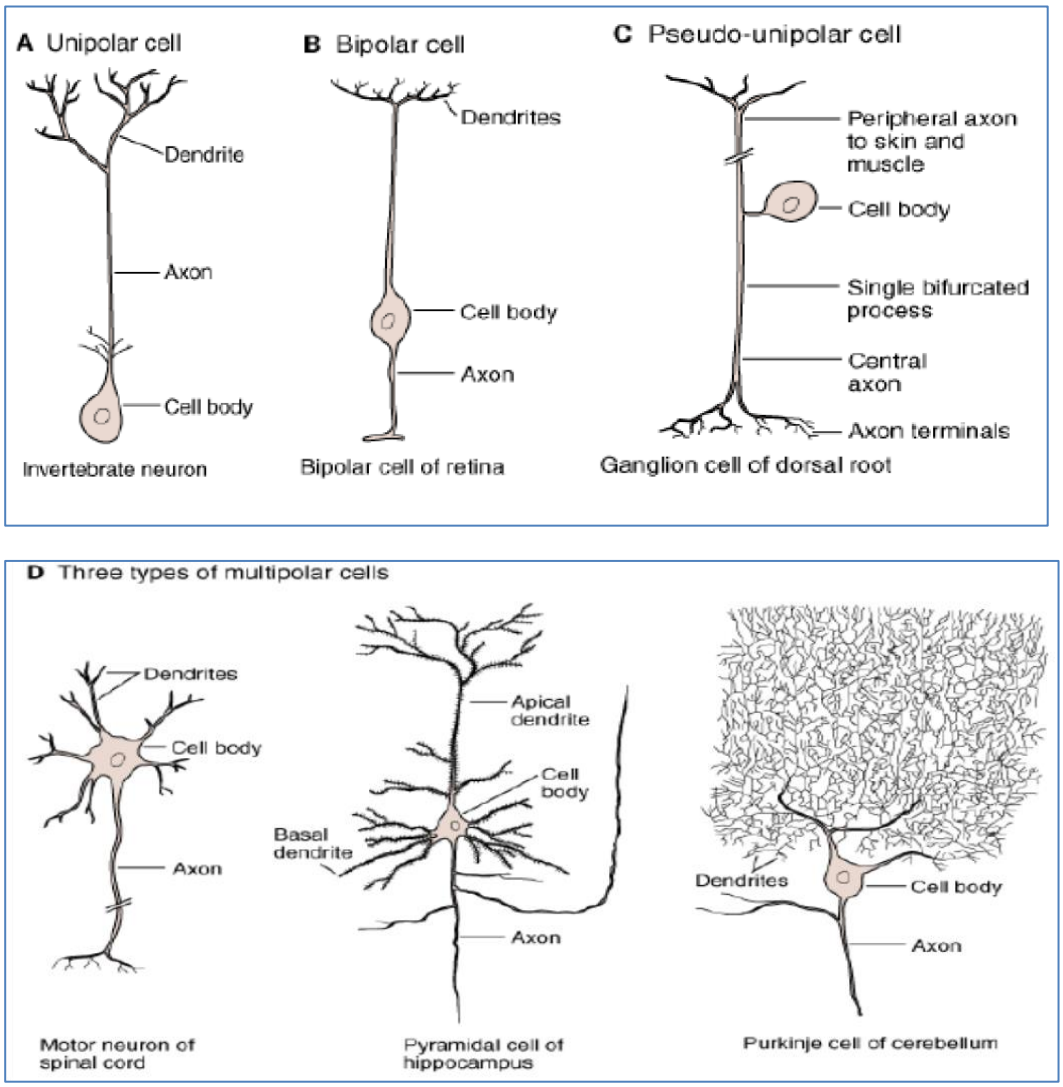

Figure 7: types of neurons in the mammalian nervous system

6. General structure of a neuron and its functions

1. Dendritic zone, or the receptor, where multiple local potential changes generated by synaptic connections are integrated
2. A site where propagated action potentials are generated (the initial segment in spinal motor neurons, the initial node of Ranvier in cutaneous sensory neurons)
3. An axonal process that transmits propagated impulses to the nerve endings
4. The nerve endings, where action potentials cause the release of synaptic transmitters