Nervous system

Nervous system controls all the activities of the body. It is formed by neurons and supporting cells called neuroglia

Neuron

Neuron is a structural and functional unit of nervous system which generate electrical signals or impulses called action potentials, which allow them to quickly transmit information over long distances.

Neuron is made up of three parts:

1. Nerve cell body (also called soma)

2. Dendrites are short processes transmits impulses towards the nerve cell body.

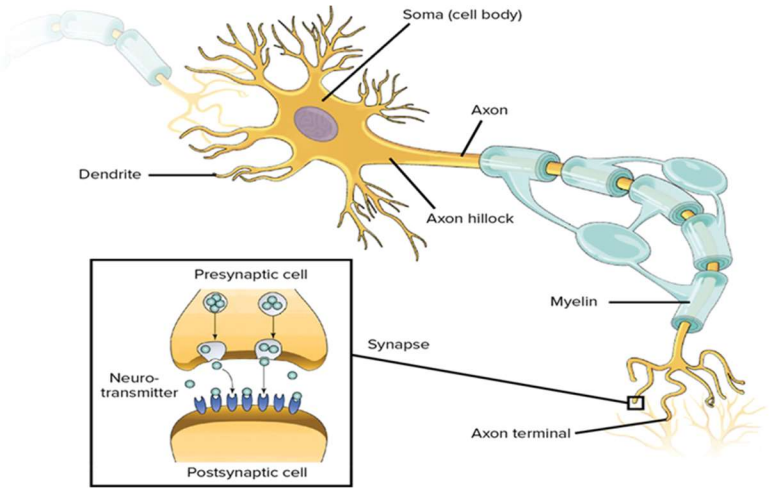
3. Axon is long processes extends for a long distance away from the nerve cell body. Axon transmits impulses away from the nerve cell body. Dendrites and axons are usually called nerve fibers.

Synapse

Synapse is the junction between two neurons (the nerve terminal and a dendrite or cell body of another neuron).

- The cell to which the axon terminal belongs (sending cell) is called the **presynaptic cell**.
- While the cell to which the dendrite or cell body belongs (receiving cell) is called the **postsynaptic cell.**
- The synaptic connections between neurons and skeletal muscle cells are generally called **neuromuscular junctions**.
- The connections between neurons and smooth muscle cells or glands are known as **neuroeffector junctions**.

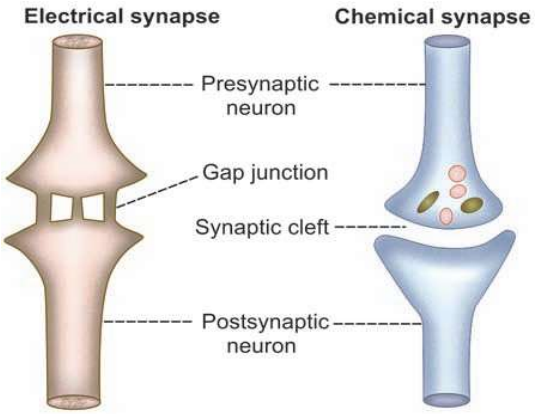
- The region between the pre- and postsynaptic membrane is very narrow.



Synapse is classified into two types:

1. Electrical synapse: is the synapse in which the physiological continuity between the presynaptic and the post synaptic neurons is provided by **gap junction** between the two neurons. There is **direct exchange** of ions between the two neurons through the gap junction.

2. Chemical synapse: Chemical synapse is the junction between the presynaptic and the post synaptic neurons, through which the signals are transmitted by the release of chemical transmitter. In the chemical synapse, there is no continuity between the two neurons because of the presence of a space called **synaptic cleft** between the two neurons.



Neurotransmitter: is a chemical substance that acts as a **mediator** for the transmission of nerve impulse from one neuron to another neuron through a synapse.

Classification of neurotransmitters

Depending upon chemical nature of neurotransmitters:

1. ***Amino Acids***

   Fast synaptic transmission such as GABA (Gamma-aminobutyric acid) and glutamate.

2. ***Amines*** (modified amino acids)

   Slow synaptic transmission such as noradrenaline, adrenaline, dopamine, serotonin and histamine.

3. ***Others***

   such substance is acetylcholine (Ach) and nitric oxide.

Depending upon function:

Some of the neurotransmitters cause excitation of postsynaptic neuron while others cause inhibition.

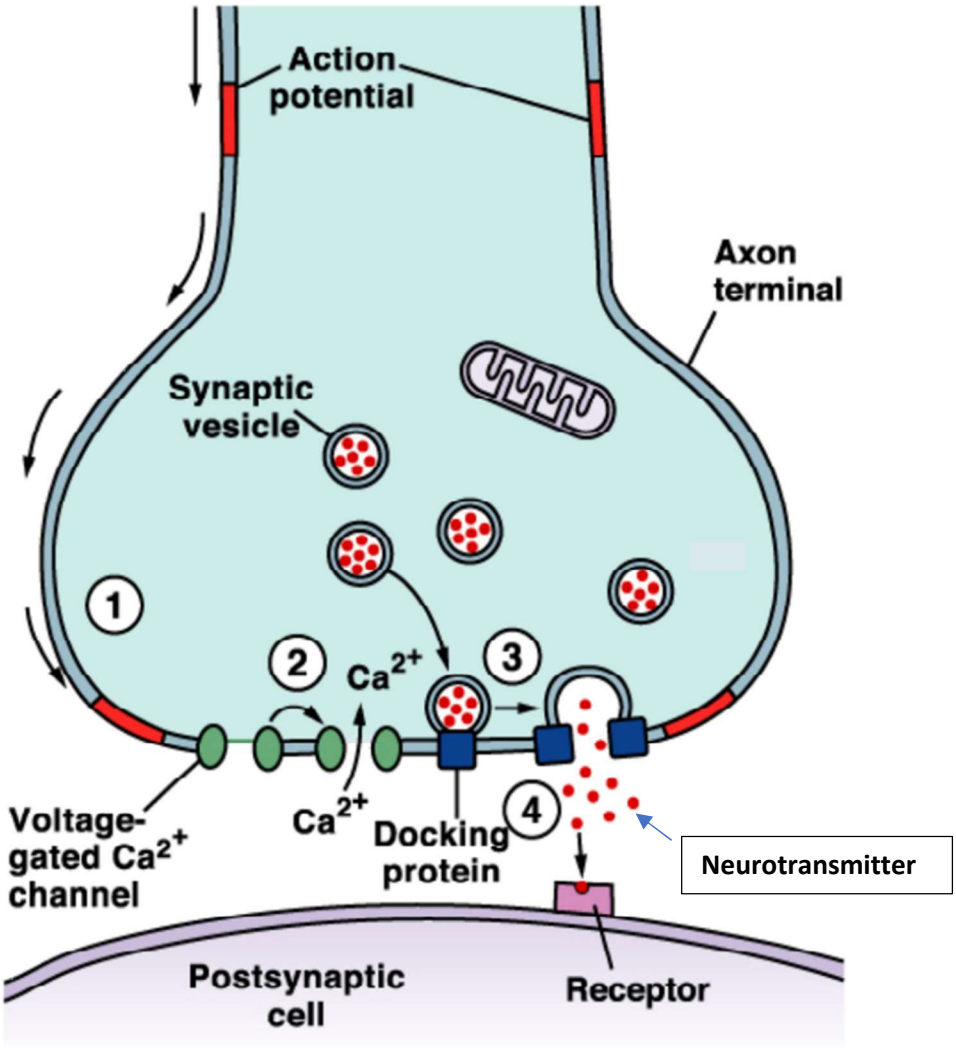
1. Excitatory neurotransmitters (acetylcholine and histamine).
2. Inhibitory neurotransmitters (GABA and dopamine).

(Adrenaline and noradrenaline act as excitatory and inhibitory neurotransmitter).

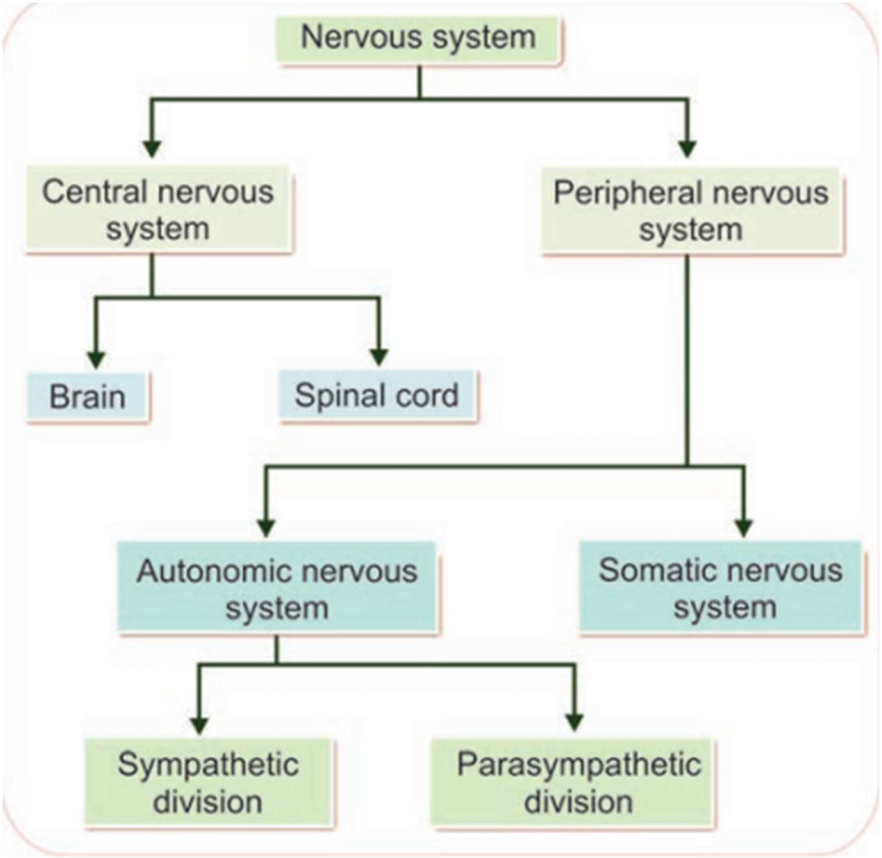
Transport and release of neurotransmitter

- The neurotransmitter is produced in the cell body of the neuron and is transported through axon.
- At the axon terminal, the neurotransmitter is stored in small vesicles.

- Under the influence of a stimulus and action potential reaches the axon terminals, voltage-gated Ca^{2+} channels open and the concentration of Ca^{2+} increases inside the end bulb.
- The Ca^{2+} helps the merging of the vesicle with the presynaptic membrane so that these vesicles open and release the neurotransmitter into synaptic cleft.
- Neurotransmitter binds to specific receptors on the surface of the postsynaptic cell.



The nervous system is divided into two parts:



Central Nervous System (CNS)

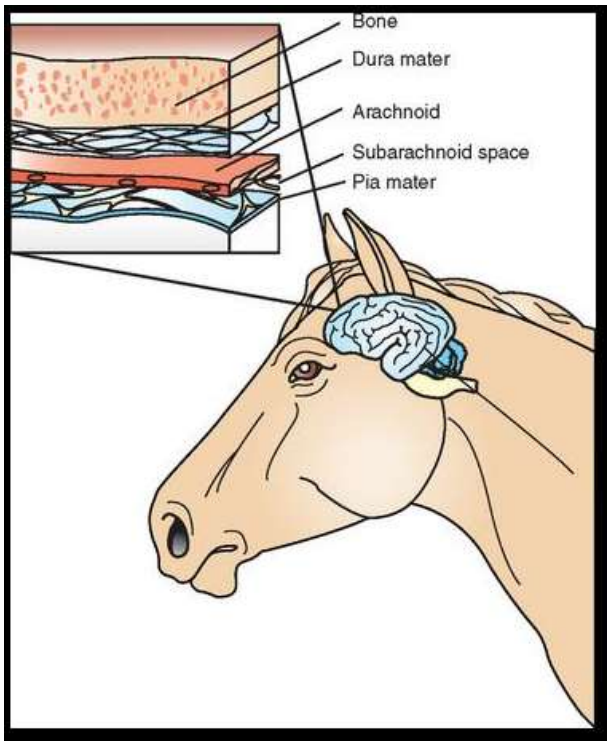
Central nervous system includes:

1. Brain and 2. Spinal cord.

Structures of brain and spinal cord are arranged in two layers, namely **gray matter** and **white matter**. In brain, white matter is placed in the inner part and gray matter is placed in the outer part. In spinal cord, white matter is in the outer part and gray matter is in the inner part.

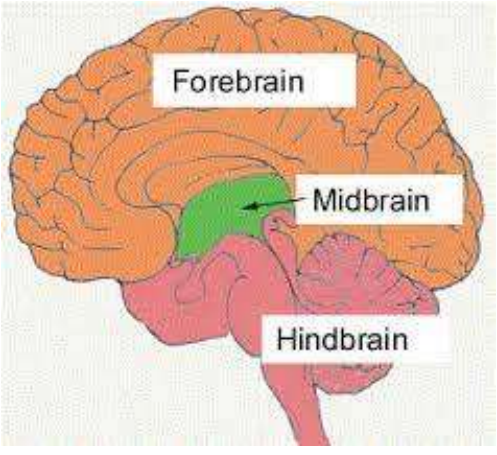
Brain and spinal cord are surrounded by three layers of **meninges** called the outer **dura mater**, middle **arachnoid mater** and inner **pia mater.**

The space between arachnoid mater and pia mater is filled with a fluid called cerebrospinal fluid. The meninges functions primarily to protect and support the central nervous system (CNS). It connects the brain and spinal cord to the skull and spinal canal.



Brain

The brain is one of the largest and most complex organs in our body; it is composed of billions of neurons that communicate together by forming numerous connections and synapses. The brain can be divided into three basic units: the forebrain, the midbrain, and the hindbrain.



Forebrain

There are three main brain divisions: cerebrum, cerebellum, brain stem.

1. Cerebrum

The cerebrum consists of two cerebral hemispheres. Both the cerebral hemispheres are not functionally equivalent. Cerebral dominance is related to handedness, i.e. Favorite of the individual to use the right or left hand. More than 90% of people are right-handed. In these individuals, the left hemisphere is dominant.

The brain has an outer layer called the cortex (gray matter) and an inner layer (white matter). There are four lobes in the cortex, the **frontal lobe, parietal lobe, temporal lobe and occipital lobe.**

Frontal Lobe

It is the largest lobe, located in front of the cerebral hemispheres, and has important **functions** for our body, and these are:

- The plans made, memory, emotions, problem solving, social interaction, and motor function
- Speech and language (Broca's area)

  ***Damage** causes Broca's aphasia, a condition in which the patient understands many written and spoken words, but has difficulty speaking them

Parietal Lobe

Function: The parietal lobe is vital for sensory perception and integration, including the management of taste, hearing, sight, touch, pain and smell.

***Damage** to it can cause problems with language, the ability to control eye gaze and verbal memory.

Temporal lobe

Function: processing auditory information and the encoding of memory.

* **Any damage** to it can cause problems with language skills, speech perception and memory.

Occipital lobes

Function: visual perception, including color, form and motion.

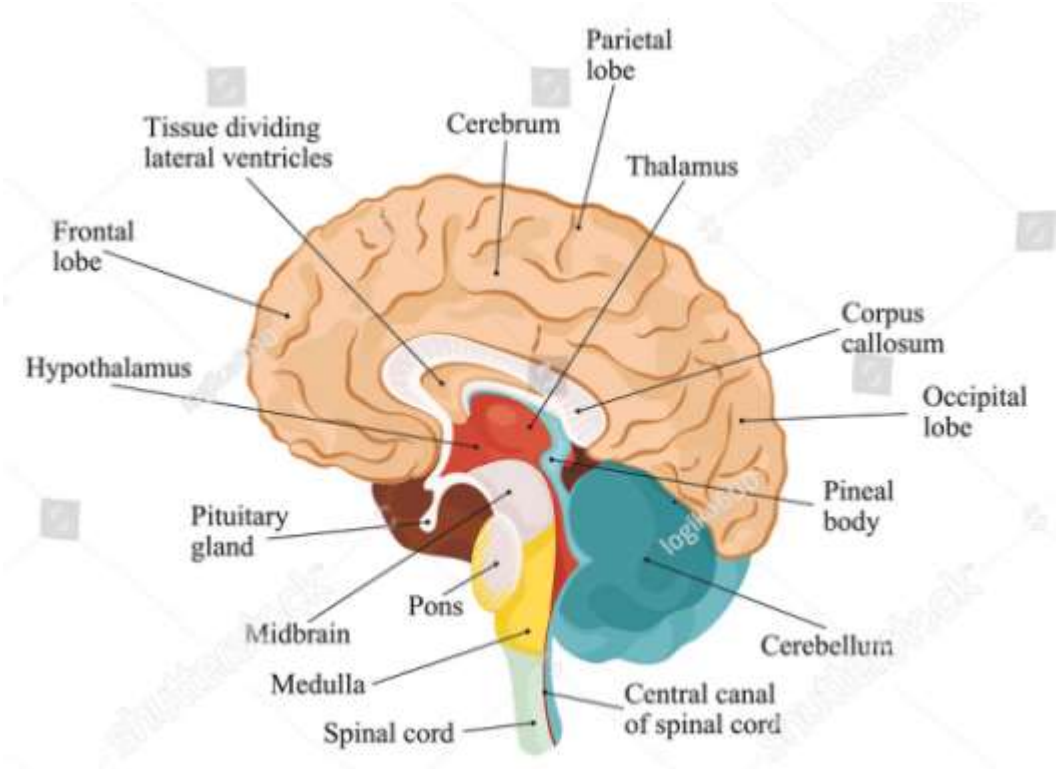
*Damaged it cause unable to recognize colors, words and objects.

2. Cerebellum

The cerebellum is known as the little brain and resembles the cerebrum for it has a highly folded surface and is distributed in 2 hemispheres. Even though the cerebellum is smaller in size, it contains more neurons than the entire brain itself This part of the brain is responsible for performing functions like:

- Balance
- Posture
- Coordination of movement.

***Damage** cause Ataxia (Lack of coordination of movements).



3. Brain stem

Brainstem is the part of brain contains ascending and descending tracts between brain and spinal cord. Brainstem formed by:

1. **Midbrain:** controls **eye movements** and **integrates them with auditory input**.
2. **Hindbrain:**
   a. Medulla oblongata: controls the **breathing, heart rate, blood pressure**, **swallowing** and other important functions.
   b. pons: involved in controlling **movements of the body** and **equilibrium.**

Limbic system

The limbic system is composed of four main parts:

1. Hypothalamus
2. Amygdala
3. Thalamus
4. Hippocampus