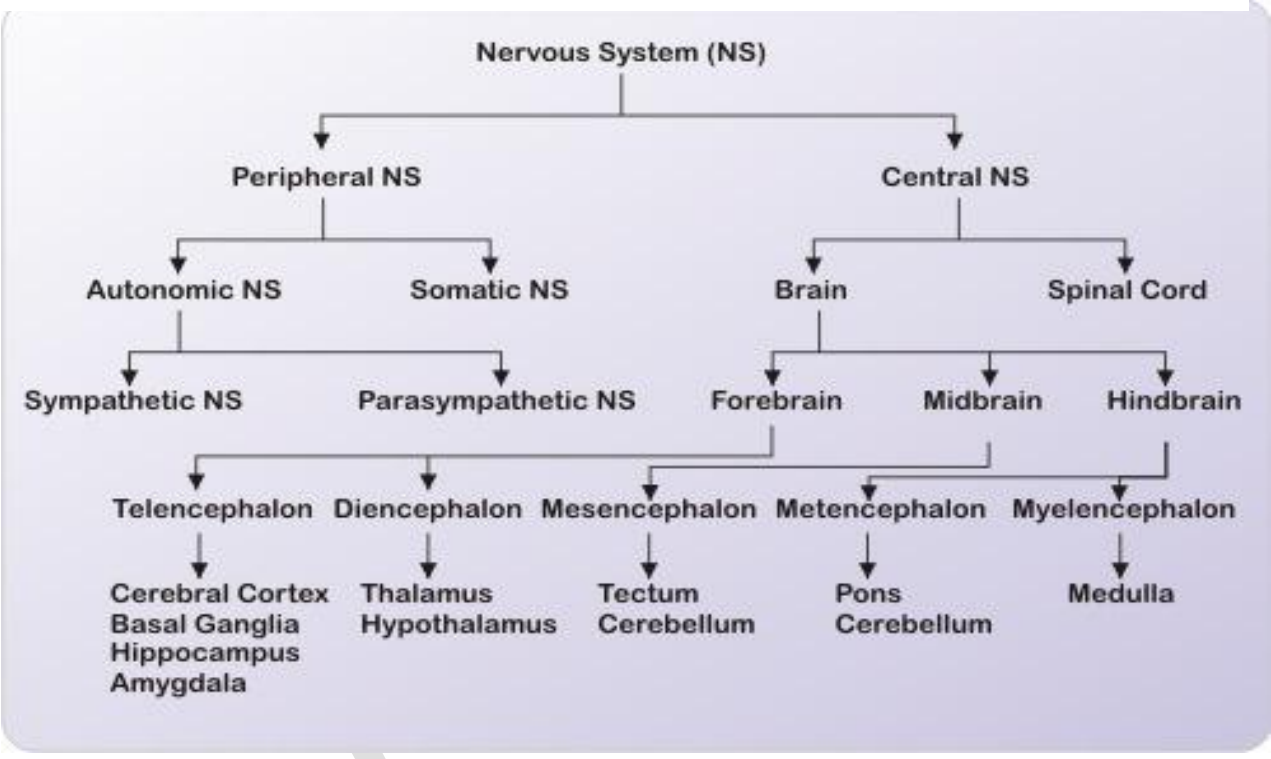
Baida Almusawy the nervous system

Lecture (6)

The nervous system is a complex network of nerves and cells that carry messages to and from the brain and spinal cord to various parts of the body. The nervous system includes both the Central nervous system and Peripheral nervous system. The Central nervous system is made up of the brain and spinal cord and The Peripheral nervous system is made up of the Somatic and the Autonomic nervous systems.



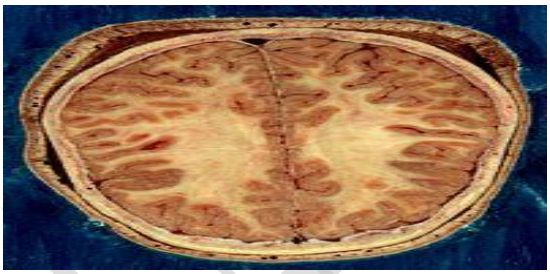
The Central nervous system

The central nervous system is divided into two major parts: the brain and the spinal cord.

1- The brain

The brain lies within the skull and is shaped like a mushroom. The brain consists of four principal parts:

- the brain stem
- the cerebrum
- the cerebellum
- the diencephalon



The brain weighs approximately 1.3 to 1.4 kg. It has nerve cells called the neurons and supporting cells called the glia.

There are two types of matter in the brain: grey matter and white matter. Grey matter receives and stores impulses. Cell bodies of neurons and neuroglia are in the grey matter. White matter in the brain carries impulses to and from grey matter. It consists of the nerve fibers (axons).

The brain stem

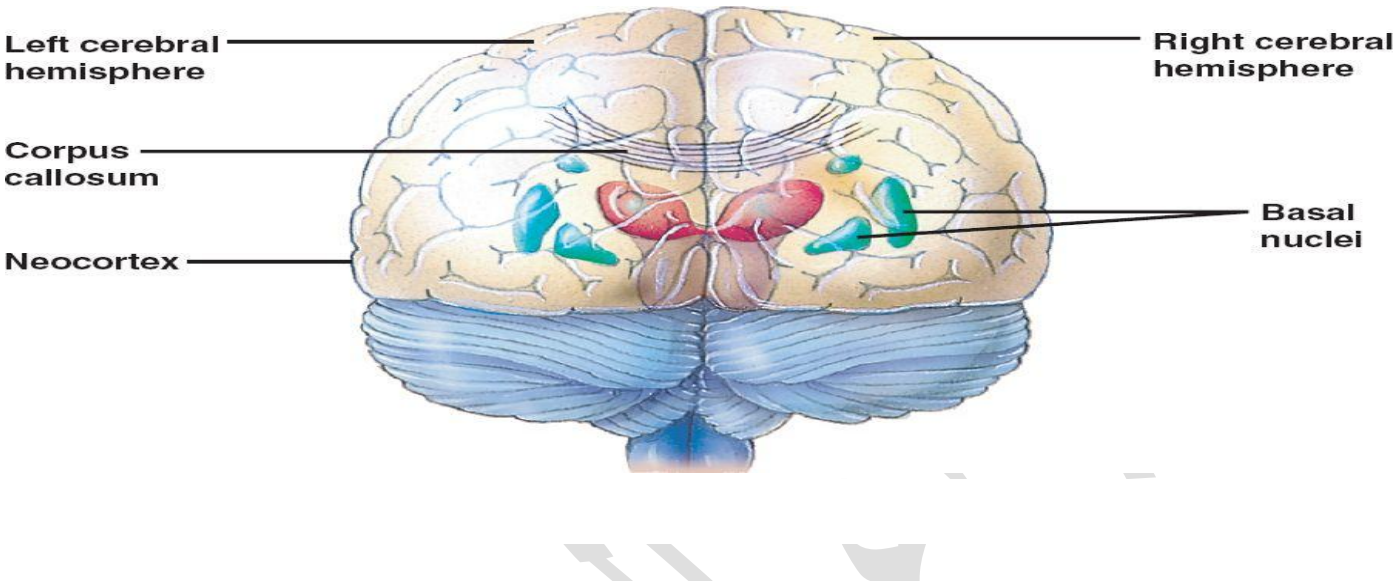
The brain stem is also known as the Medulla oblongata. It is located between the pons and the spinal cord and is only about one inch long.

The cerebrum

The cerebrum forms the bulk of the brain and is supported on the brain stem. The cerebrum is divided into two hemispheres. Each hemisphere controls the activities of the side of the body opposite that hemisphere. The hemispheres are further divided into four lobes:

- Frontal lobe
- Temporal lobes

- Parietal lobe
- Occipital lobe



The cerebellum

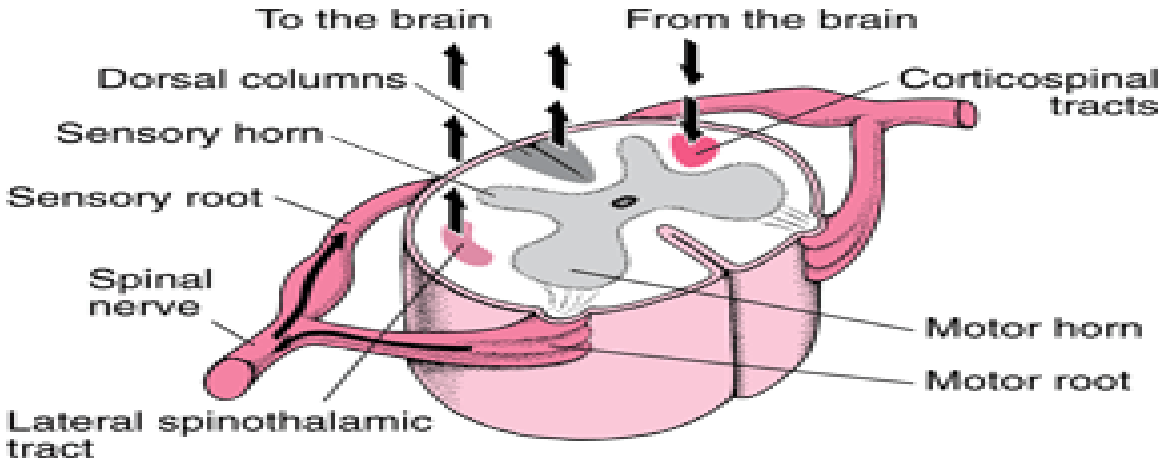
This is located behind and below the cerebrum.

The diencephalon

The diencephalon is also known as the fore brain stem. It includes the thalamus and hypothalamus. The thalamus is where sensory and other impulses go and coalesce. The hypothalamus is a smaller part of the diencephalon

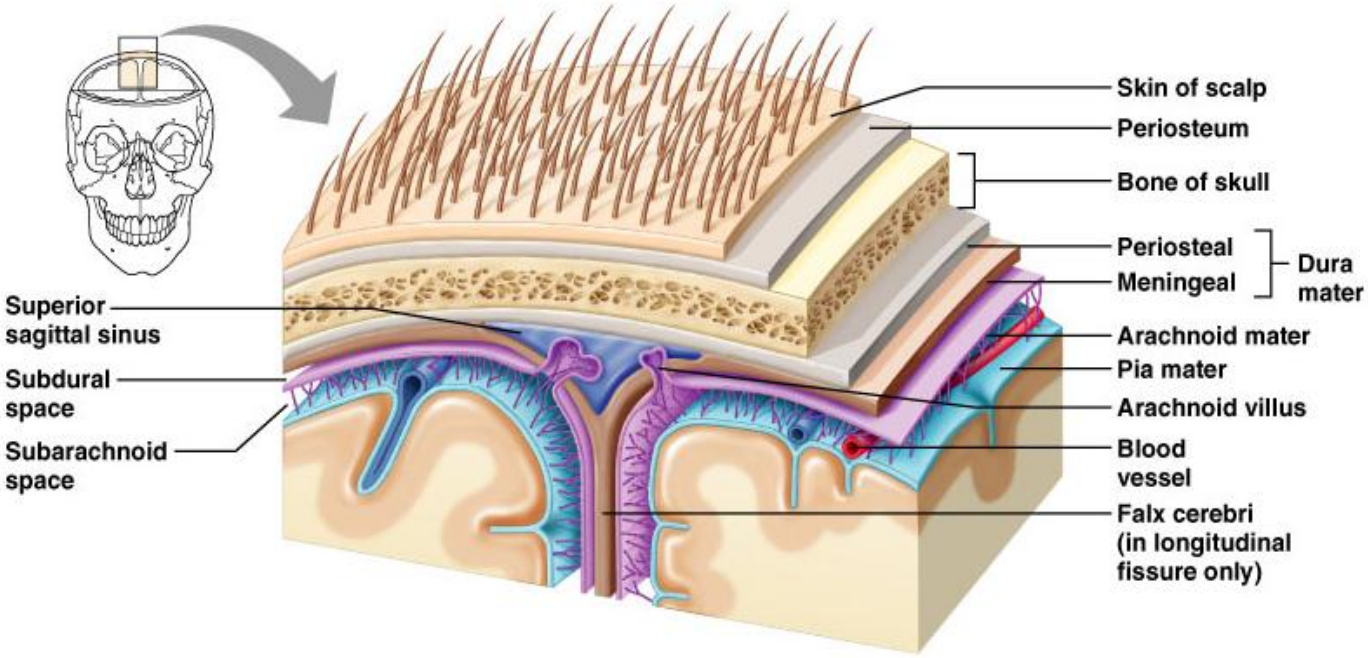
2- The spinal cord

The spinal cord is along tube like structure which extends from the brain. The spinal cord is composed of a series of 31 segments. A pair of spinal nerves comes out of each segment. The region of the spinal cord from which a pair of spinal nerves originates is called the spinal segment. Both motor and sensory nerves are located in the spinal cord. The spinal cord is about 43 cm long in adult women and 45 cm long in adult men and weighs about 35-40 grams. It lies within the vertebral column, the collection of bones (back bone).



Other parts of the central nervous system

The meninges are three layers or membranes that cover the brain and the spinal cord. The outermost layer is the dura mater. The middle layer is the arachnoid, and the innermost layer is the pia mater. The meninges offer protection to the brain and the spinal cord by acting as a barrier against bacteria and other microorganisms. The Cerebrospinal Fluid (CSF) circulates around the brain and spinal cord. It protects and nourishes the brain and spinal cord.



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Neurons

The neuron is the basic unit in the nervous system. It is a specialized conductor cell that receives and transmits electrochemical nerve impulses. A typical neuron has a cell body and long arms that conduct impulses from one body part to another body part.

There are three different parts of the neuron:

- the cell body
- dendrites
- axon

Cell body of a neuron

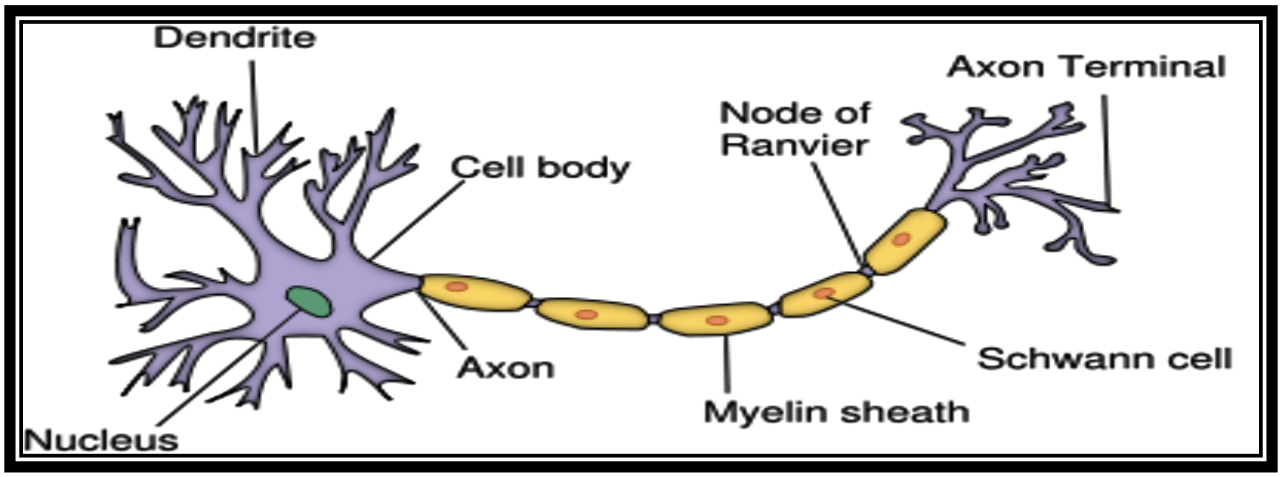
The cell body is like any other cell with a nucleus or control center.

Dendrites

The cell body has several highly branched, thick extensions that appear like cables and are called dendrites. The exception is a sensory neuron that has a single, long dendrite instead of many dendrites. Motor neurons have multiple thick dendrites. The dendrite's function is to carry a nerve impulse into the cell body.

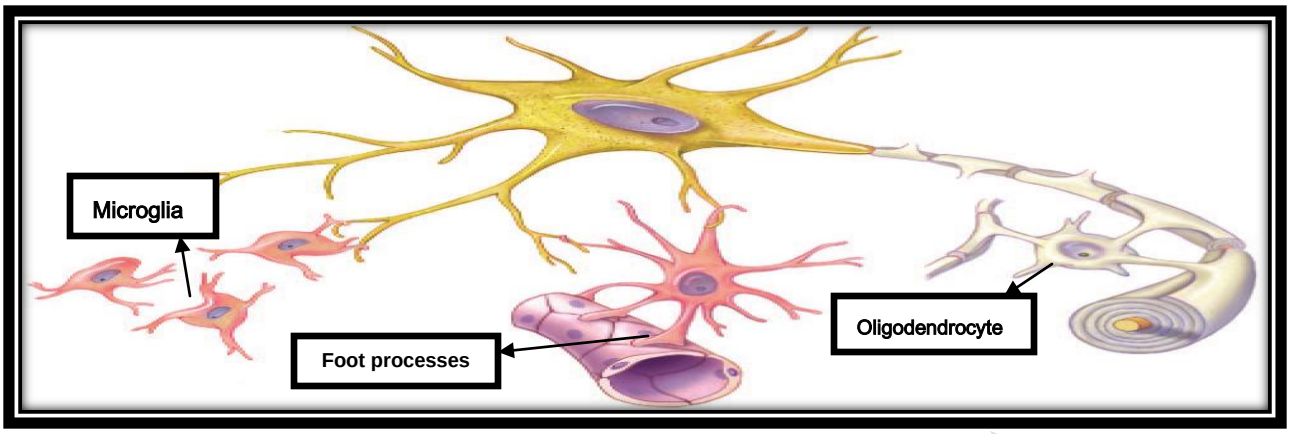
Axon

An axon is a long, thin process that carries impulses away from the cell body to another neuron or tissue. There is usually only one axon per neuron.



Glial cells

Glial cells are non-neuronal cells that provide support and nutrition, maintain homeostasis, form myelin, and participate in signal transmission in the nervous system. In the human brain, it is estimated that the total number of glia roughly equals the number of neurons, although the proportions vary in different brain areas. Among the most important functions of glial cells are to support neurons and hold them in place; to supply nutrients to neurons; to insulate neurons electrically; to destroy pathogens and remove dead neurons; and to provide guidance cues directing the axons of neurons to their targets. A very important type of glial cell (oligodendrocytes in the central nervous system, and Schwann cells in the peripheral nervous system) generates layers of a fatty substance called myelin that wraps around axons and provides electrical insulation which allows them to transmit action potentials much more rapidly and efficiently. Oligodendrocytes form myelin and microglial cells, in addition to supporting neurons, engulf bacterial and cellular debris.



Myelin Sheath

The neuron is covered with the Myelin Sheath or Schwann Cells. These are white segmented covering around axons and dendrites of many peripheral neurons. The covering is continuous along the axons or dendrites except at the point of termination and at the nodes of Ranvier.

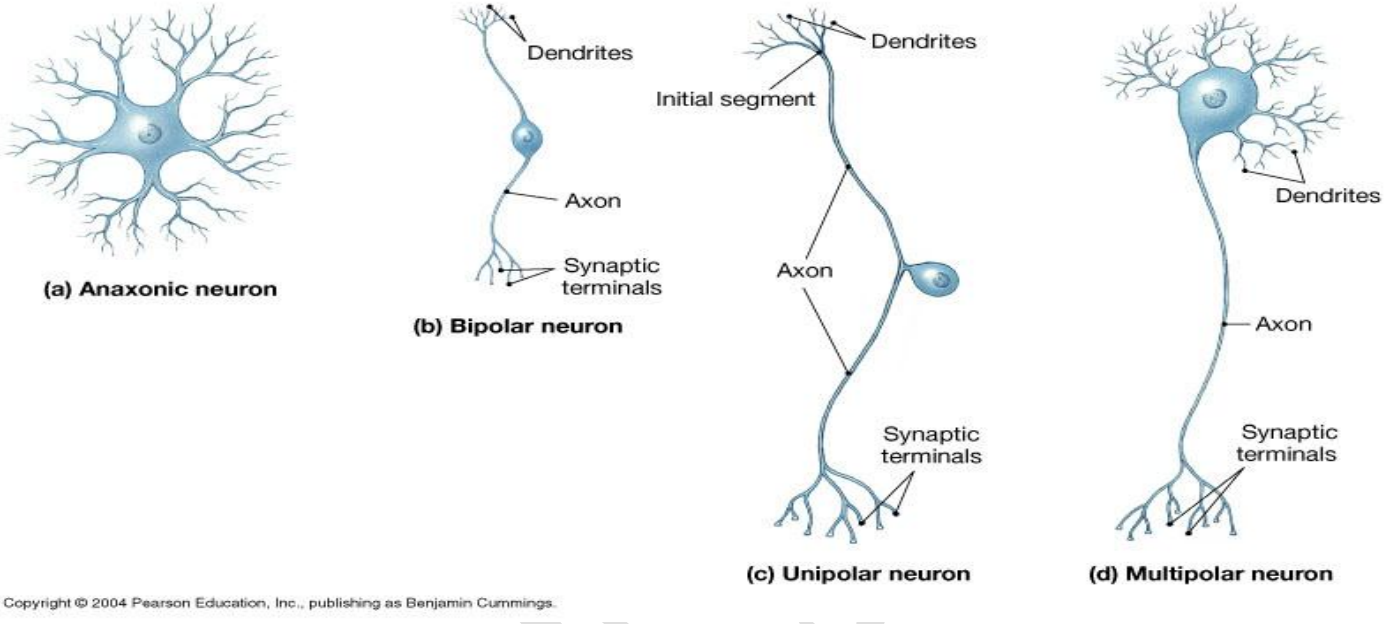
The neurilemma is the layer of Schwann cells with a nucleus. Its function is to allow damaged nerves to regenerate. Nerves in the brain and spinal cord do not have a neurilemma and, therefore cannot recover when damaged.

Types of neuron

Neurons in the body can be classified according to structure and function. According to structure neurons may be multipolar neurons, bipolar neurons, and unipolar neurons:

- Multipolar neurons have one axon and several dendrites. These are common in the brain and spinal cord
- Bipolar neurons have one axon and one dendrite. These are seen in the retina of the eye, the inner ear, and the olfactory (smell) area.
- Unipolar neurons have one process extending from the cell body. The one process divides with one part acting as an axon and the other part functioning as dendrite. These are seen in the spinal cord.

- Anaxonic neuron



The Peripheral nervous system

The Peripheral nervous system is made up of two parts:

- Somatic nervous system
- Autonomic nervous system

Somatic nervous system

The somatic nervous system consists of peripheral nerve fibers that pick up sensory information or sensations from the peripheral or distant organs (those away from the brain like limbs) and carry them to the central nervous system.

These also consist of motor nerve fibers that come out of the brain and take the messages for movement and necessary action to the skeletal muscles. For example, on touching a hot object the sensory nerves carry information about the heat to the brain, which in turn, via the motor nerves, tells the muscles of the hand to

withdraw it immediately. The whole process takes less than a second to happen. The cell body of the neuron that carries the information often lies within the brain or spinal cord and projects directly to a skeletal muscle.

Autonomic Nervous System

Another part of the nervous system is the Autonomic Nervous System. It has three parts:

- the sympathetic nervous system
- the parasympathetic nervous system
- the enteric nervous system

This nervous system controls the nerves of the inner organs of the body on which humans have no conscious control. This includes the heartbeat, digestion, breathing (except conscious breathing) etc.

The nerves of the autonomic nervous system enervate the smooth involuntary muscles of the (internal organs) and glands and cause them to function and secrete their enzymes etc.

The Enteric nervous system is the third part of the autonomic nervous system. The enteric nervous system is a complex network of nerve fibers that innervate the organs within the abdomen like the gastrointestinal tract, pancreas, gall bladder etc. It contains nearly 100 million nerves.

Neurons in the peripheral nervous system

The smallest worker in the nervous system is the neuron. For each of the chain of impulses there is one preganglionic neuron, or one before the cell body or ganglion, that is like a central controlling body for numerous neurons going out peripherally.

The preganglionic neuron is located in either the brain or the spinal cord. In the autonomic nervous system this preganglionic neuron projects to an autonomic ganglion. The postganglionic neuron then projects to the target organ.

In the somatic nervous system there is only one neuron between the central nervous system and the target organ while the autonomic nervous system uses two neurons.

Neurotransmitters

Neurotransmitters are the brain chemicals that communicate information throughout our brain and body. They relay signals between nerve cells, called "neurons." The brain uses neurotransmitters to tell your heart to beat, your lungs to breathe, and your stomach to digest. They can also affect mood, sleep, concentration, weight, and can cause adverse symptoms when they are out of balance. Neurotransmitter levels can be depleted many ways. Type of neurotransmitter :-

1- Acetylcholine stimulates the voluntary muscles on contraction.

2- Serotonin acts as a human sense of stability.

3- Dopamine is coordinating the movement of the human.

4- Epinephrine stimulates the sympathetic nervous system and prepares the body to the face of danger.

5- Alklotamk acid is also called Klotamat stimulates education and stimulate memory.

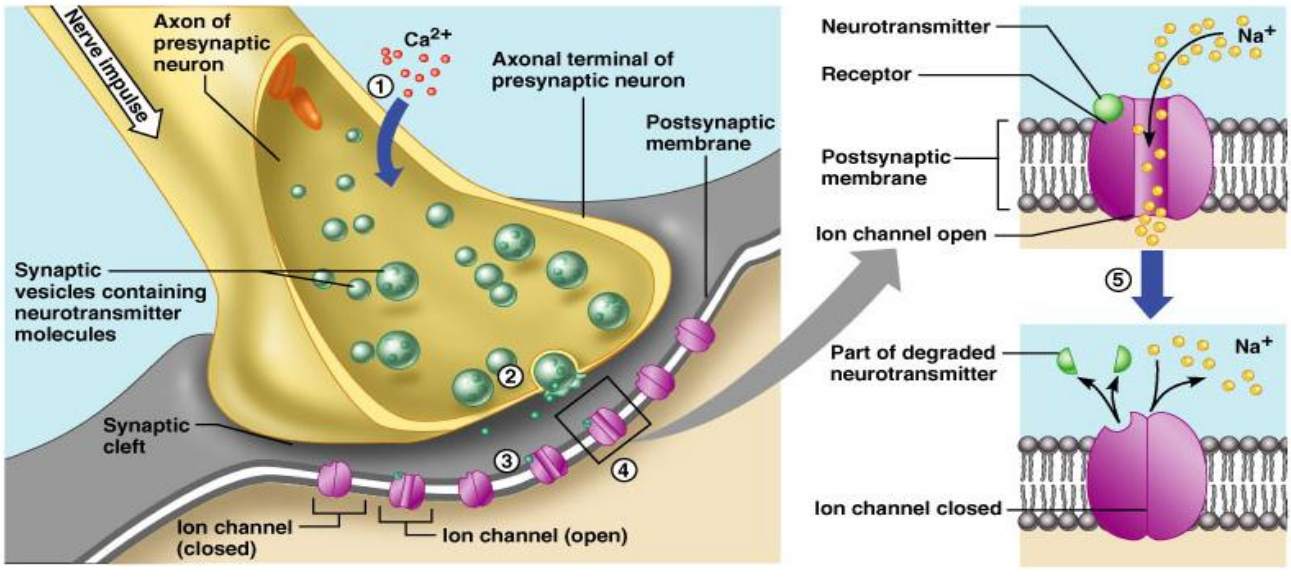
6- Melatonin regulates sleep and other activities.

Neurons and synapses

Most neurons send signals via their axons, although some types are capable of dendrite-to-dendrite communication. Neural signals propagate along an axon in the form of electrochemical waves called action potentials, which produce cell-to-cell signals at points where axon terminals make synaptic contact with other cells. Synapses may be electrical or chemical. Electrical synapses make direct electrical connections between neurons, but chemical synapses are much more common, and much more diverse in function. At a chemical synapse, the cell that sends signals is called presynaptic, and the cell that receives signals is called postsynaptic. Both the presynaptic and postsynaptic areas are full of molecular machinery that carries out the signalling process. The presynaptic area contains large numbers of tiny spherical vessels called synaptic vesicles, packed with neurotransmitter chemicals.

When the presynaptic terminal is electrically stimulated, an array of molecules embedded in the membrane are activated, and cause the contents of the vesicles to be released into the narrow space between the presynaptic and postsynaptic membranes, called the synaptic cleft. The neurotransmitter then binds to receptors embedded in the postsynaptic membrane, causing them to enter an activated state. Depending on the type of receptor, the resulting effect on the

Neurons and synapses



postsynaptic cell may be excitatory, inhibitory, or modulatory in more complex ways. For example, release of the neurotransmitter acetylcholine at a synaptic contact between a motor neuron and a muscle cell induces rapid contraction of the muscle cell. The entire synaptic transmission process takes only a fraction of a millisecond, although the effects on the postsynaptic cell may last much longer .

The Nerve Impulse

When a nerve is stimulated the resting potential changes. Examples of such stimuli are pressure, electricity, chemicals, etc. Different neurons are sensitive to different stimuli . The stimulus causes sodium ion channels to open. The rapid change in polarity that moves along the nerve fiber is called the "ACTION POTENTIAL." This moving change in polarity has several stages:

1- Depolarization

The upswing is caused when positively charged sodium ions(Na+) suddenly rush through open sodium gates into a nerve cell. . As additional sodium rushes in, the membrane potential actually reverses its polarity so that the outside of the membrane is negative relative to the inside. During this change of polarity the membrane actually develops a positive value for a moment(+40 millivolts). The change in voltage stimulates the opening of additional sodium channels.

2- Repolarization

(The downswing) is caused by the closing of sodium ion channels and the opening of potassium ion channels. Release of positively charged potassium ions (K+) from the nerve cell when potassium gates open. Again, these are opened in response to the positive voltage--they are voltage gated. This expulsion acts to restore the localized negative membrane potential of the cell.

3- Refractory phase

is a short period of time after the depolarization stage. Shortly after the sodium gates open they close and go into an inactive conformation. The sodium gates cannot be opened again until the membrane is repolarized to its normal resting potential. The sodium-potassium pump returns sodium ions to the outside and potassium ions to the inside.

Schizophrenia

An increased dopamine (DA) response in the limbic system results in schizophrenia. DA may be synthesized or secreted in excess, DA receptors may be supersensitive, and DA regulatory mechanism may be defective. Symptoms are decreased by drugs which block DA receptors. Symptoms of schizophrenia are:

1. Loss of touch with reality **2.** Decreased ability to think and reason

3. Decreased ability to concentrate **4.** Decreased memory

5. Regress in child-like behavior **6.** Altered mood and impulsive behavior

7. Auditory hallucinations

Depression

Depression is the most common major mental illness and is characterized by both emotional and physical symptoms. Symptoms of depression are:

1. Intense sadness and despair **2.** Anxiety

3. Loss of ability to concentrate **4.** Pessimism

5. Feelings of low self esteem **6.** Insomnia or hypersomnia

7. Increased or decreased appetite

8. Changes in body temperature and endocrine gland function