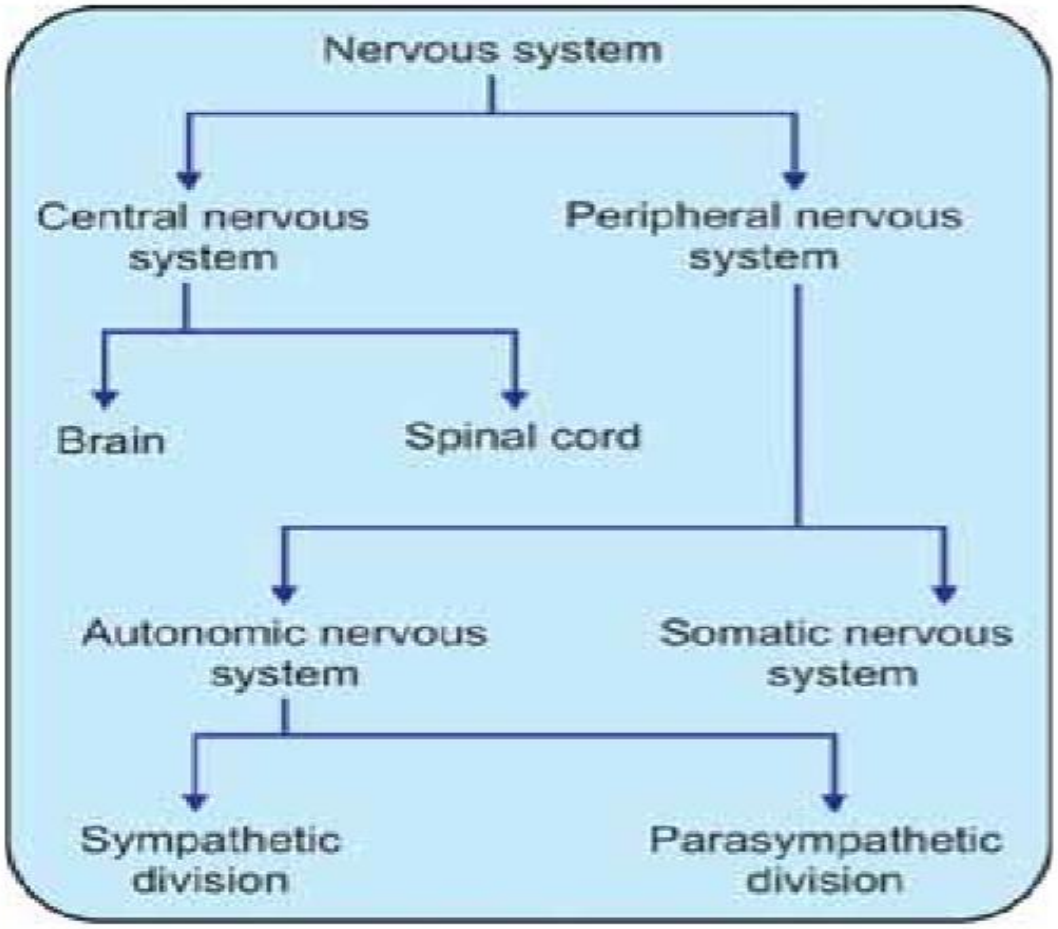
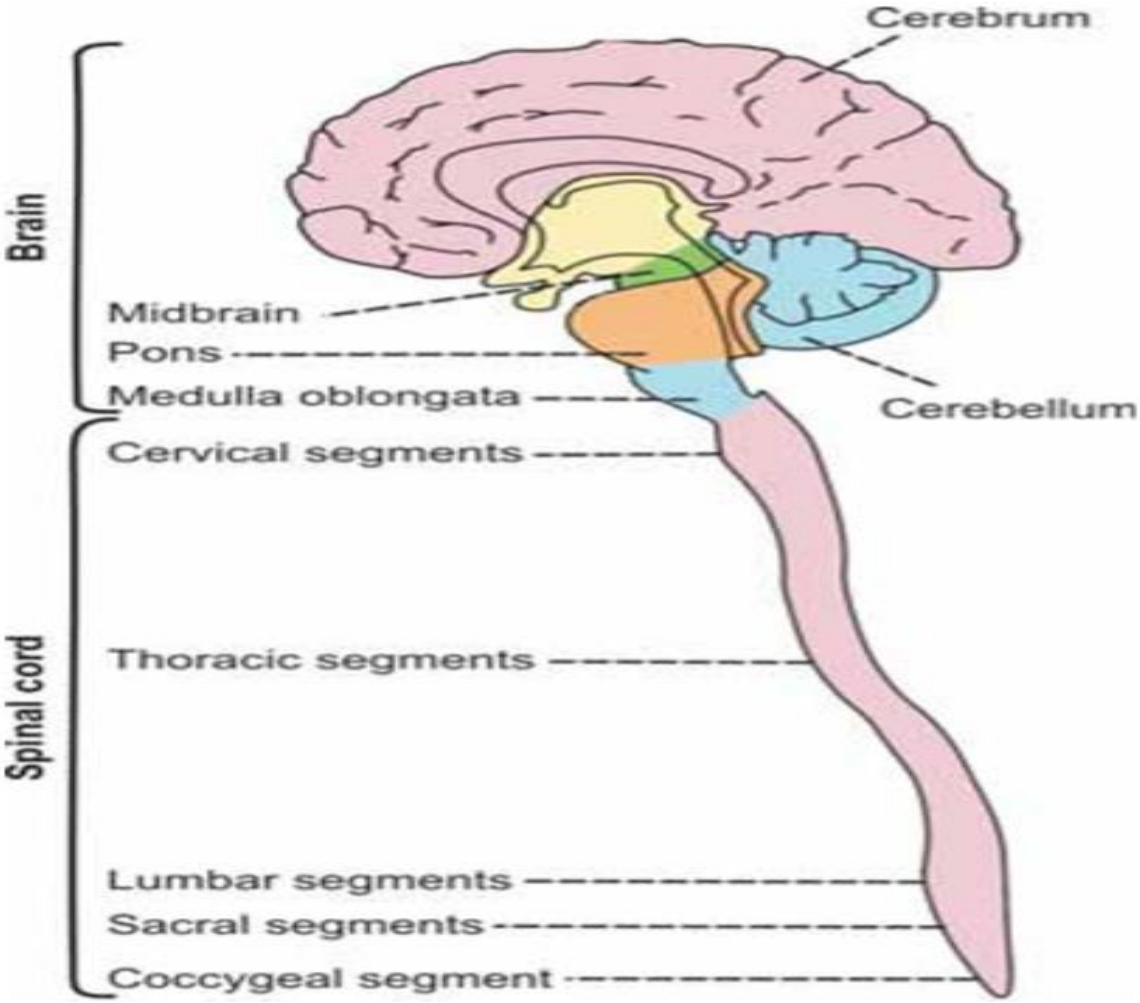
Nervous System

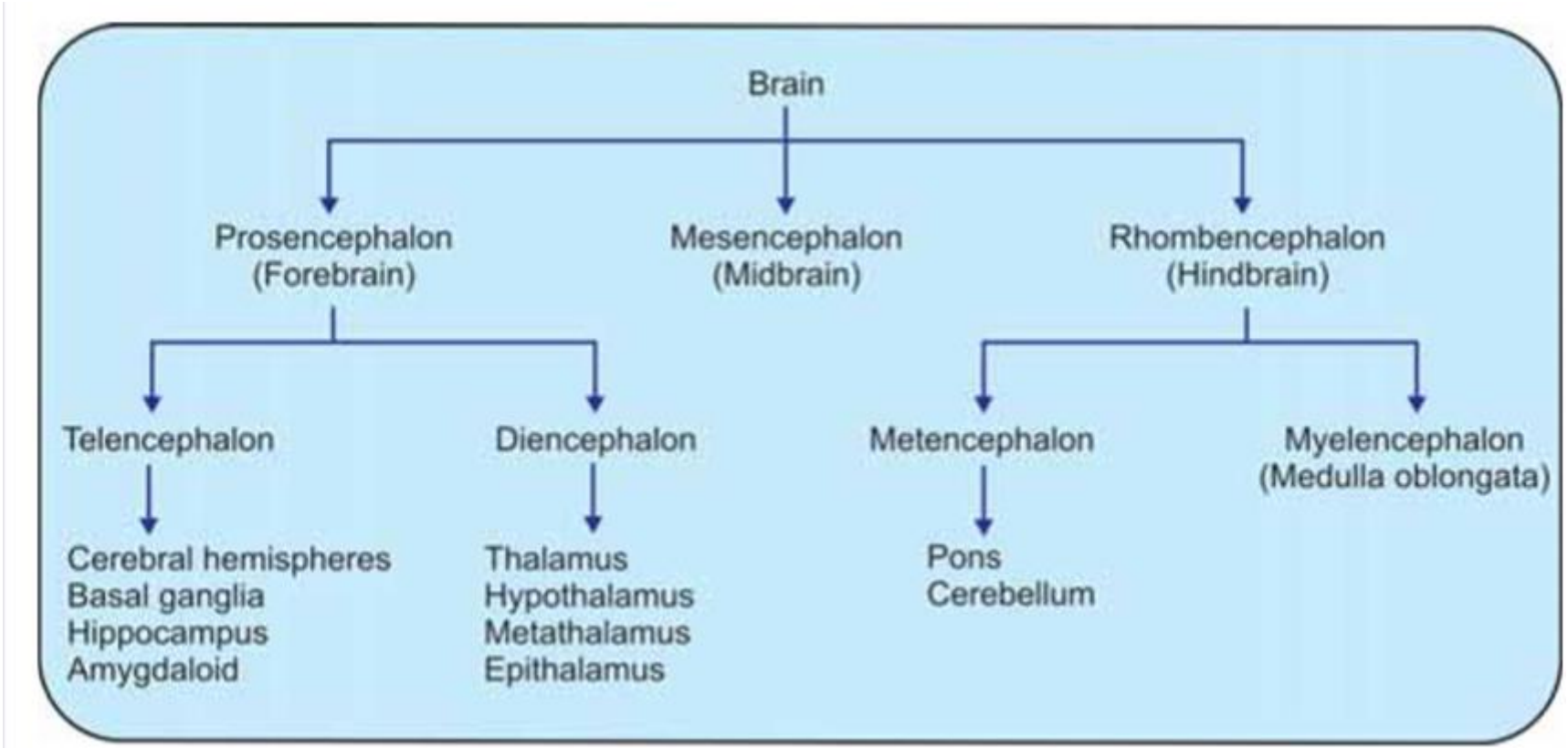
Organization of nervous system



The parts of central nervous system



The parts of brain

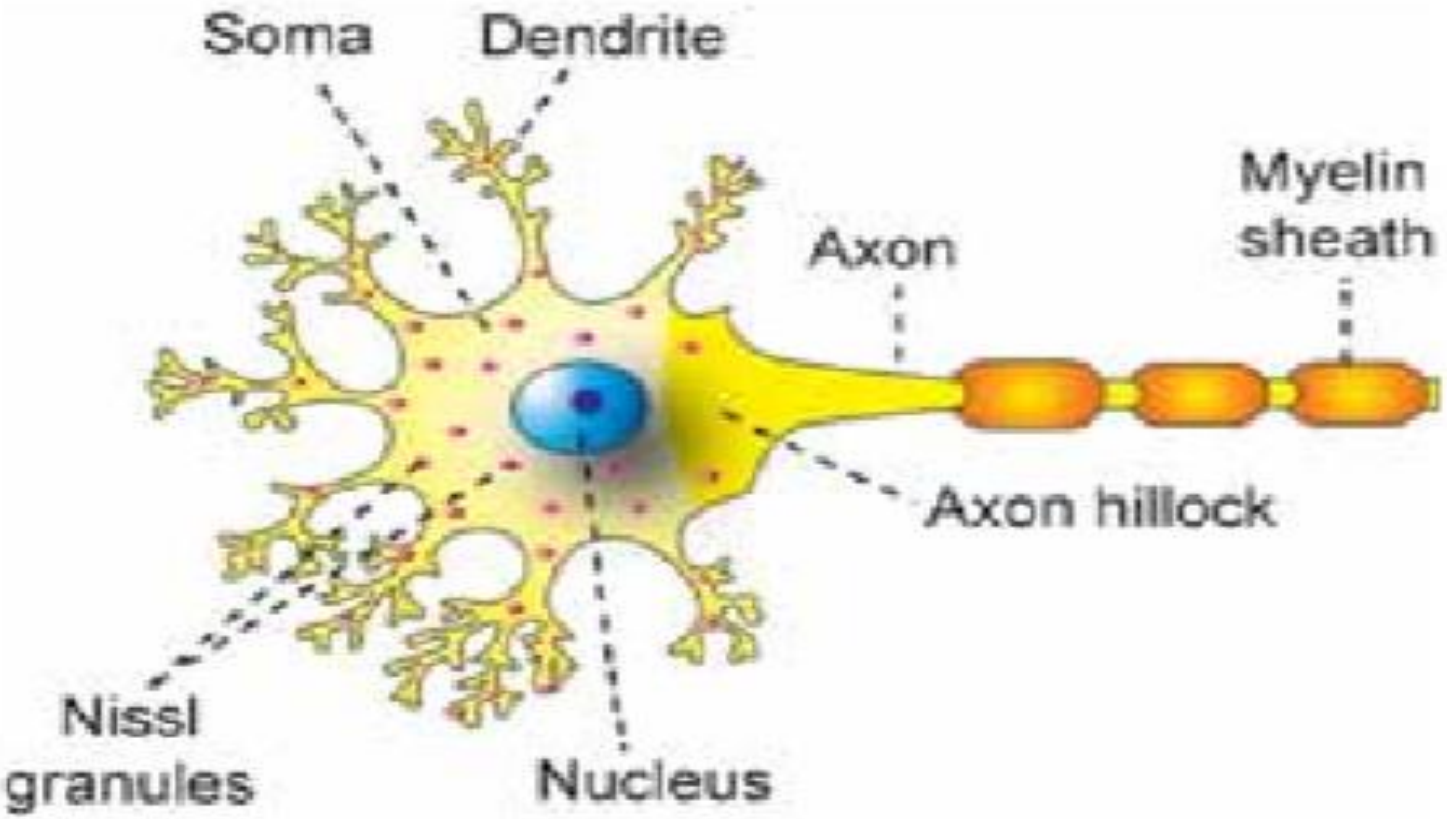


Neuron

- is defined as the structural and functional unit of the nervous system. It is otherwise called nerve cell. Neuron is like any other cell in the body having nucleus and all the organelles in the cytoplasm. However, it is different from other cells by two ways:
- 1. Neuron has branches or processes called axon and dendrites
- 2. Neuron does not have centrosome; so it cannot undergo division.

- STRUCTURE OF NEURON Each neuron is made up of three parts:
- 1. Nerve cell body
- 2. Dendrite
- 3. Axon.

Structure of a neuron



- The dendrite and axon together form the processes of neuron . In general, the dendrites are short processes and the axons are long processes. The dendrites and axons are usually called nerve fibers.

- Nerve Cell Body The nerve cell body is also known as soma or perikaryon. It is irregular in shape and, it is constituted by a mass of cytoplasm called neuroplasm which is covered by a cell membrane. The cytoplasm contains a large nucleus, Nissl bodies, neurofibrils, mitochondria and Golgi apparatus. Nissl bodies and neurofibrils are found only in nerve cell and not in other cells.
- Nucleus Each neuron has one nucleus which is centrally placed in the nerve cell body. The nucleus has one or two prominent nucleoli. The nucleus does not contain centrosome. So, the nerve cell cannot multiply like the other cells.

- Nissl bodies Nissl bodies or Nissl granules are small basophilic granules found in cytoplasm of neurons and are named after the discoverer. These bodies are present in the soma except in axon hillock. Nissl bodies are called tigroid substances since these bodies are responsible for the tigroid or spotted appearance of soma after suitable stain-ing. The Nissl granules flow into the dendrites from soma, but not into axon. So, the dendrites are distinguished from axons by the presence of Nissl granules under microscope.

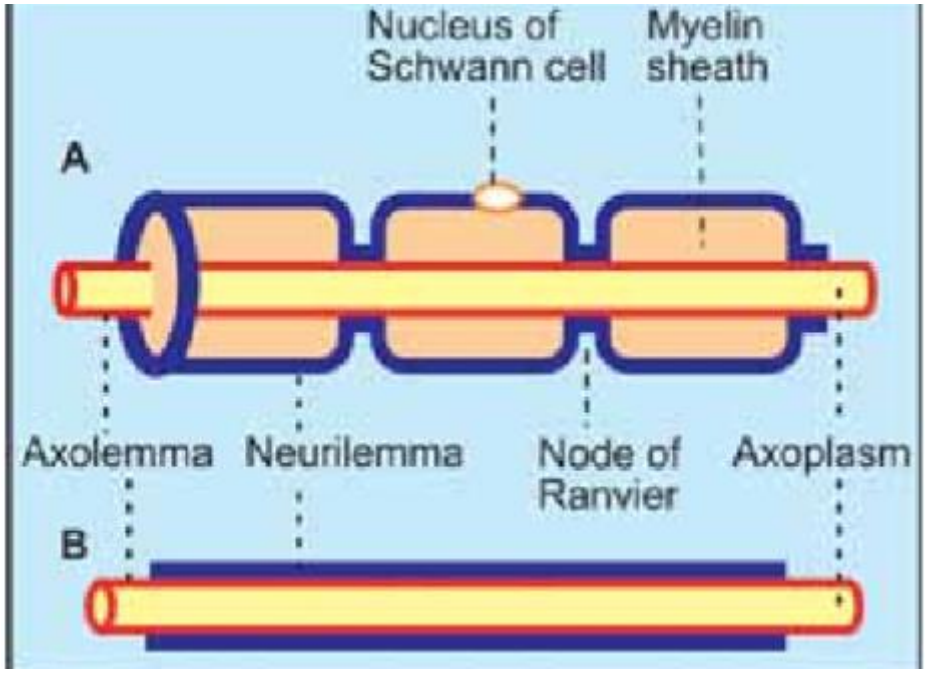
- Neurofibrils Neurofibrils are thread like structures present in the form of network in the soma and the nerve
- processes. Presence of neurofibrils is another characteristic feature of the neurons.

- Mitochondria The mitochondria are present in the soma and in axon. As other cells, the mitochondria form the powerhouse of the nerve cell, where ATP is produced.
- Golgi apparatus Golgi apparatus of the nerve cell body is similar to that of other cells. It is concerned with processing and packaging of proteins into granule

- Dendrite The dendrite is the branched process of the neuron and it is branched repeatedly. The dendrite may be present or absent. If present, it may be one or many in number. The dendrite has Nissl granules and neurofibrils. Dendrite is conductive in nature. It transmits impulses towards the nerve cell body.
- Axon The axon is longer than dendrite. Each neuron has only one axon. The axon arises from axon hillock of the nerve cell body. The axon extends for a long distance away from the nerve cell body. The length of the longest axon is about one meter.

A. Myelinated nerve fiber

B. Non-myelinated nerve fiber

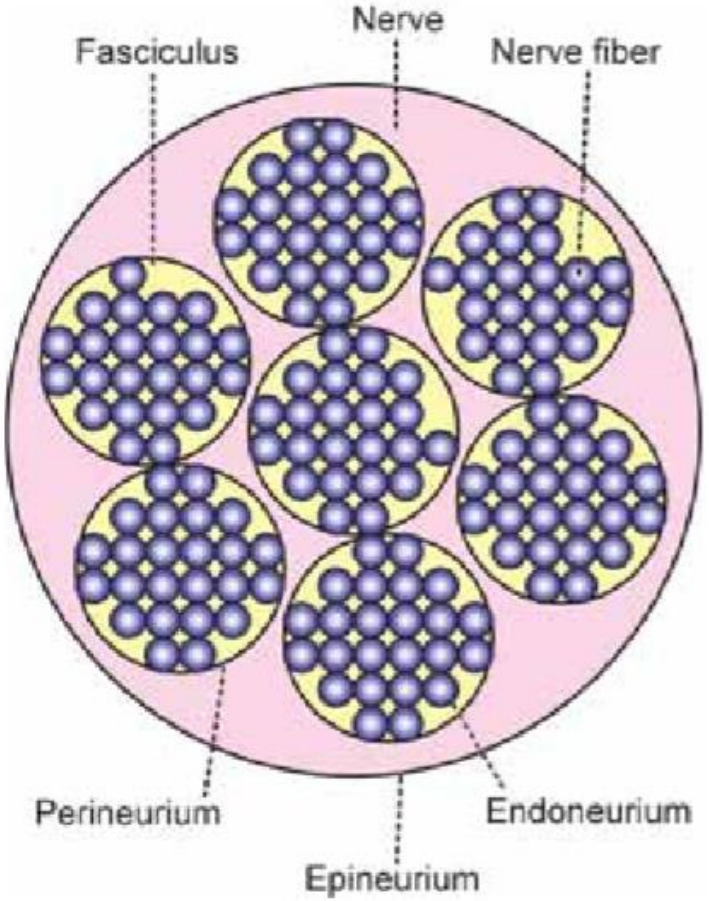


- Nonmyelinated nerve fiber The nerve fiber described above is the nonmyelinated nerve fiber which is not covered by myelin sheath.
- Myelinated nerve fiber The nerve fibers which are insulated by myelin sheath are called myelinated nerve fibers.

Functions of myelin sheath

- 1. Faster conduction: Myelin sheath is responsible for faster conduction of impulse through the nerve fibers. In the myelinated nerve fibers, the impulses jump from one node to another node by saltatory conduction.
- 2. Insulating capacity: Myelin sheath has a high insulating capacity. Because of this quality, the myelin sheath restricts the nerve impulse within the single nerve fiber, and prevents the stimulation of neighboring nerve fibers

Cross section of a nerve

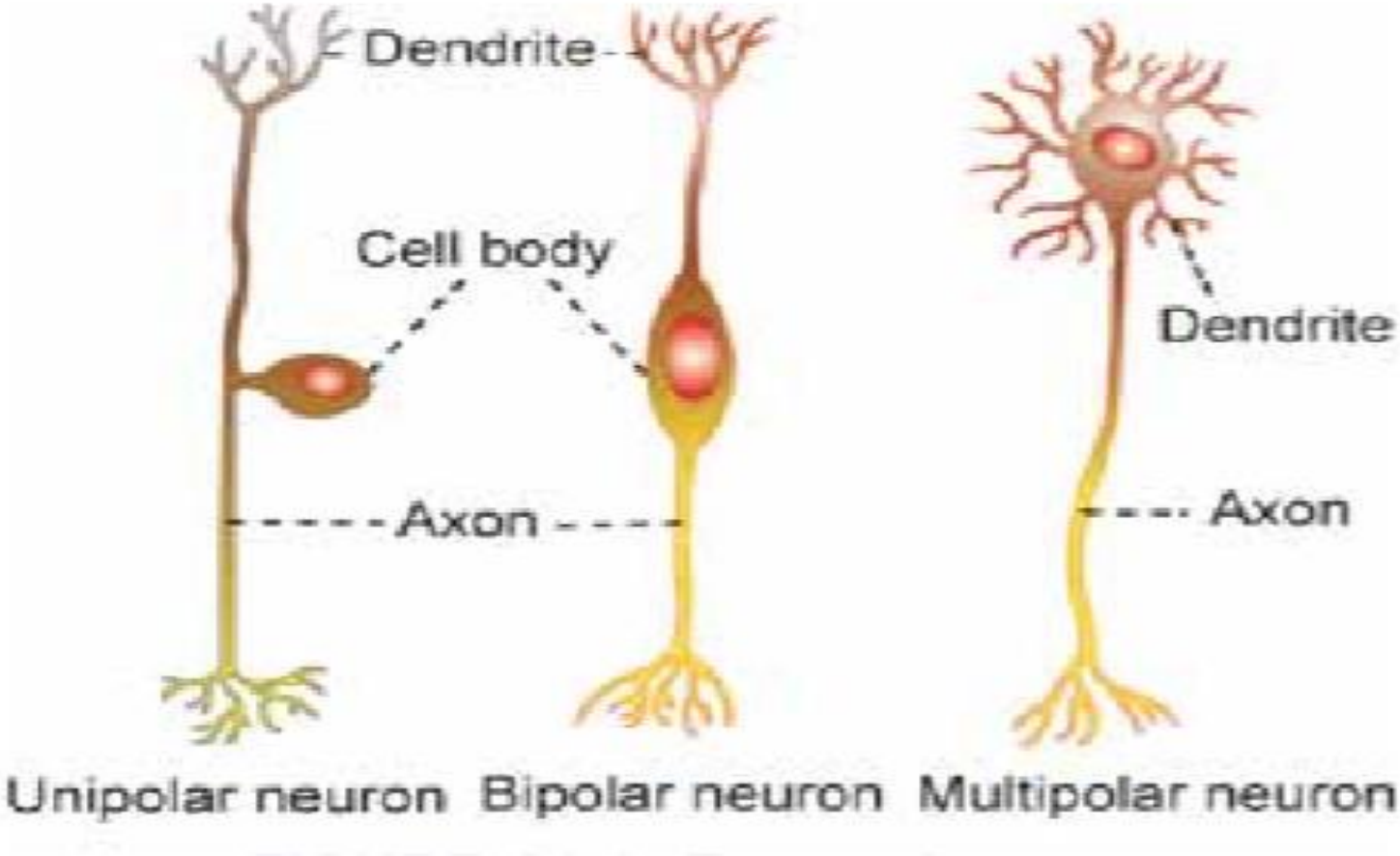


CLASSIFICATION OF NEURON

- I. Depending upon number of poles
- II. Depending upon function
- III. Depending upon length of the axon.

Depending upon Number of Poles Based on the number of poles from which the nerve fibers arise, neurons are divided into three types:

- 1. Unipolar neurons that have only one pole from which, both the axon and dendrite arise 2. Bipolar neurons which have two poles. Axon arises from one pole and dendrites arise from the other pole.
- 3. Multipolar neurons which have many poles. One of the poles gives rise to the axon and, all the other poles give rise to dendrites.


Dendrite
Cell body
Axon
Dendrite
Axon
Unipolar neuron
Bipolar neuron
Multipolar neuron

- Depending upon Function On the basis of function, the nerve cells are classified into two types:
- 1. Motor neurons or efferent neurons which carry the motor impulses from central nervous system to the peripheral effector organs like muscles, glands, blood vessels, etc.
- 2. Sensory neurons or afferent neurons which carry the sensory impulses from periphery to the central nervous system.

Depending upon Length of Axon

- Depending upon the length of axon, neurons are divided into two types:
- 1. Golgi type I neurons that have long axons. The cell body of these neurons is in central nervous system and their axons reach the remote peripheral organs
- 2. Golgi type II neurons that have short axons. These neurons are present in cerebral cortex and spinal cord.

- Action potential or nerve impulse The action potential in a nerve fiber is similar to that in a muscle, except for some minor differences.. The resting membrane potential in the nerve fiber is –70 mV. The firing level is at –55 mV. Depolarization ends at +35 mV. Usually, the action potential starts in the initial segment of nerve fiber.

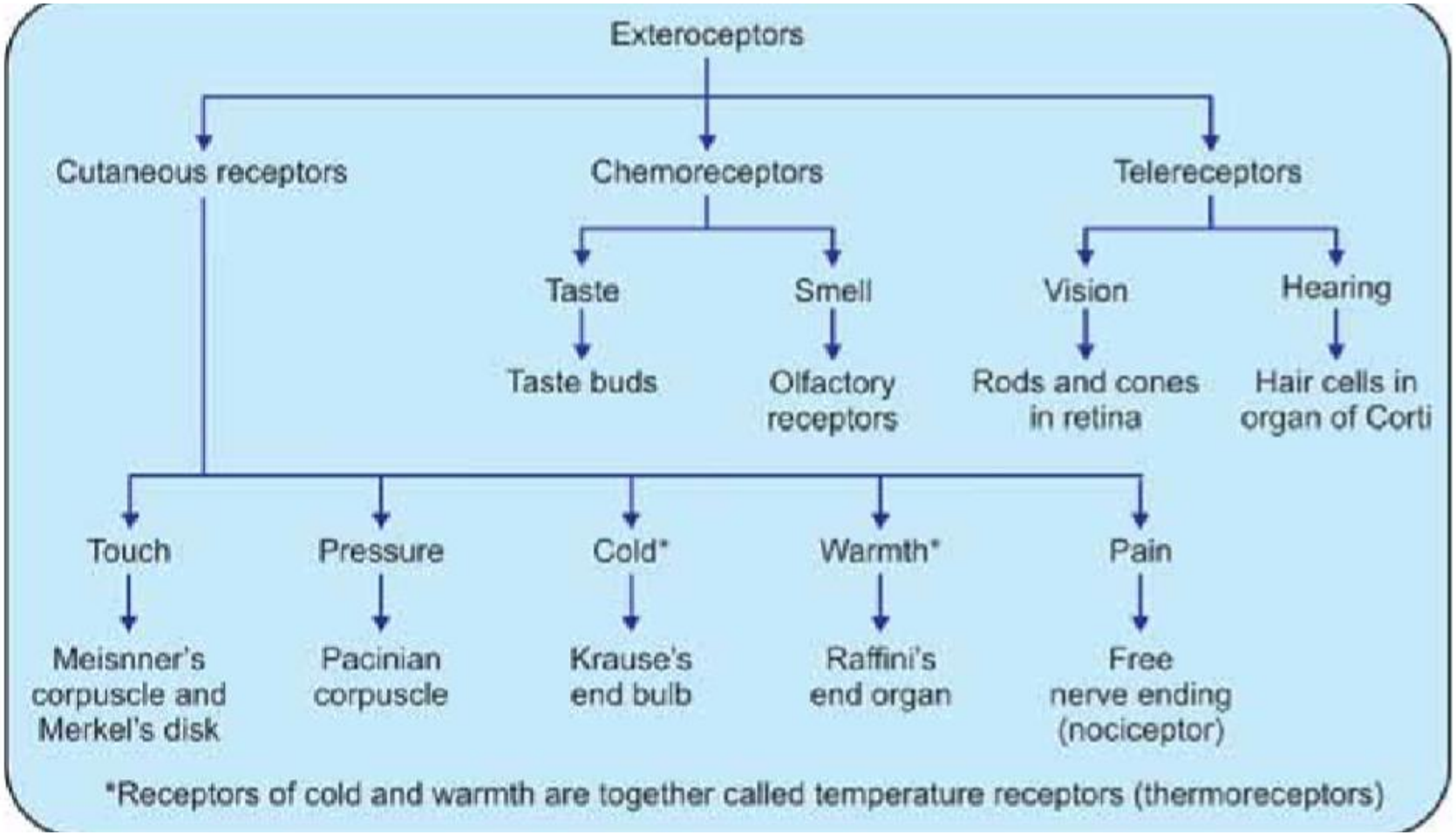
Conductivity

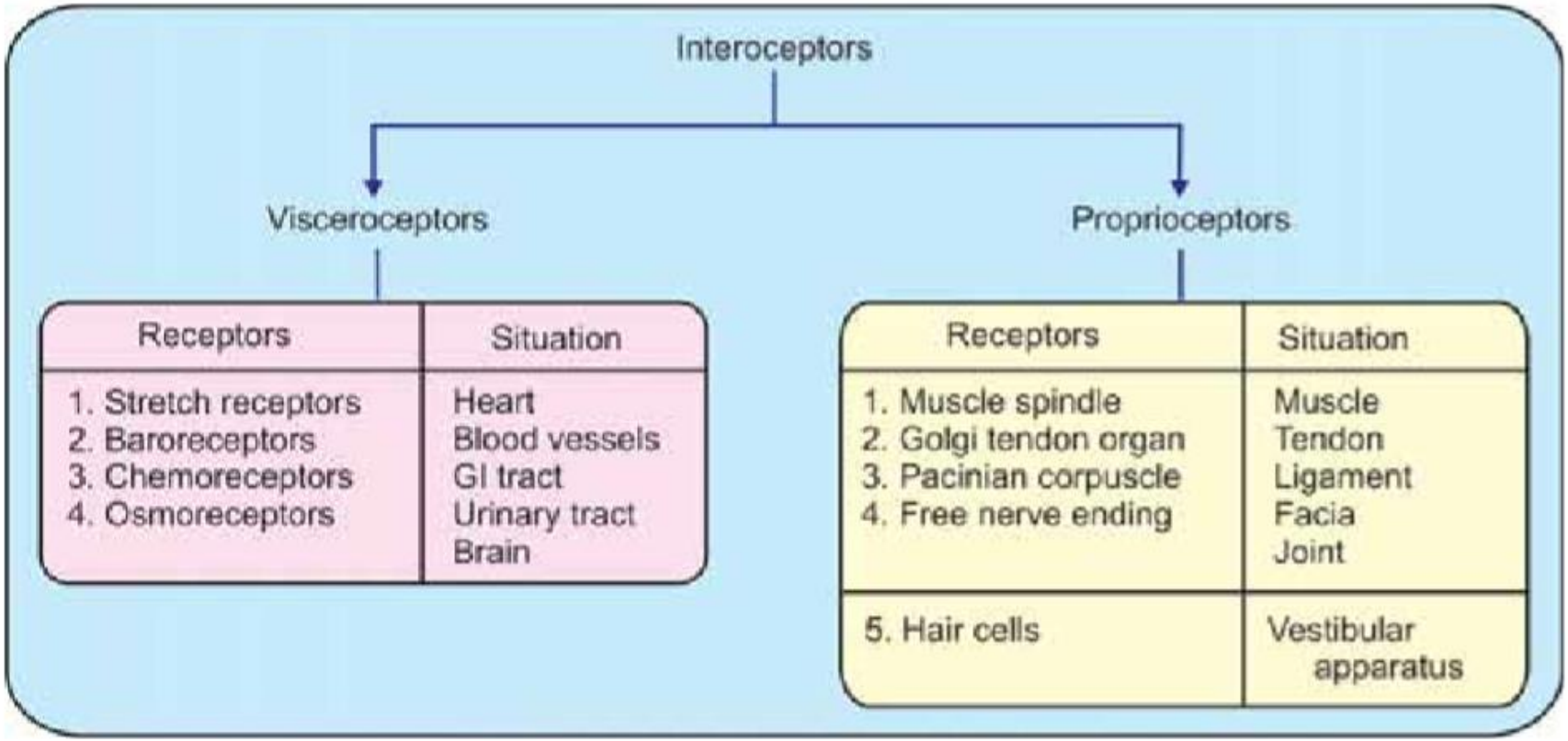
- Conductivity is the ability of nerve fibers to transmit the impulse from the area of stimulation to the other areas. The action potential is transmitted through the nerve fiber as nerve impulse. Normally in the body, the action potential is transmitted through the nerve fiber in only one direction.

- Neuroglia or the glia (glia = glue) is the supporting cell of the nervous system. The neuroglial cells are non-excitable and do not transmit nerve impulse (action potential). So, these cells are also called non-neural cells or glial cells.

Receptors

- Receptors are the sensory (afferent) nerve endings that terminate in the periphery as bare unmyelinated nerve endings or in the form of specialized capsulated structures. When stimulated, receptors produce a series of impulses which are transmitted through the afferent nerves. Actually receptors function like a transducer. Transducer is a device, which converts one form of energy into another. So, the receptors are often defined as the biological transducers which convert various forms of energy (stimuli) in the environment into action potentials in nerve fiber.

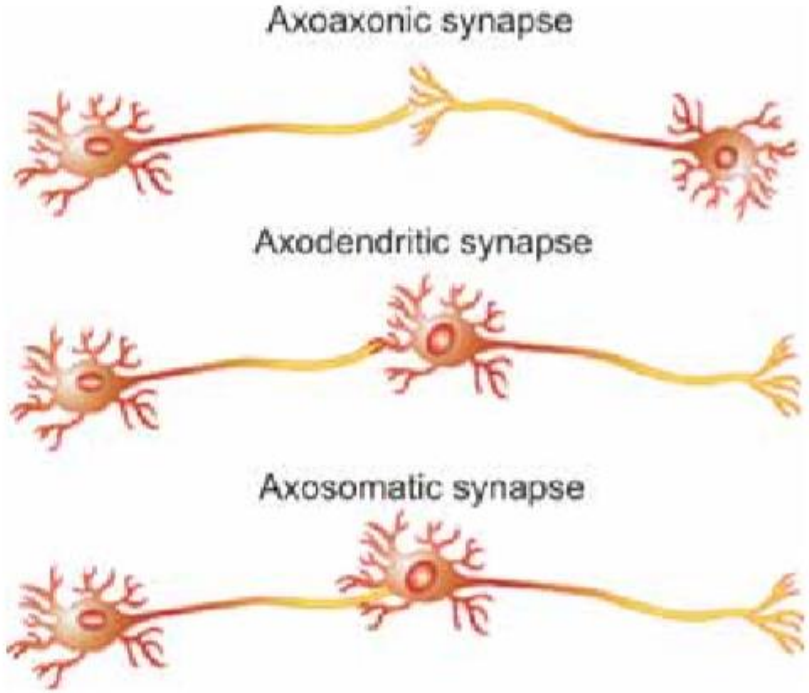

Exteroceptors
Cutaneous receptors
Chemoreceptors
Telereceptors
Taste
Smell
Vision
Hearing
Taste buds
Olfactory receptors
Rods and cones in retina
Hair cells in organ of Corti
Touch
Pressure
Cold*
Warmth*
Pain
Meisnner's corpuscle and Merkel's disk
Pacinian corpuscle
Krause's end bulb
Raffini's end organ
Free nerve ending (nociceptor)
*Receptors of cold and warmth are together called temperature receptors (thermoreceptors)

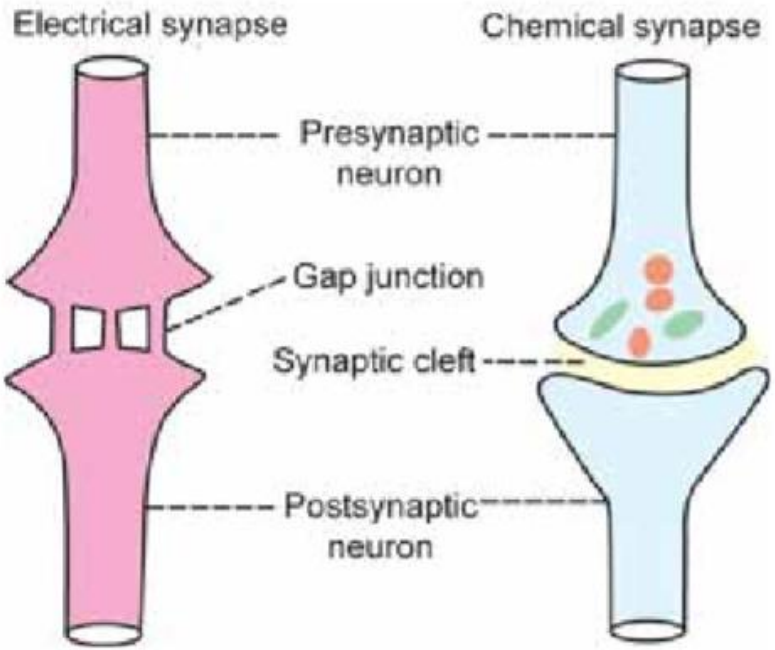

Interoceptors
Viscerоceptors
Proprioceptors
Receptors
Situation
1. Stretch receptors
2. Baroreceptors
3. Chemoreceptors
4. Osmoreceptors
Heart
Blood vessels
GI tract
Urinary tract
Brain
Receptors
Situation
1. Muscle spindle
2. Golgi tendon organ
3. Pacinian corpuscle
4. Free nerve ending
Muscle
Tendon
Ligament
Facia
Joint
5. Hair cells
Vestibular apparatus

Synapse and Neurotransmitt

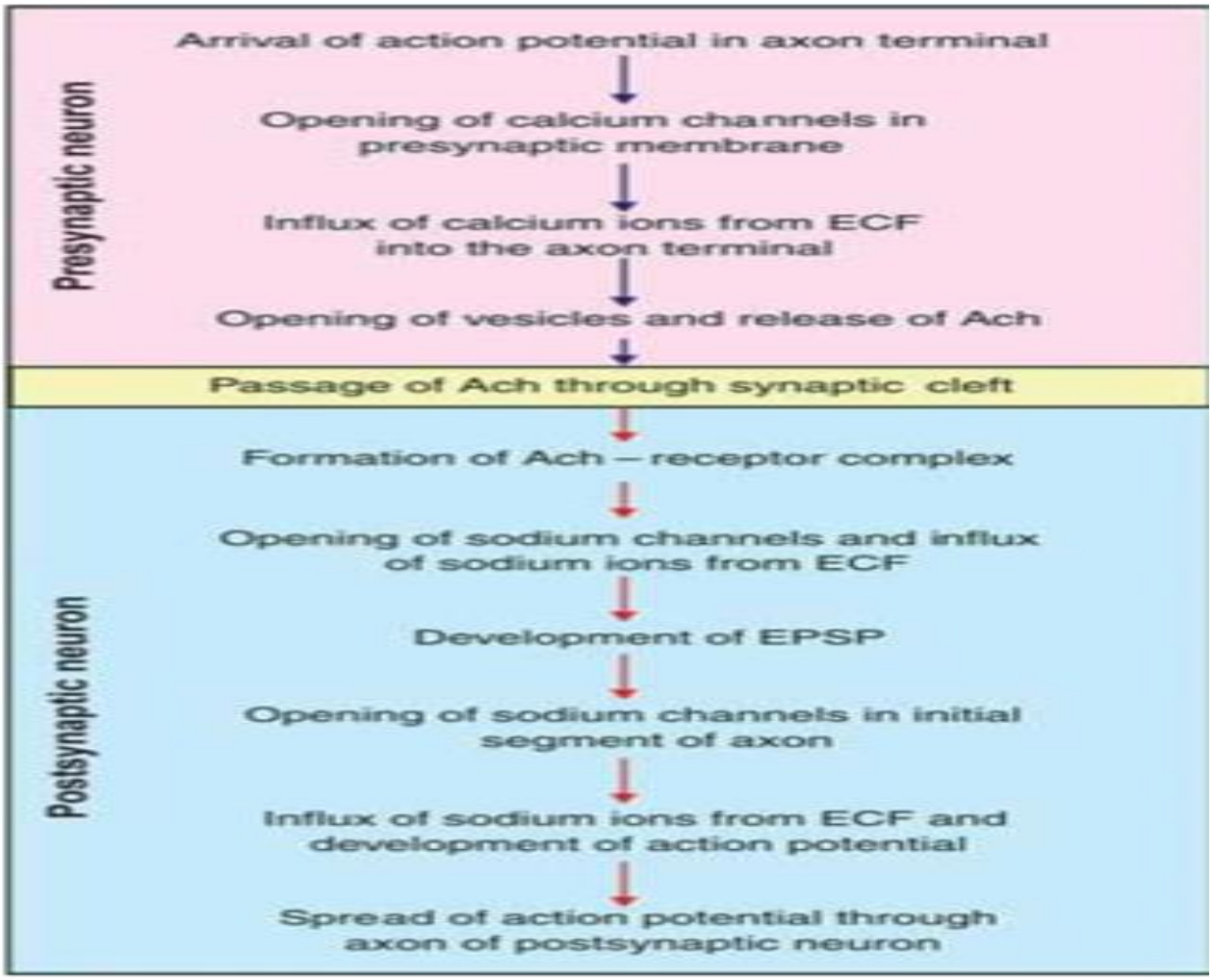
- Synapse is the junction between the two neurons. It is not the anatomical continuation. But, it is only a physiological continuity between two nerve cells.
- CLASSIFICATION OF SYNAPSE
- Synapse is classified by two methods, anatomical classification and functional classification.
- ANATOMICAL CLASSIFICATION Synapse is formed by axon of one neuron ending on the cell body, dendrite or axon of the next neuron. Depending upon the ending of axon, the synapse is classified into three types

- 1. Axoaxonic synapse in which axon of one neuron terminates on axon of another neuron
  2. Axodendritic synapse in which axon of one neuron terminates on dendrite of another neuron
- 3. Axosomatic synapse in which axon of one neuron ends on soma (cell body) of another neuron.


Axoaxonic synapse
Axodendritic synapse
Axosomatic synapse


Electrical synapse
Chemical synapse
Presynaptic neuron
Gap junction
Synaptic cleft
Postsynaptic neuron

Sequence of events during synaptic transmission. Ach = Acetylcholine. ECF = Extracellular fluid. EPSP = Excitatory postsynaptic potential



- FUNCTIONS OF SYNAPSE The function of the synapse is to transmit the impulses from one neuron to another. However, some synapses inhibit the impulses. Accordingly, synapse is divided into two types:
- 1. Excitatory synapses, which transmit the impulses — excitatory function
- 2. Inhibitory synapses, which inhibit the transmission of impulses — inhibitory function.

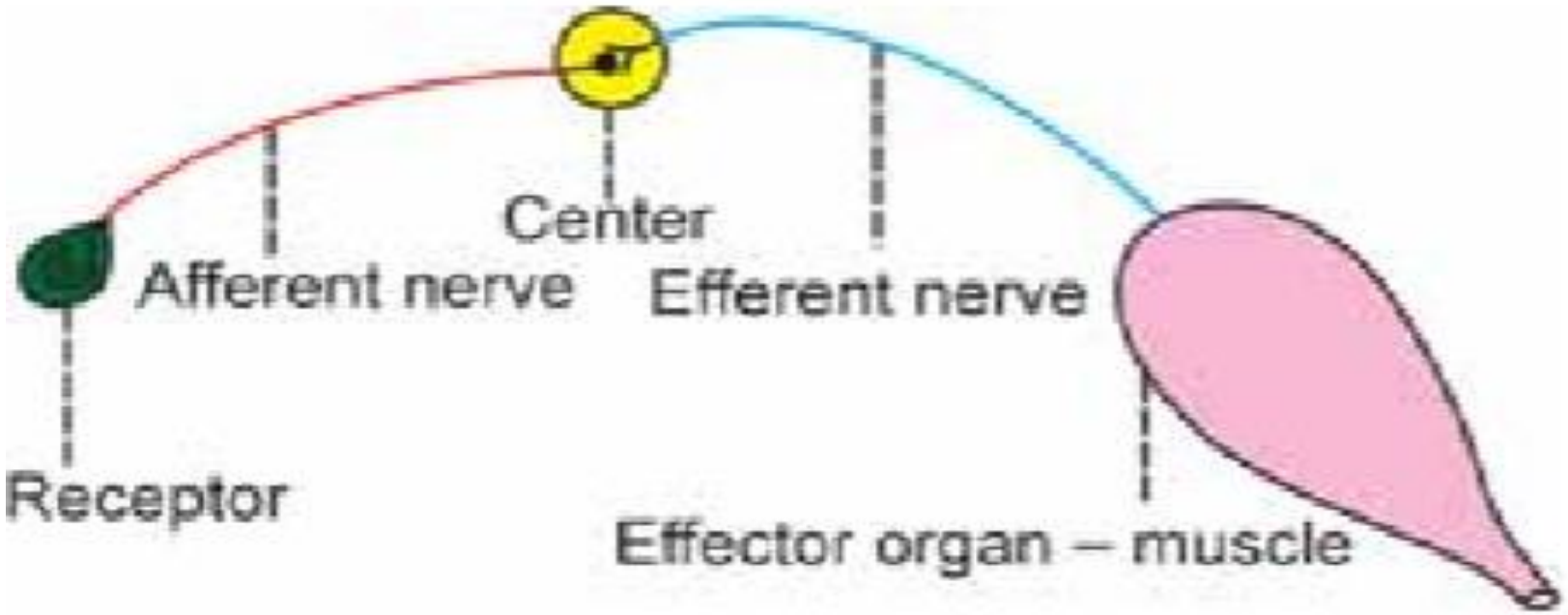
- The autonomic nervous system (ANS) is primarily concerned with the regulation of visceral or vegetative functions of the body. So, it is also called vegetative or involuntary nervous system.

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

- CLASSIFICATION OF NEUROTRANSMITTERS
- Depending Upon Chemical Nature Depending upon chemical nature, neurotransmitters are classified into three groups : 1. Amino acids 2. Amines 3. Others
- Depending Upon Function Depending upon function, neurotransmitters are classified into two types:
- 1. Excitatory neurotransmitters which are responsible for the conduction of impulse
- 2. Inhibitory neurotransmitters which inhibit the conduction of impulse Details of neurotransmitters are given in the

Reflex activity

- is the response to a peripheral nervous stimulation that occurs without our consciousness. It is a type of protective mechanism and it protects the body from irreparable damages. For example, when the hand is placed on a hot object, it is withdrawn immediately. When a very bright light is thrown into the eyes, eyelids are closed and pupil is constricted to prevent the damage of retina by the entrance of excessive light into the eyes.


Center
Afferent nerve
Efferent nerve
Receptor
Effector organ – muscle

- DIVISIONS OF ANS Autonomic nervous system is divided into two divisions:
- 1. Sympathetic division
- 2. Parasympathetic division. The differences between both the divisions of ANS are given in Table below

Actions of sympathetic and parasympathetic divisions of ANS

Effector organ		Sympathetic division	Parasympathetic division
1. Eye	Ciliary muscle	Relaxation	Contraction
	Pupil	Dilatation	Constriction
2. Lacrimal glands		Decrease in secretion	Increase in secretion
3. Salivary secretion		Decrease in secretion and vasoconstriction	Increase in secretion and vasodilatation
4. Gastrointestinal tract	Motility	Inhibition	Acceleration
	Secretion	Decrease	Increase
	Sphincters	Constriction	Relaxation
	Smooth muscles	Relaxation	Contraction
5. Gallbladder		Relaxation	Contraction
6. Urinary bladder	Detrusor muscle	Relaxation	Contraction
	Internal sphincter	Constriction	Relaxation
7. Sweat glands		Increase in secretion	-------
8. Heart rate and force		Increase	Decrease
9. Blood vessels		Constriction of all blood vessels except those in heart and skeletal muscle	Dilatation
10. Bronchioles		Dilatation	Constriction