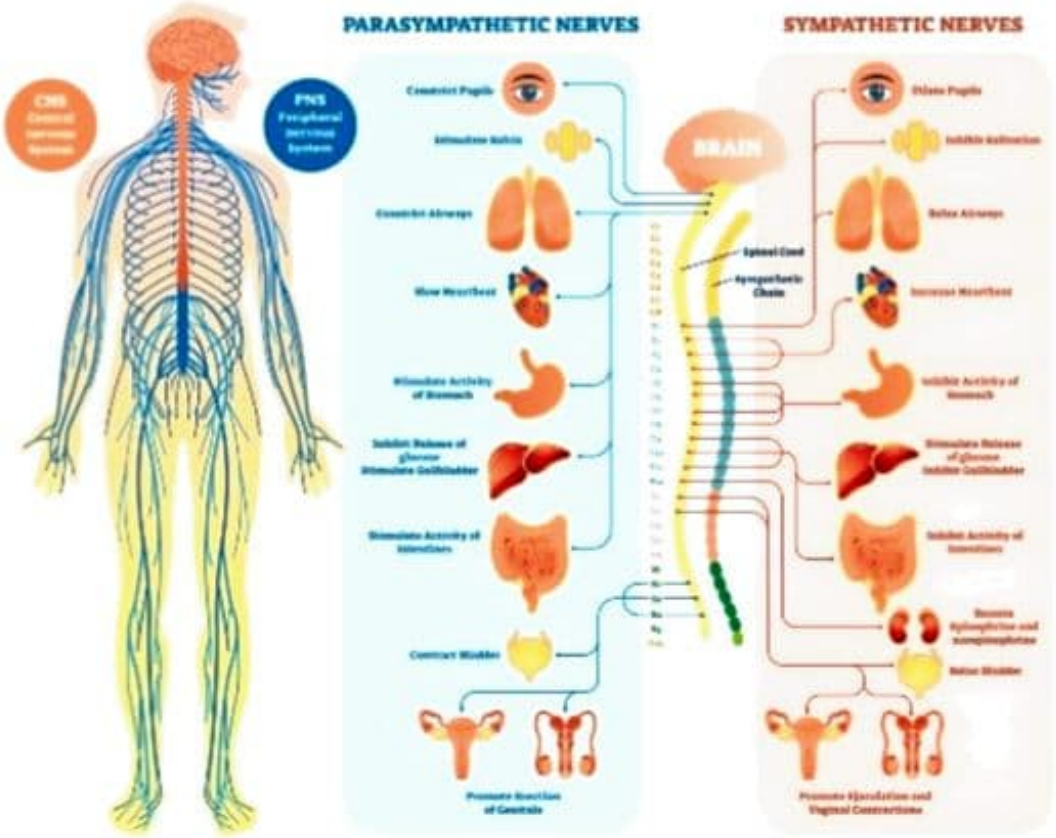
BIOLOGY-

HUMAN NERVOUS SYSTEM



Class -10

NERVOUS SYSTEM OF MAN

The nervous system is the main control system of the body. It brings about co-ordination in activities of other organ systems by transmitting information to them in the form of electrical impulses. This system also controls voluntary and involuntary activities of animals.

BASIC UNIT OF THE NERVOUS SYSTEM : NEURONS

The nervous system is made of specialised cells called neurons which number over a trillion in man. They are the basic structural unit and, adapted to transmit the information rapidly from one cell to another. They are responsible for all functions performed by the nervous system.

Structure of Neurons

Although neurons are peculiar in shape but they possess the same basic structures found in other cells, like nucleus, cytoplasm, mitochondria, Golgi complex, cell membrane etc. Each neuron has four distinct functional parts : soma, dendrites, axon and axon terminals. The soma, also called cyton or cell body is the star-shaped part. It represents the main body of the neuron. It consists of a distinct large nucleus situated centrally in the cytoplasm. The cytoplasm contains characteristic Nissl's granules which are rich in RNA. The dendrites are fibre-like structures that branch out from the cyton. The axon is a long fibre-like structure that extends from the cyton to make contact with other nerve cells. It is mostly covered by a myelin sheath which is composed of several layers of fat. It is interrupted at regular intervals by the Nodes of Ranvier. The initial region of the axon is sensitive region which triggers the discharge of electrical impulses. The axon ends in many axon terminals

which make contact with other neurons at junctions called synapses in order to send impulses to other cells. The neurons which have myelin sheath are called myelinated neurons. In contrast, there are some neurons which lack this sheath and they are called non-myelinated neurons.

The myelin sheath is not a part of the neuron. It is secreted by another kind of cells called Schwan cells which remain attached to the myelin sheath. Besides being protective in function, this sheath also insulates the axon and speeds up the rate of transmission of the electrical impulses.

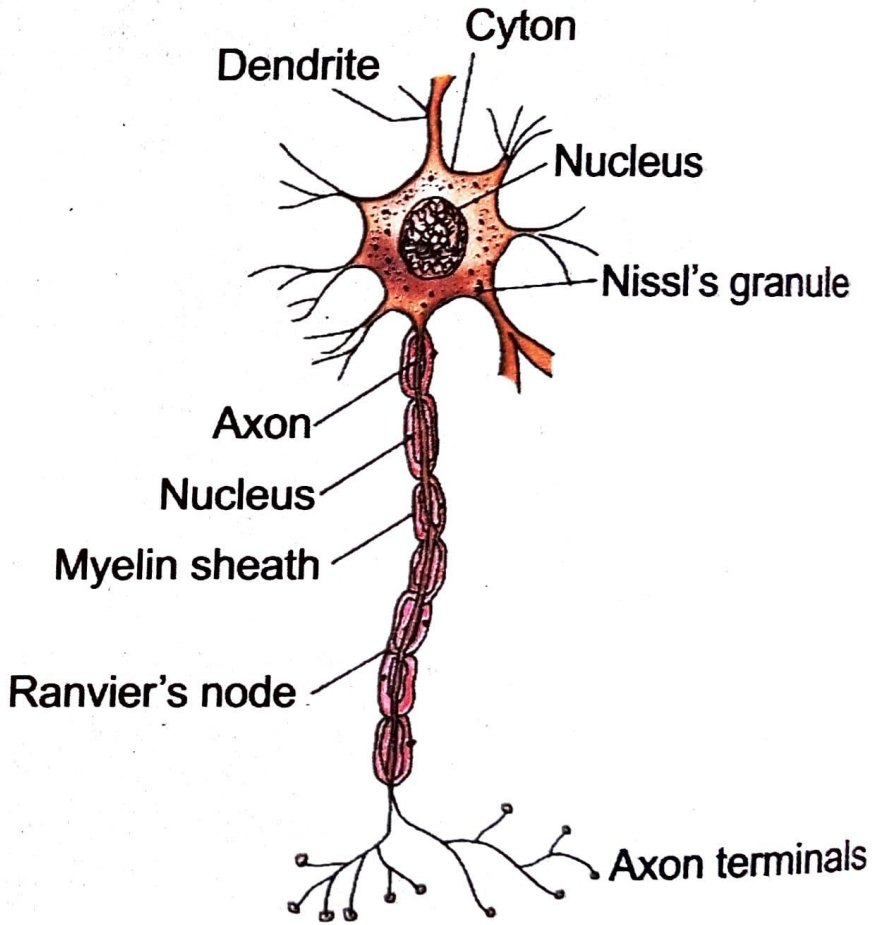


Fig. 1. Structure of a myelinated neuron.

Types of Neuron

1. On the basis of myelin sheath :
   (a) Myelinated Neuron : If the myelin sheath is present then the neuron is myelinated neuron.
   (b) Non-myelinated : In these neurons the myelin sheath is not present.
2. On the basis of function :
   (a) Sensory Neuron : These neurons transmit impulse from sense organ to the central nervous system.
   (b) Motor Neuron : These neurons carry impulse from central nervous system to the effector organs (muscles or glands).
   (c) Association/Intermediate Neuron : These neurons join the sensory neuron to motor neuron and are present only in central nervous system.

NERVE FIBER

Nerve fiber or nerve is a bundle of axons enclosed within a common sheath. Depending upon the type of neurons present in a nerve fiber, it can be classified into three types :

1. Sensory nerves : These are made of only sensory neurons. They conduct the impulse from receptors to brain or spinal cord.
2. Motor nerves : These are made of only motor neurons. They conduct the impulse from brain or spinal cord to the effector organs (muscles or glands).
3. Mixed nerves : These are made of both the types of neurons— sensory as well as motor. They can carry impulses in both the directions *i.e.*, from receptors to CNS, and from CNS to effectors.

NERVE IMPULSE

The message of the CNS transmitted by the axon is called nerve impulse. The transmission of the impulse is an electrical phenomenon and in certain respects, the axon behaves as an electrical wire.

Conduction of Nerve Impulse

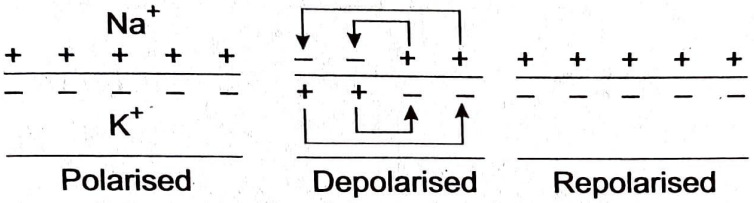
Conduction of nerve impulse along the neuron involves the following steps :

(a) **Polarization :** When there is no conduction of impulse the axon membrane is positively charged on outside due to high Na^+ concentration and negatively charged on the inside (more K^+ inside). This happens due to active Na^+-K^+ pump.

(b) When an impulse of sufficient strength arrives at the neuron the axon membrane becomes negatively charged outside and positively charged inside. The neuron at this point is called as depolarised.

This result in the development of local circuits and impulse is propagated.

(c) After the propagation of impulse the depolarised area undergoes repolarization.



SYNAPSE

A synapse represents the area of contact between the axon of one neuron and the dendrite of another neuron with a microscopic gap in between.

The axon ending represents the presynaptic membrane and the dendron represents postsynaptic membrane, the gap is called synaptic cleft.

The conduction of impulse is brought about by chemical means called neurotransmitter. The most common neurotransmitter is acetylcholine. Release of acetylcholine from presynaptic knob depolarises the post- synaptic membrane and initiates action potential in the postsynaptic neuron.

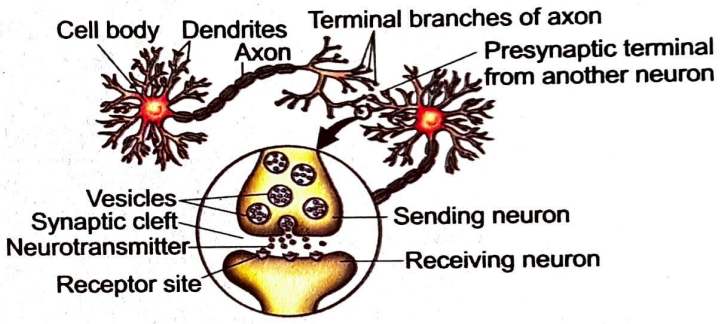


Fig. 2. Transmission of nerve impulse at a synapse.

GANGLIA AND NERVES

The ganglia are clusters of nerve cells, containing only cytons of these cells. These are always found outside central nervous system.

A nerve is a bundle of axons of different neurons. It may be sensory, motor or mixed one.

(a) **Sensory Nerves :** These are made of only sensory neurons. They conduct the impulse from receptors to central nervous system.

(b) **Motor Nerves :** These are made of only motor neurons, therefore, they conduct the impulse from central nervous system to effectors.

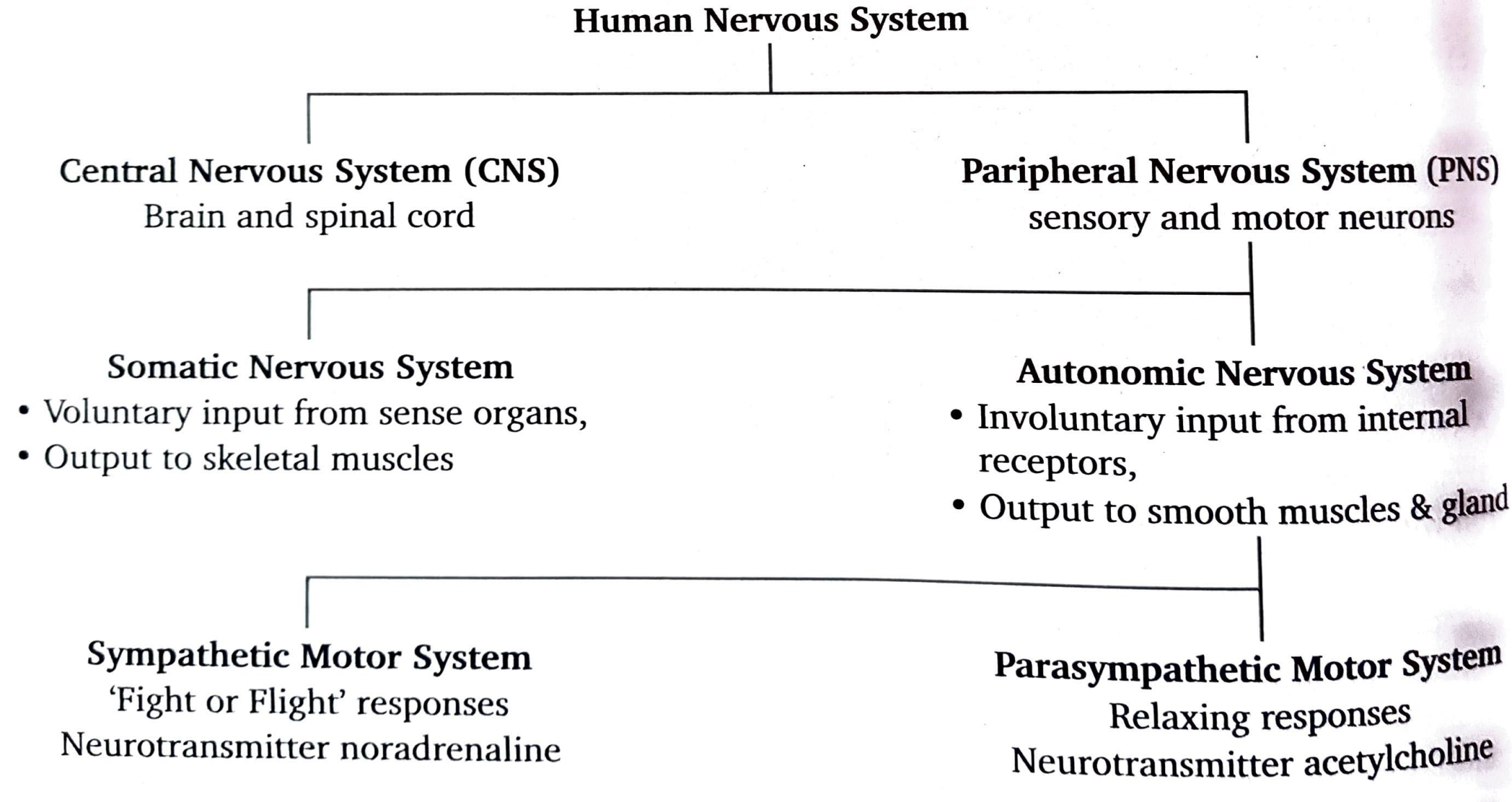
(c) **Mixed Nerves :** These are made of sensory and motor neurons, both.

DIVISIONS OF THE NERVOUS SYSTEM

The nervous system in man, is divided into two main divisions; central nervous system and peripheral nervous system. The central nervous system is present along the axis of the body and it consists of two parts : brain and spinal cord. The peripheral nervous system is composed of cranial and spinal nerves-arising from both the sides of the brain and the spinal cord. There are two components of the peripheral nervous system :

(a) The somatic nervous system, which is concerned with the control and co-ordination of voluntary activities. It receives impulses from the sense organs and sends impulses to effector organs to control the corresponding response.

(b) The involuntary nervous system or autonomic nervous system consists of sympathetic and parasympathetic nervous system which are opposite to one another in function. It controls the activity of internal (visceral) organs.



A Few Important Terms

Stimulus

Any change in external or internal environment of an organism that results in the physiological or behavioural response in an organism or any of its body parts.

Response

Change in the activity of an organism or in its parts caused by a stimulus.

Impulse

A wave of electrical or chemical disturbance that passes over the nerve cell.

Receptors

Nerve cells which receive stimuli from the external or internal environment to generate and pass an impulse to the brain or spinal cord.

Effectors

The organs such as **muscles** and **glands** which receive the message from brain or spinal cord and respond to the stimuli.

FUNCTIONS OF A NEURON

Cell Body

- **Controls metabolism** of a neuron, its axon and dendrites.
- **Provides energy** required for conduction of nerve impulse.
- **Synthesises** the neurotransmitter that passes through the axon and is released at axon terminals.
- **Synthesises proteins** required for the regeneration of neurons. Neurons cannot divide but can regenerate in special conditions.

Dendrites

- **Conduct the nerve impulse** towards the cell body.
- Branch out to **increase receptive surface area** and capacity to receive signals.

Axons

- **Conduct nerve impulse** away from the neuron to the effector organs, muscles or glands.

Axon Terminals

- **Transmit impulses** from one neuron to the other neuron of a muscle or a gland.

NERVES

Nerve is bundle of nerve fibres of separate neurons which are enclosed together in a sheath. The myelin sheath of neurons insulates one nerve fibre from the other to prevent mixing of impulses carried by axons.

Nerves are of three kinds depending upon the type of nerve fibres.

(*a*) Sensory Nerves

- These nerves contain only sensory nerve fibres.
- These carry impulse from the sensory receptors to the brain or spinal cord.
- Examples of sensory nerves are optic nerves arising from the eye and auditory nerve arising from the ear.

(*b*) Motor Nerves

- These contain only motor nerve fibres.

- These carry impulse from the brain or spinal cord to the effector organs.
- Examples of motor nerves are nerves supplying the eye muscles for blinking, rotation, etc.

(c) **Mixed Nerves**

- These nerves contain both sensory and motor nerve fibres.
- Examples of mixed nerves are spinal nerves.

HUMAN NERVOUS SYSTEM

As mentioned earlier, human nervous system is made up of Central Nervous System and Peripheral Nervous System.

The components of these systems are described in Fig. 10.5.

CENTRAL NERVOUS SYSTEM

The central nervous system (CNS) is the site of information processing. It includes **brain** and **spinal cord**. These organs are protected by three connective tissue membranes called **meninges**. These are as follows:

Pia Mater

This is the innermost, thin, highly vascular membrane which provides nourishment to the central nervous system.

Arachnoid

The middle membrane is very delicate and contains fewer blood vessels.

Dura Mater

This is the outermost and toughest fibrous membrane which protects the inner parts.

Name one animal cell organelle which is present in a nerve cell.

State whether the following statements are *true* or *false*. If *false*, correct the statement.

(*a*) A nerve fibre is a bundle of neurons enclosed in a common sheath.

(*b*) Distal ends of axons have synaptic knobs which release neurotransmitters.

Differentiate between a receptor and an effector.

Identify stimulus and response in each of the following cases:

(*a*) Shutting of eyes if suddenly a strong light is flashed.

(*b*) Applying brakes of the vehicle instantly if somebody comes in front.

(*c*) Watering of mouth after seeing food of choice.

What would happen if there are no interneurons in the central nervous system?

Name the following:

(*a*) Neurons which are without dendrites.

(*b*) Neurons which connect neurons carrying stimulus from a receptor and those which transmit information to an effector.

(*c*) The sheath around nerve fibres that helps them to conduct nerve impulse faster.

Differentiate between afferent neurons and efferent neurons.