The Nervous System

Introduction

(i) Living organisms have the ability to respond and react to their surrounding environment.

(ii) Plant responses are regulated by chemical substances called phyto-hormones.

(iii) The organ system in the animal body that helps in coordination and integration of body activities is the nervous system.

(iv) Nervous systems of animals are formed by nervous tissue, which is composed of neuron and neuroglia cells.

Neuron

1. A neuron is a structural and functional unit of nervous system.
2. Neurons are the longest cell in the body.
3. A neuron has three components - cell body, dendrites and axon.
4. A cell body is like a typical cell containing nucleus and granular cytoplasm. Dendrites are short and branched cytoplasmic projections.

5. Axon is a single, elongated fibre. Both axons and dendrites arise from the cell body.
6. There are two types of axons, namely, myelinated and non-myelinated. Axon is covered by myelin sheath. The axolemma and neurolemma are continous sheaths. There is no centrosome in the cylon because the nerve cells have lost the ability to divide.

Some basic terms :

1. Stimulus : An agent or sudden changes of the external or internal environment which results in a change in an organism or any of its body parts.

2. Response : The change in organisms resulting from a stimulus.
3. Impulse : A wave of irritability i.e an electrical disturbance, which sweeps over the nerve cell.

4. Receptors: The nerve cells which set up waves of impulses towards the central nervous system on receiving the stimulus. (3)

5. Effectors: Muscles or glands which contract or secrete substances on receiving an impulse from the brain or the spinal card.

Synapse

1. A synapse is the point of contact between the terminal branches of the axon of a neuron and the dendrites of another neuron.
2. As the nerve impulse reaches the axon terminal of one neuron, the neurotransmitter acetylcholine is released by the bulbs present in the axon.
3. Acetylcholine is then brokendown by an enzyme to ensure that the synapse is ready for the transmission of the next nerve impulse.

Transmission of nerve impulse

- In the resting condition, the outer side of the nerve fibre carries a positive charge, i.e. more Na^+ ions outside the axon membrane. This is called the polarised state or polarisation of the nerve fibre.
- On stimulation, the axon membrane at the site of stimulation becomes more permeable to Na^+ ions. Thus, Na^+ ions move inwards and result in loss of polarisation which is known as depolarised state or depolarisation of the nerve fibre. Such a region of the nerve fibre is known as the excited region.
- The point of depolarisation becomes the stimulus for the next region of axon membrane which in turn become depolarised.
- The previous region on the membrane becomes repolarised due to the active transport of Na^+ ions to the outside of the membrane.

Types of Neurons

1. Sensory neuron: convey the impulse from the receptor (sense organs) to the main nervous system (the brain or spinal cord)

2. Motor neuron: carry impulse from the main nervous system to an effector .i.e muscle or gland.

3. Associated Neurons: They inter connect sensory and motor neurons.

Types of Nerves: A nerve is a bundle of nerve fibres (axons) of separate neurons enclosed in a tubular sheath. Ganglia are an

aggregation of the nerve (cell bodies) from which the nerve fibres may arise or enter.

Types of Nerves

- **Sensory Nerve** (contain sensory fibres)
- **Motor Nerves** (contain motor fibres)
- **Mixed Nerves** (carry sensory as well as motor fibres)

Division of the nervous system

- **Nervous System**
  - Central Nervous system (CNS)
  - Peripheral Nervous system (PNS)

The central Nervous system: The central nervous system includes the brain and spinal cord.

The brain:

1. The human brain is well protected inside the cranium or the skull. In adults, it weighs about- 1.35 Kg.
2. It is protected by three meninges - dura mater, arachoid and pia mater.
3. The space between the covering membranes, central spaces of the brain and the central canal of the spinal cord consists of cerebrospinal

fluid which protects the brain from shocks.

Three primary regions of the brain

1. Forebrain:
   - The cerebrum is the centre of intelligence, memory, consciousness, will power and voluntary actions.
   - The thalamus relays pain and pressure impulses to the cerebrum.
   - The hypothalamus controls the body temperature and the activity of the pituitary gland.
2. Midbrain: This small tube like part is responsible for refleres involving the eyes and ears.
3. Hindbrain
   - The cerebellum coordinates muscular activity and balance of the body.
   - The pons carry impulses from one hemisphere to the other hemisphere and coordinate muscular movements on both sides of the body.
   - The medulla oblongata controls the activities of internal organs, heartbeat, breathing etc.

cerebrum	• The largest portion of the brain. • It is divided into two cerebral hemis-pheres connected to each other by the corpus callosum. • The corten contains cell bodies of the neuron and is greyish in colour, hence it is called grey matter. • The grey matter has many folds (i.e gyri) and grooves (i.e sulci).

	The medulla consists of the axons of the nerve fibres and is called white matter. (70)
Cerebellum	Located at the base of the cerebrum In a median section, its white matter appear like a branching trees.
Medulla oblongata	Located at the base of the skull. It is roughly triangular. It continues behind the rain as the spinal cord. Injury to the medulla oblongata results in death

The spinal cord

1. It lies within the neural canal of the vertebrae.
2. The grey matter is on the ..... side and the white matter is on the outer side of the spinal cord.
3. Similar to the brain, it is covered with three meninges - dura mater, arachnoid and pia mater.
4. functions:

(i) Responsible for the reflexes below the neck.

(ii) Conducts sensory impulses from the skin and muscles to the brain.

(iii) Conducts motor responses from the brain to muscles of the trunk and limbs.

Peripheral nervous system - The peripheral nervous system consists of nerves which carry impulses to and from the central nervous system

Sympathetic Nervous System	Parasympathetic Nervous System
• Nerves arise from the spinal cord between the neck and waist regions.	• Located anteriorly in the head and neck while posteriorly in the sacral region.

- Sympathetic and parasympathetic systems have functions which are opposite to each other.

Opposite effects of the two Systems.

Organ	Sympathetic System	Parasympathetic System
Heart	Accelerates heart beat	Retards heat beat
Intestines	Peristalsis decreased	Peristalsis increased
Lacrimal (Tear) Gland	Stimulates secretion	Inhibits secretion
Pupil of eyes	Dilation	Constriction.

Reflexes: The reflex action is an automatic, quick and involuntary action in the body brought about by a stimulus.

Differences between reflexes: Involuntary actions and voluntary actions.

Reflexes (Involuntary Actions)	Voluntary Actions.
• Initiated by some stimulus such as touch, pain, pressure, heat, light etc • Command originate in the spinal cord, autonomic nervous system and a few in the brain as well.	• Initiated by a willing thought. • Commands originate in the brain.

Types of Reflexes.

Natural (Inborn) Reflex	Conditioned (Acquired) Reflex
• Previous experience or learning is not required.	Develops during lifetime due to experiences.

Similar in all humans	Differs from individual to individual as it depends on experience and learning.
Salivation, peristalsis, swallowing	Salivation just by the smell of food.

Pavlov's Experiment.

Nervous pathways in reflexes - A reflex action must be quick to give response. Therefore, the pathway for receiving and sending information must be short. A reflex arc can be represented as follows:-

Stimulus → receptor in the sense organs → afferent (sensory) nerve fibre → CNS (spinal cord / brain) → efferent (motor) nerve fibre → muscle / gland → Response.