CHAPTER 14
CONTROL AND COORDINATION IN LIVING BEINGS

NOTES

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- **CONTROL:** It is the power of restraining and regulation by which something can be started, slowed down or stopped.
- **CO-ORDINATION:** The harmonious working of various organs of the body of an organism to produce an appropriate response to a stimulus is called coordination.
- **CONTROL AND COORDINATION:** They are the functions of the hormones and nervous system in our bodies.
- **IRRITABILITY/SENSITIVITY:** It is one of the characteristic features of living organism to respond to a stimulus.
- **STIMULUS:** The changes in the environment or an agent (like pain, heat or cold, touch, etc.) which can initiate a respond is known as stimulus.
- **RECEPTORS:** They are structures (or molecules) specialized for receiving stimuli from the environment and usually located on sense organs. They are specialized tips of nerve cells that detect information from environment.
- **OLFACTORY RECEPTORS:** They can detect smell while **Gustatory receptors** can detect. taste.

COORDINATION IN ANIMALS

1. **Nervous system/co-ordination**
2. **Hormonal/Endocrine system/co-ordination**

DIFFERENCES	
NERVOUS SYSTEM	**HORMONAL/ENDOCRINE SYSTEM**
1. The information is carried in the form of electrical impulse.	**1.** The information is carried in the form of chemical messenger.
2. The axons and dendrites pass on the information through a coordinated effort.	**2.** The information is disseminated through blood.
3. The flow of information is rapid and the response is quick and fast.	**3.** The information moves slowly and the response is also slow.
4. Its effects are short lived.	**4.** It has prolonged effects.
5. It is made up of neurons specialized for conducting information from one part to other parts of body.	**5.** It is made up of endocrine glands specialized for stimulating a target organ to produce a specific function.
6. The information flows as: **stimuli → receptors → sensory neuron → CNS → motor neuron → effector organ → response**	**6.** The information flows as : **endocrine gland → hormones → blood → target (**cell, tissue, or organ) **→ response**
7. Example – If we touch a hot object, we reflexively pull back our hands and our nerves simultaneously send pain signals to our brain.	**7.** Example – Pancreas secretes insulin when the blood glucose increases while it secretes glucagons when the blood glucose falls.

- Human nervous system includes **Nerve cells or Neurons** and **supporting cells.**

NEURON

Neuron is a specialized cell in the transmission of nerve impulses, a building block and structural & functional unit of the nervous system and an elongated cell having three components namely **cell body, dendrite and axon.**

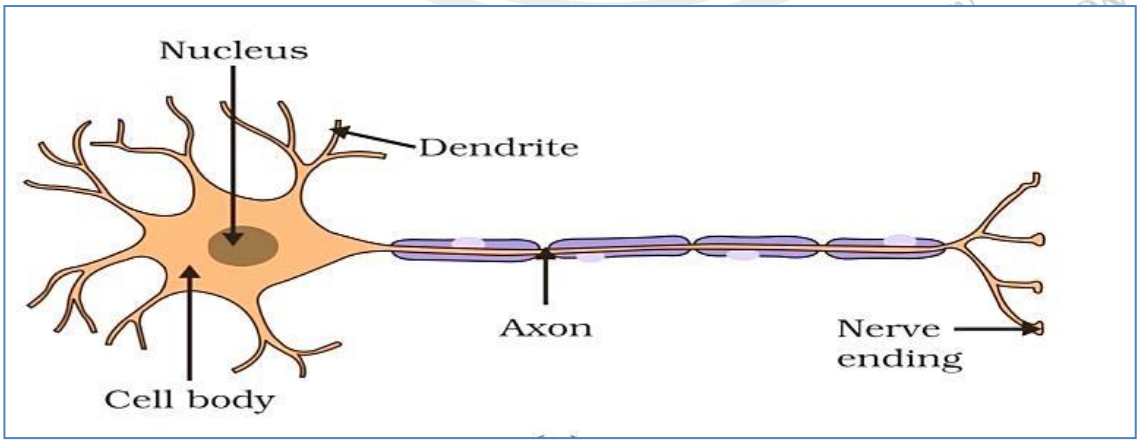

Fig. Structure of a Neuron

FUNCTIONS OF THE THREE PARTS OF A NEURON

- **Cell body –** It contains nucleus, mitochondria and other cell organelles. It is mainly concerned with the maintenance and growth.
- **Dendrite –** It receives information from axon of another cell and conducts the messages towards the cell body.
- **Axon –** It conducts messages away from the cell body.

A DIAGRAMATIC REPRESENTATION OF THE THREE PARTS OF A NEURON

NEURON

DENDRITE	**CELL BODY/AXON**	**SYNAPSE**
↓	↓	↓
(Information is acquired)	(Information moves as an electrical impulse)	(Part where electrical signal is converted into chemical message for onward transmission to next neuron by release of neurotransmitter)

- **Neurotransmitter** is a chemical that relays signals across the synapses between neurons. It travels across the synaptic space between the terminal button of one neuron and dendrites of other neuron using a lock and key type of system.
- **Synapses** provide a remarkable function as they allow each axon to communicate with many dendrites in neighbouring cells. It is a communication link among the neurons in the nervous system.
- **Scwann cell -** They are a variety of glial cells that keep the peripheral nerve fibres (both myelinated and unmyelinated) alive. In myelinated axons, Scwann cells form the myeline sheath.
- **Node of Ranvier -** They are the gaps between the myelin insulation of Scwann cells which insulate the axon of neuron. They help to electrically insulate the neuron.
- **Myelin sheath –** It is a layer of fatty tissue surrounding the axon of a neuron that both acts as insulator and allows faster transmission of the electrical signal.
- **Cell body (soma)** is usually compact, the neuron's core and contains the nucleus and specialized organelles of the cell and keeps the cell alive. It carries genetic information, maintains neuron's structure, and provides energy tp drive activities. The axon and dendrites are filaments that extrude from it.
- **Axon** is a thread-like, an elongated and a segmented fibre which transmits information away from the cell body towards other neurons or to the muscles and glands.
- **Dendrites (Dendrons)** are spikes and tree like extending out from cell body and looks like a spider web. Dendrite means branches of the tree.
- **Function of Dendrites –** The primary surfaces of dendrites receive chemical signals or neurotransmitters from the neuron and transfer to other neuron. Dendrite collects information from other cells and sends the information to the cell body (soma). It used to send and receive signals from one neuron to the other.

NERVOUS SYTEM

- The responses of the nervous system can be classified as reflex action, voluntary action or involuntary action.

Functions of Nervous System

- To receive the information from environment
- To receive the information from various body parts (Stimulus-Response)
- To act accordingly through muscles and glands

Types of Nervous System

- The two types of nervous system are: **Central Nervous System (CNS) and Peripheral Nervous System (PNS).**

Central Nervous System (CNS)

- **The CNS** is the collection of neurons that make up the **Brain** and **Spinal Cord.**
- **Brain :** It is protected and enclosed by a bony box called **cranium,** the space between cranium and brain is filled with a fluid that acts as a shock absorber & cushion and prevents brain from mechanical injury**.**
- **Human Brain** is a highly complex organ, mainly composed of the nervous tissues which are highly folded to accommodate a larger surface area in a less space.
- **Spinal cord** arises as an extension from medulla oblongata through the enclosed **vertebral column.**

Peripheral Nervous System (PNS)

- **The PNS** is the collection of neurons that link the CNS to our skin, muscles and glands.
- It includes **cranial nerves** and **spinal nerves** arising from brain and spinal cord respectively**.**
- It facilitates the communication between **CNS** and various organs of the body.

Transmission of nerve impulse inside our body

- The information received at the end of the dendritic tip of a nerve cell sets off a **chemical reaction** that create an electric impulse. This impulse passes from the **dendrite** to the **cell body** from where it moves along the axon to the nerve endings and to the next neuron through a synapse.
- The conduction of information/message occurs via electric impulses.
- The nervous system gets information from our sense organs and acts through our muscles.

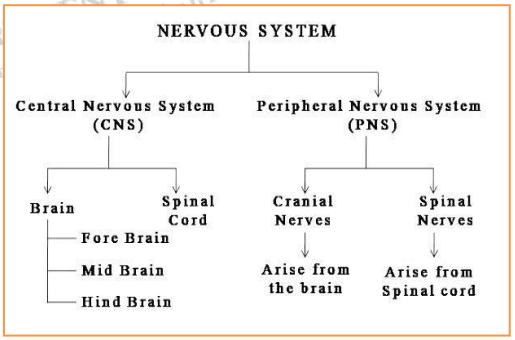

Fig. Types of Nervous System

- **Synapse** is the functional junction or gap between two adjacent neurons.
- **At the synapse** when a nerve impulse reaches nerve endings, it sets off the release of chemicals (called neurotransmitters) that cross the synapse and start a similar electrical impulse in the next neuron.

COMPARISON BETWEEN CNS AND PNS

DIFFERENCES	
Central Nervous System	**Peripheral Nervous System**
➢ It includes **Brain** and **Spinal cord.**	➢ It includes **Cranial** and **Spinal nerves.**
➢ It controls **voluntary/involuntary** responses or **reflex action.**	➢ It facilitates the communication between **CNS** with sense organs and effectors.

SUMMARY OF PARTS AND FUNCTIONS OF BRAIN

HUMAN BRAIN

FORE- BRAIN (Cerebrum, hypothalamus, olfactory lobes, diencephalon)	**MID-BRAIN** (Tectum and Tegmentum)	**HIND-BRAIN** (Cerebellum, pons and medulla oblongata)
It is the main thinking part of the brain and controls all voluntary actions like movement of voluntary muscles. It is responsible for thinking, perceiving and evaluating sensory information. It has separate areas specialized for smell, hearing, sight, eating, sleeping, reasoning, judgment, problem solving, learning, emotions **(Cerebrum),** controlling body temperature/ **homeostasis**(hypothalmus), reproductive functions, and so on.	It controls reflex movement. It connects fore-brain and hind-brain. The change in eye pupil size, and shape of eye lens, movements of eyes, auditory and visual processing. It is associated with motor functions and auditory and visual responses. Hypothalamus – chemical coordination Pituitary Gland – secretes hormones	It controls involuntary activities like *heartbeat, blood pressure, salivation, vomiting (medulla oblongata), breathing rate (pons),* hearing, taste, balance (pons), motor activity, sleep, wakefulness, digestion, etc. It also controls *body posture, maintaining balance and equilibrium* **(Cerebellum),** movement coordination (Cerebellum), conduction of sensory information.

- **Cerebrum (Forebrain)** is the most complex and specialized part of the brain controlling for smell, hearing, sight, eating, taste, touch, sleeping, reasoning, judgment, problem solving, learning, emotions, etc.
- **Cerebellum (Hindbrain)** is responsible for maintaining body posture, maintaining balance and equilibrium, movement coordination, etc.
- **Reflex Action:** An involuntary sudden (spontaneous), rapid, automatic action in response to a stimulus controlled by spinal cord is called the **reflex action**. It doesn't involve any thinking. The sudden removal of our hand while touching a hot object without thinking about it is a classic example.
- **Reflex Arc** is the nervous pathway involved in a reflex action, including its simplest a sensory nerve and a motor nerve with a synapse between. It is a special type of neural circuit that begins with a sensory neuron at a receptor (e.g. a pain receptor in the fingertip) and ends with a motor neuron at an effector (e.g. a skeletal muscle). The pathway taken by a stimulus to travel from receptor organs to effector organ is known as Reflex arc.
- They are formed in the spinal cord and information (input) reaches the brain. The brain is only aware of the signal and the response that has taken place. However, brain has no role to play in creation of the response.
- It can be represented as

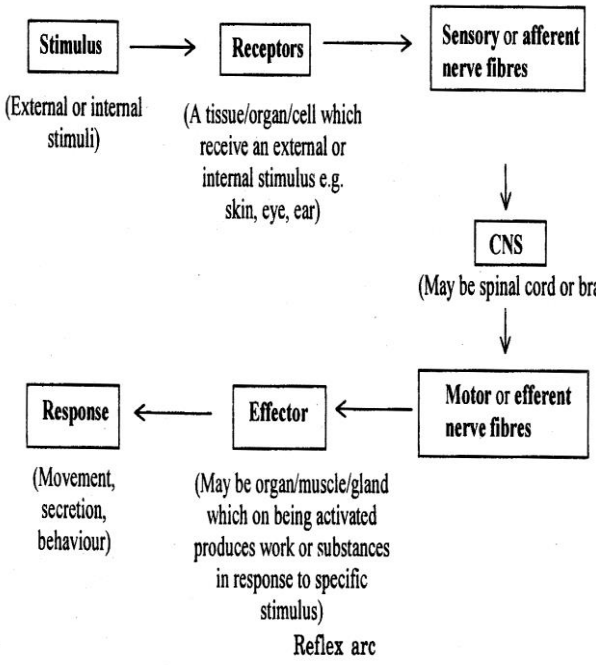

Fig : Reflex Arc

TYPES OF REFLEX ACTION

- **Inborn Reflex:** These are reflexes inherited at the time of birth like swallowing, blinking of eyes etc.
- **Conditioned Reflex:** These are the acquired reflexes during the lifetime of an individual through training, learning, experience etc. They are not transmitted by heredity, depend on previous experience, not constant, may disappear or reappear again and depend on previous experience.

- **Ian Pavlov** used to ring a bell when food was placed in order to associate salivation with **sound of bell rather than food.** The dog gradually learnt and salivated at the sound of the bell even though no food was placed. This is known as conditioned reflex.

CHEMICAL COORDINATION IN ANIMALS

Hormones are the chemical messengers secreted by endocrine gland (or ductless glands) and release their secretions directly into the blood.

SUMMARY OF ANIMAL HORMONES WITH THEIR FUNCTIONS AND DISORDERS

ENDOCRINE GLAND	HORMONE	FUNCTIONS
Pituitary Gland	Growth hormone	Control overall growth and development of the body. Over secretion causes gigantism **(giant);** under secretion causes dwarfism **(dwarf).**
Thyroid Gland	Thyroxine	Control carbohydrates, proteins and fat balance for growth. Deficiency of iodine in our diet causes **goitre** characterized by enlargement of thyroid gland in neck region.
Pancreas	Insulin	Regulate normal blood glucose level; deficiency of insulin causes high blood glucose level leading to **Diabetes** mellitus.
Adrenal Gland	Adrenaline	Prepares the animal body to cope with situations imposed during emergency.
Gonads	Testosterone (male) Oestrogen (female)	Responsible for changes occurring during puberty.

- **Pancreas** is both an endocrine and exocrine organ. It is due to it releases certain enzymes to aid in digestion delivered to the gut via the pancreatic duct. Moreover, pancreas also releases hormones like insulin and glucagon, which are hormones predominantly related to glucose metabolism, into the blood stream.

COORDINATION IN PLANTS

- Unlike animal, plant has chemical or hormonal coordination. **Rapid** and **Slow** movement are examples of coordination in plants. The rapid movement in the leaves of sensitive plant is without involving any growth
- The movement in the leaves of sensitive plant occurs without involving any growth whereas tropic movement involves growth. **Plant hormones** are organic substances which are synthesized in minute quantities in one part of the plant body and transported to another part where they influence specific physiological processes. **Tropic movement**s are also known as directional movement because the direction of response depends on the direction of stimulus; may be **positive** along the direction of stimulus or **negative** away from the stimulus.
- The movement of growing organs induced by stimulus of light, gravity, water, touch and chemical are called **Tropism.**
- Plant shoots grow upwards as they are negatively geotropic while Plant roots grow downwards as they are positively geotropic.
- Plant shoots responds bending towards light whereas Plant roots respond bending away from light in case of Phototropic Movement.

Role of auxin in Tropism

- **The downward transportation of auxins** synthesized at the shoot meristem more rapidly towards the shaded side of the stem stimulate elongation of cells more faster on the dark portion than the side away from light due to higher auxin concentration. In this way bending of stem, coiling of tendril, movement of pollen tube towards ovule can be seen as coordination brought by hormones.

FUNCTIONS OF PLANT HORMONES

PLANT HORMONES	FUNCTIONS
Plant growth promoters **Auxin**	**Stimulate elongation of cells;** responsible for apical dominance (also involve in phototropism)
Gibberelins	Stem growth by inducing elongation of internodes
Cytokinin	Stimulate **cell division** & **enlargement of cells,** promote seed germination
Plant growth inhibitors **Ethylene** ***(Gas hormone)***	Prevent longitudinal elongation of root & shoot, hasten post-harvest **maturation or ripening of fruits.**
Abscisic acid	**Induce dormancy** of bud and seed, besides control geotropism

- **Apical Dominance** is the phenomenon in which intact apical bud suppresses the growth of lateral bud, auxin the chemical responsible for it**.**

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