

CONTROL AND COORDINATION

Concepts Covered

Basic concepts of control and coordination in animals

Introduction

All living organisms respond and react to changes in the environment around them.

The changes in the environment to which the organisms respond and react are called stimuli such as light, heat, cold, sound, smell, touch, etc.

All the activities in animals are controlled and coordinated by the nervous and endocrine systems.

Plant do not have a nervous system. They possess only chemical control and coordination.

Animals - Nervous System

Receptors

- Receptors are the specialized tips of the nerve fibers that collect the information to be conducted by the nerves.
- Receptors are in the sense organs of the animals.

These are classified as follows:

- Phono-receptors: These are present in the inner ear. Functions: The main functions are hearing and balance of the body.
- (2) Photo-receptors: These are present in the eye. Function: These are responsible for visual stimulus.
- (3) Thermo-receptors: These are present in the skin. Functions: These receptors are responsible for pain, touch, and heat stimuli.

These receptors are also known as thermoreceptors.

- (4) Olfactory receptors: These are present in the nose. Functions: These receptors receive smell.
- (5) Gustatory receptors: These are present in the tongue. Functions: These help in taste detection.

During high fever the function of the enzymes in our taste buds stops since they can work effectively only at normal temperature range of the body. At high temperature they stop sending signals to the nerve center in brain.

The nervous system is composed of specialized tissues, called nervous tissue. The nerve cell or neuron is the functional unit of the nervous system. It is the nervous system that is mainly responsible for control and coordination in complex animals.

Functions of the nervous system:

- (1) Nervous system receives information from the environment.
- (2) To receive the information from the various body.
- (3) To act according to through muscles and glands.

Neuron:

A neuron is the structural and functional unit of the nervous system. It is a highly specialized cell that is responsible for the transmission of nerve impulses.





Structure of Neuron

(1) Dendrites: These are branch-like structures that receive messages from other neurons and allow the transmission of messages to the cell body.

(2) Cell Body: Each neuron has a cell body with a nucleus, Golgi body, endoplasmic reticulum, mitochondria, and other components.

(3) Axon: This is the tail of the neuron. It ends in several hair-like structures, called axon terminals. The axon terminals relay nerve impulses.

(4) Myelin sheath: There is an insulator cover around the axon. This is called the myelin sheath. The myelin sheath insulates the axon against nerve impulses from the surroundings.

(5) Synapse: The microscopic physical gap between the terminal branches of the axon of one neuron with the dendrite of another neuron is called synapse.



Types of Neurons

(1) Sensory neuron: These neurons receive signals from a sense organ.

(2) Motor neuron: These neurons send signals to a muscle or a gland.

(3) Association or relay neuron: These neurons relay the signals between the sensory neuron and motor neuron.

There are more nerve cells in the human brain than there are stars in the Milky Way. If we lined up all the neurons in our body it would be around 965 km long.

Conduction and Transmission of Nerve Impulse

Nerve impulses travel in the following manner from neuron to the next.

Dendrites \rightarrow cell body \rightarrow axon \rightarrow nerve endings at the tip of axon \rightarrow synapse \rightarrow dendrite of next neuron

- The information from receptors is acquired at the end of the dendritic tip of a nerve cell as chemical reaction that creates an electrical impulse.
- This impulse travels from the dendrite to the cell body and then at the end of the axon.
- Chemicals are released at the end of the axon by the effect of electrical impulse.
- These chemicals cross the gap (synapse) and start a similar electrical impulse in a dendrite of the next neuron.
- Axon of motor junction lunction Muscle fiber Capillary Axon of notor junction lunction luncti
- The similar synapse finally allows delivery of such impulses from neurons to other cells, such as muscle cells or glands.

Neuromuscular Junction

Neuromuscular Junction is the point where a muscle fiber comes in contact with a motor neuron carrying nerve impulses from the control nervous system.



Reflex Action

Reflex action is a sudden, involuntary reaction of the body in response to stimuli. Reflex action includes all the actions that are not under the control of our will. That means these actions are involuntary. E.g., sneezing, coughing, blinking, etc.

Reflex arc refers to the pathways taken by nerve impulses in a reflex action. It involves receptors, neurons, spinal cord and effector cells (muscles).

Response

Lifting of

hand

- When our hand touches a hot object, the heat is sensed by thermoreceptors present in skin of hand.
- The receptors trigger nerve impulse in sensory neuron. It transmits message to spinal cord, which is then passed to relay neuron which in turn passes it to motor neuron.
- The motor neuron transmit instruction to muscle in our arm. The arm muscle contract and pulls our hand away from object.
- Reflexes which involve spinal cord are termed as spinal reflex.
- Those reflexes which involve brain are called as cerebral reflexes.



Effector

Muscle of arm

Motor

neurons

• E.g. Contraction of pupil of human eye in the presence of bright light.



Check Your Concept - 1

- (i) (A) Draw the structure of neuron and label cell body and axon.(B) Name the part of neuron:
 - Where information is acquired
 - Through which information travels as an electrical impulse.
- (ii) What is reflex action? Explain.
- (iii) What is the function of receptors in nervous system?
- (iv) State one difference between dendrites and axon.

Nervous System

The vertebrate nervous system consists of two parts:

- (1) Central Nervous System
- (2) Peripheral Nervous System

Central Nervous System:

The central nervous system consists of two parts:

- (1) Brain
- (2) Spinal cord

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Human Brain

Human brain

Hypothalamus

Pituitary

Pons

Medulla

Hindbrain

Forebrain

Cerebrum Cranium (skull)

Cerebellum

Midbrain

Spinal cord

- The human brain is a highly complex organ, which is mainly composed of nervous tissue.
- The tissues are highly folded to accommodate a large surface area in less space.
- The human brain can be divided into three regions, viz. forebrain, midbrain and hindbrain.



The brain is protected by 3 main layers:

- (1) The bony skull (cranium)
- (2) The cerebrospinal fluid
- (3) The meninges (Dura mater, Arachnoid and Pia mater)

(1) Forebrain: It is made up of cerebrum, hypothalamus and many other parts.

(A) Cerebrum: The cerebrum is the largest part in the human brains. It is divided into two hemispheres called cerebral hemispheres.

Functions of cerebrum:

- The cerebrum controls voluntary motor actions.
- It is the site of sensory perceptions, like tactile and auditory perceptions.
- It is the seat of learning and memory.

(B) Hypothalamus:

- Hypothalamus receives the taste and smell impulses, coordinates message from the autonomous nervous system, controls the heart rate, blood pressure, body temperature and peristalsis.
- It also forms an axis with the pituitary which is the main link between the nervous and the endocrine systems.
- It also has centers that control emotions, hunger, thirst, fatigue, sleep, body temperature and sweating.
- It secretes neurohormones which regulate the secretion of anterior lobe of pituitary.

(2) Mid Brain:

- It is a small portion of the brain that serves as a relay center for sensory information from the eyes and ears to the cerebrum.
- It also controls the reflex movements of the ears and eyes muscles.
- It provides a passage for the different neurons going in and coming out of the cerebrum.
- It is associated with motor control, vision, hearing, temperature regulation, alertness.
- Controls reflex movements of the neck, head and trunk in response to visual and auditory stimuli.
- Also controls the reflex movements of the eye muscles, changes in pupil size and shape of the eye lens.

(3) Hind Brain: It consists of the cerebellum, pons varoli and medulla oblongata.

(A) Cerebellum: The cerebellum is responsible for maintaining equilibrium, transfer of information, fine adjustments to motor actions, coordinating eye movements etc. Coordination and body balance, posture during walking, riding, standing, swimming, running, are all maintained by the cerebellum.

(B) Pons varoli:

- It is a part of the brain stem. It is present below the midbrain and above medulla.
- It helps in conducting signals from the brain to medulla and cerebellum and carry the sensory signals to the thalamus.
- Pons helps in relaying information between the cerebellum and forebrain.

(C) Medulla oblongata

- The medulla (or medulla oblongata) is the posterior part of the brain, which continues to the spinal cord. It is a long stem-like structure and constitutes the brain stem along with midbrain and pons.
- The medulla plays an important role in regulating various life processes such as respiration, blood pressure, heartbeat, gastric secretions, etc. It also contains the center for reflex actions such as vomiting, coughing, swallowing, etc.



The spinal cord is a cylindrical structure located in the spinal canal of the vertebral column. It begins as a continuation of the medulla oblongata and ends at about the second lumbar vertebra.

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Spinal Cord

The cord is well protected within this bony canal. Protection is also provided by the meninges and the cerebrospinal fluid. The spinal cord is a series of 31 sections called segments, each segment giving rise to a pair of spinal nerves. Each pair of spinal nerves is connected to a segment of the spinal cord by two points of attachment called roots.

Functions of the spinal cord:

(1) It conveys sensory nerve impulses from the periphery to the brain and conducts motor impulses from the brain to the periphery.

(2) It serves as a reflex center.

Peripheral Nervous System

The nerves given out by the brain and the spinal cord form the peripheral nervous system (PNS).

Somatic nervous system:

The nerves of PNS that control the voluntary actions of the body form the somatic nervous system.

Somatic nervous system consists of two sets of nerves:

(1) Cranial nerves: Nerves arising from brain are called cranial nerves. 12 pairs of cranial nerves are found in humans.(2) Spinal Nerves: Nerves arising from the spinal cord are called spinal nerves. In human 31 pairs of spinal nerves are found.

The cranial nerves can have sensory functions, motor functions, or both. For example:

- The olfactory nerve has sensory function. It transmits information on smell to the brain.
- The oculomotor nerve has motor function. It controls the movements of your eyes.
- The facial nerve has both sensory and motor function. It transmits taste sensations from your tongue and also controls movement of some of the muscles in your face.

Autonomic nervous system

Nerves of the PNS that control the involuntary actions in the body constitute autonomic nervous system. Two divisions of the autonomic nervous system are:

- (1) Sympathetic nervous system
- (2) Parasympathetic nervous system

The sympathetic nervous system prepares the body for intense

physical activity and is often referred to as the fight-orflight response. The parasympathetic nervous system has almost the exact opposite effect and relaxes the body and inhibits or slows many high-energy functions.

Muscular Movements and Nervous Control

- Muscle tissues have special filaments, called actin and myosin.
- When a muscle receives a nerve signal, a series of events is triggered in the muscle.
- Calcium ions enter the muscle cells. It results in actin and myosin filaments sliding towards each other and that is how a muscle contract.
- Contraction in a muscle brings movement in the related organ.

Check Your Concept - 2

- (i) (a) How is brain protected from injury and shock?
- (b) Name the main parts of hind brain and state the functions of each.
- (ii) (a) Name the two main constituents of the central nervous system in human beings.
- (b) What is the need for a system of control and coordination in human beings?
- (iii) (a) Name the two main constituents of the central nervous system in human beings.
- (b) What is the need for a system of control and coordination in human beings?
- (iv) Name the largest part of the brain. State its functions.









(1) State the function of: (i) Gustatory receptors (ii) Olfactory receptors (i) Gustatory receptors - these are sensitive to taste Answer: (ii) Olfactory receptors - these are sensitive to smell Which part of the brain controls involuntary actions? Write the function of any two regions of (2) it. Answer: The hind brain controls the involuntary actions of our body. It consists of three parts, the Pons, the Medulla oblongata and the Cerebellum. The two functions include are to maintain equilibrium and pumping of blood of heart are one of the many functions. What is the function of receptors in our body? Think of situation where receptors do not work (3) properly. What problems are likely to arise? Answer: Receptors are present in our all parts of the body for example in skin, eve, nose tongue etc. They detect the signals and then send them to brain in the form of electrical signals. If these receptors are damaged then it they will not detect the input which leads to the harm for our body in dangerous situation. (a) Name the two main constituents of the central nervous system in human beings. (4) (b) What is the need for a system of control and coordination in human beings? Answer: (a) The two main constituents of the central nervous system in human beings are the brain and the spinal cord.

(b) A living being does not live in isolation. It has to constantly interact with its external environment and has to respond properly for its survival. For e.g. when a hungry lion spots a deer, the lion has to quickly make a move so that it can have its food. On the other hand, the deer needs to quickly make a move to run for its life. The responses which a living being makes in relation to external stimuli are controlled and coordinated by a system; especially in complex animals. So, control and coordination. is essential in maintaining a state of stability and a steady state between the internal conditions of an organism and the external environment.

(5) Define reflex action with suitable examples.

Answer: When we suddenly withdraw our hands on pricking a pin, it is a reflex action. This type of sudden response to a stimulus is involuntary. A reflex action is defined as an unconscious and involuntary response of effectors to a stimulus. In reflex actions, a message from the receptors is relayed by sensory nerves to the spinal cord, which sends information for response via motor nerves to effectors. The pathway is called reflex arc. The simplest type of reflex action is knee-jerk reflex. In this case, while sitting with freely hanging legs, a strike below the knee cap kicks the leg forward. Other reflex actions are coughing, sneezing, yawning and blinking of eyes.





(1)	Which of the following cannot be considered a receptor (A) Ear (C) Muscle	or? (B) Nose (D) Eye
(2)	Cerebellum, medulla and pons are the parts of: (A) Mid-brain (C) Forebrain	(B) Hind-brain (D) Spinal cord
(3)	Which of the following is not an involuntary action? (A) Vomiting (C) Heartbeat	(B) Chewing (D) Salivation
(4)	The junction between two adjacent neurons is called: (A) Nerve junction (C) Synapse	(B) Sensory junction (D) Neuro-muscular joint
(5)	The spinal cord originates from: (A) Cerebrum (C) Medulla	(B) Cerebellum (D) Pons
(6)	Electrical impulse travels in a neuron from: (A) Dendrite \rightarrow axon \rightarrow axon end \rightarrow cell body (B) Cell body \rightarrow dendrite \rightarrow axon \rightarrow axon end (C) Dendrite \rightarrow cell body \rightarrow axon \rightarrow axon end (D) Axon end \rightarrow axon \rightarrow cell body \rightarrow dendrite	
(7)	Which of the following statements are true? (i) Sudden action in response to something in the env (ii) Sensory neurons carry electrical signals from spina (iii) Motor neurons carry signals from receptors to spin (iv) The pathway of transmitting signals from a receptor (A) (i) and (ii) (C) (i) and (iv)	ironment is called reflex action al cord to muscles in a reflex action nal cord in a reflex action or to a muscle is a reflex action (B) (i) and (iii) (D) (i), (ii) and (iii)
(8)	Flow of impulse if from (A) Dendrite to axon in the same neuron (C) Nodes of ranvier to axon	(B) Axon to dendrite (D) None
(9)	Which of the following controls the involuntary actions(A) Medulla in forebrain(C) Medulla in spinal cord	in the body? (B) Medulla in hindbrain (D) Medulla in midbrain
(10)	You duck your head when a baseball is thrown toward (A) An internal stimulus (C) Hormones	d your face. You are responding to (B) Pigments (D) An external stimulus

Answer Key

OBJECTIVE TYPE QUESTIONS

(1)	(C)	(6)	(C)
(2)	(B)	(7)	(C)
(3)	(B)	(8)	(A)
(4)	(B)	(9)	(B)
(5)	(C)	(10)	(D)

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