Chapter 7: Control And Coordination

Coordination In Humans

Nervous System

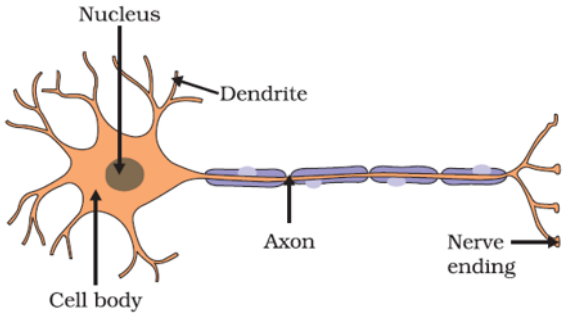
- In animals, including humans, the **nervous system**, in conjunction with muscle tissue, serves as the body's control centre.
- It is made up of highly specialised cells known as **neurons, nerves**, and neural organs that connect, coordinate, and govern the actions of the body's many organs.
- The environment's information is detected by **receptors** found in sense organs such as the inner ear, nose, and tongue.
- **Gustatory receptors** are responsible for taste detection, while **olfactory receptors** are responsible for scent detection.

Neuron Or Nerve Cell :

- The environment's information is detected by nerve cells called neurons. They are the nervous system's structural and functional units.
- A neuron is the human body's longest cell (the length of some nerve cells may be 90-100 cm). The nervous system is composed of an intricate network of nerve cells, or neurons.
- These are specialised for transmitting information from one region of the body to another through electrical impulses.

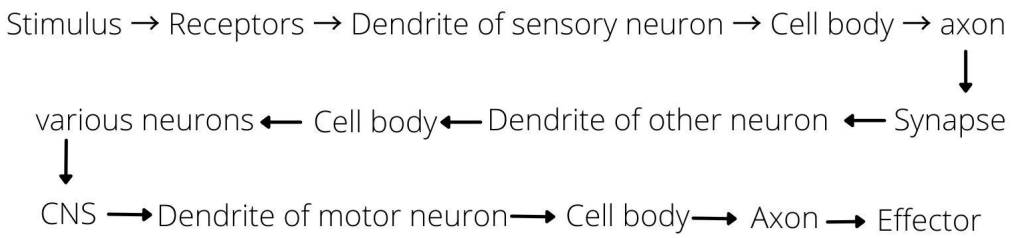
Structure Of Neuron Or Nerve Cell : The neuron is made up of the following major components:

- **Cell Body Or Cyton** : The cell body or Cyton is the wide, rounded portion of the neuron. It has a central nucleus, a large amount of cytoplasm, and a variety of cell organelles with the exception of **centrioles.**
- **Dendrites :** These are the protoplasmic, branching processes that extend from the cell body and are responsible for receiving and transmitting stimuli.
- **Axon :** These are lengthy cytoplasmic processes resembling fibres. They are responsible for conducting impulses away from the cell body. A protective coating termed myelin sheath may surround the **axon.**
- **Nerve Terminations :** These are the neurons' fine branch-like terminations.



Transmission Of A Nerve Impulse

- The transmission of a nerve impulse through the body follows a typical flow pattern. The receptors (sense organs) distributed throughout the body detect and transmit information from the environment to sensory neurons.
- The information collected at the dendritic tip of a neuron initiates a chemical process that results in the generation of an electrical impulse.
- This impulse passes from the sensory neuron's dendrite to its cell body (cyton), and then along the sensory neuron's axon to its terminus. The electrical impulse induces the release of certain molecules called neurotransmitters at the axon's end.
- These substances pass over the gap (synapse) and initiate a comparable electrical impulse in the dendrite of the neighbouring neuron.
- A similar synaptic connection enables the transmission of such impulses from neurons to other cells, such as muscle or gland cells.
- The following diagram illustrates the course taken by a nerve impulse in the body:



Neuromuscular Junction :

- The interface between a muscle fibre and a motor neuron that transmits nerve impulses from the Central Nervous System (CNS).
- The neurotransmitter responsible for transmitting nerve impulses from neuron to muscle fibre works similarly to how impulses are passed across a synapse between two neurons.

Reflex Action

- A reflex action is a fast reaction that occurs automatically in response to a stimulus, such as coughing, sneezing, or blinking of the eyelids.
- It safeguards the body from injury and does not need conscious thinking. Reflex action transmits the message directly to the motor neuron through a relay neuron.
- Reflex activities are monitored and regulated by the nervous system's spinal cord, not by the brain. This is because the brain may take longer to teach muscles to move.
- Reflex activities primarily involve the spinal cord. Here, nerves from various parts of the body create a bundle.
- As a result, the process of detecting signals or inputs and responding to them through an output action is expedited.

Reflex Arc

The reflex arc is the route travelled by nerve impulses during a reflex action. Although the information input also reaches the brain, the reflex arc is produced in the spinal cord. The reflex arc entails the following:

- Sensing organs that detect stimuli.
- Sensory (afferent) neurons transmit stimuli to the spinal cord.
- The spinal cord evaluates the input and instructs motor neurons appropriately.
- The motor (efferent) neuron transmits commands to the effectors.
- The effect is carried out by effectors or muscles through neuromuscular movements.

Animals lack reflex arcs because the brain's thinking process is insufficiently rapid. Thus, reflex arcs are extremely likely to have developed as efficient modes of operation in the absence of actual mental processes (performed by the brain).

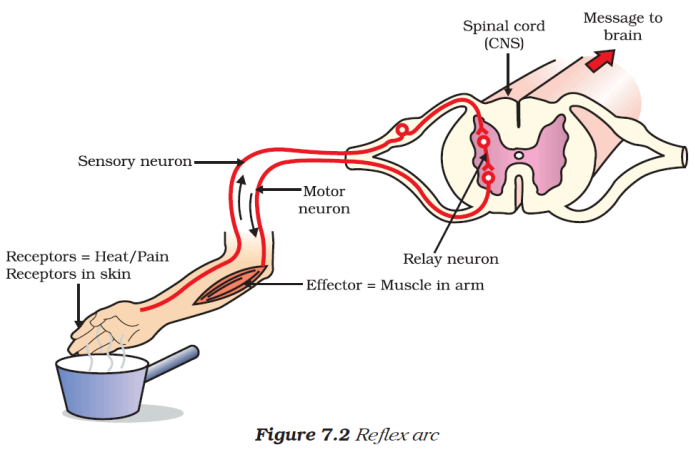
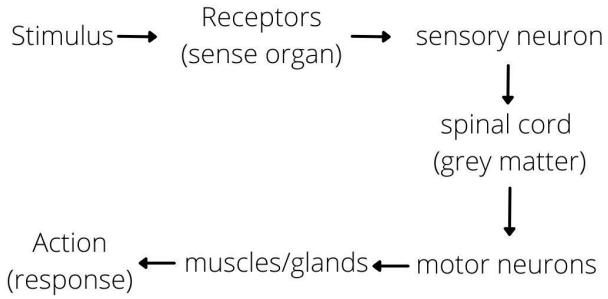


Figure 7.2 *Reflex arc*

The following flow chart illustrates the reflex arc:



Importance Of Reflex Action

Reflex action is important for the following reasons:

- It permits an organism to respond rapidly to a potentially damaging input.
- It alleviates cerebral overload.
- It boosts an organism's chances of survival.

Divisions Of Nervous System

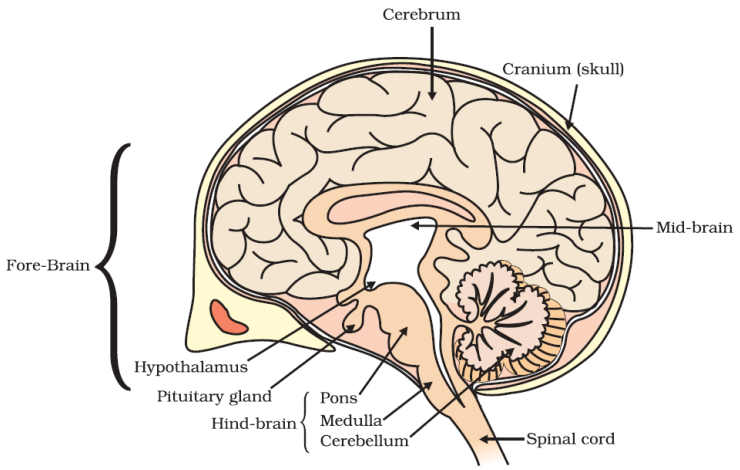
The nervous system's components are classified as follows:

- **Central Nervous System (CNS)** : the brain and spinal cord are included in this system. It receives and integrates information from all regions of the body.
- **Peripheral Nervous System (PNS)** : The peripheral nervous system facilitates communication between the central nervous system and the rest of the body. It is made up of cranial nerves that originate in the brain and spinal nerves that originate in the spinal cord.

Central Nervous System (Cns)

Human Brain

- The human brain is the body's primary coordination centre, enabling an organism to think and make choices. The brain's reasoning requires increasingly sophisticated systems and neuronal connections.
- The human brain takes data from the sensory organs, processes it, and transmits commands to the muscles or other effectors.



The human brain is divided into three major areas or portions, which are as follows:

Forebrain : It is the brain's biggest and most important thinking region. It is stimulated by sensory impulses from a variety of receptors.

It consists of the following:

- **Cerebrum :** The cerebrum is the brain's primary thinking region. It is in charge of thinking, speech, intellect, vision, hearing, and information utilisation. There are distinct regions of association in the cerebrum where sensory input is processed by integrating information from different receptors as well as Information Previously Stored In The Brain. These Areas Are As Follows:
    - **Sensory Areas :** These areas receive sensory impulses from a variety of receptors located on the skin, muscles, eyes, ears, and nose.
    - **Association Areas :** Relate sensory input to prior experiences and information from other receptors in order to interpret it.
    - **Motor Areas :** Communicate with muscles and glands through impulses. Additionally, control voluntary muscular action (leg muscles).
- **Olfactory Lobes** : This is a pair of very tiny, solid, dub-shaped structures that are far spaced. These are responsible for recognising scents emanating from various receptors.
- **Hypothalamus :** This region regulates the body's temperature, appetite, and thirst.

Midbrain : It links the forebrain and hindbrain. It directs the head, neck, and trunk in order to identify the auditory and visual responses involved in

focusing on the items. Additionally, it regulates the reflex movements of the eye muscles and the size of the pupil.

Hindbrain : It connects the spinal cord to the remainder of the brain. It is divided into three sections as follows:

- **Cerebellum** : It is responsible for controlling and coordinating various muscle activities. It is responsible for the accuracy with which voluntary acts are performed. It supports the body's posture and balance during numerous activities such as walking, drinking, catching, and riding.
- **Pons :** It is located above the medulla and is responsible for breathing. It serves as a conduit for signals between various sections of the brain.
- **Medulla Oblongata :** This structure runs parallel to the spinal cord. It is responsible for the regulation of involuntary behaviours such as respiration and blood pressure (BP), as well as reflex reactions such as salivation and vomiting.

Functions Of The Human Brain

The human brain's primary functions include the following:

- It organises the body's operations so that the body's mechanisms and hormonal responses function in harmony.
- It gets information through nerve impulses from all of the body's sensory organs.
- It correlates the stimuli from numerous sense organs and generates the appropriate reaction.
- It reacts to sensory organ impulses by delivering its own commands to the muscles and glands, causing them to operate appropriately.
- It retains knowledge so that the human being's behaviour may be adjusted in response to new experiences.

Spinal Cord : It is a long tubular bundle of nerve tissue that originates in the medulla oblongata. It is largely responsible for transmitting neurological impulses between the brain and the rest of the body.

Protection Of Human Brain And Spinal Cord

- The brain is an extremely sensitive organ that is required for a range of functions. The body is constructed in such a manner that the brain is contained inside a bony box, which is further cushioned by a fluid-filled balloon.
- At the centre of the back, a hard, bumpy structure called the vertebral column or backbone protects the spinal cord.

Mechanism Of Nervous Tissue Action

The flow diagram below illustrates the mechanism of action of nerve tissue:

- Nervous tissue collects data from various bodily areas and transmits it to the brain.
- The brain analyses data and makes judgments based on that data.
- This choice is sent to the muscle tissue.
- Muscles include unique proteins that respond to nerve signals by altering their structure and arrangement inside the cell.
- As a result of the altered protein structure, the muscle cells take on a shortened shape and travel in the direction dictated by the mind.

Peripheral Nervous System (Pns)

It is made up of nerves that enter and exit the Central Nervous System (CNS) directly and link various regions of the body. It is composed of the following nerve kinds, which contain sensory and motor neurons.

- **Cranial Nerves** : These are the nerves that originate in the brain and go throughout the skull.
- **Spinal Nerves :** These are the nerves that originate from the spinal cord and run the length of it before spreading throughout the body (except the head).
- **Visceral nerves :** These are a subset of nerves that originate primarily from the spinal cord and link to the body's internal organs.

Coordination In Plants

Plants, unlike mammals, lack a neural system and muscular structure. They do, however, exhibit movement and responsiveness. They communicate information between cells chemically. Plants' motions may be roughly categorised into two categories:

Immediate Response To Stimulus

It is not a growing process. Rather than that, the plant responds to contact by moving its leaves. Sensitive plants respond immediately to stimuli.

Movement of a plant component happens at a site other than the point of contact. The plane transmits the signal that a touch has happened.