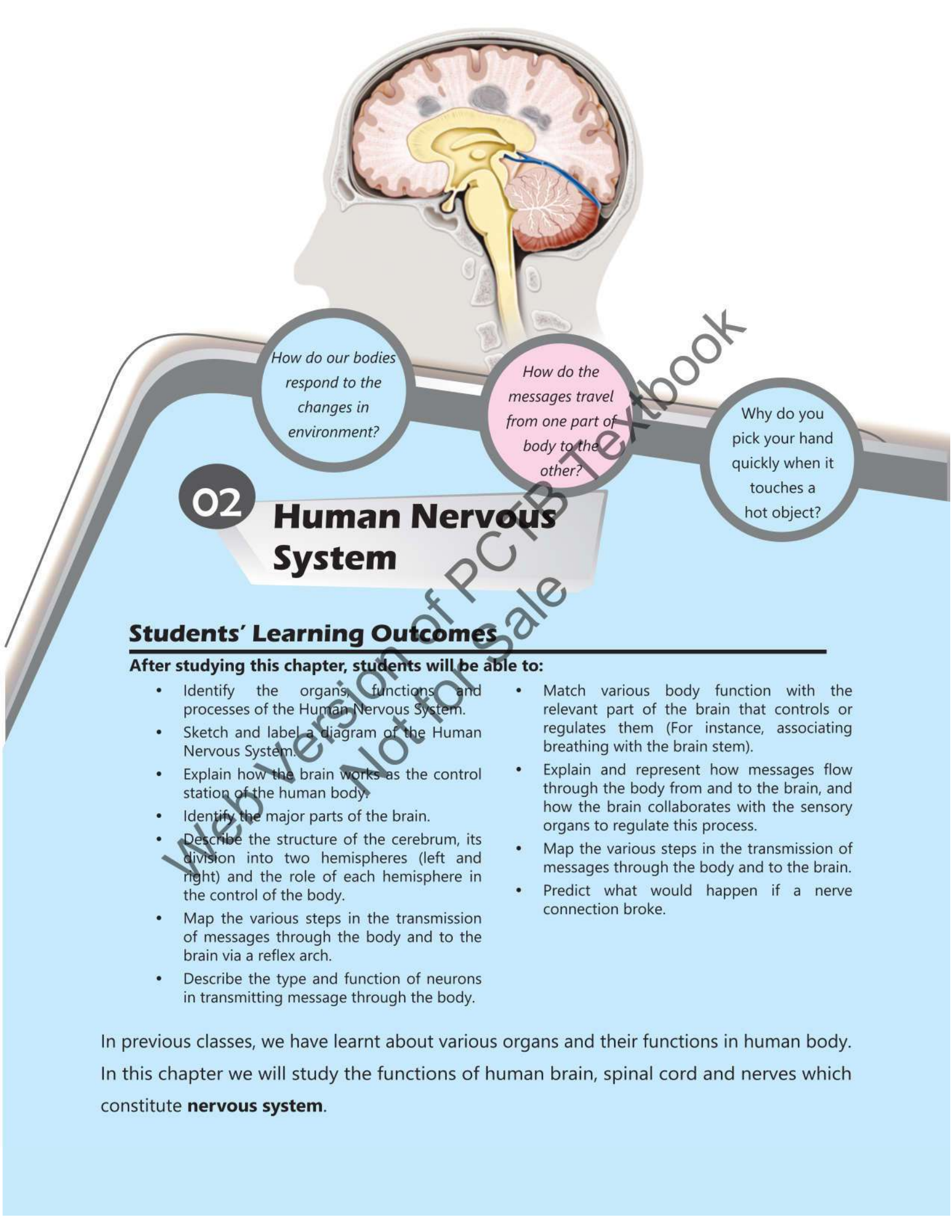


A diagram of a human head in profile, showing the brain and spinal cord. A thick grey line runs from the brain down and then curves to the left. Three circular callouts are placed along this line. The first callout (light blue) contains the text 'How do our bodies respond to the changes in environment?'. The second callout (pink) contains the text 'How do the messages travel from one part of body to the other?'. The third callout (light blue) contains the text 'Why do you pick your hand quickly when it touches a hot object?'. The number '02' is in a black circle to the left of the title.

02

Human Nervous System

Students' Learning Outcomes

After studying this chapter, students will be able to:

- Identify the organs, functions and processes of the Human Nervous System.
- Sketch and label a diagram of the Human Nervous System.
- Explain how the brain works as the control station of the human body.
- Identify the major parts of the brain.
- Describe the structure of the cerebrum, its division into two hemispheres (left and right) and the role of each hemisphere in the control of the body.
- Map the various steps in the transmission of messages through the body and to the brain via a reflex arch.
- Describe the type and function of neurons in transmitting message through the body.
- Match various body function with the relevant part of the brain that controls or regulates them (For instance, associating breathing with the brain stem).
- Explain and represent how messages flow through the body from and to the brain, and how the brain collaborates with the sensory organs to regulate this process.
- Map the various steps in the transmission of messages through the body and to the brain.
- Predict what would happen if a nerve connection broke.

In previous classes, we have learnt about various organs and their functions in human body. In this chapter we will study the functions of human brain, spinal cord and nerves which constitute **nervous system**.

2.1 NERVOUS SYSTEM

Whenever a person gets injury on his foot while walking, he feels pain and his hand immediately reaches the injured site. Who asked the hand to reach the site? In fact, there is an organ system in our body which carries messages from one part of the body to another and coordinates body functions. This system is called nervous system. Human nervous system consists of central nervous system (CNS) and peripheral nervous system (PNS) (Figure 2.1). The central nervous system is composed of brain and spinal cord. Peripheral nervous system consists of a network of nerves which connect the central nervous system to all parts of the body.

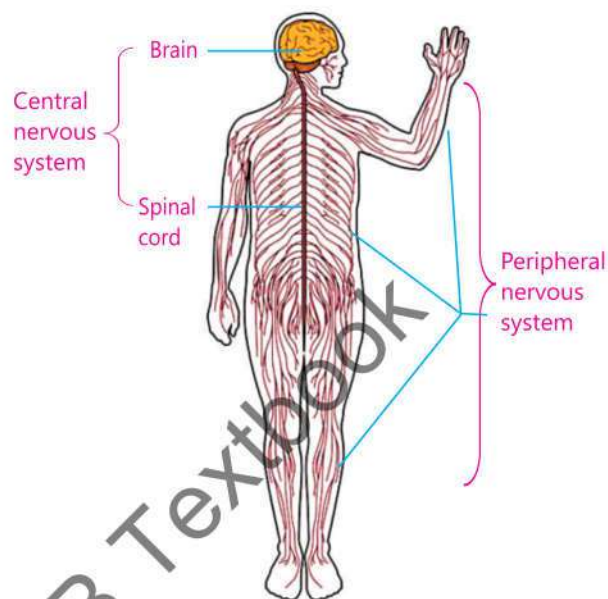


Figure 2.1 Human nervous system

Neuron or Nerve Cell

Neuron or nerve cell is the basic structural and functional unit of the nervous system. All parts of the nervous system, i.e., brain, spinal cord and nerves are made up of neurons. Neurons transmit messages in the form of electrochemical waves called **nerve impulses**.

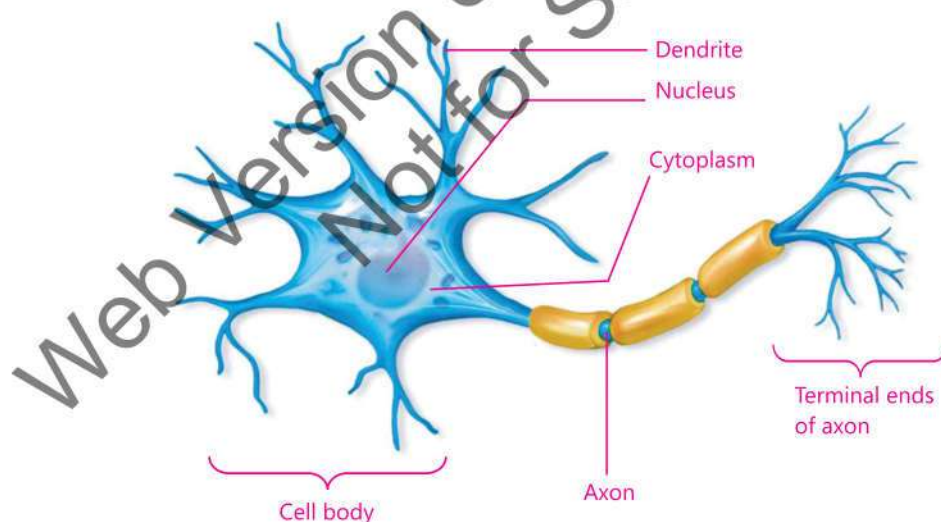


Figure 2.2 Structure of Neuron

The part of a neuron which contains nucleus and most of the cytoplasm is called **cell body**. The fine projections of the cell body which receive messages are called **dendrites**. A long projection of the cell body which conducts messages away from the cell body is called **axon** (Figure 2.2). Terminal ends of the axon transmit the messages to the next cells.

Nerve

A nerve is cable-like bundle of axons enclosed in a common sheath. Nerve transmits messages from one part of body to another.

Types of neurons

On the basis of their functions, neurons are of three types, i.e. sensory neurons, motor neurons and interneurons. **Sensory neurons** carry nerve impulses from sense organs (ears, eyes, skin, tongue, nose etc.) to the central nervous system. **Motor neurons** carry nerve impulses from central nervous system to **effectors** (muscles and glands), i.e., the parts which respond. **Inter-neurons** are present in central nervous system (brain and spinal cord). They form a link between sensory and motor neurons (Figure 2.3).

 **Interesting information**

Impulses may travel as fast as 150 metre per second or as slow as 0.2 metre per second.

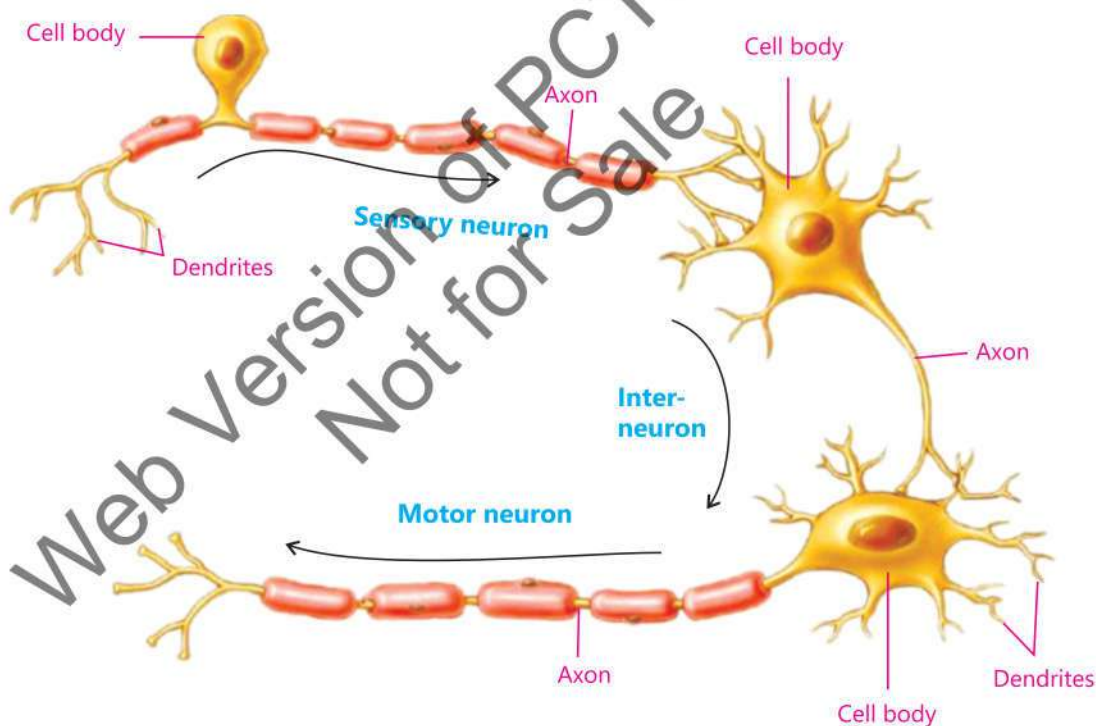


Figure 2.3 Sensory neuron, Inter-neuron and Motor neuron



Mini Exercise

Draw the structure of a neuron or nerve cell and label its different parts.

2.1.1 Central Nervous System(CNS)

Central nervous system acts as a control centre of the whole nervous system. It comprises brain and spinal cord.

Brain

Human brain (Figure 2.4) is enclosed in a bony skull called cranium, and consists of billions of inter-neurons. It is divided into the following parts:

1. Forebrain

Forebrain is the largest part of the brain. It consists of three main parts, i.e., cerebrum, thalamus and hypothalamus. **Cerebrum** is the topmost and the largest part of the brain. It is divided into right and left cerebral hemispheres. Each hemisphere controls the opposite side of the body. In general, the left hemisphere controls speech, comprehension, arithmetic, and writing. The right hemisphere controls creativity, spatial ability, artistic, and musical skills. Inside cerebrum there is a small structure called **thalamus**. It controls many sensory functions. **Hypothalamus** lies at the base of thalamus. It controls body temperature, hunger and thirst.

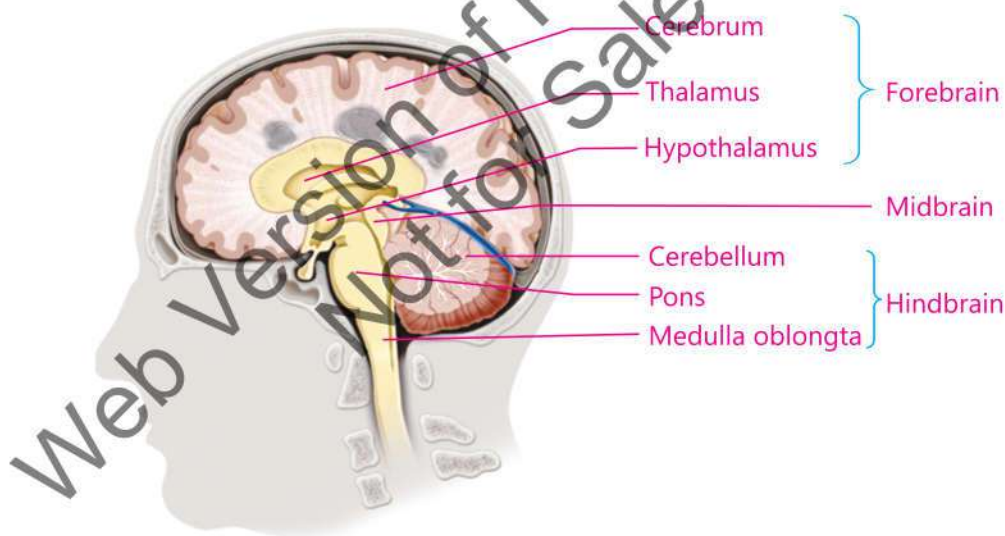


Figure 2.4 Section of skull showing different parts of human brain

2. Midbrain

Midbrain is a small part of the brain which is present below the cerebrum. It receives information from sense organs which is then passed to the appropriate part of the forebrain.

3. Hindbrain

Hindbrain consists of three parts, i.e., cerebellum, pons and medulla oblongata.

Cerebellum lies under the back part of the cerebrum. It acts as a controller for maintaining the body balance and making precise and accurate movements. **Pons** is an oval structure present beneath midbrain. It controls many functions like sleep, swallowing, equilibrium and taste, etc. **Medulla oblongata** forms the posterior part of the brain where it is connected with the spinal cord. Medulla oblongata controls heartbeat, breathing and digestion, etc. Medulla oblongata keeps on working when rest of the brain goes to sleep.



Brain of an adult weighs about 1.5 kg and consists of about one hundred billion neurons.

Spinal cord

Spinal cord is an extension of medulla oblongata (Figure 2.5). It runs backwards inside the backbone up to its lower end. It is also made up of interneurons.

Spinal cord creates a link between brain and different body parts. It also controls some reflex actions (immediate and involuntary actions) and some other involuntary actions.

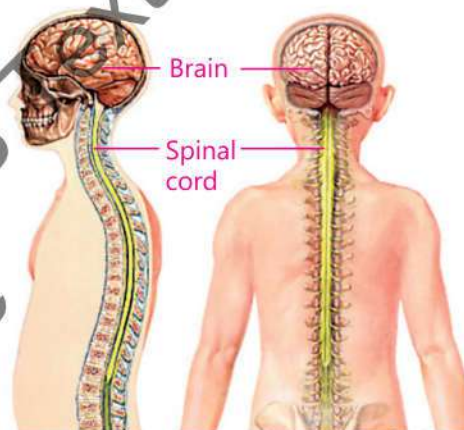


Figure 2.5 Spinal cord

2.1.2 Peripheral Nervous System

Peripheral nervous system (PNS) consists of a network of nerves which spread in the body to connect all the body parts to the central nervous system (brain and spinal cord) (Figure 2.1). The nerves which arise from brain are called **cranial nerves**. The nerves which arise from spinal cord are called **spinal nerves**. There are 12 pairs of cranial nerves and 31 pairs of spinal nerves in human body.

2.1.3 Working Model of the Nervous System

Nervous system coordinates all body functions. It also detects the changes in environment and produces response to the changes. Figure 2.6 shows the working of the nervous system as described below:

- Any change in the environment (external or internal) that can be detected by a receptor to initiate a nerve impulse is called **stimulus** (Plural: stimuli). Heat, cold, pressure, sound waves, etc. are the examples of stimuli. The special organs, tissues or

- The sensory neurons carry the messages regarding stimuli in the form of nerve impulses from receptors to central nervous system.
- The central nervous system processes the messages and transmits the nerve impulses to motor neurons.
- The motor neurons carry the nerve impulses to the parts of the body which produce responses. Such parts are called effectors. Muscles and glands in the body act as effectors.

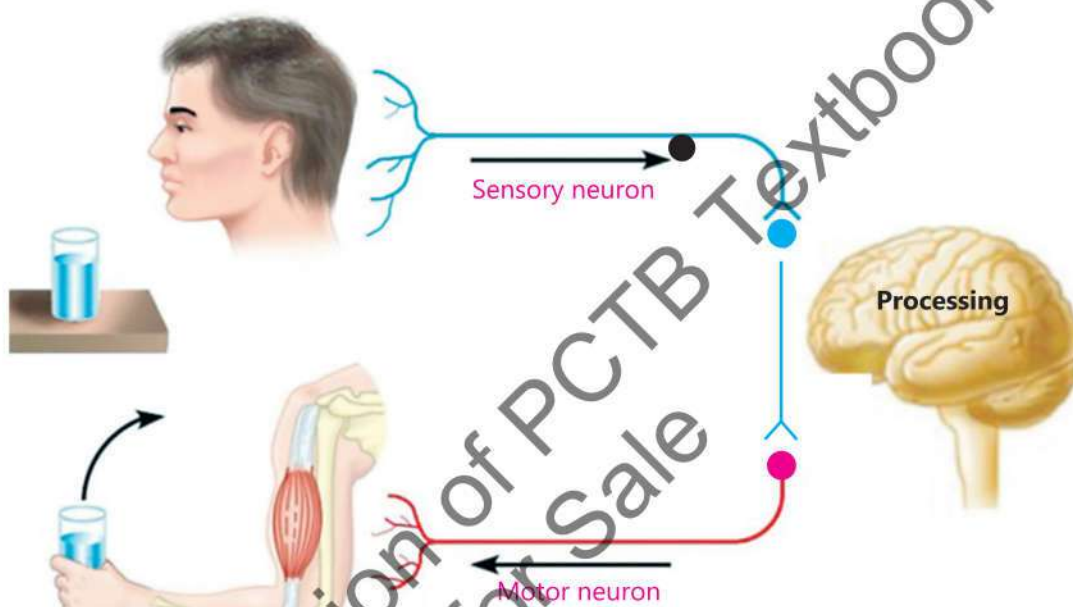


Figure 2.6 Function of nervous system



Activity 2.1

Make a flow diagram showing the pathway of a nerve impulse when you pat at the shoulder of your friend.

2.1.4 Actions Controlled by the Nervous System

Voluntary actions

The body actions which are performed under conscious control, i.e., which are done after thinking over them are called voluntary actions. For example; speaking, eating, reading, walking, running, clapping, etc., are voluntary actions.

Involuntary actions

The body actions which are performed without involvement of thinking process are called involuntary actions. Involuntary actions are not performed under conscious control.

Heartbeat, breathing, blinking of eyes, movement of small intestine, etc., are the examples of involuntary actions.

2.2 REFLEX ACTION

An immediate and involuntary response to a stimulus is called **reflex action**. Quick pulling of hand just after touching the hot object is a common example of reflex action.

In this example of reflex action shown in Figure 2.7, temperature of hot object is a stimulus which is received by the cells (thermoreceptors) of the skin. A nerve impulse is created in the sensory neuron present in skin. The nerve impulse is carried by the sensory neuron to the spinal cord. The inter-neuron of the spinal cord transmits the impulse to the motor neuron. The motor neuron carries the impulse to the arm muscles (effectors). The arm muscles contract and the hand is pulled back. The pathway of nerve impulses which complete a reflex action is called **reflex arc**. It consists of receptor, a sensory neuron, an inter-neuron, a motor neuron and effector.

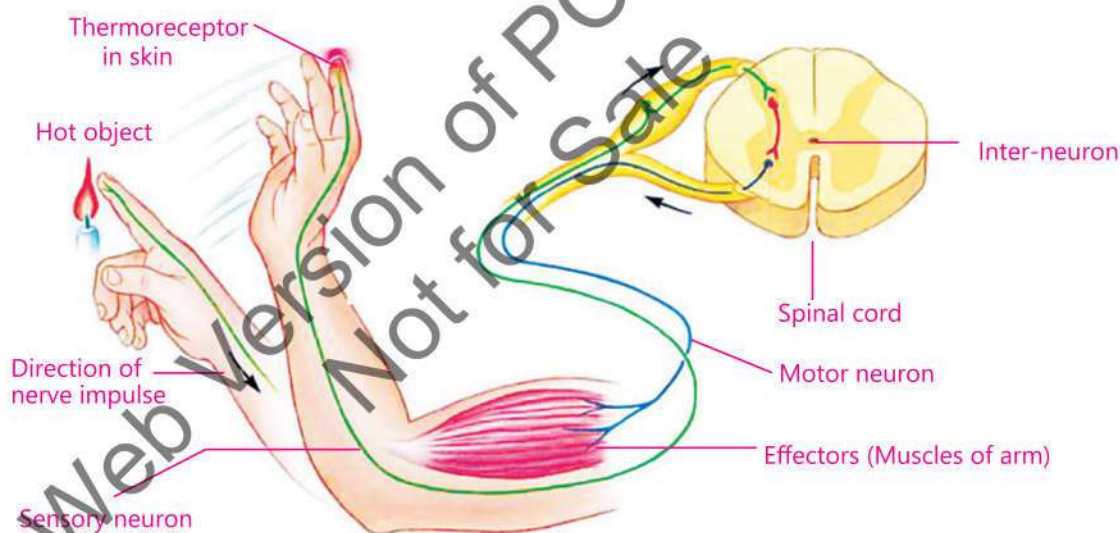


Figure 2.7 Reflex arc representing reflex action. Touching a hot object (flame in this example) results in immediate withdrawal of hand through contraction of muscles of arm.

KEY POINTS

- Nervous system carries messages from one part of the body to another and coordinates body's functions.
- Central nervous system consists of brain and spinal cord.
- Peripheral nervous system consists of a network of nerves which connects the central nervous system to all the body parts.
- Sensory neurons carry messages from sense organs to central nervous system.
- Motor neurons carry messages from central nervous system to muscles and glands.
- Inter-neurons are present in brain and spinal cord. They form a link between sensory neurons and motor neurons.
- The actions which are performed under conscious control are called voluntary actions.
- The actions which are performed without involvement of thinking process are called involuntary actions.
- An immediate and involuntary response to a stimulus is called reflex action.

QUESTIONS

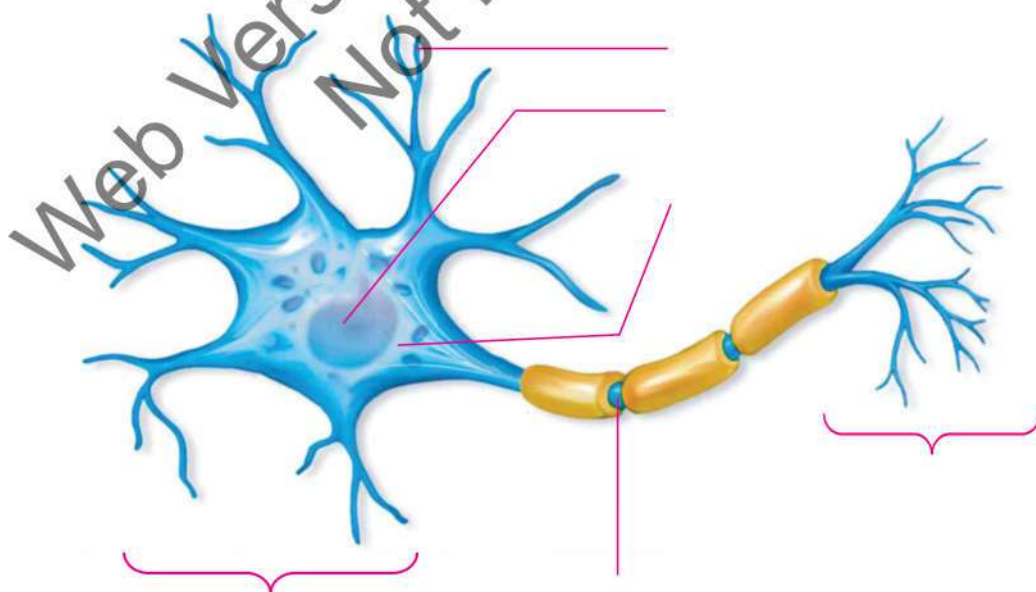
1. Encircle the correct option.

- (i) The neurons which decide about the action for a certain stimulus:
- | | |
|--------------------|------------------|
| (a) sensory neuron | (b) motor neuron |
| (c) inter-neuron | (d) all of above |
- (ii) The parts of a neuron which receive messages are:
- | | |
|-----------------|---------------|
| (a) cell bodies | (b) dendrites |
| (c) axons | (d) nuclei |
- (iii) Heartbeat is controlled by:
- | | |
|-----------------------|------------------|
| (a) cerebrum | (b) cerebellum |
| (c) medulla oblongata | (d) hypothalamus |
- (iv) Many axons present side by side and enclosed in a common sheath form:
- | | |
|----------------|-----------------|
| (a) nerve cell | (b) nerve |
| (c) dendrite | (d) spinal cord |

- (v) Sensory neurons carry messages towards:
- (a) muscles
 - (b) glands
 - (c) sense organs
 - (d) brain and spinal cord
- (vi) Which part of brain is involved in precise and accurate body movements?
- (a) Cerebellum
 - (b) Cerebrum
 - (c) Thalamus
 - (d) Midbrain
- (vii) When you have a toothache, you feel pain because:
- (a) there is a cavity in your tooth
 - (b) tiny bits of food are left between your teeth
 - (c) bacteria digest the food left between your teeth and produce an acid
 - (d) the cavity reaches the nerves and the nerves send a message to the brain

2. Write short answers.

- (i) Write the functions of midbrain, hypothalamus and spinal cord..
- (ii) Differentiate between:
- (a) Receptors and effectors
 - (b) Neuron and nerve
 - (c) Sensory neuron and motor neuron
 - (d) Cerebrum and cerebellum
- (iii) Write a note on the central nervous system.
- (iv) Identify and label the following diagram.



3. Constructed response questions

- (i) The table below shows the list of your daily activities. Write the name of that part of brain (forebrain, midbrain or hindbrain) which is controlling this activity.

No.	Activity	Part of brain controlling activity
1.	Sleeping	
2.	Brushing your teeth	
3.	Taking the breakfast	
4.	Balancing your body	
5.	Taking deep breath	

- (ii) Predict what would happen if a nerve connection broke.

4. Investigate

- (i) Why a motor cyclist is advised to wear the helmet?
- (ii) A person met an accident in a car. When he was brought to the hospital he did not know even his name. What could have happened to him? Relate your answer with reference to your nervous system.

Project

Teacher should make a group of four students and ask one of the student to read aloud a paragraph for one to two minutes. Ask other students to listen carefully. As the student stops reading, ask all the others three students to write in a given space what they have listened. After writing the paragraph ask all the students to compare their written paragraph with the actual paragraph in a book. The greater they found resemblance between the actual and written paragraph the stronger memory they have.

