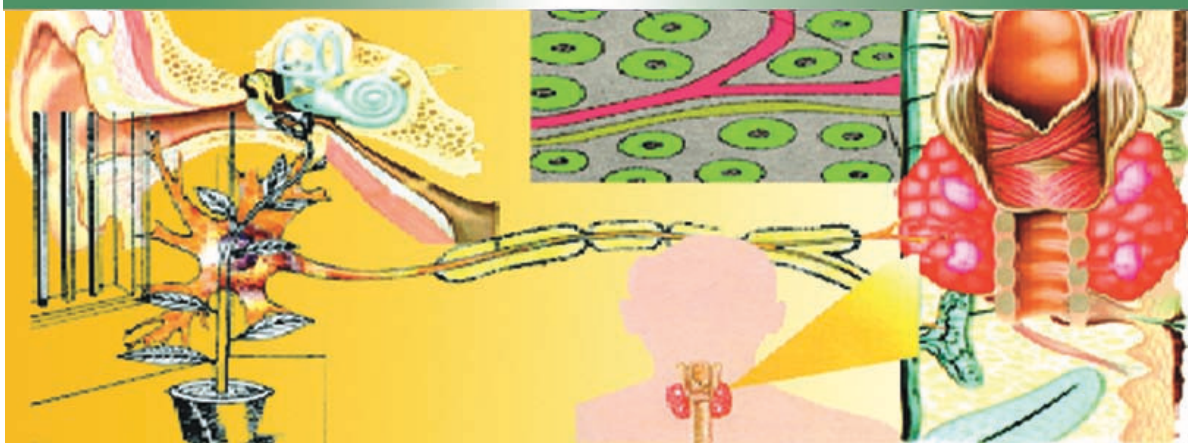
Biology

1. Mechanisms of organisms adapted for the efficient functioning of the systems



At the end of this Chapter, you will be competent to:

- Understand the mechanism of nervous coordination in man.
- Maintain the proper functioning of sensory organs.
- Understand the mechanisms of human nervous coordination and homeostasis.
- Understand plant movements, plant growth substances and their uses.

1.1 Nervous coordination in man

As you walk along the road you hear a clapping sound. You invariably turn around and listen to it. (Fig 1.1)

Fig. 1.1

What made you to turn around and look?

The clapping sound, of course!

What was the response?

You turned around and looked. That was your response. The clapping noise was sufficient to produce a response. Any change in the environment that can bring about a response in the organism is called a **stimulus**.

In the above action, the stimulus was the noise. Your looking back was the **response**. To look back you used the neck muscles. Hence, the response was by the action of the neck muscles.

The noise stimulus was felt by the sense organ, ear. The organs which respond to stimuli are known as the effectors. Here the effectors were the muscles of the neck which responded by contraction.

The smell of a tasty food will make you salivate. Here the stimulus is the smell of food. The stimulus was felt by the nose. The organs which responded were the salivary glands. The response is secretion of saliva.

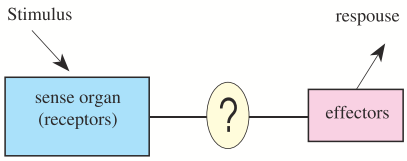
Suppose your hand touched a hot object without your knowledge. Immediately you take your hand away. In this case, the stimulus is heat. The organ which sensed it is the skin. Response was the removal of the hand. Effectors were the muscles of the hand.

Information regarding our surroundings as well as information within our body are sensed by receptors in our sense organs. Responses to these are by the effectors. There are two kinds of effectors in our body, they are the muscles and the glands.

Assignment 1

Write down the sense organs in our body and indicate the stimuli which are sensed by each.

In responding to stimuli, how is it that only the appropriate effector organs respond?



There should be a way by which messages (impulses) are conveyed to the effectors. This connection between receptors and effectors is known as 'coordination'. There are two ways in which coordination takes place, Namely, Nervous coordination; coordination by the intervention of the nervours system and Non-nervous coordination; coordination without the intervention of the nervous system but by the activity of hormones. Since hormones are chemical substances this is also called 'chemical coordination.'

Nervous coordination

In nervous coordination, impulses from the receptors are not directly conveyed to the effector organs. Impulses are first conveyed to the **central nervous system** (CNS). Central nervous system consists of the brain and the spinal cord.

Impulses regarding stimuli from the sense organs, namely the eyes, ears, nose and tongue are sent directly to the brain. The impulses from the skin generally are first sent to the spinal cord, from where they are sent to the brain. Responses which are voluntary (with our knowledge) are controlled by the brain while many actions which are automatic or involuntary (without our knowledge) are controlled by the spinal cord. The removal of one's hand on touching a hot object is an involuntary action and is controlled by the spinal cord. However, as intervening messages are immediately sent to the brain, we become aware that such a thing has happened. Pain is felt as a result of messages being sent to the brain.

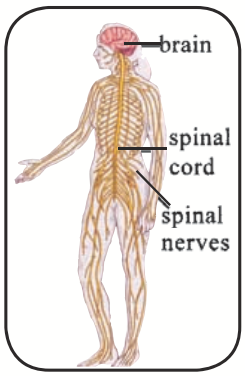


Fig. 1.2 Nervous system of man

All nerves connecting receptors to the central nervous system and those nerves connecting the central nervous system to effectors are known collectively as the **peripheral nervous system**. Central nervous system and the peripheral nervous system together form the nervous system. (Fig.1.2)

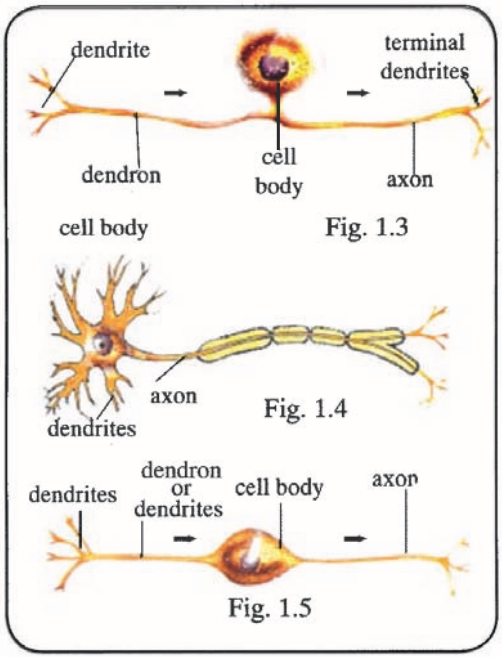
Basic units of the nervous system

The units by which the nervous system is made up of are, the nerve cells or **neurones**,many millions of which go to form the nervous system. There are three main kinds of neurones, namely;

1 Sensory neurones

2 Motor neurones

3 Intermediate neurones.



Sensory neurones

These are neurones which carry messages (impulses) from the sense organs to the central nervous system. (Fig 1.3)

Motor neurones

These are neurones which carry impulses from the central nervous system to the effectors. (Fig. 1.4)

Intermediate neurones

These are neurones that convey messages from sensory neurones to motor neurones. (Fig.1.5)

Activity 1.1

Examine prepared slides of the different types of neurones under the microscope, with the guidance of your teacher.

Fig. 1.6 T.S of a nerve

The nerve endings or dendrites of the sensory neurones are found in the sense organs. Impulses are received by these dendrites. The nerve endings of the axons of these neurones are found in the central nervous system. The motor neurone has it's dendrites in the central nervous system. The terminal dendrites of the axon of these cells are near the effectors.Outside the central nervous system, most neurones have an outer thin covering of fatty tissue called the myelin sheath. Outer to the myelin sheath is a transparent covering called the neurilemma. A nerve is a bundle of nerve fibres bound together by connective tissue.

The central nervous system

The central nervous system is made up of the brain and the spinal cord. The impulses arising from stimulation of the eyes, ears, nose and tongue are sent directly from the sense organs to the brain.

The actions of most organs of the body are under the control of the central nervous system. The brain is enclosed and protected by the cranium while the spinal cord is protected inside the vertebral column.

Activity 1.2

Try to get a brain of an ox or a goat from a meat-stall. Observe the parts (with the help of your teacher.). Compare the parts with that of the human brain.

The brain and the spinal cord are protected by three coverings, shown in Fig 1.7.

They are 1. Dura mater - the outermost covering

2 Arachnoid membrane - the middle covering

3 Pia mater - the innermost covering

These three coverings are commonly called the meninges of the brain.

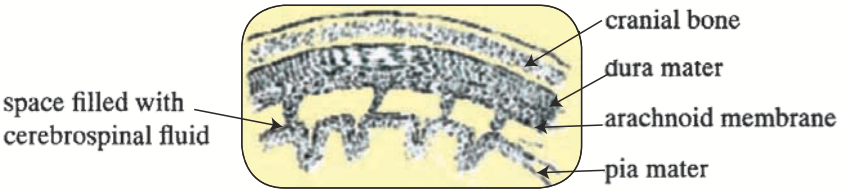


Fig. 1.7 Protective coverings of the brain

Around the brain inside the cranium, and around the spinal cord inside the vertebral column there is a fluid called the cerebrospinal fluid. This protects the brain from shocks. Brain and spinal cord are composed of grey matter which are cell bodies of neurons and white matter which are the fibers of neurons. In the brain, grey matter is on the outside and the white matter is inner to it while in the spinal cord it is the other way round.

Brain

The main parts of the brain are as follows:

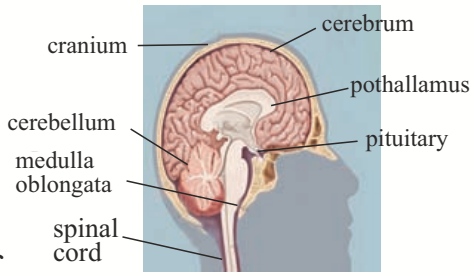


Fig. 1.8 Parts of the human brain

● Cerebrum

The most prominent part of the brain is the cerebrum. This is divided by a deep cleft into two halves, the cerebral hemispheres. The roof of the brain is formed from this part which grows backwards. The surface of the cerebrum is highly convoluted.

Because, thrown into folds which greately increases its surface area.

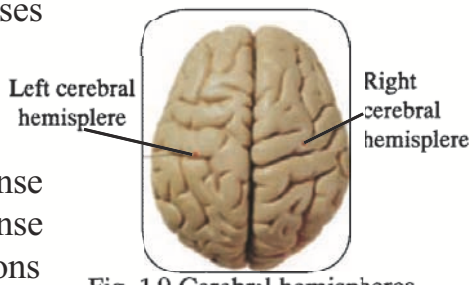


Fig. 1.9 Cerebral hemispheres

The cerebrum controls the following:

Mental activities such as memory, intelligence, sense of responsibility, thinking, reasoning, moral sense and learning. Rather than those, sensory preceptions

such as pain, temperature, touch, sight, hearing, taste and smell also controlled by cerebrum. These impulses are transmitted to the cerebrum through a part called the **thalamus** which is situated deep within the cerebrum. The centre for controlling the body temperature is the **hypothalamus** situated near the thalamus. Hunger and thursty is too controlled by the hypothalamus. The organs on the left side of the body are controlled by the centres in the right side and vice versa.

- **Mid brain**

The mid brain is a very small section. It connects the cerebrum with the lower parts of the brain.

- **Cerebellum**

The hind part of the brain which grows backwards is the cerebellum. It is ovoid in shape and has two hemispheres separated by a narrow median strip. The function of this part is coordination of voluntary muscular movement, posture and balance.

- **Medulla oblongata**

Behind the cerebellum is the medulla oblongata. This controls all involuntary actions such as heart beat, respiratory movements, vomitting, sneezing etc. The medulla oblongata is followed by the spinal cord.

A fine canal, the central canal runs through the brain and the spinal cord. At certain places inside the brain, this enlarges to form the ventricles of the brain. The central canal and the ventricles are filled with cerebrospinal fluid.

Twelve pairs of nerves originate from the brain. They are called cranial nerves.

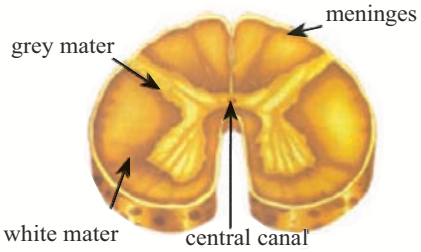


Fig. 1.10
cross section on view spinal cord

Spinal cord

The spinal cord is the elongated, cylindrical cord like structure which leaves the brain and goes down, enclosed within the vertebral column. The structure of the spinal cord is as shown in Fig.1.10. Unlike in the brain, here white matter is on the outside while grey matter is on the inside. The central canal runs through the spinal cord. It too is filled with cerebrospinal fluid. 31 pairs of spinal nerves come out symmetrically at intervals along the spinal cord.

These nerves have two roots. The root coming from the dorsal side of the spinal cord is called the dorsal root and that from the ventral side is the ventral root. These two roots join up and leave the vertebral column as a single nerve. At the base of the dorsal root, there is a knot like structure, the dorsal root ganglion. The cell bodies of sensory neurons are found here. The dendrons of sensory neurons connect with the spinal cord through the

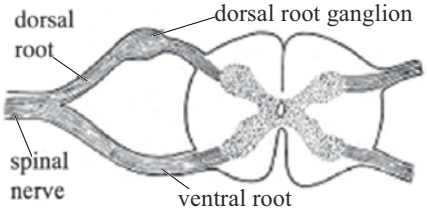
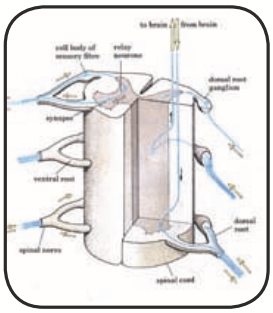


Fig. 1.11
How the special nerves are originated

dorsal root. The axons of motor neurones leave the spinal cord through the ventral root. Hence, in a spinal nerve, dendrons of sensory neurones and axons of motor nerves are both found, bound together as a common nerve. They are called mixed nerves.

The twelve pairs of cranial nerves and 31 pairs of spinal nerves are called the pheripheral nervous system.



motor nurone

Fig. 1.12

Reflex actions

Reflex action is an immediate and automatic response to a stimules. It happens without conscious thought. For example, when we touch a hot object, immediately the hand is pulled away. This is a reflex action. Here the stimules was heat. The sensory neurons in the skin felt this stimulus. The impulse was carried along sensory neurons to the spinal cord. At the spinal cord it is transferred to a motor neurone. The motor neurons which are controlled by the spinal cord carry the impulse to the effectors which are the muscles of the hand in this case, which immediately respond by contraction. The hand is pulled away.

If the action is to be controlled by the brain, it would take a longer time. Then the harm to the hand is greater. A quick reaction of this sort, reduces the harm. Along with this action, impulses are sent to the brainand the brain is informed. As a result, we may remove the hot object which is done consciously with the knowledge of the brain. But this occurred after the reflex action.

The path taken by the impulse to bring about a reflex action is called a reflex arc. The path taken for the action of pulling away the hand on contact with a hot object is given below:

Sense organ ⟶ Sensory neuron ⟶ Spinal cord ⟶ Motor neuron ⟶ Effector

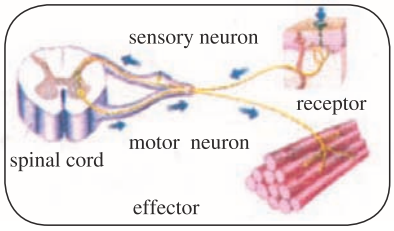


Fig. 1.13 Reflex arc

Are there reflex actions associated with the brain too?

Activity 1.3

Hold a clear plastic sheet in front of the eyes of a friend. Throw a paper ball at the glass sheet. (Take care!)

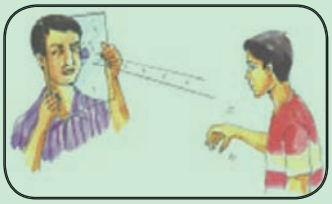


Figure 1.14

What is your friend's reaction? He will blink his eyes immediately. This is a reflex action. It was not controlled by the spinal cord. It is a cranial reflex. Some other such cranial reflexes are sneezing, salivation, coughing, swallowing, adjustment of the pupil of the eye to suit strong or weak light, moving your head away when a harmful object comes near the eyes.

Autonomous nervous system

Most of the vital activities related to the maintenance of life such as heart beat, secretions from glands, opening and closing of valves of the alimentary canal, contraction and distention of blood vessels take place involuntarily.

This system is called the **autonomous nervous** system. It has two components The activities controlled by the sympathitic system is contrast to the activities controled by the parasympathetic system.

The sympathetic system

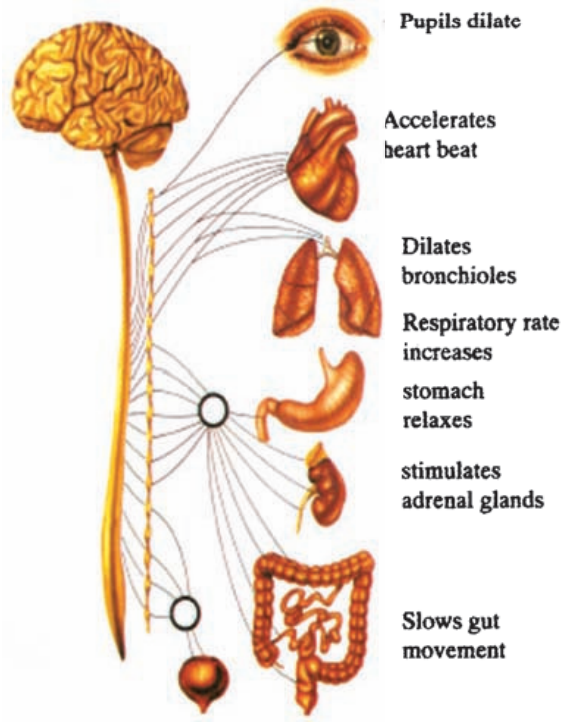


Fig. 1.15 Sympathetic system

The parasympathetic system

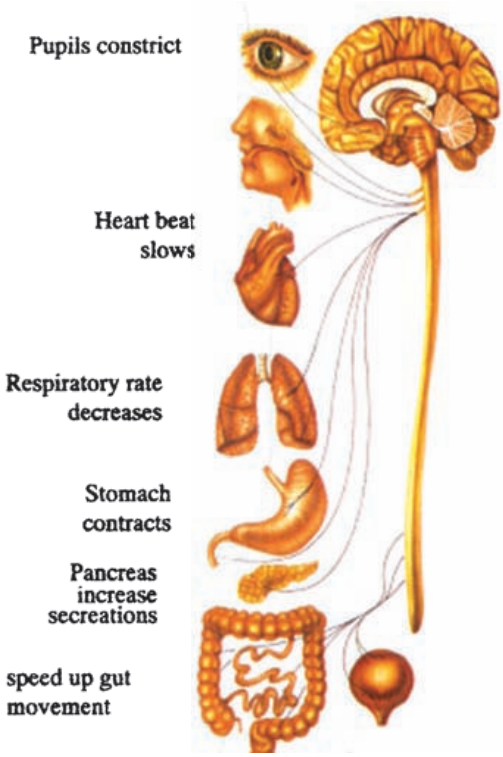


Fig. 1.16 Parasympathetic system

Sympathetic nervous system

Fig. 1.15 summarises the responses when impulses are sent out along the sympathetic nervous system. When a person is frightened, impulses are sent along these nerves. As a response, the heart beat increases, breathing becomes faster, pupils of the eyes become dilated, blood vessels contract and blood pressure increases. As a result, the organism can react speedily.