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23

CONTROL AND COORDINATION

We observe our body regularly, but few of us are able to appreciate what a well-harmonized machine it is! When we eat food, digestive juices are secreted, but these are secreted only when there is some food in the food canal and so long as the food has to be digested. Our muscles move only when stimulated. Our body temperature remains constant even when outside temperature fluctuates. Can you tell how various organs perform their functions together accurately at the right time? How does the right physiological activity occur at the exact moment? Do you know which organs are responsible for our thoughts, feelings, emotions and behaviour? We shall try to get answers to some such questions in this lesson.

OBJECTIVES

After completing this lesson, you will be able to:

- *explain the role of nervous system and hormonal system in control and coordination of various activities of the body;*
- *recognize major components of the nervous system and enlist their functions, emphasizing their role in informed decision making;*
- *explain the role of nerve cells (neuron) in the transmission of nerve impulses;*
- *identify the location and explain the functions of spinal cord in evoking a reflex action;*
- *analyze the role of some of the endocrine glands in regulating our growth and behaviour; and*
- *appreciate the role and relevance of reflex, voluntary and involuntary actions as well as hormones in efficient functioning of the human body.*

Notes

23.1 NERVOUS SYSTEM AND ENDOCRINE SYSTEM

Have you ever wondered how the various organs perform their respective functions in harmony and at the appropriate time? The **nervous system** and the **endocrine system** ensure that the body works in a controlled and coordinated manner. The nervous system includes the brain, spinal cord, sense organs and nerves while the endocrine system operates through certain chemicals called **hormones** which are produced by specialized glands and are secreted directly into the blood. The nervous system works with the endocrine system to communicate, integrate and coordinate the functions of various organs and systems in our body.

Some examples from our daily life will help us to appreciate the complexity of processes coordinated by the nervous and endocrine systems to help us execute several simple and difficult tasks. Do you know why we feel hungry? Yes! You are right. We want food when our body needs energy. The eyes see the food; brain registers this information and a series of coordinated activities are initiated. Appropriate activities in the nervous system instruct the relevant muscles in the hands and the fingers to pick up the food and put it into the mouth. When sufficient food has been eaten, signals from the hunger centre in the brain indicate a sense of fullness and the individual stops eating. The food reaches the alimentary canal and several digestive juices (for example, gastric juice, bile and pancreatic juice under the influence of specific endocrine glands) are secreted that help in digestion. After a series of digestive processes, food is absorbed into the blood stream to fulfill the energy requirement. Several other processes involved in digestion are not mentioned here. Many of these processes cannot be directly observed but they play a vital role in the digestion of food and providing energy for our day-to-day functioning. As you would have realized; eating is not as simple as it seems to be!

The above example illustrates that the nervous system and the endocrine system **work together as a team** to control and coordinate all our activities such as our physical actions, our thinking processes and our emotional behaviour.

It is noteworthy that sometimes we may not even be aware of the role that the nervous and endocrine systems play in our health and well being. For example, we do not have to remember to breathe or to digest food.

Execute: To carry out or put into effect

There is another set of action, known as the **reflex action** that are usually executed in response to an urgent or dangerous situation. For example, immediate removal of hand if it comes in contact with a hot object.

Do you now appreciate that the nervous and endocrine systems have a vital role to play in the smooth functioning of our lives on an everyday basis. Let us understand the structure and functioning of these systems in some more detail.

INTEXT QUESTIONS 23.1

1. Can you think of a real-life example, when team work helped you to achieve something that you could not have done by yourself? Please write about this incidence in 3-5 sentences.

2. Give one example of coordination of a process taking place in our body which is brought about by both the nervous system and hormonal system.

23.2 THE NERVOUS SYSTEM

The functioning of the nervous system depends on detecting a stimulus in the internal or external environment and responding to it.

A stimulus is an agent or an environmental change which can initiate a response in the body. The stimuli can be of several types. It could be physical (touch, prick, pressure), auditory, chemical, radiant (light), heat or cold, or electrical.

23.2.1 Neuron (Nerve cell)

Let us find out how **neurons** (individual cells of the nervous system) communicate with one another and other tissues to receive and transmit information throughout the body. The generalized structure of a neuron is shown in fig. 23.1. It consists of three parts-

(i) **Dendrites** are branched cytoplasmic projections from the cell body. The dendritic tip of the nerve cells receive impulses and sets off a chemical reaction that creates an electrical impulse which is further transmitted to the cell body.

(ii) The **cell body** contains a well defined nucleus, surrounded by cytoplasm. It has cell organelles like any other cells. The cell body further transmits the impulse to the axon.

(iii) **Axon**: One branch arising out of the cell body is very long in comparison to others. This branch is called **axon or**

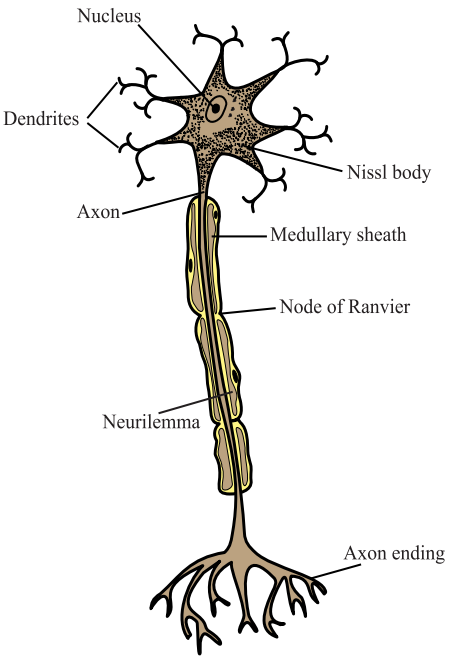


Fig 23.1: A neuron (nerve cell)

nerve fibre. In most neurons, it is covered by an insulating fatty sheath called *neurilemma*. The fatty sheath is missing at intervals which are called **Node of Ranvier**. The absence of *neurilemma* helps Node of Ranvier to generate electrical activity and in transmission of nerve impulse. The end portions of the axon have swollen ends like "bulbs" which store chemicals called **neurotransmitter**. Axon bulbs are closely placed near the dendrites of another neuron. This junction of two neurons in called **synapse** and the space at the synapse separating the two neurons called **synaptic cleft**. (Fig 23.2) There are many synapses between the millions of nerve cells present in our body.

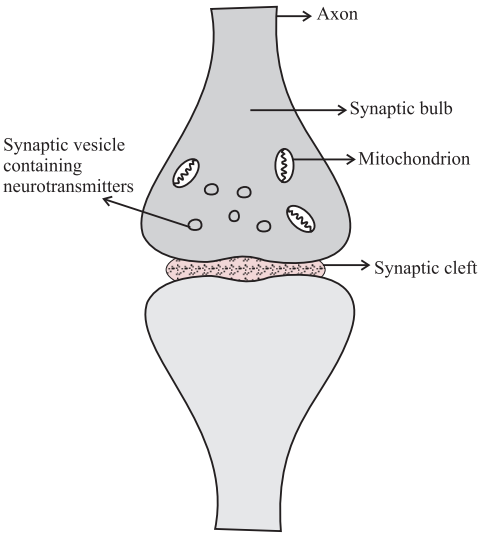


Fig 23.2: A synapse

Through the synapse the impulse passes from one neuron to the next neuron. When an impulse reaches the end of first neuron, a neurotransmitter is released in the synaptic cleft of the synapse. These chemicals cross the gap or synapse and start a similar electrical impulse in the next neuron. Finally, the impulse is delivered from neurons to other cells, for example the muscle cells or glands to elicit the desired action.

There are three types of neurons: (Fig 23.3).

1. **Sensory neurons** convey the impulse from receptor (sense organ) to the main nervous system. (brain or spinal cord).
2. **Motor neurons** carry the impulse from the main nervous system to an effector (muscle or gland).
3. **Association (Connecting) neurons** are located in the brain and spinal cord and interconnect the sensory and motor neurons.

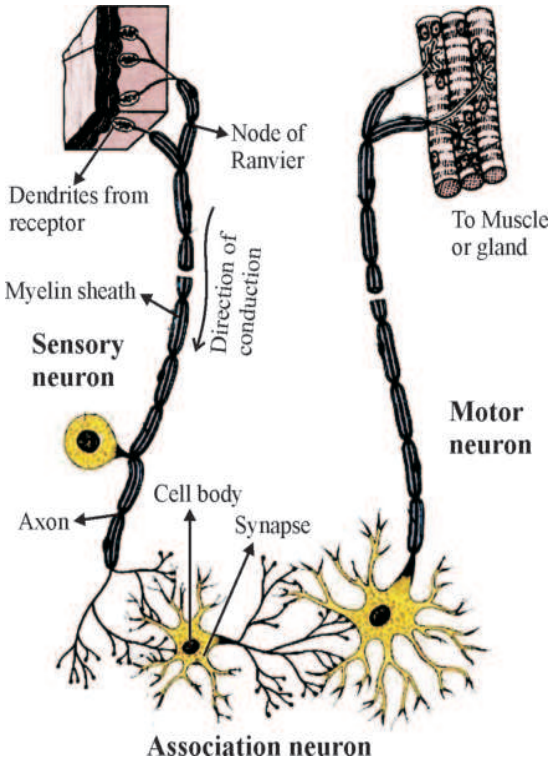


Fig 23.3: Three types of neurons (sensory, motor and association), synapse between them and the direction of transmission of nerve impulse

23.2.2 Nerves

Nerves are thread-like structures which emerge from the brain and spinal cord and branch out to almost all parts of the body. A **nerve is formed of a bundle of nerve fibres (axons) enclosed in a tubular sheath** (figure 23.4). It may be compared to an underground electric cable containing numerous conducting wires, each insulated from the other. The medullary sheath of the axon acts like an insulation preventing mixing of impulses between the adjacent axons.

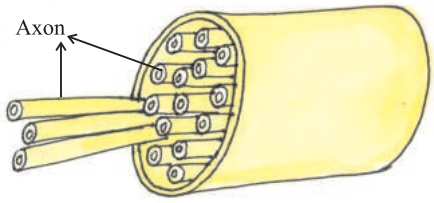


Fig 23.4: A nerve formed of a bundle of axons

There are three kinds of nerves:

(i) **Sensory nerves** that contain sensory fibres. These nerves bring impulse from the receptors (sense organs) to the brain or spinal cord. *Example:* Optic nerve arising from the eye and ending in the brain.

(ii) **Motor nerves** which contain motor fibres. These nerves carry impulse from the brain or spinal cord to the effector organ like muscles or glands. *Example*: a nerve arising from the brain and carrying impulse to the muscles of the eye.

(iii) **Mixed nerves** are those that contain both sensory and motor fibres and perform a mixed function. *Example*: a spinal nerve.

Do you know

Spinal nerves are the nerves that emerge from the spinal cord and cranial nerves are the nerves that emerge from the brain.

23.2.3 Sense organs

As shown in figure 23.5 receptor organ like nose, eyes and /or ears receive the stimulus. The stimulus than reaches the spinal cord and the brain through sensory nerves where it is integrated. The message is then send by the motor nerves to the required organ (muscles or gland) for suitable action. In this ways a response is generated.

23.2.4 Major divisions of the nervous system

Before going any further, it may be useful to know the major divisions of the nervous system as summarized in the chart below. It shows that the nervous system has two main divisions: **Central Nervous System (CNS)** that includes brain and spinal cord and **Peripheral Nervous System (PNS)** which includes the

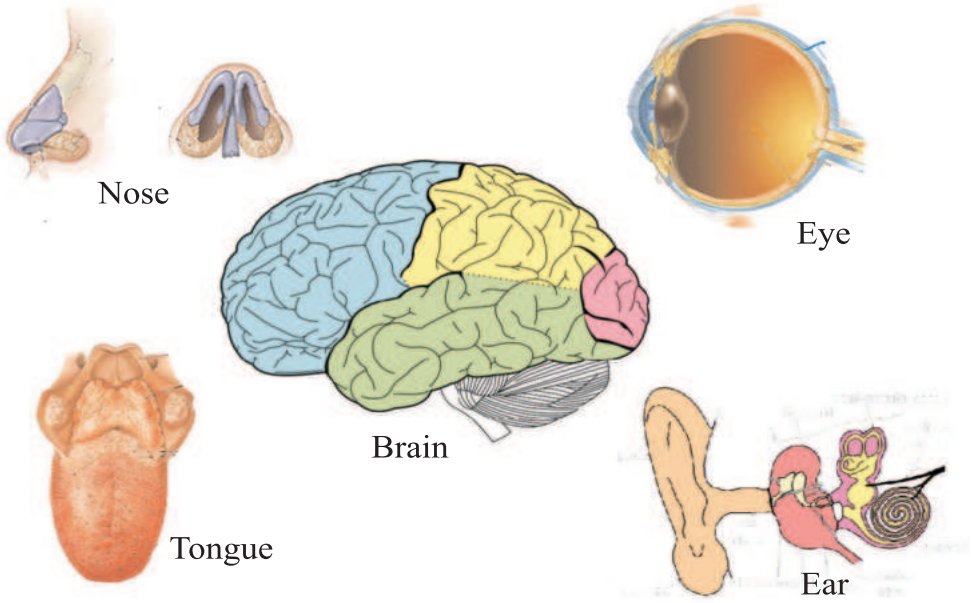
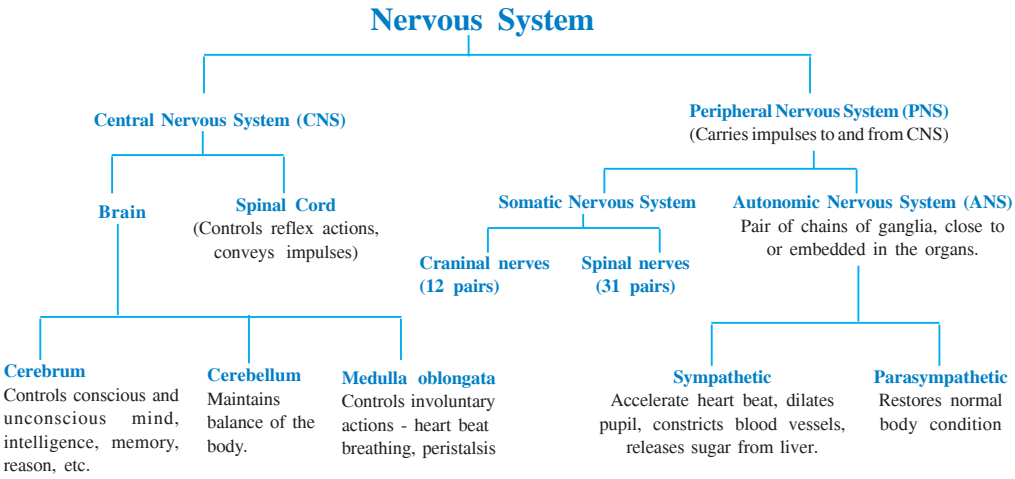


***Fig 23.5:** Major functions of the different areas of the brain*

nerves arising from the brain and spinal cord. The major division of the nervous system are summarized in the chart given below:



INTEXT QUESTIONS 23.2

1. The structural and functional unit of nervous system is (encircle the correct alternative out of the following)

   (a) Nephron (b) Neuron (c) Synapse (d) Axon

2. Consider that you are passing by a garbage disposal area and you immediately cover your nose. Arrange the events below in a logical order by marking them from 1 to 5 to trace the events that happen in the nervous system from detection of foul smell (stimulus generation) to covering your nose (response).

   (i) At the end of the axon, electrical impulse releases chemicals

   (ii) Stimulus received on the dendritic cells of a neuron sets off chemical reaction that creates an electrical impulse

   (iii) Electrical impulse transmitted through cell body and axon

   (iv) The chemicals cross the synapse and reach the next neuron. Similarly, the electrical impulse crosses several neurons

   (v) Finally, the impulse is delivered from neuron to the gland that helps in recognition of the foul smell and muscle cells that help in covering the nose

3. With the help of a suitable example, explain the term 'stimulus.'

23.3 THE CENTRAL NERVOUS SYSTEM

Central Nervous System (CNS) is regarded as the "information processor" in the body. It consists of the **brain** lying under the skull, and the **spinal cord** contained within the vertebral column.

23.3.1 The Brain

The brain is a very delicate organ. It is well protected within the bony cranium (brain box). As shown in the fig. 23.6(a), it is further protected by three **meninges** (that is, membranous coverings) which continue backward over the spinal cord. These meninges are: (i) **Dura mater,** the outermost tough fibrous membrane, (ii) **Arachnoid,** the thin delicate middle layer giving a web-like cushion, and (iii) **Pia mater,** the innermost highly vascular membrane, richly supplied with blood. The space between the covering membranes is filled with a watery fluid known as **cerebrospinal fluid** which acts like a cushion to protect the brain from shocks.

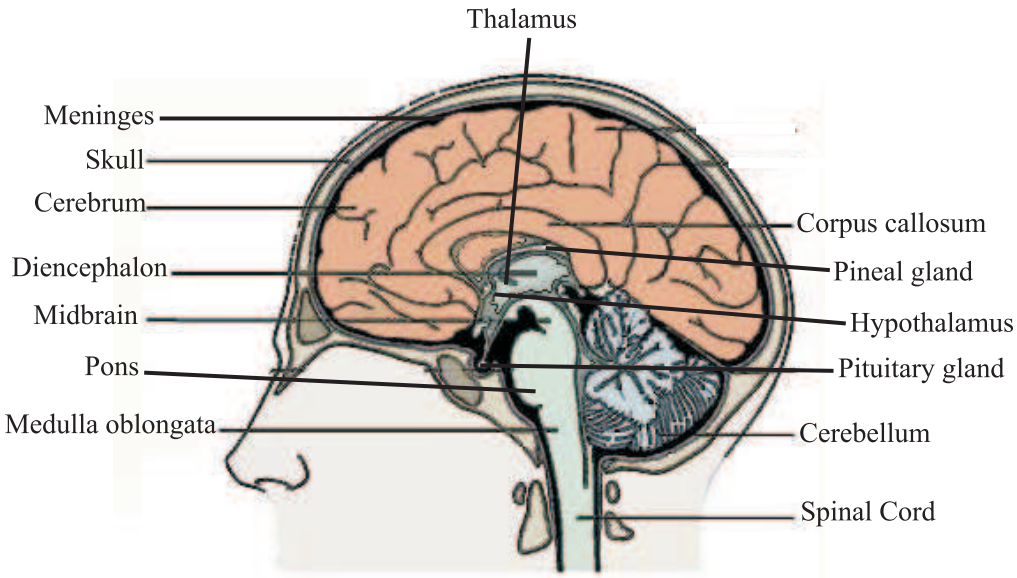


Fig 23.6 (a) Brain located inside the head (sectional view)

Do you know

You may have heard about **Meningitis** which is a serious health problem caused by inflammation of meninges. It is commonly caused by micro-organisms such as bacteria, virus, fungi and amoeba that infect the meninges and the cerebrospinal fluid surrounding the brain and spinal cord. Meningitis is a contagious disease and can spread through coughing, sneezing, kissing, sharing eating utensils, toothbrush etc. Good hygiene is helpful in preventing the disease. Effective vaccines are also available to protect against meningitis. A person with meningitis suffers with high fever, lethargy, irritability, headache, photophobia (eye sensitivity to light), stiff neck, skin rashes and seizures. (Seizures: Sudden attack of illness, especially a stroke or an epileptic fit)

Patient / care givers should seek prompt medical assistance for correct diagnosis and effective treatment.

The brain consists of three important parts: Cerebrum, Cerebellum and Medulla.

(a) Cerebrum: It is the largest portion of the brain, vertically divided into two halves: right and left **cerebral hemispheres**. Their outer surface is highly convoluted with ridges and grooves. The outer portion or the cortex of the cerebrum contains cell bodies of the neurons which is the basic unit of nervous tissue. Being grayish in colour, it is called the **gray matter**. The inner portion of the cerebrum consists of "**white matter**" which mainly contains the axons or nerve fibres of the neurons.

The highly developed cortex or gray matter enables us to think, reason out, invent, plan and memorize. Overall, the cerebrum is the seat of **intelligence,**

consciousness and will-power. It controls all voluntary actions. Cerebrum helps us to make well thought out and informed decisions, for example, decisions related to the career choices you make. Fig. 23.6 (b) shows some major functions associated with the different areas of the brain.

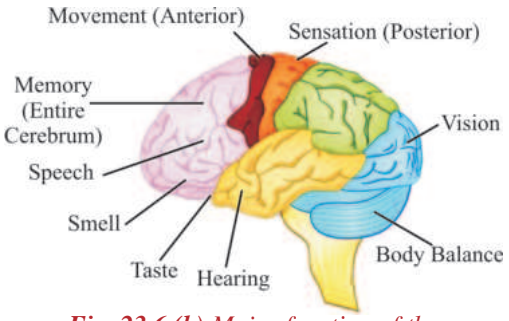


Fig. 23.6 (b) Major function of the different areas of the brain

(b) The cerebellum is a much smaller area of the brain located below the cerebrum. It has no convolutions, but has numerous furrows. This also has an outer cortex made-up of gray matter and an inner white matter.

The main function of the cerebellum is to maintain the 'balance' of the body and coordinate muscular activity. The cerebrum and cerebellum work in close coordination. For example, if you stand up and walk, the impulse for this activity arises in the cerebrum. The act of walking involves coordinated working of many muscles. Proper coordination and timing of contraction and relaxation of muscles is the responsibility of the cerebellum.

Do you know

An alcoholic, when drunk, generally walks clumsily. It is because under the effect of alcohol, the cerebellum is unable to co-ordinate muscular movements properly.

(c) The medulla oblongata is the lowest portion of the brain located at the base of the skull. It is roughly triangular and is continued behind as the spinal cord. Its function is to control the activities of our visceral organs like the alimentary canal, movement, breathing, beating of heart and many other involuntary actions. Injury to the medulla generally results in death as the involuntary and vital functions like breathing and heart beat may be stopped.

23.3.2 The Spinal cord

As mentioned above, the spinal cord is an integral part of the central nervous system. It extends from the medulla oblongata and continues downward almost throughout the length of the backbone, and lies within the neural canal of the vertebral column or the backbone. Figure 23.7 shows the internal structure of the spinal cord. In the spinal cord, the arrangement of the gray and white matter is reversed from that in the brain. The gray matter containing the cell bodies of motor neurons lie on the inner side, while the white matter on the outer side. The white matter contains axons running longitudinally to and from the brain and even

crossing from one side to the other. There is a small central canal in the centre which runs through the entire length and continues with the cavities of the brain. It is filled with **cerebrospinal fluid** which acts as a shock proof cushion and forms a medium for the exchange of food materials, waste products, and respiratory gases with neurons.

Externally, the spinal cord is covered by the same three membranes – dura mater, arachnoid and pia mater in continuation with those of the brain.

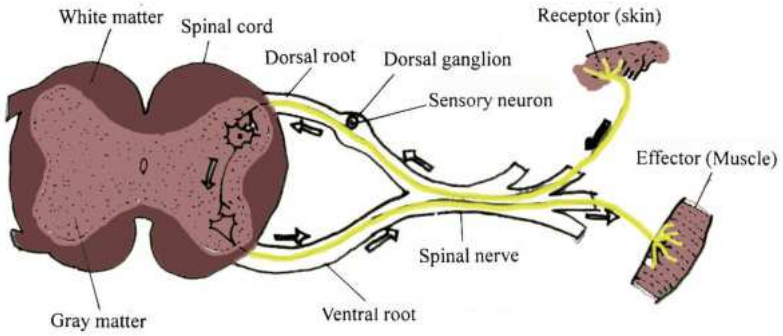


Fig 23.7 : Diagrammatic sketch of the internal structure of spinal cord and nervous pathway in spinal reflex

Functions of spinal cord

The spinal cord is concerned with the following three functions:

(i) It controls the reflexes below the neck.

(ii) It conducts sensory impulses from the skin and muscles to the brain, and

(iii) It conducts motor responses from the brain to muscles of the trunk and limbs.

INTEXT QUESTIONS 23.3

Fill in the blanks:

(i) The central nervous system consists of _____ and _____.

(ii) The two functions of the cerebrum are _____ and _____.

(iii) The major function of cerebellum is to maintain _____ of the body.

(iv) The _____ part of brain controls the activity of all internal organs of our body.

(v) The outer and inner region of the cerebrum are composed of _____ and _____ matter respectively.

23.4 REFLEX ACTION

We may be faced with an urgent and dangerous situation that requires immediate response and does not provide us with the time to think and reach a decision. Such responses are achieved through reflex action. The word 'Reflex' is used to convey sudden and immediate action in response to something. When there is a sudden dust storm what do you do to your eyes/ you immediately close your eyes to prevent the dust particles from entering your eyes. What is your reaction when you touch a hot pan while making food, you remove your hand to avoid the hot pan? In both those cases there is an instant and automatic reaction. There are certain actions in our body that are spontaneous and do not need any processing by the brain. Such actions or responses are called **reflex actions**. Reflex actions are involuntary actions that occur without conscious thought processes. For example: (i) When some particles fall into your eye, there is immediate flushing of tears to wash them out (glandular secretion) (ii) When your hand accidentally touches a hot pan, you withdraw it instantaneously (muscular movement) figure 23.8 (iii) You shiver when it is very cold (muscular contractions) or sweat when it is too hot (glandular secretion).

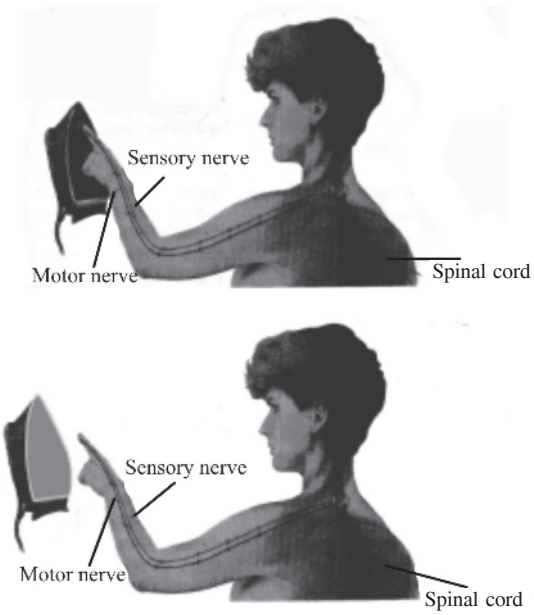


Fig 23.8 (a) and (b): *A simple reflex of withdrawal of hand on touching a hot iron, brought out by spinal cord*

Do you know

A ***reflex action*** may be defined as a spontaneous, autonomic and mechanical response to a stimulus controlled by the spinal cord and without the involvement of the brain. All involuntary actions or reflexes are initiated by some kind of sensory stimulations resulting in either a muscular action or a glandular secretion.

23.4.1 Types of reflexes

Reflexes are of two types (1) natural (inborn) reflexes and (2) conditioned (acquired) reflexes.

1. **Natural (inborn) reflex**: Close your eyes and try to follow the rhythm of your body. What do you feel? You feel that you are breathing gently. You also feel

your heart and pulse beating. All such activities in which no previous experience or learning is required are termed as **natural reflexes**. These reflexes are inborn, i.e. inherited at the time of birth. Other examples are: swallowing, coughing and blinking of eyelids.

2. **Conditioned (acquired) reflex:** What happens when you are able to smell your favourite food even without actually eating it? You are right. Your mouth starts watering (salivation) in anticipation! This phenomenon is based on your past experience by which you are able to associate a particular aroma with the specific food that you like. Aroma of the food item would not have initiated salivation if you had never eaten the food before. Such types of actions which develop during the lifetime due to experience or learning are termed as **conditioned reflex.**

   In the above example of conditioned reflex, salivation occurs at the smell of the food as the brain is able to remember the taste of the food and works in an unconscious way. Such reflexes are not inborn and hence conditioned reflexes are **acquired.**

   In order to preserve the conditioned reflex, it is necessary to reinforce it periodically. For example, once the reflex is formed, the mere smell of the food initiates salivation. However, if repeatedly the smell of the favourite food item is not followed by the food itself, you will stop reacting to the smell with salivation after a certain time.

A reflex arc may be represented as follows:

Stimulus → receptor in the sense organ → afferent (sensory) nerve fibre → CNS → efferent (motor) nerve fibre → muscle (to contract)/gland (to secrete)

INTEXT QUESTIONS 23.4

1. Name the two types of reflexes.

   _____

2. Given below are the different components of a reflex arc in a haphazard manner. Arrange them in the correct order in the space provided below:

   Sensory neuron, Effector, Stimulus, CNS, Receptor, Response, Motor neuron

   _____

3. Now that you are aware of the well-thought out voluntary actions that are co-ordinated by the cerebrum and immediate response actions or reflex actions, co-ordinated by the spinal cord, try to identify whether the following situations

may be best managed by well-thought out **voluntary actions** or quick response **reflex actions**. Please provide at least one reason for your choice.

Situation	Appropriate action voluntary action or reflex)	Reason for your choice
You need to immediately stop your bicycle as a speeding motorbike comes in front of your bicycle.		
You have scored good marks in all the subjects in class X and now need to choose between science and commerce stream. Your family feels you should study science while you like numbers and would like to study commerce.		
You are cleaning your cupboard, a sharp needle pokes you and you remove your hand immediately.		
You have moved to a new neighborhood and are trying to make new friends.		

23.5 PERIPHERAL NERVOUS SYSTEM

It connects the central nervous system with the sense organs, muscles and glands of the body and, includes the **sensory and motor nerves**. The peripheral nervous system consists of two sub divisions: (i) **Somatic nervous system** that conveys information from brain and spinal cord to skeletal muscles and regulates voluntary action. and (ii) **Autonomic nervous system** which control the involuntary action of many internal organs, smooth muscles, heart muscles and glands. (Fig.23.9)

2.5.1. Somatic nervous system

This consists of two sets of nerves – the cranial nerves and the spinal nerves

(a) **12 pairs of cranial nerves** emerge from the brain. For example optic nerve (for eyes) and auditory nerve (for ears);

(b) **31 pairs of spinal nerves** emerge from the spinal cord.

23.5.2. Autonomic nervous system

The autonomic nervous system (ANS) consists of a pair of chain of nerves and ganglia on either side of the backbone. This system controls the involuntary actions of the internal organs. As you may see in figure 23.9, there are two parts of the autonomic nervous system - Sympathetic and Parasympathetic.

The **Sympathetic Nervous System** (**SNS**) becomes more active during times of **stress.** It prepares the body for action. Its action during the stress response

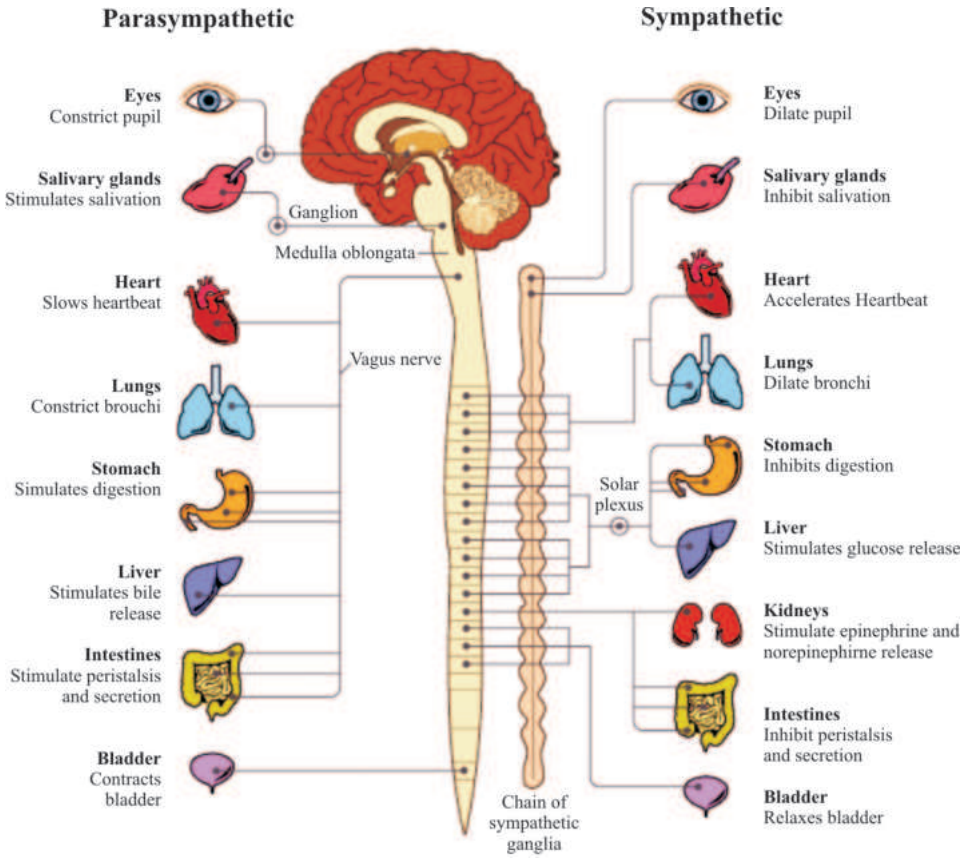


Fig 23.9: *Autonomic nervous system showing the opposing effects of the two parts - sympathetic and parasympathetic*

comprise the **'fight-or-flight response'** that is manifested largely under the influence of the hormone, *adrenaline*. The **Parasympathetic Nervous System** executes actions that do not require immediate response, for example producing of saliva and tears, digestion etc..

The functions of sympathetic and parasympathetic nervous systems may seem opposite to each other but in reality they are complementary rather than being antagonistic.

INTEXT QUESTIONS 23.5

1. How many pairs of cranial nerves are present in our body?

2. Name the two parts of autonomic nervous system.

23.6 ENDOCRINE SYSTEM

All of us observe the changes and development taking place in humans from the age of infancy to adulthood and old age. You may notice more pronounced changes in height and weight in the initial years and also very significant developments of secondary sexual characters during adolescence. In fact, our body undergoes changes as long as we live. These changes are regulated by special glands in our body known as the **endocrine glands**. The main function of these glands is to produce chemical secretions called **hormones.** Hormones play an important role in control, coordination and regulation of the functioning of tissues, organs and systems in the body. Well harmonized mechanisms regulate the release of very precise quantities of hormones to achieve optimal functioning of the human body. **The endocrine system is responsible for the chemical coordination in our body.**

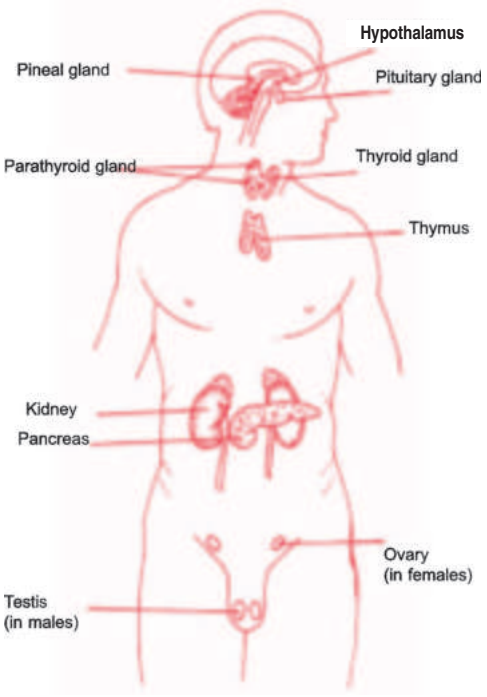


Fig 23.10: Endocrine glands

Do you know

The term hormone has been derived from the Greek word *hormaein* that means to set in motion or to spur on.

A **hormone** is a chemical secreted by an endocrine gland and carried by blood to a target organ situated elsewhere in the body to stimulate a specific activity.

Did you know that hyperactivity and hypoactivity of these glands can cause diseases? Let us learn about some important endocrine glands, the hormones they secrete and the effect they have in the body. Some of the endocrine glands are as follows:

Pituitary gland: This is a small gland located at the base of the brain. This gland plays an important role in the growth of a child from puberty to the full reproductive maturity. The pituitary gland secretes **Gonad Stimulating Hormone**, which regulates the activity of gonads (ovary in females and testis in the males). There is an increase in the activity of this gland at the time of puberty which stimulates the ovary and testes to produce the sex hormones **progesterone** and

oestrogen in females, and **testosterone** in males. These hormones initiate the development of secondary sexual characters. You will read more about secondary sexual characters in the lesson, "Reproduction". The disorders caused by the increased or decreased activity of the pituitary gland include:

- **Cushing's Disease:** It is caused by the hyperactivity of pituitary gland. In the males, this disease may lead to excessive growth of hair. In some cases, it may even cause atrophy of testes leading to impotency. In the females, this disease causes sterility and masculinization, for example, growth of beard and moustaches.
- Deficiency (hypoactivity) of growth hormone (GH) or **Somatotropic Hormone** (STH) secreted by pituitary gland causes **dwarfism** (retarded growth of the long bones) which adversely affects the height of a person. On the other hand, its excessive secretion or hyperactivity causes **gigantism** (excessive growth of long bones) making a person very tall.

Thyroid gland: It is responsible for the speed of metabolism in our body. The thyroid gland is therefore essential for life, growth and development.

When the thyroid gland becomes overactive and produces more thyroid hormone than is necessary for optimal functioning, the condition is called **Hyperthyroidism**. When the thyroid gland becomes underactive and produces less thyroid hormone than is necessary, the condition is called **Hypothyroidism.**

Cretinism is a condition of severely stunted physical and mental growth due to untreated congenital deficiency of thyroid hormone (hypothyroidism) or from prolonged nutritional deficiency of iodine.

Goitre is a disease of the thyroid gland characterized by an enlargement of the gland, visible externally as a swelling on the front of the neck. Simple goitre is caused by a deficiency of iodine in the diet. (Fig. 23.11)

Fig 23.11: Goitre

ACTIVITY 23.1

Find out what the Government of India recommends for prevention of iodine deficiency and goitre. (Hint: You could get this information from the news papers, radio, television, internet or your kitchen!)

Pancreas: This gland secretes two hormones **insulin** and **glucagon** which help in the metabolism of glucose in our body. Hyposecretion of insulin causes **diabetes mellitus** in which glucose is present in excess in the blood.

INTEXT QUESTIONS 23.6

1. Fill in the blanks:
   (i) A hormone is transported by the ..... to the target organ.
   (ii) Hypoactivity of thyroid gland causes ..... leading to cretinism in young children.
   (iii) Pancreas secretes two hormones, which help in the ..... of glucose in our body.

2. Each of the following statements has one correct response. Please choose the correct option and encircle it.
   (i) If a pathologist were to collect a hormone, where would it be collected from?
   (a) Blood (b) Brain
   (c) Specific endocrine gland (d) Any part of the body

   (ii) Hyperactivity of the pituitary gland causes:
   (a) Dwarfism (b) Gigantism
   (c) Cushing's disease (d) Cretinism.

   (iii) The neurons that carry impulses from sense organs to the brain or spinal cord are:
   (a) Sensory neuron (b) Motor neuron
   (c) Association neuron (d) Connecting neuron

   (iv) The parts of a reflex are connected to:
   (a) Brain (b) Spinal cord
   (c) Both brain and spinal cord (d) A synapse

   (v) Two neurons are connected to each other through:
   (a) Their axons
   (b) Their dendrons
   (c) The dendrites of the first neuron and the dendrites of the second one
   (d) Synapse

   (vi) An axon is:
   (a) A nerve fibre (b) A bundle of dendrites
   (c) A bundle of nerve fibres (d) The sheath of a nerve fibre.

   (vii) An individual reported to the neuro-physician with a body temperature much higher than normal. After several investigations, the neuro-

physician diagnosed that a tumor in a specific area of the brain was causing this symptom. Where do you thing the tumor may have been located?

(a) Cerebrum (b) Cerebellum
(c) Hypothalamus (d) Diencephalon

(viii) Where is the subconscious mind located?

(a) Thalamus (b) Hypothalamus
(c) Cerebellum (d) Cerebrum

(ix) Hyposecretion of insulin causes:

(a) Diabetes (b) Goitre
(c) Cretinism (d) Gigantism

(x) Which part of our brain helps in maintaining the balance of our body?

(a) Cerebrum (b) Cerebellum
(c) Medulla (d) Hypothalamus

(xi) Sudha likes to sleep in and someone always has to wake her up in the morning. However, during exams she is able to get up without an alarm or any other help. Which part of the nervous system helps her to deal with this situation?

Sleep in- sleeping beyond waking hours

(a) Parasympathetic nervous system (b) Medulla
(c) Sympathetic nervous system (d) Cerebrum

WHAT YOU HAVE LEARNT

- Nervous system and endocrine system are the two systems that control and coordinate various functions in the body.
- The human nervous system is studied under two divisions: The central nervous system and the peripheral nervous system.
- The central nervous system consists of brain and the spinal cord while the peripheral nervous system is further divided into somatic nervous system and autonomic nervous system.
- The autonomic nervous system has two parts – sympathetic and parasympathetic, which cause physical reactions opposite to each other.

- The neuron is the basic unit of nervous system. There are three types of neurons – sensory, motor and association or connecting neurons.
- A synapse is the function of the branches of the axon of one neuron with the dendrites of another neuron. It is here that the transfer of nerve impulse from one neuron to another neuron takes place.
- The reflex action is defined as a spontaneous, automatic and the mechanical response to a stimulus controlled by the spinal cord without involvement of the brain.
- The pathway followed by sensory and motor neurons in a reflex action is called reflex arc.
- Our body has a number of endocrine glands which produce chemical secretions called hormones.
- These hormones are carried by blood to the target organ situated elsewhere in the body to stimulate a specific activity.
- Pituitary gland plays an important role in the growth of the child from puberty to the reproductive maturity, i.e. upto the age of adolescence.
- Pituitary glands secretes many hormones which influence the development of secondary sexual characters among boys and girls. These hormones stimulate the production of eggs and sperms from ovaries and testes respectively. These hormones have profound influence on the behaviour as well as body shape, turning the child into an adult.
- Under secretion of thyroid gland cause cretinism and goitre.
- Pancreas secrete two hormones – the insulin and glucagon, which help in the metabolism of glucose in the body.

TERMINAL EXERCISES

A. Tick the correct answer of the followings

1. The three protective coverings over the brain also called:
   (A) Membranes (B) Layers
   (C) Meninges (D) Sheaths
2. Which part of the brain controls the body temperature?
   (A) Cerebrum (B) Cerebellum
   (C) Hypothalamus (D) Medulla oblongata

3. The spinal cord is extended from the medulla upto the whole length of the vertebral column and lies within the:
   (A) Neural canal (B) Vertebral canal
   (C) Spinal canal (D) Eustachian canal

4. Which one of the following hormones is secreted by the pancreas?
   (A) Prolactin (B) Thyroxin
   (C) Adrenalin (D) Insulin

B. Answer briefly:

1. What is the nature of the membranes covering the brain? What is the name of the fluid that fills the space between these membranes? What is its role?

2. Describe the three regions of the brain.

3. Differentiate between the following pairs of terms:
   (i) Sensory nerve and motor nerve
   (ii) Cerebrum and cerebellum.
   (iii) Sympathetic and parasympathetic nervous system

4. Define the following terms:
   (i) Receptor
   (ii) Synapse
   (iii) Hormone
   (iv) Neuron
   (v) Impulse
   (vi) Stimulus
   (vii) Effector

5. Given below is a table regarding various hormones secreted by the pituitary gland, and functions of these secretions. Fill in the blanks (1 to 4);

Hormones secreted	Functions
Somatotropic hormone	_____(1)_____
_____(2)_____	Helps in the metabolism of glucose in our body
Thyroid hormone	_____(3)_____
_____(4)_____	In males it stimulates the secretion of testosterone.

6. Imagine that you did not score good marks in your science exam. Do you:
   (a) tear the mark sheet and not let your parents know about it?
   (b) decide that you are not a good student and cannot study science any further?
   (c) discuss your mistakes with the teacher and ask for help from the teacher or another student who has done well and is willing to help you?

   Please choose one of the three options above and provide two reasons for your choice

7. Imagine that you have gone out with three friends. One of them starts smoking and offers the cigarette to the rest of you. One of your friends accepts the offer hesitatingly and also encourages you to try smoking. One amongst you refuses to smoke and says that he did not know that he was in bad company. This person leaves the group in a huff. You also do not want to smoke but at the same time you have been friends with this group for many years now and would like to continue your friendship.

   Please describe in 2-4 sentences how you will communicate with your friends in an attempt to save your friendship without accepting their offer to smoke.

   Please note: There is no single correct answer. The learner needs to demonstrate use of assertive communication skills.

8. After a week, you go out again with the two friends who had asked you to try smoking a cigarette. This time they tell you that it is smart or stylish to smoke and in order to be part of the group, you should also smoke. Would you like to continue/ not continue being friends with them?

   Please state your decision and provide at least two reasons for your decision.

   Please note: There is no single correct answer. The purpose of this activity is to enable the learner to appreciate that friends never pressurize to do things that someone is uncomfortable with. The learner also needs to realize that exploitative relationships, including friendships should be terminated.

9. When a barefoot person accidentally steps on a pin, what will be her/ his immediate response? Explain how this reaction is processed by the nervous system?

10. Give one function performed by each of the following:
    1. Cerebrum
    2. Cerebellum
    3. Hypothalamus
    4. Medulla oblongata
    5. Cerebrospiral fluid

ANSWERS TO INTEXT QUESTIONS

23.1

1. There is no single correct answer. There may be diverse examples. For instance, in farming, a group of people till the land, another group sows the seeds, someone else takes care of the crops and only then everyone enjoys the bounty of a good harvest
2. Secretion of digestive juices

23.2

1. (b) Neuron
2. The sequence should be: ii, iii, i, iv, v
3. A stimulus is an agent or an environmental change which can initiate a response in the body. The stimuli can be of several types. It could be physical (touch, prick, pressure), auditory, chemical, radiant (light), heat or cold, or electrical.

23.3

1. (i) Brain and spinal cord
   (ii) Intelligence and consciousness
   (iii) Balance
   (iv) Medulla/ medulla oblongata
   (v) Gray matter, white matter

23.4

1. Natural reflex and conditioned reflex.
2. Stimulus — receptor — sensory neuron — CNS — motor neuron — effector — response.
3. Correct response has been provided in italics for the column on 'Appropriate Action.' However, there is no single correct reason for the choice that the learner makes. The evaluator needs to keep in mind that the learner is providing logical reasons for their choice.

Situation	Appropriate action voluntary action or reflex)	Reason for your choice
You need to immediately stop your bicycle as a speeding motorbike comes in front of your bicycle.	*Reflex Action*	It is an emergency and there is no time to process information through the central nervous system.
You have scored good marks in all the subjects in class X and now need to choose between science and commerce stream. Your family feels you should study science while you like numbers and would like to study commerce.	*Well thought out voluntary action*	As the learner will have to live with the subject/ career choice that she/he makes, it is important to give priority to their individual choice. This decision should note made impulsively.
You are cleaning your cupboard, a sharp needle pokes you and you remove your hand immediately.	*Reflex Action*	It is an emergency and there is no time to process information through the central nervous system.
You have moved to a new neighborhood and are trying to make new friends.	*Well thought out voluntary action*	It is important to choose friends who care for you and wish you well. Hence, it has to be a well thought out action.

23.5

1. 12 pairs
2. Sympathetic and parasympathetic

23.6

Answers to Question I

1. Blood
2. Goitre
3. Metabolism

Answers to Question II

i-(a); ii-(c); iii-(a); iv-(c); v-(d); vi-(d);
vii-(c); viii-(d); ix-(a); x-(b); xi (c)