











3

CONTROL AND COORDINATION

What we have learned earlier

-  Various types of responses are elicited by organisms in response to stimuli.
-  Nervous system controls and coordinates numerous activities within the body.
-  Control and coordination take place even in organisms such as hydra and planaria with low level of organization.
-  Nervous system is formed of brain, spinal cord and nerves.
-  Brain is the centre that receives messages from various parts of the body and sends messages.
-  Nerves are the pathways through which messages travel.
-  Brain and nerves are formed of nerve cells.
-  Formation of clot (thrombus) within the blood vessels of the brain is called cerebral thrombosis.
-  Breakage of blood vessels of brain is called cerebral haemorrhage.
-  Stroke is a condition that results when parts of the brain are deprived of blood.

You are familiar with the fact that various life activities are going on in organisms all the time. The rate of life processes varies in accordance with the activities performed. Do you feel a rise in the rate of heart beat and circulation of blood while you are playing or doing exercises? For this additional functioning muscles need extra energy. Hence energy production increases and sense organs become more active. These activities take place simultaneously and one will not hamper the other.

How does it happen? Life activities are controlled and coordinated by the nervous system. Is the nervous system organized to perform this function? What are the diseases and disorders that affect the functioning of the nervous system? You can understand more about these aspects from this chapter.

You know that the brain is the centre that receives messages from the various parts of the body and sends appropriate reply to these messages. Let us see how communication takes place within the living organisms that make this possible.

Communication in organisms

What happens when you touch a snail? You might have seen the leaves of rain tree, tamarind etc. closing at dusk. What could be the reason for all this? Touch, light etc. are factors that can bring about certain

responses in living organisms. These factors are called stimuli.

Listen to more examples of stimuli.

- Heat
- Cold
- Pressure
- Sound waves
- Presence of chemicals
- Microbial infection

From this, find out those that we experience within the body (internal stimuli) and outside the body (external stimuli) and note down in the science diary.

Life activities take place in response to stimuli. The control and coordination of the various life activities within the organisms are made possible by the functioning of the nervous system and the endocrine system. Should communication be effective in order to make this possible?

Communication in simple organisms

You know how communication takes place in unicellular organisms. In most unicellular organisms, response to stimuli is brought about through certain chemicals.

Now let us see how communication takes place in those animals such as hydra and planaria with simple organization.

Look at the figures 3.1 (A. D).

Observe the distribution of nerve net in hydra. The nerve net helps to convey the stimulus received from any part of the body to all other parts. Have you noticed the branches that arise from the nerve cords seen on either side of the body of planaria? You can see that at the front part of the body the nerve cords and branches unite in a bilobed structure called cerebral ganglia or brain. How does it look like? The brain, which is

formed by the fusion of nerve cords, controls and coordinates all activities. What is the peculiarity of the nerve cords of earthworm and cockroach? In these organisms, the terminal part of the nerve cord becomes the brain. Can you see small swellings placed at interval in the nerve cord? These are the ganglia formed by the union of cell bodies of neurons. The nerves that arise from these ganglia reach every part of the body.

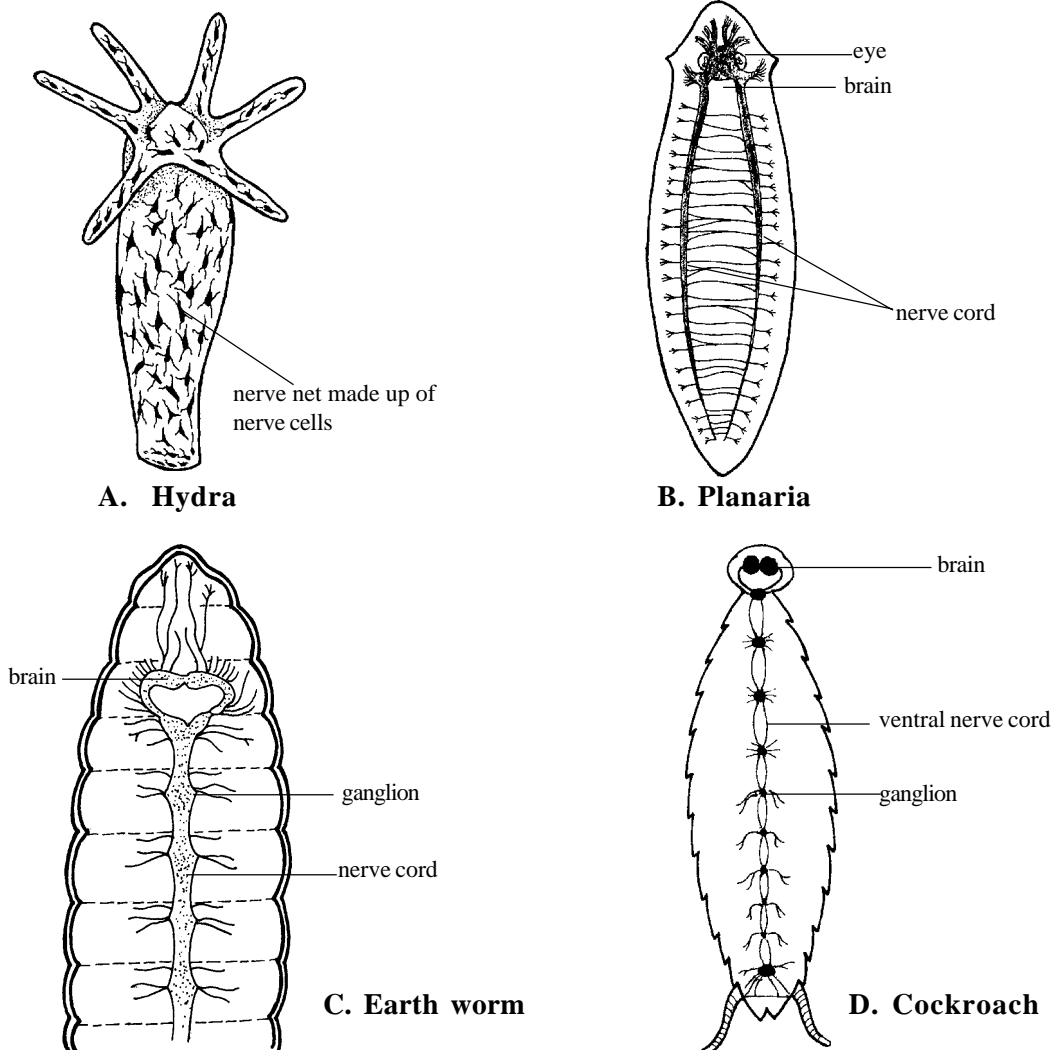


Figure 3.1
Development of nervous system - in different organisms

Don't you notice the gradual increase in complexity in the organization of the nervous system as we pass from organisms of lower grade to higher grade? Discuss and prepare a note.

Nervous system in man

We have understood the difference in the nervous systems of various animals. Nerve cell or neuron is the fundamental unit of the nervous system. Let us examine the structure of a neuron and the way in which transmission of impulse takes place.

Neuron - Structure and Function

Observe the diagram of neuron (3.2).

Have you noticed the axon arising from the neuron? How are they different from dendrons?

the cell body of neuron. From there, they pass out through the axon.

Synaptic knob is found at the tip of each axonite. From the cell body, impulse reaches the synaptic knob through the axonite. Have you noticed (Fig 3.3) how the axonites of a neuron are connected to the dendrites of another neuron? This region is called synapse.

Here the dendrites never touch the axonites. From the synaptic knob, a neurotransmitter called acetylcholine is released in to the synaptic cleft. It excites the dendrites of the succeeding neuron. In this way, the transmission of impulses continues through the neuron. These impulses finally reach the brain, muscles, or glands and

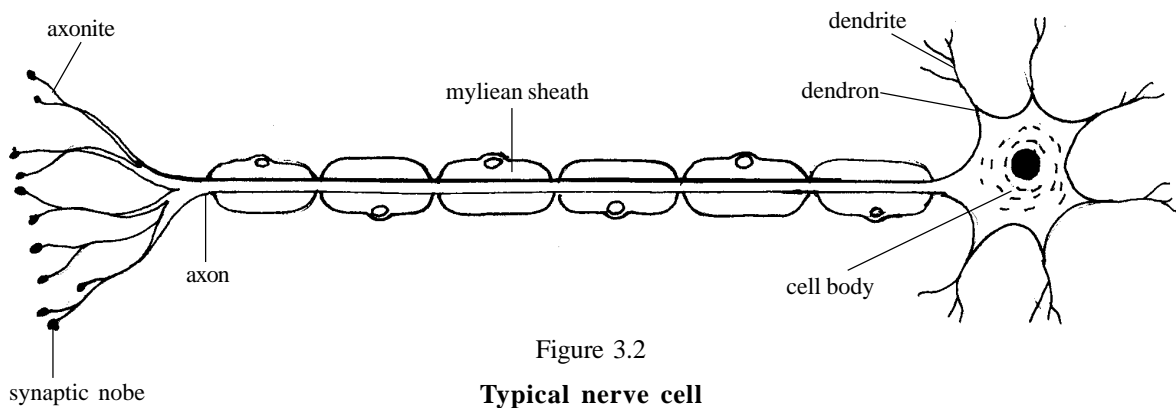


Figure 3.2

Typical nerve cell

The tips of dendrites function as receptors that receive stimuli. These stimuli from the dendrite travel through the dendron in the form of electric impulse and finally reach

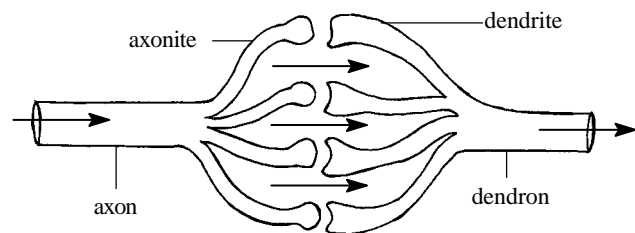


Figure 3.3
Synapse

control their activities. The speed of impulse transmission is between 0.5 to 100 metres per second.

You have now understood that the long fibre that arises from the cell body of a neuron is called axon. The myelin sheath that envelops the axon is made up of fat. This fat is contained inside the Schwann cells that

encircle the axon (Fig.3.4).

Let us see the functions of myelin sheath.

- Functions as an insulator.
- Increases the speed of impulses.
- Protects the axon from external injuries.

Myelin sheath is white in colour. That region of the brain and spinal cord where nerve fibres with myelin sheath concentrate together is called White matter. On the other hand, the cell body of the neuron is grey in colour. That region of the brain and spinal cord where cell bodies of neurons and nerve fibres without myelin sheath concentrated together is called Grey matter.

Observe the figure 3.5 and record in your science diary how impulses travel from one neuron to the next.

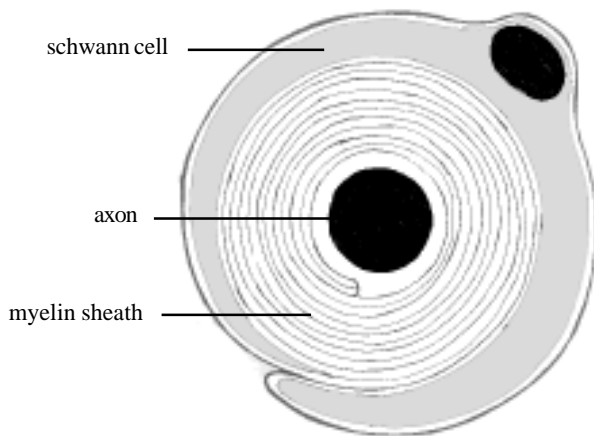


Figure: 3.4
Structure of myelin sheath

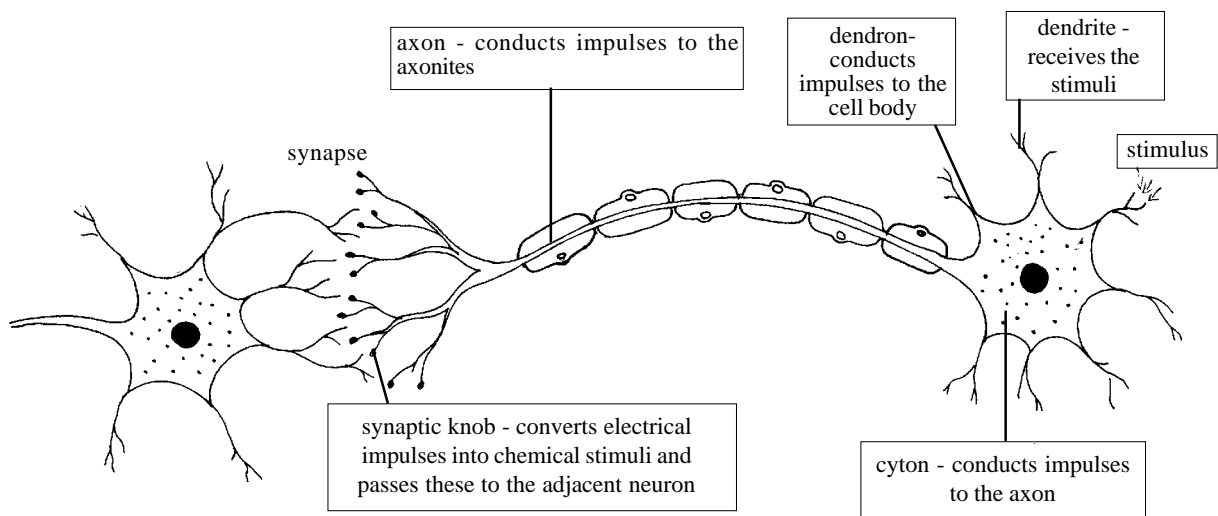


Figure 3.5
Transmission of impulses through the nerve cell

Transmission of impulses with the help of ions

The outside of the cell membrane of a resting neuron is positively charged whereas the inside is negatively charged. This potential difference is maintained with the help of a Sodium pump, which actively pumps out sodium ions (Na^+) from the inside of the nerve fibre by using energy. This potential difference is usually -70 mV. When a stimulus excites a nerve fibre, the sodium pump at that region immediately becomes inactive. As a result, the cell membrane becomes more permeable to sodium ions and sodium ions get in to the neuron. This causes a depolarization of the cell membrane so that the inside becomes positive and outside becomes negative. The sodium pump immediately resumes activity and sodium ions are once again pumped out of the neuron using energy from ATP. The cell membrane becomes impermeable to these ions. Thus the potential difference once again becomes -70 mV and the membrane reaches the resting stage. This is called repolarization. In accordance with the inward and outward movement of sodium ions, movement of potassium ions also takes place. When one region of the axon undergoes repolarization, the succeeding region is excited and is depolarized. This process continues and thus impulse travels through the membrane in the form of a wave of depolarization. This is the electrical transmission of impulse.

Do neurons differ

Look at the diversity in the structure of neurons. (Picture 3.6).

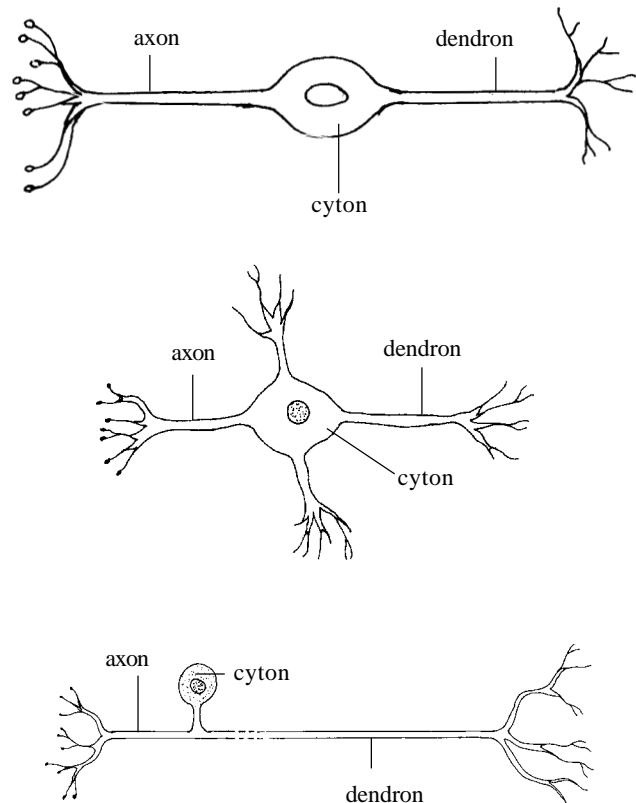


Figure : 3.6

Different types of neuron

Let us see how the neurons are varied with respect to the functions that they perform.

The neurons that carry impulses from receptors to central nervous system are called Sensory neurons. The neurons that carry impulses from the central nervous system to effectors are called Motor neurons. Effectors are organs such as muscles or glands that respond to these impulses.

The cell that cannot divide?

Unlike ordinary cells, mature neurons never divide. Even though this is a fact, it has been understood that a protein called nerve growth factor promotes the regeneration of broken and damaged nerves. It has also been found that by using embryonic stem cells, the degenerating brain cells could be repaired.

Nerves

A nerve is formed by the union of several nerve fibres. Nerve fibres are axons and they are enveloped by a covering made of lipid.

Based on the property of nerve fibres, the nerves are classified into several types.

Sensory Nerve

- Formed by the union of sensory nerve fibres.
- Carry sensory impulses from the receptors to brain or spinal cord.

eg. Optic nerve

Motor Nerve

- Formed by the union of motor nerve fibres.
- Carry motor impulses from brain or spinal cord to different parts of the body.

eg. Hypoglossal nerve (11th cranial nerve)

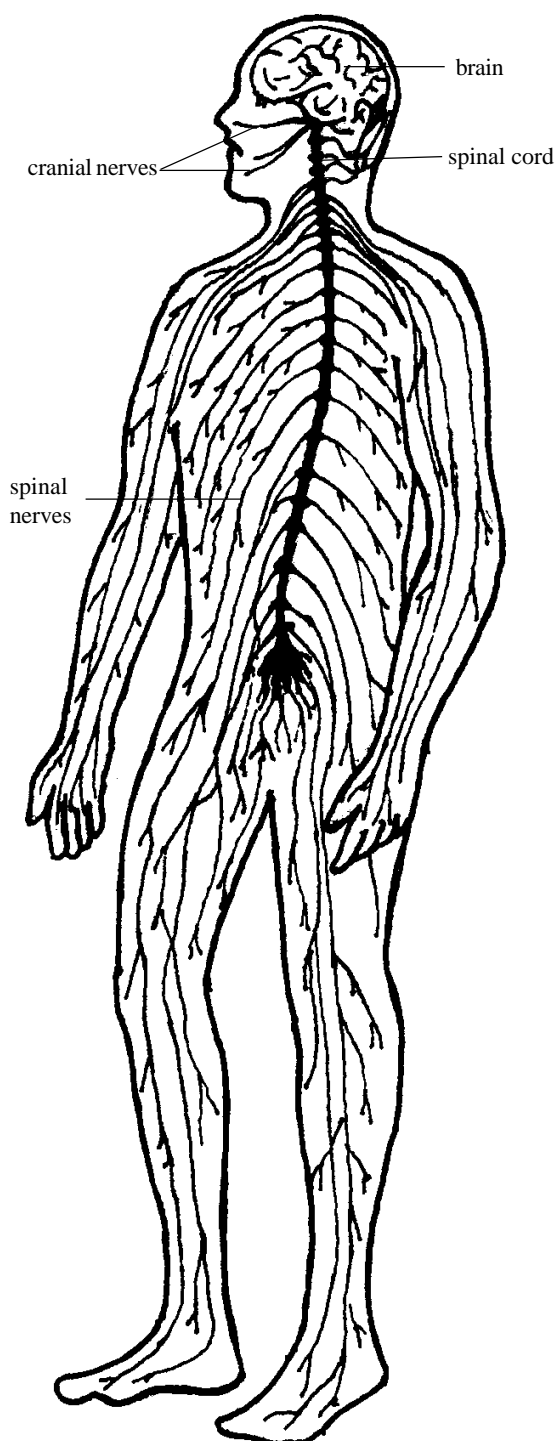


Figure : 3.7
Nervous system

Mixed Nerve

- Formed by the union of sensory and motor nerve fibres.
- Carry sensory impulses from the receptors to brain or spinal cord.
- Carry motor impulses from brain or spinal cord to different parts of the body.

Eg :- Vagus (10th cranial nerve), Facial (7th cranial nerve), spinal nerves etc.

Ganglion

You know that a group of nerve fibres is called a nerve. In certain parts of the body, cell bodies of neurons form a group enveloped by a membrane. This is called ganglion. Numerous ganglia are seen near the brain at the root of cranial nerves and on either side of the vertebral column.

Brain

The brain and the spinal cord are the important parts of the nervous system. In animals, all life activities are under the control of the brain. Let us see how far the structure of brain is suitable to perform this function.

The brain is situated inside a bony cranium. Besides cranium, it is protected in many other ways also. Let us see what they are.

The brain is covered by three layers. They are called meninges. Meninges serve the functions of protection of brain and of

providing nutrients and oxygen to brain tissue through their capillaries. The cerebrospinal fluid (CSF) fills the cavity between these layers. It is synthesized from the blood capillaries within the brain and is reabsorbed into blood. Now it is clear how the brain tissue receives oxygen and nutrients. You can also imagine how the waste formed in the brain tissue is removed. Let us see what are the other functions of cerebrospinal fluid.

- Protects the brain from external shock.
- Helps to maintain a constant pressure within the cranium.

Structure of the brain

Observe the figures 3.8, 3.9. Analyse the important parts of the brain on the basis of the following points.

- How do the cerebrum and cerebellum differ in their organization.
- From where does the spinal cord start?
- Which part is seen just below the thalamus and what is its speciality?
- Which part of the brain is most highly developed?

Functions of the brain

Have you understood the structure of the brain? Look at table III.a showing the functions performed by the different parts of the brain.

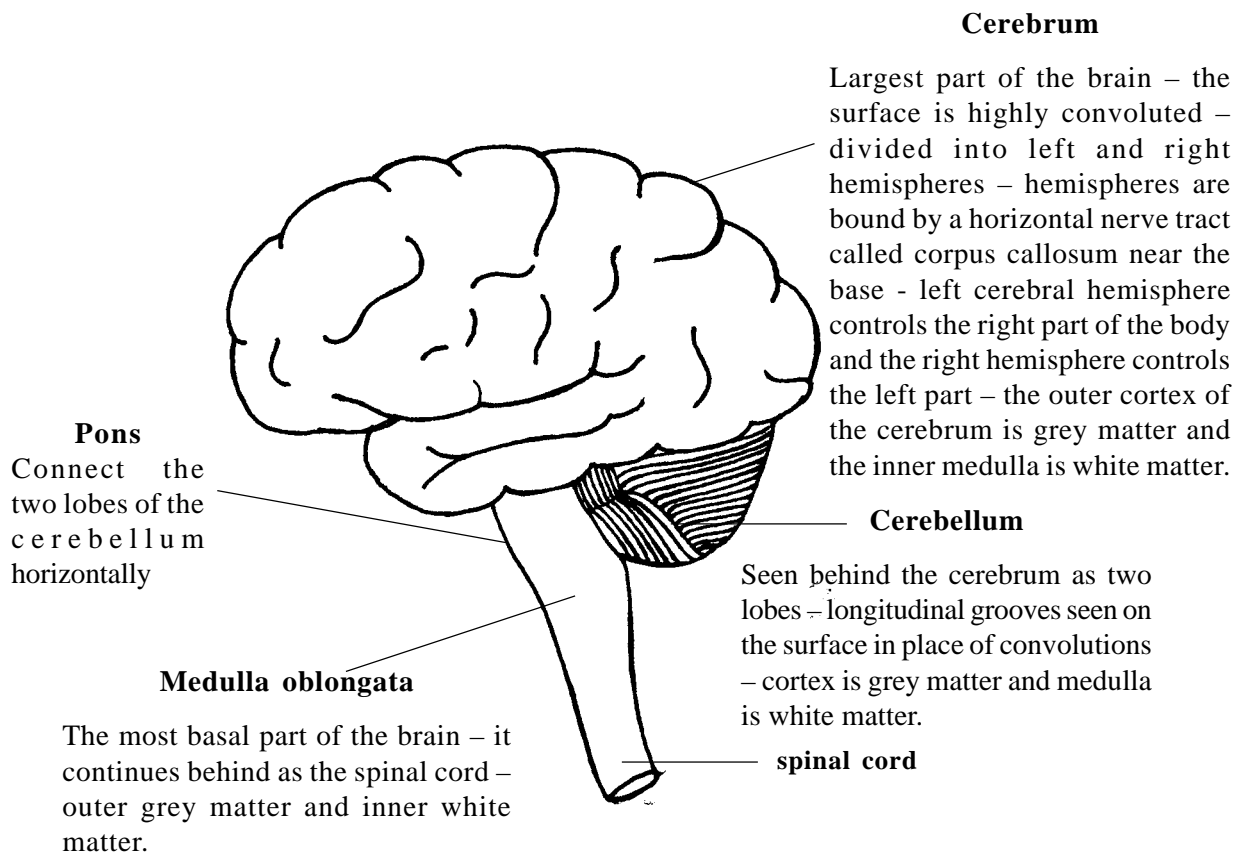


Figure 3.8
External structure of Brain

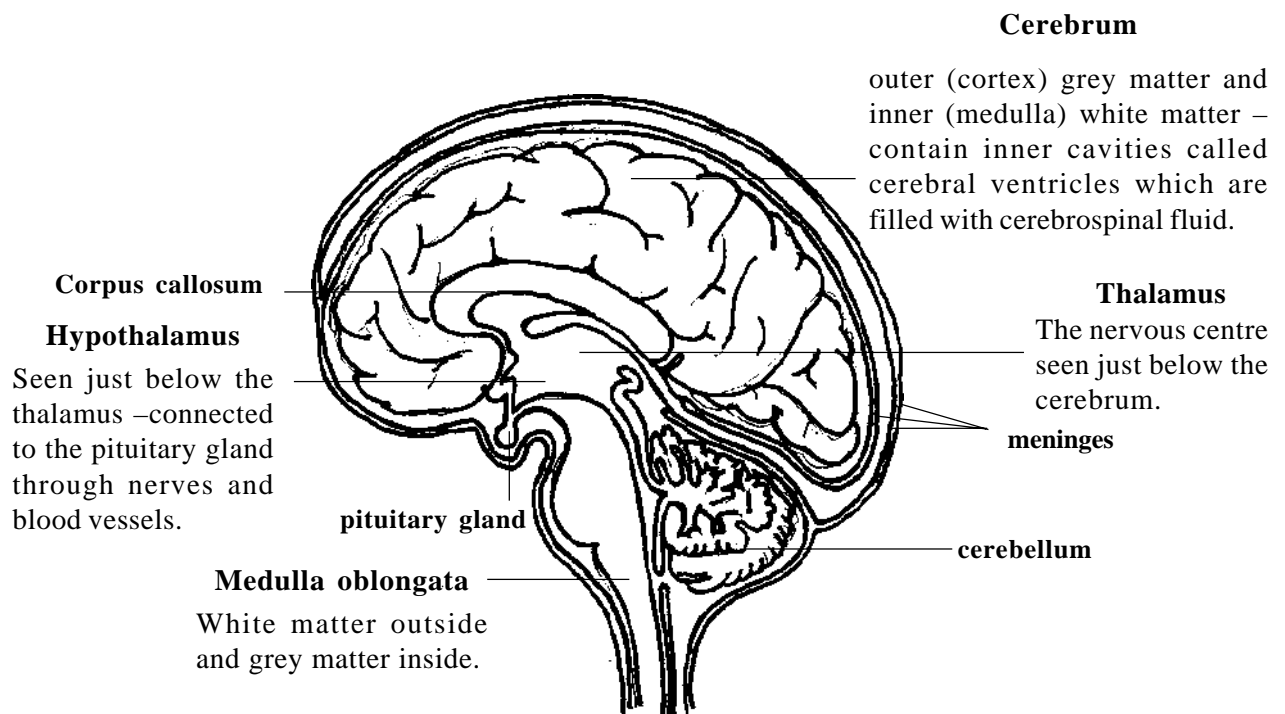


Figure 3.9
Vertical section of the Brain

- Find out the difference in the functions of cerebrum and cerebellum.
- What is the importance of medulla oblongata?
- What is the role of hypothalamus in maintaining homeostasis?

Record your findings in the science diary.

Half a litre per day

Do you know the quantity of CSF continuously formed from the choroid plexus of the brain? 20 millilitres per hour. Then how much per day? This fluid that spreads from the four ventricles of the brain to the central canal of the spinal cord is often used to investigate the disorders of brain and spinal cord by the CSF test.

Part of Brain	Function
Cerebrum	<ul style="list-style-type: none"> ● Centre of consciousness, thought, imagination, memory, analytical thinking. ● Awareness of vision, hearing, smell, taste, touch, heat etc. ● Control of voluntary actions.
Cerebellum	<ul style="list-style-type: none"> ● Maintains balance and equilibrium of body. ● Coordinates muscular activities. Impulses for this come from cerebrum.
Medulla oblongata	<ul style="list-style-type: none"> ● Controls heart beat, breathing, contraction of blood vessels, gastrointestinal movements, vomiting, sneezing, coughing and other involuntary activities.
Thalamus	<ul style="list-style-type: none"> ● Relays transmission of impulses to the cerebrum and from the cerebrum. ● Prevents passage of many of the impulses to cerebrum during sleep. ● Narcotics influence the thalamus and thus prevents the passage of pain impulses to cerebrum.
Hypothalamus	<ul style="list-style-type: none"> ● Maintains homeostasis by regulating the body temperature, water level etc. ● Centre of thirst, hunger, sexual drive etc. ● Controls the secretion of pituitary hormones. ● Production of hormones oxytocin and vasopressin. ● Helps to maintain the normal constitution of blood.
Pons	<ul style="list-style-type: none"> ● Functions as the centre through which impulses travel to and from the cerebellum, spinal cord and other parts of the brain.
Corpus callosum	<ul style="list-style-type: none"> ● Connects the left and right cerebral hemispheres.

Table III a
Functions of the Brain

The convolutions seen on the surface of cerebrum, which is the largest part of the brain, increases its surface area. This helps the cerebrum to contain large number of neurons. Let us see the other peculiarities of the brain of man in contrast to the brain of other animals.

The cerebrum contains centres for storing experiences, learning and memory. There are centres for executing this learned information in accordance with situations. Human cerebrum also contains a special centre for speech called the Broca's area.

Collect pictures that help you to understand the difference in the development of brain in various animals and exhibit on the bulletin board.

The spinal cord

You know that the spinal cord is the continuation of medulla oblongata. Let us

understand more about the spinal cord, which is situated inside the vertebral column.

What other protection does the spinal cord have besides vertebral column?

Like the brain, the spinal cord is also covered by meninges. Have you noticed the central canal seen at the centre of spinal cord? It is filled with cerebrospinal fluid.

Observe the figure 3.10 of the spinal cord. How does the position of grey matter and white matter differ from that of the brain?

Have you noticed how impulses reach the spinal cord? Sensory impulses reach the spinal cord through the dorsal root of spinal nerve. However, motor impulses reach the body parts through the ventral root of spinal nerve.

In this way, 31 pairs of the spinal nerves originate from the spinal cord.

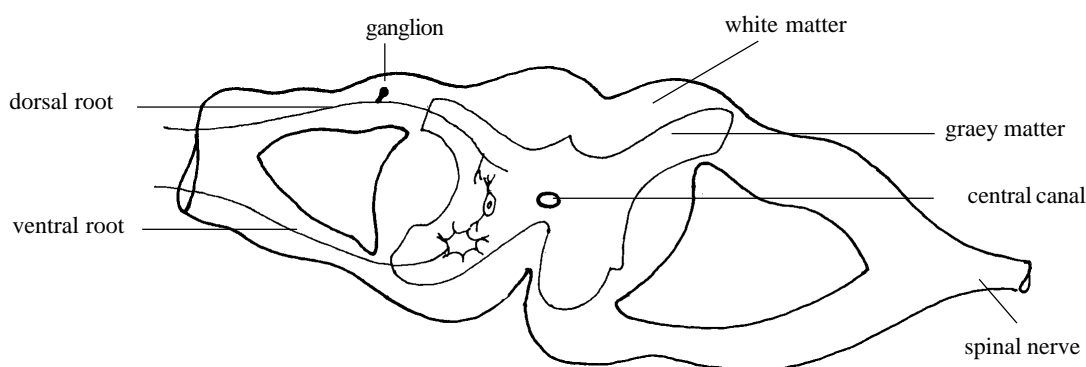


Figure 3.10

Spinal cord - structure in cross section

Reflex action

What happens if your hand accidentally touches a very hot object?

You might have had so many experiences like this. Such a spontaneous and involuntary action is called reflex action. It takes place without the knowledge of our conscious mind. Have you noticed how such activities take place within the body? How do responses take place in accordance with the stimuli that receptors receive? Observe the figure 3.11 and analyse the process. Record your findings in the science diary.

Pavlov's dog

In 1920 Pavlov, the Russian Scientist, made elaborate studies about reflexes. He found out that a hungry dog salivates when it sees food or perceives the smell of food. He called it unconditioned reflexes. For some days while the food was served, a bell was also rung. Later the dog was found to have salivated even when the bell was rung. He called the salivation, the conditioned reflex. If you happen to touch on a hot object you withdraw your hand. Do you know the reason? Find out.

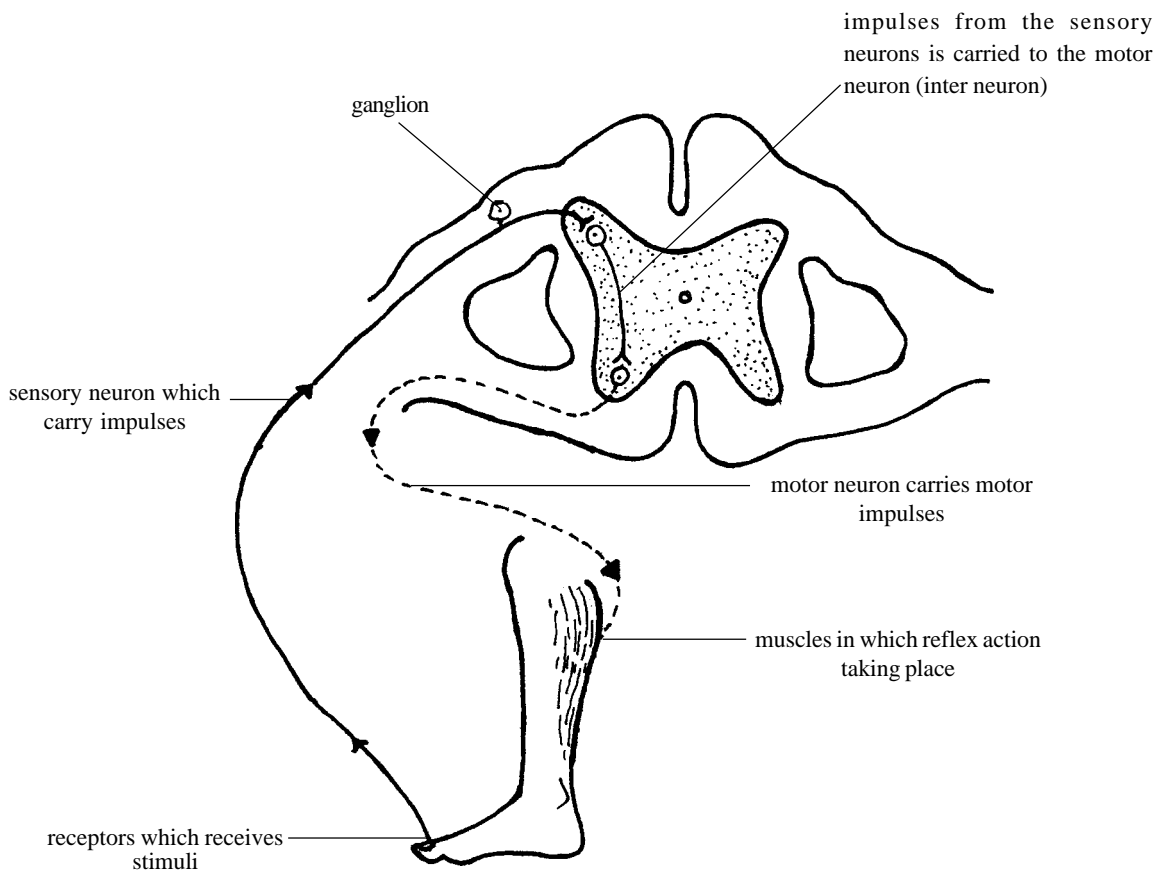


Figure 3.11
Reflex arc

- Receptors receive stimuli.
-
-
-
-

The reflex arc is the pathway through which impulses travel during reflex action.

Now you have understood the role of the spinal cord in coordinating reflex activities. What are the other functions of the spinal cord?

- To receive impulses coming from the various parts of the body and send them to the brain.
- To receive impulses coming from the brain and send them through the spinal nerves.

The sudden blinking of the eyes when light unexpectedly strikes the eyes is also a reflex action. Do you know which part of the nervous system is associated with this action? Now you have understood that cerebrum also brings about reflex action.

Now it is quite clear how the brain and spinal cord control and coordinate bodily activities. The brain and the spinal cord together constitute the central nervous system.

The area that helps you to visualize the thing that you have heard

When you hear the name of a very familiar thing, you would be able to visualize it. A specific part of the cerebrum helps you to do so. This part is called Wernicke's area. Several axons from the visual and hearing centres of the cerebrum reach there. That is why the picture of the thing comes to your mind as soon as you hear its name. Wernicke's area is essential for coordinating language and imagination. What will happen if this area is damaged? Though you are able to understand the words that you hear, you won't be able to organize them in the form of a sentence. Though you are able to read, you won't be able to understand the meaning.

The autonomous nervous System

You know that the medulla oblongata is the region that regulates heartbeat, breathing etc. The system that helps to bring about such activities of internal organs is called Autonomous nervous system. Normally such involuntary activities take place by the coordinated efforts of the medulla oblongata and autonomous nervous system.

Let us see how the autonomous nervous system influences the life activities.

Parasympathetic system

Sympathetic system

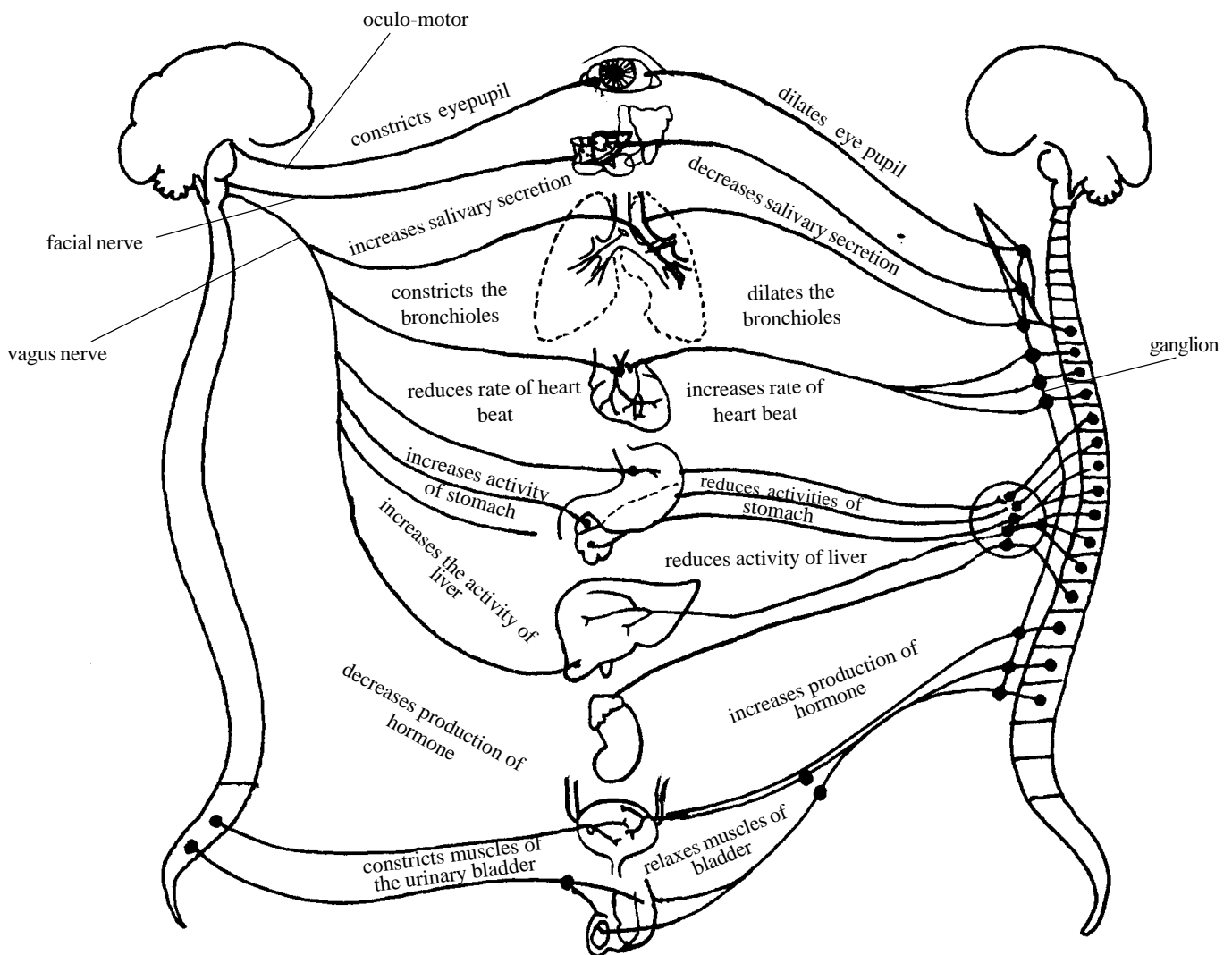


Figure : 3.12
Autonomous nervous system

Observe the figure 3.12. Based on the points given, discuss and record your inferences in the science diary.

- To which organs of the body do the nerves go from the ganglions near the vertebral column?
- Which are the organs that receive nerves starting from the brain?
- Which are the organs whose activities are influenced by the sympathetic system?
- Which are the organs whose activities are influenced by the parasympathetic system?

You have understood that the activities stimulated by the sympathetic system are inhibited by the parasympathetic system and vice versa.

Ganglia near the vertebral column are connected to the spinal cord by various nerves.

The sympathetic system is formed by the chain of ganglia on either side of the vertebral column and the associated nerves. The parasympathetic system is formed by the nerves arising from the ganglia of the brain and the posterior part of the spinal cord. These two together constitute the autonomous nervous system. It is part of the Peripheral nervous system consisting of 12 pairs of cranial nerves and 31 pairs of spinal nerves.

Look at figure 3.12 and understand what all life activities are controlled by the Vagus nerve (10th cranial nerve).

Prepare a note on the role of the autonomous nervous system in bringing about normal activities of internal organs.

You have understood the nervous system of man. Look at the flow chart given below (Illustration I) showing the various parts of the human nervous system.

Disorders and diseases that affect the nervous system

What will be the consequence if some damage occurs in the nervous system that controls and coordinates all life activities? Let us be familiar with some disorders and diseases that affect the nervous system.

Epilepsy

You might have heard about epilepsy. What are its symptoms?

- The patient becomes unconscious.
- The patient strikes his hands and limbs against the ground.
-
-

These are the symptoms of a brain disorder. This is due to the discharge of abnormal and disordered electrical impulses from the cerebral cortex.

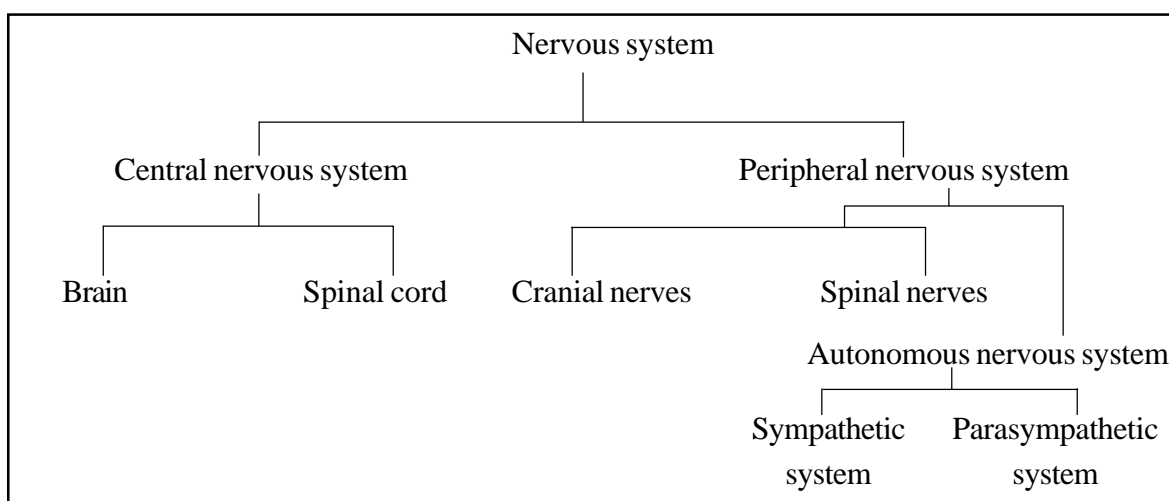


Illustration I

Stroke

The formation of clot (thrombus) within a blood vessel is called thrombosis. The thrombosis of the artery of brain is called cerebral thrombosis. What will be its consequence? That part of the brain to which blood supply is blocked becomes inactive. That part of the body, which is under control of the affected part of the brain, is paralyzed.

You might have also understood the haemorrhage that develops in the artery of brain. Both cerebral thrombosis and cerebral haemorrhage can cause stroke.

What are the precautions to be taken in the diet in order to prevent stroke? Discuss.

Meningitis

Infection to the meninges of the brain can cause meningitis. Virus, bacteria, fungus and other parasites are the causative agents. CSF test is an important method to diagnose the disease.

Rabies (Hydrophobia)

You know about rabies. How does it spread? The causative agent is rabies virus found only in mammals, especially dogs. It affects the central nervous system. The symptoms begin to appear normally 4 to 8 weeks after infection. The victims cannot drink water, even if they try, due to paralysis of lower jaw. This condition, together with the uncontrolled contractions of the muscles

of the diaphragm and larynx, develops a morbid fear about water in the patient. This is called Hydrophobia (Hydro = water; phobia = repellent). Effective vaccine is available against rabies.

Alzheimer's disease

This disease is either due to genetic factors or due to the destruction of neurons in the brain leading to irregularities in the working of the cerebral cortex. The disease is commonly seen in people aged above 60 years. The affected persons show severe memory loss.

Parkinson's disease

This disease is also usually seen in people above the age of 60. This is due to the degeneration of motor neurons of the brain that produce the neurotransmitter, dopamine. Consequently, certain muscles begin to contract involuntarily. As a result, the patient develops symptoms such as tremor in hands, lack of coordination of muscular activities and loss of ability to write or speak clearly. This disease, which is very uncommon, is not a hereditary disease.

Poliomyelitis, leprosy etc are also certain diseases that affect the nervous system. Collect more details about these diseases and record in the science diary.

Let us familiarize with certain methods to find out the disorders of the nervous system.

You know that doctors often suggest taking EEG with respect to certain diseases. Electroencephalogram (EEG), which is a record of the electrical impulses of the brain is analyzed to diagnose diseases.

Modern devices such as C.T. Scan (Computerised Tomographic Scan), MRI Scan (Magnetic Resonance Imaging Scan) are also used for this.

Mental health

Have you thought of the mind? People often say, “my mind is not well” or “I have some mental worry” and the like. What is your opinion about the mind? Discuss.

Mind and body

Whenever there is some disease for the body, we naturally develop mental restlessness. Let us see how the condition of the mind affects the body.

Depression can cause indigestion. Chest pain, headache etc are common among people having the fear of success. Mental health and physical health are complementary. Find more examples on how mental health affects body, and record in the science diary.

Let us see the factors that influence mental health.

- Disorders of the nervous system.
- Hereditary factors.
- Experiences of childhood.

- Family atmosphere.
- Alcoholism and drug addiction.
-
-

Should alcohol be avoided?

Have you noticed the behaviour of alcoholics? Do you know how alcohol affects the nervous system?

- It upsets the functioning of nervous system.
- It affects the coordination of muscular activities.
- It lowers body temperature.
- It slows down reflexes.

Find out the influence of alcoholism on the functioning of different organs and prepare a note.

The use of drugs

You might have read about the harmful effects of the use of drugs such as pan masala. Let us see how drugs affect the nervous system.

- Decreases the ability of central nervous system for coordination.
- Loss of ability for effective communication.
- Creates hallucination.
- Suppresses the nervous system.
- Develops addiction to drugs.

Various substances like ganja, hashish, L.S.D, morphine, opium, and cocaine are used as drugs. Changes are brought about in the activities of the body based on the nature of drugs. The marketing and use of drugs are strongly prohibited by law.

Discuss and present in the class seminar, the consequences of alcoholism and

drug abuse and the social problems created by these evils.

You are convinced about the role of nervous system in the control and coordination of life activities. We have to give prime importance to the care and health of the nervous system.

SUMMARY

- ❖ Nervous system plays an important role in the control and coordination of life activities.
- ❖ The complexity of nervous system increases as it goes from simple animals to complex ones.
- ❖ Neuron differs from other cells in structure and function.
- ❖ Neuron is the basic unit of nervous system. Neurons communicate through synapses.
- ❖ Impulses reach the central nervous system and from there to various parts of the body through nerves.
- ❖ Based on the function, nerves are classified into sensory nerves, motor nerves and mixed nerves.
- ❖ Cerebrum controls all voluntary activities. Medulla oblongata controls all involuntary activities. Cerebellum helps to coordinate muscular movements and maintain balance and equilibrium.
- ❖ Central nervous system is formed of brain and spinal cord.
- ❖ The complementary activities of the sympathetic system and parasympathetic system, which are parts of the autonomous nervous system, help to maintain the normal functioning of the internal organs.
- ❖ Mental health and physical health are inter related.
- ❖ Certain diseases, use of alcohol and drugs, malfunctioning of the brain etc upset the functioning of the nervous system.

FURTHER ACTIVITIES

- ⇒ How does a neuron differ from an ordinary cell in structure? Write notes. Is the structure of neuron suitable for the transmission of impulses? Analyse.
- ⇒ Suppose that the secretion and absorption of cerebrospinal fluid stop. How does it affect the brain?
- ⇒ Man is the most intelligent animal. What could be the facts that helped us to reach such a conclusion?
- ⇒ A hit to the medulla oblongata can cause sudden death. Explain why.
- ⇒ Analyse the activity of the nervous system during the following two instances;
 - a. A thorn penetrates the foot of a bare-footed person. He suddenly withdraws the foot by making a sound.
 - b. He takes out the thorn using a pin. Though he experiences pain, still he does not withdraw the foot.
- ⇒ Make a model of the neuron using suitable materials.

