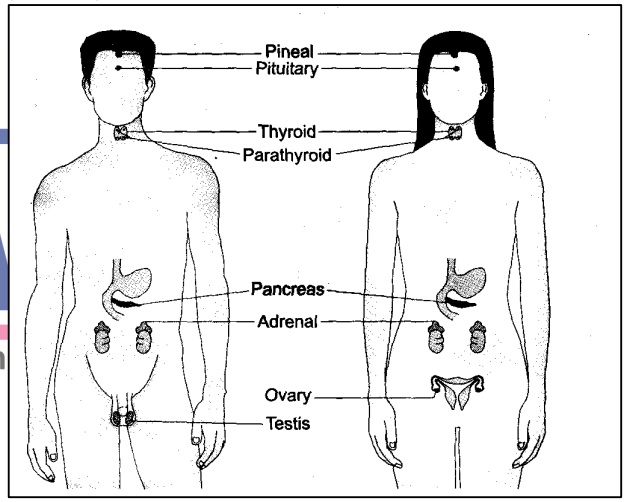
Coordination in animals: Coordination of the body functions in animals is brought about by the endocrine glands and the nervous system. The substances produced by endocrine glands are called hormones. Some characteristics of animal hormones are as follows:

1. Hormones are different compounds such as proteins, steroids, etc.
2. Hormones are chemical messengers which are discharged in the blood by endocrine glands, from where they reach different parts of the body.
3. A hormone will go to a particular organ and influence its functions. The organ that is influenced by a particular hormone is called the target organ of that hormone.

A hormone acts as a trigger or switch. Endocrine glands are directly or indirectly controlled by the nervous system, which receives information about changes in the external environment or internal conditions in the form of stimuli.

Control and coordination in animals depend on two things for information transmission— chemical signals of hormones and nerve impulses (electrical impulses). If they depended only on electrical impulses through nerve cells, a limited range of tissues would be stimulated. Since they get chemical signals in addition to the nerve impulses, a large range of tissues are stimulated. As a result, animals can show wide-ranging changes in response to stimuli.



Human Endocrine Glands:

Hormones are secreted by the endocrine glands, which are ductless glands. We shall now learn about some important endocrine glands in the human body.

Pituitary gland: The pituitary is a small gland attached to the ventral side of the brain. The pituitary is the most important endocrine gland, as it secretes a number of hormones that regulate various functions of the body. It also controls the functioning of the other endocrine glands. Therefore, it is called the master gland of the body. The pituitary gland consists of two main parts—the anterior lobe and the posterior lobe. The anterior lobe secretes various hormones. One of these is the growth hormone which regulates growth and development of the body. It promotes the growth of bones and muscles when the body is growing. An excessive secretion of this hormone leads to gigantism, an abnormal condition of excessive growth. On the other hand, insufficient secretion of the growth hormone in childhood retards growth, leading to dwarfism, an abnormal condition of stunted growth. The anterior lobe of the pituitary gland also secretes hormones that influence the secretion of milk in the mammary glands, the production of sperms in males and the maturing of ova (eggs) in females. Two types of hormones are secreted by the posterior lobe of the pituitary. One of these helps in childbirth and the other influences the reabsorption of water in the kidney.

Pineal gland: It is a small gland attached to the dorsal side of the brain. It has light-sensitive cells. It controls the biological clock (the timing mechanism by which an organism controls regular activities such as sleeping).

Thyroid gland: Thyroid is a large gland located behind the larynx (voice box) in the neck. The main hormone secreted by this gland is thyroxine, which contains iodine. Thyroxine controls the metabolism of carbohydrates, fats and proteins, and brings about balanced growth. Excessive secretion of thyroxine is called hvperthyroidism. It increases the general metabolism of the body. As a result, fat stored in the body is depleted and there is a loss of body weight. Insufficient thyroxine secretion is called hypothyroidism. It lowers the general metabolism of the body and increases body weight. By slowing down metabolic activity, hypothyroidism retards body growth and brain development in children. When the thyroid gland becomes overactive and secretes excess thyroxine, it becomes enlarged. As a result, the neck swells up and the eyeballs bulge outward. This is called exophthalmic goitre. Swelling of the thyroid may also be due to the deficiency of iodine in the diet. This is called simple goitre. To prevent this it is important for us to have iodized salt in our diet. Iodine is needed for the synthesis of thyroxine.

Parathyroid glands: These are two pairs of small glands buried in the thyroid gland. They secrete parathormone, which increases the level of calcium in the blood by taking out calcium from the bones. A certain amount of calcium in the blood is essential for functions such as muscular activity and blood clotting.

Thymus gland: This gland, located near the heart, is present in newborn babies. It gradually becomes smaller with age and is degenerated or lost in the adult. It produces WBCS which fight infection.

Islets of Langerhans: The pancreas is a digestive gland located in the C-shaped bend of the duodenum. Inside this gland there are groups of hormone-secreting cells. These groups are called the islets of Langerhans. Among the hormones produced by them, insulin is the most important. Insulin controls the rate of oxidation of glucose. It helps the liver and muscle cells to absorb glucose from the blood. It also controls the formation of glycogen from glucose in the liver.

People who are unable to secrete sufficient insulin suffer from a condition called diabetes mellitus. The level of glucose in their blood keeps on rising, and after a limit the kidney lets the extra glucose be excreted with urine. Doctors advise diabetics to take less sugar in their diet. Some diabetics are advised to take injections of insulin, if they have very high levels of blood sugar. High levels of blood sugar harm the body in many ways.

Adrenal glands: We have two adrenal glands, one on each kidney. The adrenal glands secrete the hormone called adrenaline or epinephrine. This hormone is secreted when an individual is under great physical or emotional stress or feels threatened by some kind of danger. Excitement generally stimulates adrenaline secretion. Adrenaline increases the heartbeat, rate of respiration and blood pressure. More air is inhaled as the diaphragm and the rib muscles contract, expanding the chest cavity. Adrenaline constricts all the blood vessels except those that supply blood to the heart muscles and skeletal muscles. As the small arteries around the digestive organs constrict, blood is diverted to the skeletal muscles to carry out a response. Adrenaline is called 'fight and flight' hormone

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because there is a surge of adrenaline when a person is fighting or preparing to fight or running away from danger. The changes caused by adrenaline prepare the body to react during an emergency. Hence, adrenaline is also called the 'emergency hormone'.

Testis: The main function of the testis is to produce sperms. The testes also synthesize the male sex hormone testosterone. Testosterone secretion begins at the onset of puberty (age of sexual maturity), at 10—12 years of age. It helps in the development of secondary sexual characters in males, e.g., moustache, beard, etc.

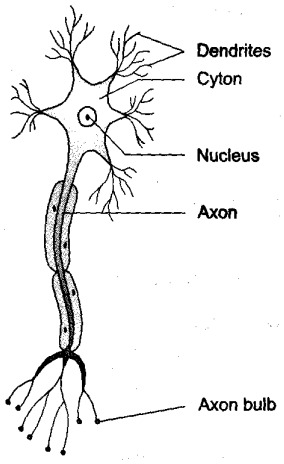
Ovary: At the onset of puberty the ovaries begin to secrete oestrogen, a female sex hormone. Oestrogen produces secondary sexual characters in females and prepares the body for pregnancy. During pregnancy, the ovaries secrete special hormones that help in the development of the baby.

Control of Hormone Secretion: We have a feedback mechanism for controlling the precise quantity and timing of hormone secretion. For example, when we take a meal, our blood sugar level rises. The response to this stimulus is the secretion of the required amount of insulin. The insulin carries glucose to the tissues. As a result, the blood sugar level falls and insulin secretion is reduced. Such control of hormone secretion helps maintain a state of balance in the body.

The human nervous system: The nervous system performs the following three functions:

1. Sensory input, that is, the detection of stimuli by the receptors, or sense organs (e.g., eyes, ears, skin, nose and tongue)
2. Transmission of this input by nerve impulses to the brain and spinal cord, which generate an appropriate response
3. Motor output, that is, carrying out of the response by muscles or glands, which are called effectors

Two types of cells constitute the nervous system—neurons and neuroglia. The neurons conduct impulses and the neuroglia support and protect the neurons. A neuron consists of a cell body called cyton, and two types of processes—dendrite and axon.



Dendrites or dendrons: These are hairlike processes connected to the cyton. They receive stimulus, which may be physical, chemical, mechanical or electrical, and pass it on to the cyton.

Cyton It is the cell body, with a central nucleus surrounded by cytoplasm.

Axon From one side of the cyton arises a cylindrical process filled with cytoplasm. This process is called axon. It is the longest part of the neuron. It transmits impulse away from the cyton. Its tip has a swelling called axon bulb. Generally, a neuron has one axon. The ending of an axon may be branched. These endings are called synaptic terminals. The gap between a synaptic terminal and the dendrite of another neuron or an effector cell is called a synapse.

How do we feel a hot or cold object? How do we feel pain? Why do different things have different smells and tastes? There are thousands of receptor cells in our

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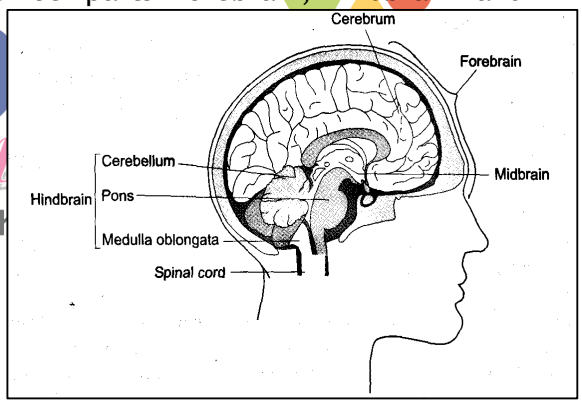
sense organs. They detect stimuli such as heat, cold, pain, smells and tastes. There are different types of receptors such as algesireceptors (for pain), tangoreceptors (for touch), gustatoreceptors (for taste), olfactoreceptors (for smell), and so on. The stimulus received by a receptor is passed on in the form of electrical signals through the dendrites of a neuron to the cyton of the neuron. The cyton transmits only strong impulses. Weak impulses are not further transmitted. An impulse passed on by the cyton travels along the axon of the neuron. When it reaches the end of the axon, it causes the axon bulb to release a chemical which diffuses across the synapse and stimulates the dendrites of the adjacent neuron. These dendrites in turn send electrical signals to their cell body, to be carried along the axon. In this way, the sensation from the receptor is passed on to the brain or spinal cord. A signal from the brain is similarly passed on to the effector, which carries out the appropriate response.

In humans and vertebrates, the nervous system may be divided into the (1) central, (2) peripheral, and (3) autonomic nervous system.

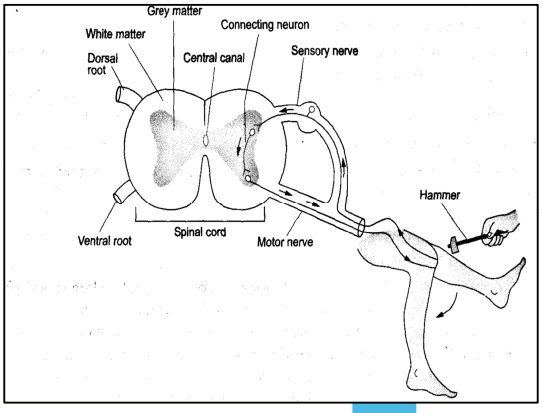
Central nervous system: The central nervous system consists of the brain and the spinal cord.

Brain: It is the most important coordinating centre in the body. It is lodged in the brain box, or cranium, which protects it. The brain is covered by membranes called meninges. Between the membranes and the brain and also inside the brain, there is a characteristic fluid, called cerebrospinal fluid. This also protects the brain. The brain may be divided into three parts—forebrain, midbrain and hindbrain.



1. The forebrain (cerebrum) is the anterior part, consisting of two large hemispheres divided by a longitudinal fissure. The surface of the hemispheres has many folds and is called cerebral cortex. The cerebral cortex consists of numerous neurons, and the folds serve to increase the surface area so that the maximum number of neurons can be present. The cerebral hemispheres are seats of intelligence and voluntary action. The forebrain also contains olfactory lobes, which are the centres of smell; and the diencephalon, which has centres of hunger, thirst, etc. To the floor of the diencephalon is attached the pituitary gland.
2. The midbrain includes optic lobes, which are the centres of vision.
3. The hindbrain is the posterior part, located below the forebrain. It consists of the cerebellum, pons and medulla oblongata. The cerebellum is the coordination centre, and maintains the body's posture and balance. It also controls some precise voluntary actions such as those involved in writing and speech. The medulla oblongata in the brain stem is the centre of involuntary actions, like swallowing, coughing, sneezing, salivation, vomiting, heartbeat and breathing. The medulla oblongata is continued into the spinal cord. The pons relays information between the cerebellum and the cerebrum.

Spinal cord It is a long cord which arises from the medulla oblongata and runs through the vertebral column (backbone). The vertebral column protects the spinal cord. The spinal cord it also covered by meninges. A cross section of the spinal cord shows the central canal, which it filled with cerebrospinal fluid. Around the canal are dusters of cytons, which form the grey matter. The peripheral part has mainly axons and is called white matter. From each side of the spinal cord two roots, the dorsal and the ventral root, arise. The dorsal root is joined by a nerve called sensory nerve, which picks up sensations from the sense organs (receptors). From the ventral root arises the motor nerve, which takes messages from the spinal cord to the muscles or glands (effectors).



Reflex action: What happens when you touch something hot or your finger is pricked by a needle? You immediately pull your hand away, without even thinking why you are doing so. Such sudden involuntary responses to stimuli are examples of reflex action. The response may be different when your conscious thought process is involved. For example, when a doctor pricks you with an injection needle to inject a medicine into your arm, you do not withdraw your arm immediately. Your conscious thinking tells you that the medicine is being administered to cure your disease. In this case, a message from the spinal cord goes to the cerebrum, the thinking part of your brain, and your thinking brain directs your arm to bear the pain and not pull away.

The spinal cord is the centre of reflex action.

Reflex actions are produced by reflex arcs, which may be formed anywhere along the spinal cord, nearest to the receptor and effector. A reflex arc is formed by a sensory nerve and a motor nerve joined by a connecting nerve present in the spinal cord. As the impulses do not have to travel all the way to the brain and back, the detection of stimuli and the completion of responses are faster.

Reflex action is an extremely quick action, which does not involve any thinking by the brain. If someone hits your leg with a hammer the leg is immediately withdrawn. In this type of reflex action the impact of the hammer (stimulus) received by the receptor is sent to the spinal cord through the sensory nerve. The message is received by the connecting nerve in the spinal cord. The connecting nerve then sends a response through the motor nerve to the muscles (effectors) to pull the leg away. Thus, reflex action is a sudden, involuntary motor response to a stimulus. The flow of food in the alimentary canal, blinking in strong light or in response to a sudden movement in front of the eye, sneezing, coughing, yawning, hiccupping, shivering, etc., are also reflex actions.

Peripheral nervous system: The peripheral nervous system includes 12 pairs of cranial nerves arising from the brain and 31 pairs of spinal nerves arising from the spinal cord. The nerves from the brain and the spinal cord connect the skeletal muscles and control their activity according to the directions and demands of the

body. These nerves are, therefore, related to voluntary acts, i.e., they act according to our will.

Autonomic nervous system: The autonomic nervous system controls and integrates the functions of internal organs like the heart, blood vessels, glands, etc., which are not under the control of our will. The autonomic nervous system has two subdivisions: sympathetic and parasympathetic. The organs receive both sympathetic and parasympathetic nerves. The two types of nerves have opposite effects on the organs, i.e., if one is stimulatory, the other is inhibitory.

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