

5

CHEMICAL CO-ORDINATION IN LIVING ORGANISMS

What we have learned earlier

- Plants and animals differ in their growth.
- The stem grows towards light and the roots grow towards water.
- The leaves of Mimosa plant fold themselves on touching.
- The roots of mangrove trees grow upwards. Some plants climb on supports.
- Plant hormones influence activities like growth of stem, flowering etc.
- Artificial hormones can be utilized for stimulating processes such as rooting, flowering etc.
- The hormones produced by endocrine glands control physiological activities.
- Over production and under-production of some hormones cause abnormalities in growth.

You have already learned about the role of nervous system in controlling and co ordinating life activities of organisms. The activities controlled by nervous system are those which happen quickly. But, activities such as growth, reproduction, maintenance of glucose level in blood, reabsorption of water in kidneys etc. that take place regularly also need to be regulated. The chemicals that regulate such activities are called hormones. The hormones co-ordinate various activities that take place within and between cells, by chemical means.

You may be aware of the different stages in the metamorphosis of a butterfly. This stepwise and systematic process is caused by the action of certain hormones (eg: Juvenile hormone, ecdysone). Life activities such as cell division in invertebrates like hydra, reproduction in flatworm are also regulated by hormones. The hormones also control activities like maintenance of osmotic and ionic balance in vertebrates like fishes, migration in birds and so on. The hormones have been identified even in unicellular organism like protozoa. Similarly, hormones play a significant role in regulating several biological activities in human beings as well.

In this chapter, we will study some of the important hormones and their functions. We will also study the hormones that regulate the activities in plants viz. growth, movement,

flowering and shedding of leaves and their beneficial use in the field of Agriculture.

Hormones in human beings

We know that the digestive glands produce enzymes involved in digestion. These enzymes are secreted from the glands through specific ducts to their sites. But the glands which secrete hormones have no ducts. The hormones are transported to their target sites of action through circulation. Therefore, these glands are called endocrine

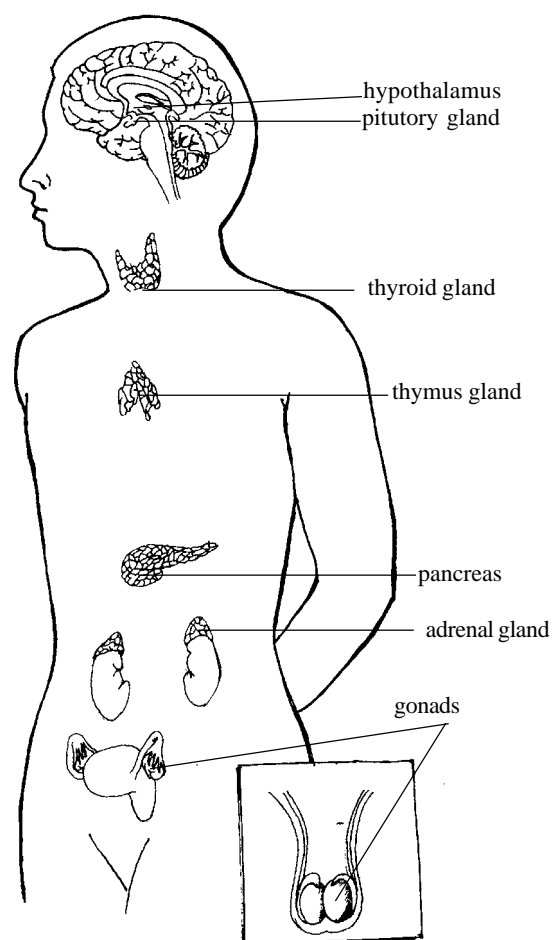


Figure 5.1
Various endocrine glands

glands or ductless glands. The hormones have action only in a target organ or tissue.

Observe the figure 5.1 and study the various endocrine glands in the human body and their position. We shall now learn about the various hormones and their functions.

Thyroid Gland

This is the largest endocrine gland in the human body. Study the figure 5.1 and find its position. Have you noticed the two lobes of this gland? The thyroid gland produces

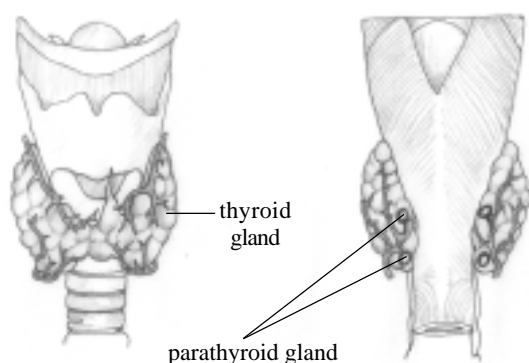


Figure 5.2
Thyroid gland

the hormone called Thyroxine. Iodine is required for the production of this hormone.

Have you heard of goitre? What are its symptoms? The enlargement of thyroid gland due to deficiency of iodine in blood is termed goitre. This condition can be prevented by eating small fishes and vegetables which contain iodine.

We shall now study the functions of thyroxine. They include :

- Break down of food and release of energy
- Growth and activity of the brain
- Growth of body
- Maintenance of healthy skin
- Heart-beat

Let us see how abnormal secretion of Thyroxine affects various functions in our body.

Hypothyroidism

A condition caused by under-production of Thyroxine. It is characterized by :

- Low energy production
- Bloating of body
- Slowing down of heart-beat
- Loss of appetite, lethargy
- Dry skin

Hyperthyroidism

A condition caused by over-production of Thyroxine. The symptoms are :

- Energy production increases
- Emaciation of body
- Increased heart-beat
- Increased appetite
- Frequent sweating
- Shivering of hands

The symptoms due to the deficiency of thyroxine are clear from the above mentioned points. Apart from these, it also causes a condition characterized by the retardation of mental and physical development. This condition is termed cretinism. But in adult the deficiency of thyroxine leads to a disease

called Myxoedema. The symptoms include puffiness, oedema, dry skin and lethargy.

What happens when there is over-production of thyroxine? The affected persons experience mental disturbance. An obvious symptom is the bulging of the eyeballs. Swelling of throat as in simple goitre is another symptom. This condition is known as exophthalmic goitre (ex-exterior, ophthalmos - eyes). The thyroid gland produces yet another hormone called calcitonin. Calcitonin together with parathormone produced by the parathyroid gland regulates the level of calcium ions in the blood.

regulate the level of calcium ions in the blood. Observe illustration I carefully.

- How can deficiency of calcium in blood be rectified?
- What is the role of Thyroid gland in regulating the level of calcium ions?

We have already learned that the above mentioned hormones viz. calcitonin and parathormone complement each other and regulate the level of calcium ions in the blood.

What happens when there is increased production of Parathormone? Calcium salts are absorbed from the bones and added to blood. Consequently the bones become

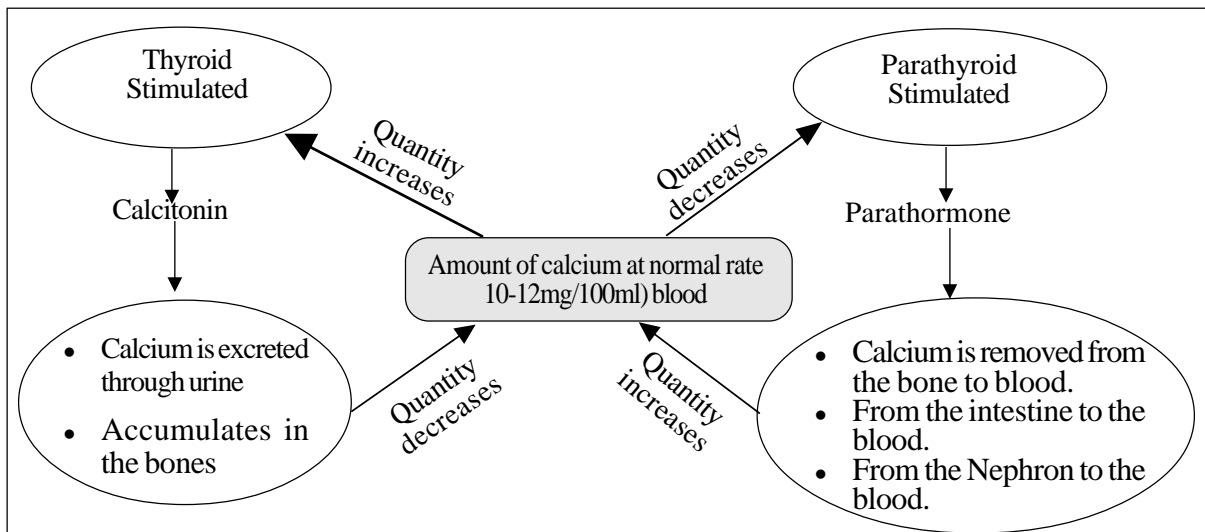


Illustration I

Parathyroid gland

You have understood the location of parathyroid gland in the human body. These are 4 glands situated on the posterior side of the thyroid gland. Let us study how parathormone produced by these glands

brittle. Moreover, the kidneys filter and excrete more calcium from the blood. This leads to stone formation in the kidneys. What happens if there is deficiency in the production of parathormone? The decrease in blood calcium level leads to a condition

called Tetany which affects the functioning of muscles. This is manifested as strong spasms of muscles. What are the consequences of this condition?

Adrenal gland

Identify the organ to which this gland is connected. It is seen like a cap situated just above the kidney. The size of this gland is smaller in females compared to that in males. Observe the figure 5.3. What are the parts of this gland? What are the hormones produced by the cortex? What are their functions? Examine Table 5.1.

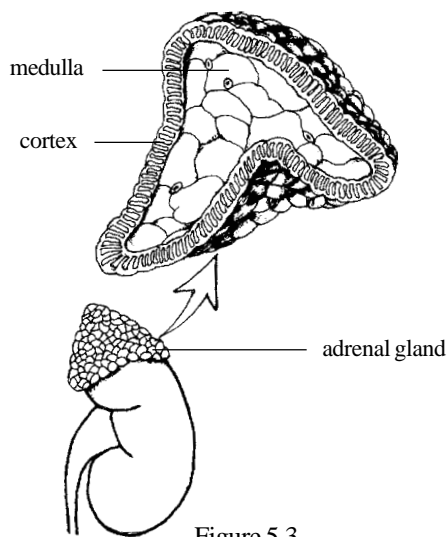


Figure 5.3
Adrenal gland

We understand that aldosterone helps to maintain the balance of salts and water in the blood. What are the functions of Cortisol? Cortisol prevents allergic diseases and oedema. Because of this, it is used in the treatment of arthritis, asthma etc. Continuous use of cortisol causes elevation of glucose level in blood.

Besides these hormones, cortex also produces sex hormones such as estrogen and androgen.

A gland seen in children

Our body also possesses a gland which starts functioning in the embryonic stage itself, becomes active during childhood and undergoes regression and gradually stops functioning after adolescence. It is known as Thymus. It produces the hormone Thymosin which imparts resistance to diseases in children. But it continues as the production centre of lymphocytes.

Hormone	Function
Aldosterone	<ul style="list-style-type: none"> Regulates loss of sodium ions through urine and sweat. Excretes potassium ions Regulates osmotic pressure.
Cortisol	<ul style="list-style-type: none"> Stimulates break-down of proteins and fats. Stimulates synthesis of glucose from amino acids. Stimulates storage of glycogen in the liver. Repairs tissues.

Table 5.1. Hormones of the adrenal cortex

Adrenaline and noradrenaline

Have you observed the inner part of adrenal gland called medulla? It is the source of two hormones called adrenaline and noradrenaline. The functions of these hormones are similar in that both of them prepare our body to overcome emergency situations. What are the physical and physiological changes that take place when a person experiences fear, anger or anxiety?

- The rate and intensity of heart beat increases.
- Blood pressure increases
- Blood flow to the limbs increases
- Causes hair of the skin to rise
- Blood glucose level increases
- Blood flow to the alimentary canal and skin is reduced.

Such changes prepare the body to face any emergency situation. Therefore, adrenaline is also termed as 'emergency hormone'.

You have learned that the above mentioned responses are also related to the sympathetic nervous system. It is clear that they are controlled by the combined actions of adrenal hormones and the sympathetic nervous system.

Pancreas

You know that the pancreas is a gland which secretes the pancreatic juice. The pancreas also contains groups of endocrine

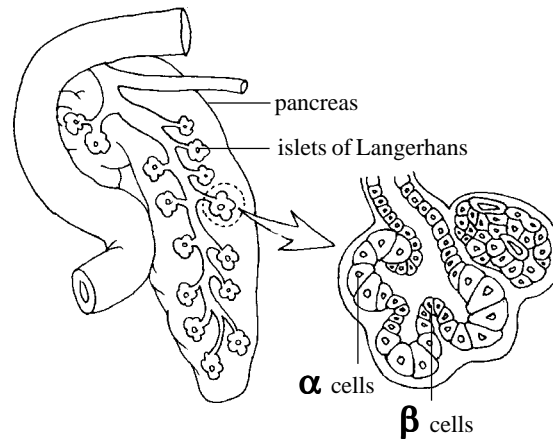
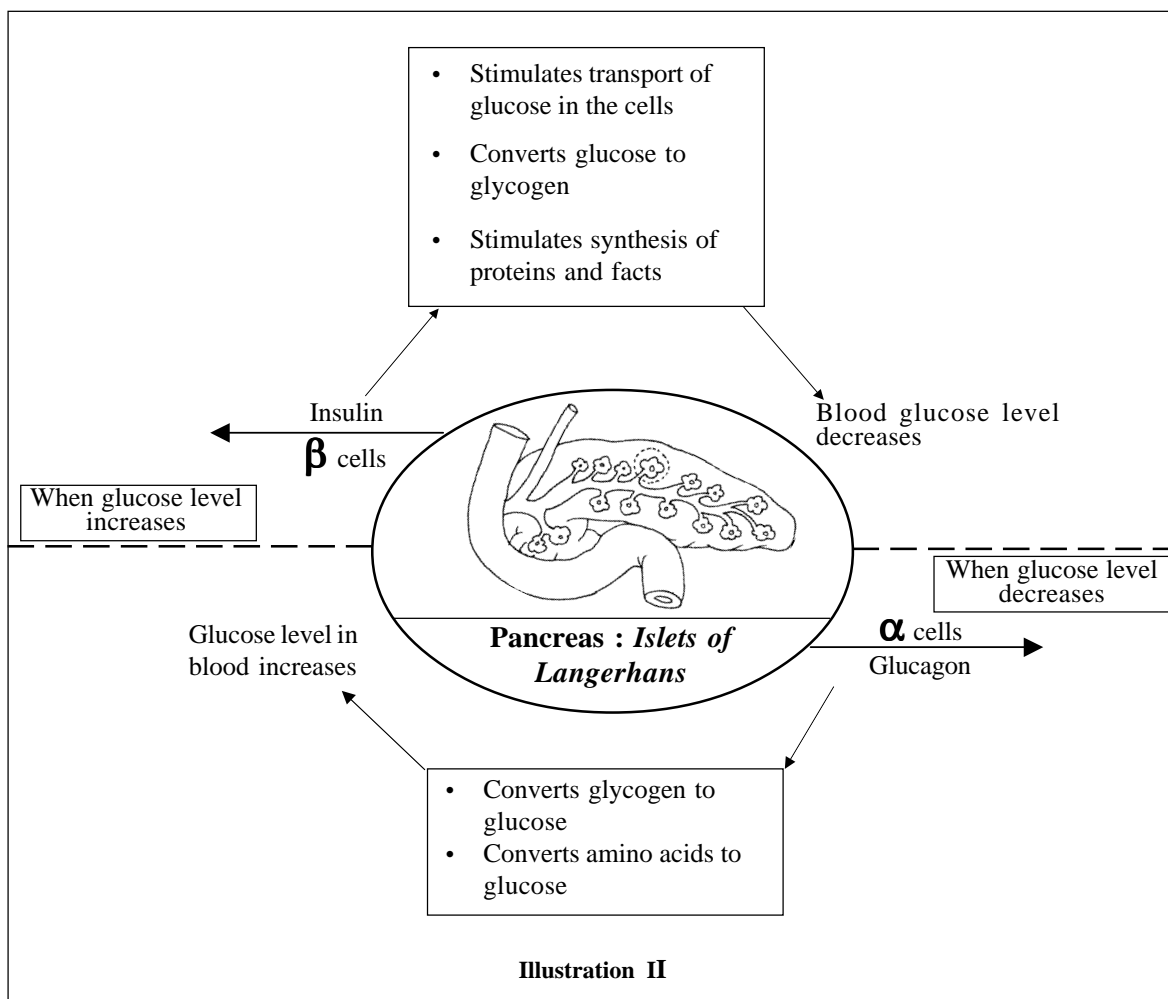


Figure 5.4
Pancreas

cells referred to as Islets of Langerhans. (fig 5.4)

You have learned the effect of cortisol on the blood glucose level. In fact, the hormones produced by the Islets of Langerhans are responsible for maintaining a constant level of glucose in the blood. The level of glucose is maintained at the rate of 80 to 120 mg per 100 ml of blood. The blood glucose level increases following absorption of digested food. On the otherhand, it drops when a person is hungry. Let us understand the mechanism that maintains a constant blood glucose level.

Observe illustration II. Learn how the hormones secreted by Islets of Langerhans (insulin, glucagon) regulate the level of glucose in the blood.



You know that the level of glucose in the blood is regulated by the complimentary action of the hormones secreted by the pancreas. You have also learned how insulin decreases the level of glucose in the blood. Dysfunction of beta cells, can cause elevation of glucose level in blood. The excess glucose is now removed from the body through urine. This condition is known as Diabetes mellitus, a common disease among our people. The excess glucose is also removed through sweating.

The first insulin experiment was done in dogs

Do you know that it was an experiment done in a dog that led to the discovery of insulin as a drug for diabetes? Even though as early as in 1868 Paul Langerhans discovered the presence of special cells in the pancreas. Their function was not known until 1921. Banting in Canada conducted later an experiment in a dog, after removing its pancreas. The insulin extracted from the pancreas of animals was found to cure diabetes in the dog whose pancreas was removed. The significance of this discovery is that it provided a method for treatment of diabetes in men.

Persons with diabetes experience loss of body weight, weakening of muscles and tiredness. The disease can be controlled by insulin administration. Normally, insulin extracted from animals is used for this purpose. But now human insulin produced from bacteria through genetic engineering is available.

Gonads

You know that testes and ovaries are the reproductive organs of human body. The gametes are produced in gonads. Moreover they also function as endocrine glands. What are the hormones secreted by gonads?

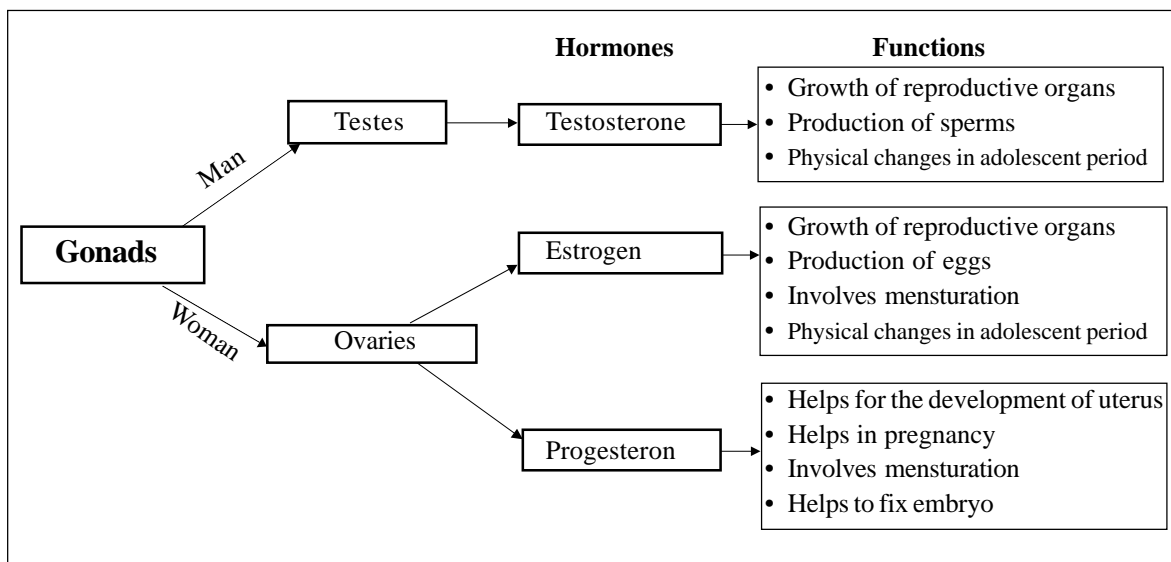


Illustration III

Urine test for glucose

You can measure the level of sugar in urine by a simple test. For this, take 5 ml of Benedict solution in a test tube and boil it. Add 8 drops of urine to it. Heat again and note the colour change. Based on the colour, the glucose level can be determined.

Observe the illustration III. The functions of gonads differ in males and females. What are their functions? Discuss and prepare short notes in the science diary.

Pituitary Gland

Pituitary gland is a pea-shaped gland seen below the brain. Observe the figure 5.5. How is it connected to the hypothalamus?

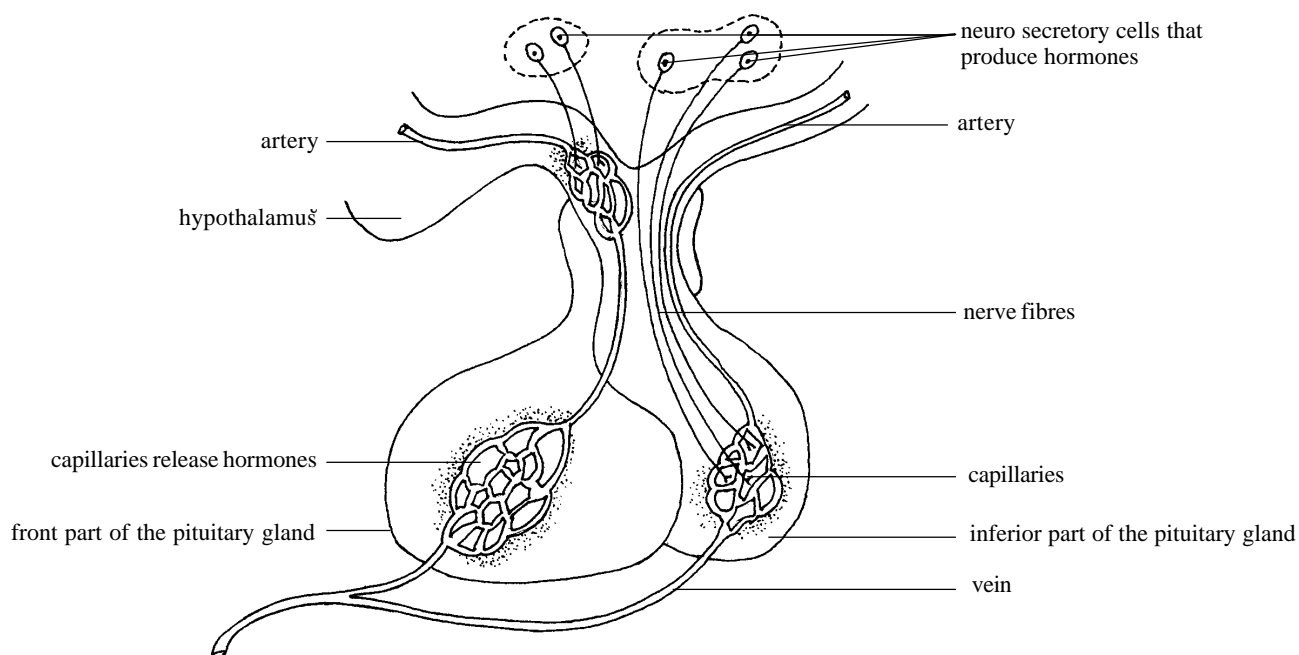


Figure 5.5
Relation between hypothalamus and pituitary gland

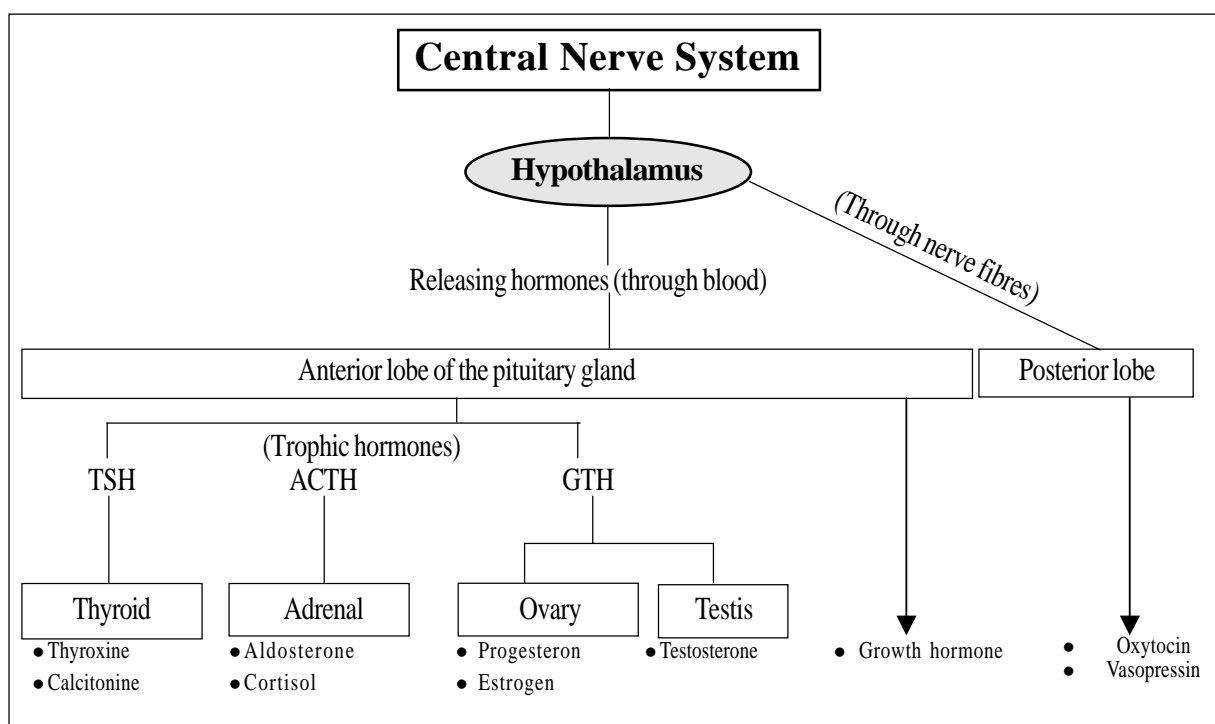


Illustration IV

See illustration IV.

- How many lobes does pituitary gland have?

- What are the hormones produced by the anterior lobe?

These hormones of the pituitary gland influence the secretion of other glands.

Therefore, they are called Trophic hormones. However, the growth hormone, somatotrophin, acts directly on various tissues of the body. It causes growth and thus effects an increase in body weight.

What will happen if the production of this hormone is deminished during the growing stages? The growth of bones becomes stunted and the body development decreases accordingly. This condition is called Dwarfism.

In some persons, somatotrophin is produced excessively. The main cause for this is the formation of tumour in the pituitary gland. The symptoms vary according to the growth stage at which the tumour develops. If somatotrophin is excessively produced during the growing stage, it leads to Gigantism. Such persons become very tall and will have overweight. If the tumour develops after growing stage is over, the internal organs and body extremities alone grow. This condition is known as acromegaly (acro = tip, mega = large, by = disease). Such persons will have large hands, feet and jawbones. The excessive growth of facial bones gives them a hideous look.

The posterior lobe of the pituitary gland stores the hormones - oxytocin and vasopressin. You know that these hormones are produced by the hypothalamus.

Hypothalamus

The two hormones secreted by hypothalamus are vasopressin and oxytocin. Study the figure 5.5. How do these hormones secreted by the specialised neurons in hypothalamus reach the pituitary gland? What are the functions of these hormones? Haven't you noticed that during summer, the urine output is low? Due to increased sweating, the water level of the blood is lowered. As a result the pituitary releases vasopressin into the blood. This hormone increases the rate of reabsorption of water from the urine by the nephrons. Therefore vasopressin is also called Anti diuretic hormone (ADH).

A Clock in Animals

You know that several activities in living beings take place in a time-specific manner. We sleep at night and wake up in the morning. Such rhythmic daily activities (circadian rhythm) are controlled by a clock working inside the body, which can be called the biological clock. The pineal gland situated opposite the pituitary gland has an important role in this respect. The secretions of the pineal gland namely melatonin and serotonin influence some rhythmic activities. The secretion of melatonin increases during night and this induces sleep. Pineal gland is more active in birds and other animals and is less developed in the mammals.

A decline in secretion of ADH occurs when the water content in the blood increases. As a result, the reabsorption of water decreases. Now, it is clear why the output of urine during rainy days is higher. What will happen if the secretion of ADH in a person becomes too low? There will be excessive loss of water through the urine. This disease is called Diabetes insipidus.

The hormone, oxytocin stimulates the contraction of uterine walls and induces labour. This facilitates child birth. Moreover, this hormone is necessary for ejection of milk from the breasts during suckling. Sometimes, pregnant women are given injections of oxytocin. What is the purpose of this?

What are the other hormones secreted by hypothalamus? Study the illustration IV.

You know that the releasing hormones produced by the hypothalamus influence the anterior lobe of pituitary gland. They induce secretion of the pituitary hormones. Each pituitary hormone has a specific releasing hormone. The hypothalamus also produces hormones which inhibit hormone secretion by the pituitary gland. From this, it is clear that the hypothalamus controls most of the endocrine glands in the body. A rise or fall in the level of a hormone in the blood provides signals to the pituitary gland and the hypothalamus to regulate its secretion to the normal level. From this, it can be seen that the activity of endocrine glands depends on the level of hormones in the blood.

Pheromones

You may know that the ants are able to move in a trail due to the presence of a pheromone. What are pheromones? These are certain chemicals secreted by an organism to the exterior.

Pheromone as an identity card

The female wolf spider accepts a male only when it identifies a pheromone. In the absence of this pheromone, after mating, the female kills and eats the male. The male silk moth can detect the presence of a female even at a distance of 4 km. In this case, the antennae of the male insect can sense the pheromone called bombykol released by the female. The pheromone produced by the queen bee in a hive inhibits the ovarian growth of other bees. Starfish releases a pheromone in the genital discharge which induces others to do the same. This ensures fertilization.

The musk secreted by the musk deer and the civetin produced by civet cat contain pheromones. Cows, dogs and other mammals also release pheromones during heat. Thus, pheromones are useful in attracting a mate and for following a trail. It also enables the organisms of the same species to communicate with one another.

You might have heard of pheromone traps. There are used in agriculture for attracting pests.

Chemical co-ordination in plants

You have studied the role of hormones in controlling the life processes in animals. Now you will study the importance of hormones in plant growth. In plants, the hormones control growth and flowering. But, plants have no hormone- producing glands. They also lack a circulatory system for transportation of hormones.

The plant tissues

As you know, the plants have special tissues for their growth. The specialised cells that are seen in the growing parts of plants are called meristems. Observe figure 5.6.

Find out how a meristematic cell differs from an ordinary cell with respect to the following aspects.

- Quantity of cell sap

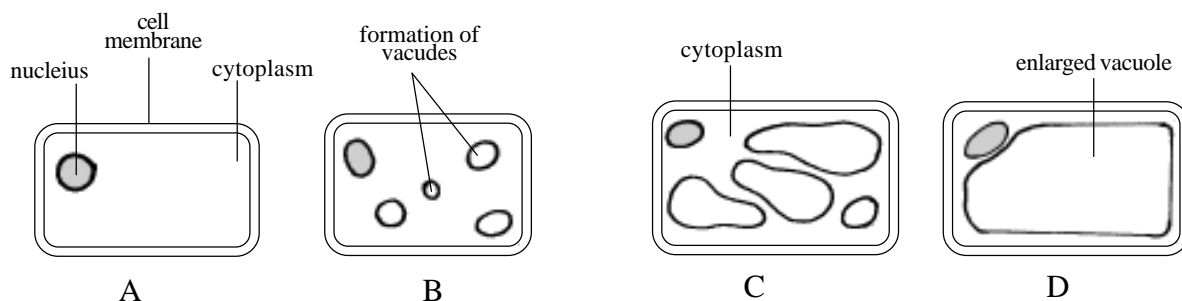


Figure 5.6
A cell formed from the meristematic cell

Dicot plant

Monocot plant

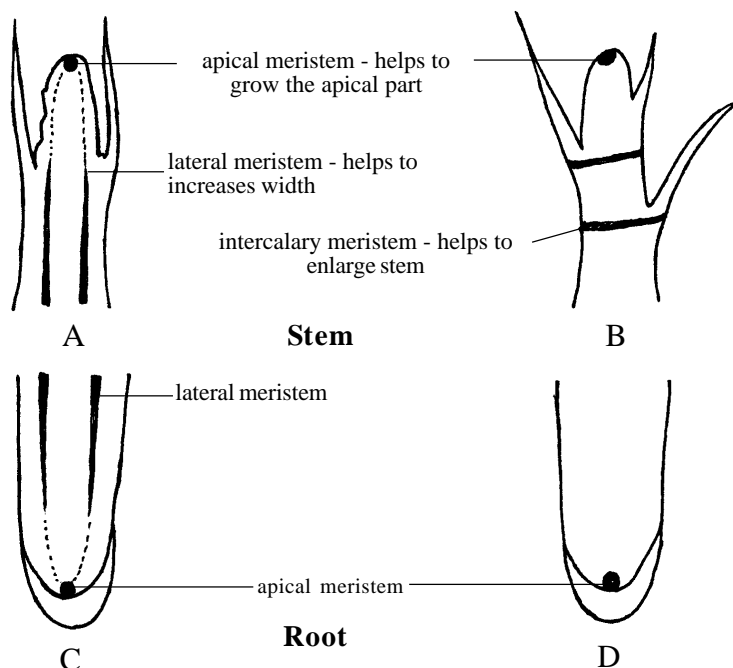


Figure 5.7
Position of meristms

- Difference in structure of vacuoles
- Thickness of cell wall
- Relative size of nucleus to the size of the cell.

Meristematic cells are capable of division. But normal cells do not have this property. Meristematic cells are responsible for growth in plants. Examine the figure 5.7 showing the positions of various meristems.

- Explain how lateral meristem and apical meristem differ in their functions.
- What is the function of intercalary meristem?
- What is the role of meristems in the growth of roots?

The explanations may be noted in the science diary.

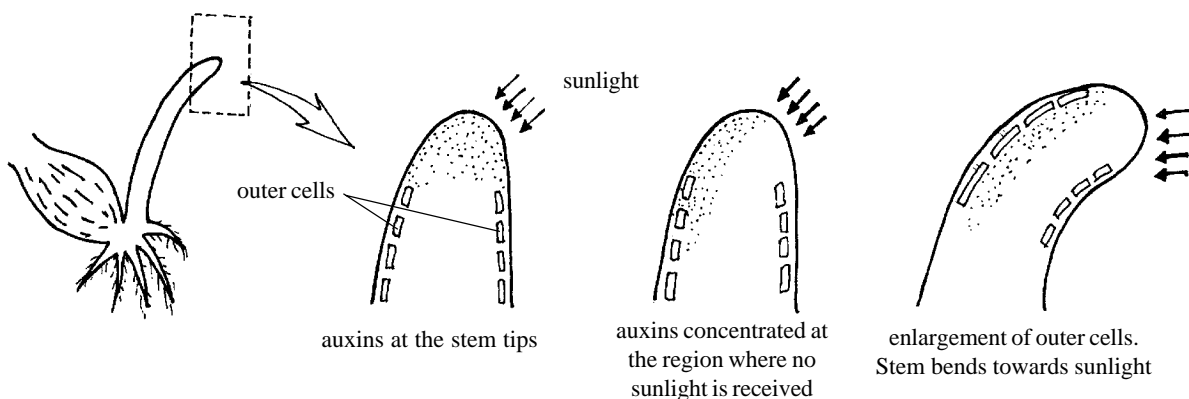
The plant tissues like Parenchyma, Collenchyma, Sclerenchyma, Xylem, phloem etc are derived from meristematic cells.

Growth in plants occurs by the division and development of meristematic cells. The factors which control plant growth are referred to as plant hormones.

Plant hormones

As you know, the plants do not possess endocrine glands. In plants, hormones are synthesized in the meristematic cells. Let us have a look at the various plant hormones. Auxins comprise a group of important plant hormones. What are their functions? Observe figure 5.8.

Auxins at the stem tip



Auxins in the root

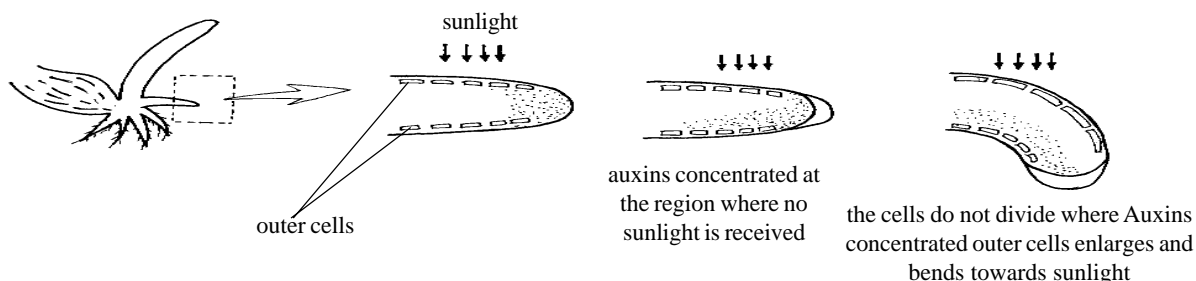


Figure 5.8
Action of Auxins

- How do auxins influence growth of stem?
- How is growth of roots related to direction of light?

Record your conclusions in the science diary.

Plant movements

You have learned how the direction of growth in plants is affected by light under the influence of hormones. A similar kind of growth is responsible for the movement in plants. Don't you think that the blossoming of flowers and the growth of pollen-tube during fertilization are examples of movement?

Find out more examples of movements in plants. Classify them according to the direction of movement.

Tropic movement and Nastic movement

You have seen how the stem grows towards light. Roots grow towards moist soil and water. In other words, the direction of the movement is influenced by the direction of the stimulus. But how does the leaves of Mimosa fold? The movement causing folding is not restricted to the part of leaves where you touch. Tropism is a movement that takes place in accordance with the direction of stimulus.

Nastic movements are those that are not related to the direction of stimulus. Find out more examples for both types of movements.

The chemistry of folding of the leaves

The hormone produced at a particular part of the mimosa plant where we touch, travels through the conducting tissues and reaches the petiole of the leaf. Consequently exosmosis of water occurs in the inter cellular spaces. This causes the folding of leaves. The stimulus travels from the tip of the leaf to the petiole and other leaves at the rate of 3cm per second.

If the direction of movement is towards the direction of stimulus, it is positive tropism and if it is in the opposite direction, it is negative tropism.

Place a big germinating seed parallel to the ground. Observe its growth. To which direction does the radicle grow? What about the plumule? Turn the seed and observe it the next day. Now what are the changes that you find in the direction of growth? Gravity acts as a stimulus in influencing growth. What can this movement be called? The root exhibits tropism. You have now learnt about the tropic movements. Fill up the table given below.

Stimulus	Tropic movement	Stem	Root
Sunlight	Phototropic movement	Positive	Negative
Gravity			
Water			

In addition to the plant movements described earlier, there are also other types of movements. We will now study these movements.

Chemotropism

Which stimulus in flowers directs growth of pollen after pollination? Some chemicals produced by the ovary are responsible for this movement. Such movements are called chemotropic movements.

Haptotropism

Have you noticed how the pea plants climb over the supports? Is it not a type of

movement? The plant winds over the support on being stimulated by touch. Movement induced by touch is called haptotropism. Find out more examples of this. Apart from these plant movements, other types of movements are also observed. Try to find out more about them.

Plant growth and hormones

How you have learned how the auxins influence plant movements. Do auxins alone have a role in them? Observe the figures given below. Identify other plant hormones

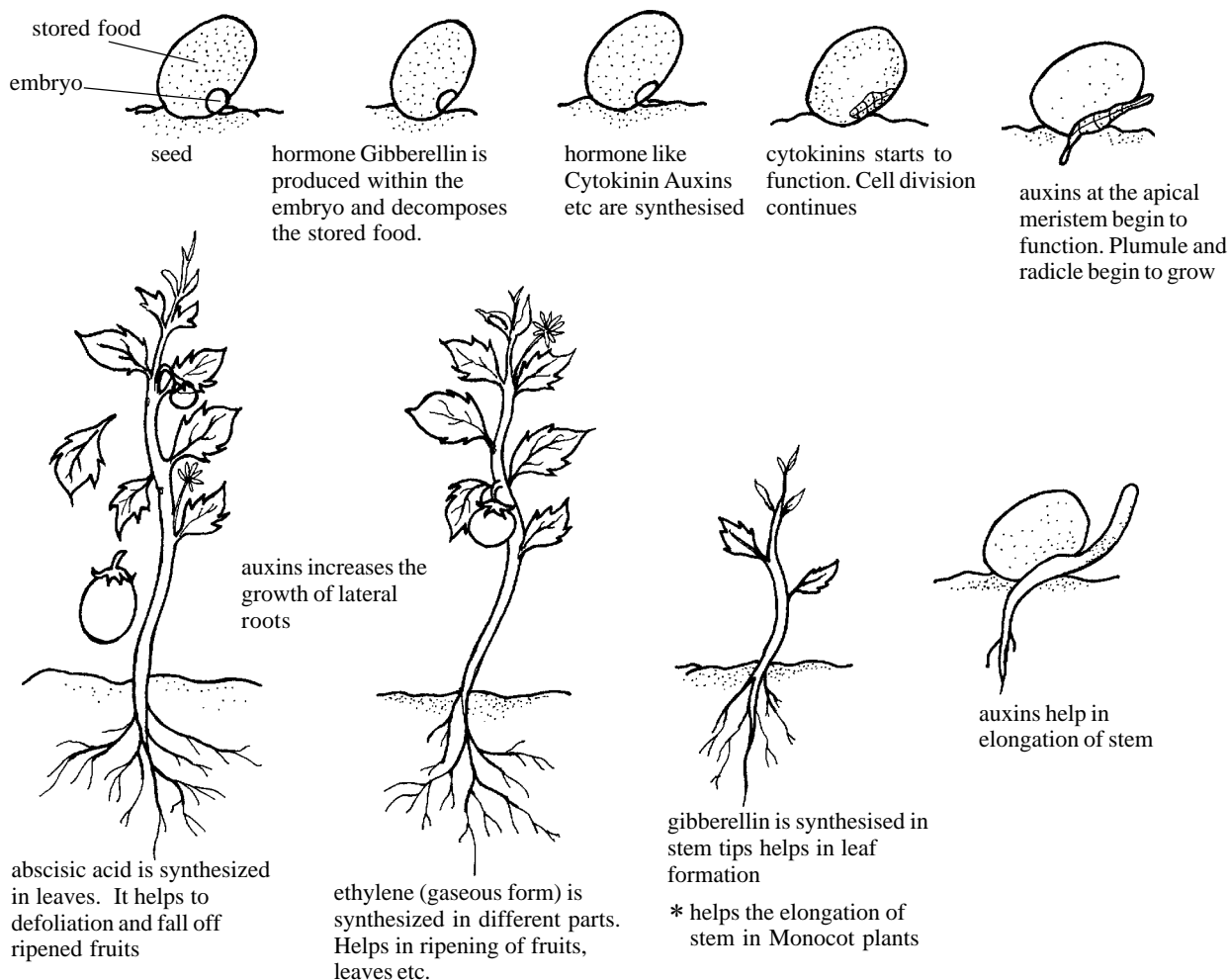


Figure 5.9
Plant growth and hormones

Plant hormones to reap profits

Have you thought how profitable it would be to harvest mangoes in their off-season? Surely it will fetch a high price. Plant hormones are known to be used for this purpose. Ethylene is used to grow pineapple in all seasons and gibberellin is sprayed on grape vines to delay the ripening of grapes so that they will be available in the off-season also. Using gibberellin, sprouting in onions and potatoes can be prevented so that they can be marketed when the price is high. Seedless grapes can be grown using gibberellic acid. Unripe lemons, pineapples and mangoes can be ripened using ethylene. The drooping of paddy and wheat can be prevented by spraying chlormegnat chloride. The flow of latex in rubber can be increased by ethylene. The list is not complete. The scope is wide and varied. Applications of scientific knowledge can indeed make agriculture more profitable.

involved in plant growth. What are their functions? Discuss, analyse and record your findings in the science diary.

The role of various hormones in plant growth has now been described.

Prepare a list showing the plant hormones, their sources and functions.

Synthetic plant hormones

You are aware that ethylene is used to ripen fruits like mango, tomatoes etc. on a commercial basis and to induce flowering in pineapple. What are the other chemicals used for this purpose?

- Growth of root can be artificially induced in the stem by immersing in Naphthalene Acetic Acid (NAA).
- Phenyl Acetic Acid (PAA) is sprayed on potatoes to prevent sprouting.
- PAA, 2-4D (2-4 Dichloro phenoxy acetic acid) etc are used as herbicides to destroy weeds.

Collect more details about such chemicals used in this field.

The field of Agriculture is witnessing revolutionary changes with the invention of synthetic plant hormones. But their unscientific use may create various problems for mankind. Therefore we should exercise utmost care in handling them.

SUMMARY

- ❖ The endocrine glands play a vital role in controlling and co-ordinating activities of life?
- ❖ The thyroid gland has an important role in physical and mental development.
- ❖ The complementary actions of calcitonin and parathormone maintain the level of calcium in the blood.
- ❖ Adrenalin prepares the body to face emergency situations.
- ❖ The islets of Langerhans in the pancreas regulate blood sugar level.
- ❖ Hormones of gonads control the growth and functions of sex organs.
- ❖ The various hormones of pituitary gland control the secretion of hormones from other endocrine glands.
- ❖ The pituitary gland and hypothalamus are connected by nerve fibres and blood vessels.
- ❖ The pituitary gland is controlled by the releasing hormones from hypothalamus.
- ❖ The under-secretion or over-secretion of various hormones can cause health problems.
- ❖ The chemicals released by organisms to the outside are called pheromones.
- ❖ Pheromones help activities such as communication between organisms of the same species, attracting a mate etc.
- ❖ Plant growth is effected by meristems.
- ❖ Based on the influence of stimulus in the direction of movement, plant movements can be recognised into tropic and nastic movements.
- ❖ Plants exhibit different kinds of tropic movements in response to different stimuli.
- ❖ Plant hormones influence activates like cell division, elongation of cells, flowering, ripening of fruits etc.
- ❖ Synthetic plant hormones are widely used in the field of Agriculture.

FURTHER ACTIVITIES

- ↻ The sugar level in the urine of a diabetic patient varies. Give reasons.
- ↻ Parathyroid hormone has a key role in maintaining life. Justify your opinion.
- ↻ A person shows symptoms like laziness, aversion towards food, swelling of body, dry skin, low heart beat etc. Suggest the changes to be made in his diet.
- ↻ Pituitary gland is connected to the hypothalamus with nerves and blood vessel. Name the region where the hormone from the hypothalamus is mixed with blood?
- ↻ Ethylene is present in ripened fruits. What will happen to unripened tomatoes which are kept among ripened fruits?
- ↻ Suggest an experiment to demonstrate hydrotropism shown by roots.
- ↻ It is seen that when bee hives are attacked by enemies, the bees begin to attack their enemies following the attacks of a single one. Give explanation for this.
- ↻ Monocot plants do not show growth in thickness as in dicots. Justify the statements.
- ↻ To obtain more plantlets of rose and red muskanda, a gardener used stem cutting of that plants. But all of them dried out. Can you help him to produce healthy plants?
- ↻ Diabetic patients feel more thirsty. They drink lots of water. Justify the statement.

