CHAPTER 1

Regulation of Internal Environment

Introduction

The body is always faced with certain conditions (be it internal or external) that are constantly making it to act in order to keep itself in a steady state. The constant changes in the body affect the rate at which metabolic processes occur. The various organs have one role or the other to play to maintain a balance. The hormones and the brain contribute immensely to making sure that the body functions properly.

The kidneys play an important role in the maintenance of constant internal environment by controlling the composition of blood. The maintenance of a fairly constant state of internal environment is known as **homeostasis.**

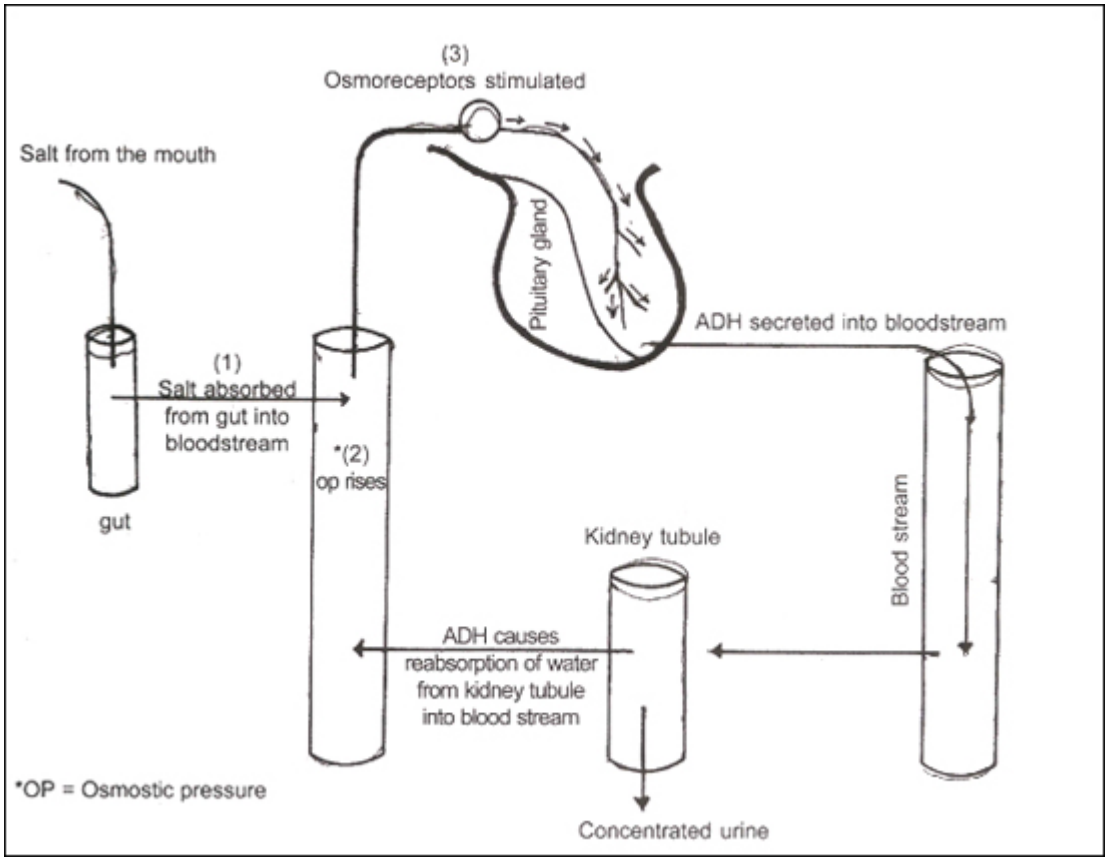

Fig. 1.1 Diagrammatic representation of what happens when the osmotic pressure of the blood and tissue fluid rises.

Sometimes we fall ill, which is an indication of an abnormal condition in our internal environment. This abnormal condition in our internal environment needs some regulation in order to maintain homeostasis.

In animals, the kidney, skin, liver and hormones (e.g. insulin and adrenalin) help in maintaining constant internal environment while in plants, auxins (e.g. gibberellin and cytokinin) help in maintaining constant internal environment. Similarly, auxins also play important roles in growth and other activities of plant parts

Factors to be kept in equilibrium

Internal conditions such as glucose level, salt concentration, osmotic pressure, body temperature, ionic concentration (e.g. Na^+, K^+, H^+) are put under control

The kidneys

In Chapter 7 of Book 2, you learnt that all vertebrates have a pair of kidneys, which form part of the excretory system. The functions and diseases of the kidney are now discussed.

Functions of the Kidneys

The process by which an organism regulates the balance of the ratio of water to salts in its body fluids is called **osmoregulation.** The relative amount of water and salts reabsorbed in mammals is strictly geared to the bodyâ€™s needs. It is on this that the osmotic pressure of the blood and tissue fluids depend. In mammals, the balance is controlled by a variation of the quantities of water returned to the blood from the kidneys during selective reabsorption using the following process:

(a) If the osmotic pressure in the blood begins to rise, more water is reabsorbed from the kidney tubules, and less is passed on to the urinary bladder.

(b) If the osmotic pressure of the blood begins to fall, less water is reabsorbed and more is passed on to the urinary bladder. This regulation is controlled by a hormone secreted by the pituitary gland known as the **anti-diuretic hormone (ADH).** Exactly how ADH exerts its effect on the kidney is not known, but it appears to make the cells lining the distal convoluted tubules and collecting duct more permeable to water, thus facilitating its osmotic withdrawal into the surrounding blood vessels. This is a good example of a homeostatic feedback process. Fluctuations in osmotic pressure are quickly detected and the corrective mechanism brought into action (see Fig. 1.1). The body becomes conscious of the salt or water level in the fluid or cell through the hypothallamus which is a part of the brain located above the

pituitary glands. If the hypothallamus detects any change in the water content or concentration, it causes the pituitary gland to secrete the hormone ADH which controls the adjustment of the salt to water ratio.

Excretion

This is the process of removal of metabolic waste products from the body of organisms (see Chapter 7, Book 2).

All organisms carry out excretion. Lower animals such as *Amoeba* get rid of their waste products by diffusion through their body surfaces. Higher animals such as worms, insects, amphibians, reptiles, birds and mammals have special excretory organs which differ in structure and in the products they excrete.

In mammals, blood carrying food and dissolved substances including urea enter the glomeruli of the kidneys through the renal artery under high pressure. These substances are forced through the walls of the capillaries into the **Bowmanâ€™s capsule** of the kidney. This is **called ultra-filtration.** A clear liquid called the glomerular filtrate passes along the tubules of the nephron where selective reabsorption takes place. Certain substances (e.g glucose, water, salts) are passed back into the blood while others are retained. Those that remain include urea, ammonium compounds, carbon (IV) oxide, small quantities of mineral salts and water. These are carried to the urinary bladder as urine and passed out of the urethra at intervals.

Maintenance of acid-base balance

The acid-base balance in the body is also maintained by the kidneys. When the body fluids become acidic (i.e. the concentration of the acids becomes more than the concentration of the bases), more acid is excreted by the kidneys with the urine. The kidneys at the same time prevent the excessive loss of bases. When the concentration of a base becomes higher, more salts will be excreted with the urine.

Factors Affecting the Functioning of the Kidneys

The following factors affect the functioning of the kidneys:

(i) change in the optimum temperature of the environment
(ii) alteration in the normal habitat of the animal
(iii) diseases and drugs

How Kidneys Perform in Different Habitats and Different Weather Conditions

The nature of environment and the weather condition affect the functioning of the kidney in different habitats.

The major types of habitats are:

(i) Freshwater
(ii) Marine
(iii) Terrestrial

Freshwater Habitat

Animals in freshwater live in an environment that has lower osmotic concentration and pressure than their body fluid. Such an environment is said to be **Hypotonic** (weaker concentration solution). Freshwater animals are faced with the problem of excessive entry of water into their cells because of the high rate of osmosis that results from the imbalance of the concentration of the internal and external environments.

To adapt to this condition, freshwater animals possess well developed kidneys with well developed glomeruli capable of getting rid of the excess water in dilute urine, and reabsorbing salts from urine. There is also active uptake of salts by certain cells.

Marine Habitat

Most marine organisms have internal body fluid that is lower in concentration than their external environment. That is, they live in â€˜hypertonicâ€™ environment. These animals are faced with the problem of excessive loss of water from their body into their environment, through osmosis, and movement of salts into them by active diffusion.

These animals therefore adapt to this condition by possessing vestigeal kidneys with poorly-developed glomeruli to reduce the water loss. Also, they actively secrete salts into the environment through certain cells rate.

Terrestrial Habitat

Terrestrial animals are faced with the problem of water loss from their body.

In cold, humid weather, temperature decreases, and the body does not remove much water by perspiration. Also when the organism consumes much liquid, the blood water content increases, the kidney does more work by actively removing water through the glomeruli so as to normalize the blood water content. The urine is plenty and dilute.

In hot habitats such as the desert and in hot weather, humidity is low and the rate of evaporation increases. Hence the animals lose much water through perspiration. Inversely, the kidney reabsorbs water from the glomerular filterate and recycles it back to the blood. The urine left out becomes scanty and concentrated.

The desert animals consequently possess vestigeal kidneys with poorly-structured glomeruli. They therefore urinate occasionally.

Diseases of the kidney and their effects

Like all organs, kidneys usually last a life time. Sometimes though, kidneys fail and can no longer perform their functions in the body efficiently. Certain conditions that can affect the functioning of the kidneys include diseases, drugs, changes in normal habit and temperature. Some of the diseases include **nephritis, kidney stones, diuresis and dropsy**.

Nephritis (Brightâ€™s disease)

This is a disease that affects the blood vessels of the kidneys, (glomeruli). Ultrafiltration during the formation of urine takes place within the glomeruli and Bowmanâ€™s capsule. When the glomeruli become inflammed, ultrafiltration is usually incomplete and some useful substances will be passed out with the urine. This disease may be acute or chronic. Its symptoms include fever, headache, pain in the back, vomiting and oedema. Swelling of some parts of the body.

Kidney stones (renal calculi)

This disease is common among middle aged people. Kidney stones are abnormal growths in the tubules of the kidney. These growths narrow the lumen of the tubules, thus obstructing the normal passage of urine. An infected person may have difficulty in passing urine and may also experience pain when passing urine. The urine may also contain albumin and blood.

Diuresis

In this condition, the cells of the kidney tubules fail to reabsorb water from the glomerular filtrate into the blood. As a result, a large quantity of water is passed out in the urine. The patient permanently produces large quantities of dilute urine and has to make up for the loss by drinking a lot of water. If he fails to do this, his body will become dehydrated very quickly. The patient therefore loses strength and weight (becomes emaciated). The clinical condition is called **diabetes insipidus**. A victim of diabetes insipidus urinates about 20 litres of urine each day but does not suffer from loss of sugar as does a victim of diabetes mellitus

Dropsy

This is a condition in which the cells of the kidney tubules are unable to absorb water from the blood, leading to the retention of water within the blood. This then leads to the swelling of some parts of the body. This condition is also known as **oedema.**

Effects of kidney diseases

Most of these disease conditions result in the following:

1. Alteration of the normal concentration of substances in the urine;
2. Inefficiency of the kidney in removing waste products from the

body;

3. Retention of waste in the body;
4. Poisoning of the cells of the kidneys;
5. Death, in some cases.

Ways of remedying kidney diseases

People with suspected kidney problems should seek immediate medical advice and attention.

1. *Kidney dialysis:* This can help many people whose kidneys do not function. In dialysis, a patientâ€™s blood is passed through a machine that removes waste as much as a kidney would. However, the procedure takes several hours and must be repeated every few days, the machine is also very expensive.
2. *Kidney transplants:* Another solution to kidney failure is to replace non-functioning kidneys with healthy ones. Kidney transplants are common these days. Sometimes however, transplants fail because of the recipientâ€™s immune response. (That is, the recipientâ€™s body attacks and kills cells foreign to it). Transplant patients are usually given drugs to suppress the immune response. Unfortunately, these drugs severely weaken the bodyâ€™s ability to fight diseases. Recently, a new drug was developed that has greatly improved the success of organ transplants.
3. *Surgery:* In the case of kidney stones, they can be surgically removed **(nephrectomy).** This entails opening up the kidneys and removing the growth. Alternatively, the stone could be sucked out without incision.

Activity 1.1

Photographs and charts of a normal and an infected kidney will be presented to you. State the differences between the normal and infected kidneys

The Liver

The liver (Fig. 1.2) is the largest gland in the body. It is situated on the right side of the upper end of the abdomen. The liver is divided into two main lobes with the right lobe further divided into three small lobes. The liver has a dark-red colour. The hepatic artery and the hepatic portal vein supply blood to, while the hepatic vein takes blood away from the liver. The gall bladder is found on the underside of the right lobe (Fig. 1.2.).

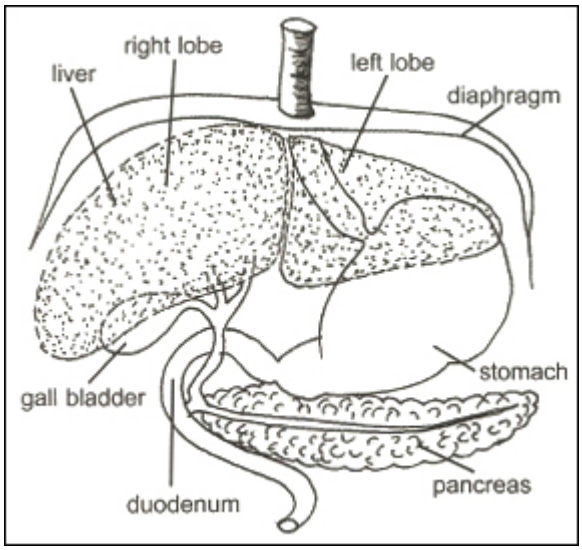

Fig. 1.2. Part of the alimentary canal

Functions of the liver

The liver has many different functions, and it is one of the most important organs concerned with metabolism. Its functions include:

1. *Control of glucose level*

The liver controls the amount of glucose in the blood stream. Glucose absorbed in the villi is transported to the liver by the hepatic portal vein which is the blood vessel that carries blood and all its content from the small intestine to the liver. In the liver, glucose is converted into **glycogen** a form of starch found in animals. Glycogen under the influence of the hormone insulin is stored in the liver cells. Glycogen is reconverted by **glucagon** (a hormone) to glucose when the body requires more glucose.

2. *Control of amino acids*

Amino acids are transported to the liver by the hepatic portal vein. There, the amino acids are acted upon by enzymes to convert any excess to urea and carbohydrates. This process is called deamination.

3. *Action on fats*

The liver acts on saturated fats and removes hydrogen, forming unsaturated fats. This is called **desaturation.** The cells in tissues can use unsaturated fats for their respiration.

4. *Production of bile*

Bile is produced in liver cells and stored in the gall bladder.

5. *Detoxication*

Overdosage of drugs, and other harmful substances are rendered harmless by the liver.

6. *Storage of vitamins and minerals*

Vitamins A, B_{12}, D and K are stored in the liver cells, and released when required into the blood stream while mineral salts such as iron, copper and potassium are also stored in the liver.

7. *Breakdown of pigments*

Haemoglobin released from worn-out red corpuscles destroyed in the bone marrow and the spleen is broken down by the liver. The products are used in the formation of bile.

8. *Production of blood proteins*

The liver produces **fibrinogen,** which is a soluble protein used in blood clotting. It also produces other soluble proteins and maintains their concentration in the plasma. The liver deaminates (splits up) excess amino acid because, excess amino acid is harmful to the body. The two components of the deaminated excess amino acids are, the amino group (RNH_2) and the carboxyl group (COOH). The amino group forms ammonia that is converted into urea and then transported to the kidney for excretion while the carboxyl group is converted to carbohydrates (CHO) and stored in the liver in form of glycogen.

9. *Production of prothrombin*

The enzyme **prothrombin,** which takes part in blood clotting is produced in the liver.

10. *Removal of lactic acid*

Lactic acid, formed as a waste product by muscles during vigorous exercises, is removed by the liver and converted into glycogen.

11. *Production of heat*

The numerous activities of the liver require its cells to carry out a considerable amount of chemical activities. The energy for these activities is obtained from respiration. The hepatic artery supplies oxygen which is used in respiration, releasing chemical energy and a large quantity of heat. The heat released is moved round the body by the blood for the maintenance of normal body temperature.

Diseases of the liver and their effects

Hepatitis

This is the inflammation of the liver. The liver turns red, becomes swollen and painful. It can be caused by a variety of agents such as infections , toxic drugs and poisons. There are three types of hepatitis: **Acute infective hepatitis, Weilâ€™s disease (leptospirosis)** and **hepatitis due to drugs** and **poisons** (arsenic, benzene and cinchophen).

The most common is acute infective hepatitis. It is caused by a

virus. It is not very infectious but epidemics can occur. A person suffering from this disease experiences loss of appetite, nausea and headache. After a few days, the urine becomes dark, owing to the presence of bile. The conjuctiva of the eye and the skin become yellow.

Diabetes Mellitus: Deficiency of insulin production.

This deficiency results in the body cells not being able to absorb glucose, hence, excess glucose cannot be converted to glycogen but is passed out with the urine.

Cancer of the liver (carcinoma)

This is one of the most dreaded diseases in the world. It is a malignant growth of the liver. It is otherwise called **carcinoma.** The growth is so called because it sends out long processes like the limbs of a crab. The cells of a malignant growth do not retain the normal function of the tissue in which they arise but become very simple and undifferentiated. Their growth cannot be restricted. Thus, the branching extends into various organs and interferes with their functions. In the case of the liver cells, they can no longer perform their normal functions as most of their energy is devoted to division. Eventually, the body will be exhausted and this will lead to death.

Gall stones

These are growths in the gall bladder. They block the ducts, making it impossible for the gall bladder to function properly. They may also cause obstructive jaundice by blocking the common bile duct.

Cirrhosis

This is the hardening of the liver caused by viral microbes or toxic substances (e.g. alcohol) and dietary deficiency

Remedies to liver diseases/Control of liver diseases

Acute infective hepatitis

Drugs play a small part in the treatment, although antihistamine drugs can be used to prevent itching if present. In most cases, the following procedures are followed:

1. The patient is put on bed rest.
2. The patient is given high protein foods and plenty of glucose and fluid. Fat should be excluded for some time in the diet particularly in Hepatitis.
3. Alcohol must be avoided for several months after recovery.

Gall stones: In all cases, an operation is needed to remove the stones. If obstructive jaundice is present, vitamin K is given before the operation to prevent haemorrhage.

Cancer of the liver

There are various methods of treatment, all of which depend on the shape and size of the growth. Surgical removal, where possible, is still the best method, though treatment with radioactive substances are applied externally.

There are methods whereby short-lived radioactive materials are *planted* internally round the growth area. These radioactive materials tend to stop the growth of carcinogenic cells and destroy them where possible.

Activity 1.2

Identify the following parts from the chart provided (a) duodenum (b) gall bladder (c) pancreas.

The skin

The **skin** is the toughest tissue in the body apart from the bones. It consists of two main layers, the **epidermis** and the **dermis** (see Fig. 1.3).

The epidermis or cuticle is made up of three layers; an outer **horny layer,** a middle **granular** layer and an inner **Malpighian layer.** The Malpighian layer contains the colour pigment **melanin** which is responsible for differences in skin colour. The dermis contains blood vessels, nerves, sense organs, hair follicle, sweat glands, hair erector muscles, sebaceous gland and a layer of fat storage cells (adipose tissue).

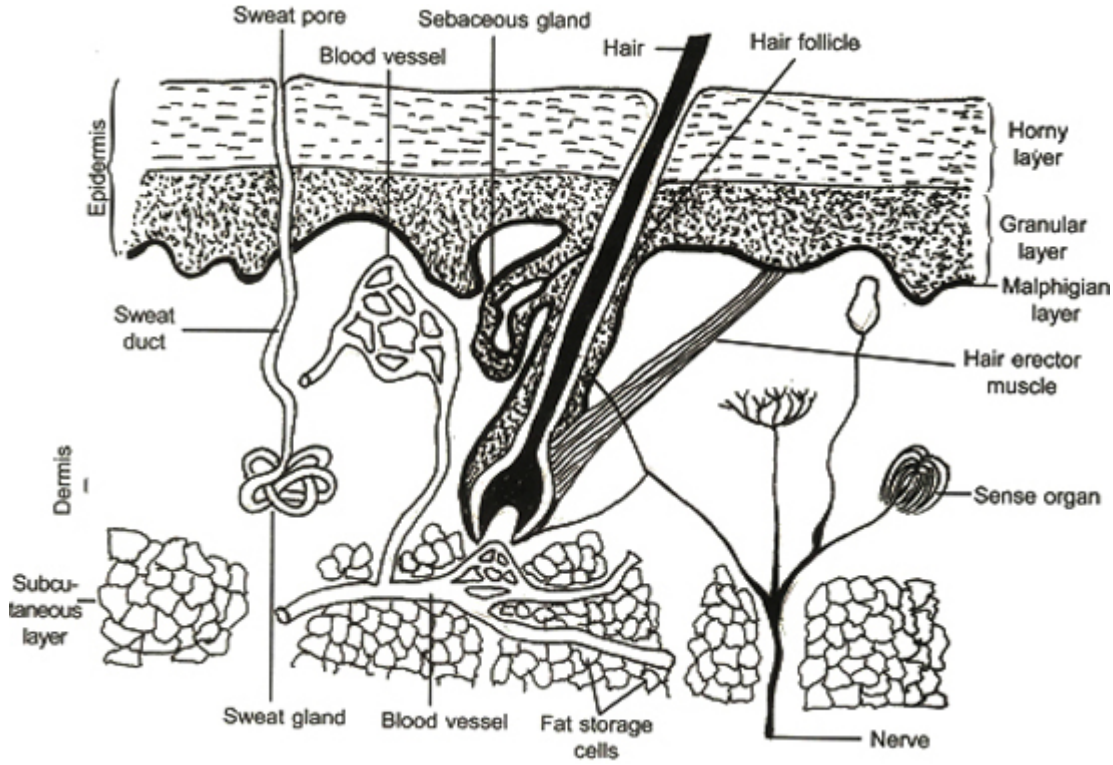

Fig. 1.3. Vertical section of the mammalian skin

Functions of the mammalian skin

The skin performs several functions. The major ones are: protection, sensitivity, excretion, temperature regulation and synthesis of vitamin D.

1. Protection

Protection from cuts and scratches is offered by the horny layer, and also with the help of hair in some parts, such as the head. Also, these dead cells that form the horny layer together with oily secretions, protect the body from excessive evaporation of water and from penetration of germs.

2. Sensitivity

Sensitivity is provided by the various types of nerve endings; each being sensitive to one particular type of stimulus (see Fig. 3.1, Chapter 3).

Each nerve ending, when stimulated, initiates an impulse, which passes along a nerve to the brain, where it is interpreted as pain, heat or pressure. With the nerve endings, we can also distinguish grades of roughness and smoothness, which we call a sense of texture.

3. Excretion

The sweat gland of the skin secretes sweat, which contains water, salts and urea.

4. The skin and body temperature regulation

Animals whose body temperature varies according to changes in their external surroundings are said to be **poikilothermic,** e.g. fish, amphibians and reptiles. Bird and mammals, whose body temperature remain constant regardless of the changes in the temperature of their external environments, are said to be **homoiothermic.**

Activity 1.3

Observe and draw a detailed structure of a section of the skin as can be seen under the microscope.

The mammalian skin helps to regulate the body temperature in specific ways. In a hot surrounding or weather, a mammal keeps its body temperature constant in the following ways:

i. The blood vessels close to the skin surface dilate (become wider) so that more blood flows to the surface and heat is lost by radiation and convection.

ii. The sweat glands absorb fluid from the blood capillaries which passes out as sweat through the sweat pores.

iii. On evaporation of the sweat, a cooling effect is produced, in the body and the body temperature is reduced.

5. Production of vitamin D

The skin produces vitamin D on exposure to early morning sunlight.

Care of the mammalian skin

Sweat and oily secretions from the skin cause dust to stick to the skin readily, resulting in blocked pores of the skin and reduction in the ability of the skin to carry out its functions.

Warm water and soap are the best for cleaning the skin and removing the dirt and bacterial spores. A cold shower, after a warm bath, invigorates the body and improves the circulation of blood.

Fresh air and sunlight are beneficial to the skin, but care should be taken to prevent too much exposure to sunlight which may lead to sunburn.

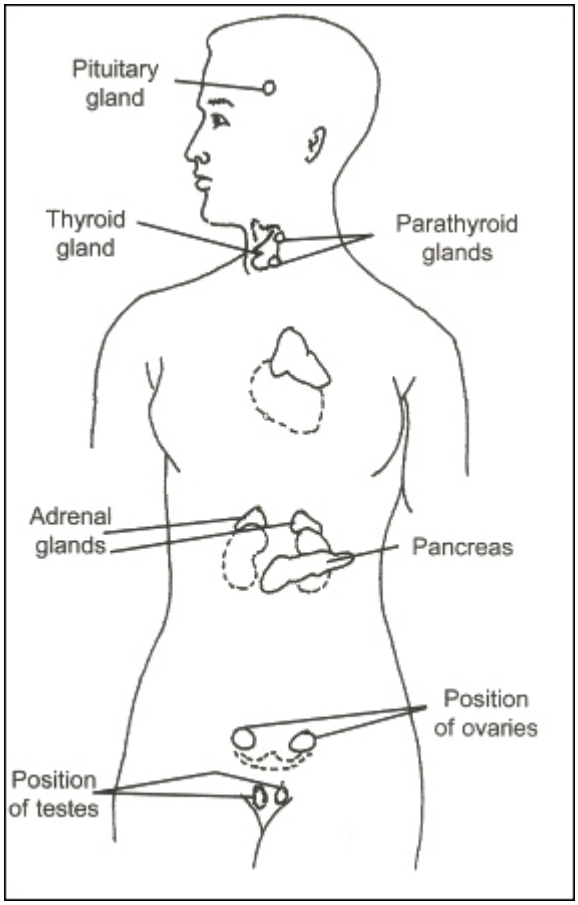

Fig. 1.4 Major endocrine glands of the human body

The skin should be kept clean as this prevents bacterial infections and also eliminates skin parasites such as lice, fleas and mites. These are potential carriers of diseases.

Wounds, cuts and abrasions should be cleaned to get rid of dirt and then dressed with an antiseptic to prevent infection from entering

such openings. Many pathogens can gain entry through the cuts in the skin, such as spirochaetes of *leptospirosis,* and yaws, the bacteria of *tetanus,* gangrene and staphylococcal infections.

Hormones

A **hormone** is any substance which is produced in one part of a plant or animalâ€™s body and acts on another part. In vertebrates, hormones are produced in organs called **endocrine glands** in the head, neck and trunk. The endocrine glands are also known as **ductless glands** because unlike the pancreas, salivary and tear glands, they have no ducts. Their secretions diffuse directly into the blood which carries them to all parts of the body, including the tissues they affect. By affecting certain cells, hormones regulate processes such as growth, development, metabolism, and response to crises. The positions of the major endocrine glands of the human body are shown in Fig. 1.4

Types of hormones and where they are secreted

The thyroid and parathyroid glands

The **thyroid gland** is an H-shaped gland located in the neck, as shown in Fig. 1.4. The thyroid lies over the top part of the trachea. It produces a hormone called **thyroxine** which regulates the rate of the bodyâ€™s metabolism in adults. In most cells, thyroxine controls the rate at which glucose is oxidized. Thyroxine is an amino acid that contains iodine. It also controls the rate of growth in young animals as well as the mental and physical development of young animals. Shortage or under-secretion of thyroxine causes the animal to look sluggish, and overweight while in children lack of thyroxine causes poor mental and physical development, a situation that causes **cretinism.**

Oversecretion of thyroxine in man leads to a voracious appetite, over-activity, thinness and high metabolic rate. Iodine deficiency causes the thyroid gland to increase in size several times in order to produce thyroxine. The condition results in a disease known as goitre (characterized by a swelling in the neck).

The **parathyroid glands** are four small glands on the posterior surface of the thyroid. They produce the **parathyroid hormone.** This hormone regulates the levels of calcium and phosphate ions in the blood. Bones, muscles and nerves need these ions to grow and function properly.

Experiment 1.1

To demonstrate the effect of thyroxin on toad metamorphosis.

Method: 1. Take two lots of tadpoles which have hind leg buds

and put them in two separate jars of water.

2. Crush 30mg thyroid tablets and spread the powder on tiny scraps of raw meat. Sprinkle the treated meat on the surface of the water in one jar.
3. Sprinkle the other jar with untreated meat as a control.

Observation: After about one week, the tadpoles in the first jar will develop forelimbs and their tails will grow smaller, while the tadpoles in the second jar will show little changes.

Conclusion: The extra thyroxin has accelerated metamorphosis.

The adrenal glands

An **adrenal gland** is located above each kidney. Each gland consists of two separate parts: the **cortex** and the **medulla.** The adrenal cortex or outer portion produces **corticoid hormones.** Some of these hormones maintain water and salt balance by regulating the absorption of these substances in the kidney tubules. Other corticoids control the conversion of proteins to glucose. This helps to maintain the proper level of sugar in the blood.

The adrenal medulla secretes **adrenalin,** also called **epinephrine.** Extreme fear, anger, pain, or cold will stimulate the adrenal medulla to produce a lot of adrenalin. Adrenalin causes the widening of blood vessels in the liver, heart and skeletal muscles. It causes the blood pressure and rate of respiration to rise. It promotes the conversion of glycogen to glucose, making more energy available for the bodyâ€™s response to adrenalin. It prepares a person either to fight danger or to flee from it. Therefore, it is known as the **emergency hormone.**

The islets of Langerhans of the pancreas

Endocrine cells are found throughout the **pancrease** in areas known as the **islets of Langerhans.** Different types of islet cells secrete two hormones into the blood stream. One is **glucagon,** which converts glycogen to glucose when the concentration of glucose in the blood is low. The other hormone, **insulin,** promotes the uptake of glucose by cells and its conversion to glycogen. Glycogen is stored in the liver.

The gonads

The **gonads** produce large quantities of sex hormones. The ovaries are the female gonads while the testes are the male gonads.

The ovaries produce a hormone called **oestrogen,** which cause the development of secondary sex characteristics. These characteristics develop during puberty, which occurs in early teenage years. At this time a girlâ€™s breasts enlarge due to development of the mammary glands. Her hips widen; she acquires an additional layer of body fat

and additional body hair (especially in the pubic region and the armpits). Oestrogens also cause the beginning of the menstrual cycle. **Progesterone** is another female hormone concerned with the control of pregnancy.

The testes produce male sex hormone or **androgens.** One androgen is **testosterone,** which causes the development of male secondary sex characteristics at puberty. Thus, in boys, the voice deepens, hairs appear all over the body; and they become more muscular.

The pituitary gland

The **pituitary gland** (the master gland) is located at the base of the brain. Both nerves and blood vessels connect the pituitary to the hypothallamus. Some pituitary hormones determine when certain other endocrine glands release their secretions. The pituitary gland has the anterior and posterior sections. The posterior pituitary stores and releases two hormones that are produced in the hypothallamus. One of these is **oxytocin.** The other is **antidiuretic hormone** or **ADH,** which is also known as **vasopressin.** Oxytocin causes the contraction of the uterine muscles during childbirth. It also promotes the flow of milk from the mammary glands. ADH regulates the reabsorption of water in the kidney tubules. If a person does not have enough ADH, less water is reabsorbed. As a consequence, the kidneys produce an abnormally large volume of urine.

The anterior pituitary produces **growth hormones,** which control the growth of bones. The anterior pituitary also produces **prolactin.** This hormone stimulates the secretion of milk in Ã woman after she has given birth. In addition, the anterior pituitary affects other endocrine glands.

Effect of oversecretion and deficiency of different hormones

If for any reason a ductless gland produces too little or too much of a hormone, the metabolism and health of the animal will be affected. Table 1.1. shows the effects of the oversecretion and deficiency of different hormones on animals.

Plant hormones (auxins)

Auxins (plant hormones) are chemicals in plants which in certain concentrations accelerate their growth. The rate of growth increases until it reaches a maximum.

Any further increase in the concentration of auxins will cause an inhibition in growth rate. Auxins are produced near the tip of shoots and roots but they diffuse into the zones of elongation to promote cell extension, root production, leaf fall, fruit fall as well as phototropic responses of roots and shoots.

Types and functions of auxins

Auxins are of different types and they perform different functions. Examples are **2, 4 dichlorophenoxy ethanoic acid (2, 4 – D) and indole -3- acetic acid (IAA).** It has been found that indole acetic acid is the auxin present in the largest quantities in plants.

The functions of auxins include:

1. Promoting terminal growth in plants
2. Stimulating the growth of lateral branches. (To replace the terminal ones especially when the apical buds are cut).
3. Prolongation of abscission and ripening of fruits. This is a feature of some auxins present in seeds and tubers.
4. Promotion of the formation of adventitious roots, e.g. beta-indole acetic acid.
5. Selective killing of certain weeds in the case of 2,4-D.

Table 1.1 Effects of oversecretion and deficiency of some hormones

Endocrine gland	Hormones secreted	Effects of oversecretion	Effects of deficiency
Thyroid	Thyroxine	Hyperthyroidism — i.e. increase in metabolic rate (Overactivity).	Hypothyroidism — i.e, low metabolic rate (sluggishness). In infants, it results in a condition known as cretinism.
Adrenal	Adrenaline	Hypersensitivity, Overanxiety, Excitement.	Lethargy, Lassitude (A state of feeling very tired in the mind or body)
Pancreas	Insulin	Fall in blood sugar level in the body.	Diabetes mellitus
Pituitary	Many hormones, including growth hormones.	Gigantism	Dwarfism

The concentration of auxins affect their functions. An auxin like indole acetic acid at low concentration, promotes growth, but inhibits growth at high concentration.

Unilateral source of light affects both the production and distribution of auxins. The side of a plant which is away from light accumulates a greater quantity of auxins, grows faster and causes a curvature towards the source of light. This explains the phenomenon of positive phototropism. A similar situation explains the upward bending of shoot when a plant is subjected to the effect of gravity. Stems exhibit positive phototropism and negative geotropism, while roots respond in the opposite way. The explanation is that the

concentration of auxins which promotes growth in shoots is known to inhibit growth in roots. The side of a root exposed to a source of light or that side away from the ground has less concentration of auxin and therefore grows faster than the other side resulting in the curvature away from the light and towards gravity.

Experiment 1.2 *To demonstrate the effect of auxins on plant growth*

Methods:

1. Divide some germinating maize grains into three groups.
2. Cover the coleoptile tip of one group with aluminium foil; cut off the coleoptile tips of the second group; leave the coleptile tips of the third group intact as control.
3. Put the tray in a lightproof box with a hole on one side.
4. Place the set-up near a window with the hole facing the window. Observe daily for about five days.

Observation: The first group covered with aluminium foil will not bend; the second group will not bend; the third group will bend towards the source of light.

Conclusion: Intact plant tips produce auxins and bend towards light.

Explanation

Stems with cut tips do not synthesize auxins and therefore cannot bend towards the source of light. On the other hand, auxins are produced at the coleoptile tips. Those with covered coleoptile tips do not curve because the zone of elongation is prevented from receiving light. Those left as control will curve towards light on, account of the uneven distribution of auxins.

Modern application of auxins

The effects of auxins have been used by agriculturists to bring about improvements with regards to crop control, harvesting and weed control in the following ways.

1. The duration of dormancy in potatoes and yams is usually prolonged by applying auxins to the tubers. This helps to preserve tubers the more.
2. Non-pollinated flowers can be made to develop fruits by the application of auxins instead of pollen. This is because it has been discovered that after fertilization, developing seeds secrete auxins into the surrounding floral parts to induce fruit growth.
3. Fruits can be made to remain longer on the plants by applying

auxins to them. Auxins can be applied at the petioles to prevent the formation of abscission layer or cause delayed abscission.

4. Farmers control the harvesting of crops like tomatoes and oranges by spraying the fruits with auxins or applying auxin tablets to the soil.
5. Gardeners select some plants, cut their shoots into bits and treat them with auxins to enhance the growth of adventitious roots. In this way, desired plants are readily propagated.
6. Auxins, like IAA and 2, 4 – D when applied at high concentration, will serve as weed killers.

Other growth promoting substances in plants

Other plant growth hormones such as gibberellin, cytokinin, ethene (ethylene) and Abscisic acid and their uses will be further discussed thus:

Gibberellins: These plant hormones are found or located in roots and embryos of germinating seeds. Gibberellins were first isolated by Japanese scientist from the culture of a fungus known to be a parasite of rice. Gibberellins promote (stimulate) growth through cell elongation and cell division. Similarly, they stimulate stem growth in dwarf varieties. They also promote development of flowers in such plants as spinach and cabbage. Other effects of gibberellins are, breaking dormancy in buds and seeds for growth initiation, retarding leaf abscission and increasing fruit size.

Cytokinins: These are also growth hormones that are produced in roots. When they act together with auxins, they strongly stimulate cell division (mitosis), enabling normal stem and root growth in meristematic tissues. Cytokinins also stimulate the growth of lateral buds into branches as well as growth of fruits. Cytokinins delay aging in such plant parts as the leaves and also increases the resistance of some plant organs to harmful influences like virus infection, weed killers, lower temperature etc.

Ethene (Ethylene) (CH_2CH_2): This hydrocarbon is produced in leaves, stems and young fruits. Ethene retards lateral bud development. This happens when auxin induces the formation of ethene around them (i.e. the lateral buds). Ethene also hastens the ripening of fruits.

Abscisic acid: This hormone is manufactured in mature green leaves, fruits and root caps. It is involved in growth inhibition (i.e. it is a growth inhibitor). It suppresses the growth of buds involved in ageing in leaves, and controls the opening and closing of stomata.

Suggested practicals

1. *Organs of a vertebrate and their relative positions to the liver.*
   a) Dissect a vertebrate (e.g. rat) and identify the liver.

b) Identify the other organs.

c) Note the relative positions of the organs to the liver.

d) Draw and label.

2. *The effect of auxin as a weed killer*

   You will be provided with trays containing grasses and some broad-leaved herbs e.g. *Tridax* and *Agerantum*

   a) Obtain a solution of 2,4 dichlorophenoxy ethanoic acid (2,4-D) from your teacher.

   b) Spray the plants in the tray with this solution once a week.

   c) Observe and record the herbicidal effect.

Summary

1. For an organism to remain healthy, there must be a balance in its internal environment.
2. The main functions of the kidneys are, osmoregulation and excretion.
3. Like all organs, the kidneys usually last a life time but sometimes, they fail and can no longer function properly.
4. The conditions that can affect the functioning of the kidneys include, diseases, drugs and temperature.
5. Diseases of the kidneys include nephritis, kidney stones, diuresis and dropsy.
6. Remedies to kidney diseases include kidney dialysis, kidney transplants and surgery.
7. The liver is one of the largest organs in the body. The liver has many different functions: it plays a role in nutrition, protection and other functions.
8. The diseases that can affect the functioning of the liver include infective hepatitis, cancer of the liver and gall stones.
9. Remedies to liver diseases include surgery, use of drugs, use of X-rays and radioactive materials.
10. The skin is the toughest organ in the body. It consists of the epidermis and dermis.
11. The functions of the skin include, protection, sensitivity, excretion, temperature regulation and synthesis of vitamin D.
12. The mammalian skin can be cared for by general cleanliness. This prevents infections and improves the circulation of blood.
13. Hormones produced by animals include thyroxin, adrenaline, oxytocin, anti-diuretic hormones (ADH), growth hormones, insulin, oestrogen and testosterone.
14. These hormones, in one way or the other, control the body metabolism.

15. Hormones are substances which are made in one part of an organism but act on another part.
16. Over secretion or deficiency of hormones affects the metabolism and health of the animal.
17. In plants, hormones called auxins are produced near the tip of shoots and roots but they diffuse into the zones of elongation to promote cell extension. They control certain activities in plants.
18. Auxins in plants include beta-indolebutyric acid, 2-4 dichlorophenoxy ethanoic acid (2, 4-D) and indole acetic acid (IAA).

The effects of auxins have been used by agriculturists to bring about improvement in crops.

Objective Questions

1. Which of the following body parts secretes a hormone which helps a person to react in a dangerous situation?
   A. Pituitary gland.
   B. Adrenal gland.
   C. Thyroid gland.
   D. Spleen.
   E. Pancrease.
2. What happens to a seedling when an aluminium foil cap is placed on the top of its plumule and it is subjected to light from one side?
   A. No further growth takes place.
   B. The shoot bends over towards the light.
   C. The root bends away from the light.
   D. The internodes show a marked elongation.
   E. The shoot continues to grow upwards.
3. The liver performs all of the following functions except the
   A. manufacture of urea.
   B. manufacture of bile.
   C. manufacture of proteins.
   D. manufacture of adrenaline.
   E. deamination of protein.
4. The part of the skin that helps in excretion is the
   A. hair.
   B. sweat gland.
   C. sebaceous gland.
   D. nerve ending.
   E. blood vessel.
5. The kidney helps to prevent the loss of useful substances from the

body through

A. pressure filtration.
B. active diffusion.
C. selective reabsorption.
D. active transportation.
E. osmoregulation.

Essay Questions

1. (a) (i) What is osmoregulation?

(ii) Describe how the kidney carries out its osmoregulatory functions.

(b) (i) List **two** diseases of the kidney.

(ii) What are the effects of these diseases on the kidney?

(iii) How can the **named** kidney diseases be remedied?

2. (a) List **five** functions of the liver.

(b) List **three** diseases that can affect the liver, and describe the effect of one of them.

(c) How can the **named** liver diseases be remedied?

3. (a) With the aid of a well labelled drawing, describe the parts of the mammalian skin.

(b) What are the functions of the mammalian skin?

(d) In what ways can you take care of your skin?

4. (a) (i) What are hormones?

(ii) In a tabular form, list the functions, effects of oversecretion and deficiency of the following hormones; thyroxin, adrenaline, insulin and growth hormones of the pituitary gland.

(b) (i) What are plant hormones.

(ii) List two of the plant hormones.

(iii) Describe an experiment to show the effect of an auxin on plantsâ€™ growth.

(c) Describe **five** ways in which auxins are useful to modern agriculturists.