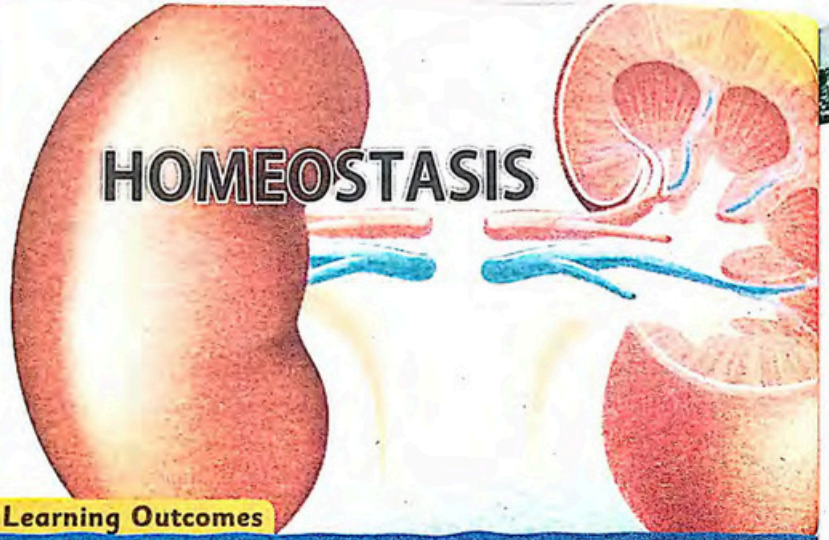
Unit 11

HOMEOSTASIS



Students Learning Outcomes

The students will be able to:

- Define homeostasis and describe its importance.
- Describe the mechanisms/adaptations in plants for the excretion/storage of CO_2, H_2O, O_2, latex, resins and gums.
- Explain osmotic adjustments in plants.
- State skin, lungs and kidneys as the major organs involved in homeostasis.
- Explain the role of the skin in regulating body temperature.
- Describe how lungs keep the carbon dioxide concentration down to certain level.
- Explain that kidneys control the blood composition.
- Identify the different organs of urinary system.
- Relate the structure of kidney with its function.
- State that nephron is the excretory unit of the kidney.
- Locate the different parts of nephrons and relate them with their function.
- State that the main role of the kidney is urine formation.
- Describe that urine formation involves three processes i.e. filtration, reabsorption and secretion.
- Explain that kidney plays an important role in osmoregulation.
- Identify the causes of kidney stones.
- Identify lithotripsy and surgery as the methods to remove kidney stones.
- Outline the causes of kidney failure.
- Explain that dialysis is one of the treatments in kidney failure.
- Describe the types of dialysis.
- Describe the contributions of Al-Farabi and Abul-Qasim in introducing the method of removing stones from the urinary bladder.

Introduction

Living organisms have been evolved and adapted according to their environment. The conditions and components of the external environment keep on changing continuously. The changes in the external environment affect the internal environment too. However, the organisms overcome the effect of these changes. They make adjustments in their internal environment. In this way, they try to maintain their internal environment in a constant state. The ability to maintain the internal environment constant is called homeostasis. Homeostasis helps an organism to survive and utilise its environment in the best possible way.

The most important components of internal environment which are readily affected by fluctuations in external environments are **water**, **solutes** and **temperature**.

For your Information

The terms internal environment and external environment were coined by Claude Bernard a century ago.

Body fluids are important components of the internal environment. These fluids are made up of water and solutes. The water-solute balance (commonly called water-salt balance) in body fluids is very important. During homeostasis, organisms maintain the water-solute balance. The process by which the amount of water and solutes are maintained in the body, is called **osmoregulation**. **Excretion** is the elimination of harmful solutes (e.g. nitrogenous wastes) and extra water from the body.

We know that all metabolic reactions in the bodies of living organisms are catalyzed by enzymes. We also know that each enzyme works best at a suitable body temperature. Changes in the temperature of the external environment affect the internal body temperature. In homeostasis, organisms maintain their internal temperature within a tolerable range. It is called **thermoregulation**.

11.1 Homeostasis in Plants

Like other organisms, plants also respond to the changes occurring in the external environment and keep their internal conditions constant.

11.1.1 Osmoregulation in Plants

On the basis of the availability of water, there are four groups of plants. The process of osmoregulation differs in all these groups according to their need and structure.

Mesophytes (meso: medium, phyte: plant) are the terrestrial plants which live where sufficient quantity of water is available. They absorb water through their roots. In sufficient supply of water, the stomata are kept open to promote loss of excess water. When they face a shortage of water, they control extra

Fig.11.1 Mesophytes

transpiration by closing their stomata. Most of their body surface is covered with waxy cuticle, which prevents water loss. Examples of mesophytes are maize (corn), clover and rose etc.

Hydrophytes (hydro: water, phyte: plant) are the plants which live in freshwater (ponds, rivers streams lakes etc.) or in wet soil. Water keeps on entering their bodies through their whole surface. They remove this extra water from their bodies by different ways. For example, many hydrophytes have broad leaves which float on the surface of the water. These leaves have a large number of stomata on their upper surfaces. Water moves out of their bodies through these stomata. The most common example of such plants is the water lily.

Fig.11.2 Water lilies (common hydrophytes)

Xerophytes (xero: dry, phyte: plant) live in dry environments (e.g. deserts). They have deep roots to absorb water from almost dry soil. Their body surface has very few stomata. It is also covered with thick waxy cuticles to reduce the loss of water. Some xerophytes e.g. Cacti (singular: Cactus) store water in their specialised stems or roots. Such stems or roots are soft and juicy and are called succulent organs.

Fig.11.3 The thick stems of xerophytes store water and carry out photosynthesis.

Halophytes (halo: salt, phyte: plant) live in habitats with salty waters (e.g. sea or salty marshes). Since their bodies have less salt concentration as compared to the external environment, water tries to move out from their bodies into the environment. Such plants absorb salts from external water by active transport. In this way, water does not move out of the cells. The excess salt can be stored in cells or excreted out from salt glands on leaves. Many sea grasses are included in this group.

11.1.2 Excretion in Plants

Plants do not possess any special organs for excretion. They get rid-off different wastes in different ways, to maintain their internal environment. The materials which plants require to excrete are carbon dioxide produced during respiration, oxygen and water released as a by product of photosynthesis and some metabolic products like latex, resins and gums.

Excretion of Carbon Dioxide and Oxygen: During the day time, when active photosynthesis is going on, CO_2 is retained in the leaves of plants and is used for photosynthesis. At night when there is no photosynthesis it is excreted through the open

stomata of the leaves. During the day, the oxygen produced during photosynthesis is utilised in cellular respiration. The extra oxygen is released out through the stomata.

Excretion of extra water: Plants store large amounts of water in the vacuoles of their cells. It results in turgor, which provides support to the soft parts of the body. If plants have extra amounts of water, they remove it in two ways.

1. Transpiration: During the day, plants remove their extra water by transpiration. There are three types of transpiration i.e. through the stomata (stomatal transpiration), cuticle (cuticular transpiration) and through lenticels (lenticular transpiration).

Recalling
Transpiration is the loss of water from the plant surface in the form of vapours.

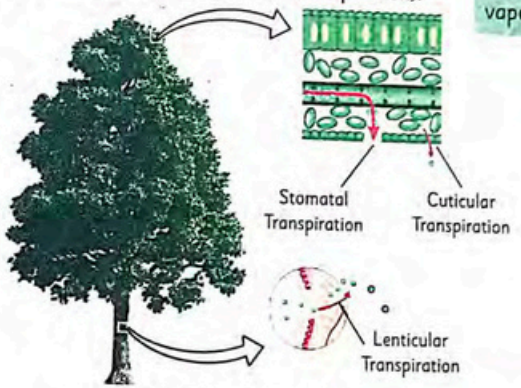


Fig.11.4 Types of transpiration

2. Guttation: Transpiration does not occur at night. Some plants such as grasses use a special method to remove extra water at night. They have small pores at the tips or edges of their leaves. They remove extra water through these pores. This water comes out in the form of little drops. This process is called guttation.

Fig.11.5 Water drops emerging from the margins of the leaves

Excretion of other wastes: Plants use different methods to excrete other wastes. Some plants store wastes in their bodies (stems, leaves or roots) in the form of harmless crystals. Some plants store their wastes in their leaves. When their leaves fall the plant body also gets rid of these wastes.

Some plants excrete their wastes through special pores by applying force. For example, the rubber plant excretes **latex**, the Acacia tree excretes **gums**, coniferous trees excrete **resins**, and the ladyfinger excretes **mucilage**.

For Your Information

Resins, gums and latex are very important plant products. They are economically very important and are used in many industrial products.

latex from a rubber plant | Gum from an Acacia tree | Resins from a coniferous tree

Fig.11.6 Excretion in Plants

11.2 Homeostasis in Humans

In human beings the main organs involved in homeostasis are skin, lungs and kidneys

a) Lungs as Homeostatic Organs

During cellular respiration, CO_2 and water are produced in every cell along with energy. CO_2 is a waste product for the body. It is an acidic gas, so, its accumulation can make the blood and other body tissues more acidic. Blood transports CO_2 from the cells to lungs. This carbon dioxide diffuses from the blood into the air in the alveoli. The air is then exhaled and so carbon dioxide is removed from the body.

b) Skin as a Homeostatic Organ

The skin of human beings and other mammals has been adapted as the organ for thermoregulation. There is a thin layer of fat cells beneath the epidermis of the skin. It does not allow heat to enter or leave the body. In cold conditions, muscles attached at the base of the hair on the skin contracts. As a result, the hairs on the skin stand up and goose bumps are formed on the skin. These goose bumps and hair make a blanket of warm air. It does not allow the body's heat to go out.

In warm conditions, the skin provides a cooling effect when sweat is produced by the sweat glands. In this way, excess body heat escapes through evaporation. Sweating also helps in the removal of some amounts of extra water, salts, and nitrogenous wastes from the body.

Do You Know?

Dogs have less number of sweat glands in their skin. Hence they keep their tongue hanging outside their mouth to increase the evaporation of water, which in response produces a cooling effect.

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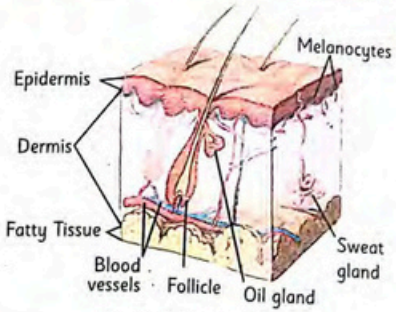

Fig.11.7 Human Skin

For Your Information

In bacterial and viral infections, leukocytes increase in number. When leukocytes kill pathogens, special chemicals are produced. These chemicals displace the set point of the hypothalamus of the brain above the normal point of 37°C. Brain sends messages to body parts to produce heat. It results in the body temperature to increase. This condition is called fever. This fever helps in stimulating the protective mechanisms against the pathogens.

c) Kidneys as Homeostatic Organs

Kidneys are the most important organs of homeostasis in human beings and other animals. Kidneys are part of the urinary system of the body.

Kidneys filter the nitrogenous wastes from the blood and excrete them from the body. In addition to this, kidneys also control the water-solute balance. If there are more solutes in the blood, kidneys excrete them and retain water in the body. But if there is more water, kidneys produce more urine to remove excess water from the body. In this way, kidneys perform osmoregulation.

For Your Information

Liver also plays role in homeostasis. It breaks the haemoglobin of dead red blood cells. The products of haemoglobin breakdown are sent to kidneys for removal. Liver changes the ammonia (produced in the metabolism of proteins) to urea. Urea is then removed from the body by kidneys.

11.3 Urinary System of Humans

The human urinary system (excretory system) consists of the following parts;

1. A pair of kidneys
2. A pair of ureters
3. A urinary bladder
4. A urethra

The kidneys remove extra water, salts and nitrogenous wastes from the blood and produce urine. From each kidney, a tube called the **ureter** carries urine to the urinary bladder. The **urinary bladder** temporarily stores urine. The **urethra** is the tube that carries urine from the urinary bladder to the outside.

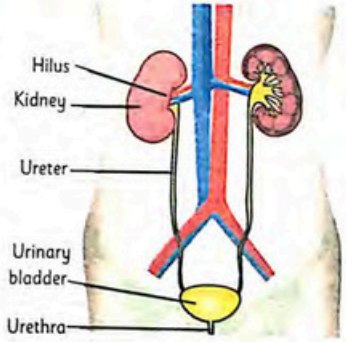

Fig.11.8 The Urinary System

11.3.1 Structure of the Human Kidney

Human beings possess a pair of kidneys. They are present below the diaphragm in the abdominal cavity, on the sides of vertebral column. They are attached to the dorsal body wall. The right kidney is slightly lower and smaller than the left one. Kidney is a dark brown and bean shaped organ (having a concave and a convex side). The concave side of each kidney is towards the vertebral column.

Do You Know?

Each kidney is about 10 cm long, 5 cm wide and 4 cm thick. The weight of both kidneys is less than 1% of the total body weight. However they receive 20% of the blood supplied to the body with each heartbeat.

Kidney is enclosed in a tissue called the **renal capsule**. On the concave side of the kidney, there is a depression called the **hilus**. It is the point where the renal artery enters the kidney and where the renal vein and ureter leave the kidney.

A longitudinal section of the kidney shows that it consists of two regions. The outer region is called the **renal cortex** whereas the inner region is called the **renal medulla**. There are many cone-shaped areas in renal medulla called the **renal pyramids**. The base of each pyramid faces the renal cortex while its tip is in a cavity called the **renal pelvis**. The pelvis extends to the outside of the kidneys and forms the ureter.

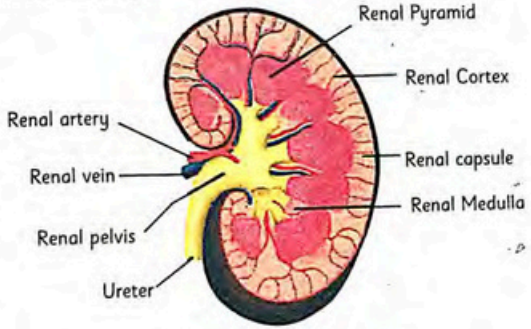

Fig.11.9 Structure of the Kidney

The functional units of the kidneys are called nephrons. There are more than one million nephrons in each kidney. A nephron consists of two parts i.e. the renal corpuscle and the renal tubule.

1. **Renal corpuscle:** It is the first part of the nephron and is composed of glomerulus and the Bowman's capsule. The **glomerulus** is a network of capillaries while the **Bowman's capsule** is the cup-shaped structure around the glomerulus.
2. **Renal tubule:** It is a long tube attached with the Bowman's capsule. It has three parts. The first part is convoluted and is called the **proximal convoluted tubule**. The middle part is U-shaped and is called the **Loop of Henle**. The last part is again convoluted and is called the **distal convoluted tubule**.

The distal convoluted tubules of many nephrons open in a single **collecting duct**. Many collecting ducts join together and open into the renal pelvis.

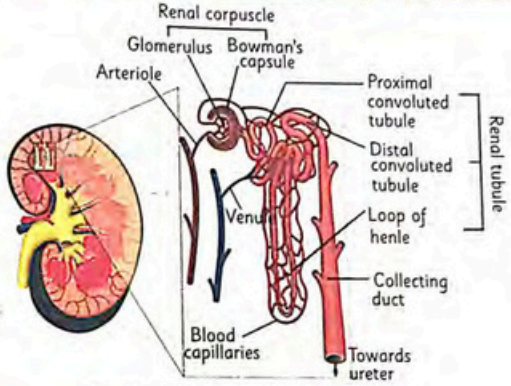

Fig.11.10 The Structure of Nephron

11.3.2 Process of Urine Formation

Process of urine formation can be divided into three sub processes.

(i). Pressure Filtration

A renal artery carries blood to the kidney. The artery divides into many arterioles. Each arteriole divides further into the capillaries of the glomerulus. When blood reaches the glomerulus, its pressure is very high. Due to the high pressure of blood in the glomerulus, a lot of materials in blood i.e. water, salts, sugars and nitrogenous wastes are filtered out of the glomerulus into the Bowman's capsule. As this filtration takes place due to the pressure of the blood in the glomerulus, it is called pressure filtration. The filtered material collected in the glomerulus is called **glomerular filtrate**. Blood cells and plasma proteins are not filtered out because they are larger in size.

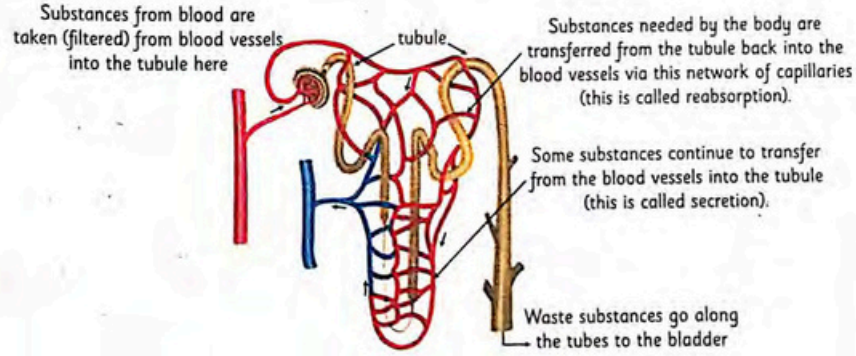

Fig.11.11 Process of urine formation in the nephron

(ii). Reabsorption

The glomerular filtrate moves to the next part of the nephron i.e. the renal tubule. The renal tubule is surrounded by blood capillaries. The useful constituents of the glomerular filtrate are reabsorbed into the blood capillaries. Some water and most of the glucose is reabsorbed from the proximal convoluted tubule. Salts are reabsorbed from the loop of Henle while most of the water is reabsorbed from the distal convoluted tubule and collecting duct.

(iii). Tubular Secretion

When useful materials are reabsorbed from the glomerular filtrate into the blood, some waste materials (e.g. salts, hydrogen ions, urea etc.) are again added from the blood capillaries to the renal tubule. This step is called tubular secretion.

After pressure filtration, reabsorption and tubular secretion, the filtrate present in the renal tubule is called urine. Urine from the collecting ducts moves to the renal pelvis. From the renal pelvis, urine moves to the urinary bladder via ureters. Here it is stored. When the urinary bladder is filled, urine is passed out through the **urethra**.

Do You Know?

A ring of sphincter muscles near the junction of the urethra and the urinary bladder controls the urine in the bladder. When about 300 to 400 ml urine is collected in the bladder, we need to discharge it. In babies this sphincter is not developed properly hence they are not able to control their urination.

11.3.3 Osmoregulation and Kidneys

Kidneys play the most important, function in the homeostasis of the body. They mainly perform the osmoregulatory and excretory functions. When body fluids including blood have limited amount of water, there is more reabsorption of water from the glomerular filtrate into the blood capillaries. As a result the net volume of urine decreases and the water is conserved in the body.

In contrast, when there is an excess of water in the body fluids and blood, the reabsorption of water from the glomerular filtrate is reduced. So, more water remains in the renal tubule and more urine is produced. In this way, the excess water is released from the body.

Tidbit

Kidney is adopted to conserve water by over 99.5% reabsorption of glomerular filtrate.

11.4 Disorders of Kidnys

Sometimes due to some internal or external factors, the normal working of the kidneys may be disturbed. These situations are called disorders of the kidney. Some important disorders of the kidneys and their treatment is described below.

Tidbit

Human kidneys start functioning right after the fourth month of gestation and keep working throughout life.

Science, Technology and Society

How does diabetes cause kidney disease?

The blood vessels in the kidneys which function as filter are damaged when there is high sugar in the blood. The damaged blood vessels then do not function as filters and the blood cannot be cleaned properly. The body will have more water and salts which can result in weight gain and ankle swelling. Urine may have more proteins and the blood may have more wastes. Many people with diabetes also develop high blood pressure, which can also damage their kidneys.

11.4.1 Kidney Stones

We know that kidneys filter harmful substances from the blood. Sometimes, the filtered harmful substances (e.g. calcium oxalate, calcium and ammonium phosphate, uric acid etc.) gather in the kidneys and make larger objects. Such objects cannot pass in the urine and are called **kidney stones**. Some stones may leave the kidneys and get trapped in the ureter or urinary bladder. These can then cause obstruction in the urinary tract.

The presence of more calcium oxalate, calcium and ammonium phosphates in a person's diet (green vegetables, fats, dairy products) is the major cause of kidney stones. Extra amounts of vitamins C and D in a diet may also cause stones. The other causes of kidney stones are reduced water intake, excess uric acid in the blood, urinary tract infections, and alcohol consumption.

For Your Information

Calcium oxalate type stones are 70% of all the kidney stones. Oxalates are present in green vegetables and tomatoes. Therefore eating green leafy vegetables and tomatoes may form oxalate stones.

Patients of kidney stones feel severe pain in kidney or lower abdomen. Other symptoms of kidney stones include nausea, vomiting, burning in urethra, frequent urination, foul-smelling urine, blood and pus in the urine and bloating.

Treatment of kidney stones

If kidney stones are small in size, the patient is advised to drink **plenty of water** so that stones can pass through the urine. If stones are large and cannot pass easily, the patient has to undergo **surgery**. Patient's kidney, ureter or urinary bladder is opened and stones are removed.

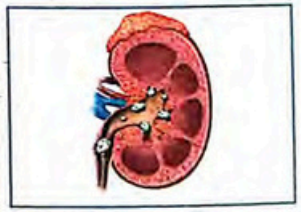

Fig.11.12 Kidney with stones

Tidbit

Lithotripsy works best with stones between 4 mm to 2 cm in diameter that are still located in the kidney. It can be used to break up stones which are located in a ureter too, but with less success.

The most recent method of removing kidney stones is called lithotripsy. It is the non-surgical removal of kidney stones. This technique is used to break up stones present in the kidney, ureter or urinary bladder. In this method, the stone inside the kidney is targeted by shock-waves. The shock waves break the stone into tiny pieces, which are passed out of the body in the urine.

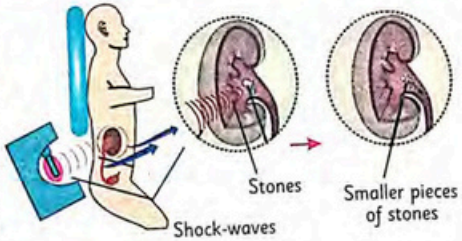

Fig.11.13 Lithotripsy

11.4.2 Kidney (Renal) Failure

Due to various reasons, the nephrons are progressively destroyed and stop functioning. This condition is termed as renal failure or kidney failure. The most common causes are long-term diabetes mellitus, and hypertension. Severe infections in the kidney and the overuse of medicine (aspirin, ibuprofen, cocaine and acetaminophen) can also cause kidney failure. In renal failure, nephrons are not able to filter the blood properly therefore the level of urea and other nitrogenous wastes in the blood increases. It causes complications like increase in blood pressure and anaemia etc. Other symptoms include weight loss, vomiting, nausea, and blood in the urine. Due to excess fluid in the body, there is swelling in the legs, feet and face.

Two types of treatments are given to the patients of renal failure.

1- Dialysis

The cleaning of the blood of a patient suffering from renal failure (by using artificial methods) is called dialysis. In dialysis, the blood and a dialysis fluid are kept on opposite sides of a membrane. The nitrogenous wastes of blood pass through the membrane and enter the **dialysis fluid**. In this way, the blood is purified. There are two methods of dialysis.

a). Haemodialysis: In this method blood is passed through a machine called a **dialyzer**. The dialyzer contains tubes, the walls of which are made of semi-permeable membranes. Blood flows inside the tubes while the dialysis fluid flows outside. Extra water and wastes diffuse from the blood into the dialysis fluid. The purified blood is then returned back to the body.

Science, Technology and Society

Science, Technology and Society

Drinking plenty of water (at least eight glasses) daily is crucial for the human body. It regulates the body temperature and transports nutrients and oxygen into the cells. It moistens the air in our lungs, protects our organs and helps them obtain nutrients. It also detoxifies, protects and moistens the joints. Waste products are removed from our body in the form of solutions. Dehydration can be dangerous so it is important to drink water and stay hydrated.

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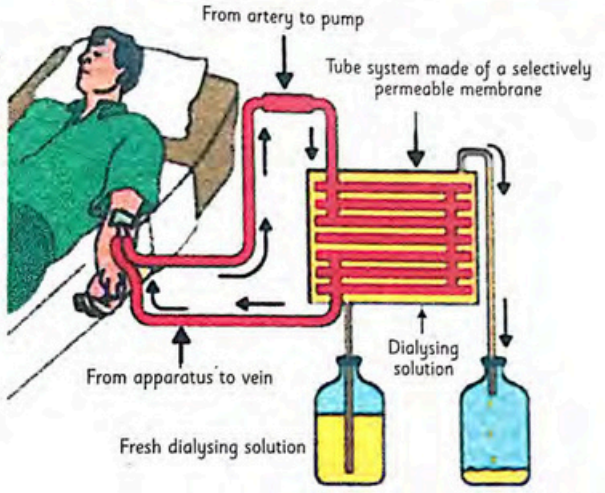

Fig.11.14 Haemodialysis

b). Peritoneal dialysis: In the abdomen, the space around the gut (alimentary canal) is called the peritoneal cavity. The walls of peritoneal cavity are lined by a thin membrane called the **peritoneum**. The peritoneum has a large number of blood vessels in it.

In this method, the dialysis fluid is filled in the peritoneal cavity through a catheter. The waste materials present in the blood vessels of the peritoneal membrane diffuse into the dialysis fluid. After some time, the dialysis fluid is drained. This form of dialysis can be done at home.

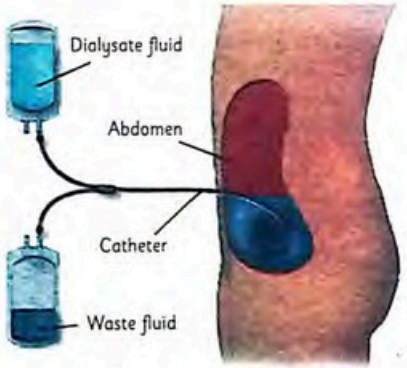

Fig.11.15 Peritoneal Dialysis

2- Kidney Transplantation

It is the advanced treatment of kidney failure. In this treatment, a healthy kidney from donor is transplanted in the patient's body. The donor of kidney may be a deceased person or a living one. A living-donor may or may not be a relative of the patient. In all cases, the donor's kidney is matched with the patient's immune system.

11.5 Contributions of Muslim Scientists to the treatment of Kidney problems

Various Muslim scientists have contributed to the studies of kidneys at various times. Among them, Abul- Qasim and Al-Farabi are well known.

Abul-Qasim

Abul-Qasim al-Zahrawi (936-1013 AD) is known in the west as Abulcasis. He is best known for his early and original breakthrough in surgery. His famous Medical Encyclopedia called Al-Tasrif is composed of thirty volumes. In this encyclopedia, he described various aspects of surgical treatments based on the operations performed by him, including the removal of stone from the urinary bladder, dissection of animals, and surgery of the eye, ear and throat.

Contributions of Al-Farabi

The great Turkish philosopher and scientist Abu Nasr Al-Farabi (known as Alpharabius: 872-950 AD) wrote many books. He provided a lot of information about kidney diseases, including stones in the urinary bladder.

For Your Information

Abu Bakar Muhammad ibn Zakariya Al Razi was a born in 865 A.D in Persia. He was famous Muslim doctor, scholar and philosopher. His most appreciated work was on kidney and bladder stones. He introduced techniques to remove kidney stones. His book, "The book of Formation of small stones" received critical acclaim all over the world.

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Key Points

- The maintenance of the internal environment as constant or nearly constant is called homeostasis.
- Regulation of the amount of water in body fluids is called osmoregulation while the regulation of internal body temperature is called thermoregulation.
- Guttation is the removal of extra water through small pores at the tips of leaves.
- Some plants remove wastes in the form of latex (e.g. rubber plant), gums (e.g. Acacia tree), resins (e.g. coniferous trees) and mucilage (e.g. ladyfinger).
- Hydrophytes have broad leaves with a large number of stomata on their upper surface.
- Xerophytes have thick cuticle and deep roots, and special juicy stems or roots.
- Halophytes take salts from sea water. Therefore, water does not move out of their bodies.
- The human urinary system consists of a pair of kidneys, a pair of ureters, a urinary bladder and a urethra.
- The functional unit of the kidneys is called nephrons.
- A nephron consists of two parts. (i) Renal corpuscle is composed of glomerulus and the Bowman's capsule. (ii) Renal tubule has three parts i.e. the proximal convoluted tubule, the Loop of Henle, and the distal convoluted tubule.
- When the glomerular filtrate moves to the renal tubule, useful materials are reabsorbed from the glomerular filtrate into the blood.
- In tubular secretion, some waste materials (e.g. salts, urea etc.) are added from the blood capillaries to the renal tubule.
- Urine from all the nephrons moves to the renal pelvis and then to the urinary bladder via ureters. From the bladder, urine is passed out through the urethra.
- Kidney stones are formed when calcium oxalate, calcium and ammonium phosphate, and uric acid etc.) gather in the kidneys and make larger objects.
- In lithotripsy, shock waves are targeted at stones from the outside to break the stones into smaller pieces.
- When one or both kidneys are not able to perform their function, the condition is called kidney failure.
- In haemodialysis, the patient's blood is pumped through a dialyzer. The blood flows inside the tubes while dialysis fluid flows outside. Extra water and wastes move from the blood and enter the dialysis fluid.
- In peritoneal dialysis, dialysis fluid is pumped into the peritoneal cavity. The waste materials pass from the blood present in the blood vessels into the dialysis fluid.

Exercise

A. Select the correct answer.

1. Organisms have the ability to change and modify their internal conditions according to the environment through:
   a. Osmoregulation b. Excretion c. Thermoregulation d. All of the above
2. All of the following are the adaptation of xerophytes except:
   a. Thick cuticle b. Large number of stomata
   c. Sunken stomata d. Deep root system
3. The loss of water from the plants in the form of small droplets is:
   a. Stomatal transpiration b. Cuticular transpiration
   c. Lenticular transpiration d. Guttation
4. From a nephron, wastes enter into the
   a. Collecting tubules b. Ureter c. Convoluted tubules d. Medulla
5. The tube between the kidney and urinary bladder is the:
   a. Ureter b. Urethra c. Renal tubule d. Nephron
6. Waste products excreted by the kidneys are:
   a. Urea, water and salts b. Salts, water and carbon dioxide
   c. Urea and water d. Urea and salts
7. Secretion of urea in sweat makes skin a:
   a. Respiratory organ b. Breathing organ
   c. Excretory organ d. Digestive organ
8. The two main functions of sweat are to;
   a. Keep the body cool and to remove excess proteins
   b. Keep the body warm and to filter the blood
   c. Filter the blood and to remove waste products
   d. Remove waste products and to cool the body
9. Which is NOT present in the filtrate entering the Bowman's capsule of a nephron?
   a. Water b. Calcium ions c. Blood cells d. Urea
10. Liver also plays a role in excretion. It makes urea from;
    a. Uric acid b. Ammonia c. Carbon dioxide d. Amino acids

B. Write short answers to the following questions.

1. Define homeostasis and osmoregulation.

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2. Differentiate between the adaptations of hydrophytes and xerophytes for osmoregulation.
3. Briefly describe how kidneys control the composition of blood.
4. Enlist materials in our diet which are more likely to cause kidney stones?
5. Define lithotripsy?
6. What is the role of the skin in thermoregulation?
7. Which term is used for the disease where one or both kidneys do not perform their function?

C. Write detailed answers to the following questions.

1. Describe the structure of kidneys in human beings.
2. Why do plants excrete? What are the different mechanisms through which plants excrete different substances?
3. What are kidney stones and how are they formed? Suggest ways in which these stones can be removed from the body.
4. Define haemodialysis. How is it performed?
5. How does a dialyzer work? Relate the function of a dialyzer with that of the kidney.

Activities

1. Examine the structure of a kidney (sheep or goat kidney / model).
2. Trace the movement of a molecule of urea from the blood to the urethra, using a flow chart diagram.