1 Nutrition in Plants

0758CH01

In Class VI you learnt that food is essential for all living organisms. You also learnt that carbohydrates, proteins, fats, vitamins and minerals are components of food. These components of food are called **nutrients** and are necessary for our body.

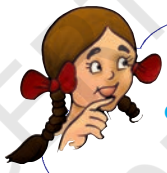
All living organisms require food. Plants can synthesise food for themselves but animals including humans cannot. They get it from plants or animals that eat plants. Thus, humans and animals are directly or indirectly dependent on plants.

Boojho wants to know how plants prepare their own food.

1.1 Mode of Nutrition in Plants

Plants are the only organisms that can prepare food for themselves by using water, carbon dioxide and minerals. The raw materials are present in their surroundings.

The nutrients enable living organisms to build their bodies, to grow, to repair damaged parts of their bodies and provide the energy to carry out life processes. **Nutrition** is the mode of taking food by an organism and its utilisation by the body. The mode of nutrition in which organisms make food themselves from simple substances is called **autotrophic** (*auto* = self; *trophos* = nourishment) nutrition. Therefore, plants are called **autotrophs**. Animals and most other organisms take in food prepared by plants. They are called **heterotrophs** (*heteros* = other).



Paheli wants to know why our body cannot make food from carbon dioxide, water and minerals like plants do.

Now we may ask where the food factories of plants are located: whether food is made in all parts of a plant or only in certain parts? How do plants obtain the raw materials from the surroundings? How do they transport them to the food factories of plants?

1.2 Photosynthesis — Food Making Process in Plants

Leaves are the food factories of plants. Therefore, all the raw materials must reach the leaf. Water and minerals present in the soil are absorbed by the roots and transported to the leaves. Carbon dioxide from air is taken in

Cells

You have seen that buildings are made of bricks. Similarly, the bodies of living organisms are made of tiny units called **cells**. Cells can be seen only under the microscope. Some organisms are made of only one cell. The cell is enclosed by a thin outer boundary, called the **cell membrane**. Most cells have a distinct, centrally located spherical structure called the **nucleus** (Fig. 1.1). The nucleus is surrounded by a jelly-like substance called **cytoplasm**.

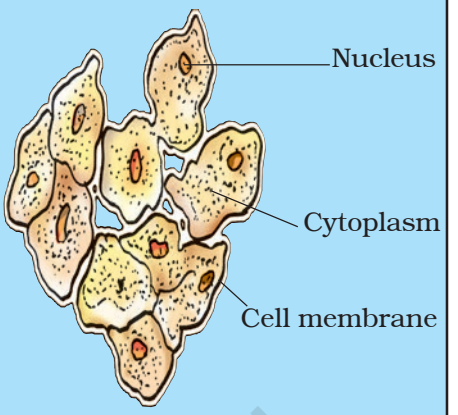
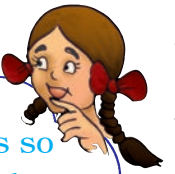


Fig. 1.1 Cell

through the tiny pores present on the surface of leaves. These pores are surrounded by 'guard cells'. Such pores are called **stomata** [Fig. 1.2 (c)].

Boojho wants to know how water and minerals absorbed by roots reach the leaves.

Water and minerals are transported to the leaves by the vessels which run like pipes throughout the root, the stem, the branches and the leaves. They form a continuous path or passage for the nutrients to reach the leaf. They are called vessels. You will learn more about transport of materials in plants in Chapter 7.



Paheli wants to know what is so special about the leaves that they can synthesise food but other parts of the plant cannot.

The leaves have a **green pigment** called **chlorophyll**. It helps leaves to capture the energy of the sunlight. This energy is used to synthesise (prepare) food from carbon dioxide and water. Since the synthesis of food occurs in the presence of sunlight, it is called **photosynthesis** (*Photo*: light; *synthesis* : to combine). So we find that chlorophyll, sunlight, carbon dioxide and water are necessary to carry out the process of photosynthesis. It is a unique process on the earth. The solar energy is captured by the leaves and stored in the plant in the form of food. **Thus, sun is the ultimate source of energy for all living organisms**.

Can you imagine life on earth in the absence of photosynthesis!

In the absence of photosynthesis there would not be any food. The survival of almost all living organisms directly or indirectly depends upon the food made by the plants. Besides, oxygen which is essential for the survival

Besides leaves, photosynthesis also takes place in other green parts of the plant — in green stems and green branches. The desert plants have scale- or spine-like leaves to reduce loss of water by transpiration. These plants have green stems which carry out photosynthesis.

of all organisms is produced during photosynthesis. In the absence of photosynthesis, life would be impossible on the earth.

During photosynthesis, chlorophyll containing cells of leaves (Fig. 1.2), in the presence of sunlight, use carbon dioxide and water to synthesise carbohydrates (Fig. 1.3). The process can be represented in an equation:

$$\text{Carbon dioxide} + \text{water} \xrightarrow[\text{chlorophyll}]{\text{sunlight}} \text{Carbohydrate} + \text{oxygen}$$

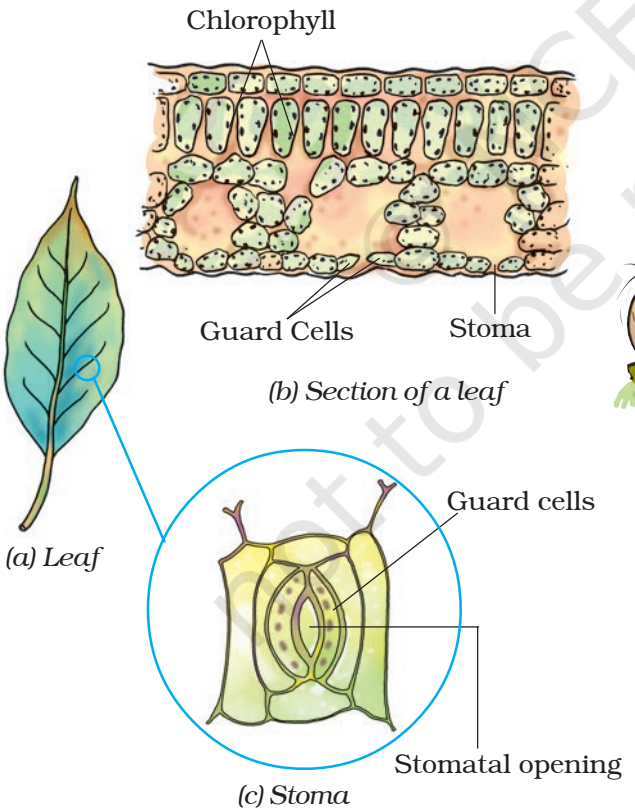


Fig. 1.2

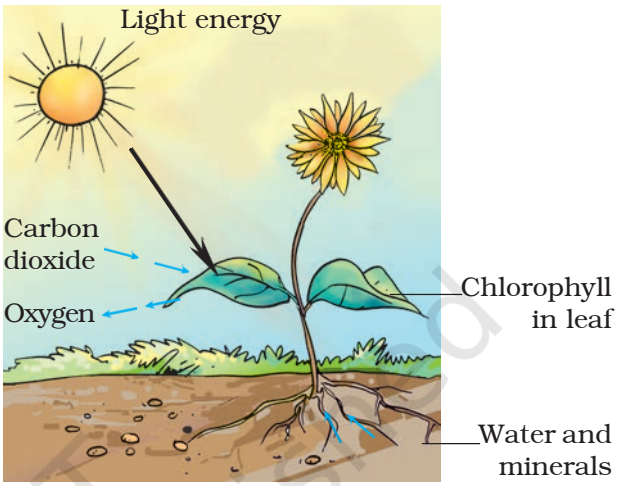
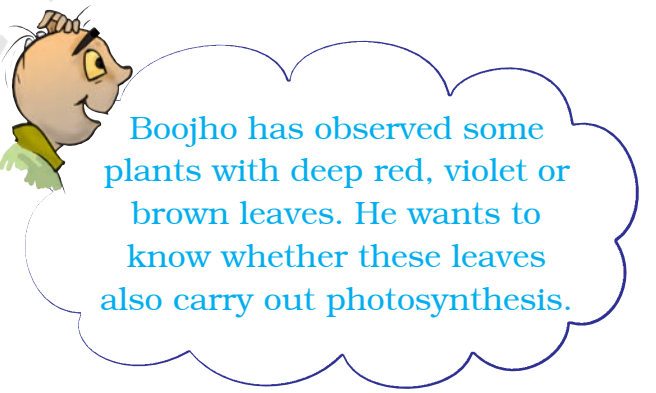


Fig. 1.3 Diagram showing photosynthesis

During the process oxygen is released. The presence of starch in leaves indicates the occurrence of photosynthesis. Starch is also a carbohydrate.



Activity 1.1

Take two potted plants of the same kind. Keep one in the dark (or in a black box) for 72 hours and the other in sunlight.

Perform iodine test with the leaves of both the plants as you did in Class VI. Record your results. Now leave the pot which was earlier kept in the dark, in the sunlight for 3 – 4 days and perform the iodine test again on its leaves. Record your observations in your notebook.

The leaves other than green also have chlorophyll. The large amount of red, brown and other pigments mask the green colour (Fig. 1.4). Photosynthesis takes place in these leaves also.

Fig. 1.4 Leaves of various colours

You often see slimy, green patches in ponds or stagnant water bodies. These are generally formed by the growth of organisms called **algae**. Can you guess why algae are green in colour? They contain chlorophyll which gives them the green colour. Algae can also prepare their own food by photosynthesis.

Synthesis of plant food other than carbohydrates

You have just learnt that plants synthesise carbohydrates through the process of photosynthesis. The carbohydrates are made of carbon, hydrogen and oxygen. These are used to synthesise other components of food such as proteins and fats. But proteins are nitrogenous substances which contain nitrogen. From where do the plants obtain nitrogen?

Recall that nitrogen is present in abundance in gaseous form in the air. However, plants cannot absorb nitrogen in this form. Soil has certain bacteria that convert gaseous nitrogen into a usable form and release it into the soil. These are absorbed by the plants along with water. Also, you might have seen farmers adding fertilisers rich in nitrogen to the soil. In this way the plants fulfil their requirements of nitrogen along with the other constituents. Plants can then synthesise proteins and vitamins.

1.3 Other Modes of Nutrition in Plants

There are some plants which do not have chlorophyll. They cannot synthesise food. How do they survive and from where do they derive nutrition? Like humans and animals such plants depend on the food produced by other plants. They use the **heterotrophic mode** of nutrition. Look at Fig. 1.5. Do you see a yellow wiry branched structure twining around the stem and branches of a tree? This is a plant called *Cuscuta* (Amarbel). It does not have chlorophyll. It takes readymade food from the plant on which it is climbing. The plant on which it climbs is called the **host**. Since it deprives the host of valuable nutrients,

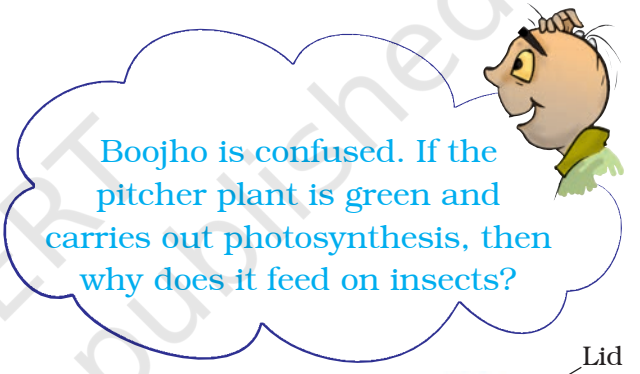
Fig. 1.5 *Cuscuta (Amarbel) on host plant*

Cuscuta is called the **parasite**. Are we and other animals also a kind of parasites? You should think about it and discuss with your teacher.

Paheli wants to know whether mosquitoes, bed bugs, lice and leeches that suck our blood are also parasites.

Have you seen or heard of plants that can eat animals? There are a few plants which can trap insects and digest them. Is it not amazing? Such plants may be green or of some other colour. Look at the plant in Fig. 1.6. The pitcher-like or jug-like structure is the modified part of leaf. The apex of the leaf forms a lid which can open and close the mouth of the pitcher. Inside the pitcher there are hair which are directed downwards. When an insect lands in the pitcher, the lid closes and the trapped insect gets entangled into the hair. The lid closes and the insect is trapped. The insect is digested by the digestive juices secreted in the pitcher and its nutrients are absorbed. Such insect-eating plants are called **insectivorous plants**.

Is it possible that such plants do not get all the required nutrients from the soil in which they grow?



Boojho is confused. If the pitcher plant is green and carries out photosynthesis, then why does it feed on insects?

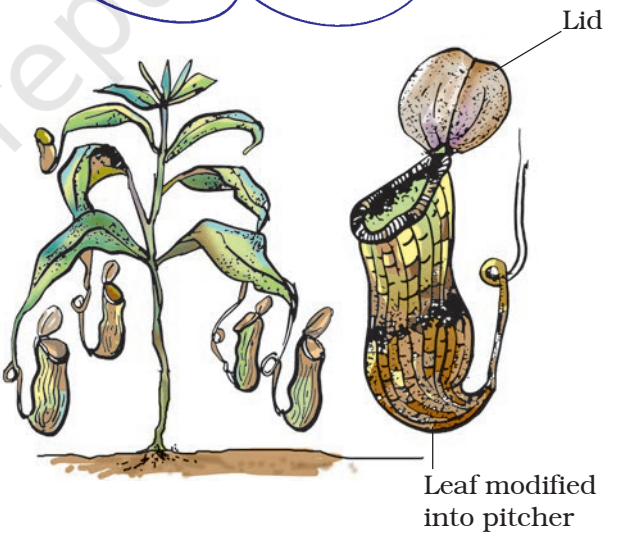


Fig. 1.6 *Pitcher plant showing lid and pitcher*

1.4 Saprotrophs

You might have seen packets of mushrooms sold in the vegetable

market. You may have also seen fluffy umbrella-like patches growing in moist soils or on rotting wood during the rainy season (Fig. 1.7). Let us find out what type of nutrients they need to survive and from where they get them.

Fig. 1.7 Packet of mushrooms, a mushroom growing on decayed material

Boojho wants to know how these organisms acquire nutrients. They do not have mouths like animals do. They are not like green plants as they lack chlorophyll and cannot make food by photosynthesis.

Activity 1.2

Take a piece of bread and moisten it with water. Leave it in a moist warm place for 2–3 days or until fluffy patches appear on them (Fig. 1.8). What is the colour of these patches? Observe the patches under a microscope or a magnifying glass. Write down your observations in the notebook. You will see cotton-like threads spread on the piece of bread.

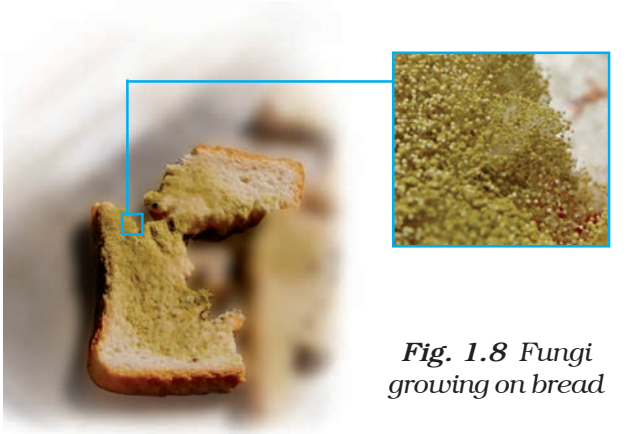


Fig. 1.8 Fungi growing on bread

These organisms are called **fungi**. They have a different mode of nutrition. They absorb the nutrients from the bread. This mode of nutrition in which organisms take in nutrients from dead and decaying matter is called **saprotrophic nutrition**. Such organisms with saprotrophic mode of nutrition are called **saprotrophs**.

Fungi also grow on pickles, leather, clothes and other articles that are left in hot and humid weather for long time. During the rainy season they spoil many things. Ask your parents about the menace of fungi in your house.

The fungal spores are generally present in the air. When they land on

Paheli is keen to know whether her beautiful shoes, which she wore on special occasions, were spoiled by fungi during the rainy season. She wants to know how fungi appear suddenly during the rainy season.

Boojho says once his grandfather told him that his wheat fields were spoiled by a fungus. He wants to know if fungi cause diseases also.

Paheli told him that many fungi like yeast and mushrooms are useful, but some fungi cause diseases in plants, animals including humans. Some fungi are also used as medicines.

wet and warm things they germinate and grow. Now, can you figure out how we can protect our things from getting spoiled?

Some organisms live together and share both shelter and nutrients. This relationship is called **symbiosis**. For example, certain fungi live inside the roots of plants. The plants provide nutrients to the fungus and, in return, the fungus provides water and certain nutrients.

In organisms called **lichens**, a chlorophyll-containing partner, which is an alga, and a fungus live together. The fungus provides shelter, water and minerals to the alga and, in return, the alga prepares and provides food to the fungus.

1.5 How Nutrients are Replenished in the Soil

Have you seen farmers spreading manure or fertilisers in the fields, or gardeners using them in lawns or in pots? Do you know why this is done?

You learnt that plants absorb minerals and nutrients from the soil. So, their amounts in the soil keep on declining. Fertilisers and manures contain nutrients such as nitrogen, potassium, phosphorous, etc. These nutrients need to be added from time to time to enrich the soil. We can grow plants and keep them healthy if we can fulfil the nutrient requirement of plants.

Usually crop plants absorb a lot of nitrogen and the soil becomes deficient in nitrogen. You learnt that though nitrogen gas is available in plenty in the air, plants cannot use it in the manner they can use carbon dioxide. They need nitrogen in a soluble form. The bacterium called *Rhizobium* can take atmospheric nitrogen and convert it into a usable form. But *Rhizobium* cannot make its own food. So it often lives in the roots of gram, peas, *moong*, beans and other legumes and provides them with nitrogen. In return, the plants provide food and shelter to the bacteria. They, thus, have a symbiotic relationship. This association is of great significance for the farmers. They can reduce the use of nitrogenous fertiliser where leguminous

plants are grown. Most of the pulses *(dals)* are obtained from leguminous plants.

In this chapter you learnt that most of the plants are autotrophs. Only a few plants are parasitic or saprotrophic. They derive nutrition from other organisms. All animals are categorised as heterotrophs since they depend on plants and other animals for food. Can we say that the insectivorous plants are partial **heterotrophs**?

Keywords

Autotrophic	Insectivorous	Photosynthesis
Chlorophyll	Nutrient	Saprotrophs
Heterotrophs	Nutrition	Saprotrophic
Host	Parasite	Stomata

What you have learnt

- All organisms need food and utilise it to get energy for growth and maintenance of their body.
- Green plants synthesise food for themselves by the process of photosynthesis. They are autotrophs.
- Plants like *Cuscuta* are parasites. They take food from the host plant.
- Plants use simple chemical substances like carbon dioxide, water and minerals for the synthesis of food.
- Chlorophyll, water, carbon dioxide and sunlight are the essential requirements for photosynthesis.
- Complex chemical substances such as carbohydrates are the products of photosynthesis.
- Solar energy is absorbed by the chlorophylls present in leaves/plants.
- Oxygen is produced during photosynthesis.
- Oxygen released in photosynthesis is utilised by living organisms for their survival.
- Many fungi derive nutrition from dead and decaying matter. They are saprotrophs.
- A few plants and all animals are dependent on others for their nutrition and are called heterotrophs.

Exercise

1. Why do organisms take food?
2. Distinguish between a parasite and a saprotroph.
3. How would you test the presence of starch in leaves?
4. Give a brief description of the process of synthesis of food in green plants.
5. Show with the help of a sketch that plants are the ultimate source of food.
6. Fill in the blanks:
   (a) Green plants are called _____ since they synthesise their own food.
   (b) The food synthesised by plants is stored as _____.
   (c) In photosynthesis solar energy is absorbed by the pigment called _____.
   (d) During photosynthesis plants take in _____ and release _____ gas.
7. Name the following:
   (i) A parasitic plant with yellow, slender and branched stem.
   (ii) A plant that is partially autotrophic.
   (iii) The pores through which leaves exchange gases.
8. Tick the correct answer:
   (a) *Cuscuta* is an example of:
   (i) autotroph (ii) parasite (iii) saprotroph (iv) host
   (b) The plant which traps and feeds on insects is:
   (i) *Cuscuta* (ii) china rose (iv) pitcher plant (iv) rose
9. Match the items given in Column I with those in Column II:

Column I	**Column II**
Chlorophyll	Rhizobium
Nitrogen	Heterotrophs
Cuscuta	Pitcher plant
Animals	Leaf
Insects	Parasite

10. Mark 'T' if the statement is true and 'F' if it is false:
    (i) Carbon dioxide is released during photosynthesis. (T/F)
    (ii) Plants which synthesise their food are called saprotrophs. (T/F)

(iii) The product of photosynthesis is not a protein. (T/F)

(iv) Solar energy is converted into chemical energy during photosynthesis. (T/F)

11. Choose the correct option from the following:

Which part of the plant takes in carbon dioxide from the air for photosynthesis?

(i) Root hair (ii) Stomata (iii) Leaf veins (iv) Petals

12. Choose the correct option from the following:

Plants take carbon dioxide from the atmosphere mainly through their:

(i) roots (ii) stem (iii) flowers (iv) leaves

13. Why do farmers grow many fruits and vegetable crops inside large green houses? What are the advantages to the farmers?

Extended Learning — Activities and Projects

1. Project

Take a potted plant with broad leaves. Take two strips of black paper and cut out a small square in the centres. Cover a part of two leaves with these papers and secure them with paper clips (Fig. 1.9). Keep the plant in sunlight for 2–5 days. Observe the difference in the colour of the covered and the uncovered portions on the leaf. Perform iodine test on this leaf. Did the two parts show different results? Now take second leaf. Remove the strip and expose the covered part to the sunlight for 2–3 days and do the iodine test again. Describe your observations.

Fig. 1.9 *Experiment to test the occurrence of photosynthesis*

2. Visit a green house if there is one near your place. Observe how they grow plants. Find out how they regulate the amount of light, water and carbon dioxide to grow the plants.
3. Try growing a sweet potato just in water. Describe your experiment and observations.

You can read more on the following website:
www.phschool.com/science/biology_place/biocoach/photosynth/overview.htm

Did you know?

Light is so important to plants that their leaves grow in many patterns so as to absorb maximum sunlight.

2 Nutrition in Animals

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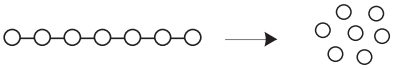
You have learnt in Chapter 1 that plants can prepare their own food by the process of photosynthesis but animals cannot. Animals get their food from plants, either directly by eating plants or indirectly by eating animals that eat plants. Some animals eat both plants and animals. Recall that all organisms including humans require food for growth, repair and functioning of the body. **Animal nutrition includes nutrient requirement, mode of intake of food and its utilisation in the body.**

You have studied in Class VI that food consists of many components. Try to recall and list them below:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

The components of food such as carbohydrates are complex substances. These complex substances cannot be utilised as such. So they are broken down into simpler substances. The breakdown of complex components of food into simpler substances is called **digestion**.



Complex substance Simpler substances

2.1 Different Ways of Taking Food

The mode of taking food into the body varies in different organisms. Bees and humming-birds suck the nectar of plants, infants of human and many other animals feed on mother's milk. Snakes like the python swallow the animals they prey upon. Some aquatic animals filter tiny food particles floating nearby and feed upon them.

Activity 2.1

What is the type of food and mode of feeding of the following animals? Write down your observations in the given Table. You may find the list of modes of feeding given below the Table helpful.

Table 2.1 Various modes of feeding

Name of animal	Kind of food	Mode of feeding
Snail		
Ant		
Eagle		
Humming-bird		
Lice		
Mosquito		
Butterfly		
House fly		

(Scraping, chewing, siphoning, capturing and swallowing, sponging, sucking etc.)

Amazing fact

Starfish feeds on animals covered by hard shells of calcium carbonate. After opening the shell, the starfish pops out its stomach through its mouth to eat the soft animal inside the shell. The stomach then goes back into the body and the food is slowly digested.

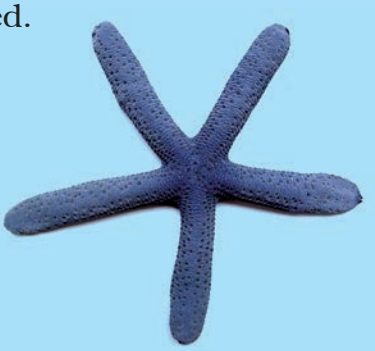


Fig. 2.1 Starfish

2.2 Digestion in Humans

We take in food through the mouth, digest and utilise it. The unused parts of the food are defecated. Have you ever wondered what happens to the food inside the body? The food passes through a continuous canal (Fig. 2.2) which begins at the buccal cavity and ends at the anus. The canal can be divided into various compartments: (1) the **buccal cavity,** (2) foodpipe or **oesophagus**, (3) **stomach**, (4) **small intestine**, (5) **large intestine** ending in the **rectum** and (6) the **anus**. Is it not a very long path? These parts together form the **alimentary canal (digestive tract)**. The food components gradually get digested as food travels through the various compartments. The inner walls of the stomach and the small intestine, and the various glands associated with the canal such as **salivary glands**, the **liver** and the **pancreas** secrete digestive juices. The digestive juices convert complex

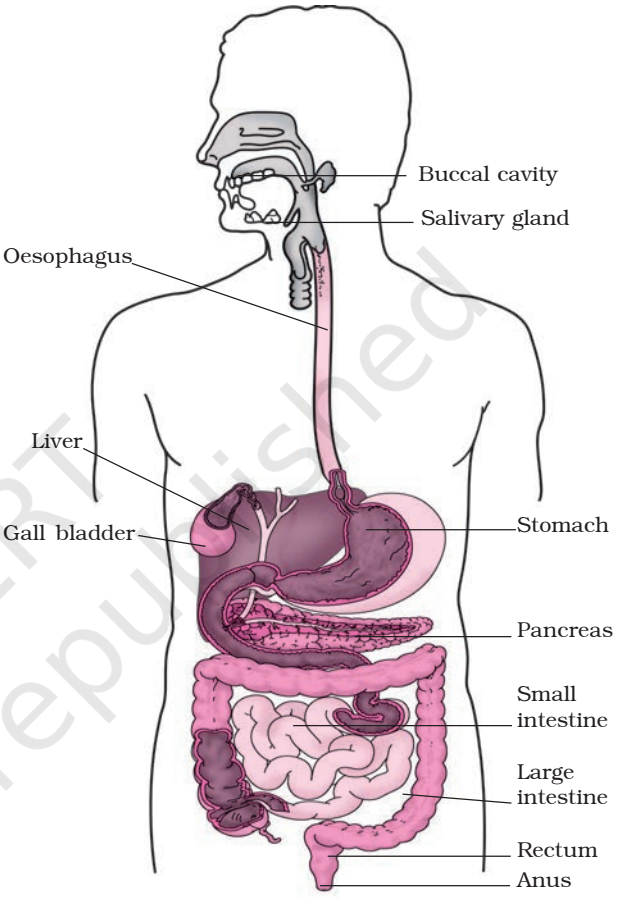


Fig. 2.2 Human digestive system

substances of food into simpler ones. The digestive tract and the associated glands together constitute the **digestive system**.

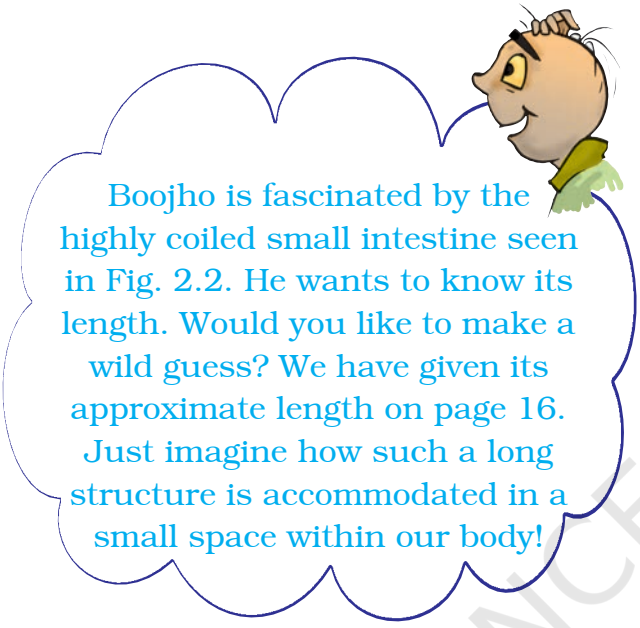
Now, let us know what happens to the food in different parts of the digestive tract.

The mouth and buccal cavity

Food is taken into the body through the mouth. The process of taking food into

Milk teeth and permanent teeth

Do you remember about falling of your teeth some years ago? The first set of teeth grows during infancy and they fall off at the age between six to eight years. These are termed **milk teeth**. The second set that replaces them are the **permanent teeth**. The permanent teeth may last throughout life or fall off during old age or due to some dental disease.



the body is called **ingestion**. We chew the food with the teeth and break it down mechanically into small pieces. Each tooth is rooted in a separate socket in the gums (Fig. 2.3). Our teeth vary in appearance and perform different functions. Accordingly they are given different names (Fig. 2.3).

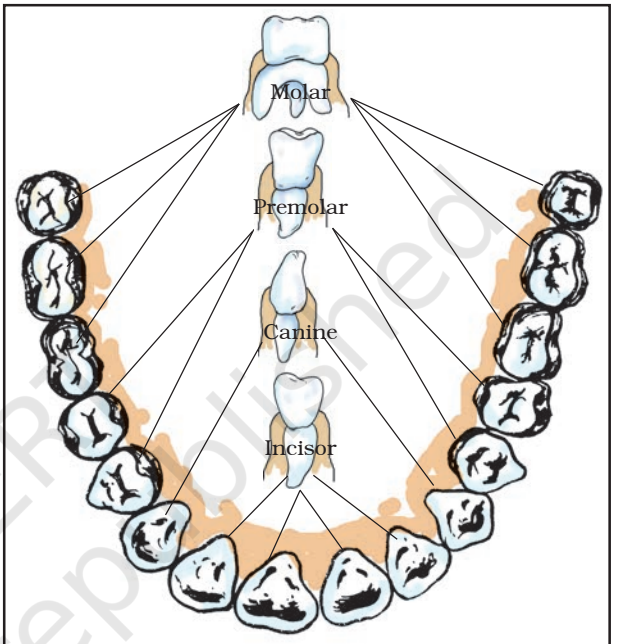


Fig. 2.3 Arrangement of teeth and different type of teeth

Activity 2.2

Wash your hands. Look into the mirror and count your teeth. Use your index finger to feel the teeth. How many kinds of teeth could you find? Take a piece of an apple or bread and eat it. Which teeth do you use for biting and cutting, and which ones for piercing and tearing? Also find out the ones that are used for chewing and grinding?

Record your observations in Table 2.2

Table 2.2

Type of teeth	Number of teeth		Total
	Lower jaw	Upper jaw	
Cutting and biting teeth			
Piercing and tearing teeth			
Chewing and grinding teeth			

Our mouth has the salivary glands which secrete saliva. Do you know the action of saliva on food? Let us find out.

Activity 2.3

Take two test tubes. Label them 'A' and 'B'. In test tube 'A' put one teaspoonful of boiled rice; in test tube 'B' keep one teaspoonful of boiled rice after chewing it for 3 to 5 minutes. Add 3–4 mL of water in both the test tubes (Fig. 2.4). Now pour 2–3 drops of iodine solution in each test tube and observe. Why is there a change in colour in the test tubes? Discuss the results with your classmates and your teacher. The **saliva** breaks down the **starch** into sugars.

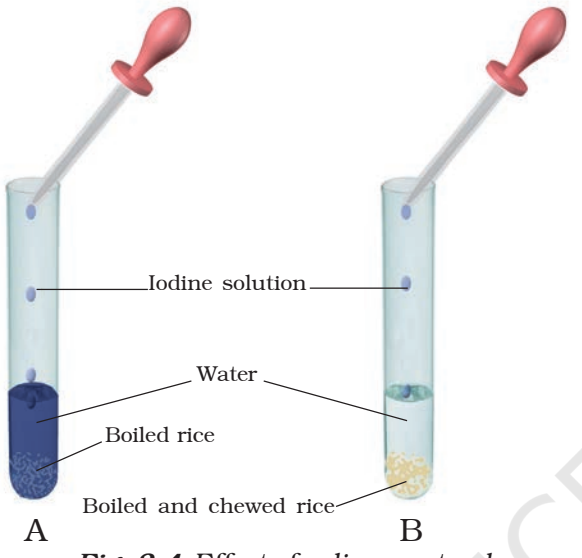


Fig. 2.4 *Effect of saliva on starch*

The tongue is a fleshy muscular organ attached at the back to the floor of the buccal cavity. It is free at the front and can be moved in all directions. Do you know the functions of the tongue? We use our tongue for talking. Besides, it mixes saliva with the food during chewing and helps in swallowing food. We also taste food with our tongue. It has taste buds that detect different tastes of food. We can find out the

Sweets and tooth decay

Normally bacteria are present in our mouth but they are not harmful to us. However, if we do not clean our teeth and mouth after eating, many harmful bacteria also begin to live and grow in it. These bacteria break down the sugars present from the leftover food and release acids (see Chapter 4 to know what an acid is). The acids gradually damage the teeth (Fig. 2.5). This is called **tooth decay**. If it is not treated in time, it causes severe toothache and in extreme cases results in tooth loss. Chocolates, sweets, soft drinks and other sugar products are the major culprits of tooth decay.

Therefore, one should clean the teeth with a brush or *datun* and dental floss (a special strong thread which is moved between two teeth to take out trapped food particles) at least twice a day and rinse the mouth after every meal. Also, one should not put dirty fingers or any unwashed object in the mouth.

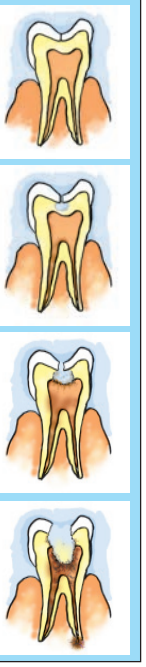


Fig. 2.5 *Gradual decay of tooth*

Sometimes when you eat in a hurry, talk or laugh while eating, you may cough, get hiccups or a choking sensation. This happens when food particles enter the windpipe. The windpipe carries air from the nostrils to the lungs. It runs adjacent to the foodpipe. But inside the throat, air and food share a common passage. Then how is food prevented from entering the windpipe? During the act of swallowing a flap-like valve closes the passage of the windpipe and guides the food into the foodpipe. If, by chance, food particles enter the windpipe, we feel choked, get hiccups or cough.

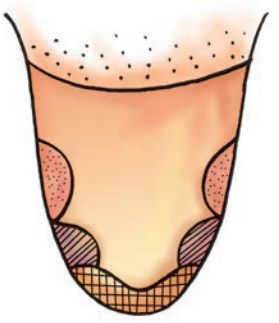


Fig. 2.6 Regions of the tongue for different tastes

position of taste buds by the following activity.

Activity 2.4

1. Prepare a separate sample each of (i) sugar solution, (ii) common salt solution, (iii) lemon juice and (iv) juice of crushed neem leaf or bitter gourd.
2. Blindfold one of your classmates and ask her/him to take out the tongue and keep it in straight and flat position.
3. Use a clean toothpick to put the above samples one by one on different areas of the tongue as shown in Fig. 2.6. Use a new toothpick for each sample.
4. Ask the classmate which areas of the tongue could detect the sweet, salty, sour and bitter substances.
5. Now write down your observations and label Fig. 2.6.

Repeat this activity with other classmates.

The foodpipe/oesophagus

The swallowed food passes into the foodpipe or oesophagus. Look at Fig. 2.2. The foodpipe runs along the neck

Paheli wants to know how food moves in the opposite direction during vomiting.

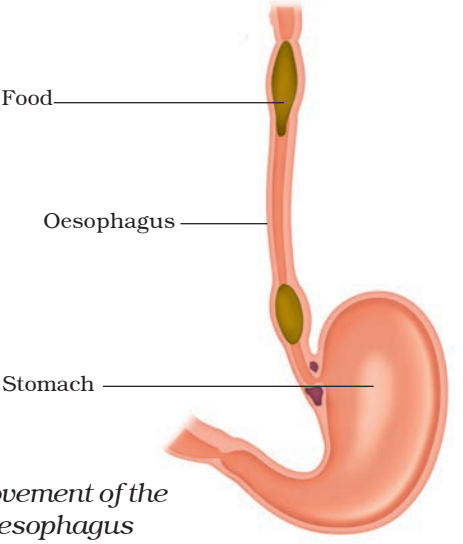


Fig. 2.7 Movement of the food in the oesophagus of the alimentary canal

and the chest. Food is pushed down by movement of the wall of the foodpipe. Actually this movement takes place throughout the alimentary canal and pushes the food downwards (Fig. 2.7). At times the food is not accepted by our stomach and is vomited out. Recall the instances when you vomited after eating and think of the reason for it. Discuss with your parents and teacher.

The stomach

The stomach is a thick-walled bag. Its shape is like a flattened J and it is the widest part of the alimentary canal. It receives food from the food pipe at one end and opens into the small intestine at the other.

The inner lining of the stomach secretes mucous, hydrochloric acid and digestive juices. The mucous protects the lining of the stomach. The acid kills many bacteria that enter along with the food and makes the medium in the stomach acidic and helps the digestive juices to act. The digestive juices break down the **proteins** into simpler substances.

The small intestine

The small intestine is highly coiled and is about 7.5 metres long. It receives secretions from the liver and the pancreas. Besides, its wall also secretes juices.

The liver is a reddish brown gland situated in the upper part of the abdomen on the right side. It is the largest gland in the body. It secretes **bile juice** that is stored in a sac called the **gall bladder** (Fig. 2.2). The bile plays an important role in the digestion of **fats**.

The pancreas is a large cream coloured gland located just below the stomach (Fig. 2.2). The pancreatic juice acts on carbohydrates, fats and proteins and changes them into simpler forms.

The working of the stomach was discovered by a strange accident. In 1822, a man named Alexis St. Martin was badly hit by a shot gun. The bullet had seriously damaged the chest wall and made a hole in his stomach. He was brought to an American army doctor William Beaumont. The doctor saved the patient but he could not close the hole properly and left it bandaged (Fig. 2.8). Beaumont took it as a great opportunity to see the inside of the stomach through the hole. He made some wonderful observations.

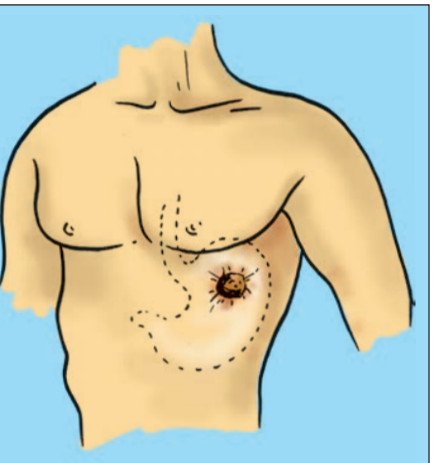


Fig. 2.8 *Alexis St. Martin's shotgun wound*

Beaumont found that the stomach was churning food. Its wall secreted a fluid which could digest the food. He also observed that the end of the stomach opens into the intestine only after the digestion of the food inside the stomach is completed.

The partly digested food now reaches the lower part of the small intestine where the intestinal juice completes the digestion of all components of the food. The carbohydrates get broken into simple sugars such as glucose, fats into fatty acids and glycerol, and proteins into amino acids.

Absorption in the small intestine

The digested food can now pass into the blood vessels in the wall of the intestine. This process is called **absorption**. The inner walls of the small intestine have thousands of finger-like outgrowths. These are called **villi** (singular villus). Can you guess what the role of villi could be in the intestine? The villi increase the surface area for absorption of the digested food. Each villus has a network of thin and small blood vessels close to its surface. The surface of the villi absorbs the digested food materials. The absorbed substances are transported via the blood vessels to different organs of the body where they are used to build complex substances such as the proteins required by the body. This is called **assimilation**. In the cells, glucose breaks down with the help of oxygen into carbon dioxide and water, and energy is released. The food that remains undigested and unabsorbed enters into the large intestine.

Large intestine

The large intestine is wider and shorter than small intestine. It is about 1.5 metre in length. Its function is to absorb water and some salts from the undigested food material. The remaining waste passes into the rectum and remains there as semi-solid faeces. The faecal matter is removed through the anus from time-to-time. This is called **egestion**.

2.3 Digestion in Grass-eating Animals

Have you observed cows, buffaloes and other grass-eating animals chewing continuously even when they are not eating? Actually, they quickly swallow the grass and store it in a part of the stomach called **rumen** (Fig. 2.9). Here the food gets

Diarrhoea

Sometime you may have experienced the need to pass watery stool frequently. This condition is known as **diarrhoea**. It may be caused by an infection, food poisoning or indigestion. It is very common in India, particularly among children. Under severe conditions it can be fatal. This is because of the excessive loss of water and salts from the body. Diarrhoea should not be neglected. Even before a doctor is consulted the patient should be given plenty of boiled and cooled water with a pinch of salt and sugar dissolved in it. This is called **Oral Rehydration Solution** (**ORS**).

Paheli wants to know why these animals cannot chew food properly at the time they take it in?

Boojho wants to know why we cannot digest cellulose like the cattle do.

partially digested and is called **cud**. But later the cud returns to the mouth in small lumps and the animal chews it. This process is called **rumination** and these animals are called **ruminants**.

The grass is rich in **cellulose**, a type of carbohydrate. In ruminants like cattle, deer, etc., bacteria present in rumen helps in digestion of cellulose. Many animals, including humans, cannot digest cellulose.

Animals like horses, rabbit, etc., have a large sac-like structure called Caecum between the oesophagus and the small intestine (Fig. 2.9). The cellulose of the food is digested here by the action of certain bacteria which are not present in humans.

So far you have learnt about animals which possess the digestive system. But there are many small organisms which do not have a mouth and a digestive system. Then, how do they acquire and digest food? In the section below you will learn another interesting way of food intake.

2.4 Feeding and Digestion in Amoeba

Amoeba is a microscopic single-celled organism found in pond water. Amoeba has a cell membrane, a rounded, dense nucleus and many small bubble-like vacuoles (Fig. 2.10) in its cytoplasm. Amoeba constantly changes its shape and position. It pushes out one, or more finger-like projections, called **pseudopodia** or false feet for movement and capture of food.

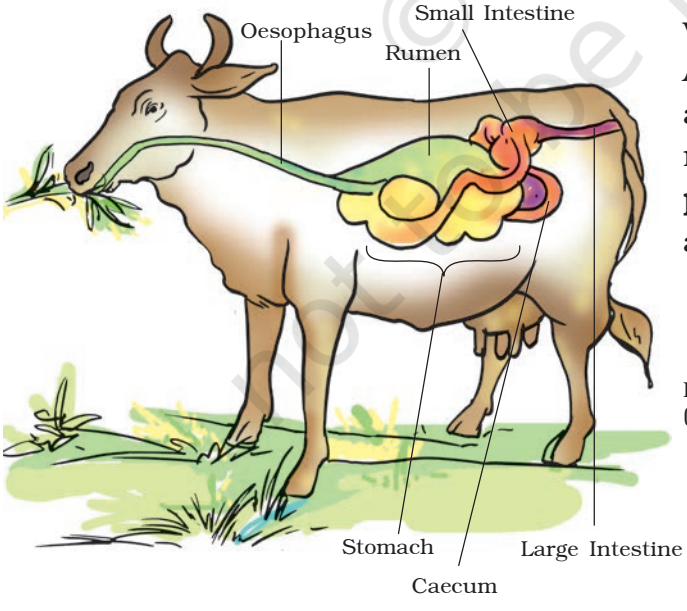


Fig. 2.9 Digestive system of ruminant

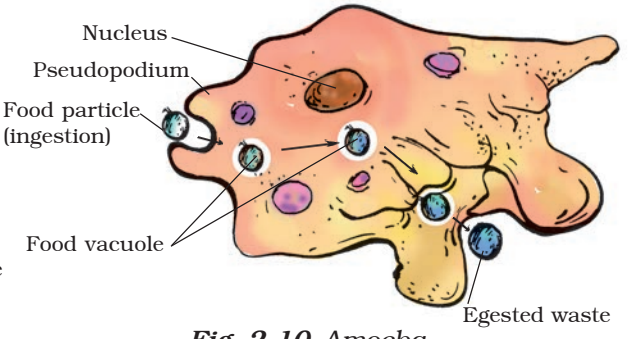


Fig. 2.10 Amoeba

Amoeba feeds on some microscopic organisms. When it senses food, it pushes out pseudopodia around the food particle and engulfs it. The food becomes trapped in a **food vacuole** [Fig. 2.10).

Digestive juices are secreted into the food vacuole. They act on the food and break it down into simpler substances. Gradually the digested food is absorbed. The absorbed substances are used for growth, maintenance and multiplication. The undigested residue of the food is expelled outside by the vacuole.

The basic process of digestion of food and release of energy is the same in all animals. In a later chapter you will learn about the transport of food absorbed by the intestine to the various parts of the body.

Keywords

Absorption	Fatty acid	Oesophagus
Amino acid	Food vacuole	Pancreas
Amoeba	Gall bladder	Premolar
Assimilation	Glycerol	Pseudopodia
Bile	Incisor	Rumen
Buccal cavity	Ingestion	Ruminant
Canine	Liver	Rumination
Cellulose	Milk teeth	Salivary glands
Digestion	Molar	Villi
Egestion	Permanent teeth	Saliva

What you have learnt

- Animal nutrition includes nutrient requirement, mode of intake of food and its utilisation in the body.
- The human digestive system consists of the alimentary canal and secretory glands. It consists of the (i) buccal cavity, (ii) oesophagus, (iii) stomach, (iv) small intestine, (v) large intestine ending in rectum and (vi) anus. The main digestive glands which secrete digestive juices are (i) the salivary glands, (ii) the liver and (iii) the pancreas. The stomach wall and the wall of the small intestine also secrete digestive juices.
- The modes of feeding vary in different organisms.
- Nutrition is a complex process involving: (i) ingestion, (ii) digestion, (iii) absorption, (iv) assimilation and (v) egestion.

- Digestion of carbohydrates, like starch, begins in the buccal cavity. The digestion of protein starts in the stomach. The bile secreted from the liver, the pancreatic juice from the pancreas and the digestive juice from the intestinal wall complete the digestion of all components of food in the small intestine. The digested food is absorbed in the blood vessels from the small intestine.
- The absorbed substances are transported to different parts of the body. Water and some salts are absorbed from the undigested food in the large intestine.
- The undigested and unabsorbed residues are expelled out of the body as faeces through the anus.
- The grazing animals like cows, buffaloes and deer are known as ruminants. They quickly ingest, swallow their leafy food and store it in the rumen. Later, the food returns to the mouth and the animal chews it peacefully.
- Amoeba ingests its food with the help of its false feet or pseudopodia. The food is digested in the food vacuole.

Exercises

1. Fill in the blanks:
   (a) The main steps of nutrition in humans are _____, _____, _____, _____ and _____.
   (b) The largest gland in the human body is _____.
   (c) The stomach releases hydrochloric acid and _____ juices which act on food.
   (d) The inner wall of the small intestine has many finger-like outgrowths called _____.
   (e) Amoeba digests its food in the _____ .
2. Mark 'T' if the statement is true and 'F' if it is false:
   (a) Digestion of starch starts in the stomach. (T/F)
   (b) The tongue helps in mixing food with saliva. (T/F)
   (c) The gall bladder temporarily stores bile. (T/F)
   (d) The ruminants bring back swallowed grass into their mouth and chew it for some time. (T/F)
3. Tick (✓) mark the correct answer in each of the following:
   (a) Fat is completely digested in the
   (i) stomach (ii) mouth (iii) small intestine (iv) large intestine

(b) Water from the undigested food is absorbed mainly in the

(i) stomach (ii) foodpipe (iii) small intestine (iv) large intestine

4. Match the items of Column I with those given in Column II:

Column I	**Column II**
Food components	Product(s) of digestion
Carbohydrates	Fatty acids and glycerol
Proteins	Sugar
Fats	Amino acids

5. What are villi? What is their location and function?
6. Where is the bile produced? Which component of the food does it help to digest?
7. Name the type of carbohydrate that can be digested by ruminants but not by humans. Give the reason also.
8. Why do we get instant energy from glucose?
9. Which part of the digestive canal is involved in:
   (i) absorption of food _____.
   (ii) chewing of food _____.
   (iii) killing of bacteria _____.
   (iv) complete digestion of food _____.
   (v) formation of faeces _____.
10. Write one similarity and one difference between the nutrition in amoeba and human beings.
11. Match the items of Column I with suitable items in Column II

Column I	**Column II**
(a) Salivary gland	(i) Bile juice secretion
(b) Stomach	(ii) Storage of undigested food
(c) Liver	(iii) Saliva secretion
(d) Rectum	(iv) Acid release
(e) Small intestine	(v) Digestion is completed
(f) Large intestine	(vi) Absorption of water
	(vii) Release of faeces

12. Label Fig. 2.11 of the digestive system.

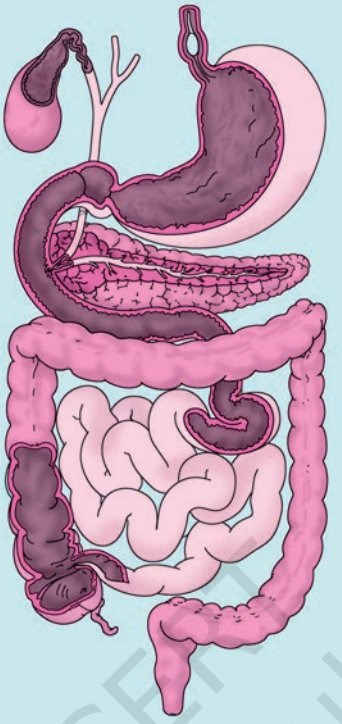


Fig. 2.11 A part of human digestive system

13. Can we survive only on raw, leafy vegetables/grass? Discuss.

Extended Learning — Activities and Project

1. Visit a doctor and find out:
   (i) Under what conditions does a patient need to be on a drip of glucose?
   (ii) Till when does a patient need to be given glucose?
   (iii) How does glucose help the patient recover?

   Write the answers in your notebook.
2. Find out what vitamins are and get the following information.
   (i) Why are vitamins necessary in the diet?
   (ii) Which fruits or vegetables should be eaten regularly to get vitamins?

   Write a one-page note on the information collected by you. You may take help of a doctor, a dietician, your teacher or any other person, or from any other source.

3. Collect data from your friends, neighbours and classmates to know more about "milk teeth".

Tabulate your data. One way of doing it is given below:

S. No.	Age at which first tooth fell	Age at which last tooth fell	No. of teeth lost	No. of teeth replaced
1.				
2.				
3.				
4.				
5.				

Find out from at least twenty children and find the average age at which children lose the milk teeth. You may take help of your friends.

Did you know?

Fats in goat's milk are much simpler than those in cow's milk. Therefore, the goat's milk is much easier to digest than the cow's milk.

6 Respiration in Organisms

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One day Boojho was eagerly waiting to meet his grandparents who were coming to the town after a year. He was in a real hurry as he wanted to receive them at the bus-stop. He ran fast and reached the bus-stop in a few minutes. He was breathing rapidly. His grandmother asked him why he was breathing so fast. Boojho told her that he came running all the way. But the question got stuck in his mind. He wondered why running makes a person breathe faster. The answer to Boojho's question lies in understanding why we breathe. Breathing is a part of respiration. Let us learn about respiration.

6.1 Why do We Respire?

In Chapter 2 you learnt that all organisms are made of small microscopic units called cells. A cell is the smallest structural and functional unit of an organism. Each cell of an organism performs certain functions such as nutrition, transport, excretion and reproduction. To perform these functions, the cell needs energy. Even when we are eating, sleeping or reading we require energy. But, where does this energy come from? Can you say why your parents insist that you should eat regularly? The food has stored energy, which is released during respiration. Therefore, all living organisms respire to get energy from food. During breathing, we breathe in air. You know that air contains oxygen. We breathe out air which is rich in carbon dioxide. The air we breathe in is transported to all parts of the body and ultimately to each cell. In the cells, oxygen in the air helps in the breakdown of food. The process of breakdown of food in the cell with the release of energy is called **cellular respiration**. Cellular respiration takes place in the **cells of all organisms**.

In the cell, the food (glucose) is broken down into carbon dioxide and water using oxygen. When breakdown of glucose occurs with the use of oxygen it is called **aerobic respiration**. Food can also be broken down, without using oxygen. This is called **anaerobic respiration**. Breakdown of food releases energy.

$$\text{Glucose} \xrightarrow[\text{of oxygen}]{\text{in the presence}} \text{carbon dioxide + water + energy}$$

You should know that there are some organisms such as yeast that can survive in the absence of air. They are called **anaerobes**. They get energy through anaerobic respiration. In the absence of oxygen, glucose breaks down into alcohol and carbon dioxide, as given below:

$$\text{Glucose} \xrightarrow[\text{of oxygen}]{\text{in the absence}} \text{alcohol + carbon dioxide + energy}$$

Yeasts are single-celled organisms. They respire anaerobically and during this process yield alcohol. They are, therefore, used to make wine and beer.

Our muscle cells can also respire anaerobically, but only for a short time, when there is a temporary deficiency of oxygen. During heavy exercise, fast running (Fig. 6.1), cycling, walking for many hours or heavy weight lifting, the demand for energy is high. But the supply of oxygen to produce the energy is limited. Then anaerobic respiration takes places in the muscle cells to fulfil the demand of energy:

$$\text{Glucose (in muscle)} \xrightarrow[\text{of oxygen}]{\text{in the absence}} \text{lactic acid} + \text{energy}$$

Fig. 6.1 During exercise, some muscles may respire anaerobically

Have you ever wondered why you get muscle cramps after heavy exercise? The cramps occur when muscle cells respire anaerobically. The partial breakdown of glucose produces lactic acid. The accumulation of lactic acid causes muscle cramps. We get relief from cramps after a hot water bath or a massage. Can you guess why it is so? Hot water bath or massage improves circulation of blood. As a result, the supply of oxygen to the muscle cells increases. The increase in the supply of oxygen results in the complete breakdown of lactic acid into carbon dioxide and water.

6.2 Breathing

Activity 6.1

CAUTION

Do this activity under the supervision of your teacher.

Close your nostrils and mouth tightly and look at a watch. What did you feel after some time? How long were you able to keep both of them closed? Note down the time for which you could hold your breath (Fig. 6.2).

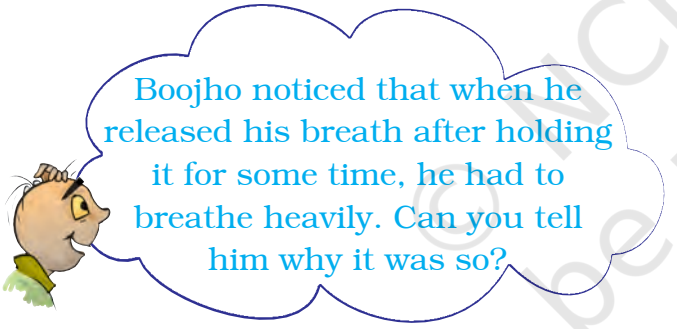
So, now you know that you cannot survive for long without breathing.

Breathing means taking in air rich in oxygen and giving out air rich in carbon dioxide with the help of respiratory organs. The taking in of air rich in oxygen into the body is called **inhalation** and giving out of air rich in carbon dioxide is known as **exhalation**. It is a continuous process which goes

on all the time and throughout the life of an organism.

The number of times a person breathes in a minute is termed as the **breathing rate**. During breathing inhalation and exhalation take place alternately. A breath means one inhalation plus one exhalation. Would you like to find out your breathing rate? Do you want to know whether it is constant or it changes according to the requirement of oxygen by the body? Let us find out by doing the following activity.

Fig. 6.2 *Holding breath*



Activity 6.2

Generally we are not aware that we are breathing. However, if you try you can count your rate of breathing. Breathe in and out normally. Find out how many times you breathe in and breathe out in a minute? Did you inhale the same number of times as you exhaled? Now count your breathing rate (number of breaths/minute) after brisk walk and after running. Record your breathing rate as soon as you finish and also after complete rest. Tabulate your findings and compare your breathing rates under different conditions with those of your classmates.

From the above activity, you must have realised that whenever a person needs extra energy, he/she breathes faster. As a result more oxygen is

Table 6.1 Changes in breathing rate under different conditions

Name of the classmate	Breathing rate			
	Normal	After a brisk walk for 10 minutes	After running fast 100 m	At rest
Self				

On an average, an adult human being at rest breathes in and out 15–18 times in a minute. During heavy exercise, the breathing rate can increase upto 25 times per minute. While we exercise, not only do we breathe fast, we also take deep breaths and thus inhale more oxygen.

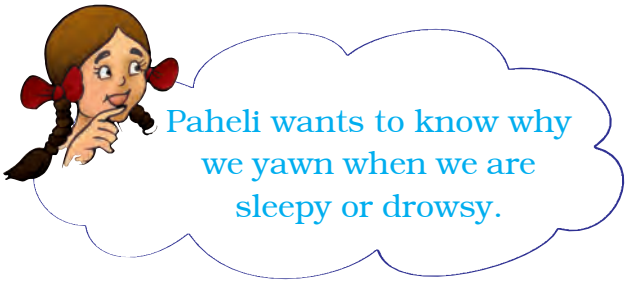
supplied to our cells. It speeds up the breakdown of food and more energy is released. Does this explain why do we feel hungry after a physical activity?

When you feel drowsy, does your breathing rate slow down? Does your body receive sufficient oxygen?

Activity 6.3

Figure 6.3 shows the various activities carried out by a person during a normal day. Can you say in which activity, the rate of breathing will be the slowest and in which it will be the fastest? Assign numbers to the pictures in the order of increasing rate of breathing according to your experience.

Fig. 6.3 *Variation in the breathing rate during different activities*



6.3 How do We Breathe?

Let us now learn about the mechanism of breathing. Normally we take in air through our nostrils. When we inhale air, it passes through our nostrils into the **nasal cavity**. From the nasal cavity, the air reaches our **lungs** through the windpipe. Lungs are present in the **chest cavity** (Fig. 6.4). This cavity is surrounded by ribs on the sides. A large, muscular sheet called **diaphragm** forms the floor of the chest cavity (Fig. 6.4). Breathing involves the movement of the diaphragm and the rib cage.

During inhalation, ribs move up and outwards and diaphragm moves down. This movement increases space in our chest cavity and air rushes into the lungs. The lungs get filled with air. During exhalation, ribs move down and inwards, while diaphragm moves up to its former position. This reduces the size of the chest cavity and air is pushed out of the lungs (Fig. 6.5). These movements in our body can be felt easily. Take a

deep breath. Keep your palm on the abdomen, feel the movement of abdomen. What do you find?

After having learnt that during breathing there are changes in the size of the chest cavity, children got involved in the chest expansion competition. Everyone was boasting that she/he could expand it the maximum. How about doing this activity in the class with your classmates?

Smoking damages lungs. Smoking is also linked to cancer. It must be avoided.

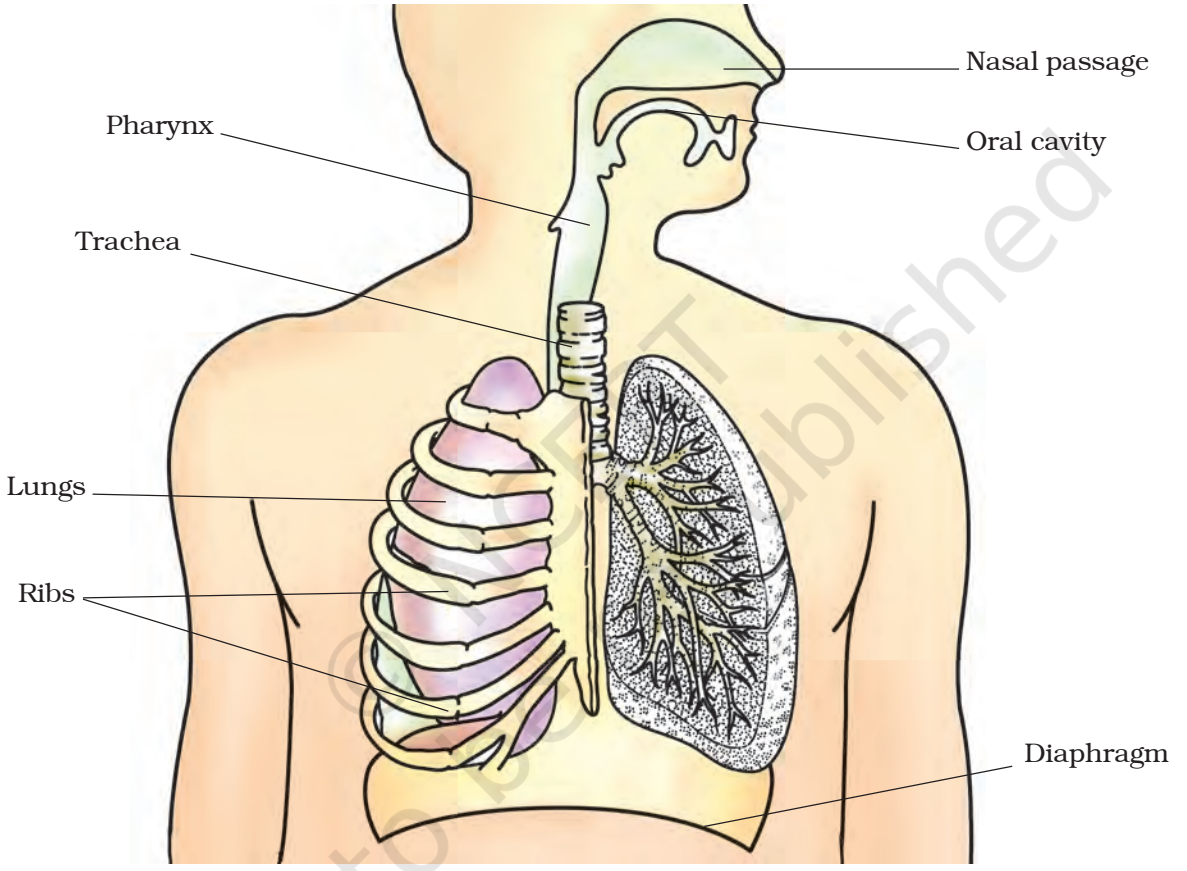


Fig 6.4 *Human respiratory system*

The air around us has various types of unwanted particles, such as smoke, dust, pollens, etc. When we inhale, the particles get trapped in the hair present in our nasal cavity. However, sometimes these particles may get past the hair in the nasal cavity. This may irritate the lining of the cavity, as a result of which we sneeze. Sneezing expels these foreign particles from the inhaled air and a dust-free, clean air enters our body.

TAKE CARE: When you sneeze, you should cover your nose so that the foreign particles you expel are not inhaled by other persons.

Activity 6.4

Take a deep breath. Measure the size of the chest with a measuring tape (Fig. 6.6) and record your observations in Table 6.2. Measure the size of the chest again when expanded and indicate which classmate shows the maximum expansion of the chest.

We can understand the mechanism of breathing by a simple model.

Activity 6.5

Take a wide plastic bottle. Remove the bottom. Get a Y-shaped glass or plastic tube. Make a hole in the lid so that the tube may pass through it. To the forked end of the tube fix two deflated balloons. Introduce the tube into the bottle as shown in Fig. 6.7. Now cap the bottle. Seal it to make it airtight. To the open base of the bottle tie a thin rubber or plastic sheet using a large rubber band.

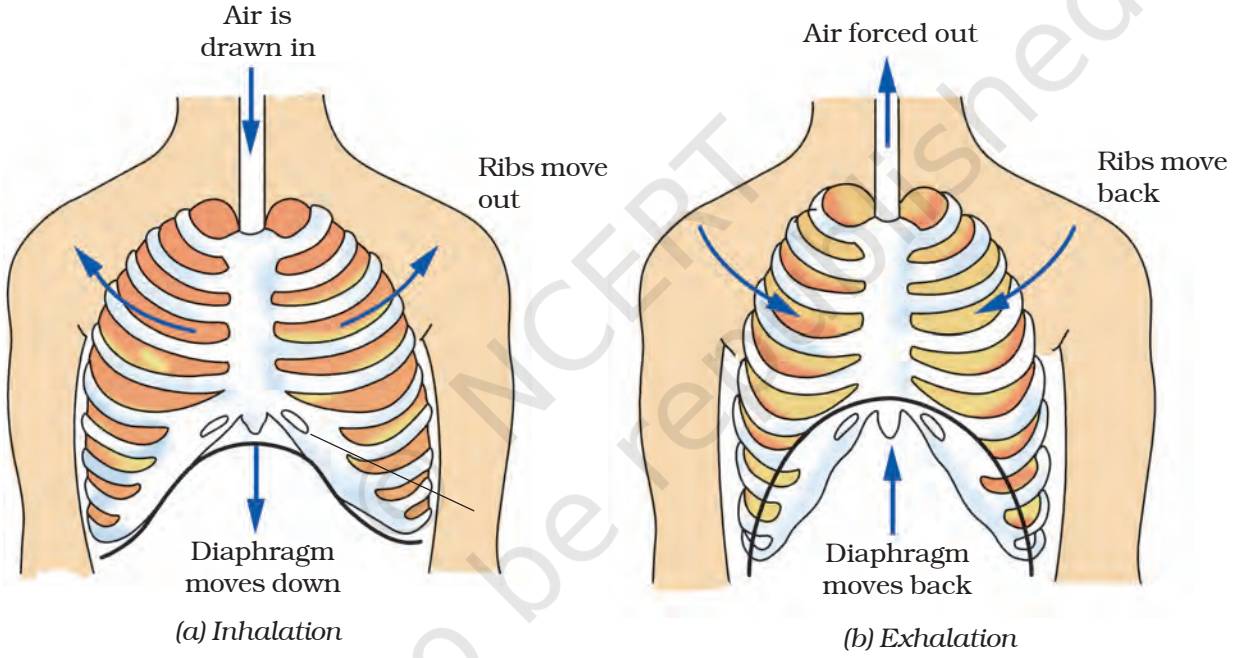


Fig. 6.5 Mechanism of breathing in human beings

Table 6.2: Effect of breathing on the chest size of some classmates

Name of the classmate	Size of the chest (cm)		
	During inhalation	During exhalation	Difference in size

Fig. 6.6 Measuring chest size

To understand the expansion of the lungs, pull the rubber sheet from the base downwards and watch the balloons. Next, push the rubber/plastic sheet up and observe the balloons. Did you see any changes in the balloons?

What do the balloons in this model represent? What does the rubber sheet represent?

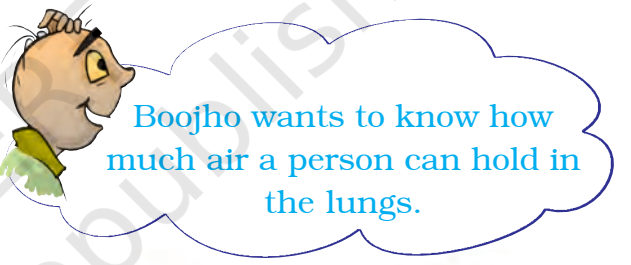
Now, you should be able to explain the mechanism of breathing.

6.4 What do We Breathe out?

Activity 6.6

Take a slender, clean test tube or a glass/plastic bottle. Make a hole in its lid and fix it on the bottle. Pour some freshly prepared lime water in the test-tube. Insert a plastic straw through the hole in the lid in such a way that it dips in lime water. Now blow gently through the straw a few times (Fig. 6.8). Is there a change in the appearance of lime water? Can you explain this change on the basis of what you learnt in Chapter 5?

You are aware that air we inhale or exhale is a mixture of gases. What do we exhale? Do we exhale only carbon dioxide or a mixture of gases along with it? You must have also observed that if you exhale on a mirror, a film of moisture appears on its surface. From where do these droplets come?



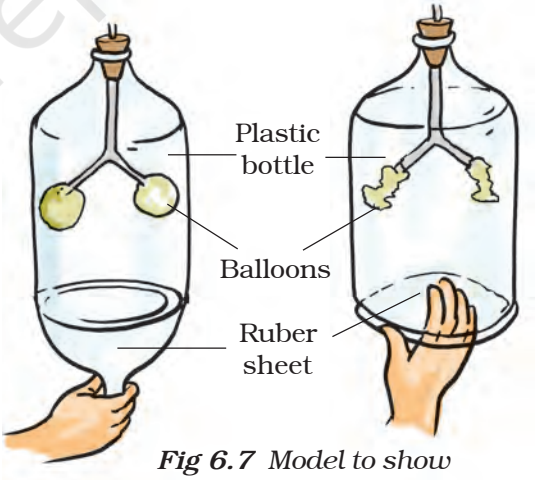


Fig 6.7 Model to show mechanism of breathing

Breathe for Better Life

Regular traditional breathing exercise (pranayama) can increase the capacity of lungs to take in more air. Thus more oxygen can be supplied to the body cells resulting in release of more energy.

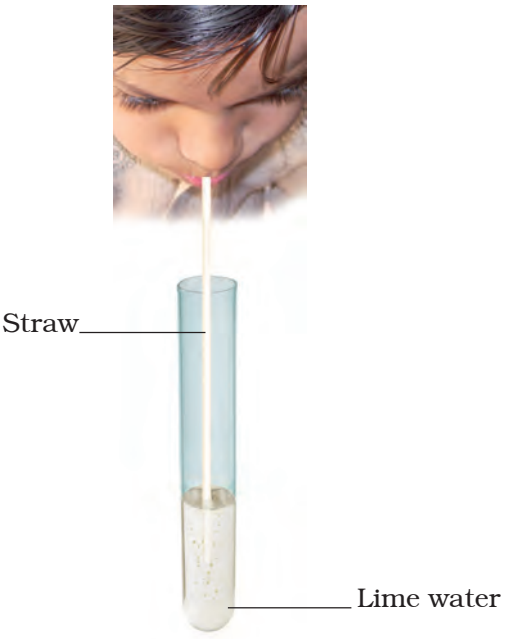


Fig. 6.8 Effect of exhaled air on lime water

The percentage of oxygen and carbon dioxide in inhaled and exhaled air.

Inhaled air	**Exhaled air**
21% oxygen	16.4% oxygen
0.04% carbon dioxide	4.4% carbon dioxide

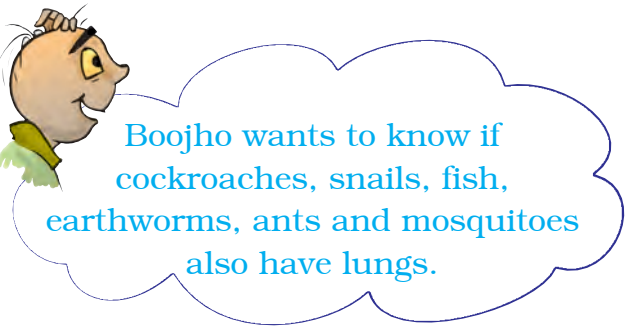
Lungs

6.5 Breathing in Other Animals

Animals such as elephants, lions, cows, goats, frogs, lizards, snakes, birds, have lungs in their chest cavities like the human beings.

How do other organisms breathe? Do they also have lungs like those of human beings? Let us find out.

Cockroach: A cockroach has small openings on the sides of its body. Other insects also have similar openings.



These openings are called **spiracles** (Fig. 6.9). Insects have a network of air tubes called **tracheae** for gas exchange. Oxygen rich air rushes through spiracles into the tracheal tubes, diffuses into the body tissue, and reaches every cell of the body. Similarly, carbon dioxide from the cells goes into the tracheal tubes and moves out through spiracles. These air tubes or tracheae are found only in insects and not in any other group of animals.

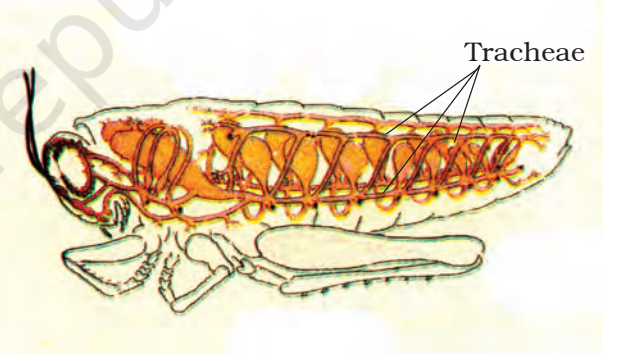


Fig.6.9 Tracheal system

Earthworm: Recall from Chapter 6 of Class VI that earthworms breathe through their skins. The skin of an earthworm feels moist and slimy on touching. Gases can easily pass through them. Though frogs have a pair of lungs like human beings, they can also breathe through their skin, which is moist and slippery.

Boojho has seen in television programmes that whales and dolphins often come up to the water surface. They even release a fountain of water sometimes while moving upwards. Why do they do so?

6.6 Breathing under Water

Can we breathe and survive in water? There are many organisms which live in water. How do they breathe under water?

You have studied in Class VI that gills in fish help them to use oxygen dissolved in water. Gills are projections of the skin. You may wonder how gills help in breathing. Gills are well supplied with blood vessels (Fig. 6.10) for exchange of gases.

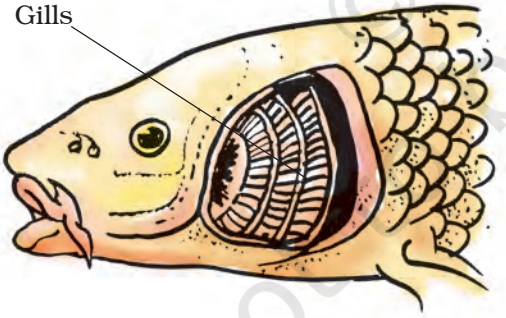


Fig. 6.10 *Breathing organs in fish*

6.7 Do Plants also Respire?

Like other living organisms, plants also respire for their survival as you have learnt in Class VI. They also take in oxygen from the air and give out carbon dioxide. In the cells oxygen is used to break down glucose into carbon dioxide and water as in other organisms. In plants each part can independently take in oxygen from the air and give out carbon dioxide. You have already learnt in Chapter 1 that the leaves of the plants have tiny pores called stomata for exchange of oxygen and carbon dioxide.

Paheli wants to know whether roots, which are underground also take in oxygen? If so, how?

Like all other living cells of the plants, the root cells also need oxygen to generate energy. Roots take up air from the air spaces present between the soil particles (Fig. 6.11).

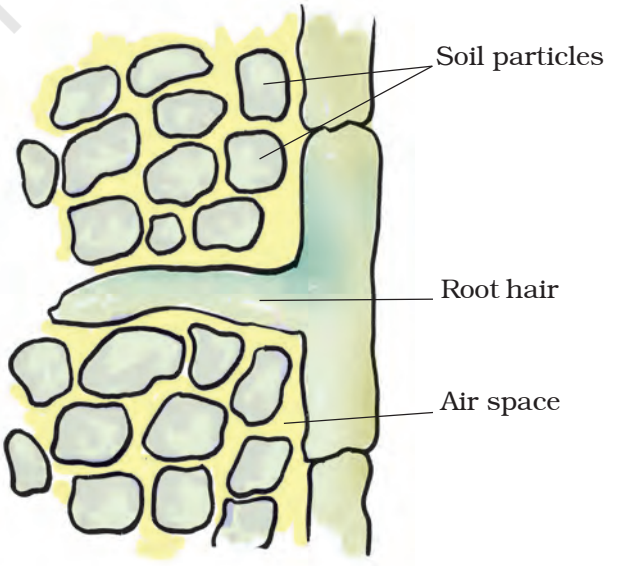


Fig. 6.11 *Roots absorb air from the soil*

Can you guess what would happen if a potted plant is overwatered?

In this chapter you learnt that respiration is a vital biological process. All living organisms need to respire to get the energy needed for their survival.

Keywords

Aerobic respiration	Diaphragm	Inhalation
Anaerobic respiration	Exhalation	Spiracles
Breathing rate	Gills	Tracheae
Cellular respiration	Lungs	Ribs

What you have learnt

- Respiration is essential for survival of living organisms. It releases energy from the food.
- The oxygen we inhale is used to breakdown glucose into carbon dioxide and water. Energy is released in the process.
- The breakdown of glucose occurs in the cells of an organism (cellular respiration).
- If the food is broken down with the use of oxygen, it is called aerobic respiration. If the breakdown occurs without the use of oxygen, the respiration is called anaerobic respiration.
- During heavy exercise when the supply of oxygen to our muscle cells is insufficient, food breakdown is by anaerobic respiration.
- Breathing is a part of the process of respiration during which an organism takes in the oxygen-rich air and gives out air rich in carbon dioxide. The respiratory organs for the exchange of gases vary in different organisms.
- During inhalation, our lungs expand and then come back to the original state as the air moves out during exhalation.
- Increased physical activity enhances the rate of breathing.
- In animals like cow, buffalo, dog and cat the respiratory organs and the process of breathing are similar to those in humans.
- In earthworm, the exchange of gases occurs through the moist skin. In fishes it takes place through gills and in insects through the tracheae.
- In a plant the roots take in air present in the soil. Leaves have tiny pores called stomata through which they exchange gases. The breakdown of glucose in the plant cells is similar to that in other living beings.

Exercises

1. Why does an athlete breathe faster and deeper than usual after finishing the race?
2. List the similarities and differences between aerobic and anaerobic respiration.
3. Why do we often sneeze when we inhale a lot of dust-laden air?
4. Take three test-tubes. Fill ¾th of each with water. Label them A, B and C. Keep a snail in test-tube A, a water plant in test-tube B and in C, keep snail and plant both. Which test-tube would have the highest concentration of CO_2?
5. Tick the correct answer:
   (a) In cockroaches, air enters the body through
      (i) lungs (ii) gills
      (iii) spiracles (iv) skin
   (b) During heavy exercise, we get cramps in the legs due to the accumulation of
      (i) carbon dioxide (ii) lactic acid
      (iii) alcohol (iv) water
   (c) Normal range of breathing rate per minute in an average adult person at rest is:
      (i) 9–12 (ii) 15–18
      (iii) 21–24 (iv) 30–33
   (d) During exhalation, the ribs
      (i) move outwards (ii) move downwards
      (iii) move upwards (iv) do not move at all
6. Match the items in Column I with those in Column II:

Column I	Column II
(a) Yeast	(i) Earthworm
(b) Diaphragm	(ii) Gills
(c) Skin	(iii) Alcohol
(d) Leaves	(iv) Chest cavity
(e) Fish	(v) Stomata
(f) Frog	(vi) Lungs and skin
	(vii) Tracheae

7. Mark 'T' if the statement is true and 'F' if it is false:

   (i) During heavy exercise the breathing rate of a person slows down. (T/F)

   (ii) Plants carry out photosynthesis only during the day and respiration only at night. (T/F)

   (iii) Frogs breathe through their skins as well as their lungs. (T/F)

   (iv) The fishes have lungs for respiration. (T/F)

   (v) The size of the chest cavity increases during inhalation. (T/F)

8. Given below is a square of letters in which are hidden different words related to respiration in organisms. These words may be present in any direction — upwards, downwards, or along the diagonals. Find the words for your respiratory system. Clues about those words are given below the square.

S	V	M	P	L	U	N	G	S
C	Z	G	Q	W	X	N	T	L
R	M	A	T	I	D	O	T	C
I	Y	R	X	Y	M	S	R	A
B	R	H	I	A	N	T	A	Y
S	T	P	T	B	Z	R	C	E
M	I	A	M	T	S	I	H	A
S	P	I	R	A	C	L	E	S
N	E	D	K	J	N	S	A	T

   (i) The air tubes of insects

   (ii) Skeletal structures surrounding chest cavity

   (iii) Muscular floor of chest cavity

   (iv) Tiny pores on the surface of leaf

   (v) Small openings on the sides of the body of an insect

   (vi) The respiratory organs of human beings

   (vii) The openings through which we inhale

   (viii) An anaerobic organism

   (ix) An organism with tracheal system

9. The mountaineers carry oxygen with them because:

   (a) At an altitude of more than 5 km there is no air.

(b) The amount of air available to a person is less than that available on the ground.

(c) The temperature of air is higher than that on the ground.

(d) The pressure of air is higher than that on the ground.

Extended Learning — Activities and Projects

1. Observe fish in an aquarium. You will find flap like structures on both sides of their heads. These are flaps which cover the gills. These flaps open and close alternately. On the basis of these observations, explain the process of respiration in the fish.
2. Visit a local doctor. Learn about the harmful effects of smoking. You can also collect material on this topic from other sources. You can seek help of your teacher or parents. Find out the percentage of people of your area who smoke. If you have a smoker in your family, confront him with the material that you have collected.
3. Visit a doctor. Find out about artificial respiration. Ask the doctor:
   (a) When does a person need artificial respiration?
   (b) Does the person need to be kept on artificial respiration temporarily or permanently?
   (c) From where can the person get supply of oxygen for artificial respiration?
4. Measure the breathing rate of the members of your family and some of your friends. Investigate:
   (c) If the breathing rate of children is different from that of adults.
   (d) If the breathing rate of males is different from that of females.

   If there is a difference in any of these cases, try to find the reason.

Did you know?

For us oxygen is essential, but for those organisms which do not use it, oxygen is toxic. In fact, for humans and other organisms it may be dangerous to breathe pure oxygen for long.

7 Transportation in Animals and Plants

0758CH11

You have learnt earlier that all organisms need food, water and oxygen for survival. They need to transport all these to various parts of their body. Further, animals need to transport wastes to parts from where they can be removed. Have you wondered how all this is achieved? Look at Fig. 7.1. Do you see the heart and the blood vessels? They function to transport substances and together form the circulatory system. In this chapter, you shall learn about transport of substances in animals and plants.

7.1 Circulatory System

Blood

What happens when you get a cut on your body? Blood flows out. But what is blood? Blood is the fluid which flows in blood vessels. It transports substances like digested food from the small intestine to the other parts of the body. It carries oxygen from the lungs to the cells of the body. It also transports waste for removal from the body.

How does the blood carry various substances? Blood is composed of a fluid, called plasma in which different types of cells are suspended.

Why is the colour of blood red?

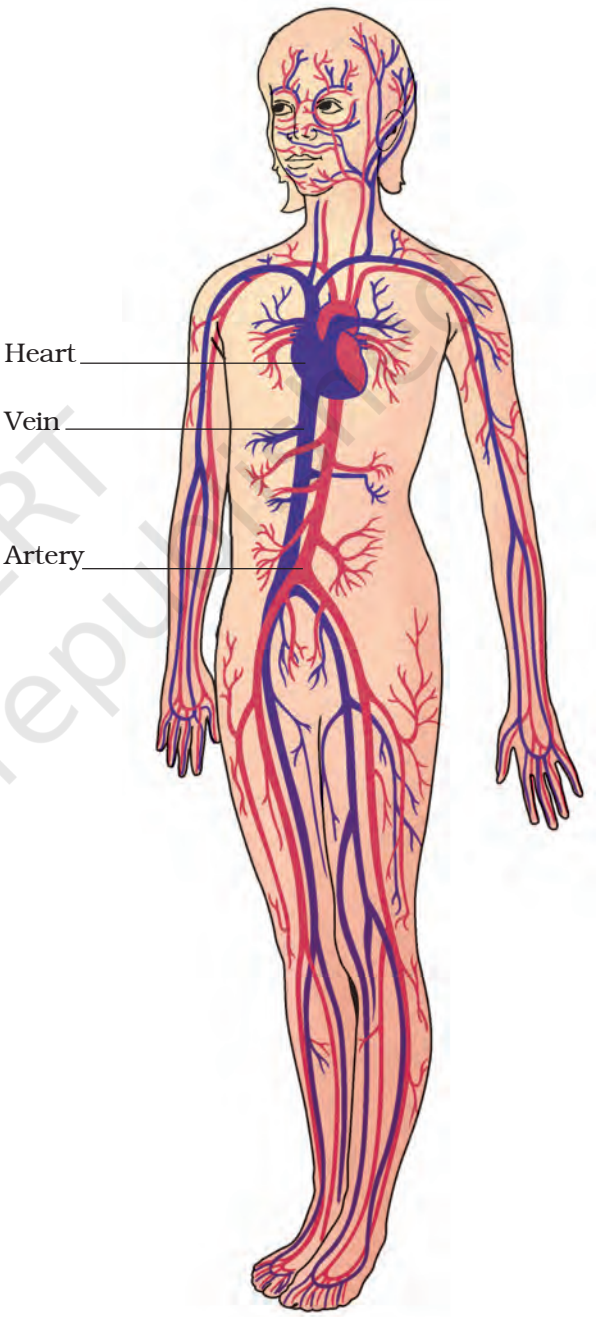


Fig. 7.1 Circulatory system
(Arteries are shown in red colour and veins in blue)

One type of cells are the **red blood cells** (RBC) which contain a red pigment called **haemoglobin**. Haemoglobin binds with oxygen and transports it to all the parts of the body and ultimately to all the cells. It will be difficult to provide oxygen efficiently to all the cells of the body without haemoglobin. The presence of haemoglobin makes blood appear red.

The blood also has **white blood cells** (WBC) which fight against germs that may enter our body.

Boojho fell down while playing a game and his knee got injured. Blood was coming out from the cut. After some time, he noticed that bleeding had stopped and a dark red clot had plugged the cut. Boojho was puzzled about this.

The clot is formed because of the presence of another type of cells in the blood, called **platelets**.

Blood vessels

There are different types of blood vessels in the body. You know that during inhalation a fresh supply of oxygen fills the lungs. Oxygen has to be transported to the rest of the body.

Also, the blood picks up the waste materials including carbon dioxide from the cells. This blood has to go back to the heart for transport to the lungs for removal of carbon dioxide as you have learnt in Chapter 6. So, two types of blood vessels, **arteries** and **veins** are present in the body. (Fig. 7.1)

Arteries carry oxygen-rich blood from the heart to all parts of the body. Since the blood flow is rapid and at a high pressure, the arteries have thick elastic walls.

Let us perform an activity to study the flow of blood through arteries.

Activity 7.1

Place the middle and index finger of your right hand on the inner side of your left wrist (Fig. 7.2). Can you feel some throbbing movements? Why do you think there is throbbing? This throbbing is called the **pulse** and it is due to the blood flowing in the arteries. Count the number of pulse beats in one minute.

How many pulse beats could you count? The number of beats per minute is called the **pulse rate**. A resting person, usually has a pulse rate between 72 and 80 beats per minute. Find other places in your body where you can feel the pulse.

Record your own pulse beats per minute and those of your classmates. Insert the values you obtained in Table 7.1 and compare them.

Fig. 7.2 Pulse in the wrist

Table 7.1 Pulse rate

S. No.	Name	Pulse per minute
1.		
2.		
3.		
4.		
5.		

Veins are the vessels which carry carbon dioxide-rich blood from all parts of the body back to the heart. The veins have thin walls. There are valves present in veins which allow blood to flow only towards the heart.

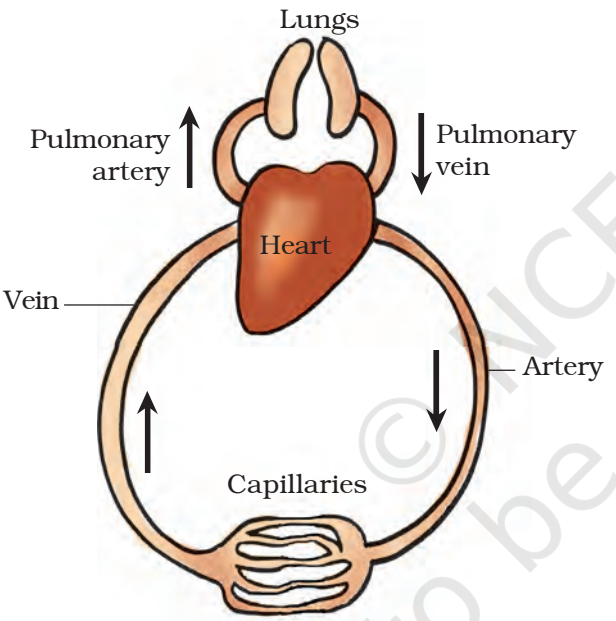
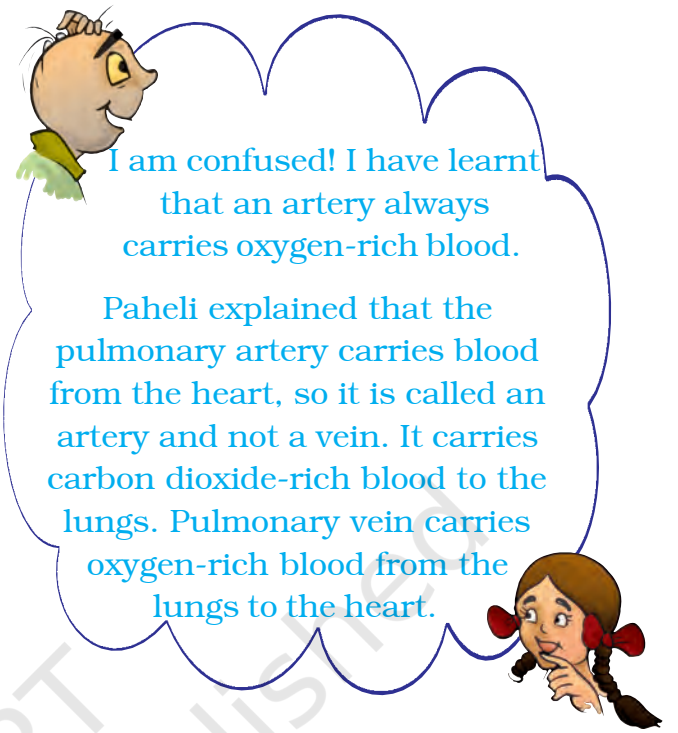


Fig. 7.3 Schematic diagram of circulation

Blood Donation

Hundreds of people die due to unavailability of blood. Voluntary blood donation is harmless and painless and can save precious lives. Blood can be donated at hospitals and other places authorised by the government. Donated blood are stored with special care in Blood Banks.



Refer to Fig. 7.3. Do you see the arteries divide into smaller vessels? On reaching the tissues, they divide further into extremely thin tubes called **capillaries**. The capillaries join to form veins which empty into the heart.

Heart

The heart is an organ which beats continuously to act as a pump for the transport of blood, which carries other substances with it.

Imagine a pump working for years without stopping! Absolutely impossible. Yet our heart works like a pump non-stop. Let us now learn about the heart.

The heart is located in the chest cavity with its lower tip slightly tilted towards the left (Fig. 7.1). Hold your fingers inwards on your palm. That

makes your fist. Your heart is roughly the size of your fist.

What will happen if the blood rich in oxygen and the blood rich in carbon dioxide mix with each other? To avoid this from happening, the heart has four chambers. The two upper chambers are called the **atria** (singular: atrium) and the two lower chambers are called the **ventricles** (Fig. 7.4). The partition between the chambers helps to avoid

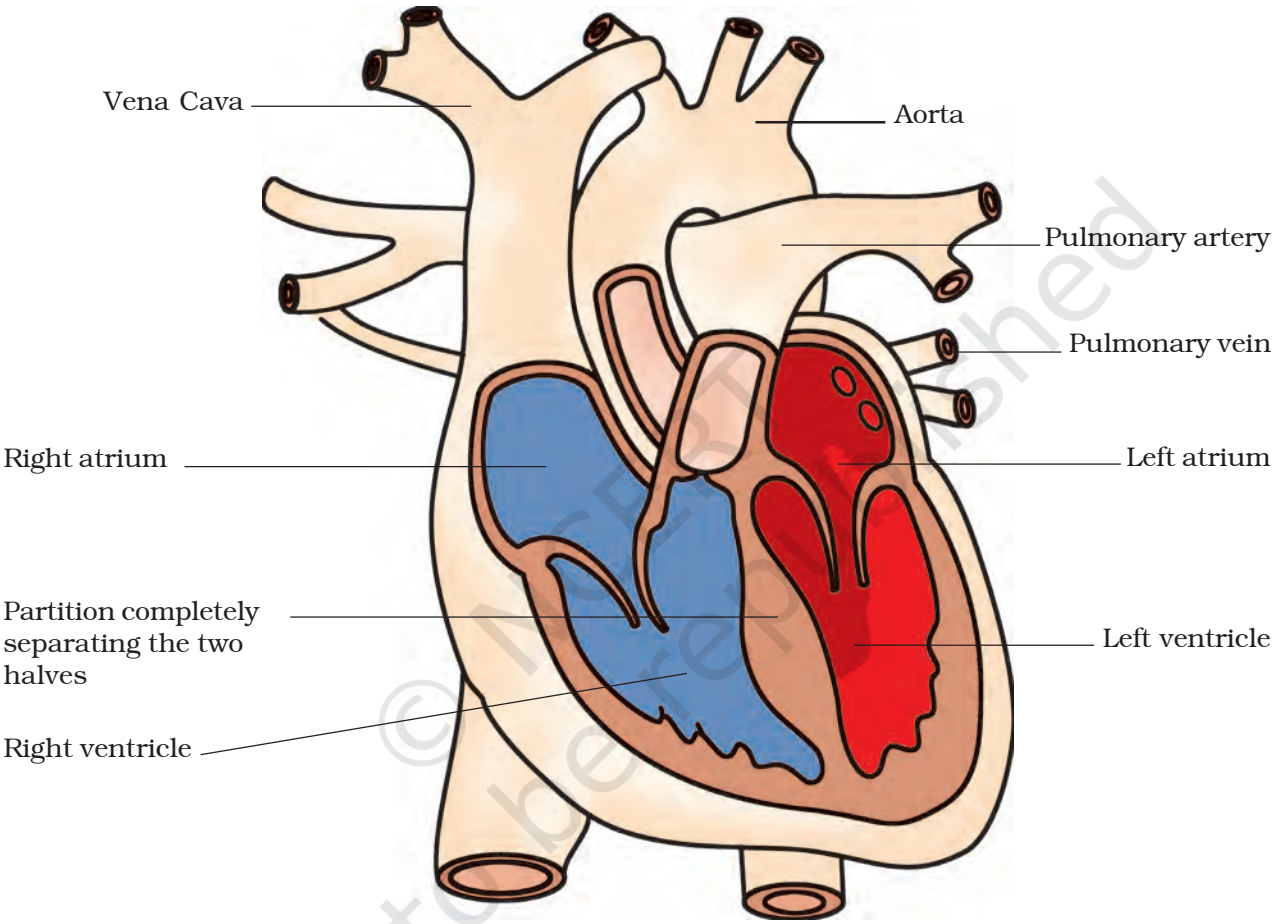


Fig. 7.4 Sections of human heart

Paheli wonders which side of the heart will have oxygen-rich blood and which side will have carbon dioxide-rich blood.

mixing up of blood rich in oxygen with the blood rich in carbon dioxide.

To understand the functioning of the circulatory system, start from the right side of the heart in Fig. 7.3 and follow the arrows. These arrows show the direction of the blood flow from the heart

to the lungs and back to the heart from where it is pumped to the rest of the body.

Heartbeat

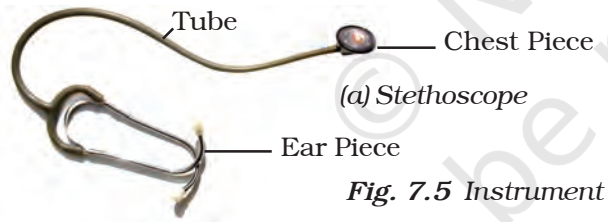
The walls of the chambers of the heart are made up of muscles. These muscles contract and relax rhythmically. This rhythmic contraction followed by its relaxation constitute a heartbeat. Remember that heartbeats continue every moment of our life. If you place your hand on the left side of your chest, you can feel your heartbeat. The doctor feels your heartbeats with the help of an instrument called a stethoscope.

A doctor uses the stethoscope as a device to amplify the sound of the heart. It consists of a chest piece that carries a sensitive diaphragm, two ear pieces and a tube joining the parts. Doctors can get clues about the condition of your heart by listening through a stethoscope.

Let us construct a model of a stethoscope with the materials that are available around us.

Activity 7.2

Take a small funnel of 6–7 cm in diameter. Fix a rubber tube (50 cm long) tightly on the stem of the funnel. Stretch a rubber sheet (or a balloon) on the mouth of the funnel and fix it tightly with a rubber band. Put the open end of the tube on one of your ears. Place



(a) Stethoscope


(b) Model of stethoscope

Fig. 7.5 *Instrument to hear heartbeat*

Table 7.2 Heartbeat and pulse rate

Name of student	While resting		After running (4–5 minutes)	
	Heartbeat	Pulse rate	Heartbeat	Pulse rate

the mouth of the funnel on your chest near the heart. Now try to listen carefully. Do you hear a regular thumping sound ? The sound is that of heart beats. How many times did your heart beat in a minute ? Count again after running for 4–5 minutes. Compare your observations.

Record your own pulse rate and heart beat and that of your friends while resting and after running and record in Table 7.2. Do you find any relationship between your heart beat and pulse rate? Each heart beat generates one pulse in the arteries and the pulse rate per minute indicates the rate of heart beat.

The rhythmic beating of the various chambers of the heart maintain circulation of blood and transport of substances to the different parts of the body.

Boojho wonders if sponges and *hydra* also have blood? Animals such as sponges and *Hydra* do not possess any circulatory system. The water in which they live brings food and oxygen as it enters their bodies. The water carries away waste materials and carbon dioxide as it moves out. Thus, these animals do not need a circulatory fluid like the blood.

Let us now learn about the removal of waste other than carbon dioxide.

The English physician, William Harvey (A.D.1578–1657), discovered the circulation of blood. The current opinion in those days was that blood oscillates in the vessels of the body. For his views, Harvey was ridiculed and was called "circulator". He lost most of his patients. However, before he died, Harvey's idea about circulation was generally accepted as a biological fact.

7.2 Excretion in Animals

Recall how carbon dioxide is removed as waste from the body through the lungs during exhalation. Also recall that the undigested food is removed during egestion. Let us now find out how the other waste materials are removed from the body. You may wonder where these unwanted materials come from!

When our cells perform their functions, certain waste products are released. These are toxic and hence need to be removed from the body. The process of removal of wastes produced in the cells of the living organisms is called **excretion**. The parts involved in excretion form the **excretory system**.

Excretory system in humans

The waste which is present in the blood has to be removed from the body. How can this be done? A mechanism to filter the blood is required. This is done by the blood capillaries in the **kidneys**. When the blood reaches the two kidneys, it contains both useful and harmful substances. The useful substances are absorbed back into the blood. The wastes dissolved in water are removed as **urine**. From the kidneys, the urine goes into the urinary **bladder** through

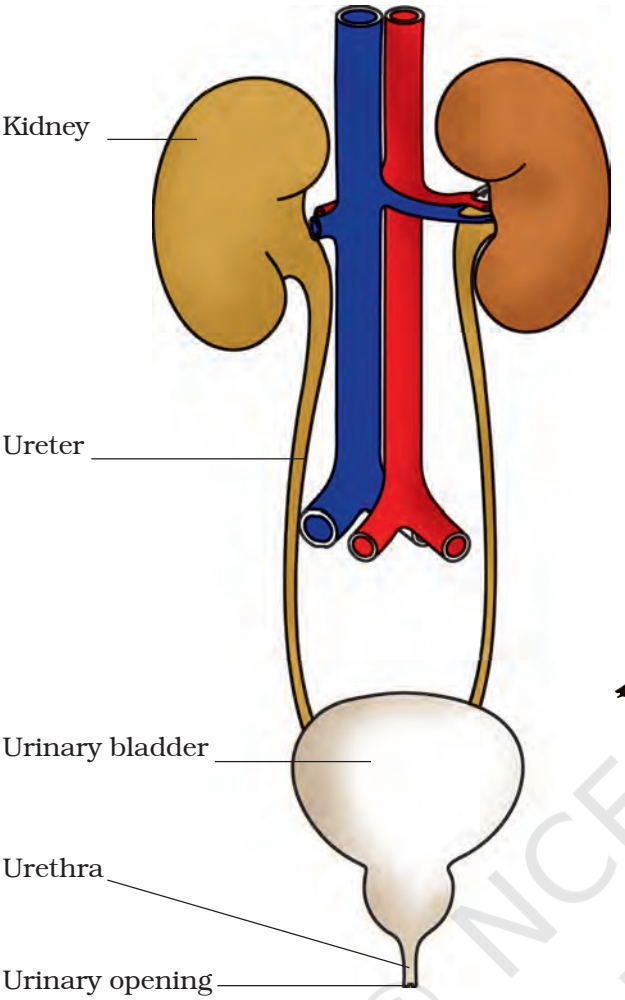


Fig. 7.6 Human excretory system

tube-like **ureters**. It is stored in the bladder and is passed out through the urinary opening at the end of a muscular tube called **urethra** (Fig. 7.6). The kindeys, ureters, bladder and urethra form the excretory system.

An adult human being normally passes about 1–1.8 L of urine in 24 hours. The urine consists of 95% water, 2.5% urea and 2.5% other waste products.

We have all experienced that we sweat on a hot summer day. The sweat contains water and salts. Boojho has seen that sometimes in summer, white patches are formed on our clothes, especially in areas like underarms. These marks are left by salts present in the sweat.

Does sweat serve any other function? We know that the water kept in an earthen pot (*matka*) is cooler. This is because the water evaporates from the pores of the pot, which causes cooling.

Paheli wants to know whether other animals also urinate?

The way in which waste chemicals are removed from the body of the animal depends on the availability of water. Aquatic animals like fishes, excrete cell waste as ammonia which directly dissolves in water. Some land animals like birds, lizards, snakes excrete a semi-solid, white coloured compound (uric acid). The major excretory product in humans is urea.

Sometimes a person's kidneys may stop working due to infection or injury. As a result of kidney failure, waste products start accumulating in the blood. Such persons cannot survive unless their blood is filtered periodically through an artificial kidney. This process is called **dialysis**.

Similarly, when we sweat, it helps to cool our body.

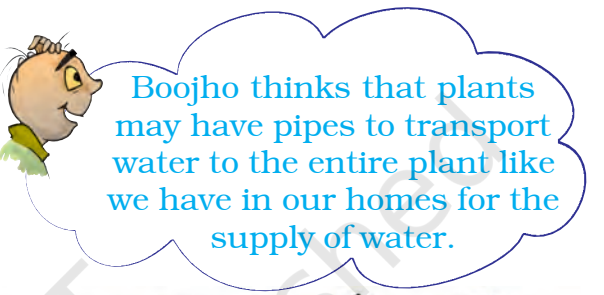
7.3 Transport of Substances in Plants

In Chapter 1 you learnt that plants take water and mineral nutrients from the soil through the roots and transport it to the leaves. The leaves prepare food for the plant, using water and carbon dioxide during photosynthesis. You also learnt in Chapter 6 that food is the source of energy and every cell of an organism gets energy by the breakdown of glucose. The cells use this energy to carry out vital activities of life. Therefore food must be made available to every cell of an organism. Have you ever wondered how water and nutrients absorbed by the root are transported to the leaves? How is the food prepared by the leaves carried to the parts which cannot make food?

Transport of water and minerals

Plants absorb water and minerals by the roots. The roots have root hair. The root hair increase the surface area of the root for the absorption of water and mineral nutrients dissolved in water. The root hair is in contact with the water present between the soil particles [Fig. 7.7 (a)].

Can you guess how water moves from the root to the leaves? What kind of transport system is present in plants?



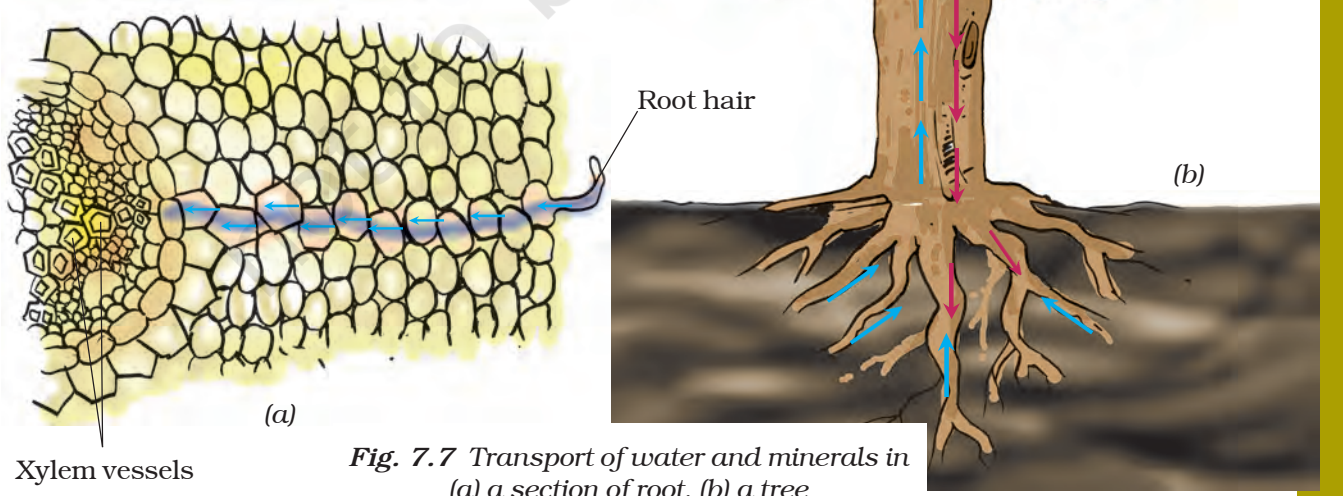
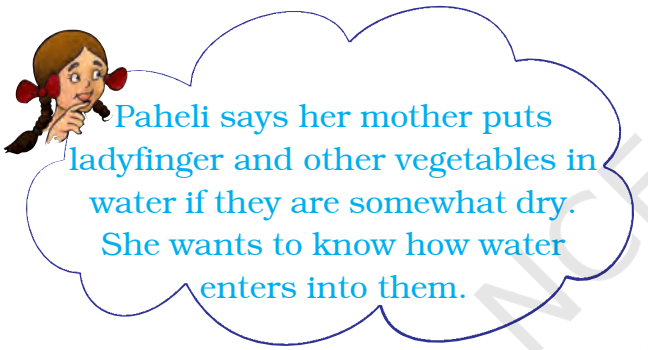


Fig. 7.7 Transport of water and minerals in (a) a section of root, (b) a tree

Well, Boojho is right. Plants have pipe-like vessels to transport water and nutrients from the soil. The vessels are made of special cells, forming the **vascular tissue**. A **tissue** is a group of cells that perform specialised function in an organism. The vascular tissue for the transport of water and nutrients in the plant is called the **xylem** [Fig. 7.7 (a)].

The xylem forms a continuous network of channels that connects roots to the leaves through the stem and branches and thus transports water to the entire plant [Fig. 7.7 (b)].



You know that leaves synthesise food. The food has to be transported to all parts of the plant. This is done by the vascular tissue called the **phloem**. Thus, xylem and phloem transport substances in plants.

Activity 7.3

We would require a glass tumbler, water, red ink, a tender herb (e.g., Balsam), and a blade for this activity.

Pour water to fill one-third of the tumbler. Add a few drops of red ink to the water. Cut the base of the stem of the herb and place it in the glass as shown in Fig. 7.8(a). Observe it the next day.

Fig. 7.8 (a) *Stem placed in coloured water*

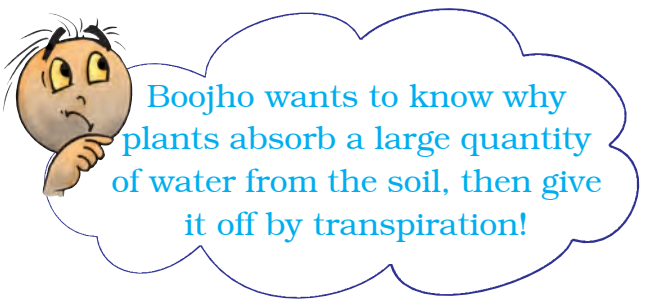
(b) *(c)*

Fig. 7.8 (b) *Water moves up in the stem*
(c) *Enlarged view of open end of stem*

Does any part of the herb appear red? If yes, how do you think the colour reached there?

You can cut the stem across and look for the red colour inside the stem (Fig. 7.8(b) and 7.8(c)).

From this activity we see that water moves up the stem. In other words, stem conducts water. Just like the red ink, minerals dissolved in water also move up the stem, along with water. Water and minerals go to leaves and other plant parts, through narrow tubes (xylem) inside the stem (Fig. 7.7(b)).



Transpiration

In Class VI you learnt that plants release a lot of water by the process of transpiration.

Plants absorb mineral nutrients and water from the soil. Not all the water absorbed is utilised by the plant. The water evaporates through the stomata present on the surface of the leaves by the process of transpiration. The evaporation of water from leaves generates a suction pull (the same that you produce when you suck water through a straw) which can pull water to great heights in the tall trees. Transpiration also cools the plant.

Keywords

Ammonia	Heart beat	Tissue
Artery	Kidneys	Urea
Blood	Phloem	Ureter
Blood vessels	Plasma	Urethra
Capillary	Platelets	Uric acid
Circulatory system	Pulse	Urinary bladder
Dialysis	Red blood cell	Vein
Excretion	Root hair	White blood cell
Excretory system	Stethoscope	Xylem
Haemoglobin	Sweat	

What you have learnt

- In most animals the blood that circulates in the body distributes food and oxygen to different cells of the body. It also carries waste products from different parts of the body for excretion.
- Circulatory system consists of the heart and blood vessels.
- In humans, blood flows through arteries and veins and the heart acts as a pumping organ.
- Blood consists of plasma, RBC, WBC and platelets. Blood is red due to the presence of a red pigment, haemoglobin.
- The human heart beats about 70–80 times per minute in an adult person. This is called heart rate.
- Arteries carry blood from the heart to all parts of the body.
- Veins carry blood from all parts of the body back to the heart.
- Removal of waste products from the body is called excretion.

- Excretory system of humans consists of two kidneys, two ureters, a urinary bladder, and urethra.
- Salts and urea are removed along with water as sweat.
- Fish excrete waste substances such as ammonia which directly dissolve in water.
- Birds, insects and lizard excrete uric acid in semi-solid form.
- Water and mineral nutrients are absorbed by roots from the soil.
- Nutrients are transported along with water to the entire plant via the vascular tissue called xylem.
- The vascular tissue for the transport of food to the various parts of the plant is phloem.
- A lot of water is lost by plants in the form of vapour through stomata during transpiration.
- Transpiration generates a force which pulls up water absorbed by the roots from the soil, to reach the stem and leaves.

Exercises

1. Match structures given in Column I with functions given in Column II.

	Column I		Column II
(i)	Stomata	(a)	Absorption of water
(ii)	Xylem	(b)	Transpiration
(iii)	Root hairs	(c)	Transport of food
(iv)	Phloem	(d)	Transport of water
		(e)	Synthesis of carbohydrates

2. Fill in the blanks.
   (i) The blood from the heart is transported to all parts of the body by the _____ .
   (ii) Haemoglobin is present in _____ cells.
   (iii) Arteries and veins are joined by a network of _____ .
   (iv) The rhythmic expansion and contraction of the heart is called _____ .
   (v) The main excretory product in human beings is _____ .
   (vi) Sweat contains water and _____ .
   (vii) Kidneys eliminate the waste materials in the liquid form called _____.
   (viii) Water reaches great heights in the trees because of suction pull caused by _____.

3. Choose the correct option:
   (a) In plants, water is transported through
      (i) xylem (ii) phloem
      (iii) stomata (iv) root hair
   (b) Water absorption through roots can be increased by keeping the plants
      (i) in the shade
      (ii) in dim light
      (iii) under the fan
      (iv) covered with a polythene bag
4. Why is transport of materials necessary in a plant or in an animal? Explain.
5. What will happen if there are no platelets in the blood?
6. What are stomata? Give two functions of stomata.
7. Does transpiration serve any useful function in the plants? Explain.
8. What are the components of blood?
9. Why is blood needed by all the parts of a body?
10. What makes the blood look red?
11. Describe the function of the heart.
12. Why is it necessary to excrete waste products?
13. Draw a diagram of the human excretory system and label the various parts.

Extended Learning — Activities and Projects

1. Find out about blood groups and their importance.
2. When a person suffers from chest pain, the doctor immediately takes an ECG. Visit a doctor and get information about ECG. You may even look up an encyclopaedia or the internet.

Did you know?

There is no substitute for blood. If people lose blood from surgery or injury or if their bodies cannot produce enough blood, there is only one way to get it — through transfusion of blood donated by volunteers. Blood is usually in short supply. Donating blood does not decrease the strength of the donors.

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8 Reproduction in Plants

To produce its kind is a characteristic of all living organisms. You have already learnt this in Class VI. The production of new individuals from their parents is known as **reproduction**. But, how do plants reproduce? There are different modes of reproduction in plants which we shall learn in this chapter.

8.1 Modes of Reproduction

In Class VI you learnt about different parts of a flowering plant. Try to list the various parts of a plant and write the functions of each. Most plants have roots, stems and leaves. These are called the **vegetative parts** of a plant. After a certain period of growth, most plants bear flowers. You may have seen the mango trees flowering in spring. It is these flowers that give rise to juicy mango fruit we enjoy in summer. We eat the fruits and usually discard the seeds. Seeds germinate and form new plants. So, what is the function of flowers in plants? Flowers perform the function of reproduction in plants. Flowers are the **reproductive parts**.

There are several ways by which plants produce their offspring. These are categorised into two types: (i) asexual, and (ii) sexual reproduction. In **asexual reproduction** plants can give rise to new plants without seeds, whereas in **sexual reproduction**, new plants are obtained from seeds.

Paheli thought that new plants always grow from seeds. But, she has never seen the seeds of sugarcane, potato and rose. She wants to know how these plants reproduce.

Asexual reproduction

In asexual reproduction new plants are obtained without production of seeds.

Vegetative propagation

It is a type of asexual reproduction in which new plants are produced from roots, stems, leaves and buds. Since reproduction is through the vegetative parts of the plant, it is known as **vegetative propagation.**

Activity 8.1

Cut a branch of rose or *champa* with a node. This piece of branch is termed a **cutting**. Bury the cutting in the soil. A node is a part of the stem/branch at which a leaf arises (Fig. 8.1). Water the cutting every day and observe its growth. Observe and record the number of days taken for roots to come out and

new leaves to arise. Try the same activity by growing money plant in a jar of water and record your observations.

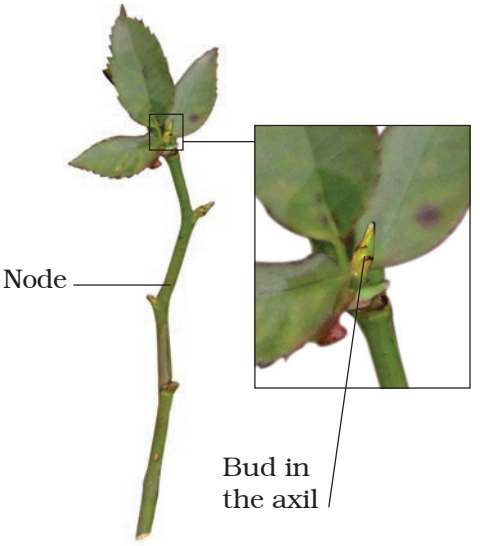


Fig. 8.1 *Stem-cutting of rose*

You must have seen flower buds developing into flowers. Apart from flower buds, there are buds in the axil (point of attachment of the leaf at the node) of leaves which develop into shoots. These buds are called vegetative buds (Fig. 8.2). A bud consists of a short stem around which immature overlapping leaves are present. Vegetative buds can also give rise to new plants.

Activity 8.2

Take a fresh potato. Observe the scars on it with the help of a magnifying glass. You may find bud(s) in them. These scars are also called **"eyes"**. Cut the potato into small portions, each with an eye and bury them in the soil. Water the pieces regularly for a few days and observe their progress. What do you find?

Fig. 8.2 *Potato plant sprouting from an 'eye'*

Likewise you can also grow ginger (Fig. 8.3) or turmeric.

Bryophyllum (sprout leaf plant) has buds in the margins of leaves (Fig. 8.4). If a leaf of this plant falls on a moist soil, each bud can give rise to a new plant.

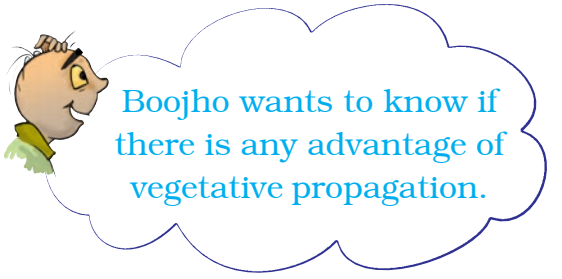
Fig. 8.3 *Ginger with new plants sprouting from it*

Roots of some plants can also give rise to new plants. Sweet potato and dahlia are examples.

Plants such as cacti produce new plants when their parts get detached

Fig. 8.4 Leaf of Bryophyllum with buds in the margin

from the main plant body. Each detached part can grow into a new plant.



Plants produced by vegetative propagation take less time to grow and bear flowers and fruits earlier than those produced from seeds. The new plants are exact copies of the parent plant, as they are produced from a single parent.

Later in this chapter you will learn that plants produced by sexual reproduction have characters of both the parents. Plants produce seeds as a result of sexual reproduction.

Budding

You have already learnt about the tiny organisms like yeast can be seen only under a microscope. These grow and multiply every few hours if sufficient nutrients are made available to them. Remember that yeast is a single-celled organism. Let us see how they reproduce?

Activity 8.3

(To be demonstrated by the teacher)

Take a piece of yeast cake or yeast powder from a bakery or a chemist shop. Take a pinch of yeast and place it in a container with some water. Add a spoonful of sugar and shake to dissolve it. Keep it in the warm part of a room. After an hour, put a drop of this liquid on a glass slide and observe under a microscope. What do you observe? You may see the formation of new yeast cells (Fig. 8.5).

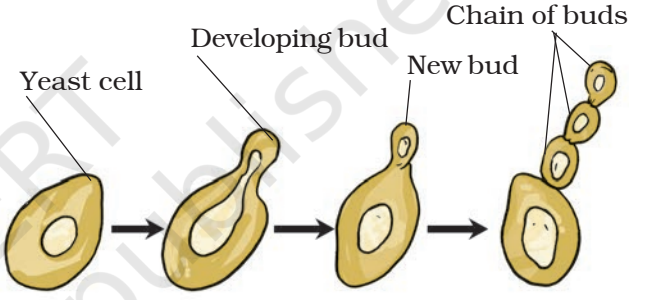


Fig. 8.5 Reproduction in yeast by budding

The small bulb-like projection coming out from the yeast cell is called a **bud**. The bud gradually grows and gets detached from the parent cell and forms a new yeast cell. The new yeast cell grows, matures and produces more yeast cells. Sometimes, another bud arises from the bud forming a chain of buds. If this process continues, a large number of yeast cells are produced in a short time.

Fragmentation

You might have seen slimy green patches in ponds, or in other stagnant water bodies. These are the algae. When

water and nutrients are available algae grow and multiply rapidly by fragmentation. An alga breaks up into two or more fragments. These fragments or pieces grow into new individuals (Fig. 8.6). This process continues and they cover a large area in a short period of time.

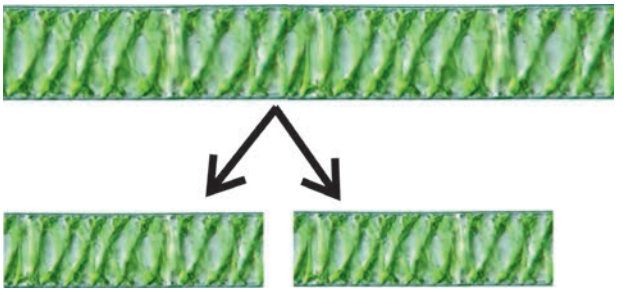


Fig. 8.6 *Fragmentation in spirogyra (an alga)*

Spore formation

In Chapter 1 you learnt that the fungi on a bread piece grow from spores which are present in the air. Repeat Activity 1.2. Observe the spores in the cotton-like mesh on the bread. When spores are released they keep floating in the air. As they are very light they can cover long distances.

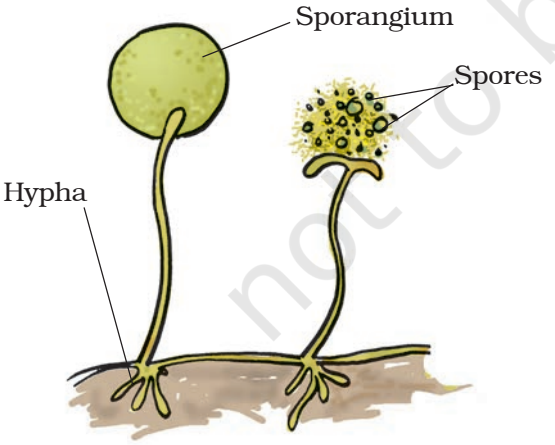


Fig. 8.7 *Reproduction through spore formation in fungus*

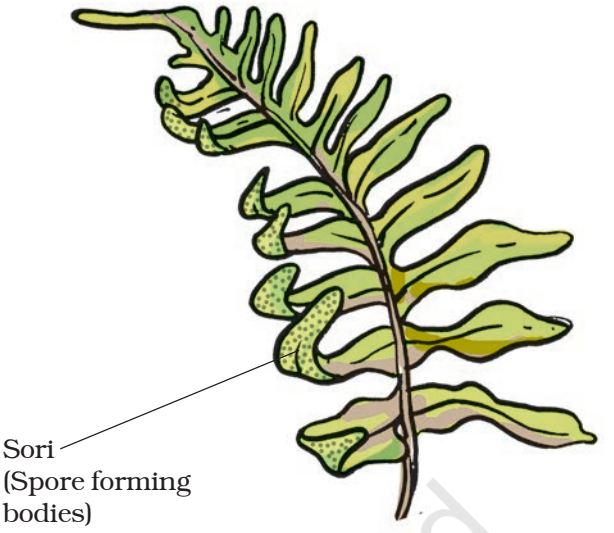


Fig. 8.8 *Reproduction through spore formation in fern*

Spores are asexual reproductive bodies. Each spore is covered by a hard protective coat to withstand unfavourable conditions such as high temperature and low humidity. So they can survive for a long time. Under favourable conditions, a spore germinates and develops into a new individual. Plants such as moss and ferns (Fig. 8.8) also reproduce by means of spores.

12.2 Sexual Reproduction

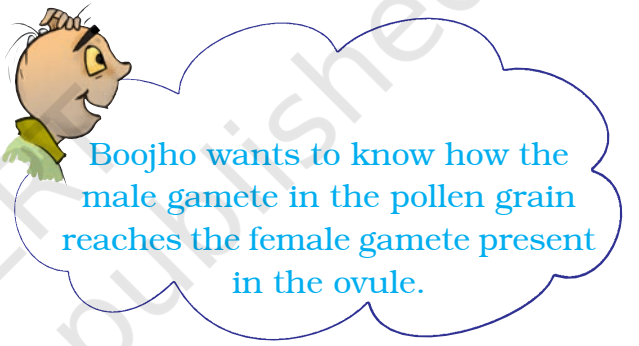
You have learnt earlier the structure of a flower. You know that the flowers are the reproductive parts of a plant. **Stamens** are the male reproductive part and **pistil** is the female reproductive part (Fig. 8.9).

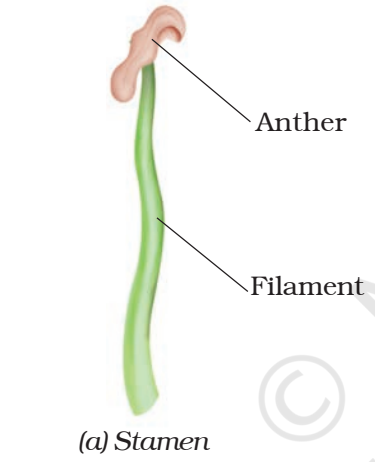
Activity 8.4

Take a mustard/China rose/petunia flower and separate its reproductive parts. Study the various parts of a stamen and pistil.

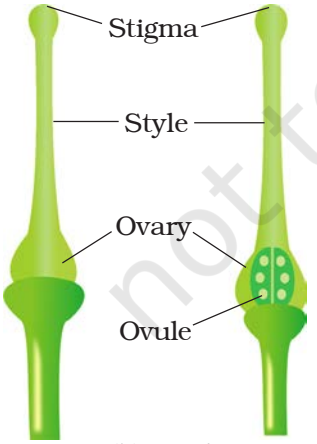
Flowers which contain either only pistil or only stamens are called **unisexual flowers**. Flowers which contain both stamens and pistil are called **bisexual flowers**. Corn, papaya and cucumber produce unisexual flowers, whereas mustard, rose and petunia have bisexual flowers. Both male and female unisexual flowers may be present in the same plant or in different plants.

Could you identify the anther and the filament of a stamen? [Fig. 8.9 (a)]. Anther contains pollen grains which produce **male gametes**. A pistil consists of stigma, style and ovary. Ovary contains one or more ovules. The **female gamete** or the **egg** is formed in an ovule [Fig. 8.9 (b)]. In sexual reproduction a male and a female gamete fuse to form a **zygote**.





(a) Stamen

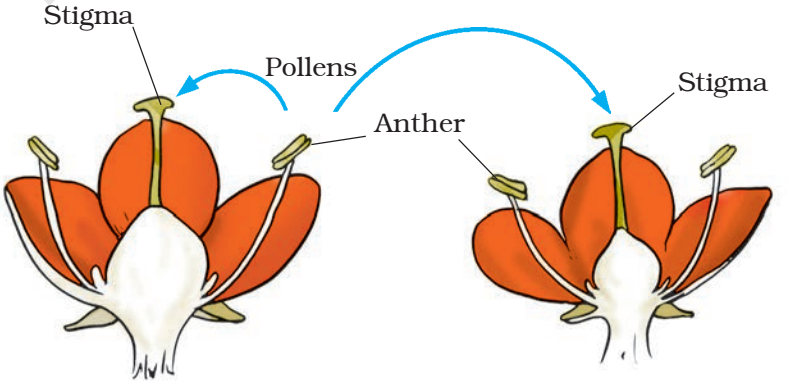


(b) Pistil

Fig. 8.9 *Reproductive parts*

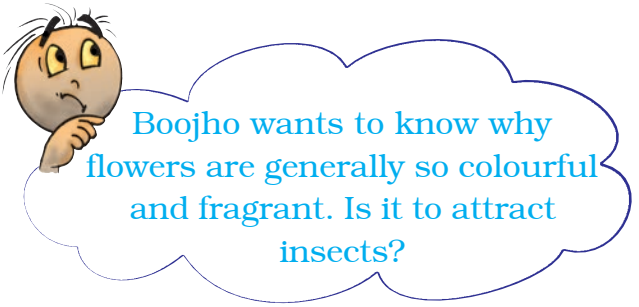
Pollination

Generally, pollen grains have a tough protective coat which prevents them from drying up. Since pollen grains are light, they can be carried by wind or



(a) Self-pollination *(b) Cross-pollination*

Fig. 8.10 *Pollination in flower*



water. Insects visit flowers and carry away pollen on their bodies. Some of the pollen lands on the stigma of a flower of the same kind. The transfer of pollen from the anther to the stigma of a flower is called **pollination**. If the pollen lands on the stigma of the same flower or another flower of the same plant, it is called self-pollination. When the pollen of a flower lands on the stigma of a flower of a different plant of the same kind, it is called cross-pollination [Fig. 8.10 (a) and (b)].

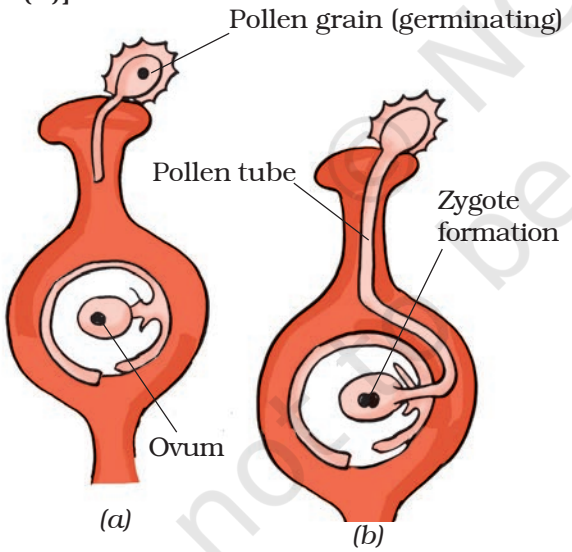


Fig. 8.11 Fertilisation (Zygote formation)

Fertilisation

The cell which results after **fusion** of the gametes is called a **zygote**. The process of fusion of male and female gametes (to form a zygote) is called **fertilisation** (Fig. 8.11). The zygote develops into an **embryo**.

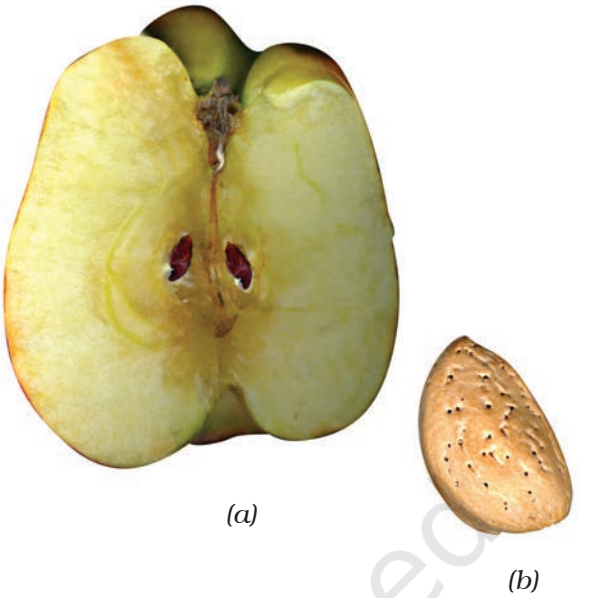


Fig. 8.12 (a) Section of an apple, (b) Almond

8.3 Fruits and Seed Formation

After fertilisation, the ovary grows into a fruit and other parts of the flower fall off. The fruit is the ripened ovary. The seeds develop from the ovules. The seed contains an embryo enclosed in a protective seed coat.

Some fruits are fleshy and juicy such as mango and orange. Some fruits are hard like almonds and walnuts [Fig. 8.12 (a) and (b)].

8.4 Seed Dispersal

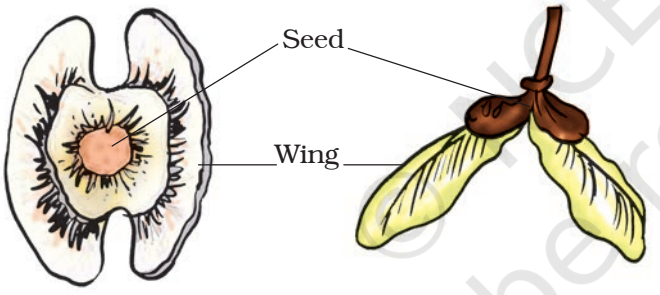
In nature same kind of plants grow at different places. This happens because **seeds are dispersed to different places**. Sometimes after a walk through a forest or a field or a park, you may have found seeds or fruits sticking to your clothes.

Did you try to observe how these seeds were clinging to your clothes?

What do you think will happen if all seeds of a plant were to fall at the same place and grow there? There would be severe competition for sunlight, water, minerals and space. As a result the seeds would not grow into healthy plants. Plants benefit by seed dispersal. It prevents competition between the plant and its own seedlings for sunlight, water and minerals. It also enables the plants to invade new habitats for wider distribution.

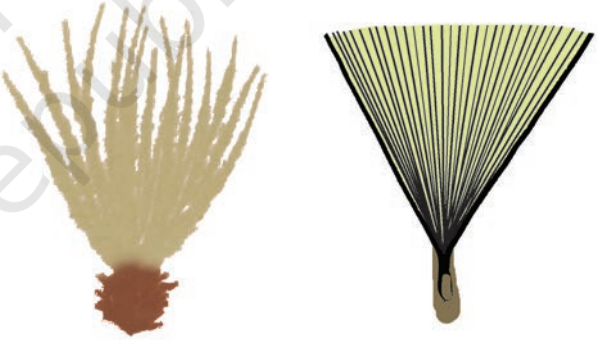
Seeds and fruits of plants are carried away by wind, water and animals. Winged seeds such as those of drumstick and maple [Fig. 8.13 (a) and (b)], light seeds of grasses or hairy seeds of aak (*Madar*) and hairy fruit of sunflower [Fig. 8.14 (a), (b)], get blown off with the wind to far away places. Some seeds are dispersed by water. These fruits or seeds usually develop floating ability in the form of spongy or fibrous outer coat as in coconut. Some seeds are dispersed by animals, especially spiny seeds with hooks which get attached to the bodies of animals and are carried to distant places. Examples are *Xanthium* (Fig. 8.15) and *Urena*.

Some seeds are dispersed when the fruits burst with sudden jerks. The seeds are scattered far from the parent plant. This happens in the case of castor and balsam.



(a) (b)

Fig. 8.13 *Seeds of (a) drumstick and (b) maple*



(a) (b)

Fig. 8.14 *(a) The hairy fruit of sunflower and (b) hairy seed of madar (aak)*

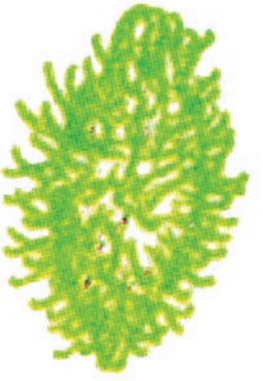


Fig. 8.15 *Xanthium*

Keywords

Asexual reproduction	Hypha	Sexual reproduction
Budding	Ovule	Spore
Embryo	Pollen grain	Sporangium
Fertilisation	Pollen tube	Vegetative propagation
Fragmentation	Pollination	Zygote
Gametes	Seed dispersal	

What you have learnt

- All organisms multiply or reproduce their own kind.
- In plants there are two modes of reproduction, asexual and sexual.
- There are several methods of asexual reproduction such as fragmentation, budding, spore formation and vegetative propagation.
- Sexual reproduction involves the fusion of male and female gametes.
- In vegetative propagation new plants are produced from different vegetative parts such as leaves, stems and roots.
- Flower is the reproductive part of a plant.
- A flower may be unisexual with either the male or the female reproductive parts.
- A bisexual flower has both the male and the female reproductive parts.
- The male gametes are found inside the pollen grains and female gametes are found in the ovule.
- Pollination is the process of transfer of pollen grains from the anther of one flower to the stigma of the same or another flower.
- Pollination is of two types, self-pollination and cross-pollination. In self-pollination, pollen grains are transferred from the anther to the stigma of the same flower. In cross-pollination, pollen grains are transferred from the anther of one flower to the stigma of another flower of the same kind.
- Pollination takes place in plants with the help of wind, water and insects.
- The fusion of male and female gametes is called fertilisation.
- Fertilised egg is called zygote. Zygote develops into an embryo.
- Fruit is the mature ovary whereas ovule develops into a seed, which contains the developing embryo.
- Seed dispersal is aided by wind, water and animals.
- Seed dispersal helps the plants to (i) prevent overcrowding, (ii) avoid competition for sunlight, water and minerals and (iii) invade new habitats.

Exercises

1. Fill in the blanks:
   (a) Production of new individuals from the vegetative part of parent is called_____.
   (b) A flower may have either male or female reproductive parts. Such a flower is called_____.
   (c) The transfer of pollen grains from the anther to the stigma of the same or of another flower of the same kind is known as _____.
   (d) The fusion of male and female gametes is termed as _____.
   (e) Seed dispersal takes place by means of _____, _____ and _____.
2. Describe the different methods of asexual reproduction. Give examples.
3. Explain what you understand by sexual reproduction.
4. State the main difference between asexual and sexual reproduction.
5. Sketch the reproductive parts of a flower.
6. Explain the difference between self-pollination and cross-pollination.
7. How does the process of fertilisation take place in flowers?
8. Describe the various ways by which seeds are dispersed.
9. Match items in Column I with those in Column II:

Column I	**Column II**
(a) Bud	(i) Maple
(b) Eyes	(ii) *Spirogyra*
(c) Fragmentation	(iii) Yeast
(d) Wings	(iv) Bread mould
(e) Spores	(v) Potato
	(vi) Rose

10. Tick (✓) the correct answer:
    (a) The reproductive part of a plant is the
    (i) leaf (ii) stem (iii) root (iv) flower
    (b) The process of fusion of the male and the female gametes is called
    (i) fertilisation (ii) pollination
    (iii) reproduction (iv) seed formation

(c) Mature ovary forms the

(i) seed (ii) stamen

(iii) pistil (iv) fruit

(d) A spore producing organism is

(i) rose (ii) bread mould

(iii) potato (iv) ginger

(e) *Bryophyllum* can reproduce by its

(i) stem (ii) leaves

(iii) roots (iv) flower

Extended Learning—Activities and Projects

1. Make your own cactus garden by collecting pieces cut from different kinds of cacti. Grow the variety in one single flat container or in separate pots.
2. Visit a fruit market and collect as many local fruits as possible. If many fruits are not available, you can collect tomatoes and cucumbers (these are fruits, though we use them as vegetables). Make drawings of the different fruits. Split the fruits and examine the seeds within. Look for any special characteristics in the fruits and their seeds.

   You can visit a library also to learn about this.
3. Think of ten different fruit-bearing plants. Remember that many vegetables are also fruits of the plants. Discuss with your teacher, parents, farmers, fruit growers and agricultural experts (if available nearby) and find out the manner of their dispersal. Present your data in the form of a table as shown below:

S. No.	Name of fruit-bearing plant	Agent through which seeds are dispersed	Part of or seed which helps in dispersal
1.			
2.			
3.			

4. Suppose there is one member of a particular kind of organism in a culture dish, which doubles itself in one hour through asexual reproduction. Work out the number of members of that kind of organism which will be present in the culture dish after ten hours. Such a colony of individuals arising from one parent is called a "clone".

12 Forests: Our Lifeline

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One evening Boojho entered the park with an elderly person. He introduced him to his friends. Prof Ahmad was a scientist working in the university. The children started playing while Prof Ahmad sat on a bench in the corner. He was tired as he had participated in the golden jubilee celebrations of the town. After a while, the children also came and sat around him. They wanted to know about the celebrations. Prof Ahmad told them that after the cultural programme, the senior people discussed the town's unemployment problem. A plan was proposed to put up a factory by clearing an area of the forest just outside the town. This would give the increasing population of the town a chance to get jobs. The children were very surprised when Prof Ahmad told them that many people had objected to this idea.

Fig. 12.1 A view of a forest

"This is because the forests serve as green lungs and water purifying systems in nature", Prof Ahmad explained. The children were confused. Prof Ahmad realised that the children had not visited a forest. The children also wanted to know more about the forest, so they decided to visit it with Prof Ahmad.

12.1 Visit to a Forest

One Sunday morning, the children packed a few things like a knife, a hand lens, a stick, a notebook and walked together through a forest trail near a village. On their way, they met Tibu, a young boy of their age group, of nearby village, who was taking cattle for grazing along with his aunt. He was very agile, running here and there to keep the herd together. When he saw the children, Tibu also started walking along with them, while his aunt went on a different path. As soon as they entered the forest Tibu raised his hand and signalled them to keep quiet because noise could disturb the animals living in the forest.

Tibu then took them to a place at a height to show them the broad view of the forest. Children were surprised because they could not see any land (Fig. 12.1). The different treetops had formed green cover over the land. However, the cover was not uniformly green. The

environment was peaceful and a cool breeze was blowing. This made children quite fresh and happy.

While coming down, they got excited on hearing a sudden sound of birds and some noise from the top branches of the trees. Tibu told them to relax since it was a normal phenomenon here. Because of the children's presence, some monkeys had climbed higher up on the trees where they disturbed the birds. Animals often give this type of warning call to alert other animals. Tibu also told that many other animals like boar, bison, jackals, porcupine, elephants live in the deeper areas of the forest (Fig. 12.2). Prof Ahmad cautioned children that they should not go deep into the forest.

Boojho and Paheli remembered that they have studied about forests as

Fig. 12.3 *Forest as habitat*

an example of a habitat in Class VI (Fig. 12.3). They could see now how the forest provides a home for many animals and plants.

Fig. 12.2 *Some forest animals*

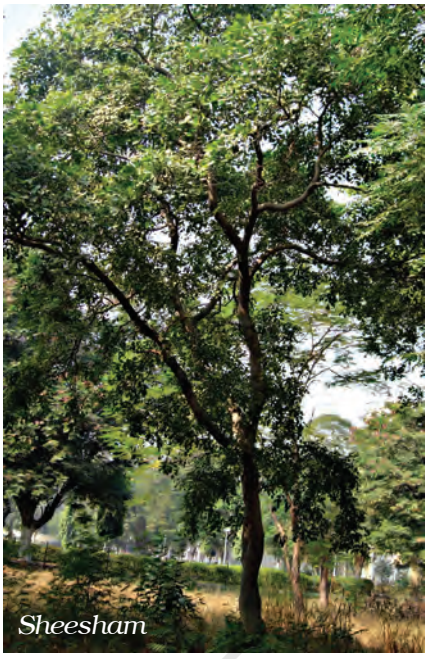


Fig. 12.4 Some forest plants

The land where the children were walking was uneven and covered with many trees. Tibu helped them to identify *sal*, teak, *semal*, *sheesham*, *neem*, *palash*, fig, *khair*, *amla*, bamboo, *kachnar* (Fig. 12.4). Prof Ahmad pointed out that there are several other trees, shrubs, herbs and grasses in the forest. The forest floor and the trees were also covered with different types of creepers and climbers. The sun was barely visible through the leaves of the trees, making it quite dark inside the forest.

Activity 12.1

Observe the various things in your home and make a list of those which are made from material which may have been obtained from the forest.

You might have many wooden items on your list like plywood, fuel wood, boxes, paper, matchsticks, and furniture. Do you know that gum, oils, spices, fodder for animals and medicinal plants are also some of the products which we get from the forest (Fig. 12.5).

Based on the products that we get from plants, try to fill Table 12.1. One example of each plant is already given. Fill the table by adding more examples.

Sheila wondered who would have planted these trees. Prof Ahmad replied that in nature trees produce enough seeds. The forest floor provides favourable conditions for them to germinate and develop into seedlings

Fig. 12.5 *Forest products*

and saplings. Some grow up into trees. He added that branchy part of a tree above the stem is known as the **crown** of the tree (Fig. 12.6).

Prof Ahmad asked children to look up and observe how the branches of the tall trees look like a roof over the other plants in the forest. He told them that this is called a **canopy** (Fig. 12.7).

Activity 12.2

Visit a forest or a park in your neighbourhood. Observe the trees and try to identify them. You can take the help of some elders or books on trees. List the characteristics of the trees that you observe, such as the height, shape of leaves, crown, flowers, and fruits. Also draw the crowns of some trees.

Prof Ahmad pointed out that trees had crowns of different types and sizes. These had created different horizontal layers in the forest. These are known as understoreys (Fig. 12.7). Giant and tall trees constituted the top layer followed by shrubs and tall grasses, and herbs formed the lowest layer.

Fig. 12.6 *Some crown shapes*

Table 12.1 Plants and their products

Gum	Timber	Medicinal	Oil
Babool	Sheesham	Neem	Sandalwood

Fig. 12.7 Canopy and under storeys in a forest

"Would we see similar kind of trees in every forest?"—asked Boojho. Prof Ahmad said, "No, due to different climatic conditions there are variations in the types of trees and other plants. The types of animals also differ from forest to forest."

A few children were busy watching beautiful butterflies fluttering here and there on the flowers of shrubs and herbs.

Fig. 12.8 Forest floor

They had a close look at the bushes. While doing that their hair and clothes had seeds and thorns clinging to them.

They came across numerous insects, spiders, squirrels, ants and various other small animals on the bark of the trees, plant leaves and on decaying leaves on the forest floor (Fig. 12.8). They started making sketches of these creatures. The forest floor seemed dark coloured and was covered with a layer of dead and decaying leaves, fruits, seeds, twigs and small herbs. The decaying matter was moist and warm.

Children picked up various seeds and leaves for their collection. Walking over the dead leaf layer on the forest floor was like walking over a spongy carpet!

Is the decaying matter always warm? Prof Ahmad suggested that the children could perform an activity to get an answer to this question.

Activity 12.3

Dig a small pit. Put vegetable waste and leaves in it. Cover them with soil. Add some water. After three days, remove the upper layer of the soil. Does the pit feel warm inside?

Paheli asked, "There are so many trees here. Also, there are many forest like this. What difference will it make if we cut some trees for a factory?"

Prof Ahmad said, "You have read about autotrophs, heterotrophs and saprotrophs. You have learnt how green plants produce food. All animals, whether herbivores or carnivores, depend ultimately on plants for food. Organisms which feed on plants often get eaten by other organisms, and so on. For example, grass is eaten by insects, which in turn, is taken by the frog. The frog is consumed by snakes. This is said to form a food chain: Grass → insects → frog → snake → eagle. Many food chains can be found in the forest. All food chains are linked. If any one food chain is disturbed, it affects other food chains. Every part of the forest is dependent on the other parts. If we remove one component, say trees, all other components would be affected."

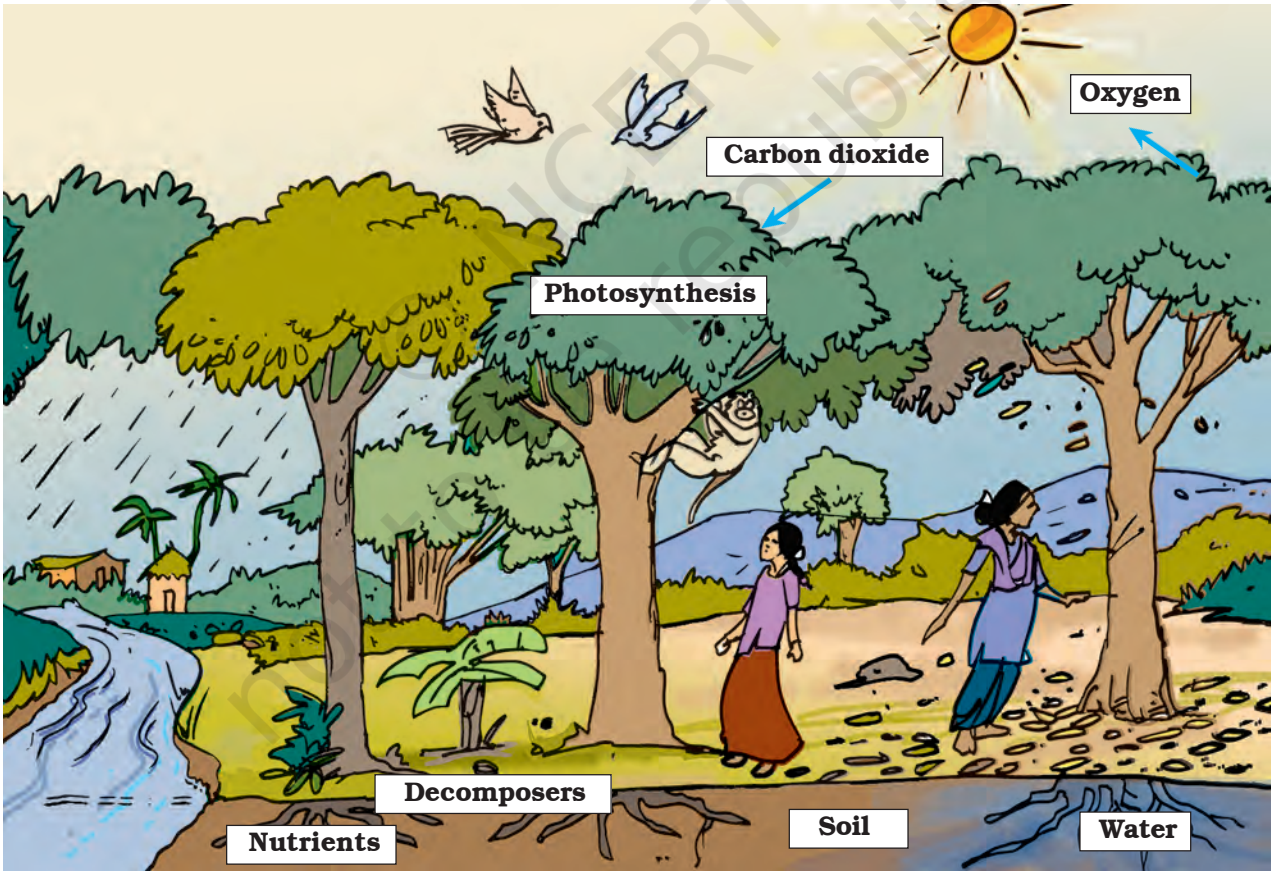


Fig. 12.9 Interrelationship of plant, soil and decomposers in a forest

Prof Ahmad asked children to pick up leaves from the forest floor and observe them under a hand lens. They found tiny mushrooms over the decaying leaves. They also saw an army of tiny insects, millipedes, ants and beetle on them. They were wondering how these organisms live there. Prof Ahmad explained that apart from these animals which are easily seen, there are several organisms and micro-organisms that live in the soil. Paheli wondered what mushroom and other micro-organisms eat. Prof Ahmad replied that they feed upon the dead plant and animal tissues and convert them into a dark coloured substance called **humus**.

In which layer of the soil would you find humus? What is its importance to the soil?

The micro-organisms which convert the dead plants and animals to humus are known as **decomposers**. These micro-organisms play an important role in the forest. Soon, Paheli removed some dead leaves and discovered under them a layer of humus on forest floor. The presence of humus ensures that the nutrients of the dead plants and animals are released into the soil. From there, these nutrients are again absorbed by the roots of the living plants. "What happens if an animal dies in the forest?" Sheila asked. Tibu replied the dead animals become food for vultures, crows, jackals and insects." In this way, the nutrients are cycled. So, nothing goes waste in a forest (Fig. 12.9).

Paheli reminded Prof Ahmad that he had not explained why forests are called green lungs. Prof Ahmad explained that plants release oxygen through the process of photosynthesis. The plants help to provide oxygen for animal respiration. They also maintain the

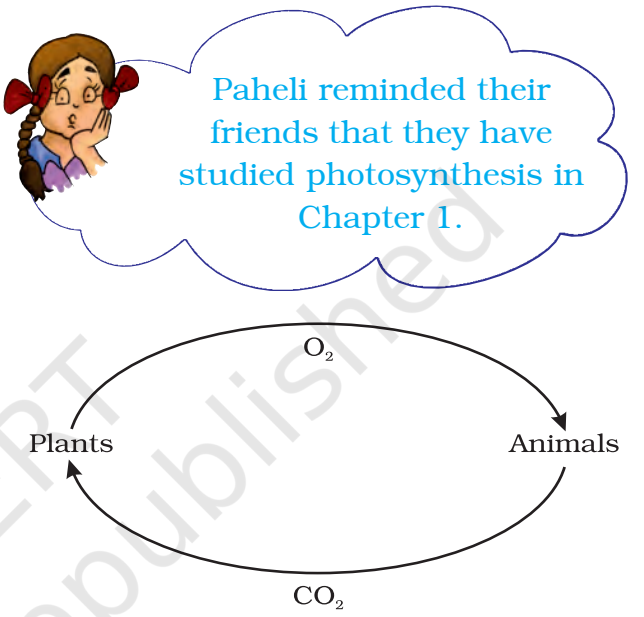


Fig. 12.10 *Balance of oxygen and carbon dioxide*

balance of oxygen and carbon dioxide in the atmosphere (Fig. 12.10). That is why forests are called lungs.

The children saw clouds forming in the sky. Boojho recalled what he had learnt about the water cycle in Class VI. Trees take in water from their roots and release water vapour into the air through evaporation.

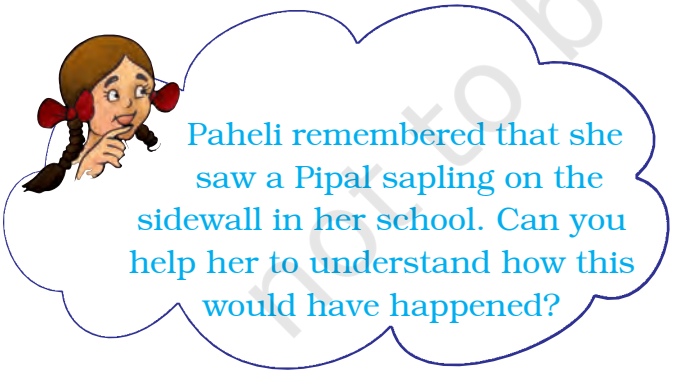
If there were fewer trees, how will the water cycle be affected?

Tibu told them that the forest is not just home to plants and animals. Many people also live in the forest. Some of

them may belong to different tribes. Tibu explained that these people depend mostly on the forests. The forest provides them with food, shelter, water and medicines. They have traditional knowledge about many medicinal plants in the forest.

While Boojho was drinking water from a small stream, he saw some deer crossing the stream (Fig. 12.11). They disappeared into the bushes. The dense bushes and the tall grass provide animals with the food and shelter. They also protect them from carnivores that live in the forest.

Fig. 12.11 Deer in a forest



Tibu then started looking closely at the forest floor. Soon he called and showed the children droppings of some animals, and explained the difference between various types of droppings. Prof Ahmad informed them that the forest officers could recognise the presence of some animals in the forest by their droppings and footprints.

Boojho called every one and showed them a large, decaying heap of animal dropping. Several beetles and grubs were feeding on the heap and a bunch of seedlings was sprouting. "These seedlings are of the herbs and shrubs.

Fig. 12.12 A sapling on a wall

The animals also disperse the seeds of certain plants and help the forest to grow and regenerate. The decaying animal dung also provides nutrients to the seedlings to grow", said Prof Ahmad.

After listening to this, Boojho noted in his notebook, "By harbouring greater variety of plants, the forest provides greater opportunities for food and habitat for the herbivores. Larger number of herbivores means increased availability of food for a variety of

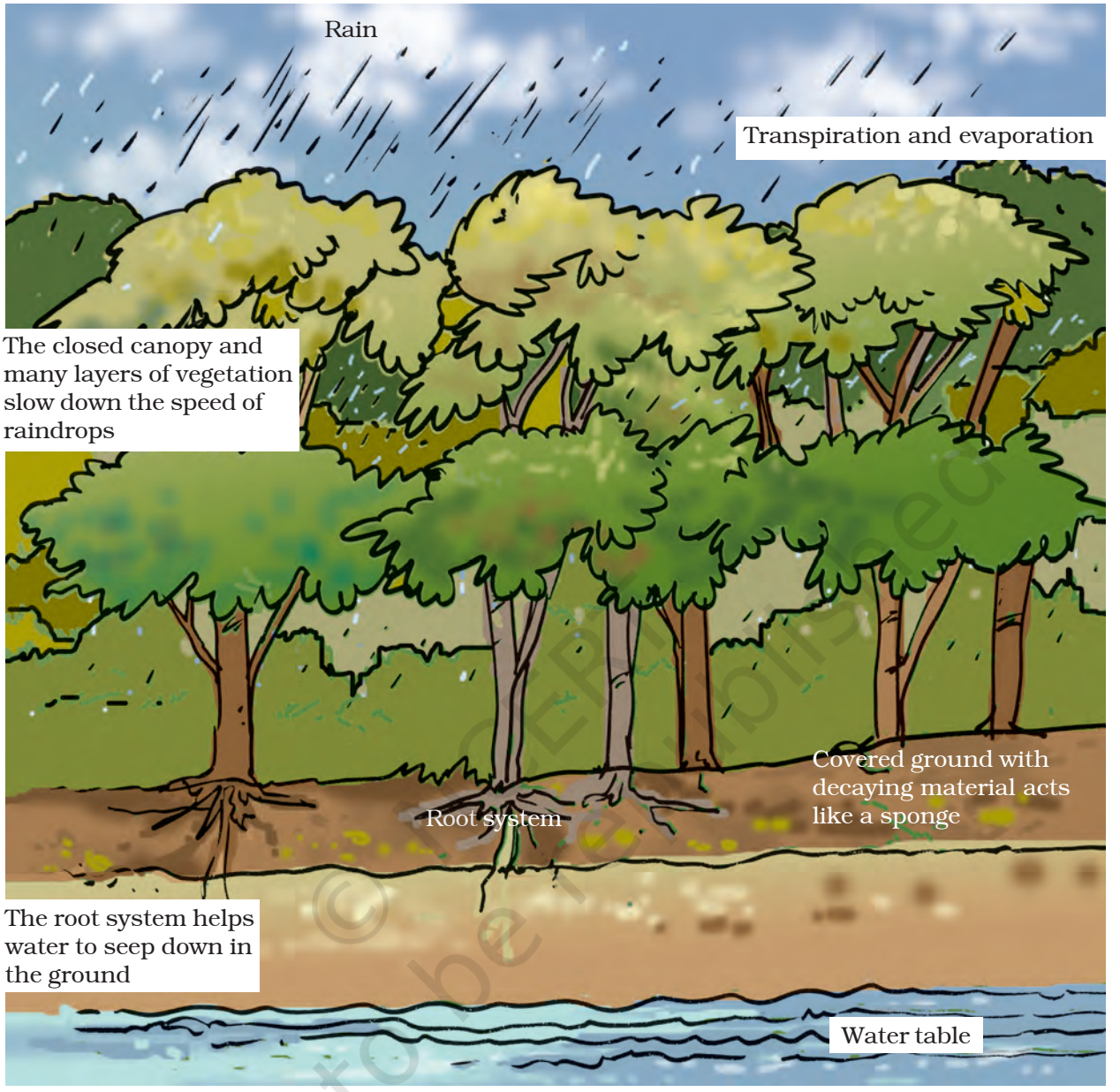


Fig. 12.13 *Rainwater drips from the trees and seeps into the ground*

carnivores. The wide variety of animals helps the forest to regenerate and grow. Decomposers help in maintaining the supply of nutrients to the growing plants in the forest. Therefore, the forest is a '**dynamic living entity**' — full of life and vitality."

It was about afternoon and the children wanted to go back. Tibu suggested another route for going back. While they were going back, it started raining. However, surprisingly, they saw that the raindrops were not hitting the forest floor directly. The uppermost layer of the forest canopy intercepted the flow of raindrops, and most of the water was coming down through the branches and the stems of the trees. From the leaves it

was dripping slowly over branches of the shrubs and herbs (Fig. 12.13). They found that the ground was still dry. After about half an hour, the rain stopped. They noticed that the layer of dead leaves over the forest floor appeared wet now. But water did not stagnate in the forest.

Boojho thought that if it had rained so heavily in his town, it would have flooded the drains and roads.

What would happen if it rains heavily in your town?

Prof Ahmad told them that the forest also acts as a natural absorber of rainwater and allows it to seep. It helps maintain the water table throughout the year. Forests not only help in controlling floods but also help maintain the flow of water in the streams so that we get a steady supply of water. On the other hand, if trees are not present, rain hits the ground directly and may flood the area around it. Heavy rain may also damages the soil. Roots of trees normally bind the soil together, but in their absence the soil is washed away or eroded.

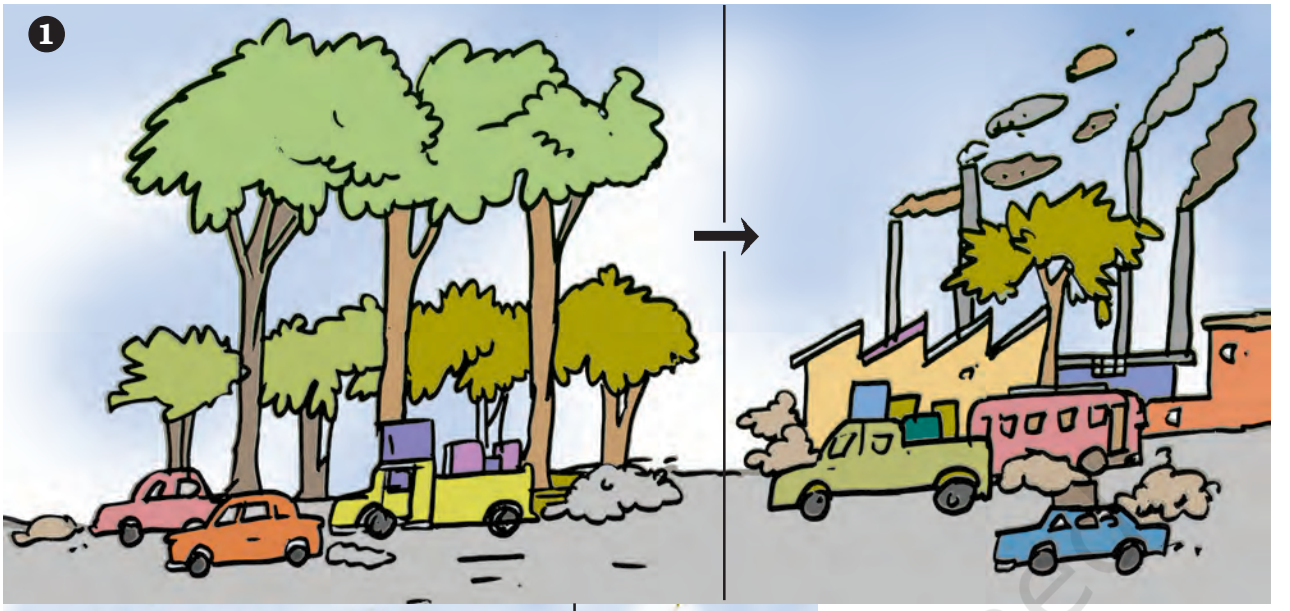
The children spent an hour at Tibu's village on their way back. The weather of the village was quite pleasant. Villagers told them that due to the surrounding forest, they receive good rainfall. The air also remained cool. Noise pollution, too is less because the forest absorbs the noise of the nearby highway.

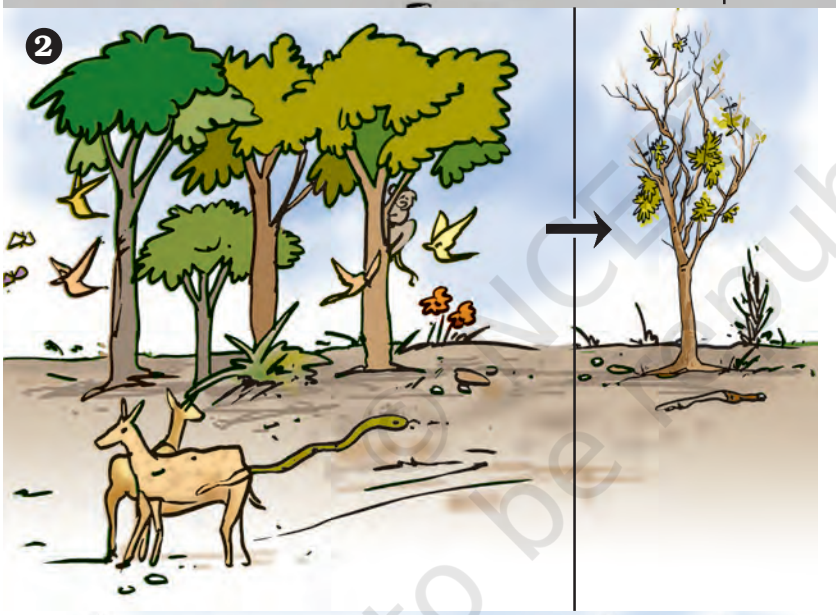
The children learnt about the history of the village. It surprised them that the villages and the agricultural fields of that area were created after clearing the forest about sixty years ago. Tibu's grandfather told them that when he was young, the village was not as large as it was now. It was also surrounded by forests. Construction of roads, buildings, industrial development and increasing demand of wood created pressure on the forests and it started vanishing. He was not happy that the forest adjoining their village is not regenerating and is on the verge of disappearing due to overgrazing of animals and indiscriminate felling of trees. Prof Ahmad said that if we did things wisely we could preserve forests and environment as well as have development.

Children prepared a few pictures to show the consequences of such an event.

At the end of the visit, Prof Ahmad asked children to sum up the importance of forests. The children wrote: Forests provide us with oxygen. They protect soil and provide habitat to a large number of animals. Forests help in bringing good rainfall in neighbouring areas. They are a source of medicinal plants, timber and many other useful products. We must preserve our forests.

What would happen if forests disappear?





(1) If forests disappear, the amount of carbon dioxide in air will increase, resulting in the increase of earth's temperature.

(2) In the absence of trees and plants, the animals will not get food and shelter.

(3) In the absence of trees, the soil will not hold water, which will cause floods.

(4) Deforestation will endanger our life and environment. Think, what we can do to preserve our forests.

4

Keywords

Canopy	Deforestation	Seed dispersal
Crown	Humus	Soil erosion
Decomposers	Regeneration	Understorey

What you have learnt

- We get various products from the forests surrounding us.
- Forest is a system comprising various plants, animals and micro-organisms.
- In a forest, trees form the uppermost layer, followed by shrubs. The herbs form the lowest layer of vegetation.
- Different layers of vegetation provide food and shelter for animals, birds and insects.
- The various components of the forest are interdependent on one another.
- The forest keeps on growing and changing, and can regenerate.
- In the forest, there is interaction between soil, water, air and living organisms.
- Forests protect the soil from erosion.
- Soil helps forests to grow and regenerate.
- Forests are the lifeline for the forest-dwelling communities.
- Forests influence climate, water cycle and air quality.

Exercises

1. Explain how animals dwelling in the forest help it grow and regenerate.
2. Explain how forests prevent floods.
3. What are decomposers? Name any two of them. What do they do in the forest?
4. Explain the role of forest in maintaining the balance between oxygen and carbon dioxide in the atmosphere.
5. Explain why there is no waste in a forest.
6. List five products we get from forests?

7. Fill in the blanks:

   (a) The insects, butterflies, honeybees and birds help flowering plants in_____.

   (b) A forest is a purifier of_____ and _____.

   (c) Herbs form the _____ layer in the forest.

   (d) The decaying leaves and animal droppings in a forest enrich the _____.

8. Why should we worry about the conditions and issues related to forests far from us?

9. Explain why there is a need of variety of animals and plants in a forest.

10. In Fig. 12.15, the artist has forgotten to put the labels and directions on the arrows. Mark the directions on the arrows and label the diagram using the following labels:

    clouds, rain, atmosphere, carbon dioxide, oxygen, plants, animals, soil, roots, water table.

11. Which of the following is not a forest product?

    (i) Gum

    (ii) Plywood

    (iii) Sealing wax

    (iv) Kerosene

12. Which of the following statements is not correct?

    (i) Forests protect the soil from erosion.

    (ii) Plants and animals in a forest are not depedent on one another.

    (iii) Forests influence the climate and water cycle.

    (iv) Soil helps forests to grow and regenerate.

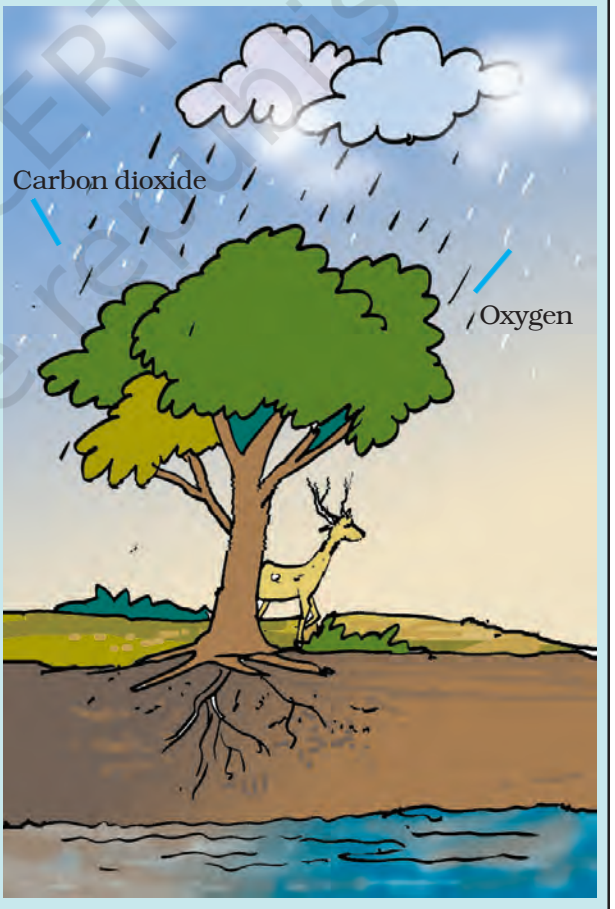


Fig. 12.15

13. Micro-organisms act upon the dead plants to produce

(i) sand (ii) mushrooms (iii) humus (iv) wood

Extended Learning — Activities and Projects

1. The Department of Environment is to decide whether some portion of a forest in your area could be cleared for a housing complex. Write a letter to the department explaining your point of view as a concerned citizen.
2. Visit a forest. Here is a list of points that would make your visit more fruitful.
   (a) Make sure that you have permission to go into the forest.
   (b) Make sure that you can find your way around. Get a map and go along with some one who is familiar with the area.
   (c) Keep a record of the things you see and do. Observations make the visit interesting. Sketches and photographs are useful.
   (d) You may record bird calls.
   (e) Collect different kinds of seeds or hard fruits like nuts.
   (f) Try to recognise various types of trees, shrubs, herbs, etc. Make lists of plants from different places in the forest and of different layers. You may not be able to name all the plants, but it is worth recording and seeing where they grow. Make a record of approximate heights of plants, crown shape, bark texture, leaf size, and flower colour.
   (g) Learn to recognise the animal's droppings.
   (h) Interview the forest officials and the people of surrounding vil lages and other visitors.

You must never collect birds' eggs, and their nests should never be disturbed.

You can read more on the following website:

www.wild-india.com

Did you know?

In India the area under forest cover is about 21% of the total area. It had steadily been falling since independence. But people now seem to have realised the importance of the forest cover. Reports suggest that the area under forest cover has slightly increased in recent years.

13 Wastewater Story

0758CH18

All of us use water in our homes and make it dirty.

Dirty! Are you surprised?

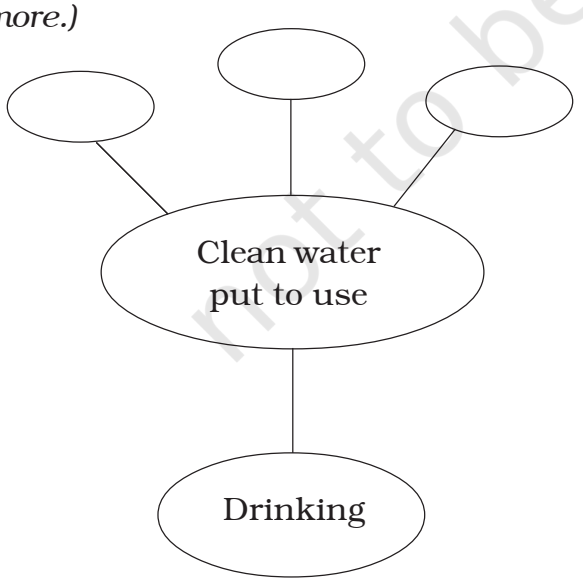
Rich in lather, mixed with oil, black–brown water that goes down the drains from sinks, showers, toilets, laundries is dirty. It is called **wastewater**. This used water should not be wasted. We must clean it up by removing pollutants. Have you ever thought where the wastewater goes and what happens to it?

13.1 Water, Our Lifeline

Clean water is a basic need of human being. Let us make a mindmap of the many uses of clean water.

Activity 13.1

(*We have given one example of the use of clean water. You can add many more.*)



Clean water that is fit for use is unfortunately not available to all. It has been reported that more than one billion of people have no access to safe drinking water. This accounts for a large number of water-related diseases and even deaths. People even children walk for several kilometres to collect clean water. Is it not a serious matter for human dignity?

WATER FOR LIFE 2005–2015

The increasing scarcity of fresh-water due to population growth, pollution, industrial development,mismanagement and other factors. Realising the urgency of the situation on the World Water Day, on 22 March 2005, the General Assembly of the United Nations proclaimed the period 2005–2015 as the International Decade for action on **"Water for life".** All efforts made during this decade aim to reduce by half the number of people who do not have access to safe drinking water.

There has been perceptible progress in the direction of the aim but still there is a lot to achieve.

Cleaning of water is a process of removing pollutants before it enters a water body or is reused. This process of wastewater treatment is commonly

known as **"Sewage Treatment"**. It takes place in several stages.

13.2 What is Sewage?

Sewage is wastewater released by homes, industries, hospitals, offices and other users. It also includes rainwater that has run down the street during a storm or heavy rain. The water that washes off roads and rooftops carries harmful substances with it. Sewage is a liquid waste. Most of it is water, which has dissolved and suspended impurities.

Activity 13.2

Locate an open drain near your home, school or on the roadside and inspect water flowing through it.

Record colour, odour and any other observation. Discuss with your friends and your teacher and fill up the following Table 13.1.

We know that sewage is a complex mixture containing suspended solids, organic and inorganic impurities, nutrients, saprophytes and disease causing bacteria and other microbes. These include the following.

Organic impurities – Human faeces, animal waste, oil, urea (urine), pesticides, herbicides, fruit and vegetable waste, etc.

Inorganic impurities – Nitrates, Phosphates, metals.

Nutrients – Phosphorus and Nitrogen.

Bacteria – Such as vibrio cholera which causes cholera and salmonella paratyphi which causes typhoid.

Other microbes – Such as protozones which cause dysentery.

13.3 Water Freshens Up — An Eventful Journey

In a home or a public building generally one set of pipes brings clean water and another set of pipes takes away wastewater. Imagine that we could see through the ground. We would see a network of big and small pipes, called

Table 13.1 Contaminant survey

S. No.	Type of sewage	Point of origin	Contaminants	Any other remark
1.	Sullage water	Kitchen		
2.	Foul waste	Toilets		
3.	Trade waste	Industrial and commercial organisations		

sewers, forming the **sewerage**. It is like a transport system that carries sewage from the point of being produced to the point of disposal, i.e. treatment plant.

Manholes are located at every 50 m to 60 m in the sewerage, at the junction of two or more sewers and at points where there is a change in direction.

Activity 13.3

Study the sewage route in your home/ school/building. Do the following:

- Make a line diagram of the sewage route.
- Walk down the street or survey the campus to find the number of manholes.
- If possible, observe open drain and record which living organisms are found in and around it.

In case you do not have a sewerage system in your locality, find out how sewage is being disposed off.

Treatment of polluted water

Perform the following activity. It will help you understand the processes that take place at the wastewater treatment plant.

Activity 13.4

Divide yourself into groups to perform the activity. Record observations at each stage:

- Fill a large glass jar 3/4 full of water. Add some dirty organic matter such as grass pieces or orange peels, a small amount of detergent, and a few drops of an ink or any colour.
- Cap the jar, shake it well and let the mixture stand in the sun for two days.
- After two days, shake the mixture and pour a small sample into test tube. Label this test tube **"Before treatment; Sample 1"**. How does it smell?
- Use an aerator from an aquarium to bubble air through the sample in the glass jar. Allow several hours for aeration; leave the aerator attached overnight. If you do not have an aerator, use a mechanical stirrer or a mixer. You may have to stir it several times.
- The next day when aeration is complete, pour another sample into a second test tube. Label it as **"After aeration; Sample 2"**.
- Fold a piece of filter paper to form a cone. Wet the paper with tap water and then insert the cone in a funnel. Mount the funnel on a support (as you have learnt in Class VI).
- Place layers of sand, fine gravel and finally medium gravel in the funnel (Fig. 13.2). (An actual filtration plant does not use filter paper, but the sand filter is several metres deep).
- Pour the remaining aerated liquid through the filter into the beakers. Do not allow the liquid to spill over the filter. If the filtered liquid is not clear, filter it a few times till you get clear water.
- Pour a sample of the filtered water into a third test tube labelled **"Filtered; Sample 3".**

Fig. 13.2 Filtration process

- Pour another sample of the filtered water into a fourth test tube. Add a small piece of a chlorine tablet. Mix well until the water is clear. Label the test tube **"Chlorinated; Sample 4"**.
- Observe carefully the samples in all the test tubes. **Do not taste**! Just smell them!

Now answer the following questions:

(a) What changes did you observe in the appearance of the liquid after aeration?
(b) Did aeration change the odour?
(c) What was removed by the sand filter?
(d) Did chlorine remove the colour?
(e) Did chlorine have an odour? Was it worse than that of the wastewater?

13.4 Wastewater Treatment Plant (WWTP)

Treatment of wastewater involves physical, chemical, and biological processes, which remove physical, chemical and biological matter that contaminates the wastewater.

1. Wastewater is passed through bar screens. Large objects like rags, sticks, cans, plastic packets, napkins are removed (Fig. 13.3).

Fig. 13.3 Bar screen

2. Water then goes to a grit and sand removal tank. The speed of the incoming wastewater is decreased to allow sand, grit and pebbles to settle down (Fig. 13.4).

Fig. 13.4 Grit and sand removal tank

3. The water is then allowed to settle in a large tank which is sloped towards the middle. Solids like faeces settle at the bottom and are removed with

Fig. 13.5 Water clarifer

a scraper. This is the **sludge**. A skimmer removes the floatable solids like oil and grease. Water so cleared is called clarified water (Fig. 13.5).

The sludge is transferred to a separate tank where it is decomposed by the anaerobic bacteria. The biogas produced in the process can be used as fuel or can be used to produce electricity.

4. Air is pumped into the clarified water to help aerobic bacteria to grow. Bacteria consume human waste, food waste, soaps and other unwanted matter still remaining in clarified water (Fig. 13.6).

Fig. 13.6 Aerator

After several hours, the suspended microbes settle at the bottom of the tank as activated sludge. The water is then removed from the top.

The activated sludge is about 97% water. The water is removed by sand drying beds or machines. Dried sludge is used as manure, returning organic matter and nutrients to the soil.

The treated water has a very low level of organic material and suspended matter. It is discharged into a sea, a river or into the ground. Nature cleans it up further. Sometimes it may be necessary to disinfect water with chemicals like chlorine and ozone before releasing it into the distribution system.

Become an active citizen

Waste generation is a natural part of human activity. But we can limit the

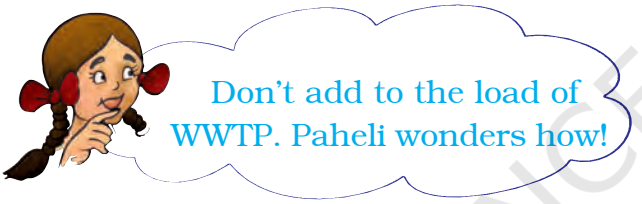
The water in a river is cleaned naturally by processes that are similar to those adopted in a wastewater treatment plant.

Did you know ?

It has been suggested that we should plant eucalyptus trees all along sewage ponds. These trees absorb all surplus wastewater rapidly and release pure water vapour into the atmosphere.

type of waste and quantity of waste produced. Often we have been repelled by offensive smell. The sight of open drains is disgusting. The situation worsens in the rainy season when the drains start overflowing. We have to wade through the mud pools on the roads. Most unhygienic and unsanitary conditions prevail. Flies, mosquitoes and other insects breed in it.

You can be an enlightened citizen and approach the municipality or the gram panchayat. Insist that the open drains be covered. If the sewage of any particular house makes the neighbourhood dirty, you should



request them to be more considerate about others' health.

13.5 Better Housekeeping Practices

One of the ways to minimise or eliminate waste and pollutants at their source is to see what you are releasing down the drain.

- Cooking oil and fats should not be thrown down the drain. They can harden and block the pipes. In an open drain the fats clog the soil pores reducing its effectiveness in filtering water. Throw oil and fats in the dustbin.
- Chemicals like paints, solvents, insecticides, motor oil, medicines may kill microbes that help purify water. So do not throw them down the drain.
- Used tealeaves, solid food remains, soft toys, cotton, sanitary towels, etc. should also be thrown in the dustbin (Fig. 13.7). These wastes choke the drains. They do not allow free flow of oxygen. This hampers the degradation process.

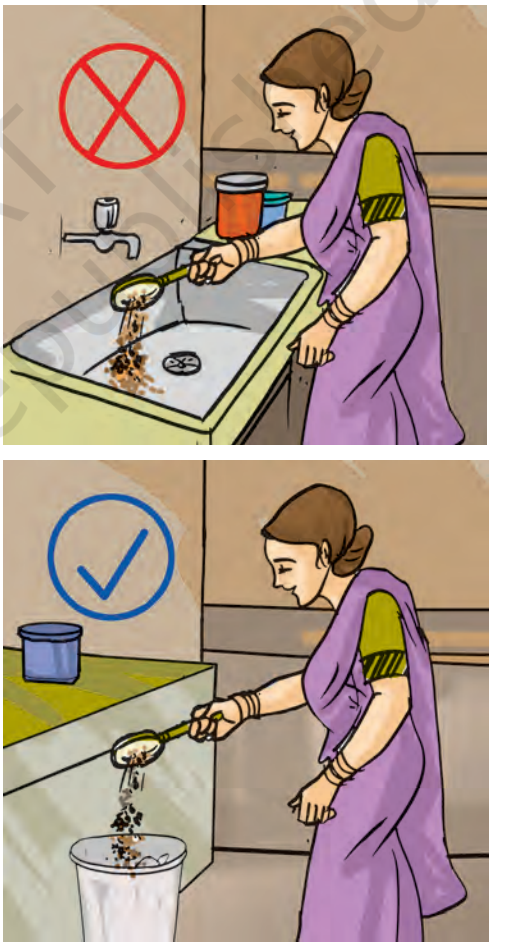


Fig. 13.7 Do not throw everything in the sink

In the year 2016, the Government of India has initiated a new mission known as **"Swachh Bharat"** under which a lot of drives such as proper sewage disposal and providing toilets for everyone have been started.

Vermi-processing toilet

A design of a toilet in which humans excreta is treated by earthworms has been tested in India. It has been found to be a novel, low water-use toilet for safe processing of human waste. The operation of the toilet is very simple and hygienic. The human excreta is completely converted to vermi cakes — a resource much needed for soil.

13.6 Sanitation and Disease

Poor sanitation and contaminated drinking water is the cause of a large number of diseases.

Let us look at our own country. A vast number of our people are still without sewerage facilities. Where do they relieve themselves?

A very large fraction of our people defecates in the open, on dry riverbeds, on railway tracks, near fields and many a time directly in water. Untreated human excreta is a health hazard. It may cause water pollution and soil pollution. Both the surface water and groundwater get polluted. Groundwater is a source of water for wells, tubewells, springs and many rivers. Thus, it becomes the most common route for water borne diseases. They include cholera, typhoid, polio, meningitis, hepatitis and dysentery.

Bhoojo wants to know how sewage is disposed of in an aeroplane.

13.7 Alternative Arrangement for Sewage Disposal

To improve sanitation, low cost **onsite sewage** disposal systems are being encouraged. Examples are septic tanks, chemical toilets, composting pits. Septic tanks are suitable for places where there is no sewerage system, for hospitals, isolated buildings or a cluster of 4 to 5 houses.

Some organisations offer hygienic on-site human waste disposal technology. These toilets do not require scavenging. Excreta from the toilet seats flow through covered drains into a biogas plant. The biogas produced is used as a source of energy.

13.8 Sanitation at Public Places

In our country fairs are organised periodically. A large number of people participate in them. In the same way railway stations, bus depots, airports, hospitals are very busy places. Thousands of people visit them daily. Large amount of waste is generated

here. It must be disposed of properly otherwise epidemics could break out.

The government has laid down certain standards of sanitation but, unfortunately, they are not strictly enforced.

However, all of us can contribute in maintaining sanitation at public places. We should not scatter litter anywhere. If there is no dustbin in sight, we should carry the litter home and throw it in the dustbin.

Conclusion

We all have a role to play in keeping our environment clean and healthy. You must realise your responsibility in maintaining the water sources in a healthy state. Adopting good sanitation practices should be our way of life. As an agent of change your individual initiative will make a great difference. Influence others with your energy, ideas and optimism. A lot can be done if people work together. There is great power in collective action.

Mahatma Gandhi said:

"No one need to wait for anyone else to adopt a humane and enlightened course of action."

Keywords

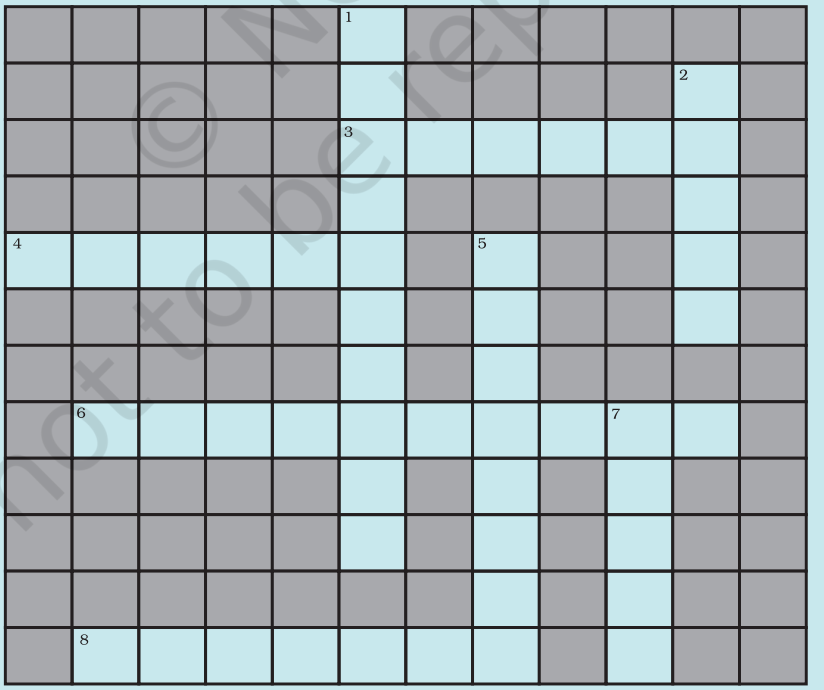
Aeration	Contaminant	Sewerage
Aerobic bacteria	Sanitation	Sludge
Anaerobic bacteria	Sewage	Wastewater
Biogas	Sewer	

What you have learnt

- Used water is wastewater. Wastewater could be reused.
- Wastewater is generated in homes, industries, agricultural fields and in other human activities. This is called sewage.
- Sewage is a liquid waste which causes water and soil pollution.
- Wastewater is treated in a sewage treatment plant.
- Treatment plants reduce pollutants in wastewater to a level where nature can take care of it.
- Where underground sewerage systems and refuse disposal systems are not available, the low cost on-site sanitation system can be adopted.
- By-products of wastewater treatment are sludge and biogas.
- Open drain system is a breeding place for flies, mosquitoes and organisms which cause diseases.
- We should not defecate in the open. It is possible to have safe disposal of excreta by low cost methods.

Exercises

1. Fill in the blanks:
   (a) Cleaning of water is a process of removing _____.
   (b) Wastewater released by houses is called _____.
   (c) Dried _____ is used as manure.
   (d) Drains get blocked by _____ and _____.
2. What is sewage? Explain why it is harmful to discharge untreated sewage into rivers or seas.
3. Why should oils and fats be not released in the drain? Explain.
4. Describe the steps involved in getting clarified water from wastewater.
5. What is sludge? Explain how it is treated.
6. Untreated human excreta is a health hazard. Explain.
7. Name two chemicals used to disinfect water.
8. Explain the function of bar screens in a wastewater treatment plant.
9. Explain the relationship between sanitation and disease.
10. Outline your role as an active citizen in relation to sanitation.
11. Here is a crossword puzzle: Good luck!



Across

3. Liquid waste products
4. Solid waste extracted in sewage treatment
6. A word related to hygiene
8. Waste matter discharged from human body

Down

1. Used water
2. A pipe carrying sewage
5. Micro-organisms which causes cholera
7. A chemical to disinfect water

12. Study the following statements about ozone:

(a) It is essential for breathing of living organisms.

(b) It is used to disinfect water.

(c) It absorbs ultraviolet rays.

(d) Its proportion in air is about 3%.

Which of these statements are correct?

(i) (a), (b) and (c)

(ii) (b) and (c)

(iii) (a) and (d)

(iv) All four

Extended Learning — Activities and Projects

1. Construct a crossword puzzle of your own using the keywords.
2. Then and now: Talk to your grand parents and other elderly people in the neighbourhood. Find out the sewage disposal systems available to them. You can also write letters to people living in far off places to get more information. Prepare a brief report on the information you collected.
3. Visit a sewage treatment plant.

   It could be as exciting and enriching as a visit to a zoo, a museum, or a park. To guide your observation here are a few suggestions.

   Record in your notepad:

   Place _____ Date _____ Time _____

   Name of the official at the plant _____ Guide/Teacher _____

(a) The location of the sewage plant.

(b) Treatment capacity.

(c) The purpose of screening as the initial process.

(d) How is air bubbled through the aeration tank?

(e) How safe is the water at the end of the treatment? How is it tested?

(f) Where is the water discharged after treatment?

(g) What happens to the plant during heavy rains?

(h) Is biogas consumed within the plant or sold to other consumers?

(i) What happens to the treated sludge?

(j) Is there any special effort to protect nearby houses from the plant?

(k) Other observations.

For more information, consult:

Millennium Development Goals:

http://www.un.org/millenniumgoals/

"Water for Life" International Decade for Action:

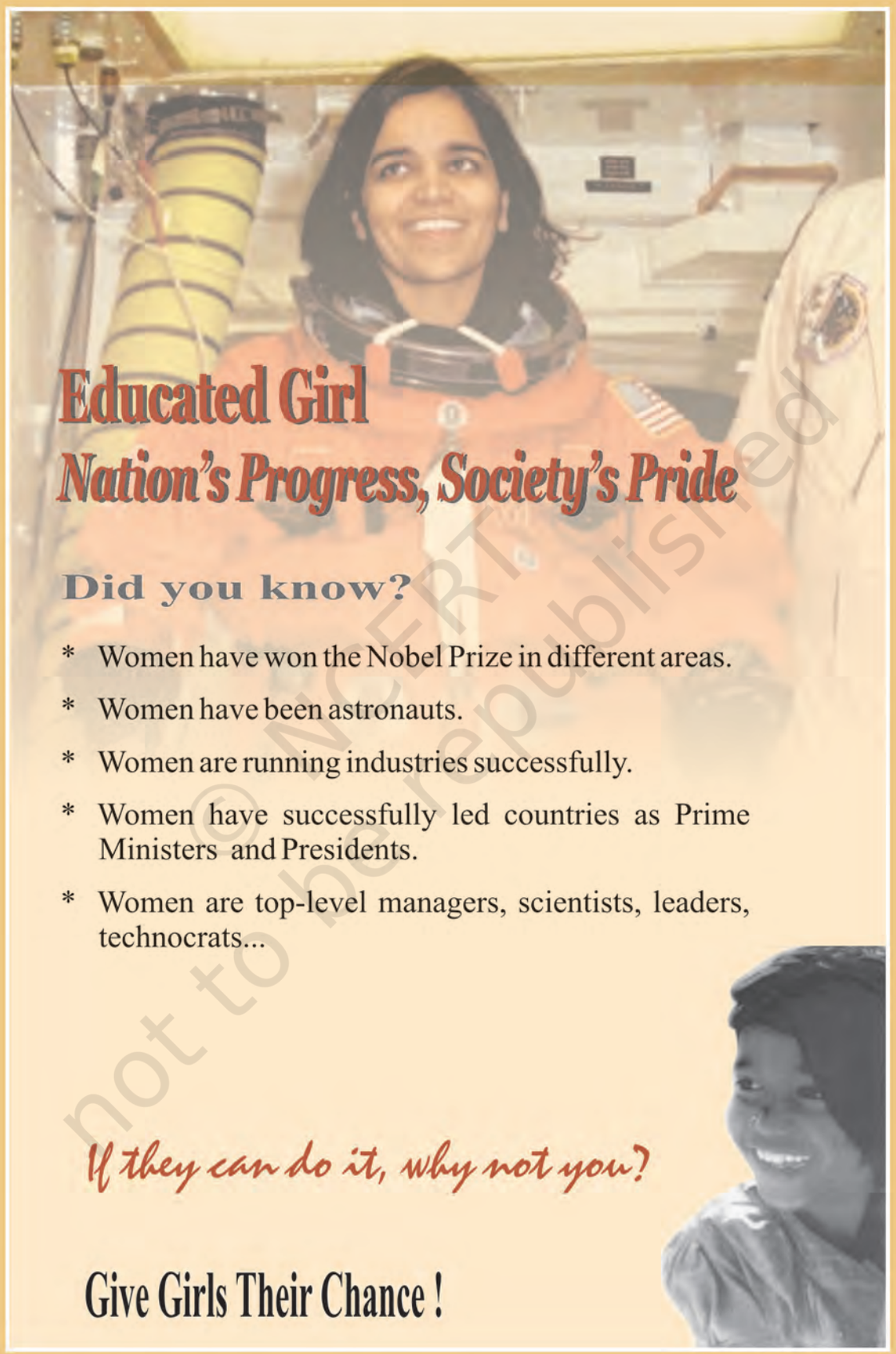
http://www.un.org/waterforlifedecade/

http://www.cep.unep.org/pubs/Techreports/tr43en/Household%20systems.htm

"By providing clean water and sanitation to the poorest people on the planet, we can reduce poverty and suffering and ensure education for all children."—UNICEF

An early engineering feat: Indus valley civilisation

One of the ancient civilisations, Harappa and Mohenjodaro had perhaps the world's first urban sanitation system. Within the city individual houses, or groups of houses, obtained water from wells. There was a separate room for bathing, and wastewater was directed to the covered drains which lined the major streets. The oldest toilet made of bricks is about 4500 years old.



Educated Girl

Nation's Progress, Society's Pride

Did you know?

* Women have won the Nobel Prize in different areas.
* Women have been astronauts.
* Women are running industries successfully.
* Women have successfully led countries as Prime Ministers and Presidents.
* Women are top-level managers, scientists, leaders, technocrats...

If they can do it, why not you?

Give Girls Their Chance !