6 Respiration in Organisms

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.

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

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:

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

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.

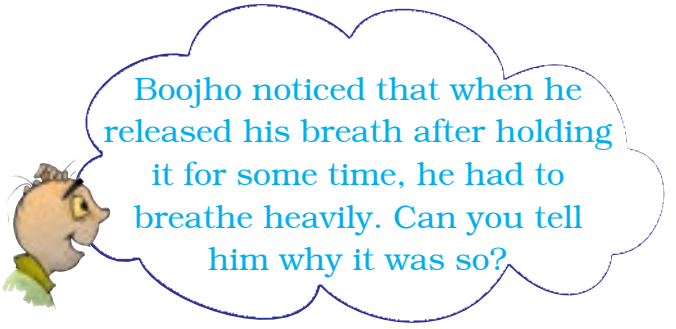
Breathing means taking in air rich in oxygen and giving out air rich in carbon dioxide with the help of respiratory organs. The taking in of air rich in oxygen into the body is called **inhalation** and giving out of air rich in carbon dioxide is known as **exhalation**. It is a continuous process which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

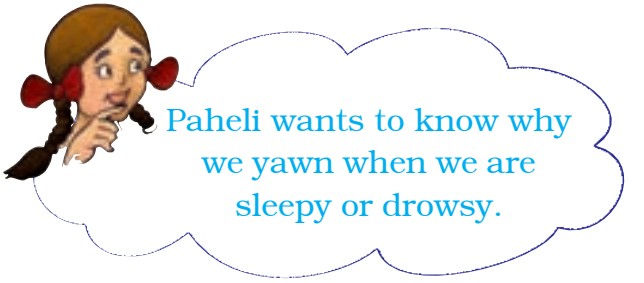
When you feel drowsy, does your breathing rate slow down? Does your body receive sufficient oxygen?

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.

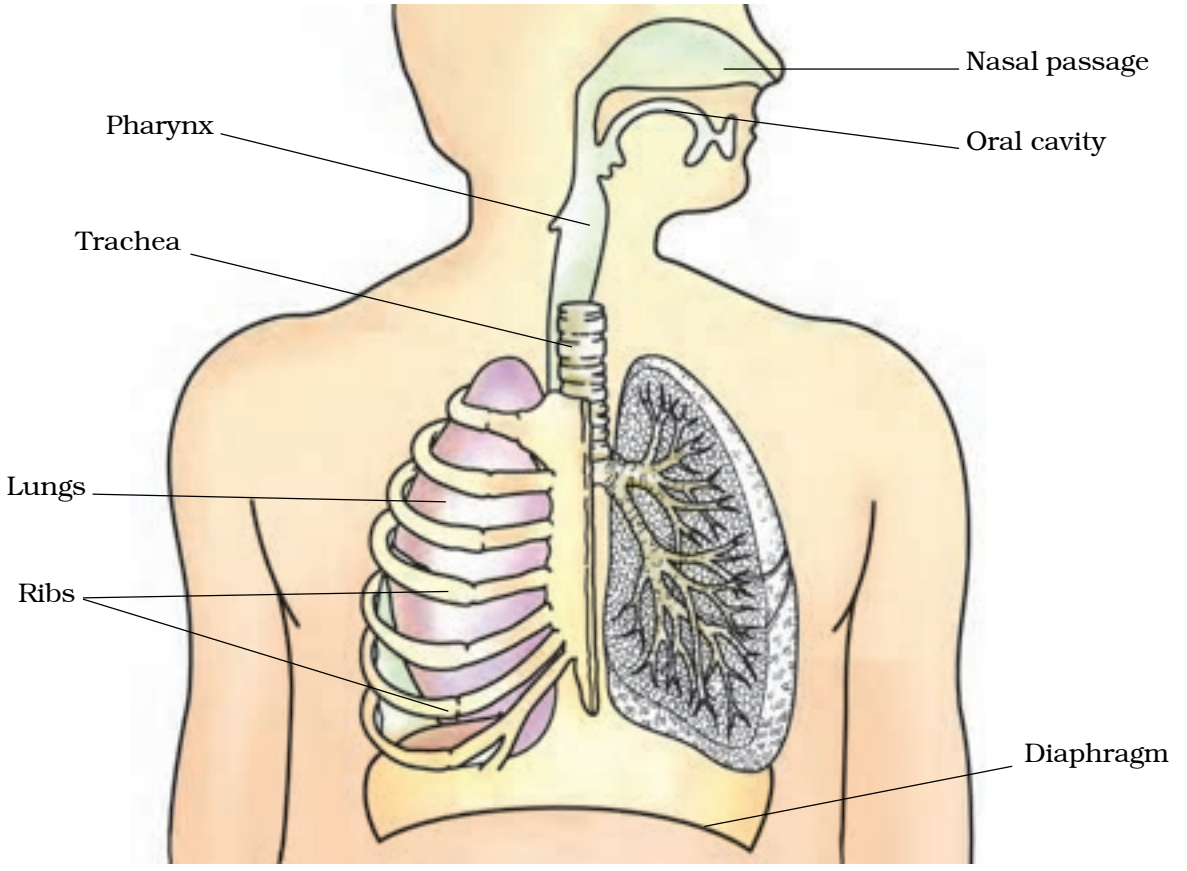


Fig 6.4 *Human respiratory system*

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.

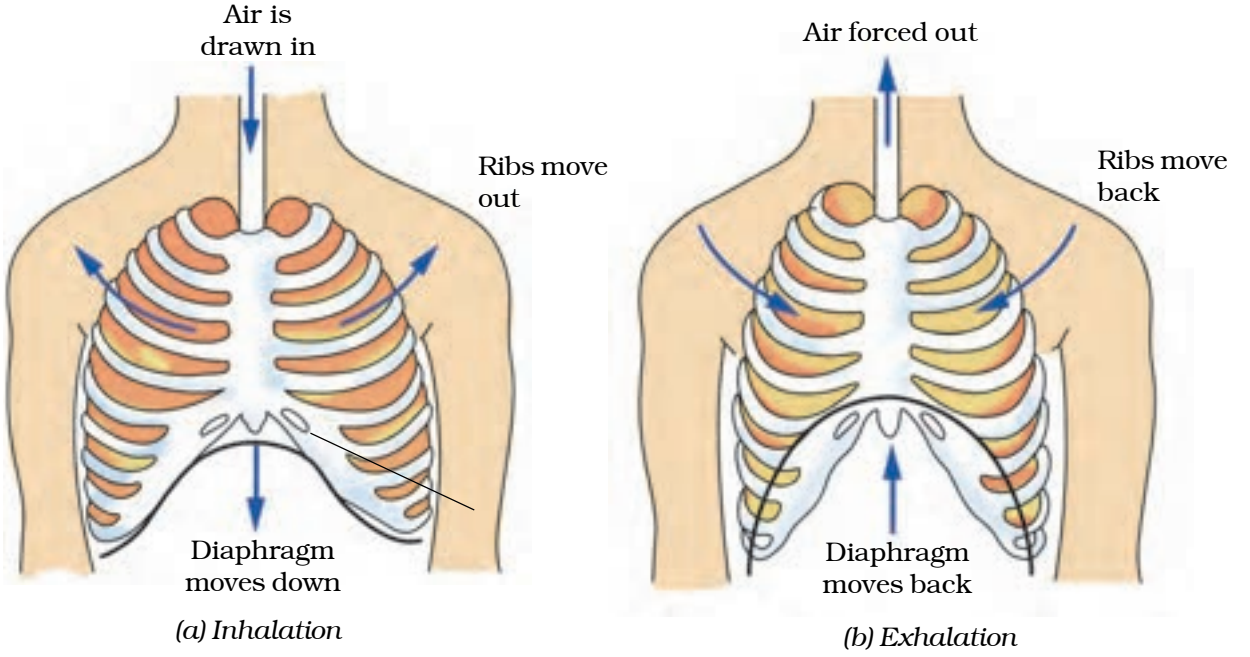


Fig. 6.5 *Mechanism of breathing in human beings*

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?

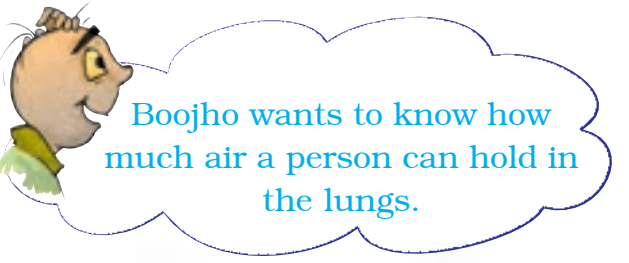
Now, you should be able to explain the mechanism of breathing.

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?



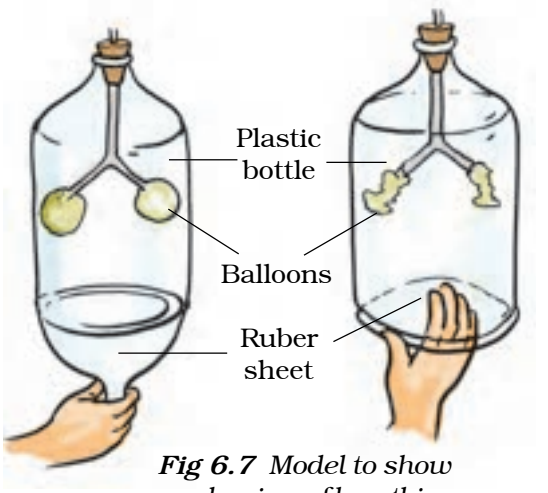


Fig 6.7 Model to show mechanism of breathing

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.

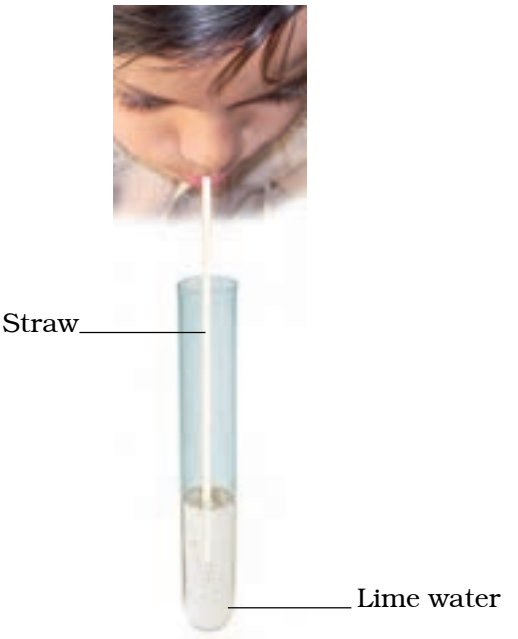


Fig. 6.8 Effect of exhaled air on lime water

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

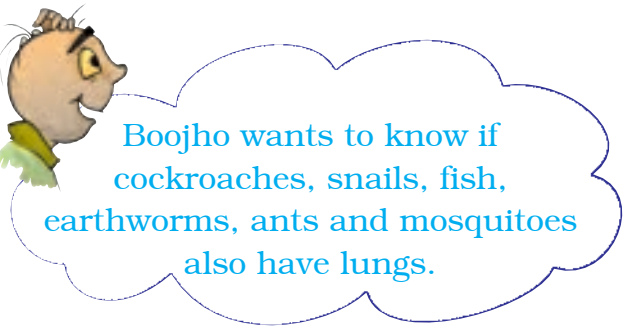
Lungs

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.

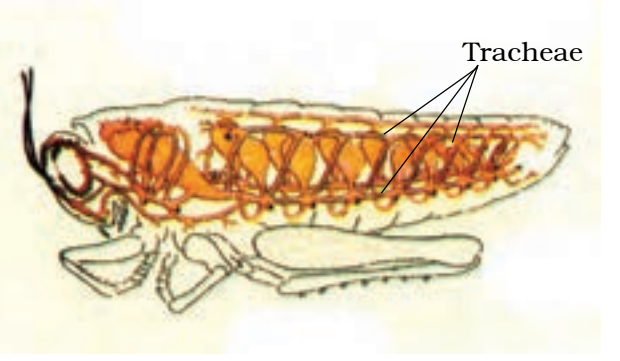


Fig.6.9 Tracheal system

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.

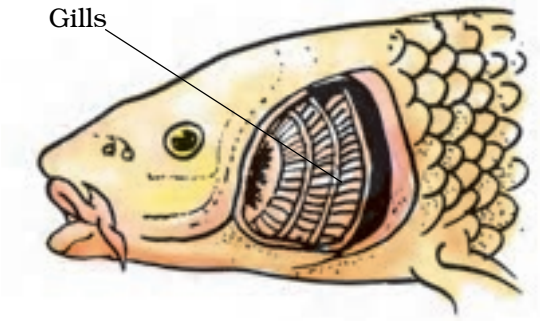


Fig. 6.10 *Breathing organs in fish*

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).

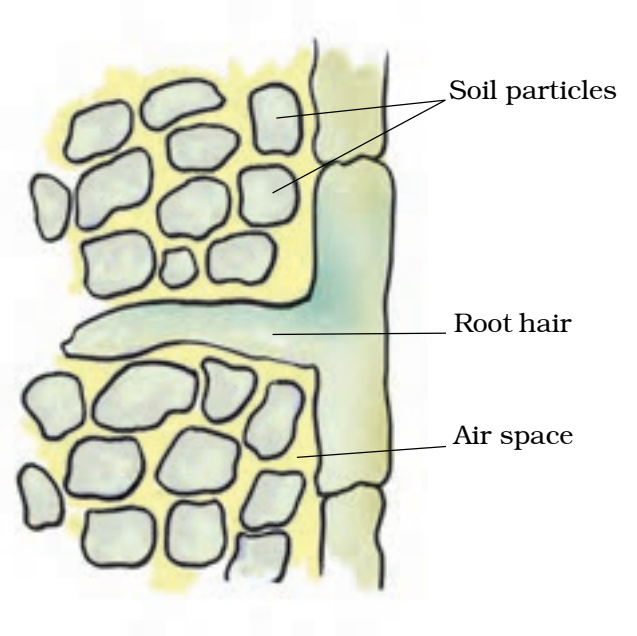


Fig. 6.11 *Roots absorb air from the soil*

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.