10 Life Processes in Plants

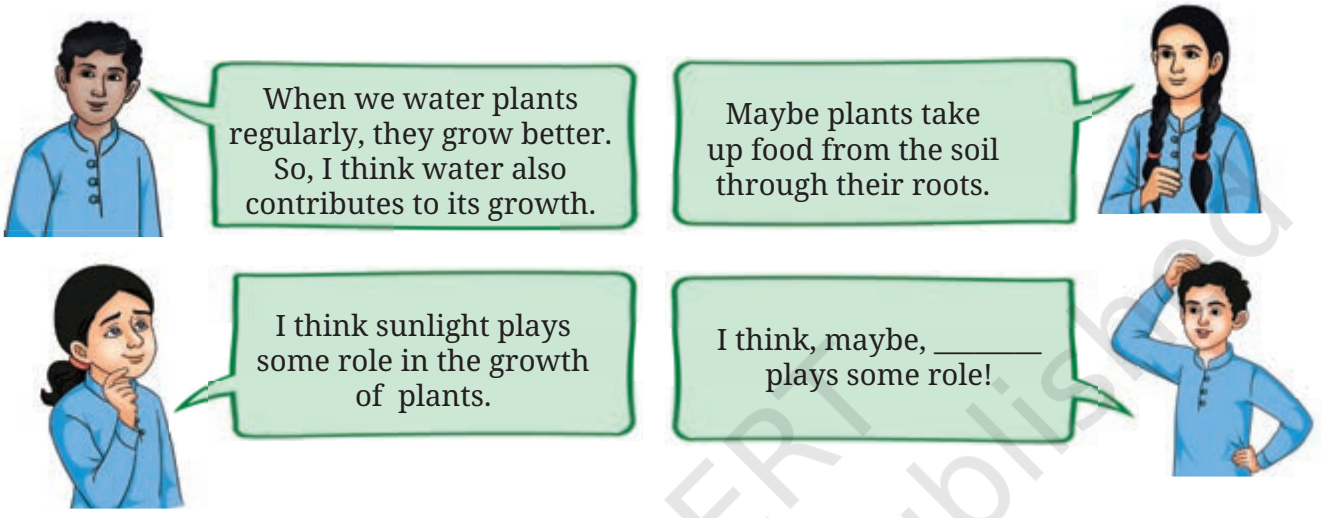
In Grade 6, we learnt that all living beings grow and need food for their growth. Also, in the previous chapter, we discussed the process through which animals obtain nutrition.

We know that animals eat food to grow, but what about plants? Have you ever seen plants eating food like animals do? As animals grow, their size and weight usually increase, and their bodies undergo various changes. What changes do you notice in plants when they grow?

We learnt that food provides nutrients like carbohydrates, fats, proteins, vitamins, and minerals, which, along with water, are all essential for growth. Let us **explore** how plants obtain nutrients for their growth.

10.1 How Do Plants Grow?

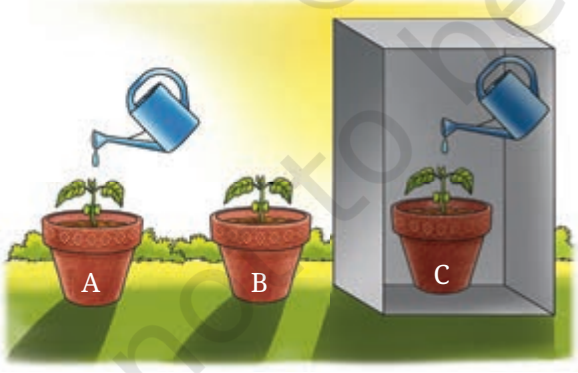
Look around your neighbourhood. Have you observed any changes in a plant during its life span? As a plant grows, new leaves and branches emerge, its height increases, and its stem thickens. What do you think causes these changes? Discuss with your friends and provide your explanation as well.



Let us perform an experiment to test some of these explanations.

Activity 10.1: Let us test some explanations

- Take three earthen pots (or used bottles/containers) of the same size filled with garden soil. Plant saplings of similar sizes of a fast-growing plant like chilli or tomato in each pot (Fig. 10.1).
- Label the pots A, B, and C.
- Count the number of leaves on each sapling and record your observations.
- Place pot A in direct sunlight. Keep the soil in this pot slightly moist by adding an adequate amount of water every day (Fig. 10.1a).
- Place pot B in direct sunlight, without adding water to the soil (Fig. 10.1b).



(a) Pot A kept in direct sunlight, with water *(b) Pot B kept in direct sunlight, without water* *(c) Pot C kept in the dark, with water*

Fig. 10.1: Experimental set-up to understand the role of sunlight and water in plant growth

- Place pot C in the dark. Keep the soil in this pot slightly moist by adding an adequate amount of water every day (Fig. 10.1c).
- **Observe** the plants for two weeks[1] and record changes in their height, number of leaves, colour of leaves, and any other changes that may appear.
- **Record** your observations in Table 10.1.

Table 10.1: Effect of sunlight and water on plant growth

Pots kept under different conditions	Availability of		Height of plant (cm)		Number of leaves		Colour of leaves (Green/Yellow)
	Sunlight	Water	Day 1	After 2 weeks	Day 1	After 2 weeks	
Pot A: In direct sunlight, with water							
Pot B: In direct sunlight, without water							
Pot C: In the dark, with water							

- What differences did you observe between the plants in the three pots?
- Which pot has the plant with the maximum growth?
- Which pot has the plant with the least growth?

Analyse the observations recorded in Table 10.1, and discuss them with your teacher and friends.

You are likely to find that the plant in Pot A, kept in direct sunlight with adequate water, grows better than the plant in Pot C, which gets adequate water but no sunlight. The plant in Pot B may have died as it did not get water even though it received adequate sunlight.

What do you **infer** from the observations made in this activity? The results indicate that plants require both sunlight and water for their growth.

1 This experiment will need two weeks. Teachers can plan this activity accordingly.

Fascinating Facts

फलकुसुमसंपदुचिता रोपणतो भवति केवलान्न यत: ।

"Trees do not produce fruits and flowers merely because they are planted."

This line is from an ancient Indian text named *Vrikshayurveda*. It records useful observations about plant growth, soil, and agricultural practices to help improve crop health, growth and production. The knowledge in the text seems to be based on practical experiences and patterns seen over time. These ideas were then systematically documented to guide farming practices. For instance, there are references to different methods of organic manure preparation, such as mixing water, barley, and various seeds, like green, black, and horse grams.

10.2 How Do Plants Get Food for their Growth?

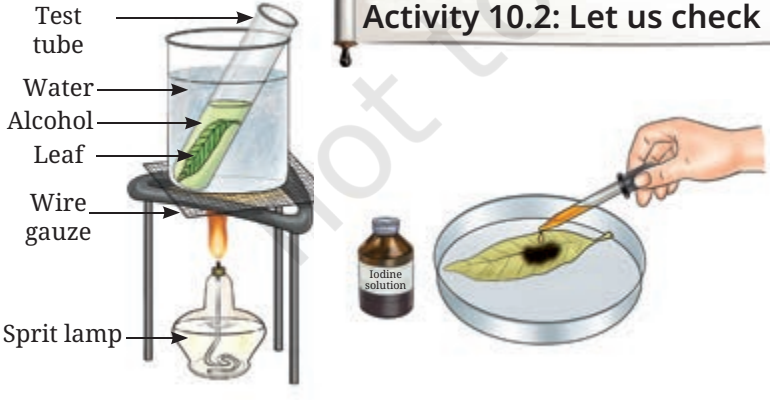
We know that animals get their food from plants, either directly by eating plants or indirectly by eating animals that in turn eat plants for their nutrition and growth. But how do plants obtain the food they need to grow? Unlike animals, plants do not *eat* food.

10.2.1 Leaves: the 'food factories' of plants

Plants store food in the form of starch, a type of carbohydrate. This starch is produced in the leaves of a plant which, by design, are generally broad and flat. These are mostly green because of the presence of a green pigment called **chlorophyll**, that helps in capturing sunlight efficiently.

Let us find out the role chlorophyll plays in the preparation of food in the form of starch in plants.

Activity 10.2: Let us check (demonstration activity)



(a) Boiling set-up *(b) Iodine test*

Fig. 10.2: Starch test in a leaf

The teacher may demonstrate this activity.

- Keep a leaf in boiling water for five minutes to soften it.
- Dip this leaf in a test tube containing alcohol.
- Place the test tube in a beaker containing boiling water. Wait until the leaf becomes colourless (Fig. 10.2a).

- Take out the leaf and place it on a plate.
- Now, put a few drops of diluted iodine solution with the help of a dropper on the decolourised leaf (Fig. 10.2b). Wait for a few minutes and observe.
- If the colour of the leaf changes to blue-black, it indicates the presence of starch.

Caution—Alcohol should never be placed near a heat source directly, as it is highly flammable and can easily lead to fire and burns.

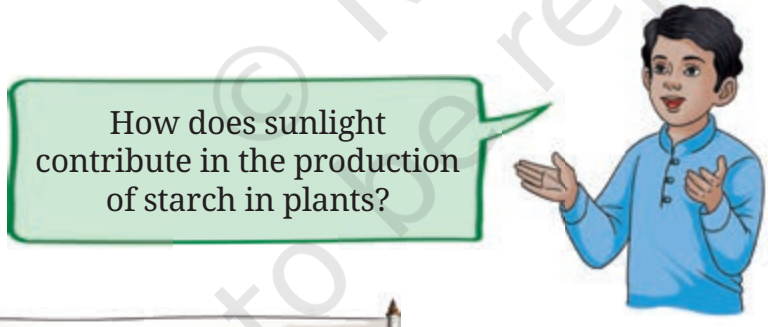
DIVE DEEPER

Did you wonder why we decolourise the leaf in the beginning of this activity?

Decolourisation of a leaf enables us to easily observe colour change and, thus, the presence of starch.

In Activity 10.1, we have learnt that water and sunlight are essential for plant growth. In Activity 10.2, we have discovered that green leaves store starch as food.

Bhaskar loves gardening during his free time. Being a curious student, he often looks around his garden and wonders how plants produce food. From his experiences, Bhaskar knows that water and sunlight are essential for plant growth. But he wonders if sunlight contributes to the production of food in the form of starch in plants.



Activity 10.3: Let us check

Bhaskar took a leaf having both green and non-green patches from each of two similar potted plants—one kept in sunlight and the other kept in the dark for 36 hours. He wanted to compare the leaves before and after the starch test.

He made a sketch of the leaves to record the location of the green and the non-green patches on them with the help of a tracing paper. After that, he performed an iodine test (as shown in Activity 10.2) on the leaves. Bhaskar recorded his observations in Table 10.2.

Table 10.2: Presence of starch in green and non-green parts of the leaves of plants

S.No.	Light conditions for potted plant	Initial colours before iodine test	Final colours after iodine test
1.	Plant kept in sunlight 	Green and non-green patches on the leaf 	Green patches of leaf turned blue-black 
2.	Plant kept in the dark 	Green and non-green patches on the leaf 	No change in colour 

In Table 10.2, Bhaskar recorded a blue-black colour (indicating the presence of starch) on the green patches of the leaf obtained from the plant placed in sunlight. Bhaskar also recorded that the leaf obtained from the plant kept in the dark does not show a blue-black colour, even on the green patches, indicating that no starch has been produced. Non-green patches of the leaf obtained from the plant placed in sunlight do not turn blue-black. Does it indicate that there is no chlorophyll present in those patches? The non-green patches may not have sufficient chlorophyll to prepare enough starch to be detected using the iodine test.

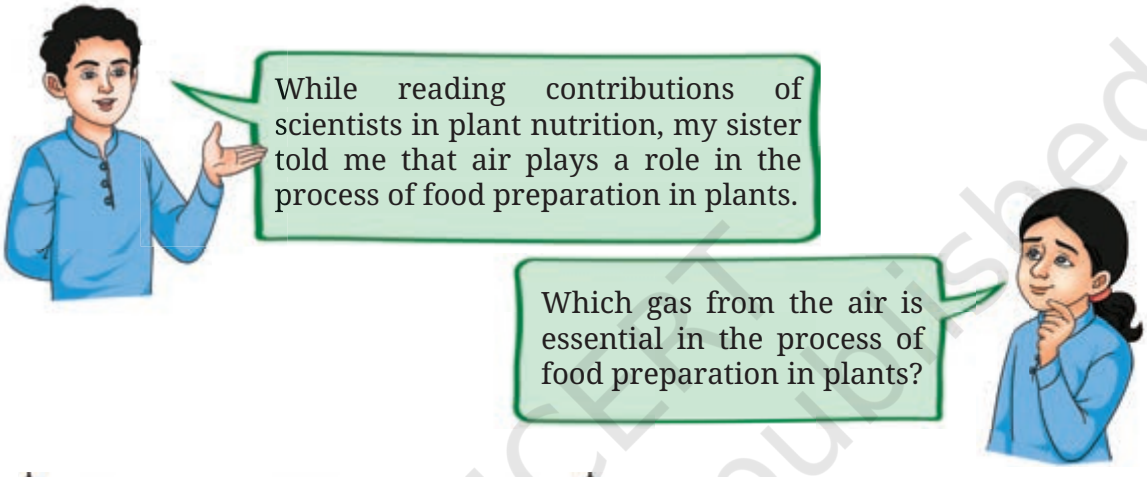
Fascinating Facts

Some plant leaves appear red, violet, or brown because they contain more of these coloured pigments than the green-coloured chlorophyll. This hides the green colour. Some of these pigments also help in photosynthesis. You can use an iodine test to check for the presence of starch in these leaves, indicating that photosynthesis has indeed taken place.

What do we infer from the observations listed in Table 10.2? As we know, leaves are mostly green because of the presence of chlorophyll. We have also seen that the starch is produced where green patches of the leaf are present. We can infer that chlorophyll helps in preparing starch in the presence of sunlight. In fact, it is essential for the preparation of starch. Hence, the leaves are also called 'food factories' of plants.

What else is essential for the preparation of food in plants? Let us find out.

10.2.2 Role of air in the preparation of food



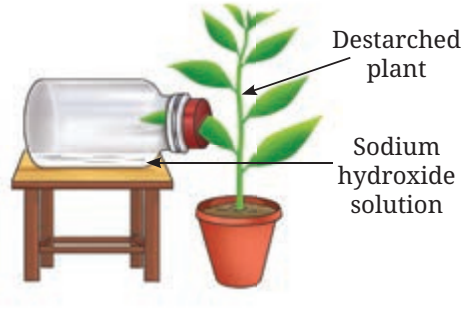
Activity 10.4: Let us experiment (demonstration activity)

The teacher may demonstrate this activity.

- Take a potted green plant and keep it in the dark for two to three days to allow it to destarch (i.e., lose any stored starch). Then, locate one leaf of this plant for this experiment.
- Take a wide-mouthed bottle and pour some caustic soda (sodium hydroxide) into it (caustic soda absorbs carbon dioxide from the air).

Caution—Caustic soda is a strong chemical that can cause skin burns; only teachers should handle it.

- Insert half of the destarched leaf into the bottle through a split cork, leaving the other half of the leaf outside, and place the bottle as shown in Fig. 10.3a.



(a) The set-up

(b) Iodine test on the leaf

Fig. 10.3: Testing the role of chlorophyll and air

- Place the set-up in sunlight for a few hours.
- Observe and record the availability of water, sunlight, chlorophyll, and carbon dioxide in Table 10.3.
- Remove the leaf and test it for starch using the iodine test, as was done in Activity 10.2.
- Record your observations in Table 10.3.

Table 10.3: Role of air in the preparation of starch by plants

Part of the leaf	Availability of				Starch present (Yes/No)
	Water	Sunlight	Chlorophyll	Carbon dioxide	
Part of the leaf inside the bottle					
Part of the leaf outside the bottle					

We **notice** that the part of the leaf that was outside the bottle turns blue-black, indicating the presence of starch. However, the part of the leaf inside the bottle does not turn blue-black in colour, indicating that food is not made in that part of the leaf. This is because the caustic soda solution inside the flask absorbs the carbon dioxide present in the air. What does this experiment show?

This experiment shows that carbon dioxide present in the air is essential for plants to prepare starch.

Based on Activities 10.3 and 10.4, what do you **conclude**? Which part of the plant is involved in the synthesis of starch?

Based on our learnings so far, we have found that **sunlight, water**, **chlorophyll** and **carbon dioxide** are essential for the synthesis of food in plants. This process by which plants prepare food in the presence of sunlight and chlorophyll is called **photosynthesis.** A leaf is the primary site for photosynthesis. Do other green parts of the plant also perform photosynthesis? Yes, other parts of the plants which have chlorophyll also perform photosynthesis.

So far, we have learnt that plants take in carbon dioxide from the air and water, and use sunlight to prepare their food by the process of photosynthesis. But have you ever thought about what more happens during this process? Do plants only take in

substances from their surroundings, or do they also release something? Let us explore this through an experiment performed by Barkha didi.

Activity 10.5: Let us explore

- Look at Fig. 10.4. **Compare** the two set-ups labelled as A and B, and analyse.
- In Fig. 10.4, set-up A is placed in sunlight, and set-up B is placed in the dark. What difference do you observe in the two set-ups? Do you observe air bubbles emerging in the inverted test tube in set-up A? The gas produced in this set-up caused bubbles to emerge and get accumulated in the inverted test tube. Which gas is this?

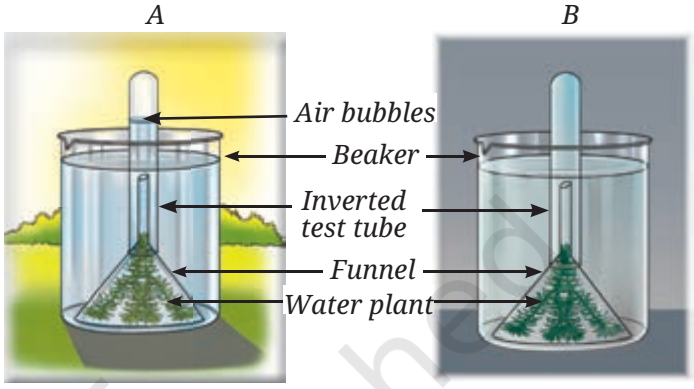
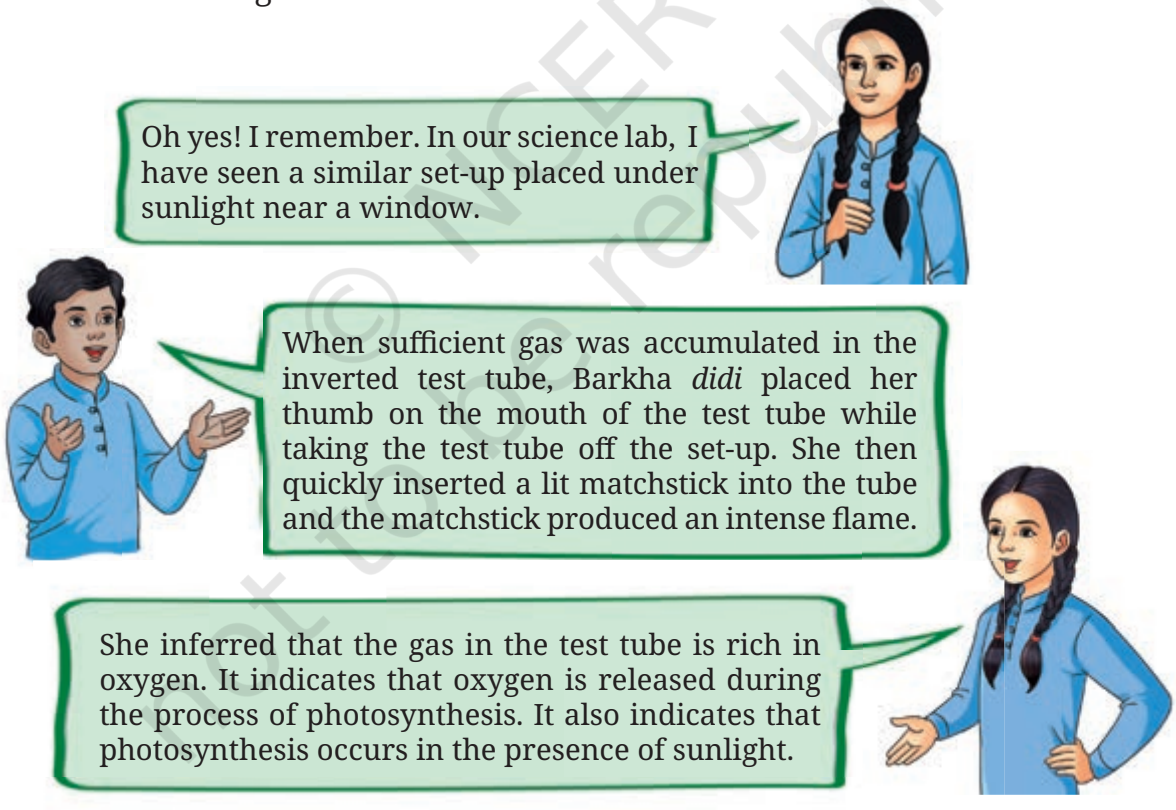


Fig. 10.4: Activity showing the release of oxygen during photosynthesis



Based on Barkha *didi*'s experiment, we can conclude that oxygen is released during photosynthesis.

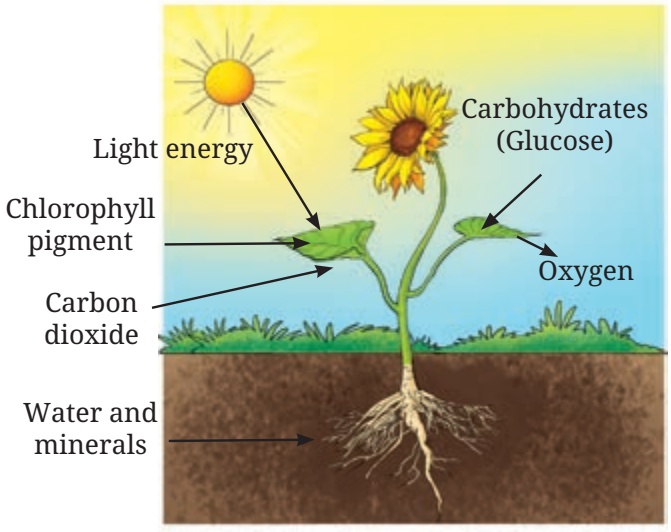


Fig. 10.5: A diagram showing photosynthesis

10.2.3 Photosynthesis: in a nutshell

We know that water, sunlight, carbon dioxide from the air, and chlorophyll are necessary to carry out the process of photosynthesis that produces carbohydrates (Fig. 10.5). During photosynthesis, food is actually produced in the form of glucose, a simple carbohydrate. This glucose not only serves as an instant source of energy but also later gets converted into starch for storage. The word equation of photosynthesis is given below—

$$\text{Carbon dioxide + Water} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{Glucose + Oxygen}$$

Know a Scientist

Many scientists across the world contributed to develop an understanding of photosynthesis. In India, Rustom Hormusji Dastur (1896–1961) studied the process of photosynthesis. He was a plant scientist and served as the head of the Botany Department at the Royal Institute of Science, Bombay (now the Institute of Science, Mumbai), from 1921–1935. He studied effects of the amount of water and temperature on photosynthesis. He examined the importance of water, temperature, and the colour of light in the process of photosynthesis.

10.2.4 How do leaves exchange gases during photosynthesis?

We now know that photosynthesis requires carbon dioxide, and oxygen is released in the process. Which part of the plant helps in the exchange of carbon dioxide and oxygen? Let us **conduct** an activity to understand where the exchange of gases takes place.

Activity 10.6: Let us examine (demonstration activity)

The teacher may demonstrate this activity.

- Collect a leaf from a plant such as rhoeo, money plant, onion, hibiscus, coleus, or any grass.
- Put it in a beaker filled with water.
- Carefully peel a thin layer from the lower surface of the leaf.
- Place the peel in a watch glass with water.
- Now, take a microscope slide and carefully put a drop of water on it.
- Using forceps, transfer the peel of the leaf from the watch glass to the slide with the help of forceps.
- Put a drop of ink on the leaf peel with the help of a dropper.
- Cover the peel with a coverslip and observe it under a microscope.

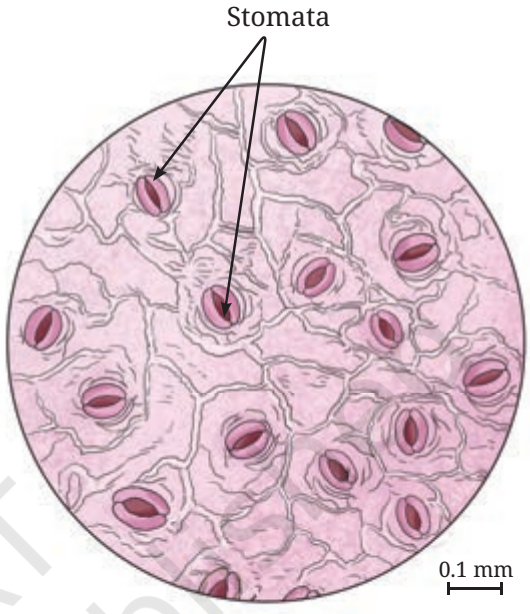


Fig. 10.6: Stomata on the lower surface of a rhoeo leaf

What do you observe? Do you notice tiny pores on the peel, as shown in Fig. 10.6? These pores are called **stomata**. Stomata, present on the surface of leaves, help in the exchange of gases.

10.3 Transport in Plants

10.3.1 Transport of water and minerals

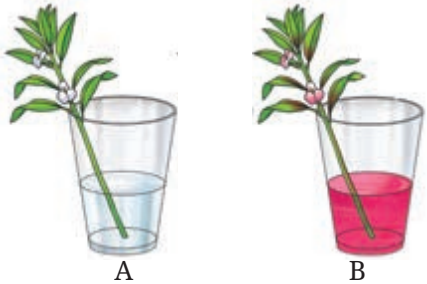
All living beings need water to grow. Plants use water in the process of photosynthesis. Water, along with minerals present in the soil, is taken up by the roots of a plant. Minerals are important nutrients for the growth of plants. How do water and minerals taken up by the roots move to all parts of the plant?

We can study water transport in plants by carrying out an activity. For this activity, we require two glass tumblers, some water, red ink, and twigs of two similar tender plants, preferably with white-coloured flowers (for example, white *sadabahar,* balsam), as shown in Fig. 10.7.

Activity 10.7: Let us experiment

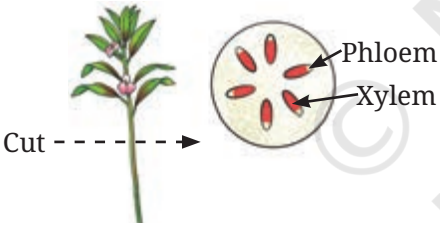
(a) With water (b) With coloured water

plant twigs placed in water with different treatments



(c) With water (d) With coloured water

plant twigs after one day



(e) Enlarged view of cut end of the twig

Fig. 10.7: Experiment to check for water transportation in plants

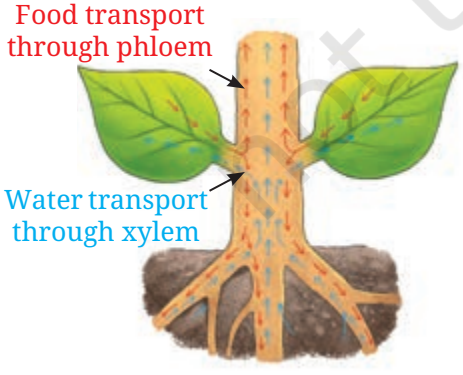


Fig. 10.8: Transport of water and minerals in a plant

- Take two tumblers and label them A and B.
- Fill one-third of each tumbler with water.
- Add a few drops of red ink to tumbler B.
- Obliquely cut the stems of both plants at their base while keeping them inside the water and immediately place one plant in each tumbler, as shown in Fig. 10.7a and Fig. 10.7b.
- Observe these plants the next day.

What do you notice? Compare the plant stems placed in the tumblers. Do you observe red colour in the stem, leaves, and flowers of the plant from Tumbler B? Fig. 10.7c and Fig. 10.7d show the plants after one day. Compare the plant in Fig. 10.7c with that in Fig. 10.7d. A red colour is visible in the stem, leaves, and flowers of the plant in Fig. 10.7d. How did different parts of the plant acquire this red colour?

Cut the stem from the upper part of the plant that is not immersed in the red-coloured water. Observe the cut stem using a magnifying glass. Do you spot the red colour in the stem (Fig. 10.7e)? How does the red colour ink move upwards? This is due to the thin tube-like structure called the **xylem** present in the stem, branches, and leaves of plants. Just like red ink, minerals dissolved in water also move up the stem through the xylem.

Now, we know that water and minerals are transported to the leaves and other parts of plants through the xylem (Fig. 10.8). The water transported through the xylem is used to perform various functions. How does food get transported to other parts of a plant?

10.3.2 Transport of food

We know that leaves are the primary site for photosynthesis. The food prepared by plants in the leaves is transported to all parts of the plant. This food is transported through another set of thin tube-like structures called the **phloem** (Fig. 10.8). The transported food may also be stored in some other parts of a plant, such as seeds and roots.

10.4 Do Plants Respire?

In the Grade 6 Science textbook *Curiosity*, chapter 'Living Creatures: Exploring their Characteristics', you learnt that all living beings respire. Do plants also respire like we do?

Activity 10.8: Let us find out (demonstration activity)

- Soak some *moong* bean seeds in water overnight.
- Put a layer of cotton in a conical flask (Fig. 10.9) and moisten the cotton with water to keep it wet.
- Place the soaked seeds over the wet cotton in the conical flask.
- Cover the mouth of the conical flask with a cork having two holes.
- Fit two tubes A and B through the two holes on the cork, as shown in Fig. 10.9.
- Leave it undisturbed for 24 hours in the dark.
- Take two test tubes and fill them with lime water.
- Cover the mouth of one test tube with a cork having one hole in it.
- Dip one glass tube in the test tube through a hole in the cork.
- Connect the flask and test tube with a rubber pipe as shown in Fig. 10.9.

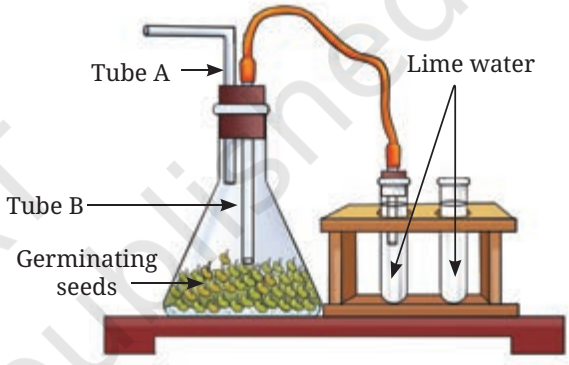


Fig. 10.9: Set-up to test respiration in plants

Compare both the test tubes for any change in colour. Does the lime water turn milky in both the test tubes? Why does the lime water turn milky in the test tube connected to the flask? Lime water turns milky due to the presence of more carbon dioxide in the flask. But where does this carbon dioxide come from? As we know, carbon dioxide is naturally present in very small quantities in the air. In the flask, additional carbon dioxide is produced by the seeds as they respire.

During respiration, glucose is broken down in the presence of oxygen, releasing carbon dioxide, water, and energy. The word equation for the proccess of respiration, is as follows—

Glucose + Oxygen $\longrightarrow$ Carbon dioxide + Water + Energy

The energy produced during respiration is used by plants for their growth and development. All parts of a plant, green or non-green, carry out respiration.

Thus, plants have different mechanisms for synthesising, transporting, and utilising food to get energy.

In a Nutshell

- All living organisms require food that provide energy for their growth and development.
- Plants use carbon dioxide and water in the presence of sunlight and chlorophyll to produce glucose and oxygen. This process of synthesis of food is known as photosynthesis.
- Leaves are the 'food factories' of a plant.
- Tiny pores on the surface of leaves, called stomata, help in the exchange of oxygen and carbon dioxide during photosynthesis and respiration.
- The xylem transports water and minerals from roots, while the phloem carries food from leaves to all parts of the plants.
- Plants break down glucose and release energy by a process called respiration. They use oxygen and release carbon dioxide in this process.

Let Us Enhance Our Learning

1. Complete the following table

S.No.	Feature	Photosynthesis	Respiration
1.	Raw materials		
2.	Products		
3.	Word equation		
4.	Importance		

2. Imagine a situation where all the organisms that carry out photosynthesis on the earth have disappeared. What would be the impact of this on living organisms?
3. A potato slice shows the presence of starch with iodine solution. Where does the starch in potatoes come from? Where is the food synthesised in the plant, and how does it reach the potato?
4. Does the broad and flat structure of leaves make plants more efficient for photosynthesis? Justify your answer.
5. X is broken down using Y to release carbon dioxide, Z, and energy.

$$X + Y \longrightarrow \text{Carbon dioxide} + Z + \text{Energy}$$

X, Y, and Z are three different components of the process.

What do X, Y, and Z stand for?

6. Krishna set-up an experiment with two potted plants of same size and placed one of them in sunlight and the other in a dark room, as shown in Fig. 10.10.

   Answer the following questions—

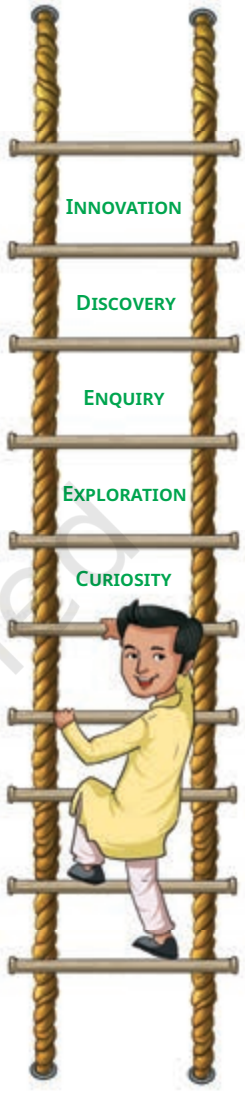
   (i) What idea might she be testing through this experiment?

   (ii) What are the visible differences in plants in both the conditions?

   (iii) According to you, leaves of which plants confirm the iodine test for the presence of starch?

(a) Sunlight *(b) Complete dark*

Fig. 10.10: Experimental pots



7. Vani believes that 'carbon dioxide is essential for photosynthesis'. She puts an experimental set-up, as shown in Fig. 10.11, to collect evidence to support or reject her idea.

(a) Sunlight with carbon dioxide *(b) Sunlight without carbon dioxide* *(c) Dark with carbon dioxide* *(d) Dark without carbon dioxide*

Fig. 10.11: A potted plant with sufficient water is placed under the prescribed conditions

Answer the following questions—

(i) In which plant(s) in the above set-up(s) will starch be formed?

(ii) In which plant(s) in the above set-up(s) will starch not be formed?

(iii) In which plant(s) in the above set-up(s) will oxygen be generated?

(iv) In which plant(s) in the above set-up(s) will oxygen not be generated?

8. Ananya took four test tubes and filled three-fourth of each test tube with water. She labelled them A, B, C, and D (Fig. 10.12). In test tube A, she kept a snail; in test tube B, she kept a water plant; in test tube C, she kept both a snail and a plant. In test tube D, she kept only water. Ananya added a carbon dioxide indicator to all the test tubes. She recorded the initial colour of water and observed if there are any colour changes in the test tubes after 2–3 hours. What do you think she wants to find out? How will she know if she is correct?

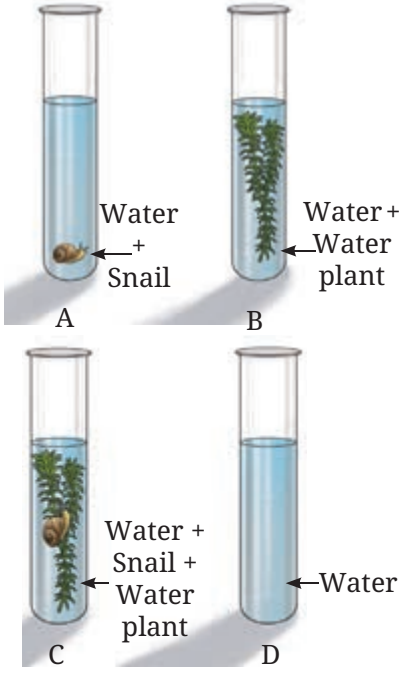
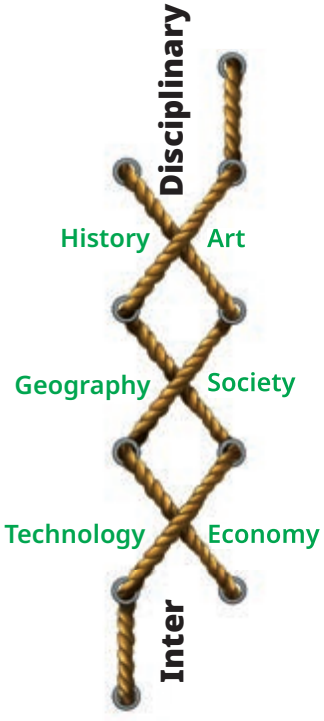


Fig. 10.12: Experimental set-up

9. Design an experiment to observe if water transportation in plants is quicker in warm or cold conditions.
10. Photosynthesis and respiration are essential to maintain balance in nature. Discuss.



Exploratory Projects

Fig. 10.13: Bottle garden

- Develop a bottle garden by planting a growing plant like spider plant or jade plant in a large transparent bottle (Fig. 10.13). After growing the plant properly for some time, seal the mouth of the bottle. Observe the growth of the plant. If the plant is growing well that means the plant is maintaining the exchange of gases, that is, carbon dioxide produced in the process of respiration of the plant is utilised for performing photosynthesis, and oxygen generated in photosynthesis is utilised in respiration by the plant inside the bottle.
- How are plant processes like photosynthesis, respiration, and water and food transportation crucial for crop production?
- Visit a greenhouse, if there is one near your place. Observe how people grow plants in a green house. Find out how they regulate the amount of light, water, and carbon dioxide used to grow plants.

Know a Scientist

Kamala Sohonie (1911–1998) was a woman scientist of India. She received a Ph.D. degree for her remarkable contribution in the area of respiration in plants from Cambridge University. She returned to India and worked at the Lady Hardinge Medical College in New Delhi, and later at the Nutrition Research Laboratory, Coonoor. Thereafter, she moved to the then Royal Institute of Science, Bombay, where she was eventually appointed as Director. Much of her work helped improve the nutritive values of plant foods. She also worked on the sap of the coconut palm as a nutritive drink called Neera.