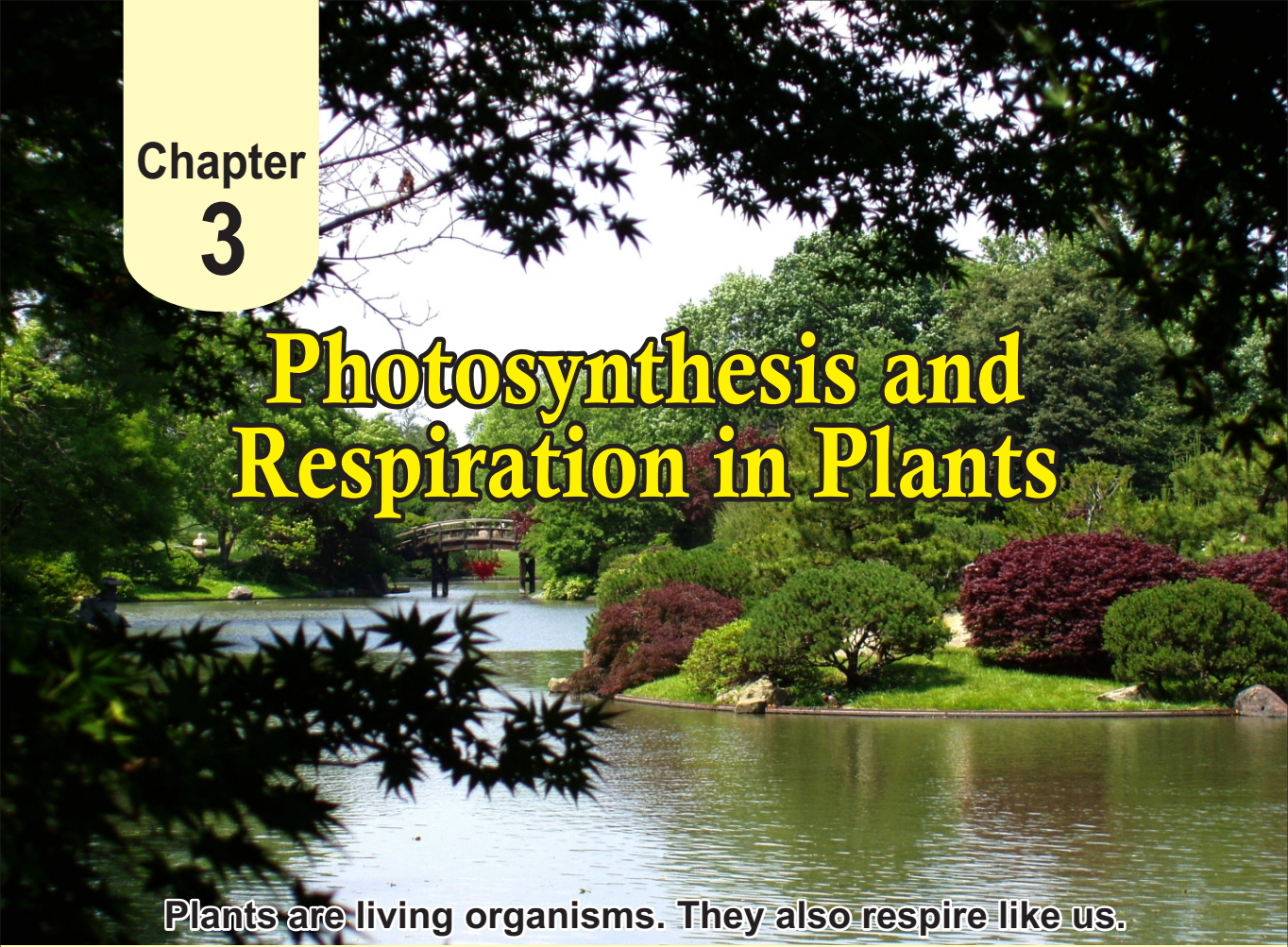
Chapter
3

Photosynthesis and Respiration in Plants



Plants are living organisms. They also respire like us.

Student Learning Outcomes

After completing this chapter, you will be able to:

- Describe the internal structure of a leaf.
- Define photosynthesis.
- Explain the importance of photosynthesis in plants.
- Describe the effects of different factors on the process of photosynthesis.
- Explain that the structure of leaves facilitates photosynthesis.
- Prove with the help of an experiment that photosynthesis takes place in a leaf.
- Explain the importance and process of respiration in plants.
- Compare and contrast the process of photosynthesis and respiration in plants.

All living things need energy to perform activities of life. You need energy to walk, talk, and play. Plants need energy too. Plants get energy from food which they prepare themselves. Two processes are very important for plants so that they may live alive.

1. Food making process (Photosynthesis)
2. Energy producing process (Respiration)

Before discussing photosynthesis and respiration, it will be very useful to study the internal structure of a leaf.

Internal Structure of a Leaf

Leaves are very important structures. They are plant's food factories. They absorb sunlight energy to make food. Under a powerful microscope, we can see three main internal parts of a leaf, i.e. epidermis, mesophyll and vascular bundle. (Fig.3.1).

Epidermis

The upper layer of a leaf is called the **upper epidermis.** The lower layer of the leaf is called the **lower epidermis.** Lower epidermis has many **stomata** (Fig.3.1). Each stoma has an opening and two bean shaped guard cells. Exchange of oxygen, carbon dioxide and water vapours between the leaf cells and the air takes place through stomata.

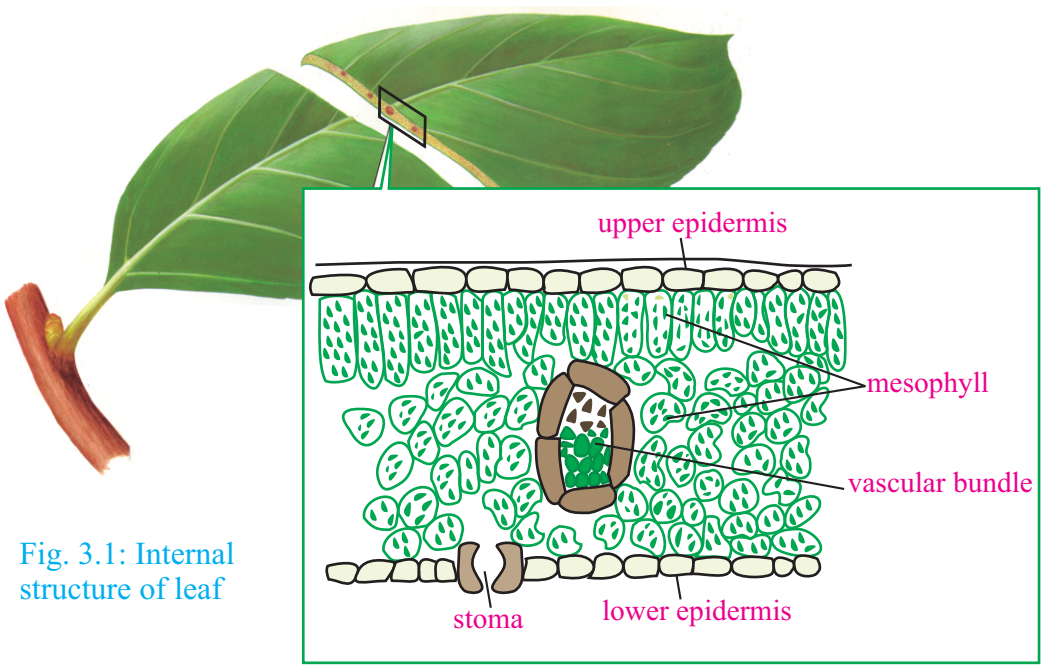


Fig. 3.1: Internal structure of leaf

Mesophyll

Between the upper and lower epidermis is the mesophyll (Fig.3.1). The mesophyll is made of cells that contain **chloroplasts**. A green pigment chlorophyll is present in chloroplasts. Chlorophyll traps light energy which is used in food making process. The mesophyll is the region where food making process called **photosynthesis** takes place.

Vascular Bundle

The central part of the mesophyll tissue is made of vascular bundle. Two types of tissues called xylem and phloem are present in vascular bundle (Fig.3.1). **Xylem** carries water from roots to the leaves. **Phloem** carries prepared food to other parts of a plant.

Interesting Fact

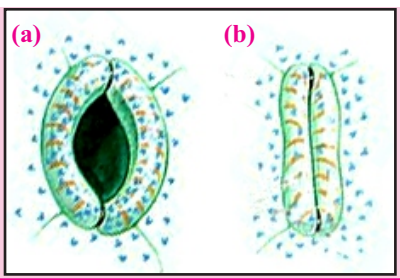
Why does a leaf look green?

The leaf looks green because the green colour of the chlorophyll shows through the clear epidermis. This chlorophyll helps to make food.

Do you know?

(a) When the guard cells absorb water, they swell and the stoma opens. (b) When the guard cells release water, the stoma closes.

Usually stomata remain open during the day and closed at night.



Photosynthesis

Plants make their food using carbon dioxide and water in the presence of sunlight and chlorophyll. This process is called **photosynthesis**. Plants also evolve oxygen during photosynthesis. Do you remember that all organisms use oxygen during respiration?

A word equation can explain the process of photosynthesis.

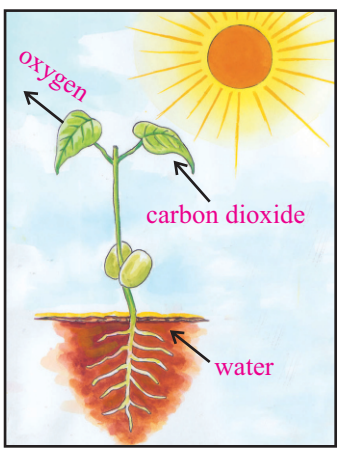


Fig.3.2: Photosynthesis in plants

Carbon dioxide + Water $\xrightarrow[\text{chlorophyll}]{\text{sunlight}}$ **Glucose + Oxygen**

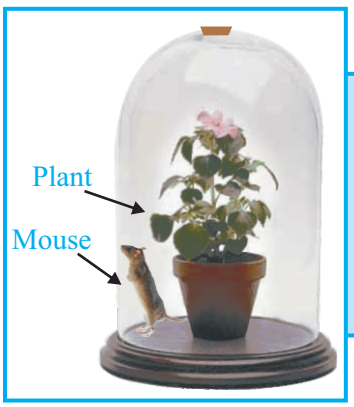
The word "Photosynthesis"

The word "photosynthesis" is a combination of two Greek words: photo and synthesis. "Photo" means light, and "synthesis" means to make.

Importance of Photosynthesis

Photosynthesis is one of the most important chemical changes that take place in our world. If photosynthesis did not take place, nearly all living things would die.

Products of photosynthesis are glucose and oxygen. All the living things use both of these products in respiration to produce energy. This energy is used in performing activities of life.



POINT TO PONDER

It has been thought that plants and animals could live in a sealed environment such as a glass globe. Do you think it is possible? If yes, how?

Effects of Different Factors on Photosynthesis

Light, temperature, carbon dioxide, water and chlorophyll are necessary factors for photosynthesis. If any of these factors falls to a low level, photosynthesis slows down or stops.

Light

Plants trap sunlight to make food by photosynthesis. Photosynthesis increases as the light intensity increases. Recall! Which structure of leaf traps light? Of the seven colours of light, chlorophyll absorbs blue, orange and red light.

Carbon dioxide

Carbon dioxide which plants absorb from air is an essential component for photosynthesis. The rate of photosynthesis increases with increasing carbon dioxide level. The level of carbon dioxide in the air is about 0.03 to 0.04 percent.

Temperature

The higher the temperature, the faster the process of photosynthesis. Normally plants grow well at 25–35°C. Temperatures below 0°C and above 40°C are not suitable for plant growth.

Water

Water is also one of the raw materials for photosynthesis and it is required in limited amounts.

> **Interesting Fact**
>
> Plants is the world are sometimes called the "lungs of the nature". They produce oxygen and decrease carbon dioxide in the air.

Chlorophyll

Chlorophyll is the green material in plants that traps sunlight for photosynthesis. It gives green colour to the leaves. Without chlorophyll the photosynthesis is impossible.

Structure of Leaf is Well Suited to Photosynthesis

Mostly photosynthesis occurs in green leaves because their structure is suitable for this process (Fig.3.3).

1. Most leaves have a flat blade to absorb maximum light.
2. Leaves are thin, so carbon dioxide and light can reach to inner cells easily.
3. Leaves have large number of stomata in the lower epidermis. Carbon dioxide can enter and oxygen and water vapours leave through these stomata.
4. Thick layer of mesophyll cells makes enough food for the plant.
5. Vascular bundle in the leaf spreads its veins in a network to carry water to photosynthesizing cells and glucose away from them.

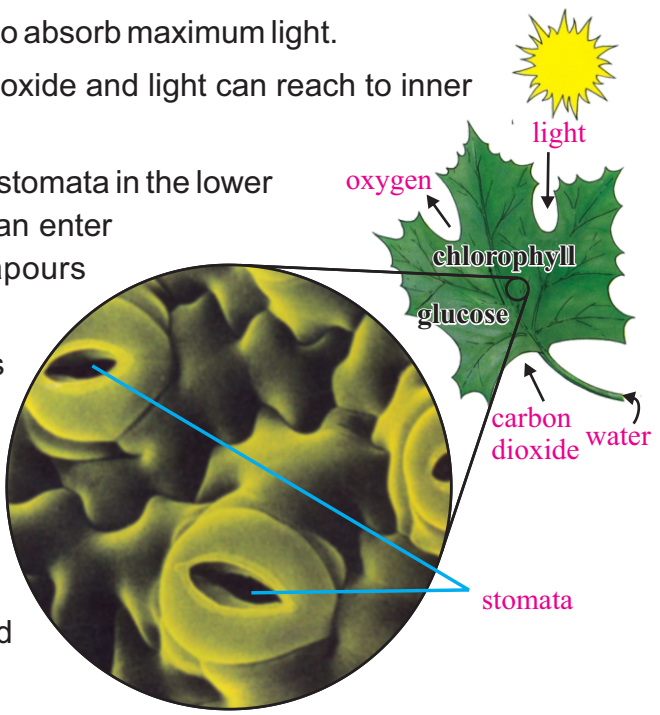


Fig.3.3: Stomata are important for the gas-exchange process during photosynthesis!

All these characteristics prove that the structure of a leaf is fit for the process of photosynthesis.

Point to think!

What would happen (especially to the amount of oxygen in the air) if photosynthesis stopped?

You will need: ◈ a plant ◈ black paper ◈ scissor and tape ◈ water

Procedure

1. Cut 2 squares of black paper. Each square should be big enough to cover completely one side of a leaf.
2. Place one square on one side of a leaf and another square on the other side. Tape the squares together.
3. Place the plant in a sunny place. Water it every other day for a week.
4. Remove the squares. Record your observations of the covered and uncovered leaves.

Things to think: Why does the colour of some leaves become different?

Respiration In Plants

Respiration is the energy producing process in living things. In this process plants use oxygen to break down glucose into water, carbon dioxide and energy. Here the word equation shows the process of respiration.

Glucose + Oxygen ⟶ Carbon dioxide + Water + Energy

Exchange of gases in plants takes place through stomata present in leaves(Fig.3.4). This exchange of gases takes place in two different steps. These steps are respiration and photosynthesis.

During daytime plants photosynthesize and produce glucose and oxygen. They use glucose and oxygen in respiration, while carbon dioxide and water are produced. These products are used in photosynthesis. At night the process of photosynthesis stops but respiration is a continuous process. Plants take in oxygen from the air and give out carbon dioxide and water in respiration.

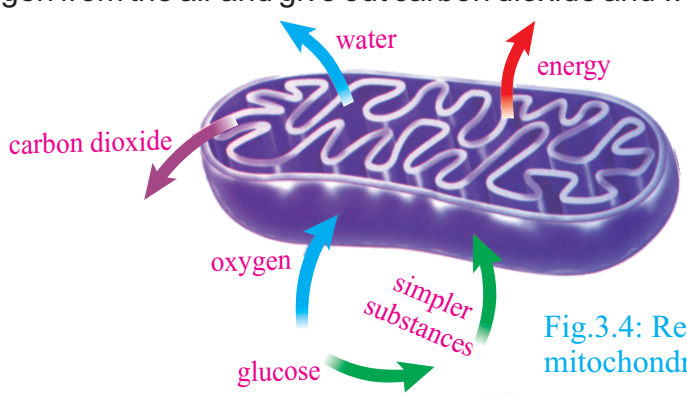


Fig.3.4: Respiration takes place in the mitochondria of all cells.

Do you know?

It is advised not to sleep under a tree during night, because of high amount of carbon dioxide and less oxygen in the air.

Comparison Of Photosynthesis and Respiration

Photosynthesis and respiration are two different processes. They are reverse to each other (Table 3.1).

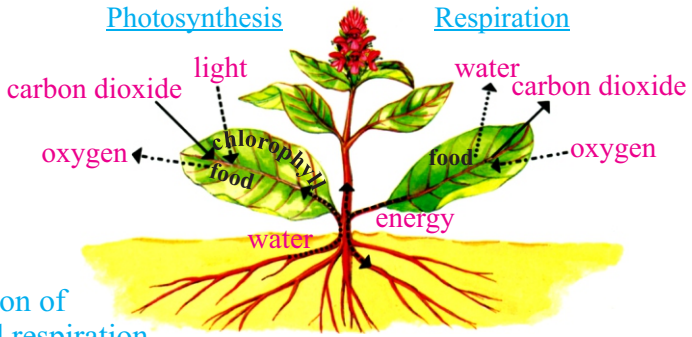


Fig. 3.5: Comparison of photosynthesis and respiration

Table 3.1: Comparing Photosynthesis and Respiration

Photosynthesis	Respiration
Occurs in plants	Occurs in all living organisms
Food-making process	Food-using process
Traps energy to produce glucose	Breaks glucose to release energy
Carbon dioxide+Water $\xrightarrow[\text{chlorophyll}]{\text{light energy}}$ Glucose+Oxygen	Glucose+Oxygen $\longrightarrow$ Carbon dioxide+Water+Energy

Do you know?

Photosynthesis occurs in chloroplasts of plant cells while respiration occurs in mitochondria of every animal and plant cell.

1. Food is prepared in the mesophyll tissues of a leaf.
2. Plants make their food by the process of photosynthesis.
3. Structure of leaf is well suited to the process of photosynthesis.
4. Light, temperature, carbon dioxide, water and chlorophyll are necessary factors for photosynthesis.
5. Respiration is the energy producing process in living things.

1. Write proper term/word against each statement.

i. Process of producing energy by the use of glucose and oxygen _____

ii. The outer protective layer of the leaf _____

iii. Process of making food by the use of water and carbon dioxide _____

iv. Green pigment in plants _____

v. Openings in a leaf _____

2. Circle the letter of the best answer.

i. Stomata open to allow _____ the plant.

(a) sugar into (b) sugar out of

(c) carbon dioxide into (d) light into

ii. Products of photosynthesis are:

(a) carbon dioxide and water (b) hydrogen and water

(c) glucose and carbon dioxide (d) glucose and oxygen

iii. How does chlorophyll help a plant?

(a) It absorbs light energy in photosynthesis.

(b) It moves water and minerals through the plant.

(c) It moves sugar and water through the plant.

(d) It absorbs water.

iv. Which is correct for leaves to make food?

(a) flat surface (b) presence of large number of stomata

(c) thick layer of mesophyll cells (d) a,b,c

v. Respiration takes place in _____ of cells.

(a) chloroplasts (b) mitochondria

(c) nucleus (d) cell membrane

3. Answer the following questions in detail.

i. Describe the internal structure of leaf.

ii. Which factors are necessary for photosynthesis?

iii. Prove that the structure of a leaf facilitates the process of photosynthesis.

iv. How does respiration occur in plants?

4. Extend your thinking.

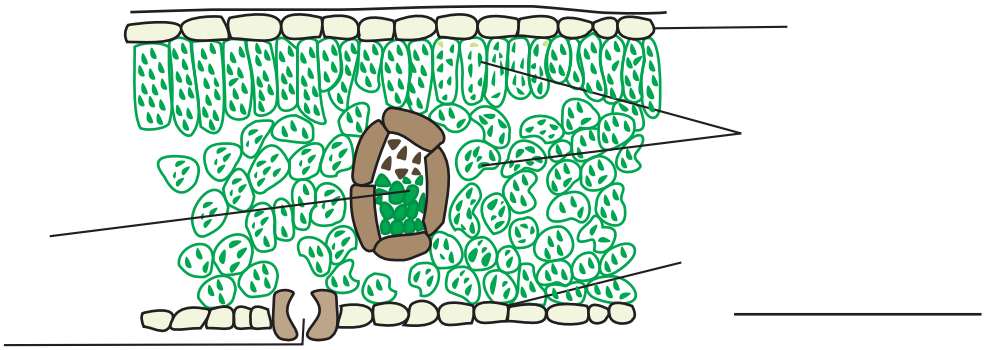
i. Which part of the leaf can best be compared to your skin?

ii. What is one cause of oxygen being found in the atmosphere?

iii. What would happen if there were no carbon dioxide in the air?

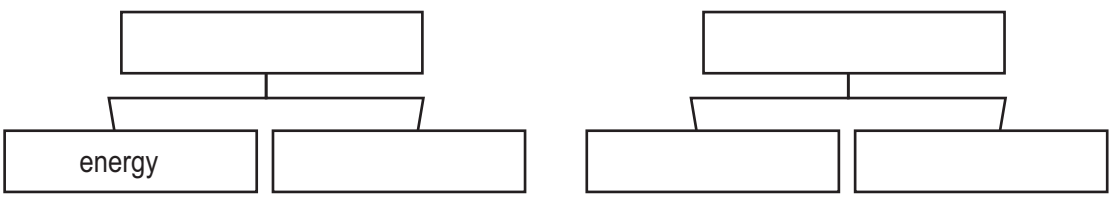
iv. Why is it important that the leaves on a stem are arranged so they do not overlap too much?

5. Identify and label the following diagram.



6. Concept Map

Complete the concept map using following words:
glucose, photosynthesis, carbon dioxide, respiration, oxygen



1. Grow two potted plants from seeds. Keep one plant in the dark and the other in the sunlight. Which plant has more chlorophyll? What does this show about chlorophyll in leaves?
2. If a microscope is available, look at a piece of epidermis peeled from an onion leaf. Find the stomata and guard cells.
3. Look at different kinds of green plants to see how their leaves are placed to catch sunlight. What do you discover?

Nearly all the living organisms in every community depend on green plants for food. To make food, green plants take carbon dioxide, water and minerals from the air and the soil. Cutting the trees is a common practice in our country. Why do you think this practice can create a great problem of food shortage? What would you suggest to avoid this problem?

Computer Links

- http://www.worsleyschool.net/science/files/photosynthesis/page.html
- www.biology4kids.com/files/plants_main.html