

# Photosynthesis

Biology

02

Food is essential for the survival of all organisms. Food is obtained by many ways, Using the knowledge about modes of nutrition of living beings, try to do the assignment given below.

## Assignment - 2.1



Figure. 2.1

- Identify the organisms in the picture
- State their modes of nutrition

As you know the food of cow and stork you can state easily how the cow and the stork obtain their food. They depend on other organisms for their food. It is known as heterotrophic mode of nutrition.

How do green plants obtain their nutrition? These plants produce their food within them. Therefore, it is called autotrophic mode of nutrition. Living organisms depend on that food directly or indirectly for their existence. Figure 2.2 shows a diagrammatic representation of the process of photosynthesis. Try to understand the phenomenon of photosynthesis by studying it.

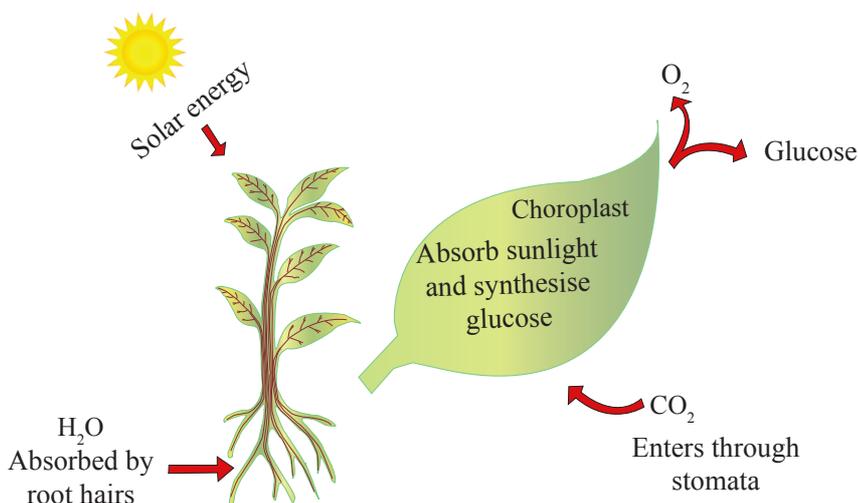


Figure. 2.2 - Factors necessary for photosynthesis and its products

Utilizing the energy from sunlight, the cells containing chlorophyll in green plants synthesize food using carbondioxide and water as raw materials. This process is called photosynthesis.

## 2.1 Factors that affect photosynthesis

Let us study how green plants obtain water and carbondioxide for photosynthesis. Terrestrial plants obtain water from soil for photosynthesis. Water in the soil is absorbed through root hairs by osmosis. The absorbed water then travels into root xylem through cortex and endodermis. From there water is transported into mesophyll cells of leaves via the xylem of stem and the veins of leaves. The network of veins in the leaves distributes water throughout the leaf.

$\text{CO}_2$  is obtained from the atmosphere for photosynthesis.  $\text{CO}_2$  diffuses into leaf through stomata. Then it reaches the mesophyll cells via inter cellular spaces.



Figure. 2.3 - Electron microscopic view of a chloroplast

The special green pigment called chlorophyll found in the chloroplasts in plant cells, absorb energy from sunlight.

Accordingly, the factors that affect photosynthesis are,

- Chlorophyll
- Sunlight
- Water
- Carbon dioxide

**Activity - 2.1**

**Materials required :-** *Hydrilla* or *vallisneria* leaves, A glass slide, A microscope

**Method :-**

- Observe a small section of a *Hydrilla* or *Vallisneria* plant leaf under the microscope.
- Observe the way that chloroplast with chlorophyll move towards the direction of sunlight for photosynthesis.

**2.2 Products of photosynthesis**

The glucose ( $C_6H_{12}O_6$ ) produced during photosynthesis will be temporarily stored as starch in leaves. Later, part of that starch is converted into sucrose ( $C_{12}H_{22}O_{11}$ ) and transport into other tissues, via phloem. The sucrose that is transported to storing organs are again stored as starch.

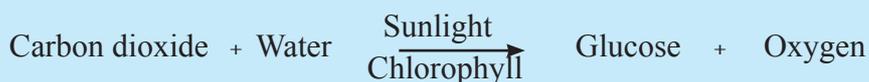
E.g :- Fruits, Vegetables, Yams, Leaves, Roots

The byproduct of photosynthesis is  $O_2$  and it is diffused into the atmosphere through stomata.

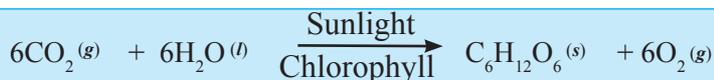
**Assignment - 2.2**

Prepare a report using the adaptations shown by plants to absorb sunlight efficiently for photosynthesis.

Photosynthesis can be expressed by a word equation as given below.



The balanced chemical equation for photosynthesis is,

**• Extra knowledge •**

Plants absorb red and blue light of sunlight during photosynthesis.

As glucose produced during photosynthesis is stored temporarily as starch in leaves, it could be tested whether the photosynthesis has taken place or not by doing a test for starch.

Carry out the activity below to identify starch produced during photosynthesis.

### Activity - 2.2

**Materials required :-** Beaker, Test tube, Tripod, Bunsen burner, Water, Alcohol, Plant leaf

**Method :-**

- Pluck a leaf from a plant which was in sunlight and boil in water.
- Place it in the test tube with alcohol and boil in a water bath.
- Wash the leaf and put few drops of iodine solution onto it and observe the colour change.

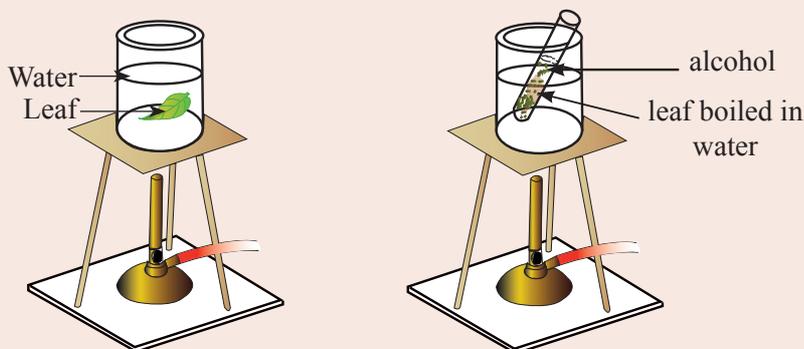


Figure. 2.4

As chlorophyll dissolves in alcohol the leaf is boiled in an alcohol solution. Then the solution becomes green in colour and the leaf turns to a pale colour. As alcohol is highly inflammable, it is boiled in a water bath.

If the leaf turns to blue or dark purple, once iodine is added, we can conclude that starch is present in the leaf.

## 2.3 Testing of factors required for photosynthesis

The plant should be kept in dark for 48 hours before the experiment to show that sunlight and carbon dioxide are needed for photosynthesis. When the plant is in the dark the stored starch completely removes from the leaves.

We will conduct the activity 2.3 to show that sunlight is required for photosynthesis.

### Activity - 2.3

#### Experiment to show that sunlight is required for photosynthesis

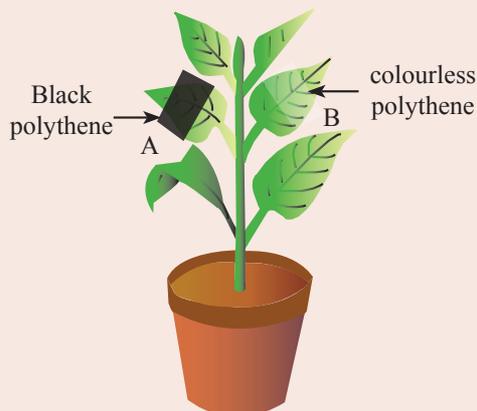


Figure. 2.5

**Materials required :-** Potted plant kept in dark for 48 hrs, materials needed for starch test, black and colourless polythene strips

#### Method :-

- Select two leaves almost similar to each other (A and B leaves) of the plant kept in dark for 48hrs
- Cover a part of leaf A with black polythene and part of leaf B with colourless polythene
- Keep it under sunlight for 3-5 hours
- Prepare the leaves for starch test as in activity 2.2

There is no colour change in the covered area of the leaf A but the covered area of leaf B turns to purple or blue.

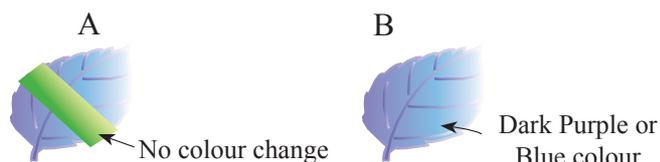


Figure. 2.6

The covered area of leaf **A** has not received sunlight. Therefore photosynthesis has not taken place. Hence, there was no colour change with Iodine solution. The covered area of leaf **B** with colourless polythene has received sunlight. Therefore photosynthesis has taken place and showed a colour change to dark purple or blue indicating starch has been produced.

Accordingly, we can conclude that sunlight is necessary for photosynthesis.

Let's conduct the activity 2.4 to show that  $\text{CO}_2$  is required for photosynthesis.

### Activity - 2.4

#### Experiment to show $\text{CO}_2$ is required for photosynthesis

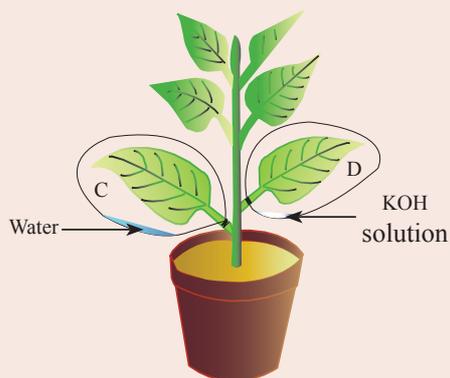


Figure. 2.7

**Materials required** :- Potted plant, materials required for starch test, two polythene bags of same size KOH solution, water

#### Method:-

- Select two similar leaves of the above plant. C and D
- Add potassium hydroxide (KOH) and water to transparent polythene bags separately. Then insert leaf **D** into the polythene bag with KOH and leaf **C** into the bag with water and make them air tight.
- Place the plant in sunlight for 3-5 hrs.
- Then detach leaves C and D and carry out starch test separately

You can observe that there is no colour change in leaf **D** and there is a colour change in leaf **C** after adding Iodine solution.

KOH present in bag D absorbs  $\text{CO}_2$ . Therefore leaf D does not photosynthesise as it does not receive  $\text{CO}_2$ . Therefore there is no colour change.

Leaf C receives  $\text{CO}_2$ , so it photosynthesises. Therefore a colour change can be observed. Leaf D has not produced starch but leaf C has produced starch.

Accordingly it can be concluded that  $\text{CO}_2$  is necessary for photosynthesis.

Let's do the activity 2.5 to show that chlorophyll is required for photosynthesis.

### Activity - 2.5

#### Experiment to show chlorophyll is required for photosynthesis

**Materials required :-** Mosaic plant leaf (Hibiscus/ Croton), white paper, materials required for starch test

**Method :-** Pluck a mosaic leaf. Draw a sketch of it with its pattern. Carry out starch test for it.

There is no color change in the white regions but a colour change can be observed in green colour regions.

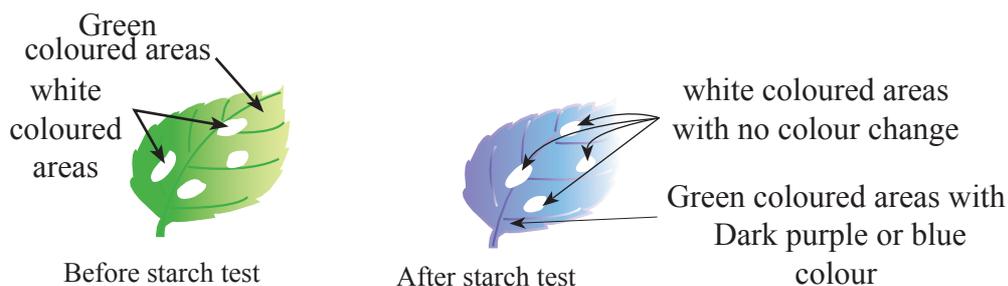


Figure. 2.9

The white colour regions lack chlorophyll, so photosynthesis has not taken place. Therefore starch has not been produced. So it can be concluded that chlorophyll is essential for photosynthesis.

An experiment cannot be designed in the laboratory to test the need of water for photosynthesis, because without water, the plant in the control experiment will die. Scientists have shown the need of water for photosynthesis using water with  $^{18}_8\text{O}$  isotope.

Let's conduct the experiment below (Activity 2.6) to show that  $\text{O}_2$  is produced as a by product of photosynthesis.

**Activity - 2.6****Experiment to show  $O_2$  is produced during photosynthesis**

**Materials required :-** Beaker, boiling tube, glass funnel, aquatic plant (*Hydrilla*, *Vallisneria*)

**Method :-** Add water into the beaker. Then place *Hydrilla* or *Vallisneria* inside the funnel. Fill a boiling tube with water and place it inverted on the funnel as in the diagram. Place the setup in sunlight.

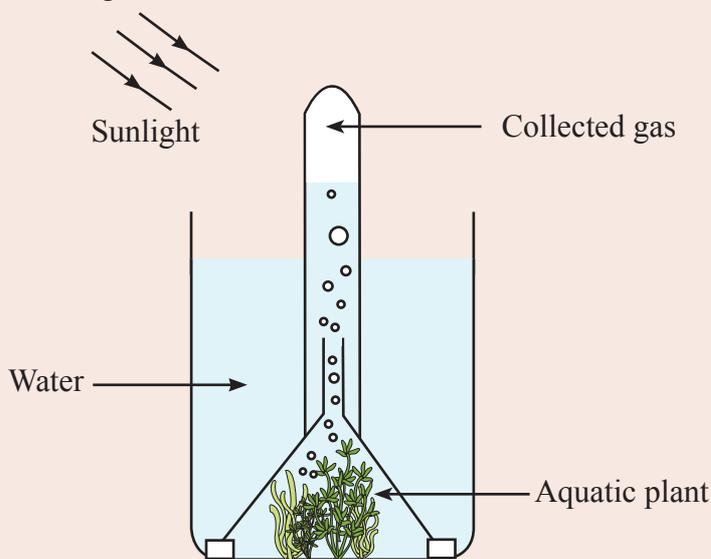


Figure. 2.10

Gas bubbles are released from the aquatic plant and the gas gets collected at the top of the boiling tube. After the accumulation of gas about  $\frac{3}{4}$ <sup>th</sup> of its volume, the tube will be taken out and a glowing splinter is inserted to test whether it is oxygen. The splinter will burn with a bright flame. So we can conclude that the gas given out in photosynthesis is oxygen.

**Extra knowledge**

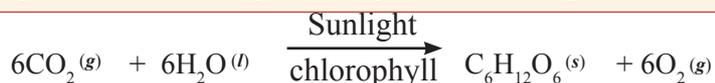
Lavoisier is the first scientist who showed that oxygen diffuses from green plants in the presence of sunlight.

## 2.4 Importance of photosynthesis

- Solar energy is converted to chemical energy during photosynthesis. Plants produce food and all organisms live on earth depend directly or indirectly on that food. Photosynthesis cannot be done artificially. Therefore this process carried out by green plants is essential for the maintenance of life on earth
- The oxygen gas which is required for the survival of aerobic organisms and combustion of materials is released mainly by photosynthesis
- Carbondioxide that is accumulated due to respiration and combustion is removed from the environment by photosynthesis. Thereby it helps to maintain O<sub>2</sub> and CO<sub>2</sub> balance in the atmosphere
- Photosynthesis helps to maintain the carbon cycle

### Summary

- Solar energy is converted into chemical energy by green plants during photosynthesis.
- Sunlight, water, CO<sub>2</sub> and chlorophyll are required for photosynthesis.
- The main product of photosynthesis is glucose and oxygen is produced as a byproduct.
- Photosynthesis can be expressed by a balanced equation as below.



- The global importance of photosynthesis is provision of food to all organisms directly or indirectly, Maintenance of O<sub>2</sub> : CO<sub>2</sub> balance in the atmosphere and maintaining the carbon cycle.

