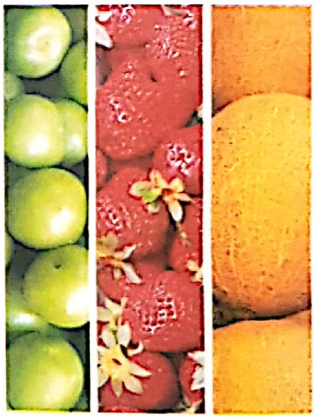
1 Nutrition in Plants

LEARNING OBJECTIVES

After completion of the Chapter the students will be able to:

1. *Understand the different modes of nutrition.*
2. *Explain photosynthesis and materials required to carry out photosynthesis.*
3. *Demonstrate the importance of photosynthesis.*
4. *Differentiate between autotrophic and heterotrophic nutrition.*
5. *Describe way plants synthesise proteins.*



Each living organism requires to carry out basic processes (such as reproduction, growth, nutrition, respiration, etc.) to maintain life. For carrying out all life processes each living organism needs daily supply of energy which is provided by the food consumed by them. Food contains substances that provide nourishment to the body. These are called nutrients.

What is Nutrition?

The process of providing or obtaining the food necessary for health and growth is known as nutrition.

There are two modes of nutrition in living organisms: Autotrophic nutrition and Heterotrophic nutrition.

Autotrophic Nutrition: The word *'auto'* means self and *'trophos'* means nourishment. Autotrophic plants make their own food by a process known as photosynthesis. All green plants and some bacteria are able to prepare their own food and are known as autotrophs.

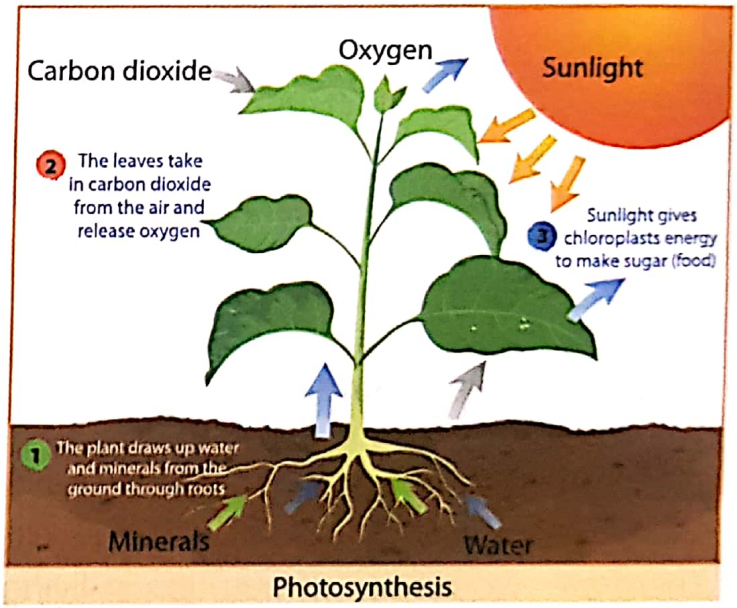
Heterotrophic Nutrition: The word *'heteros'* means other and *'trophos'* means nutrition. Heterotrophic organisms obtain their food from the bodies of other organisms.

NUTRITION IN PLANTS

- **Autotrophs**
  - 
    Green plant
- **Heterotrophs**
  - **Parasites**
    - 
      Cuscuta
    - **Partial Parasites**
      - 
        Mistletoe
    - **Total Parasites**
      - 
        Rafflesia
  - **Saprophytes or saprotrophs**
    - 
      Mushroom
  - **Insectivorous plants**
    - 
      Bladderwort

Autotrophic Mode of Nutrition

Green plants can make their own food. These self-dependent living things are known as the autotrophs. The process by which they can produce their own food and energy using sunlight and water is known as photosynthesis.



The process of photosynthesis (*photo* = light; *synthesis* = to combine) can be summarised as:

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

$$CO_2 + H_2O \longrightarrow C_6H_{12}O_6 + O_2$$

Materials Required for Photosynthesis

The materials required to carry out photosynthesis are as follows:

1. Water and Minerals

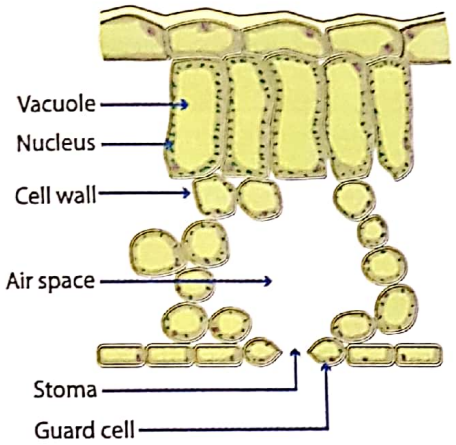
The roots of a plant absorb water and nutrients from the soil with the

help of root hairs. Plants have tissues (xylem) which move minerals and water from the roots upwards to the leaves. Photosynthesis can only occur with the help of water.

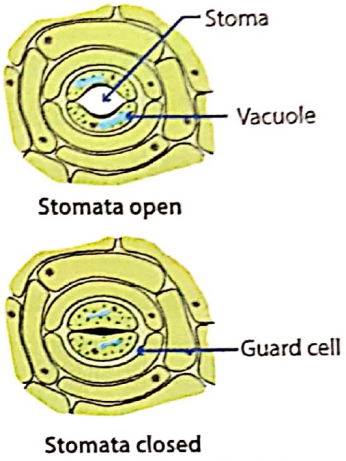
2. Carbon dioxide

It is taken from the air by the plants. Carbon dioxide from the air is taken in through tiny pores present on the leaves called stomata. Stomata are surrounded by guard cells.

The guard cells control the opening and closing of stomata. These are present abundantly on the lower surface of a leaf. Oxygen is released from the stomata as a waste product of photosynthesis from the plant body.



A section through a leaf

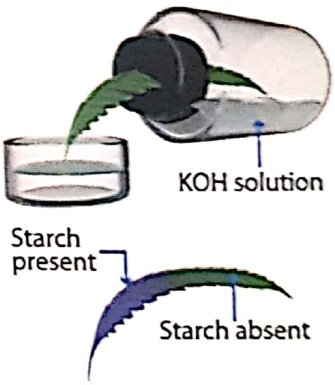


Open and closed stomata

ACTIVITY 1.1

To prove that carbon dioxide is necessary for photosynthesis

- Take a potted plant with long leaves and place it in the dark for 2–3 days to make it starch free.
- Take a leaf from this plant and insert half of it in a bottle containing caustic potash through a split cork.
- Caustic potash absorbs carbon dioxide, hence the portion of the leaf in the bottle will not get carbon dioxide.
- The portion of the leaf outside the bottle will get carbon dioxide.
- Cork the bottle and place it in sunlight for a few hours.
- Test the leaf for starch. Make a note of the part of the leaf that turns blue-black.



3. Chlorophyll

Chlorophyll is a green pigment in plants that captures light energy from the sun. It is present in chloroplasts. Without chlorophyll, plants cannot use energy of the sunlight to prepare their food.

Do You Know?

Only 0.02% of light energy falling on earth is used by plants for photosynthesis.

Variegated croton leaf

Leaf after tested with starch

ACTIVITY 1.2

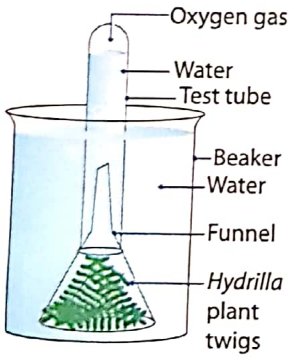
To prove that green plants produce food or starch by photosynthesis (or chlorophyll is essential for photosynthesis)

- Take a variegated croton leaf which contains green coloured patches. (Variegated means some parts of the leaves are white due to absence of chlorophyll).
- Boil it in alcohol in a water bath to dissolve out green pigment and decolourise the leaf.
- Remove the leaf from boiling alcohol and dip it in hot water.
- Spread the decolourised leaf flat on a white surface and drop iodine solution on it. The parts containing starch will turn blue-black but the parts without starch will stain brown or yellow with iodine.

4. Sunlight

Solar energy splits carbon dioxide and water into its constituents to form starch (food).

ACTIVITY 1.3



Light is necessary for photosynthesis

To prove that light is necessary for photosynthesis

- Take some twigs of an aquatic plant like *Hydrilla* in beaker filled with water.
- Invert a funnel over the twigs. Invert a test tube filled with water on the stem of the funnel.
- Keep this set-up in sunlight for sometime.
- What do you observe?
- You will notice air bubbles (oxygen gas) coming out from the twigs. If this set-up is kept in the dark, no air bubbles come out. This shows that sunlight is necessary for photosynthesis.

Importance of Photosynthesis

- It is the most important biological process on which all living organisms depend, directly or indirectly, for food.
- This process maintains the balance of carbon dioxide and oxygen in the environment.
- It provides us oxygen for breathing.

Note: Photosynthesis takes place mostly in the green leaves of plants but in some plants like cactus, it takes place in the green fleshy stem, as the leaves are reduced to spines to reduce loss of water by transpiration.

CHECK YOUR PROGRESS

1. Observe the experimental set-up given on next page and answer the questions that follow.

   (a) What is the aim of this experiment?

(b) Name a water plant that can be used in the experiment.

(c) Which gas is collected at the end of the experiment?

2. Study the equation given below and answer the questions that follow.

$$CO_2 + H_2O \longrightarrow C_6H_{12}O_6 + O_2$$

(a) What does the equation depict?

(b) Where does it occur?

(c) What happens to the products?

(d) What are the conditions required for this process to occur?

Heterotrophic Mode of Nutrition

There are some plants which do not contain chlorophyll and so they cannot prepare their own food. They depend upon other plants or other organisms to obtain their nourishment. These plants are said to have heterotrophic mode of nutrition and are called heterotrophs. Heterotrophs have been classified into following categories:

Do You Know?

Rafflesia arnoldii is an insectivorous plant which bears the biggest flower in the world, 1 m in diameter and 11 kg in weight.

Parasites

The organisms that derive nutrition from the body of other organisms are known as parasites. The organism that a parasite uses to derive its nutrition is called a host. All parasitic plants feed on other plants as either partial parasites, *i.e.*, obtaining some of their nutrition from the host, or total parasites, *i.e.*, dependent completely on the host for nutrition. Common examples of partial parasites are painted cup (parasitic on roots) and mistletoe (parasitic on branches of mango and *mahua trees*). Total parasitic plants are dodder, *Cuscuta* (*amarbel*) and certain tropical plants of the Rafflesiaceae family.

The orange wiry stems of dodder are attached to thyme plants

Saprophytes

Saprophytes are those organisms that cannot manufacture their own food through the process of photosynthesis but obtain nutrition from dead and decaying plant and animal matter. Most common examples of saprophytes are mushrooms, moulds and certain types of fungi and bacteria. Saprophytic organisms are commonly seen during or after the rain. Fungi are commonly seen growing on leather, clothes, pickles during the hot and humid weather.

Fungi— A saprophyte

ACTIVITY 1.4

Observe the growth of moulds

- Take a slice of bread. Keep it on a plate and sprinkle some water on it.
- Keep it in a warm and dark place.
- Observe it after 2-3 days.
- You will notice some fluffy growth on it.
- Use a hand lens to see it; these are moulds.

Pitcher plant

Venus fly trap

Insectivorous Plants

There are some green plants which obtain their nourishment partly from soil and atmosphere, and partly from small insects. Common examples of such plants are pitcher plant, bladderwort and Venus fly trap. These plants trap insects, kill them, consume them and throw out the waste. These plants have leaves that are modified to catch insects.

In a pitcher plant, the leaf is modified into a pitcher-like structure. The tip of the leaf forms a lid that can open and close the mouth of the pitcher. When an insect gets attracted towards the pitcher and lands on it, the lid closes. The pitcher secretes digestive juices which digest the trapped insect.

Insectivorous plants do not get enough nitrogen and so, they eat insects to fulfill their need for nitrogen.

Lichens

Symbiotic Plants

This is another method of heterotrophic nutrition in which two different organisms associate with each other to fulfil their requirement of food. For example, association of algae and fungi to form lichens. The algae and fungi mutually benefit each other and in the process fulfill all their needs. The alga makes food, which is also used by the fungus. The fungus in turn gives the alga, water and minerals it obtains from the substratum on which it lives.

Differences between autotrophic and heterotrophic plants

Autotrophic plants	Heterotrophic plants	
Green plants	Parasites	Saprophytes
■ All green plants are able to manufacture their own food from inorganic substances through the process of photosynthesis.	■ These organisms live on or inside another living organism and derive their nutrition from the host wholly or partly without contributing anything to the latter.	■ These organisms cannot manufacture their own food by photosynthesis and instead derive nutrition from dead and decaying plant and animal matter.
■ These plants contain the green pigment chlorophyll.	■ They do not contain chlorophyll.	■ They do not contain chlorophyll.
■ Such organisms are totally dependent on themselves to meet their energy requirements.	■ Such organisms show partial or complete dependence on host for energy requirements and survival.	■ Such organisms are dependent on dead autotrophs or heterotrophs.
■ These organisms lie at the base of a food chain. ■ Examples: Rose, banyan tree and all green plants.	■ These organisms constitute higher levels in a food chain. ■ Examples: Painted cup, mistletoe, *rafflesia*, etc.	■ These organisms act upon all levels in a food chain. ■ Examples: Mushrooms, moulds, fungi, certain bacteria, etc.

How are Nutrients Replenished in the Soil?

We know that plants absorb mineral nutrients from the soil. Plants require a lot of nitrogen to make proteins. Although the air contains a lot of nitrogen gas, it cannot be used by plants directly. They need nitrogen in soluble form. Therefore, the atmospheric nitrogen is converted by various ways to a form that can be absorbed by plants. This is known as nitrogen fixing.

Some bacteria have the ability to fix nitrogen. The bacterium called *Rhizobium* can take atmospheric nitrogen and convert it into a soluble form. *Rhizobium* cannot make its own food. It lives in the roots of peas, gram and other legumes and provides them nitrogen. In return, the plants provide food and shelter to the bacteria. Thus, they have a symbiotic relationship. This association is useful to farmers as they do not have to add nitrogen fertiliser to the soil.

CHECK YOUR PROGRESS

1. Match the columns.

Column I	Column II
Host	Algae and fungi
Pitcher plant	*Cuscuta*
Partial parasite	Insectivorous
Lichen	Mistletoe
Total parasite	Used by parasite

2. Give one word for the following:
   (a) These plants obtain their nitrogen supply from insects.
   (b) These organisms lie at the base of food chain.
   (c) The relationship between *Rhizobium* and roots of pea plant.
   (d) These are seen growing on leather during or after rains.

SUMMARY—A FLOW CHART

NUTRITION

- It is the mode of taking food by an organism and its utilisation by the body.
- The components of food that provide nourishment to the body are called **nutrients**.

Modes of Nutrition

Autotrophic

- Mode of nutrition in which plants make food themselves from simple substances.
- Plants that make their own food are called **autotrophs**.

Process of making food

Photosynthesis

The process by which green plants prepare their own food with carbon dioxide and water from the environment in presence of sunlight using a green coloured pigment called chlorophyll.

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

(food)

Heterotrophic

Mode of nutrition in which plants depend on food prepared by other plants or organisms.

Parasitic

- Organisms that live on the body of other organisms.
- They may be **partial parasites**: Obtain some of their nutrition from the host, e.g. painted cup or **total parasites**: Dependant completely on the host for nutrition. *Example*, mistletoe.

Saprophytic

Organisms that obtain nutrition from dead and decaying plant and animal matter. *Example*, mushrooms, moulds, etc.

Insectivorous Plants

Green plants which obtain their nourishment partly from soil and atmosphere and partly from small insects. *Example*, pitcher plant, bladderwort.

Symbiosis

Mode of nutrition in which two different individuals associate with each other to fulfil their requirement of food. *Example*, lichens.

Replenishment of Nutrients in Soil

- Nutrients like nitrogen, potassium, phosphorus, etc. are replenished by adding fertilisers and manure.
- Nitrogen is naturally replenished by leguminous plants (gram, peas, moong, etc.). Root nodules in these plants contain the bacterium Rhizobium which converts atmospheric nitrogen into a soluble form absorbed by roots.

ASSESSMENT

A. Multiple Choice Questions

Tick (✓) the correct option.

1. Which one of the following is not a saprophyte?
   (a) Mushroom ☐ (b) *Cuscuta* ☐
   (c) Bread mould ☐ (d) Bacteria ☐
2. Pitcher plant is an example of
   (a) parasitic plant ☐ (b) insectivorous plant ☐
   (c) lichen ☐ (d) saprophyte ☐
3. An organism that can convert atmospheric nitrogen into soluble form is
   (a) fungi ☐ (b) algae ☐
   (c) *Rhizobium* ☐ (d) virus ☐
4. Iodine gives blue-black colour in the presence of
   (a) cellulose ☐ (b) protein ☐
   (c) fat ☐ (d) starch ☐
5. Which part of the plant gets carbon dioxide from the air for photosynthesis?
   (a) Stomata ☐ (b) Root hair ☐
   (c) Sepals ☐ (d) Leaf veins ☐
6. Which of these is not necessary for photosynthesis?
   (a) Carbon dioxide ☐ (b) Chlorophyll ☐
   (c) Light ☐ (d) Nitrogen ☐
7. Two different organisms living together and both benefitting from each other are known as
   (a) saprophytic ☐ (b) symbiotic ☐
   (c) parasitic ☐ (d) heterotrophs ☐

B. Fill in the blanks.

1. Green plants are called _____, because they synthesise their own food.
2. The small pores on the lower surface of a leaf are called _____.
3. The mode of nutrition in lichens is _____.
4. Plants show _____ and _____ modes of nutrition.
5. The leaves of cactus are reduced to spines or thorns, to reduce loss of water by _____.

C. Write True or False for each statement. Rewrite the false statements correctly.

1. Chlorophyll traps sunlight for photosynthesis.
2. Carbon dioxide is the waste product of photosynthesis.
3. The alga and fungus together are known as lichens.
4. Plants require a lot of potassium to make proteins.
5. Parasites do not contain chlorophyll.
6. Photosynthesis in the plants like cactus takes place in roots.