1 NUTRITION IN PLANTS

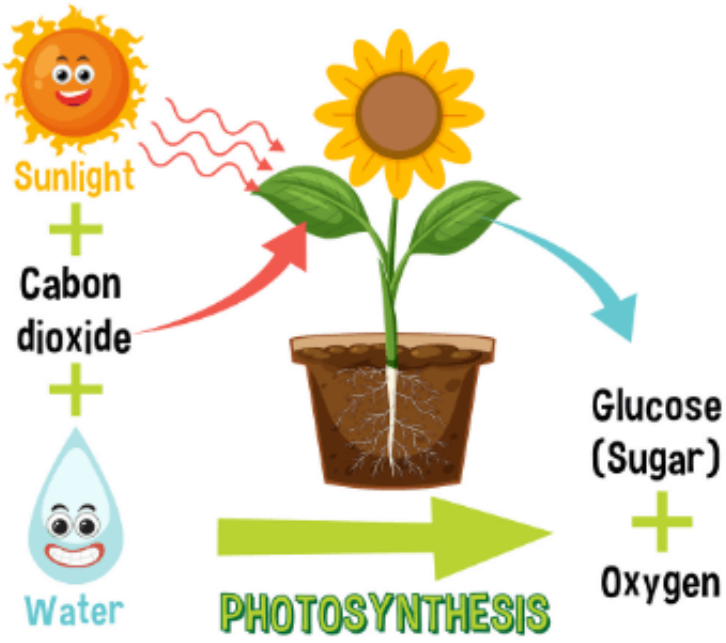
LEARNING OBJECTIVES

	♦	INTRODUCTION
	♦	MODE OF NUTRITION
	♦	PHOTOSYNTHESIS
	♦	SYMBIOSIS

1. INTRODUCTIION TO NUTRITION IN PLANTS

The process by which living organisms take in food and use it to obtain energy for growth and development is called **nutrition.**

A **nutrient** is an organic or inorganic substance required for the maintenance of life and survival of a living organism.



Nutrition

The process of taking in food by an organism and its utilization by the body for various life processes is called as **nutrition.**

Modes of Nutrition

Living organisms exhibit two main modes of nutrition : **autotrophic nutrition** and **heterotrophic nutrition. Symbiosis** is another mode of nutrition in which two different types of organisms participate.

Autotrophic Nutrition

The mode of nutrition in which an organism synthesizes its own food from simple inorganic substanes, is called autotrophic nutrition *e.g.*, green plants.

Green plants synthesize their food by the process of **photosynthesis.**

Chemical equation for photosynthesis can be summarised as :

$$6CO_2 + 6\,H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2 \uparrow$$

Heterotrophic nutrition

The mode of nutrition in which organism obtains its food from plants or other animals is called **heterotrophic nutrition** *e.g.*, animals, non-green plants, fungi, most bacteria, etc.

Heterotrophic nutrition in plants

Parasitic plant derives nutrients from other called **host.** plants Examples: *Cuscuta* (total parasite), Misfletoe (partial parasite).

Insectivorous plants are the plants which feed on insects to obtain their nitrogen as a nutrition. *e.g.*, Pitcher plant (*Nepenthes*), Venus flytrap (*Dionaea*) etc. They are referred to as **partially heterotrophic** organisms.

Saprotrophs

Saprotrophs are those organisms which cannot make their own food and obtain their nutrition from dead and decaying plant and animal matter. These organisms release digestive juices on the dead matter and convert it into liquid form. They then absorb nutrients from it *e.g.*, most fungi like mushrooms, bread moulds and many bacteria.

Symbiosis

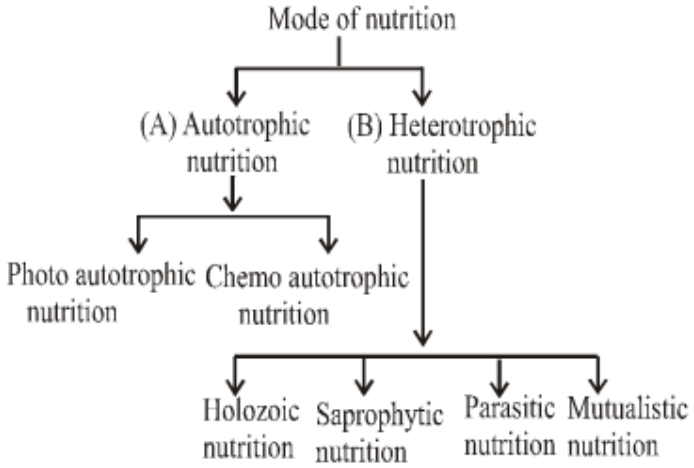
In another mode of nutrition, two different kinds of organisms work together for their **mutual benefits.** Such a relationship in which two different organisms live together and share shelter and nutrients is called as **symbiotic relationship** (or symbiosis) *e.g.*, **lichens, mycorrhizae.**

***Rhizobium* - legume association** is a symbiotic association of leguminous plants and *Rhizobium* bacteria. It is a way of replenishing essential nutrients in the soil.

2. MODE OF NUTRITION

MODE OF NUTRITION

Mainly two modes of nutrition are there on the basis of the method of food procurement.



(A) Autotrophic (Holophytic) nutrition: (Auto = self, Trophic = food). In this mode of nutrition, the living organisms synthesize their food on their own.

- **Photoautotrophs:** Green plants synthesize food through the process of photosynthesis known as **Photoautotrophs.**
- **Chemoautotrophs:** Some non-green bacteria like sulphur bacteria use chemical energy to manufacture their food known as **Chemoautotrophs.**

(B) Heterotrophic nutrition: (Hetero = different, Trophic = food). In this mode of nutrition, the living organisms depend upon autotrophs for their food supply either directly or indirectly.

- **Holozoic nutrition (Holo- Complete + Zoon- animal)**

Holozoic nutrition means animals obtain their nourishment by ingesting the whole food.

(a) Herbivores: Animals which depend on green plants are known as herbivores.
Ex: Goat, Cow, Deer, Rabbit etc.

(b) Carnivores: Animals which eat other animals as food are called as carnivores.
Ex. Lion, Tiger etc.

(C) Omnivores: Animals which eat both plants and animals as food are known as omnivores.
Ex: Rat, Pigs, Crows, Cockroaches and Humans etc.

- **Saprophytic Nutrition:** Organisms obtain their food from decaying organic substances. Ex. Bacteria, Fungi.
- **Parasitic Nutrition:** Organisms that live in or on other living organisms and derive their food from them shows**Parasitic Nutrition.**

Ex: Tape worm, Ascaris, Plasmodium, Liver flukes, Cuscuta, Mistletoe, Apodanthes etc.

- **Mutualistic Nutrition:** Symbiosis or mutualism is a partnership between two organisms in which both partners get benefited from each other.

  Ex. Lichen

- **Sanguivores:** Animals which depends on the blood of other animals.

  Ex: Bedbug, mosquito, Leech etc.

INSECTIVOROUS PLANTS

Insectivorous plants are the plants which feed on insects. They are green and synthesize their own food by the process of photosynthesis, but they also feed on insects to obtain their nitrogen as nutrition.

These plants grow in the soils that are usually nitrogen-deficient, therefore they use the nitrogen as nutrition which is obtained from insects to supplement the food they prepare by photosynthesis. Examples of such plants are **pitcher plant** *(Nepenthes)*, **Venus flytrap** *(Dionaea)*, **sundew, bladderwort,** etc. These plants have developed special mechanisms to trap, digest and absorb the insects.

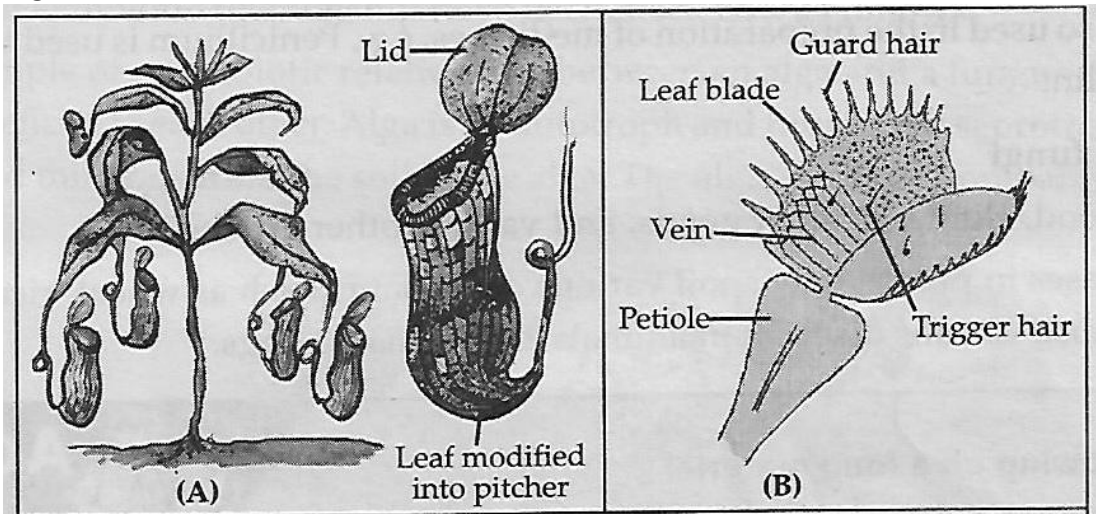


Fig. : (A) *Nepenthes*, (B) Venus flytrap

3. PHOTOSYNTHESIS (FOOD MAKING PROCESS IN PLANTS)

PHOTOSYNTHESIS

- **Plants- As Autotroph:**

  Most plants can prepare their food from sample inorganic substances. Plants are therefore, called autotrophs (auto-self; troph-food). They make their food by the process of photosynthesis.

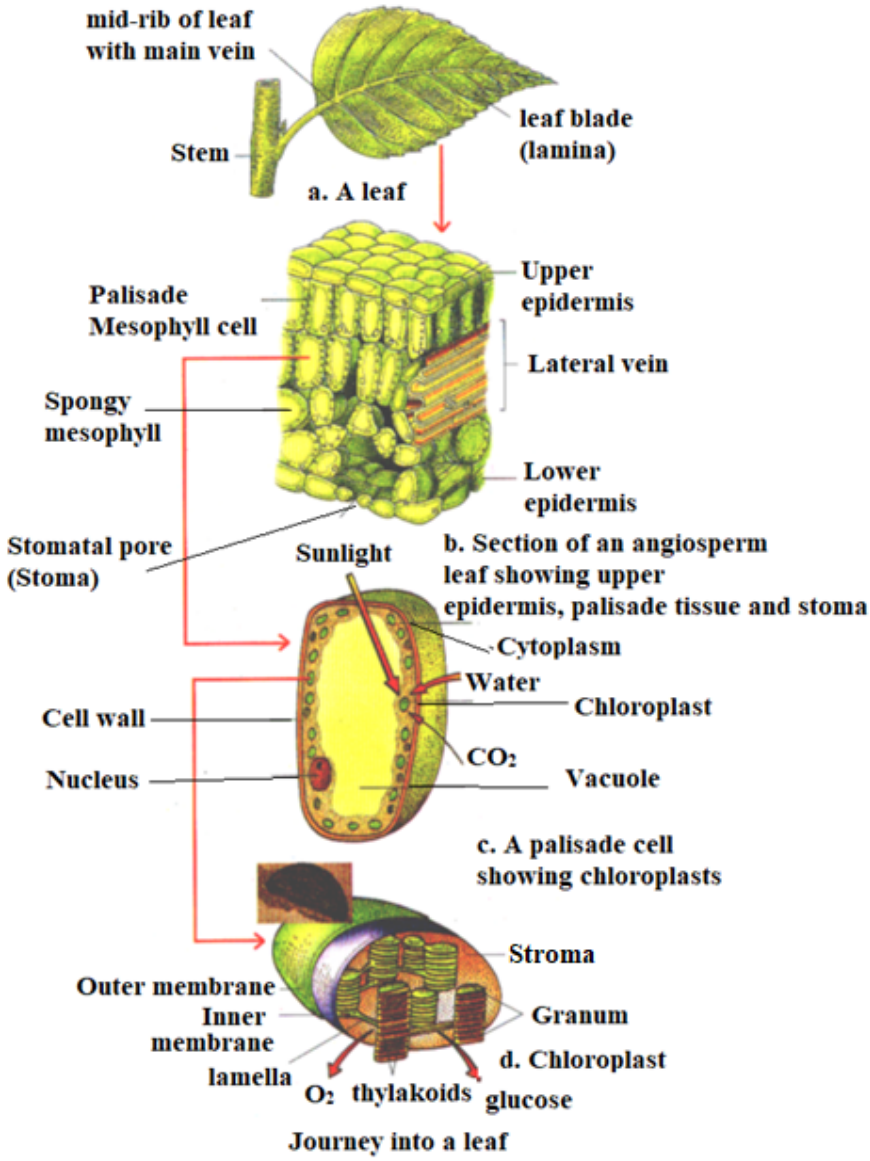
- **Photosynthesis:**

Photosynthesis is defined as the process by which green plants manufacture carbohydrates from atmospheric carbon dioxide and water from the soil, in the presence of sunlight.

The term photosynthesis was coined by Charles Reid Barners in 1893.

$$\text{Carbon dioxide} + \text{water} \xrightarrow[\text{chlorophyll}]{\text{light energy}} \text{glucose} + \text{oxygen}$$

$$6CO_2 + 12H_2O \xrightarrow[\text{Solar energy}]{\text{Chlorophyll}} C_6H_{12}O_6 + 6H_2O + 6O_2 \uparrow$$



Conditions Necessary for Photosynthesis:

Green plants need the following things to prepare their own food.

1. Carbon dioxide
2. Chlorophyll
3. Sunlight
4. Water and minerals

- **Stomata:** Minute opening present on the undersurface of the leaf for gaseous exchange.
- **Chloroplast:** Special photosynthetic organelle which contain chlorophyll.
- **Chlorophyll:** A green pigment present in the leaves which trap solar energy for photosynthesis.
- **Thylakoid:** Inside each chloroplast there are stacks of discs, each disc called a thylakoid. They contain chlorophyll and help to trap sunlight.
- **Grana:** The stacks of thylakoids are called grana. The light reaction takes place here.
- **Stroma:** The grana are arranged in a fluid matrix called stroma. The dark reactions take place here.

PROCESS OF PHOTOSYNTHESIS

Using the energy from the sun, a chemical reaction takes place in the green parts (chlorophyll) of the plant, in which carbon dioxide and water are converted into food in the form of glucose. Green plants take carbon dioxide from air and absorb water from the soil. Oxygen is released in the process. In this process solar energy is converted into chemical energy which is stored in the food.

The entire process of photosynthesis is divided in the following two major steps or reaction.

(i) Light reaction **(ii)** Dark reaction

1. **Light reaction or Photochemical reaction or Hill reaction:**

The light reaction takes place only in the presence of light in the grana (or thylakoids) of the chloroplasts. Hence, the name 'light' reaction and 'photochemical' reaction. It is also known as hill reaction because a scientist Robert Hill has discovered it.

2. **Dark reaction or Calvin cycle or Bio-synthetic reaction:**

The dark reaction is independent of light, i.e., it can occur even in the absence of light. It is slower than the light reaction and takes place in the stroma of the chloroplasts. The reactions taking place in this process were elucidated by Calvin and his co-workers. Hence, the dark reaction is also called 'Calvin cycle'.

FACTORS AFFECTING PHOTOSYNTHESIS

Mechanism of photosynthesis is affected by several external and internal factors. They are:

- **Light:** The rate of photosynthesis increases with increase in light intensity.

Highest rate of photosynthesis: Red light

Minimum photosynthesis: Green light

- **Temperature:** The rate of photosynthesis increases with rising temperature. Above 40°C, there is decrease in photosynthesis.

Optimum range = 25°C to 30°C.

- **Carbon dioxide:** The rate of photosynthesis increases with increasing CO_2 concentration of the environment. At very high concentration, photosynthesis decreases as it causes closing of stomata resulting in inhibition of gaseous exchange.
- **Water:** The rate of photosynthesis is lowered if the plants are inadequately supplied with water. Decrease in water causes closure of stomata.

INTERNAL FACTORS

- **Chlorophyll content:** Chlorophyll is essential for photosynthesis. Photosynthesis does not occur in the non-green parts of variegated leaves or in etiolated plants. (A plant is said to be etiolated when its leaves turn yellow, and the stem becomes long and pale due to prolonged absence of light.)
- **Accumulation of end products of photosynthesis:** The buildup of carbohydrates in the photosynthesizing cells slows down the rate of photosynthesis.
- **Anatomy of leaf:** The rate of photosynthesis is greatly influenced by the internal structure of the leaf. The thickness of the cuticle and epidermis, the number, structure, and distribution of stomata, and the arrangement of various tissues in the leaf affect the amount of light and carbon dioxide that can enter through the stomata.

End products of photosynthesis

The end products of photosynthesis are:

(i) glucose **(ii)** oxygen **(iii)** water

(i) Glucose ($C_6H_{12}O_6$) is either immediately utilized by the cells or stored in the form of sucrose, starch or cellulose and used in the synthesis of complex molecules like proteins and fats.

(ii) A small fraction of the oxygen produced during photosynthesis may be used by the plant for respiration while the major portion of it diffuses out through the stomata into the atmosphere.

(iii) Water produced during photosynthesis may be reused by the plant for photosynthesis.

Importance of Photosynthesis:

1.It makes food for plants.

2.It is primary source of food production for all other living organisms in the world.

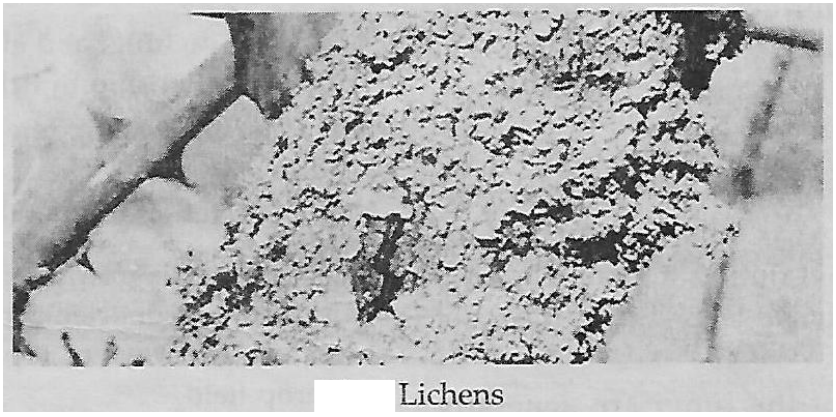
3.It maintains balance between oxygen and carbon dioxide in the atmosphere.

4. SYMBIOSIS

SYMBIOSIS - A SPECIAL MODE OF NUTRITION

When two organisms live together and share shelter and nutrients, their association is called symbiosis or symbiotic relationship, and the organisms are called symbionts. They mutually help each other. Few important examples of symbiotic relationship have been discussed as follows.

(i) Lichen is an example of a symbiotic relationship between an alga and a fungus that live together and are mutually beneficial to each other. Alga is an autotroph and fungus is a saprotroph. Fungus provides shelter, water, and minerals from the soil to the alga. The alga, in return, prepares food for the fungus by photosynthesis.



Lichens

(ii) Mycorrhiza serves another example of symbiosis in which certain fungi live in the roots of some trees. The tree being photosynthetic provides nutrients to the fungi and fungi help the plant to take up water and nutrients from the soil.

(iii) Leguminous plants and *Rhizobium* bacteria show symbiotic relationship with each other. *Rhizobium* can take atmospheric nitrogen and convert it into a soluble form (soluble nitrogenous compounds) in the soil that the plant can absorb. Rhizobium is a heterotrophy. It cannot make its own food and therefore, lives in the roots of leguminous plants like beans, gram, peas and moong where it gets food and shelter. In return, it provides the plant with nitrogen.

NUTRITION IN PLANTS

WORK SHEET LEVEL–I

SINGLE CORRECT ANSWER TYPE QUESTIONS

AUTOTROPHIC NUTRITION

1. Which of the following options contains autotrophic organisms only?
   1) Rose, Cuscuta, Hydrilla 2) Nepenthes, Rafflesia, Hibiscus
   3) Bougainvillea, rose, Hibiscus 4) Cuscuta, pitcher plant, mistletoe
2. An example of an autotrophic plant is .....
   1) Mushroom 2) Mould 3) Dodder 4) Neem
3. The life processes that provide energy are
   1) nutrition 2) respiration
   3) both nutrition and respiration 4) response to stimuli

HETEROTROPHIC NUTRITION

4. Which of the following organisms is not an autotroph?
   1) Pitcher plant 2) Mango tree 3) Alga 4) Fungus
5. Which of the following statements is correct regarding the given structure?

   1) It is the insect-catching organ of a parasitic plant.
   2) It is the modification of leaf.
   3) It is the pitcher of plant Venus flytrap.
   4) It is the haustorium of a parasitic plant.
6. Which of the following statements is true regarding insectivorous plants?
   1) They are called as partial heterotrophs.
   2) They exhibit both autotrophic and heterotrophic modes of nutrition.
   3) They trap and digest insects to obtain N_2-nutrition.
   4) All of these
7. Lichen is an association between
   1) an alga and a fungus 2) an alga and a tree
   3) a fungus and a tree 4) bacteria and legume plant.

8. Select the mismatched pair.
   1) Venus flytrap — An insectivorous plant
   2) Black bread mould — A saprotroph
   3) Rafflesia — A total parasite
   4) Rhizobium — An autotroph

PHOTOSYNTHESIS

9. The essentialgas required for the process of photosynthesis is
   1) carbon dioxide 2) oxygen 3) ammonia 4) none of these
10. What is the ultimate source of energy input to biological systems?
   1) Carbohydrates from plants 2) Light from the sun
   3) Nutrients from the soil 4) Oxygen from the air
11. Photosynthesis converts
   1) solar energy to mechanical energy 2) mechanical energy to solar energy
   3) solar energy to chemical energy 4) chemical energy to solar energy.

SYMBIOSIS

12. Symbiotic relationship is one, in which
   1) organisms feed on dead and decaying organic matter
   2) organisms trap and feed on insects.
   3) two organisms live together and get benefitted from each other.
   4) one organism grows as parasite on the body of other
13. An example of nitrogen fixing symbiotic bacteria is
   1) Rhizobium 2) E. coli 3) Mycobacterium 4) none of these

LEVEL–II

AUTOTROPHIC NUTRITION

14. Green plants are called as autotrophs because
   1) they prepare their own food by photosynthesis
   2) they cannot prepare their own food
   3) they convert organic matter into simple soluble form
   4) they depend on bacteria to obtain N_2 nutrition.
15. Autotrophic nutrition occurs in
   1) Fungi 2) Plants
   3) Some protists and prokaryotes 4) Both 2 and 3

HETEROTROPHIC NUTRITION

16. _____is a leafless and rootless parasitic plant that derives its nutrition from a living host plant.
    1) Nepenthes 2) Venus flytrap 3) Cuscuta 4) Mistletoe
17. Select the mismatched pair out of the following.
    1) CO_2 — Raw material of photosynthesis
    2) Chlorophyll — Absorbs green light
    3) Stomata — Present on leaf surface
    4) O_2 — By-product of photosynthesis
18. Which of the following statements is correct regarding stomata?
    1) Stomata are tiny pores present on leaf surface.
    2) They help in gaseous exchange during photosynthesis.
    3) The opening and closing of stomata depend on guard cells.
    4) All of these are correct
19. Mistletoe is a _____ parasitic plant that _____ green leaves.
    1) partial, does not possess 2) partial, possesses
    3) total, possesses 4) total, does not possess
20. Refer the given picture.

    Select the incorrect statement regarding the organism shown in it.
    1) It is a fungus.
    2) It feeds on dead organic matter.
    3) It can synthesize its own food.
    4) Some of its varieties are edible whereas some are poisonous.
21. In the relationship between dodder and its host plant
    1) host plant isbenefitted, and dodder is harmed.
    2) host plant is harmed, and dodder is benefitted.
    3) both the dodder and the host plant are harmed.
    4) both the dodder and the host plant are benefitted.

22. In Nepenthes (pitcher plant), _____ is modified to form pitcher.
1) root 2) stem 3) leaf 4) flower

PHOTOSYNTHESIS

23. Which of the following organisms are capable of performing photosynthesis?
1) Algae 2) Green plants
3) Insectivorous plants 4) All of these

24. Which of the following equations correctly represents the process of photosynthesis?
1) Carbon dioxide + Water $\xrightarrow[\text{Chlorophyll}]{\text{Sunlight}}$ Carbohydrates + Proteins
2) Carbon dioxide + Carbohydrates $\xrightarrow[\text{Chlorophyll}]{\text{Sunlight}}$ Oxygen + Water
3) Carbon dioxide + Water $\xrightarrow[\text{Chlorophyll}]{\text{Sunlight}}$ Carbohydrates + Oxygen+Water
4) Oxygen + Water $\xrightarrow[\text{Chlorophyll}]{\text{Sunlight}}$ Carbon dioxide + Carbohydrates

25. Which of the following options contains end products of photosynthesis?
1) $C_6H_{12}O_6 + O_2 + H_2O$ 2) $CO_2 + H_2O$
3) $C_6H_{12}O_6 + CO_2$ 4) $CO_2 + O_2$

26. Green plants synthesize their food in the form of
1) starch 2) glucose 3) proteins 4) cellulose