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It is the team-work of Lakhmir Singh and Manjit Kaur which has given some of the most popular books in the history of science education in India. Lakhmir Singh and Manjit Kaur both write exclusively for the most reputed, respected and largest publishing house of India : S. Chand and Company Pvt. Ltd.

An Open Letter

Dear Friend,

We would like to talk to you for a few minutes, just to give you an idea of some of the special features of this book. Before we go further, let us tell you that this book conforms to the NCERT guidelines prescribed by the Central Board of Secondary Education (CBSE). Just like our earlier books, we have written this book in such a simple style that even the weak students will be able to understand science very easily. Believe us, while writing this book, we have considered ourselves to be the students of the concerned class and tried to make things as simple as possible.

The most important feature of this book is that we have included a large variety of different types of questions for assessing the learning abilities of the students. This book contains:

(*i*) Objective type questions,

(*ii*) Subjective type questions,

(*iii*) Multiple Choice Questions (MCQs),

(*iv*) Questions based on High Order Thinking Skills (HOTS), and

(*v*) Activities.

Please note that answers have also been given for the various types of questions, wherever required. All these features will make this book even more useful to the students as well as the teachers. “A picture can say a thousand words”. Keeping this in mind, a large number of coloured pictures and sketches of various scientific processes, procedures, appliances, manufacturing plants and everyday situations involving principles of science have been given in this book. This will help the students to understand the various concepts of science clearly. It will also tell them how science is applied in the real situations in homes, transport and industry.

We are sure you will agree with us that the facts and formulae of science are just the same in all the books, the difference lies in the method of presenting these facts to the students. In this book, the various topics

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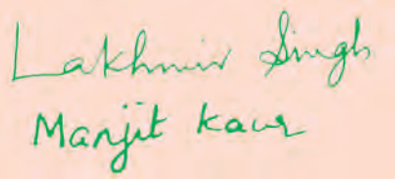
of science have been explained in such a simple way that while reading this book, a student will feel as if a teacher is sitting by his side and explaining the various things to him. We are sure that after reading this book, the students will develop a special interest in science and they would like to study science in higher classes as well.

We think that the real judges of a book are the teachers concerned and the students for whom it is meant. So, we request our teacher friends as well as the students to point out our mistakes, if any, and send their comments and suggestions for the further improvement of this book.

Wishing you a great success,

Yours sincerely,



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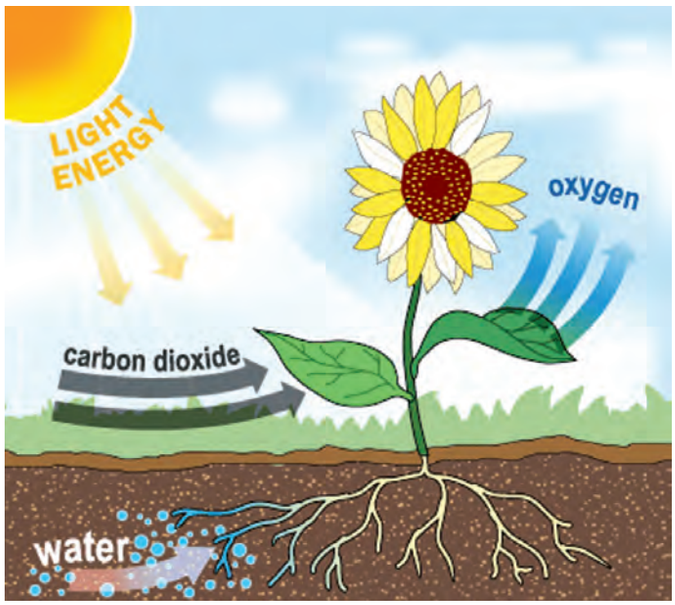


Nutrition in Plants

All the living organisms (plants and animals) require food. The organisms need to take food (*i*) to obtain energy (*ii*) to obtain materials for growth, and (*iii*) to obtain materials for the repair of damaged parts of the body. **The process of taking food by an organism as well as the utilisation of this food by the organism is called nutrition**. Plants can make their own food but animals (including human beings) cannot make food themselves. They obtain food from plants or other animals that eat plants. Thus, human beings and animals depend on plants for their food, directly or indirectly. We will now discuss the various modes of nutrition in organisms.

MODES OF NUTRITION

The methods of obtaining food are called modes of nutrition. On the basis of their modes of nutrition, all the organisms can be divided into two main groups :

1. Autotrophs (or Autotrophic), and
2. Heterotrophs (or Heterotrophic).

We will now describe both these modes of nutrition of organisms in detail, one by one.

Autotrophs : Autotrophic Mode of Nutrition

Those organisms which can make food themselves from simple substances (like carbon dioxide and water) by the process of photosynthesis, are called autotrophs (and their mode of nutrition is called autotrophic). All the **green plants are autotrophs.** This is because green plants can make their own food from simple substances like carbon dioxide and water present in their surroundings by the process of photosynthesis. In other words, **green plants have autotrophic mode of nutrition.** For example, wheat plants are autotrophs (having autotrophic mode of nutrition). Autotrophs contain a green pigment called chlorophyll which helps them make food by absorbing energy from sunlight. Most of the plants are green

and hence synthesise (make) their own food (see Figure 1). This means that most of the plants have autotrophic mode of nutrition. The green plants produce food not only for themselves, they also make food for non-green plants as well as for animals (including human beings).

Our body (and that of other animals) cannot make food from carbon dioxide and water present around us by the process of photosynthesis (like the plants do) because **our body does not have the green pigment called chlorophyll (which the plants have)**.The green pigment chlorophyll is necessary to absorb energy from sunlight required for making food by photosynthesis.

Figure 1. Green plants can make food themselves by photosynthesis, so they are autotrophs. Green plants have autotrophic mode of nutrition.

Heterotrophs : Heterotrophic Mode of Nutrition

Those organisms which cannot make food themselves by the process of photosynthesis and take food from green plants or animals, are called heterotrophs (and their mode of nutrition is called heterotrophic). All the **non-green plants and animals (including human beings) are heterotrophs**.The non-green plants do not have chlorophyll for carrying out the process of food making called photosynthesis. So, they depend on other organisms (plants or animals) for obtaining their food. The non-green plants called fungi (such as mushroom, yeast and bread mould) are heterotrophs. They have heterotrophic mode of nutrition. Certain bacteria are also heterotrophs. All the animals (including human beings) are categorised as heterotrophs because they cannot make their own food, they depend on plants or other animals for obtaining their food. Thus, all the animals like cat, dog, goat, cow, buffalo, deer, lion, tiger and human beings are heterotrophs having heterotrophic mode of nutrition (see Figure 2).

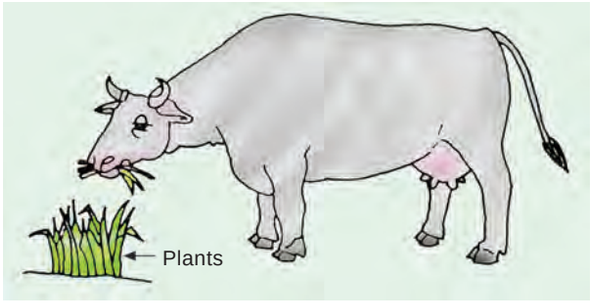


Figure 2. Animals obtain their food from other organisms (like plants or other animals), so they are heterotrophs. Animals have heterotrophic mode of nutrition. This cow is an animal which is eating plants as food.

PHOTOSYNTHESIS : FOOD MAKING PROCESS IN PLANTS

Green plants are autotrophic and synthesise (or make) their own food by the process of photosynthesis. **The green plants make their food from simple inorganic substances like carbon dioxide and water in the presence of sunlight.** The plants use the energy in sunlight to prepare food in the presence of a green colouring matter called 'chlorophyll' present in the leaves of a green plant. We can now define photosynthesis as follows :

The process by which green plants make their own food (like glucose) from carbon dioxide and water by using sunlight energy (in the presence of chlorophyll) is called photosynthesis. The process of photosynthesis can be represented by a word equation as follows :

$$\underset{\text{(From air)}}{\text{Carbon dioxide}} + \underset{\text{(From soil)}}{\text{Water}} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \underset{\text{(A carbohydrate) (Food)}}{\text{Glucose}} + \underset{\text{(Goes into air)}}{\text{Oxygen}}$$

Chlorophyll is present in the green leaves. So, the process of photosynthesis takes place in the leaves of a plant. **Oxygen gas is produced during photosynthesis**. This oxygen goes into the air. The oxygen gas released in photosynthesis is utilised by all the living organisms for their survival. The process of photosynthesis can be shown with the help of a diagram given in Figure 3.

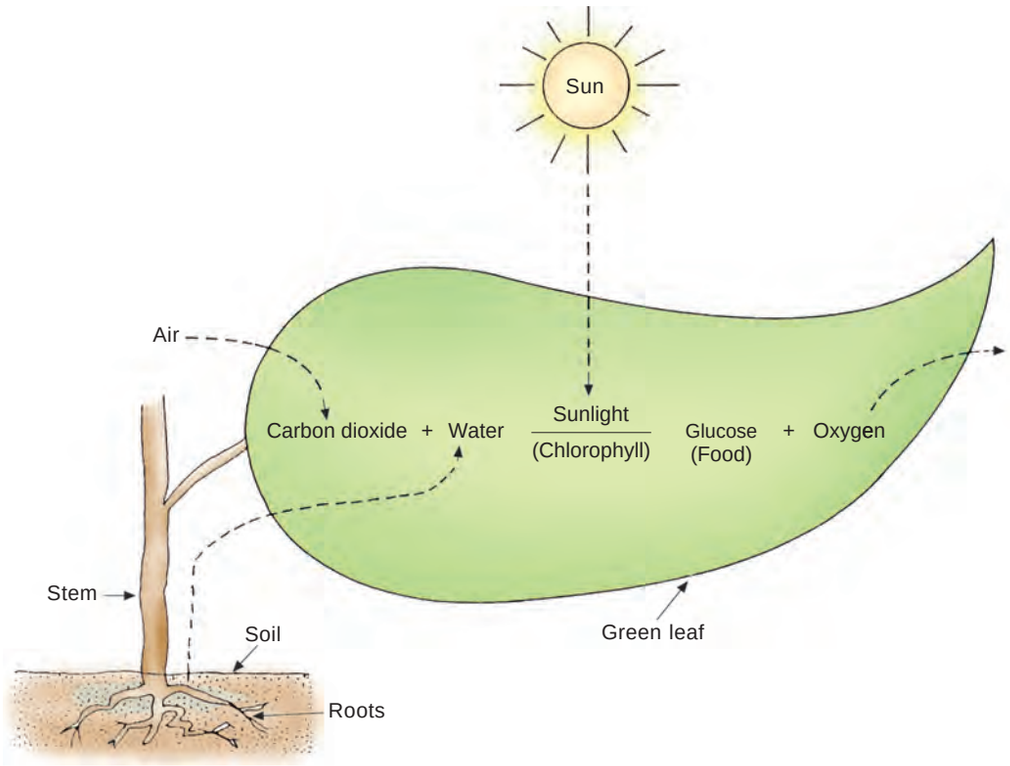


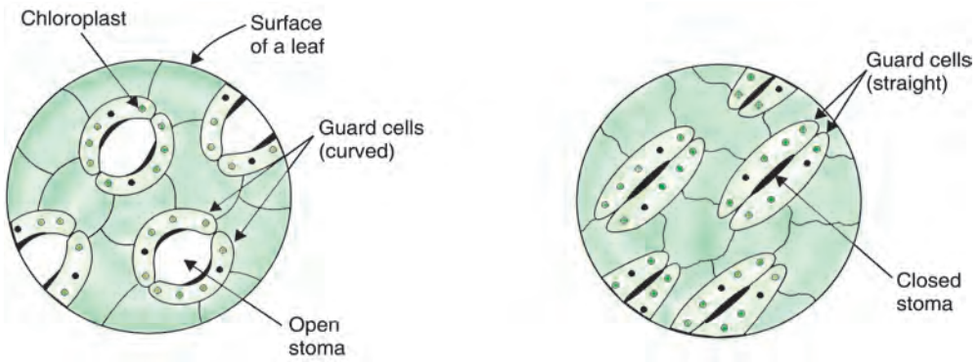
Figure 3. Diagram to show the process of photosynthesis.

The process of photosynthesis first produces a simple carbohydrate called 'glucose' as food. The glucose carbohydrate then gets converted into a complex carbohydrate called 'starch'. This **starch gets stored as food in the various parts of plant including leaves**. In fact, the presence of starch in the leaves shows the occurrence of photosynthesis in a plant. Some of the glucose is also converted into other types of plant foods such as fats and oils, proteins as well as vitamins. The synthesis of food (or making of food) occurs in the leaves of a plant (or tree). So, **leaves are the food factories of a plant.** The leaves of a plant can synthesise food because they contain a green pigment chlorophyll (which is necessary for making food). Other parts of a plant usually cannot synthesise food because they do not contain chlorophyll.

Conditions Necessary for Photosynthesis

The presence of carbon dioxide, water, chlorophyll and sunlight is necessary for the process of photosynthesis to take place. Photosynthesis cannot occur in the absence of any one of these conditions. We will now describe how the leaves of a plant get carbon dioxide and water required for making food by photosynthesis and what are the roles of chlorophyll and sunlight in photosynthesis.

1. How the Plants Obtain Carbon Dioxide for Photosynthesis. The plants take carbon dioxide gas needed for photosynthesis from the air. The plants take carbon dioxide gas from air through the tiny pores (called stomata) present on the surface of leaves (The singular of stomata is stoma). Actually, there are a large number of tiny pores called stomata on the the surface of leaves of plants (see Figure 4). Each pore (or stoma) is surrounded by a pair of guard cells. The opening and closing of stomatal pores in the leaves is controlled by the guard cells. Figure 4(*a*) shows open stomatal pores whereas Figure 4(*b*) shows the stomatal pores in closed position. The carbon dioxide gas present in air enters the leaves of a plant through the stomatal pores present on their surface and utilised in photosynthesis. The oxygen gas produced in the leaves during photosynthesis goes out into air through the same stomatal pores.The stomatal pores of leaves open only when carbon dioxide is to be taken in or oxygen is to be released otherwise they remain closed.



(*a*) Open stomata (*b*) Closed stomata

Figure 4. Tiny pores called stomata are present on the surface of leaves (one pore is called stoma).

2. How the Plants Obtain Water for Photosynthesis. The plants take water needed for photosynthesis from the soil. Soil always contains some water in it. Water present in the soil is absorbed by the roots of a plant and then transported to the leaves through the vessels which run like inter-connected pipes throughout the roots, stem, branches and leaves. The tiny, pipe-like vessels which transport water from the roots of a plant to its leaves are called xylem.

The plants also need minerals to make foods other than carbohydrates. For example, plants need nitrogen mineral to make proteins. The minerals are present in the soil (and have to be transported to the leaves). The minerals dissolve in water present in the soil and get transported with it. So, we can now say that : *Water and minerals present in the soil are absorbed by the roots of a plant and transported to its leaves through the inter-connected pipe-like xylem vessels present throughout the roots, stem, branches and leaves of the plant*.

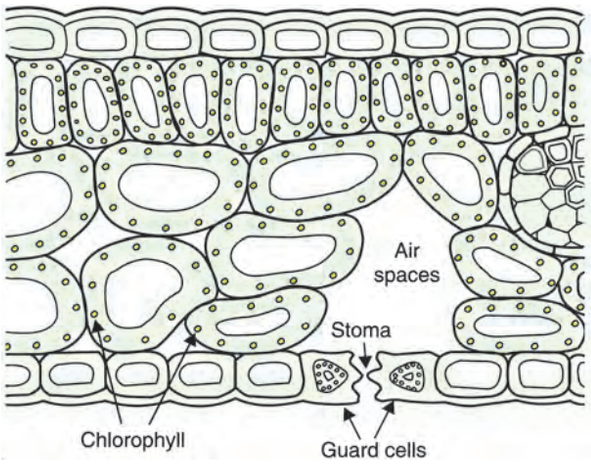


Figure 5. The inner structure of a leaf to show chlorophyll in it. The various compartments shown in the above figure are cells of the leaf. The tiny green structures in the cells are chloroplasts which contain chlorophyll.

3. The Role of Chlorophyll in Photosynthesis. Chlorophyll is a green substance which is present in the leaves of plants. In fact, it is the presence of chlorophyll which makes the leaves look green. Chlorophyll can absorb the energy from sunlight. The sunlight energy absorbed by chlorophyll is used to combine carbon dioxide and water in the green leaves to produce food (like glucose). We can now write the role of chlorophyll in photosynthesis as follows : **Chlorophyll absorbs light energy from the sun and supplies this energy to the leaves to enable them to carry out photosynthesis for making food.** Since the combination of carbon dioxide and water to make food (like glucose) occurs in the presence of sunlight, the process is called photosynthesis (Photo = light, and synthesis = to combine). Please note that chlorophyll is present in every leaf of a plant in the form of hundreds of tiny structures called chloroplasts (see Figure 5).

4. The Role of Sunlight in Photosynthesis. The sunlight supplies energy for the food making process called photosynthesis. The sun's energy (or solar energy) is captured by plant leaves with the help of chlorophyll and converted into chemical energy of food. Thus, solar energy is converted into chemical energy during photosynthesis. This chemical energy gets stored in the form of plant food. So, when plants (or animals) utilise the food made by photosynthesis, they actually use the solar energy stored in it in the form of chemical energy. **Since all the food on this earth is made by utilising solar energy, therefore, sun is the ultimate source of energy for all the living organisms**.

ACTIVITY TO TEST THE PRESENCE OF STARCH IN LEAVES

Leaves make starch as food by photosynthesis. The presence of starch in leaves can be tested as follows :

(*i*) Pluck a green leaf from a plant.

(*ii*) Boil the leaf in alcohol to remove the green pigment chlorophyll from it.

(*iii*) Wash the decolourised leaf with water to remove any chlorophyll sticking to it.

(*iv*) Pour dilute iodine solution from a dropper over the decolourised leaf.

(*v*) Appearance of blue-black colour in leaf shows the presence of starch in it.

Leaves of Various Colours

Most of the plants have green coloured leaves. Some of the plants, however, have leaves of other colours such as red, violet, brown, etc. (see Figure 6). The leaves having colours other than green also have chlorophyll in them. Actually, the large amount of red, violet, brown or other pigments in such leaves masks the green colour of chlorophyll. So, photosynthesis also takes place in leaves having colour other than green.

Figure 6. Leaves of various colours.

Photosynthesis by Plant Parts Other Than Leaves

Normally photosynthesis takes place only in the leaves of plants. In some plants, however, photosynthesis also takes place in other parts of plants such as "green stems" and "green branches". The green stems and green branches can do photosynthesis because they contain chlorophyll. For example, the desert plants such as cactus have tiny, spine-like leaves to reduce the loss of water by transpiration. These tiny, spine-like leaves of a cactus plant cannot do photosynthesis. The stem and branches of a cactus plant are green which contain chlorophyll (see Figure 7). So, the green stem and green branches of a cactus plant carry out the process of photosynthesis to make food for the plant. Please note that only those stems and branches which are green in colour can do photosynthesis. Now, the stems and branches of all the plants and trees are not green. So, the stems and branches of all the plants and trees cannot do photosynthesis.

Figure 7. The green stem and branches of a cactus plant contain chlorophyll and hence carry out photosynthesis.

Photosynthesis by Algae

Many times we have seen patches of slimy, green layer floating on the surface of a pond or lake, or even in the stagnant parts of a river (see Figure 8). It also develops in the swimming pools which have not been cleaned for a long time. This green layer is formed by the growth of tiny green plant-like organisms called algae (Algae is pronounced as algee. The singular of algae is alga). It is called *shaiwal* in Hindi. **Algae are a large group of simple, plant-like organisms**. Algae contain chlorophyll and produce food by photosynthesis just like plants. **Algae, however, differ from plants because they do not have proper roots, stems and leaves**. The green colour of algae is due to the presence of chlorophyll in them.

Figure 8. The green layer floating on the surface of water in this lake is that of algae.

Synthesis of Plant Foods Other Than Simple Carbohydrate (Glucose)

The simplest food synthesised by the plants by photosynthesis is a simple carbohydrate called 'glucose'. The glucose carbohydrate is made up of three elements : carbon, hydrogen and oxygen. The plants use the simple carbohydrate glucose to make many other foods such as starch, oils (or fats), proteins and vitamins. This is discussed below.

(*i*) Plants Make Starch as Food. Some of the simple carbohydrate 'glucose' made by the plants through photosynthesis is converted naturally into a complex carbohydrate called 'starch'. The starch is a food which is stored in various parts of a plant such as roots, stem, leaves and seeds. For example, the seeds (or grains) of wheat and rice have a lot of starch in them. Potato and carrot plants store a lot of starch in their roots.

(*ii*) Plants Make Oils (or Fats) as Food. Certain plants convert the simple carbohydrate glucose made during photosynthesis into oils and store them in their seeds. Such seeds are called oil-seeds and give us oil (or fats) for cooking food. For example, the seeds of sunflower plant contain a lot of oil stored in them. We can extract oil from sunflower seeds and use it as a food. The oils obtained from plant seeds are commonly known as vegetable oils. Please note that just like carbohydrates glucose and starch, oils (and fats) are also made up of the same three elements : carbon, hydrogen and oxygen.

(*iii*) Plants Make Proteins as Food. In addition to carbon, hydrogen and oxygen, proteins also contain nitrogen element. Plants combine some of the glucose carbohydrate made during photosynthesis with nitrate minerals (obtained from soil) to make amino acids which are then made into proteins. In this way, plants make proteins as food.

Proteins are nitrogenous substances which contain nitrogen element. We will now discuss from where do the plants obtain nitrogen for making proteins. This happens as follows : Nitrogen element is present in abundance in air in the form of nitrogen gas. However, the plants cannot absorb nitrogen gas for their needs (like making proteins). Now, the soil has certain bacteria which convert nitrogen gas of air into nitrogen compounds (like nitrates) and release them into soil. Nitrates are the water soluble nitrogen compounds which are absorbed by the plants from the soil alongwith water. In this way, the plants fulfil their requirement of nitrogen. The plants also obtain nitrogen from the nitrogenous fertilisers which the farmers add to the soil in the fields from time to time.

(*iv*) Plants Make Vitamins as Food. Vitamins are highly complex substances which are an important part of our food. Vitamins are made by plants. Vitamins are contained in vegetables, fruits and cereals made by plants. Animals usually cannot make vitamins.

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