chapter 1

# Nutrition in Plants

In previous class you learnt that food is essential for all living organisms. You also learnt that carbohydrates, proteins, fats, vitamins and minerals are components of food. These components of food are necessary for our body and are called nutrients.

All living organisms require food. Plants can make their food themselves but animals including humans cannot. They get it from plants or animals that eat plants. Thus, humans and animals are directly or indirectly dependent on plants.

**In this chapter, we will learn about :**

1. The various modes by which plants obtain nutrition
2. The process of photosynthesis

## MODES OF NUTRITION IN PLANTS

Plants are the only organisms that can prepare food for themselves by using water, carbon dioxide and minerals. The raw materials are present in their surroundings.

The nutrients enable living organisms to build their bodies, to grow, to repair damaged parts of their bodies and provide the energy to carry out life processes. Nutrition is the mode of taking food by an organism and its utilisation by the body.

Mode of nutrition is of two types :

1. Autotrophic nutrition, 2. Heterotrophic nutrition

### 1. Autotrophic Nutrition

Auto = self, Trophic = nutrition. The literal meaning of this term is self-nutrition. Autotrophic nutrition is the process of an organism being able to create/produce its own food. Autotrophic nutrition refers to a nutritional system whereby complex full molecules essential for life emerge through photosynthesis. This includes compounds such as fats, proteins and carbohydrates.

Minerals, water and carbon dioxide have a direct impact on autotrophic nutrition. Through this type of nutrition, plants can produce their own food, i.e. they use autotrophic nutrition to feed themselves and grow.

Common autotrophs include, but are not limited to: microscopic bacteria, certain types of algae and the majority of green plants.

### Maximum Yield Explains Autotrophic Nutrition

Autotrophs usually feature chlorophyll, a green-coloured pigment that traps energy from the sunlight. Consequently, the plant uses this trapped energy to process carbon dioxide and water into glucose. In some cases, the energy absorbed can separate water molecules into oxygen and hydrogen.

**Interesting Fact**

Chlorophyll gives green colour to the plants because it absorbs blue and red lights and reflects green light.

The following parts of the plant play an active role in the process of autotrophic nutrition:

- **Roots :** During photosynthesis, the roots absorb water and minerals from the soil before distributing it to the rest of the plant.
- **Stomata :** Found in the leaf's lower epidermis, the stomata absorb carbon dioxide from the air during photosynthesis.
- **Leaves :** In vascular plants, the leaves come with chloroplasts that synthesize glucose through water and carbon dioxide.

Autotrophs are also sometimes called producers or self-feeders.

## 2. Heterotrophic Nutrition

The term 'heterotroph' consists of two words 'hetero' and 'troph'. 'Hetero' means 'others' and 'troph' means 'nutrition'. So, in heterotrophic nutrition the organisms cannot make their own food from carbon dioxide, water and sunlight as they do not have chlorophyll. Such organisms depend on plants directly or indirectly for their food. All the animals, fungi, some protists and bacteria have heterotrophic mode of nutrition.

Such organisms which cannot make their own food and thus depend on other organisms for their food are called heterotrophs. For example, animals, fungi, some protists and bacteria, etc.

### MaximumYield Explains Heterotrophic Nutrition

There are four main types of heterotrophic nutrition:

- **Insectivorous :** insect eating
- **Symbiotic :** cooperate with another organism for their mutual benefit
- **Parasitic :** live on another organism
- **Saprophytic :** decomposers

Heterotrophic plants are sometimes non-green in colour and depend on other sources of food because they lack sufficient amounts of chlorophyll to naturally produce their own food via photosynthesis, or because they live in nutrient-poor soil.

# PHOTOSYNTHESIS: FOOD MAKING PROCESS IN PLANTS

Photosynthesis is a process to convert the solar energy into chemical energy to synthesize starch.

## The Substances Required

The substances required for photosynthesis are sunlight, chlorophyll, carbon dioxide ($CO_2$) and water.

### 1. Sunlight

It is an essential substance for the process of photosynthesis. Chlorophyll, the green pigment present in leaves, absorbs sunlight and initiates photosynthesis.

**Interesting Fact**

The term 'Photosynthesis' was given by 'Charles Reid Barnes'.

**Activity 1**

**Aim :** To test that sunlight is necessary for photosynthesis.

**Procedure :** 1. Keep the potted plant in dark for about 48 hours (to destarch the leaves).

2. Select a healthy leaf and cover a part of it with aluminium foil strip.

3. Now keep the potted plant in sunlight for a whole day.

4. Pluck the covered leaf and remove the aluminium foil strip from it.

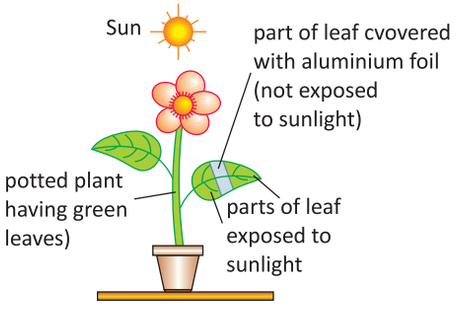
5. Put the leaf in the beaker, add some water and boil it. This makes the leaf soft.

6. Now place the leaf in the small beaker containing alcohol.

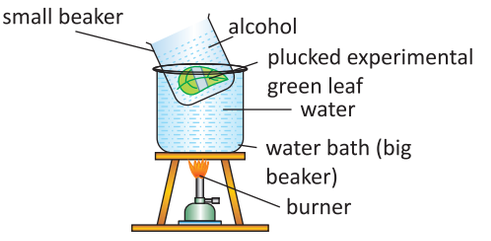
7. Place this beaker in the large beaker containing boiling water. This removes the green chlorophyll from the leaf.

8. Take out the leaf and keep it in a petri dish and wash it with water.

9. Using a dropper, pour some iodine solution on the leaf.




A. Potted plant with one leaf partly covered with aluminium foil and kept in sunlight




B. Chlorophyll being removed from green leaf by boiling it in alcohol

**Observation :** The portion of the leaf that was exposed to light turns blue-black (positive starch test). While the other portion which was covered does not show any colour change.

**Conclusion :** The covered portion did not turn blue-black because of the absence of starch in it. This confirms that only those parts of the leaf that were exposed to sunlight performed photosynthesis. This shows that sunlight is necessary for photosynthesis.

### 2. Chlorophyll

Chlorophyll present in leaves absorbs sunlight which is converted into chemical energy through the process of photosynthesis.

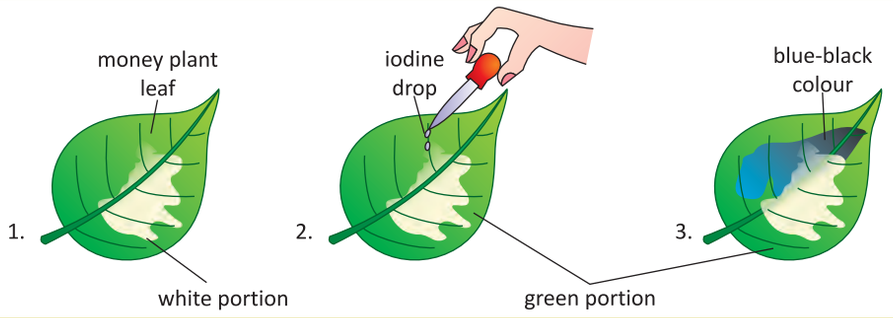
You might have seen leaves of red, brown, yellow or patches of colours. These coloured leaves also do photosynthesis from the hidden chlorophyll in such leaves.

**Activity 2**

**Aim :** To test that chlorophyll is necessary for photosynthesis.

**Materials required :** A money plant and iodine solution.

**Procedure :** Pluck a leaf from the money plant which has some green and white portions. Pour some drops of iodine solution over both the portions. Observe the colour change in both white and green portions of the leaf.




**Observation :** The green portion turns blue-black on addition of iodine while the white portion does not.

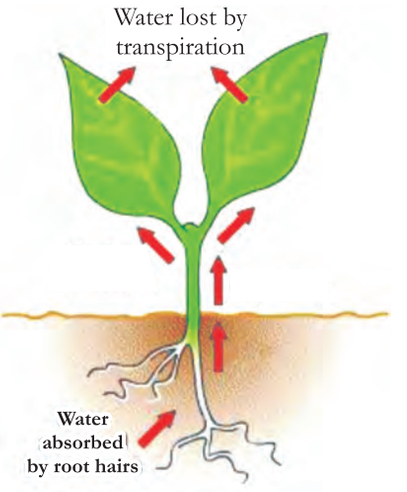
**Conclusion :** The green portion performs photosynthesis due to the presence of chlorophyll in it. As the white portion does not contain any chlorophyll, no photosynthesis occurs in this portion. This means that chlorophyll is necessary for photosynthesis.

### 3. Carbon Dioxide ($CO_2$)

The main substance used by plants in the synthesis of carbohydrate (glucose) is carbon dioxide. Carbon dioxide present in the atmosphere is taken in by plants, through the stomata, in their leaves. Thereafter, carbon dioxide on reacting with water, in the presence of sunlight and chlorophyll, forms glucose (carbohydrate).

### 4. Water

Water is another substance required for the synthesis of carbohydrates by plants. Water is absorbed by roots from soil. It is transported to the leaves through small pipe-like tissues called xylem.



Absorption of Water by Roots

**Interesting Fact**

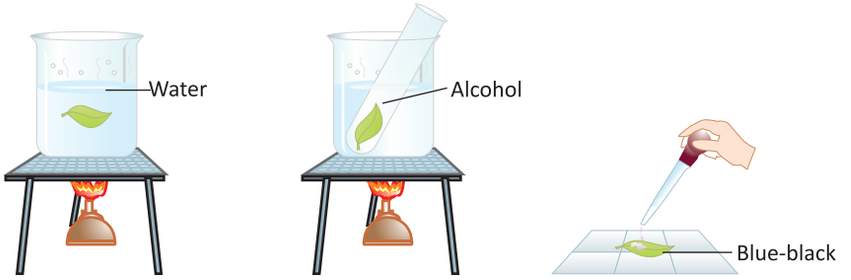
Photosynthesis maintains balance between oxygen and carbon dioxide ($CO_2$) in the atmosphere. This balance will be disturbed if there is no photosynthesis.

## Activity 3

**Aim :** To show that only green plants can photosynthesise.

**Materials required :** Beaker, water, leaf, test tube, alcohol and iodine.

**Procedure :** Take some water in a beaker. Then boil it for few minutes. Now put a leaf in this water for about two minutes. Then take out leaf and put it in a test tube filled with three-fourth part with alcohol. Now place this test tube in very hot water for about 10 minutes. When the alcohol warms up, it removes the chlorophyll from the leaf. Bring out leaf and add few drops of iodine solution on it.

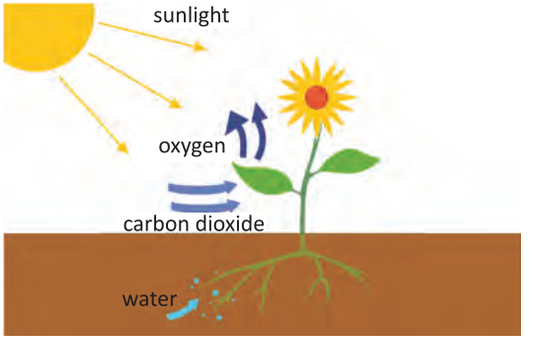



Testing a leaf

**Observation and Conclusion :** The colourless part shows no change while green part turns blue-black which shows that only green leaves can photosynthesise and make food.

Different parts of a plant play different roles to complete this process.

- **Leaves :** They are considered as the food factories of the plant.
- **Stomata :** These are present in the lower epidermis of the leaf which use carbon dioxide from the air.
- **Roots :** They absorb minerals and water from the soil and transport it to different parts of the plant.




To put it simply, plants require certain raw materials, in order to make their own food. These raw materials include carbon dioxide, water and sunlight. Plants get water from the soil that enters through the roots. And sunlight is the source of energy. But how does carbon dioxide enter the plants? You should first understand that carbon dioxide is a gas.

You have learnt in your earlier classes that plants have openings called stomata. Guard cells surround these stomata. These stomata are the openings through which carbon dioxide enters the plants. Gaseous exchange, i.e. the exchange of carbon dioxide and oxygen in plants occurs through these stomatal openings.

Water is also lost during the transpiration process through these openings. And hence, when the carbon dioxide requirement is met with for photosynthesis, plants close the stomata.

$$\underset{\text{Carbon Dioxide}}{6\ CO_2} + \underset{\text{Water}}{6\ H_2O} \xrightarrow{\text{light}} \underset{\text{Sugar}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6\ O_2}$$

The above equation shows the chemical reactions that occurs during photosynthesis.

Chlorophyll is present in structures called chloroplasts. They are disc-shaped organelles that are present in the mesophyll cells of the leaves. These help in trapping the sunlight within the plant. As the carbon dioxide enters the plant through the stoma, the light energy converts into chemical energy, by the splitting of the water molecules of the plants. Simple carbohydrates are produced in this process. Oxygen is a byproduct of photosynthesis.

In this way, plants are able to take up simple inorganic substances and convert them into simple carbohydrates, to meet their nutrient requirements.

### Importance of Photosynthesis

It is a very important process for the survival of plant and all organisms on the earth because :

1. Photosynthesis helps to maintain the balance between oxygen and carbon dioxide in the atmosphere.
2. Photosynthesis produces food for plants. These plants, in turn, provide food for other organisms like animals and human beings.
3. Photosynthesis provides oxygen to all organisms for breathing.

### Synthesis of Plant Food other than Carbohydrates

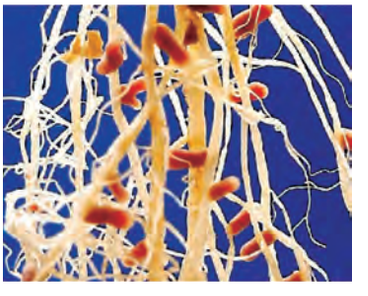
We have already learnt that plants synthesise carbohydrates by photosynthesis. Carbohydrates are made of carbon and hydrogen. But what about other nutrients like proteins and fats? For proteins, plants need nitrogen. The nitrogen present in the air cannot be used in its elemental form by the plants. Nitrogen is absorbed by plants in the following ways :

1. Farmers add manure and fertilisers rich in nitrogen, potassium and other minerals to the soil (e.g. urea). These substances dissolve in water and are taken up by the roots to various parts of the plants for synthesis of proteins. In this way, plants fulfil their requirements of nitrogen along with the other constituents. Plants can now synthesise components of food other than carbohydrates, such as protein and fats (Fats are oils).

A farmer adding fertiliser to a crop field.

2. Some bacteria present in the soil convert atmospheric nitrogen into a water soluble form, used by plants. These are known as nitrogen fixing bacteria. The nitrogen in the water soluble compound form is absorbed by the roots of the plants.

   For example, Rhizobium, a bacterium found in the root nodules of leguminous plants like peas, grams, etc. converts atmospheric nitrogen into nitrates, a useful form of nitrogen.



The roots of a leguminous plant (bean/pea/pulses)

## OTHER MODES OF NUTRITION IN PLANTS

Plants that do not make their own food by photosynthesis depend on other plants for nutrition. These plants are heterotrophs. They may or may not be green in colour.

Let us discuss a few examples of heterotrophic nutrition in plants.

## 1. Parasitic Plants

Parasites are the plants which exhibit parasitic mode of nutrition. Parasites obtain their nourishment from other living organisms. In this mode of nutrition, plants depend on other plants or animals for their nourishment. Such plants are called parasites and the ones on which parasites depend are called as hosts. For example,

(i) Cuscuta Amarbel is a parasitic plant which develop special root-like structures called haustoria. Haustoria penetrate deep into host plant's tissues and absorb the nutrients from them.

(ii) Mistletoe is a parasitic plant which receives water and minerals from the host plant.

Mistletoe

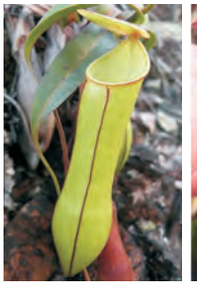
Cuscuta

## 2. Insectivorous Plants

Some plants feed on insects by trapping and digesting them. These are known as insectivorous plants. These plants have green leaves and can sysnthesise their foods. But they grow in water-logged areas and swampy soil, which is deficient in nitrogen. To fulfil their need of nitrogen, these plants capture and digest insects. The leaves of a pitcher plant are modified in the shape of a pitcher, with the top of the leaf forming a lid.

The Venus flytrap, bladderwort, sundew, etc. are some other examples of insectivorous plants. These plants develop some special modifications to trap insects.

Pitcher Plant



Pitcher

Insects Inside the Pitcher

### Activity 4

**Aim :** To grow fungus (bread mould) on a slice of bread.

**Materials required :** A slice of bread, water, hand lens.

**Procedure :** Take a slice of bread and moisten it with water. Put it between the palm and squeeze out extra water. Keep it in a moist, warm place (e.g. table drawer) for 2-3 days.

**Observation :** Coloured patches appear on the bread which later turns black. With a hand lens, see the patches.

**Conclusions :** Fungus grows on decaying and rotting materials. This fungus is called bread mould.

## 3. Saprophytic Plants

Saprophytes are the plants which exhibit saprophytic mode of nutrition. Saprophytes are the plants that obtain their nutrition from dead and decaying organic matter. Saprophytes secrete digestive juices called enzymes onto dead and decaying matter to dissolve it and then absorb nutrients from it.

For example :

(i) Indian pipe which is found on dead and rotting material inhibits fungus in its roots. These extend their mycelium and secrete enzymes to digest the decaying matter.

(ii) Mushrooms are another type of plants exhibiting saprophytic nutrition.


Indian pipe


Mushroom

## 4. Symbiotic Relationship or Symbiosis

This types of relationship is unique in which two organisms (two animals or two plants) live together. This is known as sysmbiosis and the relationship is known as symbiotic relationship. In this, both partners are benefitted.

(i) In leguminous plants (pulses, beans) and some trees, the fungus lives on the roots. The fungus provides water and nutrients absorbed from soil to the plant or tree. It gets shelter and nutrients from the plant or tree.

In legumes, root nodules have bacteria that provide nitrates for making protein by the plant. The plant in return gives shelter and nutrition.

(ii) The lichen is one such example. It has 2 partners. One is a fungus that provides shelter, water and minerals. The seconds partner is an algae which has chlorophyll. It makes food by photosysnthesis and shares with the fungus.


Lichens on a log

Lichens grow as grey-green patches on rocks, logs, etc.

### Key Words

| | | |
|---|---|---|
| **Nutrition** | : | Process of consuming food and utilizing it for the body |
| **Autotrophic** | : | Preparing one's own food |
| **Heterotrohic** | : | Taking food prepared by others |
| **Parasitic Plant** | : | A plant which lives on another plant and draws nutrition from it |
| **Symbiosis** | : | Living together |
| **Photosynthesis** | : | Process of preparation of food by green plants with the help of sunlight, chlorophyll, carbon dioxide and water. |
| **Insectivorous** | : | Insect-eating |

### Important Points

1. All organisms take food and utilise it to get energy for the growth and maintenance of their bodies.
2. Plants use simple chemical substances like carbon dioxide, water and minerals for the synthesis of food.
3. Green plants synthesise their food themselves by the process of photosynthesis. They are autotrophs.
4. Chlorophyll and sunlight are the essential requirements for photosynthesis.
5. Solar energy is stored in the form of food in the leaves with the help of chlorophyll.

6. Complex chemical substances such as carbohydrates are the products in photosynthesis.
7. Oxygen released in photosynthesis is utilised by living organisms for their survival.
8. Oxygen is produced during photosynthesis.
9. Plants like Cuscuta are prarasites. They take food from the host plant.
10. Fungi derive nutrition from dead, decaying matter, they are saprophytes.
11. A few plants and all animals are dependent on others for their nutrition and are called heterotrophs.


## Multiple Choice Questions (MCQs)

**A. Tick (✓) the correct option :**

1. Two different organisms living together and both benefitted are :
   (a) parasitic ☐ (b) autotrophic ☐ (c) saprophytic ☐ (d) symbiotic ☐
2. Food is stored in plants as :
   (a) glucose ☐ (b) cellulose ☐ (c) starch ☐ (d) sugar ☐
3. Organism involved in symbiosis is known as :
   (a) saprophyte ☐ (b) autotroph ☐ (c) parasite ☐ (d) symbiont ☐
4. Requirements for photosynthesis are :
   (a) sunlight and water ☐ (b) carbon dioxide ☐ (c) chlorophyll ☐ (d) all of these ☐
5. Chlorophyll traps sunlight and converts it into :
   (a) light energy ☐ (b) electrical energy ☐ (c) chemical energy ☐ (d) mechanical energy ☐
6. Nitrogen is supplied to the plants by :
   (a) fertilisers ☐ (b) Rhizobium ☐ (c) both (a) and (b) ☐ (d) none of these ☐
7. The lichen is an association between algae and :
   (a) fungi ☐ (b) plants ☐ (c) bacteria ☐ (d) viruses ☐
8. Plants show :
   (a) only autotrophic nutrition ☐ (b) both autotropic and heterotrophic nutrition ☐
   (c) only hetertrophic nutrition ☐ (d) none of these ☐
9. Rhizobium lives in the roots of the :
   (a) gram ☐ (b) mango ☐ (c) barley ☐ (d) wheat ☐
10. Which among the following is an insectivorous plant?
    (a) mango ☐ (b) pea ☐ (c) Cuscuta ☐ (d) Sundew ☐

**B. Fill in the blanks :**

1. Tiny pores on the lower surface of the leaves are called _____.
2. Mushrooms are _____.
3. In lichens, _____ and _____ live in symbiotic association.
4. Plants store food in the form of _____.
5. Photosynthesis occurs in the presence of _____.

6. _____ are called the food factories of plants.
7. _____ fixes nitrogen for leguminous plants.
8. The process of synthesis of food by green plants is called _____.
9. The _____ is an insectivorous plant.
10. The organelles that contain chlorophyll are called _____.

## C. Match the following :

| Column A | Column B |
|---|---|
| 1. Nitrogen | (a) Heterotrophs |
| 2. Animals | (b) Leaf |
| 3. Chlorophyll | (c) Bacteria |
| 4. Insects | (d) Parasite |
| 5. Amarbel | (e) Pitcher plant |

## D. Very Short Answer Questions :

1. Name the pigment found in the leaves of plants.
2. What is the role of chlorophyll in plants?
3. Which type of plants depend on insects for nitrogen requirement?
4. Name a fertiliser.
5. Name the plant that has root nodules.

## E. Short Answer Questions :

1. Define autotrophic nutrition.
2. Write the equation representing the process of photosynthesis.
3. Define heterotrophic nutrition.
4. What are parasites? Give examples.
5. What do you mean by nutrition?
6. What is chlorophyll?
7. Name the process by which green plants obtain their food.
8. What are saprophytes? Give examples.
9. Mention the materials essential for photosynthesis.
10. What is the function of stomata?

## F. Long Answer Questions :

1. Write an experiment to show that light is necessary for photosynthesis.
2. Explain general conditions necessary for photosynthesis.
3. Differentiate between symbiotic and parasitic nutrition.
4. Explain the major modes of nutrition.
5. What is the difference between autotrophic and heterotrophic nutrition?
6. Differentiate between a parasite and saprophyte.
7. What are the nutrients other than carbohydrates required by plants? How do plants get them?

## Assignment

**A. Read the passage and answer the following questions.**

All living things need food and energy to survive. The food-making and energy process for plants to survive is called photosynthesis. Plants make food and produce oxygen through photosynthesis. The process is complex but with the sun, water, nutrients from the soil, carbon dioxide and chlorophyll, a plant makes its own food in order to survive. Chlorophyll is a green chemical inside a plant that allows plants to use the Sun's energy to make food. Without chlorophyll a green plant would not be able to survive.

The following are the steps in the process of photosynthesis:

1. The sunlight is absorbed through a plant by its leaves or other green parts.
2. The water and nutrients from the soil are absorbed through the roots of the plants.
3. The chlorophyll inside the plant's leaves traps the energy from the sunlight.
4. Carbon dioxide in the air enters through the leaves of the plants. (Carbon dioxide is carbon and oxygen combined.)
5. Inside the chlorophyll there are chloroplasts which contain water and the carbon dioxide from the air.
6. The chloroplasts are like tiny manufacturing plants. The water and carbon dioxide from the air combine to make sugar and water. Basically, it is the food for the plant to survive and grow.
7. Sugar is then made and released into the veins of the leaf and it spreads throughout the rest of the plant.
8. The oxygen the plant has made is then released into the air.

The entire process is called photosynthesis and without it people and other animals would not be able to live and grow. This is the reason it is important for the survival of trees and plants. They give off oxygen which help people and other animals to breathe.

1. Define Photosynthesis.
2. Name the substances that trap the energy from sunlight.
3. Where the chlorophyll is found?
4. Write the importance of photosynthesis.

## Project

1. In cold countries, winters are very cold . There is snow everywhere. Plants are grown in green houses made of glass. Find out how plants are grown there, i.e. how light, water, temperature and carbon dioxide are regulated and how they reproduce.