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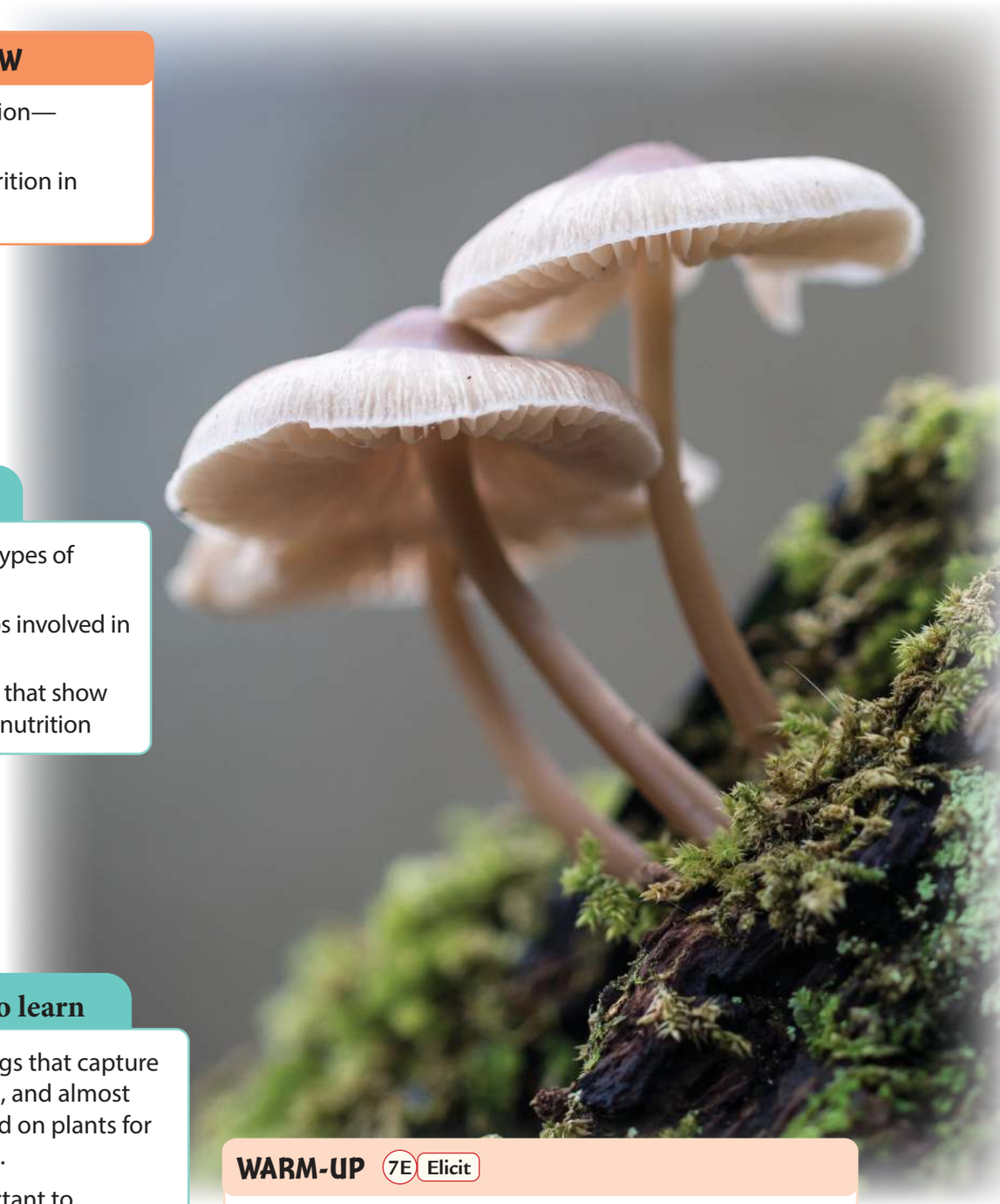
NUTRITION IN PLANTS

CHAPTER PREVIEW

- Autotrophic nutrition—Photosynthesis
- Heterotrophic nutrition in plants



What you will learn

- **Differentiate** the types of nutrition in plants
- **Sequence** the steps involved in photosynthesis
- **Identify** the plants that show different modes of nutrition

Why it is important to learn

Plants are living things that capture energy from the Sun, and almost all organisms depend on plants for food, shelter or both.

Therefore, it is important to understand different ways in which plants derive their nutrition and in turn ours too!

WARM-UP 7E Elicit

We have learnt that all living organisms need food. Animals get food from plants and other animals.

Where do plants get their food from?

If you look around yourself, you will come across several things obtained from plants. Plants provide us various materials such as wood and fuel. However, the most important role of plants is that they use light energy from the Sun to produce the food they need to survive. When we and other animals eat plants, this energy is transferred to us. In fact, directly or indirectly, all the food we eat can be traced back to plants.

Carbohydrates, proteins, fats, vitamins and minerals are components of food. These components of food are called **nutrients**. Nutrients in food enable living organisms to carry out life processes. *The process by which living things obtain food, change food into simple absorbable forms and use it to make substances needed by the body is called* ***nutrition***. This is one of the characteristics of living things. There are two main modes of nutrition: **autotrophic nutrition** and **heterotrophic nutrition**.

IVID

What is autotrophic nutrition?

The word autotrophic is made of two words—'auto' meaning 'self' and 'trophos' meaning 'nutrition' or to 'nourish'. *The mode of nutrition where an organism prepares its own food by taking in simple substances is called* ***autotrophic nutrition***. Such living things are called **autotrophs**. They are also called **producers**, as they prepare or produce their own food.

Green plants, algae and certain bacteria are examples of autotrophs. They manufacture their food through the process of photosynthesis (Fig. 1.1).

What is photosynthesis?

The process by which green plants utilise the energy from sunlight to convert simple molecules such as water and carbon dioxide into carbohydrates (sugar) and oxygen is called ***photosynthesis***.

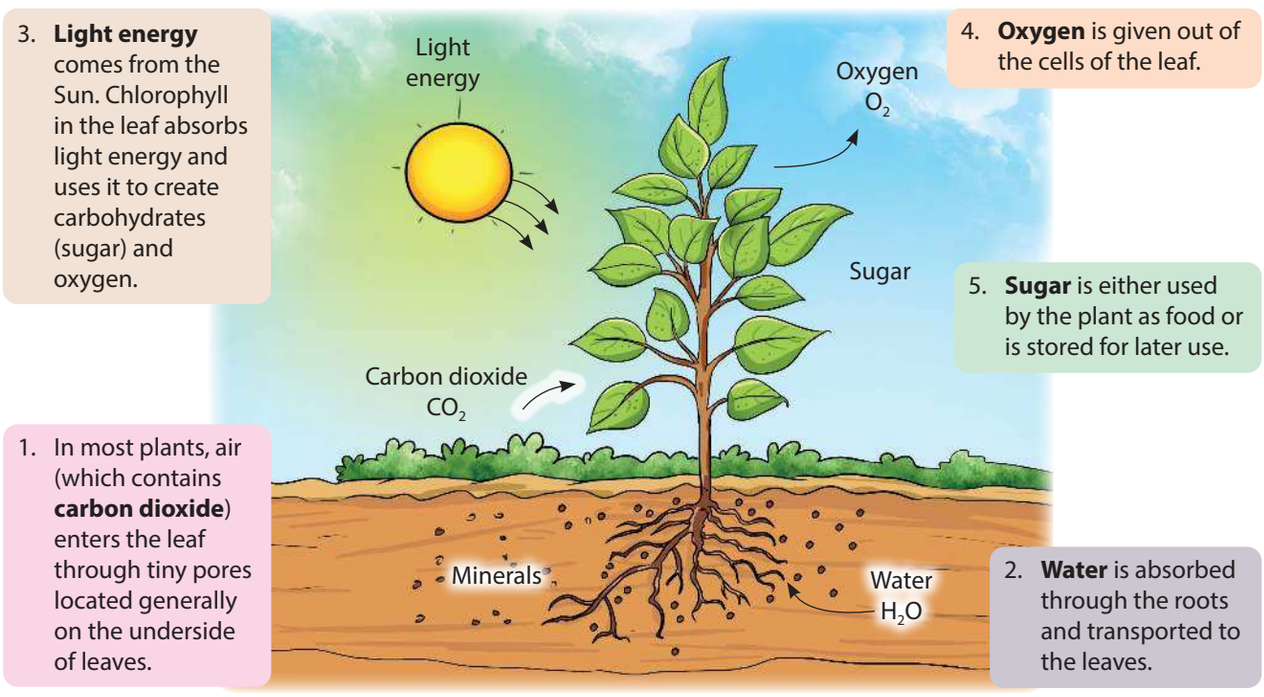


Fig. 1.1 Photosynthesis

'Photo' means light and 'synthesis' means 'to join'. We can also say that photosynthesis is a process that changes light energy into chemical energy. It is the single most important process on the Earth, as it is the only natural process which liberates oxygen to be used by living things. Photosynthesis can be expressed as a chemical reaction.

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

The equation looks straightforward. However, it is a very complex phenomenon with multiple steps. There are certain conditions required for photosynthesis to take place.

What are the conditions required for photosynthesis?

For photosynthesis to take place, sunlight is essential. The raw materials, that is, carbon dioxide and water have to reach the green leaves. Also, when the process of photosynthesis has been completed, the end products, that is, oxygen, is given out, and sugar is transported to different parts of the plant.

1. **Carbon dioxide:** Carbon dioxide from the air is taken in through tiny pores present on the surface of leaves. These pores are called **stomata**. Stomata (singular: stoma) are surrounded by 'guard cells', which open and close to let gases in and out (Fig. 1.2).

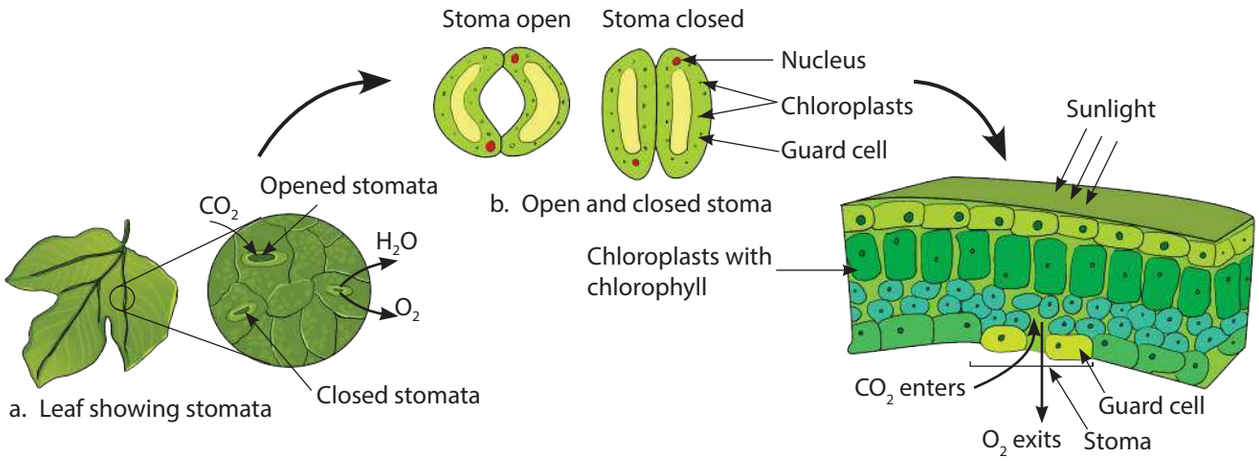


Fig. 1.2 Stomata showing exchange of gases

2. **Water:** Water present in the soil is taken in by the roots. This is then transported by vessels called **xylem** that run throughout the roots, the stem, the branches and the leaves. They form a continuous path or passage for water to reach the leaves (Fig. 1.3).

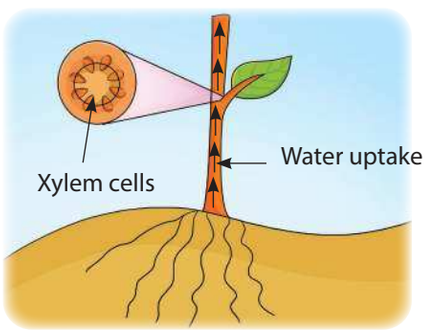


Fig. 1.3 Xylem vessels

3. **Chlorophyll:** Photosynthesis takes place in a specialised structure within the cells of the leaves called the **chloroplast**. The chloroplasts contain a green pigment called **chlorophyll**.

When light falls on a plant's leaves, chlorophyll absorbs the light energy. During photosynthesis, the chlorophyll is essentially converting light energy into chemical energy.

When chlorophyll absorbs light energy, it undergoes a reaction that results in water splitting into its components: hydrogen and oxygen.

4. **Oxygen:** The oxygen, thus formed, escapes as a gas through the stomata and is released into the atmosphere. This oxygen is used by almost all the living organisms including humans.
5. **Sugar:** In a series of complex reactions, carbon, hydrogen and some of the oxygen combine to form a carbohydrate—a sugar called **starch**. Starch is taken to all the parts of the plant by vessels called **phloem**. The plant may combine this simple sugar to form large molecules, such as starch (food storage) and cellulose (a component of cell walls), etc.

The carbohydrates produced as a result of photosynthesis are made of carbon, hydrogen and oxygen. Plants absorb nitrogen and minerals from the soil. The nitrogen required for making proteins comes from nitrogen-fixing bacteria present in the soil. Using these along with carbon, hydrogen and oxygen, plants make proteins, vitamins and fats. Thus, when different plants are eaten, different nutrients such as carbohydrates, proteins, fats, minerals and vitamins are taken in by animals including humans. That is why we should eat a variety of plants to get all the required nutrients.

Real-world Connect! 7E Elaborate

Animals eat plants, and the nutrients stored in the plants become part of the animal's body. Animals also take in oxygen released by the plants, which is in turn used to break down the nutrients, releasing energy, giving off carbon dioxide as a by-product.

This inter-relationship between plants and animals maintains the vital **balance of gases** in the atmosphere.

ANM

Test It Yourself! Scientific Proficiency — Procedural fluency

To show that starch (sugar) is formed during photosynthesis. (*Note*: Adult supervision is advised.)

1. Take a leaf from a plant that has been growing in a sunny area.
2. Fill a small glass jar with ethyl alcohol. Place the jar in a saucepan full of water and heat the pan until the ethyl alcohol in the jar begins to boil.
3. Remove from heat. Using tweezers place the leaf in the hot water for about a minute to soften it.
4. Now drop the leaf in the jar of ethyl alcohol for a few minutes or until the leaf turns almost white. (Hot water softens the leaf and the alcohol breaks down the chlorophyll, taking the green colour out of the leaf.)
5. Remove the leaf and place in a shallow dish. Now cover the leaf with some iodine solution. Iodine is an indicator that turns blue-black in the presence of starch.

What do you think will happen to the leaf in the presence of iodine? The leaf turns blue-black indicating that the leaf has been performing photosynthesis and producing starch.

Test It Yourself! 21st Century Skills — Analysis, Observation

To show that light is required for photosynthesis.

1. Take a leaf from a plant that has been kept in a dark room for about 2 days. Keeping a plant in a dark room long enough 'de-starches' it. De-starching means using up the starch found in the plant by keeping it in dark for 24 to 48 hours.
2. Follow steps 2 to 5 as listed in the above experiment.

What do you think will happen to the leaf in the presence of iodine? The leaf does not turn blue-black indicating that photosynthesis did not take place in the leaf as it was kept out of sunlight.

Test It Yourself!

21st Century Skills — Observation

To show that chlorophyll is required for photosynthesis.

1. A de-starched plant is covered using an airtight transparent plastic bag. The chemical, sodium hydroxide is placed in the bag along with the plant. Sodium hydroxide has the ability to absorb carbon dioxide.
2. The plant is left in a sunny place for 24 to 48 hours. A few leaves of the plant are tested for starch using iodine.

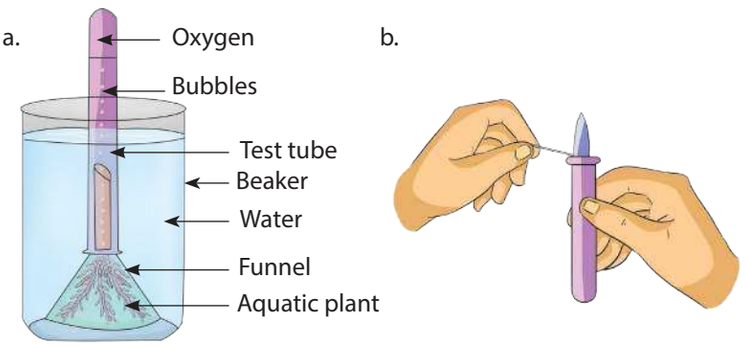
What do you think will happen to the leaves in the presence of iodine? The leaves do not turn blue-black. This shows that no starch has been made as photosynthesis did not take place without carbon dioxide.

Test It Yourself!

Scientific Proficiency — Procedural fluency

To show that oxygen is given out during photosynthesis.

1. Take an aquatic plant and place it in a beaker full of water. Cover the plant with an inverted funnel.
2. Invert a test tube filled with water over the stem of the funnel and place this set-up outdoors under sunlight.
3. After a while, bubbles are noticed rising up from the plant, reaching the top of the inverted test tube. As the bubbles rise up, it is noticed that the water level in the test tube comes down while the water level in the beaker rises.



Experimental set-up to show that oxygen is given out during photosynthesis

4. Keep this undisturbed for a few hours. Carefully remove the test tube from over the funnel and immediately bring a glowing splinter close to the mouth of the test tube.

What do you think will happen? The splinter bursts into flame, confirming that the gas inside is oxygen (as combustion occurs). This shows that it is oxygen gas that is released during photosynthesis.

Does photosynthesis only happen in green leaves?

Most plants we see around have green leaves, and it is in these green leaves that photosynthesis takes place. There are, however, exceptions. Here are a few of them.

- Some plants have leaves that have colours other than green, such as red, maroon or other colours. These also contain chlorophyll, but the green pigment is masked by more dominant pigments, such as yellow or orange pigments and red or purple pigments (Fig. 1.4). In very bright sunlight, these colourful pigments help in photosynthesis.

Fig. 1.4 *Coleus* plants

Fig. 1.5 Orchid plant

- Varieties of orchid plants can photosynthesise through their green roots. This allows them to produce food when their roots are exposed to bright sunlight (Fig. 1.5).
- Most cactus plants have green stems (Fig. 1.6) that take part in photosynthesis.

Fig. 1.6 Cactus plant

What is the significance of photosynthesis?

Life on the Earth would not have been possible without the process of photosynthesis. It is important due to the following reasons.

1. Photosynthesis is responsible for converting light energy into chemical energy, which is used by almost all living things as sources of food.
2. Carbon dioxide produced by living things is used up during photosynthesis and does not accumulate in the atmosphere.
3. Oxygen released during photosynthesis is used for respiration by living things.

INT

Section Review 1 7E Evaluate

To elaborate the photosynthetic process in plants.

Leena takes a green leaf from a plant and boils it in an alcohol bath for removal of chlorophyll. After this treatment, she adds a few drops of iodine to the boiled leaf using a dropper. After some time, she observes that the leaf turns blue-black in colour. What can be evaluated from this? Tick the correct option.

The blue-black colour with iodine shows that:

1. water is present in the leaf indicating occurrence of photosynthesis.
2. oxygen is present in the leaf indicating the occurrence of photosynthesis.
3. carbon dioxide is present in the leaf indicating the occurrence of photosynthesis.
4. starch is present in the leaf indicating occurrence of photosynthesis.

What is heterotrophic nutrition?

The word heterotrophic is made of two words 'hetero' meaning 'other' and 'trophos' meaning 'nutrition' or to 'nourish'. *The mode of nutrition where an organism depends on another organism for its nutrition is called* ***heterotrophic nutrition***. Such living things are called **heterotrophs**. They are also called **consumers**, as they do not produce food, but consume plants and other animals as food. Almost all animals and certain plants such as mushrooms and lichens are examples of heterotrophs (Fig. 1.7).

Lichens Mushrooms

Fig. 1.7 Examples of heterotrophs

What is heterotrophic nutrition in plants?

Some plants cannot synthesise their own food because they do not contain chlorophyll. Some plants live in places that do not get adequate sunlight, while some others grow in soil that is deficient in one or more nutrients. In all these cases, such plants depend on food produced by other plants or they depend on small animals as food. Their mode of nutrition is, therefore, heterotrophic. Such plants are heterotrophs.

Depending on how these plants obtain nutrition, they are of four types—**parasitic plants**, **saprophytic plants**, **insectivorous plants** and **symbiotic plants**.

Language Check Integrated Pedagogy English

Find out another meaning of the word 'host'.

Parasitic plants: *Plants that get all or part of their nutrition from another plant are called* ***parasitic plants*** *or* ***parasites***. The plant that provides the nutrition is called the **host plant**. The parasitic plant does not contribute to the benefit of the host and, in some cases, causes extreme damage to the host plant. Many parasitic plants have specialised root-like structures to penetrate host plants. Examples of parasitic plants are Dodder or *Cuscuta* (*Amarbel*), Rafflesia plant and mistletoe.

Fig. 1.8 Dodder

Dodder or *Cuscuta* (Fig. 1.8) is known as *Amarbel* in parts of India. It has thin, twining stems either pale green, yellow or bright orange in colour. It is either leafless or with tiny, triangular leaves. As the dodder grows on the host plant, it continually reattaches itself to its host and sends out shoots to attach to nearby hosts as well creating a dense mass of intertwined stems. Once attached, the dodder plant extracts nutrients and water from the host.

Rafflesia is a parasitic plant and it is believed to have the largest flower in the world (Fig. 1.9). These plants can only be found in Southeast Asia—in Thailand, Malaysia, Brunei, the Philippines and Indonesia. This plant has no stems, leaves or roots. It is a parasite that lives on the vines of a forest plant, spreading its root-like structures inside the tissue of the vine. The only part of the plant that can be seen outside the host is the five-petalled flower. The flowers smell like rotting flesh.

Fig. 1.9 *Rafflesia*

Fig. 1.10 Mistletoe

Mistletoe is a parasitic plant that grows on the stems of hard shrubs and certain fruit trees (Fig. 1.10). They are capable of some amount of photosynthesis as they have green leaves. They, however, derive water and minerals from the host plant.

Saprophytic plants: *Plants that get their nutrition from dead and decaying material are called* ***saprophytic plants*** *or* ***saprophytes***. The word saprophyte comes from 'sapros' meaning 'rotting' and 'phyton' meaning 'plants'. Such plants convert organic food materials present in decaying materials into simpler forms from which they can absorb nutrients.

Look It Up! 7E Explore

Search online for answers and discuss in class.

How large is the largest *Rafflesia* flower found so far?

Certain saprophytes are responsible for making the soil fertile by breaking down the remains of dead plants and animals to form humus. Saprophytes do not have true leaves, stems or roots and they do not carry out photosynthesis. Almost all fungi are saprophytic. Fungus is a group of living organisms that are classified neither as true plants nor animals. Examples of saprophytic plants are Indian pipe, and saprophytic fungi such as bread mould and mushrooms.

Real-world Connect! 7E Extend

Saprophytic fungi feed on dead plant and animal remains. Many of them are extremely beneficial, breaking down this organic material into humus, minerals and nutrients that can be utilised by plants. Without these fungi, our Earth would probably be a heap of undecayed, dead leaves and logs!

Indian pipe: The Indian pipe (Fig. 1.11) is also known as 'ghost plant' or sometimes 'corpse plant', because of its glowing white colour. It is found in dark, shady wooded forests that have rich, moist soil and plenty of decaying leaves and other plant matter. It is commonly found near dead tree stumps. Each plant consists of one 3- to 9-inch stem, but has no leaves. It has a white or pinkish-white, bell-shaped flower.

Fig. 1.11 Indian pipe

Bread mould: This is a fungus that grows on moist material such as stale bread. It has filaments that grow on bread. As they grow and multiply, the bread mould colony changes from white to green to almost black.

Mushroom: This is a fungus that grows on dead organic matter such as fallen leaves, plant roots and dead wood. Mushrooms extract carbon dioxide and minerals from the dead and decaying material.

Insectivorous plants: *Plants that get their nutrition mostly from small animals such as insects are called* ***insectivorous plants*** *or* ***insectivores***. They are also called **carnivorous plants**. These plants are mostly green and so carry out photosynthesis. However, they grow in soil that is generally deficient in nitrogen. To make up for the lack of nitrogen, such plants have devised various methods to capture small insects.

VID

Examples of insectivorous plants are Venus flytrap and pitcher plant.

Venus flytrap: The Venus flytrap is a flowering insectivorous plant. The 'trap' is made of two hinged flaps at the end of each leaf (Fig. 1.12). On the inner surfaces of the lobes are hair-like projections that cause the flaps to snap shut when an insect comes in contact with them. The hinged traps are edged with small bristles that interlock when the trap shuts to ensure that the insect cannot squeeze through. This plant is known to 'trap' ants, beetles, grasshoppers, flying insects, spiders, etc.

Fig. 1.12 Venus flytrap

Pitcher plant: Pitcher plants are carnivorous plants that attract, kill and digest insects. The plants have evolved modified leaves consisting of jug-like pitchers, which function as traps that 'hunt' insects that curiously approach the pitcher rim and end up falling inside. Once fallen inside, they are unable to escape the slippery inner walls and sticky fluid inside the pitcher. The pitcher plant has chemicals that break down the insects to release nutrients needed by the plant.

Fig. 1.13 Pitcher plant

Symbiotic plants: *Plants that get all or part of their nutrition by living closely connected to another plant such that it is beneficial to both the plants are called* ***symbiotic plants*** *or* ***symbionts****. This beneficial relationship is called* ***symbiosis****.*

Examples are lichens, and the association of *Rhizobium* bacteria and leguminous plants.

Lichens: They are a symbiotic partnership of two separate living things, a fungus and an alga (Fig. 1.14). Lichen, therefore, is two organisms functioning as a single, stable unit. Algae are autotrophs. They carry out photosynthesis and prepare food for themselves and also provide it to their fungal partner. Fungi are saprophytes. They are capable of absorbing water and minerals from the material they are growing on. They supply their algal partner with water and minerals. This way, they benefit each other.

Fig. 1.14 Lichens growing on a tree bark

Fig. 1.15 Root nodules of a leguminous plant

Rhizobium **bacteria and leguminous plants:** *Rhizobium* bacteria live in the root nodules of leguminous plants such as beans and peas (Fig. 1.15). *Rhizobium* converts atmospheric nitrogen into ammonia that can be used by the leguminous plants. The plant in turn provides nutrients for the bacteria's growth. Thus, they benefit each other.

How are nutrients replenished in the soil?

Plants absorb important nutrients from the soil they grow in. After some time, these nutrients decrease and this makes the soil infertile. Therefore, the soil needs to be replenished. Soil can be replenished with nutrients by either natural or artificial methods.

Natural methods

1. **By growing leguminous plants:** *Rhizobium* bacteria, living in the root nodules of leguminous plants, are also called nitrogen-fixing bacteria. *Rhizobium* can convert the nitrogen present in the atmosphere into ammonia—a form that can be easily absorbed by plants. Farmers make use of this natural process by growing leguminous crops in their fields after one crop has been cultivated in the same land. Crops are changed season by season in a planned sequence. This **rotation of crops** helps in the replenishment of soil nutrients.
2. **Decomposition:** When plants and animals die and decompose, bacteria, fungi, etc., break down the organic matter present in them and release nutrients such as nitrogen, potassium, calcium and phosphorus into the soil. These nutrients mix with the soil and make it fertile.

Artificial methods

1. **Adding natural fertilisers:** By adding natural fertilisers such as compost, vermicompost and cow dung manure into the soil, farmers increase soil fertility.
2. **Adding artificial (chemical) fertilisers:** Since, these are available in large quantities as they are manufactured in factories, farmers frequently add chemical fertilisers such as urea, ammonium phosphate and ammonium nitrate to replenish nutrients in the soil. However, overuse of chemical fertilisers degrades the soil.

INT

Section Review 2

7E Evaluate

To evaluate plants in the surroundings and classify them as autotrophs, heterotrophs, saprotrophs, parasitic or symbiotic based on their nutritional requirements.

Leena visited a forest area and observed a few plants she had studied in her science book. Help her classify the plants. Tick the correct option.

1. Lichens—Saprophytic, Dodder—Parasitic, Bread mould—Symbiotic
2. Lichens—Symbiotic, Dodder—Parasitic, Bread mould—Saprophytic
3. Lichens—Saprophytic, Dodder—Symbiotic, Bread mould—Parasitic
4. Lichens—Parasitic, Dodder—Saprophytic, Bread mould—Symbiotic

Keywords

SVID

Autotrophic nutrition: The mode of nutrition where an organism prepares its own food by taking in simple substances

Heterotrophic nutrition: The mode of nutrition where an organism depends on another organism for its nutrition

Saprophytes: Plants that get their nutrition from dead and decaying materials

Parasitic plants: Plants that get all or part of their nutrition from another plant

Insectivorous plants: Plants that get their nutrition mostly from small animals such as insects

Symbiotic plants: Plants that get all or part of their nutrition by living closely connected to another plant such that both are benefitted