The Leaf

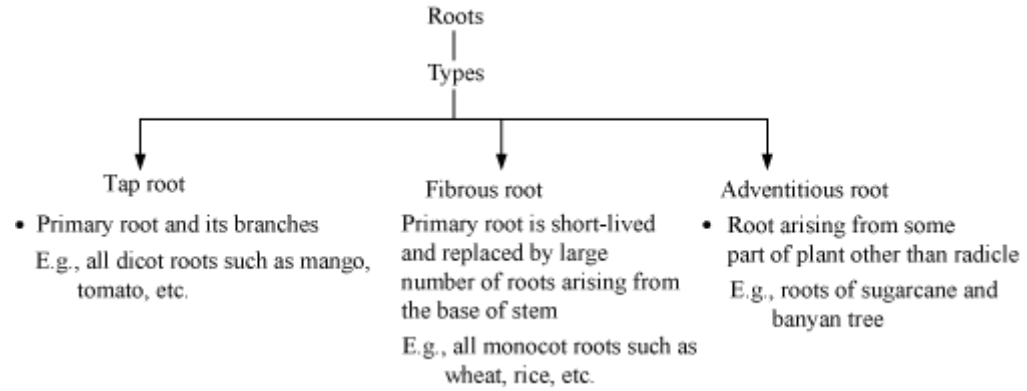
Plants have diverse morphology; still they have the following structures in common:

- Roots
- Stem
- Leaves
- Flowers
- Fruits

What is a root?

It is the underground part of a plant. It performs the function of absorbing water from soil. It also helps in the anchorage of plants to the soil.

Primary root is the direct elongation of radicle, which grows inside the soil. It is the primary root that bears several lateral roots termed as secondary roots, tertiary roots, etc.

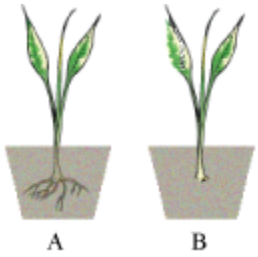


Functions of Root

The two functions of roots can be demonstrated with the help of the following activities.

(i) Absorption

Take two pots and label them as **A** and **B**. Uproot two weeds from your garden. Cut off the roots from one weed. Then, put the weed containing roots in pot **A,** and that without roots in pot **B**. Water the plants regularly for some days.



What do you observe?

You will observe that after 4-5 days, the weed without roots begins to die, while the other weed remains healthy.

Therefore, it can be concluded that roots absorb water from soil. Thus, they are important for the survival of plants.

(ii) Anchorage

Take a bowl and put some wet cotton wool in it. Then put 4-5 gram seeds in that bowl. Sprinkle water every day to keep the cotton wet.

You will observe that after one week the sprouts develop into young plants.

Now, try to separate these young plants from the cotton wool. **What do you observe?**

You will find it difficult to separate these young plants from the cotton wool. This happens because the roots of these young plants remain attached to the cotton wool.

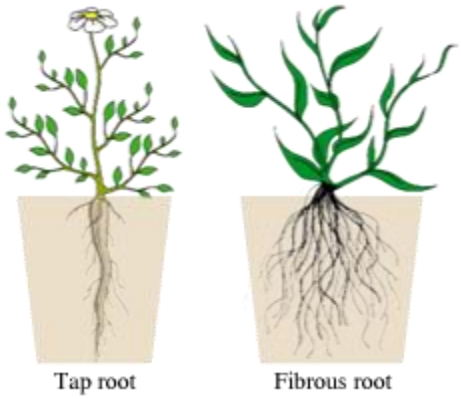
Therefore, on the basis of the above activity, it can be concluded that roots help in holding plants tightly to the soil, thereby performing the function of anchorage.

Do all plants have the same type of roots or do the roots differ in their structure?

There are mainly two types of roots in plants. They are:

(i)Tap root: Tap root consist of a main root, which grows vertically downwards. This main root gives rise to many small branches. They can be observed in the young plantlets of gram.

(ii)Fibrous root: Fibrous root arises in clusters from the base of the stem. They do not have a main root. They can be easily observed in the weeds uprooted for the above activity.



It is important to note that plants with tap roots will always have leaves with reticulate venation, while plants with fibrous roots will always have leaves with parallel venation.

Using this information, one can predict the type of roots a plant has by looking at its leaves.

Some Interesting Facts:

- **Did you know that the deepest roots are those of a wild fig tree in South Africa? They reach a depth of about 400 feet!**

- **The tallest living tree is a Mendocino tree, a coast redwood found in California. It is more than 367 feet and 6 inches tall!**

Modification of Root

- Roots of some plants modify their structure, shape, etc.
- These modifications are performing functions, other than absorption and conduction of water and minerals.
- Modified roots may perform functions such as support, respiration, and storage.
- **For storage of food** − Food can be stored in the roots by certain plants such as carrot, sweet potato, turnip, etc. These roots are eaten also.
- **For additional support** − In certain plants such as banyan tree, screw pine, etc., roots grow vertically downwards from the branches and penetrate into the soil. Such roots are called prop roots and they give additional support to the plant.
- **For respiration** − In certain plants that grow in saline areas, roots grow vertically upwards and come out of the water in the form of conical spines. Such roots are called pneumatophores.

The Stem

What is a stem? It is the main supporting stalk of a plant. It connects the roots to the other parts of

a plant such as leaves and flowers.

What is the importance of stems in a plant body? What are its functions?

Functions of stem

• It supports flowers, leaves, and fruits.

• It elevates the leaves so that they get proper sunlight for manufacturing their food.

• It transports water, minerals, and food to the roots and the other parts of the plant. The various narrow tubes present in the stem help it in performing the function of transportation.

Let us perform an activity to demonstrate the functions of stem.

Therefore, on the basis of the above activity, it can be concluded that stems conduct water from the roots to the other parts of the plant.

Some interesting facts:

- The stems of some plants such as sugarcane, bamboo, cinnamon, etc. are economically important.
- Chicle is the main ingredient of chewing gum. It is obtained from the trunks of the *Chicle* tree.
- Quinine, which is used to cure malaria, is obtained from the bark of *Cinchona* tree**.**

Modifications of Stem

Underground modifications in stem are as follows:

Underground stems are used for storage of food in potato, ginger, turmeric, etc. These structures also act as organs of perennation to help the plants survive in unfavourable conditions.

- **Rhizome –** Thick, branched underground stem containing nodes and internodes Rhizomes also have buds from which new stems and leaves develop. e.g. – ginger and turmeric

- **Tuber –** Food storing, roughly spherical stem

  It bears eyes, which are the dormant buds present on surface. For example, tubers are found commonly in potato. If potato tubers (containing a bud) are planted, then a new potato plant will develop.

- **Bulb –** In this modification, the stem is highly condensed to form a disc. A terminal bud is present on the upper end of the disc, which has numerous scale leaves. The inner scale leaves are fleshy and store food while the outer scale leaves are dry.

  Aerial modifications in stem are as follows:

- **Tendrils** – Develop from axillary bud and are spirally coiled to help the plant to climb (E.g. Present in gourds and in grapevines)

- **Thorns** – Pointed, straight, and woody modifications of axillary buds, which arise to provide protection to plant from animals present in *Citrus, Bougainvillea*

- **Photosynthetic stems** – Modification of stems into flattened and fleshy structures shown by plants of arid regions to carry out photosynthesis (shown by *Opuntia*)

- Underground stems of strawberry and grass spread to new niches to give rise to new plants when older ones die.

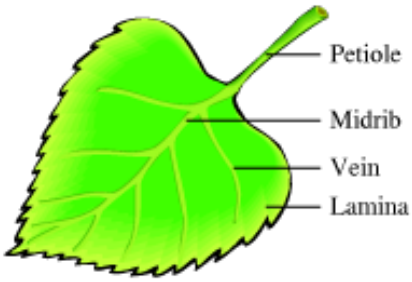
  The Leaf - Structure and Modifications

  What are leaves?

  Leaves are those parts of plants that perform the functions of photosynthesis and transpiration. In plants, leaves are found above the ground.

  Let us learn about the various parts of a leaf.

  Parts of a leaf



- A leaf is attached to the stem with the help of a petiole.

- The green broad part of a leaf is known as lamina.
- Veins are lines present on the lamina of a leaf. The thick middle vein is known as the midrib.

  The arrangement of veins on the lamina is known as venation. It can be of two types:

- **Parallel venation**: In this type of venation, the veins are parallel to each other. It is commonly found in grasses.
- **Reticulate venation**: In this type of venation, the veins are arranged in the form of a net-like structure around the midrib. It can be easily observed in the leaves of a rose plant.

Types of leaves

- **Simple** – When lamina is entire or when incised, the incisions do not touch the midrib.
- **Compound** – When incisions reach the midrib and break it into number of leaflets (bud is not present in the axil of leaflets)

  Leaves have various shapes. Some of them can be needle shaped (such as in pine trees), or heart-shaped (peepal), or oblong (banana), or circular (lotus). They also vary from each other in the pattern of their margins. Some of them have complete margin (peepal), some have wavy margin (mango), some have toothed or serrate margin (rose), and some others have spinous margins (prickly poppy).

Modifications of Leaves

Leaves are modified to perform functions other than photosynthesis.

- **Leaf tendrils** are used for support and climbing (eg. Peas) – It is actually a thin, wired, and coiled structure that supports the plant as it climbs up.

- **Leaf spines** are the thorny structures into which leaves are modified for reducing water loss and defence.

- In insectivorous plants, leaves are modified to trap insects as in pitcher plant.

- **Fleshy leaves**- Leaves are modified for storage of food in onion and garlic.

Insectivorous Plants

Some of the insectivorous plants are described below:

- **Pitcher plant –** The leaf is modified into pitcher. The leaf has a lid, which is an extension of the leaf apex, and the petiole of the leaf coils to form a tendril-like structure. Once the insect enters the pitcher, the lid closes and the insect is trapped inside the pitcher. Plant then releases digestive juices to digest the insect.
- **Bladderwort –** The leaf is highly segmented. Some of the segments modify and form tiny bladder-like structures in which insects are trapped.
- **Venus flytrap –** The edges of the leaves in this plant have long pointed hair. The leaf blade is divided into two parts and the midrib acts as a hinge. When the insect comes in contact with the leaf, it suddenly closes. Then digestive juices are secreted to digest the insect.

Vegetative Propagation Through Leaves

Usually plants propagate through seeds. These seeds are found inside fruits and are responsible for giving rise to new plants. However, in some plants, parts other than seeds can also give rise to new plants.

These vegetative parts of the plants include stem, roots, and leaves, and such type of reproduction is called vegetative propagation. A well-known example of vegetative propagation through leaves is *Bryophyllum* plant.

In this plant, new buds are formed along the margins of its leaves, these buds later on fall in the moist soil, and each bud gives rise to whole new *Bryophyllum* plant.

Functions of a leaf

Leaves perform two main functions: photosynthesis and transpiration. Let us learn about these functions in detail.

Photosynthesis

Photosynthesis is a process in which the chlorophyll-containing cells synthesize food using carbon dioxide, water, and solar energy.

Do you know what is formed as a result of photosynthesis? Let us explore by performing a simple activity.

Take a leaf from a healthy plant and put it in a test tube. Add some alcohol to it. Now, place this test tube in a beaker half-filled with water. Heat the beaker till the contents of the test tube turn green in colour.

Then, take out the leaf and wash it with water. Put the leaf in a petri plate and add some drops of iodine solution to it.

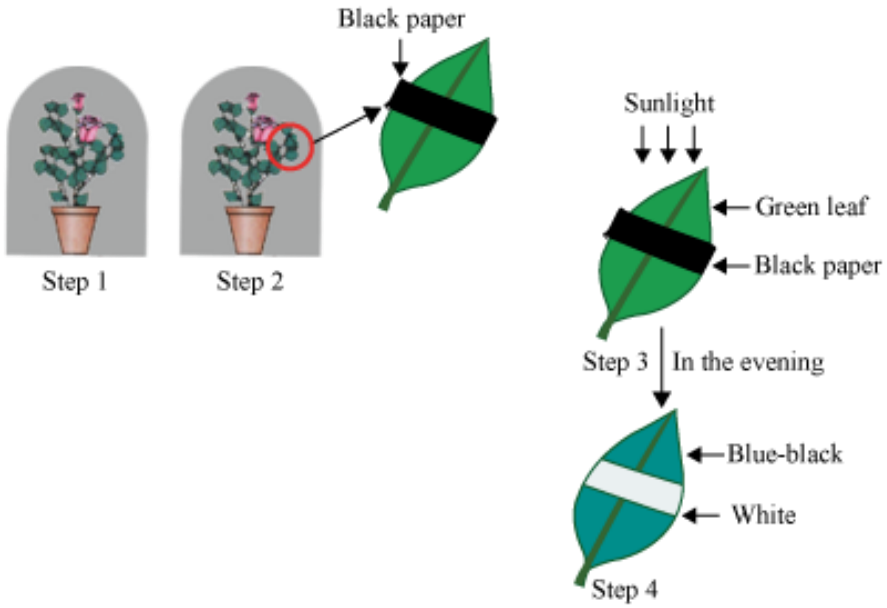
What do you observe?

You will observe that the leaf turns blue-black in colour, indicating the presence of starch. Thus, on the basis of the experiment conducted, we can say that plants make food in the form of starch during the process of photosynthesis.

But why do plants need sunlight? Let us find out.

Take a healthy, green potted plant and keep it in a dark room for one-two days (this is done to ensure that the leaves do not contain any reserve food).

Now, take a leaf from this plant (do not pluck it) and cover a portion of it with two uniform pieces of black paper on both sides. You can fix the paper using two paper clips.



Now, expose this plant to bright sunlight for a few hours (say from morning to evening). Wait till evening and then pluck the covered leaf. Decolourise it by washing it in alcohol. Then, put this leaf in an iodine solution.

What do you observe?

The blue-black colour appears only in the exposed portions of the leaf. This indicates the presence of starch in the leaf.

Therefore, on the basis of the two activities performed above, we can conclude that during photosynthesis, plants make carbohydrates using carbon dioxide, water, and sunlight. These carbohydrates later get converted into starch, which acts as a food reserve.

Now let us study about the second function performed by a leaf i.e., the function of transpiration.

Transpiration

The evaporation of water from a plant's surface, mainly through leaves, is known as transpiration.

Let us observe the process of transpiration by performing an activity.

Take a potted-plant and keep it in a polythene bag. Tie the mouth of the bag and keep it in sunlight.

You will observe that after 4-5 hours, the inner surface of the bag develops some water droplets.

Thus, it can be concluded from the above activity that leaves lose water in the form of vapour. These water vapours diffuse out of leaves' surface through small pores called **stomata**.

Some Interesting Facts:

- Did you know that up to 99% of the water absorbed by roots is lost via transpiration!
- A corn plant transpires over 200 litres of water in one growing season!

Is losing water an advantage? Is there any particular use of transpiration?

- The loss of water through transpiration helps in keeping plants cool. It especially helps them survive in hot weather conditions.
- Transpiration also helps in maintaining the concentration of cell sap inside the plant cells. If the excess water is not evaporated out through transpiration, the cell sap of the root hairs will become dilute. This will prevent the absorption of water from the soil through osmosis.

Factors Affecting Transpiration

Transpiration process is affected by a number of atmospheric factors. Let us know about them as well.

- **Sunlight**: The stomata remain open during the daytime, and close at the night time. This the rate of transpiration is much higher during daytime than at night.
- **Temperature**: More is the temperature, faster is the transpiration.

- **Wind**: More is the air velocity, faster is the transpiration.
- **Humidity**: High humidity corresponds to higher amount of water molecules in the air. The humid air cannot hold more water molecules, and thus the rate of transpiration decreases.

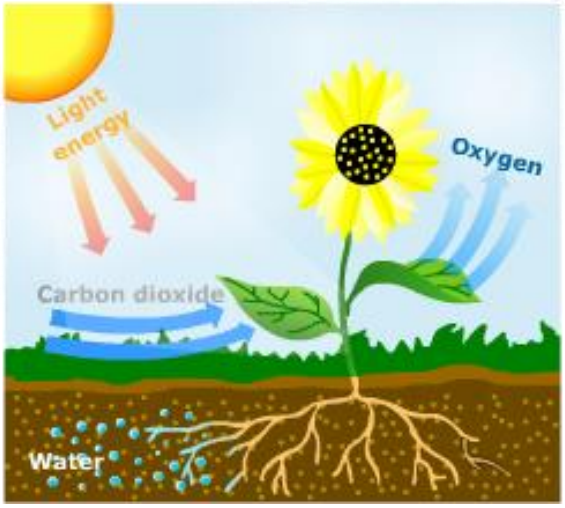
Autotrophic Nutrition in Plants

We know that plants manufacture their own food. But where does the production of food take place in plants? Let's see in this video.

Leaves are the food factories of plants. They are the sites where the synthesis of food occurs in plants.

But why do only leaves manufacture food for plants? What process is involved in the synthesis of food?

The leaves of plants contain a green pigment called chlorophyll. This pigment captures the sun's energy, which is used to prepare food from carbon dioxide and water. The process of synthesis of food using sunlight, carbon dioxide, and water is known as photosynthesis.



Since solar energy is essential for plants to prepare food, we can say that sun is the ultimate source of energy for plants.

What happens during photosynthesis? During the process of photosynthesis, the leaves containing chlorophyll convert carbon dioxide and water into carbohydrates in the presence of sunlight. This process can be represented in the form of the following equation:

Carbohydrates, which are produced during photosynthesis, are ultimately converted into starch to be stored in plants.

Know Your Scientists:

Year	**1770**	**1779**	**1854**
Name of scientist	Joseph Priestley	Jan Ingenhousz	Julius Von Sachs
Discovery/Finding	Concluded that air is necessary for the growth of a plant. He discovered the fact that plants restore oxygen in the air.	Concluded that sunlight is essential for plant processes that purify the air. He also discovered that the green parts of plants release oxygen.	Discovered that the chlorophyll is located in special bodies called chloroplast. Green parts of plants are where glucose is made, which is stored as starch.

Curiosity Corner:

Now, not all leaves are green in colour. Does photosynthesis take place in these leaves too?

Yes, Leaves which are not green in colour also contain chlorophyll. They are not green in colour because they contain other pigments such as red, brown, yellow etc, which mask the green colour of leaves.

Can you tell why potted plants are advised to be placed in well-lit areas?

Plants require sunlight to manufacture food. Without sunlight, photosynthesis cannot take place in plants, and can even lead to the death of plants. Hence, it is advisable to place potted plants in areas receiving sufficient sunlight.

Let us perform the following activity to test the production of food in plants.

We now know that plants require water and carbon dioxide, in the presence of sunlight, to carry out photosynthesis. How are raw materials supplied to plants?

The tiny pores found on the underside of leaves are called **stomata**. It allows the entry of CO_2 from the atmosphere so that it can be used for photosynthesis and releases the oxygen produced by the plants.

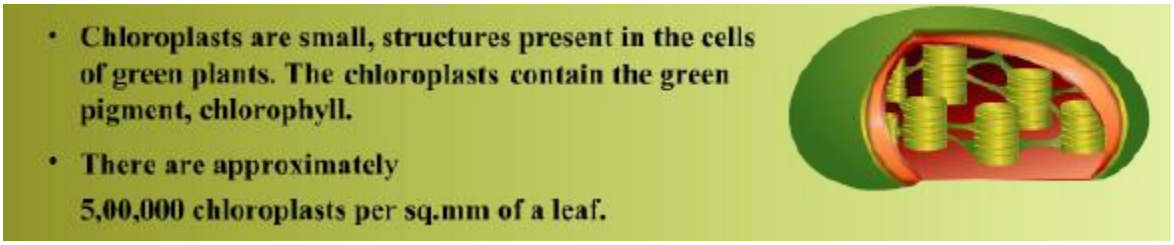
Leaf Leaf section Stomata

Structure of stomata:
Stomata are small openings present on the lower surface of leaves. These openings are surrounded by two bean shaped cells called guard cells. These guard cells contain chloroplast. In guard cells, the outer wall is thin while the inner wall is thick.

Regulation of stomata:
Opening and closing of stomata is regulated by these guard cells. During day time, in the presence of sunlight, water moves into the guard cells making them to swell up. As they swell up, their outer thin walls bulge outward, as a result of which the inner walls move apart from each other. This results in the opening of stomata.

During night, the water moves out of the guard cells which makes them flaccid. This causes the inner walls to come together, as a result of which stomata closes.

Do you know the cell organelle of the plant cell that carries out the process of photosynthesis? It is **chloroplast**.



Chloroplast is divided into two regions namely, **grana** and **stroma**.

In the **grana** region, reactions which depend on sunlight take place. These reactions are also known as light dependent or light reactions. In these reactions, water molecules break down into oxygen and hydrogen ions on absorption of energy from sunlight. Plants release oxygen gas in this phase and chemical energy obtained from light energy

is stored in the form of ATP. This chemical energy is required in the preparation of starch in the reactions independent of light.

In the **stroma** region, light independent or dark reactions take place in which chemical energy produced in the grana region is used to convert carbon dioxide into starch.

Photosynthesis is affected by various factors, such as:

- **Light**: Photosynthesis can occur only up to a certain level of concentration of light. Above that level of light, chlorophyll is destroyed and photosynthesis is affected.
- **Temperature**: At higher temperatures, photosynthesis does not take place and similarly at lower temperatures the rate of photosynthesis is less.
- **CO_2**: CO_2 levels also affect the rate at which photosynthesis is carried out. Low levels of CO_2 means lower rate of photosynthesis.