UNIT 3

The Structure and Functions of Plants

Learning Objectives

- Description of flowering parts
- Two main systems of a flowering plant in root system and shoot system
- Different modified roots, stems and leaves
- Parts of a flower and their functions
- Pollination and the description of cross-pollination and self-pollination
- Various agencies of pollination
- Structure of a seed and its dispersal
- Structure of a simple fruit

A FLOWERING PLANT

If you look around, you will find various kinds of plants. Some are big, others are small. They may differ in size but they have some structural similarities. All flowering plants have root system and shoot system. The root, stem and leaves are vegetative parts whereas flower is a reproductive part.

Take out a balsam or a mustard plant from the soil and study it. A flowering plant can be divided into two parts:

(i) An underground part called the **root system** and

(ii) The part above the ground called **shoot system**.

The root system consists of branches of roots, root hairs, etc. while the shoot system consists of branches, leaves, flowers, fruits, etc.

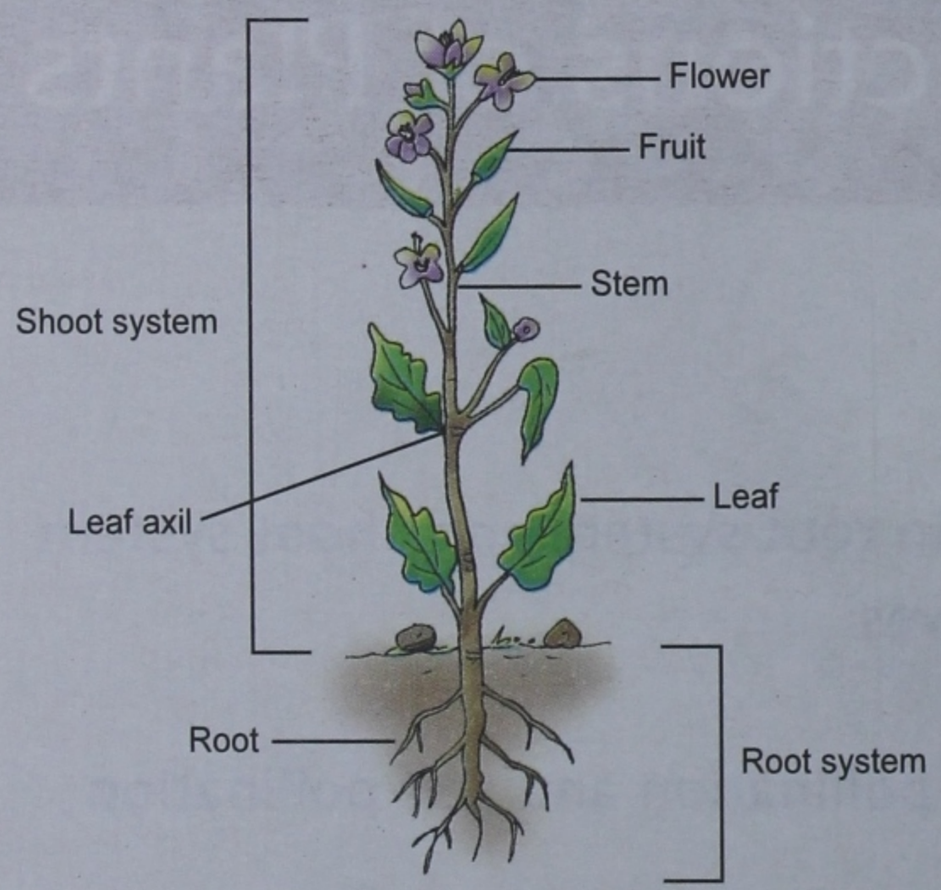


Fig. 3.1 Parts of a flowering plant

THE ROOT SYSTEM

The root fixes the plant with soil. In certain plants like balsam, mustard, pea, neem, etc. the root system consists of a main root called tap root. The tap root grows down the soil and gives out lateral branches.

In grasses and a few other plants like wheat, maize, rice, sugarcane, etc. the roots arise as a cluster from the base of the stem; there is no main root. This type of root is called fibrous root.

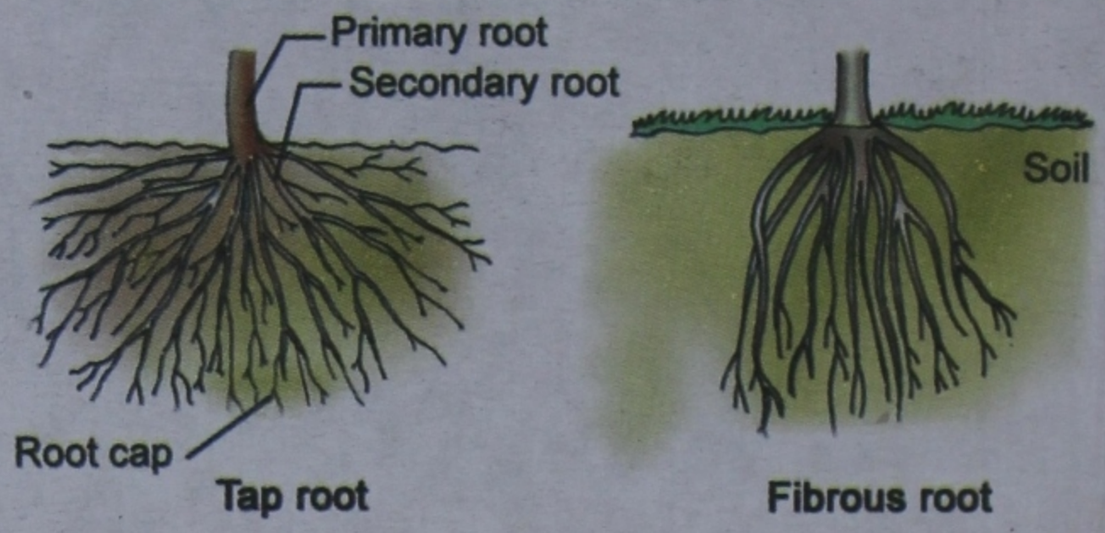


Fig. 3.2 Root system

Functions of the Root

Primary Functions

1. **Fixation:** The root fixes the plant firmly in the soil.
2. **Absorption:** The root hairs help in the absorption of water and minerals from the soil.

Secondary Functions

1. **Storage:** In plants like carrot, turnip, radish and sweet potato, the roots are modified for the storage of food.
2. **Mechanical support:** In plants like banyan and maize, the roots support heavy horizontal branches like a pillar.

Modifications of the Root

For Storage of Food

Plants likes radish, carrot, turnip and sweet potato store food in their roots. These roots swell-up and become thick due to accumulation of food. This food is utilized whenever required. Such roots are called **tuberous roots.**

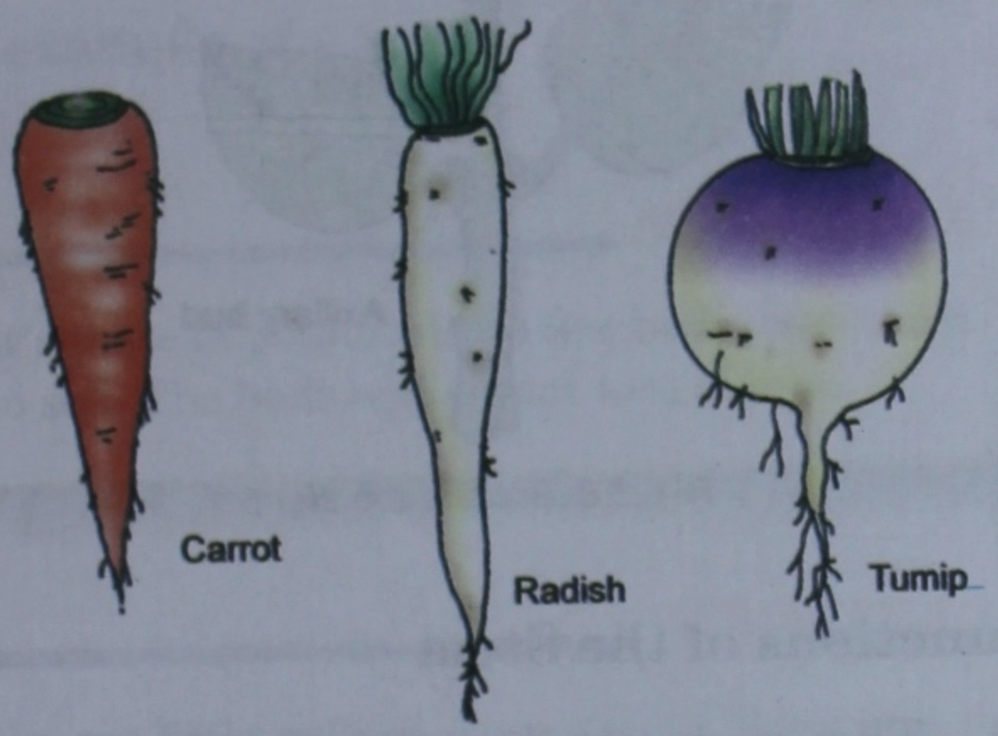


Fig. 3.3 Some storage roots

For Additional Support

In banyan tree and screw pine the roots grow downward from the branches of the tree. These roots penetrate the ground and become pillar like for additional support. These roots are called **prop roots.**

Fig. 3.4 Prop roots of banyan tree

In sugarcane and maize where the stems are tall and weak, additional roots arise from the lower portion of stem. These roots are called **stilt root.**

Fig. 3.5 Still rots of maize

For Respiration

In plants growing in marshy habitat, the root system produces vertically upward branches. These roots come out of the soil and help in breathing. These special roots are called as **pneumatophores** or **breathing roots.**

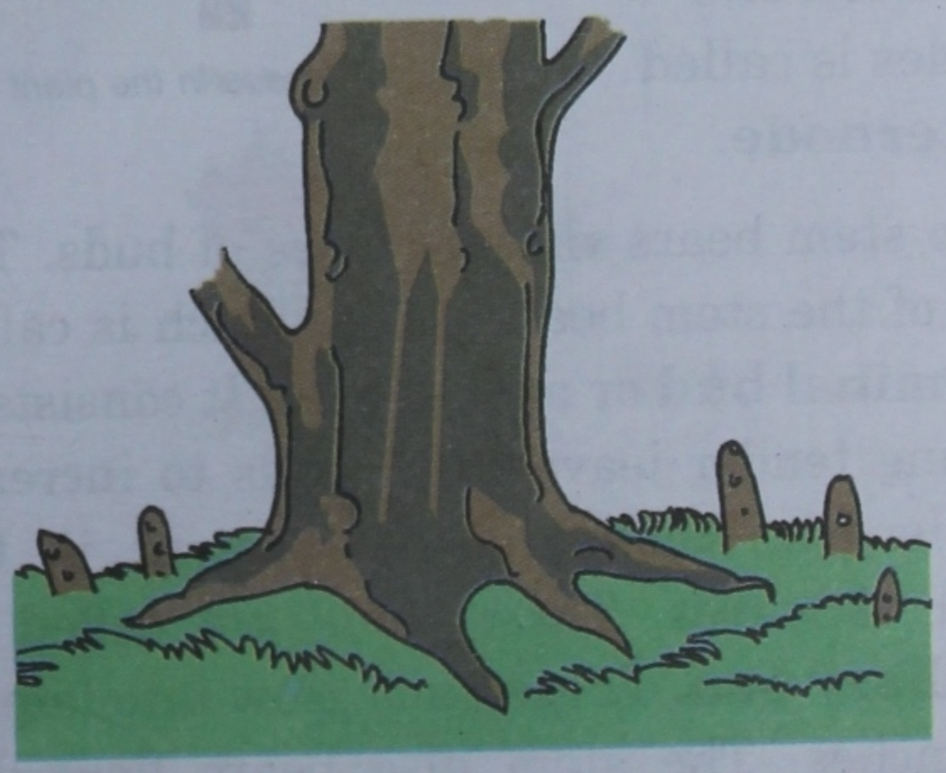


Fig. 3.6 Breathing roots

For Absorption of Nutrients and Water

A plant like a money plant develops long, fibrous roots called **feeder roots**. These roots reach the soil and absorb more nutrients and water from the soil.

THE SHOOT SYSTEM

The Stem

The portion of the plant above the ground, called shoot system consists of stem, leaves, flowers, etc. Small plants have soft and green stem. Some plants have weak stem. They cannot stand erect. They creep on the ground. Still few stems climb with some support. They swing around a support (pole or wire, etc). Trees have woody and hard stem. It is called **trunk**. The portion of stem from where leaves arise is called **node**. The portion of stem between two nodes is called **internode**.

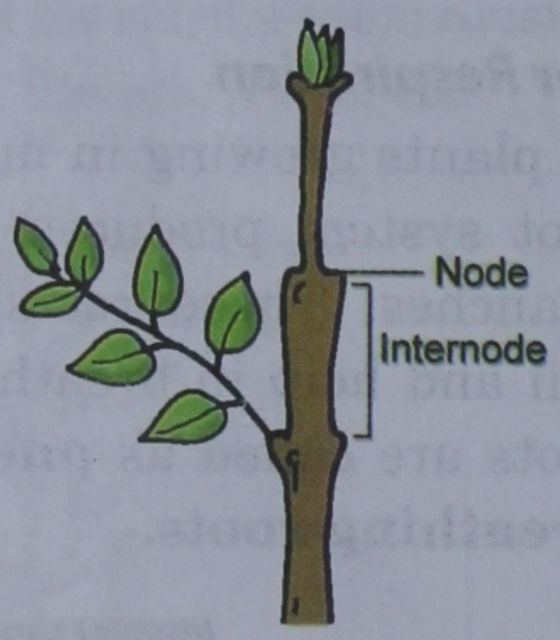


Fig. 3.7 Nodes in the plant

The stem bears various types of buds. The tip of the stem bears a bud which is called **terminal bud** or **apical bud**. It consists of young tender leaves and leads to increase in length. Buds are also present in the axil of leaves. These buds are called as **axillary bud.** These buds grow into lateral branches. The stem also bears flowering buds. On maturity flowering buds give rise to flowers.

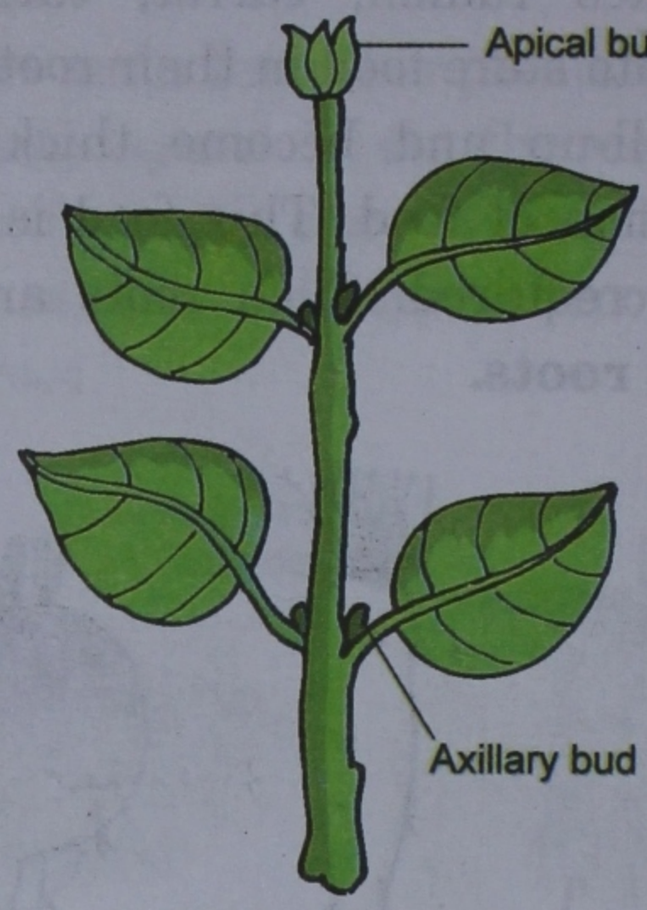


Fig. 3.8 Buds in the stem

Functions of the Stem

1. The stem conducts water to various parts of the plant.
2. The food prepared by leaves reaches various parts of the plant through stem.
3. The stem bears leaves, flowers, fruits, etc.
4. A few stems are modified to manufacture food and store food.

(a) Modification of Stem for Storage

In some plants, stems are modified to store food. Such modifications are underground modification of stem. Stems store food and swell-up. The stored food helps the plant to survive in unfavorable conditions.

The main modifications of stems

(i) **Tuber:** It is roughly spherical in shape. It has buds on its surface. Buds are called 'eyes'. It has leaves on its surface. The leaves become scaly. Potato is the example of a tuber.

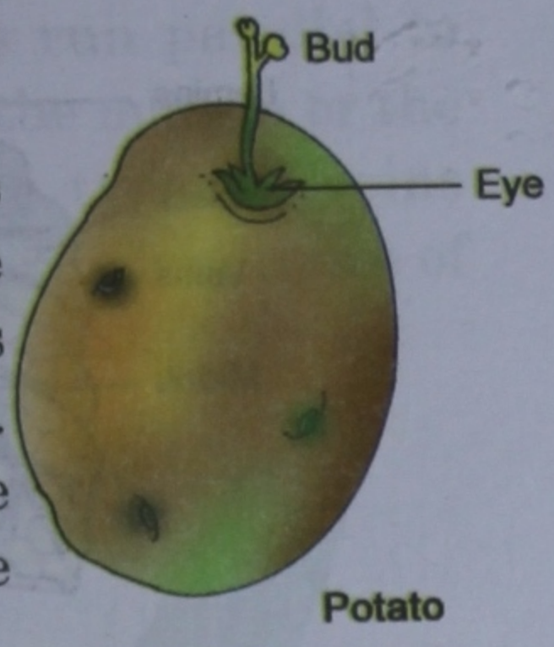


Fig. 3.9 Tuber

ACTIVITY 3.1

Cut a piece of potato with a few buds. Sow them into soil. The buds will sprout into plants.

ACTIVITY 3.2

Take out little pulp of a raw potato. Keep it in a test tube. Put a few drops of iodine solution in the test tube. Blue black colour appears showing the presence of starch.

(ii) **Bulb:** It is highly condensed (flat) stem. It becomes disc-shaped. The stem has both fleshy and scaly leaves. The fleshy leaves store food. Buds are present in the leaf axils. New bulb grows from the buds. Onion is the example of a bulb.

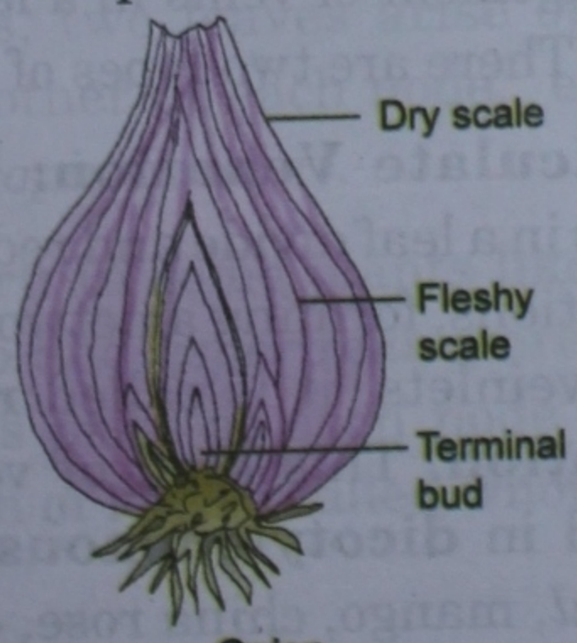


Fig. 3.10 Bulb

(iii) **Rhizome:** This stem is horizontally placed. It has nodes and internodes. It has scaly brown leaves at the axils. The stems of ginger and turmeric are the examples of rhizome.

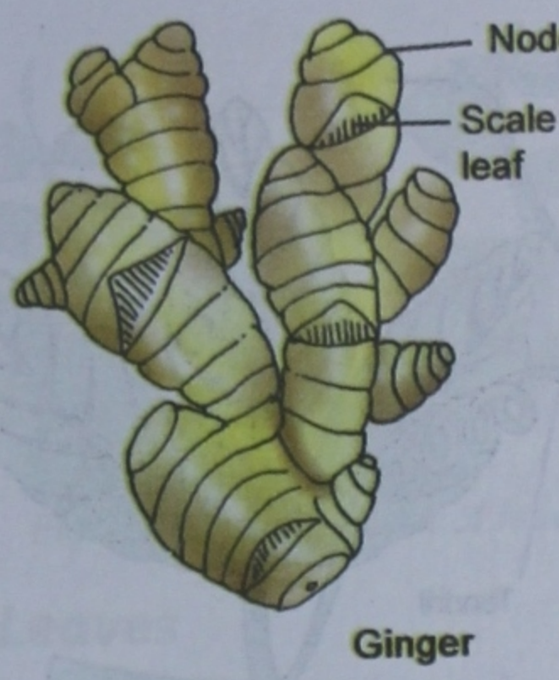


Fig. 3.11 Rhizome

(b) Modification of Stem for the Preparation of Food

In a desert plant like **opuntia**, the stem becomes thick and flat. It becomes green like a leaf and manufactures food. The actual leaves turn spiny and needle-like. The green thick stem of **opuntia** stores lots of water.

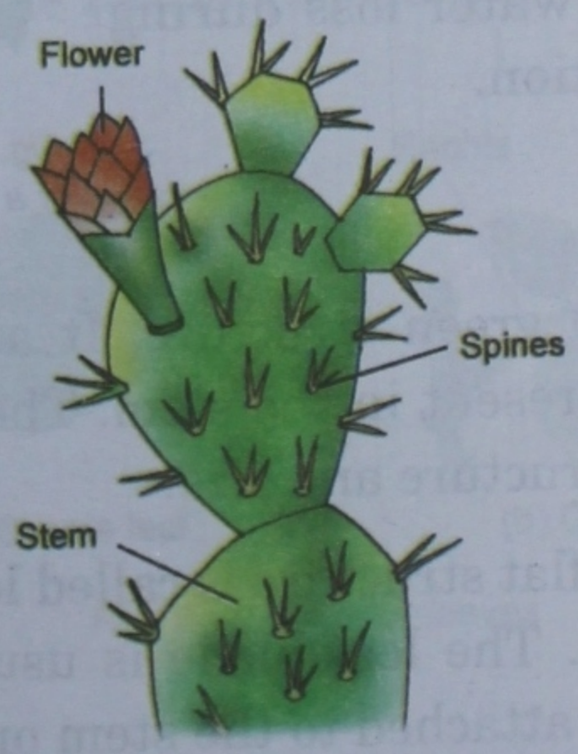


Fig. 3.12 Cactus

(c) Aerial Modification for Support

The stems of climbers such as gourd, grapevine, passion flower plants are weak. The stems of these plants develop thread-like structures called **tendrils.** Tendrils look wiry and are coiled around a support like a wire or bamboo pole, etc. to help the plant to climb.

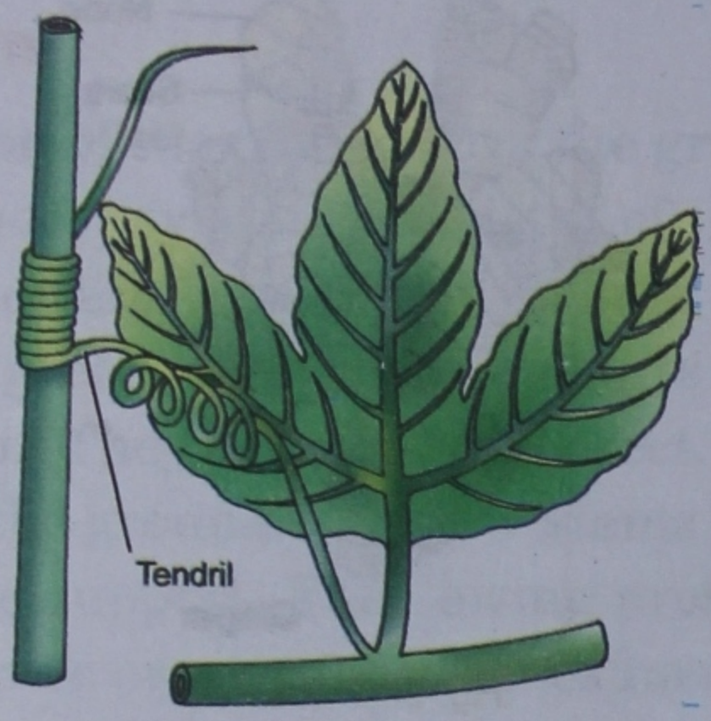


Fig. 3.13 Stem tendril of a passion flower

Thorns

Abudismodifiedin a*duranta* or rose plant. The structure becomes hard and pointed. It acts as a defensive organ to keep the grazing animals away. It also prevents excessive water loss during transpiration.

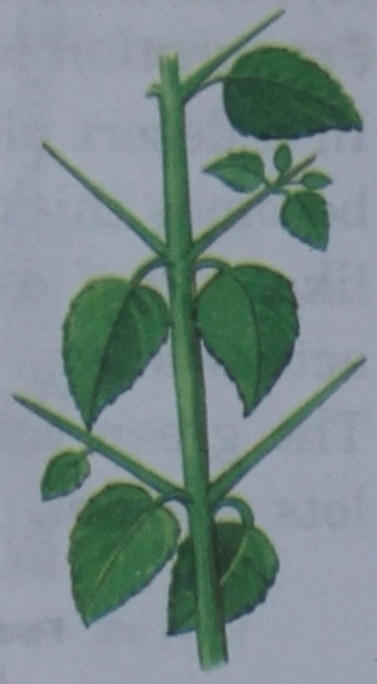


Fig. 3.14 Thorns of a duranta plant

Leaf

A leaf is a green structure. It arises from the node present in the stem. The leaf may differ in structure and size.

The green flat structure is called **leaf blade** or **lamina**. The leaf blade is usually thin. The leaf is attached to the stem or a branch of the plant by means of a **stalk** called

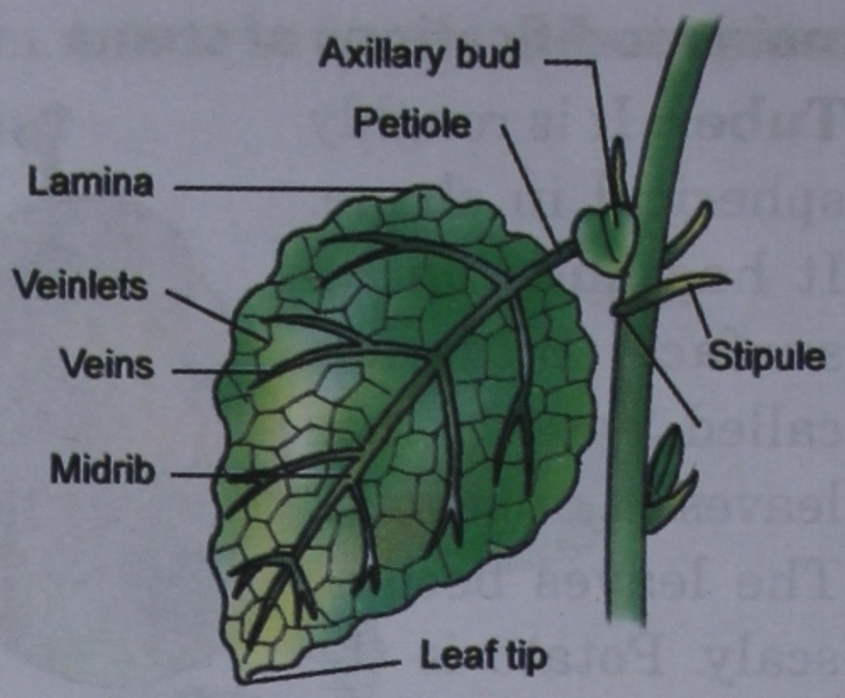


Fig. 3.15 Parts of a leaf

petiole. The petiole extends, in the leaf blade as a midrib joins the leaf to the stem of the plant. The leaf blade has a network of veins. These veins conduct water to the leaf and take away the prepared food from leaf to different parts of the plant. The leaves are green due to a pigment called **chlorophyll** that helps them in preparing food for the plant.

ACTIVITY 3.3

Collect various kinds of leaves with different sizes and shapes. Dry them and paste them on a chart paper.

Venation

The arrangement of veins in a leaf is called venation. There are two types of venation.

(i) **Reticulate Venation:** When the veins in a leaf divide and redivide in all directions, forming a network of veins and veinlets, it is called **reticulate venation**. This kind of venation is found in **dicotyledonous** leaves of *peepal*, mango, china rose, etc.

(ii) **Parallel Venation:** In this type of venation, the veins run parallel to each other towards the margin or the tip of the leaf. Such types of veins are found in monocotyledon leaves of maize, rice, grasses, etc.

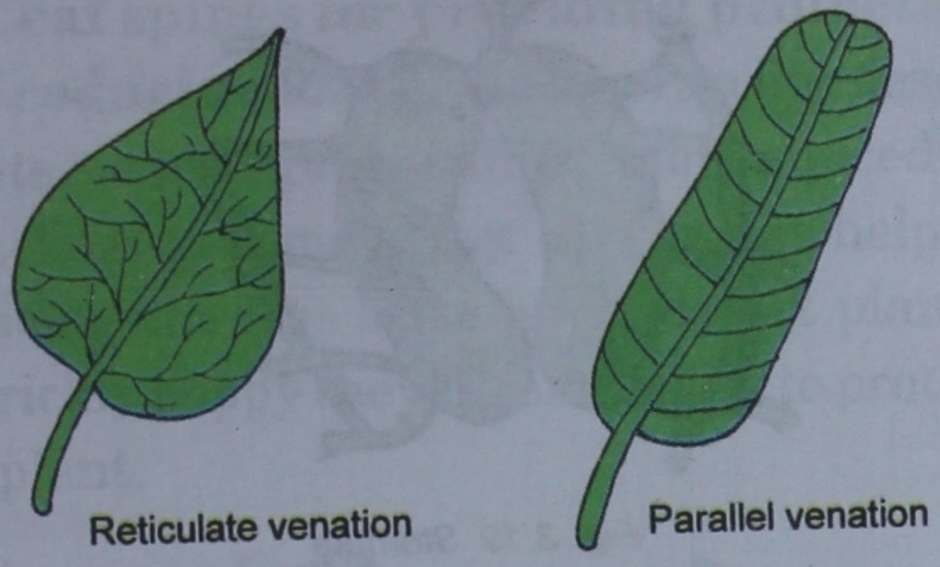


Fig. 3.16 Arrangement of veins in the leaf

Arrangement of Leaves

The leaves are arranged on a stem in various ways. The arrangement of leaves on a stem is called **phyllotaxy**. This arrangement aims to expose each leaf to maximum sunlight. Three kinds of arrangements are commonly found:

(a) **Alternate:** In this arrangement of leaves a single leaf arises at each node alternately e.g. sunflower, mango.

(b) **Opposite:** In this arrangement of leaves, two leaves arise opposite to each other at each node, e.g. guava, *calotropis* (mader).

(c) **Whorl:** In some plants like oleander shrub and *asparagus* more than two leaves arise at each node forming a bunch of leaves called whorl.

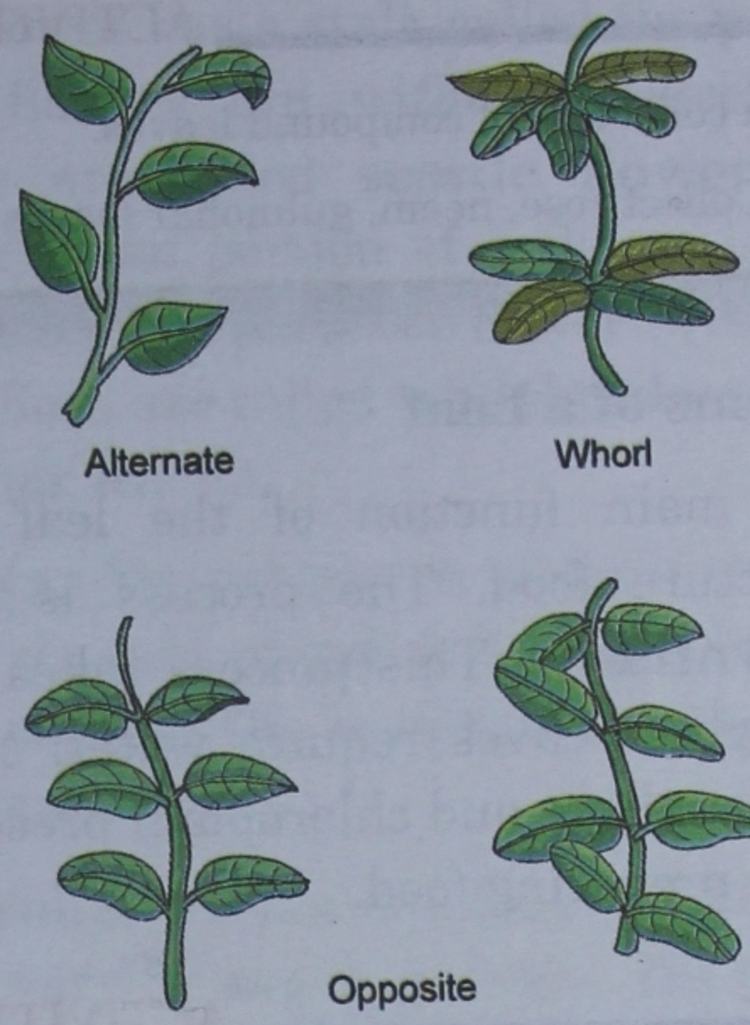


Fig. 3.17 Arrangement of leaves

Kinds of Leaves

The leaves are of two types: **simple leaf** and **compound leaf**.

Simple Leaf: The leaf with an entire leaf blade (undivided lamina) is called **simple leaf,** e.g. *peepal*, mango, china rose, etc.

Compound Leaf: The leaf in which lamina is cut into several pieces on a common stalk is called **compound leaf.** The stalk or main stem of a compound leaf is called **rachis**. The rachis has an axillary bud.

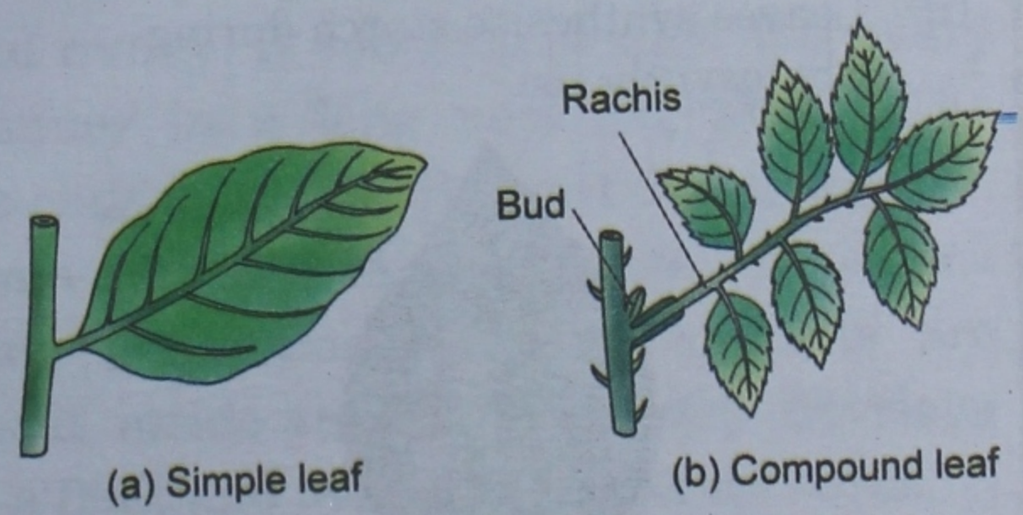


Fig. 3.18 Kinds of leaves

ACTIVITY 3.4

Make a collection of compound leaves.

Hint: Collect rose, neem, gulmohar leaves.

Functions of a Leaf

1. The main function of the leaf is to manufacture food. The process is called **photosynthesis**. This process takes place in sunlight. Leaves require water, carbon dioxide, sunlight and chlorophyll present in them for preparing food.

ACTIVITY 3.5

Take a fresh variegated leaf from a croton or coleus plant. A variegated leaf is partly green and partly white. Drop this leaf into boiling water and let it boil for a few minutes. This is done to kill the cells present in the leaf. Now, boil the leaf in the rectified spirit over a water bath to decolourise it. Place the leaf in a dilute iodine solution. What change do you observe? You will find that the green areas of the leaf turn blue black as shown in Fig. 3.20

What does this activity prove? This activity shows that:

(i) Chlorophyll is necessary for photosynthesis.

(ii) Leaves synthesise starch during photosynthesis.

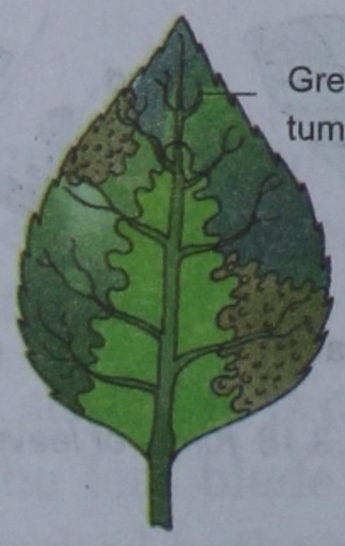


Fig. 3.20 Starch is synthesised during photosynthesis

2. The leaves have tiny pores on their lower surface. These pores are called stoma (**stomata**). Exchange of gases takes place through these pores. Oxygen required for respiration and carbon dioxide needed for photosynthesis are taken through these pores.

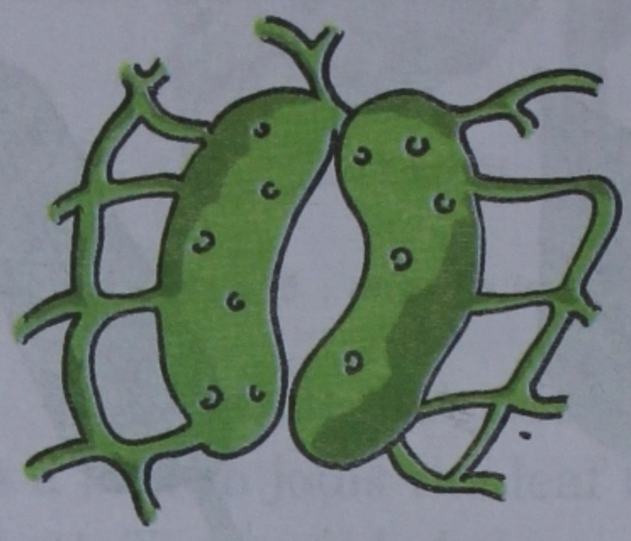


Fig. 3.19 Stomata

The plants lose extra water in the form of water vapour through these pores. This process is called **transpiration.**

KNOW YOUR SCIENTIST

Jan Ingenhousz
(1730 – 1799)

A Dutch scientist first discovered that plants take in carbon dioxide and release oxygen in sunlight but in the dark, plants take in oxygen and give out carbon dioxide like all other animals.

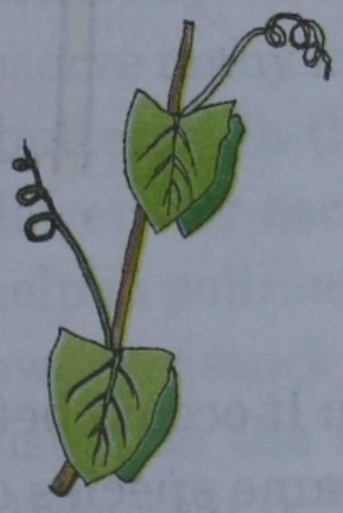
Modification of a Leaf

In certain plants, leaves are modified in shape and size in order to perform different functions for the plant.

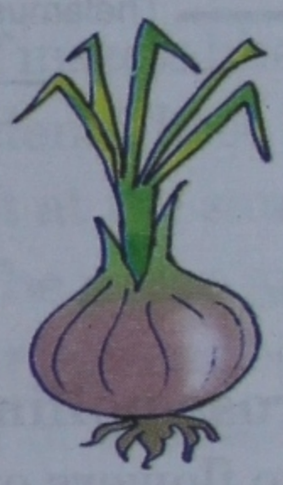
(a) Leaf tendrils for providing support: In a pea plant the leaflets are modified into thin wiry, coiled structures called tendrils. They provide support to the plants in climbing.

(b) Scale leaves for food storage: In some plants leaves are modified as scale leaves to store food and water. As in the case of onion leaves become fleshy to store food. In case of ginger the scale leaves become thin and dry.

(c) Leaf spines for providing protection and reducing loss of water: In a few desert plants, leaves get modified and reduced in size. They become spiny. The spines help in reducing the loss of water in desert plants. In prickly poppy they become spiny to protect the plant.



(a) Pea plant with a coil structure



(b) Fleshy leaves of an onion

(c) Prickly poppy

Fig. 3.21 Modifications of a leaf

PARTS OF A FLOWER

Flowers are most beautiful part of a plant. Flowers are of various shapes and sizes. You must have seen flowers in your school gardens. Let us now study in detail about the flowers.

Each flower has a stalk called the **pedicel**. Some flowers are without pedicel; such flowers are called **sessile flowers**. The basal swollen portion of a flower is called **thalamus**. The parts of a flower arranged in a ring form are called **whorls.** Most flowers have four whorls.

1. Calyx : The outermost whorl is the calyx. Calyx consists of green leaf like structure called **sepals.** The sepals protect the flower in its bud stage.

2. Corolla: Corolla consists of petals. The petals vary in size and shape. The petals of most of the flowers are colourful. Being brightly coloured, they attract insects for pollination.

3. Stamen: The third whorl is that of stamen. Each stamen consists of a filament and an anther. The anther is a sac-like structure, present at the tip of the filament. It produces powdery mass called pollen or pollen grains. Pollen grains produce male cells or the sperm. Stamen is the male part of a flower.

4. The central part of the flower is female part. It consists of a **carpel** or **pistil**. It has three parts. Basal swollen portion is called **ovary**. It contains ovules. The ovary continues in a long neck-like **style**. The style ends in a knob like part called **stigma**. Stigma serves a landing place for pollens during pollination. Female sex cells are present inside the ovules. Ovary develops into a fruit and ovules develop into seeds.

A flower which consists of all the four whorls calyx, corolla, stamen and carpel is called a **complete** flower. Some flowers with

both male and female reproductive parts are called **bisexual** or **hermaphrodite** flowers. Others may have either male or female parts, such flowers are called **unisexual** flowers.

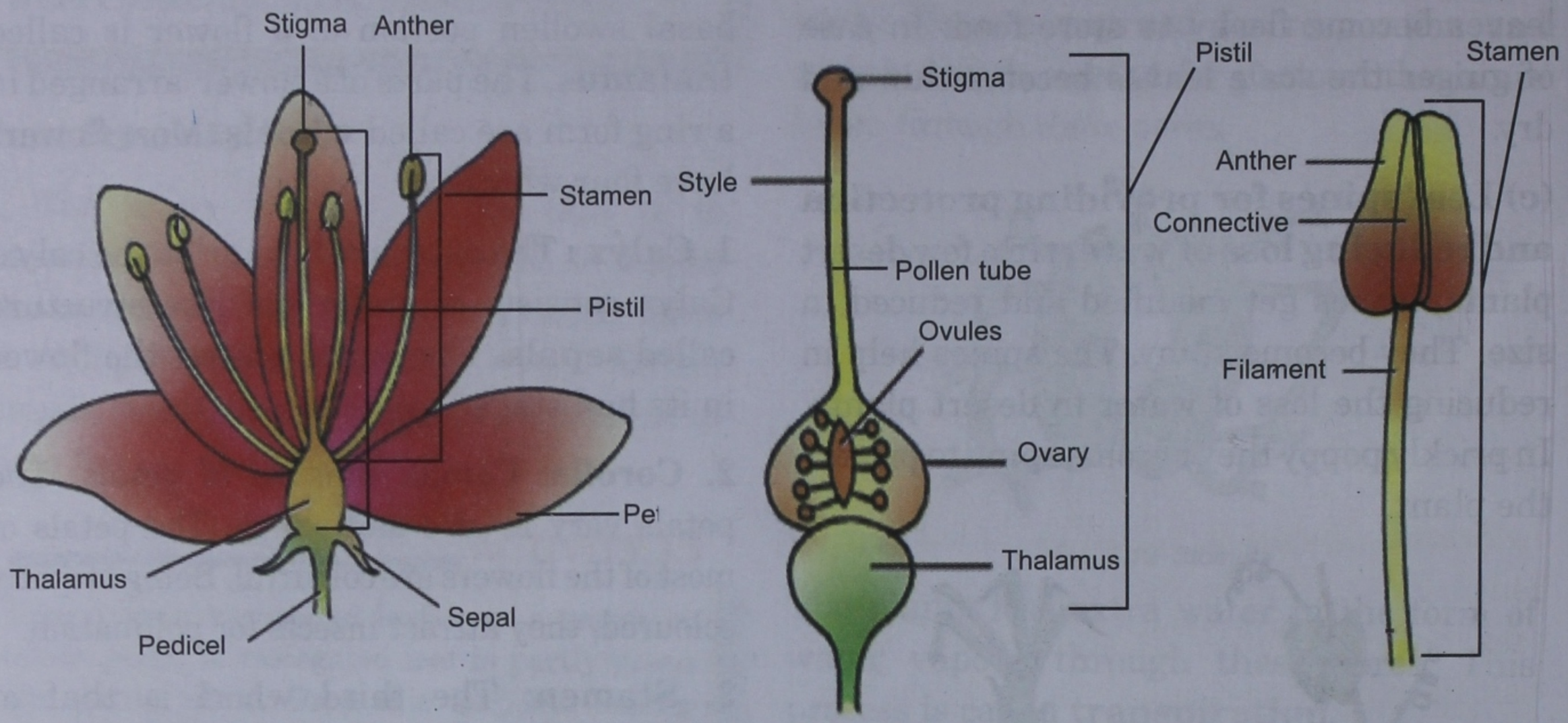


Fig. 3.22 Parts of a flower

POLLINATION

You might have seen honey bees and other kinds of insects visiting one flower to another. When they sit on a flower, the pollen grains stick to their legs which are dusted on another flower when they visit them. The bees are doing a very important job in nature unknowingly. They are bringing about pollination. Transfer of pollen grains from anther to stigma is called pollination. This may be brought about by insect, wind or any other external agencies.

Types of Pollination

(i) **Self-pollination:** When pollination occurs within the same flower or another flower of the same plant, it is called self-pollination.

(ii) **Cross-pollination:** It occurs between two flowers of the same species of two different plants.

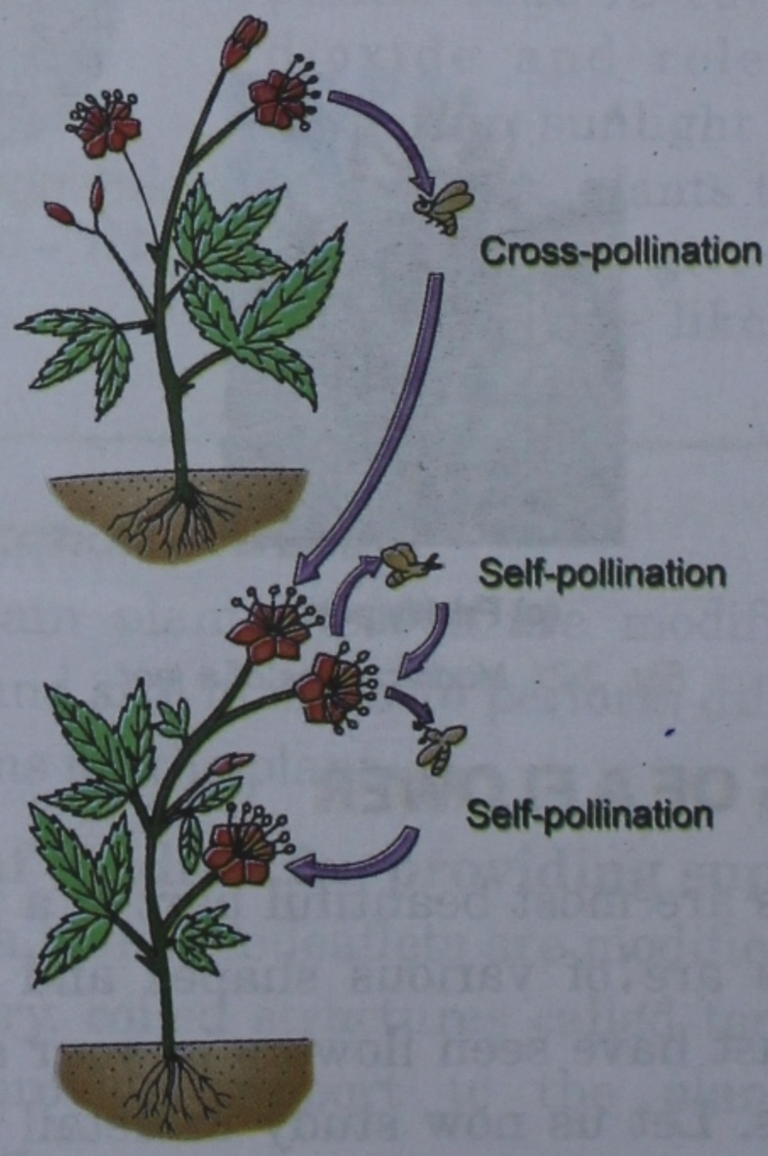


Fig. 3.23 Self-and cross-pollination

ACTIVITY 3.6

Visit your school garden or any other garden to see insect pollination. Also, note down the special features of such flowers.

Agents of Pollination

How are pollen grains transferred from anther to stigma?

The pollen grains are transferred from anther to stigma through insects, wind, water, birds etc.

Pollination by Insects

You observe many kinds of insects like honey bees, butterfly in the garden. These insects visit flowers for nectar but at the same time they help in pollination. The pollen grains of one flower get stuck to their legs and body and are dusted on the stigma of another flower when they visit it. The flowers pollinated by insects show certain characteristics. They are as follows.

1. The petal colour of a flower like rose, marigold is bright enough to attract insects.
2. The flowers are of big size.
3. The flowers like jasmine are highly scented.
4. These flowers usually have nectars in them that these insects look for.

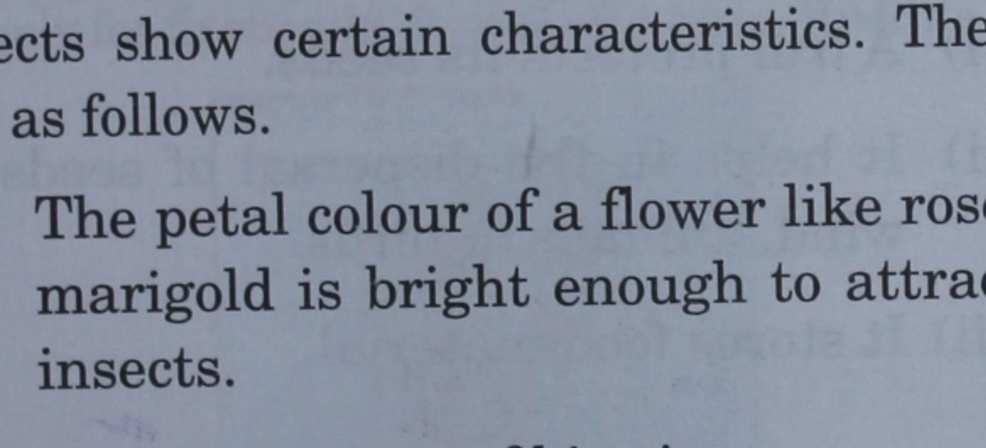


Fig. 3.24 Pollination by insects

Pollination by Wind

The flowers of maize, grass, rice, etc. are pollinated by wind. Flowers pollinated by wind have following special features:

1. Pollen grains are light and innumerable in number.
2. Stigma is large and feathery.
3. Some time stigma protrudes out of the flower.

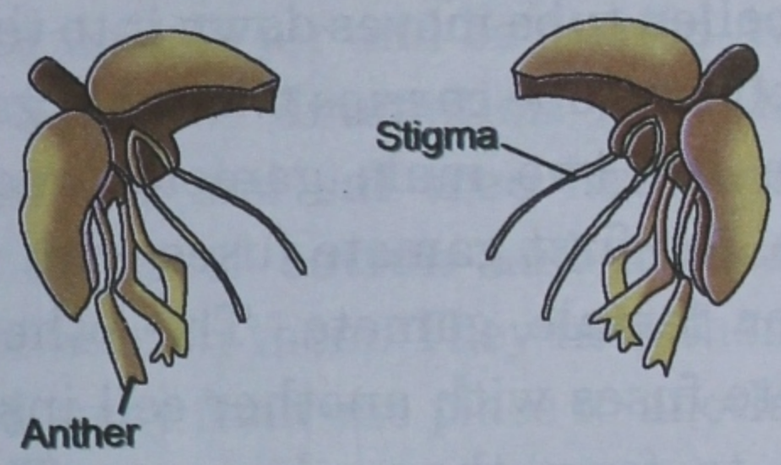


Fig. 3.25 Pollination by winds

Water Pollination

Pollination by water occurs in aquatic plants like hydrilla and vallisneria. The pollen grains float on water and flow with the current of water. They reach the stigma of the female flower as in vallisneria.

ACTIVITY 3.7

Take a few different kinds of flowers. Dust their pollen grains on a glass slide and examine under a microscope.

FERTILIZATION

The fusion of the male gamete inside the pollen grain with the female gamete is called **fertilization**.

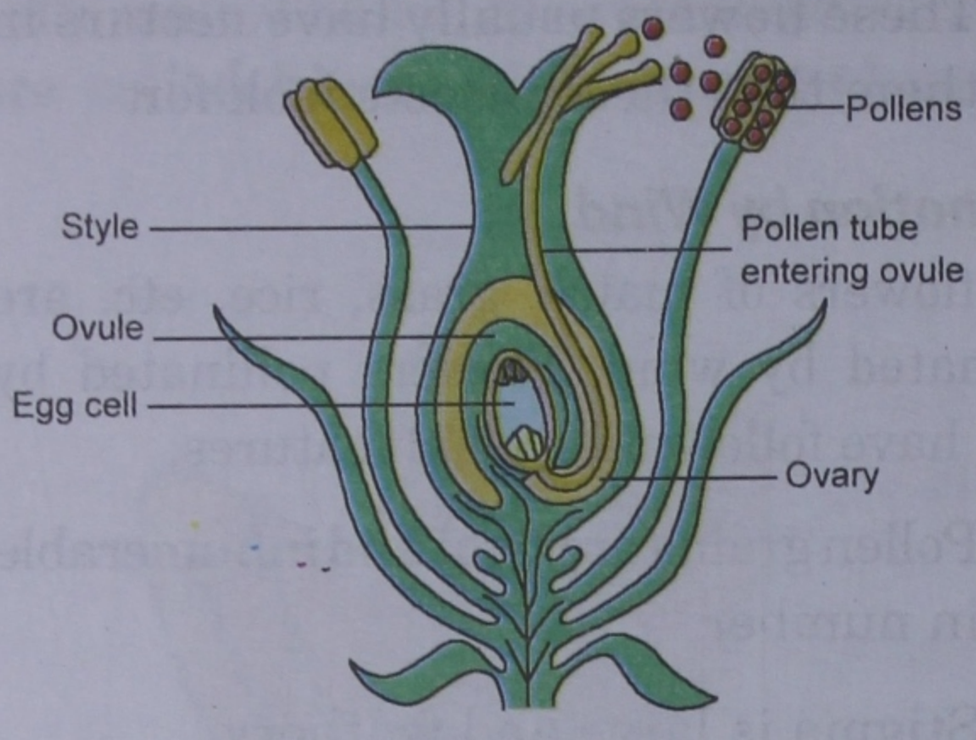


Fig. 3.26 Ovary showing ovule undergoing fertilization

Among the pollen grains falling on the stigma, only one develops a *pollen tube*. The pollen tube moves down into the style. The pollen tube carries two male gametes. When the two male gametes reach the ovule, the first gamete fuses with the *egg cell* or female gamete. The other male gamete fuses with another cell inside the ovule to form the *endosperm*. The first fusion of gametes forms the *zygote*. The second fusion forms the endosperm which nourishes the zygote initially. The zygote later forms the **seed**. The ovary forms the **fruit**.

FRUITS

Ovary develops into fruits after fertilization. Biologically ripened ovary is a fruit. All fruits enclose seeds. A typical and simple fruit consists of two parts: **Pericarp** and **Seeds**. The **pericarp** (fruit cell) develops from the wall of the ovary. It may be thin, thick, dry or fleshy. In fruits like mango, the pericarp is differentiated into three layers: (i) epicarp (ii) mesocarp and (iii) endocarp. The **epicarp** is the outer layer, **mesocarp** is the middle layer and **endocarp** is the inner layer of the fruit. In most of the fruits, the mesocarp becomes fleshy and juicy and it is an edible part. Seeds are present inside the fruits. In fact, the fruit protects the seeds and help in their dispersal. A fruit may contain one seed as in mango or many seeds as in orange, watermelon, etc.

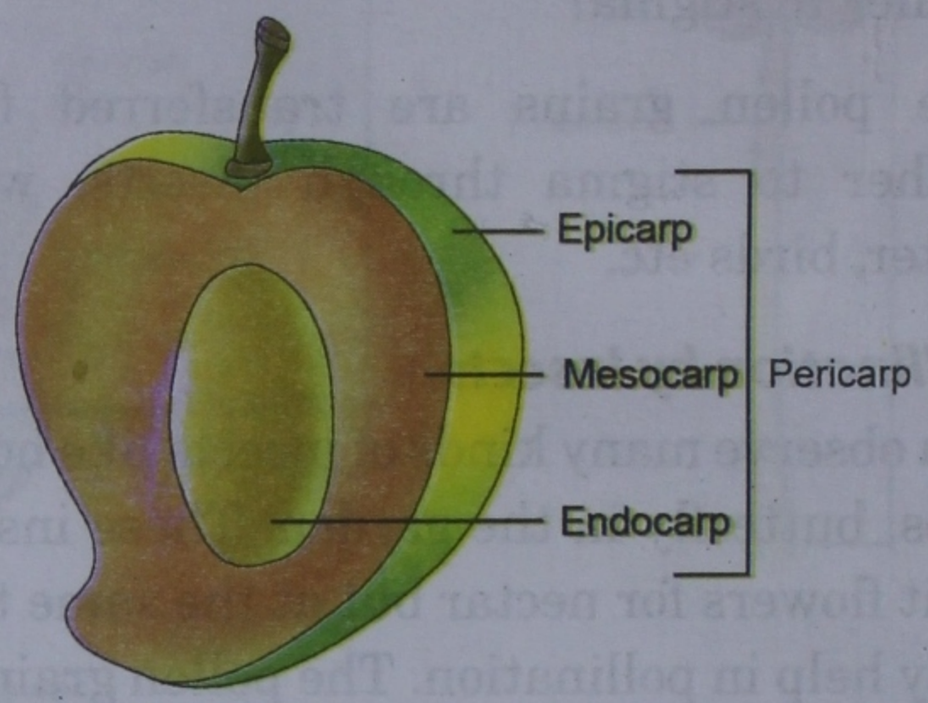


Fig. 3.27 A fruit showing different layers of pericarp

Functions of a Fruit

(i) A frui protects its seeds.

(ii) It helps in the dispersal of seeds by wind, animals or birds.

(iii) It stores food material.

SEEDS

Ovules, after fertilization become seeds. Seeds are mature ovules. A fruit may have one seed as in mango or plum or many seeds as in papaya, orange and watermelon. Seeds vary in their shape and size.

Structure: A seed contains a baby plant (embryo) inside it. It consists of one or two **cotyledons**. Each seed has a protective seed coat over it to protect it. Embryo of a seed

is represented by **plumule** and a **radicle**. The plumule develops into shoot system and radicle develops into root system. Under proper conditions that include water, air, light and temperature, a seed germinates to produce a new plant.

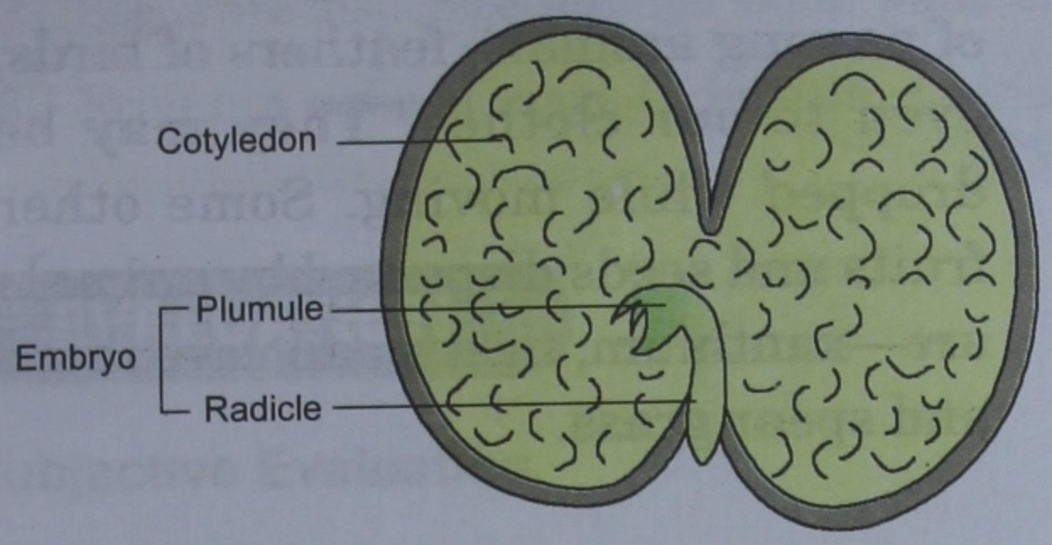
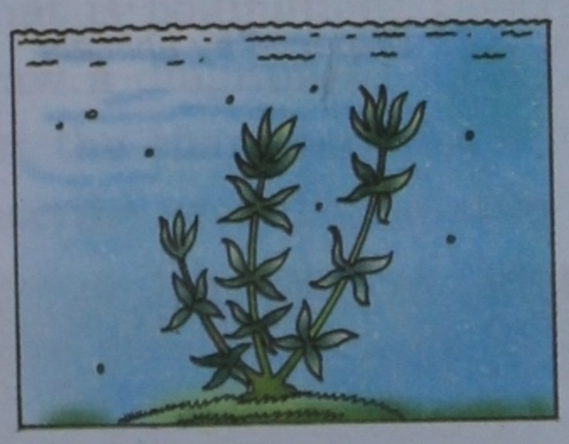


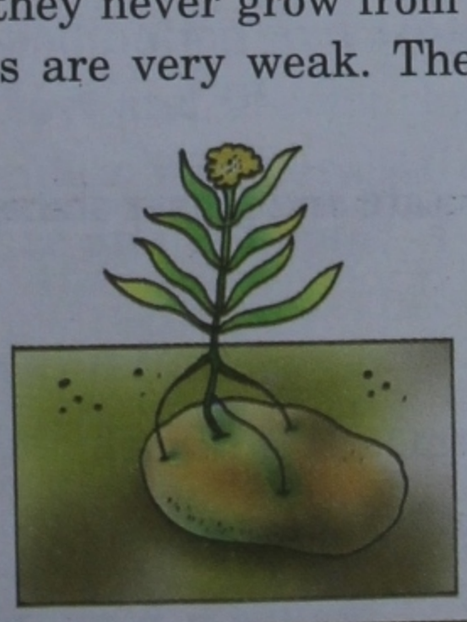
Fig. 3.28 Parts of a germinating seed

DO YOU KNOW?

1. Rootless plants: Many plants growing in water do not possess roots because there is little requirement for absorp-tion of water. Example, wolffia. They bear the smallest flowers amongst all. There are some plants in which roots develop only for fixation in the soil. Example, Hydrilla.



2. Potato plants produce flowers, fruits and seeds. Yet, they never grow from seeds because potato seeds are very weak. They rarely grow into plants



Dispersal of Seeds

Plants produce large quantities of seeds. If all the seeds of a plant fall at the same place, then there will be a strong competition for space, water and light. There are chances that most seedlings will die due to overcrowding. Therefore, seeds are dispersed far and wide. The seeds are dispersed by air, water or animals.

Agents of dispersal

1. Wind: The seeds and fruits of many plants become very light on drying up and develop thin, flat wings or tufts of hair. These help them to float in air and be carried away by wind. Seeds of **drumstick** fruit, hiptage (Madhulata) and **sal tree** have wings on them. Seeds of **cotton** and **mader** have tufts of hair on them. They help them to be carried away from one place to another.

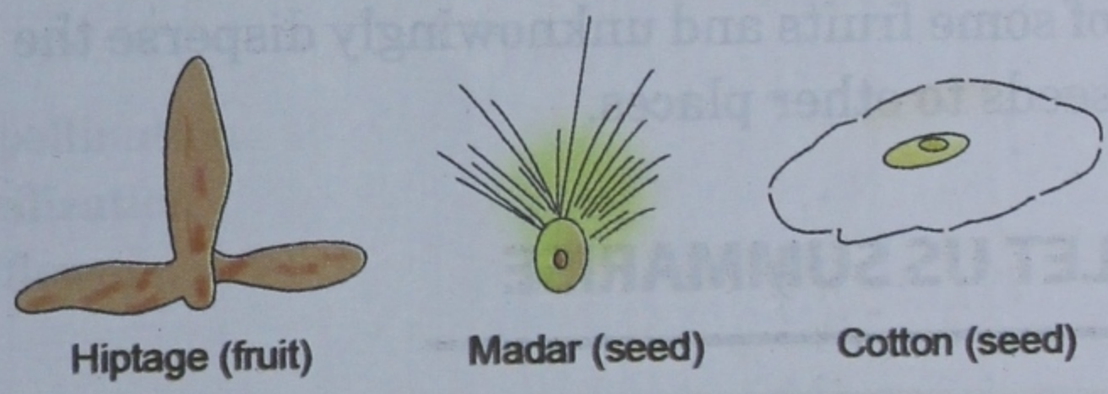


Fig. 3.29 Dispersal by wind

2. Water: Seeds and fruits of plants that grow in or near water develop spongy or fibrous outer coverings which keep them

Fig. 3.30 Dispersal by water

afloat and the water current carries them away. For example, coconuts have a very strong fibrous covering, while seeds of **lotus** are enclosed in a spongy and top-shaped thalamus.

3. Explosion: Some seeds are thrown away when the fruit bursts open with a sudden jerk. The walls of the fruit curl up while and throw the seeds when they are dried. The seeds of **balsam** and **castor** burst out of their fruits.

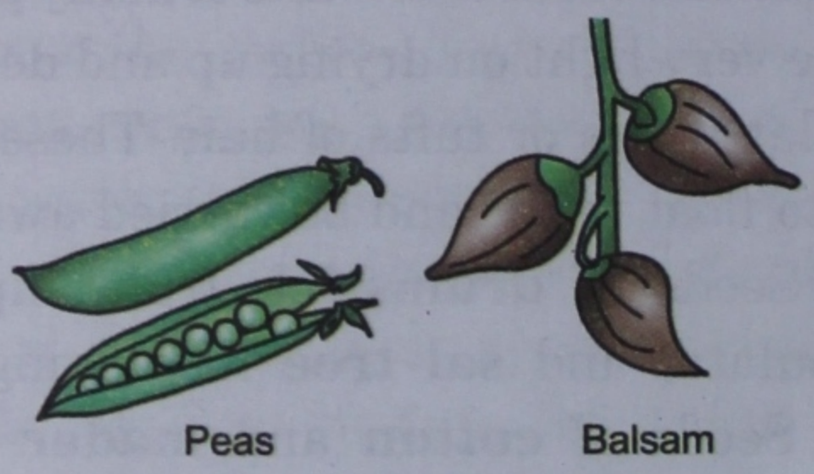


Fig. 3.31 Dispersal by explosion

4. Animals: Animals and birds eat the flesh of some fruits and unknowingly disperse the seeds to other places.

(i) Human beings eat fleshy fruits like mango and guava, and throw away their seeds.

(ii) Some plants produce dry fruits which have hooks, spines, thorns or stiff hair on them. They cling to the skin of passing animals, feathers of birds, even to our clothes. They may be dropped while moving. Some other fruits and seeds dispersed by animals are—xanthium, tiger's nail, love thorn and spear grass.

Fig. 3.32 Dispersal by animals

LET US SUMMARISE

1. Plants have two systems: root system and shoot system
2. Functions of the root:
   (i) It fixes the plant with soil.
   (ii) It absorbs water and minerals from the soil.
3. Functions of the shoot:
   (i) It bears branches, leaves, flowers and fruits. In some plants like potato and ginger stems store food.
4. Leaf may be simple or compound.
5. Leaves are modified into leaf tendrils, leaf spines and thorn etc.
6. A flower is a reproductive part of a plant. It has sepals, petals stamen and carpel.
7. Pollination—Transfer of pollen grains from anther to stigma is called pollination.

8. There are two types of pollination:
   (i) Self-pollination (ii) Cross-pollination.
9. Pollination is brought about by: (i) Insects (ii) Wind (iii) Water
10. Fertilization—Fusion of male cells with female cells is known as fertilization.
11. Seeds are dispersed far and wide to prevent overcrowding of same species of a plant.
12. Seeds are dispersed through wind, water or animals etc.
13. Fruit is a ripened ovary. It consists of pericarp and seeds.

EVALUATION

Subjective Evaluation

A. Answer the following questions briefly:

1. Name two systems in plants.
2. Give two important functions of the root.
3. Name all four whorls of a leaf.
4. Why are few flowers brightly coloured?
5. How is tap root different from fibrous root?
6. List two important functions of the stem.

B. Answer the following questions in detail:

1. What is pollination? Describe two types of pollination.
2. Draw a diagram to show the process of fertilization.
3. List the characteristics of insect-pollinated flowers.
4. Describe seed dispersal by wind.
5. Draw a diagram of a flower and label it.
6. Write various agencies of seed dispersal.

C. Differentiate between the following:

1. Simple leaf and compound leaf.
2. Self-pollination and cross-pollination.
3. Tap root and fibrous root.
4. Reticulate and parallel venation.
5. Anther and stigma.

Objective Evaluation

D. Fill in the blank:

1. The dicotyledon plants have.....root system.
2. Potato is a modified ..... .

3. The green pigment of a leaf is ..... .
4. ..... becomes seeds after fertilization.
5. Small pores on the surface of a leaf are called ..... .
6. ..... is the male part of a flower.
7. The fusion of male and female gametes is called ..... .
8. The transfer of pollen from anther to stigma is called ..... .
9. The flowers with both male and female parts is called ..... .

E. Match the columns:

Column A	Column B
(i) Stamen	(a) ginger
(ii) Ripened ovary	(b) respiration
(iii) Tap root	(c) fruit
(iv) Petiole	(d) leaf
(v) Stomata	(e) pollen
(vi) Rhizome	(f) pea plant

F. Write true (T) or false (F) against the following statements:

1. The stem absorbs water from soil.
2. Potato is a modified root.
3. The leaves are reduced to spines in cactus.
4. The wheat plants have fibrous root system.
5. Fusion of male and female gamete is called pollination.

G. Name the following:

1. An underground stem.
2. Two kinds of venation in leaf.
3. A part of the flower that produces pollen.
4. A part of the flower that contains ovules.
5. Structure inside the seed that develops into root.
6. A seed dispersed by wind.
7. A bud found on the apex of the stem.

H. Tick (✓) the correct option:

1. Which of the following is a female part of a flower?
   (a) stigma (b) anther
   (c) stamen (d) filament
2. Potato is a .....
   (a) rhizome (b) tuber
   (c) bulb (d) bud
3. Which plant does not have fibrous roots?
   (a) wheat (b) maize
   (c) rice (d) mustard

4. Lamina is found in a .....
   (a) root (b) leaf
   (c) stem (d) bud
5. Female sex cells are present in the ..... of a flower.
   (a) anther (b) stigma
   (c) ovule (d) thalamus

I. Label the different parts of a flower in the following picture of a flower