CHAPTER-05

MORPHOLOGY OF FLOWERING PLANTS

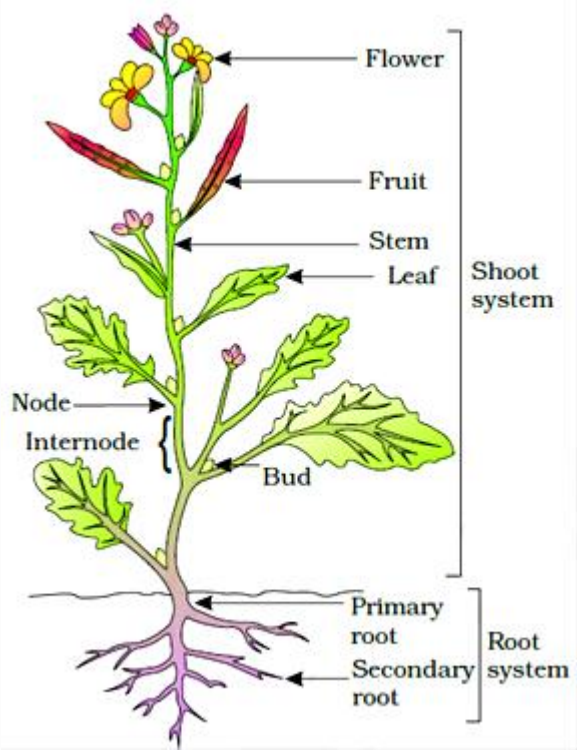
INTRODUCTION

Morphology is the branch of biological science that deals with the study of form, size, colour, structure, and relative position of various parts of organisms.

Importance of morphology-

1. Knowledge of morphology is essential for the recognition or identification of plants.
2. It gives information about the range of variations found in species.
3. Deficiency and toxicity symptoms are morphological changes that occur in response to a shortage or excess of minerals.

Parts of Flowering Plants

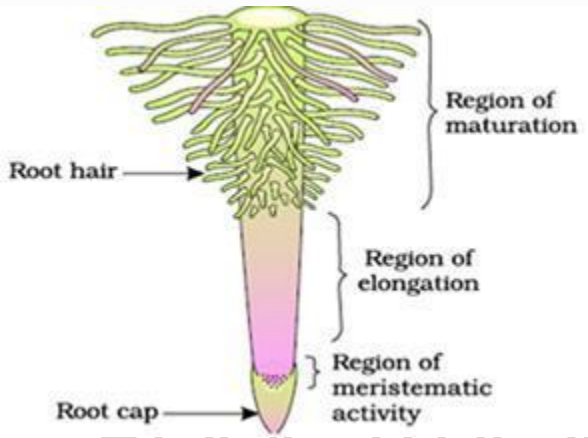


- All the flowering plants have roots, stem, leaves, flower, and fruits. The underground parts of the flowering plant are the **root system** and the portion above the ground forms the **shoot system**.

The Root

- In Dicotyledons, elongation of radicle forms the primary roots which bear lateral roots of several orders called secondary roots, tertiary roots, etc. Primary roots along with lateral roots form the **Taproot system**. Example: Mustard, Gram, etc.
- In monocotyledons, the primary root is replaced by a large number of roots at its base of the stem to constitute the **Fibrous root system**. Wheat, rice, etc.
- The roots that arise from other parts of the plant beside radicle are called **adventitious roots**. Example- Grass, Banyan tree, Maize, etc.
- The main function of the root system is the absorption of water and minerals from the soil, providing proper anchorage to the plant parts and storing reserve food materials.

Regions of Roots

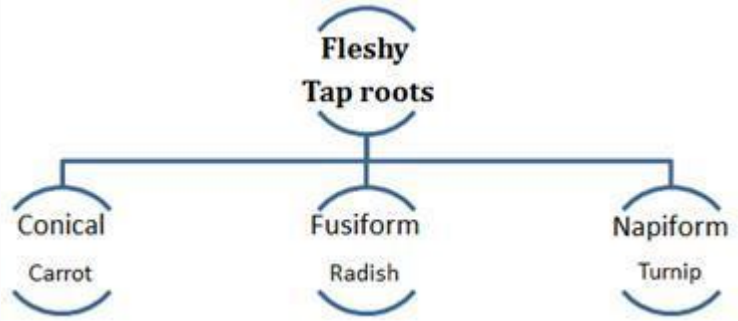


- The apex of the root is covered by a thimble-like structure called **root cap**, it protects the tender apex of the root while making way through the soil.
- Above the root cap is **the region of meristematic activity** having small cells with dense cytoplasm.
- The part above the region of meristematic activity in the **region of elongation** where cells undergo elongation and enlargement to increase the length of the root.
- **The region of maturation** contains root hairs that help in the absorption of water and minerals.

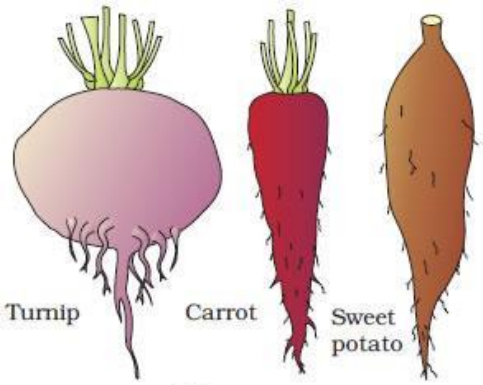
Modification of roots- Roots are modified for storage, nitrogen fixation, aeration, and support.

- The taproot of carrot, turnip, and adventitious root of sweet potato get swollen to store food.
- Prop root of Banyan and Stilt root of maize and sugarcane have supporting roots coming out from the lower node of stems.

- In Rhizophora, Pneumatophores help to get oxygen for respiration as it grows in swampy areas.



Asparagus



(a)

(b)

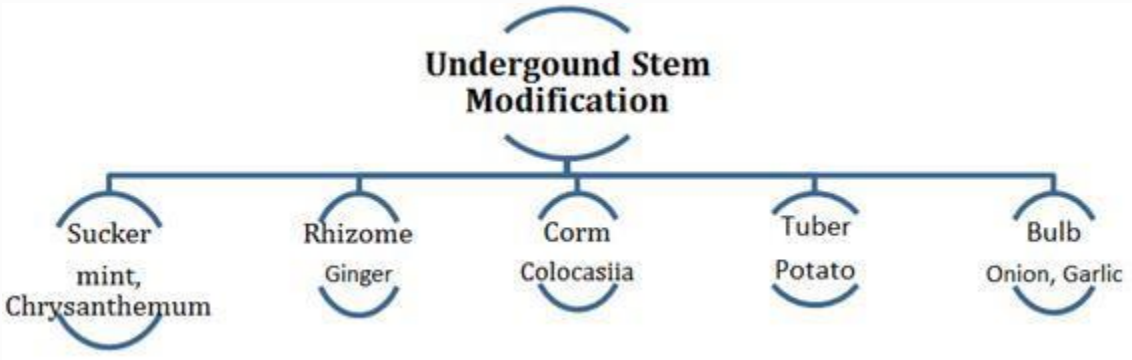
Figure 5.5 Modification of root for : (a) storage (b) respiration: pneumatophore in *Rhizophora*

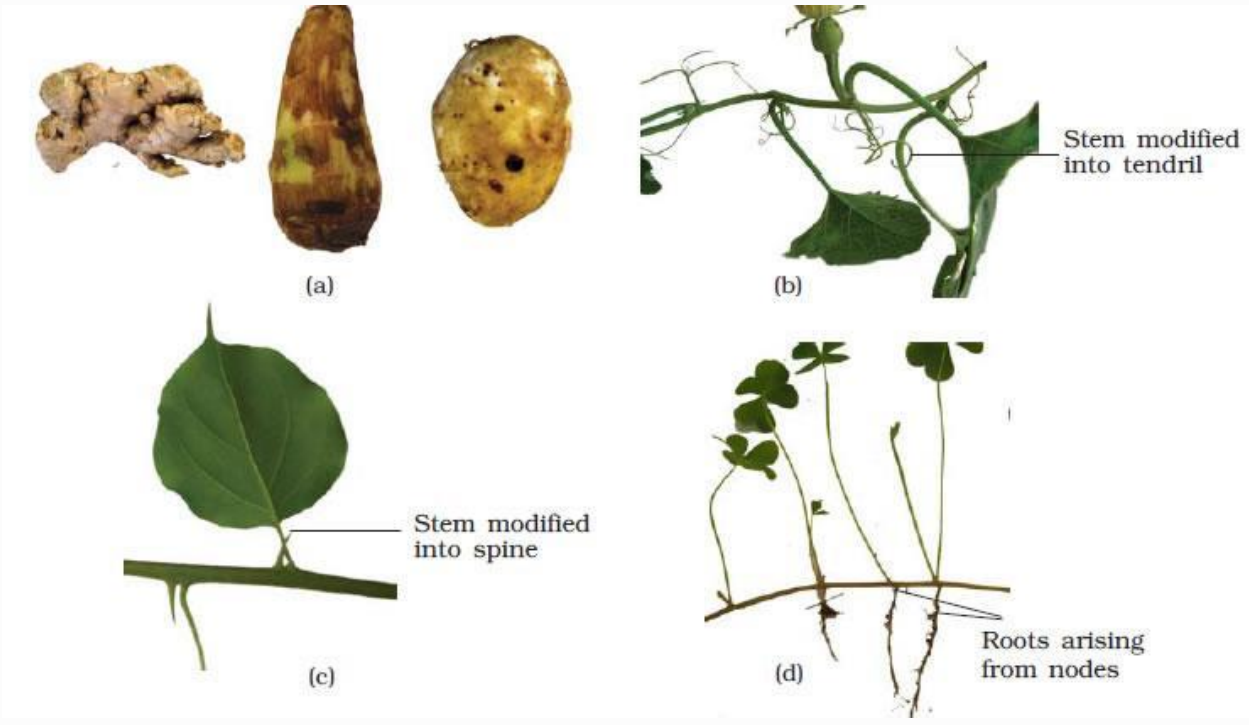
The Stem

- It is the ascending part of an axis bearing branches, leaves, flowers, and fruits. It develops from the Plumule of the embryo.
- The stem bears nodes and internodes. The region of the stem where leaves are born are called nodes and the portion between two nodes is called internodes.
- The main function of the stem is spreading branches, bearing leaves, flowers, and fruits. It also conducts water and minerals from the root to leaves and product of photosynthesis.
- Some stem performs special functions like storage of food, support, protection, and vegetative propagation.

Modification of stems–

- The underground stem of potato, ginger, and turmeric are modified to store food. They also act as the organ of perennation in unfavourable conditions.
- Stem tendril helps plants to climb as in cucumber, pumpkins, and grapes.
- Axillary buds of the stem may modify into woody, straight, that and pointed thorns as in Citrus and Bougainvillea.
- Plants of arid regions modify their stem to flattened (Opuntia), fleshy cylindrical (Euphorbia) having chlorophyll for photosynthesis.

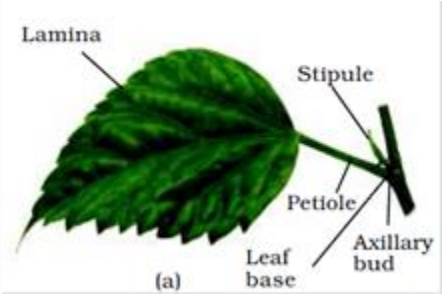




Modification of stem: (a) storage (b) Support (c) Protection (d) Vegetative propagation

The Leaf

- A leaf is a green, dissimilar exogenous lateral flattened outgrowth that is borne on the node of a stem or its branches are specialized to perform photosynthesis.



Parts of a Dicotyledon leaf

- Leaves originate from shoot apical meristem and are arranged in an acropetal order.
- A typical leaf consists of three parts- **Leaf base, Petiole, Lamina**. The leaf is attached with the stem by Leaf Base which may bear two small leaves like a structure called a stipule.
- The middle prominent vein is called the midvein. Veins provide rigidity to the leaf blade and act as a channel for the transport of water and minerals.
- The arrangement of vein and veinlets in the lamina is called venation.

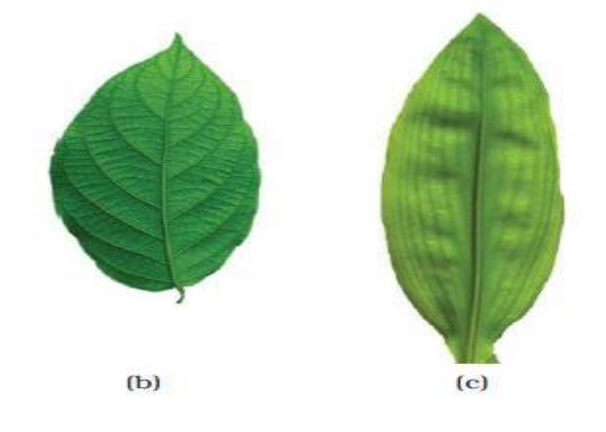
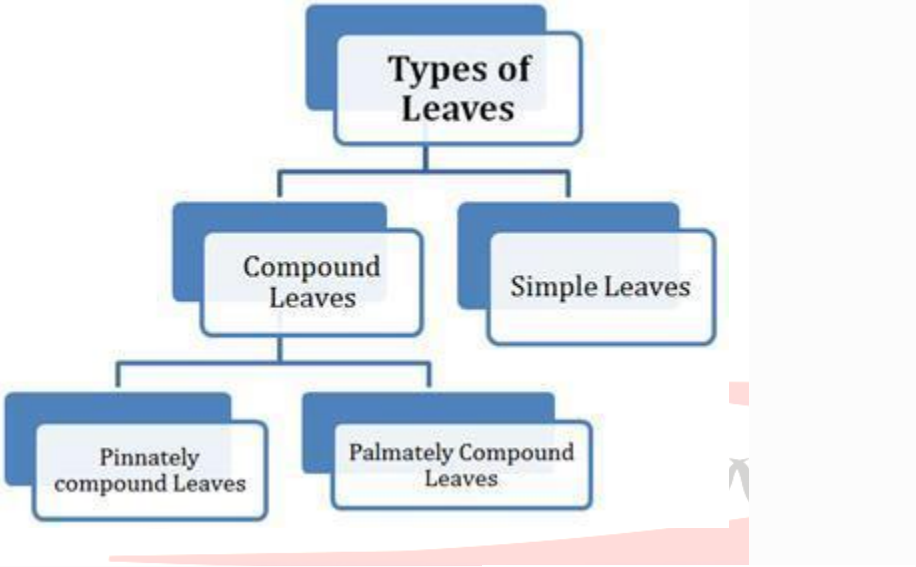


Fig: (a) Reticulate venation (b) Parallel venation

Reticulate venation	Parallel venation
1. Veinlets form a network. 2. Veins are irregularly distributed. 3. It is present in all Dicotyledons like Gram, Pea, Beans, and Mango, etc.	1. A network is absent. 2. Veins are parallel to one another. 3. It is present in Monocotyledons like Grass, Banana, Rice, etc.



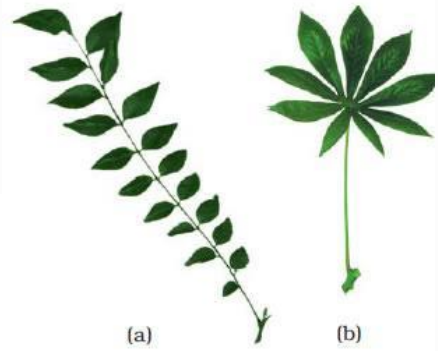


Figure 5.8 Compound leaves :
(a) pinnately compound leaf
(b) palmately compound leaf

- A leaf having a single or undivided lamina is called a **Simple leaf**. The incisions do not touch the midrib. Example- Mango, Guava, etc.
- When the incision of lamina reaches up to the midrib and breaking it into some leaflets, it is called **Compound leaves**.

- In a **Pinnately compound leaves**, some leaflets are present on a common axis called the rachis. Example- Neem.
- In **Palmately compound leaves**, the leaflets are attached at a common point. Example- Silk cotton.
- The pattern of arrangement of leaves on the stem or branch is called **Phyllotaxy**.
- In **the alternate type of phyllotaxy** single leaf arise at each node as in China rose.
- In **opposite types of phyllotaxy**, a pair of leaves arise from each node opposite to each other as in Guava.
- If more than two leaves arise at a node and form a whorl is called a **whorled type** of phyllotaxy as in Alstonia.
- Leaves are modified to perform other functions like converted to tendril for climbing as in Peas and spines for defence in Cactus.

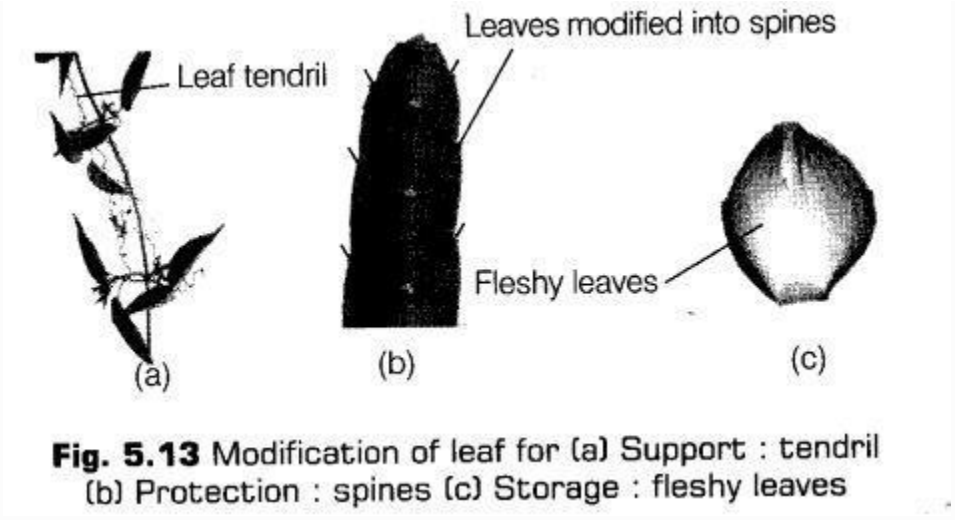


Fig. 5.13 Modification of leaf for (a) Support : tendril (b) Protection : spines (c) Storage : fleshy leaves

Inflorescence

The arrangement of flowers on the floral axis is termed an inflorescence. Two main types of inflorescence are racemose and cymose.

Racemose	Cymose
1. The main axis is continuous to grow. 2. Flowers are borne laterally in acropetal succession. 3. Example- Radish, Mustard.	1. The main axis terminates in flower having limited growth. 2. Flowers are borne in a basipetal succession. 3. Example- Jasmine, Bougainvillea.

The flower

- The flower is the reproductive part of angiosperm plants for sexual means of reproduction.
- A typical flower has four whorls arranged on a swollen end of stalk or pedicel called the **thalamus.** They are **Calyx, Corolla, Androecium, and Gynoecium**.
- When a flower has both androecium and gynoecium, the flower is called bisexual and a flower having either androecium or gynoecium only is called unisexual.

Figure 5.11 Racemose inflorescence

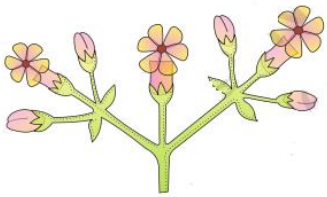
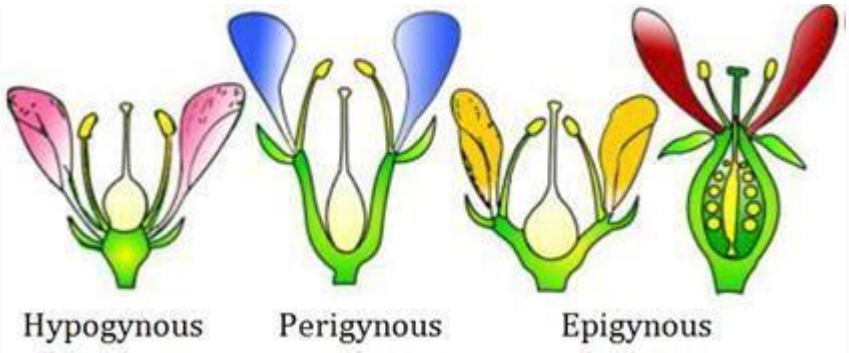


Figure 5.12 Cymose inflorescence

- When a flower can be divided into two equal radial halves in any radii passing through the centre the symmetry of the flower is called **actinomorphic** (radial symmetry) as in Mustard, Datura, and Chili.
- When a flower can be divided into two similar parts only in one vertical plane it is **zygomorphic** as in Pea, Gulmohar, Cassia, etc.
- When Floral appendages are in multiples of 3,4 or 5 they are called **trimerous, tetramerous**, and **pentamerous** respectively. Flowers with bracts are called **bracteates** and without it **ebracteate**.
- Based on the position of the ovary for other floral parts on the thalamus, flowers are of the following types:

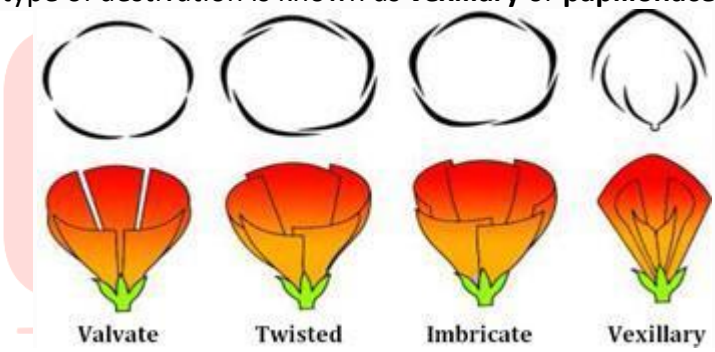


1. **Hypogynous flower**– Ovary occupies the highest position. The ovary in such a case is called superior. Eg. Mustard, brinjal, and china rose.
2. **Perigynous flowers-**If the gynoecium is situated at the centre and other parts are on the rim at the same height. The ovary is called half-inferior.
3. **Epigynous flowers-** The margin of the thalamus grows to completely cover the ovary. The ovary is said to be inferior.

The calyx is the outermost whorl of the flower; its members are called sepals. They are generally green and leafy; protect the flower in the bud stage. It may be **gamosepalous** (sepals united) or **polysepalous** (sepals free).

Corolla consists of petals, brightly coloured to attract the insects for pollination. They may be gamopetalous or polypetalous.

1. The mode of arrangement of sepals or petals in the floral bud for the other members of the same whorl is called aestivation. In **valvate**, the whorls of sepals or petals touch each other as in Calotropis. In **Twisted** aestivation, the whorls overlap each other as in China rose.
2. In **Imbricate** aestivation, margin overlaps each other but not in a particular fashion as in Gulmohur.
3. In pea and bean flowers, there are five petals- the largest (standard) overlaps the two lateral petals (wings) which in turn overlap the two smallest anterior petals (keel). This type of aestivation is known as **vexillary** or **papilionaceous.**



The Androecium

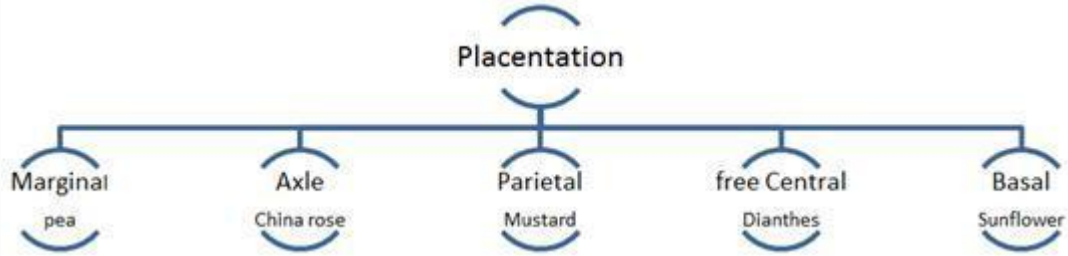
- Androecium represents the male reproductive parts of the flower, consists of stamens. Each stamen consists of filament and anther. Pollen grains are produced in the pollen sac. Sterile stamen is called **Stemenode**.
- When stamens are attached with petals it is called epipetalous (Brinjal). Stamen may be free (polyandrous) or may be united in one bundle (monadelphous), two bundles (diadelphous), more than two (polyadelphous).

The Gynoecium

- The female reproductive part of the flower consists of one or more carpels. Each carpel is made up of a stigma style and ovary.
- When more than one carpel is present, it may be free (**apocarpous**) as in lotus and rose or fused (**syncarpous**) as in mustard and tomato.
- After fertilization, ovules change into seeds and ovary mature into fruits.

Placentation

- The arrangement of ovules within the ovary is called placentation.



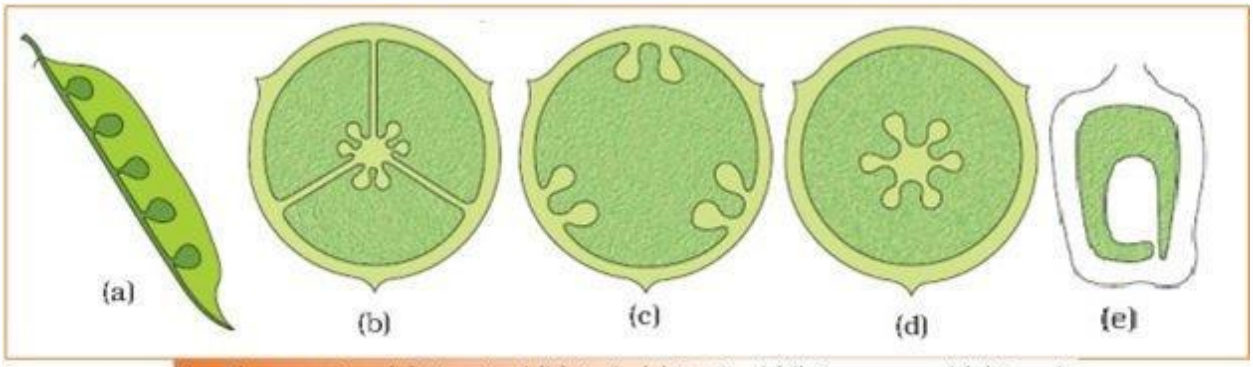


Fig: Placentation: (a) Marginal (b) Axile (c) Parietal (d) Free central (e) Basal

(a) Marginal The placenta forms a ridge along the ventral suture of the ovary and the ovules are borne on this ridge forming two rows is called marginal placentation, e.g., Pea.

(b) Axile When the placenta is axial and the ovules are attached to it in a multilocular ovary, the placentation is called axile, e.g., China rose, tomato and lemon.

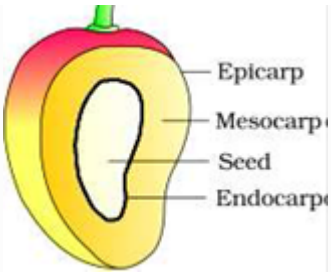
(c) Parietal When the ovules develop on the inner wall of the ovary or peripheral part, it is called parietal placentation. The ovary is one chambered but it becomes two-chambered due to the formation of the false septum, e.g., Mustard and Argemone.

(d) Free central When the ovules are borne on the central axis and septa are absent, the placentation is called free central, e.g., Dianthus and primrose.

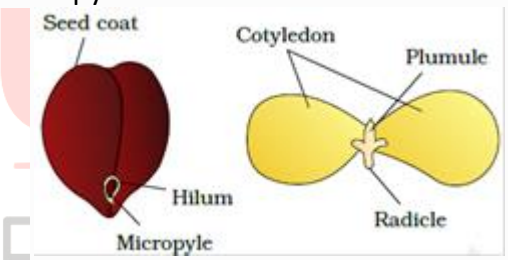
(e) Basal In this type, the placenta develops at the base of the ovary and a single ovule is attached to it as in sunflower, marigold. The placenta develops directly on the thalamus.

The fruit

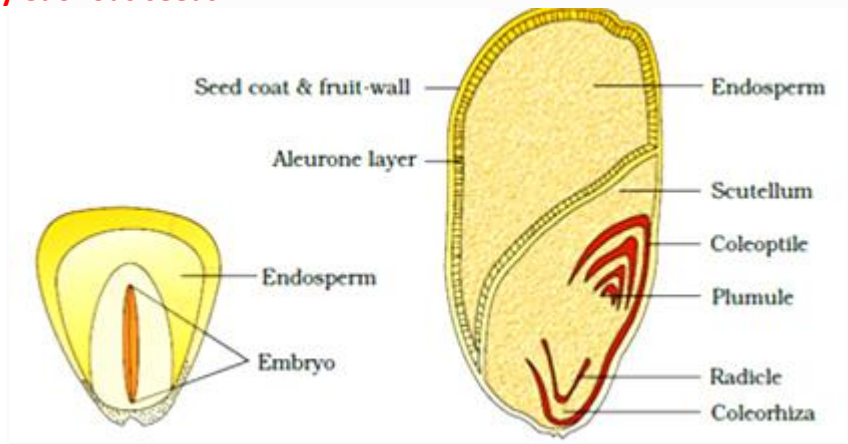
- Mature and ripened ovary developed after fertilization is fruit. If the fruit is formed without fertilization of the ovary it is called **parthenocarpic fruit**.
- The fruit consists of seeds and pericarp. The thick and fleshy pericarp is three-layered called epicarp, mesocarp, and endocarp.



- Dicotyledonous Seed is made up of a seed coat and an embryo. The embryo is made up of an embryonal axis, radicle, and cotyledons.
- The seed coat has two layers outer **testa** and inner **tegmen**. The hilum is a scar through which the seed is attached to the ovary. A small pore above the hilum is called the micropyle.



Monocotyledonous seeds



- In a monocotyledonous seed, the outer covering of endosperm separates the embryo by a proteinous layer called the **aleurone layer.**

- A single cotyledon is called scutellum having a short axis bearing Plumule and radicle.
- Plumule and radicle are closed inside sheaths called coleoptile and coleorhiza respectively.

SEMI -TECHNICAL DESCRIPTION OF A TYPICALFLOWERING PLANT

The plant is described beginning with its habit, vegetative characters – roots, stem, and leaves and then floral characters inflorescence and flower parts.

The floral formula is represented by some symbols. In the floral formula, **Br** stands for bracteate **K** stands for calyx, **C** for corolla, **P** for perianth, **A** for androecium, and **G** for Gynoecium. Fusion is indicated by enclosing the figure within bracket and adhesion by a line drawn above the symbols of the floral parts.

Family Fabaceae-

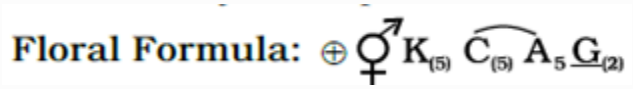
- This family was earlier known as Papilionoideae. Herbs, shrubs, or tree root with root nodules. Pinnately compound leaves with reticulate venation.

Economic importance

Plants belonging to this family are sources of pulses like Gram, Arhar, Bean. Pea etc. and edible oils like groundnut, soybean, etc.

Family Solanaceae-

- Plant body herbs or shrubs, rarely small trees, commonly known as **potato family**. Leaves simple or pinnately compound. Reticulate venation.



Many of them are a source of food (potato, tomato, Brinjal, etc.), spices (Chilli), etc.

Family Liliaceae

- Commonly known as the Lily family. Monocots, perennial herbs. Leaves alternate with parallel venation.
- Underground bulbs, corms, or rhizomes.
- Flower bisexual, actinomorphic, sepals, and petals are absent, having perianth.

It includes ornamental plants (Tulip), Medicine (aloe), and vegetable (colchicine).

IMPORTANT TERMS

Sl No.	Terms	Explanation
1	**Morphology**	The form and structure of an organism considered as a whole
2	**Adventitious roots**	A root growing from a location other than the underground, descending portion of the axis of a plant, as from a stem or leaf
3	**Prop root**	An adventitious root that supports the plant, as the aerial roots of the mangrove tree or corn.
4	**Stilt root**	Stilt roots are the adventitious roots that help in supporting the plant body.
5	**Pneumatophore**	(In mangroves and other swamp plants) an aerial root specialized for gaseous exchange
6	**Tendrils**	A tendril is a specialized stem, leaves or petiole with a threadlike shape that is used by climbing plants for support
7	**Axillary bud**	A bud that develops in the axil of a leaf of a plant
8	**Pulvinus**	An enlarged section at the base of a leafstalk in some plants, which is subject to changes of rigidity leading to movements of the leaf or leaflet.
9	**Inflorescence**	An inflorescence is a group or cluster of flowers arranged on a stem that is composed of the main branch or a complicated arrangement of branches
10	**Racemose**	Racemose is a type of an inflorescence where the main axis continues to grow indefinitely and does not terminate in a flower
11	**Cymose**	Cymose type of inflorescence is one in which the tip of the main axis ends in a flower
12	**Actinomorphic**	An actinomorphic flower is a type of flower that possesses radial symmetry
13	**Zygomorphic**	The flower is capable of division into essentially symmetrical halves by only one longitudinal plane passing through the axis
14	**Bracteate**	The condition when bracts are present then it is called as bracteate
15	**Ebracteate**	When bracts are absent then the condition is ebracteate.
16	**Gamosepalous**	Having united or partly united sepals

17	**Polysepalous**	Describing a flower that possesses a calyx consisting of free sepals.
18	**Aestivation**	Arrangement of petals and sepals in a flower bud before it opens
19	**Staminode**	A sterile or abortive stamen, frequently resembling a stamen without its anther
20	**Epipetalous**	Flowers in which the androecium anther is attached with the petals of the flower.
21	**Epiphyllous**	Sepals and petals are the same which are called perianth and when anther is attached to perianth it is called epiphyllous
22	**Monadelphous**	Filaments of the stamens are fused as a single bundle
23	**Diadelphous**	The androecium of the flower in which the filaments of a flower united into two groups or bundles
24	**Polyadelphous**	The stamens are united into more than two bundles
25	**Apocarpous**	Gynoecium consisting of two to many free carpels
26	**Syncarpous**	Ovaries of flowering plants consisting of united carpels
27	**Placentation**	Placentation refers to the arrangement of ovules inside the ovary
28	**Parthenocarpic fruit**	Is the natural or artificially induced production of fruit without fertilization of ovules, which makes the fruit seedless
29	**Endosperm**	The tissue that surrounds and nourishes the embryo in the angiosperm seed
30	**Scutellum**	A modified cotyledon in the embryo of a grass seed