

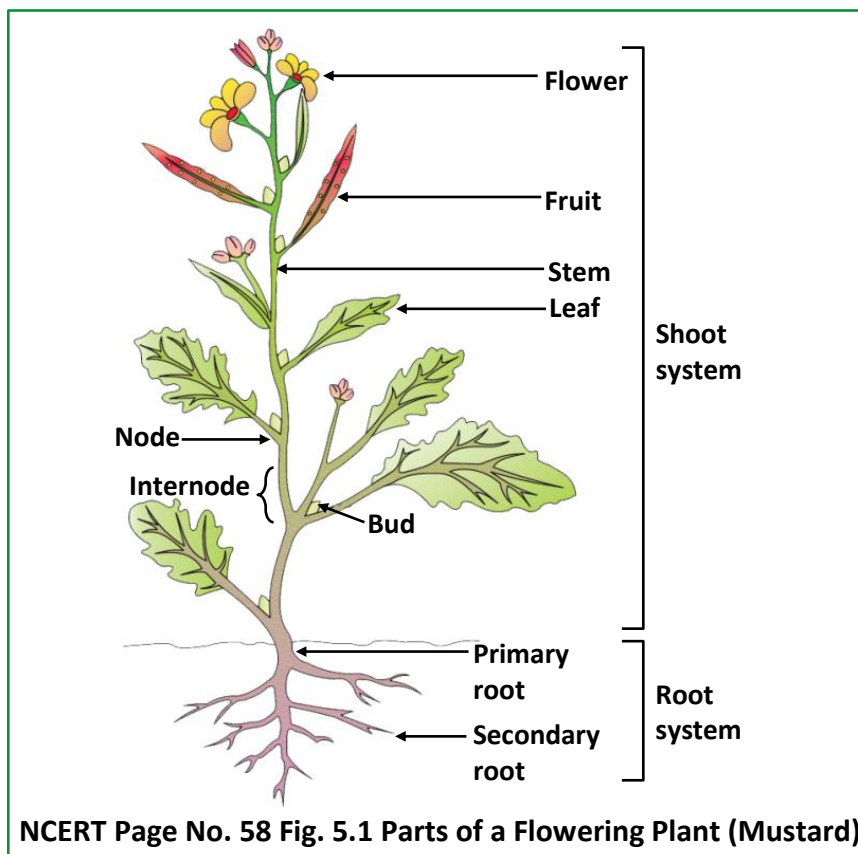
01

Morphology of Flowering Plants

01. INTRODUCTION

- Introduction
- The Root
- The Stem
- The Leaf
- The Inflorescence
- The Flower
- The Fruit
- The Seed
- Semi-technical Description of a Typical Flowering Plant
- Description of Some Important Families

- The angiosperms show large diversity in external structure or morphology.
- The angiosperms are characterized by presence of roots, stems, leaves, flowers and fruits.
- The underground part of flowering plant is the root system while the portion above the ground forms shoot system.
- For any successful attempt at classification and at understanding any higher plant (or for that matter any living organism) we need to know standard technical terms and standard definitions.
- We also need to know about the possible variations in different parts, found as adaptations of the plants to their environment, **e.g.**, adaptations to various habitats, for protection, climbing, storage, etc.

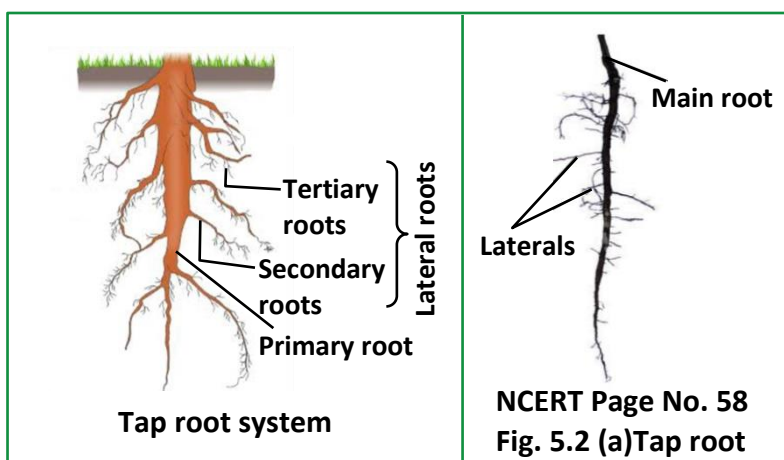


02. THE ROOT

Roots are (+) Positively geotropic, (+) Positively hydrotropic, (–) Negatively phototropic.

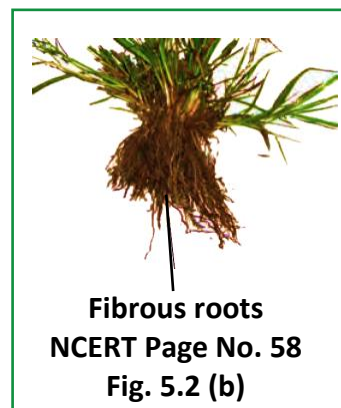
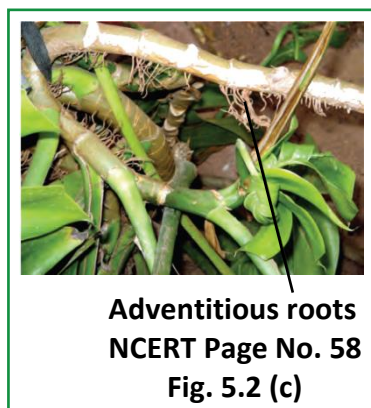
(1) TYPES OF ROOTS :

(A) **Tap Roots** : In most of the **dicot plants**, the direct elongation of the **radicle** leads to the formation of primary root. It bears lateral roots of several orders that are referred to as **secondary, tertiary roots**, etc. The primary roots and its branches constitute the **tap root system**. *e.g.* : **Mustard plant**



(B) **Adventitious Roots** : In some plants, like **grass, Monstera** and the **Banyan tree**, roots develop from parts of the plant other than the radicle and are known as **adventitious roots**.

(C) **Fibrous Roots** : In **monocot plants**, the primary root is short lived and is replaced by a large number of roots. These roots originate from the base of the stem and constitute the **fibrous root system**. *e.g.* :- **Wheat plant**.



Functions of the root system :

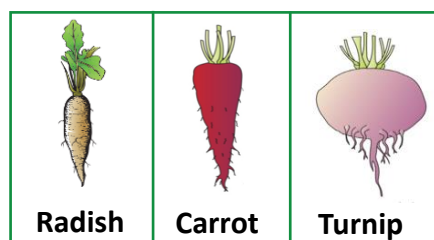
- Absorption of water and minerals. Provide a proper anchorage to the plant parts.
- storage of reserve food material (**e.g. Carrot, radish, turnip, sweet potato and Asparagus**) and synthesis of PGR (plant growth regulators).

(2) MODIFICATION OF ROOT :

- Roots in some plants change their shape and structure and become modified to perform functions other than absorption and conduction of water and minerals.

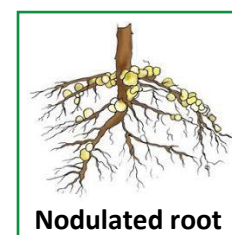
(A) MODIFICATION OF TAP ROOT :**(i) For Food Storage :**

e.g. Radish, Carrot. Turnip, Sugarbeet.

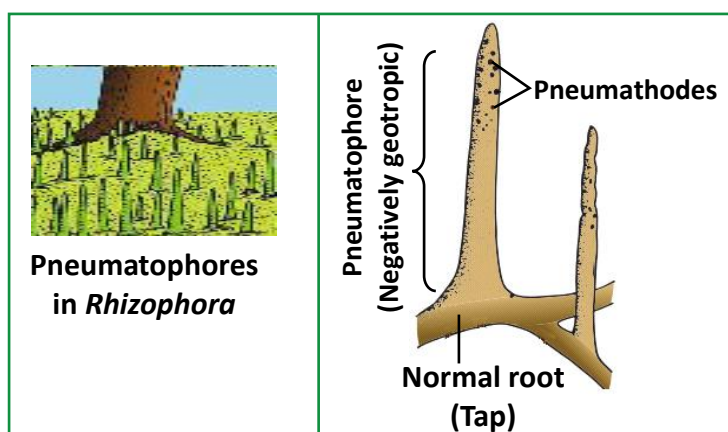
**(ii) For N₂-Fixation :**

- **Nodulated roots** - Nodules are formed on branches of roots by nitrogen fixing bacteria (*Rhizobium*).

e.g. Pea, gram, bean (members of Fabaceae family)

**(iii) For Respiration (Pneumatophores) :**

- In **marshy/swampy areas**, there is scarcity of oxygen so. Some branches of tap root of the plants which grow in this region, grow vertically upward and comes on the surface. These roots are called **pneumatophores** which have minute pores by which air enters in the plant and plant gets oxygen for respiration
- Pneumatophores are negatively geotropic. **e.g. Rhizophora** (Mangrove plant).

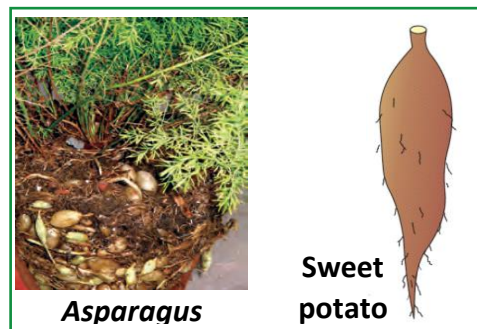


(B) MODIFICATION OF ADVENTITIOUS ROOTS :

(i) For Storage of Food :-

(a) **Fasciculated roots** : These are adventitious roots occurring in clusters and all of them are swollen. *e.g. Asparagus, Dahlia*

(b) **Tuberous adventitious roots** :
e.g. Sweet potato (Ipomoea batatas)

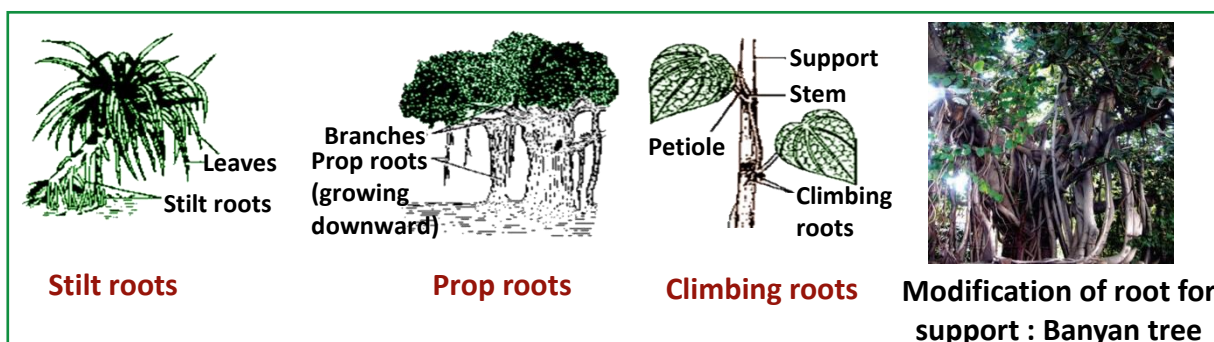


(ii) For support :

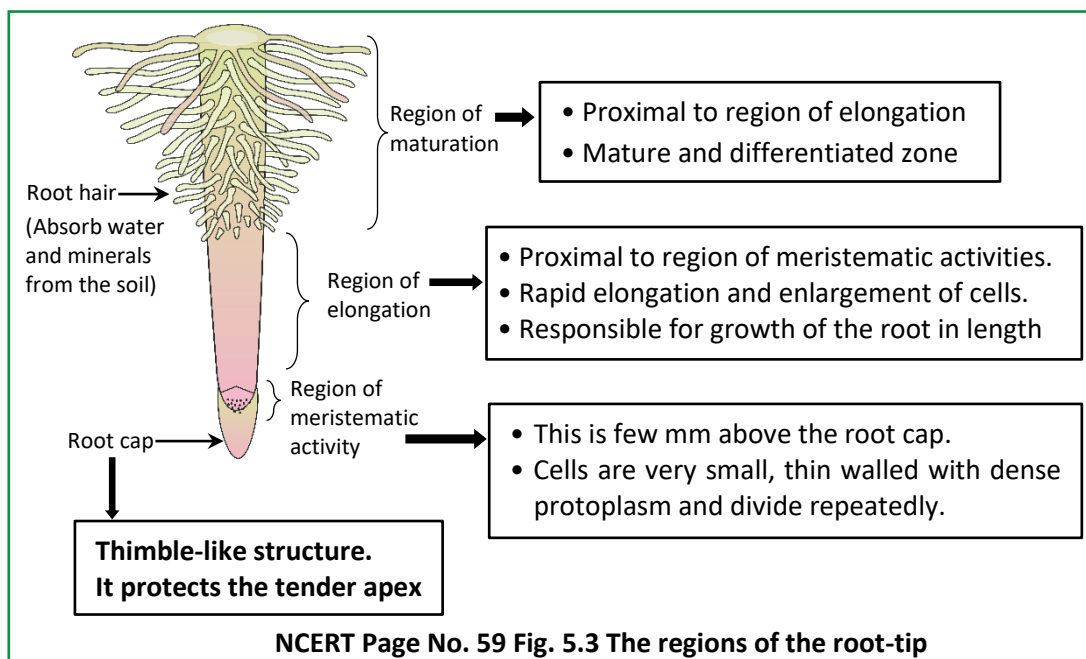
(a) **Stilt roots or brace roots** :- These roots arise from lower node and enter in the soil. These roots are **supporting roots**. *e.g. Maize, sugarcane*.

(b) **Prop roots or pillar roots** :- These hanging roots arise from branches of plant and grow downward towards the soil. These roots **support the tree**.
e.g. Banyan (Ficus benghalensis)

(c) **Climbing roots** :- These roots arise from nodes and help in climbing.
e.g. Money plant (Pothos), Monstera.



Regions of the Root :

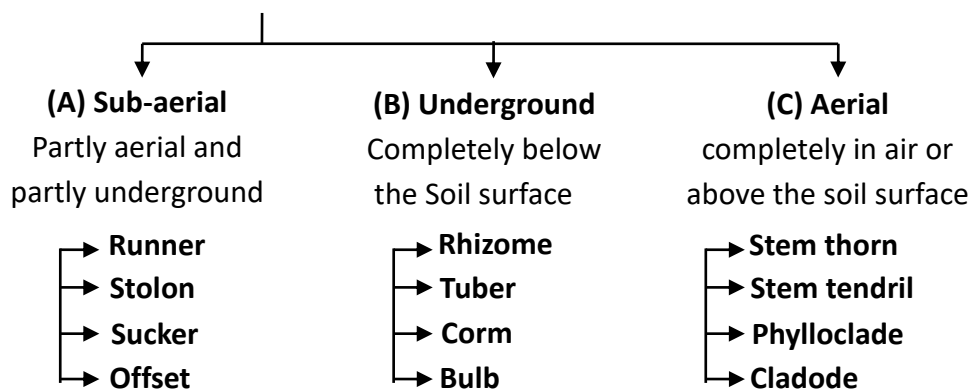


NCERT Question :

What are the features that distinguish a stem from a root?

03. THE STEM

- Stem develops from the plumule of the embryo of a germinating seed. The stem bears **nodes** and **internodes**. The region of the stem where leaves are borne are called nodes while the portions between two nodes are called internodes. Stem shows negatively geotropic growth.
- The stem bears buds, which may be terminal or axillary. Stem is generally green when young and later often become woody and dark brown.
- The main function of the stem** is spreading out branches bearing leaves, flowers and fruits. It conducts water, minerals and photosynthates (food).
- Some stems perform the function of storage of food (potato, ginger, turmeric, zaminkand and *Colocasia*), support, protection and of vegetative propagation.

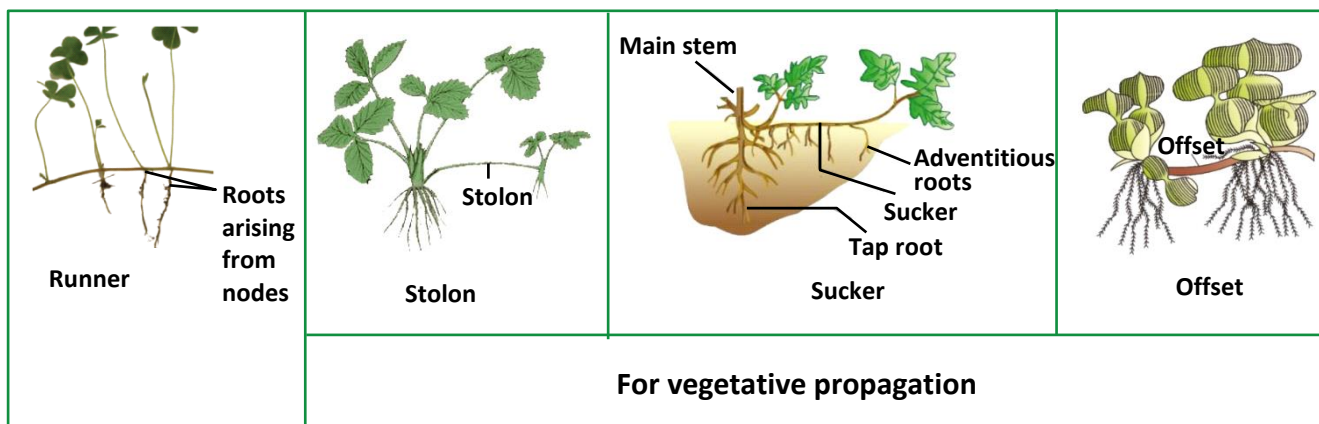
Modifications of Stems :

(A) Sub-aerial modification of stem : These are **creeping stems**.

- Runner** - In these stems roots develop at lower side and leaves at upper side from the nodes and these stems spread on the ground e.g. *Cynodon dactylon* (doob grass), *Oxalis*, Strawberry (*Fragaria ananassa*). Partially underground stems of some plants such a grass and strawberry etc. spread to new niches and when older parts die new plants are formed.
- Stolon** – In plants like *jasmine*, peppermint, a lateral branch arises from the base of the main axis and after growing aerially for some time arch downwards to touch the ground.

(iii) **Sucker** - In **mint, pineapple, Chrysanthemum, banana**, the lateral branches originate from the basal and underground portion of the main stem, grow horizontally beneath the soil and then come out obliquely upward giving rise to leafy shoots.

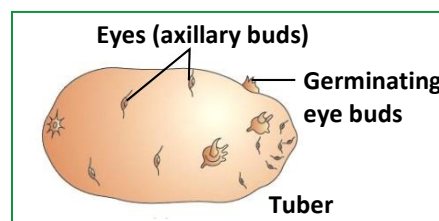
(iv) **Offset** – A lateral branch with short internodes and each node bearing a rosette of leaves and a tuft of roots is found in aquatic plants like **Pistia, Eichhornia**. It is also known as **aquatic runner**.



(B) **Underground modifications of stem** : Generally for food storage and vegetative propagation.

(i) **Tuber** - The tips of branches become swollen in the soil.

Eyes are found on tuber which are axillary buds and axillary buds are covered with scaly leaves. e.g. **Potato**.

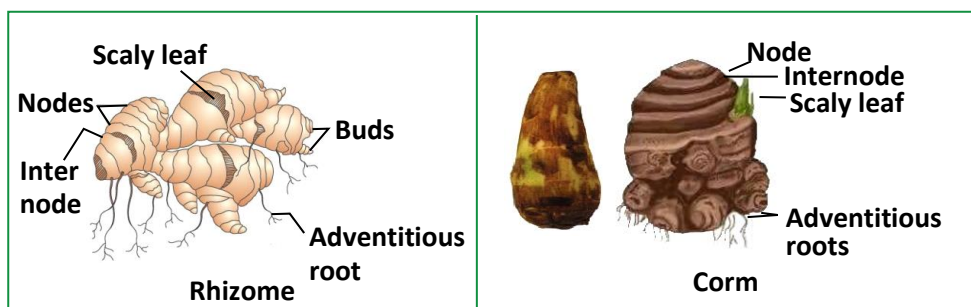


Peel of potato is periderm.

(ii) **Rhizome** - It is fleshy stem which grows horizontally in the soil. Nodes and small internodes are found which are covered by scaly leaves. e.g. **Ginger, turmeric**.

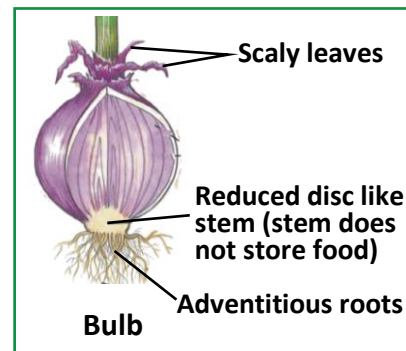
(iii) **Corm** - It is condensed structure which grows vertically under the soil surface.

e.g. **Colocasia, Zaminkand (Amorphophallus), Colchicum, Gladiolus**



- **Organ of perennation** - Underground stems of **Potato, Ginger, Turmeric, Colocasia, Zaminkand** are modified to store food in them. They also act as organ of perennation to tide over conditions unfavourable for growth.

(iv) **Bulb** - Stem is highly reduced and disc like and surrounded by numerous fleshy leaves. Many roots arise from its base. e.g. **Onion, Garlic. The fleshy leaves of onion and garlic store food.**



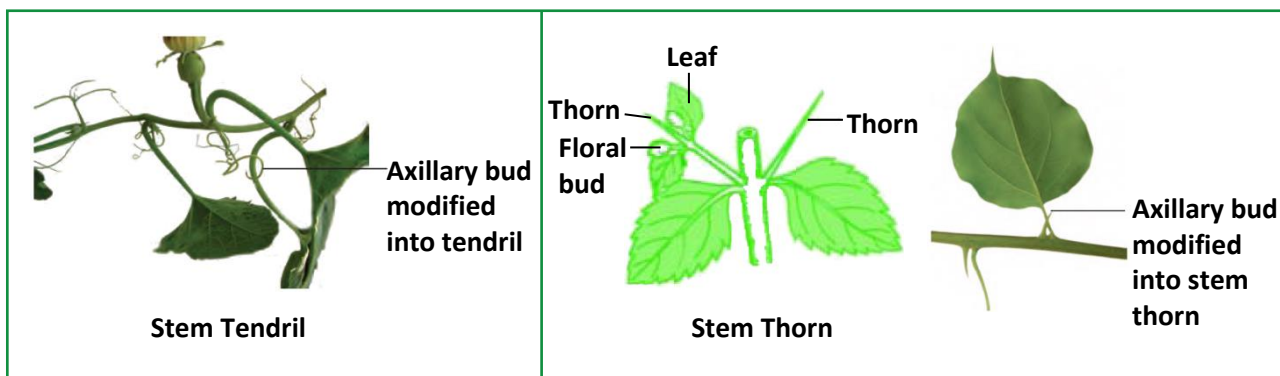
(C) **Aerial modification of stem :**

(i) **Stem tendril** : In this type of modification axillary bud forms tendril in place of branches and helps in climbing of those plants which have weak stem.

e.g. **Grapes/Grapevines, Passiflora, gourds (cucumber, pumpkins, watermelon)**

(ii) **Stem thorn** : Thorn develops usually from axillary bud of the stem. It may bear leaves and flowers. Thorn protects plant from browsing animals. It is a **woody pointed structure**.

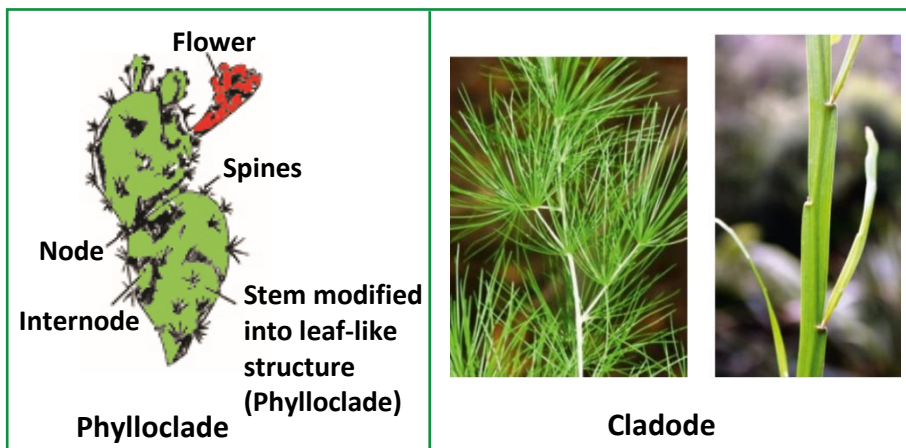
- In **Bougainvillea** and **Citrus, Duranta**, pomegranate (stem thorn develops from terminal bud).



(iii) **Phylloclade** : Stem is modified into a fleshy flat (**Opuntia**) or fleshy cylindrical (**Euphorbia, Casuarina**) and green leaf like structure and carries out photosynthesis like leaf. The leaves are modified into spines.

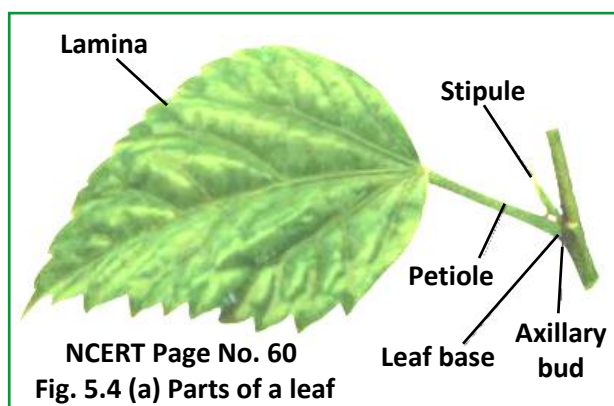
(iv) **Cladode** : In this modification branches of limited growth become green and flat like a leaf and perform photosynthesis.

e.g. **Asparagus, Ruscus**



04. THE LEAF

- The leaves develop from the nodes. Their main function is to carry out photosynthesis or food formation.
- Axillary buds are found in the axil of leaves. The axillary bud may develop into a branch.
- Leaves originate from shoot apical meristems and are **arranged in an acropetal order**.
- Leaf is a lateral outgrowth of stem developed exogenously at the node.

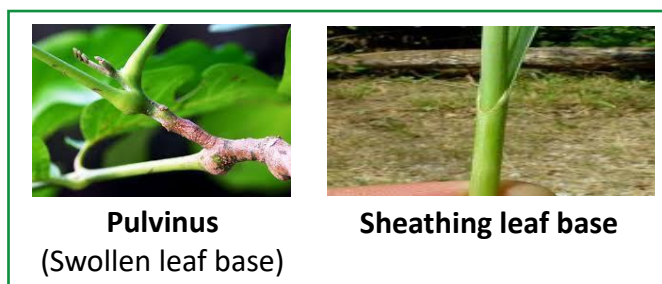


(1) PARTS OF A LEAF :

A typical leaf (**Phyllopodium**) consist of three main parts :-

(A) Leaf Base :

- The part of leaf which is attached to stem is known as leaf base.
- In **monocots**, the leaf base expands into a sheath covering the stem partially or wholly.
- In some **leguminous plants** the leaf base may become swollen, which is called the pulvinus.



(B) Petiole :

- The part of leaf connecting the lamina with the branch or stem is known as petiole.
- Petiole or stalk containing leaves are known as **petiolate leaves** and when petiole or stalk is absent then leaves are called **sessile**.
- The petiole helps hold the blade to light.
- Long thin flexible petioles allow leaf blades to flutter in wind, thereby cooling the leaf and bringing fresh air to leaf surface.
- In **Eichhornia** petiole swells up and in **Citrus** it is winged.

(C) Lamina/Leaf Blade :

- Leaf blade is the green expanded part of the leaf with veins and veinlets.
- There is, usually, a middle prominent vein, which is known as the midrib.
- Veins provide rigidity to the leaf blade and act as channels of transport for water, minerals and food materials.
- The shape, margin, apex, surface and extent of incision of lamina varies in different leaves.
- Main Functions of Leaf lamina are photosynthesis and transpiration.

Stipules :-

Leaves of some plants have two lateral appendages on either side of leaf base, known as stipules. Leaf with stipule is known as **stipulate leaf**, e.g. **Fabaceae**. Leaf without stipule is called **ex-stipulate leaf** e.g. **Solanaceae**, **Liliaceae**.

(2) VENATION :

The arrangement of veins and veinlets in leaf lamina is known as venation.

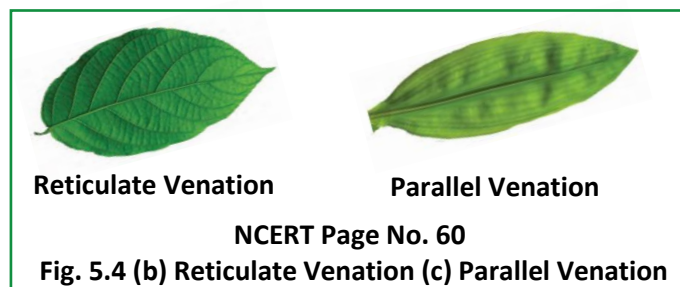
Types of Venation – Venation is of two types –

- (A) Reticulate :** When the veinlets form a network, the venation is termed as reticulate. Leaves of **dicotyledonous plants** generally possess reticulate venation.

Exception : **Calophyllum** (It has parallel venation)

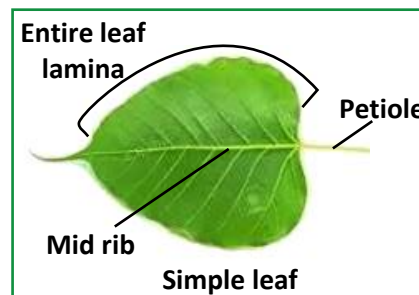
- (B) Parallel :** When the veins run parallel to each other within a lamina, the venation is termed as parallel. Parallel venation is the characteristic of most **monocotyledons**.

Exception : **Smilax** (It has reticulated venation)



(3) TYPES OF LEAVES :

- (A) **Simple Leaf** : A leaf is said to be simple, when its lamina is entire or may be incised to any depth, but not up to the midrib or petiole. **e.g. Peepal, Mango, Radish.**
- (B) **Compound Leaf** : A leaf in which the leaf blade (lamina) is incised up to the midrib or petiole, thus dividing it into several small parts, i.e. **leaflets**.



NCERT Question :

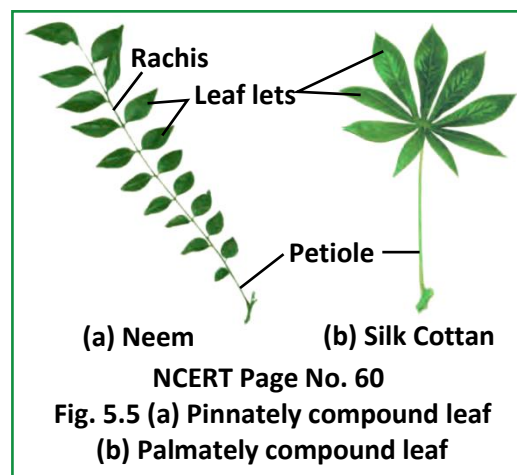
How is a pinnately compound leaf different from a palmately compound leaf?

It has two types :-

- (i) **Pinnately Compound Leaf** : In this type of leaf, leaf blade (lamina) is incised up to the mid rib and mid rib is known as rachis. A number of leaflets are present on a common axis, the rachis. **e.g. Neem**
- (ii) **Palmately Compound Leaf** : In this type incisions of leaf are directed from leaf margins to apex of the petiole and all leaflets are attached at a common point i.e. at the tip of the petiole. Rachis is absent in palmately compound leaf.

e.g. Silk cotton (*Bombax*), Oxalis.

- A bud is present in the axil of petiole in both simple and compound leaves, but not in the axil of leaflets of the compound leaf.



NCERT Question :

Explain with suitable examples the different types of phyllotaxy.

(4) PHYLLOTAXY :

Phyllotaxy is the pattern of arrangement of leaves on the stem or branch.

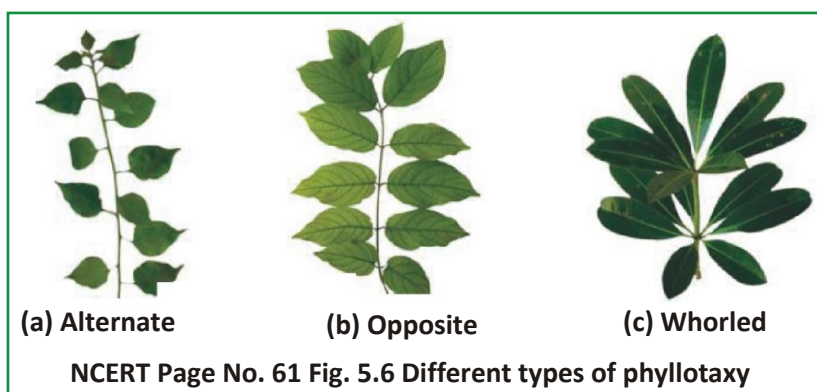
This is usually of three types.

(A) Alternate : In this type a single leaf arises at each node in alternate manner.

e.g. Mustard, China rose, Sunflower.

(B) Opposite : In this type of phyllotaxy a pair of leaves arise at each node and lie opposite to each other. *e.g. Guava, Calotropis, Ocimum*

(C) Whorled : If more than two leaves arise at each node and form a whorl, then it is called whorled phyllotaxy. *e.g. Alstonia* (devil's tree), *Nerium*.

**(5) MODIFICATION OF LEAVES :**

Leaves are often modified to perform functions other than photosynthesis.

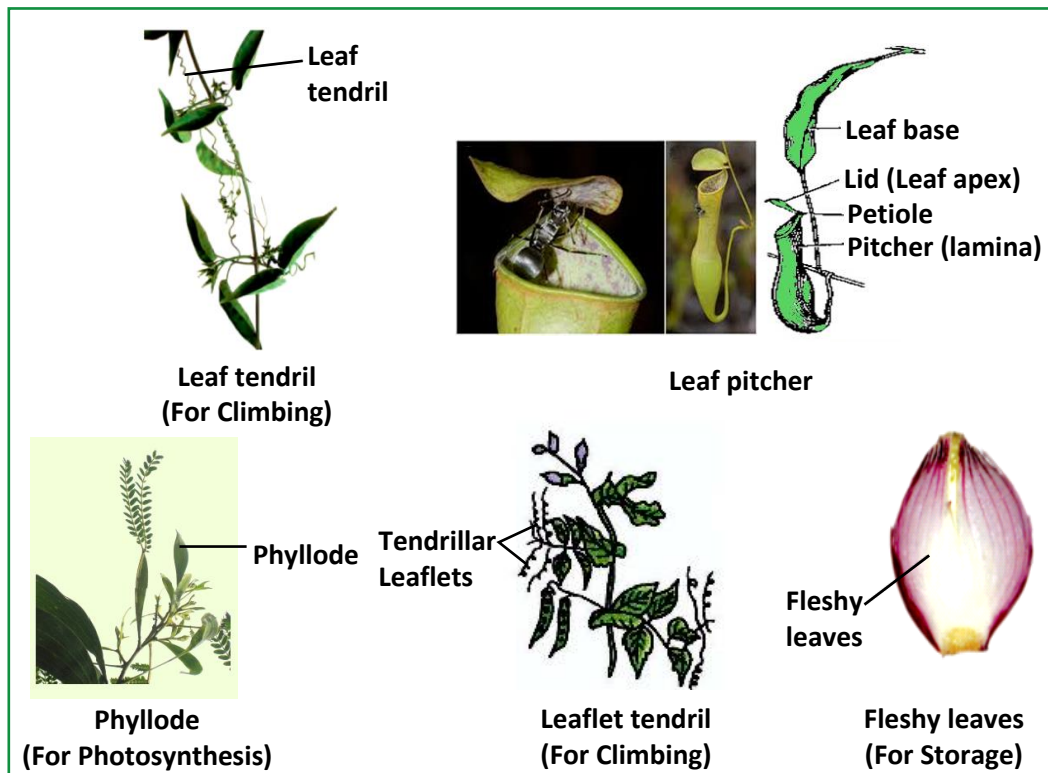
(A) Leaf Tendril : In some plants whole leaf is modified into a wire like structure which is called leaf tendril. Tendril helps a plant in climbing *e.g. Lathyrus aphaca* (wild pea) → **Peas**.

(B) Leaf Pitcher : Leaves of some plants are modified into pitcher shaped structure.

e.g. Nepenthes (pitcher plant) (Only lamina is modified into pitcher).

(C) Phyllode : In some plants petiole becomes flat leaf like green, synthesise food and function as normal leaf. *e.g. : Australian acacia, Parkinsonia*.

(D) Fleshy Leaves : In **Onion** leaves become fleshy for storage of food.



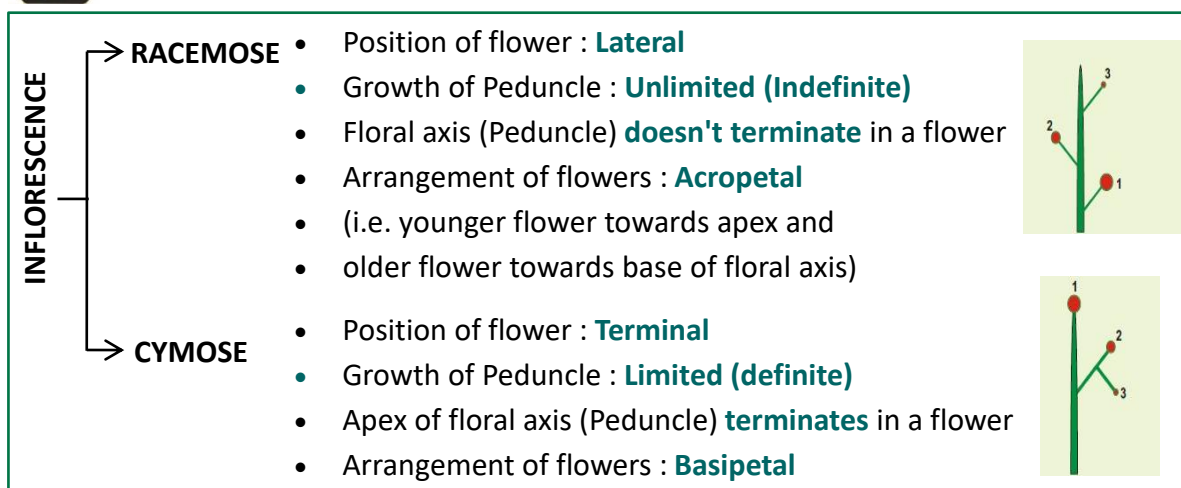
Note : *Dionaea* (venus flytrap) is insectivorous plant and it also has modified leaves.

NCERT Question :

Differentiate between Racemose and cymose inflorescence.

05. THE INFLORESCENCE

- The arrangement of flowers on the floral axis or peduncle is termed as inflorescence.
- Depending on whether the apex gets developed into a flower or continues to grow, two major types of inflorescences are defined – racemose and cymose.



(1) RACEMOSE :

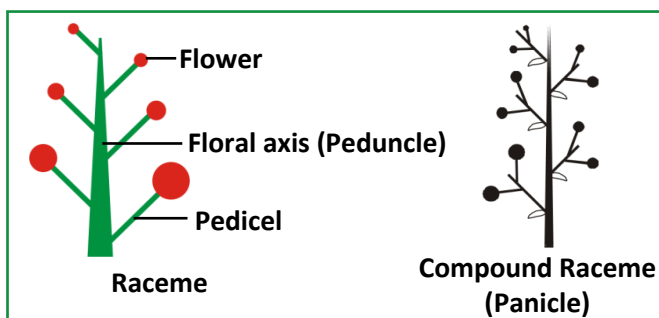
- In this type of inflorescence the main axis continues to grow and does not terminate in a flower and flowers are borne laterally in an **acropetal order/acropetal succession**.

Types of racemose inflorescence :

- (A) Raceme** - In this type of inflorescence, peduncle (main axis or floral axis) is elongated and **flowers are pedicellate**.

e.g. **Radish, mustard**

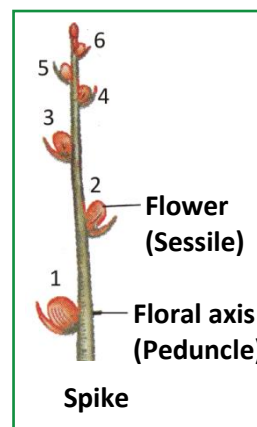
- When peduncle is branched and each branch bear pedicellate flowers like raceme and are arranged in acropetal manner then it is known as **compound raceme** or **Raceme of racemes** or **panicle** e.g. **Gulmohar, Cassia**.



- (B) Spike** - In this type of inflorescence peduncle is elongated but **flowers are sessile** (without pedicel).

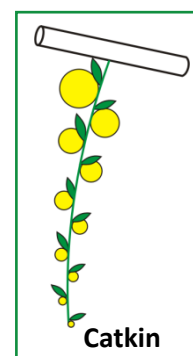
- When peduncle is branched and each branch bears spike like inflorescence then the small branch having flowers is called spikelet and this arrangement is called **spike of spikelets**.

Eg. **Grass family (Gramineae = Poaceae)**.



- (C) Catkin/Amentum** - In this type of inflorescence **peduncle is thin, long and weak, and flowers are sessile and unisexual**. Unisexual flowers develop on separate catkin.

e.g. **Mulberry (Shahtoot)**.



- (D) **Spadix** - In this type of inflorescence **peduncle is thick, long and fleshy** and it has small sessile and unisexual flowers covered with one or more **large green or colourful bracts (spathe)**.

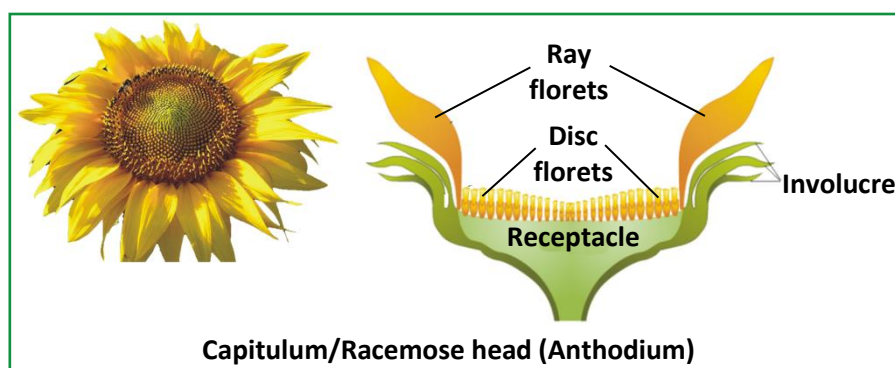
e.g. **Maize**.

Long filamentous threads (Silky hairs) protruding at the end of a young cob of maize **are styles** and stigmas (mainly styles)

- (E) **Capitulum/Racemose head (Anthodium)** : In this type of inflorescence small sessile flowers are found on receptacle. These flowers are called **florets**.

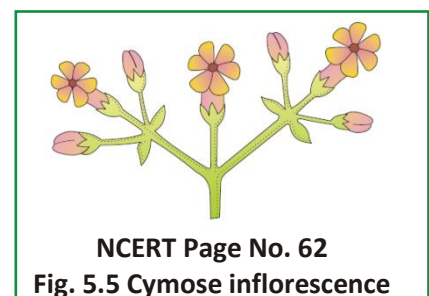
The central florets are called **disc florets** and peripheral florets are called **ray florets**.

e.g. **Compositae /Asteraceae family [Sunflower, marigold (*Tagetes*)]**.



(2) CYMOSE :

In this type of inflorescence, the main axis/peduncle Cymose inflorescence terminates in a flower hence is limited or definite in growth. Flowers are arranged in **basipetal succession/ basipetal order**. e.g. ***Solanum***

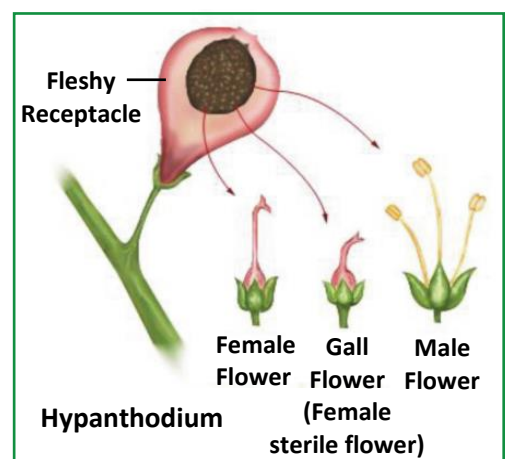


(3) SPECIAL TYPE OF INFLORESCENCE :

Hypanthodium :

Three types of flowers (**male, female, sterile female**) are present in this inflorescence.

e.g. ***Ficus benghalensis* (banyan), *Ficus carica* (fig), *Ficus religiosa* (peepal).**



★ **Golden Key Points** ★

- Tap roots arise from radicle whereas adventitious roots arise from any other part of plant other than radicle.
- Root cap is thimble like structure.
- *Gladiolus* is an example of corm.
- *Opuntia* and *Euphorbia* are examples of phylloclade.
- In *Nepenthes*, only lamina is modified into pitcher like structure.
- Banana is an example of mixed spadix.
- In *Portulaca* food storing adventitious root is present.



BEGINNER'S BOX-1

THE ROOT TO THE INFLORESCENCE

1. In which of the following type of underground modification of stem, storage of food does not occur in stem?
 (1) Bulb (2) Rhizome (3) Corm (4) Tuber
BMP361
2. Fasciculated roots are found in :-
 (1) *Asparagus* (2) *Colocasia* (3) Ginger (4) Turmeric
BMP362
3. Lamina is also known as :-
 (1) Phyllopodium (2) Epipodium (3) Mesopodium (4) Hypopodium
BMP363
4. Phyllode & cladode are :-
 (1) Homologous (2) Analogous
 (3) Vestigial organs (4) Homoanalogous organs
BMP364
5. Which of the following region of root is responsible for the growth of the root in length?
 (1) Region of meristematic activity (2) Region of elongation
 (3) Region of maturation (4) Root cap
BMP365
6. A few millimetres above the root cap is the region of :-
 (1) Elongation (2) Maturation
 (3) Meristematic activity (4) Root hairs
BMP366

7. Which is a modification of root that does not store food?
 (1) Napiform root (2) Fusiform root (3) Tuberous root (4) Stilt root
BMP367
8. Which of the following also act as an organ of perennation to tide over unfavourable conditions for growth :-
 (1) Potato, Turnip (2) Onion, Radish
 (3) Zaminkand, Ginger (4) Ginger, Carrot
BMP368
9. Stem tendrils develop from axillary bud. Stem tendrils are present in all of the following, except:
 (1) Cucumber (2) *Citrus*
 (3) Pumpkin (4) Watermelon and grapevines
BMP369
10. Bud is present in axil of petiole in :-
 (1) Compound leaf and leaflet
 (2) Simple and compound leaf
 (3) Simple leaf and leaflet
 (4) Leaflet, simple and compound leaf
BMP370
11. Thorns and spines are :-
 (1) Defensive organs (2) Respiratory organs
 (3) Both (1) and (2) (4) Storage organs
BMP371

NCERT Question :

What is a flower? Describe the parts of a typical angiosperm flower.

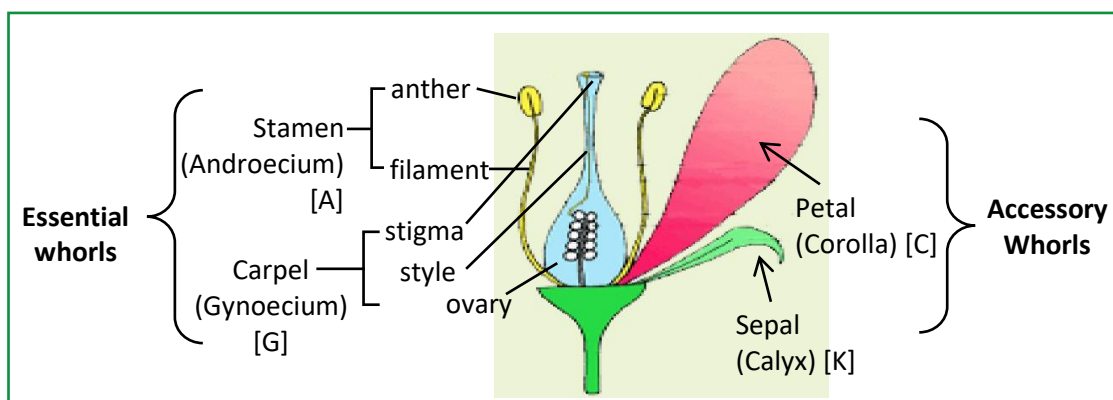
06. THE FLOWER

- A flower is a modified shoot where in the shoot apical meristem changes to floral meristem. Internodes do not elongate and the axis gets condensed. The apex produces different kinds of floral appendages laterally at successive nodes instead of leaves.
- **When a shoot tip transforms into a flower, it is always solitary.**
- The flower is the reproductive unit in the angiosperms. It is meant for sexual reproduction.
- Generally, flower has a short or long stalk which is called **pedicel**. The upper part of pedicel is swollen, which is called **thalamus**. Floral leaves are present on it.

There are 4 types of floral leaves.

- (1) Sepal (2) Petal (3) Stamen (4) Carpel

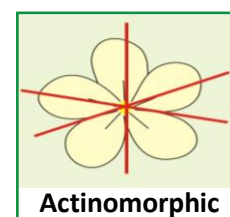
- A typical flower has four different kinds of whorls arranged successively on thalamus. These are calyx, corolla, androecium and gynoecium.
- Whorl of sepals → Calyx
- Whorl of petals → Corolla
- Whorl of stamens → Androecium
- Whorl of carpels → Gynoecium



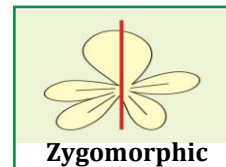
- **Calyx and corolla are accessory organs or accessory whorls while androecium and gynoecium are reproductive organs or reproductive whorls or essential whorls.**
- **Complete flower** : All four whorls are present.
- **Incomplete flower** : Any whorl is absent e.g. Unisexual flower.
- **Bisexual flower** : Perfect flower.
- **Unisexual flower** : Imperfect flower.
- A flower may be trimerous, tetramerous or pentamerous when the floral appendages are in multiple of 3, 4 or 5 respectively. **In dicots flowers are usually pentamerous while in monocots flowers are trimerous.**

(1) SYMMETRY OF FLOWER :

- (A) **Actinomorphic/radial/regular** : When a flower can be divided into two equal radial halves by any vertical plane or radial plane passing through the centre, then it is said to be actinomorphic flower **e.g. Mustard, Datura, Chilli.**



- (B) **Zygomorphic/bilateral** : When a flower can be divided into two equal (similar) halves only by one particular vertical plane, then it is said to be zygomorphic flower. *e.g. Pea, Bean, Gulmohur, Cassia.*



- (C) **Asymmetrical/irregular** : When a flower cannot be divided into two equal (similar) halves from any vertical plane passing through the centre, then it is said to be asymmetrical flower. *e.g. Canna.*



The part of flower which lies near to the mother axis is posterior part while the part while the part of flower which is away from the mother axis is anterior part.

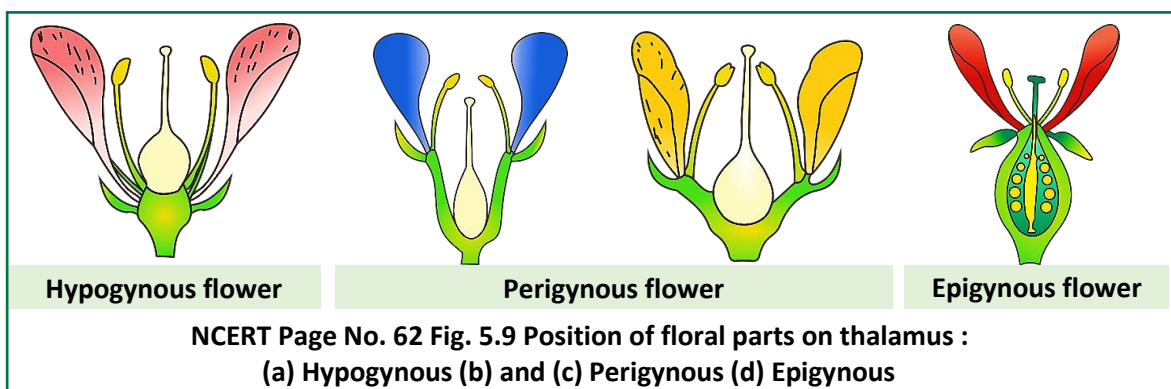
(2) TYPES OF FLOWERS ON THE BASIS OF INSERTION OF FLORAL LEAVES :

- Based on the position of calyx, corolla and androecium in respect of the ovary on thalamus, the flowers are divided into three types.

- (A) **Hypogynous Flower** : When gynoecium occupies the highest position while the other parts like petals, sepals and stamens are situated below the ovary, then the flower is called hypogynous and in this condition **ovary** will be **superior**. *e.g. Mustard, China rose, Brinjal, Mango.*

- (B) **Perigynous Flower** : In it thalamus grows upwardly and form a cup shaped structure. On the margin or rim of thalamus floral parts are attached except gynoecium, which lies at the basal part or in the centre. So, in this condition gynoecium is situated below the other floral parts. But **ovary** in this condition is said to be **half inferior**. *e.g. Rose, Plum, Peach.*

- (C) **Epigynous Flower** : When the margin of thalamus grows upward enclosing the ovary completely and getting fused with it and other parts of flower like petals, sepals & stamens are situated above the ovary, then the **ovary** is said to be **inferior** and rest of the floral parts superior. *e.g. Guava, Apple, Cucumber and the ray florets and disc florets of sunflower.*





- Bract is a reduced leaf which may be present at the base of the pedicel of flower.

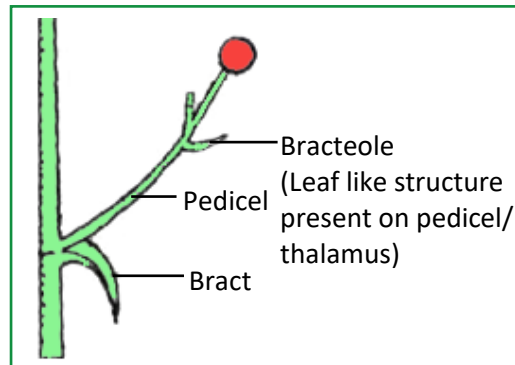
Bracteate flower - The flower with bract is called bracteate flower.

Ebracteate flower - Flower without bract is known as ebracteate flower.

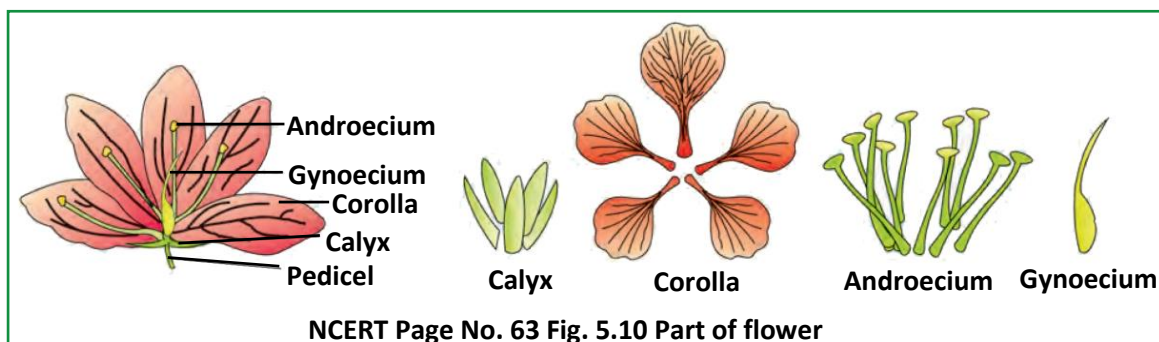
- **Involucre** - The whorl of bracts is called involucre.
- **Spathe** - When large bract completely encloses whole inflorescence, then it is called spathe.

e.g. Banana, maize

- **Petaloid bract** - When the size of bract is greater than the size of flower and it is of various coloured like petals, then it is called petaloid bract. *e.g. Bougainvillea.*
- **Glumes** - Small, dry, scaly bracts are called glumes. *e.g. Wheat (Member of Poaceae)*



(3) PARTS OF A FLOWER :



(A) CALYX :

- The outermost whorl of flower is called calyx. Each member of this whorl is called sepal, when all the sepals are free from each other, then it is called **polysepalous condition**. When the sepals are fused (united) with each other then this condition is called **gamosepalous condition**.
- Sepals are green leaf like and protect the flower in the bud stage.
- In the **family of sunflower (Compositae)** sepals are modified into hairy structure which is known as **pappus**. The pappus is modified calyx and helps in dispersal of fruit by parachute mechanism.

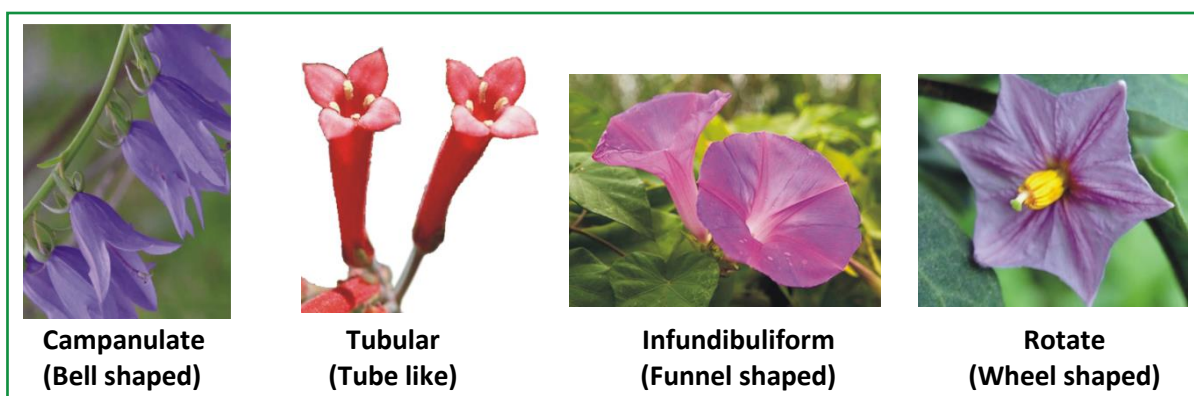
- If sepals do not fall and remain attached to fruit, then they are called **persistent sepals**.
e.g. Tomato, Chilli, Brinjal (Solanaceae family).

(B) COROLLA :

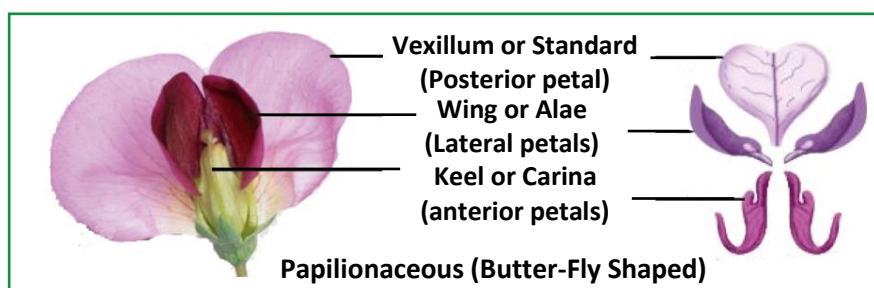
- The second whorl of flower is called corolla and each member of corolla is called petal. When all the petals are free, then it is called **polypetalous condition** and when petals are fused, then it is called **gamopetalous condition**.
- Petals are usually brightly coloured to attract insects for pollination.

(i) Forms of corolla - The shape and colour of corolla vary greatly in plants. Corolla may be tubular, bell shaped, funnel-shaped or wheel-shaped.

- Cruciform** - In cruciform corolla four petals are found. These **petals are arranged crosswise**. *e.g. Radish, Mustard etc. (Members of Family Cruciferae)*



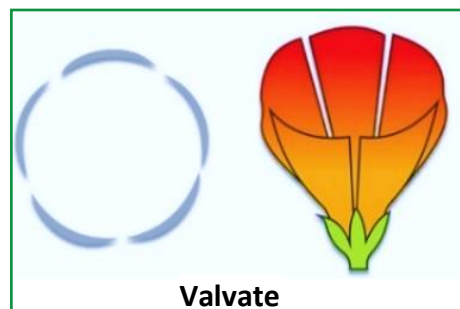
- Papilionaceous (Butter fly shaped corolla)** - In this type of corolla five petals are found. Posterior petal is largest and is known as **standard or vexillum**. Vexillum covers two lateral petals which are called **wings or alae** and the innermost anterior petals are united to form a **keel or carina**. Both lateral petals cover the keel. *E.g. Pea, bean, gram etc. (Members of Fabaceae).*



(ii) **Aestivation** : The mode of arrangement of sepals or petals in floral bud with respect to the other members of the same whorl is known as aestivation. It is of following types :-

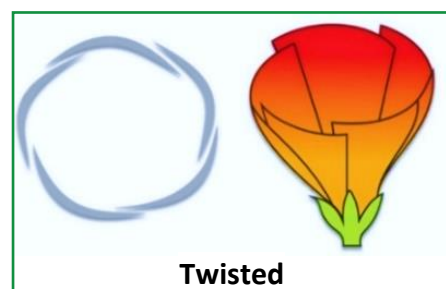
- (a) **Valvate** : When the petal of a whorl lie adjacent to other petal and just touch one another at the margin without overlapping then it is known as valvate aestivation.

e.g. Calotropis, Cruciferae, Solanaceae & Liliaceae family.



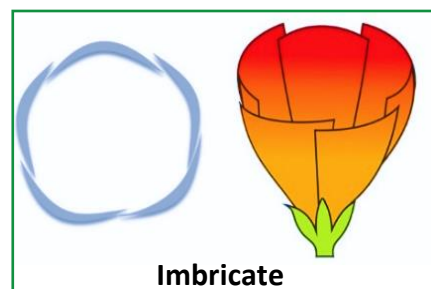
- (b) **Twisted** : In this type one margin of a petal covers adjacent petal and the other margin is covered by another petal. One margin of the petal overlaps that of the next one, and the other margin is overlapped by the another one.

e.g. Cotton, Ladyfinger, China rose (Malvaceae family).



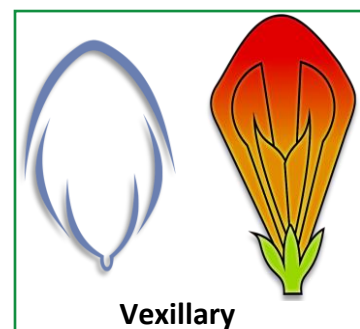
- (c) **Imbricate** : When both margins of the one petal are covered by the other two petals and both margin of another one, covers other. Rest are arranged in twisted manner. OR If the margins of sepals or petals overlap one another but not in any particular direction, then it is known as imbricate aestivation.

e.g. Cassia, Gulmohur (Delonix regia).



- (d) **Vexillary or Papilionaceous or Descending Imbricate** : The posterior petal is outermost and largest and is known as standard or vexillum which overlaps the two lateral petals **wings** or **alae**. These two laterals petals overlaps two smallest anterior petals i.e. **keel** or **carina**. Vexillary arrangement is found in pea family.

e.g. Pea, Bean (Fabaceae).



(C) ANDROECIUM :

- It is composed of stamens. When the stamens of an androecium are free from one another, then it is called polyandrous condition.

(i) **Cohesion of stamens** : When the floral parts of similar whorl are fused, then it is called cohesion.

(a) **Adelphy** - When stamens are united by their filaments only, then it is called adelphy.

It is of following types-

- Monoadelphous** - In this type of cohesion all the filaments are united into a single bundle or one bunch but anthers remain free. In this type of cohesion a tube is formed around the gynoecium which is called staminal tube.

e.g. China rose (Malvaceae family).

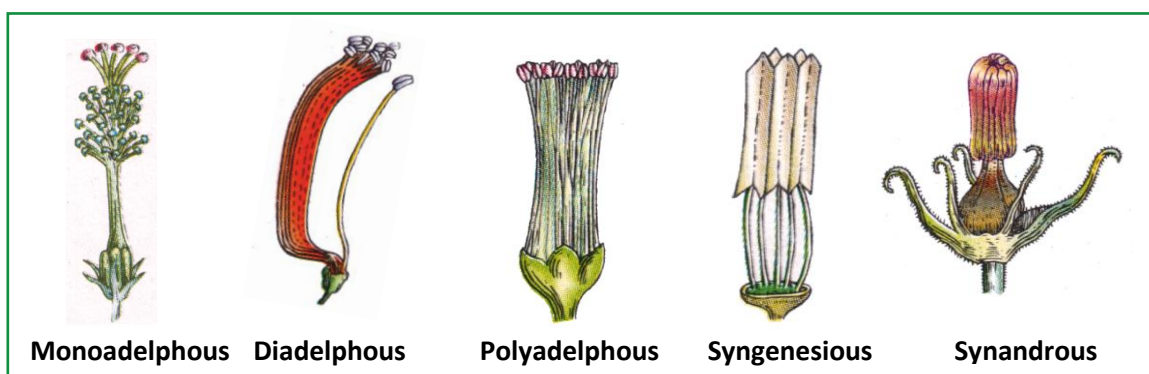
- Diadelphous** - In this type of cohesion filaments are united into two bundles but the anthers remain free. *e.g. Pea (Fabaceae)*. In these plants out of 10 stamens, 9 stamens are united into a bundle while 1 stamen remains free.

- Polyadelphous** - Filaments are united into more than two bundles.

e.g. Citrus (Rutaceae).

(b) **Syngenesious** - Only anthers are united in bundle, but filaments remain free *e.g.* Members of Compositae family.

(c) **Synandrous** - Anthers as well as filaments of stamens are united through their whole length. *e.g.* Members of Cucurbitaceae family.

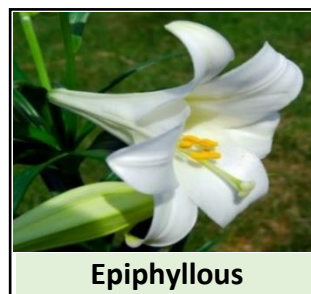


(ii) **Adhesion of stamens** : When the stamens are attached to other parts of flower, then it is called adhesion of stamens.

(a) **Epipetalous** - Stamens are attached to the petals. *e.g. Brinjal (Solanaceae)*

(b) **Epiphyllous or Epitepalous** - Stamens are attached to the tepals (perianth).

e.g. Lily (Liliaceae).

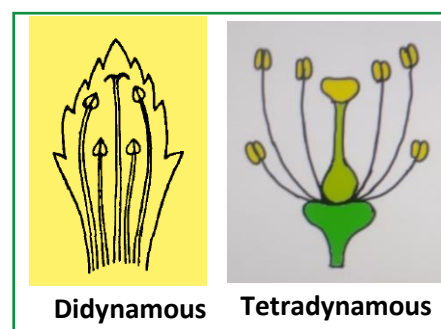


(iii) **Length of stamens** : There may be a variation in the length of filaments within a flower, as in *Salvia* and *mustard*.

(a) **Didynamous** - If four stamens are present and out of them two are long and two are short, then it is called didynamous condition.

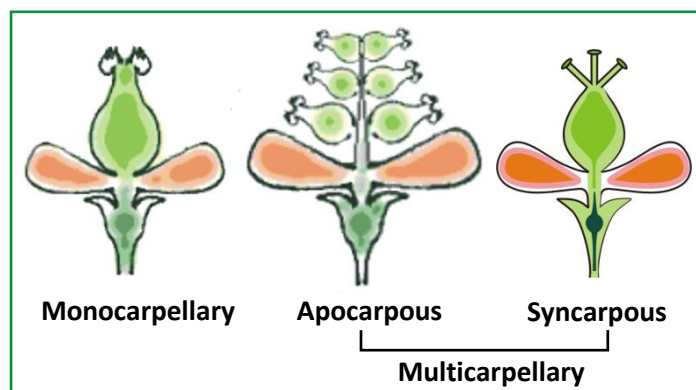
e.g. *Lamiaceae/Labiatae family* (*Salvia*)

(b) **Tetradynamous** - When there are six stamens and they are arranged in two whorls. In outer whorl, there are two short stamens while in inner whorl, there are four long stamens, this condition is called tetradynamous. e.g. *Cruciferae family* (Mustard, radish, turnip).



(D) GYNOECIUM :

- Gynoecium is female reproductive organ of the flower and is made up of one or more carpels.
- If only one carpel is present in gynoecium then this condition is called **monocarpellary** condition.



- If more than one carpel is present in gynoecium then this condition is called **polycarpellary** or **multicarpellary**.
- When all the carpels in polycarpellary/ multicarpellary condition are free, then this condition is called **apocarpous**. e.g. *Lotus*, *Rose*, *Michelia*.
- When all the carpels are fused, then this condition is called **syncarpous**. e.g. *Papaver*, *Hibiscus*, *mustard*, *tomato*.

- A carpel consists of three parts namely stigma, style and ovary.
- Ovary is the enlarged basal part, on which lies the elongated tube, the style. The style connects the ovary to the stigma. The stigma is usually at the tip of the style and is the receptive surface for pollen grains.

PLACENTATION :

The arrangement of ovules within the ovary is known as placentation. It is of following types:

(a) Marginal :

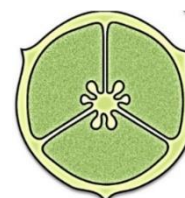
In this type of placentation placenta forms a ridge along the ventral suture of the ovary and the ovules are borne on this ridge forming two rows, as in pea. There is no true placenta. **e.g. Pea.**



(a) Marginal (L.S.)

(b) Axile :

In this type of placentation **ovary is multilocular and the ovules are borne on the central axis**. Number of chambers are equal to the number of carpels fused. **e.g. China rose, Lemon, Tomato.**

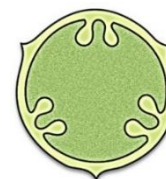


(b) Axile

(c) Parietal :

In this type of placentation the ovules develop on the inner wall of the ovary or on peripheral part.

e.g. Mustard and Argemone.



(c) Parietal

Note : In some plants, ovary is one chambered but it becomes two chambered due to formation of false septum or replum.

e.g. Cruciferae family (Mustard).

(d) Free Central/Central :

In this type of placentation the ovary is unilocular (septa are absent) and the ovules are borne on the central axis.

e.g. Primrose, Dianthus



(d) Free central

(e) Basal :

In this type of placentation a single ovule is attached at the base of ovary.

e.g. Marigold, Sunflower (Asteraceae/ Composite family), **Gramineae / Poaceae family.**



(e) Basal (L.S.)

NCERT Page No. 65 Fig. 5.12
Types of placentation

07. THE FRUIT

- The fruit is the characteristic feature of the flowering plants. It is the mature or ripened ovary, developed after fertilization.
- If a fruit is formed without fertilization of ovary, it is called a parthenocarpic fruit. In some fruits like grapes, banana seeds are not found and such type of fruits are called parthenocarpic or seedless fruits. Parthenocarpy can be induced through the application of growth hormones.

(1) PERICARP (FRUIT WALL) :

After ripening, the ovary wall changes into pericarp. This pericarp may be thick and fleshy or thick and hard or thin and soft.

In fleshy fruits pericarp (fruit wall) is made up of 3 layers :-

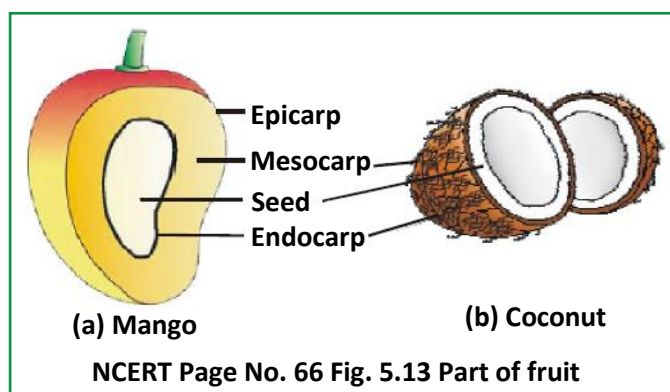
(A) Epicarp : It is the outermost layer, it may be thick or thin and hard or soft. It forms outermost layer of fruit which is also called rind.

(B) Mesocarp : It is the middle layer which is thick and fleshy in **mango**, peach and date palm. In **coconut**, this layer is made up of fibres which is also called coir.

(C) Endocarp : It forms the innermost layer, it may be thin membranous (**e.g. Orange, Date palm**) or thick and hard (**e.g. Mango, Coconut**).

(2) TRUE & FALSE FRUITS :**(A) True Fruit or Eucarpic Fruit :**

- When the fruit is developed only from the ovary then the fruit is called true fruit.
e.g. Mango, Coconut.

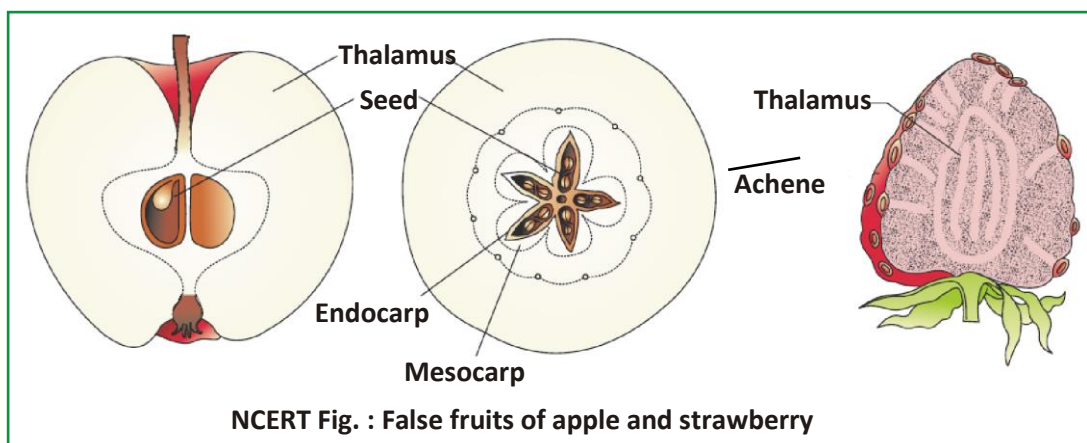


(B) False Fruit or Pseudocarpic Fruit :

- In some fruits, in place of ovary, some other parts of flower like thalamus, calyx and inflorescence are modified into fruit or a part of fruit.

e.g. Apple, Strawberry, Pear, Mulberry, fig, cashew nut

- In apple, strawberry, cashew, etc. the thalamus also contributes to fruit formation. Such fruits are called false fruits.



(3) CLASSIFICATION OF FRUITS :

Fruits are divided into 3 types :

(A) Simple Fruits :

- These fruits **develop from ovary of monocarpellary gynoecium or multicarpellary, syncarpous gynoecium** and only one fruit is formed by the gynoecium.

Simple fruits are of two types :

(i) Simple Fleshy fruits

(ii) Simple Dry fruits

- (i) Simple Fleshy fruits :** In fleshy fruits, **fruit wall (pericarp) is differentiated into epicarp, mesocarp and endocarp**, these fruits are indehiscent.

Fleshy fruits are of following types :

- (a) Drupe fruits :** The fruits in mango and coconut develop from monocarpellary gynoecium and superior ovary and are one seeded. **e.g. Mango, Coconut.**

In **mango** the outermost cover or thin rind is called epicarp. Middle edible fleshy part is **mesocarp** and the inner stony hard endocarp.

In **coconut** epicarp is hard and thin while mesocarp is thick and fibrous. The endocarp is hard and seed is protected in it. The sweet water and edible part of coconut are liquid and solid endosperm respectively.

(b) **Berry** : These fruits develop from superior or inferior ovary.

e.g. **Tomato, Brinjal**, Grapes, Guava, Banana.

(c) **Pome** : **This fruit develops from inferior ovary and having enlarged thalamus**

e.g. **Apple, Pear**. These are **false fruits**. In these fruits, edible part is **thalamus**.

Note : (1) Many glandular hairs are present on the inner side of endocarp. These **glandular juicy hairs** are edible. e.g. **Orange, Lemon**

(2) In pomegranate (*Punica granatum*) edible part is fleshy and juicy Testa of seed.

(ii) Simple Dry-fruits :

- **Pericarp (fruit wall) of simple dry fruits is not differentiated into epicarp, mesocarp and endocarp.**

Example of simple dry fruits are -

(a) **Cypsela** : This is a small, one seeded dry fruit which is developed from bicarpellary, syncarpous gynoecium and inferior ovary. In cypsela fruit pericarp (Fruit wall) and seed coat are free from each other and a bunch of hair is attached with the fruit which is known as pappus. e.g. **Compositae family (Sunflower, marigold)**.

(b) **Caryopsis** :- These are small, one seeded dry fruits, which developed from monocarpellary, superior ovary. In these fruits Pericarp is fused with the seed coat and form a joint surface. These fruits are present in family Gramineae.

e.g. **Wheat, Rice, Maize** etc.

(c) **Siliqua** :- This fruit developed from bicarpellary, syncarpous, superior ovary and ovary has **parietal placentation**. e.g. **Brassica** (mustard).

(d) **Capsule** :- e.g. **Papaver** (poppy=opium plant), **Gossypium** (cotton), **Datura**, **Abelmoschus** (lady finger), **Onion**.

(e) **Lomentum** :- These fruits are splitted in **one seeded many mericarps**, after maturity mericarps get separated with each other. e.g. **Tamarind, Cassia, Arachis hypogea** (ground nut/ pea nut), **Acacia** (babul).

(B) Aggregate Fruits :

- These fruits develop from multicarpellary, apocarpous gynoecium. In apocarpous condition each carpel is free from each other and it forms a fruitlet. Aggregate fruits are made up of a bunch of fruitlets which is known as etaerio.

e.g. **Strawberry, Lotus, Rose** etc.

(C) Composite Fruits = Multiple Fruits :

- All composite fruits are false fruits.
- In composite fruits, **generally whole inflorescence is modify into fruit.**
 - Sorosis :-** This fruit develops from spike, spadix or catkin inflorescence is called sorosis in pineapple, jack fruit (kathal) and mulberry (shahtoot).
 - Syconus or Syconium :** This fruit **develops from hypanthodium inflorescence.** Many achenes develop from the pistillate flowers. e.g. ***Ficus carica* (Fig, peepal)** etc.

Edible parts of some important fruits			
Plant		Types of Fruit	Edible parts
1.	<i>Ananas comosus</i> = <i>A. sativus</i> /Pineapple	Sorosis	Fleshy axis, bracts, fused perianth & Pericarp / Outer portion of receptacle
2.	<i>Arachis hypogea</i> /Ground nut/Peanut	Lomentum	Seeds/Cotyledons
3.	Cereals, <i>Oryza, sativa</i> (Rice), <i>Hordeum vulgare</i> (Barley), <i>Triticum aestivum</i> (Bread Wheat), <i>Zea mays</i> (Maize)	Caryopsis	Whole caryopsis fruit (Endosperm and embryo)
4.	<i>Cocos nucifera</i> /Coconut	Drupe	Endosperm
5.	<i>Juglans regia</i> /Walnut	Drupe	Lobed cotyledons of seed
6.	<i>Mangifera indica</i> /Mango	Drupe	Mesocarp
7.	<i>Prunus amygdalus</i> /Almond	Drupe	Seed (Cotyledons and embryo)
8.	Pulses	Pod/Legume	Seed

NCERT Question :

Draw the labelled diagram of the following Gram seed .

★ Golden Key Points ★

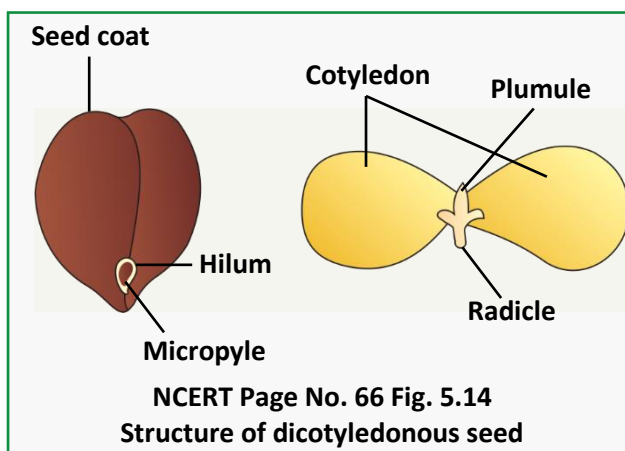
- **Bulbil** : It is modified vegetative bud with stored food, meant for vegetative reproduction. e.g. *Agave*, *Oxalis*, *Dioscorea* (Yam).
- **Pistillode** : Sterile pistil is known as pistillode.
- **Staminode** : Sterile stamen is called staminode. e.g. *Salvia*.

08. THE SEED

- The ovules after fertilisation, develop into seeds.
- A seed is made up of a seed coat and an embryo.
- The embryo is made up of a radicle, an embryonal axis and one (as in wheat, maize) or two cotyledons (as in gram and pea).

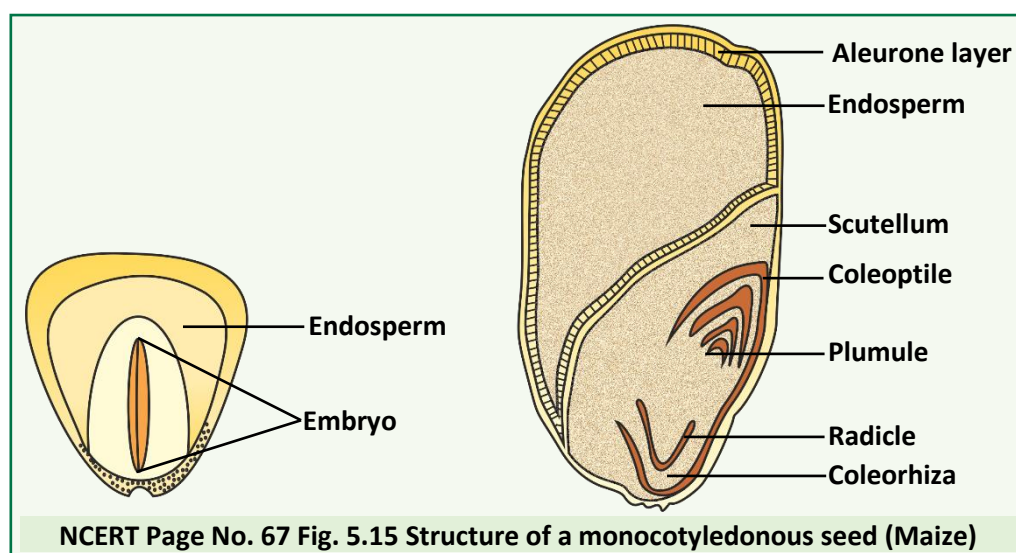
(A) STRUCTURE OF A DICOTYLEDONOUS SEED :

- The outermost covering of a seed is the seed coat. The seed coat has two layers, the outer **testa** and the inner **tegmen**.
- The **hilum** is a scar on the seed coat through which the developing seeds were attached to the fruit. Above the hilum, is a small pore called the **micropyle**. Within the seed coat is the embryo, consisting of an embryonal axis and two cotyledons. The cotyledons are often fleshy and full of reserve food materials.
- At the two ends of the embryonal axis are present the radicle and the plumule.
- In some seeds such as castor, the **endosperm** formed as a result of double fertilisation, is a food storing tissue and called endospermic seeds.
- In plants such as bean, gram and pea, the endosperm is not present in mature seeds and such seeds are called non-endospermous.



(B) STRUCTURE OF MONOCOTYLEDONOUS SEED :

- Generally, monocotyledonous seeds are endospermic but some as in orchids are non-endospermic.
- In the seeds of cereals such as maize, the seed coat is membranous and generally fused with the fruit wall. The endosperm is bulky and stores food.
- The outer covering of endosperm separates the embryo by a proteinous layer called **aleurone layer**.
- The embryo is small and situated in a groove at one end of the endosperm. It consists of one large and shield shaped cotyledon known as **scutellum** and a short axis with a **plumule** and a **radicle**. The plumule and radicle are enclosed in sheaths which are called **coleoptile** and **coleorhiza** respectively.



09. SEMI-TECHNICAL DESCRIPTION OF A TYPICAL FLOWERING PLANT

- Various morphological features are used to describe a flowering plant. The description has to be brief, in a simple and scientific language and presented in a proper sequence.
- The plant is described beginning with its habit, vegetative characters – roots, stem and leaves and then floral characters inflorescence and flower parts. After describing various parts of plant, a floral diagram and a floral formula are presented.

Following symbols are used for floral formula :-

Bracteate	=	Br
Ebracteate	=	Ebr
Actinomorphic	=	⊕

Zygomorphic	=	% or $\bigcirc$ or $\div$
Bisexual	=	$\text{♂} \text{♀}$
Unisexual male (staminate)	=	♂
Unisexual female (Pistillate)	=	♀
Epicalyx	=	Epi or Epik.
Calyx	=	$\begin{array}{l} \text{K} \rightarrow \text{K}_n \text{ - Polysepalous condition} \\ \text{K} \rightarrow \text{K}_{(n)} \text{ - Gamosepalous condition} \end{array}$
Corolla	=	$\begin{array}{l} \text{C} \rightarrow \text{C}_n \text{ - Polypetalous condition} \\ \text{C} \rightarrow \text{C}_{(n)} \text{ - Gamopetalous condition} \end{array}$
Perianth	=	$\begin{array}{l} \text{P} \rightarrow \text{P}_n \text{ - Polyphyllous or polytepalous condition} \\ \text{P} \rightarrow \text{P}_{(n)} \text{ - Gamophyllous or gamotepalous condition} \end{array}$
Androecium	=	$\begin{array}{l} \text{A} \rightarrow \text{A}_n \text{ - Polyandrous condition} \\ \text{A} \rightarrow \text{A}_{(n)} \text{ - Cohesion condition} \end{array}$
Gynoecium	=	$\begin{array}{l} \text{G} \rightarrow \text{G}_n \text{ - Apocarpous condition} \\ \text{G} \rightarrow \text{G}_{(n)} \text{ - Syncarpous condition} \end{array}$
Superior ovary	=	Hypogynous flower = $\underline{\text{G}}$
Inferior ovary	=	Epigynous flower = $\overline{\text{G}}$
Ovary half inferior or half superior	=	Perigynous flower = $\text{G}-$

Adhesion

Epiphyllous condition (or epitepalous condition)	=	$\text{P} \text{A}$
Epipetalous condition	=	$\text{C} \text{A}$
Gynandrous condition	=	$\text{A} \text{G}$

- A floral diagram provides information about the number of parts of a flower, their arrangement and the relation they have with one another.

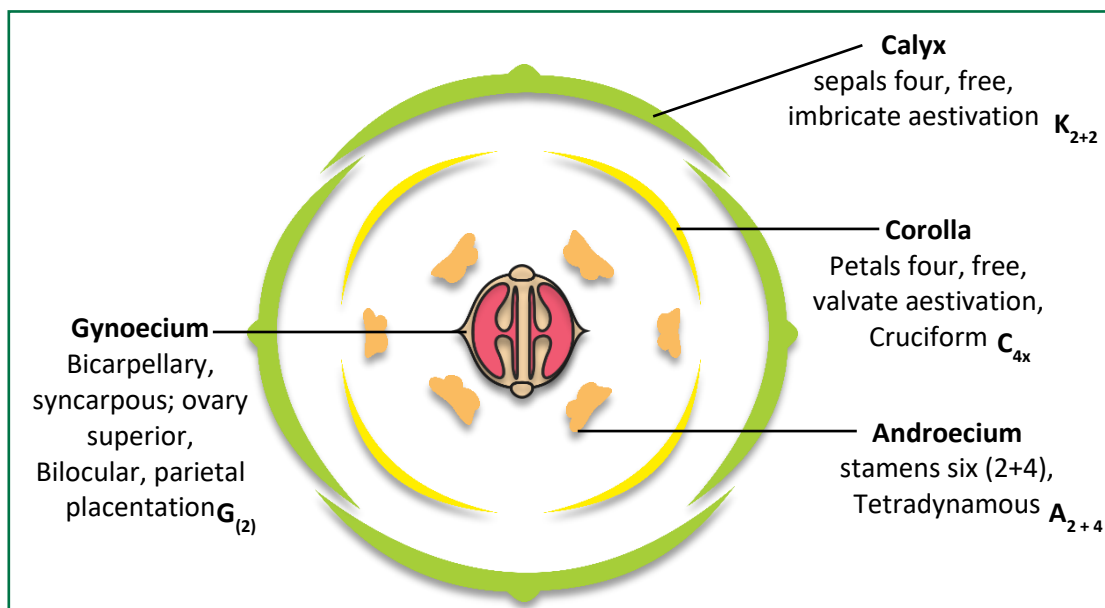
- The position of the mother axis with respect to the flower is represented by a dot on the top of the floral diagram. Calyx, corolla, androecium and gynoecium are drawn in successive whorls, calyx being the outermost and the gynoecium being in the centre.
- Floral formula and floral diagram show cohesion and adhesion within parts of whorls and between whorls.
- Floral diagram does not provide information regarding position of ovary.
- Floral formula does not provide information regarding aestivation & placentation.

10. DESCRIPTION OF SOME IMPORTANT FAMILIES

(1) BRASSICACEAE [= Cruciferae] = Mustard family

(A) Floral Characters :

- (i) **Inflorescence** - Typical raceme. **e.g.** Mustard, Radish etc.
- (ii) **Flower** - Ebracteate Bisexual or hermaphrodite, tetramerous Actinomorphic but sometimes zygomorphic.
e.g. Iberis amara (Candytuft = Chandni)
- (iii) **Calyx** - Sepals 4, polysepalous, sepals are arranged in two whorls 2 outer and 2 inner, imbricate aestivation.
- (iv) **Corolla** - Petals 4, polypetalous, **valvate aestivation and cruciform/cross form.**
- (v) **Androecium** - **Stamens 6**, arranged in two whorls - In which two outer stamens are small and inner four stamens are long. This condition is known as **tetradynamous, Polyandrous, Dithecous, Tetrasporangiate.**
- (vi) **Gynoecium** - Bicarpellary, syncarpous.
 - The ovary is unilocular in the beginning but it becomes bilocular later on due to the formation of a false septum (replum). Replum is developed from the thalamus.
 - Placentation is parietal.
- (vii) **Fruit** - Usually siliqua **e.g. Mustard**
- (viii) **Seeds** - Non-endospermic
- (ix) **Floral formula** - $\text{Ebr} \oplus \overset{\uparrow}{\underset{\downarrow}{\bigcirc}} K_{2+2} C_4 A_2 + 4 \underline{G}_{(2)}$

**(B) Economic Importance :****(i) As Food :**

- | | | |
|-------------------------------|---|---|
| (a) Radish (Muli) | = | <i>Raphanus sativus</i> - Fusiform root. |
| (b) Turnip (Shaljam) | = | <i>Brassica rapa</i> - Napiform root |
| (c) Cauliflower (Phool gobhi) | = | <i>Brassica oleracea var. botrytis</i> ,
immature inflorescence is edible. |
| (d) Cabbage (Patta gobhi) | = | <i>Brassica oleracea var. capitata</i> ,
fleshy leaves of bud are edible. |
| (e) Mustard (Sarson) | = | <i>Brassica campestris</i> . |

(ii) As Ornamental plants :

- | | | |
|----------------------|---|---------------------|
| Chandni (Candy tuft) | = | <i>Iberis amara</i> |
|----------------------|---|---------------------|

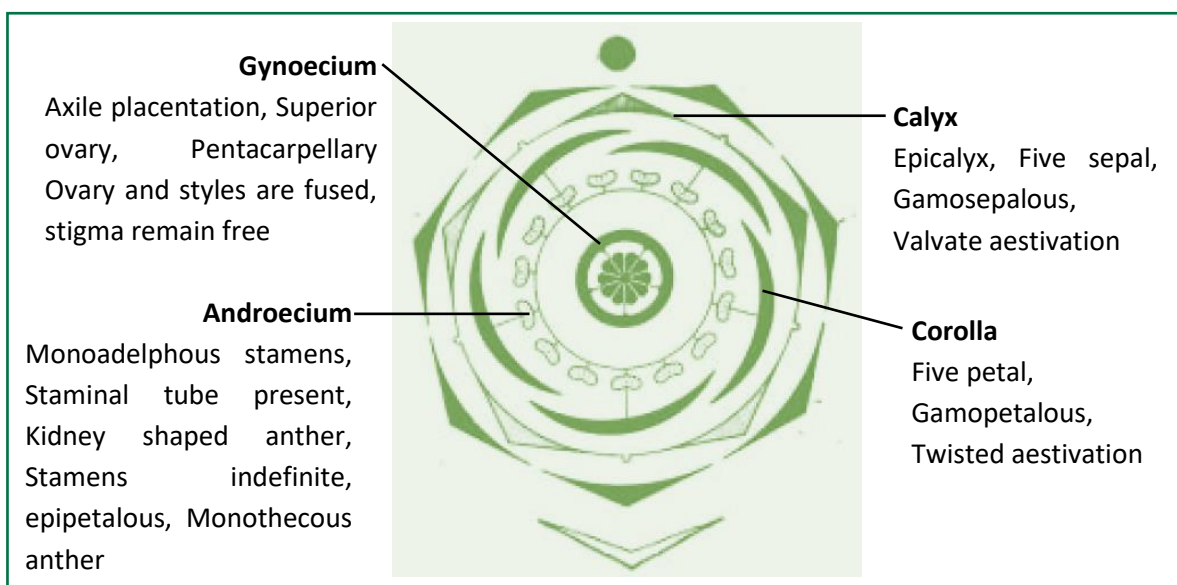
(2) MALVACEAE (Fibre Family) : (= Cotton family, Mallow family)

- The mucilage is present in various plant organs like flower, fruit. Stellate (star shaped) hairs are present on the shoot.

(A) Floral Characters :

- (i) **Inflorescence** - Cymose or solitary – solitary axillary or solitary Terminal.
- (ii) **Flower** - Bracteate, Bisexual, Actinomorphic, Hypogynous, Pentamerous.
- (iii) **Epicalyx** - Epicalyx (Bracteoles) are 3-7, free and green in colour. They are the transformed bracteoles. Valvate aestivation.

- (iv) **Calyx** – Sepals 5, Gamosepalous, Valvate aestivation. In some of the plants persistent calyx are present, it means they are present on fruit e.g. *Abelmoschus* (Bhindi) and *Gossypium* (Cotton).
- (v) **Corolla** – Petals 5, Polypetalous, Twisted aestivation, Mucilagenous and attractive.
- (vi) **Androecium** – Stamens infinite, Monoadelphous means filaments united together in one bundle and anthers remain free.
- **Anthers kidney shaped, Monothealous.**
 - The filaments are united together to form a long staminal canal or staminal tube around style.
 - Staminal tube is united with the petals at the base of the flower, so stamens are epipetalous.
- (vii) **Gynoecium** - Axile placentation, Superior ovary, Pentacarpellary. Ovary and styles are fused, stigma remain free
- (viii) **Fruit** - Capsule e.g. Cotton and Lady finger.
- (ix) **Seed** - Non-endospermic
- (x) **Floral Formula** - $\text{Br} \oplus \text{Epi}_{3-7} \text{K}_{(5)} \widehat{\text{C}_5} \text{A}_{(\infty)} \underline{\text{G}}_{(5-\infty)}$



- (B) **Economic Importance** : The family includes many plants of great economic importance e.g. food, fibres, oils, medicine and ornaments.
- (i) **As Food** : Okra/bhindi (**Lady finger**) = *Abelmoschus esculentus* used as vegetable.
- (ii) **As oils** : The seeds of *Gossypium* (**Cotton**) are used for obtaining oil which is hydrogenated to prepare vegetable ghee.

(iii) **As Fibres** : Most of the economically important fibre yielding plants belong to the family malvaceae.

(a) **Surface fibres** : These fibres are obtained from the surface of the seeds.

Cotton = *Gossypium*.

(iv) **As ornamental plants** :

(a) **China rose (Shoeflower) = *Hibiscus rosasinensis*** – **Red shoes polish** is obtained from the **petals** of this flower.

(b) **Holly hock (Gul-e-khera) = *Althaea rosea*** (Blue colour is obtained from its leaves)

(3) FABACEAE FAMILY :

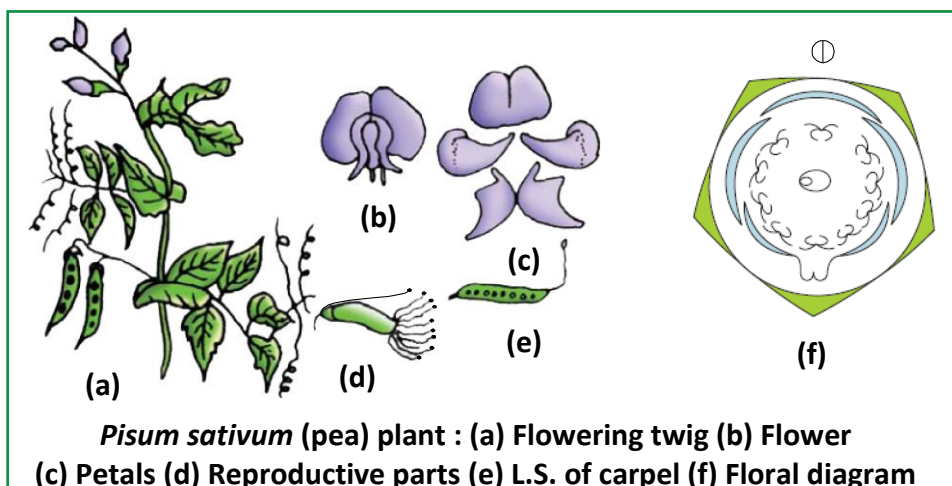
- This family was earlier called Papilionoideae, a subfamily of family Leguminosae.
- It is distributed all over the world.
- Trees, shrubs, herbs; root with root nodules.

(A) Vegetative Characters :

- (i) **Roots** - Roots are branched and **tap root system** is present. In root nodules **Nitrogen-fixing bacteria *Rhizobium leguminosarum*** are present.
- (ii) **Stem** - Erect or climber
- (iii) **Leaves** - Stipulate (foliaceous stipules), simple or pinnately compound, leaf base pulvinate/pulvinus, venation reticulate, alternate [Leaf tendril (wild pea) and leaflet tendrial (*Pisum sativum*)]

(B) Floral Characters :

- (i) **Inflorescence** - Typical raceme (**racemose**).
- (ii) **Flower** - Bracteate, **bisexual**, hypogynous, pentamerous and **zygomorphic** symmetry.
- (iii) **Calyx** - Sepals 5, gamosepalous, **aestivation imbricate** or **valvate** (mainly valvate)
- (iv) **Corolla** - **Petals 5, papilionaceous (Butterfly shaped), polypetalous**, one petal is odd out of 5—petals, towards the mother axis - means posterior in position. It is the largest and outer most petal which is called **standard** or **vexillum**.
- Below the vexillum, two small free lateral petals present which are known as wings or **alae (lateral in position)**
- Anterior two petals fused together to form a boat like structure called keel or carina which encloses the essential organs. i.e. stamens and pistil/carpel.
- Such type of aestivation is called vexillary or descending imbricate.



- (v) **Androecium** - Stamens - 10, diadelphous (9) + 1, Anther dithecous
- (vi) **Gynoecium** - Gynoecium is monocarpellary, unilocular with many ovules, **superior ovary**, style single and **marginal placentation**.
- (vii) **Fruit** - Legume or pod
Sometimes **lomentum** is also found e.g. *Arachis* (ground nut)
- (viii) **Floral Formula** - $\text{Br } \oplus \text{ } \overline{\text{K}}_{(5)} \text{C}_{1+2+(2)} \text{A}_{1+(9)} \underline{\text{G}}_1$ or $\text{Br } \oplus \text{ } \overline{\text{K}}_{(5)} \text{C}_{1+2+(2)} \text{A}_{(9)+1} \underline{\text{G}}_1$

(C) Economic Importance :

(i) As Food :

- | | | |
|--|---|---|
| (a) Arhar (Pigeon pea) - Pulse | = | <i>Cajanus cajan</i> / <i>cajanus indicus</i> |
| (b) Chana (Gram) - Pulse | = | <i>Cicer arietinum</i> |
| (c) Mattar (Pea) | = | <i>Pisum sativum</i> |
| (d) Mung (green gram) - Pulse | = | <i>Phaseolus radiatus</i> or <i>Vigna radiatus</i> |
| (e) Soyabean - Pulse | = | <i>Glycine max</i> (<i>G. soja</i>). Soyabean contains more protein than meat |
| (f) Mungphali
(Ground nut or pea nut) | = | <i>Arachis hypogea</i> . |
| (g) Sem-Pulse | = | <i>Dolichos lablab</i> |

(ii) As Fodder :

- | | | |
|--------------|---|------------------|
| (a) Berseem | = | <i>Trifolium</i> |
| (b) Dhaincha | = | <i>Sesbania</i> |

(iii) As Fibres :

- | | | |
|---------|---|--|
| Sunhemp | = | <i>Crotalaria juncea</i> (<i>ternatea</i>) |
|---------|---|--|

(iv) As Timber :

- | | | |
|---------|---|--|
| Shisham | = | <i>Dalbergia sissoo</i> (<i>Indian Red Wood</i>) |
|---------|---|--|

(v) As Dyes :

- | | | |
|-----------------|---|---|
| Neel (Blue dye) | = | <i>Indigofera tinctoria</i> (dye is obtained from leaves) |
|-----------------|---|---|

(vi) As Medicinal plants :

Mulaithi (Liquorice)

= *Glycyrrhiza glabra*

Its roots are used in cough & cold.

(vii) As Ornamentals plant :

(a) Sweet pea (Phool matar)

= *Lathyrus odoratus*

(b) Lupin

= *Lupinus albus*

(viii) As Edible oil :

= Soyabean, ground nut

(4) SOLANACEAE (= Potato family) :

It is a large family, commonly called as the 'potato family'. It is widely distributed in tropics, subtropics and even temperate zones.

(A) Vegetative Characters :

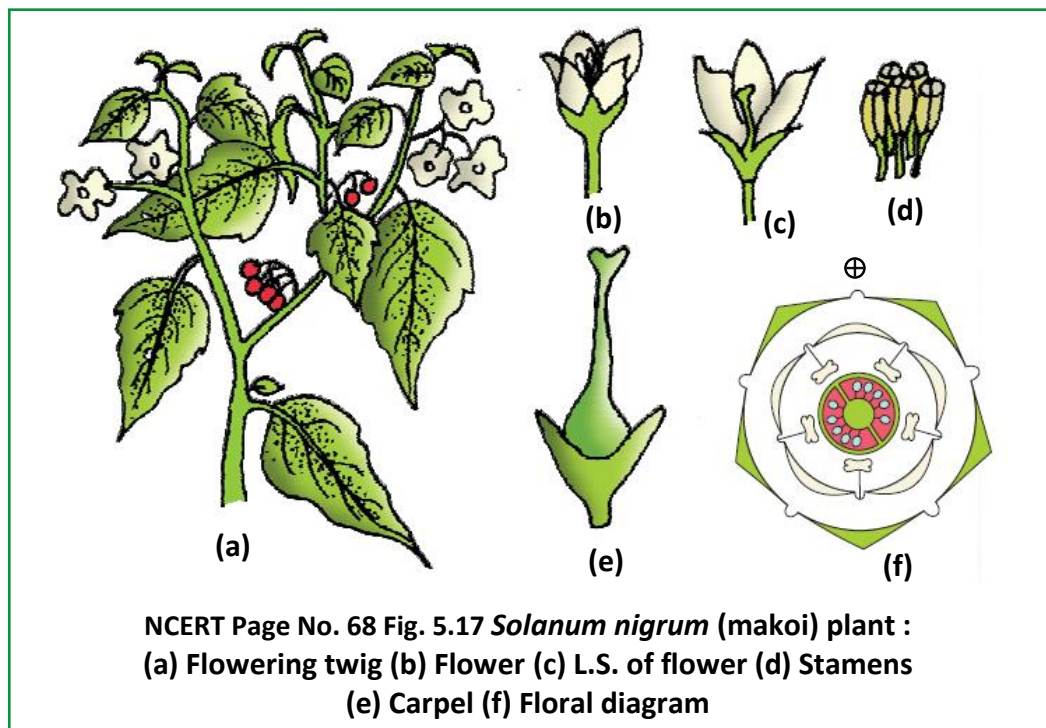
- Most of plants of this family are herbs, some of them are shrubs, rarely small trees.

Underground stem in potato.

(i) **Root** : The tap root system is present in these plants.

(ii) **Stem** : Herbaceous rarely woody, aerial, erect, cylindrical, branched, solid or hollow, hairy or glabrous, underground stem in potato (*Solanum tuberosum*).

(iii) **Leaves** : Alternate, simple, rarely pinnately compound, exstipulate; venation reticulate.



(B) Floral Characters :

- (i) **Inflorescence** - Solitary, axillary or cymose inflorescence as in *Solanum*.
- (ii) **Flower** - Flowers are bracteate or ebracteate, **bisexual**, complete, hypogynous, pentamerous and actinomorphic.
- (iii) **Calyx** - Sepals 5, gamosepalous (united), valvate aestivation and persistent.
(e.g. tomato, brinjal)
- (iv) **Corolla** - Petals -5, gamopetalous (united), aestivation valvate.
- (v) **Androecium** - Stamens -5, polyandrous, epipetalous stamens.
- (vi) **Gynoecium** - Bicarpellary obliquely placed, syncarpous, ovary superior, bilocular, swollen axile placenta with many ovules.
Special features - Swollen placenta and oblique septum. Ovaries arranged obliquely on thalamus.
- (vii) **Fruits** - Fleshy fruit - **berry (tomato, brinjal)** sometimes **capsule** (*Datura*).
- (viii) **Seeds** – Many and endospermic/endospermous.
- (ix) **Floral formula** – $\text{Br or Ebr} \oplus \frac{\text{♂}}{\text{♀}} \text{K}_{(5)} \text{C}_{(5)} \text{A}_5 \underline{\text{G}}_{(2)}$

(C) Economic Importance :

- (i) **As Food :**
 - (a) **Potato** = *Solanum tuberosum* - edible part is **under ground stem- tuber**
 - (b) **Tomato** = *Lycopersicum esculentum*
 - (c) **Brinjal (Egg plant)** = *Solanum melongena*
 - (d) **Makoi** = *Solanum nigrum*
 - (e) **Chilli** = *Capsicum annuum* (used as spice)
 - (g) **Shimla Mirch** = *Capsicum frutescence*
- (ii) **As Medicines Plants :**
 - (a) ***Atropa belladonna*** (Deadly night shade) The roots are used in the manufacture of **drug belladonna**. Atropine alkaloids is obtained from its roots which is used to dilate the pupil of the eye.
 - (b) **Nicotine & anabasin alkaloid** is obtained from the leaves of *Nicotiana tabacum* (**Tobacco**) & *N. rustica*. It is nerve stimulant and are also used as insecticide.
 - (c) ***Withania somnifera*** = Asvagandh/**Ashwagandha** - Its root are used as nerve health tonic.

(iii) **As Ornamental Plants** : Many plants of the family are cultivated for their beautiful flower and fragrance as follows:-

(a) *Petunia alba* and *Petunia hybrida*.

(iv) **As Fumigatory : Tobacco (*Nicotiana tabacum*)**

(5) ASTERACEAE OR COMPOSITAE (Sunflower family) :

It is largest family of angiosperms, having largest geographical distribution. The name of this family is based on its inflorescence.

(A) **Vegetative Characters** : In *Dahlia* fasciculated roots are present.

(B) **Floral Characters** :

(i) **Inflorescence** - racemose head or capitulum.

(ii) **Calyx** - usually represented by hairy structure called **pappus** or represented by minute scales. It is **persistent** & **attached on fruit** & helps in dispersal of fruits.

(iii) **Corolla** - 5, **gamopetalous**, valvate aestivation.

(iv) **Stamens** - 5, **epipetalous**, **syngenesious**.

(v) **Gynoecium** - Bicarpellary, syncarpous, **inferior ovary**, unilocular, **basal placentation**.

(vi) **Fruit** - **cypsela with hairy pappus i.e. important character of this family.**

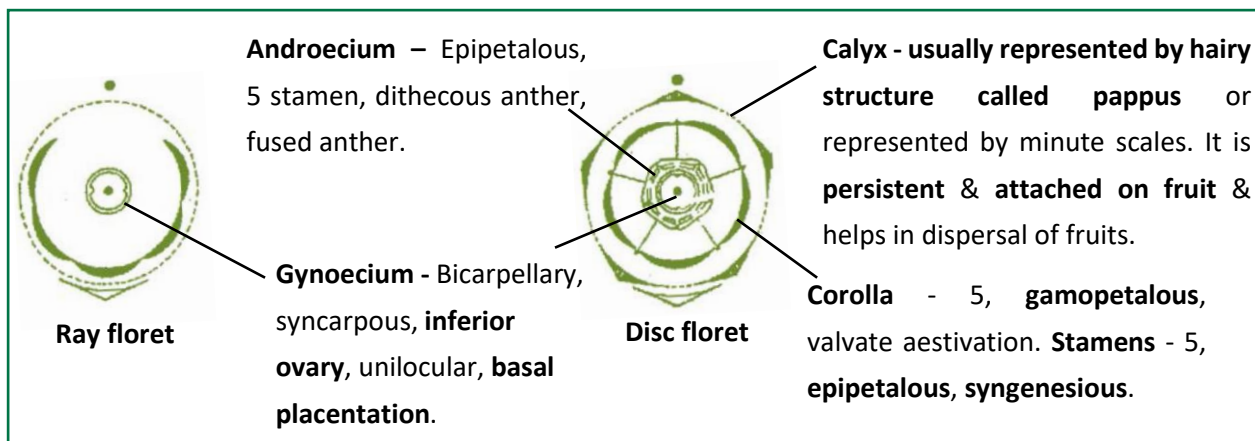
(vii) **Seed** – Many, **Non-endospermic**.

Floral Formula : Asteraceae or Compositae.

$Br\% \text{ } \bar{\text{K}}_p C_{(5)} A_0 \bar{G}_{(2)} \rightarrow \text{Ray floret}$

$Br \oplus \bar{\text{K}}_p \widehat{C_{(5)}} A_{(5)} \bar{G}_{(2)} \rightarrow \text{Disc floret}$

$Br\% K_p C_{(5)} A_0 G_0 \rightarrow \text{Neuter floret}$



(C) Economic Importance :

(i) As Food –

- (a) *Helianthus annuus* = Sunflower (Suraj mukhi) – The seeds of this yield valuable oil which is used for cooking purposes.

(ii) Medicinal plants :–

- (a) *Eclipta alba* (Bhring Raj) - Juice is used as hair tonic.
 (b) *Chrysanthemum cinerariaefolium* = Guldaudi – Pyrethrum (an insecticide) is obtained.

(iii) Ornamental :–

- (a) *Helianthus annuus* = Sunflower
 (b) *Chrysanthemum* = Gul–Daudi
 (c) *Tagetes* = Genda (Marigold)

Note : *Parthenium hysterophorus/P.argentatum* = Carrot grass or Congress grass – skin allergy develops from its pollen grains.

(6) LILIACEAE (= Lily family) :

- Plants of this family are distributed world wide.
- Liliaceae is a monocot family.
- Commonly called the 'Lily family' is a characteristic representative of monocotyledonous plants. It is distributed worldwide.

(A) Vegetative Characters :

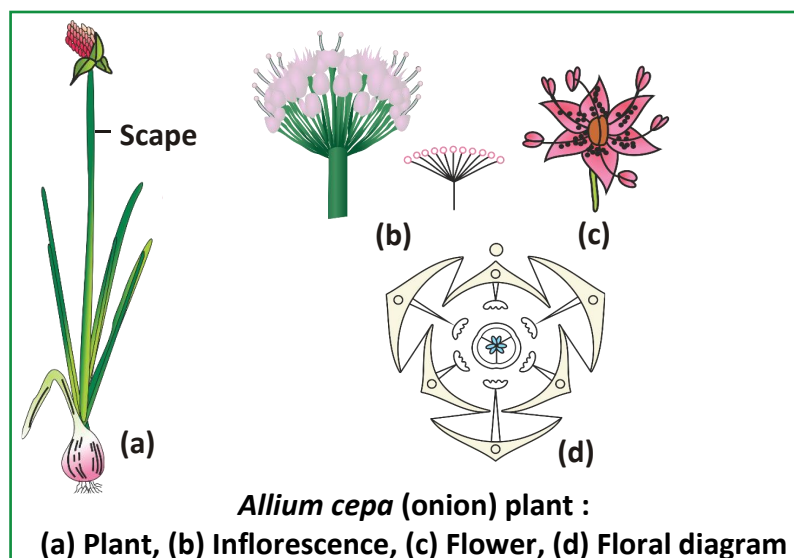
Perennial herbs with underground bulbs/corms/ rhizomes.

(i) Stem -

- (a) Bulbs - e.g. - Onion, Garlic.
 (b) Corm – e.g. - Colchicum.

(ii) Root - Usually adventitious/fibrous. Fasciculated roots are found in *Asparagus* (satawar).

(iii) Leaves - Mostly basal, alternate, linear, exstipulate with parallel venation. Exceptionally reticulate venation is found in *Smilax*.

**(B) Floral Characters :**

- (i) **Inflorescence** - Solitary / cymose; often umbellate clusters.
- (ii) **Flower** - Bracteate, bisexual, complete, actinomorphic, hypogynous and trimerous.
- (iii) **Perianth** - Tepal 6, arranged in two whorls (3+3), often united into tube; valvate aestivation.
- (iv) **Androecium** - Stamen six, 3+3, epiphyllous (epitepalous), arranged in two whorls 3 + 3, polyandrous.
- (v) **Gynoecium** - Tricarpellary, syncarpous, ovary superior, trilocular with many ovules; axile placentation.
- (vi) **Fruit** - Capsule (Onion), rarely berry (Lily).
- (vii) **Seed** - Endospermic/Endospermous
- (viii) **Floral Formula** : $\text{Br} \oplus \overline{\text{P}_{(3+3)} \text{A}_{3+3} \text{G}_{(3)}}$

(C) Economic Importance :

- (i) **As Food :**
 - Onion** = *Allium cepa* - Foul odour is due to an oil like organic compound of sulphur - allyl sulphide formed in Fleshy leaves of bulb.
 - Garlic** = *Allium sativum*
 - Satawar** = *Asparagus* - used as vegetable.
- (ii) **As Ornamental plants :**
 - Lily** = *Lilium bulbiferum*
 - Tulip** = *Tulipa*
 - Gloriosa** (Glory lily)

(iii) As Medicinal plants :

Gvar patha = *Aloe vera* - Aloin, a purgative is obtained. The juice of the leaves is used as skin tonic and it increases the eye sight.

Garlic (Lahasun) = *Allium sativum* = It is very useful in heart disease, rheumatism & diabetes.

(iv) Other Uses :

***Colchicum autumnale* - Colchicine (mitotic poison)** is obtained from corms of this plant, which is used to induce polyploidy in plants.

(7) POACEAE OR GRAMINEAE (Grass family) :

This is the largest family of the Indian flora. Poaceae is a monocot family.

(A) Floral Character :

(i) Inflorescence - spike of spikelets.

(ii) Flowers - zygomorphic, bisexual, in *Zea mays* unisexual, hypogynous and trimerous.

(iii) Perianth – 2 tepal, polyphyllous, membranous and situated in antero lateral position. They are called lodicules.

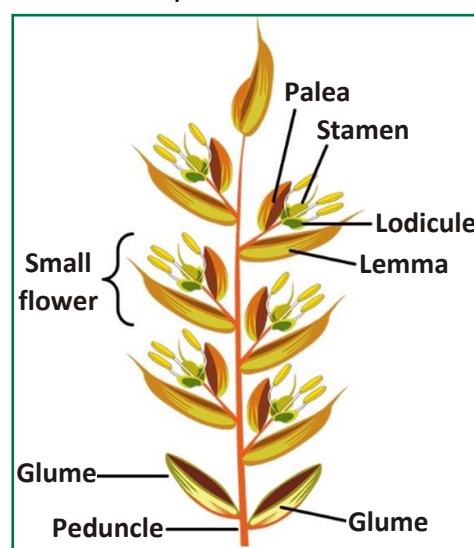
(iv) Androecium - 3 polyandrous, versatile (Long filament is attached to the back of the anther at a point only and anther can swing freely).

(v) Gynoecium - Monocarpellary or tricarpellary, syncarpous, superior, unilocular ovary, placentation is basal, stigma is feathery.

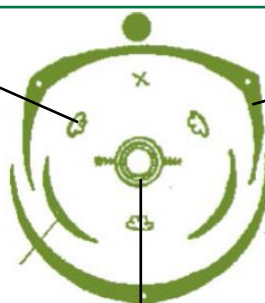
(vi) Fruit - caryopsis.

(vii) Seed – Many, Endospermic

(viii) Floral Formula : $\text{Br} \Phi \text{P}_2 \text{A}_3 \underline{\text{G}}_1 \text{ or } \underline{\text{G}}_3$



Androecium - 3 polyandrous, versatile (Long filament is attached to the back of the anther at a point only and anther can swing freely).



Perianth – 2 tepal, polyphyllous, membranous and situated in antero lateral position. They are called lodicules.

Gynoecium - Monocarpellary or tricarpellary, syncarpous, superior, unilocular ovary, placentation is basal, stigma is feathery.

Example : Wheat, Maize, Rice, Barley, Sugarcane, Bamboo, Grass, *Sorghum*, *Pennisetum*

(B) Economic Importance :**(i) Ornamental Plants - *Cynodon dactylon* = Doob****(ii) Cereals :-**

- | | | |
|---------------------------------|---|---|
| (a) <i>Avena sativa</i> | = | Jai/oat |
| (b) <i>Hordeum vulgare</i> | = | Barley/jau - It is the oldest ancient crop. |
| (c) <i>Oryza sativa</i> | = | Rice |
| (d) <i>Pennisetum typhoides</i> | = | Bajra |
| (e) <i>Secale cereale</i> | = | Rye |
| (f) <i>Sorghum vulgare</i> | = | Jawar |
| (g) <i>Triticum aestivum</i> | = | Wheat |
| (h) <i>Zea mays</i> | = | Maize |

(iii) As source of Sugar -*Saccharum officinarum* = Sugarcane**(iv) As Fibre Yielding Plants -***S. munja* = Moonj - Fibres obtained from stem is used for making ropes, mats and baskets etc.**(v) As Timber Yielding Plants -***Bambusa balcooa* = Bamboo**(vi) Other Uses -****(a) *Hordeum vulgare* (Barley = Jau) is used for making beer.****(b) *Zea mays* is used in alcohol industry.****Most advanced dicot family – Asteraceae (compositae)****Most advanced monocot family – Poaceae (Gramineae)**

★ Golden Key Points ★

- Half inferior ovary is found in plum, peach, rose.
- In apocarpous condition carpels are free.
- Generally the fruit consists of pericarp and seeds.
- In fabaceae and poaceae, flowers are zygomorphic.
- Solanaceae is commonly called 'potato family'
- Leaf tendril – Pea
- Foliaceous (leaf like) stipules are found in *Pisum sativum*.
- Tendrillar leaflets are found in *Pisum sativum*.



BEGINNER'S BOX-2

FLOWER TO FAMILIES

1. A flower can be regarded as perfect flower when :-
 (1) Only one essential whorl is present (2) Both essential whorls are present
 (3) Both accessory whorls are present (4) Both essential whorls are absent
BMP372
2. Beauty of *Bougainvillea* is due to :-
 (1) Sepal (2) Petal (3) Bract (4) Stipule
BMP373
3. Pappus is characteristic feature of :-
 (1) Cotton (2) Lady finger (3) Sunflower (4) Mustard
BMP374
4. Select the correct statement?
 (1) In syncarpous condition one carpel is present
 (2) The number of locules are always equal to number of carpels in gynoecium
 (3) Free central placentation is found in primrose
 (4) Arrangement of ovaries is called placentation
BMP375
5. Select incorrect statement ?
 (1) Berry fruits are generally single seeded
 (2) Tetradynamous stamens are found in mustard
 (3) Tricarpellary gynoecium is found in members of family Liliaceae
 (4) In family Cucurbitaceae, plants are generally monoecious
BMP376
6. Tetradynamous (2 short and 4 long stamens) condition is seen in :-
 (1) *Salvia* (2) *Mustard* (3) *Datura* (4) China rose
BMP377
7. In *Dianthus*, placentation is :-
 (1) Basal (2) Free central (3) Axile (4) Marginal
BMP378
8. If the filaments of stamens are fused in a single group, the condition is :-
 (1) Monadelphous (2) Polyadelphous
 (3) Both (1) and (2) (4) Diadelphous
BMP379
9. Coconut fruit develops from :-
 (1) Monocarpellary superior ovary
 (2) Monocarpellary inferior ovary
 (3) Multicarpellary superior ovary
 (4) Multicarpellary inferior ovary
BMP380

10. When a fruit is developed from ovary without fertilisation then which of the following is not correct about it :-

- (1) It is parthenocarpic fruit
- (2) It is true fruit
- (3) Such fruits are useful to produce in all plants
- (4) Mango, guava and tomato are not the parthenocarpic fruits

BMP381

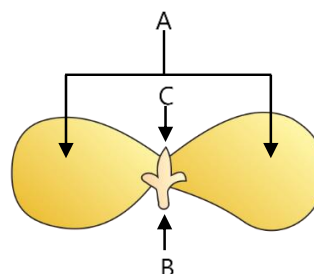
11. *Asparagus gloriosa* and onion belong to which family?

- (1) Potato family
- (2) Lily family
- (3) Pea family
- (4) Mustard family

BMP382

12. Identify A, B and C in given diagram below :-

- (1) A-Plumule, B-Radicle, C-Cotyledon
- (2) A-Seed coat, B-Plumule, C-Cotyledon
- (3) A-Seed coat, B-Micropyle, C-Radicle
- (4) A-Cotyledon, C-Plumule, B- Radicle



BMP383

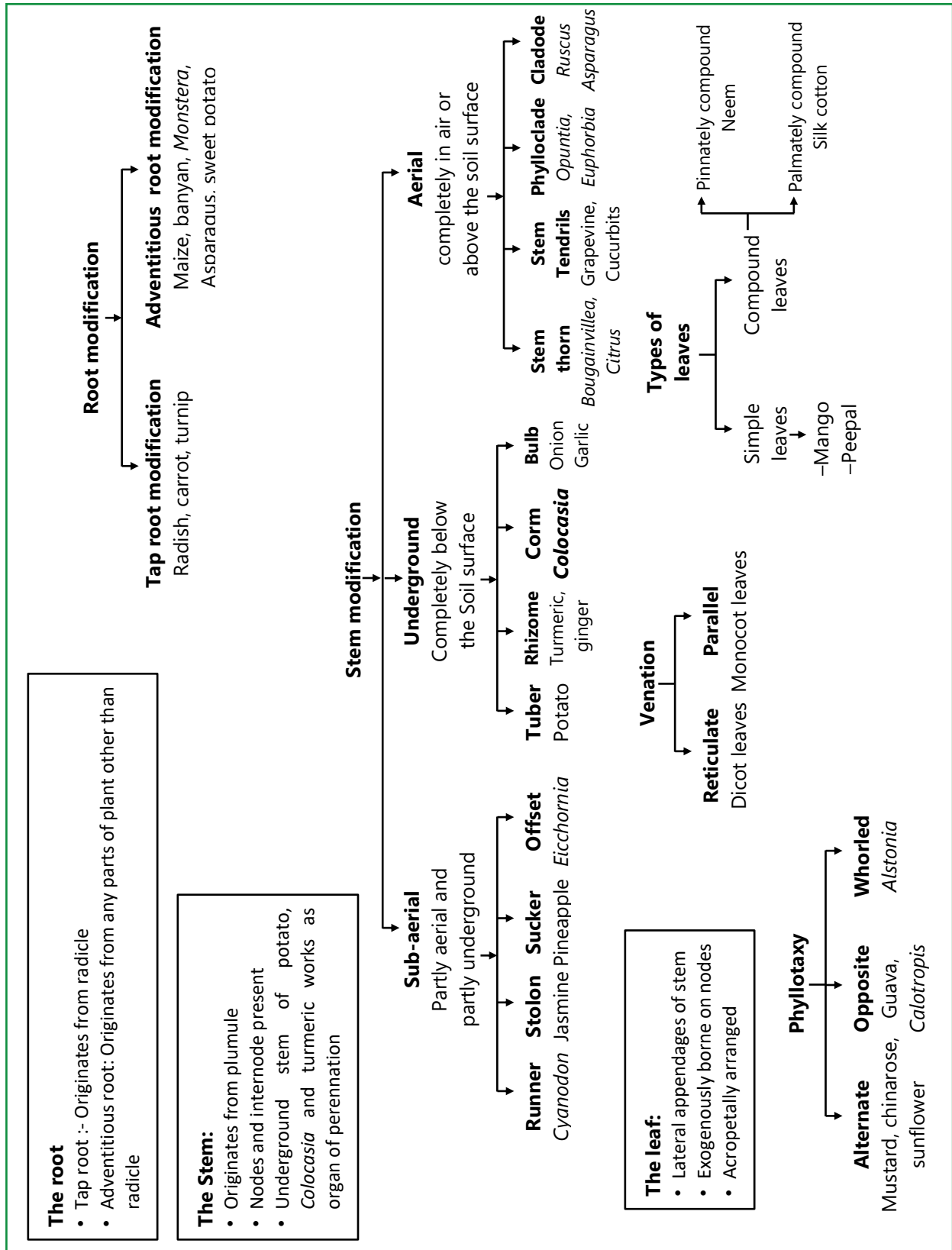


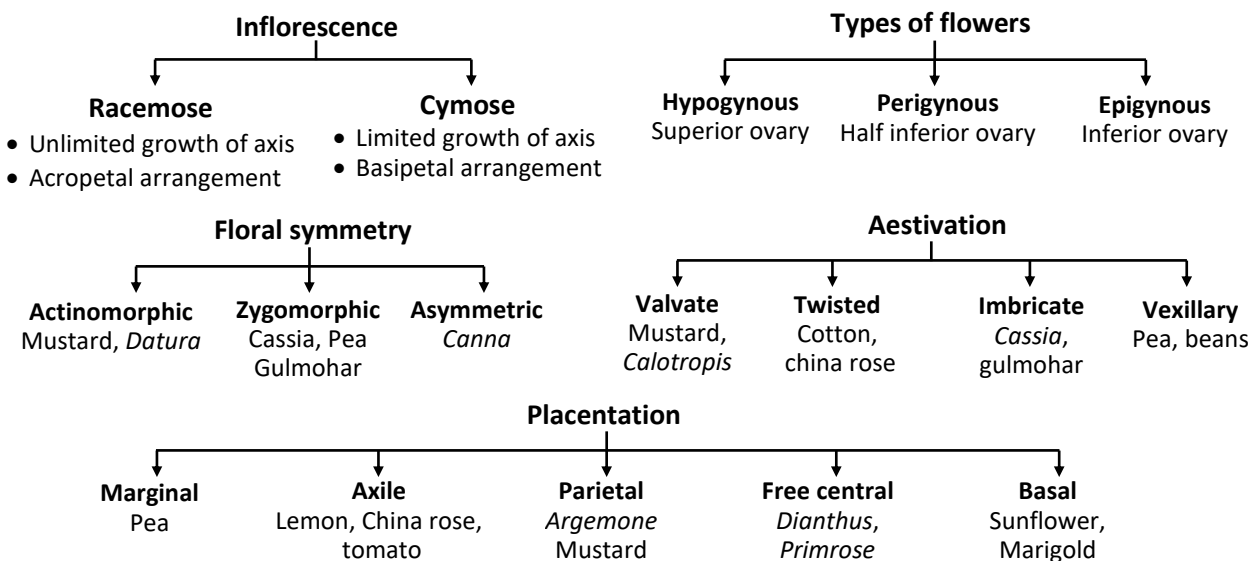
BEGINNER'S BOX

ANSWERS KEY

BEGINNER'S BOX-1	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	1	1	2	2	2	3	4	3	2	2
	Que.	11									
	Ans.	1									

BEGINNER'S BOX-2	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	2	3	3	3	1	2	2	1	1	3
	Que.	11	12								
	Ans.	2	4								



**Flower :**

- A modified shoot meant for sexual reproduction
- Unit of sexual reproduction in angiosperms
- Nodes and highly condensed internodes are present
- Calyx and corolla are accessory whorls of flowers
- Androecium and gynoecium are essential whorls of flower

Fruit :

- Ripened ovary after fertilization form fruits
- In mango and coconut drupe fruits are present
- In drupe fruits endocarp is hard and stony
- Parthenocarpic fruits are seed less

	Cruciferae or Brassicaceae	Fabaceae	Solanaceae	Liliaceae
Floral formula	$\text{Ebr} \oplus \text{♀} \text{K}_{2+2} \text{C}_4 \text{A}_{2+4} \underline{\text{G}}_{(2)}$ Or $\text{Ebr} \oplus \text{♀} \text{K}_{2+2} \text{C}_{4x} \text{A}_{2+4} \underline{\text{G}}_{(2)}$	$\text{Br} \text{⊖} \text{♀} \text{K}_{(5)} \text{C}_{1+2+(2)} \text{A}_{1+(9)} \underline{\text{G}}_1$ Or $\text{Br} \text{⊖} \text{♀} \text{K}_{(5)} \text{C}_{1+2+(2)} \text{A}_{(9)+1} \underline{\text{G}}_1$	$\text{Br or Ebr} \oplus \text{♀} \text{K}_{(5)} \text{C}_{(5)} \text{A}_5 \underline{\text{G}}_{(2)}$	$\text{Br} \oplus \text{♀} \text{P}_{(3+3)} \text{A}_{3+3} \underline{\text{G}}_{(3)}$
Floral diagram				
Class	Dicotyledonae	Dicotyledonae	Dicotyledonae	Monocotyledonae
Special characters	- Tetramerous flower - Symmetry actinomorphic - Cruciform Corolla - Tetradynamous stamens - Parietal placentation - Presence of Replum (False septum) - Siliqua Fruit - Non-endospermic seed	- Nodulated roots - Leaves stipulate - Leaf base pulvinate - Pentamerous flower - Flowers Zygomorphic - Papilionaceous Corolla - Vexillary aestivation in petals - Diadelphous stamens - Marginal placentation	- Leaves exstipulate - Pentamerous flower - Epipetalous stamens - Swollen placenta - Oblique ovary - Axile placentation - Fruit Berry and sometimes Capsule - Endospermic seed	- Adventitious fibrous roots - Mostly underground stems Bulb/Corm/Rhizome - Leaves exstipulate - Parallel venation - Inflorescence Umbellate clusters - Trimerous flower - Presence of Perianth - Axile placentation

	Exceptionally in candytuft symmetry of flower-Zygomorphic	- Fruit Legume/Pod, sometimes Lomentum as in-<i>Arachis</i> (Groundnut) - Non-endospermic seed		- Fruit usually Capsule, sometimes berry - Epitpalous stamens - Endospermic seed
Example	Radish, Turnip, Cauliflower, Cabbage, Knol-Khol, Mustard, Rai, Chandani (Candy tuft), Shepherd's purse (<i>Capsella bursa-pastoris</i>)	Pea, Gram, Arhar, Sem, Moong, French bean (Rajma), Sem, Soyabean, Groundnut, <i>Indigofera</i> , Sunhemp, <i>Sesbania</i> , <i>Trifolium</i> , Lupin, Sweet pea, Muliathi, Shisham (<i>Dalbergia</i>), <i>Pisum sativum</i> (Garden pea)	Tomato, Brinjal, Potato, Chilli, <i>Datura</i> , Belladonna, Ashwagandha (<i>Withania</i>), Tobacco, <i>Petunia</i> , Makoi (<i>Solanum nigrum</i>)	Onion (<i>Allium cepa</i>), Garlic, Tulip, Gloriosa, Lily, <i>Smilax</i> , Aloe, <i>Asparagus</i> , <i>Colchicum autumnal</i>

	Malvaceae	Asteraceae or Compositae	Poaceae or Gramineae
Floral formula	$\text{Br} \oplus \text{Epi}_{3-7} \text{K}_{(5)} \text{C}_5 \text{A}_{(\infty)} \underline{\text{G}}_{(5-\infty)}$	$\text{Br} \% \text{K}_p \text{C}_{(5)} \text{A}_0 \overline{\text{G}}_{(2)} \rightarrow \text{Ray floret}$ $\text{Br} \oplus \text{K}_p \text{C}_{(5)} \text{A}_{(5)} \overline{\text{G}}_{(2)} \rightarrow \text{Disc floret}$	$\text{Br} \oplus \text{P}_2 \text{A}_3 \underline{\text{G}}_1 \text{ or } \underline{\text{G}}_3$
Floral diagram		 Ray floret Disc floret	
Class	Dicotyledonae	Dicotyledonae	Monocotyledonae
Special characters	- Epicalyx, Five sepal, Gamosepalous, Valvate aestivation. - Five petal, Gamopetalous, Twisted aestivation. - Monadelphous stamens, Staminal tube present, Kidney shaped anther, Stamens indefinite, epipetalous, Monotheous anther - Axile placentation, Superior ovary, Pentacarpellary Ovary and styles are fused, stigma remain free.	- usually represented by hairy structure called pappus or represented by minute scales. It is persistent & attached on fruit & helps in dispersal of fruits. 5, gamopetalous, valvate aestivation. Stamens - 5, epipetalous, syngenesious. - Epipetalous, 5 stamen, ditheous anther, fused anther. - Bicarpellary, syncarpous, inferior ovary, unilocular, basal placentation.	2 tepal, polyphyllous, membranous and situated in antero lateral position. They are called lodicules. 3 polyandrous, versatile (Long filament is attached to the back of the anther at a point only and anther can swing freely). - Monocarpellary or tricarpellary, syncarpous, superior, unilocular ovary, placentation is basal, stigma is feathery.
Example	Cotton, Lady finger, China rose	Sunflower, Gul-Daudi, Marigold	Rice, Bajra, Rye, Jawar, Wheat, Maize, Sugarcane

NCERT SUMMARY

Flowering plants exhibit enormous variation in shape, size, structure, mode of nutrition, life span, habit and habitat. They have well developed root and shoot systems. Root system is either **tap root** or **fibrous**. Generally, dicotyledonous plants have tap roots while monocotyledonous plants have fibrous roots. The roots in some plants get modified for storage of **food, mechanical support** and **respiration**. The shoot system is differentiated into stem, leaves, flowers and fruits. The morphological features of stems like the **presence of nodes** and **internodes, multicellular hair** and **positively phototropic nature** help to differentiate the stems from roots. Leaf is a lateral outgrowth of stem developed exogenously at the node. These are green in colour to perform the function of photosynthesis. Leaves exhibit marked variations in their **shape, size, margin, apex** and **extent of incisions of leaf blade (lamina)**.

The flower is a modified shoot, meant for **sexual reproduction**. The flowers are arranged in different types of inflorescences. They exhibit enormous variation in structure, symmetry, position of ovary in relation to other parts, arrangement of petals, sepals, ovules etc. After fertilisation, **the ovary is modified into fruits and ovules into seeds**. Seeds either may be **monocotyledonous** or **dicotyledonous**. They vary in shape, size and period of viability. The floral characteristics form the basis of classification and identification of flowering plants. This can be illustrated through semitechnical descriptions of families. Hence, a flowering plant is described in a definite sequence by using scientific terms. The floral features are represented in the summarised form as floral diagrams and floral formula.