MORPHOLOGY OF FLOWERING PLANTS

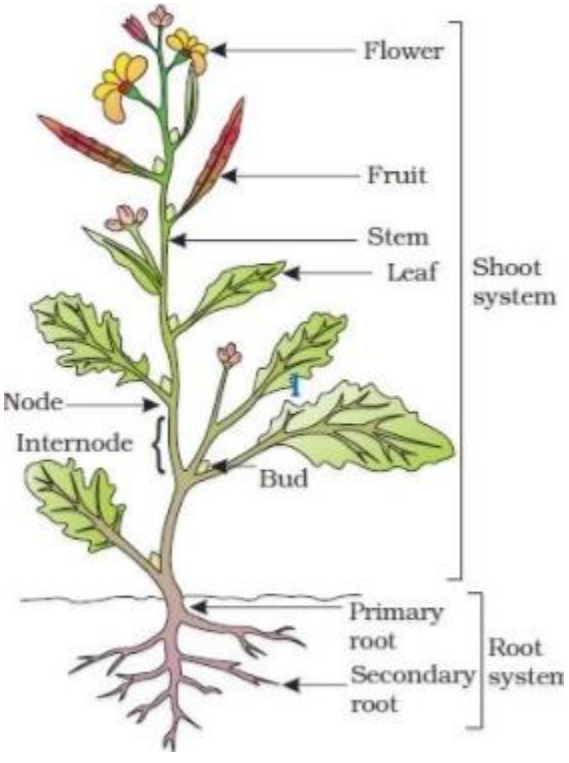
Morphology is the study of external structure of organisms. It involves the study of the size, shape, and structure of all living organisms and their relationships with their constituent parts. The term *anatomy* refers to the study of internal biological structure. It usually involves study of the details of either gross or microscopic structure.

Epidonomy: The study of external morphology or external appearance of an organism such as shape, size, colour, pattern, structure, etc.

Anatomy: The study of internal morphology or form and structure of internal parts like bones, organs, etc.

Root system: The underground parts of a flowering plant

Shoot system: The parts of a flowering plant that are above the soil

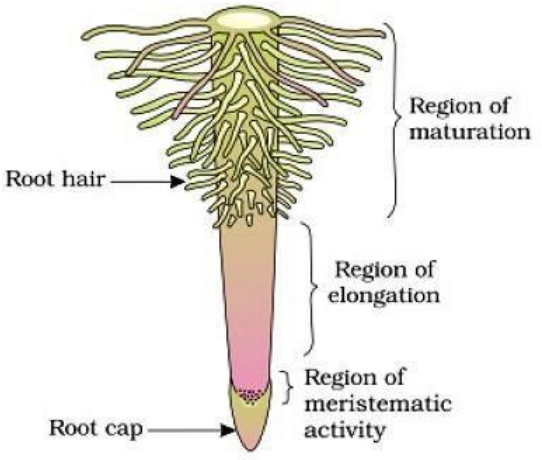


Roots

Radicle comes out from the seed coat in the form of soft structure and it moves towards the soil. It develops and shapes primary root.

Primary root: It is formed as a direct elongation of the radicle in most dicotyledonous plants. It grows inside the soil. It bears lateral roots of several orders like secondary, tertiary, etc. roots.

Lateral roots: They extend horizontally from the primary root (radicle) and serve to anchor the plant securely into the soil. The lateral roots help in uptake of water and nutrients required for the growth and development of the plant.



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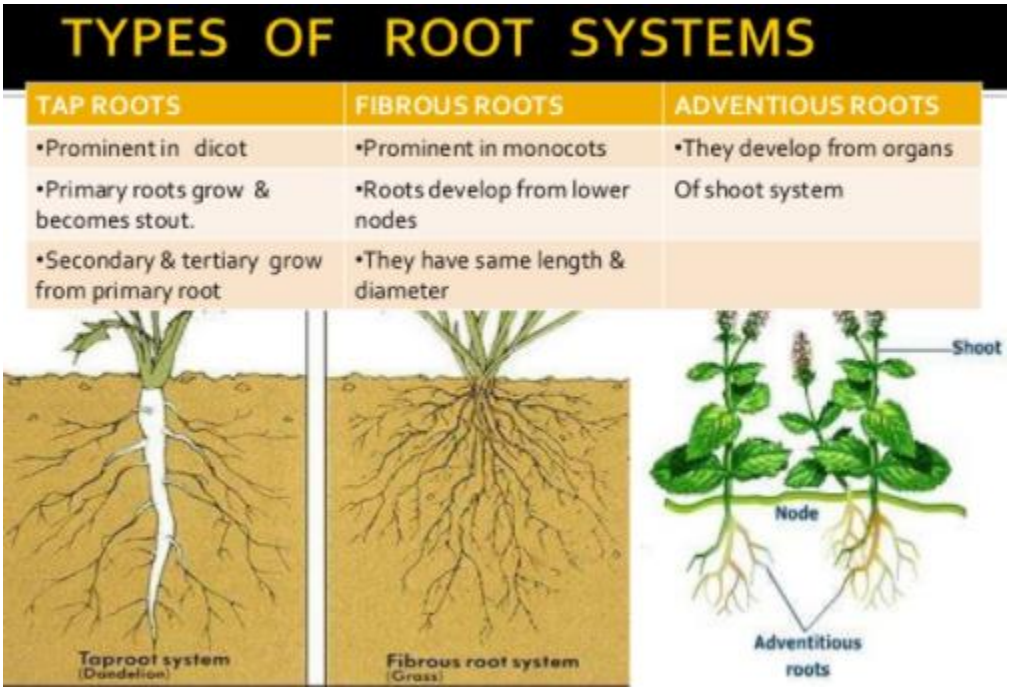
Types of Root:--

Roots are of three types:

1. Tap root
2. Fibrous root
3. Adventitious root



Tap root system: The primary root is large, central, and dominant *root* in taproot system. From the primary root other *roots* sprout laterally. This root system is generally tapering in shape and grows directly downward. It is common in dicot plants.

Fibrous root: It consists of thin, moderately branching roots growing from the base of the stem. The primary root is not prominent and is replaced by a large number of roots. The fibrous root systems appears as a thick tuft of roots forming a mat-like structure at maturity. It is universal in monocotyledonous plants and ferns.

Adventitious roots: a root that arises from any point on the plant other than the radicle or the *root* axis. For example, prop roots of banyan, corn, aerial roots of *Monstera*, etc. These roots are mainly involved in absorption of water and minerals from the soil, providing additional anchorage to the plant parts, storage of reserve food material and synthesis of plant growth hormones.

5.1.1: Regions of the Root

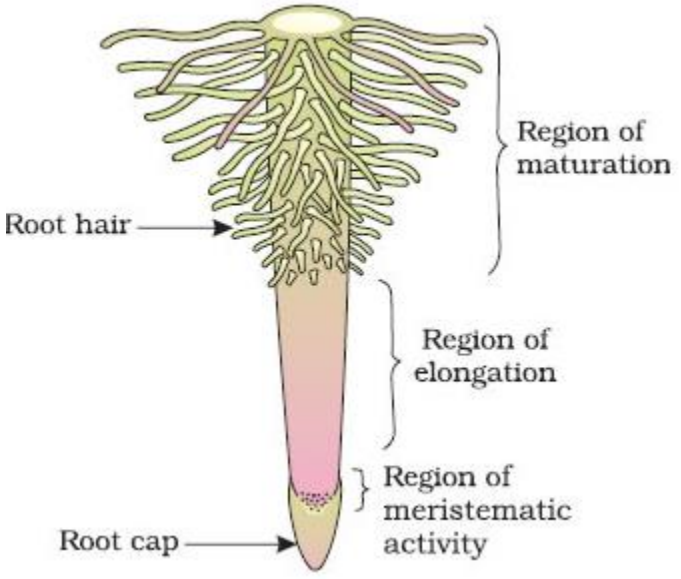
Root cap: Protective covering of the root apex. It protects the tender root tip as it makes its way through the soil.

Region of meristematic activity: Present a few millimetres above the root cap. It consists of small thin-walled cells with dense protoplasm. They divide repeatedly.

Region of elongation: It is proximal to the region of meristematic activity where the cells undergo rapid elongation and enlargement. They are help the root to grow in length.

Region of maturation: It is proximal to the region of elongation. Here the cells gradually differentiate and mature.

Root hairs: Very fine and delicate, thread-like structures formed by some epidermal cells in the region of maturation. These root hairs aid in absorption of water and minerals from the soil

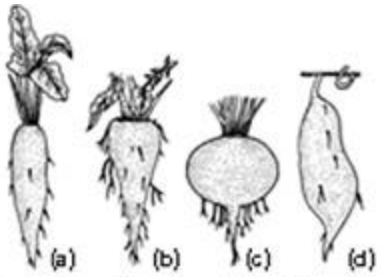


Regions of the root tip

5.1.2: Modification of Roots:-

Roots of some plants modify their shape and structure to adapt for additional functions. Rather than absorption and conduction of water they perform additional functions like support, storage of food and respiration.

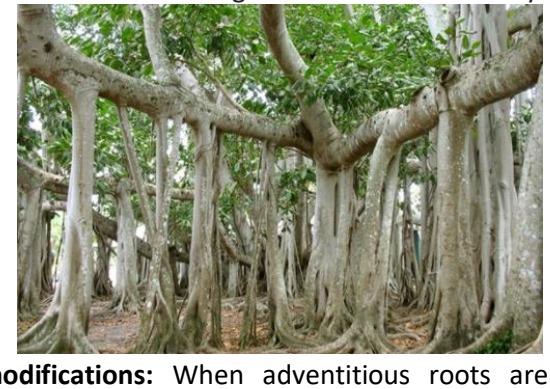
- **Storage roots:** The primary tap roots are modified for storage of reserve food materials. The secondary roots remain thin. They absorb water and minerals. The storage roots swell up and assume various forms such as conical (*carrot*), fusiform or spindle shape (*raddish*), napiform or spherical (*turnip, beet*), tuberous (4 *o'clock plant*).



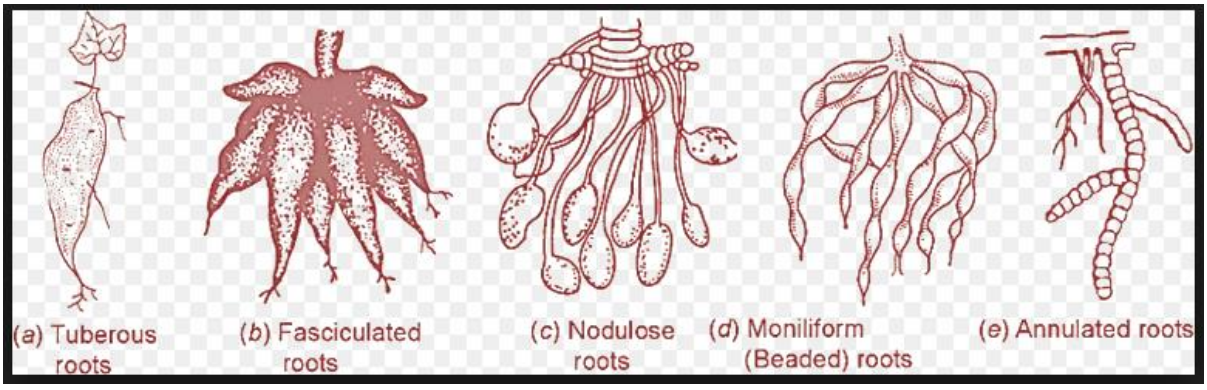
Tap root modifications (a) Fusiform (b) Conical (c) Napiform (d) Tuberous

- **Respiratory roots:** The plants which grow in marshy areas develop branches of root that come out of the ground and grow vertically upward. This occurs as there is scarcity of oxygen in such places. These roots are called **pneumatophores**. Through these roots air moves inside the plant and cells get oxygen for cellular respiration. Eg. *Rhizopora*

- **Prop roots:** Roots that arise from the higher nodes or branches of stem of certain plants to provide extra support. Such stems are usually tall and slender and the prop roots develop at successively higher levels as the stem elongates. This is seen in banyan.



- **Adventitious Root modifications:** When adventitious roots are modified for various functions.
- **Adventitious root modified for storage:** They are swollen and take up various shapes to accommodate the stored and reserve food like tuberous, fibrous, nodulose, beaded, etc.



- **Stilt roots:** Supporting roots that arise from lower nodes of the stem that are used to provide additional support as in the case of maize.

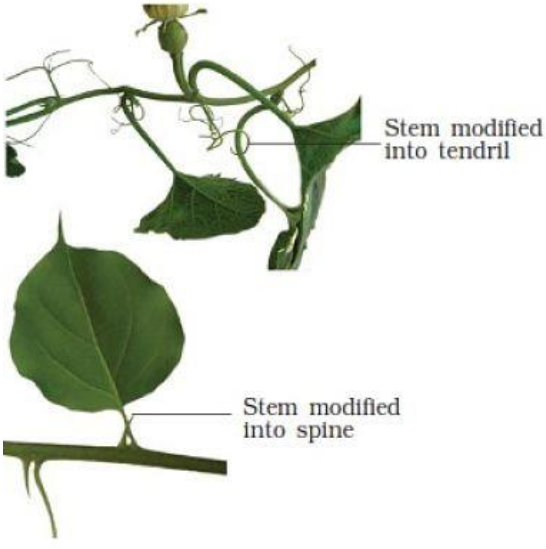
- **Climbing roots:** Roots arise from nodes that help weak stemmed plants in climbing up with help of support as in the case of money plant.

- **Foliar roots:** Roots arising from leaves as in case of *Bryophyllum*.

- **Haustorial roots:** Seen in parasitic plants. These roots pierce through the host tissue an suck out the nutrients as in *Cuscuta*.

STEM

The part of the plant that shows negative geotropic growth and lies above the soil is the stem.
It bears nodes and internodes. **Nodes** are portions that bear leaves, branches, buds, etc.
Internodes are portions that occur between two nodes.
Buds and branches may be **terminal or axillary**.
Main function is to spread out branches bearing leaves, flowers and fruits. Additionally it transports food, water and minerals.
Some stems are modified for storage, photosynthesis, support, protection and vegetative propagation.



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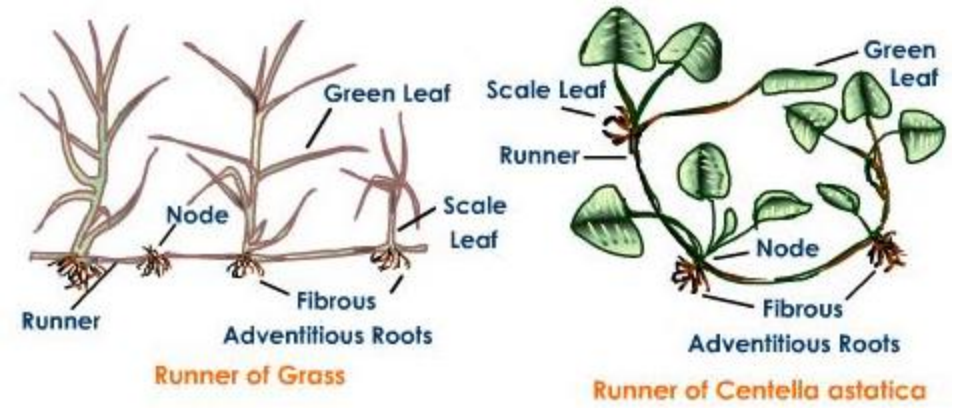
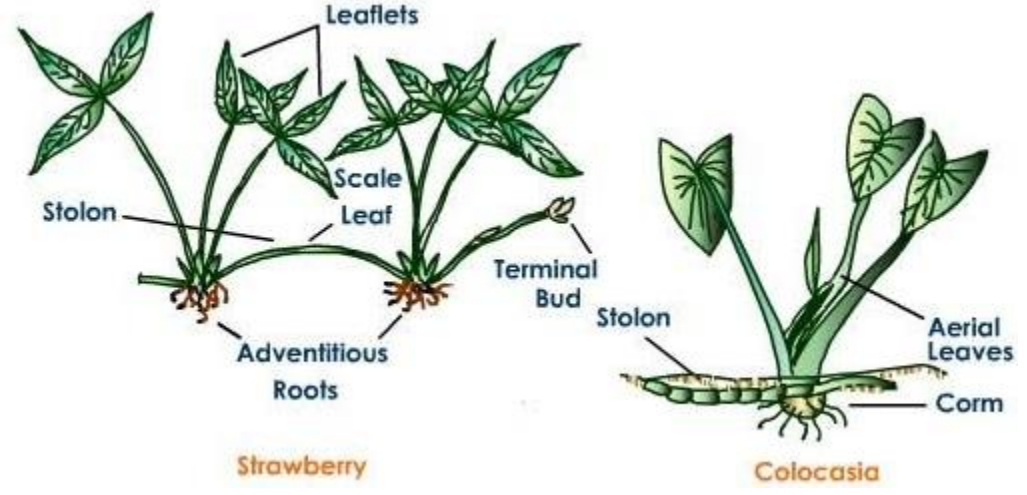
Modification of stem:

A - Sub - Aerial Modification

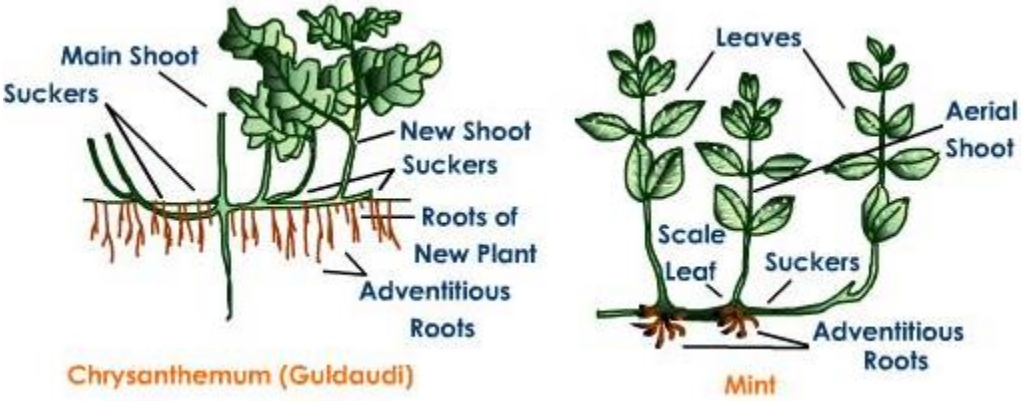
(1) **Runner** -
Stem that grows and spreads on the surface of the soil. Roots form at the lower side whereas leaves arise from the upper side of the node. E.g *Cynodon dactylon*



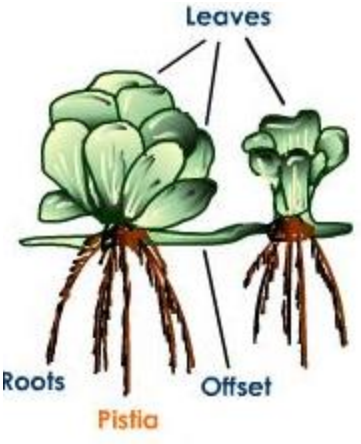
(2) **Stolon** -
They are similar to runners. In this branches are small and grow in all directions. After growing for some time their apical regions come out from the soil. E.g *Fragaria* (strawberry)

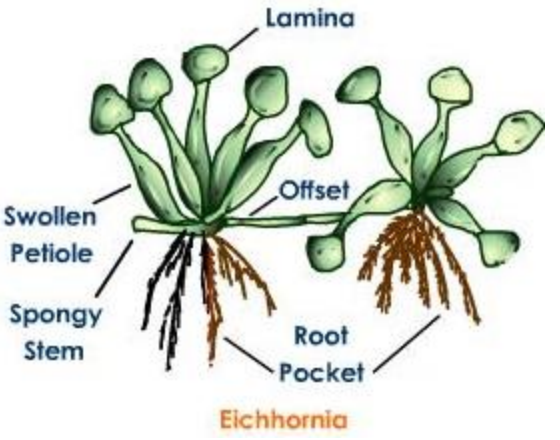


(3) **Sucker** -
In it the main stem grows in the soil but branches germinate from nodes above the soil. Eg.,**Mint**



(4) **Offset** - Generally these are aquatic plants which have and fragile stem. Eg., ***Pistia***



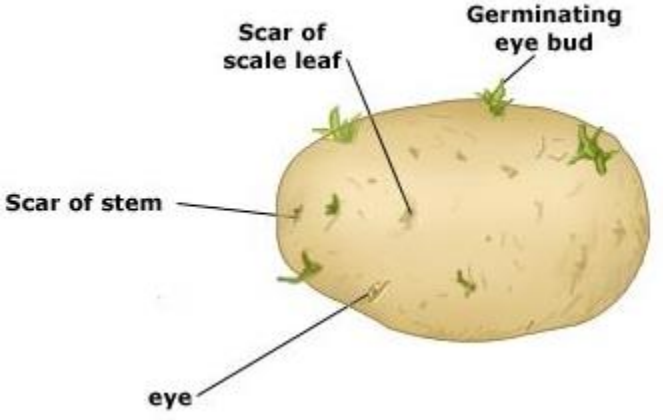


B - Underground modification

This type of modification occurs generally for food storage and vegetative propogation.

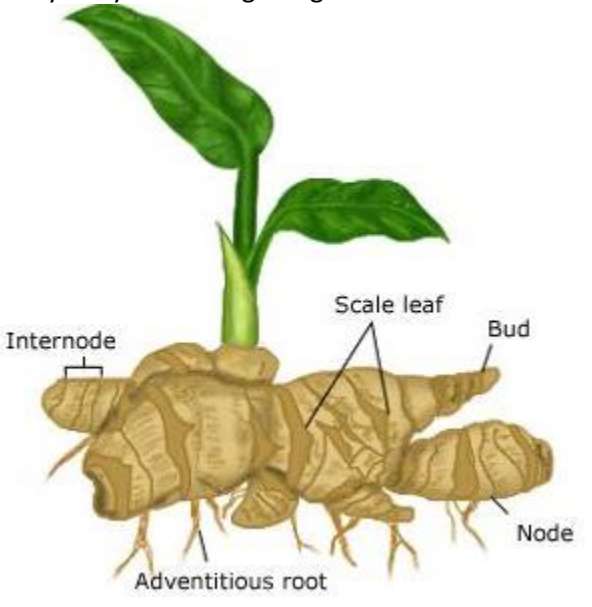
(1) **Tuber** -

Branch tips in the soil are swollen and eyes are found on them which are generally axillary buds blanketed with scaly leaves. E.g., Potato

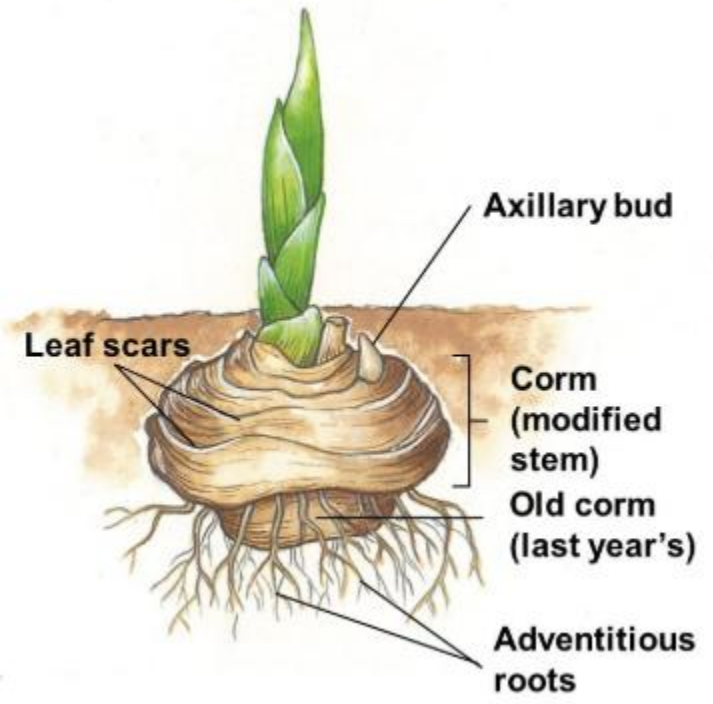


(2) **Rhizome** -

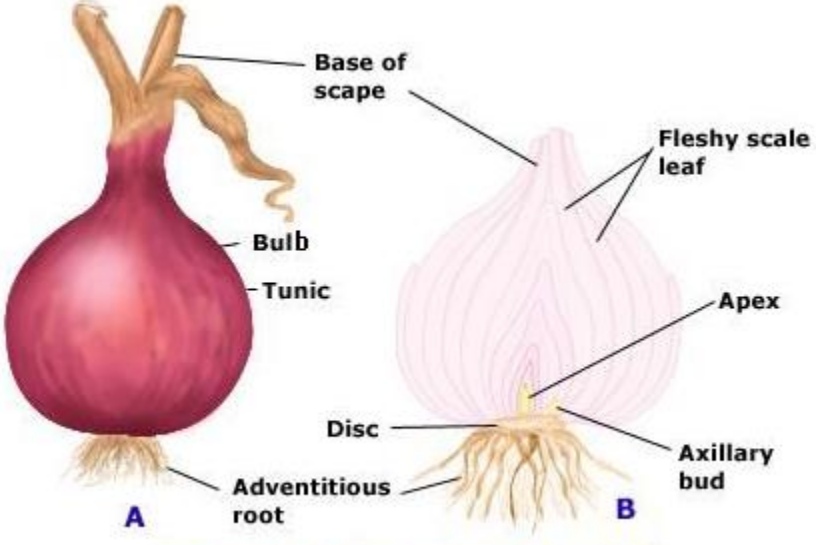
It is a fleshy, underground horizontal stem. Small nodes and internodes are present. Nodes are covered by scaly leaves. E.g. Ginger



(3) **Corm** - It is condensed structure which grow vertically under the soil surface. Eg., ***Colocasia*.**



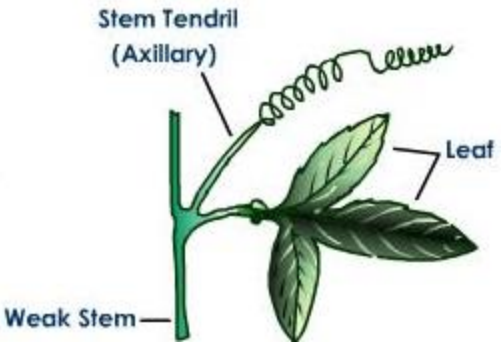
(4) **Bulb** - This stem has disc like structure and surrounded by numerous fleshy scaly leaves. Many roots are arise from its base. Eg., **Onion.**



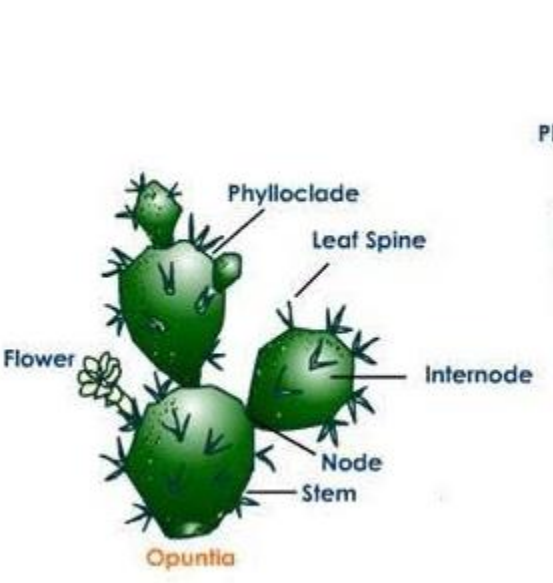
A. Tunicated bulb of onion B. L.S. of bulb

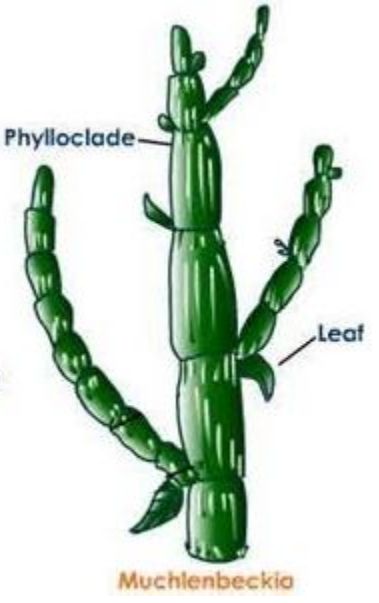
C - Aerial modification

(1) **Stem tendril** -
Axillary bud develops to form tendrils and helps in climbing of weak stemmed plants. E.g- Grapes



(2) **Phylloclade** - The stem is modified into a flat, fleshy and green leaf like structure and carries out photosynthesis like leaf. The leaves are modified into spines Eg. ***Opuntia.***





(3) **Stemthorn** - Axillary bud, modified to branched or unbranched spines Eg., ***Carrisa*****.**

Thorns are of 3 types -

(i) **Prickle** - These develop only from cortex and epidermis and found at nodes or internodes Eg. **Rose.**

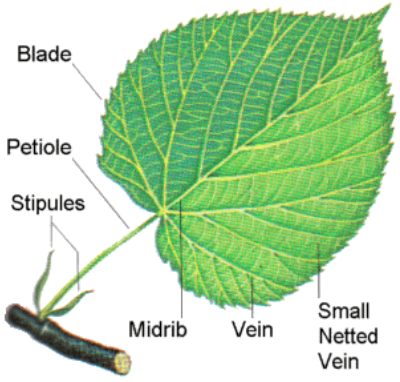
(ii) **Spine** - It is modification of stipule and found on node.

(iii) **Thorn** - It is modification of branch and are found in axil of leaf Eg. *Carrisa, Acacia*

LEAF

The leaves develop from the nodes. Their main function is Photosynthesis.

They develop from nodes and bear an axillary bud which later develops into a branch.



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Leaf is divided into 3 main parts :

(1) **Leaf base** -

The part of leaf attached to stem.

(2) **Petiole**

Stalk like structure connecting the leaf to stem or branch. When petiole is preset leaves are called petiolate. Leaves without a petiole are called sessile.

(3) **Lamina** -

It is a broad and flattened part of leaf. Its main functions are photosynthesis and transpiration.

Stipules :-

Leaves of some plants have lateral appendages on either side of leaf base, known as stipules.

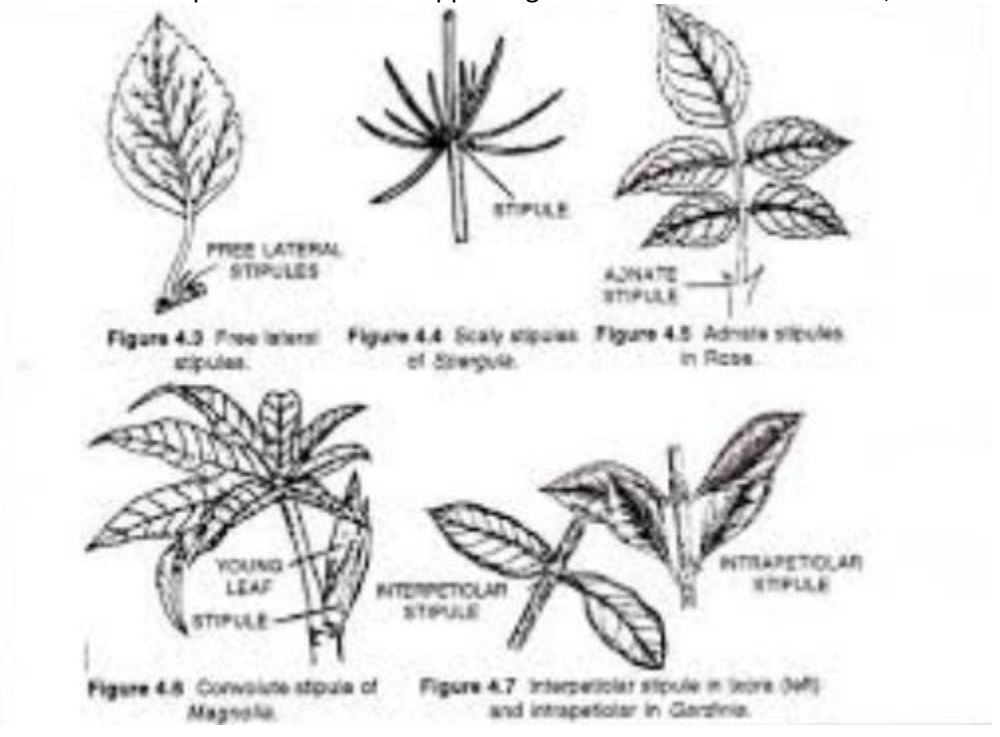


Figure 4.3 Free lateral stipules. Figure 4.4 Scaly stipules of Sterculia. Figure 4.5 Adnate stipules in Rose.

Figure 4.6 Convolute stipule of Magnolia. Figure 4.7 Interpetiolar stipule in Ixora (left) and intrapetiolar in Gardinia.

Stipules are of various types -

1. **Free lateral** - When they are independently present on either side of leaf base. Eg- *Hibiscus rosasinensis*
2. **Interpetiolar** -

When leaves are arranged opposite to each other at a node then the nearest stipules of each leaf fuse together. Thus only two stipules instead of four are present. E.g; *Ixora*

3. **Intrapetioler** - In this both stipules of a single leaf joint with each other to form a single stipule.
4. **Foliaceous** - These type of stipules form a leaf like structure Eg. Pea
5. **Scaly** - Stipules are dry, small and are paper like.
6. **Spiny** – Stipules modified into spines. Eg. *Zizyphus*
7. **Ochreate** - Both stipules combine to form a tube like structure. E.g *Polygonum*
8. **Adnate** - Both stipules are joined with petiole. Eg. rose
9. **Tendrillar** - Stipules are modified into tendrils like structure. Eg. Smilax

Types of Leaves -

1. **Foliage-leaf** - They are usually green coloured and their main function is photosynthesis.
2. **Cotyledonary leaf** Leaf that comes out during germination and nourishes the growing embryo until the first leaf is formed.
3. **Scale leaf** - Such leaves are usually dry and membrane-like and they can not do photosynthesis.
4. **Bract** - Bract are the leaves which contain flower in their axil.
5. **Bracteole** - These are leaf like structure found on pedicel.
6. **Floral leaf** - Sepals, petals and stamen, carpel are found in flower which are included in this type of leaf.

Duration of leaf :-

1. **Persistent** - Leaves of such plants are found in all season and do not (fall) shed combinedly . Eg. Pine, *Sara indica*, Date palm.
2. **Caducous** - Leaves are shed as the bud formation takes place.

Note :-

1. **Cauline leaves** - Leaves found on stem, branches and nodes.
2. **Ramal leaves** -When leaves are found on branches, then called ramal leaves.
3. **Radical leaves** - Leaves that develop from nodes of underground stem.

Venation of lamina :-

The arrangement of veins in leaves (Lamina) is known as venation. It is of 2 types

1. Reticulate 2. Parallel

1. Reticulate venation - In it many veins divide into various branches and form a net like structure. Reticulate venation is of 2 - types -

(a) **Unicostate or pinnate** - There is only one principal vein called midrib that gives out many lateral veins which proceed towards the margin and apex of the lamina. E.g- Guava, peepal, mango

(b) **Multicostate or palmate** - Many principal veins arise from the tip of the petiole and move towards the margin or apex. This is again two types :-

(i) **Multicostate divergent** -Many principal veins arising from the tip of petiole diverge from each other toward the margin of leaf blade eg. Coton, Arhar

(ii) **Multicostate convergent** - Many principal veins arise from the petiole tip. Closely arranged at the base but diverge in the middle portion before converging towards the apex. E.g: Camphor, Zyziphus, Tejpat, etc.

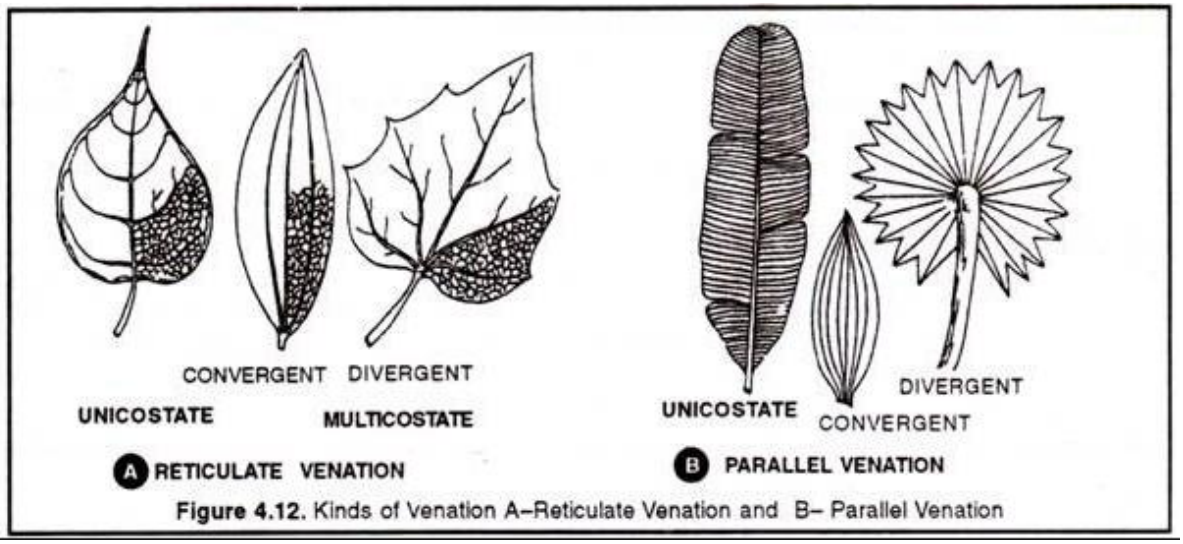


Figure 4.12. Kinds of Venation A–Reticulate Venation and B– Parallel Venation

2. Parallel venation -

In this type of venetion, all veins run parallel to each other and they do not from network.

They are of 2 types -

(i) **Unicostate or pinnate** : It has only one principal vein that gives off many lateral veins which proceed toward margin of leaf blade in a parallel manner. They lack veinlets.

(ii) **Multicostate or palmate** : It has many principal veins that arise from the tip of the petiole and proceeds upwards.

Modification of leaves :

When in place of leaf some other structure develop, then it is called modification of leaves.

(i) **Leaf Tendril** - In it whole leaf is modified into a wire like structure which is called leaf tendril Eg. *Lathyrus aphaca*. (Sweet pea)

(ii) **Leaf spine** - Leaves or any part of leaflet are modified into pointed spine. Eg. *Opuntia, Aloe*.

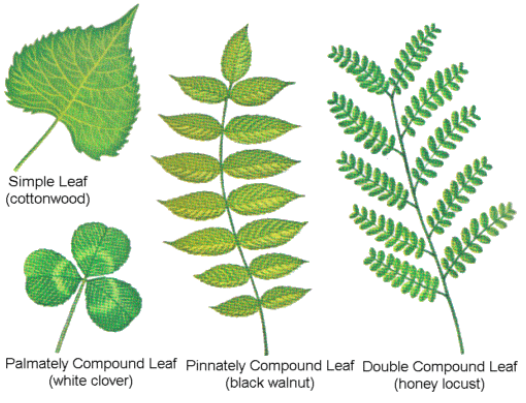
(iii) **Leaf scale** Leaf becomes thin, dry, papery or membranous. E.g- *Ruscus*

(iv) **Leaf Pitcher** - Leaves of some plants are modified to pitcher shape. Eg. *Nepenthes, Dischidia*

(v) **Leaf bladder** - In some plant, leaves are modified into bladder like structure eg., *Utricularia*

(vi) **Phyllode** - In it petiole becomes flat structure and function as normal Eg. *Acacia*

(vii) **Leaflet tendril** -Leaflet is modified into tendril like in *Pisum sativum* (pea)



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Simple and Compound Leaf

(i) **Simple Leaf** : A leaf that may be incised to any depth but not down the midrib or petiole.

(ii) **Compound leaf** Leaf in which the leaf blade is incised up to themidrib or petiole, this dividing it i nto several small parts, known as leaflets.

(A) Pinnately compound leaf: Midrib is called as rachis and leaflets are arranged on both sides of the rachis.

It is of the following types :

(i) Unipinnate : In this type of leaf division occur only once and leaf lets are directly attached on both sides of rachis. If the number of leaflet is even, then leaf is known as peripinnate.
If the number of leaflet is odd, it is known as imperipinnate

(ii) Bipinnate : twice pinate compound leaf

(ii) Tripinnate : A thrice pinnate comound leaf

(iii) Decomound : A compound leaf which is more than thrice pinnate.

(B) **Plamate compound** : In this type incision of leaf is directed from leaf margin to apex and all leaf lets are attached on the upper end of petiole.

It is of following types :

(i) Unifoliate When single leaflet is found. Eg. Lemon

(ii) Bifoliate When two leaflets are present. Eg. *Bauhinia, Regnelidium*

(iii) Trifoliate When three leaf lets are attached Eg. *Oxalis, Aegle*.

(iv) Tetrafoliate When four lets are attached to the peliole. Eg.*Marsilia*.

(v) Multifoliate When more than four leaflet are found, then leaf is called multifoliate palmate compound leaf.

Inflorescence

Arrangement of flower on shoot or peduncle system of a plant is called inflorescence.

Racemose-The main axis continues to grow and does not terminate in a flower. Flowers are arranged acropetally where old flowers are arranged on the lower side and the younger flowers are on the upper side.

This is of following different types :

1. Raceme -When peduncle or (main axis) is elongated and flowers are pedicellate.
Eg. Mustard, Raddish Gulmohar,Amaltas, *Cassia simea.*

2. Spike - In it peduncle is elongated but flowers are sessile. Eg. *Achyranthes*.

3. Catkin - In it peduncle is thin, long and weak, and flowers are sessile and unisexual Eg. Mulberry.

4. Spadix - In it peduncle is thick, long and fleshy that has small sessile and unisexual flowers covered with green or colourful bracts. E.g- *Colocasia, Musa*, Maize

5. Corymb

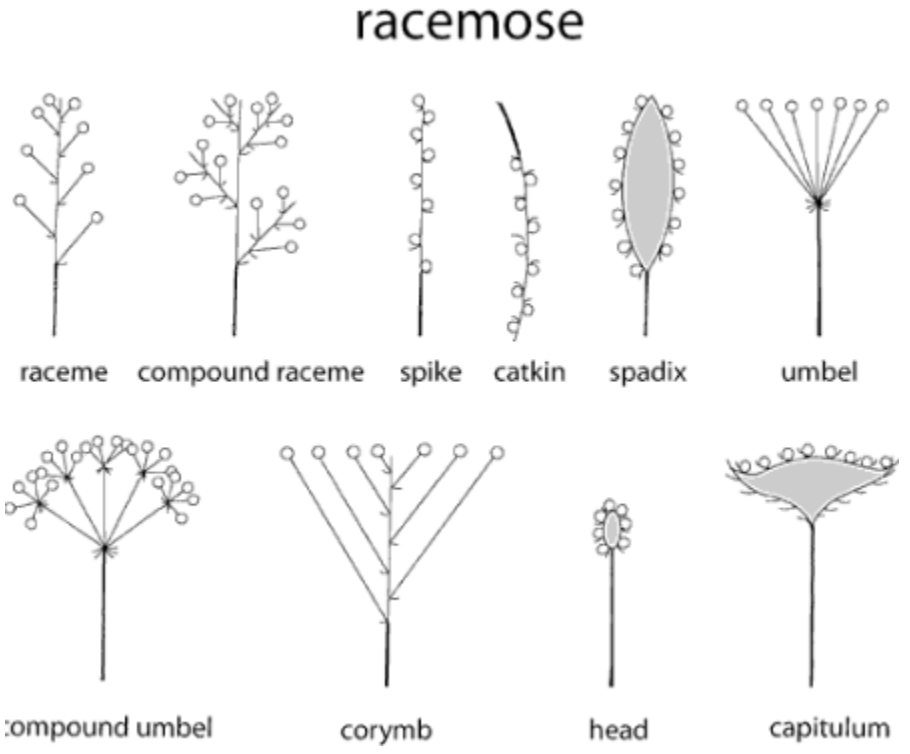
In it the peduncle is short. All flowers are present at the same level because the lower flowers have longer pedicels than the upper flowers. E.g- Candytuft (*Iberis amara*)

6. Umbel -

An inflorescence in which the flower stalks of more or less equal length arise from the same point. At the base of flower stalk, there is whorl of bracts forming the involucure. Eg. *Cantella*.

An umber inflorescence with branched peduncle with each branch forming a flower cluster at the apex is called compound umbel. E.g- Coriander.

7. Capitulum-
The peduncle is short and becomes broad, flattened, concave or convex. It bears numerous small sessile flowers called florets.
If the flowers in the capitulum are all similar then it is called homogamous.
In centripetal arrangement younger flowers are arranged towards the centre and the older obes towards the periphery. The central flowers are called disc florets and the peripheral flowers are called ray florets. This type of arrangement is heterogamous as the flowers are dissimilar.
The florets may be unisexual, bisexual or sterile.
The inflorescence is surrounded by one or more involucre. Eg. *Helianthus, Launaea*.

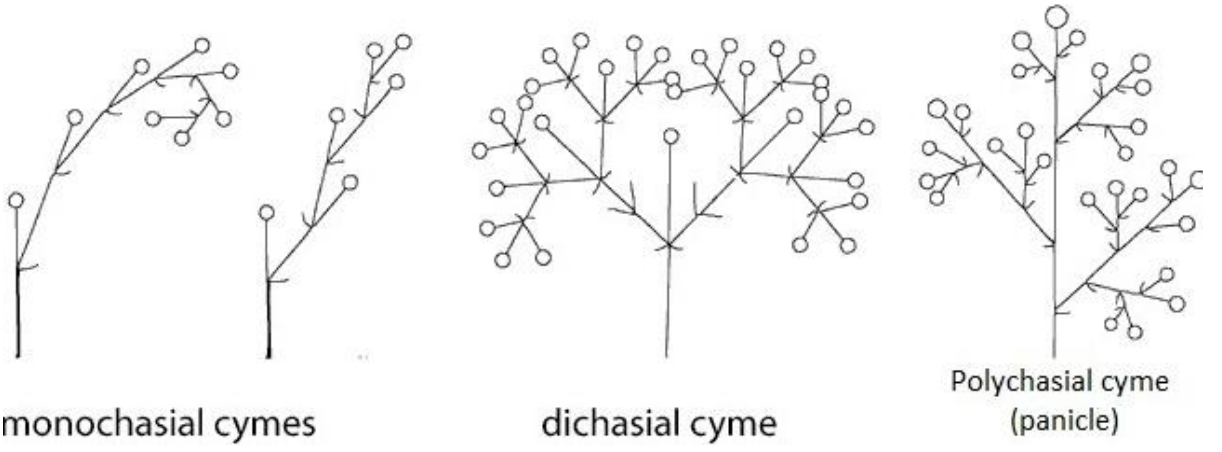


Cymose
The peduncle terminates in a flower. The older flowers are present in the upper regions and the younger flowers are arranged towards the base. Such an arrangement is called basipetal.

It is of following types -

1. Uniparous cyme - The peduncle ending in a flower producing lateral branch. It is two types -
(a) **Helicoid cyme** -When all lateral branches develop on the same side on peduncle
Eg. Heliotropism
(b) **Scorpiod cyme** -The lateral branches lie opposite and alternate to each other. E.g. *Begonia, Hamelia*
2. Dischasial or biparous cyme- Peduncle ends in a flower and from the basal part of the peduncle two lateral branches arise which also end in a flower. E.g. *Gypsophylla, Sponaria, Dianthus*
3. Multiparous cyme - Peduncle ends in a flower. From the base manu lateral branches arise that also terminate in flowers. E.g- *Calotropis*

cymose



Special Type of Inflorescence -

1. Cyathium

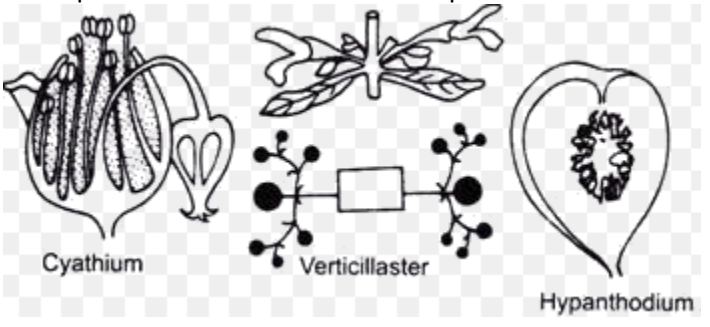
Bracts or involucre fuse to form a cup shaped structure on the margins of which secretory glands are found. The central portion of the cup-shaped structure contain female flowers which mature earlier and emerge out of the cup due to the pedicel growth. They are surrounded by small male pedicellate flowers. Male flowers towards the centre mature earlier than those present on the periphery.
It is seen in Euphorbiaceae famile like *Euphorbia, Poinsettia, Pedilanthus.*

2. Verticillaster -

Leaves are arranged in opposite manner on the stem. From the axils of the leaves branches as well as inflorescence arise. The inflorescence is dichasial cyme that changes into monochasial cyme. It is seen in Labiaceae.

3. Hypanthodium -

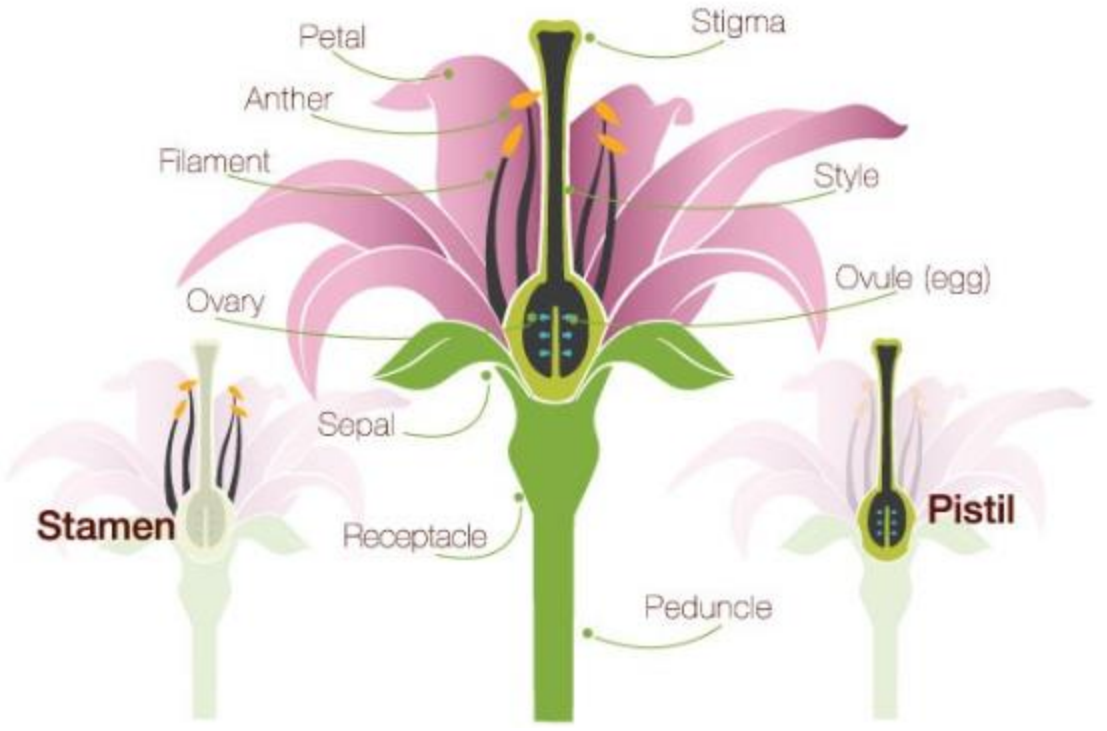
Peduncle is modified into a narrow cup-like structure. Female flower develops towards the base of the cup whereas male flowers develop towards the mouth. E.g- Banyan, Peepal



FLOWER

Flower arises at the axil of the bract. Flower may be borne on a long or short stalk called as the pedicel. The upper part of the pedicel is swollen into spherical or conical shape and is called as the thalamus. The four types of floral leaves are:

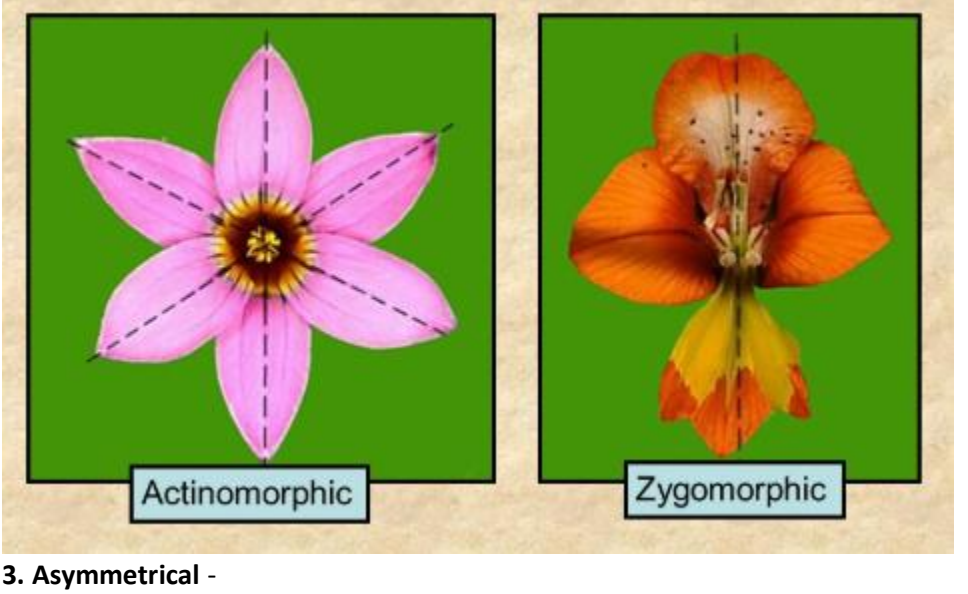
(i) Sepal
(ii) Petal
(iii) Stamen
(iv) Carpel



Symmetry of flower
Cyclic flower: Floral leaves are cyclically arranged in a flower.
Spiral/Acyclic flower: Floral leaves are arranged in a spiral or an acyclic manner.

1. Actinomorphic -
Flower can be divided into two equal halves along any vertical plane. E.g: mustard.

2. Zygomorphic -
Flower can be divided into two equal halves only along one vertical plane. The plane could be median (*Ocimum*) or lateral

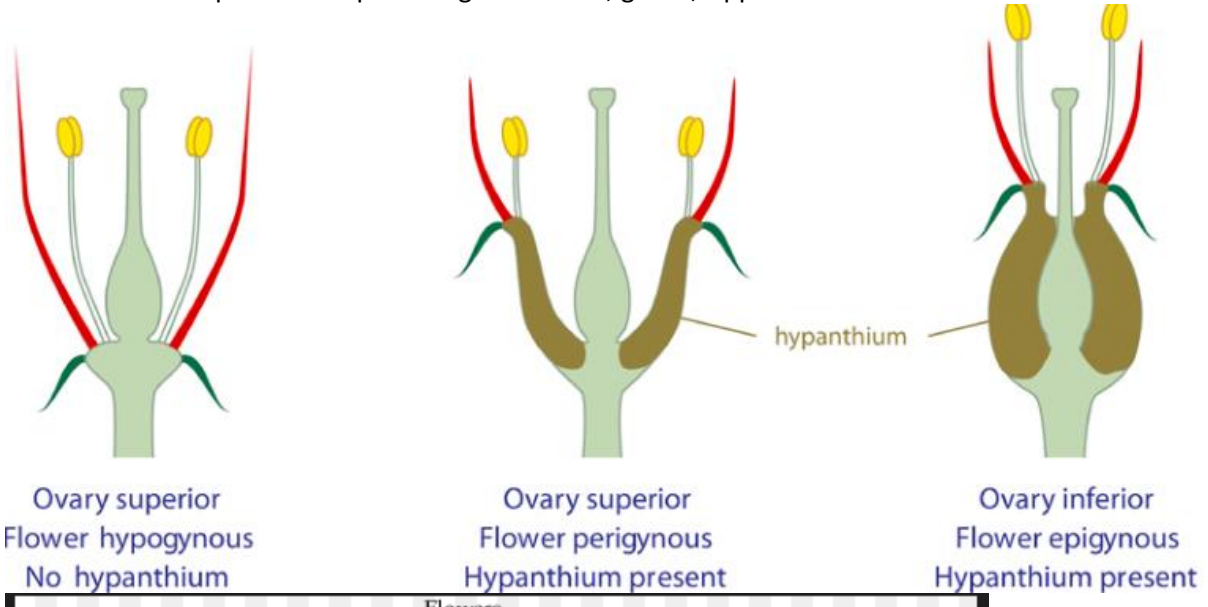


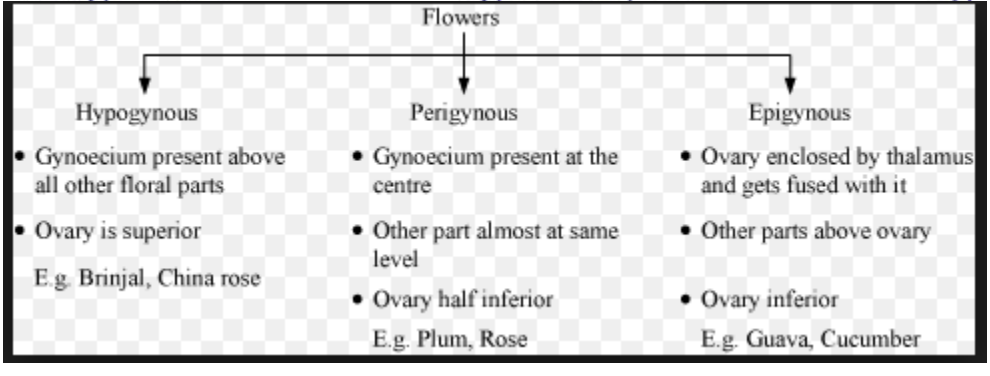
3. Asymmetrical -
Flower cannot be divided into two equal halves along any plane. E.g- *Canna*

Note :-
(i) **Anthophore** - Internode between calyx and corolla is called anthopore Eg. *Silene*
(ii) **Androphore** - Internode between corolla and androceium is called androphore, Eg. *Pasieflora*.
(iii) **Gynophore** - Internode between androcium and gynoecium is called gynophore.
(iv) **Gynandrophore or androgynophore:** Androecium and gynoecium both present on node. E.g- *Cleome gynandra*

Note :-
The part of flower which lies near to mother axis is posterior part while the part which is far from mother axis is anterior part of flower.

Insertion of floral leaves
The relative position of gynoceium changes will respect to floral parts and on this basis it is divided into three parts.
1. Hypogynous condition -
Petals, sepals and stamens are situated below the ovary. Ovary is superior. E.g- Mustard
2. Perigynous condition -
Thalamus forms a cup shaped structure from the margin of which all floral parts except gynoecium are attached. Gynoecium lies basally. Ovary is half-superior. E.g- Rose, primrose
3. Epigynous condition -
When petal, sepals & stamen are situated above the ovary, than the ovary is said to be inferior and rest of the floral parts are superior. Eg. sunflower, guava, Apple





Bract - The part of the leaf of main axis from the axil of which flower arise is called bract.

Bracteole Sometimes on the internodes of pedicel small leaves arises which are called as bracteole.
Bracteate - The flower which arise from the axil of bract is called bracteate flower.
Involucre - The whorl of bract surrounding peduncle is called involucre.
Involucel - The whorl of bract lying below pedicel is called involucel.
Petaloid bract - Bracts are larger than flowers and have various colours.
Glumes - Small, dry, scaly bracts are called Glumes. Eg. Wheat Grass

Calyx -
Outermost whorl of flower. Each member is called sepal.
Polysepalous: When the sepals are free from each other. E.g- mustard, raddish
Gamosepalous: When the sepals are fused with each other. E.g- cotton, Datura, brinjal

1. In calyx of *Mussaenda*, one of the sepals enlarges to form a leaf-like structure which may be white or brightly coloured. It attracts insects and thus acts as advertisement flag.
2. In *Trapa*, calyx is modified into spines and helps in protection of fruit.
3. In *Aceoniteem* spines are present on the surface of sepal which protect the flower bud.
4. In larkspur an balsalm, posterior part of sepal is modified into a narrow tube called as sepal spur which stores nectar.
5. In sunflower family, sepals are modified into a hairy structure called pappus which helps in fruit dispersal.

Duration of Sepals
1. Sepals that fall at the opening of the flower are called cauduceus sepals. E.g- poppy
2. In some plants, sepals fall after pollination than these are called deciduous.
3. When sepals do not fall and remain attached to the fruits then they are persistent. E.g- tomato, capsicum, brinjal, cotton, datura
Epicalyx: Whorl beneath the calyx that is similar to sepals present in some plants. E.g- Malvaceae

Corolla
The second whorl of the flower lying above the calyx. Each member is called a petal. Petals with similar shape and size are symmetrical. Petals which differ is size and shape are asymmetrical. When petals are free they are called polypetalous whereas when the petals are fused they are called gamosepalous.

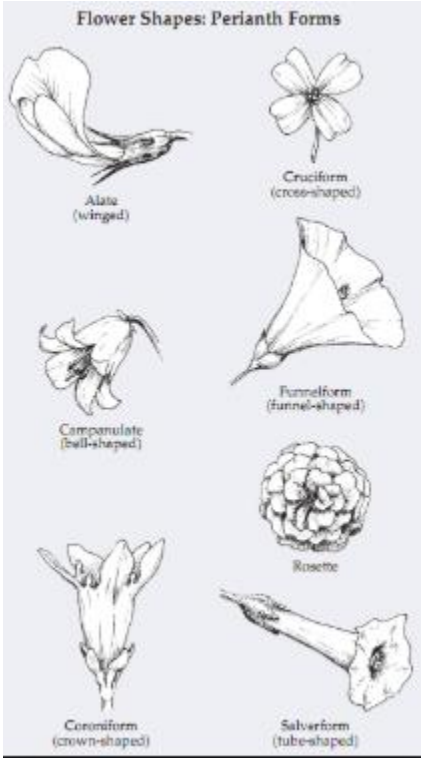
Forms of corolla -

A. Polypetalous
i. **Cruciform-** 4 petals are present and arranged crosswise. Lower part of the petal is narrow and is called as the claw whereas the upper part is called as the limb. E.g- raddish, mustard.
ii. **Caryophyllaceous** -
It consists of 5 petals. The claw of petals are short and the limb of petals from
right angle to the claw eg. Dianthus, Gypsophylla.
5 petals are present. Claw is short and the limb is present at right angle to the claw. E.g- *Dianthus, Gypsophylla*

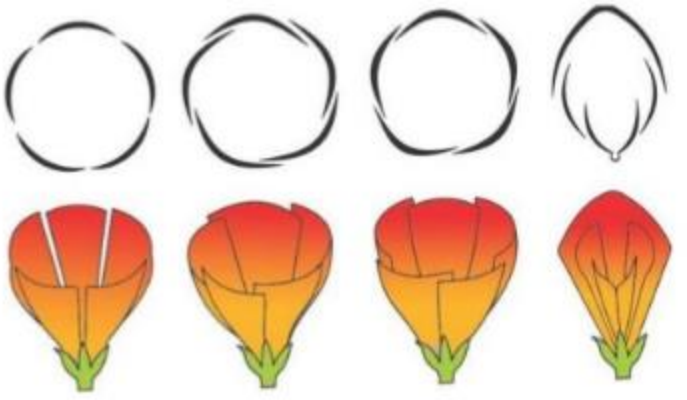
B. Gamopetalous
i. **Campanulate** In this type of corolla 5 gamopetalous petals are present. Its shape is similar to bell. Eg. Tobacco, flowers of Campanula.
ii. **Funnel shaped or infundibuliform-** 5 gamopetalous petals are present and they are shaped like a funnel or and infundible. E.g- Datura, Railway creeper

iii. **Tubular** - 5 gamopetalous petals form tubular or cylindrical structure. E.g- disc florets of sunflower
iv. **Rotate** 5 gamopetalous petals fuse to form a small tube and the petals are arranged in a whorl above the tube. E.g- brinjal

Zygomorphic polypetallous corolla -
Papilionaceous- There are 5 free petals. Posterior petal is the largest and called as standard or vexillum. Vexillum is covered by two lateral petals called as wings. The innermost basal petals unite to form a keel or carina that covers the lateral petals. E.g- members of papillionaceae like grams
Bilabiate - Gamopetalous corolla is divided into two lips and the place between the lips is called as corolla mouth. E.g- *Ocimum*
Personate - Bilabiate corolla but the two lips are close to each other. E.g- Antirrhinum
iii. **Ligulate** - Upper part of corolla os long and flattened and attached to a short narrow tube. E.g- ray florets of sunflower.



Aestivation -
Arrangement of sepals and petals in calyx and corolla is called as aestivation.
It is of following types :
1. **Valvate** -
Petals lie adjacent to each other barely touching. E.g- oak, mustard
2. **Twisted** - One part of the petal covers the adjacent petal and the other part is automatically covered by the posterior petal. E.g- cotton, ladyfinger
3. **Imbricate** -Both margins of one petal are covered by two other petals the remaining petals arrange in twisted aestivation. E.g- *Cassia, Caesalpina*
4. **Vexillary** - Vexillum covers two lateral petals and the lateral petals cover the anterior petals. It is seen in the pea family

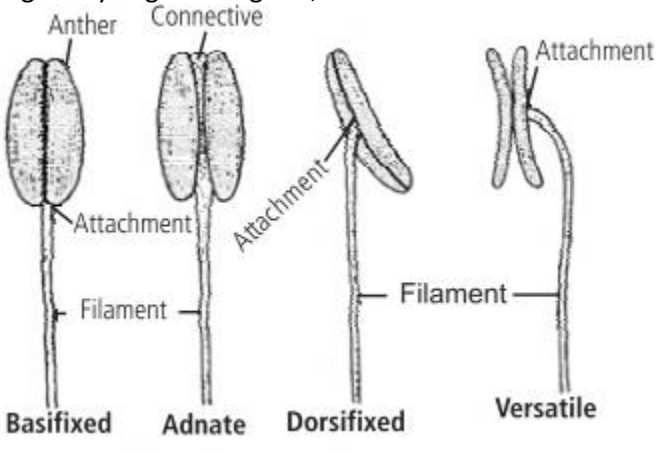


Types of aestivation in corolla : (a) Valvate (b) Twisted (c) Imbricate (d) Vexillary

Attachement of filament to anther lobe

This attachement of filament to another lobe is of 4 type :

1. **Adnate** Filament runs the entire length of the anther from the base to the apex. E.g- *Michelia* (Champa), tobacco.
2. **Basifixed** - Filament is attached to anther at its base. Eg. Datura, Raddish, Mustard flower.
3. **Dorsifired** - The filament is attached at the centre to the back of the anther. Eg. Passion flower.
4. **Versatile** Filament is attached to the back of the anther at a single point so that the anther can swing freely. E.g- wheatgrass, maize.



Cohesion of stamens :

Fusion of floral parts of similar species is called cohesion. When stamens are free then it is polyandrous.

1. **Monoadelphous** -

Anthers are free but filaments are united into a single bundle forming a tube around the gynoecium called as the staminal tube. E.g- cotton, hollyhock, ladyfinger.

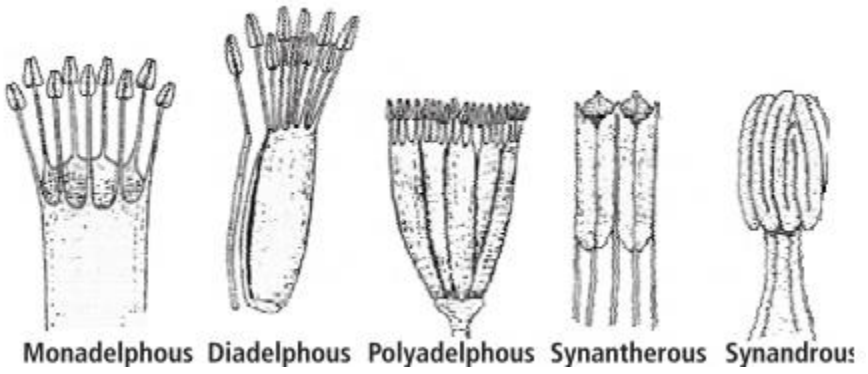
2. **Diadelphous**

Anthers remain free but the filaments unite in two bundles. Like in pea, gram, etc. of the 10 stamens 9 filaments are fused together and 1 remains free.

3. **Polyadelphous** -When filaments are united in more than two bundles. Eg. Castor, Lemon.

Synandrous - When anther as well as filaments of stamens are united through their whole length. Eg.colocasia, Alocasia,Momordica.

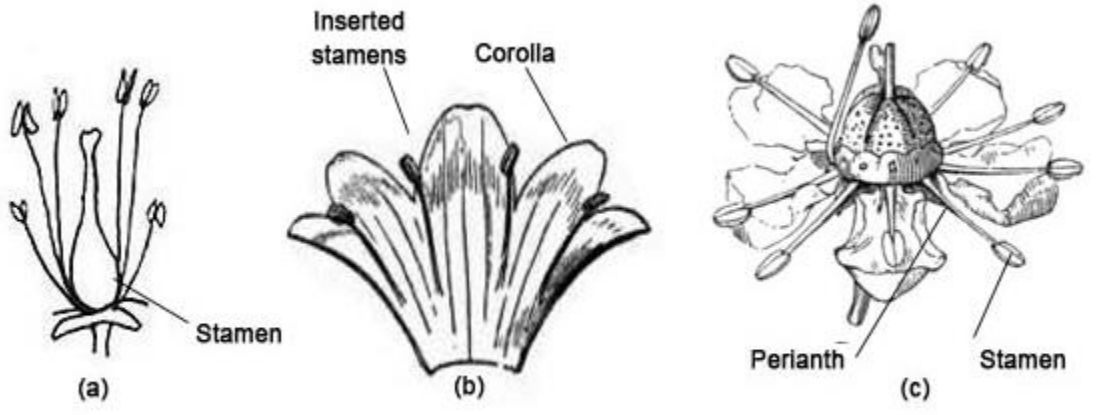
5. **Syngenesious** - In it only anthers are united in bundle but filament remain free.



Adhesion of stamens

When the stamens are attached to other parts of flower, then it is called adhesion of stamens.

1. Epipetalous -When stamens are attached to petals. Eg. Datura, Tobacco, Sunflower, Potato.
2. Epiphyllous -When stamens are attached to tepals. Eg. Onion.
3. Gynandrous - When stamens are attached to the gynoecium by anthers only. E.g- *Calotropis, Aristolochia*



Adhesion of stamens (a) Polyandrous (b) Epipetalous (c) Epiphyllous

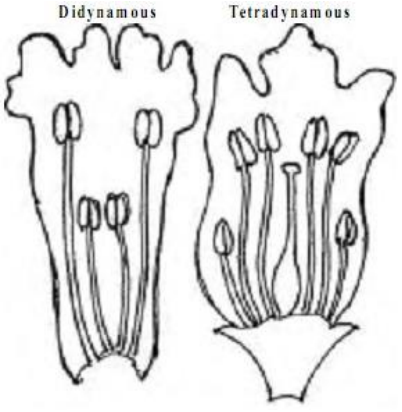
Length of Stamens -

1. **Didynamous** - Among 4 stamens two are long and two are short. E.g- *Ocimum*
2. **Tetradynamous** 6 stamens arranged in two whorls such that the outer whorl contains 2 stamens and the inner whorl contains 4 stamens.

It is of 2 types -

i. **Inserted** -When the stamens are similar to corolla in length. Eg. Datura.

ii. **Exerted** - Stamens are longer than corolla and are radially outward. Eg. Gulmohar



COHESION OF OVULE (CARPEL):

Flower may be monocarpous (1 carpel) or polycarpous (more than 1 carpel). Polycarpous flowers may be apocarpous (separate carpels) or syncarpous (fused carpels). The degree of cohesion varies.

1. Many carpels are present and fused but the stigma and style are separated from each other. E.g- *Dianthus, Plumbago*
2. Ovary may be fused with style but the stigma is free. E.g- *Hibiscus rosasinensis*
3. When stigma are fused but the carpel and style are free. eg. *Calotropis, Casis, Fistula, Nerium.*
4. Carpels are completely fused. This is seen in most flowers. E.g- mustard. *Raphanus sativus, Lycopersicon*

In syncarpous gynoceium number of carpels fused can be detected through-

(i). No of stigma (ii) No. of style (iii) No. of lobes of ovary (iv) No. of placenta

Placentation :-

Ovules attach to the ovary walls through one or more cushioned structures called placenta. The arrangement of placenta on the ovary wall is called placentation. It is of following types:

1. Axile- Seen in multicarpellary syncarpous gynoecium. The margins of the carpels fuse to form central axis forming multichambered ovary. Number of chambers is equal to number of ovules. E.g- Potato, china rose, onion.

2. Free central - Seen in syncarpous gynoecium ovary is unilocular and ovules are borne from the central septa.

This placenation is of 2 types :

i. Axile in the beginning but the walls of the chamber are destroyed after some time.

ii. Superficial - This type of placentation is found in multicarpellary syncarpous gynoceium.

The ovules are attached on the walls of locules. Eg. *Nymphae* (Water lilly).

iii. Basal - The ovary is unilocular and a single ovule is borne at the base of ovary Eg. Sunflower.

Fruit

Fleshy structure protecting the ovules. However some fruits like grapes and banana may lack seeds as they are parthenocarpic or seedless fruits.

Pericarp : After ripening the ovarian wall changes into pericarp which may be thick and fleshy or thick and hard or thin and soft.

Pericarp is made up of 3 layers :

a. Outermost layer = Epicarp

b. Middle layer = Mesocarp

c. Innermost layer = Endocarp

a. **Epicarp-** Outermost thin layer which forms the outermost layer of the fruit called rind.

b. **Mesocarp** It is the middle layer which is thick and fleshy in mango, peach, date palm. In coconut, this layer is made up of fibers which is also called coir.

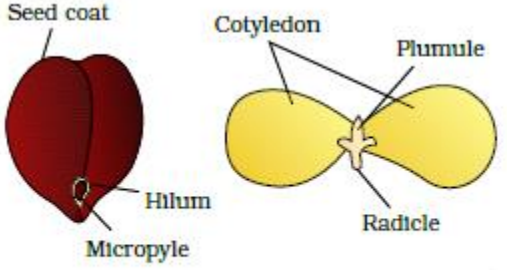
c. **Endocarp** The innermost layer which may be thin and membranous (e.g- Orange, date) or thick and hard.(e.g-mango, coconut)

True fruit : Fruit developed only from ovary. E.g- mango, coconut, etc.

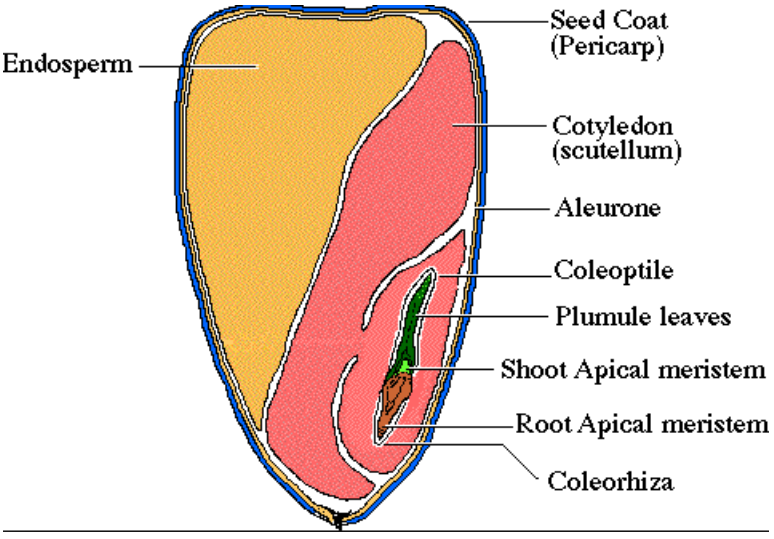
False fruit : In some fruits, in place of ovary, some other parts of flower like thalamus, Inflorescenc e, Calyx are modified to form a part of fruit.
When parts of flower other than ovary like thalamus, inflorescence, calyx, etc., develop into fruit.

Classification of fruits :Whether fruit is true or false can be broadly divided on the basis of :
1. Whether carpels present in gynoceium are free or fused.
2. One or more flowers take part in formation of fruit.
On the above two basis, fruits are divided into :
1. Simple 2. Aggregate 3. Composite

Seed:
The ovule forms the seed after fertilization. It consists of an embryo enclosed within a seed coat. The embryo consists of the plumule (shoot initial), the radicle (root initial) and cotyledons. If there are 2 cotyledons then the seed is dicotyledonous or dicot and if there is only 1 cotyledon then the seed is monocotyledonous or monocot.
Structure of a dicot seed:
Seed Coat: It consists of the outer layer testa and the inner layer tegmen.
Hilum: It represents the point of attachment of the seed to the fruit
Micropyle: A small opening above the hilum
Cotyledons: Two in number they are bean shaped, fleshy and filled with reserve food.
Embryonal axis: It bears the plumule and radicle on either end and it gives rise to the sapling.



Structure of a Monocot Seed:
Seed coat is membranous and fused with the fruit wall.
They are usually endospermic. Endosperm is fleshy and stores food. It is separated from the embryo by a proteinaceous aleurone layer.
Embryo is small and consists of a single reduced cotyledon called as scutellum and the embryonal axis. Embryonal axis is short and bears the plumule and radicle on either end. Plumule and radicle are covered by protective sheaths coleoptile and coleorhiza respectively.



Semi-Technical Description of a Typical Flowering Plant

The description of a flowering plant should be brief, sequential and in scientific language. This is required to designate a plant in its appropriate taxonomic position.

The plant can be described briefly in the following way

Habit: Herb, shrub, trees, climber, creeper, etc.

Habitat: Mesophyte, xerophyte or hydrophyte, etc.

Vegetative Character

Roots - Tap or adventitious root system.

Stem - Herbaceous or woody, smooth, hairy, prickly, cylindrical, angular or flattened, etc.

Leaves - Deciduous or persistent, phyllotaxy, petiolate or sessile, reticulate or parallel venation, simple or compound.

Floral Characters

Inflorescence: Cymose or racemose

Flower Parts Sessile or pedicellate, bracteate or ebracteate, unisexual or bisexual, zygomorphic or actinomorphic, hypogynous, perigynous or epigynous, complete or incomplete,etc.

Calyx - Polysepalous or gamosepalous, deciduous or persistent.

Corolla - Polypetalous (free) or gamopetalous (united), aestivation and special appendages.

Androecium - Polyandrous or united. If united, adelphous, syngenesious or synandrous.

Gynoecium - Free or united carpels, ovary superior or inferior, etc.

Fruits - Simple, aggregate or multiple, true or false fruits.

Seeds - Monocot or dicot, endospermic or non-endospermic, etc.

Floral formula: calyx represented as K, corolla as C, Androecium as A and gynoecium as G. The number of each part is written as a subscript. If they are fused then they are bracketed.

Some examples are given below

Sepals 6 free K_6

Sepals 6 fused $K_{(6)}$

Petals 5 free C_5

Petal 5 fused $C_{(5)}$

Stamens 10 free A_{10}

Stamens 10 in two whorls of 5 each A_{5+5}

Stamens 10, diadelphous (9 fused and 1 free) $A_{(9)+1}$
Carpels two free G_2
Bicarpellary syncarpous $G_{(2)}$

Floral Diagram

Floral diagram provides information regarding the number and arrangement of the various parts of the flower.

The floral diagram of flower tell us about the following characters of the flower.

i. Presence or absence of bract and bracteoles.
ii. The position of odd sepal.
iii. The number and arrangement of floral leaves in relation to one another.
iv. The cohesion and adhesion of floral leaves.
v. Aestivation of sepals and petals.
vi. Symmetry of the flower.
vii. Monothecous and bithecous nature of anther.
viii. Number of locules in the ovary.
ix. Types of placentation.

The position of the mother axis with respect to the flower is represented by a dot on top of the floral diagram. Calyx, corolla, androecium and gynoecium are drawn in successive whorls starting from outside.

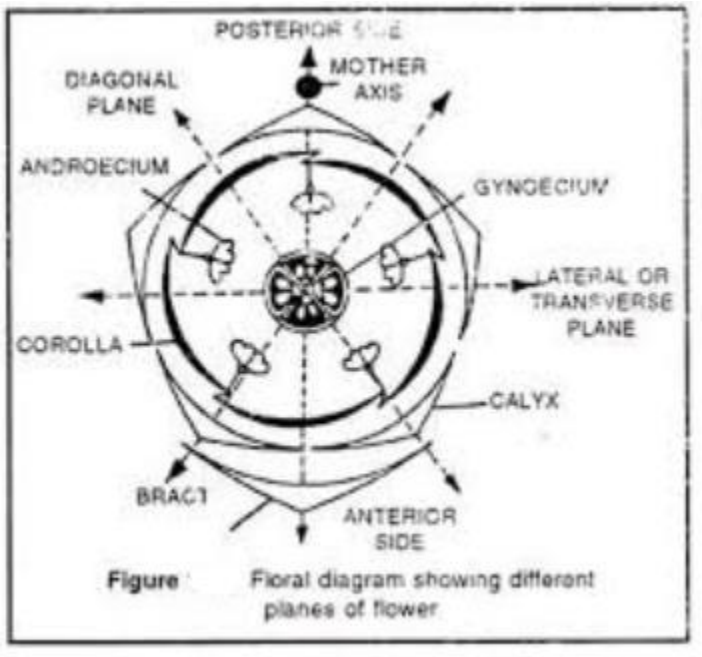


Figure Floral diagram showing different planes of flower

Description of Some Important Families

I. Family-Fabaceae

This family was earlier called Papilionoideae, a sub-family of family-Leguminosae. It is distributed all over the world.

1. Systematic Position

Division - Embryophyta
Sub-division - Angiospermae
Class - Dicotyledonae
Sub-class - Polypetalae
Series - Calyciflorae
Order - Rosales
Family - Fabaceae

2. Distribution- It includes 600 genera and 13000 species distributed globally except in the Arctic regions.

3. Habit- The plants are mostly herbs, however shrubs, trees and climbers are also common.

4. Vegetative Characters

i. **Root-** Tap root with lateral branches. The lateral branches mostly contain bacterial nodules (with *Rhizobium* bacteria which fix atmospheric nitrogen).

ii. **Stem-** Herbaceous or woody, erect or climbing.

iii. **Leaf-** Alternate, simple or pinnately compound, leaf base pulvinate, stipulate, reticulate venation

5. Floral Characters

i. **Inflorescence-** Simple raceme, axillary cyme or solitary.

ii. **Flower-** Bracteate, pedicellate, subsessile, bisexual, mostly zygomorphic, sometimes regular, pentamerous, hypogynous or slightly perigynous.

a. **Calyx-** Sepals 5, gamosepalous, imbricate aestivation.

b. **Androecium** Stamens 10, usually diadelphous (9) + 1 or monoadelphous, sometimes free, polyandrous, dithecous anther, basifixed

c. **Gynoecium**

Monocarpallary, ovary superior, unilocular withmarginal placentation, style bent, stigma simple and hairy.

d. **Fruit** Leguma (pod).

e. **Seed** One to many non-endospermic.

Economic Importance with Examples

Plants belonging to this family has their importance in the following fields

i. **Pulses and Vegetables** The family is an important source of pulses and vegetables. The pulses are rich in proteins like gram (chana), pea (matar), field bean (bankla), cluster bean (gwar), lima bean (lobia), lentil (masoor), bean (sem), soy (soyabean), etc.

ii. **Oil** - Edible oils are obtained from the seeds of *Arachis hypogea* (groundnut) and *Glycine max* (soybean). Vegetable ghee is prepared from these oils after hydrogenation.

iii. **Timber** *Dalbergia sisso* (Indian redwood) and *Dalbergia latifolia* (Indian rosewood) are important timber yielding trees.

iv. **Dye** *Indigofera tinctoria* (indigo), *Butea monosperma* (flame of the forest) is used to produced dyes.

v. **Fodder** Plants like *Trifolium alexandrium, Medicago sativa, Cyamopsis tetragonoloba* rare used for fodder for cattle.

vi. **Fibres** *Crotalaria juncea* (sunhemp) is used to produce fibres.

vii. **Ornamentals** *Lathyrus odoratus* (sweet pea), *Clitoria* (butterfly pea), *Lupinus*, etc. are common ornamental plants.

viii. **Jeweller's Weight** The seeds of *Abrus precatorius* (ratti) are used weight by jewellers.

ix. **Medicinal Plants** The flowers of *Trifolium pratense* are used in whooping cough. The gum of *Butea monosperma* (dhak) are used for treating dysentery and diarrhea.

II. Family - Solanaceae

It is a large family, commonly called as the 'potato family' it is widely distributed in tropics, sub-tropics and even temperature zones.

1. Systematic Position

Division - Spermatophyta
Sub-division - Angiospermae
Class - Dicotyledonae
Sub-class - Gamopetalae
Series - Bicarpellatae
Order - Polymoniales

Family - Solanaceae

2. Distribution

The family has 90 genera and 2800 species distributed in both tropical and temperate regions.

3. Habit

Annual or perennial herbs, shrubs or rarely soft wooded trees.

4. Vegetative Characters

i. **Root** Usually tap roots.

ii. **Stem** Herbaceous or woody, hair or prickles usually present, sometimes underground tubers also present (*Solanum tuberosum*)

iii. **Leaf** Alternate in vegetative parts and opposite in floral parts, exstipulate, simple and rarely pinnate as in potato and tomato.

Floral Characters

i. **Inflorescence** Solitary, axillary or cymose as in *Solanum*.

ii. **Flower** Bisexual, actinomorphic, ebracteate, pedicellate, pentamerous and hypogynous.

a. **Calyx** - Sepals 5, united valvate aestivation, usually persistent as in brinjal, tomato, chilly, etc.

b. **Androecium**- Stamens 5, epipetalous, alternating with petals, inserted in corolla tube, filaments usually of unequal length, anters bithecous.

c. **Gynoecium** - Bicarpellary, syncarpous, ovary superior, bilocular, placenta swollen with many ovules.

e. **Fruits** - Berry or capsule.

f. **Seeds** - Endospermic, embryo straight.

iii. $\mathrm{EbrK}_{(5)}\,\mathrm{C}_{(5)}\,\mathrm{A}_{(5)}\,\mathrm{G}_{(2)}$

Economic Importance with Examples

Plants belonging to the family-Solanaceae has their importance in the following fields.

i. **Food** *Solanum tuberosum* (potato), *S.esculentum* (tomato)*, Physalis peruviana* (ground cherry)*, Capsicum annuum* (chillies)*,* etc.

ii. **Tobacco** - *Nicotiana tabacum* and *N.rustica* contain toxic alkaloid nicotine. It is used for chewing, smoking and snuff.

iii. **Medicines** -

Atropa bellodona is used to obtain Bellodona and atropine. Bellodona is used for relieving pain and treating cough. Atropine is used dilating eye pupil.

Datura stramonium is used in asthma.

Solanum xanthocarpum,Withania somnifera, Hyoscymus niger, etc.

iv. **Ornamentals** - *Cestrum nocturnum*(Rat-kiRani), *Petunia hybrida*, *Physalis peruviana* (cape gooseberry), etc.

Cestrum nocturnum, Petunia hybrid, Physalis peruviana, etc.,

Family - Liliaceae

1. Systematic Position

Division - Spermatophyta

Sub-division - Angiospermae

Class - Monocotyledonae

Order - Liliflorae

Series - Coronarieae

Family - Liliaceae

2. Distribution

The family-Liliaceae (lily family) includes about 250 genera and 3700 species showing world wide distribution.About 200 species are available in India.

3. Habit

Mostly perennial herbs penetrating by underground rhizomes, corms or bulbs. They are rarely shrubs or climbers. E.g- *Smilax, Glorisa,* etc.

4. Vegetative Characters

i. **Root** Generally adventitious, fibrous or fleshy (eg. *Asparagus*).

ii. **Stem** Herbaceous or woody. In some species underground bulbs or rhizomes.

iii. **Leaves** Mostly basal, alternate, linear, exstipulate with parallel venation.

5. Floral Characters

i. **Inflorescence** Mostly racemose, sometimes cymose, rarely solitary.

ii. **Flower** Bracteate, pedicellate, actinomorphic, incomplete, bisexual, trimerous and hypogynous.

a. **Perianth** Tepal six (3+3), aften united into tube, valvate aestivation.

b. **Gynoecium** Tricarpellary, syncarpous, trilocular withmany ovules, axile placentation, rarely unilocular with parietal placentation, ovary superior, style simple with three lobed stigma.

c. **Fruit** A loculated capsule, rarely a berry.

d. **Seed** Endospermic, embryo curved or straight.

Economic Importance with Examples

Plants beloging to this family has their importance in the following fields.

i. **Food** *Allium cepa* (onion)*, Allium sativa* (garlic) shoots and roots of *Asparagus* are used as vegetables

ii. **Medicines** *Aloe* leaves are used to cure piles, liver problems. Roots of *Smilax* are used as blood purifier. Raw onion is useful in constipation, diarrhoea and cholera. Dried corms of *Colchicum autumnale* (meadow saffron) are used against rheumastism and gout.

iii. **Ornamentals** The common ornamentals are *Ruscus, Yucca, Aloe, Asparagus, Gloriosa, Smilax, tulips, lilies*, etc.

iv. **Fibres** The fibre yielding plants of lily family are *Yucca filamentosa, Sansevieria roxburghiana*, etc

are drawn in successive whorls, calyx being the outermost and the gynoecium in the centre