CHAPTER - 04
MORPHOLOGY OF FLOWERING PLANTS

Morphology is the study of external form and features of an organism. Looking into a plant, externally we can see all the possible organs of plant.

This chapter deals with the morphology of angiosperms, as they are having all the possible organs for a plant. In botany morphology means study of external organs of plants like root, stem, leaf, flower, fruit, seed etc . We can divide the chapter into three main parts.

Part I : Vegetative morphology. Comprises the study of structure, function and modifications of vegetative organs like root, stem and leaf.

Part II : Floral morphology. Comprises the study of sexual reproductive organs and its associated parts. Flower, inflorescence, fruit and seed.

Part III : Family description. Study of three families. Fabaceae, Solanaceae, Liliaceae ; it is to understand corelation between morphology and taxonomy.

I. VEGETATIVE MORPHOLOGY

It is the study of vegetative organs of a plants like root stem and leaf. Generally a plant originate from embryo which is present inside the seed. Seed present on the parental plant, come to the soil, undergo germination, develop into new plant. Embryo is having an embryonal axis with an upper end known as plumule and a lower end known as radicle; it is the radicle initially come out of seed.

A. THE ROOT

♦ In general, root is the descending part of plant originating from radicle, but it is not always true. So according to the specific origin, root system can be three types.

1. Types of Root system

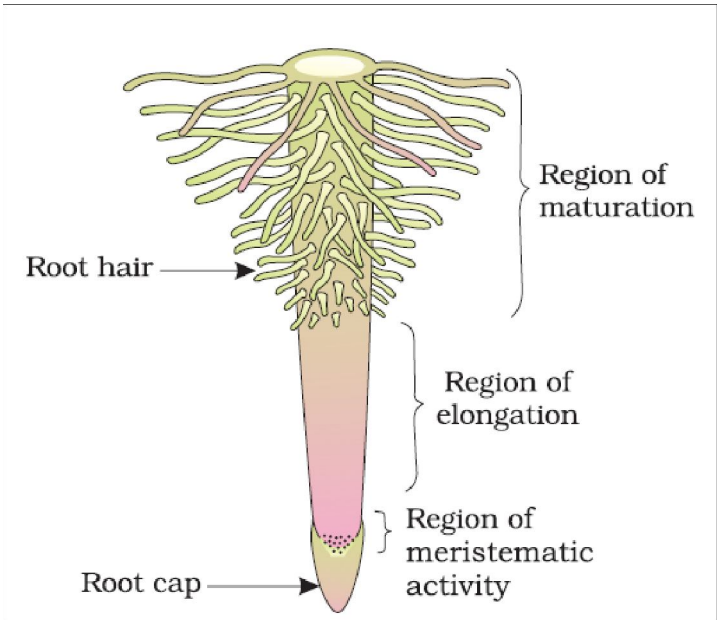
Tap root system →
Originating from radicle;
Primary root is long lived.
eg. Dicot

Fibrous root system →
Originating from radicle;
[Seems to be coming from stem]
Primary root is short lived.
Presence of seminal roots
eg. Monocot

Adventitious root →
No embryonic origin
Originating from part of plant other than radicle. Presence of seminal root.
eg. Vegetative propagated plant

2. Regions of Root

♦ Irrespective of the type of root system, there are different regions for root ; this information is essential to identify the normal morphology of root and the areas of root which is involved in absorption.



♦ Remember : **all regions except root cap region** is involved in absorption, provided that maturation region is the main area for absorption, as it is involved in the absorption of water and minerals.

: Root cap is at the extreme tip, meant for protection in terrestrial plants. **In aquatic plants** instead of root cap, **root pocket is present**

: Root cap or root pocket is usually one layered but **there are multiple root cap**. eg. Pandanus

3. Root Modifications

Meristematic region at the tip of root is representing the apical bud of root. It is the area where dividing cells are present which help in growth and synthesis of some hormones takes place.

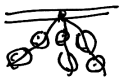
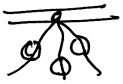
♦ Usually root is involved in fixation and absorption ; but there are root which deviate from normal function and morphology so as to perform some additional functions. Such roots are root modifications. According to additional functions performed by them, they can be grouped into three ;

a. Storage modification [Usually underground, but undergo swollening]

Tap root modification
[Primary root itself undergo swollening according to the shape]

1. Fusiform  eg. Radish
2. Conical  eg. Carrot
3. Napiform  eg. Beetroot
4. Tuberous  eg. Mirabilis

Adventitious modification
[[Group of root originating from stem undergo swollening; according to the shape, they are :]

1. Fasciculated  eg. Tapioca, Asparagus
2. Monoliform / Beeded  eg. Bittergourd
3. Nodulated  eg. Mango, Ginger
4. Tuberous eg. Sweet potato

b. Mechanical root modifications

♦ Usually aerial and adventitious, they are harder than the normal root and are originating from main stem or branch. According to the correct position of origin and the direction of growth, they are many types mainly following three types.

Prop root

* Originating from horizontal branch and grows vertically downward.
eg. Banyan tree

Stilt root

* Originating from basal node of main stem and grows oblique downwards
eg. Pandanus, Maize

Climbing root

* Originating from main stem or branch and grow towards support.
eg. Pepper

c. Vital function modification [Life activities)

♦ Usually aerial, tap root or adventitious perform life activities like respiration, photosynthesis, absorption etc. Some roots carrying out absorption like normal root, but not from soil. They are of different types like ;

(i) Pneumatophore [Respiratory root] : Halophytes [plants growing in saline soil, where O_2 concentration is low] produces some aerial root [secondary roots] which possess openings called pneumatothodes. It meant for absorbing O_2 from atmosphere. eg. Rhizophora, Avicennia etc.

(ii) Assimilatory root [Photosynthetic root] : Aerial green coloured root originating from the nodes of stem ; so they are **adventitious root.** eg. Tinospora, Trapa.

(iii) Haustoria [Parasitic root] : Aerial sucking root produced by parasitic angiosperms. It can penetrate deep into the host tissues so as to absorb nutrients from it. eg. Cuscuta, Loranthus

(iv) Velamen root [Epiphytic root] : Aerial hanging root produced by epiphyte and are mainly concerned with absorbing moisture content from the atmosphere. They are partially green in colour also so they can perform photosynthesis also. Eg. Vanda, Many orchids

B. THE STEM

Stem is the ascending axis of shoot originating from the plumule of embryo stem differ from root in the following aspects.

i) Stem axis possess two types of buds - apical bud and axillary buds. Stem can have adventitious buds also.

ii) Stem axis divisible into nodes and internodes. Nodes are the area from where leaf originate.

iii) Stem possess mechanical tissues like collenchyma, sclerenchyma etc. so stem is usually erect; but **there are weak stemmed plants**, such plants are mainly four types,

- **Creepers** : Weak stem grows through the substratum (soil/H_2O) and are able to produce adventitious roots from the node. So they help the plant in vegetative propagation and are also called as sub-aerial stem modification. They are many types.
- **Trailors** : Weak stem grows through the substratum but are fail to produce roots; so they are not supposed to be stem modifications.

  eg. Boerhaevea
- **Climbers** : Weak stemmed plant, grows through a support by the help of adhesive organs like tendrils, thorn, hook etc. eg. Grape vine, Passiflora, Pepper

  There are woody climbers, eg. Bougainvillea and are called as Liana, so non-woody climber is called vine.
- **Twiners** : Weak stemmed plant, with a tendency to grow through the support by coiling around it irrespective of adhesive organs. eg. Sweet potato, Calamus etc.
- Stem usually performs functions like ;

  (i) Being the axis of shoot, spread other parts of shoot especially leaf so as to receive maximum sunlight

(ii) Translocation of substances between root and leaf.

(iii) Provide mechanical support to the shoot.

- There are stems which performs other functions collectively called as modifications. According to the position, they are of 3 types ;

1. Underground stem modifications :

There are stem below the soil. They possess nodes which carry buds and scale leaf (non-green smaller leaf). They are involved in storage and perennation. According to the direction of growth, storage organ, intensity of storage etc. they are of four types.

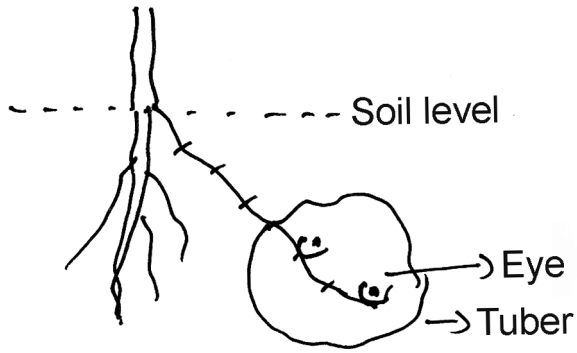
i) Rhizome : Stem grows horizontally through the soil with differentiable nodes and internodes. Nodes carry scale leaf and buds.

eg. Ginger, Turmeric

ii) Corm : Stem stands / grows vertically. Stem under maximum swollening, so stem characters are partially hidden.

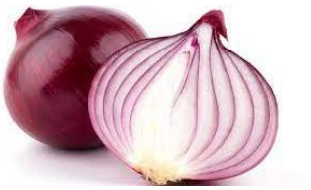
eg. Amorphophallus (Zaminkand)

iii) Tuber : It is a stem which grows oblique downwards through the soil. Only the terminal portion with few nodes undergo swollening; this swollen part is the stem tuber. The position of node with an axillary bud is represented by the 'eye' of the tuber.



eg. Potato

iv) Bulb : It is a stem which stands vertically in the soil. Node carry so many scale leaf which is fleshy due to the storage. So bulb contains smallest stem.



eg. Onion, Garlic

In rhizome, corm and tuber, storage is on stem, but in bulb, storage is on scale leaf.

2. <u>Sub-aerial stem modifications [Creepers]</u>

Some weak stemmed plants, when they grow through the substratum (soil or water) able to produce root from the node. In the presence of root, buds on the nodes can develop into shoot, there by helping the plant in vegetative propagation. They are four types ;

(i) Runner : Creeper that always grows just above the soil surface.

eg. Grasses, Strawberry etc.

(ii) Sucker : Creeper, its initial growth is just below the soil, then come above through an oblique upward growth eg. Banana, Chrysanthemum etc.

(iii) Stolon : Creeper that grows in different direction; usually initial growth upward then it arches downward to touch the soil. Eg. Jasmine, Mint etc.

(iv) Offset : It is an aquatic runner ie, it is creeper with a stem that grows above the water surface. Since nodes are so close, rosette of leaves are produced from nodes.

eg. Pistia, Eichornea etc.

3. <u>Aerial stem modification</u>

Here an erect stem, either totally or partially (branch) modified in different ways to perform different functions.

(i) Thorn : It is sharp pointed structure with endogenous origin found in the axil of leaf : ie in the place of branch which is coming from axillary buds.

Spine is also pointed structures, but is of exogenous origin and usually formed as leaf modifications.

eg. Citrus (Thorn) : Opuntia (spine)

(ii) Tendrils : Spirally coiled structure found either in the axil of leaf (axillar bud is modified) or at the tip of stem (apical bud is modified). eg. Passiflora, Bitter gourd, Grape vine etc.

(iii) Phylloclade : Entire shoot (main stem and branch) modified into green, fleshy structure meant for photosynthesis. It may be cylindrical or flattened.

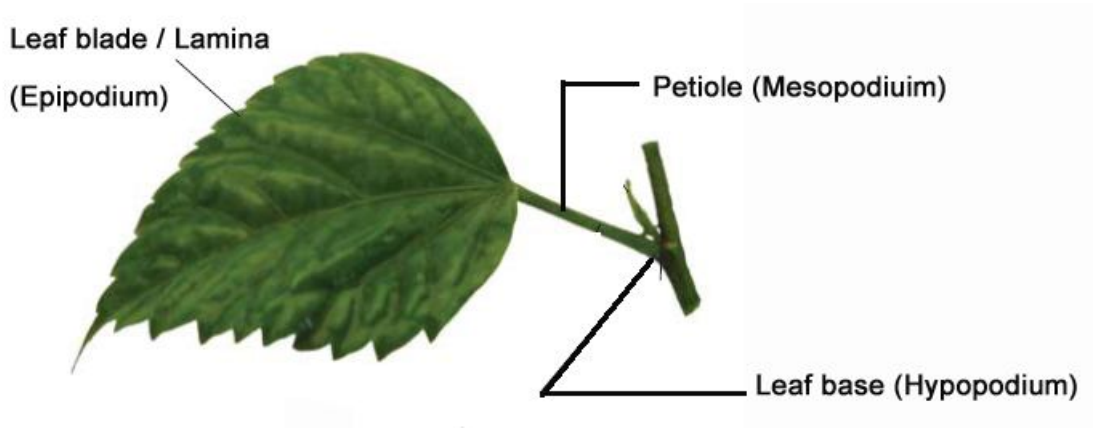
eg. Opuntia, Euphorbia etc.

(iv) Cladode : When a green curved structure is found in the axil of leaf; since it is replacing a branch, it is an aerial stem modification. eg. Asparagus

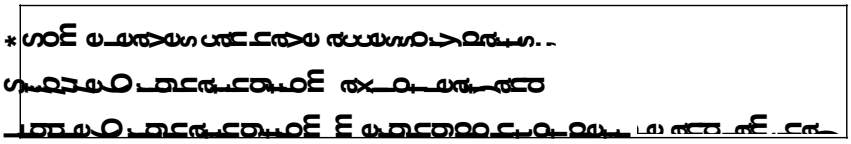
(v) Bulbil : It is a condensed, dormant axillary bud. When it comes to the soil, it can develop into shoot in the presence of root. eg. Agave, Dioscorea etc.

C. THE LEAF (Phyllopodium)

♦ It is the bifacial photosynthetic organ, originate from the node of stem. It is the main vegetative organ of plant. Typically, a leaf has three parts.



♦ In some plants (Leguminous plants) leaf base is swollen and is called as **pulvinus**. In many monocots (Grasses and palms) leaf base is said to be **sheathing**, as it encloses the internode for a small distance.



♦ **Phyllotaxy** : It is the mode of arrangement of leaves at the node ; ie, number of leaves at a node ; it is mainly three types.

(i) Alternate : If one leaf at a node. eg. China rose, Mustard

(ii) Opposite : If two leaves at a node. eg. Guava, Ocimum, Ixora

(iii) Whorled : If more than two leaves at a node. eg. Alstonia, Nerium

♦ **Venation** : Pattern of arrangement of veins especially II^{o} and III^{o} veins through the leaf lamina is venation. All leaves are having one or more primary vein (Unicostate or Multicostate) and many secondary veins.

→ When the secondary veins are interconnected through tertiary veins, forming a network of vein through the lamina is reticulate venation. Reticulate venation is common in dicot.

→ When the secondary veins, many in number are running parallel to each other, where the network of tertiary veins are almost absent, venation said to be parallel.

♦ **Types of leaf**

According to the number of lamina connected to the stalk of leaf, leaves are basically two

types.

i) Simple leaf : When the stalk connected to the node of stem carries only one lamina / blade, leaf is said to be simple. Stalk of simple leaf is petiole.

Unicostate Simple leaf

Mullticostate Simple leaf

ii) Compound leaf : When the common stalk connected to the node of stem carries more than one smaller lamina (leaflet), either at the tip of stalk or one either side of stalk leaf is said to be compound. That is, compound leaves are of two types.

Pinnately compound leaves are evolved from **unicostate simple leaf**; palmately compound leaves are evolved from **multicostate simple leaf**

→ In pinnately compound leaf, leaflets are borne on either side of rachis; according to the branching of rachis, it is of many types like ; unipinnate, bipinnate, tripinnate or decompound. eg. Neem, Rose, Tamarind

→ In palmately compound leaf, leaflets are borne at the tip of rachis, according to the number of leaflet at the tip of rachis, it is of many types like, unifoliate, bifoliate, trifoliate etc.

eg. Silk cotton.

♦ Leaf Modifications

Eventhough usual function of leaf is photosynthesis, **there are leaves which deviate from normal functions** collectively called as leaf modifications, some of them are :

(i) Leaf scales : These are non-green dry or fleshy leaves present on underground stem modifications like **Rhizome and Bulb**. **In rhizome scale leaves are dry** are concerned with protection. **In bulb, scale leaves are fleshy** and are concerned with storage.

(ii) Leaf spines : Pointed structures with exogenous origin providing protection to aerial stem modifications like phylloclade.

(iii) Leaf tendrils : Spirally coiled structure usually help the climber in climbing the support. In many plant leaf tendril which develop at the base of branch, only a part of leaf is modified, according to the part of leaf modified into tendrils, leaf tendrils are of many types.

eg. In sweet pea → Entire leaf is modified into tendril

In Smilax → Stipule is modified into tendril

In Gloriosa → Leaf tip is modified into tendril

In Nepenthes → Petiole is modified into tendril

In Garden pea → Leaflet is modified

(iv) Leaf pitcher : It is an adaptation to terrestrial insectivorous plant. Lamina is modified to bag like structure which contains digestive enzymes. eg. Nepenthes

(v) Leaf bladder : It is an adaptation to aquatic insectivorous plant. Dissected lamina segment is modified into box like structure which contains digestive enzymes. eg. Utricularia

(vi) Phyllode : When the stalk of leaf namely petiole or rachis is modified into green flattened fleshy structure so as to perform photosynthesis. eg. Australian Acacia

II. FLORAL MORPHOLOGY

It is the study of sexual reproductive organ flower and its associated parts. Eventhough flower is the main topic under this part, in most of the plants flower is in group, namely inflorescence.

A. INFLORESCENCE

Group of flowers arranged on a common axis namely peduncle is named as inflorescence. So, peduncle is the inflorescence axis. According to the order of maturation of flowers on the peduncle, inflorescence can be group into 3.

1. Racemose inflorescence : Peduncle with acropetal order of maturation (Maturation from the base to the apex), so oldest flower at the base. Peduncle never ends in a flower, so peduncle is of indefinite growth. According to the morphology of flower (sex, presence of pedicel etc) and nature of peduncle (branching, any modification); it is of many types, like

- **Simple raceme** : Bisexual pedicellate flowers. eg. Fabaceae
- **Spike** : Bisexual sessile flowers. eg. Amaranthus, Pepper
- **Spikelet** : Spike of spike, ie, branched spike. eg. Poaceae
- **Catkin** : It is a spike with unisexual flowers ie, peduncle carries unisexual sessile flowers. eg. Acalypha
- **Spadix** : Peduncle is swollen, carries many bisexual/unisexual flowers, supported by specialised bract called spathe. eg. Banana, Anthurium

- **Corymb** : Bisexual, pedicellate flowers, because of unequal length of pedicel of flower all flowers, all flowers almost at the same level. eg. Caesalpinia
- **Umbel** : Bisexual pedicellate flowers, where all flowers are originating from a common point of peduncle. The group of flowers are supported by a **whorl of bract called Involucre**. eg. **Umbelliferae**
- **Head /Capitulum** : Modified peduncle (Modified into a head like structure) carries many minute sessile flowers called florets.

  Florets are two types - **Disc and Ray**

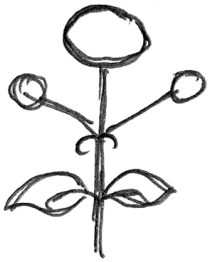
  Disc florets are bisexual and actinomorphic

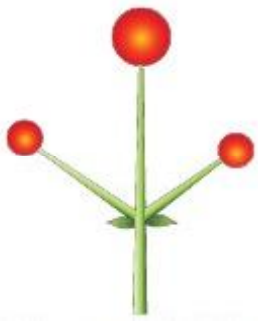
  Ray florets are unisexual and zygomorphic
- Some plants contains homogamous head (only one type of floret). Most plants contains heterogamous head (presence of two types of florets ie, Disc and Ray florets).

  eg. Astraceae (sun flower family)

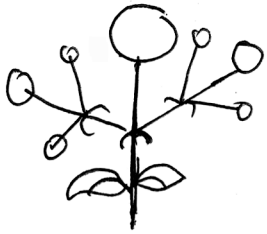
2. <u>Cymose Inflorescence</u> : Peduncle with basipetal order of maturation (Maturation from the tip towards the base). So oldest flower at the tip. Peduncle always ends in a flower, so peduncle is of definite growth. According to the branching of peduncle it is of many types like ;

- **Simple cyme** : A group of 3 flowers, where terminal flower is oldest. No branching for lateral as well as terminal flowers. eg. Jasmine





- **Dichasial cyme** (Biparous cyme) : begins as simple cyme, then branches are formed in pairs on lateral branches successively. eg. Ixora, Clerodendron



- **Polychasial cyme** (Multiparous cyme) : begins as simple cyme, then branches are formed, more than two on lateral branches successively. eg. Calotropis

- **Monochasial cyme** (Uniparous cyme) : After the formation of a terminal flower, when two buds are formed, only one of them develop into flower. It is either scorpioid or helicoid. eg. Haemelia, Drosera.

B. THE FLOWER

- Flower is a modified shoot meant for sexual reproduction as it carries micro and megasporangia at certain parts.
- Flower can arise either in **apical or axillary** in position. Flower has a stalk namely **pedicel** which get swollen at the tip forms the **floral axis namely ; Thalamus or Receptace.**
- The thalamus carries the four floral whorls namely - **calyx, corolla, Androecium and Gynoecium;** each whorl contains one to many floral leaves namely - sepal, petal, stamen and carpel respectively. Since stamen and carpel carries the sporangia, they are the essential leaves. Sepal / calyx and petal/corolla are the non-essential / accessory organs of flower.
- Before approaching each and every floral whorl, let us understand some terminologies.

  (i) Bisexual and Unisexual flower : When the flower possess both androecium and gynoecium, flower is said to be bisexual. eg. China rose, pea. When the flower possess either androecium or gynoecium, it is unisexual eg. coconut, bitter gourd

  (ii) Dichlamydeous and monochlamydeous flower : When the flower possess differentiable calyx and corolla, flower is said to be dichlamydeous. When the flower possess undifferentiable calyx and corolla, that is perianth, flower is said to be monochlamydeous.

  (iii) Actinomorphic and Zygomorphic : When a flower is divisible into equal halves in many planes passing through the central axis, flower is said to be r**adially symmetrical or actinomorphic**. eg. China rose, Ixora

  When the flower is divisible into 2 equal halves only in one plane passing through the central axis, flower is said to be **bilaterally symmetrical or zygomorphic**.

  eg. Fabaceae family

  Flower is said to be **asymmetrical**, if the flower cannot be divided into equal halves in any plane. eg. Orchids, Cana

  (iv) Isomerous flowers : When the flower possess same number of floral leaves in most of the nodes, flower is said to be isomerous. Isomerous flower may be trimerous (monocots), tetramerous or pentamerous (Dicots).

  (v) Hypogynous, Perigynous and Epigynous flowers : This classification is based on the shape of thalamus, accordingly position of ovary.

- When the **thalamus is dome shaped** or convex shaped **ovary is said to be superior** and other whorls are starting below the ovary is **hypogynous flower**.

  eg. Liliaceae, Solanaceae

- When the **thalamus is slightly concave** or cup shaped, **ovary is said to be half inferior** and other whorls are starting from the sides of **thalamus is perigynous flower**.

eg. Rose, Peach

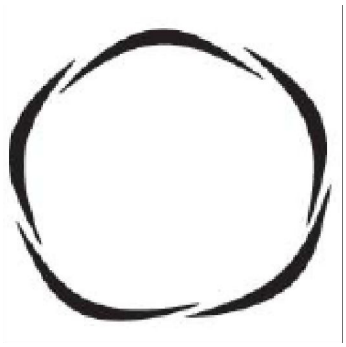
- When the **thalamus is deeply concave**, **ovary said to be inferior** and other whorls are starting above the ovary is **epigynous flower.**

(vi) Aestivation : Mode of arrangement of sepals and petals through the first and second nodes of thalamus is aestivation. According to the criteria, whether there is overlapping and whether it is regular, aestivation mainly four types.

- **Valvate** : Aestivation without any overlapping

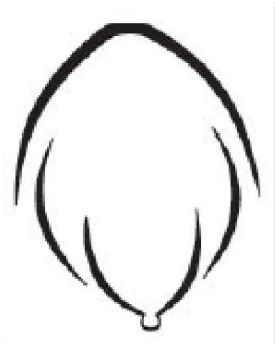
- **Twisted** : Aestivation with regular overlapping

- **Imbricate** : Aestivation with irregular overlapping in such a way that, out of total number, one leaf is completely out, one leaf is completely in others are 'in and out'.



- **Vexillary** : It is also aestivation with irregular overlapping like imbricate. It is shown by papilionaceous corolla only. Of the total 5 petals, one is largest (standard petal) is completely

out. Two lateral ones are smaller (wing petals) is 'in and out' fashion. Two are smallest (keel petals), they together completely in.



(vii) Connation (Cohesion) and Adnation (Adhesion) of floral leaves

- **When the floral leaves within a whorl undergo fusion**, it is connation, it can happens in any of the whorl.

  → Connation in calyx is gamosepalous

  → Connation in corolla is gamopetalous

  → Connation in perianth is gamotepalous

  → Connation in androecium can be three types

  (i) If the fusion is **only through the filaments of stamen, it is adelphy,** it may be monadelphy (china rose), Diadelphy (Fabaceae) or Polyadelphy (Rutaceae)

  (ii) If the fusion is **only through the anther, it is syngenesious**. eg. Asteraceae

  (iii) If the **fusion is through both filament and anther, it is synandrous**.

  eg. Cucurbitaceae

  → Connation in gynoecium is **syncarpous**, if the carpel are free gynoecium is said to be **apocarpous**.

- **When there is fusion of floral leaves of adjacent whorls**, it is adnation or adhesion. It can be three types.

  → Fusion between corolla and androecium, ie, stamen of androecium joins with petal of corolla; it is epipetalous. eg. Solanaceae

  → Fusion between perianth and androecium ie, stamen of androecium joins with tepal of perianth; it is epiphyllous / epitepalous. eg. Liliaceae

  → Fusion between androecium and gynoecium ie, stamen of androecium joins with carpel of gynoecium, it is gynandrous. In gynandrous condition, there may be a structure at the top of flower formed by the fusion of anther and stigma, called as gynostegium.

- **Let us take the floral whorls one by one**.

1. Calyx : It is the outermost whorl, consists of greenish floral leaves sepals.

- ♦ Usually calyx fall off as the last floral whorl after fertilization ⇒ Deciduous calyx
- ♦ Some calyx never fall off even after fertilization, they grow along with fruit ⇒ **Persistent calyx.** eg. Solanaceae
- ♦ Some calyx fall off even before fertilization ⇒ Fugacious / Cadaucous calyx.

2. Corolla : It is present on the second node from the base on the thalamus. It consists of brightly coloured floral leaves petal. It is involved in attracting pollinating agents.

- ♦ **Polypetalous corolla** : According to the number of petals and symmetry many types like; Cruciform, Papilionaceous, Rosaceous, Caryophyllaceous etc.
- ♦ **Gamopetalous corolla** : According to the shape of corolla tube and its symmetry many types like ; Tubular, Ligulate, Bilabiate, Personnate etc.

3. Androecium : It is the floral whorl on the 3rd node and consists of stamens, each stamen has a filament and an upper fertile part anther.

- ♦ Most of anthers are dithecous (bilobed) and tetrasporangiate. There are monothecous (one lobed), bisporangiate anthers. eg. Malvaceae
- ♦ Sterile stamen is called staminode

Usually an androecium contains many stamens with equal length of filament, but there are androecium with stamens, they are not in same height. They are of 3 types.

(i) Didynamous : Contains four stamens, where 2 are longer and 2 are shorter. eg. Salvia, Ocimum.

(ii) Tetradynamous : Contains totally six stamens but they are in two height; 4 tall and 2 short. eg. Brassicaceae / Cruciferae.

(iii) Heterostemonous : Androecium contains many stamens with different height.

eg. Convolvulaceae [Sweet potato family)

4. Gynoecium : It is the floral whorl at the 4th node of thalamus and consists of one to many carpels. Each carpel has a basal fertile part ovary, middle elongated tube like style and an upper expanded stigma.

Few gynoecium are monocarpellary. eg. Fabaceae. Majority are multicarpellary. eg. Solanaceae, Liliaceae, Malvaceae, Cucurbitaceae. Multicarpellary gynoecium is mostly syncarpous and a few are apocarpous.

- ♦ Ovary is the fertile part as it contains one to many ovules (Megasporangia) attached through the special tissue called placenta.
- ♦ According to the mode of arrangement of ovules through the placenta, there many placentation types.

(i) Marginal : Common in monocarpellary gynoecium, many ovules originate from the margin of elongated ovary eg. Fabaceae.

(ii) Basal : Common in multicarpellary syncarpous unilocular ovary. Only one ovule arise from the base of the ovary. eg. Asteraceae, Poaceae etc.

(iii) Free central : Found in multicarpellary, syncarpous, unilocular ovary. Many ovules originate from the placenta which form a central axis. eg. Dianthus

(iv) Parietal : Found in multicarpellary, syncarpous unilocular ovary. Many ovules originate from the parietal sides of ovary. eg. Cucurbitaceae, Brassicaceae

(v) Axile : Found in multicarpellary, syncarpous multilocular ovary. Many ovules originate from the placenta which form a central axis. eg. Solanaceae, Liliaceae, Malvaceae, Rutaceae

C. THE FRUIT

Fertilization happening in the ovule inside the ovary, undergo morphological changes so that ovule is transformed into seed and ovary transformed into fruit. ie, Fruit is supposed to be fertilized ovary, it is not always true, so according to the origin, fruits are of three types.

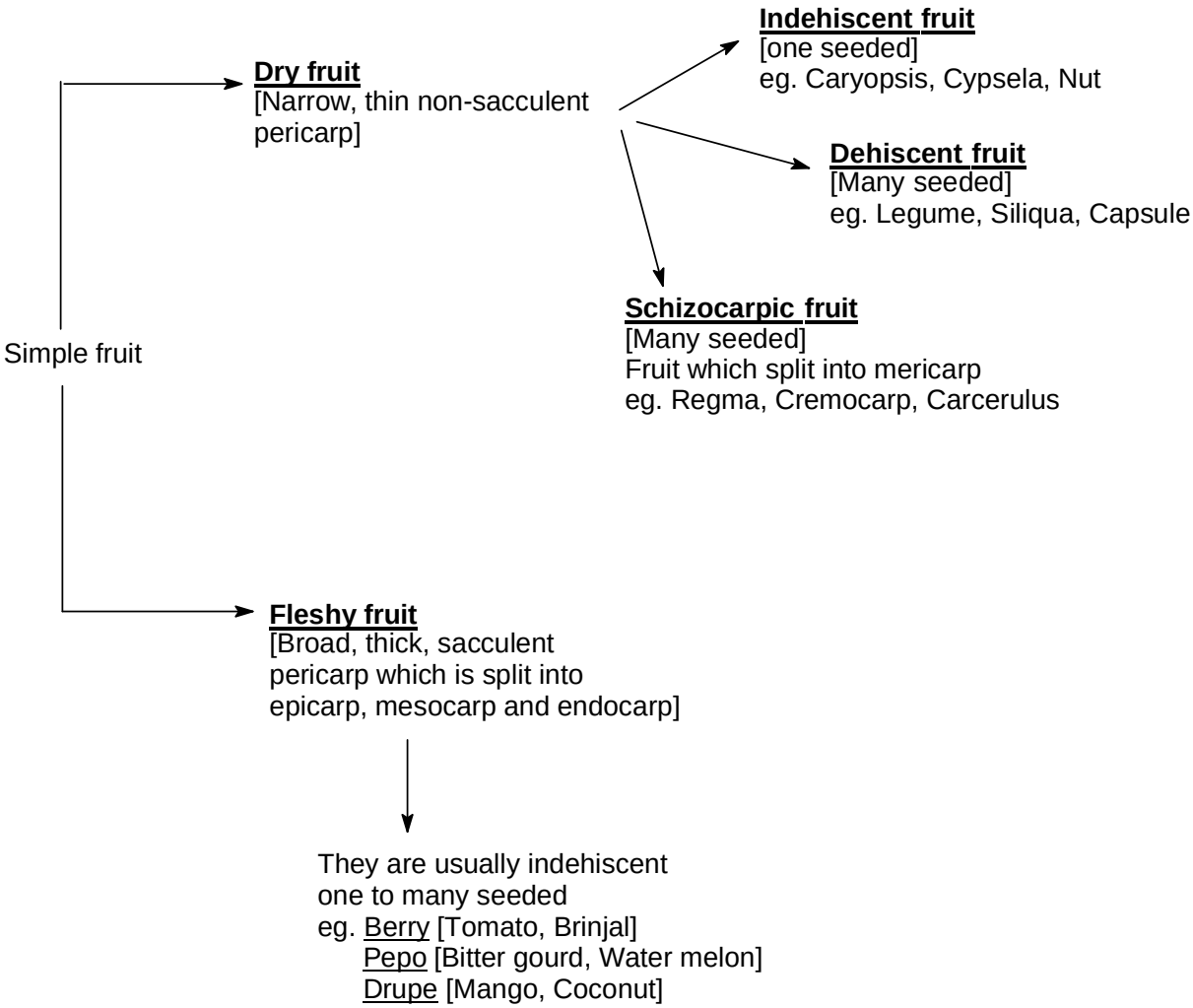
1. **True fruit** : Fruit developing from ovary of flower after completing fertilization, so the pericarp is represented by ovary wall and contains seed.
2. **Parthenocarpic fruit** : Fruit developing from ovary of flower, without completing fertilization, so the pericarp is represented by ovary wall, but devoid of seeds. eg. varieties of Grapes and Banana.
3. **False fruit** : When a part of flower other than ovary (usually thalamus) after fertilization develops into fruit. So the pericarp is not represented by ovary but they contain seed.

   eg. Apple

♦ According to the number of flowers contributing, fruits are of three types.

1. **Simple fruit** : Developing from monocarpellary or multicarpellary syncarpous gynoecium of a single flower.
2. **Agregate fruit** : Developing from multicarpellary apocarpous gynoecium of a single flower. eg. Custard apple
3. **Multiple fruit / Composite fruit** : Developing from an entire inflorescence. eg. Jack fruit

♦ Focussing a simple fruit, fruits can also be group into two according to the morphology of pericarp.



- Drupe is a one seeded fleshy fruit, where the pericarp is differentiated into outer thin epicarp, middle fleshy (Mango) or Fibrous (coconut) mesocarp, and an inner hard endocarp.

D. THE SEED

An ovule inside the ovary after fertilization undergo morphological as well as embryological changes, so as to transform into seed.

- ie, Seed is fertilized integumented megasporangium (ovule)
- A typical seed has two layered seed coat (testa and tegmen), a diploid embryo and a triploid endosperm. Some seeds are having one more layer just inner to seed coat layer, it is known as perisperm. Perisperm is the remnant of nucellus. So the compulsor parts of seed are

seed coats, embryo and endosperm provided that, endosperm is not compulsory in mature seed. According to the presence or absence of endosperm in mature seed, seeds are two types

(i) Non-endospermic / Dicot seed / Non-albuminous seed

Seeds which are not having an endosperm on maturation. Such seeds are common in dicot, and rarely in monocot. (eg. Orchids)

(ii) Endospermic / Monocot seed / Albuminous seed

Seeds which are having an endosperm even on maturation. Such seeds are common in monocot and rarely found in dicot (eg. Castor)

Compared to a non-endospermic seed, monocot seed or endospermic seed is having certain unique parts.

- **Scutellum** : Single shield shaped cotyledon
- **Coleoptile** : Sheath covering the plumule
- **Coleorhiza** : Sheath covering the radicle
- **Aleurons layer** : Outermost layer (epidermis) of the triploid endosperm cells contains aleurone grains.

III. Family Description

In order to understand the fact that morphological criterias / characters especially floral characters are valuable in taxonomy while we are describing a family; there is the description of three families.

- Summerised description of floral characters can be in the form of floral formula or floral diagram.

A. Floral formula

It is the description of floral characters using symbols. The main characters represented in formula are :

- Symmetry of flower → $\underset{\text{Zygomorphic}}{\%}$ or $\underset{\text{Actinomorphic}}{\oplus}$
- Sex of flowers → $\underset{\text{Bisexual}}{\varnothing}$ or $\underset{\text{Unisexual}}{\male \text{ and } \female}$
- Number of floral leaves in each whorl specifying the presence or absence of connation or adnation; Calyx (k), Corolla (c), Androecium (A), Gynoecium (G).
- Position of ovary accordingly whether the flower is hypogynous, perigynous or epigynous.

$\underset{\text{Hypogynous}}{\underline{G}}$; $\underset{\text{Perigynous}}{G\!-\!}$; $\underset{\text{Epigynous}}{\overline{G}}$

For eg. Floral formula of brassicaceae.

$\oplus : \male\!\female : K_{2+2}C_4A_{2+4}\underline{G}_{(2)}$

- it means : An actinomorphic, bisexual flower with a calyx made up of 4 free sepals in two whorls; corolla made up of free 4 petals; Androecium made up of 6 stamens in tetradynamous fashion; Gynoecium made up of 2 carpels which are syncarpous where the ovary is superior.

B. Floral diagram

It is the diagramatic representation of summary of floral characters specifying symmetry, sex of flower, number of floral leaves in each whorls specifying the presence or absence of connation and adnation, aestivation and placentation.

- ie, Aestivation and placentation cannot be given in floral formula

The representation of various floral leaves.

 Sepal :  Petal

 Stamen :  Carpel

 Anterior side :  Posterior side

- Let us understand the three families in our syllabus.

C. Fabaceae / Papilionaceae (Pea family)

- **Vegetative characters** : Represented by herbs, shrub or trees; **Roots are with nodules ; Leaves alternate, pulvinate stipulate**, simple or pinnately compound.
- **Floral characters**

Flowers rarely solitary, mostly racemose inflorescence ; **flower is bisexual, dichlamydeous, zygomorphic and hypogynous.**

→ **Calyx** : 5 sepals united with valvate / imbricate aestivation

→ **Corolla** : 5 petals papilionaceous with vexillary aestivation

[one standard petal, 2 wing petals and two keel petals]

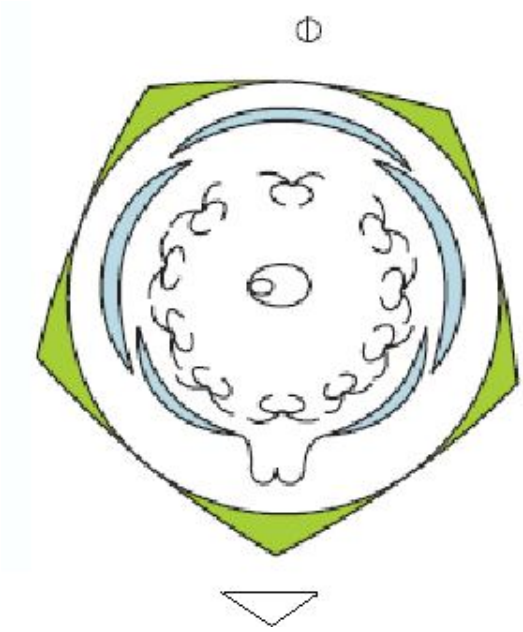
→ **Androecium** : 10 stamens, diadelphous [filaments of stamens united into 2 tubes, 9 + 1]

→ **Gynoecium** : Monocarpellary with marginal placentation, unilocular ovary with many ovules, superior.

→ **Fruit** : Legume (Dry dehiscent fruit) with one to many non-endospermic seeds.

Floral Formula : % : ♂ ♀ : $K_{(5)}C_{1+2+(2)}A_{(9)+1}\underline{G}_1$

Floral diagram



Familiar examples

- Pisum sativum (Garden pea)
- Glycine max (Soyabean)
- Lathyrus odoratus (Sweet pea)
- Arachis hypogea (Ground nut)
- Crotalarea juncea (Sun hemp)
- Indigofera tinctorea
- Cicer arietinum (chick pea/Bengal gram)
- Cajanus cajan (arhar)

D. Solanaceae (Potato family)

- **Vegetative characters**

  Represented mainly by herbs and shrubs, rarely trees. **Stem is usually herbaceous** rarely woody and some plants are having underground stem modification like tuber. **Leaves are simple rarely compound, exstipulate with alternate phyllotaxy**.

- **Floral characters**

  Flowers mostly solitary (axillary), rarely in cymose inflorescence.

  Flowers is **bisexual, dichlamydeous actinomorphic and hypogynous**.

  → **Calyx** : 5 sepals united persistent with valvate aestivation

  → **Corolla** : 5 petals united with valvate aestivation

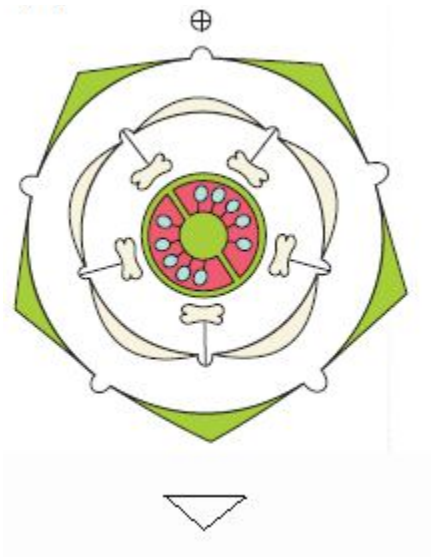
  → **Androecium** : 5 stamens epipetalous

  → **Gynoecium** : Bicarpellary, oblique with swollen placenta ; ovary superior with axile placentation

  → Fruit : Berry (Fleshy fruit) or capsule (dry fruit) with many endospermic seeds.

  Floral Formula : $\oplus : \male\!\female : K_{(5)}\widehat{C_{(5)}A_5} : \underline{G}_{(2)}$

  Floral diagram



  Familiar examples

- Solanum tuberosum (Potato)
- Solanum melongena (Brinjal)
- Solanum lycopersicon (Tomato)
- Atropa belladona
- Withania somnifera (Aswagandha)
- Petunia hybrida
- Datura stramonium
- Nicotiana tabaccum

E. Liliaceae (Lily family]

Represented by perennial herbs with underground stems like bulb.

- **Vegetative characters :** Stems are usually modified below the soil. Leaves are mostly basal with sheathing base, exstipulate with alternate phyllotaxy.
- **Floral characters**

  Flowers are solitary or in cymose inflorescence [Umbellate clusters]

  Flowers are **bisexual, monochlamydeous, actinomorphic and hypogynous.**

  → Perianth : 6 tepals in two whorls [3 + 3] mostly united with valvate aestivation.

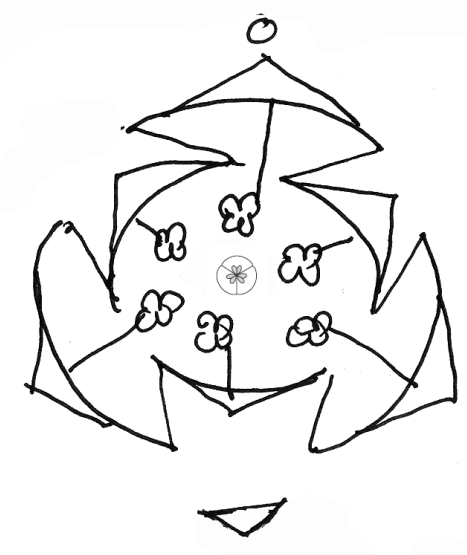
  → Androecium : 6 stamens in two whorls [3+3] epitepalous

  → Gynoecium : tricarpellary, syncarpous, ovary superior with axile placentation

  → Fruit : Mostly capsule, rarely berry with endospermic seeds

  Floral Formula : $\oplus : \male\!\!\female : \widehat{P_{(3+3)}A_{3+3}}\underline{G_{(3)}}$

  Floral diagram



Familiar examples

- Colchicum autumnale
- Allium cepa (Onion)
- Allium sativum (Garlic)
- Gloriosa superba
- Asparagus
- Smilax