

## <u>ROOT</u>

- Branch of science which deals with the study of external form, structure and various modifications of plants is called Plant Morphology.
- Body of a common angiosperm plant is differentiated into underground root system and Aerial shoot system; shoot system includes stem & branches, leaves & flowers.
- v Root, stem and leaves represent vegetative part of a plant while flowers show reproductive part of a plant.

## HABIT

Angiosperm plants are of three types on the basis of habit.

(i) Herbs :

(1) Annual herbs Ex: Pea, wheat, Mustard.

- (2) Biennial herbs Ex: Radish, Turnip.
- (3) Perennial herbs Ex: Turmeric, Musa.

(ii) Shrubs : Perennial, medium sized plants with a hard and woody stem, Ex: Rose, Heena.

(iii) **Trees :** Perennial tall plants with hard and woody stem. **Ex: Saraca indica, Mangifera indica**.



## Fig : Parts of a flowerting plant

Root

**Definition :** Root is non-chlorophyllous and under ground part of plant it is positive geotropic, positive hydrotropic and Negative phototrophic.

The main characters of root are as follows

- (1) Roots usually develop from Radicle of seed.
- (2) Roots do not bear nodes and internodes.
- (3) Roots possess unicellular root hairs.
- (4) Lateral roots arise endogenously from pericycle.
- (5) Roots do not bear buds for vegetative propagation except sweet potato and Indian rose wood.

## Types of roots :

- (1) **Tap roots :** They develop from radicle in acropetal sucession, **Ex: Dicot plants**.
- (2) Adventitious roots : They arise from any part of the plant body other than radicle, Ex: Monocot plants.

#### **Region of roots :**

- (i) Root cap : It is a smooth cap shaped structure present at the apex of root. It secretes mucilage, which lubricates the passage of root through the soil. In Hydrophytes, root cap is either absent or replaced through root pockets. Ex: Pistia, Eicchornia.
- (ii) **Zone of cell division :** The cells of this region are in active state of division.
- (iii) Zone of cell elongation : Maximum growth in the cells occurs. These cells lose the power of division.
- (iv) Zone of cell Maturation : The cells of this region are differentiated in to permanent tissue, Root hairs are also present in this zone, which help in absorption of water.



Fig. The regions of the root-tip

## Modifications of Roots :

- (I) Modifications of Tap roots :
- (1) Fleshy taproot : They are modified for storage of food.

(i) **Fusiform :** It is thickest at middle and spindle shaped.

Ex: Radish.

(ii) Conical : It is cone shaped. It is thickest at the base and gradually tapering at the apex.

Ex: Carrot.





Adventitious roots

Fig. - Different types of roots : (a) Tap (b) Fibrous (c) Adventitious

(c)

(iii) Napiform : It is quite thick at the base and abruptly tapering at the apex.

#### Ex: Turnip and beet root.

(iv) **Tuberous :** They are swollen taproots and do not possess any definite shape.

#### Ex: Mirabilis jalapa.



(b) respiration: pneumatophore in Rhizophora

#### Nodulated roots :

These are found in the plants of sub-family Papilionaceae. The secondary, tertiary roots and sometimes the primary root develop numerous small or large irregular swellings called root nodules. The latter contains symbiotic nitrogen fixing bacteria Rhizobium. **Ex: Pea, groundnut and soyabean.** 



#### Pneumatophore or Respiratory roots :

These are found in plants growing in mangroves or saline swamps near of the seashore.

## Ex: Rhizophora, Avicennia, Sonerattia.



Fig:- Pneumatophore or respiratory roots. A, mangrove tree With pnenumatophores coming out of mud. B, Pneumatophores with lenticels.

- (II) Modifications of Adventitious roots :
- Fibrous roots : They are under ground roots, which arise in groups either at the base of the erect stem or the nodes of an horizontal stem. They remain near the soil surface and are called surface feeders. Ex: Wheat. For Mechanical Support :
- (2) **Prop roots :** They are piller like roots which appear from large horizontal branches in trees. These grow

downwards, which may finally enter into soil and provide mechanical support to the tree. **Ex: Banyan** (**Ficus bengalensis**).

(3) Stilt roots : They appear from the basal nodes near the soil. They grow downwards and fix the erect stem with soil to provide extra support. Ex: Zea mays, Saccharum officinarum, Pennisetum typhoides.



Fig:- Prop or pillar roots of Ficus bengalensis (banyan three)



(4) Climbing or clinging roots : They may arise from nodes (Ex: Betal), Internodes (Ex: Ficuspumila) or both (Ex: Ivy). They penetrate the cracks for the support (Ex: Pothos) or secreting sticky juice at their tips (Ex: Ivy). Which on drying stick the plant to subtratum.



## Fig. Climbing or clinging betel: (piper betel, paan), pothos (money plants)

Fig: Stilts roots of Maize

Differences between Tap root and Adventitionus root			
S.No.	Tap root	Adventitious root	
1	They arise from the radicle of embryo.	They arise from stem as well as leaves.	
2	It is single main root.	Many long roots arise in a group.	
2	Main root is quite thick as compared to	All the roots are fibrous	
3	the others.	All the foots are horous.	
4	Primary root is perennating.	Primary root is short lived.	
5	They are always underground.	They may be underground or aerial.	
6	Distinction of primary, secondary &	There is no such distinction	
	tertiary roots is quite conspicuous.		

## <u>STEM</u>

Stem is a erect ascending part of plant which develops from plumule of embryo.

## Main characters of stem :

- (1) Stem bears Nodes and internodes.
- (2) It is positive phototropic and negative geotropic.
- (3) Stem bears leaves, flowers and fruits.
- (4) It has buds.
- (5) It bears lateral branches, which arise exogenously from cortex.
- (6) Hairs if present, they are multicellular.

(7) Terminal bud of stem is responsible for the elongation of plant.

## Modifications of stem :

Stem is of three forms on the basis of position of stem in the ground.

- (I) **Reduced stem :** Stem present as small disc on which nodes and internodes are not differentiated, Leaves are crowded together on these stems. They are called radical leaves. **Ex: Radish, Turnip.**
- (II) Erect stems : It is strong and remains erect or upright with out any external support. Ex: Mango, wheat.

(III) Weak stems : In this type, stem is soft and weak. It requires a support for spreading. It can be Upright and prostrate.

Climbers : Stem is flexible and weak. It bears clinging structures for climbing like adventitious roots, tendrils Ex: Smilax, Ivy, Pea, Bougainvillea.

**Tendril climbers :** These are green-coiled structures, which may coil around a support and the week stem to climb up. **Ex: Passiflora, pea, cucumber, pumpkins, watermelon.** 



Fig. Euphorbia prostrata: Diffused trailer

## Sub aeril weak stem

 (i) Runner : It is elongated prostrate aerial branch with long internodes and roots at nodes, Ex: Oxalis, Centella asiatica (Brahmi), grass.



(ii) Stolon : It is elongated horizontal branch, which arise from base of the stem. It produces a new plant at its tip. Ex: Dracaena mint jasmine.



Fig. Stolon

(iii) Offset : It is short horizontal branch producing a cluster of leaves above and cluster of roots below.Ex : Pistia, Eichhornia.



## Fig; offsets :1-Plstla, 2- Elchhotla

## Underground stems :

They lie below the surface of the soil and they store food and take part in perennation. They are of following types -

(i) **Rhizome :** Horizontal underground stem bears nodes and internodes. It is of two types.



Fig: Dryopteris (= aspidium): Rootstock ehizome



 (ii) Tuber: It is terminal portion of underground stem branch, which is swollen on account of accumulation of food. It does not bear adventitious roots initially but at the time of germination eye buds develop in to small shoots. The latter bear adventitious roots at its base. Ex: Potato, Artichoke (Helianthus tuberosus)

Sympodial axis



Fig. 1- Stem Tuber of Patato 2- An Enlarged Eye

(iii) Bulb : Stem is disc shaped and reduced. On the upper side the bud is surrounded by many concentric leaves. The leaf bases are fleshy and edible. Disc bears adventitious roots at its base.

#### Ex: onion





Fig. Tunicated bulb of Onion

(i) External View, (ii) V.S. bulb, (iii) T.S. bulb.

 (iv) Corm : It is short, thick, unbranched underground stem with stored food material. It grows vertically and covered by thin sheathing leaf bases of dead leaves called scales. Ex: Amorphophallus, Colocasia.



Fig : Mint (Podina) : Sucker

(v) Sucker : It develops by axillary bud of underground part of stem. The branch creeps below the soil surface and grows obliquely upward and produce new shoot. Ex: pineapple, Rose, Mentha.

## Modification of aerial stem :

- (1) **Phylloclade :** It is green flattened or rounded fleshy stem with leaves either modified into spines or feebly developed. **Ex: Opuntia, Cocoloba**
- (2) Cladode : They are green stems with one long internode. The latter take part in photosynthesis. The true leaves are reduced to spines or scales. Ex: Asparagus, Ruscus.



Modifications of stem for :(a) storage (b) support (c) protection (d) spread and vegetative propagation

- (3) **Stem tendrils :** Tendrils are thread like sensitive structures, which can coil around a support and help the plant in climbing. Ex: cucurbita, pssiflora
- (4) Hooks : Pedicels are modified into stiff curved hooks for helping in climbing. These plants are called stragglar. Ex: Artabotrys.
- (5) Stem thorns : These are modification of axillary buds in which growth is stopped and they are modified in to stiff and sharp structure, called thorns.
   Ex: Citrus, Bougainvillea, Duranta, Carissa, Pomegranate.

Function of stem :

- (1) It is helpful to translocate water and mineral salts
- (2) It translocates the prepared food from leaves to all plant parts.
- (3) It produces new cells, tissues and organs every year, which are essential for the activity of plants.

## LEAF

- ✓ Leaf is green, dissimilar exogenous lateral out growth, which is borne on the node of stem & its branches, and their major functions are photosynthesis and transpiration.
- Green leaves of the plants are called foliage leaves while nongreen are called scale leaves or cataphylls the leaves containing spores or sporangia are called sporophylls. Floral appendages like sepals, petals, stamens, carpels are called floral leaves. Leaves borne by embryo in the seed are called Cotyledons.

#### Part of a leaf (Phyllopodium) :

A leaf is made up of three parts.

- (1) Leaf blade or lamina
- (2) Petiole
- (3) Leaf base
- (1) Leaf blade or lamina (Epipodium) : It is thin, expanded, green and terminal part of the leaf which is specialized to perform photosynthesis. Lamina bears network of Veins and Vein lets. Veins provide rigidity to the leaf base and act as channels of transport for water, minerals and food materials.

- (2) Petiole (Mesopodium) : It is a cylindrical part, which bears the Lamina at its tip. If the petiole is absent it is termed sessile if leaf having petiole it is called petiolate. Long thin flexible petiole allow leaf blades to flutter in wind there by cooling the leaf and bringing fresh air to leaf surface.
- (3) Leaf base (Hypopodium) : It is the lowest part of leaf by which the leaf is joined to the node f the stem. In many legumes it is swollen. The swollen leaf base is called pulvinus. Ex: Cassia fistula, Mimosa pudica (Leguminous plants).

In monocotyledons the leaf base spread as sheath like grasses, Musa. Sheathing leaf base.







Leaf base contains two small lateral outgrowths called stipule. Leaf with stipules is known as stipulate while the leaf without stipules is termed as exstipulate.





Fig, Stipular Spines: 1- Zizyphus, 2- Acacia.

#### Phyllotaxy :

It is the arrangement of leaves on stem and its branches. It is of following types

- (i) Alternate or spiral : Only one leaf is borne on a node and the leaves of the adjacent nodes roughly lie towards the opposite sides and form two alternate rows (distichous) or three (tristichous) or more (orthostichous) vertical rows of leaves. Ex: Ipomoea, china rose, mustard, sunflower.
- (ii) **Opposite :** Two leaves are borne on the opposite sides of a single node. Ex: Guava, calotropis.
- (iii) Whorled : If more than two leaves develop from a single node. Ex: Oleander (Nerium), Alstonia.



Fig: Different types of phyllotaxy: (a) Alternate (b) Opposite (c) Whorled

Venation :

The arrangement of veins and veinlets **in** the lamina of a leaf is called venation. It is of two types:

(i) Reticulate(ii) Parallel

(i) **Reticulate :** The veinlets are irregularly distributed in lamina and form a network. **Ex: Dicot plants.** 



**Reticulate venation** 

(ii) **Parallel :** The veins run parallel to one another and reticulations are absent. **Ex: Monocot plants.** 



## Types of leaf :

(I) **Simple leaf :** Leaf which may be entire or incised and the incision do not touch the mid rib.

## Ex: Banyan, Mango.

(II) Compound leaf: Leaf blade is incised upto mid rib or petiole thus dividing it into two or more leaflets.Ex: Pea.

## They are of two types

- (1) Pinnately compound leaf
- (2) Palmately Compound leaf
- (1) **Pinnately compound leaf :** The leaf lets are borne laterally on an elongated axis called rachis which represents the midrib of the leave **Ex : Neem.**
- (2) Palmately compound leaf : In which the petiole bears leaflets at the tip (attached at acommon point) like the finger of palm Ex: Silk cotton.



(b) palmately compound leaf

## Modifications of leaves :

- (1) Leaf tendrils : These are thread like sensitive structures, which can coil around a support to help the plant in climbing. Ex: Pisum sativum, Lathyrus odoratus.
- (3) **Phyllode :** It is a flattened, green petiole, which performs the function of food synthesis instead of lamina because the latter is absent. **Ex: Australian acacia, Parkinsonia.**
- (3) Leaf spines : The leaf parts become changed into spines in order to protect the plant from grazing animals and excessive transpiration. Ex: Aloe vera, Solanum xanthocarpum, Opuntia, Asparagus.





(5) Leaf pitcher : The lamina is modified to form a large pitcher. Which is useful for catching and digesting insects. Ex: Nepenthes.



**Protection spines** 

modified into spines



Fig :- Leaf Pitchers : Nepenthes

- (6) Scaly leaves : These are small, dry whitish or brownish membranous leaves, which do not take part in photosynthesis. Ex: Casuarina, Ruscus.
- (7) Fleshy leaves : Found in Onion, and garlic.

	Differences between Simple leaf and Compound Leaf		
S.No.	Simple leaf	Compound leaf	
1	The lamina does not differentiate into	The lamina differentiates into two or more leaflets.	
	leaflets.		
2	The base of the leaf may have stipule.	The stipules may occur at the base of the whole	
		leaf.	
3	It may be borne in one or more planes.	Leaflets of compound leaf are always borne in one	
		plane.	
4	Simple leaves are produced on the	Leaflets of a compound leaf develop almost	
	stem in an acropetal succession.	simultaneously.	
5	A bud lies in its axil.	A bud lies in the axil of the whole leaf but the	
		individual leaflets do not bear axillary buds.	

## INFLORESCENCE

- A flower is a modified shoot in which shoot apical meristem changes to floral meristem. Internodes do not elongate and axis gets condensed and at the node floral appendages are found instead of leaves.
- v The arrangement and distribution of flowers on a plant is called inflorescence. The stalk of inflorescence is known as Peduncle.

## Types of Inflorescence :

It is of 3 types (1)Solitary

- (2)Racemose
- (3) Cymose

## (1) Solitary:

Flower occurs singly. They are of two types.
(a) Solitary Axillary : Single flower occurs in the axils of leaves. Ex: Lagenaria, China rose.
(b) Solitary terminal : Single flower occurs at the tips of main stem and its branches. Ex: Poppy, Lily. Note - Actually solitary flower is primtive feature while inflorescence is a advanced feature.

## (2) Racemose :

 Main axis of inflorescence does not end in a flower and axis continues to grow. The development of flowers is acropetal.



**Racemose inflorescence** 

Morphology of Flowering Plants (a) Corymb : An unbranched peduncle have pedicellate flowers in an acropetal fashion but the lower flowers have long pedicels than upper ones. So that all the flowers are brought to the same level. Ex: Candytuft.

(b) **Spike :** It is unbranched, elongated, simple and indefinite inflorescence in which flowers are sessile.

(c) Catkin : It is pendulous spike, which bears unisexual and sessile flowers. Ex: Mulberry.

## (3) Cymose :

v In this inflorescence the apex of the main axis terminates in a flower and further growth continues by one or more lateral branches, which also bear flower at their apex as main axis. The arrangement of flowers is **basipetal** and opening of flower is centrifugal. It is of following types.



**Cymose inflorescence** 

Differences between Racemose and Cymose Inflorescence		
S.No	Racemose	Cymose
1	Peduncle or floral	Peduncle is
	axis is monopodial	multipodial or
		sympodial
2	Flower arises	Flower originates
	laterally on	on terminal part of
	Peduncle	peduncle
3	The formation of	A definite number
	flowers is indefinite	of flowers is
		formed
4	The arrangement of	The arrangement
	flowers is acropetal	is basipetal

## (4) Special inflorescence :

(a) Cyathium : It possess a small conical recepticle surrounded by an involucre of five green or coloured bracts a single centrally placed, Achlamydeous Pedicellate & terminal female flower. Which is surrounded by numerous centrifugally arranged male flowers each male flower has a pedicel and a single stamen. Ex: Euphorbiaceae.



Fig:- Cyathium Inflorescence

(b) Verticillaster : Two cluster of flowers (each having 3-9 flowers), develop on a node in the axils of opposite leaves. Each cluster consists of a dichasial cyme with monochasial branches. The two opposite clusters often give the appearance of whorl. Ex: Ocimum, Salvia.



(c) Hypanthodium : Fleshy flask shaped receptacle forming a narrow canal and a terminal pore at one end. The pore is covered by few scales. Internally the male flowers are found towards pore while the female flowers towards the base of thalamus. Gall flowers occur in between the two groups. Ex: Banyan (Ficus bengalensis), Peepal (Ficus religiosa).



Fig:- L. S. of hypanthodium

## **FLOWER**

It is specialized modified shoot, which meant for carrying out the sexual reproduction.

## (I) Attachment of flower :

(i) Sessile : When pedicel is absent.

(ii) Pedicellate : When pedicel is present.



Parts of a flower

## (II) Bracts and bracteoles :

**Bract :** It is a leaf like structure present in the axil of flower or Inflorescence. Flowers with bracts are called bracteate and without bracts are called ebracteate

**Bracteole :** Some times thin small bract like structures are present at some point on the Pedicel of the flower. These structures are called bracteole.

## (III) Presence of floral whorl :

(a) **Complete :** A flower bears all the four types of floral organs (Calyx, Corolla, Androecium and Gynoecium) is called complete flower. **Ex: Solanum nigrum.** 

(b) Incomplete : The absence of any one or more of the floral organs makes the flower incomplete. Ex: Euphorbia sps.

## (IV) Symmetry :

(1) Actinomorphic (Radial) : A cyclic flower which can be divided into two equal vertical halves by any vertical plane is known as Actinomorphic flower. Ex: Ipomea, Dianthus, Mustard, Datura, Chilli.

(2) **Zygomorphic** (**Bilateral**) : A flower which can be divided into two equal vertical halves by one plane only is called Zygomorphic flower. **Ex: Pea,** 

## Gulmohur, Bean, Cassia.

(3)Asymmetrical (irregular): A flower which cannot be divided in to two equal parts by any vertical plane is known as acyclic or asymmetric flower. Ex: Opuntia, Canna.

#### Position of floral organs on thalamus :

- (i) Hypogynous : Ovary develops at its top called supeior ovary while other floral whorls like sepals, petals, stamens are borne successively below. It is called hypogyny. A flower having hypogyny is called hypogynous. Ex: Citrus, Mustard, China rose, Brinjal.
- (ii) **Perigynous :** Ovary and other floral organs sepals, petals and stamen lie at the same level This ovary is said to be half inferior.

Ex: Leguminosae, Plum, Peach.

(iii) Epigynous : Ovary is inferior while the other floral organs are borne at the top of the ovary as margin of thalamus grows up ward enclosing the ovary completaly and fused withit. Ex: Ray florets of Sunflower, Cucumber, Guava, Coriander.



(c) Perigynous (d) Epigynous

#### Some Important terms :

- 1. **Bisexual flower :** A flower having both Androecium and Gynoecium is described as Bisexual flower or hermophrodite.
- 2. Unisexual flower : If only one of the two essential floral organs (either androecium or Gynoecium) is present.
- 3. Monoecious plant : If both the types of unisexual flowers (staminate and pistillate) may be present on the same plant. It is called Monoecious plant. Ex: Zea mays, Ricinus communis.
- 4. **Dioecious plant :** When staminate and pistillate flower borne on different plant. It is known as Dioecious. **Ex: Date palm, Mulberry.**
- 5. **Trioecious :** A plant bearing three types male, female and bisexual separately, **Ex: Silene.**

#### Calyx :

- It is an outer most accessory whorl of flower, which is green, flattened, or foliaceous floral organ and provide protection to the other floral parts in the bud condition. Calyx are either gamosepalous (sepals united) or polysepalous (sepals free).
- The sepal, which lies in line with the mother axis, is called odd sepal. It is either anterior. Ex: Leguminosae or posterior. Ex: Petunia.

## Corolla :

It is a second accessory whorl of floral parts, which consists of petals. The latter are usually coloured help to attract the pollinator. Corolla are either **Polypetalous or gamopetalous**.

#### Aestivation :

It is the arrangement of accessory floral organs (Petals & sepals) in relation to one another in the floral bud. It is of following types.



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

- (1) **Twisted or contorted :** One margin of a petal overlaps regularly the margin of an adjacent petal and viseversa. **Ex: China rose, Lady's finger and Cotton.**
- (2) Imbricate : One petal External one internal and in the remain three petals; one margin external while their other margin is internal. Ex : Cassia, Gulmohur.
- (3) Vexillary (Papilionaceous) : In which posterior petal (standard) overlapping the two lateral petals (wings) the latter overlapping the two anterior petals (keel). Ex: Pea, Beans.
- (4) Valvate : Margins of adjacent petals touch each other with out overlapping. Ex: Mustard, Calotropis



Fig. Types of Polypetalous corolla.

- (1) Infundibuliform or funnel shaped : It is gamopetalous corolla having funnel shape.Ex : Petunia.
- (2) Bell shaped or Companulate : Five petals fused to form bell shaped corolla.

Ex: Cuscuta, Companula

- (3) Wheel-shaped or Rotate : With short tube having limbs placed transversely like the spoke of wheel. Ex: Solanum nigrum.
- (4) **Tubular :** Corolla is modified into tube like structure. **Ex: Disc floret of sunflower.**

#### Androecium :

 Male reproductive organ of flower and it consists of one or more stamens.Stamen is a part of flower, which

produces pollen. Each stamen is made up of a stalk like filament and knob like Anther and connective.

Usually each Anther has two lobes. It is called Dithecous. Ex: Most of the plants. In some plants, Anther has only one lobe. It is known as Monothecous. Ex: China rose (Malvaceae family). Each lobe has two chambers called pollen sacs & pollen grains are found in it.

#### **Cohesion of stamens :**

Fusion among themselves.

(1) Polyandrous : Stamen free Ex: Papaya.



**Diadelphous** 

Monadelphous





(2) Monoadelphous : The stamen are fused by means of their filaments in one bundle. Ex: China rose, Althea.

- (3) Diadelphous : When the filaments are fused into two bundles & the anther remain free.Ex: Pea.
- (4) Polyadelphous : When the filaments are united into more than two bundles but anthers are free. Ex: Lemon, Citrus.
- (5) **Syngenesious :** Stamens are fused by Anther only. The filaments are free. **Ex: Sonchus.**
- (6) **Synandrous :** Stamen are united by both their Anthers as well as filaments. **Ex: Cucurbita.**

#### Adhesion of stamens :

Fusion with other floral parts.

- Epipetalous : In which stamen are fused to the petals. Ex: China rose, Solanum, Ocimum, Brinjal
- (2) Epiphyllous : When stamens are united to parianth. Ex: Asphodelus, Lily.
- (3) **Gynandrous :** In which stamens are attached to Carpels, either throughout their whole length or by their anthers only. **Ex: Calotropis.**

## Attachment of filament to the Anther :



Fig :- Types of Attachment of filament to the anther

- (1) **Dorsifixed :** The filament is firmly fixed to the back of the Anther. **Ex: Bauhinia variegata.**
- (2) **Basifixed :** The filament is fixed to the base of the Anther. **Ex: Mustard.**
- (3) Adnate: The filament Joints throughout the length of the Anther. Ex: Ranunculus, Magnolia, Nymphaea.

(4) Versatile : The filament is attached to the back of the Anther and the Anther can swing freely. Ex: Grasses.

## Gynoecium :

v It is female reproductive organ of flower. Which is made up of one or more carpels.

## Carpel:

- It is a structural unit of compound pistil, which is leaf like and bears ovules at its margins. It consists of swollen ovary, a stalk like style and terminal receptive part stigma.
- When gynoecium bears only one carpel. It is called Monocarpellary, two-bicarpellary, threetricapellary, many-polycarpellary.

## **Cohesion of carpels :**

- (1) Apocarpous : Carpels free. Ex: Ranunculus, Rose, Lotus.
- (2) Syncarpous : Carpels more than two and fused.Ex: Most of the plants (mustard, tomato)

## Number of locules :

Ovary has locules and may be unilocular, bilocular, trilocular, tetralocular, pentalocular or Multilocular.

## **Placentation :**

The arrangement of ovules on placenta with in the ovary is called placentation.

- (i) Marginal: It is found in monocarpellary gynoecium. In which placenta developing along the junction of the two margins of the carpel on which one or two alternate rows of ovules occur. Ex: Pea, Cassia, Acacia.
- (ii) Parietal : Ovary is one chambered. Two or more longitudinal placentae develop along the wall of a syncarpous pistil. The numbers of placentae correspond to the number of fusing carpels. Ex: Radish, Papaya. Parietal placentation is found in family Cruciferae. In which a false septum called replum develops between the two parietal placentae resulting the ovary becomes bilocular mustard, Argemene.

- (iii) Axile placentation : It is found in syncarpous pistils. The ovary is partitioned into two or more chambers. Placentae occur in the central region where the septa meet so that on axile column bearing ovules is formed. Ex: Potato, Tomato, China rose, Lemon.
- (iv) Free central : The pistil is polycarpellary and syncarpous but the ovary is unilocular. The ovules are borne around a central column, which is not connected with the ovary wall by any septum. Ex: Dianthus, Primrose.
- (v) **Basal :** Ovary is unilocular and the placenta develops at the base of ovary on thalamus and bears a single ovule. **Ex: Sunflower, Marigold.**



## Types of placentation :(a) Marginal (b) Axile (c) Parietal (d) Free central (e) Basal

(vi) Superficial : The ovules develop on the septa, if present. Superfecial placentation is found in both monocarpellary (Ex: Butomus) and Syncarpous (Ex: Nymphaea) pistils.

## **Thalamus :**

 It is the swollen and broaden part of flower, which lies at the tip of pedicel and bears floral organs. It is similar to a dwarf shoot in which growth is definite and the internodes are very short.

#### **Point of Remember**

- 1. Sterile and undeveloped stamens are known as Staminodes.
- 2. The shoot on which the flower is borne is called Mother axis. The side of the mother axis is posterior.
- 3. When the different parts of each series of a flower are similar in size, shape, colour and origin then the flower is known as Regular flower.
- 4. When a flower shows any irregularity in any types of its floral organs, whether in size, shape, colour or origins is termed as irregular flower.
- 5. Study of flowers is called Anthology.
- 6. Lotus or Nelumbo nucifera is National flower of India.
- 7. Longest style takes place in Maize or Zea mays.

#### **FRUIT**

- Fertilized and ripened ovary is called fruit and it consists of pericarp (fruit wall) and seeds developed after fertilization. Study of fruits is called Pomology.
- v Three basic types of fruits are

(i) **True fruits or Eucarps :** They develop from superior ovary containing functional seeds but no additional floral parts fused with them **Ex: Mango.** 

(ii) False fruits or Pseudocarps : They develope from inferior ovary. Additional floral parts are fused with pericarp. Ex: Apple.

(iii) **Parthenocarps :** Fruits are developed without fertilization hence functional seeds are absent **Ex: Banana.** 

THE FRUIT

The fruit is a characteristic feature of the flowering plants. It is a mature or ripened ovary, developed after fertilisation. If a fruit is formed without fertilisation of the ovary, it is called a parthenocarpic fruit. Generally, the fruit consists of a wall or pericarp and seeds. The pericarp may be dry or fleshy. When pericarp is thick and fleshy, it is differentiated into the outer epicarp, the middle mesocarp and the inner endocarp.



#### Fig. Parts of a fruit : (a) Mango (b) Coconut

In mango and coconut, the fruit is known as a drupe (Figure) They develop from monocarpellary superior ovaries and are one seeded. In mango the pericarp is well differentiated into an outer thin epicarp, a middle fleshy edible mesocarp and an inner stony hard endocarp. In coconut which is also a drupe, the mesocarp is fibrous.

#### <u>SEED</u>

v The ripened ovule is called seed. The latter bears embryo or miniature plant. It has adequate reserve food for further development of the embryo and a covering for protection against pathogens, mechanical injury, loss of water. The study of seed is called spermology.

#### Structure of seed :

 Seed is surrounded by one or two protective coats. Out of them outer is testa and inner is tegmen. Both coat are absent at one point that is called micropyle.

- The part of seed except seed coat is called kernel.
   The latter is composed of embryo with or without endosperm.
- Embryo contains an embryo axis or tigellum with plumule (future shoot) at one end and radicle (future root) at the other end. The part of tigellum between the radicle and cotyledonary node is called hypocotyl while the one between plumule and cotyledonary node is called epicotyl. The tigellum has a node on which one or two cotyledons present.

#### Structure of Monocotyledonous Seed :

Generally, monocotyledonous seeds are endospermic but some as in orchids are nonendospermic. 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 (Fig.).



Fig: Structure of a monocotyledonous seed

In monocot seeds, the membranous covering around **radicle** is called **coleorrhiza** and around **plumule** is called **coleoptile**.

v



#### Fig: Structure of dicotyledonous seed



Fig:- Structure of Maize grain. L.S. or V.S of grain.

v On the basis of absence or presence of endosperm,the seeds are of two types

#### (1) Non endospermic or exalbuminous seeds :

Endosperm is completely consumed during development of the embryo, thus the seeds are called nonendospermic or exalbuminous **Ex: dicots(gram, pea, groundnut).** The seed coat is formed by integuments. The outer seed coat forms testa and inner seed coat forms tegmen. The food is stored in the cotyledons.

#### (2) Endospermic or albuminous seeds :

In monocots and castor bean (dicots) embryo does not consume all endosperm. So it persists in the mature seed. Such seeds are called endospermic or albuminous seeds. In these seeds food is stored in endosperm.

 Perispermic seeds : Mostly nucellus is consumed after fertilization due to absorption of food by the endosperm and embryo. The remains of nucellus in the seed is called perisperm. Such seeds are called perispermic seeds Ex: Piper nigrum (Black pepper).

#### Floral formula :

Position, number, structures, cohesion, adhesion of different parts of flower are represented as a formula through specific signs. It is called floral formula.

#### (i) Bracts (Br)

Br	Bracteate
Ebr	Ebracteate

#### (ii) Bracteoles (Brl)

Brl	Bracteolate
Ebrl	Ebracteolate

#### (iii) Symmetry of the flower

⊕ Actinomorphic⊕ or % Zygomorphic

## (iv) Sex

്	Staminate (male)
ç	Pistillate (female)
ð	Hermaphrodite

## (v) Calyx(K)

K <sub>5</sub>	5 sepals, polysepalous
K <sub>(5)</sub>	5 sepals, gamosepalous
K <sub>2+2</sub>	4 sepals in 2 whorls of 2 each

#### (vi) Corolla (C)

C <sub>5</sub>	5 petals, polypetalous
C <sub>(5)</sub>	5 petals, gamopetalous
C <sub>2+2</sub>	4 petals in 2 whorls or 2 each

#### (vii) Perianth (P)

P <sub>6</sub>	6 tepals, polytepalous
P <sub>(3+3)</sub>	6 tepals, gamotepalous
P <sub>3+3</sub>	6 tepals, in 2 whorls or 3, 3 each

#### (viii) Androecium (A)

A <sub>6</sub>	6 stamens, polyandrous
$A_{2+4}$	6 stamens in 2 whorls of 2 and 4 each
$A_0$	stamens absent
$A_{\alpha}$	stamens indefinite
$A_{(\alpha)}$	monoadelphous
A <sub>1+(9)</sub>	diadelphous
A <sub>(5)</sub>	5 stamens, syngenesious
A <sub>(5)</sub>	5 stamens, synandrous
ĈÀ	epipetalous
ΡÂ	epiphyllous

## (ix) Gynoecium

$G_0$	Gynoecium absent
$G_2$	2 carpels, apocarpous
G <sub>(2)</sub>	2 carpels, syncarpous
$\underline{\mathbf{G}}_{(2)}$	bicarpellary, syncarpous, superior
G <sub>(2)</sub>	bicarpellary, syncarpous, semi-inferior
$\overline{G}_{\scriptscriptstyle(2)}$	bicarpellary, syncarpous, inferior.

## DESCRIPTION OF SOME IMPORTANT FAMILIES

#### FABACEAE

This family was earlier called Papilonoideae, a subfamily of family Leguminosae. It is distributed all over the world

#### **Vegetative Characters**

Trees, shrubs, herbs; root with root nodules

Stem: erect or climber

**Leaves:** alternate, pinnately compound or simple; leaf base, pulvinate; stipulate; venation reticulate.



Fig.- Pisum sativum (pea) plant : (a) Flowering twig (b) Flower (c) Petals(d) Reproductive parts (e) L.S.carpel (f) Floral diagram

## **Floral characters**

Inflorescence: racemose

Flower: bisexual, zygomorphic

**Calyx:** sepals five, gamosepalous; imbricate aestivation

**Corolla:** petals five, polypetalous, papilionaceous, consisting of a posterior standard, two lateral wings, two anterior ones forming a keel (enclosing stamens and pistil), vexillary aestivation

Androecium: ten, diadelphous, anther dithecous

**Gynoecium:** ovary superior, mono carpellary, unilocular with many ovules, style single

Fruit: legume; seed: one to many, non-endospermic

Floral Formula: 
$$\bigoplus \mathbf{Q}^{\mathbf{T}} \mathbf{K}_{(5)} \mathbf{C}_{1+2+(2)} \mathbf{A}_{(9)+1} \mathbf{\underline{G}}_{1}$$

## **Economic importance**

Many plants belonging to the family are sources of pulses (gram, arhar, sem, moong, soyabean; edible oil (soyabean, groundnut); dye (indigofera); fibres (sunhemp); fodder (Sesbania, Trifolium), ornamentals (lupin, sweet pea); medicine (muliathi).

## SOLANACEAE

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

#### **Vegetative Characters**

Plants mostly, herbs, shrubs and small trees

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

**Leaves:** alternate, simple, rarely pinnately compound, exstipulate; venation reticulate



FIg.– Solanum nigrum (makoi) plant :
(a) Flowering twig (b) Flower (c) L.S. of flower
(d) Stamens (e) Carpel (f) Floral diagram

## **Floral Characters**

**Inflorescence :** Solitary, axillary or cymose as in Solanum

Flower: bisexual, actinomorphic

Calyx: sepals five, united, persistent, valvate aestivation

Corolla: petals five, united; valvate aestivation

Androecium: stamens five, epipetalous

**Gynoecium:** bicarpellary, syncarpous; ovary superior, bilocular, placenta swollen with many ovules

Fruits: berry or capsule

Seeds: many, endospermous

Floral Formula: 
$$\oplus \overset{\frown}{Q}^7 K_{(5)} \stackrel{\frown}{C_{(5)}} A_{(5)} \stackrel{\frown}{\underline{G}_{(2)}}$$

#### **Economic Importance**

Many plants belonging to this family are source of food (tomato, brinjal, potato), spice (chilli); medicine (belladonna, ashwagandha); fumigatory (tobacco); ornamentals (petunia).

#### LILACEAE

Commonly called the 'Lily family' is a characteristic representative of monocotyledonous plants. It is distributed world wide.

**Vegetative characters:** Perennial herbs with underground bulbs/corms/rhizomes

**Leaves** mostly basal, alternate, linear, exstipulate with parallel venation





Fig.– Allium cepa (onion) plant : (a) Plant (b) Inflorescence (c) Flower(d) Floral diagram

#### **Floral characters**

**Inflorescence:** solitary/cymose; often umbellate clusters

Flower: bisexual; actinomorphic

**Perianth** tepal six (3+3), often united into tube; valvate aestivation

Androcium: stamen six, (3+3)

**Gynoecium:** tricarpellary, syncarpous, ovary superior, trilocular with many ovules; axile placentation

Fruit: capsule, rarely berry

Seed: endospermous

Floral Formula: 
$$\bigoplus \mathbf{q}^{\mathbf{q}} P_{3+3} A_{3+3} \underline{G}_{(3)}$$

#### **Economic Importance**

Many plants belonging to this family are good ornamentals (tulip, Gloriosa), source of medicine (Aloe), vegetables (Asparagus), and colchicine (Colchicum autumnale).