MORPHOLOGY OF FLOWERING PLANTS

INTRODUCTION

- Angiosperms show a large diversity in morphology.
- A plant has root system and shoot system.

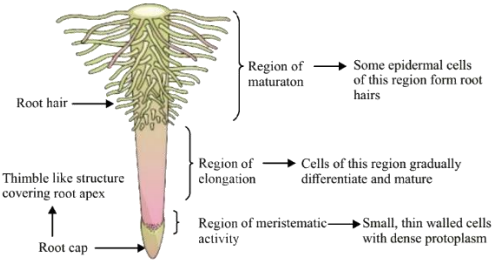
ROOT

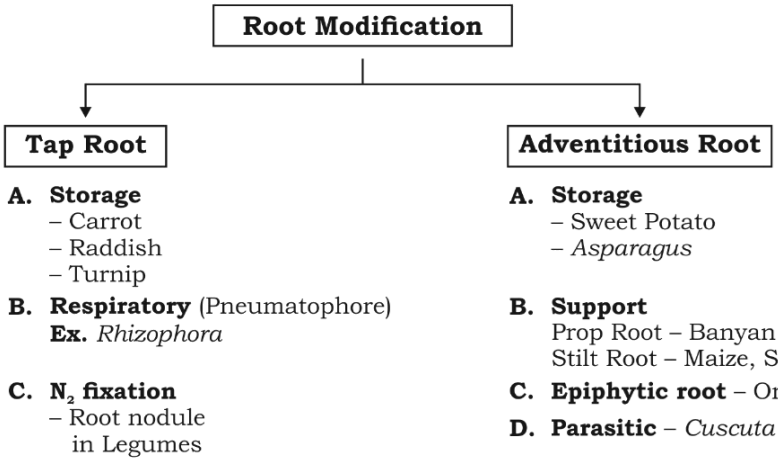
- Elongation of radicle form primary root.
- Primary root bears lateral roots of several orders that are referred to as secondary, tertiary etc. roots.

TYPES OF ROOTS

- **Tap root system:**
  - Includes primary root and its branches
  - Seen mainly in dicots e.g., Mustard
- **Fibrous root system:** In monocots, primary root is short lived and replaced by a large number of roots originate from the base of the stem.
- **Adventitious roots:** Roots that arise from parts of plants other than radicle eg. grass, *Monstera* and banyan tree.
- **Functions:**
  - ➢ Absorption of water and minerals from soil.
  - ➢ Provide anchorage to plant parts.
  - ➢ Storage of reserve food materials.
  - ➢ Synthesis of plant growth regulators (PGRs)

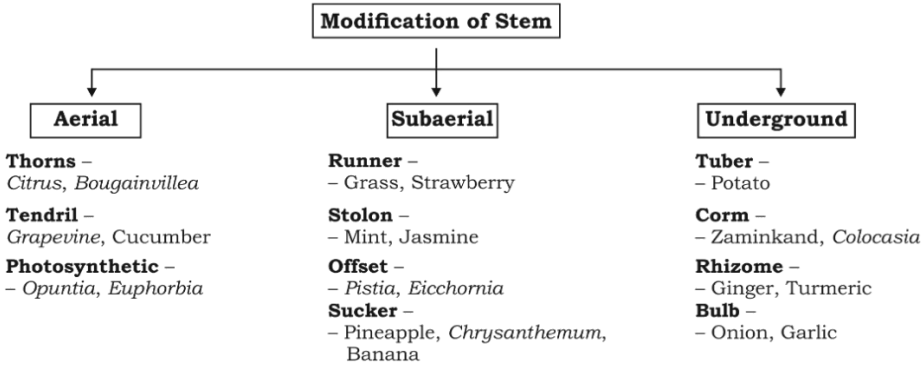
REGIONS OF ROOT





STEM

- Develops from plumule.
- Bears nodes, internodes, buds (terminal or axillary).
- **Functions:**
  Spread out branches bearing leaves, flowers, fruits
  Conducts water, minerals and photosynthates



LEAF

- Lateral generally flat structure, develops at node and bear a bud in its axil.
- Arise from shoot apical meristem and arranged in **acropetal** order.
- Consist of 3 parts: Leaf base, Petiole and Lamina.
- **Stipules:** Two lateral small leaf like structures at leaf base.
- **Pulvinus:** Leaf base may become swollen in leguminous plants.

Types of Leaves

- **Simple Leaf:** Lamina is entire or when incised, incision do not reach midrib.
- **Compound Leaf:** Incision of lamina reaches up to the midrib breaking it into leaflets. It is of two types
  (*i*) **Pinnately compound–**Leaflets are present on a common axis, the rachis. eg. Neem
  (*ii*) **Palmately compound–**Leaflets are attached at a common point i.e. at the tip of petiole. eg. Silk cotton

Venation

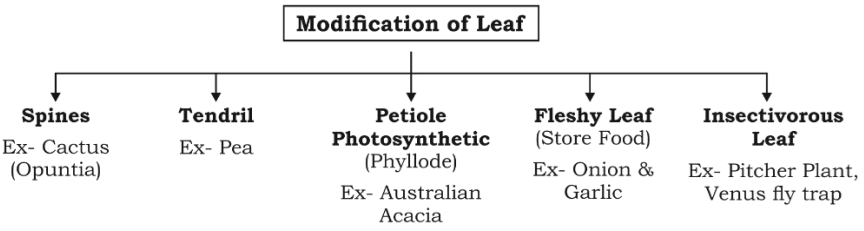
Reticulate

- Veinlets form network
- eg. generally in dicots

Parallel

- Veins run parallel to each other
- eg. most monocots

LEAF



Phyllotaxy

Alternate: Single leaf at each node arranged in alternate manner e.g., China rose, mustard, sunflower

Opposite: Pair of leaves arise at each node e.g., Guava, *Calotropis*

Whorled: More than two leaves arise at each node e.g., *Alstonia*

INFLORESCENCE

- Flower is a modified shoot
- During flowering
  - Shoot apical meristem modifies into floral meristem
  - Internode do not elongate and axis gets condensed
- **Solitary flower:** Shoot tip transforms into a flower
- **Inflorescence:** Arrangement of flowers on floral axis

Two major types

Racemose

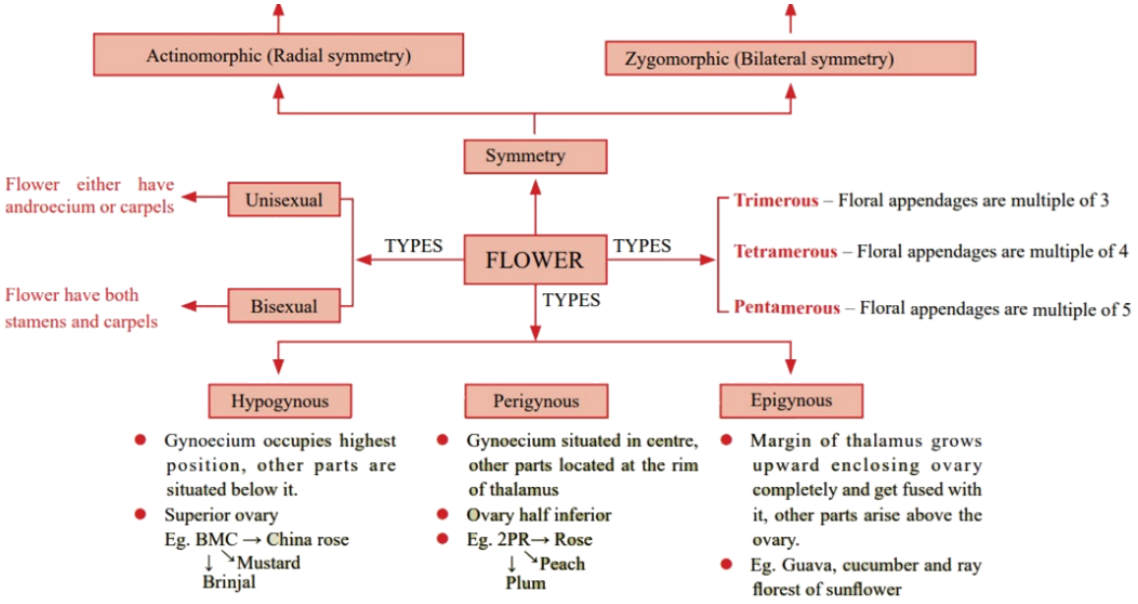
- Main axis continues to grow
- Flowers borne laterally in **acropetal** succession

Cymose

- Main axis terminates into a flower (limited growth)
- Flowers borne in **basipetal** succession

Flower can divided into two equal halves in any plane passing through centre e.g., Chilli,

Flower can be divided into two similar halves only in one particular vertical plane e.g., Pea,



A Flower is asymmetric (irregular if it cannot be divided into similar halves by any vertical plane passing through the centre. e.g., Canna

PARTS OF A FLOWER

Calyx

- Outermost whorl
- Members called sepal
- Protect flower in bud stage
- Generally green

May be

- Gamosepalous (sepals united)
- Polysepalous (sepals free)

Corolla

- Members called petals
- Brightly coloured

May Be

- Gamopetalous (petal united)
- Polypetalous (petals free)

Androecium

- Composed of stamens
- Stamens consist of **filament + anther**
- Each anther is bilobed and each lobe has two chambers
- Sterile stamen - Staminode
- Male reproductive part

Gynoecium

- Made of one or more carpels
- Consist of stigma, style and ovary
- Each ovary bears one or more ovules attached to a flat cushion like placenta.
- Carpels may be free, **apocarpous** (e.g,. lotus, rose) or united, **syncarpous** (tomato, mustard)
  When calyx and corolla are not distinct termed as **perianth** (unit tepal) eg. lily.

Aestivation: Made of arrangement of sepals or petals in floral bud w.r.t. other members of the same whorl.

TYPES

Valvate

- Sepal/petals in a whorl just touch one another at the margin without overlapping eg. *Calotropis*.

Twisted

- One margin of the appendage overlaps the next one and so on.
- eg. China rose, lady's finger, cotton.

Imbricate

- Margins of sepals of petals overlap one another but not in any particular direction.
- eg. *Cassia*, gulmohur.

Vexillary

- Five petals, one largest **(standard)** overlaps two lateral petals **(wings)** which in turn overlap two smallest anterior petals **(keel)**
- e.g., Pea, bean

STAMEN

Attachment with other floral whorl

- **Epipetalous :** Attachment with petals (brinjal)
- **Epiphyllous :** Attachment with perianth (lily)

Attachment with each other

Free

- **Free :** Polyandrous
- **Monoadelphous :** United with each other in one bundle e.g., China rose
- **Diadelphous :** United in two bundles e.g., Pea
- **Polyadelphous :** United in more than two bundles

There may be a **variation in the length of filaments** within a flower as in **Salvia** and **mustard**.

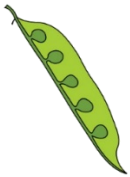
PLACENTATION

Arrangement of ovules within the ovary

Types

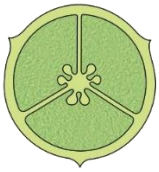
Marginal

Placenta forms a ridge along ventral suture of ovary and ovules are borne on if forming two rows e.g., pea



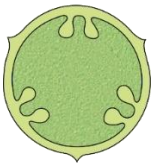
Axile

Placenta axial ovules attracted on it in a multilocular ovary. e.g., China rose tomato, lemon



Parietal

Ovules develop on inner wall of ovary or on peripheral part Ovary is one chambered but become two chambered due to **false septum** e.g., Mustard, *Argemone*

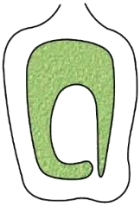


Free Central

Ovules are borne on central axis and septa are absent e.g., *Primrose, Dianthus*

Basal

Placenta develops at the base of ovary and a single ovule is attached to it e.g., Sunflower, marigold



FRUIT AND SEED

Ovule

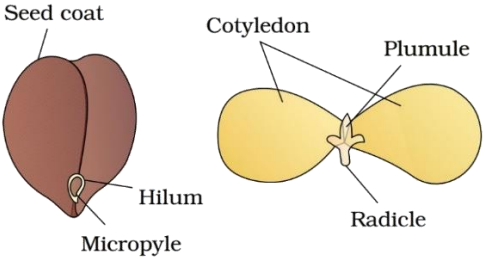
Turns into seed

SEED COAT (TESTA, TEGMEN)

Embryo

Dicot Seed

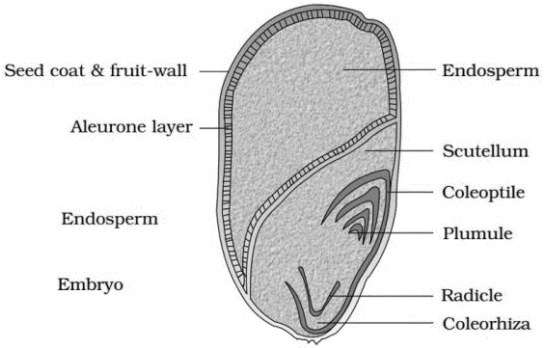
- Contains two cotyledons
- Usually lack endosperm except castor
- Embryo consists of embryonal axis (radicle + plumule) and 2 cotyledons
- **Hilum** is a scar on the seed coat.
- Above hilum is a small pore called **micropyle**
  E.g., Bean, gram, pea



MONOCOT SEED

- Single large shield shaped cotyledon called scutellum
- Endospermous in orchid non-endospermic

- In cereals, seed coat is membranous and generally fused with fruit wall
- In maize, endosperm is bulky and stores food. The outer covering of endosperm separates the embryo by a proteinaceous layer called aleurone layer.



OVARY

- Ripens into fruit
- Fruit

SEEDS

Pericarp

- May be dry or fleshy
- Divide into
  - ♦ Epicarp
  - ♦ Mesocarp
  - ♦ Endocarp

Parthenocarpic fruit : Fruit formed without fertilization.

Mango and coconut are **drupe** type of fruits, develop from **monocarpellary**, **superior ovaries** and one **seeded**, In mango, mesocarp is fleshy edible and in coconut, it is fibrous. Both have hard stony endocarp

DESCRIPTION OF SOME IMPORTANT FAMILIES

Fabaceae

- Earlier called Papillionoideaea, subfamily of Leguminosae

- **Stem:** Erect or climber
- **Leaves:** Alternate, pinnately compound pulvinate, stipulate, reticulate venation
- **Inflorescence :** Racemose
- **Flower:** Bisexual, zygomorphic
- **Calyx:** 5, gamosepalous, valvate/imbricate aestivation
- **Corolla:** 5, polypetalous, papilionaceous corolla, vexillary aestivation
- **Androecium:** 10. diadelphous, anther dithecus
- **Gynoecium:** Superior ovary, monocarpellary, unilocular, many ovules, marginal placentation
- **Fruit and seed :** Legume, non-endospermic seed
- **Floral formula :** $\%\,\male\female\, K_{(5)}\, C_{1+2+(2)}\, A_{(B)+1}\, G$

Solanaceae

- Commonly called potato family
- **Stem:** Herbaceous, rarely woody solid/hollow, hairy, underground as in potato
- **Leaves:** Alternate, simple, rarely pinnate, reticulate venation
- **Inflorescence :** Solitary, axillary or cymose as in *Solanum*
- **Flower:** Bisexual, actinomorphic
- **Calyx:** 5, gamosepalous, persistent, valvate aestivation
- **Corolla:** 5, gamopetalous, valvate aestivation
- **Androecium:** 5, epipetalous
- **Gynoecium:** Bicarpellary, obliquely placed, syncarpous. superior, bilocular, placenta swollen, axile placentation, many ovules
- **Fruit and seed :** Berry/capsule, endospermous seed
- **Floral formula :** $\oplus\male\female\, K_{(5)}\, \overbrace{C_{(5)}\, A_3}\, G_{(2)}$

Liliaceae

- A monocotyledonous family also called lily family
- **Stem:** Underground bulbs/corms/rhizome
- **Leaves:** Mostly basal, alternate, linear, exstipulate, parallel venation
- **Inflorescence:** Solitary/cymose, often umbellate clusters
- **Flower:** Bisexual, actinomorphic

- **Perianth:** Tepal 6(3 + 3), often united in tube, valvate aestivation
- **Androecium:** 6(3 + 3). epitepalous
- **Gynoecium:** Tricarpellary, syncarpous, superior ovary, trilocular, axile placentation, many ovules
- **Fruit and seed:** Capsule rarely berry, endospermous seeds
- **Floral formula :** $Br \oplus ⚥ \; \overbrace{P_{(3+3)} A_{3+3}} \; G_{(3)}$

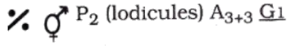
Brassicaceae :

- **Vegetative Character :** Stem are typically **erect**, leaf simple and alternate.
- **Inflorescence:** Racemose type
- **Flower**: Bisexual, complete, actinomorphic, tetramerous.
- **Calyx**: 4 sepals, polysepalous, arranged in two whorls of two each, imbricate aestivation.
- **Corolla**: 4 petals, polypetalous.
- **Androecium**: 6 stamens, polyandrous, stamens.
- **Gynoecium**: Bicarpellary (two carpels), syncarpous, ovary superior.
- **Fruits**: Siliqua or silicule.
- **Seed**: small, round to oval or elongated, non-endospermic with large curved embryo, cotyledons are oily.
- **Example** : Mustard, Cabbage, Raddish, Turnip, Cauliflower.
- **Floral formula :** $\oplus ⚥ \; K_{2+2} \, C_4 \, A_{2+4} \, \underline{G}_{(2)}$

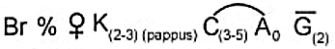
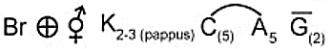
POACEAE (GRAMINEAE) MONOCOTYLEDONS

- **Vegetative Characters :** Plants are generally annual herbs, stem, cylindrical with clear nodes and hollow internodes, leaves, simple, alternate, parallel venation.
- Inflorescence spike of spikelet, panicle of spikelets, spadix of spikelets.
- Flowers small, sessile, surrounded by two scales, lemma (inferior or outer palea) and palea (superior or inner palea). The lemma bear a long, stiff process called awn.
- Flowers zygomorphic, incomplete, hypogynous, Trimerous.
- Perianth generally represented by two lodicules.
- Androecium 3 or 6, polyandrous, dithecous.
- Tricarpellary, superior, unilocular ovary with basal placentation, stigma feathery.

- Fruit is caryopsis or nut or berry.
- Seed endospermous, one cotyledon – scutellum present.
- **Example –** Wheat, Rice, Maize, Sugarcane, Oat, Bamboo, Grass.
- **Floral formula :**



ASTERACEAE (COMPOSITAE)

- **Vegetative Characters :** Stem erect, hairy, woody or prostrate, leaves petiolate or sessile exstipulate.
- Inflorescence head or capitulum with ray and disc florets surrounded by involucral bracts.
- Flowers small, sessile and are called florets.
- Flowers epigynous.
- Calyx modified into hair like structure-pappus.
- Ray florets are zygomorphic, ligulate, neuter or pistillate.
- Disc florets are sessile, bracteate, actinomorphic and tubular.
- Androecium 5, epipetalous.
- Bicarpellary, syncarpous, inferior ovary unilocular with basal placentation.
- Fruit is cypsella.
- The seed is endospermic.
- Example – Sunflower, Marigold, Chrysanthemum.
- Floral formula of Ray floret : 
- Floral formula of Disc floret : 

Malvaceae :

- **Vegetative Characters :** The plant are generally herbs, shrubs (Hibiscus, Cotton), stem branched erect, leaf alternate, petiolate, stipulate, simple.
- Flower : Pedicellate, bracteate, bracteolate in the form of epicalyx, bisexual rarely unisexual, complete, actinomorphic, pentamerous, hypogynous.
- They have five valvate sepals (gamosepalous)
- Five imbricate petals (polypetalous)

- Stamens can be 5 to numerous in number, monoadelphous.
- The pistil is composed of two to numerous carpels
- The ovary is at the superior position
- The placentation is axile.
- Fruit : Schizocarpic carcerulus, capsule (Hibiscus, Cotton), berry.
- Seed : Non-endospermic.
- Example – Cotton, *Hibiscus*, Lady's finger.
- Floral formula : $\oplus$ ⚥ $Epi_{3\rightarrow 8}\, K_{(5)}\, \overset{\frown}{C_{(5)} A_{\infty}}\, G_{(2-\infty)}$

ECONOMIC IMPORTANCES

Fabaceae

- **Pulses:** (Gram, arhar, sem, moong, soyabean)
- **Edible oil:** (Soyabean, Groundnut)
- **Dye:** (*Indigofera*)
- **Fibres:** (Sunhemp)
- **Fodder:** (*Sesbania Trifolium*)
- **Omamental:** (Lupin, sweat pea)
- **Medicine:** (Muliathi)

Solanaceae

- **Food:** (Tomato, potato, brinjal)
- **Spice:** (Chilli)
- **Medicine:** (Belladonna, Ashwagandha)
- **Fumigatory:** (Tabacoo)
- **Ornamental:** (*Petunia*)

Liliaceae

- **Vegetable:** (*Asparagus*)
- **Medicine:** (*Aloe*)
- **Ornamental:** (Tulip, *Gloriosa*)
- **Colchicine:** (*Calchicum autumnale*)