Morphology of Flowering Plants

Morphology of Root :

- The root system of a flowering plant begins its **development from the Radicle** of the embryo of the seed which gives rise to the **Primary root.**
- They do not bear leaves and buds and are not distinguished into nodes and internodes.

Parts of a Typical Root :

Root cap:

- Root cap is thickened, **thimble shaped protective cap**
- The cells of root cap secrete **mucilage / mucigel** which lubricates the passage of root through the soil.
- Possesses starch grains – for **graviperception**
- **Multiple root caps** are present in **Screwpine**
- In aquatic plants ((**Pistia** and **Eichhornia**) root cap is replaced by a loose finger gloves like thimble shaped structure called **root pocket. (**Not regenerated)

Meristematic zone or zone of cell division:

- It is a small region and about 1mm long located behind the root cap (sub-terminal).

Zone of elongation:

- The cells of this zone do not divide, and elongate rapidly.

Zone of cell maturation (differentiation):

- It is called as root hair zone.
- It forms the bulk of the root.

Kinds of Root Systems :

- **Tap root system** is more common in **dicots** and **gymnosperms**
- **Adventitious root system** is more prevalent in **monocots** and **pteridophytes** .

Tap Root System	Adventitious Root System
Given birth by the radicle of the embryo.	Given birth by any part of the plant other than radicle of the embryo.
Always underground	**May be underground or aerial.**
Consists of a single primary(main) root.	Consists of roots forming a cluster.
Primary (main) root produces distinct secondary roots ,tertiary roots, and rootlets in acropetal succession.	Primary (main) root absent and there is no such distinction.
Primary (main) root is very thick as compared to secondary or tertiary roots.	All roots of a cluster are generally identical being fibrous in appearance.
Primary root is persistent.	**Primary roots though develops but is short –lived.**
It may be **surface feeder** or **deep feeder**, the deep feeder being the usual feature.	If underground, it is usually surface feeder.

Tap Root Modifications :

1. Conical:

- Here the fleshy tap root resembles a cone
- **Carrot**

2. Fusiform:

- The root is spindle-shaped
- **Radish**

3. Napiform:

- This type of fleshy root is thickest at the base and takes the spherical shape.
- **Turnip** shalgam **Brassica rapa**
- **Beet** chukandar **Beta vulgaris**

4. Tuberous roots:

- These do not assume any definite form.
- **Mirabilis jalapa**

5. Nodulated) Roots :

- Roots in **Gram Groundnut Barseem** and **Pea**
- These contain nitrogen fixing bacteria Rhizobium leguminosarum

6. Respiratory or breathing roots :

- They are present in mangrove vegetation
- The primary root bears **horizontally growing cable roots** which in turn bears vertically growing negatively geotropic branches called **pneumatophores.**
- **Avicennia Heritiera (sundri) Rhizophora**

Adventitious Root Modifications :

1. Tuberous roots :

- Single root tuber irregular shape
- **Sweet potato** (**Ipomoea batatas**)

2. Fasciculated roots:

- The swollen roots or root tubers occur in clusters.
- **Asparagus**

3. Prop / Pillar / Columnar roots:

- These are large pillar–like roots, which appear from large horizontal branches in trees
- **Mangroves Ficus**

4. Slit roots (Brace roots):

- They are short but thick supporting roots which develop obliquely from the basal nodes of the stem
- **Sugarcane Maize Sorghum**

5. Clinging or climbing roots:

- Certain weak stemmed climbers bear roots that aid the plant in climbing.
- **Pothos (money plant) Piper betle**

6. Photosynthetic or Assimilatory roots :

- **Trapa**

7. Parasitic or Haustorial roots:

- **Cuscuta** **dodder** Amar bel

8. Epiphytic roots (Hygroscopic roots):

- The roots occur in epiphytes also called as space parasites.
- The epiphytic roots are thick, irregular and hang down in the air.
- They possess a covering of dead spongy tissue known as **velamen**.
- **Vanda**

9. Leaf roots:

- **Salvinia** **Bryophyllum**

10. Reproductive roots:

- These roots develop adventitious buds which grow into new plants
- **Sweet potato** **Dahlia**

Rootless plants:

- **Hydrilla** **Utricularia** **Pistia** **Wolffia**

Stem :

- The branches develop from buds and are **exogenous in origin**.
- **Hair,** if present are generally **multicellular.**
- In some cases, stem is unbranched and called as **caudex** Ex : Cocos nucifera, Phoenix, Sugarcane
- Erect stems with swollen nodes or jointed stems are called **culms** Ex :**Bamboo**

Buds :

According to their position, buds can be

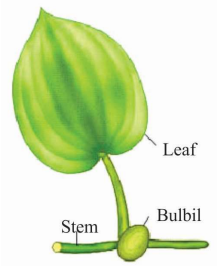
- **Terminal**
- **Lateral**
  - Extra-axillary (developing on the node but outside the leaf base)
  - Axillary (developing in the axils of leaves)
  - Accessory (additional buds occurring either on the side or above the axillary bud)

Adventitious (formed from places other than nodes).

- **Foliar - Bryophyllum, Begonia**
- **Radical - Sweet Pototo , Dalbergia,**
- **Cauline - Rose, Ficus, Jackfruit**

Bulbils

- Fleshy buds which take part in vegetative reproduction
- **Lily Agave Oxalis.**



Bulbil

Turions

- Fleshy buds functioning in perennation in aquatic plants
- **Potamogeton Utricularia**.

Upright weak Stems : They are of two kinds, **twiners** and **climbers.**

Twiners :

- The stem is long, flexible
- Tip sensitive , search for support
- Twin / coil around an upright support like a rope
- **Cuscuta**

Climbers :

- The stem is weak and flexible but is unable to coil around an upright support by itself.
- It requires the help of certain clasping or clinging structures.

Accordingly climbers are of :

- **Hook Climber : Bougainvillea**
- **Spine or thorn climber : Duranta**
- **Root climbers : Money plant Piper betel**
- **Tendril climbers :**
  - **Leaf Tendrils - Lathyrus aphaca** – jangli matter

Leaflet Tendrils Pisum Lathyrus odoratus
Petiole Tendrils - Clematis Nepenthes
Stems Tendrils –Cucurbits (Gourds (cucumber, pumpkins, watermelon) and grapevines

Prostrate or Sub-aerial weak Stems : **Trailers** and **Creepers**

Trailers / stragglers

- The shoots trail or spread horizontally along the ground without rooting at intervals.
- Rooted at one point
- **Oxalis Portulaca**

Creepers :

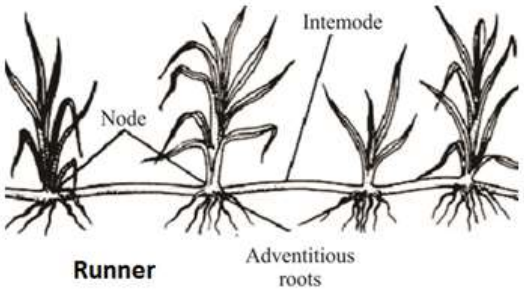
- They root at intervals while trailers do not do so.
- Creepers are of three kinds - **Runners, Stolons and Offsets.**

Runners :

- Special, narrow, green, above ground branches
- **A number of runners arise from one erect shoot**
- **Oxalis**
- **Cynodon dactylon** – doob grass
- **Grass**

Stolons :

- Elongated, horizontal or arched runners
- Grow aerially for some distance
- Form arch
- Overcome small obstacles
- **Jasmine - Jasminum**
- **Peppermint (Mentha piperita)**
- **Strawberry**



Runner


Stolon

Offsets :

- Thicker small runner
- One internode long
- Cluster of leaves above water
- Ad roots below
- **Pistia (Water Lettuce) Eichhornia (Water Hyacinth)**

Underground stems :

Rhizome :

- A **dorsiventral, elongated horizontal stem** growing beneath the surface of soil.
- Rhizomes are perennial structures.
- Rhizomes produce adventitious roots in profusion.
- Rhizomes are usually fleshy due to storage of food
- Horizontal or oblique
- Branches or unbranched
- **Lotus Ginger Turmeric (Curcuma domestica)**
- **Banana Dryopteris**

Corm :

- Vertically growing, thick, stout, spherical or sub-spherical
- Fleshy - stores reserve food material.
- Highly condensed
- Unbranched short and spherical and annual
- Nodes appear in the form of rings / circular
- Roots from basal part only
- **Colocasia Amorphophallus** (Zimikand)
- **Crocus** (Saffron) **Gladiolus Colchicum**

Sucker :

- Underground runner
- Grows horizontally in the soil and ultimately comes out to form a new aerial shoot
- Help in perennation
- **Banana Pineapple Chrysanthemum**

Bulb :

- Bulb may be regarded as a short underground stem with **fleshy leaf base** called scales.
- Stem is convex or conical in shape and bears highly compressed internodes.
- These node bear fleshy scales.
- Swollen leaf bases

Simple tunicated

- Scale leaves are arranged in a concentric manner and form a series of rings.
- Such bulbs are surrounded by a common sheath of membranous structure on outer side.
- **Allium cepa** (**Onion)** - has **sulphur allyl sulphide**

Compound tunicated

- Buds become fleshy.
- They bear their individual tunics.
- Such fleshy buds are called bulblets or cloves.
- **Allium sativum (garlic)**

Tuber (Stem Tuber) :

- Swollen tip of sucker or stolon
- Oval or spherical underground swollen stem structure
- Does not bear adventitious roots .
- Possesses number of **spirally arranged depressions** called **eyes / node.**
- Covered over by a corky skin having lenticels for aeration.
- **Potato** - **Solanum tuberosum** **Jerusalem artichoke** - **Helianthus tuberosus**

Phylloclade :

- Green, flattened or cylindrical stem and branches
- Growth unlimited and indefinite
- Fleshy and jointed
- **Opuntia** (Flattened)
- **Euphorbia** (Fleshy Cylindrical)

Cladodes or cladophylls :

- Green, cylindrical or flattened **stem branches of limited growth.**
- They are considered as phylloclades with one or two internodes.
- Limited growth
- **Asparagus Ruscus** -

Stem thorns :

- Thorns are **deep seated** structures with vascular connections.
- **Modified stem / Bud**
- **Citrus Bougainvillea**

Spines

- Leaf modification with vascular connections.

Prickles

- Develop superficially at surface of stem and are distributed irregularly as in **rose and plum** .
- Has no vascular connection

Morphology of Leaf :

- The leaves are green, flattened, thin, lateral, **exogenous appendages** borne at the nodes of the stems.
- **Leaves originate from shoot apical meristems**

Parts of a Leaf :

Lamina (epipodium)

- Leaf blade is the terminal thin, expanded, green and conspicuous part

Petiole (mesopodium)

- Cylindrical or subcylindrical stalk of the leaf.
- Leaf having **petiole** is called petiolate.
- It is termed **sessile** if the petiole is absent - **Cereals**

Leaf base (= hypopodium)

- Lowermost part of the leaf by which the leaf is joined to the node of the stem.
- **Leaf base** often contains two small lateral outgrowth called **stipules.**
- A leaf with stipules is called stipulate
- Leaf without stipules is termed as exstipulate

Ligule

- An outgrowth present **between leaf base and lamina / outgrowth on upper end of leaf sheath**
- The leaf with ligule is called **ligulate.**
- **Grasses**

Modification of leaf base :

Pulvinus :

- The swollen leaf base is known as pulvinus.
- **Legumes** **Mimosa Mango Banyan Pea Gram Cassia Fabaceae**

Sheathing leaf base :

- Leaf base may be broadened to enclose the stem / broad and flat enclosing node
- Amplexicaul and Semi -amplexicaul

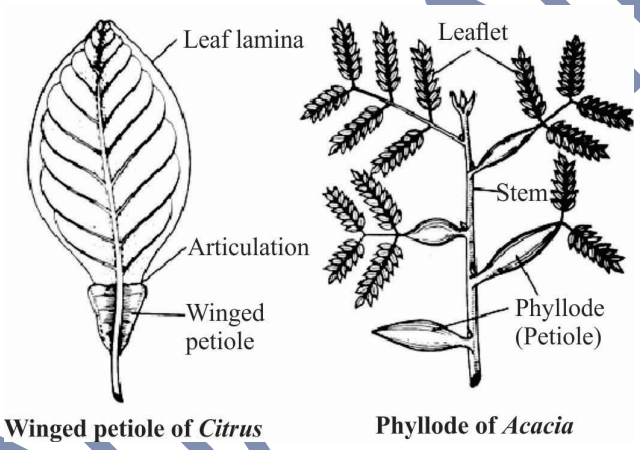
- **Grasses** Wheat

Modification of petiole :

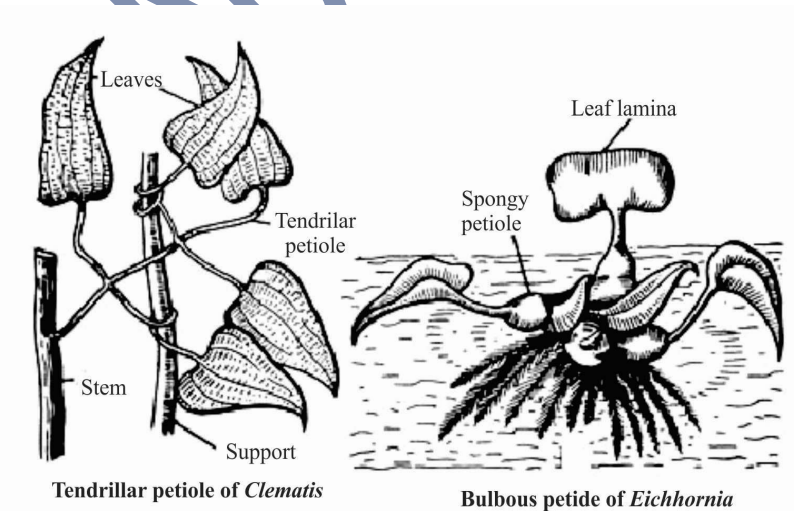
- **Bulbous (floating) Spongy petiole -** Eichhornia
- **Winged petiole -** Citrus
- **Tendrillar petiole** - Nepenthes

Phyllodes :

- Petioles expand, become green, and modified into a sickle-shaped structure
- Leaf like flattened
- **Australian acacia**



Winged petiole of *Citrus* **Phyllode of *Acacia***



Tendrillar petiole of *Clematis* **Bulbous petide of *Eichhornia***

Phyllotaxy :

- The arrangement of leaves on a stem or branch is called phyllotaxy.
- Phyllotaxy can be defined as mode of distribution of leaves on stem.

Phyllotaxy is of three main types :

Alternate , acyclic or spiral :

- When there is only one leaf borne at each node
- **Sunflower Mustard China Rose**

Opposite:

- In opposite phyllotaxy, two leaves appear at each node and lie always opposite to each other.
- **It is further of two types:**

Opposite and superposed :

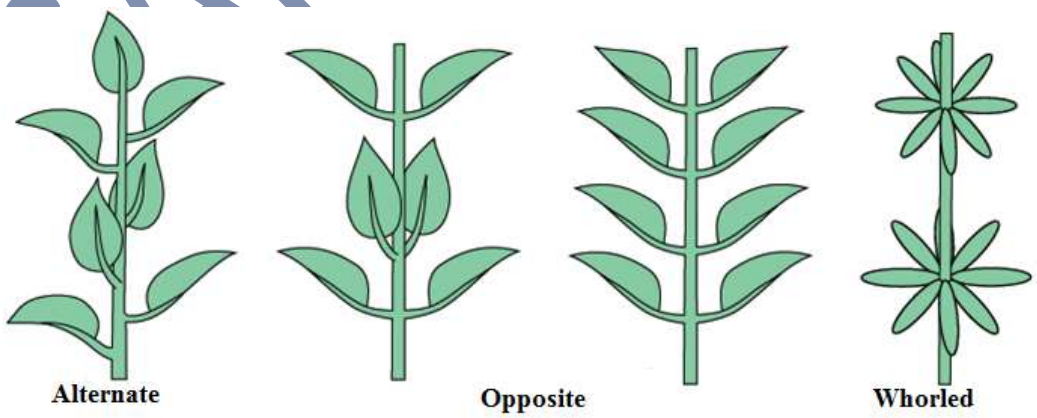
- When the opposite leaves of two adjacent nodes are in the same direction
- **Eugenia Guava**

Opposite and decussate :

- The leaves of successive nodes are placed at right angle to each other and thus the leaves get arranged in four vertical rows
- **Calotropis Tulsi**

Whorled or Verticillate:

- When three or more leaves are present at node
- **Nerium , Alstonia (devils tree)**



Venation :

- The mode of distribution or arrangement of veins in the lamina (leaf-blade) is called venation.

There are three main types of venation :

Reticulate venation:

- When the veins are irregularly distributed to form a network.
- **Dicots**
- **Smilax Colocasia (monocots)**

Unicostate reticulate

- A leaf with a single main midrib or costa
- **Mango Peepal**

Multicostate reticulate

- When there are two or more costae
- **Convergent - Smilax**
- **Divergent - Grape**

Parallel venation:

- When the veins are parallel and do not form a network
- **Monocots**
- **Calophyllum ,** (dicots)

Unicostate parallel :

- The lamina has a single prominent midvein
- **Banana Palms**

Multicostate parallel :

- Several midveins veins run parallel to one another.
- **Convergent** - **Bamboo**
- **Divergent** - **Borassus**

Simple and Compound Leaves

Depending upon the **incisions of the lamina** the leaves are of two kinds –

- **Simple**
- **Compound**

Simple Leaves :

- A leaf having **single leaf blade** is called simple leaf.
- The margins of the lamina may be entire or deeply incised to various depth.
- The incisions never divide the lamina into distinct leaflets.
- Incisions which do not touch midrib or reach upto tip of petiole
- Have axillary buds
- **Solanaceae Brassicaceae Asteraceae**

Compound Leaves :

- Lamina is completely divided into distinct segments or **leaflets** also known as pinnae
- Leaflets have base stalk and blade
- Leaflets have no axillary buds
- Leaflets are distinct, free from one another and articulated (joined) to the **rachis (midrib)** or the **tip of the petiole.**

The compound leaves are of two types :

Pinnate compound leaves :

- Leaflets are borne on an unbranched or branched axis, the **rachis**
- **Rachis** a derivative of **mid rib** or an extension of the **petiole** or **lateral veins**
- Rachis has no nodes and internodes
- Feather like outline
- Leaflets in two rows

Pinate compound leaves are of the following types :

Unipinnate:

- The lamina is divided only once in a pinnate manner.
- The rachis is unbranched and bears the leaflets (pinnae) on either side of the rachis.
- The unipinnate compound leaves may be **paripinnate** when the leaflets are even in number - **Tamarindus Cassia**
- **Imparipinnate** when the leaflets are odd in number - **Neem rose**

Bipinnate

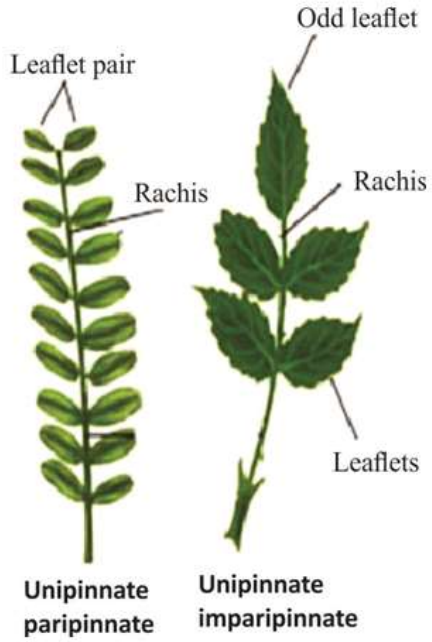
- The lamina is twice pinnate.
- Here, the rachis bears branches of the first order, the rachillae
- **Mimosa Acasia**

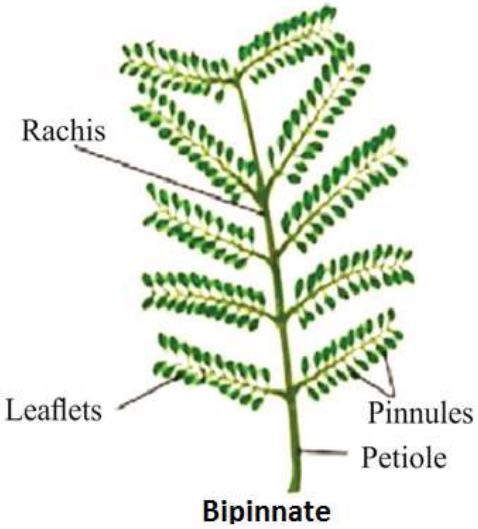
Tripinnate

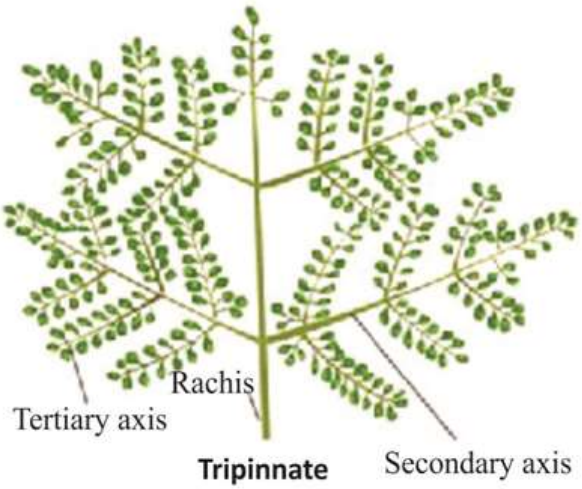
- The lamina is thrice pinnate. Here the rachis is branched twice .
- **Moringa**

Decompound

- The lamina is more than thrice pinnate.
- The rachis is branched more than twice.
- **Carrot coriander**







Tripinnate


Decompound

Palmate compound leaves :

- Leaflets are borne terminally on the petiole.
- Palm like outline
- Pinna from common point
- Leaflets in cluster
- Joint between leaflet and point of attachment / tip of petiole

They are of following types:

Unifoliate

- A single leaflet is articulated to the tip of the petiole.
- **Citrus.**

Bifoliate /binate:

- Two leaflets are joined to the petiole.
- **Bignonia**

Trifoliate/ternate

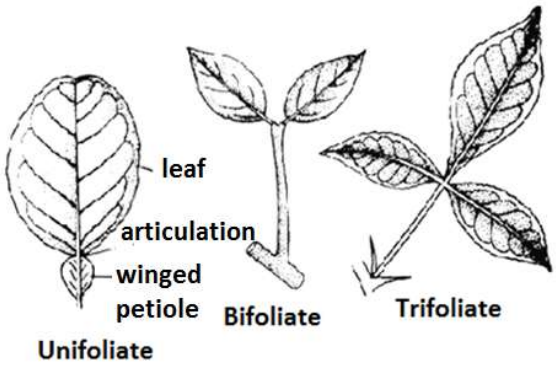
- Three leaflets are articulated at the tip of the petiole.
- **Oxalis Desmodium**

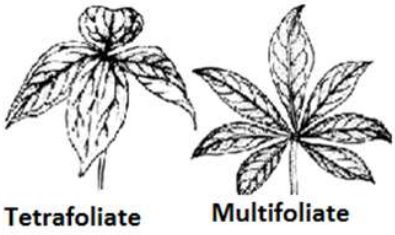
Quadrifoliate

- Four leaflets are articulated at the tip of the petiole.
- **Marsilea**

Multifoliate/ digitate :

- Five r or more leaflets are articulated to the tip of the petiole.
- **Bombax (Silk-cotton)**





Reproductive leaf - bear adventitious buds **Bryophyllum**
Leaf roots: - **Salvinia**
Leaf spines - Cactus
Leaf pitchers - Nepenthes
Fleshy leaves – Onion Garlic
Venus fly trap