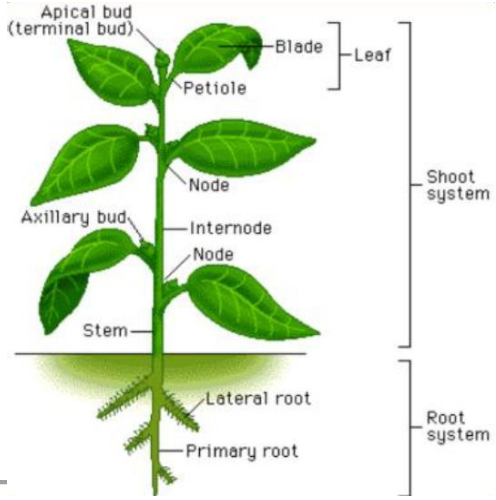
MORPHOLOGY IN FLOWERING PLANTS

Morphology: The study of external structure (**form, size, structure, colour, and external features)** of an organisms.

Angiosperms: also called **flowering plants**. Most **diverse and advanced** group of plants.

Parts of a Flowering Plant



A typical angiosperm has:

1. Underground Part – Root System

- Primary roots, secondary roots, tertiary roots, root hairs, etc.

2. Aerial Part – Shoot System

- Above ground part includes stem, leaves, buds, flowers, fruits.

3. Reproductive Part

- Flower, fruit, seed

4. Vegetative Part

- Leaf, stem, roots, tendrils, etc.

🔹 **Root System**

📌 **General Features:**

- Underground part that develops from **radicle** of the plant.
- It is **non-green** and **non-photosynthetic**.
- **Nodes and internodes are absent**.
- It shows:
  - **Positive geotropism**
  - **Positive hydrotropism**
  - **Negative phototropism**

Types of Roots

1. Tap Root System

- Found in **dicotyledonous** plants.
- Consists of **primary root** and its lateral branches (secondary and tertiary roots).
- Primary root arises from the **radicle** and **persists**.
- **Examples**: Mustard, Gram

2. Fibrous Root System

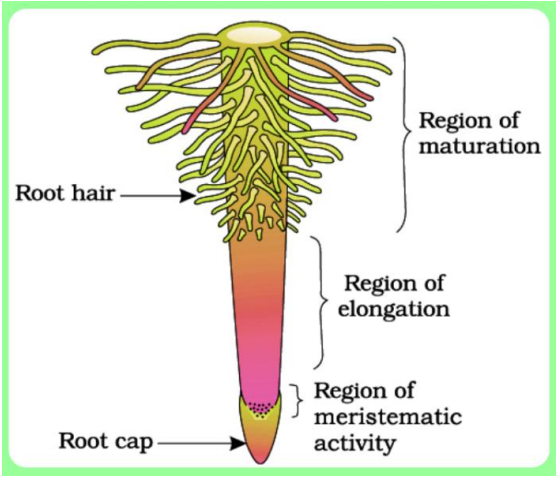
- Found in **monocotyledonous** plants.
- Develops from the **base of the stem**.
- Primary root is short-lived and replaced by a large number of **adventitious roots**.
- **Examples**: Wheat, Paddy, Maize

3. Adventitious Root System

- Roots develop from parts **other than the radicle**.
- **Examples**: Grass, Banyan, Sweet Potato

Regions of a Root

1. **Root Cap**
    - Thimble-like structure at the root tip.
    - Helps penetrate deep into soil and protects meristem.
    - **Present** in primary root, **absent** in lateral roots.
    - **Regenerates** if damaged.
    - In **aquatic plants**, **root pockets** are present instead of root cap.

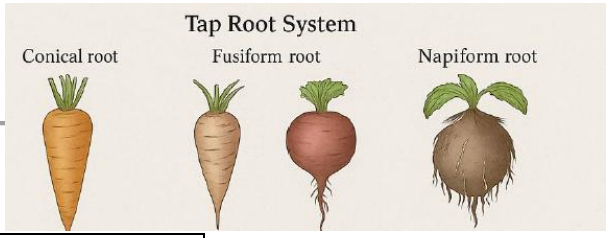


2. **Meristematic Zone**
    - Cells divide actively.
    - Cells have **dense cytoplasm**, **prominent nucleus**, and **thin walls**.
    - Gives rise to both **root cap** and **region of elongation**.
3. **Zone of Elongation**
    - Cells elongate and increase the root's length.
4. **Zone of Maturation**
    - Cells differentiate and mature.
    - **Root hairs** appear here.
5. **Root Hairs**
    - Very fine, **unicellular**, thread-like extensions from **epidermal cells**.
    - **Absorb water and minerals** from the soil.

Note: Root Caps are absent in lateral roots and Aquatic plants have root pockets instead of root cap.

Functions of Roots

- **Anchorage** – Fixes the plant in the soil.
- **Absorption** – Water and mineral uptake.
- **Conduction** – Transport to the stem.
- **Storage** – In some plants (e.g., carrot).
- **Hormone Production** – Produces growth hormones like **cytokinins**.
- **Vegetative Propagation** – In species like sweet potato.
- **Soil Erosion Prevention** – Binds soil particles.
- **Symbiotic Associations** – With Rhizobium (N-fixation) or mycorrhiza.
- **Respiration** – Pneumatophores help in gas exchange.
- **Aerial Absorption** – Epiphytic roots absorb moisture from air.



🔹 Modifications of Roots

A. Tap Root Modified for Food Storage

S.N.	Type	Feature / Shape	Examples
1.	Conical	Cone-shaped, broad at base, tapering downward	Carrot
2.	Fusiform	Spindle-shaped, middle swollen, tapered ends	Radish
3.	Napiform	Top round, bottom tapering like a tail	Turnip, Beetroot

B. Adventitious Roots Modified for Food Storage

Type	Feature / Shape	Examples
Tuberous	Irregular swollen single roots	Sweet Potato
Fasciculated	Clustered tuberous roots at base	Dahlia, Asparagus
Nodulose	Root tips swell into nodules	Roots in Turmeric, Mango,ginger

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C. Roots Modified for Mechanical Support

Type	Feature / Function	Examples
Prop Roots	Hanging or pillar-like roots from branches for support	Banyan
Stilt Roots	Oblique roots from lower nodes for anchorage	Maize, Sugarcane
Climbing Roots	Roots help climbing by attaching to support	Grapevines, Money Plant

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D. Roots Modified for Special Functions

Function	Type/Name	Description	Example(s)
Respiration	Pneumatophores	Erect aerial roots grow upward, negatively geotropic	Rhizophora (Mangroves)
Aerial Absorption	Epiphytic Roots	Spongy velamen tissue absorbs moisture from air	Vanda, Orchids
Symbiosis	Mycorrhizal Roots	Fungal association, enhances mineral uptake (esp. phosphorus)	Pinus, Orchids
Parasitism	Haustorial (Sucking)	Penetrate host plant to absorb food and water	Cuscuta, Orobanche
Vegetative Propagation	Reproductive Roots	Roots develop buds and produce new plants	Sweet Potato, Dalbergia
Photosynthesis	Photosynthetic Roots	Green roots perform photosynthesis	Trapa, Tinospora

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The Stem

📌 **General Features:**

- Arises from the **plumule** of the embryo.
- Generally **erect**, **green** (young), and **cylindrical**.
- Has **nodes** (points where leaves arise) and **internodes** (space between nodes).
- Bears **leaves, buds, flowers, fruits**.
- Usually **aerial** and **positively phototropic**.

📌 **Functions of the Stem:**

- **Support** – Bears branches, leaves, and flowers.
- **Conduction** – Transports water and minerals from roots to aerial parts and food from leaves to other parts.
- **Storage** – In potato, turmeric.

- **Photosynthesis** – Green stems (e.g., Euphorbia).
- **Vegetative propagation** – Sugarcane, Mint, Jasmine.

Modifications of Stem

A. Underground Stem Modifications

Used for **perennation, food storage, vegetative propagation**.

Type	Features	Examples
Rhizome	Horizontal stem, thick, fleshy with nodes & internodes	Ginger, Turmeric
Tuber	Terminal part of underground stem swells to store food; has eyes	Potato
Corm	Short, vertical, solid, swollen base with nodes	Colocasia, Amorphophallus
Bulb	Condensed stem with fleshy leaves	Onion, Garlic

B. Subaerial Stem Modifications

Used for **vegetative propagation**, **spreading**.

Type	Features	Examples
Runner	Long internodes; creeps on surface	Grass, Oxalis
Stolon	Grows horizontally, then curves upward	Strawberry, Jasmine
Sucker	Arises from underground base; grows obliquely	Chrysanthemum, Banana
Offset	Short, thick internode, forms new rosettes	Pistia, Eichhornia

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C. Aerial Stem Modifications

Adapted for **protection, support, photosynthesis, and food storage**.

Type	Features	Examples
Stem Tendrils	Slender, spirally coiled for climbing	Cucumber, Passionflower
Stem Thorns	Hard, woody, pointed outgrowths for defense	Citrus, Bougainvillea
Phylloclade	Flattened or cylindrical green stem for photosynthesis	Opuntia, Euphorbia

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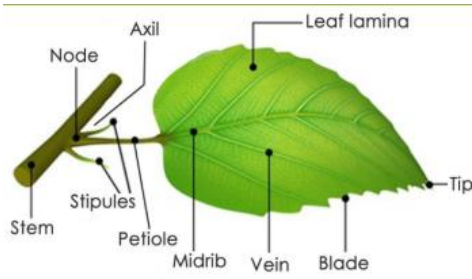
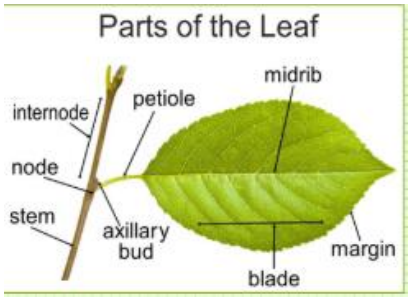


◆ **The Leaf:** It is lateral , flattened, photosynthetic structure develop from the **node of the stem.**

It is always arises from Apical Bud (Shoot apical meristem) & arranged in acropetal manner.

It bears a bud (Axillary bud) in its axil which later develops into a branch.

It has 3-Main parts:



a) **Leaf base (Hypopodium):** Part of leaf attached to stem

In Dicot leaf it may bear two later outgrowth called stipules.

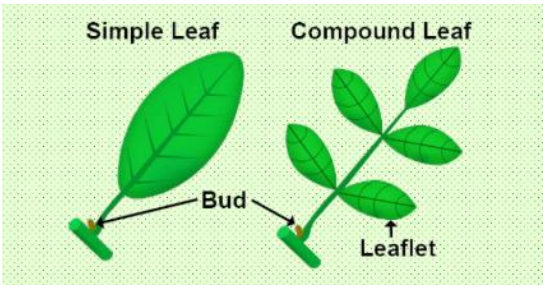
In some leguminous plans leaf base may become swollen called Pulvinus.

b) **Petiole** – Thin flexible stalk by which leaf is connected to stem.

c) **Lamina** (leaf blade) The green expanded part with veins & midrib.

Veins provide rigidity and act as channel to transport.

Types of Leaves



A. Simple Leaf

- Lamina is entire or incision do not touch the midrib, and not divided into leaflets. **Example**: Mango

B. Compound Leaf

- When incision of lamina reaches up to midrib & Lamina is divided into **leaflets**.
- A bud is seen in axil of leaflets of simple and compound leaf but not on leaflets.

Type	Features	Examples
Pinnately Compound	Leaflets arise along common axis (Rachis-represents Midrib)	Neem
Palmately Compound	Leaflets arise from a single point at tip of petiole	Silk Cotton

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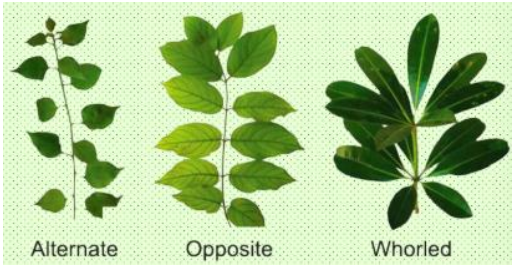
Phyllotaxy – Leaf Arrangement on Stem



Type	Description	Example
Alternate	Single leaf per node, alternating sides	China Rose, Mustard, Sunflower
Opposite	Pair of leaves arises at each node, opposite to each other.	Guava, Calotropis
Whorled	More than two leaves per node.	Alstonia

Leaf Modifications

Modification	Purpose	Examples
Tendrils	Climbing	Pea
Spines	For defense, & to prevent transpiration loss.	Cactus
Fleshy	Storage food	Onion, Garlic
Insectivorous	Trapping insects	Pitcher plant, Venus flytrap
Reproductive	Vegetative propagation	Bryophyllum

Venation : Arrangement of veins & vein lets in the leaf lamina.

Types: 1) Reticulate : Veinlets forms a network. Seen in Dicots

2) Parallel : Veins run parallel to each other. Seen in Monocots.

The Flower

A Flower is a modified shoot where in the shoot apical meristem changes to floral meristem.

Internodes do not elongate and the axis gets condensed & the condense node produces whorls (floral appendages).

Solitary: When a shoot tip is transformed into a single flower. Ex: China Rose, Lily.

Inflorescence: Arrangement of cluster of flowers on the floral axis (peduncle).

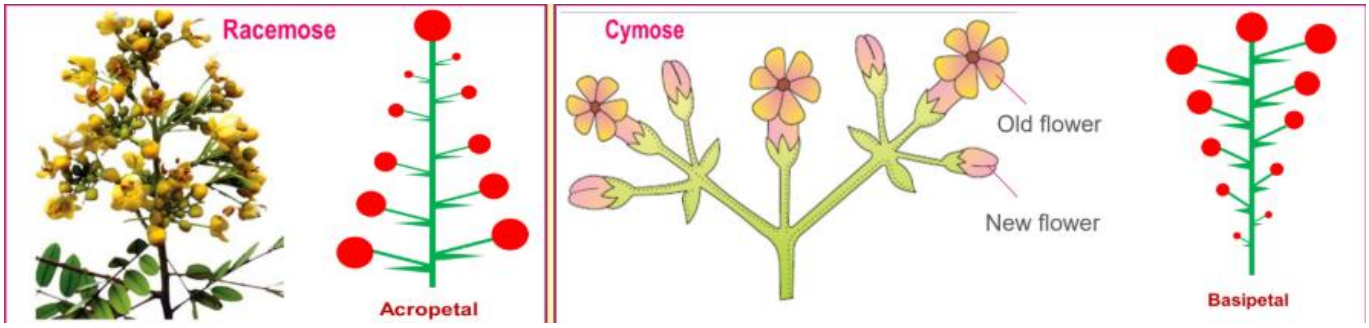
Types of Inflorescence

A. Racemose

- **Main axis** grows continuously.
- **Acropetal succession** – older flowers at base, younger towards apex.
  Ex: Maize, Mustard, Radish, Sunflower, Colocasia, Pineapple

B. Cymose

- **Main axis terminates** in a flower.
- **Basipetal succession** – older flowers at apex, younger below.
  Ex: Jasmine, Bougainvillea, Calotropis



The Flower

📌 **Definition:**

- Modified **condensed shoot**, for reproduction.

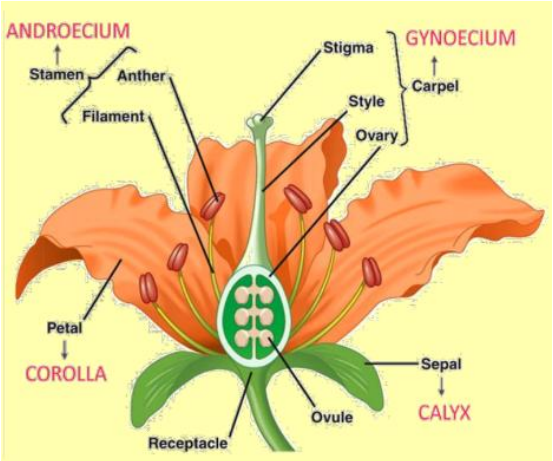
A typical flower has 4 – Whorls (Parts):

Accessory Whorls

1. **Calyx (Collection of Sepals)** – Outer green, protective
2. **Corolla (Collection of Petals)** – Colourful, attract insects

Essential/ Reproductive Whorls

3. **Androecium (Collection of Stamens)** – Male part
4. **Gynoecium (Collection of Pistil/Carpels)** – Female part



Bracteate : The flowers that **possess a small, leaf-like structure called a *bract* at the base of the flower stalk (pedicel).** Ex: mustard, china-rose

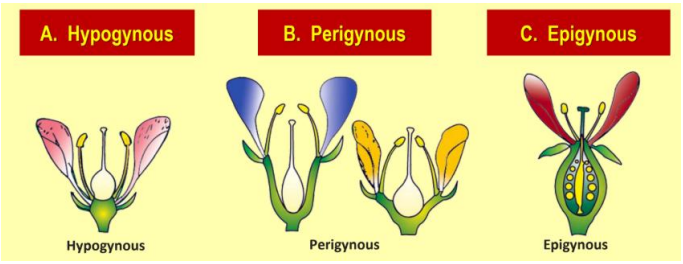
Ebracteate flowers are those **which lack bracts. Ex: Mustard, Datura, Lily**

Floral Symmetry

Type	Description	Example
Actinomorphic	Radial symmetry	(MCD) Mustard, Chilli, Datura
Zygomorphic	Bilateral symmetry	(Pe, Gu, Be, Ca) Pea, Gulmohar, Bean, Cassia
Asymmetric	No symmetry	Canna

Flower Types

Term	Description	Example(s)
Bisexual	Both androecium and gynoecium	Hibiscus, Mustard, Datura
Unisexual	Either androecium or gynoecium	Papaya, Corn, Cucumber
Complete	All four floral whorls	Datura, Mustard, Hibiscus
Incomplete	One or more floral whorls missing	Grass (no petals), Papaya (unisexual)
Hypogynous	Ovary superior; other floral parts below ovary	Mustard, China rose , Brinjal
Perigynous	Ovary half-inferior; floral parts	Rose, Peach, Plum
Epigynous	Ovary inferior; floral parts above the ovary	Guava, Cucumber, Apple



Flower Types on the basis of number of appendages:

Trimerous	Floral Appendages in multiple of three. (Common in Monocot)	Lily, Tulip, Onion
Tetramerous	Floral Appendages in multiple of four. (Common in Dicot)	Mustard, Radish, Turnip
Pentamerous	Floral Appendages in multiple of five. (Common in Dicot)	China rose, Pea, Dhatura