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XI NEET

MORPHOLOGY OF FLOWERING PLANTS

01

BIOLOGY

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MORPHOLOGY OF FLOWERING PLANTS

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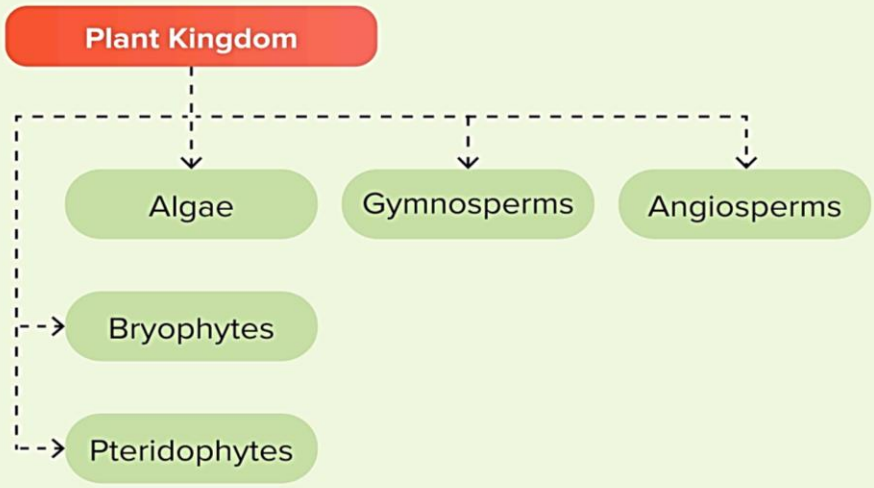
01 THE ROOT, REGIONS OF THE ROOT, MODIFICATIONS OF ROOT AND THE STEM

Key Takeaways

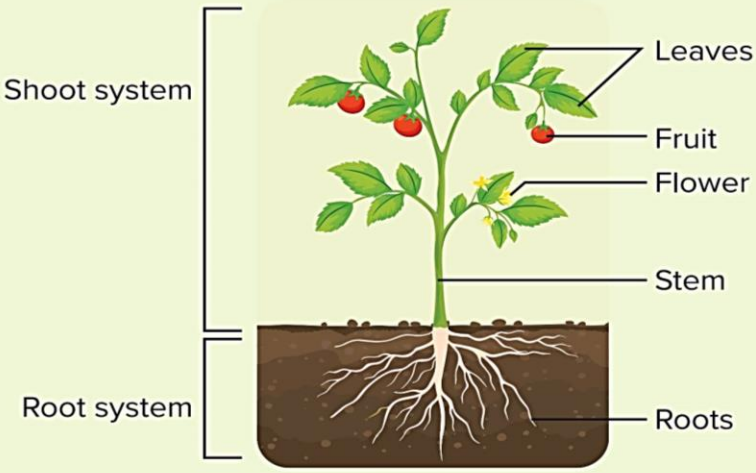
- Definition of morphology
- Root system
  - Types of roots
  - Functions of roots
  - Root modifications
- Shoot system
  - Types of shoots
  - Functions of shoots
  - Shoot modifications

Prerequisites



Morphology

- 'Morph' means 'shape' or 'form' and 'logy' means 'study of something'.
- Morphology is the science that deals with the study of external form and structure.



Parts of typical plant

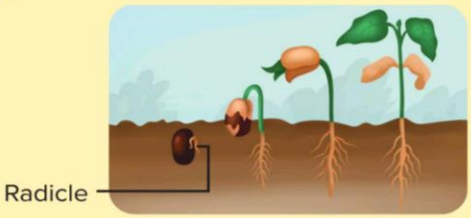
- Phytomorphology refers to the study of external form and structure of plants.
  - **Flower**: Reproductive part of plant
  - **Leaf**: Attached to the stem, performs photosynthesis
  - **Fruit**: Matured ovary, protects the seeds
  - **Stem**: Bears branches, leaves, flowers, and fruits, supports the plant
  - **Root**: Absorbs water and minerals from the soil

Did you know?

A *Ficus* tree in Transvaal (S. Africa) has roots going 400 ft underground!

Root System

- Root is the part of a plant that grows below the surface of soil. It develops from the radicle of the seed.



Radicle in a seed

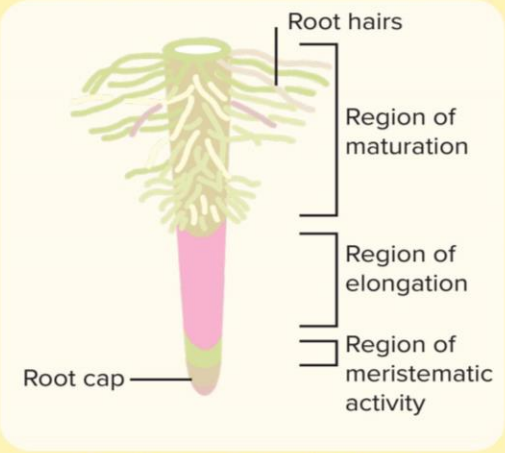
Regions of a typical root

Region of **meristematic activity**

- The region is present in the growing tip of the root.
- It consists of cells that continuously divide.
- It is protected by the root cap.

Region of **elongation**

- It has cells that rapidly elongate and enlarge.
- These cells increase the length of the roots.



Regions of a typical root

Region of **maturation**

- As the cells in the region of elongation become older, they differentiate and become mature.
- The cells are pushed upwards by the newly forming meristematic tissues.
- Some of these cells form root hairs, which absorb water and minerals from the soil.

Root cap

- It is a terminal, thimble-like (cap-like) structure.
- It is multicellular.
- It secretes mucilage for lubrication.
- It protects the tender apex of the roots.

Types of roots

Types of roots

Tap roots	Fibrous roots	Adventitious roots
		
Direct elongation of radicle	Originate from base of stem	Arise from parts of plant other than radicle
The primary root bears several lateral roots of several orders which are known as secondary and tertiary roots.	Absence of primary root (Primary root is short-lived) and is replaced by a large number of roots. Roots are fibrous and highly branched.	Can be nodal roots, stem roots, crown roots, junction roots
Dicots have tap roots. Examples: Peas, mustard	Monocots have fibrous roots. Examples: Maize, wheat	Present in some monocots (Example - orchids) and dicots (Example - *Ficus*).

Functions of roots

- Absorption of water and minerals from soil
- Providing anchorage to plant parts
- Storage of reserved food materials
- Synthesis of plant growth regulators. Plant growth regulators are chemicals that an modify plant growth by influencing stem and root elongation, flowering, fruit formation, etc.

Root modifications

Roots in some plants are modified into different shapes and structures to perform functions other than absorption and conduction of water and minerals.

Tap roots

- Tap roots are direct elongation of the radicle. Lateral roots appear from tap roots.

→ **For storage of food**

Tap (primary) roots become fleshy and swollen due to stored food, while secondary roots remain thin and stem is usually reduced.

- **Conical in shape**
  - Fleshy taproots resemble a cone.
  - They are thickest towards the base and gradually tapering towards the apex.
  - Secondary roots are found throughout.
  - Example: Carrot


Carrot

- **Fusiform**
  - They are spindle-shaped.
  - They are thicker in the middle and narrow towards both the apex and at the base.
  - Fine secondary roots arise from the apical part.
  - Example: Radish


Radish

- **Napiform**
  - They are almost spherical-shaped and wider at the top, and narrow at the tip.
  - They are very thick at the base.
  - They become thin towards the apex.
  - Example: Turnip


Turnip

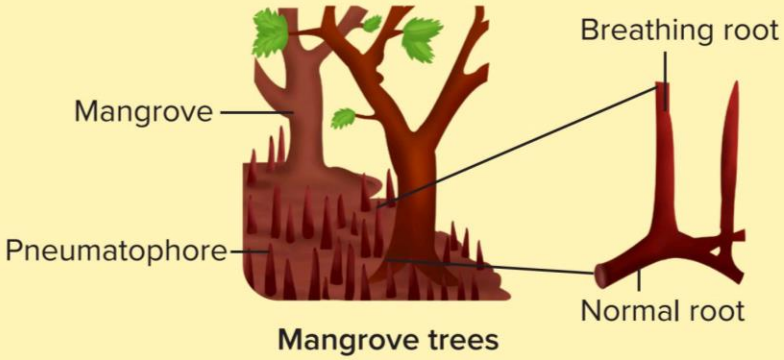
- **Tuberous**
  - They are thickened tap roots that do not have any definite form.
  - Example: Four o'clock plant


Four o'clock plant


Tuberous Roots

- **For respiration - Pneumatophores**
  - They are found in plants growing in the mangroves, swamps, and salt lakes that are deficient in oxygen.
  - Such plants are known as halophytes.

- They possess horizontal cable roots that give rise to vertically upward (negatively geotropic) aerial roots at short intervals.
- These roots are known as pneumatophores (respiratory roots). They bear pores are known as pneumatothodes (lenticels).
- Example: *Rhizophora* and mangroves.



Mangrove trees

Respiratory roots (Pneumatophores)

Adventitious roots: These are roots that arise from parts of the plant other than radicle. These adventitious roots are modified to perform functions such as:

- Storage of reserved food

Sweet potato

- Anchorage
  - Stilt roots
    - Roots arise obliquely from lower nodes of the stem.
    - Examples: Sugarcane, maize, bajra, sorghum

Maize stilt roots

- Prop roots
  - They are thick, pillar-like roots.
  - The roots arise from branches of the plant and grow downward towards soil, thereby functioning as supporting stems for the plant.
  - In the beginning, these roots appear as hanging, hygroscopic structures that are red in a moistened state.
  - Example: Banyan tree

Banyan tree

Did you know?

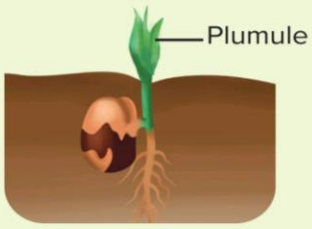
Epiphytic roots grow on surfaces of other plants. They are green, photosynthetic, and absorb water from surroundings.
Examples: *Taeniophyllum*, velamen of orchids

Taeniophyllum

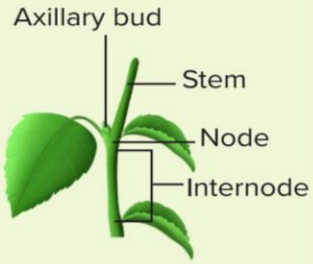
- ***Taeniophyllum*** is an epiphyte with roots that can photosynthesise and obtain water from surroundings.
- Orchids have velamen, which is a spongy tissue made of multiple epidermis that cover the roots. These aerial roots can photosynthesise and absorb moisture and CO_2.

Shoot System

- Shoot refers to the ascending part of the plant axis that bears branches, leaves, flowers, and fruits.
- Shoot system is generally found above the ground but can be modified underground in some plants.
- Shoot develops from the plumule of the seed.



Plumule of seed

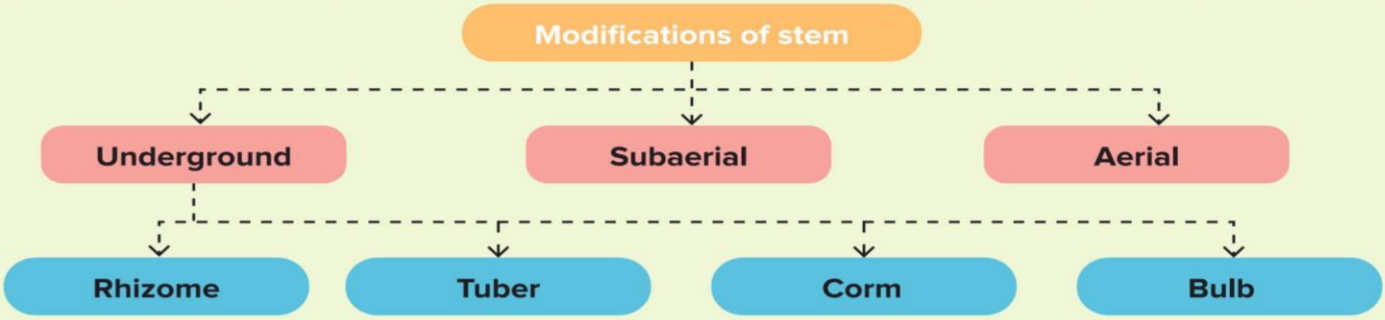


Parts of a typical stem

- Stem is green and slender when young. It becomes thick, woody, and dark brown later. Stem comprises of the following parts:
  - **Nodes**: The region where leaves are borne.
  - **Internodes**: The region of stem in between two nodes.
  - **Bud**: It is an undeveloped shoot found in the axil of a leaf or at the tip of a stem.

Functions of shoot system

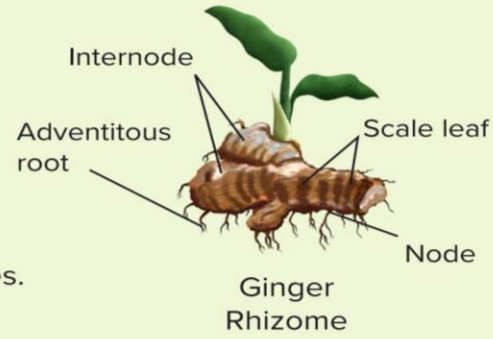
- **Support**: Bears other parts of the plant such as **flowers, fruits, and leaves**
- **Conduction**: Transports water, minerals, and products of photosynthesis
- **Storage**: Few plants can store reserved food in the stem. Example: Potato
- **Vegetative propagation**: Few plants can propagate from stem cuttings. Examples: Rose, hibiscus



Underground stem modifications

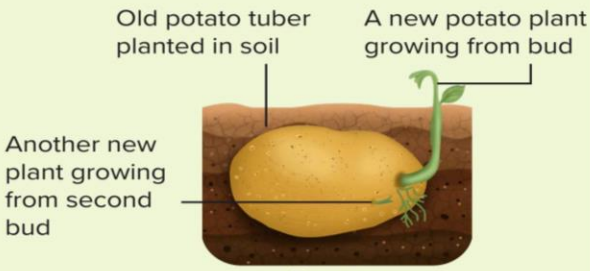
These stem modifications help plants in vegetative propagation, storage of food, and perennial survival.

- **Rhizome**
  - Rhizome is a prostrate, fleshy, dorsiventral, and horizontal underground stem.
  - Nodes and internodes in it are covered by scaly leaves.
  - Axillary buds and roots are at nodes.
    Examples: Banana, ginger, turmeric, etc.



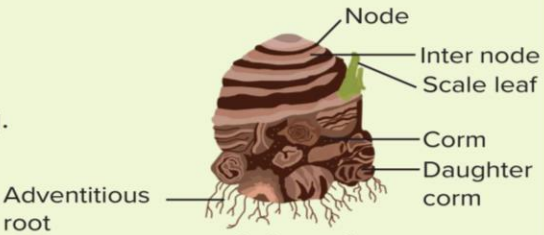
Ginger
Rhizome

- **Tuber**
  - Tuber is swollen, prostrate, fleshy, dorsiventral, and horizontal.
  - It is oval and has spirally arranged depressions known as eyes, through which new plants can arise.
  - Examples: Potato, dahlia



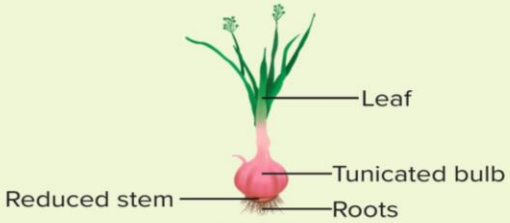
Potato
Tuber

- **Corm**
  - It is thick, swollen, and usually unbranched.
  - It can be spherical or sub-spherical and vertically growing.
  - It bears many buds in axils of scale leaves that develop into daughter corms.
  - Examples: *Amorphophallus* (zaminkand), *Colocasia* (arbi)



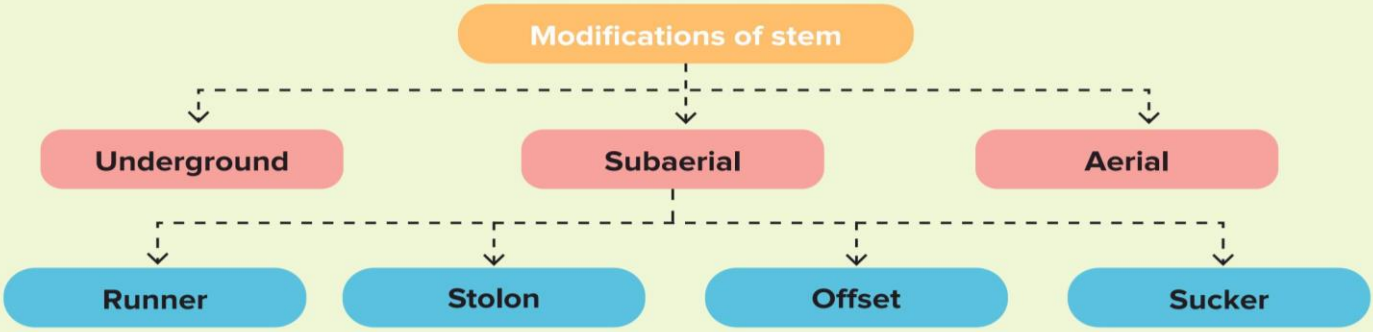
Colocasia
Corm

- **Bulb**
  - It is a reduced discoid stem with fleshy scales enclosing an apical bud.
  - It appears roughly spherical or pyriform in outline.
  - Adventitious roots are present at the base of the disc.
  - Examples: Onion, garlic, tulip



Onion
Bulb

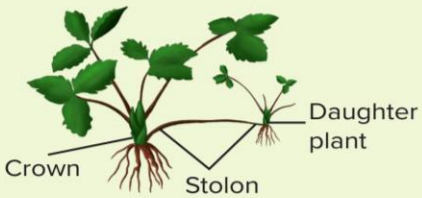
Subaerial stem modifications



- **Runner**
  - It is a narrow, green, horizontal or prostrate branch that arises from the base of the shoot known as crown.
  - It spreads in different directions.
  - Each runner has one or more internodes.
  - Roots develop at the lower side and leaves from the upper side of the node.
  - Example: Strawberry, grass

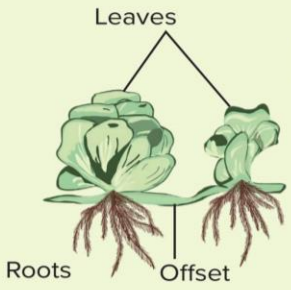
Strawberry **Grass**

- **Stolon**
  - It is an elongated, horizontal lateral branch developing from the base of the main axis.
  - It grows like an arch and then touches the ground.
  - It gives rise to new shoots and adventitious roots.
  - Example: Mint

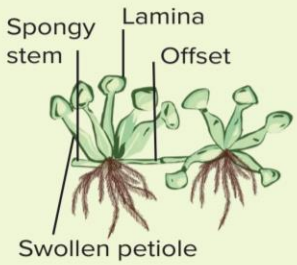


Mint

- **Offset**
  - It has lateral branches with short internodes.
  - Each node bears a rosette of leaves and a tuft of adventitious roots.
  - It is a runner of aquatic plants.
  - Examples: *Pistia, Eichhornia*

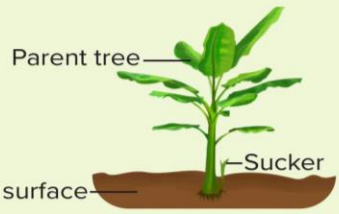


Pistia



Eicchornia

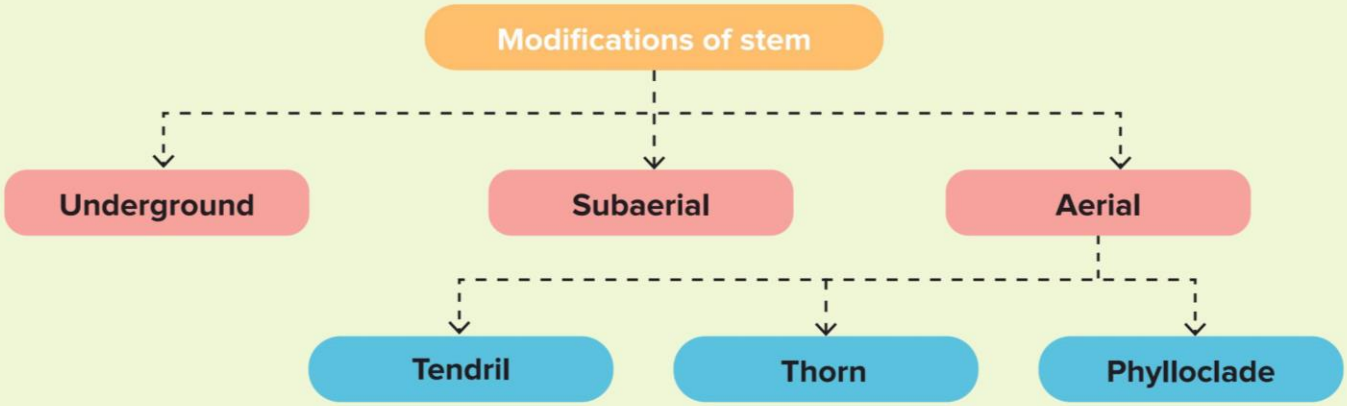
- **Sucker**
  - It comes out upward giving rise to leafy shoots.
  - It is known as an underground runner.
  - Examples: *Chrysanthemum*, pineapple, banana



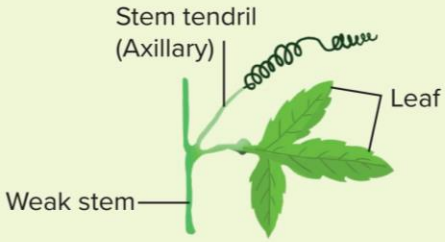
Banana

Pineapple

Aerial stem modifications



- **Tendrils**
  - Axillary bud modifies to form green, thread-like sensitive structures with adhesive glands for fixation.
  - They are found in plants with weak stems.
  - Examples: **Gourds (cucumber, pumpkins, watermelon) and grapevines**



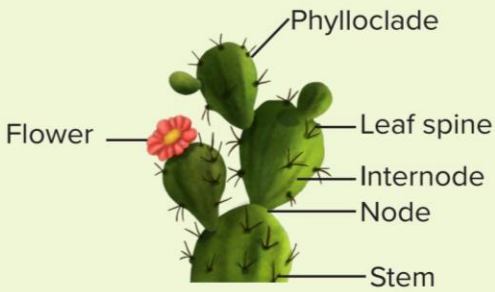
Cucurbits

- **Thorns**
  - They are stiff, pointed structures produced by modification of axillary bud.
  - They provide protection against grazing animals.
  - Examples: **Citrus, *Bougainvillea***


Lemon


Bougainvillea

- **Phylloclade**
  - It is a flat, fleshy, and green leaf-like structure.
  - It carries out photosynthesis.
  - The leaves are modified into spines.
  - Examples: **Thick, fleshy, and succulent in *Opuntia*, Cylindrical in *Euphorbia*, *Casuarina***



Opuntia

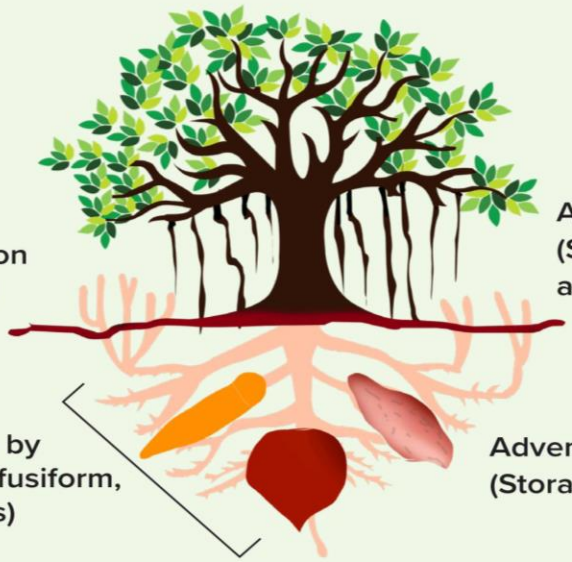
Summary Sheet

- **Morphology** is the science that deals with the study of external form and structure.
- Regions of a typical root are: **root cap, region of meristematic activity, region of elongation, and region of maturation.**

Types of roots

- **Tap roots**
- **Fibrous roots**
- **Adventitious roots**

- Root modifications



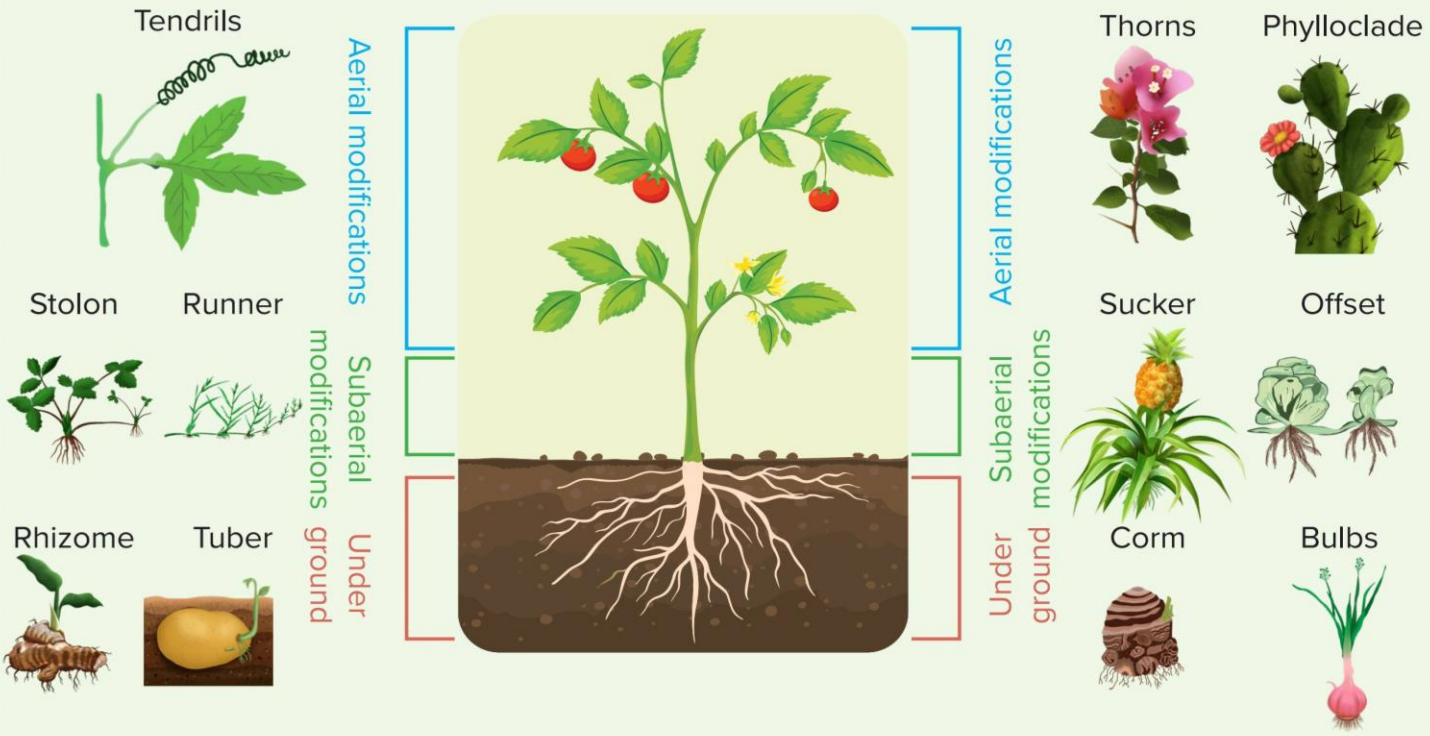
- **Shoot** refers to part of the plant axis that bears branches, leaves, flowers, and fruits.

Shoot modifications

- **Underground modifications**
  - Rhizome
  - Tuber
  - Corm
  - Bulb
- **Subaerial modifications**
  - Runner
  - Stolon
  - Offset
  - Sucker
- **Aerial modifications**
  - Tendrils
  - Thorns
  - Phylloclade

- **Stem** mainly comprises of **nodes, internodes, and axillary buds.**
  - **Functions** of stem include **support, conduction of nutrients, water and minerals, vegetative propagation, and storage of food.**

- **Modifications of stem**



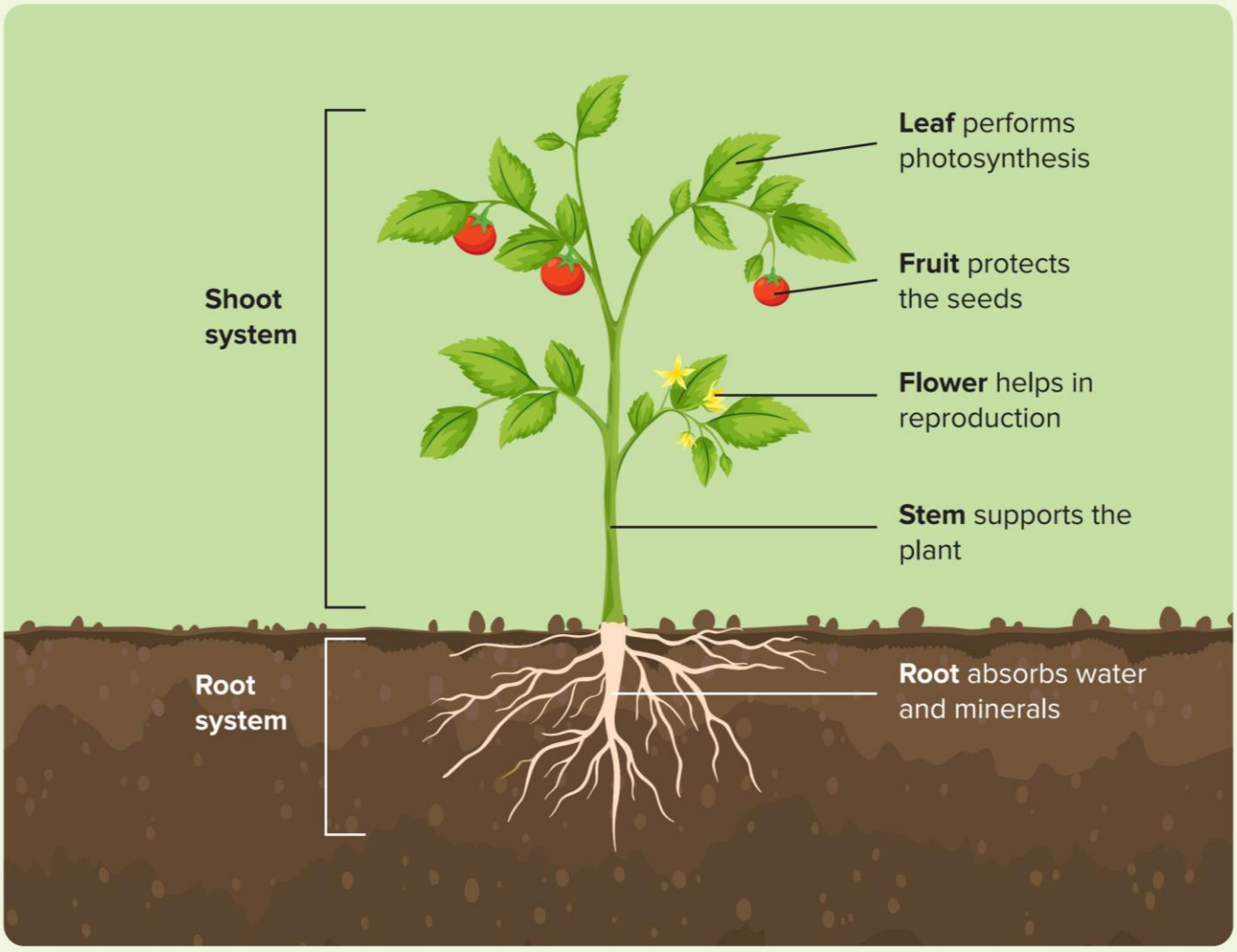
02 LEAF, VENATION, TYPES OF LEAVES, MODIFICATIONS OF LEAVES, INFLORESCENCE

Key Takeaways

- Origin of leaves in plant body
- Phyllotaxy
- Parts of typical leaf
- Modification of leaves
- Types of leaves
- Arrangement of flowers

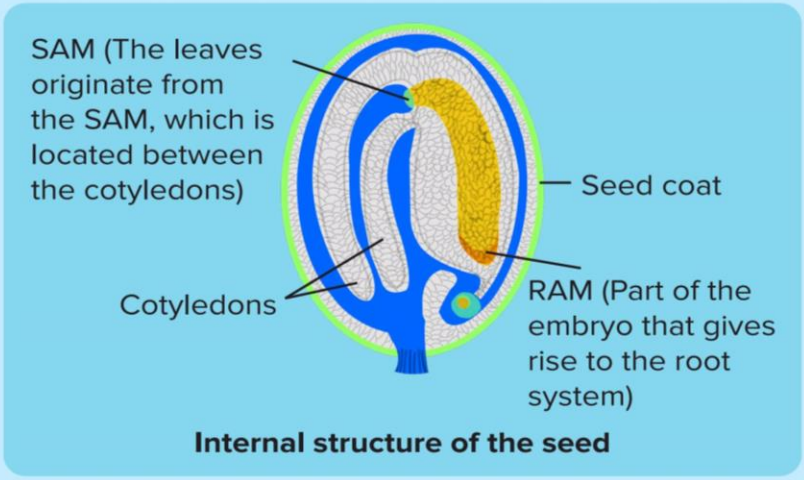
Prerequisites

- **Parts of a flowering plant**

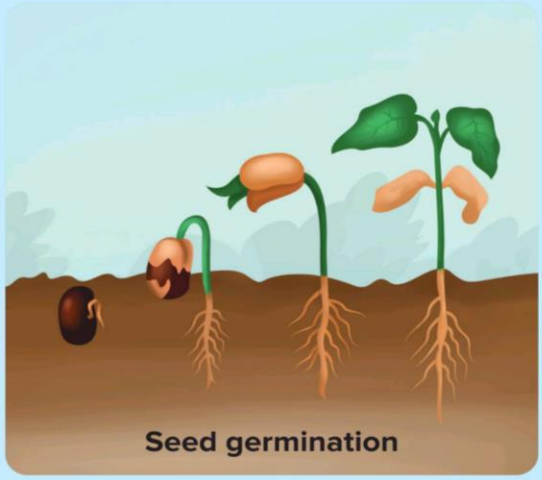


Origin of leaves in plant body

The embryo of the seed consists of the shoot apical meristem (SAM), root apical meristem (RAM) and the cotyledons.

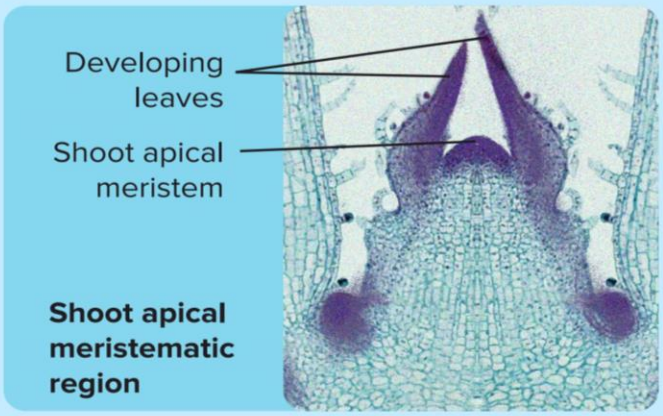


Internal structure of the seed

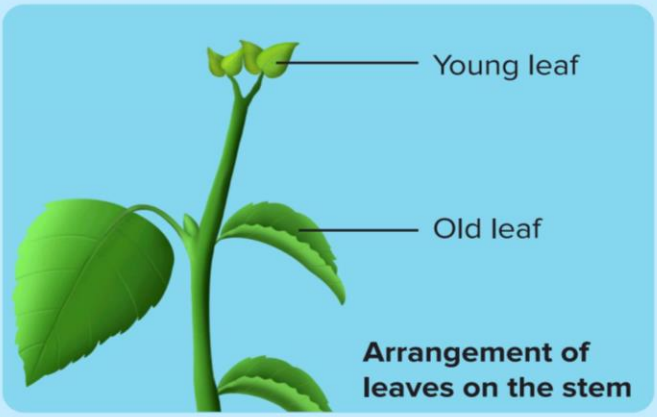


Seed germination

- As the shoot grows, the shoot apical meristematic region gets shifted to a position slightly above the region from where the first set of leaves emerge.



Shoot apical meristematic region

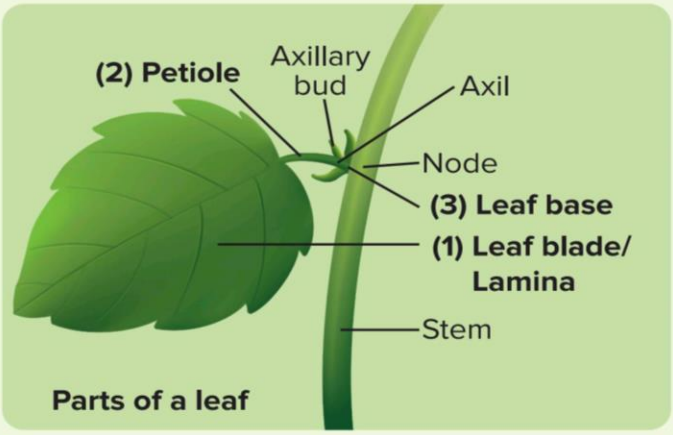


Arrangement of leaves on the stem

Leaves

- The **leaf** has a flat structure and it arises from the node of a stem.
- A bud, known as the axillary bud, arises from the axil. It later develops into the **leaf, shoot, branch,** or **flower**.

A typical leaf has three main parts:



Parts of a leaf

Leaf base (hypopodium)

- Leaf base is the point where the leaf is attached to the stem.

Leaf base modifications

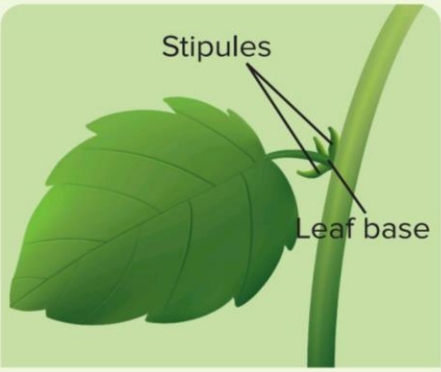


Figure 1

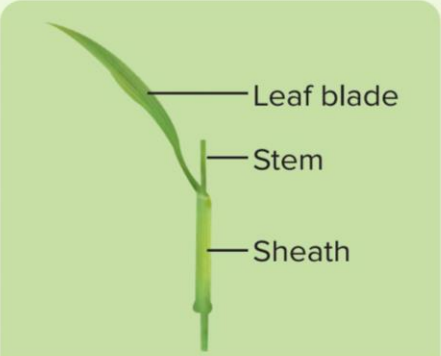


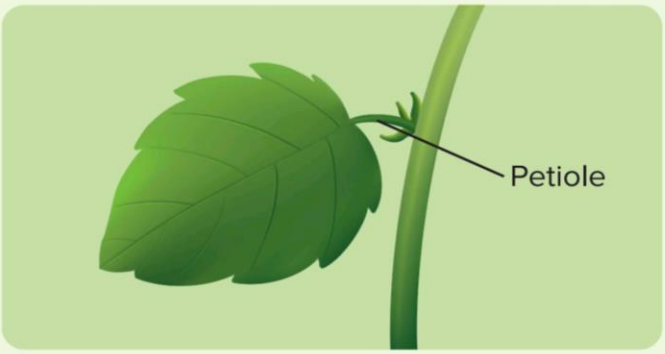
Figure 2

Figure 3

- The leaf base may bear two **lateral leaf-like structures** on **either side** of the leaf base which are known as **stipules** (figure 1).
- In **monocots** (grasses), the leaf base extends to form a **sheath**. It may cover the stem fully or partially (figure 2).
- In some **leguminous plants**, the leaf base may become swollen. This swollen leaf base is known as the **pulvinus** (figure 3).

Petiole (Mesopodium)

- Petiole is the stalk that attaches the leaf to the stem.
- It helps hold the leaf blade to light.
- Long, thin, and flexible petioles help leaf blades flutter in the wind. This brings fresh air to the leaf surface.
- Petioles are often referred to as **stalks**.



Lamina/leaf blade

- **Leaf blade** is the expanded green part of the leaf.

Midrib - The middle prominent part

Veins - Lateral veins arise from the midrib

Veinlets - Network of veins arising from the lateral veins

- **Margin** is the outer edge of the leaf and the **leaf apex** is tip of the leaf.
- Leaf lamina may be of various shapes based on differences in the apex and margins.

Shapes of leaves

Apex of leaves

Veins and Venation

- Veins provide **rigidity to the leaf blade**. They also act as **channels of transport** for water, minerals, and food material.
- **Venation** is the arrangement of veins and veinlets in the leaf lamina.
- Irrespective of the venation, veins have **xylem** and **phloem**.
  - → **Xylem** - conducts water and minerals
  - → **Phloem** - conducts food

Venation based on branching

Reticulate	Parellel
When veinlets form a **network**, the venation is termed as **reticulate**. Predominantly seen in **dicots**.	When veins **run parallel** to each other within a lamina, venation is termed as **parallel**. It is predominantly seen in **monocots**.
	

Venation based on midrib

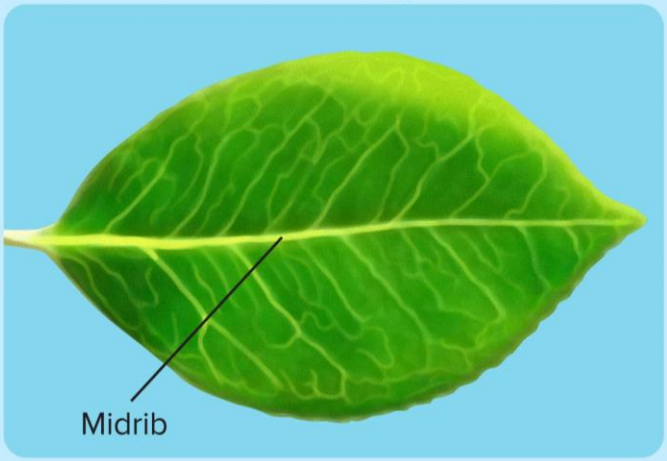
- **Unicostate venation** (Lamina has a single midrib)
- **Multicostate venation** (Lamina has more than one midrib)
  - **Convergent** (Midribs converge or meet at the leaf apex)
  - **Divergent** (Midribs do not meet at the leaf apex)

Types of leaves

- Based on the leaf blade, leaves can be classified as:

Types of Leaves

- **Simple** (Lamina is **undivided**)

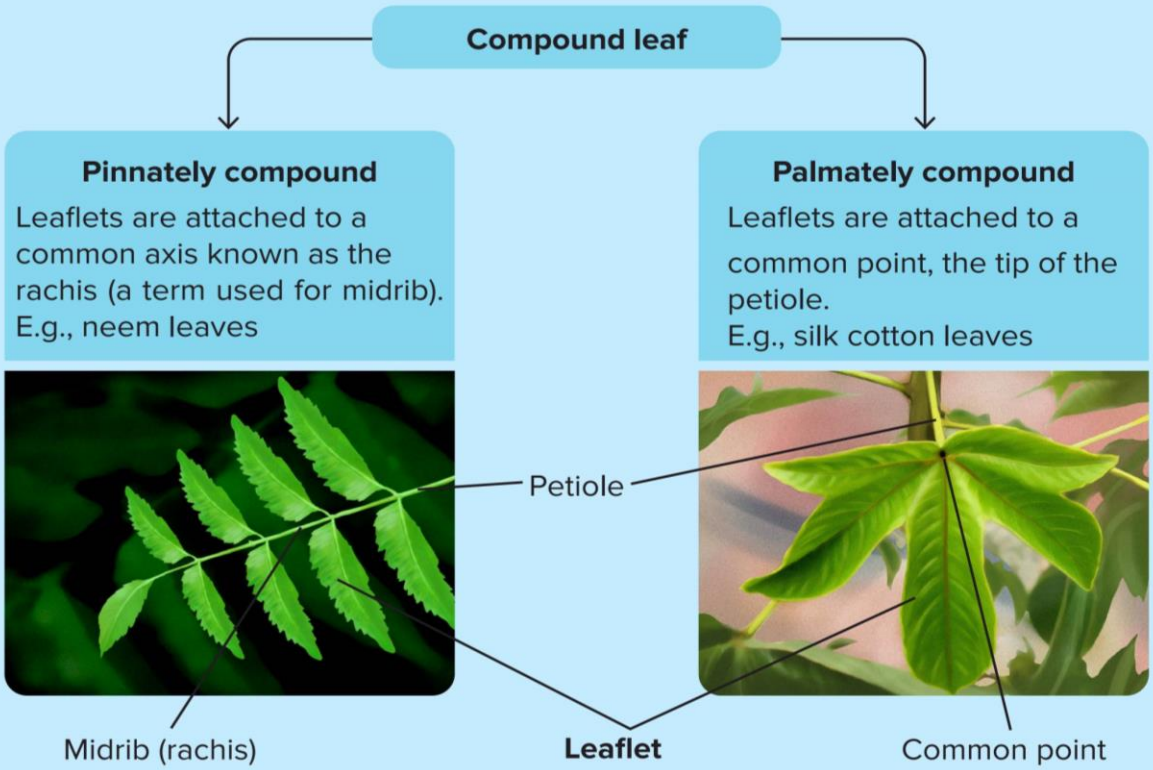


- **Incisions** of the lamina **do not touch** the midrib in **simple leaves.**
- A bud, known as the **axillary or lateral bud** is present in the axil of the petiole.

- **Compound** (Lamina is **divided** into leaflets)

- Incisions of the lamina reach up to the midrib, breaking it into a number of **leaflets**.
- **Axillary bud** is present in the axil of the petiole of compound leaves but not in the axil of leaflets.

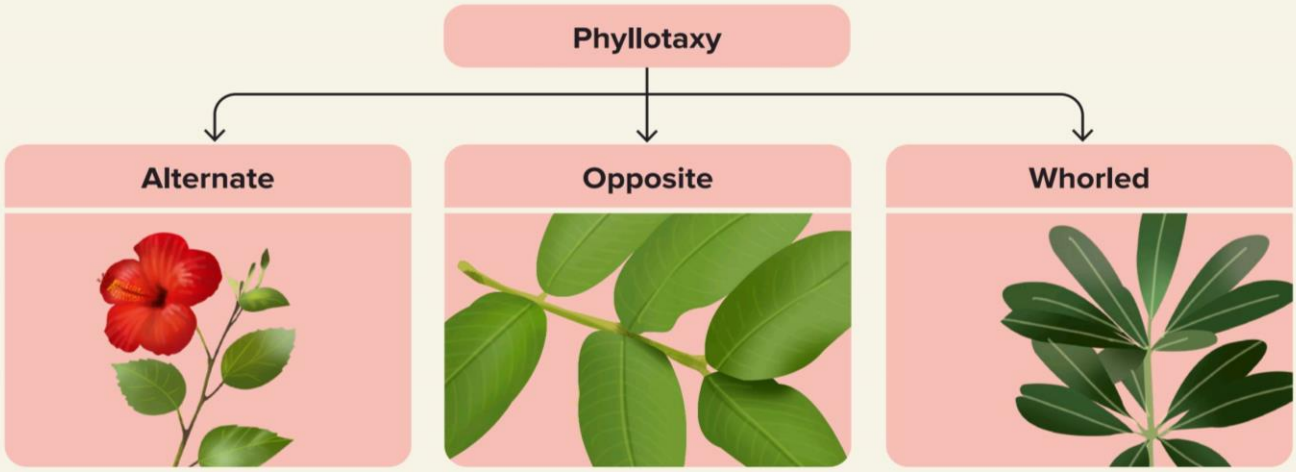
• Based on **leaflet arrangement,** compound leaves are further divided as shown:



Arrangement of leaves - Phyllotaxy

Types of phyllotaxy

• The pattern of arrangement of leaves on the stem or branch is known as **phyllotaxy.**

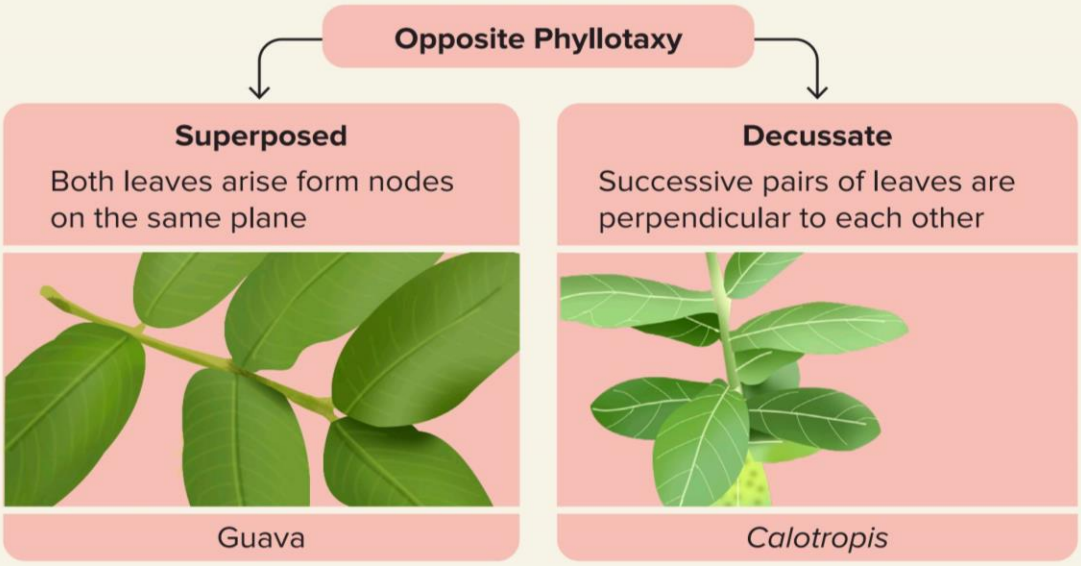


(a) Alternate

- Every leaf arises from a single node.
- E.g., *Hibiscus*, sunflower, mustard.

(b) Opposite

- The leaves are opposite to each other.
- At every node, two leaves arise.
- Opposite phyllotaxy can be further divided as:

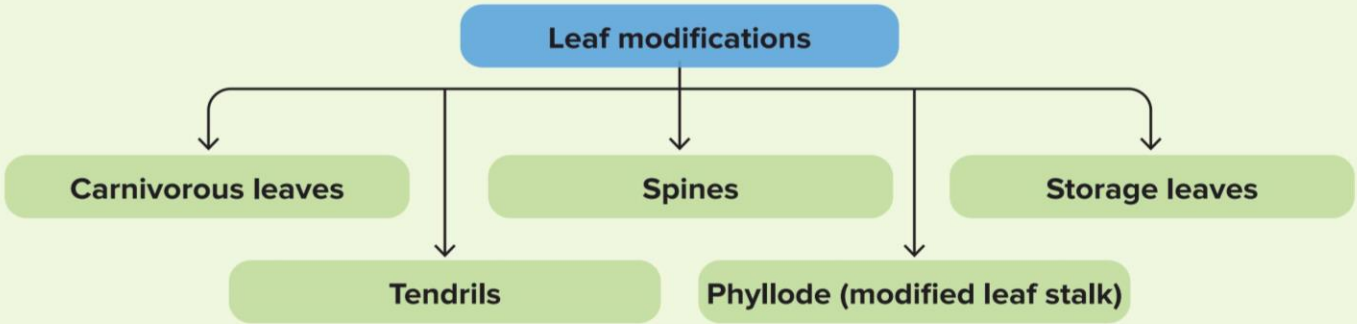


(c) Whorled

- In this arrangement, more than two leaves arise from a single node. E.g., *Alstonia*.

Modifications of leaves

- Leaves are modified for a desired function.
- There are five types of modifications:



Carnivorous leaves

- Leaf lamina is modified to **trap insects**.
- **Insectivorous plants** are **photoautotrophic** (organisms that can synthesize their own food using light and inorganic chemicals)
- However, they grow in soil which lacks nitrogen. To fulfill the requirement of nitrogen, they trap insects.

Pitcher plant
(Leaf lamina is modified into a pitcher)

Venus flytrap

Spines

- The leaves are transformed into spines to minimize water loss by reducing surface area for transpiration.
- For example, cacti have swollen stems and leaves are modified to spines.
- Spines also provide protection against predators.

Cactus

Storage leaves

- Some leaves are **modified to store food**.
- Garlic and onion are edible leaves. The outer leaves are dry scale leaves.

Garlic

Onion

Tendrils

- The leaves are modified into tender, coiled structures which provide support and help in climbing. E.g., pea plant
- In some plants, the axillary bud is modified into tendrils. E.g., cucumber.
- In some plants, the leaf tip is modified into tendrils. E.g., glory lily.
- The tendrils respond to touch and twine around objects.

Pea plant

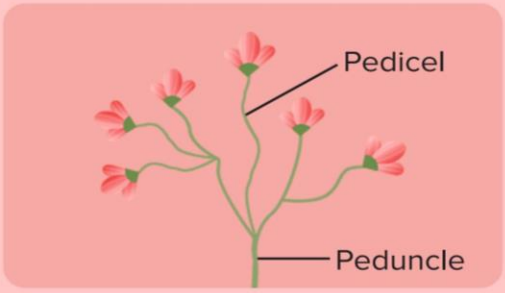
Phyllode (modified leaf stalk)

- Photosynthetic modified petioles are known as phyllodes. E.g,. *Acacia*
- The petiole expands, turns green and performs photosynthesis. the leaf petiole expands. It turns green and performs photosynthesis.
- The phyllodes are short-lived.

Acacia

Flower - modified shoot

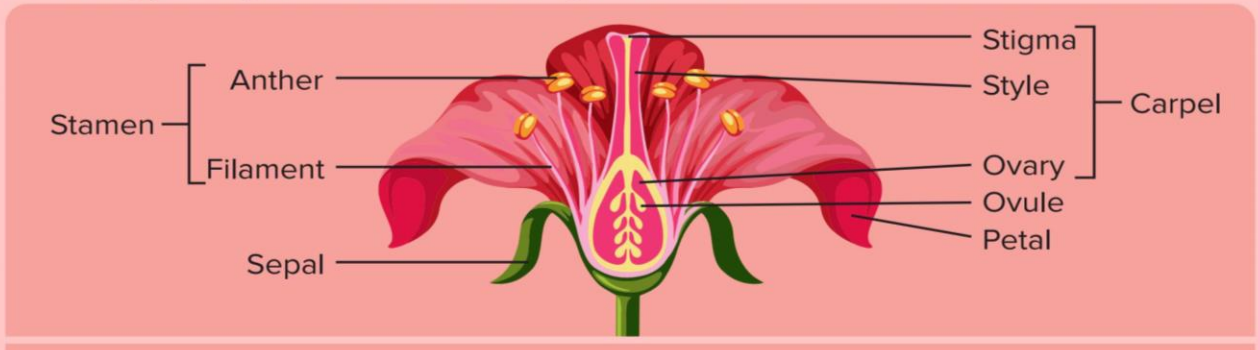
- The **flower** is a **modified shoot**. The SAM is modified to form the floral meristem.
  - ➝ Shoot tip transforms into flowers.
  - ➝ The apex produces different kinds of floral appendages laterally at successive nodes instead of leaves.
  - ➝ Internodes do not elongate.
  - ➝ Axis gets condensed.
  - ➝ The stalk which bears flowers is known as **peduncle**.
  - ➝ The stalk of a single flower is known as a **pedicel**.



Floral appendages

- **Non-reproductive parts**
  - **Petals** (attracts insects)
  - **Sepals** (protects internal parts)
- **Reproductive parts**
  - **Stamen (Androecium)** (male sex organ that produces male sex cells)
    - **Anther** (swollen structure that bears pollen grains)
    - **Filament** (slender, stalk-like structure that anchors and supports the anther)
  - **Carpel (Gynoecium)** (female sex organ that produces female sex cells)
    - **Stigma** (receptacle for pollen)
    - **Style** (long and slender)
    - **Ovary** (swollen base)

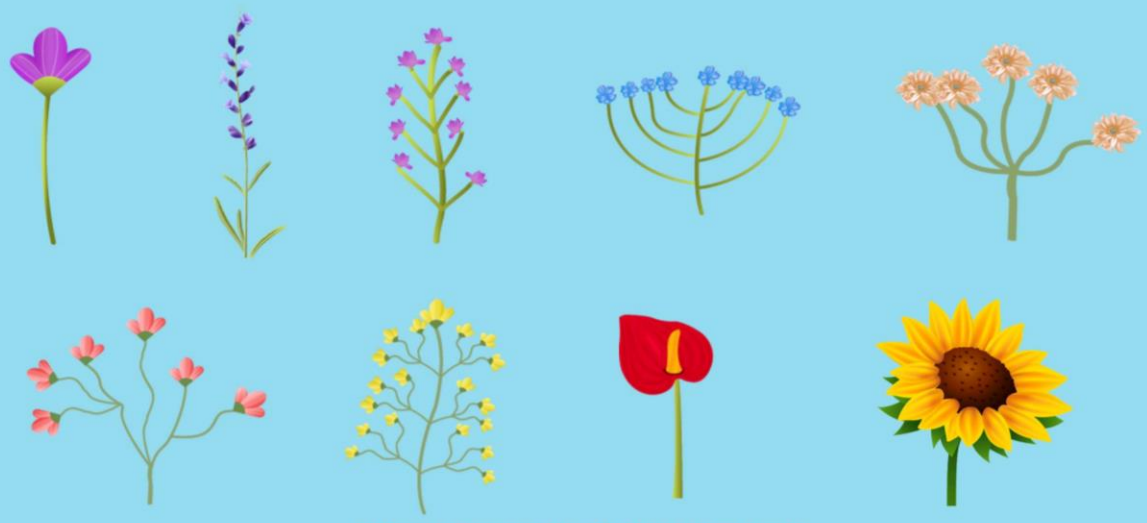
- The floral appendages include the following structures:



Parts of a flower

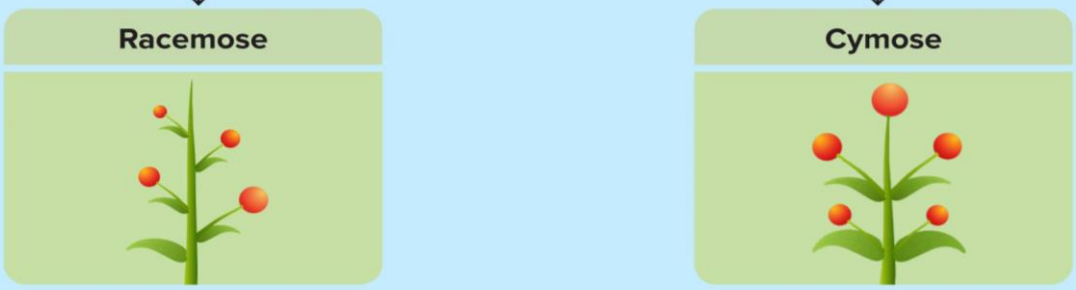
Arrangement of flowers

- Flowers may be present in the following manner:
  - ➔ At the shoot apex
  - ➔ Arranged along the stem
- The arrangement of flowers on the floral axis is known as **inflorescence**.



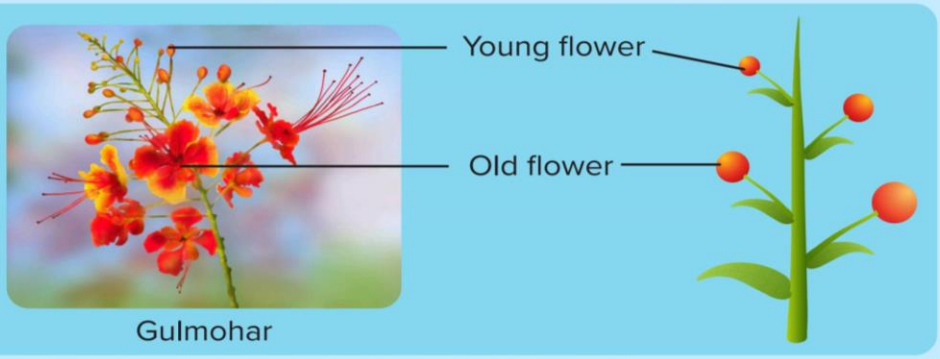
Inflorescence in different plants

Types of inflorescence



Racemose inflorescence

- Growth of the floral axis is indefinite.
- Flowers are arranged in **acropetal order** (flowers develop from the base to the apex).
- Older flowers lie at base and the younger flowers at the top. E.g., gulmohar.

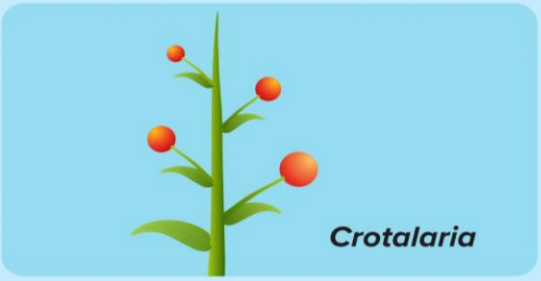


Types of racemose inflorescence

Simple raceme | **Umbel** | **Corymb** | **Head/capitulum**

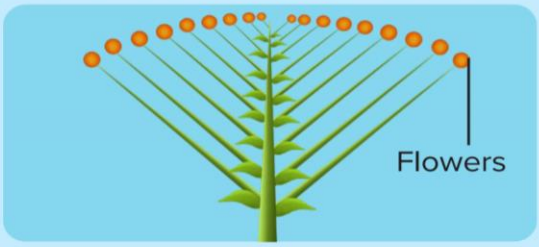
(a) Simple raceme

- The floral axis is **unbranched**.
- Many pedicellate flowers (flowers which have a stalk) are produced.
- E.g., *Crotalaria*



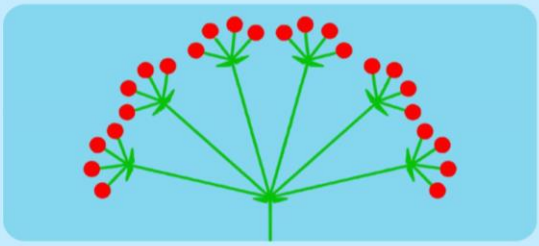
(b) Corymb

- The flowers have **stalks of varying lengths**.
- All flowers are at the **same height**.
- E.g., candytuft



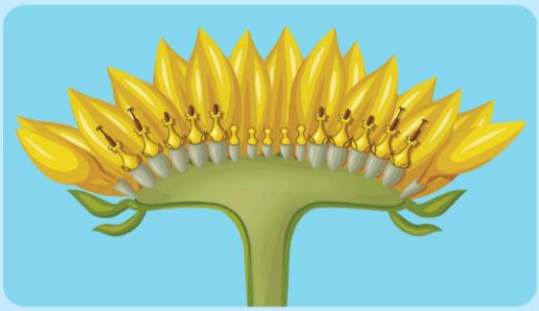
(c) Umbel

- In this type of inflorescence, the **peduncle is condensed**.
- The flowers are clustered at the apex.
  E.g., onion



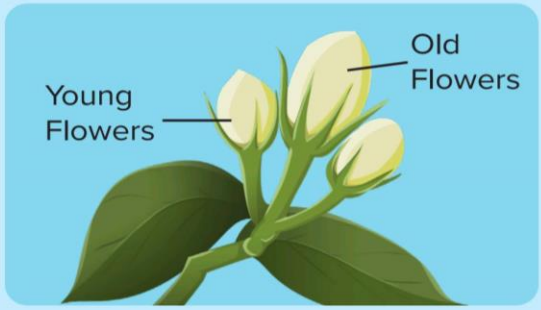
(d) Head/capitulum

- The peduncle is condensed to form flattened discs known as receptacles.
- Many flowers are closely arranged on the receptacle.
- E.g., sunflower



Cymose inflorescence

- Flowers develop from the apex to the base. This is known as **basipetal succession**.
- The older flowers lie at the apex and the younger flowers lie below it.
- Growth of the floral axis is definite and terminates into a flower.



Types of cymose inflorescence

- **Solitary cyme**
- **Monochasial cyme**
- **Dichasial cyme**

(a) Solitary cyme

- A single flower is produced. It can be at the axillary (arising from the leaf axils) or terminal (at the tip of the stem or branch) position.
- E.g., Terminal: *Datura*
  Axillary: *Hibiscus*

Datura

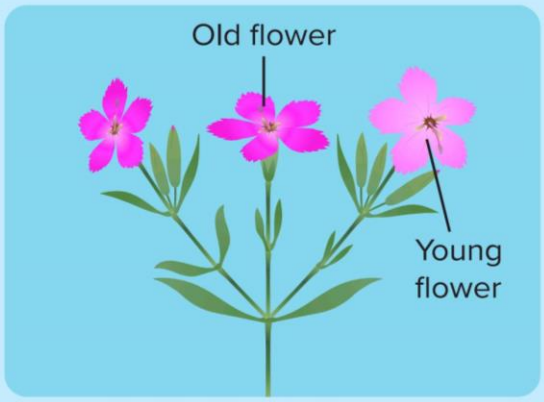
Hibiscus

(b) Monochasial cyme

- Only **one branch** emerges at a time. The branch terminates with a flower.

(c) Dichasial cyme

- Like monochasial cyme, in dichasial cyme the **peduncle terminates with flowers**.
- However, two **lateral branches** are produced (which also terminate with flowers). E.g., jasmine



Summary Sheet

- **LEAF**
  - **Parts of leaf**
    - Leaf base/Hypopodium
      - Stipules
      - Sheath
      - Pulvinus
    - Petiole/Mesopodium
    - Lamina/Leaf blade → Venation
      - Parallel 
      - Reticulate 
  - **Types of leaf**
    - Simple leaf
    - Compound leaf
      - Pinnately 
      - Palmately 
  - **Modification of leaf**
    - Stored Leaf 
    - Insectivorous/Carnivorous 
    - Phyllode 
    - Tendrils 
    - Spines 
  - **Phyllotaxy** Arrangement of Leaves
    - Alternate 
    - Whorled 
    - Opposite
      - Superposed 
      - Decussate 

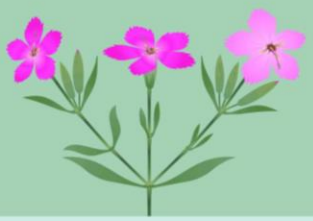
INFLORESCENCE
Arrangement of flowers

Cymose
Basipetal succession

Solitary cyme
(single terminal or axillary flower)

Monochasial cyme
(one branch arises at a time and terminates in a flower)

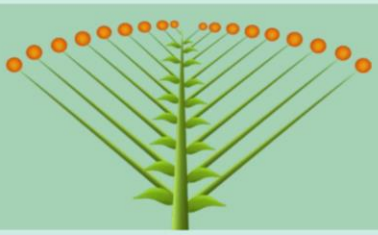
Dichasial cyme
(two lateral branches are produced which terminate in a flower)



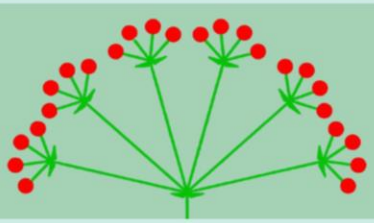
Racemose
Acropetal succession

Simple raceme
(unbranched floral axis)

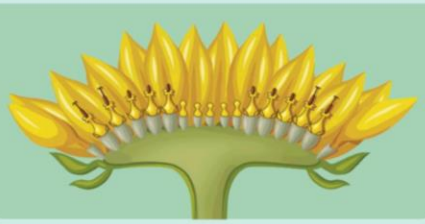
Corymb
(flowers have stalks of varying lengths and all the flowers are at the same height)



Umbel
(flowers clustered at the apex)



Head/Capitulum
(flowers are arranged at the receptacle)



C3 FLOWER, PARTS OF A FLOWER - CALYX, COROLLA, ANDROECIUM, GYNOECIUM, FLORAL FORMULA AND FLORAL DIAGRAM

Key Takeaways

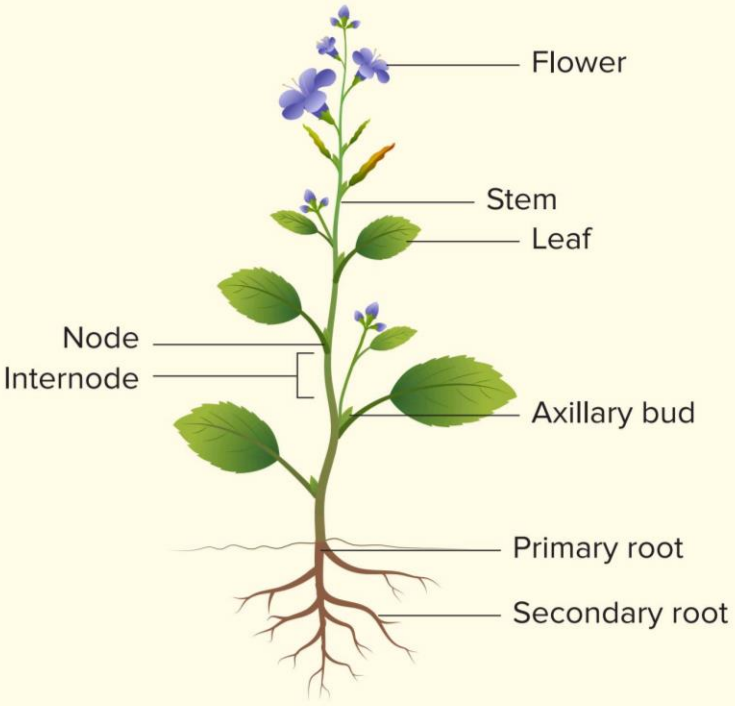
- Inflorescence
- Flower and its parts
- Classification of flowers
- Floral diagrams

Prerequisites

- Parts of flowering plants
- Root system
- Shoot system

Flower

- It is the **reproductive organ** of angiosperms.
- It facilitates **sexual reproduction** in flowering plants.



Typical flowering plant

Pedicel

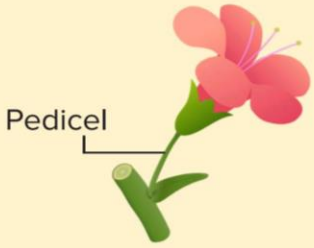
- It is the **stalk** of a plant that **connects the flower** to the stem of the plant.

Flower (Based on the presence of pedicel)

Pedicellate

Flowers that **have a pedicel**.

E.g., *Rosa indica*



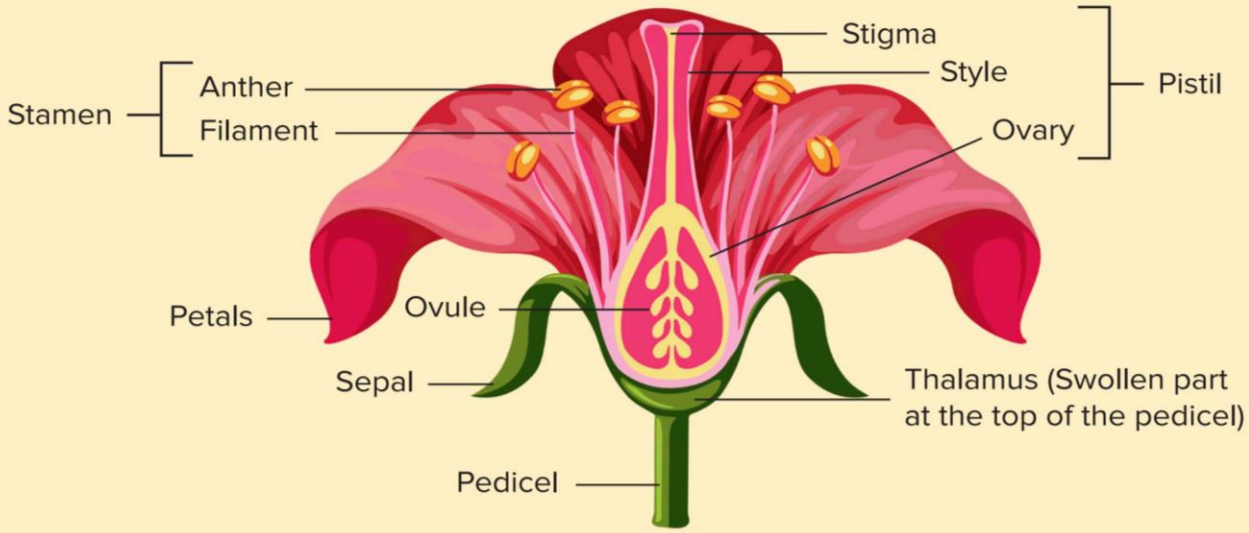
Sessile

Flowers that **do not have a pedicel** and are directly borne on the stem.

E.g., saffron flower

Parts of the flower

- A typical flower consists of the following parts:



- Each part of a flower can be represented by certain symbols.

Bracts

- Bracts are **green, leaf-like structures present at the base of the pedicel**.

Flower (Based on presence of bracts)

Bracteate

Flowers which **have bracts** surrounding the sepals.
E.g., Tulips
Symbol: **Br**

Tulips

Ebracteate

Flowers in which bracts are **absent**.
E.g., Mustard flowers
Symbol: **Ebr**

Mustard flowers

- **Spathe**: Bracts of some flowers are **modified** into colourful and bright structures. Their function is to **attract pollinators**.

  E.g., *Anthurium*

Spathe in *Anthurium*

Whorls of flowers

- Whorl is a term used for the **arrangement of sepals, petals, stamens, or carpels**, which radiate from a common point surrounding the stem or stalk.

Flower (Based on function)

Non-essential/ Accessory whorls

These are **not directly involved in sexual reproduction** of plants. However, these parts may participate in attracting pollinators.

- Calyx
- Corolla

Essential/ Reproductive whorls

These are **directly involved in sexual reproduction** and, seed formation.

- Androecium
- Gynoecium

Flower (Based on the number of appendages)

Trimerous
3 units

Number of units of whorls is 3 or a multiple of 3.
E.g., monocot flowers like lily

Tetramerous
4 units

Number of units of whorls is 4 or a multiple of 4.
E.g., dicot flowers like *Primrose*

Pentamerous
5 units

Number of units of whorls is 5 or a multiple of 5.
E.g., *Crassula ovata*

Calyx

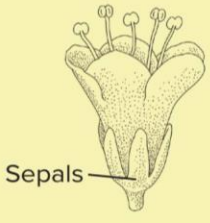
- It is the **outermost whorl** of the flower.
- It is the **collective term** for **sepals**.
- Its characteristic features are:
  - It is green in colour.
  - It has a leaf-like appearance.
- **Function**: It protects the flower in the bud stage.
- **Symbol**: It is represented by **K**.

Flowers (Based on calyx)

Gamosepalous
Sepals united

E.g., *Primrose* - 5 sepals are fused together and are represented as $K_{(5)}$.

Polysepalous
Sepals free



E.g., Rose - 5 sepals are free and are represented as K_5.

Corolla

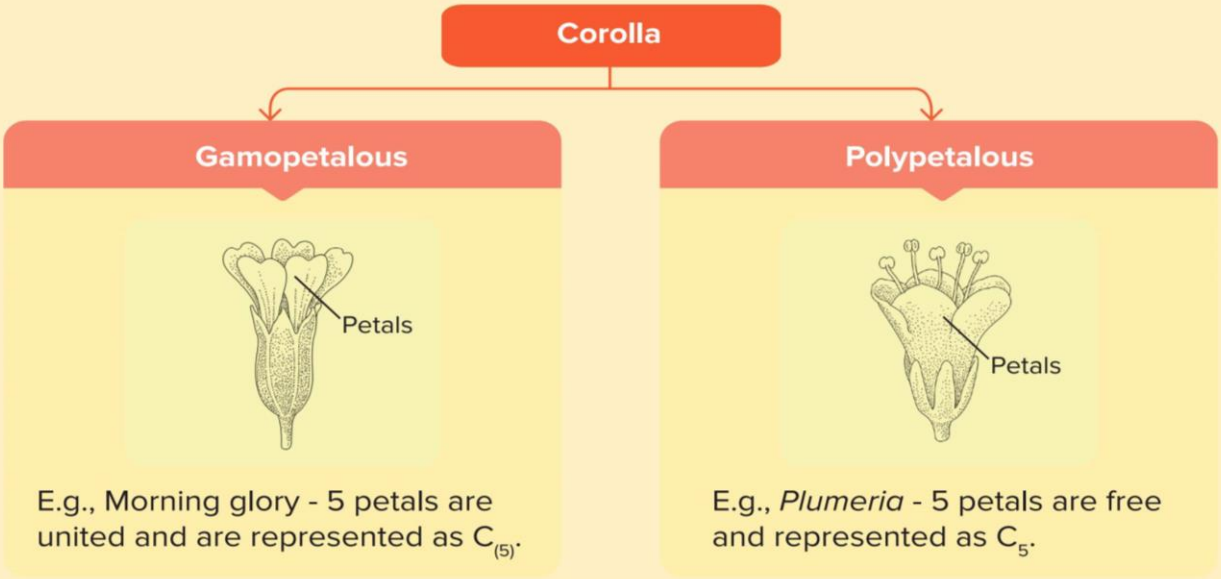
- It is a collective name for **petals**.
- **Function**: It attracts pollinators.
- **Symbol**: It is represented by **C**.
- **Shape**: It may vary from species to species. It can be tubular, bell-shaped, funnel-shaped, or wheel-shaped.

Tubular

Bell-shaped

Funnel-shaped

- **Classification of flowers based on corolla**



Perianth

- When calyx and corolla are not distinct from each other and are united they are termed as **tepals**.
- Collective term for tepals is **perianth**.
- **Occurrence**: It is commonly found in monocots.
- **Symbol**: It is represented by **P**.

Aestivation

- It is the **arrangement of sepals and petals** with respect to other members of the same whorl.
- **Types of aestivation**

Valvate

Arrangement where sepals or petals in a whorl touch one other at the margin.

E.g., *Calotropis*

Twisted

Arrangement where one margin of the appendage (sepals or petals) overlaps that of the next one.

E.g., China rose (*Hibiscus*), lady's finger flower, cotton flower

Imbricate

Arrangement where margins of sepals or petals overlap one another but not in any particular direction.

E.g., Gulmohar, *Cassia*

Vexillary (Papilionaceous)

Arrangement where the largest petal (standard) overlaps the two lateral (wings) that in turn overlap the two smallest anterior petals (keel/carina).

E.g., Pea flower, bean flower

Symmetry in flowers

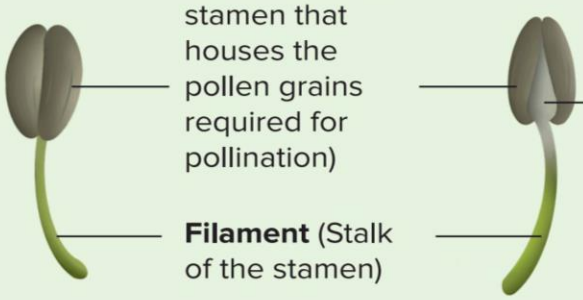
- **Symmetric flowers:** These are the flowers that can be cut into equal halves on either sides of a plane of division.

Symmetry

Actinomorphic	Zygomorphic	Asymmetric
Flowers that can be cut in any plane to get equal halves. Symbol - ⊕. E.g., Mustard flower, *Datura,* chilli flower	Flowers that can be cut in only one plane to get equal halves. Symbol - %. E.g., Gulmohar, *Cassia,* pea flower, bean flower	Flowers that can not be divided into equal halves. Symbol - (↯). E.g., *Canna*
		
Daffodil	**Orchid**	***Canna***

Androecium

- **Stamens** are collectively termed as androecium.
- **Function:** It is involved in sexual reproduction.
- **Symbol:** It is represented by **A**.
- **Parts of androecium**
  - **Stamen:** It is the **male reproductive organ** of a flower.



Parts of the stamen

Androecium (based on stamen length)

Didynamous

Six stamens are present, two are short and four are long.

E.g., mustard flower

Tetradynamous

Four stamens grouped into two sets of equal length.

E.g., *Ocimum, Salvia* flower

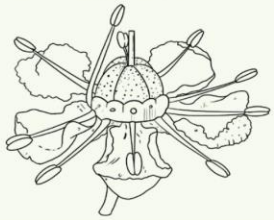
Stamen (Based on fusion to floral parts)

Epipetalous

Stamens are attached to the petals. E.g., brinjal flower

Epiphyllous

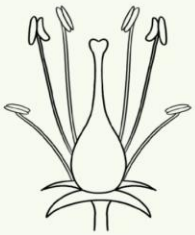
Stamens are attached to the perianth. E.g., Lily



Stamen (Based on whether stamen is free or united)

Polyandrous

Stamens are free. E.g, lotus



Adelphous (stamens are united)

Monoadelphous

Stamens are with united filaments.

E.g., China rose

Diadelphous

Filaments are divided into bundles.

E.g., pea plant

One distinct filament and a bunch of joint filaments

Polyadelphous

Filaments are divided into more than two bundles.

E.g., lemon

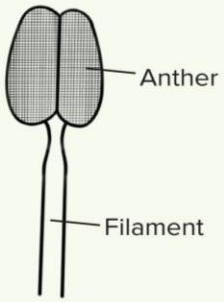
- **Classification of anther based on number of lobes**

Types of anther

Monothecous

Single-lobed structure. It has two pollen chambers hence referred to as **bisporangiate anthers**.

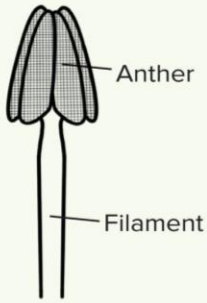
Example: *Hibiscus*



Dithecous

Double-lobed structure. It has four pollen chambers hence referred to as **tetrasporangiate anther**. It is more common.

Example: Lily



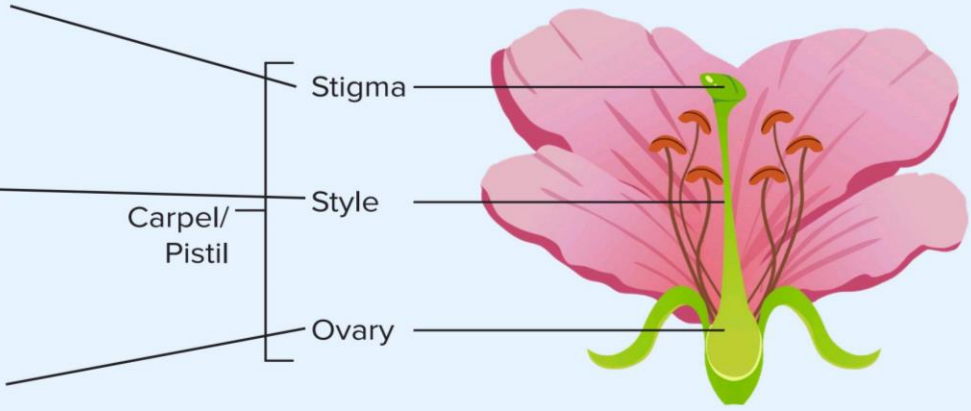
Gynoecium

- **Pistils** (also known as **carpels**) are collectively termed as gynoecium. The gynoecium is the **female reproductive organ**.
- **Function**: It is involed in sexual reproduction in plants.
- **Symbol**: It is represented by **G**.

It is the receptive surface for pollen grains. It is present at the tip of the pistil.

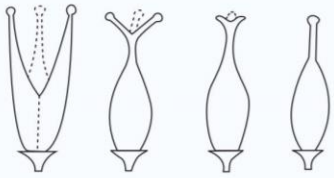
It connects the ovary to the stigma. It is the middle portion of the pistil.

It is the enlarged basal part of the style.

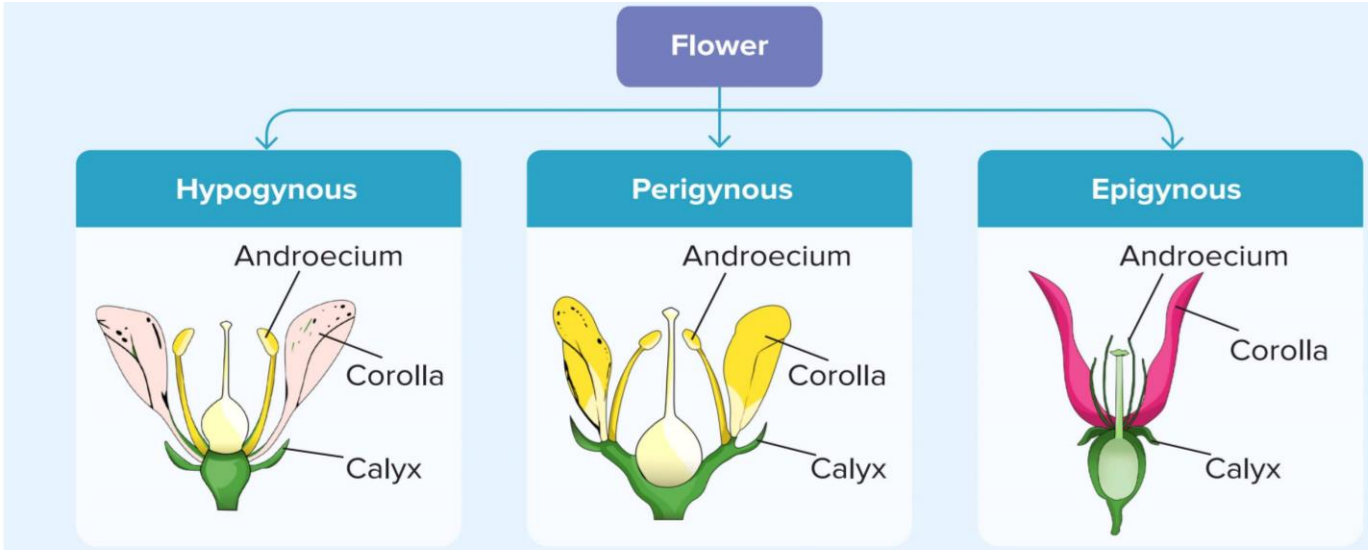


Characteristic features of the gynoecium

Gynoecium - Types
(based on whether pistils are free or united)

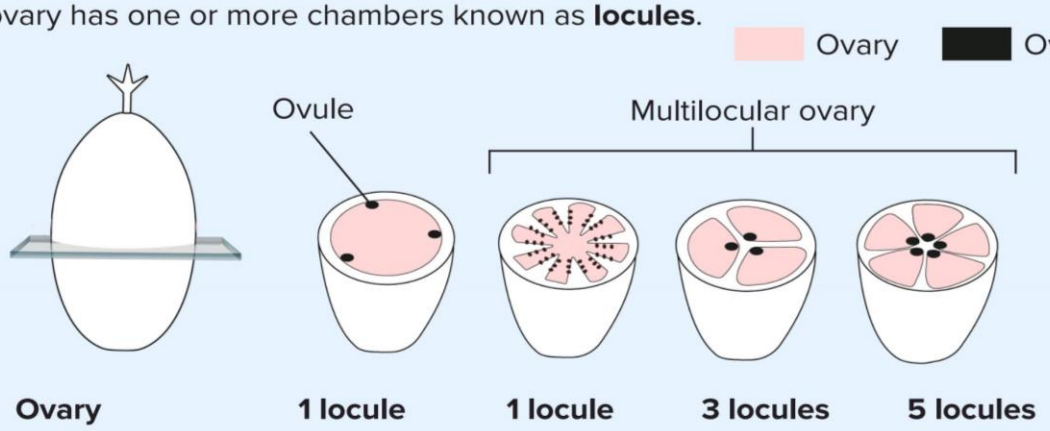
Monocarpous	Apocarpous	Syncarpous
Only single pistil is present	Multiple carpels are present freely	Multiple carpels are united
		
E.g., avacado flower	E.g., lotus, rose	E.g., tomato flower, mustard flower

- **Classification based on the position of ovary**
  - **Hypogynous**
    - Gynoecium occupies the **highest** position.
    - Calyx, corolla, and androecium are present **below** the gynoecium.
    - Ovary is **superior**.
    - **Symbol**: It is represented by $\underline{G}$.
    - **E.g.,** *Hibiscus,* mustard flower, brinjal flower
  - **Perigynous**
    - Gynoecium is situated in the **centre**.
    - Calyx, corolla, and androecium are located at the **rim of thalamus**.
    - Ovary is **half inferior**.
    - **Symbol**: It is represented by **-G-**.
    - **E.g.,** Rose, plum flower, peach flower
  - **Epigynous**
    - Thalamus margin grows **upward**, **enclosing the ovary and fusing** with them.
    - Calyx, corolla, and androecium are **above** the ovary.
    - Ovary is **inferior**.
    - **Symbol**: It is represented by $\overline{G}$.
    - **E.g.,** Sunflower, guava flower, cucumber flower

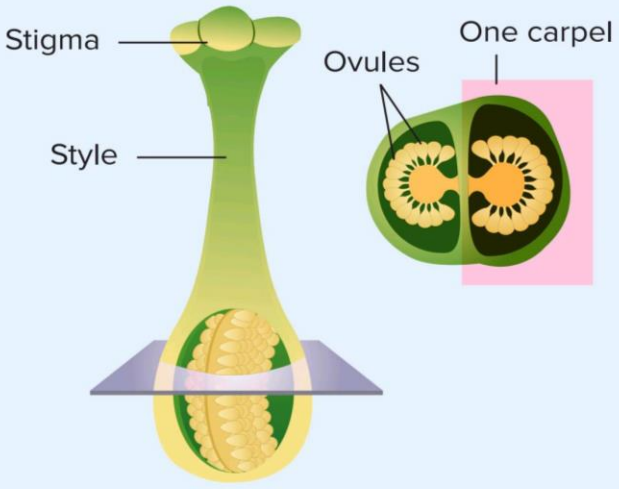


Parts of the ovary

- An ovary has one or more chambers known as **locules**.



- Each ovary bears one or more **ovules**.
- Ovules are connected to the ovary by a flattened, cushion-like **placenta**.
- A mature ovary has an **ovary wall** known as **pericarp** that encloses locules. Placenta arises from pericarp and is attached to ovules via **funiculus**.
- Ovules develop into **fruit** after fertilisation.



- **Classification based on arrangement of ovules**
  - **Axile placentation:** Ovules are attached to multilocular (ovary with multiple chambers) ovaries.

    E.g., Tomato, lemon
  - **Marginal placentation:** Placenta forms a ridge on which ovules are present.

    E.g., Pea
  - **Parietal placentation**

    Ovules develop on the inner wall of the ovary or on the peripheral part.

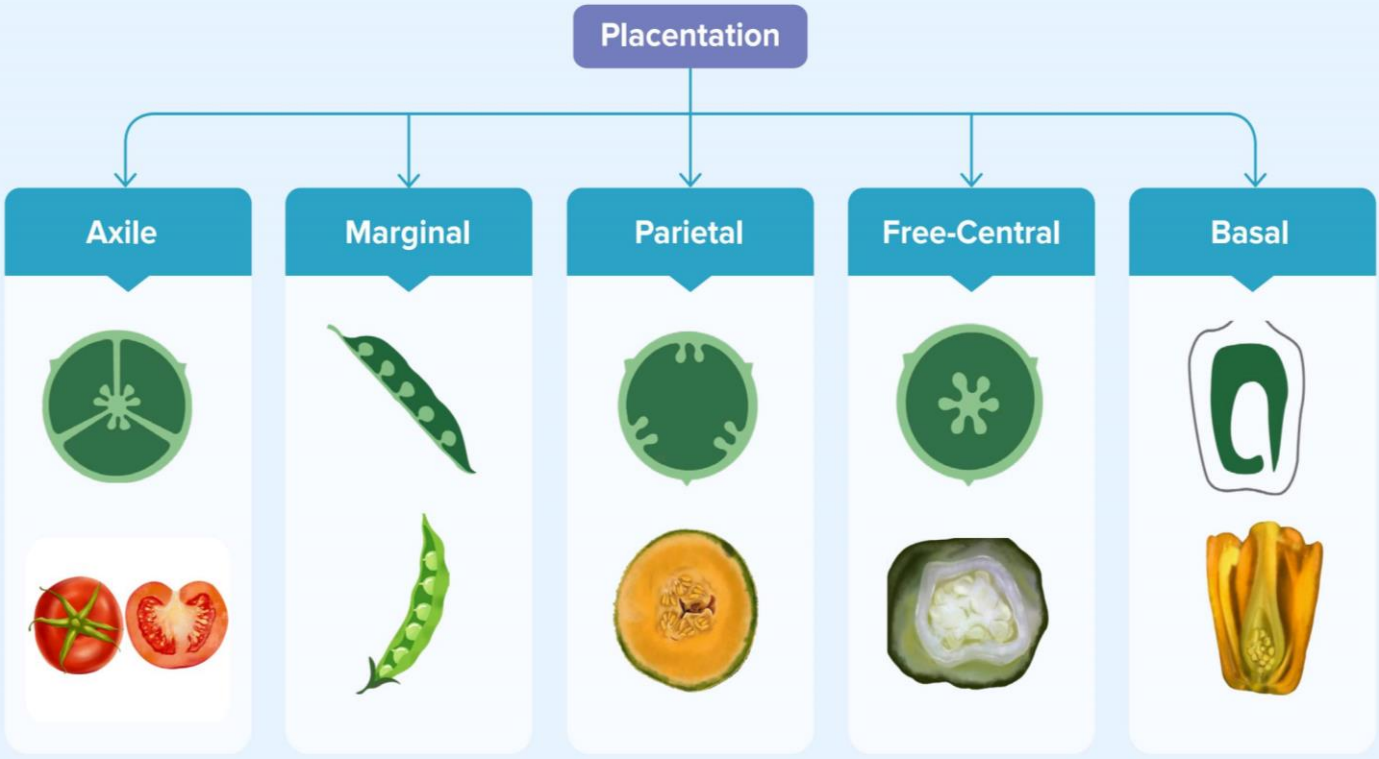
    E.g., Cantaloupe

    Ovaries become two-chambered due to false septum.

    E.g., Mustard, *Argemone*
  - **Free-central placentation:** Ovules are borne on the central axis of the ovary without any septa.

    E.g., *Primrose*, *Dianthus*
  - **Basal placentation:** Ovules develop at the base of the ovary.

    E.g., Marigold, sunflower

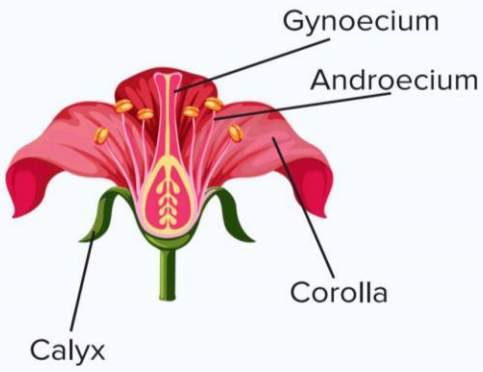


Different classifications of flower

Flower - Types (based on whorls)

Complete

Flower has all four whorls.
E.g., *Hibiscus*



Incomplete

Flower is devoid of one or more whorls.
E.g., Papaya flower (the male flowers lack the gynoecium and the female flower lacks the androecium)

- **Classification of flower based on presence of sexual reproductive organ**
  - **Staminate flower**
    - **Only androecium** is present.
    - It is found in **dioecious** plants.
    - It is also found in **unisexual** flowers in **monoecious** plants.
    - **E.g.,** Male papaya flower
  - **Staminode**
    - **Rudimentary stamen** is present.
    - Stamen is **sterile** (does not produce pollen grains).
    - **E.g.,** Banana flower
  - **Pistillate flower**
    - **Only gynoecium** is present.
    - It is found in **dioecious** plants.
    - **E.g.,** Female Cucurbit flower
  - **Bisexual flower**
    - Both **androecium** and **gynoecium** are present in the same flower.
    - It is found in **monoecious** plants.
    - **E.g.,** Mustard flower

- **Sex-switching plants**
  - They express sexual differences at different stages of growth.

Arisaema triphyllum

Non-sexual	All male	Mix of male and female flowers	Mostly female flowers
Juvenile plant	**Young plant**	**Growing plant**	**Mature plant**

Arisaema triphyllum

Summary Sheet

Section	Flower	Pedicel	Bract	Whorls of flower
Definition	• **Reproductive organ** of a plant	• **Stalk of the plant** that connects the flower with the stem.	• **Green, leaf-like structures** that protect the flower	• **Arrangement of sepals, petals, stamens, or carpels** rising from a common point around the stem or stalk
Classification	**Based on whorls** • **Complete flower**: All 4 whorls, i.e., calyx, corolla, androecium, and gynoecium are present. **E.g.**, *Hibiscus* • **Incomplete flower**: 1 or more whorl is absent. **E.g.**, Papaya flower	**Based on the presence of pedicel** • **Sessile:** Pedicel is absent. **E.g.**, *Rosa indica* • **Pedicellate** : Pedicel is present. **E.g.**, Saffron flower	**Ebracteate**: Bracts are absent. **E.g.**, Mustard flower **Bracteate:** Bracts are present. **E.g.**, Tulip **Spathe:** Modified bract, colourful to attract pollinators **E.g.**, *Bougainvillea*	**(a) Based on function of whorl** • **Essential or reproductive whorls** **Androecium:** Collection of stamens **Gynoecium:** Collection of pistils • **Non-essential whorls or non-reproductive whorls** **Calyx:** Collection of sepals **Corolla:** Collection of petals **(b) Based on number of appendages** **Trimerous:** Number of units of the whorls is 3 or a multiple of 3. **Tetramerous:** Number of units of the whorls is 4 or a multiple of 4. **Pentamerous:** Number of units of the whorls is 5 or a multiple of 5.

Section	Calyx	Corolla	Perianth
Definition	Collective term for **sepals**	Collective term for **petals**	Collective term for **tepals** (undifferentiated sepals and petals)
Features	Leaf-like, green in colour **Function**: Protects the bud	**Shapes**: Various such as bell shaped, tubular **Function**: To attract pollinators	It is commonly found in monocots.
Classification	**Gamosepalous:** Sepals are united **E.g.**, *Primrose* **Polysepalous** : Sepals are free **E.g.**, Rose	**Gamopetalous:** Petals are united **E.g.**, Morning glory **Polypetalous** : Petals are free **E.g.**, *Plumeria*	

Section	Aestivation	Symmetry	Androecium	Gynoecium
Definition	Arrangement of **sepals** and **petals** with respect to other members of the same whorl	When flower can be divided into equal proportions on either side of a plane of division.	Group of stamens	Group of pistils or carpels
Features	It is important for taxonomic classification of plants.	Not all flowers possess symmetry	**Male reproductive organ** of a plant. Has 3 parts: Anther, filament, connective	(i) **Female reproductive organ.** - Stigma - Style - Ovary (ii) **Locules** - Chambers in the ovary (iii) **Ovule** - Contained within the ovary and connected to the ovary by the placenta

Classification				
	Valvate: Sepals or petals in a whorl touch one other at the margin. **Twisted**: Margins of the sepals or petals overlap that of the next one. **Imbricate**: Margins of sepals or petals overlap one another but not in any particular direction. **Vexillary or papilionaceous**: Largest petal (standard) overlaps the two lateral (wings) that in turn overlap the two smallest anterior petals (keel/carina).	**Actinomorphic:** Any plane passing through a flower can divide it into equal halves. **Zygomorphic:** Only one plane passing through flower can divide it into 2 equal halves. **Asymmetric:** Cannot divide flower into 2 equal halves.	**Based on stamen length** **Didynamous:** 4 stamens grouped into 2 sets of equal length **Tetradynamous:** 6 stamens present, 2 are short, 4 are long **Based on fusion of stamen with other parts** **Epipetalous:** Stamens attached to petals **Episepalous:** Stamens attached to sepals **Based on whether stamen is free or united** **Polyandrous:** Free stamens **Adelphous:** United stamens **Monoadelphous:** Single bundle of united stamens **Diadelphous:** 2 bundles of united stamens **Polyadelphous:** More than 2 bundles of united stamens **Based on number of lobes of anther** **Monothecous:** Single-lobed structure **Dithecous:** Dual-lobed structure	**Based on whether pistil is united or free** **Monocarpous:** Single pistil **Apocarpous:** More than 1 pistil present freely **Syncarpous:** More than one united pistil present. **Based on position of ovary** **Hypogynous**: Calyx, corolla, and androecium present below ovary **Perigynous:** Calyx, corolla, and androecium present at rim of thalamus **Epigynous:** Calyx, corolla, and androecium present above ovary **Based on ovule arrangement** (i) Axile placentation (ii) Marginal placentation (iii) Parietal placentation (iv) Free-central placentation (v) Basal placentation

Symbols for Floral Formula

S.No.	Floral part	Classification	Symbol
1	Bracts	Ebracteate	EBr
		Bracteate	Br
2	Calyx	Gamosepalous	For n sepals in a flower $K_{(n)}$
		Polysepalous	K_n
3	Corolla	Gamopetalous	For n petals in a flower $C_{(n)}$
		Polypetalous	C_n
4	Perianth		P
5	Symmetry	Actinomorphic	$\oplus$
		Zygomorphic	%
		Asymmetric	$(\lightning)$
6	Androecium		A
7	Gynoecium	Hypogynous	$\underline{G}$
		Perigynous	-G-
		Epigynous	$\overline{G}$