5. Morphology of Flowering Plants

- **Morphology**
  - It is the branch of biology which deals with the study of external structures of plants and animals.
  - A plant consists of a root system (underground part) and a shoot system (above the ground parts).
  - Roots are the parts of the root system; and stem, leaves, flowers, and fruits are parts of the shoot system.
- **Roots**
  - It helps in anchoring plant and absorbing water and minerals.
  - Developed from the radicle part of a cotyledon
  - It consists of a region of meristematic activity covered by a root cap, a region of elongation, and a region of maturation having root hairs.
- **Types of roots system:**
  1. Tap root system
  - It consists of a primary root that grows deep inside the soil.
  - It also bears lateral roots referred to as secondary and tertiary roots.
  - Example- Dicotyledons (mustard)
- **2.Fibrous root system**
  - Primary root is short-lived and is replaced by a large number of secondary roots.
  - Example- Monocotyledons (wheat)
- **3. Adventitious roots**
  - Roots arise from parts other than the radicle.
  - Example- Banyan tree

- **Root modifications**
  - **Prop roots** – Example: banyan tree
  - **Stilt roots** – Example: maize and sugarcane
  - **Pneumatophores** (that helps in respiration) – Example: Rhizophora
- **Characteristics of Root for Absorbing Water**
  - Enormous surface area
  - Root hairs containing cell sap at higher concentration
  - Thin walled root hairs

Stem

- Bears branches, leaves, flowers, and fruits
- Conducts water and minerals to all parts of the plant body
- Bears nodes and internodes

Stem modifications

- For storage – Example: Potato, ginger, turmeric.
- For support – Tendrils in cucumber, pumpkins, watermelon.
- For protection – Thorns in *Citrus*, *Bougainvillea*.
- For vegetative propagation – Tubers and rhizomes in potato and ginger respectively.

Leaf

- Performs the function of photosynthesis
- Consists of leaf base, petiole, and lamina
- Veins help in the transport of water to all leaf parts.
- Arrangement of veins is known as **venation**.
- Parallel venation is found in monocots. Example: Banana
- Reticulate venation is found in dicots. Example: Mango
- Leaves may be simple or compound.
- Pattern of arrangement of leaves on the stem is known as **phyllotaxy**. It may be alternate as in china rose, opposite as in *Calotropis* or whorled as in *Alstonia.*

Leaf modifications

- Tendrils- Example: Peas
- Spines- Example: Cactus
- Fleshy leaves for storage- Example: Onion and garlic

Inflorescence

- Arrangement of flowers on the floral axis is termed as inflorescence.
- Racemose- In this, main axis continues to grow and flowers are borne laterally.
- Cymose- In this, main axis terminates in a flower.

Flower

- Flower is the reproductive unit in angiosperms.
- Bisexual flower has both androecium and gynoecium.
- Unisexual flower has either androecium or gynoecium.
- Actinomorphic flower has radial symmetry. Example: *Datura* and mustard
- Zygomorphic flower has bilateral symmetry. Example: Pea and bean
- Asymmetric flower cannot be divided into similar halves by any vertical plane. Example: Canna

Parts of flower

- Calyx is outermost whorl of a flower composed of sepals. It may be gamosepalous (united sepals) or polysepalous (free sepals).
- Corolla is composed of petals. Petals are brightly coloured to attract pollinators. It may be gamopetalous (united petals) or polypetalous (free petals).
- Androecium is the male reproductive part of a flower, composed of stamens.
- Based on attachment of anther with floral parts, it can be epiphyllous (attached with perianth) or epipetalous (attached with petals).
- Stamens can be monoadelphous (united in one bundle), diadelphous (united in two bundles), and polyadelphous (united in many bundles).
- A sterile stamen is called a staminode.
- Gynoecium is the female reproductive part of a flower, composed of pistil.
- Based on position of ovary, a flower can be hypogynous (ovary is superior), perigynous or epigynous (ovary is inferior).

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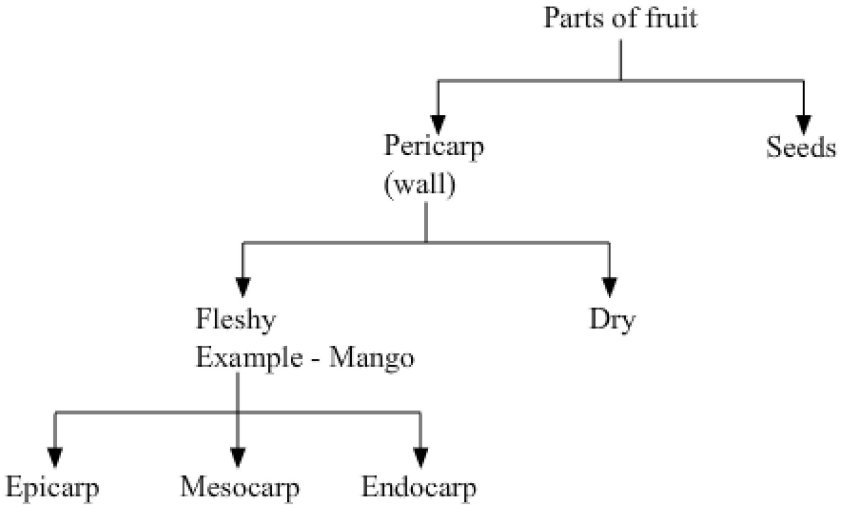
- When carpels are fused, ovary is syncarpous; when carpels are free, ovary is apocarpous.
- A flower may be trimerous, tetramerous or pentamerous when the floral appendages are in the multiple of 3, 4 or 5, respectively.

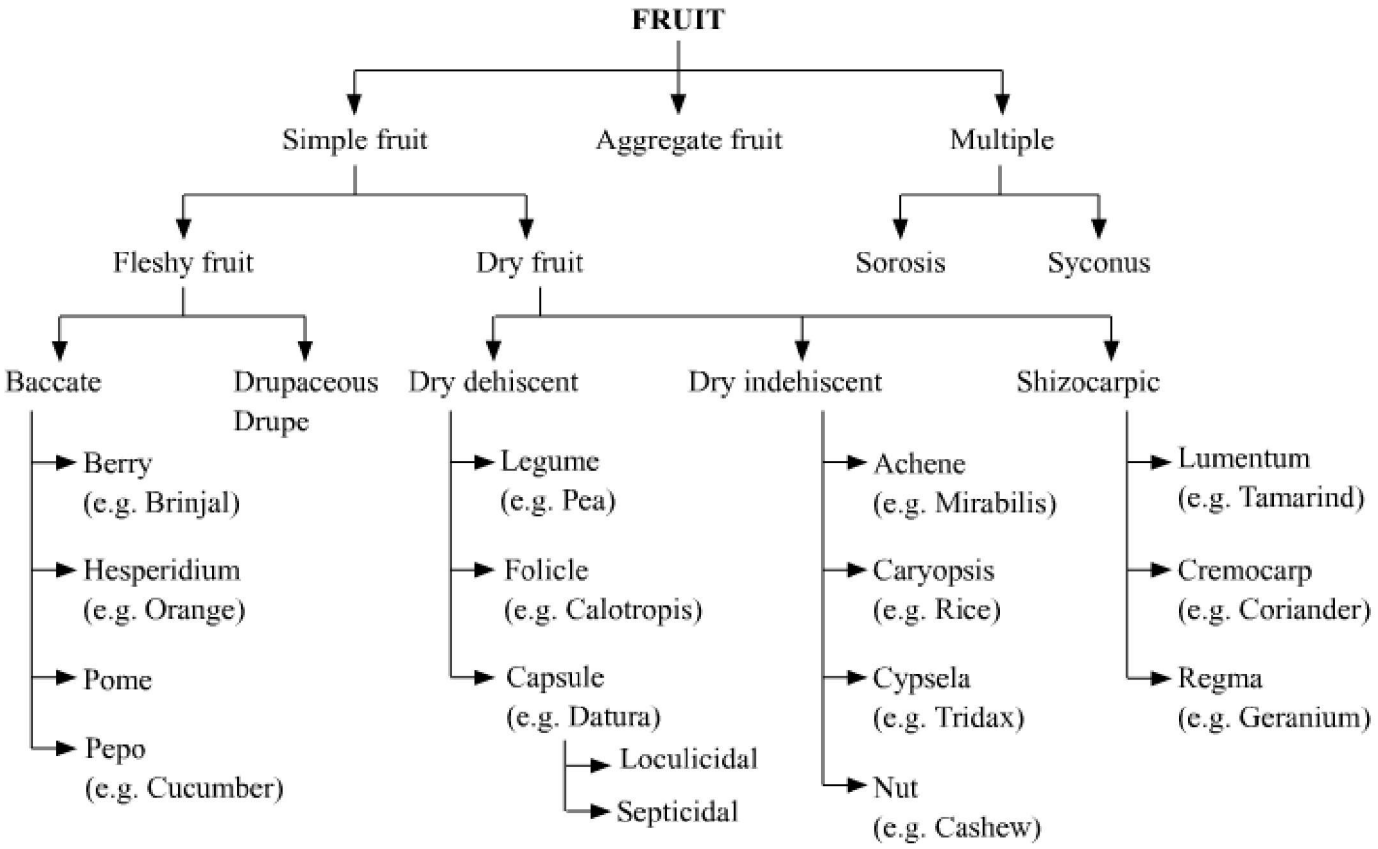
- **Aestivation** is the arrangement of sepals and petals in a flower bud. It may be
- valvate – Example: *Calotropis*
- twisted – Example: China rose
- imbricate – Example: *Cassia*
- vexillary – Example: Pea

- **Placentation** is arrangement of ovules within the ovary. It can be
- marginal – Example: Pea
- axile – Example: Tomato
- parietal – Example: Mustard
- free central – Example: *Dianthus*
- basal – Example: Sunflower

- Fruit is the matured ovary developed after fertilization.
- Parthenocarpic fruits: Fruits formed without fertilization of ovary.
- Parts of fruits:



- On the basis of origin, fruits are classified as:
- True fruits
- False fruits
- Based on floral arrangements true fruits are further classified as:



- **Seed Germination**
- It is the process of the seed develops into an individual plant utilizing the reserve nutrients present in the cotyledons.
- **Conditions necessary for germination**

  1. Water

  2. Oxygen

  3. Favourable temperature

- **Process of germination**

  1. The seed takes up water and swells.

  2. The embryonic radicle and plumule start growing and force the seed coat to rupture.

  3. The radicle comes out first and forms the root followed by the plumule which develops into the shoot.

- **Types of germination**

1. **Epigeal germination:** in this method the cotyledons are lifted above the ground and they act as the first leaves as a result of the rapid elongation of the hypocotyl. It takes place in seeds like Castor, cotton, sunflower etc.

2. **Hypogeal germination:** in this germination the cotyledons remain inside the soil and the epicotyls elongates and pushes the plumule above. It takes place in seeds like pea, maize, mango etc.

3. **Viviparous germination:** A special mode of germination in which seed starts germinating inside the fruit while it is

still attached to the parent plant. Once germinated, the seedling is dropped into the soil where it fixes itself by developing roots. It takes place in mangrove plants, like *Rhizophora* and *Sonneratia.*

Tissue

- It is a group of cells that are similar in structure and are organised together to perform a specific function.
- It is of two types: Meristematic tissues and Permanent tissues
- **Meristematic tissue**
- It consists of actively dividing cells that are found in those regions of the plant body that show growth.
- The examples include root tip, shoot tip, and base of the leaves.
- It is classified into three types:

i. **Apical meristem:** They are present in the growing tips of stems and roots. Function – helps in increasing the length of the stem and root

ii. **Intercalary meristem:** They lie at the base of leaves or internodes.

Function – helps in the longitudinal growth of plants

iii. **Lateral meristem:** They lie on the lateral sides of the stem and root.

Function – helps in increasing the thickness of stem and root

- Apical meristem and intercalary meristem help in the formation of the primary plant body. Therefore, they are called primary meristems.

Lateral meristem is formed in the mature regions of roots and shoots of plants. Hence, they are known as secondary meristem.

- **Complex tissues:** They are made up of more than one type of cells. All these cells work in coordinated manner to perform one common function.
- **Xylem:**It conducts water and minerals from roots to different parts of the plant.
- **Tracheids and vessels** are long tube-like structures with thick walls and tapering ends. Presence of vessels is the characteristic feature of angiosperms.

Function: to transport water and minerals vertically

- **Xylem fibre** is made up of dead cells.

Function: support to the cell

- **Xylem parenchyma** is made up of living cells.

Function: Storage of food and helps in radial conduction of water

- **Phloem:**

- **It transports food material from leaves to different parts of the plant.**
- **Sieve tubes are tubular cells with perforated walls.**

  Function: to transport food material

- **Companion cells** are specialised parenchymatous cells, closely associated with sieve tube elements. These are characteristic features of angiosperms.

  Function: to maintain the pressure gradient in sieve tubes

- **Phloem parenchyma** is composed of living cells that help in storage of food.
- **Phloem fibres**, also called bast fibres, provide mechanical support to the cells.

Tissue System

- **Epidermal tissue system:**
- It comprises of epidermal cells, stomata, trichomes, and hairs.
- Epidermis is protective in function. Cuticle is the waxy layer present outside the epidermis.
- Cuticle prevents the loss of water. It is absent in roots.
- Stomata help in gaseous exchange and transpiration.
- Root hair helps in absorption of water and mineral from soil.
- Trichome prevents water loss due to transpiration.

- **Ground tissue system**
- It comprises of all tissues except epidermis and vascular bundles.

- **Vascular tissue system**
- It comprises of complex permanent tissues - xylem and phloem. Cambium may or may not be present.
- **Open vascular bundle:** It contains cambium between xylem and phloem. Cambium has the ability to form secondary tissues. It is the characteristic feature of dicotyledonous stem.
- **Closed vascular bundle:** It lacks cambium between xylem and phloem. Since cambium is absent, it lacks the ability to form secondary tissues. Closed vascular bundle is the characteristic feature of monocotyledonous stems.
- **Radial vascular bundle:** Xylem and phloem are arranged alternately on different radii. Such types of vascular bundles are present in roots.
- **Conjoint vascular bundle**: Xylem and phloem are arranged at the same radius of vascular bundle. Such types of vascular bundles are found in stems and leaves.

Dicotyledonous roots

- The outermost layer is epidermis whose cells protrude in the form of root hairs.
- The layer next to epidermis is cortex.
- It is composed of several layers of parenchymatous cells.
- Endodermis is innermost layer of cortex, which bears the deposition of water impermeable waxy material called suberin. These are known as casparian strips.
- In the cells of pericycle, initiation of lateral roots and vascular cambium takes place during secondary growth.
- Pith is small.
- They possess 2-4 patches of xylem and phloem.
- Vascular bundles along with pith and pericycle constitute stele.
- Dicot roots undergo secondary growth.

Monocotyledonous roots

- It has epidermis, cortex, endodermis, pericycle, xylem, phloem, and pith.
- Pith is large and well-developed.
- It does not undergo secondary growth.
- Xylem bundles are more than six i.e., polyarch.

Dicotyledonous Stem

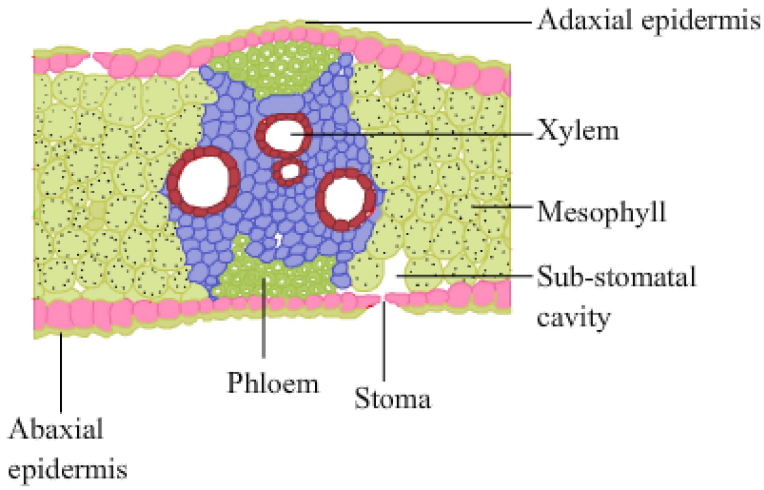
- Epidermis is covered with cuticle; may bear trichomes and stomata.
- Cortex is differentiated as outer hypodermis (having collenchymatous cells), middle cortical layer, and inner endodermis.
- Endodermal cells are rich in starch grains. Hence, the layer is also known as starch sheath.
- Vascular bundles are many and arranged in a ring form.
- Vascular bundle is conjoint, open, and with endarch protoxylem.
- Pith is well-developed.

Monocotyledonous Stem

- Vascular bundles are scattered.
- Vascular bundles are surrounded by sclerenchymatous bundle sheath.
- It is conjoint and closed.

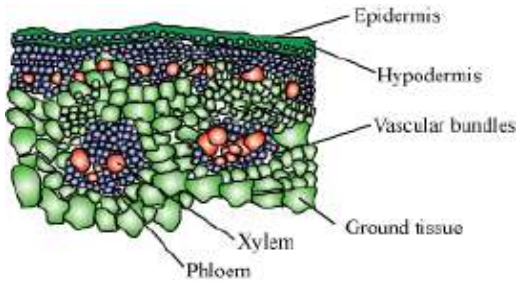
Dicotyledonous leaf

- It is also known as dorsiventral leaf.
- The abaxial (lower) epidermis bears more stomata than adaxial (upper) epidermis.
- Mesophyll is the tissue between upper and lower epidermis. It carries out photosynthesis.
- Mesophyll has two types of cells:
- **Palisade parenchyma**
- **Spongy parenchyma**
- The vascular bundles are present in the veins and midrib region of leaves.



Monocotyledonous leaf

- It is also known as isobilateral leaf.
- Some adaxial epidermal cells in grasses are modified to form bulliform cells.
- Both the surfaces of epidermis bear stomata.
- Mesophyll cannot be differentiated into spongy and palisade parenchyma.



Secondary Growth

- Secondary growth is absent in monocotyledons, but present in dicots.
- Tissues involved are - Vascular cambium and Cork cambium

  Together, vascular cambium and cork cambium are known as lateral meristem.

Vascular cambium

- Intrafascicular cambium- The cells of cambium present between primary xylem and primary phloem.
- The cells of medullary rays, adjoining these intrafascicular cambium become meristematic and form the interfascicular cambium.
- Cambial ring then cut off new cells to form secondary xylem (towards pith) and secondary phloem (towards periphery).

Spring wood (Early wood): During spring season, cambium is active and forms a wood with many xylary elements that have wider vessels.

Autumn wood (late wood): Cambium is less active and forms less number of xylary elements with narrow vessels.

- The alternate concentric rings of spring (lighter in colour) and autumn (darker in colour) form an annual ring. These rings are used to estimate the age of tree.

Heart wood contains dead elements, which gives mechanical support to stem.

Sapwood helps in conduction of water and minerals from root to leaves.

Cork cambium (Phellogen)

- **Phellogen** is a meristematic tissue that cuts off the cell into cork or phellem (outer side) and secondary cortex or phelloderm (inner side).
- Phellogen, phellem, and phelloderm are collectively known as **periderm.**
- **Bark –** It includes periderm and secondary phloem.
- **Lenticels –** help in exchange of gases