MORPHOLOGY OF FLOWERING PLANTS

Introduction

- **Morphology** is the branch of biology which deals with the study of form, structure and relative position of different organs.
- **Flowering plants** (or angiosperms) are seed bearing plants in which seeds are always enclosed in an ovary inside the fruits and the sporophylls are organized into flowers.
- These plants have been classified into **monocots** and **dicots**.
- **Plant morphology** refers to the study of external form and structure of plants.
- The flowering plants consist of an **axis**, **root system** and **shoot system**.
- Shoot system lies above the ground and the root system lies below the ground.
- Shoot system bears branches, leaves, flowers and fruits.
- The root, leaves and branches constitute the **vegetative parts of the plants**.
- The flowers, fruits and seeds form the **reproductive parts of the plants**.

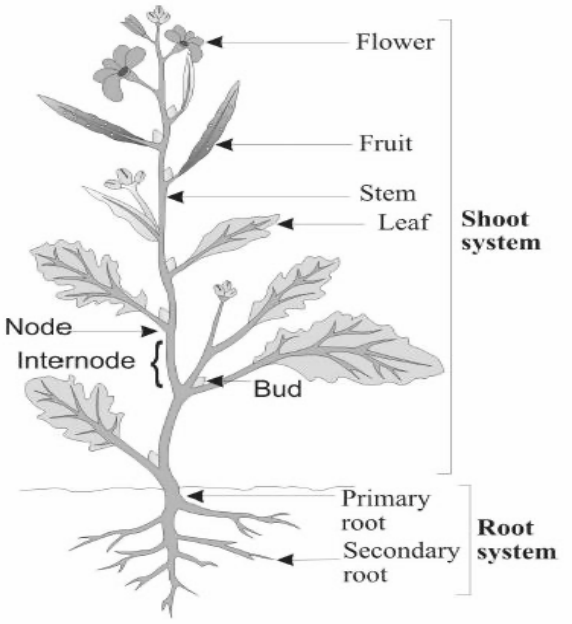

Fig. : Parts of a flowering plant

Root

- Root is the descending, non-green, underground part lacking nodes, internodes, leaves and buds.
- Root is responsible for nutrition and support.
- Radicle comes out/arise from the seed coat in the form of soft structure and moves toward the soil. It develops and forms **primary root**.

➢ **Types of roots**

- **Tap roots:** In most of the dicot plants. the direct elongation of the radicle leads to the formation of primary root. It bears lateral roots of several orders that are referred to as secondary, tertiary roots, etc. The primary roots and its branches constitute the tap root system. E.g.: mustard plant
- **Adventitious roots:** In some plants, like grass. Monstera and the banyan tree, roots develop from parts of the plant other than the radicle and are known as adventitious roots.
- **Fibrous roots:** In monocot plants, the primary root is short lived and is replaced by a large number of roots. These roots originate from the base of the stem and constitute the fibrous root system. E.g.: wheat plant

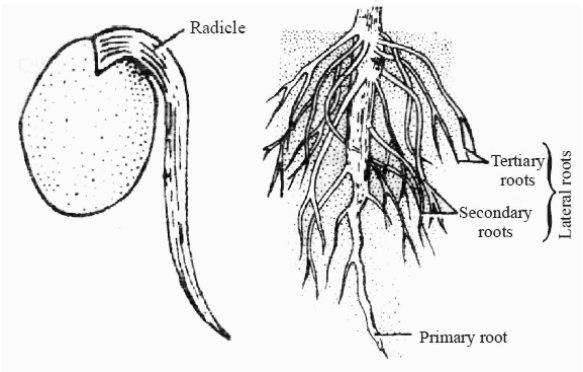

Fig. : Tap root

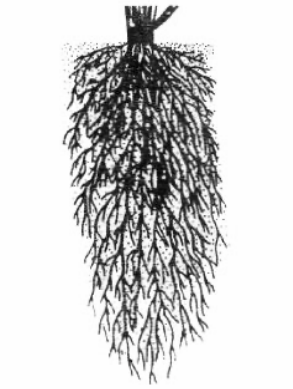

Fig. : Adventitious roots

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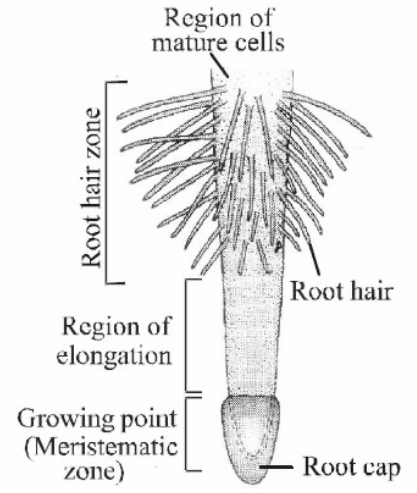
Functions of the root system
Absorption of water and minerals, provide a proper anchorage to the plant parts, storage of reserve food material (Carrot, radish, turnip, sweet potato and Asparagus) and synthesis of PGR (plant growth regulators).

Regions of the root
Root consists of 4 major zones – **root cap**, **meristematic zone**, **zone of cell elongation** and **maturation zone**.

Root Cap
- Root cap (also known as calyptra due to its origin from calyptrogen) is a cap like structure made up of thin-walled cells that covers the root apex.
- It is made of dead cells and protects the young growing cells of the apical region.
- It is absent in hydrophytes, epiphytes, parasites and mycorrhiza.

Meristematic Zone
- It is present just above the root cap.
- It is made up of compactly arranged small, thin walled isodiametric and meristematic cells having dense protoplasm and large nucleus.
- The cells of this region are in active state of division and so this is the main growing region of the root.

Zone of Cell Elongation
- The region of cell elongation is present above the meristematic zone resulting in an increase in length of the root.
- The external cells of this region possess power of absorption of water and mineral salts from the soil.



Maturation Zone
- Maturation zone is present above the zone of cell elongation.
- Secondary growth takes place in this region.
- Region of maturation zone is the area of lateral roots.
- Its only function is to anchor the plant firmly in the soil.
- Unicellular and ephemeral root hairs are formed from the epidermal cells in this zone. Root hairs helps in absorption of water. Root hairs are absent in all the plants where there are no root caps.

Modification of Roots
Tap and adventitious roots are modified in different forms to perform special functions and are called as modified roots.

Modified tap root for storage:
(1) Fusiform roots/Spindle roots - These roots are thicker in the middle and tapering on both ends. E.g.: Radish

(2) Conical roots - These roots are thicker at their upper side and tapering at lower side e.g. Carrot

(3) Napiform roots - These roots become swollen and spherical at upper end and tapering (like a thread) at their lower end. E.g. Turnip, sugar beet $=$ beet root (Beta vulgaris)

(4) Tuberous roots - These roots do not have regular shape and any portion of roots become swollen & fleshy. E.g. Mirabilis.

(5) Nodulated roots - Nodules are formed on branches of roots by nitrogen fixing bacteria (Rhizobium). E.g. Plants of Papilionatae sub family of leguminosae family - Pea, gram, bean.

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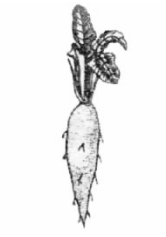


Fusiform

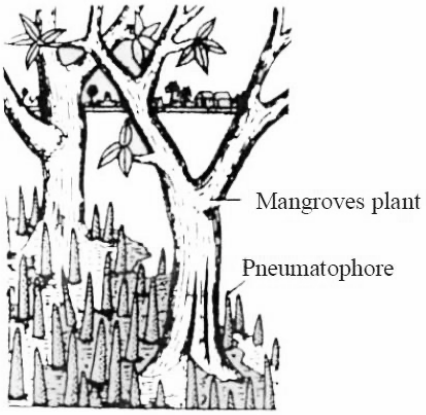
Conical

Napiform

Nodulated

Tuberous

Modified tap root for respiration are pneumatophores
The plants grow in marshy areas, where there is scarcity of oxygen. The plants, which grow in this region have some branches of taproot that grow vertically upward and comes on surface of soil. These roots are called pneumatophores. They have minute pores called pneumathodes or lenticels by which air enters inside the plant and gives oxygen for respiration. E.g., Rhizophora, Mangrove, Heritiera.



Modification of Adventitious Roots

- Adventitious roots can be modified on the basis of functions like fleshy for storage (e.g., moniliform, annulated, tuberous, fasciculated, palmate, nodulose), mechanical support and for vital functions.
- **Tuberous adventitious root**: When food is stored in these roots, they become swollen and form a bunch. E.g., sweet potato.
- **Fasciculated roots:** These are adventitious roots occurring in clusters and all of them are more swollen. E.g., Asparagus, Dahlia.
- **Fibrous roo**ts: Roots are very thin and filamentous. E.g., Grass, Wheat.
- **Nodulose roots:** In this type, tips of roots swell up. E.g., Melilotus.
- **Beaded or moniliform roots:** When root swells up like a bead at different places after a regular interval. E.g., Vitis, Momordica (Bitter gourd), Portulaca.
- **Stilt roots:** When root arises from lower nodes and enter inside the soil and form a rope-like structure, it is known as stilt roots. E.g., Maize, Sugarcane, Pandanus (screw pine).

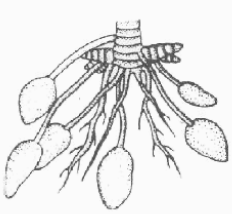


Fig. : Nodulose roots

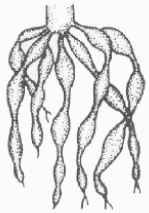


Fig. : Moniliform roots

Fig. : Tuberous roots

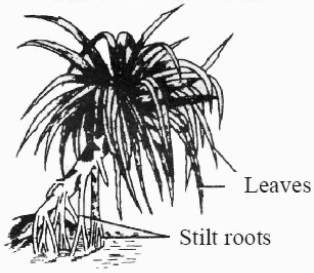


Fig. : Stilt roots

- **Prop root or pillar roots**: When root arises from branches of plant and grows downward towards soil function as supporting stem for the plant. This type of roots is called prop roots. E.g., Banyan.
- **Buttress root**: Such roots appear from the basal part of stem and spread in different directions in the soil. E.g., Terminalia.
- **Climbing roots**: These roots arise from nodes of stem and helps the plant in climbing. E.g., Money plant (pothos), Monstera (Betel), Black pepper.
- **Respiratory root**: When the quantity of oxygen is low in soil then some root comes out from the soil and helps in respiration. E.g., Avicennia, Jussiaea.
- **Foliar root or Epiphyllous root**: When roots arise from leaf they are called as foliar roots. E.g., Bryophyllum, Begonia.
- **Sucking or haustorial roots or Parasitic roots**: In parasitic plants, roots enter in the stem of the host plant to absorb nutrition from host. E.g., Dendrophthoe, Cuscuta, Viscum.
- **Annulated roots**: If the swelling is in a series of rings on the roots, it is called annulated roots. E.g., Ipecac.

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Stem

- Stem is a part of plant which lies above from surface of soil i.e., it shows negative geotropic growth. It has nodes and internodes. Branches, leaves, flower buds and bracts are developed from nodes.
- Stem facilitates conduction of water, minerals and food materials. It also produces and supports leaves and reproductive structures.
- Stem develops from the plumule.

➢ **Forms of stem are:**
  - **Caudex:** It is unbranched, erect, cylindrical stout stem and marked with scars of fallen leaves as in palms. E.g., Palm.
  - **Culm:** Stem is jointed with solid nodes & hollow internodes. E.g., Bamboo (Gramineae).

Modification of stem

Modification of stem are of three types - **subaerial**, **underground** and **aerial modification**

Sub-Aerial Modification

- Sub aerial stems are feeble and weak and aerial part of them grows horizontally on the ground while some parts remain underground and help in vegetative propagation.
- It is of 4 types – *runner, stolon, sucker and offset*.
- **Runner:** In this, stem grows and spread on the surface of soil. Roots are developed at lower side and leaves from upper side from node E.g., Cynodon dactylon (Doob grass), Oxalis.
- **Stolon:** In this, branches are small and stem is condensed and grow in all directions. After sometime of growing, their apical region comes out from the soil. E.g., Fragaria (Wild strawberry), Jasmine, Peppermint.
- **Sucker:** In this, the main stem grows in the soil but branches develop from nodes above the soil. E.g., Mint, Pineapple, Chrysanthemum.
- **Offset:** Generally, these are aquatic plants which have a short and fragile stem. E.g., Pistia, Eichhornia.

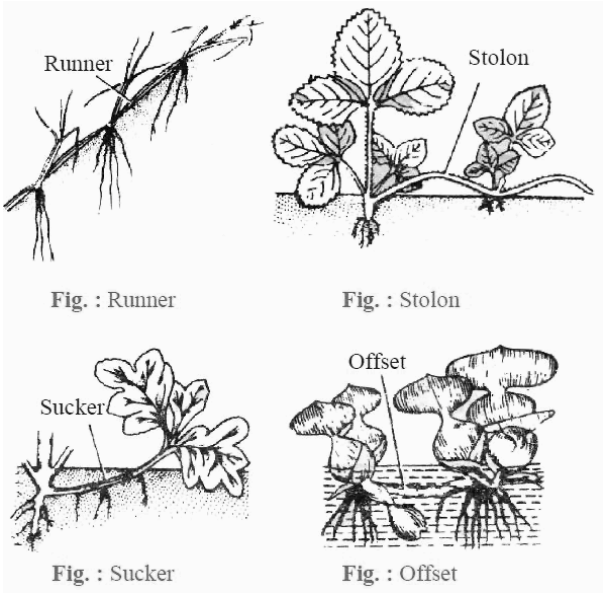

Fig. : Runner Fig. : Stolon

Fig. : Sucker Fig. : Offset

Underground Modification

- Underground stems are non-green stem and this type of modification occurs generally for food storage and vegetative propagation.
- Modified underground stems are of four types – *tubers, rhizome, corm and bulb.*
- **Tuber:** It is irregularly shaped swollen stem. The tips of branches become swollen in the soil. Eyes are found on them which are axillary buds and covered with scaly leaves. E.g., Potato.
- **Rhizome:** It is fleshy and horizontally found below the soil. Small nodes and internodes are found which are covered by scaly leaves. E.g., Ginger, Turmeric, Canna, Water lily.
- **Corm:** It is a condensed structure which grows vertically under the soil surface. It is highly swollen vertical stem. E.g., Colocasia, Alocasia, Zaminkand, Saffron.

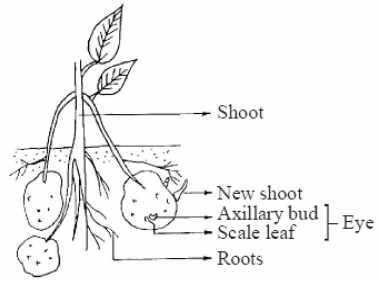

Fig. : Tuber of potato

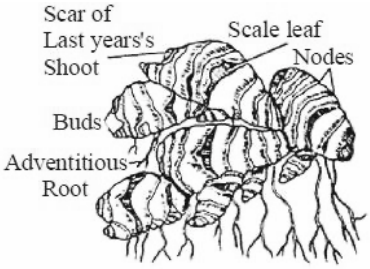

Fig. : Rhizome of Ginger

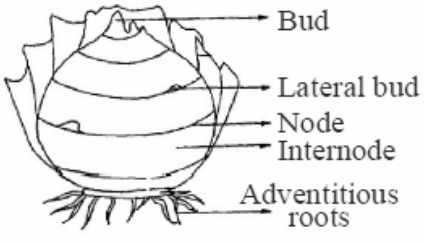

Fig. : Corm of Crocus

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Bulb: This stem has a disc like structure and surrounded with numerous fleshy scaly leaves. Many roots arise from its base. The bulbs are of two types – scaly or imbricate (e.g., garlic) and tunicate (e.g., onion).

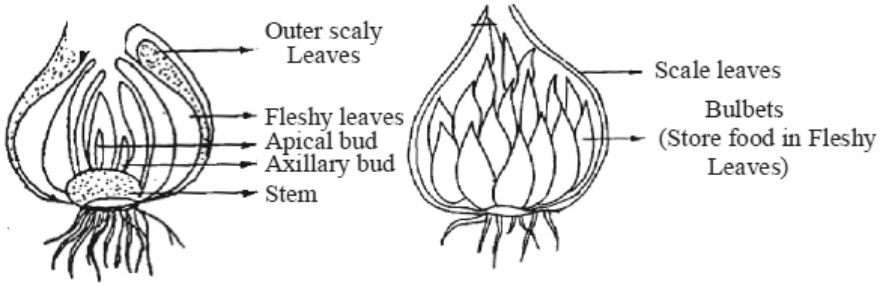

Fig. : Bulb of garlic

Aerial Modification

(1) Stem tendril - In this type of modification axillary bud forms tendril in place of branches and helps in climbing of those plants which have weak stem. E.g. **Grapes/Grapevines**, Passiflora, **gourds (cucumber, pumpkins. watermelon)**

(2) Stem thorn - Thorn develops from axillary bud of the stem. It may bear leaves, flowers.
Eg. Carissa (karonda), ***Bougainvillea***, pomegranate, **Citrus**
Thorn protects plant from browsing animals. It is a woody pointed structure.

(3) Phylloclade - Stem is modified into a fleshy flat (Opuntia) or fleshy cylindrical (Euphorbia) and green leaf like structure and carries out photosynthesis like leaf. The leaves are modified into spines Eg. *Opuntia, Euphorbia, cactus, Casuarina* (cylindrical).

Fig. : Stem tendril

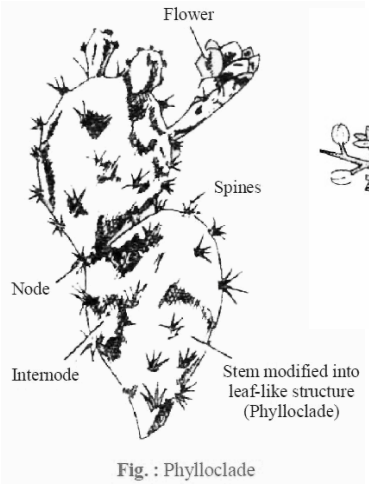

Fig. : Phylloclade

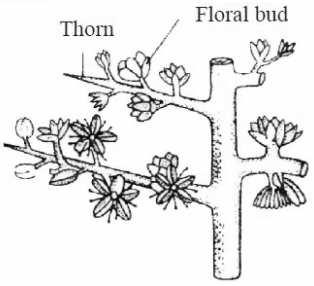

Fig. : Thorn

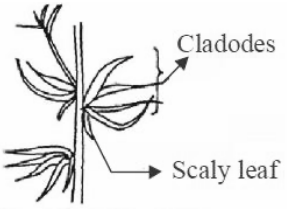

Fig. : Cladodes of *Asparagus*

Leaf

- The leaves develop from the nodes. Their main function is photosynthesis and food making. Axillary buds are found in its axil.
- Leaf is divided into 3 main parts**:**
- **Leaf base (= hypopodium):** The part of leaf attached to stem is leaf base.
- **Petiole:** The part of leaf connecting the lamina with the branch or stem. Petiolated or stalked leaves are known as petiolate and when petiole or stalk is absent then leaves are called sessile. In Eichhornia, petiole swells and in Citrus, it is winged.
- **Lamina or leaf blade:** It is a broad and flattened part of leaf. Photosynthesis and transpiration occur in this.
- Depending upon the incision lamina leaf may be simple or compound.
- **Simple Leaf** is a leaf which may be incised to any depth, but not down to the midrib or petiole. E.g., mango, guava, papaya etc.

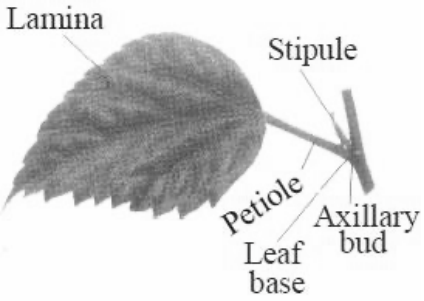

Fig. : Parts of a leaf

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- **Compound leaf** is a leaf in which the leaf blade is incised up to the midrib or petiole, thus dividing it into several small parts, known as leaflets.

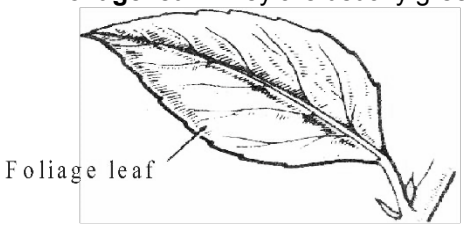
It is of two types: pinnately and palmate compound leaf.

- **Pinnately compound leaf:** In this type of leaf, mid rib is known as rachis. Leaflets are arranged on both sides of rachis. E.g., Neem.
- **Palmately compound leaf:** In this type, incision of leaf is directed from leaf margin to apex of petiole and all leaflets are attached on the upper end of the petiole. E.g., Silk cotton.
- Leaves of some plants have lateral appendages on either side of leaf base, known as **stipules**. If stipules are present in leaf it is called **stipulated leaf**, if it is absent then the leaf is called **ex-stipulated**.
- **Duration of Leaf:**
  a. **Persistent/Evergreen:** Leaves of such plants are found in all seasons and do not (fall) shed. E.g., Pine, Saraca indica, Date palm.
  b. **Deciduous:** All leaves of such plants shed at the same time. E.g., Azadirachta, Ficus.
  c. **Caducous:** Leaves are shed as the bud formation takes place. E.g., Rose.

Types of Leaves

According to the origin and function

- **Foliage leaf:** They are usually green coloured and their main function is photosynthesis.



- **Cotyledonary leaf:** This leaf comes out during germination and helps in nutrition until the first leaf is not formed.

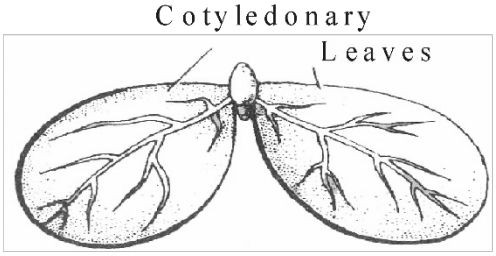


Fig.: Cotyledonary leaf

- **Scale leaf:** Such leaves are usually dry membrane like and they cannot perform photosynthesis.

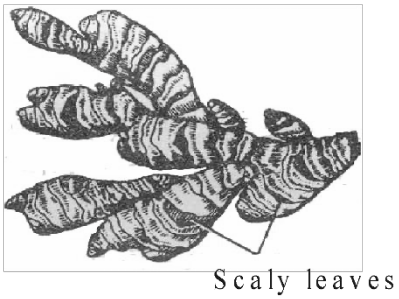


Fig.: Scale leaf

- **Bract:** Bracts are the leaves which contain flower in their axil.

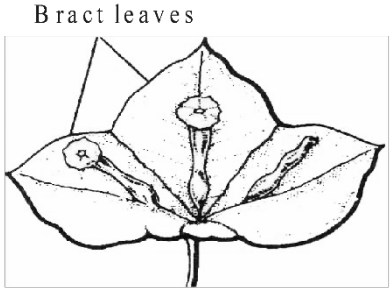


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Fig.: Bract

- **Bracteole:** These are leaf like structures found on pedicel.
- **Floral leaf:** Sepals, petals, stamens and carpel are found in a flower which are included in this type of leaf.

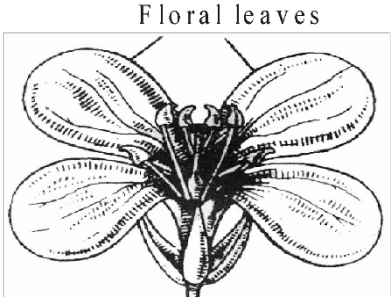


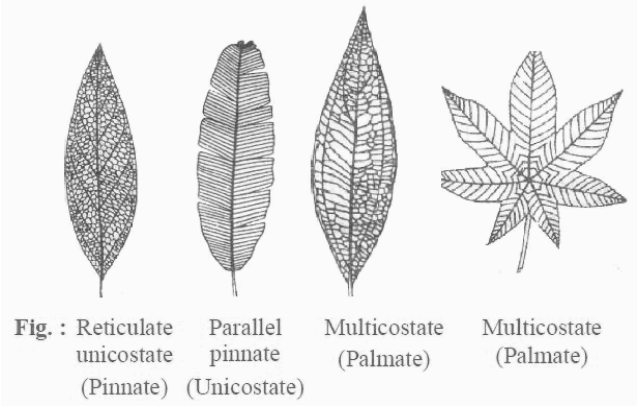
Fig.: Floral leaf

Venation of Lamina

- The arrangement of veins and veinlets in leaves (lamina) is known as **venation**.
- Venation is of 2 types - **reticulate** and **parallel**.

Reticulate Venation

- In reticulate venation, many veins divide into various branches (veinlets) and form a net like structure. It is found in dicots, exception - Calophyllum (It has parallel venation)
- Reticulate venation is of 2 types unicostate and multicostate.
- **Unicostate or pinnate:** This type of venation has only one principal vein or midrib that gives off many lateral veins which proceeds toward margin and apex of lamina of the leaf and forms a network. E.g., Mango, Guava, Papal.
- **Multicostate or palmate:** In this type of venation, many principal veins arise from the tip of petiole and proceed upward. E.g., Camphor, Zizyphus, Tejpata, China rose, plum.



Parallel Venation

- In this type of venation, all veins run parallel to each other and they do not form network. It is found in monocots. Exception - Smilax (It has reticulate venation).
- They are of 2 types – unicostate and multicostate.
- **Unicostate or pinnate:** This type of pattern has only one principal vein, that gives off many lateral veins, which proceed towards the margin of the leaf blade in a parallel manner but they do not have veinlets. E.g., Banana, Ginger, Canna.

Multicostate or palmate: This type has many principal veins arising from the tip of the petiole and proceeding upwards.

Phyllotaxy

- Phyllotaxy is the arrangement of leaves on both main stem and branches.
- Arrangement of phyllotaxy is made to facilitate the leaves to obtain maximum light for photosynthesis.
- It is of three types - **alternate**, **opposite** and **whorled** arrangement.
- In **alternate (spiral) arrangement**, only one leaf is borne at a node and leaves are arranged alternately giving a spiral form. E.g., mango, mustard, etc.

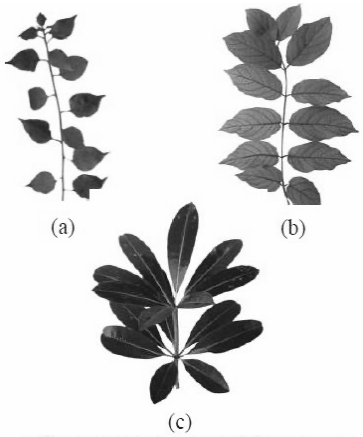


Fig. : Different types of phyllotaxy : (a) Alternate (b) Opposite (c) Whorled

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- In **opposite arrangement**, each node gives rise to two leaves arranged opposite to each other. Opposite phyllotaxy is of two types - opposite superposed (e.g., Ixora etc) and opposite decussate (e.g., Ocimum etc)
- In **whorled arrangement**, more than two leaves are formed from each node, e.g., Nerium etc.

Modification of Leaves

When leaves are modified into different structures then it is called modification of leaves.

(1) Leaf tendril - In some plants whole leaf is modified into a wire like structure which is called leaf tendril. Tendril helps is climbing. Eg. Lathyrus aphaca (wild pea)

(2) Leaf spine - Leaves are modified into pointed spines. Eg. Opuntia, Cacti, Argemone.

(3) Leaf pitcher - Leaves of some plants are modified into pitcher shaped structure. Eg. Nepenthes (pitcher plant) (Only lamina is modified into pitcher). Water is stored in the pitcher of Dischidia (complete leaf is modified into pitcher). In Nepenthes insectivorous pitcher while in Dischidia-non insectivorous pitcher is formed.

(4) Leaf bladder - In some plants, leaves are modified into bladder like structure
Eg. Utricularia (bladder wort).

(5) Phyllode - In some plants petiole becomes flat leaf like green. Sunthesises food and functions as normal leaf. Eg.: Australian acacia, Parkinsonia.

(6) Leaflet tendril - When leaflet is modified into tendril like structure then it is called leaflet tendril. Eg. : Pisum sativum (garden pea), Lathyrus odoratus (sweet pea). Note: Dionaea (venus flytrap) is insectivorous plant and it also has modified leaves.

(7) Leaflet hook - eg. Cat's nail (Bignonia unguis cati)

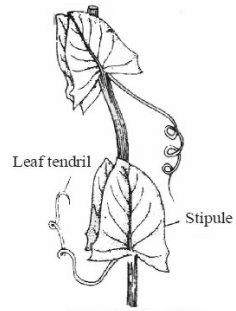

Fig. : Leaf tendril

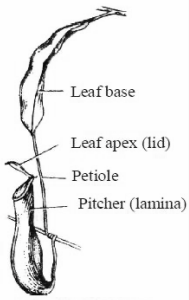

Fig. : Leaf pitcher

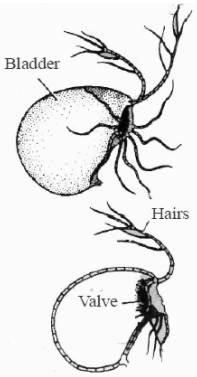

Fig. : Leaf bladder

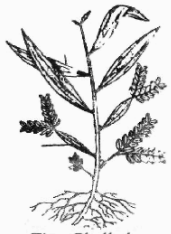
Fig. : Phyllode


Fig. : Leaflet tendril

Inflorescence

- Arrangement of flower on floral axis (peduncle) is called inflorescence.
- Types of inflorescences are - **racemose**, **cymose**, **special types of inflorescence** and **mixed inflorescence**.

Racemose

- In this type of inflorescence, the main axis continues to grow and does not terminate in a flower and gives off flowers laterally in an acropetal manner (where old flowers are arranged on lower side and young flowers on upper side).
- Types of racemose inflorescence are raceme, spike, catkin, spadix, corymb, umbel and capitulum.
- **Raceme:** When peduncle (or main axis) is elongated and flowers are pedicellate. E.g., Radish. Mustard.
  When the peduncle is branched and each branch bare pedicellated flowers like racemose and are arranged in acropetal manner then it is known as compound raceme or panicle. E.g., Gulmohar, Neem.
- **Spike:** In spike, peduncle is elongated but flowers are sessile. E.g., Achyranthes.
  When peduncle is branched and each branch bears spike like inflorescence then the small branches having flower is called spikelet and this arrangement is called as spike of spikelet. E.g., members of the grass family (Gramineae) - wheat.

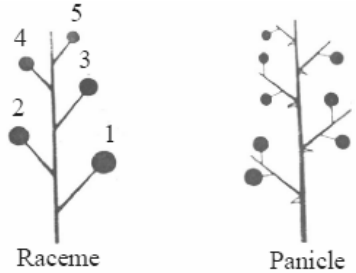

Fig. : Raceme or panicle

Fig. : Spike

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- **Catkin:** In catkin, peduncle is thin, long and weak, and flowers are sessile and unisexual. E.g. Mulberry, Betula, Oak.

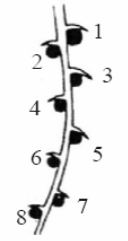


Fig. : Catkin

- **Spadix:** In spadix, peduncle is thick, long and fleshy and has small sessile and unisexual flowers covered with one or more green or colourful bracts. E.g., Colocasia, Maize

- **Corymb:** In corymb, peduncle is short and all the flowers are present at the same level because the lower flower has much longer pedicel than the upper one. E.g., Candy tuft (Iberis amara).
  In this type of inflorescence, peduncle is branched, and each branch has flower cluster. This type of inflorescence is called compound corymb.

- **Umbel:** An inflorescence in which the flower stalks of more or less equal length arise from the same point is called umbel. At the base of the flower stalk, there is whorl of bracts forming the involucre. E.g., Cantella.
  If in this type of inflorescence, peduncle is branched then each branch has flower cluster then this type of inflorescence is called compound umbel. E.g., Coriander, Foeniculum, Cuminum.

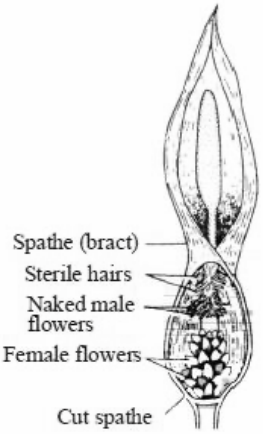


Fig. : Spadix

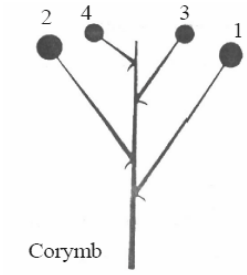
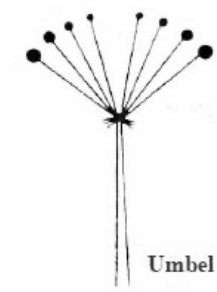
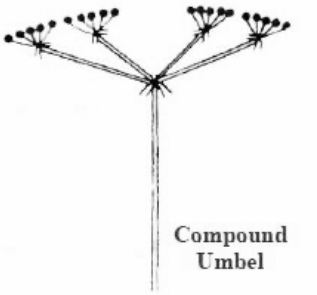


Fig. : Corymb





- **Capitulum/Racemose head:** In this, the growth of peduncle is retarded and it becomes broad, flattened concave or convex. On it, small flowers are found. These flowers are called floret.
  If all the flower of capitulum are same, then it is called homogamous. If the younger flowers are present towards centre and older towards the periphery, then it is known centripetal order. The flowers which are present in the centre is called disc floret and flowers at periphery are called as ray floret and arrangement of this type is called heterogamous.
  In this type of inflorescence, florets may be unisexual, bisexual and sterile. This inflorescence is surrounded by one or more involucre. It is most advanced type of inflorescence, because all flowers are pollinated at same time.
  E.g., Sunflower, Zinnia, Marigold.

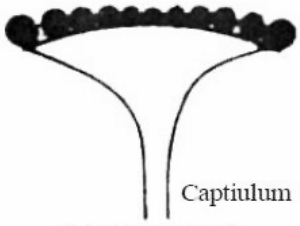


Fig. : Captiulum

Cymose

- In cymose inflorescence, the growth of the main axis is limited and the rachis or peduncle terminate in a flower. The older flowers are present at the upper portion and young buds are arranged towards base. This arrangement is called **basipetal succession**.
- Cymose inflorescence are of following types – *uniparous, biparous and multiparous* cyme.

➢ **Uniparous cyme/Monochasial cyme:** In this, the peduncle ends in a flower and produces lateral branch at the time of ending in a flower. It is of two types–

a. **Helicoid cyme:** When all lateral branches develop on the same side on the peduncle then it is called helical cyme. E.g., Heliotropism, Saraca.
b. **Scorpioid cyme:** In this, the lateral branch develops on one side and the other branch will develop opposite to the first one, i.e., they lie alternate to each other. E.g., Begonia, Vine.

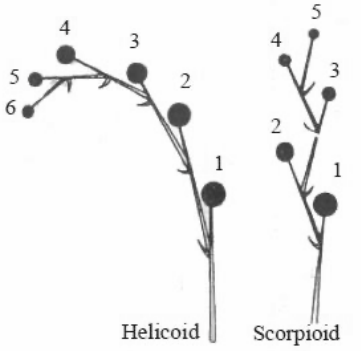


Fig. : Helicoid and Scorpioid

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- **Dichasial / Biparous cyme:** In this, peduncle ends in a flower and from the basal part of the peduncle two lateral branches arise which also end in a flower. This same arrangement occurs on these lateral branches. E.g., Bougainvillea, jasmine, teak, Datura, Mirabilis.
- **Multiparous cyme/Polychasial:** In this, peduncle ends in a flower and from the base of it many lateral branches arise, which also terminate in flower. This arrangement now also occurs on these lateral branches and is known multiparous cyme. E.g., Calotropis (madar), Nerium, Asclepias.

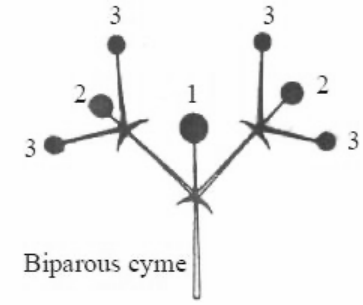

Fig. : Biparous cyme

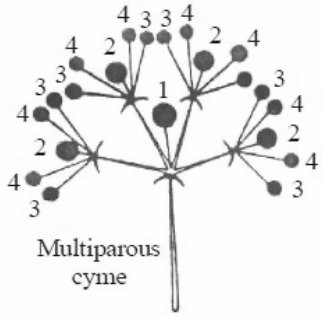

Fig. : Multiparous cyme

Special Type of Inflorescence

- **Cyathium:** The bracts or the involucre become fused to form a cup shaped structure. On the margin of it, secretory glands are found. In the central part of the cup shaped structure, a female flower is found which matures earlier. Due to the growth of pedicel, this comes out from the cup shaped structure. Female flowers are surrounded by small male flowers. These are also found on pedicel. The male flower, which lies toward centre mature earlier than the flowers which are towards the periphery.
  This inflorescence is found in euphorbiaceae family like Euphorbia, Poinsettia, Pedilanthus.

- **Verticillaster:** This type inflorescence is found in Labiatae/Lamiaceae family. In this type of inflorescence, leaves are arranged in an opposite manner on stem. From the axil of each leaf inflorescence develop. From the main axil, lateral axil arises, on which flowers are found. Now from these branches lateral branches also develops. On these branches, flowers are found. In this inflorescence, each dichasial cyme changes into monochasial (scorpioid) cyme.
  E.g., Salvia, Ocimum, Coleus.

- **Hypanthodium:** In this, peduncle is modified in to narrow cup like structure. At the base of the cup, female flowers develop while towards mouth male flower develops. All the three types of flowers are present in this inflorescence. E.g., Banyan, Peepal, Syconus, Ficus species.

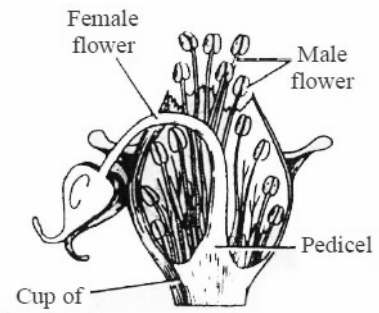

Fig. : Cyathium

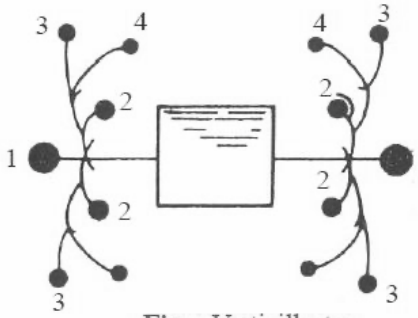

Fig. : Verticillaster

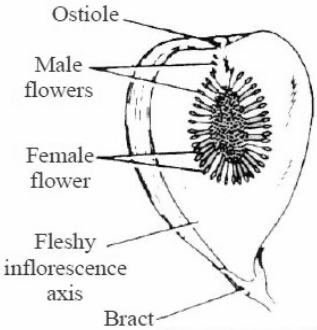

Fig. : Hypanthodium

Mixed Inflorescence

- Sometimes, flowers are arranged in both racemose and cymose manner on the same peduncle and is called as mixed inflorescence.
- Examples –
  - Mixed spadix - Banana
  - Cymose raceme - Grapes

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Flower

- Flower is a specialized branch of limited growth which bears floral leaves that carry on sexual reproduction and gives rise to seeds and fruits.
- The study of flowers is called anthology.
- The part from where flower arises is called bract.
- Flowers are borne on short or long stalk which is called **pedicel**.
- The upper part of the pedicel is swollen, spherical shaped or conical which is called **thalamus/receptacle**. Floral leaves are present on it.
- In a flower, 4 types floral leaves are found. These are - sepal, petal, stamen and carpel.
- If the floral leaves are cyclically arranged in a flower, then it is called **cyclic flower**. If floral leaves are spirally arranged then it is called **spiral or acyclic flower**.
- When a flower is divided by any vertical plane into two equal halves, then it is called **actinomorphic / radial / regular** flower. E.g., Mustard, China rose, Datura, Chilli.
- When the flower is divided into two equal halves only by one vertical plane, then it is called **zygomorphic / bilateral** flower. E.g., Pea, bean, Gulmohur, Cassia.

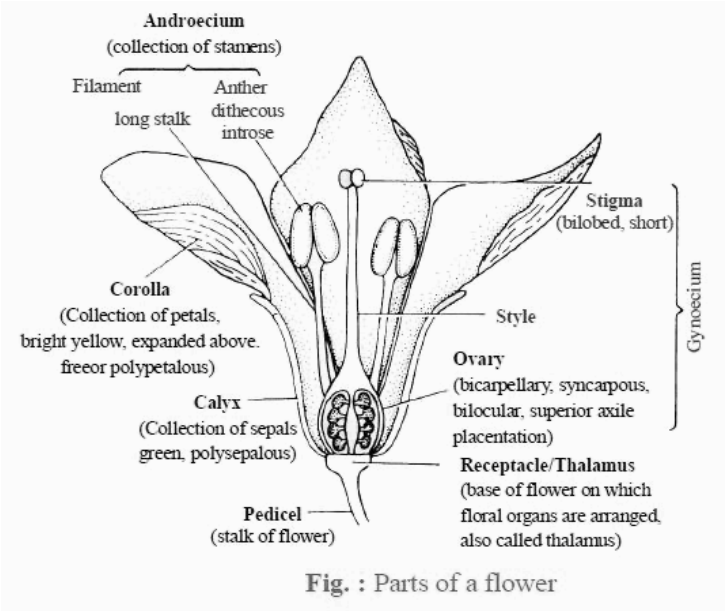

Fig. : Parts of a flower

- When the flower cannot be divided into two equal halves from any plane, then it is called **asymmetrical / irregular** flower. E.g., Canna.
- **Anthophore:** Internode between calyx and corolla is called anthophore. E.g., Silene.
- **Androphore:** Internode between corolla and androecium is called androphore. E.g., Passiflora.
- **Gynophore:** Internode between androecium and gynoecium is called gynophore. E.g., Capparis.
- **Gynandrophore or Androgynophore**
  When both conditions of androphore and gynophore are found in the same flower then this condition is called gynandrophore or androgynophore. E.g., Cleome gynandra.
- The part of the flower which lies near to mother axis is posterior part while the part which is far from mother axis is the anterior part of flower.
- The relative position of gynoecium changes with respect to floral parts and on this basis, it is divided into three parts –

Hypogynous condition
When petals, sepals and stamens are situated below the ovary, the flower is called hypogynous and in this condition ovary will be superior.
E.g., Mustard, China rose, Brinjal.

Perigynous condition
In this, thalamus grows upwardly and form as cup shaped structure. On the margin of the thalamus, floral parts are attached except gynoecium which lies at the basal part. So, in this condition, gynoecium is situated below floral part. The ovary in this condition is said to be half inferior.
E.g., Rose, Plum, Peach.

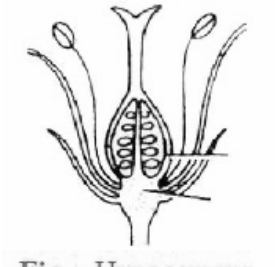
Fig.: Hypogynous

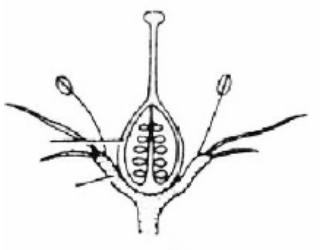
Fig. : Perigynous

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Epigynous condition

When petals, sepals & stamens are situated above the ovary, then the ovary is said to be inferior and rest of the floral parts are superior. E.g., Guava, Apple, Cucumber and the ray florets of sunflower.

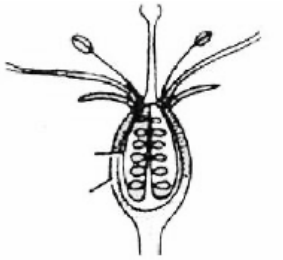

Fig. : Epigynous

- The flower which arises from the axils of bract is called **bracteate flower**.
- The whorl of bract surrounding peduncle is called **involucre**.
- In flowers, when a large bract completely encloses whole inflorescence, then it is called **spathe**. E.g., Banana, Maize
- When the size of bract of flower is greater than size of flower and these are of various colours then it is called petaloid bract. E.g., Bougainvillea.
- Small, dry, scaly bracts are called **glumes**. E.g., Wheat, Grass

Parts of Flowers

A typical flower has four main parts - **calyx**, **corolla**, **androecium** and **gynoecium**.

The individual units of a

a. *Calyx* = Sepals
b. *Corolla* = Petals
c. *Androecium* = Stamens or microsporophyll
d. *Gynoecium* = Carpels or megasporophyll

Calyx and corolla are helping or accessory whorls and androecium and gynoecium are reproductive whorls.

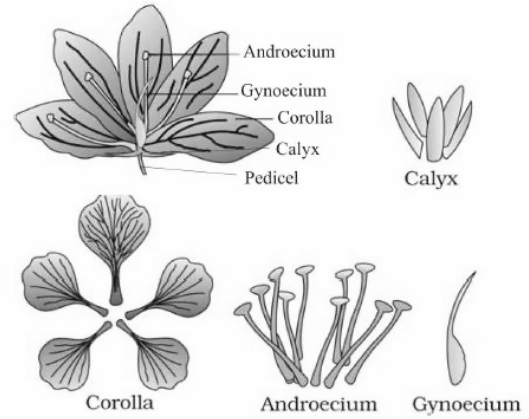

Fig.: Part of flowers

Calyx

- The outermost whorl of flower is called **calyx**.
- Each member of this whorl is called **sepal**.
- When all the sepals are free from each other, then the flower is called **polysepalous**, e.g., Mustard, Radish. When the sepals are fused with each other then it is called gamosepalous e.g., Cotton, Datura, Brinjal.
- In the green calyx of Mussaenda, one of the sepals enlarge and form a leaf like structure. It may be white or brightly coloured. It attracts the insects.
- In Trapa, calyx is **modified into spines** and helps in protection of fruit.
- In Argemone, spines are present on the surface of sepal which protects the flower bud.
- In Larkspur and Balsam, the posterior part of sepal is modified into a narrow tube. This structure is called **sepal spur** for attraction of insects in it and storing nectar.
- In the family of sunflower, sepals are modified into hairy structure. It is called **pappus**. The pappus helps in dispersal of fruit.
- Some plants in which sepals fall just at the time of opening of flower bud then are called caducous sepals, e.g., Poppy.
- In some plants, sepals fall after pollination then these are called deciduous, e.g., mustard.
- Upto fruit formation, if sepals do not fall and remain attached to fruit, then these are called persistent. E.g., Tomato, Capsicum, Brinjal, Cotton, Datura.
- Sometimes below calyx, a whorl similar to sepals is found which is called epicalyx. E.g., in Malvaceae family (China rose)

Corolla

- The second whorl of flower is called corolla and each member of it is called petals.
- Corolla is brightly coloured and attracts insects for pollination and protects the inner essential whorls from injury.
- Corolla lies above calyx. When the shape and size of petals are similar then it is called symmetrical while when they are not similar, then they are asymmetrical.
- When all the petals are free, then it is called polypetalous corolla while when petals are fused, then these are called gamopetalous corolla.

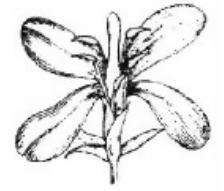

Fig. : Cruciform

- **Forms of polypetalous corolla are:**
  - **Cruciform:** In cruciform, 4 petals are found. The lower part of the petal which is narrow is called claw while the outer broad part is called limb. These petals are arranged crosswise. e.g., Mustard, Radish.

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- **Caryophyllaceous:** It consists of 5 petals. The claw of petals are short and the limb of petals form right angles to the claw, e.g., Dianthus, Gypsophila.

- **Rosaceous:** It consists of 5 or more petals. Claws are absent in it and limbs are spread regularly outwards. e.g., Rose, Coconut.

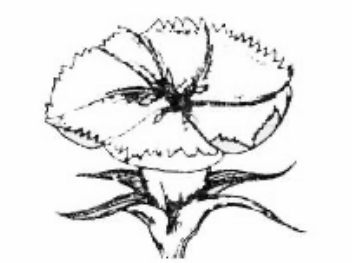

Fig. : Caryophyllaceous

Fig. : Rosaceous

- **Forms of Gamopetalous corolla are:**
  - **Campanulate:** In this type of corolla, 5 gamopetalous petals are present. Its shape is similar to a bell. E.g., Tobacco, Raspberry, flowers of Campanula.
  - **Funnel shaped:** In this, 5 gamopetalous petals are found. Its shape is similar to a funnel. E.g., Datura, Railway creeper.
  - **Tubular:** In this, 5 gamopetalous petals are found which form tubular or cylindrical structure. E.g., Disc florets of sunflower which are situated in the centre.
  - **Rotate:** In this, 5 gamopetalous petals are found and the fused part is formed above small tube and the petals are arranged in a whorl above the tube. E.g., Brinjal.

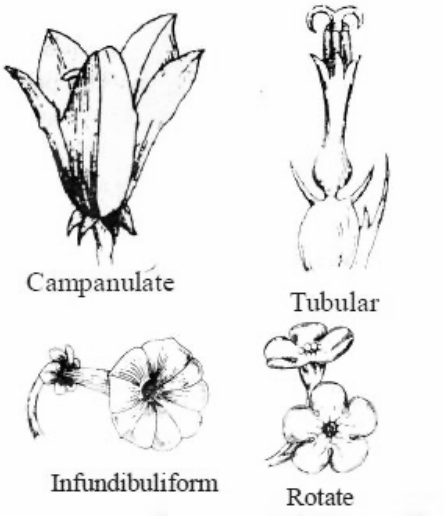

Fig. : Forms of Gamopetalous corolla

- Zygomorphic polypetalous corolla is papilionaceous. In this, five petals are found. Its posterior part is largest and is known as standard or vexillum. Vexillum covers two lateral petals which are called as wings and the innermost basal parts are united to form a keel or carina. Both lateral parts cover the keel. E.g., Pea, Gram, Arhar
- The mode of arrangement of sepals or petals in floral bud with respect to the other members of the same whorl is known as **aestivation**.
- Aestivation is of following 4 types**:**
- **Valvate:** In this, the petal of a whorl lies adjacent to other petals and just touches it. E.g., Calotropis, Custard-apple.
- **Twisted:** In this, one part of a petal covers adjacent petals and the other part is covered automatically by posterior petal. E.g., Cotton, Ladyfinger, China rose.

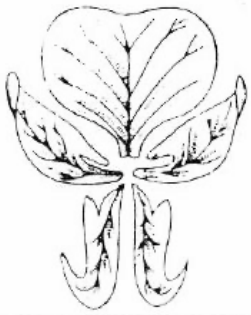

Fig. : Papilionaceous

- **Imbricate:** When both margins of the one petal are covered by the other two petals and both overlap one another at margins and rest are arranged in a twisted manner.

It is of two types:

- **Ascending imbricate:** The posterior petal is innermost i.e.; both its margins are overlapped. E.g., Caesalpiniaceae such as Cassia, Bauhinia, Gulmohar etc.
- **Vexillary or Descending imbricate:** The anterior petal is innermost and posterior petal is outermost & largest. In it, standard or vexillum covers two lateral petals. These two laterals cover two anterior ones. This vexillary arrangement is present in pea family. E.g., Pea, Bean.

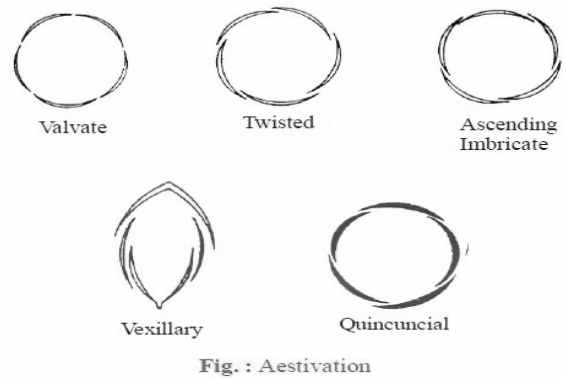

Fig. : Aestivation

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- **Quincuncial:** It is a modification of imbricate type. Out of the five petals, two are completely internal, two completely external and in the remaining petal, one margin is internal and the other margin is external. E.g., Murraya.

Androecium

- **Androecium** is the outer essential whorl consisting of stamens.
  Each stamen is distinguishable into **anther** and **filament** formed by **connective**.
- Each anther consists of two anther lobes and each lobe contains two pollen sac.
- Sterile and undeveloped stamens are called **staminodes**.
- When four stamens are present, out of them two are long and two are short, then it is called **didynamous**. E.g., Lamiaceae/Labiatae family.
- When there are six stamens and they are arranged in two whorls. In the outer whorl, there are two short stamens while in the inner whorl, there are four long stamens. This condition is called **tetradynamous**. E.g., Cruciferae family.

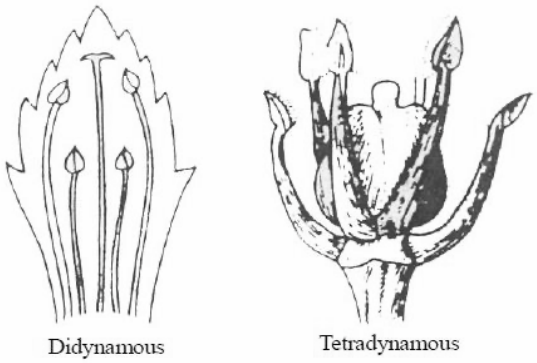

Fig. : Didynamous and Tetradynamous

- When the floral parts of similar whorl are fused, then it is called **cohesion**.
- When the stamens of an androecium are free from one another, it is called **polyandrous condition**.
- When stamens are united by their filament only, it is called **adelphi**.

It is of following types:

- **Monadelphous:** In this, all the filaments are united into a single bundle but anthers are free from each other. In this type of cohesion, a tube is formed around the gynoecium which is called staminal tube. E.g., Cotton, Hollyhock, Ladyfinger.
- **Diadelphous:** When the filaments are united in two bundles but the anther remains free. E.g., Gram, Pea, bean.
  In these plants from 10 stamens, 9 stamens are arranged in a bundle while 1 remains free.
- **Polyadelphous:** When the filaments are united into more then two bundles. E.g., Castor, Citrus.
- **Synandrous:** When anthers as well as filaments of stamens are united e.g., Colocasia, Alocasia, Momordica, Cucurbitaceae family.
- **Syngenesious:** When only anthers are united in a bundle but filaments remain free, e.g., compositae family.
- When the stamens are attached to other parts of flower, then it is called adhesion of stamens. It may be of following types –
  - **Epipetalous:** When stamens are attached to the petals. E.g., Brinjal, Datura. Tobacco, Sunflower, Potato.
  - **Epiphyllous:** When stamens are attached to tepals. E.g., Onion, Lily.
  - **Gynandrous:** When filaments of stamens are attached to gynoecium or by anthers only. E.g., Calotropis, Aristolochia.

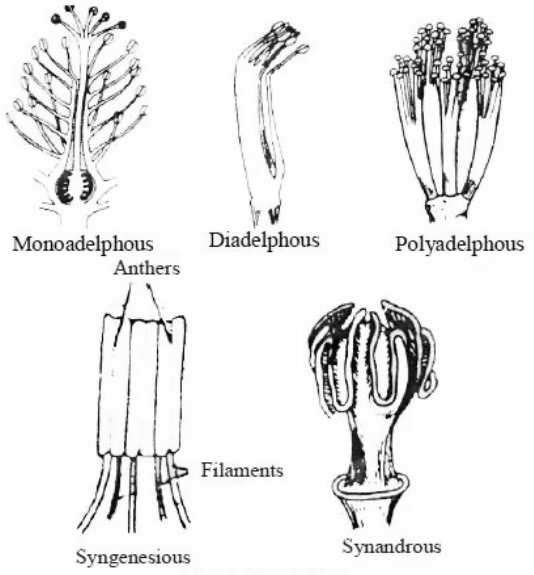

Fig.: Adelphy

Gynoecium

- Gynoecium is the female reproductive part of the flower. It constitutes the inner essential whorl of flower comprising carpels.
- Carpel consists of 3 major parts:
  - Stigma (pollen receiving region)
  - Style (connects ovary to stigma)
  - Ovary (ovule bearing region)

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- If only one carpel is present in gynoecium, this condition is called **monocarpellary**.
- If more than one carpel is present in gynoecium, this condition is called **polycarpellary**.
- If all the carpels in polycarpellary/multicarpellary condition are free, then the condition is called **apocarpous**.
- If all the carpels are fused together, then the condition is called **syncarpous**.
- In syncarpous gynoecium, four types of cohesion are found:
- When many ovaries are fused then they form syncarpous ovary. But in it, stigma and style are separated with each other, E.g., Dianthus, Plumbago
- In carpels ovary and style are fused but stigma are not fused. E.g., Malvaceae family, Hibiscus rosa sinensis, cotton.
- When stigma are fused but the ovary and style are free. E.g., Calotropis, Casia fistula, Nerium.
- Carpels are completely fused. This condition is found in maximum flowers. E.g., Mustard, Raphanus sativus, Lycopersicon.
- The ovules are attached on ovary walls on one or more cushion is called placenta. The manner in which placenta are arranged on ovary wall is known as **placentation**.

Placentation is of following types:

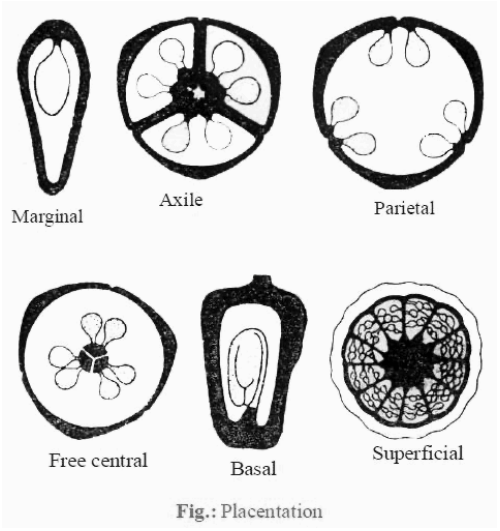

Fig.: Placentation

- **Marginal:** This type of placentation is found in monocarpellary gynoecium. The placenta develops along the junction of two fused margins. E.g., Pea and other leguminous plants.
- **Parietal:** This type of placentation is found in unilocular syncarpous ovary. In this, the ovule is formed by the fusion of two or more carpels by their adjacent margins and two or more placenta forms. In this type of placentation, the no. of placenta is equal to the no. of carpels. E.g., Cucurbita, Argemone, and Cruciferae family (Mustard)
- **Axile:** It is found in multicarpellary syncarpous gynoecium. The fusing margin of carpels grows inward and meet in the centre of the ovary. Thus, an axis forms in the centre of ovary, and ovary becomes multi chambered. The ovules are born on the central axis. Number of these chambers are equal to the number of carpel. E.g., Potato, China rose, Onion, Lemon, Orange, Tomato, etc
- **Free central:** This type of placentation is found in syncarpous gynoecium. In this, the ovary is unilocular and the ovules are borne on the axis in the centre of the ovary.
  Placentation is axile in beginning. After sometime, walls of chamber are destroyed and only ovulated central axis left. E.g., Primrose Dianthus (Caryophyllaceae)
- **Superficial:** This type of placentation is found in a multicarpellary syncarpous gynoecium. The ovules are attached on the walls of loculi. E.g., Nymphaea (Water lily).
- **Basal:** The ovary is unilocular and a single ovule is borne at the base of ovary. E.g., Marigold, Sunflower (Asteraceae family).

Fruit

- **Fruit** is a matured ovary developed after fertilization.
- After fertilization, ovary forms fruits and ovules form the seeds.
- **Pomology** is the study of fruits.
- The seeds are protected inside fruit. But in some fruits, seeds are not found in grapes, banana and such type of fruits are called **parthenocarpic** or **seedless fruit**.
- After ripening, the ovary wall changes into **pericarp**. This pericarp may be thick and fleshy or thick and hard or thin and soft.
- Pericarp is made up of 3 layers:

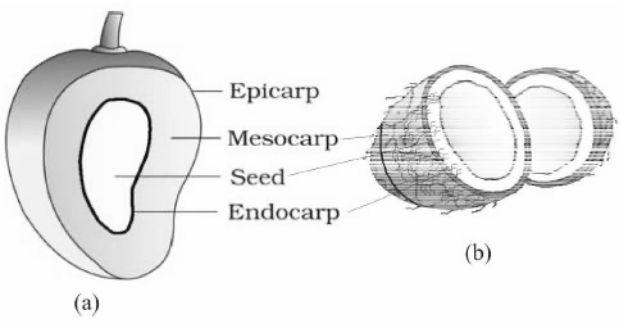

Fig. : Parts of a fruit : (a) Mango (b) Coconut

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- **Epicarp:** It is the outermost layer. It is thin and is either hard or soft. It forms outermost layer of fruit which is also called rind.
- **Mesocarp:** It is the middle layer which is thick and fleshy in mango, peach, date palm. In coconut, this layer is made up of fibres which is also called coir.
- **Endocarp:** It forms the innermost layer. It may be thin membrane (e.g., orange, date palm) or thick and hard. (e.g., Mango, coconut).
- When the fruit is developed only from the ovary, the fruit is called as true fruit. E.g., Mango, Coconut, Zizyphus.
- In some fruits, in place of ovary, some other parts of flower like thalamus, inflorescence, calyx are modified to form a part of fruit. These types of fruit are called false fruits or pseudocarp. E.g., Apple, Strawberry.

Classification of Fruits

On the basis of presence of carpels in gynoecium, (whether free or infused) or role of one or more flowers in formation, fruits are divided into: **simple**, **aggregate** and **composite**.

Simple fruit:

These fruits develop from monocarpellary ovary or multicarpellary syncarpous ovary and only one fruit is formed by the gynoecium.
Simple fruits are of two types: **fleshy fruit** and **dry fruit**.

Fleshy fruit

- In fleshy fruit, fruit wall is differentiated into epicarp, mesocarp and endocarp.
- These fruits develop from superior or inferior syncarpous gynoecium. These may be unilocular or multilocular.
- These fruits are indehiscent. Dispersal of fruit occurs after pericarp is destroyed.
- Drupe is a fleshy fruit

Drupe fruit

These fruits develop from mono or multicarpellary, syncarpous, superior ovary. In these fruits, endocarp is hard and stony, so these fruits are also called stony fruits. E.g., Mango, coconut, almond, peach, walnut, plum. In mango, the outermost cover or rind is called epicarp. Edible fleshy part is mesocarp and the part where seed is protected is called as endocarp. In ber, epicarp and mesocarp both are edible part while endocarp is drupe.
The rind of Almond and walnut are endocarp and their edible part is seed. In coconut, epicarp is hard and thin while mesocarp is thick and consists of hard fibres. The endocarp
is hard and seed is protected in it. The sweet water and edible part of coconut are liquid and solid endosperm.

Seed

- Seed is a fertilized or ripened ovule.
- Seed is characteristic of gymnosperms and angiosperms.
- Seed is a dormant structure containing protective coverings (**seed coats**), **reserve food** and **embryo** (2n).
- Seed coat develops from integuments of ovule. The outer seed coat is called testa while the inner one is called **tegmen**. Seed coat is membranous, generally fused with fruit wall.
- The seed is attached to the fruit wall or pericarp by means of stalk called **funicle**. The point of attachment of the funicle to the body of mature seed is called **hilum**.
- The surface of seed possess a fine pore at one end called micropyle. The micropyle permits the entry of water needed at the time of germination.

➢ **Seeds are of two types**
  - **Albuminous (endospermic) seeds:** In these seeds, food is stored in the endosperm. E.g., corn, wheat, onion etc.
  - **Exalbuminous (non-endospermic) seeds:** They usually store reserve food material in cotyledons. In these seeds, the endosperm is used up and not present in mature seeds. E.g., bean, gram and pea.

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Structure of Dicotyledonous Seeds

- A dicotyledonous seed contains seed coats, two cotyledons and an embryonal axis.
- The embryonal axis is attached to the cotyledons for absorbing nutrition from them.
- The embryonal axis consists of two ends - radicle and plumule.
- Radicle gives rise to root system and plumule gives rise to shoot system.
- The portion of the embryonal axis between the radicle and the point of attachment of the cotyledons is called **hypocotyl** whereas the portion between the plumule and cotyledons is called **epicotyl**.

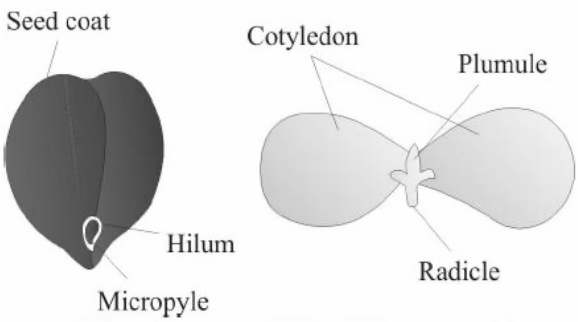

Fig. : Structure of dicotyledonous seed

- Most of the dicotyledonous seeds are exalbuminous. A few dicotyledons like castor, bean have albuminous seeds. Their cotyledons are thin and papery.

Structure of Monocotyledonous Seeds

- Monocotyledonous seeds are endospermic but some (as orchids) are non-endospermic.
- Maize grain shows structure of a typical monocotyledonous seed. In maize grain, the seed coat is fused with the pericarp.
- Major part of the grain is occupied by a large endosperm which is rich in starch
- The endosperm has one to three layered peripheral protein layer (called aleurone layer) which separates the embryo from endosperm.
- The embryo consists of a cotyledon and an embryonal axis.

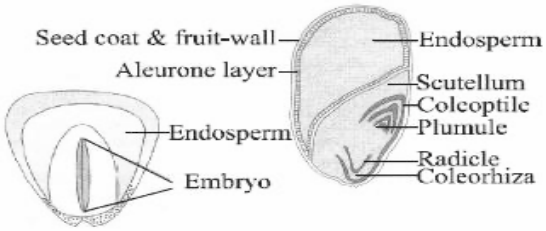

Fig. : Structure of a monocotylendous seed

- The cotyledon is also called **scutellum** in cereals.
- The lower end of the axis is called the radicle which has a protective sheath termed **coleorhiza**. The upper part of the axis is called the **plumule** which is covered by coleoptile.

Dispersal of Fruits, And Seeds

- Most of the plants do not move from one place to another. They grow, produce flowers and fruits while remaining fixed at one and the same place. The seeds falling directly under the mother plant have to germinate and develop under limited food supply and space. To overcome this problem, the fruits and seeds have developed several special devices for wide dispersal.
- Dispersal is essential to avoid struggle for existence for colonization of new areas and production of mixed population.
- The natural agents like wind, water and animals and even mechanism of dehiscence in some fruits, help the seeds and fruits to disperse from one place to another, and to long distances from the parent plant.

Wind

- In the species, where the seeds are light in weight or have some accessory part to help dissemination, are dispersed by the air current (called anemochory).
- The seeds of drumstick and Cinchona and (fruits of yam, maple) aridisol tree, are provided with one or more appendages in the form of thin, flat and membranous wings, which help them to float in the air and be carried away to long distances.

Water

- Hydrochory is the mode of dispersal of fruits and seeds by water.
- The fruits and seeds with specialised devices which may be in the form of spongy and fibrous outer walls as in coconut and spongy thalamus as in lotus, and small seeds with airy aril as in water lily, float very easily in water, and are carried away to long distances with the water current.

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Animals

- The fruits and seeds with hooks, spines, bristles, stiff hair, etc., get attached to the body of hairy and woolly animals and are carried away by them to distant places.
- For instance, fruits of Xanthium and Urena bear curved hooks, spear grass has a bunch of stiff hair, Tribulus has sharp and rigid spines, Boerhaavia has sticky hair which help in dispersal by animals.
- The edible fruits like guava, grapes, figs and plums are dispersed by birds and even human beings, either by feeding on them and passing out undigested seeds with faeces or by carrying them to other places for later feeding.

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EXERCISE

1. In Bougainvillea, thorns are the modifications of
   (A) Stipules (B) Leaf
   (C) Stem (D) Adventitious Root

2. How many plants among *Indigofera, Sesbania, Salvia, Allium, Aloe,* mustard, groundnut, radish, gram, and turnip have stamens with different lengths in their flowers?
   (A) Six (B) Five
   (C) Four (D) Three

3. This is not a stem modification
   (A) Thorns of citrus (B) Pitcher of *Nepenthes*
   (C) Flattened structures of *Opuntia* (D) Tendrils of cucumber

4. The wheat grain has an embryo with one large, shield-shaped cotyledon known as
   (A) Coleorhiza (B) Coleoptile
   (C) Epiblast (D) Scutellum

5. Placenta and pericarp are both edible portions in
   (A) banana (B) potato
   (C) tomato (D) apple

6. This is a correct statement
   (A) A sterile pistil is called a staminode
   (B) A proteinaceous aleurone layer is present in maize grain
   (C) Mango is a parthenocarpic fruit
   (D) The seed in grasses is not endospermic

7. Flowers in China rose are
   (A) actinomorphic, epigynous with valvate aestivation
   (B) actinomorphic, hypogynous with twisted aestivation
   (C) zygomorphic, epigynous with twisted aestivation
   (D) zygomorphic, hypogynous with imbricate aestivation

8. In a cymose inflorescence, the main axis
   (A) terminates in a flower
   (B) has unlimited growth but lateral branches end in flowers
   (C) bears a solitary flower
   (D) has unlimited growth

9. This is correctly matched with its three characteristics
   (A) Maize: C_3 pathway, closed vascular bundles, scutellum
   (B) Onion: bulb, imbricate aestivation, axile placentation
   (C) Tomato: twisted aestivation, axile placentation, berry
   (D) Pea: C_3 pathway, endospermic seed, vexillary aestivation

10. This is a xerophytic plant in which the stem is modified into flat green and succulent structure
   (A) *Acacia* (B) *Hydrilla*
   (C) *Casuarina* (D) *Opuntia*

11. Identify the edible underground stem among the following.
   (A) Potato (B) Carrot
   (C) Groundnut (D) Sweet Potato

12. Root growing from any other part of the plant other than the radicle is called?
   (A) Prop root (B) Adventitious root
   (C) Epiphytic root (D) Taproot

13. Which of the following has a large globular root tapering sharply at the lower end?
   (A) Conical (B) Tuberous
   (C) Napiform (D) Fusiform

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14. Roots growing vertically upwards like conical spikes and having aerating pores are called
(A) Mycorrhizal (B) Assimilatory
(C) Pneumatophores (D) Conical

15. A form of the underground stem to contain food reserve and is short and vertical is called
(A) Corm (B) Rhizome
(C) Tuber (D) Bulb

16. Among the following, in which the leaves get modified into spines?
(A) Pea (B) Silk Cotton
(C) Opuntia (D) Onion

17. What is the function of the veins of the leaves?
(A) Transport of organic nutrients (B) Mechanical support
(C) Transport of water and minerals (D) All the above

18. Which of the following stem gets modified into the flat and green organ to perform the functions of leaves?
(A) Phylloclade (B) Cladodes
(C) Scales (D) Phyllodes

19. The edible part of a coconut is known as
(A) Pericarp (B) Perisperm
(C) Endosperm (D) Cotyledon

20. The edible part of a coconut is known as
(A) Pericarp (B) Perisperm
(C) Endosperm (D) Cotyledon

21. Which of the following fruit is developed from condensed inflorescence?
(A) Etaerio (B) Aggregate fruit
(C) Composite fruit (D) Simple fruit

22. Among the following fruits, which has placenta and pericarp as edible parts?
(A) Banana (B) Potato
(C) Apple (D) Tomato

23. Which location does the Testa of seed develop from?
(A) Outer integument (B) Hilum
(C) Ovary wall (D) Funicle

24. The _____ of a flowering plant is a brown, tendril-like part of the plant axis.
(A) Stem (B) Root
(C) Fruit (D) Leaf

25. The _____ of a flowering plant is a brown, tendril-like part of the plant axis.
(A) Stem (B) Root
(C) Fruit (D) Leaf

26. Which part of the flowering plant are flattened, greenish structures?
(A) Root (B) Flower
(C) Leaves (D) Fruit

27. The stem modified into flat, green organs that perform the function of leaves is –
(A) Cladodes (B) Phylloclades
(C) Phyllodes (D) Scales

28. What is the portion of stem present between two nodes called?
(A) Internode (B) Axil
(C) Apical bud (D) Axillary bud

29. What is the second whorl of a flower known as?
(A) Petals (B) Sepals
(C) Carpels (D) Stamens

30. Gynoecium with fused carpels is known as-
(A) Syncarpous (B) Syngenecium
(C) Apocarpous (D) All of the above

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31. The arrangement of petals or sepals in a floral bud is known as-
(A) Aestivation (B) Vernation
(C) Prefoliation (D) Ptyxis

32. Water is absorbed by
(A) Root hairs (B) Root cap
(C) Root (D) Root apex

33. Pneumatophores occur in plants of
(A) Sandy soil (B) Saline marshy soil
(C) Marshy soil (D) Water

34. Roots developing from plant parts other than radicle are
(A) Epiphyllous (B) Epicaulou
(C) Adventitious (D) Fibrous

35. Roots are feebly developed in
(A) Hydrophytes (B) Mesophytes
(C) Xerophytes (D) Halophytes

36. Nodulated roots occur in
(A) Pea (B) Wheat
(C) Mustard (D) Rice

37. Root cap takes part in
(A) Formation of new cells (B) Absorption of water and minerals
(C) Protection of root meristem (D) Storage of food

38. Conical fleshy roots occur in
(A) Sweet potato (B) Dahlia
(C) Asparagus (D) Carrot

39. Napiform roots are recorded from
(A) Radish (B) Carrot
(C) Beet (D) Sweet potato

40. Fusiform roots are found in
(A) Solanum tuberosum (B) Calocasia
(C) Daucus carota (D) Raphanus sativus

41. Primary root and its branches constitute
(A) Adventitious root system (B) Tap root system
(C) Fibrous roots (D) Seminal roots

42. Root bears
(A) Nodes only (B) Internodes only
(C) Both nodes and internodes (D) None of these

43. Root pockets act as balancers and found in
(A) Hydrophytes (B) Free floating hydrophytes
(C) Fixed floating hydrophytes (D) Submerged hydrophytes

44. The root that never does primary function is
(A) Nodulated root of gram (B) Conical roots of carrot
(C) Buttress roots of Ficu (D) Stilt root of maize

45. Monocot plants are characterised by the presence of
(A) Tap roots (B) Fibrous roots
(C) Annulated roots (D) Stilt roots

46. Bacteria found in root nodules of legumes are
(A) Nitrobacter (B) Nitrosomonas
(C) Rhizobium (D) Azotobacter

47. In maize, the fibrous roots develop from
(A) Lower nodes (B) Upper nodes
(C) Upper internodes (D) None of the above

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48. Prolongation of radicle gives rise to
(A) Fibrous root system (B) Primary root
(C) Stilt root (D) Pillar root

49. Edible part of Sweet potato is
(A) Stem tuber (B) Unripe fruit
(C) Adventitious root tuber (D) Rhizome

50.Leguminous plants possess
(A) Napiform roots (B) Nodulated roots
(C) Tuberous roots (D) Fusiform roots

ANSWER KEY

(1)	(C)	**(11)**	(A)	**(21)**	(C)	**(31)**	(A)	**(41)**	(B)
(2)	(C)	**(12)**	(B)	**(22)**	(D)	**(32)**	(A)	**(42)**	(D)
(3)	(B)	**(13)**	(C)	**(23)**	(A)	**(33)**	(C)	**(43)**	(B)
(4)	(D)	**(14)**	(C)	**(24)**	(B)	**(34)**	(C)	**(44)**	(D)
(5)	(C)	**(15)**	(A)	**(25)**	(B)	**(35)**	(A)	**(45)**	(B)
(6)	(B)	**(16)**	(C)	**(26)**	(C)	**(36)**	(A)	**(46)**	(C)
(7)	(B)	**(17)**	(D)	**(27)**	(B)	**(37)**	(C)	**(47)**	(A)
(8)	(A)	**(18)**	(A)	**(28)**	(A)	**(38)**	(D)	**(48)**	(B)
(9)	(B)	**(19)**	(C)	**(29)**	(A)	**(39)**	(C)	**(49)**	(C)
(10)	(D)	**(20)**	(C)	**(30)**	(A)	**(40)**	(D)	**(50)**	(B)

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