5. Morphology of Flowering Plants

1. Morphology

Morphology is the branch of science which deals with the study of form and structure. In botany, it generally means the study of external features, forms and relative positions of different organs on plants. Angiospermic or flowering plants show a great variety of shape, size and form. The size ranges from the minute *Wolffia* and *Lamna* (0.1*cm*) to the tall *Eucalyptus* (up to 100 *meter*) and large sized Banyan (*Ficus benghalensis*).

2. Parts of Flowering Plants

The plant body consists of a main axis, which may be branched or unbranched bearing lateral appendages. The main axis is divided into two parts :

(1) **Root** : The underground root system develops from the radicle embryo and helps in fixation of the plant as well absorption of water and minerals

(2) **Stem** : The aerial shoot system develops from the plumule embryo. It contains root, stem, leaves as vegetative parts and flowers, fruits and seeds as reproductive parts. The vegetative parts are involved in various vegetative functions like structural organization, fixation, absorption, nourishment, growth and maintenance of various components and reproducting parts are for sexual reproduction and germination of new plants.

(3) **Leaves** : Leaves are usually green, flat, expanded organs of limited growth. They develop from the nodes having invariably buds at their axils, and remain arranged in acropetal order.

(4) **Flower** : The flower consists of an axis, also known as receptacle and lateral appendages. The appendages are known as floral parts or floral organs.

(5) **Fruit** : Botanically, a fruit develops from a ripe ovary or any floral parts on the basis of floral parts they develop, fruits may be true or false.

(6) **Seed** : Seed is the name of a ripened ovule which contains an embryo or miniature plant in suspended animation, adequate reserve food for future development of the embryo and a covering for protection against mechanical injury, loss of water, pathogens, etc.

3. Morphology of Roots

The root is usually an underground part of the plant which helps in anchorage of plant in soil and absorption of water and minerals from the soil. The root with its branches is known as the root system.

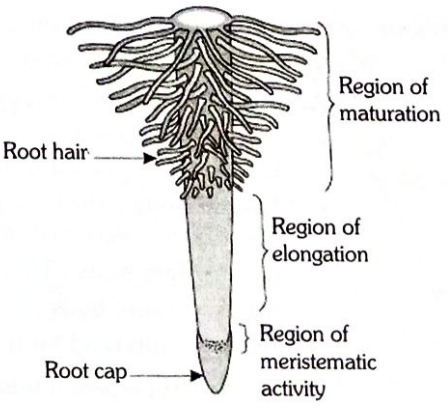
3.1. Characteristics

(1) The root is the descending portion of the plant axis and is positively geotropic.
(2) It is non-green or brown in colour.
(3) The root is not differentiated into nodes and internodes.
(4) As per the rule the root does not bear leaves and true buds.
(5) Usually the root tip is protected by a root cap.
(6) The root bears unicellular root hairs.
(7) Lateral roots arise from the root which are endogenous in origin (arises from pericycle).

3.2. Regions of the Root

The root has five main regions which are as follows:

- Root Cap is the structure that covers the apex/tip of the root. It helps in protecting the apex of the root.
- Region of Meristematic Activity located few millimeters above the root cap. The cells of this region has the property of repeated divisions which is needed for the growth of the plant.
- Region of Elongation is located proximal to the region of meristematic activity. This is required for the elongation of root.
- Region of Maturation is located proximal to region of elongation. These cells gradually differentiate and mature. Root Hairs arise from the region of maturation which helps in absorption of water and minerals from the soil.



3.3. Root System

- **Tap root system:** The tap root system develops from radicle of the germinating seed. It is also called the normal root system. The tap root system is present in dicotyledonous plants. The first root forms by the elongation of radicle and is called primary root. It continuously grows and produces lateral roots called secondary roots. The further branches of the secondary roots are called tertiary roots and so on. These types of roots are present in dicots e.g Pea, gram, groundnut etc.

- **Fibrous root system:** 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. Eg: Wheat plant.
- **Adventitious root system:** The root system that develops from any part of the plant body other than the radicle is called the adventitious root system. It is mostly seen in monocotyledonous plants.

3.4. Modification of Roots

Roots modify in structure to perform different functions as explained below:

- Fusiform root is a modified form of tap root. The root is swollen from the middle and tapers at both the ends. For
- Example: Radish
- Napiform roots are also a modified tap root. They have swollen base and then it tapers abruptly. For Example: Turnip
- Prop roots are roots which are modified for aerial support. For Example: Corn
- Stilt roots are modified roots for support. For Example; Maize
- Pneumatophores are roots modified for respiration. They grow in swampy area and grow vertically upwards. For Example: Rhizophora.

3.5. Function of Roots

- Anchoring of the plant to the soil
- Absorption of water and nutrients from the soil
- Conduction of absorbed water and nutrients to stem
- Storage of food
- Vegetative reproduction and competition with other plants
- Soil binding

4. Morphology of Stem

The stem is the most prominent, ascending and generally aerial part of the plant which develops from the plumule and epicotyl.

4.1. Characteristics

- Stem develops from the plumule and epicotyl of the embryo.
- Generally, it is an aerial and ascending part of the plant axis.
- A terminal bud is present at the apex of the main axis and lateral branches and is responsible for growth in length.
- A stem is differentiated into nodes and alternating internodes.
- Leaves emerge from the nodes of the axis and its branches.
- The young stem is green and performs photosynthesis.
- Multicellular hair may be present on the stem.
- Branches of the stem and its leaves have exogenous origin.
- Flowers and fruits develop on the stem of mature plants.
- Generally, a stem is negatively geotropic and positively phototropic.

4.2. Buds

A bud is a compact undeveloped young shoot consisting of a shoot apex, compressed axis and a number of closely overlapping primordial leaves arching over the growing apex. Buds which develop into flower are called floral buds.

(1) Nature of buds

- **Normal buds :** These buds are borne on stems either terminally or laterally. Since they are borne in normal positions, they are called normal buds.

(2) According to nature they are of following types

- **Vegetative buds** : These buds grow to form only leafy shoots.
- **Floral buds** : These buds develop into flowers.
- **Mixed buds** :They produce both vegetative and floral branches.

(3) According to the position buds can be of two types: Terminal or lateral.

- **Apical/Terminal buds :** They are borne at the apex of the main stem or a branch. They are also called terminal buds. Cabbage is a large apical bud.
- **Lateral buds :** The buds, which are borne in any other place except at the apices of main stem and its branches, are called lateral buds. Lateral buds are of four types.
  - **(i) Axillary buds :** The buds develop in the axil of leaves and produces branches.
  - **(ii) Accessory buds :** They are additional buds borne at the leaf bases. Accessory buds are of two kinds.
    - **(a) Collateral buds** : Present on the side of axillary bud e.g., lilies
    - **(b) Superposed buds** : Present above the axillary bud e.g., Aristolochia.
  - **(iii) Extra-axillary Buds :** These buds develop on the node but outside the leaf base.

(iv) **Adventitious buds** : When a bud grows from a position other than normal, it is called adventitious bud.Adventitious bud may be :

(a) Foliar buds : Appearing on leaves e.g., in Bryophyllum, Begonia, Kalanchoe.

(b) Radical buds : Developing on roots e.g., Ipomea batatus (sweet potato), Dalbergia

(c) Cauline buds : Developing on stem e.g., rose.

Bulbils or Specialised buds : Modification of whole buds into swollen structures due to storage of food materials are called bulbils. e.g., In Lilium bulbiferum and Dioscorea bulbifera, the bulbils develop in axil of leaves; in Agave, floral buds of inflorescence transform into bulbils; In Oxalis, they develop just above the swollen roots.

5. Branching of Stem

In angiosperms, always the branches are produced by the growth of axillary buds or lateral buds. This type of branching is known as lateral branching. The lateral branching is classified into two kinds racemose and cymose.

(1) **Racemose Type** In this type of branching the growth of the main stem is indefinite, i.e., it continues to grow indefinitely by its terminal bud and gives off branches in acropetal succession. Here the lower branches are older and longer than the upper branches, e.g., bPolyalthia, Casuarina, Eucalyptus, etc.

(2) **Cymose Type** In such type of branching the main axis or the stem does not grow indefinitely due to the limited growth of the terminal or apical bud. Here the growth is definite, and the main stem produces one or more lateral branches which grow more vigorously than the terminal one. The process may be repeated again and again. The cymose type of branching are of three types. They are Uniparous or monochasial, Biparous or dichasial and Multiparous or polychasial.

6. Modification of Stem

6.1. Underground Stem Modification

The underground stems lack green colour because of their geophillous nature. They can be identified as stems because of the presence of nodes, internodes, scale leaves, buds and branches. Based on the type of growth (transverse/vertical/oblique) and the part that stores food (main stem/ branch/ leaf base), the underground stems are classified into several types :

(1) Bulb: A bulb is a specialized underground stem which bears roots on it's lower side and rosette of fleshy leaf bases or fleshy scales on the upper side. In a bulb, the stem is reduced and becomes discoid. On the lower side of the disc adventitious roots develop in clusters. The upper side of the disc shows compactly arranged scale leaves so asto form an underground bulb. Bulbs are of two types, tunicated bulb and scaly bulb.

(a) Tunicated bulb : In tunicated bulb, the fleshy leaf bases are arranged in a concentric manner. The entire bulb is covered by peripheral dry membranous leaf bases called tunics, hence called the tunicated bulb. e.g., Allium cepa (Onion), Narcissus and Tulip. Compound tunicated bulbs as in Allium sativum (garlic).

(b) Scaly or Imbricated bulb : In scaly bulb, the fleshy scale leaves are arranged loosely overlapping one another. Such bulbs are not covered by any tunics, hence called naked bulbs or scaly bulbs. e.g., Lilium bulbifera (Lily).

(2) Stem tuber : Stem tuber is the tuberous tip of an underground branch. It occurs beneath the soil at an depth.The axillary branches (stolons) that are produced near the soil surface grow into the soil and their tip become swollen due to accumulation of starch and proteins e.g., Solanum tuberosum (potato). In potato, the stem nature is evident by the presence of 'eyes' on its brownish corky surface. Each eye is a pit like structure and represents the node. Axillary bud is situated in the pit of the eye. The stem tubers are differentiated from the tuberous roots by thepresence of vegetatively propagating eyes.

(3) Rhizome : The rhizome is a thickened, underground dorsiventral stem that grows horizontally at particular depth within the soil. The rhizome is brown in colour. It can be distinguished from the modified root by the presence of nodes, internodes, terminal bud, axillary bud and scale leaves. The terminal bud develops aerial shoot that bears inflorescence. Adventitious roots develop on the ventral surface of the rhizome. The rhizomes are perennial and vegetatively propagating structures. It is of following types :

(a) Rootstock : They are upright or oblique or vertical with their tips reaching the soil surface. e.g., Alocasia indica and Banana.

(b) Straggling : They are horizontal in position and generally branched (Sympodial or Monopodial), e.g., Nelumbo nucifera (Lotus), Zingiber officinale (Ginger), Curcuma domestica (Turmeric), Saccharum etc.

(4) Corm : The corm is an underground modification of main stem with more diameter than length. It grows vertically at particularly depth in the soil. The corm stores food materials and becomes tuberous. It isnon green in colour and conical, cylindrical or flattened in shape. The corm bears scale leaves at each node. In the axils of these scale leaves axillary buds arise which grow into daughter corms. The terminal bud of the corm is large. It grows into aerial shoot and bears leaves and flowers. Adventitious roots normally develop from the base or all over the body of the corm. With the help of some special adventitious roots called the contractile roots or pull roots, the corm remains constantly at a particular depth. The corm propagates vegetatively by daughter corms. e.g., Amorphophallus, Gladiolus, Colocasia and Crocus (Saffron).

6.2. Aerial Stem Modification

Aerial stem modifications are modifications to the aerial stems, vegetative buds and floral buds of plants which perform functions such as climbing, protection, synthesis of food vegetative propagation, etc. The auxiliary or the terminal part show their stem nature The aerial stems, vegetative buds and floral buds of plants growing in different conditions undergo modifications to perform special functions. These modifications are called "aerial stem modifications'. They include tendrils, thorns, hooks, phylloclade, cladodes, thalamus and bulbils.

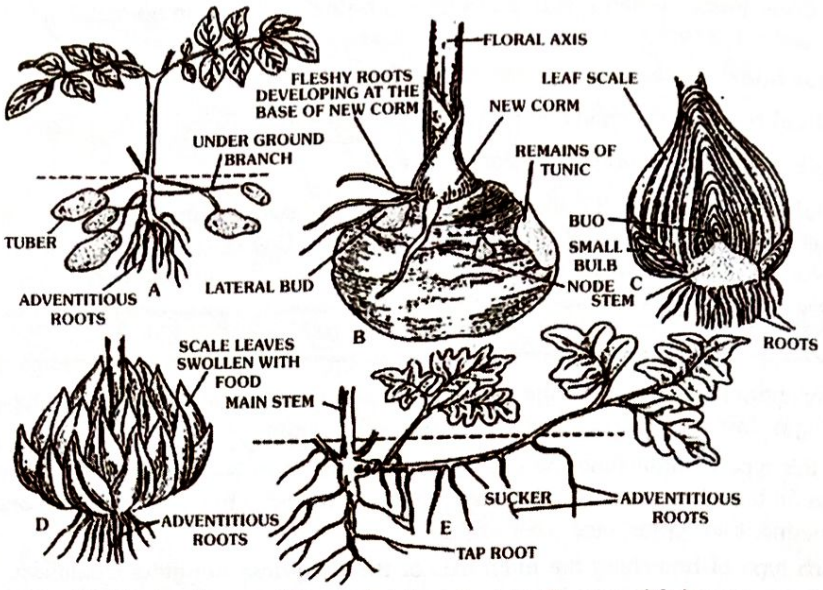


Fig. Modified underground Stems. **A,** tuber of potato, **B.** corm of Colocasia, **C.** tunicated bulb of onion, **D,** scaly bulb of Oxalis, **E.** sucker of Chrysanthemum

(1) Tendrils : Some weak stemmed plants produce wiry, coiled, sensitive and delicate organs for climbing. They are called tendrils. These may develop from either the axillary bud or the terminal bud of the stem. In *Passiflora*, the tendrils develop from the axillary bud. In *Cissus quadrangularis*. And in *Vitis vinifera* the terminal bud develops into tendrils.

(2) Thorns : These are hard, woody, pointed structures meant for protection. They are provided with vascular tissue, which may develop from the axillary bud or terminal buds. They control transpiration by reducing the vegetative growth. In *Bougainvillae, Punica granatum and Duranta* the axillary bud develop into thorns. In *Duranta*, the thorns are provided with leaves and flowers. In *Punica granatum*, the thorns bear leaves and branches. In *Carissa carandas* the terminal bud produces a pair of thorns. They help in protection.

(3) Bulbils : When axillary bud becomes fleshy and rounded due to storage of food, it is called bulbil. It gets deatched from the plant, falls on ground and develops into a new plant. e.g. Dioscorea. It is in axil (the space between leaf and stem).

(4) Phylloclades : The phylloclade is special modified photosynthetic stem present mostly in xerophytes. It is green, flattened or cylindrical structure which has distinct nodes andinternodes. Xerophytes show many adaptations to check the rate of transpiration. Reduction of leaf size, early leaf fall, formation of scale leaves, spines, thorns, thick cuticle, presence of fewer stomata are some of the xerophytic characters. In such cases, the stems become flattened to carryout photosynthesis. These modified stems are called phylloclades. Usually the phylloclades retain water in the form of mucilage. e.g., Opuntia, Casuarina, Cocoloba and Ruscus. In Opuntia, the leaves are modified into spines and the stems becomes fleshy leaf like phylloclade. In Casuarina the leaves are modified into scales. The phylloclade in Ruscus is leaf like and bear flowers. In Cocoloba, after the modification of leaves into scales the stem becomes ribbon like phylloclade with distinct nodes and internodes.

(5) Cladodes : These are green branches of limited growth(usually one internode long)which have taken up the functions of photosynthesis. True leaves are reduced to scales or spines, e.g. Asparagus.

(6) Thalamus : Thalamus of a flower is a modified stem apex. The other floral parts (sepals, petals, stamens and carpels) are born on the thalamus. It may be convex (Ranunculus), concave (Lathyrus) or flask shaped (Rosa).

6.3. Sub aerial weak stem modification

It is incapable of growing straight upright, and under natural conditions trail on the surface of the soil or climb with the help of some support.

(1) Runners : This prostrate aerial stem has a long internode and creeps horizontally. Axillary buds arise from nodes to form aerial shoots and roots. e.g., Cynodon (doob grass) and Oxalis.

(2) Stolons : They are special kinds of runners which initially grow upwards like ordinary branches and then arch down to develop new daughter plants on coming in contact with the soil. e.g., Strawberry (Fragaria vesica), Colocasia, Peppermint (Mentha piperita), Jasminum (Jasmine).

(3) Offsets : They are weak, elongated, horizontal branch of one internode that arises in the axil of a leaf. At the tip, it produces cluster of leaves above and tuft of roots below. The offset may break off from the parent plant and act as individual plants. They are found usually in aquatic plants and rarely is terrestrial plants.

(4) They are helpful for vegetative propagation. e.g., Eichhornia (water hyacinth), Agave, Pistia.

(5) Suckers:- in plants like banana, pineapple, chrysanthemum, the lateral branches originate from the basal and underground portion of main stem. They grow below the surface of the soil to some distance and then emerges out obliquely to form aerial shoot.

6.4. Function of Stem

The primary functions of the stem are to support the leaves; to conduct water and minerals to the leaves, where they can be converted into usable products by photosynthesis; and to transport these products from the leaves to other parts of the plant, including the roots.

7. Morphology of Leaf

Leaf is a green, dissimilar exogenous lateral flattened outgrowth which is borne on the node of a stem or its branch and is specialised to perform photosynthesis. Typically it is a thin expanded green structure which bears a bud in its axil. The green colour of the leaf is due to the presence of chlorophyll. Leaves are arranged in acropetal order. They develop as lateral outgrowth from shoot apical meristem.

7.1. Characteristics

- They are important vegetative organs which are specialised for photosynthesis.
- All the green leaves of a plant are collectively called foliage.
- The leaf is a lateral dissimilar appendage of the stem.
- A leaf is always borne at the node of stem.
- The growth of leaf is limited.
- The leaves do not possess any apical bud or a regular growing point

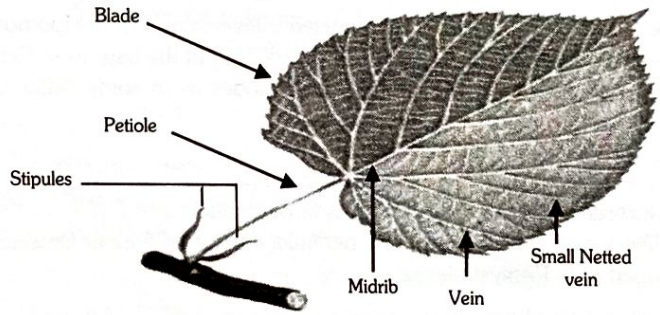
7.2. Parts of Leaves

A leaf consists of three parts - leaf base, petiole and lamina.

(1) **Lamina** (= epipodium) or leaf blade is the terminal thin,expanded, green and conspicuous part of the leaf which is specialized to perform photosynthesis. The flattened lamina or leaf blade is supported by veins and veinlet's which contain vascular tissues for conduction of water, mineral salts and prepared food.There are two surfaces - adaxial (ventral, upper) towards the upper part of stem and abaxial (dorsal, lower) towards the lowe rpart of stem. The two surfaces are quite distinct in dorsiventral leaves (most dicot leaves) but are quite similar in isobilateral leaves(most monocot leaves).

(2) **Petiole** (= mesopodium) is a cylindrical or sub-cylindrical smooth or grooved stalk of the leaf which lifts the lamina above thelevel of stem so as to provide it with maximum exposure. Leaf having petiole is called petiolate. It is termed sessile if the petiole is absent.

(3) **Leaf base** (= hypo podium) is the lowermost part of the leaf by which the leaf is joined to the node of the stem. It protects the young axillary bud. Leaf base is often indistinguishable from the petiole.In many legumes it is swollen. The swollen leaf base is known as pulvinus. It is responsible for sleep and shock movements of certain leaves, e.g., Mimosa pudica. Leaf base may be broadened to enclose the stem. It is called sheathing leaf base.

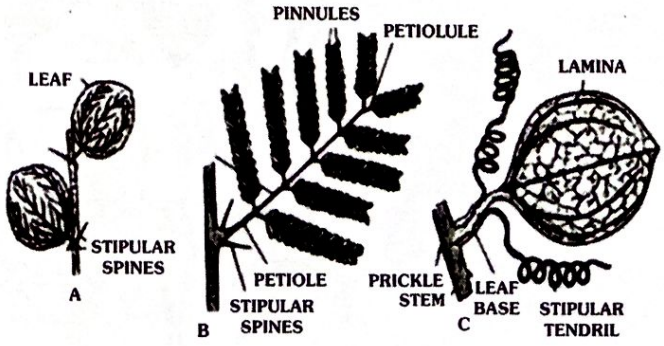


7.3. Stipules

They are two small lateral outgrowths of the leaf base which protect the young leaf and its axillary bud in the young state. In some compound leaves, the leaflets bear basal lateral outgrowths named Stipules, e.g., Bean, Clitoria, Vicia.

Different types of stipules are:

- Free Lateral : Small, free, green outgrowths, e.g., Shoeflower (Hibiscus rosa-sinensis),
- Scaly Very small dry membranous stipules, e.g., Cassia fistula,
- Axillary or Intrapetiolar : Stipules are fused from their inner margins to become axillary, e.g., Gardenia,
- Opposite : Stipules are fused from their outer margins to become opposite the leaf, e.g., Castor,
- Interpetiolar : Adjacent stipules of opposite leaves are fused to appear in between the petioles, e.g., Anthocephalus (Kadam), Ixora.
- Adnate or Petiolar : Stipules fused with petiole, e.g., Rose, Groundnut,
- Ochreate : Stipules fuse to form a sheath or ochrea around the stem, e.g., Rumex, Polygonum,
- Bud Scales : Stipules of young leaves connate to protect bud, e.g., Ficus,
- Foliaceous : Large and green, e.g., Pisum.
- Stipular Spines : Stipules are transformed into spines, e.g., Acacia, Zizyphus. The two stipular spines of Zizyphus are unequal with one straight and second bonked
- Stipular Tendrils : Stipules are modified into tendrils, e.g., Smilax (Fig. C) for climbing.



Modification of petiole

- Winged petiole : Green, flattened petioles may be called winged petioles, e.g., Citrus and Dionaea.
- Tendrillar petiole : In few plants the petioles are modified into tendrils and helps the plant in climbing. e.g., Clematis and Tropaeolum.
- Leaf like petiole (Phyllode) : A modified petiole which is flat, green and lamina like is called phyllode. It is a photosynthetic organ. e.g., Acacia auriculaeformis (Australian babool).
- Swollen or Spongy petiole : Sometimes the petiole becomes swollen and spongy due to the development of aerenchyma. This type of petioles encloses much air and helps the plant to float. It is a hydrophytic adaptation e.g., Trapa bispinosa and Eichhornia.
- Spinous petiole : In few plants, the leaf blades fall off and the petioles become hard and spinous e.g., Quisqualis (Rangoon creeper).

7.4. Shape of lamina

Lamina (Epipodium): The green expanded portion of the leaf is called the lamina. It performs vital functions like photosynthesis and transpiration

Shape of Lamina: The shape or outline of the lamina is merely a description of its form. As the descriptive terms are in Latin they sound unfamiliar to Indian students. The lamina shape may be

(a) Narrow throughout:

- **Acicular** - needle-shaped as in pine.
- **Linear** - longer and slightly broader as in many grasses, tuberose, etc.

(b) Wider but more or less of the same width at base and apex:

- **Lanceolate** - shaped like a lance as in Nerium and Polyalthia.
- **Oblong** - more or less rectangular as in banana (Musa sp.).

(c) Wider at the base and narrow towards the apex:

- **Subulate or awl-shaped** - long and narrow, tapering gradually from base to apex as in Salsola kali and Isoetes (a pteridophyte).
- **Ovate or egg-shaped** - as in china-rose and banyan.
- **Cordate or heart-shaped** –with a deep notch at the base as in betel vine (Piper betle).
- **Sagittate** - shaped like an arrowhead with the two basal lobes pointing towards the base as in Sagittaria sagittifolia and in arum.
- **Hastate** - like sagittate but the two basal lobes are directed outwards as in some Ipomoea and in Typhonium.
- **Reniform or kidney-shaped** - rounded above with a deep notoh at the base as in Centella asiatica.
- **Lunate** - shaped like a half-moon with two pointed basal lobes as in some Adiantum (a fern) and in Passiflora lunata (reversed).

(d) Wider at the apex:

- **Obovate** - reverse of ovate as in jack-fruit or Terminalia catappa.
- **Obcordate** - reverse of cordate with an apical notch as in Batihinia.
- **Spathulate** - shaped like a spatula as in Euphorbia nerifolia, Phyla nodiflora or Drosera burmanni.
- **Cuneate** or wedge-shaped as in Pistia stratiotes.

(e) Symmetrical lamina:

- **Elliptical** - like an ellipse as in Vinca rosea, guava and India-rubber.
- **Rotund** or orbicular (circular) as in lotus, water-lily and garden nasturtium.

(f) Incised forms:

- Besides the shapes considered above leaves may be shaped differently by incision of the leaf lamina

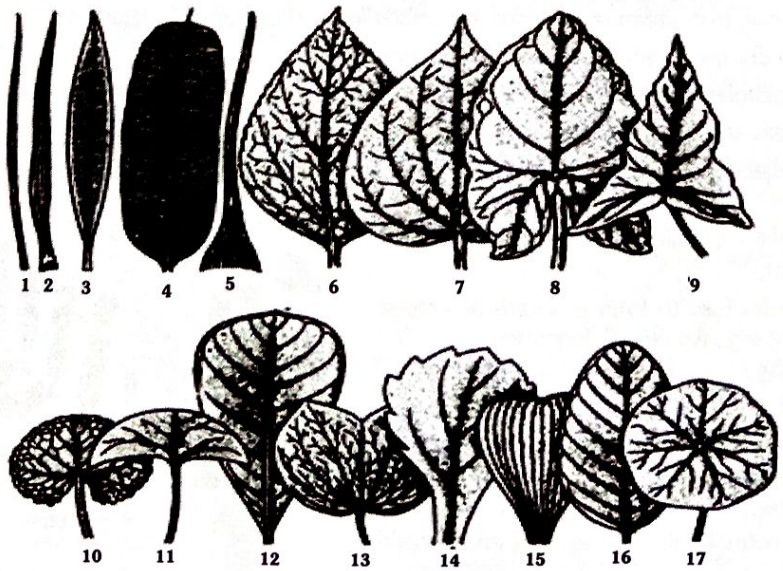


Fig. Lamina Shapes, 1. Acicular in pine, 2. Linear in grass, 3. Lamceolate in Nerism, 4. Oblong in banana, 5. Subulate in Isoetes, 6. Ovels in china-rose, 7. Cordate in betel vine, 8. Sagittote in Sagittoris, 9. Hastate in Ipomses, 10. Raniform in Censella, 11. Lamate in Passifiers hemate, 12. Obsecote in jack-fruit, 13. Obcordate in Bauhinia, 14. Spothudate in Lipia, 15. Cuneate in Pistia, 16. Elliptical in guava, 17. Refund in water-lily.

7.5. Margin of Lamina

The margin of the lamina may be :

- **Entire** - when the margin is smooth as in mango.
- **Repand** - margin wavy as in Polyalthia.
- **Serrate** - margin with teeth pointed upwards as in a saw, e.g., china-rose, rose, etc.
- **Bi-serrate** - margin toothed but the teeth again serrated as in the elm tree.
- **Retroserrate** - the teeth are pointed downwards.
- **Dentate** - margin toothed, the teeth are pointed outward, i.e., at right angles, e.g., water-lily.
- **Bi-dentate** - margin toothed and the teeth are again dentate.
- **Crenate** - margin toothed and the teeth ^re rounded as in Centella and Kalanchoe.
- **Bi-crenate** - margin toothed and the teeth are again crenate.
- **Spiny** - the marginal teeth are pointed to form spines as in pineapple (Ananas) or Mexican poppy (Argemone).
- **Lobed or incised** - when the margin is so much dissected that it can no longer be described simply as toothed. There are various types of lobing or incision which ate discussed later in connection with leaf incision.

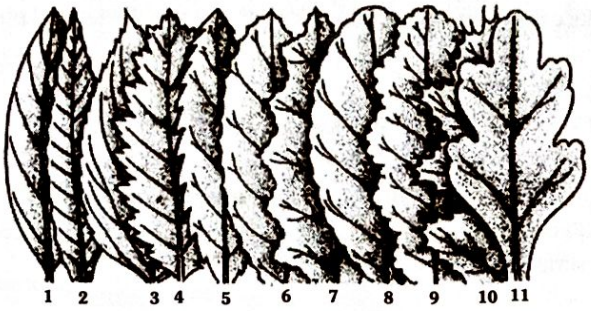


Fig. Leap Margin, 1. Entire, 2. Repand, 3. Serrate, 4. Bi-serrate, 5. Retroierrate, 6. Dentate, 7. Bi-dentate, 8. Crenate, 9. Bi-crenate, 10. Spiny, 11. Lobed

7.6. Apex of Lamina

The apex of the lamina may be :

- **Acute** - when pointed and narrow as in mango.
- **Acuminate** - when the apex is drawn out into a long tapering tail as in Ficus religiosa (pipul).
- **Obtuse** - when the apex is broad angled and blunt as in banyan.
- **Mucronate** - when the apex is broad but the tip forms a sharp point as in Vinca.
- **Cuspidate or spiny** - when the apex forms a spinous structure as in pineapple, date palm, Pandanus, etc.
- **Tendrillar** - when the apex forms a tendril for climbing as in Gloriosa.
- **Cirrhose** - when the mucronate-like apex ends in a fine thread-like structure as in banana.
- **Truncate** - when the apex is abruptly cut across as in Paris polyphylla of Lilia-ceae.
- **Retuse** - when the obtuse apex is slightly notched as in Pistia or Clitoria.
- **Emarginate** - when the obtuse apex is deeply notched as in Bauhinia.

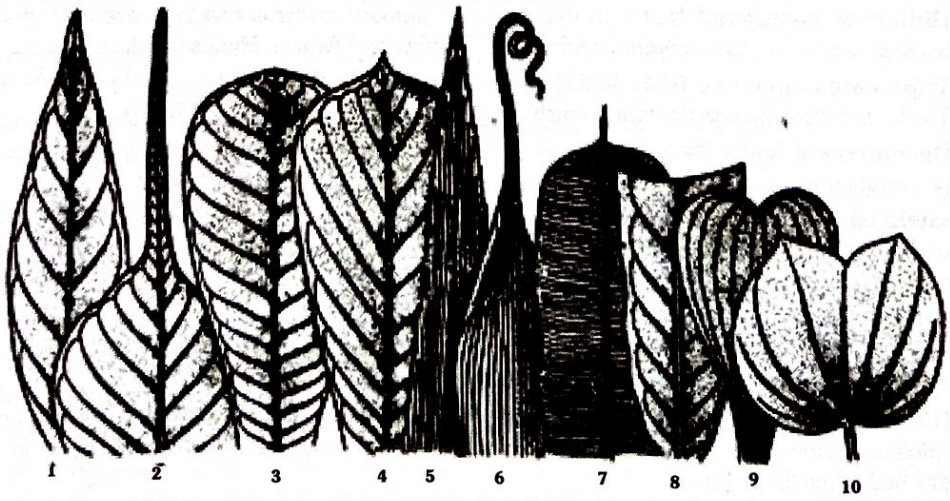


Fig. Leap Apices, 1. Acute, 2. Acuminate, 3. Obtuse, 4. Mucronate, 5. Cuspidate, 6. Tendrillar, 7. Cirrhose, 8. Truncate, 9. Retuse, 10. Emarginate

7.7. Surface of Lamina

The feel of the surface of the leaf may be:

- **Glabrous** - when smooth and without any hair, etc., as in mango.
- **Glaucus** - when the surface is covered by a waxy coating causing a shiny bluish or whitish tinge as in the leaves of lotus, arum or Calotropis.
- **Scabrous** - when the surface is rough because of the presence of short rigid points as in fig leaves.
- **Viscose** - when the surface is sticky because of some excretion as in Cltome viscosa. A similar case is the leaf of Nicotiana tabacum which is also sticky and is sometimes described as glutinous.
- **Rugose** - when the surface is somewhat wrinkled as in Rubus rugosus of Rosa-ceae.
- **Gland-dotted** - when glands are found on the leaf surface as in lemons.
- **Hairy** - when the surface is covered with hairs. These again may be of many types: (a) pubescent - when the hair is soft and woolly as in tomato; (b) pilose - when the hairs are long, distinct and scattered as in Grewia flavescens; (c) villose - when hairs are long, soft and closely arranged as in Leucas aspera; (d) tomentose - when hairs are short, dense and cottony as in Terminalia tomentosa, Calolropis procera, etc.; (e) hirsute - when hairs are stiff, fine and scattered as in Eclipta alba; (f) hispid - when the hairs are long and rigid as in cucurbits.
- **Spinose** - when the leaf surface is covered by small prickles (they are to be termed prickles and not spines) as in brinjal.

7.8. Texture of Lamina

The texture of the leaf is:

- **Herbaceous** - when the leaf is thin and membranous as in china-rose and rose.
- **Coriaceous** - when it is firm and leathery as in mango.
- **Succulent** - when soft and juicy as in Kalanchoe. The leaves are more or less brittle.
- **Gland-dotted** - the presence and nature of glands (e.g., on lemon leaves) may be considered in connection with texture as well as in connection with lamina surface.

7.9. Colour, Odour & Taste

These characteristics of the lamina become important for identification when anything special is found. Such specialities are to be described in such cases.

7.10. Types of leaves

On the basis of shape of lamina, the leaves are classified into two types, namely, simple leaf and compound leaf.

- **Simple leaves :** The leaf having single undivided lamina is called the simple leaf. The simple leaf may be entire (e.g., Mango and Hibiscus rosa sinensis) or lobed. The lobes of a simple leaf may be entire pinnately arranged (e.g., Brassica) or palmately arranged (e.g., Gossypium, Passiflora and Ricinus).
- **Compound leaves :** A compound leaf is one in which the lamina or the leaf blade is completely divided into many segments or units called leaflets or pinnae. When pinnae of leaflets are attached in various ways to the portion of leaf axis known as the rachis. The compound leaves may be of two types, namely, pinnate compound leaves and palmate compound leaves.
  - **(a) Pinnate compound leaves :** It is the most familiar and widespread type of compound leaf in which the rachis is elongated and bears two rows of simple or divided leaflets. The leaflets may be arranged alternately or in pairs along with the rachis. It is of following types :
    - **(1) Unipinnate compound leaf :** Here the primary rachis is unbranched and bear leaflets on either side. Unipinnate leaves are of two types : **Paripinnate :** The unipinnate leaf with even number of leaflets. They are borne in pairs. e.g., Tamarindus indica (Imli), Cassia etc. **Imparipinnate :** The unipinnate leaf with odd number of leaflets. The rachis is terminated by single unpaired leaflet. e.g., Neem, Rose, Murraya.
    - **(2) Bipinnate compound leaf :** In this type, the primary rachis is divided once and produce secondary rachis. The leaflets develop on the secondary rachis. e.g., Delonix and Acacia, Mimosa pudica, Albizzia (sub family mimosoideae).
    - **(3) Tripinnate compound leaf :** In this type the primary rachis divides twice and produces secondary and tertiary rachii. The leaflets develops on the tertiary rachii. e.g., Moringa (Soanjana) and Millingonia.
    - **(4) Decompound leaf :** Here the primary rachis divides many times without any definite order. The lamina is dissected into many units. e.g., Coriandrum, Carrot etc.
  - **(b) Palmately compound leaf :** In a palmately compound leaf, the leaflets are arranged at the tip of the petiole. According to the number of leaflets present at the tip of the petiole. These leaves are of following types :
    - **(1) Unifoliate :** In this case, a palmately compound leaf is reduced to a single terminal leaflet. e.g., Citrus (Khatta), Lemon, etc.
    - **(2) Bifoliate :** This type of leaf has only two leaflets attached side by side at the tip of petiole, e.g., Balanites roxburghii, Hardwickia binata, etc.
    - **(3) Trifoliate :** This type of leaf has three terminal leaflets, Aegle marmelos (Wood apple, Vern, Bael), Oxalis corniculata, Trifollium (Clover), etc. These leaves differ from trifoliate imparipinnate (e.g., Lablab) in having all the three leaflets attached at the tip of petiole.
    - **(4) Quadrifoliate :** This leaf has four leaflets attached to the tip of petiole. e.g., Paris quadrifolia, Marsilea.
    - **(5) Multifoliate(Digitate) :** A palmately compound leaf having five or more terminal leaflets, e.g., Bombax malabarica, Cleome viscosa, Gynandropsis pentaphylla, etc

7.11. Phyllotaxy

The arrangement of leaves on the stem is called phyllotaxy (Gk. Phyllon = leaf; taxis = arrangement). Types of Phyllotaxy are as follows-

- **Alternate or Spiral Phyllotaxy :** When only one leaf is found at each node. The leaves present at successive nodes alternate with each other. The arrangement is said to be alternate or spiral. The leaves are commonly arranged spirally around the stem. In spiral phyllotaxy, the leaves are arranged on the stem in regular vertical row. Such rows are called orthostichies. In practice the angular divergence is determined in the following manner : Angular divergence = No.of a circle/ Orthosticheies i.e., 360° A phyllotaxy is written by taking the number of spirals (circles) as numerator and the number of leaves as denominator. Based on the number of orthostichies seen on the stem, the spiral phyllotaxy may be described as given under. Distichous or 1/2 Phyllotaxy : Where the angular divergence is 1/2 of 360° i.e., 180°. e.g., Ravenella. Tristichous or 1/3 Phyllotaxy : Where the angular divergence is 1/3 of 360° i.e., 120°. e.g., Moss, Cyperus rotundus.
  - **Pentastichous or 2/5 Phyllotaxy :** Where the angular divergence is 2/5 of 360° i.e., 144°. e.g., China rose.b
  - **Octastichous or 3/8 Phyllotaxy :** Where the angular divergence is 3/8 of 360° i.e., 135°. e.g., Carica papaya. In these types, if one adds up two preceeding numerators and denominators, a series is formed called Schimper-Brown Series.
  - **Opposite Phyllotaxy :** When two leaves are present at a node opposite to each other the type of phyllotaxy is called opposite. It is of two types :
    - **(a) Opposite Superposed :** All the pair of leaves of a branch arise in the same plane so that only two vertical rows of leaves are formed. e.g., Jamun, Guava, etc.
    - **(b) Opposite Decussate :** A pair of leaves at one node stands at right angle to the next upper or lower pair so that four vertical rows are formed on the stem. e.g., Calotropis, Zinnia, Tulsi, Quisqualis.
  - **Whorled Phyllotaxy :** If more than two leaves are present at a node as whorl, it is called whorled phyllotaxy. It is also called cyclic or verticellate phyllotaxy. e.g., Nerium, Hydrilla and Alstonia.
  - **Leaf Mosaic :** This is a special type of arrangement of leaves. Older leaves present at the lower nodes of the stem possess longer petioles with bigger lamina and the young leaves of upper nodes bear shorter petioles with smaller lamina. e.g., Begonia, Acalypha and Sycamore.

7.12. Heterophylly

It is the occurrence of more than one type of leaves on the same plant. Heterophylly is of four types :

- **Adaptive heterophylly :** Submerged leaves are different from floating and emerged leaves of the same plant due to different adaptations. e.g., Limnophila, Heterophylla, Sagittaria, Ranunculus aquatilis. The emerged leaves are broad and fully expanded while the submerged leaves are narrow, ribbon shaped, linear or highly dissected.
- **Environmental heterophylly :** The heterophylly is due to change in environment including soil, temperature, humidity and air currents. e.g., Sagittaria.
- **Developmental heterophylly :** Young leaves are different from mature leaves, e.g., Eucalyptus.
- **Habitual heterophylly :** Leaves of different shape and incisions occur at the same time, e.g., Jack fruit tree (Artocarpus heterophyllus), Ficus heterophylla, Hemiphragma heterophyllum, Broussonetia papyrifera. In Hemiphragma, the main stem bears ovate and entire leaves while branches possess acicular leaves.

7.13. Venation

The arrangement of veins in the leaf blade or lamina is called venation. It is mainly of two types namely Reticulate venation and Parallel venation.

- **Reticulate Venation**: This type of venation is common in all dicot leaves. In this type of venation there is a prominent vein called the midrib from which arise many small veins which finally form a net like structure in the lamina. It is of two types:
  - **(a) Pinnately reticulate venation :** In this type of venation there is only one midrib in the center which forms many lateral branches to form a net work. eg. Mango.
  - **(b) Palmate reticulate venation :** The lamina consist of anumber of midribs arising from the top of the petiole. Eg.castor, papaya
- **Parallel Venation :** In this type of venation all the veins run parallel to each other. Most of the monocot leaves have parallel venation. It is of two types.
  - **(a) Pinnateley Parallel venation :** In this type, there is a prominent midrib in the centre. From this arise many veins perpendicularly and run parallel to each other eg. Banana.
  - **(b) Palmately parallel venation :** In this type several veins arise from the tip of the petiole and they all run parallel to each other and unite at the apex.

    In grass they converge at the apex and hence it is called convergent.

    In Borassus (Palmyra) all the main veins spread out towards the periphery. Hence it is called divergent

7.14. Modification of Leave Lamina

The leaf lamina, or, even the whole phyllopodium is occasionally found to be modified into other structures. Prominent instances are:

- **Leaf Spines :** Spines sometimes arise as modifications of leaf apices or the apices of marginal lobes. These spines may be comparatively small as on the leaves of Argemone mexicana, Pineapple, Agave, Aloe, etc. In the date-palm this spine is quite a hard structure. Development of spinous structures is a feature of the xerophytes. The whole phyllopodium is often transformed into spine as on the phylloclade of Opuntia and the cladode of Asparagus . In lemons and oranges (Citrus spp), the prophyll is a spine. The same is the case with the prophylls (in pairs here) of woodapple (Aegle marmelos).

- **Leaf tendrils :** It has been seen in connection with tendril climbers that various organs of the plant may be transformed into tendrils. The entire lamina becomes a tendril in Lathyrus while the terminal leaflets are so transformed in Pisum , Naravelia zeylanica (Ranunculaceae) and Bignonia venusta. The leaf apex becomes a tendril in Gloriosa superba. The tendril of Cucurbits may be a prophyll.
- **Hooks :** Climbing hooks are sometimes modified leaves. In Macfadena unguiscati from Assam, the three terminal leaflets become claw-like hooks . The leaf spines on the main branches of Asparagus also actas hooks.
- **Fleshy leaves :** Some leaves, specially in xerophytes and halophytes, become fleshy because of the storage of water, mucilage and food matter. Such leaves contain a special storage tissue. Common examples are Portulaca oleracea (Portulacaceae), Basella rubra, Suaeda maritima and Salsola kali of Chenopodiaceae, Aloe and Agaves, Kalanchoe, Sedum acre (stonecrop), etc.
- **Pitcher :** The pitchers of insectivorous pitcher plants, which are wholly or partially modified leaf lamini are described (coloured photograph on wrapper). Another such pitcher is found in the epiphytic climber Dischidia rafflesiana (Asclepiadaceae) from Assam. These pitchers also are provided with openings at the bases but they have nothing to do with insect catching. Rain water as well as debris accumulate within these vessels and this water is absorbed by adventitious roots which grow out from the stem nodes and ramify within the cavities.
- **Bladder :** The bladders which are the insect-catching traps of Utricularia have been described .These are modified lobes of leaves.
- **Absorbing organs :** The submerged leaves of many aquatic plants are finely dissected and take up the absorptive functions of roots. These plants are usually rootless
- **Free-living leaf :** The peculiar case of Lemna has already been discussed. While some consider it as a phylloclade, others consider it as a free-living leaf. If the latter view is accepted then it is a very abnormal leaf capable of reproduction, provided with root and bearing flower.

8. Inflorescence

The flowers are arranged in some definite manner on the plant in each species of the flowering plants. The mode of arrangement of flowers on a specialised branch on top of the plant which bears flowers is called inflorescence. The stalk of the inflorescence is called peduncle.

- **Solitary flowers :** They are those flowers which are not grouped into inflorescence but occur singly. Solitary flowers are of two types :
  - **(i) Solitary terminal :** Single terminal flowers develop on the tip of main stem and its branches, e.g., Poppy
  - **(ii) Solitary axillary :** Flower occurs singly in the axil of a leaf (e.g., Petunia) or tip of a peduncle (e.g., China Rose = Shoe Flower = Hibiscus rosa-sinensis).

8.1. Racemose Inflorescence

An inflorescence of indefinite or indeterminate growth having lateral or axillary flowers borne acropetally (oldest at base and youngest at apex). Different types of racemose inflorescence are as follows.

(1) Simple Racemose Inflorescence

- **Typical Raceme (= Raceme)** : Unbranched, elongated peduncle bearing pedicellate or stalked flowers acropetally, e.g., Delphinium (Larkspur), Raphanus (Radish), Linaria, Lupinus.
- **Corymb :** All the acropetally arranged flowers come to lie at the same level due to slight shortening of peduncle and slight elongation of pedicels of lower flowers, e.g., Iberis, amara (Candytuft).
- **Corymbose-Raceme :** Like a corymb near the growing point and raceme lower down though the pedicels of the lower flowers are longer, e.g., Brassica compastris (Mustard).
- **Umbel :** Pedicellate flowers arranged centripetally around an extremely reduced peduncle with an involucre below, e.g., Centella (= Hydrocotyle) asiatica (Brahmi Booti), Androsace.
- **Spike** : Sessile (i.e., without stalk) flowers borne acropetally, e.g., Callistemon (Bottle Brush), Amaranthus, Achryanthes, Adhatoda.
- **Spikelet :** It is a compact spike having a few flowers borne on axis called rachilla and surrounded by two scales (= bracts) called glumes, e.g., Wheat, Oat, Sorghum, Grass.
- **Strobile:** It is a spike having persistent and membranous bracts, e.g., Humulus (Hop).
- **Catkin :** Compact unisexual spike often hanging, e.g., Morus (Mulberry), Salix (Willow), Populus (Poplar), Betula (Birch), Acalypha, Quercus (Oak).
- **Spadix :** A fleshy spike covered with spathe is called spadix. e.g., maize, banana etc.
- **Capitulum (Racemose Head, Anthodium) :** Peduncle is flattened to form receptacle that bears centripetally arranged sessile flowers or florets surrounded by involucre of bracts, e.g., Cosmos, Zinnia, Tagetes, Chrysanthemum, Sonchus, Ageratum. Florets may be tubular or ligulate. Capitula may be homogamous (with one type of florets e.g., only ligulate in Sonchus or Zinnia and only tubular in Vernonia or heterogamous (with two type of florets). Sunflower (Helianthus annuus) is heterogamous with both ligulate female ray florets and tubular intersexual disc florets.

(2) Compound Racemose Inflorescence

- **Raceme of Racemes (= Compound Raceme = Panicle) :** Racemes are borne acropetally on a raceme, e.g., Cassia fistula, Delonix regia, (Gold Mohar), Caesalpinnea (Gulmohar), Yucca, Asparagus, Asphodelus, Margosa.

- **Corymb of Corymbs (= Compound Corymb) :** An axis bearing a number of corymbs in a corymbose fashion, e.g., Pyrus, Cauliflower. Marketed Cauliflower (Brassica oleracea var. botrytis) represents an undeveloped inflorescence.
- **Umbel of Umbels (= Compound Umbel) :** Many umbels develop from a common point in an umbellate fashion. It is characteristic of family umbelliferae. Involucre (below mother umbel) and involucels (below each umbellule) may be present, e.g., Coriander, Fennel, Carrot, Cumin.
- **Spike of Spikes :** e.g., Amaranthus spinosus.
- **Spike of Spikelets :** e.g., Wheat
- **Spadix of Spadices (Compound Spadix) :** e.g., Date Palm, Coconut
- **Capitulum of Capitula :** e.g., Echinops.
- **Panicle of Spikelets :** e.g., Jowar, Rice, Oat.

8.2. Cymose Inflorescence

A more or less flat topped, broad inflorescence of determinate growth or definite growth. Where central flower opens first (i.e., central flower is most mature). Here the main axis terminates in a flower.

(a) Uniparous or Monochasial Cyme : The flowering axis is sympodial. As the growing point ends in a flower, further growth is continued by a lateral branch which also ends in a flower. The process is repeated.

(i) Helicoid Uniparous : The flowers are borne on one side e.g., Begonia, Drosera (sundew). It can be drepanium (flower in one plane) or bostryx (flower in different planes).

(ii) Scorpioid Uniparous : The flowers are borne on both sides alternately, e.g., Tecoma, Freesia, Heliotropium, Rhipidium is scorpioid cyme having all the flowers in one plane (e.g., Solanum nigrum) while in cincinnus the flowers are borne in different planes. Solitary axillary flower of China Rose is also considered to be single flowered uniparous cyme.

(b) Biparous or Dichasial Cyme : Growth of the flowering axis is continued by two branches when the growing point of the parent axis is changed into a flower, e.g. Dianthus (Pink), Silene, Nyctanthes, Jasminum, Clerodendron, Bougainvillea, Teak. Arrangement of flowers is either basipetal (if axis elongated) or centrifugal (if axis short).

(c) Multiparous or Polychasial Cyme : More than branches continue growth of the flowering axis when the parent axis is changed into a flower, e.g., Calotropis, Hamelia, Asclepias, Arrangement of flowers is generally centrifugal.

(d) Cymose Head : A number of centrifugally arranged flowers are borne around a receptacle, e.g., Anthocephalus cadamba (Kadam). Acacia, Mimosa and Albizzia also possess such an inflorescence but it is now considered to be capitate or spikate head due to centripetal arrangement of flowers.

(e) Scapigerous Cyme Umbel : In Onion, a scape bears and umbellate cyme covered by one or more spathes.

8.3. Mixed Inflorescence

(a) Thyrsus (Thyrse) : Cymose clusters arranged acropetally, e.g., Vitis vinifera (Grape Vine).

(b) Mixed Spadix (Spadix of Cymes) : Spadices having cymose inflorescence arranged acropetally on fleshy axis, e.g.,Banana.

(c) Panicle of Spikelets : Spikelets arranged in a compound raceme, e.g., Oat, Rice.

(d) Corymb of Capitula : e.g., Ageratum.

(c) Other Types : Like umbel of capitula, cyme of capitula (e.g., Vernonia), cyme of umbels (e.g., Lantana), cyme of corymbs, etc.

8.4. Special Inflorescence

(a) Hypanthodium : It has a flask-shaped fleshy receptacle, a pore or ostiole lined by scales and a short canal bearing hair. Internally the receptacle bears male flowers ostiole, female flowers towards base and sterile female flowers between the two, e.g., Ficus (Peepal, Banyan, Fig).

(b) Coenanthium : It has a saucer-shaped receptacle with upturned margin and bearing florets like hypanthodium, e.g., Dorstena.

(c) Verticillaster : It is characteristic inflorescence of Ocimum (Tulsi) of family Lamiaceae or Labiatae. Here flowers are arranged in two opposite cymose groups on each node.

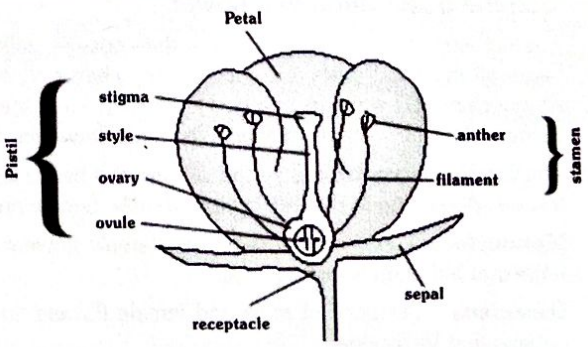
(d) Cyathium : It is characteristic inflorescence of Euphorbia, in which single female flower is present in the centre and number of male flowers around it, inside a cup-shaped involucre (whorl of bracts).

9. Flower

Flowers are attractive, colourful and often fragrant structures of flowering plants. They are the primary reproductive organs of the plants.

9.1. Parts of Flower

The flower structure is broadly divided into the following parts which are often arranged in a whorled pattern



(1) Pedicel

This is the stalk of the flower. Plants that have a stalk are known as pedicellate flowers whereas those that do not have a stalk are known as sessile flowers.

(2) Receptacle

This is the base of the flower and lies above the pedicel. It is actually a modified shoot that forms the floral axis and holds the layers of the flower.

(3) Calyx

This layer actually forms the first layer in the flower structure. They are said to be modified leaves. 'Calyx' is the word given for a collection of sepals. The sepals or calyx are often green in colour. Their main function is to protect the flower while it is still in the bud stage.

(4) Corolla

This forms the second whorl of the flower structure. 'Corolla' is the term given for a collection of petals. The petals are the colourful parts of the flower to which the pollinators are attracted to. In many flowers, the Corolla is scented to further make the flower attractive. Like the sepals, the petals are also said to be modified leaves. The petals are normally arranged in radial symmetry which means the flower can be divided into three equal parts. This type of symmetry is known as actinomorphic symmetry. In other flowers, the petals are arranged bilaterally symmetrical or an irregular pattern and this kind of an arrangement are called zygomorphic symmetry. The androecium and gynoecium often follow the symmetry seen in the calyx and corolla. The calyx and corolla are collectively called the perianth.

(5) Androecium

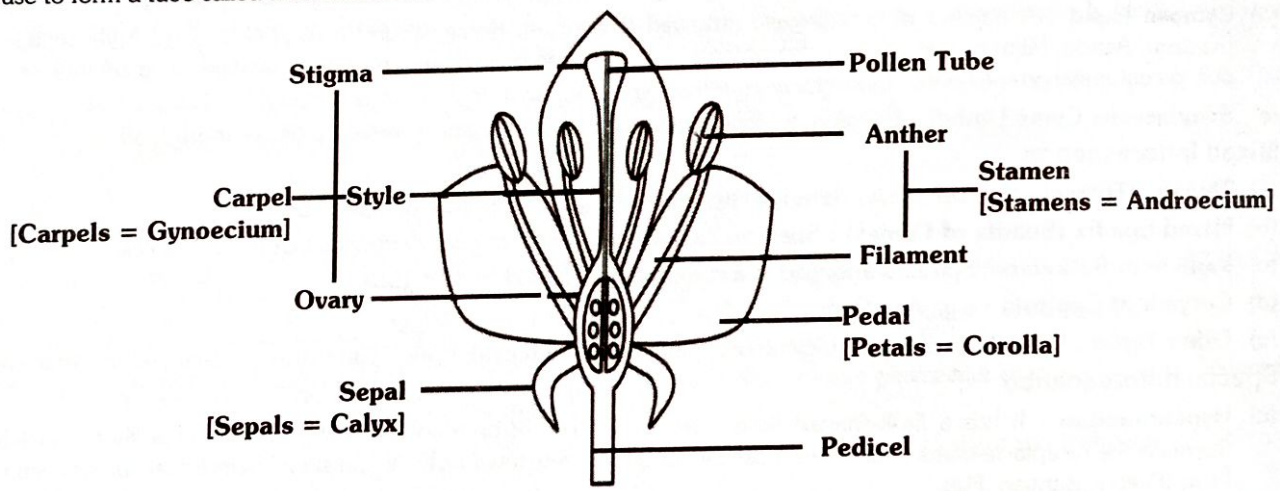
The androecium is a term given to the male reproductive system in a flowering plant. It forms the third whorl in a flower. It is made up of one or more stamens. Each stamen is made up of the following parts:

(6) Filament

It is a long slender tube-like structure that holds the anther at the top of it.

(7) Anther

It is the pollen producing part of the plant. It is made up of four chambers or segments known as pollen sacs. The anthers give rise to microspores during their development and each of these microspores forms a pollen grain that carries the male gamete. The nucleus in the pollen grain divided mitotically to form two male nuclei. The pollen grain has double layered protective coverings. The inner layer is called the intine whereas the outer layer is called the exine. The pollen grains are released by the anthers and they get pollinated to the same flower(self- pollination) or to a different flower(cross-pollination). The petals, sepals and the stamens often show fusion to form tubes: Petals fuse to form a tube and this condition is called gamopetalous. Stamens fuse to form a tube called the staminal tube.



(8) Gynoecium

It forms the fourth whorl of the flower and is often found towards the centre of the flower. This is the female reproductive part of a flower. The gynoecium is a term given to a collection of pistils or carpels. It is made up of the following structures:

Stigma: It is the sticky end of the style which is responsible for catching pollen when they are pollinated.

Style: It is a thin tube-like structure that holds the stigma and is attached to the ovary at its base.

Ovary: It is the swollen basal portion of the flower which houses the ovules which contain the female gamete.

9.2. General description of a flower

The flowers are termed pedicellate if they possess stalks and sessile if they lack them. The flower may be described as complete if it bears all the floral parts and incomplete, when one or more floral parts are absent. Flowers are called bisexual if they bear both androecium and gynoecium e.g., Hibiscus. The unisexual flowers have either androecium or gynoecium. The unisexual flowers may be male flowers or female flowers. The male flower are also called staminate flowers as they have stamens only.

The female flowers have only the carpels and hence called pistillate flowers. Flowers with sterile sex organs are described as neutral flowers. According to the distribution of male, female and bisexual flowers, various patterns are recognized.

Monoecious : Presence of male and female flowers on the same plant, e.g., Acalypha, Cocos and Ricinus. In maize flower are unisexual but plant is monoecious.

Dioecious : Presence of male and female flowers on different plants, namely, male plants and female plants. e.g., Cycas, Carica papaya and Vallisneria.

Polygamous : Presence of unisexual and bisexual flowers on the same plant, e.g., Mangifera and Polygonum.

9.3. Symmetry of flower

The number, shape, size and arrangement of floral organs in a flower determines its symmetry. On the basis of symmetry flowers can be of the following types :

- **Actinomorphic (Regular = Symmetrical) :** Actinomorphic flowers can be divided (passing through center) by any vertical plane into two equal and similar halves. e.g., Mustard, Brinjal, Catharanthus roseus.
- **Zygomorphic (Monosymmetrical) :** Zygomorphic flowers can be divided into two equal halves by only one vertical division e.g., Pea, Larkspur, Ocimum.
- **Asymmetrical (Irregular) :** Asymmetrical flowers can not be divided into two equal halves by any vertical division. e.g., Canna, Orchids.

9.4. Arrangement of floral organs

On the basis of arrangement of floral organs, three types offlowers are recognized. They are :

- **Acyclic :** Here the thalamus is conical or convex and the floral parts are spirally arranged, e.g., Water lily and Magnolia.
- **Cyclic :** Here the floral organs are arranged in regular whorls at the nodes of the thalamus, e.g., Hibiscus and Datura.
- **Hemicyclic (Spirocyclic) :** Here some floral parts (sepals and petals) are arranged in regular whorls and the remaining parts (stamens and carpels) are arranged spirally. e.g., Annona and Polyalthia.

9.5. Relative position of floral organs on thalamus

Depending upon the form of thalamus and the position of floralnwhorls with respect to the ovary, the flowers are of the following three types :

- **Hypogyny :** In this case the thalamus is convex and ovary occupies the highest position on it. The outer three whorls, viz. sepals, petals and stamens inserted one above the other but below the ovary. Since the ovary lies above the other parts, it is described as superior and the rest of the floral whorls as inferior. A flower having hypogyny is called hypogynous. e.g., China rose, Brinjal, Mustard, etc.
- **Perigyny :** In some cases, the receptacle or the thalamus forms a swallow or deep cup-shaped structure around the ovary. The pistil is attached at the centre of the concave thalamus.The sepals, petals and stamens are attached at the margins of the thalamus, the flowers are said to be perigynous and ovary is half inferior or half superior. Different type of flowers show different degrees of perigyny. e.g., Rose, Pea, Bean, Prunus, etc.
- **Epigyny :** In this condition the margin of thalamus grows further upward completely enclosing the ovary and getting fused with it and bear the sepals, petals and stamens above the ovary. The ovary in such cases is said to be inferior and the rest of the floral members superior. e.g., Apple, Sunflower, Cucumber, Guava, etc.

9.6. Perianth

The non essential organs, calyx and corolla are together called perianth. The perianth protects the stamens and carpels. In angiospermic flowers, the perianth exists in different forms.

- **Achlamydeous :** Perianth is absent and the flowers appear naked. Mostly the achlamydeous flowers occur in cyathium inflorescence. e.g., Euphorbia, Poinsettia.
- **Chlamydeous :** Perianth is present and the flowers usually appear attractive. The chlamydeous flowers are of two types. They are :
  - **(a) Monochlamydeous** flowers are with perianth in one whorl, e.g., Amaranthus and Ricinus.
  - **(b) Dichlamydeous** flowers are with perianth differentiated into calyx and corolla. They are arranged in two different whorls. The dichlamydeous condition is of two types :
    - **(i) Homochlamydeous :** The two whorl or the perianth (calyx and corolla) are similar in all respects and are not identified by different colours, e.g., Michelia.
    - **(ii) Heterochlamydeous :** The two whorls of the perianth are dissimilar in many respects. The outer whorl consists of small, green sepals and the inner whorl with large variously coloured petals, e.g., Datura and Hibiscus. The term "tepals" is used to describe the perianth units when both sepals and petals are similar. e.g., most of the monocots.

9.7. Calyx

It is the outermost whorl of the flower. It consists of sepals. Usually, the sepals are small and green. They protect other floral organs when the flower is in bud condition. The calyx is described as polysepalous when the sepals are free (e.g., Annona, Tomato) and gamosepalous when the sepals are united (e.g., Datura and Hibiscus). If sepals are fused less than half of the length of calyx tube it is called as partite and if the fusion of sepals is very little, just at the base of calyx tube, it is said to be connate. The sepals may be deciduous or persistent.

The calyx may show number of modifications. They are :

(1) Campanulate : Bell shaped, e.g., Althaea.

(2) Cupulate : Cup like, e.g., Gossypium.

(3) Urceolate : Urn shaped, e.g., Hyoscyamus.

(4) Infundibuliform : Funnel shaped, e.g., Atropa belladona.

(5) **Tubular :** Calyx tube like, e.g., Datura.

(6) **Bilabiate :** Calyx forms two lips, e.g., Ocimum.

(7) **Spurred :** One or two sepals forming a beak like structure, e.g., Larkspur.

(8) **Pappus :** Calyx are modified into hairs e.g., Sonchus, Tridax (Asteraceae/Compositae).

(9) **Spinous :** When calyx forms spines, e.g., Trapa.

(10) **Hooded :** When sepals enlarged to form a hood over the flower, e.g., Aconitum.

(11) **Petaloid :** Enlarged and brightly coloured sepals, e.g., Clerodendron, Mussaenda, Sterculia, Caesalpinia and Saraca.

9.8. Corolla

It is the second whorl of the flower consisting of petals. Usually the petals are brightly coloured and scented. They attract the insects which act as agents for pollination. The corolla may be polypetalous (with free petals), gamopetalous (with united petals) or apetalous (without petals). The corolla may undergo modifications or possess some special appendages.

9.9. Astivation

The arrangement of sepals and petals in bud condition of the flower is called "aestivation". It may be of following types

- **Open :** If the margins of perianth members in a whorl are free with wide gap between them, then the type of aestivation is called 'open', e.g., sepals of Mustard.
- **Valvate :** Here the edges of perianth members in a whorl are very nearly touching each other but do not overlap, e.g., calyx and corolla in Annona.
- **Twisted :** In this type, the perianth members of a whorl show one edge outside and one edge inside. Thus they regularly overlap the neighbouring members on one side. The twisted aestivation is also called contorted or convolute aestivation, e.g., corolla of Hibiscus.
- **Imbricate** : Here in a whorl of perianth members, one is completely inside and another is completely outside. The remaining perianth members show one edge inside and the other edge outside. The imbricate aestivation is of two types, namely, descending imbricate and ascending imbricate.
- **Descending imbricate :** Here the odd petal is posterior and completely outside. The anterior pair of petals are completely inside. The remaining petals show regular overlapping in the descending manner. e.g., Tephrosia, Crotalaria and Dolichos.
- **Ascending imbricate :** Characteristic of corolla of family Caesalpiniaceae. Here the odd petal is posterior and completely inside. One of the anterior petals is completely outside. The remaining petals show regular overlapping in ascending manner, e.g., Cassia and Delonix.
- **Quincuncial :** In this type, out of the five perianth members in a whorl two are completely outside, two are completely inside and the remaining has one edge outside and one-edge inside. This is confined to pentamerous flowers only, e.g., sepals of Ipomoea, Vinca and Thevetia.
- **Vexillary :** Same as papilionaceous corolla.

9.10. Androecium or Stamens

The androecium is the third set of floral organs composed of stamens or micro- sporophylls. Ordinarily, each stamen is composed of a slender stalk-like filament supporting a knob-like spore case or the anther.

Each anther consists of two lobes (anther lobes) connected by a connective which can be clearly seen on the dorsal side as an extension of the filament. Each anther lobe, again, has two pollen sacs or pollen chambers placed longitudinally. There are longitudinal grooves or sutures along the ventral face of the anther demarcating the pollen chambers. Each pollen chamber represents a microsporangia and contains innumerable microspores or pollens. The stamen, therefore, is a microsporophyll bearing four microsporangia. While this is the normal case, there are some flowers where the anther possesses only two pollen chambers (i.e., bisporangiate) and in Malvaceae even these two pollen chambers fuse developing a mature unilocular anther. A flower may sometimes be reduced to a single stamen as seen in the cyathium inflorescence .

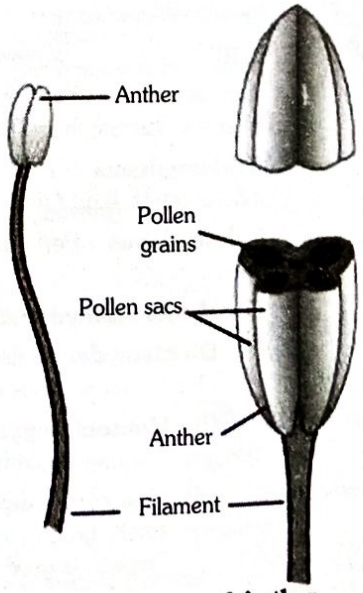


Fig. Structure of Anther

9.11. Gynoecium or Carpels

The gynoecium or pistil is the fourth essential whorl of female reproductive part of the flower and may be made up of one or more carpels (megasporophylls). A carpel has three distinct part, namely ovary, style and stigma. The lower most swollen fertile part of the carpel is the ovary. It encloses ovules. A sterile pistil is known pistillode. The number of carpels in a gynoecium varies in different flowers.

- **Monocarpellary :** It is a gynoecium with a single carpel, e.g., Bean.
- **Bicarpellary :** It is presence of two carpels in a gynoecium.e.g., Helianthus.
- **Tricarpellary :** It is presence of three carpels in a gynoeciume.g., Cocos.
- **Tetracarpellary :** It is presence of four carpels in a gynoecium. e.g., Cotton.
- **Pentacarpellary :** It is presence of five carpels in a gynoecium. e.g., Hibiscus.
- **Multicarpellary :** It is presence of many carpels in a gynoecium. e.g., Annona.

9.12. Placentation

The ovary contains one or more ovules, which later become seeds. The ovule bearing regions of the carpel is called placenta. The arrangement of placentae and ovules within the ovary is called placentation. The placenta is the cushion-like structure to which the ovules are attached inside the cavity of the placenta, placentation is of the following types

- **Marginal :** In this type of placentation, the ovary is simple, unilocular and the ovules are arranged along the margin of the unilocular ovary. The placenta develops along the ventral suture of the ovary. e.g., Pea, Gram, Gulmohur, etc
- **Axile :** It is found in a compound ovary which is two or more chambered, usually as many as the number of carpels e.g., Petunia and Asphodelus. The placentae bearing the ovules develop from the central column or axis which is formed by the fusion of margins of carpels. In certain cases the number of chambers (loculi) increases due to the false septum formation. e.g.,Dhatura, Tomato, etc.
- **Free central :** In this free central placentation, the gynoecium is polycarpellary and syncarpous. The ovary in early stages is multilocular, but soon the septa break down leaving it as a unilocular structure. e.g., Dianthus, Slience, Primula, etc.
- **Parietal :** In parietal placentation, the ovary is usually one-chambered but in some cases it becomes bilocular due to the formation of false septum called replum, e.g., Brassica compestris (Sarson). The placentae bearing the ovules develop on the inner wall of the ovary at places where the margins of two adjoining carpels meet. The number of placentae corresponds to the number of fused carpels. e.g., Poppy, Mustard, Cactus, etc. (v) Basal : In this type of placentation, ovary is bicarpellary, syncarpous and unilocular and a single ovule is borne at the base of ovary. e.g., Marigold, Sunflower, etc.
- **Superficial :** The ovary is multicarpellary, syncarpous, and large number of loculi without specific order e.g., Waterlily (Nymphea).

9.13. Style

The stalk like structure present above the ovary is called the style. The style may be long (Datura) or short (grasses) or absent (Papaver). In the family umbelliferae (apiaceae) the base of the style is swollen and forms a structure called stylopodium.

There are three types of styles as described below :

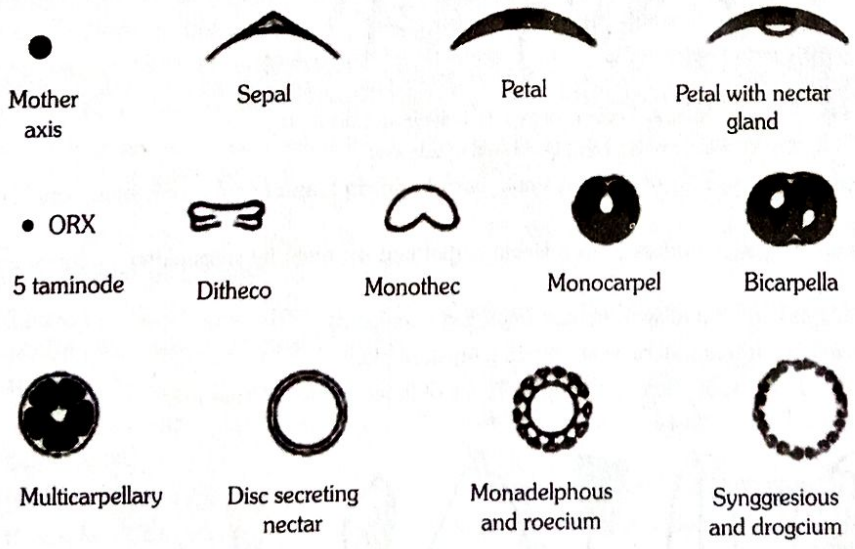
- **Terminal style :** If the style arises from terminal part of the ovary, it is called terminal style, e.g., Datura, Hibiscus and Solanum.
- **Lateral style :** If the style arises from one side of the ovary, it is called lateral style, e.g., Mango.
- **Gynobasic style :** If the style arises from the base of the ovary it is called gynobasic style. It is characteristic feature of family Labiatae., e.g., Ocimum, Salvia.

9.14. Stigma

The terminal receptive portion of the style is called the stigma. It receives pollen grains during pollination.

Usually the lobes of the stigma corresponds to the number of carpels. Accordingly the stigma may be unifid, bifid, trifid, tetrafid, pentafid or multifid. Capitate : Round stigma. e.g., Hibiscus. Forked : Divided stigma. e.g., Tridax. Feathery : Brush like stigma. e.g., Grasses.

Floral diagram : Floral formula : It represents the informations given in a floral diagram in the form of an equation. Following symbols are used in constructing a floral formula.



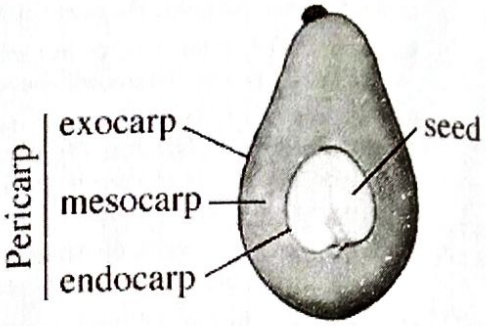
Bracteate	=	Br
Ebracteate	=	Ebr
Bracteolate	=	Brl
Actinomorphic	=	⊕
Zygomorphic	=	↻
Male	=	♂
Female	=	♀
Hermaphrodite	=	♂♀
Calyx	=	K

10. Fruit

Fruits are a characteristic of flowering plants. Once pollination and fertilization occur, the ovary of the plant becomes the fruit and the ovules become the seeds. They can be fleshy or dry. The main purpose of fruits is that they protect the seeds during development. Since they are often colourful and emanate a delectable odour, they help in attracting birds and other animals to eat seeds. This way the seeds get dispersed to other areas for generating new plants.

The fate of various parts of the ovary during the formation of fruits is summarized below :

(1) **Ovary** – Fruits
(2) **Ovary wall** – Pericarp
(3) **Ovule** – Seed
(4) **Funiculus** – Stalk of the seed
(5) **Hilum** – Hilum
(6) **Nucellus** – Perisperm (when present)
(7) **Micropyle** – Micropyle
(8) **Outer integument** – Testa (Seed coat)
(9) **Inner integument** – Tegmen (Seed coat)
(10) **Embryo sac**
(11) **Synergids** – Degenerate
(12) **Antipodals** – Degenerate
(13) **Egg cell** – Embryo
(14) **Secondary nucleus** – Endosperm



10.1. Structure of a fruit

The fruit primarily contains two parts: the pericarp and the seed. The pericarp layer is actually the outer wall of the ovary from which the fruit developed. The pericarp has three layers :

- **Exocarp or Epicarp:** This is the outermost layer of the pericarp that forms the skin.
- **Mesocarp:** It is the thick, fleshy and juicy middle layer of the pericarp.
- **Endocarp:** It is the innermost layer of the fruit which often develops into the pith.

10.2. Simple Fruit

These fruits develop from a single ovary of one or more carpels. These fruits are further divided into Dry fruits and Fleshy fruits depending upon pericarp.

(1) Dry Fruits

In these fruits, the pericarp is not succulent and the pericarp becomes dry one the fruits mature. Dry fruits are of two types: Dehiscent and Indehiscent.

(a) Dehiscent fruits: These fruits dehisce or split open when they mature. Types of dehiscent dry fruits are:

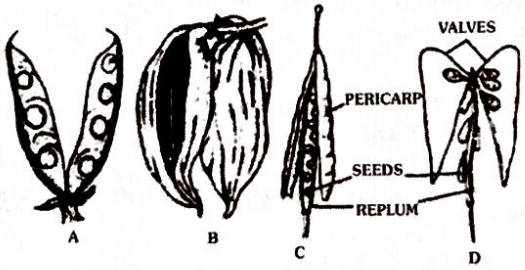
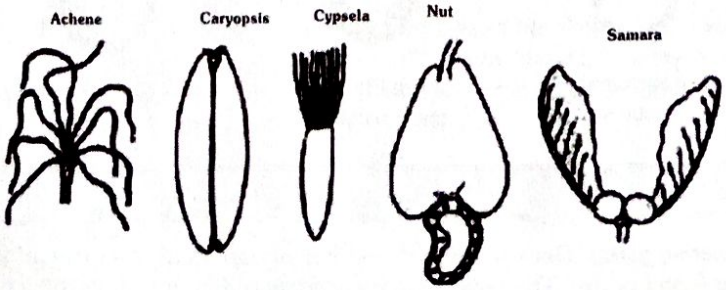


Fig. Dehiscent fruits, A. Legume of Pea, B. Follicles of Calatropis, C. Siliqua of Brassica, D. Silicula of Capsella

- **Follicle-** is a dry dehiscent fruit which arises from a single carpel and on maturity splits only along one suture. E.g. Larkspur
- **Legume-** is a dry dehiscent fruit which arises from a single carpel and on maturity splits along its dorsal and ventral sutures. E.g. Pea
- **Capsule-** made up of multiple carpals and splits in four ways. E.g Eucalyptus
- **Silique-** is made up of two carpels that split on maturity. E. g Mustard plant

(b) Indehiscent fruits: These fruits do not split open on maturity. Types of indehiscent dry fruits are:

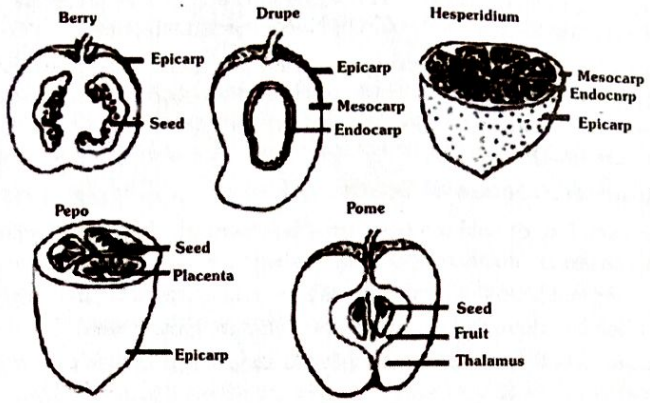


- **Akene-** where the only seed is attached to the fruit at one point only. E.g. sunflower
- **Caryopsis-** where the only seed is attached to the fruit at allpossible points. E.g. Maize

- **Samara-** is a one or two seeded which has seeds with winglikestructures. E.g.Maple
- **Schizocarp-** is made up of multiple carpels which separate onmaturity to form multiple indehiscent fruits. E.g. Dill
- **Nut**- has thick pericarps and is a one-seeded fruit formed froma compound ovary. It is hard in texture. E.g Chestnuts

10.3. Fleshy Fruits

In these fruits, the fruit wall or pericarp is thick and fleshy. They are of the following types:



(1) **Berry** is made up of one or more carpels and contains one or more seeds. The pericarp is soft, fleshy and juicy. E.g Banana, grapes

(2) **Drupe** is derived from a single carpel and containing one seed. Exocarp is present as a thin skin, the mesocarp is fleshy and the endocarp becomes stony hard. E.g Mango.

(3) **Pome** (accessory fruit) is an accessory fleshy fruit formed by a group of carpels that are firmly united with each other and surrounded by and united to the receptacle. E.g Apple.

(4) **Hesperidium** It is another type of berry; it develops from a polycarpellary, syncarpous, superior ovary with many seeds. Here the outer skin is thick and leathery that represents the epicarp, which contains oil glands. The fibrous portion fused with epicarp is the mesocarp. The endocarp consists of many chambers with juicy glands. Common examples are Citrus medica (Lemon) and Citrus sinensis (Sweet orange).

(5) **Balausta** This is many chambered, many seeded fruit developing from a multicarpellary, syncarpous but inferior ovary. The pericarp of balausta is leathery or tough. The carpels are arranged in two rows. Calyx is persistent. The seeds have succulent seed coat (testa) which form the edible part; e.g., Punica granatum (Pomegranate).

10.4. Aggregate Fruit

These fruits develop from multiple ovaries but of the same flower. So, an aggregate fruit consists of a collection of simple fruits called as *fruitlets*. E.g Blackberries, strawberries.

Composite or compound fruits : Multiple fruit develops from entire inflorescence called sorosis or syconus.

Sorosis : Develops from spike or spadix inflorescence e.g., Pineapple,Jackfruit, Mulberry, etc.

Syconus : Develops from hypanthodium inflorescence e.g.,Ficus carica. (banyan).

11. Seed

A seed develops from an ovule after fertilization. It consists of a tough coat or testa enclosing an embryo which is made up of a plumule, a radicle and one or two cotyledons. In favourable conditions the seed can grow and become a fully independent plant, bearing flowers and seeds during its life cycle. In the embryo of the seed are all the potentialities of development and growth to a mature plant resembling other members of its species in almost every detail of leaf shape, cell distribution and flower colour and structure.

11.1. Main Features of a Seed

- **Testa -** A tough, hard, outer coat, the testa protects the seed from fungi, bacteria and insects. It has to be split open by the radicle before germination can proceed.
- **Hilum -** The hilum is a scar left by the stalk which attached the ovule to the ovary wall.
- **Micropyle -** The micropyle is a tiny pore in the testa opposite the tip of the radicle. It admits water to the embryo before active germination.
- **Radicle -** The radicle is the embryonic root which grows and develops into the root system of the plant.
- **Plumule -** The plumule is the embryonic shoot. In it two or more leaves are usually visible, with a growing point enclosed between them.
- **Cotyledons -** The grasses and narrow-leaved plants like the iris and bluebell have seeds with only one cotyledon. The other flowering plants all have two cotyledons. They are leaves attached to the plumule and radicle by short stalks, and they often contain food reserves which are used during the early stages of germination. In most plants the cotyledons are brought out of the testa and above the ground where they become green and make food by photosynthesis. The cotyledons eventually fall off, usually after the first foliage leaves have been formed. The cotyledon leaves bear no resemblance to the foliage leaf, the shape of which is first apparent when the plumule leaves open and grow

11.2. Types of seed germination

- **Epigeal germination :** In this type of germination, the cotyledons come above the surface of the soil into the air and light due to the rapid growth and elongation of the hypocotyl. The cotyledons turn green and finally dry up and fall off and seedling becomes an independent plant. Germination of seeds of Bean, Gourd, Castor, Cotton, etc. is of epigeal nature.
- **Hypogeal germination :** In this type of germination, the cotyledons remain in the soil or just above the surface. In this case epicotyl elongates pushing the plumule upwards. The cotyledons do not turn green and gradually dry up and fall off. Common examples of hypogeal germination are the seeds of Pea, Mango,Groundnut, etc.
- **Viviparous germination :** This is a special type of germination found in mangrove plants. The embryo grows not only out of the seed but also out of the fruit and projects from it in the form of a green seedling displaying root and hypocotyl. Due to its increasing weight the seedlings separate from the parent tree and falls into the mud or water and soon develops lateral roots. Vivipary is seen in Rhizophora and Sonneratia.

11.3. Factors Affecting Germination Process of Seeds:

- **Temperature :** Extremely low or cold temperature is not favorable for seed germination. They prefer higher temperatures. The germination rate of seed is directly proportional to the rise in temperature.
- **Moisture or water :** Dry seeds do not germinate. Water is an essential factor to trigger off the process of seed germination.
- **Soil :** During growth, seeds require mineral elements for further growth which is obtained from the soil.
- **Light :** For seed germination light is not essential in the early stages of germination but plays a main role in the later stages of the life cycle of plants.
- **Viability of the seeds :** After the seeds are formed, they remain viable up to certain period which may vary from plant to plant or seed to seed. Many sees die or incapable of supporting growth after a certain period of time.Longest seed viability is reported in Nelumbo nucifera (= Nelumbium speciosum) or Indian lotus (Kamal). Here the viability is reported to be more than two hundred years.
- **Dormancy period :** Many seeds do not germinate abruptly after they are produced. Certain seeds undergoes a resting time through which they stay dormant and germinate when conditions are favourable. Presence of growth inhibitors like abscisic acid induce dormancy in seeds.
- **Thinness or thickness of seed coat :** Different seeds have varying degrees of thickness to enable the seeds to remain feasible. Seeds with a thin seed coat tend to germinate faster than those with thicker seed coats.

11.4. Changes during Germination Process

Seeds germination is seen when the seed starts growing its shoots and roots. The seed encloses a baby plant with its cotyledons. The cotyledons store food for the baby plant inside the seed and provide nutrients till the seed coat ruptures and the plant is capable enough of drawing nutrients from the soil and the surroundings. The first thing to come out is the main root. The skin or seed coat starts to split and the tiny shoot straightens, carrying the cotyledons with it. This is called radicle or the main root which grows bigger. Root hairs appear as the growth takes place.

Gradually, first leaves called plumule starts growing which forms the shoot in initial stages. To grow, the seed's growing conditions usually have to be damp, warm, and dark, with moderate soil. A dry seed will stay dormant unless the conditions are favorable. Later, seeds germinate supporting a new life.

11.5. Causes of seed dormancy

- The seed dormancy may be due to many causes some of which are as follows :
- Impermeability of seed coats to oxygen. (e.g., Xanthium) and water. (e.g., Chenopodium and many leguminous seeds).
- Seed coat is mechanically hard, thus resisting the growth of embryo. e.g., Mustard, Capsella, Amaranthus.
- Presence of rudimentary or immature embryo. e.g., Ginkgo biloba (a gymnosperm).
- Some plants produce such chemical compounds that inhibit the germination of their own seeds. e.g., Tomato, (possesses inhibitor ferulic acid).

11.6. Dispersal of Fruits and Seeds

(1) Dispersal by wind (Anemochory) : The wind is probably the most important agency of seed dispersal in nature. The fruits and seeds show following devices which help in dispersal by wind.

- **Light weight and minute seeds :** Seeds of some plants (e.g., (ids) are sufficiently light and minute in size to be easily carried away to great distances by air currents.
- **Winged seeds and fruits :** Some seeds (e.g., Oroxylon, Cinchona, Moringa) or fruits (Acer, Hiptage, Terminalia, Dipterocarpus) develop one or more thin membranous wings to ensure their dispersal by wind.
- **Parachute mechanism :** In members of the family Asteraceae (Compositae) e.g., Taraxacum, Sonchus, sepals are modified into tufts of hairs called pappus. The pappus is persistent and hence found attached to even small, single seeded fruits. It acts like a parachute that allows the wind to carry them to great distances. Seeds of many nasty weeds are also dispersed by this method.
- **Coma :** One or more tufts of hairs are attached on seeds constitute coma, e.g., Calotropis, Cotton etc.
- **Censer mechanism :** In Antirrhinum (dog flower), Aristolochia, Papaver (poppy), Argemone mexicana (Prickly poppy), Nigella (love-in-a-mist), etc. the fruit is a capsule. At maturity it ruptures but the seeds do not come out. However, when the capsule is shaken violently by the wind, the seeds are scattered in all directions. In this process all the seeds do not escape together.

- **Rolling mechanism :** In some species, like Amaranthus albus, Chenopodium album, etc., plants dry out after bearing fruits and seeds. Eventually the entire plant breaks off at the base of the stem due to the force of wind and rolls over the ground, shedding the seeds all along the way. Such rolling plants are collectively known as tumble weeds.
- **Hairs :** In cotton, hairs are the outgrowth from the seed coat and occur all along its surface. Persistent styles : Clematis, Naravelia, Geranium etc. have persistent and feathery styles which help the fruit to be easily carried by wind.
- **Balloon like appendages :** In plants like Cardiospermum and Nicandra fruits develop balloon like appendages which make the fruits light to be easily carried by wind.

(2) Dispersal by water (Hydrochory) : Fruits and seeds, specialized for dispersal by water, generally develop some kind of floating devices and a protective covering which makes them water resistant. e.g., fibrous mesocarp in Coconut, spongy thalamus in Lotus. The seeds of Polygonum can beheld over the surface of water and dispersed.

(3) Dispersal by animals (Zoochory) : Fruit and seeds dispersed by animals can be divided into following three categories on the basis of their adaptive features.

- **Hooked fruits and seeds :** The surface of many fruits is covered with hooks (e.g., Xanthium, Urena), barbs (e.g., Andropogon), spines (e.g., Tribulus), bristles (e.g., Pupalia), or stiff hairs (e.g., Aristida), by means of which they adhere to the body of animals or clothes of human beings and they are carried unwarily from one place to another.
- **Sticky fruits and seeds :** Some fruits like those of Boerhaavia, Cleome, and Plumbago have sticky glands by which they adhere to the fur of grazing animals and are thus dispersed. Seeds of Viscum (mistletoe), Loranthus, etc. have a viscid layer which adhere to the beak of the bird which eat them. Sticky seeds of Rafflesia are dispersed by elephants.
- **Edible fruits :** (i) The seeds are very small and capable of passing unharmed through digestive tract of animals (e.g., Mulberry, Peepal, Guava, Banyan, Tomato). (ii) The seeds are large so that they are thrown away, e.g., Apricot, Mango. (iii) Sticky so that stick to the beaks of birds. The seeds are thrown away by rubbing of beaks, e.g., Viscum, Cordia, Loranthus.

(4) Dispersal by explosive or Spring like mechanism (Autochory) : A less common method of seed dispersal is by means of explosive fruits. Such fruits open with force and scatter the seeds in all directions. e.g., Balsam fruit (Impatiens), Oxalis, night jasmine (Nyctanthus), castor (Ricinus), camel's foot climber (Bauhinia vahlii), Pea etc. Another example of autochory is the seeds of Ecballium (squirting cucumber). In squiring cucumber the fleshy and spiny fruit wall encloses a mucilaginous mass having seeds. The tip of the stalk functions as a plug. Diturbance breaks the fruit from the stalk. The mucilage containing the seeds is thrown out with a great force.

12. Taxonomy of Angiospermic Plants

12.1. Family Leguminosae Or Fabaceae

Division	:	Angiospermae
Class	:	Dicotyledonae
Subclass	:	Polypetalae
Series	:	Calyciflorae
Order	:	Rosales
Family	:	Leguminosae

Habit : Annual or biennial, herb, shrub or tree.
Root : Tap root system.
Stem : Erect or creeping, solid or weak.
Leaf : Alternate or whorled, stipulate, petiolate, simple or usually compound, reticulate venation.
On the basis of inflorescence and flower characters, this family is divided in to 3 subfamilies :

12.2. Subfamily - Papilionatae (Papilionaceae)

(1) Inflorescence : Racemose or solitary axillary.

(2) Flower : Bracteate or ebracteate rarely bracteolate (*e.g.*, *Arachis*), pedicellate, complete, irregular, zygomorphic, hypogynous, pentamerous.

(3) Calyx : Sepals 5, gamosepalous, usually campanulate, lobes unequal, rarely tubular (*e.g.*, *Cyamopsis*), odd sepal anterior, may be persistent, inferior.

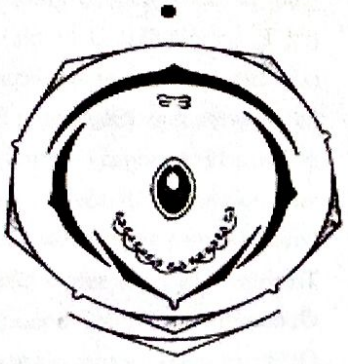
(4) Corolla : Petals 5, polypetalous, papilionaceous, descending imbricate aestivation, one posterior long standard, two lateral short wings, two anterior petals jointed to each other forming keel.

(5) Androecium : Stamens 10, usually diadelphous (9+1 in *Lathyrus*, 5+5 in *Aeschynomene*) or monadelphous (9 in *Dalbergia*, 10 in *Arachis* and *Erythrina indica*), rarely free (*e.g.*, *Sophora*), nectar gland often present on the inner bases of filaments, anther lobes bilocular, dorsifixed, introrse.

(6) Gynoecium : Monocarpellary, ovary superior, unilocular with marginal placentation ovary covered by staminal tube, style bent, stigma simple or capitate.

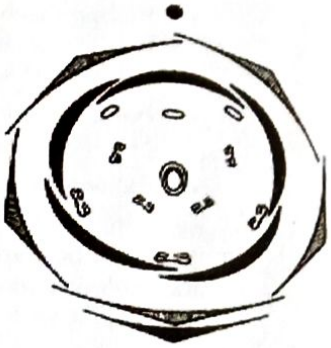
(7) Fruit : Legume or lomentum.

Floral formula : $Br\ \%\ \delta\ K_{(5)}C_{1+2+(2)}\ A_{1+(9)}\underline{G}_1$



Floral diagram of subfamily Papilionatae (sativum)

12.3. Subfamily – Caesalpinoideae (Caesalpiniaceae)



Floral diagram of subfamily Caesalpinoidae (Cassia fistula))

(1) **Inflorescence :** Raceme, umbel or a solitary flower.

(2) **Flower :** Bracteate or ebracteate, pedicellate, hermaphrodite, complete, zygomorphic, hypogynous.

(3) **Calyx :** Sepals 5, polysepalous, imbricate aestivation.

(4) **Corolla :** Petals 5, polypetalous, ascending imbricate aestivation.

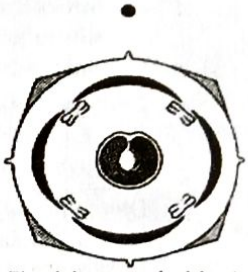
(5) **Androecium :** 10 stamens, or staminodes are found as in *Cassia*, free filaments of unequal size, anther lobes bilocular, introrse, versatile.

(6) **Gynoecium :** Monocarpellary, unilocular, ovary superior, marginal placentation, stigma capitate.

(7) **Fruit :** Legume.

(8) **Floral formula :** or $\oplus \sigma K_5C_5 A_{1+2+2+2+3}$(staminodes) or $^{7+3\ (staminodes)}\underline{G_1}$

12.4. Subfamily – Mimosoideae (Mimosaceae)



Floral diagram of subfamily Mimosoidae (Mimosa pudica)

(1) **Inflorescence :** Head or capitulum or spike, flowers arranged in acropetal succession.

(2) **Flower :** Bracteate or ebracteate, sessile, hermaphrodite, complete actinomorphic, hypogynous, pentamerous.

(3) **Calyx :** 5 sepals (4 in *Mimosa*) gamosepalous, connate at the base, valvate aestivation, rarely imbricate (*e.g.*, *Parkia*).

(4) **Corolla :** 5 petals (4 in *Mimosa*) gamopetalous or polypetalous, membranous, valvate aestivation.

(5) **Androecium :** In most of the members, stamens are indefinite and polyandrous. However, there are only 4 stamens in *Mimosa pudica*and 10 each in *Prosopis* and *Dichrostachys*. Filaments are long, usually connate at the base, sometimes they are coloured and gland dotted. Anthers are dithecous and introrse.

(6) **Gynoecium :** Monocarpellary, unilocular, ovary superior, style long, cylindrical, stigma single and capitate, marginal placentation.

(7) **Fruit :** Lomentum.

(8) **Floral formula :** Br or Ebr $\oplus \sigma K_{(4)}C_4 A_4G_1$

- **Economic importance of family Leguminosae**

12.5. Source of pulses (food)

Pulses we eat, are obtained from seeds of the members of this family, which are rich source of proteins.

(i) Pisum sativum (Garden pea or pea).

(ii) Cicer arietinum (Chick pea or Gram or Bengal gram).

(iii) Cajanus cajan (Pigeon pea or Red gram or Arhar).

(iv) Vigna radiata (Green gram or Moong).

(v) V. mungo (Black gram or Urd).

(vi) V. sinensis (Cow pea or Lobia).

(vii) Lens culinaris Syn. L. esculenta (Lentil or Masoor).

(viii) Phoseolus vulgaris (French bean) : Vegetable.

(ix) P. aconitifolius (Dal moth).

(x) Trigonella foenum-graecum (Fenugreek or Methi). Leaves are used as source of vegetable. Seeds are used as spice.

(xi) Glycine max (Soybean) : Seeds are very rich in proteins (42%). Soya milk is also prepared from it.

(xii) Arachis hypogea (Groundnut or Peanut or Moongphali).

(xiii) Dolichos lablab (Sem) : Vegetable.

(xiv) Lathyrus sativus (Grass pea or Khesari dal).

Timber : Dalbergia sissoo (Shisham or Indian red wood) and D. latifolia (Kali shisham or Indian rose wood or Indian black wood).

Ornamentals : Butea monosperma (Palas or Dhak) : Deep red flowers and thus it is also called 'flame of the forest'

Other miscellaneous plants

(i) Indigofera tinctoria (Indigo or Neel) : Indigo dye used in dyeing and printing cotton, is obtained from this plant.

(ii) Abrus precatorius (Ratti or Crab's eye) : Seed of this plant are used by jewellers for weighing purpose. Each seed is having constant weight of 1.75 grains. ↑ Leaf juice used for cure of leucoderma (skin disease).

(iii) Crotolaria juncea (Sun hemp) : Fibres from phloem and pericycle of stem (bast fibres) are obtained used for making ropes, mats etc. It is also important 'Green manure' crop.

12.6. Family – Solonaceae

Division : Angiospermae
Class : Dicotyledonae
Subclass : Gamopetalae
Series : Bicarpellatae
Order : Polimoniales
Family : Solanaceae

(1) Habit : Mostly herbs (Petunia, Solanum nigrum, Nicotiana, Withania), shrubs, a few trees (Solanum grandiflorum or potato tree) or climbers (Solanum jasminoides or potato vine, Solanum dulcamara).

(2) Root : Branched tap root system.

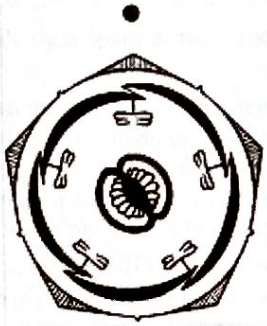
(3) Stem : Usually the stem is erect, solid, cylindrical and branched. Occasionally, it is spinous (Solanum xanthocarpum, Datura stramonium, Lycium). In potato (Solanum tuberosum) underground stem is modified into tubers.

(4) Leaves : Cauline, ramal, exstipulate petiolate or sessile, alternate, sometimes opposite, simple, entire, pinnatisect in tomato (Lycopersicum esculentum). Venation unicostate reticulate, variegated in Solanum jasminoides.

(5) Inflorescence : Axillary or extra axillary cyme. Solitary axillary in Physalis and Pentunia. Sub-sessile umbellate cyme in Withania somnifera, solitary in Datura.

(6) Flower : Bracteate or ebracteate, pedicillate, complete, actinomorphic, rarely zygomorphic (e.g., Salpiglosis, schizanthus), bisexual, rarely unisexual (e.g., Withania coagulans) pentamerous, hypogynous.

(7) Calyx : Sepals 5, gamosepalous, tubular or campanulate, persistent, accrecent (enlarging in fruit, e.g., Physalis, Withania), Valvate or imbricate, green or coloured, hairy.



Floral formula of Solanaceae (Solanum nignum)

(8) Corolla : Petals 5, gamopetalous, tubular or infundibuliform, valvate, twisted in Datura, bilabiate in Schizanthus, scale or hair like outgrowth may arise from the throat of the corolla tube, coloured.

(9) Androecium : Stamens 5, rarely 4 (e.g., Salpiglossis) or 2 (e.g., Schizanthus), epipetalous, polyandrous alternate to petals, filament inserted deep in the corolla tube, anthers dithecous, usually basifixed or dorsifixed, introrse.

(10) Gynoecium : Bicarpellary, syncarpous, ovary superior, carpels placed obliquely in diagonal plane, generally bilocular (2-4 locular in tomato, 4-locular in Datura due to false septa), placentation axile, ovules many in each locules, placentae swollen, a nectariferous disc or lobes may be present, stigma capitate or bifid.

(11) Fruit : A many seeded berry (e.g., Tomato) or capsule (e.g., Datura).

(12) Seed : Endospermic with straight or curved embryo.

(13) Floral formula : $\oplus \sigma K_{(5)} \overset{\frown}{C_{(5)}} A_5 G_{(2)}$

12.7. Economic importance of the family Solonaceae.

- **Medicinal plants**
  - (i) Datura stramonium (Datura or Jimsonweed) : Drug 'Stramonium' is obtained from dried leaves and flowering tops, which is used in treatment of asthama. Atropine, hyoscyamine and hyocine alkaloids are also obtained from this. Seeds of this plants are deadly poisonous.
  - (ii) Atropa belladona (Belladona or sag – Angoor) : Roots are source of an alkaloid – 'Atropine'
  - (iii) Withania somnifera (Asgandha) : Drug Asgandh is obtained from its roots, which is used in rheumatism, female troubles and cough.
  - (iv) Hyoscyamus niger (Henbane) : Drug Henbane is obtained from dried leaves and flowering tops, which is used for sedationand also in asthama and whooping cough.
- **Food plants**
  - (i) C. frutescents (Shimla Mirch)
  - (ii) Capsicum annum (Chillies or Red pepper)
  - (iii) Lycopersicon esculentum (Tomato or Love apple)
  - (iv) Solanum melongena (Egg plant or Brinjal)
  - (v) Solanum tuberosum (Potato or Alu)
- **Source of tobacco :** Nicotiana tabacum (tobacco) : It is source of alkaloid – 'Nicotin' and highest nicotine content is present in Nicotiana rustica.
- **Ornamentals**
  - (i) Petunia alba, P. hybrida : Flowers of different colours like white, pink etc.
  - (ii) Cestrum nocturnum (Night Jasmine or Rat Ki Rani).
  - (iii) C.diurnum (Day Jasmine or Din Ka Raja)
  - (iv) Brunfelsia hopeana (Yesterday, today, tomorrow plant).
  - (v) Schizanthus (Butterfly flower).
- **Others** Solanum nigrum (Night shade plant or Makoa).

13. Family – Liliaceae

Division	:	Angiospermae
Class	:	Monocotyledonae
Series	:	Coronarieae
Order	:	Liliales
Family	:	Liliaceae

Habit : Usually perennial herbs growing by means of rhizomes (*e.g.*, *Aloe, Polygonatum*), bulbs (*e.g.*, *Lilium, Allium*) and corms (*e.g.*, *Colchicum*). Some herbs are annual (*e.g.*, *Asphodelus*). Shrubs occur in *Aloe, Agave, Yucca* (Dagger plants, Adam's Needle), *Dracaena*(Dragon plant), and *Ruscus* (Butcher's Broom). They mostly grow in arid areas and are hence xerophytic (*e.g.*, *Aloe, Yucca*). *Xanthorrhoea* of Australia is tree-like. Climbers are seen in *Smilax, Gloriosa* and species of *Asparagus.*

Root : Adventitious, fibrous or tuberous (*e.g.*, *Asparagus*).

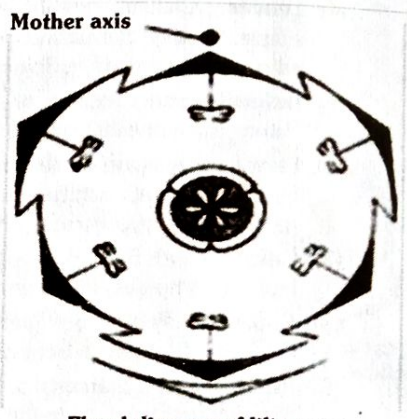
Stem : Erect or climbing as *Smilex*, branched or unbranched, herbaceous, phylloclade as *Ruscus*. Cladode as *Asparagus*, Bulb as *Allium cepa*.

Leaves : Radical or cauline and ramal show various types of phyllotaxy (alternate, opposite or whorled), exstipulate, stipulate in *Smilax* where the stipules are prolonged into tendrils, sessile or petiolate with sheathing leaf bases, venation parallel but reticulate in *Smilax*, leaves may be scaly, leathery, fleshy or modified into spines (*e.g.*, *Asparagus*), leaf apex is tendrillar in *Gloriosa*. The leaves of *Phormium tenax* (New Zealand Hemp) are 3 metres long and 10 *cm* broad.

Inflorescence : Recemose, sometimes solitary (*e.g.*, *Tulipa, Gloriosa*) or umbellate condensed cymes (umbel cyme), *e.g.*, Onion. In several cases the inflorescence possesses a leafless peduncle called scape.

Flower : Bracteate or ebracteate, pedicellate, regular, actinomorphic, zygomorphic in a few cases (*e.g.*, *Gilliesia*), complete or incomplete, perfect, unisexual in *Smilax* and *Ruscus*, hypogynous, generally pentacyclic, trimerous (rarely bimerous or tetramerous). Accessory floral organs undifferentiated and collectively called perianth.

Perianth : Tepals 6, in two whorls of 3 each, free or fused, sepaloid or petaloid, scarious or membranous, aestivation valvate or imbricate, distinguished into calyx and corolla in *Trillium*.



Floral diagram of lilia ceae (Allium cepa)

Androecium : Stamens 6 (3 in *Ruscus*, 912 in *Tofieldia*), free (polyandrous) or monadelphous (*e.g.*, *Ruscus*), arranged in two whorls, antiphyllous (antitepalous), may be epiphyllous (or epitepalous), anthers fixed variously (basifixed, dorsifixed, versatile), dehiscence longitudinal or by pores.

Gynoecium : Tricarpellary, syncarpous, ovary superior, trilocular with 2-many ovules in each locules, placentation axile, rarely parietal, styles united or separate, stigma free or fused, trilobed.

Fruit : A capsule (*e.g.*, *Asphodelus, Gloriosa*) or berry (*e.g.*, *Asparagus*).

Seed : Endospermic and monocotyledonous.

Floral formula : $\oplus \sigma P_{(3+3)} A_{3+3} G_{(3)}$

13.1. Economic Imprtance of family Liliaceae

Sources of medicines

(1) **Colchicum luteum and C. autumnale (Hirantutiya)** : An alkaloid 'Colchicine' is obtained from seeds and corms, which is used in the cure of rheumatism and liver disorders. It is also drug of choice in acute gout. Beside Colchicine is used for inducing polyploidy in plant breeds by arresting or breaking spindle formation.

(2) **Aloe vera (Aloe or Ghee Kawar)** : Used in many laxative preparations and also used in curing piles and fissures.

(3) **Urginea indica and U. maritima (Indian squill)** : Bulbs stimulate heart and are also used in rhematism and skin diseases. Raticide or Red-squill is prepared from bulbs of red variety, which is an important raticide (rat killer) for more than 20 years.

(4) **Smilax macrophylla and S.glabra (Sarasparilla)** : Roots provide a drug called 'Sarasparilla' which is cure of venereal and skin diseases.

(5) **Gloriosa superba (Malabar glory lily)** : Tubers are used in promotion of labour pains and juice of leaves is used for killing lice.

(6) **Sources of food**

(i) Allium cepa (Onion or Piaz)

(ii) Allium sativum (Garlic or Lahsun)

(iii) Asparagus officinalis and A. racemosus (Satawar)

(7) **Source of fibres**

(i) **Sansevieria roxburghiana (Bowstring hemp)** : Leaves provide a strong fibre, which is used for making bowstrings and fishing nets.

(ii) **Yucca filamentosa (Dagger plant)** : Leaves provide fibres used for cordage.

(8) Ornamentals

(i) Tulipa sps. (Tulip) : Beautiful flowers, etc.

(ii) Lilium bulbiferum (Lily) : For beautiful flowers.

(iii) Yucca gloriosa : White flowers giving perfume during night.

(iv) Gloriosa superba.

(v) Asparagus plumosus (Asparagus fern).

13.2. Family – Poaceae

The members of this family are commonly known as 'grasses'. Plants are mostly herbs having stem with marked solid nodes and hollow internodes, i.e., stem is culm. Further stem is generally circular and hollow. Leaves simple, alternate, with sheating bases and ligulate (i.e., a membranous outgrowth 'ligule' is present at junction of leaf sheath and leaf lamina). Spikelet (not flower) is the unit of inflorescence, which may be arranged in spike or panicle, i.e. inflorescence is spike of spikeletes or panicle of spikelets. Each spikelet is having 1 – 5 flowers on a reduced axis, which bear two leaf like structures (glumes) at base.

Each flower is in axil of other like structure called 'lemma' (bract). On the flower axis is another leaf-like structure called palea (bracteole). Above palea are two scale like lodicules (perianth). Flower is hypogynous and zygomorphic.

Perianth reduced and represented by lodicules. Generally 3 stamen with dithecous and versatile anthers. Carpel is generally 1, unilocular ovary with basal placentation, 2 long styles ending in feathery stigmas. Fruit is karyopsis or grain (single seeded indehiscent fruit, in which seed coat fuses with fruit wall to form husk).

F.F. (Floral Formula).

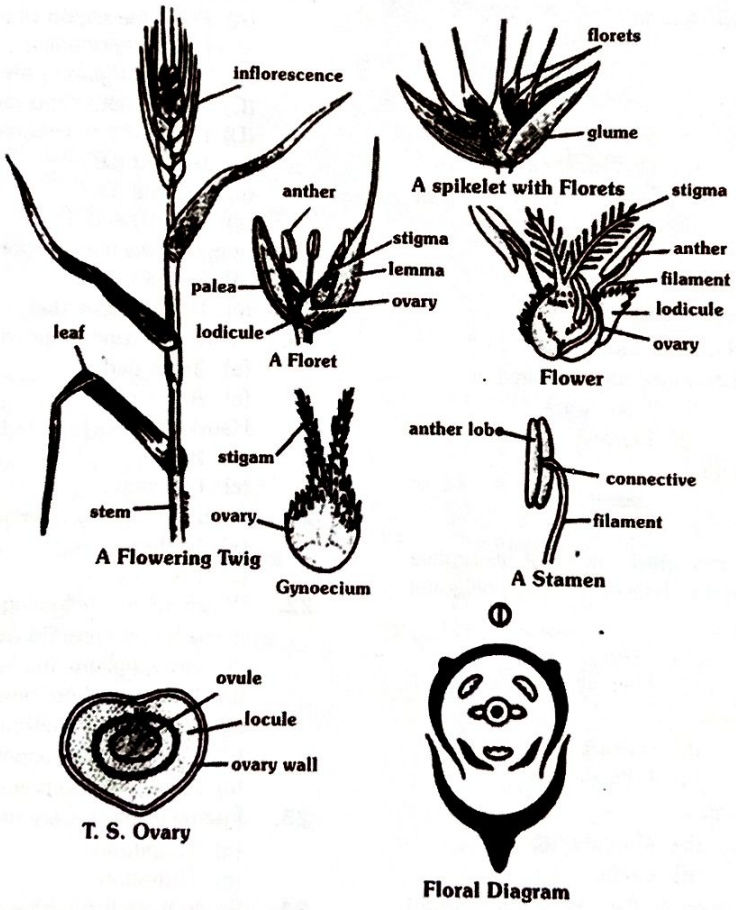


Fig. Triticum aestivum

13.3. Economic Importance of family Poaceae

(1) Cereals and millets

Most important source of food in the world is cereals having karyopsis or grain fruit, e.g., Triticum vulgare (Wheat), Zea mays (Maize), Oryza sativa (Rice), Avena sativa (Oat), Hordeum vulgare (Barley). Small sized grains constitute millets, which also provide food, e.g., Sorghum, vulgare (Jawar), Pennisetum typhoides (Bajra), Eleucine coracana (Ragi or Mandua).

(2) Source of Sugar : Saccharum officinarum (Sugar cane)

(3) Other plants

(i) Dendrocalamus sps : Both (i) and (ii) provide bamboo

(ii) Cynodon dactylon (Doob grass) : Fodder.

(iii) Andropogon muricatus (Khas) : Roots provide khas oil.

5. Morphology of Flowering Plants – Multiple Choice Questions

1. Root

1. Roots developing from plant parts other than radicle are
(a) Epiphyllous (b) Epicaulous
(c) Adventitious (d) Fibrous

2. In which the Pneumatophores are found
(a) *Tinospora* (b) *Pinus*
(c) *Rhizophora* (d) None of these

3. Fusiform roots are found in
(a) *Solanum tuberosum* (b) *Calocasia*
(c) *Daucus carota* (d) *Raphanus sativus*

4. Assimilatory (Photosynthetic) roots a characteristic of
(a) *Trapa* and *Tinospora*
(b) *Taeniophyllum* and *Podostemon*
(c) Both correct
(d) None of these

5. Stilt roots are reported from
(a) *Pandanus* (Screw Pine) (b) Radish
(c) Mango-ginger (d) *Bryophyllum*

6. A fibrous root system is better adapted than tap root system for
(a) Storage of food
(b) Anchorage of plant to soil
(c) Absorption of water and minerals
(d) Transport of water and organic food

7. In *Ipomoea batatas*/Sweet potato the food is stored in
(a) Root tuber (b) Stem tuber
(c) Bud (d) Leaves

8. Which is not a product of root
(a) Sugarbeet (b) Carrot
(c) Radish (d) Potato

9. Epiphytes like *Vanda* develop special layer of absorptive tissue velamen consisting of 4 or 5 layers of long polygonal cells. Velamen is formed by
(a) Absorbing roots (b) Stem
(c) Clinging roots (d) Hanging roots

10. Roots have thorny branches in
(a) *Vanilla* (b) *Asparagus*
(c) *Acanthorhiza* (d) *Pothos*

11. Which is not a stem modification
(a) Ginger (b) Mango-ginger
(c) Potato (d) Garlic

12. If a primary root continues to grow, the type of root system will be known as
(a) Secondary (b) Fibrous
(c) Tap (d) Stilt

13. Which of the following is correctly matched
(a) *Monstera* – Fibrous root
(b) *Dahlia* – Fasciculated root
(c) *Azadirachta* – Adventitious root
(d) Basil – Prop roots

14. Find the incorrect match
(a) Tap root: Carrot
(b) Adventitious root: Sweet potato
(c) Prop root: Banyan tree
(d) Stilt root: Turnip

15. Stilt roots which grow obliquely from basal nodes of culm stem and acting as brace are found in
(a) Sorghum (b) Maize
(c) Sugarcane (d) All of these

16. Regions of root from base to root tip are
(a) Maturation zone - Cell division zone - Elongation zone
(b) Maturation zone - Elongation zone - Cell division zone
(c) Cell division zone - Elongation zone - Maturation zone
(d) Elongation zone - Cell division zone - Maturation zone

17. Select the correct statements
(A) From the region of elongation, some of the epidermal cells for root hairs
(B) Pneumatophores are seen in *Rhizophora*
(C) Adventitious roots are seen in the Banyan tree
(D) Maize and sugarcane have prop roots
(a) (A) and (D) (b) (A), (C) and (D)
(c) (C) and (D) (d) (B) and (C)
(e) (A), (B) and (D)

18. In maize, the fibrous roots develop from
(a) Lower nodes (b) Upper nodes
(c) Upper internodes (d) None of the above

19. There is maximum growth in root
(a) In the dark (b) In the light
(c) At the root apex (d) Just behind the root apex

20. Haustoria or sucking roots occur in
(a) Betel (b) Orchids
(c) *Cuscuta* (d) *Tinospora*

21. Pneumatophores or breathing roots occur in
(a) Hydrophytes (b) Epiphytes
(c) Xerophytes (d) Mangrove plants

22. Which of the following groups of plants are propagated through underground root
(a) Bryophyllum and kalanchoe
(b) Ginger, potato, onion and zamikand
(c) Pistia, chrysanthemum and pineapple
(d) Sweet potato, asparagus, tapioca and dahlia
(e) Agave, wild jam and oxalis

23. Pneumatophores are useful in
(a) Respiration (b) Transpiration
(c) Guttation (d) Protein synthesis

24. Study the following lists

List-I		List-II	
(A)	Spongy aril	(I)	*Jussiaea*
(B)	Multiple epidermis	(II)	*Pistia*
(C)	Respiratory roots	(III)	*Nerium*
(D)	Root pockets	(IV)	*Sagittaria*
		(V)	*Nymphaea*

The correct match is

	A	B	C	D
(a)	I	III	II	V
(b)	II	I	IV	III
(c)	IV	II	III	I
(d)	V	III	I	II

25. Raphides are found in
(a) Dahlia (b) *Asparagus*
(c) Nut (d) Guava

26. Pneumatophores occur in
(a) Submerged hydrophytes
(b) Carnivorous plants
(c) Free-floating hydrophytes
(d) Halophytes

2. Stem

1. Accessory buds occur at
(a) Stem tip (b) Branch tip
(c) Leaf axil (d) Side of axillary bud

2. Vegetative reproduction occurs by bulbil in
(a) *Agave* (b) *Colocasia*
(c) *Zingiber* (d) *Vallisneria*

3. In *Amorphophallus* and *Colocasia* (Aroids) an extremely enlarged underground vertical stem meant for vegetative reproduction and storage is
(a) Tuber (b) Corm
(c) Bulb (d) Rhizome

4. In hook climber *Artabotrys*, the hooks are modified
(a) Petioles (b) Axillary shoots
(c) Leaves (d) Inflorescence axis

5. Rhizome which grows vertically upwards are
(a) Corms (b) Stolon
(c) Bulbils (d) Root stock

6. Ginger is a stem which can be differentiated from root because it
(a) Grows parallel to ground
(b) Stores food
(c) Lacks chlorophyll
(d) Has nodes and internodes

7. Stem takes part in storage and perennation in
(a) Wheat (b) Groundnut
(c) Radish (d) Ginger

8. One of single internodal branches are found in
(a) *Asparagus* (b) *Euphorbia*
(c) *Lilium* (d) *Casuarina*

9. Stem modified for photosynthetic function by appearing like leaves are known as

Or

Leaves are changed into spines in xerophytic structures called
(a) Phyllode (b) Phylloclade
(c) Cladode (d) Tendril

10. Corm is
(a) Underground shoot
(b) Underground root
(c) Horizontal stem
(d) Underground vertical stem

11. In Onion, the swollen underground structure is
(a) Root (b) Rhizome
(c) Bulb (d) Tuber

12. Thorn is a stem structure because it
(a) Develops from trunk
(b) Develops from axillary bud
(c) Grows from external surface
(d) Is pointed

13. The mature seeds of plants such as gram and peas, possess no endosperm, because
(a) These plants are not angiosperms
(b) There is no double fertilization in them
(c) Endosperm is not formed in them
(d) Endosperm gets used up by the developing embryo during seed development

14. In Gloriosa (Glory lily) the tendril is formed from
(a) Stipule (b) Leaf apex
(c) Axillary bud (d) Leaf

15. Potato is multiplied vegetatively with the help of
(a) Corm (b) Rhizome
(c) Tuber (d) Phyllode

16. A horizontal underground stem is a

Or

Ginger plant has an underground stem which is
(a) Corm (b) Phylloclade
(c) Rhizome (d) Rhizoid

17. The structure which contain vascular bundle and is modification of stem is
(a) Bristles (b) Thorn
(c) Prickle (d) Spine

18. Stem may function for
(a) Storage, support and vegetative propagation
(b) Protection
(c) Spread branches
(d) All of these

19. Thorns with leaves and flowers are found in
(a) *Bougainvillea* (b) *Carissa*
(c) *Duranta* (d) *Artabotrys*

20. Match the following and select the correct combination from the options given below

Column I (Stem Modifications)		Column II (Found in)	
A.	Underground stem	1.	*Euphorbia*
B.	Stem tendril	2.	*Opuntia*
C.	Stem thorns	3.	Potato
D.	Flattened stem	4.	*Citrus*
E.	Fleshy cylindrical stem	5.	Cucumber

(a) A–1, B–2, C–3, D–5, E–4
(b) A–2, B–3, C–4, D–5, E–1
(c) A–3, B–4, C–5, D–1, E–2
(d) A–3, B–5, C–4, D–2, E–1
(e) A–5, B–3, C–4, D–1, E–2

21. Rhizomes are mostly
(a) Sympodial (b) Diageotropic
(c) Horizontal (d) All of these

22. Which of the following plants have long slender and coiled stem tendrils developed from axillary buds
(a) Grapevine and pumpkins
(b) Australian *Acacia* and watermelon
(c) *Bougainvillea* and cucumber
(d) Strawberry and grapevine
(e) *Alstonia* and pumpkins

23. Ginger plant has an underground stem which is
(a) Rhizome (b) Bulb
(c) Tuber (d) Corm

24. Floral bud tendril is found in
(a) *Antigonon* (b) *Smilax*
(c) Rose (d) *Bryophyllum*

25. Cladodes are common among
(a) Liliaceae/*Asparagus* and *Ruscus*
(b) *Opuntia* and *Casurina*
(c) Cactus
(d) *Euphorbia*

3. Leaf

1. Approximate diameter of *Victoria* leaf is
(a) 1*m* (b) 1.3*m*
(c) 2*m* (d) 3*m*

2. Presence of sheathing leaf base and ligule are characteristic of
(a) Cycas leaf (b) Fern leaf
(c) Banana leaf (d) Grass leaf

3. In sweet pea, the tendrils are modified
(a) Stem branches (b) Leaflets
(c) Leaves (d) Stipules

4. Petiole is modified into tendril in
(a) *Passiflora* (b) *Gloriosa*
(c) *Pisum* (d) *Clematis*

5. The leaf less stem of onion which is produced to bear flower is called
(a) Thalamus (b) scape
(c) Torus (d) Pedicel

6. Parallel venation occurs in
(a) Monocots (b) Dicots
(c) All angiosperms (d) Ferns

7. In *Calotropis* the phyllotaxy is
(a) Alternate
(b) Verticellate
(c) Opposite and superposed
(d) Opposite and decussate

8. Venation is a term used to describe the pattern of arrangement of
(a) Floral organs
(b) Flower in inflorescence
(c) Veins and veinlets in a lamina
(d) All of them

9. Which of the following plants is used to extract the blue dye
(a) *Trifolium* (b) *Indigofera*
(c) *Lupin* (d) *Cassia*

10. What name has been assigned to the genus produced by a cross between cabbage and radish
(a) *Secale* (b) *Bursa pastoris*
(c) *Lysogenicophyll* (d) *Raphano brassica*

11. The bulb stores food in
(a) Enlarged roots (b) Swollen leaf bases
(c) Swollen stem (d) Inflorescence

12. Study the following statements and select the correct option
(A) Buds are present in the axil of leaflets of the compound leaf
(B) Pulvinus leaf-base is present in some leguminous plants
(C) In *Alstonia,* the petioles expand, become green and synthesize food
(D) Opposite phyllotaxy is seen in guava
(a) (B) and (D) are correct but (A) and (C) are wrong
(b) (A) and (C) are correct but (B) and (D) are wrong
(c) (A) and (D) are correct but (B) and (C) are wrong
(d) (B), (C) and (D) are correct but (A) is wrong
(e) (A) and (B) are correct but (C) and (D) are wrong

13. Study the following lists

List-I		List-II	
(A)	Entire leaf modified into a spine	(i)	*Clematis*
(B)	Leaf except stipules modified into a tendril	(ii)	*Citrus*
(C)	Stipules modified into a tendril	(iii)	*Euphorbia*
(D)	First leaf of axillary bud modified into a spine	(iv)	*Lathyrus*
		(v)	*Smilax*

The correct match is

	A	B	C	D
(a)	(iii)	(iv)	(i)	(ii)
(b)	(iii)	(i)	(iv)	(ii)
(c)	(ii)	(iii)	(i)	(v)
(d)	(v)	(ii)	(i)	(iii)

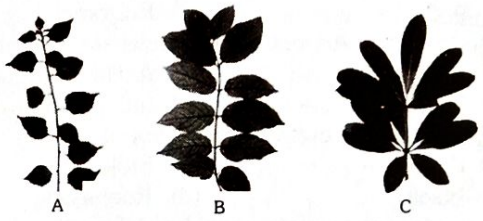
14. Match the columns

(i) Acicular	(1) Grass
(ii) Linear	(2) Nerium
(iii) Lanceolate	(3) Banana
(iv) Oblong	(4) Pine

(a) (i) 4 (ii) 1 (iii) 2 (iv) 3 (b) (i) 4 (ii) 1 (iii) 3 (iv) 2
(c) (i) 4 (ii) 2 (iii) 3 (iv) 1 (d) (i) 4 (ii) 3 (iii) 2 (iv) 1

15. The arrangement and folding of each lamina without any relationship with other leaves in bud, is called
(a) Ptyxis (b) Vernation
(c) Aestivation (d) Phyllotaxy

16. Identify the correct types of phyllotaxy which shown in the following figures



(a) A – Whorled, B – Alternate, C – Opposite
(b) A – Alternate, B – Whorled, C – Opposite
(c) A – Whorled, B – Opposite, C – Alternate
(d) A – Alternate, B – Opposite, C – Whorled

17. 

See the following figures and identify leaves A and B
(a) A – Palmately compound leaf, B – Palmately compound leaf
(b) A – Pinnately compound leaf, B – Pinnately compound leaf
(c) A – Palmately compound leaf, B – Pinnately compound leaf
(d) A – Pinnately compound leaf, B – Palmately compound leaf

4. Inflorescence

1. Amentum (Catkin) inflorescence is found
(a) Mulberry (*Morus*) (b) *Poplulus* (Poplar)
(c) *Acalypha* (Cats tail) (d) All of these

2. Inflorescence in *Musa paradisiaca* (banana) is a
(a) Raceme (b) Catkin
(c) Spadix (d) Verticellaster

3. Inflorescence with unisexual sessile flower is
(a) Spike (b) Spikelet
(c) Catkin (d) Spadix

4. Inflorescence is edible in *Brassica oleracea*
(a) Var. botrytis (b) Var. capitate
(c) Var. gongyloides (d) Var. gemifera

5. The floral formula of the given floral diagram is

(a) $Br\,K_{Pappus}C_{(5)}A_0G_{\overline{(2)}}$

(b) $Br\,\overset{\nearrow}{\varphi}.K_{Pappus}C_{(5)}A_{(5)}G(1)$

(c) $Br\,\sigma\!\!\!\!\varphi.K_{5(Pappus)}\overline{C_{(5)}A_{(5)}},G_{\overline{(2)}}$

(d) $Br\,\sigma\!\!\!\!\varphi.K_{Pappus}\overline{C_{(5)}A_{(5)}},G_{(2)}$

(e) $Br\,\sigma\!\!\!\!\varphi.K_{Pappus}\overline{C_5A_5}\,G_{\overline{(2)}}$

6. A student observed 34 inflorescences in *Bougainvillea* and 42 inflorescences in *Poinsettia*. Find out the number of flowers in *Bougainvillea* and the number of female flower in *Poinsettia*, respectively

(a) 34, 126 (b) 68, ∞

(c) 204, 164 (d) 102, 42

7. Characteristic inflorescence of family compositae sunflower is

(a) Capitulum (b) Cymose head

(c) Catkin (d) Spadix

8. The edible part of cauliflower is

(a) Mesocarp (b) Cotyledons

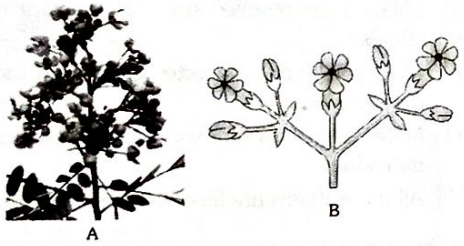
(c) Endosperms (d) Inflorescence

9. The special type of inflorescence found in *Ficus* where the female flower are at bottom and male flower near ostiole and enclosed within a cup shaped fleshy thalamus (receptacle) with ostiole is called

(a) Cyathium (b) Verticillaster

(c) Spadix (d) Hypanthodium

10. See the following diagrams and identify inflorescence A and B



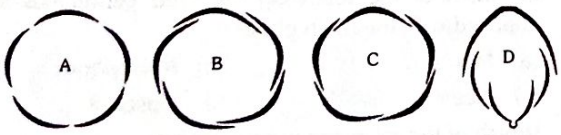
(a) A – Cymose, B – Cymose

(b) A – Racemose, B – Racemose

(c) A – Racemose, B – Cymose

(d) A – Cymose, B – Racemose

11. Examine the types of aestivation shown in the following diagram and select the correct answer



(a) A – Twisted, B – Imbricate, C – Vexillary, D – Valvate

(b) A – Imbricate, B – Vexillary, C – Valvate, D – Twisted

(c) A – Vexillary, B – Valvate, C – Twisted, D – Imbricate

(d) A – Valvate, B – Twisted, C – Imbricate, D – Vexillary

5. Flower

1. A characteristic of angiosperms is

(a) Flower (b) Root

(c) Seed (d) All of these

2. Beauty of *Bougainvillea* flower is due to

(a) Corolla (b) Calyx

(c) Bracts (d) Androecium

3. Stamens attached to petals are

(a) Antipetalous (b) Epipetalous

(c) Epiphyllous (d) Episepalous

4. Cruciform corolla is found in

(a) Pea (b) China Rose

(c) Radish (d) Sunflower

5. Pappus is modification of

(a) Bracts (b) Bracteoles

(c) Corolla (d) Calyx

6. Glumes are modified

(a) Petals

(b) Bracts (Dry and scaly bracts)

(c) Gynoecium

(d) Androecium

7. Part of pistil which receives pollen is

(a) Ovary (b) Style

(c) Stigma (d) Ovule

8. The perianth is the term used when

(a) Androecium and gynoecium are similar

(b) Androecium and calyx are similar

(c) Corolla and gynoecium are similar

(d) Calyx and corolla are similar

9. Largest flower is that of

(a) Sunflower (b) Rafflesia

(c) Nelumbo (d) Drosera

10. Flowers of Liliaceae, Malvaceae and Solanaceae are

(a) Hypogynous (b) Perigynous

(c) Epigynous (d) Amphigynous

11. Parachute like pappus is found in

(a) Liliaceae/Cotton (b) Gramineae/Paddy

(c) Compositae/Marigold (d) Solanaceae/Calotropis

12. Plants with single whorl of perianth are placed under

(a) Class: Monocot Sub class : Monochlamydeae

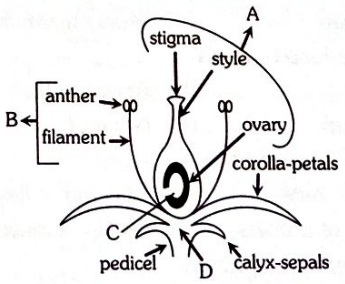
(b) Class: Dicot Series : Monochlamydeae

(c) Class: Dicot Sub class : Monochlamydeae

(d) Class: Monocot Sub class : Gamopetalae

(e) Class: Dicot Series : Bicarpellatae

13. See figure of a typical flower. In which one of the options all the four parts A, B, C and D are correctly identified



	A	B	C	D
(a)	Gynoecium	Stamen	Ovule	Thalamus
(b)	Microsporophyll	Stamen	Ovule	Thalamus
(c)	Gynoecium	Stamen	Seed	Thalamus
(d)	Gynoecium	Megasporophyll	Ovule	Thalamus

14. An apocarpous flower is found in

(a) *Ceasalpinia* (b) *Ranunculus*

(c) *Brassica* (d) *Datura*

15. Inferior ovary occurs in

(a) Cruciferae (b) Compositae

(c) Malvaceae (d) Ranunculaceae

16. The expression "gynoecium is apocarpous" implies that the
(a) Gynoecium comprises only one pistil which is fused with the stamen
(b) Gynoecium comprises more than one carpel, all of which are free
(c) Gynoecium comprises only one carpel which is free
(d) Gynoecium comprises more than one carpel which are fused

17. When placenta forms a ridge along the ventral suture of the ovary and the ovules are borne on this ridge forming two rows, the placentation is termed as
(a) Axile (b) Parietal
(c) Marginal (d) Basal

18. The most suitable flower for study of floral parts is
(a) Rose (b) Sunflower
(c) Mustard (d) Cucumber

19. Ligulate corolla found in compositae is
(a) Wheel-shaped (b) Strap-shaped
(c) Masked (d) Two -lipped

20. Monadelphous androecium occurs in
(a) Pea (b) *Hibiscus*
(c) *Brassica* (d) *Helianthus*

21. Versatile anther is attached to filament
(a) At top firmly
(b) At base firmly
(c) Throughout length
(d) About middle of connective allowing free movement

22. When margin of thalamus grows upward enclosing ovary completely and getting fused with it and the other parts of flower arise above the ovary, the flower is said to be
(a) Hypogynous (b) Perigynous
(c) Epigynous (d) Inferior

23. Smallest flower belongs to
(a) *Rosa indica* (b) *Wolffia microscopica*
(c) *Ranunculus scleratus* (d) *Colocasia antiquorum*

24. Oblique septum and swollen placenta is characteristic feature of
(a) *Gloriosa superba* (b) *Capsicum frutescence*
(c) *Althea rosea* (d) *Dalbergia sissoo*

25. Plants having flowers with free petals are placed under
(a) Polypetalae (b) Monocotyledons
(c) Gamopetalae (d) Monochlamydae

26. Gynoecium with fused carpels
(a) Syncarpous (b) Apocarpous
(c) Syngenecium (d) None of these

27. The term Anthesis is used for
(a) Cluster of anthers (b) Opening of flowers
(c) Dehiscence of anthers (d) Falling of flowers

28. A monocarpic plant is one which
(a) Has only one carpel
(b) Flowers once in a life-time
(c) Produces only one seed
(d) Produces only one fruit

29. The type of placentation in which ovary is syncarpous unilocular and ovules on sutures is called
(a) Marginal placentation
(b) Apical placentation
(c) Parietal placentation
(d) Superficial placentation

30. Match the Column I with Column II and Column III

Column I	Column II	Column III
A. Marginal	I. 	1. Sunflower, Marigold
B. Axile	II. 	2. *Dianthus*, *Primrose*
C. Parietal	III. 	3. Mustard, *Argemone*
D. Free Central	IV. 	4. China rose, Tomato, Lemon
E. Basal	V. 	5. Pea

(a) A – V, 1; B – III, 2; C – II, 4; D – I, 5; E – IV, 3
(b) A – V, 1; B – II, 4; C – I, 2; D – III, 3; E – IV, 5
(c) A – I, 5; B – II, 4; C – III, 3; D – IV, 2; E – V, 1
(d) A – V, 5; B – II, 4; C – I, 3; D – III, 2; E – IV, 1

31. The side of a flower facing the mother axis is called
(a) Anterior side (b) Posterior side
(c) Dorsal side (d) Ventral side

32. Feathery (hairy) style is persistent in
(a) *Solanum* (b) *Clematis*
(c) *Helianthus* (d) *Hibiscus*

33. In a monoecious plant
(a) Male and female sex organs are on different individuals
(b) Male and female gametes are of two morphologically distinct types
(c) Male and female sex organs are on the same individual
(d) All the stamens are fused to form one unit

6. Seeds and Fruits

1. Seeds of the orchids are
(a) Large and heavy (b) Light and dry
(c) Minute and sticky (d) None of these

2. In which of the following the seed germinates and still attached with the main plant
(a) Mango (b) *Rhizophora*
(c) Neem (d) Coconut

3. Which of the following is a wheat fruit
(a) Achene (b) Cypsela
(c) Caryopsis (d) Endosperm

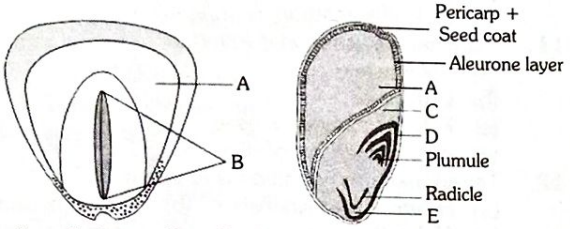
4. Aggregate fruit develops from
(a) Multicarpellary, apocarpous ovary
(b) Multicarpellary ovary
(c) Multicarpellary, syncarpous ovary
(d) Monocarpellary ovary

5. To remove seed dormancy by mechanically removing the seed coat, is called
(a) Stratification (b) Scarification
(c) Vernalization (d) Photoperiodism

6. Pepo fruit is found in
(a) Cruciferae (b) Cucurbitaceae
(c) Liliaceae (d) Solanaceae

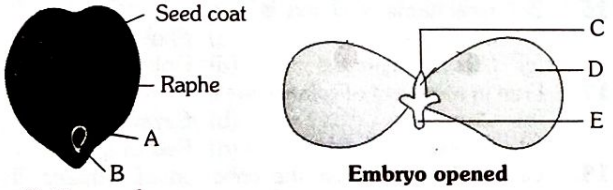
7. In which plant the fruit is a drupe, seed coat is thin, embryo is inconspicuous, and endosperm is edible
(a) Groundnut (b) Wheat
(c) Apple (d) Coconut

8. The following diagram is the typical structure of monocotyledonous seeds. Identify all the five parts A, B, C, D and E



(a) A – Embryo, B – Endosperm, C – Scutellum, D – Coleorhiza, E – Coleoptile
(b) A – Endosperm, B – Embryo, C – Scutellum, D – Coleoptile, E – Coleorhiza
(c) A – Embryo, B – Endosperm, C – Scutellum, D – Coleoptile, E – Coleorhiza
(d) A – Endosperm, B – Embryo, C – Scutellum, D – Coleorhiza, E – Coleoptile

9. The following diagram is the typical structure of dicotyledonous seeds. In which one of the options all the five parts A to E are correctly identified



Entire seed **Embryo opened**

(a) A – Hilum, B – Micropyle, C – Plumule, D – Radicle, E – Cotyledon
(b) A – Micropyle, B – Hilum, C – Plumule, D – Cotyledon, E – Radicle
(c) A – Hilum, B – Micropyle, C – Plumule, D – Cotyledon, E – Radicle
(d) A – Hilum, B – Micropyle, C – Radicle, D – Cotyledon, E – Plumule

10. Figure - I – Mango, Figure - II – Coconut are shown in the following diagram. Identify the parts of the fruit A, B, C and D are respectively

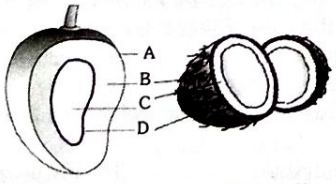


Figure – I **Figure – II**

(a) Epicarp, Mesocarp, Embryo, Endocarp
(b) Epicarp, Mesocarp, Ovary, Endocarp
(c) Epicarp, Mesocarp, Ovule, Endocarp
(d) Epicarp, Mesocarp, Seed, Endocarp

11. In a seed of maize, scutellum is considered as cotyledon because it
(a) Protects the embryo
(b) Contains food for the embryo
(c) Absorbs food materials and supplies them to the embryo
(d) Converts itself into a monocot leaf

12. ..... type of fruit is present in rice
(a) Cypsela (b) Capsule
(c) Caryopsis (d) Cremocarp

13. Maize grain is
(a) Seed (b) Embryo
(c) Ovule (d) Fruit

14. The edible dry fruit 'chilgoza' is
(a) Fruit of *Cycas*
(b) Fruit of *Pinus gerardiana*
(c) Seed of *Cycas*
(d) Seed of *Pinus gerardiana*

15. Edible part of Apple is
(a) Mesocarp (b) Calyx
(c) Thalamus (d) Pericarp

16. Match the items in column I with column II and choose the correct answer

Column I		Column II	
A.	Apple	1.	Outer portion of receptacle
B.	Coconut	2.	Fleshly thalamus
C.	Jack fruit	3.	Thalamus & pericarp
D.	Guava	4.	Endosperm
E.	Pineapple	5.	Bract, perianth & seeds

(a) A – 2, B – 3, C – 4, D – 5, E – 1
(b) A – 5, B – 3, C – 1, D – 4, E – 2
(c) A – 2, B – 3, C – 1, D – 5, E – 4
(d) A – 2, B – 4, C – 5, D – 3, E – 1
(e) A – 5, B – 4, C – 3, D – 2, E – 1

17. Match Column – I with Column – II and choose the correct answers

Column – I		Column – II	
A.	Coleorhiza	1.	Grapes
B.	Food storing tissue	2.	Mango
C.	Parthenocarpic fruit	3.	Maize
D.	Single seeded fruit developing from monocarpellary superior ovary	4.	Radicle
E.	Membranous seed coat	5.	Endosperm

(a) A – 3, B – 1, C – 4, D – 2, E – 5
(b) A – 4, B – 2, C – 5, D – 1, E – 3
(c) A – 5, B – 1, C – 3, D – 4, E – 2
(d) A – 1, B – 3, C – 2, D – 5, E – 4
(e) A – 4, B – 5, C – 1, D – 2, E – 3

18. An example of false fruit is
(a) Apple (b) Banana
(c) Grapes (d) Mango

19. In drupe of coconut the mesocarp is
(a) Fleshy (b) Fibrous
(c) Stony (d) Watery

20. Which one of the following is a true nut
(a) Walnut (b) Groundnut
(c) Cashewnut (d) Coconut

21. Read the following statements A and B
(A) Many organs of aquatic plants float in water
(B) Large air gaps are present in the collenchyma tissues of lotus leaf
Select the correct answer
(a) Statement A is correct and B is wrong
(b) Statement B is correct and A is wrong
(c) Statements A and B both are correct
(d) Statements A and B both are wrong

22. Fruit of custard apple is
(a) Etaerio of berries (b) Etaerio of follicles
(c) Etaerios of achenes (d) Ethaerio of drups

23. Persistent calyx forms a dry bladder like structure enclosing edible berry in
(a) *Physalis* (b) *Nicotiana*
(c) *Capsicum* (d) *Solanum*

24. Coleoptile represents
(a) Covering of radical (b) Covering of cotyledon
(c) Covering of plumule (d) Synonym of plumule

7. Dispersal of fruits and seeds

1. Dispersal by explosive fruits is shown by
(a) *Barleria* (b) *Impatiens* and *Rueillia*
(c) *Acanthus* and *Phlox* (d) All of these

2. In *Ruellia* and *Justicia* dispersal of seeds takes place by
(a) Jaculator mechanism (b) Censer mechanism
(c) Winged seeds (d) Parachute mechanism

3. An example of fruit which is dispersed by bird is
(a) *Calotropis* (b) *Mirabilis*
(c) *Argemone* (d) *Bignonia*

4. Seed dispersal by parachute type mechanism is found in
(a) Pea of Fabaceae
(b) Mustard of Brassicaceae
(c) Cotton of Malvaceae
(d) *Taraxacum* of Asteraceae

5. Parachute mechanism is found in
(a) Cruciferae (b) Compositae
(c) Solanaceae (d) None of these

6. Winged seeds occur in
(a) *Chorea* (b) *Moringa*
(c) *Cotton* (d) *Calotropis*

8. Taxonomy of Angiospermic plants

1. Which of the following families is characterised by the presence of perianth
(a) Malvaceae (b) Liliaceae
(c) Cruciferae (d) Solanaceae

2. The correct floral formula of Liliaceae is
(a) $\oplus\ \male\ \female\ P_{3+3}\ A_6\ \underline{G_{(3)}}$ (b) $Br \oplus\ \male\ \female\ P_{3+3}\ A_{3+3}\ \underline{G_{(3)}}$
(c) $\dagger\ \male\ \female\ P_{3+3}\ A_{3+3}\ \underline{G_{(3)}}$ (d) $\dagger\ \male\ \female\ P_{3+3}\ A_{3+3}\ \underline{G_{(6)}}$

3. The androecium of Malvaceae is
(a) Didynamous (b) Tetradynamous
(c) Diadelphous (d) Monadelphous

4. Red Gram is
(a) *Phaseolus aureus* (b) *Cicer arietinum*
(c) *Cajanus cajan* (d) *Phaseolus mungo*

5. Botanical name of Finger Millet is
(a) *Sorghum vulgare* (b) *Eleusine coracana*
(c) *Amaranthus viridis* (d) *Pennisetum typhoides*

6. Most important character of *Brassica campesteris* is
(a) False septum (b) Parietal placentation
(c) Bracteates (d) Imbricate aestivation

7. Four sepals arranged in two whorls is characteristic of family
(a) Solanaceae (b) Fabaceae
(c) Brassicaceae (d) Liliaceae

8. Largest family of flowering plants is
(a) Fabaceae (b) Liliaceae
(c) Poaceae (d) Asteraceae

9. A crop plant which can grow well even in nitrogen deficient soil is
(a) *Helianthus annuus*
(b) *Gossypium herbaceum*
(c) *Brassica campesteris*
(d) *Cajanus cajan*

10. Which of the following represents the floral characters of Liliaceae
(a) Six tepals, zygomorphic, six stamens, bilocular ovary, axile placentation
(b) Tetramerous, actinomorphic, polyphyllous, unilocular ovary, axile placentation
(c) Trimerous, actinomorphic, polyandrous, Superior ovary, axile placentation
(d) Bisexual, zygomorphic, gamophyllous, inferior ovary, marginal placentation
(e) Unisexual, actinomorphic, trilocular, inferior ovary, axile placentation

11. Marginal placentation is found in
(a) Solanaceae
(b) Cruciferae
(c) Fabaceae/Leguminosae
(d) Asteraceae/Compositae

12. Tetradynamous condition is found in
(a) *Hibiscus rosa-sinensis* (b) *Petunia hybrida*
(c) *Helianthus annuus* (d) *Brassica campestris*

13. The division of Leguminosae into its sub families is based upon (or) the Leguminosae is distinguished on the basis of
(a) K and C (b) K and A
(c) C and A (d) A and G

14. Bilocular oblique ovary with numerous shining ovule on swollen axile placenta is the characteristics of
(a) Cruciferae (b) Solanaceae
(c) Liliaceae (d) Malvaceae

15. Lady finger belongs to family
(a) Malvaceae (b) Cucurbitaceae
(c) Liliaceae (d) Brassicaceae

16. Botanical name of 'chana' is
(a) *Cicer arietinum* (b) *Phaseolus aureus*
(c) *Lablab purpureus* (d) Dolichos

17. Fruit in members of solanaceae is
(a) Drupe (b) Capsule or berry
(c) Siliqua (d) Pod or achene

18. Given diagram shows the cohesion of stamens. It is the characteristic of pulse family. Identify the type of cohesion

(a) Synandrous (b) Polyadelhpous
(c) Diadelphous (d) Monoadelphous

19. An example of liliaceae family is
(a) Lupin (b) Soyabean
(c) *Petunia* (d) Tulip

20. When placenta forms a ridge along the ventral suture of the ovary and the ovules are borne on this ridge forming two rows, the type of placentation is termed as
(a) Marginal (b) Axile
(c) Parietal (d) Free central

21. Many pulses of daily use belong to one of the families below
(a) Solanaceae (b) Fabaceae
(c) Liliaceae (d) Poaceae

22. Which of the following is not a characteristic feature of Fabaceae
(a) Descending imbricate, ten stamens, diadelphous, ovary superior
(b) Sepals five, gamosepalous, imbricate aestivation, placentation marginal
(c) Monocarpellary, ovary superior, style long, slightly bent at the apex
(d) Zygomorphic flowers, diadelphous stamens, many ovules
(e) Corolla five petals, polypetalous, anterior one large and outermost

23. Select the wrong statement
(a) Persistent calyx is seen in *Solanaceae*
(b) Flowers are hypogynous in *Asteraceae*
(c) Santonin is obtained from *Artemisia*
(d) In *poaceae*, perianth is represented by membranous scales called lodicules
(e) Parietal placentation is characteristic of *Brassicaceae*

24. Rutaceae differs from Malvaceae in having
(a) Simple leaves
(b) Polypetalous corolla
(c) Syncarpous, superior ovary
(d) Obdiplostemonous stamens

25. Which of the following is not correctly paired
(a) Fabaceae: Legume family
(b) Solanaceae: Potato family
(c) Liliaceae: Sunflower family
(d) Brassicaceae: Mustard family

26. Flower of Fabaceae is
(a) Complete, zygomorphic, pentamerous
(b) Complete, actinomorphic, trimerous
(c) Incomplete, zygomorphic, trimerous
(d) Incomplete, actinomorphic, pentamerous

27. Which one is odd
(a) *Allium cepa* (b) *Helianthus annuus*
(c) *Brassica juncea* (d) *Arachis hypogea*

28. *Raphanus* belongs to
(a) Asteraceae (b) Brassicaceae
(c) Solanaceae (d) Liliaceae

29. Bicarpellary, syncarpous, unilocular ovary with basal placentation occurs in
(a) Liliaceae (b) Solanaceae
(c) Asteraceae (d) Fabaceae

30. Datura belongs to
(a) Compositae (b) Labiatae
(c) Malvaceae (d) Solanaceae

31. Gynostegium (Fusion of anthers with stigma) and pollinia are present in family
(a) Apocynaceae
(b) Asclepiadaceae
(c) Convolvulaceae
(d) Solanaceae/Cucurbitaceae

32. Sunflower belongs to the family
(a) Liliaceae (b) Asteraceae
(c) Cruciferae (d) Fabaceae

33. Monoadelphous condition of stamens is found in
(a) Malvaceae (b) Cyperaceae
(c) Cruciferae (d) Solanaceae

34. Which of the following are not characteristic features of fabaceae
(a) Tap root system, compound leaves and raceme inflorescence
(b) Flowers actinomorphic, twisted aestivation and gamopetalous
(c) Stamens 10, introrse, basifixed, dithecous
(d) Monocarpellary, ovary superior and bent stigma
(e) Fruit is legume

35. Which of the following member of family *Solanaceae* is rich in source of vitamin C
(a) Guava (b) Tomato
(c) Gooseberry (d) Strawberry

36. The characteristic type of placentation found in the members of caryophyllaceae is
(a) Parietal (b) Marginal
(c) Basal (d) Axile
(e) Free central

37. Match the item in column I with column II and choose the correct answer

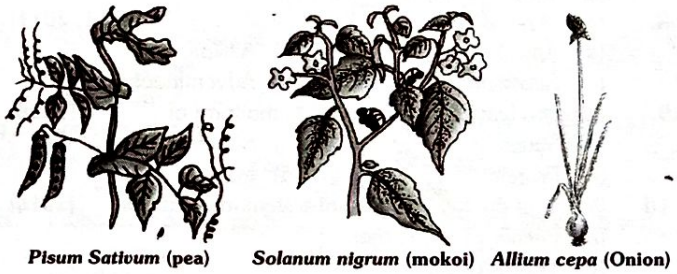
Column I		Column II	
A	Microspermae	1	Alismaceae
B	Epigynae	2	Liliaceae
C	Calycinae	3	Iridaceae
D	Apocarpae	4	Orchidaceae
E	Coronarieae	5	Palmae

(a) A – 2, B – 3, C – 4, D – 5, E – 1
(b) A – 3, B – 4, C – 5, D – 1, E – 2
(c) A – 4, B – 3, C – 5, D – 1, E – 2
(d) A – 1, B – 2, C – 3, D – 4, E – 5
(e) A – 5, B – 4, C – 3, D – 2, E – 1

38. In the members of family malvaceae, anthers are described as
(a) Diadelphous and dithecous
(b) Diadelphous and monothecous
(c) Monadelphous and dithecous
(d) Monadelphous and monothecous

39. Aloe used in Medicine belong to family
(a) Liliaceae (b) Solanaceae
(c) Malvaceae (d) Asteraceae

40. See the following figures and identify the given below species belong to which of the following families respectively



***Pisum Sativum* (pea)** ***Solanum nigrum* (mokoi)** ***Allium cepa* (Onion)**

(a) Solanaceae, Fabaceae, Liliaceae
(b) Compositae, Malvaceae, Liliaceae
(c) Fabaceae, Solanaceae, Liliaceae
(d) Liliaceae, Compositae, Malvaceae

41. Chief feature of family Brassicaceae/Cruciferae is presence of
(a) Latex (b) Pectin
(c) Alkaloids (d) Myrosin enzyme

42. Choose the correct description depicted by floral diagram

(a) United valvate sepals, free twisted petals, free stamens, unilocular ovary with marginal placenta
(b) United valvate sepale, free imbricate petals, free stamens, unilocular ovary with axile placenta
(c) United valvate sepals, free imbricate petals, epipetalous stamens, unilocular ovary with marginal placenta
(d) United valvate sepals, free imbricate petals, free stamens, unilocular ovary with marginal placentation

9. NEET

1. Pneumatophores occur in plants of **[2000]**
(a) Sandy soil (b) Saline marshy soil
(c) Marshy soil (d) Water

2. Clinging and epiphytic roots are found in **[1991, 1999]**
(a) Orchid (b) *Tinospora / Trapa*
(c) *Rhizophora / Pandanus* (d) *Pothos / Podostemon*

3. Climbing roots occur in **[1996, 1999]**
(a) *Vanilla* (b) *Vanda*
(c) *Pongamia* (d) *Taeniophyllum*

4. Sweet potato is homologous to **[2011]**
(a) Ginger (b) Turnip
(c) Potato (d) Colocasia

5. An example of edible underground stem is **[1988,1993, 2005, 2014]**
(a) Sweet potato (b) Potato
(c) Carrot (d) Groundnut

6. New Banana plants develop from **[1990, 2012]**
(a) Rhizome (b) Sucker
(c) Stolon (d) Seed

7. Which one of the following is correctly matched **[2012]**
(a) Onion–Bulb
(b) Ginger–Sucker
(c) *Chlamydomonas* – Conidia
(d) *Yeast* – Zoospores

8. Eye of potato is **[2001, 2011]**
(a) Apical bud (b) Axillary bud
(c) Accessory bud (d) Adventitious bud

9. In onion leaves food is stored in the form of **[1988]**
(a) Sugar (b) Starch
(c) Protein (d) Malic acid

10. Which of the following is not a stem modification **[2016]**
(a) Pitcher of *Nepenthes*
(b) Thorns of citrus
(c) Tendrils of cucumber
(d) Flattened structure of *Opuntia*

11. Find out correct order of vegetative propoagules of plants like potato, ginger Agave, Bryophyllum and water hyacinth **[2012, 2015]**
(a) Offset, bulbil, leaf bud, rhizome and eyes
(b) Leaf bud, bulbil, offset, rhizome and eyes
(c) Eyes, rhizome, bulbil, leaf bud and offset
(d) Rhizome, bulbil, leaf bud, eyes and offset
(e) Offset, bulbil, leaf bud, rhizome and eyes

12. Which one of the following pairs is wrongly matched while the remaining three are correct **[2011]**
(a) *Bryophyllum*-Leaf buds
(b) *Agave* – Bulbils
(c) *Penicillium* – Conidia
(d) Water hyacinth – Runner

13. Leaves are situated on **[2003, 2005]**
(a) Nodes (b) Internodes
(c) Tip (d) None of these

14. In *Opuntia* the spines are modification of **[2004, 2009, 2015]**
(a) Leaf (b) Branch
(c) Epidermis (d) Flower

15. Whorled, simple leaves with reticulate venation are present in **[2010, 2011]**
(a) China Rose (b) *Alstonia*
(c) *Calotropis* (d) Neem

16. Match list I with list II and select the correct option

	List I		List II
A.	Gemmules	1.	*Agave*
B.	Leaf-buds	2.	*Penicillium*
C.	Bulbil	3.	Water hyacinth
D.	Offset	4.	Sponges
E.	Conidia	5.	*Bryophyllum*

[2010, 2011]
(a) A–4, B–5, C–1, D–3, E–2
(b) A–4, B–3, C–2, D–1, E–5
(c) A–3, B–5, C–4, D–2, E–1
(d) A–4, B–1, C–5, D–3, E–2
(e) A–3, B–5, C–4, D–1, E–2

17. Phyllode is found in **[2003, 2012]**
(a) *Clematis* (b) *Gloriosa*
(c) Australian *Acacia* (d) *Dischidia*

18. How many plants among China rose, *Ocimum*, sunflower, mustard, *Alstonia*, guava, *Calotropis* and *Nerium* (Oleander) have opposite phyllotaxy **[2013]**
(a) Three (b) Four
(c) Five (d) Two

19. Select the correct pair of answers in which the former represents the set of characters present in *Poinsettia* and the latter in the pair represents the set of characters present in *Casuarina*
Study the following table

(i)	Modified aerial stem	Unisexual flowers develop acropetally	Chalazal entry of pollen tube
(ii)	Flowers achlamydeous	Pedicels of the all flowers are of same length	Presence of false whorl
(iii)	Cohesion of bracts forming a cup	Centrifugal opening of flower	Male flowers many
(iv)	Flower formation on one side in a spiral manner	Presence of rachilla	Terminal part of the peduncle is flowerless

[2009]
(a) (ii), (iii) (b) (i), (ii)
(c) (iv), (iii) (d) (iii), (i)

20. Cymose inflorescence is present in **[2012]**
(a) Solanum (b) Sesbania
(c) Trifolium (d) Brassica

21. In a cymose inflorescence the main axis **[2013]**
(a) Has unlimited growth
(b) Bears a solitary flower
(c) Has unlimited growth but lateral branches end in flowers
(d) Terminates in a flower

22. Inflorescence is racemose in **[2013]**
(a) Brinjal (b) Tulip
(c) Aloe (d) Soyabean

23. Flower in which only one set of essential organ is present are said to be **[2004]**
(a) Bisexual (b) Monoecious
(c) Dioecious (d) Polygamous
(e) Unisexual

24. How many plants in the list given below have marginal placentation : Mustard, Gram, Tulip, Asparagus, Arhar, Sun hemp, Chilli, Colchicine, Onion, Moong, Pea, Tobacco, Lupin **[2012]**
(a) Four (b) Five
(c) Six (d) Three

25. Compound apocarpous gynoecium is found in **[1989, 91]**
(a) Lily (b) Hollyhock
(c) Lotus/*Ranunculus* (d) Pumpkin

26. Which of the following is regarded as equivalent to perianth **[1992, 1996]**
(a) Glume (b) Lodicule
(c) Superior palea (d) Inferior palea

27. Flowers are Zygomorphic in **[2011]**
(a) Datura (b) Mustard
(c) Gulmohur (d) Tomato

28. Which one of the following statements is correct **[2011]**
(a) Flower of tulip is a modified shoot
(b) In tomato, fruit is a capsule
(c) Seeds of orchids have oil-rich endosperms
(d) Placentation in *primrose* is basal

29. Among flowers of *Calotropis*, tulip, *Sesbania*, *Asparagus*, Colchicine, Sweet pea, *Petunia*, *Indigofera*, Mustard, Soyabean, Tobacco and groundnut how many plants have corolla with valvate aestivation **[2013]**
(a) Six (b) Seven
(c) Eight (d) Five

30. The gynoecium consists of many free pistils in flowers of **[2012]**
(a) Aloe (b) Tomato
(c) Papaver (d) Michelia

31. The ovary is half inferior in flowers of **[2010,11]**
(a) Guava (b) Peach/Plum
(c) Cucumber (d) Cotton

32. Among bitter gourd, mustard, brinjal, pumpkin, chinarose, lupin, cucumber, sunnhemp, gram, guava, bean, chilli, plum, petunia, tomato, rose, withania, potato, onion, aloe and tulip how many plants have hypogynous flower **[2013]**
(a) Eighteen (b) Six
(c) Ten (d) Fifteen

33. Among china rose, mustard, Brinjal, potato, guava, cucumber onion and tulip, how many plants have superior ovary **[2015]**
(a) Six (b) Three
(c) Four (d) Five

34. The standard petal of a papilionaceous corolla is also called **[2016]**
(a) Carina (b) Pappus
(c) Vexillum (d) Corona

35. Proximal end of the filament of stamen is attached to the **[2016]**
(a) Anther (b) Connective
(c) Placenta (d) Thalamus or petal

36. Hair present on the cob of corn are **[2000]**
(a) Seed hairs (b) Modified hairs of bracts
(c) Styles (d) Stigmas and styles

37. Transmission tissue is characteristic feature of **[2015]**
(a) Solid style (b) Dry stigma
(c) Wet stigma (d) Hollow style

38. Choose the product that is derived from style and stigma **[1992]**
(a) Saffron (b) *Fenugreek*
(c) *Asafoetida* (d) *Psyllium*

39. An example of axile placentation is **[2009]**
(a) Argemone (b) Dianthus
(c) Lemon (d) Marigold

40. Which one of the following diagrams represents the placentation in Dianthus **[2011]**
(a)  (b) 
(c)  (d) 

41. In unilocular ovary with a single ovule the placentation is **[2010]**
(a) Axile (b) Marginal
(c) Basal (d) Free Central

42. Keel is characteristic of the flower of **[2010]**
(a) Bean (b) Gulmohur
(c) Cassia (d) Calotropis

43. Perigynous flowers are found in **[2015]**
(a) Cucumber (b) China rose
(c) Rose (d) Guava

44. Keel is the characteristic feature of flower of **[2015]**
(a) *Indigofera* (b) Aloe
(c) Tomato (d) Tulip

45. When the margins of sepals or petals overlap one another without any particular direction, the condition is termed as **[2014]**
(a) Twisted (b) Valvate
(c) Vexillary (d) Imbricate

46. Flowers are unisexual in **[2015]**
(a) Cucumber (b) China rose
(c) Onion (d) Pea

47. Seed develop from **[1993, 2010, 12]**
(a) Ovules (b) Ovaries
(c) Anthers (d) Pistils

48. Edible part of mango is **[2002, 2004, 2010]**
(a) Epicarp (b) Mesocarp
(c) Endocarp (d) Receptacle

49. Placenta and pericarp are both edible portions in **[2005, 2007, 2014]**
(a) Tomato (b) Potato
(c) Apple (d) Banana

50. In which of following fruits is the edible part the aril **[1999, 2005, 06, 2005, 2009]**
(a) Orange (b) Litchi
(c) Custard apple (d) Pomegranate

51. Pineapple (ananas) fruit develops from **[2006, 2009]**
(a) A cluster of compactly borne flowers on a common axis
(b) A multilocular monocarpellary flower
(c) A unilocular polycarpellary flower
(d) A multipistillate syncarpous flower

52. An enzyme that can stimulate germination of barley seeds is **[2006]**
(a) Protease (b) Invertase
(c) α-amylase (d) Lipase

53. The fleshy receptacle of syconus of fig encloses a number of **[2008]**
(a) Berries (b) Mericarps
(c) Achenes (d) Samaras

54. The scutellum observed in a grain of wheat or maize is comparable to which part of the seed in other monocotyledons **[2010]**
(a) Plumule (b) Cotyledon
(c) Endosperm (d) Aleurone layer

55. A drupe develops in **[2011]**
(a) Tomato (b) Mango
(c) Wheat (d) Pea

56. Which one of the following statements is **correct** **[2014]**
(a) A proteinaceous aleurone layer is present in maize grain
(b) A sterile pistil is called a staminode
(c) The seed in grasses is not endospermic
(d) Mango is a parthenocarpic fruit

57. Non-albuminous seed is produced in **[2014]**
(a) Wheat (b) Pea
(c) Maize (d) Castor

58. Which one of the following organisms is correctly matched with its three characteristics **[2012]**
(a) Pea: C_3 pathway, Endospermic seed, Vexillary aestivation
(b) Tomato: Twisted aestivation, axile placentation, Berry
(c) Onion: Bulb, Imbricate aestivation, axile placentation
(d) Maize: C_3 pathway, Closed vascular bundles, Scutellum

59. Cotyledons and testa respectively are edible parts in **[2009]**
(a) Groundnut and pomegranate
(b) Walnut and tamarind
(c) French bean and coconut
(d) Cashew nut and litchi

60. One of the following is a dry indehiscent fruit **[2004]**
(a) Caryopsis (b) Pod
(c) Follicle (d) Lomentum
(e) Capsule

61. A fruit developed from hypanthodium inflorescence is called **[2009]**
(a) Hesperidium (b) Sorosis
(c) Syconus (d) Caryopsis

62. An example of a seed with endoperm perisperm and caruncle is **[2009]**
(a) Cotton (b) Coffee
(c) Lily (d) Castor

63. The fruit is chambered, developed from inferior ovary and has seeds with succulent testa in **[2008]**
(a) Guava (b) Cucumber
(c) Pomegranate (d) Orange

64. How many plants in the list given below have composite fruits that develop from an inflorescence. Walnut, poppy, radish, fig, pineapple, apple, tomato, mulberry **[2012]**
(a) Four (b) Five
(c) Two (d) Three

65. Dry indehiscent single-seeded fruit formed from bicarpellary syncarpous inferior ovary is **[2008]**
(a) Berry (b) Cremocarp
(c) Caryopsis (d) Cypsela

66. In a cereal grain the single cotyledon of embryo is represented by **[2006]**
(a) Prophyll (b) Coleoptile
(c) Coleorhiza (d) Scutellum

67. Albuminous seeds store their reserve food mainly in **[2013]**
(a) Endosperm (b) Cotyledons
(c) Hypocotyl (d) Perisperm

68. Seed coat is not thin, membranous in **[2013]**
(a) Gram (b) Maize
(c) Coconut (d) Groundnut

69. The two families dominate in having maximum useful plants **[1990, 1993, 1997]**
(a) Fabaceae and Poaceae
(b) Liliaceae and Solanaceae
(c) Malvaceae and Brassicaceae
(d) Liliaceae and Poaceae

70. Botanical name of Cauliflower is **[1991]**
(a) *Brassica oleracea* var. *capitata*
(b) *Brassica campesteris*
(c) *Brassica oleracea* var. *botrytis*
(d) *Brassica oleracea* var. *gemmifera*

71. Epipetalous and syngenesious stamens occur in **[1990, 1991, 92, 2008, 2009]**
(a) Solanaceae (b) Brassicaceae
(c) Fabaceae (d) Asteraceae

72. Consider the following four statements A, B, C and D and select the right option for two correct statements
Statements
(A) In vexillary aestivation, the large posterior petal is called – standard, two lateral ones are wings and two small anterior petals are termed keel
(B) The floral formula for Liliaceae is $\oplus ♀♂ P_{3+3}A_{3+3}+\underline{G_3}$
(C) In pea flower the stamens are monadelphous
(D) The floral formula for Solanaceae is $\oplus ♀♂ K_{(3)}C_{(3)}A_{(4)}+\underline{G_{(2)}}$
The correct statements are **[2010]**
(a) (A) and (C) (b) (A) and (B)
(c) (B) and (C) (d) (C) and (D)

73. Cruciferae differ from Malvaceae in the presence of **[1992]**
(a) Bicarpellary unilocular ovary and siliqua fruit
(b) Multicarpellary multilocular ovary and capsule fruit
(c) Monocarpellary, multilocular ovary with capsule fruit
(d) Multicarpellary unilocular ovary and cypsella fruit

74. $\oplus K_{2+2}C\times_4 A_{2+4}\underline{G_{(2)}}$ is floral formula of **[1993]**
(a) *Allium cepa* (b) *Solanum nigrum*
(c) *Helianthus annuus* (d) *Brassica nigra*

75. Tetradynamous condition is characteristics of **[1986, 1990, 93, 1993, 1997, 2001, 2001, 2011]**
(a) *Liliaceae/Allium/Asphodelus*
(b) Cruciferae/Mustard/Iberis
(c) Malvaceae/*Althea/Hibiscus*
(d) Solanaceae/*Nicotiana/Petunia*

76. The floral formula of solanaceae (Chilli) is **[2006, 2011]**
(a) $E_{br}\oplus ♀♂ K_{(5)}\overset{\frown}{C_{(5)}}\ A_5\underline{G_{(2)}}$
(b) $E_{br}\oplus ♀♂ K_{(4)}C_{2+2}\ A_{2+4}G_{(2)}$
(c) $E_{br}\oplus ♀♂ K_{(5)}\overset{\frown}{C_5}\ A_\infty\underline{G_{(5)}}$
(d) $Br\%K_{(5)}C_{(5)}\ A_{(10)}G_1$

77. Pentamerous actinomorphic flowers, bicarpellary ovary with oblique septa, and fruit a capsule or berry, are characteristic features of **[2006]**
(a) Solanaceae (b) Liliaceae
(c) Asteraceae (d) Brassicaceae

78. What type of placentation of seen in sweet pea **[2006]**
(a) Free central (b) Marginal
(c) Basal (d) Axile

79. Bicarpellary syncarpous gynoecium, parietal placentation, tetradynamous stamens and siliqua fruit are characteristic features of family **[1986, 1986, 1992, 1993, 1994, 1995, 1998]**

(a) Cucurbitaceae (b) Cruciferae
(c) Compositae (d) Solanaceae

80. A family delimited by type of inflorescence is **[1990]**

(a) Fabaceae (b) Asteraceae
(c) Solanaceae (d) Liliaceae

81. Replum is present in the ovary of flower of **[2008]**

(a) Sun flower (b) Pea
(c) Lemon (d) Brassicaceae Mustard

82. The floral formula $\oplus \, ♀♂ K_{(5)} \overset{\frown}{C_{(5)}} A_5 \, \underline{G(2)}$ is that of **[2009, 2015]**

(a) Tulip (b) Soybean
(c) Sunnhemp (d) Tobacco

83. Vexillary aestivation is characteristic of the family **[2012, 2012]**

(a) Fabaceae (b) Asteraceae
(c) Solanaceae (d) Brassicaceae

84. The typical floral formula of Papilionaceae (Soybean) is **[2010, 2012]**

(a) $\oplus \, ♀♂ K_{(5)} \, C_{(5)} \, A_5 \, \underline{G_2}$ (b) $\oplus \, ♀♂ K_{(5-4)} \, C_{(5-4)} \, A \, \underline{G_5}$

(c) $\% \, ♀♂ K_{(5)} \, C_{1+2+(2)} \, A_{1+(9)} \, \underline{G_1}$ (d) $\% \, ♀♂ \, K_{(5)} \, C_5 \, A_{10} \, \underline{G_1}$

85. Placentation in tomato and lemon is **[2012]**

(a) Parietal (b) Free central
(c) Marginal (d) Axile

86. Long filamentous threads protruding at the end of a young cob of maize are **[2006]**

(a) Ovaries (b) Hairs
(c) Anthers (d) Styles

87. Tricarpellary syncarpous gynoecium is found in flowers of **[2016]**

(a) Liliaceae (b) Solanaceae
(c) Fabaceae (d) Poaceae

10. AIIMS

1. An underground specialised shoot with reduced disc like stem covered by fleshy leaves is **[1996, 2000, 2013]**

(a) Bulb (b) Bulbil
(c) Rhizome (d) Rhizophore

2. Potato and sweet potato **[2004]**

(a) Have edible parts which are homologous organs
(b) Have edible parts which are analogous organs
(c) Have been introduced in India from the same place
(d) Are two species of the same genus

3. In *Lathyrus aphaca*, the leaves are modified into **[1997]**

(a) Spine (b) Tendril
(c) Scale (d) Stem-like structure

4. Phyllotaxis is **[1996, 1999, 2002]**

(a) Mode of leaf arrangement on stem
(b) Types of roots
(c) Arrangement of sepals and petals in a flower
(d) Type of ovary

5. Axis developing between androecium and gynoecium is **[1989, 1990]**

(a) Anthophore (b) Androphore
(c) Gynophore (d) Gynandrophore

6. Two minute scales or lodicules occur in **[1997, 1997]**

(a) *Citrus medica*
(b) *Triticum aestivum*
(c) *Helianthus annus*
(d) *Gossypium herbaceum*

7. Butterfly shaped flower with one stranded, two wing-like and two keeled petal belong to **[2000]**

(a) Compositae (b) Rubiaceae
(c) Malvaceae (d) Papilionaceae

8. In china rose the flowers are **[1999, 2013]**

(a) Zygomorphic, epigynous with twisted aestivation
(b) Actinomorphic, hypogynous with twisted aestivation
(c) Actinomorphic, epigynous with valvate aestivation
(d) Zygomorphic, hypogynous with imbricate aestivation

9. The primitive type of stamens are found in the flowers family **[1994]**

(a) Liliaceae
(b) Malvaceae
(c) Gramineae/Poaceae
(d) Degeneriaceae/Magnoliaceae

10. The plant whose seeds are known to have longest viability period is **[1993]**

(a) *Nelumbo nucifera* (lotus)
(b) *Triticum vulgare* (wheat)
(c) *Zizyphus jujuba* (ber)
(d) *Carica papaya* (papaya)

11. In which of the following plants, cotyledons form the first pair of leaves **[1992]**

(a) Maize (b) Castor
(c) Rice (d) Bean

12. A fruit developed from a condensed inflorescence is **[2010]**

(a) Simple fruit (b) Aggregate fruit
(c) Composite fruit (d) Etaerio

13. Plants with inferior ovary usually bear **[2012]**

(a) Pseudocarps (b) Berries
(c) Aggregate fruits (d) Seedless fruits

14. A weed belonging to family Asteraceae which has spread in all parts of India is **[1992, 1992]**

(a) *Nicotiana* (b) *Oryza*
(c) *Parthenium* (d) *Hordeum*

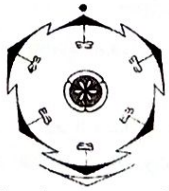
15. *Colchicum autumnale* is a member of **[1989, 2010]**

Or

Colchicine is obtained from which of the following families **[2012]**

(a) Brassicaceae (b) Liliaceae
(c) Poaceae (d) Fabaceae

16.



Plants having the above given floral diagram are **[2012]**

(a) Leguminous
(b) Dicots
(c) Medicinal and perennial
(d) Having pinnately compound leaves

17. Name the family having (9)+1 arrangement of stamens **[2001]**

(a) Solanaceae (b) Asteraceae
(c) Liliaceae (d) Fabaceae

18. Floral formula of mustard (or) Cruciferae is **[1986, 1991, 1991, 92, 95, 96, 97, 1991, 2010]**

Or

Floral formula of *Brassica campestris* is **[2010]**

(a) $\oplus \male\!\!\female K_{(5)} C_{(5)} A_5 \underline{G_{(2)}}$

(b) Ebr $\oplus \male\!\!\female K_{2+2} C_4 A_{2+4} \underline{G_{(2)}}$

(c) $\oplus \male\!\!\female K_5 C_5 A_{(5)} \underline{G_{(2)}}$

(d) $\oplus \male\!\!\female K_5 C_5 A_5 \underline{G_{(2)}}$

19. The family containing mustard, and its main characters are: **[2005]**

(a) Brassicaceae-Tetramerous flowers, six stamens, bicarpellary gynoecium, siliqua type fruit

(b) Brassicaceae-Pentamerous flowers, many stamens, pentacarpellary gynoecium, capsule type fruit

(c) Solanaceae-Pentamerous flowers, five stamens, bicarpellary gynoecium, berry type fruit

(d) Poaceae-Trimerous flowers, three stamens, monocarpellary gynoecium, caryopsis type of fruit

11. Assertion and Reason

Read the assertion and reason carefully to mark the correct option out of the options given below :

(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion

(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion

(c) If the assertion is true but the reason is false

(d) If both the assertion and reason are false

(e) If the assertion is false but reason is true

1. Assertion : In floating aquatic plants, root caps are absent.
Reason : Root pockets are present in aquatic plants.

2. Assertion : Root hairs are present on whole root surface.
Reason : Root hairs absorb water.

3. Assertion : Coconut tree is distributed in coastal areas over a large part of the world.
Reason : Coconut fruit can float and get dispersed over thousands of kilometres before losing viability.

4. Assertion : *Momordica* roots look like necklace.
Reason : *Momordica* possess moniliform roots.

5. Assertion : Epiphytes are called space parasites.
Reason : Epiphytic roots possess velamen.

6. Assertion : Ginger has a prostrate-growing rhizome.
Reason : Shoot growth is not effected by gravity.

7. Assertion : Human travellers also disperse seeds and fruits.
Reason : Generally seeds of economically important crops are introduced to new areas.

8. Assertion : Thorns of *Artabotrys* are modified floral stalks.
Reason : In *Antigonon*, the upper floral buds develop thorns.

9. Assertion : Whole compound leaf of *Clematis* converts into tendril.
Reason : *Gloriosa superba* shows whole leaf tendril.

10. Assertion : Samara is a winged achenial fruit.
Reason : Wings may or may not develop from its pericarp.

11. Assertion : China rose and rose both bear stipules.
Reason : They are of adnate types.

12. Assertion : In corymb, all the flowers lie at the same level.
Reason : Pedicels of all the flowers are of same length.

13. Assertion : In syconous type of fruit, the achiness formed is fewer than the total number of flowers in the inflorescence from which it is formed.
Reason : Upper and middle flowers cannot develop into fruits.

14. Assertion : Maize is an albuminous seed.
Reason : Endosperm is completely absorbed by its growing embryo.

15. Assertion : The mesocarp of drupe is edible in all cases.
Reason : Coconut is a fibrous drupe.

16. Assertion : Prickles of plant have a single role of protection of plant.
Reason : They are superficial in origin.

17. Assertion : Heterophylly is seen in many aquatic plants.
Reason : Aquatic plants survive in two different conditions of the environment.

18. Assertion : Spathe, a bract of spadix attracts pollinators.
Reason : Spathe is often brightly coloured.

19. Assertion : In cymose inflorescence, the main axis ends in a flower, but the lateral axis show continuous growth.
Reason : The arrangement of flower in this inflorescence is centrifugal.