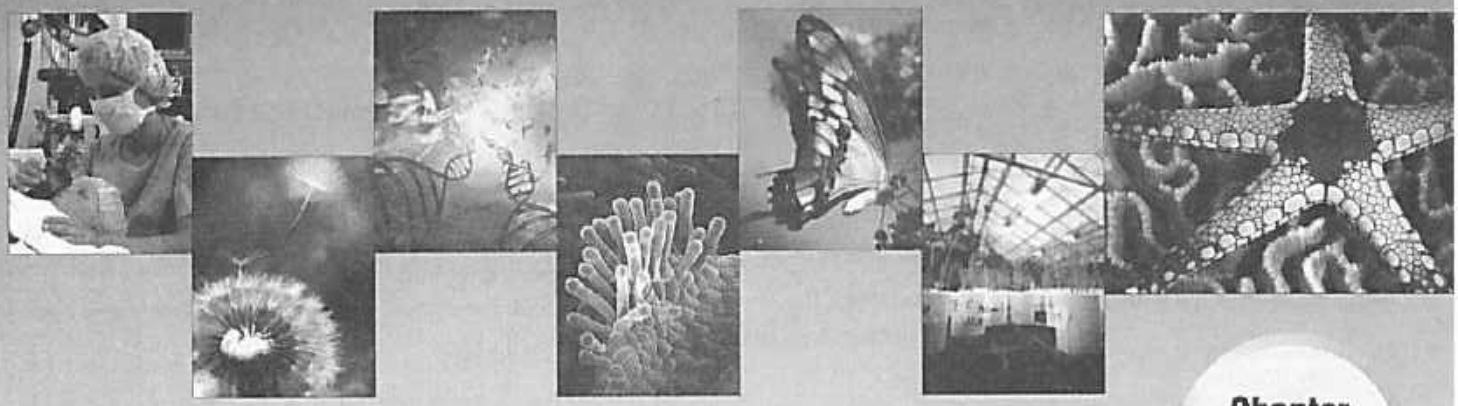


Chapter

2.1

Morphology of Flowering Plants

Morphology (Gr. Morphos = Form; logos = Study) 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.

Parts of a flowering plant : Flowering plants consist of root, stem, leaves, flower, fruits and seeds.

The root

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.

Characteristics of the root

(1) The root is the descending portion of the plant axis and is positively geotropic and negatively phototropic.

(2) It is non-green or brown in colour.

(3) The root does not bear nodes, internodes, leaves and true buds.

(4) Usually the root tip is protected by a root cap.

(5) The root bears unicellular root hairs.

(6) Lateral roots arise from the root which are endogenous in origin (arise from pericycle).

Parts of the root

(1) **Region of root cap :** The tip of the root is called calyptra or root cap. It is for protection of root tip against any injury. It is formed from meristem called calyptrogen. *Pandanus* is the only plant with multiple root caps. In the aquatic plants like *Pistia*, *Lemna* and *Eichhornia* instead of root caps, they have root pockets for buoyancy. The root caps are absent in parasites and mycorrhizal roots.

(2) **Region of cell formation or meristematic zone :** This region of cell division lies protected below the root cap. It comprises of closely arranged, small, thin walled and isodiamatric cells which have dense protoplasm. Vacuoles of the cells are either reduced in size or absent.

(3) **Region of cell elongation :** It lies behind the growing point. Cells of this region lose power of division. The cells elongate due to vacuolation i.e., formation of vacuoles.

This region chiefly concerns with absorption of minerals along with some amount of water.

(4) **Region of cell differentiation or maturation (Root hair zone) :** In this region elongated cells are differentiated into permanent tissues depending upon the functions they have to perform. It lies adjacent to the meristematic region some cell of the outermost layer of cells in this region develop root hairs. Most of the water absorption occurs through this region.

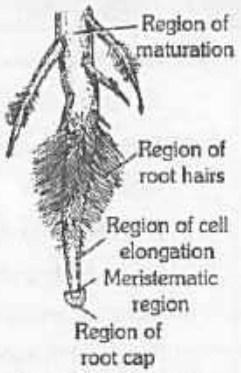


Fig : 2.1-1 Regions of the root

Types of root

Tap root : Tap root is the primary root which develops from the elongation of the radicle of embryo and persists throughout the life of plant. It forms lateral branches or secondary roots which are further branched to form tertiary roots. Thus tap root along with its branches i.e., secondary and tertiary roots form tap root system.

Adventitious root : 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. In grasses, fibrous root system is present.

Modification of roots

Sometimes the root performs functions other than fixation, absorption and conduction so get modified structurally. Both tap roots and adventitious roots may undergo such modifications. There are many types of root modifications.

Modification of tap roots

(1) **Storage roots :** In some plants, the primary tap roots are modified for storing reserve food materials. The secondary roots remain thin and they are absorptive in function. The storage roots are usually swollen and assume various forms :

(i) **Conical :** The swollen root is broad at the base and tapers gradually towards the apex giving a shape of cone, *e.g., Carrot.*

(ii) **Fusiform :** The root is swollen in the middle and narrow towards both its base *e.g.*, Radish (*Raphanus sativus*).

(iii) **Napiform :** The root is nearly globular or spherical in shape. The basal portion of root is much swollen which suddenly tapers towards the apex giving a top-shaped appearance, *e.g.*, Turnip (*Brassica napus*, vern, Shalgam) and Beet (*Beta vulgaris*, vern. Chukandar).

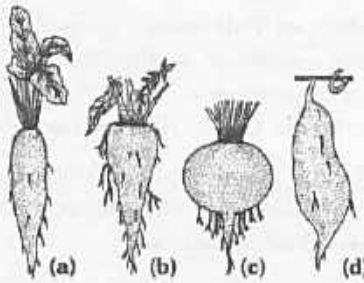


Fig : 2.1-2 Tap root modifications (a) Fusiform (b) Conical (c) Napiform (d) Tuberous

(iv) **Tuberous :** The storage root having no definite shape is called tuberous, *e.g., Mirabilis jalapa* (4 O'clock plant).

(2) **Branched roots**

(i) **Nodular roots (Tuberculated roots) :** The primary tap roots and its branches of leguminous plants, *i.e.*, plants belonging to sub-family papilionatae of the family leguminosae (*e.g.*, Pea, Gram, Ground nut, Beans etc.), bear nodule like swellings, called root nodules.

They are red in colour due to the presence of leg-haemoglobin. The nodules are inhabited by nitrogen fixing bacteria called *Rhizobium leguminosarum*. It converts atmospheric nitrogen into nitrates and supply them to the plant. In turn *Rhizobium* gets nutrients and shelter from the plant.

(ii) **Pneumatophores or Respiratory roots :** The roots of some plants growing in saline marshes (mangrove plants) suffer from the lack of oxygen. This is due to the water logged condition of the soil. To cope with this situation some root branches grow vertically upwards.

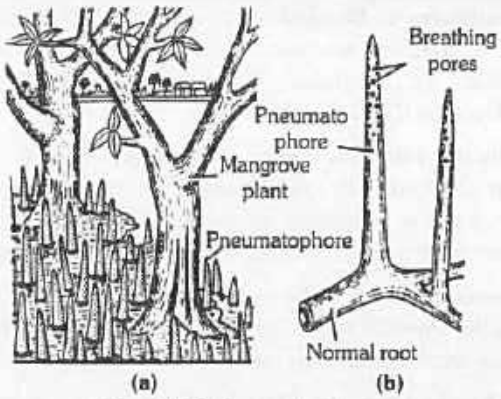


Fig : 2.1-3 Pneumatophores :
(a) Plants showing pneumatophores
(b) Part of pneumatophores showing breathing pores

They become aerial and negatively geotropic. These roots bear many minute pores called pneumathodes (lenticels) towards their upper ends. Gaseous exchange takes place through pneumathodes. Such aerial, porous, roots which help in gaseous exchange are called breathing roots. *e.g.*, *Sonneratia, Heritiera, Rhizophora, Avicennia* and *Ceriops* etc. and are found in sundarbans of West Bengal.

For physiological or Vital functions

(1) **Storage roots :** The roots where adventitious roots become swollen to store food. They are of following types :

Tuberous roots : These adventitious roots are swollen without any definite shape *e.g., Ipomoea batata* or (Sweet potato).

Fasciculated roots : These are tuberous roots arising in cluster from the base of the stem. *e.g., Dahlia, Ruellia* (Menow weed), *Asparagus* etc.

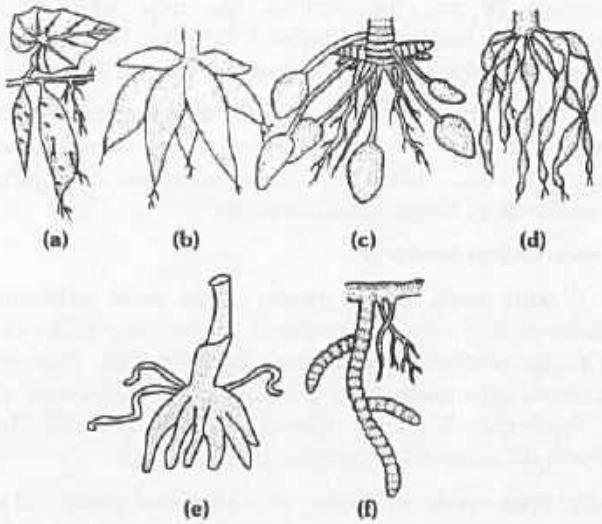


Fig : 2.1-4 Modification of adventitious root : (a) Tuberous root of sweet potato (b) Fasciculated roots of *dahlia*, (c) Nodulose roots of mango ginger, (d) Moniliform root of *Momordica*, (e) Palmate roots of *Orchis*, (f) Annulated roots of *Ipecac*

Nodulose roots : These roots become swollen at their tips due to accumulation of food *e.g., Maranta* sp. (Arrowroot), *Curcuma amanda* (Mango – ginger).

Moniliform or Beaded roots : These adventitious roots are swollen at frequent intervals. This gives the root a beaded appearance. *e.g.*, *Portulaca* (Rose moss), *Momordica* (Bitter gourd), *Cyperus* (Guinea rush).7

Palmate tuberous roots : In *Orchis* there is a pair of succulent tuberous root, one of which perishes every year while another new one is formed by its side. Such orchid roots may sometimes be of palmate shape, therefore, called palmate roots.

Annulated roots : The roots of a medicinal plant, *Cephaelis ipecacuanha* (Ipecac) yields emetine that looks like discs placed one above another, therefore, called annulated.

(2) **Epiphytic roots :** These roots are also called 'hygroscopic roots'. These roots develop in some orchids which grow as epiphytes upon the trunks or branches of trees. They hang freely in the air and absorb moisture with the help of special sponge like tissue called velamen. Velamen is modification of epidermis. *e.g.*, *Vanda*, *Dendrobium* etc.

(3) **Parasitic or Haustorial or Sucking roots :** The roots of parasitic plants, which penetrate into the host tissues to absorb nourishment, are called haustorial roots. *e.g.*, *Cuscuta* (Dodder, Vern, Amarbel).

(4) **Saprophytic roots (Mycorrhizal roots) :** The roots are associated with fungal hyphae either superficially (ectomycorrhizae) or internally (endomycorrhizae) for absorption of water and minerals. *e.g.*, *Monotropa* and *Sarcodes*.

(5) **Photosynthetic or Assimilatory roots :** These are green, aerial, adventitious roots which prepare food materials by photosynthesis are called photosynthetic roots or assimilatory roots *e.g.*, *Taeniophyllum*, *Trapa* and *Tinospora*. In some epiphytes like *Taeniophyllum*, the stem and leaves are absent. The entire plant is represented by thin green, ribbon like roots which contain velamen. These roots absorb moisture from the atmosphere and manufacture food materials by photosynthesis.

(6) **Reproductive roots :** Some fleshy adventitious root develop buds which can grow into new plants. These are called reproductive root. These roots serve as means of vegetative propagation. *e.g.*, Sweet potato, *Dahlia* etc.

For mechanical function

(1) **Stilt roots (Brace roots) :** The aerial, adventitious obliquely growing roots that develop from the lower nodes of the stem to give additional support are called stilt roots. These roots bear several large overlapping root caps called multiple root caps. *e.g.*, *Sugarcane*, *Pandanus*, *Rhizophora*, *Sorghum* and *Maize*. *Pandanus* (screw pine) is a common sea shore plant.

(2) **Prop roots or Pillar or Columnar roots :** These adventitious aerial roots arise from horizontal aerial branches of the trees like *Ficus benghalensis* (Banyan). They grow vertically downward, penetrate the soil, become thick and assume the shapes of pillars. They provide support to the spreading branches of tree. Prop roots possess lenticels for aeration.

In India, the biggest banyan tree having large number of prop roots are found at Indian Botanical Gardens, Kolkata and Kadiri (Andhra Pradesh).

(3) **Buttress roots :** The horizontal plank like aerial, adventitious roots that develop at the base of the stem to give additional support are called buttress roots or ballast roots, *e.g.*, *Terminalia* and *Salmalia*.

(4) **Climbing roots :** The aerial adventitious roots that arise from the nodes or internodes of weak stemmed plants to climb up their support are called climbing roots, *e.g.*, *Pothos*, *Piper betel*, *Vanilla* and *Hedera*. In *Pothos* and *Hedera*, climbing roots develop all over the stem. In *Vanilla*, single tendril like root arise at each node. Hence they are called tendrillar roots. In *Piper betel*, many short branched, adventitious roots arise at each node. These roots are called clinging roots.

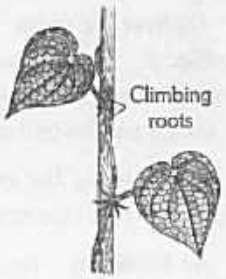


Fig : 2.1-5 Climbing root of Piper betel

(5) **Floating roots :** These roots develop from the nodes of floating aquatic plants like *Jussiaea* (=*Ludwigia*). They store air, become inflated and spongy, project above the level of water, make the plant light and function as floats.

(6) **Contractile or Pull roots :** Some roots of plants with underground stems contract or swell so that the aerial shoots are kept in a proper depth in the soil. These roots are called contractile or pull roots, *e.g.*, *Canna*, *Crocus*, *Allium*, *Lilium*, *Freesia*, etc.

(7) **Root thorns :** In aroids like *Pothos* and many palms (*Acanthorhiza* and *Iriartea*) the adventitious roots become hard and pointed hence called root thorns.

The stem

The stem develops from the plumule of the germinating seed. Normally it is the aerial part of the plant body.

Characteristics of stem

(1) Stem is an ascending axis of the plant and develops from the plumule and epicotyl of the embryo.

(2) It is generally erect and grows away from the soil towards light. Therefore, it is negatively geotropic and positively phototropic.

(3) The growing apex of stem bears a terminal bud for growth in length.

(4) In flowering plants, stem is differentiated into nodes and internodes. A node occurs where leaves are attached to the stem. Internode is the portion of stem between the two nodes.

(5) The lateral organs of stem (*i.e.*, leaves and branches) are exogenous in origin (from cortical region).

(6) The young stem is green and photosynthetic.

(7) Hair, if present, are generally multicellular.

(8) In mature plants, stem and its branches bear flowers and fruits.

Diverse forms of stem

(1) **Reduced stems :** In some plants, the stem is in the form of a reduced small disc which is not differentiated into nodes and internodes. e.g., (a) A reduced green-coloured disc-like stem lies just above the base of fleshy roots of Radish, Carrot and Turnip ; (b) Green-coloured small discoid stem occurs in free-floating *Lemna*, *Spirodela* and *Wolffia*; (c) Highly reduced non-green discoid stem occurs at the base of Onion and Garlic bulbs, etc.

(2) **Erect stems :** Majority of angiosperms possess upright, growing-ascending, vertically-erect stems. They are fixed in the soil with the help of roots.

(3) **Weak stems :** They are thin, soft and delicate which are unable to remain upright without any external support. They are of two types : upright weak stems and prostrate weak stems.

(i) **Upright weak stem**

Twiners : The stems are long, slender, flexible and very sensitive. They twin or coil around an upright support on coming in its contact due to a special type of growth movement called nutation. They may coil the support to the right (anticlockwise from the top or sinistrorse) *e.g.*, *Convolvulus* sp., *Ipomoea quamoclit Clitoria ternatea*, etc. or to the left (clockwise or dextrorse), *e.g.*, Lablab.

Climbers : The stem is weak and unable to coil around a support. They usually climb up the support with the help of some clasping or clinging structure. They are of four types :

(a) **Tendril climbers :** Tendrils are thread like green structure which help in climbing the plants. They may be modified stem (*e.g.*, *Vitis*), stem branches (*e.g.*, *Passiflora*) and inflorescence (*e.g.*, *Antigonon*).

(b) **Root climbers :** Adventitious roots arise from the nodes and penetrate into the upright support so that the climber climbs up, *e.g.*, Betel vine (*Piper betel*), *Tecoma*, *Ivy*, etc.

(c) **Scramblers or Hook climbers :** These weak stemmed plants slowly grow over other bushes and rest there. They attain this position with the help of curved prickles (*e.g.*, Rose), curved hooks on flowering peduncle (*e.g.*, *Artabotrys*), prickles on stem (*e.g.*, *Lantana*), spines (*e.g.*, Climbing *Asparagus*) or spinous stipules (*e.g.*, *Zizyphus*).

(d) **Lianas :** These are woody perennial climbers found in deep forests. At first, they are just like ordinary twiners but once they reach to the top and get sunlight, become woody. *e.g.*, *Tinospora*, *Ficus*, *Bauhinia*, *Bignonia*, etc.

(ii) **Prostrate weak stem**

Trailers : The stem creep on the ground but roots do not arise at the nodes. They are of three types :

(a) **Procumbent :** The stem creeps on the ground totally *e.g.*, *Tribulus*, *Basella*, *Evolvulus*.

(b) **Decumbent :** Branches, after growing horizontally for some length, grow vertically upwards, *e.g.*, *Portulaca*, *Tridax*, *Lindenbergia*, etc.

(c) **Diffuse :** Branches grow profusely in all directions, *e.g.*, *Boerhaavia*.

Creepers : These weak-stemmed plants grow prostrate and develop adventitious roots from their nodes. Creepers are of three kinds :

(a) **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*.

(b) **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*).

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

Modification of stem

Underground stem

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) **Sucker :** This is a sub aerial branch that arises from the main stem. Initially it grows horizontally below the soil surface and later grows obliquely upward. They are shorter and stouter than the runners. *e.g.*, *Mentha arvensis* (mint vern. Podina) and *Chrysanthemum*.

Fig : 2.1-6 Sucker

(2) **Stem tuber :** Stem tuber is the tuberous tip of an underground branch. It occurs beneath the soil at any 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 the presence 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 :

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

(ii) **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 is non 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.

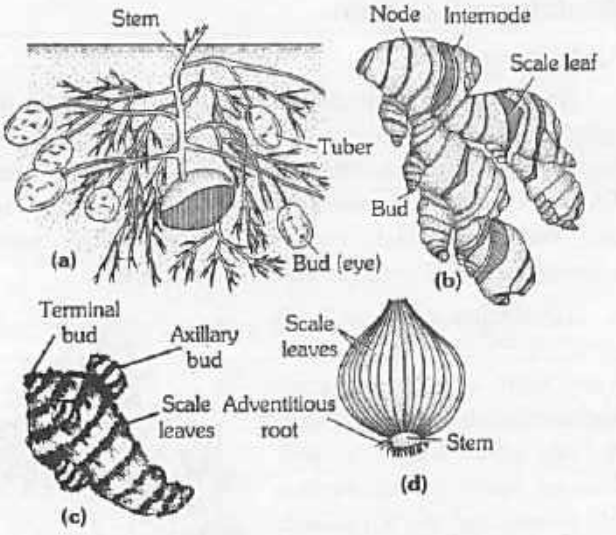


Fig : 2.1-7 Underground modification of stem
(a) Tuber s of potato (b) Rhizome of ginger
(c) Corm of *colocasia* (d) Bulb of onion

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).

(5) **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 as to form an underground bulb. The leaf bases or scales become fleshy due to accumulation of food (carbohydrates) and water. The terminal bud grows into inflorescence or aerial shoot (scape), while some of the axillary buds develop into daughter bulbs. Bulbs are of two types, tunicated bulb and scaly bulb.

(i) **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).

(ii) **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).

Aerial stem

(1) **Tendrils :** The tendrils are thin, wiry, leafless and spirally coiled branches. The terminal part of a tendril is sensitive. It holds the support by coiling round it. The tendrils help the weak stems to climb the support. In some weak stemmed plants, the axillary bud or terminal bud may modify to form tendrils which are specially called stem tendrils. Stem tendrils are of following four types :

(i) Axillary : *e.g.*, *Passiflora.*

(ii) Extra-axillary : *e.g.*, *Luffa* (vern. Ghiatori), *Cucurbita* (vern. Kaddoo), *Lagenaria* (vern. Lauki).

(iii) Apical bud tendrils : e.g., Grape Vine (*Vitis vinifera*).

(iv) Floral bud or Inflorescence tendrils : *e.g.*, *Antigonon*.

(2) **Stem thorns :** The axillary buds of some plants become arrested and get modified into stiff, sharp and pointed structures, called thorns. They are deep seated structures having vascular connections with stem. Besides reducing transpiration, they protect the plant from browsing animals. *e.g.*, *Citrus*, *Duranta*, *Bougainvillea*, *Pomegranate*, *Flacourtia*, *Aegle marmelos* etc. In Alhagi the thorns bear flowers.

(3) **Phylloclades :** The phylloclade is special modified photosynthetic stem present mostly in xerophytes. It is green, flattened or cylindrical structure which has distinct nodes and internodes. 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.

(4) **Cladodes :** These are modifications of stem and branches of limited growth. It has one internode only. Each cladode is green, flat or cylindrical, leaf like structure which performs photosynthesis. In *Asparagus*, the leaves are reduced to curved spines. In *Ruscus aculeatus*, the leaf like cladode are borne in the axils of scale leaves.

(5) **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).

Stem branching

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 branching :** In this type of branching, the terminal (or apical) bud of the main stem grows indefinitely and the axillary buds grow out into lateral branches in acropetal succession.

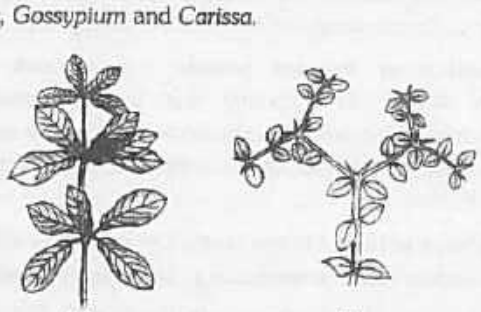
This type of branching is also called monopodial branching. Due to monopodial branching the shoot system of plant appears conical *e.g., Eucalyptus, Polyalthia* (Ashoka tree).

(2) **Cymose branching :** In cymose branching the terminal bud is active for a short period and becomes modified into some permanent structures like tendrils, thorns of flowers etc. Due to the terminal bud modification the growth of the main stem is definite. This is also called sympodial branching. Further growth in the plant is carried by one or more axillary buds. Cymose branching may be of three types :

(i) **Uniparous or Monochasial type :** In uniparous type of branching only one lateral branch is produced at each time below the modified terminal bud. Here the successive lateral branches that are formed unite to form a stem. Such a stem is called false axis or sympodium. The uniparous branching is of two kinds, helicoid and scorpioid.

(a) **Helicoid branching :** If the successive lateral branches develop on one side it is called helicoid branching. *e.g., Saraca, Canna* and *Terminalia*.

(b) **Scorpioid branching :** If the successive lateral branches develop on either side alternately, it is called scorpioid branching, *e.g., Cissus, Gossypium* and *Carissa*.



(a) (b)

Fig : 2.1-8 Types of uniparous branching
(a) Helicoid type branching in *Terminalia*
(b) Scorpioid type branching in *Carissa*

(ii) **Biparous or Dichasial type :** When the activity of terminal bud stops, further growth of plant takes place by two lateral branches, *e.g., Viscum* (Mistletoe), *Silene, Stellaria, Mirabilis jalapa* (Four O' clock), *Dianthus* (Pink), *Carissa carandas* (Karonda), etc.

(iii) **Multiparous or Polychasial type :** When the activity of terminal bud stops, further growth of plant takes place by a whorl of three or more axillary branches. The axis is said to be multipodial, *e.g., Euphorbia tirucalli, Croton, Nerium odoratum* (Oleander).

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.

Nature of buds : According to nature they are of following types :

(1) **Vegetative buds :** These buds grow to form only leafy shoots.

(2) **Floral buds :** These buds grow to form flowers.

(3) **Mixed buds :** They produce both vegetative and floral branches.

Position of buds : They are of following types :

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

Apical 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.

(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.

(vi) **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 *Bryophyllium, 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.

The leaf

The leaf is a green, flat, thin, expanded lateral appendage of stem which is borne at a node and bears a bud in its axil. It is exogenous in origin and develops from the leaf primordium of shoot apex. The green colour of leaf is due to presence of the photosynthetic pigment – chlorophyll which helps plants to synthesize organic food. The green photosynthetic leaves of a plant are collectively called foliage.

Characteristics of leaf

(1) The leaf is a lateral dissimilar appendage of the stem.

(2) A leaf is always borne at the node of stem.

(3) The growth of leaf is limited.

(4) The leaves do not possess any apical bud or a regular growing point.

Parts of a typical leaf

The leaf consists of three parts namely, leaf base (usually provided with a pair of stipules), petiole and leaf blade or lamina.

(1) **Leaf base (Hypopodium) :** Leaf base is the lower most part of the leaf meant for attachment. It acts as a leaf cushion. Some times leaf base shows different variations as follows :

(i) **Pulvinus leaf base :** In members of leguminosae the leaf base is swollen. Such swollen leaf bases are called pulvinus leaf bases as seen in mango leaves. It helps in seismonastic movements (*e.g., Mimosa pudica*) and nyctinastic movements (*e.g., Enterobium, Arachis*, Bean).

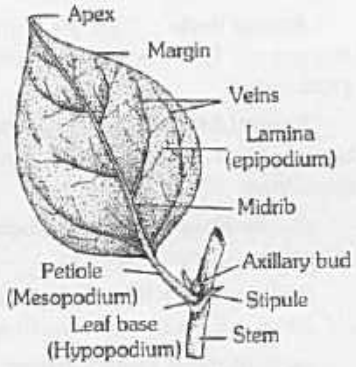


Fig : 2.1-9 Part of a typical leaf

(ii) **Sheathing leaf base :** In grasses and many monocots, the leaf base is broad and surrounds the stem as an envelope, such a leafbase is called sheathing leaf base. *e.g., Sorghum*, Wheat and Palms. In grasses (*Sorghum*, Wheat etc.) the sheathing leaf base protects the intercalary meristem.

(iii) **Amplexicaul :** Leaf base completely encircles the stem. *e.g., Polygonum.*

(iv) **Modified leaf base :** The leaf bases in few plants perform accessory functions and show modifications. In *Allium cepa* (Onion), the leaf bases store food materials and become fleshy. In *Platanus* and *Robenia*, the leaf bases protect the axillary buds and grow around them to form cup like structures.

(v) **Stipule :** The stipules are the small lateral appendages present on either side of the leaf base. They protect the young leaf or leaf primordia. Leaves with stipules are called stipulate and those without them are called exstipulate. The stipules are commonly found in dicotyledons. In some grasses (Monocots) an additional outgrowth is present between leaf base and lamina. It is called ligule. The leaves having ligules are called ligulate.

Types of stipules : Depending upon the structure and position various kinds of stipules are recognized.

Free lateral stipules : A pair of freely arranged stipules present on either side of the leaf base are called free lateral stipules, *e.g., Hibiscus* and Cotton.

Adnate stipules : The two stipules that fuse with the leaf base or petiole on either side are called adnate stipules, *e.g., Arachis* and Rose.

Inter petiolar stipules : Stipules present in between the petioles of opposite leaves, *e.g., Ixora* and *Hamelia.*

Axillary stipules : Stipules present in the axil of a leaf are called axillary stipule. These are also called intrapetiolar stipule, *e.g., Tabernamontana* and *Gardenia.*

Ochraceous stipules : Membranous tubular stipules that ensheath the axillary bud and a part of internode is called ochraceous stipule. It is formed by the union of two stipules, *e.g., Polygonum* and *Rumex.*

Hairy stipules : These are hair like stipules which are dry in nature, *e.g., Anacampsora.*

Foliaceous : Green, expanded, leaf like stipules are called foliaceous stipules. They carryout photosynthesis, hence called assimilatory stipules, *e.g., Pisum sativum* and *Lathyrus aphaca.*

Spinous : In some plants the stipules are modified into hard, pointed defensive organs called spines, *e.g., Acacia arabica, Prosopis juliflora* and *Zizyphus.*

Convolute or Bud scales : Scales which protect the buds are called bud scales. Sometimes they are modified into stipules. The bud scales fall off as the buds open, *e.g., Artocarpus* and *Ficus.*

(2) **Petiole (Mesopodium) :** A petiole or leaf stalk is a cylindrical or sub cylindrical structure of a leaf which joins the lamina to the base. A leaf with a petiole is called petiolate and the one without it is called sessile.

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).

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

Shape of lamina : It varies in different plants as follows.

(1) **Acicular type**
Needle shaped leaves.
e.g., Allium cepa, Pinus


Pinus

(2) **Linear type**
Long and slightly broader leaves.
e.g., Triticum (wheat), *Oryza sativa*


Grass

(3) **Lanceolate type**
Lance shaped leaves.
e.g., Nerium, Polyalthea.


Nerium

(4) **Orbicular or Rotund type**
More or less circular leaves.
e.g., Lotus, Nasturtium


Lotus

(5) **Elliptical oval type**
Leaves are like an ellipse.
e.g., Psidium (Guava), vinica


Vinca

(6) (i) **Ovate type**
Egg or top shaped leaves.
e.g., China rose
(ii) **Obovate type**
Inverted egg shaped. *e.g.,*
Juglans regia (Walnut), *Prunus amygdalus* (badam)


Hibscus

(7) **Spathulate**
Spoon like leaves.
e.g., Drosera, Calandula


Euphorbia

(8) **Oblique type**
Leaf lamina is with unequal half.
e.g., Margosa


Margosa

(9) **Oblong type**
Rectangular leaves.
e.g., Banana


Banana

(10) **Reniform type**
Kidney shaped leaves.
e.g., Hydrocotyle


Hydrocotyle

(11) (i) **Cordate type**
Heart shaped
(with a deep notch at the base)
leaves. *e.g., Betel, Banyan*
(ii) **Obcordate type**
Inverted heart shaped. *e.g., Oxalis, Bauhina*


Betel vine

(12) **Saggitate type**
Leaves shaped like an arrow head.
e.g., Sagittaria


Sagittaria

(13) **Hastate type**
Leaves like saggitate but
the two basal lobes are
directed outwards.
e.g., Ipomoea.


Ipomoea

(14) **Lyrate type**
Leaves shaped like a lyre.
e.g., Raphanus sativus (Raddish),
Brassica campestris (mustard)


Mustard

(15) **Centric type**
Hollow and cylindrical leaves.
e.g., Onion


Onion

(16) **Cuneate type**
Wedge shaped leaves. *e.g., Pistia*


Pistia

Margin of lamina : The margin of the lamina may be of different types as given.

Entire	**Serrate**	**Repand**	**Dentate**	**Crenate**	**Spiny**	**Biserrate**
Leaves with smooth margin.	Leaves have saw like margin.	Leaves have wavy margin.	Leaves have large pointed teeth like margin.	Leaves have round teeth margin.	Leaves have spiny margin.	Margins have incisions which are further incised.
						
Mango	*Hibiscus*	*Polyalthia*	*Aloe*	*Bryophyllum*	*Argemone*	*Ricinus*

Apex of lamina : The apex of the leaf lamina shows variations in different plants.

(1) **Acute** The apex is narrow and pointed. *e.g.*, Mango. *China rose* 	(2) **Acuminate** The apex is drawn out into a long tapering tail. *e.g.*, *Ficus religiosa.* 
(3) **Obtuse** The apex is rounded. *e.g.*, Banyan. 	(4) **Mucronate** Round apex with sharp pointed tip. *e.g.*, *Vinca.* 
(5) **Cuspidate or Spiny** The apex is spinous. *e.g.*, Date palm. 	(6) **Tendrillar** The apex form a tendril. *e.g.*, *Gloriosa.* 
(7) **Cirrhose** The mucronate like apex ends with fine thread like structure. *e.g.*, Banana. 	(8) **Truncate** The shape is abruptly cut across. *e.g.*, *Paris polyphylla.* 
(9) **Retuse** The apex obtuse is partial e.g., *Pistia* 	(10) **Emarginate** The obtuse apex is deeply notched. *e.g.*, *Bauhinia, Oxalis.* 

Surface of lamina : The surface of the lamina may be of many kinds.

Glabrous : Smooth and without hair. *e.g.*, *Mangifera indica.*

Glaucus : Covered by waxy coating with white tinge. *e.g.*, *Calotropis.*

Scabrous : Rough surface. *e.g.*, *Ficus.*

Viscose : Sticky surface. *e.g., Cleome.*

Pubescent : Covered with soft and wooly hair. *e.g., Tomato.*

Pilose : Covered with long distinct scattered hair. *e.g., Grewia pilosa.*

Hispid : Covered with long rigid hair. *e.g., Cucurbita.*

Spinose : Covered with small spines. *e.g., Solanum xanthocarpum.*

Texture of lamina : The texture of lamina also varies in different species.

Herbaceous : When the lamina is thin and soft.

Coriaceous : When the lamina is leathery.

Succulent : When the lamina is thick, soft and juicy.

Hygrophytic : When the lamina is very thin, membranous and spongy.

Life Span or Duration

(i) **Caducous** (Fugacious) : Leaves falling down soon after their appearance, *e.g., Opuntia* (vern. Chhittar Thor).

(ii) **Deciduous or Annual :** Leaves falling off almost simultaneously at the and of growing season. The phenomenon is called **leaf fall,** *e.g.,* Mulberry, Poplar. In *Euphorbia royleana* the leaves are **drought deciduous.**

(iii) **Persistent (evergreen) :** Leaves live for more than one season. They fall down individually at different times. Plants look evergreen, *e.g., Pinus, Eucalyptus, Mango, Oleander.*

Leaf Insertion

(i) **Radical :** Leaves borne on a reduced stem and appear to arise directly from the top of the root, *e.g., Radish, Turnip.*

(ii) **Cauline :** Leaves found on the nodes of the main stem, *e.g., Maize, Rose, Althaea.*

(iii) **Ramal :** Leaves produced on the nodes of the stem branches, *e.g., Dalbergia, Peepal, Zizyphus.*

Types of leaves

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

(1) **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*).

(2) **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.

(i) **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 :

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.*

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).

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.*

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.

(ii) **Palmate 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 :

Unifoliate : In this case, a palmately compound leaf is reduced to a single terminal leaflet. *e.g., Citrus* (Khatta), Lemon, etc.

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.

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.

Quadrifoliate : This leaf has four leaflets attached to the tip of petiole. *e.g., Paris quadrifolia, Marsilea.*

Multifoliate (Digitate) : A palmately compound leaf having five or more terminal leaflets, *e.g., Bombax malabarica, Cleome viscosa, Gynandropsis pentaphylla,* etc.

Phyllotaxy (Phyllotaxis)

The arrangement of leaves on the stem is called phyllotaxy (Gk. *Phyllon* = leaf; *taxis* = arrangement).

(1) **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 :

$$\text{Angular divergence} = \frac{\text{No. of circles}}{\text{Orthostichies}} \text{ of a circle } i.e., 360°$$

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.

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.

e.g., $\frac{1}{2}, \frac{1}{3}, \frac{1+1}{2+3} = \frac{2}{5}, \frac{1+2}{3+5} = \frac{3}{8}, \frac{2+3}{5+8} = \frac{5}{13}$, and so on.

(2) **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 :

(i) **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.

(ii) **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.*

(3) **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.*

(4) **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.*

Vernation (Aestivation)

Arrangement of leaves in bud condition is known as vernation e.g., Imbricate (irregular overlapping), contorted (twisted, regular overlapping of margins), induplicate (margin bent inwardly), equitant (conduplicate in two series, one overlapping the other completely), half equitant, supervolute (convolute leaves, one rolled over other).

Heterophylly

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

(1) **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.

(2) **Environmental heterophylly :** The heterophylly is due to change in environment including soil, temperature, humidity and air currents. e.g., *Sagittaria.*

(3) **Developmental heterophylly :** Young leaves are different from mature leaves, e.g., *Eucalyptus.*

(4) **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.

Modification of leaves

Leaf tendrils : The leaves are modified into slender wiry and coiled structures called leaf tendrils. The tendril may be formed by entire leaf or a part of the leaf.

Entire leaf modified into tendril, e.g., *Lathyrus aphaca* (Wild pea).

Terminal leaflets modified into tendril, e.g., *Pisum sativum* (Pea), *Lathyrus odoratus* (Sweet pea), *Narvella.*

Leaf tip modified into tendril, e.g., *Gloriosa.*

Petiole modified into tendril, e.g., *Clematis.*

Stipule modified into tendril, e.g., *Smilax.*

Midrib modified into tendril, e.g., *Nepenthes.*

Spines : A pointed structure formed by the modification of entire leaf or part of a leaf is called a spine. Different part of a leaf or entire leaf may be modified into spines. e.g., In *Opuntia* leaves of axillary branches are modified into spines.

In *Berberis* entire leaf is modified into three spines. In *Phoenix* leaf tip is modified into spine. In *Citrus* first leaf of axillary branch modified into spine. In *Argemone* leaf margin is modified into spine. In *Perkinsonia, Acacia* and *Zizyphus* stipules are modified into spines.

Scale leaves : In many xerophytes, the foliage leaves are reduced to scale leaves. They are thin, membranous, dry, small, sessile, colourless structures. e.g., *Casuarina, Orobanche* and *Balanophora.*

Phyllode : It is a green, expanded structure formed by the modification of petiole or rachis of leaf. Many xerophytes reduce the size of their leaves to minimize water loss. Such plant develop phyllodes to carryout photosynthesis e.g., *Acacia, Melanoxylon* and *Parkinsonia.*

Storage leaves : Leaves become fleshy due to storage of water or food materials. Such leaves are called storage leaves. They are usually found in succulent plants. In plants like *Aloe, Allium, Kalanchoe* and *Peperomia.*

Reproductive leaves : In some plants the vegetative propagation is carried out by the production of epiphyllous buds on leaves. Such leaves are called reproductive leaves. The epiphyllous buds when come in contact with soil develop into new plants.

Absorbing leaves : In some rootless, aquatic plants, the submerged leaves are modified into root like structure to absorb water and mineral salts. Such modified leaves are called absorbing leaves. e.g., *Utricularia.*

Floral leaves : Floral parts such as sepals, petals, stamens and carpels are modified leaves. Sepals and petals are leafly stamens are considered pollen bearing microsporophylls and carpels are ovule bearing megasporophylls.

Cotyledons : The mature embryo shows either one (monocotyledons) or two cotyledons (dicotyledons). *Cuscuta,* a

parasite is included in dicotyledon. However it has no cotyledon and many cotyledons, as in gymnosperms. These cotyledons are considered as embryonic leaves which are the first leaves of a shoot system.

Trap leaves : The trap leaves are also called insectivorous leaves or carnivorous leaves. Plants having trap leaves usually grow in nitrogen-deficient soils (boggy soils). They have poorly developed root system.

These plants get their nitrogenous requirement by capturing the insects. To attract, capture, kill and digest the insects, the leaves are modified into trap leaves. *e.g., Nepenthes.*

Leaf Bladders : Some of the leaf segments of aquatic insectivore, *Utricularia,* are modified into bladders for trapping small aquatic animals like *Cyclops.*

Leaf Pitcher : Lamina (*e.g., Nepenthes*) or whole leaf (*e.g., Dischidia, Sarracenia*) is modified into pitcher. Pitcher has lid and takes part in catching and digesting small animals in *Nepenthes* and *Sarracenia.* In *Dischidia* the pitcher stores rain water.

Leaf Fall or Leaf Abscission : It is the shedding of leaves. A special layer of parenchymatous cell appears at the base of leaf. The same is called abscission or separation layer. A layer of suberised thick walled cells (cork cells) is formed below it. It is protective layer. The cells of abscission layer gelatinise and the leaf falls leaving a scar.

Venation

The arrangement of veins in the lamina of a leaf is called venation. The veins are the hard structures consisting of xylem and pholem. The veins give mechanical strength and shape to the lamina. Angiosperms exhibit two types of venation.

(1) Reticulate venation

In this type, the lateral veins divide and redivide to form many veinlets. These veinlets are arranged in a net like fashion or reticulum. Reticulate venation is the characteristic feature of dicotyledons. But exceptionally some monocotyledons also show reticulate venation. *e.g., Smilax, Alocasia* and *Dioscorea* etc. Reticulate venation is of two types :

(i) **Unicostate or Pinnate venation :** This type of venation is characterized by the presence of a single strong midrib that extends upto the apex of lamina. The midrib produce lateral veins on either side which divide repeatedly. *e.g., Ficus* and *Mangifera.*

(ii) **Multicostate or Palmate venation :** Here more than one prominent veins start from the base of the lamina and proceed upwards.

The lateral veinlets, arising from main veins, form network. Multicostate venation is of two types :

(a) **Convergent :** When the prominent veins converge towards the apex of lamina. *e.g., Zizyphus* and *Cinnamonum camphora* (kapoor), etc.

(b) **Divergent :** When the prominent veins spread out towards the margins. *e.g.,* Papaya, *Ricinus, Cucurbita* etc.

(2) Parallel or Striate venation

In this type, veins and veinlets run parallel to each other. Parallel venation is the characteristic feature of monocotyledons.

Exceptionally few dicots show parallel venation, *e.g., Calophyllum* and *Eryngium.* It is of two types :

(i) **Unicostate or Pinnate venation :** The leaf lamina possesses single prominent vein which gives rise to a large number of lateral veins. All the lateral veins run parallel towards margin. *e.g.,* Banana, Canna, *Curcuma* etc.

(ii) **Multicostate or Palmate venation :** The leaf lamina possesses several prominent veins which run parallel to each other. It is of two types :

(a) **Convergent :** The prominent veins run parallel to each other and converge at the apex. *e.g.,* Sugarcane, Maize, Wheat, Bambooes and Grasses.

(b) **Divergent :** All the prominent veins of leaf lamina spread out towards the margin. *e.g.,* Fan palm.

Ptyxis : Folding of lamina in bud condition is called ptyxis – circinate (rolled from apex to base, *e.g.,* fern leaves), **plicate** (plaited, folded lengthwise like Japanese fan, *e.g.,* Fan Palm), **conduplicate** (folded over midrib, *e.g., Bauhinia,* Guava), **reclinate** (upper half bent over lower half *e.g.,* Loquat), **crumpled** (irregular folding, *e.g.,* Cabbage), **involute** (margins rolled on upper surface, *e.g., Colocasia*), **revolute** (margins rolled on lower surface, *e.g.,* Oleander).

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.

(1) **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*).

(2) **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 :

(a) Simple Racemose Inflorescence

(i) **Typical Raceme (= Raceme) :** Unbranched, elongated peduncle bearing pedicellate or stalked flowers acropetally, *e.g., Delphinium* (Larkspur), *Raphanus* (Radish), *Linaria, Lupinus.*

(ii) **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).

(iii) **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).

(iv) **Umbel** : Pedicellate flowers arranged centripetally around an extremely reduced peduncle with an involucre below, *e.g., Centella* (= *Hydrocotyle*) *asiatica* (Brahmi Booti), *Androsace.*

(v) **Spike** : Sessile (*i.e.*, without stalk) flowers borne acropetally, *e.g., Callistemon* (Bottle Brush), *Amaranthus, Achryanthes, Adhatoda.*

(vi) **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.

(vii) **Strobile:** It is a spike having persistent and membranous bracts, *e.g., Humulus* (Hop).

(viii) **Catkin** : Compact unisexual spike often hanging, *e.g., Morus* (Mulberry), *Salix* (Willow), *Populus* (Poplar), *Betula* (Birch), *Acalypha, Quercus* (Oak).

(ix) **Spadix** : A fleshy spike covered with spathe is called spadix. *e.g., maize, banana* etc.

(x) **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.**

(b) Compound Racemose Inflorescence

(i) **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.

(ii) **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.

(iii) **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.

(iv) **Spike of Spikes** : *e.g., Amaranthus spinosus.*

(v) **Spike of Spikelets** : *e.g.*, Wheat

(vi) **Spadix of Spadices (Compound Spadix)** : *e.g.*, Date Palm, Coconut

(vii) **Capitulum of Capitula** : *e.g., Echinops.*

(viii) **Panicle of Spikelets** : *e.g.*, Jowar, Rice, Oat.

(3) **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.

(4) **Mixed Inflorescence**

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

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

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

(iv) **Corymb of Capitula** : *e.g., Ageratum.*

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

(5) **Special Inflorescence**

(i) **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).

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

(iii) **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.

(iv) **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).

Flower

It can be defined as modified dwarf shoot which is meant for sexual reproduction. It is characteristic feature of angiosperm.

Parts of a typical flower : A typical flower of an angiosperm consists of four types of floral parts namely calyx, corolla, androecium and gynoecium.

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*.

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*.

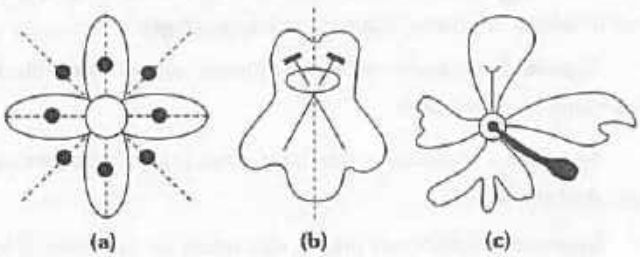


Fig : 2.1-10 Symmetry of flowers (a) Actinomorphic, (b) Zygomorphic, (c) Asymmetrical

Arrangement of floral organs

On the basis of arrangement of floral organs, three types of flowers 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*.

Number of floral parts in whorl is called the merosity. There are two kinds of flowers based on the merosity of the flower. They are isomerous flowers and anisomerous flowers.

If the number of sepals, petals, stamens and carpels of flower is equal, such flowers are called isomerous flowers.

Dimerous : Two floral parts in each whorl. *e.g.*, Poppy flower.

Trimerous : Three floral parts in each whorl. *e.g.*, Monocot flowers (Liliaceae).

Tetramerous : Four floral parts in each whorl. *e.g.*, Mustard.

Pentamerous : Five floral parts in each whorl. *e.g., Solanum*.

Detailed structure of flower

Angiospermic flowers exhibit many variations in their external morphological characters.

(1) **Bract :** Bract (hypsophyll) is a small leaf like structure on the peduncle which produces a flower in its axil. The floral buds are usually protected by the bracts.

Flower with a bract is described as bracteate and the flower without a bract is known as ebracteate. Bracteoles are small scale like structures present on the pedicel. Bracts are modified into following structures :

Foliaceous bract : Leaf like, expanded green bract is called the foliaceous bract, *e.g., Pisum, Lathyrus, Adhatoda* and *Gynandropsis*.

Spathe : A large modified bract which encloses spadix inflorescence totally or partially. It may be leathery or woody, *e.g., Alocasia, Cocoa, Musa* and *Typhonium*.

Petaloid bract : Brightly coloured petal like bract is known as petaloid bract, *e.g., Bougainvillea, Poinsettia* and *Euphorbia*.

Involucre : One or more whorls of green bracts that protect young inflorescence is called involucre, *e.g., Coriandrum, Tagetes* and *Heracleum*.

Epicalyx : Whorl of bracteoles present below the calyx or outside the calyx, *e.g., Hibiscus rosa sinensis* and *Malvaviscus arborcus*.

Scaly bracts : Reduced, membranous, scale like bracts seen in head inflorescence, *e.g.*, florets in *Tridax* and *Helianthus*.

Glumes : The bracts found on the rachilla of spikelet are called **glumes**. They may be sterile glumes or fertile glumes (lemma), *e.g., Oryza sativa*.

(2) **Thalamus :** The terminal part of the pedicel is called thalamus or torus or receptacle. It is a condensed axis of the flower from which all floral parts arise. Depending upon the position of gynoecium on the thalamus with respect to other parts, flowers are of three kinds – hypogynous, perigynous and epigynous.

In many flowers, the thalamus is condensed and the internodes are not seen clearly. But there are some flowers with elongated, distinct floral internodes as mentioned below :

Anthophore : This is the first elongated internode between the calyx and corolla, *e.g.*, *Silene*, *Pennsylvania* and *Lychnis*.

Androphore : It is the second elongated internode between corolla and androecium, *e.g.*, *Gynandropsis*.

Gynophore : It is the third elongated internode between androecium and gynoecium *e.g.*, *Capparis* and *Gynandropsis*.

Gynandrophore : It is an elongated stalk like part between non essential and essential organs of the flower. It is equivalent to androphore, *e.g.*, *Passiflora*.

Carpophore : This is a stalk like connection present between two carpels. It is formed due to expansion of the thalamus between the carpels, *e.g.*, *Coriandrum* and *Foeniculum*.

Androgynophore : When androphore and gynophore are present simultaneously, it is called androgynophore *e.g.*, in *Cleome gynandra Syn. Gynandropsis gynandra*.

(3) **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 :

Monochlamydeous flowers are with perianth in one whorl, *e.g.*, *Amaranthus* and *Ricinus*.

Dichlamydeous flowers are with perianth differentiated into calyx and corolla. They are arranged in two different whorls. The dichlamydeous condition is of two types :

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*.

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 *Hibisus*. The term "tepals" is used to describe the perianth units when both sepals and petals are similar. *e.g.*, most of the monocots.

(4) **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.

Usually the persistent calyx do not show any growth after fertilization. Such a calyx is termed as marcescent (*e.g.*, *Brinjal*, Chilies). Sometimes the persistent calyx shows continuous growth even after, fertilization. This type of calyx called acrescent (*e.g.*, *Physalis* and *Shorea*).

In some plants a whorl of green sepals like structure is present at the base of calyx called epicalyx. Epicalyx is considered a whorl of the bracteoles and mostly found in the flowers of family *Malvaceae* (*Althaea*, Cotton). The calyx may show number of modifications. They are :

Campanulate : Bell shaped, *e.g.*, *Althaea*.

Cupulate : Cup like, *e.g.*, *Gossypium*.

Urceolate : Urn shaped, *e.g.*, *Hyoscyamus*.

Infundibuliform : *Funnel shaped, e.g., Atropa belladona.*

Tubular : Calyx tube like, *e.g.*, *Datura*.

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

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

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

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

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

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

(5) **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.

Sepaloid : Green or dull coloured sepals. *e.g.*, *Anona*, *Polyalthia* and *Artabotrys*.

Saccate : The corolla tube may form a pouch on one side. *e.g.*, *Antirrhinum*.

Spurred : Sometimes one or two petals or the entire corolla tube grow downwards forming a spur that usually stores nectar. *e.g.*, *Aquilegia vulgaris*.

Corona : Special appendages of different kinds like scales, hairs develop from the corolla. Such appendages are called corona. *e.g., Passiflora, Oleander* and *Nerium*.

Forms of corolla : Both polypetalous and gamopetalous corolla exhibit great variation in their forms. It is of following types :

(i) **Polypetalous corolla :** They are of following types :

Cruciform : Four free clawed petals arranged in the form of a cross, *e.g.*, Mustard and Radish.

Rosaceous : Five free sessile petals with lobes spreading outwards, *e.g.*, Rose, *Hibiscus*.

Caryophyllaceous : Five free clawed petals with limbs at right angles to the claw, *e.g., Dianthus*.

Papilionaceous : Five free unequal petals arranged in definite fashion. The posterior petal is the largest and is called standard or vexillum. On either side of the standard, two lateral petals called wings are present. The remaining two anterior petals unite to form a boat shaped structure called the keel. *e.g.*, plants of family papilionaceae.

(ii) **Gamopetalous corolla :** They are of following types :

Tubular : Five united petals form a cylindrical tubular structure, *e.g.*, disc florets of Asteraceae.

Infundibuliform : It is a funnel shaped corolla, *e.g., Datura*.

Campanulate : It is bell shaped corolla, *e.g., Thevetia*.

Rotate : Short tubular corolla with spread out lobes appearing like a wheel *e.g.*, Brinjal.

Hypocrateriform : It is a salver shaped corolla. It is provided with a elongated narrow tube having lobes at the top placed at right angles, *e.g., Vinca*.

Ligulate : Corolla with a short tube which is drawn out into a tongue shaped structure *e.g.*, ray florets of Asteraceae.

Bilabiate : The irregular corolla is united, in such a way that it appears two lipped. It is the characteristic corolla of labiatae, *e.g., Leucas*.

(6) **Aestivation :** 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.

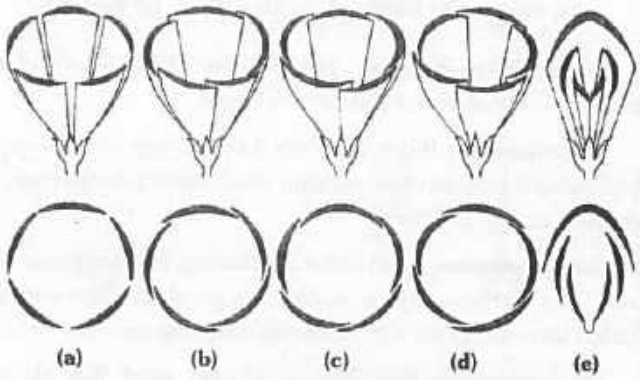


Fig : 2.1-11 Different types of aestivation
(a) Valvate, (b) Twisted, (c) Imbricate, (d) Quincuncial (e) Vexillary

(7) **Androecium or Stamens :** It is the third whorl of a flower consisting of stamens or microsporophylls. Fertile stamens produce pollen grains. Staminodes are the sterile stamens. Petaloid stamens are brightly coloured and appear like petals, *e.g., Canna*.

(i) **Structure of stamen :** A stamen shows a long or short stalk called the filament. The filament ends with a terminal fertile part known as the anther. It encloses microsporangia within which microspores or pollen grains are produced. The filament of the stamen is connected to the anther by means of a "connective". The anther may be monothecous or dithecous. The monothecous anther has only one sac. It is bilocular or bisporangiate, *e.g., Hibiscus*. The dithecous anther consists of two sacs and is tetralocular or tetrasporangiate as in *Datura*.

When the face of anther is towards centre of flower it is called introrse *e.g.*, tomato when it is towards the periphery it is called extrorse /*e.g., Ranunculus*.

(ii) **Fixation** : The mode of attachment of a filament to anther by connective is called fixation. It is of following types :

Adnate : Filament attached to the total length of the anther on the back. *e.g.*, *Michelia* (Champa).

Basifixed : Filament is attached to the base of the anther *e.g.*, *Datura*, Mustard, Radish.

Dorsifixed : Filament is attached to the anther on the dorsal side at middle portion *e.g.*, *Passiflora*.

Versatile : Filament is attached to the anther at a point so that anther can swing freely in all direction. *e.g.*, Grasses.

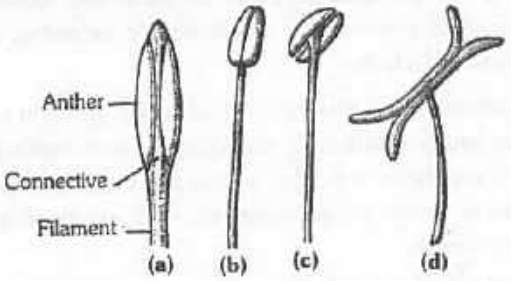


Fig : 2.1-12 Attachment of anther to filament
(a) Adnate, (b) Basifixed, (c) Dorsifixed, (d) Versatile

(iii) **Length of stamens** : Based on the relative lengths of the stamens, the conditions of androecium varies :

Didynamous : When there are four stamens in a flower of which two are long and two are short, the condition is described as didynamous, *e.g.*, *Ocimum*.

Tetradynamous : Out of the six stamens that are found in a flower, four stamens are long and the two are short. This condition is called tetradynamous, *e.g.*, *Raphanus* and *Brassica*.

The stamens are described as inserted when they do not extend beyond the petals or corolla tube (*Dolichos*). When the stamens extend beyond the petals or corolla tube, the stamens are known as exserted (*Acacia*).

(iv) **Insertion of stamens** : Based on the insertion of stamens, the condition of androecium varies :

Isostemonous : When the stamens form a single whorls and the number of stamen is the same as that of sepals and petals, the flower is isostemonous. (*e.g.*, *Solanum*) while heterostemonous condition is used for any difference in size., shape or mode of dehiscence.

Diplostemonous : Sometimes there are two whorls of stamens. The first whorl alternating with petals (antisepalous) and the second whorl alternating with sepals (antipetalous). *e.g.*, *Cassia*.

Obdiplostemonous : In this condition first whorl is antipetalous and the second whorl is antisepalous. *e.g.*, *Dianthus*.

(v) **Union of stamens** : The union of stamens takes place either among themselves (*cohesion*) or with other whorls (*adhesion*).

Cohesion of stamen : Usually following types of cohesion among stamens occur. They are :

Adelphous : When the filaments of stamens are united and the anthers remain free. It is of three types :

Monoadelphous : All filaments unite to form a single bundle *e.g.*, Family malvaceae (*Hibiscus*).

Diadelphous : Filaments unite to form two bundles. *e.g.*, Family papilionaceae (*Pisum, Sesbania, Tephrosia*). *i.e.*, $(q)+1$.

Polyadelphous : Filaments unite to form many bundles. *e.g.*, Family rutaceae (*Citrus, Melaleuca*).

Syngenesious : When the anther of filament are united and the filaments remain free. *e.g.*, *Tridax*, Sunflower etc.

Synandrous : Here all stamens of a flower are united completely to form a single structure. *e.g.*, Family Cucurbitaceae.

Adhesion of stamens : Stamens may unite with other floral organs like sepals, petals or gynoecium. Based on the floral organ involved in the union with stamens, the adhesion may be of the following types :

Epiphyllous : Stamens unite with perianth. *e.g.*, *Onion*.

Episepalous : Stamens unite with sepals. *e.g.*, *Prunus* (Peach).

Epipetalous : Stamens unite with petals. *e.g.*, *Datura*.

Gynandrous : Stamens unite with gynoecium. It is also called gynandrium or gynostegium. *e.g.*, *Calotropis*.

(8) **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 gynoecium *e.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*.

The ovary encloses one to many chambers called the locules. Based on the number of locules, the ovary may be described as follows :

Unilocular : Ovary with one locule. *e.g.*, *Dolichos*.

Bilocular : Ovary with two locules. *e.g.*, *Solanum*.

Trilocular : Ovary with three locules. *e.g.*, *Allium*.

Tetralocular : Ovary with four locules. *e.g.*, *Datura*.

Pentalocular : Ovary with five locules. *e.g.*, *Hibiscus*.

Multilocular : Ovary with many locules. *e.g.*, *Abutilon*.

Apocarpous : Pistil or gynoecium with separate or free carpels *e.g.*, in *Ranunculus*

Syncarpous : Condtition of fused carpels.

(8) **Relative position of floral organs on thalamus :** Depending upon the form of thalamus and the position of floral whorls with respect to the ovary, the flowers are of the following three types :

(i) **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.

(ii) **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.

(iii) **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.

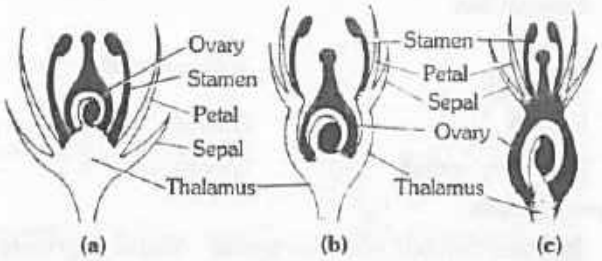


Fig : 2.1-13 Insertion of floral parts on thalamus (a) Hypogynous, (b) Perigynous, (c) Epigynous

(9) **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 :

(i) **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, Goldmohur, etc.

(ii) **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.*, Datura, Tomato, etc.

(iii) **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*, *Silence*, *Primula*, etc.

(iv) **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.

(vi) **Superficial :** The ovary is multicarpellary, syncarpous, and large number of loculi without specific order *e.g.*, Waterlily (*Nymphea*).

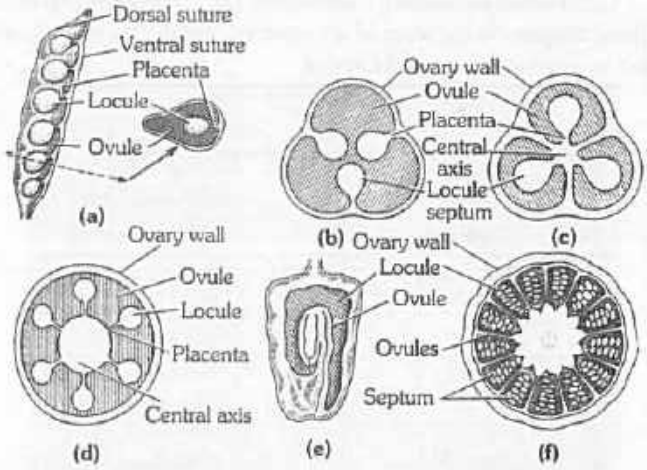


Fig : 2.1-14 Different types of placentations (a) Marginal, (b) Parietal, (c) Axile, (d) Central, (e) Basal, (f) Superficial

(10) **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 :

(i) **Terminal style :** If the style arises from terminal part of the ovary, it is called terminal style, *e.g.*, *Datura*, *Hibiscus* and *Solanum*.

(ii) **Lateral style :** If the style arises from one side of the ovary, it is called lateral style, *e.g.*, Mango.

(iii) **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*.

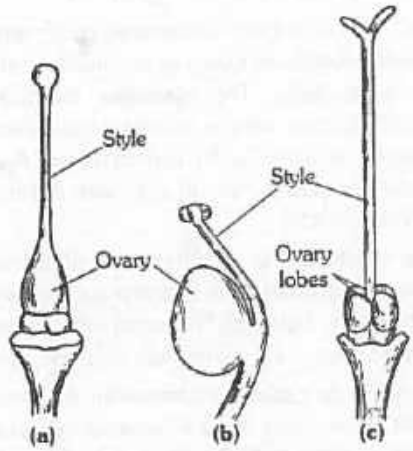


Fig : 2.1-15 Types of styles (a) Terminal, (b) Lateral, (c) Gynobasic style

(11) **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.

(12) **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.

Br.	Bracteate	**C**	Corolla-free (polypetalous)
Brl.	Bracteolate	(C)	Corolla-united (gamopetalous)
Ebr.	Ebracteate	Cx	Corolla-cruciform
Ebrl.	Ebracteolate	P	Perianth
♂	Male	A	Androecium-free (polyandrous)
♀	Female	(A)	Androecium-united (synandrous)
☿	Bisexual	P A	Epiphyllous
⊕	Actinomorphic	C A	Epipetalous
† or %	Zygomorphic	G	Gynoecium-free (apocarpous)
Ep	Epicalyx	(G)	Gynoecium-united (syncarpous)
K	Calyx-free (polysepalous)	$\underline{G}$	Superior ovary
(K)	Calyx-united (gamosepalous)	$\overline{G}$	Inferior ovary
N	Neuter	G A	Gynostegium

(12) **Floral diagram :** Following signs are used in constructing a floral diagram.

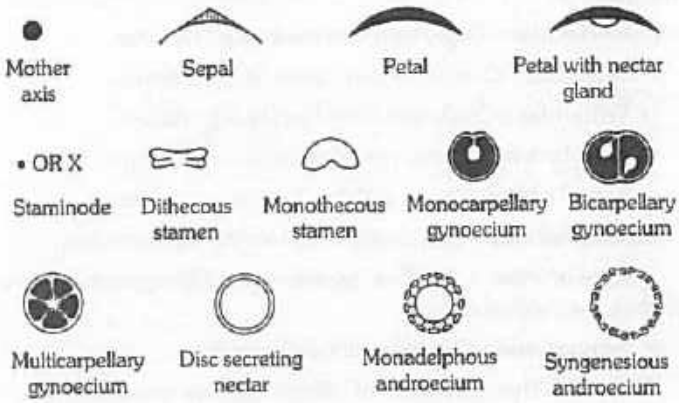


Fig : 2.1-16 Signs used in preparation of floral diagram

Fruit

Formation of fruit : Fruit is defined as fertilized ovary. The ovary develops into fruit. The ovary wall at maturity forms the wall of the fruit, which is known as *pericarp*. Sometimes, other parts of flower such as tepals, (*e.g.*, *Morus*), bracts (*e.g.*, *Ananas*) or thalamus (*e.g.*, *Pyrus*) are also involved in the formation of fruit and such fruits are called false fruits or pseudocarps.

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

Ovary	–	Fruits
Ovary wall	–	Pericarp
Ovule	–	Seed
Funiculus	–	Stalk of the seed
Hilum	–	Hilum
Nucellus	–	Perisperm (when present)
Micropyle	–	Micropyle
Outer integument	–	Testa } Seed coat
Inner integument	–	Tegmen } Seed coat
Embryo sac		
Synergids	–	} Degenerate
Antipodals	–	} Degenerate
Egg cell	–	Embryo
Secondary nucleus	–	Endosperm

Types of fruits

They are classified into three groups : Simple, aggregate and multiple or compound fruit.

Simple fruits : They are formed from mono-or polycarpellary but syncarpous ovary. They may be dry or fleshy.

(1) **Simple dry fruits** have thin, hard and dry, pericarp. They are of three kinds :

(i) Dehiscent or Capsular

(ii) Achenial or Indehiscent

(iii) Schizocarpic

(i) **Dehiscent fruit :** These fruits are dry, many seeded and split open at maturity. They are of following types :

Legume or Pod : It is characteristic of the family leguminosae; developed from monocarpellary unilocular superior ovary with marginal placentation. It can open or dehisces by both ventral and dorsal sutures. *e.g.*, in *Cicer arietinum* (Gram); *Pisum sativum* (Pea) and *Phaseolus mungo* (Black gram).

Follicle : It is very much resembles the legume but on ripening it opens generally along the ventral suture. *e.g.*, *Calotropis, Larkspur, etc.*

Siliqua : The fruit is developed from bicarpellary, syncarpous and superior ovary which bears ovules on two parietal placenta. The ovary is unilocular but later becomes bilocular due to the development of a false partition wall called *replum*. It dehisces from the base towards the apex by both the sutures *e.g.*, In *Brassica* (Mustard) and is characteristic of the family Cruciferae.

Silicula : It is flattened and short in length from siliqua type, found in *Iberis* (Candytuft) and *Capsella bursa* (Shepherd's purse).

Capsule : It is mono or polycarpellary, dry dehiscent, many seeded fruit which developes from a superior or inferior ovary. It dehisces in almost all the ways *i.e.*, longitudinal and transverse, along both the sutures. Majority of capsules show longitudinal-dehiscence which again are of different types :

Loculicidal : Lines of dehiscence appear along the dorsal sutures, *e.g.*, *Gossypium herbacium* (Cotton) and *Abelmoschus esculentus* (Lady's finger).

Septicidal : Lines of dehiscence appear along the ventral sutures or septations of the ovaries *e.g.*, in *Viola* (Pansy), *Linseed* (Linum).

Septifragal : Lines of dehiscence along irregular lines, but the seeds remain attached to the placenta, as in *Datura stramonium* (Thorn apple).

(ii) **Achenial or Indehiscent fruits :** These fruits do not burst at maturity but the seeds are liberated only by the decaying of the pericarp. These are of following types :

Achene : It is small, dry one seeded fruit which develops from a superior or inferior monocarpellary ovary. In this type, the pericarp is tough but thin and free from the seed coat, *e.g.*, in *Mirabilis* (four o'clock plant) and *Clematis*. Some times achenes occur in a group from apocarpus ovary where carpels are many *e.g.*, *Nelumbium* (Lotus).

Caryopsis : It is very small, dry and one seeded fruit which develops from a superior monocarpellary ovary. Here the pericarp is closely fused with seed coat. It is the characteristic of family graminae, *e.g.*, *Oryza sativa* (Paddy), *Triticum aestivum* (Wheat) and *Zea mays* (Maize).

Cypsela : It is dry, one seeded fruit which develops from an inferior , bicarpellary ovary. Here the pericarp is free from seed coat but the thalamus is fused with pericarp. The fruit is provided with a crown of hairs at the top called *pappus e.g.*, in *Helianthus annuus* (Sun flower), *Tridax, Cosmos, Sonchus*, etc.

Nut or Glans : It is dry, one seeded fruit which develops from a superior, bi or polycarpellary ovary having a hard pericarp, free from seed coat *e.g.*, in *Areca catechu* (Betalnut), *Anacardium occidentale* (Cashewnut) and *Trapa natans* (Water chestnut). Here the thalamus and sometimes the cotyledons of true fruit are also edible.

Samara : It is dry, one or two seeded fruit, develops from a single mono-or bicarpellary ovary. The pericarp is free from testa and produces a wing like outgrowth which helps in the dispersal of seeds *e.g.*, in *Hiptage* and *Elm*.

(iii) **Schizocarpic or Splitting fruits :** These resemble both (achenial) indehiscent fruits as well as capsular fruits having many seeds. However, they break into one seeded segments known as *mericarps*. By splitting usually the mericarps are indehiscent but in *Ricinus* (Castor) they are dehiscent. The important schizocarpic fruits are :

Lomentum : It is a dry, many seeded fruits which develops from a monocarpellary, superior, unilocular ovary with marginal placentation.

The fruit arises just like a legume but when ripened it becomes partitioned between seeds into single seeded mericarps *e.g.*, *Acacia arabica* (gum tree), *Mimosa* (touch me not) and *Dalbergia sisoo* (Indian red wood tree).

Cremocarp : It is a dry fruit, develops from bicarpellary, syncarpous, bilocular ovary. The fruit when mature breaks into single seeded mericarps which remain attached to the top of the central axis called *carpophore*, *e.g.*, *Daucus carota* (Carrot); *Foeniculum vulgare* (fennel).

Regma : It develops from tri-or penta-carpellary superior syncarpous ovary. The locules are many as the carpels known as *Cocci* (sing. Coccus), attached to carpophore and separate by splitting *e.g.*, *Euphorbia, Geranium* and *Ricinus*.

Carcerulus : It is a dry fruit, develops from bi or polycarpellary syncarpous, multilocular superior ovary with axile placentation. Many single seeded, mericarps are formed by splitting and formation of false septa. *e.g.*, *Ocimum sanctum* (Sacred basil), *Althaea rosea*.

(2) **Simple fleshy fruit :** The fruits are simple, but the pericarp is fleshy and edible. It is differentiated into three layers epicarp, mesocarp and endocarp. Fleshy fruits are of following types:

Drupe : It is a fleshy fruit formed from monoor poly carpellary superior ovary, where one or more ovules may develop into seeds. Here the epicarp is thin and leathery. The mesocarp is thick, fleshy, juicy and edible in *Mangifera* (Mango) and fibrous in *Cocos* (Coconut).

The endocarp is hard and stony in both the cases. In Cocos, pericarp is not edible. The portion inner to endocarp is the liquid endosperm which is edible.

Berry : It is usually many seeded fleshy fruit develops from polycarpellary, syncarpous, superior ovary. Rarely it is single seeded as in *Borassus* (Palm).

Here the epicarp remains as the skin of the fruit. The mesocarp and endocarp are fused together to form the pulp of the fruit. *e.g.*, Brinjal, Tomato, Banana, etc.

Pepo : It is a special type of berry. Here the epicarp and thalamus form the outer ring of the fruit. The mesocarp, endocarp and placentae are fused to form pulp which is edible; seeds are many. It is characteristics fruit of family cucurbitaceae. Common examples are *Cucurbita maxima* (Sweet gourd); *Cucumis sativa* (Cucurbit).

Pome : The fruit develops from inferior, pentacarpel ovary. The fruit is covered by the fleshy thalamus, which is fused with the pericarp and edible. The outer part again encloses the inner stiff and membranous portion enclosing the seeds; common example is *Pyrus indica* (Apple).

Table : 2.1-1 : Edible Parts of Some Fruits

Wheat	Endosperm and embryo
Maize	Endosperm and embryo
Litchi	Fleshy aril
Orange	Unicellular juicy hairs from endocarp
Lemon	Unicellular juicy hairs from endocarp
Apple	Fleshy thalamus
Pear	Fleshy thalamus
Strawberry	Fleshy thalamus
Banana	Mesocarp and endocarp
Cucumber	Mesocarp and endocarp
Muskmelon	Mesocarp and endocarp
Walnut	Cotyledons
Groundnut	Cotyledons and embryo lobe
Cashewnut	Cotyledons and fleshy pedicel
Pea	Cotyledons and embryo
Pomegranate	Juicy testa
Indian plum	Epicarp and mesocarp
Guava	Pericarp and placenta
Grape	Pericarp and placenta
Jack fruit	Bracts, perianth and seeds
Pineapple	External rachis, bracts, perianth and seed
Mulberry	Perianth
Fig	Rachis or fleshy receptacle
Coconut	Endosperm
Lotus	Thalamus and seeds
Custard apple	Mesocarp

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).

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).

Aggregate fruits : The aggregate fruits are formed from polycarpellary, apocarpous ovary. Each ripened is called *fruitlet or etaerio e.g.*, the *lotus, rose* fruit and strawberry are a collection of achenes; *raspberry*, a collection of drupes and custard apple is a collection of berries.

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).

Seed

Morphologically, ripened ovule is known as seed. In other words, seed is mature integumented megasporangium.

Development of seed : The fertilized ovule forms seed. The ovule increases greatly in size. The integuments dry up. The outer one becomes hard or leathery and forms the outer seed coat or testa while the inner one, if persist, forms the tegmen.

The nucellus is generally used up during the development of embryo but in some cases it remains outside the endosperm in the form of a thin layer, called *perisperm*. The endosperm may persist or completely digested during embryogenesis.

A scar is usually visible on one side of the outer seed coat. It is known as *hilum* and marks the point of attachment to the stalk. With these changes, the ovule changes into seed and enters a period of dormancy while the ovary ripens into a fruit.

Dicotyledonous seeds

Exalbuminous : Gram, Pea, Bean, Mustard, Mango, Groundnut, etc.

Albuminous : Castor, Poppy, *Artabotrys*, Custard apple (Ananas) etc.

Monocotyledonous seeds

Exalbuminous : *Orchids, Alisma, Najas, Pothos, Amorphophallus, Vallisneria*, etc.

Albuminous : Cereals, Millets, Palms, Lilies, etc.

Non-endospermic or Exalbuminous seeds : In exalbuminous seeds endosperm is completely consumed by the developing embryo, and the mature seeds are without endosperm. The food is stored in cotyledons.

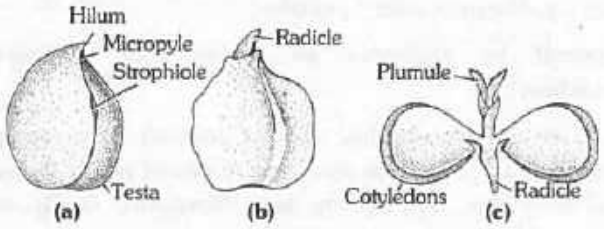


Fig : 2.1-17 Structure of gram seed

Endospermic or Albuminous seed : In albuminous seeds, embryo not consumed all endosperm. So it persists in the mature seed. In these seeds food stored in endosperm. In monocot seed the membranous covering of :

- Radicle is called coleorrhiza.
- Plumule is called coleoptile.

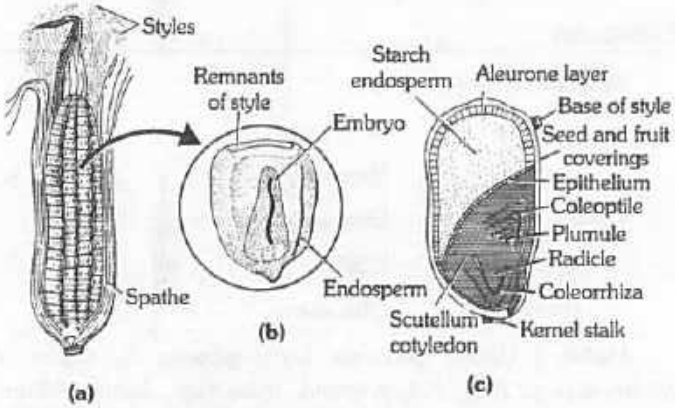


Fig : 2.1-18 Structure of maize grain
(a) Entire seed; (b) Grain in L.S. (c) Grain in T.S.

Germination of seeds : The process by which the dormant embryo of the seed resumes active growth and grows into a new plant is known as germination.

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*.

Factors for seed germination

External factors : Water, oxygen, suitable temperature.

Internal factors : Foods and growth regulators, completion of rest period, viability.

Seed dormancy : In several plants seeds germinate as soon as they have undergone maturation and provided proper conditions for germination. *e.g.*, seeds of Bean, Pea, Maize etc. In some plants seeds are incapable of germination because of some inhibitory factors. Such seeds are unable to germinate even under suitable conditions. This is called seed dormancy.

Viability of seeds : Germinating ability of the seed is called its viability. Only viable seeds are able to germinate. As the viability expires, the embryo dies and seed looses its capacity of germination. Viability of seeds varies from species to species.

- 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.**

Causes of seed dormancy

The seed dormancy may be due to many causes some of which are as follows :

(1) Impermeability of seed coats to oxygen. (*e.g., Xanthium*) and water. (*e.g., Chenopodium* and many leguminous seeds).

(2) Seed coat is mechanically hard, thus resisting the growth of embryo. *e.g.*, Mustard, *Capsella, Amaranthus*.

(3) Presence of rudimentary or immature embryo. *e.g., Ginkgo biloba* (a gymnosperm).

(4) Some plants produce such chemical compounds that inhibit the germination of their own seeds. *e.g., Tomato,* (possesses inhibitor ferulic acid).

Dispersal of fruits and seeds

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.*, Orchids) 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.

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.

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*.

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.

Taxonomy of Angiospermic plants

Liliaceae

Systematic position

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 *Smilax*, 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 : Racemose, 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, trimerous 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 (coloured), 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*.

Androecium : Stamens 6 (3 in *Ruscus*, 9–12 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 : $\oplus \varphi \overset{\frown}{P_{(3+3)}} A_{3+3}\ \underline{G_{(3)}}$

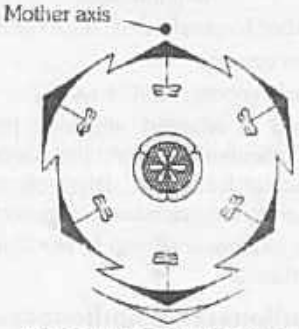


Fig : 2.1-19 Floral diagram of liliaceae (*Allium cepa*)

Economic importance of the family

(1) Sources of medicines

(i) *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.

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

(iii) *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.

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

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

(2) Sources of food

(i) *Allium cepa* (Onion or Piaz)

(ii) *Allium sativum* (Garlic or Lahsun)

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

(3) 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.

(4) 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).

Cruciferae or Brassicaceae (Mustard family)

Systematic position

Division	:	Angiospermae
Class	:	Dicotyledonae
Subclass	:	Polypetalae
Series	:	Thalamiflorae
Order	:	Parietales
Family	:	Cruciferae (Brassicaceae)

Habit : Annual, biennial or perennial herbs. *Farsetia jacquemontii* is an undershrub. The plants possess pungent juice having sulphur-containing glucosides.

Root : Tap root alongwith hypocotyl is swollen in Radish (*Raphanus sativus*) and Turnip (*Brassica rapa*).

Stem : Erect, cylindrical, hairy or glabrous, herbaceous or rarely woody. It is reduced in the vegetative phase in Radish and Turnip. The stem is swollen in Kohlrabi (Knol-Kohl = Ganthgobi, *Brassica oleracea* var. *gongylodes*). Axillary buds enlarged in Brussel's Sprouts (= Button gobhi) or *Brassica oleracea* var. *gemmifera*. *Brassica oleracea* var. *capitata* (Cabbage) has the largest terminal bud.

Leaves : Radical, cauline and ramal, alternate or sub-opposite but forming rosettes when radical, exstipulate with sheathing leaf base, sessile simple or rarely compound (*e.g.*, *Nasturium officinale*), hairy. Bulbils occur in the leaf axils of *Dentaria bulbifera* and on the leaves of *Cardamine pratensis*.

Inflorescence : Flowers are usually arranged in corymbose racemes. Occasionally they are in corymbs (candituft).

Flower : Ebracteate or rarely bracteate (*e.g.*, *Rorippa montana*), pedicellate, complete, perfect, regular, actinomorphic, rarely zygomorphic (*e.g.*, *Iberis*, *Teesdalia*), tetramerous or bimerous, hypogynous (perigynous in *Lepidium*), cyclic, cruciform.

Calyx : Sepals 4, polysepalous, aestivation imbricate, generally arranged in two whorls, outer of antero-posterior sepals and inner of lateral sepals, lateral sepals generally saccate or pouched at the base, green or petaloid, inferior.

Corolla : Petals 4, polypetalous, arranged in one whorl and alternate with sepals, often with long claws and spread out in the form of a Greek cross. This arrangement of petals which is characteristic of the family is known as the cruciform arrangement and corolla is described as cruciform corolla, valvate aestivation. Petals reduced or absent in *Lepidium* and *Rorippa*.

Androecium : Stamens 6, (four in *Cardamine hirsuta*, two in *Coronopus didymus*, 16 in *Megacarpaea*), free (polyandrous), tetradynamous, arranged in two whorls, outer of two short lateral stamens while the inner whorl is made up of 4 long stamens arranged in two median pairs, anthers basifixed or dorsifixed, dehiscence longitudinal. Green nectaries are often associated with the bases of stamens.

Gynoecium : Bicarpellary (tricarpellary in species of *Lepidium*, tetracarpellary in *Tetrapoma* and *Tropidocarpum*), syncarpous, carpels placed transversely, ovary superior, placentation parietal, ovary bilocular due to the presence of a false septum called replum, style short, stigma capitate, simple or lobed.

Fruit : Siliqua or silicula, lomentaceous siliqua occurs in radish.

Seed : Non-endospermic, often oily.

Floral formula : Ebr $\oplus$ ⚥ $K_{2+2}\ C_{\times 4}\ A_{2+4}\ G_{\underline{(2)}}$

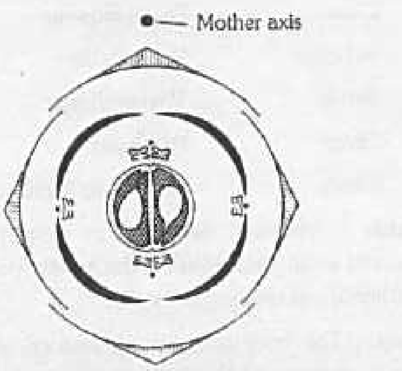


Fig : 2.1-20 Floral diagram of cruciferae (*Brassica campestris*)

Economic importance of family

(1) **Medicines and spices**

(i) *Rorippa montana* : It is stimulant and also a good appetizer.

(ii) *Cherianthus cheiri* : Fever and bronchitis are cured by the seeds of this plant.

(iii) *Lepidium sativum* : Liver troubles, asthama and piles are cured by tender shoots.

(iv) *Iberis amara* : In gout and rheumatism.

(v) *Lobularia* : Used in gonorrhoea.

(vi) *B. alba*, *B. nigra* and *B. juncea* (rye) : Seeds are used as spices.

(2) **Vegetables (Food)**

(i) *Brassica rapa* (Turnip or Shalagm)

(ii) *B. oleracea* var. *caulorapa* (*gongylodes*) – (Knol - Khol or Ganth gobhi)

(iii) *B. oleracea* var, *capitata* (Cabbage or Band Gobhi)

(iv) *Brassica campestris* var. *sarson* (Pili Sarson)

(v) *B. oleracea* var. *botrytis* (Cauliflower or Phool Gobhi)

(3) **Oils**

(i) *Eruca sativa* (Taramira) : Taramira oil is obtained from seeds.

(ii) *Brassica juncea* (Indian mustard or Rye) : Seeds produce oil.

(iii) *Brassica napus* or *B. campestris* var. *toria* – Seeds are source of **'Indian rape oil'** or **Tel toria.**

(iv) *Brassica campestris* : Seeds are source of **Colza** (Sarson Ka Tel).

(4) **Ornamentals**

(i) *Iberis amara* (Candytuff or Chandini) : Winter herb grown for its white, beautiful flowers.

(ii) *Cherianthus cheiri* (Wall flower).

Leguminosae or Fabaceae

Systematic position

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. Leaves or leaflets modified into tendrils, two lateral leaflets of telegraph plant (*Desmodium motorium* or *D. gyrans*) show autonomous movements.

On the basis of inflorescence and flower characters, this family is divided into 3 subfamilies :

Subfamily - Papilionatae (Papilionaceae)

Inflorescence : Racemose or solitary axillary.

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

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

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.

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.

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

Fruit : Legume or lomentum.

Floral formula : Br % ♂ $K_{(5)}\,C_{1+2+(2)}\,A_{1+(9)}\,\underline{G_1}$

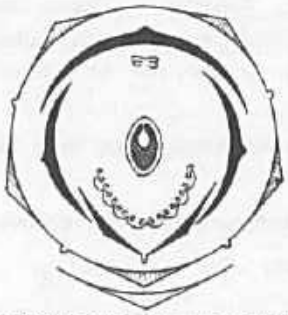


Fig : 2.1-21 Floral diagram of subfamily Papilionatae (*Pisum sativum*)

Subfamily – Caesalpinoideae (Caesalpiniaceae)

Inflorescence : Raceme, umbel or a solitary flower.

Flower : Bracteate or ebracteate, pedicellate, hermaphrodite, complete, zygomorphic, hypogynous.

Calyx : Sepals 5, polysepalous, imbricate aestivation.

Corolla : Petals 5, polypetalous, ascending imbricate aestivation.

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

Gynoecium : Monocarpellary, unilocular, ovary superior, marginal placentation, stigma capitate.

Fruit : Legume.

Floral formula : % ♂ $K_5\,C_5\,A_{1+2+2+2+3(\text{staminodes})}$ or $_{7+3(\text{staminodes})}\,\underline{G_1}$

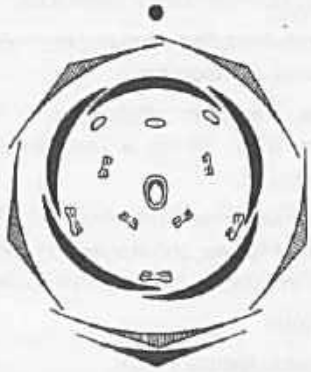


Fig : 2.1-22 Floral diagram of subfamily Caesalpinoidae (*Cassia fistula*)

Subfamily – Mimosoideae (Mimosaceae)

Inflorescence : Head or capitulum or spike, flowers arranged in acropetal succession.

Flower : Bracteate or ebracteate, sessile, hermaphrodite, complete actinomorphic, hypogynous, pentamerous.

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

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

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.

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

Fruit : Lomentum.

Floral formula : Br or Ebr ⊕ ♂ $K_{(4)}\,C_4\,A_4\,\underline{G_1}$

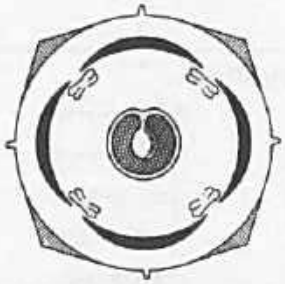


Fig : 2.1-23 Floral diagram of subfamily Mimosoidae (*Mimosa pudica*)

Economic importance of family

(1) **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)

(2) **Timber :** *Dalbergia sissoo* (Shisham or Indian red wood) and *D. latifolia* (Kali shisham or Indian rose wood or Inidian balck wood).

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

(4) **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.

Solanaceae

Systematic position

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

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*).

Root : Branched tap root system.

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.

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

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

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

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

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.

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.

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.

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

Seed : Endospermic with straight or curved embryo.

Floral formula : $\oplus \varphi \, K_{(5)} \overset{\frown}{C_{(5)}} A_5 \underline{G_{(2)}}$

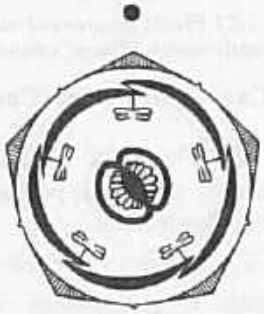


Fig : 2.1-24 Floral formula of Solanaceae (*Solanum nigrum*)

Economic importance of the family.

(1) **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 sedation and also in asthama and whooping cough.

(2) **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)

(3) **Source of tobacco :** *Nicotiana tabacum* (tobacco) : It is source of alkaloid – **'Nicotin'** and highest nicotine content is present in *Nicotiana rustica.*

(4) **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).

(5) **Others**

(i) *Solanum nigrum* (Night shade plant or Makoa).

Malvaceae

Systematic position

Division	:	Angiospermae
Class	:	Dicotyledonae
Subclass	:	Polypetalae
Series	:	Thalamiflorae
Order	:	Malvales
Family	:	Malvaceae

Habit : Plants are annual herbs (*e.g., Malva, Sida, Malvastrum, Urena*) shrubs (*e.g., Hibiscus rosa-sinensis, H. mutabilis*) or rarely trees (*e.g., Kydia, Bombax*).

Root : Branched tap root system.

Stem : Stem is erect, aerial, herbaceous or woody, usually solid, cylindrical and branched. Herbaceous portion of the stem is covered with stellate and scaly hairs; the woody part is fibrous. Plants usually have some mucilaginous substance.

Leaves : Leaves are alternate and stipulate (stipules 2, free lateral and often Caducous). They are simple and petiolate, lamina is sometimes palmately lobed (*e.g., Gossypium*) or digitate (*e.g., Bombax*). Venation is multicostate reticulate.

Inflorescence : Usually the flowers are solitary axillary or terminal. Occasionally, they are in panicle raceme (*e.g., Kydia*).

Flowers : Flowers are bracteate or ebracteate, actinomorphic, bisexual (unisexual in *Kydia*), pentamerous and hypogynous. The number of bracteoles varies from 3 to many, they form a whorl of epicalyx below the calyx. Sometimes the epicalyx is absent (*e.g., Sida* and *Abutilon*).

Calyx : Sepals 5, gamosepalous (connate at the base but free at the tip) and show valvate aestivation. Usually epicalyx present.

Corolla : Petals 5, polypetalous (slightly fused at the base), usually adnate at the base to the staminal tube. They show twisted or imbricate aestivation.

Androecium : It has indefinite stamens. They are monoadelphous. Filaments of the stamens are united to form a long staminal tube or staminal column which encloses the style. Basal part of the staminal tube is fused with the petals; thus stamens are epipetalous. Anthers are monothecous, reniform, transversely attached to the filament and extrorse. In *Bombax* stamens are polyadelphaous.

Gynoecium : It is 2 to many carpellary. It is bicarpellary in *Plagianthus*, tricarpellary in *Kydia*, pentacarpellary in *Hibiscus* and *Sida*, ten carpellary in *Althaea rosea* and 15 – 20 carpellary in *Abutilon indicum*. All the carpels are fused (syncarpous) to form a single ovary. Ovary is superior, multilocular with one or more ovules in each chamber. The placentation is axile.

Style is usually long and enclosed in the staminal tube. Stigmas are as many as the number of carpels or double the number of carpels.

Fruit : Fruit is a loculicidal capsule (*e.g., Gossypium, Hibiscus*), schizocarpic capsule (*e.g., Abutilon, Sida*) or a berry (*e.g., Malvastrum*).

Seed : Seeds are albuminous. In *Gossypium* the seeds are pubescent, *i.e.*, covered with hairs.

Floral formula : $Br \oplus \varphi^{\delta} Epi_{3-\infty}\, K_{(5)}\, \overset{\frown}{C_5}\, A_{(\alpha)}\, \underline{G}_{(2-\alpha)}$

Fig : 2.1-25 Floral diagram of Malvaceae (*Hibiscus rosa sinensis*)

Economic importance

(1) **Fibre yielding plants**

(i) *Abutilon theophrasti* (Indian Mallow or China jute) : This takes good dye and is extensively grown in China.

(ii) *Bombax malabaricum* Syn. B. ceiba (Semal or Kapok or silk cotton tree).

Woolly fibres from pericarp of fruits are source of **Kapok** or **Semal** or Silk cotton.

(iii) *Gossypium arboreum, G. herbacium, G. hirsutum* (cotton): Cotton fibres are long hairs from **seed epidermis.**

(iv) *Hibiscus canabinus* (Patsan or Deccanhemp)

(2) **Food plants**

(i) *Abelmoschus esculentus Syn. Hibiscus esculentus* (Lady's finger or bhindi or **Okra**) : Young fruits are used as favourite vegetable.

(3) **Ornamental plants**

(i) *Malva sylvestris* (Mallow) : An annual plant with purple rose flowers, is grown in gardens.

(ii) *Althaea rosea* (Hollyhock or Gulekhera) : Beautiful pink or red flowering plant.

(iii) *Hibiscus rosa-sinensis* (China rose or shoe-flower or gurhal) : This is grown extensively as an ornamental plant with red or pink flowers.

Cucurbitaceae

Systematic position

Division	:	Angiospermae
Class	:	Dicotyledonae
Subclass	:	Polypetalae
Series	:	Calyciflorae
Order	:	Passiflorales
Family	:	Cucurbitaceae

Habit : These are trailing or climbing annuals or perennial herbs. Rarely they are shrubs (*e.g., Acanthosicyos*) or trees (*e.g., Dendrosicyos*).

Stem : Herbaceous, branched, pentangular, fistular, tendrils in axil of leaf or opposite to leaves. The morphological nature of tendril is of dispute.

Leaves : Leaves are cauline and ramal. They are alternate, exstipulate, simple, petiolate and cordate (*e.g., Cucurbita maxima, Coccinia grandis*) or deeply palmately lobed (*e.g., Luffa cylindrica, Cyclanthera pedata*). Venation is reticulate multicostate.

Inflorescence : Flowers are either solitary axillary (*e.g., Cucurbita, Coccinia*) or in cymose clusters (*e.g., Cucumis*, male flowers of *Luffa*).

Most of the members of the Cucurbitaceae are monoecious but a few are dioecious (*e.g., Coccinia cordifolia, Trichosanthes dioica*).

Flower : Flowers are bracteate or ebracteate, pedicellate, unisexual, incomplete actinomorphic, pentamerous and epigynous. *Schizopepon* is the only exception which has bisexual flowers.

Male flower

Calyx : Sepals 5, gamosepalous, quincuncial aestivation.

Corolla : Petals 5, gamopetalous, campanulate or rotate, imbricate or valvate aestivation.

Androecium : Stamens 5, polyandrous as in *Fevillea*, or (2)+(2)+1 as in *Momordica*, anthers twisted, alternate to petals, sometimes epipetalous, dehiscence longitudinal.

Gynoecium : Absent.

Female flower

Calyx : Similar to male flower.

Corolla : Similar to male flower.

Androecium : Absent but sometimes 2, 3 or 5 staminodes present.

Gynoecium : Tricarpellary, syncarpous, unilocular, ovary inferior, numerous ovules, parietal placentation but looks as axile placentation, style is simple, stigma 3.

Fruit : Pepo (variation of berry).

Seeds : Exalbuminous.

Male flower : Br or $Ebr \oplus \delta K_{(5)} C_{(5)} A_{(2)+(2)+1} G_0$

Female flower : Br or $Ebr \oplus \varphi K_{(5)} C_{(5)} A_0 \overline{G_{(3)}}$

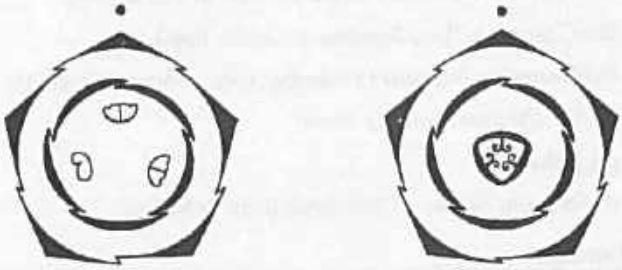


Fig : 2.1-26 Floral diagram of Cucurbitaceae (*Cucurbita maxima* / Kaddu) (a) Floral diagram of male flower (b) Floral diagram of female flower

Economic importance of family

(1) **Medicinal plants**

(i) *Coccinia indica* (Kandoori) : Extracts of root, leaf and fruit are used in treatment of diabetes.

(ii) *Citrullus colocynthis* (Indrayan) : **Colocynthis** alkaloid is obtained from its fruits, which is used in treatment of snake bite, rheumatism, etc.

(iii) *Ecballium elaterium* : **Elatarium** is obtained from fruits, which is used in treatment of hydrophobia and malaria.

(2) **Vegetables**

(i) *Cucurbita maxima* (Great pumpkin or Vilayati Kaddu or Red pumpkin).

(ii) *C. moschata* (Pumpkin or Sitaphal)

(iii) *C. pepo* (Field pumpkin or Safed kaddu).

(iv) *Citrullus vulgaris* var. *Fistulosus* (Tinda or Dil pasand).

(v) *Lagenaria vulgaris* (Bottle gourd or Lauki).

❑ Hollow, dried fruits of *Lagenaria siceraria* are used for making 'beens' (musical instruments) by snake charmers or 'saperas'.

(vi) *Luffa cylindrica syn. L. aegyptica* (Bath sponge or Ghia tori).

(vii) *L. acutangula* (Kali tori).

(viii) *Momordica charantia* (Bitter gourd or Karela).

(ix) *Trichosanthes anguina* (Snake gourd or Chichinda).

(x) *T. dioica* (Pointed gourd or Parwal).

(3) **Fruits**

(i) *Cucumis melo* (Kharbooza).

(ii) *Cucumis sativus* (Cucumber or Khira).

(iii) *Cucumis utilissimus* (Kakri).

(iv) *Cucumis melo* var. *momordica* (Phunt).

(v) *Citrullus vulgaris* (Water melon or Tarbooz).

(vi) *Benincasa hispida* (Ash gourd, Wax gourd or White gourd or Petha) – Famous sweet **'Petha'** is prepared from it.

❑ Hollow dried fruits are used for making **'Sitar'**

Compositae (Asteraceae)

Systematic position

Division	:	Angiospermae
Class	:	Dicotyledonae
Subclass	:	Gamopetalae
Series	:	Inferae
Order	:	Asterales
Family	:	Compositae (Asteraceae)
		(Largest family among the angiosperms)

Habit : Most of the plants are annual herbs (*e.g., Chrysanthemum, Lactuca, Calendula, Helianthus, Tagetes*). A few are shrubs (*e.g., Artemisia, Pluchea lanceolata*) or rarely trees (*e.g., Vernonia arborea, Wilkesia, Leucomeris*). *Milkania cordata* is a twiner.

Root : Usually there is a tap root, but in *Dahlia* and *Taraxacum officinale* fasciculated roots are present.

Stem : Stem is usually herbaceous, erect, branched, solid, fibrous and sometimes with milky latex. In Jerusalem artichoke (*Helianthus tuberosus*) the stem is underground and tuberous. In *Baccharis*, it is winged like a leaf.

Leaves : Leaves are mostly alternate and occasionally opposite (*e.g., Helianthus*) or whorled (*e.g., Eupatorium, Zinnia verticillata*). They are exstipulate, petiolate, simple, pinnately or palmately lobed or compound (*e.g., Dahlia, Cosmos*). Venation is reticulate.

Inflorescence : Inflorescence is capitulum or head with an involucre of bracts at its base. The number of flowers in each inflorescence varies from 1000 (in large flowers of *Helianthus*) to 1 (in *Echinops*). Peduncle flat on which florets are attached.

Flower : Epigynous, usually pentamerous with reduction in certain whorls, hermaphrodite or unisexual complete or incomplete, tubular (actinomorphic) or ligulate (zygomorphic), bracteate or ebracteate.

(1) **Ray florets :** Towards periphery of head, sessile bracteate, pistillate or neutral, zygomorphic, ligulate, epigynous.

Calyx : Absent or hairy pappus or scaly, persistent.

Corolla : Petals 5, gamopetalous, ligulate, strap shaped.

Androecium : Absent.

Gynoecium : Bicarpellary, syncarpous, ovary inferior, unilocular, one ovule in each locule, basal placentation, style simple narrow, stigma branched.

(2) **Disc florets :** In the centre of head, bracteate, bisexual, actinomorphic, tubular, pentamerous, epigynous.

Calyx : Absent or pappus.

Corolla : Petals 5, gamopetalous, tubular.

Androecium : 5 stamens, epipetalous, syngenesious, dithecous, bilobed, introrse, filament free.

Gynoecium : Bicarpellary, syncarpous, ovary inferior, unilocular, single ovule in the locule, basal placentation, style single, short, stigma bifid.

(3) **Neutral florets :** Androecium and gynoecium both are absent. Remaining structures are similar to ray floret and disc florets.

Fruit : Cypsella.

Seed : Exalbuminous.

Floral formula :

Ray florets : $Br.\,\% \, ♀ K_0$ or $P\,C_{(5)}\,A_0\,\overline{G_{(2)}}$

Disc florets : $Br.\,\%$ or $\oplus \, ♀ K_0$ or $P\,\overline{C_{(5)}\;\;A_{(3)}}\,\overline{G_{(2)}}$

Neutral florets : $\%$ or $\oplus \, K_0\,C_{(5)}\,A_0\,G_0$

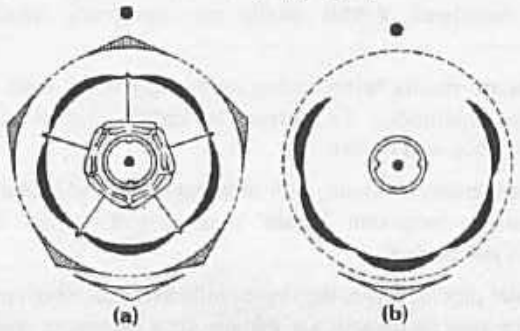


Fig : 2.1-27 Floral diagram of Compositae (*Helianthus annuus*)
(a) Ray floret, (b) Disc floret

Economic importance of the family

(1) **Sources of medicines**

(i) *Arnica montana* : This plant yields **'Arnica'**, which is used as hair vitalizer.

(ii) *Eclipta prostrata* (bhringraj) : Its extract is used as hair tonic.

(iii) *Artemisia cina* or *A. maritima* (worm weed) : A wormicide (anthelmintic) **'Santonin'** is obtained from **dried unopened flower heads,** which is used as vermifuge or in expelling the intestinal worms.

(iv) *Taraxacum officinale* (Common dendelion) : Drug **'Taraxacum'** obtained from roots and rhizomes is used as laxative and liver tonic.

(v) *Calendula officinalis* : **'Calendula'** drug obtained from dried ligulate florets is used in sprains.

(2) **Sources of food**

(i) *Lactuca sativa* (Garden lettuce or Salad) : This is a salad crop and leaves provide a valuable salad throughout the world.

(ii) *Cichorium intybus* (Chicory or Kasni) : Roots are source of **'Chicory powder'**, which is used for blending coffee.

(iii) *Helianthus tuberosus* (Jerusalem artichoke or Hathichuk) : The tubers are source of food or vegetable (having plenty of Inulin).

(3) **Sources of oils**

(i) *Carthamus tinctorius* (Safflower or Kusum) : Seeds yield oil which is edible and because it has percentage of unsaturated fatty acid, so it very good for heart patients.

(ii) A red dye **'Kusum'** is also obtained from its flowers, which is used in foods as well as clothes.

(4) **Sources of rubber**

(i) *Taraxacum kok-saghyz* (Russian dendelion) : Roots contain latex, which is the source of **'Dendelion rubber.'**

(ii) *Parthenium argentatum* In America, **Guayule rubber,** is obtained from this plant, because **'caoutchouc'** granules are present in plant body.

(5) **Sources of insecticide**

(i) *Chrysanthemum marschallii* and *C. cinerariaefolium* (Guldaodi) : Flower heads are source of a commercial insecticide **'Pyrethrum'.**

(6) **Ornamentals**

(i) *Calendula officinalis* (Pot marigold)

(ii) *Chrysanthemum sps.* (Guldaodi)

(iii) *Tagetes sps.* (Marigold or Genda)

(iv) *Helianthus annuus* (Sunflower).

Gramineae or 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 statments 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)

Br. Brl. + ⚥ $P_{2\,(\text{lodicules})}\,A_{\underset{3+3}{3 \text{ or}}}\,\underline{G_1}$

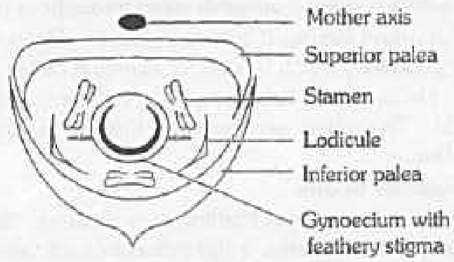


Fig : 2.1-28 Floral Diagram of *Triticum aestivum* (Wheat)

(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.

Tips & Tricks

- Culms : Their nodes and internodes are extremely clear ; internodes are hollow, *e.g.*, *Bambusa*.
- Roots arising from callus in tissue culture are adventitious.
- Life of root hairs is hardly one week. During transplantation, root hairs are shed and therefore, plant remains wilted for sometime till the formation of new root hairs.
- Roots provide more than 50% of total food.
- Acaulescent. Having a reduced stem.
- Allyl sulpride. Characteristic smell of Onion and Garlic.
- The anticancerous substance in garlic is gernium.
- Stem is quadangular in *Ocimum*, *triangular* in *Cyperus*, ribbed in *Cucurbits* and flat in *Cactus*.
- Petiole develops last in the leaf.
- CTC tea leaves are rich in iron because they are cured in iron pans.
- Plant with single leaf is *Monophyllea*.
- Plant with two leaves only in *Welwitschia*.
- Smallest leaf : *Wolffia*.
- Broadest leaf : *Victoria amazonica* (diameter 5 to 6 feet).
- Longest leaf : *Raphia vinifera* (30 to 50 feet).
- Largest leaf : *Victoria regia* is the largest leaf of plant kingdom, which are 4*m* in radius and diameteris 1.5 – 1.8 *m*.
- Anisophily : Presence of 2 types of leaves on same node of the plant of *Boerhaavia*.
- Belt's corpuscles, glands producing edible materials at the apices of leaflets in *Acacia sphaerocephala*.
- Spike is most common inflorescence.
- Capitulum (racemose head) is most evolved/highly advanced.
- Longest inflorescence : *Agave* (12*m*), *amorphophallus* (5.5*m*). *puyaraimondii* (10 metres).
- Cauliflory : The condition of developing flowers on the main stem (trunkiflory) or older branches from old or persisting axillary buds is called cauliflory. *e.g.*, *Ficus*.
- Intersexual : Perfect hermaphrodite, androgynous or monoclinous flower.
- Trioecious : Three types of plants – male, female and monoecious, *e.g.*, *Silence*.
- Longest stigma and style – Maize.
- Style and stigma of saffron (crocus) are edible and source of kesar.
- Ripeness of a flower depends on minimum number of leaves.
- Heterostyly : In this condition, stamens, style and stigma are of different heights. *e.g.*, *Primula*, *Oxalis*.
- Plants of tropics bear naked buds *i.e.*, buds without covering.
- Recalcitrant seeds : The seeds get killed on reduction of moisture and exposure to low temperature. *e.g.*, Tea, Jack fruit.
- Orthodox seeds : The seeds which can be stored for long as they tolerate reduction in moisture content (upto 5%) exposure to

low temperature and anaerobic conditions, e.g., Legumes, cereals.

- Smallest seed is of Orchis (wt. 0.004 g) and 1 gram contains 20 lakh seeds.
- Largest seed is Double coconut (Fresh wt. 6 kg).
- Seeds constitute 70% of our diet.
- Largest fruit / Largest seed is *Lodoicea maldivica*.
- All modern classifications are based on evolution, genotypes and ecological characters. They are phylogenetic in nature.
- Presence of myrosin enzyme is chief feature of family brassicaceae.

OT Ordinary Thinking

Objective Questions

Root

1. If a primary root continues to grow, the type of root system will be known as **[NCERT; DUMET 2009]**
(a) Secondary (b) Fibrous
(c) Tap (d) Stilt

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

3. Roots developing from plant parts other than radical are **[NCERT; Chd. CET 1997; HPMT 2005]**
(a) Epiphyllous (b) Epicaulous
(c) Adventitious (d) Fibrous

4. In which the pneumatophores are found **[NCERT; BVP 2001; AMU (Med.) 2009]**
(a) *Tinospora* (b) *Pinus*
(c) *Rhizophora* (d) None of these

5. Outer covering of epiphytic root is **[CPMT 2001; Odisha JEE 2005]**
(a) Osmophore (b) Rhizophore
(c) Velamen (d) Pneumatophore

6. Which of the following is correctly matched **[AIIMS 2012]**
(a) ***Monstera*** – Fibrous root
(b) ***Dahlia*** – Fasciculated root
(c) ***Azadirachta*** – Adventitious root
(d) **Basil** – Prop roots

7. Conical fleshy roots occur in
(a) Sweet potato (b) *Dahlia*
(c) *Asparagus* (d) Carrot

8. Napiform roots are recorded from
(a) Radish (b) Carrot
(c) Beet (d) Sweet potato

9. Fusiform roots are found in **[BHU 1996]**
(a) *Solanum tuberosum* (b) *Calocasia*
(c) *Daucus carota* (d) *Raphanus sativus*

10. A fibrous root system is better adapted than tap root system for **[BHU 1993, 2001; AMU (Med.) 2001; DUMET 2009]**
(a) Storage of food
(b) Anchorage of plant to soil
(c) Absorption of water and minerals
(d) Transport of water and organic food

11. Stilt roots are reported from **[Bihar PMT 1994; BHU 1996; Odisha JEE 1997, 2012]**
(a) *Pandanus* (Screw Pine) (b) Radish
(c) Mango-ginger (d) *Bryophyllum*

12. Assimilatory (Photosynthetic) roots a characteristic of **[Kerala CET 2000; BHU 2012]**
(a) *Trapa* and *Tinospora*
(b) *Taeniophyllum* and *Podostemon*
(c) Both correct
(d) None of these

13. Root cap is largest in
(a) Banyan (b) *Pandanus*
(c) *Jussiaea* (d) Maize

14. Find the incorrect match **[AMU (Med.) 2010]**
(a) Tap root : Carrot
(b) Adventitious root : Sweet potato
(c) Prop root : Banyan tree
(d) Stilt root : Turnip

15. A root is adventitious when it is **[CPMT 2002; RPMT 2005]**
(a) Swollen
(b) Growing in marshy places
(c) Formed from plumule
(d) Modified for storage

16. Monocot plants are characterized by the presence of **[NCERT; J & K CET 2005]**
(a) Tap roots (b) Fibrous roots
(c) Annulated roots (d) Stilt roots

17. Nodulated roots bearing family is **[RPMT 1993, 95, 96]**
(a) Mimosoideae (b) Caesalpinoideae
(c) Papilionatae (d) Solanaceae

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

19. Roots are absent in
(a) *Myriophyllum* (b) *Ceratophyllum*
(c) *Utricularia* and *Wolffia* (d) All of these

20. Stilt roots which grow obliquely from basal nodes of culm stem and acting as brace are found in **[NCERT; MP PMT 1993; DPMT 1999]**
(a) Sorghum (b) Maize
(c) Sugarcane (d) All of these

21. In *Ipomoea batatas*/Sweet potato the food is stored in **[Bihar PMT 1994; JKCMEE 2002]**
(a) Root tuber (b) Stem tuber
(c) Bud (d) Leaves

22. In maize, the fibrous roots develop from **[NCERT]**
(a) Lower nodes (b) Upper nodes
(c) Upper internodes (d) None of the above

23. 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 **[NCERT; Kerala PMT 2011]**
(a) (A) and (D) (b) (A), (C) and (D)
(c) (C) and (D) (d) (B) and (C)
(e) (A), (B) and (D)

24. Regions of root from base to root tip are **[NCERT; AMU (Med.) 2001]**
(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

25. Leguminous plants possess **[RPMT 1993]**
(a) Napiform roots (b) Nodulated roots
(c) Tuberous roots (d) Fusiform roots

26. Match the items in Column – I with Column – II and choose the correct alternative

Column – I		Column – II	
A.	Tubercular storage roots	1.	*Tinospora*
B.	Pneumatophores	2.	*Heritiera*
C.	Haustoria	3.	*Asparagus*
D.	Prop-roots	4.	*Viscum*
E.	Assimilatory roots	5.	*Screwpine*

[Kerala PMT 2007]
(a) A–2, B–3, C–4, D–5, E–1
(b) A–3, B–4, C–5, D–1, E–2
(c) A–3, B–1, C–2, D–5, E–4
(d) A–5, B–4, C–5, D–2, E–1
(e) A–3, B–2, C–4, D–5, E–1

27. Which of the following plant parts can respire even in the absence of oxygen **[KCET 2006]**
(a) Seeds (b) Roots
(c) Stems (d) Leaves

28. Roots play insignificant role in absorption of water in **[AIPMT 2015]**
(a) Pistia (b) Pea
(c) Wheat (d) Sunflower

29. Velamen takes part in **[Bihar PMT 1994]**
(a) Absorption of moisture from air
(b) Absorption of water from soil
(c) Exchange of gases
(d) Transpiration

30. Sweet potato is modification of **[J & K CET 2005]**
(a) Leaf (b) Root
(c) Stem (d) Flowering axis

31. Which is not a product of root **[NCERT; CPMT 1993; MP PMT 2013]**
(a) Sugarbeet (b) Carrot
(c) Radish (d) Potato

32. Aerial absorptive roots occur in **[Odisha JEE 1995]**
(a) Epiphytes (b) Mesophytes
(c) Hydrophytes (d) Xerophytes

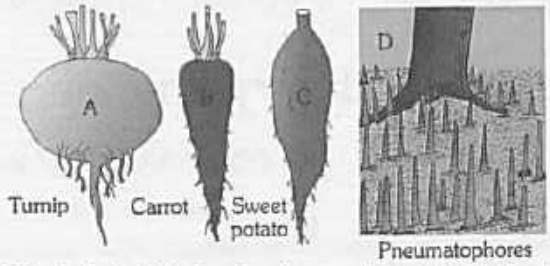
33. Epiphytes like *Vanda* develop special layer of absorptive tissue velamen consiting of 4 or 5 layers of long polygonal cells. Velamen is formed by **[BHU 1996; AIIMS 2001]**
(a) Absorbing roots (b) Stem
(c) Clinging roots (d) Hanging roots

34. Climbing roots occur in **[APMEE 1996; CBSE PMT 1999]**
(a) *Vanilla* (b) *Piper betle*
(c) Both (a) and (b) (d) *Taeniophyllum*

35. A rootless angiosperm is
(a) *Cuscuta* (b) *Balanosphora*
(c) *Utricularia* (d) All of these

36. Reproductive roots taking part in reproduction are found in
(a) *Dalbergia* (Shisham) (b) *Dahlia*
(c) Sweet Potato (*Ipomoea*) (d) All of these

37. See the following diagrams



Which of the following is not correct about A, B, C and D **[NCERT]**
(a) A, B and C are underground roots but D grows vertically upwards
(b) Pneumatophore is found in the plants that grow in sandy soil
(c) Pneumatophores help to get oxygen for respiration
(d) Tap roots of carrot, turnip and adventitious root of sweet potato, get swollen and store food

38. Buttress roots are
(a) Aerial (b) Underground
(c) Aquatic (d) Horizontal

39. Root which grow from branches of Banyan tree are **[Odisha JEE 2005]**
(a) Breathing roots (b) Climbing roots
(c) Hanging roots (d) Prop roots

40. Pneumatophores are useful in **[NCERT; CPMT 1993, 96]**
(a) Respiration (b) Transpiration
(c) Guttation (d) Protein synthesis

41. Pneumatophores are characteristics of family **[NCERT; Bihar PMT 2001]**
(a) Loranthaceae (b) Hydrocharitaceae
(c) Rhizophoraceae (d) Orchidaceae

42. There is maximum growth in root **[AFMC 1993; CPMT 1998]**
(a) In the dark (b) In the light
(c) At the root apex (d) Just behind the root apex

43. Prop roots of Banyan tree are meant for
(a) Respiration
(b) Absorption of water from soil
(c) Retention of water in soil
(d) Providing support to big tree

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

45. Haustoria or sucking roots occur in **[BHU 1996; DPMT 1999; JIPMER 1999; Pb. PMT 1999; Kerala PMT 2006]**
(a) Betel (b) Orchids
(c) *Cuscuta* (d) *Tinospora*

46. Pneumatophores or breathing roots occur in / Respiratory roots and vivipary reproduction are the characteristic of **[CPMT 1993; APMEE 1999; AMU (Med.) 2006; RPMT 2006]**
(a) Hydrophytes (b) Epiphytes
(c) Xerophytes (d) Mangrove plants

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

48. Food is stored in one of the following **[Kerala CET 2001]**
(a) Respiratory root (b) Fibrous root
(c) Fasciculated root (d) Nodulated root

49. White spongy floating roots occur in
(a) *Trapa* (b) *Nymphaea*
(c) *Eichhornia* (d) *Jussiaea*

50. Sweet potato is homologous to **[NCERT; CBSE PMT (Mains) 2011]**
(a) Ginger (b) Turnip
(c) Potato (d) Colocasia

51. Which of the following groups of plants are propagated through underground root **[Kerala PMT 2006]**
(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

52. Root pocket occurs in
(a) Maize (b) *Pandanus*
(c) *Banyan* (d) Water Hyacinth

Stem

1. In *Amorphophallus* and *Colocasia* (Ariods) an extremely enlarged underground vertical stem meant for vegetative reproduction and storage is **[DPMT 1994; AFMC 1996, 2010]**

Or

Modified stem present in Gladiolus is **[Odisha JEE 2004]**
(a) Tuber (b) Corm
(c) Bulb (d) Rhizome

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

3. Stem is modified into cladode in **[J & K CET 2008]**

Or

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

4. Find out correct order of vegetative propagules of plants like potato, ginger Agave, Bryophyllum and water hyacinth **[Kerala PMT 2012; AIPMT (Cancelled) 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

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

6. Floral bud tendril is found in **[BHU 1997; JIPMER 1997]**
(a) *Antigonon* (b) *Smilax*
(c) Rose (d) *Bryophyllum*

7. Thorn is a stem structure because it **[NCERT; CPMT 1995; Kerala PMT 2004]**
(a) Develops from trunk
(b) Develops from axillary bud
(c) Grows from external surface
(d) Is pointed

8. Which of the following statements is/are true
(A) If the stem is jointed with solid nodes and hollow internodes, it is called caudex
(B) In *Tridax* the stem is decumbent
(C) Corm is a condensed form of rhizome growing more or less in vertical direction
(D) Sucker is an underground modification of stem
(E) Biparous type of cymose branching is seen in *Saraca* **[Kerala PMT 2008]**
(a) (A), (D) and (E) only (b) (B) and (C) only
(c) (B), (C) and (E) only (d) (C) and (D) only
(e) (D) and (E) only

9. An example of edible underground stem is **[NCERT; CPMT 1993; HPMT 2005; CBSE PMT 2014]**
(a) Sweet potato (b) Potato
(c) Carrot (d) Groundnut

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

11. In *Opuntia*, the function of photosynthesis is carried out by **[NCERT; AFMC 1996; J & K CET 2010]**
(a) Cladode (b) Phylloclade
(c) Phyllode (d) Bulb

12. An underground specialised shoot with reduced disc like stem covered by fleshy leaves is **[APMEE 1996; JKCMEE 2000; AIIMS 2013]**
(a) Bulb (b) Bulbil
(c) Rhizome (d) Rhizophore

13. A horizontal underground stem is a **[Tamilnadu 2001; DUMET 2009]**

Or

Ginger plant has an underground stem which is **[CPMT 1994; JIPMER 1998; MP PMT 2004; J & K CET 2005]**

(a) Corm (b) Phylloclade
(c) Rhizome (d) Rhizoid

14. The structure which contain vascular bundle and is modification of stem is **[AFMC 2010]**

(a) Bristles (b) Thorn
(c) Prickle (d) Spine

15. Potato is (underground) stem because it **[Odisha JEE 1995]**

(a) Possesses axillary buds (Eyes)
(b) Lacks chlorophyll
(c) Does not bear roots
(d) Contains reserve food

16. New Banana plants develop from **[CBSE PMT 1990; AMU (Med.) 2012]**

(a) Rhizome (b) Sucker
(c) Stolon (d) Seed

17. Stem may function for **[AMU (Med.) 2009]**

(a) Storage, support and vegetative propagation
(b) Protection
(c) Spread branches
(d) All of these

18. Which one of the following is a xerophytic plant in which the stem is modified into the flat green and succulent structure **[CBSE PMT (Mains) 2010; Kerala PMT 2012]**

Or

Phylloclade is found in **[AMU (Med.) 2001]**

(a) *Opuntia* (b) *Casuarina*
(c) *Hydrilla* (d) *Acacia*

19. Largest bud is of

(a) Cabbage (b) Cauliflower
(c) Agave (d) Onion

20. Which one of the following is correctly matched **[NCERT; CBSE PMT (Pre.) 2012]**

(a) Onion–Bulb
(b) Ginger–Sucker
(c) *Chlamydomonas* – Conidia
(d) *Yeast* – Zoospores

21. Bulb is modified **[Bihar PMT 1994]**

(a) Leaf (b) Shoot
(c) Root (d) Flower

22. Succulent stem is found in **[Odisha JEE 2010]**

(a) *Pisum* (b) *Casuarina*
(c) *Oxalis* (d) *Euphorbia*

23. Eye of potato is **[NCERT; CBSE PMT 2001; CBSE PMT (Pre.) 2011]**

(a) Apical bud (b) Axillary bud
(c) Accessory bud (d) Adventitious bud

24. Which of the following is not related to corm **[Kerala CET 2001]**

(a) Tunic (b) Lateral buds
(c) Nodes (d) Scale leaves

25. Thorns differ from prickles in having

(a) Vascular supply (b) Endogenous origin
(c) Bark (d) All of these

26. *Mentha* (Mint) has one of the following

(a) Sucker (b) Offset
(c) Stolon (d) Rhizome

27. Stem tendrils occur in **[Odisha JEE 2000]**

(a) *Smilax* (b) *Gloriosa*
(c) *Vitis* (d) *Lathyrus*

28. Green leaf-like one internode long stem branches are called **[KCET 2003; Odisha JEE 2012]**

(a) Phylloclades (b) Phyllodes
(c) Bulbils (d) Cladodes

29. Which of the following is the subaerial stem modification with long internode **[Odisha JEE 2011]**

(a) Rhizome (b) Offset
(c) Runner (d) Sucker

30. Rhizome which grows vertically upwards are **[AFMC 2005]**

(a) Corms (b) Stolon
(c) Bulbils (d) Root stock

31. Thorn of *Bougainvillea* is modified **[NCERT; NEET 2017; Bihar PMT 1994]**

(a) Stem (b) Leaf
(c) Floral bud (d) Root

32. Ginger is a stem which can be differentiated from root because it **[MP PMT 2007]**

(a) Grows parallel to ground
(b) Stores food
(c) Lacks chlorophyll
(d) Has nodes and internodes

33. Which is not a rhizome **[Pb. PMT 1997]**

(a) *Colocasia* (b) Lotus
(c) Ginger (d) Turmeric

34. In *Passiflora*, the tendrils are modified

(a) Axillary buds (b) Upper leaflets
(c) Whole leaves (d) Stipules

35. Thorns with leaves and flowers are found in **[APMEE 2002]**

(a) *Bougainvillea* (b) *Carissa*
(c) *Duranta* (d) *Artabotrys*

36. Stem takes part in storage and perennation in **[DPMT 1994; AMU (Med.) 1994; AFMC 1994; Manipal 1997]**

(a) Wheat (b) Groundnut
(c) Radish (d) Ginger

37. Prickles of Rose are

(a) Modified leaves (b) Modified stipules
(c) Exogenous in origin (d) Endogenous in origin

38. 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

[NCERT; Kerala PMT 2011]

(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

39. Bulbil is a modification of
(a) Underground stem (b) Bases of leaves
(c) Buds (d) Radicle

40. Which of the following is **not** a stem modification **[NEET (Phase-I) 2016]**
(a) Pitcher of *Nepenthes*
(b) Thorns of citrus
(c) Tendrils of cucumber
(d) Flattened structures of *Opuntia*

41. In humid climate, presence of spines in shrubs is
(a) To reduce transpiration
(b) To defend against mammal herbivory
(c) To defend against wood cutters
(d) To check seed predation by birds

42. In onion leaves food is stored in the form of
(a) Sugar (b) Starch
(c) Protein (d) Malic acid

43. The cloves which are used in food preparation are **[Kerala CET 2005; Odisha JEE 2010]**
(a) Seeds (b) Leaves
(c) Flower buds (d) Stem tip
(e) Terminal bud

44. Rhizomes are mostly **[AFMC 1999]**
(a) Sympodial (b) Diageotropic
(c) Horizontal (d) All of these

45. Tip of twiner is sensitive and coils around support itself. This coiling is called
(a) Nutation (b) Vernation
(c) Epinasty (d) Circination

46. Multicellular hairs are found on **[MHCET 2004]**
(a) Root (b) Stem
(c) Both (a) and (b) (d) None of the above

47. Potato and sweet potato **[AIIMS 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

48. Which of the following plants have long slender and coiled stem tendrils developed from axillary buds **[NCERT; Kerala PMT 2011]**
(a) Grapevine and pumpkins
(b) Australian *Acacia* and watermelon
(c) *Bougainvillea* and cucumber
(d) Strawberry and grapevine
(e) *Alstonia* and pumpkins

49. Aroids store food in
(a) Inflorescence (b) Enlarged root
(c) Leaf bases (d) Swollen stem

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

51. Stem modified for photosynthetic function by appearing like leaves are known as **[NCERT; AFMC 1996; JIPMER 1998; JKCMEE 2002; MP PMT 2013; NEET (Phase-I) 2016]**

Or

Leaves are changed into spines in xerophytic structures Called **[CPMT 1996; Kerala PMT 2004]**
(a) Phyllode (b) Phylloclade
(c) Cladode (d) Tendril

52. Which one of the following statements is **not** correct **[NEET (Phase-II) 2016]**
(a) Water hyacinth, growing in the standing water, drains oxygen from water that leads to the death of fishes
(b) Offspring produced by the asexual reproduction are called clone
(c) Microscopic, motile asexual reproductive structures are called zoospores
(d) In potato, banana and ginger, the plantlets arise from the internodes present in the modified stem

Leaf

1. Petiole part of the leaf is known as **[Odisha JEE 2012]**
(a) Epipodium (b) Mesopodium
(c) Hypopodium (d) None of these

2. A leaf is identified from **[JKCMEE 1999]**
(a) Flat green lamina
(b) Presence of leaf blade and petiole
(c) Presence of axillary bud
(d) Occurrence of chlorophyll

3. Find the correct match **[AMU (Med.) 2010]**
(a) Mustard plant : leaves are opposite
(b) Mustard plant : leaves are alternate
(c) Guava plant : Leaves are alternate
(d) Guava plant : Leaves are whorled

4. Finely dissected leaves occur in
(a) Free floating plants
(b) Rooted floating leaved plants
(c) Submerged plants
(d) Emerged plants

5. In Tamarind (Imli) the pinnate leaf is **[Bihar PMT 1994]**
(a) Tripinnate (b) Bipinnate
(c) Paripinnate (d) Imparipinnate

6. Presence of sheathing leaf base and ligule are characteristic of **[NCERT; Chd. CET 1997]**
(a) Cycas leaf (b) Fern leaf
(c) Banana leaf (d) Grass leaf

7. Approximate diameter of *Victoria* leaf is **[BHU 1996]**
(a) 1*m* (b) 1.3*m*
(c) 2*m* (d) 3*m*

8. A dicotyledenous plant showing parallel venation is
(a) *Dioscorea* (b) *Smilax*
(c) *Calophyllum* (d) *Hibiscus*

9. Bipinnate leaves are characteristic of
(a) Cruciferae (b) Solanaceae
(c) Papilionoideae (d) Mimosoideae

10. In *Lathyrus aphaca*, the leaves are modified into **[AIIMS 1997]**
(a) Spine (b) Tendril
(c) Scale (d) Stem-like structure

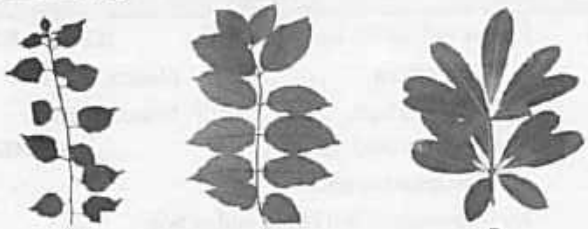
11. Foliaceous stipules are found in **[Odisha JEE 2012]**
(a) Rose (b) Wild pea
(c) Castor (d) Kadam

12. In sweet pea, the tendrils are modified **[JIPMER 2000; RPMT 2002]**
(a) Stem branches (b) Leaflets
(c) Leaves (d) Stipules

13. Bud scales of *Ficus* are modified
(a) Leaves (b) Stipules
(c) Stem (d) Prickles

14. Imparipinnate leaf is the one where
(a) Leaflets are borne in pairs
(b) Leaflets are small
(c) Leaflets are large
(d) Rachis is terminated by an odd leaflet

15. Identify the correct types of phyllotaxy which shown in the following figures **[NCERT]**



(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

16. A simple leaf is present in
(a) Peepal (b) *Mimosa*
(c) Neem (d) All of these

17. Phyllotaxis is **[NCERT; AIIMS 1996; APMEE 1999; Kerala CET 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

18. Tendrillar stipules occur in **[DPMT 1999]**
(a) *Dolichos lablab* (b) *Acacia*
(c) *Smilax* (d) Mango

19. The leaves are modified into tendrils, hooks, pitcher and bladder in the following plants respectively **[Kerala PMT 2006]**
(a) Sweet pea, Cat's nail, *Nepenthes*, *Utricularia*
(b) Sweet pea, Cat's nail, *Utricularia*, *Nepenthes*
(c) *Nepenthes*, Cat's nail, Sweet pea, *Utricularia*
(d) *Nepenthes*, Sweet pea, Cat's nail, *Utricularia*
(e) *Utricularia*, *Nepenthes*, Cat's nail, Sweet pea

20. Onion stores food in
(a) Underground stem (b) Fleshy scales
(c) Root (d) Shoot

21. 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 **[NCERT; Kerala PMT 2011]**
(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

22. Whorled, simple leaves with reticulate venation are present in **[NCERT; Kerala PMT 2010; CBSE PMT (Mains) 2011]**
(a) China Rose (b) *Alstonia*
(c) *Calotropis* (d) Neem

23. Petiole is modified into tendril in **[AFMC 1996; Odisha JEE 2000, 10]**
(a) *Passiflora* (b) *Gloriosa*
(c) *Pisum* (d) *Clematis*

24. A unipinnate compound leaf can be differentiated from a branch having simple leaves by
(a) Presence of terminal bud in compound leaf
(b) Absence of veins in the leaflets
(c) Presence of buds in the axils of leaflets
(d) Presence of buds in the axils of leaves

25. Cactaceae Stores water in leaves. It implies **[Odisha JEE 2008]**
(a) Ephemerals (b) Drought resistants
(c) Annuals (d) Non succulents

26. Ochreate stipules are found in **[Odisha JEE 2009]**
(a) Polygonaceae (b) Acanthaceae
(c) Leguminosae (d) Malvaceae

27. 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 **[EAMCET 2009]**

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

28. 1/3 spiral phyllotaxy (called Tristichous) means **[Odisha JEE 2012]**
(a) 3 rows of alternate rows
(b) In one circle, there are 3 leaves
(c) The angular divergence between 2 leaves is 120°
(d) All of these

29. Multicostate parallel type of venation is found in the leaves of **[Kerala PMT 2009; Odisha JEE 2011]**
(a) Grasses and palms (b) Banana and *canna*
(c) Castor and china rose (d) Mango and peepal
(e) Castor and tapioca

30. In 1/2 distichous phyllotaxy
(a) 2nd leaf lies on 1st leaf at 180° angle
(b) 3rd leaf on 1st leaf at 180° angle
(c) 1st leaf lies exactly below 2nd leaf at 120° angle
(d) None of these

31. Leaves are situated on **[AFMC 2003; CBSE PMT 2005]**
(a) Nodes (b) Internodes
(c) Tip (d) None of these

32. The leaves of *Utricularia* plant are modified into **[J & K CET 2005]**
(a) Hooks (b) Tendrils
(c) Bladders (d) Pitchers

33. The reticulate venation is commonly found in the leaves of **[J & K CET 2005]**
(a) Monocot plants (b) Dicot plants
(c) Bryophytes (d) Thallophytes

34. Identify in order, the plants showing alternate, opposite and whorled phyllotaxy **[NCERT; Kerala PMT 2005]**
(a) China rose, *Calotropis*, *Nerium*
(b) China rose, *Nerium*, *Calotropis*
(c) *Nerium*, China rose, *Calotropis*
(d) *Nerium*, *Calotropis*, China rose
(e) *Calotropis*, *Nerium*, China rose

35. The leaf less stem of onion which is produced to bear flower is called **[AFMC 2006]**
(a) Thalamus (b) Scape
(c) Torus (d) Pedicel

36. Leaf of which of the following plant shows circinate venation at young stage **[MHCET 2004]**
(a) Fern (b) Mango
(c) *Hydrilla* (d) *Funaria*

37. Petiole is winged in
(a) Citrus (b) Pea leaf
(c) *Dionaea leaf* (d) Both (a) and (c)

38. In *Opuntia* the spines are modification of **[Pb. PMT 2004; Kerala PMT 2009; AIPMT (Cancelled) 2015]**
(a) Leaf (b) Branch
(c) Epidermis (d) Flower

39. 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*

[Kerala PMT 2010, 11; CBSE PMT (Mains) 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

40. In *Nepenthes* the pitcher is modified **[Kerala CET 2001; Tamil Nadu 2001; Chd. CET 2003]**
(a) Whole leaf (b) Leaf apex
(c) Lamina (d) Petiole

41. In 3/8 alternate phyllotaxy (Called ostastichous)
(a) There are 8 leaves in 3 circles
(b) 3 leaves in 8 circles
(c) There are 3 rows of leaves
(d) There are 8 rows of leaves on three sided stem

42. Name the plant having reticulate venation **[Wardha 2001; Tamil Nadu 2001]**
(a) *Musa* (b) *Mangifera*
(c) *Oryza* (d) *Canna*

43. Rachis is present in
(a) Pinnate compound leaf (b) Palmate compound leaf
(c) Both correct (d) Both wrong

44. *Bombax* leaf is **[Kerala CET 2000; Tamil Nadu 2001]**
(a) Tripinnate (b) Unipinnate
(c) Multifoliate (d) Quadrifoliate
(e) Trifoliate

45. Parallel venation occurs in **[BVP 2000; Tamil Nadu 2001; Odisha JEE 2005]**
(a) Monocots (b) Dicots
(c) All angiosperms (d) Ferns

46. Arrangement of floral leaves in a floral bud is called **[Pb. PMT 1997]**
(a) Vernation (b) Prefoliation
(c) Aestivation (d) Ptyxis

47. Phyllode is found in **[NCERT; Chd. CET 2003; CBSE PMT (Pre.) 2012]**
(a) *Clematis* (b) *Gloriosa*
(c) Australian *Acacia* (d) *Dischidia*

48. Match the columns

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

Options **[AMU (Med.) 2002]**
(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

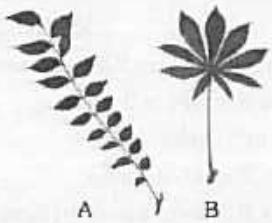
49. Spiral phyllotaxy in which sixth leaf lies above the first one after completing two circles is **[APMEE 2002]**
(a) Distichous (b) Tristichous
(c) Pentastichous (d) Octastichous

50. Ochreate stipules occur in leafy vegetable **[APMEE 2002]**
(a) *Amaranthus* (b) *Mentha*
(c) *Platanus* (d) *Rumex*

51. The arrangement and folding of each lamina without any relationship with other leaves in bud, is called **[DPMT 1997]**
(a) Ptyxis (b) Vernation
(c) Aestivation (d) Phyllotaxy

52. In spiral phyllotaxy, the number of leaves at each node is
(a) One (b) Two
(c) Many (d) Three

53.



See the following figures and identify leaves A and B **[NCERT]**
(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

54. In Banana, true stem is underground. The stem like structure outside soil is formed by
(a) Peduncle (b) Petiole of leaves
(c) Leaf bases (d) Overlapping of leaves

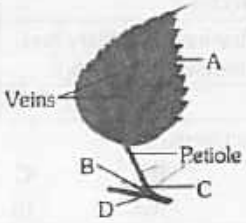
55. In *Calotropis* the phyllotaxy is **[AMU (Med.) 2009]**
(a) Alternate (b) Verticellate
(c) Opposite and superposed (d) Opposite and decussate

56. Leaf blade is spinous in case of **[Manipal 2005]**
(a) *Nerium* (b) *Zizipus*
(c) *Argemone* (d) *Cannabis*

57. 120° phyllotaxy is found in **[Odisha JEE 2011]**
(a) Tristichous (b) Distichous
(c) Pentastichous (d) Octastichous

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

59. See diagram of a typical leaf. In which of the following option all the four parts marked as A, B, C and D are correctly identified **[NCERT]**



	A	B	C	D
(a)	Leaflet	Axillary bud	Stipule	Leaf base
(b)	Lamina	Axillary bud	Stipule	Pedicel
(c)	Lamina	Stipule	Axillary bud	Leaf base
(d)	Lamina	Axillary bud	Stipule	Leaf base

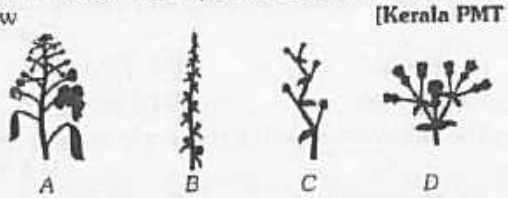
Inflorescence

1. Match List I with List II and select the correct option

List I		List II	
A.	Spike	1.	Bougainvillea
B.	Capitulum	2.	Coleus
C.	Dichasial cyme	3.	Adhatoda
D.	Multiparous cyme	4.	Zinnia
E.	Verticillaster	5.	Asclepias

[Kerala PMT 2005, 08]
(a) A – 3, B – 4, C – 1, D – 5, E – 2
(b) A – 3, B – 1, C – 4, D – 5, E – 2
(c) A – 2, B – 4, C – 1, D – 5, E – 3
(d) A – 4, B – 2, C – 5, D – 1, E – 3
(e) A – 5, B – 4, C – 1, D – 3, E – 2

2. Find out the correct sequence of labelling of diagram given below **[Kerala PMT 2006]**



(a) *A* – spike, *B* – raceme, *C* – dichasial cyme, *D* – monochasial cyme
(b) *A* – raceme, *B* – spike, *C* – monochasial cyme, *D* – dichasial cyme
(c) *A* – dichasial cyme, *B* – monochasial cyme, *C* – raceme, *D* – spike
(d) *A* – spike, *B* – dichasial cyme, *C* – monochasial cyme, *D*– raceme
(e) *A* – raceme, *B* – dichasial cyme, *C* – spike, *D* – monochasial cyme

3. 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

[EAMCET 2009]

(a) (ii), (iii) (b) (i), (ii)
(c) (iv), (iii) (d) (iii), (i)

4. In cyathium inflorescence **[Kerala CET 2005; Odisha JEE 2010]**

(a) Single male flower is surrounded by female flowers
(b) Male and female flowers are borne in different plants
(c) There is of one male and one female flowers
(d) Single female flower surrounded by many peripheral male flowers

5. The most advanced type of inflorescence is

(a) Corymb (b) Catkin
(c) Spadix (d) Capitulum

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 **[EAMCET 2009]**

(a) 34, 126 (b) 68, ∞
(c) 204, 164 (d) 102, 42

7. The flowers in the raceme/racemose are arranged **[Pb. PMT 2000]**

(a) Acropetally (b) Basipetally
(c) Centripetally (d) Centrifugally

8. Which of the following statements are correct

(i) When a fruit develops from the inflorescence, it is composite
(ii) Mesocarp is the edible part in apple
(iii) Gynobasic style is seen in *Ocimum*
(iv) Hypanthodium is a special type of inflorescence found in *Euphorbia* species **[Kerala PMT 2009]**

(a) (i) and (iv) are correct
(b) (i) and (iii) are correct
(c) (i) and (ii) are correct
(d) (ii), (iii) and (iv) are correct
(e) (ii) and (iv) are correct

9. Amentum (Catkin) inflorescence is found **[JIPMER 1996]**

(a) Mulberry (*Morus*) (b) *Populus* (Poplar)
(c) *Acalypha* (Cats tail) (d) All of these

10. Characteristic inflorescence of family compositae sunflower is **[JIPMER 2000; BHU 2000; CPMT 2004]**

(a) Capitulum (b) Cymose head
(c) Catkin (d) Spadix

11. Given inflorescence is a **[Kerala PMT 2009]**

(a) Cyathium
(b) Dichasial cyme
(c) Umbel
(d) Panicle
(e) Verticillaster

12. The whorl of bracts present below the inflorescence of *Helianthus* (sunflower) is **[Pb. PMT 2000]**

(a) Involucre (b) Involucel
(c) Stipule (d) Bract

13. Cymose inflorescence is present in **[NCERT; CBSE PMT (Pre.) 2012]**

(a) Solanum (b) Sesbania
(c) Trifolium (d) Brassica

14. Hypanthodium is a specialized type of **[BVP 2002]**

(a) Thalamus (b) Ovary
(c) Fruit (d) Inflorescence

15. Inflorescence in *Musa paradisiaca* (banana) is a **[AMU (Med.) 2002; J & K CET 2010]**

(a) Raceme (b) Catkin
(c) Spadix (d) Verticellaster

16. The unit of inflorescence in grasses / gramineae (poaceae) is **[BVP Pune 1998; Odisha JEE 2012]**

(a) Thyrsis (b) Spike
(c) Spikelet (d) Raceme

17. The capitulum type of inflorescence is found in **[J & K CET 2005]**

(a) Marigold (b) Salvia
(c) Euphorbia (d) Jasmine

18. In China rose, the inflorescence is **[MHCET 2004]**

(a) Cymose (b) Capitulum
(c) Racemose (d) Solitary cyme

19. Consider the following statements

(A) In racemose inflorescence the flowers are borne in a basipetal order
(B) Epigynous flowers are seen in rose plant
(C) In brinjal the ovary is superior

Of these statements **[Kerala PMT 2010]**

(a) (A) and (B) are true but (C) is false
(b) (A) and (C) are true but (B) is false
(c) (A) and (B) are false but (C) is true
(d) (A) and (C) are false but (B) is true
(e) (B) and (C) are true but (A) is false

20. The edible part of cauliflower is **[CPMT 2004; AFMC 2005]**

(a) Mesocarp (b) Cotyledons
(c) Endosperms (d) Inflorescence

21. In 'Tulsi' (*Ocimum*) of labiatae the inflorescence is

(a) Cyathium (b) Verticillaster
(c) Hypanthodium (d) Raceme of Racemes

22. The inflorescence in cauliflower is **[Odisha JEE 2011]**
(a) Compound corymb (b) Corymb
(c) Umbel (d) Catkin

23. Cyathium is found in genus **[KCET 1998, 2000]**
(a) *Croton* (b) *Ficus*
(c) *Euphorbia* (d) *Ricinus*

24. 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 **[Manipal 2000; BHU 2002; Pb. PMT 2004; RPMT 2006]**
(a) Cyathium (b) Verticillaster
(c) Spadix (d) Hypanthodium

25. An edible inflorescence is
(a) Corymb (b) Catkin
(c) Hypanthodium (d) All of these

26. Inflorescence with unisexual sessile flower is **[AFMC 1996, 2002; AMU (Med.) 1999]**
(a) Spike (b) Spikelet
(c) Catkin (d) Spadix

27. Most accurate function in the following statements about inflorescence is **[DPMT 1996]**
(a) Dispersal of seeds
(b) Formation of more fruit
(c) Formation of pollen grains
(d) Dispersal of pollens

28. Inflorescence is edible in *Brassica oleracea* **[AFMC 1998]**
(a) Var. botrytis (b) Var. capitate
(c) Var. gongyloides (d) Var. gemifera

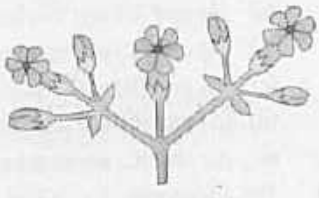
29. A beautiful whorl which encloses whole of the inflorescence is **[Manipal 2002]**
(a) Bract (b) Spadix
(c) Spathe (d) Involucre

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

31. In a cymose inflorescence the main axis **[NEET (Karnataka) 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

32. See the following diagrams and identify inflorescence A and B **[NCERT]**


A


B

(a) A – Cymose, B – Cymose
(b) A – Racemose, B – Racemose
(c) A – Racemose, B – Cymose
(d) A – Cymose, B – Racemose

33. Many plants among *Indigofera, Sesbania, Salvia, Allium, Aloe,* mustard, groundnut, radish, gram and turnip have stamens with different lengths in their flowers **[NEET (Phase-II) 2016]**
(a) Six (b) Three
(c) Four (d) Five

Flower

1. Flower is intersexual in
(a) Date palm (b) *Cucurbita*
(c) *Papaya* (d) *Hibiscus*

2. Thalamus is **[NCERT; Bihar PMT 1994]**
(a) Base of flower (b) Base of ovary
(c) Modification of pollen (d) Modification of petal

3. Synandrous condition is fusion of **[Bihar PMT 1994]**
(a) Filaments only
(b) Both filaments and anthers
(c) Anthers only
(d) Petals

4. A characteristic of angiosperms is **[HPMT 1994; Rohtak PMT 1994]**
(a) Flower (b) Root
(c) Seed (d) All of these

5. Which of these is an example for zygomorphic flower with imbricate aestivation **[Kerala PMT 2010]**
(a) *Calotropis* (b) Mustard
(c) *Canna* (d) *Cassia*
(e) Cucumber

6. Ligulate/strap-shaped corolla occurs in sunflower in **[JIPMER 2000]**
(a) Disc florets (b) Immature florets
(c) Ray florets (d) Both ray and disc florets

7. Beauty of *Bougainvillea* flower is due to **[AFMC 1996, 99; BHU 2008]**
(a) Corolla (b) Calyx
(c) Bracts (d) Androecium

8. Flower is complete when it has
(a) Calyx, corolla, androecium and gynoecium
(b) Calyx and corolla
(c) Androecium and gynoecium
(d) Corolla, androecium and gynoecium

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

10. In monoadelphous condition, stamens have
(a) Filaments of all united in one group but anthers are free
(b) Filaments united in groups but all anthers are free
(c) Anthers are fused but filaments are free
(d) Both anthers and filaments are fused

11. Stamens attached to petals are **[BHU 1993]**
(a) Antipetalous (b) Epipetalous
(c) Epiphyllous (d) Episepalous

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

13. Axis developing between androecium and gynoecium is
(a) Anthophore (b) Androphore
(c) Gynophore (d) Gynandrophore

14. A plant with both male and female flowers borne over it is **[CPMT 1993]**
(a) Monoecious (b) Dioecious
(c) Unisexual (d) Bisexual

15. The expression "gynoecium is apocarpous" implies that the **[DUMET 2010]**
(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

16. 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 **[AMU (Med.) 2009, 12]**
(a) Axile (b) Parietal
(c) Marginal (d) Basal

17. The flower of *Calotropis* has which of the following aestivations **[J & K CET 2012]**
(a) Twisted (b) Imbricate
(c) Valvate (d) Vexillary

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

19. Butterfly shaped flower with one stranded, two wing-like and two keeled petal belong to **[AIIMS 2000]**
(a) Compositae (b) Rubiaceae
(c) Malvaceae (d) Papilionaceae

20. On the basis of position of the ovary, mustard plants are **[J & K CET 2012]**
(a) Hypogynous (b) Perigynous
(c) Epigynous (d) Zygomorphic

21. In angiospermic bud condition floral bud is covered by whorls of **[Odisha JEE 2008]**
(a) Petal (b) Sepal
(c) Anther (d) Stigma

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

23. In Maize, the flowers are **[CPMT 1994]**
(a) Absent
(b) Unisexual but on different plants
(c) Bisexual
(d) Unisexual but on the same plant

24. Odd sepal is enlarged and leaf-like in
(a) Rose (b) *Smilax*
(c) *Mussaenda* (d) *Bougainvillea*

25. Sometimes sepals are modified into hairy structures which are useful in dispersal of seeds. These are called
(a) Tepals (b) Epik
(c) Pappus (d) Trichome

26. Glumes are modified **[CPMT 2009; MP PMT 2013]**
(a) Petals
(b) Bracts (Dry and scaly bracts)
(c) Gynoecium
(d) Androecium

27. Pappus is modification of **[Chd. CET 1997; BHU 2005]**
(a) Bracts (b) Bracteoles
(c) Corolla (d) Calyx

28. Cruciform corolla is found in
(a) Pea (b) China Rose
(c) Radish (d) Sunflower

29. In which type of aestivation the petal arrangement is 2 external, 2 internal and 1 partly external and partly internal seen **[Odisha JEE 2010]**
(a) Twisted (b) Imbricate
(c) Quincuncial (d) Valvate

30. Two minute scales or lodicules occur in **[AIIMS 1997; Chd. CET 1997]**
(a) *Citrus medica* (b) *Triticum aestivum*
(c) *Helianthus annus* (d) *Gossypium herbaceum*

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

32. 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 **[NCERT; CBSE PMT (Mains) 2012]**
(a) Four (b) Five
(c) Six (d) Three

33. In china rose the flowers are **[AIIMS 1999; NEET 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

34. Versatile anther is attached to filament **[BHU 1996]**
(a) At top firmly
(b) At base firmly
(c) Throughout length
(d) About middle of connective allowing free movement

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

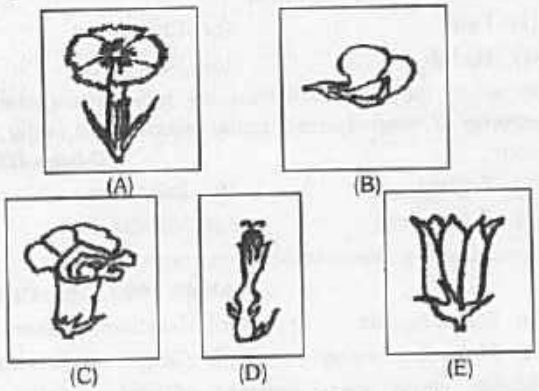
36. Ray florets of sunflower (Compositae) are
(a) Bisexual (b) Unisexual
(c) Asexual (d) None of these

37. Part of pistil which receives pollen is **[NCERT; MP PMT 2004]**
(a) Ovary (b) Style
(c) Stigma (d) Ovule

38. An example of axile placentation is **[CBSE PMT 2009; AIPMT 2015]**
(a) Argemone (b) Dianthus
(c) Lemon (d) Marigold

39. 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

40. The correct sequence of types of corolla in the following figures is **[Kerala PMT 2008]**



(a) A – Caryophyllaceous, B – papilionaceous, C – bilabiate, D – tubular, E – bell- shaped
(b) A – papilionaceous, B – bilabiate, C – tubular, D – bell-shaped, E – caryophyllaceous
(c) A – bilabiate, B – papilionaceous, C– caryophyllaceous, D – bell- shaped, E – tubular
(d) A – caryophyllaceous, B – bilabiate, C – papilionaceous, D – tubular, E – bell- shaped
(e) A – tubular, B – bell- shaped, C – caryophyllaceous, D – bilabiate, E – papilionaceous

41. A flower is zygomorphic when **[WB JEE 2011]**
(a) Any transverse section divides it into two equal halves
(b) Only one transverse section divides it into two equal halves
(c) Every vertical section passing through its centre divides it into two equal halves
(d) Only one vertical section passing through its centre divides it into two equal halves

42. Flower is a modified shoot as
(a) Thalamus may elongate to show internodes
(b) There is aggregation into inflorescence
(c) It bears essential organs
(d) It may have epicalyx

43. Usually, the whorl in a flower that attracts insects and protects the essential parts is **[KCET 2012]**
(a) Calyx (b) Androecium
(c) Gynoecium (d) Corolla

44. 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 **[AMU (Med.) 2012]**
(a) Hypogynous (b) Perigynous
(c) Epigynous (d) Inferior

45. Smallest flower belongs to **[DPMT 2004; CPMT 2009]**
(a) *Rosa indica* (b) *Wolffia microscopica*
(c) *Ranunculus scleratus* (d) *Colocasia antiquorum*

46. Largest flower is that of **[CPMT 1996; BHU 2005; Odisha JEE 2005]**
(a) Sunflower (b) *Rafflesia*
(c) *Nelumbo* (d) *Drosera*

47. Polyadelphous anthers are present in
(a) Sunflower (b) Lemon
(c) Lady's finger (d) Peanut

48. Flowers of Liliaceae, Malvaceae and Solanaceae are **[RPMT 1994, 96; BHU 1995]**
(a) Hypogynous (b) Perigynous
(c) Epigynous (d) Amphigynous

49. Flowers and stamens of compositae are
(a) Hypogynous and inferior
(b) Epigynous and superior
(c) Hypogynous and superior
(d) Epigynous and inferior

50. Compound apocarpous gynoecium is found in **[CBSE PMT 1991]**
(a) Lily (b) Hollyhock
(c) Lotus/*Ranunculus* (d) Pumpkin

51. The primitive type of stamens are found in the flowers family **[AIIMS 1994]**
(a) Liliaceae
(b) Malvaceae
(c) Gramineae/Poaceae
(d) Degeneriaceae/Magnoliaceae

52. Find out the pairs, which are correctly, matched with respect to aestivation of petals
I. Valvate – Calotropis II. Twisted – Bean
III. Imbricate– Cassia IV. Vexillary– China rose **[Kerala PMT 2012]**
(a) II and IV (b) I and II
(c) I and III (d) III and IV
(e) II and III

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

54. Ascending imbricate corolla is found in
(a) *Pisum*/Papilionatae
(b) *Tamarindus*/Caesalpinoidae
(c) *Mimosa*/Mimosoidae
(d) *Datura*/Solanaceae

55. A perennial shrub has compound leaves and solitary zygomorphic and epigynous flowers. Each flower reveals dichlamydeous condition with many stamens and multiple fruits with exalbuminous seeds. What is the ratio of advanced and primitive characters in it **[EAMCET 2009]**
(a) 1 : 2 (b) 2 : 3
(c) 1 : 1 (d) 3 : 2

56. Parachute like pappus is found in **[JKCMEE 2000]**
(a) Liliaceae/Cotton (b) Gramineae/Paddy
(c) Compositae/Marigold (d) Solanaceae/Calotropis

57. In Gossypium the type of cohesion is **[RPMT 1992, 96]**
(a) Monoadelphous (b) Diadelphous
(c) Polyadelphous (d) Monothecous

58. A plant with actinomorphic and hypogynous flowers, heterochlamydeous perianth, dorsifixed and extrorse anthers dehiscing transversely belongs to **[EAMCET 2009]**
(a) Coronariae (b) Bicarpellatae
(c) Thalamiflorae (d) Calyciflorae

59. A plant has an androecium with monadelphous stamens, monothecous and reniform anthers. The corolla exhibits contorted aestivation. The Plant could be **[BHU 1995; KCET 2009]**
(a) *Rauwolfia* (b) *Vinca*
(c) *Nerium* (d) *Hibiscus*

60. In guava, cucurbits flowers are **[WB JEE 2008]**
(a) Hypogynous flower
(b) Epigynous flower
(c) Perigynous flower
(d) Both hypogynous & perigynous

61. Gynandrous condition means **[Odisha JEE 2010]**
(a) Adhesion of stamens and carpels
(b) Cohesion of stamens
(c) Stamens united by filaments only
(d) Free stamens

62. In floral formula (K) denotes **[NCERT; WB JEE 2008]**
(a) Polysepalous (b) Gamosepalous
(c) Polypetalous (d) Gamopetalous

63. To Which of the following flower' synandrous' condition is found **[WB JEE 2008]**
(a) Sunflower (Helianthus sp) (b) Gourd (Cucurbita sp)
(c) Pea (Pisum sativum) (d) Lemon (Citrus sp)

64. A monocarpic plant is one which **[MP PMT 2009; Odisha JEE 2009]**
(a) Has only one carpel
(b) Flowers once in a life-time
(c) Produces only one seed
(d) Produces only one fruit

65. The term Anthesis is used for **[AIEEE Pharmacy 2004; AFMC 2012]**
(a) Cluster of anthers (b) Opening of flowers
(c) Dehiscence of anthers (d) Falling of flowers

66. Plants having flowers with free petals are placed under **[VITEEE 2006]**
(a) Polypetalae (b) Monocotyledons
(c) Gamopetalae (d) Monochlamydae

67. When the other floral parts are arranged at the base of the gynoecium, the flower is called **[WB JEE 2009]**
(a) Hypogynous flower (b) Perigynous flower
(c) Epigynous flower (d) Agynous flower

68. Zygomorphic condition can be represented as **[NCERT; CPMT 2009]**
(a) ⊕ (b) %
(c) P (d) G

69. Gynoecium with fused carpels **[AFMC 2008]**
(a) Syncarpous (b) Apocarpous
(c) Syngenecium (d) None of these

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

71. When the anthers mature earlier than the stigma of ones own flower, the condition is known as
(a) Herkogamy (b) Protandry
(c) Heterostyly (d) Heterogamy

72. $A_{1+(9)}$ stands for
(a) Adelphous (b) Synantherous
(c) Diadelphous (d) None of these

73. Obdiplostemonous condition is that in which the stamens are in two whorls and
(a) Outer whorl is fused to inner whorl
(b) Outer whorl is opposite to petals
(c) Inner whorl is opposite to petals
(d) Both inner as well as outer whorls are opposite to petals

74. Choose the specific characters of the flowers of Canna **[Kerala PMT 2012]**
(a) Actinomorphic and radial symmetry
(b) Irregular and bilateral symmetry
(c) Irregular and zygomorphic
(d) Irregular and radial symmetry
(e) Irregular and asymmetric

75. Plants with single whorl of perianth are placed under **[Kerala PMT 2007]**
(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

76. In some plants the style is shorter. But in some others, it is longer than the stamens. This condition is called **[MHCET 2003]**
(a) Homogamy (b) Homostyly
(c) Heterostyly (d) None of these

77. Which of the following flowers show heterostyle **[MHCET 2002, 06]**
(a) *Mirabills* (b) *Hibiscus*
(c) Primrose (d) *Pisum*

78. The example for trimerous, unisexual flower is **[KCET 2004]**
(a) *Cocos nucifera* (b) *Hibiscus*
(c) Tamarind (d) Pea

79. In many cultivated ornamental flowers, number of petal whorls is higher than the one in wild type. Extra petals are generally modified **[JKCMEE 2000]**
(a) Sepals (b) Petals
(c) Stamens (d) Pistils

80. The corolla of *Hibiscus* is **[MHCET 2002]**
(a) Gamopetalous, valvate (b) Gamopetalous, twisted
(c) Polypetalous, valvate (d) Polypetalous, twisted

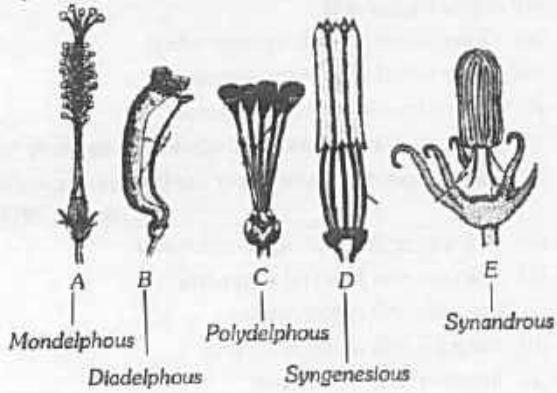
81. Arrangement of sepals and petals in the bud condition is called **[MHCET 2004, 05]**
(a) Ptyxis (b) Placentation
(c) Aestivation (d) Phyllolaxy

82. Corolla in China rose are **[MHCET 2004]**
(a) 5, gamopetalous, twisted (b) 5, gamopetalous valvate
(c) 5, polypetalous valvate (d) 5, polypetalous contorted

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

84. In unilocular ovary with a single ovule the placentation is **[NCERT; CBSE PMT (Pre.) 2010]**
(a) Axile (b) Marginal
(c) Basal (d) Free Central

85. The following diagrams A, B, C, D and E show the different types of arrangement of stamens based on the cohesion of their parts in different plants. Assign the stamens to their respective plants. Choose the correct answer **[KCET 2010]**



	A	B	C	D	E
(a)	*Hibiscus rosa-sinensis*	*Helianthus annus*	*Cucurbita pepo*	*Crotolaria juncea*	*Bombax ceiba*
(b)	*Hibiscus rosa-sinensis*	*Bombax ceiba*	*Cucurbita pepo*	*Crotolaria juncea*	*Helianthus annus*
(c)	*Hibiscus rosa-sinensis*	*Bombax ceiba*	*Helianthus annus*	*Cucurbita pepo*	*Crotolaria juncea*
(d)	*Hibiscus rosa-sinensis*	*Crotolaria juncea*	*Bombax ceiba*	*Helianthus annus*	*Cucurbita pepo*

86. Which one of the following diagrams represents the placentation in Dianthus **[CBSE PMT (Mains) 2011]**

(a) 
(b) 
(c) 
(d) 

87. Flowers are Zygomorphic in **[NCERT; CBSE PMT (Pre.) 2011]**
(a) Datura (b) Mustard
(c) Gulmohur (d) Tomato

88. Which one of the following statements is correct **[NCERT; CBSE PMT (Pre.) 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 *primose* is basal

89. Which of the following plants has the floral characters like zygomorphic flower, vexillary aestivation, diadelphous androecium and marginal placentation **[Kerala PMT 2011]**
(a) *Pisum* (b) *Belladonna*
(c) Brinjal (d) *Asparagus*
(e) *Aloe*

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

91. Thalamus of hypogynous ovary is **[Odisha JEE 2011]**
(a) Convex
(b) Concave
(c) Flat with partly cup shaped
(d) None of these

92. The type of placentation in which ovary is syncarpous unilocular and ovules on sutures is called **[CPMT 2010]**
(a) Marginal placentation (b) Apical placentation
(c) Parietal placentation (d) Superficial placentation

93. The ovary is half inferior in flowers of **[NCERT; CBSE PMT (Pre.) 2010, 11]**
(a) Guava (b) Peach/Plum
(c) Cucumber (d) Cotton

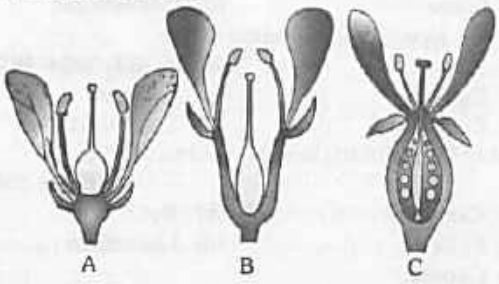
94. The gynoecium consists of many free pistils in flowers of **[CBSE PMT (Pre.) 2012]**
(a) Aloe (b) Tomato
(c) Papaver (d) Michelia

95. The condition in which stamens are fused by anthers only, whereas the filaments remain free, is termed as **[Odisha JEE 2012]**
(a) Adelphous (b) Syngenesious
(c) Synandrous (d) Polyandrous

96. 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 **[NEET 2013]**
(a) Eighteen (b) Six
(c) Ten (d) Fifteen

97. 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 **[NEET (Karnataka) 2013]**
(a) Six (b) Seven
(c) Eight (d) Five

98. Match the following figures with I, II and III
(I) Hypogynous flower (II) Perigynous flower
(III) Epigynous flower



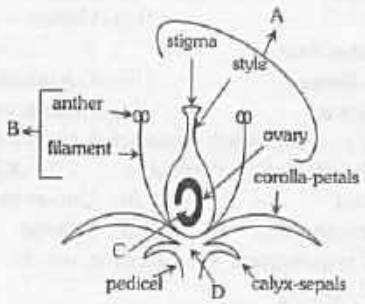
[NCERT]
(a) A – III, B – I, C – II (b) A – III, B – II, C – I
(c) A – I, B – III, C – II (d) A – I, B – II, C – III

99. 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

[NCERT; Kerala PMT 2010, 11; NEET (Phase-II) 2016]
(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

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



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

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

102. The standard petal of a papilionaceous corolla is also called [NEET (Phase-I) 2016]
(a) Carina (b) Pappus
(c) Vexillum (d) Corona

103. Proximal end of the filament of stamen is attached to the [NEET (Phase-I) 2016]
(a) Anther (b) Connective
(c) Placenta (d) Thalamus or petal

104. The term 'polyadelphous' is related to [NEET (Phase-II) 2016]
(a) Calyx (b) Gynoecium
(c) Androecium (d) Corolla

105. Radial symmetry is found in the flowers of [NEET (Phase-II) 2016]
(a) *Cassia* (b) *Brassica*
(c) *Trifolium* (d) *Pisum*

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. Single flower with multiple ovaries is called [Odisha JEE 2008]
(a) Composite fruit (b) Simple fruit
(c) Aggregate fruit (d) None of these

3. The megasporangium of the angiosperms on maturation gives rise to
(a) A fruit (b) Seed
(c) An embryo (d) Cotyledons

4. After fertilization, the seed coats of seed develop from [RPMT 2002]
(a) Integuments (b) Embryo sac
(c) Chalaza (d) Ovule

5. Cereals during germination derive their food from [Odisha JEE 2008]
(a) Starch (b) Soil
(c) Aleurone grains (d) Embryo

6. Karyopsis is [VITEEE 2008]
(a) One seeded fruit (b) Two seeded fruit
(c) Three seeded fruit (d) Four seeded fruit

7. Cotyledons and testa respectively are edible parts in [CBSE PMT 2009]
(a) Groundnut and pomegranate
(b) Walnut and tamarind
(c) French bean and cocount
(d) Cashew nut and litchi

8. Plants with inferior ovary usually bear [AIIMS 2012]
(a) Pseudocarps (b) Berries
(c) Aggregate fruits (d) Seedless fruits

9. The plant whose seeds are known to have longest viability period is **[AIIMS 1993]**
(a) *Nelumbo nucifera* (lotus) (b) *Triticum vulgare* (wheat)
(c) *Zizyphus jujuba* (ber) (d) *Carica papaya* (papaya)

10. Which one of the following is a non-endospermic seed **[MHCET 2015]**
(a) Sunflower (b) Coconut
(c) Ground nut (d) Wheat

11. "Embryo are not differentiated into different tissues at the time of fruit ripening". Select option related to this statement **[GUJCET 2014]**
(a) Exogenous dormancy, physiological dormancy
(b) Endogenous dormancy, morphological dormancy
(c) Exogenous dormancy, morphological dormancy
(d) Endogenous dormancy, mechanical dormancy

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

13. In non-endospermic seeds, food is stored in **[CPMT 1996]**
(a) Seed coat (b) Endosperm
(c) Cotyledons (d) Ovule

14. Vivipary means **[RPMT 1995]**
(a) Fruits are not formed
(b) Germination of seed on mother plant
(c) Formation of fruits directly by embryo
(d) Production of fruitless plant

15. In which of the following the seed germinates and still attached with the main plant **[AFMC 1995]**
(a) Mango (b) *Rhizophora*
(c) Neem (d) Coconut

16. Edible part of mango is **[NCERT; BVP 2002; CBSE PMT 2004; AFMC 2010]**
(a) Epicarp (b) Mesocarp
(c) Endocarp (d) Receptacle

17. Placenta and pericarp are both edible portions in **[BCECE 2005; KCET 2007; CBSE PMT 2014]**
(a) Tomato (b) Potato
(c) Apple (d) Banana

18. In caryopsis type of fruit **[MHCET 2004; J & K CET 2008]**
(a) Seed is absent
(b) Three layers of pericarp are distinct
(c) Seed coat and pericarp are fused
(d) Autochory occurs

19. Aggregate fruit develops from **[MHCET 2003; Odisha JEE 2011; CBSE PMT 2014]**
(a) Multicarpellary, apocarpous ovary
(b) Multicarpellary ovary
(c) Multicarpellary, syncarpous ovary
(d) Monocarpellary ovary

20. Which of the following is a wheat fruit **[BHU 2004; AFMC 2009]**
(a) Achene (b) Cypsella
(c) Caryopsis (d) Endosperm

21. A fleshy-fruit with leathery exocarp is called **[Odisha JEE 2004]**
(a) Drupe (b) Berry
(c) Pome (d) Hesperidium

22. ..... type of fruit is present in rice **[Odisha JEE 2004; BHU 2008]**
(a) Cypsela (b) Capsule
(c) Caryopsis (d) Cremocarp

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

24. The ground nut seeds are **[MHCET 2000]**
(a) Geocarpic (b) Photocarpic
(c) Amphicarpic (d) Hydrocarpic

25. Lomentum is a kind of **[Pb. PMT 2004]**
(a) Inflorescence (b) Plant
(c) Fruit (d) Insect

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

27. Maize grain is **[NCERT; AFMC 2005]**
(a) Seed (b) Embryo
(c) Ovule (d) Fruit

28. The fruit in *Datura* is **[MHCET 2000]**
(a) Loculicidal capsule (b) Septifragal capsule
(c) Septicidal capsule (d) Porous capsule

29. All structures within the seed coat are called **[MHCET 2002]**
(a) Endosperm (b) Cotyledon
(c) Embryo (d) Kernel

30. To remove seed dormancy by mechanically removing the seed coat, is called **[BVP 2004; AFMC 2004]**
(a) Stratification (b) Scarification
(c) Vernalization (d) Photoperiodism

31. An example of a seed with endoperm perisperm and caruncle is **[CBSE PMT 2009]**

Or

Which one of the following is an endospermic seed **[Kerala CET 2002]**

Or

In which of the following plants, cotyledons form the first pair of leaves **[AIIMS 1992]**
(a) Cotton (b) Coffee
(c) Lily (d) Castor

32. Pepo fruit is found in **[JIPMER 1997]**
(a) Cruciferae (b) Cucurbitaceae
(c) Liliaceae (d) Solanaceae

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

34. Essential requirement for seed germination **[CPMT 2005]**
(a) H_2O and O_2
(b) O_2 and light
(c) H_2O and high temperature
(d) Scarification and vernalisation

35. In orange which part is edible **[BHU 2012]**
(a) Mesocarp (b) Endocarp
(c) Aril (d) Placental hairs

36. The fruit developed from the single ovary is said to be **[J & K CET 2005; KCET 2012]**

(a) Composite type (b) Simple type
(c) Aggregate type (d) None of these

37. The fleshy fruits with hard and stony endocarp are called **[J & K CET 2005; KCET 2009]**

(a) Drupe (b) Berry
(c) Pepo (d) Pome

38. The edible dry fruit 'chilgoza' is **[BHU 2005]**

(a) Fruit of *Cycas* (b) Fruit of *Pinus gerardiana*
(c) Seed of *Cycas* (d) Seed of *Pinus gerardiana*

39. Edible part in 'sorosis' a composite fruit is **[BHU 2005]**

(a) Cotyledons (b) Endosperm
(c) Perianth and peduncle (d) Fleshy thalamus

40. Fruit of grape vine is **[Odisha JEE 2012]**

(a) Siliqua (b) Lomentum
(c) Berry (d) Drupe

41. The given figure represents anacardium (cashewnut). Which is the correct statement **[Manipal 2005]**

(a) The upper part is a false fruit
(b) The upper part is a true fruit
(c) The lower part is a seed
(d) There is no fruit at all

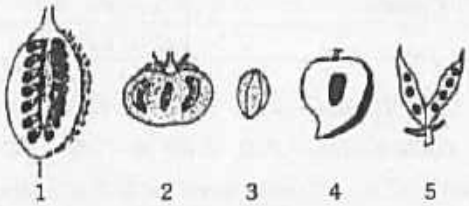
42. Edible part of Apple is **[Odisha JEE 2005; AMU (Med.) 2006; J & K CET 2012]**

(a) Mesocarp (b) Calyx
(c) Thalamus (d) Pericarp

43. The hardest part of drupe is **[Manipal 2005]**

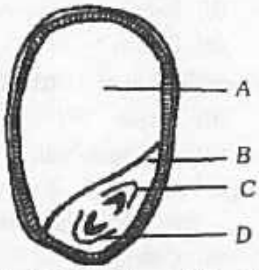
(a) Mesocarp (b) Endocarp
(c) Pericarp (d) Epicarp

44. Which of the following correctly represents the type of fruits given **[Kerala PMT 2000]**



(a) 1. Berry ; 2. Caryopsis ; 3. Drupe ; 4. Sorosis ; 5. Aggregate
(b) 2. Berry ; 3. Caryopsis ; 4. Drupe ; 1. Sorosis ; 5. Aggregate
(c) 2. Berry ; 3. Caryopsis ; 4. Drupe ; 5. Legume ; 1. Aggregate
(d) 1. Beccate ; 3. Caryopsis ; 4. Drupe ; 1. Sorosis ; 5. Composite
(e) 2. Berry ; 3. Caryopsis ; 4. Drupe ; 1. Sorosis ; 5. Legume

45. The diagram represents the L. S of monocot seed. Choose the correct combination of labelling **[Kerala PMT 2006; KCET 2009]**



(a) (A) Alerone layer (B) Scutellum (C) Coleoptile (D) Coleorhiza
(b) (A) Seed coat (B) Scutellum (C) Coleoptile (D) Coleorhiza
(c) (A) Epithelium (B) Scutellum (C) Coleoptile (D) Coleorhiza
(d) (A) Endosperm (B) Scutellum (C) Coleoptile (D) Coleorhiza
(e) (A) Endosperm (B) Scutellum (C) Plumule (D) Radicle

46. 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

[Kerala PMT 2006]

(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

47. How many plants in the list given below have composite fruits that develop from an inflorescence. Walnut, poppy, radish, fig, pineapple, apple, tomato, mulberry **[NCERT; CBSE PMT (Pre.) 2012]**

(a) Four (b) Five
(c) Two (d) Three

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

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

49. Pineapple (ananas) fruit develops from **[CBSE PMT 2006; DUMET 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

50. In which of following fruits is the edible part the aril **[CBSE PMT 1999, 2005, 06; Wardha 2005; AFMC 2009]**

(a) Orange (b) Litchi
(c) Custard apple (d) Pomegranate

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

52. Hesperidium of orange is a modification of **[DPMT 2006]**
(a) Berry (b) Drupe
(c) Pome (d) Aggregate fruit

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

54. 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

[NCERT; Kerala PMT 2007]
(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

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

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

57. In which plant the fruit is a drupe, seed coat is thin, embryo is inconspicuous and endosperm is edible **[NCERT; DUMET 2009; CPMT 2010; NEET 2017]**
(a) Groundnut (b) Wheat
(c) Apple (d) Coconut

58. Which one of the following is a true nut **[BHU 2008]**
(a) Walnut (b) Groundnut
(c) Cashewnut (d) Coconut

59. In drupe of coconut the mesocarp is **[NCERT; AMU (Med.) 2009, 12]**
(a) Fleshy (b) Fibrous
(c) Stony (d) Watery

60. An example of false fruit is **[CPMT 2009; AFMC 2010]**
(a) Apple (b) Banana
(c) Grapes (d) Mango

61. Bracts, perianth and seeds are edible parts of **[MP PMT 2010]**
(a) *Cocos nucifera*
(b) *Artocarpus heterophyllus*
(c) *Magnifera indica*
(d) *Argemone mexicana*

62. Which one of the following statements is **correct** **[NCERT; CBSE PMT 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

63. Non endospermic seeds are found in **[Odisha JEE 2010]**
(a) Wheat (b) Castor
(c) Barley (d) Bean

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

65. A drupe develops in **[CBSE PMT (Pre.) 2011]**
(a) Tomato (b) Mango
(c) Wheat (d) Pea

66. 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 **[KCET 2011]**
(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

67. Match the types of fruits listed in Column I with the examples listed in Column II. Choose the answer which gives the correct combination of the two columns

Column I		Column II	
A.	Capsule	1.	Paddy
B.	Berry	2.	Mango
C.	Drupe	3.	Sunflower
D.	Cypsela	4.	Tomato
		5.	Lady's finger

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

68. In which of the following types the fruit is multilocular and split open longitudinally along dorsal sutures **[Odisha JEE 2010]**
(a) Capsular (b) Loculicidal
(c) Septicidal (d) Septifragal

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

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

71. 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 **[NCERT]**

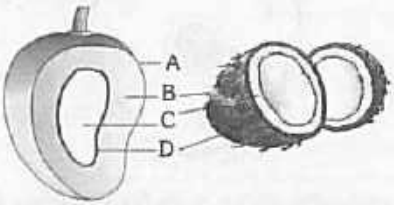
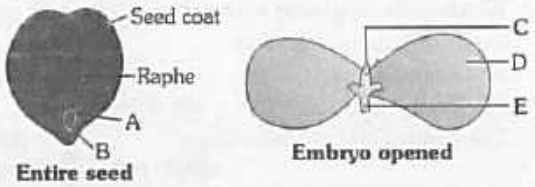


Figure – I **Figure – II**

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

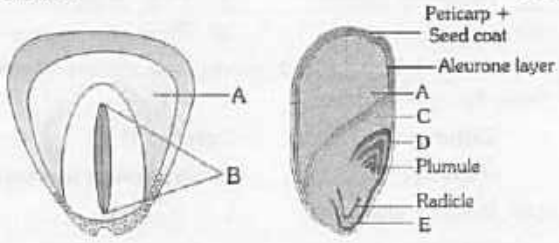
72. The following diagram is the typical structure of dicotyledonous seeds. In which one of the options all the five parts A to E are correctly identified **[NCERT]**



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

73. The following diagram is the typical structure of monocotyledonous seeds. Identify all the five parts A, B, C, D and E **[NCERT]**



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

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

Dispersal of fruits and seeds

1. The most common method for dispersal of fruits and seeds in legumes is
(a) Autochory (b) Anemichory
(c) Zoochory (d) Hydrochory

2. Bright coloured fleshy fruits are dispersed by **[Odisha JEE 2008]**

Or

Seeds of Mulberry are dispersed by
(a) Insect (b) Air
(c) Water (d) Bird

3. Parachute mechanism of seed dispersal occurs in **[MHCET 2003]**

Or

Seeds are dispersed by wind in
(a) Xanthium (b) Calotropis
(c) Mango (d) Apple

4. Hairy styles are present in
(a) *Ranunculus* (b) *Clematis*
(c) *Mucuna* (d) *Polygonum*

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

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

7. Seed dispersal by parachute type mechanism is found in **[CPMT 1998; MP PMT 2013]**
(a) Pea of Fabaceae
(b) Mustard of Brassicaceae
(c) Cotton of Malvaceae
(d) *Taraxacum* of Asteraceae / compositeae

8. The fruits and seeds which are either sticky, have different types of outgrowths are capable of undergoing
(a) Forced zoochory (b) Compensated zoochory
(c) Hydrochory (d) Anemochory

9. The dispersal of cotton and madar seeds takes place by wind because of
(a) Wings (b) Hairs
(c) Pappus (d) Bracts

10. In which of the following plants dispersal of fruits takes place by parachute mechanism
(a) Terminalia (b) Tagetes
(c) Moringa (d) Acer

11. The fruits of Xanthium are dispersed by animals because
(a) These are having sticky substance
(b) These are edible
(c) These are provided with hooks
(d) These are light in weight

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

13. In *Rafflesia*, seeds are dispersed by
(a) Wind (b) Elephant
(c) Mites (d) Flies

14. An example of compensated Zoochory is
(a) Mango (b) Apricot
(c) Tomato (d) All of these

15. In drumstick the seeds are dispersed by **[DPMT 2006]**
(a) Water (b) Animals
(c) Wind (d) Explosive mechanism

16. Aril helps in
(a) Buoyancy to seeds of *Nymphaea* to float in water
(b) Dispersal in litchi by animals
(c) None as it is an edible part
(d) Both (a) and (b)

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

18. Dispersal of fruits in Opium (poppy) occurs through shaking by wind by **[CPMT 2000]**
(a) Explosive mechanism (b) Parachute mechanism
(c) Censer mechanism (d) Jacular mechanism

19. Some plants have a habit of harbouring ants to save the plants from damage by other animals which is known as **[Kerala PMT 2006]**
(a) Entomophily (b) Myrmecophily
(c) Anemophily (d) Hydrophily
(e) Zoophily

Taxonomy of Angiospermic plants

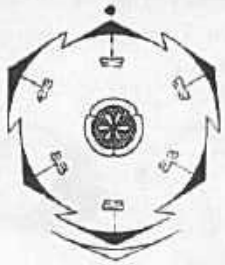
1. The correct floral formula of Liliaceae is **[RPMT 1992; APMEE 1992; CPMT 1993, 97]**
(a) $\oplus\ ♂\ ♀\ P_{3+3}\ A_6\ \underline{G_{(3)}}$ (b) $Br\ \oplus\ ♂\ ♀\ P_{3+3}\ A_{3+3}\ \underline{G_{(3)}}$
(c) $\dagger\ ♂\ ♀\ P_{3+3}\ A_{3+3}\ \underline{G_{(3)}}$ (d) $\dagger\ ♂\ ♀\ P_{3+3}\ A_{3+3}\ \underline{G_{(6)}}$

2. The two families dominate in having maximum useful plants **[Pb. PMT 1993; CBSE PMT 1997]**
(a) Fabaceae and Poaceae
(b) Liliaceae and Solanaceae
(c) Malvaceae and Brassicaceae
(d) Liliaceae and Poaceae

3. The systematic position of Cucurbitaceae according to Bentham and Hooker's system
(a) Thalamiflorae, Parietales (b) Inferae, Asterales
(c) Calyciflorae, Rosales (d) Calyciflorae, Passiflorales

4. Touch me not belongs to **[RPMT 1995]**
(a) Liliaceae (b) Solanaceae
(c) Mimosoideae (d) Malvaceae

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

6. 
Plants having the above given floral diagram are **[AIIMS 2012]**
(a) Leguminous
(b) Dicots
(c) Medicinal and perennial
(d) Having pinnately compound leaves

7. The host for *Cercospora personata* belongs to this family of angiosperms **[KCET 2012]**
(a) Gramineae (b) Leguminosae
(c) Malvaceae (d) Asclepiadaceae

8. Which of the following is phylogenetically most advanced of the dicotyledonous families **[Odisha JEE 2005]**
(a) Acanthaceae (b) Scrophulariaceae
(c) Compositae (d) Umbelliferae

9. The androecium of Malvaceae is **[RPMT 1996; AFMC 1994; AMU (Med.) 1997]**
(a) Didynamous (b) Tetradynamous
(c) Diadelphous (d) Monadelphous

10. Rutaceae differs from Malvaceae in having **[BHU 1997]**
(a) Simple leaves
(b) Polypetalous corolla
(c) Syncarpous, superior ovary
(d) Obdiplostemonous stamens

11. Which statement is wrong for compositae **[CPMT 1998]**
(a) 5-lobed stamens (b) Syngenesious stamens
(c) Basal ovule (d) Ligulate ray florets

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

13. Match the following and choose the correct combination from the options given

Column I (Family)		Column II (Androecium formula)
(A) Brassicaceae/ cruciferae	–	1. A_{3+3}
(B) Fabaceae	–	2. $A_{(5)}$
(C) Solanaceae	–	3. $A_{(9)+1}$
(D) Liliaceae	–	4. A_{2+4}

[CPMT 1997; AIIMS 2001; Kerala PMT 2012]
(a) A-4, B-3, C-2, D-1 (b) A-1, B-2, C-3, D-4
(c) A-2, B-3; C-4, D-1 (d) A-3, B-4, C-1, D-2
(e) A-4, B-3, C-1, D-2

14. Millets belong to **[APMEE 1994]**
(a) Fabaceae (b) Poaceae
(c) Liliaceae (d) Asteraceae

15. Commissural stigma (Along carpellary cohesion plane) occurs in family **[APMEE 1994]**
(a) Solanaceae (b) Liliaceae
(c) Cruciferae (d) Fabaceae

16. *Carthamus tinctorium* belongs to family
(a) Asteraceae (b) Solanaceae
(c) Malvaceae (d) Fabaceae

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

18. Plants are always herbs in
(a) Fabaceae (b) Solanaceae
(c) Brassicaceae (d) None of these

19. See the following figures and identify the given below species belong to which of the following families respectively **[NCERT]**

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

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

20. A family delimited by type of inflorescence is **[CBSE PMT 1990]**

Or

A family belongs to inferae and gamopetalae
(a) Fabaceae (b) Asteraceae
(c) Solanaceae (d) Liliaceae

21. Axile placentation occurs in
(a) Asteraceae and Fabaceae
(b) Brassicaeae and Solanaceae
(c) Solanaceae and Liliaceae
(d) All of these

22. A diagnostic trait for identification of fabaceous flower is **[NCERT]**
(a) Tetradynamous androecium
(b) Inferior ovary
(c) Cruciform corolla
(d) Vexillary aestivation

23. Which of the following is not correctly paired **[AMU (Med.) 2010]**
(a) Fabaceae : Legume family
(b) Solanaceae : Potato family
(c) Liliaceae : Sunflower family
(d) Brassicaceae : Mustard family

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

25. Flower of Fabaceae is **[JIPMER 2002]**
(a) Complete, zygomorphic, pentamerous
(b) Complete, actinomorphic, trimerous
(c) Incomplete, zygomorphic, trimerous
(d) Incomplete, actinomorphic, pentamerous

26. Most important character of *Brassica campesteris* is **[AFMC 1992; APMEE 1995; RPMT 2002]**
(a) False septum (b) Parietal placentation
(c) Ebracteate (d) Imbricate aestivation

27. In fabaceae, one of the following immediately encloses the essential organs **[APMEE 2002]**
(a) Anterior petals (b) Posterior petal
(c) Lateral petals (d) Sepals

28. Given diagram shows the cohesion of stamens. It is the characteristic of pulse family. Identify the type of cohesion **[NCERT]**

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

29. Four sepals arranged in two whorls is characteristic of family **[Manipal 2001; BHU 2002]**
(a) Solanaceae (b) Fabaceae
(c) Brassicaceae (d) Liliaceae

30. Andromonoecious guggal (Commiphora wightii) plants population are those that **[MP PMT 2013]**
(a) Produce more male flower bearing plants and a few female flower bearing plants in a population
(b) Produce more female flower bearing plants and a few male flower bearing plants in a population
(c) Produce male flowers bearing plants and female flowers bearing plants in equal number in a population
(d) Produce both male and bisexual flower bearing individual in a population

31. Largest family of flowering plants is **[Tamil Nadu 2001]**

Or

Compositae is also known as **[DPMT 2001]**
(a) Fabaceae (d) Thalamiflora
(c) Poaceae (d) Asteraceae

32. Family Fabaceae belongs to series **[APMEE 1996]**
(a) Inferae (b) Thalamiflorae
(c) Calyciflorae (d) Disciflorae

33. Familiar examples of family Liliaceae are **[KCET 1995; Pb. PMT 1999; RPMT 1999]**
(a) *Allium cepa*, *Aloe vera* and *Tamarindus indica*
(b) *Saraca indica*, *Allium cepa* and *Aloe vera*
(c) *Allium sativum*, *Allium cepa* and *Aloe vera*
(d) *Tamarindus indica*, *Allium cepa* and *Allium sativum*

34. Which one is odd **[CPMT 1993]**
(a) *Allium cepa* (b) *Helianthus annuus*
(c) *Brassica juncea* (d) *Arachis hypogea*

35. Scientific name of Sunflower is **[WB JEE 2009]**
(a) *Brassica compesteris* (b) *Pisum sativum*
(c) *Helianthus annuus* (d) *Gossypium herbaceum*

36. *Colchicum autumnale* is a member of **[NCERT; CPMT 2010]**

Or

Colchicine is obtained from which of the following families **[AFMC 2012]**
(a) Brassicaceae (b) Liliaceae
(c) Poaceae (d) Fabaceae

37. A weed belonging to family Asteraceae which has spread in all parts of India is
(a) *Nicotiana* (b) *Oryza*
(c) *Parthenium* (d) *Hordeum*

38. Epipetalous and syngenesious stamens occur in **[CBSE PMT 1991, 92; VITEEE 2008; Odisha JEE 2009]**
(a) Solanaceae (b) Brassicaceae
(c) Fabaceae (d) Asteraceae

39. Carbohydrate rich food is got from
(a) Brassicaceae (b) Poaceae
(c) Fabaceae (d) Asteraceae

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

41. 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*

42. Bicarpellary, syncarpous, unilocular ovary with basal placentation occurs in **[Tamil Nadu 2001]**
(a) Liliaceae (b) Solanaceae
(c) Asteraceae (d) Fabaceae

43. Pulses are obtained from **[NCERT; CBSE PMT 1993; RPMT 1995; KCET 1998; MP PMT 1998, 2000, 02]**
(a) Fabaceae (b) Asteraceae
(c) Poaceae (d) Solanaceae

44. Find out the correctly matched pair **[Kerala PMT 2012]**
(a) Marginal – Tomato
(b) Axile – Pea
(c) Parietal – Primrose
(d) Free Central – Argemone
(e) Basal – Marigold

45. Masses of pollen grains i.e, pollinia is found in **[Odisha JEE 2008]**
(a) Orchidaceae (b) Solanaceae
(c) Malvaceae (d) Gramineae

46. Which of the following is correct with reference to flowers of family solanaceae **[KCET 2003]**
(a) Pentamerous, actinomorphic, unisexual, hypogynous
(b) Pentamerous, zygomorphic, bisexual, epigynous
(c) Pentamerous, bisexual, actinomorphic, hypogynous
(d) Trimerous, actinomorphic, bisexual, hypogynous

47. Mark the correct statement for Gramineae
(a) The carpel has two styles
(b) Spikelets are always in pairs
(c) Palea is the bracteole
(d) Awn is an appendage of the palea

48. Bicarpellary, syncarpous ovary with axile placentation is seen in **[J & K CET 2008]**
(a) Solanaceae (b) Caesalpinaceae
(c) Asteraceae (d) Malvaceae

49. The floral formula $\oplus \male\female K_{(5)} \overset{\frown}{C_{(5)}} A_5 \underline{G(2)}$ is that of **[CBSE PMT 2009; AIPMT (Cancelled) 2015]**
(a) Tulip (b) Soybean
(c) Sunnhemp (d) Tobacco / Petunia

50. Replum is present in the ovary of flower of **[CBSE PMT 2008]**
(a) Sun flower (b) Pea
(c) Lemon (d) Brassicaceae Mustard

51. Capitulum is found in the members of the family **[MP PMT 2010]**
(a) Ranunculaceae (b) Solanaceae
(c) Asteraceae (d) Labiatae

52. An example of liliaceae family is **[NCERT; AMU (Med.) 2009]**
(a) Lupin (b) Soyabean
(c) *Petunia* (d) Tulip

53. Which of the following represents the floral characters of Liliaceae **[NCERT; BHU 2005; Kerala PMT 2008]**
(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

54. Datura belongs to **[AFMC 1996]**
(a) Compositae (b) Labiatae
(c) Malvaceae (d) Solanaceae

55. Vexillary aestivation is characteristic of the family **[NCERT; CBSE PMT (Pre.) 2012; Odisha JEE 2012]**
(a) Fabaceae (b) Asteraceae
(c) Solanaceae (d) Brassicaceae

56. Petals possess claw in
(a) Solanaceae (b) Liliaceae
(c) Malvaceae (d) Cruciferae

57. Family Gramineae is closely related to **[Odisha JEE 2005]**
(a) Cannaceae (b) Cyperaceae
(c) Arecaceae (d) Apicaceae

58. Which of the family possess perianth of six coloured tepals
(a) Mimosoideae (b) Solanaceae
(c) Liliaceae (d) Malvaceae

59. Marginal placentation is found in **[Chd. CET 1997]**
(a) Solanaceae (b) Cruciferae
(c) Fabaceae/Leguminosae (d) Asteraceae/Compositae

60. Select the incorrect match from the following **[Odisha JEE 2010]**
(a) Mimosaceae – kiker (b) Malvaceae - hollyhock
(c) Fabaceae – alfalfa (d) Caesalpiniaceae- catechu

61. 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 $\oplus \varnothing \female P_{3+3} A_{3+3} + \underline{G_3}$
(C) In pea flower the stamens are monadelphous
(D) The floral formula for Solanaceae is $\oplus \varnothing \female K_{(3)} C_{(3)} A_{(4)} + \underline{G_{(2)}}$

The correct statements are **[CBSE PMT (Mains) 2010]**
(a) (A) and (C) (b) (A) and (B)
(c) (B) and (C) (d) (C) and (D)

62. Staminodes occur in family **[RPMT 1995, 96]**
(a) Papilionatae/*Arachis* (b) Malvaceae/*Hibiscus*
(c) Caesalpinoideae/*Cassia* (d) Cruciferae/*Iberis*

63. Cruciferae differ from Malvaceae in the presence of **[CBSE PMT 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

64. Which of the family does not possess axile placentation **[RPMT 1992, 95, 96]**
(a) Solanaceae (b) Malvaceae
(c) Leguminosae/Cruciferae (d) Liliaceae

65. Perigynous condition is common among
(a) Liliaceae (b) Solanaceae
(c) Leguminosae (d) Malvaceae

66. Which of the following is/are not characteristic features of Asteraceae
(A) Cypsela type of fruit
(B) Syngenesious stamens
(C) Ovary bicarpellary and superior
(D) Placentation marginal
(E) Head type of inflorescence **[Kerala PMT 2008]**
(a) (B), (C) and (D) only (b) (C) and (E) only
(c) (C) and (D) only (d) (A) and (B) only
(e) (C) only

67. Gynostegium (Fusion of anthers with stigma) and pollinia are present in family **[AMU (Med.) 1997; Odisha JEE 2009]**
(a) Apocynaceae
(b) Asclepiadaceae
(c) Convolvulaceae
(d) Solanaceae/Cucurbitaceae

68. Placentation in tomato and lemon is **[CBSE PMT (Pre.) 2012]**
(a) Parietal (b) Free central
(c) Marginal (d) Axile

69. The typical floral formula of Papilionaceae (Soybean) is **[CBSE PMT (Mains) 2010; BHU 2012]**
(a) $\oplus \varnothing \female K_{(5)} C_{(5)} A_5 \underline{G_2}$ (b) $\oplus \varnothing \female K_{(5-4)} C_{(5-4)} A \underline{G_5}$
(c) $\% \female K_{(5)} C_{1+2+(2)} A_{1+(9)} \underline{G_1}$ (d) $\% \female K_{(5)} C_5 A_{10} \underline{G_1}$

70. Floral formula of mustard (or) Cruciferae is **[RPMT 1992, 95, 96, 97; Kerala PMT 2010]**

Or

Floral formula of *Brassica campestris* is **[AIIMS 2010]**
(a) $\oplus \varnothing \female K_{(5)} C_{(5)} A_5 \underline{G_{(2)}}$
(b) Ebr $\oplus \varnothing \female K_{2+2} C_4 A_{2+4} \underline{G_{(2)}}$
(c) $\oplus \varnothing \female K_5 C_5 A_{(5)} \underline{G_{(2)}}$
(d) $\oplus \varnothing \female K_5 C_5 A_5 \underline{G_{(2)}}$

71. Family Podostemaceae is placed under the series **[Kerala PMT 2008]**
(a) Multiovulatae aquaticae (b) Microembryeae
(c) Daphnales (d) Unisexuales
(e) Heteromerae

72. The family containing mustard, and its main characters are **[AIIMS 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

73. The presence of corollary corona, sagittate anthers and dumb-bell shaped stigma are the characteristic features of ..... **[KCET 2010]**
(a) *Musa paradisiaca*
(b) *Hibiscus rosa-sinensis*
(c) *Catheranthus roseus*
(d) *Ravenala madagascariensis*

74. Inflorescence of family compositae is **[Odisha JEE 2004]**
(a) Perianth (b) Iodicule
(c) Capitulum (d) Hypanthodium

75. Beet root (*Beta vulgaris*) belongs to family **[Odisha JEE 2004]**
(a) Apocynaceae (b) Cruciferae
(c) Chenopodiaceae (d) Asclepiadaceae

76. Sunflower belongs to the family **[DUMET 2009]**
(a) Liliaceae (b) Asteraceae
(c) Cruciferae (d) Fabaceae

77. Monoadelphous condition of stamens is found in **[BHU 2004]**
(a) Malvaceae (b) Cyperaceae
(c) Cruciferae (d) Solanaceae

78. Tetradynamous condition is found in **[NCERT; CPMT 2004; AFMC 2004]**
(a) *Hibiscus rosa-sinesis* (b) *Petunia hybrida*
(c) *Helianthus annuus* (d) *Brassica campestris*

79. Diadelphous stamens are the characteristic feature of **[CPMT 2004]**
(a) Ranunculaceae (b) Fabaceae
(c) Poaceae (d) Malvaceae

80. The distinct features of fabaceae are **[Kerala PMT 2012]**
(a) Zygomorphic, diadelphous and monocarpellary
(b) Actinomorphic, monadelphous and monocarpellary
(c) Zygomorphic, monadelphous and pentacarpellary
(d) Zygomorphic, polyadelphous and tricarpellary
(e) Zygomorphic, diadelphous and bicarpellary

81. Underground food is stored in **[RPMT 1995]**
(a) Solanaceae and Leguminosae
(b) Liliaceae and Cruciferae
(c) Cruciferae and Solanaceae
(d) Solanaceae and Malvaceae

82. The botanical name of Satawar is
(a) *Smilax* (b) *Asparagus*
(c) *Yucca* (d) *Lilium*

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

84. Tetradynamous condition is characteristics of **[NCERT; RPMT 1993; EAMCET 1993; AMU (Med.) 1997; CBSE PMT 2001; Bihar PMT 2001; Odisha JEE 2011]**
(a) Liliaceae/*Allium*/*Asphodelus*
(b) Cruciferae/Mustard/Iberis
(c) Malvaceae/*Althea*/*Hibiscus*
(d) Solanaceae/*Nicotiana*/*Petunia*

85. Floral formula of Caesalpinoideae is
(a) $+ ⚥ K_5 C_{(5)} A_{1+(9)} \underline{G_1}$ (b) $+ ⚥ K_{(5)} C_{(5)} A_5 G_1$
(c) $\% ⚥ K_5 C_{(5)} A_{10} G_1$ (d) $Br\ \% ⚥ K_5 C_5 A_{5+5} \underline{G_1}$

86. Bilocular oblique ovary with numerous shining ovule on swollen axile placenta is the characteristics of **[APMEE 1994; AMU (Med.) 2002; DPMT 2004; J & K CET 2012]**
(a) Cruciferae (b) Solanaceae
(c) Liliaceae (d) Malvaceae

87. 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

88. Legume plants are important for atmosphere because they **[RPMT 2005, 06]**
(a) Help in NO_2 fixation
(b) Do not help in NO_2 fixation
(c) Increase soil fertility
(d) All of these

89. Which of the following are not characteristic features of fabaceae **[Kerala CET 2005]**
(a) Tap root system, compound leaves and receme 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

90. Which of the following member of family *Solanaceae* is rich in source of vitamin C **[AFMC 2005]**
(a) Guava (b) Tomato
(c) Goosberry (d) Strawberry

91. Lady finger belongs to family **[BHU 2005; CPMT 2009]**
(a) Malvaceae (b) Cucurbitaceae
(c) Liliaceae (d) Brassicaeae

92. Botanical name of 'chana' is **[BHU 2005]**
(a) *Cicer arietinum* (b) *Phaseolus aureus*
(c) *Lablab purpureus* (d) Dolichos

93. The characteristic type of placentation found in the members of caryophyllaceae is **[Kerala PMT 2009]**
(a) Parietal (b) Marginal
(c) Basal (d) Axile
(e) Free central

94. Which of the following represents the condition seen in the family compositae **[Manipal 2005]**
(a) Superior ovary, syngenesious, single basal ovule
(b) Inferior ovary, monoadelphous, basal placentation
(c) Inferior ovary, syngenesious, axile, placentation
(d) Syngenesious, basal placentation and epigynous

95. From the options given below, find out the correct floral formula for a flower having the following characters namely actinomorphic, bisexual, five united sepals, five united petals, stamens five and epipetalous, bicarpellary, syncarpous with superior ovary **[Kerala PMT 2011]**
(a) $\oplus ⚥ K_{(5)} C_{(5)} A_5 \underline{G}_{(2)}$ (b) $\oplus ⚥ K_{(5)} \overline{C_{(5)} A_{(5)}}\ \underline{G}_{(2)}$
(c) $\oplus ⚥ K_{(5)} C_{(5)} A_{(5)} \underline{G}_{(2)}$ (d) $\oplus ⚥ K_{(5)} \overline{C_{(5)} A_{(5)}}\ \overline{G}_{(2)}$
(e) $\oplus ⚥ K_{(5)} C_{(5)} A_{(5)} \overline{G}_{(2)}$

96. Fruit in members of solanaceae is **[CPMT 2005]**
(a) Drupe (b) Capsule or berry
(c) Siliqua (d) Pod or achene

97. Observe the given floral diagram and choose the suitable floral formula from the followings **[Kerala PMT 2006]**

(a) $\% \oplus \delta K_5 C_5 A_{10} \underline{G}_1$

(b) $\% \varphi \delta K_{(5)} C_5 A_{10} \underline{G}_1$

(c) $\% \varphi \delta K_{(5)} C_{1+2+(2)} A_{(9)+1} \underline{G}_{(1)}$

(d) $\% \varphi \delta K_5 C_{1+2+(2)} A_{(9)+1} \underline{G}_{(1)}$

(e) $\% \varphi \delta K_{(5)} C_5 A_{(9)+1} \underline{G}_{(1)}$

98. 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

[Kerala PMT 2006]

(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

99. The floral formula of solanaceae (Chilli) is **[NCERT; Bihar CECE 2006; CBSE PMT (Pre.) 2011]**

(a) $E_{br\oplus} \varphi \delta K_{(5)} \overset{\frown}{C_{(5)}} A_5 \underline{G}_{(2)}$

(b) $E_{br\oplus} \varphi \delta K_{(4)} C_{2+2} \; A_{2+4} \underline{G}_{(2)}$

(c) $E_{br\oplus} \varphi \delta K_{(5)} \overset{\frown}{C_5} A_\infty \underline{G}_{(5)}$

(d) $Br\% K_{(5)} C_{(5)} A_{(10)} \underline{G}_1$

100. In the members of family malvaceae, anthers are described as **[NCERT; KCET 2006]**

(a) Diadelphous and dithecous
(b) Diadelphous and monothecous
(c) Monadelphous and dithecous
(d) Monadelphous and monothecous

101. Pentamerous actinomorphic flowers, bicarpellary ovary with oblique septa, and fruit a capsule or berry, are characteristic features of **[NCERT; CBSE PMT 2006]**

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

102. What type of placentation of seen in sweet pea **[CBSE PMT 2006]**

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

103. Aloe used in Medicine belong to family **[NCERT; Bihar CECE 2006]**

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

104. Which one of the following series include the orders ranales, parietales and malvales **[Kerala PMT 2009]**

(a) Bicarpellatae (b) Thalamiflorae
(c) Calyciflorea (d) Disciflorae
(e) Inferae

105. Which one of the following represent the floral characters of poaceae **[Kerala PMT 2009]**

(a) Pedicellate, bracteate, bisexual, tetramerous, actinomorphic, complete and superior ovary
(b) Pedicellate, bracteate, bisexual, pentamerous, zygomorphic complete and superior ovary
(c) Sessile, bracteate, bracteolate, incomplete, uni or bisexual, perianth modified into lodicules, stamens three, syncarpous, superior ovary and feathery stigma
(d) Bracteate, unisexual actinomorphic, stamens five and inferior ovary
(e) Bracteate, bracteolate, bisexual, pentamerous, actinomorphic, complete and superior ovary

106. Select the characters which are not applicable to the family solanaceae

(i) Epipetalous and syngenesious anthers
(ii) Bicarpellary and syncarpous ovary
(iii) Oblique ovary with axile placentation
(iv) Stamens six, arranged in two whorls
(v) Bicarpellary, syncarpous and inferior ovary

[Kerala PMT 2009]

(a) (ii) and (iii) only (b) (i), (iv) and (v) only
(c) (ii), (iv) and (v) only (d) (i) and (iii) only
(e) (iii), (iv) and (v) only

107. Tricarpellary syncarpous gynoecium is found in flowers of **[NEET (Phase-I) 2016]**

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

NCERT Exemplar Questions

1. Rearrange the following zones as seen in the root in vertical section and choose the correct option

A. Root hair zone B. Zone of meristems
C. Rootcap zone D. Zone of maturation
E. Zone of elongation

Options: **[NCERT]**

(a) C, B, E, A, D (b) A, B, C, D, E
(c) D, E, A, C, B (d) E, D, C, B, A

2. In an inflorescence where flowers are borne laterally in an acropetal succession, the position of the youngest floral bud shall be **[NCERT]**

(a) Proximal (b) Distal
(c) Intercalary (d) Any where

3. The mature seeds of plants such as gram and peas, possess no endosperm, because **[NCERT]**

(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

4. Match the followings and choose correct option

Group A		Group B	
A.	Aleurone layer	i.	Without fertilization
B.	Parthenocarpic fruit	ii.	Nutrition
C.	Ovule	iii.	Double fertilization
D.	Endosperm	iv.	Seed

Option: **[NCERT]**

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

5. Venation is a term used to describe the pattern of arrangement of **[NCERT]**

(a) Floral organs
(b) Flower in infloresence
(c) Veins and veinlets in a lamina
(d) All of them

6. Endosperm, a product of double fertilization in angiosperms is absent in the seeds of **[NCERT]**

(a) Gram (b) Orchids
(c) Maize (d) Castor

7. Which of the following plants is used to extract the blue dye **[NCERT]**

(a) *Trifolium* (b) *Indigofera*
(c) *Lupin* (d) *Cassia*

8. The placenta is attached to the developing seed near the **[NCERT]**

(a) Testa (b) Hilum
(c) Micropyle (d) Chalaza

CT Critical Thinking

Objective Questions

1. A plant called plantless root is

(a) *Arceuthobium* (b) *Podostemon*
(c) *Rafflesia* and *Sapria* (d) All of these

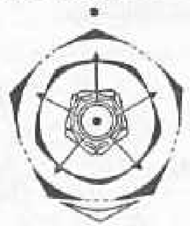
2. Study the following lists

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 **[EAMCET 2009]**

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

3. The floral formula of the given floral diagram is



[Kerala PMT 2007]

(a) $Br\,K_{Pappus}C_{(5)}A_0G_{\overline{(2)}}$
(b) Br⚥$.K_{Pappus}C_{(5)}A_{(5)}G(1)$
(c) Br⚥$.K_{5(Pappus)}\overline{C_{(5)}A_{(5)}},G_{\overline{(2)}}$
(d) Br⚥$.K_{Pappus}\overline{C_{(5)}A_{(5)}},G_{(2)}$
(e) Br⚥$.K_{Pappus}\overline{C_5A_5}\,G_{\overline{(2)}}$

4. Study the following lists

List-I		List-II	
(A)	Coleorhiza	(I)	Development of sporophyte directly from gametophyte without intervention of gametes
(B)	Apogamy	(II)	Development of gametophyte directly from sporophyte without the involvement of reduction division
(C)	Indusium	(III)	An unbranched columnar stem with a crown of leaves
(D)	Caudex	(IV)	Protective covering of radicle
		(V)	Protective structure of a sorus

The correct match is **[EAMCET 2009]**

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

5. Fruit of custard apple is **[AFMC 2004]**

(a) Etaerio of berries (b) Etaerio of follicles
(c) Etaerios of achenes (d) Ethaerio of drups

6. Which one of the following organisms is correctly matched with its three characteristics **[NCERT; CBSE PMT (Mains) 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

7. Cladodes are common among **[AMU (Med.) 1999; J & K CET 2008]**

(a) Liliaceae/*Asparagus* and *Ruscus*
(b) *Opuntia* and *Casurina*
(c) Cactus
(d) *Euphorbia*

8. Identify the incorrect statements from the following

P. Cymose inflorescence is found in *Hibiscus* sp

Q. Hypanthodium is found in *Ficus benghalensis*

R. Synandrous stamen is found in *Calotropis*

S. Hesperidium type of fruit is Mango

[WB JEE 2012]

(a) R, S (b) P, Q

(c) Q, R (d) P, S

9. In hypogeal germination due to elongation of ....plumule comes out of the ground **[Odisha JEE 2010]**

Or

The portion of embryonal axis above cotyledon is called as **[J & K CET 2012]**

(a) Hypocotyl (b) Epicotyl

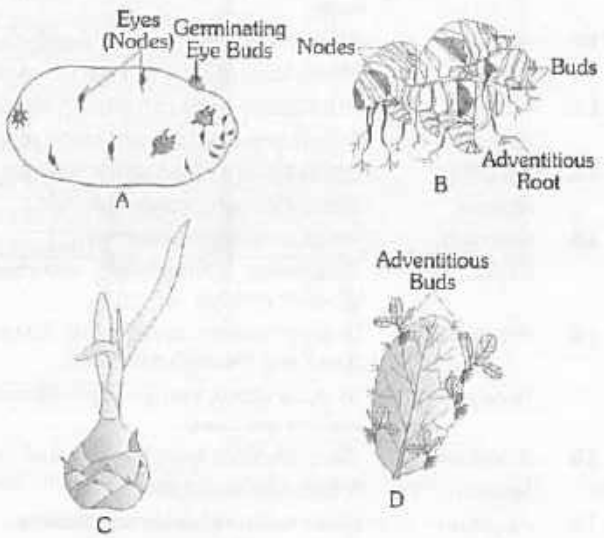
(c) Cotyledons (d) Both (a) and (b)

10. Bisexual flowers which never open, demonstrate **[MP PMT 2004]**

(a) Cleistogamy (b) Allogamy

(c) Autogamy (d) None of these

11. Study the diagrams given below and select the right options out of (a - d); in which all the 4 items A, B, C and D are correctly identified **[NCERT]**



	A	B	C	D
(a)	Offset	Sucker	Stolon	Leaf buds
(b)	Offset	Sucker	Stolon	Leaf buds
(c)	Tuber	Rhizome	Bulb	Leaf buds
(d)	Tuber	Rhizome	Bulbil	Leaf buds

12. Which is true about bulbils in Agave

(a) It has floral buds modified into bulbils

(b) Bulbils germinate while still on inflorescence

(c) Bulbils show vivipary

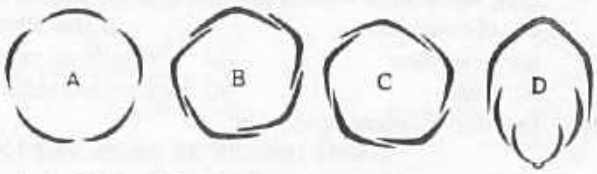
(d) All the above

13. Transmission tissue is characteristic feature of **[AIPMT (Cancelled) 2015]**

(a) Solid style (b) Dry stigma

(c) Wet stigma (d) Hollow style

14. Examine the types of aestivation shown in the following diagram and select the correct answer **[NCERT]**



(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

15. Papilionaceous flower with large vexillum covering two wings and the wings covering the keel has corolla aestivation of

(a) Descending imbricate (b) Ascending imbricate

(c) Twisted (d) Valvate

16. An apocarpous flower is found in **[BHU 1999; JIPMER 2000]**

(a) *Caesalpinnia* (b) *Ranunculus*

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

17. The side of a flower facing the mother axis is called **[RPMT 1992]**

(a) Anterior side (b) Posterior side

(c) Dorsal side (d) Ventral side

18. Which of the following is not a characteristic feature of Fabaceae **[NCERT; Kerala PMT 2007]**

(a) Descendingly 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

19. Stylopodium is present in

(a) Mustard (b) *Petunia*

(c) Coriander (d) Pea

20. Basifixed monothecous anthers (OR) anthers with two microsporangia is characteristics of **[RPMT 1995]**

(a) Leguminosae/Pea (b) Malvaceae/Cotton

(c) Solanaceae/Tomato (d) Liliaceae/Onion

21. Feathery (hairy) style is persistent in

(a) *Solanum* (b) *Clematis*

(c) *Helianthus* (d) *Hibiscus*

22. In *Acacia* species, the first few leaves are pinnately compound. Then there are leaves with flattened petiole and fewer pinnae. The leaves of adult plant has parallel veined flattened petiole and no pinnae. It shows that

(a) Leaves of adult plant are reduced to phyllodes while those of the seedling are unreduced

(b) The parallel-veined green structures of the adult plant are phylloclades

(c) The plant shows developmental heterophylly, compound in seedling and simple in adult plant

(d) The leaves of adult plant are unreduced while they are reduced in the seedling stage

23. Hair present on the cob of corn are **[CBSE PMT 2000]**

Or

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

(a) Seed hairs (b) Modified hairs of bracts
(c) Styles (d) Stigmas and styles

24. Diadelphous stamens occur in **[CPMT 1994, 95, 98, 99; Pb. PMT 1997, 99]**

(a) Gramineae (b) Cucurbitaceae
(c) Papilionatae (d) Malvaceae

25. Inflorescence is **[AFMC 1994]**

(a) Composite (multiple) fruit developed from condensed inflorescence
(b) Aggregate fruit developed from free carpels
(c) Fruit develop from inferior ovary
(d) Fruit develops from thalamus

26. Tetradynamous condition is related to **[CPMT 1993]**

(a) Androecium (b) Inflorescence
(c) Perianth (d) Gynoecium

27. Match **Column-I** with **Column-II** and select the correct option using the codes given below **[NEET (Phase-II) 2016]**

Column-I	Column-II
(A) Pistils fused together	(i) Gametogenesis
(B) Formation of gametes	(ii) Pistillate
(C) Hyphae of higher Ascomycetes	(iii) Syncarpous
(D) Unisexual female flower	(iv) Dikaryotic

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

AR Assertion & 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 : Roots contain nodes but no leaves or buds.
Reason : Root branches arise endogenously.

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

3. Assertion : Root pockets are similar in all terms to root caps.
Reason : Root caps and root pocket have the ability to regenerate.

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

5. Assertion : In syconous type of fruit, the achenses formed are fewer than the total number of flowers in the inflorescence from which it is formed.
Reason : Upper and middle flowers cannot develop into fruits. **[EAMCET 2009]**

6. Assertion : An ascending taxonomic sequence of *Gossypium herbaceum* indicates its placement in progressively higher groups.
Reason : Ascending taxonomic hierarchy indicates that a taxon is treated as belonging to a number of taxa. **[EAMCET 2009]**

7. Assertion : Deep feeder tap root system is called cymose tap root system.
Reason : Deep feeder root system is found in trees.

8. 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 kilometers before losing viability. **[AIIMS 2004]**

9. Assertion : *Orchis* root resembles human hand.
Reason : Orchis is an example of fasciculated fleshy roots.

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

11. Assertion : Assimilatory roots can photosynthesize.
Reason : Asimilatory roots possess chlorophyll.

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

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

14. Assertion : In syngenesious stamen, the filaments are fused and the anther are free.
Reason : In synandrous stamen, both filaments and anthers are fused.

15. Assertion : Stem develops from hypocotyl of embryo.
Reason : Internodes bear axillary buds.

16. Assertion : Bud may form leaves and flowers.
Reason : Bud is a condensed shoot.

17. Assertion : In cymose branching, growth of terminal bud stops after some time.
Reason : The growth of the main stem is definite.

18. Assertion : Ginger has a prostrate-growing rhizome.
Reason : Shoot growth is not effected by gravity. **[AIIMS 2004]**

19. Assertion : Some fruits are furnished with hooks, spines, barbs or other devices for sticking to the body of animals unwillingly.
Reason : Such fruits are dispersed by animals unwillingly.

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

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

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

23. Assertion : Prickles lack vascular cylinder.
Reason : Prickles show deposition of silica or calcium carbonate.

24. Assertion : Wheat is a caryopsis.
Reason : Its pericarp is well differentiated.

25. Assertion : Phyllotaxy deals with morphology of leaves.
Reason : Foliage denotes all leaves of a plant.

26. Assertion : Achenial fruits are single seeded fruits.
Reason : Capsular fruits are multiseeded fruits.

27. Assertion : In spiral phyllotaxy, many leaves are present on a node.
Reason : In opposite phyllotaxy, two leaves are borne on a node.

28. Assertion : A simple leaf has undivided lamina.
Reason : Leaves showing pinnate and palmate venation have various type of incisions.

29. Assertion : *Citrus* is a palmate compound leaf.
Reason : *Citrus* has single functional leaflet.

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

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

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

33. Assertion : Small leaflets are present on the phyllode of *Parkinsonia aculeata*.
Reason : Phyllode does not bear leaves and flowers.

34. Assertion : Persistent sepals of *Physalis* are called accrescent.
Reason : In Guava, the sepals are marcescent.

35. Assertion : An incomplete flower can be perfect.
Reason : Perfect flowers (Incomplete) are called neuter.

36. Assertion : The flowers of Hypanthodium are never exposed.
Reason : Hypanthodium flowers are bisexual.

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

38. Assertion : In caducous plants, leaves are never formed.
Reason : In deciduous plants, all leaves fall together.

39. Assertion : Onion leaves are centric and green.
Reason : Aerial leaves of onion store food.

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

41. Assertion : Verticillaster is a cymose inflorescence.
Reason : The main axis and lateral branches of inflorescence end in flowers.

42. Assertion : Leaves of *Bryophyllum*, *Begonia* help in vegetative multiplication.
Reason : Leaves of these plants possess adventitious buds.

43. Assertion : *Adiantum caudatum* is a walking fern.
Reason : *Adiantum* grows vegetatively by their leaf tips.

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

45. Assertion : Spathe, a bract of spadix attracts pollinators.
Reason : Spathe is often brightly cloloured.

46. Assertion : Flower of racemose inflorescence are pollinated by insects.
Reason : In Racemose head infloresence, the florets are arranged in a centripetal fashion.

47. 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.

48. Assertion : Compound umbel is branched.
Reason : In compound umbel, both involucre and involucels are present.

49. Assertion : In cyathium, several male flowers surround a single female flower.
Reason : The involucre is nectariferous.

Answers

Root

1	c	2	b	3	c	4	c	5	c
6	b	7	d	8	c	9	d	10	b
11	a	12	c	13	b	14	d	15	c
16	b	17	c	18	a	19	d	20	d
21	a	22	a	23	d	24	b	25	b
26	e	27	b	28	a	29	a	30	b
31	d	32	a	33	d	34	c	35	d
36	d	37	b	38	d	39	d	40	a
41	c	42	d	43	d	44	c	45	c
46	d	47	b	48	c	49	d	50	b
51	d	52	d			-			

Stem

1	b	2	a	3	b	4	c	5	d
6	a	7	b	8	b	9	b	10	d
11	b	12	a	13	c	14	b	15	a

16	a	17	d	18	a	19	a	20	a
21	b	22	d	23	b	24	a	25	d
26	a	27	c	28	d	29	c	30	d
31	a	32	d	33	a	34	a	35	c
36	d	37	c	38	d	39	c	40	a
41	b	42	a	43	c	44	d	45	a
46	b	47	b	48	a	49	d	50	d
51	b	52	a						

Leaf

1	b	2	c	3	b	4	c	5	c
6	d	7	b	8	c	9	d	10	b
11	b	12	b	13	b	14	d	15	d
16	a	17	a	18	c	19	a	20	b
21	a	22	b	23	d	24	d	25	b
26	a	27	a	28	d	29	a	30	b
31	a	32	c	33	b	34	a	35	b
36	a	37	d	38	a	39	a	40	c
41	a	42	b	43	a	44	c	45	a
46	a	47	c	48	a	49	c	50	d
51	a	52	a	53	d	54	c	55	d
56	c	57	a	58	a	59	d		

Inflorescence

1	a	2	b	3	d	4	d	5	d
6	d	7	a	8	b	9	d	10	a
11	a	12	a	13	a	14	d	15	c
16	c	17	a	18	d	19	c	20	d
21	b	22	a	23	c	24	d	25	d
26	c	27	b	28	a	29	d	30	d
31	d	32	c	33	c				

Flower

1	d	2	a	3	b	4	a	5	d
6	c	7	c	8	a	9	a	10	a
11	b	12	e	13	c	14	a	15	b
16	c	17	c	18	c	19	d	20	a
21	b	22	c	23	d	24	c	25	c
26	b	27	d	28	c	29	c	30	b
31	a	32	c	33	b	34	d	35	a
36	b	37	c	38	c	39	d	40	a
41	d	42	a	43	d	44	c	45	b
46	b	47	b	48	a	49	b	50	c
51	d	52	c	53	a	54	b	55	c
56	c	57	a	58	c	59	d	60	b
61	a	62	a	63	b	64	b	65	b
66	a	67	a	68	b	69	a	70	b
71	b	72	c	73	b	74	e	75	c
76	c	77	c	78	a	79	c	80	d
81	c	82	d	83	a	84	c	85	d
86	d	87	c	88	a	89	a	90	a
91	a	92	c	93	b	94	d	95	b
96	d	97	b	98	d	99	d	100	a
101	d	102	c	103	d	104	c	105	b

Seeds and Fruits

1	d	2	c	3	b	4	a	5	c
6	a	7	a	8	a	9	a	10	c
11	b	12	a	13	c	14	b	15	b
16	b	17	a	18	c	19	a	20	c
21	d	22	c	23	a	24	a	25	c
26	c	27	a	28	c	29	d	30	b
31	d	32	b	33	c	34	a	35	d
36	b	37	a	38	d	39	c	40	c
41	a	42	c	43	b	44	e	45	d
46	d	47	d	48	c	49	a	50	b
51	c	52	a	53	d	54	e	55	d
56	c	57	d	58	c	59	b	60	a
61	b	62	a	63	d	64	b	65	b
66	a	67	a	68	b	69	c	70	a
71	d	72	c	73	b	74	b		

Dispersal of fruits and seeds

1	a	2	d	3	b	4	b	5	d
6	a	7	d	8	a	9	b	10	b
11	c	12	d	13	b	14	d	15	c
16	d	17	b	18	c	19	b		

Taxonomy of Angiospermic plants

1	b	2	a	3	d	4	c	5	b
6	c	7	b	8	c	9	d	10	d
11	a	12	c	13	a	14	b	15	c
16	a	17	c	18	c	19	c	20	b
21	c	22	d	23	c	24	b	25	a
26	b	27	a	28	c	29	c	30	d
31	d	32	c	33	c	34	a	35	c
36	b	37	c	38	d	39	b	40	b
41	d	42	c	43	a	44	e	45	a
46	c	47	c	48	a	49	d	50	d
51	c	52	d	53	c	54	d	55	a

56	d	57	b	58	c	59	c	60	d
61	b	62	c	63	d	64	c	65	c
66	c	67	b	68	a	69	c	70	b
71	a	72	a	73	c	74	c	75	c
76	b	77	a	78	d	79	b	80	a
81	c	82	b	83	d	84	b	85	d
86	b	87	c	88	c	89	b	90	b
91	a	92	a	93	e	94	d	95	b
96	b	97	c	98	c	99	a	100	d
101	a	102	b	103	a	104	b	105	c
106	b	107	a						

NCERT Exemplar Questions

1	a	2	b	3	d	4	b	5	c
6	b	7	b	8	d				

Critical Thinking Questions

1	d	2	d	3	c	4	b	5	a
6	c	7	a	8	a	9	b	10	a
11	d	12	d	13	a	14	d	15	a
16	b	17	b	18	e	19	c	20	b
21	b	22	a	23	d	24	c	25	a
26	a	27	a						

Assertion and Reason

1	e	2	b	3	d	4	e	5	a
6	a	7	e	8	b	9	c	10	a
11	a	12	b	13	c	14	e	15	d
16	a	17	a	18	b	19	a	20	b
21	e	22	c	23	c	24	c	25	e
26	b	27	e	28	b	29	b	30	c
31	e	32	c	33	b	34	b	35	c
36	c	37	a	38	e	39	b	40	c
41	a	42	a	43	a	44	c	45	a
46	b	47	e	48	b	49	b		

Answers and Solutions

Root

2. (b) In plants growing in salty marshes some branches of tap root grow vertically upwards into the air from horizontally secondary roots. These roots are called pneumatophores.

3. (c) In monocotyledonous plants the radicle dies immediately after germination of seeds and later these roots arise from any other portion (stem, leaves etc.) of the plant.

4. (c) Pneumatophores develop from horizontal roots. They bear a number of lenticels or pneumathodes. Exchange of gases occurs through these pores. *e.g.*, *Rhizophora*.

5. (c) In epiphytic roots the outer covering is made up of spongy tissue, the velamen which absorbs moisture from air.

6. (b) Swollen adventitious roots of definite shape that occur in groups or fascicles, and arise from base of stem e.g. Dahlia.

7. (d) The swollen root is broad at the base and tapers gradually towards the apex.

8. (c) The root is nearly globular or spherical in shape. The basal portion of root is much swollen which suddenly tapers towards the apex giving a top shaped appearance, *e.g.*, Turnip and Beet.

9. (d) The storage root is like a spindle, narrow towards both base and apex. It occurs in *Raphanus sativus*. The basal part of it is made of tap root.

10. (b) They are thin thread – like adventitious roots which often develop in groups. Fibrous roots provide better and firm anchorage to the plant, *e.g.*, Grass.

11. (a) In some plants roots arise from lower nodes of stem and enter the soil to provide extra support. They behave as ropes of a tent. Such roots are called stilt or brace roots *e.g.*, *Pandanus*.

12. (c) These roots develop chlorophyll and become photosynthetic. They synthesize carbohydrates from carbon dioxide and water in presence of light, *e.g.*, *Trapa*, *Tinospora*, *Taeniophyllum* and *podostemon*.

15. (c) It is adventitious because it is not formed from radicle.

17. (c) Plants belonging to sub-family papilionatae of family leguminosae (*e.g.*, pea, gram etc.) bear nodule-like swellings, called root nodules. These nodules contain nitrogen fixing bacteria which fix atmospheric free nitrogen into ammonia.

21. (a) Some of the adventitious roots store food materials and become swollen. They arise singly and do not attain a definite shape, *e.g.*, Sweet potato (*Ipomoea batata*).

28. (a) Pistia is hydrophyte where absorption of water by root is insignificant

29. (a) Velamen is a dead spongy tissue of empty cells. It absorbs water present on the surface of these roots.

31. (d) Potato is modification of underground stem.

33. (d) These roots hang in the air and possess velamen or spongy tissue for absorbing moisture directly from atmosphere. The epiphytic roots are devoid of root hairs and root caps.

35. (d) Some aquatic and saprophytic angiosperms have no roots. In aquatic insectivorous plant-*Utricularia*, some leaves are finely dissected and carry on function of roots.

36. (d) Many roots can develop adventitious buds and take part in vegetative propagation, *e.g.*, *Dahlia*, *Dalbergia*.

38. (d) They are laterally compressed horizontal roots which travel along the ground for some distance and provide extra mechanical support, *e.g.*, *Ficus elastica*.

39. (d) Prop roots of Banyan tree helped it spread in an area of 200 acre in Indian Botanic Garden, Sibpur, Harwrach. This single Banyan tree had 1600 prop roots.

41. (c) Such roots are found in plants growing in mangroves or saline swamps near the sea shore.

42. (d) The region of fastest growth is behind the root tip. It is 4-8 *mm* long portion behind the tip. Here cells elongate rapidly due to vacuolisation.

43. (d) Prop or pillar or columnar roots : They are pillar-like roots which give extra mechanical support to heavy stem branches, *e.g.*, Banyan tree.

44. (c) In *Pothos armatus*, *Acanthorhiza* and *Iriartea*, some adventitious roots from the base of stem become hard, pointed and thorn like. Those roots are called root-thorns.

46. (d) Halophytes or mangroves like *Rhizophora*, *Raxburghiana*, *Sonneretia* etc., have pneumatophores and vivipary.

47. (b) Mango, ginger is a modification of adventitious roots. These roots become swollen at their tips due to accumulation of food.

48. (c) The roots where adventitious roots become swollen to store food. Fasiculated root is a type of storage root. *e.g.*, *Dahlia*, *Ruellia*, *Asparagus* etc.

49. (d) Floating roots are white spongy and arise from node and stem store air. They help in floatation as well as in breathing also, *e.g.*, *Jussiaea*.

52. (d) Many aquatic plants possess elongated loose cap like covering over their tips. They are called root pockets, *e.g.*, Water Hyacinth (*Eichhornia*).

Stem

1. (b) Corm is an underground modification of main stem and stores food materials and becomes tuberous. Buds present externally corms give rise to new aerial shoots and new corms.

2. (a) Bulbils are fleshy vegetative buds which store food and take part in vegetative propagation. Bulbils of *Agave* germinate which still on inflorescence and thus show vivipary.

3. (b) Cladode are somewhat similar to phylloclade with the difference that cladode may by made up of only one internode. *e.g.*, *Asparagus* (Satavar) or two internodes *e.g.*, *Ruscus*.

5. (d) Accessory buds borne at the leaf bases. They are two types : (i) Collateral buds present on the side of axillary bud, *e.g.*, lilies (ii) Superposed buds present above the axillary bud *e.g.*, *Aristolochia*.

7. (b) Thorns are actually modified axillary buds or terminal buds and they possess vascular supply.

9. (b) Sweet potato, Carrot – Edible root.
Potato – Edible underground stem.

10. (d) Pedicel or floral stalks of *Artabotrys* produces a curved hook (which are modification of inflorescence axis) to help the plant in climbing.

11. (b) Phylloclades are modification of stem. These are green fleshy leaf like structure having nodes and internodes. Stem performs the function of photosynthesis.

12. (a) In bulb the stem is highly reduced and can be seen only as a disc like structure. On this disc are present numerous fleshy scaly leaves covering a central terminal bud. Both the disc and scaly leaves collectively are called bulb.

15. (a) Potato is (underground) stem because on the surface of potato many axillary buds or eyes are formed which are capable of growing into new plant.

16. (a) A special type of rhizome which grows vertically is called root stock, for example, *Alocasia indica* and *Musa paradisiaca* (Banana).

18. (a) *Opuntia* - Phylloclade

19. (a) Cabbage represents the largest apical bud. It is a vegetative bud and stores food.

20. (a) Onion – Bulb – underground stem, Ginger – Rhizome
Chlamydomonas – Zoospore.

23. (b) Axillary buds developing at nodes/notch/eyes

24. (a) The entire bulb is covered by peripheral dry membranous leaf bases called tunics.

25. (d) Prickles are superficial (exogenous origin) outgrowths in any part of stem, branch, leaf and do not have vascular supply. Thorns are modified stem and differ from spines and prickles for example, *Bougainvillea*, *Carissa* and *Duranta*.

26. (a) Sucker is a sub aerial branch that arises from the main stem. Initially it grows horizontally below the soil surface and later grow obliquely upward. They are shorter and stouter than the runners. *e.g.*, *Mentha arvensis* and *Chrysanthemum*.

27. (c) In some weak stemmed plants, the axillary bud or terminal bud may modify to form tendrils which are specially called stem tendrils for *e.g.*, *Passiflora*, *Atigonon*, *Vitis* etc.

30. (d) Root stock rhizome is oblique or vertical with tip almost reaching the soil surface.

32. (d) Ginger (*Zingiber officinale*) is an example of underground modifications of stem (rhizome) which has nodes and internodes.

33. (a) *Colocasia* is an example of corm.

34. (a) The axillary bud or terminal bud may modify to form tendrils which are specially called stem tendrils *e.g.*, *Passiflora*.

36. (d) The rhizomes are perennial and vegetatively propagating structures and stores food materials and appear tuberous *e.g.*, Ginger, Turmeric etc.

39. (c) Vegetative buds or floral buds modify into a swollen structure called bulbils or bulblets. It separates from the parent plant and gives rise to a new plant *i.e.*, it is an vegetative reproduction, *e.g.*, *Agave*, *Oxalis* etc.

42. (a) In onion food stored in leaf base is glucose.

45. (a) Twiners are weak stemmed plants where the stem coils or twines around an upright support. Direction of coiling around the support is specific and genetically determined. The coiling is due to nutation.

46. (b) Multicellular hairs is the characteristic of stem.

47. (b) Potato is a modification of stem and sweet potato is a modification of root.

49. (d) They store food material in the basal portion and formed new corms e.g., *Colocasia*, *Alocasia*.

51. (b) Phylloclade is a modification of stem because the stem modifies into green fleshy leaf like structure having distinct nodes and internodes.

Leaf

2. (c) Leaf is a thin flattened out growth of the plant arising from the node of the stem and having a bud in its axil.

5. (c) The leaves having even number of leaflets are termed as paripinnate, *e.g.*, *Cassia*, *Tamarind* etc.

6. (d) In grasses and many monocots, the leaf base is broad and surrounds the stem as an envelope, such a leaf base is called sheathing leaf base. An additional outgrowth is present between leaf base and lamina. It is called ligule. *e.g.*, Grasses.

7. (b) *Victoria regia* an aquatic plant with floating leaves. Which are 4 meters in radius and diameter 1.5-1.8 *m*. These are the largest leaves in plant kingdom.

8. (c) Parallel venation is the characteristic feature of monocotyledons. Exceptionally few dicots show parallel venation, *e.g.*, *Calophyllum* and *Eryngium*.

9. (d) In this type, the primary rachis is divided once and produce secondary rachis. The leaflets develop on the secondary rachis. *e.g.*, *Mimosa pudica* (Mimosoideae).

10. (b) The leaves are modified into slender wire and coiled structures called leaf tendrils. The tendril may be formed by entire leaf *e.g.*, *Lathyrus aphaca* (Wildpea).

12. (b) Terminal leaflets modifies into tendril. *e.g.*, *Lathyrus odoratus* (Sweet pea).

13. (b) The stipules are the small lateral appendages present on either side of the leaf base. Bud scales stipules are scaly which protect the leaf buds by surrounding them. *e.g.*, *Ficus*, *Artocarpus*, Banyan etc.

14. (d) The unipinnate leaf with odd number of leaflets. The rachis is terminated by single unpaired leaflet. *e.g.*, Neem, Rose, *Murraya*.

16. (a) The leaf having single undivided lamina is called the simple leaf. *e.g.*, Peepal.

18. (c) When stipules are thin and modified into wire like structure these are known as tendrillar. These help in climbing of plants. *e.g.*, *Smilax*.

20. (b) In Onion and garlic (underground bulb) scale leaves store food and become fleshy.

23. (d) In few plants the petioles are modified into tendrils and helps the plant climbing *e.g.*, *Clematis* and *Tropaeolum*.

31. (a) A leaf is always borne at the node of stem.

32. (c) In *Utricularia* (Bladderwort) some of the leaves are modified to form small bladders (utricles) each of 1-3*mm* diameter.

33. (b) In this type of venation main veins divide into various branches and make a net-like structure in the lamina. It is found in most of the dicot plants.

35. (b) The underground stems having central axis, which grows and develops flower on top are called scape *e.g.*, onion, garlic etc. Pedicel is the stalk of the flower. The broadened base of flower which lies at the tip of pedicel is called thalamus or torus.

36. (a) Circinate ptyxis is a folding or rolling from apex to base like spring of watch, *e.g.*, fern leaves.

37. (d) Green, flattened petioles may be called winged petioles, *e.g.*, *Citrus* and *Dionaea*.

38. (a) A pointed structure formed by the modification of entire leaf or part of a leaf is called a spine. Leaf or entire leaf may be modified into spines. *e.g.*, *Opuntia* (axillary branches are modified into spines).

40. (c) The lamina is modified into broad pinkish pitcher of 1 to 10 inches in length.

42. (b) Because *Mangifera* (mango) is a dicot plant and reticulate venation found in dicots.

43. (a) It is the most familiar and wide spread type of compound leaf in which the rachis is elongated and bears two rows of simple or divided leaflets. The leaflets arranged alternately or in pairs along with the rachis.

44. (c) Multifoliate (Digitate) : A palmately compound leaf having five or more terminal leaflets, *e.g.*, *Bombax malabarica*, *Cleome viscosa*, *Gynandropsis pentaphylla* etc.

45. (a) In parallel venation (striate venation), veins and veinlets run parallel to each other. Parallel venation is the characteristic feature of monocots.

50. (d) Membranous tubular stipules that ensheath the axillary bud and a part of internode is called ochraceous stipule. It is formed by the union of two stipules. *e.g.*, *Polygonum* and *Rumex*.

52. (a) 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.

54. (c) Leaf base (Hypopodium) is the lower most part of the leaf meant for attachment. It acts as a leaf cushion.

55. (d) 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*.

56. (c) In some plants leaves are modified into pointed spines which are known as leaf spines. These protect the plant from grazing animals and reduce the rate of transpiration in xerophytic plants.

Inflorescence

5. (d) Capitulum (Head) : It is a characteristic of compositae (Asteraceae). Penduncle is flattened to form receptacle that bears centripetally arranged small sessile flowers called florets surrounded by involucre of bracts. *e.g.*, Marigold, Sunflower.

7. (a) Flowers are arranged in acropetal succession, *i.e.*, older flowers are towards the base and younger ones are towards the apex of the peduncle.

9. (d) Catkin (Amentum) is a compact pendent unisexual spike in which peduncle is thin and weak. e.g., *Morus* (Mulberry), *Populus* (Poplar), *Acalypha* (Cats tail), *Salix* (Willow), *Betula* (Birch).

12. (a) The florets are surrounded by an involucre of bracts.

14. (d) Hypanthodium is a special type of inflorescence formed by the condensation of main axis into a cup or flask-shaped fleshy receptacle.

15. (c) Spadix is a modification of catkin spike in which the peduncle is thick and fleshy with upper part sterile (called appendix) and lower part bearing male, neuter and female unisexual flower surrounded by a large bract called spathe. e.g., *Musa paradisiaca*.

16. (c) Spikelet is a compact spike having a few flowers borne an axis called rachilla and surrounded by two bracts called glumes. e.g., Wheat, Oat, Grass. Each flower or floret has at its base a bract called lemma and a bracteole complex called palea.

18. (d) Flower occurs singly in the axil of a leaf, e.g., *China Rose/ Shoe flower (Hibiscus rosa - Sinensis)*.

21. (b) It is a raceme of verticels or (whorls of flowers) borne on rectangular axis in the axils of opposite leaves. At each node there are two verticels. Each whorl consists of two clusters of 3-9 flowers e.g., *Ocimum* (Tulsi), *Salvia, Leucas*.

25. (d) Corymb (e.g., Cauliflower), catkin (Mulberry) and hypanthodium (Fig) are edible inflorescence.

26. (c) A pendulous spike or spike-like inflorescence consisting of small unisexual flowers, e.g., *Morus alba* (Mulberry), *Salix* (Willow).

27. (b) More flowers are pollinated at a time, more fruits are produced.

28. (a) Corymb of corymbs inflorescence found in Cauliflower. Edible Cauliflower (*Brassica oleracea* var. *Botrytis*) represents an undeveloped inflorescence.

29. (d) Involucre is whorl of bracts found in capitulum, umbel and cyathium.

Flower

1. (d) Hermaphrodite or perfect/bisexual / intersexual / androgynous / monoclinous : A flower having both the essential organs *i.e.*, stamens and pistils. e.g., *Hibiscus*.

2. (a) The broadened base of flower which lies at the tip of pedicel is called torus or thalamus or receptacle.

3. (b) Synandrous : Stamens are fused in the region of both there filaments and anthers, e.g., *Cucurbita, Luffa*.

4. (a) Flower is highly modified and condensed shoot meant for sexual reproduction. It is characteristic of angiosperms.

6. (c) The fused petals form a strap-shaped structure towards the upper end. A small hairy outgrowth, the ligule is present at the junction of the strap and the tube, e.g., ray florets of *Helianthus*.

7. (c) Beauty of *Bougainvillea* flower is due to petaloid bract (Brightly coloured petal like bract).

8. (a) The flower may be described as complete if it bears all the floral whorls or floral parts.

10. (a) Monoadelphous : Filaments of all the stamens are fused to form a tube around the gynoecium. Anthers are free. e.g., China rose.

11. (b) When stamens adnate or unite with petals. This condition is known as epipetalous. e.g., *Petunia, Datura*.

12. (e) Imperfect or unisexual or diclinous : A flower containing either stamens or pistils e.g., *Luffa*. These are of two types namely staminate which bear the stamens and pistillate bearing pistils.

13. (c) It is the third elongated internode between androecium and gynoecium e.g., *Capparis* and *Gynandropsis*.

14. (a) A plant bearing flowers of both sexes, *i.e.*, Staminate and pistillate flowers, e.g., *Ricinus, Zea mays* (maize) and Cucurbits.

19. (d) Descending imbricate aestivation in petals are found in Papilionaceae family.

23. (d) In Maize, flowers are unisexual but plant is monoecious.

24. (c) Foliaceous shape of sepals is present in *Mussaenda*.

26. (b) The bracts found on the rachilla of spikelet are called glumes. They may be sterile glumes or fertile glumes (lemma), e.g., *Oryza sativa*.

27. (d) In many members of Asteraceae family, the sepals are modified into hairs called pappus. e.g., *Tridax*.

28. (c) Four free clawed petals arranged in the form of a cross, e.g., Mustard and Radish.

30. (b) Lodicules are modified tepals (Perianth). Perianth : 2, polyphyllous, small hyaline membranous antero-lateral scales called lodicules, hairy or smooth, whitish, inferior occur in *Triticum aestivum*.

31. (a) China rose, mustard, brinjal, potato, onion and tulip– total six plants have superior ovary.

32. (c) Gram, Arhar, Sunhemp, Moong, Pea and Lupin belongs to Fabaceae family that bears marginal placentation.

36. (b) Ray florets are always unisexual pistillate or neuter in heterogamous head inflorescence. In homogamous head, these are bisexual.

37. (c) The terminal receives portion of the style is called the stigma. It receives pollen grain during pollination.

39. (d) Perianth is the collective name of the nonessential floral organs if there is no distinction between sepals and petals.

42. (a) Thalamus may show internodes, between various types of floral organs anthophore, androphore, gynophore. This evidence proves that flower is a modified shoot.

46. (b) *Rafflesia* is largest flower (1 meter).

48. (a) Hypogynous flower (hypo = below; gyny = ovary). Thalamus is conical or convex with gynoecium at top and other part below it, ovary is superior and other parts inferior. e.g., Liliaceae, Malvaceae and Solanaceae.

49. (b) Epigynous flower : Thalamus is hollowed out and fused with ovary. Other floral organs appear at the top of ovary. Gynoecium is inferior while other parts are superior.

50. (c) Gynoecium consisting of two to many free carples. Each carpel forms its own pistil, e.g., *Ranunculus*, Lotus.

54. (b) The posterior petal is the innermost. It is being overlapped on the margins by lateral petals. The lateral petals are in turn overlapped by anterior petals, *e.g.*, *Tamarindus*.

56. (c) Pappus : (Hairy or feathery sepals) sometimes sepals are modified into hairy structures which are useful in dispersal of seeds. *e.g.*, Compositae / Marigold.

70. (b) Perianth is reduced to 2-3 boat shaped membranous lodicules. Lodicules found in family Gramineae (Poaceae).

71. (b) When stamens mature earlier than the stigma, it is known as protandry and the flowers are called protandrous *e.g.*, Coriander, Jasmine, Sunflower etc.

72. (c) Filaments of a stamens are fused forming one bundle and the other bundle is represented by the filament of the tenth free stamen $A_1 + (9)$.

73. (b) Stamens inserted in two whorls : Outer whorl is opposite to petals, *i.e.*, antipetalous. Whereas inner whorl is alternipetalous *e.g.*, *Dianthus*.

77. (c) The plants of some species in which flowers are dimorphic. Thus facilitate cross pollination. Some of them possess a long style but short stamens and are known as pin-eyed while others have short style and long stamens. These are known as thrum-eyed. *e.g.*, Primrose.

78. (a) *Cocus nucifera* belongs to family Arecaceae. In this family, flower containing either stamens or pistils. The floral parts are in multiples of three.

80. (d) The corolla of *Hibiscus* is polypetalous and twisted. *Hibiscus* is the member of family Malvaceae. Malvaceae comes under series thalamiflorae of class polypetalae. The petals are 5 and free. The aestivation of coralla is twisted in this family.

82. (d) Petals are 5, free, and twisted aestivation are found in china rose.

87. (c) Datura, mustard and tomato have actinomorphic flowers.

88. (a) Tomato — Berry, Orchid seed — no endosperm formation, Primose — Free central placentation

93. (b) Ovary is half inferior in perigynous flowers.

101. (d) Imbricate aestivation – *Cassia*, gulmohur.

104. (c) The stamens may be united into one bundle (monoadelphous), or two bundles (diadelphous) or into more than two bundles (polyadelphous).

105. (b) Radial symmetry is found in flowers like mustard, *Datura*, Chilli.

Seeds and Fruits

1. (d) The orchids seeds (0.004 *gm*) are smallest in Angiosperms. These are small, dry and light and can be carried by wind to over 1000 *km*.

3. (b) Seed is a fertilized and ripened ovule (mature integumented megasporangium) found in phanerogams (spermatophytes).

4. (a) The main body of the ovule is covered with one or two envelopes called integuments.

9. (a) Viability of seeds : Ability of seed to have power of germination over a period of time is called viability. It is maximum in Lotus (*Nelumbo nucifera*)i.e.,400-2000 years.

11. (b) Morphological dormancy-embryo is small & under developed.

12. (a) The fertilized ovule forms seed. The ovule increases greatly in size. The integuments dry up.

13. (c) Non-endospermic or Exalbuminous seed : Endosperm is completely consumed by the developing embryo and the mature seeds are without endosperm. The food is stored in cotyledons. *e.g.*, *Gram*, *pea*, *Bean* etc.

14. (b) Vivipary is germination of seeds within fruit (in situ) while attached to the parent plant. Hypocotyl elongates and pushes the radicle but the seed and fruit hangs like Damocle's sword from the tree. It is found in mangroves (*e.g.*, *Rhizophora*, *Sonneratia*).

15. (b) *Rhizophora* is a mangrove plant and vivipary is found in it.

16. (b) The mesocarp is thick, fleshy, juicy and edible part in *Mangifera* (Mango).

17. (a) Berry type of simple succulent fruits the pericarp divided into three layers – a thin delicate outer epicarp, a soft middle mesocarp and an inner layer known as endocarp. Both endocarp and mesocarp are fleshy. The slippery, oval, orange, coloured seeds are attached by stalks to the placenta. *e.g.*, Tomato, Brinjal.

18. (c) Caryopsis : It is very small dry and one seeded fruit which develops from a superior monocarpellary ovary. Here the pericarp is closely fused with seed coat. It is the characteristic of family graminae. *e.g.*, Wheat, Maize.

19. (a) The aggregate fruits are formed from polycarpellary, apocarpous ovary of a single flower. *e.g.*, *Michellia*, *Rubus*, *Annona*.

20. (c) Caryopsis is one-seeded dry indehiscent fruit developed from a monocarpellary, unilocular and superior ovary. *e.g.*, Wheat, Maize, Paddy.

21. (d) Hesperidium is many chambered and many seeded fleshy fruit developed from multicarpellary, syncarpous and superior ovary. The epicarp is leathery and glandular, mesocarp is thin and smooth, *e.g.*, Lemons and oranges.

25. (c) Lomentum is a type of fruit. It is a dry many seeded fruit which develops from a monocarpellary, superior, unilocular ovary with marginal placentation.

28. (c) The fruit of *Datura* is septicidal capsule but its dehiscence is of septifragal nature in which placenta remains attached in the centre of undivided fruit and pericarp's segment becomes separated.

29. (d) The structure present within the seed coat is called kernel. Endosperm, embryo and cotyledon are the part of kernel.

30. (b) Mechanical scarification (Rupturing of seed coats) by filling, chipping or machine threshing.

31. (d) Castor is an endospermic (Albuminous seed). In albuminous seeds, embryo not consumed all endosperm. So it persists in the mature seed . In these seeds food stored in endosperm. In castor, the cotyledons come above the surface of the soil into the air and light due to the rapid growth and elongation of the hypocotyls. The cotyledons turn green and finally dry up and fall off and seedling becomes an independent plant. It is a type of epigeal germination.

32. (b) Pepo is a special type of berry, the epicarp and thalamus form the outer ring of the fruit. The mesocarp, endocarp and placenta are fused to form pulp which is edible. *e.g.*, Members of cucurbitaceae family.

34. (a) Water is of primary importance in germination. When seed protoplasm absorb the water, seed resumes vigourous physiological activities. The embryo bursts through the seed coats. O_2 is also necessary for respiration and other physiological activities.

36. (b) Simple fruits develop from monocarpellary ovary or multicarpellary syncarpous ovary.

37. (a) The pericarp of drupe consists of a thin epicarp (forms the skin), a fleshy mesocarp (forms the edible part) and hard and stony endocarp *e.g.*, *Cocos nucifera*.

38. (d) Seeds of some species are edible *e.g.*, *Pinus gerardiana* (chilgoza pine). This plant is common in dry valley North West Himalayas and Kashmir.

39. (c) Sorosis develop from spike, spadix or catkin inflorescence. Bracts, perianth and seed become simple and are used for eating in pine apple and mulberry.

47. (d) Fig- developed by hypanthodium inflorescence.
pineapple- developed by spike inflorescence.
Mulberry-developed by catkin inflorescence.

52. (a) Hesperidium is a modification of berry. It develops from a polycarpellary syncarpous, superior ovary with many seeds.

62. (a) Mango – seeded fruit
Sterile stamen – staminode
Seeds in grasses – endospermic.

65. (b) Tomato – Berry, Wheat – Caryopsis, Pea – Legume.

74. (b) Seed of garden pea is ex-albuminous or non endospermic.

Dispersal of fruits and seeds

1. (a) In legumes the dry pods split open into two valves which undergo spiral twisting to throw the seeds *e.g.*, Pea, *Abrus*.

3. (b) One or more tufts of hairs attached on seeds constitute coma *e.g.*, *Calotropis*. *Calotropis* is insect pollinated but dispersed by wind. Its seeds are plumed (hairy). It has pollinia containing anther to be carried by insects.

4. (b) The fruits of *Clematis* and *Naravelia* possess persistent hairy styles which help in floating in air.

5. (d) Autochory (Dispersal by explosion) is self dispersal of the seeds which occurs when the fruit splits up at maturity. Such fruits open with force and scatter the seeds in all directions.

6. (a) In *Ruellia* and *Justicia* (Acanthaceae) the exposed seeds are thrown away with the help of Jaculators (Jaculator mechanism). Jaculator is a curved hook at the base of seed which open with jerk to throw seeds.

7. (d) In members of the family Asteraceae, sepals are modified into tufts of hairs called pappus. The pappus is persistant 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.

8. (a) The fruit and seeds surface possesses sticky glands for attaching to the body of animals, *e.g.*, *Plumbago*, *Boerhaavia*, *Cleome viscosa*.

9. (b) Seed bear hair all around.

10. (b) The fruit of Asteraceae often possess pappus (persistent hairy calyx) which functions as a parachute for dispersal.

11. (c) The surface of many fruits is covered with hooks (*e.g.*, *Xanthium*, *Urena*), spines (*e.g.*, *Tribulus*) bunch of stiff hair or barbs (*e.g.*, *Aristida*) by means of which they adhere to the body of animals or clothes of human beings and they are carried unwairly from one place to another.

12. (d) Fruits of *Bignonia* are dispersed by birds.

13. (b) Sticky seeds of *Rafflesia* are dispersed by elephants.

14. (d) Human beings and birds are active and useful agent in distributing these fruits.

15. (c) The seeds of *Moringa* (Drumstick), *Oroxylon*, *Cinchona* and *Pinus* are winged. The dispersal of seeds by wind is called anemochory.

16. (d) Seed and fruits possess air cavities to keep them a float on water *e.g.*, spongy seed coat of water lily (*Nymphaea*), aril in the seed of water lily help seeds to float in water by giving buoyancy and fleshy, aril or a kind of third integument is edible part of *Litchi*.

17. (b) In many fruits, testa is modified to form wings as in *Cinchona*, *Oroxylam*, *Moringa*, *Swietenia* and *Largerstroemia*.

18. (c) Censer mechanism occurs when seeds are dispersed from small pores in the fruits by swinging in air. *e.g.*, Papaveraceae (Poppy), *Aristolochia* and *Aconitum*.

Taxonomy of Angiospermic plants

1. (b) Floral formula of *Allium cepa* (onion).

2. (a) Fabaceae commonly called Legume family; 4th largest and 2nd most valuable family. It has a 600 genera.
Poaceae commonly called cereal / grass family; 3rd largest family but Indian flora, they constitute the largest family (620 genera).

3. (d) Family cucurbitaceae belongs series calyciflorae (sepals are fused or free, ovary is usually inferior) and order passiflorales.

4. (c) Touch me not (*Mimosa pudica*) belongs to sub family mimosoideae. It comes under Papilionatae (fabaceae).

5. (b) Liliaceae commonly called lily family; belong to monocotyledons. Perianth (calyx and corolla undifferentiated), biseriate (2- whorled) and petaloid.

8. (c) Compositae (Asteraceae) is the largest family of plant kingdom, represented by 950 genera and 20000 species, plants mostly herbs stem with latex / oil ducts and most evolved and advanced among dicot.

9. (d) All stamens of a flower fuse by their filaments to form a single staminal tube *e.g.*, family Malvaceae (*Hibiscus*).

11. (a) In family Compositae (Asteraceae) 2 stamens, epipetalous, syngenesious, dithecous, bilobed, introse, filament free.

12. (c) *Cajanus cajan* (Pigeon pea / Red gram / Arhar) belong to family Leguminosae (fabaceae).

14. (b) Poaceae (Gramineae) is the 3rd largest but economically most valuable family as it provides cereals and millets.

16. (a) *Carthamus tinctorius* (safflower) belongs to family Asteraceae. It yield Safflower / Kusum oil containing 73% PUFA (Poly unsaturated fatty acids) its good for heart patients.

17. (c) Cauliflower is an apical bud belonging to family Cruciferae (Brassicaceae).

18. (c) Commonly called mustard family : Plants predominantly herbs and sulphur smelling being rich in sulphur rich glucosides like sinigrin and hence are pungent.

20. (b) Family Asteraceae belongs to subclass – Gamopetalae (The petals are fused, stamens are epipetalous, carpel may be syncarpous or apocarpous) and series – Inferae (ovary is inferior and stamen usually equal to petal lobes).

21. (c) Axile placentation : In a multicarpellary syncarpous gynoecium the fusing margins grow inwards to meet in the center of the ovary to form an axis thus making the ovary multilocular. The ovules are borne on the central axis. *e.g.*, Family Solanaceae and Liliaceae.

22. (d) In Fabaceous (Papilionaceous) corolla has petals 5, polypetalous, the posterior petal is largest (standard) and two laterals are wing and inner two anterior are fused to form a boat shaped structure called keel or carina.

24. (b) *Eleusine coracana* (Finger millet/Ragi) is hardest millet and its grains are free from pericarp.

26. (b) Placentation parietal but bilocular due to false septum or replum in *Brassica campesteris*.

27. (a) Anterior petals are fused to form a boat-shaped structure called keel or carina.

29. (c) Sepals 4, polysepalous, arranged in two whorls, outer of antero-posterior sepals and inner of lateral sepals, lateral sepals generally saccate or pouched at the base, green or petaloid, inferior.

31. (d) Commonly called sunflower, largest family of plant kingdom, represented by 950 genera and 20000 species.

33. (c) *Allium sativum* (garlic), *Allium cepa*(onion) and *Aloe vera* belongs to family Liliaceae.

34. (a) *Allium cepa* belongs to monocot family – Liliaceae, when remaining three are dicot.

36. (b) Corm of *Colchicum autumnale* is source of an alkaloid colchicine used to induce polyploidy.

37. (c) *Parthenium hysterophorus* (carrot grass / congress grass), a most nasty weed, came into India from USA during congress rule in 1950's along with wheat.

38. (d) Epipetalous (Epiphyllous) : Stamens adnate with tepals. Syngenesious (synantherous) : Anthers fused, filaments free in a flower.

39. (b) Cereals are one seeded fruit called caryopsis. They are rich in carbohydrate, poor in lysine and tryptophan. Cereals comes under family Poaceae.

41. (d) *Cajanus cajan* is leguminous plant belongs to family Leguminosae. It has root nodules by which they can fix atmospheric nitrogen.

43. (a) All pulses belong to family Fabaceae. This family is known for protein rich pulses.

46. (c) Flower of family Solanaceae is bracteate or ebracteate, pedicellate, complete, hermaphrodite, actinomorphic, pentamerous, hypogynous.

47. (c) Bracteoles modify into palea.

56. (d) Petals 4, polypetalous, arranged in one whorl and alternate with sepals, often with long claws and spread out in the form of a Greek cross. This arrangement of petals is known as cruciform arrangement.

59. (c) 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.

61. (b) Pea- Diadelphous

62. (c) Under- developed, sterile stamens non-functional that do not produce pollens, *e.g.*, *Salvia*, *Cassia*.

63. (d)

Parietal	Ex. – Mustard
Free central	Ex. – Primula and Dianthus
Marginal	Ex. – Pea
Axile	Ex. – Tomato, lemon, Chinarose

64. (c) Leguminosae family possess marginal and Cruciferae possess parietal placentation.

65. (c) In Leguminosae ovary is superior.

78. (d) Tetradynamous condition of stamens is found in mustard (*Brassica campestris*) plant of family Cruciferae (Brassicaceae). In tetradynamous condition four stamens remain long and two short.

79. (b) In diadelphous condition, stamens are arranged in two bundles. Diadelphous stamens are the characteristic features of family Fabaceae.

83. (d) *Brassica nigra* (Black mustard) comes under Cruciferae (Brassicaceae) family.

84. (b) There are six free stamens, inner four are large and outer two are small, *e.g.*, Mustard, *Iberis* (Cruciferae family).

86. (b) In solanaceae bilocular, axile placentation, ovary obliquely placed due to rotation of posterior ovary towards right side and anterior carpel to left side by 45°. Placentae highly swollen, ovules are maximum per locule in this family.

87. (c) On the basis of characters of corolla (symmetry) of flower, type of petals and their fusion and aestivation) and androecium (No. of arrangement), this family is divided into 3 sub families.

88. (c) The bacteria (*Rhizobium* spp.) associated with the root nodules of legumes fix atmospheric nitrogen.

Critical Thinking Questions

1. (d) In plants like *Arceuthobium*, *Rafflesia*, Sapria, *Podostemon*, shoot develops for flowering otherwise roots form main part of the plant.

5. (a) Aggregate of small berries, *e.g.*, Custard apple. Apical parts of berries fuse with each other to form a common rind.

6. (c) Onion - Bulb - Underground stem-Imbricate aestivation-Axile placentation - Member of Liliaceae.

7. (a) Cladodes (Cladophylls) : They are green photosynthetic stems of limited growth (generally one internode only) with leaves reduced to scales or modified into spines, *e.g., Ruscus, Asparagus.*

10. (a) Some plants never open to ensure complete self-pollination. This condition is called cleistogamy *e.g., Commelina bengalensis, Oxalis, Viola,* etc. The cleistogamous flower are bisexual small, inconspicious, colourless and do not secrete nectar.

12. (d) Bulbils are fleshy buds produced in the axil of foliage leaves in place of axillary buds. In century plant (Agave sp.) the floral buds are modified into bulbils which grow into new plants when shed from the mother plant.

15. (a) Descending imbricate or Vexillary aestivation : The posterior large standard petals overlaps the lateral petals called wings or alae on the margins while the lateral wings overlap the anterior keel or carinal petals, *e.g.,* Pea, Gram.

16. (b) Apocarpous : Gynoecium consisting of two to many free carpels. Each carpel forms its own pistils, *e.g., Ranunculus.*

17. (b) Mother axis : The shoot on which the flower is borne is called mother axis. The side of the mother axis is always posterior while the side of the bract is anterior.

19. (c) Stylopodium : Swollen base of style in Umbelliferae (Apiaceae).

20. (b) In Malvaceae/cotton anther single-lobed, 2 chambered (bisporangiate), connective is absent. Filament is attached to the base of the anther.

21. (b) Hairy styles : The fruits of *Clematis* possess persistent hairy styles which help in floating in air.

22. (a) In several species, of Australian *Acacia* (*e.g., A. melanoxylon, A. auriculiformis*), the petiole and part of rachis expands to form phyllode. Phyllodes are vertical, have fewer stomata and therefore, lose less water in transpiration.

23. (d) Stigma feathery or papillate. Silken threads of Maize are very long stigmas but some authors regard them as long styles bearing equally long stigmas in the apical region.

24. (c) Diadelphous : The filaments are united forming two bundles, *e.g.,* in *Lathyrus* (sweet pea), *Pisum* (edible pea) there are 10 stamens; filaments of 9 stamens are fused forming one bundle and the other bundle is represented by the filament of the tenth free stamen ($A_1 + (9)$).

25. (a) Composite fruits : These fruits are developed from the complete inflorescence and are known as infructescence. These are of 2 types :
(1) Sorosis (2) Syconus or Syconium

26. (a) Tetradynamous : There are six free stamens, inner four are large and outer two are small, *e.g., Brassica* (mustard).

Assertion and Reason

1. (e) Root is typically a non green underground cylindrical structure forming the descending axis of the plant which gives rise to endogenous branches and does not possess nodes, leaves or buds. Presence of nodes and internode is the characteristic feature of stems.

2. (b) The root cap protects the root meristem from friction of the soil particles. In this process, its outer cells are continuously peeled off and replaced by new cells formed from root meristem. In floating aquatic plants the root apices possess finger glove-like coverings called root pockets instead of root cap.

3. (d) Root pockets are found in floating aquatic plants. They act as balancers. They are structurally similar to root caps but differ from them in the fact that the damaged root pockets are not regenerated.

4. (e) Root hair zone is 1–6 *cm* in length. The root hairs increase the exposed surface of the root for absorption of water and minerals.

5. (a) Syconous fruit develops from hypanthodium inflorescene in which 3 types of flowers are found i.e., male, female and sterile gall flowers. Male flowers and gall flowers cannot develop into fruits. So in syconous type of fruit, the achences formed are fewer than the total number of flowers in the inflorescence.

6. (a) *G. herbaceum* belongs to family-Malvaceae. Taxonomic hierarchy is the system by which various taxonomic categories are arranged in a proper descending order. The ascending taxonomic hierarchy shows that a taxon belongs to a number of taxa and its placement in progressively higher groups.

7. (e) Deep feeder tap root system has an elongated tap root which penetrates the deeper layers of the soil. It is mostly met in trees. Deep feeder tap root is also called racemose tap root system. In surface feeders the tap root does not elongate very much. The secondary roots spread to a greater extent. Such a system is also named as cymose tap root system.

8. (b) Coconut require the hot and wet climate hence it is grown in coastal areas. It is widely grown in coastal and deltic regions of tropical and subtropical countries.
Coconut fruit show hydrochory *i.e.,* the dispersal takes place through water medium. Being the habitat of coastal area the fruit is so adapted that it can float and dispersed over thousand of kilometers before losing viability.

9. (c) The fleshy roots are thickened like the palm of human hand. They similarly possess finger like outgrowth, *e.g., Orchis.* They are Palmate roots. Fasciculated fleshy roots are the swollen roots or root tubers occurring in clusters.

10. (a) Moniliform or beaded roots are swollen at regular intervals like beads of a necklace. Hence the roots has the appearance of necklace. Such roots are found in *Discorealata, Momordica charauter* etc.

11. (a) Assimilatory roots are green roots (as they contain chlorophyll) which are capable of photosynthesis. *e.g., Taeniophyllum,* is a leafless epiphytic orchid with thick flattened photosynthetic roots.

12. (b) Epiphytes live on the surface of other plants for shelter and space only, hence also called space parasites. Epiphytic roots possess a covering of dead spongy tissue known as velamen. With the help of velamen, they are able to absorb water from moist atmosphere, dew and rain.

13. (c) Albuminous seeds are those where endosperm is present, as in maize and castor bean. The endosperm persists in their seeds. In exalbuminous seeds, the endosperm is completely absorbed by the growing embryo and the food reserve gets stored in the cotyledons.

14. (e) In syngenesious condition when the stamens are united by their anthers only, the filaments remaining free. In synandrous, stamens are fused by both these filaments as well as anthers.

15. (d) Stem is usually the above-ground erect ascending part of the plant body that develops from the plumule, grows by means of a terminal bud and shows distinction of nodes and internodes. The nodes bear leaves having axillary buds.

16. (a) A bud is a condensed immature or embryonic shoot having a growing point surrounded by closely placed immature leaves. The largest bud is cabbage.

According to their nature, buds can be vegetative, reproductive and mixed.

17. (a) In cymose branching the growth of the main stem is definite, that is the terminal bud does not continue to grow, but lower down, the main stem produces one or more lateral branches which grow more vigorously than the terminal one. In some plants the terminal bud gets modified into a flower, tendril, thorn etc.

18. (b) Ginger is horizontal in position and generally branched and producing aerial leaves or shoots aboveground and adventitious roots on lower side in favourable season. Thus shoot growth is not effected by gravity.

19. (a) Many fruits are provided with hooks, barbs, spines, bristles, stiff hairs etc., on their surface by means of which they adhere to the body of woolly animals as well as to the clothing of mankind and are often carried by them to distant places. The animals are forced to carry such fruits and seeds, *e.g.*, forced zoochory.

20. (b) Human travellers have always taken plants from one area to another. Potato was brought from New World by the Portuguese. Many economically important crops and plants such as maize, tobacoo, groundnut, chillies, tea, cabbage, cauliflower, rubber etc. are dispersed by man, as they have been introduced to new areas from their original home. However, many weeds are also dispersed alongwith useful plants.

21. (e) The pericarp of drupe is differentiated into epicarp, mesocarp and endocarp. Endocarp is stony. Hence drupes are also called stone fruits. Coconut called fibrous drupe due to fibrous mesocarp, possesses edible endosperm. Among drupes, the mango has edible mesocarp, cherry, peach, plum and *Zizyphus* have edible epicarp and mesocarp.

22. (c) The pedicles or floral stacks of *Artabotrys* are modified into stiff curved thorns or hooks for helping in climbing. In *Antigonon* the flowers occur in bunches in the axils of scale leave on the floral shoot. The upper floral buds develop into tendrils instead of forming flowers.

23. (c) Prickles are superficial outgrowths of stem or leaves which do not possess a vascular cylinder. They can be easily pulled off. Bristles are stiff hair which become thickened due to deposition of silica or calcium carbonate.

24. (c) Caryopsis is a superior achenial fruit where testa and pericarp are inseparably fused, *e.g.*, wheat, maize etc. Achenial fruits are single seeded indehiscent dry and simple fruits. The pericarp is dry and undifferentiated. The pericarp of wheat is thus dry and it is fused with testa.

25. (e) Leaf is a green, dissimilar exogenous lateral outgrowth which is borne on the node of a stem or its branch and is specialised to perform photosynthesis. All the green leaves of a plant are collectively called foliage. Phyllotaxy is the arrangement of leaves on the stem or its branches.

26. (b) Achenial fruits are single seeded indehiscent dry and simple fruits. The pericarp is dry and undifferentiated. Capsular fruits are many seeded dry and simple fruits in which the pericarp splits open to expose the seeds.

27. (e) In spiral arrangement, each node bears a leaf and the leaves of the adjacent nodes roughly lie towards the opposite sides. In opposite arrangement, two leaves are borne on the opposite sides of a single node. When three or more leaves develop on the nodes, they form whorled arrangement.

28. (b) A leaf having a single or undivided lamina is called simple leaf. The lamina can have different types of incisions, which may reach upto half (-fid), more than half (-partite) or near the base or midrib (-sect). Depending upon the pinnate or palmate venation, the incisions are known as pinnatifid palmatifid, pinnatipartite, palmatipartite, pinnatisect and palmatisect.

29. (b) The palmate compound leaf is one in which the petiole bears leaflets at the tip like the fingers of the palm. *Citrus* is actually a palmate compound leaf where the two lateral leaflets have been suppressed and only the central leaflet is functional. Such a palmate compound leaf, with one functional leaflet is called unifoliate compound leaf.

30. (c) The petiole, rachis and the stalks of the leaflets in *Clematis* are sensitive to contact and can coil around the support to help the plant in climbing. In whole leaf tendril, the whole leaf is modified into a tendril for climbing. The leaf apices of *Gloriosa superba* are greatly elongated to function like the tendrils.

31. (e) Prickles are defensive organs of plants but prickles being usually curved are commonly used for climbing. They are superficial outgrowths of stem or leaves which do not possess a vascular cylinder.

32. (c) Samara is an achenial fruit having winged pericarp, *e.g.* *Ulmus* (Elm). Achenial fruits are single seeded indehiscent dry and simple fruits. Achenial winged fruits are called samaroid if the wings develop from places other than pericarp, *e.g.*, sepals in *Shorea*.

33. (b) Phyllodes do not bear leaves, branches, flowers, etc. In *Parkinsonia aculeata*, the rachis ends in a spine. Rachis branches are elongated, flattened and green to function as phyllodes. They bear small leaflets which fall off very easily.

34. (b) Persistent sepals are called accrescent it they grow along with the fruit (*i.e., Physalis*). They (persistent sepals) are marcescent when they assume a dried up form before being shed, *i.e.*, Guava.

35. (c) A flower is regarded as complete if it has all the four floral whorls, *i.e.*, calyx, corolla, androecium and gynoecium. If any of these whorl in missing the flower is described as incomplete. An incomplete flower can either be perfect, having male as well as female sex organs or imperfect with either of the sexes missing. When both the essential organs are absent, the flower is spoken as neuter.

36. (c) Hypanthodium has a flask – shaped fleshy receptacle which possesses a narrow canal and a terminal pore at one end. Internally the receptacle bears male flowers towards the pole and female flowers towards the pole and female flowers towards the base. Sterile, neuter or gall flowers occur in between the two groups.

37. (a) Heterophylly is met within many aquatic plants, particularly in those growing in shallow running water. Here the floating or aerial leaves and the submerged leaves are of different kinds; the former are generally broad, more or less fully expanded and undivided or merely lobed; while the latter are narrow, ribbon-shaped, linear or much dissected. Examples are *Sagittaria, Ranunculus aquatilis, Limnophila heterophylla.*

38. (e) In caducous, leaves fall down soon after their appearance, *e.g., Opuntia.* In deciduous almost all leaves fall off almost simultaneously at the end of growing season. The phenomenon is called leaf fall, *e.g.*, Mulberry, Poplar. In *Euphorbia royleana* the leaves are drought deciduous.

39. (b) When the leaf is more or less cylindrical and directed upwards or downwards, as in onion such leaf is called centric leaf. A centric leaf is equally illuminated on all sides and, therefore, it is evenly green. Centric leaves of onion is aerial. It is underground scale leaves of bulb which store food.

40. (c) China–rose has free lateral stipules and rose bears adnate stipules. Free lateral stipules are free stipules, usually small and green in colour, borne on the two sides of the leaf-base. Adnate stipules are two lateral stipules that grow along the petiole upto a certain height, adhering to it and making it somewhat winged in appearance.

41. (a) Cymose inflorescence is the name of determinate or definite inflorescence in which the tip of the main axis terminates in a flower and further growth continues by one more lateral branches which also behave like the main axis.

Verticillaster is a special form of cymose inflorescence. The first axis ends in a flower, it bears two lateral branches, each ending in a flower, succeeding lateral branches are produced in an alternating manner.

42. (a) Leaves of a number of plants develop or possess adventitious buds for vegetative propagation, *e.g., Bryophyllum. Begonia* leaf develops buds only when the leaf is injured or detached.

43. (a) Walking ferns (*e.g., Adiantum caudatum*) reproduce vegetatively by their leaf-tips. Leaves bow down to the ground, their tip strikes roots and forms a bud which grows into a new plant.

44. (c) In corymb, the main axis is shortened and lower flowers have much longer stalks or pedicels than the upper ones so that all the flowers are brought more or less to the same level. Corymb inflorescence is found in *Cassia* sp.

45. (a) The spadix contains a large green or coloured bract called spathe. For example, in banana and aroids, the brightly coloured spathe attracts insects to facilitate pollination.

46. (b) In racemose head, the main axis or receptacle is suppressed, becoming almost flat. It bears a mass of small sessile flowers (florets) on its surface, with one or more whorls of bracts at the base forming an involucre.

The florets are arranged in a centripetal fashion, *i.e.*, younger towards the centre and older towards the periphery. The advantages of this kind of inflorescence are that the head as a whole becomes more showy and attractive and the florets being close together, one or a few insects can pollinate most of them within a short time.

47. (e) In cymose inflorescence, the main axis ends in a flower and similarly the lateral axis also ends in a flower. Thus the growth of each axis is checked. In cymose inflorescence, the terminal flower is always older and opens earlier than the lateral ones, *i.e.*, the order of opening of flowers is centrifugal.

48. (b) Compound umbel is branched umbel, where several small or daughter umbels arise from a common point in an umbellate fashion. A whorl of bracts, called involucre is present at the base of the daughter umbels are called involucels.

49. (b) Cyathium is a special kind of inflorescence found in *Euphorbia, i.e., Poinsettia* and *Euphorbia*.

In cyathium there is a cup – shaped involucre, often provided with nectar – secreting glands. The involucre encloses a single female flower in the centre, seated on a comparatively long stalk and a number of male flowers around this, seated on short slender stalks.

Morphology of Flowering Plants

SET Self Evaluation Test

1. A plant which lives for a few days is called **[Odisha JEE 2004]**
(a) Annual (b) Perennial
(c) Biennial (d) Ephemeral

2. Perianth in the spikelet of jawar is represented by **[MHCET 2004]**
(a) Lodicules (b) Sepals and petals
(c) Glumes (d) Lemma and palea

3. Heterostyly is show by **[MHCET 2004]**
(a) *Primula* (b) *Mirabilis*
(c) *Helianthus* (d) China rose

4. Which is odd one **[MHCET 2004]**
(a) China rose (b) Maize
(c) Mango (d) Sunflower

5. Bicarpellary syncarpous gynoecium, parietal placentation, tetradynamous stamens and siliqua fruit are characteristic features of family **[CBSE PMT 1992; APMEE 1993; RPMT 1994, 95; CPMT 1998]**
(a) Cucurbitaceae (b) Cruciferae
(c) Compositae (d) Solanaceae

6. What name has been assigned to the genus produced by a cross between cabbage and radish **[BHU 2004]**
(a) *Secale* (b) *Bursa pastoris*
(c) *Lysogenicophyll* (d) *Raphano brassica*

7. The condition where filaments and anthers are fused throughout the entire length is **[Odisha JEE 2004]**
(a) Synandrous (b) Gynadrous
(c) Protandrous (d) Syngenesius

8. In a seed of maize, scutellum is considered as cotyledon because it **[AIEEE Pharmacy 2004]**
(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

9. Ephemerals are drought **[Odisha JEE 2009]**
(a) Loving (b) Enduring
(c) Escaping (d) Resistant

10. In a monoecious plant **[DUMET 2009]**
(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.

11. Viral infection is usually absent in **[MP PMT 2009]**
(a) Phloem cells (b) Xylem cells
(c) Pith cells (d) Apical meristem

12. Transparent hairs on catkins and caterpillars function to **[Odisha JEE 2008]**
(a) Trap heat (b) Trap moisture
(c) Reflect light (d) Drink water

13. In coconut fruit, the hard shell is **[MP PMT 2010]**
(a) Endocarp
(b) Fused structure of mesocarp and endocarp
(c) Fused structure of epicarp and mesocarp
(d) Epicarp

14. Ginger multiplies vegetatively by **[DPMT 2004]**
(a) Tuber (b) Corn
(c) Sucker (d) Rhizome

15. The floral formula for Malvaceae is **[RPMT 1997]**
(a) $\oplus \; \underset{+}{\sigma} \; Epi_{(3-7)}\, K_{(5)}\, \overset{\frown}{C_{(5)}}\, \overset{\frown}{A_{(\infty)}}\, \underline{G_{(5)}}$
(b) $\oplus \; \underset{+}{\sigma} \; Epi_{(3-7)}\, K_{(5)}\, \overset{\frown}{C_5}\, \overset{\frown}{A_5}\, \underline{G_{(5)}}$
(c) $\oplus \; \underset{+}{\sigma} \; Epi_{(3-7)}\, K_{(5)}\, \overset{\frown}{C_5}\, \overset{\frown}{A_{(\infty)}}\, \underline{G_{(5)}}$
(d) $\oplus \; \underset{+}{\sigma} \; Epi_{(3-7)}\, K_{(5)}\, \overset{\frown}{C_{(5)}}\, \overset{\frown}{A_{(\infty)}}\, \underline{G_{(3-\infty)}}$

16. A monocot showing reticulate venation is **[APMEE 1995]**
(a) *Bombusa* (b) *Smilax*
(c) *Callophyllum* (d) *Ginkgo*

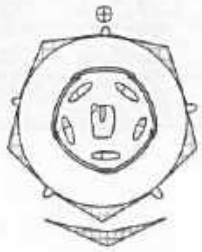
17. Chief feature of family Brassicaceae/Cruciferae is presence of **[APMEE 1994; BHU 2002]**
(a) Latex (b) Pectin
(c) Alkaloids (d) Myrosin enzyme

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

19. Select the wrong statement **[NCERT; Kerala PMT 2007]**
(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*

20. Largest inflorescence is found in
(a) *Acalypha* (b) *Populus*
(c) *Amorphophallus* (d) Cabbage

21. Choose the correct description depicted by floral diagram **[NCERT; KCET 2002]**



(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

22. Which of the following is not a flower **[KCET 1997; BVP 2002]**

(a) Rose (b) Lotus
(c) Sunflower (d) Passion flower

23. Adaptive heterophylly is found in **[MP PMT 2013]**

(a) *Limnophila heterophylla* (b) *Alysicarpus heterophyllus*
(c) Eucalyptus (d) Jack fruit tree

24. Inferior ovary occurs in **[CPMT 1995]**

(a) Cruciferae (b) Compositae
(c) Malvaceae (d) Ranunculaceae

25. Which of the following are floral characters of Malvaceae **[Kerala PMT 2007]**

(a) Pedicellate, bracteate, hermaphrodite, tetramerous, actinomorphic, complete and superior ovary
(b) Compound spike, flowers bracteate, bracteolate, incomplete, bi or unisexual and hypogynous
(c) Pedicellate, hermaphrodite, zygomorphic, complete and superior ovary
(d) Head inflorescence, bracteate, hermaphrodite or unisexual, actinomorphic, or zygomorphic and inferior ovary
(e) Jointed pedicel, bracteate, bracteolate, hermaphrodite, pentamerous, actinomorphic, complete and superior ovary

26. Coleoptile represents **[NCERT; MP PMT 2013]**

(a) Covering of radical (b) Covering of cotyledon
(c) Covering of plumule (d) Synonym of plumule

Answers and Solutions

1	d	2	a	3	a	4	b	5	b
6	d	7	a	8	c	9	c	10	c
11	d	12	b	13	c	14	d	15	c
16	b	17	d	18	b	19	b	20	c
21	d	22	c	23	a	24	b	25	e
26	c								

1. (d) A plant which lives for a few days is called ephemeral because of a very short growing season. Such plant are found near deserts or in very cold countries. *e.g.*, *Arabidopsis* species have life span of 20-28 days.

2. (a) Lodicules are two scale like structures that lie at the base of the ovary of a grass flower including jawar.

3. (a) In heterostyly condition, stamens, style and stigma are of different heights, *e.g.*, *Primula*, *Oxalis*, *Linum* etc.

4. (b) Maize is a monocotyledonous plant where as China rose, Mango and Sunflower are dicotyledonous plants.

5. (b) In Cruciferae.
Bicarpellary : Gynoecium consisting of two carpels fused laterally forming a compound pistil.
Parietal placentation : Ovary is bi to multicarpellary but unilocular.
Tetradynamous : There are six free stamens, inner four larger and outer two are small.
Siliqua fruit : Siliqua is a dry dehiscent fruit develop from bicarpellary, syncarpous and superior ovary.

6. (d) *Raphanobrassica*, *Triticale* and Bromato are some intergeneric hybrids. *Raphanobrassica* (Cabbage) is the result of distant cross between *Raphanus* (Radish) and *Brassica* (Cabbage).

15. (c) Actinomorphic, bisexual, epicalyx 3 to 7, calyx 5 gamosepalous, corolla 5 polypetalous usually adnate at the base to the staminal tube, Androecium indefinite stamens, gynoecium pentacarpellary to indefinite. syncarpous, ovary superior.

17. (d) In members of Cruciferae (Brassicaceae), secretory cells are found which contains myrosin enzyme. This also accompanies the sulphur containing glucosides which hydrolyses them into glucose and isothiocynates (oil).

18. (b) The apex form a tendril called tendrillar, *e.g.*, *Gloriosa*.

20. (c) *Amorphophallus* (simple spadix inflorescence) is largest inflorescence which 5.5 *m* long.

22. (c) Sunflower (*Helianthus annus*) is a inflorescence (capitulum). It is a plant of family compositae (Asteraceae).

23. (a) Basal type of placentation, ovary is bicarpellary, syncarpous and unilocular and a single ovule is borne at the base of ovary, *e.g.*, compositae (Marigold, sunflower). In family compositae carpels 2, connate, ovary inferior and basal placentation.

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