9. Morphology of Flowering Plants

Can you recall?

You have learnt the diversity and structure of Angiospermic plant in 6th standared.

9.1 Angiosperms :

Our earth has a vast diversity of plants. The flowering plants dominate the world of plants as they are well adapted to the environmental conditions. These plants show considerable variation in their general external and internal characters with respect to their habitat. Such variations help the plant body to carry out different functions. You have studied a broad classification of kingdom Plantae. Angiosperms are one of flowering plants from phanerogams.

Angiosperms can be classified into different types on the basis of habitat and it can be represented as follows :

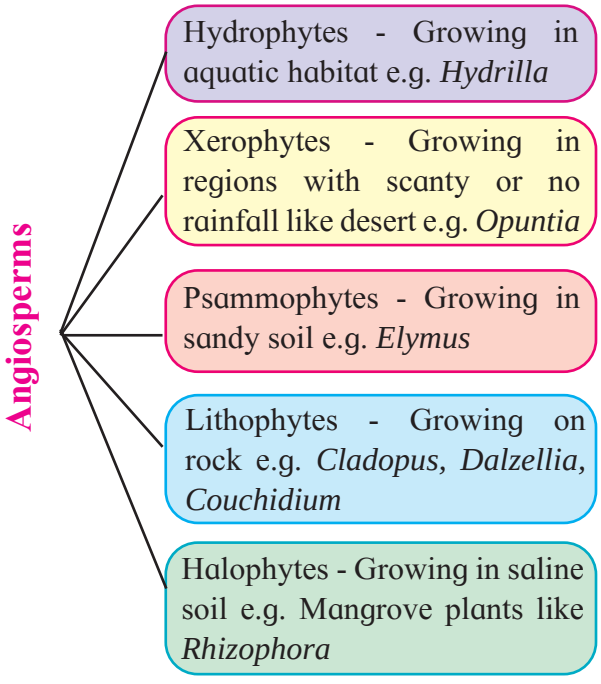


Chart 9.1 Angiosperm classification- based on habitat

In angiosperms seed germinates under favourable environmental conditions and produces a seedling which develops into a new plant.

9.2 Morphology :

Morphologically plant shows vegetative structures like root, stem, leaf and reproductive structures such as flowers, fruits and seeds.

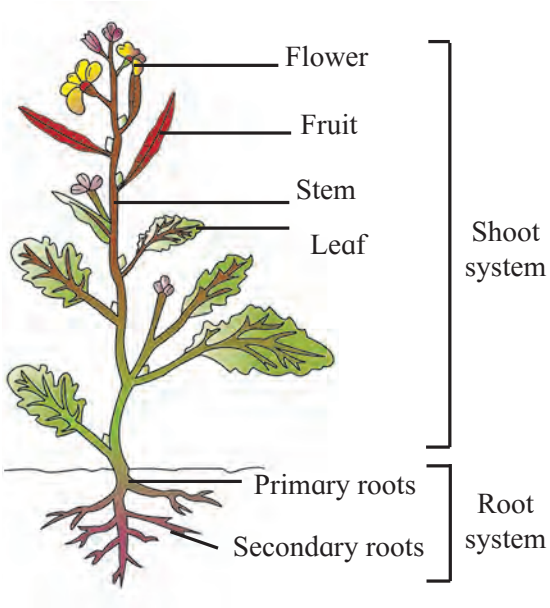


Fig. 9.2 Typical Angiospermic plant

A. Root : Root is descending axis of plant body which is positively geotropic and hydrotropic but negatively phototropic and aerotropic. Root grows beneath the soil surface towards gravity. Roots are generally non-green, cylindrical and without nodes and internodes.

Typical Root Structure : A typical root has different regions :-

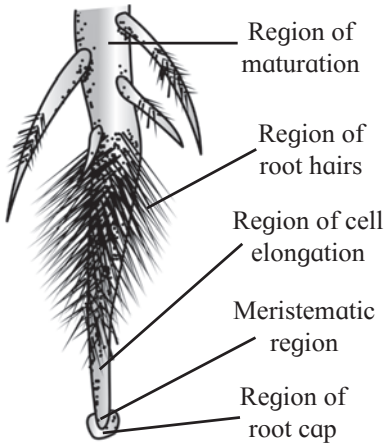


Fig. 9.3 Regions of root

A parenchymatous multicellular structure in the form of cap, present over young growing root apex is known as **root cap**. Cell of root cap secrete mucilage for lubricating passage of root through the soil. Cells of root cap show presence of starch granules which help in graviperception and geotropic movement of root. Usually single root cap is present in plants. But in plants like *Pandanus* or screw pine multiple root caps are present. In hydrophytes root caps are replaced by root pockets e.g. *Pistia*, *Eichhornia* etc. Due to presence of root cap the growing apex of root is subterminal in position. The apex of the root is a growing point about 1 mm in length protected by root cap. This region is called as **region of cell division** or **meristematic region**. The structure is developed by compactly arranged thin walled actively dividing meristematic cells. These cells bring about longitudinal growth of root. It is followed by **Region of elongation.** This region of cells is present just above zone of cell division. The cells are newly formed and show rapid elongation to bring about increase in length of the root. The cells help in absorption of mineral salts. A **Region of root hairs / absorption/piliferous zone** is made up of numerous hair like outgrowths. The epiblema or piliferous layer produces tubular, elongated, unicellular structures known as **root hair**. They are in close contact with soil particles and increase surface area for absorption of water. Root hair are short lived or ephimeral and are replaced after every 10 to 15 days. **Region of cell maturation or differentiation** is major portion of root is developed by this region. The cells of this region are quite impermeable to water due to thick walled nature. The cells show differentiation and form different types of tissues. This region helps in fixation of plant and conduction of absorbed substances. Development of lateral roots also takes place from this region.

Function of Root : Roots carry out several functions which can be categorized into primary and secondary functions. Primary functions of root are, fixation or anchorage of plant body in the soil, absorption of water and minerals from soil and conduction of absorbed materials up to the stem base etc.

Types of Root :

On the basis of origin, roots can be classified as **Tap roots or true roots** and **Adventitious roots.**

a. Tap root : The root which develops from the radicle of an embryo during seed germination is known as tap root or true root. The main root is called as primary root; its branches of first order are called as secondary roots whereas branches of second order are called as tertiary roots e.g. Pea, Bean, Sunflower etc.

The main root with all its branches constitutes tap root system. Tap root system is commonly seen in dicotyledonous plants.

b. Adventitious roots : A root that develops from any part other than radicle is known as **adventitious root**. Such root may develop from the base of the stem, nodes or from leaves. In monocots, radicle is short lived and from the base of stem a thick cluster of equal sized roots arise. This is adventitious root system. eg. Maize, Wheat, Sugarcane etc. It is also known as fibrous root system as they look like thin fibre. The growth of roots is superficial. Adventitious root in some plants are used for vegetative propagation. eg. *Euphorbia*, *Carapichea ipecacuanha* (Ipecac) etc.

a. Tap root system **b. Adventitious root system**

Fig. 9.4 Types of root

Modification of root : When roots have to perform some special type of function in addition to or instead of their normal function they develop some structural changes. Such roots are called as metamorphosed roots.

Modifications of tap root

a. Food storage : When tap root stores food it becomes swollen fleshy and also develops definite shape. Main or primary root is the main storage organ but sometimes hypocotyl part of embryo axis also joins the main root. Secondary roots remain thin. Stem in such cases remain reduced, discoid and leaves are radicle leaves. On the basis of shape swollen tap roots are classified as **Fusiform, Conical** and **Napiform.**

The **fusiform root** is swollen in the middle and tapering towards both ends forming spindle shaped structure. e.g. Radish (*Raphanus sativus*) The **conical root** is broad at its morphological base and narrows down towards its apex is called as conical root. e.g. Carrot (*Daucus carota*) In **napiform root**, base of root is highly swollen, almost spherical in shape and abruptly narrows down towards its apex. e.g. Beet (*Beta vulgaris*)

Conical root Fusiform root Napiform root

Fig. 9.5 Swollen tap roots

b. For Respiration : Pneumatophores or **Respiratory Roots** : Halophytes are the plants which grow in saline swamps, marshy places and salt lakes. These plants produce special kind of roots called as pneumatophores or breathing roots. The main root system of these plants do not get sufficient air for respiration as soil is water logged. Due to this, mineral absorption of plant also gets affected.

To overcome this problem underground roots develop special roots which are negatively geotropic; growing vertically upwards. These roots are conical projections present around main trunk of plant.

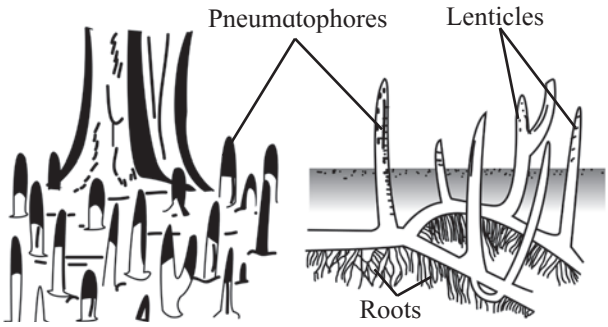
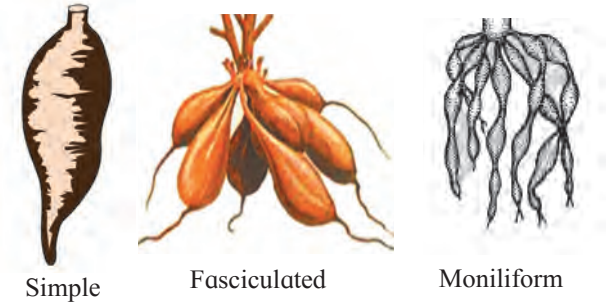


Fig. 9.6 Respiratory roots

The roots show presence of lenticels i.e. minute pores for gaseous exchange (Pneuamatic - Hollow, phore - stalk) e.g. *Rhizophora*, *Avicennia*, *Sonneratia*, *Heritiera* (ver. sundri) etc.

Modifications of Adventitious Roots :

a. Food storage : Fibrous roots also show food storage like tap root but the main difference is that fibrous root usually do not develop definite shape. These roots are further classified as **Simple tuberous, Fasciculated tuberous, Beaded** and **Nodulose roots.**



Simple Fasciculated Moniliform

Fig. 9.7 Tuberous root

Simple tuberous roots become swollen and do not show definite shape. They are produced singly. The roots arise from nodes over the stem and penetrate into the soil. E.g. sweet potato or shakarkand (*Ipomoea batatas*). A cluster of roots arising from one point which becomes thick and fleshy due to storage of food is known as **fasciculated tuberous root**. These clusters are seen at the base of the stem. E.g. *Dahlia*, *Asparagus*, etc. The beaded roots are also called as **moniliform roots**. These roots show swellings at regular intervals like beads of a necklace. e.g. *Spinacia oleracea* (Indian Spinach).

The cluster of long slender roots become enlarged at the tips forming nodules is known as **nodulose roots**. E.g. Arrow (*Maranta root*) Amhaldi (*Curcuma amada*).

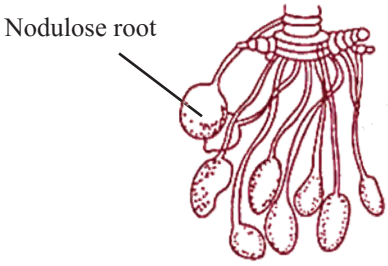


Fig. 9.8 Nodulose root

Do you know ?

A banyan tree growing in the Indian Botanical Garden, howrah (Kolkata) has nearly 1700 such prop roots. The crown of tree has a large circumference. The tree is about 200 years old.

b. For mechanical support :

1. Prop roots/ Columnar roots : These roots arise from horizontal branches of tree like Banyan tree (*Ficus benghalensis*) and grow vertically downwards till they penetrate the soil. These prop roots show secondary growth, become thick, act like pillars to provide mechanical support to the heavy branches.

Fig. 9.9 Banyan tree

2. Stilt roots : These roots normally arise from a few lower nodes of a weak stem in some monocots shrubs and small trees. They show obliquely downward growth penetrating soil and provide mechanical support to the plant. In the members of family Poaceae, the plants like Maize, Jowar, Sugarcane etc. produce stilt root in whorl around the node.

Fig. 9.10 Maize plant roots

These roots provide additional support to the plant body. In Screwpine or *Pandanus* (Kewada), stilt roots arise only from the lower surface of obliquely growing stem for additional support. These roots show multiple root caps.

3. Climbing roots : Different climbers with weak stem produce roots at their nodes by means of which they attach themselves to support and thereby raise themselves above the ground e.g. Betel leaf or Pan, black pepper or *Piper nigrum* (Kali Mirch), Pothos or money plant.

Fig. 9.11 Climbing roots (Betel leaf)

4. Clinging Roots : These tiny roots develop along internodes, show disc at tips, which exude sticky substance. This substance enables plant to get attached with walls of buildings. They do not damage substratum. e.g. English Ivy (*Hedera helix*).

Fig. 9.12 Clinging roots

5. Plank Roots/Buttresses : Often develop at the base of large trees form plank like extensions around stem. e.g. Silk cotton, Pipal etc.

Fig. 9.13 Plank roots

6. Buoyont roots : Roots developed at the nodes of aquatic herbs like (*Jussiaea repens*), become highly inflated and spongy providing buoyancy and helping the plant to float.

Fig. 9.14 Spongy roots

c. For special functions :

1. Epiphytic roots : Small epiphytic plants such as orchids growing on the branches of huge trees in dense rain forests are unable to obtain soil moisture. They produce specialized root to hang in the air. The roots are provided with a spongy membranous absorbent covering of the velamen tissue. The cells of velamen absorb moisture from air. Velamen tissue is hygroscopic and show porous walls The roots may be silvery white or green but without root cap e.g. *Vanda*, *Dendrobium* etc.

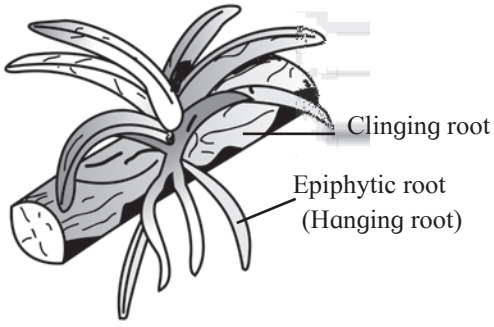


Fig. 9.15 Epiphytic roots

2. Sucking roots or Haustoria : Specialised microscopic sucking roots developed by parasitic plants to absorb nourishment from the host. *Viscum album* is a partial parasite. It develops haustoria which penetrate into xylem of host plant for absorption of water (nutrients). In *Cuscuta reflexa* or Dodder (Amarvel) haustoria penetrates vascular strand and suck food from phloem, water and minerals from xylem. *Cuscuta* is leafless plant with yellow stem. It is a total parasite.

Fig. 9.16 Sucking roots

B. Stem : The aerial part of the plant body is know as shoot system. Stem is the main axis of this shoot system. Stem is the ascending part of the plant body which develops from plumule and bears reproductive units i.e. buds. It is differentiated into nodes and internodes. It is usually positively phototropic, negatively geotropic and negatively hydrotropic. It shows different types of buds (axillary, apical, accessory, etc.). At nodes, it produces dissimilar lateral organs such as leaves and flowers and similar organs such as branches. Young stem is green and capable of photosynthesis.

The primary functions of the stem are to produce and support branches, leaves, flowers and fruits; conduction of water and minerals and transportation of food to plant parts.

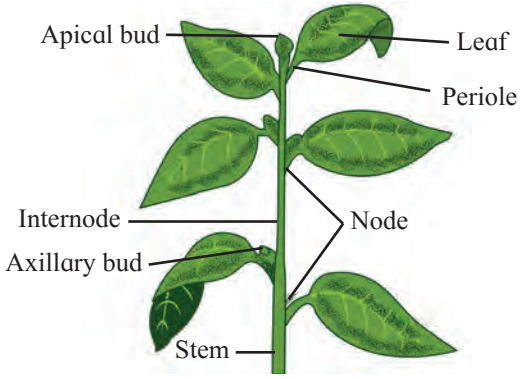


Fig. 9.17 Stem structure

Modifications of stem : Stem develops some modifications for additional or accessory functions. To perform such function stem shows different modifications :

a. Underground stem : In some herbaceous plants stem develops below the soil surface called as underground stem. Underground stem remains dormant during unfavourable condition and on the advent of favourable condition produces aerial shoots. Underground stem is known to store food, helps in perennation and vegetative propagation.

Use your brain power

Why underground stem is different from roots?

1. Rhizome : It is prostrate, dorsiventrally thickened and brownish in colour. It grows either horizontally or obliquely beneath the soil. Rhizome shows nodes and internodes, scals leaves and bears terminal and axillary buds at nodes. Terminal bud under favourable conditions produces aerial shoot which degenerates at the end of favourable condition Growth of rhizome takes place with lateral buds such growth is known as sympodial growth. e.g. Ginger (*Zingiber officinale*), Turmeric (*Curcuma domestica*), Canna etc. In plants where rhizomes grows obliquely, terminals bud brings about growth of rhizomes. This is known as monopodial growth. e.g. *Nymphea*, *Nelumbo* (Lotus), *Pteris* (Fern) etc.

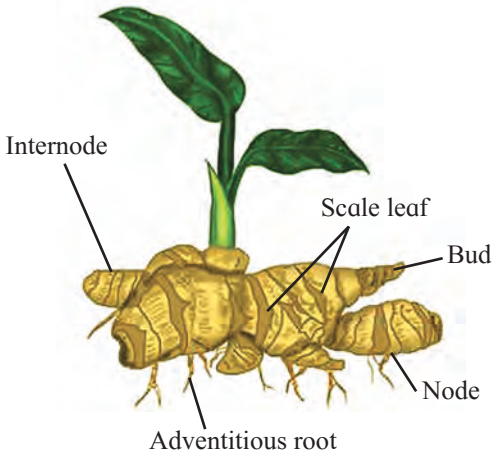


Fig. 9.18 Rhizome of Ginger

2. Stem Tuber : Special underground branches of stem at their tips become irregularly swollen due to storage of food material which is mostly starch. Presence of distinct nodes but not internodes classifies tuber as stem. At nodal part scale leaves are present with axillary buds commonly known as 'eyes'. 'Eyes' can produce aerial shoots under favourable conditions. Tubers are porpogated vegetatively e.g. Potato (*Solanum tuberosum*), Matalu (*Helianthus tuberosus*). Tuber has two distinct ends viz. apical end and basal end called as rose and heel end respectively. The number of nodes and eyes is more towards rose end.

Fig. 9.19 Tuber of potato

3. Bulb : Bulb is an underground spherical or pyriform stem. Stem is highly reduced and discoid. It bears a whorl of fleshy leaves. The scale leaves or fleshy leaves show concentric arrangement over the stem. These store food material. Some outer scale leaves become thin and dry. The reduced stem produces adventitious roots at its base. The bulb is of different types **Tunicated or layered bulb** is made up of fleshy leaves arranged in concentric manner with outer dry scale leaf. e.g. Onion. In garlic the bulb is **scaly** or **compound tunicated**. The fleshy scales (cloves) are arranged in overlapping pattern.

a. Scaly bulb e.g. Garlic

b. Tunicate bulb e.g. Onion

Fig. 9.20 Bulbs

4. Corm : Corm is swollen underground spherical or subspherical internode of vertically growing stem. It is condensed structure with circular or ring like nodes. Presence of axillary buds and scales is observed. Adventitious buds are produced which help in vegetative propagation. Adventitious roots are produced at lower part of stem e.g. *Colocasia* (Arbi), *Amorphophallus* (Zamikand or Elephant foot) etc.

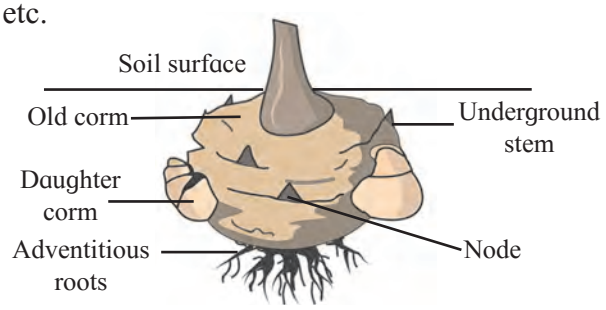


Fig. 9.21 Corm

b. Sub aerial stem : The stems are generally weak or straggling stems growing over the ground and need support for perpetuation. Sometimes these stems are found to grow beneath the soil surface also. Thus they show contact with both air and soil. Sub aerial stems are meant for perennation and vegetative propagation. Scale leaves and axillary buds are present over stem surface. The latter produces aerial shoots.

The different types of sub aerial shoots are as follows:

1. Trailer : The shoot spreads over the ground without intervals. The branches are either flat i.e. procumbent or partly vertical i.e. decumbent e.g. *Euphorbia*, *Tridax* etc.

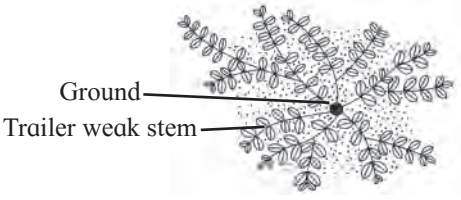


Fig. 9.22 *Euphorbia*

2. Runner : They are special narrow, prostrate or horizontal green branches which develop at the base of erect shoots known as crown. Runners spread in all directions to produce new crowns with bunch of adventitious roots.

Presence of nodes with scale leaves and axillary buds is observed. Eg. *Cynodon* (Lawn grass) *Centella* (Hydrocotyl), *Oxalis* etc.

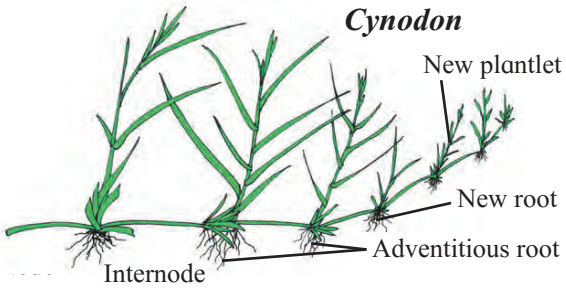


Fig. 9.23 Runner

3. Stolons : The slender lateral branch arising from the base of main axis is known as stolon. In some plants it is above ground (wild strawberry). Primarily stolon shows upward growth in the form of ordinary branch, but when it bends and touches the ground terminal bud grows into new shoot and adventitious roots e.g. *Mentha.*

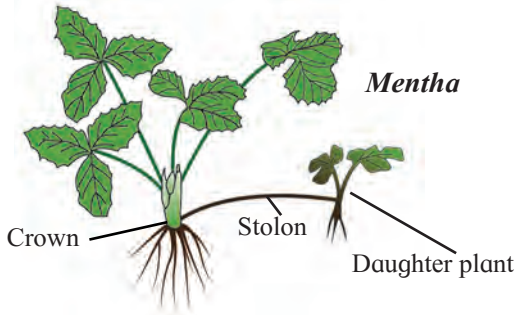


Fig. 9.24 Stolon

4. Sucker : It is non green runner like branch of stem which develops from underground base of roots. It grows horizontally below soil and finally comes above the soil surface to produce a new plant. Sucker can be termed as underground runner eg. *Chrysanthemum*, Banana etc.

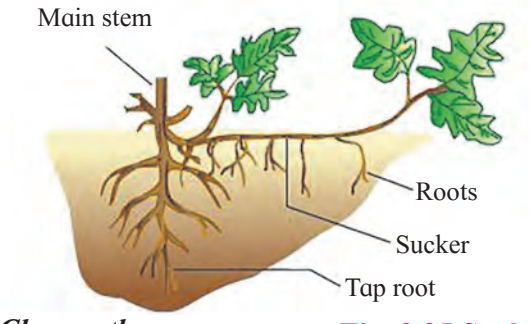
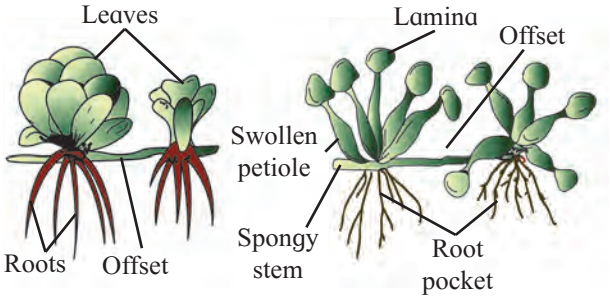


Fig. 9.25 Sucker

5. Offset : These are one internode long runners in rosette plants at ground or water level. Offset helps in vegetative propagation e.g. Water hyacinth or Jal kumbhi (*Eichhornia*) and *Pistia*.



a. *Pistia* **b. *Eichhornia***

Fig. 9.26 Offset

c. Aerial modification : Stem or it's vegetative part modify to carry out specialized functions. They develop various modifications for this purpose. Such modified stems are called as metamorphosed stems. The different modifications can be discussed as under :

1. Thorn : It is modification of apical or axillary bud. Thorn is hard pointed and mostly straight structure (except *Bougainvillea* where it is curved and useful for climbing). It helps in reducing transpiration and being hard and pointed, provides protection device against browsing or marauding animals. Apical bud develops into thorn in *Carrisa* whereas axillary bud develops into thorn in *Duranta*, *Citrus*, *Bougainvillea*, etc.

Fig. 9.27 Thorn

2. Phylloclade : Modification of stem into leaf like photosynthetic organ is known as phylloclade. Being stem, it possesses nodes and internodes. It is thick, fleshy and succulent, contains mucilage for retaining water e.g. *Opuntia*, cylindrical in *Casuarina* and ribbon like in *Muehlenbeckia*.

Fig. 9.28 Phylloclade

3. Cladodes : The branches of limited growth i.e. one internode long and performing photosynthetic function are called as cladodes. True leaves are reduced to spine or scales. E.g. *Asparagus*.

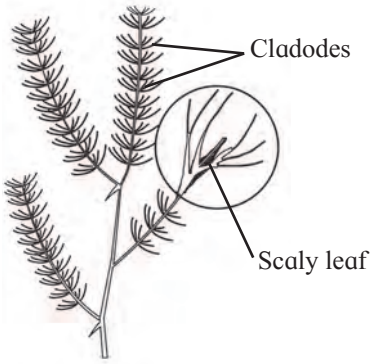


Fig. 9.29 Cladodes

Use your brain power

Why the stem has to performs photosynthesis in xerophytes?

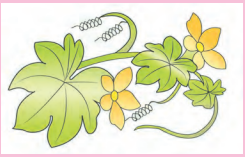
4. Cladophylls : These are leaf like structures bore in the axil of scale leaf. It has floral bud and scale leaf in the middle i.e. upper half is leaf and lower half is stem. e.g. *Ruscus*.

Fig. 9.30 Cladophylls

Stem tendrils : Tendrils are thin, wiry, photosynthetic, leafless coiled structures. They give additional support to developing plant. Tendrils have adhesive glands for fixation.

Apical bud in *Vitis quadrangularis* gets modified in to tendril. The further growth is carried out by axillary bud. This branching pattern is termed dichotomous.

Axillary tendril in *Passiflora* axillary bud gets modified in tendril



Extra axillary bud is the one which grows outside the axil. This bud in *Cucurbita* gets modified in to tendril.

Normally floral buds are destined to produced flowers. But in plants like *Antigonon* they produce tendrils.

5. Bulbils : In plants like *Dioscorea*, axillary bud becomes fleshy and rounded due to storage of food called as bulbil. When it falls off it produces new plant and help in vegetative propagation.

Fig. 9.31 Bulbils

C. Leaf :

Leaves are the most important appendages as they carry out photosynthesis and also help to remove excess amount of water from plant body. Leaf develops from leaf primordium. Leaf is dorsiventrally flattened lateral appendage of stem. It is produced at nodal region. Leaf is thin, expanded and green due to presence of photosynthetic pigments. It shows exogenous origin. Axil of leaf shows presence of axillary bud. Leaf shows limited growth, does not show apical bud or a growing point.

1. Typical leaf structure : It shows presence of three main parts **Leaf base or Hypopodium, Petiole or Mesopodium and Leaf lamina/ blade or epipodium.**

Leaf base : The point by which leaf remains attached to stem is known as leaf base.

The nature of leaf base is varies in different plants. It may be pulvinus (swollen), sheathing or ligulate etc.

In some plants leaves possess a pair of lateral outgrowths called as **stipules**. The leaf with stipule is said to be **stipulate** and without stipule is **exstipulate**. Stipules are normally green protective structure.

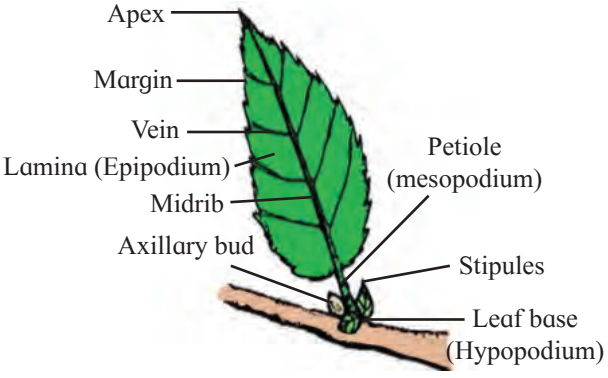


Fig. 9.32 Structure of typical leaf

Petiole or mesopodium : The part of leaf which connect leaf lamina with the leaf base is known as petiole of leaf. A leaf with petiole is **petiolate** and a leaf without petiole is termed as **sessile** leaf.

Petiole helps lamina to get exposed to light and also helps in conduction.

Lamina or epipodium : Large expanded, flat and green part of leaf. The lamina surface plays important role in photosynthesis, gaseous exchange and transpiration. Anatomically, the leaf is either dorsiventral or isobilateral. Dorsiventral leaf is common in Dicots and isobilateral in Monocots.

Centric or cylindrical leaves are those in which both the surfaces of leaf cannot be distinguished distinctly. Leaf lamina varies greately in shape, margin and apex.

2. Leaf venation : Arrangement of veins and veinlets in leaf lamina, is known as venation. Veins are responsible for conduction of water and minerals as well as food. The structural framework of the lamina is developed by veins.

Internet my friend

Collect imformation of types of leaf venation.

R

P

3. Types of leaf : Based on incision of lamina leaves are of two main types. i.e. simple and compound. The leaf with entire lamina is called **simple leaf** and leaf in which lamina is divided into number of **leaf lets** called as compound leaf.

Compound leaves are of two types..

a. Pinnately compound : Leaflets are present laterally on a common axis called rachis, which represents the midrib of the leaf.

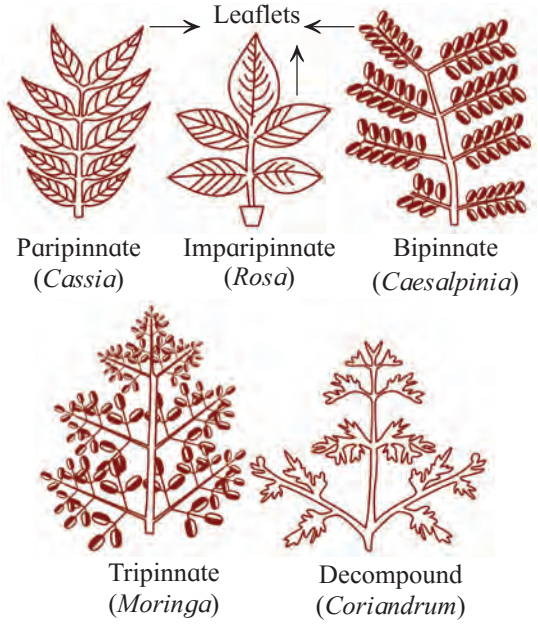


Fig. 9.33 (a) Types of Compound leaf

b. Palmately compound : In which all the leaflets are attached at tip of petiole.

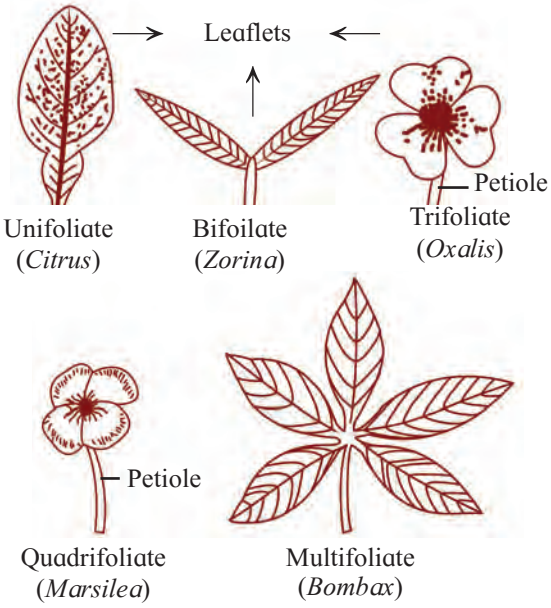


Fig. 9.33 (b) Types of Compound leaf

4. Modification of leaves : Apart from photosynthesis, leaf also performs transpiration gaseous exchange and perception of light for flowering. However leaves may undergo modifications to perform several other functions. As per the modification their are different types of leaves shown below.

a. Leaf spines: Sometimes entire leaf is modified into spines (*Opuntia*) or margin of leaf becomes spiny (*Agave*) or stipule modifies into spine (*Acacia*) to check the rate of transpiration or to protect plant from grazing. E.g. *Zizyphus* etc.

Fig. 9.34 Leaf Spines

b. Leaf tendril: In some weak stems for providing addtitional support; leaf, leaflet or other part modifies to produce thin, green, wiry, coiled structure called as leaf tendril. It helps in climbing.

Whole leaf tendril
E.g. *Lathyrus*

Leaflet tendril
E.g. *Pisum sativum*

Leaf tip tendril
E.g. *Gloriosa*

Stipular tendril
E.g. *Smilax*

Fig. 9.35 Leaf tendrils

c. Leaf hooks: In plants like *Bignonia unguis-cati* (Cat's nail) the terminal leaflets get modified into three stiff, curved and pointed hooks used to cling over bark of tree.

Fig. 9.36 Leaf hooks

d. Phyllode: When petiole of leaf becomes flat, green and leaf like it is called as phyllode. In *Acacia auriculoformis* the normal leaf is bipinnately compound and falls off soon. The petiole modifies itself into phyllode. It is xerophytic adaptation.

Fig. 9.37 Phyllode

5. Phyllotaxy : Arrangement of leaves on the stem and branches in a specific manner is known as phyllotaxy. It enable leaf to get sufficient light.

Alternate
Single leaf from each node E.g. Mango

Whorled
Many leaves from each node E.g. *Nerium*

Opposite decussate
A pair of leaf from each node and the consecutive pair at right angle E.g. *Calotropis*

Opposite superposed
A pair of leaf from each node and the consecutive pair is arranged just above. E.g. Jamun

Fig. 9.38 Types of phyllotaxy

D. Inflorescence :

A specialised axis or branch over which flowers are produced or borne in definite manner is known inflorescence. Inflorescence has two parts **Peduncle and flowers**. There are basic types of inflorescence.

All the flowers do not mature at same time. Chances of pollination increase and large number of flowers can be pollinated in single visit and also makes the plant attractive.

Types of inflorescence :

a. Racemose : Growth of peduncle is infinite or unlimited. Apical bud is free for continuous growth. Older flowers at the base. Flowers are borne in acropetal succession. Order of opening is centripetal, when peduncle is disc shaped.

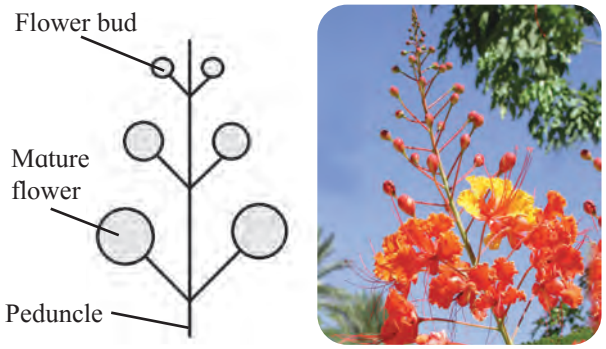


Fig. 9.39 Racemose

b. Cymose : Growth of peduncle is finite or limited. Apical meristem terminates into flower. Oldest flower is the apex. Flowers are borne in basipetal succession. Order of opening is centrifugal, if peduncle is compressed from the top.

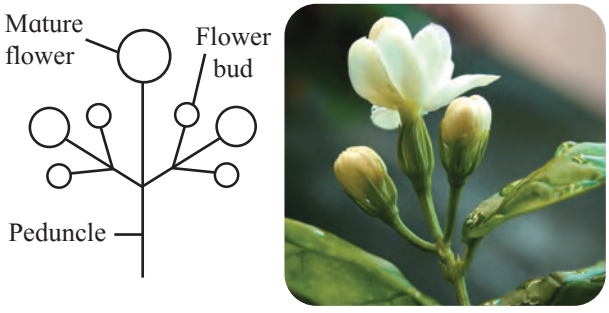


Fig. 9.40 Cymose

E. Flower : Flower is highly modified and condensed shoot meant for sexual reproduction.

On the basis of position, a flower can be axillary or terminal. In a typical flower, the thalamus (Consists of four compactly arranged nodes and three highly condensed internodes. From each node of thalamus, a circle or whorl of modified leaves is produced.

A flower may or may not show presence of bract at base of pedicel or over the pedicel, such a flower is said to be **bracteate** or **ebracteate** respectively. A flower with pedicel is said to be **pedicellate** flower and without pedicel is called as **sessile** flower.

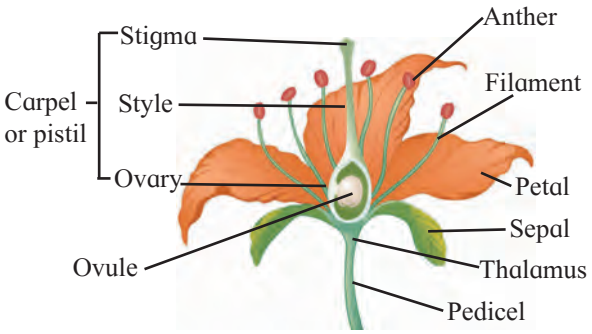


Fig. 9.41 Typical Flower (Digrammatic)

Flower with bilateral symmetry is called zygomorphic flower e.g. Sweet pea where there is only one plane along which if flower is cut, shows mirror images. Flower with radial symmetry where it can be cut along diameter in any plane and shows mirror images. It is called actinomorphic flower e.g. *Hibiscus*.

Always Remember

Terminologies related to flower :

1. Complete : Presence of all four floral whorls.
2. Incomplete : Absence of any one of the floral whorl.
3. Perfect : Both androecium and gynoecium are present in a flower; also called monoclinous or bisexual flower.
4. Imperfect : Any one reproductive whorl is present in a flower; also called as diclinous flower or unisexual flower.
5. Unisexual : It can be either staminate (male)/ pistillate (female) flower; also called dicliny.
6. Neuter : When both reproductive whorls are absent, it is said to be neuter flower e.g. Ray florets of *Tagetus* (marigold).
7. Monoecious plant : Male and female reproductive flowers are borne on same plant. E.g. Maize.
8. Dioecious plant : Only one type of unisexual flowers are present on a plant e.g. Date palm, papaya.

a. Insertion of floral whorls : The position and arrangement of rest of the floral whorls with respect to gynoecium on the thalamus is known as insertion of floral whorls. In a typical flower thalamus consist of four compactly arranged

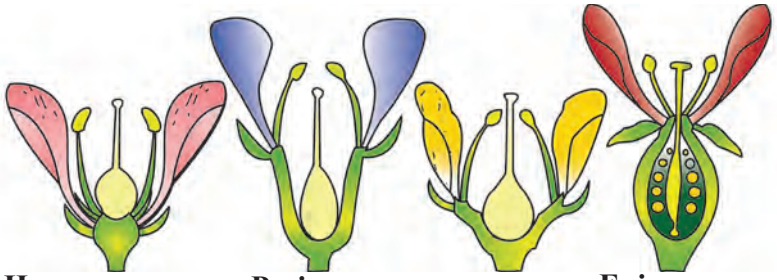


Fig. 9.42 Insertion of floral whorls

Do you know ?

Mango is polygamous plant and produces all types of flowers, staminate, bisexual and neuter.

nodes and three internods. Shape of thalamus decides insertion of floral whorls.

a. Hypogyny : When the convex or conical thalamus is present in flower, ovary occupies the highest position while other floral parts are below ovary. Ovary is said to be superior and flower is called as **hypogynous** flower. E.g. Brinjal, Mustard, China rose etc. It is denoted as $\underline{G}$ in floral formula.

b. Perigyny : When cup shaped or saucer shaped thalamus is present in a flower, ovary and other floral parts occupy about same position. Such an ovary is said to be semi-superior or semi-inferior. All floral whorls are at the rim of thalamus. Flower is perigynous e.g. Rose, Pea, Bean, etc. It is denoted as $\overline{G}$ in floral formula.

c. Epigyny : When closed cup like thalamus completely encloses ovary and may show fusion with wall of ovary the other floral parts occupy superior position and ovary becomes inferior. Such flower is said to be epigynous flower, e.g. Sunflower, Guava etc. It is denoted as $\overline{G}$ in floral formula.

b. Floral parts and their structure : All floral parts are developed from thalamus from different nodes. From each node of thalamus circle or whorl of modified leaves is produced. Thalamus is called as **torus** or **receptacle**. Thalamus is green in colour hence it can perform the process of photosynthesis.

1. Calyx (K) : It is outermost floral whorl and individual members are known as sepals. Sepals are usually green in colour and perform photosynthesis. If all the **sepals** are **united**, the condition is gamosepalous and if they are **free**, the condition is called as **polysepalous**. Gamosepalous calyx is found in china rose and polysepalous calyx is found in *Brassica.*

The main function of sepals is to protect inner floral parts in bud condition. Sometimes sepals become brightly coloured (petaloid sepals) and attract insects for pollination e.g. *Mussaenda.* Calyx i.e. Sepals modify into stiff, hairy structures called **pappus**. Such persistent calyx helps in wind dispersal of fruits. E.g. *Tridax, Sonchus*.

2. Corolla (C): It is second floral whorl from outer side and variously coloured. The individual member is called as **petal**. Petals may be sweet to taste, posses scent, odour, aroma or fragrance etc. The condition in which petals are free is said to be **polypetalous** (e.g. Rose) and if they are fused, it is called as **gamopetalous** (e.g. *Datura*). The main function of corolla is to attract different agencies for pollination.

Perianth (P) : Many times calyx and corolla remain undifferentiated. Such member is known as tepal. The whorl of tepals is known as **Perianth**.

Do you know ?

Type of Calyx	Nature of Sepals	Example
Caducous	Sepals fall off as soon as the flower bud opens.	e.g. *Argemone* (Poppy)
Deciduous	Sepals survive till (withering of petals) fruit formation	e.g. *Lotus*, Mustard
Persistent	Sepals remain even after fruit formation	e.g. Brinjal, Pea, etc.

	**Valvate :** Margins of sepals or petals remain either in contact or lie close to each other but do not overlap. e.g. Calyx of *Datura*, *Calotropis*.
	**Twisted :** Margins of each sepal or petal is directed inwards and is overlapped. While the other margin is directed outwards and overlap the margin of adjacent. e.g. Corolla of China rose, Cotton etc.
	**Imbricate :** One of the sepals or petals is internal and is overlapped at both the margins. One is external i.e. completely outside Rest of the members. Overlap and get overlapped. e.g. Calyx of Cassia, *Bauhinia*, etc.
	**Vexillary :** Corolla is butterfly shaped and consists of five petals. Outermost and largest is known as standard or vexillum, two lateral partly overlapping petals are wings and two smaller inner, and fused forming boat shaped structures keel. e.g Corolla of *Pisum sativum*

Table 9.43 Arrangement of sepals, petals or tepals

If all the tepals are free the condition is called as **polyphyllous** and if they are fused the condition is called as **gamophyllous**. Sepaloid perianth shows green tepals while petaloid perianth brightly coloured tepals. E.g. *Lily*, *Amaranthus*, *Celosia*, etc. It protects other floral whorls. Petaloid tepal helps in pollination and sepaloid tepals can perform photosynthesis.

Aestivation : The mode of arrangement of sepals, petals or tepals in a flower bud with respect to the members of same whorl is known as aestivation. (Refer table 9.42)

Epicalyx : It is an additional whorl of sepal like structures formed by bractioles which occurs on the outside of calyx. These are 5-8 in number. It is a characteristic feature of family Malvaceae. They are protective in function. e.g. Ladies finger

3. Androecium (A): It is third floral whorl from outer side. Androecium is male reproductive part of a flower. The individual member is known as **stamen**. If all the stamens are free the condition is **polyandrous**

(Cohesion = Fusion between members of a same whorl.

Adhesion = Fusion between members of different whorls)

Typical stamen shows three different parts :

1. Anther : It is terminal in position. Anther produces pollen grains in its locules. It is usually bilobed. Each lobe contains two locules, hence anther is tetralocular/ tetrasporangiate structure. e.g. *Datura.* In some plants there is single anther lobe having two locules. Some other times, anther lobe has only one locule. Then it is called monothecous, formed due to fusion of two locules. e.g. *Hibiscus*.

2. Filament : It is a stalk of stamen and bears anther at its tip. It raises anther to a proper height for easy dispersal of pollen grains.

3. Connective : It is in continuation of the filament. It is similar to mid rib and connects two anther lobes together and also the anther with the filament.

Cohesion of stamens : When stamens are united by filaments and anthers are free, the condition is **adelphy**.

Adhesion of stamens : When the stamens are united with petals or tepals they are described as epipetalous (e.g. *Datura*) or epiphyllous (e.g. Lily).

Syngeneious and Synandrous : When anthers are united and filaments are free, it is known as **syngeny**. e.g. Sunflower. Stamens are fused

by both filaments and anthers in **synandrous** conditions e.g. *Cucurbita.*

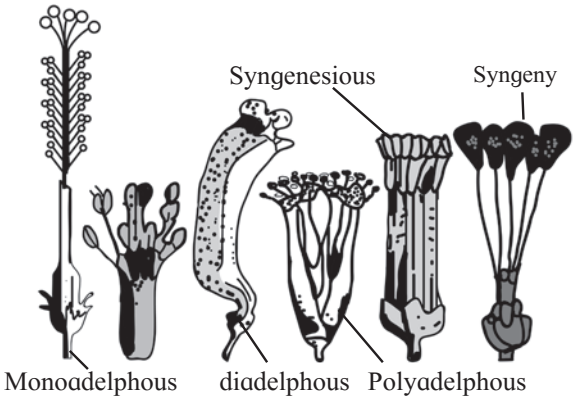


Fig. 9.44 Cohesion of Stamens

4. Gynoecium (G): It is the female reproductive part of flower and innermost in position. It is also known as **pistil**. The individual member of gynoecium is known as **carpel**. The number of carpels may be one to many. If all the carpels are fused the condition is described as **syncarpous** and if they are free the condition is described as **apocarpous**. The polycarpellary gynoecium can be bicarpellary (two carpels e.g. *Datura*) tricarpellary (three carpels e.g. *Cucurbita*), pentacarpellery (five carpels e.g. *Hibiscus*) and so on.

A typical carpel consists of three parts viz, stigma, style and ovary. Stigma is a terminal part of carpel which receives pollen grains during pollination. It helps in germination of pollen grain. Stigma shows variation in structure to suit the pollinating agent. Style is narrow thread like structure that connects ovary with stigma. Ovary is basal, swollen, fertile part of the carpel. Ovules are produced in an ovary on a soft fertile tissue called placenta.

Placentation : The mode of arrangement of ovules on the placenta within the ovary, is placentation.

Types of Placentation :

Marginal : Ovules are placed on the fused margins of unilocular ovary. e.g. Pea, Bean etc.

Axile : Ovules are placed on the central axis of a multilocular ovary. e.g. Chinarose, Cotton; etc.

Parietal : Ovules are placed on the inner wall of unilocular ovary of multicarpellary syncarpus gynoecium. e.g. Papaya, Cucumber,

Basal : Single ovule is present at the base of unilocular ovary. e.g. Sunflower, Rice, Wheat.

Free central : Ovules are borne on central axis which is not attached to ovary wall. e.g. *Argemone*, *Dianthus, Celosia.*

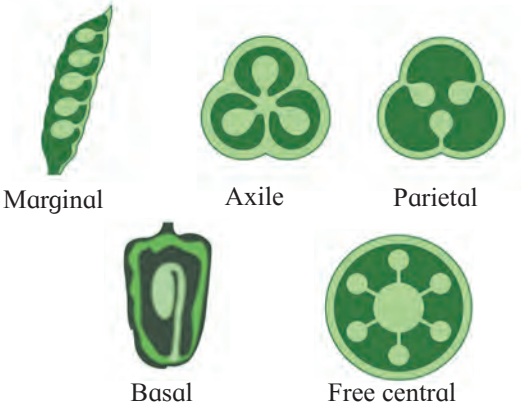


Fig. 9.45 Types of placentation

F. Fruit : Angiosperms produce fruit, after fertilization, from ovary. Sometimes fruit is produced from ovary without fertilization. Such types of fruits are called as **parthenocarpic fruits** and the phenomenon is called parthenocarpy. E.g. Cultivated varieties of Banana and seedless Grapes. The fruit that develops only from ovary, is true fruit. e.g. Mango. The fruit which develops from other floral parts than ovary, is called false fruit or pseudocarp. e.g. Apple.

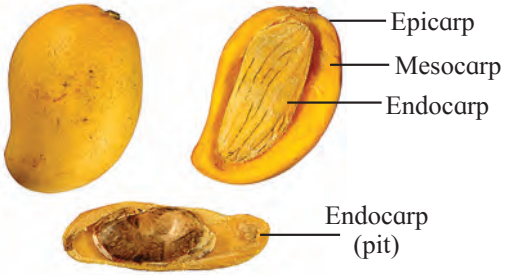


Fig. 9.46 Mango

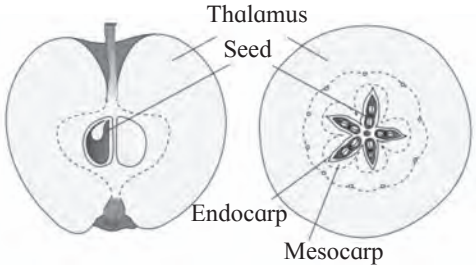


Fig. 9.47 Apple

Observe and Discuss

Types of fruits

A typical true fruit has a protective wall (pericarp) and seed/s. In fleshy fruits, pericarp is further divided in outer epicarp, middle mesocarp and inner endocarp. e.g. Mango

Fruits can develop from one ovary of one flower. Such fruits are **simple fruits**. Simple fruits are further classified on the basis of their pericarp. Those having thin pericarp are dry fruits but those with thick pericarp are fleshy fruits. In dry fruits, the pericarp becomes dry and thin. It breaks open (dehiscent) at maturity. But in some others, it does not break open (indehiscent).e.g. Achene (*Mirabilis*), Caryopsis (Maize) and Cypsela (Sunflower) are indehiscent fruits. Capsule (Lady's finger) and legume (Pea) are dry dehiscent fruits. In fleshy fruits berry (Tomato) has a very soft pericarp but drupe (Coconut) has stony endocarp.

Many ovaries of apocarpous gynoecium can form one fruit. Such fruits are **aggregate fruits**. Aggregate fruits are a collection (Etario) of many varieties. Accordingly they can be etario of achenes (Strawberry), etario berries (Custard apple), etario of follicles (*Calotropis*), etc.

Many ovaries of many flowers but of one inflorescence can form one fruit. Such fruits are **composite fruits**. These fruits develop from one inflorescence. The one which develops from hypanthodium inflorescence is syconus (fig). Sorosis (Pineapple) develops from Catkin inflorescence.

G. Seed : Seed is a reproductive unit that is developed from a fertilized, mature ovule. The seed is composed of seed coat and embryo, with or without endosperm. Embryo contains radicle, plumule and one or two cotyledons. Outer most covering of a seed is called seed coat, shows outer layers called **testa** and inner **tegmen**. Hilum is a scar on the seed coat through which seed attaches to the fruit. Embryo of a seed enclosed within seed coat. Embryonal axis consists of **radicle** and **plumule**. The part of embryonal axis between cotyledon and plumule is **epicotyl**, while the part between cotyledons and radicle is **hypocotyl**. Endosperm formed in the seed is a nutritive tissue. The food stored in the endosperm is partially or completely used during embryo formation. When partially used up, the resultant seed is **endospermic** e.g. castor. When completely used up, the resultant seed is **non-endospermic** e.g. pea.

9.3 Study of some important families :

Families are group of plants having very distinguished common characters.

Fabaceae : The plants are either trees, shrubs or herbs. Pea plant belongs to this family. The root shows root nodules. Pea is an erect climber. The leaves are pinnately compound, arranged in alternate phyllotaxy. The inflorescence is racemose-raceme type. Flowers are bisexual and zygomorphic. Calyx has five fused sepals (gamosepalous) arranged in imbricate aestivation. Corolla has five free petals (polypetalous) arranged vexillary aestivation. The petals are unequal in size. The largest petal is vexillum, two free small petal are wings and two fused smallest petals are keel. Androecium has ten stamens arranged in

diadelphous [(g)+1] condition. Gynoecium is monocarpellary. Unilocular ovary is superior with many ovules on marginal placenta. Ovary develops in legume type of fruit. Seeds are non-endospermic.

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

Floral diagram :

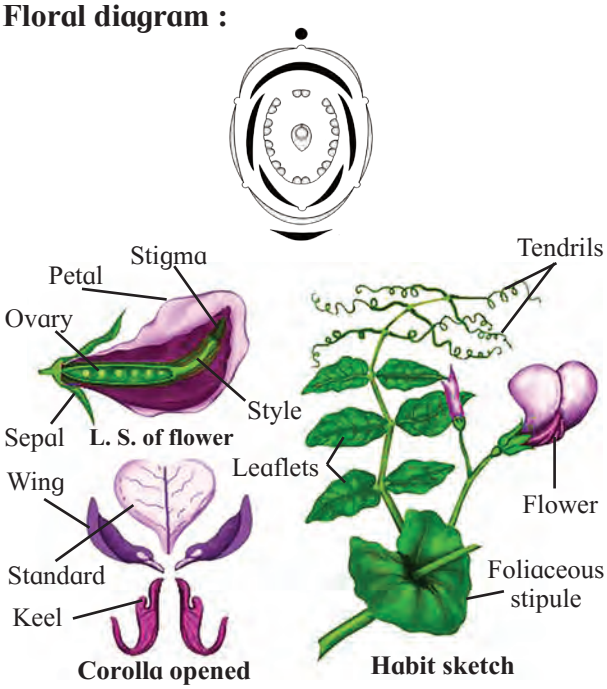


Fig. 9.48 Pea plant details

Solanaceae : Plants are herbs, shrubs or small trees. *Datura* plant belongs to this family. The root shows tap root system. The stem is erect, woody and branched. It is covered by hairy structures in some plants. In potato, it is underground tuber. The leaves are simple, arranged in alternate phyllotaxy with reticulate venation. The inflorescence is Cymose- solitary type. Flowers are solitary, bisexual and actinomorphic. Calyx has five, fused sepals (gamosepalous) arranged in valvate aestivation and persistant. Corolla has five fused petals (gamopetalous) arranged in contorted aestivation. Androecium has five, free but epipetalous (adhesion) stamens. Gynoecium is bicarpellary and syncarpous.

Bilocular ovary is superior with many ovules arranged in axile placentation on swollen placenta. Ovary develops in berry or capsule type of fruit. Seeds are endospermic.

Floral formula : ⊕ ♂ ♀ $K_{(5)}\ C_{(5)}\ A_5\ \underline{G}_{(2)}$

Floral diagram :

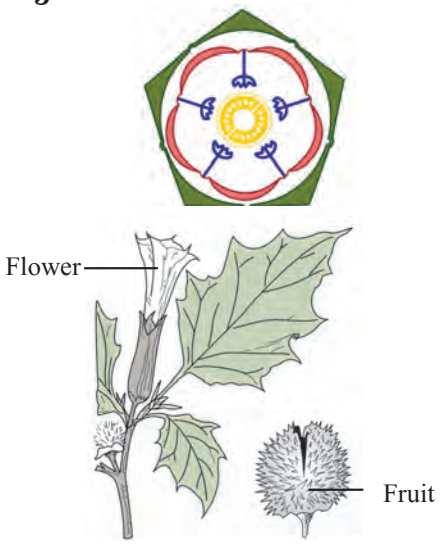


Fig. 9.49 *Datura* plant

Activity : Study family Liliaceae, prepare a table of following characteristics.

Character/Part	Description
Symmetry of flower	
Bisexual/Unisexual	
Calyx	
Corolla	
Androecium	
Gynoecium	
Aestivation	
a. Calyx	
b. Corolla	
Placentation	
Position of ovary	
Type of fruit	

Exercise

1. Choose correct option

A. Which one of the following will grow better in moist and shady region?
   a. Opuntia
   b. Orchid
   c. Mangrove
   d. Lotus

B. A particular plant had a pair of leaves at each node arranged in one plane. What is the arrangement called?
   a. Alternate phyllotaxy
   b. Decussate phyllotaxy
   c. Superposed phyllotaxy
   d. Whorled phyllotaxy

C. In a particular flower the insertion of floral whorls was in such a manner, so the ovary was below the level other three whorls, but its stigma was taller than other three whorls. What will you call such flower?
   a. Hypogynous
   b. Perigynous
   c. epigynous
   d. Half superior - half inferior

D. Beet and Arum both store food for perennation. Do these examples represent two different types?
   a. Beet is a stem but Arum is a root
   b. Beet is a root but Arum is a stem
   c. Beet is a stem but Arum is a leaf
   d. Beet is a stem but Arum is an inflorescence

2. Answer the following questions

A. Two of the vegetables we consume are nothing but leaf bases. Which are they?

B. *Opuntia* has spines but *Carissa* has thorns. What is the difference?

C. Teacher described *Hibiscus* as *solitary* Cyme. What it means?

3. Write notes on

A. Fusiform root.
B. Racemose inflorescence
C. Fasciculated tuberous roots
D. Region of cell maturation
E. Rhizome
F. Stolon
G. Leaf venation
H. Cymose inflorescence
I. Perianth
J. Vexillary aestivation
K. Axile placentation

4. Identify the following figures and write down the types of leaves arrangement

5. Students were on the excursion to a botanical garden. They noted following observation. Will you be able to help them in understanding those conditions?

A. A wiry outgrowth was seen on a plant arising from in between the leaf and stem.

B. There was a green plant with flat stem, but no leaves. The entire plant was covered by soft spines.

C. Many obliquely produced roots were given out from the lower nodes, apparently for extra support.

D. Many plants in the marshy region had upwardly growing roots. They could be better seen during low tide.

E. A plant had leaves with long leaf apex, which was curling around a support.

F. A plant was found growing on other plant. Teacher said it is not a parasite. It exhibited two types of roots.

G. While having lunch, onion slices were served to them. Teacher asked which part of the plant are you eating?

H. Students observed large leaves of coconut and small leaves of *Mimosa*. Teacher asked it what way they are similar?

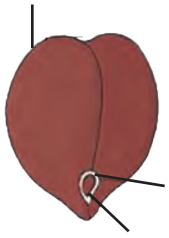
I. Teacher showed them *Marigold* flower and said it is not one flower. What the teacher meant?

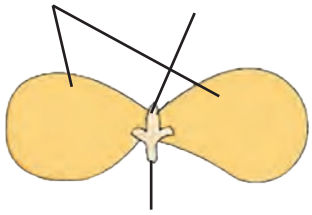
J. Students cut open a Papaya fruit and found all the seeds attached to the sides. Teacher inquired about the possible placentation of Papaya ovary.

6. Match the following

	'Group A'	'Group B'
1		**A** Marginal
2		**B** Basal
3		**C** Axile
4		**D** Free central
5		**E** Parietal

7. Observe the following figures and label the different parts





8. Differentiate with diagramatic representation.

A. Racemose and cymose infloresance

B. Reticulate and parallel venation

C. Tap root and Adventitious roots

Practical / Project :

1. **Collect different leaves from nearby region and observe variation in margin, leaf base, apex etc.**
2. **Find out and make a note of economically important plant from family Fabaceae, Solanaceae and Liliaceae.**
3. **Collect different leaves from garden and observe their veins and classify it.**