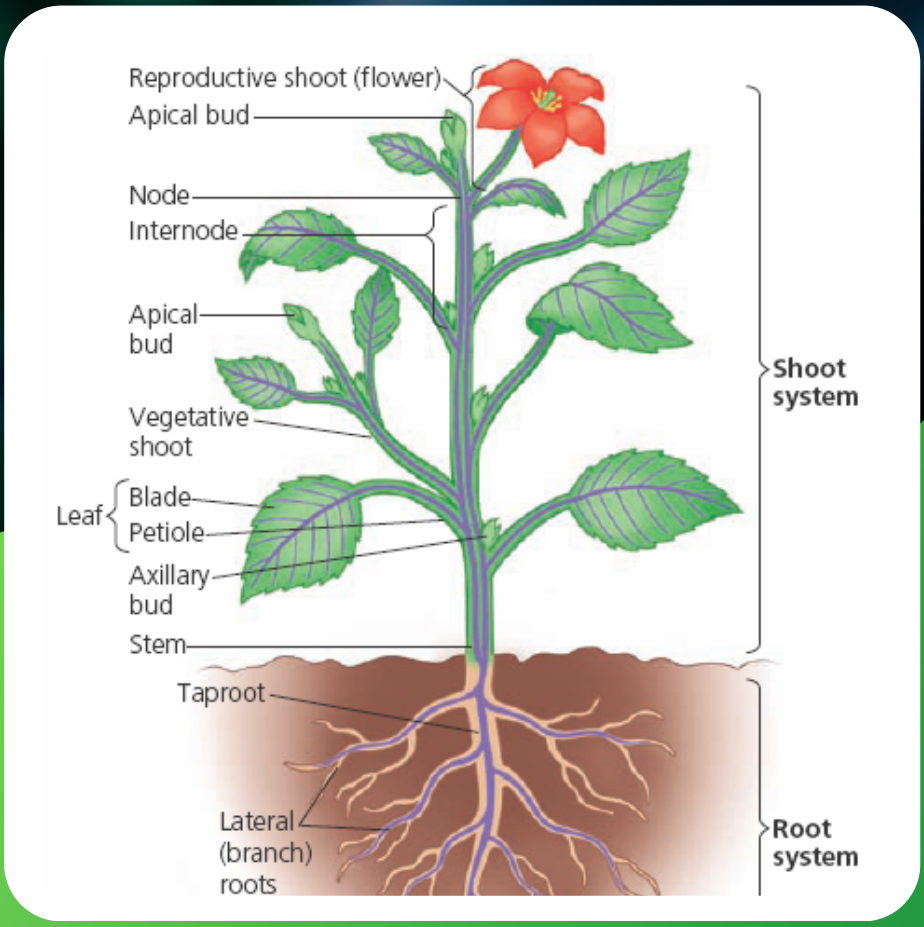
PRE-MEDICAL

BOTANY

ENTHUSIAST | LEADER | ACHIEVER



STUDY MATERIAL

Morphology of Flowering plants

ENGLISH MEDIUM

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Obtained DSc (1940) from Agra University. He was Principal of Meerut College, Meerut (1965-69). He worked in the areas of floral morphology. He offered a new interpretation of crucifer gynoecium and classified placentation in cucurbitaceae and other families. He discussed the morphology of inferior ovary. He also authored the book 'History of botany' (Floral anatomy). Puri was member of INSA council and also editor of the journal of the Indian Botanical Society. Puri won the Birbal Sahni Medal (1964) and Professor Panchanan Maheshwari Memorial Lecture Award by INSA (1990). The Indian Botanical Society has Instituted the Medal in his honour, awarded annually since 1981.

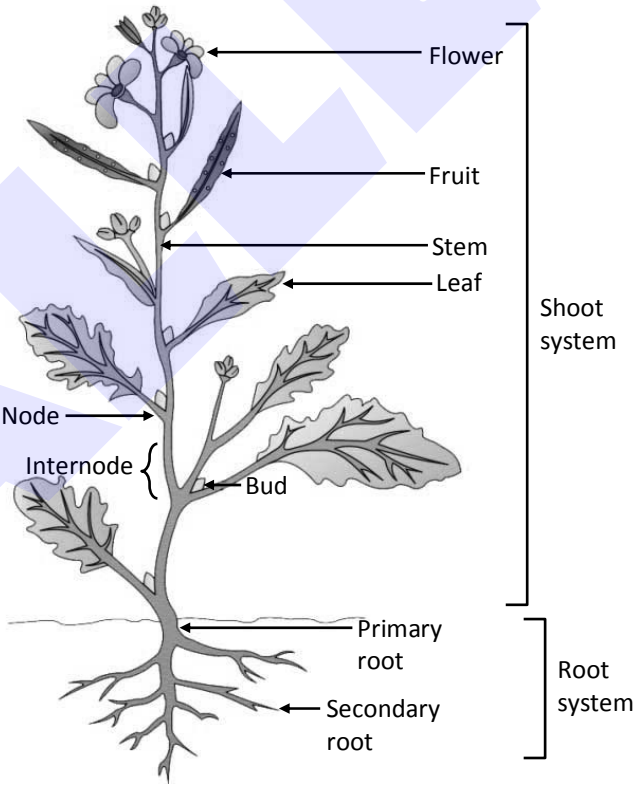
PROFESSOR V. PURI
(1909-2002)

MORPHOLOGY OF FLOWERING PLANTS

01. INTRODUCTION

- **Introduction**
- **The Root**
- **The Stem**
- **The Leaf**
- **The Inflorescence**
- **The Flower**
- **The Fruit**
- **The Seed**
- **Semi-technical Description of a Typical Flowering Plant**
- **Description of Some Important Families**

- The angiosperms show large diversity in external structure or morphology
- The angiosperms are characterized by presence of roots, stems, leaves, flowers and fruits
- The underground part of flowering plant is the root system while the portion above the ground forms shoot system



Parts of a flowering plant

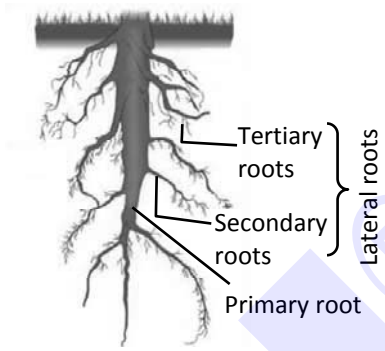
NCERT XI Page No. 66, Figure No. 5.1

02. THE ROOT

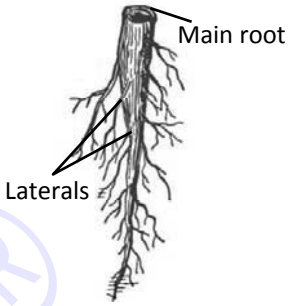
Roots are (+) vely geotropic, (+) vely hydrotropic, (–) vely phototropic.

1. TYPES OF ROOTS

(A) Tap roots :- In most of the **dicot plants**, the direct elongation of the **radicle** leads to the formation of **primary root**. It bears lateral roots of several orders that are referred to as **secondary, tertiary roots,** etc. The primary roots and its branches constitute the **tap root system. e.g. :- Mustard plant**



Tap root system



Tap root

NCERT XI Page No. 66
Figure No. 5.2(a)

(B) Adventitious roots :- In some plants, like **grass**, ***Monstera*** and the **banyan tree**, roots develop from parts of the plant other than the radicle and are known as **adventitious roots.**

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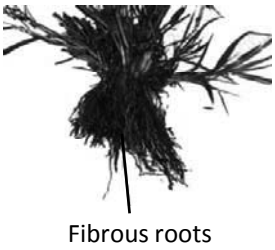
Figure No. 5.2(c)

(C) Fibrous roots :- In **monocot plants**, the primary root is short lived and is replaced by a large number of roots. These roots originate from the base of the stem and constitute the **fibrous root system. e.g. :- Wheat plant**



NCERT XI Page No. 66
Figure No. 5.2(b)

Functions of the root system :-

- Absorption of water and minerals, provide a proper anchorage to the plant parts,
- Storage of reserve food material

  (e.g. Carrot, radish, turnip, sweet potato and *Asparagus*)
- Synthesis of PGR (plant growth regulators).

2. MODIFICATIONS OF ROOT

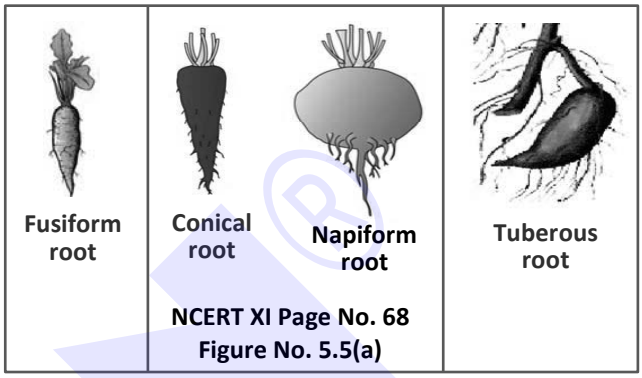
Roots in some plants change their shape and structure and become modified to perform functions other than absorption and conduction of water and minerals.

(A) Modifications of tap root

(i) For storage of Food :

(a) Fusiform roots/Spindle roots- These root are thicker in the middle and tapering on both ends. **e.g. :- Radish**

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



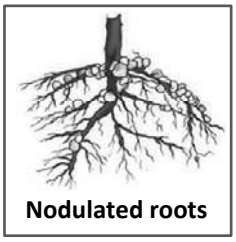
NCERT XI Page No. 68
Figure No. 5.5(a)

(c) Napiform roots - These roots become swollen and spherical at upper end and tapering (like a thread) at their lower end. **e.g. Turnip, sugarbeet (beet root)**

(ii) For Nitrogen Fixation : Nodulated roots -

Nodules are formed on branches of roots by nitrogen fixing bacteria (*Rhizobium*).

e.g. **Pea, gram, bean** (members of Fabaceae family)

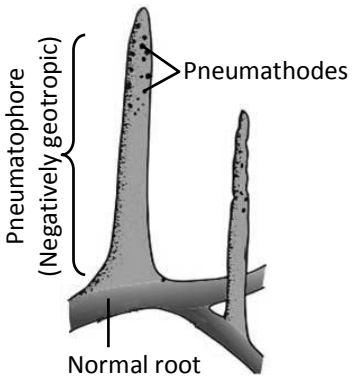

Nodulated roots

(iii) For Respiration : Pneumatophores

In marshy/swampy areas, there is scarcity of oxygen so, Some branches of tap root of the plants which grow in this region, grow vertically upward and comes on the surface. These roots are called **pneumatophores** which have minute pores called **pneumathodes** or **lenticels** by which air enters in the plant and plant gets oxygen for respiration.


Pneumatophore in *Rhizophora*

NCERT XI Page No. 68
Figure No. 5.5(b)



- Pneumatophores are negatively geotropic.
  e.g. *Rhizophora* (Mangrove plant)
- *Rhizophora* (Mangrove plant) is an example of halophyte.

(B) Modifications of adventitious roots :

(i) For Storage of Food -

(a) **Fasciculated roots** - These are adventitious roots occuring in clusters and all of them are swollen due to storage of food. **e.g.** ***Asparagus*****, dahlia**

(b) **Tuberous adventitious roots** : These roots become swollen due to storage of food. These roots have no definite shape **e.g. Sweet potato (*Ipomoea batatas*)**

Asparagus

NCERT XI Page No. 68
Figure No. 5.5(a)

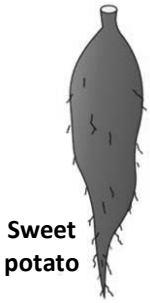


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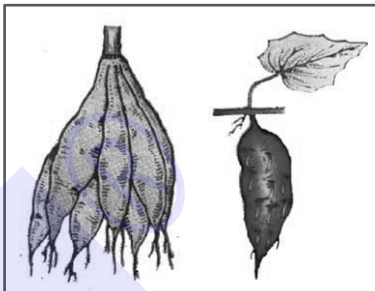
Figure No. 5.5(a)



(ii) For Support –

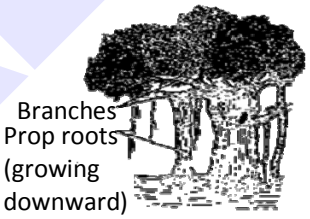
(a) **Stilt roots** - These roots arise from lower node and enter in the soil. These roots are **supporting roots. e.g. Maize, sugarcane**

(b) **Prop roots or pillar roots** - These hanging roots arise from branches of plant and grow downward towards the soil. These roots **support the tree branches. e.g. Banyan (*Ficus benghalensis*)**

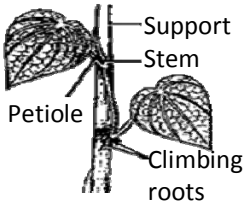
(c) **Climbing roots** - These roots arise from nodes and help in climbing.

e.g. Money plant *(Pothos), Monstera.*

Stilt roots



Prop roots



Climbing roots

Modification of root for support : Banyan tree

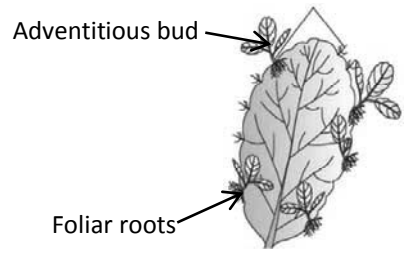
NCERT XI Page No. 67
Figure No. 5.4

(iii) For Special Functions –

(a) **Foliar roots or Epiphyllous roots :–** When roots arise from leaf then they are called foliar roots.

e.g. *Bryophyllum*

(b) **Sucking roots or Haustorial roots or Parasitic roots :-** In parasitic plants, roots enter in the host plant to absorb nutrition from the host. **e.g. *Cuscuta***



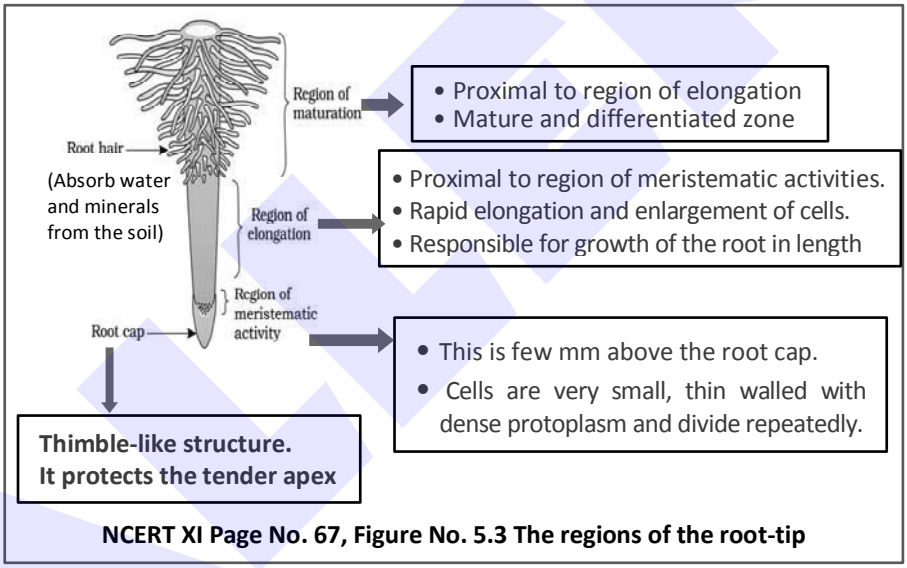
NCERT XII Page No. 7,
Figure No. 1.4(d) Leaf buds of *Bryophyllum*

Parasitic roots –
For absorption of nutrients from host

(c) **Photosynthetic roots (Assimilatory roots)** – Green roots are found in *Tinospora* and *Trapa.*

Function - Photosynthesis

Regions of the Root-tip



NCERT XI Page No. 67, Figure No. 5.3 The regions of the root-tip

03. THE STEM

- Stem develops from the plumule of the embryo of a germinating seed. The stem bears **nodes** and **internodes.** The region of the stem where leaves are borne are called nodes while the portions between two nodes are called internodes. Stem shows negatively geotropic growth.
- The stem is the ascending part of the axis bearing branches, leaves, flowers and fruits. The stem bears buds, which may be terminal or axillary. Stem is generally green when young and later often become woody and dark brown.
- **The main function of the stem** is spreading out branches bearing leaves, flowers and fruits. It conducts water, minerals and photosynthates (food). Some stems perform the function of storage of food (potato, ginger, turmeric, zaminkand and *Colocasia*), support, protection and of vegetative propagation.

1. MODIFICATION OF STEMS

- **(A) Sub-aerial** — Partly aerial and partly underground
  - Runner
  - Stolon
  - Sucker
  - Offset
- **(B) Underground** — Completely below the soil surface
  - Rhizome
  - Tuber
  - Corm
  - Bulb
- **(C) Aerial** — Completely in air or above the soil surface
  - Stem thorn
  - Stem tendril
  - Phylloclade
  - Cladode

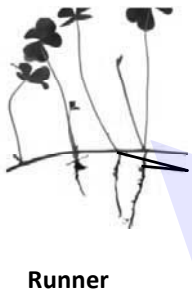
(A) *Sub-aerial modification of stem* -

(i) **Runner** - In these stems roots develop at lower side and leaves at upper side from the nodes and these stems spread on the ground e.g. ***Cynodon dactylon*** **(doob grass),** ***Oxalis,*** **Strawberry** (*Fragaria ananassa*). Partially underground stems of some plants such a grass and strawberry etc., spread to new niches and when older parts die new plants are formed.

(ii) **Stolon –** In plants like **jasmine**, peppermint, a lateral branch arises from the base of the main axis and after growing aerially for some time arch downwards to touch the ground.

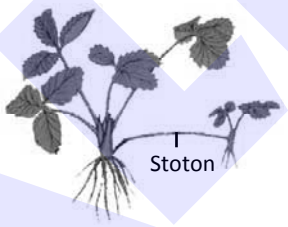
(iii) **Sucker** - In **Mint, pineapple,** ***Chrysanthemum*****, banana**, the lateral branches originate from the basal and underground portion of the main stem, grow horizontally beneath the soil and then come out obliquely upward giving rise to leafy shoots.

(iv) **Offset –** A lateral branch with short internodes and each node bearing a rosette of leaves and a tuff of roots is found in aquatic plants like ***Pistia, Eichhornia***. It is also known as **aquatic runner**.

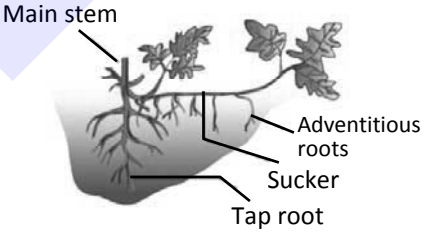


Runner

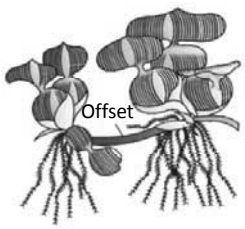
NCERT XI Page No. 69 Figure No. 5.6(d) For spread and vegetative propagation



Stolon



Sucker



Offset

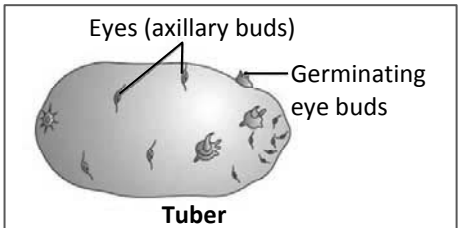
NCERT XII Page No. 7 Figure No. 1.4(e)

For vegetative propagation

(B) *Underground modification of stem*

- Generally for food storage and vegetative propagation.

(i) **Tuber** - The tips of branches become swollen in the soil. **Eyes are found on tuber which are axillary buds** and axillary buds are covered with scaly leaves. **e.g. Potato.**



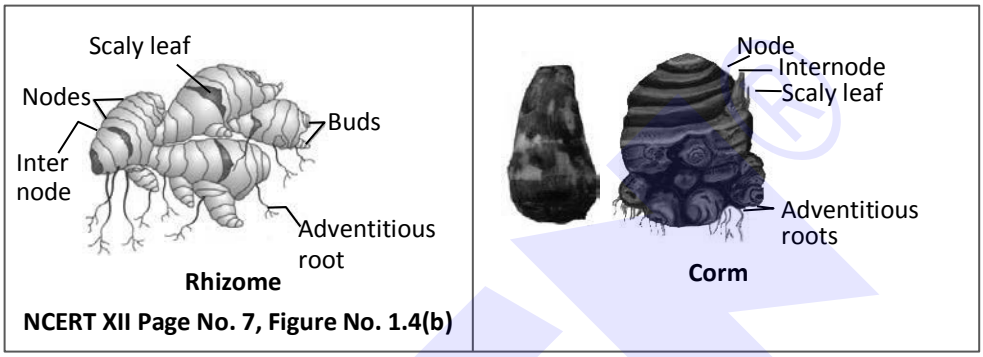
Tuber

NCERT XII Page No. 7, Figure No. 1.4(a)

Peel of potato is periderm.

(ii) **Rhizome** - It is fleshy stem which grows horizontally in the soil. Nodes and small internodes are found which are covered by scaly leaves. e.g. **Ginger, turmeric, banana**.

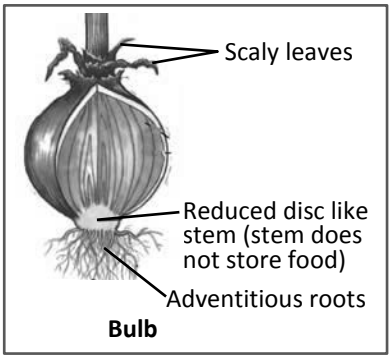
(iii) **Corm** - It is condensed structure which grows vertically under the soil surface. e.g. ***Colocasia,* Zaminkand (*Amorphophallus*),** *Colchicum*, *Gladiolus*



NCERT XII Page No. 7, Figure No. 1.4(b)

- **Organ of perennation -** Underground stems of **potato, ginger, turmeric, *Colocasia, zaminkand*** are modified to store food in them. They also act as organ of perennation to tide over conditions unfavourable for growth.

(iv) **Bulb** - Stem is highly reduced and disc like and surrounded by numerous fleshy leaves. Many roots arise from its base. e.g. **Onion, garlic. The fleshy leaves of onion and garlic store food.**



Banana is example of both rhizome and sucker stems. Banana propagates through rhizome. Aerial part of banana plant which looks like stem is called pseudo-stem (leaf bases).

(C) *Aerial modification of stem*

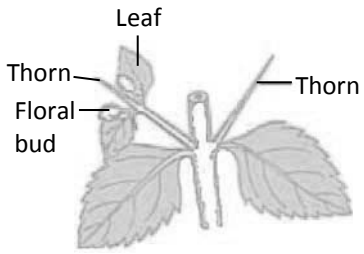
(i) **Stem tendril :** In this type of modification axillary bud forms tendril in place of branches and helps in climbing of those plants which have weak stem. e.g. **Grapes/Grapevines, gourds *(cucumber*, pumpkins, watermelon),** *Passiflora.*

(ii) **Stem thorn :** Stem thorn develops usually from axillary bud of the stem. It may bear leaves and flowers. Thorn protects plant from browsing animals. It is a **woody pointed structure.**

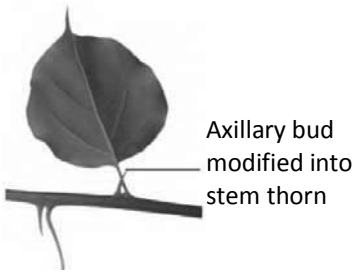
- In ***Bougainvillea*** **and** ***Citrus,*** *Duranta,* pomegranate (Stem thorn develops from axillary bud)

Stem Tendril

NCERT XI Page No. 69, Figure No. 5.6(b)



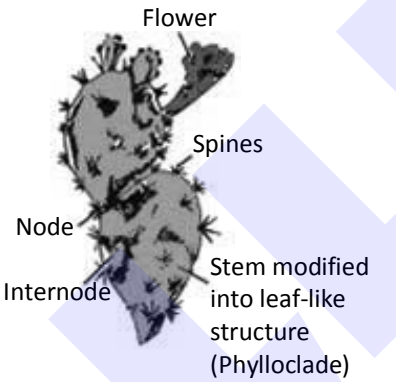
Stem Thorn



NCERT XI Page No. 69
Figure No. 5.6(c)

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

(iv) Cladode : In this modification branches of limited growth become green and flat like a leaf and perform photosynthesis. e.g. ***Asparagus***, ***Ruscus.***

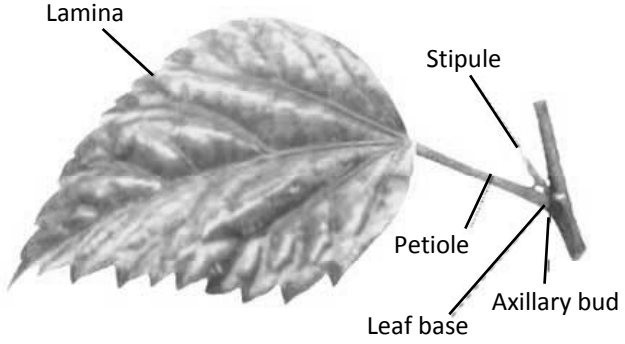


Phylloclade

Cladode

04. THE LEAF

- The leaves develop from the nodes. Their main function is to carry out photosynthesis or food formation.
- Axillary buds are found in the axil of leaves. The axillary bud may develop into a branch.
- Leaves originate from shoot apical meristems and are **arranged in acropetal order.**
- Leaf is a lateral outgrowth of stem developed exogenously at the node.



Parts of a leaf

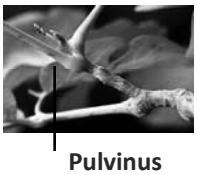
NCERT XI Page No. 70, Figure No. 5.7(a)

1. PARTS OF A LEAF

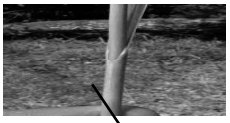
A typical leaf consist of three main parts :-

(A) Leaf base - The part of leaf which is attached to stem is known as leaf base.

- In **monocots**, the leaf base expands into a sheath covering the stem partially or wholly.



Pulvinus
(Swollen leaf base)



Sheathing leaf base
(Leaf base expands into a sheath covering the stem partially or wholly.)

- In some **leguminous plants** the leafbase may become swollen, which is called the pulvinus.

(B) Petiole - The part of leaf connecting the lamina with the branch or stem is known as petiole.

- Petiole or stalk containing leaves are known as **petiolate leaves** and when petiole or stalk is absent then leaves are called **sessile**.
- The petiole helps hold the blade to light.
- Long thin flexible petioles allow leaf blades to flutter in wind, thereby cooling the leaf and bringing fresh air to leaf surface.

(C) Lamina / Leaf Blade – Leaf blade is the green expanded part of the leaf with veins and veinlets.

- There is, usually, a middle prominent vein, which is known as the midrib.
- Veins provide rigidity to the leaf blade and act as channels of transport for water, minerals and food materials.
- The shape, margin, apex, surface and extent of incision of lamina varies in different leaves.
- Main Functions of leaf lamina are photosynthesis, gaseous exchange and transpiration.

STIPULES

Leaves of some plants have two lateral appendages on either side of leaf base, known as stipules.

Leaf with stipule is known as **stipulate leaf**, e.g. **Fabaceae** Leaf without stipule is called **ex-stipulate leaf** e.g. **Solanaceae, Liliaceae**.

2. VENATION

The arrangement of veins and veinlets in leaf lamina is known as venation.

Types of Venation – Venation is of two types -


RETICULATE VENATION

(A) Reticulate Venation :-

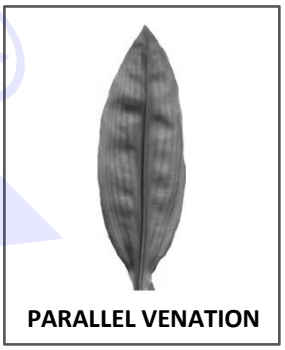
- When the veinlets form a network, the venation is termed as reticulate. Leaves of **dicotyledonous plants** generally possess reticulate venation.

  Exception – ***Calophyllum*** (It has parallel venation)

(B) Parallel venation :

- When the veins run parallel to each other within a lamina, the venation is termed as parallel. Parallel venation is the characteristic of most **monocotyledons**.

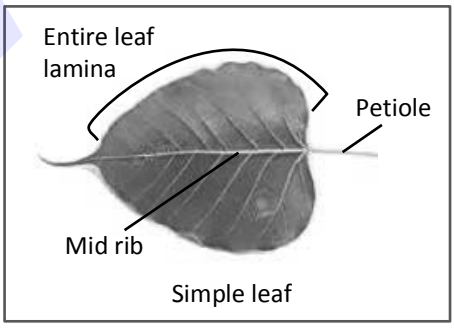
  Exception – ***Smilax*** (It has reticulate venation)


PARALLEL VENATION

3. TYPES OF LEAVES

(A) Simple Leaf : A leaf is said to be simple, when its lamina is entire or may be incised to any depth, but not up to the midrib or petiole.

e.g. :- Peepal, mango, radish.

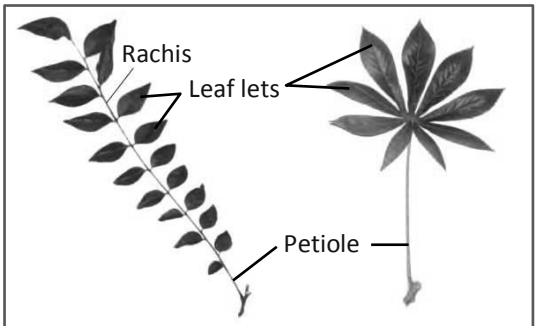


Simple leaf

(B) Compound Leaf : A leaf in which the leaf blade (lamina) is incised up to the midrib or petiole, thus dividing it into several small parts, i.e. leaflets.

It has two types :-

(i) Pinnately compound leaf : In this type of leaf, leaf blade (lamina) is incised upto the mid rib and mid rib is known as rachis. A number of leaflets are present on a common axis, the rachis. e.g. Neem



NCERT XI Page No. 70, Figure No. 5.8

(ii) **Palmately compound leaf :** In this type incisions of leaf lamina are directed from leaf margins to apex of the petiole and **all leaflets are attached at a common point i.e. at the tip of the petiole. Rachis is absent** in palmately compound leaf. **e.g. Silkcotton (*Bombax*)** & *Oxalis*.

- **A bud is present in the axil of petiole in both simple and compound leaves, but not in the axil of leaflets of the compound leaf.**

4. PHYLLOTAXY

Phyllotaxy is the pattern of arrangement of leaves on the stem or branch.
This is usually of three types.

(A) Alternate :

In this type a single leaf arises at each node in alternate manner. e.g. **Mustard**, **chinarose**, **sunflower.**

(B) Opposite :

In this type of phyllotaxy a pair of leaves arise at each node and lie opposite to each other. e.g. **Guava, *Calotropis, Ocimum***

(a) Alternate **(b) Opposite** **(c) Whorled**

Different types of phyllotaxy
NCERT XI Page No. 71, Figure No. 5.9

(C) Whorled :

If more than two leaves arise at each node and form a whorl, then it is called whorled phyllotaxy. e.g. ***Alstonia*** (devil tree), *Nerium*

5. MODIFICATION OF LEAVES

Leaves are often modified to perform functions other than photosynthesis.

(A) Leaf Tendril :

In some plants whole leaf is modified into a wire like structure which is called leaf tendril. Tendril helps is climbing. e.g. *Lathyrus aphaca* (wild pea) → **Peas**.

(B) Leaf Spine :

Leaves are modified into pointed spines. Spines provide protection. e.g. ***Opuntia*** (Cacti)

(C) Leaf Pitcher : Leaves of some plants are modified into pitcher shaped structure. e.g. ***Nepenthes* (pitcher plant).** Only lamina is modified into pitcher in *Nepenthes.*

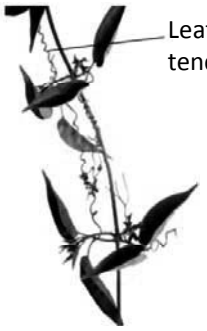
(D) Leaf bladder : In some plants, leaves are modified into bladder like structure e.g. ***Utricularia*** **(bladder wort)**

(E) Phyllode : In some plants leaves are small and short lived. Petiole becomes flat leaf like green, synthesises food and functions as normal leaf.

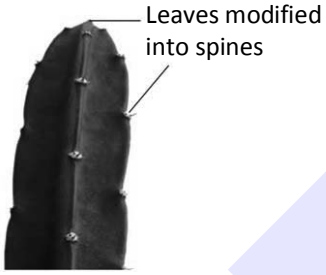
e.g. : **Australian acacia, *Parkinsonia.***

(F) Leaflet Tendril : In *Pisum sativum* (garden pea) and *Lathyrus odoratus* (sweet pea) leaflets are modified into tendril for climbing.

(G) Fleshy Leaves : In **Onion** leaves become fleshy for storage of food



Leaf tendril
(For Climbing)
NCERT XI Page No. 71
Figure No. 5.10(a)



Leaf spines
(For Protection)
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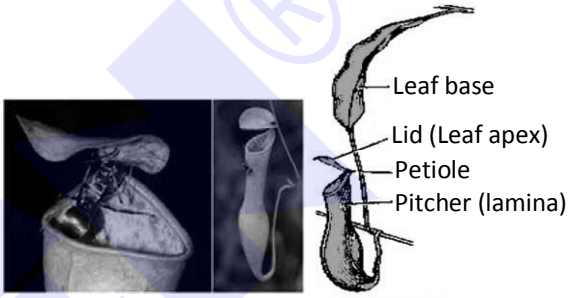
Figure No. 5.10(b)

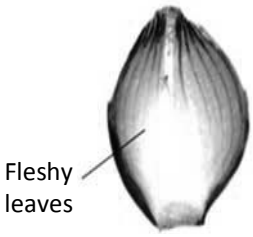


Leaf pitcher

Leaf bladder

Phyllode
(For Photosynthesis)

Leaflet tendril
(For Climbing)
NCERT XI Page No. 79
Figure No. 5.21(a)



Fleshy leaves
(For Storage)
NCERT XI Page No. 71
Figure No. 5.10(c)

Note : ***Dionaea*** (**venus flytrap**) is insectivorous plant and it also has modified leaves.

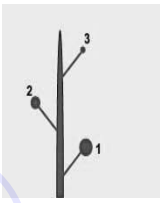
5. THE INFLORESCENCE

The arrangement of flowers on the floral axis is termed as inflorescence.

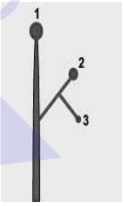
Depending on whether the apex gets developed into a flower or continues to grow, two major types of inflorescences are defined – racemose and cymose.

INFLORESCENC

→ **RACEMOSE** Position of flower : **Lateral**
Growth of Peduncle : **Unlimited (Indefinite)**
Floral axis (Peduncle) **doesn't terminate** in a flower
Arrangement of flowers : **Acropetal**
(i.e. younger flower towards apex and older flower towards base of floral axis)



→ **CYMOSE** Position of flower : **Terminal**
Growth of Peduncle : **Limited (definite)**
Floral axis (Peduncle) **terminates** in a flower
Arrangement of flowers : **Basipetal**



1. RACEMOSE

In this type of inflorescence the main axis continues to grow and does not terminate in a flower and flowers are borne laterally in an **acropetal order/acropetal succession**

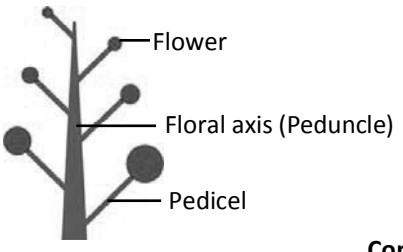
Racemose inflorescence
NCERT XI Page No. 72
Figure No. 5.11

Types of racemose inflorescence :

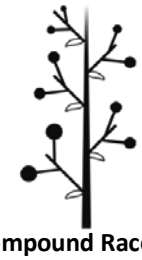
(A) Raceme - In this type of inflorescence, peduncle (main axis or floral axis) is elongated and **flowers are pedicellate.**

Eg. **Radish, mustard**

- When peduncle is branched and each branch bear pedicellated flowers like raceme and are arranged in acropetal manner then it is known as **compound raceme** or **Raceme of racemes** or **panicle** *e.g.* Gulmohar, *Cassia*.

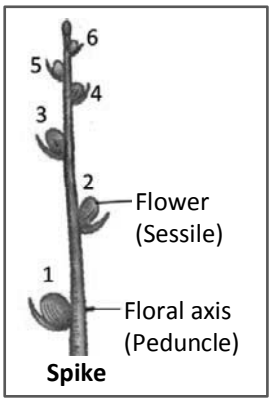


Raceme



Compound Raceme (Panicle)

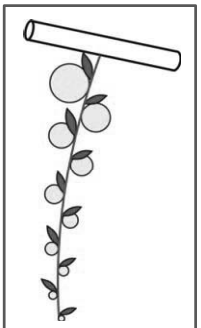
(B) Spike - In this type of inflorescence peduncle is elongated but **flowers are sessile** (without pedicel).



Spike

(C) Catkin/Amentum - In this type of inflorescence **peduncle is thin, long and weak, and flowers are sessile and unisexual.** Unisexual flowers develop on separate catkin.

e.g. **Mulberry (Shahtoot)**.

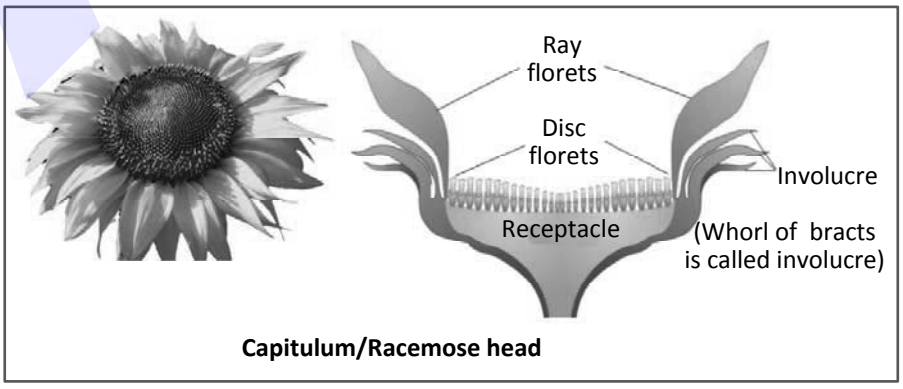

Catkin

(D) Spadix - In this type of inflorescence **peduncle is thick, long and fleshy** and it has small sessile and unisexual flowers covered with one or more **large green or colourful bracts (spathe).** *e.g.* **Maize**

- **Long filamentous threads** (Silky hairs) protruding at the end of a young cob of maize **are styles** and stigmas (mainly styles)

(E) Capitulum/Racemose head - In this type of inflorescence small sessile flowers are found on receptacle. These flowers are called **florets**.
The central florets are called **disc florets** and peripheral florets are called **ray florets.**

e.g. **Compositae/Asteraceae family [Sunflower, marigold (*Tagetes*)].**

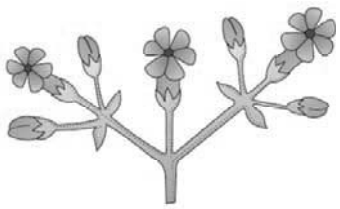


Capitulum/Racemose head

2. CYMOSE

In this type of inflorescence, the main axis/peduncle terminates in a flower hence is limited in growth. Flowers are arranged in **basipetal succession/basipetal order.**

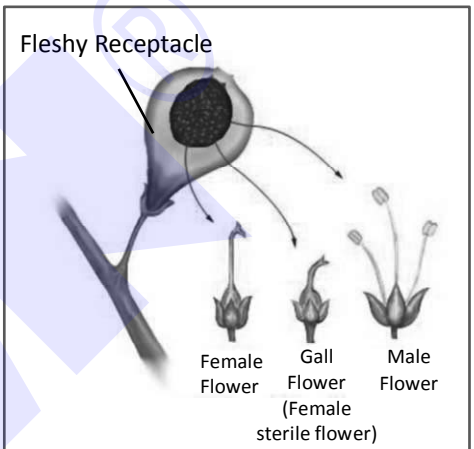
e.g. ***Solanum***



Cymose inflorescence
(Dichasial Cyme)
NCERT XI Page No. 72
Fig. No. 5.12

3. SPECIAL TYPE OF INFLORESCENCE

Hypanthodium : In this type of inflorescence upper part of peduncle is modified into a pear shaped structure having cavity with a pore (ostiole). At the base of cavity female flowers develop while towards the pore male flowers develop. **Three types of flowers (male, female, sterile female) are present** in this inflorescence. e.g. - ***Ficus benghalensis*** **(banyan),** ***Ficus carica*** **(fig),** ***Ficus religiosa*** **(Peepal).**



Hypanthodium

BEGINNER'S BOX — ROOTS TO INFLORESCENCE

1. In which of the following type of underground modification of stem, storage of food does not occur in stem?
(1) Bulb (2) Rhizome (3) Corm (4) Tuber

2. Fasciculated roots are found in :-
(1) *Asparagus* (2) *Colocasia* (3) Ginger (4) Turmeric

3. Which type of racemose inflorescence is found in mulberry.
(1) Catkin (2) Spadix (3) Spike (4) Raceme

4. Phyllode & cladode are :-
(1) Homologous (2) Analogous
(3) Vestigial organs (4) Root modifications

5. Which type of racemose inflorescence is found in maize.
(1) Raceme (2) Spike
(3) Catkin (4) Spadix

Golden Key Points

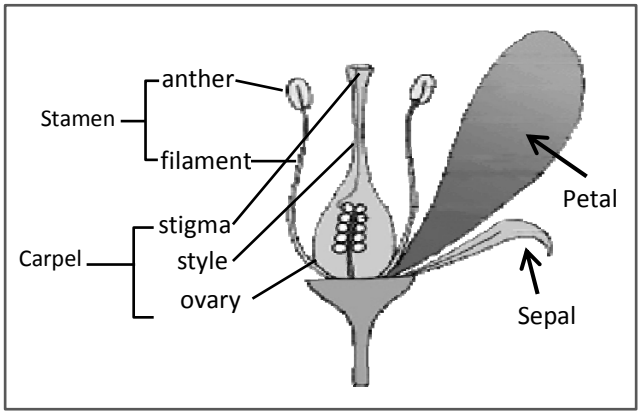
- Tap roots arise from radicle whereas adventitious roots arise from any other part of plant other than radicle.
- Root cap is thimble like structure.
- *Gladiolus* is an example of corm.
- *Opuntia* and *Euphorbia* are examples of phylloclade.
- Swollen petiole → *Eichhornia*. Winged petiole → *Citrus*
- In *Nepenthes*, only lamina is modified into pitcher like structure.
- In *Portulaca* food storing adventitious roots are present.

06. THE FLOWER

- **A flower is a modified shoot where in the shoot apical meristem changes to floral meristem. Internodes do not elongate and the axis gets condensed. The apex produces different kinds of floral appendages laterally at successive nodes instead of leaves.**
- **When a shoot tip transforms into a flower, it is always solitary.**
- The flower is the reproductive unit in the angiosperms. It is meant for sexual reproduction.
- Generally flower has a short or long stalk which is called **pedicel**. The upper part of pedicel is swollen, which is called **thalamus**. Floral leaves are present on it.

  There are four types of floral leaves.

  • Sepal • Petal • Stamen • Carpel
- A typical flower has four different kinds of floral whorls arranged successively on thalamus. These are calyx, corolla, androecium and gynoecium.
  - Whorl of sepals → Calyx
  - Whorl of petals → Corolla
  - Whorl of stamens → Androecium
  - Whorl of carpels → Gynoecium

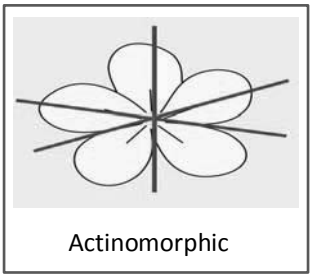


- **Calyx and corolla are accessory organs or accessory whorls while androecium and gynoecium are reproductive organs or reproductive whorls or essential whorls.**
- **Complete flower** : All four floral whorls are present.
- **Incomplete flower** : If any floral whorls is absent e.g. Unisexual flower
- **Bisexual flower** : Perfect flower
- **Unisexual flower** : Imperfect flower
- A flower may be trimerous, tetramerous or pentamerous when the accessory floral appendages are in multiple of 3,4 or 5, respectively. **In dicots flowers are usually pentamerous while in monocots flowers are trimerous.**

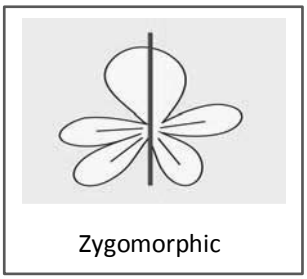
Note : Flowers are tetramerous in members of brassicaceae.

1. SYMMETRY OF FLOWER

(A) Actinomorphic/Radial/Regular : When a flower can be divided into two equal radial halves by any vertical plane or radial plane passing through the centre, then it is said to be actinomorphic flower **e.g. Mustard, *Datura*, chilli.**


Actinomorphic

(B) Zygomorphic/Bilateral : When a flower can be divided into two equal (similar) halves only by one particular vertical plane, then it is said to be zygomorphic flower. **e.g. Pea, bean, gulmohar, *Cassia.***


Zygomorphic

(C) Asymmetrical/Irregular : When a flower cannot be divided into two equal (similar) halves from any vertical plane passing through the centre, then it is said to be asymmetrical flower. **e.g. *Canna*.**

- **The part of flower which lies near to the mother axis is posterior part while the part of flower which is away from the mother axis is anterior part.**

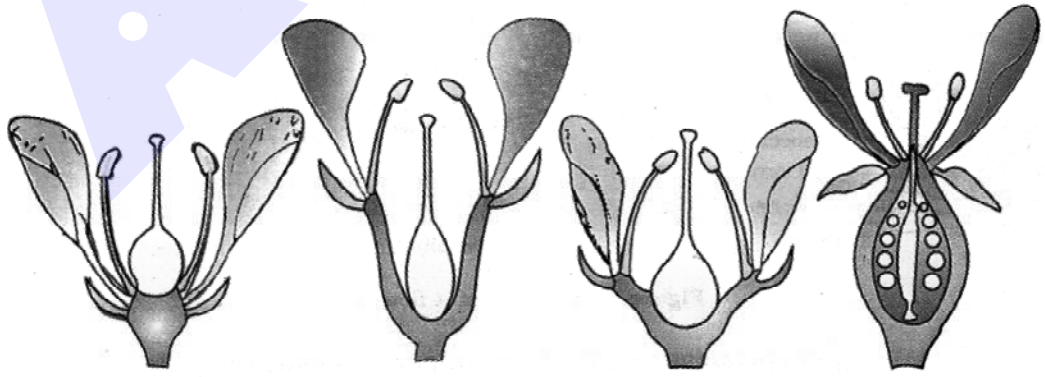
2. TYPES OF FLOWERS ON THE BASIS OF INSERTION OF FLORAL LEAVES/FLORAL PARTS ON THALAMUS

Based on the position of calyx, corolla and androecium in respect of the ovary on thalamus, the flowers are divided into three types.

(A) Hypogynous flower - When gynoecium occupies the highest position while the other parts like petals, sepals and stamens are situated below the ovary, then the flower is called hypogynous and in this condition **ovary** will be **superior**. **eg. Mustard, china rose, brinjal, mango.**

(B) Perigynous flower - In it thalamus grows upwardly and form a cup shaped structure. On the margin or rim of thalamus floral parts are attached except gynoecium, which lies at the basal part or in the centre. So **ovary** in this condition is said to be **half inferior**. **Eg. Rose, plum, peach.**

(C) Epigynous flower - When the margin of thalamus grows further upward enclosing the ovary completely and getting fused with it and other parts of flower like petals, sepals & stamens are situated above the ovary, then the **ovary** is said to be **inferior** and rest of the floral parts superior. e.g. **Guava**, **apple**, **cucumber** and the **rayflorets and disc florets of sunflower.**

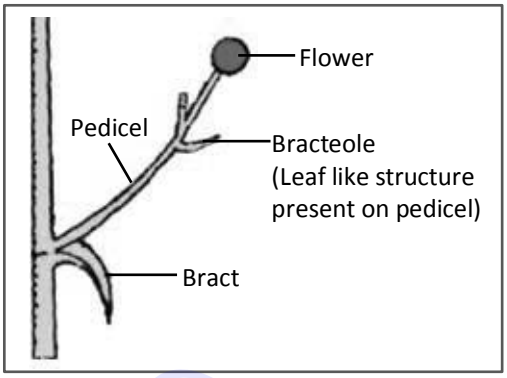


NCERT XI Page No. 73, Figure No. 5.13 : Position of floral parts on thalamus

- **Bract is a reduced leaf which may be present at the base of the pedicel of flower.**

  Bracteate flower - The flower with bract is called bracteate flower.

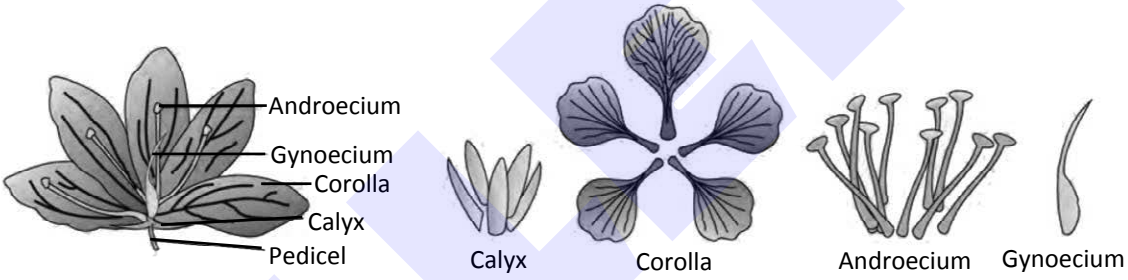
  Ebracteate flower - Flower without bract is known as ebracteate flower.



- ***Spathe*** - Large bract which completely encloses whole inflorescence is called spathe.

  e.g. **Banana, maize**

3. PARTS OF A FLOWER



NCERT XI Page No. 74, Figure No. 5.14 Parts of a flower

(A) Calyx : The outermost whorl of flower is called calyx. Each member of this whorl is called **sepal**, when all the sepals are free from each other, then it is called **polysepalous condition.** When the sepals are fused (united) with each other then this condition is called **gamosepalous condition**.

- Sepals are green leaf like and protect the flower in the bud stage.
- In the **family of sunflower (compositae)** sepals are modified into hairy structure which is known as **pappus**. The pappus is modified calyx and helps in dispersal of fruit by parachute mechanism.
- If sepals do not fall and remain attached to fruit, then they are called **persistent sepals**.

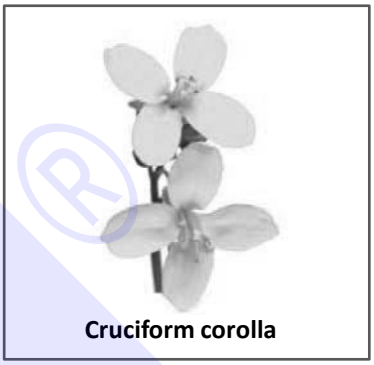
  e.g. **Tomato**, chilli, **brinjal** (Solanaceae family)

(B) Corolla :

The second whorl of flower is called corolla and each member of corolla is called petal. When all the petals are free, then it is called **polypetalous condition** and when petals are fused, then it is called **gamopetalous condition**.

- Petals are usually brightly coloured to attract insects for pollination.

(i) Forms of corolla - The shape and colour of corolla vary greatly in plants. Corolla may be tubular, bell shaped, funnel-shaped or wheel-shaped (Rotate).



Cruciform corolla

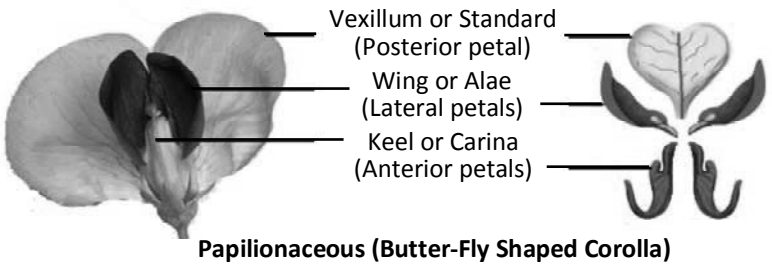
- **Cruciform** - In cruciform corolla four petals are found. These **petals are arranged crosswise.** Eg. Radish, mustard etc. **(Members of family Cruciferae)**

Campanulate (Bell shaped)
Eg. Tobacco

Tubular (Tube like)
Eg. Disc florets of sunflower.

Infundibuliform (Funnel shaped)
Eg. *Petunia*

- **Papilionaceous (Butter fly shaped corolla)** - In this type of corolla five petals are found. Posterior petal is largest and is known as **standard or vexillum**. Vexillum covers two lateral petals which are called **wings or alae** and the innermost anterior petals are united to form a **keel or carina**. Both lateral petals cover the keel. e.g. Pea, bean, gram etc. (Members of Fabaceae family).



Papilionaceous (Butter-Fly Shaped Corolla)

(ii) AESTIVATION

The mode of arrangement of sepals or petals in floral bud with respect to the other members of the same whorl is known as aestivation. It is of following types :-

(a) **Valvate** - When the petal of a whorl lie adjacent to other petal and just touch one another at the margin without overlapping then it is known as valvate aestivation. e.g. ***Calotropis*** **plant, Cruciferae, Solanaceae & Liliaceae family.**

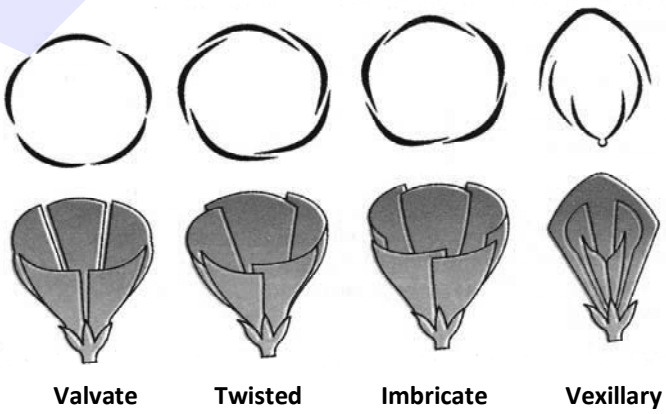
(b) **Twisted** - In this type one margin of a petal covers adjacent petal and the other margin is covered by another petal. One margin of the petal overlaps that of the next one, and the other margin is overlapped by the another one. Eg. **Cotton**, **ladyfinger**, **china rose** **(Members of Malvaceae family).**

(c) **Imbricate** - When both margins of one petal are covered by the other two petals and both margin of another one, covers other. Rest are arranged in twisted manner. OR If the margins of sepals or petals overlap one another but not in any particular direction, then it is known as imbricate aestivation.

e.g.: ***Cassia***, **gulmohar** **(*Delonix regia*).**

(d) **Vexillary or Papilionaceous** - The posterior petal is outermost and largest and is known as **standard** or **vexillum** which overlaps the two lateral petals **wings** or **alae**. These two laterals petals overlaps two smallest anterior petals i.e. **keel or carina**. Vexillary arrangement is found in pea family.

e.g. **Pea, bean** (**Fabaceae**).



NCERT XI Page No. 74, Figure No. 5.15 : Types of aestivation in corolla

(C) Androecium : It is composed of stamens. When the stamens of an androecium are free from one another, then it is called **polyandrous** condition.

(i) Cohesion of stamens :

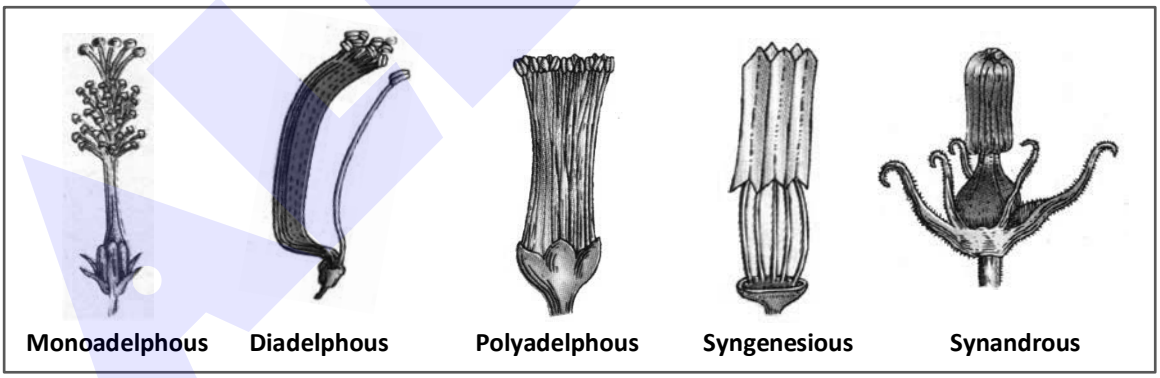
When the floral parts of similar whorl are fused, then it is called cohesion.

(a) Adelphy - When stamens are united by their filaments only, then it is called adelphy. It is of following types-

- **Monoadelphous** - In this type of cohesion all the filaments are united into a single bundle or one bunch but anthers remain free. In this type of cohesion a tube is formed around the gynoecium which is called staminal tube e.g. **China rose** (**Malvaceae family**).
- **Diadelphous** - In this type of cohesion filaments are united into two bundles but the anthers remain free e.g. **Pea (Fabaceae)**.
- **Polyadelphous** - Filaments are united into more than two bundles. e.g. **Citrus (Rutaceae)**.

(b) Syngenesious - Only anthers are united in bundle, but filaments remain free e.g. Members of Compositae family.

(c) Synandrous - Anthers as well as filaments of stamens are united through their whole length. e.g. Members of Cucurbitaceae family.



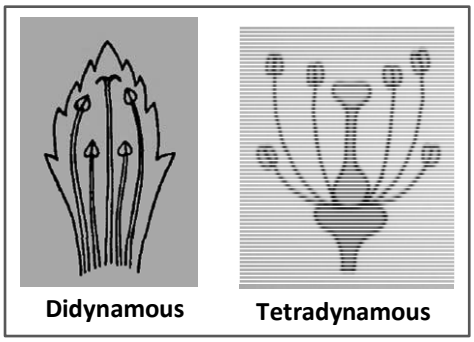
(ii) Adhesion of stamens :

When the stamens are attached to the members of other floral whorl of flower, then it is called adhesion of stamens.

(a) Epipetalous : Stamens are attached to the petals. e.g. **brinjal (Solanaceae)**

(b) Epiphyllous or Epitepalous - Stamens are attached to the tepals (perianth). e.g. **Lily (Liliaceae)**

(iii) Length of Stamens : There may be a variation in the length of filaments within a flower, as in *Salvia* and mustard.

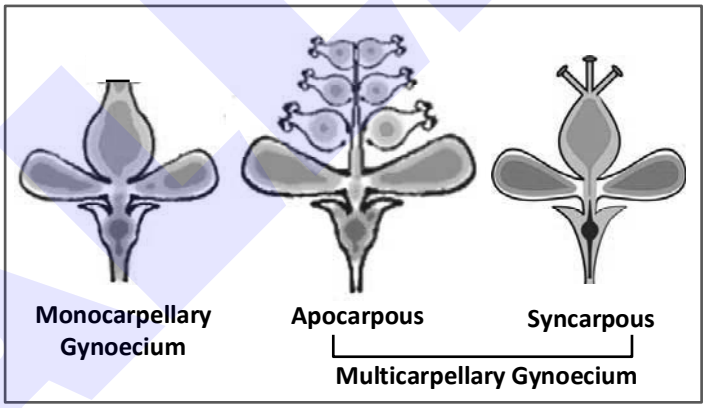


(a) Didynamous - If four stamens are present and out of them two are long and two are short, then it is called didynamous condition.
e.g. Lamiaceae/Labiatae family (***Salvia***)

(b) Tetradynamous - When there are six stamens and they are arranged in two whorls. In outer whorl, there are two short stamens while in inner whorl, there are four long stamens, this condition is called tetradynamous.
e.g. Cruciferae family (**Mustard**, **radish, *turnip***).

(D) Gynoecium :

- **Gynoecium is female reproductive organ of the flower and is made up of one or more carpels.**
- If only one carpel is present in gynoecium then this condition is called **monocarpellary** condition.



- If more than one carpel is present in gynoecium then this condition is called **multicarpellary.**
- When all the carpels in polycarpellary/multicarpellary condition are free, then this condition is called **apocarpous**. **e.g. lotus, rose, *Michelia*.**
- When all the carpels are fused, then this condition is called **syncarpous**.
e.g. *Papaver, Hibiscus*, mustard, tomato.
- A carpel consists of three parts namely stigma, style and ovary.

- Ovary is the enlarged basal part, on which lies the elongated tube, the style. The style connects the ovary to the stigma. The stigma is usually at the tip of the style and is the receptive surface for pollen grains.

PLACENTATION

The arrangement of ovules within the ovary is known as placentation. It is of following types:

(a) **Marginal :** In this type of placentation placenta forms a ridge along the ventral suture of the ovary and the ovules are borne on this ridge forming two rows e.g. **Pea.**

(b) **Axile** : In this type of placentation ovary is multilocular and the ovules are borne on the central axis.

e.g. **china rose**, **lemon**, **tomato**.

(c) **Parietal** : In this type of placentation the ovules develop on the inner wall of the ovary or on peripheral part.

e.g. **Mustard** and ***Argemone.***

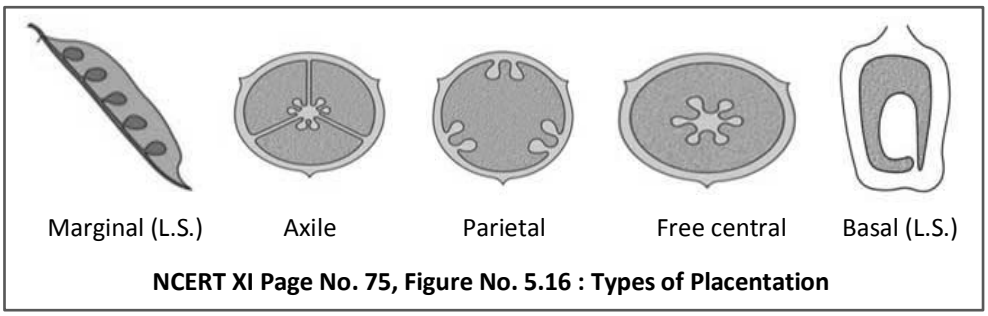
Note : In some plants, ovary is one chambered but it becomes two chambered due to formation of false septum or replum.

e.g. Cruciferae family (Mustard) and *Argemone*.

(d) **Free central/Central :** In this type of placentation the ovary is unilocular (septa are absent) and the ovules are borne on the central axis.

e.g. ***Primrose, Dianthus***

(e) **Basal : In this type of placentation a single ovule is attached at the base of ovary. e.g. marigold, sunflower (Members of Asteraceae / Compositae family), and in members of Gramineae / Poaceae family.**



NCERT XI Page No. 75, Figure No. 5.16 : Types of Placentation

07. THE FRUIT

The fruit is the characteristic feature of the flowering plants. It is the mature or ripened ovary, developed after fertilization. If a fruit is formed without fertilization of ovary, it is called a parthenocarpic fruit. In some fruits like grapes, banana seeds are not found and such type of fruits are called parthenocarpic or seedless fruits. Parthenocarpy can be induced through the application of growth hormones.

(1) PERICARP (Fruit wall) :

After ripening, the ovary wall changes into pericarp. This pericarp may be thick and fleshy or thick and hard or thin and soft.

In fleshy fruits pericarp (fruit wall) is made up of three layers :-
- (A) Epicarp
- (B) Mesocarp
- (C) Endocarp

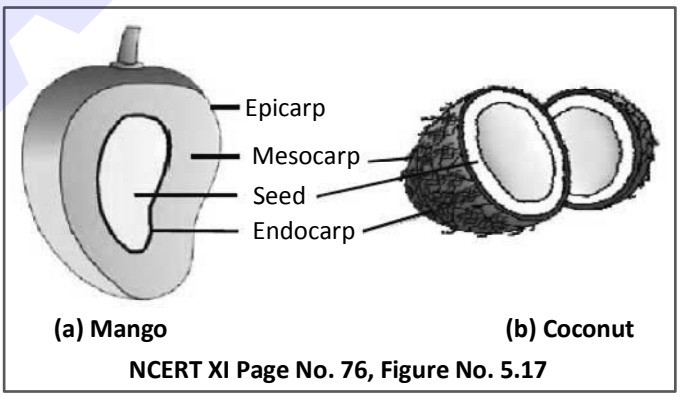
(A) Epicarp : It is the outermost layer, it may be thick or thin and hard or soft. It forms outermost layer of fruit which is also called rind

(B) Mesocarp : It is the middle layer which is thick and fleshy in **mango**, peach and date palm. In **coconut**, this layer is made up of fibres which is also called coir

(C) Endocarp : It forms the innermost layer, it may be thin membranous (e.g. orange, datepalm) or thick and hard (e.g. mango, coconut)

(2) TRUE & FALSE FRUITS :

(A) True fruit : When the fruit is developed only from the ovary then the fruit is called true fruit. e.g. **mango, coconut.**

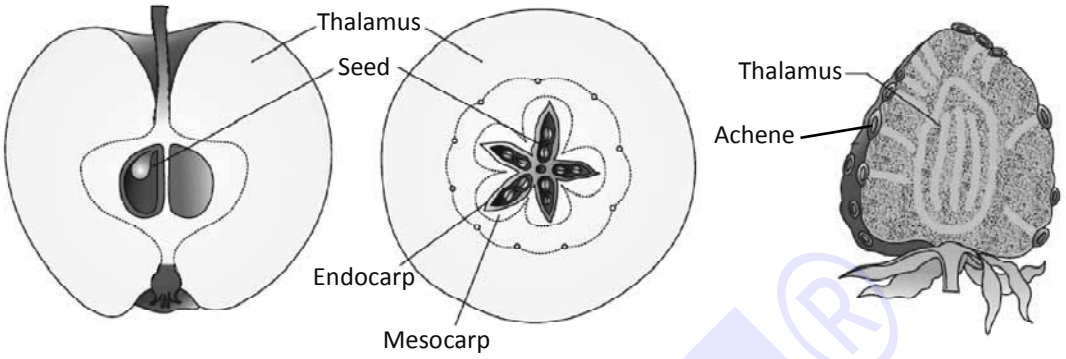


(a) Mango **(b) Coconut**

NCERT XI Page No. 76, Figure No. 5.17

(B) False fruit :

In false fruits, alongwith ovary, some other parts like thalamus, inflorescence etc. are also developed into fruit or a part of fruit. e.g. **apple**, **strawberry**, **pear**, **mulberry, fig,** **cashew nut**



False fruits of apple and strawberry

NCERT XII Page No. 37, Figure No. 2.15(b)

- In apple, strawberry, cashew, etc. the thalamus also contributes to fruit formation. Such fruits are called false fruits.

(3) CLASSIFICATION OF FRUITS :

Fruits are divided into three types :

(A) Simple fruits :

These fruits are **developed from ovary of monocarpellary gynoecium or multicarpellary, syncarpous gynoecium** and only one fruit is developed from gynoecium.

Simple fruits are of two types :

(i) Simple Fleshy fruits **(ii) Simple Dry fruits**

(i) **Simple fleshy fruits :** In simple fleshy fruits, **fruit wall (pericarp) is differentiated into epicarp, mesocarp and endocarp**.

Fleshy fruits are of following types :

(a) **Drupe fruits** : The fruits in mango and coconut develop from monocarpellary gynoecium and superior ovary and are one seeded. In these fruits **endocarp is hard and stony,** so these fruits are **also called stony fruits**. e.g. **Mango, coconut, almond, walnut,** plum. In **mango** the outermost cover or thin rind is called epicarp. Middle edible fleshy part is mesocarp and the inner stony hard endocarp.

In **coconut** epicarp is hard and thin while mesocarp is thick and fibrous. The endocarp is hard and seed is proteced in it. The sweet water and edible part of coconut are liquid and solid endosperm respectively.

(b) **Berry :** These fruits developed from superior or inferior ovary.

e.g. **Tomato, brinjal**, banana, grapes, guava

(c) **Pome : This fruit is developed from inferior ovary and having enlarged thalamus.**

e.g. **Apple**, **pear**. These are **false fruits**. In these fruits edible part is thalamus.

(e) **Hesperidium :** This fruit is found in members of Rutaceae family.

e.g. **Orange, lemon.**

Many glandular hairs are present on the inner side of endocarp. These **glandular juicy hairs** are **edible**.

(f) **Balausta :** This fruit is **developed from inferior ovary. Testa of seed is fleshy and juicy. Testa** is the **edible part**.

e.g. **Pomegranate** (***Punica granatum***) = **anar**.

(ii) **Simple dry Fruits :**

Pericarp (fruit wall) of simple dry fruits is not diffrentiated into epicarp, mesocarp and endocarp.

Simple dry fruits can be divided into following three groups :

(a) Indehiscent **(b) Dehiscent** **(c) Schizocarpic**

(a) **Indehiscent Fruits :**

- **Cypsela** : This is a small, one seeded dry fruit which is **developed from** bicarpellary, syncarpous gynoecium and **inferior ovary**. **In cypsela fruit pericarp (Fruit wall) and seed coat are free from each other and a bunch of hair is attached with the fruit which is known as pappus.** e.g. **Compositae family (Sunflower, marigold).**
- **Caryopsis** : These are small, one seeded dry fruits, which is developed from monocarpellary gynoecium and superior ovary. In these fruits **Pericarp is fused with the seed coat and form a joint surface**. These fruits are present in **family Gramineae**. e.g. **wheat, maize etc.**
- **Achene** : **In these fruits pericarp is free from the seed coat & pappus are absent.** e.g. *Mirabilis*
- **Nut** : **This is a single seeded** fruit, its **pericarp is hard.** e.g. Cashew, **litchi.**
- In **litchi aril is fleshy and edible part**.

(b) **Dehiscent Fruits :**

- **Legume or Pod** : **These fruits are developed from monocarpellary gynoecium and unilocular, superior ovary with marginal placentation**.
  e.g. **Pea**, **beans, gram**.

- **Siliqua** : This fruit is developed from bicarpellary, syncarpous gynoecium and superior ovary having parietal placentation. e.g. **Mustard.**
- **Capsule :** e.g. ***Papaver*** (**poppy=opium plant**), **Cotton**(*Gossypium*), ***Datura***, **Lady finger**, **Onion.**

(c) Schizocarpic fruits = Splitting Fruits :

- **Lomentum** : These fruits are splitted in **one seeded many mericarps,** after maturity mericarps get separated with each other. e.g. **Tamarind**, ***ground nut/pea nut***, *Acacia* **(babool).**

(B) Aggregate fruits : These fruits develop from multicarpellary, apocarpous gynoecium. In apocarpous condition each carpel is free from each other and it forms a fruitlet. Aggregate fruits are made up of a bunch of fruitlets which is known as etaerio.

e.g. **Strawberry**, **lotus, rose etc.**

In strawberry, thalamus is fleshy and small achenes are found on its surface.

(C) COMPOSITE FRUITS = Multiple fruits

All composite fruits are false fruits.

In composite fruits, **whole inflorescence is modify into fruit**. These are of two types :

(i) Sorosis : This fruit **develops from spike, spadix or catkin inflorescence.**
e.g. : **Pineapple (annanas) jack fruit (kathal), mulberry (shahtoot)**.

(ii) Syconus or Syconium : This fruit **develops from hypanthodium inflorescence.** Many achenes develop from the pistillate flowers. e.g. ***Ficus species*** **(Fig, peepal)**

(4) EDIBLE PARTS OF SOME IMPORTANT FRUITS :

	PLANT	TYPE OF FRUIT	EDIBLE PARTS
1.	***Anacardium occidentale***/Cashew/Kaju	Nut	Cotyledons and Peduncle
2.	***Ananas comosus*** = ***A. sativus***/Pineapple	Sorosis	Fleshy axis, bracts
			fused perianth & Pericarp /
			Outer portion of receptacle
3.	***Annona squamosa***/Custard Apple/	Etaerio of Berries	Mesocarp & Thalamus / Pericarp
	Sitaphal		
4.	***Arachis hypogea***/Ground nut/Peanut	Lomentum	Seeds/Cotyledons

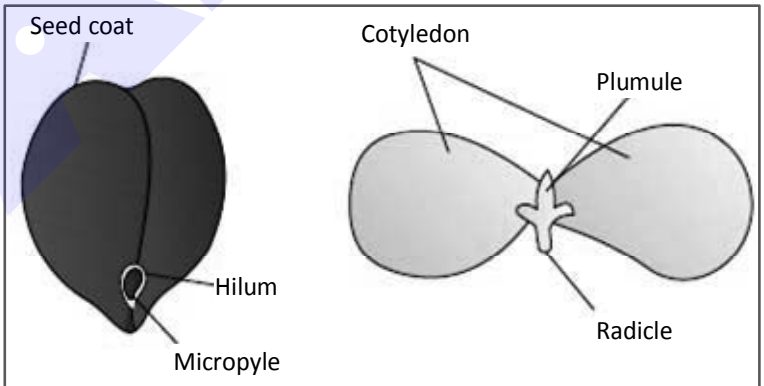
5.	***Artocarpus heterophyllous***/Jack Fruit/ Kathal	Sorosis	Bracts, perianth and seeds (as vegetable and fruit)
6.	Cereals, ***Oryza***, ***sativa*** (Rice), ***Hordeum vulgare*** (Barley), ***Triticum aestivum*** (Bread Wheat), ***Zea mays*** (Maize)	Caryopsis	Whole fruit (Endosperm and embryo)
7.	***Citrus reticulata***/Orange, ***Citrus sinensis***/Sweet Orange, ***Citrus aurantifolia***/Lime	Hesperidium	Juicy glandular hair
8.	***Cocos nucifera***/Coconut	Drupe	Endosperm
9.	***Ficus carica***/Fig/Anjeer	Syconus	Fleshy receptacle
10.	***Fragaria ananassa***/Strawberry	Etaerio of achenes	Fleshy thalamus
11.	***Juglans regia***/Walnut	Drupe	Lobed cotyledons of seed
12.	***Litchi chinensis***/Litchi	Nut	Aril
13.	***Lycopersicum esculentum***/Tomato	Berry	Whole fruit (Pericarp and placenta)
14.	***Pyrus malus*** (M. sylvestris)/Apple	Pome	Fleshy thalamus
15.	***Mangifera indica***/Mango	Drupe	Mesocarp
16.	***Prunus amygdalus***/Almond	Drupe	Seed (Cotyledons and embryo)
17.	***Musa paradisiaca***/Banana	Berry	Less developed mesocarp and well developed endocarp
18.	***Psidium guajava***/Guava	Berry	Whole fruit (Thalamus, pericarp and placenta)
19.	Pulses	Pod/Legume	Seed
20.	***Punica granatum***, Pomegranate/Anar	Balausta	Fleshy juicy testa of seeds
21.	***Pyrus communis***/Pear	Pome	Fleshy thalamus
22.	***Solanum melongena***/Brinjal	Berry	Whole fruit (Pericarp & Placenta)
23.	***Vitis vinifera***/Grapes	Berry	Whole fruit, pericarp and placenta

- **Bulbil :** It is modified vegetative bud with stored food, meant for vegetative reproduction. Eg. ***Agave, Oxalis, Dioscorea*** **(Yam).**
- **Pistillode** : **Sterile pistil** is known as pistillode.
- **Staminode : Sterile stamen** is called staminode. eg. *Salvia*, Caesalpinoidae (*Cassia*, gulmohur, tamarind)
- **Clove (*Syzygium aromaticum*) = Unopened floral bud**
- **Saffron (*Crocus sativus*) = Stigmas + Styles.**
- **Geocarpic fruits : Underground fruits** are called geocarpic fruits. **e.g. *Arachis*** **(groundnut)**.
- Spike of spikelets inflorescence is found in wheat.
- Mixed spadix inflorescence is found in banana.
- **Versatile stamen :-** Long filament is attached to the back of the anther at a point only and anther **can swing freely.** e.g. Wheat, grass, maize (Members of **Poaceae family**).

08. THE SEED

- The ovules after fertilisation, develop into seeds.
- A seed is made up of a seed coat and an embryo.
- The embryo is made up of an embryonal axis with a radicle and a plumule and one (as in wheat, maize) or two cotyledons (as in gram and pea).

(A) Structure of a Dicotyledonous Seed :



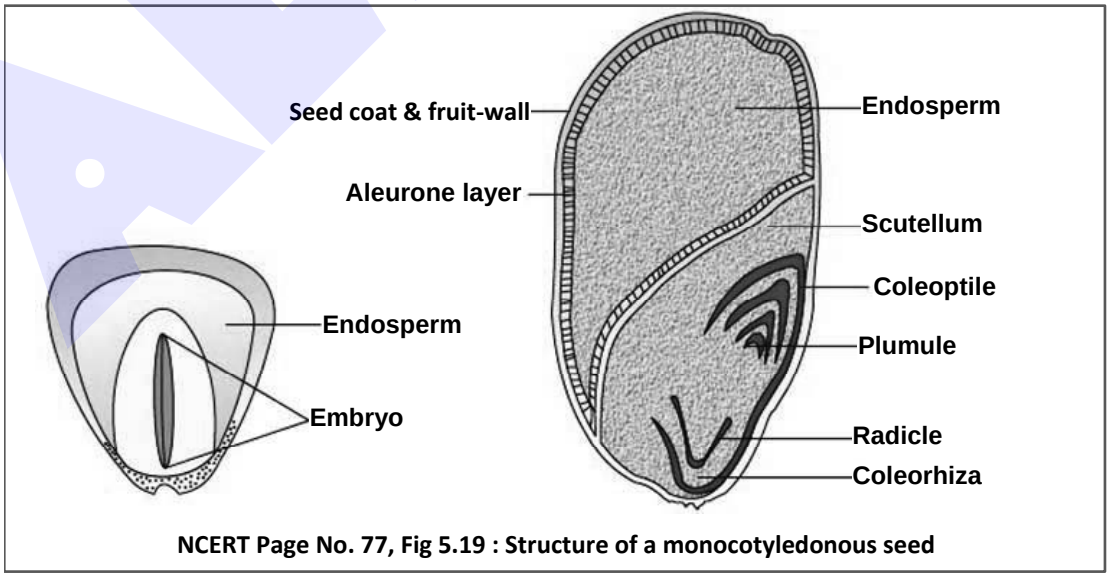
NCERT Page No. 77, Fig. 5.18 Structure of dicotyledonous seed

The outermost covering of a seed is the seed coat. The seed coat has two layers, the outer testa and the inner tegmen.

- The hilum is a scar on the seed coat through which the developing seeds were attached to the fruit. Above the hilum is a small pore called the micropyle. Within the seed coat is the embryo, consisting of an embryonal axis and two cotyledons. The cotyledons are often fleshy and full of reserve food materials.
- At the two ends of the embryonal axis the radicle and the plumule are present.
- In some seeds such as castor the endosperm formed as a result of double fertilisation, is a food storing tissue and called endospermic seeds.
- In plants such as bean, gram and pea, the endosperm is not present in mature seeds and such seeds are called non-endospermous.

(B) Structure of Monocotyledonous Seed

- Generally, monocotyledonous seeds are endospermic but some as in orchids are non endospermic.
- In the seeds of cereals such as maize the seed coat is membranous and generally fused with the fruit wall. The endosperm is bulky and stores food.
- The outer covering of endosperm separates the embryo by a proteinous layer called aleurone layer.
- The embryo is small and situated in a groove at one end of the endosperm. It consists of one large and shield shaped cotyledon known as scutellum and a short axis with a plumule and a radicle. The plumule and radicle are enclosed in sheaths which are called coleoptile and coleorhiza, respectively.



NCERT Page No. 77, Fig 5.19 : Structure of a monocotyledonous seed

09. SEMI-TECHNICAL DESCRIPTION OF A TYPICAL FLOWERING PLANT

Various morphological features are used to describe a flowering plant. The description has to be brief, in a simple and scientific language and presented in a proper sequence. The plant is described beginning with its habit, vegetative characters – roots, stem and leaves and then floral characters inflorescence and flower parts. After describing various parts of plant, a floral diagram and a floral formula are presented.

Following symbols are used in floral formula :-

Bracteate	=	Br
Ebracteate	=	Ebr
Actinomorphic	=	$\oplus$
Zygomorphic	=	% or Φ or ÷
Bisexual flower	=	$\varnothing$
Unisexual male (staminate) flower	=	$\male$
Unisexual female (Pistillate) flower	=	$\female$
Epicalyx	=	Epi or EpiK
Calyx	=	K $\begin{cases} K_n \text{ - Polysepalous condition} \\ K_{(n)} \text{ - Gamosepalous condition} \end{cases}$
Corolla	=	C $\begin{cases} C_n \text{ - Polypetalous condition} \\ C_{(n)} \text{ - Gamopetalous condition} \end{cases}$
Perianth	=	P $\begin{cases} P_n \text{ - Polyphyllous or polytepalous condition} \\ P_{(n)} \text{ - Gamophyllous or gamotepalous condition} \end{cases}$
Androecium	=	A $\begin{cases} A_n \text{ - Polyandrous condition} \\ A_{(n)} \text{ - Cohesion condition} \end{cases}$
Gynoecium	=	G $\begin{cases} G_n \text{ - Apocarpous condition} \\ G_{(n)} \text{ - Syncarpous condition} \end{cases}$
Superior ovary	=	Hypogynous flower = $\underline{G}$
Inferior ovary	=	Epigynous flower = $\overline{G}$
Ovary half inferior or half superior	=	Perigynous flower = G–
Epiphyllous / Epitepalous stamens	=	$\overset{\frown}{P}A$
Epipetalous stamens	=	$\overset{\frown}{C}A$
Gynandrous stamens	=	$\overset{\frown}{A}G$

- A floral diagram provides information about the number of parts of a flower, their arrangement and the relation they have with one another.
- The position of the mother axis with respect to the flower is represented by a dot on the top of the floral diagram. Calyx, corolla, androecium and gynoecium are drawn in successive whorls, calyx being the outermost and the gynoecium being in the centre.
- Floral formula and floral diagram show cohesion and adhesion within parts of whorls and between whorls.
- Floral diagram does not provide information regarding position of ovary.
- Floral formula does not provide information regarding aestivation & placentation.

10. DESCRIPTION OF SOME IMPORTANT FAMILIES

1. CRUCIFERAE [=BRASSICACEAE] = Mustard family

(A) Floral characters :-

(i) Inflorescence- Typical raceme. e.g. Mustard, Radish etc.

(ii) Flower- Ebracteate, bisexual or hermaphrodite, **tetramerous**

Actinomorphic but sometimes zygomorphic

e.g. *Iberis amara* (Candytuft = Chandani)

(iii) Calyx- Sepals 4, polysepalous, sepals are arranged in two whorls 2 outer and 2 inner, imbricate aestivation.

(iv) Corolla- Petals 4, polypetalous, **valvate aestivation and cruciform/cross form**.

(v) Androecium- Stamens 6, arranged in two whorls - in which **two outer stamens are small and inner four stamens are long**. **This condition is known as tetradynamous**.

(vi) Gynoecium- Bicarpellary, syncarpous.

* **The ovary is unilocular in the begining but it becomes bilocular later on due to the formation of a false septum (replum)**. Replum is developed from the thalamus.

* **Placentation is parietal.**

FLORAL DIAGRAM

NCERT XI Page No. 78
Figure No. 5.20

(vii) Fruit- Usually siliqua (eg. Mustard)

(viii) Seeds - Non endospermic

(ix) Floral Formula -

$$\text{Ebr} \oplus \female K_{2+2}\, C_4\, A_{2+4}\, \underline{G}_{(2)}$$

(B) Economic Importance :-

(i) As Food :

(a) Radish (Muli) = ***Raphanus sativus*** - Fusiform root.

(b) Turnip (Shaljam) = ***Brassica rapa*** - Napiform root

(c) Cauliflower (Phool gobhi) = ***Brassica oleracea*** var. *botrytis*, **immature inflorescence is edible.**

(d) Cabbage (Patta gobhi) = ***Brassica oleracea*** var. *capitata*, fleshy leaves of bud are edible.

(e) Mustard (Sarson) = ***Brassica campestris***

(ii) As Ornamental plants :-

Chandani (Candy tuft) = ***Iberis amara***

2. FABACEAE FAMILY

- This family was earlier called Papilionoideae, a subfamily of family Leguminosae.
- It is distributed all over the world.
- Trees, shrubs, herbs are found in this family.

(A) Vegetative characters :-

(i) Roots :- Roots are branched and **tap root system** is present. In root nodules **Nitrogen–fixing bacteria *Rhizobium leguminosarum*** are present.

(ii) Stem – Erect or climber

(iii) Leaves :- Stipulate, simple or pinnately compound, leaf base pulvinate/pulvinus, venation reticulate, alternate

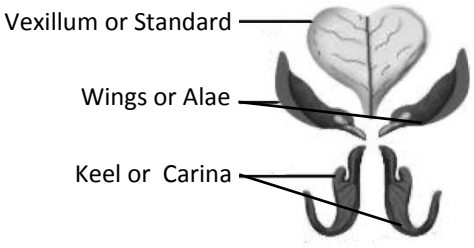
(B) Floral characters :-

(i) Inflorescence :- Typical raceme (**racemose**).

(ii) Flower :- Bracteate, **bisexual**, hypogynous, pentamerous and **zygomorphic** symmetry.

(iii) Calyx :- Sepals 5, gamosepalous, aestivation imbricate or **valvate** (mainly valvate)

(iv) **Corolla :- Petals 5, papilionaceous (Butterfly shaped), polypetalous**, one petal is odd out of 5–petals, towards the mother axis - means **posterior** in position. It is the **largest and outer most petal** which is called **standard or vexillum.**

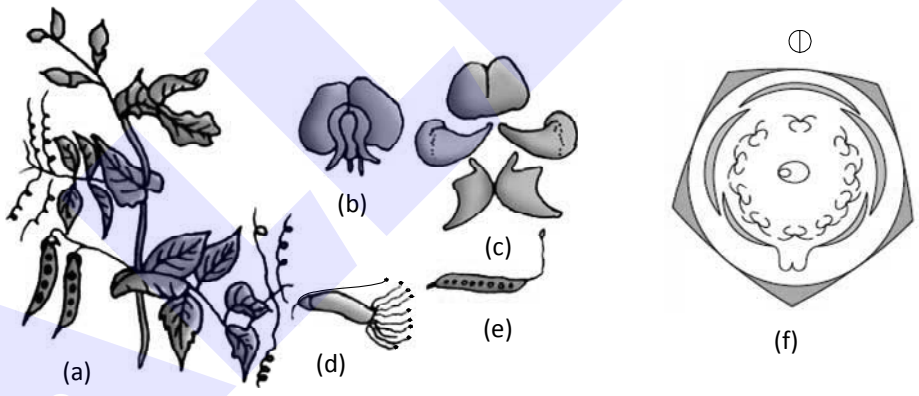


PAPILIONACEOUS COROLLA

→ Below the vexillum, two small free lateral petals present which are known as **wings** or **alae**. (**lateral in position**)

→ Anterior two petals fused together to form a boat like structure called keel or carina which encloses the essential organs. i.e. stamens and pistil/carpel.

Such type of aestivation is called vexillary



***Pisum sativum* (pea) plant :** (a) Flowering twig (b) Flower (c) Petals (d) Reproductive parts (e) L.S. of carpel (f) Floral diagram

NCERT XI Page No. 79, Figure No. 5.21

(v) Androecium

Stamens - 10; diadelphous (9) + 1

*** Anther dithecous**

(vi) Gynoecium :- Gynoecium is **monocarpellary, unilocular with many ovules, superior ovary, style single** and **marginal placentation.**

(vii) Fruit :- Legume or pod

Sometimes lomentum is found eg. *Arachis* (ground nut)

(viii) Seed :- Non-endospermic, one to many

(ix) Floral Formula :-

$\boxed{\text{Br}\ \%\ ♂♀\ K_{(5)}\ C_{1+2+(2)}\ A_{(9)+1}\ \underline{G}_1}$ **or** $\boxed{\text{Br}\ ⊕\ ♂♀\ K_{(5)}\ C_{1+2+(2)}\ A_{1+(9)}\ \underline{G}_1}$

(C) Economic Importance :

(i) As Food :

(a) **Arhar** (Pigeon pea) - **Pulse** = ***Cajanus cajan / cajanus indicus***

(b) **Chana** (**Gram**) - **Pulse** = ***Cicer arietinum***

(c) **Mattar (Pea)** = ***Pisum sativum***

(d) **Mung** (green gram) - **Pulse** = ***Phaseolus* radiates *or vigna* radiatus**

(e) **Soyabean** - **Pulse** = ***Glycine max (G. soja) – Soyabean contains more protein than meat***

(f) **Mungphali (Ground nut or pea nut)** = ***Arachis hypogea.***

(g) **Sem- Pulse** = ***Dolichos lablab***

(ii) As Fodder

(a) **Berseem** = *Trifolium*

(b) **Dhaincha** = *Sesbania*

(iii) As Fibres

Sunnhemp = ***Crotalaria juncea (ternatea)***

(iv) As Timber

Shisham = ***Dalbergia sissoo (Indian Red Wood)***

(v) As Dyes

Neel (Blue dye) = *Indigofera* ***tinctoria***
(dye is obtained from leaves)

(vi) As Medicinal plants

Mulaithi (Liquorice) = ***Glycyrrhiza glabra***
Its **roots** are used in **cough & cold.**

(vii) As Ornamental plants

(a) Indian telegraph plant = ***Desmodium gyrans***

(b) **Sweet pea (Phool matar)** = ***Lathyrus odoratus***

(c) **Lupin** = ***Lupinus albus***

(viii) As Edible oil = **Soyabean, ground nut**

3. SOLANACEAE = Potato family

It is distributed in tropics, subtropics and even temperate zones.

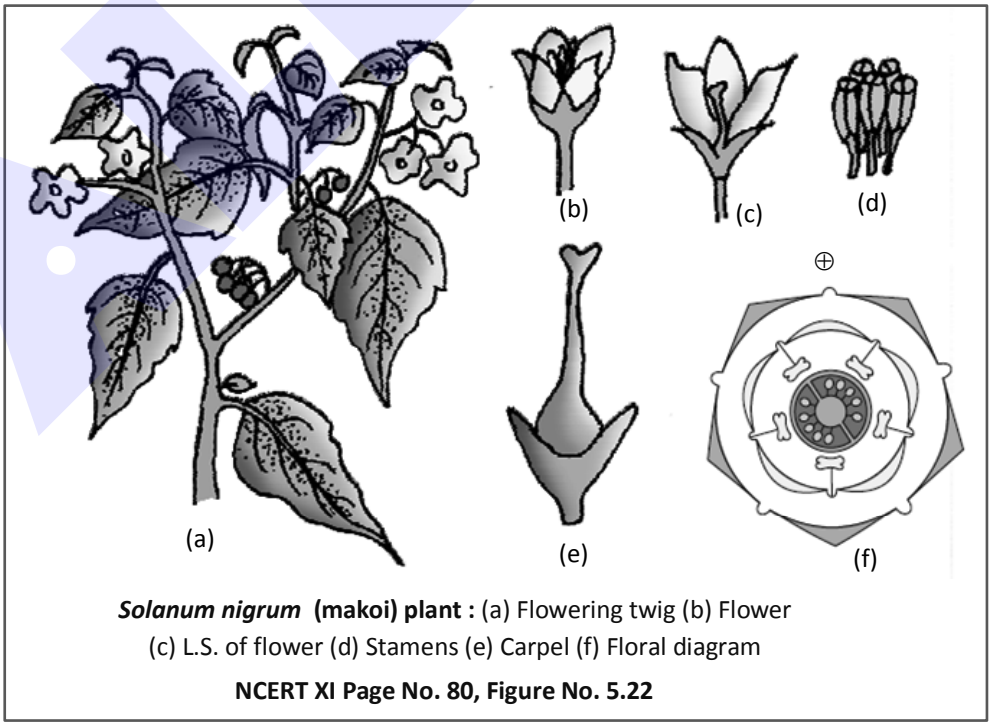
(A) Vegetative characters :-

Most of plants of this family are herbs, some of them are shrubs , rarely small trees. Underground stem is found in potato.

(i) Root : The tap root system is present in these plants.

(ii) Stem : Stem herbaceous rarely woody, aerial, erect, cylindrical, branched, solid or hollow, hairy or glabrous (Smooth). Underground stem (tuber) is found in potato.

(iii) Leaf : Leaves are simple rarely pinnately compound and exstipulate, alternate, venation reticulate.



***Solanum nigrum* (makoi) plant :** (a) Flowering twig (b) Flower (c) L.S. of flower (d) Stamens (e) Carpel (f) Floral diagram

NCERT XI Page No. 80, Figure No. 5.22

(B) Floral characters :-

(i) **Inflorescence:-** Solitary axillary, or cymose inflorescence as in ***Solanum***.

(ii) **Flower :-** Flowers are bracteate or ebracteate, **bisexual**, complete, hypogynous, **pentamerous** and **actinomorphic**.

(iii) **Calyx:-** Sepals 5, gamosepalous (united), valvate aestivation and persistent.

(e.g. tomato, brinjal)

(iv) **Corolla:-** Petals -5, gamopetalous (united), aestivation valvate.

(v) **Androecium:-** Stamens -5, polyandrous, epipetalous stamens

(vi) **Gynoecium:-** Bicarpellary, syncarpous, ovary superior, bilocular and axile placentation.

Special features :- Swollen placenta with many ovules and oblique septum. Ovaries arranged obliquely on thalamus.

(vii) **Fruit:-** Fleshy fruit - berry (tomato, brinjal) sometimes capsule (*Datura*).

(viii) **Seeds :-** Many and endospermic/endospermous.

(ix) **Floral formula :**

$$\text{Br or Ebr} \oplus \female K_{(5)}\, \overset{\frown}{C_{(5)}\, A_5}\, \underline{G}_{(2)}$$

(C) Economic Importance :-

(i) **As Food :**

(a) **Potato** = ***Solanum tuberosum*** - edible part **under ground stem-tuber**

(b) **Tomato** = ***Lycopersicum esculentum/Solanum lycopersicum.***

(c) **Brinjal** (Egg plant) = ***Solanum melongena***

(d) **Makoi** = ***Solanum nigrum***

(e) **Chilli** = ***Capsicum annuum (*****used as spice*****)***

(f) Shimla Mirch **=** ***Capsicum frutescence***

(ii) **As Medicinal plants :-**

(a) ***Atropa belladonna*** (Deadly night shade) :- The **roots** are used in the manufacture of **drug belladonna**. Atropine alkaloids is obtained from the roots. **Atropine is used to dilate the pupil of the eye**.

(b) *Stramonium* is obtained from the seeds of *Datura* (Thorn apple) in which Scopolamine alkaloid is present. It is pain reliever and sedative.

(c) **Nicotine** & anabasin **alkaloid** obtained from the leaves of ***Nicotiana tabacum* (Tobacco)** & *N. rustica.* It is nerve stimulent and are also used as insecticide.

(d) ***Withania somnifera*** = Asvagandh/**Ashwagandha** - Its root used as nerve tonic, leaves used in fever.

(e) *Solanum nigrum* = (Makoi) - The fruits are laxative.

(iii) As Ornamental Plants :- Many plants of the family are cultivated for their beautiful flower and fragrance are as follows :-

Petunia, Raat ki Rani, Din ka Raja.

(iv) As Fumigatory :- Tobacco (*Nicotiana tabacum*)

4. LILIACEAE = Lily family

- Plants of this family are distributed world wide.
- Liliaceae is a monocot family.

Perianth is present in this family, It means there is no difference in between calyx and corolla.

(A) Vegetative character

Perennial herbs with underground bulbs/corms/rhizomes.

(i) Stem

Majority of the plants have underground stem. It is of following types -

(a) **BULBS** eg. - **Onion, Garlic**.

(b) **CORM -** eg. - ***Colchicum.***

(c) **RHIZOME -** eg. ***Aloe***.

The aerial stem is present in few plants. (*Dracaena*, *Yucca, Smilax* etc.)

* **Modification of stem**

Cladode - eg. ***Asparagus, Ruscus***

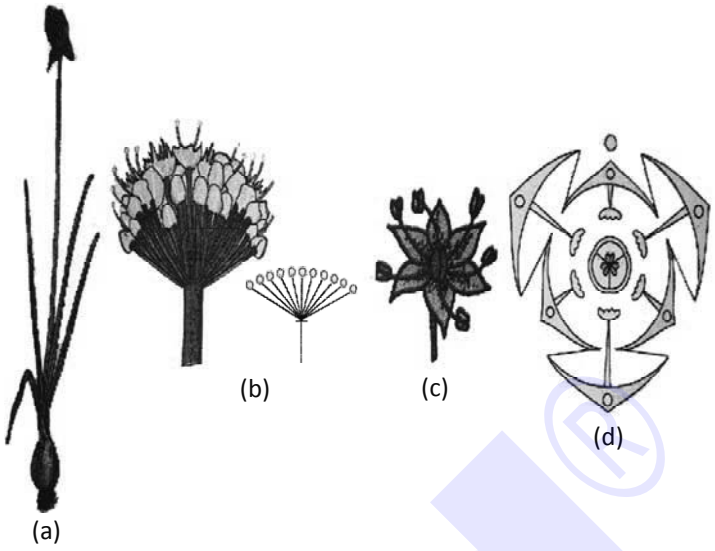
(ii) Root

Usually adventitious/fibrous. Fasciculated roots are found in *Asparagus* (satawar).

(iii) Leaves

→ Mostly basal, linear, alternate, exstipulate with parallel venation.

→ Exceptionally reticulate venation is found in *Smilax*



Allium cepa (onion) plant : (a) Plant (b) Inflorescence (c) Flower (d) Floral

NCERT XI Page No. 81, Figure No. 5.23

(B) Floral Character :-

(i) Inflorescence :- Solitary / Cymose; Often umbellate clusters.

(ii) Flower

Bracteate, bisexual, complete, actinomorphic, hypogynous and trimerous.

(iii) Perianth

Tepals 6, arranged in two whorls (3 + 3), Often united into tube, valvate aestivation

(iv) Androecium

6 stamens, epiphyllous(epitepalous), arranged in two whorls 3 + 3, polyandrous.

(v) Gynoecium

Tricarpellary, syncarpous, superior ovary, trilocular with many ovules, axile placentation, superior ovary.

(vi) Fruit

Capsule (Onion), **rarely berry** (Lily).

(vii) Seeds :- Endospermic/Endospermous

(viii) Floral formula

$$Br \oplus \female P_{(3+3)}\, A_{3+3}\, \underline{G}_{(3)}$$

(C) Economic Importance :

(i) As food

- **Onion** = ***Allium* cepa** - Foul odour is due to an oil like organic compound of sulphur - allyl sulphide formed in Fleshy leaves of bulb.
- **Garlic** = ***Allium sativum*** - Antidiabetic property is due to sulphur containing AA- S - Allyl - Cystine Sulphoxide (SACS) in Fleshy leaves of bulb.
- **Satawar** = ***Asparagus*** - **used as vegetable.**

(ii) As ornamental plants :-

- **Lily** = ***Lilium*** *bulbiferum*
- **Tulip** = ***Tulipa***
- ***Gloriosa*** (Glory lily)

(iii) As medicinal plants :-

- **Gvar patha** (Ghee quar) = ***Aloe vera*** - Aloin, a purgative is obtained. The juice of the leaves is used as skin tonic and it increases the eye sight.
- **Garlic (Lahasun)** = ***Allium sativum*** = It is very useful in **heart disease**, **rheumatism & diabetes**.

(iv) Other uses :-

***Colchicum* autumnale - Colchicine** (**mitotic poison**) is obtained from **corms** of this plant, which is used to induce polyploidy in plants.

BEGINNER'S BOX — FLOWER TO FAMILIES

1. A flower can be regarded as perfect flower when :-
(1) Only one essential whorl is present
(2) Both essential whorls are present
(3) Both accessory whorls are present
(4) Both essential whorls are absent

2. Select the correct statement?
(1) In syncarpous condition one carpel is present
(2) Marginal placentation is found in mustard.
(3) Free central placentation is found in primrose
(4) Arrangement of ovaries is called placentation

3. Select incorrect statement ?

(1) Berry fruits in found in mango.

(2) Tetradynamous stamens are found in mustard

(3) Tricarpellary gynoecium is found in members of family Liliaceae

(4) Monoadelphous stamens are found in Chinarose.

4. Cruciform corolla is found in :-

(1) *Petunia* (2) Pea (3) Mustard (4) Brinjal

5. Which type of placentation is found in mustard.

(1) Marginal (2) Basal (3) Parietal (4) Free central

★ Golden Key Points ★

- Half inferior ovary is found in plum, peach, rose.
- In apocarpous condition carpels are free.
- Generally the fruit consists of pericarp and seeds.
- In fabaceae, flowers are zygomorphic.
- Solanaceae is commonly called 'potato family'
- Free lateral stipules are found in chinarose.
- Foliaceous (leaf like) stipules are found in *Pisum sativum*.
- Advertising flag (modified sepal) is found in *Mussaenda*.

BEGINNER'S BOX ANSWERS KEY

ROOTS TO INFLORESCENCE

Que.	1	2	3	4	5
Ans.	**1**	**1**	**1**	**2**	**4**

FLOWER TO FAMILIES

Que.	1	2	3	4	5
Ans.	**2**	**3**	**1**	**3**	**3**

The root
- Tap root :- Originates from radicle
- Adventitious root: Originates from any parts of plant other than radicle

The Stem:
- Originates from plumule
- Nodes and internode present
- Underground stem of potato, *Colocasia* and turmeric works as organ of perennation

Examples of Root modifications
- **Tap root modification**: Radish, carrot, turnip
- **Adventitious root modification**: Maize, banyan, *Monstera*, Asparagus, sweet potato

Stem modification
- **Sub-aerial** (Partly aerial and partly underground)
  - **Runner**: *Cyanodon*
  - **Stolon**: Jasmine
  - **Sucker**: Pineapple
  - **Offset**: *Eicchornia*
- **Underground** (Completely below the Soil surface)
  - **Tuber**: Potato
  - **Rhizome**: Turmeric, ginger
  - **Corm**: ***Colocasia***
  - **Bulb**: Onion, Garlic
- **Aerial** (completely in air or above the soil surface)
  - **Stem thorn**: *Bougainvillea, Citrus*
  - **Stem Tendrils**: Grapevine, Cucurbits
  - **Phylloclade**: *Opuntia, Euphorbia*
  - **Cladode**: *Ruscus Asparagus*

The leaf:
- Lateral appendages of stem
- Exogenously borne on nodes
- Acropetally arranged
- Originates from shoot apical meristem

Venation
- **Reticulate**: Dicot leaves
- **Parallel**: Monocot leaves

Types of leaves
- Simple leaves
  - –Mango
  - –Peepal
- Compound leaves
  - Pinnately compound: Neem
  - Palmately compound: Silk cotton

Phyllotaxy
- **Alternate**: Mustard, chinarose, sunflower
- **Opposite**: Guava, *Calotropis*
- **Whorled**: *Alstonia*

Inflorescence

- **Racemose**
  - Unlimited growth of axis
  - Acropetal arrangement
- **Cymose**
  - Limited growth of axis
  - Basipetal arrangement

Types of flowers

- **Hypogynous** – Superior ovary
- **Perigynous** – Half inferior ovary
- **Epigynous** – Inferior ovary

Floral symmetry

- **Actinomorphic** – Mustard, *Dathura*
- **Zygomorphic** – Cassia, Pea Gulmohar
- **Asymmetirc** – *Canna*

Aestivation

- **Valvate** – Mustard, *Calotropis*
- **Twisted** – Cotton, chinarose
- **Imbricate** – *Cassia*, gulmohar
- **Vexillary** – Pea, beans

Placentation

- **Marginal** – Pea
- **Axile** – Lemon, Chinarose, tomato
- **Parietal** – *Argemone* Mustard
- **Free central** – *Dianthus*, *Primrose*
- **Basal** – Sunflower, Marigold

Flower :

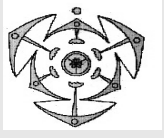
- A modified shoot meant for sexual reproduction
- Unit of sexual reproduction in angiosperms
- Calyx and corolla are accessory whorls of flowers
- Androecium and gynoecium are essential whorls of flower

Fruit :

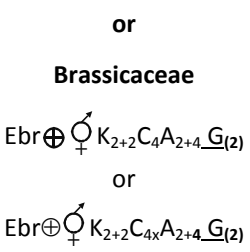
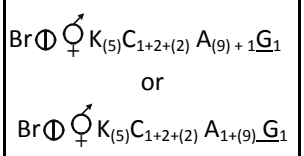
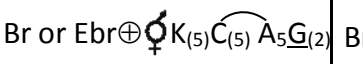
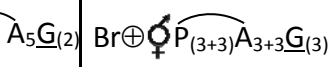
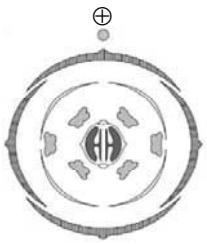
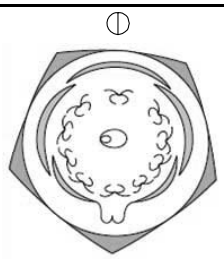
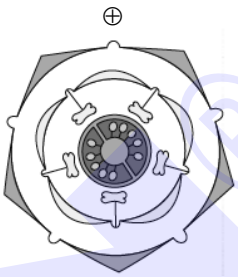
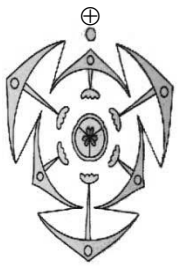
- Ripened ovary after fertilization form fruits
- In mango and coconut drupe fruits are present
- In drupe fruits endocarp is hard and stony
- Parthenocarpic fruits are seed less

Families of angiosperms :

- A flower can be semi technically described by floral formula and floral diagram
- Position of ovary can not be determined by floral diagram
- Aestivation and placentation can not be determined by floral formula
- Adhesion and cohesion can be shown by both floral formula and floral diagram

	Floral formula	Floral diagram
Cruciferae	$\text{Ebr} \oplus \male\female K_{2+2}\, C_{4x}\, A_{2+4}\, \underline{G}_{(2)}$	
Fabaceae	$\text{Br} \odot \male\female K_{(5)}\, C_{1+2+(2)}\, A_{(9)+1}\, \underline{G}_{1}$	
Solanaceae	$\text{Br or Ebr} \oplus \male\female K_{(5)}\, \overset{\frown}{C_{(5)}}\, A_{5}\, \underline{G}_{(2)}$	
Liliaceae	$\text{Br} \oplus \male\female \overset{\frown}{P_{(3+3)}}\, A_{3+3}\, \underline{G}_{(3)}$	

FAMILIES OF ANGIOSPERMS

Floral formula	**Cruciferae or Brassicaceae** 	**Fabaceae** 	**Solanaceae** 	**Liliaceae** 
Floral diagram				
Class	Dicotyledonae	Dicotyledonae	Dicotyledonae	Monocotyledonae
Special characters	• Tetramerous flower • Symmetry actinomorphic • Cruciform Corolla • Tetradynamous stamens • Parietal placentation • Presence of Replum (False septum) • Siliqua Fruit • Non-endospermic seed	• Nodulated roots • Leaves stipulate • Leaf base pulvinate • Pentamerous flower • Flowers zygomorphic • Papilionaceous Corolla • Vexillary aestivation in petals • Diadelphous stamens • Marginal placentation • Fruit Legume/Pod, sometimes Lomentum as in - *Arachis* (Groundnut) • Non-endospermic seed	• Leaves exstipulate • Pentamerous flower • Epipetalous stamens • Swollen placenta • Oblique ovary • Axile placentation • Fruit Berry and sometimes Capsule • Endospermic seed	• Adventitious fibrous roots • Mostly underground stems Bulb / Corm / Rhizome • Leaves exstipulate • Parallel venation • Inflorescence Umbellate clusters • Trimerous flower • Presence of Perianth • Axile placentation • Fruit usually capsule, Sometimes berry • Epitepalous stamens • Endospermic seed
Example	**Radish, Turnip, Cauliflower, Cabbage, Knol-Khol, Mustard, Rai, Chandani (Candy tuft), Shepherd's purse (*Capsella bursa - pastoris*)**	**Pea, Gram, Arhar, Sem, moong, French bean (Rajma), Sem, Soyabean, Groundnut, *Indigofera,* Sunhemp, *Sesbania, Trifolium,* Lupin, Sweet pea, Muliathi, Shisham (*Dalbergia*)**	**Tomato, Brinjal, Potato, Chilli, *Datura*, Belladonna, Ashwagandha (*Withania*) Tobacco, *Petunia,* Makoi**	**Onion, Garlic, Tulip, *Gloriosa, Lily, Smilax, Aloe, Asparagus, Colchicum autumnale***