

Chapter 4 Reproductive Morphology

Inflorescence

Group of flowers arranged together on our preference is a bouquet.

inflorescence is a group of flowers arising from a branched or unbranched axis with a definite pattern.

Types of Inflorescence Based On Position -three major types.

Terminal: Inflorescence grows in the terminal shoot. Ex: Raceme of *Nerium oleander*

Axillary: Present in the axile of leaf. Ex: *Hibiscus rosa-sinensis*

Cauliflorous: Developed directly from a woody trunk. Ex: *Theobroma cocoa*, *Couroupita guianensis*.

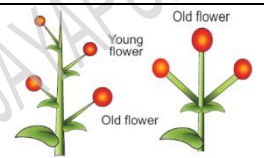
Based on branching pattern and other characters

I. Indeterminate (racemose)

II. Determinate (cymose)

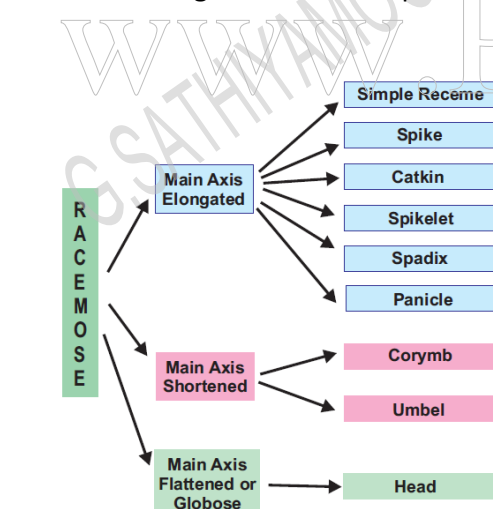
III. Mixed inflorescence: a combination of indeterminate and determinate pattern

IV. Special inflorescence: Inflorescence which do not confined to these patterns

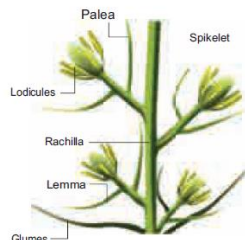
	Racemose		Cymose
Main axis	Unlimited growth		Limited growth.
Flowers arrangement	An acropetal succession		A basipetal succession
Opening of flowers	Centripetal		Centrifugal
Oldest flower	At the base of the axis.		At the top of the axis.

I. Racemose -Three types

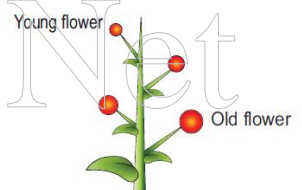
I. Main axis elongated -- contains pedicellate or sessile - flowers - 2 types



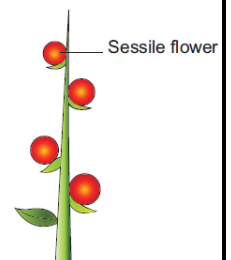
Racemose



a. **Simple raceme:** Unbranched inflorescence axis bears pedicellate flowers in acropetal succession. Ex: *Crotalaria retusa*, mustard and radish.



b. **Spike:** unbranched inflorescence axis bears sessile flowers. Ex: *Achyranthes*, *Stachytarpheta*.



c. **Spikelet:** Spike with branched central axis.

Each branch is a **spikelet**.

Sessile flowers in acropetal succession .

Glumes - A pair of inflorescence bracts

Lemma – Bract

Palea - Bracteole.

Lodicule- Tepals reduced to colourless scaly leaves .

Each flower has stamen and pistil only.

Ex: Paddy, Wheat, Barley, *Sorghum*.

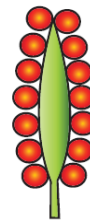
d. Catkin:

Pendulous spikes with a long and drooping axis bearing small unisexual or bisexual flowers. It is also called **ament**. Example: *Acalypha hispida*, *Prosopis juliflora*, *Piper nigrum*.



e. Spadix:

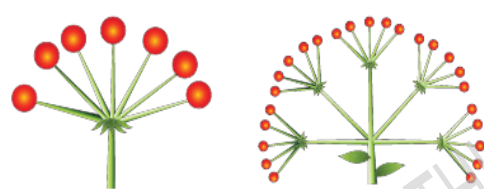
Unisexual sessile flowers on fleshy central axis.
 Female flowers at the base and male flowers at the apex.
 These covered by a brightly coloured bract called a **spathe**.
 Ex: *Amorphophallus*, *Colocasia*, *Phoenix*, *Cocos*.

**f. Panicle or Compound raceme or raceme of racemes:**

A branched raceme is called **panicle**.
 Ex: *Mangifera*, neem, *Delonix regia*.

2. Main axis shortened: Two types**a. Corymb:**

Shorter pedicellate flowers at the top and
 Longer pedicellate flowers at the bottom.
 All flowers appear at the same level to form convex or flat
 Ex: *Caesalpinia*. **Compound corymb:** A branched corymb. Ex: Cauliflower.

**b. Umbel:**

Indeterminate central axis.
 Pedicellate flowers arise from a common point of peduncle
 at the apex.
 Ex: *Allium cepa*, *Centella asiatica*, *Memecylon umbellatum*.

Compound umbel: A branched umbel. Each unit is called **umbellule**.

Ex: *Daucus carota*, *Coriandrum sativum*, *Memecylon edule*.

3. Main axis flattened:

The main axis of inflorescence is mostly flattened (convex or concave) or globose.

A head or capitulum

Group of sessile or sub sessile flowers arising on a receptacle or torus.

Covered by an involucre. Found in Asteraceae

some members of Rubiaceae. Ex: *Neolamarkia cadamba*, *Mitragyna parvifolia*

some members of Fabaceae -Mimosoideae. Ex: *Acacia nilotica*, *Albizia lebbek*, *Mimosa pudica*
 (sensitive plant) .

two types of florets: 1. Disc floret or tubular floret. 2. Ray floret or ligulate floret. Heads are two types.

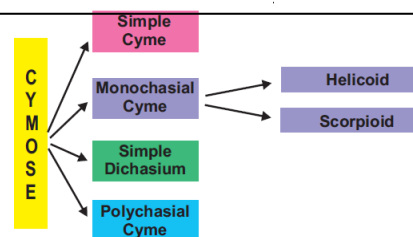
i. Homogamous head: single kind of florets in head .

Disc florets alone. Ex: *Vernonia*, *Ageratum*

Ray florets alone. Ex: *Launaea*, *Sonchus*.

ii. Heterogamous head: both types of florets in head . Ex: *Helianthus*, *Tridax*.

Disc florets at the centre the **ray florets** at the margin of the head .

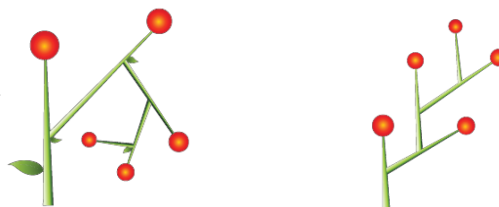
II. Cymose inflorescence.

Cyme

1. Simple cyme (solitary):

A single flower may be terminal or axillary.

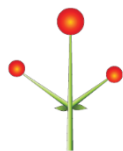
Ex: terminal in *Trillium grandiflorum* and axillary in *Hibiscus*.

**2. Monochasial Cyme (uniparous):**

The main axis ends with a flower. From two lateral bracts, only one branch grows further. Two types

a. **Helicoid:** Axis develops on only one side and forms a coil at earlier stage Ex: *Hamelia*, potato.

b. **Scorpioid:** Axis develops on alternate sides and often a coil structure. Ex: *Heliotropium*.

**3. Simple dichasium (Biparous):**

A central axis ends in a flower further produced by two lateral buds.

Three flowers of which central one is old one.

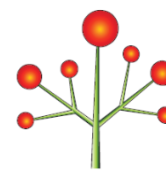
This is **true cyme**. Ex: *Jasminum*.

4. Compound dichasium:

A terminal old flower develops lateral simple dichasial cymes on both sides.

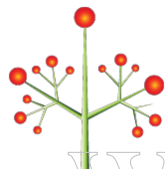
Seven flowers are found. Ex: *Clerodendron*.

A small, simple dichasium is called **cymule**.

**5. Polychasial Cyme (multiparous):**

The central axis ends with a flower.

The lateral axes branches repeatedly. Ex: *Nerium*

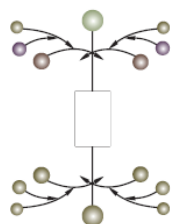


III. Mixed Inflorescence: Both racemose and cymose patterns of development occur in a mixed manner. Two types.

1. Thyrsus: It is a 'Raceme of cymes'.

Indefinite central axis bears lateral pedicellate cymes, (simple or compound dichasia).

Example: *Ocimum*, *Anisomeles*.

**2. Verticil or Verticillaster:**

Main axis bears two opposite lateral sessile cymes at the axil of the node, each of it produces monochasial scorpioid lateral branches so that flowers are crowded around the node.

Example: *Leonotis*, *Leucas*.

IV. Special Inflorescence: The inflorescences do not show any of the development pattern types.

1. Cyathium:

Small unisexual flowers enclosed by a involucre.

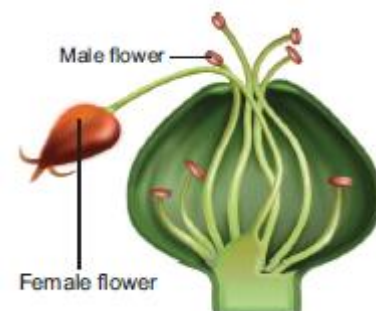
Male flowers are organised in a scorpioid manner.

Female flower is solitary and centrally located on a long pedicel.

Male flower is represented only by stamens and female flower is represented only by pistil.

Nectar is present in involucre.

Cyathium may be actinomorphic (*Euphorbia*) or zygomorphic (*Pedilanthus*).





2. Hypanthodium: Receptacle is a hollow, globose.

unisexual flowers present on the inner wall of the receptacle.

Receptacle contains small opening called **ostiole**.

which is covered by a series of bracts.

Male flowers are present nearer to the ostiole, female and neutral flowers are found in a mixed form below. Example: *Ficus sp.* (Banyan and Pipal).

3. Coenanthium:

Circular disc like fleshy open receptacle that bears pistillate flowers at the center and staminate flowers at the periphery.

Example: *Dorstenia*

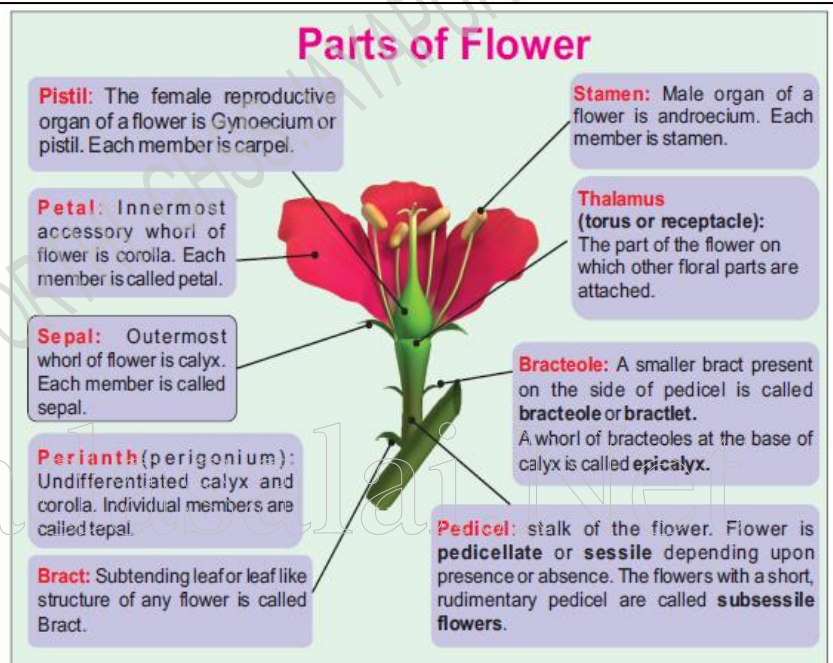


FLOWER

- The flower is a significant feature of angiosperms.
- It is a modified condensed reproductive shoot.
- The growth of the flower shoot is determinate.

Whorls of flower:

- Two whorls 1. accessory and 2. essential.
- **Accessory whorl** consists of calyx and corolla
- **Essential whorl** comprises of androecium and gynoecium.
- **Complete flower** -- contains all four whorls.
- **An Incomplete flower** -- devoid of one or more whorls.



Flower sex:

Presence or absence of androecium and gynoecium within a flower.

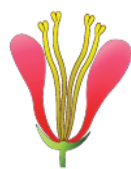
1. Perfect or bisexual (monoclinous) : Flower contains both androecium and gynoecium .

2. Imperfect or unisexual (diclinous): Flower contains only one of the essential whorls. Two types: i) **Staminate flowers:** Flowers only with androecium alone.

ii) **Pistillate flowers:** Flowers with only gynoecium.



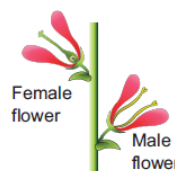
Bisexual flower



Male flower



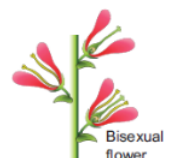
Female flower



Monoecious



Dioecious



Polygamous

Plant sex

presence and distribution of flowers with different sexes in an individual plant.

1. Hermaphroditic: All the flowers of the plant are bisexual.

2. Monoecious (mono-one; oikos-house): Both male and female flowers are present in the same plant Ex: Coconut.

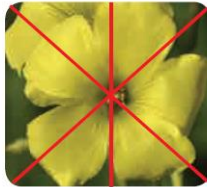
3. Dioecious (di-two; oikos-house): Male and Female flowers are present on separate plants. Ex: Papaya, Palmyra.

4. Polygamous: Bisexual and unisexual (staminate/pistillate) flowers occur in a same plant. Ex: Musa, *Mangifera*.

Flower symmetry

➤ Flower symmetry is an important structural adaptation related to pollination systems.

- 1. Actinomorphic (or) radial or polysymmetric:** The flower can be divided into equal halves in any plane through the centre. Example: *Hibiscus*, *Datura*, water lily.
- 2. Zygomorphic (bilateral symmetry) or mono symmetric:** The flower can be divided into equal halves in only one plane.. Example: *Pisum* , Bean, Cassia, Gulmohar, *Salvia*, *Ocimum*.
- 3. Asymmetric (amorphic) :** Flower cannot be divided into equal halves in any plane. Parts of such flowers are twisted. Example: *Canna indica*.



Actinomorphic



Zygomorphic



Asymmetric

Accessory organs :

Arrangement of whorls:

The position of sepals/petals/ tepals are relative to one another.

- 1. Cyclic or whorled :** All the floral parts are arranged in definite whorls. Example: *Brassica*, *Solanum*.
- 2. Acyclic or spiral:** The floral parts are arranged in spirals. Example: *Magnolia*.
- 3. Spirocyclic or hemicyclic:** Some parts are in whorls & others parts are in spirals. Ex: *Nymphaea*, *Annona*, *Polyalthia*

Cyclcy

Number of whorls of floral parts. Perianth cyclcy is the number of whorls of perianth parts.

- 1. Uniseriate:** single whorl of accessory floral part. It is rare. Example: *Sterculia*.
- 2. Biseriate (dicyclic):** Two whorls of accessory floral parts. Most common type. Example: *Hibiscus*.
- 3. Multiseriate: (triseriate,tetraseriate)** More than two whorls of accessory floral parts.

Example: *Chrysanthemum*.

- 4. Dichlamydeous:** A flower is composed of distinct outer calyx and inner corolla.
 - 5. Homochlamydeous:** Perianth is un-differentiated into calyx and corolla(**tepals**).
- Most monocots have a homochlamydeous perianth.
- 6. Achlamydeous:** Perianth is absent altogether.

Apetalous - Flowers without petals

Asepalous - Flowers without sepals



Uniseriate



Biseriate



Multiseriate



Dichlamydeous



Homochlamydeous

Merosity Number of floral parts per whorl is called merosity.

- 1. Isomerous:** Presence of same number of perianth parts . (five sepals, five petals). Example: *Hibiscus*.
- 2. Anisomerous:** Each whorl of flower contains different number of sepals and petals. Example: *Annona*.
- 3. Bimerous:** Floral parts in two or multiples of two. Example: *Ixora*
- 4. Trimerous:** Floral parts in three or multiples of three. Example: *Allium*, Monocots.
- 5. Tetramerous:** Floral parts in four or multiples of four. Example: *Brassica juncea*.
- 6. Pentamerous:** Floral parts in fi ve or multiples of fi ve. Example: *Hibiscus*, Dicots.



Trimerous



Tetramerous



Pentamerous

Calyx

- Calyx protects bud .
- Outermost whorl of flower .
- Unit of calyx is sepal.
- Normally green in colour.



Aposepalous



Synsepalous

1. Fusion:

a. Aposepalous (polysepalous or chorisepalous):

The flower with distinct sepals. Example: *Brassica*, *Annona*.

b. Synsepalous: The flower with united or fused sepals. Example: *Hibiscus*, *Brugmansia*.

2. Duration of floral parts:

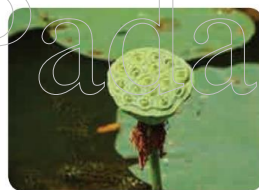
a. Caducous or fugacious calyx: Calyx that withers or falls during the early development stage of flower.

Example: *Papaver*.

b. Deciduous: Calyx that falls after the opening of flower (anthesis) Example: *Nelumbo*.

c. Persistent: Calyx that persists and continues to be along with the fruit. Example: Brinjal.

d. Accrescent: Calyx that is persistent, grows along with the fruit and encloses the fruit either completely or partially. Example: *Physalis*, *Palmyra*.

Caducous bud
with sepalCaducous flower
without sepal

Deciduous



Persistent calyx



Accrescent

3. Shapes of calyx

- Bell shaped calyx called **Campanulate**. . Ex. shoe flower's
- Urn shaped fruiting calyx is called **urceolate** . Ex. *Withania* .
- calyx is tube like known as **tubular**. Ex. *Datura*
- Two lipped calyx is present. Ex. *Ocimum*.
- Sometimes calyx is coloured and called **petaloid**. Ex: *Saraca*, *Sterculia*.
- Calyx is distinctly leafy, large and often yellow or orange coloured sometimes white. Ex. *Mussaenda*.
- Calyx is modified into hair like structure or scaly called **pappus** Ex. *Tridax* of *Compositae*.



Mussaenda



Campanulate



Pappus



Cruciform



Caryophyllaceous

Corolla

Most attractive part of the flowers and brightly coloured. Corolla helps in pollination.

1. Fusion:

- Apopetalous (polypetalous, choripetalous)** : Petals are distinct. Example: *Hibiscus*.
- Sympetalous (gamopetalous)** : Petals are fused. Example: *Datura*.

2. Shapes of corolla

I. Apopetalous Actinomorphic

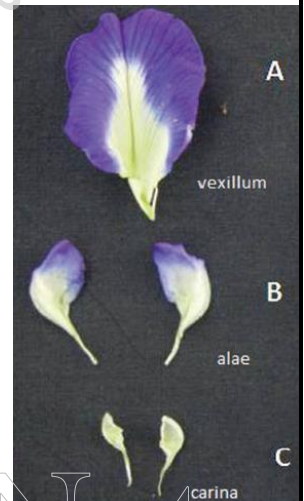
- Cruciform** : Four petals arranged in the form of a cross. Ex: *Brassica*, mustard, radish, cauliflower.
- Caryophyllaceous** : Five petals with long claws with limb at right angles to the claw.
Ex: Caryophyllaceae *Dianthus*.

3. Rosaceous: Five to many sessile or minutely clawed petals with radiating limbs. Ex: Rose, Tea.

II. Apopetalous Zygomorphic

1. Papilionaceous:

- Made up of five distinct petals organized in a butterfly shape.
- Corolla has three types of petals. One large posterior petal called **vexillum**(standard)
- Two lateral petals- wings (**alae**) and
- Two anterior sympetalous petals called **carina**.
- Ex: *Clitoria ternatea*, Pea, Bean.



Apopetalous		Sympetalous	
Actinomorphic	Zygomorphic	Actinomorphic	Zygomorphic

III. Sympetalous Actinomorphic

- Tubular**: Petals united to form a narrow tubular with very short limbs. Ex: Disc floret of sunflower.
- Companulate**: Petals fused to form a bell-shaped corolla . Ex: *Physalis*, *Cucurbita maxima*, *Campanula*.
- Infundibuliform**: Petals fused to form funnel-shaped corolla. Tube gradually widens into limbs. Ex: *Datura*, *Ipomoea*.
- Rotate**: Petals fused to form a wheel shaped corolla with very short tube and a spreading circular limb.
Ex: brinjal, *Evolvulus*
- Salver shaped or Hypocrateriform**; Petals fused to form a long narrow tube with spreading limbs.
Ex: *Catharanthus*, *Ixora*, *Tabernaemontana*
- Urceolate**: Petals fused to form urn-shaped or pot- shaped corolla. Ex: *Bryophyllum calycinum*, *Diaspyras*.



Companulate



Infundibuliform



Rotate



Salvershaped



Urceolate



Bilabiate



Personate

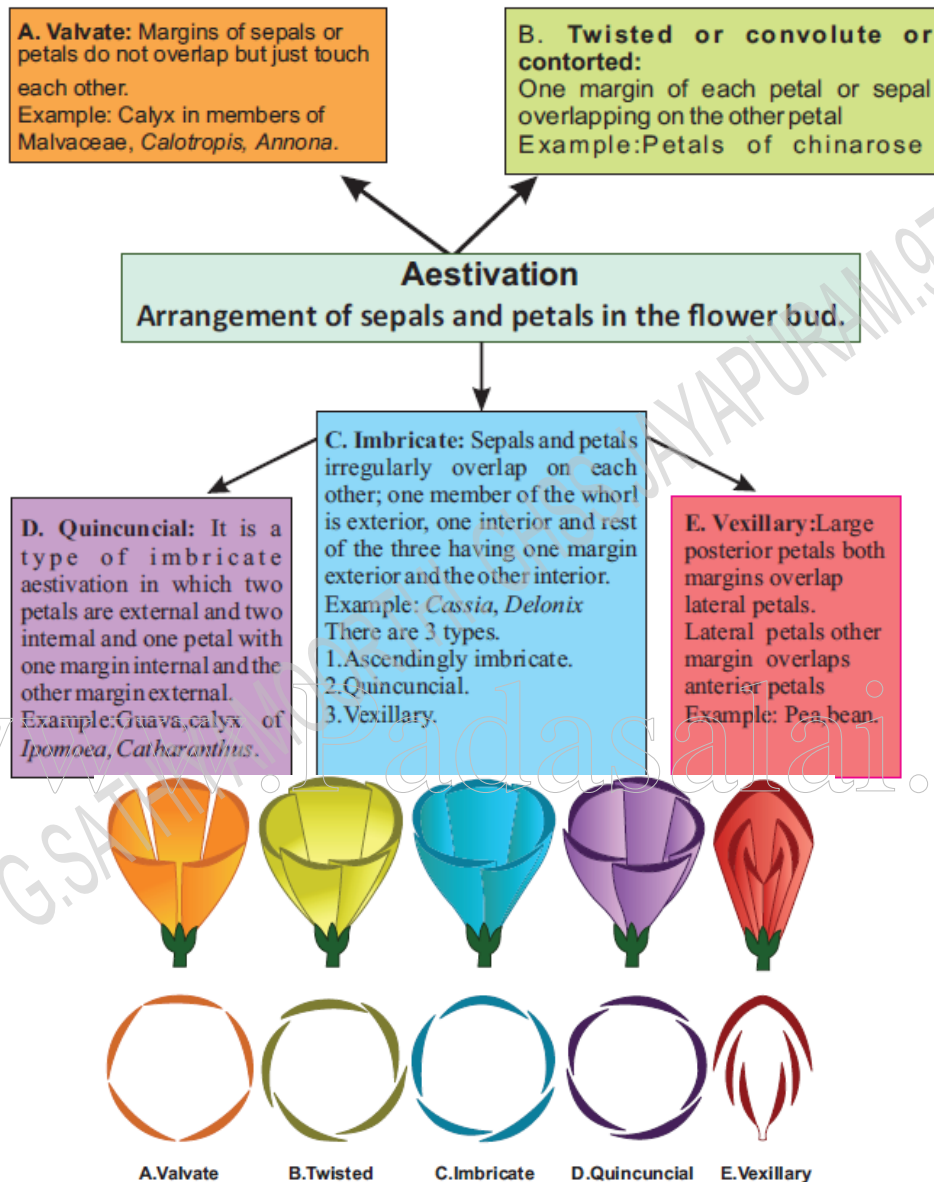
IV. Sympetalous Zygomorphic

- Bilabiate**: Corolla with two lips. Ex: *Ocimum*, *Leucas*, *Adhatoda*.
Tubular corolla with a single strap-shaped limb. Ex: Ray floret of *Helianthus*
- Personate**: Corolla made up of two lips with the upper arched and the lower protruding into the corolla throat. Ex: *Antirrhinum*, *Linaria*.
- Ligulate**: Tubular corolla with a single strap-shaped limb. Ex: Ray floret of *Helianthus*.

Perianth

- undifferentiated calyx and corolla in a flower is called **perianth**.
- Each member is called **tepal**.
- Tepals are distinct they are called **Apotepalous** (Polyphyllous). Ex: *Allium sativum*.
- Fused tepals are called **Syntepalous**. (Gamophyllous). Ex: *Allium cepa*.

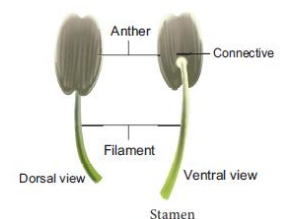
Aestivation: Arrangement of sepals and petals in the flower bud is said to be aestivation.



Lodicule: Reduced scale like perianth in the members of Poaceae is called lodicule.

Essential Parts of Flower

- **Androecium:** Third whorl of flower is the male reproductive part of the flower.
- It is composed of stamens (microsporophylls). Each stamen consists of 3 parts,
- **Anther:** Upper swollen part with microsporangia.
- **Filament:** Stalk of stamen
- **Connective:** Tissue connecting anther lobes with filament
- Anther contains two compartments called **thecae** (singular theca). Each theca consists of two microsporangia.
- Two microsporangia fused to form a **locule**. Sterile stamens are called **Staminodes**. Ex: *Cassia*.



- **Distinct:** stamens which do not fuse to one another. **Free:** stamens which do not fuse with other parts of flower.
- **Apostemonous:** flowers with stamens that are free and distinct.

Fusion of stamens: The stamens fusing among themselves or with other parts of flower. Two types.

1. Connation: The fusion of stamens among themselves. Three types.

a. Adelphy: Filaments connate into one or more bundles but anthers are free. Three types.

1. **Monadelphous:** Filaments of stamens connate into a single bundle. Ex: malvaceae (chinarose, cotton).
2. **Diadelphous:** Filaments of stamens connate into two bundles. Example: Fabaceae, pea.
3. **Polyadelphous:** Filaments connate into many bundles. Example: *Citrus*, *Bombax*

b. Syngenesious: Anthers connate, filaments free. Example: Asteraceae.

c. Synandrous: Filaments and anthers are completely fused. Example: *Coccinea*.



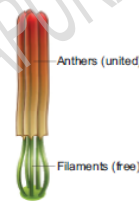
Monadelphous



Diadelphous



Polyadelphous



Syngenesious



Synandrous

2. Adnation: Refers to the fusion of stamens with other floral parts.

Epipetalous (petalostemonous): Stamens are adnate to petals. Example: brinjal, *Datura*.

a. Episepalous: stamens are adnate to sepals. Example: *Grevillea* (Silver oak).

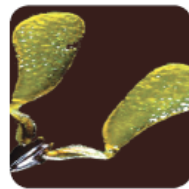
b. Epitpalous (epiphylous): stamens are adnate to tepals. Example: *Aphodelus*, *Asparagus*.

c. Gynostegium: Connation product of stamens and stigma is called **gynostegium**. Ex: *Calotropis* and *Orchidaceae*.

d. Pollinium: Pollen grains are fused together as a single mass.



Gynostegium



Pollinium

Arrangement of stamens relate to length of stamens:

1. **Didynamous (di-two, dynamis-strength):** Four stamens in which two with long filaments and two with short filaments is called **didynamous**. Ex: *Lamiaceae*, *Ocimum*.

2. **Tetradynamous (tetra-four):** Six stamens of which four with long filaments and two with short filaments. Ex: *Brassicaceae*, (*Brassica*).

3. **Heterostemonous:** stamens are of different lengths in the same flower. Ex: *Cassia*, *Ipomoea*.



Didynamous



Tetradynamous



Heterostemonous

Stamen insertion

1. **Inserted:** Shorter than the corolla tube and included within. Ex: *Datura*.

2. **Exserted:** Longer than the corolla tube and project out. Ex: *Mimosa*, *Acacia arabica*

stamen cycly : The number of whorls of stamens present in a flower .Two types

1. **uniseriate**, a single whorl of stamens and 2. **biseriate**, two whorls of stamens.



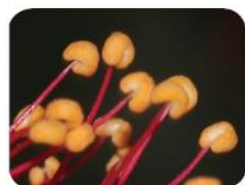
Inserted

Exserted

Anther types

1. **Monothechal:** One lobe with two microsporangia. kidney shaped in a cross section. Ex: Malvaceae

2. **Dithechal:** Two lobes with four microsporangia. butterfly shaped in cross section. Ex: solanaceae.



Monothechal



Dithechal



Basifixed



Dorsifixed



Versatile



Adnate

Anther attachment

1. **Basifixed:** (Innate) Filament attached at the base of anther. Ex: *Brassica*, *Datura*.

2. **Dorsifixed:** Filament is attached to the dorsal side of the anther. Ex: *Citrus*, *Hibiscus*.

3. **Versatile:** Filament is attached to the anther at midpoint. Ex: Grasses.

4. **Adnate:** Filament is attached from the base to the apex of anther. Ex: *Verbena*, *Ranunculus*, *Nelumbo*

Anther dehiscence

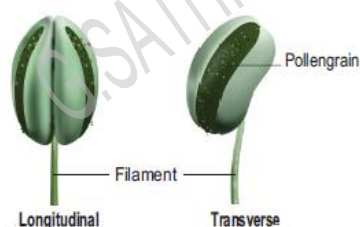
Opening of anther to disperse pollen grains.

1. **Longitudinal:** Anther dehisces along a suture parallel to long axis of each anther lobe. Ex: *Datura*, chinarose, cotton.

2. **Transverse:** Anther dehisces at right angles to the long axis of anther lobe. Ex: Malvaceae.

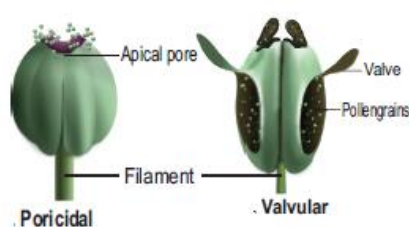
3. **Poricidal:** Anther dehisces through pores at one end of the thecae. Ex: Ericaceae, *Solanum*, potato, brinjal, *Cassia*.

4. **Valvular:** Anther dehisces through a pore covered by a flap of tissue. Ex: Lauraceae, *Cinnamomum*.



Longitudinal

Transverse



Poricidal

Valvular



Introrse



Extrorse

Anther dehiscing direction

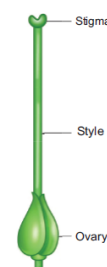
The position of anther opening relative to the anther of the flower.

1. **Introrse:** Anther dehisces towards the center of the flower. Example: *Dianthus*.

2. **Extrorse:** Anther dehisces towards periphery of the flower. Example: *Argemone*.

Gynoecium or pistil

- Female reproductive part of the flower.
- A pistil consists of an expanded basal portion called the ovary,
- an elongated section called a **style** and
- an apical structure that receives pollen called a **stigma**.
- Ovary with stipe is called **stipitate ovary**.
- **Carpel:** They are components of a gynoecium.
- Gynoecium is made of one or more carpels.
- Carpels may be distinct or connate.



Number of carpel

Unicarpellary (monocarpellary) Single carpel Example: Fabaceae	Bicarpellary Two carpels Example: Rubiaceae	Tricarpellary Three carpels Example: Cucurbitaceae	Tetracarpellary Four carpels Example: Lamiaceae.	Multicarpellary Many carpels Example: Nymphaeaceae.
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Fusion of carpels

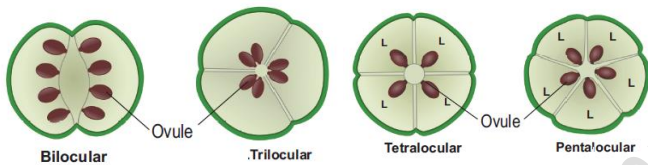
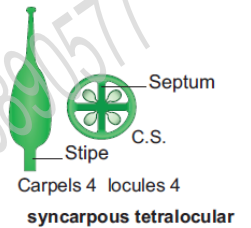
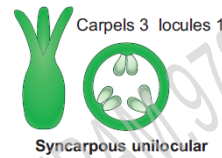
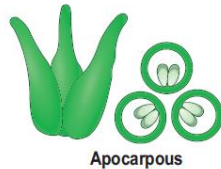
It is an important systematic character. Apocarpous gynoecium is ancestral condition in Angiosperms.

Apocarpous

A pistil contains two or more distinct carpels.
Example: Annona.

Syncarpous

A pistil contains two or more carpels which are connate.
Example: Citrus, tomato.

**Number of locules**

Ovary bears ovules on a specialized tissue called **placenta**.

A **septum** is a crosswall or partition of ovary.

The walls of ovary and septa form a cavity called **locule**.

Number of locules

Like that tetralocular and pentalocular ovaries are present according to the locule numbers four and five. More than one locule ovaries are called **plurilocular**.

Unilocular

Ovary with one chamber
Example:
pea,
groundnut.

Bilocular

Ovary with two chambers
Example:
mustard,
Crossandra.

Trilocular

Ovary with three chambers
Example:
banana,
Euphorbia.

Style and stigma

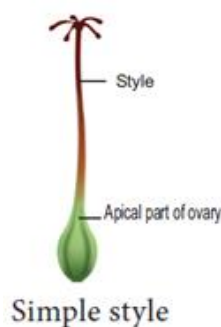
1. Style is a stalk like structure of a pistil connecting ovary and stigma.

a. Simple: Single unbranched style. Example: *Hibiscus*.

b. Bifid: A style branched into two. Example: Asteraceae

c. Gynobasic style: arising from base of the ovary. Ex: Lamiaceae (*Ocimum*), characteristic of Boraginaceae.

d. Lateral style: Style arises from the side of ovary. Example: *Mangifera*.



2. Stigma:

Tip of a pistil is called stigma It receives the pollen grains.

a. **Discoid:** A disk-shaped stigma is called **discoid**.

b. **Capitate:** Stigma appearing like a head. Ex: *Alchemilla*

c. **Globose:** Stigma is spherical in shape is called **globose**.

d. **Plumose stigma:** Stigma feathery which is unbranched or branched as in Asteraceae, Poaceae.

3. Pistillode: A reduced sterile pistil. Example: ray floret of head inflorescence in *Helianthus*.

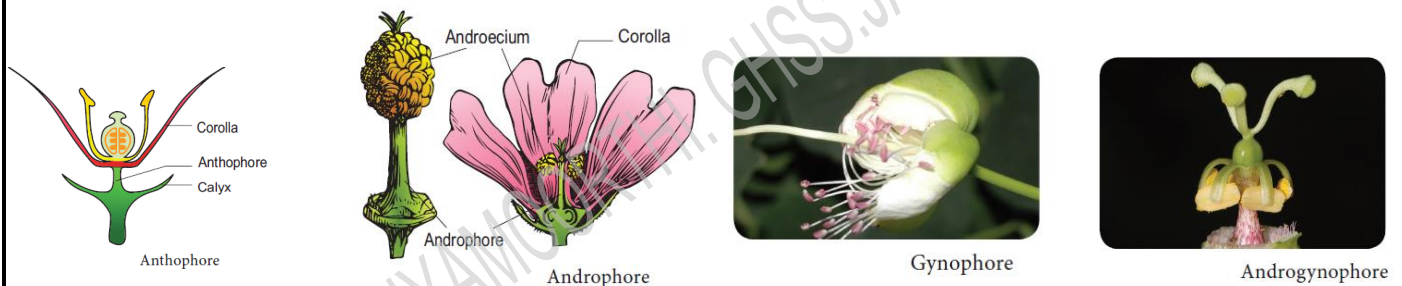
Extension of the condensed internode of the receptacle

1. **Anthophore:**The internodal elongation between calyx and corolla. Ex: caryophyllaceae (*Silene conoidea*)

2. **Androphore:** The internodal elongation between the corolla and androecium. Ex: *Grewia*.

3. **Gynophore:** The internodal elongation between androecium and gynoecium. Ex: *Capparis*.

4. **Gynandrophore or Androgynophore:** The unified internodal elongation between corolla and androecium and androecium and gynoecium. Example: *Gynandropsis*.

**Ovary position**

The position or attachment of ovary relative to the other floral parts.

1. **Superior ovary:** it is the ovary with the sepals, petals and stamens attached at the base of the ovary.

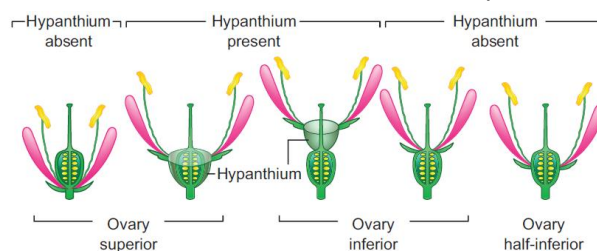
2. **Inferior ovary:** It is the ovary with the sepals, petals and stamens attached at the apex of the ovary.

3. **Half-inferior ovary:** It is the ovary with the sepals, petals and stamens or hypanthium attached near the middle of the ovary.

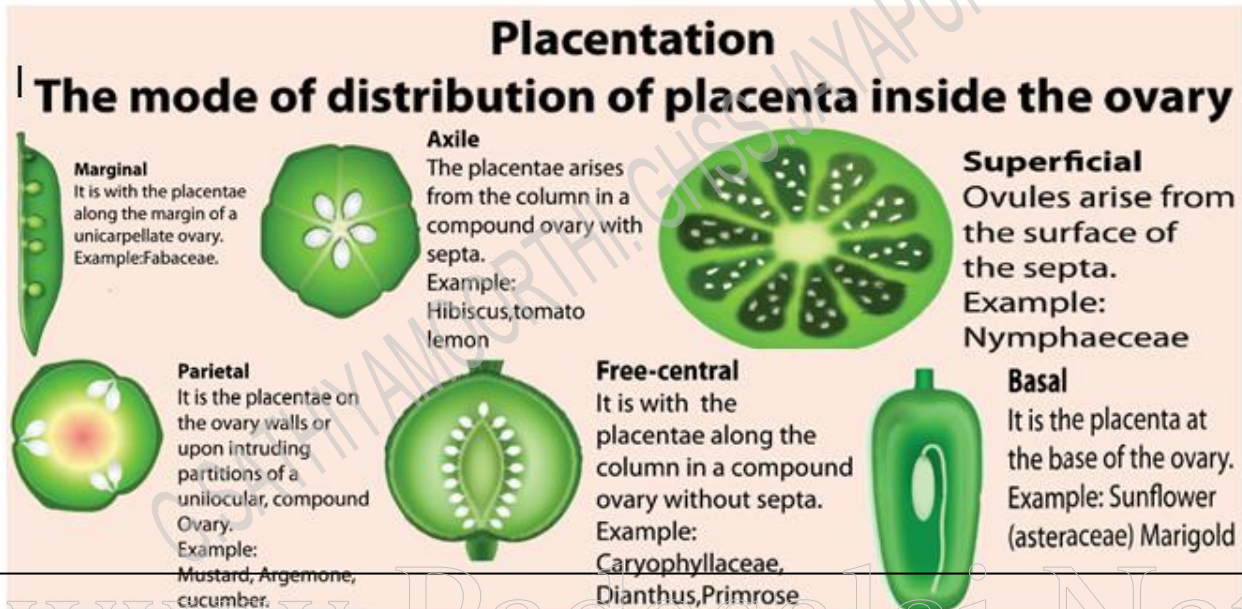
<p>Hypogynous: The term is used for sepals, petals and stamens attached at the base of a superior ovary. Example: Malvaceae</p>	<p>Epihypogynous: The term is used for sepals, petals and stamens attached at the middle of the ovary (half-inferior). Example: Fabaceae, Rosaceae.</p>	<p>Epigynous: The term is used for sepals, petals and stamens attached at the tip of an inferior ovary. Example: cucumber, apple, Asteraceae.</p>
<p>G.SATHIYAMOORTHY, GOVT.HR.SEC.SCHOOL JAYAPURAM.VLR.DT 9788890577</p>	<p>Perigynous: The term is used for a hypanthium attached at the base of a superior ovary.</p>	<p>Epiperigynous: The term is used for hypanthium attached at the apex of an inferior ovary.</p>

Perianth / androecial position on thalamus:

placement of the perianth and androecium relative to the ovary and to a hypanthium.

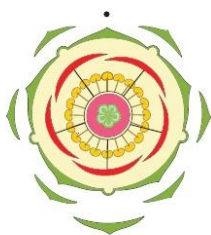


Parietal axile: It is with the placentae at the junction of the septum and ovary wall of a two or more locular ovary. Example: Brassicaceae.	Apical pendulous It is with placenta at the top of ovary. Ovules hanging down.
Parietal septate: It is with placentae on the inner ovary walls but within septate locules as in Aizoaceae.	Apical axile It is with two or more placentae at the top of a septate ovary. Example: Apiaceae.

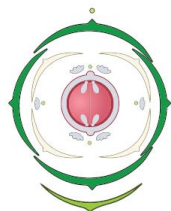
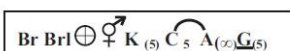


Construction of floral diagram and floral formula

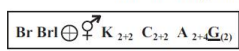
- **Floral formula** - simple way to explain the salient features of a flower.
- **Floral diagram** - representation of the cross section of the flower. Floral diagram shows the number and arrangement of bract, bracteoles and floral parts, fusion, overlapping and placentation.
- **Mother axis** :The branch that bears the flower.
- **Posterior side** The side of the flower facing the mother axis .
- **Anterior side** The side facing the bract .



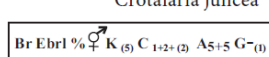
Hibiscus rosa sinensis



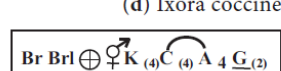
Brassica campestris



Crotalaria juncea



(d) Ixora coccinea

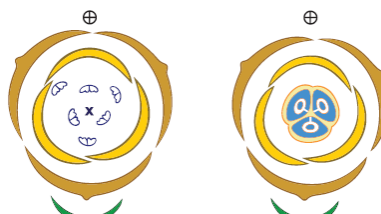
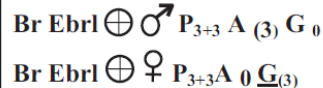




Male flower

Female flower

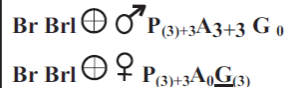
Phyllanthus amarus



Male Flower

Female Flower

Cocos nucifera



Floral formula

Br : Bracteate.	Ebr : Ebracteate	Brl : Bracteolate	Ebrl : Ebracteolate
\oplus Actinomorphic flower or polysymmetric		$\%$: Zygomorphic or monosymmetric	
σ^{P} Staminate	P Pistillate	σ^{P} Bisexual flower	
K : Calyx,	K ₅ five sepals, aposepalous	K ₍₅₎ five sepals synsepalous	
C : Corolla	C ₅ five petals, apopetalous	C ₍₅₎ five petals sympetalous	
C _(2/3) corolla bilabiate with upper lib two lobes.			
A : Androecium	A ₃ three stamens free		
A ₂₊₂ Stamens 4, two whorls (didynamous) each whorl two stamens (free)			
A ₍₉₎₊₁ – stamens ten, two bundles (diadelphous) 9 stamens unite to one bundle, 1 another bundle			
C ₅ A ₅ – Epipetalous represents by an arc		A ⁰ : Staminode (sterile stamen)	
G . Gynoecium or pistil	G ₂ – Carpels two, free (apocarpous)	G ₍₃₎ – Carpels three, united (syncarpous)	
G ⁰ – pistillode (sterile carpel)	G – superior ovary, the line under G	G inferior ovary, the line above G	
G – semi-inferior ovary, the line before middle of G.		∞ – Indefinite number of units	

FRUITS

- Fruits are the products of pollination and fertilization,
- The fruit is a fertilized and ripened ovary.
- **Pomology**. Branch of horticulture that deals with the study of fruits and their cultivation .

Structure of Fruit

- Fruit wall is called **pericarp**. It is differentiated into outer **epicarp**, middle **mesocarp** and inner **endocarp**. The inner part of the fruit is occupied by the seed.

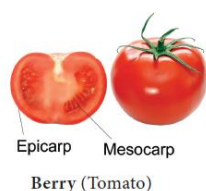
Types of Fruit -- Simple Fruits

- The fruits are derived from a single ovary of a flower Ex: Mango, Tomato.
- Based on the nature of pericarp Simple fruits as follows

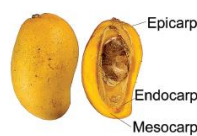
A. Fleshy Fruit

The fruits are derived from single pistil where the pericarp is fleshy, succulent and differentiated into epicarp, mesocarp and endocarp. It is subdivided into the following.

	Develops from	Pericarp nature	Examples
a. Berry	bicarpellary / multi carpellary, syncarpous ovary	epicarp is thin, mesocarp and endocarp undifferentiated	Tomato, Date Palm, Grapes, Brinjal
b. Drupe	monocarpellary, superior ovary one seeded	outer skinny epicarp, fleshy and pulpy mesocarp and hard and stony endocarp.	Mango, Coconut
c. Pepo	tricarpellary inferior ovary	Pericarp leathery or woody encloses, fleshy mesocarp and smooth endocarp	Cucumber, Watermelon, Bottle gourd, Pumpkin.
d. Hesperidium	multicarpellary, multi locular, syncarpous superior ovary	leathery epicarp with oil glands, a middle fibrous mesocarp. endocarp forms chambers, containing juicy hairs	Orange, Lemon
e. Pome	multicarpellary, syncarpous, inferior ovary	receptacle -fleshy, epicarp is thin and endocarp is cartilagenous	Apple, Pear
f. Balausta fleshy indehiscent	multicarpellary, multilocular inferior ovary	pericarp is tough and leathery. Seeds attached irregularly. testa is edible.	Pomegranate



Berry (Tomato)



Drupe (Mango)



Pepo (Cucumber)



Hesperidium (Orange)



Pome (Apple)



Balausta (Pomegranate)

Dry Fruit : Develops from single ovary. Pericarp is dry and not differentiated. two types.

1. Dry dehiscent fruit: Pericarp is dry and splits open along the sutures to liberate seeds.

	Develops from	dehiscence nature	Examples
a. Follicle:	monocarpellary, superior ovary	dehiscence along one suture.	<i>Calotropis</i> .
b. Legume or pod	monocarpellary, superior ovary	dehiscence through both dorsal and ventral sutures.	<i>Pisum</i>
c. Siliqua:	bicarpellary, syncarpous, superior ovary	one chambered due to false septum two chambered (replum). dehiscence along two suture	<i>Brassica</i> .
d. Silicula	similar to siliqua but shorter and broader		<i>Capsella, Lepidium,</i>
e. Capsule	multicarpellary, syncarpous, superior ovary. Based on the dehiscence. six types		
i) Septicidal	splitting along septa and valves		<i>Linum, Aristolochia</i> .
ii) Loculicidal	splitting along locules and valves		Lady's finger
iii) Septifragal	Capsule splitting. valves fall off leaving seeds attached to the central axis		<i>Datura</i>
iv) Poricidal	Dehiscence through terminal pores		<i>Papaver</i>
v) Denticidal	opening at top exposing a number of teeth		<i>Primula, Cerastium</i>
vi) Circumscissile (pyxidium)	Dehiscence transversely so that top comes off as a lid or operculum.		<i>Anagallis arvensis, Portulaca, Operculina</i> .

Follicle (*Calotropis*)Legume (*Pisum*)Siliqua (*Brassica*)Silicula (*Capsella*)

Loculicidal (Lady's finger)

Septifragal (*Datura*)

2) Dry indehiscent fruit Does not split open at maturity. Six types

	Nature of fruit	Developes from	Examples
a) Achene	Single seeded dry fruit. from apocarpous pistil,	single carpel with superior ovary	<i>Clematis, Delphinium, Strawberry.</i>
b) Cypsel	Single seeded dry fruit	bicarpellary, syncarpous, inferior ovary with scales	<i>Tridax, Helianthus</i>
c) Caryopsis	a one seeded fruit	monocarpellary, superior ovary. Pericarp is fused with seed.	<i>Oryza, Triticum</i>
d) Nut	one seeded fruit with hard, woody or bony pericarp.	mulicarpellary, syncarpous, superior ovary	<i>Quercus, Anacardium</i>
e) Samara	one seeded fruit	pericarp devlops into thin winged structure around the fruit.	<i>Acer, Pterocarpous</i>
f) Utricle	pericarp loosely enclosing the seeds	bicarpellary, unilocular, syncarpus, superior ovary	<i>Chenopodium.</i>

Achene (*Clematis*)Cypsel (*Tridax*)Caryopsis (*Oryza*)Nut (*Anacardium*)Samara (*Acer*)Utricle (*Chenopodium*)

3) Schizocarpic Fruit :intermediate between dehiscent and indehiscent fruit..

	Develops from	dehisces nature	Examples
a) Cremocarp	bicarpellary, syncarpous, inferior ovary	splitting into two one seeded segments-- mericarps.	Coriander, Carrot
b) Carcerulus	bicarpellary, syncarpous, superior ovary	splitting into four one seeded segments -- nutlets	<i>Leucas, Ocimum, Abutilon</i>
c) Lomentum	monocarpellary, unilocular ovary	A leguminous fruit, constricted between the seeds to form a number of one seeded compartments	<i>Desmodium, Mimosa</i>
d) Regma:	tricarpellary, syncarpous, superior, trilocular ovary	splits into one- seeded cocci attached to carpophore	<i>Ricinus, Geranium</i>

Cremocarp (*Coriander*)Carcerulus (*Abutilon*)Lomentum (*Mimosa*)Regma (*Castor*)

Aggregate Fruits :

- Develop from a single apocarpous pistil.
- each of the free carpel is develops into a simple fruitlet.
- A collection of simple fruitlets makes an **aggregate fruit**.
- An individual ovary develops into a drupe, achene, follicle or berry.

- An aggregate of these fruits borne by a single flower is known as **Cremocarp** (Coriander)
- **Schizocarpic Fruit Carcerulus** (*Abutilon*)
- **Lomentum** (Mimosa)
- **Regma** (Castor)
- an **etaerio**. Example: *Magnolia*, Raspberry, *Annona*, *Polyalthia*



Annona

Polyalthia

Aggregate Fruits

Multiple or Composite Fruit

- Develops from the whole inflorescence peduncle.

a) Sorosis:

- Develops from a spike or spadix.
- Succulent perianth become fleshy or juicy.
- The whole inflorescence forms a compact mass.
- Example: Pineapple, Jack fruit, Mulberry



Sorosis (Jack fruit)

Syconus (*Ficus*)

Multiple or composite fruit

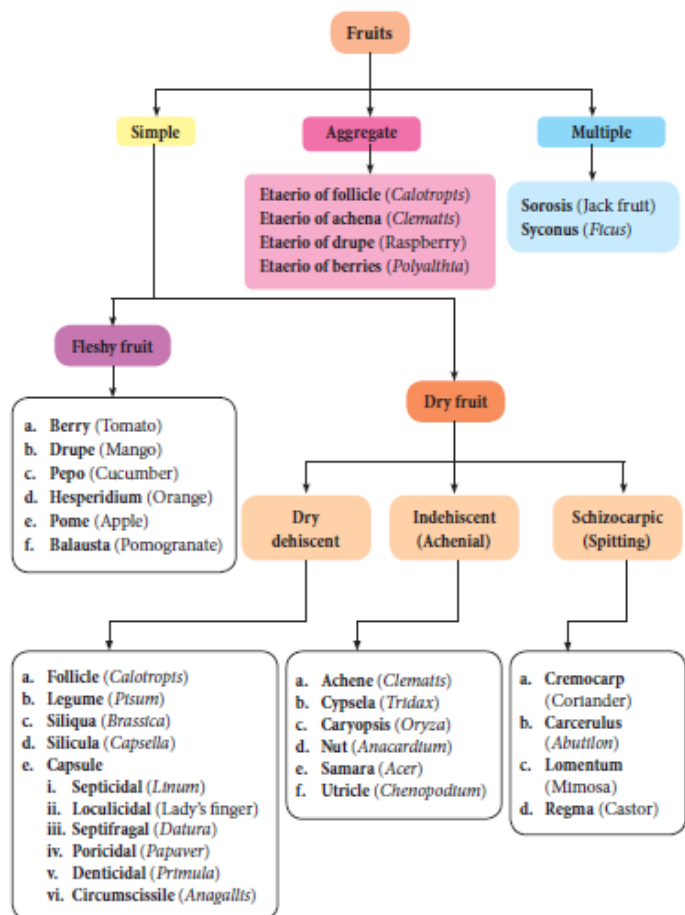
b) Syconus:

- Develops from (female flower) hypanthodium inflorescence.
- The receptacle converts into fleshy fruit which encloses a number of true fruit or achenes.
- Example: *Ficus*

Functions of Fruit

1. Fruit is a source of food, energy for animals.
2. Source of many chemicals like sugar, pectin, organic acids, vitamins and minerals.
3. Fruit protects the seeds from unfavourable climatic conditions and animals.
4. Both fleshy and dry fruits help in the dispersal of seeds to distant places.
5. In certain cases, fruit may provide nutrition to the developing seedling.
6. Fruits provide source of medicine to humans.

Edible Parts of Fruit			
Type of Fruit	Common Name	Botanical Name	Edible Part
Berry	Tomato	<i>Lycopersicon esculentum</i>	Whole fruit
	Brinjal	<i>Solanum melongena</i>	Tender fruit
	Guava	<i>Psidium guajava</i>	Whole fruit
	Date	<i>Phoenix dactylifera</i>	Pericarp
Drupe	Mango	<i>Mangifera indica</i>	Mesocarp
	Coconut	<i>Cocos nucifera</i>	Endosperm (both cellular and liquid)
Pepo	Cucumber	<i>Cucumis sativus</i>	Whole fruit
Hesperidium	Citrus (Orange, Lemon)	<i>Citrus sinensis</i>	Juicy hairs on the endocarp
Pome	Apple	<i>Pyrus malus</i>	Thalamus (false fruit) and a part of pericarp
Balausta	Pomegranate	<i>Punica granatum</i>	Succulent testa of the seeds
Legume	Pea	<i>Pisum sativum</i>	Seed
Siliqua	Mustard	<i>Brassica campestris</i> var.	Seed
Poricidal capsule	Poppy	<i>Papaver somniferum</i>	Seeds
Loculicidal capsule	Lady's finger	<i>Abelmoschus esculentus</i>	Tender fruit
Cypsela	Sunflower	<i>Helianthus annuus</i>	Seed (for oil)
Caryopsis	Maize	<i>Zea mize</i>	Seed
	Paddy	<i>Oryza sativa</i>	Seed
Nut	Cashew nut	<i>Anacardium occidentale</i>	Pedice (false fruit) and cotyledons (true fruit)
Cremocarp	Coriander	<i>Coriandrum sativum</i>	Mertcarps
Lomentum	Touch-me-not	<i>Mimosa pudica</i>	Seed
Aggregate fruit	Custard apple	<i>Annona squamosa</i>	Pericarps
Composite fruits			
Sorosis	Jack fruit	<i>Artocarpus heterophyllus</i>	Perianth, seeds
	Pine apple	<i>Ananas comosus</i>	Perianth, rachis
	Mulberry	<i>Morus alba</i>	Whole fruit
Syconus	Fig	<i>Ficus carica</i>	Whole inflorescence



Seed

- A fertilized mature ovule
- Possess an embryonic plant,
- Usually stores food material and has a protective coat.

Types of Seed

I. Based on the number of cotyledons.

i. **Dicotyledonous seed:** Seed with two cotyledons.

ii. **Monocotyledonous seed:** Seed with one cotyledon.

II. Based on the presence or absence of the endosperm.

i. **Albuminous or Endospermous seed:**

The cotyledons are thin, membranous and mature seeds have endosperm persistent.

It nourishes the seedling during its early development. Ex: Castor, sunflower, maize.

ii. **Ex-albuminous or non-endospermous seed:**

Food is utilized by the developing embryo and so the mature seeds are without endosperm.

In such seeds, cotyledons store food and become thick and fleshy. Example: Pea, Groundnut.

Significance of Seeds:

- Seed protects the embryo for next generation.
- It contains food for the development of embryo.
- It is a means for the dispersal of new individuals.
- Seed get suitable condition for germination . (Dormant during unfavorable conditions)
- Seeds of various plants are used as food, both for animals and men.
- They are the basis of agriculture.
- Seeds provide genetic variations and recombination in a plant.