

FLOWER :

The specialized reproductive structures or *sporophylls* borne as *modified Shoot* in *Angiosperms* bearing atleast one or more Pistils or Stamen or both can be referred to as Flowers. Like any other shoot there is a presence of an axis in the structure of a flower known as *Thalamus*;

On the thalamus, the floral leaves are arranged somewhat similar to how leaves are arranged on the Leaf rachis. Depending on the type of arrangement, a flower may be-

Cyclic: Where the floral leaves arranged in Cyclic manner as in most of the cases, as separate floral whorls.

Spiral: Where the arrangement may be spiral on the thalamus,

Hemicyclic: where the arrangement is intermediate to two of the above mentioned types.

As stated above a typical flower shows the cyclic or whorled type of arrangement of Floral leaves(Phyllotaxy) in successive manner, hence they are referred to as Floral Whorls. A typical flower shows four sets of floral members arranged in successive whorls on the thalamus-

- A) **Calyx**- composed of **Sepals**,
 - B) **Corolla**- composed of **Petals**,
 - C) **Androecium**- composed of **Stamens (microsporophylls)** and
 - D) **Gynoecium or pistils**- composed of **Carpels (megasporephylls)**.
- Accessory whorls(Secondary Purposes
like protection and making the flower attractive)
- Essential whorls

Sessile Flower: A flower without stalk is called sessile Flower.

Pedicellate Flower: A flower provided with a stalk.

Complete Flower: When all four whorls are present in a Flower.

Incomplete Flower: When any of above four whorls are missing.

Perfect Flower : When both the essential whorls *i.e.* Stamens and Carpels are present. Also called bisexual or hermaphrodite.

Imperfect Flower: When either stamens or carpels are missing, also known as Unisexual or diclinous. Unisexual flowers can be either **male or staminate** flowers or **female or pistillate** flowers.

[Dioecious Plant : if both male flowers and female flowers are borne on different plants.

Monoecious Plants: if male flowers and female flowers are borne on the same plant.]

Neutar Flower: A flower having no functional stamen or carpel.

Achlamydeous Flower: When no sepals or petals present on the flower, formed only of stamen and carpels. Such flowers are also called *naked flowers*.

Monochlmydeous Flower: When only one accessory whorl (calyx or corolla or Perianth) is present. If Calyx and Corolla not differentiated and represented by perianth the units of perianths are called **tepals**.

Dichlamydeous Flower: Flowers with both calyx and corolla are called dichlamydeous.

Depending on the

Regular or Actinomorphic Flower: When the flower is divisible into two equal halves in any vertical plane through centre.

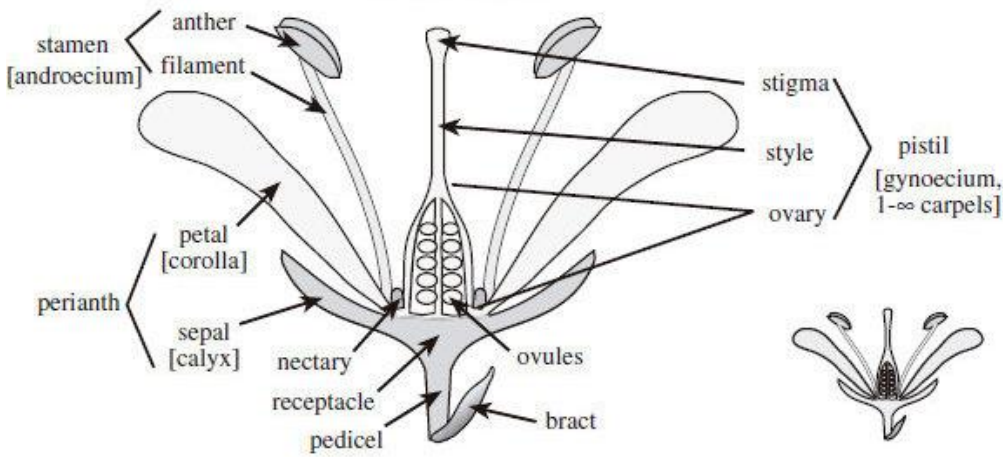
Irregular or Zygomorphic Flower: When the flower is divisible only in one vertical plane.

Hypogynous Flower: When the gynoecium is situated above the other whorls of the flowers.

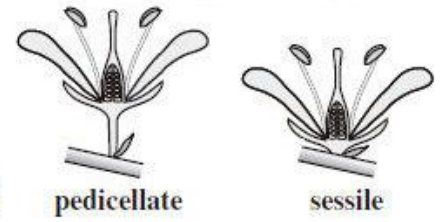
Epigynous Flower: When the gynoecium is situated below the other whorls of the flower.

Perigynous Flower: When the gynoecium of a flower is situated at the bottom of a cup-shaped thalamus(hypanthium) and the other whorls develop from the top of the rim.

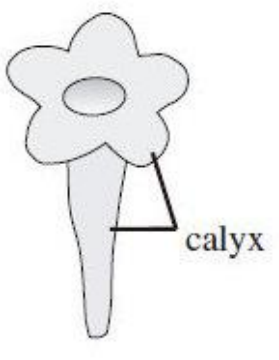
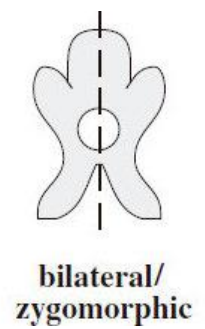
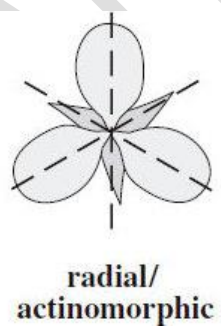
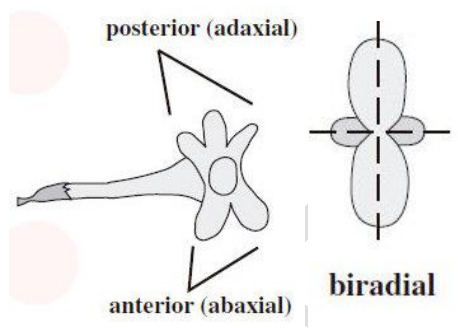
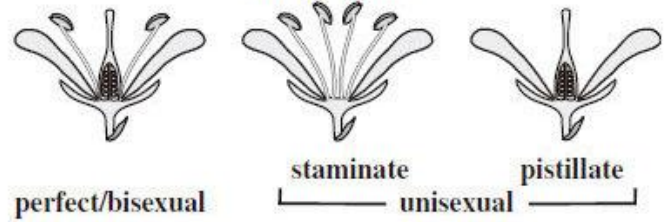
Flower Parts



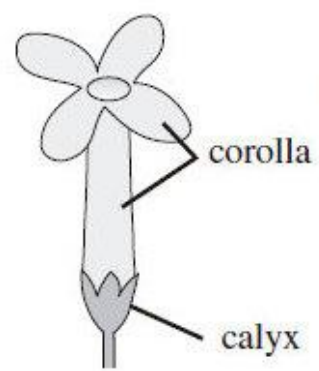
Flower Attachment



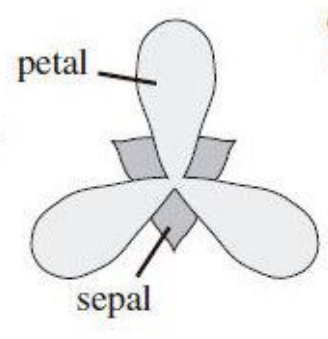
Flower Sex



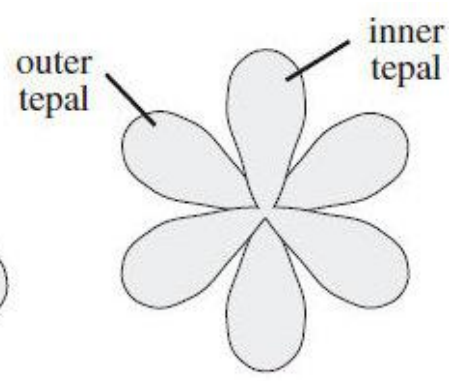
uniseriate
pentamerous



biseriate
tetramerous



dichlamydeous



homochlamydeous
biseriate / trimerous

CALYX:

The outermost whorl usually green in colour or scaly in nature and perform the protective function in a flower (specially during bud condition) is known as Calyx. Parts of calyx are known as Sepals.

Epicalyx: When an additional row of calyx like structure comprising of a whorl of bracteoles, found outside the calyx in some plants. e.g. *Hibiscus rosa-sinensis*.

Polysepalous and Gamosepalous: When sepals are free in calyx, the flower is known as Polysepalous. E.g. *Cassia sophera*. But when the sepals are united into a calyx it is said to be gamosepalous. E.g. as in *Hibiscus rosa-sinensis*.

Shape of Calyx: When sepals united to form a calyx cup, it may be of following shape.-

Tubular: Long and tubular in structure, e.g. *Datura metel*

Bell-Shaped or Campanulate : The shape resembles a small bell. E.g. *Cucurbita maxima*.

Urceolate : The calyx looks like an urn. E.g. *Hyoscyamus niger*.

Rotate: When calyx is organised into a short tube and teeth dialated in right angle. E.g. *Mazus japonicus*.

Modification of Calyx:

- A) Pappus: When calyx is modified into few hairy or scaly or feathery structures as seen in the members of Asteraceae (Compositae) e.g. *Tagetes patula*.
- B) Spinous: When calyx is modified into spinous structure. Noted in *Trapa bispinosa*.
- C) Spurred : When calyx is prolonged into tubular or beak-like structures. E.g. *Impatiens balsamina*.
- D) Hooded : When the sepals enlarged and modified into hood like structures. As in *Aconitum sp.*

Depending of duration (how long they remain attached with the flower) calyx can be categorized into following types:

- A) Cauducous: When calyx falls off before the opening of the flower becomes complete. e.g. *Argemone mexicana*.
- B) Deciduous: When Calyx falls off at the time corolla falls off *i.e.* after fertilization.
- C) Persistent: When Calyx do not fall of and remain attached with the flower and can be
 - (i) Marcescent : When the sepals shows shriveled and withering appearance. e.g. *Psidium guajava*.
 - (ii) Accrescent : When persistent sepals grow in size along with fruit. e.g. *Dillenia indica*.

COROLLA:

The second accessory member of floral whorls, which is usually variously colored and shaped and perform the function of attracting pollinators mainly is referred to as Corolla. Each member of Corolla is known as Petal, which sometimes provided with a stalk called *Claw* and the remaining expanded portion is then called *limb*. When the petals are fused together it is called gamopetalous and when petals are free from one another called polypetalous in nature.

Forms of Corolla:

Polypetalous Regular Corolla:

Cruciform : Here Four Clawed Petals are arranged in a single whorl in a diagonal manner appearing like a Cruce. It is a characteristic feature of the Brassicaceae family (Family of Mustard).

Rosaceous: Here typically five petals arranged in one whorl having outwardly spreading wide limb and very short Claw.

Caryophyllaceous: Here 5 clawed petals arranged in a whorl having their limbs right angled to claws.

Polypetalous irregular Corolla: Only one type called **Papilionaceous corolla** where there is one largest posterior petal called *Standard* or *Vexillum*, two lateral *wings* almost covering two anterior petals which joined loosely among themselves forming a boat shaped structure called *keel*. E.g. as seen in *Clitoria ternatea*.

Gamopetalous Regular corolla :

Tubular : When all petals are joined together as a more or less uniform tube. As found in the disc floret of Asteraceae members like *Helianthus annuus*.

Campanulate : When the limbs and tube of corolla are almost in same dimension and corolla resembles a bell as seen in *Cucurbita maxima* Flowers.

Hypocrateriform: When the limbs of the corolla is very broad and placed right angle to the tube of the corolla. e.g. As in *Catharanthus roseus*.

Rotate : Here the tube is very short with spreading wheel shaped limb. As seen in *Solanum sp.* , *Nyctanthus arbor-tristis*.

Urceolate : When the corolla is swollen and contracted at both ends in apex and base. Noted in *Vaccinium sp.*

Infundibuliform : Where the wide upper portion of the corolla tube is spreading like a funnel. Observed in *Ipomoea reptans*.

Gamopetalous Irregular corolla:

Bilabiate : Where the 5 petals are united to form two lipped structure, the upper lip consists of two petals and lower lip consists of three petals. The tube remains open at the throat (the entrance gap leading to the tube inside). Characteristic of the flowers in Labiatae, Scrophulariaceae , Acantheceae.

Personate : It is one type of bilabiate corolla in which the throat of corolla is closed by a projection of the lower lip known as palate. E.g. *Lindenbergia* (Scrophulariaceae).

Ligulate: Here five petals joined together to form a strap or tongue shaped corolla. Noted in ray florets of Asteraceae members like *Helianthus annuus*.

Aestivation (Mode of Arrangement) of Accessory members (Sepals and Petals or Perianth) :

- a) **Valvate:** Where the margins of the sepals or petals simply touch one another but do not overlap. Seen in the family Malvaceae (*Hibiscus rosa-sinensis*).
- b) **Twisted or Contorted:** Here the sepals or petals arranged in a manner that one margin overlap the margin of the next member and the other margin is overlapped by the margin of another in floral bud.
- c) **Imbricate:** Here One of the Petals or Sepals remain outermost overlapping two of its adjoining members and one Petal or Sepal remain innermost overlapped by two of its adjoining member and rest of the members remain in Contorted manner *i.e.* One of it's margin overlapping adjoining member and the other margin being overlapped by the next one.
- d) **Quincuncial :** The margins of the sepals or petals are arranged in a manner that two are outer, two are inner and rest remaining one present in twisted condition.
- e) **Vexillary:** It is a special type of imbricate aestivation where the largest posterior petal is outermost which overlaps two lateral wings which in turn partly overlap the two smallest innermost petals known as keel.

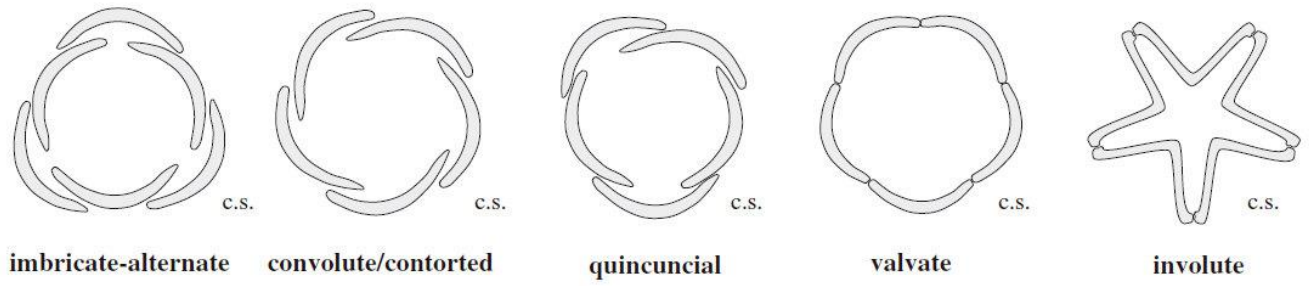
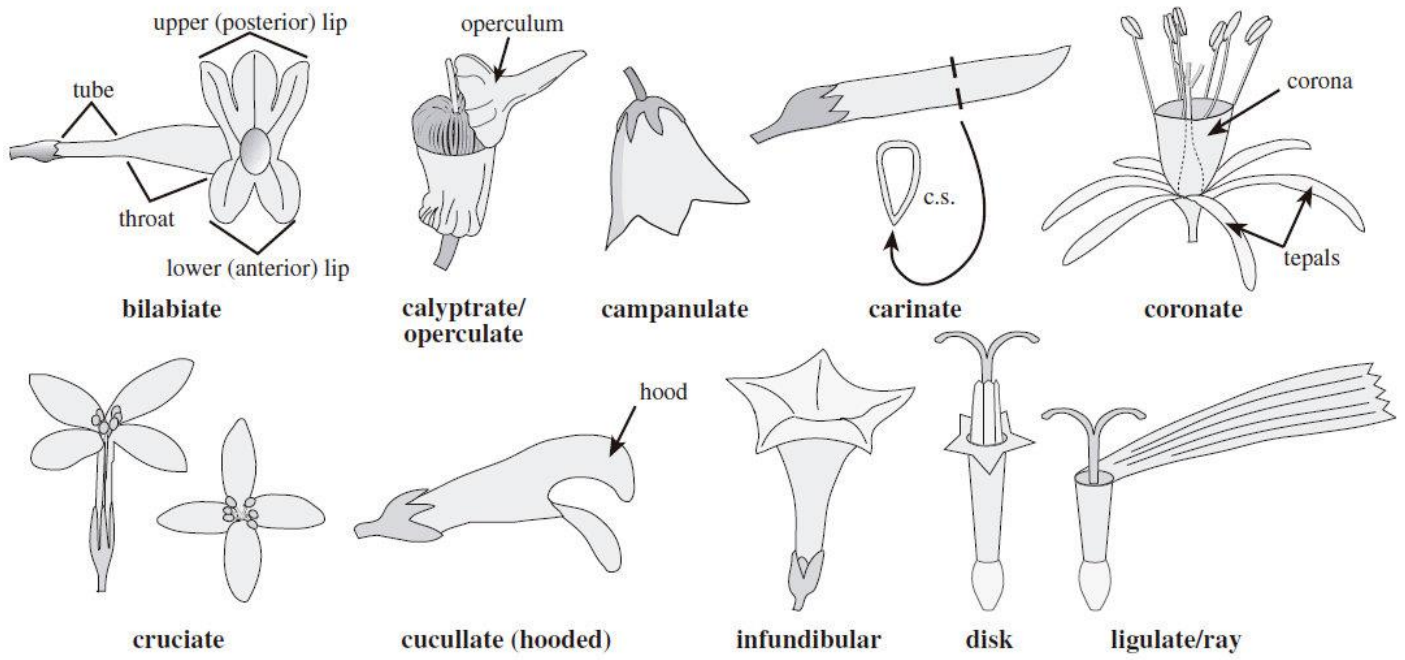


FIGURE 9.20 Perianth aestivation.



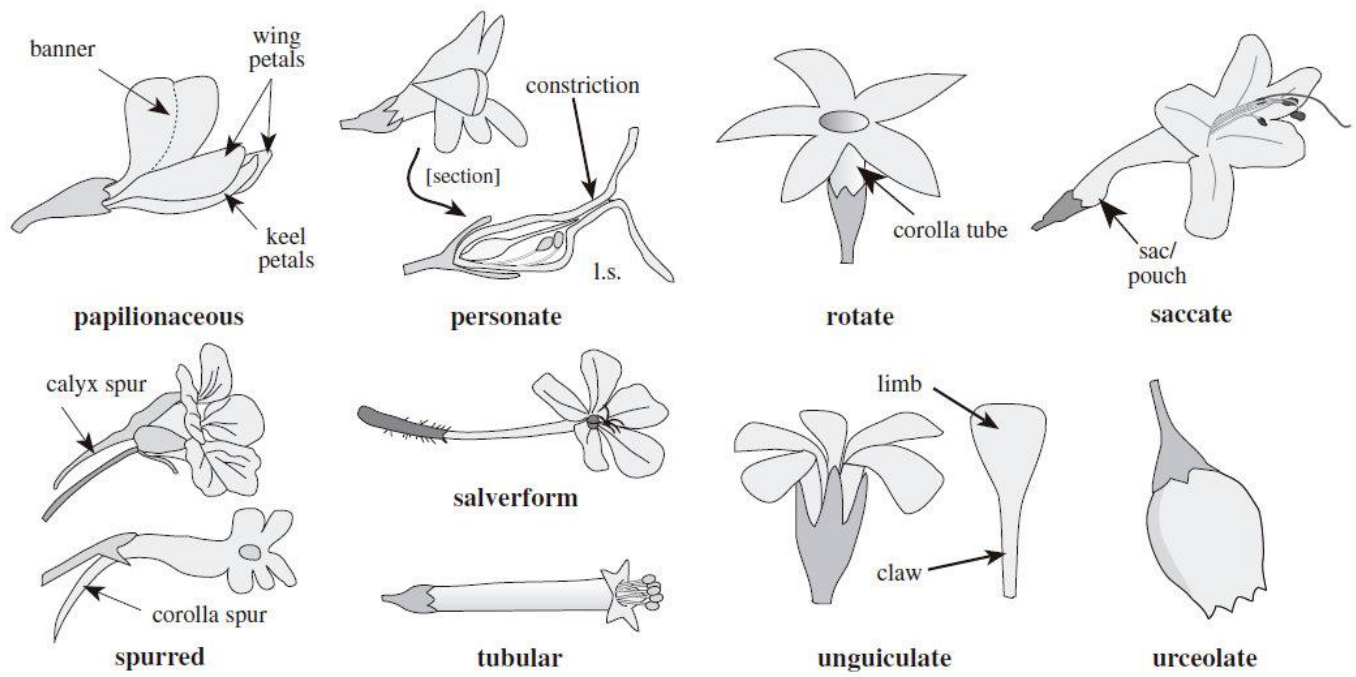


FIGURE 9.19 Perianth types/parts. (c.s. = cross-section; l.s. = longitudinal section)

GGDCATKAL

ANDROECIUM:

It is one of the essential whorl and third member of the floral whorl representing male reproductive component of the flower. Its individual members are called Stamens which are microsporophylls. Each Stamen consists of a filament and a sac like structure at the apex called Anther. For each anther there are two lobes which are joined together by a connective. In each anther lobe there are two pollen sacs which produce numerous pollen grains. Generally these stamens are present in numerous in number and arranged in cyclic or spirally. Sometimes stamens do not bear anther or anther do not produce pollen grains. In such cases these stamens are referred as Staminodes.

Attachment of Anther to the Filament: The anther can remain attached with the filament in the following manner.

- A) Basifixed : When the filament firmly attached to the base of the anther. *E.g. Solanum.*
- B) Adnate: When the filament or its continuation, the connective attached to the base of the anther throughout the whole length and also often seen extending beyond the anther. *E.g. Nymphaea sp.*
- C) Dorsifixed: When the filament is firmly attached to the back of the anther. *E.g. Passiflora.*
- D) Versatile: When the filament is attached at the point near the middle of the back of the connective in such a way that the anther can swing freely in air. *E.g. in some members of Graminae (Family of grasses) like Oryza sativa.*

Dehiscence of Anther:

- A) Transverse : When the dehiscence occurs transversely slit like the lead of the box, as occurs in one celled anther called monotheous anther in Family Malvaceae (*e.g. Hibiscus rosa-sinensis*).
- B) Apical or Porus: When anther matures an apical pore appear through which the pollens get dispersed. *E.g. Solanum melongena.*
- C) Vulvular: When dehiscence or bursting of anther occurred by means of trap-door-like flappy valves as seen in *Barberis sp., Litsea sp.*
- D) Longitudinal: The most common one where anther lobe splits lengthwise from base to apex along the line suture. *E.g. Vitis vinifera, Datura sp.*

Forms of Anther:

- A) Linear- When anther lobes are long and narrow. As in *Acalypha*.
- B) Oval or Round: as in *Mercurialis annua* (Euphorbiaceae).
- C) Reniform: Kidney shaped anther as seen in members of Malvaceae (*e.g. Hibiscus rosa-sinensis*).
- D) Appendiculate: When the anther lobes are provided with appendages of different kinds e.g. leafy appendages in *Erica* and pointed appendages in *Justicia*.
- E) Sagittate: Arrow shaped anther. As in *Lochnera*.
- F) Filamentous: When the lobes are thread like, e.g. *Zostera sp.* (Potomagetonaceae)

Relative length of Stamens:

The length of the stamens could be same for a flower or there may be variation in the length of the stamen in the same flower. The variation can be of the followings-

Didynamous: Here four stamens are in one whorl, out of which two are larger than the other two. *e.g.* As seen in members of the family Labiatae, Acantheceae, Scrophulariaceae.

Tetradynamous: Where Six stamens are present out of which four are larger and two are smaller. *e.g.* Characteristics of the members of Brassicaceae.

Heterodynamous: When in one whorl stamens of different sizes occur as in *Cassia sp.*

Union of Stamens: The stamens may be united among themselves (Cohesion of Stamens) or may be united with the other floral whorls like Perianth or Petal or Gynoecium (*i.e.* Adhesion of Stamens).

Cohesion of Stamens:

Union of Filaments-

Monadelphous: When all the filaments are fused together forming a single bunch but the anther remains free. *e.g.* Most of the members Malvaceae.

Diadelphous: When the filaments are fused together like in previous case but forming two bunch. *e.g.* *Pisum sativum*, *Clitoria ternatea* (Fabaceae).

Polyadelphous: Here filaments fused together forming multiple bunch as seen in *Bombax malabarica*.

Union of Anthers-

Syngenesious: Here the filaments remain free but the anthers fused together. *e.g.* in the members of Asteraceae (*e.g.* *Helianthus annuus*).

Synandrous: Where both the anther and filament fused together along with their length. *e.g.* *Cucurbita pepo*.

Adhesion of Stamens:

Epipetalous : When stamens are adnate to petals. *e.g.* *Leucas aspera*, *Solanum melongena*.

Epiphyllous : When stamens are adnate to the Perianth. *e.g.* *Polyanthus tuberosa*.

Gynandrous : When stamens are adnate to any part of the Gynoecium. When stamens and carpels united completely forming Gynostegium or Gynostemium. *e.g.* *Calotropis sp.* and *Orchis sp. etc.*

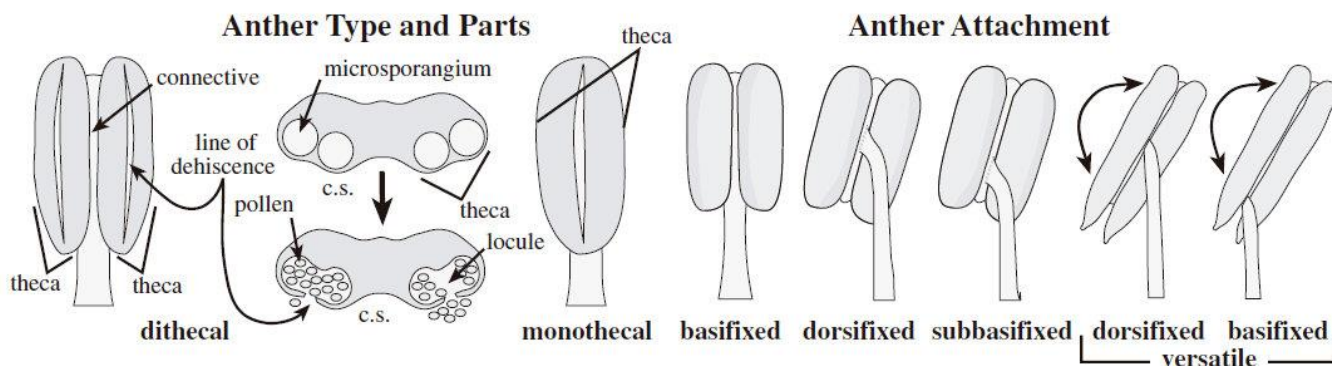


FIGURE 9.26 Anther types, parts, and attachment (c.s. = cross-section)

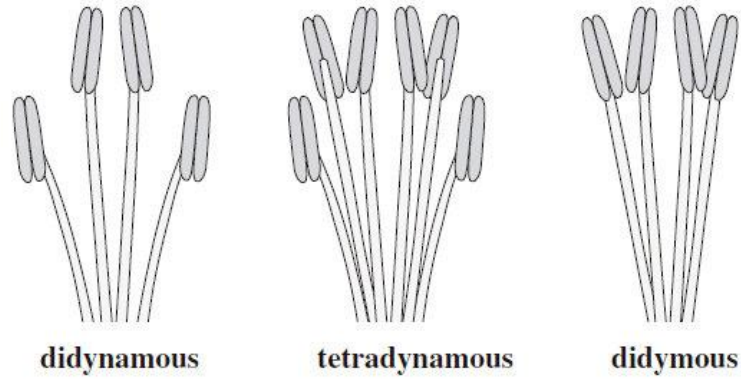


FIGURE 9.22 Stamen arrangement.

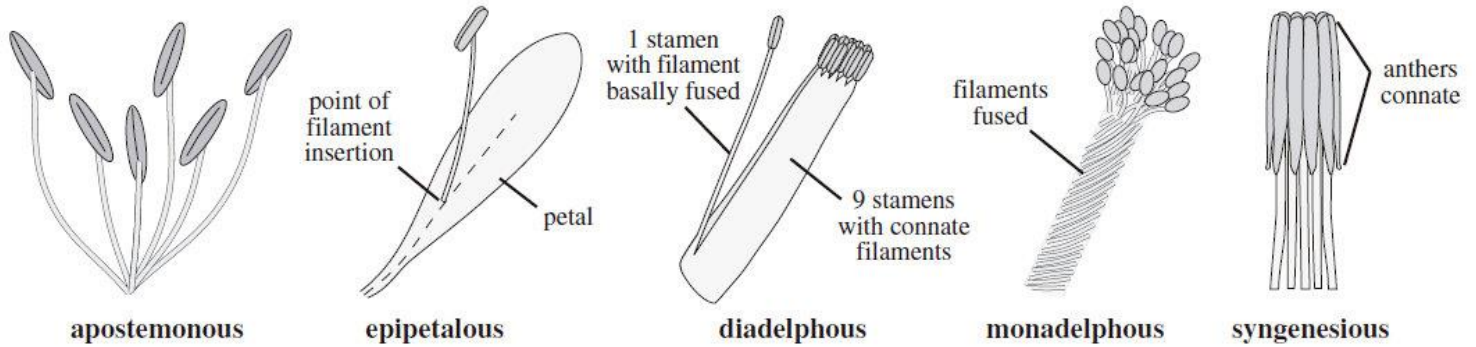


FIGURE 9.25 Stamen fusion.

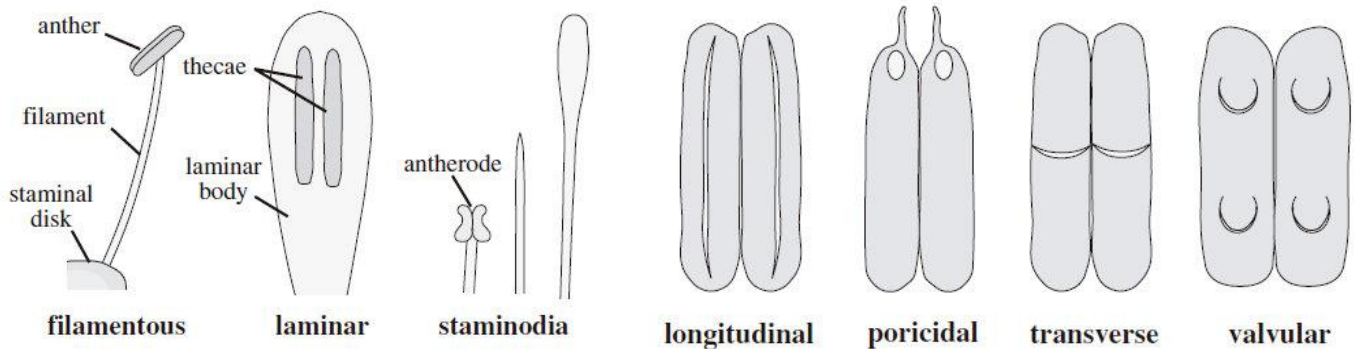


FIGURE 9.21 Stamen types and parts.

FIGURE 9.27 Anther dehiscence types.

GYNOECIUM:

It is the other essential whorl of flower representing female reproductive structure *megasporophyll*. This whorl is made up of Carpels.

Gynoecium is referred to as simple when it is made up of a single carpel *i.e.* *monocarpellary*, *e.g.* *Pisum sativum*.

When Gynoecium is composed of more than one carpel then it called compound gynoecium as in most cases, which can be *Apocarpous* *i.e.* when each carpels are present separately from one another; *Syncarpous* *i.e.* when carpels are fused together and make up the gynoecium.

Generally there are three parts of carpel.

1) *Ovary*, it is the lowermost swollen part of the carpel attached with the thalamus. In monocarpellary ovary there is one chamber and in multicarpellary ovary there may be more than one chamber. The ovules are arranged in these chambers.

Position of Ovary:

According to the position the ovary can be of following types-

Superior Ovary: When ovary is situated above the zone of attachment of the accessory whorls and androecium.

Inferior Ovary: When the ovary is situated below the the zone of attachment of the accessory whorls and androecium and ovary is united with the receptacle both laterally and basally.

Half-Inferior Ovary: When ovary adherent to the receptacle *i.e.* an intermediate position between the inferior and superior condition.

2) *Style*, it is the short or long stalk-like protrusion of the ovary.

Depending on from where the style arises it can be of following types-

Apical- When it arises from the top of the ovary as in most of the cases.

Basillar- When it arises from the base of the ovary(Also referred as Gynobasic style and characteristic type of the member of Lamiaceae).

Lateral: When it arises from the side of the ovary.

3) *Stigma*, it is the receptive end of the style which is generally knob like in appearance. Depending on the shape of the stigma it can be one of the followings-

- (i) Capitata or globose
- (ii) Bifid
- (iii) Feathery/Plumose
- (iv) Bilobed etc.

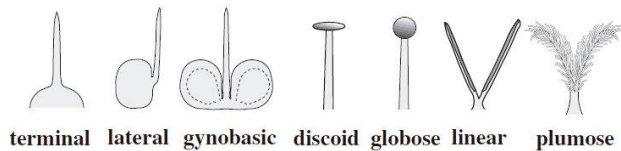


FIGURE 9.34 Gynoecium: style position (left) and stigma/ stigmatic region type (right).

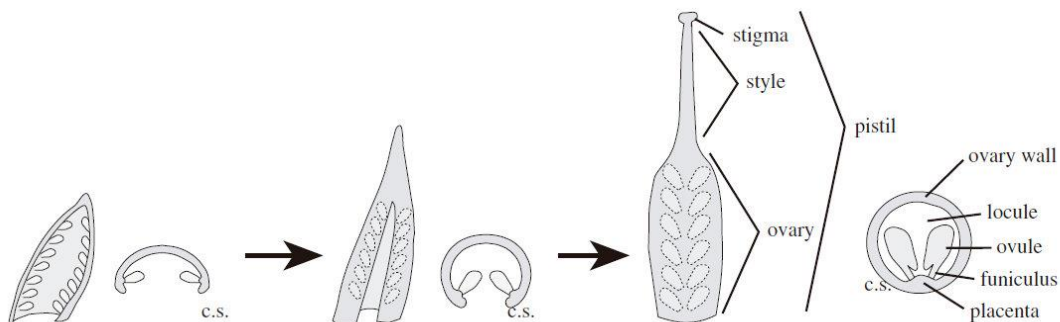


FIGURE 9.29 Gynoecium: carpel development. (c.s. = cross-section; l.s. = longitudinal section)

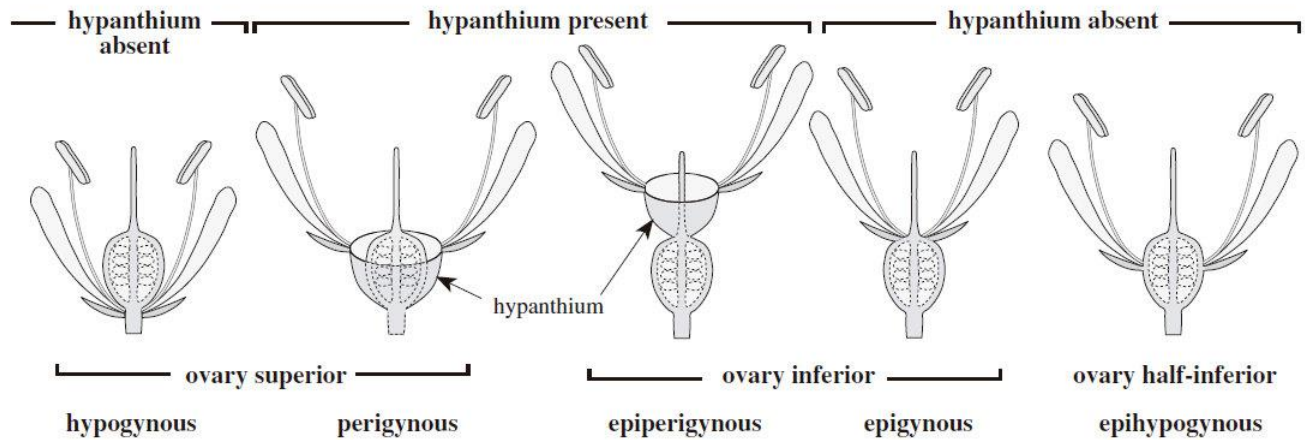


FIGURE 9.32 Ovary position and perianth/androecial position.

Placentation:

Placenta is referred to the portion of the inner wall of the ovary from where the ovules are attached. The arrangement of the placentas bearing ovule in the ovary chamber is called placentation. The following types of placentation is noted-

- i) Marginal- When Placenta develops along the fused margin of the carpel in the ovary *i.e.* along the ventral suture and ovules are in two rows along this suture. Ovary is single chambered. Found in the family Leguminosae.
- ii) Parietal- When the ovary is multicarpellary but single chambered and placentas are arranged from the inner side of the fused margin of the carpels. The number of placentas are equals to the number of carpels. Mostly found in many members of Cucurbitaceae like *Cucurbita pepo*, *Cucumis sativa* etc.
- iii) Axile: Here the ovary is compound (*i.e.* Multicarpellary) but the margins of carpels are folded inside and fused with one another along the axile junction thereby forming an axis at the centre of ovary around which the ovules are arranged. The number of chamber corresponds with the number of carpels present. *e.g.* *Hibiscus rosa-sinensis*, *Musa paradisiaca*.
- iv) Free Central: It is a modified axile placentation where the folded wall of chambers get lost so that the ovary seems to be single chambered and the placentas produced surrounding the axis present at the centre of ovary. It is noted in *Portulacca sp.*
- v) Basal: Here the ovary is single chambered and there is only single ovule is present on the base of the ovary on thalamus. It is a characteristic placentation in the family Asteraceae.
- vi) Superficial: In this placentation type the ovary is compound and multilocular (many chambered) and placentas originated from throughout all portions of the carpellary walls *i.e.* each part of the ovary is receptive. Found in *Nelumbo nucifera*, *Nympahea stellata*.

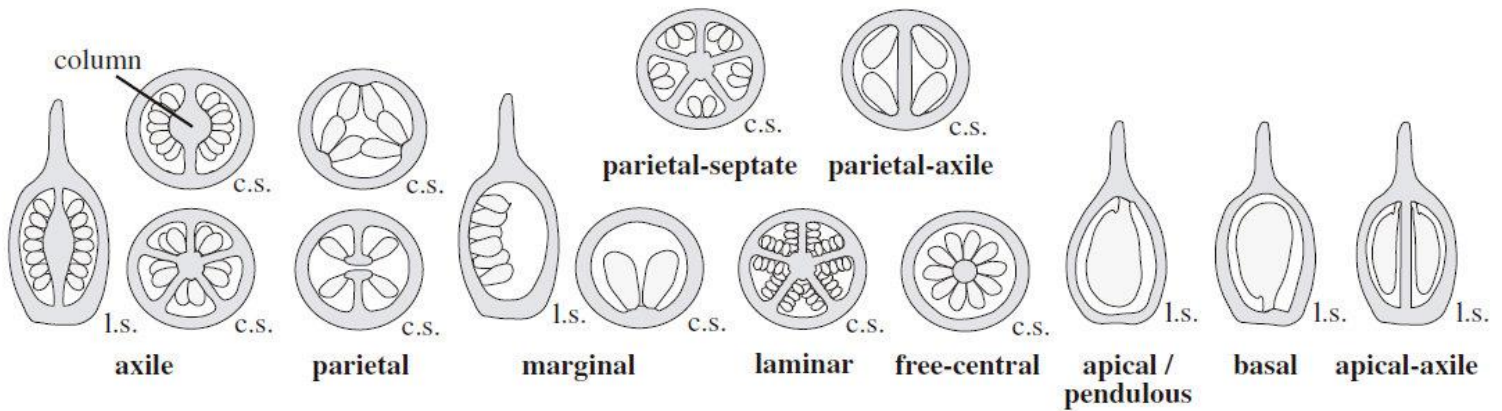


FIGURE 9.33 Gynoecium: placentation. (c.s. = cross-section; l.s. = longitudinal section).

POLLINATION:

Pollination is the transference of pollen grains from anther to stigma whether of the same flower or of a different flower.

Self-Pollination-

Autogamy : Transfer of Pollen grains from anther of a flower to stigma of the same flower. As in case of bisexual Flowers.

Geitonogamy- Transfer of Pollen grains from anther of one flower to stigma of another flower of the same plant.

Cross-Pollination or allogamy- The transference of pollen grains from anther of one flower to the stigma of another flower borne on different plant.

Xenogamy- When the cross-pollination occurs between two plants of different species.

Hybridization- When the cross-pollination occurs between two plants of different species.

Device for Cross-Pollination: There are many devices to ensure cross-pollination in plants like the followings-

- i) **Dicliny or Unisexuality:** In case of dioecious plants where unisexual flowers are borne on different plants, Cross-pollination is obligatory, as in case of *Trichosanthes dioica*. In case of monoecious plant however the geitonogamy may take place.
- ii) **Self-Sterility-** Sometimes the sterile condition of the pollen of the bisexual flower enforce cross-pollination as self-pollination cannot occur in the same flower. *E.g. Solanum sp.*
- iii) **Dichogamy:** It refers to maturation of anther or stigma at two different time.
 - a) **Protandry-** Where anthers mature earlier than stigma as in *Helianthus sp., Hibiscus sp.*
 - b) **Protogyny-** Here the stigma matures earlier than anther. As in Magnolia.
- iv) **Herkogamy-** When self-pollination is impossible due to presence of a barrier inbetween anther and stigma. *e.g. Iris sp.*
- v) **Heteromorphism:** The occurrence of two or three forms of flowers with anther and stigma are at different level *i.e.* flowers may have short styles and long stigma or vice-versa, is known as Heteromorphism which prevent flowers from being self-pollinated.

Devices (Contrivances) for Self-Pollination:-

- i) **Cleistogamy-** Cleistogamy is a phenomom where flowers are remain closed so that self-pollonation is ensured. *e.g.* Flower never open since bud condition. As in *Commelina benghalensis*.
- ii) **Homogamy-** It is a condition where anther and stigma mature at the same time so that self pollination is achieved by various means. *e.g. Argemone mexicana.*

Agents of Pollination-

- i) Anemophily- Pollination affected with the help of wind. *e.g.* Members of the family Graminae, Cyperaceae.
- ii) Hydrophily- When Pollination affected with the help of water. *e.g.* *Vallisneria*, *Hydrila*, *Najas etc.*
- iii) Entomophily- When Pollination affected with the help of insects. *e.g.* *Helianthus annuus*.
- iv) Ornithophily- When Pollination affected with the help of birds, *e.g.* *Butea monosperma*, *Bombax ceiba*.
- v) Malacophily- When Pollination affected with the help of slugs, snails, squirrels etc. Large number of trees visited by squirrel exhibit this type of pollination.
- vi) Chiropteriphily- When Pollination affected by bats. *e.g.* *Adansonia digitata*.

GGDC AT KALIGANJ