CORE PAPER VII

MORPHOLOGY, EMBRYOLOGY OF ANGIOSPERMS

AND SEED TECHNOLOGY

UNIT II

Flower- as a modified shoot

The flower is generally defined as a highly specialized reproductive shoot, comparable to leaves- bearing shoot.

The sepals and petals may be regarded as modified leaves. Stamens and carpels also show some resemblance to leaves in position, arrangement, internal structure and development.

Based on these similarities, they are comparable with leaves which bear reproductive organs.

The terms microsporophylls and megasporophylls are often applied to stamen and carpel respectively. The flower, then, can be defined as a group of sporophylls usually surrounded by perianth.

That "flower is a modified shoot" can be explain d citing the following facts:

(I) Homology of the floral bud:

A floral bud and a vegetative bud appear quite different externally, yet there is great similarity between the two.

Such as:

(i) Floral and vegetative buds both emerge either in terminal or in axillary position,

(ii) The floral buds may sometimes get modified in to vegetative buds or bulbils (e.g. Agave, Allium). Thus proving that the two are analogous structures.

(II) Axis nature of receptacle:

That the receptacle (thalamus) is in fact an axis producing flower can be proved by the following:

(i) Though in majority of cases, the internodes in floral axis remain highly reduced, yet in a number of plants such as Capparis, Gynandropsis , Passiflora etc. the receptacle shows prominent nodes and internodes.

(ii) Second evidence comes from monstrous development of foliage leaves in some flowers (e.g., rose, larkspur, pear etc.). In the flowerpot' these plants, the receptacle of the flower continues its growth even after producing all the four types of floral appendages and then produces normal foliage leaves .

(iii) A third evidence comes from Michelia champaca where the thalamus elongates like an ordinary stem beyond carpels and bears aggregate fruit.

(III) Foliage nature of floral appendages:

That floral appendages, calyx, corolla, androecium and gynoecium are modified leases can be proved by the following facts:

(i) Phvllotaxy: Foliage leaves and floral appendages have identical arrangement on the stem.

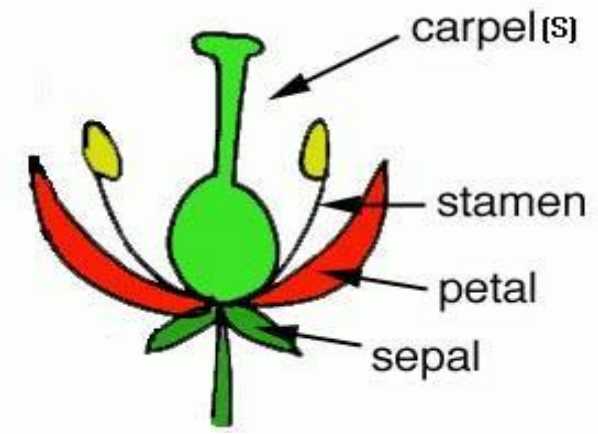
(ii) Aestivation: Pre-foliation of foliage leaves and aestivation of floral leaves (calyx and corolla) is virtually identical.

(iii) Foliar nature of sepal: That sepal is a modified leaf can be clearly seen in Mussaenda. Hen- one of the sepals enlarges abnormally and becomes green like any foliage leaf.

(iv) Transition of floral leaves: In nature, in many cases, such as Nymphaea (water lily) all degrees of transition from sepals to petals and from petals to stamens can be seen. In Canna, the stamens and the style become petaloid. In Zinnia, some of the stamens and carpels

become petaloid or sepaloid. In Hibiscus rosasinensis (China rose) it is believed that stamens have modified into petals. This point has been proved by identical vasculature of the two

Floral Morphology



Floral parts

The essential parts of a flower can be considered in two parts: the vegetative part and the reproductive parts. A typical flower consists of four kinds of structures attached to the tip of a short stalk. Each of these kinds of parts is arranged in a whorl on the receptacle. The four main whorls are as follows: calyx, corolla, androecium, and gynoecium.

Perianth Collectively the calyx and corolla form the perianth

The two major types of **floral** organ **arrangement** are **spiral and whorled arrangements**. A **cyclic flower** is a flower type formed out of a series of whorls; sets of identical organs attached around the axis at the same point. Most flowers consist of a single whorl of sepals termed a calyx; a single whorl of petals termed a corolla; one or more whorls of stamens (together termed the androecium); and a single whorl of carpels termed the gynoecium. This is a cyclic arrangement.

A typical flower has a circular section with a common centre, which can be clearly observed and distinguished from the top of the flower. The **receptacle** is the stem portion. It is found at the base in the center of the flower.

Some flowers contain flower parts with a spiral arrangement. Such flowers are not cyclic. However in the common case of spirally arranged sepals on an otherwise cyclic flower, the term **hemicyclic** may be used.

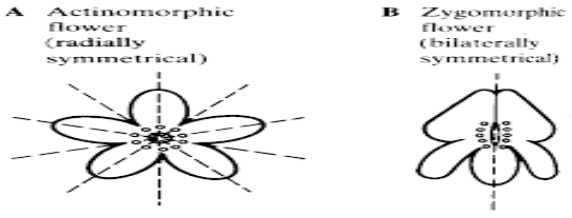
The suffix **-cyclic** is used to denote the number of whorls contained within a flower. The most common case is the **pentacyclic** flower, which contains five whorls: a calyx, a corolla, two whorls of stamens, and a single whorl of carpels. Another common case is the **tetracyclic** flower, which contains only one whorl of stamens, and therefore only four whorls in total. **Tricyclic** flowers also occur, generally where there is a single undifferentiated perianth. Flowers with more than five whorls are also not uncommon. The greatest variation occurs in the calyx and the androecium. Calyces of up to nine whorls have been recorded, and up to 12 whorls of stamens have been observed.

A **bract** is a modified or specialized leaf, especially one associated with a reproductive structure such as a flower, inflorescence axis or cone scale. Bracts are often (but not always) different from foliage leaves. They may be smaller, larger, or of a different color, shape, or texture. Typically, they also look different from the parts of the flower, such as the petals or sepals. The state of having bracts is referred to as **bracteate** or **bracteolate**, and conversely the state of lacking them is referred to as **ebracteate** and **ebracteolate**, without bracts.

Complete flower Flower having a perianth, androecium, and gynoecium.
Incomplete flower Flower lacking one or more of the floral parts, i.e., missing either the perianth, androecium, and/or gynoecium.
Imperfect flower Flower lacking either an androecium (stamens) or a gynoecium (carpels); also called a unisexual flower.
Flowers are **Perfect**, if both stamens and carpels are present, **Imperfect** if one or the other is lacking. In the latter case, both staminate and carpellate flowers may occur on the same plant **monoecious** or may be on separate plants **dioecious.** Flowers may be regular, exhibiting **radial symmetry**, or be irregular and show **bilateral symmetry**.

Floral symmetry

Floral symmetry describes whether, and how, a flower, in particular its perianth, can be divided into two or more identical or mirror-image parts. Uncommonly, flowers may have no axis of symmetry at all, typically because their parts are spirally arranged. Actinomorphic Most flowers are actinomorphic ("star shaped", "radial"), meaning they can be divided into 3 or more identical sectors which are related to each other by rotation about the centre of the flower.



Zygomorphic flowers can be divided by only a single plane into two mirror-image halves, much like a yoke or a person's face.

Asymmetry

A few plant species have flowers lacking any symmetry,

Trimerous flowers have sepals, petals etc in threes.

Tetramerous flowers have flower parts in fours

Pentamerous flowers have flower parts in fives: five sepals, 5 petals, five stamens.

Calyx:

The outer whorl of perianth consisting of sepals is called calyx. **Calyx**

The calyx is the outermost whorl of a flower. It comprises sepals, tiny leaves present at the base of a flower. These protect the flower whorls against mechanical injuries and desiccation. Some plants have coloured sepals the calyx and are called petaloid.

If the sepals are free the calyx is called polysepalous, and if they are united it is called gamosepalous.

In many flowers, the sepals fall off before the flower even opens fully. Such sepals are known as caducous.

In some, the sepals fall off after fertilization. Such sepals are known as deciduous.

The persistent sepals remain up to the fruiting stage.

1. Polysepalous: When calyx lobes or sepals are free, e.g., Cassia.

2. Gamosepalous: When calyx lobes or sepals are fused or united, e.g., Datura.

3. Caducous: When sepals wither or drop off very soon, e.g., poppy.

4. Persistent: When sepals persist even in the fruit, e.g., Solanum nigrum.

5. Petalloid: When sepals are coloured, e.g., Delphinium.

Forms of Calyx:

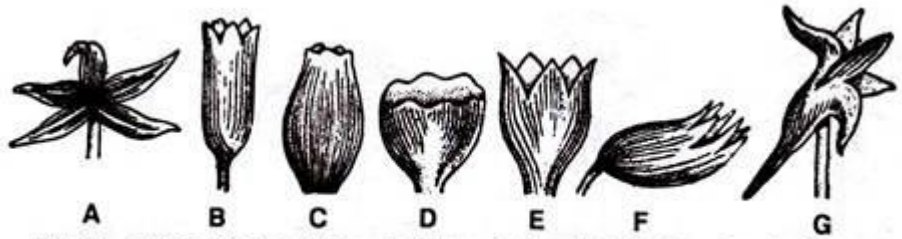


Fig. 81. Forms of calyx. A, Free; B, Tubular; C, Urceolate; D, Cupulate; E, Campanulate; F, Bilabiate; G, Spurred.

Calyx may be of following types:

1. Tabular: Like a tube, e.g., Nicotiana.
2. Urceolate: Un-shaped, e.g., Hyoscyamus.
3. Cupulate: Cup-like, e.g., Gossypium.
4. Infundibuliform: Funnel-shaped, e.g., Atropa belladona.
5. Campanulate: Bell-shaped, e.g., Lathyrus odoratus.
6. Bilabiate: Consisting of two lips, e.g., Ocimum.
7. Spurred: When one or more sepals are produced into spur, e.g., Delphinium.
8. Pappus: Reduced and hairy, as in Asteraceae.

Corolla is the second axillary whorl composed of petals. Like the calyx, the corolla also protects the more essential stamens and carpels within.

The petals are usually brightly coloured Petals may sometimes be green or have some dull colour like the sepals when they are termed sepaloid as in Annona, Polyalthia, Artabotrys, etc., of Annonaceae or in the green rose.

Petals are usually smooth but sometimes the surface may be hairy. Though usually thin, sometimes they may be thick fleshy structures. In a petal the lower part is usually narrow like the stalk of a leaf and is called the claw or unguis.

When a claw is present the petal is called clawed or unguisculate. The expanded portion of the petal is the limb . A clawless petal is sessile. A petal resembles the lamina not only in this but also in other characteristics.

It may be shaped linear, oblong, etc., and its margin may be entire, dentate, serrate, etc., just as in the leaf lamina. In some flower petals, as in Dianthus , the margin is deeply slashed or divided giving it a frilled appearance when it is called fimbriated or fringed.

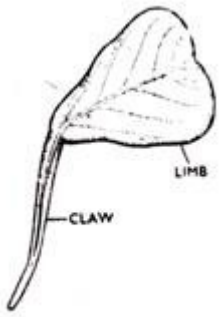


FIG. 325. A petal showing limb and claw.

The corolla may be regular or irregular. It is polypetalous or dialypetalous if the petals are free from one another and gamopetalous or sympetalous if there is any degree of cohe¬sion. When united, the united portion is the corolla tube and the free portion above shows the corolla lobes. The junction of the tube and the lobe is called the throat.

Considering its duration, the corolla is caducous (e.g., grape vine) or, more commonly, deciduous. Very rarely it is persistent, as in heather, where it remains in a dry and shrivelled up marcescent form.

Like the calyx, the corolla also may have appendages. In Antirrhinum (snapdragon) the tube of the corolla is slightly dilated on one side forming a pouch. This condition is termed, saccate or gibbous. In some cases one or more petals, or the tube itself is prolonged downwards, forming a spur which usually stores nectar. Such a flower is called spurred. There may be only one spur as in pansy or there may be several spurs as in Aquilegia vulgaris where each petal is spurred. Sometimes appendages of different kinds, such as scales, hairs, etc., develop from the inner wall of the throat. This gives rise to what is known as the corona. Beautiful coronas are seen in passion flower, oleander etc. The corona of daffodil is a united tubular structure.

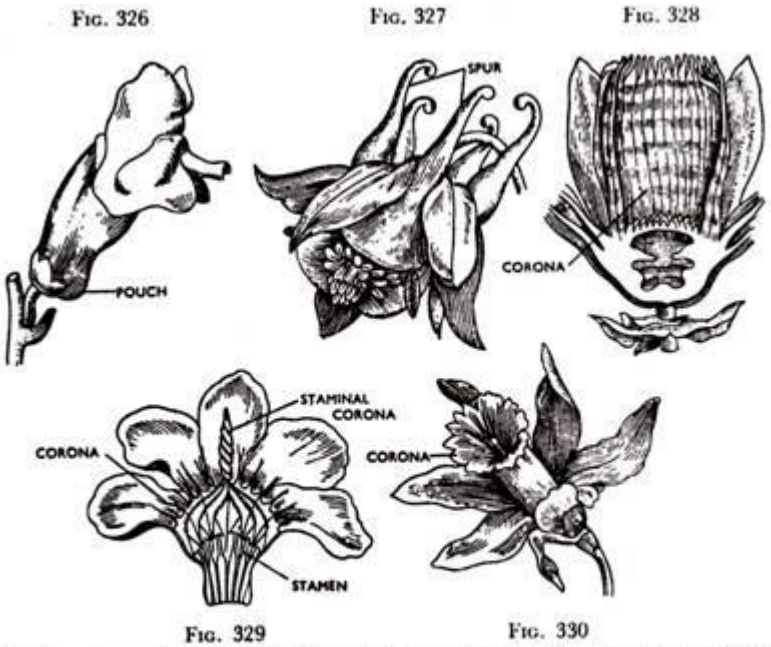


Fig. 326. Saccate corolla of *Antirrhinum*. Fig. 327. Spurred petals in *Aquilegia vulgaris*. Fig. 328. Corona developed on corolla of *Passiflora*. Fig. 329. *Nerium odorum* showing corona developed on corolla as well as staminal corona developed by staminal appendages. Fig. 330. Tubular corona developed on corolla of daffodil (*Narcissus pseudonarcissus*).

Corolla and its Forms

Forms of Corolla: According to the nature of cohesion, shape, etc., corollas of the following types are usually met with:

A. Polypetalous or Dialypetalous:

(a) Regular forms:

1. Cruciform: Four free clawed petals are arranged in the form of a cross as in the Cruciferae family, e.g., mustard .

2. Caryophyllaceous: This is formed by five free clawed petals with limbs at right angles to the claws as in the family Caryophyllaceae, e.g., the pink flower (Dianthus).

3. Rosaceous: There are five sessile (or with very short claws) petals with the limbs spreading outwards. The odd petal is anterior. This is found in the family Rosaceae (e.g., wild rose) and also in tea (Thea chinensis). Most cultivated roses however show more petals because of reasons explained .

(b) Irregular forms:

4. Papilionaceous: Here five free petals resemble a butterfly (papilion=butterfly). The posterior superior petal is larger than the others and is termed the vexillum or standard; two anterior inferior ones are usually more or less united forming a boat-shaped struc¬ture and are called the carina or keel. Two lateral petals called alae or wings overlap the carina and are themselves overlapped by the vexillum. This is a characteristic of the sub¬family Papilionaceae, e.g., the pea

flower.

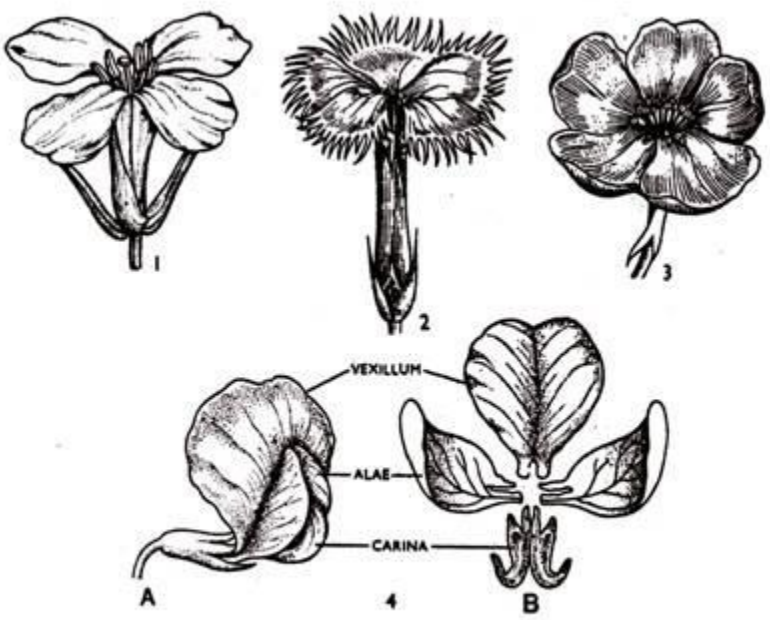


FIG. 331. POLYPETALOUS COROLLA FORMS. 1. Cruciform in mustard (*Brassica nigra*). 2. Caryophyllaceous in pink (*Dianthus chinensis*). 3. Rosaceous in wild rose. 4. Papilionaceous in pea. A. Complete flower. B. Corolla dissected to show arrangement and forms of petals.

B. Gamopetalous or Sympetalous:

(a) Regular forms:

1. Tabular: The corolla tube is nearly cylindrical throughout and the limbs are not spreading. The central florets of most Composite are tubular, e.g., sunflower disc florets.

2. Campanulate or bell-shaped: Corolla tubes are rounded at base gradually widening upwards like a bell. This may be seen in the family Campanulaceae and in many cucurbits , in Physalis, etc.

3. Infurdibuliform or funnel-shaped: The corolla resembles an inverted cone like a funnel as seen in Datura or many plants of the family Convolvulaceae like Ipomoea pulchella .

4. Hypocrateriform or salver-shaped: The corolla tube is long and narrow with the limb placed at right angles to it as seen' in Vinca rosea of Apocynaceac.

5. Rotate or wheel-shaped: Here the tube is shorter than in hypocrateriform while the limb is at right angles to it as seen-in brinjal (Solarium melongena), Nyctanthes arbor-tristis of Oleaceae , etc.

6. Urceolate or urn-shaped: Corolla tube is swollen in the middle tapering towards both base and apex as in Kalanchoe pinnata of Crassulaccae.

7. Ligulate or strap-shaped: Five petals unite to form a short tube at base which splits on one side and becomes flattened like a strap above as seen in many Compo¬sitae, e.g., the ray florets of marigold where one can see that the strap is formed by the union of five petals.

8. Bilabiate or labiate or two-lipped: This irregular corolla is united in such a way that the limb is divided into an upper posterior part (usually formed by the union of two petal lobes) and an unequal lower anterior part (usually formed by the union of three petal lobes) with the mouth gaping wide open.

This is characteristic of the family Labiatae (e.g., Leucas) and is also seen in some allied families (e.g., Hygrophila and Adhatoda of Aearithaceae).

9. Personate or masked: It resembles the bilabiate but the two lips are placed so close together that the mouth is closed. The projection of the lower lip closing the mouth is called the palate.

This type of corolla may be seen in snapdragon (Antirrhinum) or Lindenbergia.

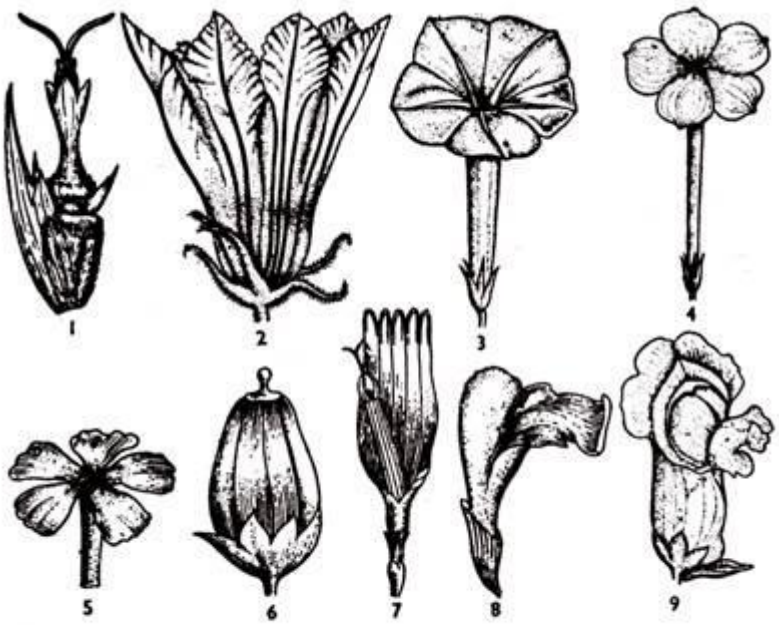


FIG. 332. GAMOPETALOUS COROLLA FORMS. 1. Tubular in sunflower disc floret. 2. Campanulate in *Cucurbita*. 3. Infundibuliform in *Ipomoea*. 4. Hypocrateriform in *Vinca*. 5. Rotate in *Nyctanthes*. 6. Urceolate in *Kalanchoe* . 7. Ligulate in marigold ray floret. Note 5 lobes signifying 5 petals. 8. Bilabiate in *Leucas*. 9. Personate in snapdragon.

Aestivation:

The mode of arrangement of sepals or petals; with respect to the other members of the same whorl is called aestivation. Following are the main types of aestivation:

1. Valvate: Floral leaves in a whorl may just touch one another at the margins without overlapping as seen in the family Anonaceae or the subfamily Mimoseae.

2. Contorted or twisted: When overlapping is regular in one direction so that one margin overlaps the next member on one side while its other margin is overlapped by the one before, giving a twisted appearance to the bud.This is seen in Malvaceae (china-rose, cotton, etc.) and Apocynaceae (Nerivm, Thevetia, etc.).

(b) Floral Leaves Not in One Whorl:

3. Imbricate: When the margins overlap one another but not in any particular order as in the subfamily Caesalpinieae. In imbricate flowers the petals do not actually lie in a single whorl.

4. Quincuncial: The floral leaves are not in a whorl but spirally arranged . Leaves 1 and 2 are external, 3 partly external, 4 and 5 internal. This is seen in guava (Psidium guyava of Myrtaceae), etc.

5. Vexillary: This is the typical aestivation of the papilionaceous corolla. The pos¬terior vexillum overlaps the two alae which again overlap the paired anterior carina.

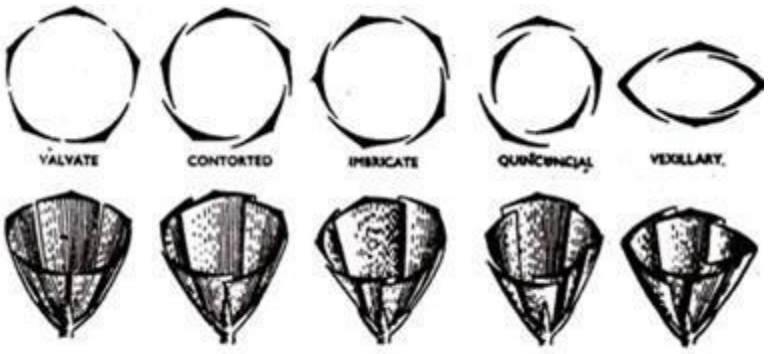


FIG. 333. Aestivation types. T.s. on top and lower half of flower bud below.

Perianth:

In most monocotyledons the calyx and the corolla are not differentiated and the general accessory whorls form the perianth as seen in Polyanthes, Crinum, etc. The perianth is often brightly coloured or petaloid as in Gloriosa superba (Liliaceae), Crinum asiaticum (Amaryllidaceae), etc. The perianth in some members of Amarantaceae is membranous and persistent. In Graminaceae the perianth is represented by two lodicules as seen in Festuca.

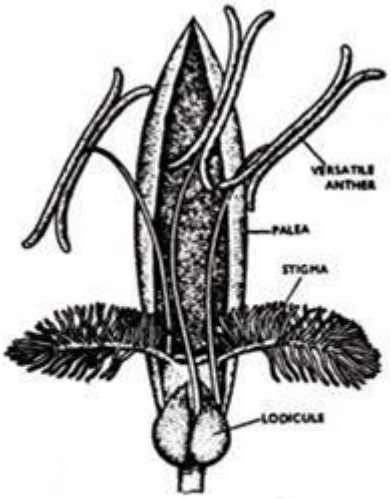


FIG. 334. Flower of *Festuca pratensis* with lemma removed showing lodicules, feathery stigmas and versatile anthers. (After Strasburger).

If the perianth members are free from one another as in Gloriosa superba , the perianth is termed polyphyllous. When the perianth members are united as in Poly¬anthes tuberosa , the perianth is gamophyllous.

FIG. 335. Polyphyllous petaloid perianth in *Gloriosa superba* flower. Also note extrorse anthers and style placed at right angles to the ovary.

tepal is one of the outer parts of a flower (collectively the perianth). The term is used when these parts cannot easily be classified as either sepals or petals.

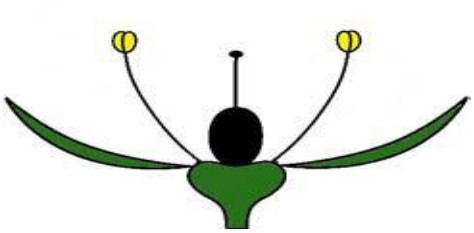
In flowering plants, the perianth may be described as being either **dichlamydeous**/**heterochlamydeous** in which the calyx and corolla are clearly separate, or **homochlamydeous**, in which they are indistinguishable (and the sepals and petals are collectively referred to as **tepals**). When the perianth is in two whorls, it is described as **biseriate**. While the calyx may be green, known as **sepaloid**, it may also be brightly coloured, and is then described as **petaloid**. When the undifferentiated tepals resemble petals, they are also referred to as "petaloid", as in petaloid monocots, orders of monocots with brightly coloured tepals. Since they include Liliales, an alternative name is lilioid monocots. The corolla and petals have a role in attracting pollinators, but this may be augmented by more specialised structures like the **corona** (see below).

When the corolla consists of separate tepals the term **apotepalous** is used, or **syntepalous** if the tepals are fused to one another. The petals may be united to form a tubular corolla (**gamopetalous** or **sympetalous**). If either the petals or sepals are entirely absent, the perianth can be described as being **monochlamydeous**.

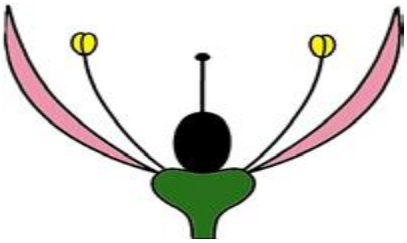
Types of perianth

- Achlamydeous floral meristem without a corolla or calyx

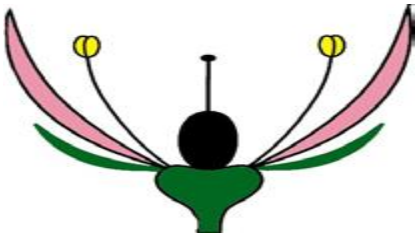
- Monochlamydeous perianth with non-petaloid calyx only



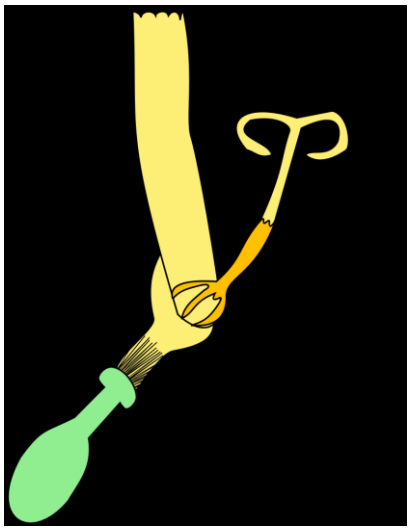
- Monochlamydeous perianth with corolla only or homochlamydeous perigonium with tepals



- Dichlamydeous/heterochlamydeous perianth with separate whorls



Corona



Flower of *Narcissus* showing an outer white corolla with a central yellow corona (paraperigonium)

Ligulate floret, typical for some members of the family Asteraceae:

A. inferior ovary

B. The calyx is a crown-shaped pappus, called a **corona**.

C. Anthers are united in a tube around the style, though the filaments are separate.

Flower of *Passiflora incarnata* showing corona of fine appendages between petals and stamens

An additional structure in some plants (e.g. *Passiflora*), some is the **corona** (paraperigonium, paraperigon, or paracorolla), a ring or set of appendages of adaxial tissue arising from the corolla or the outer edge of the stamens. It is often positioned where the corolla lobes arise from the corolla tube.[1]

The pappus of Asteraceae, considered to be a modified calyx, is also called a corona if it is shaped like a crown.

Androecium

The stamens in a flower are collectively called the **androecium**. **Stamens**

Stamen is also known as the third whorl of the flower and is the male reproductive part. It consists of a filament which is a thread-like structure with a circular structure anther on the top. Pollen is produced by the anther which contributes to the male reproductive process of the plant. All the stamens do not bear fertile anthers.

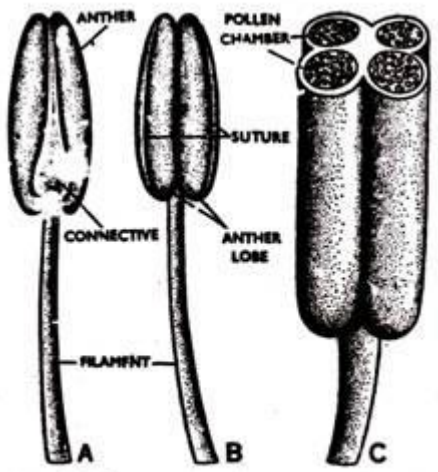


Fig. 336. Stamen showing parts. A. Dorsal view. B. Ventral view. C. Enlarged portion showing t... of anther.

Each anther consists of two lobes (anther lobes) connected by a connective which can be clearly seen on the dorsal side as an extension of the filament. Each anther lobe, again, has two pollen sacs or pollen chambers placed longitudinally. There are longitudinal grooves or sutures along the ventral face of the anther demarcating the pollen chambers.

Filament:

In rare cases a stamen may be devoid of a filament or sessile . Filament

A column formed from the fusion of multiple filaments is known as an **androphore**. Stamens can be **connate** (fused or joined in the same whorl) as follows:

- **extrorse**: anther dehiscence directed away from the centre of the flower. Cf. **introrse**, directed inwards, and **latrorse** towards the side.
- **monadelphous**: fused into a single, compound structure
- **declinate**: curving downwards, then up at the tip (also – declinate-descending)
- **diadelphous**: joined partially into two androecial structures
- **pentadelphous**: joined partially into five androecial structures
- **synandrous**: only the anthers are connate (such as in the Asteraceae). The fused stamens are referred to as a **synandrium**.

Anther

All Angiospermous anthers are bilobed and quadrilocular (i.e., formed of four micro- sporangia) at an early stage of development and this condition is seen in most mature stamens.
Rarely, however, the anther becomes unilocular or one-chambered either by the abortion of one lobe and destruction of the portion wall between the two chambers or the destruction of the entire partition tissue separating the four chambers.

This condition is seen in the family Malvaceae . The grooved ventral side of an anther usually faces the gynoecium or the centre of the flower and this condition is known as introrse; but, in a

few cases as in Gloriosa superba, Iris, Colchicum, etc., the anther faces the petals when the condition is called extrorse.

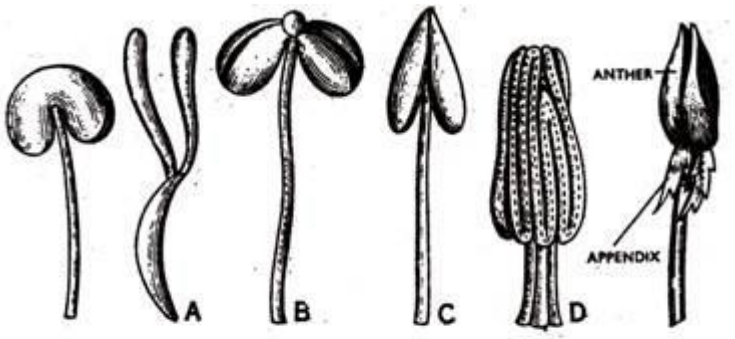


FIG. 347 FIG. 348 FIG. 349

ANTHER. FIG. 347. Unilocular and reniform in *Hibiscus rosa-sinensis*. FIG. 348. A. Linear in *Acalypha*. B. Rounded in *Mercurialis*. C. Sagittate in *Vinca*. D. Sinuous in *Cucurbita maxima*. FIG 349. Appendiculate in *Erica cinerea*.

Anther shapes are variously described by terms such as **linear**, **rounded**, **sagittate**, **sinuous**, or **reniform**.

The anther can be attached to the filament's connective in two ways:

- **basifixed**: attached at its base to the filament
  - **pseudobasifixed**: a somewhat misnomer configuration where connective tissue extends in a tube around the filament tip
- **dorsifixed**: attached at its center to the filament, usually **versatile** (able to move)

When the filament is attached along the entire length of the anther, it is called adnate fixation.

. When the filament is attached to a point at the base of the anther such that the anthers can swing, it is called versatile.

. When the anther is attached to the dorsal side of the anther, it is called dorsifixed.

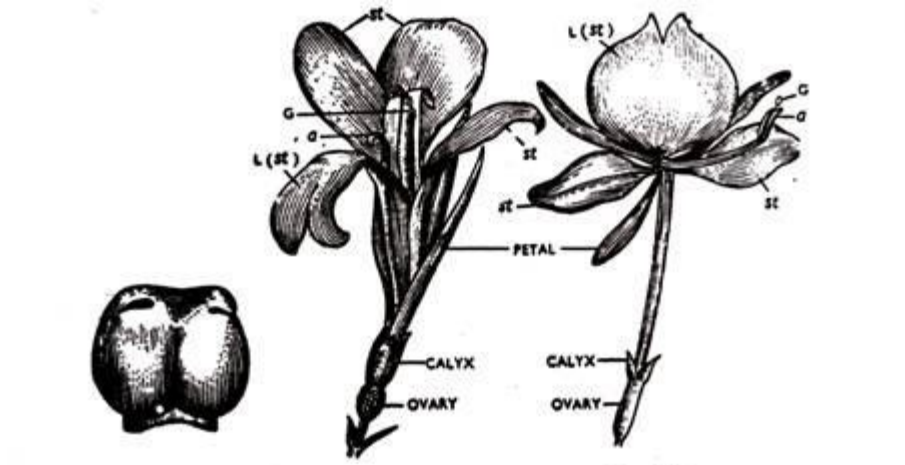


Fig. 337 Fig. 338 Fig. 339

Fig. 337. Sessile stamen of *Arum maculatum*. Fig. 338. Flower of *Canna indica* (Cannaceae of Scitaminae). Fig. 339. Flower of *Hedychium coronarium* (Zingiberaceae of Scitaminae). *st*=staminode; L=Labellum; *a*=anther; G=pistil.

The filament may be white or coloured yellow, blue, black, etc., like petals. While the filament is ordinarily simple, in Ricinus communis it is found to be branched. When filaments are very long, stamens protrude out of the flower and are term¬ed exserted. On the contrary, when stamens remain within the flower; they are termed inserted. Filaments sometimes bear appendages. Most characteristic of these is the staminal which is horny in Calotropis and cup-shaped in Eucharis , Pancratium and some other flowers of Amaryllidaceae.

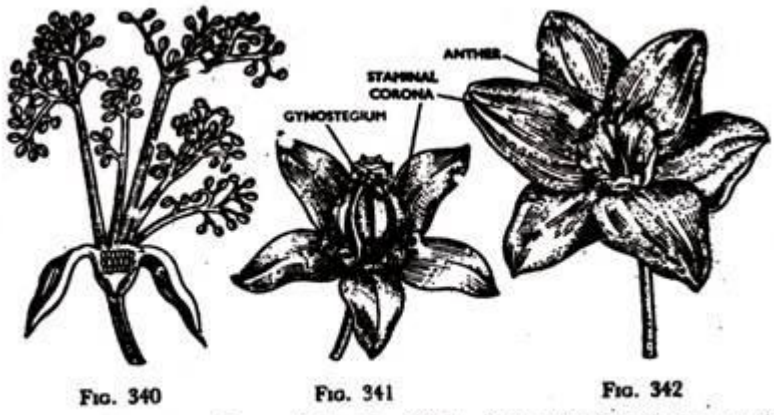


Fig. 340 Fig. 341 Fig. 342

Fig. 340. Branched stamen of castor (after Van Tieghem). Fig. 341. Staminal corona in *Calotropis procera* flower. Fig. 342. Staminal corona in *Eucharis amazonica*.

Connective:

Where the connective is very small, or imperceptible, the anther lobes are close together, and the connective is referred to as **discrete**, e.g. *Euphorbia* pp., *Adhatoda zeylanica*. Where the connective separates the anther lobes, it is called **divaricate**, e.g. *Tilia, Justicia gendarussa*. The connective may also be a long and stalk-like, crosswise on the filament, this is a **distractile** connective, e.g. *Salvia*. The connective may also bear appendages, and is called **appendiculate**,

e.g. *Nerium odorum* and some other species of Apocynaceae. In *Nerium*, the appendages are united as a staminal corona.

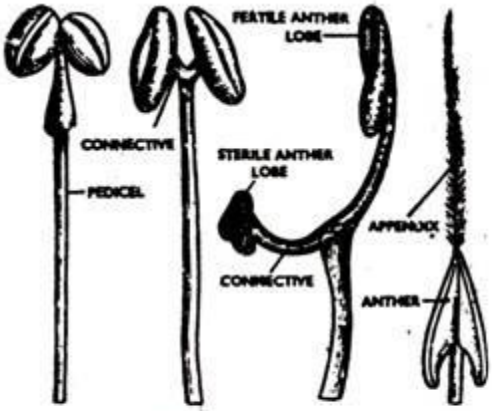


FIG. 343 FIG. 344 FIG. 345 FIG. 346

CONNECTIVE. FIG. 343. Discrete in *Poinsettia (Euphorbia) pulcherrima*. FIG. 344. Divaricate in *Tilia*. FIG. 345. Distractile in *Salvia verbenaca*. FIG. 346. Appendiculate in *Nerium odorum*.

Attachment of the Anther to the Filament:

The mode of attachment of the anther to the filament varies . (1) It is adnate when the filament or its continuation, the connective, appears to be attached throughout the whole length of the back of the anther as seen in magnolia and water-lily.

(2) In mustard, Carex and other members of Cyperaceae, etc., the filament ends just at the base of the anther, the latter being firmly fixed on the top of the former. This condition is called basifixed or innate.

(3) The attach¬ment is dorsifixed when the filament is firmly fixed to some position on the back of the an¬ther as in passion-flower, Sesbania, etc.

(4) In most grasses and in many lilies the attachment is versatile where the filament, is attached merely at a point about the middle of the connective so that the anther can swing on it freely.

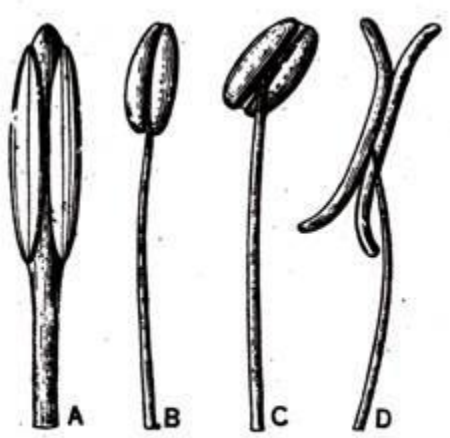


Fig. 350. Attachment of anthers. A. Adnate. B. Basifixed. C. Dorsifixed. D. Versatile.

Dehiscence of Anthers:

When the anthers become ripe they burst discharging the dry pollens. This act is called dehiscence and the time when this takes place is called anthesis.

Dehiscence may be of different types:

(1) Longitudinal—this is the common type of dehiscence when the anther lobes burst along the longitudinal sutures (i.e., the lines of fusion of the two pollen chambers in the two anther lobes) as may be seen in Datura, etc.;

(2) Transverse —seen in some unilocular anthers as those of Malvaceae (it appears to be transverse as the suture .is placed that way);

(3) Porous or apical—-the discharge of pollens is through apical processes seen in potato, brinjal, etc.;

(4) Valvular—when the whole or portions of the wall of the anther Open out like trap-doors releasing the pollens as seen in Berberis, Laurus, Cinnatnomum, etc.

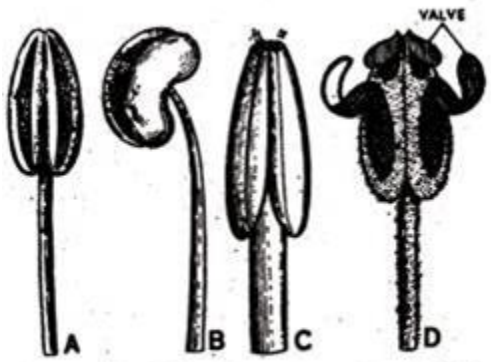


FIG. 351. Dehiscence of anthers. A. Longitudinal. B. Transverse. C. Porous. D. Valvular in *Laurus* sp.

Number and Insertion of Stamens:

A flower may be monandrous (Poinsettia), diandrous (Acanthaceae), triandrous (many monocots), tetrandrous (Labiatae), pentaindrous (most dicots), hexandrous (rice, bamboo, etc.) or polyandrous (Rosaceae) according as the usual number of stamens in the flower is 1, 2, 3, 4, 5, 6 or many. The number of stamens, however, may sometimes vary as discussed later.

When the stamens form a single whorl and the number of stamens is the same as that of the sepals and petals, the flower is isostemonous. In such a flower the stamens alter¬nate with the petals, i.e.; they are antisepalous.

Occasionally, however, such stamens may be antipetalous as found in different members of Rhamnaceae, Portulacaceae, etc. Some times there are two whorls of stamens, the first whorl alternating with petals (antisepa¬lous) and the second whorl alternating with sepals (antipetalous).

This type of flower is termed diplostemonous. A third condition is seen in some Rutaceae where there are two whorls of stamens of which the first whorl is antipetalous and the second whorl is antisepalous. This condition is described as obdiplostemonous.

Like other floral members, stamens also may be epigynous, perigynous or hypogynous in their insertion on the thalamus.

The stamens in an androecium may not be of the same length.

Two conditions are rather common:

(1) In the family Cruciferae there are six stamens of which the four in the inner whorl are taller than the two in the outer whorl. This condition is termed tetradynamous .

(2) Similarly, it is didynamous when out of four stamens present two are longer than the two others. This is found in Labiatae and the allied families Acanthaceae, Verbenaceae and Scrophulariaceae. Presence of stamens of different sizes in the same whorl, as often seen in Cassia flowers, is known as heterostemony.

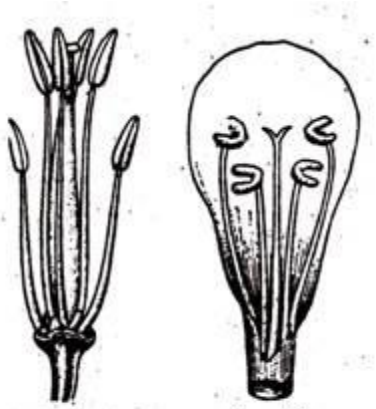


Fig. 352 Fig. 353

Fig. 352. Tetradynamous stamens in mustard. Fig. 353. Didynamous stamens in *Leonurus*.

Union of Stamens:

Union of stamens may involve adhesion (union with other members, viz., petals, perianth leaves or gynoecium) or cohesion, i.e., among the stamens themselves.

When stamens adhere, to petals they are termed epipetalous—a condition found in many flowers. When the adherence is to perianth leaves, the condition is termed epiphyllous as seen in the tuberose.

Another inteiesting adhesion is between stamens and carpels (gynandrous condidon) as seen in the gynostegiom of Asclepia- daceae and the gynostemium of Orchidaceae .

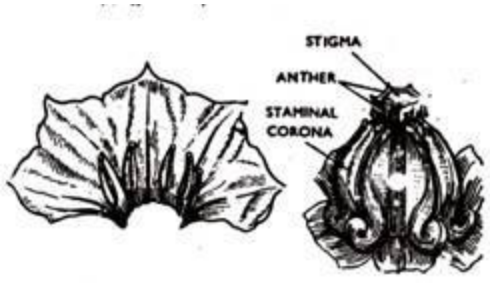


Fig. 354 Fig. 355

Fig. 354. Epipetalous stamens in brinjal.
Fig. 355. Gynostegium in *Calotropis*

Cohesion usually involves either only the filaments (adelphy) or only the anthers (syngeny). In adelphy, all the stamens may unite by their filaments forming one bundle of stamens with all the anthers free.

This is the monadelphous condition. In the family Malvaceae and in many other flowers the united filamen's form a staminal lube through which the long style of the pistil passes.

Oxalis (Oxalidaceae) also show's a similar staminal tube in which the few stamens are clearly unequal . In unisexual female flowers of Jatropha (Euphorbiaceac), the filaments unite to form a central column.

Diadelphy (two bundles) is very commonly seen in Papilionaceous flowers where rine stamens form one bundle and the tenth remains free as the second bundle .

In the silk-cotton tree (Salmalia or Bombax ceiba) the stamens form several separate groups with the filaments uniting to form several bundles or fascicles giving rise to the polyadelphous condition.

This is often seen in the families Guttiferae, Tilia- ceae, Bombacaceae, Rutaceae (e.g., orange), Myrtaceae (e.g., Melaleuca), etc. When the stamens unite only by the anthers leaving the filaments free, the condition is termed syngenesious.

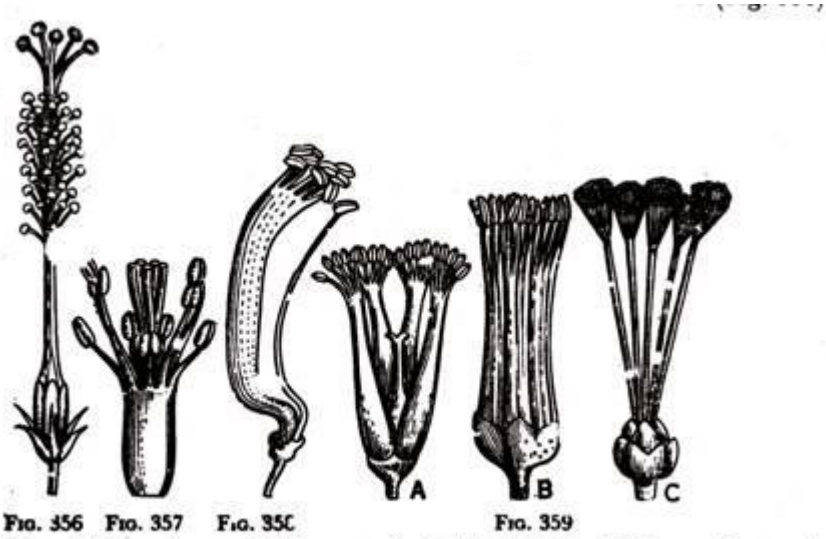


FIG. 356 FIG. 357 FIG. 358 FIG. 359

FIG. 356. Monadelphous stamens of *Hibiscus rosa-sinensis*. FIG. 357. Monadelphous and unequal stamens of *Oxalis*. FIG. 358. Diadelphous stamens of pea. FIG. 359. Polyadelphous stamens in A. *Bombax ceiba* ; B. Orange and C. *Melaleuca* (after Van Tieghem).

This is characteristically shown by the family Compositae . Here, the syngenesious anthers form a tube enclosing the style and the stigma. In Compositae the syngenesious stamens are also epipetalous .

In the family Cucurbitaceae, of the five stamens four unite in pairs so that the andro¬ecium shows three bundles 2+2+1- Each composite structure of two stamens shows complete union of the filaments as well as the sinuous anthers . This is called the synandrous condition.

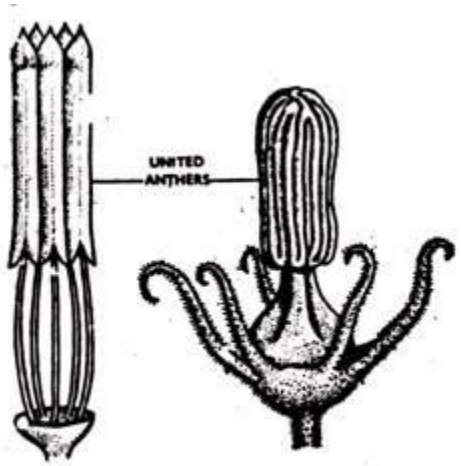


FIG. 360 FIG. 361

FIG. 360. Syngenesious stamens of Compositae.
FIG. 36. . Synandrous stamens of *Cucurbita maxima*.

A stamen typically consists of a stalk called the **filament** and an **anther** which contains *microsporangia*. Most commonly anthers are two-lobed and are attached to the filament either at the base or in the middle area of the anther. The sterile tissue between the lobes is called the **connective**, an extension of the filament containing conducting strands. It can be seen as an extension on the dorsal side of the anther. A pollen grain develops from a microspore in the microsporangium and contains the male gametophyte.

Stamens can also be **adnate** (fused or joined from more than one whorl):

- **epipetalous**: adnate to the corolla
- **epiphyllous**: adnate to undifferentiated tepals (as in many Liliaceae)

They can have different lengths from each other:

- **didymous**: two equal pairs
- **didynamous**: occurring in two pairs, a long pair and a shorter pair
- **tetradynamous**: occurring as a set of six stamens with four long and two shorter ones

or respective to the rest of the flower (perianth):

- **exserted**: extending beyond the corolla
- **included**: not extending beyond the corolla

They may be arranged in one of two different patterns:

- **spiral**; or
- **whorled**: one or more discrete whorls (series)

They may be arranged, with respect to the petals:

- **diplostemonous**: in two whorls, the outer alternating with the petals, while the inner is opposite the petals.
- **haplostemenous**: having a single series of stamens, equal in number to the proper number of petals and alternating with them
- **obdiplostemonous**: in two whorls, with twice the number of stamens as petals, the outer opposite the petals, inner opposite the sepals, e.g. Simaroubaceae (*see diagram*)

Anther dehiscence is the final function of the anther that causes the release of pollen grains. This process is coordinated precisely with pollen differentiation, floral development, and flower opening.

The anther wall breaks at a specific site. Usually this site is observed as an indentation between the locules of each theca and runs the length of the anther, but in species with *poricidal* anther dehiscence it is instead a small pore. If the pollen is released from the anther through a split on the outer side (relative to the center of the flower), this is **extrorse** dehiscence, and if the pollen is released from the inner side, this is **introrse** dehiscence. If the pollen is released through a split that is positioned to the side, towards other anthers, rather than towards the inside or outside of the flower, this is **latrorse** dehiscence.

The union of stamens when takes place among themselves is called as cohesion.

There are three different types of cohesion of stamens:

Type	Description	Examples
1. Adelphous(3-types)	Filaments are fused, anthers free. Fused filaments form staminal tube.	
a. Monoadelphous	Filaments of all stamens fused to form one bundle	Hibiscus, Cotton, Ladies finger
b. Diadelphous	Filaments of all stamens fused to form two bundles	Pea, Bean, Clitoria
c. Polyadelphous	More than two bundles of filaments	Citrus, Lemon
2. Syngenesious	Anthers fused, filaments free	Sunflower, Tridax
3. Synandrous	Both anthers and filaments are fused	Cucumber, Cucurbita, Cucumis

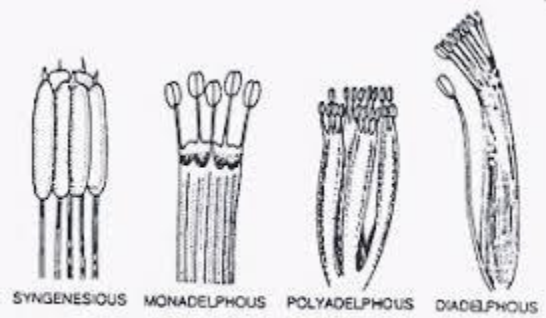


Fig. 34.63. Cohesion of stamens.

he androecium is the third set of floral organs composed of stamens or micro- sporophylls.

Ordinarily, each stamen is composed of a slender stalk-like filament supporting a knob-like spore case or the anther .

Gynoecium:

The carpel is the fourth whorl of the flower present in the centre. It mainly comprises the style, stigma and ovary- the female parts of a flower. A single flower can have one or more carpels. The pistil is the innermost, seed-bearing, female part of a flower. It is located generally to the centre and consists of a swollen base called the ovary. The pistil can also be referred to as a collection of carpels, which are fused together. The gynoecium or pistil is the central or the topmost whorl of the flower usually terminating the thalamus. It is composed of one or more carpels .

Pistil

An alternative term for the female parts. This table shows how it is used:

Comparison of gynoecium terminology using *carpel* and *pistil*

Gynoecium composition	***Carpel* terminology**	***Pistil* terminology**	**Examples**
Single carpel	Monocarpous (unicarpellate) gynoecium	A pistil (simple)	Avocado (*Persea* sp.), most legumes (Fabaceae)
Multiple distinct (unfused) carpels	Apocarpous (choricarpous) gynoecium	Pistils (simple)	Strawberry (*Fragaria* sp.), Buttercup (*Ranunculus* sp.)
Multiple connate ("fused") carpels	Syncarpous gynoecium	A pistil (compound)	Tulip (*Tulipa* sp.), most flowers

Carpel

A **carpel** is the basic unit of the female reproductive organ of a flower (the gynoecium). The parts of the carpel are:

When there is a single carpel the pistil is called simple or monocarpellary which is not very common although it is a characteristic of the large families of Leguminosae and Gramaneae .

A typical carpel has three parts—ovary, style and stigma. The lowermost swollen part is the ovary contain¬ing one or more swollen bodies called ovules which are the rudiments of seeds.

Above the ovary the carpel is protruded into a long or short style which ends in a somewhat rounded and usually sticky stigma on which the pollens are depo¬sited during pollinatior. A sterile pistil devoid of fertile ovules is called a pistillode.

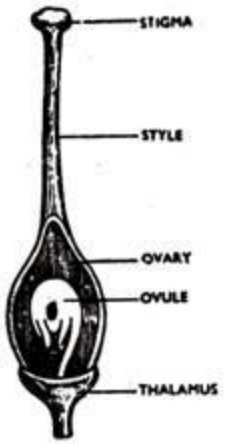


FIG. 362. A typical carpel.

Types

If a gynoecium has a single carpel, it is called *monocarpous*. If a gynoecium has multiple, distinct (free, unfused) carpels, it is *apocarpous*. If a gynoecium has multiple carpels "fused" into a single structure, it is *syncarpous*. A syncarpous gynoecium can sometimes appear very much like a monocarpous gynoecium.

Comparison of gynoecium terminology using *carpel* and *pistil*

Gynoecium composition	***Carpel* terminology**	***Pistil* terminology**	**Examples**
Single carpel	Monocarpous (unicarpellate) gynoecium	A pistil (simple)	Avocado (*Persea* sp.), most legumes (Fabaceae)
Multiple distinct ("unfused") carpels	Apocarpous	Pistils	Strawberry (*Fragaria*

	(choricarpous) gynoecium	(simple)	sp.), Buttercup (*Ranunculus* sp.)
Multiple connate ("fused") carpels	Syncarpous gynoecium	A pistil (compound)	Tulip (*Tulipa* sp.), most flowers

Compound or polycarpellary gynoeciums are much more common than the simple type. In such a gynoecium, the different carpels may remain completely free from one another when it is termed apocarpous (apocarpous multiple, as opposed to simple, as there are multiple carpels) or the carpels may unite with each other, wholly or partially, forming syncarpous gynoeciums.
Apocarpous gynoeciums may be seen in the familie Annonaceae, Magnoliaceae, Ranunculaceae, Nymphaeaceae, Rosaceae, etc.

In Annonaceae and Magnoliaceae the carpels are arranged on a more or less elongated thalamus, in Nymphaeaceae they are sunk on the flat spongy top of the thalamus shaped like an inverted cone, while in Rosaceae they are arranged on the bottom of the cup-shaped thalamus.
The syncarpous gynoecium is much more common and involves union of different degrees, e.g., in Solatium the carpels are com¬pletely united ; in china-rose the ovaries are united to form a five-locular compound ovary, the styles are united completely while the five stiginas are free; in Linum usitatissimum of Linaceae and in the pink flower the ovaries are united but the styles and stigmas are free.

In Apocynaceae and Asclepiadaceae the two carpels have free ovaries and styles uniting only at the stigmas at the gynostegium. Rather interesting is the cafe of the union of the gynoeciums of two different flowers.

In Lonicera of Caprifoliaceae (honey-suckle or woodbine) the ovaries of two adjoining flowers may fuse while the other parts of the Sowers remain free. This is termed syngynia. Ovaries of banana, etc., fuse abnormally in a like manner giving rise to paired fruits.

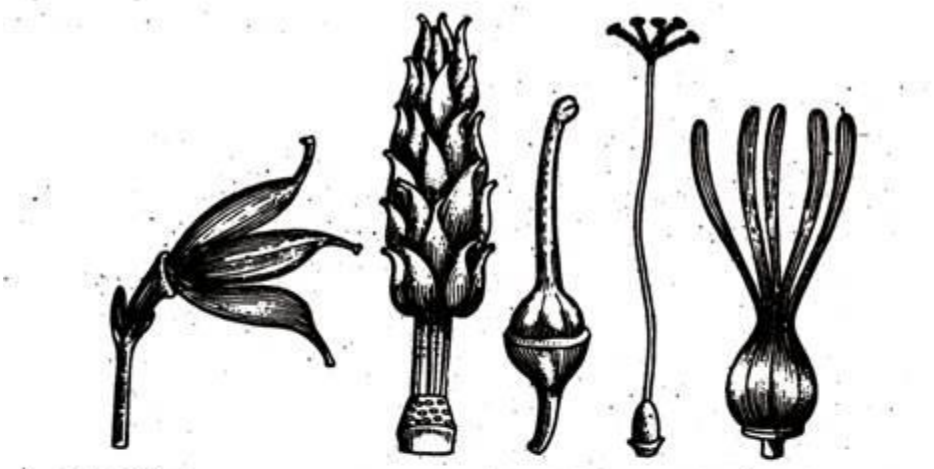


FIG. 363 FIG. 364 FIG. 365 FIG. 366 FIG. 367

FIG. 363. Apocarpous pistil of three carpels in *Aconitum* of Ranunculaceae. FIG. 364. Apocarpous pistil of many carpels in *Michelia champaca* of Magnoliaceae. Note elongated thalamus. FIG. 365. Completely united pistil of *Solanum melongena*. FIG. 366. Pistil of china-rose with free stigmas. FIG. 367. Pistil of *Linum usitatissimum* with free styles and stigmas.

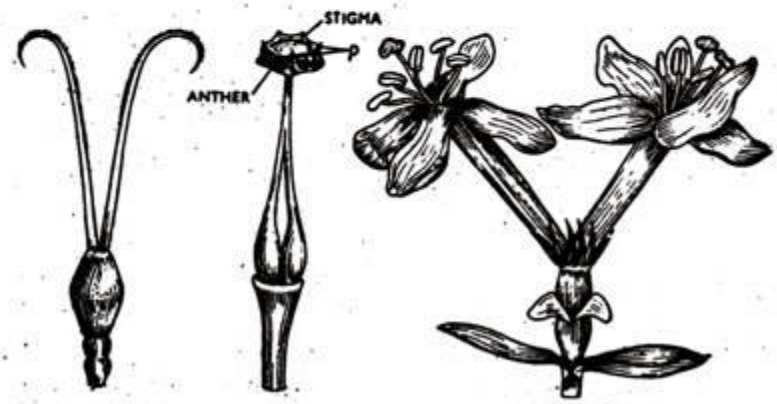


FIG. 368 FIG. 369 FIG. 370

FIG. 368. Pistil of *Dianthus* like that of *Linum*. FIG. 369. Pistil of *Calotropis* (Asclepiadaceae) united only at the stigma which again is united with anthers forming *gynostegium*. (Filaments and corona removed). *p* shows location of pollinia. FIG. 370. Syngynia in *Lonicera*.

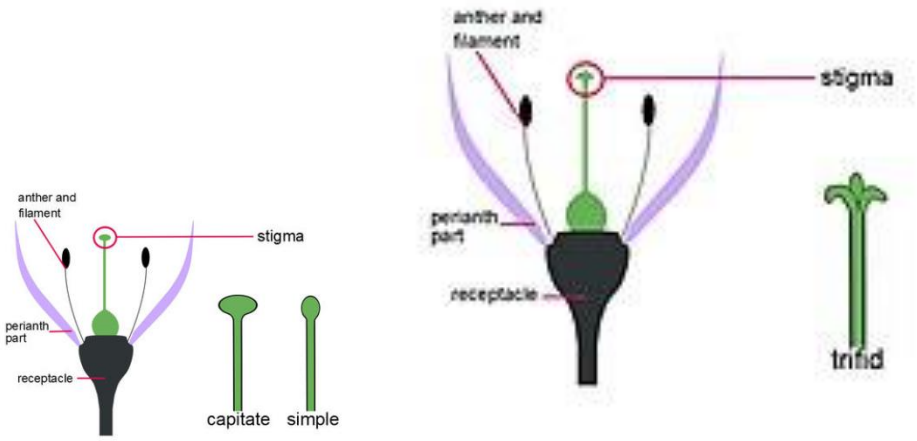
Style and Stigma:

Stigma

The **stigma** (plural: stigmas or stigmata) is the receptive tip of a carpel, or of several fused carpels, in the gynoecium of a flower.

The stigma, together with the style and ovary comprises the pistil, which in turn is part of the gynoecium or female reproductive organ of a plan

The stigma is often split into lobes, e.g. trifid (three lobed), and may resemble the head of a pin (capitate), or come to a point (punctiform). The shape of the stigma may vary considerably:



Style

The style is a narrow upward extension of the ovary . It may be absent in some plants in the case the stigma is referred to as sessile. Styles are generally tube-like—either long or short.

The style connects the ovary with the stigma and usually arises from the top or the summit of the ovary, i.e., it is apical. In some cases, however, the ovary apex itself may be deflected so that the style may appear to originate from near the base (basillar) or from the side (lateral) as in Alchemilla and mango .

The style is usually deciduous, dropping off after fertilization. But, in some cases, as in Naravelia zeylanica, Clematis, Digitalis, etc., it may be persistent . The style of Carina , Iris, etc., is petaloid. The base of the style in the family Umbelliferae is swollen forming what is known as the stylopodium.

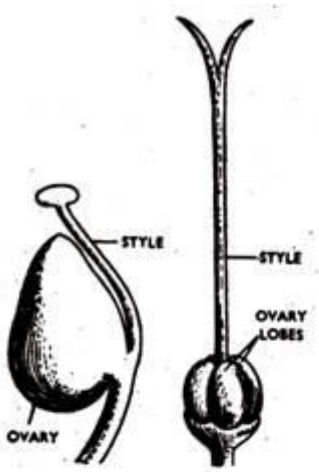


FIG. 371

FIG. 372

FIG. 3. Lateral style.
FIG. 37. Gynobasic style.

FIG. 373. Branched styles. (After Green).

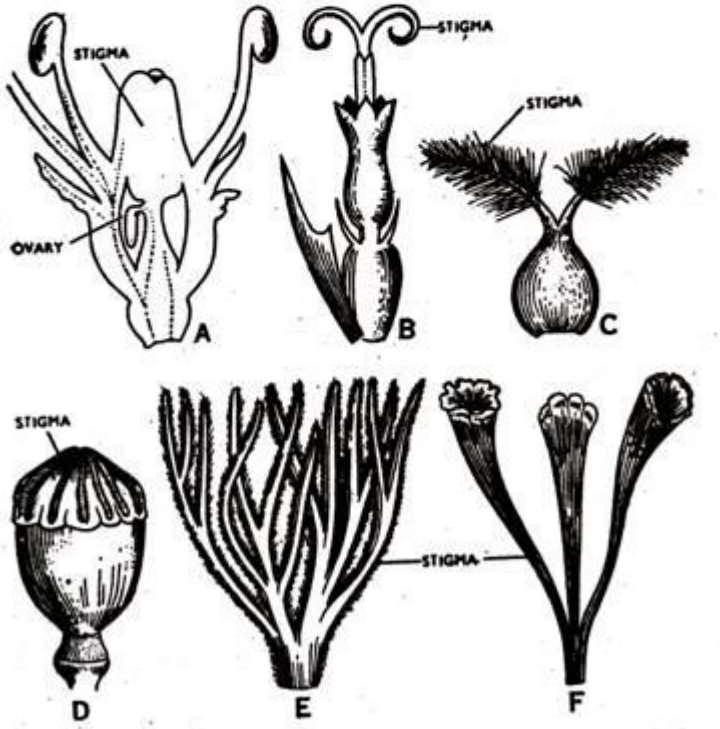


FIG. 374. STIGMA. A. Sessile in *Sambucus nigra*. B. Bifid in sunflower. C. Bifid and feathery in rice. D. Striate and sessile in poppy. E. Highly branched in *Begonia*. F. Funnel-shaped in *Crocus sativus*.

The styles of a compound pistil may sometimes be completely united as in china-rose . But, even when united, anatomical study shows separate vascular supplies for the different carpels. Thus, a cross-section of the china-rose style shows five vascular traces corresponding to the five carpels. When the styles are free, usually there is one style for each carpel but sometimes the style may be branched as in some Euphorbiaceae .

Stigma

The stigma is usually placed on the style. Sometimes, there may be no style, the stigma being placed on the top of the ovary as in Sambucus , Berberit, lotus, etc. Then it is termed sessile. The stigma top is usually rough, papillose or even hairy and somewhat sticky due to secretions. This shows a receptive surface where the pollens alight and germinate. In a syncarpous ovary there may be separate stigmas as in china-rose or the stigma may be lobed when it is described as bifid (e.g., Compositae), trifid, etc. Usually, the number of lobes correspond to the number of carpels but, monocarpellary flowers of Graminaceae show bifid feathery stigmas . The stigma of poppies (Papaver) is sessile as well as striate showing a star like radiate appearance . The Begonia stigma is highly branched. The three stigmas of Crocus have peculiar funnel-shaped forms. These are the stigmas which, when dried, form the saffron (zafran) of commerce.

Ovary:
Ovary is the most important part of the carpel as it contains the ovules which deve¬lop into seeds. A carpel without a functional ovary is sterile. The foliar origin of the ovary is rather clear in the simple ovary of pea .

Ovary position
If the ovary is inserted (on the floral axis, or receptacle) above all the other parts (the more primitive version), it is called an superior ovary If the ovary is inserted below all the other parts (often fused down in to the receptacle), it is called an inferior ovary (more advanced condition) The terms epigynous, hypogynous and perigynous also apply to where the ovary is situated, but refers to the placement of the other floral parts . A hypogynous flower is one where the floral parts are inserted below the ovary (i.e., the ovary is superior) An epigynous flower is one where the floral parts are inserted above the ovary (i.e., the ovary is inferior) A perigynous flower is one where the floral parts are inserted around the ovary. This is a special case for flowers with a hypanthium.

Technically, the ovary is superior for these flowers Pistil .A simple pistil is composed of a single, free carpel A compound pistil is composed of 2 or more fused carpels A locule is a chamber: in a simple carpel, there isone locule (and 1 carpel).In a compound pistil, the number of carpels and the number of locules may or may not be the same. Monocarpellary, bicarpellary,tricarpellary and polycarpellary.

There is a special tissue called placenta along the margin and the marginal line along which the carpel fuses is called the ventral suture, the midrib being the dorsal suture . Ovules develop from this placental tissue and remain within the ovary chamber.

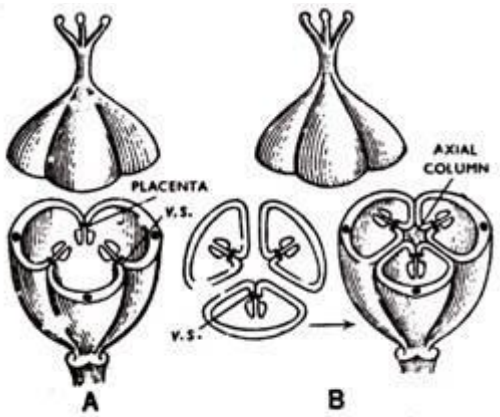


FIG. 377. Union of carpels. A. Fusion along margins (*v.s.*) only. B. Fusion along margins (*v.s.*) to form an axial column

Placentation:

It has already been seen that the placental tissue develops along the margin of the megasporophyll so that, when the latter closes to form a chamber, the placenta is located along the ventral suture.

But, ma-gin is not the only place where placenta develops. Placenta may also deve¬lop on a direct prolongation of the thala¬mus at the base of the carpel. As a result, we get different types of placentation, i.e., distribution of placenta, in different ovaries.

As this placenta is the tissue on which the ovules or the future seeds deve¬lop, a study of placentation is of importance in the study of the fruit and the flower.

The following types of placentation are usually met with:

Placentation – Arrangement of ovule within the ovary is known as placentation. Various types of placentations found in flowering plants are

(1) Marginal placentation: The placenta forms a ridge along through the ventral suture of the ovary, ovules are borne on the ridge to form two rows. Example: Pea

(2) Axile placentation: The placenta is axial and ovules are attached to it in a multilocular ovary. Example: Lemon

(3) Parietal placentation: Ovules develop on the inner wall of the ovary or on the peripheral. It is single-chambered, but due to the formation of a false septum, it becomes two-chambered. Example: Mustard

(4) Basal placentation : Placenta develops at the base of the ovary wherein a single ovule is attached to it. Example: Marigold

(5) Free central placentation: Ovules are borne on the central axis and septa are absent. Example: Primrose

In flowering plants, placentation is the attachment of ovules inside the ovary. The ovules inside a flower's ovary (which later become the seeds inside a fruit) are attached via *funiculi*, the plant part equivalent to an umbilical cord. The part of the ovary where the funiculus attaches is referred to as the *placenta*.

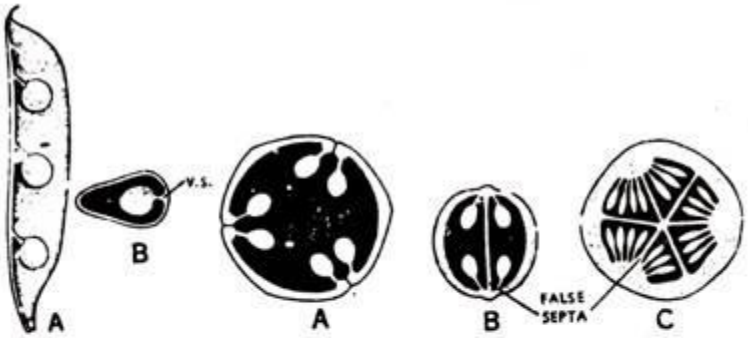


FIG. 378 FIG. 379

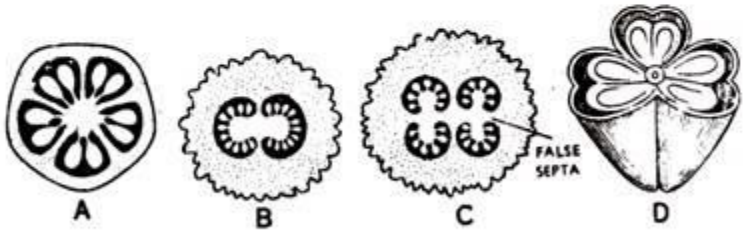


FIG. 380

PLACENTATION TYPES. FIG. 378. Marginal. A. Longitudinal half of pea pod. B. T.s. FIG. 379. Parietal. A. Typical. B. Mustard—Falsely bilocular. C. Cucumber—Falsely trilocular or hexalocular. FIG. 380. Axile. A. Typical. B. *Datura* showing normal bilocular ovary. C. *Datura* showing tetralocular ovary by formation of false septa. D. Axile in inferior ovary of lily.

Such an ovary may arise in two different ways:

(i) In a placentation which was originally axile, the partition walls may break down at a later stage making the ovary falsely one-chambered. This is the case in the family Caryophyllaceae (pink flower, etc.).

(ii) The thalamus may slightly extend into the ovary and placenta may develop on it as in the family Primulaceae .

(6) Superficial:

The multicarpellary flower of Nymphaea (water-lily) develops multilocular ovaries in which the whole inner walls of the chambers are lined with placental tissue so that ovules develop all round.

This is really an overdevelopment of the axile type, the placenta spreading to the chamber walls from the axial column .

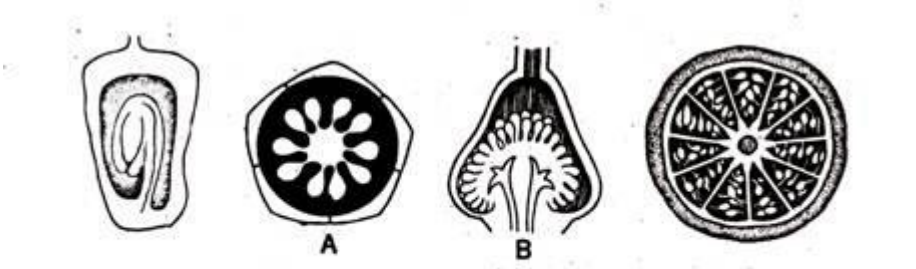


FIG. 381 FIG. 382 FIG. 383

PLACENTATION TYPES. FIG. 381. Basal in Compositae. FIG. 382. Free-central. A. T.s. of ovary showing typical free-central placentation. B. Free-central in Primulaceae (l.s.) where the axial column of placenta seems to be a projection of the thalamus. FIG. 383. Superficial in water-lily.

.

The ovule

The **ovule**, when mature, has one or two coats round the central **nucellus**, except at the top where there is an opening, the **micropyle**. The nucellus is a tissue round one large cell, the megaspore. The one large cell divides, giving the egg and some other cells.

An example of a simple carpel is that of a pea, bean or *Arabidopsis*: the fruit develops from the single carpel consisting of two rows of ovules aligned beside one another along the *placental* margin.

Floral diagrams and floral formulae

A *floral formula* is a way to represent the structure of a flower using specific letters, numbers and symbols, presenting substantial information about the flower in a compact form. The structure of a flower can also be expressed by the means of *floral diagrams*. The use of schematic diagrams can replace long descriptions or complicated drawings as a tool for understanding both floral structure and evolution.

Arrangement of Gynoecium:

a. Aporcarpous: When carpels are free, they are called apocarpous, e.g. lotus and rose.

b. Syncarpous: When carpels are fused, they are called syncarpous, e.g. mustard and tomato.

Placentation

The arrangement of ovules in the ovary is called placentation. There are different types of placentation which are as follows:

Fruits are the means by which angiosperms disseminate seeds.

The outer, often edible layer, is the *pericarp*, formed from the ovary and surrounding the seeds, although in some species other tissues contribute to or form the edible portion. The pericarp may be described in three layers from outer to inner, the *epicarp*, *mesocarp* and *endocarp*.

Fruit that bears a prominent pointed terminal projection is said to be *beaked*.

Plant scientists have grouped fruits into three main groups, simple fruits, aggregate fruits, and composite or multiple fruits. The groupings are not evolutionarily relevant, since many diverse plant taxa may be in the same group, but reflect how the flower organs are arranged and how the fruits develop.

Simple fruit

Dewberry flowers. Note the multiple pistils, each of which will produce a drupelet. Each flower will become a blackberry-like aggregate fruit. Simple fruits can be either dry or fleshy, and result

from the ripening of a simple or compound ovary in a flower with only one pistil. Dry fruits may be either dehiscent (they open to discharge seeds), or indehiscent (they do not open to discharge seeds).[Types of dry, simple fruits, and examples of each, include:

- achene – most commonly seen in aggregate fruits (e.g., strawberry)
- capsule – (e.g., Brazil nut)
- caryopsis – (e.g., wheat)
- cypsela – an achene-like fruit derived from the individual florets in a capitulum (e.g., dandelion).
- fibrous drupe – (e.g., coconut, walnut)
- follicle – is formed from a single carpel, opens by one suture (e.g., milkweed), commonly seen in aggregate fruits (e.g., magnolia)
- legume – (e.g., bean, pea, peanut)
- loment – a type of indehiscent legume
- nut – (e.g., beech, hazelnut, oak acorn)
- samara – (e.g., ash, elm, maple key)
- schizocarp – (e.g., carrot seed)
- silique – (e.g., radish seed)
- silicle – (e.g., shepherd's purse)
- utricle – (e.g., strawberry)

Fruits in which part or all of the *pericarp* (fruit wall) is fleshy at maturity are *simple fleshy fruits*. Types of simple, fleshy, fruits (with examples) include:

- berry – (e.g., cranberry, gooseberry, redcurrant, tomato)
- stone fruit or drupe (e.g., apricot, cherry, olive, peach, plum , mango)

An aggregate fruit, or *etaerio*, develops from a single flower with numerous simple pistils.[17]

- Magnolia and peony, collection of follicles developing from one flower.
- Sweet gum, collection of capsules.
- Sycamore, collection of achenes.
- Teasel, collection of cypsellas
- Tuliptree, collection of samaras.

The pome fruits of the family Rosaceae, (including apples, pears, rosehips, and saskatoon berry) are a syncarpous fleshy fruit, a simple fruit, developing from a half-inferior ovary.

Schizocarp fruits form from a syncarpous ovary and do not really dehisce, but rather split into segments with one or more seeds; they include a number of different forms from a wide range of families. Carrot seed is an example.

Aggregate fruit

Aggregate fruits form from single flowers that have multiple carpels which are not joined together, i.e. each pistil contains one carpel. Each pistil forms a fruitlet, and collectively the

fruitlets are called an etaerio. Four types of aggregate fruits include etaerios of achenes, follicles, drupelets, and berries. Ranunculaceae species, including *Clematis* and *Ranunculus* have an etaerio of achenes, *Calotropis* has an etaerio of follicles, and *Rubus* species like raspberry, have an etaerio of drupelets. *Annona* have an etaerio of berries.

The raspberry, whose pistils are termed *drupelets* because each is like a small drupe attached to the receptacle. In some bramble fruits (such as blackberry) the receptacle is elongated and part of the ripe fruit, making the blackberry an *aggregate-accessory* fruit. The strawberry is also an aggregate-accessory fruit, only one in which the seeds are contained in achenes. In all these examples, the fruit develops from a single flower with numerous pistils.

Multiple fruits

A multiple fruit is one formed from a cluster of flowers (called an *inflorescence*). Each flower produces a fruit, but these mature into a single mass. Examples are the pineapple, fig, mulberry, osage-orange, and breadfruit.

In some plants, such as this noni, flowers are produced regularly along the stem and it is possible to see together examples of flowering, fruit development, and fruit ripening.

In the photograph on the right, stages of flowering and fruit development in the noni or Indian mulberry (*Morinda citrifolia*) can be observed on a single branch. First an inflorescence of white flowers called a head is produced. After fertilization, each flower develops into a drupe, and as the drupes expand, they become *connate* (merge) into a *multiple fleshy fruit* called a *syncarp*.

Berries

Berries are another type of fleshy fruit; they are simple fruit created from a single ovary The ovary may be compound, with several carpels. Types include (examples follow in the table below):

- Pepo – berries whose skin is hardened, cucurbits
- Hesperidium – berries with a rind and a juicy interior, like most citrus fruit

Accessory fruit

The fruit of a pineapple includes tissue from the sepals as well as the pistils of many flowers. It is an accessory fruit and a multiple fruit. Main article: Accessory fruit

Some or all of the edible part of accessory fruit is not generated by the ovary. Accessory fruit can be simple, aggregate, or multiple, i.e., they can include one or more pistils and other parts from the same flower, or the pistils and other parts of many flowers.

Table of fruit examples

Types of fleshy fruits					
True berry	**Pepo**	**Hesperidium**	**Aggregate fruit**	**Multiple fruit**	**Accessory fruit**
Banana, Blackcurrant, Blueberry, Chili pepper, Cranberry, Eggplant, Gooseberry, Grape, Guava, Kiwifruit, Lucuma, Pomegranate, Redcurrant, Tomato	Cucumber, Gourd, Melon, Pumpkin	Grapefruit, Lemon, Lime, Orange	Blackberry, Boysenberry, Raspberry	Fig, Hedge apple, Mulberry, Pineapple	Apple, Pineapple, Rose hip, Stone fruit, Strawberry

Fruit

Achene : Fairly small, indehiscent, dry fruit with a thin and close-fitting wall surrounding but free from the single seed.
Berry : Indehiscent, fleshy fruit with (one or) a few to many seeds; the flesh may be more or less homogeneous, or the outer part of the fruit may be firm, hard, or leathery.
Capsule : Dry to rarely fleshy fruit from a two- to many-carpellate gynoecium that opens in various ways to release the seed or seeds.
Caryopsis : Small, indehiscent, dry fruit with a thin wall surrounding and more or less fused to a single seed.
Drupe : Indehiscent, fleshy fruit in which the outer part is more or less soft (to occasionally leathery or fibrous) and the center contains one or more hard pits or stones consisting of a bony endocarp surrounding a seed or seeds.
Follicle : Dry to rarely fleshy fruit derived from a single carpel that opens along a single (usually adaxial) longitudinal suture.
Hesperidium : A berry with a tough exocarp where the fleshy mesocarp is derived from glandular hairs, as in Citrus.
Legume : Dry, more or less elongated fruit derived from a single carpel that opens, often explosively, along two longitudinal sutures; the most common fruit type of members of Fabaceae.
Nut : Fairly large, indehiscent, dry fruit with a thick bony wall surrounding a single seed.
Pome : Indehiscent, fleshy fruit in which the outer part is soft and the center contains papery to cartilaginous structures enclosing the seeds; characteristic fruit of apples, pears, quinces, and most other members of Rosaceae subfam. Maloideae.
Aggregate fruit : Fruit that develops from several separate carpels of a single flower. Aggregate of achenes,
Multiple fruit : Fruit produced by the gynoecia of several closely clustered flowers.

Seedless fruits

A seed is a basic part of any plant. The ovules after fertilization, develop into seeds. A seed is made up of a seed coat and an embryo. The embryo is made up of a radicle, an embryonal axis and one (wheat, maize) or two cotyledons (gram and pea). A seed is found inside a fruit which converts into a new plant when we plant it. Hence, the seed is the most important part.

Let us now look at the different types of seeds and study their characteristics.

Types of Seeds

A Seed is primarily of two types. The two types are:

- Monocotyledonous Seed
- Dicotyledonous Seed

Let us now study about these types of seeds in brief.

Structure of a Monocotyledonous Seed

A Monocotyledonous seed, as the name suggests, has only one cotyledon. There is only one outer layering of the seed coat. A seed has the following parts:

- **Seed Coat:** In the seed of cereals such as maize, the seed coat is membranous and generally fused with the fruit wall, called Hull.
- **Endosperm:** The endosperm is bulky and stores food. Generally, monocotyledonous seeds are endospermic but some as in orchids are non-endospermic.
- **Aleuron layer:** The outer covering of endosperm separates the embryo by a proteinous layer called aleurone layer.
- **Embryo:** The embryo is small and situated in a groove at one end of the endosperm.
- **Scutellum:** This is one large and shield-shaped cotyledon.
- **Embryonal axis:** Plumule and radicle are the two ends.
- **Coleoptile and coleorhiza:** The plumule and radicle are enclosed in sheaths. They are coleoptile and coleorhiza.

Structure of a Dicotyledonous Seed

Unlike monocotyledonous seed, a dicotyledonous seed, as the name suggests, has two cotyledons. It has the following parts:

- **Seed coat:** This is the outermost covering of a seed. The seed coat has two layers, the outer testa and the inner tegmen.
- **Hilum:** The hilum is a scar on the seed coat through which the developing seed was attached to the fruit.
- **Micropyle:** It is a small pore present above the hilum.
- **Embryo:** It consists of an embryonal axis and two cotyledons.
- **Cotyledons:** These are often fleshy and full of reserve food materials.
- **Radicle and plumule:** They are present at the two ends of the embryonal axis.
- **Endosperm:** In some seeds such as castor, the endosperm formed as a result of double fertilisation, is a food storing tissue. In plants such as bean, gram and pea, the endosperm is not present in the matured seed. They are known as non-endospermous.

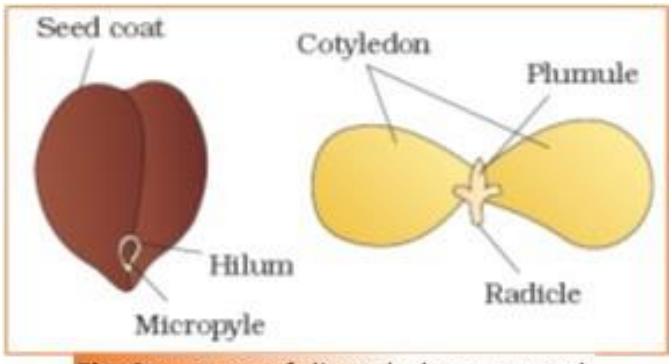


Fig: Structure of dicotyledonous seed