MORPHOLOGY OF REPRODUCTIVE PARTS

Chapter No. 3 FLOWER

e-content by
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Introduction:

- A flower is a group of reproductive organs of the flowering plants.
- It is the most conspicuous, highly attractive and essential organ of angiosperms, which is specialized for reproduction.
- After pollination and fertilization flower develop into fruit and seeds.
- Thus these seeds germinate to form new plant

Definition:

“A flower is defined as highly condensed and modified shoot of limited growth specialized for sexual reproduction”

OR

“Shoot of limited growth performing the function of reproduction”
Parts of Flower:

1. **Floral axis**: It corresponds to the axis of shoot. The axis consist of two parts: The stalk and Thalamus

2. 2. **The stalk**: It is the basal part of axis which is without floral leaves. It may be long or short. A flower with stalk referred as **pedicillate** e.g. *Hibiscus*, Rose etc. A flower without stalk is referred as **sessile** e.g. Tuberose

3. 3. **The thalamus**: It is the swollen tip of the stalk of a flower. It is similar to the tip of the stem. It has nodes and internodes. It always bears floral leaves on it. The thalamus is also known as **torus** or **receptacle**. Thalamus may be conical (*Annona*), **disc-like** (*Citrus*), **elongated** (*Michelia*), **flat** (*Lotus*) or **concave** or **cup shaped** in nature. Receptacle sometimes enlarges into the axis to which pistils attached in beginning and get seperated at maturity. This prolongation of receptacle is called **carpophore**
STRUCTURE OF TYPICAL FLOWER

- **pollen tube**
- **stamen**
  - **anther**
  - **filament**
- **petal**
- **ovule**
- **receptacle**
- **sepal**
- **pedicel**
- **stigma**
- **style**
- **pistil**
- **ovary**
Symmetry of the Flower

Symmetry is the arrangement of floral members with respect to an imagination of central axis. The number, shape, size and arrangement of floral leaves in a flower determines its symmetry. On the basis of symmetry, flowers are described as:

1. Actinomorphic:
   - It is also called as regular or symmetrical flower.
   - In such a flower all parts of each floral whorl are similar in size, shape and are evenly arranged on the thalamus.
   - Such a flower when cut in any plane produce two equal halves.
   - Thus, such a radially symmetrical flower is called actinomorphic e.g. Hibiscus, Datura, Mustard.

2. Zygomorphic:
   - It is also called as irregular or bisymmetrical flower.
   - In such a flower all parts of each floral whorl are not similar in size, shape and are not evenly arranged on the thalamus.
   - Such a flower can be cut through only one longitudinal plane in two equal halves.
   - Thus, such a bilateral symmetrical flower is called zygomorphic e.g. Pea, Ocimum, Adathoda.
3. **Asymmetrical flower:**
- When flower cannot be cut into equal halves along any plane.
- In this type of flower shape, size of floral leaves is unequal.
  e.g. *Canna*
Insertion of floral whorls on thalamus:

Depending on arrangement floral leaves on thalamus with respect to gynoecium it has 3 types:

i) **Hypogynous** - Hypo-below, gynous- gynoecium

➢ In this the **thalamus is swollen**, conical, elongated, convex or concave
➢ In this ovary is placed on the top of the thalamus and the calyx, corolla, androecium are **inserted below** the gynoecium.
➢ In other words ovary occupies **top-most position** on thalamus.
➢ Ovary is **superior** and the flower is hypogynous

* e.g. Hibiscus, Datura, Brinjal, Caesalpinia

ii) **Epigynous** - Peri-periphery, gynous-gynoecium

➢ In this the **thalamus is flat** or concave
➢ In this, calyx, corolla, androecium are inserted on the margin or rim of the thalamus
➢ The gynoecium is placed at the centre of cup shaped thalamus, thus all four whorls are inserted almost at equal level.
➢ The flowers which show such arrangement are referred as perigynous and the ovary is said to be semi-inferior or half-superior/half inferior *e.g.* Rose, Guava, Syzygium, Cassia, Bauhinia etc.
iii) **Epigynous** - Epi-above

- In this the thalamus is deeply concave or cup shaped the margin of thalamus grows upward which completely encloses ovary.
- The calyx, corolla, androecium are inserted above the gynoecium.
- In other words ovary occupies lower-most/basal position on thalamus.
- Ovary is inferior and the flower is epigynous

**e.g.** Tubersoe, *Cucurbita, Tridax, Ixora, Strawberry*

*Fig. Insertion of floral leaves on thalamus*
**Floral leaves:**

A typical flower has four kinds of floral leaves arranged in four successive whorls on thalamus. They are as follows

1. **Calyx:**
   - It is the first outermost accessory whorl of floral leaves
   - The calyx is made up of **sepals**
   - The sepals together form calyx
   - These are generally **green** in color
   - Sometimes sepals are **colored** e.g. Mustard
   - Sepals may be free-**Polysepalous** or fused **gamoepalous**
   - Sepals protect petals, stamens and carpels in bud condition
Calyx and Corolla

**Duration of Calyx:**

**Caducous:** If sepals fall off as soon as the flower open e.g. Poppy, *Argemone*

**Deciduous:** If sepals remain attached on the flower and fall off with petals after fertilization e.g. Mustard

**Persistent:** The sepals remain attached to fruit e.g. Tomato, Brinjal

It is of **two** types

**Accrescent:** The calyx is not only persistent but also grows in size along with fruit e.g. *Physalis, Withania*

**Macrescent:** The calyx is persistent but shrival and dries up e.g. Guava

**Modification of Calyx**

**Petaloid:** In some members sepals are colored and attractive like petals e.g. *Caesalpinia, Mustard, Sterculia*

**Pappus:** Sepals modified into stiff, nongreen hairy or feathery structures e.g. *Tridax, Launea, Sonchus*

**Spurred:** when sepal from its base produces tubular outgrowth called spur and calyx as spurred e.g. *Impatiens*
Fig: A Pappus Calyx (*Tridax*) B. Pappus (*Valeriana*) C. Spinous calyx (*Trapa*) D. Spurred calyx (*Impatiens*) E. Hooded Calyx (*Aconitum*)
2. Corolla:

- It is the second accessory whorl of a flower.
- The individual members of this whorl are called petals.
- Generally the petals are brightly colored and attractive due to presence of pigments like anthocyanin, anthoxanthin, betacyanin and carotenoids.
- The petals protect stamens and carpels in bud condition.
- Each petal consists of a narrow basal portion called the claw and an upper expanded portion called the limb.
- The petals may be polypetalous (free) or gamopetalous (united).
- The corolla may be actinomorphic (regular) or zygomorphic (irregular).
- In a gamopetalous corolla the united basal portion is known as corolla tube and the upper free portions are known as the corolla lobes.
- Tube- like appendages develop from the corolla to store nectar. These are called the spurs.
- The scaly or hairy outgrowths produced from the petals constitute corolline corona.

  e.g. Nerium
**Forms of Corolla**

- **Corolla**
  - **Polypetalous**
    - Regular
      1. Cruciform
      2. Rosaceous
      3. Caryophyllaceous
    - Irregular
      Papilionaceous (Butterfly)
  - Gamopetalous
    - Regular
      1. Infundibuliform
      2. Tubular
      3. Campanulate
    - Irregular
      1. Bilabiate
      2. Ligulate
      3. Personate
Polypetalous (free) and regular (actinomorphic):

1. Cruciform (Cross like +):
   - In this case, the corolla consists of four petals.
   - The petals are free.
   - The petals are arranged in the form of a cross
   - Each petal has a distinct claw & limb,
   
   e.g. *Raphanus* (raddish), *Brassica* (mustard- family Cruciferae/Brassicaceae) etc.

Polypetalous and irregular (zygomorphic):

2. Papilionaceous or Butterfly-like:
   - It consists of five, free unequal petals.
   - The outermost petal is the largest, posterior is known as the *standard* or *vexillum*.
   - The two lateral petals which are partially covered by standard is known as *wings* or *alae*
   - The remaining two innermost smallest anterior petals are called the *keel* or *carnia* which united to forms boat-shaped structure it encloses stamens and carpels.
   - The general appearance of the Papilionaceous corolla is like a butterfly.
It shows vexillary aestivation or descending imbricate aestivation
It is characteristic of family Papilionaceae
e.g. *Pisum* (pea), *Dolichos* (country bean), *Clitoria* (butterfly pea) etc.

**Gamopetalous (united) and regular:**

3. **Tubular:**
   - The corolla is said to be tubular when the petals become united to form a short cylindrical tube-like structure with small lobes e.g. disc florets of *Tagetes* (marigold), *Tridax*, *Helianthus* (sunflower), Tuberose etc.

4. **Campanulate or bell shaped:**
   - In Campanulate or bell shaped corolla, the petals are united and the corolla looks like a bell e.g. *Spathodia, Cucurbita* (gourd).

5. **Infudibuliform or funnel shaped:**
   - When the petals are united to form a tube below and gradually widened upwards, the corolla is called infundibuliform,
   - The spreading limbs resulting into a funnel shaped appearance
   e.g. *Datura, Ipomoea* (water bind weed) etc.
Gamopetalous and irregular:

6. Bilabiate or Bilipped/ Two-lipped:

- The corolla gives the two lipped a appearance at mouth. So called bilabiate
- It consists of five petals which are unequal and united to form short tube
- The lip of corolla is divided into **upper** portion and **lower portion** is called the **lips**.
- The **upper lip** is larger, posterior one and consists of **two petals**, while the smaller, anterior **lower lip** consists of **three** petals.
- The mouth of the corolla remains wide open

**e.g.** *Ocimum* (basil), *Leucas*, *Hygrophila*, *Adhatoda* (malabar nut) etc.

**Significance of Corolla:**

- The corolla lobes are brightly coloured which attracts insects, bees, birds for cross pollination
- The petals protect inner whorls i.e. stamens and carpels in bud condition
Forms of corolla
**Perianth**

- When calyx and corolla are not differentiated the fused structure is known as perianth.
- It is an accessory whorl.
- The individual members of this whorl are called **tepals**.
- Generally the tepals are variously colored.
- The tepals protect stamens and carpels in bud condition.
- The tepals may be **polypehyllous/polypepalous** (free) or **gamophyllous/gamotepalous** (united).
- The tepals may be **actinomorphic** (regular) or **zygomorphic** (irregular).
- E.g. *Tuberose*, Euphorbiaceae family.
1. **Valvate**: Margins of the adjacent petals touch each other but without overlapping.
   E.g.: *Brassica*, Bottle brush, Chinarose (Sepals)

2. **Twisted/ Contorted**: One margin of a petal overlaps regularly the margin of an adjacent petal. E.g.: Chinarose, *Datura*

3. **Imbricate**: Irregular overlapping of petals by one another. Out of five petals one is completely internal, one completely outer, three are arranged in overlapping and overlapped manner. E.g.: *cassia*, Gulmohar, Neem

4. **Quinquincial**: Irregular overlapping of petals. Out of five petals two are completely inner, two are completely outer and one is twisted. E.g. *Cucurbita, Ranunculus*

5. **Vexillary**: This is the typical aestivation of the papilionaceous corolla. The posterior vexillum overlaps the two alae which again overlap the paired anterior carina. This is also called descending imbricate aestivation.
   E.g. Pea, *Clitoria, Sesbania* family-Papilionaceae
Types of Aestivation

Valvate
Twisted
Imbricate
Quinquuncial
Vexillary
3. Androecium

- It is the third whorl of floral leaves of flower placed inside corolla
- It is the essential whorl of flower
- It is the male reproductive part of the flower
- It is made up of stamens
- The function of stamen is to produce pollen grains or microspores
- On germination they gives rise to male gametes.

1) Parts of Stamen:

A typical stamen consists of **three** parts:

a) **Filament:**

- It is a slender stalk of the stamen.
- It may be long or short
- Sometimes the filament may be very short or even absent.
- The stamen without filament is a called **sessile**
- Generally filament is simple but rarely it is profusely branched

**e.g.** Castor, *Jatropha*, Citrus
b) Connective:
- It is sterile tissue which connects the antherlobes with filament
- It is nothing but the extension of the filament. Between the antherlobes.
- Sometimes the connective may prolong beyond the antherlobes into a hairy, scaly or feathery appendage.
- This outgrowth is known as staminal corona e.g. Nerium

c) Anther:
- This is a swollen bag-like part placed at the top of filament
- It is made up of one or two antherlobes.
- Each antherlobe contains the one or two pollen chambers or sacs
- The pollen chamber contains numerous pollen grains.
- Thus a typical anther is bilocular or quadrilocular.
- The pollen grains are free from each other. But in some plants such as Calotropis and Orchids the pollen grains from each sac remain together and form pollen masses called Pollinia. The stamens without anthers are nonfunctional and are known as staminodes e.g. Cassia
**ANDROECIUM**

**Parts of Stamen:**

i) Filament — Basifixed e.g. *Cassia*

ii) Anther — Dorsifixed e.g. *Michelia, Nymphaea*

iii) Connective — Versatile e.g. *Poaceae*

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**Images:**

(a) Basifixed

(b) Dorsifixed

(c) Versatile

*a- basifixed, b- Dorsifixed, c- Versatile*
Modifications /Variation in Stamen:

a) Staminode (S): Stames modified into petal like structure

b) Labellum

c) Staminal corona
Fixation of anther:

Fixation is the mode of attachment of filament to anther. Different type are as follows:-

A) Basifixed:

When the filament is attached to the base of anther e.g. *Brassica, Datura*

B) Adnate:

When filament run throughout the length and become continuous with the connective e.g. *Magnolia, Annona, Ranaculus*.

C) Dorsifixed:

When filament is attaches to the dorsal side of anther e.g. *Citrus*.

D) Versatile:

When filament attaches in the middle of the connective in such a way that the anther can swing freely as seen in grasses.
Androecium

Union of Stamen: Variations of stamens

i) **Cohesion**: Union between similar parts of flower

ii) **Adhesion**: Union between two dissimilar parts of flower

Free: Polyadelpous

Fused-Adelphy-Various types

i) **Cohesion of stamens**:

1. **Adelphy**: When stamens are united by their filaments only leaving anthers free. Such a condition is called as adelphous condition. The adelphy is of following types-
   a. **Monoadelphous**, Mono-Single Adelphy-bundle e.g. *Hibiscus*, Family-Malvaceae
   b. **Diadelphous**, Di-Two, Adelphy-bundle e.g. *Clitoria*, Pea, Shevari Family Fabaceae
   c. **Polyadelphous**, poly-many, Adelphy-bundle e.g. *Castor*, Citrus Family-Rutaceae

2. **Syngenys**: Filaments free anthers united condition is known as syngenesious condition e.g. Aster, Sunflower

3. **Synandry**: Both the filaments and anthers unites throughout their length condition is known as synandrous e.g. *Cucurbita* (Bhopla) Family- Cucurbitaceae
ii) **Adhesion of stamens** - Union of stamens with other floral parts i.e. sepals, petals, carpels

   a) **Epipetalous**: Filaments of Stamens fused with petals eg. *Jasminum*, *Tecoma*

   b) **Epiphyllus**: Filaments of Stamens fused with tepals eg. Tuberose, lily

   c) **Gynandrous**: Gynoecium and Androecium gets fused eg. *Calatropis*

   d) **Episepalous**: Filaments and sepals get united eg. *Combretum*

Depending on length of filaments in stamens- 2 types of conditions occur-

- **Didynamous**: total 4 stamens 2 with long filament and 2 with short filaments
  
  e.g. *Tecoma* (Phutani), Pichkari

- **Tetradynamous** Total 6 stamens 4 with long filaments and 2 with short filaments
  
  e.g. Mustard
**ANDROECIUM**

- Connective
- Anther
- Filament

**ATTACHMENT OF THE FILAMENT TO THE ANTHERS**

- Basifixed (eg: Datura)
- Adnate (eg: Nelumbo)
- Dorsifixed (eg: Hibiscus)
- Versatile (eg: Oryza sativa)

**Structure of a Stamen**

- a. Dorsal view
- b. Ventral view

**Types of Androecium**

- Synandey
- Syngeny
- Polyadelphous
- Diadelphous
- Monoadelphous
Modifications in stamens

1. **Androphore** eg. Passionflower (Krishnakamal)

2. **Gynophore** eg. *Bauhinia*

3. **Carpophore** eg. *Geranium, Foeniculum* (Badishep)
4. **Androgynophore** e.g. *Capparis*, *Varun*, *Gynandropsis* (Tilwan)

5. **Gynostegium** e.g. *Calatropis*
4. Gynoecium:

- It is the fourth whorl of floral leaves present inside the androecium.
- It is the essential whorl of the flower.
- It is the female reproductive part of flower.
- It is made up of carpels collectively called gynoecium or pistil.
- Carpels consist of three parts: basal swollen ovary, a slender tube-like part above the ovary is style and the tip of style called as stigma.
- The stigma receives the pollen grains.
- Ovary consists of one or many ovules which are nothing but the future seeds.
- Each ovule produces egg or the female gametes which take part in fertilization.
Types of gynoecium:

a) Simple

b) Compound

c) **Compound**: Depending upon number of carpels involved in formation of gynoecium it includes following types-

1. **Monocarpellary** - Single carpel e.g. Pea, Gokarna, Bougainvel, Pangara, Karanj (Leguminosae, Nyctaginaceae) family-

2. **Bicarpellary** - Two carpels e.g. Sunflower, Tulas (Family-Asteraceae, Lamiaceae)

3. **Tricarpellary** - Three carpels e.g. Tuberose, Lily (Family-Cucurbitaceae, Euphurbiaceae, Amarylidaeae, Liliaceae,

4. **Pentacarpellary** - Five carpels e.g. China rose (*Hibiscus*) (Family, Malvaceae,

5. **Polycarpellary** - Many carpels

   i) **Apocarpus**: All carpels free e.g. *Michelia*

   ii) **Syncarpus**: All carpels fused e.g. *Hibiscus*
**Cohesion of Carpels:**

Union of carpels shows different degrees of fusion as follows:

- Complete union of parts i.e. ovary style and stigma e.g. *Solanum*, Orange.
- Only ovary & style unites while stigma remains free e.g. *Hibiscus*, *Thespedia*.
- Only ovaries fused while style & stigma free e.g. *Linum*.
- Ovaries and styles free while stigma united e.g. *Calatropis*, *Vinca*.
Placentation:
The ovules are attached to the ovarian tissue through a stalk called placenta. The type of attachment is called placentation or The mode of attachment of ovules within ovary is called as **placentation**. It is studied by taking T.S. or L.S. of ovary

Types of placentation:

Depending on arrangement of ovules inside ovary following types are made:

1. Marginal
2. Parietal
3. Axile
4. Free central
5. Basal
6. Superficial

1. **Marginal Placentation:**
   - It is **primitive** type of placentation found in simple or polycarpellary apocarpous gynoecium.
   - The placenta develops on the **ventral suture** of the ovary i.e. along the fused margins of the carpels hence called marginal.
   - Ovules are many and are attached to the placenta in two vertical rows e.g. Pea
2. Axile placentation:

- The gynoecium is formed by fusion of two or more carpels.
- The margins of the adjacent carpels fuse to form the all of the ovary, project inwards and meet in the middle to form the central axis.
- The ovary is divided into as many as chambers or locules as the number of carpels.
- The ovules develop on the central axis corresponding to the fused margins of the carpels, hence called axile.

  e.g. *Datura* (Bicarpellary), *Onion* (Tricarpellary), *Ipomoea* (Tetracarpellary), *Hibiscus* (Pentacarpellary)

3. Parietal Placentation:

- This type of placentation is found in syncarpous and unilocular ovary formed by fusion of two to many carpels.
- The ovules develop at fused margins of ovary wall.
- Since ovules are parietal i.e. towards periphery, it is known as parietal placentation.
- The number of ovules corresponds to the number of carpels.

  e.g. *Argemone*, Passion flower, *Cucurbita*, *Cucumis*
4. Free central placentation:
- It is found in syncarpous, polycarpellary multilocular ovary.
- The partitions between the chambers are lost and the ovules develop on central column which has no connection with wall of the ovary
  e.g. *Dianthus*

5. Basal placentation:
- It is found in syncarpous, unilocular ovary.
- A single ovule is borne at the base of the ovary.
- The placenta is placed at the tip of the thalamus
  e.g. Sunflower (Family Asteraceae), *Bougainvillea*

6. Superficial Placentation:
- The gynoecium is polycapellary, syncarpous, and multilocular
- The ovules are not only restricted to the margins of the carpels but develop all over the inner surface of the locules
  e.g. *Nymphea*
## Gynoecium

<table>
<thead>
<tr>
<th>Number of locules in the ovary</th>
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<tbody>
<tr>
<td>Stigma</td>
</tr>
<tr>
<td>Style</td>
</tr>
<tr>
<td>Ovary</td>
</tr>
<tr>
<td>(Datura gynoecium)</td>
</tr>
<tr>
<td><strong>Monolocular</strong> eg: Dolichos</td>
</tr>
<tr>
<td><strong>Bilocular</strong> eg: Solanum</td>
</tr>
<tr>
<td><strong>Trilocular</strong> eg: Allium</td>
</tr>
<tr>
<td><strong>Tetralocular</strong> eg: Ocimum</td>
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</tbody>
</table>

## Types of Placentation

| Marginal eg: Dolichos          |
| Parietal eg: Brassica          |
| Axile eg: Hibiscus             |
| Free central eg: Dianthus      |
| Basal eg: Tridax               |
| Superficial eg: Nymphaea       |
Thank you...