

1. Details of Module and its structure

| Module Detail | |
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| Subject Name | Biology |
| Course Name | Biology 01 (Class XI, Semester - 1) |
| Module Name/Title | Morphology – Inflorescence And Flower – Part 3 |
| Module Id | kebo_10503 |
| Pre-requisites | Basic Characteristics of Plants, Diversity Amongst Angiosperms (Moncots And Dicots), Basic Understanding of Different Parts of Plant Reproduction. |
| Objectives | After going through this lesson, the learners will be able to understand the following: <ul style="list-style-type: none">• The basic structure of a flower as the reproductive part of angiosperms.• The different parts of the flower.• What is Inflorescence and the different type of Inflorescence. |
| Keywords | Inflorescence, Racemose, Cymose, Pedicel, Thalamus, Calyx, Corolla, Androecium, Gynoecium, Perianth, Actinomorphic, Zygomorphic, Hypogynous, Perigynous, Epigynous, Aestivation Etc . |

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Table of Contents :

1. Introduction
2. General Discription Of Plants
3. Parts Of A Flower
4. Inflorescence
5. Summary

1. Introduction

Flowering plants or the angiosperms evolved during the cretaceous period about 135 million years ago making their evolution comparatively a recent one. Flowering plants conquered the terrestrial land and became to dominate Earth's plant life. The evolution of angiosperm has been a great success story and much of its credit goes to its unique reproductive organs called flowers. The flower gives angiosperms selective evolutionary advantages. The angiosperms have diversified to give rise to many individual species with their unique colorful floral morphology that helps them to attract pollinators like bees, humming birds, variety of insects and animals .In fact some angiospermic species have co-evolved along with their specific pollinators. These pollinators provide angiosperms a much more efficient way of pollination mechanism. Another significant feature of flower is that unlike gymnosperms where seeds are naked angiosperms have flowers that contains ovary which surrounds and protects the seed. The angiosperms are incredibly a large group and in this chapter we will be studying about the morphology of the unique reproductive organ of angiosperms that is FLOWER, its arrangement within plants (Inflorescence) along with study about the various parts of the flower.

2. General description of the flower :

The flower is the reproductive unit in the angiosperms. It is meant for sexual reproduction. A typical flower has four different kinds of whorls arranged successively on the swollen end of the stalk or pedicel, called thalamus or receptacle. These are calyx, corolla, androecium and gynoecium. Floral leaves are borne on thalamus in whorls. Calyx and corolla are accessory whorls of the flower whereas androecium and gynoecium are called essential whorls of the flower.

The flowers are termed **pedicellate** if they possess stalks and **sessile** if they lack them .

The flowers may be described as complete if it bears all the floral parts and incomplete when one or more floral parts are absent. Flowers are called bisexual if they bear both androecium and gynoecium the unisexual flowers have either androecium and gynoecium. The unisexual flowers may be male flowers or female flowers. The male flowers are also called **staminate** flowers as they have stamens only. The female flowers have only the carpels and hence called **pistillate** flowers. Flowers with sterile sex organs are described as neutral flowers. According to the distribution of male, female and bisexual flowers, various patterns are recognised.

Monoecious : presence of male and female flowers on the same plant example *Acalypha*, *Cocos*, and *Ricinus*.

Dioecious : presence of male and female flower on different plants namely male plants and female plants example *Cycus*, *Carica papaya* and *Vallisneria*.

Polygamous: presence of unisexual and bisexual flowers on the same plant example *Mangifera* and *Polygonum*

Symmetry of flower: the number shape size and arrangement floral organs in a flower determines its symmetry on the basis of symmetry flowers can be of the following types:

Actinomorphic: Actinomorphic flowers can be divided by any vertical plane into two equal and similar halves example Mustard, Brinjal, *Catharanthus roseus* etc.

Zygomorphic flowers: Zygomorphic flowers can be divided into two equal halves by only one vertical division e.g., Pea

Asymmetrical (irregular): Asymmetrical flowers cannot be divided into two equal halves by any vertical division e.g., *Canna*

Position of floral leaves on the thalamus

Hypogyny : In a hypogynous flower the ovary occupies the highest position on the thalamus, while the stamens, petals and sepals are separately and successively inserted below the ovary. Thus the ovary is said to be superior and rest of the floral parts are inferior e.g., China rose

Perigyny : In this condition the margin of the thalamus grows upwards to form a cup-shaped structure called calyx tube enclosing the ovary but remaining free from it, carrying with it: sepals, petals and stamens. The ovary is said to be half inferior, e.g., Rose

Epigyny : in this condition the margin of thalamus grows further upward completely enclosing the ovary and getting fused with it and bear the sepals, petals and stamens above the ovary. The

ovary in such cases is said to be inferior and the rest of the floral members superior e.g., Sunflower

Bracts : Bracts are specialized leaves from the axil of which flower arise. • **Foliaceous (Leafy)**

bracts : They are leaf-like e.g., *Adhatoda*

Petaloid bracts : These bracts look like petals Bougainvillea

Epicalyx : There are one or more whorls of bracteoles found at the base of calyx. Found in most members of Malvaceae

Involucre: These are green coloured and in one or more whorls round and below the entire inflorescence e.g., Sunflower

Scaly bract : At the base of each floret of members of compositae e.g., Sunflower there is usually a membranous small bract different from involucre bracts.

2. Parts of The Flower :

(i) **CALYX** - Calyx is the outermost whorl and is made up of sepals which are usually green but sometimes coloured. All the sepals of a whorl may be free (polysepalous condition) or they may be fused (gamosepalous condition). Sepals are modified as follows :

- a) Pappus : In some plants e.g., Sunflower the sepals are modified into hairy structure called pappus.
- b) Leafy : In *Mussaenda*, one of the sepals is modified into a large leaf like coloured structure.
- c) Spinous : In *Trapa* the calyx is persistent and modified into two spines.
- d) Spurred : In Larkspur, from the base of one of the sepals arises a tubular outgrowth called spur.

(ii) **COROLLA**: It is the second whorl of flower and made up of petals.

- a) Cruciform : It consists of 4 petals arranged crosswise, each petal is clawed e.g., Mustard.
- b) Caryophyllaceous : It consists of 5 petals, each with a comparatively.
- c) Claw and the limbs of petals are placed at right angles to the claw e.g., *Dianthus*.

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- d) Rosaceous : It consists of 5 petals. Petals are with short claws or none. e.g., Rose
Campanulate or Bell shaped : In this case the shape of the corolla is like a bell
e.g., *Physalis*
 - e) Tubular : In this case the corolla is tubular or cylindrical. e.g., disc floret of
sunflower.
 - f) Infundibuliform or Funnel shaped : e.g., *Datura*
 - g) Rotate or Wheel shaped : e.g., Brinjal
 - h) Papilionaceous : It is composed of five petals out of which one posterior
largest and is known as standard or vexillum., the two lateral ones, covered by
standard are known as wings or alae, and the two innermost anterior smaller are
united to form a boat shaped structure keel or carina. e.g., pea, gram.

Aestivation

The mode of arrangement of petals (also sepals) in a flower bud with respect to members of the same whorl is known as aestivation. It may be of the following types.

- a) Valvate : When the petals of a whorl lie close to each other e.g., mustard
- b) Twisted or contorted : When one margin of a petal of a whorl covers the margin of the adjacent petal and the other margin is covered over by the margin of adjacent petal. e.g. china rose.
- c) Imbricate : When both margins of one of the petals are covered by the others and both margins of another one are external e.g., *Cassia*
- d) Quincuncial : it is a special type of imbricate aestivation in which 2 petals are external (both margins overlapping), 2 are internal (both margins overlapped) and in one petal one margin is overlapped and other overlapping e.g., Calyx of *Cucurbita maxima*, Corolla of *Ranunculus*.
- e) Vexillary : Papilionaceous corolla

iii) ANDROECIUM

Monadelphous stamens : When all the filaments are united into a single bundle but anthers are free. e.g., China rose

Diadelphous stamens : When the filaments are united in two bundles the anthers remaining free e.g., pea.

Polyadelphous stamens : When the filaments are united into more than two bundles but anthers are free e.g., Castor (*Ricinus*)

Syngenesious stamens : When the anthers are united into a bundle but the filaments are free e.g., Sunflower.

Synandrous stamens When anthers as well as filaments of stamens are united throughout their whole length e.g., *Colocasia* and most cucurbits.

Adhesion of Stamens In adhesion the stamens are attached to the tepals, petals or gynoecium.

(1) It is epiphyllous, when stamens are attached to perianth e.g., in Liliaceae.

(2) It is epipetalous, when they are attached to petals e.g., *Datura*,

(3) It is gynandrous, when stamens are attached to gynoecium .e.g. *Calotropis*. **Length of stamens** : *Ocimum* (labiateae) has four stamens, two of which are long and two short. This condition is called didynamous.

In Cruciferae family e.g., mustard, radish etc., of the six stamens four are longer and in inner whorls and two in outer whorl are shorter. Such a condition is called tetradynamous condition.

iv) Gynoecium (Pistil) Gynoecium is made up of one or more carpels. The gynoecium may be monocarpellary (made up of one carpel only) or multicarpellary (made up of many carpels). When the number of carpels in a gynoecium are two or more, they may be free or united. If they are free it is called apocarpous gynoecium if they are fused it is called syncarpous gynoecium. Syncarpous gynoecium may be bicarpellary, tricarpellary, tetracarpellary, pentacarpellary or multicarpellary (if number of carpels exceeds five).

Placentation

Types of placentation

- a) Marginal : In the monocarpellary (Pea) or each carpel of multicarpellary apocarpous gynoecium, there is single placenta which develops along the junction of two fused margins.
- b) Parietal : When the gynoecium is formed by the fusion of two or more carpels by their adjacent margins, the ovary is unilocular and has two or more longitudinal placenta e.g., *Cucurbita*.
- c) Axile : In a multicarpellary syncarpous gynoecium the fusing margins grow inwards to meet in the center of the ovary to form an axis thus making the ovary, e.g., China rose.
- d) Free central : The ovary is unilocular and the ovules are borne on the axis in the center of the ovary e.g., *Dianthus*.

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- e) Basal : The ovary is unilocular and a single ovule is borne at the base of ovary e.g., Sunflower.
 - f) Superficial : The gynoecium is multicarpellary syncarpous and large number of ovules are borne on the walls of loculi without specific order e.g., *Nymphaea* (Water lily).

In some flowers like lily, the calyx and corolla are not distinct and are termed as **perianth**.

3. Inflorescence :

A flower is a modified shoot wherein the shoot apical meristem changes to floral meristem. Internodes do not elongate and the axis gets condensed. If single flower is found on the terminal part of a branch it is called **solitary terminal flower** e.g., Poppy. If they are born in the axil of a leaf it is called **solitary axillary flower** e.g., Guava. The apex produces different kinds of floral appendages laterally at successive nodes instead of leaves. When a shoot tip transforms into a flower, it is always solitary. **The arrangement of flowers on the floral axis is termed as inflorescence.** Depending on whether the apex gets converted into a flower or continues to grow, two major types of inflorescences are defined – **racemose** and **cymose**.

- a) Racemose Inflorescence -In **racemose** type of inflorescences the terminal bud or the main axis continues to grow and has indeterminate growth , the flowers are borne laterally in an acropetal succession which means that older flowers are at the base and younger flowers are at the tips . Example Mustard , *Crotolaria* , Wheat , Gulmohar , Sunflower etc

(I) **Racemose**

(i) **Main Axis Elongated :**

- (a) Raceme : Peduncle is elongated and flowers are pedicellate e.g., Larkspur, Mustard. Radish
- (b) Spike : Central axis is elongated but flowers are sessile e.g., *Achyranthes*
- (c) Spadix : Spike with fleshy axis and having both male and female flowers. It is surrounded by a large bract (usually coloured brightly) called spathe e.g., Musa, Palm, *Colocasia*.

(ii) Main Axis Shortened :

- (a) **Corymb** : The main axis is comparatively short, and the lower flowers have much longer pedicels than the upper ones so that all the flowers are brought more or less to the same level. e.g., Candytuft (*Iberis*)
- (b) **Umbel** : The main axis is very much shortened and all flowers appear to be arising from the same point. The younger flowers are in the center and older ones towards the periphery. e.g. *Centella*

(iii) Main Axis Flattened Capitulum: The receptacle is flattened and bears numerous sessile and small florets in a centripetal manner i.e., youngest in the center and older towards the periphery. Individual florets are bracteate. Also the whole cluster of florets is surrounded by a whorl of bracts collectively called involucre. Two kinds of florets can be recognized on the receptacle.

(a) **Ray florets** : Arranged on the rim of receptacle having distinct yellow and strapshaped petals. These florets are female or sterile and are always zygomorphic. They may be arranged in one or more whorls.

(b) **Disc florets** : Grouped in the center and are bisexual and actinomorphic.

(II) Cymose Inflorescence: In Cymose type of inflorescence the main axis terminates in a flower, hence is limited or determinate in growth. In cymose inflorescence the apical meristem of peduncle produces the first flower. Other flowers which arise later and are younger and are borne on lateral branches. The flowers are borne in a basipetal succession i.e. older flower are in the top and the younger flowers are at the base. *Dianthus*, *Ranunculus*, *Ixora* etc.

A. **Uniparous-Monochasial cyme** : A single lateral branch arises from the peduncle of old flower which terminates in a flower. The lateral branch also terminates in a flower. Monochasial cyme can be of two types.

(a) **Helicoid cyme or Bostryx** : The main peduncle ends in a flower. It gives off a lateral branch on one side which again ends in a flower. This branch gives rise to another lateral branch on the same side i.e., all the lateral branches arise either on left side or right side. e.g., *Heliotropium*, *Drosera*.

(b) **Scorpioid cyme or Cincinnus** : In this case the lateral branches arise alternately on the left and right sides e.g., *Ranunculus*, *Solanum nigrum*.

B. Biparous cyme (= Dichasial cyme) : In this case the peduncle bears a terminal flower and stops growing. This peduncle bears two bracts at a node from which arise two branches. *Stellaria media*, *Spergula arvensis*, *Dianthus chinensis*

C. Multiparous cyme (Polychasial cyme) : The peduncle bears a single terminal flower and below it more than two lateral branches arise at a node.

D. Cymose Head : In *Acacia nilotica* (Keekar) and *Albizzia lebbek*, the peduncle is reduced or condensed to a circular disc. It bears sessile flowers (or subsessile). The oldest flower is in the center and youngest towards the periphery of the disc (centrifugal). The flowers form a compact globose head.

Compound Inflorescence: In a compound inflorescence the peduncle or main axis branches repeatedly once or twice in racemose or cymose manner and ultimate branches bear flowers in a racemose or cymose manner. It can be of the following types:

1. Compound raceme or panicle or raceme of racemes e.g.,: Gulmohur (*Delonix regia*), Amaltas (*Cassia fistula*), *Yucca*
2. Compound spike or spike of Spikelets: Wheat (*Triticum aestivum*)
3. Compound umbel: *Coriandrum sativum*, *Daucus carota*

Special Type of Inflorescence

1. **Cyathium:** The bracts or the involucre become fused to form a cup shaped structure. This cup completely encloses a single female flower surrounded by large number of male flowers. In *Euphorbia splendens* and *Poinsettia (Euphorbia pulcherrima)* the cyathium are surrounded by brightly coloured bracts .

2. **Verticillaster:** It is a condensed dichasial cyme type of inflorescence. Each dichasial cyme changes into monochasial cyme of scorpid type.

3. **Hypanthodium:** The fleshy receptacle forms a hollow pear shaped cavity. The flowers are borne on the inner wall of the cavity. At the base of the cavity are developed normal female flowers and male flowers towards the mouth. In between the two on the sides of cavity are developed female gall flowers e.g., *Ficus*.

Summary

The flower is a modified shoot, meant for sexual reproduction. The flowers are arranged in different types of inflorescences. They exhibit enormous variation in structure, symmetry, position of ovary in relation to other parts, arrangement of petals, sepals, ovules etc. After fertilisation, the ovary is converted into fruits and ovules into seeds. In the next module we would learn about the seeds , fruits and floral formula and floral diagram of some of the angiospermic families.