Morphology - Seed, Fruit, Floral Diagram & Floral Formula

Objectives

After going through this lesson, the learners will be able to understand the following:

- Classify different types of fruits
- Understand the structural difference between monocotyledonous and dicotyledonous seeds
- Briefly describe angiospermic family like fabaceae, solanaceae and liliaceae through floral formula and floral diagram

Content Outline

- Introduction
- The Fruit
- The Seed and Its Structure
- Semi-Technical Description of a Typical Flowering Plant (Floral Formula and Floral Diagram)
- Description of Some Important Families (Fabaceae, Solanaceae and Liliaceae)
- Summary

Introduction

The series of events beginning with a newly opened flower ends with development of mature fruits and seeds. Soon after double fertilization the ovule increases rapidly in size as a result of the formation of endosperm tissue and development of new embryos. 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 (as in wheat, maize) or two cotyledons (as in gram and pea). Soon after fertilization the ovary gets ripened and is called a fruit. In this module study different types of fruits produced by different species of angiosperms along with studying about the structure of seeds in monocots and dicots. Also we will also study about the flowers of three important families within angiosperms that includes Fabaceae, Solanaceae and Liliaceae through floral formula, floral diagram along with a brief description of each one of them.

The Fruit

In flowering plants the seeds are protected from the mechanical injury and other unfavorable conditions by the development of fruit. The fruit is a characteristic feature of the flowering plants. It is a mature or ripened ovary, developed after fertilization. When we eat a slice of watermelon, we eat the pink or red fleshy part and throw the green rind away. Both of these parts are protective layers of fruit and enclose the seeds. Tomatoes, pea pods, bean pods, are examples of fruits that contain seeds. This may seem a bit strange as we usually think of peas, beans, and tomatoes as vegetables. Like watermelon they are true fruits derived from ovaries of flowers. Other familiar examples of a great variety of fruits produced by flowering plants are oranges, grapes, coconut, all other types of nuts in their husk and the grains of all kinds. If a fruit is formed without fertilisation of the ovary, it is called a parthenocarpic fruit if a fruit is parthenocarpic it is seedless like in case of banana and Musa sp.

Pericarp: Generally, the fruit consists of a wall or pericarp and seeds. The pericarp may be dry or fleshy. After ripening, the ovary wall changes into pericarp. When pericarp is thick and fleshy, it is differentiated into the outer epicarp, the middle mesocarp and the inner endocarp. Pericarp is differentiated in 3 layers –

- **Epicarp**: It is the outermost layer, which is also called rind.
- **Mesocarp**: It is the middle layer.
- **Endocarp**: It forms the innermost layer.

True and false fruit:

True fruit: When the fruit is developed only from the ovary, the fruit is called as true fruit. e.g., Mango, Coconut, Zizyphus.

False fruit or Pseudocarp: In some fruits, in place of ovary, some other parts of flower like thalamus, inflorescence and calyx are modified to form a part of the fruit. These types of fruit are called false fruits. e.g., Apple, Strawberry, Pear.

Classification of fruits: Fruits are divided in three groups:

A. Simple
B. Aggregate
C. Composite

Simple Fruits

A single fruit develops from a single ovary of a single flower. The ovary may be from monocarpellary or multicarpellary syncarpous gynoecium. These are divided into 2 categories: Dry fruits and fleshy/succulent fruits.

- **Dry fruits:** The fruit is not fleshy and has thin, hard and dry pericarp. The pericarp is not differentiated into 3 layers. These are distinguished into 3 categories: dehiscent (or capsular), indehiscent (or achenial) and schizocarpic (or splitting).

- **Dehiscent fruits:** These fruits are dry, where pericarp is ruptured by splitting along the sutures on maturity/ripening and seeds are dispersed.

  Depending on the mode of dehiscence these are of following types:

  - **Pod or legume:** It is characteristic feature of the family Leguminosae; develops from a monocarpellary, unilocular superior ovary with marginal placentation, which dehisces along both ventral and dorsal sutures, dehiscence starts from apex towards the basal part. *e.g.,* members of the family Leguminosae, *Pisum sativum* (pea), *Cicer arientinum* (Gram).
  - **Follicle:** develops from a monocarpellary, unilocular superior ovary which dehisces along one ventral suture only. *e.g., Delphinium ajacis, Vinca rosea, Larkspur, Calotropis etc.*
  - **Siliqua:** it is multi seeded elongated fruit, develops from a bicarpellary, syncarpous superior ovary with parietal placentation, is initially unilocular but becomes bilocular due to false septum called replum. It dehisces along both the sutures from base upwards, the seeds remain attached to the replum. *e.g.,* in members of family cruciferae, *Brassica compestris* (mustard).
  - **Silicula:** is a shorter, broader and flattened siliqua with a few seeds. *e.g., Iberis amara* (candytuft), *Capsella bursa (Shepherd's purse).*
  - **Capsule:** The fruit which develops from multicarpellary or monocarpellary, syncarpous, superior ovary usually with axile placentation and dehisces in a variety of ways.
    - ***Poricidal:*** fruit dehisces through terminal pores with flap-like valves. *e.g., Papaver* rhoeas (poppy).

- ***Circumscissile (pyxis):*** fruit dehisces transversally such that top comes off as a lid or operculum. *e.g., Celosia cristata* (cock's comb), *Eucalyptus citriodora.*
- ***Loculicidal:*** fruit dehisces longitudinally by slits which open into the cavity of the locule separating into as many valves as the number of locules. *e.g.,* members of the family Malvaceae, Acanthaceae, *Epilobium, Abelmoschus* (lady's finger).
- ***Septicidal:*** fruit dehisces longitudinally along the septa and valves remain attached to the septae. *e.g. Linum* sp.
- ***Septifragal:*** fruit dehisces by valves breaking away from the septae and the seed remain attached to the central axis. *e.g. Datura stramonium.*

- **Indehiscent or Achenial fruit: These fruits do not burst at maturity but the seeds are liberated only by the decaying of the pericarp**.

  These are of the following types:
  - **Achene: It is small, dry,** one seeded dry indehiscent fruit which develops from a monocarpellary, superior ovary or inferior in which the seed coat is free from the pericarp and the pericarp is tough but thin. *e.g., Mirabilis* sp., *Fagopyrum* sp.
  - **Caryopsis: It is very small,** one seeded dry indehiscent fruit which develops from a monocarpellary superior ovary (similar to achene) in which the seed coat is fused with the pericarp. *e.g.,* Members of family graminae, *Triticum aestivum (*Wheat), *Zea mays* (Maize).
  - **Cypsela:** One seeded dry indehiscent fruit which develops from bicarpellary, syncarpous, inferior and unilocular ovary in which the with seed coat free from pericarp. The fruit has a crown of hair-like structure called pappus which helps in fruit dispersal, (pappus is modified calyx). *e.g.,* Members of family Compositae, *Helianthus annuus, Sonchus brachyotus.*
  - **Nut or glans: It is dry** one seeded indehiscent fruit which develops from bicarpellary or polycarpellary, superior ovary with hard, woody or stony pericarp at maturity, the pericarp is free from seed coat. *e.g., Trapa natans (*Chestnut), *Quercus (*Oak), *Anacardium occidentale* (cashewnut), Litchi. Here the thalamus and sometimes the cotyledons of true fruit are also edible.
  - **Samara:** one or two seeded dry indehiscent fruit which develops from bi or tricarpellary, syncarpous and superior ovary with pericarp expanded as wings

which help in dispersal. *Holoptia*, Acer. In *Shorea robusta* wings develop from calyx instead of pericarp and the fruit is called samaroid. e.g., *Hiptage* and *Elm*

- **Schizocarpic or Splitting fruit:** these are intermediate between dehiscent and indehiscent fruits. They resemble both achenial fruits as well as capsular fruits having many seeds. The pericarp is divided into one or more seeded segments from which seeds are dispersed only after the decay of pericarp. The one seeded segments are also called mericarp. These are of following types:
    - **Lomentum:** fruit is modified legume with constricts between the seeds to form one or many seeded segments that separate transversely on maturity. *e.g. Mimosa pudica*, *Arachis hypogea* (groundnut), Tamarind.
    - **Cremocarp:** dry two seeded fruit which develops from bicarpellary, syncarpous, inferior ovary which on maturity splits into two, one seeded segments called mericarps. The mericarps that remain attached to the central axis or carpophores (which is the extended end of receptacle). *e.g.,* Members of family Umbelliferae, *Corriandrum sativum, Foeniculum vulgare.*
    - **Carcerulus:** develops from bicarpellary, syncarpous, superior ovary which breaks into four, one seeded units called nutlets. *e.g., Ocimum sanctum, Salvia splendens, Althea rosea.*
    - **Regma:** develops from tricarpellary or multicarpellary, syncarpous, superior ovary which on maturity splits into as many units (called cocci) as the number of carpels. The outer surface of pericarp has spines. *e.g., Ricinus communis* has tricarpellary ovary so regma of *Ricinus* splits.

- **Fleshy or succulent fruits:** the fruit wall or pericarp is fleshy or juicy, differentiated into 3 layers: outer epicarp, middle mesocarp and inner endocarp. The fruits develop from unilocular or multilocular, superior or inferior, syncarpous gynoecium. The fruits are indehiscent; seeds are liberated after fruit decays. These are of following types:
    - **Drupe:** one seeded fruit in which the pericarp of the fruit wall is differentiated into outer thin epicarp (forms a skin), fleshy mesocarp and hard and stony endocarp (thus also called as stony fruits). *e.g.,* Mango, Coconut, Peach, and Almond. In mango outermost covering is epicarp, mesocarp is juicy and edible and the seed is enclosed in the endocarp; in coconut epicarp is thin and hard, mesocarp is fibrous, endocarp is hard enclosing the seed, the edible part is the

solid and liquid endosperm; in almond epicarp and mesocarp are peeled off, hard endocarp is visible and the seed/cotyledons are edible.

- **Pome:** develops from pentacarpel, syncarpous, inferior ovary and the fruit is surrounded by a fleshy thalamus which is the edible part and is fused with the pericarp. Thus it's a false fruit. *e.g.,* Apple, Pear.
- **Berry:** pulpy or uniformly fleshy pericarp that develops from mono or multicarpellary, syncarpous, superior ovary with many seeds which get detached from the placenta. *e.g.,* Tomato, Brinjal. Berries which develop from inferior ovaries with fused thalamus and pericarp are called as false berries *e.g.* Banana, guava. In bananas the thalamus and epicarp are peeled off, the mesocarp and endocarp is the edible portion. In date palm epicarp and mesocarp are the edible parts whereas the endocarp is thin and papery which gets removed along with the seed.
- **Pepo:** pulpy or fleshy fruit with many seeds like berry but develops from tricarpellary unilocular syncarpous inferior ovary with parietal placentation, seeds remain attached to placenta while the epicarp forms a tough rind. *e.g.,* members of the family Cucurbitaceae, *Cucurbita maxima, Coccinia cordifolia.*
- **Hesperidium:** develops from multicarpous syncarpous superior ovary with axile placentation, epicarp and mesocarp are fused together to form a rind, endocarp projects inwards to form discrete chambers with hair like juicy vesicles which are edible. *e.g.,* members of the family Rutaceae, *Citrus*, lemon, orange.
- **Balausta:** is a multi seeded multilocular fruit which develops from an inferior ovary; epicarp and part of mesocarp forms an outer hard rind, mesocarp is folded inwards to form chambers lined by papery endocarp enclosing a group of irregularly arranged seeds that are covered by succulent juicy testa which is edible. Calyx is persistent and arranged as a crown. *e.g., Punica granatum* (Pomegranate).
- **Amphisarca:** fruit develops from multicarpellary, multilocular, syncarpous and superior ovary; the epicarp is woody, inner layers of pericarp and placenta is pulpy and edible. It has many scattered seeds. *e.g., Aegle marmelos* (wood apple or bael).

Aggregate Fruit: fruit develops from multicarpellary apocarpous ovaries which ripen together. Each ovary forms a fruitlet and the collection of fruitlets is called an etaerio. An aggregate fruit is named according to the nature of fruitlets, which are of following types:

- **Etaerio of drupes:** an aggregate of small drupes. *e.g., Rubus idaeus* (raspberry)
- **Etaerio of follicles:** an aggregate of follicles. *e.g., Calotropis procera, Magnolia*, *Michaelia champaca*
- **Etaerio of berries:** an aggregate of berries. *e.g., Artabotrys*, *Anona squamosa* (custard apple). In *Anona* all berries are aggregated closely on thalamus.
- **Etaerio of achenes:** an aggregate of achenes. *e.g., Ranunculus sceleratus, Fragaria* (strawberry), *Rosa*, *Nelumbo*. In strawberry the thalamus becomes red and fleshy on maturity, achene are embedded in it and is the edible part; in rose the etaerio is surrounded by cup shaped thalamus called hypanthium and the fruit is called **hip**, in *Nelumbo* the thalamus becomes spongy and the achenes are embedded in it.

Composite or Multiple fruit: Fruit develops from a number of closely associated fruits and other floral parts, usually from the entire inflorescence. These are of following types:

- **Sorosis:** fruit develops from an entire inflorescence usually spike, spadix or catkin; the spongy sepals of flowers fuse, the axis becomes fleshy or woody to form a compact structure. *e.g., Morus alba* (mulberry), *Artocarpus* (jackfruit) and Pineapple. In mulberry fruit develops from catkin inflorescence with fleshy perianth and dry seeds, in pineapple edible portion is formed by peduncle, perianth and fleshy bracts, in jackfruit fleshy rachis, perianth and seeds are edible.
- **Syconus:** fruit develops from hypanthodium inflorescence with hollow pear shaped fleshy receptacle bearing number of achenes inside which develop from pistillate flowers. *e.g., Ficus sp.,* Fig, Peepal.

The Seed and Its Structure

The ovules after fertilisation, 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 (as in wheat, maize) or two cotyledons (as in gram and pea).

Structure of a Dicotyledonous Seed: The outermost covering of a seed is the seed coat. The seed coat has two layers, the outer testa and the inner tegmen. The hilum is a scar on the seed coat through which the developing seeds were attached to the fruit. Above the hilum is a small pore called the micropyle. Within the seed coat is the embryo, consisting of an embryonal axis and two cotyledons. The cotyledons are often fleshy and full of reserve food materials. At the two ends of the embryonal axis are present the radicle and the plumule. 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 mature seeds and such seeds are called non-endospermous.

Structure of Monocotyledonous Seed: Generally, monocotyledonous seeds are endospermic but some as in orchids are non-endospermic. In the seeds of cereals such as maize the seed coat is membranous and generally fused with the fruit wall. The endosperm is bulky and stores food. The outer covering of endosperm separates the embryo by a proteinous layer called aleurone layer. The embryo is small and situated in a groove at one end of the endosperm. It consists of one large and shield shaped cotyledon known as scutellum and a short axis with a plumule and a radicle. The plumule and radicle are enclosed in sheaths which are called coleoptile and coleorhiza respectively.

Semi-Technical Description of a Typical Flowering Plant (Floral Formula and Floral Diagram)

Various morphological features are used to describe a flowering plant. The description has to be brief, in a simple and scientific language and presented in a proper sequence. The plant is described beginning with its habit, vegetative characters – roots, stem and leaves and then floral characters inflorescence and flower parts. After describing various parts of the plant, a **floral diagram** and a **floral formula** are presented. The floral formula is represented by some symbols. In the floral formula, Br stands for bracteate K stands for calyx, C for corolla, P for perianth, A for androecium and G for Gynoecium, G for superior ovary and  for inferior ovary, ♂ for male, ♀ for female, ⚥ for bisexual plants, ⊕ for actinomorphic and % for zygomorphic nature of flower. Fusion is indicated by enclosing the figure within brackets and adhesion by a line drawn above the symbols of the floral parts. A floral diagram

provides information about the number of parts of a flower, their arrangement and the relation they have with one another. The position of the mother axis with respect to the flower is represented by a dot on the top of the floral diagram. Calyx, corolla, androecium and gynoecium are drawn in successive whorls, calyx being the outermost and the gynoecium being in the centre. Floral formula also shows cohesion and adhesion within parts of whorls and between whorls.

Description of Some Important Families

- **Fabaceae**: This family was earlier called Papilionoideae, a subfamily of family Leguminosae. It is distributed all over the world.

  Vegetative Characters: Trees, shrubs, herbs; root with root nodules Stem: erect or climber Leaves: alternate, pinnately compound or simple; leaf base, pulvinate; stipulate; venation reticulate.

Floral characters

Inflorescence: racemose

Flower: bisexual, zygomorphic

Calyx: sepals five, gamosepalous; valvate/imbricate aestivation

Corolla: petals five, polypetalous, papilionaceous, consisting of a posterior standard, two lateral wings, two anterior ones forming a keel (enclosing stamens and pistil), vexillary aestivation

Androecium: ten, diadelphous, anther dithecous

Gynoecium: ovary superior, mono carpellary, unilocular with many ovules, style single .

Fruit: legume; seed one to many, non-endospermic

Floral Formula: $\% \, ♂ \, K_{(5)} \, C_{1+2+(2)} \, A_{(9)+1} \, \underline{G}_{1}$

Floral Diagram

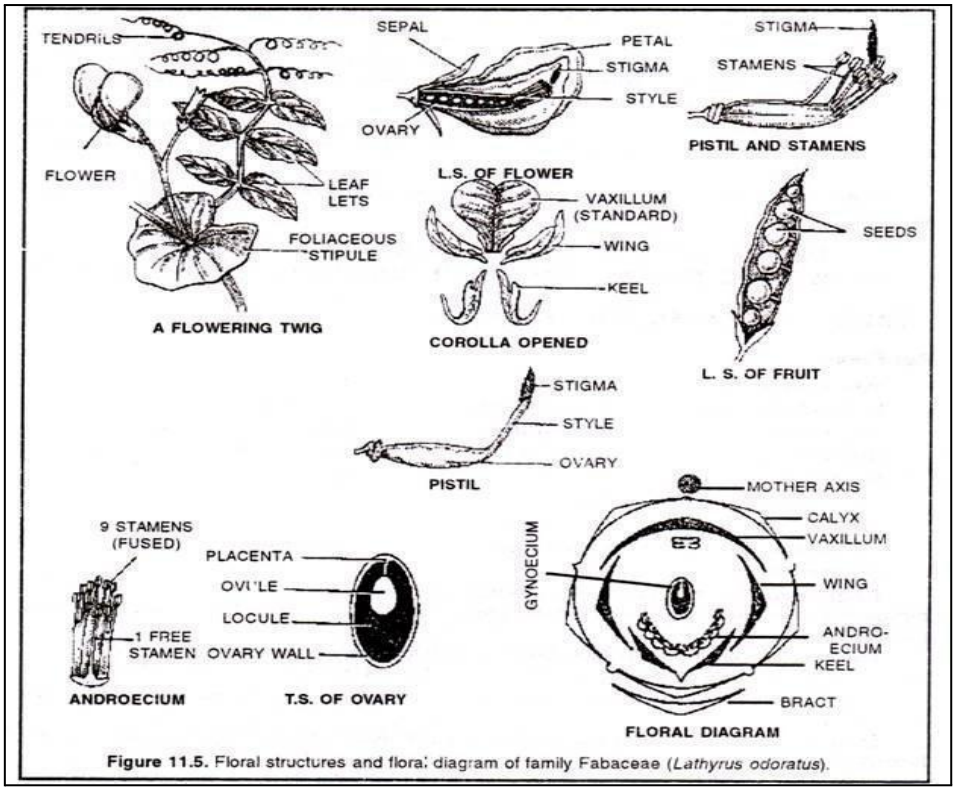


Figure 11.5. Floral structures and floral diagram of family Fabaceae (*Lathyrus odoratus*).

Image 1- Ref:

http://www.biologydiscussion.com/plants/families-of-flowering-plants-and-their-economic-importance/6580

Economic importance: Many plants belonging to the family are sources of pulses (gram, arhar, sem, moong, soyabean; edible oil - soyabean, groundnut); dye (Indigofera); fibres (sunhemp); fodder (Sesbania, Trifolium), ornamentals (lupin, sweet pea); medicine (muliathi).

- **Solanaceae**: It is a large family, commonly called the 'potato family'. It is widely distributed in tropics, subtropics and even temperate zones .

  Vegetative Characters Plants mostly herbs, shrubs and rarely small trees. Stem: herbaceous, rarely woody, aerial; erect, cylindrical, branched, solid or hollow, hairy or glabrous, underground stem in potato (Solanum tuberosum). Leaves: alternate, simple, rarely pinnately compound, exstipulate; venation reticulate.

Floral Characters

Inflorescence: Solitary, axillary or cymose as in Solanum

Flower: bisexual, actinomorphic

Calyx: sepals five, united, persistent, valvate aestivation

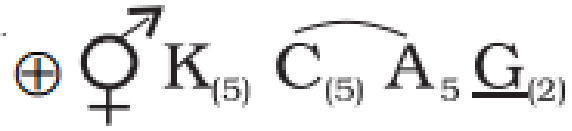
Corolla: petals five, united; valvate aestivation

Androecium: stamens five, epipetalous

Gynoecium: bicarpellary, syncarpous; ovary superior, bilocular, placenta swollen with many ovules Fruits: berry or capsule

Seeds: many, endospermous

Floral Formula



Floral Diagram

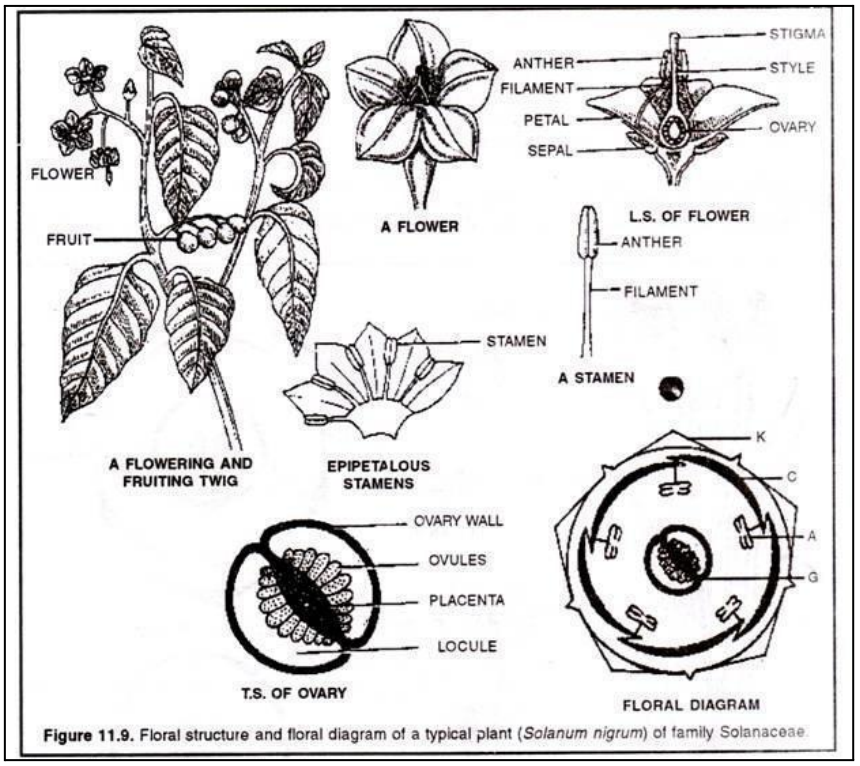


Figure 11.9. Floral structure and floral diagram of a typical plant (*Solanum nigrum*) of family Solanaceae

Image 2 - Ref:

http://cdn.biologydiscussion.com/wp-content/uploads/2014/12/clip_image034_thumb3.jpg

Economic Importance: Many plants belonging to this family are the source of food (tomato, brinjal, potato), spice (chilli); medicine (belladonna, ashwagandha); fumigatory (tobacco); ornamentals (petunia).

- **Liliaceae:** Commonly called the 'Lily family' is a characteristic representative of monocotyledonous plants. It is distributed world wide.

Vegetative characters: Perennial herbs with underground bulbs/corms/rhizomes Leaves mostly basal, alternate, linear, exstipulate with parallel venation.

Floral characters

Inflorescence: solitary / cymose; often umbellate clusters

Flower: bisexual; actinomorphic Perianth tepal six (3+3), often united into tube; valvate aestivation

Androecium: stamen six, 3+3, epitepalous

Gynoecium: tricarpellary, syncarpous, ovary superior, trilocular with many ovules; axile placentation

Fruit: capsule, rarely berry

Seed: endospermous

Floral Formula $Br \oplus ⚥ \overparen{P_{(3+3)} A_{3+3}} G_{(3)}$

Floral Diagram

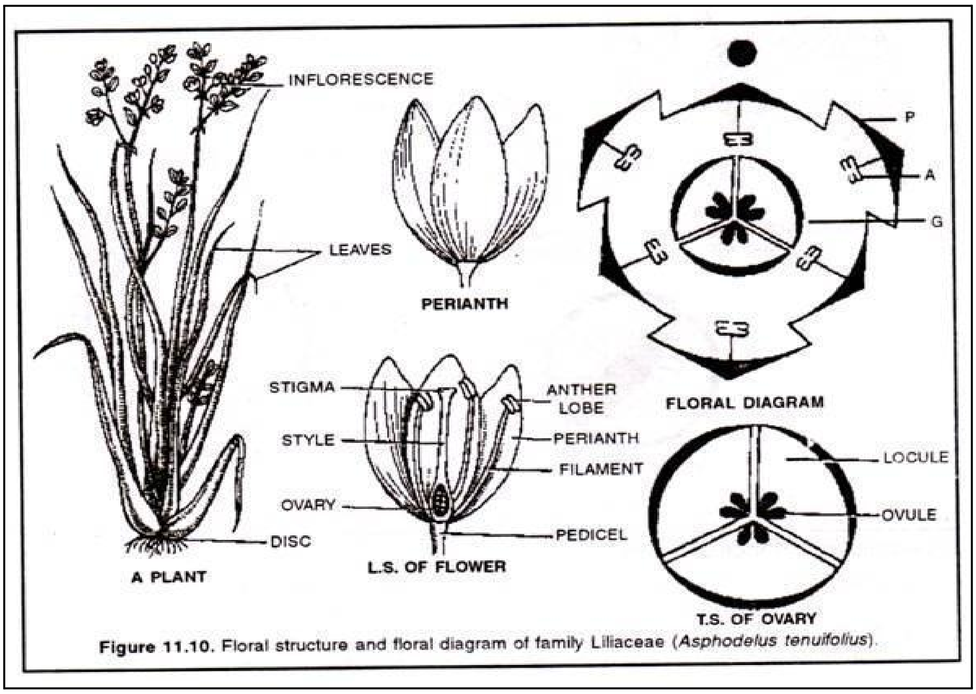


Figure 11.10. Floral structure and floral diagram of family Liliaceae (*Asphodelus tenuifolius*).

Image 3 - Ref:

http://cdn.biologydiscussion.com/wp-content/uploads/2014/12/clip_image0382.jpg

Economic Importance: Many plants belonging to this family are good ornamentals (tulip, Gloriosa), source of medicine (Aloe), vegetables (Asparagus), and colchicine (Colchicum autumnale).

Summary

After fertilisation, the ovary is converted into fruits and ovules into seeds. Seeds either may be monocotyledonous or dicotyledonous. They vary in shape, size and period of viability. The floral characteristics form the basis of classification and identification of flowering plants. This can be illustrated through semi-technical descriptions of families. Hence, a flowering plant is described in a definite sequence by using scientific terms. The floral features are represented in the summarised form as floral diagrams and floral formula.