

## Biology 3B

### Flowers and Fruits

#### Objectives

- To understand the structure and function of a typical flower
- To relate floral structure/function and its importance in angiosperm lifecycle
- To understand early embryonic development in a monocot and eudicot
- To understand dispersal mechanisms utilized by angiosperms
- Examine various types of fruit

#### Introduction

In angiosperms, the flower bears the sporophyll which has limited growth duration which ultimately produces the seed. Angiosperm flowers may be a solitary flower or clustered into floral aggregations called **inflorescences**. In either case, the stalk or **peduncle** supports the entire flower. In an inflorescence, a **pedicel** supports the individual flower. The **receptacle** is the actual portion above the peduncle in which the flower parts attach.

As you recall, the structure of a flower is composed of four whorls: calyx, corolla, stamen and carpel. The first two whorls are sterile and attached to the receptacle. The collection of sepals form the **calyx** which often times resemble thick green leaves. The collection of petals form the **corolla**. Unlike the sepals, the petals are often brightly colored and thinner. However, in some species, the petals resemble the sepals in color and texture. Together, the calyx and corolla form the **perianth**.

The stamens and the carpels form the fertile part of the flower. The stamens are microsporophylls consisting of anther and filament. The **filament** is the stalk structure that supports the **anther**. Most anthers are bi-lobed containing four **pollen sacs** in pairs. Collectively the reproductive male parts are called the **androecium** or “house of man.”

The carpels (or pistil) are megasporophylls consisting of the stigma, style and ovary. Collectively, the female reproductive parts are called the **gynoecium** or “house of woman.” The **stigma** is the upper portion of the carpel and produces a sticky substance in which the pollen grains adhere. The pollen tube that develops grows down through the narrow **style** (absent in some flowers) towards the **ovary** containing the **ovule(s)** in the lower part of the carpel. Some flowers contain only a single carpel while other plants may have multiple carpels that are fused. With flowers that have fused carpels, there may be a single style or each carpel may have its own style. In either case, carpels that are fused typically form chambers within the ovary called **locules**. The number of locules is often related to the number of carpels.

Most flowers have both male and female reproductive parts on the same flower. These are called **perfect flowers** and are **monoecious** (“single house”). **Imperfect flowers** have either the male or female reproductive part is absent from the flower. These flowers are **dioecious** (“two houses”). Imperfect flowers are either **staminate** (male) or **carpellate/pistillate** (female).

To add more confusion to floral names, flowers that have all four whorls are called **complete** flowers. **Incomplete** flowers are those that lack one or more of the four whorls. Thus imperfect flowers are also incomplete. However, not all incomplete flowers are imperfect.

The insertion points for the perianth and stamens vary in relation to the ovary or ovaries. If the perianth and stamens insert on the receptacle beneath the ovary, the insertion point is termed **hypogynous**. In this case, the ovary is said to be **superior**. If the perianth and stamens insert on

top of the ovary, the insertion point is termed **epigynous**. The ovary is said to be **inferior**. When the petals and the stamens adnate to the top of the calyx, they form a **hypanthium** or short tube that arises from the base of the ovary. This type of insertion is called **perigynous**.

- Review your basic floral whorls. Identify the following on a flower: peduncle, pedicel if it is an inflorescence and receptacle. Here's a webpage that can assist you in learning the basic floral whorls and components: <http://www.botany.uwc.ac.za/ecotree/flowers/flowerparts.htm#top>

## TYPES OF INFLORESCENCE

Observe the various flowers in the laboratory and be able to identify the following:

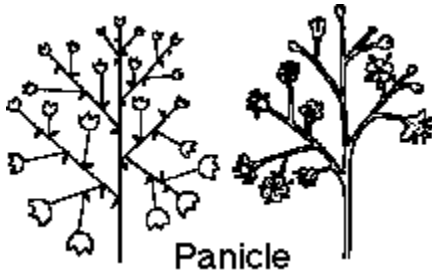
- **Spike:** the main axis is unbranched and elongated with sessile flowers are directly attached



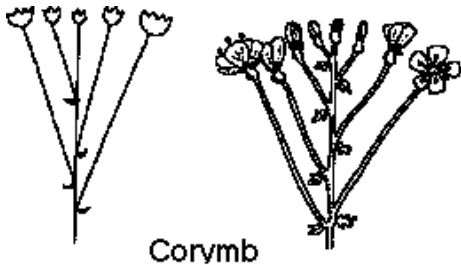
- **Raceme:** main axis is unbranched and elongated with flowers attached via a pedicel



- **Panicle:** main axis is branched with the branches bearing flower clusters

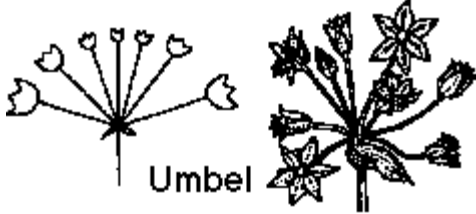


- **Corymb:** an inflorescence appearing to have a flat top; indeterminate inflorescence with outer flowers opening first; all flowers typically attached via pedicel



Corymb

- **Simple umbel:** indeterminate inflorescence, usually but not necessarily flat topped with the pedicels arising from a common point (resembles the stays of an umbrella)



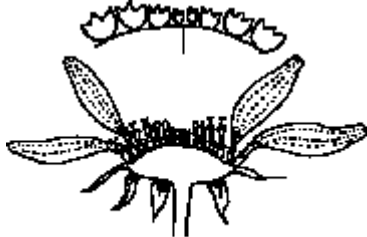
Umbel

- **Compound umbel:** indeterminate inflorescence, usually but not necessarily flat topped with the peduncles and pedicels arising from a common point



Compound umbel

- **Head:** a cluster or ray and disk flowers on a very short axis, peduncle can either be flat or round



Head

- **Catkin:** a spike-like inflorescence with either staminate or carpellate flowers, typically found in woody species



- Examine the various flowers in the lab and fill in the following chart:

Name	Perfection	Completeness	Ovary position	Inflorescence	Monoecious/Dioecious
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## FRUITS

The ovary evolved through the modification of leaf material resulting in protection and facilitating dispersal of seeds. The ovules develop from the **placenta** and are attached to the ovary walls until maturation. The arrangement of the placenta is called **placentation**. If the ovules are on the outer ovary wall or extensions of it the placentation is termed **parietal**. **Axile** placentation occurs in flowers where there are several partitions forming **locules** within the ovary along a central column. Flowers with **free central** placentation have ovules that are along a central column, however there are no partitions. A flower with a single ovule that develops at either the base or apex of the ovary has either a **basal** or **apical** placentation.

After pollination, the pollen tube develops and travels down the style to the ovule(s). In angiosperms, there is a double fertilization process that occurs. One sperm fuses with the ovule to form the developing embryo while the other sperm fuses with a diploid body forming the triploid **endosperm**, the nutrients for the embryo. The embryo and ovary mature simultaneously developing into the fruit. Essentially, the fruit is the mature ripened ovary which may or may not contain floral parts.

Fruits are generally classified as either simple, multiple or aggregate. This depends on the arrangement in which the fruit develops. Simple fruits are the most diverse and when ripened, they may be: soft and fleshy, dry and woody or papery. **Simple fruits** are considered simple because there is one carpel or several fused carpels in the formation of the fruit. **Aggregate fruits** have a number of separate carpels in one gynoecium. So essentially, you have many ovaries on a single flower. **Multiple fruits** contain more than one gynoecia of more than one flower. The carpels of many flowers all fuse together to form a multiple fruit.

In any case, a typical fruit has an outer wall called the **pericarp** which is composed of an **exocarp**, **mesocarp** and **endocarp**. For example, if you cut an apple in half longitudinally, the skin is the exocarp, the fleshy portion is the mesocarp and the papery part is the endocarp. Inside the endocarp is the seed, which develops from the ovules of the flower. You may or may not be able to distinguish these layers in all fruits.

### Dichotomous Key to Major (not all) Types of Fruit

- I. Fleshy fruits
  - A. Simple fruits → from a single ovary
    - 1. Flesh mostly of ovary tissue
      - a) Endocarp hard and stony; ovary superior and single seeded ..... **Drupe**  
(examples: cherry, olive, coconut, avocado, walnut, pecan, cashew)
      - b) Endocarp fleshy or slimy; ovary usually many seeded ..... **Berry**  
(examples: tomato, grape, peppers, cucumbers)
        - 1a) a special berry from an epigynous flower of the Cucurbitaceae ..... **Pepo**  
(examples: cucumber, squash, watermelon, melons)
        - 2b) a special berry with numerous carpels (separable as sections);  
locules filled by juice sacs; pericarp covered by oil glands ..... **Hesperidium**  
(examples: *Citrus* – orange, lemon, lime, grapefruit)

2. Flesh mostly of receptacle tissue; leathery ovarian wall; inferior ovary ..... **Pome**  
(examples: apple, pear)
  - B.** Complex fruits → from more than one ovary
    1. Fruit from many carpels on a single flower ..... **Aggregate**  
(example: strawberry, raspberry, blackberry, magnolia)
    2. Fruit from carpels of many flowers fused together ..... **Multiple**  
(example: pineapple, mulberry, ear of corn)
- II.** Dry fruits
- A.** Fruits that split open at maturity (usually more than one seed)
    1. Split occurs along two seams in the ovary. Seeds borne on one of the halves of the split ovary ..... **Legume**  
(examples: pea and bean pods, peanuts)
    2. Seeds released through pores or multiple seams ..... **Capsule**  
(examples: irises, lilies, poppies, okra)
  - B.** Fruits that do not split open at maturity (usually one seed)
    1. Pericarp hard and thick, with a cup at its base ..... **Nut**  
(examples: acorn, chestnut, hickory)
    2. Pericarp thin and winged (examples: maple, ash, elm) ..... **Samara**
    3. Pericarp thin and not winged
      - a) Seed remains attached to ovary wall by stalk, seed lies free ..... **Achene**  
(examples: sunflower, buttercup)
      - b) Seed coat is permanently united with ovarian wall ..... **Caryopsis**  
(examples: cereal grains – barley, oats, wheat, rice; grasses)

➤ Examine a **legume** – pea pod. Identify the following, if present: **sepals, stigma, style, ovary**. The two seams can open to release the seeds. This is called **dehiscent**. Carefully separate one side of the ovary wall and locate the seeds. Remove a seed and find the **micropyle**. Cut the seed in half and examine the **seed coat** and **embryo**.

➤ Examine another **legume** – peanut. Identify the **dry pericarp** and **seed coat**. Carefully open the seed and look for the following: **cotyledons, embryonic leaves, stem** and **root**.

➤ Examine a bean. Identify the following: **micropyle, hilum** and **seed coat**. Remove the seed coat and carefully separate the **cotyledons**. Find the **root** and **shoot**.



- Examine **pepo** – a special “berry” form an epigynous flower of the family Cucurbitaceae. Leathery or hard rind (pericarp + hypanthium), 1 locule and 3 lines of ovules. How many carpels?
  
- Examine **hesperidium** – a special “berry” with numerous carpels. Each citrus piece is a locule with numerous **juice sacs**. Seeds may or may not be present with some aborted seeds.
  
- Examine a **pome** (apple and pear). Identify the sepals, stigma and stamen on an intact apple. Cut the apple in half longitudinally and find: **pollen tube, pericarp, mesocarp, endocarp, ovary wall** and **seeds**. What’s the ovary position?
  
- Examine **aggregate fruits** – fruit from many flowers on a single flower.
  - Strawberry: fruits is a tiny achene. Red, sweet and expanded receptacle.
  
- Examine **multiple fruits** – the fruits of many flowers are fused. Find the stigma and stamen in the “eyes” of a pineapple.



## KEY TO INFLORESCENCE TYPES

### A. **Inflorescence** determinate:

B. **Inflorescence** branched ..... *Paniculate Cyme*

### B. **Inflorescence** unbranched:

C. Flowers occurring on both sides of **inflorescence** ..... *Simple Cyme*

C. Flowers only on one side of **inflorescence**..... *Scorpioid Cyme*

### A. **Inflorescence** indeterminate:

#### D. **Inflorescence** unbranched:

##### E. Flowers pedicellate:

F. Pedicels 1 mm long or less..... *Spike-like*

F. Pedicels more than 1 mm long:

G. Flowers occurring along axis of **inflorescence** ..... *Raceme*

G. Flowers all borne at apex of peduncel..... *Simple Umbel*

##### E. Flowers sessile:

H. **Inflorescence** flattened and flowers sessile on an expanded receptacle..... *Head*

H. **Inflorescence** elongated, flowers not sessile on an expanded receptacle:

I. **Inflorescence** axis and flowers fleshy..... *Spadix*

I. **Inflorescence** axis and flowers not fleshy:

J. **Inflorescence** upright..... *Spike*

J. **Inflorescence** hanging downward ..... *Catkin*

#### D. **Inflorescence** branched:

##### K. **Inflorescence** flat-topped:

L. Pedicels borne at apices of **inflorescence** branches ..... *Compound Umbel*

L. Pedicels borne along main axis or branches of **inflorescence**:

M. Pedicels borne along main axis of **inflorescence** ..... *Simple Corymb*

M. Pedicels borne along branches of **inflorescence**..... *Compound Corymb*

##### K. **Inflorescence** rounded or elongate:

N. **Inflorescence** rounded ..... *Compound Umbel*

N. **Inflorescence** elongate:

O. **Inflorescence** once or twice branched:

P. **Inflorescence** upright..... *Panicle*

P. **Inflorescence** hanging downward ..... *Catkin*

O. **Inflorescence** more than twice branched ..... *Thyrse*