

Angiosperms: Flowers, Inflorescences, and Fruits

Before Coming to Lab: Read the lab sections A1, A3, B1, and Appendix B, then answer the following questions before coming to lab.

1. Label the following flowers as having a superior or inferior ovary, as appropriate.



2. On which page in the lab manual and in which figure did you get that information about ovary position?
3. How many stamens are pictured in the flower above on the left? On which page in this manual do you find the definition and illustration of a stamen?
4. What is the fruit type that is derived from a single pistil (ovary) that when mature is small, dry, does not open, and has a single seed whose seed coat is not fused to the pericarp?
5. What is the pericarp? On what page is pericarp defined in this manual?

Angiosperms: Flowers, Inflorescences, and Fruits

A. Background Terminology for Flower and Inflorescence Structure

Angiosperms are also known as the Flowering Plants. They have flowers. Flowers are often arranged into clusters called inflorescences.

A1. The flower

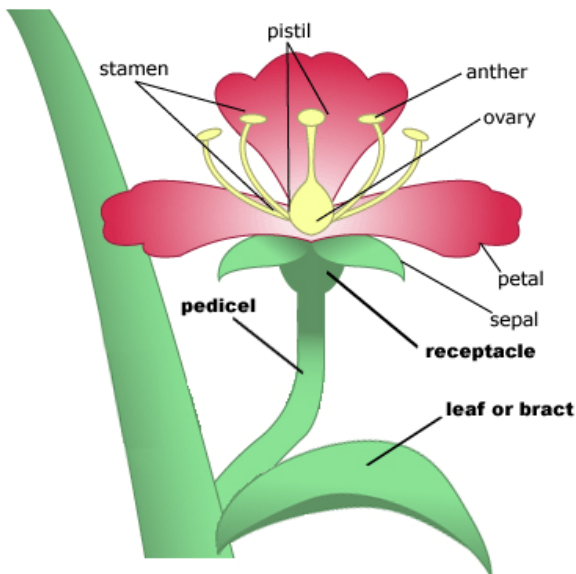


Fig. 1. Basics of flower structure and position.

The Receptacle and Pedicel.

All four whorl classes of the flower are inserted onto a receptacle. Below the receptacle is typically a pedicel (“stalk”). If the flower is unstalked, it is said to be sessile.

The Perianth.

Sepals are the leafy organs that comprise the outermost whorl called the calyx.

Petals are the leafy organs that comprise the next whorl in, the corolla.

Collectively, sepals and petals comprise the perianth. The perianth is sterile (i.e., non-fertile) in that they do not bear sporangia, seeds or pollen.

Sometimes, the sepals are not very sepal-like (i.e., are not green, but rather colored and textured like the petals). In this case, some botanists refer to these organs not as sepals or petals, but as tepals. This is common in monocots, for example (see Figure 2 below).

Androecium. The first fertile whorl is the androecium (with male function) and is made up of stamens. Each stamen is comprised of filament and anther. The anther typically has four sporangia or, more specifically, microsporangia, in which first the microspores, then the microgametophytes (pollen grains) develop. Being the microgametophyte, the pollen will eventually make sperm (but only two sperm).

Gynoecium. The second, last, and innermost fertile whorl is the gynoecium which is made up of one or more carpels. Carpels are the modified leaves that make up what we call in common language the pistil. There can be more than one pistil per flower. Pistils are often differentiated into ovary, style, and stigma. Ovaries contain the ovules. Ovules contain the megasporangium in which one functional megaspore will develop into a megagametophyte (complete with egg). After fertilization, the zygote develops into the embryo and the ovule itself develops into the surrounding seed. The ovary will develop into a fruit. Because fruits are derived from ovaries, the placentation of seeds in fruit will be the same as the placentation of ovules in the unripened ovary.

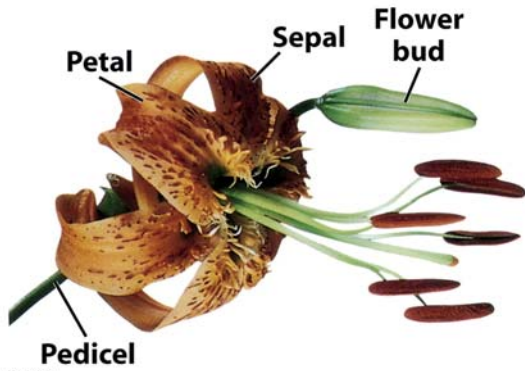


Figure 19-6a
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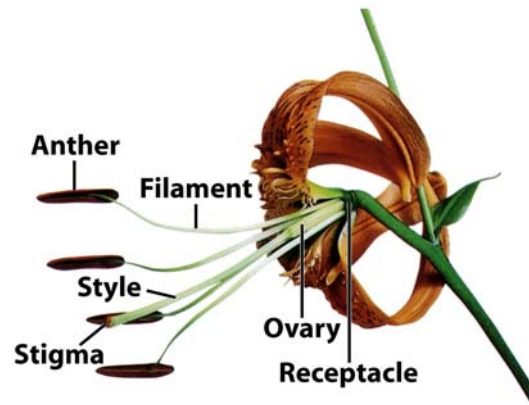
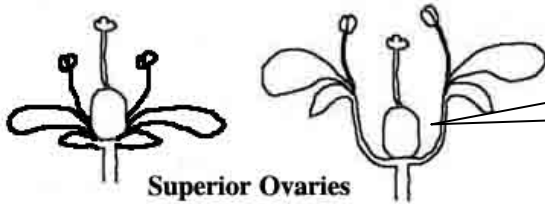


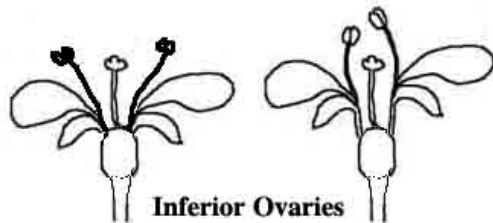
Figure 19-6b
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Fig. 2. Flower structure and morphology in a lily. Perianth of right flower partially dissected to expose ovary and receptacle. Contrast the morphology of the outer whorl “sepals” here with those in Figure 1.



Superior Ovaries

Note the floral “cup” around this superior ovary on the right is called a hypanthium.



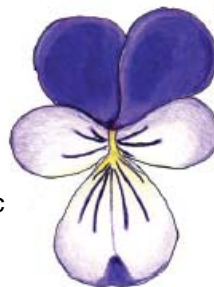
Inferior Ovaries

Fig. 3. Ovary position can vary. Superior ovaries sit atop the receptacle to which all other floral organs are inserted. Inferior ovaries sit below the insertion of the other floral organs, and appears to be embedded in the receptacle.

Fig. 4. Floral symmetry varies with the species (illustrations by Jess Landis '08).



actinomorphic
(radial, regular)



zygomorphic
(bilateral,
irregular)

A2. Flower exercise

Make detailed observations and drawings of the flowers at your table. You must learn how to dissect and interpret flower structure.

Lily Family flowers (e.g., onion, grape-hyacinth, tulip, or star-of-Bethlehem lily):

Is the flower as a whole actinomorphic (radial) or zygomorphic (bilateral)?

How many sepals and petals? Or are there just tepals? What color are they?

How many stamens are there?

How many pistils are there?

Is the ovary superior or inferior?

With the aid of a dissecting scope, transversely section the ovary, count the number of locules and determine the number of carpels this flower has.

Can you see the ovules inside the ovary? What do they look like?

On a separate piece of paper, diagram a higher magnification of the pistil/ovary in cross-section. Identify and label the carpels and the rows of ovules attached to each.

Mint Family flowers:

Is the flower as a whole actinomorphic (radial) or zygomorphic (bilateral)?

How many sepals and petals?

Are the sepals and petals differentiated from one another? What color are they?

Is there fusion of sepals?

Fusion of petals?

How many stamens are there? Are their filaments fused to the corolla? If so, draw how so.

How many pistils are there?

Is the ovary(s) superior or inferior?

Make a longitudinal median section through a flower and its receptacle: look at the receptacle and the attachments of all the organs. This will give you a good view of the number of carpels/pistils and the position of the ovary(s). Use a dissecting scope. Diagram this on a separate piece of paper.

Butterfly-bush flowers:

Is the flower as a whole actinomorphic (radial) or zygomorphic (bilateral)?

How many sepals and petals?

Are the sepals and petals differentiated from one another? What color are they?

Is there fusion of sepals?

Fusion of petals?

How many stamens are there? Are their filaments fused to the corolla? If so, draw how so.

How many pistils are there?

Is the ovary(s) superior or inferior?

Make a longitudinal median section through a flower and its receptacle: look at the receptacle and the attachments of all the organs. This will give you a good view of the number of carpels/pistils and the position of the ovary(s). Use a dissecting scope. Diagram this on a separate piece of paper.

Additional flowers (if available):

Flower species's name:

How many sepals and petals?

Are the sepals and petals differentiated from one another? What color are they?

How many stamens are there?

How many pistils are there?

Is the ovary(s) superior or inferior?

Which of the aforementioned three major groups of angiosperms might this species belong to?

Flower species's name:

How many sepals and petals?

Are the sepals and petals differentiated from one another? What color are they?

How many stamens are there?

How many pistils are there?

Is the ovary(s) superior or inferior?

Which of the aforementioned three major groups of angiosperms might this species belong to?

A3. The inflorescence

A flower may be borne solitarily or in clusters or groups called INFLORESCENCES. Either each flower or the entire inflorescence, or both, may be subtended by one or more leaves, which if modified in shape, size, or appearance is (are) called BRACT(S).

Developmentally, subtending bracts (and leaves) and flowers are related because the flower is technically an axillary shoot (i.e., a branch), and branch buds always are produced above leaves.

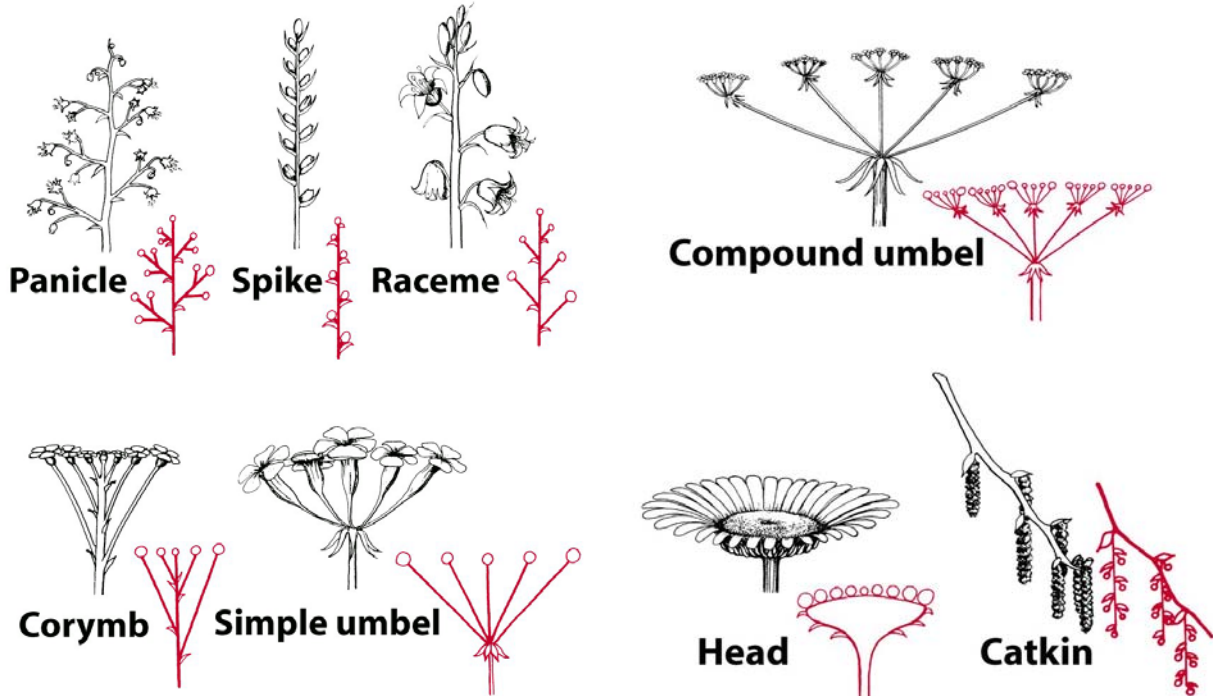


Figure 19-7 part 1
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Figure 19-7 part 2
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Fig. 5. Some types of inflorescences.

1. Review the inflorescences diagrams and names above, then apply them as appropriate to the sample inflorescences at the inflorescence station at the back or side of the room.

Plant	Inflorescence Type
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	

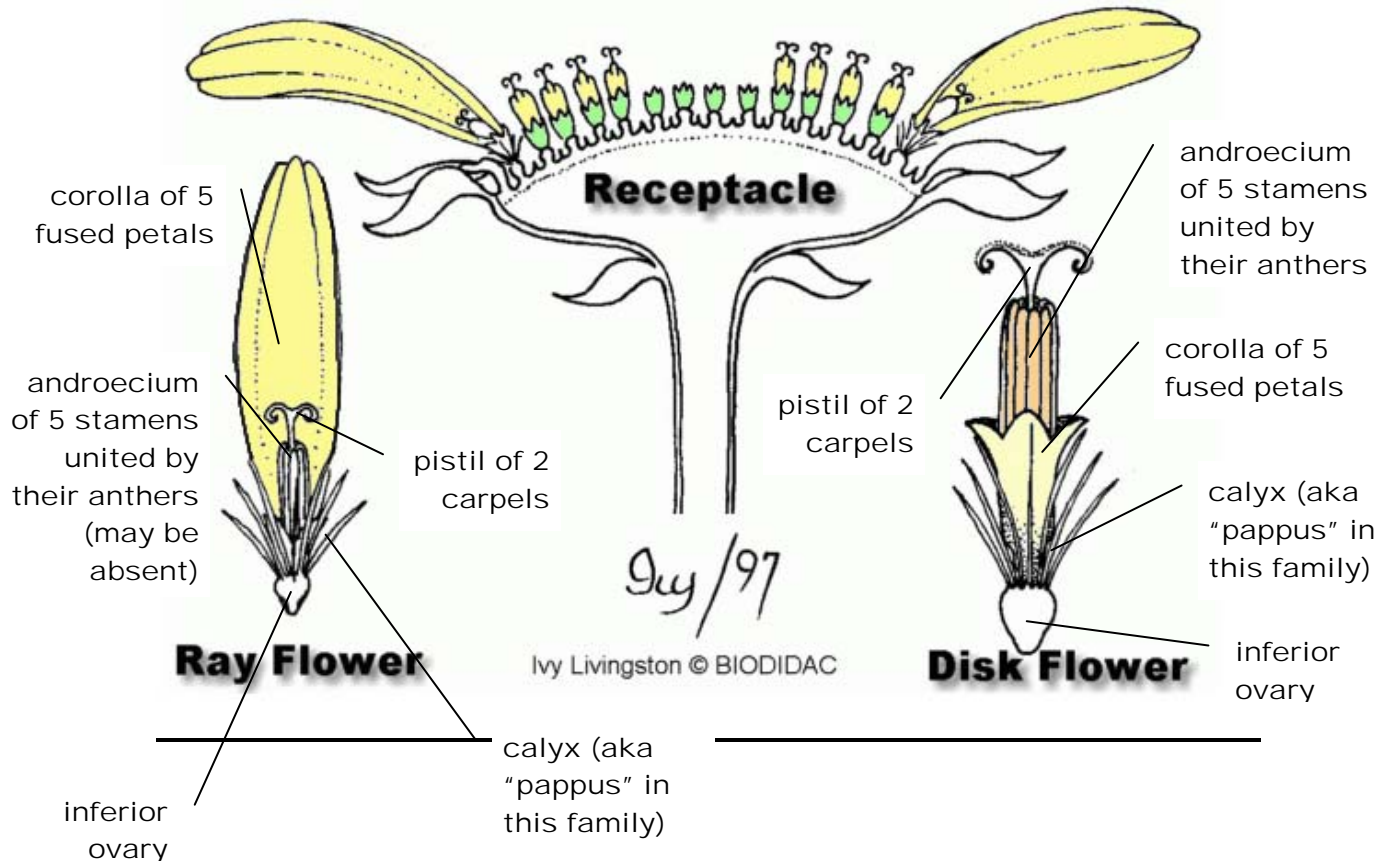
2. Focus on Asteraceae Inflorescences:

The Head

The apparent “flower” of a sunflower or any of its relatives in the same family Asteraceae is actually a composite of many small flowers.

In a typical radiate head such as the sunflower, disk flowers in the center are surrounded by ray flowers around the periphery (see below).

Some heads have only disk-like flowers, and these are called discoïd or disciform heads. Other heads have only ray-like flowers and these are called ligulate heads.





Is the head pictured above a radiate head or is a discoid, disciform, or ligulate head?

Label one or more bracts that “subtend” each flower.

Label one or more of the ovaries. Are the ovaries inferior or superior?

Label the pistil.

Label of the “receptacle” of the inflorescence.

Make a study of each of the other sunflower family representatives in lab today. By yourself, back at your table, make a medial longitudinal section through the heads of the plants below and draw them.

1. Plant Name:

a. Is this a radiate, ligulate, or discoid head?

b. On a separate paper, draw an individual flower. Can you find stamens? Can you find a pistil?

2. Plant Name:

a. Is this a radiate, ligulate, or discoid head?

b. On a separate paper, draw an individual flower. Can you find stamens? Can you find a pistil?

B. Fruits

B1. The Ovary-Fruit Connection

The ovary is a defining characteristic of angiosperms. The ovary (and pistil) envelops the ovules such that pollen is not delivered directly to the ovule. Rather, pollen must land on the stigma of the pistil, after which the pollen tube must grow down the style and into the ovule for fertilization to occur.

A fruit develops from the ovary, after pollination and fertilization has been achieved.

Thus, the ovary wall becomes the fruit wall and flesh, the ovules of the ovary become the seeds.

Thus, the ovary (fruit) wall is the vessel that contains the ovules (seeds). In fact, *angios* is derived from Greek for “vessel”, and *sperma* is derived from Greek for “seed”.

The wall of the fruit is called the pericarp. Sometimes the pericarp is differentiated into an exocarp (the outer portion of the fruit wall), a mesocarp (the inner portion of the fruit wall), and an endocarp (the innermost portion of the fruit wall).

B2. Working in Pairs at your bench: conduct the following studies of fruits

1. Pokeweed

Pokeweed fruits are simple (derived from a single ovary), the pericarp is fleshy at maturity and the fruit is indehiscent (does not open to release the seeds). The fruit type is a berry. Work your way through the attached fruit classification key to see that it matches a berry.

- a. Compare the ripe fruit to the flower.
 - 1) *Does fruit resemble the ovary of the flower in any way?*
 - 2) *Are there any persistent sepals or tepals subtending the fruit?*
 - 3) *How can you tell that the flower’s ovary is superior?*
 - 4) *How can you tell that the fruit came from a superior ovary?*

2. Tomato

- a. Look at but do not cut a large vine-ripened tomato.
 - 1) *Can you see the pedicel and sepals of the flower from which the tomato came?*
 - 2) *Can you tell that it came from a superior ovary?*
- b. Take a cherry tomato
 - 1) *Look for any pedicels, sepals, or scars of where these had been attached.*
 - 2) *Cross-section the fruit and count the number of locules. How many carpels do you think make up this fruit?*
 - 3) *Is this fruit a berry (check the fruit classification on last page)? Why or why not?*

3. Raspberry or blackberry

a. Take one raspberry or blackberry (both of which are from the same genus, *Rubus*). This came from a single flower.

- 1) *How can you tell that this fruit came from multiple ovaries?*
- 2) *Is this a simple, aggregate or multiple fruit (see fruit classification on last page)?*
- 3) *Can you see any remnant styles or stigmas attached to the little fruitlets? Draw this on a separate piece of paper.*

4. Redbud fruits.

a. Take one redbud fruit.

- 1) *Is this fruit dry or fleshy at maturity?*
- 2) *Is this fruit dehiscent or indehiscent at maturity?*
- 3) *This fruit is a legume. Use the fruit classification on last page to tell us what characteristics make it such.*

5. Blueberries.

a. Take one blueberry.

- 1) *Is this simple fruit from a superior or inferior ovary? How can you tell? (Hint: do you see any persistent sepals or petals? Where they with respect to the ovary?)*
- 2) *Is this fruit a berry or a capsule?*

6. Hibiscus fruits.

a. Take one hibiscus fruit.

- 1) *Is this simple fruit from a superior or inferior ovary? How can you tell?*
- 2) *Is this fruit a berry or a capsule?*
- 3) *If a capsule, how many carpels do you suppose make it up? (Hint: look at the number of “valves” by which it opened).*

B3. Working in Pairs in the back & side of

the room: Various other fruits are available for you to look at in the back or side of the room. *Using the posters on the wall and the fruit hierarchical classification provided in the back of this lab manual, identify the types (classes) of fruit represented by the following:*

Fruit Species Name	Is this fruit dry or fleshy at maturity?	Is the fruit dehiscent or indehiscent?	Is the fruit a simple, aggregate, or multiple fruit?	Specific Fruit Type

Appendix B: A Classification of Common Fruit Types

(NOTE: the term fruit here is used loosely to refer to any angiosperm structure that develops and ripens around seeds and functions for the purposes of seed dispersal)

I. SIMPLE FRUIT—develops from the single ovary of one flower.

A. SIMPLE DRY FRUIT—pericarp becomes leathery, papery, or woody.

1. DEHISCENT—opens when ripe.

a. FOLLICLE—develops from a simple pistil, opens along one side only.

b. LEGUME—from a simple pistil, opens along two sides.

c. CAPSULE—from a compound pistil (i.e., one with two or more carpels). Opens a variety of ways.

d. SILIQUE—from a single pistil, the lateral walls of the flattened fruit opening, leaving behind the seeds attached to a persistent, free-standing partition. Members of the mustard family.

2. INDEHISCENT—fruit does not open at maturity.

a. ACHENE—small, one-seeded; seed coat free from pericarp (e.g., dandelion).

b. GRAIN or CARYOPSIS—seed coat is fused with pericarp. Members of grass family.

c. SAMARA—usually one-seeded, has a wing formed by an extension of the ovary wall.

d. SCHIZOCARP—fruit breaks into 1-carpellate seeded units with the seeds inside.

d. NUT—a rather large, hard-walled, 1-2-seeded fruit. Bracts usually wholly or partially enclose the hard pericarp.

B. SIMPLE FLESHY FRUIT—a portion or all of the pericarp is fleshy at maturity.

1. DEHISCENT—opens when ripe. Fleshy fruits are, with few exceptions, indehiscent.

a. FLESHY CAPSULE.

2. INDEHISCENT—fruit does not open at maturity (fleshy fruits are generally indehiscent).

a. SIMPLE, NON-ACCESSORY FRUIT – the “fruit wall” consists only of carpel tissue.

1) BERRY—entire pericarp fleshy; exocarp may be thin and skin-like, but rest of mesocarp is fleshy and the mesocarp and endocarp are not differentiated from one another.

a) normal BERRY – where the pericarp (minus the is soft and generally juicy all the way until the seeds.

b) “HESPERIDIUM”—a special type of berry in which the pericarp is leathery, and the inner wall of the carpels has extra-plump and juicy trichomes.

Characteristic of one very important genus from the Mediterranean!

c) “PEPO”—a special type of berry in which the pericarp is thick, forming a “rind”. Characteristic of one very important family!

2) DRUPE—pericarp divided into three parts: outer EXOCARP (the “skin”), middle MESOCARP (usually fleshy), and inner ENDOCARP (which is stony). The stony endocarp or “pit” encloses the seed.

b. SIMPLE ACCESSORY FRUIT - from only a single ovary of a single flower, BUT fruit includes ovary wall AND OTHER floral parts or nearby structures. For example, a hypanthium or the base of the perianth parts fused to the ovary (which makes it inferior) may develop around the ovary and become fleshy and fruit-like.

1) ACCESSORY BERRY – a berry derived from an inferior ovary such that the wall includes other floral parts (such as sepal tissue).

A special type of this is called a POME—from an inferior ovary of some members of the rose family: where most of the flesh of the fruit is actually the receptacle and/or fused bases of the sepals, etc. Can usually see remnants of sepals and, in some cases, stamens atop the fruit.

II. AGGREGATE FRUIT—develops from a number of separate ovaries of one flower. The component fruit *sensu stricto* are called “fruitlets”.

- A. SIMPLE AGGREGATE FRUIT—simple fruits from multiple pistils of one flower are loosely aggregated together and, together, separate from the dry receptacle.
 - B. AGGREGATE ACCESSORY FRUIT—receptacle is incorporated into the “fruit”.
- III. MULTIPLE FRUIT—develops from a number of individual ovaries of flowers grouped closely together in an inflorescence. A fruit is produced from each flower, and these fruits remain together (or even fuse) in a single mass. Often, even the bracts subtending the individual flowers are incorporated into the “fruit”!