LESSON 9

Sexual Reproduction in Flowering Plants

CORBIS/ROYALTY-FREE

While this hummingbird feeds on nectar from the flower, it may also provide a valuable service for the plant. Can you guess what that service is?

INTRODUCTION

What are flowers for? Many of them are beautiful, but what function do they serve for plants? In this lesson, you will discover answers to these questions. You will examine a flower to observe its structures. Then you will apply what you learned when you work with your Wisconsin Fast Plants flowers. You'll be busy as a bee in this lesson—in more ways than one!

OBJECTIVES FOR THIS LESSON

Examine two or more flowers and develop an understanding of their structure and function.

Cross-pollinate the Wisconsin Fast Plants flowers in your growing system.

Explain several ways in which flowers are pollinated in nature.

Demonstrate an understanding of the difference between cell division and meiosis.

Update the Wisconsin Fast Plants organism photo card.

Getting Started

1. Follow along as student volunteers read "Methods of Reproduction." Ask questions to clarify points you do not understand.

2. The Fast Plants in your growing system should be flowering by now. Briefly observe a Fast Plants flower and the flower you brought to class. With your group, discuss and agree on the function of a flower. Describe that function in one sentence on a fresh page in your science notebook.

3. Share your ideas with the class and participate as your teacher guides your class in a discussion about flowering plants.

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Figure 9.1 *These students are comparing a Fast Plants flower with the one they brought to class, seeking to determine a flower's function.*

MATERIALS FOR LESSON 9

For you

- 1 copy of Student Sheet 9.1: Template for Flower Drawings

For your group

- 1 set of organism photo cards
- 2 perfect flowers
- 2 hand lenses
- 2 compound light microscopes
- 2 plastic slides
- 2 coverslips
- 2 cotton swabs
- 2 scalpels
- 1 black marker

Inquiry 9.1
Dissecting a Perfect Flower

PROCEDURE

1. With the class, discuss Figure 9.2.

2. You will work with your partner for this inquiry; however, you will each do your own drawing. Observe carefully the flower you brought to class. Place it in a position that allows you to see it clearly. You may need to bend the front petals down for a better view. Sketch your flower in the upper circle on Student Sheet 9.1: Template for Flower Drawings. Title your drawing "XXX—A Perfect Flower." Replace "XXX" with the name of your flower. For example, if you drew a tulip, your title would be "Tulip—A Perfect Flower." Use Figure 9.2 to help you identify each flower part and observe the characteristics of a perfect flower.

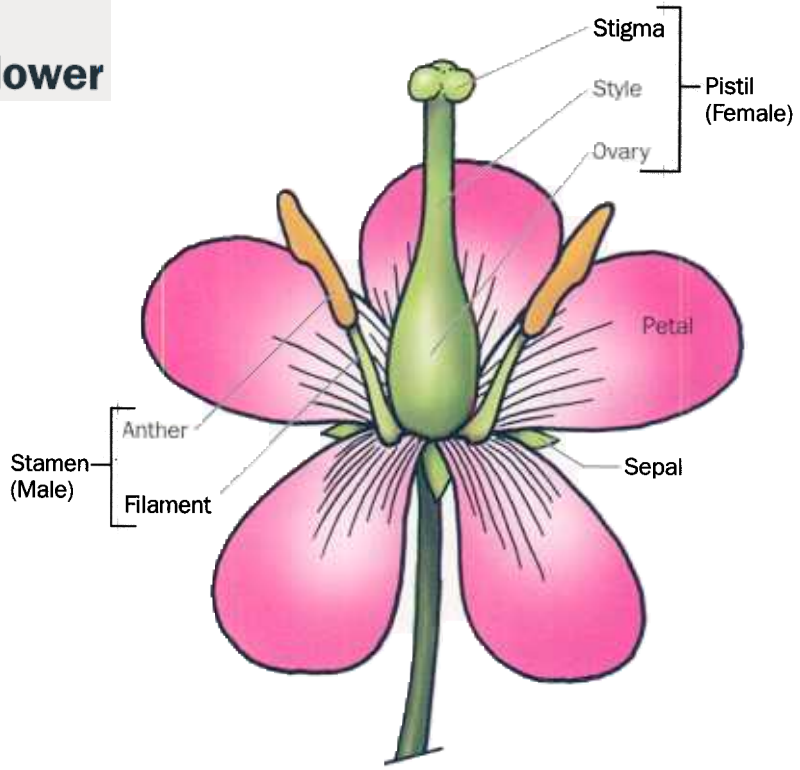


Figure 9.2 *A perfect flower contains both male and female reproductive structures. What do you think an imperfect flower is?*

3. Use your scalpel to cut and remove an entire stamen, one of the male reproductive structures, from your flower. Draw the stamen in the lower circle on the front of Student Sheet 9.1. Label the anther and filament. Title your drawing "Male Reproductive Structure—The Stamen."

SAFETY TIP

Always cut in a direction away from your fingers when using a scalpel.

4. Tap the anther of your flower against the top surface of a microscope slide. Pollen is likely to fall from the anther onto the slide. If it does not, use the tip of your pencil to scrape pollen from the anther and put it on the slide.

5. Add a coverslip. Center a pollen grain in the field of view and bring it into focus under a magnification of 100×; then switch to a magnification of 400× and refocus.

6. Divide the upper circle on the back of Student Sheet 9.1 into three equal sections. Mark the three sections "A," "B," and "C." Print the title "Pollen Grains" below the circle. Draw a pollen grain from your flower in section A. Label the pollen grain with the name of the flower. Then trade slides with a pair of students that has pollen grains from a flower of a different species. Follow Step 5 again to get a pollen grain in focus under 400×. Draw the grain in Section B of the upper circle. Label this pollen grain with the appropriate name. Compare these pollen grains with the highly magnified grains of a ragweed plant shown in Figure 9.3.

7. Clean your slide. Remove a stamen from one of your Fast Plants flowers and scrape some of its pollen onto the slide. View the Fast Plants pollen under a magnification of 400×. Draw one of the pollen grains in Section C of the upper circle. Label this pollen grain "Fast Plants Pollen Grain." Discuss with your partner why the pollen grains of different species appear so dissimilar. Also discuss how pollen moves from one plant to another.

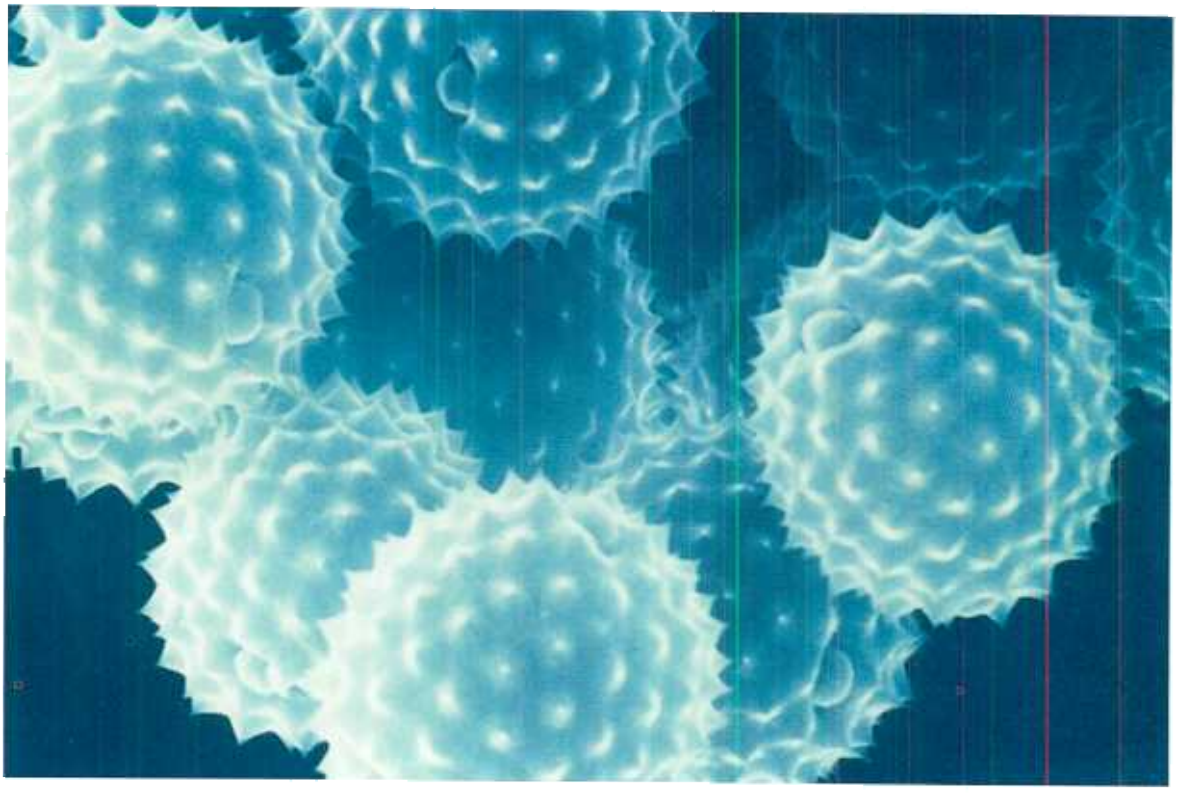


Figure 9.3 *This is a photo of ragweed pollen taken through an electron microscope. You may be allergic to this pollen.*

8. Remove the petals and the remaining stamens from your flower and set them aside. The only flower part left will be the pistil, the female reproductive structure. Use your scalpel to cut the pistil across the middle of the ovary, as shown in Figure 9.4. Note the safety procedure followed by the student in Figure 9.5. Use your hand lens if necessary to observe the columns of immature seeds, called ovules, in the cut-away ovary.

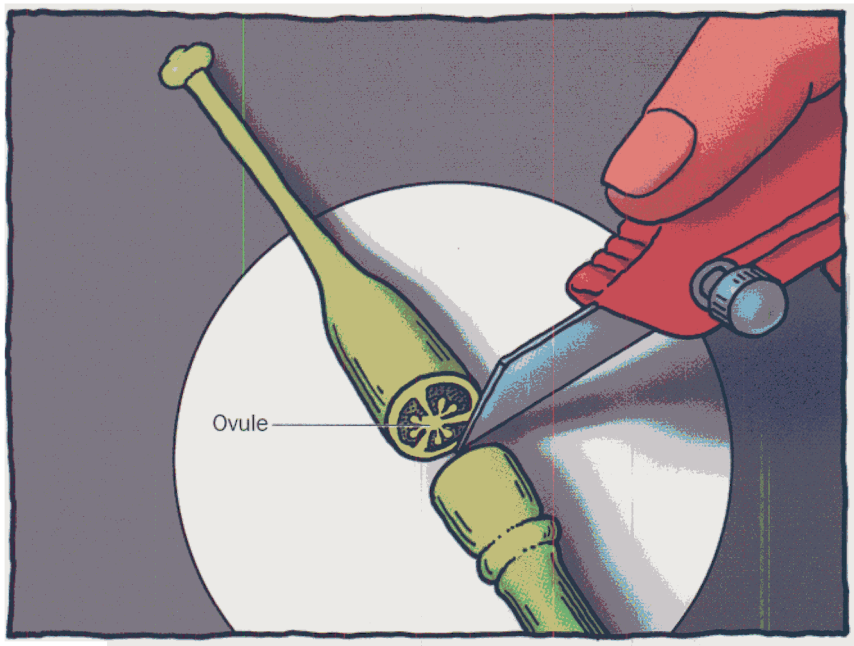


Figure 9.4 *Slice the ovary for observation.*

9. Clean your slide. Remove an ovule with the tip of your scalpel and put it on the slide. Use your microscope to focus on the ovule under a magnification of 400×. Sketch the ovule in the lower circle on the back of Student Sheet 9.1. Title your drawing "XXX" Ovule. Substitute the name of your flower for "XXX."

If you planted these ovules, do you think they would grow? Why or why not?

Figure 9.5 *This student is holding the ovary with her left hand and pulling the scalpel blade across the ovary in a direction away from her fingers.*

Inquiry 9.2 Pollinating the Fast Plants Flowers

PROCEDURE

1. Locate the pistil of one of your Fast Plants flowers. Use Figure 9.6 as a guide.

2. Collect pollen with a cotton swab by dabbing the swab gently onto the anthers of a Fast Plants flower. Next, dab the swab onto the stigma of one or more Fast Plants flowers on another plant, as shown in Figure 9.7. The process of transferring pollen from a flower of one plant to a flower of another plant is called cross-pollination. Repeat the process until you have cross-pollinated each of the flowers in your growing system.

3. Take turns pollinating your Fast Plants flowers for several days. Your teacher will explain how to do this and why it is necessary. On the last day of pollination, pinch off any unopened flower buds.

4. With your group, update the Fast Plants organism photo card with new information from this lesson.

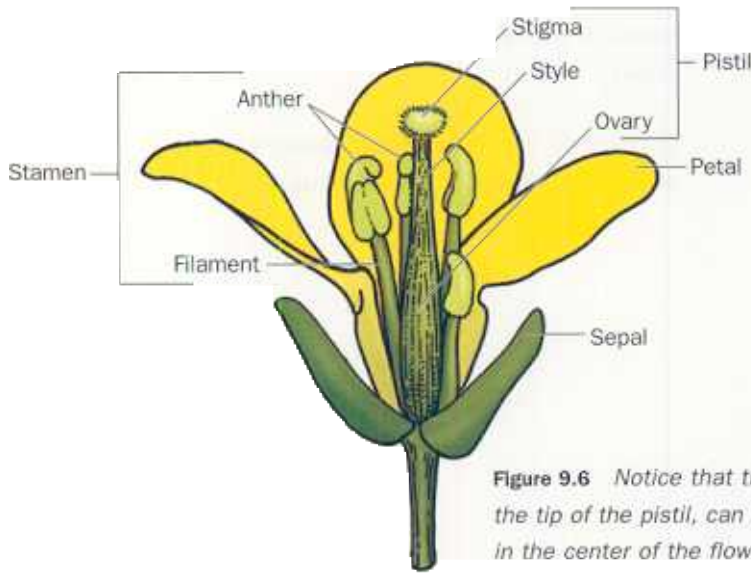


Figure 9.6 *Notice that the stigma, the tip of the pistil, can be seen in the center of the flower.*

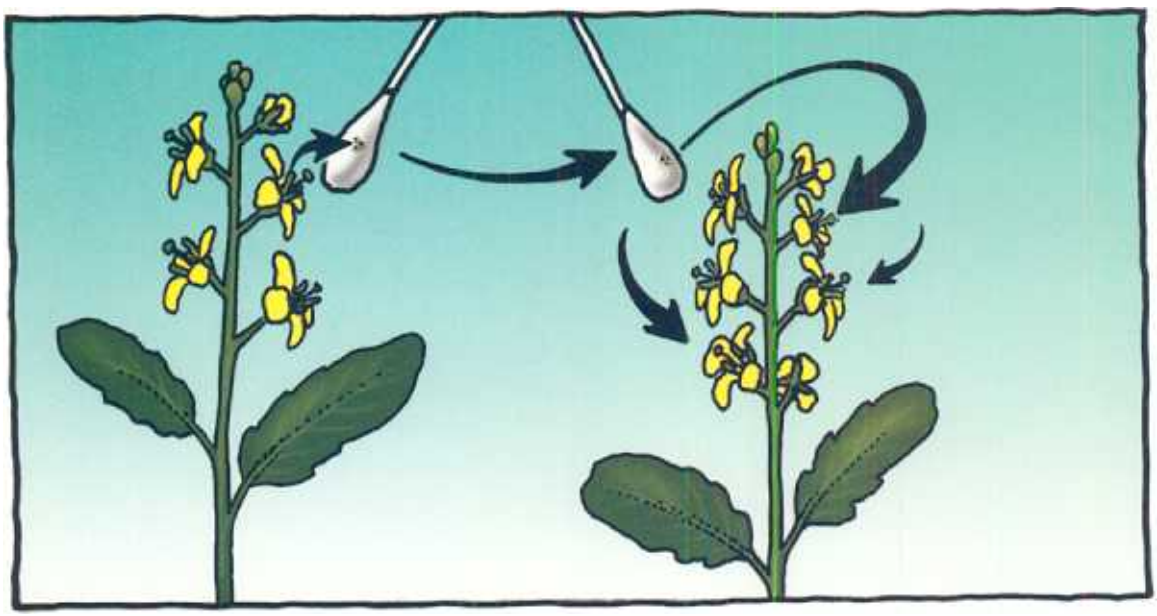


Figure 9.7 *Make sure you transfer the pollen to one or more flowers on a different Fast Plant.*

REFLECTING ON WHAT YOU'VE DONE

On the basis of what you have learned about reproduction in flowering plants, answer the following questions on Student Sheet 9.1:

A. Using "The Wonder of Flowering Plants" as a reference, explain what happens inside the flower after pollination.

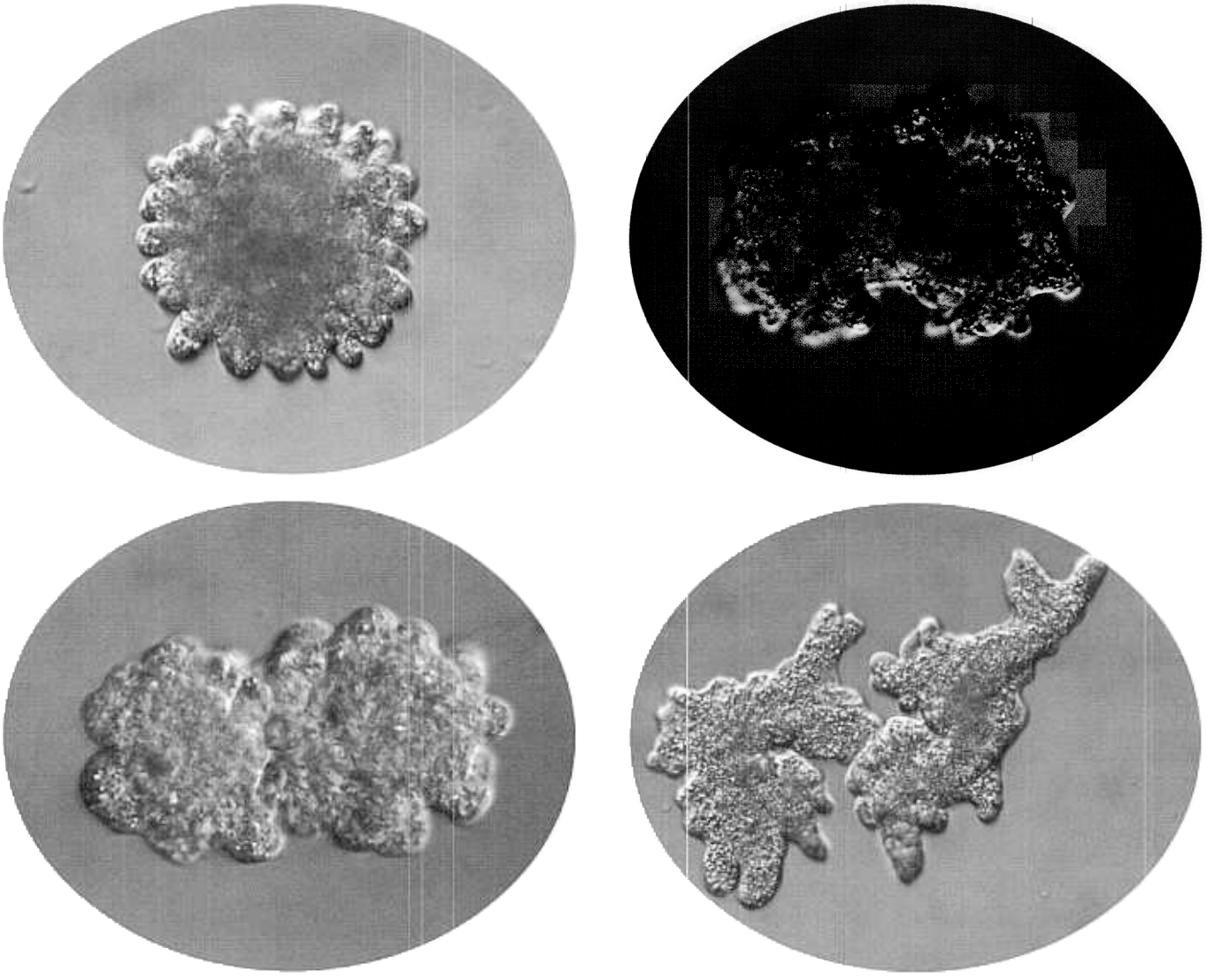
B. What do you think will develop as the flowers wither? Hint: Think about the name of the structure that protects the seeds.

C. Why do you think some flowers have so many pollen grains and ovules?

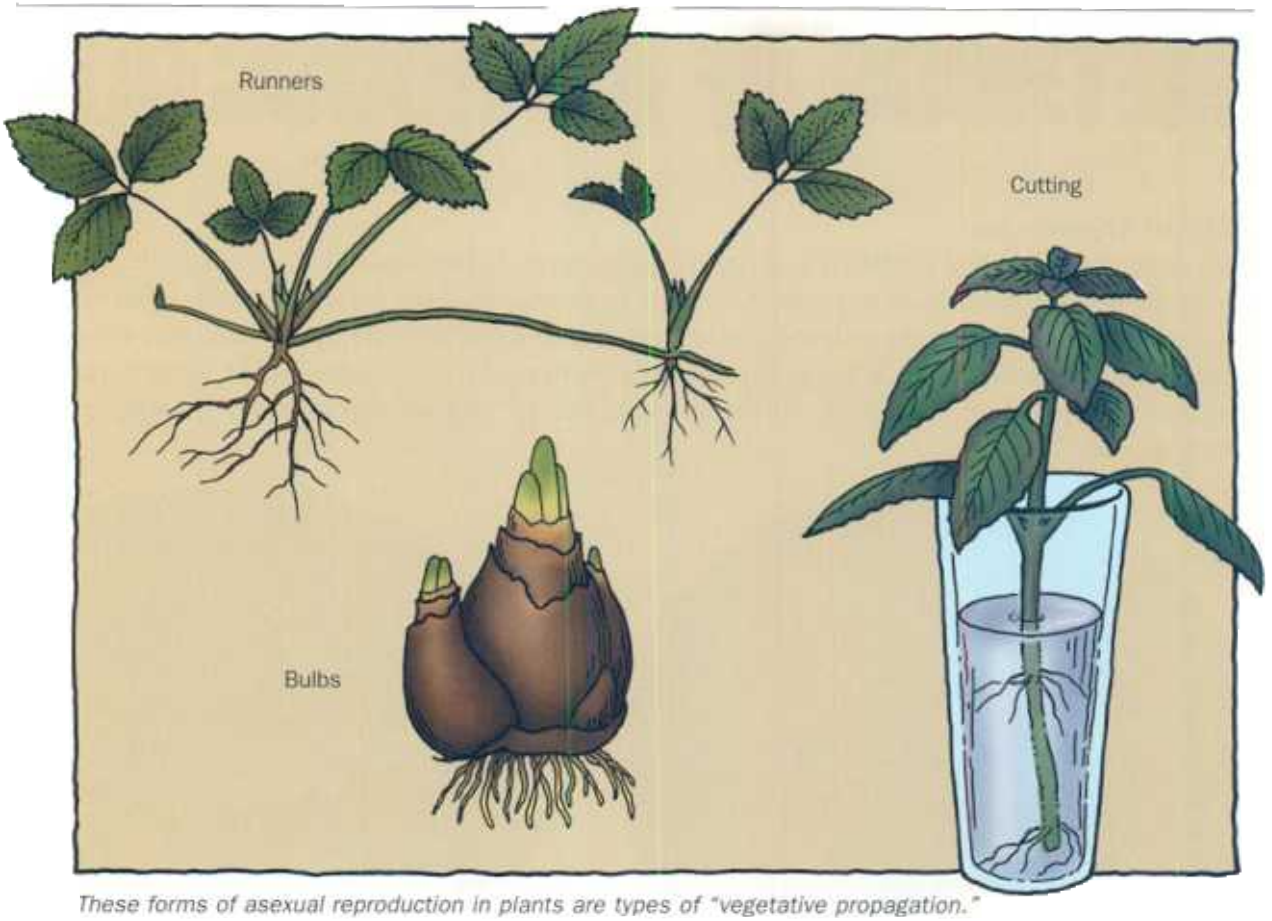
METHODS OF REPRODUCTION

Asexual Reproduction

In Lesson 8, you learned about the cell cycle. Cell division, an important part of that cycle, enables multicellular organisms, such as humans, to grow by producing more cells. For single-celled organisms, cell division is often the only method of reproduction. Cell division does not involve the union of male and female sex cells. When new organisms are formed from a single parent, without the union of male and female sex cells, the process is known as "asexual reproduction." Asexual means "without sex."



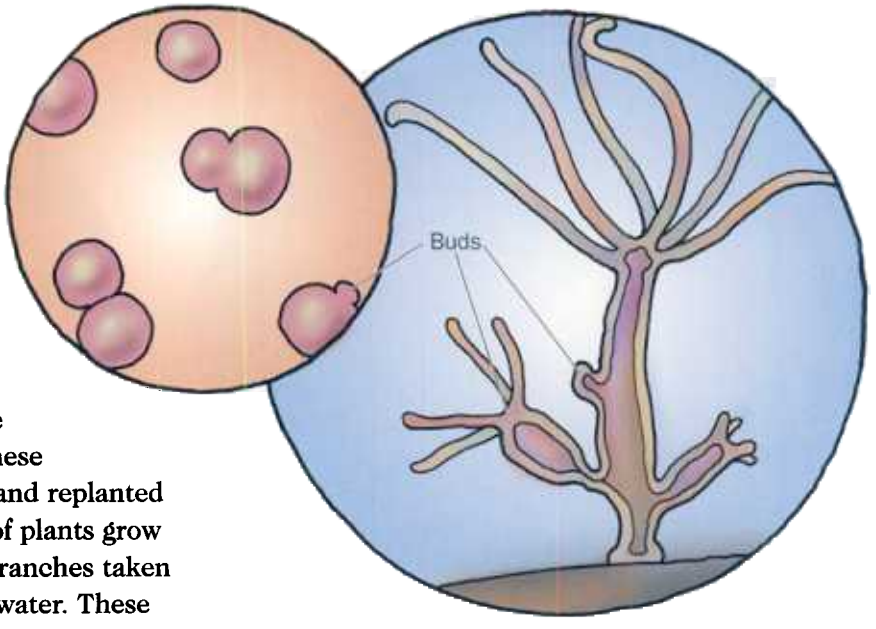
This is an amoeba reproducing by fission, a form of cell division and asexual reproduction.



These forms of asexual reproduction in plants are types of "vegetative propagation."

Many multicellular organisms, including many species of plants, also reproduce asexually. Strawberry plants, for example, develop overground stems called runners, which run over the ground for a short distance, touch down and take root, and grow into new strawberry plants. Some plants, such as tulips, grow thick daughter bulbs beside the parent bulb underground. These bulbs can be dug up, separated, and replanted to grow new tulips. Many kinds of plants grow new plants from small twigs or branches taken from them and placed in soil or water. These pieces are called "cuttings."

Some organisms, such as the single-celled yeast and the multicellular *Hydra,* reproduce asexually by a process known as "budding."



The outgrowths on these organisms, called buds, are formed through cell division. The buds eventually will break off and become self-sufficient.

Asexual reproduction has advantages and disadvantages. On the one hand, it is convenient because it requires only one parent. The quality of an organism that results from asexual reproduction will remain more or less the same. For example, if a plant has fruit or flowers of exceptional quality, the quality of the fruit and flowers can be maintained over time through asexual reproduction. On the other hand, in nature, there are rarely improvements in a plant produced through asexual reproduction. Thus, if a plant has fruit or flowers of average or poor quality, so too will any plant produced from it by asexual means.

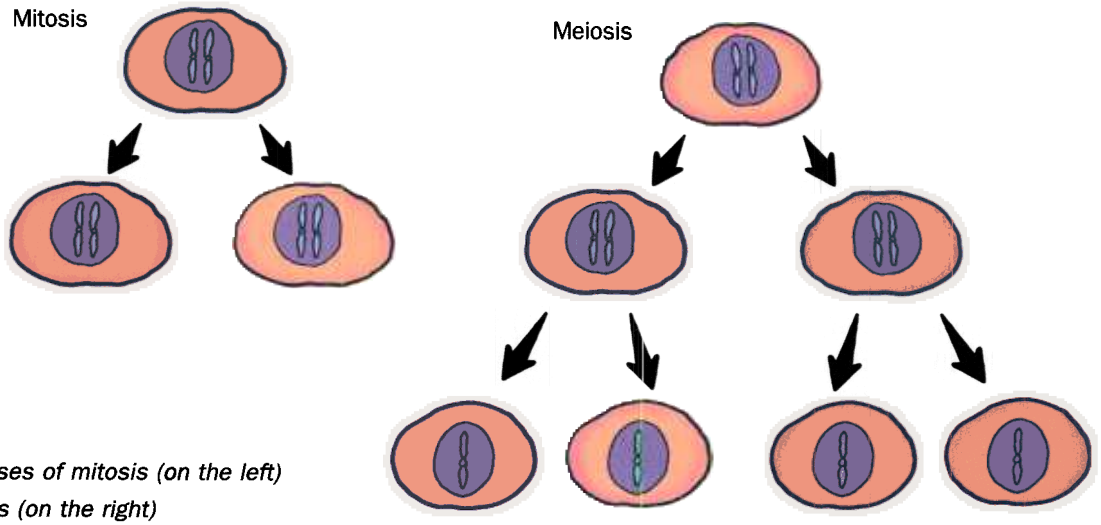
Sexual Reproduction

Many life processes enable an organism to live and grow. Reproduction enables a species to produce more of its own kind and persist through time. Sexual reproduction is accomplished through the union of a male sperm and a female egg, sex cells that form through a process called "meiosis."

Meiosis begins like cell division does: a cell that is destined to be a male or female sex cell divides, resulting in two cells that are genetically identical to it. But in meiosis, a second nuclear division follows, with each of the two daughter cells dividing again. During this second division, the members of each pair of chromosomes separate and each moves into one of the new cells. This means that the new sex cells—the male (sperm) or female (egg) cells—contain only half the number of chromosomes as do regular body cells. They also are no longer genetically identical. The same basic process of meiosis occurs in all animals and in flowering plants.

For example, Wisconsin Fast Plants cells normally have 10 pairs of chromosomes (a total of 20 chromosomes). When pollen grains (the male sex cells) or ovules (the female sex cells) are formed, each has only 10 single chromosomes. When fertilization takes place, the pollen grain contributes 10 chromosomes and the ovule contributes 10 chromosomes. The resulting seed has the normal 10 pairs of chromosomes. If the number of chromosomes in the sex cells were not halved, organisms would double their number of chromosomes every generation. After a few generations, this would result in very large numbers of chromosomes. Thus, meiosis serves to keep the number of chromosome pairs stable over time. Since heredity is determined by sections of the chromosomes called genes, it is this pairing up of chromosomes from different parents during sexual reproduction that makes each organism genetically unique among its species.

Your Fast Plants reproduce sexually. However, before they can do so, another process must first occur, as you will discover in this lesson. □

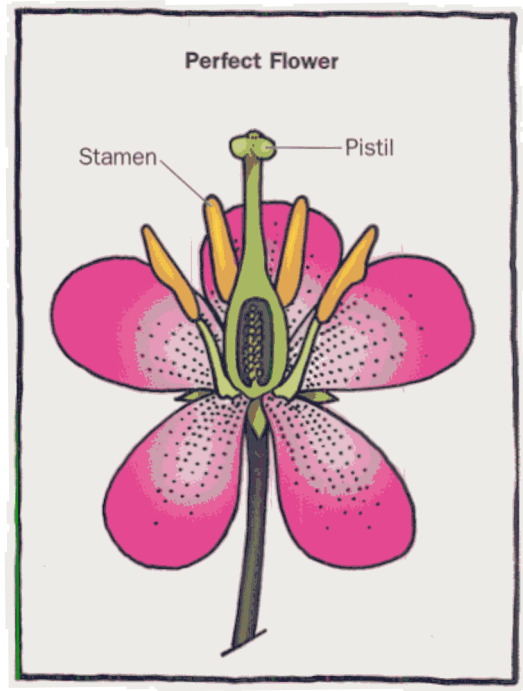


The processes of mitosis (on the left) and meiosis (on the right)

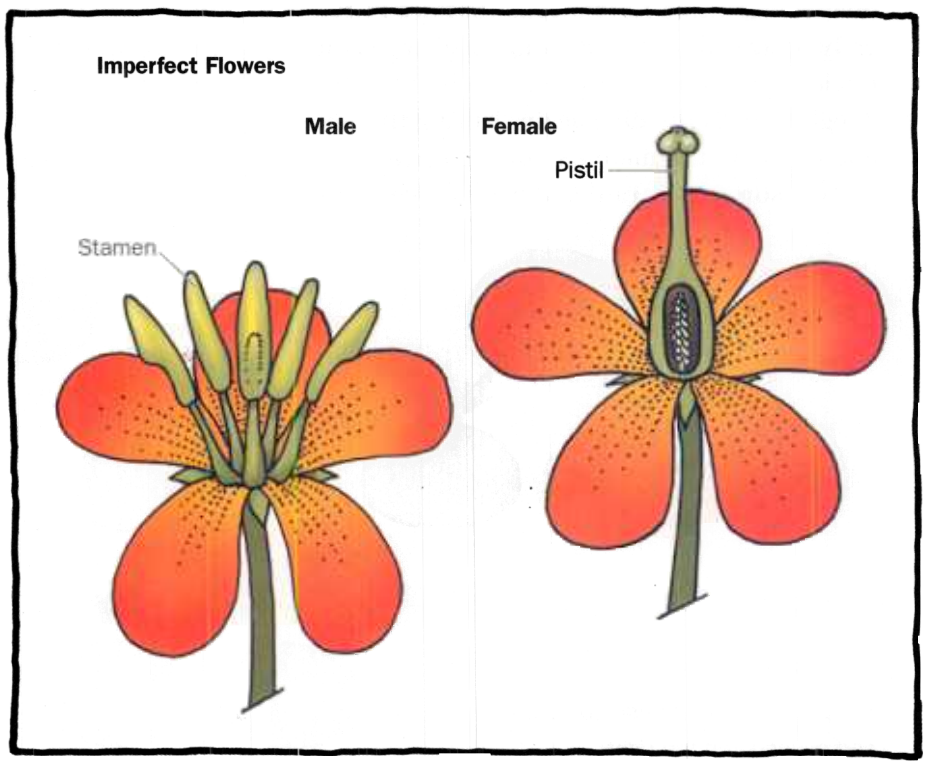
The Wonder of Flowering Plants

It takes both male and female sex cells to create a human being, through a process called "sexual reproduction." The same is true for many flowering plants. The flower is the reproductive organ of a flowering plant.

Within the flower are male structures called "stamens" and one or more female structures called "pistils." The stamen consists of the anther, which produces the pollen, and the filament, which supports the anther. The pollen contains the sperm nuclei. At the top of the pistil is the sticky stigma, which is supported by a structure called a style. At the bottom of the style is the ovary, which produces the eggs (ovules). Each egg contains an egg nucleus.



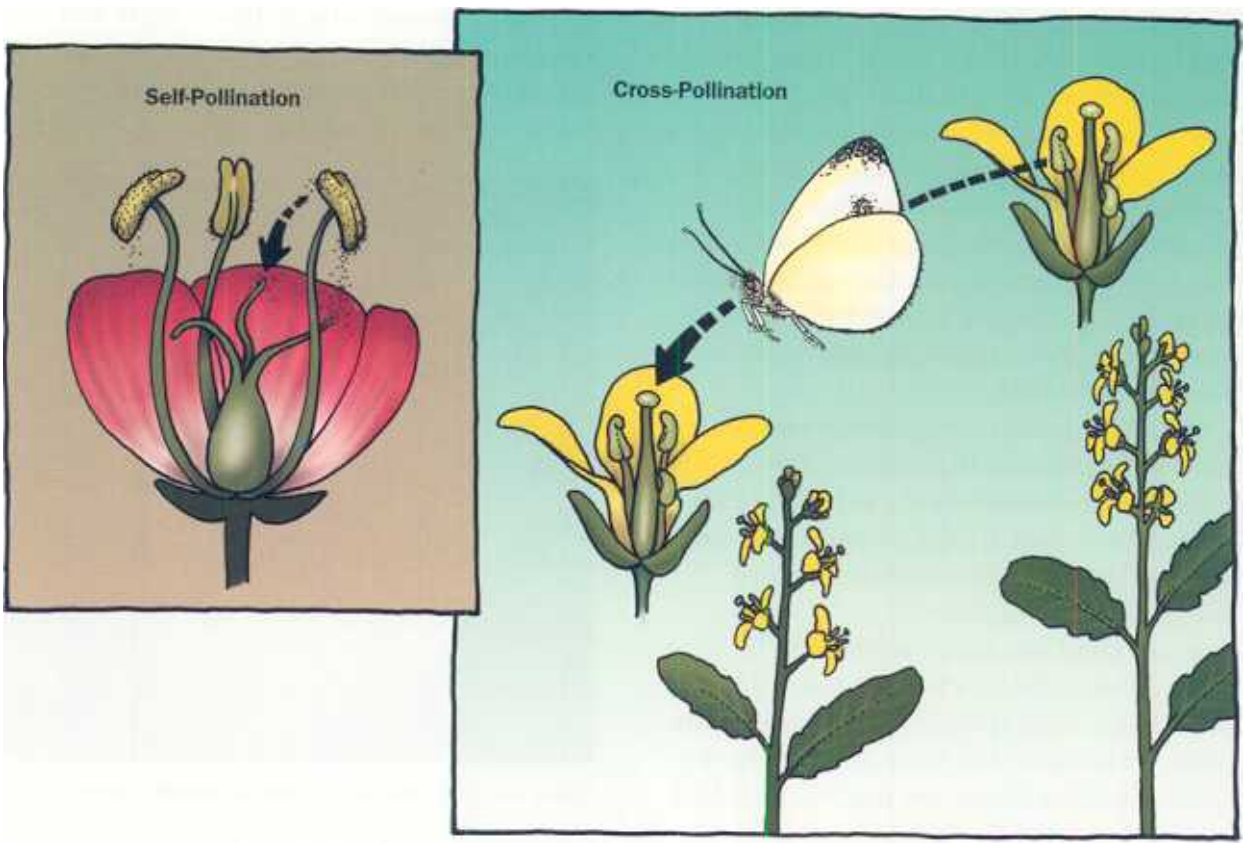
Some species of plants have flowers that include both male and female structures—that is, both stamen and pistil. Others have only the male or female structure. A flower that has both a male and female reproductive structure is called a "perfect flower." A flower that has only male or female reproductive structures is referred to as an "imperfect flower." (These names are historical ones. Perhaps if we named them now, we'd use the terms "complete" and "incomplete.") The illustration shows a perfect flower on the top and two imperfect flowers on the bottom.

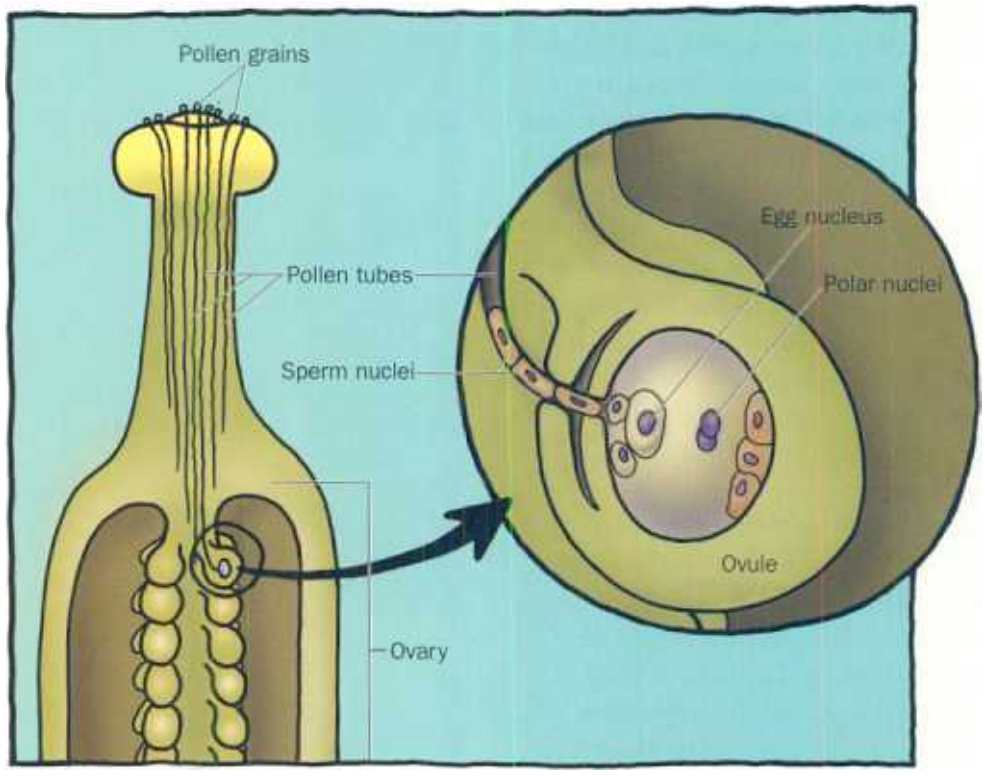


For a plant to make seeds, pollen from an anther must contact the sticky stigma of a pistil. This is called "pollination." There are two kinds of pollination—self-pollination and cross-pollination. Self-pollination occurs when pollen is transferred to the stigma of a flower on the same plant. Cross-pollination occurs when pollen is transferred to the stigma of a flower on another plant of the same species. Some species of plants, such as Fast Plants, cannot self-pollinate. In order for seeds to be produced in Fast Plants, cross-pollination must occur. In general, plants that cross-pollinate need pollen from their own species.

Self-pollination is pretty simple. Gravity, an insect, a gust of wind, or even a raindrop can accomplish the task easily. Cross-pollination, by contrast, requires pollen to move from one plant to another. Without the help of wind, water, and animals like insects, pollination would not occur as often and many flowers would fail to make seeds. Without seeds, there would be fewer new plants.

Notice the many pollen grains sticking to the hairs on the bee's body.

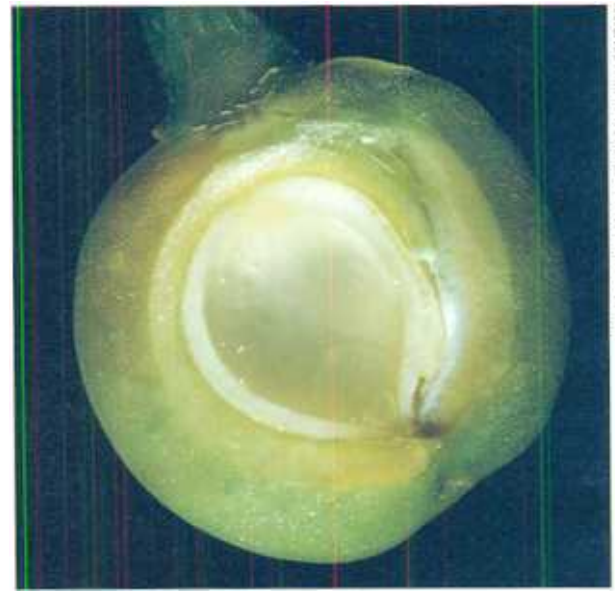




Pollen grains generally contain three nuclei—two sperm nuclei and one tube nucleus. When the pollen lands on the stigma of a flower of the same species, the tube nucleus begins forming a tube that grows down to the ovary. The two sperm nuclei then move down the tube to the ovary. The waiting ovule contains an egg nucleus, two polar nuclei that fuse, and five other nuclei that eventually disintegrate. One sperm nucleus unites with the egg nucleus in an ovule. This process is called "fertilization." After fertilization occurs, the egg begins to develop into a seed.

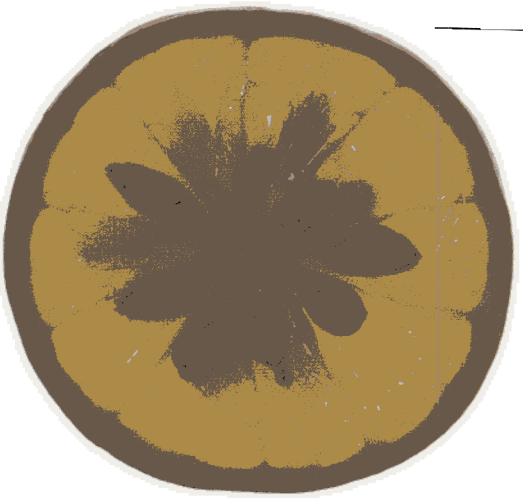
The other sperm nucleus unites with the fused polar nuclei in the center of the egg. This stimulates the formation of a substance called endosperm, which is food for the developing embryo. One or more seed coats develop around the growing embryo.

At this point, the flower withers, and the ovary develops into a structure called a fruit. Some fruits, such as cherries and oranges, are edible by humans, and some, such as the dry pods of the Fast Plants, are inedible. The fruit helps protect the seeds and serves as a way to disperse them. Some fruits, like cherries, contain only one seed; others, like oranges and squash, contain many seeds. A squash, cut lengthwise, has the familiar shape of most flower ovaries.

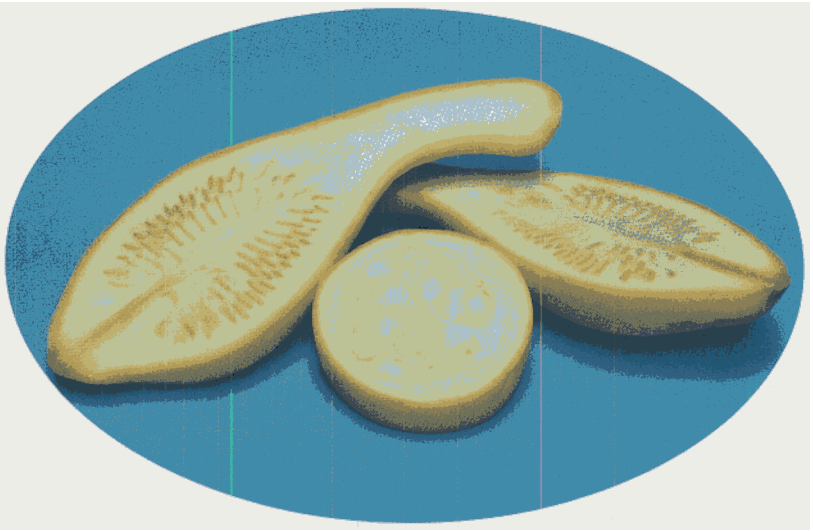


There was only one seed in this dissected cherry.

TOP PHOTOS COURTESY OF CAROLINA BIOLOGICAL SUPPLY COMPANY



Notice the orderly arrangement of seeds in this orange slice.



The squash, cut lengthwise, retains the original shape of the ovary. It's larger now because of the stored food.

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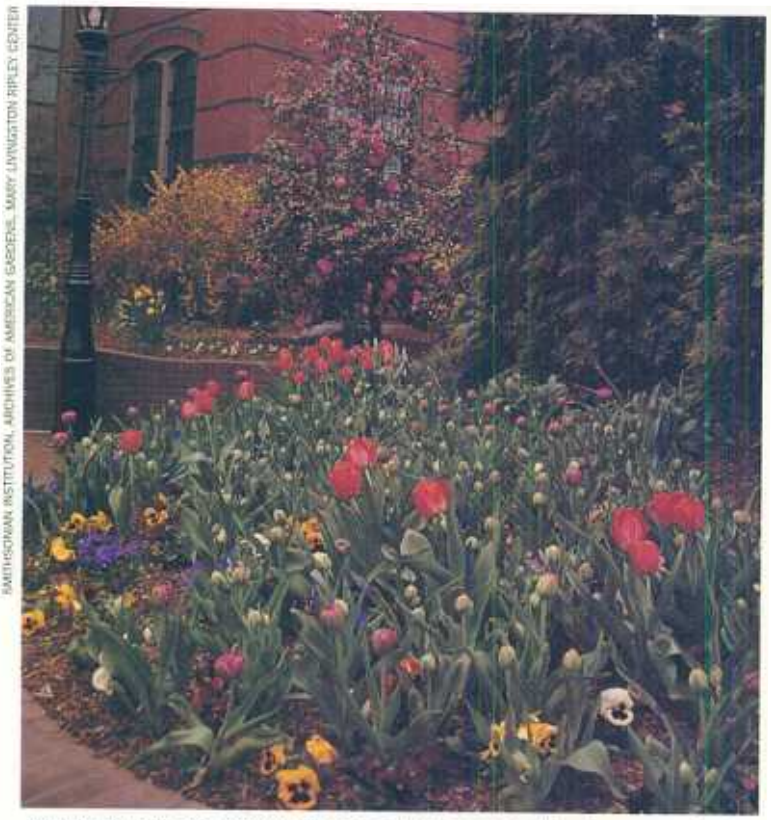

While flowers are necessary for sexual reproduction in many plants, they also provide us with a source of natural beauty.

Because a flower's real function is to promote pollination, fertilization, and seed production, it is not surprising that flowers have developed many ways to make these processes more efficient. Since plants are rooted and cannot move about, flowers have adapted in ways that encourage visits by potential pollinators, such as bees or hummingbirds. In some ways, flowers are like people. When people want to attract attention, they may wear cologne and put on bright, colorful clothes. Some flowers, too, have strong scents and a rainbow of colors that attract attention from bees, butterflies, and other animals. □