

Inquiry project: Finding the Flower Inside the Fruit

In this lesson students will learn how flowers mature into fruits by identifying the types of ovaries of local flowers and relating them to the types of seed arrangement they can find in fruits.

Learning Goals

At the end of this project, students will be able to:

- Identify the different parts of a flower and understand their functions
- Classify different kinds of flower ovaries
- Know that flowers, particularly their ovaries, mature into fruits
- Understand the role of flowers and fruits in plant reproduction
- Classify fruits upon their seed arrangement
- Hypothesize a flower that could have given origin to a specific fruit
- Hypothesize a fruit that could be originated by a given flower

Background Information

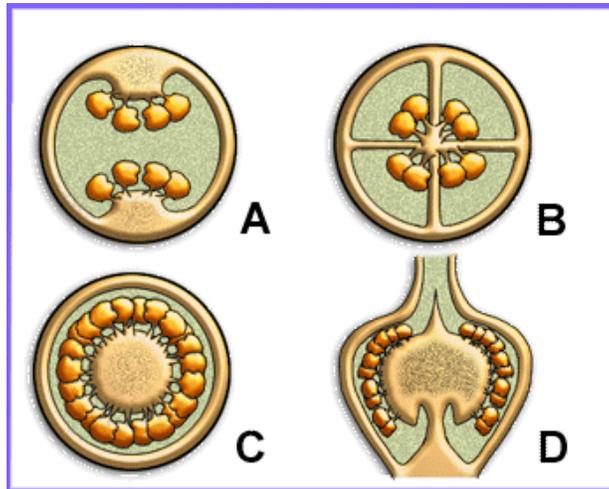
Many of the plants we see everyday belong to the class of *Angiospermae*, or flowering plants, which produce seeds enclosed in an ovary. Flowers are the plant organs involved in sexual reproduction, as they contain the gametes that will fuse to originate a new plant.

If the plant is female, the gamete is called the ovule, which is fertilized by the male gametes present in pollen. Ovules are stored in the flower ovary, which is part of the flower pistil or female organ (see *Go Wild in New York City*, page 42). One flower can have one or more pistils (and therefore, one or more ovaries) and sometimes the pistils are fused. On the other hand, pollen, which contains the male gametes, is stored in the flower anthers. The transfer of the male gamete to the female gamete, called pollination, is accomplished by wind, insects or birds. Many flowers have evolved to attract a particular type of pollinator, which explains why they have developed such a variety of fragrances and colors.

When the ovule is fertilized by the male gamete a process that ends in the transformation of the flower into a fruit begins. In a strict sense, it is the flower ovary that matures into the fruit, although other parts of the flower, such as the sepals, can also become part of it. Fertilized ovules become seeds that will generate a new plant if they find the suitable conditions to grow.

Flower ovaries may consist of one or more chambers or locules in which ovules are located. The **number of compartments** of an ovary is a criterion used for taxonomic purposes, and ovaries can be classified as having one (**unilocular**) or several (**multilocular**) compartments.

In addition, the area of the ovary wall where the ovules are attached is called the placenta. The arrangement of the placenta (so-called the **placentation**) varies in different species and thus constitutes another taxonomic feature. When the ovules are positioned on the outer wall of the ovary it is called **parietal** placentation (A) (the word parietal comes from the Latin word for wall). If the ovules are placed in the angles between chambers, something that often occurs in ovaries with multiple compartments, it is called **axial** placentation (B). And finally, if they are located in the center of the ovary, it is called **central** placentation (C and D).



In most cases, the ovary placentation is preserved in the fruit. In this activity, students will learn to classify fruits and flowers using both the placentation and the number of chambers taxonomic criteria.

Development of the activity

1. Warming-up

As an introduction to this activity, discuss with students the following questions:

- Why do plants have flowers?
- Do all plants have flowers?
- Why do many flowers have bright colors or nice fragrances?
- Where do fruits come from?
- What is the role of the fruit in a plant?

After discussing with students what they know about flowers and fruits, the teacher will give a short introduction of plant reproduction to start the activity with clear concepts of what the roles of flowers and fruits are in plant reproduction. The teacher must explain that after pollination, flowers mature into fruits, and talk about the evolution of

colors and smells in flowers as an adaptation for pollination. It should also be discussed the role of animal consumers in scattering the seeds inside the fruits after they digest them, and the evolution of fruits in order to be attractive and nutritive for animals in order to maximize seed dispersion.

Students will then conduct the activity in small groups. Prepare in advance the following list of materials:

2. Materials (per group of students):

- About 7 flowers of different kinds (make sure that they have female organs), such as lily, carnation, iris, sunflower, geranium, etc.
- About 7 fruits of different kinds, both fleshy and dry, such as avocado, orange, lemon, walnut, plumb, peach, apple, cucumber, etc.
- 2 knives to cut the fruits
- 1 razor blade to cut the flowers
- Newspaper
- Students' journals

3. Classifying flowers

Show students a picture of the typical flower structure (see *Go Wild in New York City*, page 42) and ask them to identify the basic organs of their flowers, including the petals, anthers (if they have), stigma, style, ovary and sepals. Ask them to choose one of their flowers and draw it on their journals, labeling the different organs on their drawing.

Draw the different kinds of ovaries shown in the figure above and explain students the two taxonomic criteria discussed in the Background Information section (i.e. the number of ovary compartments and the type of placentation). Then, tell students to cover their tables with newspaper and cut all their flower ovaries in halves, in order to see their number of locules and placentation.

Ask students to observe all their flower ovaries carefully. How many ovaries does the flower they are observing have? How many chambers do the ovaries contain? What kind of placentation do they have? Students will complete the tables below on their journals, providing examples of the flowers they have observed (we provide here some possible examples).

Type of ovary (number of compartments)	Examples
Unilocular	Sunflower
Multilocular	Geranium, lily

Type of placentation	Examples
Parietal	Passion flower, violet
Axial	Iris, lily, tulip, geranium
Central	Carnation, primrose
Other (draw it!)	

4. *Classifying fruits*

Ask students to cut their fruits in halves in order to observe the position of the seeds. How many compartments can they observe? Where are the seeds located? Students will complete the tables below, as they did before, providing examples of the fruits they observed (some examples are provided here).

Number of compartments	Examples
One	Avocado, walnut, plumb, peach
Multiple	Apple, orange, tomato

Position of seeds	Examples
Parietal	Cucumber, papaya, melon
Axial	Orange, lemon, tomato
Central	Avocado, walnut, plumb, peach
Other (draw it!)	

5. Finding the flower inside the fruit

After having classified the flowers and fruits, ask students to select one flower and draw it on the table below (Flower 1). Then, tell them to imagine, based on its ovary anatomy, the kind of fruit that their chosen flower could mature into, and draw it on the table as well (Fruit 1). Along the same line, ask them to choose a fruit, draw it (Fruit 2) and imagine and draw what kind of flower might have generated it, drawing it on the table (Flower 2).

Flower 1	Fruit 1
Flower 2	Fruit 2

After that, ask students to look for information, either using the Internet or in the school library, about the actual fruit derived from flower 1 and the actual flower that originated fruit 2. This can be done as homework. As a way of summative assessment, ask students to compare their proposed flower and fruit with the real ones and identify the similarities and differences. Finally, ask them to propose a pollinator (either the wind, an insect or a bird) for Flower 1 and to suggest an animal that might disperse the seeds of Fruit 2 and explain the reasons for their choice.

Assessment

This project provides various opportunities to assess students' learning (see Learning Goals) in formative and summative ways. Student's skills and conceptual understanding can be assessed through:

-Students' participation in the initial discussion (formative)

- Students' performance in the flower and fruit classification activity (formative)
- Students' flower and fruit classification on their journals (summative)
- Students' hypothesized flower and fruit drew on their journals (summative)
- Students' homework research regarding the actual flower and fruit related to the ones they observed (summative)

Extensions

As an extension of this activity, ask students to classify the fruits they eat everyday according to the criteria they learned, and do the same for the flowers they can find in the local stores or in the parks close to their homes.

As proposed in the “Bringing Students Resources to the Science Classroom” section, Students can also research which of the vegetables they usually eat are fruits, and classify the vegetables on their diets in fruits or other parts of the plants such as stems, leaves or roots (see Go Wild in New York City, page 45).

Finally, students can research the best conditions to plant the seeds of some of the fruits they have observed and grow the ones that are suitable for the classroom (see page 39 for an example of how to grow an avocado tree).

Connection to New York City Standards

This activity addresses the following NYC Performance Standards for Middle School Science:

S2a Life Science Concepts: The student produces evidence that demonstrates understanding of structure and function on living systems

S5b, c and f Scientific Thinking: The student:

- b. Uses concepts from Science Standards 1 to 4 to explain a variety of observations and phenomena
- c. Uses evidence from reliable sources to develop descriptions, explanations and models
- f. Works individually and in teams to collect and share information and ideas

S6b and d Scientific Tools and Technologies: The student:

- b. Records and storage data using a variety of formats
- d. Acquires information of multiple sources

S7a, b and f Scientific Communication: The student:

- a. Represents data and results in multiple ways
- b. Argues from evidence
- f. Communicates in a form suited to the purpose and the audience