Understanding Plant Reproduction, Hybridization, and the Effects of Biotechnology on World Population Growth

Lesson Introduction

For thousands of years, farmers and gardeners have used forced breeding techniques to create plants that contain desirable characteristics. This form of plant hybridization gradually developed into more sophisticated methods of hybrid plant breeding. Breeders today follow complicated methods of cross-pollination to create vigorous crops. New methods in biotechnology have also contributed to the formation of higher yielding, herbicide tolerant, insect resistant, and vitamin-enhanced foods. It is important for students to be knowledgeable about the process of plant hybridization and the advances in genetically modified foods.

Grades: 6-8
Time Needed: Three, 45-min class periods

Learning Objectives:

After completing this lesson, students will be able to:

1. Identify the structures and functions of the reproductive parts of a common flower
2. Identify the structures and functions of the reproductive parts of a corn plant
3. Compare and contrast the structures and functions of the reproductive parts of a flower versus a corn plant
4. Explain plant hybridization
5. Identify crops that use hybrid seeds
6. Explain the benefits of creating genetically modified foods

Next Generation Science Standards (NGSS)

As a result of activities in grades 6 - 8, all students should develop:

Topics

- **LS1**: Structure, Function & Information Processing
- **LS5**: Natural Selection & Adaptations

Performance Expectations

- **MS-LS1-4:** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- **MS-LS4-5:** Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.

Dimensions

Practices:

- Constructing Explanations & Designing Solutions
- Obtaining, Evaluating, & Communicating Information

Disciplinary Core Ideas:

- **LS1.B:** Growth & Development of Organisms
- **LS4.B:** Natural Selection

Cross-Cutting Concepts:

- Patterns

Connections to Engineering, Technology & Applications to Science

- Influence of Science, Engineering, and Technology on Society and the Natural World

Materials:

- ☐ Fresh flowers (1 per group of 2 students)
- ☐ Styrofoam meat trays (1 per group)
- ☐ Hand lenses (1 per group)
- ☐ 11” X 17” white paper (1 per group)
- ☐ Clear tape
- ☐ Dissection probes (1 per group)
- ☐ Dissection scissors (1 per group)
- ☐ Forceps (1 per group)
- ☐ Metric ruler (1 per group)
- ☐ Student handouts (3)

Instructional Process

Day 1

1. Obtain supplies for the flower dissection activity. Be sure to have enough flowers for groups of two.
2. Make copies of the Student Handouts (3). Distribute to students the Flowering Plant Dissection Handout to students.
3. Verbally walk through the dissection activity and explain how to set up the **flower whorl** using a diagram on the white board. Highlight the need to follow directions carefully.
4. Have students complete the lab activity and answer the discussion questions.

Day 2

1. Go over discussion questions from ***Day 1 Flower Dissection Activity***.
2. Have students complete a quick quiz entitled “How much do you know?” using a pen.
3. Present the PowerPoint entitled ***Corn: It’s Amaizing!*** Students will receive information regarding the importance of corn, products made from corn, the reproductive structures and functions of corn, and the hybridization of corn.
4. Have students retake the same quiz worksheet using a pencil. Discuss the answers as a class.

Day 3

1. Allow students to view the GetBiotechSmart.com course online in the computer lab entitled ***The Value of Biotechnology*** to acquire additional information on advances in creating genetically modified foods.
2. Have students complete ***Follow-Up Questions***.
3. Go over Follow-up questions as a class.

Sources

Flower dissection lab adapted from the following site:

http://www.battaly.com/science/flowerlab_no.htm

Images:

http://images.paraorkut.com/img/clipart/images/f/forth_of_july_firecracker-697.gif
http://www.infobarrel.com/media/image/8270.jpg
http://www.theintellectualdevotional.com/blog/wp-content/uploads/2011/01/toothpaste-1.jpg
http://www.google.com/imgres?q=fuel+alcohol+from+corn&um=1&hl=en&sa=G&rlz=1R2ACAW_enUS378&tbm=isch&tbnid=B88jvDvJcLZuDM:&imgrefurl=http://econintersect.com/b2evolution/blog1.php/2011/08/04/ethanol-corrodes-gas-pipelines&docid=TfyQmjRWFA_8PM&w=343&h=400&ei=m5BaTvz2HfCksQLs3JDSDA&zoom=1&iact=hc&vpx=135&vpy=61&dur=79&hovh=242&hovw=208&tx=105&ty=142&page=1&tbnh=125&tbnw=114&start=0&ndsp=15&ved=1t:429,r:0,s:0&biw=1024&bih=524
http://thestarvingtransman.files.wordpress.com/2011/08/istock_photo_of_corn_chex_cereal1.jpeg
http://www.shaneeubanks.com/images/016_flower.jpg
http://bioweb.uwlax.edu/bio203/s2008/knudsen_ashl/Images/corn%20tassel.jpg
http://www.minnesotaorganic.com/images/thumbs/0000188.jpg
http://www.cotton-bales.com/Bales%20of%20Cotton.jpg
http://www.birdsong-peanuts.com/images/peanuts.jpg
http://www.trishabird.com/wp-content/uploads/2011/07/wheat.gif

Resources:

http://www.ehow.com/list_7682906_different-parts-corn-plant.html
http://www.livinghistoryfarm.org/farminginthe30s/crops_03.html
http://www.cornfarmerscoalition.org/press-room/faq/so-corn-is-a-hugely-important-crop-why-didnt-i-know-this-until-now/
http://www.ontariocorn.org/classroom/products.html#Products that use Corn
http://getbiotechsmart.com/student/elearning-course

Plant Reproduction and Hybridization Student Sheet

Introduction

Plant hybridization, or the process where plant species are crossed to create desirable characteristics in new plants, has been going on for thousands for years. As plant hybridization has become more specialized, alternative forms of biotechnology have developed to create higher yielding, more nutritious food products for humans and animal consumption. In order to make informed decisions about the new science and technology behind genetically modified foods, it is important to understand the process of plant hybridization and other procedures that create genetically modified foods.

Materials:

- ☐ Fresh flowers (1 per group of 2 students)
- ☐ Styrofoam or meat trays (1 per group)
- ☐ Hand lenses (1 per group)
- ☐ 11” X 17” white paper (1 per group)
- ☐ Clear tape
- ☐ Dissection probes (1 per group)
- ☐ Dissection scissors (1 per group)
- ☐ Forceps (1 per group)
- ☐ Metric ruler (1 per group)
- ☐ Student handouts (3)

Procedure:

Day 1

1. Read the Background information and Procedure on the Flowering Plant Dissection Activity Sheet.
2. Follow your teacher's directions on the activity including how to create a Flower Whorl.
3. Collect supplies for the activity.
4. Follow directions on the activity sheet, making sure to complete the Flower Dissection Data Table.
5. Once complete, view the Flower Whorls of other groups in your class and answer the Follow-Up Questions.

Day 2

1. Students will discuss the Follow-up Questions from the flowering plant dissection as a class.
2. Students will take the short "How much do you know?" quiz.
3. Students will view the PowerPoint entitled "Corn: It's Amaizing!"
4. Students will retake the "How much do you know?" quiz and a class discussion will follow.

Day 3

1. Students will work in the computer lab on the short course entitled *The Value of Biotechnology.* Here is the link: http://getbiotechsmart.com/student/elearning-course
2. Students will take the Post Assessment
3. Students will answer the Follow-up Questions.
4. Students will discuss the Follow-up Questions as a class.

Flowering Plant Dissection

Background Information

Angiosperms are seed-bearing plants that produce flowers. The seeds, which contain the plant embryo, are produced in the flower. All the parts of a flower are actually modified leaves that are specialized for their roles in the reproductive process. Flower parts are arranged in circles called **whorls**. They are attached at the enlarged base of the flower, the **receptacle**.

Flower structures can be divided into two groups: the essential organs and the accessory organs. The **essential organs** are the reproductive structures, which include the **stamens** (male) and the **pistils** (female). The **accessory organs** are the **sepals** and **petals**, which surround and protect the essential organs.

The **stamen** is the male reproductive organ and consists of two parts: the anther and the filament. The **anther** is the enlarged structure at the top of the stamen. Inside the anther are **pollen sacs**. Special cells within the pollen sacs undergo meiosis to form **pollen grains**. Each pollen grain contains two **sperm nuclei**. When the pollen grains mature, the pollen sacs split open to release the dust-like **pollen**. The **filament** is a thin stalk that supports the anther.

The **pistil** is the female reproductive organ and consists of three parts: the stigma, style, and ovary. The **stigma** is an enlarged portion at the top of the pistil that becomes moist and sticky when mature. The **style** is the middle portion of the pistil. It can be long and slender, short, or even absent, depending upon the species. The **ovary** is the enlarged structure at the bottom of the pistil. The ovary contains one or more hollow compartments called **locules**. Each locule contains one or more **ovules**. Special cells within the ovule undergo meiosis to form **ova (eggs)** containing **egg nuclei**.

Pollination occurs when pollen grains land on the sticky surface of the stigma and are trapped there. The pollen grain germinates and a **pollen tube** emerges from the grain. It releases special enzymes that digest a cell the wall on the surface of the stigma. The pollen tube grows down through the style to the ovary and enters the ovule, making a continuous passageway for the two sperm nuclei to enter the ovum. **Fertilization** occurs when the sperm nuclei join the egg nuclei.

The fertilized egg becomes an **embryo**. The wall of the ovule thickens and forms a **seed**, thus enclosing and protecting the embryo. The ovary wall also thickens and develops into a **fruit**. In some plants such as apples, the ovary walls become fleshy and contain stored sugars and starches. In other plants such as walnuts, the ovary walls become dry and hard.

Purpose

1. To study the structure of a typical flower.
2. To study the male and female reproductive organs needed for sexual reproduction in flowering plants.

Materials

- ☐ Fresh flower(s)
- ☐ Hand lens
- ☐ Plain paper
- ☐ Dissecting needle
- ☐ Dissection scissors
- ☐ Forceps
- ☐ Ruler
- ☐ Clear tape

Procedure

1. As you examine your flower, you will be carefully removing parts beginning with the outer whorl and working your way in towards the pistil. You will arrange each whorl in a circle on the plain paper, beginning with the sepals as the largest outermost circle. As you proceed with your dissection, you will carefully tape each whorl of flower parts into position and label them (please use pencil!). As each whorl is observed and removed, answer the questions from each procedure step in the **Observations** column of the chart. Use the **Background Information** and information given in the procedure to complete the **Function** column of the chart.

2. The **sepals** form the outermost whorl of the flower. The sepals are leaf-like structures that are usually green in color. Sometimes, the sepals are the same color as the petals, or appear to be another set of petals of a different color. The function of the sepals is to protect the inner part of the flower before it blossoms. **Gently remove the sepals**, tape them into position onto the paper, and label them. **On the chart,** record the following **observations**:
    a) How many sepals does your flower have?
    b) Describe the appearance of the sepals (color, markings, etc.).

3. The petals are found directly under the sepals. The color and odor of the petals help to attract birds and insects to the flower for pollination. **Gently remove the petals**, tape them into position onto the paper, and label them. **On the chart,** record the following observations:
    a) How many petals does your flower have?
    b) Describe the appearance of the petals (color, markings, etc.).

4. The stalk-like structures inside the petals are the **stamens**, the male reproductive organs. Depending on the species, the stamens may be attached to the receptacle, to the petals, or to the pistil. The enlarged portion at the top of the stamen is the **anther**. Inside the anther are **pollen sacs**, which produce pollen grains. When the **pollen grains** mature, the pollen sacs split open, releasing the dust like pollen grains. The filament is the thin structure that supports the anther. **Gently remove the stamens**, tape them into position onto the paper, and label them. **On the chart,** record the following observations:
    a) How many stamens does your flower have?
    b) To which structure(s) were the filaments attached?
    c) Have the pollen sacs opened? How can you tell?
    d) If pollen grains are visible, describe their appearance.

5. The central structure of the flower is the female reproductive organ, the **pistil**. The top of the pistil is the **stigma**. When mature, the stigma is enlarged and its surface is moist and sticky. The **style** is the middle portion of the pistil. It supports the sigma. Some flowers lack a style. The **ovary** is the enlarged structure at the bottom of the pistil. The ovary contains one or more hollow compartments known as **locules**. The locules contain **ovules**, which in turn, contain the **egg nuclei**. **Carefully remove the pistil** by cutting it from the stem just under the ovary. Using pencil, **make a life-sized sketch of the entire pistil** (just the outline) in the center of the plain paper and label it. **Cut** the style just at the top of the ovary, **tape** it next to your sketch, and **label the stigma and style**. Using the ruler, **measure the length of the style** in millimeters. **Cut a thin cross-wise section of the ovary** and **tape** it under the stigma and style. **On the chart,** record the following **observations**:
    a) What color is the pistil?
    b) Describe the appearance of the stigma. Is the stigma mature? How can you tell?
    c) How long is the style (in mm)?
    d) Describe the appearance of the ovary.

6. Check to make sure of the following:
    a) All flower parts are correctly taped in place.
    b) All flower parts are labeled correctly (in pencil).
    c) The pistil is drawn on the paper (in pencil).
    d) Your name(s) and class period are written on the paper.
    e) The **Observations** and **Functions** columns of your chart are complete.

Flower Dissection Data Table

Structure	Function	Observations
Receptacle		
Sepals		2a) _____ 2b)
Petals		3a) _____ 3b)
Stamens		4a) _____
Filament		4b) _____
Anther		4c)
Pollen grains		4d)

Pistil		5a) _____
Stigma		5b)
Style		5c) _____
Ovary		5d)
Locule		
Ovule		

Flowering Plant Dissection

Follow-up Questions:

1. What is the purpose of flower petals? Why are they so colorful?

2. Examine the *whorl diagrams* of each group. Why do you think the reproductive structures of each flower look different in each species of flowers?

3. How are the anthers and pollen grains adapted for distributing pollen?

4. How is the stigma adapted for capturing pollen?

5. There are a few different ways that pollen can be brought to the pistil including the following: insects, wind, birds, animals and water. Which do you think pollinates *your* flower and why?

6. Describe how plant fertilization occurs.

7. What part of the flower becomes the seed? What part of the flower becomes the fruit?

How much do you know?

_____1. True or False. Wheat is the most important economic crop in the United States.

____2. True or False. Corn has always looked the same as it does now.

_____3. True or False. Fireworks are made from corn.

_____4. True or False. Biotechnology can add nutrients to crops.

_____ 5. True or False. Wheat, soybeans, and corn have been genetically altered through biotechnology.

The Value of Biotechnology

Follow-up Questions

1. What impact does a growing population have on…
   a. human health?

   b. the environment?

   c. food production?

2. What is biotechnology?

3. How can biotechnology assist in reducing the impact of human population growth?