Agricultural Lesson Plan

LESSON PLAN :	HORTICULTURE

Lesson Title:	APPLE GENETICS: A TASTY PHENOMENA		
Grades:	6-8	Lesson Duration:	60 minutes

Lesson Objectives:

Using the context of apples, students will apply their knowledge of heredity and genetics to distinguish between sexual and asexual reproduction as they explain how new varieties of apples are developed and then propagated to meet consumer demand for a tasty, uniform, consistent product..

Standards:

a. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

MS-LS4 Biological Evolution: Unity and Diversity

- MS-LS4-4
- MS-LS4-5

MS-PS1: Matter and Its Interactions

- MS-PS1-2

Materials / Equipment:

Activity 1:

 Apple Genetics PowerPoint(https://naitc-api.usu.edu/media/uploads/2018/12/17/Powerpoint_-_Apple_Genetics.pptx)

 Apple Genetics worksheet, 1 per student (https://naitc-api.usu.edu/media/uploads/2018/12/14/Apple_Genetics_worksheet.pdf)

Apple Genetics Teacher Key (https://naitc-api.usu.edu/media/uploads/2018/12/17/Teachers_Notes_-_Apple_Genetics.pdf)

 Per group of students:

- 1 Paper Plate
- 1 Whole Braeburn Apple
- 1 Whole Royal Gala Apple
- 1 Whole Jazz Apple
- 1 Knife (or apple slicer to cut apple)

Activity 2:

 Apple - How Does it Grow? video (https://www.youtube.com/watch?v=UWLmEh1HIBw)

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Summary of Tasks / Actions:

Vocabulary

Punnet Square: a diagram used to predict an outcome of a particular cross or breeding experiment

allele: a variant of a gene

dominant allele: an allele whose trait always shows up in the organism when the allele is present (written as uppercase letter)

gene: a section of DNA that codes for a certain trait

genotype: an organism's genetic makeup or allele combinations

heredity: the passing of traits from parents to offspring

heterozygous: having 2 different alleles for a trait.

homozygous: having two identical alleles for a trait.

phenotype: an organism's physical appearance or visible trait

probability: a number that describes how likely it is that an event will occur

recessive allele: an allele that is masked when a dominant allele is present (written as lower case letter)

trait: a characteristic that an organism can pass on to its offspring through its genes

Did you know? (Ag Facts)

- Apples are a member of the rose family.1
- More than 2,500 varieties of apples are grown in the United States, but only the crabapple is native to North America.1
- The average person eats 65 apples per year.1
- Apples are 25% air, which is why they float in water.1

Background Agricultural Connections

This lesson can be nested into a storyline as an episode exploring the phenomena of taste and other characteristics that can be observed in apples. In this episode, students investigate the question, "What makes apple characteristics different?" Phenomena-based lessons include storylines which emerge based upon student questions. Other lesson plans in the National Agricultural Literacy Curriculum Matrix may be used as episodes to investigate student questions needing science-based explanations. For more information about phenomena storylines visit nextgenstorylines.org.

Prior to this lesson, students should have a basic understanding of inherited traits and know that all cells of an organism have DNA. DNA is the blueprint providing the organism with coded instructions for proper function and development. Students should also know that genes are sections of DNA that are responsible for passing specific traits from parent to offspring. Students will need to be familiar with vocabulary such as phenotype, genotype, homozygous, and heterozygous to successfully complete the lesson and student worksheet and determine probabilities associated with possible offspring using a Punnett Square. Students will be introduced to several varieties of apples and discover how new varieties can be created through crossbreeding.

Key STEM Ideas

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Genetics is the study of heredity, while heredity is the passing of traits from parents to offspring. This lesson will help solidify key genetics vocabulary words.

The main idea of this lesson is to show the application of genetic crossing for the benefit of agriculture by producing apples with a variety of traits.

Gregor Mendel was a priest who worked with the genetic crossing of pea plants. He would cross purebred short pea plants with purebred tall pea plants. Through his experiments he determined that some traits were visible in the plant (dominant traits) while others were not, but were still able to be passed on to future generations (recessive traits). Understanding what we see and what the genetic makeup of an organism is can be quite different. When you look at an organism, its physical characteristics are all dependent on a specific allele combination. This is the difference between phenotype and genotype. Students will use Punnett Squares in this lesson to help determine all the possible allele combinations in a genetic cross and their probabilities.

Crossbreeding allows breeders to create better quality apples by incorporating traits from two parent plants into the seeds of a new generation of plants. Breeders must understand both genotypes and phenotypes to accomplish this task. Breeders must also decide which traits are desirable and should be selected. This is an intensive process that involves breeding successive generations of apples with the preferred traits in order to get the final product. There are several crop modification techniques breeders use to develop new plant/fruit varieties.

Connections to Agriculture

Apples are an important agricultural crop. There are about 7,500 apple producers in the United States. Washington, New York, and Michigan are the leaders in apple production. Growers produce a variety of different kinds of apples. Some apples are better for baking while others are typically consumed fresh. Apples are a good snack choice as they satiate hunger, contain no fat and relatively few calories while being high in fiber and vitamin C.

Apples are grown through a process called grafting rather than being grown from seed. This is done because most apple varieties are self-unfruitful, which means their blossoms must be fertilized with the pollen of a separate variety in order to produce fruit. The fruit has traits from the parent tree, but the seeds inside will be a cross of the two varieties. This mixture of genetic material in the seeds means the grower won't know what traits a tree grown from these seeds will have and what the resulting fruit will taste like.

To avoid this uncertainty apple growers do not grow new trees from seed. Instead, new apple trees are propagated through a process called grafting. In this process a special cut is made into the rootstock of a tree. Then, they graft or transplant a section of a stem with leaf buds called a scion from a variety that has desirable traits into the cut. In time the two pieces fuse together allowing for growth of the scion. Eventually, blossoms on the scion will be pollinated and will produce a consistent variety of fruit with the desired traits. For more information and pictures of the grafting process, please visit the website Apple Tree Propagation: Grafting.

The goal of apple breeding is to continuously produce quality apples with desirable traits. Cross breeding and genetic engineering are two methods that have allowed breeders to produce better quality apples. See Crop Modification Techniques)

Interest Approach – Engagement

This lesson has been adapted for online instruction and can be found on the 6-8th grade eLearning site.

1. Ask students to think about their favorite apple. Ask them why that variety is their favorite. Ask them why they think a green Granny Smith apple is so tart/sour? This should lead to a discussion about various apple traits such as sweetness, tartness, flavors, crunchiness, color, etc.

2. Tell students that there are thousands of varieties of apples grown in the United States. Most of the varieties will not be familiar to them because they are only found in orchards grown for research, the development of new apple varieties, or hobby orchards. Challenge students to try to list the top 10 apple varieties in the United States. These varieties are more likely to be familiar to your students in addition to other local varieties.

3. Ask students if they know how these different apple varieties became available.

4. Ask your students to use their understanding of heredity and genetics to explain how apple varieties could be developed. Use student responses to transition to Activity 1.

Procedures

This lesson investigates the phenomenon of apple taste along with other observed apple characteristics. Natural phenomena are observable events that occur in the universe that we can use our science knowledge to explain or predict.

Phenomenon-Based Episode: What makes apple varieties different?

Disciplinary Core Ideas: Growth and Development of Organisms

Question Science and Engineering Practices Student Engagement in Practices Explanation

1. How do apple characteristics differ? □ Planning and Carrying Out Investigations Students carry out investigations to compare the Braeburn, Royal Gala, and Jazz apples. Students ask and refine questions that lead to descriptions and explanations about the different traits found in apples such as color, taste, texture, and size. The traits found in apple varieties are determined by their genetic makeup, or genotype. Heritable traits are passed from parent to offspring.

2. How are new varieties of apples created? □ Asking Questions and Defining Problems Students use science to ask and refine questions that lead to explanations about the process of selectively breeding apples to produce new apple varieties with desirable traits. Apple breeders cross pollinate the flowers of specific apple varieties (sexual propagation) and then plant the seeds to obtain a tree and apples genetically different than the parent trees. It takes hundreds or even thousands of crosses, to find the desirable result.

3. What makes every apple of a given variety taste and look the same? □ Constructing Explanations and Designing Solutions Students can use science to explain that forms of asexual propagation produce genetically identical offspring. In contrast to apple breeders, apple farmers use grafting to produce new apple trees. This form of asexual plant propagation allows the genetics of each variety of apple to be exact clones, therefore producing a consistent crop of apples for consumers.

Activity 1: Apple Genetics - Making them Different (Episode Questions 1 and 2)

1. Give each student one copy of the Apple Genetics worksheet. Divide the class into small groups of students (2-4).

2. Give each group of students the following supplies:

- 1 paper plate (this will be the cutting board as well as an area to keep the apples)
- 1 Braeburn Apple
- 1 Royal Gala Apple (Note: DO NOT hand out the Jazz apple yet).
- 1 knife (or pre-slice apples)

3. Have students draw a line down the center of their paper plate and label each side with "Gala" or "Braeburn." The apples will look similar, so it will be important to avoid confusing the two apples.

4. Have students complete "Part 1" and "Part 2" of the worksheet and then stop.

5. Project the Apple Genetics PowerPoint for students to see. Using slide 2, hold a brief class discussion about the traits they have observed in the apples so far. Draw on the student's prior knowledge of heredity and genetics to conclude that each trait is an expression of its genotype.

6. Use slide 3 of the PowerPoint to review vocabulary if needed. Make sure students are familiar with the terms.

7. Have students complete "Part 3" of the worksheet to review the possible genotypes of the Gala and Braeburn apples. These genotypes can be found on the worksheet and slide 4-5 of the PowerPoint.

8. Once students have finished their Punnet squares, give each group of students a Jazz apple. Students will follow the same procedure and complete "Part 4" and "Part 5" of the worksheet.

9. Facilitate a class discussion about the 3 varieties of apple (slide 6). Reveal to the students that the Jazz apple is a cross between the Gala and Braeburn apple. Using slide 7, share a few more facts about the Jazz Apple.

10. Talk about the concept of crossbreeding and how it is used to produce better quality organisms (slide 8).

11. Explain that the Honeycrisp apple (slide 9) was also developed by crossbreeding, and is a competitor of the Jazz apple.

12. Summarize with students by connecting what they know about genetics with what they have learned about apples:

- Genes determine genetic traits found in apples such as color, taste, and texture.
- To develop a new, improved variety of apple, apple breeders cross pollinate apple varieties. This form of sexual reproduction results in an offspring (seed) that is genetically different from the parent trees.
- Scientists use a knowledge of genetics and heredity to cross breed apples and produce new varieties of apples. The Jazz and Honeycrisp apples are examples.

Three Dimensional Learning Proficiency: Crosscutting Concepts

Students engage in scientific investigation as they investigate and build models and theories about the natural world.

Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

Activity 2: Apple Genetics - Keeping Them the Same (Episode Question 3)

1. Ask students if they have ever eaten Jelly Belly jelly beans. Have they ever eaten or heard of the Jelly Belly jelly beans that have "bad" flavors like toothpaste, stinkbug, or stinky socks? (Perhaps in the game Beanboozled.) While this may be a fun game or practical joke, have a discussion with your students about what they (as consumers) want in their food. Conclude that every time they purchase milk, meat, bread, vegetables... or an apple, they want it to taste consistently the same without surprises.

2. Students have just learned how new varieties of apples are created. Ask, "How do apple farmers all across the nation grow specific varieties of apple that all taste and look the same? For example, how does a Granny Smith always taste like a Granny Smith and a Gala always taste like a Gala?" Does a [Granny Smith] grown in one region of the country taste the same as a [Granny Smith] grown in another region of the country?

3. To discover the answer, show Apple - How Does it Grow?

1. From the video, students should recognize grafting as the answer to the question. Apple farmers do not grow trees from seed, they use a technique called grafting (slide 10).

2. Ask students, "What is the genetic similarity of two trees grafted from the same source?" (They are genetically identical clones. Therefore, every apple tree grafted from the same source will produce apples with the same genetic makeup.)

3. Summarize with students by connecting what they know about genetics with what they have just learned about apples:

- Grafting, a form of asexual propagation is used by apple farmers to produce the apples we eat. It produces apples consistent to consumer expectations for each variety of apple by eliminating the genetic variability of sexual propagation methods.

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In addition to growing a consistent apple crop, farmers use grafting to propagate apple trees because it is significantly faster than growing a tree from seed. An apple tree grown from seed will take 6-10 years to produce fruit. A grafted apple tree will take 2-3 years depending on the type and size of the graft.

Concept Elaboration and Evaluation:

After completing these activities, have students create a Venn Diagram to list both the similarities and differences found in sexual and asexual propagation methods. Discuss the benefits and drawbacks of each.

Phenomena Episode Extensions:

Effective phenomena-based instruction continues to evolve as students learn. New questions should arise throughout the learning process. The following questions may arise providing opportunity for other episodes in this storyline:

- Why can other fruits and vegetables be propagated with sexual reproduction (seeds) and produce a consistent crop, but apples cannot?
- What makes an apple (such as the Honeycrisp) crunchy?
- How was the Opal apple selectively bred to not brown after it is cut?
- How was the Arctic® apple genetically engineered to be non-browning?

Follow up /References

https://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=490

Activity 1 was originally written in the lesson "Apple Genetics" written by Kevin Atterberg (Culler Middle School, Lincoln NE), Erin Ingram, and Molly Brandt (University of Nebraska-Lincoln, IANR Science Literacy Initiative). The lesson was updated in 2018 to follow a phenomena-based format.

Phenomenon chart adapted from work by Susan German.

German, S. (2017, December). Creating conceptual storylines. Science Scope, 41(4), 26-28.

German, S. (2018, January). The steps of a conceptual storyline. Science Scope, 41(5), 32-34.

Agricultural Lesson Plan

LESSON PLAN :	HORTICULTURE

Lesson Title:	FLOWER POWER		
Grades:	6-8	Lesson Duration:	Two 40 minute sessions

Lesson Objectives:

Students will observe the anatomical structures of flowers and explain a flower's role in plant growth and reproduction as well as their connection to our food supply..

Standards:

a. MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

b. MS-LS2-E-3 Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

Within SCIENCE

MS-LS1 From Molecules to Organisms: Structures and Processes

- MS-LS1-4

MS-LS3 Heredity: Inheritance and Variations of Traits

- MS-LS3-2

Materials / Equipment:

Interest Approach:

 Fruit Development video clip(https://www.youtube.com/watch?v=bwCpQflmQG4)

Activity 1:

 Flower Power: Anatomy and Function handout, 1 per student (https://naitc-api.usu.edu/media/uploads/2020/02/10/Flower_Power-_Anatomy__Function.pdf)

 Flower Dissection Lab handout, 1 per student (https://www.youtube.com/watch?v=LU_KD1enR3Q)

 Flower Anatomy PowerPoint(https://naitc-api.usu.edu/media/uploads/2015/05/07/Origami_flower_instructions.pptx)

 Cut flowers, 1 per student

• Contact a local florist and ask if they have some old flowers they will be discarding; look for flowers that exhibit easily identifiable parts. Carnations are recommended.)

 Clear tape

Activity 2:

- 6" x 6" colored origami paper,* 4–5 pieces of each color per student
- Green chenille stems (15 mm x 12"),* 1 per student
- White chenille stems (6 mm x 6"),* 1 per student
- Yellow chenille stems (6 mm x 6"),* 4 per student
- Green bump chenille stems (15 mm x 12"),* 1 per student
- Green tissue paper (3" x 3"),* 1 per student
- Yellow pony beads (6 mm x 9 mm),* 2 per student
- White pony beads (6 mm x 9 mm),* 5 per student
- Glue sticks
- Scissors
- Origami Flower Instructions PowerPoint

*These materials are included in the Origami Parts of a Flower Kit, which is available for purchase from agclassroomstore.com.

Activity 3:

- Pollination: Trading Food for Fertilization video (https://www.youtube.com/watch?v=LiczM-w3V-U)
- CUCUMBER | How Does it Grow? (https://www.youtube.com/watch?v=Ua1TbZAyqjc&list=PLv9GnIwtmHxAhT90iRqip49gGm7rNBCkU&index=3)

(Optional) Activity 4:

- What's the Waggle Dance? And Why Do Honeybees Do It? video
- 4–5 treat bags (treats selected at your discretion)
- Honey, I'd Love to Dance handout (https://www.youtube.com/watch?v=LU_KD1enR3Q)
- Written directions to each hidden treat bag

Vocabulary

pistil: female parts of a flower, including the stigma (where pollen lands), style (stalk-like part between stigma and ovary), and ovary (at the base, develops into the fruit and contains the seeds)

pollenizer: plant that provides pollen

pollinator: agent that moves pollen resulting in the pollination of flowers

stamen: male parts of a flower, including the anther (produces and contains pollen) and filament (stalk supporting the anther)

Summary of Tasks / Actions:

Did you know? (Ag Facts)

- About one-third of the total human diet is derived directly or indirectly from insect-pollinated plants.
- An estimated 80% of insect crop pollination is accomplished by honey bees.
- While pumpkins and other squash are self-pollinating, they are a bit unique. The flowers on these plants are considered "incomplete" because the flowers are either male or female. The pollen-bearing male flowers contribute the pollen to the female, fruit-bearing, flowers.

Background Agricultural Connections

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Gregor Mendel was a monk in the 1800s. His study of pea plants demonstrated how offspring inherit traits from parent plants. Sadly, no one seemed interested in Mendel's studies until around 1900, when three other scientists discovered similar evidence of inherited traits. Since then, researchers have continued to build on what Mendel discovered. The first activity in this lesson can serve as an introduction for teaching about inherited traits; students will dissect a flower to learn how plants reproduce, passing traits on to offspring through seeds.

To understand inherited traits in plants, you need to understand how seeds are produced. Seeds contain embryos that develop into plants. Before a plant can form a seed embryo, pollination and fertilization must occur in the flower. The reproductive organs of plants are found in the flower. The male parts of the flower include the filament, which looks like a stalk, and the anther at the top of the filament, which produces pollen grains. Pollination occurs when pollen from an anther is transferred to a stigma. The stigma is the female part of the flower that is specially developed to catch pollen grains. Below the stigma is the style. A pollen grain that has been caught by the stigma reaches down the style to fertilize the egg (or eggs) in the ovary. This fertilization process creates a seed (or seeds) inside the ovary. In most cases, the ovary then swells and becomes the fruit of the plant (e.g., cherries, avocados, apples, cucumbers).

Many flowers contain both male and female parts. Some plants can pollinate themselves; they are self-fertile. Other plants have chemical or physical barriers to self-pollination and need to be cross-pollinated. In cross-pollination, pollen is delivered to a flower of a different plant. Plants adapted to cross-pollinate usually have taller stamens (collective male parts) than pistils (collective female parts) to better spread pollen to other flowers. In self-pollination, pollen moves from the anther to the stigma of the same flower or to another flower on the same individual plant. The seeds from self-pollinated flowers produce plants that look like the parent plant. This isn't true with cross-pollination, which yields offspring of two different parents. The offspring of cross-pollinated plants may show some traits from both parents or may not resemble either parent.

Plants that cannot self-pollinate require a pollenizer—a separate plant to provide pollen. Even plants that can self-pollinate will often produce larger fruit and healthier offspring with a pollenizer. A good pollenizer is a plant of the same species that blooms at the same time as the plant to be pollinated and provides compatible, viable, and plentiful pollen. Peaches are considered self-fertile because fruit can be produced without cross-pollination, although cross-pollination usually produces a better crop. Apples are considered self-infertile; most apple trees will not form fruit without cross-pollination by an apple tree of a different variety. Pollination is critical for the production of many important agricultural crops, including corn, wheat, rice, apples, oranges, tomatoes, and squash.

In addition to planting the proper pollenizers for their crop, farmers must also consider whether their crops require a special pollinator. The terms pollenizer and pollinator are often confused—a pollenizer is a plant that provides pollen; a pollinator is an agent that moves pollen, whether it be wind, water, bees, bats, moths, or birds. Insects are among the most common pollinators.

Many flowers grow flashy petals and produce unique smells to attract insect pollinators to their rich supplies of pollen and/or nectar (sticky, sweet liquid on the end of the stigma). These flowers trade sweet nectar and protein-rich pollen in return for the pollination service that insects perform as they move from flower to flower. Insects don't just pollinate flowers for fun; most are collecting food.

Different insects are attracted to different types of flowers depending on color, scent, and size. Butterflies are attracted to orange, yellow, pink, and blue flowers that have large landing pads. Moths are active at night, requiring flowers that are open and provide nectar at night. Large, white flowers are particularly easy for moths to find in the dark. Honey bees see colors on the higher end of the human visual spectrum, including ultraviolet, which humans cannot see. Honey bees tend to prefer blue, purple, and yellow flowers that have sweet scents.

It's common to see bee boxes in orchards because honey bees are good pollinators for many fruit crops. Once a honey bee finds an abundant source of nectar and pollen, it will return to the hive and tell other bees how to locate that source by performing a dance. After a hive is placed in an orchard, it doesn't take long for a steady stream of busy bees to start buzzing from flower to flower. Honey bees have lots of little hairs on their bodies, and a furry bee moving around inside a flower picks up a lot of pollen. Some of this pollen will be brought back to the hive for food, but some will be deposited on the stigmas of other flowers that the bee visits, pollinating those flowers. In an orchard, lots of pollinated flowers will lead to lots of tasty fruit!

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Interest Approach – Engagement

1. Ask students to brainstorm the ways we use and rely on flowers each day. Make a list on the board. Allow students to offer their ideas using their background knowledge. (They will likely think of ornamental flowers used in flower arrangements or landscaping first.)

2. As a clue to add to their brainstorm, show the video clip, Fruit Development. Following the video, ask for another important way that we rely on flowers. (food!)

3. Ask students what other foods develop from flowers. (nearly all fruits and vegetables.) Conclude that many foods are developed from flowers on a plant. Explain to students that next they will be learning about the anatomy of a flower and the process of pollination.

Procedures

Activity 1: Flower Anatomy and Dissection

1. Explain that flowers contain the reproductive organs of [angiosperm] plants. Flowers produce the seeds that can be used to produce new plants.

2. Give each student one copy of the Flower Power: Anatomy and Function handout. Instruct students to read the first page and then describe in their own words each of the flower parts.

3. Project the Flower Anatomy PowerPoint and have students label their flower diagram found on the back of their worksheet.

4. Demonstrate a flower dissection to your students using the tips from the Flower Dissection Tutorial.

5. Following the demonstration, give each student one copy of the Flower Dissection Lab sheet, one flower to dissect, and access to clear tape. Instruct students to dissect their flower and place a sample of each anatomy part in the appropriate box on their lab sheet.

6. Discuss the following comprehension questions:

- If the flower is pollinated, can the seeds from the ovary be planted to grow more flowers? (Yes)
- Which three parts make up the pistil, or female flower parts? (Ovary, Style, and Stigma)
- Which two parts make up the stamen, or male flower parts? (Anther and Filament)
- What contains the genetic material from the male? (pollen)
- If the seeds from this flower were planted, would this be an example of sexual or asexual propagation? (sexual propagation)

Activity 2: Origami Flower Model

1. Explain to the students that they will be creating an origami flower to model the anatomy of a flower.

2. Follow the instructions on the Origami Flower PowerPoint to create the flower petals.

3. Each student should add the following parts to their flower:

- The white chenille stem represents the style. Use one yellow pony bead to represent the ovary, and attach it to the bottom of the style.
- The yellow chenille stems represent the filaments. Push the white and yellow chenille stems up through the bottom center hole of the origami flower. Trim the chenille stems to the desired length, making sure the white chenille stem is slightly taller than the yellow chenille stems.
- Create the stigma and anthers by attaching a yellow pony bead to the top of the style and white pony beads to the tops of each filament.
- Use green tissue paper to create the sepal. Poke a small hole into the center of the sepal with the sharp point of a pencil. Glue the sepal around the bottom of the origami flower petals.
- Place the green chenille stem into the bottom hole of the flower. Create leaves around the stem using the green bump chenille stems.

4. Ask the students to use their flower models to point out each part of the flower and explain the parts' functions.

Activity 3: Pollination and Fruit Development

1. Using the origami flower or the flower diagram from the Flower Anatomy PowerPoint, illustrate and describe the process of pollination.

2. Explain that pollen is a powdery substance containing the male gamete cells for seed plants. Plants reproduce seeds and fruits only after being pollinated.

3. Watch Pollination: Trading Food for Fertilization. As students watch the video, have them keep a list of all the ways flowers can be pollinated. This will include a list of animals and insects as well as modes of transportation for pollen such as wind.

4. As an example, show students the video clip CUCUMBER | How Does it Grow? This seven minute video clip shows the process of growing cucumbers including the importance of flowers and pollination. Inform students that after the video clip they should be able to describe the relationship between flowers and cucumbers.

• Tip: If time is short, begin the video at 3:20 and end at 6:00.

5. Ask the following questions:

• What correlation is there between a flower and a cucumber? (Cucumbers develop from a pollinated flower.)

• How many times does a cucumber flower need to be pollinated for a perfectly straight cucumber? (seven)

• What type of weather does a bee prefer? (Cool, sunny, and no rain or wind. Otherwise they tend to stay in the hive.)

(Optional) Activity 4: The Bee Dance

This activity needs lots of room. Try it outside!

1. Ask students how humans communicate non-verbally (body language, hand signals, facial expressions). Have a few students demonstrate in a charades-type manner.

2. Explain that bees communicate to tell one another where to go for good sources of food (nectar). Watch What's the Waggle Dance? And Why Do Honeybees Do It?

3. Review the Honey, I'd Love To Dance handout. Discuss both dances and what each movement means.

4. Divide the class into teams of 4–5, depending on class size. Have each team choose a scout. This student/bee will find the food source (treat bag) and communicate its whereabouts through bee dances to the team members.

5. Give each scout written directions to a different treat bag (that you have hidden), and then send the scouts out to find them. Do not let the other students witness their search.

6. When the scouts return, have them communicate the direction and distance of the treat bag to their team members using either the round dance or the waggle dance. No verbal or "human" body language allowed!

7. Once all the teams have found their reward, follow up with a class discussion about the ease or difficulty of communicating through dance. Is it difficult to judge distance without a tape measure or other tools? Do they believe honey bees are intelligent creatures?

Concept Elaboration and Evaluation

After conducting these activities, review and summarize the following key concepts:

 A flower contains the reproductive organs of a [angiosperm] plant.

 Flowers can be beautiful to look at, but some flowers develop into food that we eat. All fruits and even some vegetables develop from the flower of a plant.

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- A flower must be pollinated before it will produce a fruit. This can be done by insects such as bees or by the wind.
- Pollination is important in producing our food. Pollinators like bees are one example of a natural resource used in agriculture.

Follow up /References

https://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=542

Agricultural Lesson Plan

LESSON PLAN :	HORTICULTURE

Lesson Title:	PLANT LIFE CYCLE BOUTONNIERE		
Grades:	4-12	Lesson Duration:	30+ minutes

Lesson Objectives:

Purpose: Students will organize the stages of a plant's life cycle in the correct order, and use that knowledge to select three states of that life cycle to feature in a tiny bouquet that can be worn or given as a gift.

Standards:

NGSS

- 4-LSI-I Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction
- 5-LS2-I Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment
- MS-ESS2-I Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process
- HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. [Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models. Assessment Boundary: Assessment does not include specific biochemical steps.]

Materials / Equipment:

- Plant life cycle cards (Shelburne Farms)
- Open area with plants in different stages of life cycle such as a garden or field OR plant materials cut in advance
- Example of a boutonniere
- Scissors (multiple pairs)
- Florist tape or washi tape or florist wire (multiple rolls)
- Large safety pins (one for each student)
- Table or workspace for cutting stems and arranging flowers
- Optional: Small paper bags to protect boutonniere

Summary of Tasks / Actions:

Part 1

Hand out plant life cycle cards to students. Ask them to put themselves in order, according to what happens first and what happens last, holding cards facing out toward the group. Indicate where the line should begin and what direction it should go.

Ask students, once they have put themselves in order, to describe what is happening on each card. Elicit corrections that result in rearrangement from the group if necessary.

Ask students to link arms, and make a circle – a plant's life begins and ends with a seed. Link to seed saving.

Part 2

Ask students to harvest parts of plants that represent three distinct stages in a plant's life cycle. For instance, leaves, flowers, seeds. Pass out scissors.

Part 3

Bring plant parts to an area set up with example and florist supplies (keep safety pins in your pocket and give to students once their project is complete). Encourage students to get artistic and make one along with them.

Follow up /References

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