Apple Genetics

Grade Level(s)

6 - 8

Estimated Time

60 minutes

Purpose

Students learn about apple genetics related to production through a hands-on activity exploring the characteristics of apple varieties. Students will apply their knowledge of heredity and genetics to discover how new varieties of apples are developed through cross-breeding techniques.

Materials

- *Apple Genetics* PowerPoint
- *Apple Genetics* worksheet, 1 per student

Per Group of 2 or more:

- 1 Paper Plate
- 1 Whole Braeburn Apple
- 1 Whole Royal Gala Apple
- 1 Whole Jazz Apple
  - *Do not substitute the apple varieties. Jazz apples can be found at most grocery stores.*
- 1 Knife (to cut apple)
- 1 Sheet of Paper (Printer or Notebook paper)

Essential Files (maps, charts, pictures, or documents)

- SpongeBob Genetics worksheet (optional Enriching Activity)

  [https://naitc-api.usu.edu/media/uploads/2016/08/01/SpongeBob_Genetics.pdf]
- Apple Genetics worksheet

  [https://naitc-api.usu.edu/media/uploads/2016/08/01/Apple_Genetics_worksheet.pdf]
- Apple Genetics worksheet: Teacher Key

  [https://naitc-api.usu.edu/media/uploads/2016/08/01/Apple_Genetics_worksheet_key.pdf]
- Apple Genetics PowerPoint

  [https://naitc-api.usu.edu/media/uploads/2016/08/01/Powerpoint_-_Apple_Genetics.pptx]

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

Interest Approach – Engagement

1. Ask students what their favorite apple is. Ask them why that is their favorite apple and lead into a discussion about various apple traits such as sweetness, tartness, flavor, crunchiness, color, etc. You may even consider having students bring their favorite apple to class.
2. Play the first minute from the podcast "The Miracle Apple."
3. Use slide 2 of the attached *Apple Genetics* PowerPoint to give students a brief background on apple production in the United States and world.
4. Share interesting facts about apples (slide 3) with students to give them some general background about this agricultural product.
5. Highlight the nutritional benefits of apples (slide 4). Encourage students to eat an apple as a snack.
6. Bring up the original question about students' favorite apples. Using slide 5, show students a few different varieties of apples. Ask students if they prefer their apples to be sweet or tart.
7. Continue playing the "The Miracle Apple" podcast from the one minute mark to the six minute mark.
8. Introduce the concept of grafting. Make sure students realize that most apple trees are not grown from seed. (slide 6.)
9. Ask your students, "How were multiple varieties of apples developed... each with a different color, texture, and taste?" Allow students to offer their ideas using their prior knowledge and inform them that they will be learning the answer to this question.

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 a year.[1]
- Apples are 25% air, which is why they float in water.[1]

Background - Agricultural Connections

Prior to this lesson, students should 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 understand 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

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.

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 used for baking while others are used for eating. Apples are a good snack choice as they 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.

Procedures

Explore:

1. Give each student a copy of the *Apple Genetics* worksheet.
2. Be sure to wash all apples prior to distributing them to the students.
3. Per group of 2 or more students, hand out:
   - 1 paper plate (this will be the cutting board as well as an area to keep the apples)
   - 1 Braeburn Apple and 1 Royal Gala Apple (Note: DO NOT hand out the Jazz apple).
   - 1 knife (or have apples already pre-sliced)
   - 1 sheet of paper (This is where students are able to place seeds or other apple particles).
4. 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.
5. Have students complete "Part 1" of the worksheet by making observations and recording them for both the Royal Gala and Braeburn apples in the following order (slide 8):

a. Look, Smell, Touch OUTSIDE of the apple

b. Cut open and Look, Smell, Touch the INSIDE of the apple
   - To cut the apple: Have students hold their apples so the stems are pointing towards them (laying on their side) slice open the apples with a crosscut. Then, have students cut their apple again so that it is now quartered.

c. Finally, Taste the apple

6. After Students have recorded their observations in "Part 1," they should move onto "Part 2: Analyzing the Data" where students will find the similarities and differences found between the 2 apples. Facilitate a group discussion using slide 9 so students can share their findings.
7. Review basic genetics vocabulary with students using slide 10. Make sure students are familiar with terms. Instruct them that they will be applying genetics knowledge to apple situations.

Explain:

8. In "Part 3" of the worksheet, students will review the possible genotypes of the Gala and Braeburn apples. These genotypes can be found on the worksheet and slide 11 of the PowerPoint.
9. Assign students to complete the Punnett Squares on page three of the worksheet. Students will determine the possible probabilities for the genotypes of six apple traits.
10. Continue playing the "The Miracle Apple" podcast from the six minute mark to the 7:16 minute/second mark.

Extend:

11. Hand out the Jazz apple. Students will follow the same procedure and complete "Part 4" of the worksheet.
12. Once completed with the observations for the Jazz apple have students use their previous data from the Royal Gala and Braeburn apples and the observations from the Jazz apple to find out how they are connected through genetic crossing. Facilitate a class discussion using slide 14. Students will record findings on "Part 5" of worksheet.
13. Reveal to the students that the Jazz apple is a cross between the Gala and Braeburn apple. Using slide 15, share a few more facts about the Jazz Apple.
14. Talk about the concept of crossbreeding and how it is used to produce better quality organisms on slide 16.
15. The Honeycrisp apple was also developed by crossbreeding, and it is a competitor of the Jazz apple. Share some facts from slide 17 with students.
16. Continue playing the "The Miracle Apple" podcast from the 7:21 minute mark to the end of the story, 10:06 minutes.

Concept Elaboration and Evaluation:

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

- Apples are a healthy snack containing fiber and vitamin C.
- In apples, characteristics such as color, texture, sweetness/tartness, juiciness, and crunchiness are determined by the genetic make-up of the apple.
- Scientists use a knowledge of genetics and heredity to cross breed apples to produce new varieties of apples. The Jazz apple is an example.
- Continue playing the "The Miracle Apple" podcast from the 7:21 minute mark to the end of the story, 13:57 minutes.

Enriching Activities

- Show the 4-minute video clip, Have We Engineered The Perfect Apple? to see the science behind the taste of the Honeycrisp apple.
- If students need additional practice with completing Punnet Squares, complete the attached SpongeBob Genetics worksheet found in the Essential Files.

- If cut apples are in the room at the end of the lesson, ask students if they see any browning occurring. Discuss what causes this. Teach students about Arctic apples, a genetically modified apple which does not brown.

Suggested Companion Resources

- Selectively Breeding Sheep: Punnet Square Practice (Activity)

  [https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=637]

- Crop Modification Techniques (Poster, Map, Infographic)

  [https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=768]

- Have We Engineered the Perfect Apple? video (Multimedia)

  [https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=839]

- Garden Genetics: Teaching With Edible Plants (Teacher Reference)

  [https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=718]

- All About Apples (Website)

  [https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=664]

- Producepedia (Website)

  [https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=528]

- Genetic Science Learning Center (Website)

  [https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=255]

- DNA Learning Center (Website)

  [https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=313]

Sources/Credits

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- Molly Brandt: University of Nebraska-Lincoln, IANR Science Literacy Initiative, National Center for Agricultural Literacy
- NPR - Planet Money: The Economy Explained. Episode 627: The miracle Apple. Retrieved from http://www.npr.org/sections/money/2015/05/27/410085320/episode-627-the-miracle-apple

Ag Fact Sources:

1. http://www.care2.com/greenliving/22-fun-facts-about-apples.html

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