DRIVING QUESTION: WHAT IS SELECTIVE BREEDING?

LENGTH: 1 hour

OBJECTIVES: Students will be able to:

- define selective breeding
- describe how selective breeding changes a population over time

Standards:

Next Generation Science Standards Addressed

Disciplinary Core Ideas

LS3.A Inheritance of Traits

LS3.B Variation of Traits

Practices

Developing and Using Models

Cross-Cutting Concepts

Cause and Effect: Cause and effect relationships may be used to predict phenomena in natural systems.

Common Core English Language Arts Standards Addressed

Reading Standards for Literature 6-12:
Craft and Structure, 4

Writing Standards 6-12:
Production and Distribution, 4

Materials:

- Scissors (1 per group of 2 students)
- Copies of Lesson 3 Student Handout: Superhero! (1 per group of 2 students)
- Lesson 3 Resource: Wild Mustard Plant (1 copy per student, or display using projector)
- Internet access and projector or printed images from "How Your Food Would Look If Not Genetically Modified Over Millennia" http://www.geneticliteracyproject.org/2015/02/02/how-your-food-would-look-if-not-genetically-modified-over-millennia/

Suggested Video:

"Backcross Breeding" by University of Nebraska

http://passel.unl.edu/pages/animation.php?a=BXbreed.swf&b=990818773 (self-paced)

"Marker Assisted Selection" by University of Nebraska

http://passel.unl.edu/pages/animation.php?a=MASBreeding.swf&b=1130281891 (self-paced)

Lesson Context

This section provides guidance for teachers for how lessons build on each other.

At this point, students have seen DNA for themselves in Lesson 2. They learned how genes can be isolated and then replicated using bacteria. It is now time to learn that people have been selecting preferred traits for thousands of years. During Lesson 3, students will learn about the process involved in selectively breeding plants with desirable traits. In fact, the food that we enjoy in the grocery store would look much different if selective breeding had not happened. A few examples of what food would have looked like without selective breeding will be shared via one of the suggested website links.

KEY CONCEPTS: Selective breeding is not a new phenomenon. Humans have been trying to systematically improve their food supply for at least 10,000 years. As people began selecting and breeding plants and animals for desired traits, they improved these plants and animals for agricultural purposes.[iii]

We have been selecting plants and animals based on certain qualities for years! Moravian monk Gregor Mendel pioneered the study of inheritance and selective breeding. He discovered the interaction of dominant and recessive traits and patterns of inheritance with simple pea plants.

Today there are many food products we enjoy that humans have genetically modified over time through selective breeding. Nobel Laureate Norman Borlaug started the Green Revolution with successful selective breeding of wheat in Mexico, and as a result is said to have "saved more lives than any person who has ever lived."[iv]

SETUP: Write the following quote about Norman Borlaug on the whiteboard or display with a projector: "[He] saved more lives than any person who has ever lived."

Outline:

1. Direct students' attention to the quote about Dr. Borlaug. Ask students to speculate what a person with this descriptor may have done. Share with students that this quote is about Dr. Norman Borlaug, a man who received the Nobel Peace Prize for his work breeding wheat plants which helped nourish billions of people around the world.
2. Ask students to recall key information from the previous lesson.

   In the last two lessons, we explored the structure of DNA. Today we'll take a closer look at an amazing process that has enabled scientists like Dr. Borlaug to save countless lives in a growing world. But first, we'll start with a superhero challenge!
3. Inform students that they will create a powerful colony of superheroes. Distribute the Superhero! student handout. Have students work in pairs to complete the handout.
4. After students have completed the student handout, talk through each scenario. For each scenario, ask students which offspring they selected and why. Listen for selections based on genetic traits that are beneficial in the given situation.
5. Ask students to identify the effect of their selection on the population of superheroes. Have students reflect on the action (selecting for specific traits) that caused this effect.
6. Reinforce that genes, which are encoded in the DNA located in our chromosomes/cell nuclei, control genetic traits. The process of selecting offspring based on their traits is called "selective breeding." This is a process that has been used for thousands of years to breed the right plants and animals for a specific situation.
7. Ask students to describe the ways we use plants and animals. Listen for answers such as food, fuel, shelter, medicines, transportation, etc.
8. Explain to students that humans have been using plants and animals for their benefit for thousands of years.
   - For example, humans harvested the best seed of wild grasses, saved it and planted it the next spring. Soon humans crossed one grass with another (or perhaps several) and created wheat on one continent and corn on another. Neither wheat nor corn, as we know them today, ever existed as a wild grain. This marked the beginning of manipulating genes to create new products that humans desired.
   - Domestication of animals soon followed through genetic modifications made by humans. For example, animal scientists and anthropologists believe that humans domesticated the dog from wolves 12,000 to 14,000 years ago.[v]
9. Connect superhero activity to selective breeding decisions in real-life. Just like the students selected superheroes for specific scenarios, people have selected plants and animals for specific scenarios over time.
   - *What might have been the most important trait selected in animals?* (Listen for: amount of meat produced, amount of milk produced, quality of wool, amount of fat, size, using feed efficiently, flavor of meat, tenderness of meat, rapid growth, ability to reproduce easily, good mothering behaviors (takes good care of offspring), ease of giving birth, for draft animals like oxen or workhorses: strength, sound feet and legs, good disposition, willingness to work, etc.)
   - *What might have been the most important trait selected in plants?* (Listen for: yield, flavor, texture, ability to dry, growing season/conditions needed, etc.)
10. Share the Lesson 3 Resource: Wild Mustard Plant illustrating the variety of crops we enjoy today which were developed through selectively breeding the wild mustard plant (Brassica oleracea). Ask students to evaluate the images and hypothesize the trait which breeders selected for to achieve each plant.
    - Kohlrabi – selected for stem
    - Kale – selected for enlargement of leaves
    - Broccoli – selected for suppression of flower development
    - Brussels sprouts – selected for lateral leaf buds
    - Cabbage – selected for terminal leaf bud
    - Cauliflower – selected for sterility of flowers[vi]
11. Display pictures of watermelon, corn, banana, eggplant, carrot and cabbage/kale from "How Your Food Would Look If Not Genetically Modified Over Millennia" at https://geneticliteracyproject.org/2014/06/19/how-your-food-would-look-if-not-genetically-modified-over-millennia/
12. Ask students to share observations and summarize selective breeding in their own words. Listen for students to clarify that animals or plants are selected because of a desired trait and bred to continually improve that trait over generations. Direct students' attention back to the quote about Dr. Borlaug. Inform students that Dr. Borlaug used this technology to breed specific varieties of wheat that could grow well in different areas, providing food for people who would otherwise be hungry.
13. As a take-home challenge, have students review the article and series of poems "Mendel's Peas" at http://www.thehumangenome.co.uk/THE_HUMAN_GENOME/Mendels_Peas.html. Have students draft their own poem about selective breeding of a food item and bring it to the next class period.

ENRICHMENT OPPORTUNITY: (Global) Have students research global agricultural challenges, such as breeding better corn in drought prone areas like Africa, and report back on how selective breeding could be applied to help people. (Local) If agriculture is prevalent in your area, bring in different seeds and plants from surrounding fields. Have students research why farmers choose the crop variety for your specific area, soil type and climate.

FOR MORE INFORMATION, CHECK OUT:

- "The Man Who Fed the World" by Leon Hesser. Book and educator guide available at www.agfoundation.org.
- Wieczorek, A., & Wright, M. (2012). History of agricultural biotechnology: How crop development has evolved.[vii]

Additional Content Support

Pre/Post Assessment

This section provides a suggested assessment tool that may be used before and after a lesson to assess student readiness. See the Pre/Post Assessment file for a ready-to-distribute copy for your students.

1. What is selective breeding? The process of changing a population over time by selecting for desired genetic traits in the following generations. Plant breeders and researchers use molecular markers, which are identified gene sequences, to identify these traits without altering the genes in the organism.
2. Why has selective breeding become part of human impact on plant and animal life? Humans have learned to take advantage of selecting organisms with desirable traits and breed them with other organisms with desirable traits.

Suggested Accommodations

This section provides optional tools to enrich learning and meet students where they are.

1. For students struggling to meet performance expectations:
    a. Have students complete the self-paced module found at http://passel.unl.edu/pages/animation.php?a=MASBreeding.swf&b=1130281891 (self-paced).
    b. Students will learn about important traits that modern breeders (farmers) use to select the best crops. They will also learn about the Traditional Selection Process for disease resistance in plants along with today's biotechnology method of Marker Assisted Selection (MAS).
    c. Although these exercises are "self-paced," teacher guidance is highly recommended. Display the module with a projector and assist students with the content.
2. For students who have already met performance expectations and have high interest:
    a. Ten thousand years ago humans started cultivating wild plants. All the grains that feed billions of people today — wheat, rice and corn — come from annual plants. They sprout seeds, produce new seeds and die every year. Why didn't humans cultivate perennials instead of annuals? In your answer, be sure to include the advantages and disadvantages of each type of plant (annual, perennial).
3. For students who are English Language Learners, have special needs or are reading below grade level:
    a. Provide a translation of the word "superhero" in your students' native languages. Understanding this term is key to the student experience with their selection of traits for desired purposes.
4. For engaging ways to connect learning to students' home and community:
    a. Let's get back to the question about dogs from Lesson 1. We named a few different dog breeds a few days ago and also discussed the traits of each breed. It is believed that all dogs we know today started as wolves that have been bred for selected traits to meet the preferences of humans.
    b. What traits of the dachshund or "wiener-dog" were bred to become the ideal burrow hunting dog? Listen for short legs, long bodied, good scent. According to the American Kennel Club, the dachshund was bred to hunt small animals. They were developed to scent, chase and flush out badgers and other burrow-dwelling animals.

Rubrics

We have created two optional tools for evaluating learning at the end of each lesson.

- **LESSON RUBRIC:** This can be provided to students and used by the teacher for evaluation.
- **STUDENT REFLECTION:** This can be provided to students to empower them to self-assess learning before turning in the rubric and completed work.
  The general Student Reflection sheet can be found at the end of this educator guide.

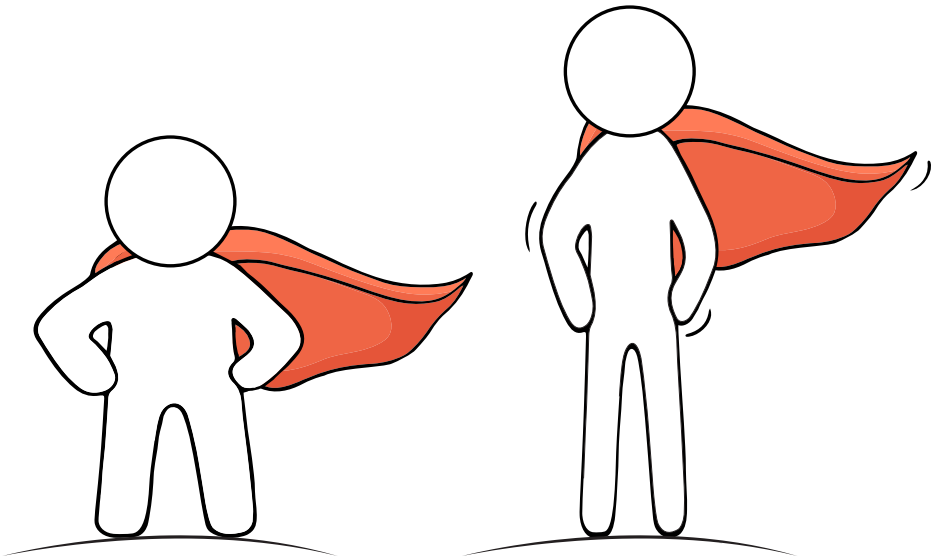
NAME: _____ **DATE:** _____ **CLASS PERIOD:** _____

SUPERHERO!

DIRECTIONS: You have a chance to save the world by creating an amazing superhero. Follow the steps to build your superhero family.

SETUP: Cut out the four genetic trait cards included with this activity. Place the two height cards in a pile, and the two strength cards in a separate pile. Fold all cards so that you cannot see the trait inside.

STEP 1: Meet your superheroes! We're crossing two superheroes to start your family.



Short and Strong

Tall and Weak

STEP 2: Build your superhero family! You have a chance to build 10 superheroes by crossing the parents we just met. For each child (1-10), draw one height card and one strength card. Record the outcome in the table below. Height: T (tall) S (short). Strength: S (strong), W (weak). After each drawing, put the cards back before you draw again.

	1	2	3	4	5	6	7	8	9	10
Height										
Strength										

(continued)

NAME: _____ **DATE:** _____ **CLASS PERIOD:** _____

Superhero! (Continued)

STEP 3: Pick the right superhero for the job! Read each scenario below and decide which superhero child/children you would use for the job.

SUPERHERO SCENARIO A: Villains have overrun the city. They have flipped every car upside down and moved them under the shortest bridges. We need a superhero to turn the city right side up again.

Which of your superhero kids are right for the job?

Why?

SUPERHERO SCENARIO B: An evil villain has hidden all of the money for the entire town in tight places, high in the trees. We need a superhero to get all of the money back.

Which of your superhero kids are right for the job?

Why?

SUPERHERO SCENARIO C: The Super Rail is down! We need a superhero to lift the train cars back to the tallest train bridge.

Which of your superhero kids are right for the job?

Why?

GRADING RUBRIC – FOR TEACHER		
Genetic traits of 10 offspring are clearly identified. Score _____/_____	Working knowledge of selective breeding is demonstrated through logical responses to scenarios. Score _____/_____	Sections are thoroughly completed on handout. Score _____/_____

NAME: _____ **DATE:** _____ **CLASS PERIOD:** _____

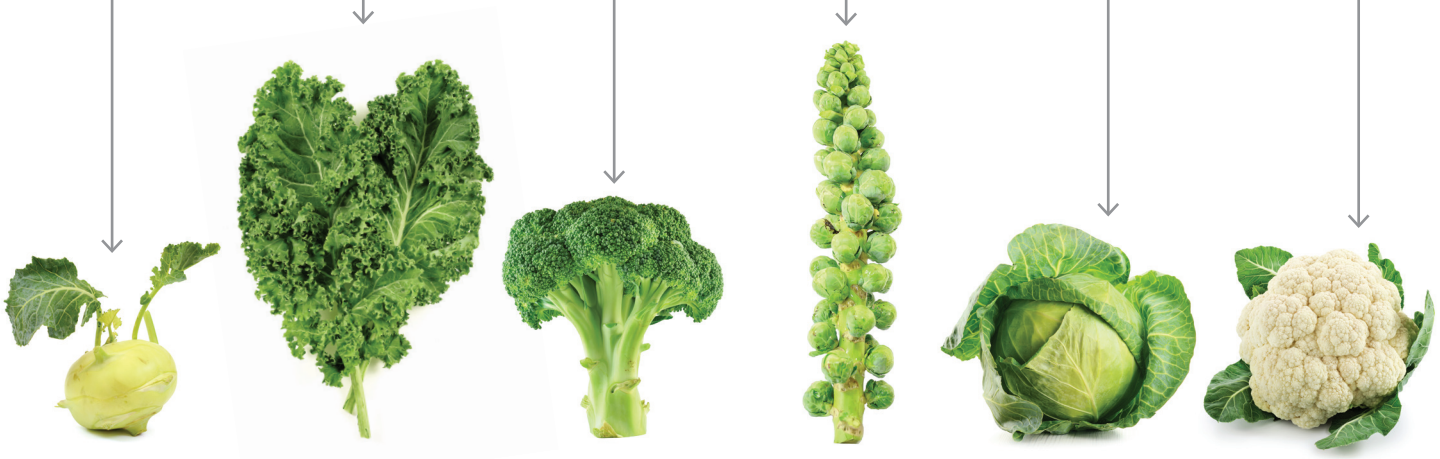
Superhero! (Continued)

GENETIC TRAIT Height: **Short**	GENETIC TRAIT Height: **Tall**
GENETIC TRAIT Strength: **Strong**	GENETIC TRAIT Strength: **Weak**

NAME: _____ DATE: _____ CLASS PERIOD: _____

WILD MUSTARD PLANT

WILD MUSTRAD PLANT (BRASSICA OLERACEA)



Kohlrabi	Kale	Broccoli	Brussels sprouts	Cabbage	Cauliflower

STRAIN

NAME: _____ **DATE:** _____ **CLASS PERIOD:** _____

Pre/Post Learning Assessment

1. What is selective breeding?

2. Why has selective breeding become part of human impact on plant and animal life?

3 LESSON HANDOUT
Bringing Biotechnology to Life · Educator's Guide

NAME: _____ DATE: _____ CLASS PERIOD: _____

Pre/Post Learning Assessment

1. What is selective breeding?

2. Why has selective breeding become part of human impact on plant and animal life?

NAME: _____ **DATE:** _____ **CLASS PERIOD:** _____

RUBRIC

		ADVANCED	PROFICIENT	NOVICE
DISCIPLINARY CORE IDEAS	Inheritance of Traits	Student can explain plants and animals have desirable traits and humans have participated in selective breeding of plants and animals for thousands of years. Student can explain the advantages and disadvantages of selectively breeding annual plants versus perennials.	Student can explain plants and animals have desirable traits and humans have participated in selective breeding of plants and animals for thousands of years.	Student can explain that plants and animals have desirable traits that humans want to duplicate through selective breeding.
	Variation of Traits			
PRACTICES	Developing and Using Models	Student followed the superhero procedures and was able to select the correct superhero kids for each job scenario. Student correctly explained why the superhero traits match the job scenario.	Student followed the superhero procedures and was able to select the correct superhero kids for the job scenarios.	Student followed the superhero procedures but did not select all the correct superhero kids for the job scenarios.
CROSS-CUTTING CONCEPTS	Cause and Effect	Student can explain if humans select and breed organisms with desirable traits, then the result is a percentage of the offspring will have the desirable traits. Student can explain there are different processes of selection of desirable traits.	Student can explain if humans select and breed organisms with desirable traits, then the result is a percentage of the offspring will have the desirable traits.	Student can explain if humans select and breed organisms with desirable traits, then the result is the offspring will have the desirable traits.