The Potato That Made It to McDonald's

SMILE Language Booster

Long ago, in a quiet Idaho valley, a young farmer named Lily grew Russet potatoes. These were no ordinary potatoes—they were long, golden-brown, and perfect for making French fries. Lily loved her potatoes, but there was a problem. Some grew too short, some had strange shapes, and others had spots that turned black when fried. Only a few were good enough for restaurants like McDonald's.

One day, a plant scientist named Dr. Evans visited Lily's farm. She studied how crops had changed over time to feed people better.

"Did you know potatoes didn't always look like this?" Dr. Evans asked. "Thousands of years ago, people in South America began **domestication**—choosing wild potatoes that were bigger, less bitter, and safer to eat. These are examples of **phenotypes.** That was the first big step in **crop improvement**.

Lily was amazed. "So people have been picking better **traits** for a long time?"

"Exactly," said Dr. Evans. "Then came the **Green Revolution** in the 1940s–60s. Scientists helped farmers increase food production by utilizing improved crop varieties, fertilizers, and irrigation systems. That helped stop hunger in many parts of the world."

"But we still have problems," Lily said, holding a potato with dark spots.

"That's why we use **genetic modification** now," Dr. Evans replied. "It lets us carefully change the **genotype** – the genetic makeup of the organism – to result in **phenotypes** such as disease resistance or lower bruising. That's how scientists improved the **Innate Russet potato**—so it could make perfect fries and waste less food."

Soon, Lily's fields were full of these improved potatoes. McDonald's called—they wanted more fries than ever. Lily smiled. Her farm was thriving, thanks to thousands of years of smart decisions about **traits**—from ancient farmers to modern scientists.

And that's how a better potato made its way from the ground to your fries.

Talk with your partner and answer the following questions:

1. Do you think improving crops is beneficial? Why or why not?

2. What are some foods you eat that might have been improved by science?

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Build a Better Potato!
Science Investigation

In this investigation, you will learn how farmers and scientists have improved crops over time by selecting or designing traits during the Domestication era, the Green Revolution, and Genetic Modification.

Materials:

- Eras of Crop Improvement Worksheet
- Domestication Activity Flashcards
- Green Revolution Activity Flashcards
- Genetic Modification Flashcards
- Eras of Plant Improvement Presentation (optional)
- Paper "Potato Trait Cards" (see below – can be printed and cut out)
- 3 large posters or labeled stations:
    1. Domestication
    2. Green Revolution
    3. Genetic Modification
- Markers, glue, scissors
- Optional: potato-shaped paper cutouts or drawings

Procedure:

1. Introduction (20-30 minutes)

Read the Language Booster "The Potato That Made It to McDonald's." Then, learn about the three crop improvement eras with the following breakout activities:

- **Domestication** – Farmers chose the best wild plants with useful traits.
- **Green Revolution** – Scientists improved crops using breeding, fertilizers, and irrigation.
- **Genetic Modification (GM)** – Scientists can now directly add or improve traits in crops using biotechnology.

Domestication

- Match the flashcards with a trait that might have been selected by humans as they domesticated their crops.
- Once all flashcards have been matched, justify your choices with your group/class.

Green Revolution

- Analyze the graphs and answer the questions on the worksheet. Discuss your answers with your group/class.

Genetic Modification (GM)

- Analyze the graphs and answer the questions on the worksheet. Discuss your answers with your group/class.

Discussion

- Discuss the following questions with your group/class:
    - What changes did people make to plants?
    - Why might farmers or eaters want different things?
    - How do you think plants will change in the future?

2. Build Your Potato (20-30 minutes)

You're going to create the ultimate potato for McDonald's fries. But you must choose your traits step by step—through history!

1. Work in small groups or pairs. Use a blank "Potato Profile" sheet (just a potato shape on paper) and review the Trait Cards.

2. Go to each of the three stations set up for each era:

    Domestication (Pick 2):
    - Larger size
    - Less bitter taste
    - Thin skin
    - Fewer eyes

    Green Revolution (Pick 2):
    - Grows faster
    - Higher yield per plant
    - Stronger stems (doesn't fall over)
    - Resistant to drought

    Genetic Modification (Pick 2):
    - Bruise-resistant
    - Fewer black spots after frying
    - Pest-resistant
    - Stores longer in the fridge without turning brown

3. At each station, choose two trait cards that they think are most important for making the best French fry potato. Glue or tape their chosen traits to their potato drawing and write a brief explanation for why they selected each one.

4. Present & Discuss (10–15 minutes)
    a. In your group, present your "Ultimate Potato" to the class, responding to these questions:
        i. Why did you pick those traits?
        ii. Which era gave you the most helpful traits?
        iii. How do you think these traits help farmers or companies like McDonald's?

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Family Activity

Family Food Choices: Why We Pick What We Eat

Overview:
In class, we're learning about the *eras of crop improvement* — how humans have changed plants over time through **domestication**, the **Green Revolution**, and **genetic modification**. We're also learning how traits (the characteristics we can see or taste, such as color, texture, or flavor) are connected to genes.

Now it's your turn to explore how *your family* makes food choices — and how those choices connect back to plant traits!

Activity Instructions:

1. **Choose a Common Food**
   As a family, pick a type of food you eat often — it could be rice, potatoes, apples, tomatoes, corn, or something else that comes in different varieties.
2. **Compare Varieties**
   Look at or talk about the different types you've seen or used:
   - White rice vs. brown rice
   - Russet vs. red potatoes
   - Roma vs. heirloom tomatoes
   - Sweet corn vs. field corn
   - Gala vs. Granny Smith apples
3. **Discuss Together:**
   - Why do we usually choose this type of food?
   - Does texture, taste, color, or cooking time matter most?
   - Are there some varieties we use only for certain meals (like mashed potatoes vs. fries)?
   - Do we ever buy different types for different reasons — like price, appearance, or health?
4. **Connect to Science:**
   - Which *traits* make each food better for its purpose (e.g., stickiness in rice, starchiness in potatoes, firmness in tomatoes)?
   - Which *era of crop improvement* might have influenced these traits?
     - **Domestication:** Early farmers selected plants with traits they liked.
     - **Green Revolution:** Scientists bred plants for high yield or resilience.
     - **Genetic Modification:** Modern scientists can directly change genes for specific traits.
5. **Family Reflection:**
   - What did you learn about how and why plants have been changed over time?
   - What do you think is the most important trait in food: flavor, nutrition, sustainability, or something else?

domestication/ domesticación

It is when people take wild plants and grow them to make them more useful for humans, such as growing larger fruits or producing more seeds, so they become useful for food or other purposes.

Es cuando las personas toman plantas silvestres y las cultivan para hacerlas más útiles para los humanos, como hacer crecer frutos más grandes o producir más semillas, de modo que se vuelvan útiles como alimento u otros fines.

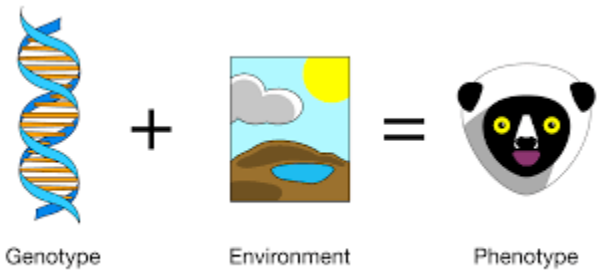
Coffee spread widely throughout the Arab world in the first century after its domestication.

Concept Card

phenotypes/ fenotipos

All the things you can see and observe about a living thing, like color and height.

Todo lo que puedes ver y observar sobre un ser vivo, como el color y su altura.



A phenotype is any observable characteristic or trait of an organism.

Concept Card

Crop improvement/ Mejora de cultivos

The practice of making plants that we eat better, stronger, and more nutritious.

La práctica de hacer que las plantas que comemos sean mejores, más fuertes y más nutritivas.

Crop improvement is the modification of crops using traditional or laboratory techniques.
Concept Card

Green revolution/ Revolución verde

The Green Revolution aimed to end food shortages by improving agriculture using new methods, new plant varieties, pesticides, and fertilizers.
La Revolución Verde tuvo como objetivo acabar con la escasez de alimentos mejorando la agricultura utilizando nuevos métodos, nuevas variedades de plantas, pesticidas y fertilizantes.

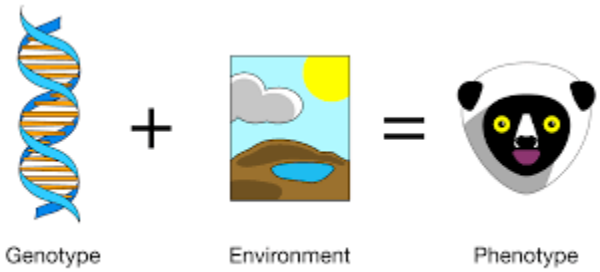
The green revolution transformed agriculture.

Concept Card

Genotype/ genotipo

The genetic makeup of an organism.

La composición genética de un organismo.



My eye color is a result of my genotype.

Concept Card

Genetic modification/ Modificación genética

Scientists can now directly add or improve traits in crops using biotechnology.

Los científicos ahora pueden agregar o mejorar directamente características en los cultivos utilizando biotecnología.

Genetic modification is the process of altering an organism's genetic material,

Concept Card

Innate russet potato/ papa russet innata

A type of russet potato genetically modified to reduce bruising and black spots.

Un tipo de papa modificada genéticamente para reducir los hematomas y las manchas negras.

The Innate Russet potato is less prone to bruising.

Concept Card

Trait/
rasgo

A special feature or characteristic that a plant has.
Una característica o rasgo especial que tiene una planta.

Breeders were selecting a trait that allowed the crop to thrive.
Concept Card

Teacher Page

Build a Better Potato!

Video Description: https://youtu.be/XSRI23-LGTM

NGSS Standards

3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.

3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.

MS-LS4-5. Gather and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms.

MS-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

Objectives:

1. Students will understand:
    a. Goals of conventional breeding and genetic modification in agriculture
    b. Three different eras of plant improvements – domestication, Green Revolution, and genetic modification
2. Students will be able to:
    a. Identify different types of agricultural traits that are desirable for food production and/or consumption
    b. Identify similarities and differences between non-domesticated and domesticated varieties of plants
    c. Interpret graphs to make meaningful conclusions
    d. Justify their choices of traits to build the Perfect Potato

Description:

Students learn about why farmers/plant scientists would want to improve traits, with students brainstorming the different types of traits that may be desirable for food producers and consumers (e.g. increased fruit size, enhanced taste, efficient production). Students engage in breakout activities related to 3 eras of agricultural improvements: domestication, the Green Revolution, and genetic modification. The goal here is for students to learn that all of these eras include similar goals – developing safe and nutritious food more efficiently for a growing population. This culminates in an activity to Build You Potato by having groups justify the traits they've chosen for their perfect potato.

Lesson Procedure

1. **Intro:**
    - Hand out the Language Booster to the students and have them read it (or read it to them) to activate prior knowledge, build vocabulary, and encourage students to think and talk about the lesson topic. Make sure that the Concept Cards are visible when reading/students read.

- Have students ask their elbow partners the questions that follow the Language Booster and give them time to discuss their answers.
- Tell students that they will learn about Crop Improvement and apply this knowledge to how we think about agriculture and farming today.

2. **Reviewing the Eras**
    - The class brainstorms different traits that are important for agriculture. Provide students with a few minutes to think on their own before sharing with the group.
        - What do/don't you want as a consumer? What does your perfect apple look like?
        - What would/wouldn't you want as a farmer?
    - Briefly introduce students to the 3 different eras of crop improvement: **Domestication, Green Revolution, and Genetic Modification,** using the Breakout Activities.
3. **Breakout Activities**
    - Pass out the "Eras of Plant Improvement" worksheet to students.
    - Students rotate through 3 breakout activities.
        - Domestication Activity Flashcards
        - Green Revolution Activity Flashcards
        - Genetic Modification Flashcards
    - Students share what they noticed at each of the stations.
        - Domestication was focused on making the plants easier to grow in a uniform way to make it easier to harvest (specific traits outlined above in the Teacher Background), whereas the Green Revolution was focused on creating high yielding varieties of important staple crops (especially wheat and rice).
        - Another important concept for students to understand is that the Green Revolution was a response to the increased use of chemicals (such as pesticides and fertilizers) in agriculture. Scientists and farmers were interested in increasing crop yields without increasing the need for these chemicals.
        - Genetic modification is even more crucial in the context of enhancing complex agricultural systems and improving food availability, particularly in the face of a changing climate.

4. **Build your Potato**
    - Hand out the Potato Profile Sheet to groups.
    - Groups choose 2 traits from each era to create their perfect potato.
    - Once groups have chosen their traits, they must present and justify their perfect potato to the other groups.

Discuss:

- What are some things you noticed about the different crops?
- Why would farmers and consumers want different types of traits in their food products?
- What were the major themes of each era? What were the most notable changes?
- Should we continue to genetically modify crops? Why or why not?

Resources and References:

- International Food Policy Research Institute. 2002. Green Revolution: Curse or Blessing? Link: https://oregonstate.edu/instruct/css/330/three/Green.pdf
- Current GMO Crops. GMO Answers. Link: https://gmoanswers.com/current-gmo-crops
- Genetically Engineered Crop: Experiences and Prospects. Chapter 8: Future Genetically Engineered Crops. Link: https://www.nap.edu/read/23395/chapter/11

Definitions

Term	What It Refers To	Example	Relationship to Others
Gene	DNA sequence that codes for a trait	Eye color gene	Determines possible traits
Trait	Observable characteristic	Brown eyes	Expression of genes and environment
Genotype	Genetic makeup (allele combination)	Bb	Determines potential phenotype
Phenotype	Physical expression of genotype	Brown eyes	Result of genotype + environment

Teacher Background:

DNA is a self-replicating material present within chromosomes of all living organisms. It is the basic building block of heredity and genetics. DNA is made up of nucleotides, and specific sequences of nucleotides comprise a **gene** – the unit of heredity. Specific genes are associated with **traits** such as eye color, height, and hair color. Traits are sometimes influenced by a single gene or can be tied to multiple specific genes that control how the trait is expressed.

For thousands of years, humans have been domesticating plants to exhibit desired traits through breeding. Traits that simplify production and cultivation were especially desirable. Subsequently, domestication was often focused on improving physical characteristics of the plant (aka "**phenotype**"). Domesticating plants enabled humans to establish permanent civilizations around their farming areas, rather than relying solely on hunting and gathering food as it became available. This was an important societal transition that allowed individuals to focus more energy on agriculture to feed growing populations in their civilizations and develop more sophisticated farming tools. Additionally, the crops that were originally selected by these early farmers set the stage for the crops that make our modern food supply (e.g., corn/maize, wheat, and rice).

Here is a list of traits that were prioritized during **domestication** breeding efforts (approx. 5,000 – 10,000 years ago):

- grew **straighter** and **taller** (as opposed to bush-like structure) to increase productivity by increasing the number of plants on a specific land area, and simplify harvesting because branches/stalks are clearly defined
- had **seeds without shells** (known as "non-shattering seeds") to make it easier to collect and reuse seeds from crops
- Had **increased fiber content** (such as cotton plants) to increase fiber availability for cloths and other goods
- **Bigger fruit** to increase calorie availability for human populations

Agricultural advancements have continued since this time. In the 1950s-60s, there was another large period of agricultural innovation known as the **Green Revolution**. During the early 1900s, agricultural operations were becoming larger and more complex. Industrialization also increased the amount of chemicals that were available within the marketplace, including those for farming. Subsequently, there was a significant increase in the use of toxic chemicals (fertilizers, pesticides, herbicides) to improve productivity on farms. This sparked concern about environmental and human health, prompting scientists and plant breeders to investigate ways to improve plant productivity without requiring extensive use of these types of chemicals. Primarily, these breeding efforts were focused on developing:

- **high yielding varieties** of crops that could produce a greater yield during a single growing season
- Varieties with **shorter, stiffer stalks** to support the weight of increased grain production (e.g. rice, wheat) without the plant breaking
- varieties that were **drought resistant** and **herbicide resistant** to simplify production processes.

The advent of biotechnology and the ability to **genetically modify** plants have greatly expanded the types of traits that can be established. These methods enable scientists to investigate a plant's genetics and edit its DNA, allowing the plant to exhibit a specific trait. Now, scientists can establish traits that were previously unavailable by using DNA/gene sequences from other species. Instead of breeding a trait into a variety over the course of multiple generations, scientists can insert the DNA into the variety to establish the trait. This expedites the process. Although many of the desired traits focus on improving production and harvesting, scientists have also used genetic modification to develop varieties that benefit consumers. Some of the primary traits that have come from these advancements include:

- **Herbicide tolerance** varieties (e.g. "Round Up Ready Soybean") that are resistant to specific types of herbicide, simplifying farmers' weed management efforts.
- **Insect and pest resistance** (e.g., Rainbow Papaya – resistant to Ringspot Virus, Bt corn – resistant to a variety of pests) to reduce crop loss from pests and pathogens, which greatly affects productivity and farm profitability.
- **Non-browning** varieties (e.g., Arctic Apple, Innate Potato) that do not brown when cut, reducing food waste and increasing consumer satisfaction.
- **Increased nutritional content** (e.g,. Golden Rice with significantly greater concentrations of beta carotene to facilitate Vitamin A production) to address malnutrition and nutritional deficiencies that greatly affect the developing world.

- **Increased sugar content** (e.g., sweet corn) to improve consumer satisfaction.

Currently, the majority of genetic modification has been focused on improving commodity crops (e.g., corn, soybean, canola, cotton) to impact large-scale production of these crops. **Moving forward**, scientific advancements in genetics may allow scientists to increase resilience for crops, especially in the context of a **changing climate**. These types of applications could help us ensure that our crops are able to withstand the various climatic changes that are anticipated – helping ensure our food supply remains. The National Academies of Sciences expect that we will see genetically modified varieties of crops that express these types of traits in the future:

- Drought tolerance
- Water-use efficiency
- Nitrogen-use efficiency
- Nutrient uptake and use efficiency
- Carbon fixation
- Cold/heat tolerance
- Salt tolerance

These techniques will likely be applied to improve other products, which may be more niche and produced on a smaller scale. For example:

- Reduced gluten content in wheat varieties
- Improved oil content/reduced fatty acid content in soybean oil
- Improved nutritional content

Ultimately, whether you are breeding or genetically modifying plants, the goal is to increase farm productivity and efficiency while growing safe and nutritious food for an increasing population.

Domestication Era – Trait Cards

Bigger sizes

- Selected by early farmers for more food

Less bitter taste

- Safer to eat (some wild potatoes were toxic)

Thin, edible skin

- Easier to cook and eat

Grows near human homes

- Adapted to farm environments

Fewer toxic chemicals

- Safer for families to eat

Green Revolution Era – Trait Cards

Higher yield

- More potatoes per plant

Faster growth

- Ready to harvest sooner

Disease resistance

- Fights common potato diseases like late blight

Stronger stems

- Plants don’t fall over easily

Works well with fertilizer

- Grows better with added nutrients

Genetic Modification Era – Trait Cards

Bruise-resistant

- Doesn’t turn black when dropped or cut

Fewer black spots after frying

- Makes prettier, more appetizing fries

Lower acrylamide

- Reduces a possible harmful chemical when frying

Late blight resistance

- Stronger defense against crop disease

Longer shelf life

- Stays fresh longer in storage