

DRIVING QUESTION: WHAT IS BIOTECHNOLOGY?

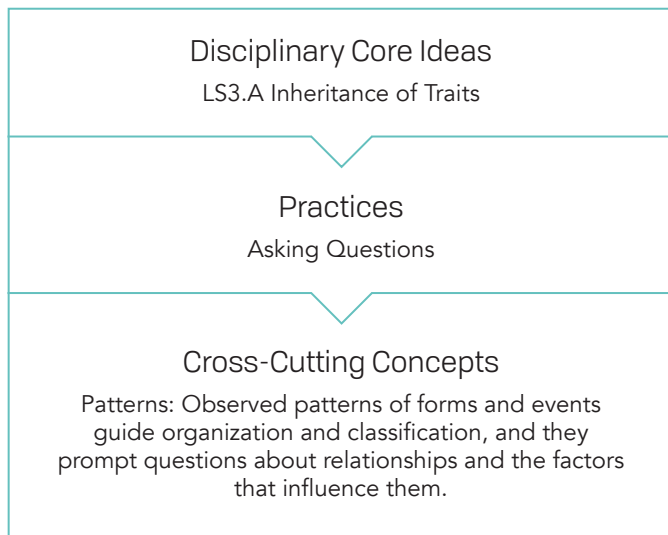
LENGTH: 1 hour

OBJECTIVES: Students will be able to:

- define biotechnology
- identify how biotechnology can help the environment
- identify how biotechnology can improve our food supply

Standards:

Next Generation Science Standards Addressed



Common Core English Language Arts Standards Addressed

Writing Standards 6-12, Text Types and Purposes (2)
Write informative/explanatory texts to examine a topic and convey ideas, concepts and information through selection, organization and analysis of relevant content.

Materials:

- Copies of Lesson 4 Student Handout: The Technology of Life (1 per student)
- TV monitor or projector/screen and speakers
- Internet connection with YouTube access

Suggested Video:

"Your Food, Farm to Table" by FoodInsightTV
<https://www.youtube.com/watch?v=K1XbEpNZ5yk> (2:41)

"Food Biotechnology: Get the Facts" by FoodInsightTV
<https://www.youtube.com/watch?v=b8EDEimG-DY> (1:48)

Lesson Context

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

Students will continue to build their understanding of DNA and selective breeding during Lesson 4 as they dive into biotechnology. After a short review of DNA and selective breeding, there is a particular focus on biotechnology assistance with the food supply and the environment. This continues with a challenge for the students to organize their questions and understandings of selective breeding, plant biotechnology and organic production. They are finally encouraged to research any unanswered questions from reliable sources to bring back to class for a continued discussion. By the end of this lesson, students will have defined biotechnology and pursued their understanding of the overlapping relationships of selective breeding, biotechnology and organic production.

KEY CONCEPTS: The USDA's National Institute of Food and Agriculture defines plant biotechnology as "a set of techniques used to adapt plants for specific needs or opportunities."

SETUP: Write the key terms "DNA" and "Selective Breeding" on a whiteboard or display with projector. Preview videos and prepare copies of student handouts.

Outline:

1. Set context for lesson by reviewing key concepts from previous lessons. Refer to the terms on the board.
 - *What is DNA?* (Listen for: DNA is a large molecule that contains the genetic information for organisms.)
 - *What is selective breeding?* (Listen for: Selective breeding is the process of changing a population over time by selecting for desired genetic traits to produce the next generation. Plant breeders and researchers use molecular markers, which are identified gene sequences, to identify these traits without altering the genes in the organism.)^x
 - *What do you imagine could be some of the challenges of selective breeding?* (Listen for: Selective breeding takes a significant amount of time. Selective breeding also does not allow you to isolate one trait; many traits are passed on together to each generation, which may have a positive or negative impact in the given scenario.)
2. Play the video "Your Food, Farm to Table" (2:40) by FoodInsightTV at <https://www.youtube.com/watch?v=K1XbEpNZ5yk>.
3. Add the word "biotechnology" to the white board or projector screen. Give students a few minutes to brainstorm what they know about biotechnology independently or in groups.

4. Ask students to break down the word and define each part.
 - “bio”: life
 - “technology”: using science to invent things or solve problems*
5. Share with the students that there are many definitions of biotechnology. Surprisingly, the term biotechnology was first coined in 1919. Karl Ereky, a Hungarian engineer, first used the term and defined it as “all lines of work involved in creating products from raw materials with the aid of living organisms.” We are going to focus on plant biotechnology. The USDA’s National Institute of Food and Agriculture defines plant biotechnology as “a set of techniques used to adapt plants for specific needs or opportunities.”
 - Ask students: What do you hear about biotechnology? What concerns do you have?
 - Emphasize that students will have the opportunity to form their own opinion. The goal of this exercise is to take a look at what science says about biotechnology.
6. Distribute student handout *The Technology of Life*. Have students capture the definition of plant biotechnology.
7. Preview two guiding principles: Plant biotechnology can help the environment and the food supply. Ask students to look for examples of these two claims as they watch a short video.
8. Play the video “Food Biotechnology: Get the Facts” (1:47) by FoodInsightTV at <https://www.youtube.com/watch?v=b8EDEimG-DY>.
9. Have students capture notes and share responses. Ask students: *What is the need driving this technology?* (Listen for students to share about the demands on our environment to produce enough food to sustain a growing population.) Clarify that we will need all farming technologies/practices to feed, fuel and provide fiber to a growing population, and these methods can coexist.
10. Direct students’ attention to the second half of the student handout *What’s in a Name?* This section helps students distinguish between the terms “selective breeding,” “plant biotechnology,” and “organic production.” Have students begin by writing down their assumptions in the table. Next, share the following information:
 - **Selective Breeding** is the process of changing a population over time by selecting for desired genetic traits. Plant breeders and researchers use molecular markers, which are identified DNA, to identify these traits without altering the genes in the organism.^{xii} It is actually only very recent that the use of molecular markers has become widespread. For most of the history of selective breeding, the selection has been based on choosing preferred phenotypes, which are characteristics of the visible appearance of a plant or animal.
 - **Plant Biotechnology** is defined by USDA’s National Institute of Food and Agriculture as a set of techniques used to adapt plants for specific needs or opportunities.
 - **Organic Production** refers to the growing process a farmer uses, not the actual seed. Organic production must follow specific guidelines as outlined by the USDA.^{xiii} The use of genetically engineered seed is prohibited in organic production.^{xiv}
11. Challenge students to review the organization of these three classifications and generate questions about their relationships.
12. Create a space on the whiteboard or a bulletin board for unanswered questions. Challenge students to seek answers from reliable sources and bring information back to class.

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 DNA? Deoxyribonucleic acid
2. Why is DNA important in trait inheritance? DNA carries the genetic information from parent to offspring from generation to generation.
3. 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 specific gene sequences, to identify these traits without altering the genes in the organism.
4. What is plant biotechnology? The USDA’s National Institute of Food and Agriculture defines plant biotechnology as “a set of techniques used to adapt plants for specific needs or opportunities.”
5. How can plant biotechnology help the environment? Less pesticides, less land and less water use are needed with advancements made in biotechnology.
6. How can plant biotechnology help the food supply? Enhance nutrition, more healthful fats, eliminate trans fats, enhance food production
7. What is organic production? Organic production is a system that integrates “cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity.” (Source: National Organic Program)

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. The videos are excellent resources for information. The “Your Food, Farm to Table” video is paced very quickly and the information delivery is by reading only. It is recommended that the teacher mute the sound and push pause as appropriate for students to read through each screen change. Teacher should read aloud to the students and elaborate on any words that may be new to them.
 - b. The “Food Biotechnology: Get the Facts” video may need to be played more than once for the students to capture all the food and environmental benefits to biotechnology. Ask students to share observations. As students share, others in the class will write down any information any that they missed.

2. For students who have already met performance expectations and have high interest:
 - a. Organic production is a system that integrates “cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity.” (Source: National Organic Program) Research what “conserve biodiversity” means and address its relationship with biotechnology.
3. For students who are English Language Learners, have special needs or are reading below grade level:
 - a. The video modifications suggested for all students will assist ELL students. The videos are picture/graphic rich, which will help with some comprehension. Translation of the key terms for this lesson will benefit the student also. Biotechnology, environment, food supply and organic production are all key terms.
 - b. Partnering the ELL student with a bilingual student may assist as information from the videos is a critical foundation for the products of Lesson 4.
4. For engaging ways to connect learning to students' home and community:
 - a. Research where the closest farm is from where you live. If possible, identify conventional and certified organic farms.
 - b. What methods of biotechnology are located in your area?
 - c. Research how many people lived in your city in 1975 as compared to today. If a U.S. farm then could feed less than 100 people a year, how many farmers were needed in 1975 to feed all our citizens? Research how many people live in your city today. Today, each U.S. farm can feed 168 people each year. How many farmers are needed to feed your city? Do you think there has been an increase in farmland available or a decrease in recent years? Why?

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:** _____

THE TECHNOLOGY OF LIFE

What is plant biotechnology?

How can plant biotechnology help the environment?	How can plant biotechnology help the food supply?

What's in a name?

Selective Breeding	Biotechnology	Organic Production

GRADING RUBRIC – FOR TEACHER

Specific examples for helping the environment and food supply are listed. Score _____/_____	Table shows clear comparison of terms. Score _____/_____	Sections are thoroughly completed on handout. Score _____/_____
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NAME: _____ **DATE:** _____ **CLASS PERIOD:** _____

Pre/Post Learning Assessment

1. What is DNA?

 2. Why is DNA important in trait inheritance?

 3. What is selective breeding?

 4. What is plant biotechnology?

 5. How can plant biotechnology help the environment?

 6. What is organic production?

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

Pre/Post Learning Assessment

1. What is DNA?

2. Why is DNA important in trait inheritance?

3. What is selective breeding?

4. What is plant biotechnology?

5. How can plant biotechnology help the environment?

6. What is organic production?

NAME: _____ DATE: _____ CLASS PERIOD: _____

RUBRIC

		ADVANCED	PROFICIENT	NOVICE
DISCIPLINARY CORE IDEAS	Inheritance of Traits	Students can explain the impact plant biotechnology has had as beneficial traits of plants have impacted the food supply and the environment. Students can list the benefits for <u>both</u> food and environment.	Students can explain the impact plant biotechnology has had as beneficial traits of plants have impacted the food supply and the environment. Students can list the benefits for food <u>or</u> environment.	Students can explain the impact plant biotechnology has had as beneficial traits of plants have impacted the food supply and the environment but cannot list any specific benefits.
PRACTICES	Asking Questions	Student followed-up with the handout chart and created seven or more questions to research from a reliable source and the source citation was included.	Student followed-up with the handout chart and created at least six questions to research from a reliable source and the source citation was included.	Student followed-up with the handout chart and created at least three questions to research from a reliable source and the source citation was included.
CROSS-CUTTING CONCEPTS	Patterns	Student can explain the similarities <u>and</u> differences of selective breeding, plant biotechnology and organic production. Student can elaborate on organic production focused on conserving biodiversity and what that means in a world of ever-increasing use of plant biotechnology.	Students can explain the similarities <u>and</u> differences of selective breeding, plant biotechnology and organic production.	Students can explain the similarities <u>or</u> differences of selective breeding, plant biotechnology and organic production.