



**DISCOVERING
FARMLAND**
ABOUT FOOD & AGRICULTURE

Get to Know GMOs

Exploration Activity for “Your Shopping Experience”

Time: 1-2 sessions, 45 minutes each

Overview:

When you see a food packaging label and it says “Made Without GMOs,” does it mean that food is better for you than food made with GMOs?

Not necessarily! There is no evidence that genetically modified organisms (or GMOs) are harmful to humans. In fact, some genetically modified crops are bio-fortified. That means that their nutritional value is even greater than conventional crops!

But, what exactly is a genetically modified organism?

Genetically modified organisms are crops whose DNA is altered by humans to produce a desired trait.¹ Here’s how it works:

- First, scientists identify specific genes of interest and isolate that trait.
- Next, the scientists insert those genes within the genome of a particular plant. The implanted gene will now be able to express itself in the cell of the plant. This new gene expression can help protect the plant against specific herbicides and pesticides or improve its texture, size, extended shelf life, and overall quality.
- In a testing process, that can take up to several years, plants with the new gene sequence are planted and tested to ensure that the modified crop is safe to eat, has improved nutritional properties, and/or is no longer vulnerable to disease.

Genetic engineering is a modern version of an ancient practice—selective breeding. Selective breeding combines different crops together over many generations to produce advantageous traits. Selective breeding enables us to have different varieties of apples, potatoes and countless other crops. It adapts plants to different climates, provides natural protection against pathogens and helps to increase harvests. This method is less precise than genetic modification because it mixes all the DNA of the breeding crops together. That means the new crop will display the advantageous trait, but it might also have undesirable traits. With genetic modification, scientists can pinpoint the exact gene that they want to introduce into a crop. That means that they can produce the positive, desirable traits without any of the negative ones.

Crop rotations involve planting different crops on the same field from one year to the next. Some crops, like tomatoes, use up nutrients in the soil as they grow. Others, like legumes, bring nutrients like nitrogen back into the soil. There are many benefits to rotating crops—it prevents soil erosion, keeps nutrients like nitrogen and phosphorous in the soil and combats the spread of harmful insects.⁴

In this activity, students explore how genetically modified crops maximize profitability, maintain the land and mitigate pests. Students will research genetically modified crops to dispel four common misconceptions. Students will use the knowledge gained through this activity and the digital exploration to collect evidence to refute each claim.

Objectives:

Students will be able to:

- **Understand** how GMOs improve soil condition and crop yield,
- **Apply** that understanding to a farming simulation, and
- **Evaluate** common ideas about agriculture and support or refute them.

Materials

- The Get to Know GMOs workbook—one per student
- Smartphone, tablet or computer with access to the internet
- Whiteboard or chalkboard
- Projector/screen or smartboard

Have you ever wondered . . .

Are genetically modified crops (GMOs) bad for me?

There is no evidence genetically modified crops are bad for us. Since they were introduced 20 years ago, genetically modified crops have been studied by many organizations, including the National Academies of Science, Engineering and Medicine (NAS), The U.S. Food and Drug Administration (USDA) and the Environmental Protection Agency (EPA). These studies have found GMO crops to be completely safe for consumption, safe for the environment, and that genetically engineered crops contain just as many, if not more nutrients than non-GMO crops.⁵

How is genetic engineering any different from selective breeding—a process farmers have used for thousands of years?

Genetic modification is a more precise way to create new breeds of crops with desirable traits. For instance, let's say a farmer wants to create a new variety of apple that won't bruise. She chooses to breed together a type of apple that is very hearty but not very sweet with a very sweet, fragile apple. As she breeds the new apple variety, the genetic traits of the two original apples will mingle. The resulting apple will have good traits (less bruising), but it will also have undesirable traits (not as sweet). Genetic modification allows scientists to explore the DNA of an apple and isolate the part of the genetic code that makes that apple bruise-resistant. They can snip that small bit of DNA out of the hearty apple and insert it directly into the DNA of the sweet apple. The resulting apple has all of the positive traits and none of the negative traits!

Make connections!

How does this connect to students?	How does this connect to careers?	How does this connect to our world?
<p>We all rely on the crops that farmers grow. These crops become the food we eat, the clothes we wear and even the fuel we use. In this activity, students will learn about how the food they eat every day is produced. They will also learn about genetically modified organisms (GMOs), something they might have learned about in the grocery store or through the media, and will be able to think critically about these important crops and dispel myths about GMOs.</p>	<p>Geotechnical Engineers— Geotechnical engineers are civil engineers who focus on rock, soil and the general shape of the land. Their understanding of the landscape helps builders to understand the environmental issues they may face during and after construction. They also help to design the irrigation systems that are used on farms.⁷</p> <p>Agricultural and Food Scientists— Agricultural and food scientists research and test crops and farm practices. They also research the soil and how it impacts crop growth.⁸</p> <p>Farmers and Ranchers— Farmers and ranchers operate the farms that produce our food. They produce crops and/or raise livestock.⁹</p> <p>Biological Technicians— Biological technicians work with scientists and medical professionals to conduct lab experiments. They are responsible for testing genetically modified crops to ensure that they are healthy and safe.¹⁰</p>	<p>Governments, farmers and companies bear the responsibility of providing healthy, sustainable food for their peoples. Genetically modified crops help these entities feed the world's growing population, protecting our food source for generations to come.</p>

Blueprint for Discovery

GMO Scavenger Hunt (15 minutes)

1. Begin by drawing a square with nine boxes (like a tic-tac-toe board with borders) on the board.
2. Ask students to raise their hands if they have heard the term "GMO."
3. Have students write down three things they know or have heard about GMOs in the allotted space in the Great Rotations workbook.
4. Ask a few students to share some of their answers. Students might share negative connotations about GMOs and/or names of crops that they believe are GMOs.
5. Explain to students that GMO stands for genetically modified organisms. GMOs are crops whose DNA has been modified to include a strain of DNA from another organism in order to produce a desired trait.
6. Ask students to name a couple of traits that farmers might want their crops to have. Answers might include pest resistance, disease resistance, drought tolerance and appearance/bruise resistance. Explain that by genetically modifying certain crops, farmers have a better chance of growing crops that can be used and eaten.
7. Tell students that one common misconception about GMOs is that they are found in most of the foods we eat. Explain that there are only nine currently approved GMOs available, and it is their job to find them.⁵
8. Provide students with 5 minutes to use a smartphone, tablet or computer to find the 9 GMOs currently approved for consumption. Have students record the GMOs in their Great Rotations workbook. Ask students to come up and fill in the squares on the board one by one with each of the nine GMOs.
9. Ask students to turn to the Reflecting on GMOs page in their Great Rotations workbook.
10. Explain to students that they have been presented with three claims about GMOs.
11. Provide students with 30 minutes to research these claims and write a paragraph response either confirming or refuting the claim. Students should evidence from Digital Exploration as one of their data-based resources.
12. Lead the class in a discussion on how food marketing impacts what we buy and how we eat. Ask students how they can be smart consumers when it comes to agricultural products like meat, dairy and crops.

Lesson Enhancement: Connect the learning on GMOs to the sustainable farm practice of crop rotation with the Great Rotations activity, included in the Get to Know GMOs workbook.

Optional Extension: Have students engage on a fact-finding mission to determine the truth about GMOs. Split the class into two groups, one that is pro-GMO and one that is anti-GMO. Give students 10-15 minutes to research and build their case in these teams. Then, have students debate the following question: are genetically modified organisms (GMOs) good for agriculture?

Take action!

Want to extend the learning on genetic modification and agricultural practices? Explore these resources and classroom activities:

National Agriculture in the Classroom (USDA)

- [AgVenture: Sourcing Ag Careers](#)
- [Applying Heredity Concepts](#)
- [DNA: Expressions in Agriculture](#)
- [Fertilizer and the Environment](#)

Illinois Agriculture in the Classroom

- [The Scoop on Soil](#)
- [Exploring Corn!](#)
- [Super Soybeans!](#)

National Standards

Science	<p><u>Next Generation Science Standards</u></p> <ul style="list-style-type: none">● HS-LS4-6 Biological Evolution: Unity and Diversity Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.● HS-ESS3-1 Earth and Human Activity Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.● HS-ETS1-4 Engineering Design Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.● HS-ESS3-3 Earth and Human Activity Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.● HS-ETS1-1 Engineering Design Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
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Works Cited

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12. Community Manager: GMO Answers. "How Do GMO Crops Impact Soil Health?" Council for Biotechnology Information. January 21, 2015. <https://gmoanswers.com/how-do-gm-crops-impact-soil-health>

Get to Know GMOs Workbook

GMO Scavenger Hunt

You have seen or heard the term “GMO” before. In the space below, write down three things that come to mind when you hear “GMO.”

1.

2.

3.

Now, let's separate GMO fact from GMO fiction...

Fact:

1. Genetically modified crops, or GMOs, are plants whose DNA is altered by humans to produce a desired trait.
2. GMOs help fight plant diseases, curb the spread of pests and eliminate the need for harmful pesticides.
3. GMO crops contain as many nutrients as non-GMO crops and there is no scientific evidence that GMOs are bad for us.⁵

Fiction:

1. All of the food we eat contains GMOs unless it says, “GMO free.”

So, what are the GMOs that we eat and buy? There are just nine GMO crops that have been approved for sale in the U.S. Research and enter the names of these crops, their uses, and their genetic modification in the spaces provided.

The GMOs we know are...

Crop: Use(s): Genetic Modification:	Crop: Use(s): Genetic Modification:	Crop: Use(s): Genetic Modification:
Crop: Use(s): Genetic Modification:	Crop: Use(s): Genetic Modification:	Crop: Use(s): Genetic Modification:
Crop: Use(s): Genetic Modification:	Crop: Use(s): Genetic Modification:	Crop: Use(s): Genetic Modification:

Reflecting on GMOs

Through this activity, you have learned:

1. **What** genetically modified organisms (GMOs) are
2. **Where** to find GMOs in the foods we eat
3. **When** it is helpful for farmers to plant GMO crops
4. **Why** farmers and scientists modify the genetics of certain crops
5. **How** GMOs benefit the soil and create better harvest for farmers ¹²

Read the following three statements on GMOs. Using what you have learned, write a response that either supports or argues against the statement. For each response, include two points of evidence from online sources that support your claim. Be sure to cite your sources.

Response Question #1:

Genetically modified organisms have not been tested enough.

Response Question #2:

Genetically modified organisms are bad for the environment.

Response Question #3:

Genetically modified organisms are responsible for illnesses in humans.

Great Rotations Teacher Guide

Time: 1 session, 45 minutes

Materials:

- Great Rotations capture sheet—one per student
- Smartphone, tablet or computer with access to the internet
- Image annotation app or software program (the iOS/Android app [ThingLink](#) is recommended)
- Whiteboard or chalkboard
- Projector/screen or smartboard

Blueprint for Discovery:

Plan Your Rotation (15 minutes)

1. Have students take out their Great Rotations workbook and turn to the Plan Your Rotation page. Explain that many farmers choose to rotate crops year over year. Ask students to provide guesses as to why farmers might engage in this practice, called crop rotation. Highlight to students that crop rotations have been shown to have the following benefits:
 - a. They help maintain or return nutrients back to the soil
 - b. Crop root systems aerate the soil, making it easier for plants to access nutrients
 - c. Rotation stops the spread of pests and diseases that attack specific crops
 - d. Planting crops helps to prevent soil erosion
 - e. Rotating crops diversifies our food supply³
2. Explain that crops can be divided into three groups:
 - a. Heavy-feeding crops that deplete nutrients from the soil (corn, tomatoes, etc.)
 - b. Light-feeding root crops that bring nitrogen back into the soil (soybeans)
 - c. Cover crops, also known as green manure, that fertilize soil by providing more organic matter (clover and rye)¹¹
3. Divide students into four teams. Assign each team to one of the regions provided on the Plan Your Rotation worksheet. Provide each team with 8-10 minutes to research and select three crops to rotate on their given farm—one heavy-feeding crop, one light-feeding root crop and one cover crop. Explain that each crop must be able to grow successfully in the provided region.

Map it Out (15 minutes)

1. Ensure that each student group has a tablet, smartphone or computer that will allow them to write on a digital image.
2. Provide student groups with 10 minutes to map out their crop rotation on the provided digital image of their farm.
3. Have each of the four groups present their digital image to the class. As students present, have the rest of the class enter their selected crops on their Plan Your Harvest worksheet.

Great Rotations Student Capture Sheet

Have you ever wondered how the crops we grow affect the soil?

Soil is a material made of many things, including decomposed organic matter and lots of little microorganisms. Farmers must keep nutrients like nitrogen and phosphorous in their soil in order to have healthy crops. Most crops like corn and wheat take nutrients out of the soil to grow. If these crops are planted in the same fields year after year, they can deplete the soil and make it challenging to grow more crops. Farmers can do a few things to return nutrients to the soil. For instance, they can add nutrient-rich fertilizers or rotate the crops they grow in their fields. Genetically modified soybeans are resistant to pests and enrich the soil by attracting bacteria that create nitrogen. If a farmer plants corn one year and soybeans the next, the rotation helps to keep their soil healthy.⁶

In this activity, you will work in groups to devise a crop rotation for a specific region. When you have chosen your rotation, use the app [ThingLink](#) to mark the linked picture of your farm with your crop rotation plan.

Objective

You are a team of farmers or ranchers planning a crop rotation. To do this, you must:

- 1.) Look at the farm profiles below to learn the unique needs of your farm
- 2.) Use this information to research and plan a crop rotation of at least 3 crops: one heavy-feeding crop, one light-feeding root crop and one cover crop
- 3.) Make sure each crop is suited to grow in your assigned region
- 4.) Research, select and write your crop in your farm's square below

Farm Profiles

<p><u>Midwestern U.S.</u> Large farm</p> <p>Soil character: Dry Weather patterns: Hot summer, cold winters Equipment level: Sophisticated Needs/Concerns: Fertilization, invasive pests</p> <p>Heavy-Feeding Crop: Light-Feeding Root Crop: Cover Crop:</p>	<p><u>Northeastern U.S.</u> Small farm</p> <p>Soil character: Medium to damp Weather patterns: Mild summer, cold winter Equipment level: Basic Needs/Concerns: Expense, maintenance</p> <p>Heavy-Feeding Crop: Light-Feeding Root Crop: Cover Crop:</p>
<p><u>Southwestern U.S.</u> Large ranch</p> <p>Soil character: Arid Weather patterns: Consistently hot Equipment level: Sophisticated Needs/Concerns: Feed, fertilization</p> <p>Heavy-Feeding Crop: Light-Feeding Root Crop: Cover Crop:</p>	<p><u>Southeastern U.S.</u> Mid-size farm</p> <p>Soil character: Moist Weather patterns: Humid, mild winter Equipment level: Moderate Needs/Concerns: Invasive pests, erosion</p> <p>Heavy-Feeding Crop: Light-Feeding Root Crop: Cover Crop:</p>