Cotton

*Lesson Plan for Grade 4, Science*

*Prepared by NAITC*

*Modified by Mississippi State University, School of Human Sciences*

*for Mississippi Farm Bureau Federation - AITC*

# OVERVIEW & PURPOSE

In this lesson, students will explore the process of genetic engineering and discover the ten genetically modified crops approved in the United States.

# EDUCATIONAL STANDARDS

**Mississippi College-and-Career Readiness Standards:**

L.4.2: Students will demonstrate an understanding of life cycles, including familiar plants and animals (e.g., reptiles, amphibians, or birds).

ELA-RF.4.4 Read with sufficient accuracy and fluency to support comprehension.

**NALOs:**

T4.3-5 b: Describe how technology helps farmers/ranchers increase their outputs (crop and livestock yields) with fewer inputs (less water, fertilizer, and land) while using the same amount of space

T4.3-5 c: Identify examples of how the knowledge of inherited traits is applied to farmed plants and animals in order to meet specific objectives (i.e., increased yields, better nutrition, etc.)

T4.3-5 d: Provide examples of science being applied in farming for food, clothing, and shelter products

# OBJECTIVES

* Students will be able to define Genetically Modified Organisms (GMO).
* Students will be able to identify crops that are genetically modified.

# MATERIALS NEEDED

Interest Approach

* [Do You Know GMO? PowerPoint](https://docs.google.com/presentation/d/1_SMufByWVgaL3h6iJjihOInJaU87g7vT/edit?usp=drive_link&ouid=109918902593538910659&rtpof=true&sd=true)

Activity

* D[o You Know GMO?](https://docs.google.com/presentation/d/1_SMufByWVgaL3h6iJjihOInJaU87g7vT/edit?usp=drive_link&ouid=109918902593538910659&rtpof=true&sd=true) PowerPoint
* [DNA Sam Animation](https://youtu.be/jfML6ThvBWs) video
* [Corn Borer Worm Activity Pictures](https://drive.google.com/file/d/1mRu71O4IcIGgay21Zgkxoa5p9CiQ9o1P/view?usp=drive_link) with a copy of the [Corn Borer Worm Skit](https://cdn.agclassroom.org/media/uploads/2020/09/07/Corn_Borer_Worm_Skit_1.pdf) attached to the back of each picture, 1 for the teacher
* [Draw a Crop](https://drive.google.com/file/d/1W8AmVZhHZLxoNeCGL5XMxeOr5GILBbFN/view?usp=drive_link) Activity Sheet, 1 per student
* [Build a Crop Instructions](https://drive.google.com/file/d/17K5H2qGO2AlGBrMtVc1IKo0ot33kEfEP/view?usp=drive_link), 1 for the teacher
* [Do You Know GMO? Handout](https://drive.google.com/file/d/1umlYdfrhoA8xD080YI4UBNuwBKiGp4yF/view?usp=drive_link), 1 per student

Essential Files:

* [Build a Crop Instructions](https://cdn.agclassroom.org/media/uploads/lp777/Build_a_Crop_Instructions.pdf)
* [Corn Borer Worm Activity Pictures](https://cdn.agclassroom.org/media/uploads/2020/09/07/Do_You_Know_GMO_Activity_Printout.pdf)
* [Corn Borer Worm Skit](https://drive.google.com/file/d/1mRu71O4IcIGgay21Zgkxoa5p9CiQ9o1P/view?usp=drive_link)
* [Do You Know GMO? Handout](https://drive.google.com/file/d/1umlYdfrhoA8xD080YI4UBNuwBKiGp4yF/view?usp=drive_link)
* [Do You Know GMO? PowerPoint](https://docs.google.com/presentation/d/1_SMufByWVgaL3h6iJjihOInJaU87g7vT/edit?usp=drive_link&ouid=109918902593538910659&rtpof=true&sd=true)
* [Draw a Crop Activity Sheet](https://cdn.agclassroom.org/media/uploads/lp777/Draw_a_Crop.pdf)

# Lesson Set Up:

1. Print a copy of the [Corn Borer Worm Activity Pictures](https://cdn.agclassroom.org/media/uploads/2020/09/07/Do_You_Know_GMO_Activity_Printout.pdf) and the [Corn Borer Worm Skit](https://cdn.agclassroom.org/media/uploads/2020/09/07/Corn_Borer_Worm_Skit_1.pdf). Attach the Corn Borer Worm Skit to the back of each of the Corn Borer Worm Activity Pictures.
2. Depending on which activity you choose to do, either have a copy of the [Draw a Crop Activity Sheet](https://cdn.agclassroom.org/media/uploads/lp777/Draw_a_Crop.pdf) for each student or have a copy of the [Build a Crop Instructions](https://cdn.agclassroom.org/media/uploads/lp777/Build_a_Crop_Instructions.pdf) for you to assist students in building their 3-D model.
3. Before class begins, have the PowerPoint [Do You Know GMO?](https://cdn.agclassroom.org/media/uploads/lp777/Do_you_Know_GMO_MicrosoftPPT-2-2.pptx) displayed on the screen.
4. Additionally, have the [DNA Sam Animation](https://youtu.be/jfML6ThvBWs) video pulled up for quick access.

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# VOCABULARY

**agrobacterium:** a type of bacteria that lives naturally in the soil and has a unique ability to transfer its DNA to plants

**bacteria:** a group of single-celled living things that cannot be seen without a microscope that reproduce rapidly and sometimes cause diseases

**disease:** sickness that can be caused by germs

**DNA:** deoxyribonucleic acid - a molecule that carries the genetic instructions used in the growth, development, functioning, and reproduction of all known living organisms

**fertilizer:** a substance used to increase the level of nutrients in soil

**food additive:** a substance added to food to enhance its flavor or appearance or to preserve it

**gene:** a section of DNA that codes for a certain trait

**genetic engineering:** the deliberate modification of the characteristics of an organism by manipulating its genetic material

**genetically modified organism (GMO):** an organism whose genetic material has been modified or altered, especially through genetic engineering techniques

**greenhouse gas:** a gas that contributes to the greenhouse effect by absorbing infrared radiation

**herbicide:** a substance that is toxic to plants and is used to kill unwanted vegetation

**organic:** term used to classify farming methods that limit the use of some common practices such as biotechnology and types of fertilizer or pesticide

**pesticides:** substance used to destroy insects or other organisms harmful to cultivated plants or animals

**resistant:** not affected or harmed by something

**soil tillage:** turning the soil to control for weeds and pests and to prepare for seeding

**sustainability:** a method of harvesting or using resources so that they are not depleted and/or permanently damaged

**tolerant:** ability of a plant or animal to endure

**trait:** a distinguishing characteristic or quality

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# Ag Facts:

* 1,310,000 bales of cotton produced in Mississippi in 2020.
* 780 farms produced cotton in Mississippi in 2020.

# Background information for teachers:

Farmers face risks everyday—weather extremes, pests, and other factors that can negatively affect a plant growing in a field. Drought, flooding, hail, wind, frost, heat, weed population, insect infestations, disease outbreaks, and numerous other elements can adversely impact food production. Despite all that can go wrong, grocery store shelves are stocked and livestock are well fed. Farmers are able to grow usable crops all the way to completion. How is this possible? How are farmers today able to use less land and grow 430% more corn than was grown in 1950? The answer is science, technology, and the ability to harness and apply new ideas and discoveries to improve crop resiliency. **Genetic engineering** (GE) is a development that has majorly impacted agriculture.

Genetic engineering is the deliberate modification of the characteristics of an organism by manipulating its genetic material. The Rainbow papaya is an example of a plant that has been genetically engineered. In the 1990s, the papaya ringspot virus had nearly wiped out the entire papaya industry on the island of Hawaii. However, a scientist named Dennis Gonsalves engineered a papaya tree to be **resistant** to the virus and provided hope and **sustainability** to papaya producers who were facing the loss of their livelihood.Along with papaya, other GE crops that are on the market as of 2020 in the United States include corn (field and sweet), cotton, canola, apples, alfalfa, potatoes, soybeans, summer squash, and sugar beets. Each crop was engineered for different reasons, including drought **tolerance**, **herbicide** tolerance, insect resistance, **disease** resistance, and non-browning ability. Along with protecting the livelihoods of farmers, GE can benefit the environment due to less **pesticide** use, less **soil tillage**, and less **greenhouse gas emissions**.

The process of genetically engineering a plant has four main steps—identifying the problem, finding the solution, inserting the desired **gene**, and growing the engineered plant. Identifying the problem that needs to be solved for a specific crop is the most straightforward step. In the case of the papaya, the problem was the ringspot virus. After identifying the problem, scientists search for the specific gene sequence that expresses the desired **trait**. When insect-resistant corn was being developed, scientists found the desired gene sequence in the Bacillus thuringiensis (Bt) bacteria. Once the desired gene is found, it needs to be inserted into the plant. Originally, this was accomplished by a machine called the gene gun, which bombarded plant tissue with microscopic pieces of gold covered with millions of copies of the desired gene; however, the method used today is far more advanced and precise. Scientists genetically engineer plants through **agrobacterium**. Agrobacterium is a **bacteria** found naturally in soil. It infects wounded plants and inserts a portion of its own **DNA** into the plant's DNA, forcing the plant to create food for the bacteria and killing the plant. Scientists used this knowledge and were able to engineer the bacteria to insert one special gene, such as the Bt gene in corn, in place of the bacteria of the gene that kills the plant. Finally, the plant is grown in order to determine if the desired trait is expressed and to test for possible consumer health and environmental impacts.

**Genetically Modified Organism** (GMO) is the broad term for any plant that has undergone the process of genetic engineering. GMOs go through an extensive testing process that lasts many years. Testing is implemented by the Environmental Protection Agency (EPA), the Food and Drug Administration (FDA), and the United States Department of Agriculture (USDA). Once all regulatory processes are complete, the plant can be approved for commercial use. Scientists and the majority of health organizations around the world agree that GMO crops are safe for human and animal consumption.

Consumers who prefer not to eat GMOs have options. In recent years, some agricultural producers have made the decision to produce **organic** food which is grown without the aid of synthetic pesticides or chemical **fertilizers**, and produced without the use of genetically modified organisms or chemical **food additives**.

# LEARNING PROCEDURES

Interest Approach:

1. Project slide 1 of the [Do You Know GMO?](https://cdn.agclassroom.org/media/uploads/lp777/Do_you_Know_GMO_MicrosoftPPT-2-2.pptx) PowerPoint. Ask the students to raise their hand if they have ever heard of a GMO. Ask, "What does GMO stand for?"
2. Show slide 2 and explain that GMO stands for Genetically Modified Organism.
3. Show slide 3 and ask the students to raise their hand if they have seen labels like these before. Ask, "What do these labels mean?" (*Manufacturers sometimes put these labels on their products to show that the food has been genetically engineered.*)
4. Show slide 4 and ask students to raise their hand if they have heard of genetic engineering. Ask, "Did you know scientists can change the genes in a plant?"
5. Explain to the students that they will be exploring DNA so that they can better understand genetic engineering.

Procedures

1. Project slide 5 of the [Do You Know GMO?](https://cdn.agclassroom.org/media/uploads/lp777/Do_you_Know_GMO_MicrosoftPPT-2-2.pptx) PowerPoint. Explain to the students that in order to understand genetic engineering, they must first know what DNA is. Lead a discussion about DNA. Include the following points in the discussion:
   1. DNA stands for deoxyribonucleic acid.
   2. DNA is the building block of all living organisms.
   3. DNA gives each living organism its own unique traits and characteristics.
   4. Traits are found in sections of DNA called genes.
2. Show slide 6 and play the [DNA Sam Animation](https://youtu.be/jfML6ThvBWs).
3. Show slide 7. Choose four students to come to the front of the room and assign them each a [Corn Borer Worm Activity Picture](https://cdn.agclassroom.org/media/uploads/2020/09/07/Do_You_Know_GMO_Activity_Printout.pdf)with the[Corn Borer Worm Skit](https://cdn.agclassroom.org/media/uploads/2020/09/07/Corn_Borer_Worm_Skit_1.pdf)attached to the back of each picture. Explain that the two corn kernel images represent two corn genes, the worm represents the corn borer worm, and the Bt gene represents one gene from the Bt bacteria that is resistant to the corn borer worm.
4. Have the corn genes stand together on one side of the room, the Bt gene stand on the opposite side of the room, and the corn borer worm stand next to the corn.
5. Have the students read the skit to demonstrate how corn was genetically modified:
   1. **Corn borer worm**: The corn borer worm is a real problem farmers face today. (*Point to the picture on the screen.*) As you can see by the picture, the corn borer worm destroys corn.
   2. **Corn genes**: Scientists were able to help farmers by genetically engineering corn.
   3. **Bt gene**: Scientists found a gene in Bt bacteria that the corn borer worm does not like. (*Move in between the two corn genes.*) The scientists moved that special gene into the corn's DNA.
   4. **Corn borer worm**: (*Move away from the two corn genes with fear.*)
   5. **Corn genes**: Now that the Bt gene is in the corn, the corn is resistant to the corn borer worm.
6. Have the students return to their seats and show slide 8. Explain that moving genes is not as easy as what just happened in the skit. Real genes are microscopic. We will look at two methods of genetic engineering.
7. Show slide 9 and explain that the first method scientists used to genetically engineer plants is the gene gun. The gene gun is an amazing machine that shoots microscopic pieces of gold covered with billions and billions of copies of the one special gene into a plant cell with hopes that one of those copies will insert itself into the plant's DNA. The gold dissolves quickly and does not affect the plant cell.
8. Show slide 10 and explain that another way scientists genetically engineer plants is through agrobacterium. Agrobacterium is a bacteria found naturally in soil. It infects wounded plants and inserts a portion of its own DNA into the plant's DNA, forcing the plant to create food for the bacteria and killing the plant. Scientists used this knowledge and were able to engineer the bacteria to insert one special gene, such as the Bt gene in corn, in place of the bacteria of the gene that kills the plant.
9. Show slide 11 and explain that there are ten genetically engineered crops approved in the United States.
10. Show slide 12 and have ten students each read one of the ten GMO crops. Explain that an easy way to remember the ten crops is by remembering the word C3A2P2S3.
    1. C3 = Corn, Cotton, Canola
    2. A2 = Apples, Alfalfa
    3. P2 = Potato, Papaya
    4. S3 = Soybeans, Summer Squash, Sugarbeets
11. Show slides 13-22 and explain what problem each crop is genetically engineered to overcome. As appropriate, ask the following questions:
    1. Have you ever eaten this crop?
    2. What do we use this crop for?
    3. What can be made with this crop?
12. Have the students either draw one of the ten crops using the [Draw a Crop](https://cdn.agclassroom.org/media/uploads/lp777/Draw_a_Crop.pdf) activity sheet or build a 3-D model of an apple, corn, cotton, canola, or a potato by following the [Build a Crop Instructions](https://cdn.agclassroom.org/media/uploads/lp777/Build_a_Crop_Instructions.pdf).

Many seed varieties are available to farmers. Just because there is a GMO seed variety available (as in the case of corn, cotton, canola, apples, alfalfa, potato, papaya, soybeans, summer squash, and sugarbeets), it does not mean that all farmers grow the GMO variety. Farmers select plant varieties to meet the needs of their farm. In some cases it might be a GM variety, and in other cases it will not.

**Concept Elaboration and Evaluation**

* Show slides 23-34 and ask students the questions on the slides to review what they learned. Click on the following slide to reveal the answer.
* Provide each student with the [Do You Know GMO? Handout](https://cdn.agclassroom.org/media/uploads/lp777/Do_You_Know_GMO_Handout-1.pdf).

# Additional Learning Procedures

To help students review and elaborate more about cotton, try using the “[Think Pair Share](https://drive.google.com/file/d/1N1w_FTb0MBHHE9X2c6YojqkAN_QQH8UN/view?usp=drive_link)” method to allow students to think deeper and make new connections.

Additional Text to Include:

[Eli Whitney and the Cotton Gin](https://www.agfoundation.org/recommended-pubs/eli-whitney-and-the-cotton-gin)

[From Cotton to T-Shirt](https://www.agfoundation.org/recommended-pubs/from-cotton-to-t-shirt)

[The Invention of the Cotton Gin](https://www.agfoundation.org/recommended-pubs/the-invention-of-the-cotton-gin)

Source: <https://www.agclassroom.org/teacher/matrix/>

*The MS Farm Bureau Women’s Committee has additional resources to help aid you in this lesson such as a cotton gin, please contact Dedra Luke at 601-977-4169 to learn more!*

*For more information and additional lessons visit*

*https://msfb.org/ag-in-the-classroom/lesson-plans/.*