

FEAST OR FAMINE?

Are GMO's (Genetically Modified Organisms) the Answer?

GRADE LEVELS

10-12

TIME ALLOTMENT

Four class periods of 45-minutes each

OVERVIEW

In this lesson students will learn about what genetically modified organisms (GMO's), how they are modified, and the pros and cons to using them. They'll investigate Web resources to answer fundamental questions about and to understand the issues around the development and use of GM foods. Students will share this information as "experts" in a roundtable discussion. The lesson concludes with students writing a position paper to outline their recommendations for the development and use of GMO's backed by the scientific basis for these reasons. These papers will then be presented to a mock congressional committee making decisions on the development and use of GMO's.

SUBJECT MATTER

Science

LEARNING OBJECTIVES

Students will be able to:

- Identify what foods are currently genetically modified.
- Determine how plants are genetically modified using current terminology: vectors, cloned gene, and transfection.
- Identify the advantages and disadvantages of genetically modifying foods.

- Analyze the arguments supporting and discouraging the use of GMO's.

STANDARDS

The Maine Learning Results Standards:

<http://www.state.me.us/education/lres/lres.htm>

Science and Technology

A. Classifying Life Forms, grades 9-12

Students will understand that there are similarities within the diversity of living things.

1. Explain the role of DNA in resolving questions of relationship and evolutionary change.
3. Analyze the basic characteristics of living things including their need for food, water, and gases and the ability to reproduce.

B. Ecology, grades 9-12

Students will understand how living things depend on one another and on non-living aspects of the environment.

3. Analyze the factors that affect population size (e.g., reproductive and survival rates).
4. Analyze the impact of human and other activities on the type and pace of change in ecosystems.

C. Cells, grades 9-12

Students will understand that cells are the basic units of life.

2. Illustrate how cells replicate and transmit information, including the roles of DNA and RNA.
5. Analyze and debate basic principles of genetic engineering: how it is done, its uses and some ethical implications.

D. Continuity and Change

Students will understand the basis for all life and that all living things change.

1. Explain how mutations can be caused by gene mutation or chromosomal alteration and describe the possible results of such mutations on individuals or populations.
4. Describe how genetic manipulation can cause unusually rapid changes in species.

NATIONAL SCIENCE EDUCATION STANDARDS**F. Science in Personal and Social Perspectives**

Changes in environments can be natural or influenced by humans. Some changes are good, some are bad, and some are neither good nor bad. Pollution is a change in the environment that can influence the health, survival, or activities of organisms, including humans.

MEDIA COMPONENTS**Video**

PBS: Frontline: "Harvest of Fear,"
A Frontline/NOVA Special

Web sites**Frontline: Harvest of Fear**

<http://www.pbs.org/wgbh/harvest>

This Web page is designed to answer questions raised by the video. Shockwave and Flash plug-ins are required to access this site.

**Colorado State University Transgenic Crops:
An Introduction and Resource Guide**

[http://www.colostate.edu/programs/lifesciences/
TransgenicCrops/](http://www.colostate.edu/programs/lifesciences/TransgenicCrops/)

The site gives an introduction and resource guide to transgenic crops.

MATERIALS**Per class**

- VCR and TV
- Computers and Internet access

Per student

- GUESS WHAT'S COMING FOR DINNER? Worksheet
- HARVEST OF FEAR Worksheet
- ENGINEER A CROP Worksheet
- GUESS WHAT'S COMING FOR DINNER? Worksheet

PREP FOR TEACHERS

- Bookmark all Web sites.
- Load the plug-ins Shockwave and Flash plug-ins onto the computer(s).
- Preview the video and cue it the appropriate starting point.
- Make a copy of each student worksheet for every student.

INTRODUCTORY ACTIVITY**Step 1**

Have students explain how traditional plant breeding happens. Write their explanations on the board as they respond.

- Traditional breeding involves all the genetic materials from two related plants. The pollen from one is transported from the anther to the stigma of another. The seeds will have the desired combination of traits (hybrid).

Step 2

Ask students how define Genetically Modified Organisms. Discuss students' answers.

- The terms "GM foods," or "GMO's," are most commonly used to refer to crop plants created for human or animal consumption using the latest molecular biology techniques.

Step 3

Ask if students can explain or predict the process of genetic engineering and how it differs from traditional breeding.

- In genetic engineering, you are transferring one or two desired genes that are new to a plant. The source of the genes does not have to be closely related. Genetically modified foods are plants in which one or two genes have been inserted to give them a specific trait.)

Step 4

Explain that students will be working in teams of two to learn as much as each student can about how plants are genetically modified and the issues surrounding their use. Distribute the HARVEST OF FEAR Worksheet to each student. Ask students to read through the question as you **CUE** the PBS video, "Harvest of Fear." Provide students with a **Focus for Media Interaction**: instruct them to write their answers on their Worksheet as they identify the answers while viewing the

video. **START** the video at the beginning of the tape. **STOP** the video after about 40 minutes at the **AUDIO CUE** of the Minnesota farmer describing what they wear when they spray for pesticides. You will hear the farmer say, "Don't want the grandkids around. Those are the types of things we don't have to have around with BT corn."

Give students enough time to complete the worksheets. Once the worksheets are completed, discuss student answers.

Step 5

Provide students with a **Focus for Media Interaction** and distribute the GENETICALLY MODIFIED FOODS BENEFITS/RISKS Worksheet. Ask students to log on to the **Colorado State University Transgenic Crops** Web site at <http://www.colostate.edu/programs/lifesciences/TransgenicCrops/>. Give students an opportunity to read through the home page, then, ask students to click on the "Risks & Concerns" link on the navigational bar to the left. Have teams of students work through the sheet as they investigate this area of the site. They should be sure to cite any health, environmental, and economic risks and benefits they read about. Discuss the answers students recorded on their Worksheet.

LEARNING ACTIVITY

Assemble students into teams. Now ask them to log on to the **Harvest of Fear** Web site at <http://www.pbs.org/wgbh/harvest>. Distribute the GUESS WHAT'S COMING FOR DINNER? Worksheet as a **Focus for Media Interaction**. Ask students to list any GM foods they find that are currently on the market. On the Web site, direct students to the "Guess What's Coming for Dinner" option. Then, students should click on the animation button to the right. There will be a fly circling a table of food. When students click on the plates of food, they will find a description of the food, the engineered traits, sources of new genes being tested, and the commercial name. Working with a partner, have students complete the GUESS WHAT'S COMING FOR DINNER? Worksheet. Discuss what students have learned about these genetically modified foods.

Provide a **Focus for Media Interaction** by distributing the ENGINEER A CROP Worksheet. While still on the **Harvest of Fear** Web site, have students click on the "Engineer a Crop" link from the home page. Ask the teams of students to answer the Worksheet questions about how selective breeding differs from transgenic manipulation.

- A transgenic crop plant contains a gene or genes that have been artificially inserted instead of the plant acquiring them through pollination. The inserted gene sequence (known as the transgene) may come from another unrelated plant, or from a completely different species: transgenic BT corn, for example, which produces its own insecticide, contains a gene from a bacterium. Plants containing transgenes are often called genetically modified or GM crops, although in reality all crops have been genetically modified from their original wild state by domestication, selection and controlled breeding over long periods of time.

Provide students time to complete the Worksheet. Discuss the answers students discovered.

CULMINATING ACTIVITY

Step 1

Ask students to formulate an opinion about GMO's and provide scientific reasons why we should or shouldn't use GMO's. Instruct each individual student to write a position paper, providing information and scientific facts to substantiate their point of view. With their partner, students must prepare a presentation for another class. Students will be paired with another team that has the opposing view to present a debate to the audience.

If possible, have the second partner videotape the presentation while the other student speaks. Explain to students that their audience might know very little about the subject, and may understand none of the scientific facts about GMO's. Stress that the presentations should be clear and descriptive.

Step 2

Students will read and/or present their position papers to their audience. Alternate proponent and opponent speakers and be sure that students are aware of timing their responses so that the opposing team of students has time to present their point of view. The speakers should leave enough time for questions and answers from the audience.

Back in the assigned class, have students report on their presentations to the other class, and, if possible, show the videotape. How did the audience react to each of the views? Discuss what types of questions the audience asked, making sure to present both the pro and con views of GMO's. Discuss whether the issues about the use of GMO's were presented appropriately.

CROSS-CURRICULAR EXTENSIONS**Social Studies**

Take students on a field trip to meet with a state or federal legislator. Ask students to identify how policy is established for the use of new consumable products on the market. Have students identify the relationship between politics, economics, and science and report their findings and discoveries to the class.

Communication/Speech

Ask students to prepare a debate about the issue of labeling genetically modified foods.

COMMUNITY CONNECTIONS

Have students identify where starvation occurs in the world. What are the growing conditions in these areas? How much arable land is available for farming? What measures are currently employed in these areas to reduce starvation? Invite guest speakers from the standard farming community, the organic farming community, and farmers growing GMO's to present their opinions.

TEACHER RESOURCES**Biotechnology Industry Organization**

<http://www.bio.org/about.asp>

This Web site gives the industry position on food and agricultural biotechnology. It includes discussion on food labeling and government regulation information and lists production or coming to market products.

Article by Channapatna S. Prakash

<http://www.plantphysiol.org/cgi/content/full/126/1/8?view=full%20&pmid-11351063>

An article that explains "The Genetically Modified Crop Debate in the Context of Agricultural Evolution."

Agribiological Foundation

<http://www.agbioworld.org>

This Agribiological Foundation site provides information on supporting the use of GMO's, including endorsements from famous scientists.

Union of Concerned Scientist

<http://www.ucsusa.org>

This site gives information on biotechnology and genetically engineered crops. HARVEST OF FEAR
Student Worksheet

HARVEST OF FEAR

Student Worksheet

NAME: _____

1. What are "Frankenfoods?"
2. What is the importance of the papaya crop in Hawaii?
3. From what organism is the gene that is used to modify papaya?
4. How are these genes inserted into plants?
5. What is meant by the term "Transgenic?"
6. Where does the gene for BT corn come from?
7. Name two other crops that have been genetically modified:
8. Name one environmental consideration in support of GM foods:

HARVEST OF FEAR

Teacher Answer Sheet

NAME: _____

1. What are "Frankenfoods?"
 - Answer: Genetically modified foods.

2. What is the importance of the papaya crop in Hawaii?
 - Answer: It is a major food source and economic crop in Hawaii.

3. From what organism is the gene used to modify papaya?
 - Answer: It came from a harmless gene from the ring spot virus.

4. How are these genes inserted into plants?
 - Answer: "Gene gun." Tiny tungsten balls with the gene of interest attached which are then fired into the leaf of the plant.

5. What is meant by the term "Transgenic?"
 - Answer: Containing genes from two different organisms.

6. Where does the gene for BT corn come from?
 - Answer: From the origin of the gene used: *Bacillus thuringiensis*.

7. Name two other crops that have been genetically modified:
 - Answer: Potatoes, rice, cotton.

8. Name one environmental consideration in support of GM foods?
 - Answer: It reduces the amount of pesticides sprayed into the environment.

ENGINEER A CROP

Student Worksheet

NAME: _____

1. How would you produce a crop with a specific trait using selective breeding?
2. How many seasons or generations would it take to produce this new crop by selective breeding?
3. How do you make a plant transgenic?
4. How did you make the tomato crop insect resistant?
5. How many steps does it take to produce a transgenic plant?
6. Name two advantages to transgenic manipulation:
7. Name two disadvantages to transgenic manipulation:

ENGINEER A CROP

Teacher Answer Sheet

NAME: _____

1. How would you produce a crop with a specific trait using selective breeding?
 - Answer: A Farmer would save the seeds from the "best" plant and grow them next season.
2. How many seasons or generations would it take to produce this new crop by selective breeding?
 - Answer: Four seasons
3. How do you make a plant transgenic?
 - Answer: One or more genes are artificially inserted into the DNA of the plant's chromosomes. The gene can come from the same type of plant, but sometimes it comes from another types of plant or even another type of organism.
4. How did you make the tomato crop insect resistant?
 - Answer: You first add a gene to a vector, and then add the vector to *Agrobacterium tumefaciens* (a bacterium that causes disease in plants) by transferring a portion of its DNA into plant cells. This bacterium will grow and divide on a media plate. Now add small pieces of tomato plant leaf to the bacteria. The DNA of the bacteria enters the cells of the leaf. Move the plant cells to the growth medium for plants. Spray herbicide on the plant cuttings. Only the ones with the new gene will then survive.
5. How many steps does it take to produce a transgenic plant?
 - Answer: Six
6. Name two advantages to transgenic manipulation:
 - Answer: It is faster to develop and a less random process.
7. Name two disadvantages to transgenic manipulation:
 - Answer: Inserting new genes may lead to problems with resistance, allergenicity or toxicity. Report genes may also cause problems in the environment.