Genetic Engineering & Genetically Modified Organisms: Forming Informed Opinions

By Smith, Lisa

Scientific Theme(s):
Science and Technology
*Relationships among science, technology, and society

Grade Level(s):
6-8

Lesson Duration:
Designed for one 70 minute lesson

Overview

This lesson provides students an introduction to genetic engineering and genetically modified organisms, and raises student awareness of the potential bias of available information and the importance of forming informed, defendable opinions regarding controversial topics in science.

The lesson was designed as an introduction for students to the genetic engineering and genetically modified organisms in preparation for a two-week research project exploring GMO topics, culminating with student presentations giving their opinions on the topics.

Objectives

Students will:

1. Define the term, 'biotechnology'.
2. Understand the difference between selective breeding and genetic engineering.
3. Identify different applications of genetic engineering, and recognize that all genetically engineered organisms are genetically modified organisms (GMOs).
4. Recognize bias in print media, and to be aware of the need to identify sources.
5. Understand the importance of forming informed, defendable opinions.

Grade Level Expectations (GLEs) Addressed

Science as Inquiry and Process
[7] SA2.1 identifying and evaluating the sources used to support scientific statements

Science and Technology
[7] SE1.1 describing how public policy affects the student's life (e.g., public waste disposal)
[7] SE3.1 recognizing the effects of a past scientific discovery, invention, or scientific breakthrough (e.g., DDT, internal combustion engine)

Required Background

This lesson builds upon concepts covered in previous lessons on DNA, genes, and heredity. Students should have a solid understanding of the basics of these concepts, including the idea that DNA is the "blueprint" of life, that genes are coding regions of DNA, and that traits encoded by genes can be inherited.

Prior to the lesson, teachers can find relevant information about GMO products, as well as some arguments both in support of, and against, genetic engineering of foods can be found at:
http://access.teachersdomain.org/resources/tdc02/sci/life/gen/breeding/index.html

Vocabulary

Biotechnology
Breeding
Selective Breeding
Genetic Engineering
Genetically Modified Organism (GMO)

Materials

(Print materials can be found at end of lesson plan)

- Food item (boxed, canned, etc.) displaying a "Non GMO" or "No GMO" label (or something GMO related)
- KWL Chart
- Video: Classical vs. Transgenic Breeding, from NOVA/Frontline "Harvest of Fear", available at: *http://www.pbslearningmedia.org/resource/tdc02.sci.life.gen.breeding/classical-vs-transgenic-breeding/*
- 3 x GMO information flyers (two biased, one balanced). Electronic copies available at: http://www.yesmagazine.org/for-teachers/curriculum/curriculum-resources-the-debate-on-genetically-modified-organisms-gmos
- Photo slideshow of GMO organisms, available at: *http://www.reuters.com/news/pictures/slideshow?articleId=USRTXTZ7A*

Activity Preparation and Procedure

1. Begin the class by displaying the GMO labeled food item to students. Most students will associate the term "GMO" with food products. Some students may be unfamiliar with the concept of "GMOs"; this is okay. The lesson is designed as an introduction to the topic.
2. Ask students to fill out the "K" and "W" portions of the provided KWL chart, allowing sufficient time for students to generate observations and questions. (~5 minutes)
3. As a class, discuss some of the answers and questions generated in the KWL charts. Write some of these on the board. Discuss where students have seen the "GMO" mark, and other possible examples of genetically modified organisms. Generate a list of questions that the class would like to know answers to. (~5 minutes)
4. Provide vocabulary to students, taking time to discuss each term and providing examples with the students as definitions are provided. Students may need clarification on the difference between 'breeding' and 'selective breeding'. Discussing the selective breeding of domestic dogs from wolves is an example that most students can relate to. If time permits, students may find interesting the Russian study in domestication of fox via selective breeding (http://blogs.scientificamerican.com/guest-blog/2010/09/06/mans-new-best-friend-a-forgotten-russian-experiment-in-fox-domestication/) (~6-10 minutes)
5. Emphasize that both 'selective breeding' and 'genetic engineering' are forms of bioengineering, one being a more traditional approach, and the other taking advantage of technological advances. Here, show the NOVA video, "Classical vs. Transgenic Breeding". After watching the video clip, discuss with the class some of the differences between the classical approach to breeding, and the transgenic approach. (NOTE: It may be necessary to explain the term "Transgenic" to students, who may not associate it with

"genetic engineering"). Discuss and ask for student opinions about the introduction of various plant, animal, and insect genes to the food we eat. (~10 minutes)

6. Ask students if they can think of any examples of genetic engineering in non-food organisms. Pull up the slideshow of various genetic organisms, and go through the images and captions with students. Be sure to emphasize that in addition to the 'cool' modifications that can be made (glowing animals), the genetic modifications may have more applicability (generation of medicines, improving agricultural and farming throughput). As a class, discuss what they perceive to be possible benefits and potential consequences of genetic engineering. (~10 minutes)
7. Use the discussion of "pros" and "cons" to transition to the next activity: identifying bias in sources. Explain the importance of identifying bias and finding credible sources in print media. Using the three provided fliers, go over each as a class, assessing the information provided and determining whether the flyer appears to be favorably or negatively biased, or whether it provides balanced information. Fliers may be distributed to individual students, groups of students, or projected via powerpoint or overhead projector. Identify the publisher of the flyer and their sources, and consider whether the presented information is likely to be credible. Ask students to vote on which poster they felt provided the most credible information. (~15-20 minutes)
8. Using the last 5-10 minutes of class, ask students to fill in the last column "L" of their KWL charts. Review the class KWL chart to ensure questions from earlier have been addressed. Ask students to share examples of things that they have learned from the lesson. Students should turn in their KWL charts.

Assessment

Questions should be utilized throughout the lesson as a means of formative assessment to gauge student understanding of discussion topics. Make adjustments to the class discussion as needed to address any areas of confusion.

Students' completed KWL charts can be used as another means of formative assessment.

Complementary/Extension activities may also be used as formative assessment.

Complementary Activities and Extension Ideas

Activity #1. Design a GMO

Give the students the following question: "If you could engineer an organism, what would you engineer, and why? What impact would your genetically modified organism have on the environment/society?"

Ask students to write a paragraph addressing the question, and then draw a picture of their engineered organism. Have students share their organisms with the classroom.

Activity #2. GMO poster

Break students into groups of 3-4. Assign each group a GMO. Possible examples include: FlavrSavr Tomatoes, Golden Rice, and Corn. Give students time to research each modified food, and to design an infographic for the food. Infographics can be biased or balanced, but be sure that each group identifies their graphic as positively biased, negatively biased, or balanced. For those that are biased, ask students to provide examples of what information can be added/subtracted to produce a more balanced poster.

References

Loosely adapted from:
NOVA. (2001). "Harvest of Fear". *NOVA Web site*. 12 December 2013. http://www.pbs.org/wgbh/harvest/

Name:_____

KWL

What do you **K**now?	What do you **W**ant to know?	What have you **L**earned?

Name:_____

KWL

What do you **K**now?	What do you **W**ant to know?	What have you **L**earned?

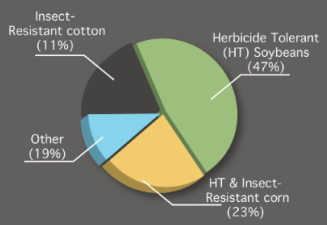
What do you know about GMOs?

A genetically modified organism (GMO) is an organism altered to incorporate genes with a desirable trait. GM crops are plants whose DNA have been genetically modified and used in agriculture.

Genetically Engineered... to do what?

Commercially

GMO crops, as a % of total biotech area



In Research

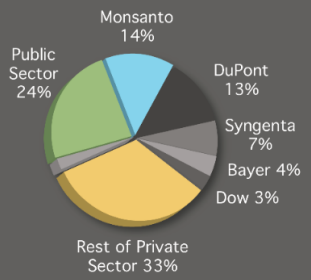
Enhanced Nutritional Content
Beta-carotene producing "Golden Rice" to help with widespread Vitamin A deficiency in developing nations.

Salination and Drought Tolerance
Drought will likely cause salination of arable lands by 2050. Promising genetic modifications to corn will increase heat and salinity tolerance.

Non-food Applications
GMOs are being explored for medicine (vaccines, monoclonal antibodies) and industry (biofuels, plastics).

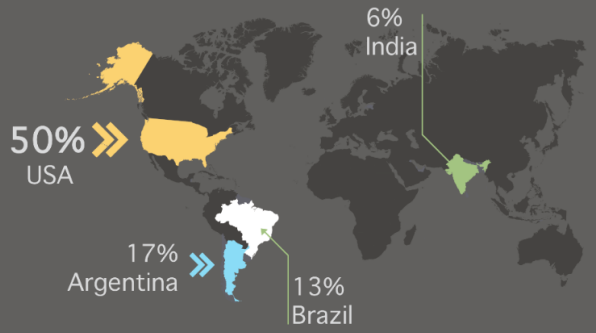
Who owns it?

Biotech patent ownership



Who grows it?

% World GMO Crop Area by country



9 of every 10 farmers planting GMOs are resource-poor and living in developing countries.

the good

Reduction in insecticide use
As adoption of insect-resistant crops has increased, insecticide usage has decreased.

Can produce higher yields
To varying degrees, GMO crops have produced higher yields, largely due to improved pest control.

Benefits for farmers
Many GMO farmers have experienced increased profitability, decreased exposure to pesticides and improved crop management.

Can provide defence against aggressive disease
In the 90s, Hawaii's papaya industry faced a crisis as the due to the Papaya ringspot virus (PRSV). A GMO variety of papaya with resistance to PRSV saved the industry.

May help fix big world problems
"Agricultural biotechnologies provide opportunities to address the significant challenges of ensuring food security without destroying the environmental resource base."
-- Food and Agriculture Organization of the UN

the bad

Concerns about health
Use of an allergenic protein in a GMO crop could result in allergic reactions. The WHO raises concerns about potential gene transfer of antibiotic resistance.

Concerns with IP ownership
GMO opponents are concerned that corporations will charge unreasonable rates for GMOs and subsequently hurt economies and the viability of small farms.

Superbugs and superweeds
Herbicide-resistant weeds and insecticide-resistant bugs can arise from the use of the HT and Bt GMOs, potentially negating many future GM benefits.

Lack of transparency
In the US, there is no mandatory labeling of GMOs. While an estimated 70% of foods sold in the US contain GMOs, the lack of labeling prevents consumers from making an informed decision.

May cause big world problems
Gene transfer from GMO crops could contaminate non-GMO crops and wildlife. Genetic modifications could create super-invasive species. Opponents are concerned about these and other unknowns.

and the ugly

The conversation is confusing & sensational
"In the debate over biotech crops, differentiating fact from fiction is not easy. The debate has been confused by the influence of rigid, absolutist views (both supportive of and opposed to biotech crops)."
--International Food Policy Research Institute

Major GMO producers are hard to trust
Much of commercially available GMOs are from Monsanto, who has violated the public trust over PCBs and other issues in the past. Without proper regulation, GMO opponents fear that companies producing GMOs will prioritize profits over human welfare and the environment.

Sources: FAO :: WHO :: Nature :: American Phytopathological Society :: National Academy of Sciences :: WSJ.com :: ISAAA :: St George's University of London :: washingtonpost.com
Full sources available at visualism.org

Created by Visualism.org

ACTIONS SPEAK LOUDER *Than Words*

THE TRUTH ABOUT BIOTECHNOLOGY

THE TALK	THE TRUTH
GMO FOOD IS DANGEROUS AND UNHEALTHY	**GMO FOODS ARE NUTRITIONALLY AND CHEMICALLY IDENTICAL** TO FOOD GROWN FROM NON-BIOTECH CROPS And GMO foods are still exhaustively assessed for safety by groups like the FDA and the USDA.
BIOTECHNOLOGY IS BAD FOR THE ENVIRONMENT	IN 2009, BIOTECHNOLOGY HELPED FARMERS REDUCE CO_2 EMISSIONS BY 39 BILLION POUNDS That's the same as removing 8 MILLION CARS FROM THE ROAD FOR THE ENTIRE YEAR
BIOTECHNOLOGY IS A NEW AND UNPROVEN SCIENCE	FOR ROUGHLY 10,000 YEARS, OUR ANCESTORS HAVE BEEN GENETICALLY ALTERING PLANTS AND SEEDS TO DEVELOP THINGS LIKE: CHEESE BREAD WINE BEER Modern biotechnology simply offers a quicker, more efficient path to accomplishing the same goals.

BOTTOM LINE

In the 12-plus years that modern biotech crops have been commercially grown, there has not been a single documented case of an ecosystem disrupted or a person made ill.

SOURCES: BestFoodFacts.org
International Service for the Acquisition of Agri-Biotech Applications
Biotechnology Industry Organization

commonground™
Conversations About Farming and Food

FindOurCommonGround.com

Brought to you by America's soybean and corn farmers and their checkoffs.

WHAT ON EARTH ARE "GMOs"?

Genetically Modified Organisms are experimental plants or animals that have been genetically engineered in a laboratory with DNA from other plants, animals, bacteria & viruses

WHY GMOs?

There are two main reasons

1. Seed producers modify their seed to make it resistant to their brand of herbicide

2. Seed producers modify plants to contain built-in pesticides

GMO INGREDIENTS ARE FOUND IN 80% OF PACKAGED FOODS IN THE US

GMO crops are also added to processed foods as oils, sweeteners & soy proteins and in things like amino acids, aspartame, vitamin C, flavorings (natural & artificial), maltodextrins and more

GMO CROPS GROWN IN THE US

Percentage of each crop that is GMO, 2010

- 86% Corn
- 90% Canola
- 93% Soy
- 93% Cotton

HEALTH

GMOs have not been proven safe. The long term consequences of GMOs on our health & environment have not been adequately investigated

AVOIDING GMO INGREDIENTS

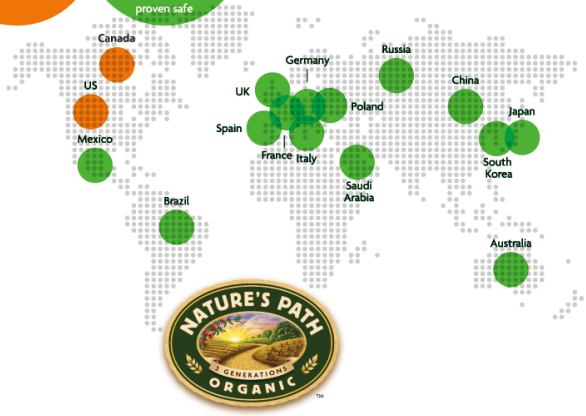
Organic Food
The USDA Certification states that "The use of genetically engineered organisms and their products are prohibited at any stage in organic production, processing or handling."

NON-GMO Project Verified Products
Products bearing this seal have undergone independent testing to ensure they have been made according to best practices for GE avoidance

LABELING & BANS

No
The United States and Canada do not require labeling of genetically engineered foods

Yes
In 40 countries, incl. Australia, Japan and all European Union nations, there are significant restrictions or outright bans on the production of GMOs because they are not considered proven safe



NATURE'S PATH
3 GENERATIONS
ORGANIC

Sources: Organic Consumers Association, Greenpeace, Non-GM O Project, Grocery Manufacturers' Association