STSE Case Study
Genetically Modified Foods

Introduction

Genetically Modified Foods (GM foods) have been highlighted in the news and other public forums recently. In the light of controversial information, many public interest groups are actively protesting the production and sale of GM foods worldwide. In response large biotechnology companies (like Monsanto, Novartis and Agrevo) continue to reassure the public of the safety and potential benefits of GM products. The fears and issues surrounding GM foods are wide-ranging including social, environmental, economic and health aspects. It also brings into question the reliability and credibility of information that both sides claim to be "scientific".

WISE Issue	Resources/Factors in Decision-making			WISE Action
Impact of Genetically Modified Foods on societies	**STSE Expertise** **Possible health, societal and environmental impacts associated with the consumption and production of GM foods.**	**Products Expertise** **Ability to discuss the use of simple genetic engineering techniques to produce new varieties of crops and livestock**	**Activism Expertise** **-Decision making-weighing scientific and non-scientific evidence** **-Developing and carrying out an action plan**	**Possible action projects:** **-Education campaigns about alternatives to avoid GM foods** **-Lifestyle changes e.g. choosing organic alternatives, eating fresh instead of packaged foods** **-Lobbying/letter writing campaign demanding labeling of GM foods**
	NoST Expertise **Opportunities to explore:** **-Tentativeness of science knowledge** **-Science products are value laden** **-Motives for the use of science knowledge e.g. profit vs. humanitarian**	**Skills Expertise** **Expertise for:** **-Interpreting the reliability and credibility of scientific evidence** **-Scientific communication by debating an issue focusing on scientific evidence**	**Project(s) Findings** **Conclusions about the extent, reliability and credibility of scientific evidence about health and environmental impacts of GM foods.**	

Previous Knowledge
Students should be able to:
- Describe cell theory and apply its processes to cell division, including mitosis, and its function in sexual and asexual reproductive systems
- Discuss cell division and the factors affecting cell reproduction

Additional Teacher Information:
This case is appropriate for the following grades and strands:

Course	Strand	Topics
Science 9 Academic, Applied	Biology: Reproduction	The impact of developments in reproductive biology on global and local food production, populations, the spread of disease, and the environment

Information Sheet #1

What are Genetically Modified Foods?
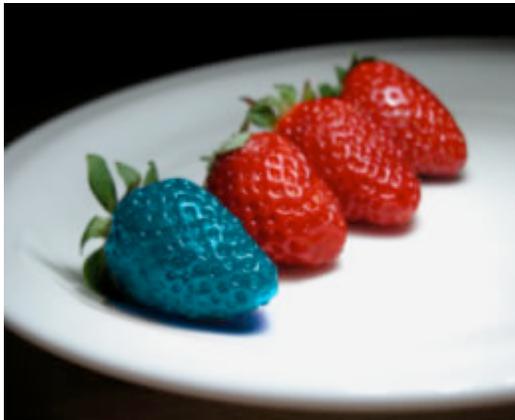
A genetically modified food (GM food) is a plant or animal that has been modified in the laboratory to produce desirable traits like resistance to disease or improved nutritional content.

The production of desirable traits in agricultural stock has traditionally been done through "selection" and "breeding" techniques. These traditional methods can be time consuming often requiring years as organisms take time to grow, mature and reproduce. Modern genetic engineering, on the other hand, claims to be able to create organisms with desired traits very rapidly and with great accuracy. To do this scientists isolate the gene for a desired trait from one type of organism and insert it into another organism. The receiving organism then gains the trait. Not only can genes be transferred from plant species to plant species but from animals or bacteria to plants as well!

Bt Corn: An Example Of Genetic Modification

Traditional corn varieties are susceptible to attack by insect pests like the European corn borer. Pest infestation can significantly reduce the yield of corn crops. *Bacillus thuringenesis*, is a naturally occurring bacterium that produces crystal proteins that are lethal to insect larvae. Using genetic engineering techniques, scientists have transferred Bt crystal protein genes into corn, enabling the Bt corn to produce its own pesticides and become resistant to insect attack. The diagram below summarizes the process simply.
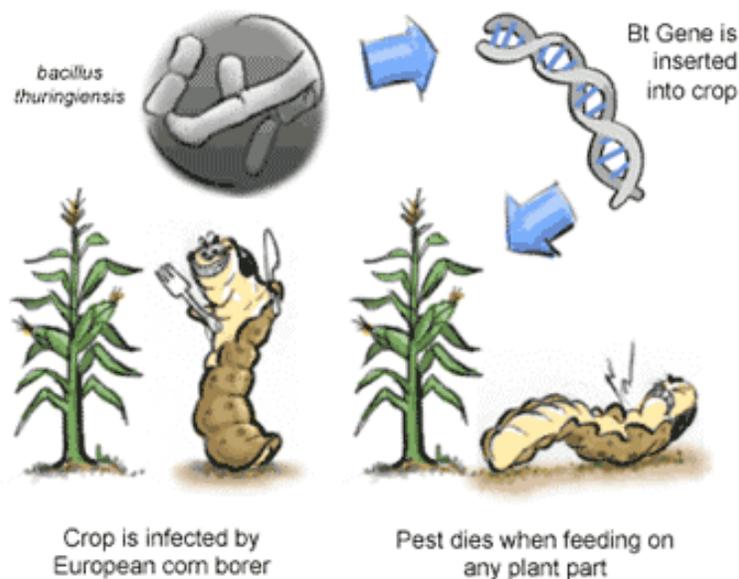
Engineering resistant corn.
(Hall, H (2005). Bt corn is it worth the risk. Science Creative Quarterly,
http://www.scq.ubc.ca/quarterly023/0203hall.html)

How Common are GM Foods?

Here is a summary of crops, foods and ingredients that have been genetically modified as of July 2007.

- **Common GM Crops**
  Soy
  Cotton
  Canola
  Corn

Hawaiian papaya
Alfalfa, zucchini and yellow squash

- **Common GM Animal Products**
Dairy products from cows injected with rb growth hormone
Meat, eggs and dairy products from animals that have eaten GM feed
Honey and bee pollen that may have used GM sources of pollen
Food additives such as enzymes, flavoring and artificial sweeteners

- **Common Foods that May Contain GM Ingredients**

Infant formula	Veggie burgers	Powdered sugar (often
Salad dressing	Meat substitutes	contains corn starch)
Bread	Ice cream	Confectioner's glaze
Cereal	Frozen yogurt	Alcohol
Hamburgers and	Tofu	Vanilla
hotdogs	Tamari	Powdered sugar
Margarine	Soy sauce	Peanut butter
Mayonnaise	Soy cheese	Enriched flour
Crackers	Tomato sauce	Vanilla extract
Cookies	Protein powder	(sometimes contains
Chocolate	Baking powder	corn syrup)
Candy	(sometimes contains	Pasta
Fried food	corn starch)	Malt
Chips		White vinegar

(Adapted from the Seeds of Deception website: http://www.seedsofdeception.com/Public/BuyingNon-GMO/GMFoodsataGlance/index.cfm)

Information Sheet #2

Judging the Evidence: The Case For and Against GM foods

There is a great deal of conflicting information about GM foods currently available both electronically and in print. Much of this information comes from two sources:
- large biotechnology companies who produce and sell GM organisms
- citizen groups/organizations protesting the farming and consumption of GM organisms.

Online Resource Videos
For:
Net Income $27 Billion Greater: GM Crops Improve Yields and Farm Incomes
http://www.monsanto.com/biotech-gmo/asp/videogallery.asp

Value and Safety of GM Crops Proven
http://www.monsanto.com/biotech-gmo/asp/videogallery.asp

Health and Well-Being Improves: GM Crops Contribute to Quality of Life
http://www.monsanto.com/biotech-gmo/asp/videogallery.asp

Against:
Genetically Modified Food, panacea or poison.
http://video.google.com/videoplay?docid=5207412505897358694

Genetically Modified GM poison food
http://video.google.com/videoplay?docid=-6065026255320281406

The Health Dangers of Genetically Modified Foods
http://www.youtube.com/watch?v=94d-KVorSHM&feature=related

Some Websites about GM foods

CSA Discovery Guides
Genetically Modified Foods Harmful Or Helpful
http://www.csa.com/discoveryguides/gmfood/overview.php

The Debate Over Genetically Modified Foods
http://www.actionbioscience.org/biotech/sakko.html

Genetically Modified Foods: Are They a Risk to Human Health?
http://www.actionbioscience.org/biotech/pusztai.html

AgBioWorld Scientists in Support of Biotechnology
http://www.agbioworld.org/biotech-info/articles/agbio-articles/index.html

The Campaign – A grassroots activist group against Genetically Modified Foods
http://www.thecampaign.org/

The Center for Food Safety- A non-profit organization working against "harmful" technologies in food production.
http://www.centerforfoodsafety.org/geneticall7.cfm

Conversations About Plant Biotechnology- Website of the Agri-biotech company Monsanto
http://www.monsanto.com/biotech-gmo/asp/default.asp

Summary of the Major Advantages of GM Foods

- **Pest Resistance**- Some GM plants are engineered to be "naturally" pest resistant. This means that such crops promise increased yield and require less use of external pesticides e.g. Bt corn
- **Herbicide Tolerance**- Plants are engineered to be resistant to one powerful herbicide. Developers claim this will reduce the variety and amount of herbicides farmers need to use e.g. Roundup Ready Soybeans
- **Disease Resistance**- Crop plants are engineered to resist bacterial, fungal and viral diseases e.g. Blight resistant wheat and barley
- **Weather Tolerance**- Plants are engineered to withstand a wide variety of adverse conditions like drought, cold and high salinity e.g. transgenic potato contains an antifreeze gene from coldwater fish.
- **Enhanced Nutrition**- Livestock and crops are being engineered to increase their nutritional content e.g. Golden rice

Summary of Major Criticisms against GM Foods
- **Unintended harm to other organisms**- Toxins from pesticide resistant plants may harm other organisms e.g. pollen from Bt corn may kill useful insects like butterflies
- **"Superweeds"**- Herbicide tolerant GM plants may naturally crossbreed with common weeds to produce herbicide tolerant weeds or "superweeds".
- **Human Health Risks-** There is growing concern that introduced genes may have unexpected and negative impacts on human health. Critics claim that too few credible studies have been done to determine the health risk of GM foods especially in the long term
- **Economic Concerns-** Genetic engineering techniques and products are costly. Consumer advocates worry that increasing price of seeds and other agri-biotech products may impact negatively on small farmers and food production in "poorer" countries.

Information Sheet #3

GM Foods and WISE Activism

By this time you should be able to make a personal informed choice about GM foods. If your inquiry of the topic far has made you skeptical about the production and consumption for GM foods what can you do?

Here are some suggestions from activist groups for individuals who oppose the use of GM foods:

- **Shop Organic**- GM organisms are not allowed in organically grown foods

- **Avoid Packaged Foods**- Fresh grains, nuts, fruits and vegetables are less likely to contain GM food additives and preservatives.

- **Buy Local**- Small, local family farmers are less likely to use GM supplies than large, industrial farms.

- **Demand labeling**- Presently, it is not mandatory for agri-businesses to label foods that have been genetically modified. Lobby your government representative demanding that GM products are clearly labeled.

Suggested Teaching Strategies

The issue of GM food is a complex one. Although teachers are free to use Information Sheets #1-3 in whatever ways might best suit their unique situations the following suggestions are also available for consideration.

1. a. Present students with Information Sheet #1.
    b. Use the example Bt corn to discuss the question:
    - What does the term genetic modification mean?

2. Jigsaw Activity. Divide the class into small groups 4-5 members each. Using Information Sheet #1each group should discuss one set of questions from the list below. Groups report major conclusions to the whole class at the end of the exercise.
    - Some people claim that genetic engineering is the same as traditional breeding methods except that it is faster and more accurate. How true or false is this statement?
    - A positive trait of Bt corn is that it can resist pest attack by producing its own pesticide. Can you think of any possible negative impact of corn that can produce its own pesticide?
    - Look at the list of common GM foods. Estimate how often the people in your group are consuming GM products.

Whole group discussion:
- Do you feel comfortable with your exposure to GM foods? Why or why not?

3. Student debate "The Case For and Against GM Foods" (using the resources from Information Sheet #2 and their own research). Encourage students when preparing their arguments to question the credibility of the scientific evidence that exists about the health and environmental impacts of genetically modified foods. At the end of the debate students should be encouraged to make and justify a personal stance about GM foods.

4. WISE Activism. Present Students with Information Sheet #3. Encourage students who are skeptical about the production and consumption of GM foods to adopt, explore and develop a suitable action plan based one or more of the suggested activities.