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To accompany the peer-reviewed article by Laura Spinney for Oxfam GB
“**Biotechnology in Crops: Issues for the Developing World**” (May 1998)
http://www.actionbioscience.org/biotech/oxfam_spinney.html

Will Biotech Crops Solve World Problems? (February 2003)

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Grades & Levels:

- **Handout 1:** high school (general/advanced)
- **Handout 2:** grades 10-12 (advance/AP) – undergraduate (year 1)

Time Recommendations:

- 1-2 days for article review and discussion
- 1-3 days for project assignments in Student Handout 1
- 1-3 weeks for project assignments in Student Handout 2
- 1-2 days for activities in Supplementary Student Handout

NSES (USA) Content Standards, 9-12:

- NSES 2.2 Science and Inquiry: understanding about scientific inquiry
- NSES 4.2 Life Science: molecular basis of heredity
- NSES 6.1 Science and Technology: abilities of technological design
- NSES 7.3 Science in Personal & Social Perspectives: community & personal health
- NSES 7.6 Science in Personal & Social Perspectives: local, national, & global challenges

Learning Objectives: Students will...

- develop an understanding of the rationale for producing biotechnology crops
- research biotechnology crop production methods
- consider an individual’s right to know whether consumer products contain GMOs
- analyze how to evaluate the development and success of biotechnology crops

Key Words Include:

agricultural biotechnology, biopiracy, bioprospecting, bioremediation, botany, Bt, cultivar, developing world, gene banks, genetically engineered (GE), genetically modified (GM), genetics, herbicide, life form patents, monoculture, plant breeding, sustainable agriculture, transgenic

Preparation

Article Discussion:

- Before students read the article by Spinney, ask the following in class:
 - a) What do you already know about biotechnology?*
 - b) What do you think agricultural biotechnology means?*
- Distribute or ask students to download and read the article by Spinney at:
http://www.actionbioscience.org/biotech/oxfam_spinney.html
- Follow the reading with questions about the article (listed on page 2). Students can answer questions orally in class, brainstorm answers in groups, or complete questions as a written assignment.

Student Handouts 1 and 2:

Follow article discussion with project assignments suggested in the handouts. These can be assigned as an individual or team activity.

Re: Student Handout 2, Activity #3:

- **Objective:** This activity guides students through the thought processes involved in the development of biotechnology crops.
- **Instructions:** It is suggested that the activity be assigned as group take-home projects that are followed by an in-class presentation. Explain to students that they are to present theoretical (but realistic) genetically modified plant(s) to solve the need identified in the topic.
- **Assessment:** The presentations can be graded on accuracy, completeness, and quality of work. This activity can be assessed using multiple-choice questions asking facts about the genetic engineering of plants. A short essay about the activity's learning objectives is a way to test higher-order learning.

Supplementary Student Handout:

Since Spinney's report for Oxfam is dated 1998, the supplementary handout provides opportunities for students to update Spinney's information and to discover new developments in agrobiotechnology. It is suitable as a supplement to both handouts 1 and 2.

For Educators: Article Discussion

About the article by Laura Spinney for Oxfam GB:

“Biotechnology in Crops: Issues for the Developing World”

http://www.actionbioscience.org/biotech/oxfam_spinney.html

Content Questions

1. Name and briefly describe five types of genetically modified plants mentioned in the article.
2. What is the most abundant transgenic field crop trait used in the United States?
3. Explain the rationale for producing plants resistant to *herbicide*.
4. Explain the rationale for producing plants resistant to *viruses*.
5. Explain the rationale for producing plants resistant to *insect pests*.
6. How do property rights affect the development of new transgenic plants?
7. Describe conservation efforts needed to ensure that there will be a supply of plant seeds for the future?
8. Identify and explain the benefits and risks of using herbicide-resistant plants as field crops.
9. How does biopiracy infringe on the economics and rights of nations?
10. Why is sustainable agriculture important to a nation's economy?

Extension Questions

1. Explain what each of the following acronyms means and how they differ: *GM, GE, GMO, Bt*
2. Should companies or individuals have the right to own patents on agricultural plant products? Why or why not?
3. Do you agree or disagree with the statement: “*The general welfare of the public is more important than economic liberty in the case of agricultural biotechnology.*” Explain your reasons to the class.
4. Do you think that consumer products should be labeled for their genetically modified content? Why or why not?
5. A recent Canadian study estimated mandatory labeling would require a 10% increase in food prices. This would mean, for example, that a package of tortilla chips costing \$1.50 would increase to \$1.65. Would you be willing to pay the increased price in order to have mandatory labeling?
6. Do you think this article has a balanced view? Why or why not?

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Student Handout 1

1. GE Foods: Mandatory Labeling?

- In a group, read and discuss the arguments for and against mandatory labeling, shown below.
- Take a vote to find out who in your group agrees or disagrees with each argument.
- Present the results of your vote to the class.

Pro-labeling arguments

- Consumers have a right to know what's in their food, especially concerning products for which health and environmental concerns have been raised.
- Surveys have indicated that a majority of citizens support mandatory labeling.
- To date, over 20 countries have announced plans to institute some form of mandatory labeling. Other nations could follow their lead in handling the logistics of product separation.
- For religious/ethical reasons, some consumers want to avoid eating animal products, including animal DNA.

Anti-labeling arguments

- Labels on GE food imply a warning about health effects, whereas no significant differences between GE and conventional foods have been detected. If a nutritional or allergenic difference were found in a GE food, current food regulations require a label to that effect.
- Labeling of GE foods to fulfill the desires of some consumers would impose a cost on all consumers. Persons at lower income levels would be the most affected.
- Consumers who want to buy non-GE food already have an option: to purchase certified organic foods, which by definition cannot include GE ingredients above defined threshold levels.
- The food system infrastructure (storage, processing, and transportation facilities) could not currently accommodate the need for segregation of GE and non-GE products.
- Consumers wanting to avoid animal products need not worry about GE food. No GE products currently on the market or under review contain animal genes.

Source: Colorado State University, *Transgenic Crops: An Introduction & Resource Guide*, 2003.

2. GM Dinner

You have guests coming over for dinner who prefer GM food. Go online shopping to find what you need.

- Search the Internet to discover biotech crops or foods already available commercially.
- Jot down notes about each product description, who makes it, and the site where you found the info.
- Create a menu for your dinner. Include a one-line description of each menu item, e.g., *Tomato & Corn Salad: pest-free GM tomatoes from BioGreen Inc. tossed with Bt corn from Monsanto Co.*
- Present your menu to the class and describe the GM ingredients using your Internet search notes.

3. Famous Scientists

Write a short biography of one of these scientists that focuses on how their work applies to agricultural biotechnology:

- Gregor Mendel
- the team of Stanley Cohen and Herbert Boyer
- Barbara McClintock

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Student Handout 2

1. GM Labels and Economics

Your team acts as economic advisors to the food industry. Your team has been asked to make a presentation at a conference about the economic impact of labeling food products to indicate GM ingredients. Create a visual presentation, such as Power Point, to illustrate:

- the identity preservation system from farmer to elevator to grain processor to food manufacturer to retailer that would be required to create accurate labels
- the possible price impact on the players at each stage of the system above and the consumer should companies be required to add GM labeling to their packaging

2. Testing for GE Crops and Food

Your team has launched a service company for the testing of genetically engineered crops and food.

- Create a brochure or other type of advertisement to explain the types of testing available to detect GE components in crops and food and why your services are better than other companies.
- Research your competition on the Internet to evaluate how you can surpass your competition. See “Useful Links” in the *Educator Resources* section at the end of Spinney’s article for suggested sites as a starting point for your research.

3. World Health Organization (WHO)

Your team serves as advisors on agricultural biotechnology to the United Nations World Health Organization. Your job is to recommend specific genetically modified crop(s) to solve particular problems for a developing nation. The plant(s) must be realistic using actual agricultural plants, genetic traits, and current biotechnology techniques. Present your findings in an illustrated report.

Choose one of these situations for your advisory role:

- Belize has soils that are becoming too salty for agriculture.
- Guatemala has a high incidence of cholera.
- Mexico has a high amount of foot and mouth disease that kills cattle. Almost all of the farmers cannot afford to give cattle medicines to fight the disease.
- India needs to increase paper and wood production because of the great demand for these products.
- China has a large, aging female population in need of estrogen therapy. Most cannot visit a doctor or afford medical therapies.
- Ethiopia loses almost all of its stored grains to beetles that eat the seeds.
- Indigenous Canadians have trouble getting adequate vitamin C in their diets. Their climate does not let them grow crops normally high in vitamin C.
- Malaysia suffers greatly from protein deficiency in the diets of children. Almost all families cannot afford to grow or purchase eggs, legumes, and meats that are high in protein.

To complete your project you will need to:

- investigate the methods and genes used by scientists to develop genetically modified plants
- evaluate the economic benefits and risks of using your plant(s) to resolve the need of the nation

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Supplementary Student Handout

1. Statistics: What's New?

Spinney's report for Oxfam dates back to 1998. How have the statistics she provides changed since then?

- Per team, choose one section of the report. For example, the article's introduction.
- Scan the section to find statistics. For example, "In 1997, 30 million acres worldwide were planted with genetically modified (GM) crops."
- Search the Internet to find updated statistics, if any.
- Rewrite Spinney's sentences using updated statistical information.

2. GE Crops: What's New?

Spinney's report only covers genetically engineered crops in developing nations up to 1998.

- Per team, choose one nation mentioned in the report. For example, India or Kenya.
- Search the Internet to find one new GE crop that has been introduced to that nation since then. For example, India started planting Bt cotton in 2001.
- Write a fact sheet about the new GE crop. Include notes about whether the GE crop has lived up to its expectations. For example, if the crop plant was meant to resist pests, did it do so?

3. GE Crop Patents: What's New?

Spinney mentions several companies that claimed ownership rights on crops or crop products.

- Per team, choose one such ownership claim from the article. For example, Ricetec, Inc.'s claim on basmati rice.
- Search the Internet to find out if there were any further developments on the patents, such as court challenges.
- Present your findings to the class orally or in a written summary.

4. Top Agricultural Biotech Companies: What's New?

In her conclusion, Spinney refers to the constantly changing players in agriculture biotechnology. Who are the top players, based on sales, today?

- Per team, search the Internet to find one of the top companies.
- Find out as much as you can about the company's biotech products and profits.
- Find out if the company is listed on a stock exchange and how well it is doing.
- Present your findings in a graphic presentation, such as charts, or as a statistical fact sheet.