



Throughout the guide teaching tips are in red.

## Life Science: What Is Biotechnology?

### Overview

In this three-day activity, students will discuss issues related to genetically modified organisms (GMOs) and agricultural biotechnology in general. A brief sample issue about Roundup Ready soybeans is provided to start the discussion. On day 1, students read about the sample issue. On day 2, they research, investigate a few internet sites, and either take a position or remain undecided. On day 3, those who are pro or con try to persuade the undecided group to join their side.

After this, at the teacher's discretion, the class is prepared to discuss GMOs in general. Students can use the internet to learn more about biotechnology tools and techniques, and visit the NC Biotechnology Center website to locate biotechnology businesses near your school. The NC Biotechnology Center website also includes information about biotechnology careers.

### Objectives

After doing this activity, students will be able to:

- Discuss ethical issues of agricultural biotechnology using relevant information about the field.
- Discuss economic benefits of biotechnology and careers in biotechnology.

### North Carolina Essential Science Standards

#### 8.L.2 Understand how biotechnology is used to affect living organisms.

8.L.2.1 Summarize aspects of biotechnology including:

- Specific genetic information available
- Careers
- Economic benefits to North Carolina
- Ethical issues
- Implications for agriculture

### Background for the Teacher

Biotechnology is the use of biology to solve problems and make products. This broad definition includes fermentation, selective breeding, in-vitro fertilization, and leavening bread. However, the term more often refers to the development of genetic engineering in the 1970s that enabled scientists to manipulate DNA. Manipulating DNA paved the way for the creation of pest resistant crops, which could not have been made through traditional breeding. It also provided techniques for altering bacteria to produce pharmaceuticals. More recently, biotechnology is combining biological information and computer technology to advance research in nanotechnology and regenerative medicine. Today, biotechnology corporations manufacture genetically engineered substances for medicine, agriculture, and ecology.

A narrower definition of biotechnology concerns the tools used to work with DNA and RNA to insert new genetic material into an organism's genome. This direct altering of genetic material is often called genetic engineering. The process consists of first isolating and copying the genetic material of interest. This is either taken from an organism or synthesized. After the desired DNA is isolated and copied, scientists insert it into a host organism where it functions to produce the intended result. Other techniques may remove a gene or target a gene to be studied or changed. Organisms created through genetic engineering are called genetically modified organisms (GMOs). Among these are genetically modified crops, many of which are on the market today. The Roundup Ready Soybeans discussed in this activity are an example.

**Materials**

- Computer access to the internet
- Ability to project BLM 2 “Positions”
- (Optional) means to project information from websites

**Materials for individual students**

- Computers with access to the internet
- 1 copy of BLM 1 “Roundup Ready Soybeans”
- 1 blank 4 x 6 information card

**Preparation**

1. Read over BLM 1 and make copies.
2. If you wish, look over Case Studies in Benefits and Risks of Agricultural Biotechnology: Roundup Ready Soybeans and Bt Field Corn by Janet E. Carpenter, 2001: [www.ncfap.org/documents/benefitsandrisk.pdf](http://www.ncfap.org/documents/benefitsandrisk.pdf)

**Procedure****Procedure Day 1**

1. Ask the class what they know about biotechnology in general, and then about genetically modified organisms (GMOs). Hold a 5-minute discussion about GMOs, primarily to hear students’ thoughts about the subject. At the end of this, if it has not come up, mention that one important application of biotechnology is food production.
2. Explain that the class will discuss an issue involving soybeans that were altered by biotechnology. Give out BLM 1 and allow 10 minutes to read it.
3. After students read, give each student a note card and project the following three options (BLM 2) for all to see:
  - A. I am for using Roundup Ready soybeans in the food supply.
  - B. I am against using Roundup Ready soybeans in the food supply.
  - C. There is not enough information to take a position. I need to know more about...(list needed information).
4. Ask all students to use one side of the note card to choose a position, A, B, or C. On the back of the card, ask them to write 2 or more reasons for taking that position. Those who choose C (not enough information) will list the information they need in order to take a position. Allow 10-15 minutes.
5. Assemble groups of students who took the same position and ask them to discuss their reasons. Ask group C to discuss how the missing information would help them decide.

**Procedure Day 2**

6. Ask groups A and B to plan and research a presentation to persuade Group C. Ask them to look for evidence on websites that support their positions.

**If you haven’t already worked with students about arguing from evidence, this is a good time to do it.**



Ask each student to write the information (evidence) they gather in their notebooks.

- Group A can use these web sites:

<http://www.monsanto.com/products/pages/biotechnology-safety-info.aspx>

<http://www.agbioforum.org/v2n2/v2n2a02-carpenter.htm>

<http://www.vnews.com/news/7899343-95/roundup-ready-or-not>

- Group B can use these web sites:

<http://nutritionfacts.org/video/are-gmos-safe-the-case-of-roundup-ready-soy>/<http://web.mit.edu/demoscience/Monsanto/players.html>

<http://www.arc2020.eu/roundup-ready-soybeans-worse-than-you-thought>

- Group C should look at both sets of websites.

### Procedure Day 3

7. Ask groups A and B to meet and agree on arguments and evidence they will present to group C. Ask group C to discuss and list evidence that would sway them in both directions. Allow 10 minutes for this.
8. Give 5 minutes each for groups A and B to persuade group C, and 5 minutes for group C to respond to what they have heard.
9. Ask the class what questions this discussion raises for them about GMOs. Afterward, you might want to discuss biotechnology in general. At this point, all students should consider whether they still hold the same position, or if they have changed. If anyone has changed positions, please share why.

### Optional procedure for further research

1. At this point, the class is ready for you to teach about biotechnology using whatever means you have available.
2. The North Carolina Biotechnology Center has information about biotechnology in NC, some of which is appropriate for grade 8 reading.
  - Information about careers and local biotech companies can be found at:  
<http://ncbcjobs.ncbiotech.org/>
  - Information about the biotech industry in NC can be found at:  
<http://www.ncbiotech.org/business-commercialization/why-choose-nc/numbers>
3. If you ask the class to research more about biotechnology on the internet, many of the topics are complex and could be confusing. If you choose to do a brief internet search, ask for students to produce some definitions that everyone can understand, and provide a few keywords such as:
  - genetic engineering
  - recombinant DNA
  - bioengineering
  - genomics
  - plus any topics of interest that have come up...

Roundup Ready soybeans are genetically engineered to resist the herbicide Roundup. Monsanto Corporation makes both the soybeans and the herbicide. The Roundup herbicide kills plants, including ordinary soybeans, by stopping them from making compounds that they need to survive. However, Roundup Ready soybeans destroy the Roundup inside the plant before it can harm them, and they leave the herbicide in the soil and on weeds. This technology allows farmers to control weeds without killing their soybeans. The use of Roundup has increased dramatically with the adoption of Roundup Ready crops. Most (but not all) scientists agree that food made from Roundup Ready soybeans poses no greater risk to human health than from other soybeans. However, as you will see, there is controversy about this and other aspects of Roundup Ready soybeans.

### **BENEFITS**

- Better weed control increases yield. Roundup Ready soybeans used with Roundup can increase yield by 20%, which results in greater profits.
- Roundup can reduce plowing for weed control. This helps maintain topsoil, important where much of the soil washes away.
- By controlling both broadleaf and grass weeds, and being able to kill them after they are larger, Roundup reduces the amount of chemicals used. In the past, growers often applied three or more chemicals and made more trips across fields, costing more in fuel and equipment.
- Roundup does not harm corn that follows soybeans in rotation, making it easier to rotate crops.

### **RISKS**

- Some health effects do not easily appear in tests on small populations over short periods, making it difficult to rule out health risks. Controversy has led to lawsuits, trade disputes, protests, and laws restricting Roundup Ready soybeans in some countries. US regulatory agencies reviewed health risks, and although they found some information lacking, granted approval for use in food.
- Genetically modified (GM) crops can pollinate non-GM crops, spreading “artificial genes.” Organic farms fear such contamination of their products.
- GM crops are subject to patents, and patent owners can, to some extent, raise prices without competition. This applies equally to GM and non-GM crops. Because this product is linked to an herbicide, some groups argue that it gives Monsanto too much power over farmers and food production.
- If a new plant disease affects a genetically identical crop in widespread cultivation, that crop is devastated nationwide, threatening food supplies.
- Repeated use of Roundup over many years promotes weed species that are resistant to Roundup.

- A. I am for using Roundup Ready soybeans in the food supply.
- B. I am against using Roundup Ready soybeans in the food supply.
- C. There is not enough information to take a position.