

## UNIT I - INTRODUCTION TO BIOTECHNOLOGY

### Lesson 1: An Overview of Biotechnology

Competency/Objective: Summarize the importance of biotechnology to agriculture.

#### Study Questions

1. **What is biotechnology?**
2. **What has been the role of biotechnology in agriculture?**
3. **What is the current role of biotechnology in agriculture?**
4. **How does agricultural biotechnology influence consumer perspectives?**
5. **How does agricultural biotechnology influence producer perspectives?**
6. **What other areas of life have been affected by biotechnology?**

#### References

1. *Biotechnology: Applications in Agriculture (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1998, Unit I.
2. Suggested reference: Access Excellence's "Basic Biotechnology for Beginning Teachers" at <http://www.gene.com/ae/AE/AEPC/WWC/1993/basic.html>.
3. Activity Sheet  
AS 1.1: What is . . . ? Facts about Biotechnology



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#### TEACHING PROCEDURES

##### A. Introduction

Biotechnology has been around for thousands of years. Almost every seed that a producer plants today is a result of crossbreeding and hybridization, which are aspects of biotechnology. Selective breeding and crossbreeding are forms of biotechnology that are standard practices in the livestock industry. Modern biotechnology takes traditional methods of crop and livestock production to a new level. Instead of breeding whole plants or animals to produce a desired trait, modern biotechnology makes it possible to transfer specific traits from one organism to another.

##### B. Motivation

1. Show the video "Fields of Promise" (Monsanto, 27 min.) available from MVRC.
2. Discuss the size of the biotechnology industry in the United States. Point out that in 1993, 1,300 biotechnology companies in the United States employed 80,000 people and generated \$8.1 billion in annual sales. The industry has grown since 1993. Speculate on the future of the industry.
3. Bring two tomatoes to class, one from a home garden and one from a grocery store. Ask the class to compare the way they look. Drop each tomato from a height of five feet into a trash can. Did one squash or splatter more than the other? Discuss why.

##### C. Assignment

##### D. Supervised Study

##### E. Discussion

1. Have students define "biotechnology" in their own words. Write these definitions on the board and then compile them into one working definition. Point out the broad scope of biotechnology and that many different definitions exist.

#### **What is biotechnology?**

- a) Biotechnology can be defined as the application of scientific principles to living things. It involves harnessing the natural biological processes of cells from microorganisms, animals, and plants to develop useful products.
  - b) A narrower definition of modern biotechnology includes only those processes that involve the recombination of genes from living things in a laboratory setting.
2. Have students identify examples of agricultural biotechnology. Point out that yeast was first used to brew beer and make wine as long ago as 6,000 B.C. Cheese, yogurt, bread, and cider are all common products of biotechnology. More information about the history of biotechnology is available on the Internet at the Access Excellence website "About Biotech: The Biotech Chronicles" at <http://www.gene.com/ae/AB/BC/index.html>.

#### **What has been the role of biotechnology in agriculture?**

- a) Crop production

- 1) Greeks developed fruit tree grafting techniques (300 B.C.).
  - 2) Gregor Mendel experimented with garden peas, discovering the foundations of genetics (1865).
  - 3) The first hybrid corn plant was developed in the United States (1879).
  - 4) Improved wheat and rice varieties were developed internationally (1946-1965).
- b) Animal production
- 1) Selective breeding of livestock was practiced by people in the Middle East (18,000 B.C.).
  - 2) Animal crossbreeding and purebreeding were practiced in Europe (1500 A.D.)
  - 3) A procedure for artificial insemination was first developed in Italy (late 1700s).
- c) Food processing
- 1) The use of bacteria to make cheese, bread, and alcohol began in Egypt (4,000-2,000 B.C.).
  - 2) The modern distillery was invented in United States (1830).
  - 3) Louis Pasteur discovered that fermentation was carried out by bacteria and confirmed the existence of microorganisms, leading to applications such as the large scale brewing of beer and wine (1860s).
3. Use newspaper articles or Internet sites to show examples of current developments in agricultural biotechnology.

**What are the emerging areas of agricultural biotechnology?**

- a) The modern era of biotechnology began with the first successful recombination of DNA (1973).
  - b) The technique of plant tissue culture was developed (late 1970s).
  - c) New technologies have been developed in animal biotechnology.
    - 1) Embryo transfer techniques were developed (early 1980s).
    - 2) A Chinese scientist cloned a fish (1981).
    - 3) The first adult mammal was cloned in Scotland (1997).
    - 4) A calf was cloned from cells taken from a 30-day-old fetus (1997).
  - d) The ability to alter DNA through genetic engineering has made many new products possible.
    - 1) The first genetically modified food product, an enzyme used in making cheese, was approved for use in the United States (1990).
    - 2) The first genetically modified crop plant, a tomato plant, was approved in the United States (1994).
    - 3) Insect-resistant and herbicide-tolerant crops were approved in the United States (1995-1996).
    - 4) Animal vaccines were produced by genetically modified bacteria (mid-1990s).
  - e) Future biotechnology products may include environmentally tolerant crops or genetically modified plants used as biofuels.
4. Ask students if they have ever helped buy food at a grocery store. Ask them how they would decide whether to buy vegetables that have been genetically modified.

**How does agricultural biotechnology influence consumer perspectives?**

- a) Positive
  - 1) Lower food costs
  - 2) Increased nutrient content of food
  - 3) Availability of fresh fruits and vegetables year-round
  - 4) Increased and cheaper food supply in developing countries
- b) Negative
  - 1) Fear of unsafe foods
  - 2) Fear of environmental damage from genetically altered organisms

5. Ask students if they know of any local producers who plant genetically modified seed or use other inputs developed through agricultural biotechnology.

**How does agricultural biotechnology influence producer perspectives?**

- a) Positive
    - 1) Increased profits from higher yields or lower input costs
    - 2) Reduction in the amount of chemicals used
    - 3) Profitable customized crops
  - b) Negative
    - 1) Fear that small farms may not have the opportunity to use biotechnology and be forced out of business by more competitive, large corporate farms
    - 2) Fear of the creation of “super weeds”
6. Ask if anyone knows someone who is diabetic and must take insulin injections. Explain that improved insulin from bacteria modified to produce human insulin is one example of a nonagricultural advancement in biotechnology.

**What other areas of life have been affected by biotechnology?**

- a) Human health industry
  - 1) Pharmaceuticals
    - (a) Insulin produced by bacteria
    - (b) Genetically engineered vaccines
    - (c) Antibiotics and growth hormones
  - 2) Tests for detecting genetic disorders
    - (a) Huntington’s disease
    - (b) Down’s syndrome
    - (c) Tay-Sachs disease
    - (d) Cystic fibrosis
- b) Biomining - modified bacteria that break down metal ore
- c) Forensics - DNA fingerprinting
- d) Waste management
  - 1) Bacteria that break down sewage
  - 2) Bacteria that clean up crude oil spills
  - 3) Bacteria that improve soil contaminated with organic compounds
  - 4) Bacteria that feed on solid waste and produce methane gas for fuel

**F. Other Activities**

- 1. Show a video such as “Green Cows, Quags, and Mummies,” available from MVRC.
- 2. Have students conduct an Internet search using the term “agricultural biotechnology” and report on their findings.

**G. Conclusion**

The biotechnology industry is large and is expanding at a rapid rate. New products and processes will be developed as long as a market exists for them, and agriculture will change as they are developed. How will producers and consumers react to new products? Will the products of biotechnology pose risks to humans, animals, or the environment? While the answers to these questions are not yet clear, biotechnology will have a huge impact on agriculture and many other industries.

H. Answers to Activity Sheet

AS 1.1

1. Biomining
2. Dolly
3. 1879
4. Genetic engineering
5. DNA fingerprinting
6. Egypt
7. Plant tissue culture
8. Corn
9. Biotechnology
10. Customized crop
11. 18,000 B.C.
12. 1973
13. Human insulin
14. FlavrSavr™ tomato

I. Answers to Evaluation

1. b
2. c
3. d
4. Fear that small farms will lose money on biotechnology and be forced out of business by large corporate farms; fear of the development of “super weeds”
5. Fear of unsafe foods; fear of environmental damage from genetically altered organisms
6. Biotechnology can be defined as the application of scientific principles to living things. It involves harnessing the natural biological processes of cells from microorganisms, animals, and plants to develop useful products.





**What is . . . ? Facts about Biotechnology**

**Objective:** Identify facts about biotechnology.

**Using your *Biotechnology: Applications in Agriculture* student reference, read the description in the column titled “Answers” and write in the corresponding term that completes the question.**

Answers	What is . . . ?
1. Using modified bacteria to break down metal ore	1. _____
2. Name of the ewe that was the first animal cloned from an adult mammal	2. _____
3. The year that the first hybrid corn was developed in the United States	3. _____
4. A technology used to alter the genetic material of living cells to give them new characteristics	4. _____
5. Process used in the application of biotechnology to forensics	5. _____
6. The country where bacteria were first used to make cheese, bread, and alcohol	6. _____
7. Growing a full-sized plant from a few plant cells	7. _____
8. The first hybrid crop plant	8. _____
9. The application of scientific principles to living things	9. _____
10. Corn developed especially for the production of ethanol	10. _____
11. The earliest date that selective breeding was practiced	11. _____
12. The year that modern biotechnology began	12. _____
13. The first genetically engineered product approved for sale	13. _____
14. The first genetically modified crop plant approved in the U.S.	14. _____

Answers	What is . . . ?

