

## Lesson A7-1

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# Determining the Nature of Biotechnology

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**Unit A.** Agricultural Literacy

**Problem Area 7.** Recognizing the Impact of Technology on Agriculture

**Lesson 1.** Determining the Nature of Biotechnology

### **New Mexico Content Standard:**

**Pathway Strand:** Plant Systems

**Standard: I:** Apply principles of anatomy and physiology to produce and manage plants in both a domesticated and natural environment.

**Benchmark: I-C:** Explain and use basic methods for reproducing and propagating plants.

**Performance Standard:** 1. Determine the role of genetics in plants. 2. Describe the components and functions of plant reproductive parts. 3. Identify and practice methods of asexual/sexual propagation. 4. Describe the principles of plant micro-propagation. 5. Apply principles and practices of biotechnology to plant propagation.

**Student Learning Objectives.** Instruction in this lesson should result in students achieving the following objectives:

1. Briefly describe biotechnology and its use throughout history.
2. Describe the capabilities of biotechnology today.
3. Distinguish between the two main areas of biotechnology.

**List of Resources.** The following resources may be useful in teaching this lesson:

**Recommended Resources.** One of the following resources should be selected to accompany this lesson:

Cooper, Elmer L. *Agriscience Fundamentals and Applications*. Albany, New York: Delmar Publishers, 1997. (Textbook, Unit 3)

Lee, Jasper S. and Diana L. Turner. *AgriScience*, Third Edition. Danville, Illinois: Interstate Publishers, Inc., 2003. (Textbook and Activity Manual, Chapters 2 and 15)

**Other Resources.** The following resources will be useful to students and teachers:

Biondo, Ronald J. and Jasper S. Lee. *Introduction to Plant and Soil Science and Technology*, Second Edition. Danville, Illinois: Interstate Publishers, Inc., 2003.

*Plant Genetics I: Crop Origins and Plant Improvement*. University of Illinois, Urbana, Illinois: Vocational Agriculture Service.

*Plant Genetics II: Plant Life Cycles and Breeding*. University of Illinois, Urbana, Illinois: Vocational Agriculture Service.

## List of Equipment, Tools, Supplies, and Facilities

Writing surface  
Overhead projector  
Transparencies from attached masters  
Copies of Student Lab Sheet

**Terms.** The following terms are presented in this lesson (shown in bold italics):

Biotechnology  
Hybridization  
Improvement by selection  
Selective breeding  
Molecular biotechnology  
Organismic biotechnology

**Interest Approach.** Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. Two possible approaches are included here.

**Approach One:** *Bring several newspaper articles about biotechnology to class. Read the main points to the students or have them read copies of the articles. Ask the students questions concerning the articles,*

such as: *Why is so much attention being given to biotechnology? What does biotechnology involve? Is biotechnology new to human civilization?*

**Approach Two:** Bring samples of foods that have been produced through biotechnology to class. Examples are bread, cheese, and the Flavr-Savr Tomato. Offer the opportunity for the students to taste the foods. Follow up the sampling by asking if they noticed anything special about the foods. Direct the class discussion towards the lesson objectives.

## Summary of Content and Teaching Strategies

**Objective 1:** Briefly describe biotechnology and its use throughout history.

**Anticipated Problem:** What is biotechnology and how has it been used throughout history?

- I. Applying technology to living organisms to improve existing products or make new ones is a simple definition of **biotechnology**.
  - A. The broader agriscientist's view of biotechnology applies to operations involving plants and animals to produce food, fiber, and shelter.
  - B. Biotechnology has been used by people for centuries.
    1. Yeast used for bread and bacteria used in fermentation and cheese production were some of the first applications of biotechnology.
    2. **Improvement by selection** was an early method to choose and keep the best plants and animals for further use.
    3. **Hybridization** of crops involves the controlled pollination of plants.
    4. Breeding livestock to obtain desired characteristics in the offspring is known as **selective breeding**.

*Create student interest with an interest approach. Use TM: A7–1A as a visual material for lecture and discussion that highlights the use of biotechnology throughout history. An alternative approach is to transfer the information from the transparency master to a multimedia presentation.*

**Objective 2:** Describe the capabilities of biotechnology today.

**Anticipated Problem:** What are the current capabilities of biotechnology?

- II. Plants, animals, and microbes can be improved by modifying the genetic content of cells.

*Use TM: A7–1B as a visual material for lecture and discussion. An alternative approach is to transfer the information from the transparency master to a multimedia presentation. Use text material to strengthen student understanding of concepts. Unit 3 in Agriscience Fundamentals and Applications and Chapter 15 in AgriScience are recommended.*

**Objective 3:** Distinguish between the two main areas of biotechnology.

**Anticipated Problem:** How do the two main areas of biotechnology differ?

- III. Biotechnology has two main areas of application, one that deals with the entire organism and another that involves work with individual cells.
1. **Organismic biotechnology** involves practices that promote healthier and more productive organisms.
  2. The area of biotechnology that involves changing an organism at the cellular level is referred to as **molecular biotechnology**.

*Text material can be used to strengthen student understanding of concepts. Unit 3 in Agriscience Fundamentals and Applications and Chapter 15 in AgriScience are recommended. Use LS: A7–1A, Biotechnology Survey, as a class project to promote critical thinking and awareness on issues pertaining to biotechnology. Require the involvement of all students.*

**Review/Summary.** Focus the review and summary of the lesson around the student learning objectives. Call on students to explain the content associated with each objective. Use their responses as the basis for determining any areas that need reteaching. Questions at the end of each chapter in the recommended textbooks may also be used in the review/summary. Use the lab activity in reviewing and reinforcing student learning.

**Application.** Application can involve the following student activity using the attached lab sheet:

Biotechnology Survey—LS: A7–1A

**Evaluation.** Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activity. A sample written test is attached.

**Answers to Sample Test:**

1=c, 2=b, 3=a, 4=d, 5=f, 6=g

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# Test

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## Lesson A7–1: Determining the Nature of Biotechnology

*Instructions.* Match the term with the correct response. Write the letter of the term by the definition.

- |                             |                             |
|-----------------------------|-----------------------------|
| a. biotechnology            | d. selective breeding       |
| b. hybridization            | e. molecular biotechnology  |
| c. improvement by selection | f. organismic biotechnology |

- \_\_\_\_\_ 1. An early method to choose and keep the best plants and animals for further use.
- \_\_\_\_\_ 2. Practice with crop breeding that involves the controlled pollination of plants.
- \_\_\_\_\_ 3. Applying technology to living organisms to improve existing products or make new ones.
- \_\_\_\_\_ 4. Breeding livestock to obtain desired characteristics in the offspring.
- \_\_\_\_\_ 5. Practices that promote healthier and more productive organisms.
- \_\_\_\_\_ 6. The area of biotechnology that involves changing an organism at the cellular level.

# Landmarks in Molecular Biotechnology Research

**1860s—Gregor Mendel recognizes that hereditary information is stored in discrete units called genes.**

**1870s—Scientists discover chromosomes within cells.**

**1953—The structure of DNA is described by James Watson and Francis Crick.**

**1965—Plasmids are discovered in bacteria.**

**1966—Scientists decipher the genetic code along the DNA molecule.**

**1967—The ligase enzyme is discovered (gluing enzyme).**

**1970—Restriction enzymes are discovered (cutting enzymes).**

**1972—First recombinant DNA molecule is formed from two viruses by Paul Berg.**

**1973—First DNA fragments are inserted into plasmid DNA and then reinserted into *E. coli* bacterium.**

**1975—First practical system for doing recombinant work is developed.**

**1978—Recombinant insulin is produced in bacterial cells.**

**1980—U.S. Supreme Court rules that “manufactured organisms” are patentable.**

**1983—Tobacco becomes the first genetically engineered plant.**

**1987—First environmental release of ice minus (genetically engineered organisms that lower frost temperature 2–3 degrees) occurs.**

**1994—Flavr-Savr Tomato is introduced as the first genetically engineered plant food product.**

**1997—First agricultural animal is cloned, a sheep named Dolly.**

# Advancement in Agricultural Production

## **KEYS TO ADVANCEMENT TO DATE:**

- Mechanization
- Cost-effective crop protection and fertilization
- Improved plant and animal breeding
- Efficient transportation system

## **LIMITATIONS TO CONTINUED PROGRESS:**

- Lack of purchasing power of poor countries
- Predicted world population growth—additional 2.5 billion people by 2020, total 8 billion
- Economic development raises demand for high quality foods

## **LIMITATIONS TO TRADITIONAL BREEDING TECHNIQUES:**

- Slow
- Unpredictable
- Limited gene pool (biggest limitation)

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# Lab Sheet

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## Biotechnology Survey

The advances in biotechnology have created great public debate across the country. How do people feel about biotechnology in your community? What is their level of understanding? A survey can give you an idea of their views and encourage you to examine your own.

**Instructions:**

1. Develop a survey with other class members that can be used to poll people's opinions concerning biotechnology. Write at least 10 questions to be considered for use in the survey. Review the questions with your instructor and with other class members. As a class, decide upon which questions should be included in the survey.
2. Survey at least 10 people in the community using the questions developed by the class.
3. Compile the responses obtained by everyone in the class.
4. Discuss the results and draw conclusions.
5. Prepare a written report of the results. Publish the results of your survey in the chapter newsletter, the high school newspaper, or the community newspaper.