

Lesson C2–5

Using Crossbreeding and Hybrids

Unit C. Plant and Soil Science

Problem Area 2. Basic Principles of Plant Science

Lesson 5. Using Crossbreeding and Hybrids

New Mexico Content Standard:

Pathway Strand: Plant Systems

Standard: III: Apply fundamentals of production and harvesting to produce plants.

Benchmark: III-A. Apply fundamentals of plant management to develop a production plan.

Performance Standard: 1. Identify and select seeds and plants.

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

1. Define plant breeding.
2. Define the processes of selection and hybridization.
3. Explain genetic engineering in plants.

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 the lesson:

Biondo, Ronald J. and Jasper S. Lee. *Introduction to Plant and Soil Science and Technology*. (2nd Ed.) Danville, Illinois: Interstate Publishers, Inc., 2003 (Textbook and Activity Manual, Chapter 4)

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

Lee, Stephen J., Christy Mecey-Smith, Elizabeth M. Morgan, Ray E. Chelewski, Randi Hunewill, and Jasper S. Lee. *Biotechnology*. Danville, Illinois: Interstate Publishers, Inc., 2001 (Chapter 11)

Parker, Rick. *Introduction to Plant Science*. Albany: Delmar Publishers, 2000 (Chapter 16)

List of Equipment, Tools, Supplies, and Facilities

Writing surface

Overhead projector

Transparencies from attached masters

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

Agrobacterium tumefaciens

Ballistic gene transfer

Cultivar

Genetic engineering

Genotype

Hybrid vigor

Hybridization

Microprojectiles

Mutation

Phenotype

Plant breeding

Selection

Totipotent

Transgenic plants

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. A possible approach is included here.

Ask the students to tell you what they have heard about genetically modified organisms (GMO). Make a list of these items on the board. Discuss these items briefly. Ask the students to make a copy of this list. Tell them that you will take another look at the items on this list after you have completed the unit. At that time, ask what the students know about GMO's now. What items changed?

Summary of Content and Teaching Strategies

Objective I: Define plant breeding.

Anticipated Problem: What is plant breeding?

- I. **Plant breeding** is the systematic process of improving plants using scientific methods. There are a variety of methods used to make certain plants pollinated, as well as methods to prevent unwanted pollination of plants.
 - A. The goals of plant breeding vary according to the type of improvement in the plant that is desired by the plant breeder. Plant breeding may be used to accomplish a variety of goals. Some of them are:
 1. Gain disease resistance.
 2. Gain insect resistance.
 3. Improve environmental adaptation.
 4. Improve productivity.
 5. Make a species more suited to cultural practices.
 6. Obtain a more desirable product from plants.
 - B. The **genotype** is the genetic makeup of a plant. Plant breeders are continually looking for new plant genotypes that will produce desired results. The outward or physical appearance of a plant is the plant's **phenotype**. Changes in plant genotype will most often result in a change in the plant's phenotype as well. In their work to develop new plants, plant breeders often develop new plant cultivars. A **cultivar** is a cultivated plant that has specific and distinguishable characteristics. Another important attribute of a cultivar is that plants within a cultivar will retain the characteristics of that group when reproduced.

Use a variety of techniques to help students master this objective. Students should use text materials to help understand plant breeding. Introduction to Plant and Soil Science and Technology is recommended.

Objective 2: Define the processes of selection and hybridization.

Anticipated Problem: What are selection and hybridization?

- II. There are many methods a plant breeder can use in the plant breeding process. Two of the most common methods are selection and hybridization.
 - A. **Selection** is the process of breeding plants that are selected for a particular characteristic. This leads to the dominance of certain genetic traits. A **mutation** is a genetic variation that naturally occurs in the plant. Mutations cannot be predicted.
 - B. **Hybridization** is the process of breeding individuals from distinctly different varieties. The goal of this procedure is to gain a superior characteristic in the offspring. Often hybrid plants exhibit a trait known as hybrid vigor. **Hybrid vigor** is a condition where the offspring may have greater yield, height, disease resistance, or other traits than either of the parents.

Use a variety of techniques to help students master this objective. Students should use text materials to help understand selection and hybridization. Introduction to Plant and Soil Science and Technology is recommended.

Objective 3: Explain genetic engineering in plants.

Anticipated Problem: How is genetic engineering accomplished in plants?

- III. The process of altering an organism by deliberately changing its DNA is called **genetic engineering**. The plants into which genes from another organism have been incorporated are called **transgenic plants**. To genetically modify an entire plant, the initial transfer of genetic information occurs at the single cell level. This process is aided by the fact that plants are totipotent. **Totipotent** means that an organism has the ability to grow from a single cell. There are a number of techniques that have been developed to accomplish the task of moving genetic information from one organism to another. Two common processes involve *Agrobacterium tumefaciens* and ballistic gene transfer.
 - A. *Agrobacterium tumefaciens* is a bacterium that causes a disease known as crown gall in plants. This bacterium infects the plant by transferring its genetic material into the plant cell. This is accomplished by moving the plasmid DNA of the bacteria into an injured site on the plant.
 - B. For plants where *agrobacterium tumefaciens* is not effective, another method must be used. **Ballistic gene transfer** is the use of tiny DNA-coated projectiles as carriers. It is used to transport DNA through the walls of intended recipient cells. These projectiles are tiny gold particles called **microprojectiles**. The success rate of this method is from less than 1 percent to about 10 percent. This method is accomplished with a device known as a “gene gun” or microprojectile unit. A gene gun typically uses an enclosed vacuum system with a high-powered ammunition charge to “shoot” DNA into plant cells.

Use a variety of techniques to help students master this objective. Students should use text materials to help understand genetic engineering in plants. Biotechnology is recommended. Use TM: C2–5A and TM: C2–5B to aid in discussion on this topic.

Review/Summary. Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at the end of each chapter in the recommended textbooks may also be used in the review/summary.

Application. Have students complete the laboratory activity “Genetically Engineered Soybeans” on pages 81–84 in the Activity manual for Biotechnology.

Evaluation. Focus the evaluation of student achievement on mastery of the objectives as stated in the lesson.

Answers to Sample Test:

Part One: Matching

1 = e, 2 = d, 3 = f, 4 = b, 5 = a, 6 = c, 7 = g

Part Two: Completion

1. mutation
2. Plant breeding
3. Ballistic gene transfer

Part Three: Short Answer

Answers will vary. Some possible answers are:

1. Gain disease resistance.
2. Gain insect resistance.
3. Improve environmental adaptation.
4. Improve productivity.
5. Make a species more suited to cultural practices.
6. Obtain a more desirable product from plants.

Test

Lesson C2–5: Using Crossbreeding and Hybrids

Part One: Matching

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

- | | | |
|---------------|----------------------|------------------------|
| a. Totipotent | d. Genotype | g. Genetic engineering |
| b. Cultivar | e. Transgenic plants | |
| c. Phenotype | f. Hybridization | |

- _____ 1. Plants into which genes from another organism have been incorporated.
- _____ 2. The genetic makeup of a plant.
- _____ 3. The process of breeding individuals from distinctly different varieties.
- _____ 4. A cultivated plant that has specific and distinguishable characteristics.
- _____ 5. The ability to grow from a single cell.
- _____ 6. The outward or physical appearance of a plant.
- _____ 7. The process of altering an organism by deliberately changing its DNA.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

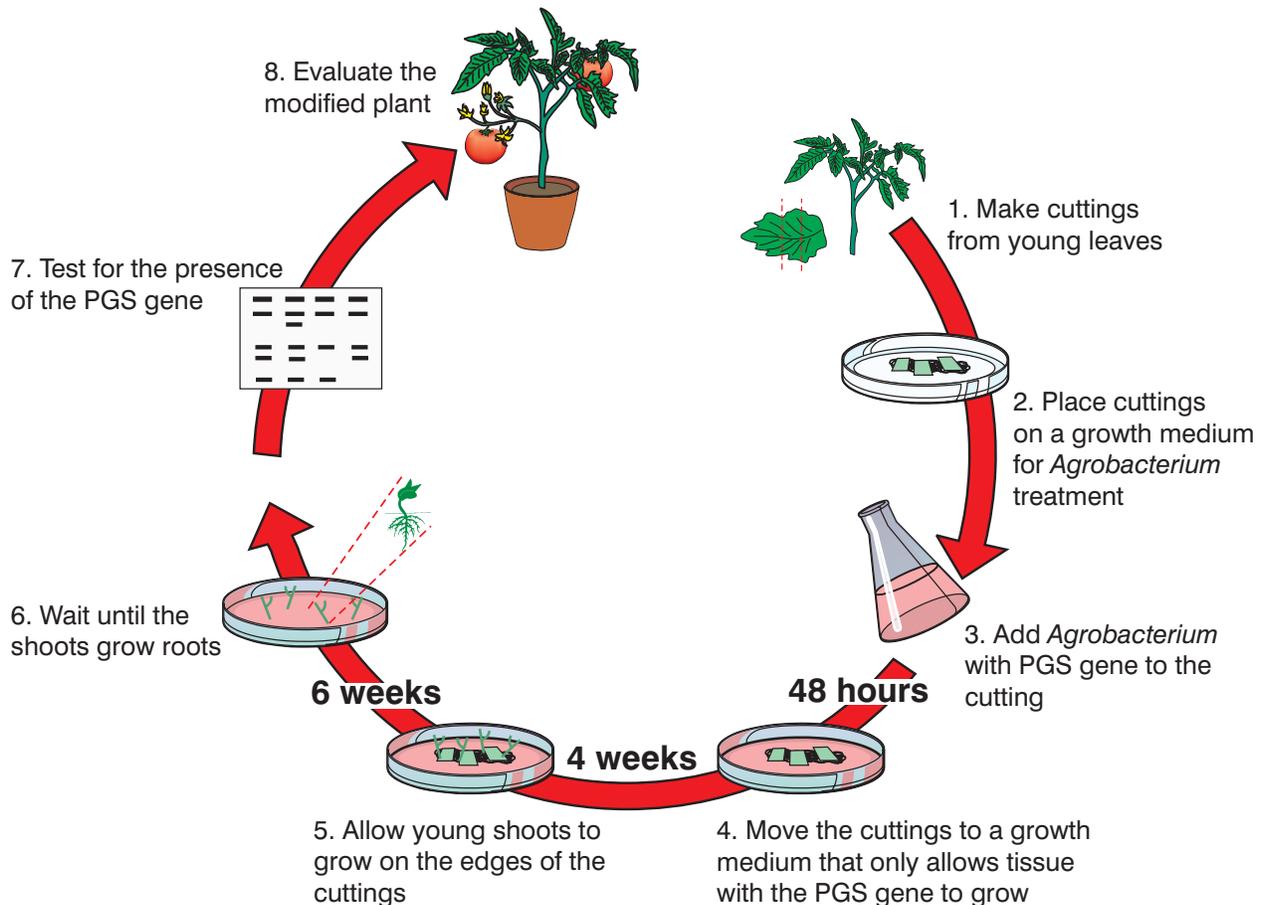
1. A _____ is a genetic variation that naturally occurs in the plant.
2. _____ is the systematic process of improving plants using scientific methods.
3. _____ is the use of tiny DNA-coated projectiles as carriers of genetic material.

Part Three: Short Answer

Instructions. Provide information to answer the following question.

What are some types of improvements in plants that can be made through plant breeding?

PROCEDURE IN USING AGROBACTERIUM TUMEFACIANS IN CREATING A TRANSGENIC TOMATO



THE MAJOR PARTS OF A GENE GUN

