

## UNIT II - PLANT SCIENCE

### Lesson 1: The Importance of Plants

**Competency/Objective:** Describe how plants affect our lives.

#### **Study Questions**

1. **What are the benefits of plants?**
2. **What are the areas of science related to plants?**
3. **What is the economic importance of plants in Missouri?**

#### **References**

1. *Exploring Agriculture in America* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit II.
2. *Turfgrass Management - Your Field of Dreams* (Ag Video 261). Missouri Resource Center for Career & Technical Education, University of Missouri-Columbia, 1990.
3. Transparency Master  
TM 1.1 Value of Leading Missouri Crops in 1998
4. Activity Sheets  
AS 1.1 Soil Dessert (Instructor)  
AS 1.2 Landscaping Plant Material Collection  
AS 1.3 Plant Science Businesses

## UNIT II - PLANT SCIENCE

### Lesson 1: The Importance of Plants

#### TEACHING PROCEDURES

##### A. **Introduction**

Plants are an important part of life. Without plants, humans would not be able to breathe or eat. They also help make the environment more enjoyable. This unit on plant science is designed to provide a basic understanding of the importance of plants and the related areas of agronomy and horticulture. It will provide information about plant growth and plant care, and students will have an opportunity to care for a plant and watch it grow.

##### B. **Motivation**

1. Conduct AS 1.1. Introduce basic concepts (e.g., common plant names, reproduction, benefits of plants, signs of plant health, and types of soil) that will be learned during this unit.
2. Bring in a wide variety of materials from horticulture and the related sciences. Mushrooms, ferns, garden flowers, lumber samples, fruits, vegetables, grain crops, cattails, cut flowers, and peanut butter are some examples. Have the students discuss how the items are similar and how they are different. Discuss how each item is or is not important to humans.
3. Have students identify and make a list of the houseplants that are in their homes and plants that grow in their yards and gardens. They may also use relatives' or neighbors' homes. Relatives and friends are encouraged to help them identify the plants. Discuss their plant lists and what benefits the plants provide.
3. Obtain scented geraniums and have students guess the fragrance after carefully rubbing the leaves. The foliage is used in potpourris and jellies, and the oil in the leaves is often distilled for perfume making.
4. Students will care for the plants each day that they grew earlier in the course.

##### C. **Assignment**

##### D. **Supervised Study**

##### E. **Discussion**

#### Q1. **What are the benefits of plants?**

##### A1.

- a) **Biological benefits**
  - 1) **Convert carbon dioxide to oxygen**
  - 2) **Provide food**
- b) **Physical benefits**
  - 1) **Provide materials for shelter**
  - 2) **Provide materials for clothing**
  - 3) **Provide shade, cooling, and wind control**
  - 4) **Reduce wind and water erosion**

- 5) **Provide energy sources**
- 6) **Provide habitat for wildlife**
- c) **Emotional benefits**
  - 1) **Provide beauty from landscapes and individual specimens**
  - 2) **Provide an enjoyable hobby**
  - 3) **Provide a relaxing effect**

Bring in several items made from plants that are important to people. Examples might include peanut butter, cotton clothing, a board, firewood, vegetables, fruits, and a blooming flower. Ask students why each item is important.

**Q2. What are the areas of science related to plants?**

**A2.**

- a) **Botany is the science of plants: anatomy, ecology, pathology, physiology, and taxonomy.**
- b) **Horticulture includes producing, processing, and marketing of fruits, vegetables, flowers, ornamental shrubs, and trees; nursery and landscaping; and turf management.**
- c) **Agronomy is the study of field crops and soil management.**
- d) **Forestry is the science of managing trees for lumber, paper, and other wood products.**

Bring in samples of plants that fall into these areas and discuss which area of plant science they belong in. Some examples might include algae or plankton for botany; field corn, cotton, or hay for agronomy; a walnut or redwood board to represent forestry; and examples of fruits, vegetables, and ornamental plants for horticulture. Assign AS 1.2 for students to complete by themselves or in teams. The fall quarter is an excellent time for this activity.

**Q3. What is the economic importance of plants in Missouri?**

**A3. The value of plants in Missouri in 1998 was approximately \$3 billion.**

Show TM 1.1 and ask students how they are personally affected by the various amounts of money represented in this chart. Is their life enriched in any way? What advantages do they enjoy? Are any members of their family affected by the plants in Missouri? Several businesses are derived from the economic importance of plants as seen in AS 1.3.

**F. *Other Activities***

- 1. Have people from plant industries talk to the class.
- 2. Make a bulletin board with examples of how people benefit from plants or with pictures of different plant science careers.
- 3. Take a field trip to a floral shop, greenhouse, nursery, orchard, agronomy research facility or park.
- 4. Have students make a bud vase or small flower arrangement.

**G. *Conclusion***

Plants are essential for humans to breathe and eat. Plants make life more comfortable because they provide shelter, clothing, and shade. Plants also make our world more pleasant through their beauty. Botany, horticulture, agronomy, and forestry are all related plant sciences. The

value of plants produced in Missouri in 1998 was approximately \$3 billion, which would make the Fortune 500 list.

H. ***Answers to Activity Sheets***

The instructor should determine if answers to all activity sheets are appropriate.

I. ***Evaluation***

A unit test is provided at the end of this unit. If a lesson quiz is needed, use questions pertaining to this lesson from the unit test.

## Value of Leading Missouri Crops in 1998

Crop	Approximate Value (Millions of Dollars)
Soybeans	857
Corn	550
Hay	533
Winter wheat	137
Cotton	119
Rice	64
Grain sorghum	46
Floriculture	44
Tobacco	11
Potatoes	10
Watermelons	6
Apples	5
Peaches	4
Grapes	1
Oats	1

## Major Areas of Floriculture Production by Commercial Growers

Item	Wholesale Value (Millions of Dollars)
Bedding plants (flats) & baskets	21
Indoor/patio plants	11
Cut flowers	.6

Reference: *Missouri Farm Facts 1999*



### Soil Dessert

**Objective:** Students will become aware of some basic plant science concepts.

**Materials and Equipment:**

Ingredients for soil dessert recipe (see below)

One houseplant  
One medium flowerpot  
Plastic wrap  
Bowls  
Plates and spoons  
Serving utensils

Soil dessert recipe

24 oz. chocolate sandwich cookies (such as Oreos)  
1 cup powdered sugar  
8 oz. cream cheese  
Two 3-oz. boxes instant chocolate pudding  
2 cups milk  
One 12-oz. container whipped topping (such as Cool Whip)  
1 package gummy worms candy

**Procedure:**

Note: This activity is to be used as an interest approach and an introduction to basic concepts about soil and plants. Depending on the portion and number of students, a bigger batch of soil dessert may have to be made.

1. Complete steps 2 through 9 below before class begins.
2. Crush cookies (mixture one) and set aside.
3. Mix powdered sugar and cream cheese (mixture two) and set aside.
4. Mix instant chocolate pudding and milk, then blend with whipped topping (mixture three).
5. Layer the three mixtures in numerical order in the flowerpot, saving some crushed cookies (mixture one) to sprinkle on top.
6. Place gummy worms into the dessert.
7. Chill in a refrigerator for approximately three hours.
8. Put plastic wrap around the root system of the houseplant. The roots may have to be pruned. Put the houseplant in the soil dessert in the flowerpot.
9. Keep the rest of the mixtures in the refrigerator until needed.
10. Use the houseplant as an interest approach to begin the lesson. Place the houseplant on a table at the front of the classroom. Ask students the key questions below to assess their prior knowledge of some basic plant science concepts.

- a. What type of plant is it? What are some names of other common houseplants?
  - b. How does it reproduce? Could you cut off part of the plant and make a new one? (Actually do this, especially if it is a plant that can asexually reproduce.)
  - c. What does the plant provide us?
  - d. Is it a healthy plant? (You may want to select an unhealthy plant.) How can you tell and what do you look for?
  - e. What is in the potting mix or soil? Does the type of soil have an effect on the plant?
11. Finally, surprise the students by asking them if they would like a closer look at the soil. Serve them some soil.



**Landscaping Plant Material Collection**

**Objective:** Students will press, mount, and identify plants.

**Directions:** Collect, press, mount and correctly identify 12 plants from the list below. Your sample should be representative so a positive identification can be made. Be sure to include stems, leaves, flowers, and seeds as appropriate.

**Materials and Equipment:**

- Cardboard
- Newspaper or paper
- Heavy objects like books or bricks
- Clear contact paper

**Procedure:**

1. Immediately after collecting your sample, place it between a newspaper or other paper and then place it between some cardboard.
2. Place the cardboard, containing the sample, between or under books, bricks, or other heavy objects. The purpose of pressing the plant is to remove moisture and make a more representative sample.
3. Leave the plant in the press for 2 or 3 days.
4. Take the sample out of the press and cover it with clear contact paper.
4. Label the plant by common name and include a picture and description from the publication\* provided by your instructor.
5. Organize your collection by making a cover. Decide how to arrange the plants in the collection and put in a notebook, binder, ring, etc.

This major assignment is due on \_\_\_\_\_.

The collection is worth a total of 30 points with each plant worth 2 points. Neatness in labeling and applying contact paper, cover design, and organization will be worth 6 of the points. Up to 5 extra credit points can be earned by collecting more than 12 plants from the list or other plants found in the publication.

- |  |                                       |  |
|--|---------------------------------------|--|
| <input type="checkbox"/> Arborvitae          | <input type="checkbox"/> Ginkgo       | <input type="checkbox"/> Oak             |
| <input type="checkbox"/> Ash, White          | <input type="checkbox"/> Honey Locust | <input type="checkbox"/> Pine            |
| <input type="checkbox"/> Barberry            | <input type="checkbox"/> Juniper      | <input type="checkbox"/> Spruce          |
| <input type="checkbox"/> Birch               | <input type="checkbox"/> Linden       | <input type="checkbox"/> Winged Euonymus |
| <input type="checkbox"/> Dogwood             | <input type="checkbox"/> Maple        | <input type="checkbox"/> Yew             |
| <input type="checkbox"/> Flowering Crabapple |                                       |  |

\*Suggested publication: *Effective Landscaping*, Missouri Landscape and Nursery Association, 23750 State Route V, Clarksdale, MO 64430, 816-233-1481



Lesson 1: The Importance of Plants

Name \_\_\_\_\_

**Plant Science Businesses**

**Objective:** Students will be able to identify plant science businesses in the community.

**Directions:** Using a phone book, list the names of plant science businesses that are examples of the following categories.

- |   |                                |
|---|--------------------------------|
| 1. Nursery                                | 6. Lawn Management             |
| a.  | a.                             |
| b.  | b.                             |
| 2. Floral Designer                        | 7. Tree Specialist or Arborist |
| a.  | a.                             |
| b.  | b.                             |
| 3. Landscape Designer or Landscape Artist | 8. Seed Store                  |
| a.  | a.                             |
| b.  | b.                             |
| 4. Greenhouse                             | 9. Agronomist/Research         |
| a.  | a.                             |
| b.  | b.                             |
| 5. Golf Course                            |                                |
| a.  |                                |
| b.  |                                |



## UNIT II - PLANT SCIENCE

### Lesson 2: Plant Parts and Processes

**Competency/Objective:** Describe the parts of a plant and major processes.

#### **Study Questions**

1. **What are the functions of the parts of a plant?**
2. **How do plants reproduce?**
3. **What are the parts of a flower?**
4. **What is germination?**
5. **What is photosynthesis?**
6. **What is the difference between annuals, biennials, and perennials?**
7. **What is the difference between monocots and dicots?**

#### **References**

1. *Exploring Agriculture in America* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000. Unit II.
2. Transparency Masters
  - TM 2.1 Main Parts of a Plant
  - TM 2.2 Plant Propagation
  - TM 2.3 Asexual Propagation Methods
  - TM 2.4 Methods of Taking Cuttings
  - TM 2.5 Parts of a Complete Flower
  - TM 2.6 Can You Name an Annual, Biennial, or Perennial?
  - TM 2.7 Monocot or Dicot?
  - TM 2.8 Stages in Germination and Emergence of a Monocot
  - TM 2.9 Stages in Germination and Emergence of a Dicot
3. Activity Sheets
  - AS 2.1 Starting Plants from Stem Cuttings (Asexual Propagation)
  - AS 2.2 Parts and Functions of a Complete Flower
  - AS 2.3 Effect of Light on Photosynthesis

## UNIT II - PLANT SCIENCE

### Lesson 2: Plant Parts and Processes

#### TEACHING PROCEDURES

##### A. **Review**

Plants provide people with oxygen to breathe, food to eat, clothing, shelter, and landscaping beauty. Many plant science careers are available in agronomy, horticulture, and forestry.

##### B. **Motivation**

1. Show examples of seeds that are small (bentgrass) and large (lima bean). Ask students if they are living or dead. What causes them to sprout (germinate)?
2. Bring in examples of plants showing different stress problems such as excessive light, too little light, excessive water, compacted soil, lack of fertilizer, or pollution damage. Discuss the plant problems and what caused them. Discuss how proper conditions would allow for better growth.
3. Is a room with plants healthier than one without? If this were true, why would plants make a difference? Discuss photosynthesis with students.
4. Demonstrate several methods of plant propagation. Examples may include air layering a rubber plant, grafting a fruit tree, planting a bulb or tuber, or dividing a perennial flower.

##### C. **Assignment**

##### D. **Supervised Study**

##### E. **Discussion**

#### Q1. **What are the functions of the parts of a plant?**

##### A1.

- a) **Roots**
  - 1) **Absorb water and minerals from the soil**
  - 2) **Anchor the plant**
  - 3) **Food storage area**
- b) **Stem**
  - 1) **Supports the plant's leaves and flowers**
  - 2) **Transports water, minerals, and manufactured food to all parts of the plant**
  - 3) **Site of some photosynthesis**
  - 4) **Food storage area**
- c) **Leaves**
  - 1) **Major producer of food for the plant (through photosynthesis)**
  - 2) **Food storage area**
  - 3) **Site of respiration and transpiration**
- d) **Flower**
  - 1) **Site of sexual propagation**
  - 2) **Source of fruit and seed**
  - 3) **Attracts pollinators**

Bring into class a flowering plant and have the class discuss the main parts. Ask students to tell the function of the main parts. Use TM 2.1 to display the main parts of a plant.

**Q2. How do plants reproduce?**

**A2.**

- a) **Sexually**
  - 1) **Sexual propagation occurs within the flower as a result of pollination.**
  - 2) **This produces fruit and seeds.**
- b) **Asexually**
  - 1) **Asexual propagation uses vegetative parts.**
  - 2) **Asexual techniques can produce new plants from leaves, stems, and roots, depending on the plant.**
  - 3) **There are several common asexual propagation methods.**
    - (a) **Cuttings**
    - (b) **Grafting**
    - (c) **Division**
    - (d) **Layering**
    - (e) **Budding**
    - (f) **Tissue culture**
  - 4) **There are four main reasons for using asexual propagation.**
    - (a) **Some plants do not produce seed or seeds are difficult to germinate.**
    - (b) **It is usually a faster process than seeding.**
    - (c) **It is more economical.**

Bring in some garden flower seeds to show the product of sexual propagation and how easily they may be handled. Also, bring in a banana and a naval orange to illustrate the need for asexual propagation due to their lack of viable seeds. Remind students about the seeds that they planted in Unit 1, Lesson 1. Point out that starting plants from seed is sexual propagation. Use TMs 2.2, 2.3, and 2.4 to illustrate plant reproduction.

Bring in samples of several plants or pictures of plants propagated by the various asexual propagation methods. Discuss how they were propagated. Pass out AS 2.1 and demonstrate how to take stem cuttings, then allow students to take some cuttings. Students should be allowed to take cuttings from several different plants.

**Q3. What are the parts of a flower?**

**A3.**

- a) **Petals - attract insects for pollination**
- b) **Pistil**
  - 1) **Female structure of the flower**
  - 2) **Site of fruit and seed formation**
  - 3) **Contains the stigma, style, and ovary**
- c) **Sepal - protects flower in the early stages**
- d) **Stamen**
  - 1) **Male structure of the flower**
  - 2) **Produces pollen**
  - 3) **Contains the anther and filament**

Bring in a flower, such as a tulip, lily, or petunia, or a model of a flower to illustrate the different parts and explain their importance. Use TM 2.5 to review the process of pollination after discussing the parts of a flower. Have students complete AS 2.2 to test their knowledge on plant parts and functions.

**Q4. What is germination?**

**A4.**

- a) **Germination is the beginning of plant growth as seen by the sprouting of the seed.**
- b) **The seed is in a dormant, or resting, stage with a supply of food and a protective seed coat until the requirements for germination are met.**
- c) **The following are needed for a seed to germinate:**
  - 1) **Favorable temperature that varies by species**
  - 2) **Sufficient moisture**
  - 3) **Air**
  - 4) **Presence or absence of light (depends on plant species)**

Ask students for their definition of germination. Bring in some soybeans and cover them with water. Ask students what they think will happen to the soybeans overnight. The soybeans will swell to rupture the seed coat, the first stage of germination.

**Q5. What is photosynthesis?**

**A5. Photosynthesis is the process that occurs in green parts of plants. The chlorophyll in the plant reacts with water, carbon dioxide, and sunlight to produce oxygen and simple sugars.**

Bring in examples of plants with different leaf sizes and colors and have the students discuss how plants may differ in their ability to photosynthesize. Have students complete AS 2.3 to illustrate how light and lack of light affects plant growth.

**Q6. What is the difference between annuals, biennials, and perennials?**

**A6.**

- a) **Annuals are plants that complete their life cycle (grows, flowers, produces seed, and dies) in one year.**
- b) **Biennials are plants that grow during one year and flower, produce seed, and die during the next year. They live for two years.**
- c) **Perennials are plants that live for more than two years. They can grow year after year without replanting.**

Ask students to identify common plant examples that are annuals, biennials, and perennials. Use TM 2.6 to show examples of each life cycle.

**Q7. What is the difference between monocots and dicots?**

**A7.**

- a) **Monocots (e.g., corn, wheat)**
  - 1) **One cotyledon (seed leaf)**
  - 2) **Leaves with parallel veins**
  - 3) **Fibrous root system**
- b) **Dicots (e.g., soybeans, alfalfa)**
  - 1) **Two cotyledons**
  - 2) **Leaves with netted veins**
  - 3) **Taproot system**

Summarize using TMs 2.7, 2.8, and 2.9 to illustrate the differences in physical makeup and germination stages.



F. **Other Activities**

1. Do an in-depth study of one of the propagation techniques and demonstrate it to the class.
2. Ask someone from a nursery to demonstrate advanced propagation techniques, such as grafting, budding, or tissue culture.
3. Get a tissue culture kit from a science supply company (e.g., Carolina Biological Supply Co.). Do the tissue culture experiment with the help of the class.
4. Bring in potatoes and have the students cut them into pieces and plant them in pots. Have the students discuss why they will grow.
5. Show the videos *Plant Propagation* Vol. I and II (Ag Video 46 & 47) available from the Missouri Resource Center for Career & Technical Education, University of Missouri-Columbia.

G. **Conclusion**

Plants have major parts that serve important functions and are important for plant survival or reproduction. Plants can be reproduced sexually by germinating seeds or asexually using vegetative plant parts. The main parts of a flower are the petals, pistil, sepal, and stamen. Germination is the sprouting of a seed when conditions are favorable. Photosynthesis occurs when the chlorophyll in the plant reacts with water, carbon dioxide, and sunlight to produce oxygen and simple sugars (food for the plant). The plant's life cycle may be completed in one year (annual), two years (biennial), or more than two years (perennial). Plants may be classified as monocots (single-seed leaf) or dicots (two-seed leaves).

H. **Answers to Activity Sheets**

AS 2.1 Starting Plants from Stem Cuttings (Asexual Propagation)

The instructor should determine if the student completes the activity in an appropriate manner.

AS 2.2 Parts and Functions of a Complete Flower

- |    |          |
|----|----------|
| A. | Petals   |
| B. | Anther   |
| C. | Filament |
| D. | Stamen   |
| E. | Sepal    |
| F. | Ovary    |
| G. | Style    |
| H. | Stigma   |
| I. | Pistil   |
- 
- |    |   |
|----|---|
| A. | Attracts insects for pollination                        |
| D. | Male part of flower, produces pollen                    |
| E. | Protects the flower in the bud stage                    |
| I. | Female part of flower, site of fruit and seed formation |

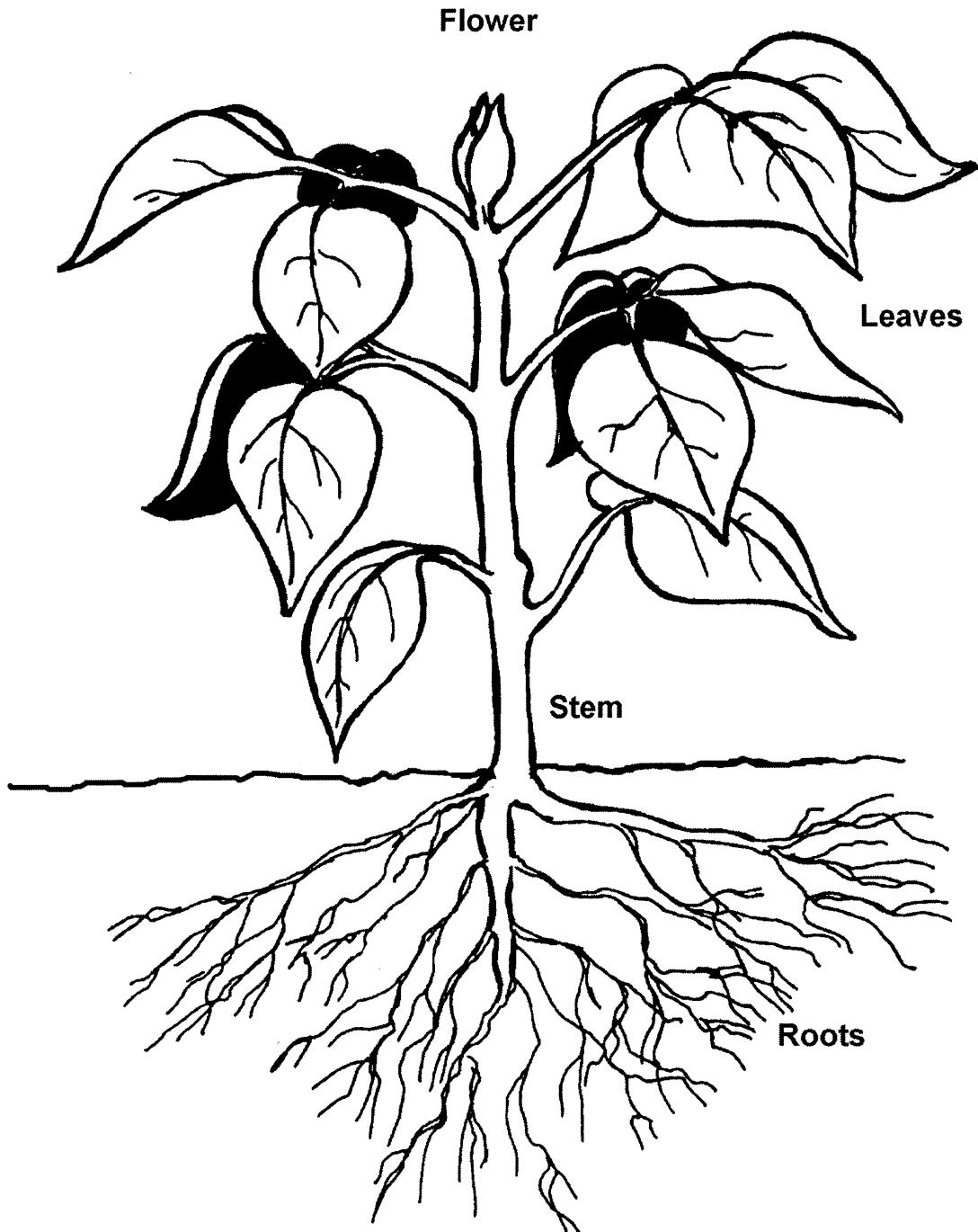
AS 2.3 Effect of Light on Photosynthesis

The instructor should determine if answers are appropriate.

I. ***Evaluation***

A unit test is provided at the end of this unit. If a lesson quiz is needed, use questions pertaining to this lesson from the unit test.

# Main Parts of a Plant





# Plant Propagation

Propagation – To increase in number, to reproduce

## Two Methods

- 1) Sexual – by seed
- 2) Asexual – vegetative method

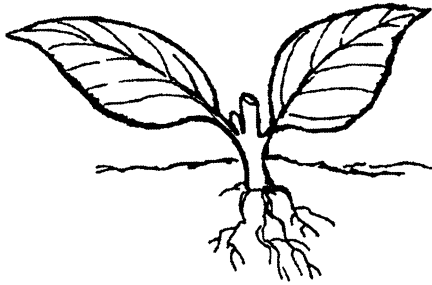
## Examples of Asexual Propagation

- 1) Cuttings
- 2) Grafting
- 3) Division
- 4) Layering
- 5) Budding
- 6) Tissue culture

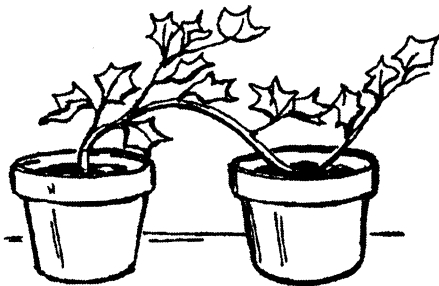
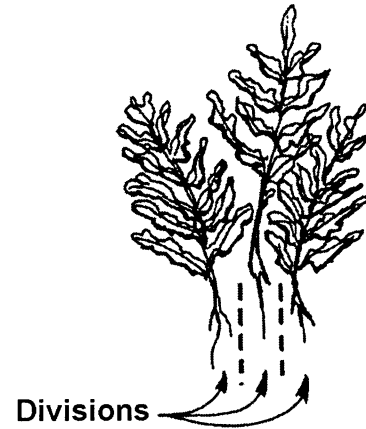


# Asexual Propagation Methods

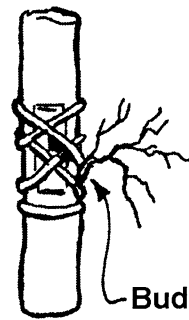
Cutting



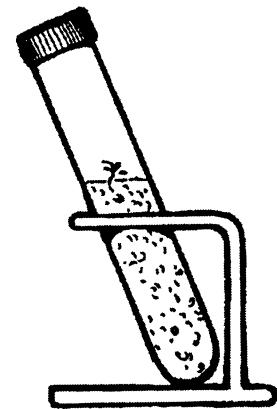
Grafting



Layering



Budding



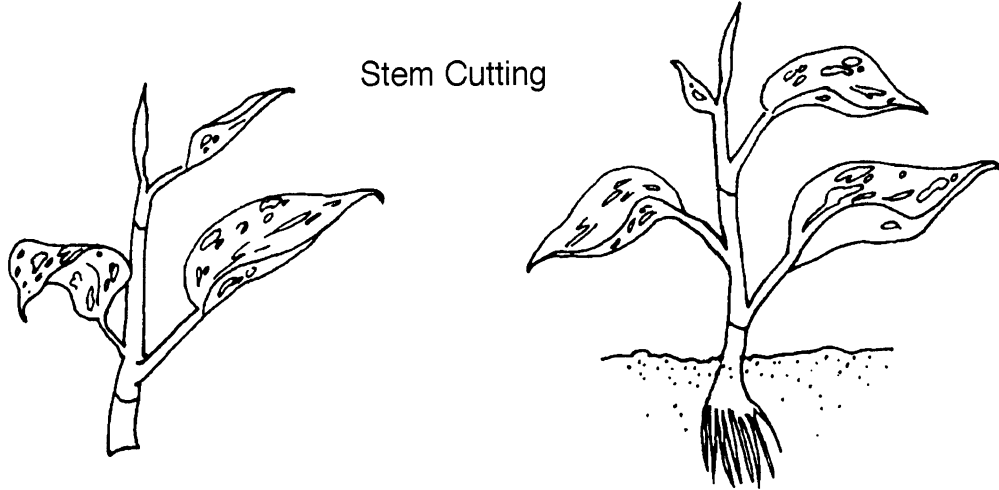
Tissue Culture



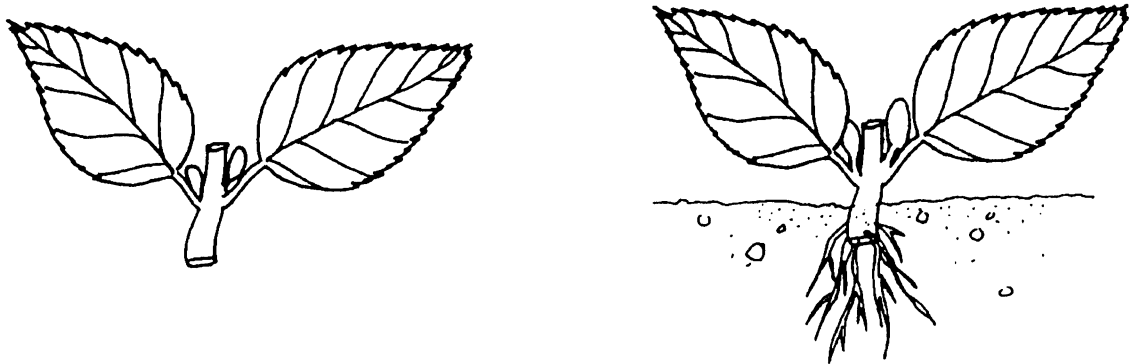


# Methods of Taking Cuttings

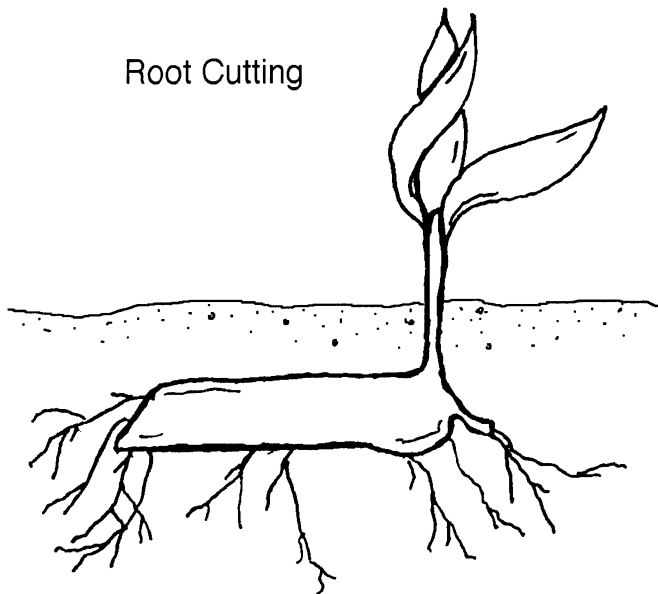
Stem Cutting



Leaf and Bud Cutting

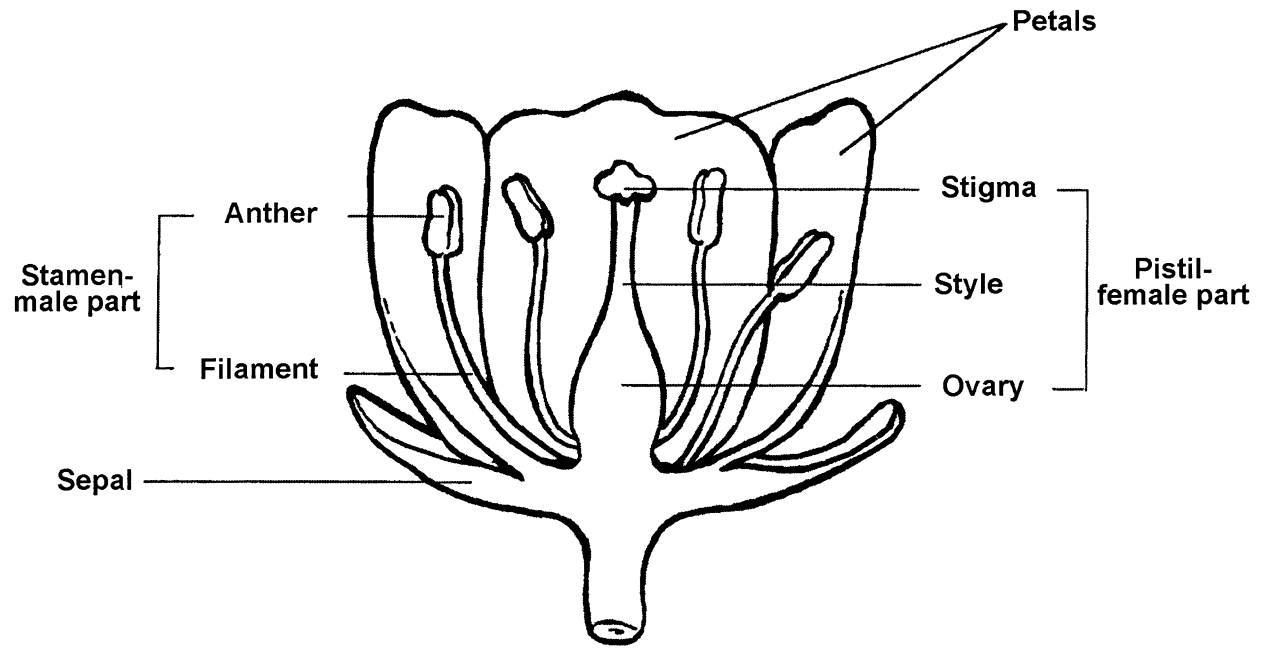


Root Cutting





# Parts of a Complete Flower





# Can You Name an Annual or Perennial?

**Annual**

**Vegetables:** Cucumber  
 Lettuce  
 Peas  
 Radish  
 Snap bean  
 Sweet corn

**Flowers:** Petunia  
 Geranium  
 Impatiens  
 Marigold

**Perennial**

**Vegetable:** Asparagus

**Fruit:** Strawberry

**Flowers:** Chrysanthemum  
 Hibiscus  
 Peony

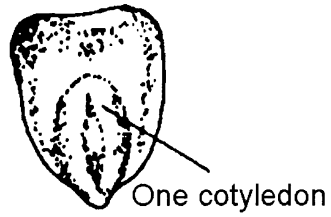
**All trees**

**Source:** *Introduction to Horticulture: Science and Technology* (1995)

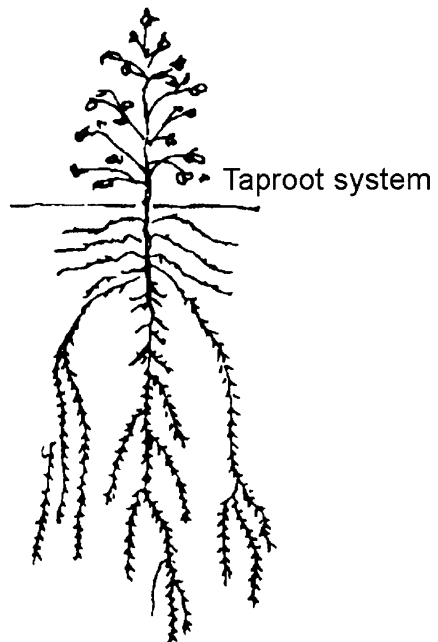
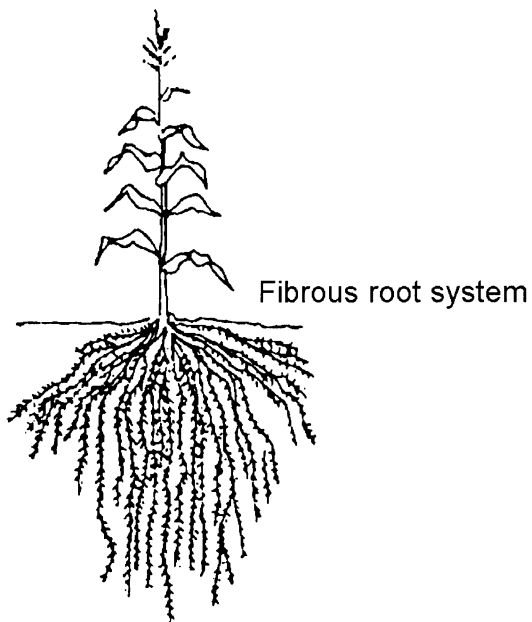
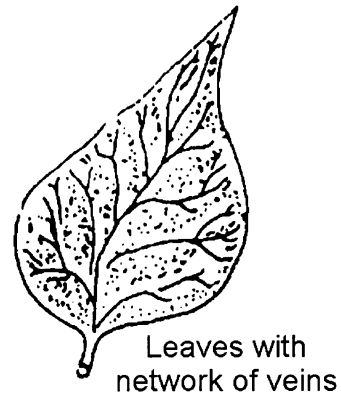
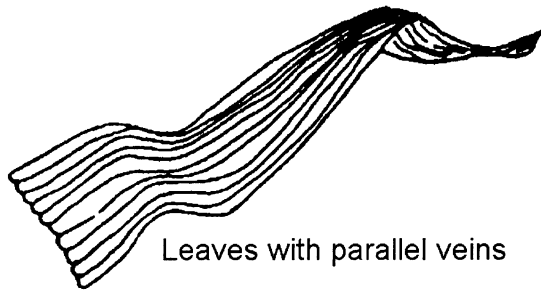
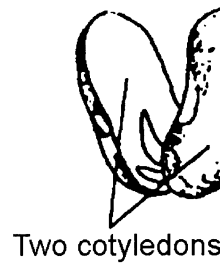


# Monocot or Dicot?

MONOCOT (e.g. Corn)



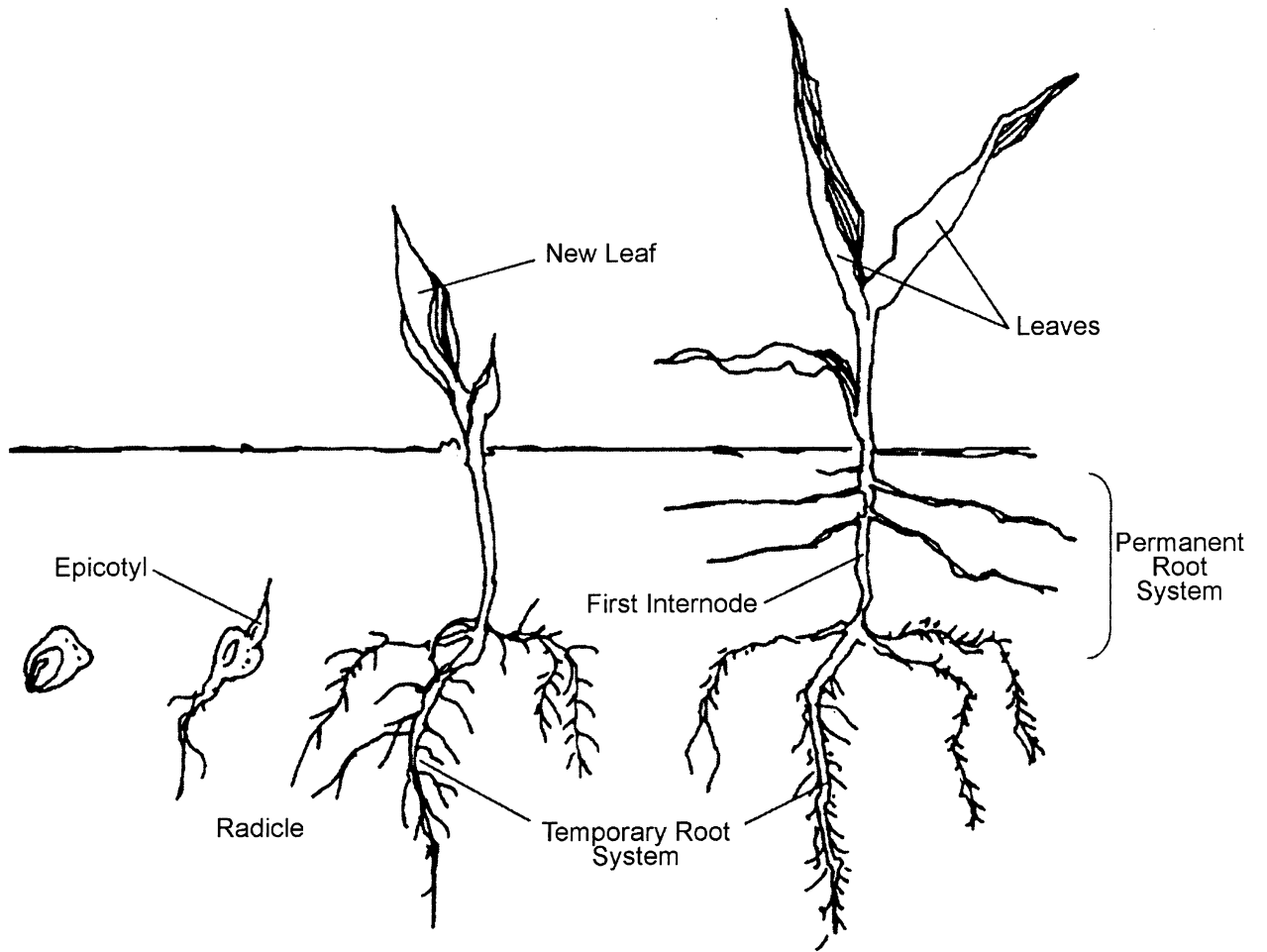
DICOT (e.g. Bean)





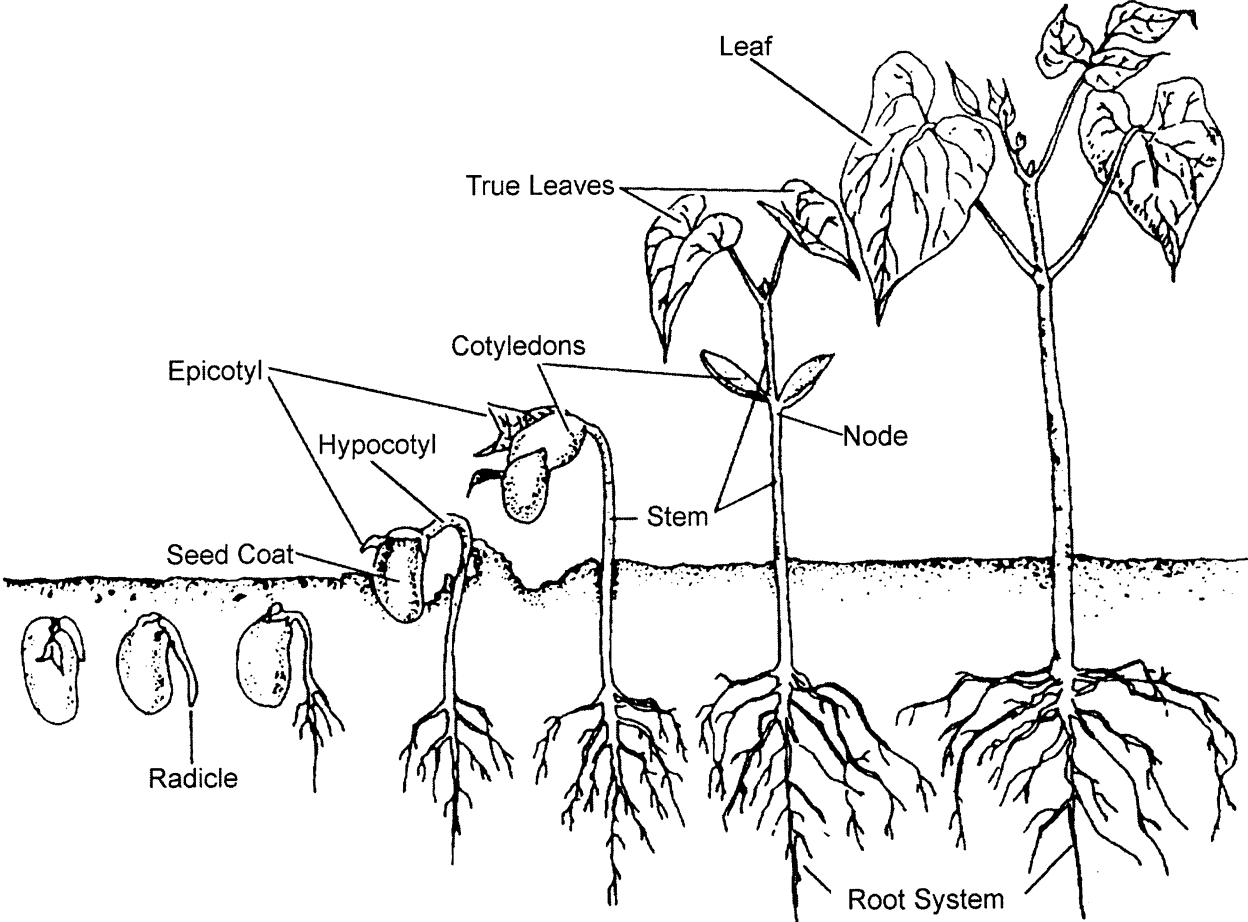


# Stages in Germination and Emergence of a Monocot





# Stages in Germination and Emergence of a Dicot





**Starting Plants from Stem Cuttings  
(Asexual Propagation)**

**Objective:** Students will be able to start a plant from a stem cutting.

**Materials and Equipment:**

Potting soil  
Pot, flowerpot, cup, etc.  
Plant for stem cutting such as Swedish ivy  
Rooting hormone  
Knife  
Water  
Small clear plastic bag with tie

**Procedure:**

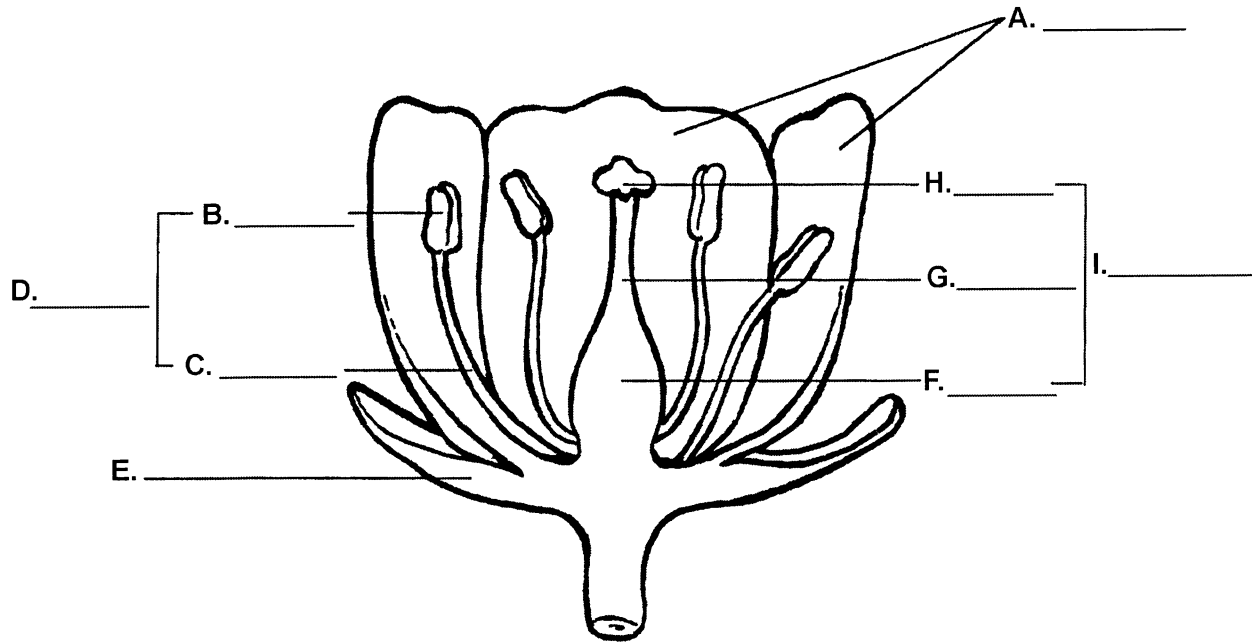
1. Watch the instructor demonstrate how to start plants from stem cuttings.
2. If you are using a cup instead of a pot, place a small hole in the bottom so the water can drain out.
3. Fill the pot with the soil up to 1/2 inch from the top.
4. Use your finger to make a hole 1 inch deep in the soil.
5. Take the stem cutting from a plant determined by the instructor.
6. The cutting should have three to seven leaves or nodes.
7. Remove the bottom two leaves from the stem.
8. Place rooting hormone on the bottom 1/2 inch of the stem.
9. Insert the cutting into the soil and firm the soil around it.
10. Water thoroughly.
11. Place the pot in a small clear plastic bag and tie it closed to hold in the moisture.
12. Place the pot in a well-lighted area.
13. Check the pot every day. Open the plastic bag and water the soil when it is dry to the touch.



**Parts and Functions of a Complete Flower**

**Objective:** Students will be able to identify the parts of a complete flower and give their functions.

**Directions:** Label the parts of a complete flower and give their functions below.



Functions:

A. \_\_\_\_\_

D. \_\_\_\_\_

E. \_\_\_\_\_

I. \_\_\_\_\_





**Effect of Light on Photosynthesis**

**Objective:** Students will be able to describe the effect of light on photosynthesis.

**Materials and Equipment:**

Two 2-liter empty soda bottles  
Knife or scissors  
Potting soil  
Two plants of equal size (tomatoes, cabbage, geranium, etc.)  
Water  
Black plastic bag with tie

**Procedure:**

1. Rinse out the soda bottles and allow them to dry.
2. Use the knife or scissors to cut off the top one-third of the bottle.
3. Put 2 inches of soil in the bottom of each soda bottle.
4. Carefully transplant one plant into each container.
5. Moisten the soil and replace the tops of the soda bottles.
6. Place one container in a window to receive good light.
7. Place the other container in a black plastic bag. Tie it securely so that it will not receive light.
8. Allow plants to grow for 2 weeks, being sure to water the plant when the soil is dry to the touch.
9. Examine the plants.

**Key Questions:**

1. Did the plants grow the same amount?
  
  
  
  
  
  
  
  
  
  
2. How did light or the lack of light affect photosynthesis?



## UNIT II - PLANT SCIENCE

### Lesson 3: The Growing Medium

**Competency/Objective:** Describe the importance of the growing medium to plants

#### **Study Questions**

1. **What is soil?**
2. **What are the components of soil?**
3. **What is a growing medium?**
4. **What is a soilless mix and where is it used?**
5. **What is hydroponics?**

#### **References**

1. *Exploring Agriculture in America* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit II.
2. Transparency Masters
  - TM 3.1 Components of Soil
  - TM 3.2 Relative Sizes of Sand, Silt, and Clay
  - TM 3.3 What Is in a Soilless Mix?
  - TM 3.4 Aquarium Hydroponic System
3. Activity Sheets
  - AS 3.1 Examining Soil
  - AS 3.2 Water-Holding Capacity of Soil (Instructor)
  - AS 3.3 Design Your Own Medium

## UNIT II - PLANT SCIENCE

### Lesson 3 - The Growing Medium

#### TEACHING PROCEDURES

##### A. **Review**

The major parts of plants are essential to the growth and reproduction of the plant. The roots and stem absorb and transfer nutrients, the leaves are the primary site for photosynthesis, and the flower is the site of sexual reproduction. Many plants can also be reproduced by asexual (vegetative) methods using stems, leaves, and roots.

##### B. **Motivation**

1. Obtain a soil profile(s) (monolith(s)-undisturbed sample in a frame) from the soil and water conservation district in your area and measure the depth of topsoil. Discuss other differences that can be seen.
2. Obtain samples of different colors of soil (light, dark, red, mottled, gray, etc.) and ask students why there is a variation in color. There are several explanations as follows. Color of soil can be a result of rainfall and vegetation. In general, more rainfall results in more vegetation. This increased organic matter coats the mineral particles of soil and gives it a dark color. Brighter subsoils (red and yellow) result from low-moisture levels. Dark subsoils (gray tones) result from poor air and water relationships as evident in water-logged soils.
3. What is the difference between soil and dirt? Discuss this question with students.
4. Ask students the ways soil is important to them.

##### C. **Assignment**

##### D. **Supervised Study**

##### E. **Discussion**

###### Q1. **What is soil?**

###### A1.

- a) **Soil is the naturally occurring top layer of the earth's surface that provides food, water, air, and support for plant life.**
- b) **Soil is a natural resource that humans depend on for food, clothing, and materials for shelter.**
- c) **Soil is composed of a great amount of life. Scientists agree there is more life below the surface of the earth than there is above it. The life-forms are earthworms, insects, bacteria, fungi, and many other microscopic organisms.**
- d) **Soil is not dirt. Dirt is misplaced soil.**

Prepare for AS 3.1 by obtaining some soil. Using a spade, obtain soil that includes the vegetation on top, the topsoil, and subsoil. Place the soil on shop or classroom tables and have students identify and list all items found in the soil. Depending on the time of year and weather conditions, this activity could be conducted outside at a field or other location near the school. In either case, the instructor will do the digging and provide the soil. When completing AS 3.1, the students must be encouraged to examine and sort

through the soil. This activity will lead into identifying the components of soil. The students will also identify items that cannot be seen (fungi, bacteria, etc.).

**Q2. What are the components of soil?**

**A2.**

**The ideal soil contains the following components:**

- a) **45% mineral matter - inorganic (not from plants or animals) and varies in size**
  - 1) **Sand - largest particles**
  - 2) **Silt - medium-size particles**
  - 3) **Clay - smallest particles**
- b) **5% organic matter - originates from a living source, usually a plant or animal**
- c) **25% water**
- d) **25% air**

Use TM 3.1 to review components of soil and TM 3.2 to demonstrate relative sizes of mineral matter particles. Conduct AS 3.2 to illustrate the water-holding capacity of soil. Have students assist you as you conduct this activity. The instructor may want to organize this activity by groups. In this case, ensure that proper safety rules are followed.

**Q3. What is a growing medium?**

**A3.**

- a) **Growing medium (singular) or growing media (plural) are the materials in which the roots of plants grow.**
- b) **The growing medium supports, or anchors, the plant in place, even after watering.**
- c) **The growing medium must retain sufficient moisture, yet be porous enough to allow excess water to drain.**

Plants derive nutrients from a variety of growing media. Each plant has its own medium that supports its growing needs best.

**Q4. What is a soilless mix and where is it used?**

**A4.**

- a) **A soilless mix is a medium that contains no soil.**
- b) **Soilless mixes contain various combinations of the following materials.**
  - 1) **Perlite - gray-white material of volcanic origin used to improve aeration**
  - 2) **Vermiculite - heat-treated mica (a very thin, layered mineral) with a high moisture-holding capacity**
  - 3) **Peat moss - partially decomposed vegetation with a high moisture-holding capacity**
  - 4) **Tree bark - usually the bark of fir, pine, or cedar as a source of organic matter**
- c) **Almost all greenhouses and nurseries use a soilless medium to grow plants in flats, pots, and other containers.**

Use TM 3.3 to discuss the items found in a soilless mix. Put each of the items (perlite, vermiculite, peat moss, and tree bark) in a separate sealed plastic bag and pass them around the class during discussion.

Have students examine the contents of a soilless medium and identify each of the components listed on the label. Finally conduct AS 3.3 to have students design their own medium. Before conducting this activity, pasteurize the sand and soil by heating at 180° F for at least 30 minutes.

**Q5. What is hydroponics?**

**A5.**

- a) **Hydroponics is a method of growing plants in water (nutrient solution) rather than soil.**
- b) **This technique is used to grow high-value crops in greenhouses, especially during the winter.**
- c) **Some hydroponic systems use sand, gravel, rockwool, peatlite, or sawdust, rather than soil.**
- d) **Bare root systems mist the roots of plants at regular intervals with a nutrient solution, use shallow pools with plants floating on the surface, or use recirculating streams of nutrient solutions.**

Explain hydroponics to the students using TM 3.4 to illustrate.

**F. *Other Activities***

1. Invite an agronomist, horticulturist, soil conservationist, turf manager, etc., to speak to the class.
2. Take a field trip to a greenhouse to assist in mixing media and transplanting seedlings, and to observe a hydroponics system, etc.
3. Take a soil sample of the school lawn and have students analyze the soil using a soil testing kit. Kits can be obtained from companies such as NASCO, 1-800-558-9595. Optionally, the sample can be sent to a commercial lab for analysis and students can review the analysis.
4. Tour a golf course and have the superintendent discuss how the course was managed relative to the growing medium.
5. Grow plants hydroponically in an aquarium or at the school greenhouse.
6. Have students investigate the produce department at area grocery stores and report if vegetables have been grown hydroponically. Rather than ask produce workers, have students check for labels indicating the process was used. Optionally, this activity could be assigned for extra credit to have one student call an area store.

**G. *Conclusion***

The plant's underground environment is very important to its overall health. Nearly every product people use or consume can be traced back to the soil. The ideal soil is 45% mineral matter, 5% organic matter, 25% water, and 25% air. The growing medium is the material in which the roots of plants grow and is critical to the overall health of a plant. Today almost all greenhouses and nurseries use a soilless mix to grow plants in flats, pots, and containers. Hydroponics is a technique of growing plants in water (nutrient solution) rather than soil.

**H. *Answers to Activity Sheets***

The instructor should determine if the answers are appropriate.

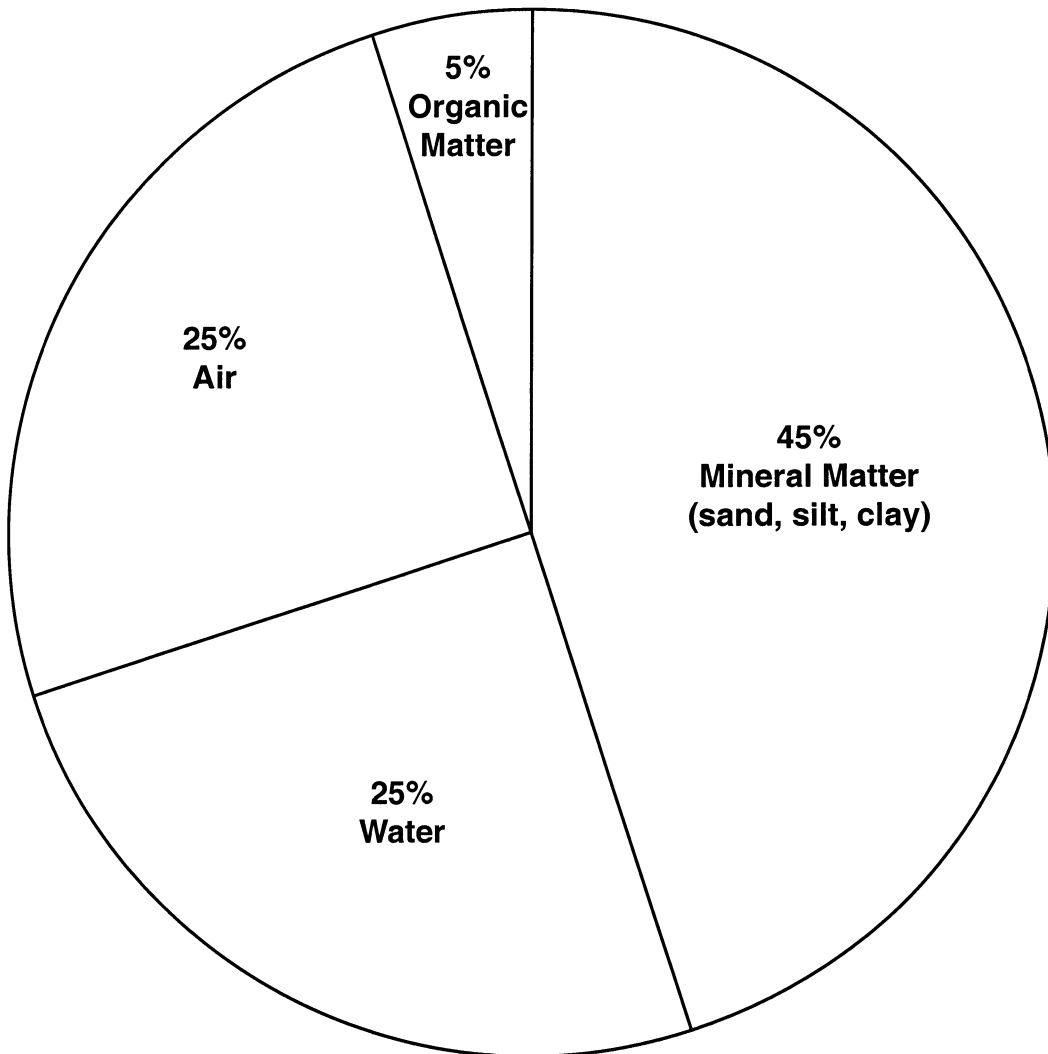
I. ***Evaluation***

A unit test is provided at the end of this unit. If a lesson quiz is needed, use questions pertaining to this lesson from the unit test.



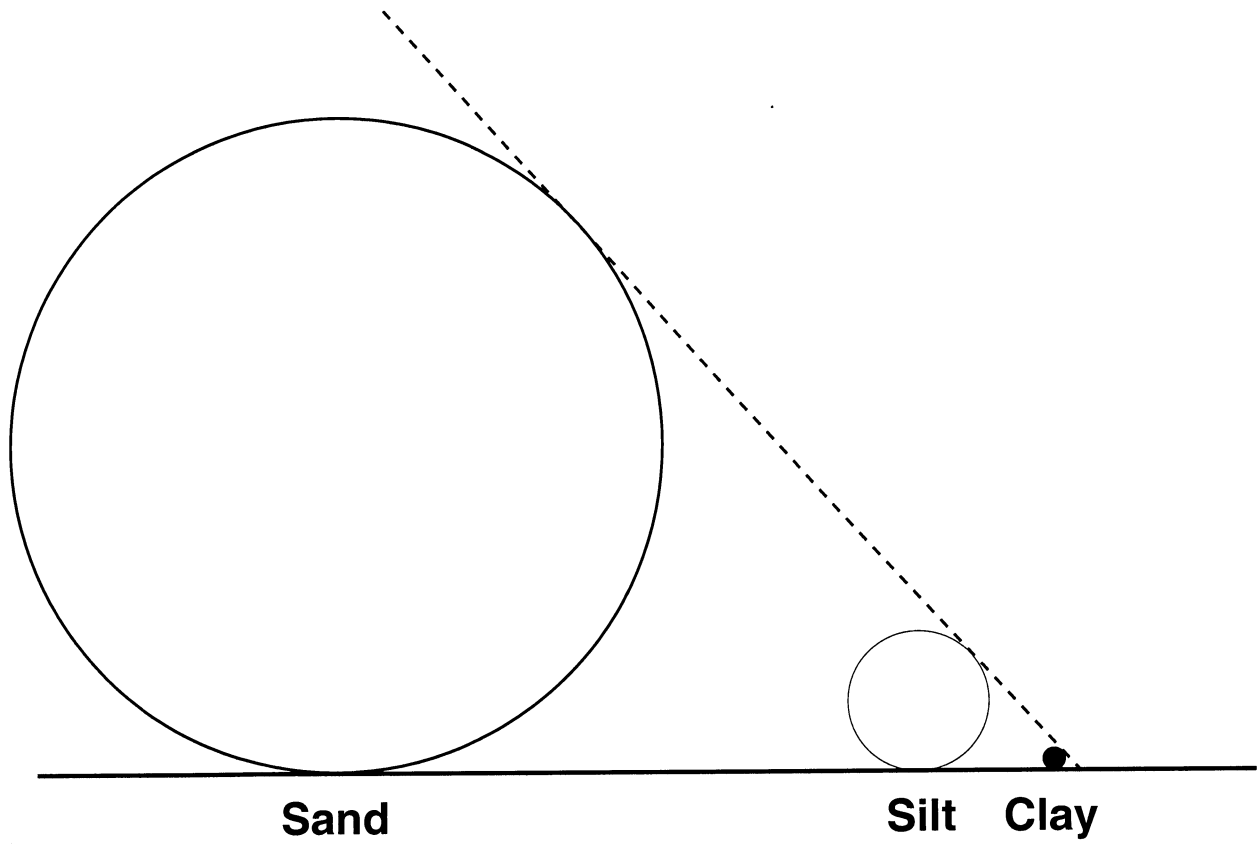


# Components of Soil





# Relative Sizes of Sand, Silt, and Clay





## What Is in a Soilless Mix?

### **Perlite**

- Gray-white material of volcanic origin
- Improves aeration

### **Vermiculite**

- Heat-treated mica
- Improves moisture-holding capacity

### **Peat Moss**

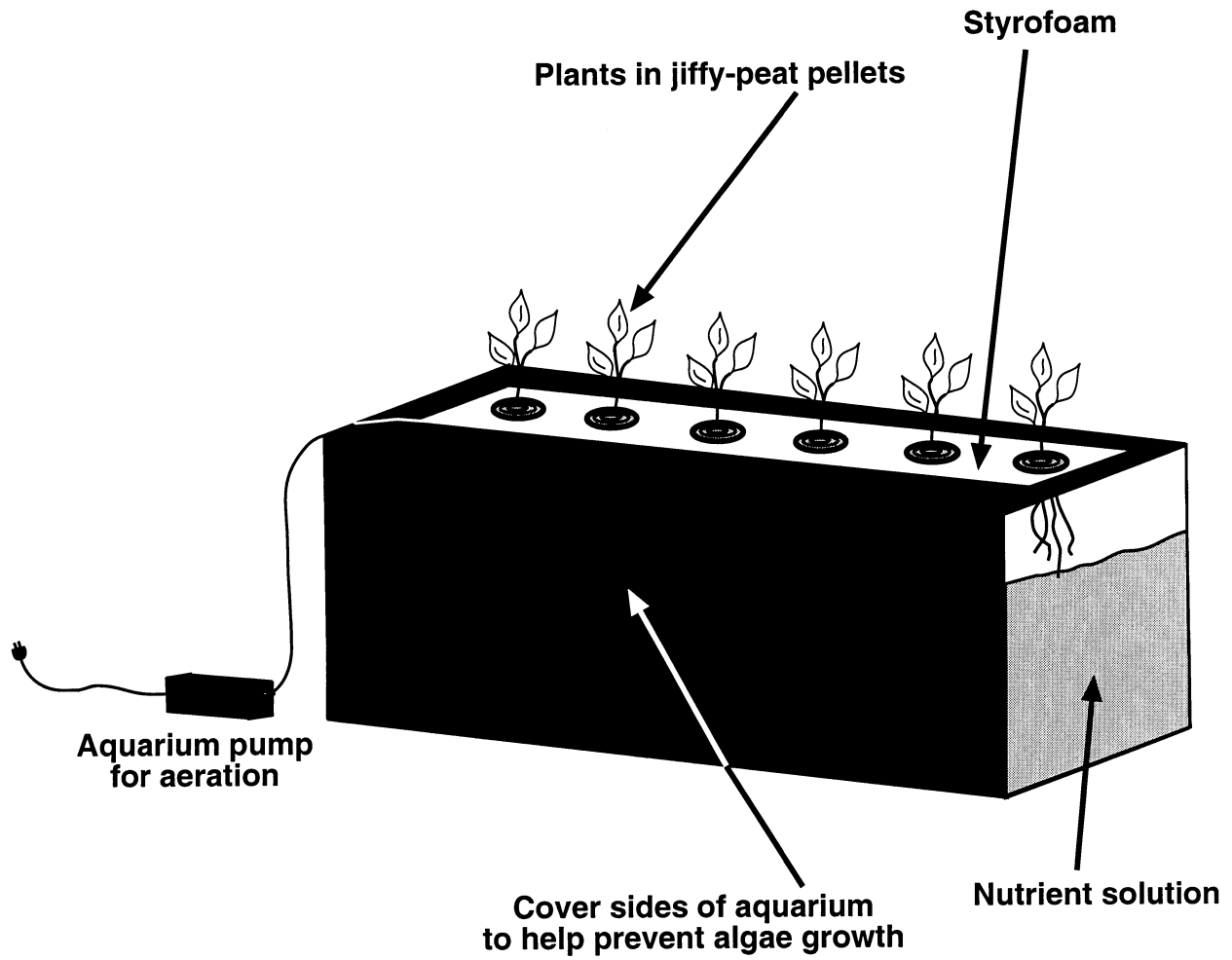
- Partially decomposed vegetation
- Improves moisture-holding capacity

### **Tree Bark**

- 1/4" diameter or less pieces of fir, pine, or cedar bark
- Source of organic matter



# Aquarium Hydroponic System











### Water-Holding Capacity of Soil

**Objective:** Students will identify the water-holding capacity of soil.

**Materials and Equipment:**

Three 1-gallon containers (e.g., plastic milk containers)  
 Three soil samples with different particle sizes (sand, loam, and clay)  
 Measuring equipment to collect water (1/2 gallon)  
 Timer

**Procedure:**

1. With a nail and hammer, punch small holes in the caps of the 1-gallon containers. Cut a hole in the bottom of each container so soil and water can be added.
2. Select three students to assist. One student fills the first gallon container with sand, another student fills the second with loam, and the third student fills the last container with clay. Do not completely fill each container, but rather fill the container about  $\frac{3}{4}$  full.
3. Have each student place the measuring equipment under his/her container to collect the water.
4. Each student then slowly pours  $\frac{1}{2}$  gallon of water into his/her container.
5. The entire class records the following observations in the table below.

SOIL	AMOUNT OF WATER COLLECTED				
	After 1 min.	After 2 min.	After 3 min.	After 4 min.	After 5 min.
Sand					
Loam					
Clay					

6. Students record their conclusions from this experiment.



**Design Your Own Medium**

**Objective:** Students will design a medium for plants.

**Materials and Equipment:**

- Seedlings or small plants started by you or supplied by the instructor
- Cups/containers for measuring parts
- Quart or ½ gallon container for medium
- Flats or containers for mixing the ingredients
- Perlite
- Vermiculite
- Peat moss
- Pasteurized sand
- Pasteurized soil

**Procedure:**

1. Select each ingredient you want for your medium.
2. Match the total amount of medium to your container size. For example, a medium for a quart container could consist of 1 cup (part) of peat moss, 1 cup of perlite, 1 cup of sand, ½ cup of vermiculite, and ½ cup of soil.
3. Measure each ingredient using cups or containers and record the information in the chart below.

INGREDIENT	WEIGHT OR PARTS

4. Mix and blend the ingredients so your medium is a uniform consistency.
5. Transplant the seedling or small plant into your container.
6. Pour your medium around the plant's root system and then fill the entire container.
7. Water the plant and check for dryness at regular intervals. Water when the medium is dry to the touch.



## UNIT II - PLANT SCIENCE

Lesson 4: Plant Care Requirements

**Objective:** Identify the important factors to consider in caring for plants

### **Study Questions**

1. **What are the factors affecting plant growth?**
2. **What are the essential nutrients for plant growth?**
3. **What care should be provided for indoor plants?**
4. **What care should be provided for outdoor plants?**

### **References**

1. *Exploring Agriculture in America* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit II.
2. Transparency Masters  
TM 4.1 What Do the Numbers 10-15-10 Mean?  
TM 4.2 Rules of Proper Watering
3. Activity Sheets  
AS 4.1 Plant Care Contest (Instructor)  
AS 4.2 Plant Care Requirements

## UNIT II - PLANT SCIENCE

### Lesson 4: Plant Care Requirements

#### TEACHING PROCEDURES

##### A. **Review**

The previous lesson focused on the underground environment of plants, which is very important to their overall health. Nearly every product people use or consume can be traced back to the soil. This lesson will focus on the aboveground needs and the essential nutrients for plant growth.

##### B. **Motivation**

1. Ask students how many have houseplants at home. Discuss the problems they have noticed. Identify procedures a parent, brother/sister, or they do that result in healthy plants. See if the concept of proper watering of houseplants surfaces as the number one factor in plant survival.
2. Bring in samples of healthy plants and samples of plants showing water stress, soil problems, sun damage, or pest problems. Have students look at the top growth and root system. Discuss the differences between the healthy plants and those with problems. Discuss how proper care could help prevent these problems.
3. Ask students what humans need to survive. What do plants need to survive and grow?
4. Have students begin AS 4.1. Remind them that the information they learned earlier about plants will assist them in this activity.

##### C. **Assignment**

##### D. **Supervised Study**

##### E. **Discussion**

#### Q1. What are the factors affecting plant growth?

##### A1.

- a) **Water**
  - 1) **Essential for photosynthesis**
  - 2) **Maintains cell shape**
  - 3) **Enables nutrients to be absorbed and transported throughout the plant**
  - 4) **Transports manufactured food to all parts of the plant**
- b) **Growing medium**
  - 1) **Provides support for the roots**
  - 2) **Allows water and air filtration and movement**
  - 3) **Stores needed nutrients**
- c) **Nutrients (fertilizer) - 16 nutrients essential for plant growth**
- d) **Light**
  - 1) **Plants need different levels of light intensity.**
  - 2) **Light is required for photosynthesis.**
- e) **Temperature**
  - 1) **Plants differ greatly in their tolerance for hot and cold temperatures.**
  - 2) **Extremes in temperature can cause slow growth, fruit or flower damage, or death of the plant.**



- f) **Humidity - to help prevent leaves from drying**
- g) **Gases - important in photosynthesis**
- h) **Pest control - increases plant growth**

Bring in samples of plants with different water requirements, such as cactus, water lily, and philodendron. Discuss how knowledge of their water requirements is important. Also bring in plants that have different light requirements, such as ferns, hostas, and geraniums. Discuss how trying to grow them under the same conditions will result in the death of some plants.

**Q2. What are the essential nutrients for plant growth?**

**A2. The 16 essential nutrients are broken down into four categories:**

- a) **Primary macronutrients (large amounts)**
  - 1) **Nitrogen (N)**
  - 2) **Phosphorus (P)**
  - 3) **Potassium (K)**
- b) **Secondary macronutrients (moderate amounts)**
  - 1) **Calcium (Ca)**
  - 2) **Magnesium (Mg)**
  - 3) **Sulfur (S)**
- c) **Micronutrients (small amounts)**
  - 1) **Boron (B)**
  - 2) **Chlorine (Cl)**
  - 3) **Copper (Cu)**
  - 4) **Iron (Fe)**
  - 5) **Manganese (Mn)**
  - 6) **Molybdenum (Mo)**
  - 7) **Zinc (Zn)**
- d) **Elements from air**
  - 1) **Carbon (C)**
  - 2) **Hydrogen (H)**
  - 3) **Oxygen (O)**

Most fertilizers contain three primary macronutrients: nitrogen (N), phosphorus (P), and potassium (K). Bring in a lawn fertilizer bag and have students identify the nutrients supplied by the fertilizer. Show TM 4.1 during your discussion.

**Q3. What care should be provided for indoor plants?**

**A3.**

- a) **Provide proper water.**
  - 1) **Use a well-drained growing medium.**
  - 2) **Water plants as needed.**
  - 3) **Water thoroughly at every watering.**
- b) **Control humidity levels.**
- c) **Maintain appropriate temperature range.**
- d) **Maintain appropriate light levels.**
- e) **Fertilize the growing medium as needed.**
- f) **Provide appropriate pinching and pruning.**
  - 1) **Pinch or prune dead/damaged leaves and branches.**
  - 2) **Pinch or prune to maintain plant shape.**

Ask students what care should be provided for indoor plants. Bring in several plants and discuss their care requirements. Use TM 4.2 to discuss proper watering rules.

**Q4. What care should be provided for outdoor plants?**

**A4.**

- a) **Watering is usually only required during dry periods.**
- b) **Grow in areas where they are adapted.**
- c) **Select tolerant plants for locations where pollution can be a problem.**
- d) **Fertilizer is generally only needed once per year.**
- e) **Prune occasionally to remove dead and damaged leaves and branches.**
- f) **Prune to maintain the plant's natural shape, when required.**

Ask students to discuss the growing conditions that outdoor plants need. Which conditions are supplied by nature? Have students complete AS 4.2 to reinforce what they have learned about plant care.

**F. *Other Activities***

1. Provide plants for students to care for at the school or in the community for several weeks. Students could help the garden club or city plant flowers downtown or in parks.
2. Have students design experiments to see how different levels of light, water, fertilizer, etc., affect plant growth.
3. Plant several trees at the school or conduct a landscaping project at the school or in the community.
4. Allow a geranium to grow naturally from the start of the course to the end. Pinch a second geranium to develop a more compact and desired shape during the course. Compare them at the conclusion of the course.

**G. *Conclusion***

Many factors need to be considered in caring for plants. Plants differ in their need for these factors depending on the variety and location. However, all plants require three major nutrients: nitrogen (N), phosphorus (P), and potassium (K). A key skill to be mastered in caring for plants is watering. More plants are damaged or die from overwatering than underwatering. Keeping a plant in good health will reduce the possibility of having pest problems.

**H. *Answers to Activity Sheets***

The instructor should determine if the answers are appropriate.

**I. *Evaluation***

A unit test is provided at the end of this unit. If a lesson quiz is needed, use questions pertaining to this lesson from the unit test.

# What Do the Numbers 10-15-10 Mean?



**10% Nitrogen (N)**  
**15% Phosphorus (P)**  
**10% Potassium (K)**



## **Rules of Proper Watering**

### **Use a well-drained growing medium.**

- The medium should be porous yet retain water.

### **Water plants as needed.**

- Observe the color of the medium.
- Test for moisture by touch.

### **Water thoroughly at every watering.**

- Water should flow out the bottom of the container.



### **Plant Care Contest**

**Objective:** Students will demonstrate their ability to care for plants.

**Directions:** Provide students with a small/young houseplant that does not have critical care requirements (a geranium is a good example). The school or a commercial greenhouse might provide a plant for each student. The horticultural science class could start enough vegetative or seed geraniums for Exploring Agriculture in America students to use. A key factor for this project is to have uniform plants for the students.

Use AS 4.2 as a way to obtain important plant care requirements. Start the project at school and use this activity to teach students how to care for indoor plants. After one or two weeks, the students can take the plants home and care for them for the rest of the course.

During the last week of the course, students should bring their plants back to class. Evaluate the students on how good their plants look. In addition, it may be time to put the houseplant in a larger container. The instructor can demonstrate repotting, and then students can do the same with their plants.

Prizes could be awarded to the largest, smallest, best looking, etc.





**Plant Care Requirements**

**Objective:** Students will identify care requirements of selected plants.

**Procedure:**

1. Select two houseplants and two outdoor plants to research.
2. Use general references such as the ones listed below to find care information about the plants to fill in the chart. One example has been provided.

A few suggested references include:

*Green and Blooming Plants.* Redbook Florist Services, 1992.  
 (Available for free loan at the Missouri Resource Center for Career & Technical Education (MRCCTE), University of Missouri-Columbia.)

Ingels, Jack E. *Ornamental Horticulture: Principles & Practices.* Albany, NY: Delmar Publishers, 1985.  
 (Available for free loan at the MRCCTE, University of Missouri-Columbia.)

Reiley, H. Edward and Shry Jr., Carroll L. *Introductory Horticulture,* 5<sup>th</sup> ed. Albany, NY: Delmar Publishers, 1997.

The Ohio State University Horticulture and Crop Science in Virtual Perspective, <<http://www.hcs.ohio-state.edu/hcs/hcs.html>>.

University Extension Bulletins: University of Missouri-Columbia.

Plant Name	Light Needs	Water Needs	Fertilizer Needs	Type of Growing Medium	Common Pests	Other Information
Boston Fern	partial sun	keep moist	feed lightly every 4 months	1-peat 2-sand 1-soil	mealy bugs	50-70°F temperature, mist often



## UNIT II - PLANT SCIENCE

### Lesson 5: Technologies Used in Plant Agriculture

**Competency/Objective:** Identify current and emerging technologies of plant agriculture.

#### **Study Questions**

1. **How are satellite systems used in plant production?**
2. **How is genetic engineering used in plant production?**
3. **What are the effects of emerging technologies on plant production?**
4. **What are the major issues with plant technologies?**

#### **References**

1. *Exploring Agriculture in America* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit II.
2. Current news and magazine articles regarding emerging plant technologies (e.g., *U.S. News & World Report*).
3. *Seeds of Progress* (Ag Video 262). Missouri Resource Center for Career & Technical Education, University of Missouri-Columbia, 1999.
4. Transparency Masters  
TM 5.1 Precision Agriculture Is Managing Small Areas of a Field  
TM 5.2 One Acre Is About the Size of a Football Field  
TM 5.3 Gene Splicing
5. Activity Sheets  
AS 5.1 Yield Maps on the Internet (Instructor)  
AS 5.2 Wonder Plants (Instructor)  
AS 5.2 Wonder Plants (Student)  
AS 5.3 Genetic Engineering Conference (Instructor)  
AS 5.3 Genetic Engineering Conference (Student)  
AS 5.4 Biotechnology Survey (Instructor)  
AS 5.4 Biotechnology Survey (Student)

## UNIT II - PLANT SCIENCE

### Lesson 5: Technologies Used in Plant Agriculture

#### TEACHING PROCEDURES

##### A. **Review**

The previous lessons in this unit have focused on the importance of plants, plant parts and processes, the growing medium, and plant care requirements. This lesson will help students become familiar with current and emerging technologies of plant agriculture.

##### B. **Motivation**

1. Ask students where they live. After sharing answers such as street address, house number, section number, township, three miles south of town, etc., ask them if it would be important to know exactly where they live. Would latitude, longitude, and altitude be useful in locating where they live?
2. Have students ever been lost? How did they find their way back home? Could they have used technology called Global Positioning System (GPS)?
3. Ask students if they have ever used a lawn spray (herbicide) to kill weeds. What happens if the weed killer gets on good plants such as trees, flowers, etc.? Discuss selective herbicides that only kill certain weeds, and nonselective herbicides that kill any plant they are sprayed on. The nonselective types are an excellent weed killer. It would be great to use them on crops and not worry about killing the good plants. Ask students if they think this will be possible in the future. Due to genetic engineering, it is possible today. Herbicide resistance is available in soybeans, cotton, and corn with the Roundup Ready gene.

##### C. **Assignment**

##### D. **Supervised Study**

##### E. **Discussion**

#### Q1. How are satellite systems used in plant production?

##### A1.

- a) **Global Positioning System (GPS) uses 24 satellites to identify the location of a tractor, combine, or person. With the most accurate and expensive equipment, an item can be pinpointed to the nearest centimeter (.4 inch).**
- b) **Precision farming is managing crop inputs such as fertilizer, seed, herbicide, and insecticide on a subfield basis.**

Show TM 5.1 to illustrate precision farming. Show TM 5.2 to illustrate how large an acre is. Conduct AS 5.1 so students can learn how a yield map works.

#### Q2. How is genetic engineering used in plant production?

- ##### A2.
- Genetic engineering is modifying and enhancing the genetic components of organisms to benefit society. This technology is being used to develop new plants with extraordinary potential for increasing productivity that will help to feed the world.**

Show TM 5.3, which depicts gene splicing, and conduct AS 5.2 and AS 5.3 to have students imagine what new products might emerge.

**Q3. What are the effects of emerging technologies on plant production?**

**A3.**

- a) **Plants of the future will be developed with a much more specific purpose than today. It will mean food can be produced that will be more nutritious, taste better, and be of better quality.**
- b) **Two new areas of plant science will be developed as a result of genetic engineering:**
  - 1) **Nutraceuticals - health supplements or vitamins delivered through food**
  - 2) **Farmaceuticals - use of antibodies, medicines, or vaccines that can be inserted into plant-based products.**

Discuss the advantages of these new products. Ask students how they think they could be developed. Students could suggest new products or new uses for plants.

**Q4. What are the major issues with plant technologies?**

**A4.**

- a) **Safety of consuming genetically modified food**
- b) **Labeling of genetically modified food**
- c) **Effect on the environment of growing genetically modified plants**
- d) **Ethics of genetic engineering and cloning**
- e) **Impact of biotechnology on the structure of agriculture**

Show the *Seeds of Progress* video, which presents the positive aspects of biotechnology. Discuss the positive aspects and challenge students to identify concerns not addressed on the video. Read AS 5.4 (Instructor) and assign AS 5.4 (student) to have students survey individuals about their view on biotechnology.

**F. Other Activities**

1. Invite an agronomist, crop consultant, or equipment dealer, etc., who uses GPS in his/her work to speak to the class. Ask the guest to bring color yield maps and demonstrate using the GPS receiver and other equipment.
2. Obtain GPS receivers by borrowing them from a local community college or purchasing them and have students locate various sites on the school property.
3. Visit a plant or agronomy research facility to learn about its future plans with genetic engineering.

**G. Conclusion**

Current and emerging technologies will help to improve productivity and help feed and clothe the increasing world population. Humans will be supplied with more nutritious, higher quality, and better tasting food. Plant scientists continue to work on genetic engineering so medicines and vitamins can be delivered through food. The use of new technology, particularly genetic engineering, will cause close scrutiny by many people and organizations. Biotechnology promises to raise food production to new levels, but concerns held by the public may slow its acceptance.

**H. Answers to Activity Sheets**

The instructor should assign students to

I. **Answers to Evaluation**

1. a
2. c
3. d
4. c
5. b
6. d
7. d
8. b
9. a
10. c
11. c
12. c
13. d
14. a
15. d
16. b
17. a
18. c
19. c
20. b
21. b
22. a
23. d
24. d
25. c
26. b
27. a
28. d
29. c
30. a
31. b
32. Any two of the following:
  - a. Some plants do not produce seed.
  - b. Some plants germinate with difficulty.
  - c. It is a faster process than seeding.
  - d. It is more economical.
33. Water only when needed by (1) observing the color of the medium and (2) using the finger test by checking the media at the one-inch level.
34. Soil is the living and naturally occurring top layer of the earth's surface. Dirt is misplaced soil.
35. Any two of the following:
  - a. Increased productivity that will help to feed the world
  - b. Less dependence on pesticides
  - c. More nutritious food or nutraceuticals
  - d. Higher quality food
  - e. Better tasting food
  - f. Pharmaceuticals
36. Any two of the following:
  - a. Safety of consuming genetically-modified food
  - b. Labeling of genetically-modified food
  - c. Effect on the environment of growing genetically-modified plants
  - d. Ethics of genetic engineering and cloning
  - e. Impact of biotechnology on the structure of agriculture

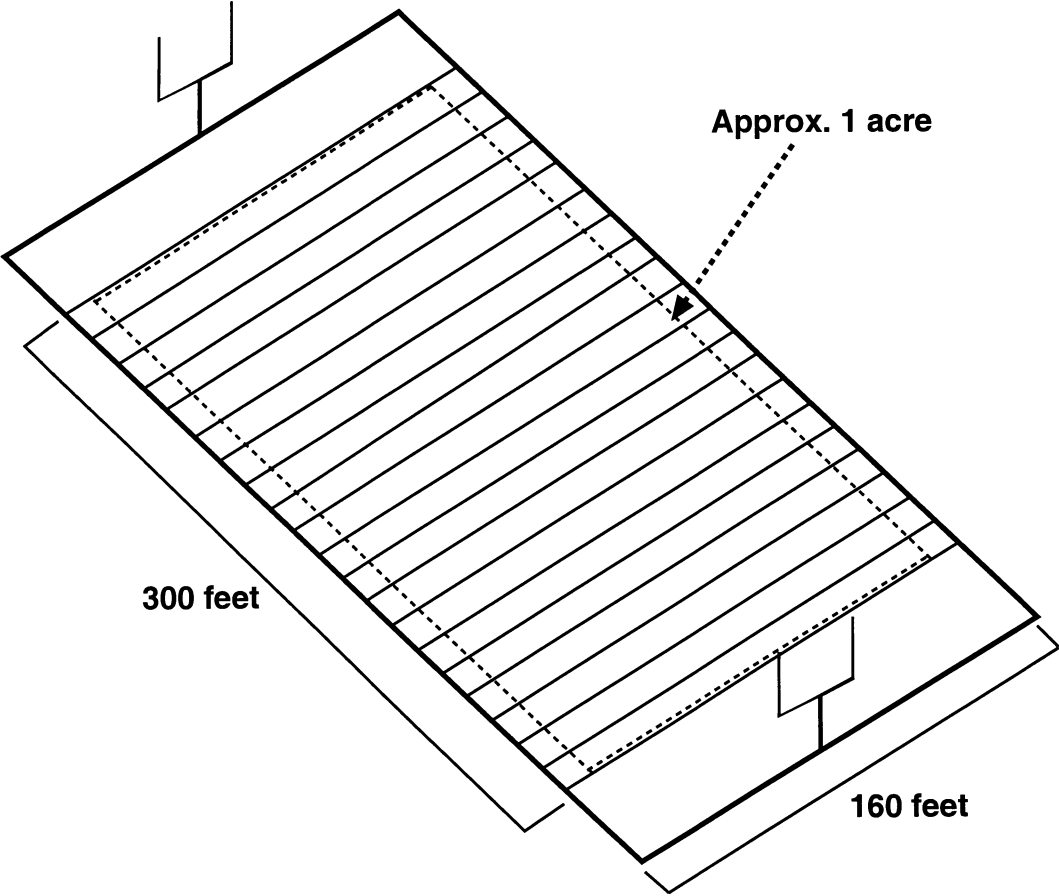
# Precision Agriculture Is Managing Small Areas of a Field

4 ½ Acres				
90-ACRE FIELD				



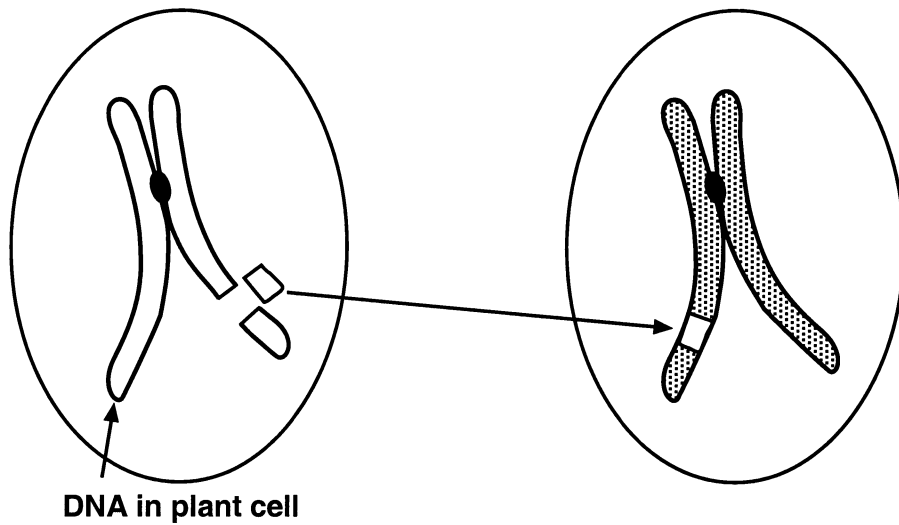


# One Acre Is About the Size of a Football Field





# Gene Splicing



DNA in plant cell

**Enzymes are used to separate the DNA at a particular location on the gene.**

**The cut DNA is combined with DNA of another plant cell.**



### **Yield Maps on the Internet**

**Objective:** Students will analyze how a yield map works.

**Directions:**

1. Have students access this site: <<http://www.geofarm.com>> for a look at a yield map of a 57.8-acre cornfield.
2. Students should click on the "NEW FOR KIDS! Yield Map Math" link.
3. Students can follow the directions on-line and answer questions related to the yield map. Answers are provided at the end of each section.



**Wonder Plants**

**Objective:** Students will generate ideas for new genetically engineered plants by brainstorming.

**Directions:** The instructor should remind students that this is a brainstorming activity. The assignment does not require students to conduct research on the topic, but rather to think of problems in producing, processing, and marketing crops or food products from plants. The instructor may wish to use one of the examples below to start students thinking about possible wonder plants.

<b>Problem or Trait to be Improved</b>	<b>Name of Plant to be Genetically Modified</b>	<b>Plant or Organism that will Supply the Genetic Material by Gene Splicing</b>	<b>Result</b>
Strawberries can't grow in freezing conditions	Strawberry	Alaska tundra plant	Strawberries could be grown year-round
Corn will die in drought conditions	Corn	Desert cactus	A corn plant that could grow in the desert and thus conserve water resources
Malnutrition of people in poor, third-world countries	Wheat	Vitamin A, C, D, etc., sources from the orange, etc.	A nutritious food source with all essential vitamins represented

Other possible plant GMOs:

1. Adding flavor to products, thus reducing the processing
  - a. Chocolate-flavored fruits and vegetables
  - b. Cucumbers with pickle flavoring
  - c. Popcorn with caramel flavor
2. Weather- or environment-tolerant plants
  - a. Cold tolerant
  - b. Drought tolerant
  - c. Green grass the entire year
  - d. Crops that can be grown in salty water
3. Growth-regulation plants - faster-growing landscaping shrubs and trees
4. Nutritious and healthy plants
  - a. Plants that reduce cholesterol
  - b. Vitamin plants
  - c. Apples that are a completely balanced meal
  - d. Plants that prevent or treat diseases like cancer
5. Insect-resistant plants
6. Pesticide-resistant plants





**Wonder Plants**

**Objective:** Students will generate ideas for new genetically engineered plants by brainstorming.

**Background Information:**

Genetic engineering has been defined as the process in which genetic material (DNA) is taken from one organism and inserted into the cells of another organism. It also can be the rearrangement of the location of genes.

A procedure to accomplish genetic engineering is called gene splicing. It can be compared to the cut and paste feature on a word processing program. You take information from one computer document and cut and paste it into a different document.

**Scenario:**

You are a genetic engineer in a biotechnology company who has been challenged to brainstorm possible genetically modified organisms (GMO). You are to list at least five new plants to be genetically engineered and leave the feasibility and ethical issues for other departments in the company.

**Assignment:**

Complete the chart below, listing at least five new plant GMOs that will be developed by gene splicing. Reminder: This is a brainstorming activity and allows you to be creative.

Problem or Trait to be Improved	Name of Plant to be Genetically Modified	Plant or Organism that will Supply the Genetic Material by Gene Splicing	Result



### Genetic Engineering Conference

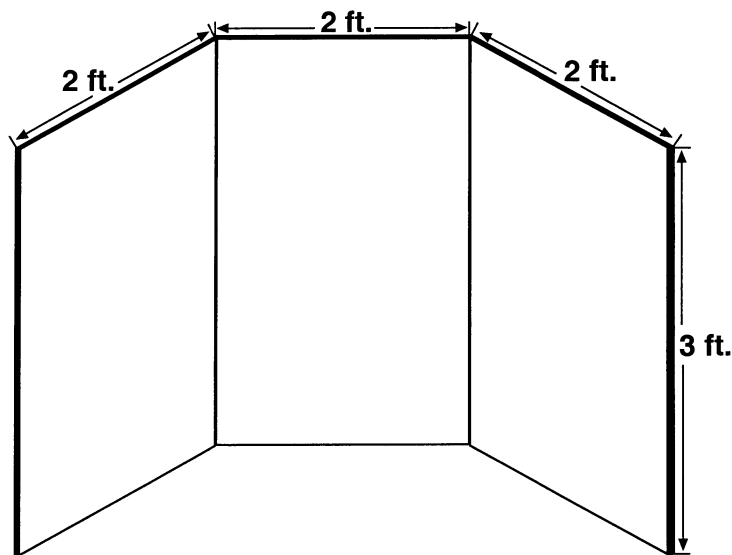
**Objective:** Students will demonstrate their knowledge of genetic engineering.

**Materials and Equipment:**

Cardboard or sheets of poster paper

**Directions:**

1. Have students individually brainstorm new plant GMOs by completing AS 5.2 (Student).
2. Organize students into teams of three.
3. Have students develop a three-way display board with the approximate measurements shown below.



You can assist students in finding cardboard by contacting stores in the area that might receive merchandise in large cardboard packages such as appliance stores, furniture stores, etc.

These displays could be put up at school functions or special observations like National Agriculture Week, etc. Another option would be to use one to three sheets of poster paper. Then the displays could be posted on walls in the classroom, etc.

4. Arrange for administrators, teachers, ag business persons, etc., to view the displays at the conference. One suggested format is for each team or team member to prepare a short explanation about the new plant GMO. Then the conference can take place with judges moving from display to display in a science fair format, and they can ask questions about the new product in a one-on-one environment that is less stressful for students.

5. Depending on the time available, there are several additional components or modifications that could be part of the project:
  - a) Computers - Create brochures and product-information pamphlets.
  - b) Business - Discuss and apply advertising and buying motives.
  - c) Careers - Identify the new job titles the GMO will create.
  - d) Inventions - Expand the concept to future inventions rather than just plant GMOs.

**Genetic Engineering Conference**

**Objective:** Students will demonstrate their knowledge of genetic engineering.

**Scenario:** You are part of a vision team for a genetic engineering company, whose task is to design new plant products. At an upcoming genetic engineering conference, large cash awards will be given to the GMO that offers the best potential to benefit society. The award is intended to fund production of the product and market it to the public. Your team will be given the opportunity to promote your new GMO to the judges. Complete the following steps before the conference begins.

1. Use your creativity to develop a company name. Use the results from AS 5.2 to brainstorm your new plant. Consider developing a logo and information the customer could keep.
2. Create a display for the conference. Your instructor will explain the type and size of display to develop. Key areas to address in the display are the following:
  - a) Display is attractive and attention-getting.
  - b) Potential benefits to society are clearly explained with before and after improvements noted.
  - c) The drawing/model of the plant GMO encourages customer business.
  - d) The display addresses buying motives and convinces the customer to purchase.
  - e) The price of the new plant GMO has been established.
3. Your instructor will explain the format the conference will follow. Consider the following concerning your communication about the new plant GMO.
  - a) Be enthusiastic.
  - b) Show conviction and passion for the benefits that customers will receive.
  - c) Develop something the customers could take with them so they might contact you later for further information or to purchase.
  - d) Thank the judges for visiting your display.



### **Biotechnology Survey**

**Objective:** Students will investigate the reactions of the public to biotechnology.

**Procedure:**

1. Give each student four copies of AS 5.4, because they must interview four people.
2. When the surveying is complete, have students assist in tabulating the results.
  - a) First, sort the surveys into age groups and have four groups of students tabulate the results.
  - b) Post the results on the board to compare, contrast, and summarize.
3. If desired, share the results with the school newspaper, local newspaper, radio station, etc.

Other options:

The survey technique can also be expanded to the entire eighth grade and other middle school grade levels. It can be used to gain local input on other timely agricultural issues. Other teachers may be interested in an interdisciplinary unit on issues and projects of this nature. Biotechnology is an issue that applies to social studies, science, family and consumer science, and math, as well as agriculture.





Lesson 5: Technologies Used in Plant Agriculture

Name \_\_\_\_\_

**Biotechnology Survey****Objective:** Students will investigate the reactions of the public to biotechnology.**Directions:** Survey four people about their views on biotechnology. Select one person from each age group, and have the person respond to each of the questions. The survey should be administered individually and not in a group situation where opinions might be influenced.

Age group (circle one): Under 20 20-40 41-50 Over 50

Gender (circle one): Male Female

1. Food products from genetically modified plants are safe to eat.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral or Unsure	Agree	Strongly Agree

2. Genetically modified foods sold in a grocery store should carry a label that states they are genetically modified.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral or Unsure	Agree	Strongly Agree

3. As foods are processed, it may be impossible to keep genetically modified foods separate from nongenetically modified foods.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral or Unsure	Agree	Strongly Agree

4. The U.S. Food and Drug Administration (FDA) has concluded that genetically modified foods are "virtually unchanged," and do not require labels. What is your reaction to this conclusion?

1	2	3	4	5
Strongly Disagree	Disagree	Neutral or Unsure	Agree	Strongly Agree

5. I feel that all genetically modified plants should be banned from agriculture.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral or Unsure	Agree	Strongly Agree

6. I feel that accidents in the environment may result from growing genetically modified plants.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral or Unsure	Agree	Strongly Agree

7. Genetically modifying plants is ethically wrong.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral or Unsure	Agree	Strongly Agree

8. Genetic engineering will help increase food production in the next ten years.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral or Unsure	Agree	Strongly Agree

9. Biotechnology will improve the profits of producers.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral or Unsure	Agree	Strongly Agree

10. Biotechnology will help to reduce the use of pesticides in agriculture.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral or Unsure	Agree	Strongly Agree

Additional comments on biotechnology: \_\_\_\_\_

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UNIT EVALUATION

Circle the letter that corresponds to the best answer.

1. Which of the following is a biological benefit provided by plants?
  - a. Oxygen
  - b. Shade
  - c. Clothing
  - d. Stress reduction
  
2. The production, processing, and marketing of fruits, vegetables, flowers, ornamental shrubs, and trees; nursery and landscaping; and turf management is called \_\_\_\_\_.
  - a. Ornamental horticulture
  - b. Botany
  - c. Horticulture
  - d. Agronomy
  
3. The study of field crops and soil management is called \_\_\_\_\_.
  - a. Ornamental horticulture
  - b. Botany
  - c. Horticulture
  - d. Agronomy
  
4. In 1998, the value of crops produced in Missouri was approximately \_\_\_\_\_.
  - a. \$10 million
  - b. \$100 million
  - c. \$3 billion
  - d. \$4 billion
  
5. Which part of the plant is the major plant food producer?
  - a. Root
  - b. Leaf
  - c. Stem
  - d. Flower
  
6. Which part of the plant is the site of sexual propagation?
  - a. Root
  - b. Leaf
  - c. Stem
  - d. Flower
  
7. Which of the following is an asexual propagation method?
  - a. Pollination
  - b. Multiplication
  - c. Petal
  - d. Cuttings

8. The \_\_\_\_\_ is the female structure of the flower.
- Petal
  - Pistil
  - Sepal
  - Stamen
9. What is needed for a seed to germinate?
- Sufficient moisture
  - Fertilizer
  - Tissue culture
  - Grafting
10. What is photosynthesis?
- The reproduction of plants
  - The absorption of water and nutrients
  - The process of food production for the plant
  - The process of cooling the plant
11. \_\_\_\_\_ is a plant that lives for more than 2 years and can grow year after year without replanting.
- Annual
  - Biennial
  - Perennial
  - Dicot
12. An example of a dicot is \_\_\_\_\_.
- Corn
  - Wheat
  - Soybeans
  - Bluegrass
13. Organic matter \_\_\_\_\_.
- Is sand
  - Is a herbicide
  - Was clay at one time
  - Originated from a living source
14. An ideal soil contains \_\_\_\_\_ % mineral matter, \_\_\_\_\_ % organic matter, \_\_\_\_\_ % air, and \_\_\_\_\_ % water.
- 45, 5, 25, 25
  - 50, 5, 25, 20
  - 25, 25, 45, 5
  - 45, 10, 15, 20
15. Which statement below is not true about soilless media?
- They are sterile.
  - They drain very well.
  - They are lightweight.
  - They have poor drainage.

16. Hydroponics is \_\_\_\_\_.
- Growing plants in soil without water
  - Growing plants in water (nutrient solution)
  - Raising fish
  - A new propagation method
17. Which item below is not important for plant growth?
- wind
  - humidity
  - light
  - gases
18. N-P-K are \_\_\_\_\_.
- Herbicides
  - Micronutrients
  - Primary macronutrients
  - Pesticides
19. A key watering principle for indoor plants is \_\_\_\_\_.
- Water once per month
  - Water the same amount each time
  - Water thoroughly at each watering
  - Prune when watering
20. Outdoor plants usually require \_\_\_\_\_.
- shade
  - regular watering during dry periods
  - full sun
  - daily pruning
21. GPS was developed by \_\_\_\_\_.
- The Extension Service
  - The U.S. Department of Defense
  - The U.S. Department of Agriculture
  - The U.S. Aviation Association
22. GPS uses \_\_\_\_\_ to determine exact locations.
- 24 satellites orbiting the earth
  - The Internet
  - Four laser beam systems
  - 80 acres as subfields
23. An example of a GMO is \_\_\_\_\_.
- Nitrogen fertilizer
  - Fish grown through aquaculture
  - Round-down wheat
  - Bt corn

**Match the definition in the right column with the term in the left column.**

- |           |             |    |  |
|-----------|-------------|----|--|
| 24. _____ | Peat moss   | a. | Heat-treated mica with high moisture-holding capacity                          |
| 25. _____ | Perlite     | b. | Source of organic matter in soilless mixes                                     |
| 26. _____ | Tree bark   | c. | Gray-white material of volcanic origin used to improve aeration.               |
| 27. _____ | Vermiculite | d. | Spongy, partially decomposed vegetation with a high moisture-holding capacity. |

**Match the definition in the right column with the term in the left column.**

- |           |                     |    |  |
|-----------|---------------------|----|--|
| 28. _____ | Farmaceuticals      | a. | Health supplements or vitamins delivered through food                  |
| 29. _____ | Genetic engineering | b. | Managing small areas (subfields) within a field                        |
| 30. _____ | Nutraceuticals      | c. | Modifying and enhancing the genetic component of organisms             |
| 31. _____ | Precision farming   | d. | Inserting antibodies, medicines, or vaccines into plant-based products |

**Complete the following short answer questions.**

32. Identify two reasons asexual propagation would be used to propagate plants.
- a.
  - b.
33. Explain two ways to prevent overwatering of indoor plants.
- a.
  - b.
34. Explain the difference between soil and dirt.
35. Identify two advantages provided by biotechnology.
- a.
  - b.
36. List two concerns about biotechnology.
- a.
  - b.