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. <u>How are satellite systems used in plant production</u>?

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. <u>How is genetic engineering used in plant production</u>?

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 immerge.

Q3. <u>What are the effects of emerging technologies on plant production</u>?

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. <u>What are the major issues with plant technologies</u>?

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 determine if the answers are appropriate.

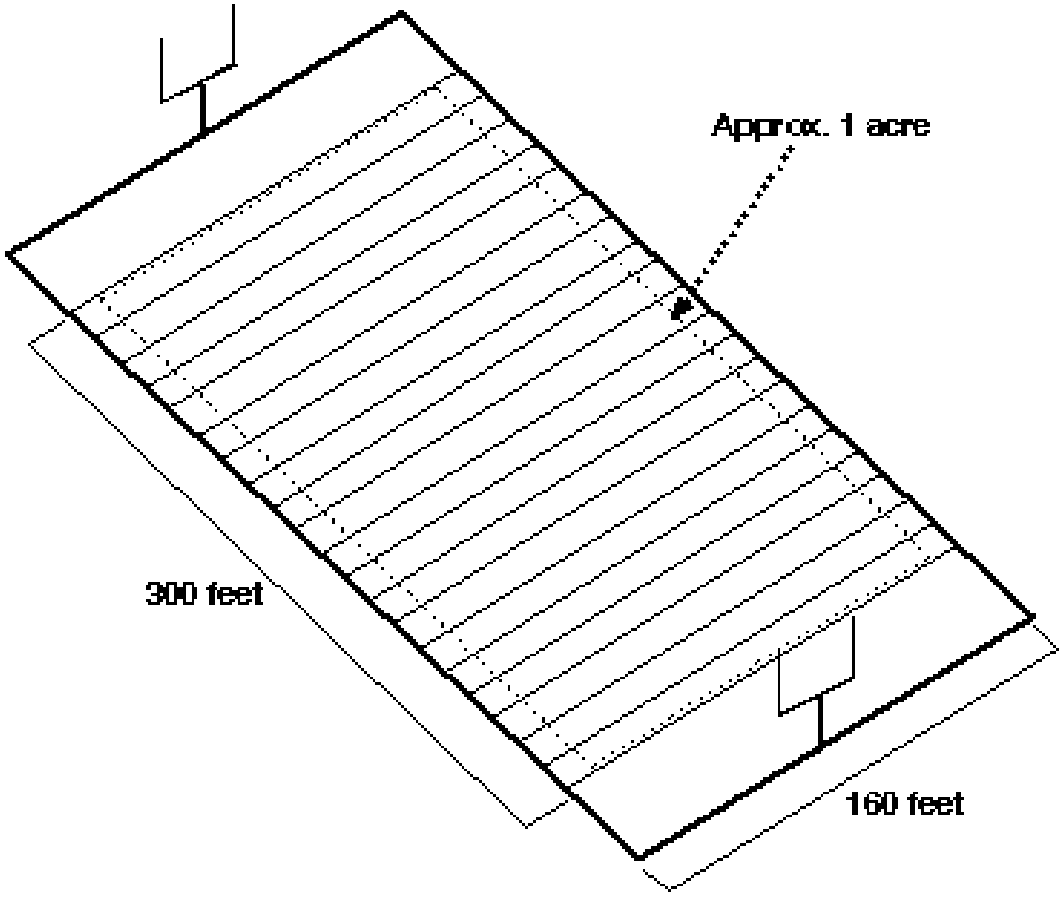
I. ***Answers to Evaluation***

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. Farmaceuticals
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

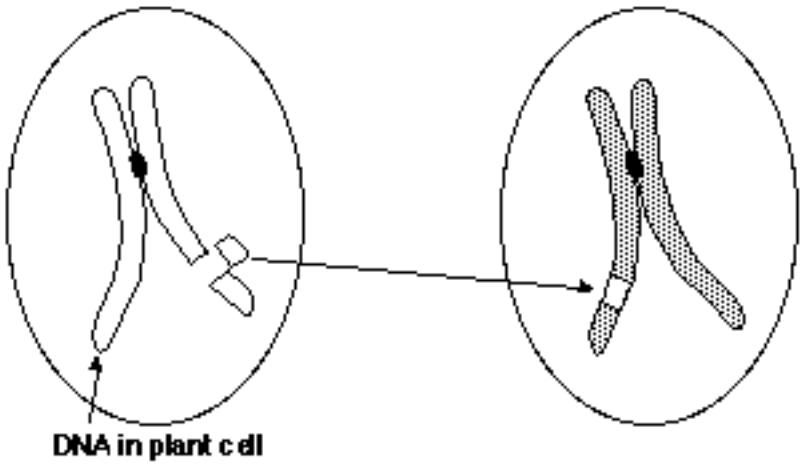
Precision Agriculture Is Managing Small Areas of a Field

4 ½ Acres				
90-ACRE FIELD				

One Acre Is About the Size of a Football Field



Gene Splicing



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.

Source: ***Agriscience & Technology*** **(1992)**

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.

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
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

Lesson 5: Technologies Used in Plant Agriculture Name_____

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:

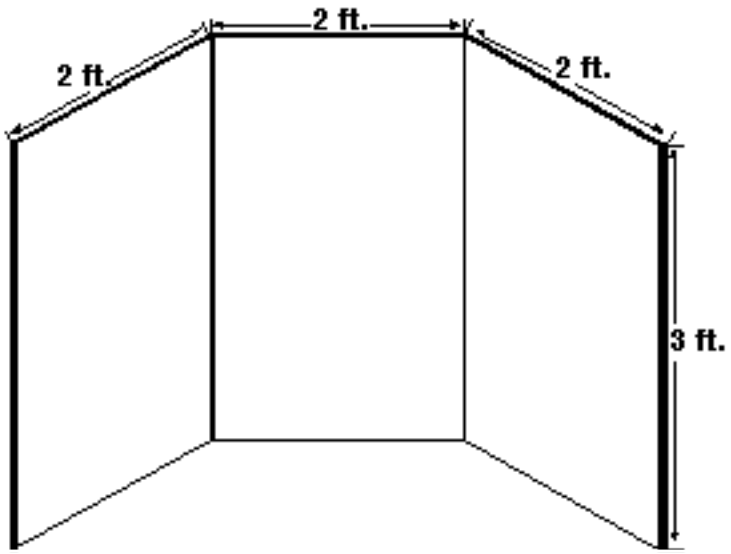
Cardboard or sheets of poster paper

Directions:

1. Have students individually brainstorm new plant GMOs by completing AS 5.3 (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.

Lesson 5: Technologies Used in Plant Agriculture Name_____

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.

Lesson 5: Technologies Used in Plant Agriculture Instructor

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:

Name _____

Date _____

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.

   a. Petal
   b. Pistil
   c. Sepal
   d. Stamen

9. What is needed for a seed to germinate?

   a. Sufficient moisture
   b. Fertilizer
   c. Tissue culture
   d. Grafting

10. What is photosynthesis?

    a. The reproduction of plants
    b. The absorption of water and nutrients
    c. The process of food production for the plant
    d. 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.

    a. Annual
    b. Biennial
    c. Perennial
    d. Dicot

12. An example of a dicot is _____.

    a. Corn
    b. Wheat
    c. Soybeans
    d. Bluegrass

13. Organic matter _____.

    a. Is sand
    b. Is a herbicide
    c. Was clay at one time
    d. Originated from a living source

14. An ideal soil contains _____ % mineral matter, _____ % organic matter, _____ % air, and _____ % water.

    a. 45, 5, 25, 25
    b. 50, 5, 25, 20
    c. 25, 25, 45, 5
    d. 45, 10, 15, 20

15. Which statement below is <u>not</u> true about soilless media?

    a. They are sterile.
    b. They drain very well.
    c. They are lightweight.
    d. They have poor drainage.

16. Hydroponics is _____.

a. Growing plants in soil without water
b. Growing plants in water (nutrient solution)
c. Raising fish
d. A new propagation method

17. Which item below is <u>not</u> important for plant growth?

a. wind
b. humidity
c. light
d. gases

18. N-P-K are _____.

a. Herbicides
b. Micronutrients
c. Primary macronutrients
d. Pesticides

19. A key watering principle for indoor plants is _____.

a. Water once per month
b. Water the same amount each time
c. Water thoroughly at each watering
d. Prune when watering

20. Outdoor plants usually require _____.

a. shade
b. regular watering during dry periods
c. full sun
d. daily pruning

21. GPS was developed by _____.

a. The Extension Service
b. The U.S. Department of Defense
c. The U.S. Department of Agriculture
d. The U.S. Aviation Association

22. GPS uses _____ to determine exact locations.

a. 24 satellites orbiting the earth
b. The Internet
c. Four laser beam systems
d. 80 acres as subfields

23. An example of a GMO is _____.

a. Nitrogen fertilizer
b. Fish grown through aquaculture
c. Round-down wheat
d. 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.