

## UNIT V - ANIMAL TECHNOLOGIES

### Lesson 3: Applications of Biotechnology in Animal Agriculture

Objective/Competency: Identify other applications of biotechnology in animals.

#### Study Questions

1. **What are supplemental hormones?**
2. **How is biotechnology used to produce supplemental hormones and animal health products?**
3. **How is DNA fingerprinting used in the livestock industry?**
4. **What are the emerging applications of biotechnology in the animal industry?**

#### References

1. *Biotechnology: Application in Agriculture (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1998, Unit V.
2. Transparency Master
  - a) TM 3.1: Producing BST
3. Activity Sheet
  - a) AS 3.1: Emerging Applications of Biotechnology



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### Lesson 3: Applications of Biotechnology in Animal Agriculture

#### TEACHING PROCEDURES

##### A. Review

Livestock producers have benefited from advances in biotechnology like artificial insemination and embryo transfer. Biotechnology is now having an impact on livestock performance in ways not directly related to breeding. The development of economical growth hormones, genetically engineered vaccines, and other products has begun to affect animal agriculture substantially.

##### B. Motivation

A swine producer annually markets approximately 800 hogs weighing an average of 220 pounds each and receives an average price of \$0.49 per pound for them. If the producer could increase production by 12 percent by using a biotechnology product, how much is the product worth to the producer? Assume that the biotechnology product costs \$3.50 per pig. The animals would produce 21,120 additional pounds of pork, worth \$10,348.80. Subtracting \$2,800 for buying the product leaves the producer with \$7,548.80 in extra income. A hormone supplement that can increase pork production is nearing the marketing stage.

##### C. Assignment

##### D. Supervised Study

##### E. Discussion

1. Ask students to recall what hormones are. Explain that hormones are complex proteins that trigger certain chemical changes in an animal's body. Discuss the use of supplemental hormones.

#### **What are supplemental hormones?**

- a) Supplemental hormones are chemical messengers administered to animals to stimulate them to grow, produce more milk, or improve their performance in another way.
  - b) Bovine somatotropin (BST) - When injected into a cow, BST causes a secondary hormone to be released that increases blood flow in the mammary glands, thus increasing the amount of milk produced.
  - c) Porcine somatotropin (PST) - When injected into a pig, the hormone causes the pig to grow about 15 percent faster and consume 20 percent less feed; muscle mass increases, while backfat is reduced.
  - d) Growth hormone releasing factor (GHRF) - GHRF is not itself a hormone, but it stimulates the pituitary gland to release larger amounts of growth hormones.
  - e) Chicken growth hormone and chicken molting hormone - The growth hormone shortens the time needed for broilers to reach market size by 15 percent, while the molting hormone increases egg production.
2. Use TM 3.1 to show the process of producing BST by genetically modifying bacteria. Discuss other applications of biotechnology in producing animal health products.

#### **How is biotechnology used to produce supplemental hormones and animal health products?**

- a) Supplemental hormones
    - 1) The gene responsible for the production of somatotropin was inserted into a plasmid taken from a bacterium; the plasmid ring was opened with a restriction enzyme, and the gene was spliced into the opening.
    - 2) The plasmid was reinserted into the bacterium.
    - 3) Modified bacteria are placed in a fermentation tank under ideal conditions for growth and division.
    - 4) After a substantial number of bacteria are produced, the somatotropin can be purified from the bacteria.
  - b) Animal health products
    - 1) Monoclonal antibody technology - Monoclonal antibodies are produced by fusing together a tumor cell and an immune system cell that produces antibodies against a specific antigen, yielding a cell that divides rapidly and produces the desired antibody.
    - 2) Therapeutic proteins
      - (a) When injected, therapeutic proteins like interferon and interleukin-2 attack viruses; they also stimulate the animal's immune system to attack the viruses.
      - (b) They are produced by genetically modified bacteria.
    - 3) Genetically engineered vaccines - These vaccines produced by genetically modified bacteria contain only the antigen of the disease-causing organism, which triggers the immune system to produce antibodies against the antigen.
3. Ask students to recall what a DNA fingerprint is and how it is made. Ask students how DNA fingerprinting is used in the livestock industry.

#### **How is DNA fingerprinting used in the livestock industry?**

DNA fingerprinting is used in the livestock industry to positively identify individual animals, such as stolen animals, offspring for breed registration, and transgenic animals for patent purposes.

4. Ask students to speculate about the possible benefits of cloning adult livestock. Explain that possible applications of a technology play an important part in driving research efforts. Discuss other emerging applications of biotechnology. Have students complete AS 3.1.

#### **What are the emerging applications of biotechnology in the animal industry?**

- a) New vaccines, such as vaccines for foot rot in cattle and strangles in horses
- b) Protein for livestock feeds that are produced by genetically modified bacteria
- c) Engineered rumen bacteria that allow animals to better use feedstuffs that are normally hard to digest
- d) Cloning of adult animals

#### **F. Other Activities**

1. Show the class a simulated DNA fingerprint to have students match an animal to its parents. A mock DNA fingerprint can be created by drawing in lines representing bands for different animals. Refer to Lesson 3 in Unit 2.
2. Have students search the Internet for current biotechnologies being developed that would affect animal agriculture.

#### **G. Conclusion**

Research in biotechnology is very expensive, but if the potential income for products is high enough, someone will do the research. The actual application of biotechnology to the livestock industry is very

slow. However, biotechnology products are now being used on a daily basis. Livestock producers will use these tools if they prove to be both effective and economical.

H. Answers to the Activity Sheet

AS 3.1

Answers will vary with the sources used.

I. Answers to the Evaluation

1. c
2. b
3. d
4. b
5. a
  
6. Monoclonal antibodies are produced by fusing together a tumor cell and an immune system cell that produces antibodies against a specific antigen, yielding a cell that divides rapidly and produces the desired antibody.
  
7. The livestock feed industry is developing genetically modified bacteria that produce protein for feeds and engineered rumen bacteria that allow animals to better use feedstuffs that are hard to digest.



EVALUATION

**Circle the letter that corresponds to the best answer.**

1. What are supplemental hormones?
  - a. Organic substances produced by endocrine glands and carried in the bloodstream to produce a metabolic effect
  - b. Genetically modified bacteria that contain the antigen of a disease and trigger the immune system to produce antibodies
  - c. Chemical messengers administered to animals to stimulate growth, milk production, or other types of performance
  - d. Therapeutic proteins that stimulate an animal's immune system to attack viruses
2. Why is bovine somatotropin (BST) used?
  - a. It stimulates the pituitary gland to release larger amounts of growth hormones.
  - b. It causes a secondary hormone to be released that increases blood flow in the mammary glands, thus increasing the amount of milk.
  - c. It reduces animal fat and increases muscle mass.
  - d. It causes the animal to grow about 15 percent faster and consume 20 percent less feed.
3. How are supplemental hormones produced by biotechnology?
  - a. By fusing a tumor cell and an immune system cell that produces antibodies against a specific antigen
  - b. Drawing the hormone from the endocrine gland with a syringe
  - c. Collecting the hormone from the brains of slaughtered animals
  - d. Genetically modifying bacteria with the gene responsible for production of the hormone
4. What is not a reason to use DNA fingerprinting in the livestock industry?
  - a. To identify individual animals
  - b. To prevent the spread of disease
  - c. To verify the parentage of an offspring animal
  - d. To identify transgenic animals for patenting
5. Which of the following is an example of a currently emerging application of biotechnology in the animal industry?
  - a. Cloning of adult animals
  - b. DNA fingerprinting
  - c. Developing tests for diseases
  - d. Genetically modifying bacteria

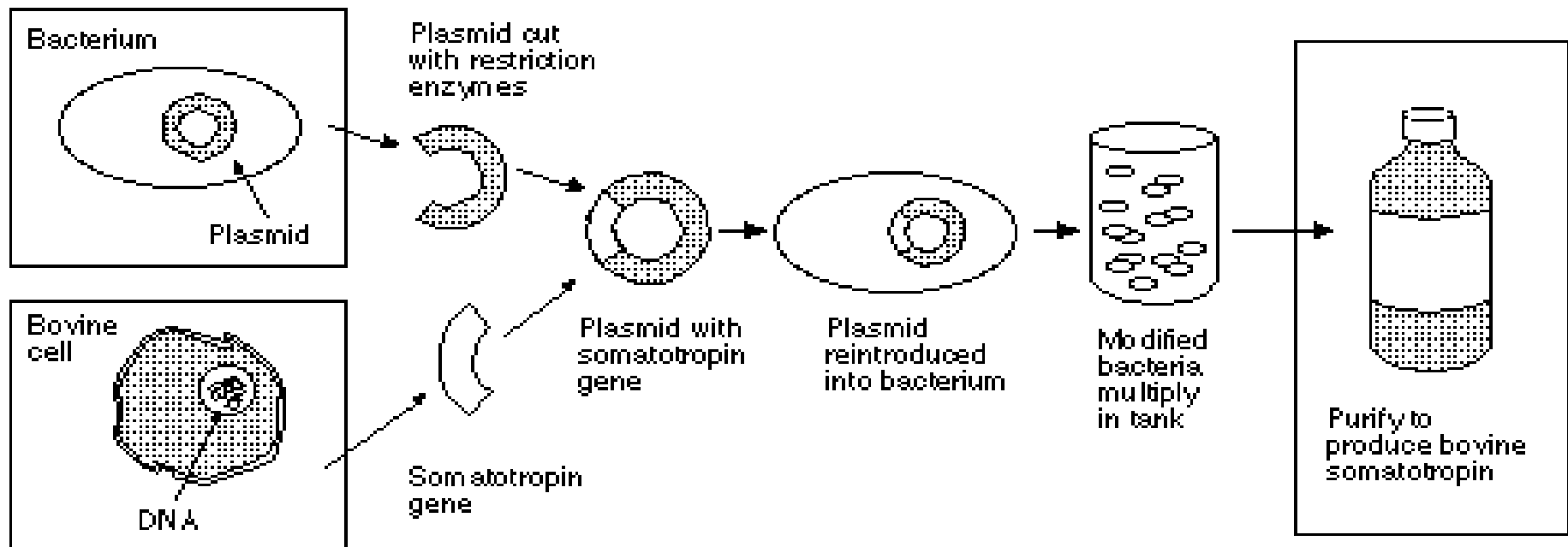
**Complete the following short answer questions.**

6. How are monoclonal antibodies produced?

7. What two currently emerging applications of biotechnology involve the livestock feed industry?



# Producing BST





Name \_\_\_\_\_

**Objective:** Research new applications of biotechnology in animal agriculture.

1. What are some developments that have taken place in the last year in livestock vaccines? (Hint: search for information from companies that produce animal vaccines.)

2. What biotechnology products for feed enhancement are currently available or under development? (Hint: search for information on livestock feed companies or genetically engineered livestock feed.)

3. What is the current status of the use of somatotropin in the livestock industry and the predictions for its use in the future?
4. What are the uses and the expected uses of monoclonal antibodies?
5. What are the latest advances in transgenic livestock?

