

## UNIT V - ANIMAL TECHNOLOGIES

### Lesson 1: Artificial Insemination

Objective/Competency: Describe the process of artificial insemination.

#### Study Questions

1. **What is artificial insemination?**
2. **What are the benefits of artificial insemination compared to natural breeding?**
3. **What equipment is needed for artificial insemination?**
4. **What steps are involved in artificial insemination?**
5. **How can the estrous cycle be manipulated to aid in artificial insemination?**

#### References

1. *Biotechnology: Applications in Agriculture (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1998, Unit V.
2. Activity Sheet
  - a) AS 1.1: Evaluating Semen



## UNIT V - ANIMAL TECHNOLOGIES

### Lesson 1: Artificial Insemination

#### TEACHING PROCEDURES

##### A. Introduction

Biotechnology has been used in the animal industry for many years. Animal biotechnology has its foundation in selective breeding practices. In the early twentieth century, animal biotechnology included artificial insemination. In the late 1970s, embryo transfer technology emerged in the animal industry. In 1997 animal cloning was performed using an adult sheep, and biotechnology continues to open new opportunities in animal production. This lesson will examine the technology of artificial insemination.

##### B. Motivation

The livestock industry is becoming an industry that demands a more uniform product. How does a producer achieve this improved level of product quality? Many producers are using artificial insemination to accomplish this goal. Purebred producers who want exceptional breeding stock but view buying superior male animals as too expensive commonly use artificial insemination. Artificial insemination technology has also made the international exchange of breeding stock economically feasible.

##### C. Assignment

##### D. Supervised Study

##### E. Discussion

1. Ask students to define artificial insemination in their own words.

##### **What is artificial insemination?**

Artificial insemination is the process of collecting semen from a male animal and placing it in the reproductive tract of a female animal.

2. Ask students what the benefits of artificial insemination are.

##### **What are the benefits of artificial insemination compared to natural breeding?**

- a) AI allows for the selection and use of male animals regardless of where the animals are physically located.
- b) AI helps reduce the spread of reproductive or venereal diseases.
- c) AI reduces or eliminates the cost of owning and maintaining a male animal.
- d) The genetic improvement of livestock through the use of superior animals occurs more quickly due to a dramatic increase in the number of offspring a male animal can produce (sire) per year.

3. Show students the actual equipment used in AI or pictures of the equipment.

##### **What equipment is needed for artificial insemination?**

- a) Dummy - female replica mounted by male so that semen can be collected
- b) Artificial vagina - water-filled plastic sheath used to collect the semen
- c) Microscope - to check the quality of the semen

- d) Semen straw - thin plastic tube used to store the amount of semen needed to inseminate one female
  - e) Semen tank - aluminum tank used to store semen in liquid nitrogen
  - f) Insemination instrument - syringe-like tool that holds the straw and deposits the semen into the reproductive tract
4. Ask students to describe the process of artificial insemination. Have students complete AS 1.1. Students must be given pictures of primary, secondary, and tertiary sperm abnormalities to complete the activity. These pictures may be available in reproductive physiology or veterinary husbandry textbooks. Point out that the activity only addresses a few factors that affect the quality of sperm and does not provide an absolute measure of fertility.

**What steps are involved in artificial insemination?**

- a) Semen is collected using an artificial vagina.
  - b) The semen is tested for quality, which is determined by the motility, shape, and quantity of the sperm.
  - c) Extenders are added to increase the volume. The extenders that are most commonly used are citrate, egg-yolk phosphate, and homogenized milk.
  - d) The semen is placed in straws and frozen in liquid nitrogen at -320 degrees Fahrenheit.
  - e) The timing of insemination must be carefully managed; generally, insemination should occur shortly before ovulation.
  - f) The semen must be properly thawed.
  - g) A trained technician should inseminate the female by placing the straw in the inseminating instrument, which is inserted into the vagina and guided through the cervix; the semen is placed at the end of the cervix or the beginning of the uterus.
5. Ask students why one would want to manipulate the estrous cycle of animals. Explain that if producers can breed all of the animals at once management costs will be reduced and the resulting offspring will be more uniform in age.

**How can the estrous cycle be manipulated to aid in artificial insemination?**

- a) Through the injection of certain hormones that affect the estrous cycle, a producer can cause females to begin estrous as a group.
- b) This process, which is called estrous synchronization, simplifies the management of an artificial insemination program because animals in the group can all be bred within one or two days of each other.

**F. Other Activities**

- 1. Obtain a cow's reproductive tract from a slaughterhouse and demonstrate the insemination process.
- 2. Invite a local AI technician to bring AI equipment and talk to the class.
- 3. Arrange a field trip to observe a technician performing AI.

**G. Conclusion**

Artificial insemination is an important management practice for livestock producers. The availability of a wide selection of animals for breeding and accurate performance records motivates producers to use artificial insemination. The dairy industry most commonly uses AI. However, beef cattle producers, dog breeders, horse breeders, and swine producers are using AI more frequently.

H. Answers to the Activity Sheet

AS 1.1

Answers will vary.

I. Answers to the Evaluation

1. b
2. d
3. Based on the motility, shape, and quantity of the sperm
4. Students may list any three of the following: dummy, artificial vagina, microscope, semen straws, semen tank, or insemination instrument.
5. Students may list any of two of the following.
  - AI allows for the selection and use of male animals regardless of where the animals are physically located.
  - AI helps reduce the spread of reproductive and venereal diseases.
  - AI reduces or eliminates the cost of owning and maintaining a male animal.
  - The genetic improvement of livestock through the use of superior animals occurs more quickly due to a dramatic increase in the number of offspring a male animal can have per year.



EVALUATION

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

1. Artificial insemination (AI) can be defined as the:
  - a. Process of depositing sperm.
  - b. Process of collecting sperm from a male animal and placing it in the female reproductive tract.
  - c. Process of collecting an egg from a female animal, fertilizing it, and placing it in the reproductive tract of another female animal.
  - d. Process of fusing a sperm and an egg.
2. How is the estrous cycle manipulated?
  - a. Through the injection of vitamins
  - b. By using artificial insemination
  - c. By placing a group of females together
  - d. Through the injection of hormones

**Complete the following short answer questions.**

3. How is the quality of semen evaluated?
4. What are three pieces of equipment used in artificial insemination?
  - a.
  - b.
  - c.
5. What are two benefits of artificial insemination?
  - a.
  - b.





## Lesson 1: Artificial Insemination

Name \_\_\_\_\_

**Evaluating Semen****Objective:** Visually examine semen to evaluate semen quality.**Materials and Equipment:**

Microscope with a 100x oil immersion objective  
 Small amount of immersion oil  
 Hot water bath (at approximately 98°F)  
 Several glass test tubes  
 Microscope slides and cover slips  
 Frozen semen samples  
 Semen stain (Blom's Esin-Nigrosin stain)  
 Several eye droppers

**Procedure:**

1. Place the semen sample in test tubes in the water bath.
2. Place the microscope slides and cover slips in the water bath; they should be warm when used.

Evaluation of Individual Motility

3. Place one drop of semen on a slide and place a cover slip over it. Using a 40x objective, focus the microscope and observe the sample. Select an individual sperm cell and observe the speed at which it moves. Observe ten different sperm cells and use the chart below to find the score for each of these sperm cells based on how long it takes for each of them to move across the viewing field. Total the scores and divide by ten to calculate the individual motility score for the semen sample.

<u>Observed Behavior</u>	<u>Points</u>
Very rapid forward motion that may be hard to follow	5
Rapid forward progression	4
Steady forward progression at a moderate speed	3
Slow progression or slightly erratic (stop and start) motion	2
Weak rocking movement without forward motion	1
No motion	0

Average score \_\_\_\_\_

Evaluation of Sperm Morphology (Sperm Structure)

4. Place one drop of semen on a slide and add one drop of semen stain. Mix the semen and stain together and place the cover slip on the solution.
5. Using oil immersion, focus the microscope. Next, search for an area that has at least five sperm cells in the viewing field. Count and record the number of sperm in the field. Use the pictures of sperm abnormalities provided by your instructor to help you identify abnormal sperm cells. Count and record the number of abnormal cells that have primary abnormalities (those relating to the sperm head and the caplike structure at its tip) and the number with secondary (involving droplets on the tail) or tertiary

(other defects of the tail) abnormalities. Select a new group of sperm cells and repeat this process until 100 cells have been observed.

6. Score the morphology of the semen sample.

<u>Primary Abnormalities</u>	<u>Points</u>
less than 10	20
10 to 19	15
20 to 29	10
more than 29	5

<u>Secondary and Tertiary Abnormalities</u>	<u>Points</u>
less than 25	20
26 to 39	15
40 to 59	10
more than 59	5

7. Calculate the average morphology by finding the sum of the primary abnormalities and the secondary and tertiary abnormalities and dividing by two.

Primary abnormalities score	_____
Secondary and tertiary abnormalities score	_____
Total	_____ ÷ 2
Average score	_____

## UNIT V - ANIMAL TECHNOLOGIES

### Lesson 2: Embryo Transfer Technologies

Objective/Competency: Describe the process of embryo transfer.

#### Study Questions

1. **What is embryo transfer?**
2. **What are the advantages of embryo transfer?**
3. **What equipment is needed for embryo transfer?**
4. **How is the donor managed for superovulation?**
5. **What are the steps in the embryo flush process?**
6. **What are the steps in transferring the embryo to the recipient?**
7. **What is cloning, and how is it accomplished?**
8. **What are the benefits of cloning?**
9. **What is in vitro fertilization (IVF)?**

#### References

1. *Biotechnology: Applications in Agriculture (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1998, Unit V.
2. Transparency Master
  - a) TM 2.1: Catheter
3. Activity Sheets
  - a) AS 2.1: Examining Embryos (Instructor)
  - b) AS 2.1: Examining Embryos (Student)



## UNIT V - ANIMAL TECHNOLOGIES

### Lesson 2: Embryo Transfer Technologies

#### TEACHING PROCEDURES

##### A. Review

As discussed in Lesson 1, the use of artificial insemination in the livestock industry has enabled livestock producers to select highly desirable male animals for their breeding programs. However, producers must own many high quality female animals to improve a herd's genetic potential rapidly. Through the development of embryo transfer technologies, producers can obtain high quality embryos and improve the genetic potential of their herds more quickly.

##### B. Motivation

Congratulations! Your two-year-old heifer has been named Grand Champion at four major Angus shows across the country. You have put a great deal of hard work and money into this animal, and now you have the opportunity to make money by raising or selling calves. You could use embryo transfer. If semen from a prizewinning bull is used in the embryo transfer process and three or four live births are predicted, would you choose to use embryo transfer technology? What are the factors that might influence your decision?

##### C. Assignment

##### D. Supervised Study

##### E. Discussion

1. Remind students that an embryo is a fertilized egg. Ask them to explain what embryo transfer is.

#### **What is embryo transfer?**

- a) Embryo transfer (ET) is the process of transplanting embryos from a donor female to a recipient female.
  - b) Embryo transfer has six basic steps.
    - 1) Synchronization of estrous in donor and recipient
    - 2) Superovulation of the donor
    - 3) Breeding the donor
    - 4) Recovering the embryos from the donor through flushing
    - 5) Isolating and examining the embryos
    - 6) Transferring embryos to the recipients or freezing the embryos
2. Ask students to identify when embryo transfer might be of the greatest benefit.

#### **What are the advantages of embryo transfer?**

- a) Increases the reproductive potential of superior females
  - b) Increases the rate of genetic improvement in a herd
  - c) Allows female animals to be progeny tested more easily and accurately
  - d) Provides a way to use breeding stock from other countries
3. Point out to students that some of the equipment used in embryo transfer is similar to the equipment used in AI. Show students a semen straw and an embryo straw as examples. Discuss the equipment used in ET.

#### **What equipment is needed for embryo transfer?**

- a) Equipment needed to flush a donor
    - 1) Catheter
    - 2) Stylet
    - 3) Collection cylinder
    - 4) Shoulder-length glove
    - 5) Lubricant
    - 6) Syringes
  - b) Equipment needed to examine the embryos
    - 1) Microscope
    - 2) Pipette embryo-handling tool
    - 3) Gridded search dish
  - c) Equipment needed to transfer the embryo to a recipient
    - 1) Embryo straw
    - 2) Embryo transfer gun
4. Ask students to recall the name of the hormone that causes the follicle (egg or ovum) to be released at ovulation. Tell students that if large amounts of this hormone (FSH) are given, multiple eggs will be released.

#### **How is the donor managed for superovulation?**

- a) If prostaglandin is used to manipulate the heat cycle, preparation of the donor cow begins ten days after she is in standing heat with an injection of the hormone FSH.
  - b) FSH injections are given once in the morning and once in the evening until a total of seven injections have been given.
  - c) Prostaglandin is injected in the morning and evening on the third day of the procedure, which causes the donor to come into estrus in 48 hours.
  - d) When estrus begins, the donor is bred naturally or through AI.
5. Ask students where the egg cells (ova) are produced. Explain that each female animal has thousands of immature ova in their ovaries. Review the reproductive cycle of the female, focusing on ovulation. Have students complete AS 2.1.

#### **What are the steps in the embryo flush process?**

- a) The embryo flush process is performed seven days after breeding.
  - b) An epidural anesthesia is injected into the space between two cervical vertebrae.
  - c) With the aid of the stylet, the catheter is inserted into the vagina, through the cervix, and into the right uterine horn.
  - d) The technician must palpate the donor carefully to guide the catheter into the right location.
  - e) The inflatable bulb near the end of the catheter is inflated to block off the uterine horn while it is being flushed.
  - f) The sterile flushing solution is allowed to flow into the uterine horn under the force of gravity until 500 milliliters of the solution is in the uterine horn, and the horn is then massaged to loosen the embryos.
  - g) When the fluid has filled the uterine horn, the outlet tube of the catheter is opened and the fluid and embryos are collected in a collection cylinder.
  - h) This process is repeated in the left uterine horn.
  - i) The embryos settle to the bottom of the collected fluid, and the fluid is siphoned off so the embryos can be counted and characterized, or examined for quality.
6. Describe the procedure for transplanting the collected embryo into the recipient.

**What are the steps in transferring the embryo to the recipient?**

- a) Embryos that are to be transferred to recipients are loaded into plastic embryo straws.
  - b) They are then prepared to be either transferred into recipient cows or frozen in a container of liquid nitrogen at -320 degrees Fahrenheit.
  - c) The embryo transfer gun is loaded with a straw and inserted into the vagina.
  - d) It is guided through the cervix and into the uterus, where the embryo is expelled.
7. Ask students to give examples of animals that have been cloned. Explain that sheep, cattle, and goats have all been cloned.

**What is cloning, and how is it accomplished?**

- a) Cloning - the asexual reproduction of an organism in which the resulting organisms are identical
  - b) Two methods of cloning
    - 1) Splitting an embryo
      - (a) A researcher physically splits the embryo into two halves as it is dividing.
      - (b) Each half is transferred to a recipient and develops normally.
    - 2) Nuclear transfer
      - (a) A cell is extracted from a parent organism, and an electrical pulse is used to fuse it to an unfertilized ovum that has had its nucleus removed.
      - (b) The new cell has a diploid number of chromosomes and will develop as if it were a natural embryo; however, it must be stimulated to act like a fertilized ovum and begin dividing.
8. Ask students to list some reasons why a group of genetically identical animals could be useful.

**What are the benefits of cloning?**

- a) Cloning can increase the number of highly prized animals produced.
  - b) Fewer animals could be used in live animal tests because all of the animals--control animals and experimental animals--would be identical.
  - c) Animals genetically altered to produce pharmaceuticals could be cloned, which would reduce the cost of producing the animals.
9. Ask students to recall what in vitro means ("in glass"). Explain that IVF is one of the newest biotechnologies. A few dairy producers have begun to use it.

**What is in vitro fertilization (IVF)?**

- a) IVF is a process in which immature follicles are collected from the ovaries of a female animal, stimulated to mature, and fertilized outside the female reproductive tract.
- b) The fertilized embryos can be transferred to recipient animals.

**F. Other Activities**

- 1. Using a female reproductive tract from a slaughterhouse, simulate the embryo transfer process.
- 2. Show the video "Embryo Transfer" from Creative Educational Video (CEV), which is available from MVRRC.
- 3. Contact an ET technician or veterinarian and ask if he or she would bring the ET equipment to class or if the class could borrow the equipment for a day so students could do an equipment identification activity.

4. Take students to a farm or veterinarian's office to observe an actual or simulated nonsurgical flush.

G. Conclusion

In the early 1980s, embryo transfer was an expensive and difficult process involving the surgical removal of embryos. Today, more and more producers, particularly those who produce breeding animals, are looking to embryo transfer to give them more progeny from their high performing animals.

H. Answers to Activity Sheet

AS 2.1

Answers will vary.

I. Answers to the Evaluation

1. d
2. b
3. d
4. c
5. b
6. d
7. 3
8. 2
9. 4
10. 1

11. Students may list any two of the following.

- Cloning can increase the number of highly prized animals produced.
- Fewer animals could be used in live animal tests because all of the animals--control animals and experimental animals--would be identical.
- Animals genetically altered to produce pharmaceuticals could be cloned, which would reduce the cost of producing the animals.

12. Embryo transfer (ET) is the process of transplanting embryos from a donor female to a recipient female.

13. IVF is a process in which immature follicles are collected from the ovaries of a female animal, stimulated to mature, and fertilized outside the female reproductive tract. The fertilized embryos can be transferred to recipient animals.



## EVALUATION

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

1. Which of the following is not an advantage of embryo transfer technology?
  - a. Embryo transfer allows for easier and more accurate progeny testing of female animals.
  - b. Embryo transfer provides a way to use breeding stock from other countries.
  - c. Embryo transfer increases the rate of genetic improvement in a herd.
  - d. Embryo transfer reduces the management needed for breeding programs.
2. A stylet is used to:
  - a. Insert the embryo into the recipient.
  - b. Insert the catheter into the donor for the flushing procedure.
  - c. Manipulate the embryos when counting and grading them.
  - d. Collect the embryos after they have been flushed.
3. The hormone that causes a cow to superovulate is:
  - a. Prostaglandin.
  - b. Syncromate-B.
  - c. Progesterone.
  - d. Follicle stimulating hormone.
4. How many days after a donor cow has been superovulated and bred is the flush procedure done?
  - a. 2
  - b. 3
  - c. 7
  - d. 11
5. The process in which a cell is extracted from a parent organism and fused into an ovum that has had its nucleus removed is called:
  - a. In vitro fertilization.
  - b. Nuclear transfer.
  - c. Embryo splitting.
  - d. Embryo flushing.
6. Which of the following is not equipment required for embryo transfer?
  - a. Catheter
  - b. Straw
  - c. Collection cylinder
  - d. Surgical supplies

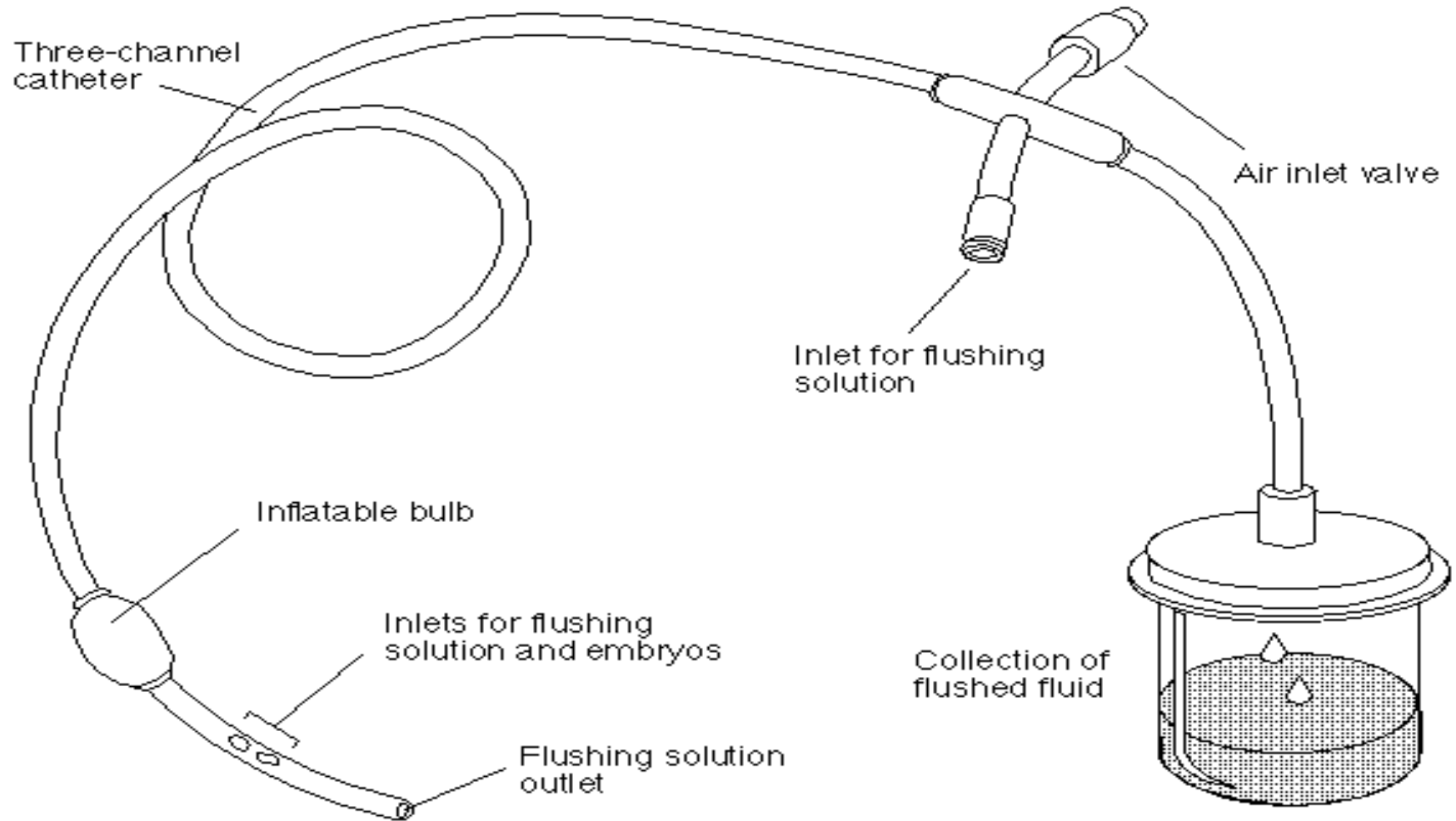
**Superovulation involves several steps. Put the following steps in the correct order by placing "1" by the first step, "2" by the second step, etc.**

7. Prostaglandin is injected into the donor cow.
8. The donor cow is injected with FSH.
9. The donor cow is bred.
10. Ten days pass after estrous is detected in the donor cow.

**Complete the following short answer questions.**

11. What are two reasons cloning may be useful?
  - a.
  - b.
12. What is embryo transfer?
13. What is in vitro fertilization?

# Catheter





## Lesson 2: Embryo Transfer Technologies

**Examining Embryos**

**Objective:** Examine and grade embryos.

**Materials and Equipment:**

1-5 microscopes (magnifying **less** than 100x, preferably 10x and 50x)  
4-6 petri dishes (preferably gridded dishes)  
500 ml of embryo-holding media or flushing fluid  
Liquid nitrogen tank  
Warm water bath

**Procedure:**

Before conducting this activity, frozen cattle embryos must be obtained from a local breeding service or veterinarian. Embryos can also be obtained from ABS (American Breeders Service) for a fee; the price charged for these embryos will vary.

Obtain a tank containing liquid nitrogen from a local veterinarian or livestock breeder to store the embryos correctly. Remember to thaw the embryos properly by first allowing them to warm in the air for 10 to 15 seconds and then placing them in a warm water bath. Place a known number of embryos in a gridded petri dish containing holding solution and label it "A." Place a single Grade 1, Grade 2, or Grade 3 embryo in each of the other petri dishes and label them "B," "C," and "D"; these dishes should contain holding media and have a lid.

**Note:** It can sometimes be difficult to find Grade 3 embryos, since they are not often frozen.

Divide students into groups. The number of groups will depend on the number of microscope observation stations. Place one or more of the petri dishes containing embryos at each station. Demonstrate how to remove the cover and focus the microscope so that the embryos in the dish are visible. Have the students examine the embryos and complete the activity.



## Lesson 2: Embryo Transfer Technologies

Name\_\_\_\_\_

**Examining Embryos****Objective:** Examine and grade embryos.**Materials and Equipment:**1-5 microscopes (magnifying **less** than 100x, preferably 10x and 50x)

4-6 petri dishes (preferably gridded dishes)

500 ml of embryo-holding media or flushing fluid

Liquid nitrogen tank

Warm water bath

**Procedure:**

1. Use the microscope to observe each of the petri dishes prepared by your instructor.
2. Count the embryos in dish "A" and record the number in the space provided. \_\_\_\_\_
3. Grade the embryos in dishes "B," "C," and "D." The different classifications used when grading embryos are described below.  
  
Grade 1: The embryo is nearly perfect. More than 98 percent of the cells in the embryo are apparently active. It is rounded in appearance.  
  
Grade 2: The cell mass of the embryo is apparently 70 to 98 percent active. Some cells are extruded from the surface of the embryo, so it may not be rounded in appearance.  
  
Grade 3: Less than 70 percent of the cell mass of these embryos is apparently active. Several cells are extruded from the surface of the embryo, which may be severely malformed.  
  
Degenerate: None of the cell mass of the embryo appears active. It may be flat or concave in shape.
4. Answer the following questions.
  - a. What is the grade of the embryo in dish "B"?
  - b. What is the grade of the embryo in dish "C"?
  - c. What is the grade of the embryo in dish "D"?







## 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



## UNIT V - ANIMAL TECHNOLOGIES

### 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

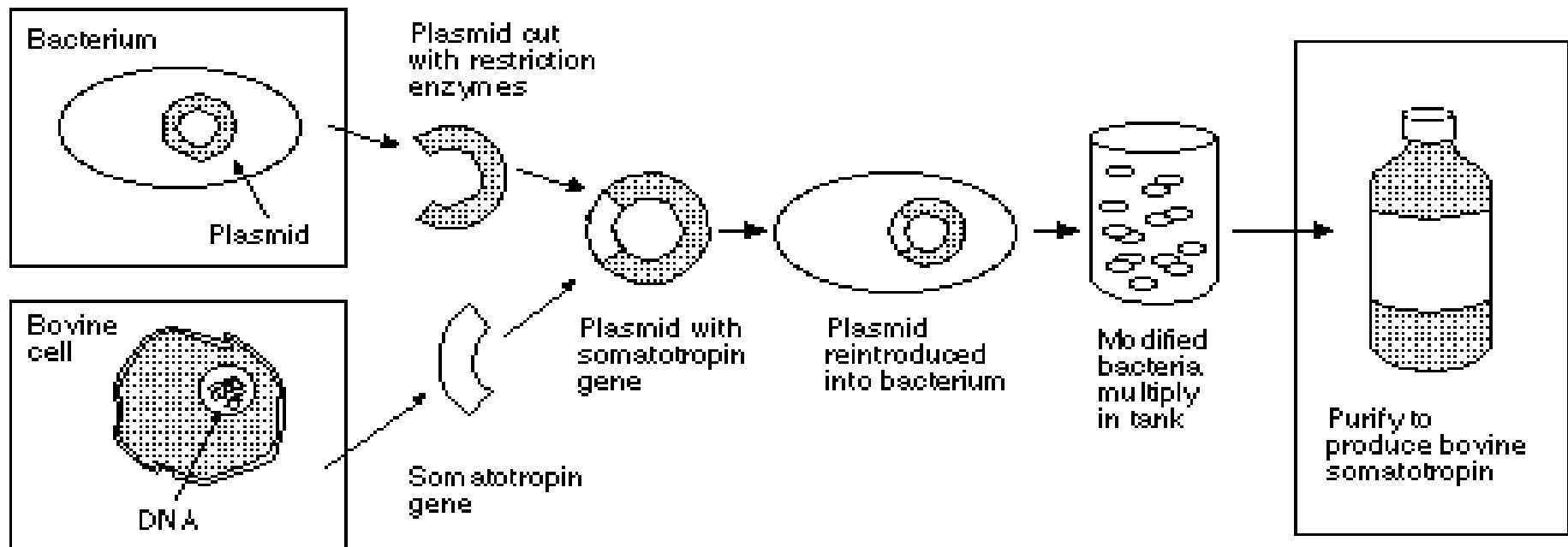


**Complete the following short answer questions.**

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.)

- V-35

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?



## UNIT V - ANIMAL TECHNOLOGIES

### Lesson 4: The Impact of Biotechnology in Animal Agriculture

Objective/Competency: Summarize the impact of biotechnology in animal agriculture.

#### Study Questions

1. **What are some career opportunities in animal biotechnology?**
2. **What are some economic factors of animal biotechnology that affect producers?**
3. **What are health and safety concerns of consumers of animal biotechnology?**
4. **What are the global social impacts of animal biotechnology?**

#### References

1. *Biotechnology: Applications in Agriculture (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1998, Unit V.
2. Activity Sheet
  - a) AS 4.1: Careers in Animal Biotechnology





## UNIT V - ANIMAL TECHNOLOGIES

### Lesson 4: The Impact of Biotechnology in Animal Agriculture

#### TEACHING PROCEDURES

##### A. Review

Animal agriculture is a multibillion dollar industry in the United States. Biotechnology is just beginning to make a substantial impact on this industry. As discussed in the previous lessons, the livestock breeding and animal health sectors of animal agriculture have already felt the impact of biotechnology. As the technology advances, more areas of livestock production will be affected. Advancements in this field will increase the number of career opportunities available. However, the growth of animal biotechnology will bring with it a number of issues that must be resolved, including economic concerns for producers, health and safety concerns for consumers, and global social impacts.

##### B. Motivation

Some individuals who first entered careers in the computer industry when it was in its infancy in the early 1980s are among the wealthiest people in America today. Bill Gates, the founder of Microsoft, is a good example. Some people have classified biotechnology as the next explosive industry. Career positions in biotechnology are increasing in number between 10 and 20 percent per year. As this industry grows, so will the opportunities for those interested in biotechnology.

##### C. Assignment

##### D. Supervised Study

##### E. Discussions

1. Ask students to list career opportunities related to animal biotechnology. Group these jobs into the eight categories listed below.

#### **What are some career opportunities in animal biotechnology?**

- a) Research and development
  - 1) Glass washer
  - 2) Laboratory assistant
  - 3) Research assistant
  - 4) Postdoctoral fellow
  - 5) Research director/principle investigator
- b) Quality control
  - 1) Quality control analyst
  - 2) Environmental health and safety specialist
  - 3) Equipment validation engineer
  - 4) Validation technician
- c) Clinical research
  - 1) Clinical coordinator
  - 2) Clinical data specialist
  - 3) Clinical research associate
  - 4) Animal handler/technician
- d) Manufacturing and production
  - 1) Product development engineer
  - 2) Manufacturing engineer/technician
  - 3) Instrument calibration technician

- 4) Packaging operator
  - e) Regulatory affairs
    - 1) Regulatory affairs specialist
    - 2) Documentation specialist
  - f) Information systems
    - 1) Scientific programmer analyst
    - 2) Literature research assistant
  - g) Marketing and sales
    - 1) Market research analyst
    - 2) Sales representative
    - 3) Customer service representative
  - h) Administration
    - 1) Human resources representative
    - 2) Supply buyer
    - 3) Patent administrator
2. Ask students to describe how livestock producers decide whether or not to use a new technology. Explain that the economics of using a new product versus not using the product are very important.

**What are some economic factors of animal biotechnology that affect producers?**

- a) Benefit-to-cost ratio of biotechnology products
  - b) Cost of not using a biotechnology product
  - c) Reliability of the biotechnology products
  - d) Cost of additional management or training
3. Ask students to recall the results of the biotechnology opinion survey taken earlier in this course. Have students list some concerns about animal products. Ask students if most people in their community believe that biotechnology is safe.

**What are health and safety concerns of consumers of animal biotechnology?**

- a) Fear of new technology because of a lack of understanding about it
  - b) Skepticism about safety research
  - c) Fear about the wholesomeness of foods produced through the use of biotechnology
4. Explain that by the year 2030 the world's population is expected to double to 12 billion people. Ask students to speculate about how food production can be doubled by that year. Ask students to further speculate as to who will be able to obtain food if the demand exceeds the supply.

**What are the global social impacts of animal biotechnology?**

- a) Biotechnology has the potential to increase the global production of meat, dairy products, and eggs.
- b) International concerns must be addressed; the international political environment will determine the extent of the use of animal biotechnology.
- c) Biotechnology may change the number of livestock producers needed.

F. Other Activities

Have someone with a career in animal biotechnology speak to the class about the job and the field of biotechnology.

G. Conclusion

As biotechnology products such as feed quality enhancers, growth stimulants, protein feeds, and transgenic breeding stock become available to producers, the economic and social impacts of these products will have to be addressed. Career opportunities in animal biotechnology are increasing steadily as the industry expands. Animal biotechnology must, however, address the health and safety concerns of consumers for the products of animal biotechnology to be fully accepted.

H. Answers to Activity Sheet

AS 4.1

Answers will vary.

I. Answers to the Evaluation

1. d
2. c
3. d
4. g
5. b
6. e
7. f
8. a
9. c

10. Consumers are concerned about the new technology because of a lack of understanding about it, skepticism about safety research, and a fear about the healthiness of foods produced through the use of biotechnology.



## EVALUATION

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

1. What is a possible global social impact of biotechnology?
  - a. Advancements in biotechnology may decrease the global production of meat, dairy products, and eggs.
  - b. Advancements in biotechnology will decrease the costs of management for producers.
  - c. Advancements in biotechnology will decrease consumer concerns about the safety of food products.
  - d. Advancements in biotechnology may change the number of livestock producers needed.
2. Which of the following is not an economic factor that affects producers?
  - a. Reliability of biotechnology products
  - b. Cost of not using a biotechnology product
  - c. Fear of the new technology
  - d. Cost of additional training or management

**Match the following positions to the major area of employment by writing the letter from the right-hand column in the correct blank.**

- |                                       |                                    |
|---------------------------------------|------------------------------------|
| 3. _____ Research and development     | a. Literature research assistant   |
| 4. _____ Quality control              | b. Animal handler/technician       |
| 5. _____ Clinical research            | c. Customer service representative |
| 6. _____ Manufacturing and production | d. Postdoctoral fellow             |
| 7. _____ Regulatory affairs           | e. Product development engineer    |
| 8. _____ Information systems          | f. Documentation specialist        |
| 9. _____ Marketing and sales          | g. Equipment validation engineer   |

**Answer the following short answer question.**

10. What are health and safety concerns of consumers of animal biotechnology?



Name \_\_\_\_\_

**Objective:** Investigate a specific career opportunity in animal biotechnology.

1. What are the responsibilities of someone with this job?

2. Where are available jobs located?

3. What is the average salary?

4. What personality traits are needed for someone working in this job?

5. What level of education is needed to obtain this position?

6. Where can this education be obtained?

7. What is the job market like for someone looking for a position?