

Unit B: Understanding Animal Reproduction

Lesson 3: Understanding Animal Reproduction Technology

Student Learning Objectives:

Instruction in this lesson should result in students achieving the following objectives:

1. Explain the process of artificial insemination.
2. Discuss the advantages and disadvantages of artificial insemination.
3. Define the processes of estrous synchronization, embryo transfer, cloning, and genetic engineering.

Recommended Teaching Time: 1 hour

Recommended Resources: The following resources may be useful in teaching this lesson:

- Baker, M & Mikesell, R.E. *Animal Science Biology and Technology*. Danville, IL: Interstate Publishers, Inc. 1996.
- Gillespie, J.R. *Modern Livestock and Poultry Production, 6th Edition*. Albany, NY: Delmar. 2002.
- Lee, Jasper S., Hutter, J., Rudd R., Westrom, L., Bull, A.M., Embry Mohr, C. & Pollock, J. *Introduction to Livestock and Companion Animals 2nd Edition*. Danville, Illinois: Interstate Publishers, Inc., 2000.
- Taylor, R.E. *Scientific Farm Animal Production: An Introduction to Animal Science, 4th Edition*. New York: MacMillian Publishers Co. 1992.

List of Equipment, Tools, Supplies, and Facilities:

- Writing surface
- PowerPoint Projector
- PowerPoint Slides
- Transparency Masters

Terms: The following terms are presented in this lesson (shown in bold italics and on PowerPoint Slide 2):

- Artificial insemination
- Cloning
- Donor female
- Embryo transfer
- Estrous synchronization
- Genetic engineering
- Progestin
- Prostaglandin
- Recipient female
- Sexed semen
- Standing heat
- Superovulation

Interest Approach:

Place some of the various equipment needed to perform artificial insemination in the front of the classroom. If the equipment is not available, show the students pictures. Ask students if they can identify the uses of the various tools. Lead this discussion into the first objective of the lesson.

SUMMARY OF CONTENT AND TEACHING STRATEGIES

Objective 1: Explain the process of artificial insemination.

Anticipated Problem: What are the steps involved in artificial insemination?

(PowerPoint Slides 3 and 4)

- I. **Artificial insemination** is the placing of semen in the female reproductive tract by artificial techniques. The use of this technique has increased over the past several years. There are several different segments of this process. Some of the major parts are:

(PowerPoint Slide 5)

- A. Semen collection—Artificial insemination requires that semen be collected from the male. Semen may be collected via manual stimulation, or use of an artificial vagina. The technique used depends on the species from which the semen is being collected. Semen collection is generally improved if time is given for the male to become stimulated. After the semen is collected from the male, it is evaluated, slowly cooled and frozen at a temperature of -196°C. Liquid nitrogen is used to obtain these extreme temperatures. Properly frozen and stored semen can remain viable and be used for 30 to 40 years later.

(PowerPoint Slide 6)

- B. Sexed semen—The sex of the offspring produced through artificial insemination can be controlled by the producer by the use of sexed semen. **Sexed semen** is semen that has been prepared to produce all male or all female offspring. It is collected in the same manner as other semen used in artificial insemination. Generally sexed semen will predict sex with approximately 90 percent accuracy. The cost of sexed semen is normally about four times higher than the cost of unsexed semen.

(PowerPoint Slide 7)

- C. Detecting estrus—in order to insure high conception rates, the artificial insemination technician must be able to detect when the female is in estrus or heat. Estrus signs vary between species. The best indication of estrus from most species is standing heat. **Standing heat** is the stage of estrus when a female stands when mounted by another animal. Many animals display extra mucus and redness in the vulva.

(PowerPoint Slide 8)

- D. Insemination—The timing and the placement of semen vary depending on the species. All require that frozen semen be thawed properly to 33 to 34°C. Fresh semen should be used within an acceptable time, depending on species.

Use TM: 3-1, TM: 3-2, and TM: 3-3 to review with the students the process of artificial insemination.

Objective 2: Discuss the advantages and disadvantages of artificial insemination.

Anticipated Problem: What are some of the advantages and disadvantages of artificial insemination?

(PowerPoint Slide 9)

- II. As with all management practices in cattle production, there are several advantages and disadvantages of using artificial insemination.

(PowerPoint Slide 10)

- A. Some of the advantages of utilizing artificial insemination are:
 1. Increases the use of outstanding sires—Through artificial insemination, many producers can use an outstanding sire to breed their females. The actual sire does not need to be present.
 2. Eliminate the danger of keeping a sire—Some hazards are usually involved in keeping a sire on site. Also sires, when not breeding, are typically kept in separate facilities. This need is eliminated with the use of artificial insemination.
 3. Reduce sire costs—In smaller herds, artificial insemination is usually less expensive than the ownership of a quality sire including building, feed, and labor costs.
 4. Increase number of different sires in herd—Through artificial insemination, it is possible to introduce several different genetic lines into the herd through the use of different sires.

(PowerPoint Slide 11)

- B. Some of the disadvantages or limitations of artificial insemination are:
 1. Requires skilled technician—In order to be successful, artificial insemination must be carried out by a person that has received training and had experience.
 2. High initial investment—Considerable money is necessary to begin an artificial insemination operation.
 3. Equipment costs can be high along with paying of training needed to conduct procedure.
 4. Increase management—To be successful, the level of observation and management by the producer must increase in an artificial insemination operation.

Use TM: 3-4 to aid in summarizing the discussion on the advantages and disadvantages of using artificial insemination.

Objective 3: Define the processes of estrous synchronization, embryo transfer, cloning, and genetic engineering.

Anticipated Problem: What are estrous synchronization, embryo transfer, cloning, and genetic engineering?

(PowerPoint Slide 12)

III. There are several other techniques used in cattle reproduction in addition to artificial insemination. Some of the more common techniques are:

(PowerPoint Slide 13)

A. Estrous synchronization—**Estrous synchronization** is bringing a group of animals into heat simultaneously. This is done to assist the producer in scheduling animal breeding and birthing. Synchronization usually involves the use of prostaglandin, progestin, or a combination of the two.

Prostaglandin causes the corpus luteum to stop producing progesterone. This allows the animal to come into estrus. **Progestin** has the effect of keeping progesterone levels high, holding animals in an extended diestrus. When the progestin source is removed, the animal quickly comes into estrus.

(PowerPoint Slide 14)

B. Embryo transfer—**Embryo transfer** is moving embryos from one female, called the **donor female**, to the reproductive tract of another female called the **recipient female**. Donor females usually carry extraordinary genetics. Recipient animals have far less worth and are used as surrogate mothers. Embryo transfer is used following superovulation. **Superovulation** involves getting a female to release more than the usual number of eggs during a single estrous cycle. Embryos can be frozen in liquid nitrogen and transferred later; however, the success rate is higher when transferring fresh embryos.

(PowerPoint Slide 15)

C. Cloning—**Cloning** is the production of one or more exact genetic copies of an animal.

1. There are several methods of cloning animals.
2. One method of cloning involves letting embryos grow to the 32-cell stage before splitting into 32 identical embryos.
3. Another method takes a cell from an adult animal. This method was used in creation of the famous sheep Dolly.
4. A third technique involves taking cells from primordial germ cells during fetal development. These are more stable cells and can be cultured and frozen for indefinite periods of time.

(PowerPoint Slide 16)

D. Genetic engineering—**Genetic engineering** is removing, modifying, or adding genes to DNA. Genetic engineering using gene-splicing or recombinant DNA along with other reproductive technology will have a great deal of impact on future animal production.

Use TM: 3-5 to aid in the discussion of other reproductive technologies.

Review/Summary: Focus the review and summary of the lesson around the student learning objectives (**PowerPoint Slide 17**). Call on students to explain the content associated with the objectives.

Application: Invite a local veterinarian to class and have them demonstrate how to artificially inseminate a cow. It may be necessary to meet the veterinarian at a local cattle producer to watch the process of artificial insemination.

Evaluation: Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activity. A sample written test is included.

Answers to Sample Test:

Matching

1. G
2. E
3. F
4. D
5. H
6. B
7. C
8. A

Fill-in-the-blank

1. -196°C
2. Liquid nitrogen
3. Estrous synchronization
4. Training

Short Answer

Refer to Objective 2 in this lesson for scoring this question.

Understanding Natural Animal Reproduction

Name: _____

Matching: Match each word with the correct definition.

- | | |
|------------------------|----------------------------|
| a. Cloning | e. Progestin |
| b. Prostaglandin | f. Superovulation |
| c. Embryo transfer | g. Estrous synchronization |
| d. Genetic engineering | h. Standing heat |

- _____ 1. Bringing a group of animals into heat simultaneously.
- _____ 2. Has the effect of keeping progesterone levels high, holding animals in an extended diestrus.
- _____ 3. Getting a female to release more than the usual number of eggs during a single estrous cycle.
- _____ 4. Removing, modifying, or adding genes to DNA.
- _____ 5. The stage of estrus when a female stands when mounted by another animal.
- _____ 6. Causes the corpus luteum to stop producing progesterone.
- _____ 7. Moving embryos from one female to the reproductive tract of another female.
- _____ 8. The production of one or more exact genetic copies of an animal.

Fill-in-the-blank: Complete the following statements.

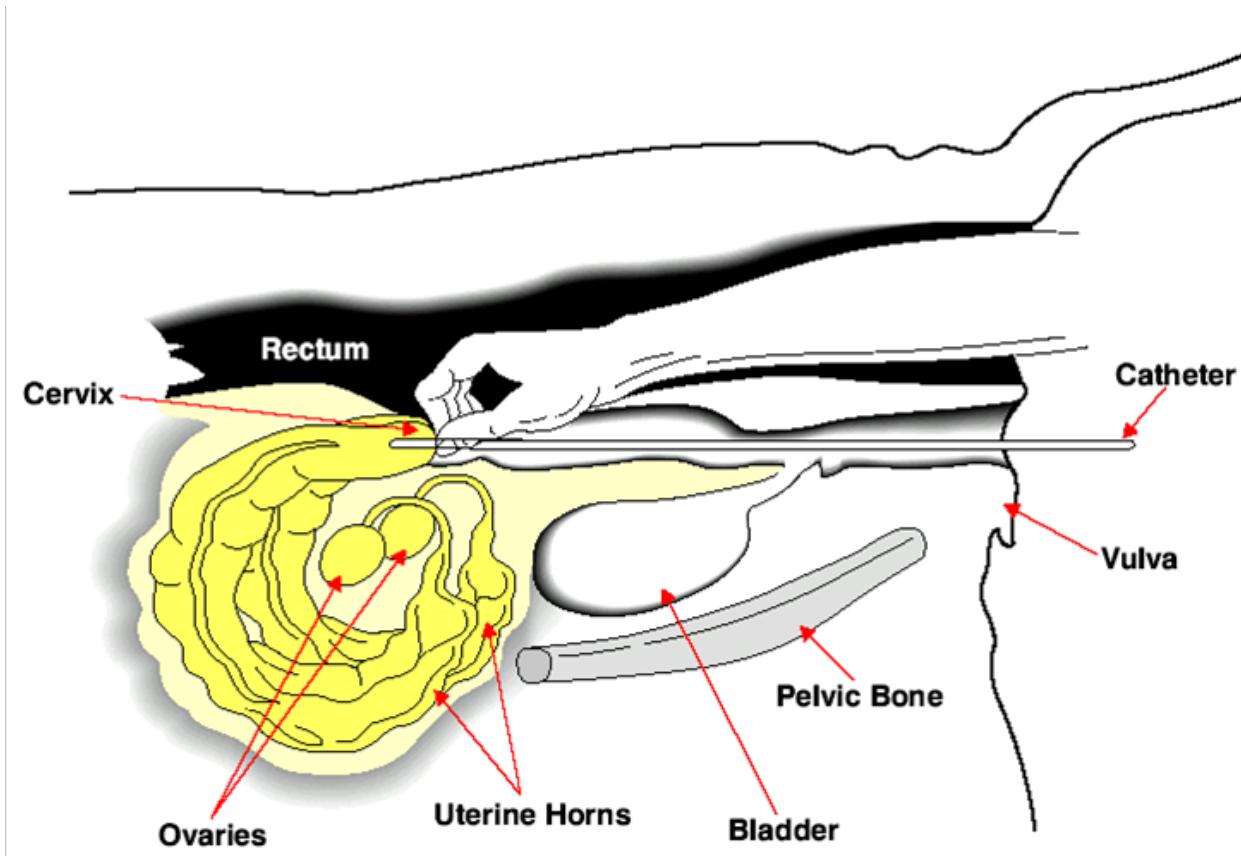
- 1. After the semen is collected from the male, it is evaluated, slowly cooled and frozen at a temperature of _____.
- 2. Embryos can be frozen in _____ and transferred later; however, the success rate is higher when transferring fresh embryos.
- 3. _____ is done to assist the producer in scheduling animal breeding and birthing.
- 4. In order to be successful, artificial insemination must be carried out by a person that has received _____.

Short Answer: Answer the following question.

Identify and discuss two advantages and two disadvantages of artificial insemination.

TM: 3-1

ARTIFICIAL INSEMINATION IN COWS



ESTRUS CYCLES AND REPRODUCTIVE TRAITS

- ✓ Species: Cow
- ✓ Puberty age: 4-12 months (6-8 more common)
- ✓ Length of cycle: 16-24 days (21 average)
- ✓ Length of estrus: 6-35 hours (16-18 average)
- ✓ Time of Ovulation: 20-40 hours from beginning of estrus; 10-14 hours after end of estrus
- ✓ Best time to breed: First, early in estrus; second, 12-20 hours after start of estrus
- ✓ Length of gestation: 278-289 days (283 average)

SIGNS OF ESTRUS FOR CATTLE

- ✓ Standing when mounted by another cow
- ✓ Nervousness
- ✓ Swelling of the vulva
- ✓ Inflamed appearance around lips of vulva
- ✓ Frequent urination
- ✓ Mucus discharge from the vulva
- ✓ Trying to mount other cattle

ADVANTAGES AND DISADVANTAGES

➤ Advantages

- Increases the use of outstanding sires
- Eliminate the danger of keeping a sire
- Reduce sire costs
- Increase number of different sires in herd

➤ Disadvantages

- Requires skilled technician
- High initial investment
- High Equipment costs
- Increase management

OTHER REPRODUCTIVE TECHNOLOGIES

- Estrous synchronization
 - Bringing a group of animals into heat simultaneously
- Embryo transfer
 - Moving embryos from one female, called the donor female, to the reproductive tract of another female called the recipient female.
- Cloning
 - The production of one or more exact genetic copies of an animal.
 - Letting embryos grow to the 32-cell stage before splitting into 32 identical embryos.
 - Takes a cell from an adult animal.
 - Taking cells from primordial germ cells during fetal development.
- Genetic engineering
 - Removing, modifying, or adding genes to DNA.