UNIT III - REPRODUCTION

Lesson 1: Importance of Reproduction in Livestock

Objective: The student will be able to identify the importance of reproduction in livestock production.

Study Questions

1. **What careers are associated with livestock reproduction?**
2. **What are the economic factors associated with reproduction?**
3. **Identify parts and functions of the male reproductive system.**
4. **Identify parts and functions of the female reproductive system.**

References

1. Student Reference
2. Transparency Masters

   TM 1.1: Comparison of Male Livestock
   TM 1.2: Parts of a Cow's Reproductive Tract (Cut-Away View)

UNIT III - REPRODUCTION

Lesson 1: Importance of Reproduction in Livestock

TEACHING PROCEDURES

A. Review

Review previous unit on animal genetics.

B. Motivation

How does livestock reproduction affect the average consumer? For producers to receive the optimum price for their products, they must improve the herd's quality through reproduction and genetics. This improvement influences the quality of products available in the store. In turn, consumers influence livestock quality through their buying power.

C. Assignment

D. Supervised study

E. Discussion

1. Help students discuss careers associated with livestock reproduction and determine what education requirements are needed for these occupations.

   What careers are associated with livestock reproduction?

   a) A veterinarian deals with a wide spectrum of livestock reproduction activities. Some of these activities are: AI programs, semen collecting, pregnancy testing, embryo transfer, cloning, and assisting with births.
   b) Breed association representatives are constantly improving the breed through genetics and selective breeding.
   c) Breeding services, such as ABS, provide assistance such as access to semen for use in herds.
   d) Livestock scientists provide the latest research on livestock reproduction, such as genetic engineering.
   e) An Extension livestock specialist provides information to the producer on new and old methods of livestock breeding. These specialists are a resource used by livestock producers throughout the country.
   f) Livestock producers manage livestock reproduction for their income.
   g) A sales representative for livestock breeding products deals with the large supply of livestock products used in purebred and commercial breeding programs.

2. Ask students about inherited traits associated with livestock reproduction. These traits determine profit or loss in a livestock operation.

   What are the economic factors associated with reproduction?

   a) Beef cattle
      1) Calving interval - Cows which do not produce yearly calves are too costly for the producer to keep long.

2) Birth weight is associated with calf survival rate; usually, larger calves are healthier and more vigorous.
3) Weaning weights are a good indication of the mother's milking ability. Gains before weaning are cheaper to achieve than gains after weaning, resulting in increased profits for heavier weights.
4) Maternal ability is important for calf survival and weaning weights.
5) Daily rate of gain is significant in getting animals to market weight in a shorter period of time and is highly correlated with efficiency gain.
6) Pasture gain becomes important when animals are raised on pasture. This is most apparent in backgrounding operations and cows on pastures.
7) Efficiency of gain is important in rate of gain and conversion of feed into muscling.
8) Final feedlot weight - More money is earned with animals that reach this weight at a faster rate. This weight is influenced by birth weight, weaning weight, and rate of gain.
9) Conformation score becomes important in relation to animal longevity (life span) and appearance.
10) Carcass traits become important in the quality and quantity of the edible final product. More profit results by producing more of a quality product.

b) Dairy cattle
1) Milk production is the essence of a dairy operation. The more milk produced per animal, the more income that results for the producer.
2) Percent fat is the icing on the cake. A higher percentage of butterfat in milk increases the price paid per pound of milk.
3) Percent protein also determines the price per pound of milk. The higher the percentage of protein, the higher the price per pound of milk.
4) Soluble nitrogen-free extracts help animals take advantage of more nutrients in feed and convert nutrients into usable products.
5) Feedlot gain is not as important in dairy cattle as in beef cattle, but it is vital for dairy steers on a feedlot.
6) Stature is significant to an animal's longevity and production, especially on hard surfaces.
7) Legs and feet become very important for animals that are on concrete floors and lots.
8) Udder support is vital to the length of time an animal can continue to produce milk.
9) Milking speed - Time is money, especially in a dairy operation. The quicker a cow milks, the quicker milking proceeds, and the producer can move on to the next project.
10) Birth weight is associated with calf survival rate and calving ease.
11) Temperament becomes extremely important in the milking parlor. If an animal becomes excited and becomes hard to milk, that animal will have to be replaced or require more labor.
12) Fertility is extremely important in milk production. The longer it takes a female to become fertile, the longer it takes for her to come into her milk cycle, which costs the producer.

c) Sheep
1) Multiple births - The more lambs produced, the more money that can be made.
2) Birth weights - Larger lambs generally mean more vigorous lambs and higher rates of gains.

3) Weaning weights reflect that it is cheaper to add pounds from birth to weaning than after weaning.
4) Rate of gain generally reflects milking ability of the mother and a faster growth rate, which means money in the pocket.
5) Type score determines market value and the animal's ability to flourish in its environment.
6) Finish or condition at weaning is important for market lambs. The better the condition and finish at weaning weight, the better the price.
7) Wrinkles and skin folds determine the shearing ease and wool fiber uniformity.
8) Face covering determines the ease of grazing for animals and increases labor costs for trimming. For example, sheep that are wool-blinded have facial wool that blocks their sight until it is trimmed.
9) Fleece weight determines the price received for wool.
10) Staple length influences the price received for wool because it measures the length of fibers.
11) Carcass quality largely determines profit or loss for a farm flock producer.

d) Swine
1) Litter size at birth - The more pigs that are produced, the more money that can be made.
2) Litter size at weaning - Most of the pigs are lost between birth and weaning, so the more pigs saved, the more money that can be made.
3) Birth weight - Heavier pigs have more vigor and an increased survival rate.
4) Litter weight at weaning is very important to the feeder pig producer. Remember, it is cheaper to add pounds from birth to weaning than after weaning.
5) Daily rate of gain from weaning to market weight is important to the market hog producer. The more efficient the hogs, the quicker they go to market.
6) Feed efficiency - The better the conversion rate of feed to gain, the quicker the hogs go to market.
7) Conformation score becomes very important for hogs in confinement that are on concrete surfaces.
8) Carcass quality is very important for any swine producer. The higher the carcass quality, the more premium the price received for the product.

3. Parts of male reproductive system are also important economic traits for a livestock producer to consider when selecting sires. Show TM 1.1 to illustrate male reproductive parts and to discuss differences among classes of livestock.

Identify parts and functions of the male reproductive system.

a) Parts and functions of the male reproductive system.
1) The scrotum is a heat-regulating structure that provides the proper temperature for sperm production. Sperm cannot be produced at normal body temperatures. The scrotum lowers the testes to cool them and contracts them when warmth is needed. For sperm production to occur, the testes must be 4-7 degrees Celsius lower than normal body temperature.
2) Testes - All classes of male livestock have two testes. The testes produce sperm and secrete male sex hormones. The testes are made up of several thousand feet of very small, tangled tubes called seminiferous tubules.

3) Epididymis is an elongated body close to the testes. It consists of three parts--the head, the body, and the tail. The epididymis has four functions: to store, mature, transport, and concentrate the sperm. Sperm storage occurs in the tail of the epididymis. Sperm maturation is achieved through cell excretions. Sperm transportation is aided by water absorption.
4) The vas deferens transports sperm from the tail of the epididymis to the penis. The sperm pass by accessory glands like the seminal vesicles, prostate gland, and the Cowper's gland to produce the fluid called semen.
5) Seminal vesicles are located posteriorly under the prostate gland and empty into the urethra. Secretions produced by the seminal vesicles make up 50 percent of the fluid in semen. This yellow fluid consists of high concentrations of proteins, potassium, citric acid, fructose, and several enzymes. It usually has a pH of 5.7-6.2.
6) The prostate gland surrounds the urethra, and secretions pass into the urethra through small ducts along the urethra. Prostate secretions are similar to the secretions produced by the Cowper's gland. Prostate fluid usually has a pH of 7.5-8.2.
7) The Cowper's gland is located close to the rectum and above the urethra near its exit from the pelvic cavity. The Cowper's gland is about the size of a walnut and produces secretions to flush the urethra before mounting. The secretions are clear, watery, and sperm-free. This fluid has the same pH as in the prostate gland.
8) The urethra is a jointed canal used for both semen and urine. It runs throughout the length of the penis and carries urine or semen from the originating glands to the head of the penis.
9) The penis excretes urine or deposit semen into the reproductive tract of the female. Its length begins at the bladder and accessory sex glands and ends at the sheath.
10) The sigmoid flexure straightens, causing an erection of the penis, which aids copulation. Blood is pumped into the chambers of penis during sexual excitement, which causes the straightening of the sigmoid flexure.
11) Retractor muscles are used to retract the penis into the sheath. After copulation, the sigmoid flexure contracts and the retractor muscle retracts the penis into the sheath.
12) The sheath is the protective opening where the retracted penis is placed; it keep the penis in a fixed position in the non-erect state.

b) Differences in male reproductive tracts among classes of livestock
1) The ram's scrotum is shorter than the scrotum found on a bull. The ram's scrotum is also covered in wool. The ram's urethral opening extends out further than the head of the penis, which rotates and sprays semen during ejaculation.
2) The boar's scrotum is located just below the rectum, not hanging from the bottom of the animal as in some species. In the boar, the free part of the penis is shaped like a corkscrew. The boar has a preputial pouch located right above the opening to the sheath that is responsible for the strong sex odor in boars. This pouch contains a mixture of decomposing urine and macerated epithelial cells, which permeates the meat and gives it a bad taste. This is why most boar carcasses are not used for human consumption.
3) A stallion's scrotum is less pendulous than a bull's. In a relaxed state, the stallion's testes lie horizontally; in an excited state, the testes become almost vertical in nature. A stallion does not have a sigmoid flexure.

4. Functioning female reproductive parts are also considered important economic traits for consistent breeding ease and fertility. Show TM 1.2 to illustrate female reproductive parts.

Identify parts and functions of the female reproductive system.

a) The bladder stores urine. The urethral opening is the opening for the bladder.
b) The vulva is the external opening of the urinary tract and the female reproductive tract.
c) Ovaries are the structures that produce the egg or ovum.
d) The infundibulum is a funnel-like structure that connects the ovary to the Fallopian tube.
e) The Fallopian tube carries the egg or ovum from the ovary to the horn of the uterus. The ovary releases the ovum or egg 12 hours after the estrous cycle is complete. Fertilization occurs when the egg unites with the sperm in the upper third of the Fallopian tube.
f) The uterus provides a pathway for sperm and is where the development of the fetus takes place. The fertilized egg empties from the Fallopian tube into the uterus, where it begins to develop.
g) The cotyledon is an attachment point for connecting the placenta to the uterus.
h) The cervix acts as a plug for the uterus when fertilization occurs. After fertilization, the cervix closes completely, sealing the uterine cavity and protecting the fetus from bacterial and foreign invasions. The cervix liquifies shortly before birth, allowing the fetus to be expelled from the uterus.
i) The vagina is the female organ where the semen is deposited at copulation. Semen is deposited at different places, depending on the class of livestock and the copulation process. Semen can be deposited as far in as the uterus. Like the cervix, the vagina dilates during birth.
j) The clitoris is the sensory organ that allows the penetration of the male penis. It is located in the vulva. This sensory organ allows copulation to occur and is stimulated during the estrous cycle.

F. Other activities

1. As a visual aid, consider using a reproductive tract from a slaughter house to point out parts of the female reproductive tract.

2. Show the video, *Beef Reproduction II* (43 minutes, AG video 7), available from the Missouri Vocational Resource Center.

G. Conclusion

A good knowledge of animal reproduction helps people in livestock production and related occupations understand the complexity of this process. Knowing economically important reproductive traits is a necessity for a person in this field.

H. Competency

Identify the importance of reproduction in livestock production.

Related Missouri Core Competencies and Key Skills

10B-4: Describe the structure and function of human reproductive organs.

I. Answers to Evaluation

1. Scrotum
2. Epididymis
3. Sigmoid flexure
4. Retractor muscles
5. Urethra
6. Seminiferous tubules
7. 4-7
8. Seminal vesicles
9. Cowper's gland
10. Sheath

11. Four of the following: Veterinarian, breed association representative, breeding services technician, livestock scientist, Extension livestock specialist, livestock producer, sales representative for livestock breeding products

12. j
13. f
14. g
15. i
16. k
17. a
18. h
19. d
20. e
21. b

22. a, b, c, d, f, h, i, l (question worth 12 points)

23. a, d, e, f, h, i, l (question worth 12 points)

24. b, c, d, e, h, i (question worth 10 points)

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EVALUATION

Fill in the blank with the best answer.

1. The _____ is the temperature-regulating structure of sperm production.
2. The tail of the _____ stores the sperm.
3. The _____ straightens, causing an erection of the penis and allowing for copulation.
4. The _____ are used to retract the penis back into the sheath.
5. The _____ is the canal inside the penis that carries sperm and urine.
6. The testes are made up of several thousand very small, tangled tubes that are called _____.
7. The testes must be _____ to _____ Celsius degrees lower than normal body temperature for sperm production to occur.
8. Secretions produced by the _____ make up 50 percent of the fluid in semen. These secretions consist of high concentrations of potassium and proteins.
9. The _____ is a structure about the size of a walnut, which secretes fluids to clean out the urethra.
10. The _____ is the structure that holds the penis in a fixed position in a non-erect state.

Complete the following short answer question.

11. List four careers associated with livestock reproduction.

    a.

    b.

    c.

    d.

Match the female reproductive term on the left with the definition on the right.

12.	____ Bladder	a.	Structure that produces the egg
13.	____ Cervix	b.	External opening of the urinary and reproductive tracts
14.	____ Cotyledon	c.	Sensory organ of the female reproductive tract
15.	____ Fallopian tube	d.	Opening for the bladder
16.	____ Infundibulum	e.	Female organ where the semen is usually deposited at copulation
17.	____ Ovary	f.	Seals the uterus from bacterial and foreign invasions after fertilization
18.	____ Uterus	g.	Attachment point for connecting the placenta to the uterus
19.	____ Urethral opening	h.	Where the fetus develops
20.	____ Vagina	i.	Where the egg is fertilized
21.	____ Vulva	j.	Storage place for urine
		k.	Funnel-like structure that connects the ovary to the Fallopian tube

Complete the following multiple answer questions.

22. Check the economic traits influenced by reproduction in beef cattle.

____ a.	Calving interval	____ g.	Polled
____ b.	Carcass traits	____ h	Daily rate of gain
____ c.	Birth weight	____ i.	Pasture gain
____ d.	Weaning weight	____ j.	Type of diet
____ e.	Horned	____ k.	Daily water intake
____ f.	Maternal ability	____ l.	Conformation score

23. For dairy cattle, check the economic traits influenced by reproduction.

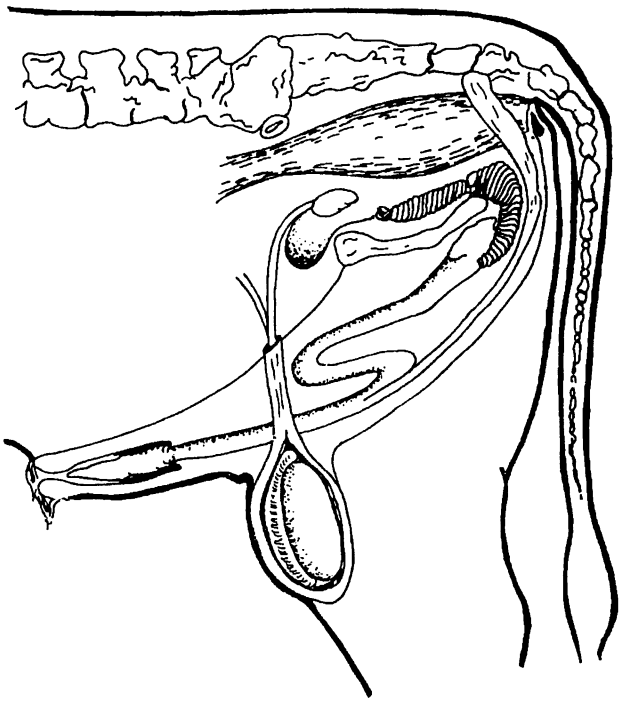
____ a.	Milk production	____ g.	Mastitis infection
____ b.	Horned	____ h.	Birth weight
____ c.	Type of idet	____ i.	Temperament
____ d.	Percent fat	____ j.	Daily water intake
____ e.	Udder support	____ k.	Daily feed intake
____ f.	Milking speed	____ l.	Fertility

24. Check the economic traits influenced by reproduction in sheep.

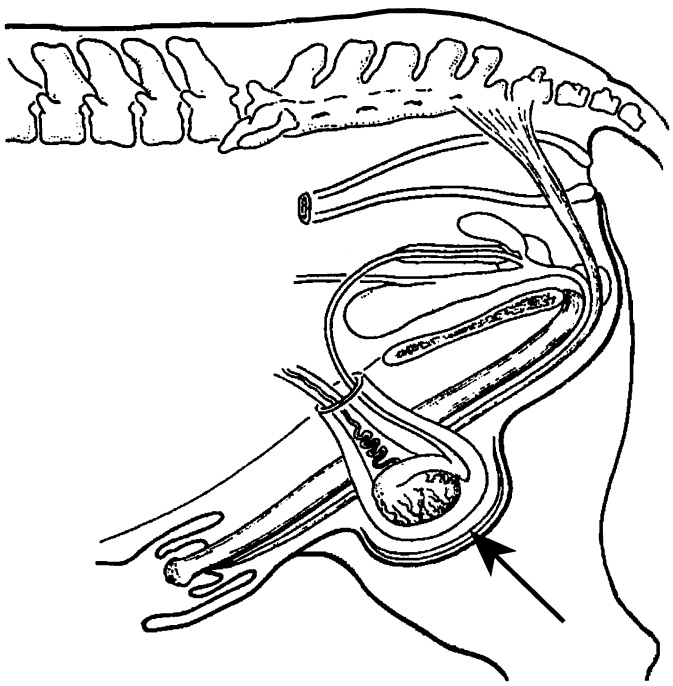
____ a.	Type of diet	____ f.	Polled
____ b.	Multiple births	____ g.	Daily water intake
____ c.	Rate of gain	____ h.	Fleece weight
____ d.	Finish or condition	____ i.	Wrinkles and skin folds
____ e.	Carcass quality	____ j.	Number of lambs weaned

Comparison of Male Livestock

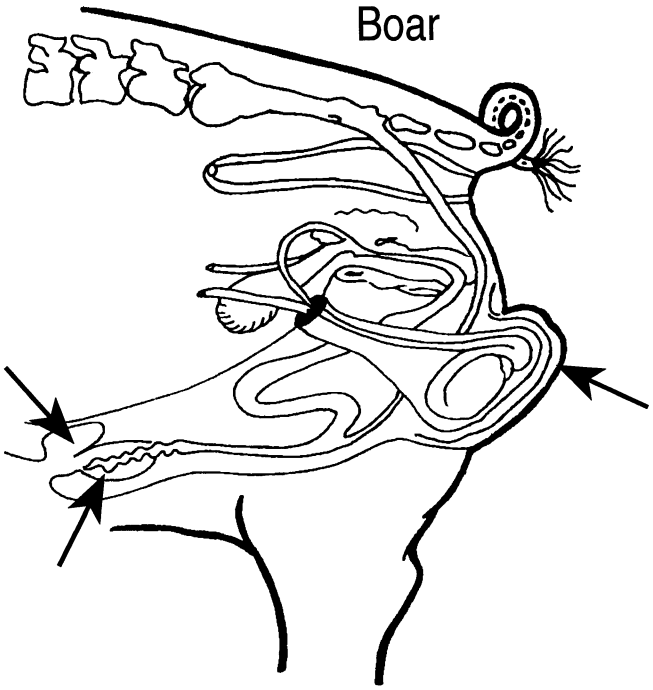
Bull



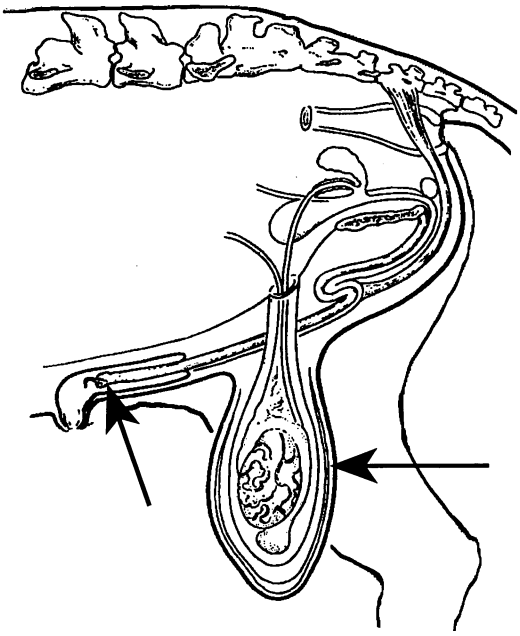
Stallion



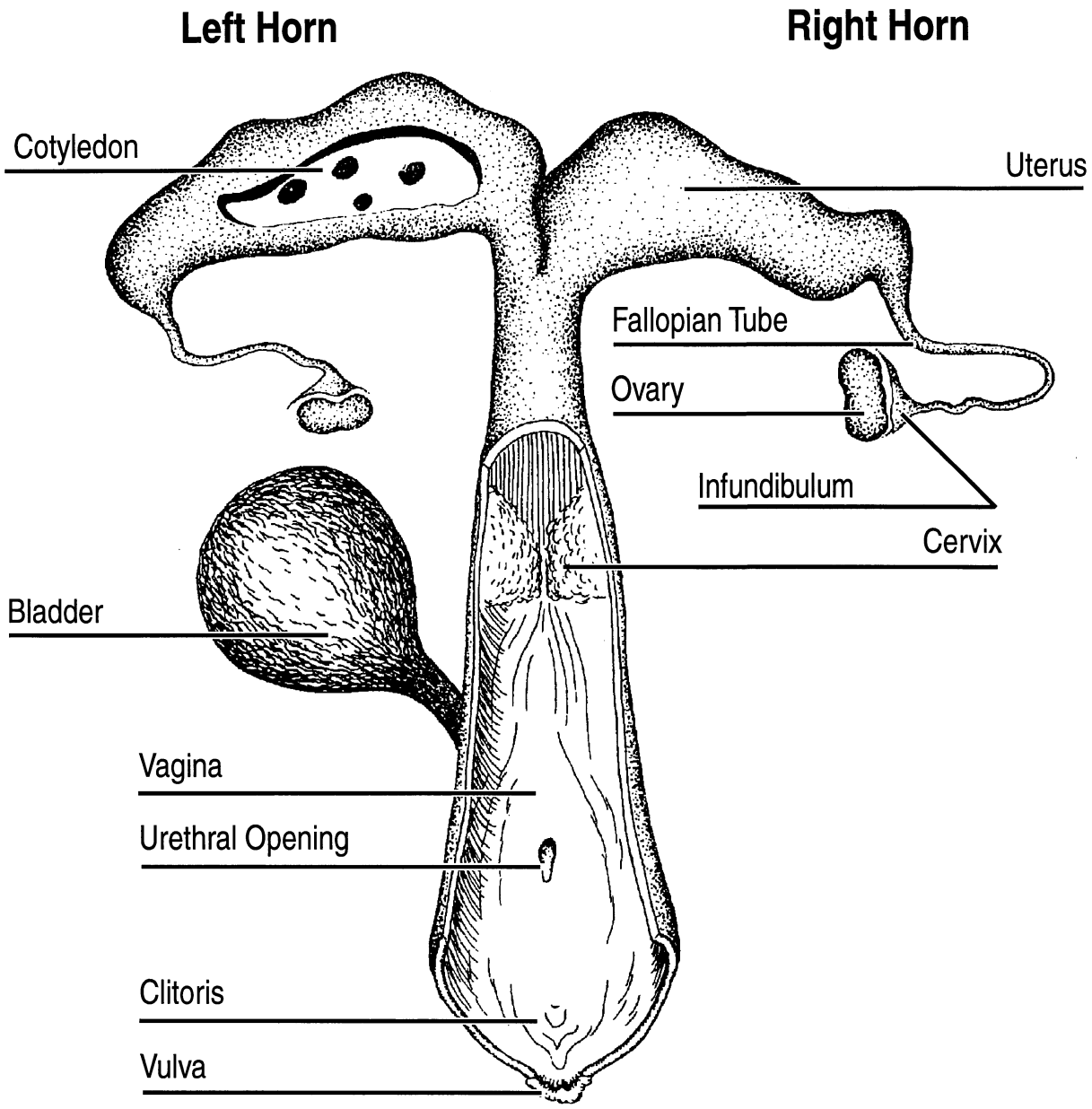
Boar



Ram



Parts of a Cow's Reproductive Tract (Cut-Away View)



UNIT III - REPRODUCTION

Lesson 2: Reproductive Hormones

Objective: The student will be able to describe the hormonal systems in livestock production.

Study Questions

1. **What are the common female reproductive hormones and their functions?**
2. **What are the common male reproductive hormones and their functions?**

References

1. Student Reference

UNIT III - REPRODUCTION

Lesson 2: Reproductive Hormones

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Most animal reproductive systems are regulated by the photoperiod--when day lengths begin to increase, the mating process begins. Offspring are born in the spring and summer and nurtured so they can survive the harsh winter months. However, most domesticated livestock are not seasonal breeders; instead, they have a continual breeding cycle. How is this breeding cycle regulated? Hormones regulate the reproductive systems of cattle, swine, sheep, and horses. Hormones aid in maintaining pregnancy, lactation, egg release, sex drive, and sperm formation.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss how hormones affect reproduction. Ask students to name some hormones that they think would be related to reproduction.

   What are the common female reproductive hormones and their functions?

   a) Hormones are substances produced in the animal's body. Various glands secrete natural hormones into body fluids, such as the bloodstream.
   b) Estrogen is produced by the ovaries and has several effects.
      1) Body - Development of female sex characteristics
      2) Uterus - Causes uterine growth and contractions
      3) Mammary glands - Causes mammary duct growth
      4) Brain - Control of the estrous cycle
   c) Follicle-stimulating hormone (FSH) is produced by the anterior pituitary gland. FSH stimulates follicular growth.
   d) Luteinizing hormone (LH) is produced by the anterior pituitary gland.
      1) Effect on the gonads - Sends signal for ovulation
      2) Effect on the gonads - Stimulates production of progesterone, causes the maturation of follicles
      3) Maintains the corpus luteum
   e) Progesterone is produced by the corpus luteum and is important for several effects.
      1) Uterus - Prepares reproductive tract for pregnancy, maintains pregnancy, and blocks uterine contractions
      2) Mammary glands - Causes mammary lobule-alveolar growth
      3) Brain - Blocks the estrous cycle
   f) Oxytocin is produced by nerves in the brain and is stored in the posterior pituitary gland.
      1) Effect on the uterus - Causes uterine contractions
      2) Effect on the mammary glands - Milk let-down
      3) Effect on poultry - Causes the expulsion of eggs

g) Relaxin is produced in the corpus luteum of most livestock and in the placenta of mares.
   1) Effect on the cervix - Causes dilation
   2) Effect on the pelvic ligaments - Causes relaxation to assist in birth process

h) Prolactin is produced in the anterior pituitary gland.
   1) Initiates lactation
   2) Induces maternal behavior

i) Prostaglandin f-2-alpha is produced in the uterus. It causes corpus luteum regression.

2. Ask the students how the male hormones differ from the female hormones. Are there similarities?

What are the common male reproductive hormones and their functions?

a) Testosterone is produced by the testes and has several effects.
   1) Body - Development of sex glands and male sex characteristics
   2) Reproductive tract - Sperm formation (maturation) and seminal plasma production
   3) Brain - Sex drive control

b) Follicle-stimulating hormone (FSH) is produced by the anterior pituitary gland. FSH stimulates sperm formation (spermatogenesis).

c) Luteinizing hormone (LH) is produced by the anterior pituitary gland. It causes testosterone formation in the gonads.

F. Other activities

Bring in reproductive tracts of livestock. Trace when and where the hormones would affect reproductive cycle parts and production of the egg and sperm.

G. Conclusion

Hormones are chemical compounds that help regulate body functions. Hormones have a tremendous effect on the reproductive cycles of livestock. They control the development of sex characteristics, mating, and eventually fertilization. Therefore, hormones control the entire life cycle of livestock.

H. Competency

Describe the hormonal system in livestock reproduction.

I. Answers to Evaluation

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

UNIT III - REPRODUCTION

Name_____

Lesson 2: Reproductive Hormones

Date_____

EVALUATION

Circle the letter that corresponds to the correct answer.

1. Which hormone is responsible for female sex characteristics?

   a. Progesterone
   b. Oxytocin
   c. Estrogen
   d. Relaxin

2. Which hormone is produced in the placenta of mares but by the corpus luteum in other livestock?

   a. Oxytocin
   b. Prostaglandin
   c. Estrogen
   d. Relaxin

3. Which hormone is NOT produced by the anterior pituitary gland?

   a. Follicle-stimulating hormone
   b. Luteinizing hormone
   c. Prolactin
   d. Progesterone

4. Which hormone is responsible for alveolar growth in the mammary system?

   a. Progesterone
   b. Oxytocin
   c. Estrogen
   d. Testosterone

5. Which hormone is commonly given to lactating females to stimulate milk let-down?

   a. Estrogen
   b. Oxytocin
   c. Progesterone
   d. Relaxin

6. Which hormone sends the signal for ovulation?

   a. Estrogen
   b. Oxytocin
   c. Luteinizing hormone
   d. Follicle-stimulating hormone

7. Corpus luteum regression is caused by which hormone?

   a. Prostaglandin
   b. Relaxin
   c. Testosterone
   d. Follicle-stimulating hormone

8. Which hormone is responsible for the male sex characteristics and libido?

   a. Estrogen
   b. Testosterone
   c. Relaxin
   d. Luteinizing hormone

9. Sperm production is stimulated by which hormone?

   a. Relaxin
   b. Prostaglandin
   c. Follicle-stimulating hormone
   d. Estrogen

10. Which hormone blocks the estrous cycle?

    a. Follicle-stimulating hormone
    b. Estrogen
    c. Testosterone
    d. Progesterone

UNIT III - REPRODUCTION

Lesson 3: Reproductive Cycles of Common Livestock

Objective: The student will be able to understand and describe the reproductive cycles of common production livestock.

Study Questions

1. **At what age do different livestock species reach puberty?**
2. **Explain the estrous cycle and the interaction of hormones.**
3. **Explain spermatogenesis.**
4. **What are gestation lengths of various livestock?**

References

1. Student Reference
2. Activity Sheet

   AS 3.1: Reproductive Functions of Livestock

UNIT III - REPRODUCTION

Lesson 3: Reproductive Cycles of Common Livestock

TEACHING PROCEDURES

A. Review

Review previous lesson on hormonal systems in livestock production.

B. Motivation

What is puberty? How do we know when humans reach puberty? How is puberty stimulated? In humans, puberty occurs when male and female characteristics become more prominent than in the adolescent stage. Puberty begins with the release of hormones into the bloodstream that stimulates the growth of reproductive organs. Like humans, animals reach puberty in the same way. Animals mature at a much faster rate than humans, however. Most production livestock species have reached puberty by their first year of life.

C. Assignment

D. Supervised study

E. Discussion

1. Why is it so important that livestock producers understand when animals reach puberty? Discuss the differences among species.

At what age do different livestock species reach puberty?

a) Cattle
   1) The first sign of puberty in the female is the first estrous cycle, which begins at 8-12 months. This age difference depends on breed, nutritional, and environmental factors. Smaller breeds usually mature faster than larger breeds. A poor nutritional diet could delay puberty, as could poor environmental conditions.
   2) In the male, the first signs of puberty are the production of viable sperm and the desire to mount. Both signs are influenced by the hormone testosterone. These signs will begin to appear at 8-12 months. The desire to mount can appear earlier, but viable sperm are not present, usually.
   3) Heifers can be bred when they have reached 13-14 months or weigh 600-650 lbs. Bulls can begin servicing smaller numbers of females at 12 months.

b) Sheep
   1) The initial sign of puberty in the female is the first estrous cycle, which can begin at 8-10 months of age. The beginning of the estrous cycle depends on the type of breed, nutritional requirements, and environmental conditions. In general, ewe lambs of mutton breeds have their first estrous cycle in the fall of their first year. Ewe lambs are somewhat slower reaching their sexual maturity than ram lambs.
   2) The first signs of puberty in the male are the production of viable sperm and the desire to mount. These signs generally occur at 5-7 months.
   3) Ewe lambs can be bred after they have reached 12 months so that they lamb when they are approximately 24 months old. Young rams used for service before they are yearlings usually service smaller numbers of females.

c) Swine
   1) Again, the first sign of puberty in the female is the first estrous cycle. The first estrous cycle can begin at 4-8 months. Most gilts do not begin their first cycle until they weigh 180 lbs. or more. The wide age range depends on the breed, environmental conditions, and especially nutrition.
   2) Nutrition is extremely important because puberty is more centered around weight than age.
   3) The first signs of puberty in the male are the production of viable sperm and the desire to mount. Again, the desire to mount usually comes before the production of viable sperm. The first sign of puberty generally begins at 4-8 months. Usually, boars take longer to reach sexual maturity than do gilts.
   4) Gilts are usually bred to farrow at 11-12 months of age. In swine, breeding gilts largely depends on the development instead of age. A general rule is to breed gilts when they reach 225 lbs., not at a certain age. Boars can begin service at 8-12 months. Younger boars service smaller numbers of females in the earlier stages of their maturity.

d) Horses
   1) In horses, sexual maturity is reached at 12-15 months. As in other classes of livestock, the first sign of puberty in the female is the estrous cycle. In the male, it begins with the production of viable sperm and the desire to mount. Puberty can be delayed by poor nutrition and poor environmental conditions.
   2) The age to breed mares depends on the mare's maturity level. Well-developed mares have been bred as early as 2 years old to foal when they are 3 years old. It is best to breed mares when they are 3 years old so they foal when they are 4 years old. Stallions are ready for service when they reach puberty.

2. Understanding the interaction of hormones is important because hormones regulate the estrous cycle, which is the essence of livestock reproduction.

Explain the estrous cycle and the interaction of hormones.

a) Before puberty occurs, the female reproductive tract and ovaries slowly grow in size and show no functional activity. This growth seems to parallel the increase in body weight as the animal ages.
b) As puberty nears, the anterior pituitary gland releases FSH (follicle-stimulating hormones) into the bloodstream. FSH stimulates follicle growth in the ovary. Then, the ovarian weight increases and estrogen is released into the bloodstream. This stimulates growth in the other parts of the female reproductive tract.
c) When follicles mature, the egg is released by a hormone called LH (luteinizing hormone), which is also produced by the anterior pituitary gland. The luteinizing hormone ruptures the follicle and releases the egg (ovulation). Once ovulation has occurred, the animal has reached puberty.
d) Puberty is reached at different ages, depending on the species. The estrous cycle or heat period occurs when the female is willing to accept the male for mating. The estrous cycle begins with the release of estrogen from the ovaries, and the egg is ovulated.
e) The length of the heat period, the distance between heat periods, and the release of the egg are different in each class of livestock. Table 3.1 shows the differences for each class of livestock.

TABLE 3.1 - Differences in Estrous Cycles

Type of stock	*Length of heat period*		*Interval of heat period*		*When egg is released*
	Range	*Average*	*Range*	*Average*	*Time*
Cattle	6-30 hrs.	16-20 hrs.	19-23 days	21 days	12 hrs. after estrous is completed
Sheep	20-42 hrs.	30 hrs.	14-20 days	16-17 days	24-30 hrs. after estrous cycle is complete
Swine	1-5 days	2-3 days	18-24 days	21 days	36-40 hrs. after onset of heat
Horses	2-10 days	4-6 days	10-37 days	21 days	In latter part of the estrous cycle

f) Outward signs of the estrous cycle (heat period)
   1) How to find cows in heat
      (a) Cows in heat are under the influence of a sudden, high-level occurrence of the female sex hormone, estrogen. The egg-containing follicle which produces the hormone is at the height of its growth.
      (b) The nervous system is greatly affected. The cow is excitable and may bawl more than normal. She is restless and often walks the fences.
      (c) Cows in heat attempt to ride other cows. They stand to be mounted by other cows. Under conditions of natural service, they would stand and accept service by a bull. Standing is the only reliable, practical test for heat. When a cow stands, she is in heat and is ready for breedubg,
      (d) Ruffled hair over the tail head suggests that a cow has recently been ridden; she may or may not have been in heat. Many heifers and cows in heat flatten themselves down in the loin region. This presents a "sway back" and "high tail head" appearance.
      (e) Genital mucous may flow from the vulva in long strings. Wet mucous smears are often noticeable on the buttocks, over the pin bones, and under the tail.
      (f) The vulva of a cow in heat appears somewhat swollen.
      (g) In the second or third day after heat, but sometimes earlier, bloody mucous passes from the cow's vulva. Bleeding from the cow means that she has been in heat (ovulation implied) 2-3 days before.
   2) Females of other livestock classes show similar conditions to some of those described for cows in heat.
   3) When checking heat for artificial insemination purposes, check for heat at least twice each day. Animals in pasture must be carefully observed.

3. Discuss how sperm is produced and how an offspring's sex is determined.

Explain spermatogenesis.

a) Spermatogenesis is the production of viable sperm within the seminiferous tubules. The process occurs through meiosis and mitosis.
b) The process of spermatogenesis
   1) The process starts with spermatogonia, which are carriers of both sets of chromosomes (XY). Spermatogonia are sex cells in the form of immature sperm. Spermatogonia become mature sperm through spermatogenesis. The spermatogonium has two X chromosomes and two Y chromosomes.

2) Mitosis is cell division where one cell divides into two separate cells, both containing two complete sets of chromosomes.
3) In meiosis, the sex cell division splits the number of chromosomes in half.
4) Spermatogonia divide by mitosis, making like cells with two X chromosomes and two Y chromosomes. A diploid occurs with two X chromosomes and two Y chromosomes.
5) The first meiotic division occurs when the diploid is split in half, creating a haploid. A haploid has only one X chromosome and one Y chromosome. This haploid divides one more time through meiosis.
6) Once this division occurs, the new haploid is left with either an X or a Y chromosome; it does *not* possess both. This decides the sex of the offspring.
7) Before the second haploid becomes a mature sperm, it must first go through a metamorphosis. During this metamorphosis, the haploid receives a head and a tail to move through the female reproductive tract.
8) Once this haploid changes into a mature sperm, it becomes a male or female, depending the chromosome it carries. The sperm determines the sex of the offspring by which type of sperm reaches the egg first.
9) This whole process of spermatogenesis takes about 46-49 days to occur.

4. It is important that livestock producers understand gestation periods so they can prepare for calving or farrowing times.

What are gestation lengths of various livestock?

a) Gestation or pregnancy period is the length of time between fertilization and the birth of the offspring (parturition).
b) To understand gestation, begin with the ruptured follicle that released the egg. This ruptured follicle develops into an endocrine gland called the corpus luteum.
   1) The endocrine gland produces hormones for the reproductive system.
   2) The corpus luteum produces a hormone called progesterone, which helps maintain pregnancy.
c) Once the egg is fertilized, it floats freely in the uterus for a while. After a short time, the fertilized egg begins development of the placenta. The placenta is attached to the uterus by the cotyledons, which keeps the placenta in place for the remainder of the gestation period.
d) Gestation lengths vary from one class of livestock to another. Table 3.2 shows the differences of gestation lengths in each class of livestock.

TABLE 3.2 - Gestation Length

Livestock	*Range (days)*	*Average*
Cattle	240-330	283 (9.5 months)
Swine	111-115	114 (3.8 months)
Sheep	144-152	148 (5 months)
Horses	315-350	336 (11 months)

F. Other activities

Have students do Activity Sheet 3.1. This sheet will help coordinate estrous cycle, gestation, spermatogenesis, and puberty.

G. Conclusion

It is especially vital for any livestock producer to understand the reproductive cycle of livestock. This understanding aids producers in making decisions about AI programs, hand or pasture mating, determining the number of females per male, and the age at which to breed young stock.

H. Competency

Describe the reproductive cycle of common production livestock.

Related Missouri Core Competencies and Key Skills

10A-2: Distinguish between mitosis and meiosis
10B-4: Describe the structure and function of (human) reproductive organs

I. Answers to Evaluation

1. Nutrition, environment or breed
2. Mitosis
3. Meiosis
4. Diploid
5. Follicle
6. Follicle-stimulating hormone
7. Haploid
8. Testosterone
9. Estrous cycle
10. Estrogen
11. Viable sperm, desire to mount
12. Spermatogenesis
13. Progesterone
14. Anterior pituitary
15. Swine
16. Ovulation
17. Corpus luteum
18. Ram, ewe
19. Gilt, boar
20. Fall
21. 283 days, 21 days
22. 114 days, 21 days
23. 148 days, 16-17 days
24. 336 days, 21 days

J. Answers to Activity Sheet 3.1

	Cattle	Sheep	Swine	Horses
Age at which male reaches puberty	8-12 mos.	8-10 mos.	4-8 mos. or 180 lbs.	12-15 mos.
Age at which female reaches puberty	8-12 mos.	5-7 mos.	4-8 mos.	12-15 mos.
Length of heat period (average)	16-20 hrs.	30 hrs.	2-3 days	4-6 days
Interval of heat period (average)	21 days	16-17 days	21 days	21 days
Time when egg is released (average)	12 hrs. after estrous is completed	24-30 hrs. after estrous is completed	24-30 hrs. after estrous is completed	In the latter part of estrous
Gestation length (average)	283 days	148 days	114 days	336 days
Age/size at which to breed females that have reached first estrous cycle	13-14 mos. or 600-650 lbs.	12 mos.	11-12 mos. or 225 lbs.	3 yrs. old
Age/size at which males can begin service	12 mos.	12 mos.	8-12 mos.	12-15 mos.

UNIT III - REPRODUCTION Name_____

Lesson 3: Reproductive Cycles of Common Livestock Date_____

EVALUATION

Fill in the blank with the best answer.

1. Puberty can be delayed by _____ and _____ in livestock.
2. Cell division, in which one cell divides into two separate cells containing two complete sets of chromosomes, is called _____.
3. Cell division, in which one cell divides and the chromosomes are equally divided between the two cells, is called _____.
4. A spermatogonium that possesses two X chromosomes and two Y chromosomes is called _____.
5. The egg is released through the rupture of a _____ in the ovary.
6. FSH stands for _____.
7. A spermatogonium that possesses one X chromosome and one Y chromosome is called _____.
8. The male sex hormone responsible for sperm production is called _____.
9. The first sign of sexual maturity in the female is the _____.
10. The hormone released by the ovaries before puberty is reached is called _____.
11. In the male, the first signs of puberty are _____ and _____.
12. The process of producing viable sperm in livestock is called _____.
13. The hormone called _____ maintains pregnancy in livestock.
14. The luteinizing hormone and FSH are produced by the _____ gland.
15. A poor nutritional diet affects the delaying of puberty more in _____ than in any other class of livestock.
16. The release of the egg from the follicle is called _____.
17. The hormone used to maintain pregnancy in livestock is produced by the _____.
18. In sheep, generally the _____ reaches sexual maturity before the _____.
19. In swine, generally the _____ reaches sexual maturity before the _____.
20. In sheep, ewe lambs usually have their first estrous cycle in the _____ of their first year of life.

Fill in the blanks with the correct answer for each class of livestock.

		Gestation length Ave. days (±2)	*Interval of heat period* Ave. days (±2)
21.	Cattle	_____	_____
22.	Swine	_____	_____
23.	Sheep	_____	_____
24.	Horses	_____	_____

Lesson 3: Reproductive Cycles of Common Livestock Name_____

Reproductive Functions of Livestock

Fill in the answers for each class of livestock.

	Cattle	Sheep	Swine	Horses
Age at which male reaches puberty				
Age at which female reaches puberty				
Length of heat period (average)				
Interval of heat period (average)				
Time when egg is released (average)				
Gestation length (average)				
Age/size at which to breed females that have reached first estrous cycle				
Age/size at which males can begin service				

UNIT III - REPRODUCTION

Lesson 4: Fetal Developmental Stages

Objective: The student will be able to sequence the fetal development stages of livestock.

Study Questions

1. **Describe the developmental stages of the livestock fetus and mother during gestation.**

2. **Describe the developmental stages of the embryo (egg) and hen during incubation.**

3. **What are the nutritional requirements during the different stages of pregnancy and lactation?**

References

1. Student Reference

2. *Agriscience 332: Animal Science (Student Reference).* Texas A & M University: Instructional Materials Service, 1989.

UNIT III - REPRODUCTION

Lesson 4: Fetal Developmental Stages

TEACHING PROCEDURES

A. Review

Review the gestation lengths of livestock from Agricultural Science I and the previous lesson.

B. Motivation

Bring in reproductive tracts with fetuses in different stages of development. These can be obtained from a local veterinarian or a meat locker. Discuss the different stages observed.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss how the fetus grows and how it affects the mother during gestation.

Describe the developmental stages of the livestock fetus and mother during gestation.

a) The development and growth of the livestock fetus is similar across species, but the rate of growth varies due to the differences in gestation length. Therefore, general terms will be used when describing fetal development.

b) Animal life begins as a single cell (the fertilized egg). Through the processes of cell division, this cell multiplies and develops into a mature animal. Growth includes all of the physiological processes that allow the fertilized egg to develop into a many-celled animal.

c) Prenatal development

1) During embryonic growth, all body cells increase in size and number.

2) Prenatal growth pertains to the development prior to birth. It involves the time between birth and fertilization of the ovum by the sperm (forming a zygote).

3) The zygote begins as one cell containing chromosome pairs, one each from the father and mother. The zygote's single cell begins a series of divisions into two cells, then four, then eight, etc.

4) The newly fertilized egg free-floats in its mother's reproductive tract. This embryo spends the first few days traveling in the oviduct toward the uterus. By the time it reaches the uterus, 16 or more cell divisions have taken place.

5) After reaching the uterus, the egg continues to free-float and absorb nourishment from fluids in the uterus. The embryo is surrounded by a set of membranes called the placenta (afterbirth).

(a) In hogs, the entire placenta attaches to the entire surface of the uterus.

(b) In sheep, cattle, and horses, there are cotyledons (button-like spots on the placenta) which attach to caruncles (spots) on the uterus. These points of attachment, along with the arteries and veins in the umbilical cord, provide the embryo with nourishment from the mother and waste disposal.

6) The cells then go through morphogenesis, a process of differentiation in which cells are organized into specific structures. Cells divide into three basic layers: ectoderm, mesoderm, and endoderm.

(a) Ectoderm
    (1) Brain and other parts of the central nervous system
    (2) Skin, hair, wool, and hooves
    (3) Certain endocrine glands
(b) Mesoderm
    (1) Voluntary muscle tissue
    (2) Involuntary muscle tissue (heart)
    (3) Circulatory system
    (4) Connective tissue - bone, cartilage, ligaments, and tendons
(c) Endoderm
    (1) Liver
    (2) Digestive system
    (3) Other endocrine glands

7) Body organs develop in a specific sequence. The head is formed before the tail, and the beginning of the spinal cord is formed before other organs.

8) The rate of prenatal growth in animals livestock varies among species due to the varying lengths of gestation. Although the rate of prenatal growth varies, most young are born at the same stage of maturity.

TABLE 4.1 - Timetable of calf development

	Time (days)	Development
First trimester	0	Fertilization in oviduct
	4	Embryo (in eight- to 16-cell stage) reaches uterus.
	8-11	Embryo transfer possible
	12	Embryo forms weak attachment to uterine wall
	18	Amnion encloses embryo.
	21	Heart begins to beat; reproductive tract begins to develop.
	23	Head region is recognizable.
	25	Forelimb buds appear.
	30	First placental plates appear.
	33	Fragile cotyledonary attachment forms.
	37	Facial features appear.
	46	Developing animal is now a fetus.
	60	Eyelids able to close.
Second trimester	100	Horn pits appear.
	110	Tooth development begins.
Third trimester	230	Hair covers the body.
	283	Birth

2. Discuss how egg incubation is similar and different from the gestation of other livestock.

Describe the developmental stages of the embryo (egg) and hen during incubation.

a) In birds, the process of incubation (causing something to develop or take form) corresponds to gestation in mammals.

b) Terms
   1) Amnion - the sac that surrounds the embryo
   2) Chorion - the lining between the egg shell and the internal portion of the egg
   3) Allantois - part of an egg which stores excretory wastes; fills the space between the amnion and the chlorion

c) When fertilization occurs in poultry, the embryo begins development around a well-defined germinal disk. This area is clearly visible to the naked eye when a freshly laid, fertilized egg is broken.

d) Within 48 hours after fertilization, a chick embryo establishes an intricate blood circulation system between itself and the life-sustaining yolk. Since there is no placenta, as in mammals, the poultry embryo has to depend on this intricate blood vessel network to provide nutrients and remove wastes.

e) By the end of the third day, the embryo has a full set of membranes. The allantois, which stores excretory wastes, fills the space between the amnion and the chorion.

f) The allantois then merges with the chorion to form the chorio-allantois, which expands and contacts the shell membrane. The chorio-allantois serves as the respiratory organ for the developing embryo until the pulmonary organ takes over about 24 hours after hatching.

g) The shell and the membranes also protect the developing embryo from harmful microorganisms or molds.

h) The embryo floats within the fluid in the amniotic cavity. The developing embryo (chick) is protected by this floating movement, which must continue until the last 3-4 days before hatching. Without the movement, malformations can occur that endanger the life of the newborn chick.

i) In an incubator, the egg must be turned several times a day to prevent adhering of the embryo to the chorio-allantois membrane. In nature, the hen instinctively shifts the egg several times a day.

j) Physical factors necessary for incubation and hatching
   1) Temperature - Outside the incubator, store the eggs for a maximum of seven days at 60°F. This allows for development processes to continue without adverse effects after the eggs are placed in the incubator. Maintain a temperature range of 98-104°F within the incubator.
   2) Humidity - Since the egg is approximately 70 percent water, it is important to maintain a certain humidity to prevent water loss. Pre-incubation storage of hatching eggs should be at 85 percent humidity and 60-65 percent humidity during incubation.
   3) Air velocity - A constant supply of fresh air is necessary for the developing embryo.
   4) Energy supply

TABLE 4.2 - Timetable of chick development

Time (days)	Development
3	Blood circulation between embryo and yolk is established.
5	Sex can be determined.
8	General outline is recognizable.
8-9	Lungs, nervous, muscular, and sensory systems are in place.
10-11	Embryo is covered with down and first feathers.
21	Hatching occurs.

3. Discuss how the nutritional requirements change during gestation. Relate back to Unit I - Nutrition.

What are the nutritional requirements during the different stages of pregnancy and lactation?

a) Cattle
   1) The period during which the calf crop is affected most by nutrition extends from 30 days before calving until 70 days after calving.
   2) The nutritional needs of nursing cows are greater and more critical than those of pregnant cows. After a cow calves, her energy needs jump about 50 percent; her protein needs double; her calcium and phosphorus needs triple.
   3) During the last three months of pregnancy, the nutritional requirements are higher than for an open female because of the requirements of the growing fetus.

b) Sheep (Goats)
   1) Pregnant ewes - In general, feeding a suitable, well-balanced ration with necessary minerals and vitamins will ensure a strong, healthy lamb crop.
   2) During the last 4-5 weeks of pregnancy, the fetus develops rapidly, and the demands on the ewe are heavy. Ewes should be fed 0.5-1 pounds of grain per head daily during this period.
   3) Lactating ewes - Following lambing, the feed allowance of the ewe should be increased according to her capacity and needs. Though varying somewhat with size and condition of the ewe (and whether she is raising twins or a single lamb), an adequate ration could consist of 4 lbs. of high-quality alfalfa hay plus 1-2 lbs. of grain daily.

c) Swine
   1) Pregnant sows - Approximately two-thirds of the fetal growth occurs in the last month. During gestation, it is important that body reserves be stored for lactation. Feed should be increased to 4-5 lbs. per day.
   2) Sows should not be overfed because fat sows have farrowing difficulties. Four to five days before farrowing, it is a good practice to decrease feed intake and feed a bulky, laxative feed.
   3) Lactating sows - The nutrient requirements of a lactating sow are more rigorous than those during gestation. The lactating sow should be fed 2.5-4.5 lbs. daily for each 100 lbs. of body weight.

F. Other activities

1. Obtain an incubator for poultry eggs. Buy some fertilized eggs and keep them until hatching occurs. Until hatching time, have students chart what should be occurring each day of incubation.

2. Track the development of the fetus and mother of someone's SAE project.

G. Conclusion

Although gestation periods of various species of livestock differ, the stages of fetal growth and the effects of gestation on the mother are very similar. The growth of the fetus is just more rapid when the length of gestation is shorter. To ensure a safe pregnancy and healthy offspring, it is important to make management changes that relieve stresses placed on the mother during gestation.

H. Competency

Sequence the fetal developmental stages of livestock

Related Missouri Core Competencies and Key Skills

10B-4: Describe the structure and function of (human) reproductive organs
10C-7: Sequence the developmental stages of the (human) fetus

I. Answers to Evaluation

1. a
2. c
3. b
4. d
5. a
6. b
7. c
8. Temperature, humidity, air velocity, energy supply

UNIT III - REPRODUCTION Name_____

Lesson 4: Fetal Development Stages Date_____

EVALUATION

Circle the letter that corresponds to the best answer.

1. What does the ectoderm develop into?

   a. Brain
   b. Digestive system
   c. Liver
   d. Connective tissues

2. The mesoderm develops into the _____.

   a. Digestive system
   b. Hair, skin, and hooves
   c. Connective tissue
   d. Brain

3. What does the endoderm develop into?

   a. Involuntary muscle tissue
   b. Liver
   c. Connective tissue
   d. Brain

4. When does the female require the most nutrition?

   a. Breeding
   b. Gestation
   c. Grazing
   d. Lactation

5. The sac surrounding the embryo within an egg is called the _____.

   a. Amnion
   b. Placenta
   c. Chorion
   d. Allantois

6. The placenta of sheep, cattle, and horses attaches to the uterus at points called _____.

   a. Allantois
   b. Cotyledons
   c. Oviduct
   d. Mesoderm

7. Which pregnant females benefit from a decrease in feed intake for the last 4-5 days before giving birth?

   a. Sheep
   b. Goats
   c. Swine
   d. Cattle

Complete the following short answer questions.

8. List the four physical factors that limit the incubation and hatching of eggs.

   a.

   b.

   c.

   d.

UNIT III - REPRODUCTION

Lesson 5: Effects of the Environment on Reproduction

Objective: The student will be able to identify the effects of the environment on the reproductive cycle of breeding stock.

Study Questions

1. **How does nutrition and body condition affect the reproductive cycle?**
2. **How does the photo period affect different species of livestock?**
3. **How does temperature affect the reproductive cycle?**

References

1. Student Reference
2. Body Condition Poster. Columbia, MO: Feed Division, MFA, Inc.

UNIT III - REPRODUCTION

Lesson 5: Effects of the Environment on Reproduction

TEACHING PROCEDURES

A. Review

Review previous lesson on fetal development stages in livestock

B. Motivation

Ask students if plant growth is affected by the photo period, environmental conditions, and fertilization requirements. Well, animals are affected by the same three factors. Both plants and animals are affected by the length of daylight hours. Like plants, animals that do not receive the correct amount of nutrients have reproductive (growth) problems. Finally, plant growth is greatly influenced by extreme heat, cold, lack of water, and excess water. Like plants, livestock reproductive difficulties become more apparent during extreme environmental conditions. If animals cycle naturally and receive adequate nutrition and temperature, they will also reproduce abundantly.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss why body condition and nutrition are important factors in animal reproduction. Use the body condition chart from MFA to illustrate different levels of conditioning.

How does nutrition and body condition affect the reproductive cycle?

a) How nutrition affects reproductive failure in females
   1) Nutrition is related to several reproductive difficulties, which are more prominent in younger females than in more mature females.
      (a) Once the breeding season begins, a small percentage of females come into their heat period in the first 21 days after giving birth, which results in a longer calving season.
      (b) A lower percentage of females conceive on the first service by the sire, which also results in a longer calving season and more unproductive days.
      (c) A higher percentage of calf deaths at birth and within the first two weeks causes extreme losses for that year.
   2) All these difficulties can be prevented through a proper diet. Livestock producers must be aware of the nutritional requirements for females during lactation, gestation, and the pre-breeding period.
   3) Flushing is a nutritional technique used by swine and sheep producers to prepare breeding stock for the breeding season. Flushing keeps sows and ewes on a full feed ration to allow the body and reproductive tract to build back up before the next breeding. If this method is used, reproductive problems associated with nutrition will be reduced.
   4) Nutrition is critical during the 100-day pre-birth period. Most reproductive failures are caused by deficiencies in one or more nutrients during the pre-birth 100-day period and the days immediately following birth. During this period, conception rates and calving deaths are determined for the next breeding season.

5) Research on animal reproduction problems shows significant breakthroughs.
   (a) Energy is more vital than protein when it comes to reducing reproductive problems.
   (b) Livestock receiving inadequate levels of energy reproduce at a lower level.
   (c) Low phosphorus diets decrease calf crop.
   (d) Supplements of vitamin A to bred heifers on a dry forage diet will increase calf crop.
   (e) The amount and type of feedstuffs fed before and after calving determine conception rate and proper timing of heat periods for the next breeding season. Feed requirements increase after calving, so feeding allowances must parallel this need. If this does not occur, the female will have severe weight loss, which will delay heat cycle and decrease conception rate.
   (f) The condition of the female also has an effect on reproductive difficulties. The poorer her condition, the greater the reproductive difficulties become.
   (g) An average conditioned cow should gain a minimum of 100 lbs. during gestation. After calving, an average conditioned cow should gain ½ to ¾ lb. daily to build up reserves for next breeding season.
      (1) A thin cow should also have a 100 lb. minimum gain during gestation. After calving, a thin cow should gain 1½ to 2 lbs. daily to build up reserves for next breeding season.
      (2) Nutrition should not be ignored during gestation and after giving birth. A proper diet during these periods will produce healthier calves, lower mortality rates, quicker breed back, and longer female productive life. These procedures also apply to other classes of livestock.

6) In prepubertal females, a restricted or nutrient-lacking diet can delay puberty or cause hypoplasia. Hypoplasia is the defective or incomplete development of reproductive organs, which usually accounts for reproductive organs remaining below normal size.
   (a) Nutritional disorders can be detected in females by lack of an estrous cycle or signs of puberty.
   (b) Nutritional disorders can be solved through proper diets. If caught in time and started on a proper diet, prepubertal females with a delayed puberty can resume normal growth in reproductive organs.

b) How nutrition affects reproductive failure in males
   1) Reproductive failures due to nutritional disorders have greater effects on younger bulls than more mature sires. Older sires can manage for a year on a poor or deficient diet without decreasing sperm numbers. Older sires use body reserves to maintain proper sperm production.
   2) Younger or prepubertal sires can be greatly influenced by improper nutritional diet. A poor diet can delay puberty and can be fatal if the nutrient deficiency is extreme enough. A nutritional deficiency in younger sires can cause irreparable damage if continued for long periods of time. This damage results in reduced testes size, low sperm production, and slow sperm replenishment.

2. Ask students to describe photo period and how it affects reproduction in livestock.

How does the photo period affect different species of livestock?

a) Photo period refers to the length of daylight hours in a day. Like plants, animals are influenced by the hours of light. Imported livestock breeds had to adjust to their new environment's photo period. Sometimes, these new breeds never adjusted to their new environment and they could not reproduce in this country.

b) The photo period affects different species of livestock.
   1) Cattle are considered continuous breeders. Most beef producers aim for calving during September, October, and November, so the breeding season is during the months of January, February, and March.
   2) Swine are also continuous breeders. For this reason, most confinement pork producers plan breeding systems to keep their farrowing houses full year-round. For producers farrowing twice a year, breeding systems are more influenced by heat, funds available, and available feeds, not by photo period. Feed costs aren't significant in breeding swine since they are continually fed.
   3) Sometimes, horses are considered continuous breeders. The breed has a greater influence on the reproductive cycle than the photo period, since most equine breeds originated overseas. Horses do show more sexual activity during the spring months, however.
   4) Sheep are not considered continuous breeders, but some sheep breeds can produce more than one lamb crop per year. Generally, the sheep breeding season is stimulated by the photo period. Estrous cycles usually begin in September and end in March. The Dorset breed has the longest breeding season, which begins in June and ends in April, allowing for two lambing seasons. Sheep are heavily influenced by the shortening of day hours.
   5) The early ancestors of poultry only laid eggs in the spring months. Through selection and improved management techniques, poultry now lay continuously. Photo period has the greatest influence on poultry because the bird's optic nerve is sensitive to light intensity. When light intensity increases, activity in the pituitary gland increases. The increased pituitary gland activity continues hormone production, which stimulates the reproductive cycle. Continual light in hen houses is the sole reason for continuous laying by hens.

3. Ask students if they know of other factors affecting the reproductive cycle in livestock.

How does temperature affect the reproductive cycle?

a) In the female
   1) Heat stress affects female reproductive cycle in many ways. Extreme heat can delay the estrous cycle in many classes of livestock, especially sheep. Sheep have a limited breeding season and do not show external signs of the estrous cycle during the hot summer months. Sheep do not begin showing signs of heat until late summer and early fall months.
   2) Extreme heat also influences offspring weights at birth. Extreme heat causes the female to expel more energy for cooling instead of using that energy for the offspring, which creates low birth weights. Extreme heat causes a lack of appetite in animals, which decreases feed intake, which reduces the amount of nutrients going toward the offspring.
   3) During the last trimester, extreme heat conditions can be detrimental. These extreme heat conditions cause abortions, fetal deaths, low birth weights and litter sizes, and abnormality in offspring.
   4) Placenta size is reduced under extreme heat conditions, which can cause birthing difficulties.
   5) Extremely cold temperatures usually do not have the same impact on reproduction. When extremely cold temperatures do occur, usually the only result is a lower birth weight. During extreme cold temperatures, the female uses more energy to control body temperatures.
b) In the male
   1) Environmental conditions affect reproduction in the male, but to a lesser degree. A fluctuation of testosterone production does not occur during extreme heat

conditions, but there is a fluctuation in sperm production and increased sperm abnormalities. Seasonal variations in sperm production have little effect on the reproduction efficiency of sires.

2) The number of females serviced during extreme heat is decreased because sires become exhausted more quickly.
3) Extreme cold temperatures usually do not affect male reproduction because most breeding seasons do not occur during these periods.

F. Other activities

1. For Body Condition Posters, contact:

Feed Division, MFA Agri Services
615 Locust
Columbia, MO 65201
573/876-5244

2. Have students set up a breeding schedule for each class of livestock considering the factors of photo period, nutrition, and environmental conditions.

G. Conclusion

For people associated with livestock production, it is vital to have a good knowledge of factors influencing the reproductive cycle. The maximum number of offspring results in more profits for the operation. Knowing that nutrition, photo period, and environmental conditions influence livestock reproduction will greatly improve monetary success for a producer.

H. Competency

Describe the effects of the environment on the reproductive cycle.

Related Missouri Core Competencies and Key Skills

10A-7: Describe the significance of the light and dark phases of photosynthesis

I. Answers to Evaluation

1. Photo period
2. Younger, older
3. Lower
4. Optic nerve
5. Poultry, sheep
6. Pituitary
7. Abnormalities
8. Swine, cattle
9. Energy, protein
10. Puberty
11. a, c, g (question worth 7 points)
12. a, d, e, f (question worth 6 points)

UNIT III - REPRODUCTION Name_____

Lesson 5: Effects of the Environment on Reproduction Date_____

EVALUATION

Fill in the blank with the best answer.

1. The amount of daylight hours is called the _____.

2. Reproductive difficulties created by nutrition are more predominant in _____ females than _____ females.

3. If nutritional deficiencies are present in the diet, a _____ percentage of females conceive on the first service by the sire.

4. In poultry, the _____ is responsible for detecting light intensity.

5. The two classes of livestock that are influenced the most by the amount of daylight hours are _____ and _____.

6. In poultry, increased light intensity increases activity in the _____ gland.

7. Extreme heat periods increase sperm _____ in the testes of the male.

8. Because their estrous cycles continue throughout the year, _____ and _____ are considered to be continuous breeders.

9. When reducing reproductive problems in gestating females, the nutrient _____ is more vital than the nutrient _____ when figuring rations.

10. A poor nutritional diet can delay _____ in young females.

Complete the following multiple answer questions.

11. Check all the factors associated with extreme heat and reproductive problems in female livestock.

    ____ a. Can delay the estrous cycle
    ____ b. Can advance the estrous cycle
    ____ c. Can reduce birth weights
    ____ d. Can increase placenta size
    ____ e. Affects the first trimester more than the last trimester
    ____ f. Affects the second trimester more than the last trimester
    ____ g. Can increase the number of abortions

12. Check all the factors describing ways nutrition can affect reproductive problems in livestock.

____ a. Low phosphorous diets decrease calf crop.
____ b. Vitamin C supplements to bred heifers on dry forage diets increase calf crops.
____ c. Protein is more vital than energy in reducing reproductive problems.
____ d. A poorly conditioned female will have greater reproductive difficulties.
____ e. Feed requirements increase after calving.
____ f. An average conditioned cow should gain a minimum of 100 lbs. during gestation.

UNIT III - REPRODUCTION

Lesson 6: Management and Technology in Reproduction

Objective: The student will be able to describe management and technology utilization to affect the reproductive cycle of livestock.

Study Questions

1. **What is artificial insemination (AI) and why is it important?**
2. **What is estrous synchronization and why is it important?**
3. **What products are available for estrous synchronization?**
4. **What is embryo transfer (ET) and when should it be utilized?**
5. **What is sexing semen and what is its economic importance?**
6. **What is cloning?**

References

1. Student Reference

UNIT III - REPRODUCTION

Lesson 6: Management and Technology in Reproduction

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

1. Work with a local veterinarian and producer to get a semen sample from a local producer's bull. Bring in the semen sample and prepare slides for your class to view under a microscope.

2. Bring in samples of products used for estrous synchronization. Discuss uses of the products.

3. Bring in AI tools and possibly a reproductive tract or model cow to demonstrate the techniques.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students to explain AI's purpose and on which animals it might be used.

What is artificial insemination (AI) and why is it important?

a) Introduction of male reproductive cells (sperm) into the reproductive tract of a female by artificial means
b) History of AI
   1) The origin of AI is unclear, but an Arabian legend dating to 1322 maintains that the method was first used by a chieftain who had stolen the "seed" of an enemy's stallion to deposit into his own mare.
   2) The first recorded scientific research in AI of domestic animals was done on dogs by an Italian physiologist in 1780. By the late 1800s, American veterinarians used it to get mares in foal that consistently did not settle by natural methods.
   3) Today, AI is used extensively in the U.S. in many species of livestock. However, the greatest use of AI is in the dairy industry.
c) Benefits of using AI
   1) Increased uniformity
   2) Economics
   3) Better health protection (no venereal contact)
   4) Improved herd records
   5) Shorter time turnaround
d) Limitations of AI
   1) Training needed
   2) Inferior genetic traits perpetuated, as well as superior ones
   3) Some potential for abuse
   4) Requires more time and management
e) Two methods of semen collection
   1) Artificial vagina

2) Electrical stimulation in conjunction with the artificial vagina

f) Semen processing
   1) Testing semen
      (a) Semen density is tested to estimate the number of sperm in the semen.
      (b) Semen is examined under a microscope to determine mobility. If 80 percent or more of the sperm move, the "percent mobility" is good.
   2) Extending semen
      (a) Millions of sperm are ejaculated by the male at mating. An ejaculation can now be extended or diluted (so that many more females can be bred with it). This is accomplished by adding materials to the semen that help keep the sperm alive and increase the volume.
      (b) Common extenders are listed in Table 6.1.

TABLE 6.1 - Semen Extenders

Type of diluent	Animals used for
Egg-yolk citrate	Bull, ram
Egg-yolk phosphate	Bull, ram, stallion
Homogenized milk	Bull, ram, boar
Glycine-containing diluents	Boar

g) Storing semen
   1) After special treatment of semen with extenders, the sperm can withstand freezing to extremely low temperatures. Bull semen is generally frozen, while boar semen is used fresh because boar semen will not survive the freezing/thawing process.
   2) The basic unit for semen storage and shipment is an individual plastic straw containing just enough semen for a single insemination. Each straw is identified with the sire's name and registration number.
   3) Semen is frozen using liquid nitrogen or dry ice in an alcohol bath. Liquid nitrogen is maintained at -320°F in a semen tank, and the semen is stored there until used for breeding.

h) General management practices
   1) Avoid breeding diseased or infected females.
   2) Have a veterinarian examine females that have been bred two or more times without conception.
   3) Wait at least 60 days after calving to breed cows back.
   4) Sows should be bred back 35-50 days after farrowing.
   5) All semen collection equipment should be clean and sterile.

i) AI use in cattle
   1) Timing of insemination
      (a) Generally, good conception rates for cattle herds are achieved by inseminating 12 hours after standing heat.
      (b) Ovulation occurs 12 hours after estrous is completed; inseminate during ovulation.
   2) Insemination techniques
      (a) After properly thawing the semen and loading the gun, the insemination gun is inserted with the tip upward at a 30° angle into the vagina. This angle keeps the gun from entering the urethra.
      (b) After the gun is inserted into the vagina, place a gloved hand into the anus of the cow to direct the gun.
      (c) Direct the gun tip through the vagina and into the cervix. Inserting the gun into and through the cervix can be difficult. If the opening of the cervix is

difficult to locate, straddle the cervix with the first two fingers of the gloved hand. Pin the cervix to the floor of the pelvis and locate the opening of the cervix with the thumb.

(d) Bring the tip of the gun up until it strikes the thumb. Insert the gun into and through the cervix by using light but steady forward pressure.

(e) The cervical channel consists of three cartilage-type rings. Hold the cervix with the gloved hand until the gun has worked through the three rings.

(f) After passing through the three rings of the cervical channel, the gun will slip forward with little resistance. When this happens, the tip of the gun will be in the uterine body. Since the uterine wall is thin, you should be able to feel the tip of the gun with the gloved hand.

(g) Insert the gun 2" into the cervix; otherwise, the semen is deposited in one uterine horn instead of both.

(h) Take about five seconds to deposit the semen slowly. Then, slowly pull the gun from the tract and clean the equipment.

j) AI in horses

1) Timing of insemination

(a) A mare's heat period lasts 2-10 days.

(b) The egg ovulates 1-2 days before the end of the heat period.

2) AI has become popular for use in horses, although fresh semen is required by many breed associations.

3) Normally, breed associations will not accept registration for foals conceived from frozen semen.

4) When AI is used, a syringe is attached by a rubber adapter to a disposable insemination tube.

5) Using a sterile sleeve glove, the inseminating tube is inserted directly into the vagina. Then the gloved fingers open the cervix and pass the rod into the uterus to place the semen directly into the uterus.

k) AI in sheep

1) AI is not widely used outside of research for sheep

2) In sheep, AI has taken longer to develop for the following reasons.

(a) There are no reliable indicators of the onset of heat in ewes.

(b) The ewe has a small and highly folded cervix, making it difficult to deposit semen directly into the uterus

(c) No suitable long-term storage method has been developed for ram semen.

(d) No method has been developed for identifying greatly superior sires.

(e) Conception rates from a single insemination are not high enough to produce an adequate lamb crop.

(f) The additional labor requirements for AI economically outweigh its benefits.

l) AI in swine

1) Timing of insemination

(a) The average length of the heat period is 2-3 days, but gilts' heat periods are usually slightly shorter than those of sows.

(b) Ovulation occurs 36-40 hours after the onset of heat. Even with daily observation, it is difficult to know precisely when the first standing heat occurs.

(c) Rule of thumb: Breeding should take place about 12 hours after observing heat and at 24-hour intervals for as long as the female will stand.

(d) Higher conception rates and larger litter sizes result from at least 2-3 services.

2) AI techniques

(a) Confine the female in a small pen.

(b) Put about 100cc of extended semen in a 4 oz. squeeze bottle with a cone-shaped tip.

(c) Place a few drops of lubricant on the tip of the spirette. Insert the tip into the vulva, pointing it toward the backbone at a 45° angle to avoid the opening of the urethra. The cervix is usually 8-10" inside the vulva.
(d) When the cervix is located, start rotating the catheter counterclockwise until it becomes "locked" into the cervix.
(e) When the spirette is in place, connect the semen container and begin squeezing the semen through the spirette. If the semen starts to run out of the vulva, release pressure, wait a few moments, and start again.
(f) When finished, remove the catheter and clean equipment.

3) Problems of using frozen semen in swine
(a) On the average, conception rates with frozen semen are 10-20 percent lower than those obtained with the use of freshly collected semen.
(b) Also, litter sizes show a reduction of one pig per litter with the use of frozen semen.

m) AI in poultry (turkeys)
1) Natural mating in broad-breasted turkeys generally results in low fertility rates.
2) More than 90 percent of U.S. turkey breeders use AI with natural mating.
3) The insemination is done with a syringe.

2. Ask the students what they know about estrous synchronization. Relate back to the motivation. When it would be used?

What is estrous synchronization and why is it important?

a) For AI and embryo transfer, it is important to have a large number of females in estrous at the same time--hence the term synchronization of estrous.
b) Importance of controlling estrous cycles
1) Horse breeders often strive to breed their mares so that they foal shortly after January 1.
2) Swine and sheep breeders try for two crops of offspring per year.
3) In all species, it is desirable to shorten the period from the birth to the conception of the next offspring.
4) With AI, breeding more females at one time cuts down on labor costs.

3. Show the students various products used for estrous synchronization.

What products are available for estrous synchronization?

a) Hormonal control of heat
1) Progestogens - These compounds mimic the hormone progesterone, which controls the timing of estrous.
2) Prostaglandins - These hormone-like substances cause blood levels of progesterone to fall, which induces estrous within 2-4 days.
b) Human Chorionic Gonadotropin (HCG) - This hormone, which has been used with some success in horse breeding, stimulates follicles to ovulate.
c) Synchro-Mate B® (SMB) - This is a trade name for an estrous synchronization product that was approved by the FDA in 1982. It contains Norgestomet®, a patented, potent, synthetic progestin, and estradiol valerate, a synthetic estrogen. SMB, which is used as an ear implant, is designed to cause cows and heifers to ovulate in a predictable period of time.
d) MGA (melengestrol acetate) - This synthetic progesterone suppresses heat in feedlot heifers. A drawback of MGA is that FDA approval is pending. Research has shown that a combination of MGA and prostaglandins can make estrous synchronization practical for cattle producers. Feeding MGA to heifers for 14 days and then following up 16-18 days

later with an injection of prostaglandin has resulted in a majority of the heifers coming into heat within five days.

4. Discuss the procedures performed to capitalize on genetically superior stock.

What is embryo transfer (ET) and when should it be utilized?

a) Embryo transfer (ET) is the placing of an embryo into the lumen of the oviduct or uterus.
b) History of ET
    1) In cattle ET was developed as a result of research done by Jim Rowson at Cambridge, England, in the early 1950s. The earliest work was done with sheep, then cattle and hogs.
    2) The first commercial transfers were done in the U.S. in the early 1970s.
c) Steps of ET for cattle
    1) Synchronization of estrous in donor and recipient cows
    2) Superovulation of the donor cow
    3) Breeding the donor cow
    4) Recovering the embryos from the donor cow 6-10 days after breeding
    5) Isolating and characterizing each embryo
    6) Transferring healthy embryos to the recipient cows
d) Recipient pregnancy determined in about 35 days
e) No genetic influence from recipient cows on the calves they carry
f) Advantages of ET
    1) Increases the reproductive potential of superior females
    2) Increases rate of genetic improvement in herd

5. Discuss what type of heifer calves a dairy producer wants. What if a procedure could be used to choose the sex of calves?

What is sexing semen and what is its economic importance?

a) Sexing semen determines if the semen contains the X or Y sex chromosome. If the semen contains the X chromosome, it will produce a female; if the semen contains the Y chromosome, it will produce a male.
b) Obtaining semen that has been sexed has great economic importance. Because the dairy producer has little use for most bull calves, the use of sexed semen to produce only females makes milk production more efficient. Swine producers could market more pork if they could only produce females because females grow faster than males. The opposite is true in beef cattle and sheep breeds, where more males are desired unless trying to produce replacement females.
c) Semen is sexed by the amount of DNA present on X and Y chromosomes. DNA content of the Y chromosome contains less DNA than the X chromosome.

6. Discuss the political and economic ramifications of cloning.

What is cloning?

a) Cloning of an animal is the production of an exact genetic copy.
b) Cloning is usually the result of splitting embryos, which produce genetically identical twins.

F. Other activities

1. Bring in a semen sample, either fresh or frozen, and view it under a microscope.

2. With materials for a semen test from the local veterinarian, perform a semen test in class.

3. Bring in a cow model or actual reproductive tract to demonstrate AI techniques.

4. Show the videos, *Embryo Transfer of Beef and Dairy Cattle* (13 min., AG video 177) and *Artificial Insemination of Beef and Dairy Cattle* (10 minutes, AG video 178), available from the Missouri Vocational Resource Center.

G. Conclusion

There are many management and technological techniques to control or manipulate an animal's reproductive cycle. All of the techniques need to be carefully analyzed before a producer decides whether to use any of them.

H. Competency

Describe how management and technology are utilized to affect the reproductive cycle.

Related Missouri Core Competencies and Key Skills

10C-4: Associate the roles of genetic variation and natural selection with change in organisms over time.

I. Answers to Evaluation

1. a, c, e (question worth 7 points)
2. a, d, f, g, i (question worth 10 points)
3. b, c (question worth 6 points)

4. Two of the following:
   a) Breed more females per day
   b) Shorten time period for rebreeding
   c) Helps provide two offspring crops a year in swine and sheep operations
   d) Helps mares foal close to Jan. 1

5. Two of the following:
   a) HCG (Human Chorionic Gonadotropin)
   b) SMB (Synchro-Mate B®)
   c) MGA (melengestrol acetate)

6. b
7. c
8. c
9. b

UNIT III - REPRODUCTION

Name_____

Lesson 6: Management and Technology in Reproduction

Date_____

EVALUATION

Complete the following multiple answer questions.

1. Check the advantages of using artificial insemination in livestock.

___a. Reduction of reproductive diseases
___b. Reduction of respiratory disease
___c. Improved herd records
___d. Reduction of records kept
___e. Increased uniformity in herd
___f. Costs of semen and services exceed the value of progeny.
___g. Reduction in technical assistance in breeding program

2. Check the disadvantages of using artificial insemination in livestock.

___a. An increase in management skills
___b. A reduction in management skills
___c. Requires less time
___d. Requires more time
___e. A reduction in technical assistance in breeding program
___f. An increase in technical assistance in breeding program
___g. Subject to abuse, like improper labeling
___h. Reduces the occurrences of abuse
___i. Negative traits are perpetuated more rapidly.
___j. Reduces reproductive diseases

3. Check the advantages of embryo transfer.

___a. Increased calving rate of cows in herd
___b. Increased number of calves produced by superior female
___c. Increased rate of genetic improvement in herd
___d. Increased costs in breeding program
___e. Reduction in costs in breeding program
___f. Reduction in technical assistance in breeding program
___g. An increase in technical assistance in breeding program

Complete the following short answer questions.

4. What are two advantages to synchronizing estrous in animals?

a.

b.

5. List two products used for estrous synchronization.

   a.

   b.

Circle the letter that corresponds to the best answer.

6. Who is believed to have performed artificial insemination first?

   a. U.S. physiologist on cattle
   b. Arabian chief on his prized mare
   c. Farmer in rural England
   d. Ancient Turkish chief on his prized mare

7. Which ingredient is NOT included in semen extenders?

   a. Egg yolk
   b. Milk
   c. Mayonnaise
   d. All of the above

8. Sexing semen can be done because of the differing amounts of _____ found in X and Y chromosomes.

   a. RNA
   b. Genes
   c. DNA
   d. Protein

9. How is cloning most commonly accomplished?

   a. Sexing semen
   b. Splitting embryos
   c. Splitting chromosomes
   d. Synchronizing estrous