Instructor Guide

ANIMAL SCIENCE

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FOREWORD

Development of this *Animal Science* unit is the result of MVATA Teaching Aids Committee suggestions. The unit was developed to enhance curriculum for 11th and 12th grade agriculture students. Depending on local need, an Animal Science course could replace traditional advanced production course(s).

This instructor guide and the corresponding student reference contain 30 lessons grouped into four units: Nutrition, Genetics, Reproduction, and Animal Health. Transparency masters and activity sheets have been included where appropriate. Check the Table of Contents for a detailed listing of lessons. Additional student reference copies can be purchased separately.

In an effort to provide challenging test questions that reduce guesswork, multiple-choice questions with multiple answers have been included in some of the lesson evaluations. When scoring this type of question, each possible response can be worth one point. Of course, it is the teacher's option to increase the weight of a question, if desired.

During the summer of 1981, the Missouri State Board of Education formally adopted the concept of "Instructional Management Systems" (IMS) as a priority for the 1981-82 school year. The Missouri Commissioner of Education described the IMS concept as a practical way of "organizing for excellence" in education. To meet the demand for greater productivity and accountability, the director of Vocational Education applied the elements of IMS to form the Vocational Instructional Management System (VIMS). The VIMS process provides a framework to use in planning and organizing to assure excellence in Missouri's vocational education system by focusing greater attention on the management of teaching and learning.

This guide incorporates the needed component parts to aid agriculture teachers in the implementation of VIMS. For ease of use, performance objectives and competencies have been included at the beginning of the guide, as well as incorporated within each lesson. A competency profile has been provided in the front of the guide for convenient record keeping.

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OBJECTIVES

Unit I - Nutrition

1. The student will be able to identify the importance of nutrition in livestock.
2. The student will be able to compare and contrast the different digestive systems in livestock.
3. The student will be able to describe the function of energy in livestock nutrition.
4. The student will be able to describe the function of protein in animal nutrition.
5. The student will be able to describe the function of minerals in animal nutrition.
6. The student will be able to describe the function of vitamins in livestock nutrition.
7. The student will be able to understand the function of water in animal nutrition.
8. The student will be able to determine the environmental effects on animal nutrition.
9. The student will be able to formulate a ration for livestock at the teacher's discretion.

Unit II - Genetics

1. The student will be able to describe the importance of an animal's genetic makeup and its effect on agriculture.
2. The student will be able to describe and identify basic building blocks of animal genetics.
3. The student will be able to describe and understand the process of animal cell division.
4. The student will be able to explain and apply the basic principles of genetics.
5. The student will be able to describe the use of selection tools for genetic improvement of the beef herd.
6. The student will be able to use various selection tools and develop a plan to genetically improve dairy cattle.
7. The student will be able to use selection tools for genetic improvement of the sheep flock.
8. The student will be able to describe and choose selection tools to improve a swine operation genetically.

Unit III - Reproduction

1. The student will be able to identify the importance of reproduction in livestock production.
2. The student will be able to describe the hormonal systems in livestock production.
3. The student will be able to understand and describe the reproductive cycles of common production livestock.
4. The student will be able to sequence the fetal development stages of livestock.
5. The student will be able to identify the effects of the environment on the reproductive cycle of breeding stock.
6. The student will be able to describe management and technology utilization to affect the reproductive cycle of livestock.

Unit IV - Animal Health

1. The student will be able to understand the significance of animal health in livestock.
2. The student will be able to describe aspects of the immune system of livestock.
3. The student will be able to understand and describe the diseases of the respiratory system affecting livestock.
4. The student will be able to describe the diseases of the GI tract in livestock.
5. The student will be able to understand and describe the diseases of the reproductive system in livestock.
6. The student will be able to describe the external and internal parasites of livestock and poultry.
7. The student will be able to understand and describe animal health quality assurance programs.

COMPETENCIES

Unit I - Nutrition

1. Identify the importance of nutrition to agriculture
2. Compare and contrast the digestive systems of livestock
3. Describe energy's role in nutrition
4. Describe protein's role in nutrition
5. Describe minerals' role in nutrition
6. Describe vitamins' role in nutrition
7. Describe the role of water in nutrition
8. Describe environmental effects on nutrition
9. Formulate a ration for different classes of livestock

Unit II - Genetics

1. Describe the importance of genetics on agriculture
2. Describe the basic building blocks of genetics
3. Describe animal cell division
4. Describe basic principles of genetics
5. Describe selection tools for genetic improvement of beef
6. Describe selection tools for genetic improvement of dairy herds
7. Describe selection tools for genetic improvement of sheep
8. Describe selection tools for genetic improvement of swine

Unit III - Reproduction

1. Identify the importance of reproduction in livestock production
2. Describe the hormonal system in livestock reproduction
3. Describe the reproductive cycle of common production livestock
4. Sequence the fetal developmental stages of livestock
5. Describe the effects of the environment on the reproductive cycle
6. Describe how management and technology are utilized to affect the reproductive cycle

Unit IV - Animal Health

1. Identify the importance of animal health in livestock
2. Describe aspects of the immune system of domestic livestock
3. Describe the diseases of the respiratory system affecting livestock
4. Describe the diseases of the gastrointestinal tract in livestock
5. Describe the diseases of the reproductive system in livestock
6. Describe the major external and internal parasites of livestock
7. Describe animal health quality assurance programs

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1) *Horse Feeding and Nutrition* (AG SL 23)

2) *Cutting Costs . . . Pocketing Profits* (12 minutes)

3) *Profit by Using EPDs* (14 minutes, AG video 147)

4) *Cattle Breed Identification: Dairy* (21 minutes, AG video 220)

5) *Beef Reproduction II* (43 minutes, AG video 7)

6) *Embryo Transfer of Beef and Dairy Cattle* (13 minutes, AG video 177)

7) *Artificial Insemination of Beef and Dairy Cattle* (10 minutes, AG video 178)

8) *Cattlemen Care About Animal Welfare* (10 minutes, AG video 188)

9) *Cattlemen Care About Beef Safety* (12 minutes, AG video 190)

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2) GO2851: Health Hints for Your Horse

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Also included on this disc are the University Extension Directory for the University of Missouri System and the MU Center for Independent Study Course Catalog.

Minimum computer requirements are: IBM-compatible machine with 80386 or better processor, ISO 9660 compatible CD-ROM drive, Microsoft Windows 3.1, 4 megabytes of RAM, and at least 4 MB free space on the hard drive.

For the special academic price, call 800/292-0969 or write to Extension Publications, 2800 Maguire, University of Missouri, Columbia, MO 65211. E-mail can be sent to xplor@ext.missouri.edu.

6) The Agricultural Electronic Bulletin Board Service contains a wealth of information. It is available via modem call at 573/882-8289, 9600 baud, protocol N-8-1 or E-7-1.

CROSS-REFERENCE TABLE

Animal Science Competencies	Missouri Core Competencies and Key Skills for Science
Unit I - Nutrition	
1. Identify the importance of nutrition to agriculture	
2. Compare and contrast the digestive systems of livestock	
3. Describe energy's role in nutrition	
4. Describe protein's role in nutrition	
5. Describe minerals' role in nutrition	
6. Describe vitamins' role in nutrition	
7. Describe the role of water in nutrition	
8. Describe environmental effects on nutrition	
9. Formulate a ration for different classes of livestock	
Unit II - Genetics	
1. Describe the importance of genetics on agriculture	10C-1: Predict the phenotypic and genotypic ratios of the offspring of a dihybrid cross using a Punnett square 10C-4: Associate the roles of genetic variation and natural selection with change in organisms over time
2. Describe the basic building blocks of genetics	10B-1: Describe the functions of the organelles of a cell (cell wall, cell membrane, nucleus, ribosome, mitochondrion, chloroplastid, vacuole) 10B-3: Describe the structure and function of DNA 10D-8: Compare and contrast photosynthesis and cellular respiration
3. Describe animal cell division	10A-2: Distinguish between mitosis and meiosis 10B-1: Describe the functions of the organelles of a cell (cell wall, cell membrane, nucleus, ribosome, mitochondrion, chloroplastid, vacuole)
4. Describe basic principles of genetics	10C-1: Predict the phenotypic and genotypic ratios of the offspring of a dihybrid cross using a Punnett square 10C-4: Associate the roles of genetic variation and natural selection with change in organisms over time 10D-9: Analyze the risks and benefits of genetic engineering to society
5. Describe selection tools for genetic improvement of beef	
6. Describe selection tools for genetic improvement of dairy herds	10C-4: Associate the roles of genetic variation and natural selection with change in organisms over time 10D-9: Analyze the risks and benefits of genetic engineering to society

Animal Science Competencies	Missouri Core Competencies and Key Skills for Science
7. Describe selection tools for genetic improvement of sheep	
8. Describe selection tools for genetic improvement of swine	10C-4: Associate the roles of genetic variation and natural selection with change in organisms over time 10D-9: Analyze the risks and benefits of genetic engineering to society
Unit III - Reproduction	
1. Identify the importance of reproduction in livestock production	10B-4: Describe the structure and function of human reproductive organs
2. Describe the hormonal system in livestock reproduction	
3. Describe the reproductive cycle of common production livestock	10A-2: Distinguish between mitosis and meiosis 10B-4: Describe the structure and function of (human) reproductive organs
4. Sequence the fetal developmental stages of livestock	10B-4: Describe the structure and function of (human) reproductive organs 10C-7: Sequence the developmental stages of the (human) fetus
5. Describe the effects of the environment on the reproductive cycle	10A-7: Describe the significance of the light and dark phases of photosynthesis
6. Describe how management and technology are utilized to affect the reproductive cycle	10C-4: Associate the roles of genetic variation and natural selection with change in organisms over time
Unit IV - Animal Health	
1. Identify the importance of animal health in livestock	
2. Describe aspects of the immune system of domestic livestock	10C-2: Hypothesize how genetic resistance develops from continued exposure to pesticides or antibiotics
3. Describe the diseases of the respiratory system affecting livestock	
4. Describe the diseases of the gastro-intestinal tract in livestock	10B-5: Associate common human diseases with organs affected
5. Describe the diseases of the reproductive system in livestock	
6. Describe the major external and internal parasites of livestock	10A-6: Classify species associations into types of symbiosis: commensalism, mutualism, and parasitism
7. Describe animal health quality assurance programs	

SUGGESTED TEACHING CALENDAR
(in days, one period per day)

		DAYS
Unit I - Nutrition		**50**
1.	Importance of Nutrition to Agriculture	5
2.	Livestock Digestive Systems	7
3.	Energy's Role in Livestock Nutrition	7
4.	Protein's Role in Animal Nutrition	7
5.	Minerals' Role in Animal Nutrition	4
6.	Vitamins' Role in Animal Nutrition	5
7.	Water's Role in Animal Nutrition	5
8.	Environmental Effects on Nutrition	5
9.	Formulating and Blanacing Rations	5
Unit II - Genetics		**40**
1.	Importance of Genetics in Agriculture	4
2.	Basic Building Blocks of Genetics	7
3.	Animal Cell Division	5
4.	Basic Principles of Genetics	8
5.	Tools for Genetic Improvement of Beef	4
6.	Selection Tools for Genetic Improvement of Dairy Cattle	4
7.	Tools for Genetic Improvement of Sheep	4
8.	Selection Tools for Genetic Improvement of Swine	4
Unit III - Reproduction		**30**
1.	Importance of Reproduction in Livestock	6
2.	Reproductive Hormones	5
3.	Reproductive Cycles of Common Livestock	4
4.	Fetal Developmental Stages	4
5.	Effects of the Environment on Reproduction	5
6.	Management and Technology Effects in Reproduction	6
Unit IV - Animal Health		**50**
1.	Importance of Animal Health	7
2.	Immune System of Livestock	7
3.	Respiratory Diseases Affecting Livestock	7
4.	Diseases of the Gastrointestinal Tract	7
5.	Reproductive Diseases in Livestock	7
6.	External and Internal Parasites	7
7.	Quality Assurance Programs	8

ANIMAL SCIENCE
Competency Profile

Directions: Evaluate the student by checking the appropriate number or letter to indicate the degree of competency. The rating for each task should reflect **employability readiness** rather than the grades given in class.

Rating Scale: **3 Mastered** - can work independently with no supervision
2 Requires Supervision - can perform job completely with limited supervision
1 Not Mastered - requires instruction and close supervision
N No Exposure - no experience or knowledge in this area

3	2	1	N	**A. Nutrition**
				1. Identify the importance of nutrition to agriculture (A001)
				2. Compare and contrast the digestive systems of livestock (A002)
				3. Describe energy's role in nutrition (A003)
				4. Describe protein's role in nutrition (A004)
				5. Describe minerals' role in nutrition (A005)
				6. Describe vitamins' role in nutrition (A006)
				7. Describe the role of water in nutrition (A007)
				8. Describe environmental effects on nutrition (A008)
				9. Formulate a ration for different classes of livestock (A009)

3	2	1	N	**B. Genetics**
				1. Describe the importance of genetics on agriculture (B001)
				2. Describe the basic building blocks of genetics (B002)
				3. Describe animal cell division (B003)
				4. Describe basic principles of genetics (B004)
				5. Describe selection tools for genetic improvement of beef (B005)
				6. Describe selection tools for genetic improvement of dairy herds (B006)
				7. Describe selection tools for genetic improvement of sheep (B007)
				8. Describe selection tools for genetic improvement of swine (B008)

3	2	1	N	**C. Reproduction**
				1. Identify the importance of reproduction in livestock production (C001)
				2. Describe the hormonal system in livestock reproduction (C002)
				3. Describe the reproductive cycle of common production livestock (C003)
				4. Sequence the fetal developmental stages of livestock (C004)
				5. Describe the effects of the environment on the reproductive cycle (C005)
				6. Describe how management and technology are utilized to affect the reproductive cycle (C006)

3	2	1	N

D. Animal Health

1. Identify the importance of animal health in livestock (D001)
2. Describe aspects of the immune system of domestic livestock (D002)
3. Describe the diseases of the respiratory system affecting livestock (D003)
4. Describe the diseases of the gastrointestinal tract in livestock (D004)
5. Describe the diseases of the reproductive system in livestock (D005)
6. Describe the major external and internal parasites of livestock (D006)
7. Describe animal health quality assurance programs (D007)

										Animal Science Class/Section: Students:
										A. Nutrition
										1. Identify the importance of nutrition to agriculture (A001)
										2. Compare and contrast the digestive systems of livestock (A002)
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										4. Describe protein's role in nutrition (A004)
										5. Describe minerals' role in nutrition (A005)
										6. Describe vitamins' role in nutrition (A006)
										7. Describe the role of water in nutrition (A007)
										8. Describe environmental effects on nutrition (A008)
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										3. Describe animal cell division (B003)
										4. Describe basic principles of genetics (B004)
										5. Describe selection tools for genetic improvement of beef (B005)
										6. Describe selection tools for genetic improvement of dairy herds (B006)
										7. Describe selection tools for genetic improvement of sheep (B007)
										8. Describe selection tools for genetic improvement of swine (B008)

										Students:	**Animal Science (continued)** Class/Section:
											C. Reproduction
											1. Identify the importance of reproduction in livestock production (C001)
											2. Describe the hormonal system in livestock reproduction (C002)
											3. Describe the reproductive cycle of common production livestock (C003)
											4. Sequence the fetal developmental stages of livestock (C004)
											5. Describe the effects of the environment on the reproductive cycle (C005)
											6. Describe how management and technology are utilized to affect the reproductive cycle (C006)
											D. Animal Health
											1. Identify the importance of animal health in livestock (D001)
											2. Describe aspects of the immune system of domestic livestock (D002)
											3. Describe the diseases of the respiratory system affecting livestock (D003)
											4. Describe the diseases of the gastrointestinal tract in livestock (D004)
											5. Describe the diseases of the reproductive system in livestock (D005)
											6. Describe the major external and internal parasites of livestock (D006)
											7. Describe animal health quality assurance programs (D007)

UNIT I - NUTRITION

Lesson 1: Importance of Animal Nutrition to Agriculture

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

Study Questions

1. **What careers are associated with nutrition?**
2. **Who sets the guidelines for nutrition?**
3. **What information is supplied on feed tags, and what is its purpose?**
4. **What is the economic importance of understanding nutrition?**
5. **What are the general functions which nutrients serve in the animal body?**

References

1. Student Reference
2. Transparency Master
    a) TM 1.1: Example Feed Tag

UNIT I - NUTRITION

Lesson 1: The Importance of Animal Nutrition to Agriculture

TEACHING PROCEDURES

A. Review

Review the nutrition unit in Ag Science I core curriculum.

B. Motivation

1. Have students research occupations associated with animal nutrition and their contributions.

2. Who sets the guidelines for livestock requirements? (not the farmer or the feed store) Why are these guidelines necessary?

3. What is a feed tag? What information is provided on a feed tag? Why are these requirements important to a person who feeds livestock?

4. Why is important to understand animal nutrition? How does it affect your everyday life?

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students what careers they view as nutrition careers and what the educational requirements might be.

What careers are associated with nutrition?

a) More than 20% of the U.S. labor force works in an ag-related occupation. Approximately 540,000 are employed in the meat, poultry and dairy production industry. Careers associated with nutrition are numerous. The careers may be directly or indirectly related to nutrition. They include:
   1) Agricultural instructors
   2) Livestock producers/farmers
   3) Nutrition specialists
   4) Feedlot employees/managers
   5) Feed sales reps
   6) Horse trainers
   7) Feed store managers
   8) Veterinarians
   9) Nutrition researchers

b) Most occupations require a college degree or years of experience. More and more areas are requiring a master's degree or more. Today, most feed sales reps are required to have a college degree.

2. Ask the students who sets the guidelines and determines the recommended nutritional requirements. Relate that Missouri uses national NRC guidelines.

Who sets the guidelines for nutrition?

a) The work of research scientists has resulted in greatly improved methods of feeding livestock. Many of the U.S. Agriculture Experiment Stations conduct feeding trials. Results of these experiments relate to the value of feeds and rations under controlled feeding conditions.
b) The National Research Council of the National Academy of Sciences develops the requirements for different livestock species.
c) The respective sets of requirements are available in publications specific to each species. Subcommittees on each specie are formed to review the requirements that were set through years of experimentation.
d) The NRC reviews and/or revises its requirements every several years.

3. Ask the students what information is provided on feed tags.

What information is supplied on feed tags, and what is its purpose?

a) Individual states generally regulate the manufacturing and sale of feeds. However, regulations relating to feed additives are made by the federal government. The Association of the American Feed Control Officials has published the "Uniform State Feed Bill," after which many states pattern their regulations. This results in fairly uniform state guidelines regarding the sale and manufacturing of feed.
b) The feed tag found on a bag of commercial feed is important to the livestock feeder. It contains information about the content of the feed and its proper use. The format and content of the feed tag or label is regulated by state laws.
c) The tag generally contains the following information.
    1) Net weight
    2) Product name and brand name
    3) Guaranteed analysis of the feed
        (a) Minimum percentage of crude protein
        (b) Maximum or minimum percentage of equivalent protein from nonprotein nitrogen
        (c) Minimum percentage of crude fat
        (d) Maximum percentage of crude fiber
        (e) Minimum and maximum percentages of calcium and salt
        (f) Minimum percentage of phosphorus
        (g) Other minerals
        (h) Vitamin content
    4) When drugs are used as an additive, requirements must be met.
        (a) The word "medicated" must be on the label.
        (b) The purpose of the medication must be stated.
        (c) Directions for use and precautionary statements must be included.
        (d) Active drug ingredients must be listed.
d) Certain exemptions on labeling are common.
    1) No mineral guarantee is needed *if* no label claims concerning minerals are made *and* the total mineral content is less than 6.5% of the total contents.
    2) No vitamin information is required when the feed contains no claims concerning vitamins or is not being sold as a vitamin supplement.
    3) Crude protein, crude fat and crude fiber guarantees are not needed if the feed is not intended to furnish these substances or if they are a minor part of the total

ingredients. (For example, in drug premixes, mineral or vitamin supplements and molasses)

e) This general description of feed tag labeling is not intended to be a specific guide for a given state. Instead, the Department of Agriculture in each state establishes committees to set state standards. The feed laws, rules and regulations of each state should be considered to determine specific requirements for that state.

4. Have the students list what they feel are the assets of understanding nutrition.

What is the economic importance of understanding nutrition?

a) Agriculture is the largest industry in the U.S.
   1) The total assets of agriculture exceed one trillion dollars.
   2) Production of livestock is an important part of the total agriculture industry.
   3) About 50% of farm cash receipts comes from the sale of livestock and livestock products.
b) The cost of feed is 50-75% of the total cost of raising livestock.
   1) Careful attention to animal nutrition can help reduce feed costs and thus increase the potential profit from livestock.
   2) The lowest cost feed ration may not be the most profitable. One must also consider feeding efficiency and nutrition value when selecting rations.
c) Estimated feed costs for different species vary somewhat.
   1) Swine = 65-80% of total costs
   2) Poultry = 55-65%
   3) Dairy = 50-60%
   4) Finishing beef cattle = 70%
   5) Finishing lambs = 50%

5. Ask the students how nutrients found in feed help the animal.

What are the general functions that nutrients serve in the animal body?

a) There are three general functions that nutrients serve.
   1) Maintenance--maintain basic life processes without any work or production
      (a) Heat to maintain body temperature
      (b) Energy for vital functions and a minimum amount of movement
      (c) Small amounts of protein, minerals and vitamins
   2) Growth (assimilation of tissue)
   3) Reproduction
b) There are also functions which are specific to the purpose of the animal.
   1) Finishing/fattening for market
   2) Fitting for show
   3) Production
      (a) Meat
      (b) Milk
      (c) Eggs
      (d) Wool and mohair
   4) Work
      (a) Horses
      (b) Movement in environment

F. Other activities

1. Have the students research income for a nutrition-related career.

2. Have a local feed sales rep or feed store manager talk to the class about careers, feed requirements, and the importance of understanding nutrition.

3. Have the students bring in feed tags from feed used at home. Compare and contrast the information listed.

4. Tour an animal nutrition research facility.

G. Conclusion

Nutritionists formulate livestock rations to provide the nutrients needed by animals for maintenance and production. Producers are rarely interested in just maintaining animals, yet the maintenance requirements must be met before animals will provide any productivity.

H. Competency

Identify the importance of nutrition to agriculture.

I. Answers to Evaluation

1. d
2. b
3. c
4. c
5. Maintenance, growth and reproduction
6. Any of the careers listed in the lesson or discussed in class
7. Any of the requirements listed in the lesson

UNIT I - NUTRITION

Name_________________

Lesson 1: The Importance of Nutrition to Agriculture

Date_________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Who sets the nutritional requirements for domestic animals?

   a. Farmers
   b. University nutrition specialists
   c. Feed manufacturers
   d. National Feed Council

2. Who sets regulations for feed tags?

   a. Feed manufacturers
   b. Individual states
   c. U.S. Department of Agriculture
   d. Feed stores

3. The cost of feed is _______% of the total cost in livestock production.

   a. 10-20
   b. 25-40
   c. 50-75
   d. 100

4. How much of total farm cash receipts do livestock sales make up?

   a. 10%
   b. 25%
   c. 50%
   d. 80%

Complete the following short answer questions.

5. List the three general functions that nutrients serve in the animal.

6. List four careers associated with nutrition.

7. List four items required to be on a feed tag.

Example Feed Tag

NET WEIGHT 50 LBS.

SUPER COW
16% TEXTURED

GUARANTEED ANALYSIS

Crude Protein, not less than	16.0%
Crude Fat, not less than	3.0%
Crude Fiber, not more than	7.5%

INGREDIENTS

Grain Products, Processed Grain By-Products, Plant Protein Products, Animal Protein Products, Cane Molasses, Salt, Calcium Carbonate, Dicalcium Phosphate, Manganese Oxide, Ferrous Sulfate, Copper Sulfate, Magnesium Oxide, Potassium Chloride, Cobalt Carbonate, Zinc Oxide, Ethylenediamine Dihydriodide, Sodium Selenite, Lignin Sulfonate and Sodium Bentonite (pellet binders), Vitamin A Acetate, D-Activated Animal Sterol (source of Vitamin D-3), Vitamin E Supplement, Niacin Supplement, Dried Lactobacillus Acidophilus Fermentation Products, Zinc Methionine.

FEEDING DIRECTIONS

Feed Super Cow 16% Textured as a high-energy supplement to excellent legume hay or haylage or lush legume-grass pasture when used as the only source of roughage for the lactating cow. Feed 1 lb. of this feed for each 2-3 lbs. of milk produced.

Manufactured by
MFA INCORPORATED
Columbia, MO 65201

378X1F 1WR56244

UNIT I - NUTRITION

Lesson 2: Livestock Digestive Systems

Objective: The student will be able to compare and contrast the different digestive systems in livestock.

Study Questions

1. **How is food digested in a ruminant?**
2. **How is food digested in a nonruminant?**
3. **How is food digested in a modified nonruminant?**
4. **How is food digested in poultry?**

References

1. Student Reference
2. Transparency Masters

    a) TM 2.1: Comparison of Digestive System Parts
    b) TM 2.2: Digestive System Parts of a Ruminant
    c) TM 2.3: Digestive System Parts of a Nonruminant
    d) TM 2.4: Digestive System Parts of an Avian

UNIT I - NUTRITION

Lesson 2: Livestock Digestive Systems

TEACHING PROCEDURES

A. Review

1. Review the previous lesson on the importance of animal nutrition.

2. Reinforce that ruminants include cattle, sheep and goats; nonruminants include swine and humans; modified nonruminants include horses and rabbits; and poultry (avian) include ducks, chickens, and turkeys.

B. Motivation

1. Are there any similarities between human and livestock digestive systems? The human digestive system is very similar to the nonruminant's digestive system (such as swine). They consist of a mouth, esophagus, simple stomach, small intestine, large intestine, and anus. They both use these parts to mechanically and chemically breakdown food for absorption.

2. How long is the digestive tract in humans? How long is the digestive tract in swine? From mouth to anus, the digestive tract in a human is 30 feet in length. The digestive tract in swine is about 80 feet in length. In hogs, this added length permits some absorption in the large intestine, while little or no absorption occurs in the large intestine of humans.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students about the differences between the digestive systems of ruminants and non-ruminants. (A ruminant animal has a four-compartment stomach, where each compartment serves a different function in the digestion of roughage. A nonruminant animal has one stomach, which cannot digest roughage.)

How is food digested in a ruminant?

a) Parts in the ruminant digestive system
   1) Mouth
   2) Esophagus
   3) Rumen
   4) Reticulum
   5) Omasum
   6) Abomasum
   7) Liver
   8) Gallbladder
   9) Pancreas
   10) Duodenum
   11) Small intestine
   12) Colon
   13) Cecum

14) Rectum

b) Functions of digestion in ruminants

1) Mouth--Three physical processes occur in the mouth.
NOTE: Same functions as nonruminants and modified nonruminants
(a) Prehension--the act of bringing food into the mouth
(b) Mastication--the act of chewing food (Saliva is added and enzymatic digestion begins.)
(c) Deglutition--the act of swallowing

2) Esophagus
NOTE: Same functions for all classes of livestock
(a) Pharynx--structure which controls the passage of air and feed
(b) The passageway for food and water from mouth to stomach

3) Reticulum and rumen
(a) Microorganisms (bacteria and protozoa) are present to aid in digestion.
(b) Fatty acids are produced and absorbed.
(c) Vitamins K, C and B-complex are synthesized.
(d) Muscular action stirs and mixes food and water, which aids in digestion.

4) Omasum
(a) Absorbs water
(b) Aids in grinding of food
(c) Absorbs volatile fatty acids

5) Abomasum
(a) This is considered the "true stomach" in of ruminants.
(b) Digestive juices containing acids and enzymes are added, which increase the moisture content of food.
(c) A small percentage of feed protein (the hard-to-digest part) is digested here.

6) Pancreas
NOTE: Same functions as nonruminants, modified nonruminants, and poultry
(a) Endocrine gland secretes hormones such as insulin and glucagon.
(b) Exocrine gland secretes fluids necessary for digestion.

7) Liver
NOTE: Same functions as nonruminants and modified nonruminants
(a) Secretion of bile, which emulsifies fat
(b) Vitamin storage
(c) Detoxification of harmful compounds
(d) Metabolism of proteins, carbohydrates, and lipids (fats)
(e) Storage of carbohydrates when needed
(f) Destruction of red blood cells
(g) Urea formation
(h) Formation of plasma proteins
(i) Inactivation of polypeptide hormones

8) The gallbladder stores bile.
NOTE: Same functions as nonruminants and avians

9) Duodenum
(a) Bile and pancreatic fluids are stored here.
(b) Fats are emulsified here.
(c) Enzymes in the pancreas aid in breaking down carbohydrates and proteins.

10) Small intestine
(a) Vitamins and minerals are absorbed into the bloodstream.
(b) Proteins (80%) are absorbed here.
(c) Lipids (fats) are also absorbed here.

11) Cecum and colon (large intestine)

(a) Fiber (5 to 15%) is digested in the cecum.
(b) The majority of water is absorbed in the colon, which causes fecal formation.
(c) Mucus is added to feces for lubrication.
(d) The mixture still remains neutral.

2. Ask students about the similarities between the digestive systems of ruminants and nonruminants.

How is food digested in a nonruminant?

a) Parts in the nonruminant digestive system
   1) Mouth
   2) Esophagus
   3) Stomach
   4) Liver
   5) Gallbladder
   6) Pancreas
   7) Duodenum
   8) Small intestine
   9) Colon
   10) Cecum
   11) Rectum
b) Functions of digestion in nonruminants
   1) Mouth--Three physical processes occur in the mouth.
      NOTE: Same functions as ruminants and modified nonruminants
      (a) Prehension--the act of bringing food into the mouth
      (b) Mastication--the act of chewing food (Saliva is added and enzymatic digestion begins.)
      (c) Deglutition--the act of swallowing
   2) Esophagus
      NOTE: Same functions for all classes of livestock
      (a) Pharynx--structure which controls the passage of air and food
      (b) The passageway for food and water from mouth to stomach
   3) Stomach
      (a) Food is mixed with acids and enzymes; this mixture becomes acidic in nature.
      (b) Fats are partially broken down.
      (c) Digestion begins on proteins.
      (d) Carbohydrates move through the stomach at a faster rate than other nutrients.
   4) Pancreas
      NOTE: Same functions as ruminants, modified nonruminants, and poultry
      (a) Endocrine gland function is to secrete hormones such as insulin and glucagon.
      (b) Exocrine gland secretes fluids necessary for digestion.
   5) Liver
      NOTE: Same functions as ruminants and modified nonruminants
      (a) Secretion of bile, which emulsifies fat
      (b) Vitamin storage
      (c) Detoxification of harmful compounds
      (d) Metabolism of proteins, carbohydrates, and lipids (fats).
      (e) Storage of carbohydrates
      (f) Destruction of red blood cells

(g) Urea formation
(h) Formation of plasma proteins
(i) Inactivation of polypeptide hormones

6) The gallbladder stores bile.
NOTE: Same functions as ruminants and avians

7) Duodenum
(a) Food mixture becomes a neutral mixture with the addition of alkaline enzymes.
(b) Emulsification of fats by bile makes fats soluble in water.
(c) Further breakdown of proteins and carbohydrates occurs.

8) Small intestine
(a) Digested nutrients are absorbed into the bloodstream.
(b) Peristalsis is the coordinated contraction and relaxation of smooth muscles to create unidirectional movement of food.

9) Cecum and colon (large intestine)
(a) The cecum has a very limited function but does contain microorganisms.
(b) Water is absorbed in the colon; fecal formation occurs.
(c) Mucus is added to feces to provide lubrication.
(d) The mixture remains neutral.

3. Encourage discussion about the similarities between nonruminants and modified nonruminants. (The only real difference is an active cecum in the modified nonruminant.)

How is food digested in a nonruminant?

a) Parts in the modified nonruminant digestive system
1) Mouth
2) Esophagus
3) Stomach
4) Liver
5) Pancreas
6) Duodenum
7) Colon
8) Cecum
9) Rectum

b) Functions of digestion in modified nonruminants
1) Mouth--Three physical processes occur in the mouth.
NOTE: Same functions as ruminants and nonruminants
(a) Prehension--the act of bringing in food into the mouth
(b) Mastication--the act of chewing food (Saliva is added and enzymatic digestion begins.)
(c) Deglutition--the act of swallowing

2) Esophagus
NOTE: Same functions for all classes of livestock
(a) Pharynx--the structure which controls the passage of air and food
(b) The passageway for food and water from the mouth to the stomach

3) Stomach
(a) Food is mixed with acids and enzymes; this mixture becomes acidic in nature.
(b) Fats are partially broken down.
(c) Digestion begins on proteins.
(d) Carbohydrates move through the stomach at a faster rate than other nutrients.

4) Pancreas

NOTE: Same functions as ruminants, nonruminants, and poultry
(a) Endocrine gland secretes hormones such as insulin and glucagon.
(b) Exocrine gland secretes fluids necessary for digestion.

5) Liver
NOTE: Same functions as ruminants and nonruminants
(a) Secretion of bile
(b) Vitamin storage
(c) Detoxification of harmful compounds
(d) Metabolism of proteins, carbohydrates, and lipids
(e) Storage of carbohydrates
(f) Destruction of red blood cells
(g) Urea formation
(h) Formation of plasma proteins
(i) Inactivation of polypeptide hormones

6) Duodenum
(a) Food mixture becomes a neutral mixture with the addition of alkaline enzymes.
(b) Emulsification of fats by bile makes fats soluble in water.
(c) Further breakdown of proteins and carbohydrates occur.

7) Small intestine
(a) Digested nutrients of concentrates are absorbed into the bloodstream.
(b) Peristalsis is the coordinated contraction and relaxation of smooth muscles to create unidirectional movement of food.

8) Cecum
(a) Quite functional and much larger than most nonruminant animals
(b) Digestion of roughage takes place here.
(c) Contains microorganisms to aid in digestion of roughage

9) Colon
(a) The majority of the water is absorbed in the colon; fecal formation occurs.
(b) Mucus is added to feces to provide lubrication.
(c) The mixture remains neutral.

4. Point out that the digestive system of poultry is considerably different than those of the three groups discussed so far.

How is food digested in poultry?

a) Parts in the avian digestive system
1) Mouth
2) Esophagus
3) Crop
4) Proventriculus
5) Gizzard
6) Liver
7) Gallbladder
8) Pancreas
9) Small intestine
10) Large intestine
11) Ceca
12) Cloaca
13) Vent

b) Functions of digestion in poultry
1) Mouth--*Two* physical processes occur in the mouth.
(a) Prehension--the act of bringing in food into the mouth

(b) Deglutition--the act of swallowing

2) Esophagus

NOTE: Same functions for all classes of livestock

(a) Pharynx--the structure which controls the passage of air and food

(b) The passageway for food and water from the mouth to the crop

3) Crop

(a) Storage of food

(b) Mucus is secreted and added to the food, which softens and lubricates it.

4) In the proventriculus, gastric fluids are secreted and added to ingested food.

5) Gizzard

(a) This muscular organ aids in digestion by mechanically mixing and grinding food.

(b) Gastric fluids are mixed with food.

6) Pancreas

NOTE: Same functions as ruminants, nonruminants, and modified nonruminants

(a) Endocrine gland secretes hormones such as insulin and glucagon.

(b) Exocrine gland secretes enzymes necessary for digestion.

7) Liver

(a) Secretion of bile

(b) Vitamin storage

(c) Detoxification of harmful compounds

(d) Metabolism of proteins, carbohydrates, and lipids

(e) Storage of carbohydrates

(f) Destruction of red blood cells

(g) Formation of plasma proteins

(h) Inactivation of polypeptide hormones

8) The gallbladder stores bile.

NOTE: Same functions as ruminants and nonruminants

9) Small intestine movements

(a) Pendular motion--Shortening and lengthening of the intestine create a mixing motion.

(b) Segmentation contractions--Ringlike contractions at regular intervals create a mixing motion.

(c) Peristalsis--The coordinated contraction and relaxation of smooth muscles create unidirectional movement of food.

(d) Digested nutrients are absorbed into the bloodstream.

10) Ceca

(a) Ceca is the plural form of cecum.

(b) This blind-ended tube is found at the junction of the small intestine and the large intestine.

11) The colon (large intestine) does not play a significant role in digestion, except for water absorption.

12) In the cloaca, urinary and fecal materials are mixed together before leaving the body through the vent.

F. Other activities

1. Obtain a digestive tract from a slaughter house to show the movement of food through the digestive system.

2. Activities on salivary digestion, gastric digestion, pancreatic digestion, and digestion of fat are available from:

   "Digestive Systems of Domesticated Animals" (#8833-C). *Agriscience 332H: Advanced Animal Science.* College Station, TX: Instructional Materials Service, Texas A&M University, 1990.

G. Conclusion

Understanding livestock digestive systems is critical to success of a producer or another in a related nutrition occupations. The person who can apply nutrition utilization to a situation can greatly improve the profit capability of an operation or business.

H. Competency

Compare and contrast the digestive systems of livestock.

I. Answers to Evaluation

1.	h	10.	d	19.	f
2.	b	11.	b	20.	e
3.	a	12.	g	21.	a
4.	g	13.	d	22.	b
5.	e	14.	c	23.	a
6.	c	15.	i	24.	b
7.	j	16.	k	25.	d
8.	k	17.	a	26.	c
9.	i	18.	j	27.	b
				28.	c

29-46. Refer to TM 2.1 for answers. (section worth 72 points)

UNIT I - NUTRITION Name__________________

Lesson 2: Livestock Digestive Systems Date__________________

EVALUATION

Match parts on the right with functions of the ruminant digestive system on the left.

___ 1. Where saliva is mixed with food	a.	Abomasum
___ 2. Where a majority of water is absorbed	b.	Colon
___ 3. "True stomach"	c.	Duodenum
___ 4. Detoxification of harmful compounds	d.	Esophagus
___ 5. Storage of bile	e.	Gallbladder
___ 6. Emulsification of fats	f.	Large intestine
___ 7. Where B-complex vitamins are synthesized	g.	Liver
___ 8. Where minerals are absorbed	h.	Mouth
___ 9. Location of endocrine and exocrine glands	i.	Pancreas
___ 10. Where the pharynx is located	j.	Rumen
	k.	Small intestine

Match parts with functions of the poultry digestive system.

___ 11. Where fecal and urinary materials are mixed	a.	Ceca
___ 12. Storage of vitamins	b.	Cloaca
___ 13. Passageway from mouth to crop	c.	Crop
___ 14. Where food is softened and lubricated	d.	Esophagus
___ 15. Where insulin is secreted	e.	Gallbladder
___ 16. Location of pendular motion	f.	Gizzard
___ 17. Blind-ended tube between small intestine and large intestine	g.	Liver
___ 18. Where gastric fluids are secreted	h.	Mouth
___ 19. Where mixing and grinding of food occurs	i.	Pancreas
___ 20. Storage of bile	j.	Proventriculus
	k.	Small intestine

Circle the letter that corresponds to the best answer.

21. Which describes the coordinated contraction and relaxation of smooth muscles to create unidirectional movement of food?

    a. Peristalsis
    b. Pendular
    c. Segmentation
    d. Mastication

22. In the small intestine of poultry, which mixing movement is caused by shortening and lengthening the intestine?

    a. Peristalsis
    b. Pendular
    c. Segmentation
    d. Mastication

23. In poultry, which mixing movement is caused by ring-like contractions at regular intervals in the intestine?

    a. Segmentation
    b. Mastication
    c. Deglutition
    d. Prehension

24. Which describes the act of chewing food?

    a. Segmentation
    b. Mastication
    c. Deglutition
    d. Prehension

25. Which describes the act of bring food into the mouth?

    a. Segmentation
    b. Mastication
    c. Deglutition
    d. Prehension

26. Where are red blood cells destroyed?

    a. Pharnyx
    b. Pancreas
    c. Liver
    d. Gallbladder

27. Which structure which controls the passage of air and food?

    a. Liver
    b. Pharnyx
    c. Pancreas
    d. Gallbladder

28. Where is urea formed?

a. Pharnyx
b. Pancreas
c. Liver
d. Gallbladder

Place a check in each part of the table that pertains to that class of animal. (The first one has been done for you as an example.)

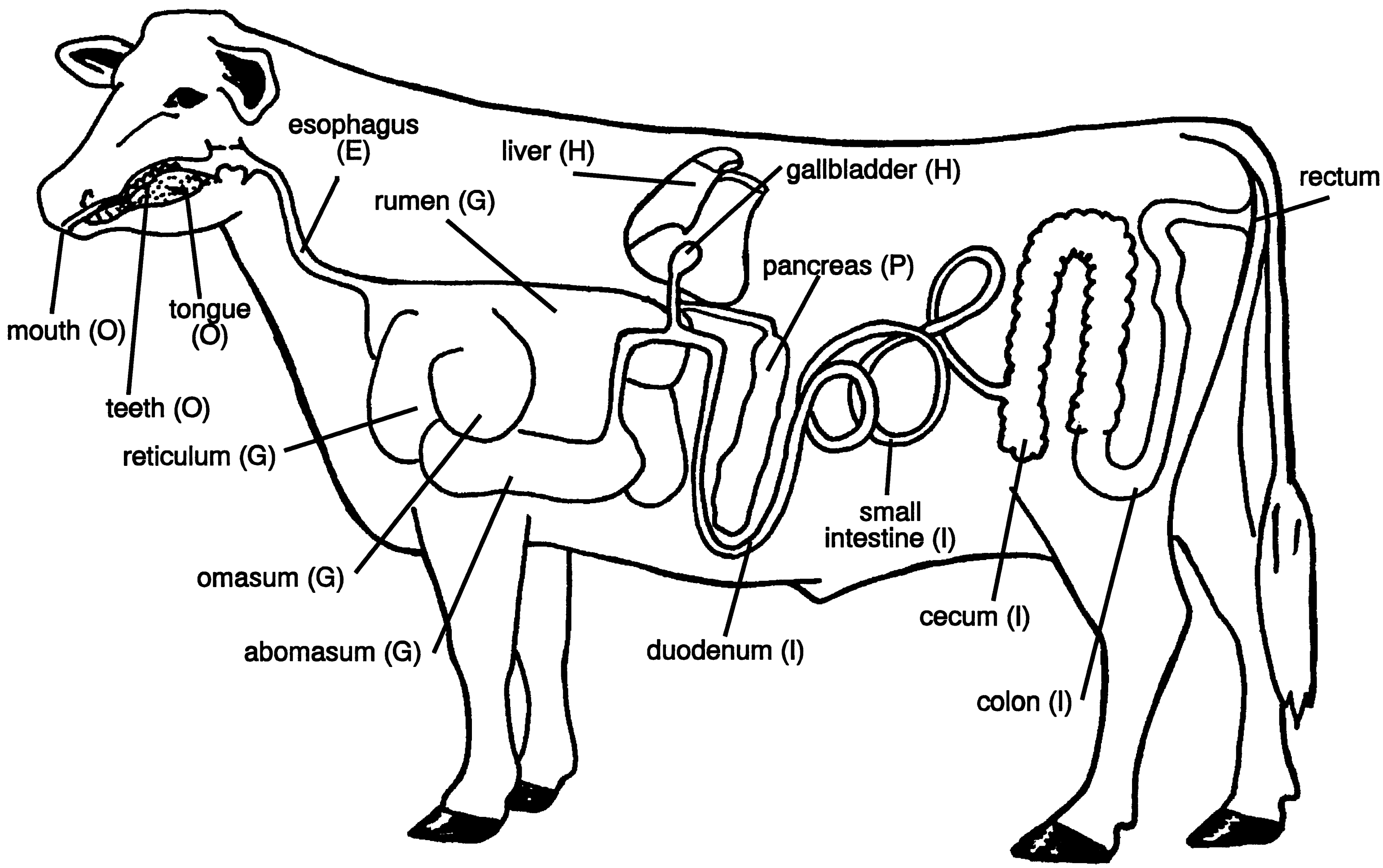
Body part	**Ruminants**	**Nonruminants**	**Mod. non-ruminants**	**Poultry (avian)**
Oral Mouth	✓	✓	✓	✓
Esophageal 29. Esophagus				
Gastric 30. Rumen				
31. Reticulum				
32. Omasum				
33. Abomasum				
34. Stomach				
35. Crop				
36. Proventriculus				
37. Gizzard				
Pancreatic 38. Pancreas				
Hepatic 39. Liver				
40. Gallbladder				
Intestinal 41. Duodenum				
42. Colon				
43. Cecum				
44. Small intestine				
45. Cloaca				
46. Rectum				

Comparison of Digestive System Parts

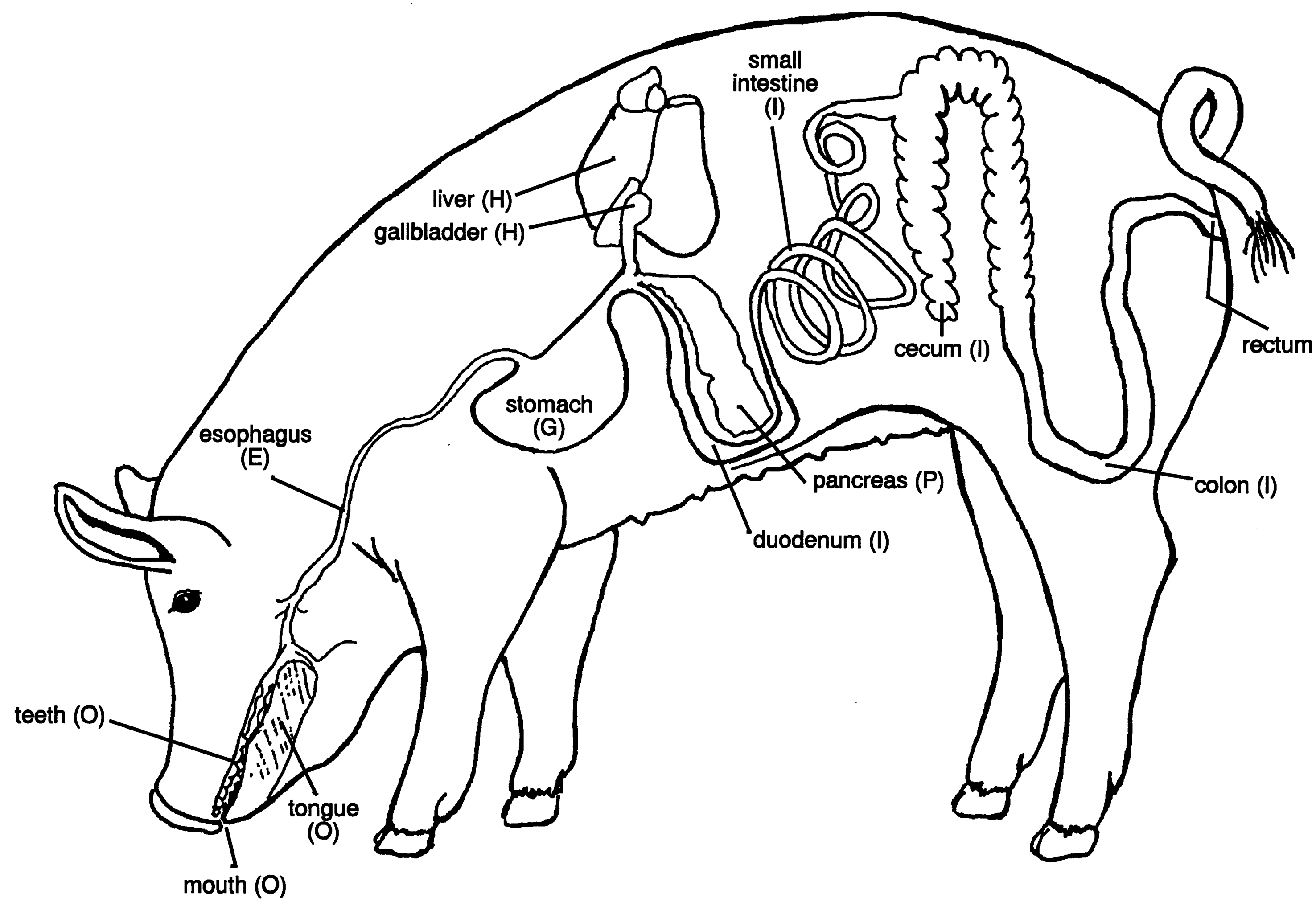
NOTE: Shaded areas show that those animals have that part.

Body part	Ruminants	Non-ruminants	Mod. non-ruminants	Poultry (avian)
Oral Mouth				
Esophageal Esophagus				
Gastric Rumen				
Reticulum				
Omasum				
Abomasum				
Stomach				
Crop				
Proventriculus				
Gizzard				
Pancreatic Pancreas				
Hepatic Liver				
Gallbladder				
Intestinal Duodenum				
Colon				
Cecum/ceca				(ceca)
Small intestine				
Cloaca				
Rectum/vent				(vent)

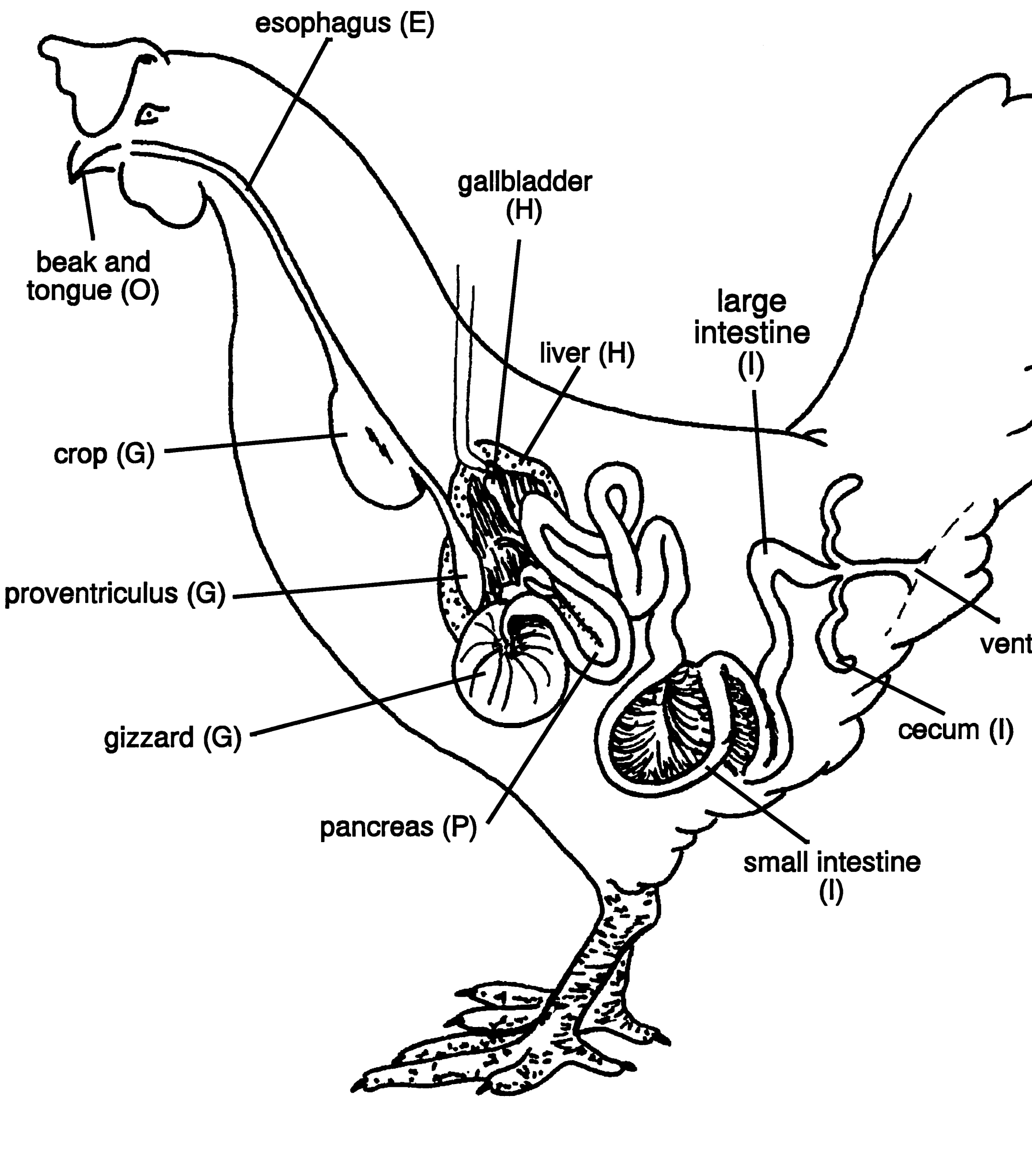
Digestive System Parts of a Ruminant



Digestive System Parts of a Nonruminant



Digestive System Parts of an Avian



UNIT I - NUTRITION

Lesson 3: Energy's Role in Livestock Nutrition

Objective: The student will be able to describe the function of energy in livestock nutrition.

Study Questions

1. **What are the basic functions of energy in the body?**
2. **How are carbohydrates and fats related to energy?**
3. **Where are carbohydrates and fats absorbed in the digestive system?**
4. **What are the sources of energy for ruminants and nonruminants?**
5. **What are deficiency and toxic effects of carbohydrates and fats?**

References

1. Animal Science

UNIT I - NUTRITION

Lesson 3: Energy's Role in Livestock Nutrition

TEACHING PROCEDURES

A. Review

1. Review the previous lesson on digestive systems of livestock.

B. Motivation

1. What are two sources of energy? (carbohydrates and fats)

2. What are some signs of energy deficiencies in humans?

   a) Always feeling rundown can be a sign of a lack of carbohydrates and fats.
   b) Insufficient fats in the body cause a lack of fat-soluble vitamins.

3. What are sources of carbohydrates and fats for humans?

   a) Carbohydrates--breads, pasta, sugars, cereals, fresh fruit, starchy vegetables
   b) Fats--dairy products, meats, and oils

4. What are the signs of excess consumption of energy in humans? (Excess carbohydrates are changed to fat and stored in the body as excess body weight. Excess weight causes other problems, such as heart conditions and high blood pressure.)

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students to discuss the functions of energy in the body. Discuss why it is important to understand energy requirements.

   What are the basic functions of energy in the body?

   a) Maintenance of life
      1) Controls basal metabolism, such as beating of the heart, blood pressure maintenance, nerve impulse transmission, breathing, and internal organ work
      2) Keep muscles in state of tension
      3) Supply fuel to maintain body temperature
   b) Growth and production
      1) Fattening
      2) Lactation--milk production
      3) Development of a fetus
      4) Reproduction
      5) Work

2. Ask the students for the two types of energy sources. How do they differ?

How are carbohydrates and fats related to energy?

a) Carbohydrates and lipids (fats and oils) are the major sources of energy in livestock rations.
b) Carbohydrates--most important
    1) Readily available
    2) Easily digested in greatest quantities in most feeds
    3) Generally lower in cost
c) Fats and oils
    1) It is difficult to store feeds high in fat content during warm weather because feeds tend to become rancid (bad odor and flavor).
    2) Feeds become less palatable, and animals are reluctant to eat them.
    3) Fatty feeds may make the animal sick.
d) Carbohydrates are organic compounds made of carbon (C), hydrogen (H), and oxygen (O).
    1) Plants produce carbohydrates by photosynthesis.
        (a) Energy from the sun, plus water and carbon dioxide, produce glucose and oxygen.
        (b) Carbohydrates include:
            (1) Starch
            (2) Sugars
            (3) Hemicellulose
            (4) Cellulose
            (5) Pectins
            (6) Gums
            (7) Lignins
        (c) Most carbohydrates are combinations of saccharides or sugars.
        (d) One way carbohydrates are classified is by the number of molecules of sugars they contain. For example, monosaccharides contain only one sugar molecule.
    2) In digestion, carbohydrates in feed are changed into simpler forms.
        (a) Glucose levels in the bloodstream of animals are maintained at a level of 0.05-0.1 percent concentration.
        (b) Because glucose can be used by all animals, it is the most important sugar found in the body.
    3) Two groups of carbohydrates
        (a) Fiber: contains hard-to-digest hemicellulose, cellulose, and lignin
        (b) Nitrogen-free extract (NFE)
            (1) Includes starches and sugars
            (2) Plants store energy as starch in grain; grains have a high feeding value since starch is easily digested.
    4) Digestion of fiber is related to the presence or absence of bacteria in the digestive system.
        (a) Ruminants
            (1) High bacteria population in the rumen
            (2) Make use of energy from the fiber portion of the ration
            (3) Bacterial action breaks fiber down into volatile fatty acids absorbed through the rumen wall
            (4) Roughage in a ruminant's ration can provide much of the maintenance energy needed by the animal

(b) Nonruminants, modified nonruminants, and avians
(1) No rumen
(2) Low bacteria population in stomach and intestines
(3) Less ability to utilize energy from fiber
(4) For mature breeding animals, increase the level of fiber in the ration to prevent excessive weight gain.
(5) Fiber assures adequate elimination of waste products (keeps animals "regular").

e) Lipids (fats and oils) are made up of carbon, hydrogen, and oxygen.
1) Lipids have higher carbon and hydrogen levels than carbohydrates, but lower oxygen levels.
2) Lipids supply 2.25 times as much energy as an equal amount of carbohydrates.
3) At body temperature, fats are solids and oils are liquids.
4) Fats are composed of two units--fatty acids and glycerol.
(a) Fatty acids consist of a carbon chain, 2-20 carbons in length, which contains a carboxyl group (COOH).
(1) Saturated fatty acids contain carbons attached with all single bonds.
(2) Unsaturated fatty acids contain carbons attached by double bonds. These double bond sites are chemically reactive; as a result, they are less stable than saturated.
(3) As the number of double bonds increases, the melting point of fat is lowered and the fats become softer (oils).
(b) Glycerol is the second constituent of fat.
(c) Fats are formed when one glycerol combines with three fatty acids to form a triglyceride.
5) Rancidity may be a problem with both saturated and unsaturated fats. Oxidative rancidity occurs only in unsaturated fats.
(a) Requires presence of oxygen
(b) Alters flavor, odor, and nutritional value
(c) Favored by moist conditions
(d) Part of hyperoxide formation, which promotes aging and destroys the immune system
(e) Destroys essential fatty acids
(f) Prevented with antioxidants (Vitamin E) and storing fats in cool environment
6) Three fatty acids are considered dietary essential nutrients since they are not synthesized by nonruminant animals. However, these fatty acids are synthesized by microorganisms in the rumen.
(a) Linoleic acid
(b) Linolenic acid
(c) Arachidonic acid
7) Storage of fats in the body
(a) Marbling is fat stored in muscle tissue.
(b) Fat stored in adipose (fatty) tissue contains reserve energy, which can help sustain life for a while if feed supplies are cut off.
8) Uses of fats in feed
(a) Raise energy level
(b) Improve flavor, texture, and palatability
(c) Reduce dustiness
(d) Improve glossiness of hair coat in show animals
9) Guidelines for fat content in feed
(a) Ruminants: no more than 3-5 percent
(b) Nonruminants: no more than 15-20 percent

3. Ask the students for ideas on what happens to nutrients to make them usable by the animal's body. (Refer to Lesson 2, if necessary.)

   Where are carbohydrates and fats absorbed in the digestive system?

   a) Carbohydrates (ruminants and nonruminants)
      1) Mostly in the small intestine
         (a) Starches and sugars are converted to glucose, fructose, and galactose when digested.
         (b) Crude fiber is converted to short, chained fatty acids or glucose by digestion.
         (c) By osmosis, nutrients pass into the blood capillaries through semipermeable membranes of the digestive tract, then through the liver into the bloodstream.
      2) Some in the large intestine
   b) Fats (ruminants and nonruminants)
      1) Fats are digested into fatty acids and glycerols called chyle.
      2) Chyle is absorbed by lacteal (lymphatic vessels) and carried through the lymphatic system.

4. Ask students to list sources of readily available carbohydrates and fats.

   What are the sources of energy for ruminants and nonruminants?

   a) Grains (major source)
      1) Shelled corn
         (a) Highest energy feed available
         (b) Economical and superior source of energy for livestock
      2) Oats
         (a) Contains 85 percent of the energy of shelled corn
         (b) Higher in crude protein; add fiber and bulk to rations
         (c) Helps maintain rumen functions in ruminants
      3) Barley
      4) Grain sorghum (similar to shelled corn)
      5) Wheat
   b) Roughage
      1) Roughage supplies some energy needs in livestock rations but is not a concentrated source.
      2) The value of forages is highly dependent upon time of harvest.
      3) As the plant matures, crude fiber content increases; this lowers the digestibility of the feed.
         (a) Corn silage
         (b) Hay
         (c) Pastures
   c) Fats
      1) Feed-grade animal fat is a byproduct of packing, poultry processing, and animal rendering plants.
      2) Animal fat is an economical source of energy used in manufacturing commercially mixed feeds.

5. Ask students to list signs of a lack of energy in an animal's diet.

   What are deficiency and toxic effects of carbohydrates and fats?

a) Deficiency symptoms
   1) Slower growth in the young
   2) Delay of onset of puberty
   3) Decrease in milk yield in lactating females
   4) Shortened lactation period
   5) Loss of body weight
   6) Reduced fertility and delayed estrus
   7) Higher mortality rates
   8) Lowered resistance to disease and parasites
b) Toxic effects
   1) Obesity
      (a) Decreased fertility
      (b) Delayed estrus
   2) Ketosis
      (a) Ketosis occurs when an animal has a higher energy demand (such as lactating dairy cattle) and a low supply of carbohydrates.
      (b) To meet the energy demand, the animal increases the metabolism of fats.
      (c) The increased fat metabolism rate overloads the liver with ketone acids.
      (d) Ketone acids can provide energy for muscles but **cannot** provide energy for the brain.
      (e) If the situation is not corrected, glucose blood levels drop so low that the animal collapses, goes into a coma, and dies.
      (f) This often happens to the best milk cows because of high energy requirements.

F. Other activities

1. Have students bring in feed tags from various commercial feeds and compare the energy values.

2. Visit a local feed mill or elevator. Ask the operator to explain how they formulate feeds and determine the energy nutrients to include in them.

3. Have students keep track of the foods they eat for a week, and have them determine which of the foods would be considered energy nutrients.

4. For quick response, feed small animals (especially chickens) different protein levels to see the results.

5. Consider using a kit to demonstrate the solubility and saturation of fats and carbohydrates. Carolina Biological Supply Co. (800/334-5551) has two kits: "Introduction to Properties of Lipids" and "Introduction to Analysis of Carbohydrates."

G. Conclusion

Fuel is supplied to the body by energy nutrients. The major sources of energy in livestock rations are carbohydrates and fats. Energy is used for digestion; absorption of nutrients; breathing; heart action; movement of muscles; production of milk, eggs, wool, and mohair; waste formation and excretion; and to supply heat to maintain body temperature. Some feed energy is lost through the feces, urine, and gases produced in the body. Excess energy not used to sustain life is stored as body fat.

H. Competency

Describe energy's role in nutrition.

I. Answers to Evaluation

1. Maintenance of life; growth and production
2. Carbohydrates and fats
3. Carbon, hydrogen, and oxygen
4. Fiber and nitrogen-free extract (NFE)

5. Three of the following:
   a) Raise energy level of feed
   b) Improve flavor and texture of feed
   c) Reduce dustiness of feed
   d) Improves glossiness of hair coat

6. Carbohydrates are absorbed through the liver and then the bloodstream, while fats are first absorbed through the lymphatic system before entering the bloodstream.

7. d
8. b

Name__________________

Lesson 3: Energy's Role in Livestock Nutrition

Date__________________

EVALUATION

Complete the following short answer questions.

1. What are the basic functions of energy in the body?

   a.

   b.

2. What are the two major sources of energy in the livestock ration?

   a.

   b.

3. What are the three elements that make up the molecules of fats and carbohydrates?

   a.

   b.

   c.

4. What are the two major groups of carbohydrates?

   a.

   b.

5. List three reasons to add fat to a ration.

   a.

   b.

   c.

   d.

6. Explain the main difference between how carbohydrates and fats are absorbed and circulated through the body.

Circle the letter that corresponds to the best answer.

7. Which is a possible toxic effect of carbohydrates and fats?

   a. Slower growth in the young
   b. Decrease in milk yield in lactating females
   c. Shortened lactation period
   d. Lower conception rates

8. Which source of energy contains 85 percent of the energy of shelled corn?

   a. Animal fat
   b. Oats
   c. Grain sorghum
   d. Wheat

UNIT I - NUTRITION

Lesson 4: Protein's Role in Animal Nutrition

Objective: The student will be able to describe the function of protein in animal nutrition.

Study Questions

1. **What are the functions of protein?**
2. **What are amino acids and their role in protein synthesis?**
3. **What are the essential amino acids?**
4. **What are the major symptoms of protein deficiency?**
5. **What are sources of protein?**
6. **What determines which proteins should be used in livestock diets?**

References

1. Student Reference
2. Transparency Masters
   a) TM 4.1: Protein Utilization in the Ruminant
   b) TM 4.2: Barrel Stave Illustration of the Effect of Limiting Amino Acid Supplementation on Milk Production

UNIT I - ANIMAL NUTRITION

Lesson 4: Protein's Role in Animal Nutrition

TEACHING PROCEDURES

A. Review

Review previous lesson on the importance of the nutrient energy in livestock.

B. Motivation

1. What are the signs of protein deficiency in humans? Lack of energy, loss of weight, and tiredness are all signs of protein deficiency in humans. Kwashiorkor is a childhood disease caused by protein deficiency. Symptoms are stunted growth, discolored skin, body sores, and a bulging abdomen. Good protein sources for humans are poultry, fish, dairy products, and dried peas and beans.

2. What are the signs of too much protein in the human diet? Proteins that are not used by the body are converted into body fat, which causes excess amounts of body fat.

C. Assignment

D. Supervised study

E. Discussion

1. See if students know how proteins are used in the body and the purposes they serve.

   What are the functions of protein?

   a) Functions of proteins in all classes of livestock
      1) Build, repair, and maintain muscles, skin, body tissues, hair, and hooves
      2) Produce body regulators, including enzymes and some hormones
      3) Good source of blood glucose
      4) Provide energy when fed in amounts higher than the body requires
      5) Building blocks in some genetic compounds, including DNA, RNA, and ATP
      6) Used as precursors of some B-complex vitamins
   b) Signs of protein deficiencies in livestock
      1) Animal appears thin and has a rough hair coat.
      2) Animals have poor appetites, low digestive efficiencies, and lower production rates.
      3) Animal may die if these deficiencies aren't corrected.

2. Ask students about how amino acids are formed.

   What are amino acids and their role in protein synthesis?

   a) Definition/functions
      1) Nitrogen compounds that originate from proteins provided in the diet
      2) The bricks and mortar of which muscles, body tissues, skin, and hair are built

b) Amino acids groups
   1) Amino acids are separated into two groups: essential and nonessential amino acids.
   2) There are 23 amino acids; 10 are essential and 13 are nonessential.
   3) All classes of livestock require both groups of amino acids.

c) The role of the amino acids in protein synthesis
   1) Ruminants can synthesize their own amino acids if there is enough nitrogen in the diet.
   2) Non-ruminants must be supplied with essential amino acids in their diet because they cannot synthesize amino acids.
   3) DNA serves as the information center that links amino acids together to form a specific protein with a particular physiological function.

3. Ask students about differences between essential amino acids and non-essential amino acids. Relate the memory aid, "Pvt. Tim Hall," to help students remember amino acids.

What are the essential amino acids?

a) Phenylalanine
b) Valine
c) Threonine
d) Tryptophan
e) Isoleucine
f) Methionine
g) Histidine
h) Arginine
i) Lysine
j) Leucine

4. Ask students if they can tell when an animal is lacking protein in the diet.

What are the major symptoms of protein deficiency?

a) Why symptoms occur in protein synthesis
   1) For a protein to be synthesized, all of the amino acids must be present and available.
   2) If an amino acid is deficient, the protein cannot be made; it must be supplied for the animal.
   EXAMPLE: Corn is deficient in lysine, so lysine must be supplied through another source.

b) Symptoms of amino acid deficiencies
   1) Lack of animal growth
   2) Poor hair coat
   3) Lack of muscling
   4) Lack of energy

5. Discuss the importance of knowing crude protein percentages for feedstuffs.

What are sources of protein?

NOTE: Crude protein is abbreviated CP. The following are book values. Home-raised protein sources should be tested for accurate CP values.

a) Animal protein sources
   1) Feather meal, 87 percent CP
   2) Blood meal, 86 percent CP
   3) Fish meal, 60 percent CP
   4) Poultry byproduct meal, 55 percent CP
   5) Meat scrap, 55 percent CP
   6) Meat and bone meal, 61 percent CP
   7) Dried skim milk, 34 percent CP
   8) Dried whole milk, 25 percent CP
b) Plant protein sources
   1) Sunflower meal, 47 percent CP
   2) Soybean meal, 48 percent CP
   3) Cottonseed meal, 41 percent CP
   4) Rapeseed meal, 37 percent CP
   5) Dehydrated alfalfa meal, 18 percent CP
   6) Alfalfa hay, 15 percent CP
   7) Red clover hay, 13 percent CP
   8) Wheat grain, 12 percent CP
   9) Oat grain, 12 percent CP
   10) Corn grain, 8 percent CP
c) Synthetic sources (N = nitrogen)
   1) Urea is 45 percent N. (Feed only to ruminant animals with a high energy ration.)
   2) Urea is a good source of nitrogen for amino acids.
   3) If the full amount of urea is not used in the rumen, urea toxicity could occur when the byproduct ammonia is produced.

6. Discuss the types of proteins available for feedstuffs. (Use Transparency Masters 4.1 and 4.2.) Using a wooden barrel as an example, describe how the first limiting amino acid influences production. For example, using a barrel with staves cut at different heights, that barrel will hold fluid only to the height of the shortest stave. Similarly, cows will produce milk only to the level of the most limiting nutrient. By providing supplemental rumen-pass protein, we can increase the amount of that limiting amino acid (height of the short barrel stave), thereby increasing milk production.

What determines which proteins should be used in livestock diets?

a) The first step in deciding which proteins to feed **ruminants** is to determine which proteins will be used to feed the microorganisms or "bugs" in the rumen. These microbes can synthesize amino acids from nonprotein nitrogen that nonruminants cannot.
   1) A producer can choose true proteins, such as soybean meal or cottonseed meal. The other option is to feed a nonprotein nitrogen (NPN) feedstuff, such as urea or anhydrous ammonia. These two types of proteins supply nitrogen used by the microbes for protein synthesis.
   2) When using true proteins such as plant protein or animal protein, crude protein does not determine digestibility (amount of protein available to the animal). Crude protein is the total amount of protein available in the feedstuff, but an animal cannot digest all the protein available.
   3) Digestible protein best describes the amount of protein used by the animal.
   4) Price, of course, is another influencing factor.
b) The next consideration is the amount of protein digested by the rumen. Most nonprotein nitrogen feedstuffs are digested and utilized by microbes in the rumen.
   1) In TM 4.1, nonprotein feedstuffs are considered rapidly degraded proteins. Excess amounts of nonprotein nitrogen can result in higher levels of ammonia

in the rumen. Excess rumen ammonia is absorbed into the bloodstream and converted to urea in the liver. The nonprotein nitrogen (rapidly degraded protein) is converted into NH_3 (ammonia), and the excess enters the bloodstream, is transformed into urea in the liver, and leaves the body through the urine. Excess nonprotein nitrogen can result in ammonia toxicity due to high levels of blood ammonia. Only limited amounts of NPN can be used. (Four pounds of urea per cow per day is a safe maximum.)

2) In TM 4.1, bound proteins are the undigestible portions of true proteins. These proteins cannot be digested by the rumen or the small intestine. These proteins are the difference between crude protein and digestible protein. Bound proteins enter and leave the body virtually undigested.

3) There are also true proteins that are considered rapidly degraded proteins. A large part of these proteins are used by microbes in the rumen.

4) The last form of protein is slowly degraded protein. Part of these true proteins are digested in the rumen. Microbes in the rumen use some of them, and the remaining portions escape into the small intestine, where it is digested along with microbial protein and then used for muscle formation and milk production.

c) The last step in classifying feedstuffs is based on rumen digestion.

1) Solubility - Soluble proteins disappear or are digested in two hours or less after entering the rumen. These proteins are classified as "rapidly degraded protein" in TM 4.1. Example sources are urea, alfalfa silage, and anhydrous ammonia. Most of these proteins are used by microbial cells ("bugs").

2) Degradability - Degradable proteins are broken down at a measurable rate over time. The amount of protein digested in the rumen depends on the rate and amount of time spent in the rumen.

(a) These proteins are classified as "rapidly and slowly degraded proteins" in TM 4.1. These proteins are used by microbial cells and the small intestine.

(b) Examples are soybean meal and cottonseed meal.

3) Escape or bypass - These proteins bypass or escape rumen digestion. Most of them are digested and absorbed in the small intestine. These proteins are classified as "slowly degraded proteins" in TM 4.1. Examples are fish meal, blood meal, meat and bone meal, and corn gluten meal.

4) Nonprotein feedstuffs cannot supply all the protein necessary in the diet, but true proteins can. Nonprotein feedstuffs must be supplemented with true proteins.

5) TM 4.2 shows the effects of amino acids on milk production. Milk production in dairy cattle is limited by the lowest limiting amino acid (here, lysine).

(a) In TM 4.2, this animal would only produce 75 lbs. of milk daily because the lysine becomes limiting at this level of milk production.

(b) TM 4.2 also shows what would happen if the diet was supplemented with a bypass protein high in lysine. When this occurs, lysine is no longer the limiting amino acid; methionine now becomes the limiting amino acid.

(c) This change results in increased milk production (75 lbs. to 92 lbs. daily). Paying close attention to ration balancing can mean a much more profitable operation.

(d) This concept of limiting amino acids also applies to nonruminants.

d) Protein digestibility is easier to understand in **nonruminants** because there are no microbial cells to feed and no predigestion before entering the stomach.

1) Table 4.1 in the Student Reference shows the requirements for a growing 100 lb. market hog, as well as the crude protein, digestible protein, and amount of amino acids present in different feedstuffs.

2) A 100 lb. market hog requires a 16 percent crude protein diet. The average 100 lb. hog consumes 4.1 lbs. of feed daily. Of that, 16 percent needs to be crude protein, which is .66 lb. of crude protein. (Remember, this is an estimate.)

e) To further understand the hog's requirement, look at the bottom line of Table 4.1. It shows that the amino acid requirement for the 100 lb. hog is .019 lb. of isoleucine, .025 lb. of leucine, .031 lb. of lysine, .017 lb. of methionine and cystine, .02 lb. of threonine, and .005 lb. of tryptophan.

1) Use blood meal as an example. It has a crude protein percentage of 86 percent, of which 70 percent can be digested.

EXAMPLE: Of 100 lbs. of blood meal, 86 lbs. are crude protein, while 70 lbs. are usable (digestible) protein. Of the 100 lbs. of blood meal, the total amount of isoleucine is 1.13 lbs. There is .75 lb. of usable (digestible) isoleucine available in 100 lbs. of blood meal. To find out the digestible amount of isoleucine available in 50 lbs. of blood meal, multiply 50 lbs. of blood meal by .0075 digestible isoleucine. (50 x .0075 = .375 lb. of digestible isoleucine)

2) To find the available digestible leucine in 50 lbs. of blood meal, multiply 50 lbs. of blood meal by .0924. (50 x .0924 = 4.62 lbs.)

3) Let's use this information in a real life ration. On the average, a 100 lb. hog eats 4.1 lbs. a day. To find out if the ration below meets the amino acid requirements of this hog, find out the total amount of each feedstuff. In the following ration, 3.28 lbs. of the 4.1 lbs. eaten is corn, and .82 lb. is soybean meal. Usually, lysine is the limiting amino acid in most hog rations. Soybean meal will supply .021 lb. of lysine (.82 lb. x .0255 = .021). The corn supplies .006 lb. of lysine (3.28 x .0018 = .006). The hog requires .031 lb. of lysine; these feedstuffs supply .027 lb. of lysine (.021 + .006). This ration, therefore, is lacking lysine. Remember that all hog rations need vitamins and minerals, which have not been figured in yet. In real life, this ration would be balanced for lysine (not protein) to prevent this deficiency form occurring.

EXAMPLE: Balancing a ration

Corn 8		32	80% x 4.1 = 3.28 lbs. of corn
	16		
Soybean meal 48		8	20% x 4.1 = .82 lb. of soybean meal
		40	

4) Remember that the 4.1 lbs. eaten daily is an average. In the winter, hogs will eat more than in the summer. To the average producer, using the above ration in the winter wastes money because it includes more amino acids than the hog needs. In the summer, the hog's appetite decreases and its needs are not met because it eats less than 4.1 lbs. a day. Figure 4.1 in the Student Reference shows this difference in eating habits.

5) If using the above ration, packers receive leaner hogs in the winter because hogs are eating more, so their amino acid needs are met, resulting in more muscle. In the summer, when hogs eat less, their amino acid needs are not met and fat is produced instead of muscle.

f) The processing of feedstuffs improves protein digestibility.

1) Compare raw soybeans to heated soybeans on Table 4.1 in the Student Reference. Crude protein remains about the same, but the digestibility of heated soybeans jumps up seven percent.

2) This concept also applies to digestibility of amino acids.

F. Other activities

1. "Litmus Milk Test," *Digestive System of Domesticated Animals (#8833-C).* Agriscience 332H: Advanced Animal Science. College Station, TX: Instructional Materials Service, Texas A & M University, 1990.

2. Compare feather meal (87% CP) and milk. Discus amino acid balances of the two.

3. Students can finish figuring the rest of the amino acids for the example ration to see if the ration is balanced. Or, they can make up a new ration with a new concentrate to see how closely the new ration meets the 100 lb. hog's amino acid requirements.

G. Conclusion

Understanding protein's role in nutrition is economically important because protein is one of the more expensive components in ration development.

H. Competency

Describe protein's role in nutrition.

I. Answers to Evaluation

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

UNIT I - NUTRITION

Name_________________

Lesson 4: Protein's Role in Animal Nutrition

Date_________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is true regarding amino acids?

    a. There are 10 essential and 13 nonessential amino acids.
    b. Amino acids are carbon compounds that originate from plant proteins.
    c. Non-ruminant animals can synthesize their own amino acids.
    d. Ruminants do not synthesize their own amino acids.

2. Which is *false* regarding proteins?

    a. Proteins are used in genetic compounds, such as DNA.
    b. Proteins are essential for body regulators, including enzymes and hormones.
    c. Urea can be fed to non-ruminant animals.
    d. When too much protein is used in the diet, the excess becomes fat.

3. Of the following plant proteins, which has the highest CP value?

    a. Cottonseed meal
    b. Sunflower meal
    c. Alfalfa hay
    d. Oat grain

4. Which is the information center that links amino acids together to form a specific protein the animal can use?

    a. Brain
    b. DNA
    c. RNA
    d. Stomach

Complete the following multiple answer questions.

5. Which are considered essential amino acids? (Check all that apply.)

____	a.	Arginine	____	f.	Valeucine
____	b.	Threonine	____	g.	Histidine
____	c.	Lysine	____	h.	Phenylalanine
____	d.	Lousine	____	i.	Isoleucine
____	e.	Valine	____	j.	Isocine

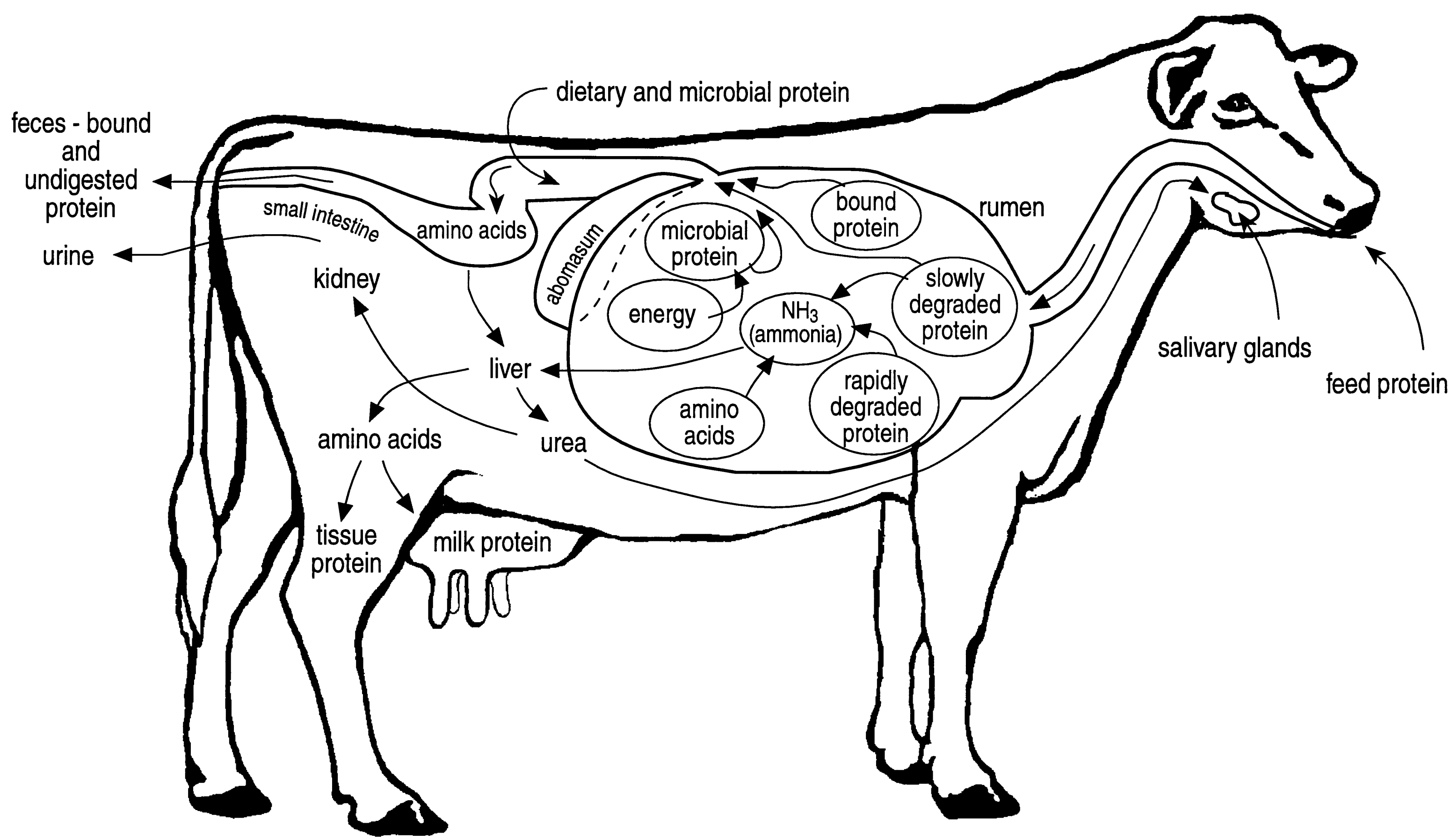
6. Mark with a check the symptoms of protein deficiency.

a.	___ Increased eye watering	e.	___ Poor growth
b.	___ Hearing loss	f.	___ Poor appetite
c.	___ Poor hair coat	g.	___ Diarrhea
d.	___ Lack of energy	h.	___ Lack of muscling

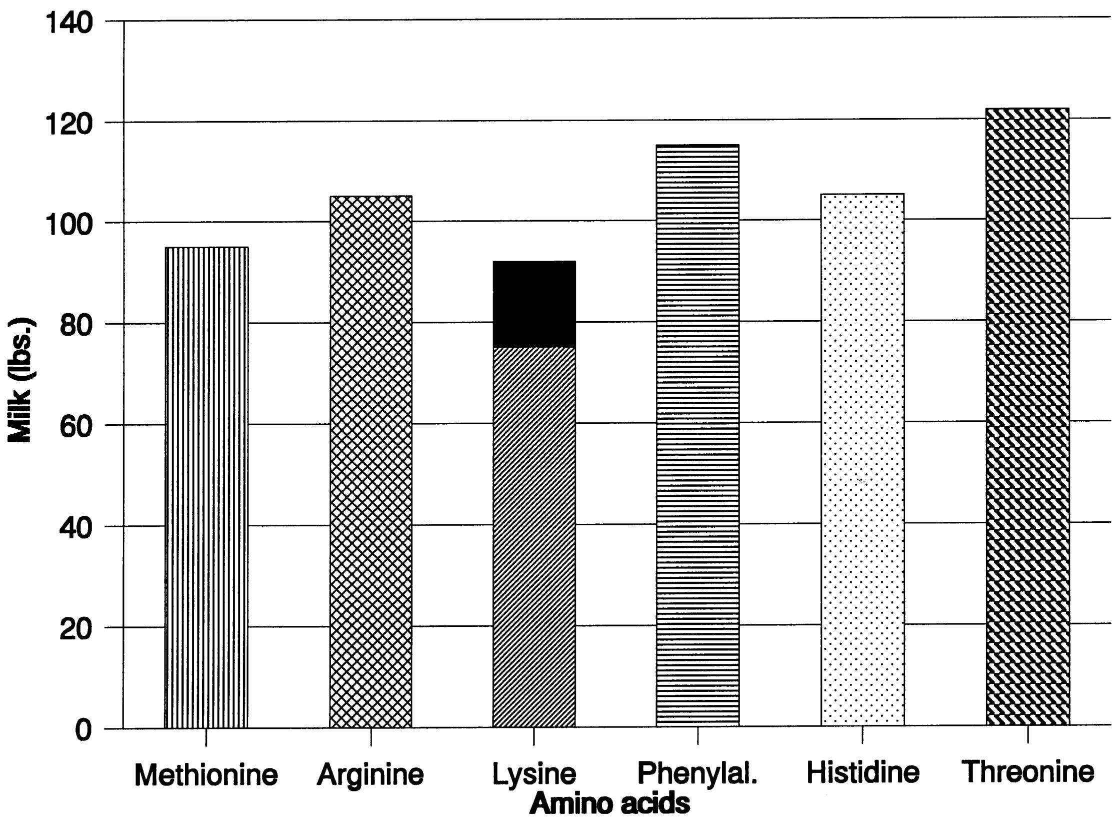
7. What factors need to be considered when determining amount of protein to be fed in a ruminant's diet?

a.	___ Amount of nonproteins fed	e.	___ The limiting amino acid
b.	___ Mineral content of protein	f.	___ Protein digestibility
c.	___ Vitamin content of protein	g.	___ Energy level in the protein
d.	___ Amount of true proteins fed	h.	___ Price of the protein

Protein Utilization in the Ruminant



Barrel Stave Illustration of the Effect of Limiting Amino Acid Supplementation on Milk Production



Darkest section shows effects of supplemental rumen-bypass lysine.

Credit: Jim Spain, Dairy Science Extension, University of Missouri-Columbia, 1994

UNIT I - NUTRITION

Lesson 5: Minerals' Role in Animal Nutrition

Objective: The student will be able to describe the function of minerals in animal nutrition.

Study Questions

1. **What basic minerals are required for proper animal nutrition?**

2. **What are the functions, deficiency and toxicity symptoms, and sources of macro-minerals?**

3. **What are the functions, deficiency and toxicity symptoms, and sources of micro-minerals?**

References

1. Student Reference

UNIT I - NUTRITION

Lesson 5: Minerals' Role in Animal Nutrition

TEACHING PROCEDURES

A. Review

Review the previous lesson on the role of protein in nutrition.

B. Motivation

1. What are some symptoms of mineral deficiencies in humans? What are the roles that minerals play in human nutrition? Deficiencies in calcium and phosphorus cause improper bone growth. Osteoporosis is caused by a lack of calcium. Deficiencies in magnesium cause major kidney malfunctioning and severe diarrhea. Shortages of sodium, chlorine, and potassium are rare, but in cases of severe diarrhea, burns, and vomiting, these minerals need to be replaced.

2. What happens if minerals are taken in excessive amounts by humans? In most cases, the human body will get rid of any excess amounts of minerals. Except for sodium, it is very difficult to consume too many minerals. (Sodium is connected to high blood pressure and fluid retention in the body.)

C. Assignment

D. Supervised study

E. Discussion

1. Ask students to discuss the minerals they know that are recommended for animals.

   What basic minerals are required for proper animal nutrition?

   a) Minerals are a group of inorganic elements needed by livestock for production and maintenance.
      1) Because they are inorganic, minerals cannot be synthesized by animals or microorganisms.
      2) If a particular mineral is needed, it must be provided in the diet in a form that can be digested, absorbed, and used in metabolism.
      3) Rations must be formulated so that a mineral imbalance does not occur.
   b) Dissolved minerals are absorbed into the bloodstream through villi in the small intestine. Leftover minerals are absorbed directly into the bloodstream through capillaries in the wall of the large intestine.
   c) Minerals are classified according to the dietary concentration needed to fulfill the animal's requirements.
      1) Macro- and micro-minerals are both important, but macro-minerals are needed in larger amounts. Macro-minerals are:
         (1) Calcium (Ca)
         (2) Salt--sodium chloride (NaCl)
         (3) Phosphorus (P)
         (4) Magnesium (Mg)
         (5) Potassium (K)

2) Trace or micro-minerals
   (1) Sulfur (S)
   (2) Chromium (Cr)
   (3) Cobalt (Co)
   (4) Copper (Cu)
   (5) Fluorine (F)
   (6) Iodine (I)
   (7) Iron (Fe)
   (8) Manganese (Mn)
   (9) Molybdenum (Mo)
   (10) Selenium (Se)
   (11) Silicon (Si)
   (12) Zinc (Zn)

d) General functions of minerals
   1) Filling in soft bone and teeth cells to make a cell that is hard and rigid
   2) Cell structure and integrity
   3) Part of organic compounds such as proteins, amino acids, carbohydrates, and fats
   4) Control the location of body water through osmotic pressure
   5) Provide an acid-base balance, which regulates the pH of body fluids at about 7.0
   6) Coenzymes that activate enzymes
   7) Necessary components of hormones
   8) Essential part of blood, body fluids, and some secretions in the body
   9) Egg production

e) Some minerals, such as arsenic, cadmium, mercury, and lead, are toxic to animals.

2. Discuss the functions of the required macro-minerals and what happens when enough minerals are not consumed.

What are the functions, deficiency and toxicity symptoms, and sources of macro-minerals?

a) Calcium (Ca)
   1) Major functions
      (1) Bone and teeth formation and maintenance
      (2) Approximately 99 percent of the body's calcium present in bones and teeth
      (3) Nerve function
      (4) Muscle contraction
      (5) Blood coagulation
      (6) Essential for milk production and for forming eggshells in poultry
   2) Deficiency symptoms
      (1) Rickets in youth
      (2) Osteoporosis in adults
      (3) Milk fever in dairy cows
      (4) Thin-shelled eggs, drop in egg production, and lowered hatchability in poultry
   3) Major interrelationships/toxicities
      (1) The calcium-to-phosphorus ratio is important.
      (2) Vitamin D is critical because a deficiency of vitamin D in the ration prevents the proper utilization of calcium.
      (3) Excess Ca reduces the absorption and utilization of Zn.
      (4) Excess Mg decreases Ca absorption, replaces Ca in the bones, and increases Ca excretion.

4) Good sources for animals
   (1) Oyster shells
   (2) Limestone
   (3) Protein supplements of animal origin
   (4) Legume forages, such as alfalfa or clover hay
   (5) Milk
   (6) Bonemeal

   NOTE: Only 20-30 percent of Ca in the average ration is absorbed from the intestinal tract and taken into the bloodstream.

b) Salt (sodium chloride, NaCl)
   1) Major functions
      (1) Salt helps maintain osmotic pressure in body cells, upon which depends the transfer of nutrients to the cells and the removal of waste materials.
      (2) Sodium (Na) is associated with muscle contraction and is important in making bile, which aids in the digestion of fats and carbohydrates.
      (3) Chlorine (Cl) is required for the formation of hydrochloric acid in the gastric juice, which is vital to protein digestion.
   2) Deficiency symptoms
      (1) Reduced growth and efficiency of feed utilization in growing animals
      (2) Reduced milk production and weight loss in adults
      (3) Lowered reproduction (infertility in males and delayed sexual maturity in females)
      (4) Craving for sodium, evidenced by behavior such as drinking urine or licking the ground
      (5) In laying hens, lowered production, loss of weight, and cannibalism
   3) Major interrelationships/toxicities
      (1) Salt toxicity, which is accentuated by low water intake, readily occurs in nonruminants. It is characterized by a staggering gait, blindness, and other nervous disorders.
      (2) Salt toxicity rarely occurs in ruminants.
      (3) Salt-starved ruminants can overeat if given unlimited access to salt, causing digestive disturbances or death.
   4) Good sources for animals
      (1) Salt given free choice
      (2) Salt added to the ration at a level of 0.25-0.50 percent

c) Phosphorus (P)
   1) Major functions
      (1) Bone and teeth formation and maintenance
      (2) Component of phospholipids, which are important in lipid transport and metabolism, as well as cell-membrane structure
      (3) Milk secretion
      (4) Energy metabolism
      (5) A component of RNA and DNA
      (6) Constituent of several enzyme systems
      (7) Affects conversion of carotene into vitamin A
      (8) Utilization of vitamin D
   2) Deficiency symptoms
      (1) Rickets in young
      (2) Osteoporosis in adults
      (3) Poor appetite
      (4) Breeding problems
      (5) Reduced egg production in hens
      (6) Poor utilization of vitamins A and D

3) Major interrelationships/toxicities
   (1) The Ca-P ratio is important.
   (2) Sufficient Vitamin D is necessary for P assimilation and utilization.
   (3) Excess Ca and Mg cause a decrease in P absorption.
   (4) P is more efficiently absorbed than calcium; about 70 percent of ingested phosphorus is absorbed.
   (5) Excess P may result in lameness and spontaneous fracture of long bones.
   (6) High P has a laxative effect.
4) Good sources for animals
   (1) Adequate level of vitamin D
   (2) Most cereal grains and their by-products (notably wheat bran)

d) Magnesium (Mg)
1) Major functions
   (1) Essential for normal skeletal development
   (2) Constituent of bones and teeth
   (3) Enzyme activator
   (4) Involved in activating certain enzyme systems and in protein digestion
   (5) Relaxes nerve impulses
   (6) Serves as a ruminant alkalizer and buffer
2) Deficiency symptoms
   (1) Vasodilation, with resulting reduction in blood pressure (shown by the flushing of the skin)
   (2) Hyperirritability
   (3) Grass tetany, characterized by loss of appetite, convulsions, staggering, and death
   (4) Decreased utilization of phosphorus
3) Major interrelationships/toxicities
   (1) Excess Mg upsets calcium and phosphorus metabolism.
   (2) Added Mg can cause a zinc deficiency.
4) Good sources for animals
   (1) Magnesium sulfate or oxide
   (2) Mixed with feed or in a commercial mineral

e) Potassium (K)
1) Major functions
   (1) Major cation (positively charged ion) in intracellular fluid, where it is involved in osmotic pressure and acid-base balance
   (2) Relaxes the heart muscle
   (3) Involved in secretion of insulin
   (4) Involved in carbohydrate metabolism and protein synthesis
2) Deficiency symptoms
   (1) Reduced growth
   (2) Unsteady gait
   (3) General muscle weakness
   (4) Diarrhea
   (5) Enlargement of the heart and kidneys, followed by death
   (6) May occur in dry lot finishing cattle or sheep on a high-concentrate ration
3) Major interrelationships/toxicities
   (1) Excessive levels of potassium interfere with magnesium absorption.
   (2) The resulting magnesium deficiency results in failure to retain potassium, leading to potassium deficiency.
   (3) Excessive salt intake depletes the body's potassium.
4) Good sources for animals--generally adequate in most animal rations

3. Ask the students about the functions of micro-minerals. What happens when too little (or too much) is fed?

What are the functions, deficiency and toxicity symptoms, and sources of micro-minerals?

a) Sulfur (S)
   1) Major functions
      (1) Sulfur is required as a component of sulfur-containing amino acids cystine and methionine.
      (2) A component of biotin, sulfur is important in lipid metabolism.
      (3) As a component of coenzyme A, sulfur is important in energy metabolism.
      (4) Sulfur is a component of hair, wool, and feathers.
   2) Deficiency symptoms
      (1) There is reduced and slowed growth, primarily due to not meeting the sulfur amino acid requirement for protein synthesis.
      (2) Sheep that are fed nonprotein nitrogen without sulfur supplements show reduced wool growth. (Wool contains about 4 percent sulfur.)
   3) Major interrelationships/toxicities--none
   4) Good sources for animals
      (1) Forages, especially legumes which are harvested in the earlier growth stages, should contain enough sulphur for ruminants.
      (2) Nonruminants should be provided sulfur-containing proteins.

b) Chromium (Cr)
   1) Major functions
      (1) Glucose metabolism
      (2) Activator of certain enzymes
      (3) Stabilizer of nucleic acids
      (4) Stimulation of the synthesis of fatty acids and cholesterol in the liver
   2) Deficiency symptoms
      (1) Impaired glucose tolerance
      (2) Disturbance of lipid and protein metabolism
   3) Supplements not generally needed

c) Cobalt (Co)
   1) Major functions
      (1) Essential for vitamin B_{12} synthesis
      (2) Used by rumen microorganisms in the growth of rumen bacteria
   2) Deficiency symptoms
      (1) Symptoms similar vitamin B_{12} deficiency are shown in cattle and sheep.
      (2) Ruminants grazing in cobalt-deficient areas show loss of appetite, reduced growth, and loss in body weight, followed by emaciation, anemia, and eventually death.
   3) Major interrelationships/toxicities
      (1) Related to vitamin B_{12}
      (2) Toxicity not likely
   4) Good sources for animals
      (1) Commercial minerals
      (2) Poultry by-product meal, soybean meal, and molasses

d) Copper (Cu)
   1) Major functions
      (1) Along with iron and vitamin B_{12}, necessary for hemoglobin formation
      (2) Essential in enzyme systems
      (3) Essential for hair development and pigmentation
      (4) Essential for lactation and reproduction

2) Deficiency symptoms
   (1) Fading hair coat
   (2) Severe diarrhea
   (3) Abnormal wool growth and straight, hairlike fibers
   (4) Condition known as swayback in newborn lambs
   (5) Nutritional anemia
3) Major interrelationships/toxicities
   (1) Excess copper is toxic; it accumulates in the liver, and death may result, especially in sheep.
   (2) Cu is involved in iron metabolism.
4) Good sources for animals
   (1) Trace-mineralized salt containing copper sulfate
   (2) Commercial minerals
5) Additional comments
   (1) A variable store of copper is located in the liver and spleen.
   (2) Milk is low in copper; therefore, young animals raised solely on milk may develop anemia.
   (3) Do not supply sheep with commercial minerals containing copper; it may be lethal because copper accumulates in bodies and does not metabolize.

e) Fluorine (F)
   1) Major function--necessary for sound bones and teeth
   2) Deficiency symptoms--uncommon
   3) Major interrelationships/toxicities
      (1) Large amounts of calcium, aluminum, or fat will lower the absorption of fluorine.
      (2) High dietary Ca depresses F uptake in bone
      (3) Since fluorine is a cumulative poison, toxic effects may not be noticed for some time.
      (4) High levels result in enlarged bones; softening, mottling, and irregular wear of the teeth; roughened hair coat; delayed maturity and less efficient utilization of feed.
   4) Good sources for animals--supplements not needed

f) Iodine (I)
   1) Major functions
      (1) Iodine is needed by the thyroid gland to make thyroxin.
      (2) Thyroxin controls the rate of body metabolism or heat production.
   2) Deficiency/toxicity
      (1) Goiter (big-neck) in humans, calves, lambs, and goats; stillbirths and weak young; hairless pigs and wool-less lambs at birth
      (2) No satisfactory treatment for animals that have developed pronounced iodine deficiency symptoms
      (3) Enlargement of the thyroid gland (goiter) is nature's way of trying to make enough thyroxin when there is insufficient iodine in the diet.
      (4) Long-term chronic intake of large amounts of iodine reduces the thyroid uptake of iodine.
   3) Good sources for animals
      (1) Calcium iodate
      (2) Iodized salt
      (3) Whey and molasses

g) Iron (Fe)
   1) Major functions
      (1) Constituent of hemoglobin, the iron-containing compound that transports oxygen in the blood
      (2) Plays a role in cellular oxidation

2) Deficiency symptom--iron-deficient anemia in nursing pigs in confinement
3) Major interrelationships/toxicities
   (1) Copper is required for proper Fe metabolism.
   (2) Too much iron interferes with phosphorus absorption.
4) Good sources for animals
   (1) Iron dextran given orally or by injection to young pigs
   (2) Leafy portions of plants
   (3) Legumes
   (4) Trace-mineralized salt
5) Additional comments
   (1) Iron is stored in the liver, spleen, and kidneys.
   (2) Young animals are born with a store of iron, but milk is low in iron. Therefore, if young animals continue on milk for a long time, particularly under confined conditions, anemia will likely develop.

h) Manganese (Mn)
1) Major functions
   (1) Essential for normal bone formation and growth of other connective tissues
   (2) Blood clotting
   (3) Synthesis of fatty acids
2) Deficiency symptoms
   (1) Poor growth
   (2) Lameness, shortening, and bowing of the legs, and enlarged joints
   (3) Swollen and stiff joints
   (4) Impaired reproduction
   (5) Slipped tendons in poultry
   (6) Pinkeye
3) Major interrelationships/toxicities
   (1) Excess Ca and P decrease absorption.
   (2) Mn is not toxic in moderate excesses.
4) Good sources for animals
   (1) Trace-mineralized salt
   (2) Rice, wheat, and hay

i) Molybdenum (Mo)
1) Major functions
   (1) Component of three different enzyme systems involved in the metabolism of carbohydrates, fats, proteins, and iron
   (2) Stimulates action of rumen organisms
2) Deficiency symptoms--none
3) Major interrelationships/toxicities
   (1) Utilization is reduced by excess copper sulfate and tungsten.
   (2) Molybdenum is related to uric acid formation in poultry and microbial action in ruminants.
   (3) Toxic levels of Mo interfere with copper metabolism.
   (4) Mo toxicity results in severe scours and loss of condition.
4) Good sources for animals--no supplementing of normal rations necessary

j) Selenium (Si)
1) Major functions
   (1) Protects tissue against certain poisonous substances, such as arsenic, cadmium, and mercury
   (2) Involved in vitamin E absorption and retention
   (3) Prevents degeneration and fibrosis of the pancreas in chicks

2) Deficiency symptoms
   (1) Nutritional muscular dystrophy (called white muscle disease in calves) or stiff lamb disease in sheep
   (2) Liver damage in swine
3) Major interrelationships/toxicities
   (1) Excess selenium consumption results in blind staggers, lameness, anemia, excess salivation, grinding of the teeth, and blindness.
   (2) Excess in poultry results in reduced egg production and deformities such as lack of eyes and deformed wings and feet.
4) Good sources for animals
   (1) Marine by-products, such as seaweed and kelp
   (2) Cereal grains and wheat by-products

k) Silicon (Si)
   1) Major function--necessary for normal growth and skeletal development of chicks
   2) Deficiency symptoms
      (1) Slow growth
      (2) Skeletal deformities, especially in the skull
   3) Good sources for animals--present in large amounts in soil and plants
   4) Additional comments--On purified diets, the addition of silicon has increased the growth rate of chicks.

l) Zinc (Zn)
   1) Major functions
      (1) Needed in normal skin, bones, hair, and wool
      (2) Component of several enzyme systems
      (3) Gives bloom to the hair coat
   2) Deficiency symptoms
      (1) Loss of appetite
      (2) Stunted growth
      (3) Poor hair or feather development
      (4) Rough and thickened skin in swine (parakeratosis)
   3) Major interrelationships/toxicities
      (1) Excess calcium reduces the absorption and utilization of zinc.
      (2) Excess zinc interferes with copper metabolism and may cause anemia.
   4) Good sources for animals
      (1) Fish meal
      (2) Corn gluten feed and meal
      (3) Poultry by-products
      (4) Added to trace-mineralized salt

F. Other activities

1. Have students bring in tags from various commercial mineral mixes and compare the amounts and types of minerals that are present.

2. Invite a nutrition specialist or feed representative talk about the importance of minerals in an overall nutrition plan.

3. Obtain videos to show abnormalities in animals. Contact Creative Educational Videos, PO Box 65265, Lubbock, TX 79424 (800/922-9965) for:

   a) Cattle Abnormalities (26 min., #2010108WIS15002Q)
   b) Sheep Abnormalities (24 min., #2010108WIS15000Q)
   c) Swine Abnormalities (26 min., #2010108WIS15001Q)

G. Conclusion

At least 18 mineral elements are needed by animals. Those needed in large amounts are referred to as major or macro-minerals, while those needed in small amounts are called trace or micro-minerals. Minerals are required for the development of bones and teeth, as well as for many other functions in the body. Deficiencies cause lower production and poor gains, but rarely cause diseases or death. Commercial feeds and mineral mixes are the most common sources of minerals in livestock rations. Minerals can be mixed in complete feeds or fed free choice.

H. Competency

Describe minerals' role in nutrition.

I. Answers to Evaluation

1. a
2. h
3. g
4. f
5. d
6. i
7. e
8. b
9. j
10. i
11. a
12. g
13. d
14. f
15. h

16. Any four of the following:
    a. Filling in soft bone and teeth cells to make a cell that is hard and rigid
    b. Cell structure and integrity
    c. Part of organic compounds such as proteins, amino acids, carbohydrates, and fats
    d. Control the location of body water via osmotic pressure
    e. Provide an acid-base balance, which regulates the pH of body fluids at about 7.0
    f. Coenzymes that activate enzymes
    g. Necessary components of hormones
    h. Essential part of blood, body fluids, and some secretions in the body
    i. Egg production

17. Sodium = Na
    Potassium = K
    Magnesium = Mg
    Copper = Cu
    Iron = Fe

18. Small intestine and large intestine

UNIT I - NUTRITION | Name__________________

Lesson 5: Minerals' Role in Animal Nutrition | Date__________________

EVALUATION

Match the following minerals on the right with their corresponding functions on the left.

___ 1. Bone and teeth formation; nerve function; muscle contraction and blood coagulation.

___ 2. Helps maintain osmotic pressure in body cells; required for muscle contraction; required for making bile and hydrochloric acid

___ 3. Relaxes the heart muscle and is involved in the secretion of insulin

___ 4. Component of RNA and DNA

___ 5. Needed by the thyroid gland to produce thyroxin

___ 6. Needed for normal skin, bones, hair, and feathers

___ 7. Constituent of hemoglobin; plays a role in cellular oxidation

a. Calcium
b. Copper
c. Fluorine
d. Iodine
e. Iron
f. Phosphorus
g. Potassium
h. Salt
i. Zinc

Match the following minerals on the right with their correct deficiency symptom(s) on the left.

___ 8. Emaciation, anemia, and eventually death in ruminants

___ 9. Rough and thickened skin in swine (parakeratosis)

___ 10. Stunted growth and skeletal deformities in chicks

___ 11. Tetany or milk fever in cows

___ 12. Enlargement of the heart and kidneys

___ 13. Goiter (enlargement of the thyroid gland)

___ 14. Lameness, swelling of the joints, and fragility of the bones

___ 15. White muscle disease in calves and stiff lamb disease in sheep

a. Calcium
b. Cobalt
c. Fluorine
d. Iodine
e. Iron
f. Manganese
g. Potassium
h. Selenium
i. Silicon
j. Zinc

Complete the following short answer questions.

16. List four general functions of minerals.

    a.

    b.

    c.

    d.

17. Give abbreviations for the following minerals.

    a. Sodium =

    b. Potassium =

    c. Magnesium =

    d. Copper =

    e. Iron =

18. Where minerals are absorbed?

UNIT I - NUTRITION

Lesson 6: Vitamins' Role in Animal Nutrition

Objective: The student will be able to describe the function of vitamins in livestock nutrition.

Study Questions

1. **What basic vitamins are required?**

2. **What are the functions, deficiency symptoms, and important sources of fat-soluble vitamins?**

3. **What are the functions, deficiency symptoms, and important sources of B complex vitamins?**

4. **What are the functions, deficiency symptoms, and important sources of other water-soluble vitamins?**

References

1. Student Reference

UNIT I - NUTRITION

Lesson 6: Vitamins' Role in Animal Nutrition

TEACHING PROCEDURES

A. Review

Review previous lesson on the role of minerals in animal nutrition.

B. Motivation

1. What are some vitamin deficiencies found in humans? What are the functions of vitamins in human nutrition? Deficiencies of vitamin A cause night blindness, rough skin, stunted growth, and eyes that are light sensitive. Deficiencies of vitamin D cause improper usage of calcium and phosphorus, which can result in rickets. Deficiencies of vitamin E are very rare. Severe vitamin K deficiency causes hemorrhaging. A lack of vitamin C causes loss of appetite, soreness of joints, bleeding gums, bruising, and scurvy. In humans and dogs, a lack of folic acid can result in a sore, red tongue, disturbance of the digestive tract, and poor growth.

2. What happens if vitamins are taken in excessive amounts by humans? Extra amounts of vitamins are discarded by the body, but there are extreme cases for each vitamin. Too much vitamin C may cause diarrhea. Too much vitamin K or E may be toxic. Excessive vitamin D may result in severe damage to kidneys, lungs, and bones. Too much vitamin A may cause fatigue, headaches, vomiting, and nausea.

3. What are some similarities between swine and humans? How are the nutrient requirements the same? Both swine and humans cannot produce B-complex vitamins. These vitamins must be provided in their diet.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students to discuss why vitamins are important and what vitamins are required for good nutrition.

What basic vitamins are required?

a) General definition
   1) Vitamins are a feedstuff component distinct from carbohydrates, fat, protein, minerals, and water.
   2) They are essential for development of tissues and the growth and maintenance of the animal.

b) Classification by solubility
   1) Fat-soluble vitamins
      (a) Stored in the animal's fat tissue
      (b) Enable livestock to survive on vitamin-deficient diets for lengths of time without deficiency symptoms.
      (c) Includes:
         (1) Vitamin A

(2) Vitamin D
(3) Vitamin E
(4) Vitamin K

2) Water-soluble vitamins
   (a) Stored within the animal for only 2-4 days
   (b) Must be contained in the diet
   (c) Includes:
      (1) Inositol
      (2) Niacin
      (3) Vitamin C
      (4) B_1 (thiamine)
      (5) B_2 (riboflavin)
      (6) B_3 (pantothenic acid)
      (7) B_6 (pyridoxine)
      (8) B_{12}
      (9) Biotin
      (10) Choline
      (11) Folic acid
      (12) Para-aminobenzoic acid (PABA)

c) General sources for all vitamins
   1) Protein supplements
   2) Mineral premixes
   3) Feed tags show the guaranteed minimum and maximum percentages of calcium, minimum percentage of phosphorus, and minimum and maximum percentages of salt in the feed.
   4) Vitamins are usually added to mixed rations or provided free choice.

d) Arsenic, cadmium, lead, and mercury are all toxic to livestock. Prevent contamination of feed by these elements.

2. Discuss with students the functions of the various required vitamins that dissolve in fat.

What are the functions, deficiency symptoms, and important sources of fat-soluble vitamins?

a) Vitamin A
   1) Major functions
      (a) Eyesight maintenance (formation of visual purple in the eye for night vision)
      (b) Essential for body growth, bone growth, and normal tooth development
      (c) Epithelial tissue maintenance in respiratory, urogenital, and digestive tracts, and the skin
   2) Deficiency symptoms
      (a) Night blindness and potential blindness
      (b) Stunted growth or loss of weight and loss of appetite
      (c) Nervous incoordination as shown by a staggering gait
      (d) Unsound teeth and rough, dry skin
      (e) Sterility in males and females
      (f) Wobbly gait in chicks
      (g) Reduced egg production and hatchability in hens
   3) Good sources for animals
      (a) Vitamin A can be provided as a synthetic vitamin or as carotene.
      (b) Major sources of carotene are:
         (1) Leafy green hays, not over one year old
         (2) Grass silage

(3) Lush green pastures
(4) Whole milk
(5) Dehydrated alfalfa meal
(6) Yellow corn

4) Additional comments
(a) Vitamin A itself is only present in animals. Plants contain the precursor, carotene.
(b) Animals can store considerable amounts of vitamin A. Young animals suffer from deficiency sooner because of their greater requirements and reduced storage ability.
(c) Vitamin A and carotene are readily destroyed by oxidation, thus resulting in considerable losses in processing and storing (such as in making and storing hay).

b) Vitamin D
1) Major functions
(a) Aids in the assimilation and utilization of calcium and phosphorus
(b) Necessary for the normal bone development of animals, including the bone in the fetus
(c) Promotes sound teeth
2) Deficiency symptoms
(a) Rickets in young
(b) Osteoporosis in adults
(c) Tetany, which is characterized by muscle twitching, convulsions, and low serum calcium
(d) Poor eggshells and lowered hatchability in hens
3) Good sources for animals
(a) Sunlight
(b) Sun-cured hays
4) Additional comments
(a) When animals are exposed to direct sunlight, the ultraviolet light in the sunlight penetrates the skin and produces vitamin D from traces of certain cholesterol in the tissues.
(b) Tissue storage is very limited.
(c) The vitamin D requirement is less when the proper balance of calcium and phosphorus exists.

c) Vitamin E
1) Major functions
(a) Antioxidant
(b) Essential for the integrity of red blood cells
(c) Essential in cellular respiration, primarily in heart and skeletal muscle tissue
(d) Regulator in the synthesis of DNA and vitamin C
2) Deficiency symptoms
(a) Muscular dystrophy (stiff-limb disease in lambs and white muscle disease in calves)
(b) Reproductive failure
(c) Poor hatchability in hens
3) Good sources for animals
(a) Rice polishings
(b) Wheat germ meal
(c) Alfalfa meal
(d) Green grass
(e) Early cut hay

4) Additional comments
   (a) Vitamin E is widely distributed in all natural feeds.
   (b) Utilization of vitamin E depends on adequate selenium.

d) Vitamin K
   1) Major function--essential for blood clotting
   2) Deficiency symptoms
      (a) Prolonged blood clotting time
      (b) Generalized hemorrhages
      (c) Death, in severe cases
   3) Good sources for animals
      (a) Green pastures
      (b) Well-cured hays
      (c) Fish meal
      (d) Usually widely distributed in normal farm rations
      (e) Synthesized by all classes of farm animals

      NOTE: A well-known enemy of vitamin K is dicoumarol, which is present in moldy sweet clover hay.

3. Discuss with students the functions of the various B vitamins, which are water-soluble. Do they have similarities?

   What are the functions, deficiency symptoms, and important sources of B complex vitamins?

   a) Biotin
      1) Major functions
         (a) Required in many reactions in the metabolism of carbohydrates, fats, and proteins
         (b) Serves as a coenzyme for transferring CO_2 from one compound to another
         (c) Serves as a coenzyme for the production of energy
      2) Deficiency symptoms
         (a) Pigs exhibit spastic hind legs, cracks in the feet, dermatitis, and lower feed efficiency.
         (b) Hatchability is severely reduced in hens.
      3) Good sources for animals
         (a) Synthetic biotin
         (b) Alfalfa meal
         (c) Black strap molasses
         (d) Green forages
         (e) Soybean meal
      4) Ordinary farm rations probably contain ample biotin, or farm animals synthesize all they need.
   b) Choline
      1) Major functions
         (a) Involved in the prevention of fatty livers
         (b) Involved in transmitting nerve impulses
         (c) Involved in the metabolism of fat
      2) Deficiency symptoms
         (a) Poor growth and fatty livers in most species
         (b) Slipped tendons in chickens and turkeys
         (c) In swine, abnormal gait in growing pigs and reproductive failure in adult females
      3) Good sources for animals
         (a) Soybean lecithin

- (b) Yeast
- (c) Canola meal
- (d) Fish meal

4) Additional comments
- (a) With a high-protein diet, enough choline is synthesized from certain precursors and amino acids.
- (b) Deficiency symptoms are more visible as the protein content is lowered.

c) Folic acid

1) Major functions
- (a) Involved in combining single carbon units into larger molecules
- (b) Related to vitamin B_{12} metabolism
- (c) Formation of many essential amino acids

2) Deficiency symptoms
- (a) In chicks, reduced growth and depigmentation of colored feathers
- (b) Lower egg production and hatchability

3) Good sources for animals
- (a) Synthetic folacin
- (b) Wheat germ
- (c) Soybean meal
- (d) Alfalfa hay
- (e) Cottonseed meal

d) Vitamin B_1 (thiamine)

1) Major functions
- (a) Coenzyme in energy metabolism
- (b) Functioning of the peripheral nerves
- (c) Maintains normal appetite
- (d) Maintains muscle tone
- (e) Maintains healthy mental attitude

2) Deficiency symptoms
- (a) Utilization of thiamin is hindered by high fat diets.
- (b) Reduced appetite, anorexia, and loss in weight
- (c) Slower heartbeat and enlargement of the heart
- (d) Lowered body temperature
- (e) Lowered egg production in hens

3) Good sources for animals
- (a) Dietary source of vitamin B_1 needed for all animals but ruminants
- (b) Cereal grains
- (c) Green, leafy hay
- (d) Commercial vitamin premixes

e) Riboflavin (vitamin B_2)

1) Major functions
- (a) Promotes growth and functions in the body as a constituent of several enzyme systems
- (b) Important in carbohydrate, fatty acid, and amino acid metabolism

2) Deficiency symptoms
- (a) Stunted growth
- (b) Periodic moon blindness in horses
- (c) Reproductive failure in the sow
- (d) Slow growth, anemia, diarrhea, and abnormal gait in the young pig
- (e) Curled toe paralysis in birds

3) Good sources for animals
- (a) Synthetic riboflavin
- (b) Milk
- (c) Alfalfa hay

        (d) Green pastures
    4) Additional comments
        (a) Grains are poor sources of riboflavin.
        (b) Many common rations, especially swine and poultry rations, are borderline or deficient in riboflavin.
        (c) Riboflavin is destroyed by light or heat.

f) Vitamin B_3 (pantothenic acid)
    1) Major functions
        (a) B_3 is a component of coenzyme A, which is required for energy metabolism.
        (b) Coenzyme A is required by the cells in the biosynthesis of fatty acids.
    2) Deficiency symptoms
        (a) All species exhibit reduced growth, loss of hair, and enteritis.
        (b) Signs of deficiency in calves are a rough coat, dermatitis, anorexia, and loss of hair around the eyes. (Mature ruminants synthesize vitamin B_3 in the rumen.)
    3) Good sources for animals
        (a) Yeast
        (b) Whey
        (c) Alfalfa meal
    4) Additional comments
        (a) Grain is very deficient in vitamin B_3.
        (b) Of all the B vitamins, B_3 is most likely to be deficient under dry lot conditions.
        (c) Vitamin B_3 is commonly added to commercial swine and poultry rations.

g) Vitamin B_6 (pyridoxine)
    1) Major functions
        (a) Coenzyme in protein and nitrogen metabolism
        (b) Involved in red blood cell formation and in absorption of amino acids
        (c) Involved in carbohydrate and fat metabolism
    2) Deficiency symptoms
        (a) All species exhibit convulsions.
        (b) Pigs show anorexia and poor growth.
        (c) Chicks experience stunted growth and abnormal feathering.
        (d) Hens show lowered egg laying and hatchability.
    3) Good sources for animals
        (a) Green pasture
        (b) Wheat
        (c) Alfalfa hay
    4) Additional comments
        (a) B_6 is synthesized in the rumen of cattle and sheep and perhaps in the cecum of the horse.
        (b) Normally, animal rations are not lacking in vitamin B_6.

h) Vitamin B_{12}
    1) Major functions
        (a) B_{12} functions as a coenzyme in a variety of metabolic reactions.
        (b) B_{12} is necessary for the maturation of red blood cells.
    2) Deficiency symptoms
        (a) Generally, there is stunted growth.
        (b) Pigs show uncoordinated hind leg movements, and there is reproductive failure in sows.
        (c) Eggs from B_{12} deficient hens do not hatch.
    3) Good sources for animals
        (a) Synthetic B_{12}

(b) Protein supplements of animal origin
(c) Fermentation products
4) Additional comments
(a) Ruminants synthesize B_{12} in the rumen.
(b) B_{12} is apt to be lacking in swine and breeder poultry rations.

i) Para-aminobenzoic acid (PABA)
1) Major functions
(a) Essential part of the folacin molecule
(b) Essential growth factor for certain microorganisms
2) Deficiency symptoms are not demonstrated in animals.
3) Good sources for animals
(a) Synthetic PABA
(b) Lecithin
(c) Soybean meal
(d) Peanut meal
4) PABA is abundantly synthesized in the intestines.

4. Discuss with students the functions of other water-soluble vitamins, besides the B complex. Do they have similarities?

What are the functions, deficiency symptoms, and important sources of other water-soluble vitamins?

a) Inositol
1) Major functions
(a) In combination with choline, it prevents hardening of the arteries and protects the heart.
(b) Inositol helps reduce blood cholesterol.
2) Deficiency symptoms are not demonstrated in animals.
3) Good sources for animals
(a) Synthetic inositol
(b) Yeast
(c) Liver meal
4) Additional comments
(a) Widely distributed in animal feeds
(b) Synthesized in the intestines

b) Niacin
1) Major functions
(a) Constituent of two coenzymes, which are necessary in cell respiration
(b) Necessary to release energy from carbohydrates, fats, and protein
2) Deficiency symptoms
(a) Often, there is reduced growth and appetite.
(b) Swine have diarrhea, vomiting, dermatitis, unthriftiness, and ulcerated intestines.
(c) Chicks show poor feathering and scaly dermatitis.
3) Good sources for animals
(a) Synthetic niacin
(b) Meat and bone meal
(c) Green alfalfa
4) Additional comments
(a) Niacin is a dietary essential for pigs, chickens, and humans.
(b) It is synthesized in the digestive tract of ruminants. Mature ruminants do not need dietary niacin under most conditions because of rumen bacteria.

(c) Niacin that is present in most cereal grains is not available to pigs and other simple-stomached animals.

c) Vitamin C (ascorbic acid)
   1) Major functions
      (a) Necessary for collagen formation
      (b) Absorption and movement of iron
      (c) Metabolism of fats and lipids and cholesterol control
      (d) Sound teeth and bones
      (e) Strong capillary walls and healthy blood vessels
      (f) More needed in periods of stress
   2) Deficiency symptoms
      (a) Scurvy--swollen, bleeding, and ulcerated gums
      (b) Loosening of teeth
      (c) Weak bones
   3) Good sources for animals
      (a) Vitamin C
      (b) Citrus pulp
      (c) Well-cured hay
      (d) Green pasture
   4) Ordinary rations and body synthesis provide adequate vitamin C.

F. Other activities

1. Have students formulate a nutrition plan for various species, include the necessary vitamin supplements that would be needed, and justify the need.

2. Have a nutrition specialist speak to the class about the importance of vitamins in a ration.

G. Conclusion

Vitamins are organic compounds essential for life but needed only in trace amounts. Sixteen vitamins have been identified as essential in animal nutrition. They are classified by their solubility--either fat-soluble or water-soluble. Fat-soluble vitamins can be stored in the body, reducing the need for dietary sources. Water-soluble vitamins are not generally stored in the body and need to be supplied in the animal's diet. Vitamins play a vital role in various functions of the body's system and are an important part of the animal's overall nutrition.

H. Competency

Describe vitamins' role in nutrition.

I. Answers to Evaluation

1.	j	6.	g
2.	b	7.	h
3.	a	8.	e
4.	d	9.	c
5.	i	10.	f

11. Fat-soluble and water-soluble. Fat-soluble vitamins can be stored in the body, whereas water-soluble vitamins cannot. Therefore, the water-soluble vitamins must be supplied in the diet on daily basis.

UNIT I - NUTRITION

Name__________________

Lesson 6: Vitamins' Role in Animal Nutrition

Date__________________

EVALUATION

Match each vitamin on the right with the appropriate function on the left.

___ 1. Aids in assimilation and use of calcium and phosphorus; promotes normal bone development

___ 2. Essential for blood clotting

___ 3. Prevents night blindness; necessary for the maintenance of epithelial tissue

___ 4. Involved in red blood cell formation and in absorption of amino acids

___ 5. Maintains normal appetite, muscle tone and healthy mental attitude

___ 6. Component of coenzyme A; required for energy metabolism and of acyl carrier protein (ACP)

___ 7. Promotes growth and functions in the body as a constituent of several enzyme systems; is important in carbohydrate, fatty acid, and amino acid metabolism

___ 8. Necessary for cell respiration and in energy release from carbohydrates, fats, and protein

___ 9. Necessary for collagen formation and for iron absorption and movement

___ 10. Serves as a coenzyme for transferring CO_2 from one compound to another

a. Vitamin A

b. Vitamin K

c. Vitamin C

d. Vitamin B_6

e. Niacin

f. Biotin

g. Vitamin B_3 (pantothenic acid)

h. Vitamin B_2 (riboflavin)

i. Vitamin B_1 (thiamin)

j. Vitamin D

k. Vitamin B_{12}

Complete the following short answer question.

11. What are the two ways in which vitamins are classified?

Explain the differences between these ways.

UNIT I - NUTRITION

Lesson 7: Water's Role in Animal Nutrition

Objective: The student will be able to understand the function of water in animal nutrition.

Study Questions

1. **What is the function of water?**

2. **What are daily requirements for water?**

3. **What is water toxicity, and what are its symptoms?**

4. **What happens if there is an inadequate water supply?**

References

1. Student Reference

UNIT I - NUTRITION

Lesson 7: Water's Role in Animal Nutrition

TEACHING PROCEDURES

A. Review

Review previous lesson on vitamins' role in animal nutrition.

B. Motivation

Why is water important to the human body? What happens when the human body is lacking water? Water makes up 50-75 percent of a human's weight. It helps in digestion, cell growth, chemical reactions, body temperature regulation, joint lubrication, and body structure and shape. Lack of water can cause kidney failure, fever, increased pulse rate, and flushed skin.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students why water is so vital in the lives of humans. How many of these functions apply to livestock?

   What is the function of water?

   a) Important part of the body fluids
      1) Lubricates joints
      2) Lubricates eyes
      3) Acts as a cushion for nerves
      4) Helps conduct sound in the ear
      5) Helps dilute toxic substances, such as urea, and carry them through the digestive system (Urea is harmless to the urinary tract if it is diluted in water.)
   b) Important part in the circulatory system
      1) Transfers heat from one part of the body to another, like a car radiator
      2) Cools the animal's body since animals do not have sweat glands to keep cool them like humans (They use evaporation of water to cool the body.)
   c) Important part in gas exchange in the body
      1) Water vapor is mixed with other gases and expelled during respiration.
      2) Water is used in body temperature regulation.
   d) Acts as a carrier in the mouth
      1) Carries chemicals in food to taste buds for the animal's recognition
      2) Aids in maintaining an animal's body shape
      3) Used in metabolism, digestion, and absorption of nutrients in the animal
      4) Essential in the bloodstream to carry and transport nutrients throughout the animal's body
      5) Aids in the elimination of waste products in the animal, usually in the urine and fecal material

2. See if students know what determines daily water requirements in livestock. Discuss which conditions change an animal's need for water.

What are daily requirements for water?

a) Daily requirements for livestock depend on the following:
   1) Species
   2) If the animal is lactating, since milk consists of 87 percent water
   3) Age, because younger animals require more water and have higher water content in their bodies
   4) Environmental temperature (Consumption increases when environmental temperatures increase.)
   5) The amount of exercise the animal gets (Water consumption increases as the animal becomes more active.)
   6) Moisture content of diet (Feeds with higher moisture content decrease the animal's free consumption.)
   7) Environmental humidity (As humidity increases, so does water consumption.)
   8) Level and kind of production of the animal (such as gestating, lactating, wool or meat producing)
   9) Mineral content of the animal diet (As the mineral content of the diet increases, so do the water requirements.)
b) Average daily requirements of livestock
   1) Beef cattle
      (a) Growing cattle
         (1) 100 lbs. = 1.5 gallons
         (2) 400 lbs. = 5 gallons
         (3) 800 lbs. = 7 gallons
      (b) Mature, fattening cattle = 9 gallons
      (c) Lactating = 10-15 gallons
   2) Lactating dairy cattle
      (a) Average production = 12-25 gallons
      (b) Heavy production = 35+ gallons
   3) Growing sheep
      (a) 20 lbs. = .5 gallon
      (b) 50 lbs. = .4 gallon
      (c) 150-200 lbs. = 1+ gallons
   4) Growing swine
      (a) 50 lbs. = 1+ gallons
      (b) 100 lbs. = 1.5+ gallons
   5) Mature swine
      (a) Pregnant = 5+ gallons
      (b) Lactating = 6+ gallons
c) Sources of water
   1) For drinking
      (a) Drinking water must be fresh, clean, and provided at all times for the animal's use.
      (b) Moisture in feed provides some water.
      (c) Fresh green pastures are 80 percent moisture.
      (d) Green cut forages, such as silage, have 65-75 percent moisture.
      (e) Dry harvested forages, such as hay, are 15 percent moisture.
      (f) Many grains, such as corn, have 10-15 percent moisture.
   2) From body metabolism
      (a) Some water is produced when fats, proteins, and carbohydrates are digested and metabolized.

(b) This source is impractical when figuring the animal's needs.

3. Ask students if they have ever heard of water toxicity. How do they know if an animal has acquired water toxicity?

What is water toxicity, and what are its symptoms?

a) Water toxicity is dehydration accompanied by concentration of sodium and other ions in the brain cells that cause cerebral edema if:
   1) Thirsty animals are suddenly given fresh water.
   2) Dehydrated body tissues can't overcome the sudden overdose of water that the animal tries to drink to overcome its thirst.
   3) Toxicity is more common in calves or young animals because they try to drink 35-50 percent of total body water within a half hour period.
b) Symptoms of water toxicity
   1) Hemoglobinuria (red urine)
   2) Diarrhea
   3) Irregular heart beat
   4) Body hair stands on end
   5) Excessive salivation
   6) Extended position of the head and neck
   7) Fluids collecting in soft tissues under the skin; appears as apparently swollen eyelids
   8) Nervousness
      (a) Animal's walk appears unstable.
      (b) Excessive licking and rubbing occur.
   9) Coma, then death
c) Guidelines for treatment of water toxicity
   1) Administer saline or hypertonic glucose intravenously to remove excess water from body tissues.
   2) Give animal salt water.
   3) Be especially observant of animals if there was a lack of water for a long time.
   4) It takes 4-6 hours for water toxicity to be fatal.

4. Ask students what happens when there is insufficient water for humans. Is it the same for livestock?

What happens if there is an inadequate water supply?

a) Occurrences in animals with low water intake
   1) Lack of appetite (eats less feed)
   2) Blood thickens
   3) Weight loss
   4) Reduction in performance and production
   5) Possible death by dehydration
b) Normal body functions that can increase water intake
   1) If animal develops scours or diarrhea, more water is needed. Water is lost because of a digestive disturbance.
   2) Through respiration, moist air is exhaled during respiration.
   3) When excess body heat leaves the animal's body through moist air, water is lost.

F. Other activities

Check with Extension and/or public health department employees for proper water sampling methods. Students can bring in water samples yearly for testing by Extension personnel. Contact the public health department for litmus paper testing (nitrogen) availability.

G. Conclusion

Understanding the roles of nutrients is vital for the management of livestock. A deficiency in one or more nutrients can cause severe losses in the production of livestock. Water is critical in maintaining all animal body functions; understanding this concept will lead to success as a livestock producer.

H. Competency

Describe the role of water in nutrition.

I. Answers to Evaluation

1. a
2. c
3. a

4. Six of the following:
    a) Lubricates joints
    b) Lubricates eyes
    c) Acts as a cushion for nerves
    d) Helps conduct sound in the ear
    e) Helps dilute toxic substances carry them through the digestive system
    f) Transfers heat from one part of the body to another
    g) Cools the animal's body by evaporation since animals do not have sweat glands to keep cool them like humans
    h) Mixes with other gases and expelled during respiration
    i) Used in body temperature regulation
    j) Carries chemicals in food to taste buds for the animal's recognition
    k) Aids in maintaining an animal's body shape
    l) Used in metabolism, digestion, and absorption of nutrients in the animal
    m) Essential in the bloodstream to carry and transport nutrients
    n) Aids in the elimination of waste products in the animal

5. Two of the following:
    a) Administer saline or hypertonic glucose intravenously to remove excess water from body tissues.
    b) Give animal salt water.
    c) Be especially observant of animals if there was a lack of water for a long time.

6. Two of the following:
    a) If animal develops scours or diarrhea
    b) Through respiration
    c) When excess body heat leaves the animal's body through moist air

UNIT I - NUTRITION

Lesson 7: Water's Role in Animal Nutrition

Name__________________

Date__________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is NOT a symptom of water toxicity?

   a. Tail extension
   b. Coma
   c. Diarrhea
   d. Swollen eyelids

2. How long does it take for water toxicity to be fatal?

   a. 45 minutes
   b. 1-2 hours
   c. 4-6 hours
   d. 8 hours

3. Which is true regarding water?

   a. Water acts as a cushion for nerves within the body.
   b. Water produced by body metabolism is important in figuring an animal's water needs.
   c. Decreased environmental humidity increases the animal water consumption.
   d. Increased appetite is a sign of inadequate water supply.

Complete the following short answer questions.

4. List six functions of water.

   a.

   b.

   c.

   d.

   e.

   f.

5. List two treatments for water toxicity.

   a.

   b.

6. List two normal body functions that can increase water intake.

   a.

   b.

UNIT I - NUTRITION

Lesson 8: Environmental Effects on Nutrition

Objective: The student will be able to determine the environmental effects on animal nutrition.

Study Questions

1. **What is included in the animal's environment?**

2. **Identify weather factors that affect nutrition requirements and how animals react to them.**

3. **What are other factors affecting nutrition needs, and how do animals react?**

4. **How do feed requirements and production yields vary with temperature?**

References

1. Student Reference

UNIT I - NUTRITION

Lesson 8: Environmental Effects on Nutrition

TEACHING PROCEDURES

A. Review

Review previous lesson on water's role in animal nutrition.

B. Motivation

How does the environment affect human nutrient requirements? Wind chill, humidity, wind, and temperature strongly affect environmental conditions. Both hot and cold environments increase nutrient intake because it takes more calories to maintain body functions. Health, stress, and physical activity changes human nutrient requirements. How does the environment affect animal nutrient requirements? The same four environmental factors affect animal nutrient requirements--weather, stress, health, and nutrition.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students what factors are included in the animal's environment that can affect digestion and nutritional needs.

   What is included in the animal's environment?

   a) Everything surrounding and affecting the growth, development, and production of animals
   b) Involves nutrition, space requirements, light, relative humidity, air temperature and velocity, wet bedding, dust, ammonia buildup, odors, and manure disposal
   c) Factors with the most impact on nutritional needs
      1) Nutrition
      2) Weather and facilities/shelter
      3) Health
      4) Stress

2. Ask students to discuss what changes in the weather affect the nutritional needs of animals.

   Identify weather factors that affect nutrition requirements and how animals react to them.

   a) Weather is the "state of the atmosphere with respect to heat or cold, wetness or dryness, calm or storm, clearness and cloudiness." (Webster's dictionary)
   b) Animals have a thermo-neutral (comfort) zone.
   c) Extreme weather can cause wide fluctuations in animal performance.
   d) An animal's requirements increase as temperature, humidity, and wind exceed or fall short of its comfort zone. These three factors influence an animal's heat loss, as well.
   e) Animals adapt to cold weather by using various heating mechanisms.
      1) Increased insulation from hair growth and more fat

2) Increased thyroid activity
3) Seeking protective shelter and warming sunshine
4) Huddling together
5) *Consuming more feed, which increases the heat increment and warms the animal
6) *Increasing activity

NOTE: The most important heating mechanisms are noted with an asterisk (*).

f) Animals adapt to hot weather by using the following cooling mechanisms.
   1) Moisture vaporization (from the skin and lungs)
   2) Avoidance of the sunshine
   3) Depression of thyroid activity
   4) Loafing
g) Heat production (metabolism) is plotted against ambient temperature to depict the relationship between chemical and physical heat regulation.
h) Rain reduces feed intake by 10-30 percent and mud by 5-30 percent, depending upon its depth and the amount of bedded area.
i) There are several ways in which animals cope with inclement weather.
   1) Environmentally controlled buildings
   2) Adaptation
      (a) Brahman cattle are more heat tolerant.
      (b) British breeds, such as Herefords, are more cold tolerant.
   3) Increased or decreased nutrient needs

3. Have students discuss factors, other than the weather, that change nutrient requirements of animals.

What are other factors affecting nutritional needs, and how do animals react?

a) Gestation
   1) Nutrient requirements for pregnant females are most critical during the last trimester, when the developing fetus grows most.
   2) Especially critical are nutrient requirements for young females during their first pregnancy. Poor nutrition at this stage will result in a poorly developed fetus and poor growth of the mother.
b) Lactation
   1) Milk production requires a liberal supply of energy, protein, minerals, and vitamins in the ration.
   2) After giving birth, feed requirements increase tremendously because of milk production.
   3) A female suckling young needs approximately 50 percent greater feed allowance than during the pregnancy period.
c) Stress
   1) Any environmental factor that is counter-productive to an animal's well-being, either external or internal
   2) The more the stress, the more nutrition that is needed
   3) Kinds of stress
      (a) Excitement
      (b) Presence of strangers
      (c) Changing animals that are together
      (d) Crowding
      (e) Disease
      (f) Hauling
      (g) How animals are handled
      (h) Weaning

4) Handling that reduces stress
   (a) Preconditioning (started on feed, vaccinated, etc.) before weaning
   (b) Proper handling during vaccinations, movement, and hauling

d) Health
   1) In the U.S., animal diseases and parasites decrease animal productivity by 15-20 percent.
   2) Improper nutrition has some involvement in up to 85 percent of cases treated by veterinarians.

e) Muddy lots
   1) Mud increases scours and other diseases in newborn animals; in older animals, it reduces production and feed efficiency.
   2) Studies show that mud can reduce finishing cattle gains *and* increase the feed required per pound of gain by as much as 10-35 percent. (California Agricultural Experiment Station)
   3) These problems can be minimized by proper management.
      (a) Lots that are properly located and constructed for proper drainage
      (b) Mounds that are 6-12 feet high as a dry place on which cattle can lie
      (c) Lessening the number of cattle in the lots during the muddy seasons

4. Ask the students how nutritional requirements might change when animals are subjected to any of the above factors.

How do feed requirements and production yields vary with temperature?

a) Dairy cows
   1) The optimum temperature for the production of milk is 55-64˚F.
   2) Temperatures below optimum
      (a) Reduction of water intake
      (b) Approximately 35 percent increase in feed intake (down to -4˚F)
      (c) Corresponding decrease in milk yield
      (d) Can be corrected by increasing the proportion of concentrate in the diet (20 percent roughage/80 percent concentrate) and providing shelter
      (e) Better maintained milk yields with higher concentrate levels
   3) Temperatures above optimum cause:
      (a) Increase in water intake
      (b) Decrease in feed intake at 77-81˚F, with greater decrease above 85˚F
      (c) Decrease in dry-matter intake
      (d) Corresponding decrease in milk yield
      (e) At 95˚F, milk yield reduced as much as 33 percent
      (f) Impact of environmental extremes reduced by using confined housing for lactating dairy cows

b) Beef cattle
   1) The temperature range of 59-77˚F is considered optimum.
   2) Variations from this range change feed intake.
      (a) At 77-95˚F, feed intake depressed 3-10 percent
      (b) At 41-59˚F, feed intake increased 2-5 percent
      (c) At 23-41˚F, feed intake increased 3-8 percent
      (d) At 5-25˚F, feed intake increased 5-10 percent
      (e) Below 5˚F, feed intake increased 8-25 percent
   3) During cold weather, increase the amount of roughage for cattle on restricted feed intake.
   4) With cattle on full feed, increasing the amount of roughage during cold weather can actually *decrease* the amount of energy available.

c) Sheep
   1) There is little data available that describes the interaction of temperature and feed intake for sheep.
   2) Sheep can tolerate colder climatic extremes than other animals.
   3) The length of the fleece and the level of feeding affect feed intake as temperatures change.
   4) Sheep need higher energy intake during cold stress. This can be done economically by increasing the roughage in the ration.
   5) During hot weather, decrease the roughage; this lowers the amount of heat produced by digesting the feed.

d) Swine
   1) A temperature range of 64-70˚F is considered optimum for growing/finishing swine.
   2) For each 1.8˚F of temperature drop, the feed requirement increases 1-1.4 oz. daily.
   3) Heavier hogs are more sensitive to hot weather than lighter hogs.

e) Poultry
   1) Laying hens can adjust to a fairly wide range of temperatures. When the temperature change occurs, feed intake will change temporarily and then return to approximately the level before the temperature change.
   2) Adequate drinking water is more critical to maintaining growth or production in poultry. Compared to water intake at 70˚F, water intake is doubled at 90˚F and is 2.5 times greater at 98˚F.

F. Other activities

1. Have the class chart the various weather factors including precipitation, wind, temperature, and humidity for a length of time (week, month, etc.). Then, for a specific species, identify changes that would need to be made in feeding, handling, etc., according to the changes in weather.

2. Have the students further research animal behaviors. Have them choose a species or a behavior to write papers that describe the behavior, affect on the animal, and ways to adjust or handle the situations that occur.

G. Conclusion

Livestock nutrient requirement tables are generally based on the assumption that no environmental stress is present. Feed and nutritional requirements need adjusting for changes in the animal's environment. Efficiency of nutrient use is affected by the weather, stress, health, and facilities.

H. Competency

Describe environmental effects on nutrition.

I. Answers to Evaluation

1. Three of the following:
   Nutrition, weather and facilities/shelter, health, stress

2. Four of the following:
   a. Increased insulation from growth of hair and more subcutaneous fat
   b. Increase in thyroid activity
   c. Seeking protective shelter and sunshine

d. Huddling together
e. Consumption of more feed
f. Increasing activity

3. Three of the following:
   a. Moisture vaporization
   b. Avoidance of the sunlight (seeking shade)
   c. Depression of thyroid activity
   d. Loafing (decreased activity and production)

4. Three of the following: gestation, lactation, stress, health, muddy lots

5. Two of the following:
   a. Mounds
   b. Proper drainage
   c. Decreased number in the lot

6. d
7. a
8. c

Name____________________

Lesson 8: Environmental Effects on Nutrition

Date____________________

EVALUATION

Complete the following short answer questions.

1. List three of the four factors that affect nutritional needs the most.

   a.

   b.

   c.

2. Name four of the heating mechanisms employed by animals during cold weather.

   a.

   b.

   c.

   d.

3. Name three cooling mechanisms employed by animals during hot weather.

   a.

   b.

   c.

4. Name three factors, other than the weather, that affect nutritional requirements.

   a.

   b.

   c.

5. Give two ways in which the stress of a muddy lot can be alleviated.

   a.

   b.

Circle the letter that corresponds to the best answer.

6. Which class of livestock can adjust to widely ranging temperature variations?

   a. Dairy
   b. Beef
   c. Swine
   d. Poultry

7. For milk production, which is the optimum temperature range for dairy cattle?

   a. 55-64˚F
   b. 59-77˚F
   c. 64-70˚F
   d. 70-77˚F

8. Which is the optimum temperature range for finishing swine?

   a. 55-64˚F
   b. 59-77˚F
   c. 64-70˚F
   d. 70-77˚F

UNIT I - NUTRITION

Lesson 9: Formulating and Balancing Rations

Objective: The student will be able to formulate a ration for livestock at the teacher's discretion.

Study Questions

1. **What are the general principles in formulating a ration?**

2. **What are the steps in balancing a ration?**

3. **What are eight essentials to balancing a ration?**

References

1. Student Reference

2. Activity Sheet

    a) AS 9.1: Formulating Rations

UNIT I - NUTRITION

Lesson 9: Formulating and Balancing Rations

TEACHING PROCEDURES

A. Review

Review Pearson Square computation from Agricultural Science core curriculum.

B. Motivation

Ask the students how they decide what foods to eat during a given day. Are there guidelines about fixing certain foods together for a meal? (Yes--Food Pyramid)

C. Assignment

D. Supervised study

E. Discussion

1. Ask students what they believe are the components of a good livestock ration. How do you decide what feed to use in a feeding program?

   What are the general principles in formulating a ration?

   a) Diet must meet the nutritional needs of the animal.
      1) Nutrient requirements are listed in tables usually available from the National Research Council.
      2) Balanced rations have nutrient allowances that are only 1-3 percent below the animal's requirement.
   b) Diets must include a minimum level of dry matter for proper digestive tract functioning.
   c) Diets are commonly balanced to meet the protein, energy, calcium, phosphorus, and vitamin A requirements for the animal.
      1) Protein
         (a) The amount of protein in the diet can be measured by crude protein (CP) or digestible protein (DP) content.
         (b) In diets balanced for nonruminants, essential amino acids must be considered.
         (c) Protein is an expensive part of the diet; using unneeded amounts raises the cost of the ration excessively.
      2) Energy
         (a) Four measures of energy are commonly used when formulating diets.
            (1) Digestible energy (DE)
            (2) Total digestible nutrients (TDN)
            (3) Metabolizing energy (ME)
            (4) Net energy (NE)
         (b) Energy provided in the diet should not be more than about five percent above requirements because animals are limited in the total amount of energy they can use.

3) Minerals
   (a) Calcium (Ca) and phosphorus (P) are the two minerals generally needed in larger amounts.
   (b) The ratio of Ca to P should be between 1:1 and 2:1.
   (c) There are usually enough minerals provided in the ingredients used or by the addition of trace-mineralized salt.

4) Vitamins
   (a) A vitamin supplement is usually added to the ration to meet the vitamin needs of the animal.
   (b) Always add a vitamin supplement to a gestation ration.
   (c) Sheep and cattle fed low-quality legume hay during pregnancy might exhibit symptoms of vitamin deficiency.

d) Cost of nutrients
   1) The cost per pound of each nutrient must be considered when developing least-cost rations for maximum efficiency.
   2) Energy and protein nutrients are the major ones to consider when making nutrient cost comparisons.

2. Ask the students how they would decide on a ration's components. Ask students what characteristics are important to consider when balancing a ration.

What are the steps in balancing a ration?

a) Identify the kind, age, weight, and function of the animal for which the ration is being formulated.
b) Consult a table of nutrient requirements to determine the nutrient needs of the animal.
c) Choose the feeds to be used in the ration and consult a feed composition table to determine the nutrient content of the selected feeds.
d) Calculate the amounts of each feed to use in the ration.
   1) Pearson square
   2) Algebraic equations
   3) Computer programs
e) Check the ration formulated against the needs of the animal. Be sure it meets the requirements for vitamins and minerals.
f) Check the cost of the nutrients in the ration to determine if this is the most economical, practical ration.

3. Ask the students about what they feel are essentials to a good ration.

What are the eight essentials to balancing a ration?

a) Nutrients in the ration should be balanced. Faster gains, less expense, and more profits are realized when feeding balanced rations.
b) The ration should contain a variety of feeds. This variety generally increases the palatability of the ration and makes it easier to balance the nutrients.
c) The ration should be fresh and appealing. Livestock consume more of a fresh ration, thus increasing productivity.
d) A ration should be palatable (agreeable to the taste).
e) The ration should be bulky; one containing a bulky feed (ground oats, beet pulp, etc.) usually is more desirable.
f) A ration should be slightly laxative. A laxative ration usually improves efficiency.
g) The ration should be economical. Low-cost, high-quality rations keep the producer in business.

h) The ration should be suited to the animal. Digestive systems are different among species. Cattle and sheep can consume large quantities of roughage, while poultry and swine rations must consist of largely concentrates.

F. Other activities

1. In conjunction with the activity sheet, use raw ingredients to make feed.

2. Computer programs

   a) Stallings, Charlie, et. al. *DAIR4* (IBM dairy and beef program). Blacksburg, VA: Virginia Tech. (Can be downloaded from Agriculture Electronic BBS, 573/882-8289, system operator 573/882-4827)
   b) *Taurus* (IBM cattle ration program). University of California-Davis, 1990.
   c) *Apollo* (IBM swine ration program). University of California-Davis, 1990.

3. Show the slides, *Horse Feeding and Nutrition* (AG SL 23), available from the Missouri Vocational Resource Center.

G. Conclusion

This lesson will help students understand and compute basic nutritional needs for different classes of livestock. For growth to occur, every one of the five nutrients (protein, energy, minerals, vitamins, and water) must be present in sufficient quantity.

H. Competency

Formulate a ration for different classes of livestock.

I. Answers to Evaluation

1. d
2. b
3. a
4. a, c, d, e (question worth eight points)
5. a, b, c, e, f, g (question worth eight points)

J. Answers to Activity Sheet 9.1

1. Example using problem 1 and the Pearson Square

Step 1: Construct a square with percent crude protein in the center of the square. Put the two feed ingredients in the corners on the left side. Diagonally subtract the smaller number from the larger number (18 - 9 = 9 and 32 - 18 = 14). Add the two remainders together (9 + 14 = 23).

corn 9%	↗	14 lb. corn
	18	
supplement 32%	↘	9 lb. supplement
		23 lb.

Step 2: Write the "9" and "14" on the square. Therefore, in 23 lbs. of feed, there are 14 lbs. of corn and 9 lbs. of supplement.

Step 3: To determine the ton mixture, divide by 2000 lbs. to calculate the percentage of each feed in the mixture. Round to one decimal place.

$^{14}/_{23}$ = .608 or 61% x 2000	=	1217.4	lbs. of corn
$^{9}/_{23}$ = .391 or 39% x 2000	=	782.6	lbs. of supplement
		2000.0	lbs. (ton)

Step 4: Check the mixture for protein content.

1217.4 lbs. of corn x .09	=	109.6
782.6 lbs. of supplement x .32	=	250.4
		360.0

Step 5: To get a 100 lb. ration from the 2000 lb. figures, divide by 20 (360 ÷ 20 = 18%). This ration is balanced for crude protein only. The ration must be checked for energy, minerals, and vitamins. Adjustments must be made to meet animal requirements and to be a complete, balanced ration.

2. *Step 1:* 14 - 9 = 5 and 44 - 14 = 30; 5 + 30 = 35

corn 9% ↗ 30 lb. corn

14

soybean meal 44% ↘ 5 lb. soybean meal

35 lb.

Step 2: In 35 lbs. of feed, there are 30 lbs. of corn and 5 lbs. of soybean meal.

Step 3:

$^{30}/_{35}$ = .857 or 86% x 100	=	85.7	lbs. of corn
$^{5}/_{35}$ =.142 or 14% x 100	=	14.3	lbs. of soybean meal
		100.0	lb. ration

Step 4: Check the mixture for protein content.

85.7 lbs. of corn x .09	=	7.71
14.3 lbs. of soybean meal x .44	=	6.29
		14%. This ration is balanced for crude protein.

3. *Step 1:* 16 - 9 = 7 and 22 - 16 = 6; 6 + 7 = 13

corn 9% ↗ 6 lb. corn

16

haylage 22% ↘ 7 lb. haylage

13 lb.

Step 2: In 13 lbs. of feed, there are 7 lbs. of corn and 6 lbs. of haylage.

Step 3:

$^{7}/_{13}$ = .538 or 54% x 4000	=	2153.8	lbs. of corn
$^{6}/_{13}$ = .461 or 46% x 4000	=	<u>1846.2</u>	lbs. of haylage
		4000.0	lbs.

Step 4: Check the mixture for protein content.

2153.8 lbs. of corn x .09	=	193.84
1846.2 lbs. of haylage x .22	=	<u>406.16</u>
		600.00

Step 5: 600 ÷ 40 = 15%. Ration is balanced for crude protein.

4. *Step 1:* 12 - 9 = 3 and 18 - 12 = 6; 6 + 3 = 9

corn 9%	↗	6	lb. corn
	12		
hay 18%	↘	<u>3</u>	lb. hay
		9	lb.

Step 2: In 9 lbs. of feed, there are 6 lbs. of corn and 3 lbs. of hay.

Step 3:

$^{6}/_{9}$ = .666 or 67% x 500	=	333.33	lbs. of corn
$^{3}/_{9}$ = .333 or 33% x 500	=	<u>166.66</u>	lbs. of supplement
		499.99	(500) lbs.

Step 4: Check the mixture for protein content.

333.33 lbs. of corn x .09	=	29.99
166.66 lbs. of hay x .18	=	<u>29.99</u>
		59.98 (60)

Step 5: 60 ÷ 5 = 12%. This ration is balanced for crude protein only.

5. *Step 1:* 14 - 9 = 5 and 44 - 14 = 30; 30 + 5 = 35

corn 9%	↗	30	lb. corn
	14		
soybean meal 44%	↘	<u>5</u>	lb. soybean meal
		35	lb.

Step 2: In 35 lbs. of feed, there are 30 lbs. of corn and 5 lbs. of soybean meal.

Step 3: $^{30}/_{35}$ = .859 or 86% x 800 = 685.7 lbs. of corn
$^{5}/_{35}$ = .142 or 14% x 800 = 114.3 lbs. of soybean meal
800.0 lbs.

Step 4: Check the mixture for protein content.
685.7 lbs. of corn x .09 = 61.71
114.3 lbs. of soybean meal x .44 = 50.29
112.0

Step 5: 112 ÷ 8 = 14%. This ration is balanced for crude protein only.

6. *Step 1:* 14 - 9 = 5 and 80 - 14 = 66; 66 + 5 = 71

corn 9%	↗	66	lb. corn
	14		
bloodmeal 80%	↘	5	lb. bloodmeal
		71	lb.

Step 2: In 71 lbs. of feed, there are 66 lbs. of corn and 5 lbs. of bloodmeal.

Step 3: $^{66}/_{71}$ = .929 or 93% x 10,000 = 9295.8 lbs. of corn
$^{5}/_{71}$ = .070 or 7% x 10,000 = 704.2 lbs. of bloodmeal
10,000.0 lbs.

Step 4: Check the mixture for protein content.
9295.8 lbs. of corn x .09 = 836.62
704.2 lbs. of bloodmeal x .80 = 563.36
1399.98

Step 5: 1400 ÷ 100 = 14%. This ration is balanced for crude protein only.

UNIT - NUTRITION Date__________________

Lesson 9: Formulating and Balancing Rations Name__________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. What two minerals are needed in the greatest quantities in most livestock rations?

    a. Zinc and boron
    b. Zinc and phosphorus
    c. Boron and calcium
    d. Calcium and phosphorus

2. Amino acids have the greatest influence when figuring a ration for which type of livestock?

    a. Ruminants
    b. Nonruminants
    c. Modified nonruminants
    d. Avians

3. Energy provided in the diet or ration should not exceed what percentage over the animal's requirements?

    a. Five
    b. Eight
    c. Ten
    d. Twenty

Complete the following multiple answer questions.

4. Check the physical traits needed to formulate a ration.

    ____ a. Age
    ____ b. Height
    ____ c. Weight
    ____ d. Type of livestock
    ____ e. Level of production
    ____ f. Hair color
    ____ g. Conformation score
    ____ h. Polled or horned
    ____ i. Breed
    ____ j. Environmental conditions

5. Check the essentials for balancing a ration

    ____ a. Cost
    ____ b. Palatability
    ____ c. Feedstuff variety
    ____ d. Cheapest possible ration
    ____ e. Slightly laxative
    ____ f. Match type of animal
    ____ g. Low-cost, high-quality ration
    ____ h. Fewest number of ingredients

Lesson 9: Formulating and Balancing Rations Name__________________

FORMULATING RATIONS

Complete the following short answer questions. State whether each ration is balanced for crude protein.

1. Formulate an 18 percent protein ration for a 100 lb. hog. Feedstuffs used are corn at 9 percent and a 32 percent protein supplement. Figure a 1 ton ration.

2. Formulate a 14 percent protein ration for a 180 lb. hog. Feedstuffs used are corn @ 9 percent protein and soybean meal at 44 percent protein. Figure a 100 lb. ration.

3. Formulate a dairy 16 percent protein ration for a 1200 lb. lactating cow using the feedstuffs of 22 percent protein in alfalfa haylage and 9 percent protein in corn. Figure a 2 ton ration.

4. Formulate a dairy 12 percent protein ration for a 1200 lb. dry cow using 18 percent protein in alfalfa hay and 9 percent protein in corn. Figure a 500 lb. ration.

5. Formulate a sheep 14 percent protein ration for an 80 lb. market lamb using feedstuffs of 9 percent protein in corn and 44 percent protein in soybean meal. Figure an 800 lb. ration.

6. Formulate a 14 percent protein ration for an 800 lb. beef steer using 9 percent protein corn silage and 80 percent protein in bloodmeal. Figure a 5 ton ration.

UNIT II - GENETICS

Lesson 1: Importance of Genetics in Agriculture

Objective: The student will be able to describe the importance of an animal's genetic makeup and its effect on agriculture.

Study Questions

1. **What careers are associated with livestock genetics?**

2. **What is the economic importance of genetics in livestock?**

3. **How has genetic selection of animals changed over the years?**

References

1. Student Reference

2. Activity Sheets

    a) AS 1.1: Heritability Traits
    b) AS 1.2: Beef Herd Selection

UNIT II - GENETICS

Lesson 1: Importance of Genetics in Agriculture

TEACHING PROCEDURES

A. Review

Review the previous unit on animal nutrition.

B. Motivation

1. How was the color of your eyes or hair determined? How can you predict if you will become bald? All these characteristics can be determined through genetics. Knowing your parents' dominant or recessive genes and if their chromosomes are homozygous or heterozygous, you can foretell baldness, eye color, and hair color.

   The same principle applies to livestock. Genetics influences economic traits in livestock more than in humans. If rate of gain is influenced 40% by genetics, producers can genetically improve rate of gain in a herd by selecting a sire with a high rate of gain.

2. In the same way, color of hair coat, polled or horned characteristics, and dwarfism can be determined in animals. As with humans, determining recessive and dominant genes in the parents aids in determining these factors before birth. It is also important to know if chromosomes are homozygous or heterozygous. Review the checker board to determine genetic outcomes.

SIRE

		P	P
	p	Pp	Pp
DAM	p	Pp	Pp

KEY: P = Dominant gene
p = Recessive gene
PP = Homozygous
pp = Heterozygous

C. Assignment

1. Have students write down environmental factors that affected each trait for each class of livestock. An example would be that 75% of milk production is influenced by environmental factors. Some of these might be environmental temperature, humidity, diet, and age.

2. Compare and contrast the different classes of livestock, picking important traits used in animal selection. An example of traits that are heavily influenced by heritability is percent butterfat and percent protein found in milk. Meanwhile, feet and legs have a low heritability, so feet and leg development is more influenced by environment.

D. Supervised study

E. Discussion

1. See if students can associate occupations with animal genetics. Discuss the educational and experience requirements needed for various occupations.

What careers are associated with livestock genetics?

a) Production
  1) Farm manager
  2) Animal breeder
  3) Dairy herd owner
  4) Horse rancher
  5) Cattle rancher
  6) Sheep rancher
  7) Swine producer
  8) Poultry producer
  9) Specialty animal breeder
b) Supplies and services
  1) Veterinarian
  2) Artificial breeding technician
  3) Veterinarian assistant
  4) Ova transplant specialist
  5) Breeding services representative
  6) Breed association employee
  7) Field sales representative for animal breeding products
  8) Artificial inseminator
  9) Cloning technician
  10) Embryo transfer technician
c) These are only a few occupations in livestock genetics. This field of agriculture is growing rapidly because of new breeding technologies such as cloning, AI, and embryo transfer. Occupations in the supplies and service area require a rigorous academic background for employment. Production occupations need a good academic foundation but use work experience to determine qualifications for a job.

2. What is meant by a trait that has economic importance?

What is the economic importance of genetics in livestock?

a) Beef cattle traits affected by heritability
NOTE: (M) = management trait, (Ph) = physical trait, and (Pr) = production trait
  1) (M) Calving interval or fertility has 10% heritability to offspring and 90% environment.
  2) (M) Birth weight has 40% heritability to offspring and 60% environment.
  3) (Pr) Weaning weight has 30% heritability to offspring and 70% environment.
  4) (M) Cow maternal ability has 40% heritability to offspring and 60% environment.
  5) (Pr) Feedlot gain has 45% heritability to offspring and 55% environment.
  6) (Pr) Pasture gain has 30% heritability to offspring and 70% environment.
  7) (Pr) Efficiency of gain has 40% heritability to offspring and 60% environment.
  8) (Pr) Final feedlot weight has 60% heritability to offspring and 40% environment.
  9) (Ph) Conformation score has heritability of 25% at weaning and 40% at slaughter.
  10) (Pr) Carcass trait heritability is 40% carcass grade, 70% rib eye area, 60% tenderness, and 45% fat thickness.
  11) (Ph) Cancer eye susceptibility has 30% heritability to offspring and 70% environment.

b) Dairy cattle traits affected by heritability

1) (Pr) Milk production has 25% heritability to offspring and 75% environment.
2) (Pr) Percent fat has 50% heritability to offspring and 50% environment.
3) (Pr) Percent protein has 50% heritability to offspring and 50% environment.
4) (Pr) Percent of soluble nitrogen-free extracts (soluble fats) has 50% heritability to offspring and 50% environment.
5) (Pr) Feed lot gain has 45% heritability to offspring and 55% environment.
6) (Ph) Stature has 40% heritability to offspring and 60% environment.
7) (Ph) Udder support has 20% heritability to offspring and 80% environment.
8) (Ph) Legs and feet have 15% heritability to offspring and 85% environment.
9) (Pr) Milking speed has 25% heritability to offspring and 75% environment.
10) (M) Birth weight has 40% heritability to offspring and 60% environment.
11) (M) Temperament has 40% heritability to offspring and 60% environment.
12) (M) Fertility has 5% heritability to offspring and 95% environment.

c) Sheep traits affected by heritability

1) (M) Multiple births have 15% heritability to offspring and 85% environment.
2) (M) Birth weights have 30% heritability to offspring and 70% environment.
3) (Pr) Weaning weight heritability to offspring is 10% at 60 days and 30% at 100 days.
4) (Pr) Rate of gain has 30% heritability to offspring and 70% environment.
5) (Ph) Type score has 10% for weanling and 40% for yearling heritability to offspring.
6) (Pr) Finish or condition at weaning has 17% heritability to offspring and 83% environment.
7) (Ph) Wrinkles or skin folds have 39% for neck folds and 40% for body folds heritability to offspring.
8) (Ph) Face covering has 56% heritability to offspring and 44% environment.
9) (Pr) Fleece weight has 38% grease weight and 40% clean weight heritability to offspring.
10) (Pr) Staple length has 39% for weanling and 47% for yearling heritability to offspring.
11) (Pr) Fleece grade has 35% heritability to offspring and 65% environment.
12) (Pr) Fat thickness over loin eye has 35% heritability to offspring and 65% environment.
13) (Pr) Loin eye area has 53% heritability to offspring and 47% environment.
14) (Pr) Carcass weight/day of age has 22% heritability to offspring and 78% environment.
15) (Pr) Carcass grade has 12% heritability to offspring and 88% environment.
16) (Pr) Carcass length has 31% heritability to offspring and 69% environment.

d) Swine traits affected by heritability

1) (M) Litter size at birth has 15% heritability to offspring and 85% environment.
2) (M) Litter size at weaning has 12% heritability to offspring and 88% environment.
3) (M) Birth weight of pigs has 5% heritability to offspring and 95% environment.
4) (Pr) Litter weight at weaning has 15% heritability to offspring and 85% environment.
5) (Pr) Daily rate of gain from weaning to market has 40% heritability to offspring and 60% environment.
6) (Pr) Days to 230 lbs. has 35% heritability to offspring and 65% environment.
7) (Pr) Efficiency of feed utilization has 30% heritability to offspring and 70% environment.
8) (Ph) Conformation score has 29% heritability to offspring and 71% environment.
9) (Pr) Carcass characteristic heritability is 60% on length, 40% on back-fat thickness, 50% on loin muscle area, 58% on predicted percent lean, and 50% percent lean cuts to offspring.

3. What is meant by genetic selection in livestock? Discuss how this type of selection has changed over time.

How has genetic selection of animals changed over the years?

a) Traditionally, animals were selected from physical traits. Management and production records were not kept or available. Animals were selected by the type of individual, its pedigree, and by show-ring winnings. Now, there is an abundance of production, physical, and management records kept on animals, especially purebred and show animals. These records have introduced the latest selection method--production testing.
b) Today, animal selection is based on three types of testing:
   1) Performance testing--the practice of evaluating and selecting animals on their merit or performance
   2) Progeny testing--the practice of selecting animals on the merit of their progeny (offspring)
   3) Production testing--involves the taking of accurate records of both performance and progeny, rather than casual observations.
      (a) Includes systematic measurement of differences in economically important traits, recording these differences, and using them in selection
      (b) A selection tool used to increase the rate of genetic improvement in individual herds
      (c) Used to compare animals that are handled alike. Not reliable in comparing herds--just individuals (This method is used to cull animals that seem alike but perform differently.)

F. Other activities

AS 1.1 is a pretest for students' knowledge of EPDs. EPDs will be covered more extensively in Lesson 5, but students can classify the traits on AS 1.1 for physical, production, or management traits. Ask students what other traits might influence their selection of a sire.

G. Conclusion

It is vital for livestock producers and others in livestock-related occupations to understand economic traits associated with genetics and to select livestock based on genetic improvement.

H. Competency

Describe the importance of genetics on agriculture.

Related Missouri Core Competencies and Key Skills

10C-1: Predict the phenotypic and genotypic ratios of the offspring of a dihybrid cross using a Punnett square.
10C-4: Associate the roles of genetic variation and natural selection with change in organisms over time.

I. Answers to Evaluation

1.	a	6.	a	11.	a	16.	c
2.	b	7.	b	12.	c	17.	b
3.	c	8.	c	13.	b	18.	a
4.	c	9.	c	14.	a	19.	c
5.	a	10.	b	15.	c	20.	a

21. Any five of the following:
    Farm manager
    Animal breeder
    Dairy herd producer
    Horse rancher
    Cattle rancher
    Sheep rancher
    Swine producer
    Poultry producer
    Specialty animal breeder

22. Any five of the following:
    Supplies and services
    Veterinarian
    Artificial breeding technician
    Veterinarian assistant
    Ova transplant specialist
    Breeding services representative
    Breed association employee
    Field sales representative for animal breeding products
    Artificial inseminator
    Cloning technician
    Embryo transfer technician

23. a, c, d, e (question worth six points)

J. Answers to Activity Sheets

AS 1.1

1. (Pr) Percent fat - High
   (Pr) Percent protein - High
   (Pr) Percent soluble NFE - High
   (Pr) Feed lot gain - Medium
   (Ph) Stature - Medium
   (Ph) Udder support - Low
   (Ph) Legs and Feet - Low
   (Pr) Milking speed - Medium
   (M) Birth weight - Medium
   (M) Temperament - Medium
   (M) Fertility - Low

2. (M) Calving interval or fertility - Low
   (M) Birth weight - Medium
   (Pr) Weaning weight - Medium
   (M) Maternal ability - Medium
   (Pr) Feed lot gain - Medium
   (Pr) Pasture gain - Medium
   (Pr) Efficiency of gain - Medium
   (Pr) Final feedlot weight - High
   (Ph) Conformation score - Medium
   (Pr) Carcass grade - Medium
   (Pr) Ribeye area - High
   (Pr) Tenderness - High

(Pr) Fat thickness - Medium
(Ph) Cancer eye susceptibility - Medium

3. (M) Litter size at birth - Low
   (M) Litter size at weaning - Low
   (M) Birth weight - Medium
   (Pr) Litter weight at weaning - Low
   (Pr) Daily rate of gain - Medium
   (Pr) Days to 230 pounds - Medium
   (Pr) Efficiency of feed utilization - Medium
   (Ph) Conformation score - Medium
   (Pr) Carcass length - High
   (Pr) Back fat thickness - Medium
   (Pr) Loin area muscle - High
   (Pr) Predicted percent lean - High
   (Pr) Percent lean cuts - High

4. (M) Multiple births - Low
   (M) Birth weight - Medium
   (Pr) Weaning weight 60 days - Low
   (Pr) Type score weaning - Low yearling - Low
   (Pr) Finish or condition at weaning - Low
   (Ph) Wrinkles or skin folds - Medium
   (Ph) Face covering - High
   (Pr) Fleece weight - Medium
   (Pr) Staple length - Medium
   (Pr) Fleece grade - Medium
   (Pr) Fat thickness over loin eye - Medium
   (Pr) Loin eye area - High
   (Pr) Carcass weight/day of age - Low
   (Pr) Carcass grade - Low
   (Pr) Carcass length - Medium

AS 1.2

1. Bull 1. The herd females are yearling heifers, which have not reached their mature weight and size. Bull 1 will produce a smaller or average size calf. Bull 2 could result in pulling a large percentage of calves, which adds to production expense and risk.

UNIT II - GENETICS Name________________

Lesson 1: Importance of Genetics in Agriculture Date________________

EVALUATION

In the following list of livestock heritability traits, place the appropriate letter in the space provided to indicate if it is a management, physical, or production trait.

A = management trait, B = physical trait, C = production trait

1.	_____	Fertility	11.	_____	Maternal ability
2.	_____	Udder support	12.	_____	Carcass grade
3.	_____	Rate of gain	13.	_____	Leg and feet
4.	_____	Weaning weights	14.	_____	Milking speed
5.	_____	Birth weights	15.	_____	Fleece weight
6.	_____	Temperament	16.	_____	Pasture gain
7.	_____	Stature	17.	_____	Wrinkles or skin folds
8.	_____	Fat thickness	18.	_____	Multiple births
9.	_____	Loin eye area	19.	_____	Carcass length
10.	_____	Face covering	20.	_____	Litter size

Complete the following short answer questions.

21. List five production occupations involved with livestock genetics.

a.

b.

c.

d.

e.

22. List five genetics occupations in the supplies and service area.

a.

b.

c.

d.

e.

23. Check the factors associated with production testing of livestock.

____ a. Used to increase the rate of genetic improvement within an individual herd
____ b. Used to compare different herds
____ c. Used to compare animals within a herd handled alike
____ d. Uses a systematic measurement of differences between economically important traits
____ e. Accurate and precise records must be kept.
____ f. Used just for casual observation

Lesson 1: Importance of Genetics in Agriculture Date____________________

HERITABILITY TRAITS

List the heritability traits for dairy, beef, swine, and sheep. Rate each trait as to which you would consider influenced highly, moderately, or slightly by genetics (0-24% = low, 25-49% = moderate, 50% and above = high). Indicate which type of trait it is (Pr = production, Ph = physical, and M = management).

1. Dairy cattle:

   EXAMPLE: (Pr) Milk production - Medium

2. Beef cattle:

3. Swine:

4. Sheep:

Date________________

BEEF HERD SELECTION

Compare the following bulls using their production records and EPDs. Determine which animal you would select for the herd. The bull would be used to breed 20 yearling heifers. In paragraph form, support your selection by writing the reasons you picked that animal.

Bull #1	Actual data	EPDs	ACC
(M) Birth weight	75	+1	.91
(Pr) Weaning weight	690	+32	.90
(Pr) Yearling weight	1190	+47	.90
(Ph) Frame score	6.5		
(Ph) Hip height	52"		
(Pr) Ave. daily gain	3.0		

Bull #2	Actual data	EPDs	ACC
(M) Birth weight	83	+8	.51
(Pr) Weaning weight	710	+36	.42
(Pr) Yearling weight	1270	+61	.42
(Ph) Frame score	7.5		
(Ph) Hip height	54"		
(Pr) Ave. daily gain	3.5		

1. Which bull would be best to improve weaning weight? __________ Why?

UNIT II - GENETICS

Lesson 2: Basic Building Blocks of Genetics

Objective: The student will be able to describe and identify basic building blocks of animal genetics.

Study Questions

1. **How do cells function?**

2. **How does DNA affect genetics in livestock?**

3. **How does RNA affect genetics in livestock?**

References

1. Student Reference

UNIT II - GENETICS

Lesson 2: Basic Building Blocks of Genetics

TEACHING PROCEDURES

A. Introduction

B. Motivation

How does hair grow back? How do fingernails grow? Why do wounds heal? What starts the disease, sickle cell? All these questions deal with the basic building blocks of all living things--*cells!* With proper nutrition and health, cells reproduce through division to produce hair, fingernails, and new tissue. The sickle cell disease occurs when a specific amino acid cannot be produced. If that amino acid cannot be produced, the body slowly deteriorates. Encourage discussion on cell functions, parts, and differences.

C. Assignment

Have the class draw an animal cell by including the organelles and parts that make up a cell. This suggested exercise should be done before or during the discussion on cell parts.

D. Supervised study

E. Discussion

1. Discuss how the function and structure of cells apply to livestock genetics.

How do cells function?

a) Definition: Cells are the basic, microscopic units of structure and function of all living things. Cells reproduce through division.
b) Parts of the cell
    1) Organelles - In every cell, the smaller structures are called organelles ("little organs"). The organelles determine the function of the cell.
    2) Plasma membrane - The thin layer surrounding all cells is called plasma membrane. This active part of the cell controls which molecules can enter or exit the cell.
    3) Phospholipid - The plasma membrane consists of two layers of molecules called phospholipids. Phospholipids are made up of a lipid and a phosphate group. Lipids are not soluble in water, but phosphates are. Phosphates sandwich the lipid layer in the plasma membrane. This allows molecules to enter or exit the plasma membrane, but not lipids.
    4) Cell nucleus - The nucleus is a spherical organelle that is located near the center of the cell. It controls the production of proteins in the cell.
        (a) Nuclear membrane - This separates the content of the nucleus from the rest of the cell. The nuclear membrane allows substances to exit and enter the nucleus.
        (b) Chromatin - The chromatin holds the necessary hereditary information about the cell.
        (c) Chromosomes - During cell reproduction, the chromatin becomes more apparent in long strands of hereditary material called chromosomes.

(d) Nucleolus - The nucleolus, the darker part of the chromatin, is involved in ribosome production.

5) Cytoplasm - Cytoplasm is the gel-like substance that surrounds and suspends organelles within the cell.

6) Mitochondria - The mitochondrion is the organelle containing enzymes that release energy from food during cellular respiration. The number of mitochondria depend on the function of the cell. An active muscle cell, such as one in the heart, contains more mitochondria than less active muscle cells because it requires more energy.

7) Ribosomes - Ribosomes are tiny, round organelles that are involved in protein synthesis.

8) Endoplasmic reticulum - Endoplasmic reticulum is made up of long strands of membrane, to which a majority of ribosomes are attached. These ribosomes synthesize proteins that are released from the cell for use by other cells. Unattached ribosomes in the cytoplasm synthesize proteins used by the cell itself. A rough endoplasmic reticulum has ribosomes attached to it. A smooth endoplasmic reticulum lacks ribosomes and is not involved with protein synthesis, but adds structure to the cell.

9) Golgi bodies - These flat, membrane-bound sacs prepare proteins for secretion from the cell. Golgi bodies aid in the release of proteins from the cell. *Vesicles* are tiny pieces of membrane pinched off the Golgi body that actually carry the protein to the plasma membrane.

10) Vacuoles - Vacuoles are membrane-bordered, fluid-filled spaces within the cytoplasm. Vacuoles usually contain water used in the cell and provide structure for the cell.

11) Lysosomes - Lysosomes are organelles that digest proteins. Enzymes present in lysosomes break down proteins and recycle the amino acids to make new proteins.

12) Cytoskeleton - The cytoskeleton is the tiny internal support system found in cells. The cytoskeleton is made up of microtubules, which are tiny protein strands that provide support in the cell. The microtubules provide the cell with its shape, which limits the movement of organelles within the cell.

13) Centrioles - Centrioles are organelles that contain bundles of microtubules which lie close to the nucleus. The centrioles play an important role in cell division. Centrioles exist in pairs and are composed of nine sets of microtubules.

c) Types of cells

1) Eukaryotes - Eukaryotes are cells that contains a membrane-bound nucleus. The eukaryote's chromatin is held within a well-defined nucleus. (Not all organisms contain a nucleus.)

2) Prokaryotes - Prokaryotes are cells that do not have a membrane-bound nucleus. Bacteria are considered prokaryotes because the chromatin is stretched out within the cytoplasm, not held within the nucleus. Another distinction between eukaryotes and prokaryotes is that prokaryotes lack organelles such as mitochondria and Golgi bodies, which are also membrane-bound.

d) Functions of cells

1) Nutrition - ability of cells to manufacture their own food or obtain food from another environmental source

2) Cellular respiration - process of changing the energy in food molecules into a usable form of energy

3) Absorption - process of absorbing water, minerals, and other necessary elements from their environment

4) Biosynthesis - process of synthesizing complex compounds from simpler compounds, e.g., changing proteins into amino acids

e) Differences between plant and animal cells
   1) Cell walls - Plant cells contain a cell wall that surrounds the plasma membrane. Animal cells possess only a plasma membrane.
   2) Chloroplasts - Plant cells contain chloroplast, which provides the green color.
   3) Chlorophyll - In plant cells, chlorophyll utilizes sunlight to manufacture food.
   4) Plastids - Plant cells contain plastids, which are organelles capable of storing food for the cell.
   5) Chromoplasts - Plant cells contain chromoplasts, which give flowers and fruits their color (e.g., red tomatoes and yellow apples).

2. Explain DNA.

How does DNA affect genetics in livestock?

a) Definition: **D**eoxyribo**n**ucleic **a**cid (DNA) is a nucleic acid molecule that controls the production of proteins. DNA is similar to a library in that it stores vital information about the cell. The DNA instructions are used repeatedly in cell division and protein synthesis.

b) In eukaryotes, the DNA is stored in the chromosomes of the nucleus.

c) In prokaryotes, the DNA is stored in circular strands in the cytoplasm.

d) Structure of DNA
   1) DNA is composed of nucleotides. Through chemical analysis, it has been determined that nucleotides are made up of three parts: a phosphate group, a five-carbon sugar called deoxyribose, and a nitrogen base. The four types of nitrogen bases are:
      (a) Adenine
      (b) Guanine
      (c) Thymine
      (d) Cytosine
   2) The "base pairing rule for DNA" means that adenine is paired with thymine and guanine is paired with cytosine. These pairs are then attached to a phosphate and a deoxyribose sugar. These DNA strands are then twisted into a spiral, like a spiral staircase. This spiral twist is called double helix. Table 2.1 shows the structure of a DNA strand.
   3) A single DNA molecule can be millions of base pairs long. The order in which the bases are paired determines the DNA's ability to run and the function of the cell.
   4) Amino acids are formed by codons. Codons are three nitrogen bases attached together to form an amino acid. See Table 2.3 for a list of codons that make up the 20 most common amino acids.

TABLE 2.1 - DNA strand

S ------	GC	------ S
P		P
S ------	CG	------ S
P		P
S ------	AT	------ S
P		P
S ------	TA	------ S
P		P
S ------	GC	------ S
P		P
S ------	CG	------ S
P		P
S ------	AT	------ S
P		P
S ------	TA	------ S

P-Phosphate
S-Deoxyribose sugar
A-Adenine
T-Thymine
G-Guanine
C-Cytosine

TABLE 2.3 - The 20 Most Common Amino Acids

Essential amino acids	Non-essential amino acids
Arginine (TCT, TCC, GCA, GCG, GCT, GCC) Histidine (GTA, GTG) Isoleucine (TAA, TAG, TAT) Leucine (AAT, AAC, GAA, GAG, GAT, GAC) Lysine (TTT, TTC) Methionine (TAC) Phenylalanine (AAA, AAG) Threonine (TGA, TGG, TGT, TGC) Tryptophan (ACC) Valine (CAA, CAG, CAT)	Alanine (CGA, CGG, CGT, CGC) Asparagine (TTA, TTG) Aspartic acid (CTA, CTG) Cysteine (ACA, ACG) Glutamic acid (CTT, CTC) Glutamine (GTT, GTC) Glycine (CCA, CCG, CCT, CCC) Proline (GGA, GGG, GGT, GGC) Serine (AGA, AGG, AGT, AGC, TCA, TCG) Tyrosine (ATA, ATG)

5) Any one of the codon triplets could make up the amino acid. It does not take all of the triplets to make the amino acid. Several codons represent the same amino acid. Since they have the same meaning, the redundant codons are like synonyms of words.

3. Explain RNA.

How does RNA affect genetics in livestock?

a) Definition: **R**ibo**n**ucleic **a**cids (RNA) are much shorter than DNA. RNA carries messages, transforms proteins, and aids in ribosome formation.

b) Types of RNA (m-RNA, t-RNA, r-RNA)

   1) In eukaryotes, DNA never leaves the nucleus, so RNA carries the messages from nucleic DNA to ribosomes. This RNA is called messenger RNA or m-RNA.

      (a) Transcription - Transcription is the process of copying the DNA code to RNA strands. Transfer RNA (or t-RNA) get all the necessary amino acids and line them up in the right order to build a specific protein. The cytoplasm contains all the amino acids necessary for building a specific protein. The t-RNA gathers the proper amino acids and brings them to the m-RNA.

      (b) Translation - Translation is the process of assembling chains of amino acids according to the directions carried by m-RNA and translating the message into a particular protein.

   2) The formation of the structure of ribosomes is called ribosomal RNA or r-RNA. These r-RNA are made in the nucleolus.

Table 2.2 - RNA strand
R--G P R--A P R--U P R--C P R--G P R--A P R--U P R--C
R-Ribose sugar P-Phosphate G-Guanine A-Adenine U-Uracil C-Cytosine

c) Differences between DNA and RNA

   1) RNA nucleotides contain the sugar, ribose, instead of deoxyribose.

   2) RNA contains the nitrogen base, uracil, instead of thymine. Like thymine, uracil forms a complementary pair with adenine.

3) RNA usually has only one strand instead of DNA's two. RNA does not form a helix. See Table 2.2.

F. Other activities

Have students research a current genetics topic based on topics covered in this lesson.

G. Conclusion

Cells, DNA and RNA are the starting points for all genetic occurrences in livestock. That is why it is so important to comprehend the functions and structures in cells.

H. Competency

Describe the basic building blocks of genetics.

Related Missouri Core Competencies and Key Skills

10B-1: Describe the functions of the organelles of a cell (cell wall, cell membrane, nucleus, ribosome, mitochondrion, chloroplastid, vacuole).
10B-3: Describe the structure and function of DNA.
10D-8: Compare and contrast photosynthesis and cellular respiration.

I. Answers to Evaluation

1. c
2. k
3. d
4. j
5. g
6. i
7. e
8. b
9. f
10. h
11. Eukaryotes
12. Vesicles
13. Organelles
14. Prokaryotes
15. DNA
16. Codons
17. Biosynthesis
18. Adenine
19. Cytosine
20. RNA

21. Two of the following:
    a) RNA nucleotides contain the sugar ribose instead of deoxyribose.
    b) RNA contains uracil instead of thymine.
    c) RNA has one strand instead of two and forms no helix.

22. Amino acids are formed by codons. Codons are three nitrogen bases attached together to form an amino acid.

UNIT II - GENETICS

Name__________________

Lesson 2: Basic Building Blocks of Genetics

Date__________________

EVALUATION

Match the word on the left with the definition on the right.

1. ____ Cell nucleus
2. ____ Centrioles
3. ____ Cytoplasm
4. ____ Cytoskeleton
5. ____ Golgi bodies
6. ____ Lysosomes
7. ____ Mitochondria
8. ____ Plasma membrane
9. ____ Ribosomes
10. ____ Vacuoles

a. Long strands of membrane to which a majority of ribosomes are attached

b. Thin layer surrounding the cell which allows molecules to enter and exit the cell

c. Spherical organelle that controls protein production in the cell

d. Gel-like substance that suspends organelles in the cell

e. Organelle containing enzymes that release energy from food

f. Tiny, round organelles that are used to synthesize proteins

g. Flat, membrane-bound sacs that prepare proteins for secretion from the cell

h. Membrane-bound, fluid-filled spaces within the cytoplasm

i. Organelles that digest proteins

j. The tiny internal support system in cells

k. Organelles that contain bundles of microtubules, which aid in cell division

Fill in the blank with the best answer.

11. Cells that contain a membrane-bound nucleus are called ______________.

12. Pinched off Golgi bodies, the tiny pieces of membrane that carry proteins to the plasma membrane are called _______________.

13. Smaller membrane-bound structures that determines the function of the cell are called _______________.

14. Cells that do not have a membrane-bound nucleus are called _______________.

15. A nucleic acid that controls protein production and stores vital information about the cell is called ________________.

16. A set of three nitrogen bases that determine an amino acid is called _______________.

17. The cellular process of synthesizing complex compounds from simpler compounds is called ________________.

18. Thymine is always paired with ________________ in a DNA strand.

19. Guanine is always paired with _________________ in a DNA strand.

20. A nucleic acid that carries messages, transforms proteins, and aids in ribosomes formation is called ________________.

21. What are two of the three differences between DNA and RNA?

    a.

    b.

22. How are amino acids formed within the cell?

UNIT II - GENETICS

Lesson 3: Animal Cell Division

Objective: The student will be able to describe and understand the process of animal cell division.

Study Questions

1. **What are the functions of chromosomes?**

2. **How many chromosomes are present in common production livestock?**

3. **What is mitosis?**

4. **What is meiosis?**

References

1. Student Reference

2. Transparency Masters

   TM 3.1: Phases of Mitosis
   TM 3.2: Stages of Meiosis

UNIT II - GENETICS

Lesson 3: Animal Cell Division

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Do all animals possess the same number of chromosomes? If not, why? Normally, animals of the same species possess the same number of chromosomes. The difference among species is that some animals carry more (or fewer) hereditary characteristics, so in turn, they need more (or fewer) chromosomes to carry these hereditary characteristics.

C. Assignment

D. Supervised study

E. Discussion

1. Have the students discuss how genetics are passed from the parents to their offspring. Ask the students how the genes are carried and arranged in the animal's cells.

   What are the functions of chromosomes?

   a) Inside the nucleus of the cell, there are rod-shaped bodies called chromosomes. Chromosomes are composed of minute parts called genes. Genes determine the hereditary characteristics of animals and are transmitted to the offspring from the parents.
   b) Chromosomes are diploid in number (exist in pairs) in all body cells, except sperm and egg cells. One chromosome of each pair comes from the father and one pair comes from the mother.
   c) The two chromosomes within the pair are called homologous chromosomes, meaning alike or equal.
   d) Chromosomes contain millions of genes. It is because of the large number of genes and possible combinations of genes that very few animals are exactly alike.

2. Ask the students if they think the number of chromosomes is the same in all animals.

   How many chromosomes are present in common production livestock?

   a) Animals of the same species have the same number of homologous chromosomes.
   b) The numbers of chromosomes found in the body cells of some domestic animals are shown in the following table.

TABLE 3.1 - Characteristic Numbers of Chromosomes in Selected Animals

ANIMAL	CHROMOSOME NUMBER (2n)	ANIMAL	CHROMOSOME NUMBER (2n)
Horse	64	Cattle	60
Human	46	Mule	63
Dog	78	Swine	38
Domestic cat	38	Sheep	54
Chicken	78	Goats	60

3. How are the genetic traits passed on from parental cells to offspring cells? Use TM 3.1 to illustrate the stages of mitosis.

What is mitosis?

a) All cells increase in number by cell division. Mitosis refers to the type of cell division in which body cells divide and form two new cells, each containing the complete set (or diploid number) of chromosomes found in the parent cell.
b) The process of mitosis consists of several stages.
    1) Prophase
        (a) Chromosomes shorten and thicken.
        (b) Each chromosome divides into a strand of two identical chromatids connected by a centromere.
        (c) The nuclear membrane disappears, and the centromeres of chromosomes attach to structures called spindle fibers, which are fibers sent out from the centromeres when they divide.
        (d) Located outside the nucleus, the centriole cell, divides and begins moving to opposite sides or poles of the cell.
    2) In the metaphase, chromosome centromeres align the equatorial plane of the spindle fibers at the cell's center (Refer to Figure 3.1) with the spindle fibers radiating to the centrioles at opposite ends of the cell.
    3) Anaphase
        (a) Chromosomes are ready to divide into the two chromatids, which will become the chromosomes of the new cell.
        (b) The centromeres of each chromosome divide in half, as do the chromosomes themselves.
        (c) The chromatids become the new chromosomes and are pulled to the centrioles at opposite ends of the cell.
    4) Telophase
        (a) The nuclear membrane of the two cells is formed.
        (b) The cytoplasm of the original cell divides, forming two new cells containing the same number of chromosomes as the mother cell.
    5) Interphase is the time that elapses before another prophase begins.

4. How is the sex of offspring determined at the time of fertilization? Use TM 3.2 to explain meiosis stages and to compare mitosis with meiosis.

What is meiosis?

a) The type of cell division that forms gametes (sex cells) is similar to mitosis in some ways and different in others.
b) Meiosis involves a first and second cell division.
c) Meiosis is called oogenesis in the female and spermatogenesis in the male. Each of these types of reproductive cells contains the haploid number of chromosomes. Thus,

each contains genetic information that can be passed to the next generation. If meiosis did not occur, the life cycle could not continue.

d) First meiotic division
   1) Prophase
      (a) Homologous chromosomes pair up, giving the appearance of four chromatids side by side.
      (b) These homologous chromosomes can exchange parts or cross over, resulting in chromosomes that are different from either of the parent chromosomes.
   2) In metaphase, the chromosome pairs align themselves at the equator of the spindle fibers.
   3) Anaphase
      (a) Each pair of chromosomes separates into two dyads, consisting of a pair of chromatids connected by a centromere.
      (b) Each chromosome itself does not divide as in mitosis.
   4) Telophase
      (a) Nuclear membranes form.
      (b) Cytoplasm divides and the resulting new cells contain only one chromosome of each original pair. This is why meiosis is called reduction division.
   5) Gametes developed by meiosis are essential to the maintenance of the embryo's diploid number of chromosomes. In fertilization, the ova and sperm join, each of which is haploid in chromosome number.

e) In the second meiotic division, each nucleus contains only one of each chromosome (haploid). The cell goes through the same stages as in mitosis.
   1) Each chromosome, consisting of the two chromatids, divides in half and becomes a new chromosome in the gamete.
   2) However, because of the reduced division in the first stage of meiosis, each new cell has only one homologous chromosome. Each resulting gamete contains only one-half of the number of chromosomes present in the parent cell.

F. Other activities

Have students write down the hereditary characteristics carried by chromosomes for different species, such as cattle, humans, swine, etc. By compiling the results you can determine the differences in the number of chromosomes for each species.

G. Conclusion

An animal's body is made up of millions of cells. Animals grow by cell division. The cell nucleus contains chromosomes, which are found in pairs. One chromosome of the pair comes from the father and one comes from the mother. Ordinary cell division is called mitosis; each cell is exactly like the old cell. The reproductive cells are called gametes. Gametes divide by the process of meiosis.

H. Competency

Describe animal cell division.

Related Missouri Core Competencies and Key Skills

10A-2: Distinguish between mitosis and meiosis.

10B-1: Describe the functions of the organelles of a cell (cell wall, cell membrane, nucleus, ribosome, mitochondrion, chloroplastid, vacuole).

I. Answers to Evaluation

1. a. Prophase
   b. Metaphase
   c. Anaphase
   d. Telophase
   e. Interphase

2. Meiosis involves a first and second cell division. Meiosis is called oogenesis in the female and spermatogenesis in the male. Each of these types of reproductive cells contains the haploid number of chromosomes.

3. Cattle: 60
   Swine: 38
   Sheep: 54
   Horses: 64

4. c
5. a
6. c
7. a

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EVALUATION

Complete the following short answer questions.

1. Name the five stages of mitosis.

   a.

   b.

   c.

   d.

   e.

2. How is meiosis different from mitosis?

3. How many chromosomes do following animals have?

   Cattle: _____ Swine: ______

   Sheep: ______ Horses: _____

Circle the letter that corresponds to the best answer.

4. In body cells, chromosomes occurring in pairs are called ___________ in number.

   a. Haploid
   b. Double
   c. Diploid
   d. Twins

5. What are the minute parts of chromosomes called?

   a. Genes
   b. Chromatids
   c. Spindles
   d. Cytoplasm

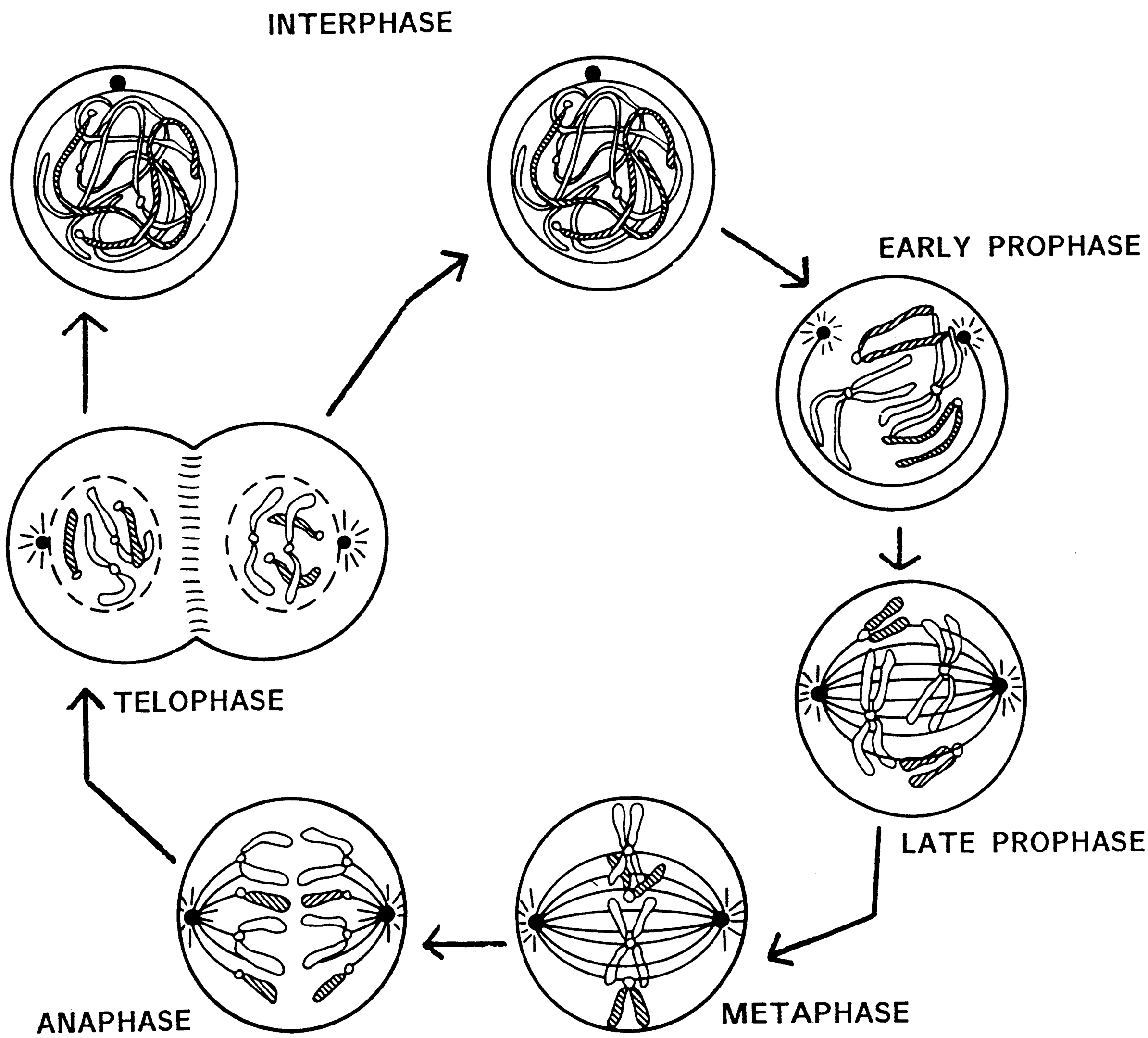
6. What is meiosis in the female called?

   a. Spermatogenesis
   b. Telophase
   c. Oogenesis
   d. Ovaries

7. What is meiosis in the male called?

   a. Spermatogenesis
   b. Oogenesis
   c. Testosterone
   d. Anaphase

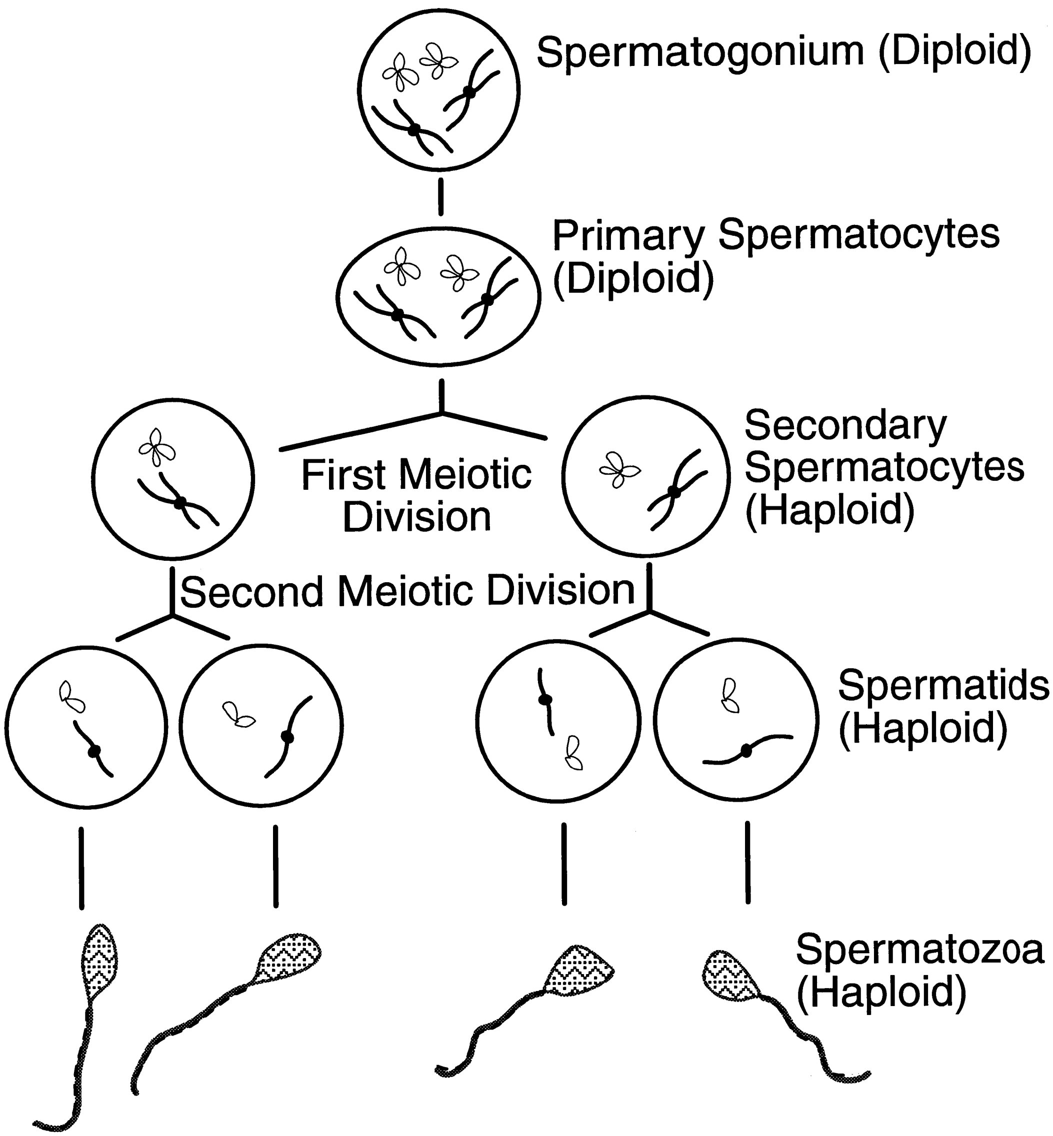
Phases of Mitosis



Credit: *Agriscience 332: Animal Science (Student Reference).* Texas A & M University: Instructional Materials Service, 1989, topic 8406. Courtesy of Instructional Materials Service, Texas A & M University, College Station, Texas.

Stages of Meiosis

SPERMATOGENESIS



Credit: *Agriscience 332: Animal Science (Student Reference).* Texas A & M University: Instructional Materials Service, 1989, topic 8406. Courtesy of Instructional Materials Service, Texas A & M University, College Station, Texas.

UNIT II - GENETICS

Lesson 4: Basic Principles of Genetics

Objective: The student will be able to explain and apply the basic principles of genetics.

Study Questions

1. **What role do genes and alleles play in genetics?**
2. **What is the difference between phenotype and genotype?**
3. **What are the differences between dominant and recessive genes?**
4. **What are the differences between homogenous and heterogenous traits?**
5. **What are the basic laws of genetics, and how do they influence the genetic makeup of animals?**

References

1. Student Reference
2. Transparency Master
   a) TM 4.1: Punnett Square Examples

UNIT II - GENETICS

Lesson 4: Basic Principles of Genetics

TEACHING PROCEDURES

A. Review

1. Spend one class period reviewing the genetics unit of Agricultural Science I.

2. Review previous lesson.

B. Motivation

What are the differences between Angus and Polled Hereford cattle? What are the differences between Duroc and Hampshire hogs? How do you know if a cattle breed is going to be polled or horned? These traits are considered hereditary. They are controlled by the genetic makeup of the animal, which is largely controlled by genes.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students where the word "genetics" comes from. Do they know how traits are passed from parent to offspring?

What role do genes and alleles play in genetics?

a) Genes are the basic units of heredity.
   1) The development of specific traits of animals is controlled by genes.
   2) They are part of the DNA molecule of chromosomes.
   3) Two genes, which are located on the same loci on each homologue, constitute a gene pair.
   4) Genes control traits in two ways.
      (a) Additive gene effects
         (1) These effects control a trait by the number of these genes that are present.
         (2) Each gene pair for this trait adds to its presence.
         (3) The effect of each pair is separate, but the effects of all the pairs for the trait add up to determine the trait's strength.
         (4) Traits with high heritability usually result from additive gene effects.
         EXAMPLE: Carcass quality in swine is a trait that results from additive gene effects.
      (b) Non-additive gene effects
         (1) This effect controls traits by how gene pairs act in different combinations with one another.
         (2) When gene pair combinations give good effects, the offspring will be better than either of its parents (heterosis or hybrid vigor).

b) Alleles
   1) Each gene pair contains two alleles.
   2) These two alleles interact to influence the character traits of an organism.

3) A species might contain different forms of the same gene (multiple alleles).
EXAMPLE: Flower colors, such as red, white, and yellow

2. Show students some genetic makeups (eg. TT, tt, Tt) and ask them what the animal would look like. Use TM 4.1 to illustrate Punnett square use.

What is the difference between phenotype and genotype?

a) A genotype is the actual configuration of genes in the animal's cells.
b) A phenotype describes the visible differences in the physical makeup of animals (color, weight, horned or polled, etc.).
c) Traits are phenotypic characteristics of animals. Traits are controlled by a pair of genes or several pairs of genes.
d) A checkerboard system (Punnett square) is used to predict the results of crossing animals with various kinds of genotypes.
   1) Male gametes are shown across the top of the checkerboard.
   2) Female gametes are shown along the left side of the checkerboard.
e) Phenotypic and genotypic ratios

3. Why are some traits exhibited by the animal and some are not? Why is one person tall and one person short, although the same gene controls height?

What is the difference between dominant and recessive genes?

a) Dominant
   1) The phenotypic expression of some genes is dominant.
   2) Genes are dominant when they cover or hide the expression of the allele, the corresponding gene on the other chromosome of the pair.
   3) Capital letters designate dominant genes (P for polled) when genotyping animals.
b) Recessive
   1) The allelic gene whose actions are covered up and not expressed is recessive.
   2) Lowercase letters designate recessive genes (p for horned) when genotyping animals.

TABLE 4.1 - Common Dominant and Recessive Traits

Dominant	**Recessive**
Black-colored Holstein	Red-colored Holstein
Polled cattle	Horned cattle
White-wooled sheep	Black-wooled sheep
Mule-footed swine	Normal-footed swine
Black-colored Angus	Red-colored Angus
White-faced Herefords	Self-faced Angus
Black-colored horse	Chestnut horse
Dutch-belt pattern	No belting pattern

4. Ask students how they think dominant and recessive traits affect the animal's genotype and the visible phenotypes that animal passes on.

What is the difference between homogenous and heterogenous traits?

a) When considering two alleles, there is a possibility of three genotypes (PP, pp or Pp), but only two phenotypes (polled or horned).

b) Homogenous (homozygous)

1) An individual having two like genes for a trait (PP or pp) is pure or homozygous for that trait.

2) The allele can be dominant or recessive for the particular trait it represents.

c) Heterogenous (heterozygous)

1) An individual having two unlike genes for a trait (Pp) is heterozygous for that trait.

2) Usually, the dominant allele decides the phenotypic characteristics, even if only one chromosome of the pair carries that information.

EXAMPLE: A Pp animal will be polled because P is the dominant trait.

5. Ask the students what influences how traits are passed from parent to offspring. Are there certain laws that cause one trait to appear?

What are the basic laws of genetics, and how do they influence the genetic makeup of animals?

a) Incomplete dominance

1) A trait's phenotypic expression can also be the result of a lack of dominance.

2) A typical example is the coat color in Shorthorn cattle.

(a) The two allelic genes are R (red color) and W (white color).

(b) If the genotype is RR, the animal is red.

(c) If the genotype is WW, the animal is white.

(d) However, if the genotype is RW, the animal will be roan or a mixture of red and white.

3) The roan color is an example of incomplete dominance where neither the red nor the white gene is dominant over the other, so each trait is expressed in the offspring.

b) Epistasis

1) Sometimes, a gene pair controls or affects the actions of another gene pair.

2) One result of epistasis is the albino animal. This animal's hair, skin and eyes contain no pigment (coloring matter).

3) Although the animal has genes for a typical body color, another gene pair prevents their normal expression. In this case, the gene pair that controls the function of the color genes is epistatic.

c) Sex-linked characteristics

1) Some genes are carried only on the sex chromosomes.

2) Because the X-chromosome is larger than the Y-chromosome, there are some traits on the X that do not pair up with genes on the Y.

3) There are also certain portions of the Y that do not link to the X.

4) The portions on the Y, therefore, are only transmitted from fathers to sons.

5) Sex-linked traits are often recessive and are covered up in the female by dominant genes.

F. Conclusion

Much of the improvement in livestock results from using the principles of genetics. Genes control an animal's traits, and they are the basic units of heredity. Understanding the processes of gene action can assist in further genetic improvement in livestock.

G. Competency

Describe basic principles of genetics.

Related Missouri Core Competencies and Key Skills:

10C-1: Predict the phenotypic and genotypic ratios of the offspring of a dihybrid cross using a Punnett square.

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

10D-9: Analyze the risks and benefits of genetic engineering to society.

H. Answers to Evaluation

1. Genes and alleles are chromosomes within the cell nucleus; they act as carriers for the genes.

2. a. Mutations - Genes can duplicate themselves. When a mistake occurs in duplication, a new gene, called a mutation, is born. Mutations can be either defective or beneficial and will result in a change in the code sent by the mRNA to the protein formation process.
   b. Incomplete dominance - The phenotypic expression of a trait can also be the result of a lack of dominance.

3. The genotype of an animal refers to the actual configuration of genes in the animal's cells. The phenotype refers to visible differences in the physical makeup of animals (color, weight, body structure, horned or polled, etc.).

4. Homogenous traits occur when an animal has two like genes for a trait (PP or pp), while heterogenous traits result from unlike genes.

5.

		Homozygous horned bull (pp)	
		p	p
Heterozygous polled heifer (Pp)	P	Pp	Pp
	p	pp	pp

The offspring will have a 50 percent chance of being heterozygous polled, and a 50 percent chance of being homozygous horned.

6.

		Horned bull (pp)	
		p	p
Polled cow (PP)	P	Pp	Pp
	P	Pp	Pp

		Roan bull (Rr)	
		R	r
Red cow (RR)	R	RR	Rr
	R	RR	Rr

Offspring will always be polled. Offspring will have a 50 percent chance of being red and a 50 percent chance of being roan colored.

UNIT II - GENETICS

Name_______________

Lesson 4: Basic Principles of Genetics

Date_______________

EVALUATION

Complete the following short answer questions.

1. What are the functions of genes and alleles?

2. List and describe two basic genetic laws.

   a.

   b.

3. Explain differences between phenotype and genotype.

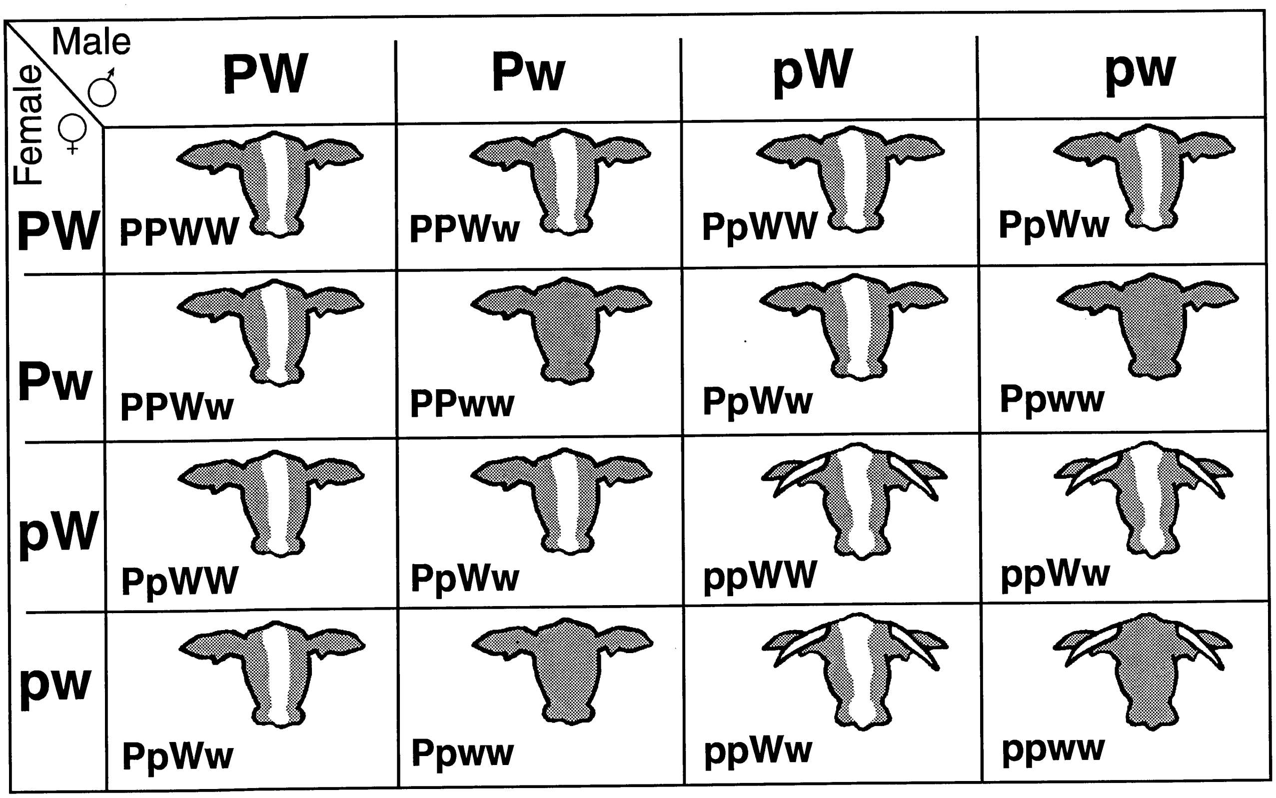
4. Explain differences between heterogenous and homogenous.

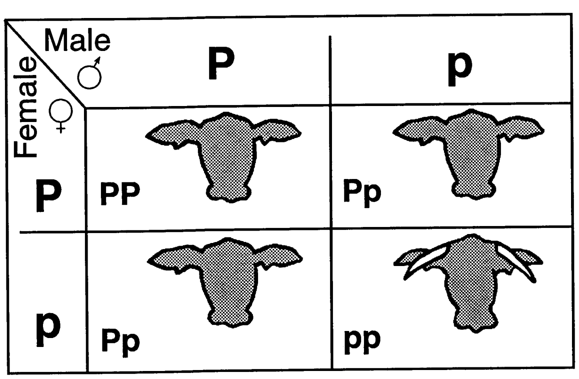
Determine the phenotypic and genotypic ratio of the following using the Punnett square. Show work.

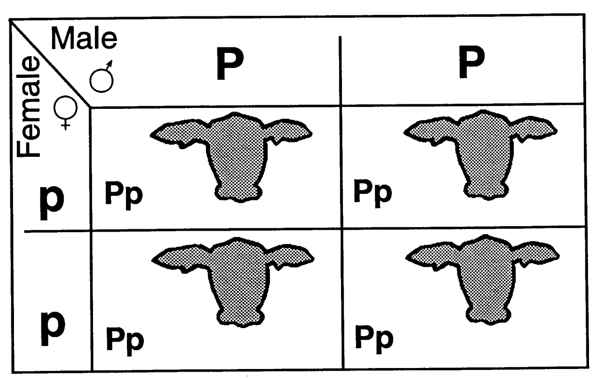
5. Homozygous horned bull (pp) X heterozygous polled heifer (Pp)

6. Horned roan bull (pp Rr) X polled red cow (PP RR)

Punnett Square Examples







Credit: *Agriscience 332H: Advanced Animal Science (Student Reference).* Texas A & M University: Instructional Materials Service, 1990, topic 8406. Courtesy of Instructional Materials Service, Texas A & M University, College Station, Texas.

UNIT II - GENETICS

Lesson 5: Tools for Genetic Improvement of Beef

Objective: The student will be able to describe the use of selection tools for genetic improvement of the beef herd.

Study Questions

1. **What factors are important in sire and female selection of beef?**

2. **What is meant by crossbreeding systems and hybrid vigor?**

3. **What are EPDs and how are they used?**

References

1. Student Reference

2. University of Missouri-Columbia Extension Division agricultural publication

    a) GO2032: Understanding and Using Sire Summaries

UNIT II - GENETICS

Lesson 5: Tools for Genetic Improvement of Beef

TEACHING PROCEDURES

A. Review

Review previous lesson on animal cell division and Unit II, Lesson 1.

B. Motivation

What are some factors to consider when establishing a beef herd? How are the best animals selected? Factors to consider when establishing a beef herd are: purebred or commercial, purebred or crossbred, price, adaptation, condition, age, longevity, health, herd size, and milking ability. Animal selection should be based on pedigree, individual performance and appearance, show-ring winnings, and performance testing.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss the methods used in selecting beef cattle sires and dams.

What factors are important in sire and female selection of beef?

a) Factors to consider when establishing a herd
  1) Purebred or commercial cattle
    (a) Purebred operators are a select few. They produce seed stock for other purebred producers and commercial producers.
    (b) Commercial operators produce the majority of cattle in America. Their goal is to convert land, grass, and crops into a monetary form through traditional cow-calf operations, backgrounding, and feedlots. Crossbreeding is the most widely used breeding system in commercial operations.
  2) The selection of a breed or cross
    (a) Purebred lines are usually chosen on personal preference or the breed with which the operator had the greatest success.
    (b) This a difficult decision for commercial operators because of the increasing number of crosses. If there are 10 breeds, there are be 45 single-cross choices and 360 possibilities in a three-way cross. Since there are more than 10 breeds (closer to 54 breeds), imagine all the possibilities.
  3) Milking ability strongly affects weaning weights, which are very important in the beef industry. The single most important factor in weaning weights is the ability of the mother to provide milk for her offspring. Remember, a lot of milk--a lot of calf, little milk--little calf.
  4) Uniformity
    (a) The essence of a purebred operation is a uniform herd. Having the same size and color are absolutely essential in the purebred industry.
    (b) In a commercial operation, uniformity is just as important. When it comes time to market the product, buyers like to see uniform groups of cattle from

the same operation. Uniformity in size and muscling is probably more important for a commercial operation.

5) Herd size does not determine herd quality. Quality cattle have been produced on a smaller scale. Cost is the one factor in deciding upon the herd size. The cost factor applies to both purebred and commercial operations.

6) Animal health is a factor in animal selection. The purebred industry requires a health certificate when an animal is sold. The commercial industry tests animals for diseases before the sale of an animal. Healthy beef are vital for the future of the industry.

7) Adaptation to environmental conditions in certain areas is not practical for certain breeds. This applies to both the purebred and commercial industries.

8) The condition of breeding stock is an important factor in selection of herd stock. Extremely thin or fat stock have lower reproduction rates.

9) Price
   (a) The price of purebred stock is largely determined by the operator's reputation and the quality of stock. Purebred stock costs more than market price because of extra costs in a purebred operation, the quality of stock, and genetic superiority.
   (b) In the commercial industry, it is seldom necessary to pay more than market price for females, but is beneficial to pay more for a sire to assure a quality animal.

10) Consider longevity and age. The longer a female can be productive reduces the cost of buying replacement animals. When deciding whether to buy younger or older stock, remember the number of years the animal has left to produce quality offspring.

b) Basis of selection in beef cattle
   1) There are four bases of selection in beef cattle. Each selection method has its purpose, so it is up to the producer to emphasize one area of selection over the other.
      (a) Individuality and appearance
      (b) EPDs and performance records
      (c) Show-ring winnings
      (d) Pedigree
   2) Selection based on individuality and appearance
      (a) The traditional score card lists different body parts of the animal. It lists parts such as flank, rump, loin area, structure, head, and neck. The score card places a numerical value on each part of the animal. A perfect score is 100 points. Breed associations have their own scorecards for their breed. This system is very valuable because appearance does not tell everything.
      (b) The functional scoring system divides the parts of the animal into areas: reproductive efficiency, muscling, size, freedom from waste, structural soundness, and breed type. The points given are 20, 20, 15, 15, 15, 15, respectively. These six areas are combined for a maximum of 100 points. Each area has economic importance.
         (1) Female reproductive efficiency - long body, leanness, sound udder structure, smooth muscles, functional udder, and feminine characteristics
         (2) Male reproductive efficiency - masculine, well muscled, well-developed genitalia, equal-sized testicles, and proper neck-to-scrotum length.
         (3) Muscling - Muscles smooth and round (not square), muscles bulge and move when walking, and loin bulges on both sides. Muscling applies more to bulls and steers than heifers.

(4) Size - Height at the hip and shoulder, adequate length of body, and leanness. Avoid early maturing bulls because they will not continue to grow.

(5) Freedom of waste - Trimness in both breeding and slaughter animals. Fat animals have lower reproductive rates and lower-quality carcasses. Avoid animals with loose hides.

(6) Structural soundness - Squarely set legs that are straight and true, toes and hocks squarely set, and equally sized toes. Avoid hocks and joints that appear swollen.

(7) Breed type - The animal should show signs of the breed, such as color; body markings, shape, and size; polled or horned; and shape of head.

3) In general, performance testing is the record keeping or data collecting as an animal matures. Performance testing is data collected on birth weight, weaning weight, yearling weight, rate of gain, feed efficiency, pasture gain, feedlot gain, carcass traits, and conformation score.

4) Selection based on pedigree

(a) Pedigree selection is based on the ancestors' performance. The pedigree is used more extensively in the purebred industry than in commercial.

(b) Economically important traits that can be inherited include fertility, birth weight, weaning weight, rate of gain, and carcass traits.

5) Selection can be based on show-ring winnings. However, animals that win in the show-ring usually have a high price tag. Show-ring winnings appeal to commercial producers, as well.

2. Why is crossbreeding important in beef cattle breeding systems?

What is meant by crossbreeding systems and hybrid vigor?

a) What is crossbreeding?

1) Mating animals of different breeds is called crossbreeding.

2) Crossbreeding is used for several reasons.

(a) Increased productivity over purebred animals (hybrid vigor)

(b) To produce animals with a combination of desirable traits not found in any one breed

(c) Produces foundation stock for developing new breeds

3) Advantages of crossbreeding

(a) Crossbreeding introduces new and desired genes quickly or at a faster rate than selection within a breed. A good example of this is crossing a dairy breed with a beef breed. Beef females then have improved milking ability, which means bigger calves and more profit.

(b) Hybrid vigor (heterosis) is the biological phenomenon that causes crossbred offspring to outproduce the average of their parents. Hybrid vigor occurs because the dominant genes in parents are usually more favorable than the recessive partner. When two separate gene pools are mixed together, the traits that were been lacking before become superior. (Example: dairy-beef cross)

(c) Complementary traits are an the advantage a cross has over another cross or over a purebred. Here, two or more characteristics complement or combine with each other. This results in the maximum desired traits in a cross. Each breed is known for certain desirable characteristics. Matching them with another breed that does not possess those desired traits refers to complementary crossing.

4) Types of crossbreeding
   (a) A two-breed cross is the mating of a purebred sire to a purebred female of another breed. Hybrid vigor will only appear in the offspring, which is a limitation of this cross. Another limitation is that the cross does not make use of a crossbred female.
   (b) A two-breed backcross or crisscross is a system that involves mating a purebred sire of breed A with a female of breed B, then backcrossing the offspring to either breed A or breed B, resulting in a 1/4 to 3/4 breed. (Example: Mating a purebred Hereford sire and to a purebred Angus female, then mating the offspring to a purebred Angus sire, which results in a two-breed backcross or crisscross.)
   (c) A three-breed rotational cross uses three breeds to make the cross. An example of this is mating a purebred Beefmaster sire to purebred Angus female and then mating the offspring to a purebred Hereford sire. The offspring is then mated back to a purebred Angus sire so that all three breeds had sired the offspring, results in a three-breed cross. Hybrid vigor will appear in all sets of offspring.
   (d) A three-breed fixed or static cross (terminal cross) is a system where crossbred females (a two-breed cross) are mated to a third breed sire, results in three-breed fixed or static cross. In this system, all offspring are sold. When replacement females are needed, new females of a two-way cross are purchased. A limitation of this system is buying the same quality of crossbred replacement females.

3. Discuss how using them helps improve selection methods in beef cattle.

What are EPDs and how are they used?

a) What are EPDs?
   1) Expected Progeny Difference (EPDs) can be used to estimate how future progeny of the subject animal will compare to progeny of other animals within the breed. EPDs are designed to compare bulls based on estimated performance of the progeny, not to predict the performance on one or two progeny of a sire.
   2) A bull with a +50 lbs. yearling weight would be expected to sire calves 20 lbs. heavier, on the average, than calves out of a bull with +30 yearly weight EPD.
b) EPDs are used heavily in all phases of beef enterprises.
c) How can one tell if the EPD is accurate?
   1) ACC (accuracy) is the reliability measure of the EPD. An accuracy of 1.00 is of highest reliability. Accuracy is categorized as low, 0.00 to .5; medium, .51 to .75; and high .76 to 1.00. The possible change in pounds for each trait is more for lower accuracy. Reliability is increased as the number of progeny reported per sire increases.

      EXAMPLE: An ACC of .2 for weaning weight means that the EPD can change ±13.8. An accuracy of .9 in the same trait and breed means weaning weight would change ±1.7 lbs. for that sire.

   2) These examples of standards are set up by breed associations. In Table 5.1, Bull A has an ACC figure of .91, which means a calf sired by Bull A will have a weaning weight of 22.2-25.6 pounds heavier than Bull B. Another example of ACC figures is that a .2 ACC figure for birth weight represents ±3.1 lbs., and a .9 ACC figure represents ±0.4 lbs. This means a calf sired by Bull A will have a birth weight of 7.1-7.9 lbs. heavier than Bull B.
d) Table 5.1 shows an example of sire summary data for EPDs on four sires.

TABLE 5.1 - Sample Sire Summary Data								
Sire	Birth weight		Weaning weight		Yearling weight		Milk	
	EPD	ACC	EPD	ACC	EPD	ACC	EPD	ACC
Bull A	+7.7	.93	+29.6	.91	+42.3	.78	-20.3	.85
Bull B	+0.2	.67	+5.7	.7	+29.1	.42	+4.9	.4
Bull C	+6.5	.89	+39.3	.85	+62.0	.72	+16.5	.72
Bull D	+0.5	.05	+10.2	.05	+31.1	.05	+8	.05

F. Other activities

1. Have students research different beef breeds. They can choose appropriate breeds for certain situations or contact associations for information, as the instructor prefers. (Letters should be approved by the instructor.)

   a) Missouri Beef Industry Council
   2015 Missouri Blvd.
   Jefferson City, MO 65109
   800/441-6242 or 573/636-6033

   b) Beef Improvement Federation
   ATTN: Ron Bolze
   Northwest Research Extension Center
   105 Experiment Farm Road
   Colby, KS 67701
   913/462-7575

2. Show the video segments, *Cutting Costs . . . Pocketing Profits* and *Profit by Using EPDs* (12 and 14 minutes, AG video 147), available from the Missouri Vocational Resource Center.

G. Conclusion

Application of correct selection methods and usage of EPDs are vital for beef producers to stay on the cutting edge of beef production.

H. Competency

Describe selection tools for genetic improvement of beef.

I. Answers to Evaluation

1. d
2. c
3. a
4. a
5. d
6. b, c, d, g (question worth 7 points)
7. a, c, d, e, f, h (question worth 8 points)
8. b, c, f, g (question worth 7 points)
9. a, d, e (question worth 8 points)

UNIT II - GENETICS | Name_______________

Lesson 5: Tools for Genetic Improvement of Beef | Date_______________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which cross involves mating a sire of breed A to a crossbred female of breed B and C, selling all offspring, and buying replacement females of the same cross?

   a. Two-breed cross
   b. Two-breed backcross or crisscross
   c. Three-breed rotational cross
   d. Three-breed fixed or static cross

2. Which cross mates a sire of breed A to a female of breed B, then mates the offspring to a sire of breed C before mating the offspring to a sire of breed B?

   a. Two-breed cross
   b. Two-breed backcross or crisscross
   c. Three-breed rotational cross
   d. Three-breed fixed or static cross

3. Which is true regarding EPDs?

   a. EPDs place a plus or minus value on a measurable trait.
   b. EPDs are used to measure progeny performance of purebred females.
   c. EPDs are used only in purebred operations.
   d. EPD stands for Expected Performance Difference.

4. Which animal part receives the more possible points in a functional scoring system?

   a. Reproductive efficiency
   b. Size
   c. Structural soundness
   d. Breed type

5. What is another name for hybrid vigor?

   a. Substitution
   b. Substraction
   c. Hetorosis
   d. Heterosis

Complete the following multiple answer questions.

6. Check the advantages of crossbreeding.

___ a. New and desired genes are slowly introduced.
___ b. Hybrid vigor
___ c. Offspring outproduce the average of their parents.
___ d. Complementary traits
___ e. Takes several generations to see desired traits appear.
___ f. Superior traits become less apparent.
___ g. New, desired genes are quickly introduced.

7. Check the factors to consider when establishing a beef herd.

___ a. Uniformity of herd
___ b. The larger the herd, the better the quality
___ c. Price of purchased stock
___ d. The selection of purebred or commercial operation
___ e. Breed of cattle
___ f. Matching type of cattle to environmental conditions
___ g. Selecting stock by condition instead of health
___ h. Type of breeding system to be used
___ i. Selecting stock for size instead of production levels
___ j. Selecting stock for price instead of longevity and age

8. Check all the characteristics of ACC (accuracy) figures.

___ a. It is a validity measure of the EPD.
___ b. It is a reliability measure of the EPD.
___ c. The higher the ACC figure, the more accurate the EPD
___ d. The lower the ACC figure, the more accurate the EPD
___ e. ACC figures are reported in ± numbers.
___ f. More progeny reported per sire results in a higher ACC figure.
___ g. More progeny reported per sire results in less change in the EPD figure.

9. Check all the characteristics of EPD figures.

___ a. EPD figures are reported in ± numbers.
___ b. EPD figures are valid measures of the ACC.
___ c. EPD figures are reliable measures of the ACC.
___ d. EPDs are an estimate of how future progeny of a subject animal will compare to progeny of another subject animal.
___ e. EPDs measure performance traits.
___ f. EPDs measure breed characteristics.
___ g. EPD figures are reported in percentages.
___ h. EPDs estimate how future progeny of a subject animal will compare to other progeny of the same subject animal.

UNIT II - GENETICS

Lesson 6: Selection Tools for Genetic Improvement of Dairy Cattle

Objective: The student will be able to use various selection tools and develop a plan to genetically improve dairy cattle.

Study Questions

1. **What factors are considered when selecting dairy cows?**

2. **How is sire evaluation data used in sire selection?**

References

1. Student Reference

2. Transparency Master

   a) TM 6.1: Dairy Cow Pedigree

UNIT II - GENETICS

Lesson 6: Selection Tools for Genetic Improvement of Dairy Cattle

TEACHING PROCEDURES

A. Review

Review Lesson 5.

B. Motivation

If you had two identical Holstein cows--same age, height, weight, udders, and physical traits--which one would you choose? Since the physical traits are the same, the choice would be very difficult. This is where genetics plays a role in dairy selection. If one cow produced 5 lbs. of milk more per day, she would pass on this hereditary trait to her offspring. This genetic selection also applies to butterfat percentage, birth weight, and multiple births.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students to discuss factors they would use in selecting dairy cows. Have them justify why those points are important. Use TM 6.1 as an example of a pedigree.

What factors are considered when selecting dairy cows?

a) Breed
    1) Availability of breeding stock of the desired type and quality
    2) The producer's markets for milk and butterfat
    3) Availability of forage crops and pastures, since larger, more rugged breeds require more roughage
    4) Climatic conditions
    5) Age of maturity
    6) A breed that is popular in the community, especially in terms of breeding stock sources and a market for surplus stock
    7) The size and vigor of newborn calves
b) Individual dairy animals
    1) Type or physical appearance (linear classification)
        (a) Form - Includes stature, strength, body depth, and angularity
        (b) Rump - Includes angle, length, and width
        (c) Legs and feet
        (d) Udder - Includes fore attachment, rear height, rear width, support, and depth
        (e) Teats
    2) Production records
        (a) Dairy Herd Improvement Association (DHIA) records - Testing of cows is carried out by an approved tester who visits the dairy one day each month to weigh and sample milk, make butterfat tests, and calculate production and feed records. This information is sent to a data processing center for computation and summarization. The report contains individual cow records, such as daily milk weights, butterfat percent, concentrates fed,

reproductive status, value of milk produced, feed costs, and income-over-feed costs.

(b) Owner-sampler records - The owner of the dairy collects data for the herd.

3) Pedigrees

(a) These show the summaries of official production records for the animal's ancestors back three generations.

(b) Consideration should be given to the sire and dam, as they contribute 50 percent to the animal's makeup. Other ancestors contribute the other 50 percent.

4) Health and vigor

(a) General herd health can be determined by the calving record of the cows during the past year, the number of cows in production, the stages of production, and the amount of milk being produced.

(b) It is desirable to purchase animals only from herds that have been vaccinated or tested for Bang's disease (brucellosis) and tested for tuberculosis and leptospirosis.

(c) To minimize health problems, one should select animals from reputable breeders of disease-free herds.

2. Ask the students for factors to consider when selecting a sire for a dairy herd.

How is sire evaluation data used in sire selection?

a) Production of sires

1) Planned mating of superior cows and bulls can produce superior sires for artificial insemination.

2) Look for a cow that produces 4,000+ pounds of milk above her herd mates and for half-siblings producing 2,000-3000+ pounds above herd mates. Take note of cow families for desirable conformation type, longevity, good temperament, and reproductive efficiency.

3) Mate the cow with a superior AI stud for high PD and repeatability. Semen collection from the offspring begins at 10-12 months of age. Then, in herds throughout the U.S., enough cows are mated with the young bull to obtain 50-100 production-tested daughters. The bull is placed "on the shelf" for 4-6 years until daughters mature and provide milk production records. Bulls with high PDs are widely used.

b) Sire selection

1) Various indexes can be used to select a dairy sire.

(a) Daughter average - selection based on the average production of the sire's daughters

(b) Daughter-dam difference - considers the amount of increase or decrease in milk produced by a bull's daughters, as compared to their dams

(c) Equal-parent index - based on the premise that the sire and dam contribute equally to the inherent milk-producing ability of the progeny. It is equal to twice the average production of the daughters, minus the average production of dams.

(d) Daughter-contemporary herd difference - substitutes the herd average for the dam's average in the daughter-dam difference index. The sire index is equal to the daughter's average minus the herd average.

(e) Daughter-contemporary herd index - substitutes the herd average for the dam's average production in the equal parent index. The sire index is equal to twice the average production of the daughters minus the herd average.

(f) Herd mate comparison - compares a sire's daughters with herd mates that freshen during the same season of the same year. This index removes most environmental differences, such as the season of calving.

(g) Adjusted herd mate average - adjusts each lactation of a sire's daughter for comparison with one another

(h) Predicted Transmitting Ability (PTA) - an estimate of the amount of superiority or inferiority an animal will transmit to its offspring. It is the most accurate measure available of an animal's genetic ability.

2) For herd improvement, a dairy producer should choose the following.

(a) Bulls with the highest Predicted Transmitting Ability (PTA)

(b) Bulls with high PTA values that also have high reliability values (narrow confidence interval)

(c) Several bulls with high PTA values when the reliability value is below 75 percent

(d) Bulls with a low percent of difficult births when breeding heifers

F. Other activities

1. Tour a local dairy. Ask the owner/manager to discuss the breeding plan and how replacement heifers and sires are chosen.

2. Have students research different dairy breeds. They can choose appropriate breeds for certain scenarios or contact associations for information, as the instructor prefers. (Letters should be approved by the instructor.)

a) Holstein Association USA, Inc.
Attention: Jason Devino
PO Box 808
Brattleboro, VT 05302
802/254-4551

b) Purebred Dairy Cattle Association
Attention: Jason Devino
PO Box 808
Brattleboro, VT 05302
802/254-4551

c) American Jersey Cattle Club
6486 E. Main
Reynoldsburg, OH 43068
614/861-3636

3. Show the video, *Cattle Breed Identification: Dairy* (21 minutes, AG video 220), available from the Missouri Vocational Resource Center.

4. Using pedigrees and sire PTA information, have students choose what sire they would select when given a specific dairy and that dairy's production goals.

G. Conclusion

When selecting for high-production dairy cattle, producers must evaluate the genetic potential for milk production, as well as visual selection for conformation. Production records help determine how long the cow will stay in the herd by providing information on good feet and legs, proper udder attachments, etc. Therefore, study the overall picture before making major decisions on replacement heifers/cows and sires.

H. Competency

Describe selection tools for genetic improvement of dairy herds.

Related Missouri Core Competencies and Key Skills:

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

10D-9: Analyze the risks and benefits of genetic engineering to society.

I. Answers to Evaluation

1. c, d, f, h, I, j (question worth 10 points)
2. a, c, e, g (question worth 9 points)
3. a, c, d, f h (question worth 10 points)
4. a, e, f, g (question worth 10 points)
5. d, e (question worth 9 points)
6. b
7. b
8. b

UNIT II - NUTRITION

Name________________

Lesson 6: Selection Tools for Genetic Improvement of Dairy Cattle

Date________________

EVALUATION

Complete the following multiple answer questions.

1. Select proper udder characteristics, as evaluated on the unified score card.

___ a. Tissue is hard and firm to the touch.
___ b. Six evenly spaced teats
___ c. Teats are perpendicular to udder floor.
___ d. Fore udder attachment is long and curves smoothly into cow's underline.
___ e. An ill-defined cleft separates the udder's left and right sides.
___ f. Udder is evaluated by sections and then as a whole.
___ g. The four quadrants are unbalanced and ill-defined.
___ h. Prominent mammary vein
___ i. Evenly spaced, equally sized teats
___ j. Rear udder attachment extends high and wide.

2. As evaluated on the unified score card, check desirable leg and feet characteristics.

___ a. Soles of feet are level with the ground.
___ b. Front legs are narrowly spaced.
___ c. Leg bones are flat, strong, and smooth.
___ d. When viewed from the side, the hock is straight and perpendicular to the ground.
___ e. When viewed from the rear, legs are straight and far apart.
___ f. The animal should **not** walk when evaluating feet.
___ g. Legs fit squarely under the body.
___ h. Regular hoof fitting will help prevent feet and leg problems.
___ i. Leg bones are fine and brittle.
___ j. Correct legs and feet reduce the longevity of milk production.

3. Which records are contained in a DHIA report?

___ a. Daily milk weights
___ b. Roughages fed
___ c. Reproductive status
___ d. Butterfat percentage
___ e. Expense-over-feed cost
___ f. Value of milk produced
___ g. Breeding costs
___ h. Feed costs
___ i. Birth weights
___ j. Weaning weights

4. Select the indexes used in dairy sire selection.

___ a. Daughter average
___ b. Daughter-sire difference
___ c. Herd sire comparison
___ d. Unadjusted herd mate average
___ e. Daughter-contemporary herd index
___ f. Daughter-contemporary herd difference
___ g. Equal-parent index
___ h. Feed conversion index
___ i. Milk yield index
___ j. Sire-contemporary herd index

5. Which are wise choices for a dairy producer to make when selecting sires for herd improvement?

___ a. Choose bulls with average PTA values and high reliability values.
___ b. Choose bulls with high PTA values and low reliability values.
___ c. Use several bulls when sires have high PTA values and reliability values less than 90 percent.
___ d. Use bulls with low percentage of difficult births when breeding mature cows.
___ e. Choose a bull with a high PTA value and high reliability values.
___ f. Use several bulls when sires have high PTA values and reliability values less than 70 percent.
___ g. Use only bulls with a narrow confidence interval.
___ h. Do **not** choose bulls with high PTA values.
___ i. Use only bulls with a wide confidence interval.
___ j. Choose bulls with a high percentage of difficult births when breeding heifers.

Multiple Choice: For each question that follows, use the table below to choose the best answer. Write its letter in the space provided.

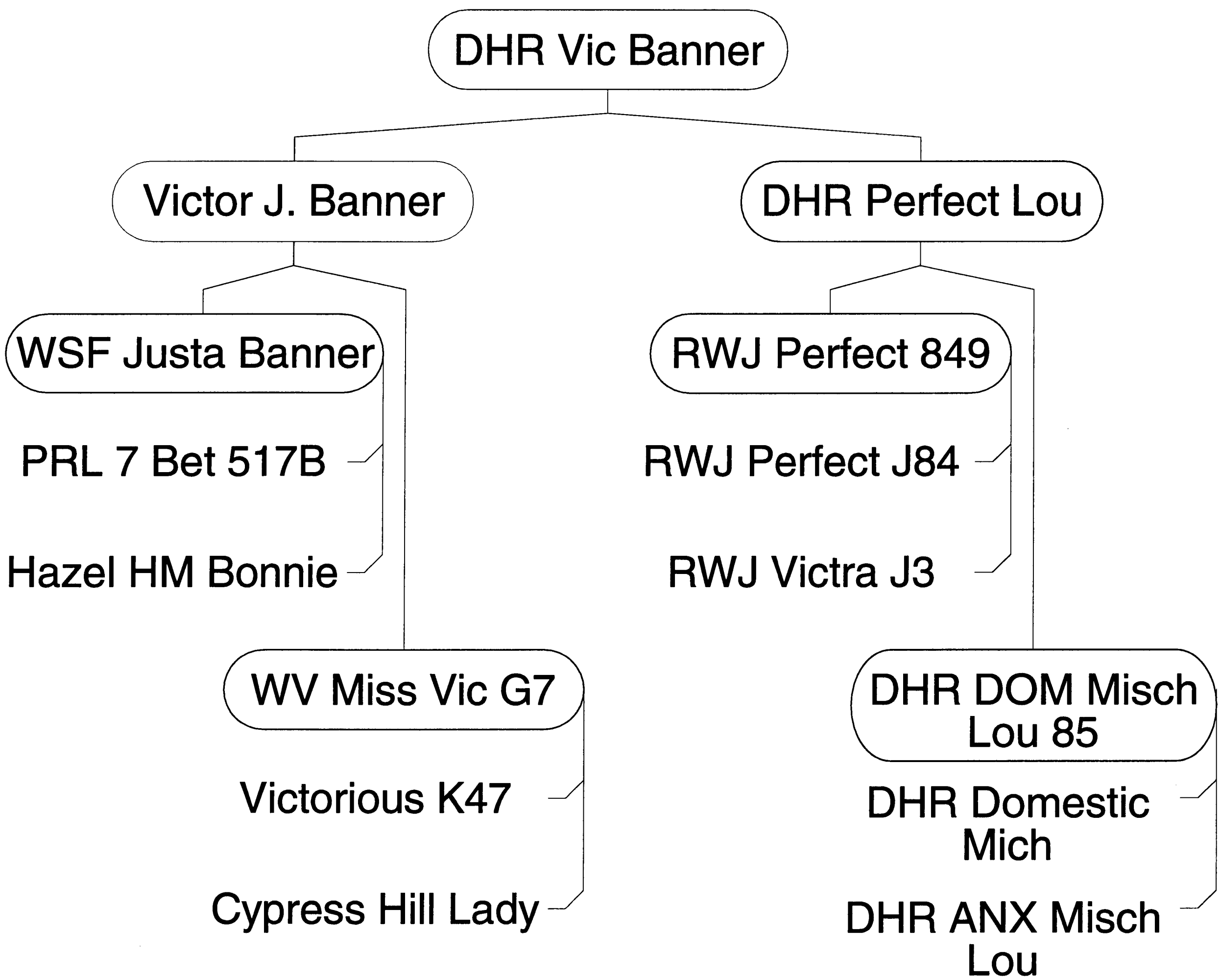
		Fat			**Protein**		
Name of bull	Milk	%	lbs.	$$	%	lbs.	$$
Bull A	+2,100	+.03	+42	+32	+.02	+39	+35
Bull B	+2,600	-.02	+61	+98	-.03	+59	+87
Bull C	+2,150	+.01	+37	+25	+.02	+40	+38

___ 6. Which bull would be the best choice if trying to improve offspring milk production?

___ 7. Which bull is best if trying to increase offspring production of pounds of fat?

___ 8. Which bull would be the best choice if trying to increase offspring production of pounds of protein?

Dairy Cow Pedigree



UNIT II - GENETICS

Lesson 7: Tools for Genetic Improvement of Sheep

Objective: The student will be able to use selection tools for genetic improvement of the sheep flock.

Study Questions

1. **What factors are important in breeding stock selection?**
2. **Explain crossbreeding systems and hybrid vigor.**
3. **Why is performance data important in sheep selection?**

References

1. Student Reference
2. Activity Sheet

   AS 7.1: Analyzing Performance Data

UNIT II - GENETICS

Lesson 7: Tools for Genetic Improvement of Sheep

TEACHING PROCEDURES

A. Review

Review previous lesson on genetic improvement of dairy herds.

B. Motivation

What are some factors to consider when establishing a sheep flock? How is animal selection determined? Can a producer genetically improve a flock in one or two generations? Factors to consider when starting a flock are: selection of breed, native or western, uniformity, size of flock, health, age, soundness of udder, and price. Selection methods used in sheep are based on individuality or type, pedigree, show-ring winnings, and performance testing. Genetic improvement occurs through culling of undesirable animals, crossbreeding, and hybrid vigor.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss some factors to consider when establishing a sheep flock.

What factors are important in breeding stock selection?

a) Factors to consider when establishing a flock
 1) Experience should the main consideration when deciding whether to begin a purebred, crossbred, or grade flock. A purebred operation requires considerable experience with sheep and sheep selection, unless the price is comparable with crossbred or grade stock. A vast majority of the sheep operators elect to use high-grade ewes and a purebred ram.
 2) Breed selection is usually based on personal preference. Breed selection depends on what the producer wants from the herd--herding ability, long or fine wool, size, mutton or wool type, and adaption to environmental conditions.
 3) Native or western ewes
 (a) Native ewes are sheep produced outside the western range area. They are known for their mutton-type breeding. Native sheep are usually larger and cost more than western sheep.
 (b) Western ewes are usually smaller and less expensive than native sheep. Western sheep are more parasite resistant, which is vital in a range operation. Produced in the western ranges of the U.S., these sheep are usually a fine-wool by long-wool cross, which is essential for range animals.
 4) Uniformity is vital to a sheep producer because it is essential to have uniform market lambs and wool quality. Breeding stock should be selected by uniform size, conformation, and fleece quality.
 5) The ram is selected to match the female stock for ease of breeding and matching desirable traits.
 6) The size of a flock is usually decided by the experience of the operator, capital, amount of land, and the method of management. Larger operations are usually

commercial or grade flocks. The smaller flocks are usually the purebred operations. A beginner can gain valuable experience through a small flock without subjecting a larger flock to this inexperience.

7) The optimum time to begin a sheep operation is late summer when lambs are weaned and before ewes are bred.

8) All breeding stock should be thrifty, vigorous, and in very good condition. Stock should be capable of producing healthy, strong offspring.

9) When establishing a flock, age is an important factor. Older breeding stock is usually considered a bad investment. Begin the flock with yearling ewes to avoid getting someone else's problems. Also, replacement costs shouldn't appear for several years.

10) Udders should be soft and pliable. There should be four working teats of equal size and shape. Reject any ewes that are missing teats or have meaty or abnormal teats.

11) The price of sheep is like any other production operation. Premium prices will be paid for quality foundation stock. Price is usually based on the production of wool and the ability to produce quality lambs. Sheep prices are generally lower than other livestock, which should be considered when deciding on the type of livestock operation.

b) Selection bases of sheep

1) There are four criteria when selecting sheep for production and breeding stock. They are: type and individuality, pedigree, show-ring winnings, and production testing.

2) Selection based on type and individuality

(a) With fleece, the art of selecting sheep by observation is difficult. Production record use is extremely important when selecting stock for the flock.

(b) The "touch method" helps eliminate fleece-covering problems. The touch method helps determine economically important traits such as muscling, loin area, leg of lamb, and udder problems. It is used in culling ewes, eliminating light-fleece animals, and removing wool-blinded animals.

(c) Like cattle, there are score cards to use when evaluating sheep. The score card places numerical values on different parts of the animal, and the perfect score is 100 points.

3) Without a doubt, pedigree selection carries less weight in sheep than in any other livestock. It is rare to find a commercial producer contemplating a purchase because of pedigree. More emphasis of pedigree selection is put on stud rams than on ewes. Blood lines do carry some weight in the price of purebred stock, however.

4) Like other livestock, show-ring winnings usually dictate consumer wants and needs in sheep. Therefore, show-ring winners and their progeny are in great demand. Show-ring winners are usually a good investment if one is willing to pay a premium, but this usually done by purebred operators. Show-ring winners provide the type of animal that is productive and useful.

5) Selection basis on performance testing

(a) Like other livestock, selection based on production/performance testing is emphasized a great deal by producers and sheep buyers. Unlike other livestock, sheep have two products instead of one.

(b) Sheep production testing is divided into two areas--mutton and fleece production. Wool production is more prominent in the southwestern part of the U.S., and mutton production is more prominent in other parts of the country where feed grain is abundant.

(c) Production testing in sheep is a more accurate method of selection than any other method. Some of the economically important traits measured are multiple births, birth weight, weaning weight, rate of gain, fleece grade, and loin area.

2. Discuss the importance of crossbreeding in sheep production.

Explain crossbreeding systems and hybrid vigor.

a) Crossbreeding is the mating of two animals of different breeds.
b) Crossbreeding is used because of:
  1) Production of two products--mutton and wool
  2) The diverse conditions in which sheep are expected to produce
  3) The emphasis of hybrid vigor produced by crossbreeding
c) Advantages of crossbreeding
  1) Hybrid vigor or heterosis is the biological phenomenon that causes crossbred offspring to outproduce the average of their parents.
  2) Complementary traits are used to maximize desirable traits and minimizing undesirable traits. In sheep, rams and ewes do not contribute equally in offspring, so breeds of sheep are divided into ram breeds and ewe breeds.
  3) Crossbreeding introduces new and desired genes quickly or at a faster rate than selecting within a breed. Crossbreeding increases the yield of females compared to straight breeding in sheep.
d) Types of crossbreeding systems
  1) A two-breed cross mates a purebred ram of breed A to a purebred or high-grade ewe of breed B.
  2) A two-breed backcross or crisscross mates a purebred ram of breed A to a purebred or high-grade ewe of breed B, then mates the offspring back to a ram of either breed A or B.
  3) A three-breed cross mates a purebred ram of breed A to a purebred ewe of breed B, then mates the offspring to a purebred ram of breed C before mating the offspring to a purebred ram of breed B.

3. Explain how the National Sheep Improvement Program has become a resource for sheep producers. After the section on performance testing is covered, give students Activity Sheet 7.1 to evaluate their comprehension of performance testing.

Why is performance data important in sheep selection?

a) The National Sheep Improvement Program (NSIP) is a tool which helps producers improve the efficiency of lamb and wool production. The program was solely developed for genetic improvement for sheep flocks.
b) The NSIP is a computer-based program that provides output on the most accurate estimates of genetic merit for economically important traits. This output is based on individual sheep available in the U.S.
c) Input needed for NSIP
  1) Ewe data collected
    (a) Number of lambs born
    (b) Number of lambs reared
    (c) Weights at birth and at various ages (30, 60, 90, 120, 240, or 365 days) NOTE: Only three are needed.
    (d) Gains between designated ages
    (e) Ram days to lambing
    (f) Fleece weight as a yearling and annually thereafter
    (g) Fleece grade of the side and britch (hind quarters) (The micron count is optional.)

(h) Staple length

2) Individual data collected

(a) Individual lamb identification number

(b) Sire identification number

(c) Dam identification number

(d) Type of birth

(e) Sex of lamb

(f) Type of rearing

(g) Date ewe was exposed to ram

(h) Date lamb was born

(i) Weights at birth and at various ages (30, 60, 90, 120, 240, 365 days) NOTE: Only three are needed.)

(j) Fleece weight

(k) Fleece grade of side and britch

(l) Micron count

(m) Staple length

(n) Other options are whether birth was assisted or unassisted, face scores, wrinkle scores, shoulder height, and carcass merit.

d) Types of output from NSIP

1) The three types of output provided by NSIP are: flock genetic evaluation summary, ewe lifetime production summary, and flock management summary.

2) Flock genetic evaluation summary is the most important output provided by NSIP. It provides accurate estimates of genetic merit for every ewe, ram, and lamb in the flock. Measurements are provided by the inputs previously taken on ewes and individuals in the flock.

(a) Expected Progeny Difference (EPD) is also a part of flock genetic evaluation summary. EPDs are figured the same way as in cattle.

(b) Example: A ewe with a +3.2 for 90-day weight will produce lambs that are expected to be +3.2 lbs. heavier than an average lamb in the flock. An average lamb would have a 0 EPD rating. EPDs are also available for rams.

3) Ewe lifetime production summary is an output provided for each individual ewe in the flock. It contains the ewe's pedigree, performance as a lamb, lambing intervals, lambs born and weaned, and the actual performance of every lamb to which she has given birth. This type of output is very useful for purebred producers to promote specific ewes and their progeny. This output also aids commercial producers in identifying truly outstanding ewes.

4) Flock management summary provides a summary of the average performance of the flock for the present production year and the immediate previous year. This kind of output helps monitor of flock performance and identify management strengths and weaknesses.

(a) Distribution of lambing from the start of lambing season

(b) Age distribution of ewes

(c) Percent of single and multiple births for age group

(d) Reasons for culling

(e) Deaths

F. Other activities

1. Invite an Extension representative to come in with the NSIP computer program to show students the actual outputs a producer can receive.

2. Have students research different sheep breeds. They can choose appropriate breeds for certain scenarios or contact associations for information, as the instructor prefers. (Letters should be approved by the instructor.)

a) Missouri Goat Breeders Association
Rt. 1, Box 660
Humansville, MO 65674
417/754-8135

b) Missouri Sheep Producers, Inc.
HCR 3, Box 165
Edgar Springs, MO 65462
573/435-6508

G. Conclusion

It is critical for sheep producers and those in related occupations to use available resources in sheep selection and flock improvement. These resources can be beneficial in genetically improving any flock.

H. Competency

Describe selection tools for genetic improvement of sheep.

I. Answers to Evaluation

1. a
2. c
3. b
4. a
5. c
6. d
7. Any nine of the following:
   - Individual lamb identification number
   - Sire identification number
   - Dam identification number
   - Type of birth
   - Sex of lamb
   - Type of rearing
   - Date ewe was exposed to ram
   - Weights at birth, 30, 60, 90, 120, 240, and 365 days (only three are needed)
   - Fleece weight
   - Fleece grade of side and britch
   - Micron count
   - Staple length
   - Other options are: whether the birth was assisted or unassisted, face scores, wrinkle scores, shoulder height, and carcass merit
8. a) Flock genetic evaluation summary provides estimates of genetic merit for each individual sheep in a flock, which will help in culling and complementing ewe and ram genetically. EPDs will help in picking rams for flock.
   b) Ewe lifetime production summary provides each individual ewe's pedigree and performance records and their offspring performance records, which will help in culling and promoting certain ewes.
   c) Flock management summary provides data on flock performance for that year and the previous year to help evaluate strengths and weaknesses in flock.

J. Answers to Activity Sheet 7.1

1. Ram B would predictively produce a lamb 2.3 lbs. lighter than Ram C and a 1.2 lb. heavier lamb than Ram A. It also has a fairly high ACC figure of .83.

2. Ram A would predictively produce a lamb 2 lbs. heavier than Ram C and a 4.5 lb. heavier lamb than Ram B. It also has a fairly high ACC figure of .82.

3. Ram A would predictively produce a lamb 5.4 lbs. lighter than Ram B and a 12.9 lb. lighter lamb than Ram C. Its ACC figure ensures that these figures are fairly accurate.

4. Ram C is above average in two out of three categories. Most importantly, it will produce the heaviest lamb at the end of the year. It also possesses the highest ACC figures throughout.

UNIT II - GENETICS Name_______________

Lesson 7: Tools for Genetic Improvement of Sheep Date_______________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is **false** regarding the NSIP?

   a. A flock evaluation summary gives data for the present and previous years.
   b. NSIP provides estimates for economically important traits.
   c. NSIP is available to every sheep producer throughout the U.S.
   d. NSIP is a computer program available at county extension offices.

2. In sheep, which is the most accurate method of selection?

   a. Individuality or type
   b. Show-ring winnings
   c. Performance testing
   d. Pedigree

3. When is the best time to begin a sheep flock?

   a. Mid-spring
   b. Late summer
   c. Mid-fall
   d. Late winter

4. Which describes native or western ewes?

   a. Known for their mutton-type breeding
   b. Usually smaller and less expensive
   c. Less likely to be infested with parasites
   d. Usually a fine-wool by long-wool cross

5. Why is crossbreeding frequently used in sheep production?

   a. Production of mutton vs. wool
   b. Helps feedlot sheep production
   c. Achieves hybrid vigor
   d. Improves the breed

6. Of the EPD scores below, which indicates a below-average ram?

   a. +3.4
   b. +2.2
   c. 0
   d. -1.8

Complete the following short answer questions.

7. List nine individual characteristics needed in data collection for NSIP.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

   h.

   i.

8. Explain how the three outputs provided by NSIP can help a sheep producer genetically improve the flock.

   a. Flock genetic evaluation summary:

   b. Ewe lifetime production summary:

   c. Flock management summary:

Lesson 7: Tools for Genetic Improvement of Sheep Name________________

ANALYZING PERFORMANCE DATA

TABLE 7.1 - Sample Sire Summary Data

Sire	Birth weight		Weaning weight		Yearling weight	
	EPD	ACC	EPD	ACC	EPD	ACC
Ram A	-1.2	.75	+2.0	.82	-5.4	.90
Ram B	0	.83	-2.5	.87	0	.85
Ram C	+2.3	.91	0	.92	+7.5	.98

Complete the following short answer questions using the table above. Comment on ACC figures for each ram chosen, and assume the ram will be used with breeding aged ewes.

1. From the provided data, which ram would be considered average for birth weight? ______ Why?

2. From the provided data, which ram would be considered above average for weaning weight? ______ Why?

3. From the provided data, which ram would be considered a below-average ram for yearling weight? ______ Why?

4. From the provided data, which ram would you pick to sire a flock for all three categories? ______ Why?

UNIT II - GENETICS

Lesson 8: Selection Tools for Genetic Improvement of Swine

Objective: The student will be able to describe and choose selection tools to improve a swine operation genetically.

Study Questions

1. **What factors are evaluated in breeding stock selection?**

2. **Explain breeding systems used in swine.**

3. **How are other tools used in swine selection?**

References

1. Student Reference

UNIT II - GENETICS

Lesson 8: Selection Tools for Genetic Improvement of Swine

TEACHING PROCEDURES

A. Introduction

Review previous lesson and the swine unit from Agricultural Science I.

B. Motivation

Present the class with a situation in which they have been asked to choose a herd boar for a local swine producer. Give them photos, production records, goals of the producer, EPDs, and pedigrees. Ask the students to choose a herd boar from the situation given. Then, ask them if they needed to learn how to utilize the information effectively in order to make a more educated choice.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students to discuss what characteristics they feel would be important to consider when choosing breeding stock for a swine operation.

   What factors are evaluated in breeding stock selection?

   a) Breeds are selected based on seed stock or commercial operation goals. The most common U.S. breeds are:
      1) Duroc
      2) Yorkshire
      3) Hampshire
      4) Landrace
      5) Chester White
      6) Berkshire
      7) Spot
      8) Poland China
   b) Composite lines are homogeneous lines of animals have been developed from crosses among two or more breeds and subsequently closed. These lines are managed much like a pure breed.
   c) Performance testing is the practice of measuring the performance of the pigs in a herd for traits of economic importance.
      1) Traits that are economically important to the swine producer include:
         (a) Litter size (usually considered the most important trait)
         (b) Litter 21-day weight
         (c) Growth rate
         (d) Back-fat thickness
         (e) Loin eye area (along with back-fat thickness, helps determine slaughter hog price)
         (f) Feed efficiency
      2) Pigs must be identified using a marking system, ear tags or a standard pattern of ear notches. The performance of the pigs must be measured and recorded.

3) The performance testing program can be as simple as recording litter size, the birth date of pigs, their date of slaughter and market weight.

d) The next step up in complexity of performance testing involves weighing pigs and measuring back-fat thickness.
   1) Calculation is done for:
      (a) Litter weights at 21 days of age
      (b) Gains during the growing and finishing periods
      (c) Measurement of leanness
   2) Records must be adjusted to a common basis of comparison. Adjustment factors have been determined that help eliminate known sources of error.
   3) The National Swine Improvement Federation produces publications that contain adjustment factors.
   4) Computer software such as "PigChamp" and "PigTales" are an alternative to adjusting records by hand.

e) At the highest level of performance testing, records are used to evaluate breeding values or expected progeny differences (EPD). EPDs are the current state-of-the-art for estimating an animal's genetic merit.

2. Ask the students what different types of swine production systems are used. Do all producers select similar types of swine for their herds?

Explain breeding systems used in swine.

a) Crossbreeding produces approximately 95 percent of swine that are commercially slaughtered. There are two reasons for crossbreeding in commercial production.
   1) Frequently, heterosis (hybrid vigor) is favorably expressed by the crossbred animal.
      (a) Individual heterosis, expressed by the crossbred offspring, is measurable for traits such as growth rate and feed efficiency.
      (b) Maternal heterosis is expressed by crossbred sows, affecting progeny performance for traits such as 21-day litter weight.
      (c) Paternal heterosis is expressed by crossbred boars for traits such as sperm production and libido.
      (d) The amount of heterosis expressed in any cross is related to the common breed makeup of the parents and is described as a percentage. If the two parental breeds share no common breed makeup, heterosis is maximized at 100 percent.
   2) Another reason for using crossbreeding is to merge the desirable characteristics of two breeds into a single animal. The ability to combine specialized maternal or terminal characteristics of a breed is known as breed complementation.

b) In general, rotational crossbreeding systems are easily managed and relatively inexpensive to operate.
   1) They suffer from less-than-maximum heterosis and no breed complementation.
   2) These systems are particularly well suited for medium- to small-sized operations.

c) Terminal crossbreeding systems require purchase of replacement females or their production in a separate component of the herd, either of which is relatively expensive.
   1) This is offset by the maximization of breed complementation and heterosis (individual and maternal).
   2) These systems are well suited to large operations of 100+ sows.

d) Rotaterminal crosses have some advantages of rotational and terminal systems.
   1) Replacement gilts are produced within a small component of the system. Breed complementation and individual heterosis are maximized in the terminal cross component.

2) However, management of replacement female production and designing appropriate matings is complex in a rotaterminal crossbreeding system.

3. What types of records are kept on swine herds? Can these records be beneficial in selecting swine?

How are other tools use in swine selection?

a) The STAGES (Swine Testing and Genetic Evaluation System) program is a computer package that evaluates expected progeny differences for traits of economic importance in swine production.
   1) STAGES operates through breed association offices. Performance records are sent to the associations for processing.
   2) The STAGES program estimates the genetic merit of animals relative to other animals in the breed.

b) Independent culling level refers to a method in which animals are culled if they perform below expectation for any trait considered important. In most selection programs, two or more traits must be considered simultaneously when making selection decisions.

c) A selection index that includes weightings for various traits might be used. The appropriate weightings or multipliers have been determined for different conditions and are given in National Swine Improvement Federation materials; these should be available from a local extension specialist.

d) In marker-assisted selection, DNA is recognizable for many genes that have small influences on economically important traits.

e) Several physiological defects are occasionally observed in swine herds.
   1) Porcine stress syndrome (PSS) can result in pigs with a recessive gene at a particular location on both copies of a chromosome pair. PSS can be fatal to stressed pigs. Signs include labored breathing, shaking and a blotchy appearance on the skin. A DNA blood test is now available that can test whether an animal carries 0, 1 or 2 copies of the gene that results in PSS.
   2) Rectal prolapse happens when the rectum becomes loose from its supporting connective tissue and protrudes through the anus. Often, this condition is associated with estrogenic compounds in the feed, an inflammation of the lower gut, and excessive piling or coughing among pigs.
   3) Umbilical and scrotal hernias result when abdominal organs protrude through the umbilical ring.
   4) In newborn pigs, splayleg causes the rear legs extend outward to the side of the body and the pig is unable to stand properly. This condition frequently results from the sow's intake of moldy feed.
   5) Inverted nipples do not extend outward from the body. A poorly inherited genetic component is often involved in causing inverted nipples.

f) Genetics is usually the cause if a defect shows up in a particular sire's progeny across multiple litters, but not in progeny produced by other sires.

F. Other activities

1. Bring in breed association magazines so students can identify some of the genetic selection tools learned.

2. Set up a scenario so the students must select a herd boar for a local producer using production information. Bring in catalogs from boar test stations or boar studs to provide the students with a selection of boars from which to choose.

3. Have students research different swine breeds. They can choose appropriate breeds for certain scenarios or contact associations for information, as the instructor prefers. (Letters should be approved by the instructor.)

   a) National Pork Producers Association
      PO Box 10383
      Des Moines, IA 50306
      515/223-2600
   b) Missouri Swine Improvement Federation
      (Missouri Pork Producers Association)
      6235 Cunningham Drive, Rt. 11
      Columbia, MO 65202-9612
      573/445-8375

G. Conclusion

In this increasingly competitive age, it is important to utilize all selection tools available in the swine industry today. Careful research must be done to ensure that the best choice is made.

H. Competency

Describe selection tools for genetic improvement of swine.

Related Missouri Core Competencies and Key Skills

10C-4: Associate the roles of genetic variation and natural selection with change in organisms over time.
10D-9: Analyze the risks and benefits of genetic engineering to society.

I. Answers to Evaluation

1. Four of the following: litter size, litter 21-day weight, growth rate, back-fat thickness, loin eye area, feed efficiency

2. a. Heterosis or hybrid vigor
   b. Breed complementation

3. Three of the following: litter size, birth date of pigs, date(s) of slaughter, market weight

4. b
5. c
6. a
7. d
8. d
9. a

UNIT II - GENETICS

Name_______________

Lesson 8: Selection Tools for Genetic Improvement of Swine

Date_______________

EVALUATION

Complete the following short answer questions.

1. List four traits of economic importance to the commercial swine producer.

   a.

   b.

   c.

   d.

2. List two reasons for using crossbreeding in commercial production.

   a.

   b.

3. List three simple components of production records.

   a.

   b.

   c.

Circle the letter that corresponds to the best answer.

   a. Purebred
   b. Rotational crossbreeding
   c. Terminal crossbreeding
   d. Rotaterminal crossbreeding

5. Which breeding system maximizes breed complementation and individual heterosis?

   a. Purebred
   b. Rotational crossbreeding
   c. Terminal crossbreeding
   d. None of the above

6. Which test identifies the presence of PSS?

   a. DNA
   b. Urine
   c. Skin
   d. Treadmill

7. Which group produces adjustment factors for production record comparisons?

   a. State veterinarian office
   b. Local extension office
   c. Purdue University
   d. National Swine Improvement Federation

8. STAGES estimates the genetic merit of animals relative to other __________ .

   a. Gilts and sows
   b. Boars and barrows
   c. Herd animals
   d. Animals in the breed

9. Which defect results in labored breathing, shaking, blotchy skin and frequently death?

   a. PSS
   b. Rectal prolapse
   c. Umbilical hernia
   d. Splayleg

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)

UNIT III - REPRODUCTION

Name__________________

Lesson 1: Importance of Reproduction in Livestock

Date__________________

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
13. ____ Cervix
14. ____ Cotyledon
15. ____ Fallopian tube
16. ____ Infundibulum
17. ____ Ovary
18. ____ Uterus
19. ____ Urethral opening
20. ____ Vagina
21. ____ Vulva

a. Structure that produces the egg
b. External opening of the urinary and reproductive tracts
c. Sensory organ of the female reproductive tract
d. Opening for the bladder
e. Female organ where the semen is usually deposited at copulation
f. Seals the uterus from bacterial and foreign invasions after fertilization
g. Attachment point for connecting the placenta to the uterus
h. Where the fetus develops
i. Where the egg is fertilized
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
____ b. Carcass traits
____ c. Birth weight
____ d. Weaning weight
____ e. Horned
____ f. Maternal ability
____ g. Polled
____ h Daily rate of gain
____ i. Pasture gain
____ j. Type of diet
____ k. Daily water intake
____ l. Conformation score

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

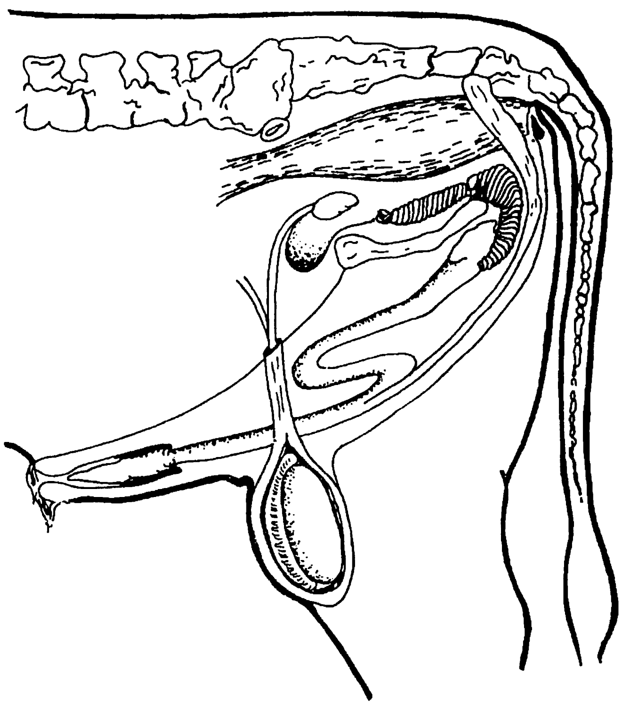
____ a. Milk production
____ b. Horned
____ c. Type of idet
____ d. Percent fat
____ e. Udder support
____ f. Milking speed
____ g. Mastitis infection
____ h. Birth weight
____ i. Temperament
____ j. Daily water intake
____ k. Daily feed intake
____ l. Fertility

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

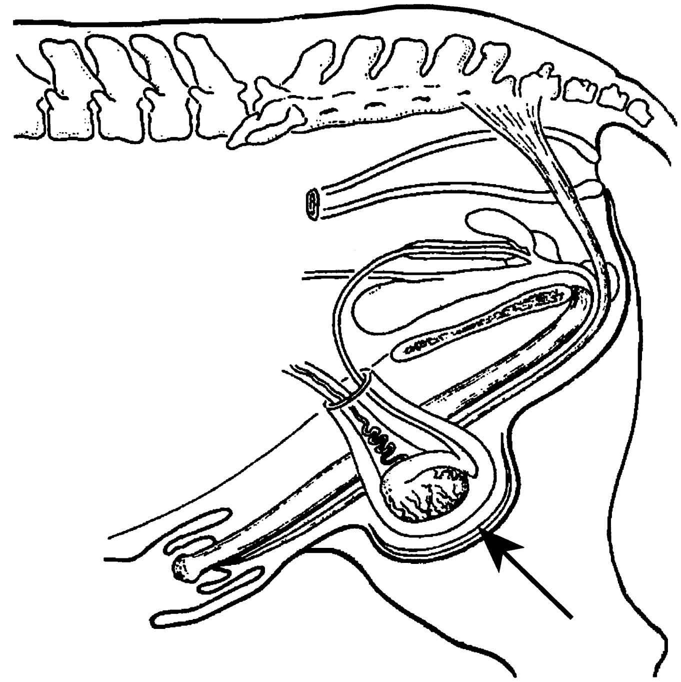
____ a. Type of diet
____ b. Multiple births
____ c. Rate of gain
____ d. Finish or condition
____ e. Carcass quality
____ f. Polled
____ g. Daily water intake
____ h. Fleece weight
____ i. Wrinkles and skin folds
____ j. Number of lambs weaned

Comparison of Male Livestock

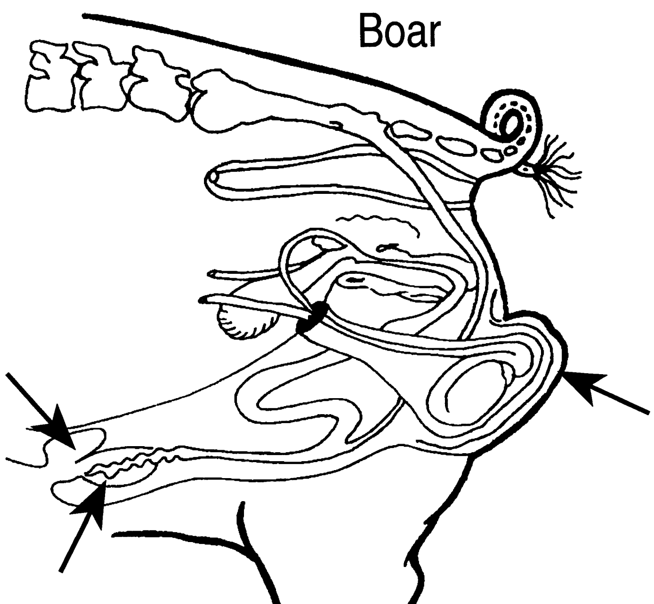
Bull



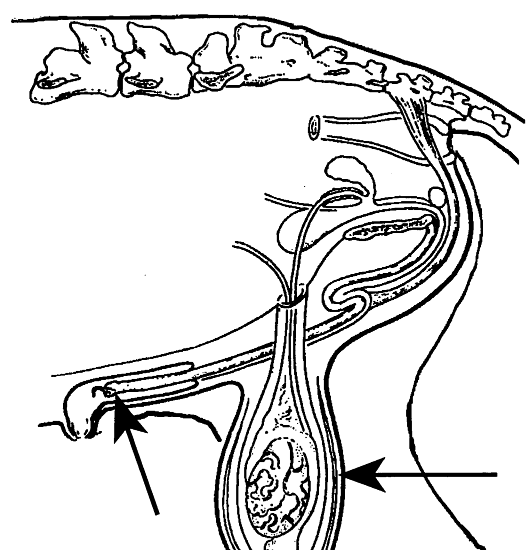
Stallion



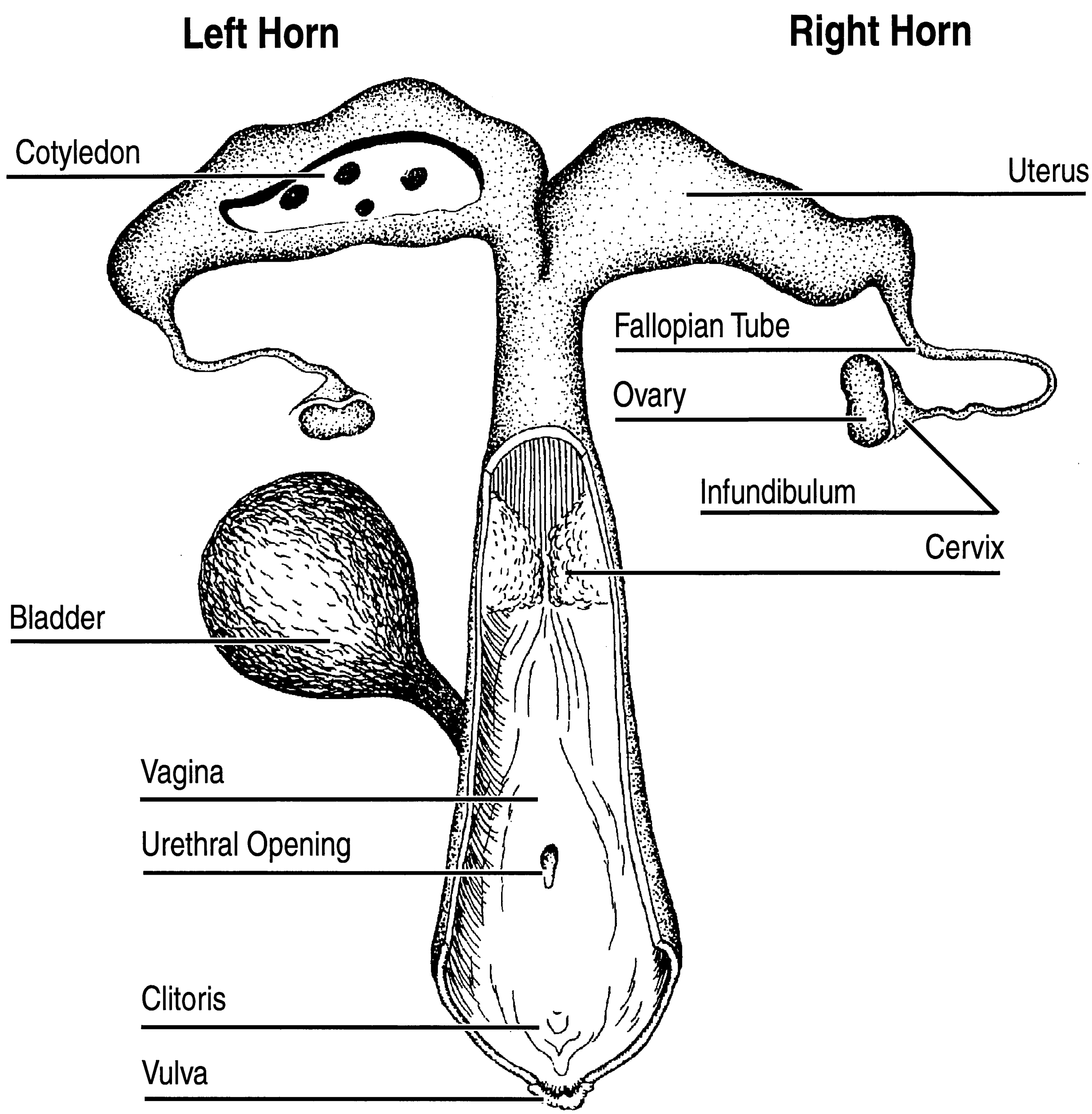
Boar



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 $^3/_4$ 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)

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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

UNIT IV - ANIMAL HEALTH

Lesson 1: Importance of Animal Health

Objective: The student will be able to understand the significance of animal health in livestock.

Study Questions

1. **Identify careers in animal health.**
2. **What is the economic importance of animal health?**
3. **How are drugs approved?**
4. **What are differences between population and individual medications?**
5. **What are government health regulations for movement of livestock interstate and intrastate?**

References

1. Student Reference

UNIT IV - ANIMAL HEALTH

Lesson 1: Importance of Animal Health

TEACHING PROCEDURES

A. Review

B. Motivation

What are the annual costs associated with animal health? What does animal health (or sickness) cost the average livestock producer? A whopping $11 billion is lost every year due to animal health problems, costing the average livestock producer 15 percent of annual cash receipts. Animal health is a large factor in the profit or loss of a livestock operation.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students if they know what occupations are associated with livestock health and the educational background needed.

   Identify careers in animal health.

   a) Veterinarian - This occupation is involved with many aspects of livestock health. These include vaccinations, setting up health programs, deworming, curing sick or unhealthy animals, and detecting livestock diseases.
   b) Livestock producer - If they have the facilities, livestock producers do most of the on-farm vaccinations and treatments. Livestock producers also detect and observe diseases that affect their herds.
   c) Extension livestock health specialist - The Extension Service provides information about animal health programs. It provides health, sanitation, and prevention programs to producers.
   d) Animal health products representative - An animal health sales rep sells equipment, medicine, and necessary tools for administering on-farm vaccinations.
   e) Livestock health scientists - These scientists provide the latest research for new cures and detection of new diseases. They work at major universities, the USDA, and in industry.
   f) Animal health enforcement - People in this occupation enforce state or national regulations regarding animal transportation, quarantines, and health certificates. They also monitor for new livestock diseases to keep them from entering the country.

2. Ask students how animal health affects the profit or loss of a livestock operation. How could a livestock operation benefit from a health program or preventive measures?

   What is the economic importance of animal health?

   a) There are billions of dollars lost every year because of poor animal health. Approximately 15 percent of all producer cash receipts in a year are used to cover losses caused by diseases associated with animal health. This 15 percent translates into $11 billion lost annually.

b) The following items occur every year and determine profit or loss for a livestock producer.
   1) Approximately 12 percent of cows bred never calve due to diseases, which cause cows to abort the fetus, and general health or nutrition problems, which prevent or hinder conception.
   2) Approximately 6 percent of all calves die between birth and weaning because of general health and/or nutrition problems.
   3) About 10 percent of all calves are afflicted with scours; about 18 percent of dairy calves afflicted with scours die.
   4) Cow-calf operators spend approximately $26.95 per cow on disease prevention and death losses.
   5) Approximately 1.5 million cattle are lost in the feedlot due to general health problems, costing approximately $750 million.
   6) About one in 10 dairy females have breeding difficulties due to general health and nutritionally related problems.
   7) Approximately 40 percent of dairy cows are afflicted with a form of mastitis, which means $225 per year, per cow. (Mastitis-infected products cannot be used for human consumption.)
   8) About 5 percent of all ewes never lamb due to general health problems.
   9) Approximately 20 percent of all lambs die between birth and weaning because of general health and/or nutrition problems.
   10) Approximately 3 percent of all lambs on finishing rations die due to general health problems.
   11) Nearly 15 percent of all bred sows never farrow due to general health problems.
   12) Approximately one-fourth of all pigs die between birth and weaning.
   13) Approximately 50 percent of all bred mares abort or have weak foals due to general health problems. (This means that two mares are kept to produce one foal.)
   14) Approximately 6 percent of all foals die between birth and weaning due to general health problems.

c) There are also hidden costs that are not figured into the $11 billion lost yearly due to general health problems. These costs are reflected in poor meat quality, infected carcasses, added labor costs, retarded growth, inspector salaries, depreciation of infected land, and many other costs.

d) Some animal diseases can be transferred to humans by contact. There are strict regulations for these diseases because of the effects on humans. Here are some important animal diseases that can be transferred to humans.
   1) Lyme disease - Transmission of this disease is usually by a bite from a tick or by crushing an infected tick on broken skin. The increased risk to humans has been caused by more animals bringing the infected ticks closer to human habitations. Human cases of Lyme disease have been reported in the East coast, West coast, Great Lakes, and a few southern states. Human symptoms are skin lesions around the bite and arthritis in large joints. Sometimes symptoms do not appear until four years after contact. It is a curable disease, but there could be some permanent damage to a fetus and some neurological damage, which could be prevented by early detection.
   2) Brucellosis - Transmission of this disease can occur by contacting an aborted, stillborn fetus or placental tissues with cuts or scrapes on a person's hand. (It cannot penetrate normal skin.) It can also be transmitted by breathing aerosols containing the organism (such as in a packing plant) or consumption of unpasteurized dairy products. This organism cannot survive in dry conditions, in sunlight, or extremely hot conditions, but under favorable conditions it can survive for 3-4 months. Human symptoms are continued and intermittent occurrences of fever, headaches, profuse sweating and chills, depression, body aches, and weight

loss. Without proper treatment, these symptoms persist for several months. This disease cannot be transmitted to other members of the family by humans.

3) Rabies - Transmission of this disease occurs from a bite of a rabid animal. This natural disease occurs in animals to regulate overpopulation. In humans, 90 percent of the rabies cases are reported by wild animals, and the other 10 percent is from domesticated pets. This is why vaccination of pets is so vital. In humans, rabies is a curable disease if caught in time, but even the cure is very painful.
4) Salmonellosis - Transmission of this disease occurs through consumption of contaminated foods not properly stored or cooked. Salmonellosis can be found in pork, beef, poultry, eggs, milk, and even vegetables grown with infected fecal fertilizers. Symptoms occurring in humans from salmonellosis are intestinal infections, fever, abdominal cramps, vomiting, nausea, and diarrhea. Salmonellosis is a treatable disease by correcting dehydration and electrolyte imbalances.
5) Trichinosis - Transmission of this disease occurs by eating infested meat. Primary sources of trichinosis are under-cooked pork and wild animals, primarily carnivores such as bears. With proper cooking, this disease can be prevented. Symptoms are inflamed muscles or allergic reactions.
6) Cryptosporidiosis - Transmission of this disease occurs by ingesting contaminated food or water and by working around infected fecal material. Generally, people do not even know they are infected by cryptosporidiosis because the human body develops immunity to this disease. Diarrhea is the typical symptom in humans. This disease is more prominent in the population affected by Acquired Immune Deficiency Syndrome (AIDS) because their immune systems can no longer fight off disease.
7) Cowpox - Transmission occurs when a human comes in contact with an infected animal during the milking process. There appears to be a relationship between cowpox and smallpox immunizations. There are artificial immunizations for cowpox in humans. Human symptoms include sores on the skin. For dairy producers, the infections will usually appear on hands and arms, which are two areas that come into contact with the animal the most.
8) Brucellosis - Transmission occurs when a human comes in contact with an infected animal. This usually happens when disposing of dead, infected animals without knowledge of the cause of death. Infection in humans can also occur by ingesting contaminated dairy products. This disease is highly regulated and controlled by state institutions because of its contagious nature to humans.
9) Ringworm - Transmission occurs when a human comes in contact with the fungus through an infected animal or infected quarters where the animal has been. Human symptoms usually appear as discolored spots on the skin. This fungus can live up to 18 months on fence posts, animal brushed, or curry combs.

3. It costs approximately $3 million for a drug to be approved for human use. Ask students how drugs are approved for livestock and the procedure used for drug authorization.

How are drugs approved?

a) Development of new drugs
   1) A new drug begins when a manufacturing company sees the need for it and has the research capabilities for developing it. Generally, a new drug is developed through the discovery of a new compound that could be useful in animal health. Research and development must prove that the compound is effective, safe, and convenient to use.
   2) Research and development of a new drug is expensive, time-consuming, and exacting. In 1988, animal health institutions spent $340 million on research and development of new drugs.

b) Approval process for new drugs

1) Discovery - The first step in drug approval is the discovery of a new compound that is suitable for animal health. This discovery could be accidental or discovered through research and development.

2) Preliminary trials - Once a compound is found helpful in animal health, it goes through some preliminary trials. Three questions must be answered before intense development procedures take place.

   (a) Does the new drug have any undesirable traits? What is the potential activity of the new compound?

   (b) What are the estimated costs for research and the anticipated demand for this new compound?

   (c) Can it be confirmed that the new compound will do what it is supposed to do?

3) Pre-clinical trials - Pre-clinical trials target animals on which the drug could be used. These trials are usually done in a laboratory setting on lab animals. Exaggerated dosages are given to determine the effects. If the manufacturer is still convinced of the effectiveness of the compound, appropriate agencies are notified.

4) INAD/EUP notification - INAD (Investigational New Animal Drug) is the branch of the FDA that is notified. If the new compound is a pesticide, an EUP (Experimental Use Permit) is the notification to the EPA. These applications show the results of safety, effectiveness, and toxicity studies of the compound, as well as plans for continued testing and small amounts of the compound. After receiving an INAD or EUP file number, the manufacturer makes the final decision to go ahead with clinical testing.

5) Clinical trials - Clinical trials consist of full-scale field trials. At this point, the manufacturer has a sizable investment in the compound and determines if it will be economical to continue research. Field trials are done on animals targeted for usage of the drug. These studies consist of toxicity levels, dosage, residue studies, effectiveness, and blind studies. In blind studies, animals receive the compound in such a way that researchers are not aware of which animals received it. The data is evaluated to show the effectiveness of the compound.

6) Drug and pesticide approval - Here, a manufacturer applies to federal agencies for the right to produce the new drug. The manufacturer files for a NADA (New Animal Drug Application) or a pesticide permit. The typical NADA application would fill an average encyclopedia volume. It reveals the results of environmental effects, safety to users, animals, and consumers.

7) Monitoring - Once the drug or pesticide is marketed, the manufacturer must report findings back to federal agencies every six months for the first year, as well as yearly for the remaining years the drug or pesticide is produced. Further monitoring is done by veterinarians across the country, who report on any adverse conditions that occur through usage of the drug or pesticide.

4. Why is it important to know the differences between population and individual medications?

What are differences between population and individual medications?

a) Individual medications are administered to one individual animal. The label verifies the dosage per individual, which is justified by body weight, age, or type of production.

b) Individual medications can be over-the-counter drugs, extra label drugs, or prescription drugs administered by veterinarians.

c) Population medications are mixed with feed, a complete feed, or fed by themselves. These drugs are usually classified as feed additives and administered for a population of animals.

d) To deworm a pen of finished cattle, mix the dewormer in the feed and medicate the whole population. Population medications are usually mixed into feed.

e) As mentioned previously, individual medications are approved after going through a long, expensive process.

f) Population medications and feed additives go through a different process for approval than individual medications. However, both have federal agencies regulating the approval of these medications.

5. Ask students if they know the legalities of transporting animals in state and out of state.

What are government health regulations for movement of livestock interstate and intrastate?

a) Intrastate regulations
   1) It is a "buyer beware" market when purchasing and transporting livestock within the state of Missouri. Livestock can be transported anywhere in the state without a health certificate.
   2) A buyer can request health papers, but the seller does not have to provide them.
   3) If a producer buys livestock at an auction, some health tests will be run at that sale barn. The actual types of tests are determined by the operator of the sale barn.
   4) Most purebred and crossbred operations have health papers on all stock in their operation.
   5) Most other states have similar intrastate regulations.

b) Interstate regulations
   1) Each state has different regulations on interstate transportation of livestock. If a Missouri producer sells cattle to a Kansas producer, the seller is responsible for finding out Kansas health regulations so the cattle can be transported legally. Then, a veterinarian can run the required health tests. If the cattle pass the required tests, a health certificate is issued for that group of cattle that stays with them through the entire process of interstate transportation.
   2) A health certificate is not necessary for each state that the cattle pass through--just the state of destination. To be safe, however, contact each state veterinarian's office.

c) Federal regulations
   1) Livestock cannot be transported on a rail car for more than 28 hours without rest, food, and water. This rest period must last for five hours before being loaded back up for transportation.
   2) Livestock traveling by truck or trailer cannot be transported for more than 24 hours without rest, food, and water. The break must last at least five hours before the animals are loaded up again.

F. Other activities

1. Invite personnel from the state Dept. of Agriculture to discuss the rules and regulations of livestock transportation.

2. If a speaker phone is available, demonstrate the Voice Response Service coordinated by the USDA's Center for Epidemiology and Animal Health. Using a touchtone phone, call 800/545-USDA (8732) to connect with the service, which supplies information on state regulations (including transportation), emergency notices, animal care, etc.

3. Show the video, *Cattlemen Care About Animal Welfare* (10 minutes, AG video 188), available from the Missouri Vocational Resource Center.

G. Conclusion

It is important to understand the economic importance of animal health and the costs associated with it. As a consumer, it is vital to understand diseases associated with eating animal products and the possible human effects. Consumers and livestock producers should understand the importance of drugs and how they are approved for animal health.

H. Competency

Identify the importance of animal health in livestock.

I. Answers to Evaluation

1. 11 billion, 15
2. Hidden
3. Brucellosis
4. Salmonellosis
5. Trichinosis
6. Intrastate
7. New Animal Drug Application
8. Experimental Use Permit
9. Population
10. a, c-h (question worth eight points)
11. b, c, d, f, g (question worth eight points)
12. b, e (question worth five points)
13. a-f (question worth six points)

UNIT IV - ANIMAL HEALTH Name_______________

Lesson 1: Importance of Animal Health Date_______________

EVALUATION

Fill in the blank with the best answer.

1. Animal health problems cost livestock producers $____________ annually, which is ______ percent of cash receipts per livestock producer.

2. Infected carcasses, poor meat quality, additional labor costs, and depreciation of infected land are called ____________ costs, which are not figured in annual health problems.

3. The disease, _________________ , is transmitted to humans by contact with an infected fetus or placental tissues. Symptoms are fever, headaches, profuse sweating and chills, depression, and body aches.

4. Improper storage and cooking techniques can transmit ___________________ to humans. Symptoms are intestinal infections, fever, vomiting, nausea, and abdominal cramps.

5. The disease, _________________ , is transmitted to humans by ingesting contaminated meat, mainly pork. Symptoms are inflamed muscles or allergic reactions.

6. The transportation of livestock within a state, which does not require a health certificate, is called ________________ transportation.

8. EUP stands for ______________________________ .

9. A feed additive is considered to be a ________________ medication.

Complete the following multiple answer questions.

10. Check the appropriate steps in drug approval of animal health products.

____ a. Monitoring
____ b. Scheduling
____ c. Discovery
____ d. Clinical trials
____ e. Pre-clinical trials
____ f. Drug and pesticide approval
____ g. INAD/EUP notification
____ h. Preliminary trials

11. Check the factors that are true about individual medications.

____ a. Can be administered through mixing of bulk feeds
____ b. Can be prescribed by veterinarians
____ c. Can be purchased over the counter
____ d. Administered by specific dosages
____ e. Can be administered through the water supply
____ f. Are administered to individual animals
____ g. Are approved by the FDA
____ h. Go through the same approval procedures as population medications

12. Check the requirements needed for interstate transportation of livestock.

- ____ a. A health certificate for every state the livestock passes through
- ____ b. A health certificate for only the state of destination
- ____ c. The rest period for transported livestock must be at least three hours long.
- ____ d. Livestock transported by rail car cannot travel more than 30 hours without a rest.
- ____ e. Livestock transported by truck or trailer cannot travel more than 24 hours without a rest.

13. Check the careers that are associated with animal health.

- ____ a. Veterinarian
- ____ b. Livestock producer
- ____ c. Extension livestock health specialist
- ____ d. Animal health enforcement
- ____ e. Livestock health scientist
- ____ f. Animal health products representative

UNIT IV - ANIMAL HEALTH

Lesson 2: Immune System of Livestock

Objective: The student will be able to describe aspects of the immune system of livestock.

Study Questions

1. **What are the causes of different types of diseases in livestock?**
2. **What are the different types of immunity?**
3. **What are the different types of immunizing agents, and how do they work?**
4. **What is an antibiotic, and how does it work?**

References

1. Student Reference

UNIT IV - ANIMAL HEALTH

Lesson 2: Immune System of Livestock

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Bring in different types of vaccines and talk about what they are used for and how they work.

C. Assignment

D. Supervised study

E. Discussion

1. A disease is any condition that detracts or interferes with an animal's well-being. Discuss ways producers can control and prevent diseases within their herds.

What are the causes of different types of diseases in livestock?

a) Noninfectious diseases - not caused by infectious organisms
   1) Nutritional diseases
      (a) These can occur when the animal receives too little or too much of a particular nutrient in the diet.
      (b) A deficiency of certain vitamins and minerals can produce a variety of symptoms, such as poor growth, weak bones, weak muscles, poor eyesight, and a decreased resistance to other diseases.
   2) Metabolic diseases
      (a) Can occur when the animal's organs do not function correctly
      (b) Can happen when the animal undergoes major changes in its life
      EXAMPLE: Milk fever at parturition
   3) Toxic diseases
      (a) Exposure to poisonous materials cause toxic diseases.
      (b) Common livestock poisonings involve farm chemicals (such as insecticides and herbicides) and automotive products (batteries, antifreeze).
      (c) Some poisons form when mold grows on grain or hay that is used for feed.
      (d) Some plants are poisonous.
   4) Injury or trauma
      (a) Lightning strikes
      (b) Lameness after foot injury on rough or rocky surfaces
      (c) Predator animals (such as wolves and coyotes)
   5) Congenital diseases (present at birth)
      (a) These are often caused by faulty development of the fetus inside the mother's uterus.
      (b) Some examples are cleft palate (a hole in the roof of the mouth) and ventricular septal defect (an abnormal opening between two heart chambers).

6) Genetic diseases (inherited from parents)
   (a) Symptoms of genetic diseases may or may not be present at birth.
   (b) One example is porcine stress syndrome.

b) Infectious diseases
   1) Infectious diseases are caused by other living organisms (pathogens) that infect and cause disease.
   2) The way that these organisms cause disease varies.
      (a) Killing the cells or tissues that they infect
      (b) Producing toxins or poisons, which have an adverse effect on the animal's body
      (c) Bacteria and viruses (most common)
         (1) Bacteria are microscopic, single-celled organisms.
         (2) Bacteria are very common; most are harmless, and some may even be beneficial.
         (3) However, a few bacteria are pathogenic and can be harmful to the animal. Pathogenic bacteria require moisture, warmth, and nutrients to grow and multiply. An animal's body provides all of these requirements.
         (4) Bacteria cause disease when they grow in places where they are not supposed to grow or when they produce by-products that are harmful to the animal's body. Some examples of bacterial diseases are *E coli* diarrhea in calves and piglets, blackleg in calves, and erysipelas in pigs.
         (5) Viruses are extremely small particles that can only be seen by the most powerful electron microscopes.
         (6) Viruses cannot grow or reproduce unless they infect the cells of another organism. Some examples of viral diseases in livestock are infectious bovine rhinotracheitis (IBR or red nose) in cattle and transmissible gastroenteritis (TGE) diarrhea in pigs.
      (d) Fungi and protozoa
         (1) Fungi are usually more complex in form than bacteria.
         (2) Fungi can consist of more than one cell with different functions.
         (3) Most familiar fungi (mushrooms, molds) do not infect animals. However, some diseases, such as ringworm and thrush, are caused by fungi, which can infect animals.
         (4) Protozoa are single-celled animals. As with bacteria, most protozoa are harmless and some are even beneficial (helping in digestion, for example). Other kinds of protozoa, such as coccidia, infect animals and cause disease.

2. Animals are faced with exposure to potentially pathogenic organisms every day and usually do not get sick from these exposures. Fortunately, animals have mechanisms to ward off these threats to their health: natural and acquired immunity. Discuss reasons that certain livestock species are resistant to diseases, while others are not.

What are the different types of immunity?

a) Natural, physical barriers protect animals from infection with disease-causing organisms or trap pathogens before they can infect the body.
   1) Skin
   2) Mucus
   3) Tears

b) Certain body cells in the body examine everything they contact to determine whether or not it belongs there.
   1) If found, these cells notify the immune system to produce antibodies against that particular pathogen.
   2) Antibodies are protein molecules that bind with the pathogen and help other cells in the body eliminate it.

c) Active immunity is the process of producing antibodies against a pathogen by a natural exposure to that pathogen or by vaccination.

d) In passive immunity, animals may also receive antibodies that another animal has made (e.g., colostrum or blood serum).

3. Vaccines are basically a modified form of the pathogen that will not cause disease. Discuss what vaccinations are used for and how the students think they work. Ask the students about diseases for which they have been vaccinated. How do producers prevent the spread of disease throughout herds?

   What are the different types of immunizing agents, and how do they work?

   a) Modified live vaccines
      1) Live viruses or bacteria that have been changed so that they will not produce disease
      2) Very effective at stimulating the animal's immune system
   b) Killed vaccines
      1) Viruses or bacteria that have been killed, often by treatment with heat or chemicals
      2) Sometimes called bacterins
   c) Toxoids
      1) A changed form of toxin or poison that will help the animal produce antibodies against the toxin
      2) Tetanus vaccine for horses and sheep
   d) Antisera and antitoxins (passive immunity)
      1) Antibodies to specific pathogens and toxins that have been formed in the blood serum of another animal
      2) Quick protection against certain diseases, but not as long lasting as the active immunity stimulated by vaccines and toxoids

4. Discuss what antibiotics are used for and how the students think they work.

   What is an antibiotic, and how does it work?

   a) Antibiotics are compounds produced by microorganisms (often fungi) that either kill or inhibit the growth of other bacteria or fungi.
   b) They are often given either by mouth or by injection.
   c) Many different antibiotics are available.
      EXAMPLES: Penicillin and tetracycline
   d) Some pathogens are resistant to the effects of certain antibiotics.
   e) Antibiotics have no effect on viruses.

F. Other activities

1. Look at bacteria under the microscope.

2. Ask the local veterinarian or school nurse to talk to the class about vaccinations and antibiotics.

G. Conclusion

Animal diseases are the world's oldest and toughest enemies. Losses from animal diseases and parasites cost producers and the economy billions of dollars. Much of this waste could be reduced by disease-prevention programs.

H. Competency

Describe the aspects of the immune system of domestic livestock.

Related Missouri Core Competencies and Key Skills

10C-2: Hypothesize how genetic resistance develops from continued exposure to pesticides or antibiotics.

I. Answers to Evaluation

1. c
2. a
3. d
4. d
5. a
6. a
7. b
8. d-f (question worth eight points)

UNIT IV - ANIMAL HEALTH

Name_______________

Lesson 2: Immune System of Livestock

Date_______________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which type of vaccine lasts the shortest period of time?

   a. Modified live vaccine
   b. Toxoid
   c. Antiserum and antitoxin
   d. Killed vaccine

2. Antibiotics have no effect on which of the following?

   a. Viruses
   b. Bacteria
   c. Fungi
   d. Protozoa

3. Which is true of antibiotics?

   a. Produced by microorganisms (often bacteria)
   b. Never given by mouth
   c. Few kinds are available.
   d. Effects can be resisted by some pathogens.

4. Feeding colostrum to newborn animals is a form of which type of immunity?

   a. Active
   b. Required
   c. Natural
   d. Passive
   e. Individual

5. From what do antibiotics originate?

   a. Living microorganisms
   b. Dead microorganisms
   c. Toxic materials
   d. Metabolic materials

6. What is produced by the tissues in reaction to disease?

   a. Antibodies
   b. Antiserum
   c. Bacterins
   d. Toxoids

7. Which is produced in the blood serum of another animal?

   a. Modified live vaccines
   b. Antiserum and antitoxins
   c. Killed vaccines
   d. Toxoids

Complete the following multiple answer question.

8. Check natural defense mechanisms animals use to fend off infectious diseases.

____ a.	Vaccines	____ e.	Mucus
____ b.	Toxoids	____ f.	Antibodies
____ c.	Bacteria	____ g.	Hair
____ d.	Skin	____ h.	Antibiotics

UNIT IV - ANIMAL HEALTH

Lesson 3: Respiratory Diseases Affecting Livestock

Objective: The student will be able to understand and describe the diseases of the respiratory system affecting livestock.

Study Questions

1. **What are the major swine respiratory diseases, their symptoms, and treatments?**
2. **What are the major cattle respiratory diseases, their symptoms, and treatments?**
3. **What are the major equine respiratory diseases, their symptoms, and treatments?**

References

1. Student Reference
2. Activity Sheet
    a) AS 3.1: Respiratory Diseases

UNIT IV - ANIMAL HEALTH

Lesson 3: Respiratory Diseases Affecting Livestock

TEACHING PROCEDURES

A. Review

Review previous lesson on aspects of the immune system of domestic livestock.

B. Motivation

Why is it important for non-veterinarians to know respiratory diseases of livestock? Someone in livestock production or a related occupation should understand the effects of respiratory diseases on a single operation and the entire livestock industry. To prevent diseases from spreading throughout the herd and causing extreme losses, a producer must be able to recognize the symptoms of these diseases. Everybody should understand how outside influences can trigger a respiratory infection within a herd. The effects of stress lead to many infections in livestock. Like humans, animals under stress are more likely to be invaded by viruses or bacteria because their bodies are run down.

C. Assignment

D. Supervised study

E. Discussion

1. See if students can come up with some major respiratory diseases in swine.

   What are the major swine respiratory diseases, their symptoms, and treatments?

   a) Atrophic rhinitis
      1) Description - Atrophic rhinitis is a highly transmissible disease in swine caused by bacteria *(Bordetella* and *Pasteurella).* It causes distortion of the nasal passages. Infected swine have lower production levels and are more susceptible to other respiratory diseases. Atrophic rhinitis is not a fatal disease--just an unwanted disease. It is transmitted as an aerosol from an infected hog to a noninfected one. Other carriers are dogs, cats, rabbits, mice, turkeys, horses, and humans.
      2) Symptoms - Sneezing and sniffling are the most common symptoms in swine and are good early detections for the disease. Coughing and snorting are other symptoms of atrophic rhinitis. Inflammation of nose membranes is also a good indication of this disease. As the disease matures, the shape of the nose becomes deformed. The nose turns to one side or the other by as much as 45 degrees.
      3) Prevention - A producer must monitor the contact with outside animals. A producer must also correct environmental deficiencies in sanitation, temperature, humidity, and ventilation. Control dust, drafts, excessive ammonia, and over-crowding.
      4) Treatments - A producer can protect against *Bordetella* and *Pasteurella* organisms by medicating feed with sulfamethazine or oxytetracycline.
   b) Mycoplasma pneumonia
      1) Description - Transmission of the disease occurs easily by contact. Other means of transmission are: infected clothing, dust, and wind transmission from shed to shed. Young pigs are most susceptible at 3-9 months. Pigs showing symptoms of this disease that appear to have recovered still become carriers of the disease. Also, symptoms can reappear if pigs become stressed. The mortality rates for

Mycoplasma pneumonia are relatively low, but secondary infections can increase death, so treatment is important in controlling the disease.

2) Symptoms - A dry, hacking, repetitive cough in young pigs are typical chronic symptoms of mycoplasma pneumonia. Infected pigs remain alert and still have a healthy appetite but have reduced growth rates, weights, and feed efficiency. Acute cases cough and pant and appear to have a fever, little appetite, and a staggering gait.

3) Prevention - Isolate and observe outside animals brought into the herd. This also applies to animals that are suspected to be infected. After working with infected animals, change and wash clothing worn during the process. Make sure there is appropriate feed and water so animals do not come under further stress. There are vaccines available to prevent this disease.

4) Treatments - There are a wide variety of antibiotics and feed additives to treat animals. It is recommended that different medications be used so the disease does not become resistant to one medication. Keep infected animals isolated in a dry, warm, well-ventilated area with appropriate feed and water.

c) *Pasteurella* pneumonia

1) Description - Like most respiratory diseases, *Pasteurella* pneumonia spreads in the aerosol form. Younger pigs are generally affected by the disease. Pigs of 8-24 weeks are most susceptible to *Pasteurella* pneumonia. Mortality rates are high if effective treatments are not administered. Death can occur as quickly as 5-10 days if not treated.

2) Symptoms - Fever, coughing, depression, mouth breathing, and labored abdominal movements are all typical acute symptoms of *Pasteurella* pneumonia. Chronic symptoms are intermittent coughing and signs of unthriftiness.

3) Prevention - Chilling, dusty conditions, poor nutrition, a change in ration, overcrowding, poor ventilation, and poor hygiene can trigger *Pasteurella* pneumonia. All these factors are signs of poor management.

4) Treatment - Infected animals can be treated with antibiotics through injections. Other animals that shared the same airspace can be treated with feed or water additives for 5-7 days. Like most respiratory diseases, *Pasteurella* pneumonia is a treatable and preventable disease if caught early enough.

d) Haemophilus pneumonia

1) Description - Weaning-age pigs are the most susceptible to Haemophilus pneumonia, but all ages of swine can be infected. Like most respiratory diseases, Haemophilus pneumonia is transmitted in the aerosol form. Mortality rates are as high as 60 percent if it is not treated quickly.

2) Symptoms - Severe respiratory distress, severe abdominal respiration, and bloodstained discharge from the nose and mouth are acute symptoms of Haemophilus pneumonia. This particular disease hits fast. Some infected pigs die within a few hours or in a couple of days. A true, fatal sign of this disease is when pigs lie down and are not inclined to move. Chronic cases are usually non-fatal, and pigs show signs of ill thrift, persistent cough, fever, and respiratory distress.

3) Prevention - A good preventive measure for Haemophilus pneumonia is to provide well-ventilated, clean, and properly spaced conditions. Infected pigs that have been treated might develop immunity to future outbreaks of this disease. Also, sows that have been infected and treated might pass immunity to the offspring by colostrum in the milk. It is also a good idea to isolate outside animals for a while to observe for symptoms.

4) Treatment - There are several available antibiotics used to treat secondary infections in pigs. Treatments come in the forms of feed or water additives and injections. It is very treatable if infected animals can be isolated quickly to prevent spreading of the disease to the herd.

e) *Salmonella choleraesuis*

1) Description - This organism enters the body orally, multiplies in the intestinal tract, crosses the intestinal wall, and spreads throughout the rest of the animal. It undergoes its most rapid growth and does the most damage in the lungs. This disease is usually seen in pigs from 40 pounds to finish weight but can occur in any aged pig.

2) Symptoms - The most common sign is sudden death in pigs that had been doing very well. If observation is frequent enough and detailed enough, one may actually see pigs become somewhat listless, experience difficulty breathing, and progress rapidly to severe respiratory difficulty and death. Animals dying from this disease often have purplish discoloration of the ears, belly, and/or feet and lower legs.

3) Prevention - Sanitation efforts are extremely cost-effective in preventing this disease because it is transmitted through the feces. Minimizing stress also helps in prevention; many hogs can be carriers but yet will never have problems if they are not stressed enough to lower their resistance. Stressors include overcrowding, drastic temperature fluctuations, feed/water shortages, movement, mixing, etc. While preventive antibiotic therapy and/or use of vaccines can offer some benefit, their long-range cost-benefit ratio will not be as great as improved sanitation and decreased stress.

4) Treatment - In an outbreak, water medication and individual injections with appropriate antibiotics are the best approaches. Antibiotic selection needs to be based on cultures tested in a laboratory and known successes in the local region.

f) Porcine Reproductive and Respiratory Syndrome (PRRS)

1) Description - This disease was first diagnosed in the mid-1980s. It is caused by a type of virus, which produces two known syndromes: a reproductive herd problem and a respiratory syndrome found primarily in pigs younger than 10 weeks old. The virus is usually transmitted through pig-to-pig contact. The virus is shed from the respiratory system, in the feces, and in the semen. There may be some transmission through the air.

2) Symptoms - PRRS presents itself primarily as a difficulty in breathing that often progresses to a deep cough, rough hair coat, poor growth, and an increase in secondary bacterial infections of the respiratory tract (e.g., *Pasteurella, Bordetella, Haemophilus, Streptococcus, Actinobacillus, Salmonella,* etc.). Death losses can often be as high as 25 percent within a group of pigs. Deaths are from secondary infections, not from the virus itself.

3) Prevention - The best prevention is maintaining a negative herd through tight biosecurity and obtaining replacement stock from a known negative herd. In addition, making use of all-in, all-out pig flows will help prevent the disease from reaching its most severe level. A commercially approved vaccine is available to help prevent the disease. It is approved for use in pigs that are 3-16 weeks of age.

4) Treatment - There is no treatment for the viral disease itself, so treatment efforts are aimed at secondary invaders that complicate and worsen the disease.

2. See if students can come up with some major respiratory diseases in cattle.

What are the major cattle respiratory diseases, their symptoms, and treatments?

a) Infectious Bovine Rhinotracheitis or "Red Nose" (IBR)

1) Description - This disease is transmitted by infected droplets that are spread by coughing and by nose-to-nose contact. Also, the disease can be spread venereally or by contaminated examination instruments. The virus can be found in infected tissues of aborted fetuses and in nasal or ocular (eye) fluids of infected animals, but rarely in blood. All ages and breeds of cattle are susceptible. IBR can

be fatal, but generally it only causes reproductive and respiratory problems to appear.

2) Symptoms - Symptoms are: open-mouth breathing, fever, large amounts of nasal discharge, and a fiery red nose. Symptoms such as depression, a lack of appetite, labored breathing, and coughing are prominent signs of IBR.

3) Prevention - IBR is so widespread it is hard to find a herd that does not have a carrier. Prevention is usually by vaccines and natural immunity. Less-confined environments reduce chances of an outbreak of IBR. Cattle can develop a natural immunity to this disease, but vaccinations prevent secondary infection.

4) Treatment - Antibiotics on severely affected animals helps suppress secondary infections, but antibiotics have little to no effect on the virus.

b) *Pasteurella* infections

1) Description - *Pasteurella* is a bacterial infection usually affecting feedlot or grouped, well-confined animals. This disease can affect all ages of cattle. A *Pasteurella* infection can be spread by droplets in the air, contact, coughing, or feeding equipment. This is a very treatable disease, especially in older animals. More severe and fatal cases hit the younger population.

2) Symptoms - Infected animals show signs of fever, persistent cough, discharge from the nose, rapid respiration, and sometimes diarrhea. Other symptoms are depression, lowering of the head, and sometimes eye discharge.

3) Prevention - Prevention depends largely on good management practices for stress prevention. Avoid quick ration changes, overcrowding, outside infections, and stressful movement of cattle.

4) Treatment - It is essential to keep isolated animals in a dry, warm, well-ventilated area. Antibiotics and the proper environment will speed the recovery process.

c) Bovine Respiratory Syncytial Virus (BRSV)

1) Description - BRSV usually targets the younger population of cattle in feedlots. Transmission of the disease occurs through the aerosol form or contact. Generally, weaning-age stock is infected the heaviest with the disease. Cattle of 6-9 months are most susceptible in feedlot conditions and have very high mortality rates. Older cattle can be affected with the disease, but not as fatally.

2) Symptoms - Coughing, depression, large quantities of nasal discharge, open mouth breathing, and frothing are true indications of BRSV. Fever, severe respiratory distress, and extension of the neck are other symptoms. July through October seem to have the highest number of cases. Once it becomes colder, the cases decline in number.

3) Prevention - Weaning-age stock in feedlot conditions are the most susceptible population. Isolate suspected animals as quickly as possible to reduce the spread of the disease. Sudden changes in diet or water supply will induce extra stress on the animals.

4) Treatment - Antihistamines and vitamins are used for treating infected animals with BRSV. Revaccinating for IBR has also been effective against BRSV. Remember, isolating infected animals and providing proper environmental conditions will aid in treating these animals.

d) Bovine Virus Diarrhea (BVD)

1) Description - BVD generally occurs by contact, infected urine, or by the aerosol form. All populations of cattle can be affected, but the most susceptible animals are 6-18 months old. More cases of this disease are reported during the winter and early spring months. A persistently infected bull can spread the disease through his semen to uninfected cows and their fetuses.

2) Symptoms - Acute cases generally show signs of a fever, depression, weakness, oral and nasal lesions, dehydration, diarrhea, lameness, nasal discharge, and increased salivation. In acute cases, fatalities usually occur 3-4 days after infection. Since the disease is carried through the bloodstream, a pregnant cow

can abort her fetus. Chronic cases can linger for 2-6 months and sometimes past a year. These chronic cases remain carriers for the disease.

3) Prevention - Stress, hormonal changes associated with puberty, and the enhancement of an already existing virus can trigger the infection of BVD.

4) Treatment - Vaccinations control the spread of the disease to uninfected animals. The infected animals usually die, and the ones that survive should be destroyed.

3. See if students can come up with some major equine respiratory diseases. Explain that horses, donkeys, zebras and mules belong to the equine family, just as beef and dairy cattle are in the bovine family.

What are the major equine respiratory diseases, their symptoms, and treatments?

a) Strangles

1) Description - Due to bacterial *Streptococcus equi,* younger horses are particularly susceptible to strangles, but any horse that has not suffered from the disease previously will also be susceptible. Infection spreads through inhaling or ingesting droplets breathed or coughed from infected animals. This very contagious bacterial disease affects the upper respiratory tract in horses. This is a very treatable disease, but it can also be fatal. Strangles spreads quickly.

2) Symptoms - Animals infected by strangles have a very high fever, coughing, snorting, and thick mucus discharge. The throat, pharynx, and larynx become inflamed, and the animals have difficulty swallowing. Often when food or water is swallowed, these substances are regurgitated back through the nostrils.

3) Prevention - Isolating infected animals helps control spreading of the disease. Cold, poorly ventilated stables and very confined conditions can lead to an outbreak. Overworked animals and severe weather conditions can also increase the chances for this disease. Since humans can also spread the disease, disinfect all clothing after working with infected animals.

4) Treatment - There are several antibiotics available for treatment; early treatment will help prevent abscesses.

b) Rhinopneumonitis

1) Description - Rhinopneumonitis is a viral disease transmitted by droplets in the aerosol form. The virus circulates through the bloodstream and localizes in the respiratory tract. The disease is usually concentrated to younger horses. Donkeys and horses are the only species that have been reported to be infected naturally. Rhinopneumonitis is a treatable disease but is known for aborting foals.

2) Symptoms - Generally an outbreak occurs in the autumn and winter months and is usually mistaken for a cold. Horses infected by the disease will have a fever, congestion, and nasal discharge. Sometimes coughing and loss of appetite can be symptoms. This disease is very difficult for a rancher to diagnosis without the help of a licensed veterinarian.

3) Prevention - Isolate infected animals from the herd. A rancher could reduce outbreaks by not confining animals in tight, poorly ventilated areas. There are vaccinations, but they are not proven 100 percent effective.

4) Treatment - There are a number of antibiotics that can be used to control secondary infections. Certain antibiotics are used strictly for nursing mares, while others are used for gestating mares.

c) Equine influenza

1) Description - Equine influenza is an acute, highly infectious, viral disease in horses. The disease is transmitted in the aerosol form and has very high mortality and abortion rates. Outbreaks usually occur when moving or grouping horses. This disease is so infectious that horse shows require health papers stating the animal has been vaccinated against the disease.

2) Symptoms - Symptoms of Equine influenza are very similar to other respiratory diseases in horses. These symptoms include: fever, nasal discharge, depression, weakness, dehydration, and loss of appetite. This disease is fatal but can be treated if caught quickly. Death and aborted foals are extreme symptoms of Equine influenza.
3) Prevention - Ranchers and owners must be aware of this disease when grouping and moving animals or introducing outside animals. There are vaccinations to prevent this disease.
4) Treatment - Isolating infected horses is important in treating them and preventing the spread of the disease throughout the herd. Keeping the infected animal in a dry, warm, well-ventilated area will also help. There are antibiotics available to prevent secondary infections for infected animals.

F. Other activities

1. A visit from a licensed veterinarian would help students apply this material. A veterinarian should have real-life examples to use so the students can better understand these diseases. The interaction with students might shed some light on other respiratory diseases.

2. As students work through the lesson, have them fill out Activity Sheet 3.1 as they learn about the respiratory diseases for each class of livestock. This will help students see the differences and similarities in the diseases.

G. Conclusion

It is important for livestock producers and others in the livestock health field to have a good knowledge base of respiratory diseases, their symptoms, and treatments. The producer is the first step in the prevention, treatment, and detection of any respiratory diseases because they come into contact with the animals more often than any other person. Everyday observations of livestock are critical for prevention, treatment, and detection of respiratory diseases.

H. Competency

Describe the diseases of the respiratory system affecting livestock.

I. Answers to Evaluation

1. Antibiotics
2. Vaccines
3. Atrophic rhinitis
4. Strangles
5. Isolate
6. a-h (question worth eight points)
7. a, c, d, f, i, j (question worth 10 points)
8. a-e, i, j (question worth 10 points)

J. Answers to Activity Sheet

AS 3.1 (Answers may vary but should be similar to the following.)

Swine	What is it?	Mode of infection	Symptoms	Prevention	Treatment
Atrophic rhinitis	Disease that causes distortion of the nasal passages	Hog-to-hog (aerosol) or from dogs, cats, rabbits, mice, turkeys, horses, humans	Sneezing, sniffling, coughing, snorting, inflammation of nose membranes	Monitoring contact with outside animals; controlling sanitation, temperature, humidity, ventilation, dust, drafts, extra ammonia, overcrowding	Isolating infected animals; medicating feed for uninfected animals
Mycoplasma pneumonia	Affects pigs 3-9 mos.	Contact; infected clothing, dust, and wind	Dry, hacking, repetitive cough; reduced growth rates, weights and feed efficiency **Acute cases:** coughing, panting, fever, reduced appetite, staggering gait	Isolating and observing outside animals entering the herd; always changing and washing clothes after being around infected pigs; providing plenty of food and water	Antibiotics; feed additives; keeping infected animals in dry, warm, well-ventilated area with enough feed and water
Pasteurella pneumonia	Respiratory disease affecting pigs 8-24 weeks	Aerosol form	**Acute:** fever, coughing, depression, mouth breathing, labored abdominal movements **Chronic:** intermittent cough, ill thrift	Good management practices; catching and treating it early to avoid spreading	Injected antibiotics for infected pig, others treated with feed or water additives for 5-7 days
Haemophilus pneumonia	Respiratory disease	Aerosol form	Severe respiratory distress, severe abdominal respiration, bloody discharge from nose and mouth **Fatal:** lying around with no desire to move **Chronic:** ill thrift, persistent cough, fever, respiratory distress	Well-ventilated, clean, uncrowded conditions	Antibiotics in feed and water; injections; isolating infected animals to prevent spreading; treating ASAP; immunity usually developed by treated pigs and passed on by immune sows through milk
Salmonella choleraesuis	Lung damaging	Enters body orally, multiplies in intestinal tract and spreads all over	Sudden death in previously healthy pigs; listlessness, difficulty breathing, death; purplish discoloration of ears, belly, feet or lower legs	Sanitation efforts, minimizing stress, preventive antibiotic therapy/vaccines	Water medication, individual injections; feed medications for long-term control
PRRS	Caused by a virus; produces a reproductive herd problem and a respiratory syndrome in pigs younger than 10 weeks	Pig-to-pig contact; aerosol form; shed from respiratory system, feces and semen	Difficulty breathing, deep cough, rough hair coat, poor growth, increase in secondary bacterial respiratory tract infections	Maintaining negative herd with tight biosecurity; getting replacements from known negative herds; using vaccines and all-in, all-out pig flows	No treatment for disease itself, so treat secondary problems

Cattle	What is it?	Mode of infection	Symptoms	Prevention	Treatment
Infectious Bovine Rhinotrache-itis	Causes other respiratory and reproductive problems	Aerosol form and nose-to-nose contact, venereally or from contaminated examination instruments	Open-mouth breathing, fever, large amounts of nasal discharge, fiery red nose, depression, lack of appetite, labored breathing, coughing	Vaccines and natural immunity, less-confined environments	Antibiotics for secondary infections, but animals need to rid bodies of virus naturally
Pasteurella infections	Bacterial infec-tion affecting feedlot, grouped or well-confined animals	Aerosol form, contact, feeding equipment	Fever, persistent cough, discharge from nose, rapid breathing, perhaps diarrhea, depression, lowering of heat, eye discharge	Reducing stress by avoiding quick ration changes, over-crowding, outside infections, stressful movements	Isolation in dry, warm, well-venti-lated area; using antibiotics and proper environ-mental conditions to speed recovery
Bovine Respiratory Syncytial Virus	Usually affects weaning-age stock in feedlots during the summer	Aerosol form or contact	Coughing, depression, lots of nasal discharge, open-mouth breathing, frothing; also fever, severe respiratory distress and extension of the neck	Watching young stock closely, making gradual changes in diet or water, vaccinating	Providing anti-histamines and vitamins; revac-cinating for IBR
Bovine Virus Diarrhea	Frequently affects young (6-18 mo.) during winter	Aerosol form, by contact or infected urine and semen	Fever, depression, weakness, oral and nasal lesions, dehydration, diarrhea, lameness, nasal discharge, increased salivation, abortion **Acute:** death 3-4 days after infection	Vaccinating, avoiding stress	None--survivors to be destroyed

Horses	What is it?	Mode of infection	Symptoms	Prevention	Treatment
Strangles	Very contagious bacterial disease of upper respira-tory tract	Inhaling/in-gesting droplets from infected ani-mal or from contact with humans who have been in contact with the disease	Very high fever, coughing, snorting, thick mucous discharge; throat, pharynx, larynx inflamed; difficulty swallowing	Isolating infected animals; providing heat, ventilation, room to move; avoiding overwork or severe weather conditions; disin-fecting clothing afterward	Antibiotics, isolation of infected animals
Rhinopneu-monitis	Viral disease in horses and donkeys	Aerosol form only	Usually mistaken for a cold--fever, congestion, nasal discharge, occasional coughing, loss of appetite	Providing well-ventilated, roomy quarters; vaccina-tions available but not guaranteed effective	Isolating infected animals; using anti-biotics for secondary infections (special ones for nursing and gestating mares)
Equine influenza	Highly infectious, acute respiratory disease	Aerosol form, usually when moving/group-ing horses	Fever, nasal discharge, depression, weakness, dehydration, loss of appetite	Vaccine, limiting outside contact with other horses	Treating quickly by isolating infected horses and keeping them in dry, warm, well-ventilated area; using antibiotics for secondary infections

UNIT IV - ANIMAL HEALTH Name_______________

Lesson 3: Respiratory Diseases Affecting Livestock Date_______________

EVALUATION

Fill in the blank with the best answer.

1. Administered medications used to prevent secondary infections from appearing in livestock are called __________________.

2. Medications used to prevent specific diseases from appearing in livestock are ______________.

3. When the nose of a hog turns to the left or right, this deformation is a symptom of _________________.

4. Food and water being regurgitated back through nostrils in horses is a symptom of _____________.

5. A producer should always _____________ infected animals from the rest of the herd to prevent spreading of disease.

Complete the following multiple answer questions.

6. Check all the modes of infection that apply to livestock respiratory diseases.

____ a. Feeding equipment
____ b. Human contact
____ c. Other animal contact
____ d. Aerosol form
____ e. Contaminated veterinarian utensils
____ f. Contaminated food
____ g. Contaminated water
____ h. Venereally

7. Check the appropriate symptoms of respiratory diseases in livestock.

____ a. Coughing
____ b. Increased appetite
____ c. Dehydration
____ d. Depression
____ e. Muscle contractions
____ f. Nasal discharge
____ g. Eye watering
____ h. Blindness
____ i. Open-mouth breathing
____ j. Fever

8. Check the appropriate preventive measures for livestock respiratory diseases.

____ a. Avoid stress.
____ b. Vaccinate.
____ c. Isolate infected animals.
____ d. Avoid ration changes.
____ e. Avoid overcrowding.
____ f. Avoid well-ventilated areas.
____ g. Avoid dry areas.
____ h. Avoid any sanitation practices.
____ i. Water down work area when working animals.
____ j. Develop a herd health program.

Lesson 3: Respiratory Diseases Affecting Livestock

Name_______________

RESPIRATORY DISEASES

While working through the lesson, fill out this chart to help you see the differences and similarities in the diseases.

Swine	What is it?	Mode of infection	Symptoms	Prevention	Treatment
Atrophic rhinitis					
Mycoplasma pneumonia					
Pasteurella pneumonia					

Swine	What is it?	Mode of infection	Symptoms	Prevention	Treatment
Haemophilus pneumonia					
Salmonella choleraesuis					
PRRS					

Horses	What is it?	Mode of infection	Symptoms	Prevention	Treatment
Strangles					
Rhinopneumonitis					
Equine influenza					

Cattle	What is it?	Mode of infection	Symptoms	Prevention	Treatment
Infectious Bovine Rhinotracheitis					
Pasteurella infections					
Bovine Respiratory Syncytial Virus					
Bovine Virus Diarrhea					

UNIT IV - ANIMAL HEALTH

Lesson 4: Diseases of the Gastrointestinal Tract

Objective: The student will be able to describe the diseases of the GI tract in livestock.

Study Questions

1. **What are the major GI diseases of swine, their symptoms, and treatments?**

2. **What are the major GI diseases of cattle, their symptoms, and treatments?**

3. **What are the major GI diseases of horses, their symptoms, and treatments?**

References

1. Student Reference

UNIT IV - ANIMAL HEALTH

Lesson 4: Diseases of the Gastrointestinal Tract

TEACHING PROCEDURES

A. Review

Review Lesson 2 in Unit I (Livestock Digestive Systems).

B. Motivation

Bring in the digestive tracts of different species of livestock. Consider bringing in disease-infested GI tracts. Bring in products used to treat GI diseases.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students what diseases they can think of that affect the digestive system of swine.

What are the major GI diseases in swine, their symptoms, and treatments?

a) Baby pig diarrhea
  1) Especially a problem in sows with poor milk flow and in unsanitary, continuous flow farrowing areas
  2) Causes: *Escherichia coli* (*E coli*), transmissible gastroenteritis (TGE), rotavirus, coccidiosis, *Clostridium perfringens* type C, and various combinations
  3) Symptoms
    (a) *E coli* bacteria adhere to the lining of the small intestine and produce toxins, which cause the intestine to secrete excess fluid. The affected pig has diarrhea and becomes ill from dehydration.
    (b) The viruses TGE and rotavirus infect and destroy the lining of the small intestine. The affected pig is contagious and has diarrhea and vomiting, which produces dehydration and starvation.
    (c) *Clostridium perfringens* type C is a toxin-producing bacterium that kills the lining of the small intestine. The pig can have bloody diarrhea and can die of dehydration and starvation.
    (d) Coccidia is a protozoan that infects the lining of the small intestine and causes death with improper absorption and digestion. As with the other pathogens, this produces diarrhea and results in dehydration and starvation. Pigs can only be treated with oral or injectable fluids.
  4) Treatment (except coccidiosis): antibiotics and oral or injectable fluids
  5) Prevention (except coccidiosis): sow vaccination before parturition for colostrum antibody production, cleaning, and disinfection to reduce the number of pathogens in the environment
b) Adult diarrhea and gastrointestinal disease
  1) General
    (a) Usually occur after a pig has been weaned but can also occur in adult breeding animals
    (b) Controlled with good sanitation and all-in/all-out pig flow management

2) Swine dysentery
   (a) Causes: bacteria; can be carried by symptom-free animals
   (b) Symptoms: bloody diarrhea and inflammation of the large intestine
   (c) Treatment: appropriate antibiotics to the feed or water
3) Salmonellosis
   (a) Causes: bacteria, most commonly *Salmonella choleraesuis*
   (b) Symptoms: diarrhea, inflammation of both small and large intestines, infection of the bloodstream, high fevers, purplish skin around ears, snout, and flank
   (c) Treatment: antibiotics added to the feed or water
4) Proliferative enteritis
   (a) Causes: bacteria
   (b) Symptoms: inflammation and thickening of the intestinal lining, resulting frequently in dark, bloody diarrhea
   (c) Treatment: antibiotics
5) Whipworms
   (a) Cause: worm parasites
   (b) Symptoms: inflammation of the large intestine and bloody diarrhea
   (c) Treatment: deworming medicines
6) Gastric ulcers
   (a) Causes: finely ground feed and other factors
   (b) Symptoms: poor appetite and bleeding into the stomach, resulting in dark, tarry manure
   (c) Treatment: none practical

2. Ask the students if they think GI diseases in cattle will differ from those in swine. Have them review parts of the bovine digestive system. Discuss how this can cause diseases to differ. Also, emphasize that colostrum must be received by newborns within the first few hours of birth to ensure antibody protection.

What are the major GI diseases in cattle, their symptoms, and treatments?

NOTE: Proper management is extremely important, both in treating sick animals and eliminating factors that enhance bacteria and virus growth. Infected animals should be isolated and handled last. Keep newborns from having nose-to-nose contact. Keep birthing pastures or pens clean, treat navels to eliminate infection, and prevent overcrowding.

a) Four major categories: anatomical problems, mechanical problems, toxins, and infections (viral and bacterial)
b) Displaced abomasum

   NOTE: Early diagnosis is particularly important as a case of simple displaced abomasum can progress to left displaced abomasum (LDA), right displaced abomasum (RDA), or abomasal volvulus, which is life threatening. Diseases such as ketosis, mastitis, and metritis can occur at the same time.

   1) Cause: unknown--occurs when the abomasum (true stomach) gets out of position and becomes twisted
   2) Symptoms: adults--decreased appetite, no cud chewing, decreased milk production, abdominal pain, a sprung rib cage, a temperature; calves--chronic bloating
   3) Prevention: good feed management
      (a) Do not change feed rations too rapidly just before, or immediately after, parturition.

(b) Make sure the dietary fiber needs are met in both quantity and fiber size.
(c) With simple displaced abomasum, laxatives or antacids can be effective, as can a "rolling" technique.
(d) Surgery is usually required for valuable cattle with LDA, RDA, or abomasal volvulus.

c) Vagus indigestion
1) Occurs when the main nerve (vagus nerve) controlling gastrointestinal movement (motility) is damaged or pinched
2) Symptoms: lack of appetite, lack of intestinal sounds, death
3) Treatment: recovery time or veterinary treatment

d) Extreme wear or loss of teeth
1) Can occur very rapidly, depending on the geographic region and feeding practices
2) Causes: age and some diseases, primarily nutrient deficiencies or excesses of calcium, phosphorus, and Vitamins D and A

e) Intestinal tortions, intussusception, and hernias
1) Symptoms: loss of appetite, blockage of the intestine, severe pain, and eventual death
2) Treatment: surgical intervention of a veterinarian

f) Prolapsed rectum
1) Causes: severe coughing/respiratory disease, diarrhea, or straining from constipation
2) Treatment: early recognition, surgical repair, and correction of the true cause

g) Hardware disease
1) Most frequently seen with dairy cows
2) Cause: swallowed debris, such as wire and nails
3) Symptoms: appetite loss, standing quietly with an arched back, impaired milk and other body functions, frequent urination, difficult breathing, slight temperature, grunting sound
4) Treatment: reducing feed intake, allowing the animal to remain still, broad-spectrum antibiotics, surgery
5) Prevention: magnet in reticulum
6) X-ray or exploratory surgery needed for definite diagnosis
7) Chronic cases difficult to diagnose because of confusing signs as the hardware moves through the body

h) Bloat
1) Occurs when the esophagus becomes blocked where it opens into the rumen; prevents the animal from burping normal rumen gases
2) Causes: something lodged in the esophagus, a cancerous growth, overeating of grain or legumes, or injury
3) Symptoms: off their feed, a ballooned left abdominal wall, or in severe cases, both sides of the abdomen and death
4) Treatment: passing a tube down the esophagus to release the gas, placing supporting medication into the rumen, surgical release of the gas

i) Ulcers
1) Can occur at any point along the gastrointestinal tract, although true stomach ulcers occur only in the abomasum
2) Causes: ingested toxins, viruses, or improper diets
3) Symptoms: poor appetite, dark feces if bleeding is occurring
4) Treatment: Supportive care and medication until the ulcers heal themselves

j) Toxins
1) Causes: contact with harmful manufactured sources or naturally occurring plants; orally or through the skin
2) Symptoms: vary from mild lack of appetite to severe constipation or diarrhea; can affect other organ systems

3) Treatment: (by veterinarian) antidotes, laxatives, and absorbents
4) Prevention: prevent exposure to toxins

k) Scours/diarrhea
1) Particularly deadly for calves younger than 10 days old
2) A veterinarian and diagnostic laboratory often needed for diagnosis
3) Causes
(a) Bacteria: *E coli, Salmonella,* and *Clostridium perfringens* types A, B, C, E
(b) Viruses: rotavirus, coronavirus, IBR, and BVD
(c) Contributing environmental factors, such as overcrowding, lack of colostrum, vitamin deficiency, and parasites
4) Symptoms: watery feces, weight loss, dry skin, weakness, depression, death
5) Treatment
(a) For dehydration, oral fluids, electrolyte therapy, antibiotics
(b) For sick calves, milk replacer, electrolytes, antibiotics
6) Prevention: cow vaccination against colibacillosis, *Salmonella, Clostridium,* rotavirus, coronavirus, IBR, and BVD so that antibodies will be passed on in colostrum; proper management; internal parasite control

3. Ask the students if GI diseases in horses are similar to or different from those in other livestock. Does the difference in digestive tracts have an effect on the types of GI diseases horses can contract?

What are the major GI diseases in horses, their symptoms, and treatments?

a) Equine colic
1) Most frequently seen gastrointestinal problem in horses
2) Not a single disease, but a symptom of pain in the abdomen
3) Causes: anatomical combined with poor management
(a) Anatomical: relatively small stomach; inability to vomit; and large, free-moving intestines
(b) Management: sudden changes in feeding or watering, too little forage, over-feeding/overwatering recently worked horses, working horses immediately after a full feeding, moldy grain or hay, and parasite buildup
4) Symptoms
(a) Mild pain: depression, pawing, lack of appetite, decreased bowel movement, yawning, looking toward flanks, excessive lying down, repeatedly getting up and down, frequent attempts to urinate, tail twitching, and kicking at the belly
(b) Moderate pain: rolling or thrashing dangerously, patchy sweating, rapid breathing
(c) Severe: rolling and thrashing uncontrollably, profuse sweating, and ignoring attempts at restraint
5) Treatment: keeping horse on its feet while waiting for the veterinarian, walking the horse slowly
(a) Medical colic: pain relievers, laxatives, withholding feed, general nursing care, follow-up exam
(b) Surgical colic: surgery, euthanasia

b) Diarrhea
1) Less common in horses
2) Causes: strongyle infestation, too much milk, bacterial and viral diseases, sudden changes in feed, or at the first normal heat after foaling
3) Treatment: antibiotics and medicines containing kaolin or pectin

F. Other activities

1. Have the local veterinarian bring in GI tracts from various species and talk about disease causes and treatments.

2. Bring in various products used in the treatment of GI diseases. Discuss how they work and how to use them properly.

G. Conclusion

The symptoms and causes of many digestive disturbances are very similar. Correct treatment depends on identifying the specific disease properly. Prevention, through proper sanitation and management, seems to be the key to controlling GI diseases.

H. Competency

Describe the diseases of the gastrointestinal tract in livestock.

Related Missouri Core Competencies and Key Skills

10B-5: Associate common human diseases with organs affected.
10D-1: Describe general ways in which human activities affect environmental quality.
10D-3: Identify problems caused by overpopulation and develop possible solutions.
10F-4: Identify the relationship among volume, pressure, and temperature of a confined gas.

I. Answers to Evaluation

1. d
2. b
3. a
4. c
5. a
6. d
7. a, c, d, f, g, h, i (question worth 10 points)
8. b, e, g (question worth 8 points)

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Lesson 4: Diseases of the Gastrointestinal Tract Date_______________

EVALUATION

Circle the letter corresponding to the correct answer.

1. Which of the following destroys the lining of the small intestine and causes death in pigs?

   a. Scours
   b. Rumenstasis
   c. Salmonellosis
   d. TGE

2. Newborn animals should receive a full feeding of ______________ during the first few hours of life to ensure defense against many diseases.

   a. Electrolytes
   b. Colostrum
   c. Milk replacement
   d. Water

3. Placing a magnet into the animal's reticulum can prevent which condition?

   a. Hardware disease
   b. Rumenstasis
   c. Colic
   d. Bloat

4. An animal doing complete, continuous rolls on its back shows signs of which disease?

   a. Diarrhea
   b. Constipation
   c. Equine colic
   d. Salmonellosis

5. For which disease is the cause unknown?

   a. Displaced abomasum
   b. Vagus indigestion
   c. Prolapsed rectum
   d. Bloat

6. Vaccination and antibiotics are effective against all but which cause of baby pig diarrhea?

   a. *E coli*
   b. TGE
   c. Rotavirus
   d. Coccidiosis

Complete the following multiple answer questions.

7. Which of the following contribute to colic in horses?

___a. Relatively small stomach
___b. *E coli* bacteria
___c. Inability to vomit
___d. Large, free-moving intestines
___e. Lack of colostrum
___f. Sudden changes in feeding or watering
___g. Too little forage
___h. Moldy grain or hay
___i. Parasite buildup
___j. Overcrowding

8. A cow is off her feed and her left side is swollen around the abdomen. Which are appropriate treatments?

___a. Isolation from the herd
___b. Passing a tube down the esophagus
___c. Plenty of fluids
___d. Broad-spectrum antibiotics
___e. Medication in the rumen
___f. Antidotes and absorbents
___g. In severe cases, surgery
___h. Euthanasia

UNIT IV - ANIMAL HEALTH

Lesson 5: Reproductive Diseases in Livestock

Objective: The student will be able to understand and describe the diseases of the reproductive system in livestock.

Study Questions

1. **What are the major reproductive diseases of swine, their symptoms, and treatments?**
2. **What are the major reproductive diseases of cattle, their symptoms, and treatments?**
3. **What are the major reproductive diseases of horses, their symptoms, and treatments?**

References

1. Student Reference

UNIT IV - ANIMAL HEALTH

Lesson 5: Reproductive Diseases in Livestock

TEACHING PROCEDURES

A. Review

Review previous lesson on the diseases that affect the gastrointestinal tract in livestock.

B. Motivation

Why is it important to know reproductive diseases in livestock? People in the livestock industry are well aware of the economic importance of preventing reproductive diseases in livestock. Reproductive diseases can cause major losses in a single livestock operation, as well as the entire livestock industry. To keep losses from occurring, a producer must be aware of symptoms, preventive measures, and treatments. Quick isolation of infected animals helps prevent spreading of the disease. Good management and sanitation practices are effective preventive measures.

C. Assignment

D. Supervised study

E. Discussion

1. Abortions in animals represent genetic and economic losses and frequently cause a serious disposal problem, especially if the abortion resulted from an infectious disease. Abortions can be caused by thousands of factors, so diagnosis of the cause of an abortion can be very difficult. The diagnostic success rate for abortion is only about 30 percent. Researchers say abortion losses of 2-3 percent can be tolerated without undue concern in well-managed livestock operations. See if students can come up with some major reproductive diseases in swine.

   What are the major reproductive diseases of swine, their symptoms, and treatments?

   a) Pseudo-rabies
      1) Description - Pseudo-rabies is an acute, frequently fatal disease occurring in all ages of swine. The most susceptible population is less than two months of age. This disease is usually spread by a virus present in the sow's milk or in the boar's semen.
      2) Symptoms - Young pigs usually die right away or are aborted by the sow. Older pigs or weaning-age pigs show signs of fever, incoordination, walking sideways, tremors, mouth frothing, eye discharge, and sometimes convulsions. Vomiting, diarrhea, and death will soon follow. Adult swine show signs of fever, vomiting, muscle spasms in limbs, convulsions, or intense itching. Adults might also have respiratory problems. The most prominent sign in females is aborting their young.
      3) Prevention - The only preventive measure is to test incoming stock for pseudo-rabies. Any stock that tests positively for pseudo-rabies must be destroyed.
      4) Treatment - The only treatment for positively tested stock is to destroy those animals to prevent further spreading of the disease.
   b) Leptospirosis
      1) Description - Leptospirosis affects all populations of swine. It is transmitted through wallowing in muddy areas infected by contaminated urine. Other methods of transmission are infected dead pigs and outside animals entering confined

quarters. The organism usually confines itself to the area of the bladder. The organism can survive for several months in stagnant waters. Infection usually occurs through the nasal and oral passages by nosing at urine or eating contaminated fetus, food, soil, or water.

2) Symptoms - Reproductive disorders usually show as abortions, infertility, stillbirths, fever, reduced milk, and neonatal mortality. Acute cases show signs of dullness, diarrhea, hindquarter weakness, incoordination, staggering gait, and stiffness of neck.

3) Prevention - Vaccinations are available to prevent leptospirosis. Vaccinations for sows should be done prior to mating and just before farrowing. This method is very beneficial for confined farrowing operations. Outside animals entering the herd should be isolated, vaccinated upon arrival, and again 4-6 weeks after they enter the herd. Pigs should be vaccinated at weaning and again 4-6 weeks later. Good management practices, such as cleaning pens and eliminating stagnant waters and rodents, are good preventive measures.

4) Treatments - Feed additives can eliminate carrier animals by treating the entire herd for 8-11 days. There are several drugs available that are effective for treating infected animals.

c) Brucellosis

1) Description - Brucellosis attacks all breeds, classes, and ages of swine. There is no lasting immunity for brucellosis; infected animals that recover can be reinfected with the disease later in their lifetime, usually 6-12 months after recovery. There are several modes of infection. The germ can be present in the urine of both sows and boars, in semen, vagina discharges, food and water troughs, sow's milk, and even in the soil. The germ enters the body through the mouth from any of the above sources. It can be transferred from pen to pen by human clothing, boots, farrowing crates, and feed buckets. Transmission of brucellosis can also occur when hogs eat or come in contact with infected, aborted fetuses. The disease can be readily transferred from the boar to sow during mating.

2) Symptoms - In boars, one or both testicles appear swollen. If not caught early enough, the boar generally becomes impotent. In the female, symptoms appear in their offspring, not in the sow herself. Since each fetus has its own placenta, some pigs are born normally developed, but others might be born dead and underdeveloped. Abortions can occur but are rare in swine. Once an abortion occurs, the sow generally eats her young.

3) Prevention - Isolating and testing sows that have abortions or stillborns is a good preventive measure. Good sanitation practices, such as cleaning and disinfecting farrowing crates, help prevent brucellosis. Always isolate and test outside animals coming into the herd to ensure containment of the disease.

4) Treatment - No drugs are available at this time to effectively treat brucellosis, so destroying all animals that test positive for it is the only treatment.

d) Parvovirus

1) Description - Parvovirus is probably the most infectious virus that affects swine because of its resistance to heat, cold, acidity, alkalinity, and disinfectants. Parvovirus affects all breeds, classes, and ages of swine. Infection can occur venereally, by inhalation, and by ingestion. Pigs affected by parvovirus in their adolescent years will probably develop a natural immunity for the remaining years of production.

2) Symptoms - Parvovirus usually appears in the form of reproductive problems in swine. Sows will have problems conceiving, stillbirths, reduced litter sizes, and mummification of fetuses. Boars will have infertility problems.

3) Prevention - It is important to isolate animals that are suspected of infection and outside animals entering the herd for testing. Infected animals generally shed the

virus in their fecal matter, so good sanitation practices are also important. There are vaccinations available for parvovirus.

4) Treatment - Isolating and vaccinating infected animals is usually the best form of treatment for parvovirus.

2. See if students can come up with some major reproductive diseases in cattle.

What are the major reproductive diseases of cattle, their symptoms, and treatments?

a) Brucellosis

1) Description - Brucellosis is a very contagious bacterial disease in cattle. Brucellosis is an important livestock disease because it can be transmitted to humans very easily. The bacteria enters the body through the mouth or venereally. Transmission occurs by licking genital organs, infected fetus, infected placenta, or by licking vaginal discharges. Transmission can also occur during natural servicing of females, but this is very rare. Females are more susceptible than males, and older animals seem to be more susceptible than younger animals. Time of the year, climate, and weather have little influence on the brucellosis bacteria.

2) Symptoms - Abortions in cattle are a significant sign of brucellosis, but not all infected females abort their fetuses. Other symptoms are weak calves at birth, retained placenta, and vaginal discharge. These symptoms lead to a period of infertility for both the female and male. An infected male will usually have a reduced sex drive and enlargement of one or both testicles.

3) Prevention - Calf vaccination and good sanitary practices are vital in preventing brucellosis from entering the herd. Annual brucellosis testing of the herd is a good preventive measure.

4) Treatment - Isolating infected animals is vital in preventing the disease from spreading. All infected animals must be destroyed.

b) Mastitis

1) Description - Mastitis is more common in dairy than in beef cattle because dairy cattle come in contact with more outside sources. All breeds of dairy and beef cattle are susceptible to this disease. It is considered a reproductive disease because it appears only after parturition. Infection usually occurs by bacteria transfer from the milker's hand, milking equipment, flies, or by lying on infected ground. The bacteria enters the body through the hole in the end of the teat. Cows that have been affected by the disease will not become immune to the disease; it can reoccur again and again.

2) Symptoms - A true sign of mastitis is changing the true nature of milk. Infected milk has thick, white, pus-like clots in it. Clots resemble paper spit-wads. The milk usually becomes paler and thinner. The infected milk has a very unpleasant odor since it is infected with pus. The udder becomes hot, tense, and painful for the animal. The udder might also develop lumps that can be felt by the producer.

3) Prevention - There are several teat dips available to prevent mastitis. Dipping the teats after milking is a good management practice. Good cleaning practices for the milking parlor and milking equipment are also good preventive measures.

4) Treatment - There are several drugs available for treating mastitis. These drugs should be administered to the infected animal until the animal is fully recovered. Infected milk must be disposed of properly. There is usually a waiting period until the milk returns to the herd's milk supply.

c) Metritis

1) Description - Metritis means inflammation of the uterus or breeding bag. Metritis is not a specific disease but a condition or symptom of a variety of bacterial diseases. Infection can occur venereally, through contaminated obstetrical equipment (calf pullers and chains), by human contact after working with infected

animals, and improper clean-up. Afterbirth removal by manual, rough, or early means are predisposing causes for metritis. The retained placenta acts as a wick for infection to the uterus.

2) Symptoms - Females affected by metritis have inflammation of the mucus membrane lining of the uterus. This inflammation creates outward signs of vaginal discharge in the form of excess mucus, pus flakes, or excess pus. Breeding problems usually occur, such as conception problems, missed heat cycles, and a fertilized egg that cannot attach itself to the uterus wall. These problems occur because of inflammation in the uterus. Bulls are usually unaffected by the disease but can be carriers.

3) Prevention - Good sanitation and feeding practices are preventive measures. If an outbreak occurs, isolate infected animals; make sure equipment and clothing are cleaned after working with infected animals. An outbreak of metritis is more likely to occur in confined areas like calving barns. (There is a higher concentration of infectious diseases in confined areas than in the outside environment.)

4) Treatment - There are several drugs available for treatment of infected females. Consulting the veterinarian will produce the most effective results.

d) Leptospirosis

1) Description - Leptospirosis affects all classes, breeds, and ages of cattle. Like swine, the disease is transmitted through infected urine. Transmission generally occurs by inhaling infected urine droplets that are present in the air. Animals that recover from leptospirosis generally develop a high resistance to reinfection. Low-lying ground with swampy conditions and stagnant puddles of water are predisposing causes for leptospirosis.

2) Symptoms - Acute symptoms of leptospirosis are fever, depression, failure to eat, and reduced milk production. Some chronic symptoms are abortions, breeding difficulty, death, and retained placenta.

3) Prevention - The best form of prevention is to isolate infected animals from the rest of the herd. Be aware of any stagnant bodies of water if there is an outbreak of leptospirosis in the herd. There are vaccinations available for prevention of this disease.

4) Treatment - Several drugs are available for treatment of leptospirosis. It is best to consult a veterinarian for effective treatment.

3. See if students can come up with some major reproductive diseases in horses.

What are the major reproductive diseases of horses, their symptoms, and treatments?

a) Metritis

1) Description - Metritis affects all classes and breeds of breeding stock in horses. The most susceptible population is breeding mares. Infection can occur venereally, through contaminated obstetrical equipment (such as foal pullers and chains), by human contact after working with infected animals, and improper clean-up. The retained placenta acts as wick for infection to have a direct route to the uterus.

2) Symptoms - Symptoms of metritis are more difficult to detect than other diseases because animals usually appear to have breeding problems. Mares show no signs of vaginal discharge. The only signs are failure to conceive or maintain pregnancy. Other signs of metritis are repeated service to a known fertile stallion. Sometimes a mare appears to have conceived by missing a heat cycle, but after 2-3 months later a fetus is not found because the fertilized egg could not attach itself to the uterus wall.

3) Prevention - If an outbreak occurs, isolate infected animals and make sure equipment and clothing are cleaned after working with infected animals.

4) Treatment - The following are effective treatments for metritis: local antibiotic therapy, systemic antibiotics, topical antiseptic therapy, uterine flushes, plasma infusion, and a combination of plasma infusions and antibiotics.

b) Fescue toxicity

1) Description - Fescue toxicity affects female breeding stock in horses. Infection occurs when gestating mares eat fungi-infected fescue grass. By eating infected fescue, production of the hormone prolactin is reduced. Prolactin reduction decreases or eliminates milk production in the mare. This process generally takes place in the last 60 days of gestation.

2) Symptoms - Fescue toxicity is generally too hard to detect until it is too late, but there is one indication that can lead to the detection of it. If the mare was on a fescue diet and gestating, the lack of udder development is a good indication of fescue toxicity. After foaling, signs of fescue toxicity are stillborns and thick, discolored placenta.

3) Prevention - A good preventive measure is to pull gestating mares off their fescue diet 60 days prior to foaling to reduce fescue toxicity chances.

4) Treatment - Since fescue toxicity is not an infection, treatment for the disease is not necessary to aid in recovery. Good management practices are the most effective way to prevent fescue toxicity.

F. Other activities

A local veterinarian could talk to students about setting up health programs necessary for a healthy herd.

G. Conclusion

It is important for livestock producers and others in the livestock industry to understand the impact of reproductive diseases. The producer is the first step in detection, prevention, and treatment of reproductive diseases, so it is vital that a producer understand the impact of health on the herd.

H. Competency

Describe the diseases of the reproductive system in livestock

I. Answers to Evaluation

1. b
2. a
3. d
4. b
5. c
6. d
7. b
8. c
9. d
10. b
11. a, b, e, f, g (question worth 10 points)
12. b, c, d, g, h (question worth 10 points)
13. a, d, e (question worth 10 points)

UNIT IV - ANIMAL HEALTH Name_______________

Lesson 5: Major Reproductive Diseases in Livestock Date_______________

EVALUATION

Circle the letter that corresponds to the best answer.

_____ 1. Which pork reproductive disease is transmitted by inhaling infected urine droplets?

a. Pseudorabies
b. Leptospirosis
c. Brucellosis
d. Parvo virus

_____ 2. Which reproductive disease in cattle is the most infectious to humans?

a. Brucellosis
b. Mastitis
c. Metritis
d. Leptospirosis

_____ 3. A good preventive measure for fescue toxicity is to remove horses from a fescue diet _____ days before foaling.

a. 30
b. 45
c. 50
d. 60

_____ 4. White, pus-like clots found in milk are symptoms of what reproductive disease in cattle?

a. Brucellosis
b. Mastitis
c. Metritis
d. Leptospirosis

_____ 5. Which reproductive disease deals strictly with a cow's uterus or breeding bag?

a. Brucellosis
b. Mastitis
c. Metritis
d. Leptospirosis

_____ 6. Which reproductive disease is considered the most infectious viral disease in swine?

a. Pseudo-rabies
b. Leptospirosis
c. Brucellosis
d. Parvovirus

_____ 7. In swine, the destruction of infected animals is the only effective treatment for which two diseases?

a. Pseudo-rabies and leptospirosis
b. Pseudo-rabies and brucellosis
c. Parvovirus and brucellosis
d. Parvovirus and leptospirosis

_____ 8. Placenta removal before it is ready to be taken away, manual removal, and rough removal of placenta are predisposing causes for which reproductive disease in cattle?

a. Brucellosis
b. Mastitis
c. Metritis
d. Leptospirosis

_____ 9. What reproductive disease is likely when a mare appears to have conceived but has not formed a fetus three months later?

a. Leptospirosis
b. Brucellosis
c. Fescue toxicity
d. Metritis

_____ 10. Stagnant, infected bodies of water is a predisposing cause for which reproductive disease in swine?

a. Pseudo-rabies
b. Leptospirosis
c. Brucellosis
d. Parvovirus

Place a check by the appropriate symptoms for the following diseases.

11. What are the acute symptoms of leptospirosis in swine?

____ a. Dullness
____ b. Diarrhea
____ c. Retained placenta
____ d. Lumps in udder
____ e. Incoordination
____ f. Staggering gait
____ g. Stiffness of neck
____ h. Lack of appetite
____ i. Nervous disorders
____ j. Tail biting

12. What are the symptoms of mastitis in cattle?

____ a. Lack of appetite
____ b. White clots in milk
____ c. Unpleasant odor from milk
____ d. Lumps in udder
____ e. Diarrhea
____ f. Fever
____ g. Udder feels hot
____ h. Milk thinner in nature
____ i. Staggering gait
____ j. Respiratory problems

13. What are symptoms of fescue toxicity in horses?

____ a. Lack of development of udder
____ b. Diarrhea
____ c. Lack of appetite
____ d. Discolored placenta
____ e. Stillborns
____ f. Fever
____ g. Staggering gait
____ h. Dullness
____ i. Lumps in udder
____ j. Respiratory problems

UNIT IV - ANIMAL HEALTH

Lesson 6: External and Internal Parasites

Objective: The student will be able to describe the external and internal parasites of livestock and poultry.

Study Questions

1. **What are the major external parasites of livestock, their symptoms, and treatments?**
2. **What are the major internal parasites of livestock, their symptoms, and treatments?**
3. **What are the external parasites of poultry, their symptoms, and treatments?**
4. **What are the major internal parasites of poultry, their symptoms, and treatments?**

References

1. Student Reference

UNIT IV - ANIMAL HEALTH

Lesson 6: External and Internal Parasites

TEACHING PROCEDURES

A. Review

Review Lesson 4.

B. Motivation

Bring in pictures of internal and external parasites. Bring in products used in the treatment of internal and external parasites. Discuss what they are and what they are used for.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss what some external parasites of livestock might be. Ask the students what products are used to control parasites in livestock. Are there any similarities in parasites of different species?

What are the major external parasites of livestock, their symptoms, and treatments?

a) Ticks
   1) Hosts - Ticks attack all classes of livestock but are of greatest concern to cattle and horse producers.
   2) Life cycle - After leaving the host, the adults lay eggs that hatch into larvae in 10-21 days to three weeks. The larvae become nymphs and attach to a host until they become mature adults, which range from a few days to several months, depending upon the species.
   3) Damage - The greatest damage to hosts by ticks is the sucking of blood, which can cause anemia, weight loss, and even death. They also leave a wound that encourages bacterial infection or other injury.
   4) Symptoms - Infestations are usually found by visual inspection.
   5) Control - Extreme temperatures and pasture rotation help control ticks. The most effective method of control is chemical treatment.

b) Louse
   1) Hosts - Lice are species specific, and only one species affects swine--the hog louse.
   2) Life cycle - The adult female glues her eggs to the hairs of the host. Hatching times range from 1-2 weeks, when the nymphs are produced. In 2-4 weeks, the nymphs become mature adults.
   3) Damage - Bloodsucking lice can cause the hosts to become anemic. Irritation and discomfort cause rubbing and scratching. This decreases feeding and grazing time, resulting in loss of gains, unthriftiness, and even death.
   4) Symptoms - The primary symptoms of lice infestations are rough hair coats, rubbing, and scratching.
   5) Control measures - Chemical control by pesticide sprays, dips, dust, and self-treatment devices are most effective.

c) Mite
   1) Hosts - Mites attack all classes of livestock.
   2) Life cycle - Mites spend their entire lives on the host. The adult female lays its eggs on the surface of the host's skin. The eggs hatch in approximately four days, and larvae emerge. The larvae molt, become nymphs, molt again, and become adults. The entire life cycle takes 12 days or less.
   3) Damage and symptoms - Hair falls out and the skin becomes rough and crusty.
   4) Control measures - Mites can be chemically controlled. Animals having this pest are placed under quarantine.

d) Screwworm
   1) Hosts - The screwworm affects all livestock. Usually, infestation is only through wounds; however, some infestations have been found without wounds.
   2) Life cycle - The screwworm is the larvae stage of the blowfly. It feeds on living flesh for 5-7 days, drops to the ground, and pupates.
   3) Damage - The larvae or maggots live on live flesh and can cause weight loss, permanent injury, or even death.
   4) Symptoms - The primary signs of screwworms in a wound are an unpleasant odor, enlargement of the wound, and seepage of blood serum from the wound.
   5) Control - Sprays are available for the treatment of screwworm infestation.

e) Heel fly or cattle grub
   1) Hosts - Cattle are the primary hosts for the cattle grub; however, they have been found with other species.
   2) Life cycle - The adult fly lays eggs on the hairs of the legs and lower parts of the host's body. The eggs hatch into larvae that penetrate the hair follicles and enter the animal's body. During a period of months, the larvae migrate through fleshy tissues of the animal's body until they reach the back.
   3) Damage - The primary damage is to the hides because of decreased values from the holes. During fly strike, when flies attack cattle in swarms, cattle are likely to hurt themselves as they try to get away from the flies. There is also damage to meat that must be trimmed away as waste.
   4) Symptoms - The presence of the host fly is evident during egg laying. There is visible swelling of the grubs once they arrive in the animal's back.
   5) Control - The best control method is to use systemic insecticides before heel flies reach the animal's back.

f) Horn fly
   1) Hosts - Cattle are the main hosts, but horn flies will attack other species.
   2) Life cycle - The adult female lays her eggs in manure, where they hatch in nearly 24 hours. The larvae mature in 5-10 days and then pupate. Young flies emerge from the pupae in 3-7 days and become adults in a few days.
   3) Damage - The adult fly bites and sucks blood from the head, neck, back, and belly of cattle. The biting transmits disease, annoys the animal, and indirectly causes weight loss.
   4) Symptoms - Horn flies are easily seen on infested animals. Unless they are controlled, horn flies will cover the backs and necks of cattle during the spring and summer.
   5) Control - Chemical control is the best method. Feed additives and ear tags containing insecticides are other available methods for controlling horn flies.

g) Other flies
   1) Hosts - Flies are parasites of all classes of livestock.
   2) Life cycle - The adult female lays eggs in manure, debris, and other dead and decaying organic matter. The eggs hatch into larvae in approximately 24 hours. The larvae mature and pupate in 5-10 days. Flies emerge from the pupae in 5-7 days and become adults in only a few days.

3) Damage - Besides biting, sucking blood, and transmitting diseases, flies annoy animals, indirectly causing lowered feed gains and weight loss.
4) Symptoms - Flies are easily seen, and heavy infestations are common around lots and barns.
5) Control - Most flies can be controlled with chemical sprays and dusts or feed additives. Because most species build up an immunity to nearly all chemicals, rotation in the use of chemicals is recommended.

h) Nose bots
1) Hosts - The nose bot is a parasite of horses and sheep and is closely related to the heel fly.
2) Life cycle - The adult fly emerges from the pupae, which lies dormant in feces and other debris until the first warm days of spring, late summer, or early fall. While grazing, the animals rub their noses against the ground; the fly deposits the eggs on the nose and chin of the animals.
3) Damage - Large infestations of the bot in the animal's stomach reduce digestion and usually leave an ulcerated area.
4) Symptoms - The presence of the adult fly is very obvious because of the irritation it causes the animals.
5) Control - Chemical control through deworming is the only method of control.

2. Discuss what some internal parasites of livestock might be. Ask the students about products used to control parasites in livestock. Are there any similarities in parasites of different species?

What are the major internal parasites of livestock, their symptoms, and treatments?

a) The internal parasites which affect livestock are divided into three major groups.
1) Roundworms
2) Flukes
3) Tapeworms

b) Roundworms - From an economic standpoint, roundworms are the most important parasites. There are many types that affect almost every species of livestock. Although there are species which attack every system in the body, the ones of greatest concern are found in the digestive system (mostly the stomach and intestines).
1) Stomach worms - There are several species of stomach worms, but the twisted stomach worms and the brown stomach worms are most important.
(a) Hosts - Stomach worms are found in all classes of livestock but commonly affect cattle, sheep, and horses.
(b) Life cycle - In the adult stage, stomach worms live as bloodsucking parasites attached to the stomach wall. The eggs pass from the host in the feces and hatch into larvae in 15-20 days, depending on temperature and humidity. The larvae crawl up a blade of grass, are eaten by the animal, and travel to the stomach lining until they mature.
(c) Damage - While penetrating the stomach lining before maturing, they cause severe damage by reducing nutrient digestion and producing poisons. Young, undernourished, or diseased animals are hardest hit.
(d) Symptoms - The most common symptom is anemia. In light infestations, the animal will have a dull hair coat, an unthrifty appearance, and sometimes scours. In severe infestations, there will be persistent scouring, weight loss, anemia, weakened condition, and possibly death.
(e) Control - Sanitation and pasture rotation are good control measures. Chemical dewormers are used in treating infested animals. The type of dewormer used is dependent upon the class of livestock. Drenches and injectable dewormers are most often used in cattle and sheep. Feed and water additives are generally used for swine. Liquid dewormers,

administered by tubing, are the most effective treatment for horses. Feed additives are also very effective.

2) Strongyles - There are several species of strongyles (bloodworms) that normally inhabit the small intestine and are also found in the abomasum of ruminants.
   (a) Hosts - Strongyles attack all species and have a greater effect on young animals of each species. After cattle and horses reach an age of 4 or 5 years, they build up a partial immunity and are less affected.
   (b) Life cycle - Adult stage strongyles live as bloodsucking parasites attached to the lining of the intestines. Eggs pass from the host in the feces and hatch into larvae within 5-20 days, depending upon temperature and humidity. The larvae then attach to a blade of grass, are eaten by an animal, pass through the stomach, and attach to the wall of the intestine. The larval stage strongyles can live for months in the grass before being eaten. Larvae pass through the arteries and other internal organs, sometimes causing irreparable damage.
   (c) Damage - Strongyles (bloodworms) are the most detrimental of all internal parasites. Besides sucking blood, which results in anemia, their presence and the scar tissue they leave greatly reduce digestion in the intestines. They are the major cause of colic in horses. In chronic infestations, their presence results in unthriftiness, poor feed conversion, weakened condition, and even death in all livestock.
   (d) Symptoms - The most common symptom is anemia. In moderate and severe infestations, animals have weight loss, rough hair coats, scouring, loss of appetite, colic, and weakness.
   (e) Control - Sanitation and pasture rotation are effective in helping control strongyles. The use of chemical dewormers in a regular deworming program is the best method of control. In cattle and sheep, deworming, boluses, drenches, and injectable dewormers are the most effective. For swine, water and feed additives are most often used. For horses, tubing at regular intervals plus feed dewormers between tubings give the best results.

3) Ascarids - Largest of the roundworms
   (a) Hosts - Primarily, ascarids prey on cattle, sheep, hogs, and horses. Younger animals are most often affected.
   (b) Life cycle - Eggs are passed in the feces and contaminate pastures, lots, and stable areas, where they are ingested by susceptible hosts. The larvae burrow into the intestine wall and migrate through the liver, heart, and finally the lungs, where they are coughed up and swallowed. After reaching the intestines the second time, they develop into the adult stage, where they reach a length of 8-15".
   (c) Damage - Affected animals can develop pneumonia and lung damage due to the larval migration through the lungs. Unthriftiness, weight loss, and colic due to intestinal blockage are common in heavy infestations.
   (d) Symptoms - Weight loss, dull hair coat, general unthriftiness, and colic are noticed.
   (e) Control - Generally, ascarids are controlled by the same means as other stomach and intestinal roundworms--pasture rotation, sanitation, and deworming programs.

4) Pinworms - Small roundworms usually found in the colon or rectum of horses
   (a) Hosts - Predominantly, pinworms are a parasite of horses.
   (b) Life cycle - Adult females lay eggs around the anus of the horse. These eggs drop off and contaminate pastures, stables, and watering and feeding areas. After eggs are ingested by the host, they pass to the colon and rectum to mature.

(c) Damage - Damage by pinworms is minor. However, they do cause severe irritation around the tail area, which causes horses to rub their tails.

(d) Symptoms - Tail rubbing is the most noticeable symptom. Also, white scaly deposits are visible around the anus.

(e) Control - Chemical worming programs used to control other species of roundworms will control pinworms. Sanitation measures around barns and lots are effective in reducing infestations.

5) *Habronema* - This species affects the host in two stages.

(a) Host - The horse is the major host of the *Habronema* stomach worm, but the house fly is an intermediate host.

(b) Life cycle - The adult stage is found in the horse's stomach, where little damage occurs other than an occasional tumor. Larvae are passed in the feces, which are ingested by house fly maggots. They remain in the fly when it emerges from the pupal stage. The larvae of the *Habronema* are swallowed, deposited on the lips of the horse by the fly, and mature in the horse's stomach.

(c) Damage - Real damage of the *Habronema* does not involve its normal life cycle. If the larvae is deposited on an open wound, a summer sore develops. These summer sores are difficult to heal and are the result of the migration of *Habronema* larvae throughout the wound. They can permanently disable or disfigure horses. These sores also develop around the medial canthus (corner of the eye nearest the bridge of the nose), especially in stabled horses.

(d) Symptoms - A summer sore is easily detected by a seepy, hard-to-heal crusty sore. In the eye there is excessive tearing and running, which later forms an open sore. The larvae can be seen upon close inspection.

(e) Control - As with other roundworms, disruption of the life cycle is necessary. The best control is a regular deworming program. Sanitation is important, along with a fly control program in and around the stable area.

6) Lungworms - These roundworms affect the circulatory system and lungs.

(a) Hosts - Lungworms affect all species of livestock.

(b) Life cycle - Eggs are laid in the lungs, then coughed up and swallowed. The eggs hatch in the stomach or intestine and the larvae are passed in the feces. After a period of development in moist earth or water, the larvae are ingested by the host and pass to the intestine. There, they burrow through the intestinal wall into the lymph nodes and are carried to the lungs, where they mature into the adult stage.

(c) Damage - In heavy infestations, there can be mechanical blockage of the lungs, causing a collapse of the infected area. This furnishes an ideal location for the invasion of other organisms. They can also cause blockage of the windpipe and bronchia.

(d) Symptoms - Coughing is the first indication of this parasite, and it is accompanied by faster and more forceful breathing. In severe cases, the animal breathes with its mouth open and its tongue protruding. The animal is reluctant to move, usually develops a fever, goes off feed and water, and becomes gaunt.

(e) Control - Sanitation and pasture rotation are the best control practices. Chemical control is relatively effective.

c) Tapeworms - Tapeworms are far less important than roundworms.

1) Broad tapeworm

(a) Hosts - The broad tapeworm is a parasite of all classes of livestock, as well as humans.

(b) Life cycle - The adult lives in the small intestine, where it can reach a length of 10' or more. Tapeworm segments containing eggs break off continuously and pass out in the feces. The eggs are eaten by the oribatid mite, which lives in grass and weeds and serves as an intermediate host. The eggs develop in these mites, then are eaten by livestock and hatch in the small intestines. They feed on foodstuff eaten by the animal and grow to maturity.

(c) Damage - There is no physical damage to the host. However, the tapeworm is in competition with the host for foodstuff.

(d) Symptoms - Unthriftiness, loss of weight, diarrhea, and emaciation are the major symptoms.

(e) Control - Chemicals can rid the host of tapeworms.

2) Beef tapeworm - Although not a serious cattle parasite, it is a serious parasite of humans.

(a) Host - Although the beef tapeworm is a parasite of cattle, humans are the necessary intermediate host.

(b) Life cycle - Adult beef tapeworms only live in humans and can reach a length of 25'. The eggs contaminate the feed of cattle and pass down into the intestines. There, the eggs hatch out, bore through the intestinal wall and lodge in a muscle, causing a cyst. Beef affected by these cysts are called measly beef. The parasite is then passed to humans when infected, undercooked beef is eaten.

(c) Damage - There is little economic damage to cattle by the parasite; however, it is a problem for humans.

(d) Symptoms - There are almost no visible symptoms in beef cattle except in the carcasses of slaughtered animals.

(e) Control - Since humans are the necessary intermediate host and the beef tapeworm is transferred through the meat, the best control is eating only well-cooked beef. People who raise or work around cattle should have themselves checked regularly.

3) Pork tapeworm - This tapeworm is the same as the beef tapeworm, except that the larvae live in the muscle tissue of pork.

d) Liver fluke

1) Hosts - The liver fluke is a parasite of cattle, sheep, goats, and humans. It is especially damaging to young animals.

2) Life cycle - The adult lives in bile ducts, where eggs are laid and pass down into the intestines and out in the feces. Eggs must land in water to hatch. The larvae that hatch from these eggs swim about seeking a snail, which is necessary for completing the liver fluke's life cycle. The larvae develop for a period in the snail, then emerge and attach to plants along the water. Livestock eat the water plants and become infested. The young flukes pass to the intestines and burrow through the abdominal cavity and into the liver, where they live principally on blood. Egg production begins about three months after entering the animal.

3) Damage - The fluke causes irritation, thickening of the bile duct, and fibrosis of the liver, making it unfit for human consumption.

4) Symptoms - The usual symptoms are anemia and weight loss. Highly infested animals might die.

5) Control - Pasture rotation and using water troughs help in control. The use of chemical treatment will kill adult flukes in the animal. Control of snails will break the cycle, but it is difficult to do.

3. Relate external parasites of poultry. Why do they differ from other livestock? Ask about products used to control parasites. Mites (including common chiggers) can be found on humans and other mammals.

What are the external parasites of poultry, their symptoms, and treatments?

a) Poultry producers lose millions of dollars annually to damage caused by external parasites. These parasites transmit pathogens or kill birds, decrease egg production, increase feed costs, reduce weight gains, and lower carcass quality.

b) Lice
   1) Lice are more abundant in summer than in winter.
   2) Lice are permanent parasites of their hosts. They spend all life stages on the same bird. Sometimes, they will pass from one bird to another, particularly from an older bird to a younger bird.
   3) Although lice eggs are laid singly, they can be abundant enough to form dense clusters on the fluffy area of contour feathers of badly infested chickens.
   4) Eggs cemented to the bird's feathers are oval, white, and sometimes beautifully ornamented with fine spines. Eggs hatch in a few days or weeks.
   5) Young nymphs immediately begin running about and feeding on the host.
   6) After a few weeks, they gradually become adult sized in form and color.
   7) All lice infecting poultry are sucking and chewing types.
   8) Lice irritate, cause weight loss, reduce egg production, decrease carcass quality, and can even kill birds.
   9) Several species of lice attack poultry. These include: body lice, head lice, wing lice, and fluff lice.

c) Mites
   1) Mites vary in size and structure. Poultry are susceptible to many types of mites.
   2) Mites usually occur on or under the bird's skin or feathers. A few can exist in body tissues, feather quills, or nasal and respiratory passages such as the air sac.
   3) Mites feed by piercing the bird's skin or tissue, sucking blood or body fluids, or by biting bits of skin or feathers.
   4) Mites slow the growth of birds, reduce egg production, lower vitality, damage plumage, and even kill birds.
   5) Much of the injury, consisting of constant irritation and loss of blood, is unapparent unless one examines the bird.

d) Ticks
   1) Several species of ticks affect poultry. These include the fowl tick, Lone Star tick, and Gulf Coast tick.
   2) The tick is a bloodsucker and injures poultry by transmitting disease, causing weight loss, lowering egg production, and causing skin blemishes that reduce market value.
   3) Ticks are difficult to eradicate. Houses and surrounding areas require thorough pesticide treatment.

e) Mosquitoes transmit poultry diseases, including malaria and fowlpox.

f) Many pesticides exist to control external parasites of poultry. Because the list of approved material changes rapidly, consult a poultry specialist for a recommendation.

g) Besides applying pesticides, producers can apply good management practices to their operation. Poultry houses and surrounding areas should be free of foreign materials, including manure and stagnant water.

4. Discuss internal parasites of poultry. Discuss similarities with parasites learned previously. Ask students about treatments.

What are the internal parasites of poultry, their symptoms, and treatments?

a) Various worms are major internal parasites of poultry. The number of worms that occur in any given bird depends upon the number of infectious eggs that the bird ingests. Worms do not multiply within the host bird.

b) Roundworms
   1) Large roundworms
      (a) Hosts - Chickens, turkeys, ducks, geese, and pigeons are susceptible to large roundworms.
      (b) Life cycle - The large roundworm has a simple and direct life cycle. The female lays thick, heavy-shelled eggs in the bird's intestines. The eggs are expelled in the feces. Poultry ingest the eggs, the eggs hatch, and the larvae develop into mature worms to complete the life cycle.
      (c) Symptoms and damage - Heavily infested birds exhibit droopiness, emaciation, and diarrhea. Very heavy infestations result in death. Primary damage is reduction in efficiency.
   2) Cecal worm
      (a) Hosts - These exist in the ceca of chickens, turkeys, and other birds.
      (b) Life cycle - A cecal worm's cycle is similar to that of the large roundworm.
      (c) Symptoms and damages - This common worm parasite does not affect the bird's health seriously. There are no marked symptoms or pathology occurrences due to the presence of cecal worms.
   3) Capillary worms
      (a) Hosts - Capillary worms occur in the bird's crop and esophagus.
      (b) Life cycle - The life cycle is direct or bird-to-bird. Worms lay their eggs in the bird's feces. Poultry eat the infected eggs.
      (c) Symptoms or damage - The worm produces a catarrhal inflammation and sometimes causes hemorrhaging. The bird's intestinal lining might erode extensively and result in death. Heavy infestations, especially in houses with deep litter, reduce growth, egg production, and fertility of birds.

c) Tapeworms
   1) These differ from roundworms because they are flat, ribbon-like, and segmented. They also differ from other worm parasites by having both male and female sexual organs on each segment.
   2) Worms attach to the intestinal lining by suction cups located on the worm's head.
   3) Symptoms of tapeworm infestation in poultry include weakness, unthriftiness, and poor growth. Diarrhea develops in some cases.
   4) Tapeworms affect young birds more severely than older birds.

d) Flukes
   1) Flukes are leaf-like flatworms that affect various parts of a bird's body.
   2) Flukes do not cause significant losses in poultry.

e) Prevention and control of worm infestations involves more than treatment. Proper diet, sanitation, and medication are essential.
   1) Poultry should receive feed rations adequate in vitamins A and B complex. Rations lacking these vitamins make poultry more susceptible to worm infestations.
   2) Sanitation practices are essential to prevention and control of worms. Remove poultry litter regularly. Avoid overcrowding birds.
   3) Treat infected birds with commercial drugs.

F. Other activities

Collect several feces samples from various species of livestock. Examine the samples under a microscope for types of internal parasites.

G. Conclusion

Proper management and sanitation is the best control measure for both internal and external parasites in all species of livestock and poultry. Proper identification of the parasites leads the way to appropriate prevention and treatment. There are many drugs available commercially to help control parasites.

H. Competency

Describe the major external and internal parasites of livestock.

Related Missouri Core Competencies and Key Skills

10A-6: Classify species associations into types of symbiosis: commensalism, mutualism, and parasitism

I. Answers to Evaluation

1. a, b, d-f, i, j (question worth 10 points)
2. a, b, e, f, i, j (question worth 10 points)
3. a, e, f, j (question worth 10 points)
4. e-h, j (question worth 10 points)
5. e
6. b
7. d
8. g
9. j
10. a
11. i
12. h
13. c

UNIT IV - ANIMAL HEALTH | Name_______________

Lesson 6: External and Internal Parasites | Date_______________

EVALUATION

Complete the following multiple answer questions by marking the correct answers.

1. Select the host, life cycle, damage, symptoms, and control characteristics for flies.

____ a. Flies can be controlled by ear tags containing insecticides.
____ b. Flies can be controlled by medicated feed additives.
____ c. Eggs hatch in approximately 12 hours.
____ d. A symptom is excessive watering of the host's eyes.
____ e. A symptom is loss of weight.
____ f. Fly damage is caused by diseases that are transmitted.
____ g. Cattle are exclusive hosts.
____ h. Hogs are exclusive hosts.
____ i. Damage occurs by annoying biting and sucking of blood.
____ j. For control, chemical rotation is recommended.

2. Mark the host, life cycle, damage, symptoms, and control characteristics for screwworms.

____ a. A symptom is an unpleasant odor.
____ b. Enlargement of an existing wound is a symptom.
____ c. Cattle are exclusive hosts.
____ d. Hogs are exclusive hosts.
____ e. Screwworms can be controlled by medicated sprays.
____ f. The adult screwworm is called the blowfly.
____ g. Larvae feed on living flesh for 10-12 days.
____ h. Larvae pupate in the animal.
____ i. Damage can result in the animal's death.
____ j. Permanent damage and weight loss can result.

3. For the broad tapeworm, check the host, life cycle, damage, symptoms, and control characteristics.

____ a. Humans can be a host.
____ b. Cattle are exclusive hosts.
____ c. Hogs are exclusive hosts.
____ d. Poor quality hides are a result.
____ e. A symptom is weight loss.
____ f. Diarrhea is a symptom.
____ g. Eggs hatch in the large intestine of the animal.
____ h. Eggs hatch in the animal's stomach.
____ i. Eggs are released from the body through urine.
____ j. Eggs are released from the body through feces.

4. Select the host, life cycle, damage, symptoms, and control characteristics of the lungwork.

____ a. Cattle are exclusive hosts.
____ b. Hogs are exclusive hosts.
____ c. Humans can be hosts.
____ d. Eggs hatch in the lungs.
____ e. Eggs hatch in the stomach or intestine.
____ f. Pasture rotation is a good form of control.
____ g. Good sanitation practices help control lungworms.
____ h. A symptom is coughing.
____ i. Diarrhea is a symptom.
____ j. Windpipe blockage can be a result.

Match the parasite on the right with the symptom on the left.

5. ____ The animal rubs and scratches its body excessively.
6. ____ A hard-to-heal, crusty sore is apparent in the eye's corner nearest the bridge of a horse's nose.
7. ____ White, oval eggs are cemented to the chicken's feathers
8. ____ Hair falls out and the skin becomes rough.
9. ____ Anemia, unthriftiness, and scours are apparent.
10. ____ Chickens have inflammation and hemorrhaging of mucous membranes.
11. ____ There is an unpleasant odor and enlargement of a wound.
12. ____ The horse rubs its tail excessively, and white, scaly deposits appear on the tail.
13. ____ There is a visible swelling on the back of cattle where these are present.

a. Capillary worm
b. *Habronema*
c. Heel fly
d. Lice
e. Louse
f. Lungworm
g. Mite
h. Pinworm
i. Screwworm
j. Stomachworm

UNIT IV - ANIMAL HEALTH

Lesson 7: Quality Assurance Programs

Objective: The student will be able to understand and describe animal health quality assurance programs.

Study Questions

1. **What is the pork quality assurance program?**
2. **What is the beef quality assurance program?**
3. **What is the dairy quality assurance program?**

References

1. Student Reference

UNIT IV - ANIMAL HEALTH

Lesson 7: Quality Assurance Programs

TEACHING PROCEDURES

A. Review

Review previous lesson on external and internal parasites of livestock.

B. Motivation

How safe are the foods we eat? How are the foods we eat regulated? Livestock associations have developed programs to ensure quality in animal products. Quality animal products start on the farm with the producer. Producers should be responsible for their products. This responsibility will instill consumer confidence in animal products and (hopefully) increase demand for these products.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students if they know what the pork quality assurance program is and how it helps the swine industry.

What is the pork quality assurance program?

a) The pork industry's Quality Assurance Program has three levels. A swine producer interested in the Quality Assurance Program can request information about levels I and II from the National Pork Producers Council. The producer must read the information in the booklet and then take the evaluation at the end. Once the understands the idea of quality assurance, he/she sends the self-addressed card back to the NPPC, which sends the level III booklet. The producer must follow guidelines in the level III booklet to qualify for the "Quality Assurance Program."
b) Level III: Ten critical control points for "Quality Assured Pork Production"
   1) Establish an efficient, effective herd health management plan. A swine producer should provide a clean, healthy environment, as much as possible. A checklist helps ensure management practices are in line for a healthy herd. The herd health management plan also sets up a vaccination program and compares the herd to recent trends in the swine industry. The herd health management plan should be completed in the presence of the presiding veterinarian.
   2) Establish a valid veterinarian/client/patient relationship. The veterinarian/client/patient relationship exists when the following conditions are met:
      (a) When the client or swine producer agrees to the instructions provided by the veterinarian on animal health and medical treatments.
      (b) Veterinarian has sufficient knowledge of client's livestock to make proper judgments on medical treatments.
      (c) Veterinarian is readily available for follow-up evaluation on infected livestock to observe any adverse conditions that still exist.
   3) Store all drugs correctly. Always follow label instructions and pay close attention to expiration dates. If the label reads, "use the entire bottle," do so or discard. Store leftover medications in a cool, dry, and dark place, preferably in a

refrigerator. A pick-up dashboard is unacceptable. Clean syringes and discard used needles. Do not store medications in syringes. Keep medications out of reach of children. Keep water or feed additives dry to prevent caking or clumping.

4) Use only FDA-approved OTC (over-the-counter) or Rx (prescription) drugs with professional assistance. Remember, prescription medications can be administered only by a licensed veterinarian. Over-the-counter medications can be administered by anyone after carefully reading label directions. A swine producer must use only FDA-approved drugs whether the drugs are prescription, extra label, or OTC medications. (Extra label medications require extra instructions from the vet.) The producer must follow the guidelines on dosage, withholding times, mixing, safety, and efficacy. Producers are discouraged from buying unapproved FDA medications and drugs from uninformed suppliers.

5) Administer all injectable drugs and oral medications properly.
   - (a) A swine producer must know the following about administration of injectables:
     - (1) Use smallest recommended needle to lessen stress, minimize tissue and skin damage, and reduce leakage.
     - (2) Know the four types of delivery systems for injectable medications:
       - i) Intramuscular (IM): in the muscle
       - ii) Subcutaneous (SQ): under the skin
       - iii) Intraperitoneal (IP): in the abdominal cavity
       - iv) Intravenous (IV): in the vein
     - (3) Are injections ever given in the muscle of the ham?
     - (4) Are syringes adjusted correctly to give proper dosages?
     - (5) Are label directions followed for quantity of medication and site selection?
     - (6) Are animals restrained to prevent needle breakage and inappropriate dosages?
   - (b) A swine producer must know the following about administering water medications:
     - (1) When are water medications used?
     - (2) How are medicators calibrated?
     - (3) How often are medicators calibrated?
     - (4) Where are medications stored?
     - (5) How are lines flushed, if medications are used?
     - (6) Are medications mixed daily, and is consumption monitored?
     - (7) What is the recording system for water medications?
   - (c) If the producer cannot answer the previous questions correctly, he/she must seek assistance from the veterinarian.

6) Follow label instructions for use of feed additives. If a swine producer cannot answer the following questions correctly, he/she should seek assistance from the veterinarian.
   - (a) When is the last time the mixer or scale was calibrated? What is the period the owner's manual recommends?
   - (b) Are written records kept on calibration dates?
   - (c) When is the last time a feed analysis was done to check mixer accuracy?
   - (d) How often is the mixer checked for wear?
   - (e) How often is the mixer or mill cleaned?
   - (f) How are spills of medicated feeds handled?
   - (g) Is the mixer flushed after mixing medicated feeds?
   - (h) How are feed additives stored?
   - (i) Are label directions and withdrawal times followed carefully?

7) Maintain proper treatment records and adequate identification of all treated animals. A swine producer is responsible for keeping accurate records on all

health-related events associated with livestock. These records must include the identification of animals, what medications were administered, times treated, and withdrawal times.

8) Use drug residue tests when appropriate. The following situations should be considered for residue testing of swine:
   (a) Sows culled directly from the farrowing house for selling or marketing
   (b) Animals that received extra label medications
   (c) Swine shown at fairs or livestock shows
   (d) Pigs sold to individuals for roasting or slaughter at private slaughter houses
   (e) Newly purchased animals entering the herd, since it is rare to get treatment records on newly purchased animals

9) Implement employee/family awareness of proper drug use. Swine producers, employees, and family members who are involved with administering medications should be educated on proper administration techniques and product label information. Remember, the swine producer is ultimately responsible for those hogs!

10) Complete quality assurance checklist annually. The swine producer must complete the "Quality Assurance Checklist" annually with residing veterinarian. Consider this checklist as a minimum for swine health programs. This checklist assesses one's attitude, knowledge, and commitment to the pork industry.

2. Ask students if they know what the beef quality assurance program is and how it helps the cattle industry.

What is the beef quality assurance program?

a) Missouri Beef Quality Assurance Program is different from pork and dairy programs. The Missouri beef producers have set up a code of ethics for producing beef in Missouri. They have also set up beef management practices that should be followed by beef producers. Instead of 10 critical control points, the Missouri beef producers have set up five "beef tips" that producers should follow to ensure quality beef products. These tips follow.

b) When processing cattle
   1) Handle cattle in a way that minimizes bruising when administering injections.
   2) Avoid injecting cattle during wet weather to prevent contaminants from entering the injection site. Make sure injection site is dirt- and manure-free.
   3) Avoid using disinfectants when using any modified live virus product.
   4) Consider needle size when administering medications. Use smallest needle possible to prevent abscesses.
   5) Wet down work area around the chute to reduce dust or other foreign materials. Secondary infections could result from these materials entering the body at injection sites and open incisions.
   6) Select injection sites carefully. Consider injecting medications in the neck or lower thigh to prevent loss of expensive cuts of meat and market docks.
   7) Consider the volume of medication injected at one site. There are limitations on the amount given at a selected injection site.
   8) Know the differences between intravenous (IV), intramuscular (IM), and subcutaneous (SQ) injections. Inject these medications appropriately and follow label directions.
   9) Always place implants properly to avoid excess trimming of meat.
   10) Keep the working area, equipment, and employees clean to avoid any secondary infections when working with cattle.

c) Current Good Manufacturing Practices
   1) Buildings, grounds, work and storage areas, and equipment should be routinely maintained, metered, cleaned, and properly stored to ensure purity and intended potency.
   2) The manufacturer must keep accurate records of all laboratory tests done on product testing.
   3) Proper storage for different medications should be designed and maintained. Make sure proper clean-out procedures are followed with equipment to prevent contamination of products.
   4) Adequately label products to prevent mix-ups and assure correct labels are used on medicated feed.
   5) Keep production records on formulation, mixing dates, and shipping dates to ensure quality assurance.

d) Violations and inspections - Route of communication if residue is found
   1) If a residue is detected in an animal, the inspector will report the finding to the USDA's Food Safety and Inspection Service. A case number and identification number are assigned to the owner of the cattle. Then, the producer will be asked questions about the incident and why the animal(s) tested positively.
   2) Every time the producer ships animals to market, the USDA office should be notified of shipments. This monitoring will continue until the USDA office is satisfied that the occurrence will not happen again.
   3) The USDA office reports this incidence to the FDA. If the violation only occurs once, there will probably not be a visit. However, if there are several violations, there will be a visit to the facility. The FDA has the legal right to inspect any facility they want, and the producer's cooperation is critical.
   4) If one does not cooperate with the FDA during their inspection, the FDA can do the following:
      (a) Get a federal court injunction against the facility to halt all further activities.
      (b) Begin civil or even criminal prosecution against a producer for not complying with FDA regulations.
      (c) Seize all cattle that remain at the facility.
   5) Residue violations are critical. Producers must understand label directions concerning residue withdrawal times or pay the consequences.

e) Record keeping and inventory control
   1) Beef producers must keep accurate records on all aspects of animal health. To maintain market share and consumer confidence, producers must prove, through effective documentation, that they have tight control over risk factors.
   2) Animal health product inventories are also important for beef producers to control. Knowing the amounts of medications and the amounts used are vital to maintaining a tight control over risk factors.

f) Feed ingredients quality control - A beef producer must be aware of implications associated with residues found in feed ingredients. If a producer buys a load of medicated feed from a supplier and the cattle have a residue violation, who is responsible? If the producer does not have accurate records verifying that the load of medicated feed was received on a certain date, the producer is responsible. If the producer can produce accurate records of all incoming feed ingredients, the producer can pass the liability to the supplier.

3. Ask students if they know what the dairy quality assurance program is and how it helps the dairy industry.

What is the dairy quality assurance program?

a) Ten critical control points for "Quality Assured Dairy Production"

1) Preventive herd health management program - A dairy producer should maintain the herd in a clean, healthy environment, as much as possible. The nutritional program should meet growth, maintenance, and lactation needs of animals. A producer should have the veterinarian implement a health program that encompasses preventive medical procedures and monitoring of reproductive status of breeding stock. Good management practices and health programs keep animals producing efficiently; therefore, they are less depends on medical therapy.

2) Establish a valid veterinarian/client/patient relationship. The veterinarian/client/patient relationship exists when the following conditions are met.

(a) The client or dairy producer agrees to the instructions provided by the veterinarian on animal health and medical treatment judgments.

(b) Veterinarian has sufficient knowledge of client's livestock to make proper judgments on medical treatments.

(c) The veterinarian is readily available for a follow-up evaluation on infected livestock to observe any adverse conditions that still exist.

3) Dairy producers should use FDA-approved drugs, whether they are prescription or over-the-counter drugs. The producer must follow label guidelines on dosage, withholding times, mixing, safety, and efficacy.

4) All drugs labels comply with "Grade A" milk control labeling requirement.

(a) Over-the-counter drugs used by the dairy producer must have the following requirements specified on the label.

(1) The manufacturer's label with indications for use on lactating cows and withholding time

(2) The manufacturer's label with indications for use on non-lactating cows

(3) If used according to label directions, no further instructions are needed.

(b) Prescription drugs used by the dairy producer must have the following requirements specified on the label.

(1) The prescribing veterinarian's name and address, as well as the manufacturer's label indicating milk withholding time on lactating cows.

(2) The prescribing veterinarian's name and address, in addition to the manufacturer's label indicating use for non-lactating cows.

(3) Prescription drugs are given by the veterinarian, and the medication should be used up totally. There shouldn't be any left over; if there is, return it to the vet. It should not be stored at the producer's facility.

(c) Extra label drugs used by the dairy producer must have the following requirements specified on the label.

(1) The veterinarian's name and address

(2) Active ingredient

(3) Directions

(4) Cautionary statements as necessary

5) All drugs are stored according to "Grade A" milk control labeling requirements. All drugs used in a dairy operation must be stored properly so they do not contaminate the milk supply, equipment, or utensils. Drugs used for lactating animals must be stored separately from drugs used for non-lactating animals. Drugs for lactating animals must be labeled for "lactating animals" and include the name and address

of the veterinarian if it is a prescription drug. Drugs for non-lactating animals must be labeled for "non-lactating animals."

6) All drugs are administered properly, and treated cows are properly identified. Before administering or dispensing drugs for any animal, a producer must consider the following.
   - (a) What FDA drugs are approved for all classes of cattle on the farm? (Use label.)
   - (b) Follow proper dosages.
   - (c) Follow approved routes of administration.
   - (d) Be familiar with and follow withholding times.

7) Treatment records are properly maintained, and treated animals are adequately identified. A producer is responsible for keeping accurate records on all health-related events associated with animals. These records must include the identification of animals, what drugs were administered, times treated, and withholding times.

8) Proper drug residue testing capabilities are readily available to producers for on- and off-farm usage. Producers must test milk and urine by appropriate tests for best results.
   - (a) A dairy producer must consider the following factors to prevent drug residue from entering the milk supply or the slaughter residue testing.
     - (1) Testing milk from sick animals that have received medication to detect any drug residue. Remember, withholding times on labels are based on healthy animals, so sick animals may have longer withholding times.
     - (2) Testing milk on animals that have been administered extra label drugs, because extra label drugs officially do not have withholding times.
     - (3) Testing dry animals returning to the milking herd that have been administered any type of drug during dry period
     - (4) Testing any newly purchased lactating animals entering the herd, since it is rare to get treatment records on newly purchased animals
     - (5) Testing the urine of any culled animals or calves weaned from treated cows headed for the sale barn. Urine testing detects any drug residues present in the animals. Calves can be infected by drinking milk from a treated cow.
     - (6) Urine or milk testing on animals intended for slaughter to ensure no residue violations during slaughter
   - (b) Precautions and misuses of residue testing
     - (1) NEVER use residue testing to shorten withholding times.
     - (2) NEVER test bulk tank milk to test milk from individual cows. Treated cows should be tested individually, not with the population.
     - (3) NEVER add milk that has tested residue-positive to the bulk tank to dilute it.

9) Employees must show awareness and knowledge of proper drug use and methods to avoid marketing adulterated products. Producers and employees who are involved with administering medications should be educated on proper administration techniques and product label directions.

10) The dairy producer must complete an annual "Quality Assurance Checklist" with the residing veterinarian. Consider this checklist as a minimum for dairy health programs. Each dairy operation should be customized to fit the "Quality Assurance Checklist."

F. Other activities

1. When preparing to teach the lesson, some extra preparation might be needed. Possessing the actual assurance programs for each livestock class will greatly improve the presentation on this lesson. Most assurance programs have printed work sheets and checklists for producers to fill out. These work sheets and checklists would add another dimension to the lesson. Use the following addresses to write for information about quality assurance programs.

   a) National Pork Producer Council
   PO Box 10383
   Des Moines, IA 50306
   515/223-2600

   b) Missouri Cattlemen's Association
   PO Box 315
   Ashland, MO 65010
   573/657-2169

   c) Dairy Quality Assurance Center
   801 Shakespeare Box 497
   Stratford, IA 50249
   515/838-2793

2. Teachers can request "Handle with Care" video from Missouri Cattlemen's Association. The tape talks about quality assurance in beef and is 20 minutes in length.

3. Show the video, *Cattlemen Care About Beef Safety* (12 minutes, AG video 190), available from the Missouri Vocational Resource Center.

G. Conclusion

Quality assurance programs help alleviate consumer apprehension about medication usage, placements of injections, drug residues, and environmental conditions. Producers need to make a conscious effort to reevaluate procedures and practices to realign them with these program guidelines. Student awareness of these programs will reenforce the importance of quality production and give them the tools required to defend the industry against opposition or misinformation.

H. Competency

Describe animal health quality assurance programs.

I. Answers to Evaluation

1. b
2. d
3. c
4. b
5. d
6. c
7. d
8. b
9. a
10. b, d, e (question worth eight points)
11. a, d, e, f (question worth eight points)
12. a, d, e, f (question worth six points)

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EVALUATION

Circle the letter that corresponds to the best answer.

_____ 1. Rx stands for what type of medication?

a. Extra label medication
b. Prescription medication
c. Unapproved FDA medication
d. Over-the-counter medication

_____ 2. OTC stands for what type of medications?

a. Extra label medication
b. Prescription medication
c. Unapproved FDA medication
d. Over-the-counter medication

_____ 3. Where are IM injectable medications given?

a. In the vein
b. Under the skin
c. In the muscle
d. In the abdominal cavity

_____ 4. Where are SQ injectable medications given?

a. In the vein
b. Under the skin
c. In the muscle
d. In the abdominal cavity

_____ 5. Where are IP injectable medications given?

a. In the vein
b. Under the skin
c. In the muscle
d. In the abdominal cavity

_____ 6. The Pork Quality Assurance program has how many levels?

a. 1
b. 2
c. 3
d. 4

____ 7. How often should the "Quality Assurance Checklist" be completed by the producer and veterinarian?

a. Every three months
b. Every six months
c. Every nine months
d. Once a year

____ 8. How many critical control points are there in the Pork Quality Assurance Program?

a. 5
b. 10
c. 15
d. 20

____ 9. What should a producer do to reduce tissue and skin damage, leakage, and stress with injectable medications?

a. Use the smallest recommended needle.
b. Use the largest recommended needle.
c. Inject in the muscle.
d. Inject under the skin.

Complete the following multiple answer questions.

10. A veterinarian/client/patient relationship exists when which conditions are met?

____ a. When producer makes all decisions on health-related events of livestock
____ b. When the veterinarian has sufficient knowledge of producer's livestock
____ c. When producer stores all medications properly
____ d. When veterinarian is readily available to make a follow-up evaluation on livestock
____ e. When producer agrees to follow instructions provided by veterinarian on medical judgments on livestock
____ f. When producer agrees to follow instructions provided by a fellow producer
____ g. When the veterinarian's assistant makes a suggestion on medical treatments
____ h. When producer has sufficient knowledge on his/her livestock

11. Check the appropriate factors that are required on extra-label medications.

____ a. Name and address of prescribing veterinarian
____ b. Producer's name and address
____ c. Producer's telephone number
____ d. Active ingredient
____ e. Cautionary statements
____ f. Directions
____ g. Animal's identification number
____ h. Animal's body weight

12. Mark statements that are true of the Missouri Beef Quality Assurance Program.

____ a. Based on a code of ethics for producers
____ b. Includes 10 critical control points
____ c. Uses a checklist as a minimum for health programs
____ d. Includes injection guidelines to reduce infection risk
____ e. Emphasizes drug withdrawal times to avoid residue problems
____ f. Requires feed ingredient record keeping