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

DAM	P	P
p	Pp	Pp
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.

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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

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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:

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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?

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

a) Definition: **Ribo**nucleic **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.

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.

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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

UNIT II - GENETICS Name_____

Lesson 3: Animal Cell Division Date_____

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

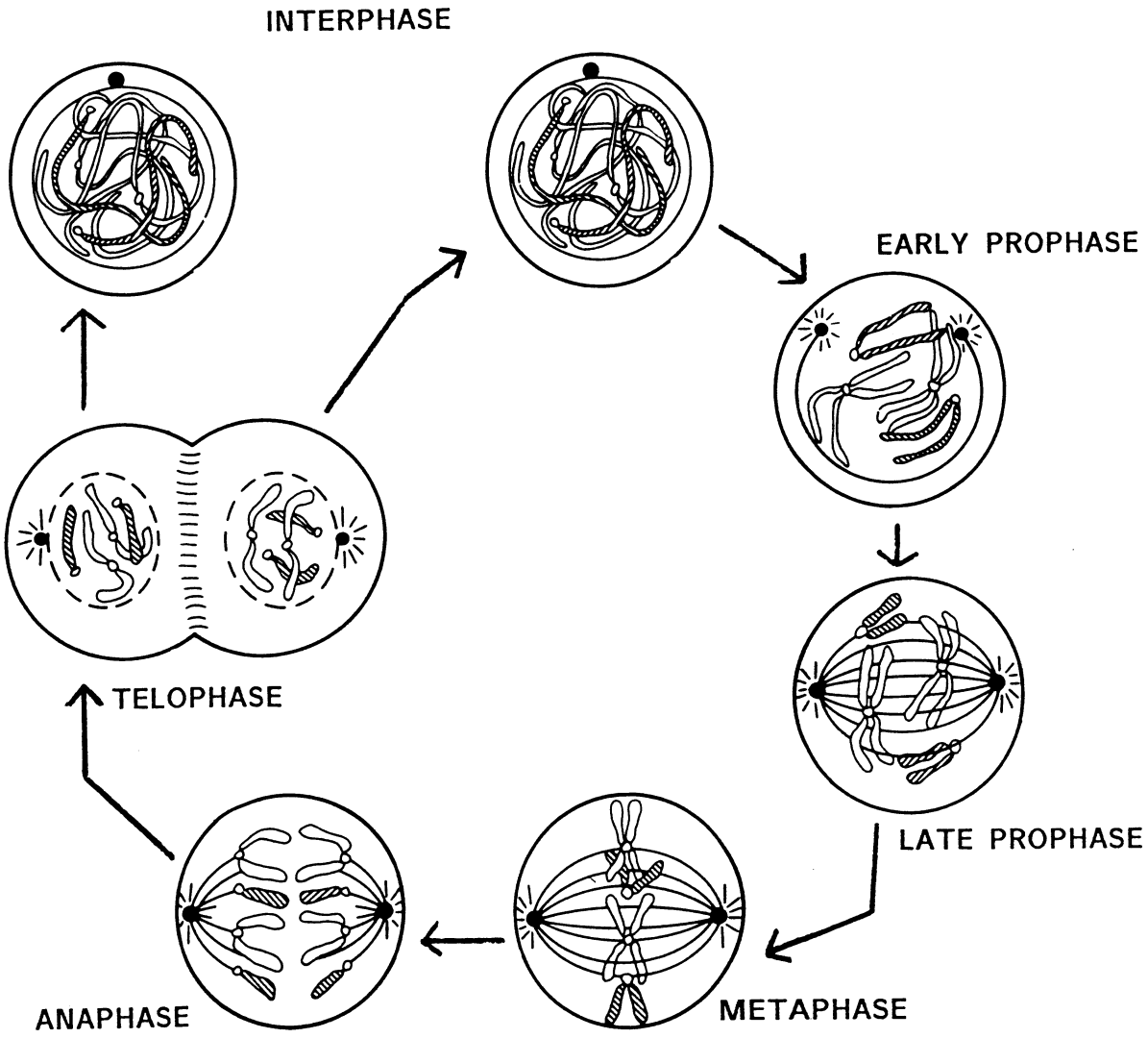
6. What is meiosis in the female called?

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

7. What is meiosis in the male called?

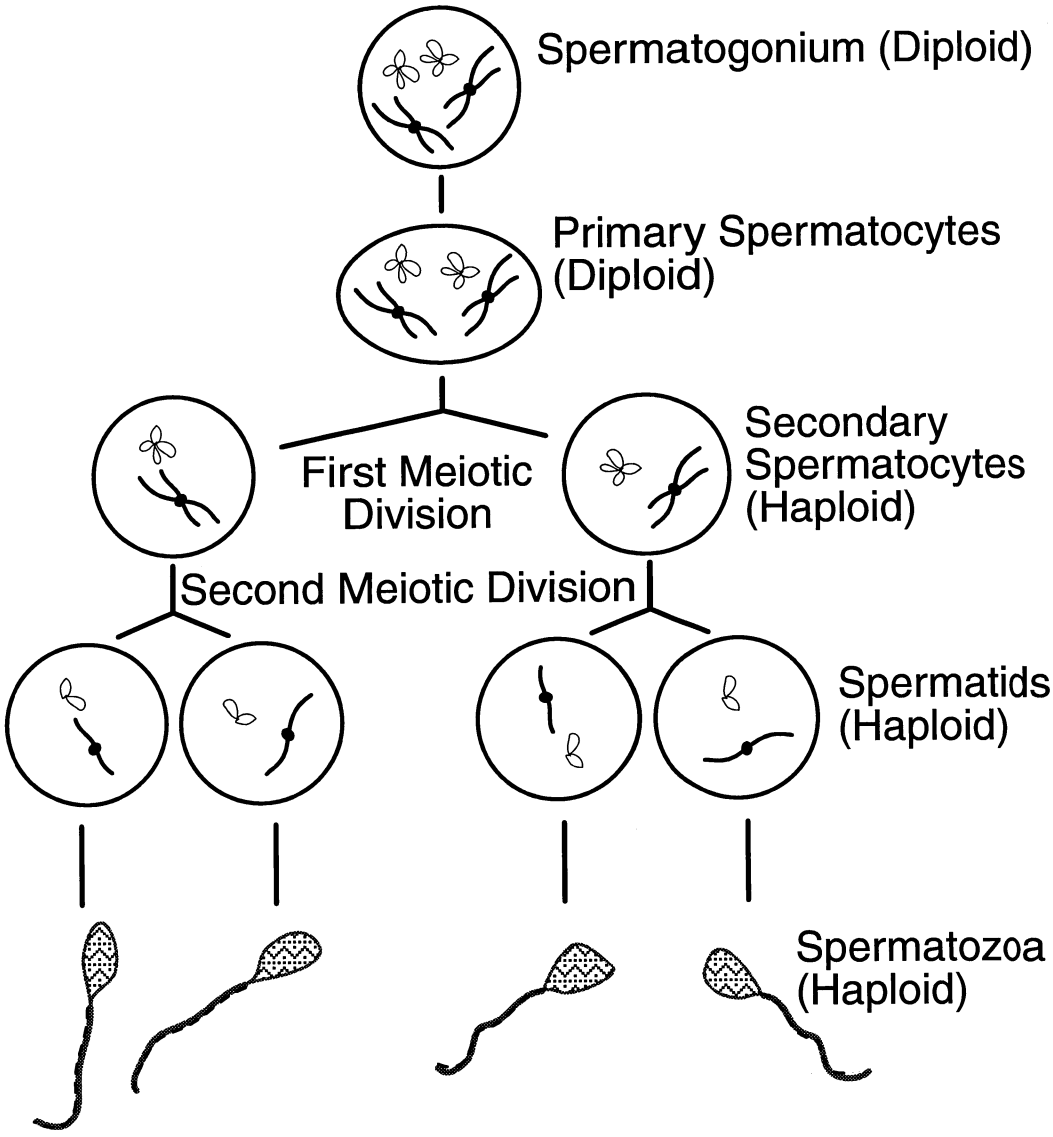
a. Spermatogenesis
b. Oogenesis
c. Testosterone
d. Anaphase

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



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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.

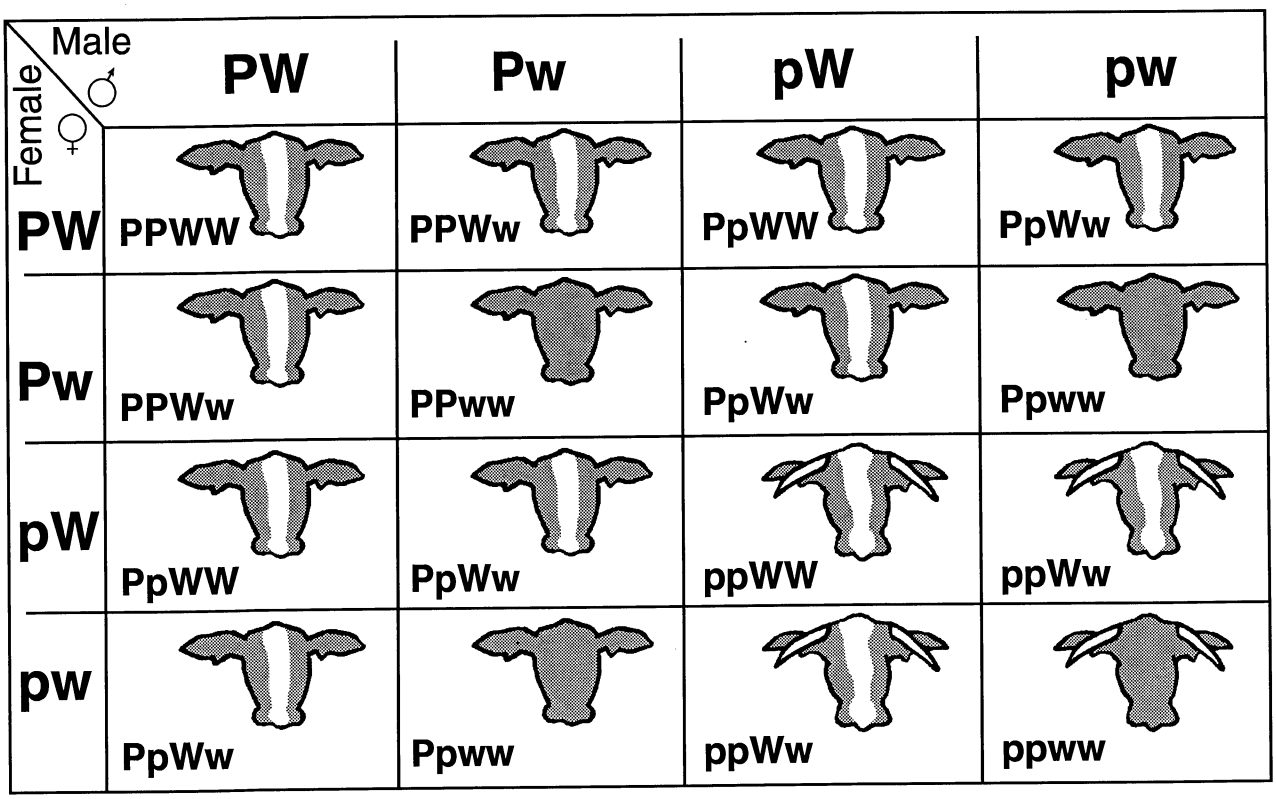
4. Explain differences between heterogenous and homogenous.

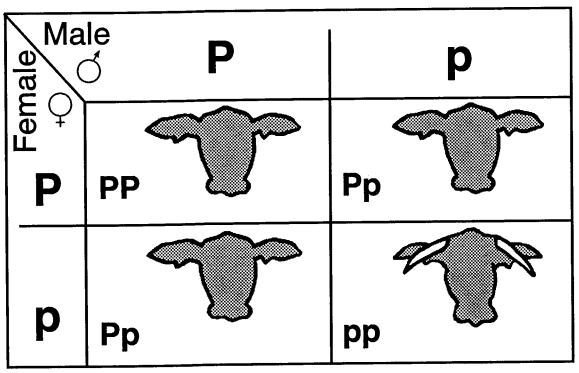
Determine the phenotypic and genotypic ratio of the following using the Punnett square. Show work.

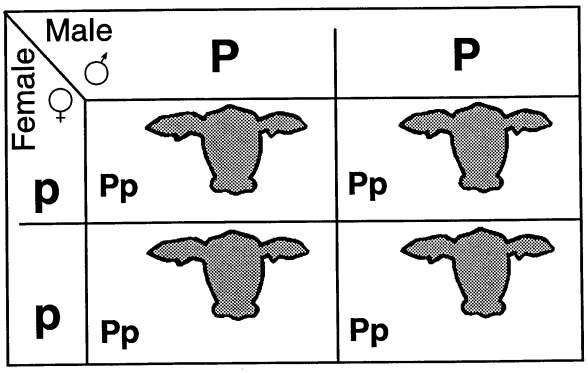
5. Homozygous horned bull (pp) X heterozygous polled heifer (Pp)

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, l, 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

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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.

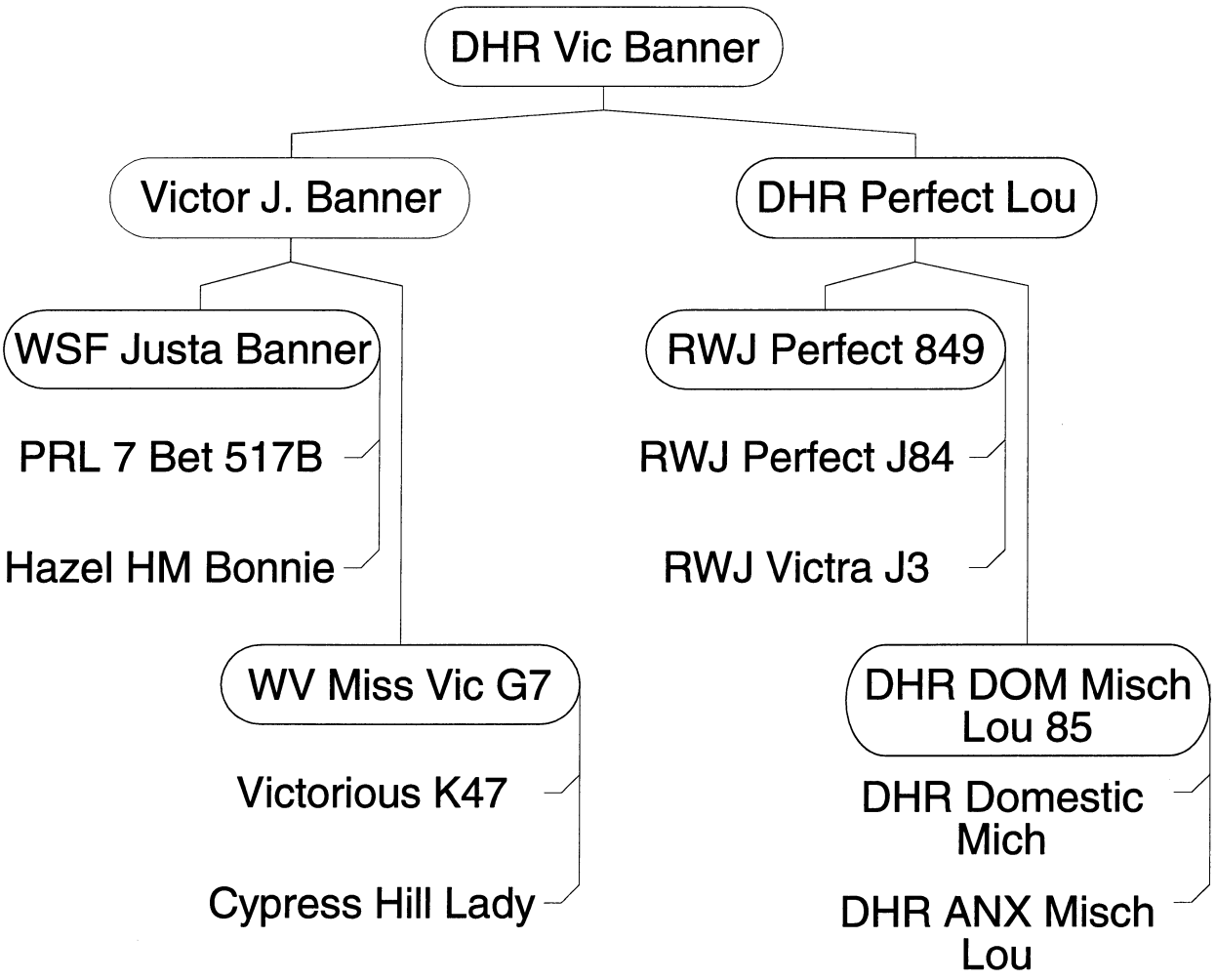
		Fat			Protein		
Name of bull	Milk	%	lbs.	$$	%	lbs.	$$
Bull A	+2,100	+.03	+42	+32	+.02	+39	+35
Bull B	+2,600	-.02	+61	+98	-.03	+59	+87
Bull C	+2,150	+.01	+37	+25	+.02	+40	+38

___ 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:

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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

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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