

Coats and Genes

Genetic Traits in Cattle

Objective

The student will read about heredity and explore genetic traits in cattle.

Background

Agriculturists are pioneers in the study of genetics and heredity. For centuries farmers and ranchers have selected plant varieties and livestock for specific traits. Plant breeders select plant varieties which produce more seed or fruit. Livestock producers select animals with specific traits such as increased milk production, ample muscle mass or structural correctness. Selecting for these traits has allowed agriculturalists to produce a higher quality and more abundant food supply.

Heredity is the passing on of traits from parents to offspring. Most plants and animals have two of every kind of gene, one from their mother and one from their father. Only one gene from each parent is passed to each offspring for a particular trait. There are different forms of a gene that are referred to as alleles. Alleles are forms of the same gene with small differences in their DNA sequence. These small differences contribute to each organism's unique physical features. These physical features are called "phenotypes."

Some alleles are dominant, while others are recessive. Dominant alleles overpower recessive alleles and are always expressed in offspring. Recessive alleles are only expressed in offspring if both parents contribute a recessive allele. In human eye color, the allele for brown eyes is dominant, and the allele for blue eyes is recessive. Therefore, if the offspring receives a brown eye allele from either parent, the offspring will have brown eyes. The offspring would have to receive a blue eye allele from each parent to have blue eyes.

In cattle, the allele that causes horns to grow is recessive. The hornless, or polled, allele is dominant. There are additional genes that affect horn-like growth on an animal's head. The horn-like growths are called scurs. Scurs are incompletely developed horns which are generally loose and movable beneath the skin and not attached to the skull. They range in size from small scab-like growths to occasionally almost as large as horns. Because the gene for scurs is transmitted separately it has no effect on the presence or absence of horns. Not all horned cattle carry the gene for scurs, and not all polled cattle lack the scur gene.

The following diagram is a Punnett square which shows all the possible combinations of two gene sets—Pp and Pp—and the resulting genetic traits. P is the dominant gene for a polled, or hornless, parent; p is the recessive gene for a horned parent. Punnett square boxes show the possible combinations of genes that an offspring may receive from its parents.

Oklahoma Academic Standards

GRADE 7

Life Science: 3.1.2,5,6

GRADES 9-12

Life Science: 1.1; 3.1,2;
4.1,2,3,4

Materials

coins for flipping

black and red beans

square, empty tissue boxes

11- by 17-inch paper

Coats of Many Colors

The absence of horns in cattle is a desirable trait for cattle producers because of the safety factor. Producers are also concerned about economically beneficial traits such as growth and reproduction.

One trait that has fascinated cattle breeders for hundreds of years is coat color. Red and black are probably the two most common coat colors in cattle. They occur as an either/or in breeds such as angus and Holstein. In other breeds, modifier genes change the shades of these colors to a much wider range of possibilities. The black gene is dominant over the red gene and causes the hair to be black. The red gene is recessive and causes the production of red pigment only.

PUNNETT SQUARE: POLLED OR HORNED IN CATTLE (Pp X Pp)

Polled or Horned Parent	P ▼ (polled)	p ▼ (horned)
P (dominant trait) ▶	PP = polled	Pp = polled
p (recessive trait) ▶	Pp = polled	pp = horned

OR

Polled or Horned Parent	p ▼ (horned)	p ▼ (horned)
P (dominant trait) ▶	Pp = polled	Pp = polled
p (recessive trait) ▶	pp = horned	pp = horned

Probability is the chance that something will happen. By examining the Punnett square box above, we can see that there is a 75 percent chance of an offspring being polled if both parents have both dominant and recessive genes. There is a 25 percent chance of the offspring being horned. When both dominant and recessive genes are present (Pp), the condition is called “heterozygous.” When both genes are either dominant or recessive (PP or pp), the condition is called “homozygous.”

This simple diagram demonstrates how the genetics of one gene functions. Humans, plants and animals have multiple genes which have complex interactions to determine offspring traits.

Background Sources: Kirkpatrick, David F., “Color Patterns in Beef Cattle,” University of Tennessee; “Genes for Cowboys,” university of Saskatchewan, <http://homepage.usask.ca/%7Eeschmutz/Cowboys.html>

Science

1. Divide students into pairs, and give each pair a coin and a copy of the “Dominant or Recessive?” worksheet.
 - Students will take turns flipping the coins—one to determine the mother’s traits and one to determine the father’s traits.
 - If the coin lands on heads, the student will circle the dominant trait. If the coin lands on tails, the students will circle the recessive trait.
 - Students will repeat this process for all seven traits.
 - Once all the traits have been randomly selected from the mother and father, students will transfer the selected traits to the “Genetic Trait” worksheet.
 - Students will circle the appropriate genetic traits which will be expressed in the offspring.
2. Hand out the “Calf Outline” worksheet.
 - Students will each draw and color the calf so that it reflects all the randomly selected genes.
 - Lead a discussion based on these questions: “Are all the calves the

same?” “How are the calves different?” “Why?”

—Count the number of calves with no horns. Is it 75 percent of the calves, as the Punnett Square predicted? Do the same for the other traits.

3. Students will repeat the genetic activity, and compare the results. Are the results the same? Is the percentage of horned cows the same? Other traits?
4. Students will develop a chart and determine the percent of dominant vs. recessive for each trait from both activities.
5. Students will develop a Punnett square diagram for the other traits. Why is there a 50 percent chance of the offspring being female?
6. Students remain in pairs for this activity to demonstrate coat color distribution in a herd of cattle.
 - On the chalkboard write the basic colors of cattle (black and red) and show which colors are dominant (black > red).
 - Provide each group with a box and 50 each black and red beans. All the beans should be roughly the same size and shape.
 - Explain that each box of beans represents the genetic makeup of a herd of cattle.
 - As a class, list on the board the three possible combinations of beans. (black/black; black/red; red/red)
 - Students will take turns reaching blindly into the boxes to remove two beans at a time.
 - Students will place matching bean combinations in lines or columns on 11- by 17-inch white paper to create line graphs.
 - For each pair of beans, students will determine the genotype and phenotype of the cow and record it on a chart of their own design.
 - Students will determine the ratio of black to brown to red cattle in their herds.
7. Students will design an experiment similar to Activity One to show common human characteristics (eye color, face shape, eye shape, etc.) Do 75 percent of the students have brown eyes? What percentage of students' eyes are blue or green?

Extra Reading

Bledsoe, Karen, *Heredity*, Perfection Learning, 2007.

Cefrey, Holley, *Cloning and Genetic Engineering*, Children's, 2002.

Glass, Susan, *Genetics*, Perfection Learning, 2005.

Vocabulary

agriculturist—someone involved in the science, art, and business of cultivating the soil, producing crops and raising livestock

allele—one of two or more alternative forms of a gene that controls the same inherited characteristic

dilute—lacking normal strength especially as a result of being mixed with something

cross-pollinate—transfer pollen from one flower to the stigma of another

DNA (deoxyribonucleic acid)—molecule that contains genetic information and is located in the nucleus of every cell inside an organism

gene—the basic unit of heredity that serves as a blueprint for each protein product produced in the human body

genotype—the whole set of genes of an individual or group

heredity—the passing of traits from parents to offspring

heterozygous—having at least one gene pair that contains different genes

homozygous—having at least one gene pair that contains identical genes

inherit—to receive by genetic transmission

phenotype—the visible characteristics of a plant or animal that result from the combined effects of the genes and the environment

pigment—a natural coloring matter in animals and plants

polled—having no horns

Punnett Square—diagram used by scientists to help them to figure out how inherited traits (characteristics) will be distributed

selection—a process that favors the survival and reproduction of some individuals but not of others with the result that only the inherited characteristics of the favored individuals continue to be passed on

scurs—incompletely developed horns in cattle and other

trait—an inherited distinguishing feature or characteristic of an organism

Name _____

Dominant or Recessive?

Use the flip of a coin to determine which sex chromosomes and which genes your offspring will carry. Flip a coin to determine which sex chromosome and which genetic traits (from the list on the next page) each parent will pass on to his/her offspring. If the coin flip lands on heads, select the dominant trait. If the coin lands on tails, select the recessive trait.

Flip coin and circle selected trait

MOTHER'S TRAITS

FATHER'S TRAITS

	heads dominant	tails recessive		heads dominant	tails recessive
1. male/female	X	X	1. male/female	X	Y
2. polled/horned	P	p	2. polled/horned	P	p
3. black coat/red coat	B	b	3. black coat/red coat	B	b
4. solid coat/spotted coat	S	s	4. solid/spotted	S	s
5. white face/black face	F	f	5. white face/black face	F	f
6. solid tail/striped tail	T	t	6. solid tail/striped tail	T	t
7. solid legs/stocking legs	L	l	7. solid legs/stocking legs	L	l

Name _____

Genetic Trait

sample trait	mother's trait B	father's trait b	possible trait combinations Circle appropriate trait		
			black coat BB	black coat Bb	red coat bb
1. male/female			male XY	female XX	n/a*
2. polled/horned			polled PP	polled Pp	horned pp
3. black coat/red coat			black coat BB	black coat Bb	red coat bb
4. solid/spotted			solid SS	solid Ss	spotted ss
5. face color			white FF	white Ff	black ff
6. solid tail/striped tail			solid TT	solid Tt	striped tt
7. solid legs/stocking legs			solid LL	solid Ll	stocking ll

Name _____

Calf Outline

Use the traits selected on the previous page to draw unique features on the calf below.

1. male/female boy/girl
2. polled/horned
3. black coat/red coat
4. solid/spot
5. white face/black face
6. solid tail/striped tail
7. solid legs/stocking legs

