Hairy Kitty Cat Genes & Kitty Cat Toes*

*Adapted from *Science Up to Standards,* McGraw-Hill Children's Publishing
Lesson Plan Presented by Pamela Darnell

Background: Many animals and plants are bred to produce certain traits. Many of these traits can be visible, such as hair color, eye color, gender, etc. Traits can also be invisible, such as temperament and health characteristics. This lesson uses a familar animal, the domestic cat, to look at genetics. The same genetic analysis can be done with other animals whose dominant and recessive traits are known. Cats are traditional farm animals that help control rodent populations that would otherwise consume and contaminant grain supplies.

Grade Level: 5-8

Alaska Content Standards: A-11, B-1, B-2, B-3, B-4, B-6, C-2, D-1

NSTA Objectives: Most of the cells in a human can contain two copies of each of 22 different chromosomes. In addition, there is a pair of chromosomes that determines sex; a female contains two X chromosomes and a male contains one X and one Y chromosome. Transmission of genetic information to offspring occurs through egg and sperm cells that contains only one representative from each chromosome pair. An egg and a sperm unite to form a new individual. The fact that the human body is formed from cells that contain two copies of each chromosome — and therefore two copies of each gene — explains many features of human heredity, such as how variations that are hidden in one generation can be expressed in the next.

Specific Objectives:
• Students will determine the probable percentage of short-haired kittens that will be produced if a hybrid (heterozygous), short-haired female is bred with a purebred (homozygous) long-haired male. (This is a partial inquiry lab to compare the inheritance of hair length in cats. Short hair is dominant while long hair is recessive in cats.)
• Using supporting evidence, students will show that traits are transferred from a parent organism to its offspring. Students will determine the probable percentage of five-toed cats that will be produced if a pure (homozygous) six-toed female is bred with a hybrid (heterozygous) six-toed male. (This is a full inquiry lab that deals with five-toed and six-toed cats. Six toes are dominant over five toes.)

Time required: At least two 50-minute class periods. Using three or four periods allows students to share their individual experiments with the group.

Materials:
Copies of Background Information for students and Pre-Lab questions
Two pennies for each student
Masking Tape
Pen
Copies of "Hairy Kitty Cat Genes" Data Table and Instructions for each student
Copies of Pre- and Post-Lab Questions for each student.

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Procedures:

As an introductory activity, ask students what they believe is the probability that a couple's first child will be male. Most students will say 50-50. Show them that they are correct by placing masking tape around a penny. On one side of the penny write an X. On the opposite side write a Y. On a second penny covered with masking tape, write an X on both sides. Explain to students that the penny with XX represents the female with her two X chromosomes and that the XY represents the male with one X and one Y chromosome.

To demonstrate fertilization, toss the two coins in the air. When the pennies land, observe the two letters that are facing upward. Record these two letters on the chalkboard as either XX or XY. Repeat this process 19 more times, recording the two resulting letters each time. After 20 tosses, calculate the number of male (XY) and female (XX) children produced. You should find that the percentage is close to 50-50. Explain to students that this figure will not always be 50-50 with small numbers of tosses. However in 100 tosses, it falls very close to a 50-50 percentage.

Students review the background information pages and answer the Pre-Lab questions.
Students will then perform a Partial Inquiry on Dominant and recessive genes by conducting an experiment to determine the probable percentage of short-haired kittens that will be produced if a hybrid, short-haired female is bred with a long-haired male. First, they will place a small piece of masking tape on both sides of a penny. On one side of the penny they will write an "S" for the gene for short hair. On the other side of the penny they will write an "l" for the gene for long hair. This penny represents the genes of a female hybrid short-haired cat. Notice that she has one dominant gene, "S" for short hair, and one recessive gene, "l" for long hair.

Students will place a small piece of masking tape on both sides of the second penny. On one side of the penny write an "l" and on the other side also write an "l". This ll combination represents two recessive genes for long hair for the male, long-haired cat in this lab.

Students will then gently toss these two coins into the air at the same time so that they land on their desk. Tossing pennies represents the actual breeding of the male and female cat. The combination of genes that lands face upward represents the gene combinations for hair length of kittens from these two parents. Students record their tosses on the Data Table. Each combination will indicate the hair length of that kitten. For example, if the first toss results in "Sl", they check "Sl" in the Data Table for Toss 1. This represents a kitten with short hair because the "S" gene is dominant.

Students toss the coins and record the genes that are facing upward a total of 49 more times and record the gene combination each time in the Data Table. This represents the female giving birth to 50 kittens over a period of several years. The same male cat is the father of all the kittens.

Students add the number of "Sl" combinations and enter this total beside "Total" under "Sl". Then they add the "ll" combinations and enter this total beside "Total" under "ll".

Students then calculate the percentage of "Sl" genes and the percentage of "ll" genes using the formula below. They enter the percentages in the Data Table. The total of the two percentages should equal 100%.

$$\% \text{ offspring with Sl gene} = \frac{\text{Total Sl tosses}}{50} \times 100\%$$

$$\% \text{ offspring with ss gene} = \frac{\text{Total ss tosses}}{50} \times 100\%$$

Students complete the Post-Lab Questions at the end of the experiment.

(Background information and lab sheets also provided as Word documents in lesson plan file for your adaptions.)

Background Information:

Children receive their genes from their parents. In humans and all other animals, traits are determined by the inheritance of genes. Often you can look at people and see the resemblance between them and their parents. Dark-haired parents often have children with dark hair. Similarly, brown-eyed parents often have children with brown eyes. A short-haired cat often gives birth to short-haired kittens.

However, there are cases in which offspring look very different from their parents. Brown-eyed parents can give birth to blue-eyed children, just as short-haired cats can give birth to long-haired kittens. Why don't all offspring look like their parents?

Many traits in organisms are controlled by two genes. Of these two genes, one is contributed by the mother and the other by the father. When these two genes combine, the trait of the offspring is determined. In this combination of genes, one trait usually dominates over the other one. The presence of a dominant trait masks the expression of the recessive trait.

A pure dominant organism is one that inherited two dominant genes for a trait. For example, if the gene for dark hair is D and the gene for light hair is d, a pure dominant organism has genes DD. A hybrid organism has only one dominant gene for that trait. The hybrid's other gene is recessive. The genes in a hybrid are Dd for hair color. A pure recessive organism expresses the recessive trait because inherited two recessive genes for that trait. The genes in a pure recessive are dd for hair color.

Most of the time, a hybrid and a pure dominant organism look alike because they both express the dominant gene for that trait. Black coat in cattle is dominant over white coat. A black cow could either be pure dominant or hybrid. There would be no way of knowing the cow's genetic makeup by visual examination. However, you could look at its ancestors to get this information.

A hybrid bull carries both a dominant gene and a recessive gene for hair coat color. The dominant gene causes black color. This gene masks the recessive gene for white coat color. During mating, this bull can pass his dominant gene for black color to his offspring, or he can pass the recessive gene for white color. A cow with a white coat has two recessive genes for white coat color. She can pass only a recessive white gene to her offspring. If the black bull and the white cow mate, the offspring will inherit a recessive gene for white coat from the mother and will inherit either a dominant or a recessive gene from the father. If the offspring receives the dominant gene from the father, the calf will have a black coat. If it receives a recessive gene from the father, the coat of the calf will be white. (When going over this background information with students, it is helpful to draw diagrams or Punnet squares on the board.)

Many cats have short hair. In cats, short hair is due to a dominant gene while long hair is due to a recessive gene. The presence or the absence of the gene for short hair determines the hair length in cats.

Extension: ("Kitty Cat Toes" — Students determine the probable percentage of five-toed kittens that will result from breeding a pure six-toed cat and a hybrid six-toed cat by designing their own experiment. (Six toes is dominant to five toes in cats.)

Pre-Lab Questions *(with answers)*

What is the difference in a pure dominant and a hybrid animal? *(A pure dominant has two dominant genes while a hybrid has one dominant and one recessive.)*ow many genes govern the expression of most traits? *(two)*
What is the relationship between a dominant and a recessive gene? *(A dominant gene masks the appearance of the recessive gene.)*
In cows, if black coat color is dominant over white coat color, can a white bull and a white cow have a black calf? Explain. *(No. Both parents possess only recessive genes.)*
Can a black cow and a black bull have a white calf? Explain. *(Yes. If the black cow and black bull are hybrids, they have recessive white genes that could be passed on to the offspring.)*
Can two long-haired cats have a short-haired kitten? Explain. *(No. They do not have any dominant genes for short hair to pass on to the offspring.)*

See Lab Sheet (separate sheet in this pdf file and as Word document for your alternations)

Post-Lab Questions to Kitty Cat Genes *(with answers)*

Out of 50 kittens, how many did you determine would have short hair? *(Answers will vary, but you would expect about 25 to be short-haired and about 25 to be long-haired)*

Why was it not possible to get a pure, short-haired kitten in the 50 kittens? *(The male cat does not possess any dominant genes for short hair to pass on to his offspring.)*

Dominant genes are those that cover the effects of recessive genes. If a cat carries a dominant gene for orange coat color and a recessive gene for black coat color, what color will this animal be? Why? *(Orange. It masks the black coat color.)*

If a pure, short-haired cat is bred with a long-haired cat, predict the percentage of their kittens that will have short hair. *(100%)*

How many of the 50 kittens that resulted from this breeding activity are hybrids? *(Student results will vary.)*

Post-Lab Questions for Kitty Cat Toes *(with answers)*

What was the problem you were trying to solve in this investigation? *(What percentage of five-toed cats will result from breeding a pure six-toed cat with a hybrid six-toed cat?)*

How did you simulate cat breeding? *(Answers will vary.)*

What percentage of five-toed kittens resulted from this cross? *(None)*

If a hybrid, six-toed cat is mated with a five-toed cat and they produce 20 kittens, how many kittens would you expect to have six toes? Explain your answer. *(About 10 kittens. About half of the kittens will receive the father's dominant gene for six toes.)*

Based on what you learned from this lab, would it be possible for two five-toed cats to produce a six-toed kitten? *(No)*

Terms to Define
heterozygous
homozygous
genetics
chromosome
dominant
recessive
hybrid
genetic cross
genetic manipulation
selective breeding
biotechnology

Related Alaska AITC lessons
Biotechnology: Changing Our Future
Flower Genetics: Alaska Bops

Other Related Lessons on Heredity and Traits

"Paint's Family Tree" – Utah Agriculture in the Classroom, www.agclassroom.org/ut – Heredity
"Rock, Paper, Scissors" - Utah Agriculture in the Classroom, www.agclassroom.org/ut – Heredity