Who's the Lead Dog?

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Discipline / Subject: Life Science

Topic:
Genetics/Selective Breeding/Inheritance

Grade Level:
9-12

Resources / References / Materials Teacher Needs:
Students should have a basic understanding of Mendel's genetic principles of segregation, independent assortment, and simple dominance. Prior to carrying out this activity, students should have experience identifying and working with genotypes, phenotypes, and genetic probability. Key concepts applied in this simulation are Law of Dominance, Incomplete Dominance, Codominance, Multiple Alleles, and Polygenic Inheritance. Students should be provided with background information on each of these rules of inheritance. The following Online resources may be used as tutorials for genetics concepts or as a supplement to other texts.

http://learn.genetics.utah.edu/content/begin/traits/

http://www2.edc.org/weblabs/

Teachers should provide each student with five Iditarod Dollars prior to beginning the activity. These can be any objects used to model five individual units of money. Board game money or buttons work well. Each student should also have a coin for flipping and a dice to roll for determining inherited alleles.

Teachers act as the Iditarod Champion during the activity. Prior to the activity, teachers should create six genotype cards, three for each gender. One card should be of excellent quality genotype, one should be of medium quality genotype, and one should be of poor quality. See the suggested example.

Excellent: KkBBHHTPDDEEFF
Medium: KKBWHhTTDdEdFf
Poor: kkWWhhOOddeeff

When a student comes to the Iditarod Champion to purchase a dog, they pay the teacher and take a chance picking a card. Students will also pay the teacher when choosing to inbreed.

Lesson Summary:
Students learn about the history and selective breeding of the Alaskan Husky sled dog by applying specific rules of inheritance and simulating a musher's breeding program to achieve a lead dog with superior traits.

Standard's Addressed: (Local, State, or National)

1) Use probability to explain the variation and distribution of expressed traits in a population.
2) Communicate information about the role of the structure of DNA and mechanisms in meiosis for transmitting genetic information from parents to offspring.
3) State the relationship between functions of the cell and functions of the organism as related to genetics and heredity.
4) Evaluate data and sources of information when using scientific information to make decisions.
5) When making decisions, construct a plan that includes the use of current scientific knowledge and scientific reasoning.
6) Use the rules of probability to compute probabilities of compound events in a uniform probability model.

Learning Objectives:	Method of assessment for learning
1) Students will investigate how selective breeding can be used to achieve desirable hereditary traits. 2) Students will apply rules of inheritance by planning and modeling a selective breeding program. 3) Students will apply the Product Rule to predict the probability of desired phenotypes.	Students can create a breeding program journal. Careful documentation of each dog's genotype, breeding decision, and offspring should be recorded. Students should also document receipts of purchased dogs, sale of dogs, or inbreeding. Teachers may require students to include notes in their journals explaining reasoning for decisions made in their breeding program. Correct use of the Product Rule and accurate calculations of predictions can also be assessed.

Procedural Activities

Each student should receive a copy of the "Who's the Lead Dog?" cover page introduction prior to beginning the simulation (this page can be updated with a picture of the previous year's Iditarod champion under the burled arch with his/her lead dogs). Students should also be supplied with a copy of the *Rules and Guidelines*, *Genotype Scoring Chart*, and the *Sample Journal Organizer.*

Student Directions:
- Determine the genotypes of your original breeding pair by designating alleles as either a head or tails. Flip for each gene of your male and female separately to get two distinct parental genotypes. To determine genotype for the trait "Willingness to Travel and Pull," roll a dice (See directions at bottom of G*enotype Scoring Chart*). Once the genotypes of your original breeding pair have been determined, a coin can again be used to determine the alleles passed on to the 1st generation of offspring. This first breeding is free.
- Either the male or the female of the 1st generation offspring must be chosen as a member of the next breeding pair. Students have choices for the other parent. A dog can be purchased from a fellow classmate for a negotiated price, inbred/line bred to a previous dog in the pedigree for a $4.00 fee, or purchased from the Iditarod Champion for $3.00. Champion dogs may have an excellent, average, or poor genotype. Students choosing have a one in three chance of getting each of the possible genotypes. Once a new breeding pair has been chosen, a coin is again used to determine the genotypes inherited by the 2nd generation male and female. The procedure is then repeated on last time to achieve a 3rd generation.
- Each student must strategize when choosing breeding mates. Inbreeding is expensive due to the increased chance of inheriting negative traits. Students take a risk of choosing a dog with poor traits from the Iditarod Champion. Fellow students may require top dollar for their unused dogs. **MAKE SURE** your strategy allows you enough money to pay your bills!
- Follow the guidelines provided by your teacher. No student wants to be scratched from the competition for getting off the trail!
- Once a student achieves their 3rd generation male and female, they may choose one to be their Lead Dog. Use the *Genotype Scoring Chart* to add up the total point value for your dog's genotype. See the example below. Don't forget to add one point for each Iditarod Dollar you have left in your budget.

   Sample Genotype with Points:

   2pt 3pt 1pt 2pt 2pt 0pt 1pt   **Total**
   KK BB hh PP DD ee Ff = 11pt

Materials Students Need:
Each student should receive a copy of the "Who's the Lead Dog?" introduction prior to beginning the simulation. Students should also be supplied with a copy of the *Rules and Guidelines*, *Genotype Scoring Chart*, and the *Sample Journal Entry*. Students will need five Iditarod Dollars, a coin, dice, and a journal notebook for keeping records.

Technology Utilized to Enhance Learning:
Although there is no technology used directly in this activity, it may be beneficial to students if the teacher projects a blank copy of the *Sample Journal Organizer* and demonstrates the intended procedure by determining and filling in the original breeding pair.

Other Information:
Please note that the traits used in this activity are not necessarily controlled by the rules of inheritance suggested. They have been matched for simulation purposes only.

Modifications for Special Learners/ Enrichment Opportunities:
Higher-level students may be asked to use the Product Rule in their journals to figure out the probability that they will get the desired genotypes from the crosses they choose. A number of modifications can be made for other special learners, including reducing the number of traits crossed and providing predetermined genotypes for the student to cross and determine the total point value of each genotype.