Animal Breeding & Genetics

Genetics

Grade Level
9-12

Lesson Length
2 periods x 55 Minutes

STEM Careers
- Geneticist, Statistician

Nebraska Science Standards
- SC 12.3.2 (Heredity)

Next Generation Science Standards
- LS3.A (Inheritance of traits)

Animal Biology
- 1. (Apply genetic principles in the selection and breeding of animals for food production and human welfare)

These lessons aim to bring the science, skills of inquiry, critical thinking, and problem solving to life through an agricultural context.

Learning Objectives

By the end of the unit, students should be able to:
- Describe DNA and its structure.
- Describe properties of qualitative traits.
- Determine possible qualitative genotypic outcomes.
- Describe complete dominance, codominance, and multiple allelic combinations using blood type as an example.
- Using basic principles of genetics in combination with biological blood tests, solve the mystery of who the baby belongs to.

Materials List – (per student team)

- Blood typing slide
- 3 blue mixing sticks
- 3 yellow mixing sticks
- Paper towels

Materials List – (common working area)

- Synthetic Blood Sample 1, 2, & 3
  Sample 1 = B, Sample 2 = O, Sample 3 = A
- Vial of synthetic anti-A serum
- Vail of synthetic anti-B serum
- Groups also need access to tap water & sink

Preparation

- Print Power Point slides
- Print lab reports, guidelines, and data collection/analysis forms.

- Collect, organize, and prepare materials to be used for the creation of an experiment to test differences in blood type that may be used to determine potential parentage.

Do

Introduction (Interest Approach)

Quickly, ask everyone in class to standup and orient themselves in one line with the tallest person in the middle and the two shortest people on each end. Take a "group selfie", and reflect upon what you just created and how it relates to genetics.

1) You likely created a "bell-shaped curve"; reflective of continuous variation.

Next, all at once, and without thinking, clasp your hands together.

1) How many placed their right thumb on top? Left thumb on top?
2) Purposely switch the clasp. Is it comfortable?

One study with identical twins indicated that hand clasping has a strong genetic basis; 55% prefer left thumb on top, 45% prefer right thumb on top, and < 1% have no preference.

Essential Questions

- *How do we use genetics to make improvement in animal performance?*
- *How can we determine expected outcomes of animal matings?*

Learning Activity 1: Understanding DNA & Basic Genetics

As a class, view the following YouTube video.

- What is DNA and Genes, 3:34, https://www.youtube.com/watch?v=V04jvRh5YFE

After reviewing the YouTube videos of actual news reports, discuss the following questions (and be sure to let students know that there are no right or wrong answers):

1) What is the basic structure of DNA?
2) What are genes? Section of DNA that provides "instructions" for coding proteins.

Review the associated lesson. Assuming students understand how to use a Punnett Square to determine simple genotypes of traits that exhibit complete dominance that are controlled by a single gene pair, ask them how they could use a Punnett Square to determine the possible genotypic combinations for a trait that has multiple allelic possibilities (i.e., Blood Type), and the

2nd allele of one or both parents may NOT be known. Explanation is illustrated in Slides 10-12. We encourage you to encourage students to "figure it out" before providing any explanations.

- Father = Type A, Mother = Type B
- Father = Type AB, Mother = Type B
- Father = Type A, Mother = Type AB

Learning Activity 2: Did they switch the babies?

Distribute the "Did They Switch the Babies?" guidelines to each student. Students may work in teams of 2-5 depending on class size.

For humans, there are four basic blood types (ignoring the +/- Rh factors). Those blood types are A, B, AB, and O. The A & B alleles are codominant, whereas the O allele is recessive to both A & B. Each has two alleles for blood type.

- Blood Type A = AA or AO
- Blood Type B = BB or BO
- Blood Type AB = AB (universal recipient)
- Blood Type O = OO (universal donor)

For this activity, students will be given the phenotypic blood types of two sets of parents. They will also be given "blood" samples from 3 infants; one set of twins (brother & sister) and one other baby girl. There is some belief that the two baby girls were potentially switched! Students will play the role of a genetic detective. They will test the infants' "blood" to determine type and which baby girl belongs to which parents.

Reflection

Using the prompts below to facilitate reflection, allow each student to respond in writing to the prompts and then facilitate a whole class discussion.

1) In Learning Activity 2, it was presumed that the infant girl was switched because her blood type didn't match that of either parent. How was this possible?

Apply

Let's assume there is a paternity lawsuit. The child is Type O. The presumed father is also Type O. The known biological mother is Type AB. Genetically, can you exonerate and prove the innocence of this man? Explain.

Someone breaks a window of a store during a robbery. Blood left at the scene is tested; it is Type O. A suspect who has a cut on his arm is apprehended two blocks away. His

blood is tested and agglutinates with Antigen A, but not B. Did this suspect cut his arm on the glass at the store? Explain.

References:

- Doherty, J., and Waldron, I. Department of Biology, University of Pennsylvania, 2016. http://serendip.brynmawr.edu/exchange/waldron/bloodtests.

Did They Switch the Babies? Experiment Guidelines

Objective: Using basic principles of genetics in combination with biological blood tests, solve the mystery of who the baby belongs to.

Guidelines:

1. Students will need to determine all possible blood type phenotypic combinations that could result from two presumed parents. Then, students will biologically test the blood type of 3 infants to determine if they were potentially "switched".
2. Each student in the group will use the provided lab report to document their findings.

Procedures:

1. Using the dropper vial, place a drop of the Sample 1 synthetic blood from baby girl 1 into each well of the blood typing slide. Close the cap on the dropper vial.
    a. To prevent cross-contamination, always close the cap on one vial before opening the next vial.
2. Add a drop of synthetic anti-A serum (blue) to well A. Close the cap.
3. Add a drop of synthetic anti-B serum (yellow) to well B. Close the cap.
4. For this activity, we will NOT use well Rh.
5. Using the blue mixing stick for Anti-A (well A) and the yellow mixing stick for Anti-B (well B), gently stir the synthetic blood and antiserum drops for 30 seconds.
    a. Remember to use a NEW mixing stick for each sample to avoid contamination of your samples.
6. Carefully examine the resulting thin films of liquid mixture in the well.
    a. If the film is uniform in appearance, there was no agglutination (No).
    b. If the sample appears granular, agglutination occurred (Yes).
        i. Agglutination implies that the antigen to that antibody is present, and that particular allele (A or B) is present in the genotypic blood type.
7. Record agglutination results (yes or no for each antigen) for Sample 1 in Table A.
8. Thoroughly rinse the blood typing slide, and then repeat steps 1-7 for synthetic blood Samples 2 (baby girl 2) and 3 (twin baby boy).

Did They Switch the Babies? Data Collection & Analysis

Situation:

Recently, three babies were born at Bedrock General Hospital. Fred and Wilma had twins (one girl, one boy). In the room next door, Barney & Betty welcomed into the world, a baby daughter. As the three babies slept in the nursery, somebody started to question which girl belonged to which set of parents. From hospital records, the blood types of each parent were known. A staff member then collected a blood sample from each of the three infants, knowing that the boy was a twin sibling of one of the baby girls, and that he was the son of Fred and Wilma.

Your Task:

From the parental genetic information (Blood Types) provided, and your evaluation of the baby's blood types, can you determine which girl belongs to which set of parents?

Parental Blood Type Information:

Person	Blood Type
Wilma (mother of twins)	AB
Fred (father of twins)	O
Betty (mother of baby girl)	A
Barney (father of baby girl)	B
Baby Girl 1	Blood Sample 1 =
Baby Girl 2	Blood Sample 2 =
Twin Baby Boy (son of Fred & Wilma)	Blood Sample 3 =

Table A. Blood Sample Evaluation

	Sample 1 (Baby Girl 1)	Sample 2 (Baby Girl 2)	Sample 3 (Twin Baby Boy)
Anti-A (Well A; Blue)			
Anti-B (Well B; Yellow)			
Blood Type			

Name:

Lab Report

Please complete the following report during the design and implementation of your experiment.

Research Problem
- Describe what you are investigating and justify why you are investigating the problem.

Hypothesis
- Formulate one or more hypotheses for your experiment.

Procedures
- Create the steps you will follow for your experiment.

Data Collection
- Describe the data that you will collect during your experiment.
- Provide graphs, tables, charts, and raw data as necessary.

Results
- Explain your results.

Conclusion
- Based on your data:
  - What can you conclude?
  - Were your hypotheses supported?
  - Were their limitations to your experiment?
  - What are new research questions that derived from this study?