Packet 5.3 - Traits & Genes Unit

First & Last Name: _____ Period/Hour:_____

NOTE: Packets are due after completing Part 5. Check each page to be sure all blanks are completed.

Driving Question: Can we predict traits?

Anchoring Phenomenon: We know that offspring inherit their traits from their parents. Can we predict the traits of offspring? Can we know what traits they'll have before they're born? We will focus on a red and white calf born to black and white cows. How could this happen? And can we predict how likely it is to happen again?

Deeper Questions

1. How does dominance affect how genes interact with each other?
2. How can we use a Punnett square to predict an offspring's traits?
3. Can genes be something other than dominant or recessive?

Schedule

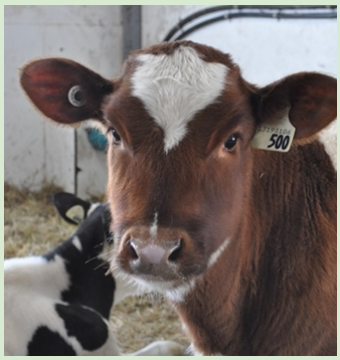
Part 1: Introduction
- Initial Ideas & Data Dive - The Red Calf
- Discussion & Developing Explanations

Part 2: Core Ideas
- Core Ideas
- Revisions of Part 1 Explanations

Part 3: Investigation
- A: RPS Goat Genetics
- B: Genetic Case Studies

Part 4: Review & Assessment
- Ranking Your Readiness
- Formative Assessment & Mastery Check

Part 5: Life Connections
- Life Connections - Genetics & Society



NGSS Standards (*PEs* & *CCCs are summarized below. SEPs are noted throughout the packet*).
HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. HS-LS3-1 - Role of DNA/chromosomes as instructions for traits inherited from parents via meiosis. LS-LS3-3 - Predicting likelihood of different traits in a population/offspring. HS-LS1-4: How does mitosis and differentiation enable complex organisms?

Semester Schedule

5. Traits & Genes
5.1: What determines the traits of an organism?
5.2: How are traits inherited from parents?
5.3: Can we predict traits?
5.4: Unit Assessment

6. DNA & Proteins
6.1: What is DNA and how does it work?
6.2: How does DNA affect protein assembly?
6.3: Unit Assessment
6.4: How are genes modified? *(mini-unit)*

7. Mutations & Change
7.1: How does a protein get its shape & function?
7.2: How do mutations change genes & proteins?
7.3: How can mutations create new traits & species?
7.4: Unit Assessment
7.5: How Does Antibiotic Resistance Occur?

8. Biodiversity
8.1: How does biodiversity affect ecosystems? Why is biodiversity being lost?

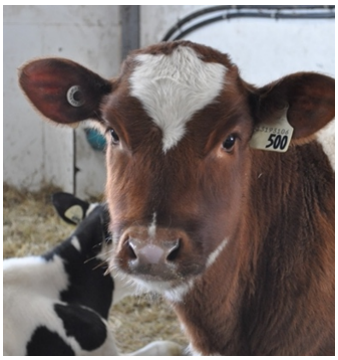
These materials were partly developed with assistance from artificial intelligence.

Resource Links: Class Website; Core Ideas; Summary Video; Practice Test; Cow/Calf Mix-up; Practice Problems; Part 3A Example Goats;

Part 1: Introduction – The Red Calf (5.3.1)

Overview: You will begin by discussing your initial ideas about how different genes interact to determine traits. You will then analyze data and work in teams to develop your initial explanations.

Initial Ideas - *Record your ideas separately (e.g., on a white board or scratch paper).* *SEP: Arguments from Evidence*



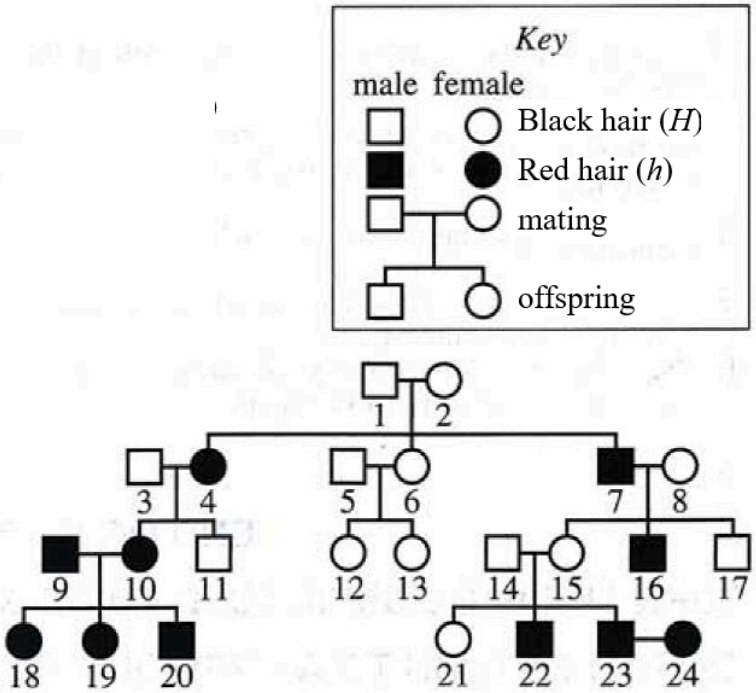
Ben was assisting his parents on their dairy farm as a cow gave birth to a calf. Both parents of this calf had black spots. However, the calf had red spots! How did this calf inherit a trait that was not visible in either parent? Ben, as the only member of his family to have red hair, wondered if maybe the same explanation applied to him. (*To see a calf like this, watch the following video individually or as a class*)

1. **Do you agree or disagree with each student's claim?**
   - Ben: " I think that both parents of the calf had the genes for red hair but didn't express them." *Agree / Disagree*
   - Nina: "I think that maybe there was some interruption or change as the calf developed in the cow's uterus, resulting in a different color." *Agree / Disagree*
   - Jessie: "I think that maybe the cow's diet changed, and this changed the calf's appearance (kind of like a flamingo)." *Agree / Disagree*

2. **Work in your small groups to discuss your ideas.** How are your ideas similar or different? Decide as a group whether each statement is correct (and why). Be prepared to present your ideas to the class.

Data Dive - *Read the directions below.* *SEP: Analyzing & Interpreting Data*

Data Dive: The figure shown here is a pedigree that shows the inheritance of the hair color in cattle. The color of hair in cattle is determined entirely by the hair color gene, which we will refer to as the *H Gene*. This gene in cattle has two alleles (versions): *H* which is *dominant* (always expressed if present) and codes for black hair; and *h* which is *recessive* (only expressed if no dominant genes are inherited for that trait) and codes for red hair.



Each individual represented in this pedigree was assigned a number for reference (shown below the symbol for the individual). Scientists determined that the *H Gene* genotype (genetic makeup) of Individual 20 is *hh*. The *H Gene* genotype of Individual 21 is *Hh*. Based on this information, scientists concluded that red hair is a recessive trait. *Source* - Testbig.com

Individual Questions - *Complete the questions below individually.* *SEP: Analyzing & Interpreting Data*

1. **How many generations are shown in the figure?** A. 3 B. 4 C. 22 D. 24
2. **Based on the figure, the two individuals in which of the following pairs most likely have the greatest genetic similarity across their genomes?**
   A. Individual 3 and Individual 4
   B. Individual 12 and Individual 13
   C. Individual 16 and Individual 24
   D. Individual 18 and Individual 21
3. **Suppose that Individual 23 and Individual 24 have four biological offspring. Based on the figure, how many of the offspring, if any, have red hair?** A. 0 B. 1 C. 3 D. 4
4. **According to the figure, how many of the grandchildren of Individual 1 and Individual 2, if any, have red hair?** A. 0 B. 1 C. 2 D. 7
5. **Based on the figure, is it likely that red hair is a sexlinked trait?**
   A. Yes, because females with red hair always passed red hair to their male offspring.
   B. Yes, because females with red hair did not always pass red hair to their male offspring.
   C. No, because females with red hair always passed red hair to their male offspring.
   D. No, because females with red hair did not always pass red hair to their male offspring.
6. **Based on the information provided, will an individual with the genotype *Hh* have red hair?**
   A.Yes, because red hair is a dominant trait.
   B. Yes, because red hair is a recessive trait.
   C. No, because red hair is a dominant trait.
   D. No, because red hair is a recessive trait.
7. **Further Discussion: How does this help to explain how and why two black cows can give birth to a red calf? If offspring inherit two different versions of a gene, what decides which is expressed?**

Discussion - *Record your ideas in the spaces below.* *SEP: Asking Questions & Defining Problems*

We generally agree that…	***We disagreed or were unsure if…***

Initial Explanations - *Record your ideas in the spaces below.* *SEP: Constructing Explanations & Designing Solutions*

Why do parents sometimes give birth to offspring with different traits? Write down an initial explanation below. Don't worry if you are unsure. You will revise this explanation over time.

_____

_____

Part 2: Core Ideas (5.3.2)

Overview: In this activity, you will use a short presentation to provide you with information that will help you improve and revise your initial ideas. Your instructor will decide on how to implement this portion. You will then work in small teams to address the questions listed below.

Driving Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Developing & Using Models

1. Briefly summarize Gregor Mendel's work and his findings.
2. How are traits affected by genes and proteins? How does this relate to sperm and egg cells?
3. What is the difference between a dominant and a recessive gene?
4. What determines whether a dominant or a recessive gene is expressed as a trait?
5. What is meant by the terms homozygous dominant, homozygous recessive, and heterozygous?
6. What is a genotype? What is a phenotype? How are these terms related?
7. True or false: a Punnett square can tell us exactly what kinds of traits that will be inherited by offspring of two parents. Explain.
8. Demonstrate how to use a Punnett square to predict the traits of offspring.
9. What are codominant traits? Explain with an example.
10. What are incompletely dominant traits? Explain with an example.
11. What are polygenic traits? Explain with an example.
12. How does coat color in Labrador retrievers illustrate how genes can influence each other?

Revising Explanations - *Record your ideas in the spaces below.* *SEP: Constructing Explanations & Developing Solutions*

Why do parents sometimes give birth to offspring with different traits? Based on this new info, how would you now respond?

_____

_____

_____

Use this space for notes if needed.

Part 3A: RPS Goat Genetics (5.3.3a)

Pre-Investigation Questions - *Work as a group to prepare verbal responses for these questions. When you think you are all ready to provide responses, raise your hand. Your instructor will listen to your explanations, provide feedback, and determine if you are ready to move on to the investigation.*
SEP: Developing & Using Models

1. What is the difference between a dominant and a recessive gene?
2. What is meant by the terms homozygous dominant, homozygous recessive, and heterozygous?
3. What is a genotype? What is a phenotype? How are these terms related?
4. True or false: a Punnett square perfectly predicts the traits of offspring. Explain.

This activity was completed _____ (*instructor signature*)

Directions: Complete this group lab activity using Rock, Paper, Scissors (RPS) to determine the genotype and phenotype of your goat. The older person represents the "dominant" gene, and the younger person represents the "recessive" gene. If the older person wins RPS that gene is dominant (and vice versa). Play RPS twice for each trait. Record the phenotype. Draw your goat based on its genotype and phenotype (see examples here).

Horns	Dominant: No Horns; *Recessive*: Horns	**Ear Length**	Dominant: Long; *Recessive*: Short
Wattles (*neck lobes*)	Dominant: Wattle; *Recessive*: No Wattle	**Markings**	Dominant: Blotches; *Rec*: Solid Color
Hair Length	Dominant: Long; *Recessive*: Short	**Behavior**	Dominant: Wild; *Recessive*: Tame

1. **Horns**: 1st Winner: Dominant *recessive* 2nd Winner: Dominant *recessive*

   Genotype: HH Hh hh Phenotype: _____
2. **Wattle**: 1st Winner: Dominant *recessive* 2nd Winner: Dominant *recessive*

   Genotype: WW Ww ww Phenotype: _____
3. **Hair**: 1st Winner: Dominant *recessive* 2nd Winner: Dominant *recessive*

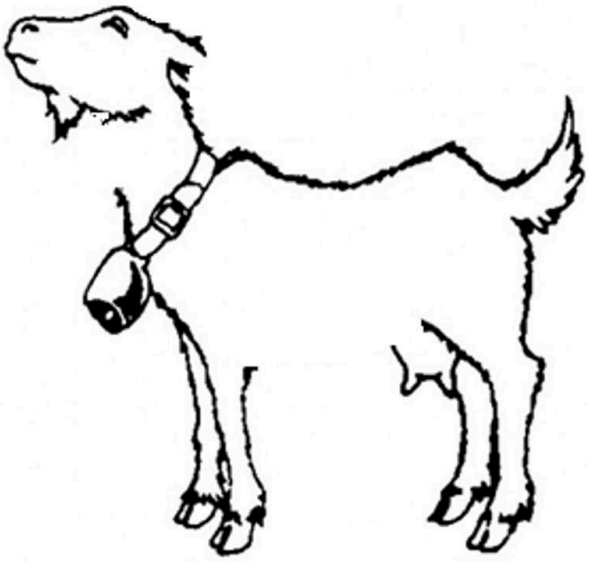
   Genotype: LL Ll ll Phenotype: _____
4. **Ears**: 1st Winner: Dominant *recessive* 2nd Winner: Dominant *recessive*

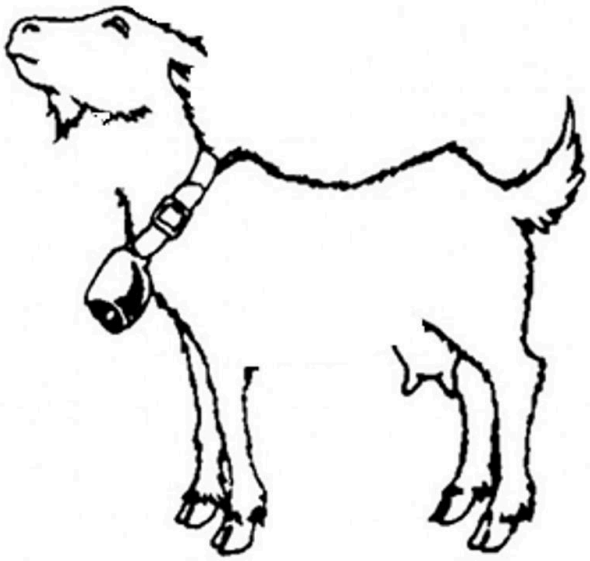
   Genotype: EE Ee ee Phenotype: _____
5. **Behavior**: 1st Winner: Dominant *recessive* 2nd Winner: Dominant *recessive*

   Genotype: BB Bb bb Phenotype: _____
6. **Markings**: 1st Winner: Dominant *recessive* 2nd Winner: Dominant *recessive*

   Genotype: MM Mm mm Phenotype: _____

7. **Draw your goat below (left)**. See examples here.





8. **Choose another group's goat for mating.** List the mate's genotypes and phenotypes. Draw it above.

Horns - Phenotype_____ Genotype_____

Wattle - Phenotype_____ Genotype_____

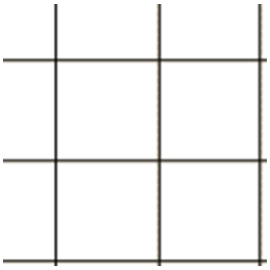
Hair - Phenotype_____ Genotype_____

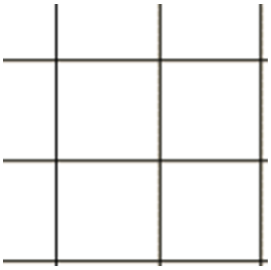
Ears - Phenotype_____ Genotype_____

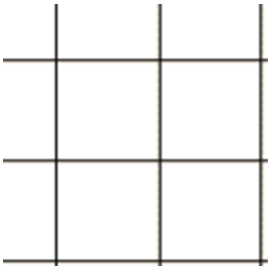
Behavior - Phenotype_____ Genotype_____

Markings - Phenotype_____ Genotype_____

9. Complete Punnett Squares for the three traits of your choosing. Use the genotype of your goat and the genotype of the mate of your goat (a goat from another group with consent, or randomly choose genes).







10. In the space below, describe the most likely traits of your offspring based on the Punnett squares above.

_____

_____

Part 3B Investigation: Genetics Case Studies (5.3.3b)

1. A male and female bird have 4 unhatched eggs. The lighter female on the left is *heterozygous*; the darker male on the right is *homozygous recessive*. Use *B* and/or *b* for your genotypes.

   a. Write the genotype of the parents below:

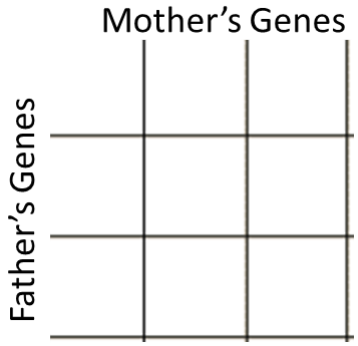
      Female:_____ Male:_____

   b. Which color is dominant, gray or black? How do you know?

      *Gray / Black, because...*_____
      Circle one

   c. Record each phenotype: Female:_____ Male:_____

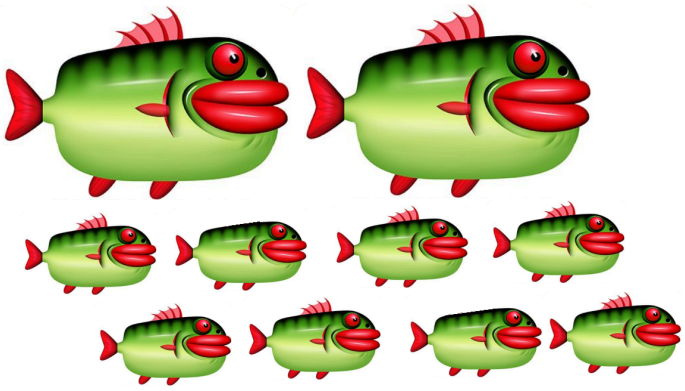
   d. Complete the Punnett Square below for this couple →



   e. What are the odds the offspring will be **gray**? Circle one.
      0% (0/4) 25% (1/4) 50% (2/4) 75% (3/4) 100% (4/4)

   f. What are the odds the offspring will be **black**? Circle one.
      0% (0/4) 25% (1/4) 50% (2/4) 75% (3/4) 100% (4/4)

2. A family of fish is shown here. Dorsal fins (top fins) are **dominant**; no dorsal fin is *recessive*.



   a. Based on their phenotypes/traits, circle the genotypes that are possible for both adult fish.

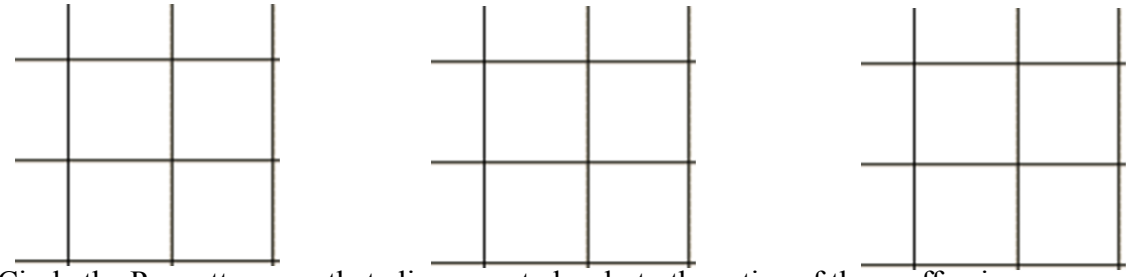
      AA *Aa* *aa*

   b. How many baby fish have…

      Dominant phenotype:____ / 8

      Recessive phenotype:____ / 8

   c. Complete Punnett squares for all possible genotype combinations of the adults (AA/AA, AA/Aa, Aa/Aa).



   d. Circle the Punnett square that aligns most closely to the ratios of these offspring.

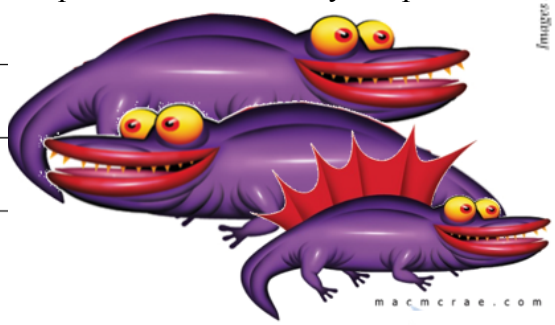
e. Based on the offspring, what are the genotypes of the parents?_____ & _____

3. Back fins are dominant on this species of salamander. Could this couple have had this baby? Explain.

_____

_____

_____



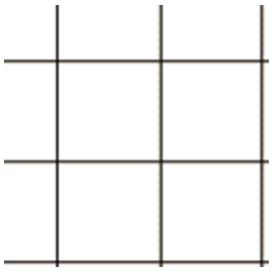
4. Two yetis have four babies

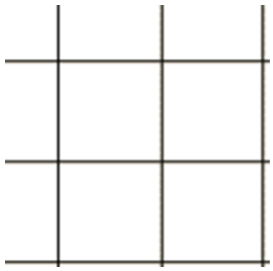
a. What is the dominant phenotype? _____

b. What is the recessive phenotype? _____

c. Create two Punnett squares that could be possible based on the phenotypes of the parents.

d. Circle the Punnett square that predicts these offspring.





Part 4: Review & Assessment (5.3.4)

Step 1: Review each Driving Question. Circle any questions that are still unclear to you.
Step 2: Identify and discuss any remaining confusion with your instructor.
Step 3: Complete the Formative Assessment (individually or small groups). Compare responses as a class.
Step 4: Individually complete a Mastery Check. If needed, your instructor will provide further support.

Traits & Genes Unit - Packet 5.3 Formative Assessment

Name: _____ Hour_____ Date:_____ Score:_____ /_____

Directions: A 3x5 notecard with handwritten notes can be used to guide your answers.

1. **A cow and bull with black spots gave birth to a calf with red spots. How could this happen?** Include and underline the terms *dominant genes, recessive genes, heterozygous,* and *homozygous recessive*.
   Note: black spots are dominant; red spots are recessive.

_____

_____

_____

2. **Use the information from the previous question to answer the questions below.** *Phenotype* refers to the color of each animal. For the *genotypes*, use "*B*" and/or "*b*".

   What was the phenotype of the calf's mother? _____ What was her genotype? _____

   What was the phenotype of the calf's father? _____ What was his genotype? _____

   What was the phenotype of the calf? _____ What was her genotype? _____

   What is the difference between genotype and phenotype?_____

_____

_____

3. In the space below**, complete a Punnett square using the genotypes of the parents above. Then summarize what this indicates about how two black & white cows could have a red & white calf**.

_____

_____

_____

_____

Mother's Genes

Father's Genes

4. Two bugs mate. One has wings; the other does not. The bug with wings is *homozygous dominant*. The bug without wings is *homozygous recessive*. Use "winged" or "wingless" for phenotypes**.** Use *B* and/or *b* for genotypes.

Images by MacMcRae

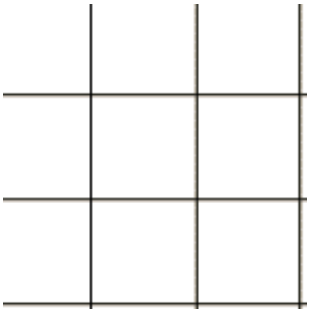
Phenotype of the left bug: _____

Genotype of the left bug _____

Phenotype of the right bug: _____

Genotype of the right bug: _____

Complete a Punnett square for the offspring of this pair →



Based on this Punnett square, what are the possible genotypes and phenotypes for the offspring of this pair?

_____

_____

_____

5. **The resulting offspring of a red and a white flower are pink. This suggests that this trait is**
   a. Dominant/Recessive b. Co-dominant c. Incompletely Dominant d. Polygenic

   Explain why you chose this answer.

   _____

6. **A black fish mates with a yellow fish, creating offspring that are black & yellow. This trait is…**
   a. Dominant/Recessive b. Co-dominant c. Incompletely Dominant d. Polygenic

   Explain why you chose this answer.

   _____

7. **Height in humans is determined by six different genes. This suggests that this trait is**
   a. Dominant/Recessive b. Co-dominant c. Incompletely Dominant d. Polygenic

   Explain why you chose this answer.

   _____

Part 5: Life Connections – Genetics & Society (5.3.5)

Initial Ideas: *While feeding a red spotted calf, Ben excitedly mentioned to a neighbor that it came from black and white parents. The neighbor disliked this, claiming red calves are always problematic and are dangerous as adults. Ben questioned if red coloration could determine a calf's behavior. Ben's parents thought this was an absurd idea. They argued that hair color proteins don't affect productivity, friendliness, or safety. They suggested the neighbor's opinion might be influenced by one negative experience with a red calf.*

1. Three students shared their ideas. **Do you agree or disagree with each student's claim**?
   a. Ben: "I think hair color is totally different from those other traits." *Agree / Disagree*
   b. Nina: "I think that maybe the neighbor might be correct. Maybe the hair color determines all those other traits. After all, we did just learn that some genes are linked." *Agree / Disagree*
   c. Jessie: "I am pretty sure that an animal's productivity, friendliness, and other traits are affected by lots of factors, including non-genetic factors like diet and upbringing." *Agree / Disagree*

2. **Work in your small groups to discuss your ideas.** How are your ideas similar or different? Decide as a group whether each statement is correct (and why). Be prepared to present your ideas to the class.

Background: Humans are incredibly similar on a genetic level. We share 99.9% of our DNA! That tiny 0.1% difference accounts for things like eye color, hair type, and other minor physical traits. But the core blueprint that makes us human is almost identical for everyone. Most of our bodies function in nearly-identical ways.

While our physical traits are mostly determined by our genes, our behaviors are much more complex. Things like intelligence, creativity, and how we treat others are influenced by both our genes and the environment we grow up in. Most of the time, we learn most of these behaviors - they're not simply "coded" into our DNA.

Even though we know that physical traits don't predict behavior, some people still make false assumptions about others based on race, sex, or other biological factors. This is called *prejudice*.

For this activity, you will use an internet search engine to explore different types of prejudice in different cultures throughout history. Examples are listed below. Be prepared to share your findings with the class and discuss the impact of prejudice in our society today. (Image Source)

Examples of Prejudice in Different Cultures

- Japan: Blood Type Harassment ("it-bura-hara") (*Source: BBC*)
- Rwanda: Genocide Against the Tutsi (*Source: Montreal Holocaust Museum*)
- Germany: Nazis and Racism (*Source: US Holocaust Memorial Museum*)
- United States: "Red Lining" & Racial Discrimination (*Source: NPR*)
- US & Europe: Phrenology & Skull Shapes (*Source: Medical News Today*)
- United States: Japanese-American Internment (*Source: USHistory.org*)

Questions

1. In what way does each example pertain to the definition of prejudice (*inaccurately making assumptions about a group of people based on a particular trait*)?
2. What damage results or resulted from this form of prejudice? How did/does this result in harm?
3. Has this problem been resolved, or does it still occur today?
4. What do you think are your personal roles and obligations for addressing prejudice? Could you prevent harm due to prejudice from occurring?