

VANDERBILT STUDENT VOLUNTEERS FOR SCIENCE
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Crazy Traits

2018-2019 VINSE/VSVS Rural

Goal: To understand some basic principles of heredity by building creatures determined by flipping a coin for different traits.

This lesson was adapted from CPO Crazy Traits Lesson.

Fits TN State standards:

VSVSer Lesson Outline:

_____ **I. Introduction:** VSVS team will explain some background about heredity, including the concept of dominant and recessive traits, as well as some history about Gregor Mendel. It is very important to include the definition of an allele, genotype and phenotype as these words appear often in the lesson.

_____ **II. Determining the Genotype:** Students will flip coins to determine the gender and 13 traits so that they can build their creatures. VSVS team will draw a Punnett Square on the board and have the students help fill it in so that students will be able to write down the genotype of their crosses on their observation sheet.

_____ **III. Building Your Creature:** Students will assemble their creature by matching the inherited genotypes with the corresponding phenotype. A chart with the genotypes and phenotypes will be on their Instruction Sheet.

_____ **IV. Dominant and Recessive Traits and Clean-up**

_____ **V. Optional Activity:** Students will taste PTC paper.

LOOK AT THE VIDEO BEFORE YOU GO OUT TO YOUR CLASSROOM

<https://studentorg.vanderbilt.edu/vsvs/lessons/>

USE THE PPT AND VIDEO TO VISUALIZE THE MATERIALS USED IN EACH SECTION.

2. During the Lesson:

Here are some Fun Facts for the lesson

- Humans have at least 30,000 genes, which are found on chromosomes (single pieces of coiled DNA).
- Humans have 23 sets of chromosomes in each cell in their body that determine traits like height and eye color as well as more complex traits like personality and likelihood of developing disease.
- If you uncoil all the DNA you have in all your cells, you could reach the moon 6000 times.
- Gregor Mendel developed his famous laws of inheritance in the 1800s, though their profound significance was not recognized until the beginning of the 20th century.

UNPACKING THE KIT - What you will need for each section

For Introduction Part II. Determining the Genotype

32 Observation Sheets, 16 Instruction Sheets, 8 sets of 3 laminated parts sheets, 8 circular tins containing 1 red X/X coin, 1 blue T/t coin, 1 green T/t coin, and 1 black X/Y coin, 16 handouts with pictures of mother Crazee (Tt) and father Crazie (Tt)

For Part III. Building Your Creature

8 sets Crazy Traits creatures

For Part IV: Dominant and Recessive Traits and clean-up

8 sets of 3 laminated parts sheets

For Part V: Optional Activity – Tasting PTC Paper- 1 container PTC paper

I. Introduction

Learning Goals:

- **Students distinguish between the terms allele genotype, and phenotype, and can describe their role in inheritance**
- **Students describe the role of dominant alleles, recessive alleles, incomplete dominance, and codominance in determining phenotype**

- Write the following terms on the board: **heredity, gene, dominant allele, recessive allele, allele**
- Ask students: *What things about you distinguish you from other people?*
 - Some examples should include hair color, height, eye color, etc.
 - These are examples of **traits**.
- Ask students: *Why do you look different from your parents? Your siblings?*
 - The passing of traits from parents to their children (offspring) is a process known as **heredity**.
- Ask students: *What are traits?* A trait is a characteristic of an organism.

Tell students to raise their hand if they have the trait you name:

curly hair
straight hair
freckles
blue eyes
taller than the average person their age

Tell students that these are just a few of the many traits they possess.

Ask students *if they have heard of Gregor Mendel.*

- Mendel is called the Father of Heredity because he discovered some of the very first ideas of heredity based on experiments with peas.
- Mendel discovered that when pea plants with different traits were crossed, their offspring would exhibit one trait more often than the other.
- Now we know that traits are controlled by a basic unit of heredity called a **gene**.
 - **Genes** are located on the genetic material called **DNA**.
 - **Different forms of the same gene are called alleles.**
 - For each trait, one **allele** comes from your mother and one from your father.
 - The alleles you have depend on the alleles your parents have and on chance.
- The combination of alleles is called a **genotype**. It determines a trait.
 - That trait that an offspring shows physically is called the **phenotype**.
- **Dominant** alleles trump **recessive** alleles. This means that if an offspring has one dominant version of the gene and one recessive version of the gene, the dominant allele will be the one that shows. Example: if you have one allele for brown eyes and one allele

Your Notes:

for blue eyes, your eye color will be brown. This is because the brown eye gene is dominant over the blue eye gene.

- Today, we will explore how different traits can be produced in offspring when two parents are crossed.

II. Determining the Genotype

Learning Goals:

- Students distinguish between the terms allele genotype, and phenotype, and can describe their role in inheritance
- Students understand and use Punnett Squares as a visualization tool for predicting the likelihood that an offspring will have a particular genotype

1. Show the students the mother Crazee and father Crazie.
 - Tell them that both parents have the same genotype, Tt for all traits.
 - **Usually, the capital T represents the dominant allele, and the lowercase t represents the recessive allele**
 - Each group is going to create an offspring from these same parents.
2. Tell students that the first step is **to determine the sex of their offspring**.
 - a. Remove all coins from the tin.
 - b. Choose the male sex chromosome coin. It has an X on one side and a Y on the other.
 - c. Now select the female sex chromosome coin, it should have an X on both sides.
 - d. Place the two coins in the tin, shake them and toss them onto the table.
 - e. Record your results on your Observation Sheet.
3. Students will now determine the genotypes for all the traits that the offspring creatures will inherit.
 - a. Tell students to look at the sperm coin (green) and the egg coin (blue).
 - b. Notice that the coins have a T (dominant allele) on one side and a t (recessive allele) on the other (= genotype Tt).
 - c. Ask students: What do the letters on the coins represent? *Alleles*
 - d. Place these coins in the tin (remove the sex chromosome coins.)

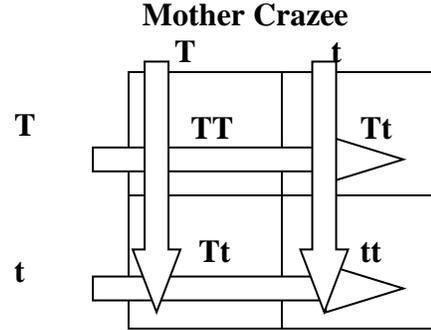
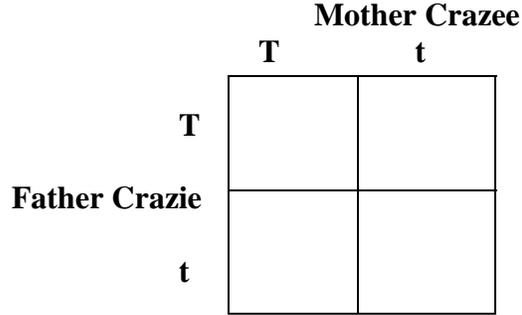
Observation Sheet

Trait	Genotype of mother for the trait	Genotype of father for the trait	Genotype of offspring (after tossing coins)	Phenotype of offspring
Gender	XX	XY		
Skin color	Tt	Tt		
Leg	Tt	Tt		

4. A Punnet square can help students visualize all the possible combinations of alleles from parents. In this lesson, dominant alleles have capital T's and recessive alleles have lowercase t's.

Your Notes:

Draw the following Punnett square on the board, and have the students help you to fill in the different combinations.



Ask students what is the chance of inheriting the genotype tt? (25%)

5. The first trait the students will shake for is skin color:
 - a. Place the blue and green coins in the tin.
 - b. Shake the coins and toss them onto the table.
 - c. Write your results (TT, Tt or tt) for each trait on the observation sheet.
 - d. Continue for all traits.

6. Now we will use the genotypes from the observation sheet to make our creatures.
 - a. Have students look at the instruction sheet. The table contains the key for the phenotype for each of the genotypes. Remember the **phenotype** is the **physical** appearance of a genotype and genotype is the genetic code,
 - b. Match the genotype for your creature with the corresponding phenotype on the key. Have students fill in the last column on their observation sheet.

Team members should circulate the classroom to see if there are any questions and make sure students are filling in their table correctly.

Trait	Genotypes and Phenotypes
1. Gender	XX: female; XY: male
2. Skin Color	TT: red; Tt: purple, tt: blue
3. Leg	TT: short; Tt: short; tt: long
4. Foot	TT: webbed; Tt: webbed; tt: talons
5. Arms	TT: long; Tt: long; tt: short
6. Hands	TT: paws; Tt: paws; tt: claws
7. Eye Color	TT: red; Tt: one red, one green; tt: green
8. Eyebrows	TT: unibrow; Tt: unibrow; tt: separate
9. Beak	TT: trumpet; Tt: trumpet; tt: crusher
10. Ears	TT: elephant; Tt: elephant; tt: mouse
11. Antenna	TT: long; Tt: long; tt: short
12. Antenna Shape	TT: knob; Tt: knob; tt: star
13. Tail	TT: long; Tt: short; tt: none
14. Wings	TT: no wings; Tt: no wings; tt: wings

Your Notes:

III. Building Your Creature

Learning Goals:

- **Students distinguish between the terms allele genotype, and phenotype, and can describe their role in inheritance.**
- **Students describe the role of dominant alleles, recessive alleles, incomplete dominance, and codominance in determining phenotype.**

- After students have completed their table, they can use their kit to build their creature.
- Each phenotype should be matched to the correct body part.

Building hints:

1. The female bodies have the rounded part closest to the head. The male bodies have the pointed part closest to the head.
2. Put the skin on; then, attach the head and leg.
3. Next, find the correct foot, place the foot on the base and put the creature in the base.
4. Finish matching the correct traits with the body parts.
5. Have students compare their creatures with other creatures from the class.

Note: If the students are rowdy, this may be difficult and last too long. Set a time limit, or have VSVS team members hold up the creatures for the class to see.

- Ask students: Do any of the creatures look the same? *They shouldn't.*
- Ask students: Even though the parents are the same, why do the creatures look different?
 - Students may have difficulty with this, but illustrate that this is similar to siblings. Siblings have the same parents, but sometimes look quite different.
 - This is because the phenotype or trait is determined by the genotype of the parents **and** by chance.
 - Even with only 13 traits (humans have many more traits), none of the creatures were identical. This is because the chance of getting two identical creatures is very small.
 - For VSVS information: On the other hand, siblings look more similar to their parents than other unrelated adults. This is because humans have many more traits and some are linked and inherited together
- Have students report whether their creatures were male or female. Write each total on the board.
 - What number would we have expected? *50%*
 - Is the number the same? *It may be, but it may not be. Our prediction was made because there was a 50% chance of getting a female, and a 50% chance of getting a male. This does not mean that we will get exactly 50% males and 50% females all the time.*

IV. Dominant and Recessive Traits and Clean up

- **Tell students to look at the Table on their Instruction sheet.**
- Ask students: *Which traits are dominant traits? Which traits are recessive traits?*

Your Notes:

- Make two columns on the board, one for dominant and one for recessive. The answers are below.

Dominant	Recessive
short legs	long legs
webbed feet	talons
long arms	short arms
Paws	claws
Unibrow	separate eyebrow
trumpet beak	crusher beak
elephant ears	mouse ears
long antenna	short antenna
knob antenna shape	star antenna shape
no wings	wings

- Students should notice that three traits aren't dominant or recessive.
 - Skin color and tail are examples of **incomplete dominance**, where the heterozygous condition (Tt) produces a different condition all together. So, red + blue = purple.
 - The eye color is an example of **codominance** where both traits are expressed together. In this case, the heterozygous condition produces one red eye (T) and one green eye (t).

Important: As students finish with their creatures, have them take the creature apart and place each part on the parts sheet to make sure they return every part. One volunteer will lead the optional activity while the other volunteers go around the room for clean up!

Important: Make sure that you have **all** of the parts in each box **before** you leave the classroom

V. Optional Activity – Tasting PTC Paper

- Learning Goals: Students describe the role of dominant alleles, recessive alleles, incomplete dominance, and codominance in determining phenotype

- Have each student taste a small piece of PTC paper.
- **Ask students** to raise their hand if they can taste the paper and to put their heads down on the desk if they cannot taste the paper.
- Write down the number of students who can taste the PTC paper and the number of students who cannot taste the PTC paper down on the board.
- Explain to students that the ability to taste PTC is genetic.
- Ask the students *if they think that the ability to taste PTC is dominant or recessive based on the numbers on the board.* **Dominant**

Your Notes:

**Crazy Traits
Observation Sheet**

Trait	Genotype of mother for the trait	Genotype of father for the trait	Genotype of offspring (after tossing coins)	Phenotype of offspring
Gender	XX	XY		
Skin color	Tt	Tt		
Leg	Tt	Tt		
Foot	Tt	Tt		
Arms	Tt	Tt		
Hands	Tt	Tt		
Eye Color	Tt	Tt		
Eyebrows	Tt	Tt		
Beak	Tt	Tt		
Ears	Tt	Tt		
Antenna	Tt	Tt		
Antenna shape	Tt	Tt		
Tail	Tt	Tt		
Wings	Tt	Tt		

Look around at the creatures for other groups. Do any of the creatures look the same?

List the dominant traits below.

List the recessive traits below.

Are there any traits that are not dominant or recessive?

**Crazy Traits
Observation Sheet Answers**

Trait	Genotype of mother for the trait	Genotype of father for the trait	Genotype of offspring (after flipping)	Phenotype of offspring
Gender	XX	XY		
Skin color	Tt	Tt		
Leg	Tt	Tt		
Foot	Tt	Tt		
Arms	Tt	Tt		
Hands	Tt	Tt		
Eye Color	Tt	Tt		
Eyebrows	Tt	Tt		
Beak	Tt	Tt		
Ears	Tt	Tt		
Antenna	Tt	Tt		
Antenna shape	Tt	Tt		
Tail	Tt	Tt		
Wings	Tt	Tt		

Look around at the creatures for other groups. Do any of the creatures look the same? *No, and they should not, even though all of the parents had the same genotype. This is because the creatures are determined by genotype of parents and by chance.*

List the dominant traits below.

Short legs, webbed feet, long arms, paws, unibrow, trumpet beak, elephant ears, long antenna, knob antenna shape, no wings.

List the recessive traits below.

Long legs, talons, short arms, claws, separate eyebrow, crusher beak, mouse ears, short antenna, star antenna shape, wings.

Are there any traits that are not dominant or recessive? *Skin color, tails and eye color do not display typical inheritance. See lesson for explanation.*

Crazy Traits Instruction Sheet

II. Determining the Genotype

1. Look at the pictures of the parents - **Both parents have a Tt genotype.**
2. Determine the sex of your offspring.
 - a. Take the male sex chromosome coin (it will have an X on one side and a Y on the other) and the female sex chromosome coin (it will have an X on both sides).
 - b. Place both coins in the tin and toss them onto the table.
 - c. Record your results on the Gender part of the observation sheet.
3. For every trait listed below, place a green sperm coin and a blue egg coin into the tin.
 - a. Shake the tin with the green sperm coin and blue egg coin and toss the coins onto the table.
 - b. Write down your results for each trait on your Observation Sheet.

III. Building Your Creature

1. Match the genotype for the offspring in column 4 of the Observation sheet with the phenotype listed in the key below. For example, for the skin color, if column 4 has TT, then put "red" in the column 5 of the Observation Sheet. Likewise, if column 3 has Tt, put "purple" in column 5.
2. Use your kit to build your creature with the correct phenotype (from the last column in the Observation Sheet).

Trait	Genotypes and Phenotypes
1. Gender	XX: female; XY: male
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4. Foot	TT: webbed; Tt: webbed; tt: talons
5. Arms	TT: long; Tt: long; tt: short
6. Hands	TT: paws; Tt: paws; tt: claws
7. Eye Color	TT: red; Tt: one red, one green; tt: green
8. Eyebrows	TT: unibrow; Tt: unibrow; tt: separate
9. Beak	TT: trumpet; Tt: trumpet; tt: crusher
10. Ears	TT: elephant; Tt: elephant; tt: mouse
11. Antenna	TT: long; Tt: long; tt: short
12. Antenna Shape	TT: knob; Tt: knob; tt: star
13. Tail	TT: long; Tt: long; tt: short
14. Wings	TT: no wings; Tt: no wings; tt: wings

Answer the questions on the observation sheet.

**Make sure to return all parts of the pieces of the creature with the kit!
Your instructor will check each box when you are done to make sure no pieces are left behind.**



Father Crazy

Mother Crazee