May 2021

Lesson Plan - Marshmallow Mutt Genetics

Center for Urban Resilience

LESSON #3: MARSHMALLOW MUTT GENETICS

OVERVIEW:

The purpose of this lesson is to introduce students to a simplified model of genetic crosses. They will consider the limits of this model, yet they can use the ideas raised to think more deeply about the breeding of dogs.

SUB-QUESTION:

What traits will my dog have?

WAYS OF KNOWING URBAN ECOLOGY:

	Students will…
Understand	• Explore the variation in traits that result from sexual reproduction.
Talk	• Discuss the limitations of models. • Distinguish between recessive and dominant traits.
Do	• Create their own dog based on the genetic combinations they select.
Act	*No specific goals connected with acting on urban ecology in this lesson.*

SAFETY GUIDELINES:

None.

PREPARATION:

Time:

2 class periods

Day 1: Activity 3.1
Day 2: Activity 3.2, 3.3

Prepare before class:

Chromosomes (https://www.sciencenews.org/sites/default/files/educator-guides-pdf/HS-guide_121215_Gene_Drivesa.pdf)

Print 1 set of pink paper, one set on blue paper and cut out shapes. Place in an envelope for every 2 students.

Materials:

Activity 3.1

Internet access and projector or devices for each pair of students

Activity 3.2

"Where did you get your…?" handout
mirrors (optional)

Activity 3.3

Materials for the class (adapt based on what you have available):

- 2 bags of large marshmallows
- 1 bag of small marshmallows (3 colors)
- box of thumbtacks
- box of push pins w/ colored plastic covers
- 40 pipe cleaners
- box of small nails
- box of cocktail sticks
- 1 roll of paper towels
- images of dog and it's possible pups

Materials for each pair of students:

- Marshmallow mutt handout
- An envelope containing:
    - 1 set of the *Chromosomes Master* duplicated onto pink paper, each piece cut out
    - 1 set of the *Chromosomes Master* duplicated onto blue paper, each piece cut out

  These cut outs represent a complete set of chromosomes.

INSTRUCTIONAL SEQUENCE

Activity 3.1: Who was Mendel?

1. Ask students what they know about the work of Gregor Mendel (They might not know anything, which is ok).

> **A little background on Gregor Mendel:** In the 1860s, Gregor Mendel proposed the principle of segregation and the principle of independent assortment. Reginald Punnett, the British geneticist who the Punnett square is named for, understood that each parent contributes an allele for any given gene from the gamete (egg or sperm cell). These alleles can be homozygous or heterozygous and by examining all the possible combinations of alleles, the probability that offspring have a particular genotype can be determined.

2. You have options:
    - Show students a brief video on Mandel's work (http://www.youtube.com/watch?v=Mehz7tCxjSE)
    - Give students some time to explore an interactive online game in which they discover the principles of Mendelian genetics through reading, trial and error (http://www2.edc.org/weblabs/Mendel/MendelMenu.html)

3. Follow the video with some practice with Punnett squares. Have students think with you about the probability that a trait will be expressed for any given generation.
    - Tell students that for generation 1, Mendel planted a pea plant with yellow seeds (YY) and one with green seeds (gg). Make the following graphic and discuss what the offspring will look like:

Father		Mother	
		Y	Y
	g	Yg	Yg
	g	Yg	Yg

Explain that 100% of offspring will be heterozygous GY. It is known that yellow seeds are dominant over green seeds, so it is most likely that all the plants will be yellow. Recognize that since a genetic cross is a *probability*, there is always some chance that the expected result may not occur.

- Have students select two offspring from generation 1 and allow them to pollinate:

Father		Mother	
		g	Y
	g		
	Y		

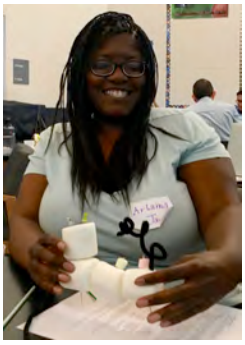
Based on the results, they can determine what percent of the offspring will be homozygous yellow, heterozygous yellow, homozygous green, and heterozygous green.

- To challenge students, have them determine what generation 3 would look like. How many Punnett squares will they need to map all the possibilities based on Generation 2? Students can share out their results.

Activity 3.2: Where did you get your…"

1. Give each student a copy of the handout. Use the PowerPoint, "Where did you get your…?" to help students identify each trait.
2. Students can work in pairs or small groups to mark the traits they have.
3. Have students chart their findings as a class-wide data sheet. For each trait, how many have trait A or B? Identify columns as *dominant* and *recessive.* Discuss whether the class data shows the dominant trait as always the most common and why this might not always be the case.

Activity 3.3: Marshmallow Mutt



1. Decide how you will make the class materials available to students. Will they be passed out or available at a station?
2. Begin by asking students, "Where do our genes come from(*We get half our genetic information from each parent)?* Take a moment to review the relationship between chromosomes, genes, and alleles (*Chromosomes are made of genes, and genes exist in different forms, called alleles*).
3. Distribute the handout "Marshmallow Mutt" to students and have them preview what they will be doing.
4. Give students their envelopes, have them follow the directions on the handout, and record the genotype information.
5. The students will then build their puppy.
6. When students have built their puppy, have them observe the one they created and compare it with the puppies created by other teams.

7. Ask: Were your puppies created through sexual or asexual reproduction? (*Sexual*) What are the dominant traits that your puppy inherited? (*Answers will vary.*) Does your puppy have any recessive traits? (*Answers will vary.*) What is the genotype responsible for that recessive trait? (*Answers will vary.*) What does it mean when an organism is homozygous or heterozygous for a trait? (*An organism is homozygous for a trait if chromosomes from both parents carry the same allele. An organism is heterozygous for a trait if the alleles on the chromosomes differ, if, for example, one is dominant and one is recessive.*)
8. Have students place all the chromosomes back in the envelope.

Concluding the Lesson:

1. Have students look at an image of a pair of breeding dogs and a variety of puppies. Have students guess which pups actually came from the dogs' litter. What makes it hard to determine which dogs come from a particular litter? Discuss the limitations to the Marshmallow Mutt model.
2. Discuss how breeders select for specific traits. What could go wrong? Why is it ok in our culture to select for specific traits with our pets? Should parents be able to do this for their children? What do they want to know more about?

Activity inspired by: Science News for High School Educator's Guide