

EMS Lesson 2: Outrageous Offspring

(Post-Exhibit Visit)

Objective:

After completing this lesson, students will have an understanding that the principles of probability can be used to predict hereditary traits.

Curriculum Link:

This lesson reinforces the concept that inheritance is like a game of chance. It would work well as an introduction to the study of genetics and heredity. Additionally, students will apply prior knowledge of mathematical probability to the process of single gene inheritance.



Exhibit Link:

Heredity Slots: Inheritance: A game of chance

In this part of the exhibit, heredity is compared to a game of chance. Using the Punnett square helps students graphically display the outcomes of chance or probability.

Time Required:

Teacher Preparation: 30 minutes **Class Time:** 30-45 minutes

Materials Needed:

- Box, bag, or basket from which to choose slips of paper with traits written on them
- Generous supply of colored markers or crayons, scissors, double-sided scotch tape
- Two colors of felt material or construction paper; OR stencil letters or small pieces of paper with one upper or lower-case letter per piece of paper
- Enough Outrageous Offspring traits/alleles (either colors or letters) for each pair of students to have 12; (with colors: quarter-sized dominant traits and dime-sized recessive traits for students to use; larger sizes for teacher demonstration)
- Worksheets with a Punnett square large enough to accommodate the felt or letters, and empty space at the bottom for drawings

Lesson Steps/Activity:

1. After reviewing the principles of probability, have partners predict the outcome of 20 coin tosses, (or have each student toss a coin and compare outcomes with a partner) and then proceed with the coin toss, recording outcomes on a simple chart.
2. Have students share and compare the outcomes. Reinforce the concept that since there are two sides to a coin, there is one chance in two ($1/2$ or 50%) that the outcome will be heads up. Tell students they will see in this lesson how the same law applies to genetic outcomes.
3. Before the lesson, decide on a wacky set of traits generated by matching two imaginary creatures. Example: a Red-breasted Daffy Bird and a Green-breasted Daffy Bird. Red represents the dominant trait, and Green the recessive.
4. Demonstrate how to use upper case letters to represent dominant traits/alleles, and lower case letters for recessive traits/alleles. Tell students that scientists such as Mendel used the Punnett square to demonstrate the probable offspring of two parent's organisms. (While Mendel's traditional pea plant model shows crosses for height (T=the dominant tall trait; t=the recessive short trait), this example uses the Daffy Bird traits. Feel free to substitute the pea plant height traits if you wish.)

		Red-Breasted Daffy Bird	
		R	r
Green-Breasted Daffy Bird	r	Rr	rr
	r	rr	rr

5. Emphasize that this model shows two forms (alleles) of the same gene, and therefore it is abbreviated with two forms of the same letter R=red; r=green).

6. Explain that in this example there are two letters for each trait, because each parent has two traits but passes only one on to each offspring. Hence, the law of probability. In this case it is a cross between one green parent with two recessive traits (rr) for color and one red parent with a dominant trait and a recessive trait (Rr) for color.
7. Have each pair of students choose four letters from the box/bag/basket at random, and set them up as the parents, using two for Mom and two for Dad. RR or Rr = Red-breasted Daffy Bird, and rr=Green-breasted Daffy Bird. After students have set up the Punnett square, have them return to get the correct letters to complete the problem (or simply have students write in the correct letter). Then, have them draw and color in their four Outrageous Offspring.
8. Have student groups explain their outcomes to the class.

Extensions & Modifications:

Once students have worked with the Punnett squares, they could toss two coins at a time in order to see how the probabilities work out with four traits/alleles (the two that each parent has). Heads can represent a dominant trait and tails a recessive trait; thus only when both coins come up tails would the “offspring” display the recessive trait.

Elementary:

- Instead of using letters, use colored shapes (such as circles cut from felt or construction paper) to represent different alleles. Make the circle for the dominant trait (red) larger than the circle for the recessive trait (green). On a large sheet of paper, demonstrate how four combinations of offspring can result by pairing one trait of each parent four different ways.
- Explain that the red circle represents the trait we can see, whether it pairs with another red or with a green. Show the red/green combination by covering the green circle with the red. Show that the green trait can only be seen if there are two of them together.
- If students have already covered conversion of probability to fractions and percent, have them write each phenotype and/or genotype outcome as a fraction and percent.

Middle:

- Have students write each outcome as a fraction and a percent.
- Extend the offspring into an additional generation. Have students pair one of their offspring with the offspring of another pair of students, create a Punnett square for the two birds, and see what possible third-generation offspring could result.

Important terms: heredity, trait, offspring, probability

Additional Middle School terms: gene, phenotype, genotype, homozygous, heterozygous, allele, Punnett square

Writing Prompts/Discussion Questions:

1. Why do you think a dominant gene is referred to as “dominant”?
2. Identify the genotype (genetic makeup) and phenotype (physical appearance) of each of your offspring.
3. What is the probability that your parent sets could produce each of the four offspring?
4. Explain why each offspring is the color that you depict in your pictures.
5. Which of your offspring are homozygous? Heterozygous? Explain.
6. If brown eyes are a dominant trait, how could two brown-eyed parents have a child with blue eyes (a recessive trait)?

National Standards Addressed:

K-4 Content Standard C – Life Cycles of Organisms

- Plants and animals closely resemble their parents.
- Many characteristics of an organism are inherited from the parents of the organism, but other characteristics result from an individual’s interactions with the environment. Inherited characteristics include the color of flowers and the number of limbs of an animal. Other features, such as the ability to ride a bicycle, are learned through interactions with the environment and cannot be passed on to the next generation.

5-8 Content Standard C – The Molecular Basis of Heredity

- Every organism requires a set of instructions for specifying its traits. Heredity is the passage of these instructions from one generation to another.
- The characteristics of an organism can be described in terms of a combination of traits. Some traits are inherited and others result from interactions with the environment.