Dihybrid Cross Simulation

Mendel later wondered if traits always travelled together or if they were inherited separately. To answer the question he considered parents which were heterozygous for two traits- a **dihybrid cross**. In one cross he studied the inheritance of seed color and seed shape. The allele for yellow seeds (Y) is dominant to the allele for green seeds (y). The allele for round seeds (R) is dominant to the allele for wrinkled seeds (r).

Mendel crossed true-breeding plants that had yellow, round seeds (YYRR) with true-breeding plants that has green, wrinkled seeds (yyrr). If the two traits are transmitted from parents to offspring as a package, the F_1 spring would produce yellow, round seeds. The F_2 offspring would produce two phenotypes (yellow + round; green + wrinkled) in a 3:1 ratio, just like a monohybrid cross. If, however, the alleles separated independent of one another, we should observe four different combinations. The four different kind of sperm and four different kinds of eggs should give 16 different combinations in the offspring.

In this activity we'll simulate a dihybrid cross so you can learn about the possible outcomes.

Procedure

1. Use 2 nickels to represent the genes for seed color, with heads representing the dominant allele for YELLOW SEED (Y) color and tails representing the recessive allele for GREEN SEED (y) color.
2. Use 2 quarters to represent the genes for seed shape, with heads representing the dominant allele for a ROUND SEED (R) shape and tails representing the recessive allele for a WRINKLED SEED (r) shape.

a) We know that the coins are being used to represent the genes of the parent plants. Are the parents pure-breeding or hybrids for seed color and seed shape?
b) How many alleles does each parent donate to the offspring for seed color? For seed shape?
c) What are the possible gametes that the parents can produce?

3. Flip all 4 coins and record the results by putting a mark on the data table in the space labelled "Flip results" in the appropriate row. For example, if you got heads on both quarters and a heads and tails on the two nickels, you would put a mark in the second row (for YYRr).
4. Flip all 4 coins 19 more times, and record the results.
5. Add up all the combinations of alleles that produced each of the following:
    i) yellow seeds with round seed shape (Y_, R_)
    ii) yellow seeds with wrinkled seed shape (Y_, rr)
    iii) green seeds with round seed shape (yy, R_)
    iv) green seeds with wrinkled seed shape (yy, ss)

6. Now we can see the ratio of the four possible phenotypes. Convert your results to the smallest ratio (i:ii:iii:iv) by dividing each of them by the smallest of the numbers. Round off to one decimal place.

7. Pool your data with the class.

8. Record the class totals and then convert the data to the smallest ratio (i:ii:iii:iv) by dividing each of them by the smallest of the numbers. Round off to one decimal place.

d) Compare your ratio to that from the class data. Account for any difference. Why is it useful to pool your individual results with those of the class?
e) What does this activity tell us about the expected results from a dihybrid cross?
f) What have you learned about the inheritance of the alleles for seed color and for seed shape?

Table 1. Results from individual coin tosses and resulting phenotypes.

Genotype	Flip results	Phenotype	Total
Nickel: 2 Heads (YY) Quarter: 2 Heads (RR)			
Nickel: 2 Heads (YY) Quarter: 1 Head, 1 Tail (Rr)			
Nickel: 1 Head, 1 Tail (Yy) Quarter: 1 Head, 1 Tail (Rr)			
Nickel: 1 Head, 1 Tail (Yy) Quarter: 2 Heads (RR)			
Nickel: 1 Head, 1 Tail (Yy) Quarter: 2 Tails (rr)			
Nickel: 2 Heads (YY) Quarter: 2 Tails (rr)			
Nickel: 2 Tails (yy) Quarter: 2 Heads (RR)			
Nickel: 2 Tails (yy) Quarter: 1 Head, 1 Tail (Rr)			
Nickel: 2 Tails (yy) Quarter: 2 Tails (rr)			

Table 2: Individual and class data for number of offspring and phenotypic ratios

		yellow, round seeds	yellow, wrinkled seeds	green, round seeds	green, wrinkled seeds
Individual	# offspring				
	Ratio				
Class	# offspring				
	Ratio				