

Guiding Questions:

How is the frequency* of alleles in a gene pool related to the chances of a particular genotype occurring? What happens to the frequency of alleles in a gene pool from one generation to the next? (*frequency = fraction, expressed as a decimal)

In this investigation we will try to understand how gene pools in populations work by studying a model of a gene pool. In our model, the two alleles for a trait will be represented by beans of different colors. You will make pairs of genes by picking one "allele" each from the male and female gene pools of the model population. This random choice of pairs of genes represents the joining of genes that happens in fertilization. The new pairs of alleles represent individuals of the new generation in the population. You will apply the laws of probability to predict the chances of getting individuals of each "genotype" in the next generation, basing your predictions on the amount (frequency) of the alleles in the original gene pools.

*If there are two alleles (we have used 1's and 2's to represent them, but for convenience in this activity we will use the colors of the beans: **W** = white, **R** = red) for a certain trait in a population, there are three possible gene combinations when members of the population mate: **WW**, **RW**, and **RR**. Unlike a cross between two individuals, in a population the chances of each possible fertilization occurring are not necessarily equal – the probability of getting a particular combination depends upon how many R and W alleles are in the gene pool. If we know how many of each allele there are in a gene pool will we be able to accurately predict the chances of the various outcomes using the laws of probability?*

MATERIALS

2 cups - marked: ♂ and ♀ gene pools
40 red beans and 60 white beans in each cup.

PRELAB QUESTIONS

1. What does each bean represent?
2. What does each cupful of beans represent?
3. What does putting a bean from each cup together represent?
4. Once together, what does each pair of beans represent?
5. Based on the number of red and white beans in the cups, what are the chances of pulling a red bean from:
 - a. the male gene pool?
 - b. the female gene pool?
 - c. what are the chances of picking a white bean from each gene pool?
6. Make two data tables like TABLE B-8-1. Label one "1st Generation" and the other "2nd Generation".
7. Using your answers to 5a, b and c, determine the probabilities of getting each of the possible combinations (**WW**, **RW** and **WR**, **RR**) in the first generation. Record in the "mathematically expected" column of your "1st Generation" table.

PROCEDURE

1. Count the beans in the male and female cups to be sure there are 60 white (**W**) and 40 red (**R**) in each cup. Adjust if necessary.
2. Gently shake each cup to mix up the beans.
3. Model each fertilization that will produce a new individual in the first generation as follows: Randomly pick a bean from each cup (male and female). Place the pair together on the table. This represents a new person! Provide a separate place for rows of each of the three possible combinations (**WW**, **RW** & **WR**, **RR**). Keep it organized so you'll be able to easily count at the end. (See Fig. B-8-2).
4. When all of the beans in the cup are used, the first generation of new individuals is complete. Count how many individuals in the first generation have each of the possible combinations and record on your data table. **KEEP THE PAIRS TOGETHER AND ORGANIZED!!**
5. Each pair of beans represents a new individual of the population. Since, statistically, half the individuals in a population are males and half females, assume that half of your bean pairs are males and half are females. Place half the pairs of beans of each combination into the male gene

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pool and half into the female. For example, if you have 18 **RR** pairs, put 9 **RR** pairs into the male cup and 9 into the female.

6. Once all the genes of the first generation are back in the cup, **count the number of red beans and white beans in each cup**. These are your gene pools for the second generation. Use these numbers to determine the "mathematically expected" for the 2nd generation as you did for the 1st generation. Record on your data table.
7. Determine and record the combinations for the second generation as you did for the first generation in steps 3 and 4.
8. Record your results on the Class Data Table.



Data table for comparison of predicted and actual "allele" combinations.

Combinations	Mathematically Expected (in %)	Individual Results (in %)	Group results (in %)
WW			
RW and WR			
RR			

DISCUSSION QUESTIONS

1. What was the percentage of each color of bean in:
 - a. the original male gene pool?
 - b. the original female gene pool?
2. How did the "mathematically expected" for the first generation compare with:
 - a. your individual results?
 - b. the group results?
3. How does the number of red and white beans in each cup at the beginning of the second generation compare to the numbers you started with in the first generation? If you were to repeat this experiment do you think this would occur again?
4. Based on the results of this investigation, state a hypothesis about the expected gene frequencies and gene combinations that occur from generation to generation in a population.
5. Compare the percent of each genotype (**WW, RW, WR and RR**) between the 1st and 2nd generations. Did they change or stay the same?
6. Suppose that one of the combinations (say **RR**) produced a condition that reduced the chances of the individual surviving to produce offspring.
 - a. What do you predict would happen to the frequency of the **R** allele in the population over time?
 - b. What would happen to the frequency of the **W** allele?
7. Can you tell from this activity which bean color represents the dominant allele and which the recessive allele? Explain why or why not.