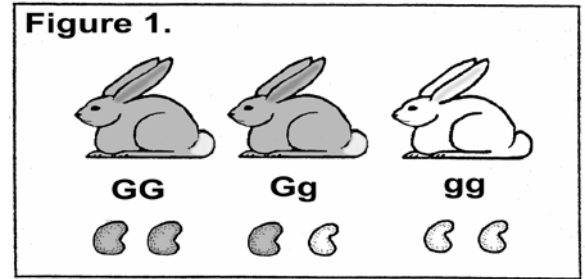


# BIOLOGY LAB: NATURAL SELECTION AND ALLELE FREQUENCY

## INTRODUCTION:

Evolution can be described as the change in the allele frequencies of a gene pool over time. Natural selection can place pressure upon specific phenotypes and cause a change in the frequency of the alleles that produce the phenotypes. For example, predators often select as prey individuals that are different from the majority of a population. From a litter of mostly normal-colored gray rabbits, an eagle would probably be more likely to select an albino rabbit than a normal-colored one. The reason for this seems obvious: the albino is different and stands out among the population. The eagle represents a natural selection pressure that selects *against* the albino rabbit and the genes that produce the albino condition.



## OBJECTIVES:

- ✓ Simulate natural selection by using beans of two different colors.
- ✓ Calculate the frequencies of alleles subjected to selection pressure over five generations.
- ✓ Draw a graph that demonstrates the changes of allele frequencies over five generations.
- ✓ Describe how natural selection can affect allele frequencies over time.

## MATERIALS:

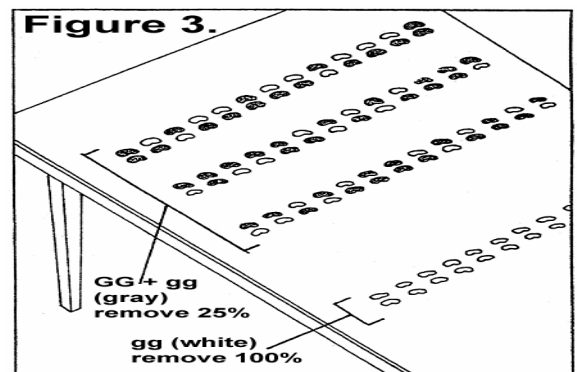
colored pencils (2)      paper bag      graph paper  
pinto beans      white navy beans

## PROCEDURE:

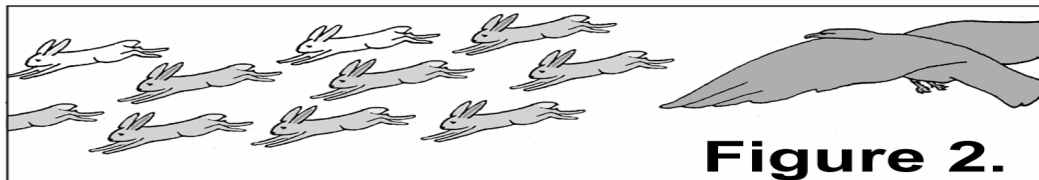
Assume that the pinto beans represent alleles that produce normal-colored gray rabbits and that gray fur is dominant to white fur. The white navy bean, then, represents a recessive allele that produces albino rabbits in the homozygous condition. The dark-colored pinto bean represents a dominant allele that, when present, produces normal-colored gray rabbits. Selection *against* gray-colored rabbits (GG or Gg) occurs 25% of the time. That is, predators remove 25% of all the normal phenotypes each generation. Selection against "albino" rabbits (gg) is 100%. This means that *all the* albino rabbits present in the population are eaten by predators in each generation.

1. Place 50 pinto beans and 50 white navy beans into the paper bag.
2. Shake up the beans. Without looking, reach into the bag and remove two beans. These represent an individual rabbit's genotype. Set these beans aside. Continue to remove beans, two at a time, until you have 50 "rabbits," each with two alleles for fur color.
3. Arrange the beans on a flat surface in two columns as shown in Figure 3. The two columns represent the two possible rabbit phenotypes, gray (GG and Gg) and albino (gg).
4. Examine your columns of "rabbits" and remove 25% of the normal-colored rabbits (GG, Gg) and 100% of the albino individuals (gg). If the number of rabbits you calculate is a fraction, remove a whole rabbit. Assume that it was injured, but that it escaped and later died. To calculate the number of "rabbits" to be removed, multiply the total number of "rabbits" in the column by the percentage to be removed, and divide by 100. For example, 25% of 30 "rabbits" equals 7.5 "rabbits." You would then remove 8 "rabbits."

$$\frac{25}{100} \times 30 = 7.5 \text{ rabbits}$$



5. Count the number of pinto beans and navy beans that remain and record the numbers in Table 1.
6. Calculate the percentage of each type of bean remaining and record your results in the table. To calculate percentage, divide the number of beans of one type by the total number of beans and multiply by 100. For example, if there are 15 pinto beans and 10 navy beans remaining, the percentage of pinto beans is 15 divided by 25 (15 + 10) times 100, or 60%.
7. Begin the next generation by placing 100 beans into the paper bag. The proportions of pinto and navy beans should be the same as the percentages you calculated in the previous step. In the given example you would place 60 pinto beans and 40 navy beans into the bag. Repeat steps 2 through 7 until you've generated data for five generations.
8. Calculate the frequencies of each allele and record them in the table. The frequency is the percentage expressed as a decimal. For example, 55% is equivalent to a frequency of 0.55; 100% is a frequency of 1.00.
9. Graph the frequencies of each allele over five generations. Plot the frequency of the alleles on the vertical axis and the number of the generation on the horizontal axis. Use a different colored pencil for each allele.



**Table 1.**

<b>ALLELE FREQUENCIES</b>						
	<i>Allele G</i>			<i>Allele g</i>		
<b>Generation</b>	<b>Number</b>	<b>Percentage</b>	<b>Frequency</b>	<b>Number</b>	<b>Percentage</b>	<b>Frequency</b>
<b>Start</b>	50	50	0.5	50	50	0.5
<b>1</b>						
<b>2</b>						
<b>3</b>						
<b>4</b>						
<b>5</b>						

**DISCUSSION:**

1. Did allele frequencies change over time? Why or why not?
2. Did either of the alleles totally disappear? Why or why not?
3. What does your graph show about allele frequencies subjected to natural selection?
4. What does the shaking of the bag of beans simulate?
5. Why do you remove two beans for each individual?
6. How does natural selection affect allele frequency?
7. What would happen to the allele frequencies if the number of eagles declined (if, for example, the eagle's eggs did not hatch because of humans' use of the pesticide DDT)?