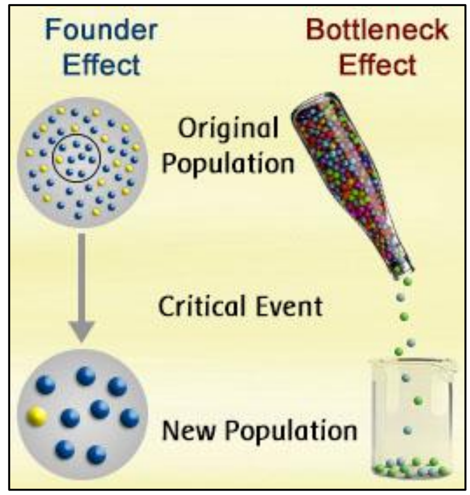
Name ____ Date ________________ Period _______

Lab: Investigating Genetic Drift

HONORS BIOLOGY: UNIT 8



BACKGROUND: It should now be clear that population size will affect the number of alleles present in a population. But small population sizes also introduce a random element called genetic drift into the population genetics of organisms.

Genetic drift is a process in which allele frequencies within a population change by chance alone as a result of sampling error from generation to generation. Genetic drift is a random process that can lead to large changes in populations over a short period of time. Random drift is caused by recurring small population sizes, severe reductions in population size called "***bottlenecks***" and ***founder events*** where a new population starts from a small number of individuals. Genetic drift leads to fixation of alleles or genotypes in populations. Drift increases the inbreeding coefficient and increases homozygosity as a result of removing alleles. Drift is probably common in populations that undergo regular cycles of extinction and recolonization.

Bottleneck Effect

The Bottleneck Effect occurs when there is a disaster of some sort that reduces a population to a small handful, which rarely represents the actual genetic makeup of the initial population. This leaves smaller variation among the surviving individuals.
Genetic bottlenecks are defined by the textbook as "events in which the number of individuals in a population is reduced drastically." Essentially, this is genetic drift at its finest. It occurs when the true frequency of alleles of a certain population, is not accurately presented in the new population. There is no other way to avoid a bottleneck effect because having a certain phenotype or genotype does not matter. This can have an extreme effect on the genetic diversity of the population. To illustrate this point: if a large population, say of a bacteria, were to be growing on a surface and then one was to clean it with Lysol or the like, we would expect that not all the bacteria in the population would be killed and thus survive to pass on their genes. This dramatic population decrease would effectively cut out most of the genetic variation that existed within the population pre-Lysol attack. Now, on the same surface, we can expect that the remaining alleles frequencies have shifted dramatically, and all the forthcoming generations will be limited to this gene pool (barring the introduction of new genes to the population). This, effectively, can spread a trait like resistance through the entirety of a population in a few generations. And we know that bacteria run through generations quickly, leading to issues like MRSA.

Founder Effect

A founder effect occurs when a new colony is started by a few members of the original population. This small population size means that the colony may have:

- Reduced genetic variation from the original population.
- A non-random sample of the genes in the original population.

For example, the Afrikaner population of Dutch settlers in South Africa is descended mainly from a few colonists. Today, the Afrikaner population has an unusually high frequency of the gene that causes Huntington's disease, because those original Dutch colonists just happened to carry that gene with unusually high frequency. This effect is easy to recognize in genetic diseases, but of course, the frequencies of all sorts of genes are affected by founder events.

PROCEDURE:

In this lab, you will investigate the phenomena of ***genetic drift****. Specifically, you will be designing a detailed experiment to test your student-designed lab simulating genetic drift. The directions below will guide you in planning the experiment. The goal is to understand how genetic drift can change the* ***allele frequencies*** *of a resulting population.*

1. Read the background information at the beginning of the lab to understand the different modes of genetic drift so you can begin designing your experimental setup. Conduct additional research on genetic drift using your textbook, phones, or Chromebooks before you design your lab.

2. Design a controlled experiment that shows the effects of genetic drift on the allele frequencies of a population.

3. Write up a detailed experimental plan on the **EXPERIMENTAL DESIGN GUIDE** below. Make sure your experimental design addresses your hypothesis.

4. You will be able to perform your experiment once you receive approval of your experimental design from your teacher. When you complete the lab your team will prepare a formal lab write-up.

MATERIALS PROVIDED (provided by me):

- Colored M&Ms (*Colored candius*)
- Small cups
- Paper towels
- Coffee stirrers (use these to avoid touching M&Ms with your fingers)

ADDITIONAL MATERIALS (provided by you):

EXPERIMENT RESEARCH PROPOSAL FORM

Teacher Approval _______________

1. Team Members:

2. Research Relationship (What is affecting what?)

3. Research Prediction (What results do you expect?)

4. **Hypothesis** (Be specific. Include a variable you are measuring. In an If/then/because form)

5. Experimental Design (List the steps in your **procedure**)

6. **Independent Variable**:

7. **Dependent Variable**:

8. List at least 3 other factors that must be **controlled**?

9. **Data Table** (Create a table to collect your data in)

10. Proposed Plan to Analyze Data (In what way will you compare these numbers after you collect them?)

11. Explain what results you would need to see in your data to support your hypothesis.

12. Complete the experiment. Collect the data in your Data Table. Graph your results if appropriate. Answer the Analysis Questions where appropriate in your formal lab write-up.

ANALYSIS QUESTIONS: (Include these in VI. Discussion in your formal lab write-up)

1. Clearly **describe** the results of your experiment. Be sure to indicate which "cause" you are describing, how it happened, and include terms such as ***bottle neck effect*** or ***founders effect.***

2. Look at the colors in your genetic drift population and the corresponding percentages. Now, compare those to the same colors/percentages in the original population (for example, in the genetic drift population, red might have had percentage of 50% while in the original population red was only 16%). Write these comparisons down in a list format.

3. Does the new genetic drift population (resulting population) accurately represent the original population? Explain by citing your data.

4. What colors in the original population are NOT represented in the genetic drift population (resulting population)? What effect does this have on the genetic diversity of the resulting population?

5. Let's assume that the M&M's are Praying Mantises and that they were placed into a new environment consisting of lots of greenery and many bright red flowers. Which colors in the genetic drift population would have better fitness in this new environment? Why/how? How might that affect the alleles for those individuals?

6. Which M&M's (Praying Mantises) would have less fitness in question number 5? Why/how? What might happen to the alleles for those individuals that have less fitness?

7. Pick a cause, other than the scenario you choose, for why the M&M organisms might have experienced genetic drift. Be sure to indicate which "cause" you are describing, how it happened, and include terms such as bottleneck effect or founders effect.