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POPULATION GENETICS- Sources of Variation in a Population

In 1908 two researchers studying population genetics came to one conclusion: if a population is not evolving, the allele frequencies in the population remains the same. This idea is called the Hardy-Weinberg principle. The constant state of allele frequencies is called genetic equilibrium. This is a hypothetical situation and never occurs in natural populations.

Evolution occurs when allele frequencies change and the genetic equilibrium is disrupted. Allele frequencies can be calculated by dividing the number of one allele in the population by the total number of alleles.

Example: In a population the dominant allele (Y) codes for yellow, the recessive allele (y) codes for pink. Assume that there are 100 individuals in the population. 50 of the individuals are homozygous yellow, 30 are heterozygous, and 20 are homozygous pink.

- Considering that each individual carries two alleles for the gene, how many total alleles are in the population?_____
- Since each homozygous yellow individual carries two Y alleles and each heterozygous individual carries one Y allele, how many Y alleles are in the population? _____
- **Allele frequency of Y = # Y alleles/ # total alleles**
- What is the allele frequency for Y?_____

Departures from genetic equilibrium (change in allele frequencies) can happen in several ways: **Mutation, Gene Flow (migration), Genetic Drift, and Natural Selection.**

This activity is designed to demonstrate sources of variation and the effect of that variation on the allele frequencies in a population.

Materials: 15 yellow Y Squares 5 pink y Squares
1 green g Square 1 bag extra squares
* squares represent alleles for the same gene

Procedure:

- In a population there are two alleles for one gene. **Y codes for yellow, y codes for pink**

Construction of the Population

- use the yellow and pink squares
- using the squares, create 10 individuals (each individual carries two alleles)

1. What are the numbers of each genotype in your population?
   homozygous dominant (YY): _____
   homozygous recessive (yy): _____
   heterozygous (Yy); _____

2. What are the allele frequencies for each allele in your population? (see example)
   allele frequency of Y: _____ allele frequency of y:_____

Scenario 1: Mutation

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- create a mutation in the population
- remove a pink square from one individual and replace it with a green
- green (g) is recessive to Y, but dominant to y

3. What are the allele frequencies for each allele in your population?
   allele frequency of Y: _____
   allele frequency of y:_____
   allele frequency of g:_____

HINT: Use the formula: **# of Y alleles / # of total alleles**

4. Did the allele frequencies change from the original population? _____

Scenario 2: Gene Flow (migration)

- a new individual has moved into your population from another area
- the new individual is homozygous pink
- take two pink squares from your extra squares and add this individual to the population.

5. What are the allele frequencies for each allele in your population?
   allele frequency of Y: _____
   allele frequency of y:_____
   allele frequency of g:_____

6. Did the allele frequencies change from the original population? _____

Scenario 3: Genetic Drift

- due to a random event some of your population was wiped out. (boo hoo!!)
- disregard 2 of the individual in your population (put back in bag)

7. What are the allele frequencies for each allele in your population?
   allele frequency of Y: _____
   allele frequency of y:_____
   allele frequency of g:_____

8. Did the allele frequencies change from the original population? _____

Scenario 4: Natural Selection

- a virus has struck your population
- the virus affects only those individuals that carry two y alleles
- remove any individuals that are homozygous pink from your population

9. What are the allele frequencies for each allele in your population?
   allele frequency of Y: _____
   allele frequency of y:_____
   allele frequency of g:_____

10. Did the allele frequencies change from the original population? _____

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Questions:

11. What is the definition of evolution?

12. What happens to a population if they are not evolving?

13. What is genetic equilibrium?

14. In which scenarios (1 through 4) did evolution occur? How do you know?

15. If females prefer to mate with yellow individuals, what would you expect to happen to the frequency of the Y allele in the population?