Pasadena Unified School District
Performance Task Overview

Topic and Type of Task: *EVOLUTION – POPULATION GENETICS* **Subject, Grade Level** *BIOLOGY GRADES 9THRU 12*

- **Essential Question:** What mechanism promotes change in organisms?

Teacher's Overview*:

How does this task give evidence of my *Desired Results* for students?
THE INVESTIGATION

OBJECTIVES
In this experiment, students will

- Investigate a genetically inherited trait and apply the Hardy-Weinberg Principle to a population.
- Calculate allele frequencies and genotypes for a population using the Hardy-Weinberg formula.
- Compare allele frequencies within the classroom to North American averages.
- Demonstrate the stability of allele frequencies over five generations in an ideal Hardy-Weinberg population.

Examine the effects of natural selection, heterozygous advantage, and genetic drift on allele frequencies in a simulated mating exercise.

How long will this task take? Two Weeks

Any additional planning notes or reminders?
MATERIALS

PTC paper
control paper
4 index cards
coin

*** This page is for teachers only. The following page is for students.**

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- **Essential Question:** What mechanism promotes change in organisms?

Background Information or Overview of Situation

During the 19th century, Darwin published his theory of evolution, stating that members of a population vary considerably in their genetic makeup. Those that are the "fittest" for their environment are better able to survive and reproduce, and therefore pass these suitable traits on to the next generation. This "***natural selection***" creates a population that is different from the previous generations. Since Darwin's theories were published, several others have expounded on his work, leading to the ideas of adaptation and mutation. Recent research has determined that chromosomes, present in each sex's reproductive material, carry the genes that determine individual characteristics.

A ***population***—all the individuals of a species that live in the same place at the same time—are affected by their own characteristics. There are three key elements of any population: ***size***, ***density***, and ***dispersion***. Population size is important to the groups' ability to reproduce without a lot of inbreeding. ***Inbreeding*** can be the downfall of a population if recessive traits, many of which are harmful, become a common occurrence. Population density can affect the ability of individuals to reproduce, based on whether they ever encounter another to mate with. Dispersion, or how populations are arranged, can also affect populations.

Populations evolve by responding to their surroundings through natural selection. This change actually occurs in the frequency of gene alleles in the population. William Castle, an American scientist; Geoffrey Hardy, a British mathematician; and Wilhelm Weinberg, a German physician, independently determined that the frequencies of ***genes*** in a population remain constant unless certain forces act on the population. ***Dominant alleles*** will not replace ***recessive alleles***, and the ratio of heterozygous and homozygous individuals does not change over the course of several generations. This theory has come to be known as the Hardy–Weinberg principle; it is the basis of the study of population genetics.

The ***Hardy–Weinberg principle*** is normally stated as a mathematical equation:

$$p^2 + 2pq + q^2 = 1$$

The frequencies of the dominant and recessive alleles are represented by p and q, respectively. For example, if a diploid individual has two alleles, "A" and "a", at a particular locus, only three possible genotypes can be the result: AA, Aa, and aa. The probability of receiving the "A" alleles from both parents is p x p, or p^2; for the "a" alleles, q x q, or q^2. Those who received the Aa combination are described by 2pq, since it is possible for the "A" or the "a" to come from either parent, thereby doubling the chance.

If the relationship between p and q are constant through randomly mating generations, the population is said to be in Hardy–Weinberg equilibrium; no evolution occurs. However, ***five evolutionary forces*** act on a population to affect it: mutation, migration, non-random mating, genetic drift, and natural selection. If any of these conditions are present, the proportions of ***heterozygotes*** and ***homozygotes*** can differ. Therefore, the Hardy–Weinberg principle is a useful tool for measuring the degree of genetic change or evolution occurring in a population.

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Task Instructions/Guidelines/Details:
Include information from the green section of your planning document: *Does it ask the students to **do** the subject through a clear **product**?*

- Assigned readings and reading assignments
- Class notes
- Videos/visual aids
- Lab notebook (for lab work)
- Other related activities and labs
    - Beak Activity – Darwin's Finches
    - Natural Selection For The Birds – Populations
    - Reading Plants – Plant Adaptations
    - BLAST Activity – Comparing DNA Sequences
- Vernier Lab
    - Population Genetics and Evolution

How will you be assessed?
Students will be guided into the three sections of the laboratory report.
The Pre Lab, the In Lab and the Post Lab work. In preparation for the lab students will answer a set of pre lab questions before the actual experiment is conducted. Followed that, the students will be guided with a demonstration of the set up on the day of the In Lab. After the demonstration of the apparatus students will review the pre lab and begin their lab. During post lab students will be guided to answer the post lab questions by analyzing and interpreting their data and observations.

Benchmarks/Check-ins

- Students will complete a pre-lab assignment, background research about similar experiments that have been previously conducted as related to the topic.

- Lab reading and background will be assigned to each student. The following will be checked as follows:
    - **Pre-lab assignment** – 2 days after initial lab assignment
    - **In-lab work** – students will be given 1-2 days to complete in-lab work. This will depend on the length of the class periods.

Post-lab work (including the typed up lab report, when mandated) – students will be expected to turn in a typed up lab report one week after the post-lab work is completed.