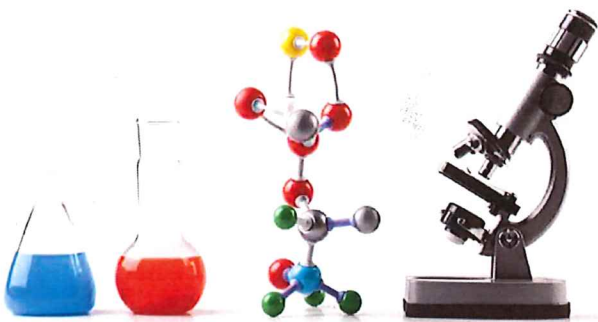




LAB ASSIGNMENT 10

Hardy-Weinberg Equilibrium

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The Hardy-Weinberg formulas allow scientists to determine whether evolution has occurred. Any changes in the gene frequencies in the population over time can be detected. The law essentially states that if no evolution is occurring, then equilibrium of allele frequencies will remain in effect in each succeeding generation of sexually reproducing individuals. Hardy-Weinberg *equilibrium* is an ideal state that provides a *baseline* against which change can be analyzed. In the simplest case of a single locus with two alleles: the dominant allele is denoted **A** and the recessive **a** and their frequencies are denoted by p and q ; $\text{freq}(\mathbf{A}) = p$; $\text{freq}(\mathbf{a}) = q$; $p + q = 1$.

In order for equilibrium to remain in effect (i.e. that no evolution is occurring) then the following five conditions must be met:

1. No mutations must occur so that new alleles do not enter the population.
2. No gene flow can occur (i.e. no migration of individuals into, or out of, the population).
3. Random mating must occur (i.e. individuals must pair by chance)
4. The population must be large so that no genetic drift (random chance) can cause the allele frequencies to change.
5. No selection can occur so that certain alleles are not selected for, or against.

Obviously, the Hardy-Weinberg equilibrium cannot exist in real life. Some or all of these types of forces all act on living populations at various times and evolution at some level occurs in all living organisms. The Hardy-Weinberg formulas allow us to detect some allele frequencies that change from generation to generation, thus allowing a simplified method of determining that evolution is occurring. There are two formulas that must be memorized:

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

and

$$p + q = 1$$

p = frequency of the dominant allele in the population

q = frequency of the recessive allele in the population

p^2 = percentage of homozygous dominant individuals

q^2 = percentage of homozygous recessive individuals

$2pq$ = percentage of heterozygous individuals

If mating is random, then new individuals will have $\text{freq}(\text{AA}) = p^2$ for the **AA** homozygotes in the population, $\text{freq}(\text{aa}) = q^2$ for the **aa** homozygotes, and $\text{freq}(\text{Aa}) = 2pq$ for the heterozygotes.

The Hardy–Weinberg principle may be applied in two ways, either a population is assumed to be in Hardy–Weinberg proportions, in which the genotype frequencies can be calculated, or if the genotype frequencies of all three genotypes are known, they can be tested for deviations that are statistically significant.

Answer the following questions below.

1. You have sampled a population in which you know that the percentage of the homozygous recessive genotype (aa) is 36%. Using that 36%, calculate the following:
 - a. The frequency of the "aa" genotype.
 - b. The frequency of the "a" allele.
 - c. The frequency of the "A" allele.
 - d. The frequencies of the genotypes "AA" and "Aa."
 - e. The frequencies of the two possible phenotypes if "A" is completely dominant over "a."
2. There are 100 students in a class. Ninety-six did well in the course whereas four blew it totally and received a grade of F. Sorry. In the highly unlikely event that these traits are genetic rather than environmental, if these traits involve dominant and recessive alleles, and if the four (4%) represent the frequency of the homozygous recessive condition, please calculate the following:
 - a. The frequency of the recessive allele.
 - b. The frequency of the dominant allele.
 - c. The frequency of heterozygous individuals.
3. After graduation, you and 19 of your closest friends (let's say 10 males and 10 females) charter a plane to go on a round-the-world tour. Unfortunately, you all crash land (safely) on a deserted island. No one finds you and you start a new population totally isolated from the rest of the world. Two of your friends carry (i.e. are heterozygous for) the recessive cystic fibrosis allele (c). Assuming that the frequency of this allele does not change as the population grows, what will be the incidence of cystic fibrosis on your island?
4. The ability to taste PTC is due to a single dominate allele "T". You sampled 215 individuals in biology, and determined that 150 could detect the bitter taste of PTC and 65 could not. Calculate all of the potential frequencies.