

## Hardy-Weinberg Problem Set

The Hardy-Weinberg Theorem basically states that if no evolution is occurring, then the allele frequencies will remain in equilibrium in each succeeding generation of sexually reproducing individuals. 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.

To estimate the frequency of alleles in a population, we can use the Hardy-Weinberg equation. According to this equation:

$p$  = the frequency of the dominant allele

$q$  = the frequency of the recessive allele

For a population in genetic equilibrium:

$$p + q = 1.0 \text{ (The sum of the frequencies of both alleles is 100\%.)}$$

And,

$$(p + q)^2 = 1$$

So,

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

The three terms of this binomial expansion indicate the frequencies of the three genotypes:

$$p^2 = \text{frequency of AA (homozygous dominant)}$$

$$2pq = \text{frequency of Aa (heterozygous)}$$

$$q^2 = \text{frequency of aa (homozygous recessive)}$$

Notice that allele frequencies are represented by  $p$  and by  $q$ , whereas genotype frequencies of individuals are represented by  $p^2$ ,  $2pq$  and  $q^2$ .

Answer the following questions using the Hardy-Weinberg equation. Be sure to express the relative frequencies as decimals (i.e., 0.16) and percentages as percentages (i.e., 16%)

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 "a" allele: \_\_\_\_\_

b. The frequency of the "A" allele: \_\_\_\_\_

c. The frequency of the "aa" genotype: \_\_\_\_\_

d. The frequency of the "AA" genotype: \_\_\_\_\_

e. The frequency of the "Aa" genotype: \_\_\_\_\_

2. Within a population of butterflies, the color brown (B) is dominant over the color white (b) and 40% of all butterflies are white. Given this simple information, calculate the following:

- a. The frequency of recessive allele: \_\_\_\_\_
- b. The frequency of the dominant allele: \_\_\_\_\_
- c. The percentage of the "Bb" genotype: \_\_\_\_\_

3. In a population of fruit flies, 250 are homozygous dominant for red eyes and 500 are heterozygous for red eye. The remaining 250 flies have white eyes. Given this information, calculate the following:

- a. The frequency of the recessive allele: \_\_\_\_\_
- b. The frequency of the dominant allele: \_\_\_\_\_

4. Brown fur is dominant to white fur in mice. In a population of mice, 64% have brown fur and 36% have white fur. Based on these facts, calculate the following:

- a. The frequency of the dominant allele: \_\_\_\_\_
- b. The frequency of the recessive allele: \_\_\_\_\_
- c. The percentage of mice that are homozygous dominant: \_\_\_\_\_
- d. The percentage of mice that are heterozygous: \_\_\_\_\_
- e. The percentage of mice that are homozygous recessive: \_\_\_\_\_

5. In humans, tongue rolling is dominant to non-rolling. In a population of 1000 individuals, 910 can roll their tongues while 90 cannot. Based on these facts, calculate the following:

- a. The frequency of the dominant allele: \_\_\_\_\_
- b. The frequency of the recessive allele: \_\_\_\_\_
- c. The percentage of the population that is homozygous dominant: \_\_\_\_\_
- d. The percentage of the population that is heterozygous: \_\_\_\_\_
- e. The percentage of the population that is homozygous recessive: \_\_\_\_\_

6. Approximately 1% of a given human population is lactose intolerant, a recessive condition. Based on this simple fact, calculate the following:

- a. The frequency of the dominant allele: \_\_\_\_\_
- b. The frequency of the recessive allele: \_\_\_\_\_
- c. The percentage of the population that is homozygous dominant: \_\_\_\_\_
- d. The percentage of the population that is heterozygous: \_\_\_\_\_
- e. The percentage of the population that is homozygous recessive: \_\_\_\_\_