KEY

AP Biology Hardy-Weinberg Practice Problems

1. If 98 out of 200 individuals in a population express the recessive phenotype, what percent of the population would you predict would be heterozygotes?

(a) I have given you information on the frequency of the homozygous recessive (or q*2*). So start by determining q*2* and then solving for q.

$\frac{98}{200} = 0.49 = q^2 \rightarrow q = 0.7$

(b) Now that you have q, you can solve for p. Remember there are only two alleles in the population, so if you add the frequency of the two alleles, you have accounted for all possibilities and it must equal 1. So p + q = 1.

$p + 0.7 = 1, \quad p = 0.3$

(c) Now what is the formula for heterozygotes? Think back to the Hardy-Weinberg equation -- it is dealing with the genotypes of individuals in the population.

$2pq = 2(0.7)(0.3) = 0.42 = 2pq$

(d) Now that you have figured out the % of heterozygotes, can you figure out the % of homozygous dominant? Does the % of homozygous dominant, heterozygotes and homozygous recessive individuals add up to 100%? If not, you have made an error. Those are the only three genotypes possible with only two alleles and a simple dominant and recessive relationship.

$0.3 = p$

$p^2 = 0.3^2$

$p^2 = 0.09$

→ All add up to 1

$0.09 + 0.42 + 0.49 = 1$

2. Your original population of 200 was hit by a tidal wave and 100 organisms were wiped out, leaving 36 homozygous recessive out of the 100 survivors. If we assume that all individuals were equally likely to be wiped out, how did the tidal wave affect the predicted frequencies of the alleles in the population? NOTE: assume the new population is at equilibrium -- AFTER the event - so you are comparing two populations what are at equilibrium to look for changes in allele frequencies.

Again, start with the frequency you know -- homozygous recessive. Follow the same step-by-step procedure as above.

What is the frequency of homozygous recessive?

$\frac{36}{100} = 0.36 = q^2$

What is the predicted frequency of homozygous dominant?

$q^2 = 0.36$

$q = 0.6$

$p = 0.4 \rightsquigarrow p^2 = 0.42 \rightsquigarrow \boxed{0.16 = p^2}$

What is the predicted frequency of heterozygotes?

$2pq \rightarrow 2(0.4)(0.6) = \boxed{0.48 = 2pq}$

3. Let's say that brown fur coloring is dominant to gray fur coloring in mice. If you have 168 brown mice in a population of 200 mice.....

What is the predicted frequency of homozygous recessive?

$\frac{32}{200} = \boxed{0.16 = q^2}$

What is the predicted frequency of homozygous dominant?

$0.16 = q^2$

$0.4 = q$

$p = 0.6$

$\boxed{p^2 = 0.36}$

What is the predicted frequency of heterozygotes?

$2(0.6)(0.4)$

$\boxed{0.48 = 2pq}$

4. ***If 81% of a population is homozygous recessive for a given trait… find out the frequencies of each of the genotypes in the population.***

$\boxed{0.81 = q^2}$

$0.9 = q$

$p = 0.1$

$2(0.1)(0.9) = \boxed{0.18 = 2pq}$

$p^2 = 0.1^2$

$\boxed{p^2 = 0.01}$

5. ***If 51% of the population carries at least one copy of the recessive allele.....***

What is the predicted frequency of individuals in the population that express the dominant phenotype? What is the predicted frequency of individuals in the population that express the recessive phenotype?

$p^2 = 0.49$

$p = 0.7$

$p+q=1$

$q = 0.3 \rightsquigarrow$ $q^2 = 0.09$

~~$2(0.7)(0.3) = 0.42$~~

6. While monitoring a flock of 912 sandhill cranes, researchers noticed that 95 of the cranes had white tail feathers, a recessive trait, and the remaining had red tail feathers. What is the frequency of the dominant allele? How many cranes are homozygous dominant? How many cranes are heterozygous?

912

$95/912 = 0.104 = q^2$

$q = 0.3224903$

$p = 0.68$

$912 \times 0.46 =$ 420 cranes are homozygous dominant

$0.46 = p^2$

$0.4\cancel{4} = 2pq$

0.435

$912 \times 0.4\cancel{4} =$ ~~400~~ 397 ~~3000~~ cranes are heterozygous

7. While trudging through the deep grassland of South Dakota, scientists encountered a rare species of black-crowned prairie chicken. Occasionally a recessive trait results in a yellow crown. In this population of 183 chickens, 135 individuals had black crowns and the rest had yellow crowns. What is the frequency of the recessive allele in the population? How many black-crowned chickens carry the recessive allele? What is the frequency of the dominant allele?

$183 - 135 = 48$ yellow-crowned prairie chickens (recessive phenotype)

$q^2 = \frac{48}{183} = 0.26$

$q = 0.51$

$p = 0.49$

$2pq = 2(0.51)(0.49) = 0.50$

91 black-crowned chickens carry the recessive allele

8. A horticulturalist is raising purple-flowered and white-flowered geraniums in a greenhouse. The allele that produces purple flowers is dominant. There are 922 plants in the greenhouse and 22% of them have white flowers. What is the frequency of the dominant allele in the population? How many purple-flowered plants are heterozygous at the gene locus for flower color? If this population is in Hardy-Weinberg equilibrium, what do we expect the frequency of heterozygotes to be in five years time?

922 plants total

$922 \times 0.22 = 204$ recessive plants

$0.22 = q^2$

$0.47 = q$

$0.53 = p$

$p^2 = 0.28$

$2(0.53)(0.47)$

$0.50 = 2pq$

expect this to be consistent after 5 years time if population is in H-W equilibrium

$.5 \times 922 =$ 461 purple-flowered plants are heterozygous

9. 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.

$q^2 = \frac{65}{215} = 0.302 = q^2$

$q = 0.55$

$p = 0.45$

$p^2 = 0.20$

$2(0.55)(0.45) = 0.50$

10. What are the five requirements for a population to be in equilibrium and meet the Hardy-Weinberg principle?

- No natural selection
- Large population size
- No sexual selection (non-random mating)
- No mutation
- No gene flow