Part III: Hardy-Weinberg Problems

Remember:

p = dominant allele / q = recessive allele

p^2 = homozygous dominant individuals

2pq = heterozygous individuals

q^2 = homozygous recessive individuals

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

$$p + q = 1$$

1. *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 then . . . .*

a. What is the predicted frequency of heterozygotes? **$2pq = 2(0.6)(0.4) = 0.48$**

b. What is the predicted frequency of homozygous dominant? **$p^2 = (0.6)^2 = 0.36$**

c. What is the predicted frequency of homozygous recessive **$q^2 = (0.4)^2 = 0.16$**

$q = 0.4$ **$p = 0.6$**

2. The allele for the hair pattern called "widow's peak" is dominant over the allele for no "widow's peak". In a population of 1,000 individuals, 510 show the dominant phenotype. How many individuals would you expect of each of the possible three genotypes for this trait?

$q = 0.7$ **$p = 0.3$**

Homozygous Dominant: **$p^2 = (0.3)^2 = 0.09 \times 100 = 90$ individuals**

Heterozygous: **$2pq = 2(0.3)(0.7) = 0.42 \times 100 = 420$ individuals**

HomozygousRecessive: **$q^2 = (0.7)^2 = 0.49 \times 100 = 490$ individuals**

3. In the United States about 16% of the population is Rh negative. The allele for Rh negative is recessive to the allele for Rh positive. If the student population of a high school in the U.S. is 2,000, how many students would you expect for each of these three possible genotypes?

$q = 0.4$ **$p = 0.6$**

Homozygous Dominant: $p^2 = (0.6)^2 = 0.36 \times 2000 = 720$ individuals

Heterozygous: $2pq = 2(0.6)(0.4) = 0.48 \times 2000 = 960$ individuals

HomozygousRecessive: $q^2 = (0.4)^2 = 0.16 \times 2000 = 320$ individuals

4. In certain African countries 4% of the newborn babies have sickle cell anemia, which is a recessive trait. Out of a random population of 1,000 newborn babies, how many would you expect for each of the three possible genotypes?

q = 0.2 **p = 0.8** **Homozygous Dominant: $p^2 = (0.8)^2 = 0.64 \times 1000 = 640$ individuals**

Heterozygous: $2pq = 2(0.8)(0.2) = 0.32 \times 1000 = 320$ individuals

HomozygousRecessive: $q^2 = (0.2)^2 = 0.04 \times 1000 = 40$ individuals

5. In a certain population, the dominant phenotype of a certain trait occurs 91% of the time. What is the frequency of the dominant allele?

p = 0.7

6. A very large population of randomly-mating laboratory mice contains 25% white mice. White coloring is caused by the double recessive genotype, "aa". Calculate allelic and genotypic frequencies for this population.

Allelic Frequencies

q = 0.5 **p = 0.5**

Genotypic Frequencies

Homozygous Dominant: $p^2 = (0.5)^2 = 0.25$

Heterozygous: $2pq = 2(0.5)(0.5) = 0.50$

HomozygousRecessive: $q^2 = (0.5)^2 = 0.25$

7. In Drosophila (fruit fly), the allele for normal wing length is dominant over the allele for short wings. In a population of 1000 individuals, 360 show the recessive phenotype. How many individuals would you expect to be homozygous dominant for the trait.

q = 0.6 **p = 0.4** **Homozygous Dominant: $p^2 = (0.4)^2 = 0.16 \times 1000 = 160$ individuals**

8. The allele for a widow's peak (hairline) is dominant over the allele for a straight hairline. In a population of 500 individuals, 9% show the recessive phenotype. How many individuals would you expect to be homozyous dominant and heterozygous for the trait?

q = 0.3 **p = 0.7** **Homozygous Dominant: $p^2 = (0.7)^2 = 0.49 \times 500 = 245$ individuals**

Heterozygous: $2pq = 2(0.7)(0.3) = 0.42 \times 500 = 210$ individuals

9. In a given population, only the "A" and "B" alleles are present in the ABO system; there are no individuals with type "O" blood or with O alleles in this particular population. If 200 people have type A blood, 75 have type AB blood, and 25 have type B blood, what are the alleleic frequencies of this population?

		Frequency of A allele	Frequency of B allele
200	**AA - Homozygous**	**(200 x 2) + (75 x 1)**	**(25 x 2) + (75 x 1)**
75	**AB – Heterozygous**	**600**	**600**
+25	**BB - Homozygous**		
300		**475**	**125**
x 2		**600**	**600**
600 alleles			
		0.792 = 0.8	**0.208 = 0.2**

10. In Mr. Collea's AP Biology class at North Salem High School, ____ members of the class have free earlobes. Free earlobes are controlled by the dominant gene "F" and attached earlobes are controlled by the recessive gene "f." Determine the **allelic frequencies** (p and q) along with the **number of individuals** you would expect to have each of the possible three genotypes for this trait?

	Phenotypes				**Allele Frequency Based on the H-W Equation**	
	Free Earlobes (p2 + 2pq)		**Attached Earlobes** (q2)		**p**	**q**
Class Population	#	%	#	%		
North American Population	0.45		0.55			

Free Earlobes **Attached Earlobes**