

### Population Genetics Homework

**Be sure to show your work** (i.e. set up each problem with the equation and then inserting the numbers into the equation to show how you calculated your answers; you don't need to show the longhand math). **You will not get full credit if you just have an answer without the work.** You must staple your assignment before turning it in (there is no stapler in the classroom).

1. The *Secretor* gene is an obscure human blood group with two alleles, *S* and *s*. In one group of 1600 persons, there were the following genotypes:

$$SS = 425$$

$$Ss = 800$$

$$ss = 375$$

- A. Calculate the allele frequencies of this population:

$$\text{freq}(S) = p = \underline{\hspace{4cm}}$$

$$\text{freq}(s) = q = \underline{\hspace{4cm}}$$

- B. Calculate the *expected* genotype frequencies if the population is at Hardy-Weinberg equilibrium:

$$\text{freq}(SS): \underline{\hspace{4cm}}$$

$$\text{freq}(Ss): \underline{\hspace{4cm}}$$

$$\text{freq}(ss): \underline{\hspace{4cm}}$$

- C. Calculate the *expected number* of each genotype for the total population size of 1600 by multiplying the frequency of each by the total population size.

$$\# \text{ of } SS \text{ individuals: } \underline{\hspace{4cm}}$$

$$\# \text{ of } Ss \text{ individuals: } \underline{\hspace{4cm}}$$

$$\# \text{ of } ss \text{ individuals: } \underline{\hspace{4cm}}$$

- D. Using the Chi-square test, determine if this population is at Hardy-Weinberg equilibrium for the *Secretor* gene. Use the critical value for a probability of 0.05 and 1 degree of freedom, which is 3.841. If you need more room, show your calculations on the back of this sheet.

2. A large artificial population is established in which **all** individuals are heterozygous for a gene with two alleles, **Aa** (i.e., the genotype frequencies are:  $\text{freq}(\mathbf{AA}) = 0$ ,  $\text{freq}(\mathbf{Aa})=1$ ,  $\text{freq}(\mathbf{aa}) = 0$ ). If these individuals are allowed to mate at random without selection or mutation, how many generations of such reproduction are required for the genotype frequencies to reach Hardy-Weinberg equilibrium?
  
3. In a population of flowers that are capable of self-fertilization, the following genotypes are present at the indicated frequencies:  
 $\text{freq}(\mathbf{AA}) = 0.40$   
 $\text{freq}(\mathbf{Aa}) = 0.45$   
 $\text{freq}(\mathbf{aa}) = 0.15$   
What will the genotype and allele frequencies be after one generation of complete self-fertilization?
  
4. What would be the heterozygosity of a population with an expected Hardy-Weinberg heterozygosity of 0.5 and an inbreeding coefficient,  $F$ , of 0.25?
  
5. A population is polymorphic for a gene with two alleles, **R** and **r**, with allele frequencies of  $p = 0.6$  and  $q = 0.4$ , respectively. The frequency of the heterozygous genotype, **Rr**, is 0.25. Assuming there is no selection or migration, determine the inbreeding coefficient,  $F$ , for this population.

6. The following table presents data on both the genotype numbers and the rate of survival to reproductive age for those genotypes for a population.

A. Complete the table by calculating the number of individuals of each genotype that are expected to contribute to the next generation. Calculate the relative fitness by dividing the survival rate of each genotype by the survival rate of the most fit phenotype.

Genotype	Number of individuals	Survival (%)	# Surviving to reproductive age	Relative Fitness ( $w$ )
<b><i>BB</i></b>	250	75%		
<b><i>Bb</i></b>	200	85%		
<b><i>bb</i></b>	150	10%		

B. Calculate the allele frequencies of this population *before selection* (i.e., use the given numbers):

$$\text{freq}(\mathbf{B}) = p = \underline{\hspace{10em}}$$

$$\text{freq}(\mathbf{b}) = q = \underline{\hspace{10em}}$$

C. Calculate the allele frequencies of this population *after selection* (i.e., use the calculated numbers):

$$\text{freq}(\mathbf{B}) = p = \underline{\hspace{10em}}$$

$$\text{freq}(\mathbf{b}) = q = \underline{\hspace{10em}}$$

D. Is this population at Hardy-Weinberg equilibrium? Explain why or why not.

E. If this population continues to experience this type of selection, do you expect the ***B*** allele, the ***b*** allele or neither allele to disappear from the population over time?

7. Calculate the expected change in allele frequency ( $\Delta p$ ) for a population in which  $p = 0.5$  and the genotypes have the following fitnesses:

Genotype:	<b><i>DD</i></b>	<b><i>Dd</i></b>	<b><i>dd</i></b>
Fitness ( $w$ ):	1	1	0.6

8. Determine the expected equilibrium frequency ( $\hat{q}$ ) for a recessive allele (***a***) if the mutation rate for ***A***  $\rightarrow$  ***a*** is 1 per 100,000 copies of allele ***A*** and the selection coefficient is 0.50.