

**Genetics 320, Problem Set 9 (15 points)**

**Due Wes. November 26 2003 at 11 am**

**1 (2 points):** Consider a locus with four alleles ( $A_1$  to  $A_4$ ) at the following frequencies:  $p_1 = 0.1$ ,  $p_2 = 0.2$ ,  $p_3 = 0.3$ ,  $p_4 = 0.4$ . Assume random mating and all other Hardy-Weinberg conditions. What is the frequency of

- (a)  $A_2A_3$ ?
- (b)  $A_4A_4$ ?
- (c) All heterozygotes involving allele  $A_2$ ?
- (d) All heterozygotes?
- (e) Of a mating between  $A_1A_2$  and  $A_3A_3$  parents.

**2 (2 points):** Let  $p(0) = \text{freq}(A)$  in the initial generation (which we call generation 0). Assuming Hardy-Weinberg conditions:

- (a) What is the frequency of  $AA$  homozygotes in the next generation (generation 1)?
- (b) What is the frequency of heterozygotes involving  $A$  in generation 1?
- (b) Given these genotype frequencies, show that  $p(1) = \text{freq}(A \text{ in generation 1}) = p(0)$ .

**3 (2 points):** This problem examines what happens when there are different allele frequencies in the two sexes (as would occur if one mates males from one population with females from a second). Assume an autosomal locus, where the frequency of allele  $A$  in the male and female founding populations is  $p$  and  $r$ , respectively. Assuming all other Hardy-Weinberg conditions hold,

- (a) What is the frequency of  $AA$  homozygotes in their offspring?
- (b) What is the frequency of  $A-$  heterozygotes?
- (c) What is the frequency of allele  $A$  in their male offspring? In their female offspring?
- (a) What happens to the allele and genotype frequencies in subsequent generations?

**4 (2 points):** Now consider what happens when the two sexes show different frequencies for an  $X$ -linked gene. Let the frequency of allele  $A$  (on an  $X$ -linked locus) be 0.25 in males and 0.8 in females in the founding population (generation 0). Assuming all other Hardy-Weinberg conditions hold,

- (a) What is the frequency of  $AA$  homozygotes in their female offspring in generation 1?
- (b) What is the frequency of  $A-$  heterozygotes in their female offspring in generation 1?
- (c) What is the frequency of  $AY$  hemizygotes in their male offspring in generation 1?
- (d) What are the frequencies of  $AA$  homozygotes,  $A-$  heterozygotes (in females), and  $AY$  hemizygotes in generation 2?

**5 (2 points):** Consider the  $M/N$ ,  $S/s$  blood group data from the Ugandan population in the Table in lecture 42. Suppose the recombination frequency between these two loci is  $c = 0.05$ .

- (a) If these gametes combine at random, what is the frequency of  $MM$  individuals? Of  $Ss$  individuals? Of  $MMSs$  individuals?
- (b) For these gamete frequencies, what is the disequilibrium (if any) for  $MS$  gametes? For  $Ms$  gametes?
- (c) After ten generations of random mating, what is the expected disequilibrium for  $MS$  gametes? For  $Ms$  gametes?

- (c) After ten generations of random mating, what is the expected frequency of *MMSs* individuals?

**6 (2.5 points):** Geneticists in Finland have isolated a genetic locus which gives the dreaded *dential* phenotype, in which individuals enjoy drilling in other people's mouths. Two linked marker loci have been isolated, and the following haplotype frequencies are seen for normal and *dential* chromosomes:

Marker haplotype	Chromosome type	
	<i>Dential</i>	Normal
$M_1N_1$	0.860	0.120
$M_1N_2$	0.044	0.280
$M_2N_1$	0.091	0.180
$M_2N_2$	0.005	0.420

- (a) What was the haplotype on which the original *dential* mutant arose?  
 (b) Assuming 100 generations, what is the *dential* - *M* recombination frequency? The *dential* - *N* recombination frequency?  
 (c) What does the resulting genetic map look like?

**7 (1.25 points):** Suppose a population shows inbreeding, with inbreeding coefficient  $F = 3/4$ . In this population, the frequency of a recessive disease allele  $d$  is  $10^{-3}$ .

- (a) What is the expected frequency of diseased individuals ( $dd$ ) in this population?  
 (b) What would the frequency of  $dd$  individuals be if this population was undergoing random mating?  
 (c) What is the increased disease risk due to inbreeding?

**8 (1.25 points):** Recall under genetic drift that the time back to common ancestry for two random sequences follows a geometric distribution (relevant formulae can be found in Lecture 43).

- (a) For a population of size  $N = 100$ , what is the probability that two random sequences will have a common ancestor no older than 100 generations ago? 1000 generations?  
 (b) For a population of size  $N = 1000$ , what are probabilities for 100 and 1000 generations?