BIOL 403 EVOLUTION Exam 2 Spring 08

1 (12 pts). List four assumptions of the Random Mating (Hardy-Weinberg) Model. For each assumption, give an example of an evolutionary model developed in lecture which relaxes or removes this assumption.

2. (4 pts) The Hardy-Weinberg model does not allow evolution (of allele frequency). What good is a population genetic model without evolution? List one application of the H-W model.

3. (8 pts) Given the following (human) genotype frequencies for a genetic polymorphism affecting resistance to HIV infection, is there significant evidence for deviation of genotype frequencies from random mating expectations? Show your work.

	Genotype		
	+/+	+/Δ32	Δ32 /Δ32
# Obs'd	80	20	0

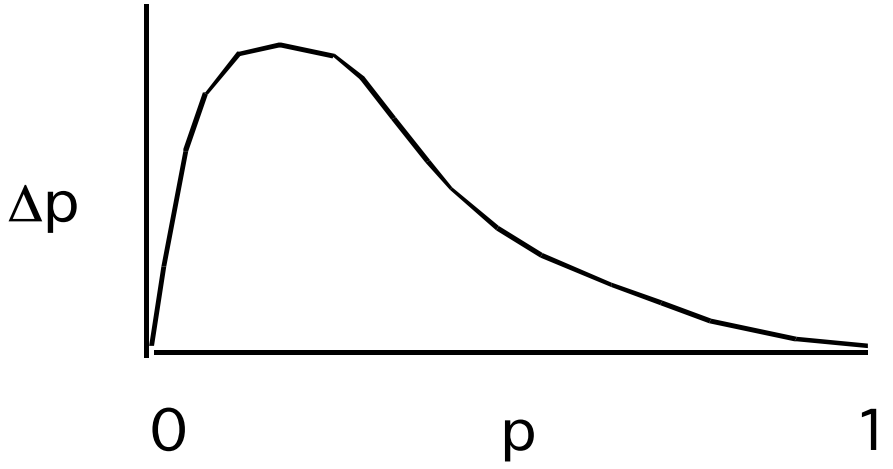
4. (4 pts) Does this example resemble any real world population in terms of genetic variation for the Δ32 allele? If so, which one?

5. (4 pts) For genotypes with the following fitnesses and frequencies at birth

Genotype	A_1A_1	A_1A_2	A_2A_2
Birth Freq'cy	p^2	$2pq$	q^2
Fitness	1	1	$1-s$

Write down an expression for the frequency of the A_1 allele after selection:

6. (4 pts) The plot below depicts the rate of progress of directional selection for a dominant favored allele with frequency p, as a function of the allele frequency. Explain the leftward skew of the plot.



7. (4 pts) Assuming overdominant selection where the fitnesses of the three genotypes A_1A_1, A_1A_2 and A_2A_2 are 0.8, 1 and 0.2 respectively, calculate the average fitness of the population when $p = f(A_1) = 0.8$.

8. (4 pts) Refer to the preceding problem. For $p = f(A_1) = 0.8$, calculate the average excess of the A_1 allele in this case as $p\,w_{11} + q\,w_{12} - \bar{w}$ (where $\bar{w}$ is the average fitness of the population). Explain your result; what is the utility of this equation?

9. (4 pts) The maintenance of the HbA/HbS polymorphism is due to overdominant selection for resistance to malaria. The HbC allele provides superior protection against malaria in the homozygous state. Nevertheless, the HbC allele is rare in populations in which the HbS allele is common. Conversely, in other populations the HbC allele is common when the HbS is rare. Assuming that these observations represent evolutionary equilibria, explain both observations.

10. (6 pts) List three evolutionary forces other than selection, and characterize each one as strong or weak, in terms of its potential to change allele frequencies.

11. (6 pts) Cystic fibrosis is an example of a recessive genetic disease in humans whose frequency was not found to be consistent with selection-mutation balance. List the (three) pieces of information needed to make this assessment.

12. (6 pts) Recall our discussion of gene flow between racial groups in Claxton, Georgia. Draw a picture of the island model of migration. Why was the use of the island model of migration appropriate in this case?

13. (4 pts) Migration is sometimes referred to as the glue that holds species together. Why?

14. (4 pts) For a population containing 100 individuals where the frequency of two alternative alleles A_1 vs. A_2 is p =q = 1/2, describe the most likely state(s) of the population after 1000 generations when genetic drift is the only evolutionary force acting.

15. (6 pts) Explain why we think genetic drift accounts for the prevalence of Achromatopsia in Pingelap Islanders. Why don't we think selection is important? Why not mutation?

16. (4 pts) What (if anything) does the Neutral Theory assume about the relative prevalence of advantageous, disadvantageous and neutral mutations?

17. (4 pts) What is the most likely explanation for the observation of a dN/dS ratio close to 1 for a gene coding sequence (not a pseudogene)?

18. (4 pts) According to the Nearly Neutral Theory, would a large or small population be expected to show a higher rate of substitution *per generation* (assume the absence of positive selection)? Why?

19. (4 pts) A generalization emerging from the Nearly Neutral Theory is that small populations evolve (largely) by drift, whereas large populations evolve (largely) by selection. Provide a real world piece of evidence suggesting that genetic drift has been an important factor in the evolution of the human genome.