Genetics 320, Problem Set Ten

Due Wednesay 10 December 2003 at 11 am

1 (1 point): Recall that the number of mutations follows a Poisson distribution. For a population of size $N = 10^5$ and a mutation rate of $u = 10^{-6}$,

(a) What is the probability that a random individual is a heterozygote?

(b) Assuming that the common ancestor to two random sequences occurs $2N$ generations ago, what is the probability that two randomly-chosen sequences differ by one mutation? By two mutations? By five mutations?

2 (2 points): In an infinite population, what happens for each of the following fitnesses

(a) $W_{AA} = 1$, $W_{Aa} = 1.001$, $W_{aa} = 1.002$

(b) $W_{AA} = 0.95$, $W_{Aa} = 0.94$, $W_{aa} = 0.85$

(c) $W_{AA} = 1$, $W_{Aa} = 1$, $W_{aa} = 0.75$

(d) $W_{AA} = 1$, $W_{Aa} = 0.75$, $W_{aa} = 0.75$

(e) $W_{AA} = W_{Aa} = W_{aa}$

3 (2 points): Suppose we sample 1000 individuals and the number of offspring they leave. Focusing on a specific diallelic locus, we find the following:

Genotypes:	AA	Aa	aa
Numbers observed	160	480	360
Average number of offspring:	10.5	12.0	12.5

(a) Setting $W_{aa} = 1$, what are the relative fitnesses of the three genotypes?

(b) What is the change in the frequency of allele A after one generation of selection?

4 (2 points): Suppose the fitnesses at a locus are $W_{AA} = 1 - s$, $W_{Aa} = 1$, and $W_{aa} = 1 - t$. For freq(A) $= t/(s + t)$, show that

(a) $W_A = W_a = \overline{W}$.

(b) Showing that the change in freq(A) = the change in freq(a) = 0.

5 (2 points): Consider a locus with five alleles. Two populations are considered, with the following allele frequencies and marginal fitnesses:

Population one

Allele:	A_1	A_2	A_3	A_4	A_5
Frequency:	0.1	0.2	0.5	0.1	0.1
Marginal fitness:	3.5	1.2	4.0	3.3	6.2

Population Two

Allele:	A_1	A_2	A_3	A_4	A_5
Frequency:	0.2	0.1	0.1	0.3	0.3
Marginal fitness:	1.5	2.5	2.0	4.5	2.4

Compute the change in the frequency of allele A_3 in both populations.

6 (1 point): Individuals homozygous for the sickle-cell allele (ss) die before reproducing. However, normal/sickle heterozygotes (Ss) have greater fitness that normal homozygotes (SS) due to increased resistance to marlia. If the frequency of s in equilibrium populations is 0.2, what is the fitness advantage of Ss relative to SS individuals?