

Genetics 320, Problem Set 10

Due Wednesday 7 December 2004 at 11 am

- 1 (2 point):** Consider a population of size $N = 10^5$ and a mutation rate of $u = 10^{-6}$,
- Assuming the Infinite alleles model, what is the probability that a random individual is a heterozygote?
 - Recall that the number of mutations follows a Poisson distribution (See Problem 7 of PS 1). 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?
 - What is the probability for this population size that two randomly-chosen alleles have their most recent common ancestor in the last 10,000 generations? 25,000 generations? 50,000 generations?

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

- $W_{AA} = 1, W_{Aa} = 1.001, W_{aa} = 1.002$
- $W_{AA} = 0.95, W_{Aa} = 0.94, W_{aa} = 0.85$
- $W_{AA} = 1, W_{Aa} = 1, W_{aa} = 0.75$
- $W_{AA} = 1, W_{Aa} = 0.75, W_{aa} = 0.75$
- $W_{AA} = W_{Aa} = W_{aa}$

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:	<i>AA</i>	<i>Aa</i>	<i>aa</i>
Numbers observed	160	480	360
Average number of offspring:	10.5	12.0	12.5

- Setting $W_{aa} = 1$, what are the relative fitnesses of the three genotypes?
- 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 $\text{freq}(A) = t/(s + t)$, show that

- $W_A = W_a = \bar{W}$.
- Showing that the change in $\text{freq}(A) = \text{the change in } \text{freq}(a) = 0$.

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 than normal homozygotes (SS) due to increased resistance to malaria. If the frequency of s in equilibrium populations is 0.2, what is the fitness advantage of Ss relative to SS individuals?