Population Genetics
Problem set 4

1. Assume that the fitnesses are 0.8 for A_1A_1, 1.0 for A_1A_2, and 0.4 for A_2A_2.

   a) Calculate the mean fitness if the allele frequency of A_2 was 0.3.

Answer: $\bar{w} = (.7)^2(.8) + 2(.7)(.3)(1) + (.3)^2(.4)$

$= .392 + .42 + .036 = .848$

   b) What is the expected equilibrium frequency of A_2 if these fitness values continue?

Answer: $q_e = \frac{S_1}{S_1 + S_2} = \frac{.2}{.2+.6} = .25$

2. Five alleles (A_1, A_2, A_3, A_4, and A_5) at a single locus (A) have been identified on a plant that prevents self-fertilization by self-incompatibility. If the A locus is at equilibrium, what is the expected allele frequency of A_3?

Answer: $q_{eA3} = 1/(\text{n alleles}) = 1/5 = .2$

3. Assume that the initial and final allele frequencies before and after selection are 0.2 and 0.1.

   a) How many generations does it take for this amount of change when there is a recessive lethal?

Answer: $t = 1/.1 - 1/.2 = 10 - 5 = 5$ generations

   b) How many generations does it take for this amount of change when selection is against a recessive with selection coefficient equal 0.4?

Answer: $t = \frac{1}{S}\left(\frac{q_0 - q_t}{q_0 q_t} + ln\ \frac{q_0(1-q_t)}{q_t(1-q_0)}\right)$

$= \frac{1}{.4}\left(5 + ln\ \frac{.2(1-.1)}{.1(1-.2)}\right)$

$= 2.5\left(5 + ln\ \frac{.18}{.08}\right) = 2.5[5 + ln\ 2.25]$

$= 2.5[5.81093] = 14.527 \sim 14.5$ generations