Genome 562 Population Genetics
Winter, 2017 J. Felsenstein

Homework 2
due Thursday January 19, 2017

Do these problems, and email the results (if you can, in a PDF or else in Word .DOC or .DOCX format). Like all of the weekly homeworks this one totals 25 points and is due at the end of that day (at midnight).

This one is more algebra. Nevertheless it is not as hard as it may look.

1. (12 points) A sex-linked locus has two alleles, A and a. The aa genotype is lethal in females, as is the aY genotype in males. The a allele is completely recessive, so that The AA and Aa genotypes have equal fitnesses in females. We want to know how gene frequencies will change as a result of this natural selection. Consider adults who have survived the natural selection, and suppose that in females the gene frequency of A in the gametes that they produce is p_f.

   (i) What are the genotype frequencies in males and females, before selection, in the offspring?

   (ii) What is the gene frequency in the females after selection?

   (iii) What is the gene frequency in the males after selection? *Yes, this is as easy as it seems.*

   (iv) Does the formula for the change of gene frequencies look simpler if instead you do the calculation for the gene frequency of the allele a instead of A. (Since theose two must add up to 1, this should be an equally valid description of the changes of gene frequencies)

   If you have difficulties with this, try instead some actual genotype frequencies, and calculate the changes in one generation, until you get a feel for how these change. Then you should be able to do it with quantities like p_f.

2. (13 points) Suppose that we have a locus with 3 alleles in a haploid organism, and the three alleles have relative fitnesses 1.5 : 1.2 : 1. If the initial gene frequencies (p_1, p_2, and p_3) are 0.01, 0.1, and 0.89, what will the gene frequencies be after 5, 10, 15, and 20 generations?

   (How to do it.: *Don't* just crank out the frequencies using a computer. Consider the ratio p_1/p_2. Can you derive a formula for how it changes in one generation of selection? You can just work out formulas for p'_1 and for p'_2, and take their ratio, which will show a helpful cancellation. Show the work. From this figure out what happens in 5 generations of selection Do the same for p_2/p_3. That should enable you to get the ratios of gene frequencies in each of those generations. From that, it is easy to work out the gene frequencies. Explain how you did that.)

   Someone argues that for this kind of selection, the gene frequency of each allele should either be continually rising or continually falling, because it will either be favorable or unfavorable. Is that true? Why?