2005 7.03 Problem Set 6

Due before 5 PM on WEDNESDAY, November 23, 2005.
Turn answers in to the box outside of 68-120.
PLEASE WRITE YOUR ANSWERS ON THIS PRINTOUT.

1. Two populations (Population One and Population Two) send a randomly selected group of their inhabitants to settle on a new and previously uninhabited island. Before sending anyone off to the island, both populations are at Hardy-Weinberg Equilibrium for an autosomal recessive trait displayed by individuals with the genotype bb. In Population One, 1 out of 2,000 people express the trait. In Population Two, the frequency of the b allele is 0.1.

(a) What is the allele frequency of the b allele in Population One?

The two populations send off their settlers to the island, where the 100,000 settlers randomly mate. Each couple has two children, and thereby creates a new generation of 100,000 people (500 of whom express the trait).

(b) What is the allele frequency of the b allele in the new merged population on the island?

Answer the next parts assuming that the two populations of settlers have merged on the island and have reached Hardy Weinberg equilibrium.

(c) If you selected a female at random, what would the probability be that she was a carrier?

(d) What proportion of all b alleles are present in carriers?

(e) What fraction of all matings are between parents who are the same genotype as one another?

2. A rare X-linked recessive trait affects 1/5000 males in a certain population.

(a) What is the allele frequency of the allele for the recessive trait?

(b) How many affected men are there for each affected woman?

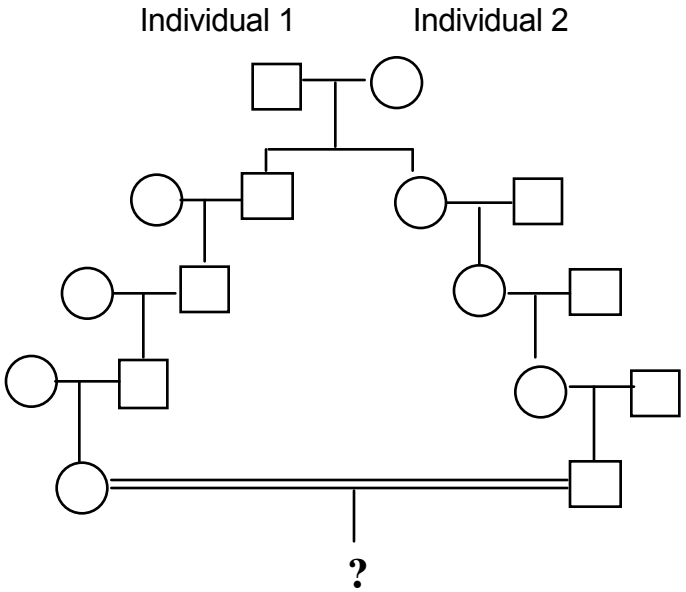
(c) In what proportion of matings would this trait affect half of the children of each sex?

(d) In what proportion of matings would the children have no chance of having the trait?

(e) Now assume that individuals showing the trait have a fitness of 70% as compared to individuals that do not show the trait. There are no other factors affecting the frequency of the trait. By how much would the allele frequency change between the current generation and the next generation?

(f) Now assume that there are new mutations being introduced into the population. The mutation rate at the locus associated with this trait is 10^{-4}. What would the allele frequency of the allele associated with the trait equal when a steady state between mutation and selection is reached?

3. Consider the following pedigree, which illustrates a family in a very large population. The two relatives shown are considering having a child, and if they do, they will be the first example of inbreeding in the entire population.



Assume no new mutations occur, that penetrance is complete, and that selection is negligible. Also assume that all traits are rare.

(a) What is the inbreeding coefficient for this pedigree?

(b) For the child indicated by a question-mark, how many genes on average will he/she be homozygous by descent (i.e. the child has inherited two alleles of a gene, both of which came from the same DNA in one of the great great great grandparents)? (There are about 20,000 genes in the human genome.)

(c) Assume that you do not know the genotypes of the great great great grandparents, but that you do know that neither exhibits an **autosomal recessive** trait with an incidence in the population of 10^{-6}. What is the chance that Individual 2 is a carrier of the allele for the trait, **and** Individual 1 is not a carrier?

(d) For the same trait described in part **(c)**, if Individual 2 is a carrier of the allele for the trait, and Individual 1 is not a carrier (and does not show the trait), what is the chance that the unborn child denoted in the pedigree by a question-mark will have the trait?

(e) Assume that an **autosomal recessive** trait in this population has an incidence of 10^{-6}. Imagine that, in the next generation of the population, every person decides to inbreed with a person of the same degree of relatedness as the two relatives who are mating in the pedigree shown above. What will the frequency of the trait be in the next generation?

(f) Assume that an **autosomal dominant** trait in this population has an incidence of 10^{-6}. Now say that you know that Individual 2 is heterozygous for the allele for the trait, and Individual 1 does not have the trait. What is the chance that the unborn child denoted in the pedigree by a question-mark will have the trait?