

## 7.03 Problem Set 2

Due before 5 PM on Friday, September 29

Hand in answers in recitation section or in the box outside of 68-120

**1.** Hemophilia A is a X-linked recessive disorder characterized by dysfunctional blood clotting, due to a mutation in the gene for the clotting component, Factor VIII.

Jennifer's brother has hemophilia A, but neither Jennifer nor anyone else in her family show symptoms of the disorder.

- a) If Jennifer has a son, what is the probability that he will have hemophilia?
- b) Would this probability be different if Jennifer's husband had hemophilia? Explain.

Imagine that there is a DNA-based marker on the X chromosome that is 5 cM away from the gene for Factor VIII. This marker has two alleles, designated  $x_1$  and  $x_2$ , that can be distinguished by a simple analysis of the DNA in a blood sample. The genotype of Jennifer for this marker is  $x_1/x_2$ , the genotype of her mother is  $x_1/x_2$ , the genotype of her father is  $x_2$ , and the genotype of her brother is  $x_1$ .

- c) Based on this marker data, calculate the probability that Jennifer is a carrier for hemophilia. (Note that a correct answer must take into account the possibility of recombination in Jennifer's mother.)
- d) Say that prenatal blood test reveals that Jennifer has a son that carries marker  $x_1$ . What is the probability that he will have hemophilia?

**2.** The traits controlled by three autosomal *Drosophila* genes are easily distinguishable, since one locus determines body color, one eye color, and the other wing size. Mutants homozygous for recessive alleles of these genes exhibit black body ( $b/b$ ), purple eyes ( $pr/pr$ ), and vestigial wings ( $vg/vg$ ). [Wild-type flies have brown bodies, red eyes, and large wings.]

The gene order is  $Vg-Pr-B$  and the distance between  $Vg$  and  $Pr$  is 13 cM and the distance between  $Pr$  and  $B$  is 7 cM. You cross a fly from a true-breeding line with brown body, red eyes, and large wings to a fly from a true-breeding line with black body, purple eyes, and vestigial wings. The F1 progeny (which have brown bodies, red eyes, and large wings) are then crossed to flies with black body, purple eyes, and vestigial wings. List all of the phenotypic classes that you would expect from this cross and calculate the number of each class expected out of a total of 1000 progeny.

**3.** Consider two unlinked yeast genes,  $His_3$  and  $His_4$ . Each of these genes codes for an enzyme in the histidine biosynthesis pathway and therefore  $His_3^-$  and  $His_4^-$  mutants require histidine for growth (i.e. the mutants are phenotypically  $His^-$ ).

- a) You mate a  $MATa His_3^-$  strain to a  $MAT\alpha His_4^-$  strain to produce heterozygous diploids. If the resulting diploids are  $His^+$  what does this tell you about the  $His_3^-$  and  $His_4^-$  mutations?

- b)** Next you sporulate the diploids to produce 60 tetrads. Describe the types of tetrads you should get (in terms of the ratio His<sup>+</sup>: His<sup>-</sup>) and the expected number among the 60 tetrads.
- c)** Would you expect the result from part (b) to be different if both the His3<sup>-</sup> and His4<sup>-</sup> mutants were dominant? Explain.
- d)** Now you cross a wild type MAT $\alpha$  strain to a MAT $\alpha$  His3<sup>-</sup> His4<sup>-</sup> double mutant. Out of 60 tetrads from this cross, how many of each tetrad type would you expect to get?
- e)** The His4 gene is relatively large. Say that you have a His4-1<sup>-</sup> mutation that is at one end of the gene and a His4-2<sup>-</sup> mutation at the other end of the gene. If the His4-1<sup>-</sup> and His4-2<sup>-</sup> mutations are exactly 1 cM apart, how many of each tetrad type would you expect from a cross of a MAT $\alpha$  His4-1<sup>-</sup> strain with a MAT $\alpha$  His4-2<sup>-</sup> strain (you analyze a total of 50 tetrads)?
- f)** How many of each tetrad type would you expect from a cross of a wild type MAT $\alpha$  His4-1<sup>-</sup> strain with a MAT $\alpha$  His4-1<sup>-</sup> His4-2<sup>-</sup> double mutant (you analyze a total of 50 tetrads)?