

Name: \_\_\_\_\_

Section : \_\_\_\_\_

# 7.014 Problem Set 6

**Answers to this problem set are to be turned in. Problem sets will not be accepted late.  
Solutions will be posted on the web.**

## Question 1

You are a UROP studying inheritance patterns in Alligators. Some of your alligators have angry dispositions while some are friendly. You determine that the gene for attitude is encoded by a single locus.

You cross true-breeding friendly male alligators by true-breeding angry female alligators and notice that all of the off-spring (male or female) are angry.

a. What are the possible modes of inheritance of angry dispositions in your alligators?

Autosomal dominant  
Autosomal recessive  
Sex-linked dominant  
Sex-linked recessive

b. For each of the inheritance patterns you selected in (a.), cross an F1 generation angry, female alligator with an F1 generation angry, male alligator. What will be the phenotypic AND genotypic ratios of the resulting offspring?

Use A to refer to the allele conferring dominant attitude phenotype, and a to refer to the allele conferring recessive attitude phenotype.

Assume anger is not a sex-linked trait. You notice that oftentimes the angry alligators have long tails while the friendly alligators have short tails. You determine that the short-tailed phenotype is dominant while the long-tailed phenotype is recessive.

You want to determine if tail length and attitude are linked. You cross a true-breeding, angry, long-tailed male alligator with a true-breeding, friendly, short-tailed female alligator to get an F1 progeny. You then cross your F1 generation animals and look at the results in the F2 generation.

c. What are the genotypes of the parental generation?

Use T to refer to the allele conferring dominant tail length phenotype and t to refer the allele conferring recessive tail length phenotype.

## Question 1, continued

- d. What is(are) the genotype(s) of the F1 generation animals?
- e. What is(are) the phenotype(s) of the F1 generation animals?
- f. What ratio of phenotypes do you expect to see in F2 generation if the traits are not linked?
- g. What ratios of genotypes do you expect to see in the F2 generation if the traits are not linked?
- h. The F2 generation yields the following results:  
Angry, short-tailed (93); Angry, long-tailed (30); Friendly, short-tailed (30)  
Explain these results in genetics terms.
- i. Based on the results observed in (h), are tail length and attitude linked traits? Explain your answer.

## Question 2

As it turns out, studying alligators is too dangerous for you, and you decide to turn your attention to a much less hostile organism, the fruit fly. You begin another UROP in a *Drosophila* lab. Your advisor tells you that you have to count thousands of flies. You are committed to the new UROP, but you secretly wonder if you shouldn't have stuck with alligators.

You are studying two genes known to be linked, wing shape and body color.

- a. If two genes are linked, where are they located in relation to one another in the genome?
- b. Do two genes showing linked inheritance have to show a related function? Why or why not?

Rounded wings (R) are dominant over pointed wings (r) and black bodies (B) are dominant over brown bodies (b). You perform the following cross:

Male:  $\frac{R}{r} \frac{B}{b}$                       X                      Female:  $\frac{r}{R} \frac{b}{B}$

- c. What are the expected genotypes and genotype ratios of the offspring if there is no recombination between these two genes?
- d. What are the expected phenotypes and phenotype ratios of the offspring if there is no recombination between these two genes?

After you perform your cross, you get the following result:

725 Round wing, black body flies  
 255 Pointed wing, brown body flies  
 12 Round wing, brown body flies  
 8 Pointed wing, black body flies

- e. What is the recombination frequency between wing shape and body color? Show your work.

### Question 3

Hemophilia is a disorder characterized by the inability to properly form blood clots. Perhaps the most famous hemophiliac in history was the heir to the Russian throne, Alexei, the son of the last Tsar of Russia, Nicholas II and Tsarina Alexandra, granddaughter of Queen Victoria. Hemophilia is sometimes called “the royal disease” because it entered the royal lines of Germany, Russia, and Spain through the descendants of Queen Victoria. Alexei, together with his parents and four sisters, was executed in 1918.

Until recently, hemophilia was untreatable, and only a few hemophiliacs survived to reproductive age because any small cut or internal hemorrhaging after even a minor bruise was fatal. Now hemophilia is treated with blood transfusions and infusions of a blood derived substance known as anti-hemophilic factor.

Here is the pedigree that includes Alexei (Alexis in the figure), starting with his grandmother Alice, second daughter of Queen Victoria. Known carriers are depicted with half-filled circles in the figure.

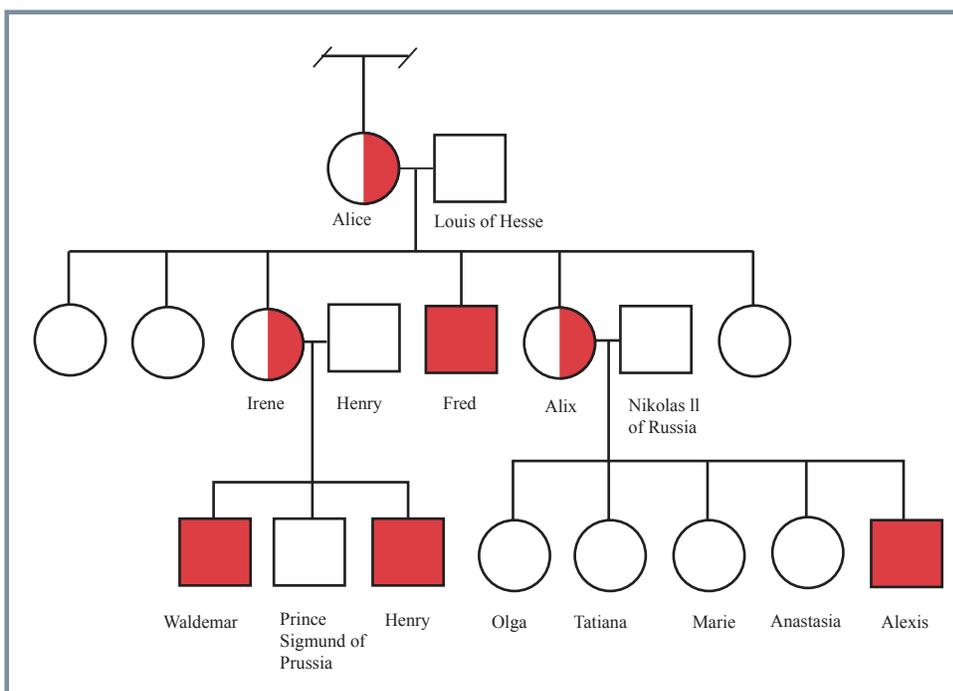


Figure by MIT OCW.

### Question 3, continued

- a) What is the mode of inheritance of hemophilia?
- b) Is it possible for females to get hemophilia? If yes, explain how. If no, explain why not.

All four of Alexei's sisters are depicted as non-carriers. However, their status was never actually ascertained due to their untimely demise.

- c) What is the probability that none of the sisters was a carrier of hemophilia? Justify your answer.

### Question 4

*C. elegans* cDNA library is commercially available.

- a) What is the difference between a *C. elegans* cDNA library and a *C. elegans* genomic library?

You want to clone a *C. elegans* gene into the pUC19 vector, shown below. The Ap region is the ampicillin resistance gene.

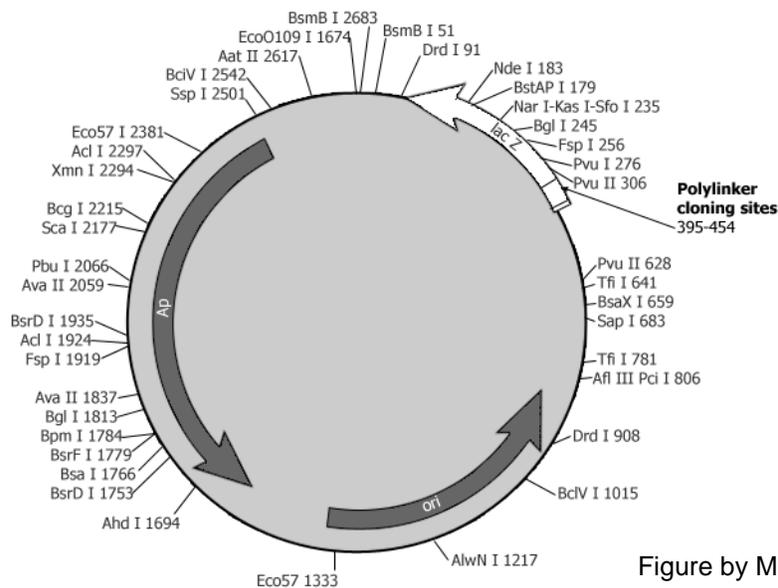


Figure by MIT OCW.



## Question 4, continued

A day later, many colonies appear on your plates.

f) Not all the colonies represent cells that contain the *C. elegans* gene? Why?

g) How do you now find the colonies that contain the *C.elegans* gene?

Suppose that when successfully cloned, the protein of interest is expressed in the cell.

h) What promoter is used to drive the expression of the cloned *C. elegans* gene?