

NAME \_\_\_\_\_ TA \_\_\_\_\_ Section # \_\_\_\_\_

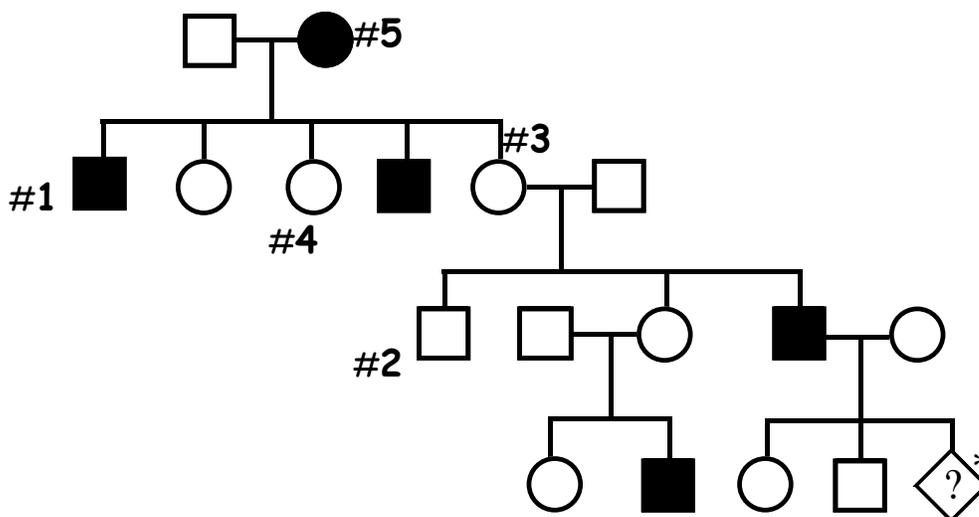
## 7.013 Problem Set 1

FRIDAY February 13, 2004

**Problem sets will NOT be accepted late.**

### Question 1

In the following pedigree, assume no outsiders marrying in carry a disease allele.



a) What is the mode of inheritance of this disease? Circle one.

Autosomal dominant

Autosomal recessive

X-linked dominant

Y-linked

mitochondrial inheritance

X-linked recessive

b) Explain your choice in a). (Give two lines of reasoning.)

c) Write the genotypes of the following individuals.

(If more than one genotype is possible, write down **all** the possibilities.)

#1 \_\_\_\_\_ #2 \_\_\_\_\_ #3 \_\_\_\_\_ #4 \_\_\_\_\_ #5 \_\_\_\_\_

d) Name a disease that follows this pattern of inheritance.

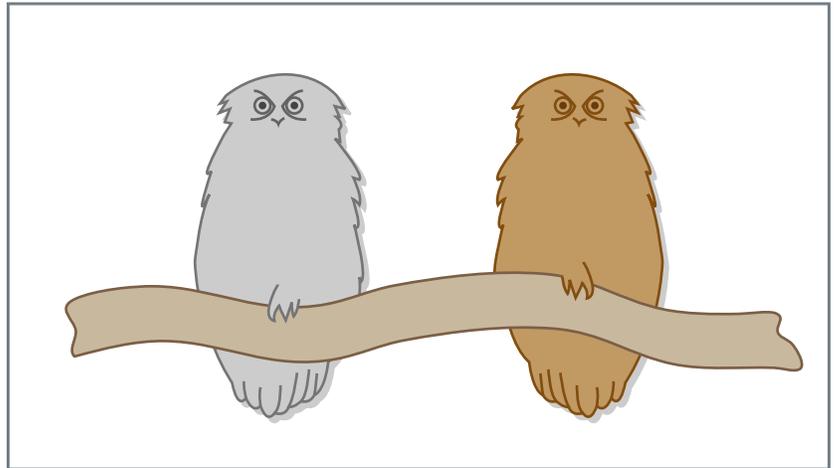
(You may go to OMIM to answer this. → <http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=OMIM>)

e) What is the probability that the asterisked individual will be affected with the disease  
 if male? \_\_\_\_\_ if female? \_\_\_\_\_

## Question 2

Harry wants to buy his friend's parents some owls for their anniversary, but he doesn't have a lot of money. He goes to the owl store anyways hoping to make an arrangement with the owner. Turns out that a disgruntled employee managed to erase all of the owner's computer files containing the genetic information of the extensive owl collection. If Harry can help the owner associate each phenotype with a genotype, he gets all the owls he wants.

a) Harry notices there are both gray and brown colored owls. If gray and brown hues are determined by a single Mendelian locus what are all the **genotypes** that could correspond to each of the **two** phenotypes if:



Figures by MIT OCW.

(Use **H** as your symbol for the dominant trait allele and **h** for the recessive trait allele.)

i) brown is dominant to gray?

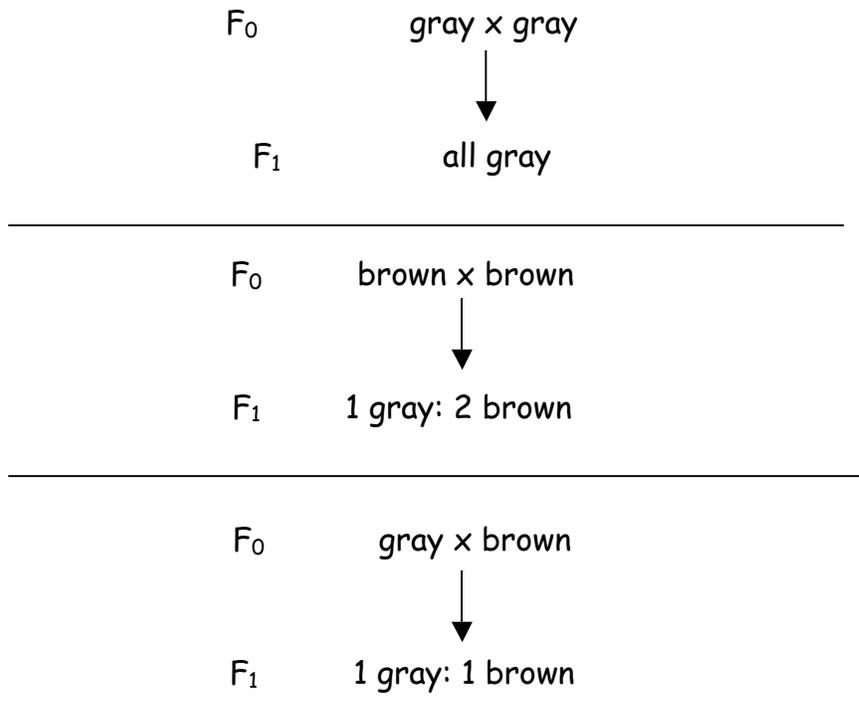
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ii) gray is dominant to brown?

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b) Harry sets up following matings, which always result in the same **ratios** of offspring indicated below.

i) Based on the results of **all** three crosses, and using the same symbols as on the previous page, what are the genotypes for each of the parents and offspring? Write clearly adjacent to each F<sub>0</sub> parent or F<sub>1</sub> class.



ii) Explain the ratios seen in the offspring for each of the crosses in i).

## Question 2 cont.

Figure removed due to copyright reasons.

In a different and **very cute** species of owl, Harry notices that members of this species emit two different noises which he names "loud" and "quiet", and that they have either smooth or rough eyelids. Harry sees a tank of very young owls, with no indication of who the parents were.

a) Assuming all of these young owls come from the same mating pair and given the following ratio of phenotypes that Harry tabulated below, what phenotype and genotype were associated with the **parents**? Use N and n to denote the alleles for noise, and E and e for eyelid textures.

17	loud and rough
5	loud and smooth
6	quiet and rough
2	quiet and smooth

b) Draw a Punnett square to show the genotypes of the young owls discussed in a) and indicate which phenotypes correspond to these genotypes of the owls.

c) If Harry mates a randomly chosen loud and rough eyed owl to any quiet and smooth-eyed owl, could he determine the genotype of the loud and rough owl by looking at the offspring?

Explain how.

d) Luckily, Harry finds some of these same cute owl species, whose genotypes for the alleles conferring flight ability (normal flight speed vs. wicked fast flight speed) and beak length (long vs. normal) are written on their cages.

i) Since he has all possible genotypes, what mating could Harry set up to determine if the two genes (loci) conferring flight ability and beak length are on the same chromosome?

ii) What ratio of offspring classes would Harry get if the loci are unlinked?

iii) How would this ratio change if the loci are tightly linked?

iv) How should he calculate the recombination frequency between the two loci?

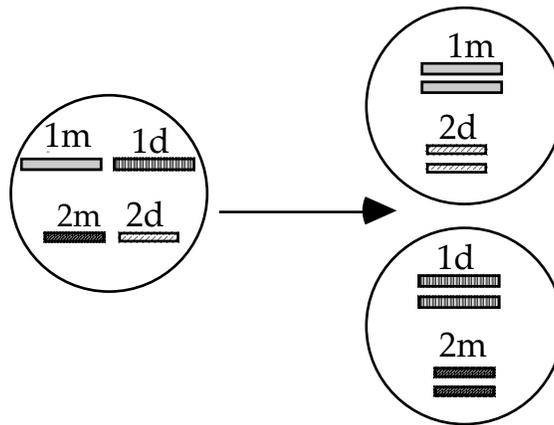
v) What does this number represent with respect to the DNA?

e) What would be the genotype(s) of **your** ideal owl? Explain why.

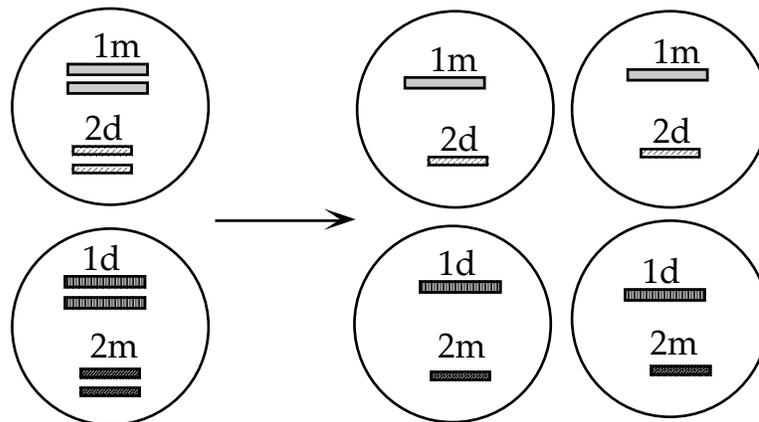
**Question 3**

The following diagrams show a diploid cell with 2 chromosomes, 1 and 2. The chromosome derived from the mother is denoted "m", and the chromosome derived from the father is denoted "d"

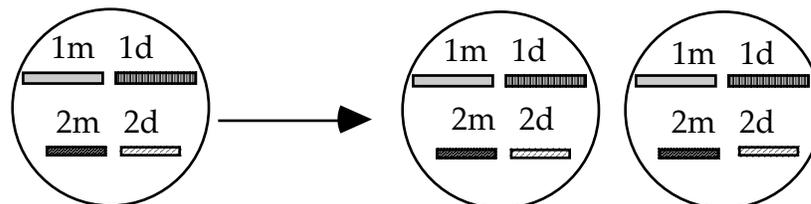
a) The picture below shows the end of mitosis/meiosis I/meiosisII. (Circle one.)



b) The picture below shows the end of mitosis/meiosis I/meiosisII. (Circle one.)



c) The picture below shows the end of mitosis/meiosis I/meiosisII. (Circle one.)



d) In which stage of mitosis or meiosis does most of the recombination occur? Explain why.

#### Question 4

A woman with blood type O has a child with blood type O. She claims that a friend of hers is the child's father. In the ABO system,  $I^A$  and  $I^B$  are both dominant to  $I^O$  and are codominant to each other. ABO genotypes are summarized below and described on page 187 of the 6<sup>th</sup> edition of *Purves et al.*

$I^A I^A$ and $I^A I^O$	A
$I^B I^B$ and $I^B I^O$	B
$I^A I^B$	AB
$I^O I^O$	O

a) Her friend's blood type is A. Can he be excluded as the father on this evidence alone? Why?

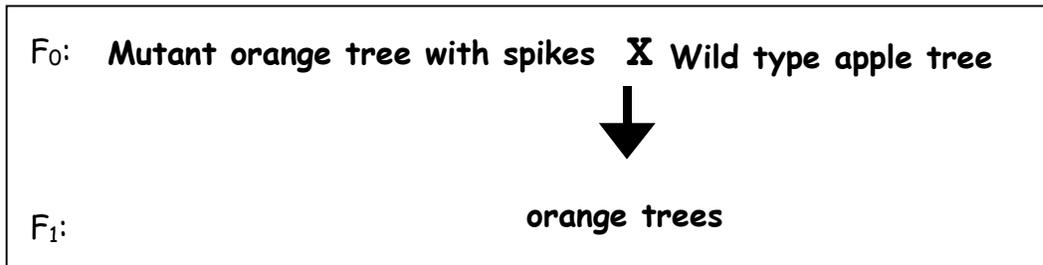
b) Does the fact that the accused man's mother has type A and his father has type AB exclude him from being the parent? Why?

c) Does the additional information that his mother's parents are both AB permit him to be excluded? Why?

### Question 5

Harry got his genetic savvy studying apple tree genetics.

He had a pure-breeding mutant strain of apple trees that has two unusual characteristics; the mutant tree produces oranges instead of apples and there are huge spikes growing out of the branches. Harry crossed the mutant with a pure-breeding wild-type apple tree. The  $F_1$  progeny produce oranges, but have no spikes.



a) For each pair, circle the dominant phenotype.

Apples    Oranges

Spikes    No spikes

b) Harry performed a backcross of an  $F_1$  individual with an  $F_0$  individual from the mutant strain. If there are **32** progeny trees from this cross how many trees have each of the following phenotypes?

Apples, spikes    \_\_\_\_\_

Apples, no spikes    \_\_\_\_\_

Oranges, spikes    \_\_\_\_\_

Oranges, no spikes    \_\_\_\_\_

Harry performed a test cross of an  $F_1$  individual (from the very first cross) with a tree exhibiting both of the phenotypes that you have identified as recessive. He got progeny with the following characteristics.

<i>Phenotype</i>	<b># of individuals in <math>F_2</math> generation</b>
Apples, spikes	103
Apples, no spikes	903
Oranges, spikes	897
Oranges, no spikes	97

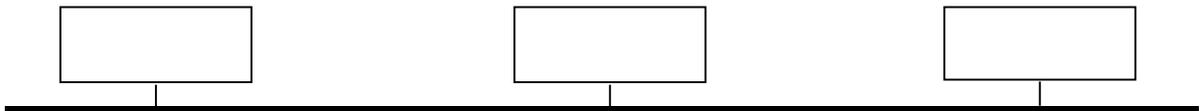
c) What is the recombination frequency between the "orange" and the "spike" genes? Show your work.

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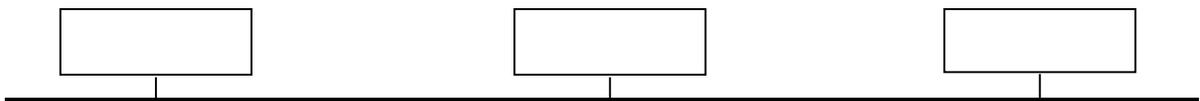
Harry had previously identified a mutant apple tree whose branches are magical, and can be used to make magic wands. The gene that produces this phenotype (the "wand" gene) was previously determined to be 6 map units away from the "spike" gene on one chromosome.

d) Based on the above data, there are two possible arrangements for the "orange", "spike", and "wand" genes on the chromosome. Draw them below naming the genes in the boxes and indicating between them the distances in map units.

*Arrangement 1:*



*Arrangement 2:*



e) What experiment could Harry perform to distinguish between these two possibilities?