1. The genes for mahogany eyes and ebony body are recessive and 25 map units apart on an autosome in Drosophila. A mahogany- eyed female (wild type body, homozygous) was mated to an ebony-bodied (wild type eyes, homozygous) male and the resulting F1 phenotypically wild type females were mated to mahogany, ebony males.

a. What percentage of the offspring would have the phenotype mahogany eyes and wild type body?
b. What percentage of the offspring would have the phenotype mahogany eyes and ebony body?
c. What percentage of the offspring would be phenotypically wild type for both genes?
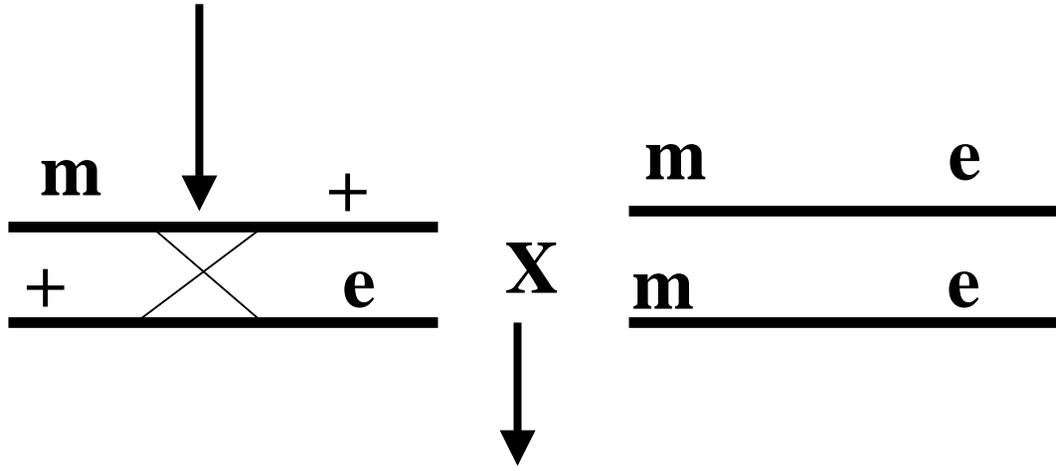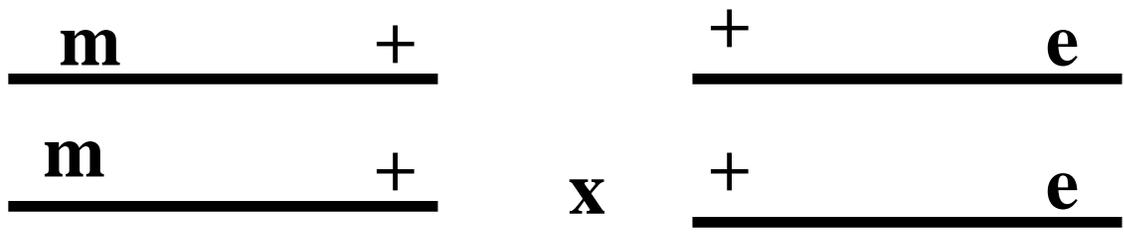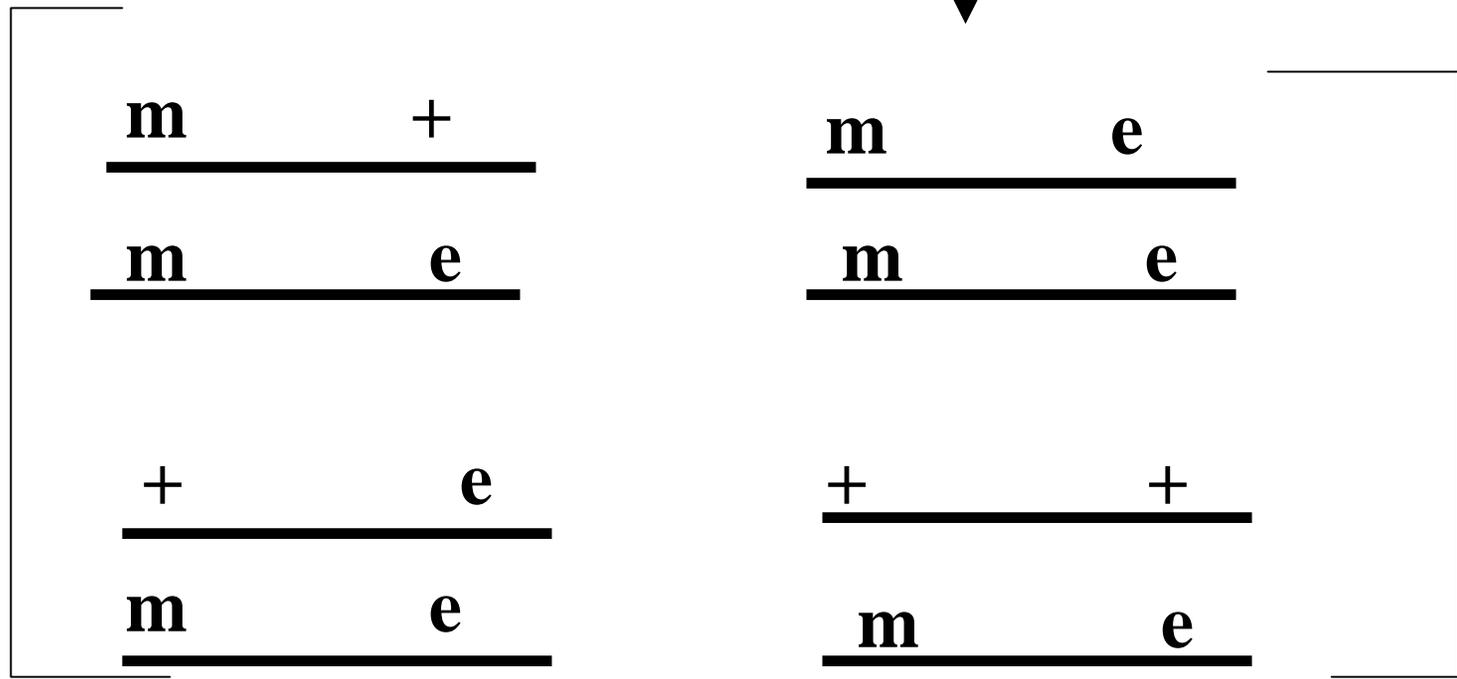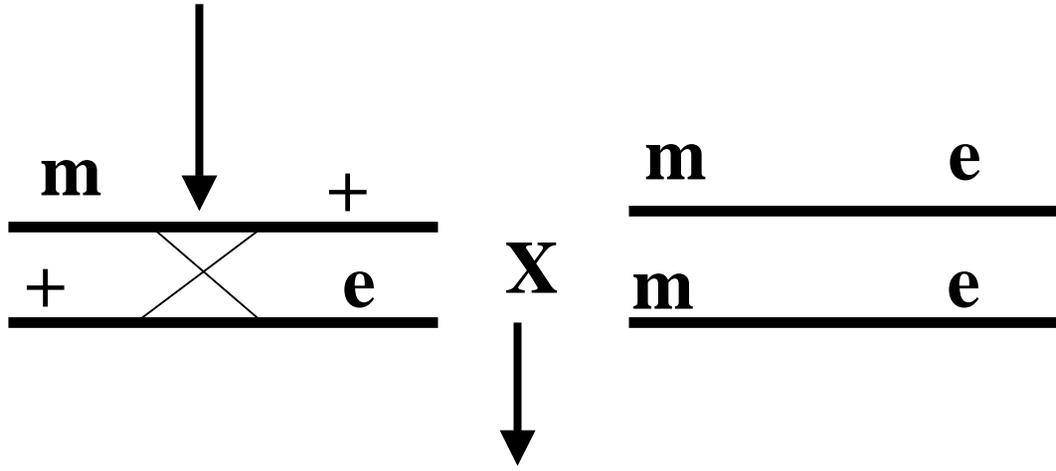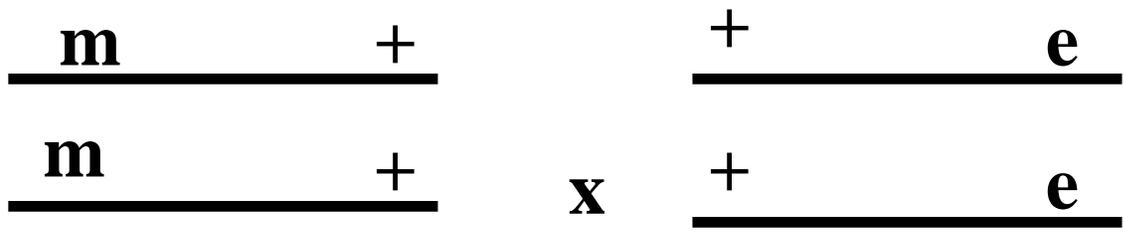
a. **What percentage of the offspring would have the phenotype mahogany eyes and wild type body?**

25 units means 25% recombinants formed so 75% are nonrecombinant, one-half of these or 37.5% will be mahongeny and wild for body color.

b. What percentage of the offspring would have the phenotype mahogany eyes and ebony body?

Those would be the recombinants, 1/2 of 25% = 12.5%

m	+
m	+

x

+	e
+	e

m	+
+	e

X

m	e
m	e

75%

m	+
m	e

m	e
m	e

+	e
m	e

+	+
m	e
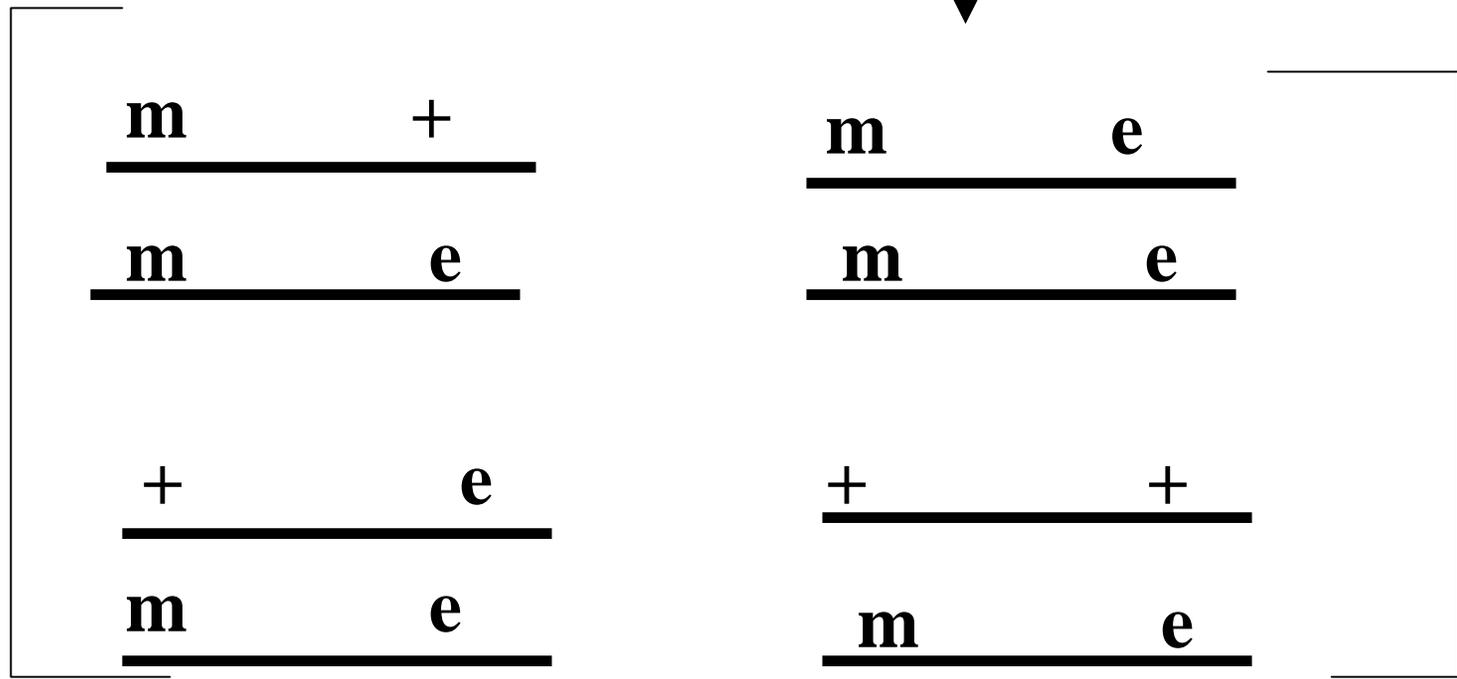
25%

c. **What percentage of the offspring would be phenotypically wild type for both genes?**

These would be the recombinants, 1/2 of 25% =12.5%

2. In corn the gene for colored (C) seeds is completely dominant to the gene for colorless (c) seeds. Similarly, for the character of the endosperm (the part of the seed that contains the food stored for the embryo), a single gene pair controls whether the endosperm is full or shrunken. Full (S) is dominant to shrunken (s). A true-breeding colored, full seeded plant was crossed with a colorless, shrunken-seeded one. The F1 colored, full plants were test-crossed to the doubly recessive type, that is, colorless and shrunken. The result was as follows:

colored, full	4032
colored, shrunken	149
colorless, full	152
colorless, shrunken	4035

a. From these results, are the gene for color and the gene for endosperm shape linked?

b. What is the genotype of the F1 plants?

c. How many map units separate the two loci for these genes?

a. From these results, are the gene for color and the gene for endosperm shape linked?

P_1 CCSS x ccss

↓

F_1 CcSs x ccss

If not linked would expect:

1/4 CcSs
1/4 ccSs   **Must be linked**
1/4 Ccss
1/4 ccss

b. What is the genotype of the F1 plants?

$$\frac{C \qquad S}{C \qquad S} \quad \text{x} \quad \frac{c \qquad s}{c \qquad s}$$

$$\downarrow$$

$$F_1 \qquad \frac{C \qquad S}{c \qquad s} \qquad \text{X} \quad \frac{c \qquad s}{c \qquad s}$$

CcSs
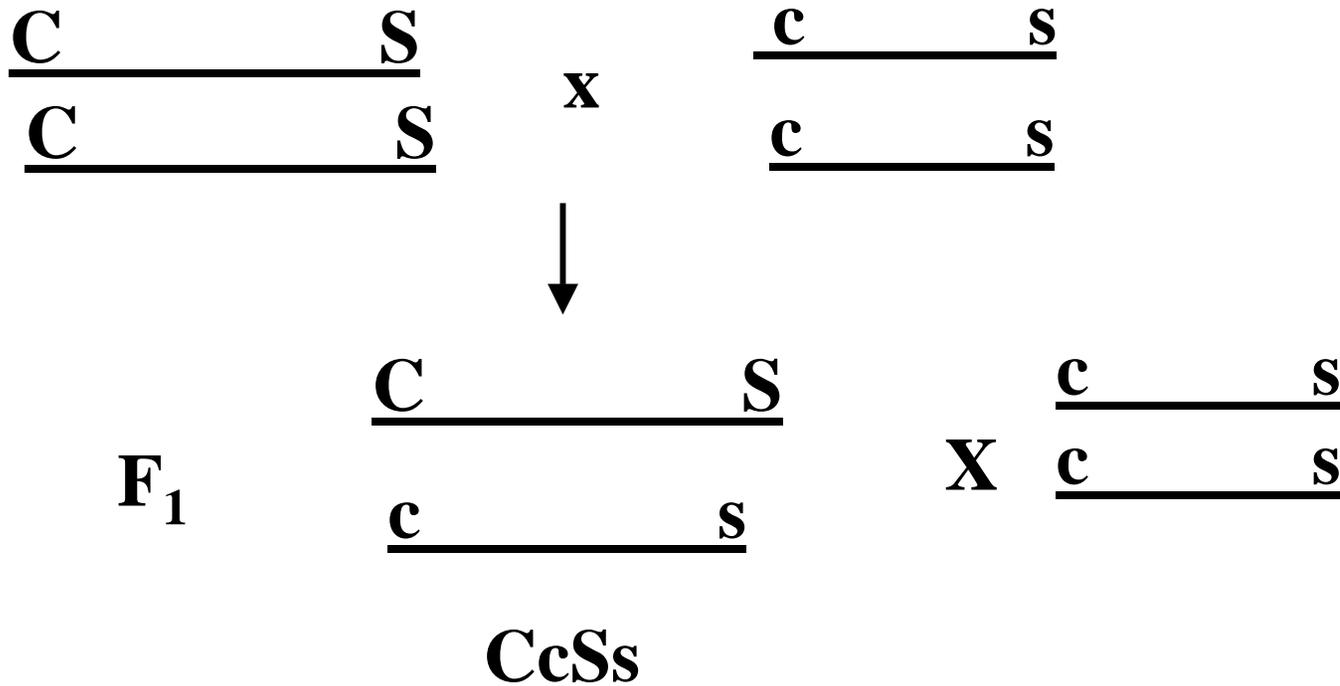
c. How many map units separate the two loci for these genes?

colored, full	4032
colored, shrunken	149
colorless, full	152
colorless, shrunken	4035

$$\text{-------}$$
$$8,368$$

% Recombinants = $\dfrac{301}{8,368}$ = 3.6% = 3.6 map units

3. Below are listed the frequencies of crossing over between 3 different genes (A, B, C).

A and C = 40%
A and B = 5%
C and B = 35%

a. Which two genes have the greatest distance between them?

b. Which two genes are the closest together?

c. How many map units is A from B?

40%

A   B   C

5%   35%
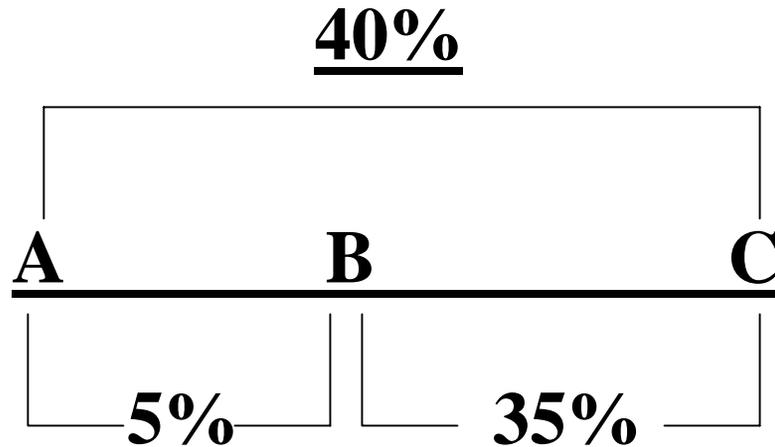
a. Which two genes have the greatest
   distance between them? A and C

b. Which two genes are the closest together? A & B

c. How many map units is A from B? 5

4. Genes A and B are linked and are 20 map units apart. An AABB individual was mated with an aabb individual.

a. List the genotypes of the gametes produced by AABB.   AB

b. List the genotypes of the gametes produced by aabb. ab

c. With respect to these two genes, how many types of recombinant gametes will both of these individuals produce? 0

C.

$$\dfrac{A \qquad B}{A \qquad B} \quad X \quad \dfrac{a \qquad b}{a \qquad b}$$

5. Three of the many recessive mutations in Drosophila that affect body color, wing shape or bristle morphology are black (b) body versus grey in the wild type, dumpy (dp) versus long wing in the wild type, and hooked (hk) bristles at the tip versus not hooked in the wild type. These genes are linked. From a cross of a dumpy female (wild type for other two traits) with a black and hooked male (wild for other trait), all the F1 were wild type for all three traits. The testcross of an F1 female with a dumpy, black, hooked male gave the following results (if a trait is not listed it is considered to be wild type in that group):

wild type	168
black	19
black, hooked	301
dumpy, hooked	21
hooked	8
hooked,dumpy,black	172
dumpy, black	6
dumpy	305

Total = 1000

a. Using genetic symbols above and below a line, what is the genotype of the F1 female?

b. Which groups are due to double crossing over?

c. What is the correct sequence of these genes?

$$\underline{\text{dp} \qquad + \qquad +} \qquad \qquad \underline{+ \qquad \text{b} \qquad \text{hk}}$$

$$\underline{\text{dp} \qquad + \qquad +} \qquad \text{X} \qquad \underline{+ \qquad \text{b} \qquad \text{hk}}$$

$$\downarrow$$

$$\text{F}_1 \quad \underline{\text{dp} \qquad + \qquad +} \qquad \text{X} \qquad \underline{\text{dp} \qquad \text{b} \qquad \text{hk}}$$

$$\underline{+ \qquad \text{b} \qquad \text{hk}} \qquad \qquad \underline{\text{dp} \qquad \text{b} \qquad \text{hk}}$$

b. Which groups are due to double crossing over?

wild type	168 (single cross.)
black	19 (single cross)
black, hooked	301 (nonrecomb.)
dumpy, hooked	21 (single cross)
hooked	8 (double cross)
hooked,dumpy,black	172(single cross)
dumpy, black	6 (double cross)
dumpy	305 (nonrecomb.)

Total = 1000

c. What is the correct sequence of these genes?

Three possibilities :

Double cross-overs

dp   +   +
_____

+   b   hk
_____

dp   b   +   *
_____

+   +   hk *
_____

dp   +   +
_____

+   hk   b
_____

dp   hk   +
_____

+   +   b
_____

+   dp   +
_____

b   +   hk
_____

+   +   +
_____

b   dp   hk
_____

6. In Drosophila, the three gene pairs for red eyes (cn+) vs.cinnabar (cn), normal bristle number (rd+) vs. reduced (rd), and long wings (vg+) vs. vestigial (vg) are known to have their loci on chromosome 2. Suppose that a female fly that is heterozygous for all three genes with all wild type alleles on one homologue and all mutant alleles on the other is crossed with a male that is recessive for all three genes (three-point test-cross) and yields the following offspring:

cinnabar, reduced, vestigial	406
cinnabar, reduced, long	46
cinnabar, normal, vestigial	28
cinnabar, normal, long	3
red, normal, long	438
red, normal, vestigial	45
red, reduced, long	33
red, reduced, vestigial	1

a. Which progeny classes are the double recombinant types?

b. What is the correct sequence of these genes?

c. What is the distance between eye color (cn+, cn) and wing type (vg+,vg)?

$$\frac{\text{cn} \qquad \text{rd} \qquad \text{vg}}{+ \qquad\quad + \qquad\quad +} \quad \textbf{x} \quad \frac{\text{cn} \qquad \text{rd} \qquad \text{vg}}{\text{cn} \qquad \text{rd} \qquad \text{vg}}$$

a. Which progeny classes are the double recombinant types?

cinnabar, reduced, vestigial	406
cinnabar, reduced, long	46
cinnabar, normal, vestigial	28
cinnabar, normal, long	3*
red, normal, long	438
red, normal, vestigial	45
red, reduced, long	33
red, reduced, vestigial	1*

b. What is the correct sequence of these genes?

cn   rd   vg
_____
+   +   +
_____

rd   cn   vg
_____
+   +   +
_____

cn   vg   rd
_____
+   +   +
_____

cn   +   vg
_____
+   rd   +
_____

rd   +   vg *
_____ **bristle number**
+   cn   + * **eye color**
_____ **wing type**

cn   +   rd
_____
+   vg   +
_____

c. What is the distance between eye color (cn+, cn) and wing type (vg+,vg)?

		%
cinnabar, reduced, vestigial	406	40.6
cinnabar, reduced, long	46	4.6
cinnabar, normal, vestigial	28	2.8
cinnabar, normal, long	3	0.3
red, normal, long	438	43.8
red, normal, vestigial	45	4.5
red, reduced, long	33	3.3
red, reduced, vestigial	1	0.1
	1000	

$$\underline{\overset{?}{\text{rd} \qquad \text{cn} \qquad \text{vg}}}$$

$$\underline{+ \qquad + \qquad +}$$

Single cross-overs - $\underline{\text{rd} \qquad \text{cn} \qquad +}$ **= 4.6%**

$$\underline{+ \qquad + \qquad \text{vg}} = \textbf{+4.5\%}$$

double recomb.   + .4%

9.5 units

7. In chickens the dominant allele O causes egg shell color to be bluish and the recessive genotype oo produces white eggs.

Also the allele P produces a variant in comb type referred to as pea comb. P is incompletely dominant to the allele for single comb, p, although in small wattled breeds PP and Pp are practically indistinguishable.

Both loci are locate on the second chromosome.

Single

Walnut

Rose

Pea

Assume the mating : PPoo (pea comb, white eggs) x (single comb, blue eggs) ppOO producing the dihybrid PpOo

The dihybrid is then mated to chickens with the ppoo genotype.

Which two of the four possible dihybrid gametes represent recominant gametes?

PO, Po , pO, po

$$\frac{P \qquad o}{P \qquad o} \quad X \quad \frac{p \qquad O}{p \qquad O}$$

↓

$$\frac{P \qquad o}{p \qquad O} \quad X \quad \frac{p \qquad o}{p \qquad o}$$

PO, po

Assume the following phenotypic distribution is observed from mating the dihybrids (produced from crossing the ppOO by PPoo lines) and the completely recessive ppoo:

Phenotype

Comb	Egg color	# Observed
Pea	Blue	4
Pea	White	96
Single	Blue	96
Single	White	4

$$\frac{p \qquad O}{p \qquad O} \qquad X \qquad \frac{P \qquad o}{P \qquad o}$$

$$\downarrow$$

$$\frac{p \qquad O}{P \qquad o} \qquad X \qquad \frac{p \qquad o}{p \qquad o}$$

$$\downarrow$$

NR

$$\frac{p \qquad O}{}$$

$$\frac{P \qquad o}{}$$

R

$$\frac{p \qquad o}{}$$

$$\frac{P \qquad O}{}$$

What is the recombination frequency (hence, map distance) between these two loci?

$$\frac{8}{200} = 4\ \%$$

8. In rabbits the dominant allele B produces a black coat color and the recessive genotype bb produces a brown coat. Body fat color in rabbits is white if a dominant allele Y is present and yellow if the genotype is yy.

Assume the mating between rabbits with the following genotypes : Black with white fat(BBYY) and Brown with yellow fat (bbyy) which produces the dihybrid BbYy

Calculate the recombination frequency if the dihybrids are mated back to brown rabbits having yellow fat, bbyy, and the following ratio of phenotypes is observed:

Phenotype		
Coat color	Fat color	# Observed
Black	White	125
Black	Yellow	75
Brown	White	85
Brown	Yellow	115

Phenotype

Coat color	Fat color	# Observed
Black	White	125
Black	Yellow	75
Brown	White	85
Brown	Yellow	115

		400

$$\frac{160}{400} = 40\%$$