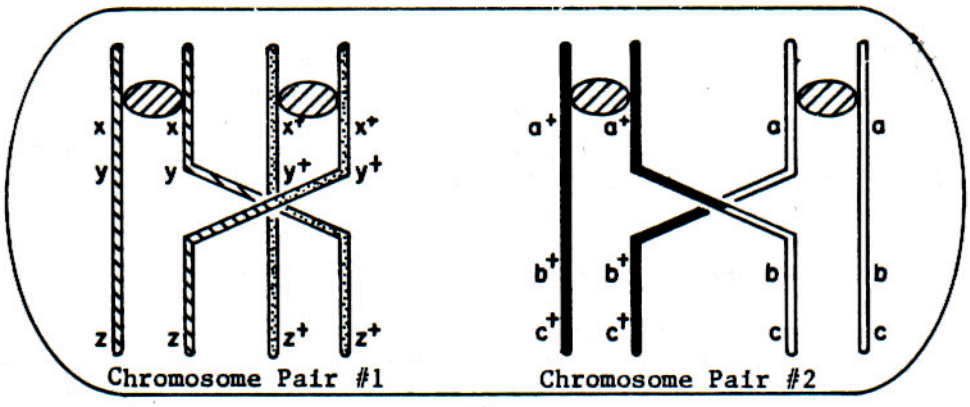
Crossover: An Introduction to Mapping

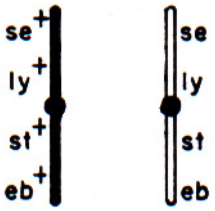
1. Which would lead one to expect linkage of genes if we assume genes are on chromosomes?
   a. Multiple alleles sometimes occur.
   b. The number of hereditary traits always exceeds the number of chromosomes.
   c. The most complex organism does not always have the most chromosomes.
   d. Chromosomes physically cross over during nuclear divisions.

2. What types of gametes are found if some crossing over occurs between two linked genes during meiosis?
   a. Only parental types.
   b. Both parental and recombinant types.
   c. Only double crossover types.
   d. Only recombinant types.

3. The following cell from an animal with two pairs of chromosomes is in meiosis. DNA doubling and chromosome pairing have occurred and the following crossovers took place. What types of gametes could be formed?



4. A male insect (which has crossing over) has the following alleles, in the order given, on a chromosome. One meiosis produced the group sperm shown below. Diagram the crossovers necessary to produce these sperm.



se = sepia eyes
ly = lyra wings
st = stubble bristle
eb = ebony body

a + superscript indicates the wild-type allele for that trait.

5. A female *Drosophila* has the following combinations of alleles on her second chromosome. They are in the order given.

$\frac{+ves^{+} \quad lob \quad fat}{+ves \quad lob \quad fat^{+}}$

ves = vestigial wings
lob = lobed eyes
fat = fat b

(a + superscript indicates the wild-type allele)

A single crossover occurs between the vestigial and lobe genes. What meiotic products will be produced?

The next two questions are based on the following data:

Cinnabar eyes, curved wings and smooth abdomen are all genes linked in the order given on chromosome 2 of *Drosophila*. The mutant alleles are all recessive to the wild-type alleles. A female heterozygous for the mutant alleles at each locus is crossed to a homozygous recessive male (*ci cw sa/ci cw sa*). They have the following progeny:

Phenotype	Genotype	Number	Class
Cinnabar, straight wings, normal abdomen		300	
Wild type		50	
Cinnabar, curved, smooth		45	
Cinnabar, curved, normal abdomen		10	
Wild-type eyes, curved, normal abdomen		150	
Wild-type eyes, curved, smooth		308	
Cinnabar, straight wings, smooth		125	
Wild-type eyes, straight wings, smooth		12	

6. Draw the second chromosomes of the female parent showing the linkage of the mutant and wild-type alleles. *(Hint: Determine the genotype of each class to decide which are the parental types.)*

7. Why are there eight classes of progeny?

8. Two autosomal recessive mutations in *Drosophila* are hairy head (*h*) and scarlet eyes (*sc*). If a female heterozygous for these genes, *ha sc/H SC*, is mated to detect recombinants among her offspring, what male genotype should be chosen as a mate?
   a. *h sc/H SC*
   b. *H sc/h sc*
   c. *H SC/H SC*
   d. *h sc/h sc*

9. If the genes *C B D E A F* were on the same chromosome and linked in the order given, crossing over probably would be most frequent between loci of genes:
   a. *B* and *D*
   b. *A* and *F*
   c. *C* and *E*
   d. *B* and *E*
   e. *A* and *E*
   f. *C* and *F*

10. A female of the genotype *a*, a^+; *b*, b^+ is crossed to a male of the genotype *a,a; b,b*; where a^+ is dominant to *a*, b^+ dominant to *b*. The progeny show a ratio of:

    1*ab*:1a^+b^+:1a^+b:1ab^+

    These genes are:
    a. completely linked.
    b. linked by recombining.
    c. assorting independently.
    d. *a* and a^+ assort independently, *b* and b^+ are linked

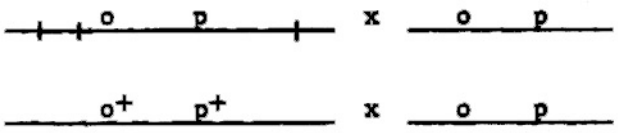
11. The genes for albinism and sickle-cell anemia are thought to be linked in man and both mutant alleles are recessive to their respective wild-type alleles. The heterozygous condition for sickle-cell anemia can be detected by appropriate blood tests, but none of the people mentioned below were tested.

    Two phenotypically normal people marry and have a son who has sickle-cell anemia. He marries an albino girl who does not have sickle-cell anemia. They have four children. One is phenotypically normal. One is albino. One has sickle-cell, and the last has sickle-cell anemia and is also albino. Assume there have been no crossovers and the genes are linked.

What was the genotype of the man and his wife (i.e., which alleles were linked) and what are the possible genotypes of the man's parents?

12. In yeast the chromosomes are very difficult to see. However, extensive genetic analysis has shown that there are 17 linkage groups. How many chromosomes should be present in a diploid cell?
    a. 10
    b. 17
    c. 34
    d. 58
    e. 170

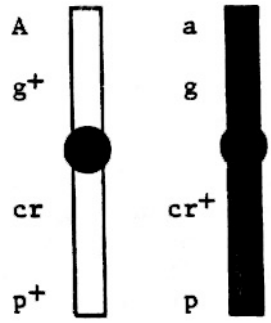
13. In a certain organism, the cross shown below was made.



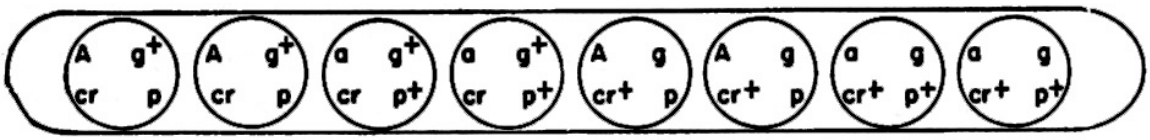
The knobs (small vertical lines drawn on the chromosomes) can be seen under the microscope. The alleles at each gene are easily distinguished and the genes are known to be between the knobs shown. Draw the two progeny classes that, if produced by this cross, would provide evidence that exchange of chromosome pieces accompanies genetic exchange.

14. Each member of a small population of self-fertilizing plants is tested for the presence of different alleles at each of 20 genetic loci. At each gene only one allele is found (i.e., all the plants are homozygous for the same alleles at each tested gene). Which of the following statements is true of this population?
    a. This population shows a great deal of genetic variability at these loci.
    b. This population shows no genetic variability at these loci.
    c. Recombination would increase genetic variability in this population.
    d. Mutation could not increase genetic variability in this population.

15. In *Neurospora*, the following cross was made.



One of the asci (the eight spores produced in a single meiosis) produced is given below:



What were the crossover(s) necessary to produce this ascus?

16. In the goldfish, the allele for dark color (*C*) is dominant to that for albino (*c*) and the allele for long fins (*L*) is dominant to the allele for short fins (*l*). A dark, long-finned goldfish is crossed to an albino, short-finned goldfish and the following phenotypes are observed in the progeny:

Phenotype	Number
Dark, short fins	420
Albino, long fins	432
Dark, long fins	72
Albino, short fins	76
	1000

What is the best explanation for the results?

a. The genes for color and fin length are either far apart on the same chromosome, or on separate chromosomes.
b. The dominant alleles were located on the same homolog in the parent heterozygous for both genes.
c. The dominant alleles were located on different homologs in the parent heterozygous for both genes.
d. The genes for fin length and color are so far apart on the same chromosome that an excess of recombinant progeny was observed

17. If two Neurospora with the genotypes *AB ce* and *ab CD* are crossed and produce ascospores arranged in the following order, what must have happened in meiosis? (Assume genes *A, B, C* and *d* are located on the same chromosome in that order, with *A* nearest that centromere and *D* furthest.)

ABCD ABCD AbCD AbCD abcd abcd aBcd aBcd

a. No crossover
b. Single crossover
c. Two chromatid double crossover
d. Three chromatid double crossover
e. Four chromatid double crossover

18. Huntington's chorea is an autosomal dominant condition that leads to death at middle age, after showing no signs in childhood or early adulthood. A young man whose mother had Huntington's chorea wants to know how likely it is that he might have it. A medical geneticist studying his family tree collected the following information about the EF blood groups in his relatives. The E and F alleles are co-dominant and the system is very closely linked to the gene for Huntington's chorea.

Father's father:	EF	Mother's father:	FF (had Huntington's chorea)
Father's mother:	EF	Mother's mother:	EE
Father:	EE	Mother:	EF (had Huntington's chorea)

The young man's blood type was EE. What is the probability that he will develop Huntington's chorea?
a. Practically 0
b. Practically 1
c. 1/2
d. 1/4
e. 3/4