Biology 131 Solutions to Practice Linkage Problems

1. Given: two loci, K and L, with complete dominance at each locus. Let's call the possible phenotypes with respect to each of these loci K and **k** and **L** and **l**.
(a) Suppose that:

phenotype Kl is crossed with phenotype kL -- both true breeding lines

What is the genotype and phenotype of the F_1

Phenotype = K,L; Genotype = KkLl

(b) Next, a testcross of the F_1 (above) yields the following results, by phenotype:

KL	441
Kl	4423
kl	421
kL	4715

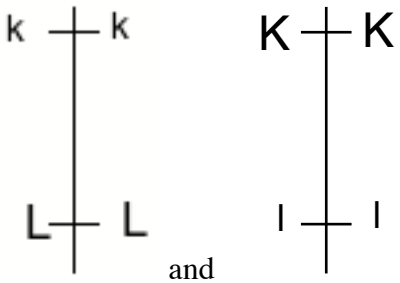
(i) Are loci K and L linked?

Yes -- in a dihybrid cross like this (with independent assortment we expect these four phenotypes in a ratio of 1:1:1:1[1]
The observed ratio (given above) is decidedly skewed towards the Kl and kL phenotypes. This implies linkage.

(ii) If so, what is the crossover frequency?
= # of crossover types / total number of offspring
= 862/10000 = 0.0862

(c) Using "chromosome notation" (a line with loci on it, as used in lecture) diagram the genes for:

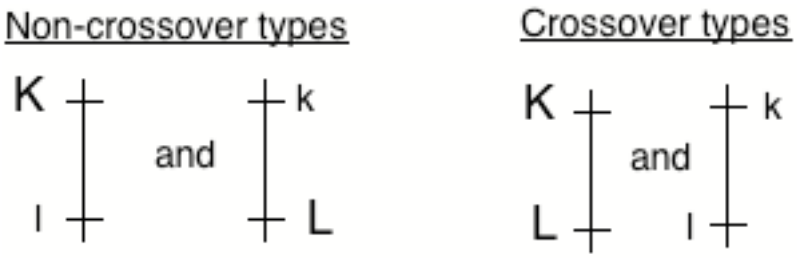
(i) the original parental lines



[1] With independent assortment , for KkLk*kkll the chance of KL = 0.5*0.5, Kl= 0.5*0.5, kL = 0.5*0.5 and kl = 0.5 * 0.5 – a 1:1:1:1 predicted ratio.

(ii) the F_1:

(iii) the gametes of the F_1 individuals

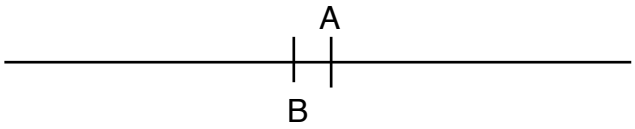


(iv) the gametes of the testcross individuals

2. Linkage and Recombination (a) (Easy). Suppose that you find the following recombination frequencies. Draw a correct linkage map, including distances between adjacent loci:

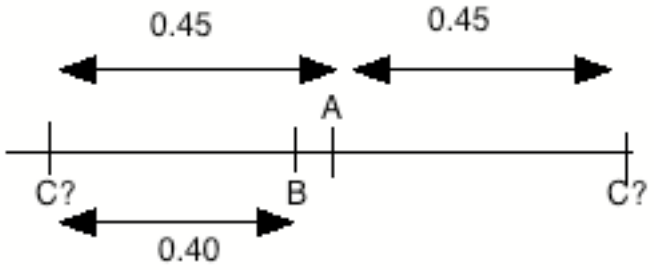
Locus	Recombination Frequency
A to B	0.05
A to C	0.45
B to C	0.40

First, let's arbitrarily place two loci on a chromosome, being sure that they are the correct distance apart:

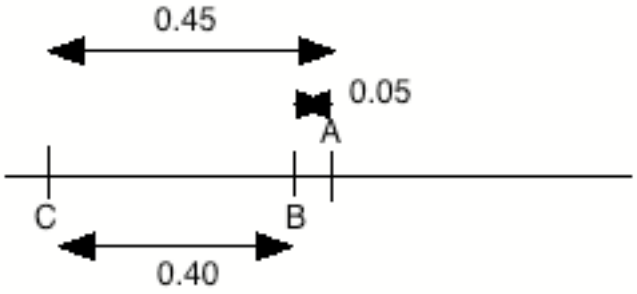


(0.05 map units)

The only thing left to do is figure out where the third gene (c) belongs. Note that it is 0.4 map units from A. But which way? The picture shows two possible locations. However, we also know that it is 0.40 map units from B and thus the correct position is to the side of B away from A:



and so here is the answer (which can also be drawn in reverse)



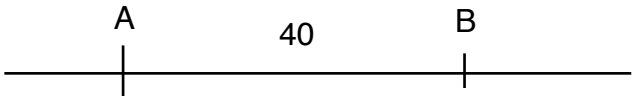
(b) (Harder) Draw a correct linkage map, including distances between adjacent loci, for the following recombination data:

Locus	Recombination Frequency
A to E	0.5
A to B	0.4
B to E	0.5
A to C	0.3
C to E	0.2
B to C	0.5

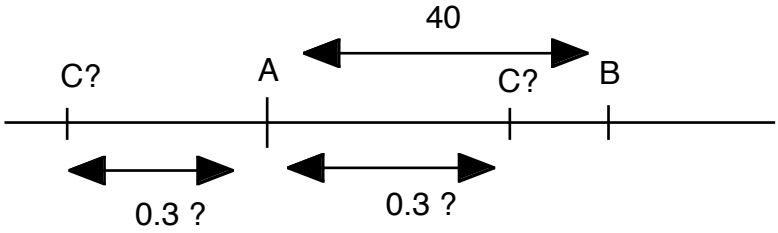
A to D	0.1
D to E	0.5
B to D	0.3
A to F	0.5
B to F	0.5
C to F	0.5
D to F	0.5
E to F	0.5

Here we must keep in mind that map distances of 50 units (50% recombination) indicate independent assortment. This most likely means that the loci are on different chromosomes but it is possible that they are on the same chromosome but a long ways apart (with enough distance, crossovers become inevitable). Also keep in mind that the largest crossover frequency we can get is 50% but total map distances might be greater than 50 units (if the loci are actually linked).

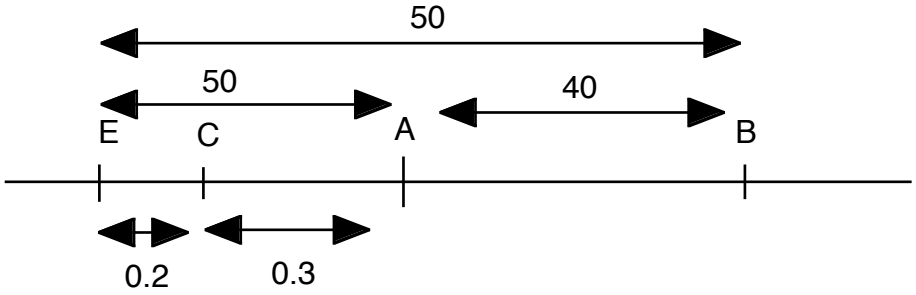
This said, we need to start with loci that are obviously linked – for example, A and B and then proceed:



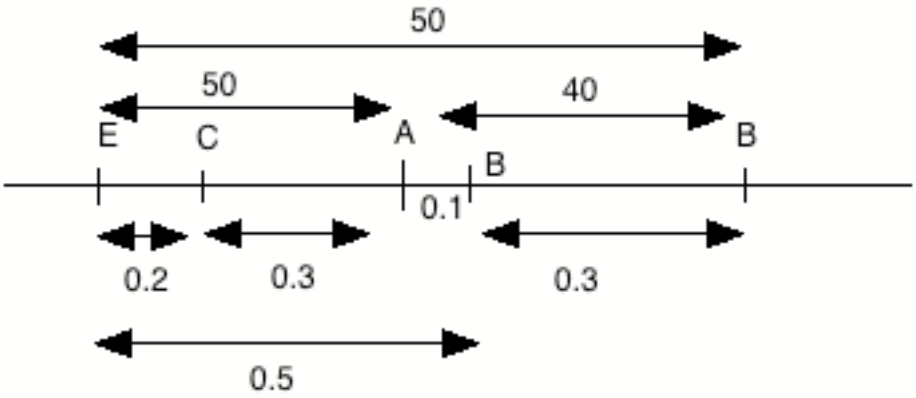
We now add C but we are not yet sure of its exact location:



Now, we also know that C is 0.2 from E and that A is 0.5 from E. On the other hand, B is 0.5 from C. Thus:



Next we know that A to D i s 0.1 and B to D is O.4, and D to E i s 0.5 – therefore it is on the "B" side of A:



(c) Are all of these loci necessarily on the same chromosome? Explain.

Notice that "F" has a recombination frequency of 0.5 with all other loci. This implies that it is most likely (but not certainly) on another chromosome (*i.e.*, not linked).