Chromosome Mapping Practice

Background Information

A.H. Sturtevant, a student who worked with Thomas Morgan, made the following hypothesis: Genes are located in a linear series along a chromosome, much like beads on a string. Remember that crossing over takes place when breaks occur in the chromatids of homologous chromosomes during meiosis. The chromatids break and join with the chromatids of their homologous chromosomes. This causes an exchange of alleles between the chromosomes. Crossing over is a random event so we would expect genes that are closer together to be separated less frequently than those that are farther apart. This means that we should be able to use crossover frequencies to tell us how far apart genes are and, therefore, construct gene maps. In fact, Sturtevant's work with Drosophila helped establish this very technique for mapping chromosomes.

In 1913, Sturtevant used crossover frequencies of *Drosophila* to construct chromosome maps. To determine map distances, he arbitrarily decided that one recombination for every 100 fertilized eggs (*i.e.*, 1%) would equal one map unit. For example, genes that had a crossover frequency of 15% were said to be 15 units apart. Genes that had a recombination frequency of 5% were much closer - 5 units apart.

1) A researcher is trying to map the genes W, X, Y, and Z and the genes A, B, C, and D. A series of crosses is performed for each set of genes and the number of times the genes cross over is reported in the tables below. The data represent the recombination frequencies (in percent) for each gene pair. For both examples, draw a map showing the relative positions of each of the genes along the chromosome and indicate the distance between each of the genes.

a)

Genes	W	X	Y	Z
W	-	5	7	8
X	5	-	2	3
Y	7	2	-	1
Z	8	3	1	-

b)

Genes	A	B	C	D
A	-	12	15	4
B	12	-	3	8
C	15	3	-	11
D	4	8	11	-

2) Your job is to draw a map of one of the chromosomes of *Chromosomus fictitionus* a small, nocturnal beetle found in Peru. Using the results of the following three crosses, determine the distance between the genes for body color, antenna length, and spots that are known to be on the same chromosome. The genes are not sex-linked.

- Males with black bodies and long antennae are crossed with females having brown bodies and short antennae. Of the 1166 offspring, 34 have black bodies and short antennae and 36 have brown bodies and long antennae.
- Males with black bodies and red spots are crossed with females with brown bodies and white spots. Among the offspring, there are 435 with black bodies and red spots, 447 with brown bodies and white spots, 44 with black bodies and white spots, and 54 with brown bodies and red spots.
- Males with long antennae and red spots are crossed with females with short antennae and white spots. 52 of the 1300 offspring look different from the parents.