PLEASE: If you draw pictures to help answer these questions, draw BIG pictures. They are impossible to grade otherwise.

1. A standard lab strain of mice has the following arrangement of genes on its first chromosome (where capital and small letters represent different alleles of the same locus):

   `A--B--C--centromere--D--E--F--G--H (type 1)`

   `a--b--c--centromere--d--e--f--g--h (type 2)`

   (a) If we have an animal which is heterozygous for the two chromosomes shown, and a homogolous (normal) crossover happens in the segment between the E and F loci, what will the two recombinant daughter chromosomes look like? Be sure to show whether each locus has the capital or small allele, and where the centromeres are.

   (b) An inversion occurs which reverses the E-F-G part of the chromosome, so that the arrangement (call it type 3) is now:

   `a--b--c--centromere--d--g--f--e--h`

   If we have an animal which is heterozygous for type 1 and type 3, and a crossover takes place in the segment between the E and F loci, what will the two recombinant daughter chromosomes look like?

   (c) What does this predict about the fertility of the animal in part (b)? Will it be higher, lower, or the same as in part (a)?

   (d) Which is generally worse, a big non-centromere-containing inversion or a small one? Why?

2. Humans have one chromosome less than other great apes, because two chromosomes have become fused together. The centromere of one chromosome was lost in the fusion, but assume for this problem that no genes were lost.

   (a) What difficulties would a heterozygote for the old (24 chromosomes) and new (23 chromosomes) arrangements encounter?

   (b) What problem would the new chromosome face in becoming established in the population? It may be useful to know that most human chromosomes contain some genes which need to be present in exactly two copies.

   (c) Suggest a situation which could have helped the new chromosome become established.

3. Wheat and rye are not in the same genus, but it is possible to cross them. We cross a tetraploid (4N) strain of wheat with a diploid (2N) rye. The resulting hybrids are sterile. However, if the parent plants are treated with colchicine, a drug that causes doubling of chromosome number via meiosis failure, fertile hexaploid (6N) plants, called "triticale," are produced.

   (a) What is a likely reason for the sterility of the original hybrids? (Be sure your explanation does not also predict sterility of triticale.)

   (b) Why are fertile hybrids between two distantly related **diploid** plants frequently tetraploid rather than diploid? (Hint: What advantage would tetraploidy give them in meiosis?)