Practice Problems 4

1. The diploid chromosome number in a variety of chrysanthemum is 18. What would you call varieties with the following chromosome numbers?

(a) 19 _____

(b) 36 _____

(c) 17 _____

2. A normal chromosome has the following gene sequence: A B C D E F G H. Write the name of each of the following kinds of chromosomal mutation:

(a) A B C F E D G H _____

(b) A B D E F C G H _____

(C) A B D E F G H _____

3. Draw diagrams showing the appearance of synapsed chromosomes in prophase of meiosis I, in cells that are heterozygous for (a) a deletion; (b) a duplication; (c) an inversion; and (e) a reciprocal translocation.

4. Imagine a cross between two species of plants, where the hybrid is sterile for the same reason that you found above for mules. Now suppose that in the germ line of the plant, there is a breakdown in the mechanism controlling the cell cycle in a cell, such that the cell goes through two consecutive S phases without any intervening mitosis. What will be the chromosome composition of the microspore or megaspore mother cell(s) which are eventually formed? (Assume the same simple model of chromosomes as in the preceding question.)

5. DNA molecules can be denatured or "melted" by heating them until all H-bonds break. When they are cooled, the single strands renature or reanneal, i.e. complementary regions re-form H-bonds to create double-stranded DNA molecules again. Suppose that you isolated DNA from two strains of a virus. The DNA of these two strains differ only in that a particular gene is duplicated in one strain. These DNA's are mixed and then denatured and renatured. If you examine the resulting molecules in the electron microscope, what would they look like?

6. Suppose a transposable element inserted itself, or a copy of itself: (a) with the portion of a gene that codes for a protein; or (b) immediately upstream from a gene. What do you predict would be the effect on that gene?

7. What would be the ploidy of the zygote that results from each of the following events?
(a) An egg is fertilized by two sperm instead of one.
(b) A cell in the germ line begins mitosis but fails to undergo anaphase, so all the chromosomes end up in one nucleus. A descendent of this cell undergoes meiosis and the resulting egg is fertilized.

(c) A secondary spermatocyte fails to undergo the second meiotic division. One of the resulting sperm fertilizes an egg.
(d) The second polar body nucleus fuses with the egg nucleus; then the egg is fertilized.

8. Diagram the results of the following types of cross-overs. In each case carefully draw the chromosome(s) with homologous regions paired and trace the chromosome(s) from one end, e.g. the centromere (shown as a circle on the left end).

(a) Intrachromosomal crossing-over between direct repeats:

o 1 2 3 1 2 3

(b) Unequal sister-strand exchange (crossing-over) involving tandem repeats:

o 1 2 3 1 2 3
o X
1 2 3 1 2 3

(c) Intrachromosomal crossing-over between inverted repeats:

o 1 2 3 a b c 3 2 1

(d) Crossing-over between repeats on different chromosomes:

o 1 2 3 o **1 2 3**

9. This illustrates how trisomics can be used to determine on which chromosome a gene lies. In heterozygous trisomics, the alleles on the three copies of the trisomic chromosome segregate randomly with respect to genotype, in the following proportions:

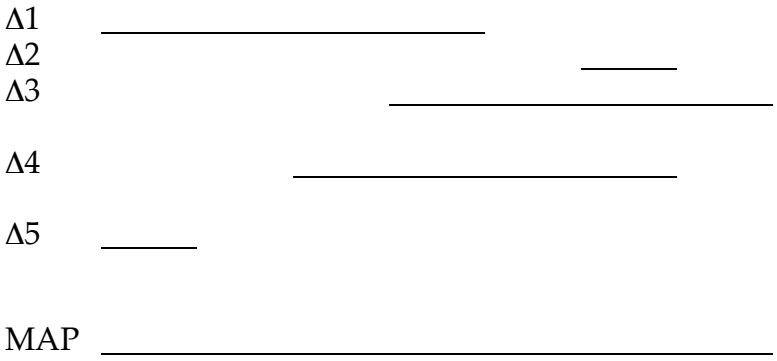
Thus the final proportions of gametes produced by a trisomic A A a organism will be 1/6 A A, 2/6 A a, 2/6 A, and 1/6 a.

In maize, the *su* locus is on chromosome VI; the mutant allele causes the endosperm to be sugary. Suppose you cross a homozygous *Su* plant to a homozygous *su* plant and then textcross the trisomic F_1. What phenotypic ratios

will be seen in the testcross progeny if the P_1 *Su* plant is (a) trisomic for chromosome VI; and (b) trisomic for another chromosome, e.g. V?

10. Three point mutants (a, b and c) were tested for complementation with the 5 deletion mutants (D1 through D5) diagrammed below. The data obtained from complementation tests is given in the table (+ = complementation; 0 = no complementation).

Show the approximate locations of the point mutations a, b and c on the line labeled "MAP".



	Deletions				
	1	2	3	4	5
a	o	+	o	o	+
b	o	+	+	+	o
c	o	+	+	o	+

11. Suppose you are doing genetics with maize and are trying to locate the gene *pr* (red endosperm). You have a strain of maize of genotype *pr pr* and in which both copies of chromosomes 9 have knobs (karyotype 9k 9k). You cross this with a strain of genotype *Pr Pr* in which neither chromosome 9 has a knob (9 9). The F_1 is testcrossed to a knobless *pr pr* strain. The numbers and phenotypes of the testcross progeny are as follows:

pr pr 9k 9	46
pr pr 9 9	3
Pr pr 9 9	45
Pr pr 9k 9	5

Is the *pr* locus on chromosome 9? In a sentence or two, explain how you can tell.

12. In her studies of yeast genetics, Janet isolated 5 adenine auxotroph mutants: *ade1*, *ade2*, *ade3*, *ade4*, *ade5*. She did some crosses to get each one in mating type **a** and α. Then she mated them in all pairwise combinations and tested the resulting diploids for their ability to grow on medium without adenine. Results are shown below, where "yes" means that the diploid can grow without adenine and "no" means it cannot.

ade1	*ade2*	*ade3*	*ade4*	*ade5*

ade1	no	no	yes	yes	yes
ade2		no	yes	yes	yes
ade3			no	yes	no
ade4				no	yes
ade5					no

(a) How many complementation groups did she find, and what mutants are in each group?
(b) How many different genes are represented in her collection of five mutants?
(c) Are *ade1* and *ade2* alleles? Are *ade1* and *ade3* alleles?