

1. (16 pts) The following two factor crosses were carried out, producing the indicated results. For each cross, answer the following: Are the genes linked?; If linked, determine the distance between the genes; If possible, indicate the genotypes of the true-breeding parents that produced the individuals that are underlined.

A. Aa Bb x Aa Bb → 45 AB, 15 aB, 15 Ab, 5 ab

not linked

can't tell parents

B. Cc Dd x cc dd → 15 CD, 60 Cd, 60 cD, 15 cd

linked, distance = $30/150 = 0.2$ or 20 map units

parents: CC dd x cc DD

C. Jj Kk x jj kk → 100 JK, 100 jk

linked, 0 map units (no recombinants produced)

parents: JJ KK x jj kk

D. Ee Ff x ee ff → 75 EF, 25 Ef, 25 eF, 75 ef

linked, distance = $50/200 = 0.25$ or 25 map units

parents: EE FF x ee ff

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2. (15) The following DNA sequence comes from the middle of the protein coding portion of a bacterial gene.

5'- CCTATTTAGATGAGTAAGTGTTCTGCATGAGC -3'

A. What is the sequence of the other DNA strand from this region?

5' - GCTCATGCAGAACACTTACACATCTAAATAGG -3'

B. What is the sequence of the mRNA from this region?

5' - GCUCAUGCAGAACACUUACACAUCUAAAUAGG -3'

C. On the mRNA sequence, mark the codons from this region of the gene.

5'G C|U C A|U G C|A G A|A C A|C U U|A C A|C A U|C U A|A A U|A G G3'

3. (20) Three independent mutations to leucine auxotrophy are recovered in *Saccharomyces cerevisiae*, and are called *leu1*, *leu2*, and *leu3*. Diploids were made by all three pairwise crosses. The diploids were sporulated, the asci dissected, and the spores that grew up were tested for growth on medium lacking leucine. The following results were obtained (+ indicates a spore that grew without leucine, - indicates a spore that did not grow without leucine):

leu1 x *leu2*

-	-	-
-	-	-
+	-	-
<u>+</u>	<u>+</u>	<u>-</u>
0	16	34

leu1, *leu2* linked: distance = $(16/2)/50 = 16$ mu

leu1 x *leu3*

-	-	-
-	-	-
+	-	-
<u>+</u>	<u>+</u>	<u>-</u>
20	10	20

leu1, *leu3* cen-linked: distance = $(10/2)/50 = 10$ mu

leu3 x *leu2*

-	-	-
-	-	-
+	-	-
<u>+</u>	<u>+</u>	<u>-</u>
66	18	66

leu3, *leu2* cen-linked: distance = $(18/2)/150 = 6$ mu

Make a map showing the linkage relationships of these three mutations.



4. (10) Three yeast genes are linked in the order $a—b—c$. The distance between a and b is 10 mu; the distance between b and c is 13 mu. In a cross of $a + by + c$, after the diploids are sporulated, what types of tetrads will be produced and with what frequencies? Assume that there is no chiasma interference.

like 5-34 in your assignments, correct answer on web site

20% of meioses have a crossover between a and b ; 26% have a crossover between b and c . If there is no interference, 5.2% have a crossover in each region at the same time.

$NPD = 1/4 \times 5.2\% = 1.3\%$, this accounts for 3.9 mu by our formula for distance.

$23 - 3.9 = 19.1$ mu that must be accounted for by tetratypes = 38.2% T.

The remainder ($100 - 38.2 - 1.3 = 60.5$) are PD.

5. (15) *Drosophila* females heterozygous for each of three recessive autosomal mutations with independent phenotypic effects (thread antennae, *th*; hairy body, *h*; and scarlet eyes, *st*) were testcrossed to males showing all three mutant phenotypes. The 500 progeny of this testcross were:

thread hairy scarlet	213
wild type	211
thread hairy	17
thread scarlet	18
hairy	21
scarlet	20

one of your assigned problems, 5-24

two classes are missing: thread and hairy scarlet; these are dco

A. Show the arrangement of alleles on the relevant chromosomes in the triply heterozygous females.

$h\ th\ st/+ + +$

B. Draw the best genetic map that explains these data.

$$h - th = (21 + 18)/500 = .078 = 7.8\ \text{mu}$$

$$th - st = (17 + 20)/500 = .074 = 7.4\ \text{mu}$$

C. Calculate any relevant interference values.

$$I = 1$$

6. (12) The pathways for the biosynthesis of glutamine (gln) and proline (pro) involve one or more common intermediates. Auxotrophic yeast mutants numbered 1-7 are isolated that require either pro or gln or both amino acids for growth, as shown in the following table (+ means growth; - means no growth). These mutants are also tested for their ability to grow on intermediates A-E. What is the order of these intermediates in the glutamine and proline pathways, and at which point in the pathway is each mutant blocked?

Mutant	A	B	C	D	E	gln	pro	gln + pro
1	+	-	-	-	-	-	+	+
2	-	-	-	-	-	-	+	+
3	-	-	+	-	-	-	-	+
4	-	-	-	-	-	+	-	+
5	-	-	+	+	-	-	-	+
6	+	-	-	-	-	-	+	+
7	-	+	-	-	-	+	-	+

one of your assigned problems, 7-30

7. (12) You found six T4 *rII* mutants that will not grow on *E. coli* K(lambda). You mixed together all possible combinations of two mutants (as indicated in the following table), and each mutant with wildtype, and scored for the ability of the mixtures to grow and make plaques (indicated as + in the table).

	1	2	3	4	5	6	wildtype
1	-	+	-	+	+	-	+
2		-	+	-	-	-	+
3			-	+	+	-	+
4				-	-	-	+
5					-	-	+
6						-	+
wildtype							+

A. How many genes does this test identify?

like 7-21, except #6 added, and wildtype (so that you can tell #6 is not dominant)
two genes

B. Which mutants are in which gene?

1, 3, 6

2, 4, 5, 6

C. One of these mutants behaves differently than the others in these tests - which mutant is it, and what is a likely explanation for its behavior?

#6 is probably a deletion of part or all of both genes, could also be a double mutant