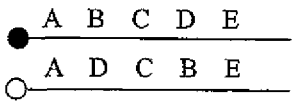
1. Inversions are known to affect crossing–over. The following homologs with the indicated gene order are given (the filled and open circles are homologous centromeres): (10%)



(a) Diagram the alignment of these chromosomes during meiosis.
(b) Diagram the results of a single crossover between homologous genes B and C in the inversion.
(c) Considering the position of the centromere, what is this sort of inversion called?

2. Three species are crossed and their progeny are examined cytologically. The chromosomal associations are as follows:

Cross	Bivalents	Univalents
A × A	10	0
B × B	5	0
C × C	5	0
A × B	5	5
A × C	5	5
B × C	0	10

Does this information shed any light on their evolutionary relationship? (10%)

3. Analysis of unordered yeast tetrads from the cross + + + × a b c yielded the following data: (10%)

Tetrad class	Spores				Number of asci
1	a b c	a b c	+ + +	+ + +	36
2	a b c	a + c	+ b +	+ + +	14
3	a + +	a + +	+ b c	+ b c	32
4	a b +	a + +	+ b c	+ + c	16
5	a b +	a b +	+ + c	+ + c	2

(a) Among these three genes, which of these genes is linked? Why?
(b) What is the map distance between linked genes?

4. During the first meiotic prophase, (a) when does crossing over occur? (b) When does synaptonemal complex begin to form? (c) Which stage are the chromosomes least condensed? (d) When are chiasmata first visible? (e) During which stage are the chiasmata terminalization completed? (10%)

5. Give the name of enzyme which catalyzes the following event? (6%)
(a) The addition of a specific amino acid to a tRNA molecule
(b) The formation of the peptide bond in protein synthesis during translation.
(c) Maintains chromosome lengths by adding repetitive sequences to the chromosome ends.

6. Compare the duplicate recessive epistasis and duplicate dominant epistasis. (4%)

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7. *HY5* is a gene that encodes a positive regulator of gene expression in response to light in *Arabidopsis*.
   (a) What do you predict would happen to expression of light regulated genes in a loss of function *hy5* mutant? (2 %)
   (b) To examine the action of the HY5 protein at the molecular level, the expression of two promoter-GUS reporter gene fusions was monitored. One of the fusions contained a light response element (G box) and the other lacked the light response element. Results are in the following. (A "+" indicates an increase in expression)

Promoter elements	*Light-activated GUS expression*			
	HY5$^+$ (wild type)		*hy5*$^-$ (mutant)	
	No light	+light	No light	+light
G box	--	+	--	--
No G box	--	--	--	--

   What would you conclude about the action of HY5? (3 %)
   (c) If you want to determine if HY5 regulates expression in nonphotosynthetic as well as photosynthetic tissues of the plant, how would you carry out the experiment? (5 %)
8. Three different pure-breeding strains of corn that produce ears with white kernels were crossed to each other. In each case the F1 plants were all red, while both red and white kernels were observed in the F2 generation in a 9:7 ratio. These results are tabulated below.

	F1	F2
White-1 X White-2	red	9 red : 7 white
White-1 X White-3	red	9 red : 7 white
White-2 X White-3	red	9 red : 7 white

   (a) How many genes are involved in determining kernel color in these three strains? (2 %)
   (b) Define your symbols and show the genotypes for these pure-breeding strains, White-1, White-2, and White-3. (3 %)
   (c) Diagram the cross between White-1 and White-2, showing the genotypes and phenotypes of the F_1 and F_2 progeny. Explain the observed 9:7 ratio. (5 %)
9. (a) Does the following pedigree suggest mitochondrial inheritance? Why or why

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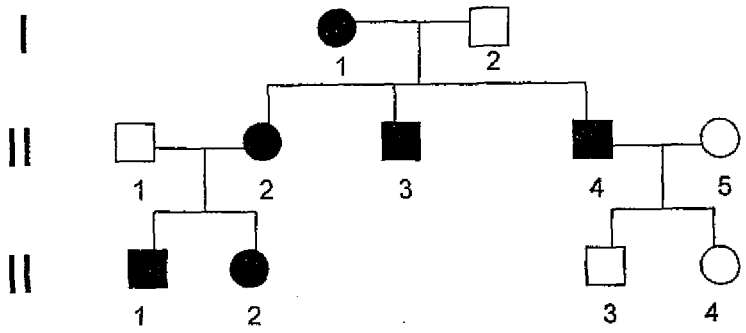
not? (2 %)

(b) Is there another mode of inheritance that is consistent with this data? (3 %)



10. Given the data below, explain which strains and growth conditions are important for reaching the following conclusions.
    (a) Arabinose induces coordinate expression of the *araBAD* genes (encoding kinase, isomerase, and epimerase). (2 %)
    (b) The *araC* gene encodes a positive regulator of *araBAD* expression. (3 %)

Genotype	Arabinose in Medium	Kinase	Isomerase	Epimerase
1. $C^+B^+A^+D^+$	no	--	--	--
2. $C^+B^+A^+D^+$	yes	+	+	+
3. $C^-B^+A^+D^+$	no	--	--	--
4. $C^-B^+A^+D^+$	yes	--	--	--

11. The gravitropic response in plants includes upward curve of the hypocotyl and flowering stalk and downward growth of the root.
    (a) It has been postulated that this response is auxin mediated. What is a genetic experiment to test this hypothesis? (5 %)
    (b) Auxin-regulated mRNAs have been identified in *Arabidopsis*. How would you determine the distribution of these auxin-regulated mRNAs in the part of the plant responding to gravity? (5 %)
12. In maize trisomics, $n + 1$ pollen is not viable. If a dominant allele at the *B* locus produces purple color instead of the recessive phenotype bronze, and a *Bbb* trisomic plant is pollinated by a *BBb* plant, what proportion of the progeny produced will be trisomic and have a bronze phenotype? (10 %)