

Exam Key
Biol/ MBios 301 (General Genetics) Spring 2003
First Midterm Examination A (100 points possible)
Note: this is one of three versions, with different orders of questions.
February 18, 2003

10 Multiple Choice Questions-4 pts. each (Choose the best answer)

1. You observe a 9:7 ratio of visible types in the F₂ generation of a cross between two homozygous lines of corn. Choose the correct statement(s) about this result.
 - a. A single gene is involved in the cross
 - b*. Two phenotypes are observed in the F₂ generation
 - c*. 9/16 of the progeny appear to have a dominant allele at both genes
 - d. a and b
 - e. b and c**

2. You cross two mouse strains heterozygous for four genes (AaBbCcDd). What proportion of the total offspring would be homozygous for all four genes?
 - a. 1/256
 - b. 1/32
 - c. 1/16**
 - d. 1/8
 - e. 1/4

3. Choose the correct statements about tetrad analysis in Neurospora.
 - a*. All of the products of a single meiosis are arrayed in order in the ascus.
 - b*. Crossovers between the gene and the centromere result in an alternating pattern known as "second division segregation".
 - c. Tetrad analysis in animals is done by studying cases where more than one offspring is born at the same time.
 - d. a and b**
 - e. a and c

4. Choose the correct ordering of the events in meiosis. Events:
 - (1) homologous chromosomes separate
 - (2) chromosomes split at the centromere and sister chromatids separate.
 - (3) homologous chromosomes pair
 - (4) homologous chromosomes recombine
 - a. (4), (3), (1), (2)
 - b. (2), (3), (4), (1)
 - c. (3), (4), (1), (2)**
 - d. (1), (2), (3), (4)
 - e. (2), (4), (3), (1)

5. Choose the correct statement(s) about the packing of DNA in a chromosome.
- a*. Histones are involved in the first level of folding, the nucleosome.
 - b*. Compaction is greatest at metaphase of mitosis in the cell cycle.
 - c. The DNA is less tightly packed in regions of heterochromatin.
 - d. a and b**
 - e. a and c
6. Mendel's basic observations were that:
- a*. Factors he called genes which determined traits were present in pairs in individuals, that they separated from each other during gamete formation, and that they re-joined in forming the next generation.
 - b. The factors affecting one trait were inherited independently of the factors affecting other traits.**
 - c. Genes located on the same chromosome tended to be inherited together in a cross.
 - d. Both a and b**
 - e. Both a and c
- Note: full credit for answers b or d, one point for answer a.**
7. What type of inheritance seems to be taking place in the human pedigree below?
- a. Autosomal recessive
 - b. Autosomal dominant
 - c. X-linked recessive**
 - d. X-linked dominant
 - e. Y-linked
8. Choose the correct statement(s) about chromosome abnormalities in humans
- a*. Chromosome abnormalities are present in about half of spontaneous abortions.
 - b*. The relatively good survival of individuals with some X chromosome abnormalities (such as XO and XXX) is thought to be related to the phenomenon of X chromosome inactivation.
 - c. XYY individuals are common among spontaneous abortions but not among live births.
 - d. a and b**
 - e. b and c

9. Genes far from each other on the same chromosome will show 50% recombination because:
- The sum of the map distances (cM) will be 50 when the distances for intervals between the genes are added.
 - Because crossing over is at the four strand stage, single crossovers between markers give 50% recombination, and multiple crossovers will average out to 50% recombination because crossing over is random with respect to strand.**
 - The presence of a centromere between the markers will result in preferential sister chromatid segregation.
 - Only one of the four products of meiosis in males is functional.
 - Chromosome rearrangements prior to meiosis transfer the genes onto other, non-homologous chromosomes, resulting in independent assortment
10. You are studying three recessive mutations (which we will call d, e and f) , all of which result in white coat color in gerbils instead of the wild-type brown color. Crossing dd individuals with ee gives brown-colored progeny, crossing dd with ff results in white progeny and crossing ee with ff results in brown-colored progeny. What is your interpretation of these results?
- The d and e mutations are in different genes
 - The d and f mutations are in different genes
 - The e and f mutations are in different genes
 - Both a and b are true
 - Both a and c are true**

* these answers to multiple choice questions are worth one point.

10 Short Identification- 2 Pts. each

11. phenotype- **observable characteristics of an organism**

12.tetraploid- **having four sets of chromosomes**

13.linkage- **joint inheritance of alleles located near each other on a chromosome**

- 14.allele- alternate form of a gene
- 15.centromere- location on a chromosome where sister chromatids are held together and where spindle fibers attach.
- 16.dosage compensation- process by which expression of X-linked genes is balanced between males and females Done by X chromosome inactivation in mammals.
- 17.Turner syndrome- XO type in humans; sterile, short female with lack of secondary sexual characteristics.
- 18.trisomy- an extra copy of one chromosome, $2n + 1$. Example: Down syndrome in humans.
- 19.RFLP- restriction fragment length polymorphism. DA variations detected by restriction enzyme digestion, electrophoresis, and probing using specific sequences.
- 20.variable expressivity- A particular genotype (e.g., Aa) may not express the phenotype to the same degree in all individuals.

6 Problems (40 Points total) (Showing your work will make it easier for us to give partial credit).

21. (10 points) The following cross is performed in fruit flies: +++/+++ X abc/abc to give F1 progeny of the genotypes +++/abc. These F1s are crossed with abc/abc testers, giving the following cross:

+++/abc X abc/abc

The following testcross progeny are observed:

Genotype	Number
+++/abc	321
abc/abc	303
++c/abc	134
ab+/abc	122
+bc/abc	50
a++/abc	46
+b+/abc	13
a+c/abc	11

- a) What is the map distance between the a and b genes?
 $50 + 46 + 13 + 11 = 120$; $120 / 1000 = 12\% = 12 \text{ cM}$
- b) What is the map distance between the b and c genes?
 $134 + 122 + 13 + 11 = 280/1000 = 28\% = 28 \text{ cM}$
- c) What is the observed frequency of double recombinants?
 $24/1000 = 2.4\%$
- d) What is the map distance (cM) between the a and c genes?
 $12 + 28 = 40 \text{ cM}$
- e) What is the level of interference (i)?
 $c = 24/33.6 = 0.71$; $i = 1 - c = 0.29$

22. (6 points) The following numbers of various types of asci are observed in a Neurospora cross (a+b+ X ab). (Each genotype of spore is represented twice, for a total of eight spores).

Type of spore	Number of asci with this type
a+b+ a+b+ a b a b	180
a+b+ a+b a b+ a b	20

- a) Are these genes linked?

Yes, lots of PD, no NPD seen.

- b) What is the map distance, if any, between the a gene and the centromere?

0 cM (no second division segregation)

- c) What is the map distance, if any, between the b gene and the centromere?

5 cM = 1/2 (% sds) = 1/2 (20/200) (100) = 1/2 (10)

23. (4 points). Test the hypothesis of single gene Mendelian segregation in the backcross below with the Chi square test. Please show your results, reporting your Chi-square value, degrees of freedom and p-value. What are your conclusions? (Chi square figure from book is provided on the last page).

Parents: Red X White

F1 progeny are all Pink.

Backcross of Pink progeny to White parent gives 120 Pink and 80 White progeny.

	<i>Pink</i>	<i>White</i>
<i>Observed</i>	<i>120</i>	<i>80</i>
<i>Expected</i>	<i>100</i>	<i>100</i>
<i>O - E</i>	<i>20</i>	<i>-20</i>
<i>(O - E)²</i>	<i>400</i>	<i>400</i>
<u><i>(O - E)²</i></u>	<i>4</i>	<i>4</i>
<i>E</i>		

Chi square value is 4 + 4 = 8. There is one degree of freedom (one less than number of classes, 2). The p value (from figure) is about 0.005, which is less than .05, so we reject the hypothesis of single gene Mendelian inheritance.

24. (5 pts). Given the following results from tests for a DNA marker (F) located at the centromere of the X chromosome in the parents of an XXY child and in the child himself, interpret which parent provided the extra chromosome and at which meiotic division the error occurred.
 Father has the F 65 allele.
 Mother has the F 43 and F 24 alleles.
 XXY son has (is homozygous for) the F 43 allele.

Two Xs from mother (both with the 43 allele) so the error was in the mother. Error was at the second meiotic division, since two copies of one allele from the mother were transmitted.

25. (5 points) It has been proposed that there is average of one cM (centimorgan) of genetic distance per one megabase (Mb, million bases) of DNA (physical distance). What types of genetic material or chromosome regions would be likely to have different relationships of these values from this average?

There is less crossing over in regions of heterochromatin, which are usually near the centromeres and the telomeres of the chromosomes.

26. (5 pts.) Albinism (white body color, pink eyes) (c) is recessive to the presence of color (C) in mice. Black (B) is dominant to brown (b) in the presence of the color (C) gene. What ratio of color types would you expect to see in the F₂ generation of a cross (P generation) of ccBB (albino) to CCbb (brown) mice?

9 C-B- (black)

3 C-bb (brown)

3 ccB- (albino)

1 ccbb (albino)

Overall ratio is 9:3:4

27. (5 pts). A woman with normal vision and type A blood type, whose father was color blind (X-linked recessive) and had type O blood, marries a man with normal vision who had type O blood. Blood type is inherited autosomally. What proportion of all of their offspring will be colorblind males with type O blood? Explain your result.

Woman was $X^+X^c, I^A I^O$, Man was $X^+Y, I^O I^O$

Chance of colorblind male type O child =

(1/2) X^c frm mother, (1/2) I^O allele from mother, (1/2) Y from father.

Overall probability is $1/2 \times 1/2 \times 1/2 = 1/8$