BIOLOGY 240 - GENERAL GENETICS

Circle your discussion section/TA:

W 12:20 (Amy Russell)  
W 3:35 (Amy Russell)  
R 9:05 (Amy Creekmore)  
F 12:20 (Amy Creekmore)  
R 12:20 (Amy Donhardt)  
R 3:35 (Amy Donhardt)

EXAM 1, 2000

This closed-book exam is worth 50 points. PLEASE! Eyes on your paper only!!

1. (3 pts) The white eye gene in Drosophila is recessive and sex-linked. Assume that a white-eyed female is mated to a wild type male. Provide the phenotypes of the offspring and give their proportions.

\[ \text{ww} \times \text{w}^+ \text{Y} \]

\[ \frac{1}{2} \text{w}^+\text{w} \quad \text{wild female} \]

\[ \frac{1}{2} \text{w}^+\text{Y} \quad \text{white eye male} \]

2. (3 pts) The trait for medium-sized leaves in iris is determined by the genetic condition Aa. Plants with large leaves are AA while plants with small leaves are aa. Plants with red flowers have genotype RR, pink have Rr, and white have rr. A cross is made between a plant that has medium-sized leaves and pink flowers, and a plant with medium-sized leaves and white flowers. If they produce 320 seedlings, what phenotypes and in what numbers would you expect? Assume no linkage. Show your work. (You should be able to do the arithmetic by hand but if you cannot, simply set up the equations.)

\[ \text{AaRr} \times \text{Aarc} \]

\[ \text{AA Rr} + \frac{1}{4} \text{Ar} + \frac{1}{2} \text{Aa} + \frac{1}{8} \text{rr} \]

40 large leaf pink flower

40 large leaf white flower

80 medium leaf pink flower

80 medium leaf white flower

40 small leaf pink flower

40 small leaf white flower
3. (9 pts) In the fruit fly, *Drosophila melanogaster*, a spineless (no wing bristles) female fly is mated to a male that is claret (dark eyes) and hairless (no thoracic bristles); these are all recessive conditions of wild-type phenotypes. Phenotypically wild-type F1 female progeny were mated to fully homozygous (mutant) males and the following progeny (1000 total) were observed; note that unless the mutant phenotype is mentioned, the fly is wild type for that gene.

<table>
<thead>
<tr>
<th>PHENOTYPE</th>
<th>NUMBER OBSERVED</th>
</tr>
</thead>
<tbody>
<tr>
<td>spineless</td>
<td>321</td>
</tr>
<tr>
<td>claret, hairless</td>
<td>309</td>
</tr>
<tr>
<td>wild</td>
<td>38</td>
</tr>
<tr>
<td>hairless, claret, spineless</td>
<td>32</td>
</tr>
<tr>
<td>claret</td>
<td>18</td>
</tr>
<tr>
<td>hairless, spineless</td>
<td>12</td>
</tr>
<tr>
<td>claret, spineless</td>
<td>130</td>
</tr>
<tr>
<td>hairless</td>
<td>140</td>
</tr>
</tbody>
</table>

(a) (1 pt) Identify parental (P), single crossover (SXO), and double crossover (DXO) progeny by putting the abbreviations next to the appropriate classes in the list above.

(b) (2 pts) Which gene is in the middle? Show your work. Circle your answer.

(c) (2 pts) With respect to the three genes mentioned in the problem, what are the genotypes of the homozygous parents used in making the phenotypically wild F1 heterozygote?

(d) (4 pts) Give the map distances between the gene pairs. Show your work. Circle your answer. (If necessary, use the back of the page for computations. If you don't have a calculator, just set up the computations.)
4. (5 pts total) Consider the pea plants that Mendel studied. Assume that a cross is made between a heterozygous tall pea plant and a homozygous short pea plant. Fifty offspring are produced in the following numbers:

30 = tall  
20 = short

a) (1 pt) What frequency of tall and short plants is expected?

\[ \frac{25}{50} \text{ tall} \]
\[ \frac{25}{50} \text{ short} \]

b) (2 pts) Test whether the observed and expected values differ significantly. Compute a chi-square value associated with the appropriate test of significance. (If you didn't bring a calculator, set up the computations, eyeball an approximate value, and use that in the table. But note you should be able to do these computations by hand.)

\[ \chi^2 = \sum \frac{(O - E)^2}{E} \]

\[ \frac{(30 - 25)^2}{25} = 1 \]
\[ \frac{(20 - 25)^2}{25} = 1 \]
\[ \chi^2 = 2 \]

C) (1 pt) How many degrees of freedom are associated with the test of significance?

1

d) (1 pt) What do you conclude about the data? (Indicate how you reached this conclusion.) The data indicates the gene are on different chromosomes. This is supported because the calculated \( \chi^2 \) is less than the \( \chi^2 \) given in the table under 0.05 probability. This means the genes segregate independently. Use this table to test the significance of your computation:

<table>
<thead>
<tr>
<th>df</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.05</td>
</tr>
<tr>
<td>1</td>
<td>3.84</td>
</tr>
<tr>
<td>2</td>
<td>5.99</td>
</tr>
<tr>
<td>3</td>
<td>7.82</td>
</tr>
<tr>
<td>4</td>
<td>9.49</td>
</tr>
</tbody>
</table>
5-7. Multiple choice. Choose the best answer; more than one answer may be true, but only one is completely relevant to the question.

5. (2 pts) An allele is
   a) one of the bases in DNA
   b) an alternate form of a gene
   c) another term for epistasis
   d) present only in males and is responsible for sex determination
   [Correct answer: b]

6. (2 pts) The human condition of Huntington disease is unusual because
   a) It shows variable expressivity
   b) It is inherited as a sex-linked dominant lethal
   c) It is inherited as a dominant lethal
   d) It is linked to albinism
   [Correct answer: c]

7. (2 pts) Which of the following illustrates epistasis?
   a) Sickle-cell anemia.
   b) Albinism in mammals.
   c) An allelic series.
   d) Genetic control of color in peas.
   [Correct answer: b]

8. (2 pts) In Neurospora, the genes a and b are located on the same chromosome; the mutant alleles are a and b and + indicates the wild-type alleles. Crosses are made between a wild-type strain (+ +) and the doubly mutant strain (a b). The spores are dissected from the spore cases in order and the phenotype of each is determined. Circle any and all of the statements below that are TRUE with respect to the findings:
   a) Spore cases with only both parental types have them in a ratio of 4:4.
   b) Spore cases that have recombinant a + spores also have recombinant + b spores.
   c) All spore cases have either only wild-type (+ +) or only mutant (a b) spores.
   d) Some spore cases have a + or + b spores, but no + + or a b spores.
   [Correct answer: a, b, c, d]

9. (2 pts) The human condition XXY arises by meiotic nondisjunction of sex chromosomes. Generally, nondisjunction can occur in the female, or maternal, parent at either the first or second meiotic division (mat MI error and mat MII error, respectively) and also in the male, or paternal, parent, also either during the first or second meiotic division (pat MI and pat MII errors, respectively).
   For the condition XXY, assume that there is no more than one nondisjunction event that causes the condition. State the types of error (mat MI, mat MII, pat MI, and pat MII) that could give rise to the condition (list all that apply if more than one can account for the condition).
10. (1 pt each) Mark each of the following statements T (true) or F (false). If a statement is false, rewrite it to make it true. You will need to make a substantial rewrite; don’t simply change “is” to “is not” or vice versa.

To test Mendel’s Law of Independent Assortment one needs a minimum of two different genes with two alleles each.

True

A 9:3:3:1 ratio is expected from a dihybrid testcross.
False

 Hemizygosity would most likely be associated with incomplete dominance.
False. Hemizygosity would most likely be associated with codominance.

A chromosome may contain one or two chromatids in different phases of the mitotic or meiotic cell cycle.

T

During its vegetative cycle, *Neurospora crassa* is a haploid organism.
T

During meiosis chromosome number reduction takes place in anaphase II.
F. During meiosis, chromosome number reduction takes place in anaphase I.

A bivalent at-pachytene contains four chromatids.
T

In the ordered tetrad spore cases of *Neurospora*, we can recover exactly half the products of a single meiosis.

False. In the ordered ..., we can recover all the products ...

In humans, the male is the homogametic sex.
False. In humans, the female is homogametic.

In the experiment by Creighton and McClintock to investigate the physical basis of recombination, chromosomes from genetically recombinant progeny resembled those of the parents.
False. Non-recombinant

11. (2 pts) Dragons have a diploid chromosome number of 48.

a. How many homologous pairs of chromosomes are present at metaphase I of meiosis?

24

b. How many chromosomes are present at metaphase II of meiosis?

24
12. (4 pts) This question concerns inheritance of the X and Y chromosomes in humans.

a. Circle the grandparent(s) from which a female could possibly inherit an X chromosome:

maternal grandmother, mat. grandfather, paternal grandfather, pat. grandfather, all

b. Circle the grandparent from which a male MUST inherit a sex chromosome (either X or Y):

maternal grandmother, mat. grandfather, paternal grandmother, pat. grandfather

13. (4 pts total) Below is a pedigree of a fairly common human hereditary trait where the boxes represent males and circles, females. Shading symbolizes the abnormal phenotype. Only one gene pair is involved.

(a) (2 pts) Is the inheritance pattern X-linked or autosomal, dominant or recessive?

autosomal (recessive)

(b) (2 pts) Give the genotype of each individual in the youngest generation; if more than one genotypic possibility exists, present all possible alternatives.

\[
\begin{array}{c}
\text{aa} & \text{Aa} & \text{aa} \\
\text{AA} & \text{Aa} & \text{aa} \\
\text{AA} & \text{Aa} & \text{AA}
\end{array}
\]