Biology 105: Introduction to Genetics
Midterm EXAM
Fall 2006

Name ____________________________________

Student ID ______________________________

Before starting, write your name on the top of each page
Make sure you have all 10 pages

You can use the back-side of the pages for scratch, but we will not grade answers written on the back-side of the page.
Unsolved fractions are acceptable answers

Part I Definitions
20 points

Part II Short Answer
20 points

Part III True or False
15 points

Part IV Multiple Choice
25 points

Part V Extended Calculation
20 points

Total

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Part 1
Definitions

Allele

Different forms of a gene

Chromosome theory of inheritance

The inheritance pattern of genes parallels the behavior of chromosomes at meiosis. It was therefore deduced that genes reside on chromosomes and the segregation and behavior of chromosomes during meiosis dictates the inheritance of genetic traits

Map unit

A measure of distance between two genes. Based on the frequency of meiotic recombination that occurs between them. Defined as #recom/total progeny x 100%

Mendels law of independent assortment

Different genes assort independently from one another during gamete formation.

Barr body

The inactive X chromosome in human females. It is highly condensed chromosome and exists due to dosage compensation – to equal the amount of expression of X-linked genes in females and males
Part2
Short answers

1. Why is the recombination frequency between two genes far apart on the same chromosome never higher than 50%?

Multiple crossovers and the fact that recombination occurs between two non-sister chromatids at the four strand stage in meiosis I.

2. An X-linked dominant allele causes hypophosphatemia in humans. A man with hypophosphatemia marries a normal woman. What proportion of their sons will have the disease?

0%

3. A farmer maintains two true-breeding lines of strawberries—sweet tasting strain and a bitter tasting strain. He crosses these two strains and in the F1 obtains plants that produce tangy tasting berries. He crosses the F1 to themselves in the hope of obtaining a true-breeding tangy tasting berry. In the F2 only half the plants are tangy tasting. The rest have either sweet or bitter tasting berries. Explain this pattern of inheritance.

Incomplete inheritance
Two genes T and S code for height and skin tone in vampires. (T=tall, t=short; S=smooth, s=wrinkled). A heterozygous TtSs individual mates with a homozygous ttss individual. They have progeny: 39 tall wrinkled; 40 short smooth; 9 tall smooth; 10 short wrinkled. Are the two genes linked or on separate chromosomes. If linked what is the distance between these two genes.

If the two are not linked then you should see 1:1:1:1 of the four classes. You don’t, therefore the genes are linked.

Parental class is at least 50%. Therefore 39 and 40 are parental class and 10 and 9 are recombinant. MU= 19/98   19%

A species of deer bearing a single long chromosome is discovered. A rare triploid female is crossed to a rare triploid male. With respect to ploidy, describe the type and frequency of progeny expected from this mating. Include a punnet square in your answer

Male and female triploids will produce two types of gametes

-----0------
or
-----0------  -----0------

Expected progeny will be ¼ tetraploid, 2/4 triploid, ¼ diploid
Part 3
True/False
Indicate whether the following statements are true or false.

1. _____F____Mendel identified seven traits that assorted independently. The only explanation for this behavior is that the genes controlling these traits reside on different chromosomes.

2. _____F____A breeder identifies a dog with clumpy hair. Through multiple generations he crosses clumpy hair dogs with one another to establish a true-breeding line. However, with each generation he obtains 25% short hair dogs, 50% clumpy hair dogs and 25% long hair dogs. He concludes that multiple genes control the clumpy hair trait.

3. _____T____Wild-type (red eye) Drosophila males are crossed to white eyed females. The eye color gene resides on the X-chromosome. One out of every 2000 female progeny flies is white eyed. These females are most likely the result of a rare chromosomal non-dysjunction during meiosis.

4. _____F____A true breeding double dominant strain of corn (AABB) is crossed to a true breeding double recessive strain (aabb). The F1 plants (AaBb) are then test crossed. If the A/a locus is linked to the B/b locus then we should expect more Ab and aB gametes compared to AB and ab gametes in the F1 plants.

5. _____F____In the pedigree below, the incidence of a common hereditary disease is indicated by darkened symbols. The best interpretation from the pedigree is that an autosomal recessive gene causes the disease.
Part 4
Multiple choice

1. _____A_______A human disease afflicted a family as shown in the accompanying pedigree.

The most likely mode of inheritance is
A  X-linked dominant
B  X-linked recessive
C  Y-linked dominant
D  Y-linked recessive
E  autosomal dominant

2. _____D_______Inversions result in
A  the loss of chromosomal material
B  the gain of chromosomal material
C  rearrangements involving two different chromosomes
D  rearrangements involving only a single chromosome
E  none of the above

3. _____D_______Drosophila homozygous for the mutation called delta have abnormally curved wings. Drosophila homozygous for the wild type allele of this gene have normal wings. The delta mutation behaves as a
A  dominant
B  co-dominant
C  incomplete dominant
D  more information needed
E  lethal mutation
4  ____A______ In humans, XXY and XO individuals are
A  male and female respectively
B  female and male respectively
C  males only
D  females only
E  lethal

5  ______E______ Which of the following does not occur during meiosis I
A  recombination
B  replication of homologous chromosomes
C  separation of homologous chromosomes
D  pairing of homologous chromosomes
E  separation of sister chromatids

6  ______C______ How many types of gametes will an individual of the genotype
AaBBCcDDEEFFGg produce
A  2
B  4
C  8
D  16
E  32

7  ______A______ Three genes on the second chromosome of Drosophila are shown
below

--------S-----------------------------P-----------------------------T--------
        18 MU                20 MU

Given the map, in a cross between a SsTt x sstt fly, what percentage of recombinant
progeny do you expect
A  slightly less than 38%
B  slightly greater than 38%
C  38%
D  50%
E  0%

8  _____E_______ Dosage compensation refers to a phenomenon in which
A  a set of autosomes becomes inactive in mammalian females
B  a set of autosomes becomes inactive in mammalian males
C  The Y chromosome becomes inactive in mammalian males
D  extra chromosome resulting from a non-dysjunction are expelled from the nucleus
E  An X chromosome becomes inactive in mammalian females
9 _____B____ In a cross of BbDd x BbDd what proportion of the progeny will have the dominant B allele AND the dominant D allele

A  1/4  
B  9/16  
C  3/16  
D  1/16  
E  none of the above

10 _____C_____ The most common form of color-blindness in humans’ results from an X-linked recessive gene. A phenotypically normal couple has a normal daughter and a son who is colorblind. What is the probability that the daughter is heterozygous

A  100%  
B  75%  
C  50%  
D  25%  
E  0%

11 _____B_____ An allele was identified in human populations that produces hairy ears. This trait is passed exclusively from father to son. On which chromosome is the gene most likely to reside

A  X  
B  Y  
C  autosome  
D  either sex chromosome  
E  polytene chromosome

12 _____D______ The region of the chromosome to which the spindle attaches is known as the

A  chromatid  
B  telomere  
C  acromere  
D  centromere  
E  octamer
Part 5  
Extended calculations  
Problem 1)  
Autosomal genes B and F are separated by a distance of 15 MU. Female Drosophila with one homolog bearing the B---f alleles and the other homolog bearing the b----F alleles are crossed to males doubly homozygous for the recessive alleles (b----f) of these genes. 

A) list the genotypes and frequency of gamete classes produced by the male  
Genotype= bbff  
One gamete class= bf  

B) list the genotypes and frequency of gamete classes produced by the female  
Genotype= B---f  
b----F  
gamete classes  

Parental B----f 0.425  
b----F 0.425  
recombinant B----F 0.075  
b----f 0.075  

C) What proportion of the progeny from this cross will be Bbff  

bf  

0.425 Bf Bbff  
0.425 bF bbFf  
0.075 BF BbFf  
0.075 bf bbff  

0.425  

D) What proportion of the progeny from this cross will be bbff  

0.075
Problem 2)
An individual heterozygous for three genes (AaBbCc) is test-crossed to an aabbcc individual and the progeny are classified by the gamete contribution from the heterozygous parent as follows:

<table>
<thead>
<tr>
<th>Gamete Contribution</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>A B c</td>
<td>299</td>
</tr>
<tr>
<td>a b C</td>
<td>282</td>
</tr>
<tr>
<td>a b c</td>
<td>158</td>
</tr>
<tr>
<td>A B C</td>
<td>142</td>
</tr>
<tr>
<td>a B c</td>
<td>48</td>
</tr>
<tr>
<td>A b C</td>
<td>51</td>
</tr>
<tr>
<td>A b c</td>
<td>8</td>
</tr>
<tr>
<td>a B C</td>
<td>10</td>
</tr>
</tbody>
</table>

A) Are the three genes linked? Show your reasoning.
Yes.

B) Which alleles are present on each of the parental chromosomes? Show your reasoning.
The most frequent classes represent parental Allelic configuration: ABc and abC

C) What is the order of these genes on the parental chromosomes? Show your reasoning.
Expected three DCO classes are
ABc or AcB or BAc
abC aCb baC

DCO

Abc ACB BaC
aBC acb bAc
Observed DCO class is Abc and aBC
Therefore gene order is ABC

D) Indicate map distance between these three genes

A to B \[ \frac{48+51+10+8}{998} = 11.7 \]

B to C \[ \frac{158+142+10+8}{998} = 31.9 \]