Name: _____ Student #: _____

BIOL2107 Fundamentals of Genetics
Midterm I

Version 1

February 9, 2015

Name: _____ Student #: _____

A. Multiple choice (15 questions worth 1 mark each). Answer multiple choice questions on the answer sheet provided.

1. _____ are changes to the nucleotide sequence of a DNA.
a. alleles
b. mutations
c. genotypes
d. linkage groups
e. dyads

2. _____ is a form of cell division that involves a reductional division step.
a. meiosis
b. prophase
c. telophase
d cytokinesis
e. mitosis

3. _____ refers to the interaction of two alleles at a single locus in which the heterozygotes resemble both of their parents. The parents are homozygous for different alleles of this gene and thus have different phenotypes.
a. Codominance
b. Incomplete dominance
c. Pleiotropy
d. Polymorphism
e. Multimorphic

4. Sickle cell anemia is a recessive genetic disorder occurring in individuals carrying two copies of the $HB\beta^S$ allele of the β-globin gene. The $HB\beta^S$ allele of the β-globin gene_____.
a. is dominant to $Hb\beta^A$.
b. is recessive to $Hb\beta^A$.
c. is codominant with $Hb\beta^A$.
d. is incompletely dominant to $Hb\beta^A$.
e. exhibits a variety of dominance relationships with $Hb\beta^A$.

Name: _____ Student #: _____

5. Pure breeding sweet pea plants with white flowers are crossed to yield an F1 generation with all purple flowers. Following a F1 selfcross, a 9:7 ratio of purple to white flowers in the F2 generation was observed. What is the most plausible explanation?
a. This is an example of incomplete dominance involving 2 loci.
b. Alleles at two independent assorting genes are exhibiting complementary gene action.
c. Flower colour is controlled by two genes that are linked.
d. This represents a monohybrid cross with incomplete dominance.
e. This represents an example of dominant epistasis.

6. In a dihybrid cross in which the A and B genes sort independently,, the A and B alleles exhibit incomplete dominance over their respective a and b alleles. The A allele controls seed colour while the B allele controls flower colour. How many possible combinations of phenotypes can be generated?
a. 3
b. 4
c. 9
d. 16
e. 25

7. What is the phenotype of fruit flies (*Drosophila melanogaster*) carrying two copies of the X chromosome and 1 copy of the Y chromosome?
a. Normal female
b. Normal male
c. Hermaphrodite
d. Klinefelter syndrome
e. Dies before hatching.

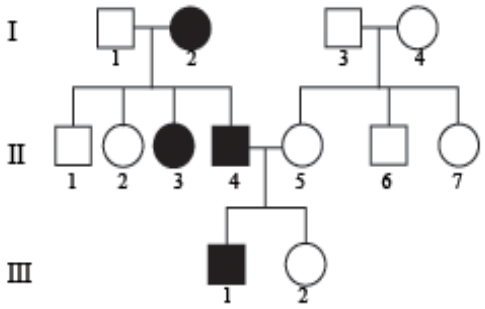
8. How many sister chromatids are present during metaphase I and metaphase II of meiosis in *Fishus stinkus* if this organism has 2n=8 chromosomes?
a. 4 and 4
b. 4 and 2
c. 8 and 8
d. 16 and 8
e. 8 and 4

9. What combination listed below best describes chromosome number and DNA content during metaphase I?
a. the cells are diploid with 2C DNA content.
b. the cells are diploid with 4C DNA content.
c. the cells are tetrads with 2C DNA content.
d the cells are tetraploid with 4C DNAcontent.
e. the cells are haploid with 2C DNA content.

10. In females (human), meiosis _____.

a. is initiated following puberty.
b. is initiated once a month.
c. is asymmetrical.
d. is initated following fertilization.
e. is symmetrical.

Use the following pedigree to answer questions 11-13 and assume that the disease causing trait under consideration is rare with 100% penetrance and that there is no consanguineous mating in previous generations.



11. What pattern of inheritance is most likely represented in the pedigree above.
a. recessive lethal
b. autosomal recessive
c. autosomal dominant
d. recessive X linked
e. dominant x-linked

12. Using the same pedigree, what is the probability that the father of individual I-2 (1st generation #2) was unaffected?
a. 0 %
b. 25 %
c. 50 %
d. 75 %
e. 100 %

13. Using the same pedigree, what is the probability that the future great grand children of individual III-1 (3rd generation # 1) will be affected by the disease?
a. 0 %
b. 12.5 %
c. 25 %
d. 50 %
e. 100 %

14. In *Saccharomyces cerevisiae*, meiosis leads to the formation of _____.
a. ordered tetrads
b. unordered tetrads
c. ordered octads
d. disordered tetrads
e. disordered octads

15. Considering 2 genes in a tetrad analysis in *Saccharomyces cerevisiae*, how would you interpret the outcome of a cross that leads to very few non-parental ditypes compared to parental ditypes?
a. the genes are close to the centromere.
b. one gene is on each side of the centromere.
c the genes are linked.
d. the genes are on separate chromosomes
e. the genes on the same chromosome but far apart.

Name: _____ Student #: _____

B. Short answer section
Answer 2 of these 4 questions in the space provided. (5 marks each)

1. The ABO blood system is controlled by 3 alleles at the I locus (I^A, I^B and I^O).
(a) Indicate the known dominance relationships between each pair of alleles and then express these relationships as a dominance hierarchy (1 mark).
(b) How many blood types can be produced from these 3 alleles alone (1 mark).
(c) If a male with type A blood has 2 children with a woman with type B blood and the first born has type O blood, what is the chance that the second child has AB blood type? Show all relevant genotypes at I and explain the rationale and your calculation (3 marks).

a) $I^A = I^B > I^O$ (1 mark)
b) 4 blood types (1 mark)
c) 25% or 1/4 (1 mark)

Rationale:
for 1 mark
A blood type corresponds to either $I^A\ I^A$ or $I^A\ I^O$.
B blood type corresponds to either $I^B\ I^B$ or $I^B\ I^O$.
However the fact that the first born had type O blood ($I^O\ I^O$) indicates that both parents must have been heterozygous for their respective dominant alleles ($I^A\ I^O$ and $I^B\ I^O$).

for the 2nd mark
From this cross, we expect a 1:1:1:1 ratio of $I^A\ I^B$: $I^A\ I^O$: $I^B\ I^O$: $I^O\ I^O$. Therefore, the probably that any of their children have AB blood type is 1/4 or 25%.

NOTE: you didn't need to write all possible genotypes as long as you indicated the genotypes of the parents and the probability of $I^A\ I^B$.

Name: _____ Student #: _____

2. You have identified a new species of *Drosphila* and you have mapped several genes to specific chromosomes. In 2 point crosses, you found that the white eye (w) gene and the spotted body (s) genes are 10 map units apart on the X chromosome. White eyes (w) is recessive to red eyes (w+) and spotted body (s) is recessive to solid (s+). You cross a true breeding white-eyed female fruit fly with solid colour to a red-eyed male fruitfly with a spotted body. You then self cross the F1 generation to generate F2 progeny. Outline these crosses in the space provided and answer the following questions.

(a) what percent of the male offspring will have spotted body with white eyes in the F1 generation?
(b) What proportion of the F2 male progeny are expected to be parentals? Show all male genotypes.
(c) What percentage of these F2 males are expected to have red eyes and a solid body?
(d) What genotypes and corresponding phenotypes do you expect among the female F2 offspring?

P	ws+/ws+	x	w+s/Y
F1	ws+/w+s		ws+/Y

F2 **parentals**

females	**males**
ws+/ ws+	ws+/Y
w+s/ws+	w+s/Y

recombinants

females	**males**
ws/ws+	ws/Y
w+s+/ws+	w+s+/Y

a) 0 % because all F1 males will have white eyes with solid body (X comes from mother).
b) 90%. 100%-10% recombinants because genes separated bu 10 mu.
c) 5%. half of the recombinants are w+s+/Y (0.5x10%)
d) From F2 above

ws+/ ws+	white eyes with solid colour
w+s/ws+	red eyes with solid colour
ws/ws+	white eyes with solid colour
w+s+/ws+	red eyes with solid colour

Name: _____ Student #: _____

3. You have been trying to determine the genetic interaction between 2 genes that control coat colour in mice (B and C). In monohybrid experiments, you have found that B (black) is dominant over b (brown). Using other true breeding strains in a separate monohybrid experiment, you determined that C (black mice) is dominant over c (albino mice). To determine how these genes interact, you cross true breeding albino mice with true breeding brown mice. The F1 progeny were all black. In the F2 generation, you observed black, brown and albino mice. Assuming that the true breeding albino mice were not heterozygous at b (i.e. not Bb), answer the following questions and show your work.

(a) Give the starting genotypes of the pure breeding parental albino and brown mice as well as their hybrid F1 progeny (1 mark).
(b) Use a Punnett square to visualize the genotypes produced in the F2 generation? (2 marks)
(c) What interaction between C and B best explains the results of an F1 selfcross that results in 18 black, 6 brown and 8 albino mice (1 mark).
(d) what cross would you perform to conclusively determine the genotype of the albino mice at the b and c loci? Include the genotypes in your answer (1 mark)

(a) BBcc albino and bbCC brown gives BbCc

(b) BC Bc bC bc are gamete types in both dimensions of the Punnett square. Fill in the blanks.

(c) recessive epistatic relationship where cc masks the phenotype of the B gene (B- or bb). One expects a 9:3:4 ratio

(d) test cross with bbCC. The CC is required to unmask the epistatic relationship.

Name: _____ Student #: _____

4. In *Drosophila*, a fully heterozygous female at 3 linked genes a, b, c (+++/abc) was mated with a male that was homozygous recessive at all three loci. The following progeny were counted:

genotypes	Numbers
+,+,+	430
a,b,c	420
a,+,+	23
b, c,+	25
c,+ ,+	43
a, b,+	44
b,+,+	8
a, c,+	7
Total	1000

(a) Determine the order of these 3 genes.
(b) Calculate the distance in map units between each pair of genes using the data provided.
(c) Was their interference? Explain.

a) a b c or c b a

b) a to b: RF= (23+25+8+7)/1000*100%=6.3% therefore 6.3 mu
b to c: RF=(43+44+8+7)/1000*100%=10.2% therefore 10.2 mu
a to c is the sum of a to b and b to c or 16.5 mu
or a to c: RF=(23+25+8+7+43+44+8+7)/1000*100%=16.5% or 16.5 mu

c) expected DCO=.063*,102=.00126
observed DCO=(8+7)/1000=0.015
since observed DCO> expectedDCO there was no interference