

Name:

Student #:

---

# **BIOL2107 (fundamentals of genetics)**

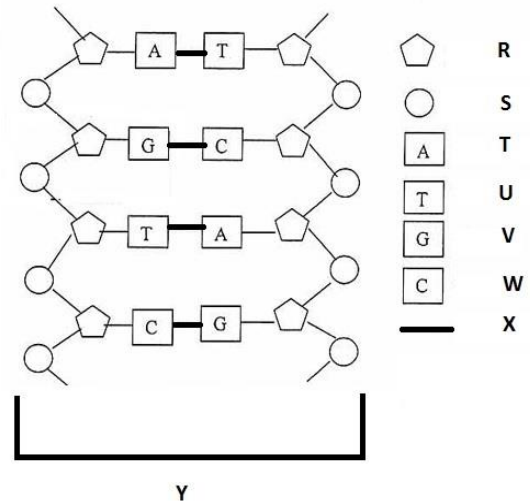
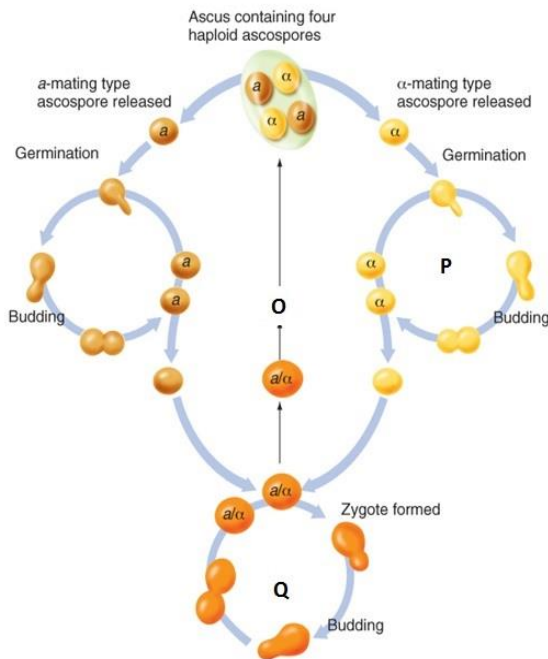
## **Midterm 2**

**March 20<sup>th</sup> , 2019**

**A. Matching, 25 choices worth 0.6 mark each. Please match alphabetic choices in each figure to the written statements. There are 15 extra statements which do not match.**

Complement of Sex Chromosomes							
	A	B	C	D	E	F	G
<i>Drosophila</i>	Dies	Normal female	Normal female	Sterile male	Normal male	Normal male	Dies
Humans	Nearly normal female	Normal female	Klinefelter male (sterile); tall, thin	Turner female (sterile); webbed neck	Normal male	Normal or nearly normal male	Dies

	♀	♂
H	XX	XY
I	XX (hermaphrodites in <i>C. elegans</i> )	XO
J	ZW	ZZ
K	Diploid	Haploid
L	Cool temperature	Warm temperature
M	Warm temperature	Cool temperature
N	Older adults	Young adults



1. XXYY
2. Moths and *C. elegans* (nematode) I
3. Bees and Wasps K
4. Ionic bond
5. XO D
6. XXY C
7. XXX A
8. Vegetable life cycle (Haploid) P
9. Non vegetable life cycle (Haploid)
10. Amino acid
11. Non vegetable life cycle (Diploid)
12. OY G
13. Hydrogen bond X
14. Tortoises and Turtles M
15. Covalent bond
16. Lizards and Alligators L
17. YYY
18. Thymine U
19. XY E
20. Tetramer
21. Mitosis
22. RNA
23. Adenine T
24. Deoxyribose sugar R
25. XX B
26. Birds and Butterflies J
27. Phosphate group S
28. DNA Y
29. OOO (no sexual chromosome)
30. Mutation
31. Protein
32. Meiosis O
33. Vegetable life cycle (Diploid) Q
34. Guanine V
35. Cytosine W
36. Anemone Fish N
37. Humans and *Drosophila* H
38. XYY F
39. Chromosome
40. Non independent segregation

---

**B. Multiple choices, 20 questions worth 1.5 mark each. Please answer multiple choice questions on the answer sheet (scantron) provided.**

1. In meiosis, the separation of homologous chromosomes occurs during\_\_\_\_\_.

- a. anaphase I
- b. metaphase I
- c. anaphase II
- d. metaphase II
- e. it does not occur

2. During the pachytene stage of prophase I,\_\_\_\_\_.

- a. crossover may occur
- b. the synaptonemal complex forms
- c. chromosomes condense
- d. the synaptonemal complex dissolves
- e. chiasmata become visible

3. If a recessive lethal allele exists for an X linked gene, what is the probability that a female inherits the gene from an affected male?

- a. 0%
- b. 25%
- c. 50%
- d. 75%
- e. 100%

4. In humans, how many tetrads are expected per cell during Metaphase II?

- a. 44
- b. 23
- c. 46
- d. 0
- e. 22

5. The Hershey-Chase Waring blender experiment determined that \_\_\_\_\_.

- a. bacteriophage replicate by semi-conservative DNA synthesis.
- b. radiolabelled bacteriophage DNA enters host cells during infection but that proteins do not.
- c. bacteriophage are made up of roughly equal amounts of protein and DNA, using radioactive sulphur and phosphorous.
- d. bacteriophage integrate into the host genome, becoming insensitive to external shear forces.
- e. all of the other answers are correct.

- 
6. DNA replication is initiated at \_\_\_\_\_ of replication.
- promoters
  - origins
  - bidirectional sites
  - semi-conservative sites
  - termination sites
7. Which of the following ratios is indicative of codominance?
- 1:2:1
  - 9:3:1
  - 9:7
  - 3:1
  - none of the above
8. *Drosophila* have  $2n=8$  chromosomes. How many linkage groups are present in *Drosophila* sperm?
- 0
  - 1
  - 2
  - 3
  - 4
9. DNA replication is \_\_\_\_\_.
- conservative
  - liberal
  - semiconservative
  - semi-dispersive.
  - dispersive
10. DNA polymerase reads sequence in the \_\_\_\_\_.
- 5' to 3' direction
  - 5' to 2' direction
  - 3' to 5' direction
  - N-terminal to C-terminal direction
  - C-terminal to N-terminal direction
11. How many hydrogen bonds form between guanine and cytosine in B-form DNA?
- 0
  - 1
  - 2
  - 3
  - 4

12. B-form of DNA forms \_\_\_\_\_ and Z-form of DNA forms \_\_\_\_\_.
- left-handed, Left-handed
  - right-handed, left-handed
  - left-handed, right-handed
  - right-handed, right-handed
  - asymmetric, symmetric

13. If a male and female with *xeroderma pigmentosum* have a child, what is the probability that the child is affected with the disease if the male is in complementation group A and the female is in complementation group V? (assume that the XP genes are not X-linked)
- 0%
  - 25%
  - 50%
  - 75%
  - 100%

Use the following information for questions 14-16.

Genes "a" and "b" are linked with a recombination frequency of 10%. "A" is completely dominant over "a" and "B" is completely dominant of "b". Assuming you start with the following parental genotypes AAbb and aaBB in a dihybrid cross; answer questions 14-16.

14. What is the expected genotypic ratio in the F1 generation?
- AAbb:aaBB in a 9:1 ratio
  - AaBb in 100% of offspring
  - AAbb:AaBb:aaBB in a 5%:90%:5% ratio
  - AAbb:AaBb:aaBB in a 45%:10%:45% ratio
  - none of the above
15. What are the parental and recombinant gametes genotypes in the F1 self-cross?
- parental: Ab and aB and recombinants: AB and ab
  - parental: Aa and Bb and recombinants: AA, aa, bb and BB
  - parental: AB and ab and recombinants: Ab and aB
  - parental: AaBb and recombinants: aAbB
  - parental: Ab and aB and recombinants: bA and Ba
16. Indicate the percentage of F2 progeny following an F1 self-cross that have: only parental types, both parental and recombinant types and only recombinant types.
- 90%, 10% 0%
  - 45%, 45%, 10%
  - 85%, 10%, 5%
  - 81%, 18%, 1%
  - 89%, 10%, 1%

17. Phosphodiester bonds are present in \_\_\_\_\_.

- a. proteins
- b. DNA
- c. RNA
- d. DNA and RNA
- e. complex carbohydrates.

18. The rate of forward mutations is generally \_\_\_\_\_ than the rate of reverse mutation.

- a. less than
- b. equal to
- c. higher
- d. it depends on whether the mutation gives rise to a dominant or recessive trait.
- e. none of these other answers is correct.

19. Which of the following is not related to variation within populations of between species?

- a. chromosomal duplication
- b. crossing over
- c. mutation
- d. sexual reproduction
- e. mitosis

20. What is the reverse complementary sequence of GTACCTAGTTCAAC?

- a. GTTGAAGCTAGGTAC
- b. GTTGAAGCTGAATAC
- c. CATGGATCAAGTTG
- d. CATGGATCAAGTTG
- e. GTACCTAGTTCAAC

**C. Please answer all the questions (2) in this section (15 marks)**

C-1. You identify a recessive mutation in the NHEJ repair pathway in *Schizosaccharomyces pombe*, which is a fungi with haploid and diploid life cycle. During the diploid phase of their life cycle, the fungi are viable but haploid strains die rapidly. Why this is the case? (6 marks)

**NHEJ repair system is one of the essential pathways for cell viability but the effect of a recessive lethal mutation would not be detected in heterozygotes so diploid yeast should be viable. During the haploid phase of the yeast lifecycle, there is no wild type allele in yeast carrying the mutation so they are not viable.**

C-2. What is the difference between germline and somatic mutations?  
Name at least one way that each of these types of mutations can affect human health (Indicate how each type affects human health; provide one example for each)(9 marks)

**Germline mutations occur in gametes or cells that give rise to gametes so they are passed to the next generation. Somatic mutations occur in cells that do not produce gametes so they are not passed on to the next generation.**

**Germline mutations can contribute to heritable diseases like xeroderma pigmentosum, colour blindness etc... In contrast, somatic mutations only affect the individual in which they occur. Somatic mutations can lead to sporadic forms of cancer.**

**D. Please answer the following questions:**

1. In *Drosophila*, a fully heterozygous female with the recessive alleles a, b, c (not necessarily in the order on the chromosome) 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,+	27
c,+ ,+	43
a, b,+	47
b,+,+	3
a, c,+	7
Total	1000

- Determine the order of these 3 genes (4 marks)
- Calculate the distance in map units between each pair of genes using the data provided (5 marks).
- Calculate the interference (5 marks).

(a) double crossover class b,+,+ and a,c,+ differ from parents at the b locus. Therefore b is in the middle. a, b, c and c, b, a are both correct.

$$\begin{aligned} \text{(b) RF(a-b)} &= (23+27+3+7)/1000 \times 100\% \\ &= 60/1000 \times 100\% \\ &= 6\% \end{aligned}$$

therefore, 6 mu

$$\begin{aligned} \text{RF(b-c)} &= (43+47+3+7)/1000 \times 100\% \\ &= 100/1000 \times 100\% \\ &= 10\% \end{aligned}$$

therefore, 10 mu

$$\begin{aligned} \text{RF(a-c)} &= (23+27+43+47+3+7+3+7)/1000 \times 100\% \\ &= 160/1000 \times 100\% \\ &= 16\% \end{aligned}$$

therefore, 16 mu

- (c) double crossovers:  
 expected frequency:  $.06 \times .1 = .006$  or a total of 6 out of 1000.  
 observed number 10.  
 10 is not less than the expected (6 expected) therefore there was no interference detected.

2. In lab, you perform a cross between a true breeding white-eyed female fruit fly with a brown body and a red-eyed male fruit fly with a gold body. A white eye ( $w$ ) is recessive to red eyes ( $w^+$ ) and gold body ( $y$ ) is recessive to brown ( $y^+$ ). The  $w$  and  $y$  genes are 1.1 mu apart on the x chromosome (14 marks).

**Show all work required to answer the following questions (2 marks).**

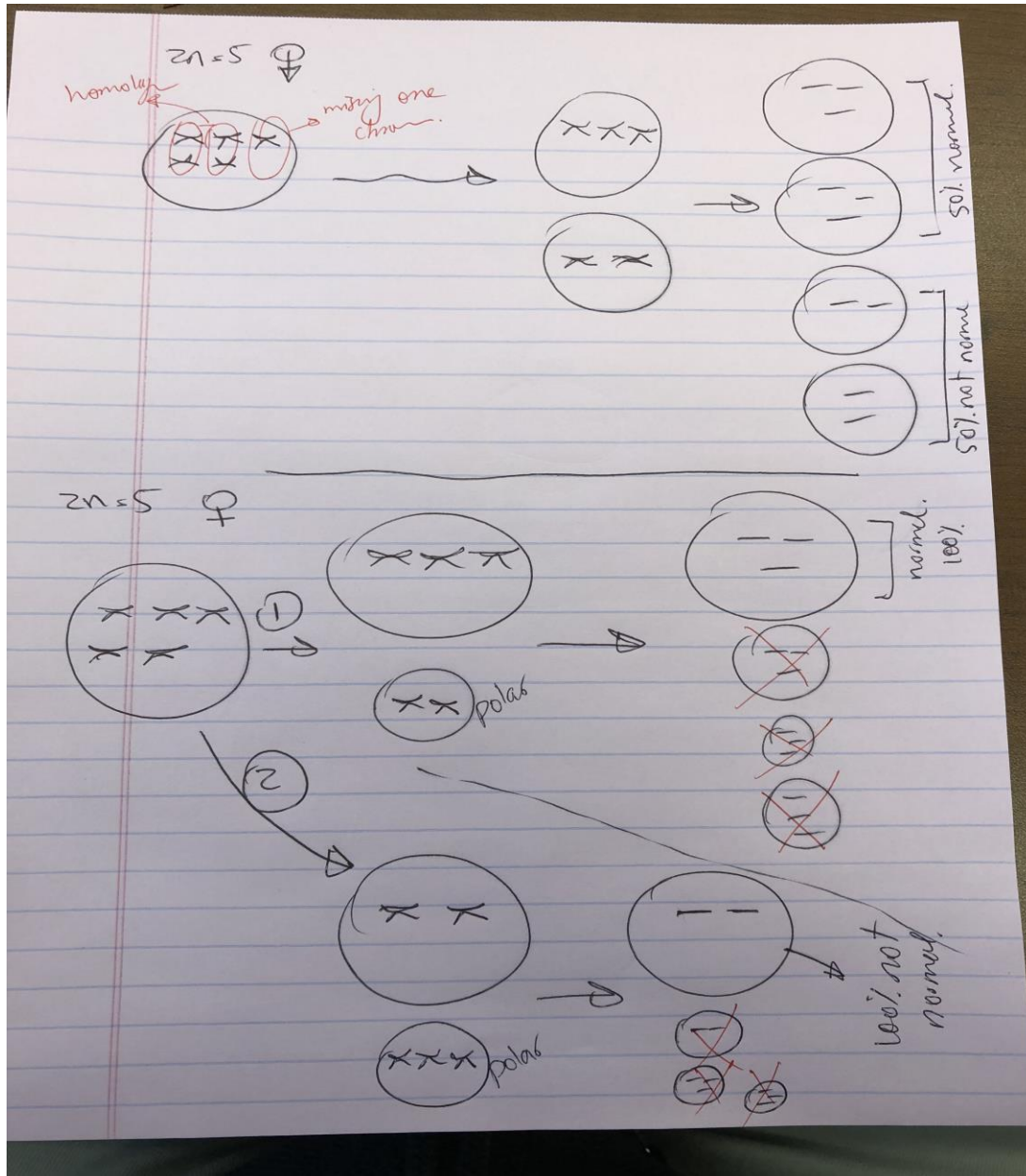
- What percent of the male offspring will have white eyes and a brown body in the F1 generation? (3 mark)
- If F1 females and F1 males are crossed, what proportion of the F2 male progeny are expected to be recombinants? (3 mark)
- What fraction of the F2 male progeny are expected to have white eyes? (3 mark)
- What percentage of the F2 males are expected to have red eyes and a brown body? (3 mark)

parental:	$wy^+/wy^+$	x	$w^+y/Y$	
F1	$wy^+/w^+y$ females and $wy^+/Y$ males			
F2	males:	parental types (98.9%):	$wy^+/Y$	$98.9/2=49.45\%$
			$w^+y/Y$	$98.9/2=49.45\%$
		recombinant types (1.1%)	$wy/Y$	$1.1/2=0.55\%$
			$w^+y^+/Y$	$1.1/2=0.55\%$

- 100 % ( $wy^+/Y$ )
- 1.1 %
- 50 % (from 49.45  $wy^+/Y$  + 0.55%  $wy/Y$ )
- 0.55 % ( $w^+y^+/Y$ )

3. Let's imagine a diploid animal cell ( $2n=5$ ) (12 marks)

- Draw the final outcome of Oogenesis, including number of chromosomes (6 marks).
- Draw the final outcome of Spermatogenesis, including number of chromosomes (6 marks).



---

**E. Bonus questions (5 marks)**

1- What is Dr. Samanfar's first name? (2 marks, bonus)

**Bahram**

2- Regarding the RAP songs:

- How many RAP song(s) has (have) been played in the class? (1mark, bonus) **2**
- On what topic(s)? (1mark, bonus) **Mitosis and DNA**
- What was the hair color of the singer in the RAP song(s)? (1mark, bonus) **he is Bold**