Biology 121
Practice Midterm 1 ANSWERS
September, 2022

Name : _____ _____
FAMILY NAME FIRST NAME

Student Number : _____

Instructions:

1. Answer all questions in the space provided.
2. Writing can be in pencil or ink, but pencil or erasable ink answers **cannot** be remarked.
3. Answers may be in sentences or point form. Illustrations are acceptable but must be annotated.
4. Answer all questions in the space provided. The back of the exam will not be marked unless it is an exact replacement for material that is crossed out and the question number is clearly indicated.
5. Students suspected of any of dishonest practices will be immediately dismissed from the examination and will be subject to disciplinary action.
6. Other than **a one page** study sheet based on the provided instructions and a non-programmer calculator, no other memory devices are permitted.
7. Students may not speak or in any other way communicate with other students while in the examination room.
8. Students may not expose their written paper to other students. The excuse of accidental exposure, forgetfulness, or ignorance will not be accepted.
9. Make sure you have **6** written pages (3 pieces of paper) including this cover page.

I have read and fully understand these instructions.

Student signature _____

Mark allocation:

Question	Marks possible	Your mark
1.	6	
2.	10	
3.	8	
4.	7	
5.	9	
Total	**40**	

Q1: Miscellaneous multiple choice, fill-in-blank or short-answer questions. **8 marks total**

Which of the following are important functions of **meiosis** in different organisms? Choose all that apply. (**1 mark)**

a) repairing wounds by generating new cells
b) generating genetic variation in daughter cells
c) producing identical copies of the parent cell
d) reducing the number of chromosomes in daughter cells

Choose all that apply. During meiosis, the ploidy of a cell changes…**(1 mark)**

a) After DNA replication
b) After meiosis I
c) After meiosis II
d) After anaphase II

Your classmate in Biology 121 tells you that a haploid cell (a cell containing one copy of the genome) cannot undergo cell division. Do you agree? Circle one: yes / no **(2 marks)**

In one sentence, explain your answer: a haploid cell can underdo mitosis because mitosis produces exact copies of the parent cell and does not result in a reduction in chromosome number.

The genes A and B are located on the same chromosome. An individual is heterozygous for both genes. The cellular process of ___crossing over__ is responsible for the production of gametes during meiosis with a different arrangement of alleles on a chromosome compared to the parent cell. This process takes place during _prophase 1_. (**1 mark**)

___mutation__ is the mechanism responsible for generating a new allele of a gene; in other words, the original source of variation. (**1 mark**)

You have a diploid plant with the genotype Rr, Ff, Ww, qq. If this individual was self-pollinated, what would be the frequency of offspring with the genotype RR ff Ww qq? Show your calculations and write your answer as a fraction. (1 mark)

frequency RR = ¼

frequency ff = ¼

frequency Ww = 2/4

frequency qq = 1

frequency RR ff Ww qq = ¼ x ¼ x 2/4 x 1 = 2/64 = 1/32

You have a diploid salamander species and are studying three linked genes "Q" and "G" and P. The Q, g and P alleles are on one homolog, the q, G and P alleles are on the other homolog. List all of the gamete genotypes this individual can produce and indicate which are most frequent and which are least frequent. Crossing-over can occur.

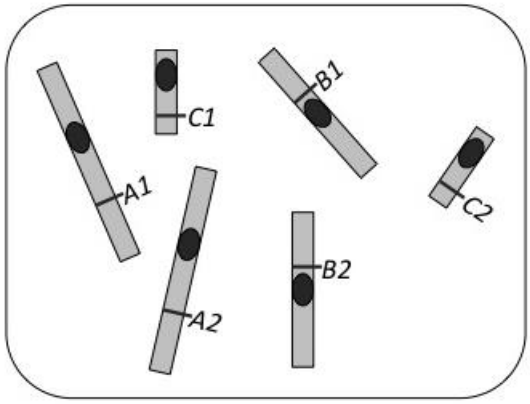
4 possible gamete genotypes $2^n = 2^2 = 4$

QgP and qGP most frequent (parental) genotypes
QGP and qgP least frequent (recombinant) genotypes

2. A geneticist is studying genetic variation in three butterfly traits:
   - The *stripes* gene has two alleles, *A1* and *A2*
   - The *spots* gene has two alleles, *B1* and *B2*
   - The *colour* gene has two alleles, *C1* and *C2*

   These three genes are on three different chromosomes. **(10 marks total)**

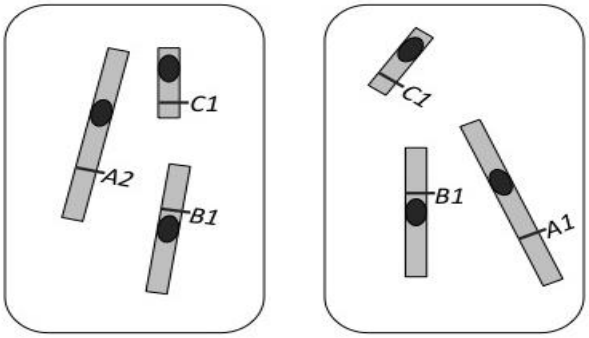
   A) A butterfly has the genotype *A1/A2; B1/B2; C1/C2*, as shown in the diagram below.



The maximum number of different types of gametes (i.e., with different genotypes) this butterfly is capable of producing by meiosis is: (1 mark)
8 (eight)

The maximum number of different gametes that can be produced when a single sex cell from this butterfly undergoes meiosis is: (1 mark)
4 (four)

   B) A sex cell from this butterfly undergoes meiosis and produces four gametes. Two of these four gametes are represented in the diagrams below:

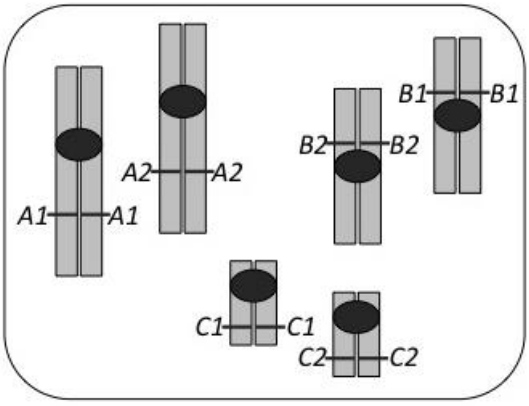


Based on the gametes shown above, draw clear diagrams showing the chromosomes of the original butterfly sex cell that produced these two gametes:

i. i. at G2 (after DNA replication, before the start of meiosis): (4 marks)

1 mark for each of:

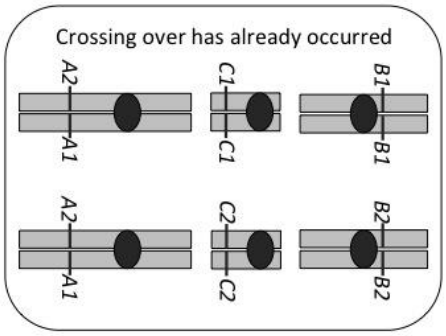
- Must have right number of chromosomes
- Chromosomes must have sister chromatids, clearly attached to each other and relatively parallel to each other
- Homologs need to look homologous enough
- Sister chromatids must have identical alleles (alleles must be marked or indicated on both chromatids)
- Example (next page)

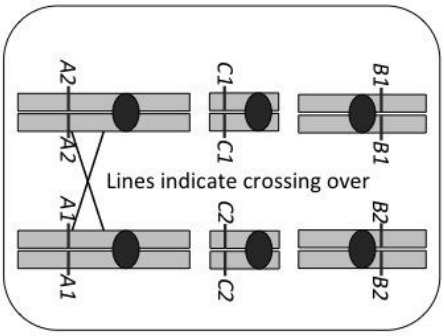


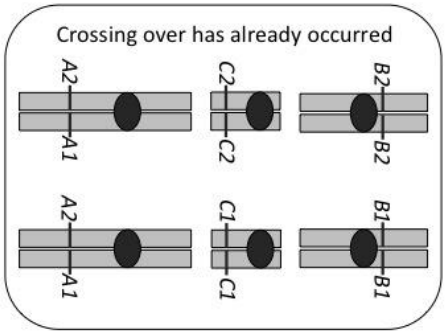
ii. ii. at metaphase of meiosis I, clearly indicating the direction in which the chromosomes will segregate/move: (4 marks)

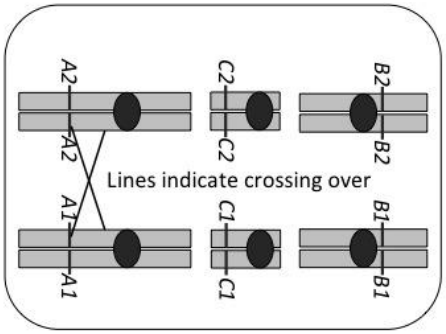
- homologs have to be paired
- pairs have to be lined up head to tail
- direction of segregation has to be clear and result in *A1*;*B1*;*C1* and *A2*;*B1*;*C1* gametes
- there has to be evidence of crossing over somewhere between the A gene and the centromere of the chromosome it is on, involving two non-sister chromatids (see diagrams for examples)

Any of **one** of the four examples below are valid; it's also fine if the metaphase plate is vertical rather than horizontal









3a. **8 marks total.** In a certain breed of dog long hair is dominant over short hair; the gene involved is autosomal. Another gene, B controls hair colour, which is X-linked, one allele B1 produces gray coloured hair; the other allele B2 produces red coloured hair; and the heterozygous combination B1B2 produces brindle coloured hair (a mix with patches of both gray and red coloured hairs).

If a red male homozygous for long hair is mated with a brindle short-haired female, what kind of puppies could be produced in the F1? (for each possible kind of puppy, state the length of their hair, their colour and their sex) (4 marks)

Long-haired red male
Long-haired gray male
Long-haired brindle female
Long-haired red female

3b. A dominant gene, A, causes yellow color in rats. The dominant allele of another independent gene, R, produces black coat color. When the two dominants occur together (A_R_), they interact to produce gray. Rats of the genotype aarr are cream-colored. If a gray male and yellow female produce approximately 3/8 yellow, 3/8 gray, 1/8 cream, and 1/8 black offspring, what are the genotypes of the two parents? (4 marks)

Gray male = AaRr

Yellow female = Aarr

4. **(7 marks total)** A true-breeding *Drosophila* with red eyes and small body size was crossed with a true-breeding *Drosophila* with scarlet eyes and normal body size. The F1 all had red eyes and normal body size. The F1 were crossed with *Drosophila* with scarlet eyes and small bodies. The progeny were as follows:
   red eyes and normal body size 56
   red eyes and small body size 218
   scarlet eyes and normal body size 182
   scarlet eyes and small body size 44

Explain why you suspect these genes are on the same chromosome.

If they were on different chromosomes they would assort independently at meiosis (1) and the F2 ratio would be 1:1:1:1 (or equal numbers of each phenotype) (2). But there are more of the parental phenotypes (2) and fewer of the recombinants (2).

5. Squash fruits come in three distinct shapes: round, long, and disk. A squash farmer set up as series of crosses between the three varieties of squash and obtained the following results: **(9 marks total)**

Cross	Parents	Offspring
1	round x round	13 round, 6 long, 5 disk
2	long x long	21 long
3	disk x disk	18 disk
4	round x long	13 round, 11 long
5	round x disk	12 round, 10 disk
6	long x disk	19 round

a) Define the letters or symbols you will use for the alleles. **(1 mark)**

Here in the key the following symbols are used:
s^D=disk
s^L=long

Students may use any letter/letter-number/symbols they want as long as they are properly defined and used consistently. Their notation should clearly show that the alleles are alleles of the same gene (e.g. same letter with different superscripts, same letter in capital and lower-case, etc)

b) What are the genotypes of the parents and offspring in cross #1? **(4 marks)**

both parents: s^D/s^L *1 mark*
offspring: disk = s^D/s^D *1 mark*
long = s^L/s^L *1 mark*
round = s^D/s^L *1 mark*

c) What are the genotypes of the parents and offspring in cross #4? **(4 marks)**

round parent: s^D/s^L *1 mark*
long parent s^L/s^L *1 mark*
round offspring: s^D/s^L *1 mark*
long offspring: s^L/s^L *1 mark*