

UNIVERSITY OF BRITISH COLUMBIA
Biology 121 Sections 222 Instructor: Dr. Brett Couch
PRACTICE Midterm 1, February 6, 2023

Question 1 (Mitosis & Meiosis) – 13.5 marks

Q1.1 Consider a $2N=6$ animal. Fill in the blanks below: **(2 marks; 0.25 each)**

- a. Meiosis I followed by cytokinesis produces _____ cells. Each cell is _____-ploid and has _____ chromosomes and _____ chromatids.
- b. Meiosis II followed by cytokinesis produces _____ cells in total. Each cell is _____-ploid and has _____ chromosomes and _____ chromatids.

Q1.2 Which of the following statements apply only to MEIOSIS but not MITOSIS? Choose all that apply. **(1 mark)**

- ☐ Crossing over with genetic recombination happens.
- ☐ Independent assortment happens.
- ☐ Microtubules are responsible for moving the chromosomes during metaphase and anaphase.
- ☐ Chromosomes are replicated prior to division.

Q1.3 Which of the following statements about the X and Y chromosomes are correct? Choose all that apply. **(1.5 marks)**

- ☐ The X chromosomes can undergo crossing over in females.
- ☐ Males can be heterozygous for genes located on the X chromosome.
- ☐ Genes located on the X or Y chromosome are said to be 'sex-linked'.
- ☐ X and Y chromosomes don't pair during meiosis I.
- ☐ In males it is possible to determine genotype directly from phenotype for genes on the X chromosome.
- ☐ The X and Y chromosomes contain genes associated with determining the sex of the organism.

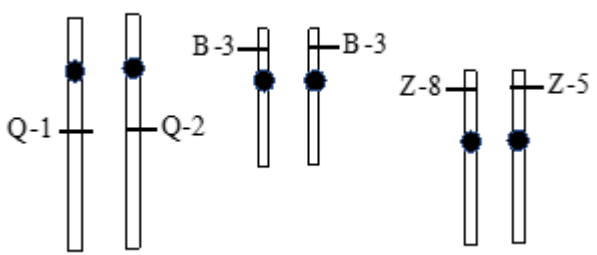
Q1.4 Consider a $2n=18$ animal that is capable of self-fertilization (produces sperm and eggs which can fuse) and is heterozygous for many genetic loci. If this organism self-fertilizes the offspring will be: **(0.5 marks).**

- ☐ Genetically identical to the parent.
- ☐ Genetically identical to each other.
- ☐ Genetically different from the parent but genetically identical to each other.
- ☐ Genetically different from the parent and each other.

Q1.5 The concepts of “male” and “female” have been taken from animals and applied to other kinds of organisms like the pea plants Mendel studied. What features that are used to define “male” and “female” in animals apply to plants. (1 mark; choose all correct statements)

- ☐ Female pea plants have two X chromosomes (XX); male pea plants have an X and Y chromosome.
- ☐ Pea plants have different sexes. Some plants only produce pollen, some only produce ovules containing eggs.
- ☐ In pea plants, pollen grains are the small gametes and considered “male”.
- ☐ In pea plants, the “male” gamete is small.
- ☐ In pea plants, the female gamete is larger than the male gamete

The next questions (Q1.6-Q1.13) are related to the figure below

<p>A G1 cell from an individual is shown (right). Given this individual's genotype, answer the following questions:</p>	
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<p>Q1.6 How many different genotypes can be produced by multiple mitotic divisions of this cell? (0.5 marks)</p> <hr style="border: 0; border-top: 1px solid black; margin-top: 20px;"/>	<p>Q1.9 What process would result in the expected frequencies of the genotypes you listed for products of many meiotic divisions? (0.5 marks)</p> <hr style="border: 0; border-top: 1px solid black; margin-top: 20px;"/>
<p>Q1.7 The haploid number of this cell is: (0.5 marks)</p> <hr style="border: 0; border-top: 1px solid black; margin-top: 20px;"/>	<p>Q1.10 What cellular process generates new combinations of alleles of genes when the genes are on the same chromosome? Indicate the process and when it occurs. (1 mark)</p> <hr style="border: 0; border-top: 1px solid black; margin-top: 20px;"/>
<p>Q1.8 If this cell contains 1.4 pg (picograms) of DNA, how much DNA would be in the cell at anaphase 1 of meiosis? (0.5 marks)</p> <hr style="border: 0; border-top: 1px solid black; margin-top: 20px;"/>	<p>Q1.11 Following gamete formation, what process generates genetic variation among offspring? (0.5 marks)</p> <hr style="border: 0; border-top: 1px solid black; margin-top: 20px;"/>

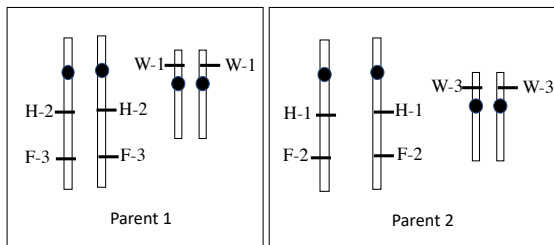
Q1.12 What are the expected genotypes of cells that could be produced by this cell following multiple **meiotic** divisions? Indicate the frequencies of each of the genotypes. (2 marks)

Q1.13) If the individual, diagrammed at the beginning of the question, produced offspring by self-fertilization what would be the expected frequency of offspring with the genotype:

Q-1 Q-2; B-3, B-3; Z-8 Z-8? Show your work. (2 mark)

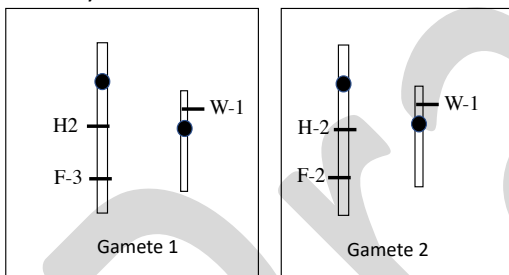
Question 2 (Meiosis) – 6 marks

Consider a diploid salamander species. A salamander breeder chooses two individuals to breed. The genotypes and chromosomal compliments of two parents are given in the figure below. These individuals mate and produce a baby salamander that the breeder nicknamed Axol.



Q2.1 What is the genotype of Axol? (1 mark)

Q2.2 A single cell in Axol undergoes meiosis to produce gametes. Two gametes are shown below. Diagram the arrangement of chromosomes in a cell at Metaphase I that would produce these gametes. Add gene and allele labels and the direction of movement of the chromosomes at Anaphase I. In this species, only a single crossover event can occur per chromosome per meiosis. (5 marks)



Question 3 (Mode of Inheritance) - 9 marks

Zilla manilla is a species of lizard. In this species, females are XX and males are XY. Their scale colour may be green, yellow, or brown, and in rare cases blue or golden. Some individuals have tails without spots some individuals have spots on their tails.

You cross pure breeding male lizards with green scales and without spots with pure-breeding female lizards with yellow scales and spots. The F1s were then crossed with each other. The results are shown in the table below.

Cross #1 (P generation): Males: green scales with no spots x Females: yellow scales with spots

F1 Generation:

F1 males	F1 females
275 males all green with spots	280 females all green with spots

Cross #2: F1 males x F1 females

:

	Green, no spots	Green, spots	Yellow, no spots	Yellow, spots
Males	125	131	45	41
Females	0	225	0	76

Q3.1a Which allele for scale colour is dominant in these lizards? **(0.5 marks)**

- ☐ allele for green scales
- ☐ allele for yellow scales

Q3.1b Use the outcome from either cross #1 (P generation) or cross #2 (F1 cross) to support your claim about which scale colour allele is dominant (circle your choice below). As part of your explanation, compare observed and expected offspring phenotype frequencies for your chosen cross. If you think the gene for scale colour is autosomal, use "R" and "r" for the alleles. If you think the gene for scale colour is X-linked, use " X^R " and " X^r " for the alleles. There is space at the top of the next page if needed. **(3 marks)**

Cross #1 (P-generation cross) OR Cross #2 (F1 cross)

Q3.2a What is the most likely mode of inheritance for the tail spot phenotype in these lizards? **(0.5 marks)**

- ☐ **Autosomal**
- ☐ **X-linked**

Q3.2b Use the outcome of **either** cross #1 (P-generation cross) or cross #2 (F1 cross) to support your claim about the likely mode of inheritance for the tail spot phenotype in these lizards (circle your choice below). As part of your explanation, compare observed and expected offspring phenotype frequencies for your chosen cross. If you think the gene for tail spot phenotype is autosomal use “T” and “t” for the alleles. If you think this gene is X-linked, use “X^T” and “X^t” for the alleles. **(3 marks)**

Cross #1 (P-generation cross) OR Cross #2 (F1 cross)

Q3.4 Researchers discovered a third gene (Q gene) that is linked on the same chromosome as the allele for scale colour. The allele for long claws (Q) is dominant to the allele for short claws (q).

In a new experiment, researchers crossed lizards that were pure-breeding for green scales and short claws with pure-breeding lizards with yellow scales and long claws. All F1s had green scales and long claws.

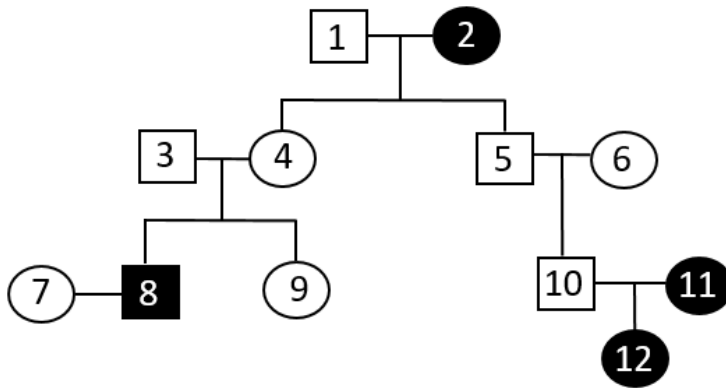
The F1s were then crossed with lizards with yellow scales and short claws. If no crossing-over occurred during meiosis, what would be the predicted F2 offspring phenotypes and in what ratio? Select all that apply. **(2 marks)**

- | | |
|---|--|
| <input type="radio"/> Green scales and long claws | <input type="radio"/> 1:1 phenotypic ratio |
| <input type="radio"/> Green scales and short claws | <input type="radio"/> 3:1 phenotypic ratio |
| <input type="radio"/> Yellow scales and long claws | <input type="radio"/> 1:1:1:1 phenotypic ratio |
| <input type="radio"/> Yellow scales and short claws | <input type="radio"/> 9:3:3:1 phenotypic ratio |

QUESTION 4 (Pedigree) – 7 marks

Bendii Syndrome is a rare, heritable disease in Vulcans (a species of humanoid from a popular Science Fiction Series). In this species females are XX and males are XY. The symptoms are sudden bursts of emotion and irrational anger.

Below is a pedigree for a family that has some family members affected by Bendii Syndrome.



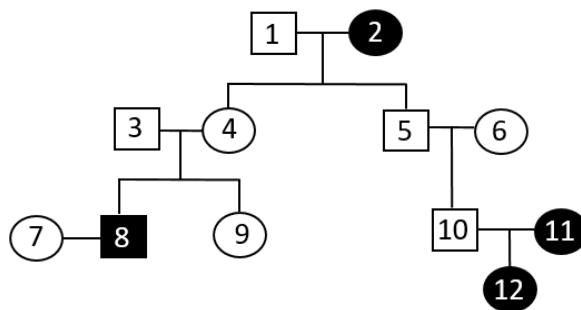
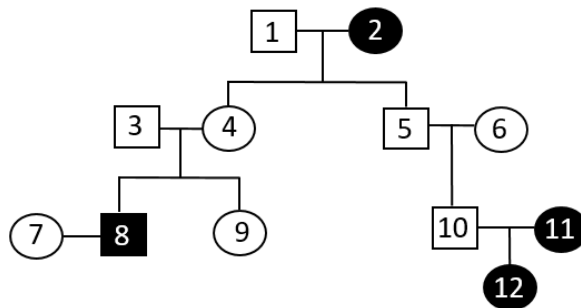
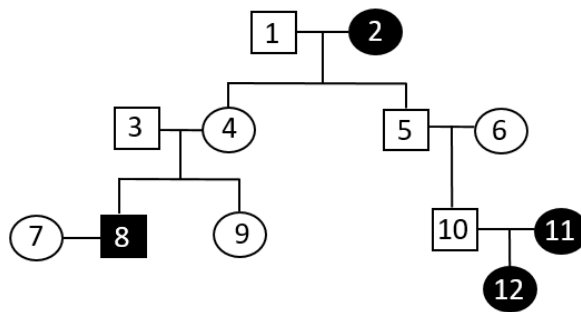
Q4.1 Explain why X-linked dominant is an impossible mode of inheritance for Bendii Syndrome. In your explanation, refer to a specific cross that demonstrates that this mode of inheritance is impossible. In your explanation, refer to specific individuals, their phenotype and predicted genotype. Please use “ X^B ” for the dominant allele and “ X^b ” for the recessive allele. **(3 marks)**

Q4.2 Which mode(s) of inheritance is/are possible for the “Bendii Syndrome” phenotype? Circle all answers apply. Note – incorrect choices will be subtracted from correct choices. The pedigree has been copied 3 times below. **(2 marks)**

☐ Autosomal Dominant

☐ Autosomal Recessive

☐ X-linked Recessive



Q4.4 If individuals 10 and 11 were to have a second child, what is the probability that child would be a son that would not be affected by Bendii syndrome? Please show your work by providing a Punnett Square. **(2 marks)**

Bonus Question (1 mark).

What was something you found personally important or significant about either the Cedar Activity in the first class or the Sex and Gender class? Briefly explain your reasoning.

Question		Total Mark	Your Mark
1	Mitosis & Meiosis	13.5	
2	Meiosis	6	
3	Genetic Crosses	9	
4	Pedigrees	7	
Bonus		1	
Total/34		35.5	