UNIVERSITY OF BRITISH COLUMBIA
Biology 121 Midterm 1 ANSWER GUIDE
January/February, 2018

Name : _____ _____
FAMILY NAME FIRST NAME

Student Number : _____

Instructions:

1. 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.
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. Students suspected of any of dishonest practices will be immediately dismissed from the examination and will be subject to disciplinary action.
5. Other than **a one page** study sheet based on the provided template, no other memory devices are permitted.
6. Students may not speak or in any other way communicate with other students while in the examination room.
7. Students may not expose their written paper to other students. The excuse of accidental exposure, forgetfulness, or ignorance will not be accepted.
8. 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.	17	
2.	6	
3.	8	
4.	15	
Concept Map	1	
Total	**47**	

1. Fruit flies have an XX/XY sex determination system similar to humans. You are examining the mode of inheritance of two traits in fruit flies, fat wings and brown eyes.
You begin with flies from two pure breeding populations. You cross a female that has fat wings and red eyes with a male that has normal wings and brown eyes.

All of the resulting F1 female offspring have normal wings and red eyes.
All of the male offspring have fat wings and red eyes.
You then cross an F1 male with an F1 female and get the offspring shown in the table below:

F2 Phenotypes	**Number of Individuals**
Males with fat wings and red eyes Males with normal wings and red eyes	76 76
Males with fat wings and brown eyes Males with normal wings and brown eyes	24 24
Females with fat wings and red eyes Females with normal wings and red eyes	73 73
Females with fat wings and brown eyes Females with normal wings and brown eyes	27 27

a. Using only the information above, how are the traits of fat wings and brown eyes inherited? Explain how you reached your conclusion for the mode of inheritance of these traits. When describing crosses, indicate the genotypes and phenotypes of the parents and offspring (you may use a Punnett square to support your explanation). Be sure to define all genes, alleles and the type of inheritance pattern of each version of the trait. **(14 marks)**

Wing shape (normal or fat)
Mode of inheritance – Fat wings are recessive to normal wings and the gene is X-linked

Genotype – Phenotype (Must be one gene, two alleles, sex-linked)
X^F = fat wing allele
X^N = normal wing
$X^F X^F$ = fat wing phenotype female
$X^F X^N$ = normal wing phenotype, female
$X^N X^N$ = normal wing phenotype, female

$X^F Y$ = fat wing phenotype, male
$X^N Y$ = normal wing phenotype, male

Parental Cross: female that has fat wings and red eyes with a male that has normal wings and brown eyes.

	X^N	Y
X^F	$X^F X^N$	$X^F Y$
X^F	$X^F X^N$	$X^F Y$

Explanation – in a cross involving an x-linked trait, when a female homozygous for a recessive allele is crossed with a male with the dominant allele, we would expect all of the females to inherit the dominant allele from their fathers and have the dominant phenotype; all males would inherit the recessive allele from their mothers and a Y chromosome from their fathers so all would express the recessive trait. This is what was observed in the offspring of the parental cross.

Eye colour (red or brown)
Mode of inheritance –brown eyes are recessive to red eyes

Genotype – Phenotype (Must be one gene, two alleles, autosomal)
b = brown eye allele
B = red eye allele
bb = brown eyes
Bb = red eye
BB = red eye

*Cross: F1 male x F1 female (**1 mark** for Punnett square or equivalent written explanation)*

	b	*B*
b	*bb*	*bB*
B	*Bb*	*BB*

Explanation – in a cross between individuals heterozygous for an autosomal trait, we would expect a 3:1 ratio of individuals with the dominant: recessive pheonotypes. In the F2 generation there are 298 individuals with red eyes and 102 individuals with brown eyes
(close to 3:1) which is consistent with the expectations.

In fruit flies, brown eyes are caused by a reduction in the amount of red pigment in the eye. Initially, you determined eye color by observing flies using a microscope. When you quantify the amount of eye pigment in flies you get the following results.

Generation	**Phenotype**	**Red Pigment Amount**
P	Red eyes	1.0 unit
	Brown eyes	0.2 units
F1	Red eyes	0.6 units

b. Given this new information, briefly describe how protein production or a molecular mechanism could explain these results (**3 marks**).

The proteins produced by the two alleles differ in their ability to produce red pigment OR this trait is inherited by incomplete dominance or co-dominance.
The B allele produces more red pigment than the b allele. Individuals with two copies of the B allele produce more functional proteins and therefore more red pigment than the heterozygotes.
The individuals that are homozygous for b only produce proteins that are inefficient at making red pigment so make very little red pigment. [Need to talk about proteins or molecules for full marks]

Part marks only if only amounts of pigments made by the alleles are listed: R=0.5 and r=0.1, but no reference to protein production and how it relates to pigment production.

Part marks if only dominance is explained (non-dominant, incomplete dominant or codominant all okay) or just say the heterozygotes produce less pigment, but don't give the amounts or discuss the alleles and proteins.

2. Explain how this cellular mechanism affects variation: Independent assortment

Briefly explain **how** the mechanism could contribute to genetic variation in offspring.

Be specific how this mechanism gives this result and when it occurs during the cell cycle. Be specific in describing the genetic variation produced (choose the appropriate level/s from genes to chromosomes to whole genomes). (**6 marks**)

Differing alignment of chromosomes create new combinations of paternal and maternal chromosomes in different daughter cells.

This results in gametes that contain new combinations of alleles compared to the parental cell.
OR Could also describe how gametes differ from each other.
(needs to describe the specific level at which variation is produced, new combinations of alleles from a mixture of maternal and paternal chromosomes).

It occurs during metaphase [will accept anaphase] of Meiosis I.

Part marks if answer only shows a picture of chromosome alignment with explanation, but doesn't give details of result with reference to alleles and maternal vs. paternal chromosomes. Marks off if answer refers to crossing-over (which is separate from independent assortment).

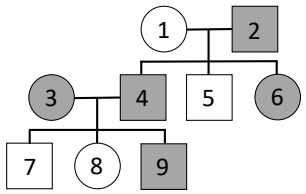
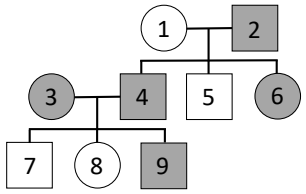
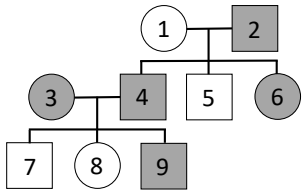
3. The following pedigree shows the inheritance of disease Z in one family. The individuals who are affected are indicated with shaded boxes. (**8 marks total**)

a. For each mode of inheritance listed below, please indicate whether the mode is possible or impossible. In your answers, use "A" for the dominant allele and "a" for the recessive allele. Fill in the table below to explain your answer (**4 marks**)

	Autosomal Dominant	Autosomal Recessive	X-linked Dominant	X-linked Recessive
Possible or Impossible	Possible	Impossible	Impossible	Impossible

b. For **<u>one</u>** mode of inheritance that is **impossible** please provide support for your answer below.

- In your answer, use "A" for the dominant allele and "a" for the recessive allele.
- Label the copy of the pedigree below with possible genotypes of specific individuals that explain why this mode of inheritance is impossible.
- Refer to these specific individuals' phenotypes in your explanation. (**4 marks**)

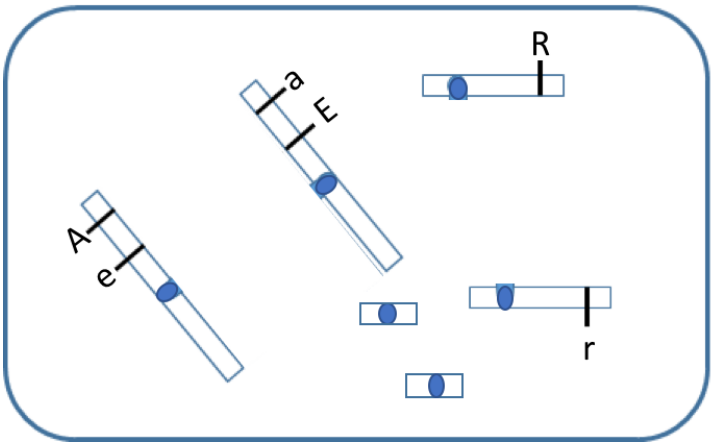
	Example explanations, needs to be accompanied by genotypes on the pedigree. Also needs to mention phenotype (disease Z or affected vs. no disease or unaffected) and allles.
Autosomal recessive	 3 and 4 are affected and would therefore have aa genotypes, but their children would also be aa and so 7 and 8 would be affected, but they are not.
X-linked dominant	 1 is unaffected and would therefore have XaXa, their son 4 would get Y from dad and Xa from mom and should not be affected, but he is.
X-linked recessive	 3 and 4 are affected and would therefore have XaXa and XaY genotypes, their son 7 would get Y from dad and Xa from mom and should be affected.

4. A scientist is studying a species of lizard (a diploid organism, 2n=6) with a particular interest in the following traits:

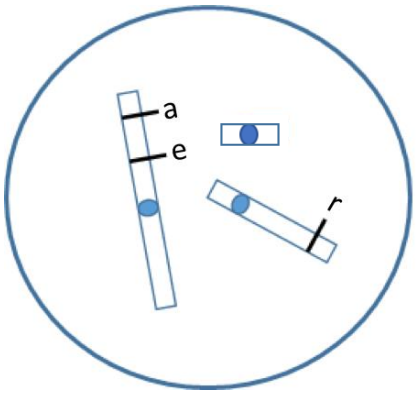
- Tongue length gene has two alleles: A and a
- Eye colour gene has two alleles: E and e
- Skin texture gene has two alleles: R and r

The eye gene and the tongue gene are physically linked. As an experiment, the scientist makes the following cross A/A;e/e;R/R x a/a;E/E;r/r, which results in an F1 offspring. Consider a single cell of the F1 offspring undergoing meiosis.

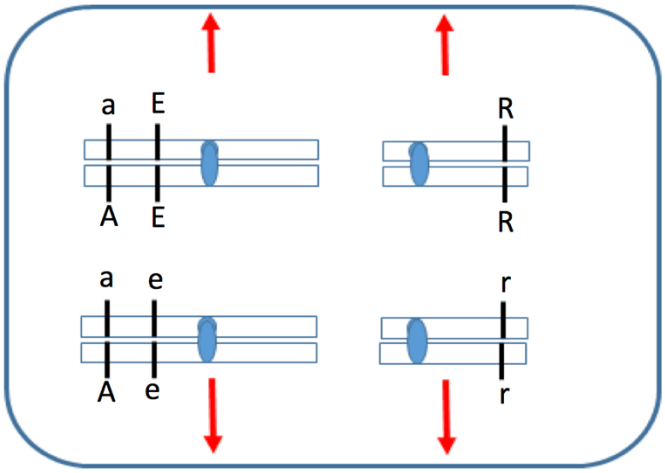
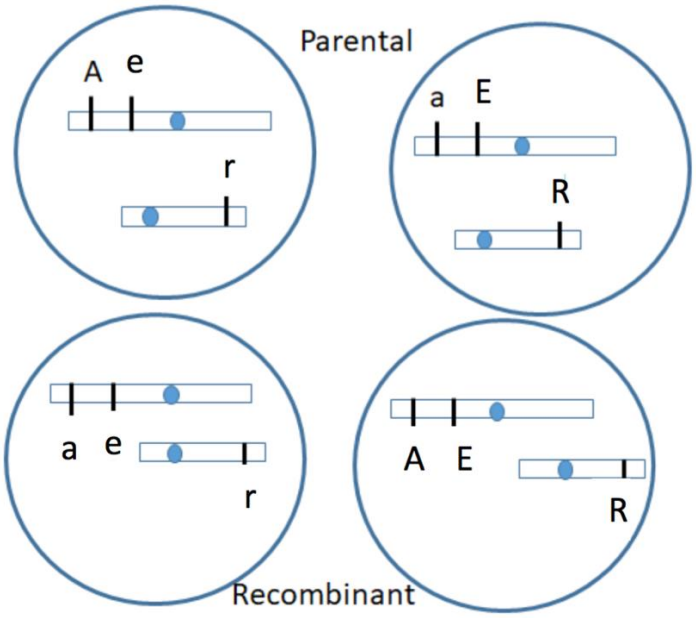
In the table, draw this cell at **metaphase of meiosis I** and the **four gametes produced** (one gamete is given). It is important to consider what cellular mechanisms could result in the gamete provided. Show spindle fibers or use arrows to indicate the direction of chromosome movement (if relevant), and clearly label the genes and alleles on the chromosomes. **(15 marks)**



Cell before meiosis in G1



One of the four gametes produced
(not to scale with parent cell)

	Diagram
Cell at metaphase of meiosis I	 • chromosomes must have two sister chromatids and crossover has already happened (that happened in prophase, this is metaphase) • homologs must be paired, and six chromosomes shown with each other (only four chromosomes with the marked alleles shown, but other two must be included in answer) • arrangement of alleles and chromosomes needs to be consistent with gametes produced (see attached diagram for one possibility, there are others) • direction of movement needs to be clear and accurate, accept arrows or spindle fibers of metaphase plate
The four resulting gametes (one of them is given)	 **Must be consistent with drawing at metaphase and include given gamete (bottom left in diagram). There should be three chromosomes drawn in each gamete, only the ones with alleles marked are shown here.**