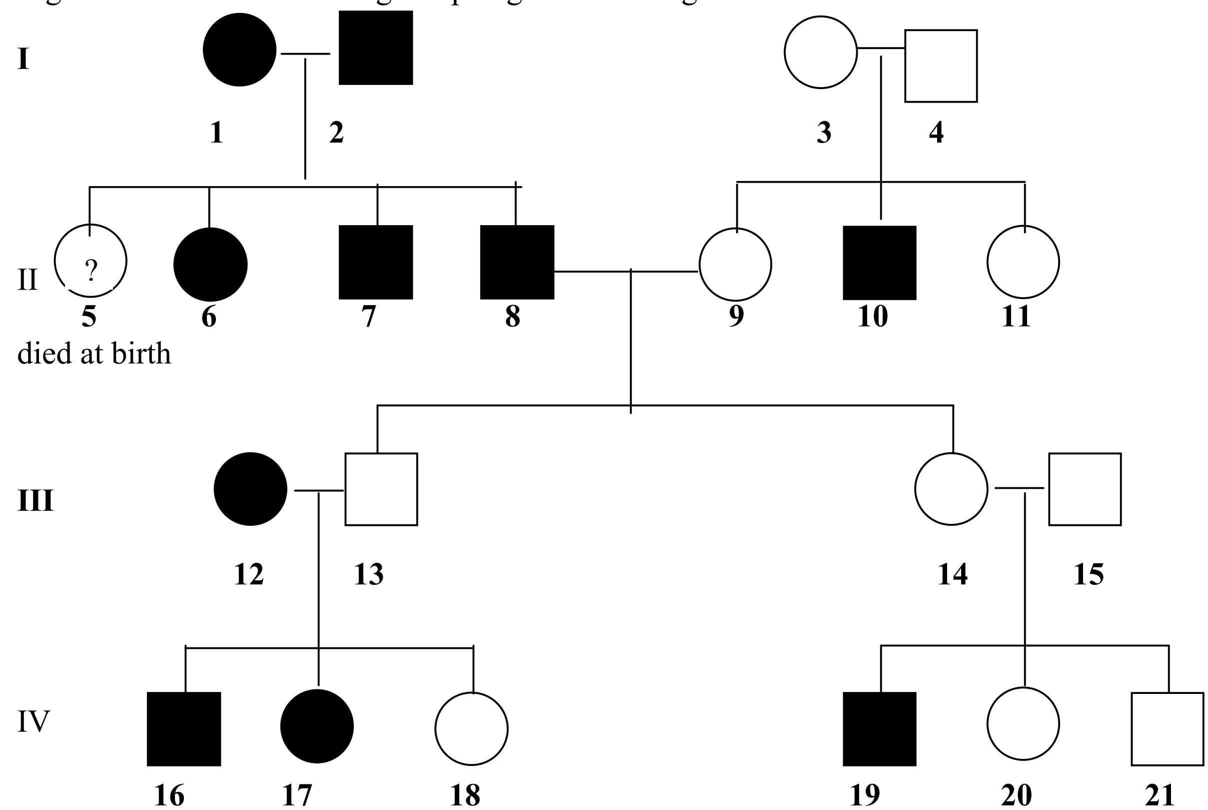
Biology 121 – PRACTICE Midterm 2 Answer Key **Instructor: Greg Bole**

1. (10 marks) Lactose intolerance is a common genetic condition where adults cannot digest lactose, the sugar in milk. The following is a pedigree indicating individuals with lactose intolerance:



a. What is the best explanation for how this trait is inherited, i.e., is it recessive or dominant? Is it autosomal or sex-linked? Justify your answer by referring to specific individuals from the pedigree. (5 marks)
autosomal (1/2) recessive (1/2)
1 mark for reason and 1 mark for referring to individuals - most have at least one reason for recessive and one for autosomal
e.g., 1 and 2 are both lactose intolerant (LI) and all their living children are also LI, indicative of a recessive trait (2)
OR 3 and 4 are both normal yet have an LI son, also indicative of a recessive trait (2)
4 passes the recessive to his son which would not be possible if LI were sex-linked (2)

b. Write the possible genotypes of the following individuals: (3 marks)
L = normal (1/2), l = lactose intolerant (1/2)
(sorry, the numbers of the individuals were erased in the practice question)
5 *ll (1/2)*
9 *Ll (1/2) or LL (1/2)*
13 Ll (1/2)

c. If individuals 8 and 9 had a third child, what is the probability that it would be lactose intolerant? Show all your work. (2 marks)
Probability 9 is heterozygous = 2/3. If she is heterozygous the probability of an affected child is 2/3 x ½ = 2/6 = 1/3(1 for 2/3 x ½ and 1 for answer)

2. (8 marks) A true-breeding *Drosophila* with red eyes and normal body size (wild type) was crossed with a true-breeding *Drosophila* with sepia eyes and small body size. The F1 were all wild type for eye colour and body size. The F1 were crossed with *Drosophila* with sepia eyes and small bodies. The progeny were as follows:

red eyes and normal body size 218
red eyes and small body size 56
sepia (dark brown) eyes and normal body size 44
sepia eyes and small body size 182

Explain why you suspect these genes are on the same chromosome. (4 marks)
If they were on different chromosomes they would assort independently at meiosis (1) and the F1 ratio would be 1:1:1:1 (or equal numbers of each phenotype) (1). But there are more of the parental phenotype (1) and fewer of the recombinants (1).

3. (6 marks) You have been hired as a summer student to work in the UBC *Drosophila* lab. You are given a strain with apricot-colored eyes and asked to determine how this trait is inherited. You do the following crosses and then self the F1 (F1 x F1). You obtain these results:
Cross A: Red-eyed female x apricot -eyed male
F1: all have red eyes
F2: 100 red-eyed females, 46 red-eyed males, 44 apricot -eyed males

Cross B: Apricot -eyed female x red-eyed male
F1 all females have red eyes, all males have apricot eyes
F2: 48 red-eyed females, 52 apricot-eyed females, 46 red-eyed males, 45 apricot -eyed males

Use the results from crosses A and B (F1 and F2) to explain how apricot eye colour is inherited. Justify your answer and show all your work.

X-linked (1)
Define alleles: red eyes = X^{ap+} *(½) apricot eyes =* X^{ap} *(½) accept any dominant and recessive letters (same letters for the trait) but must show the "X" or define it as the X chromosome with that allele. If X-linked predict:*
Cross A: Genotypes of parents and F_1 $X^{ap+}X^{ap+}$ x $X^{ap}Y$ *(½)* F1: $X^{ap+}X^{ap}$ x $X^{ap+}Y$ *all red eyes as observed (½)*
Predicted F2 from F1 self: since all females inherit X^{ap+} from their fathers, they will all have red eyes. *(½)*
Since 50% chance of males inheriting X^{ap+} *or* X^{ap} *from their mothers, ½ the males will be* X^{ap+}Y (red eyes) and ½ will be X^{ap}Y (apricot eyes) as observed. *(½)*
Can also show this using a Punnett square.
Cross B: Genotypes of parents and F_1 $X^{ap}X^{ap}$ x $X^{ap+}Y$ *(½)* F1: $X^{ap+}X^{ap}$ x $X^{ap}Y$ *all ♀ red eyes all ♂ apricot eyes as observed. (½)*
Since 50% chance of ♀inheriting X^{ap+} *or* X^{ap} *from their mothers and 100% chance of inheriting* X^{ap} from their fathers, *½ the ♀will be* X^{ap+} X^{ap} (red eyes) and ½ will be X^{ap} X^{ap} (apricot eyes) as observed. *(½) Since 50% chance of males inheriting* X^{ap+} *or* X^{ap} *from their mothers, ½ the males will be* X^{ap+}Y (red eyes) and ½ will be X^{ap}Y (apricot eyes) as observed. *(½)*
Can also show this using a Punnett square.

4. (8 marks) Jane and John Doe recently gave birth to a darling baby boy. When he was brought to Jane for one of his feedings she had a strange feeling that he was not her son. There were two other boy babies in the nursery that day. These are their blood types as well as those of their parents:

Baby Doe – type O
Jane Doe type A
John Doe type AB

Baby X – type B
Mommy X – type O
Daddy X – type B

Baby Y – type AB
Mommy Y type A
Daddy Y type O

a. Based on the blood type is Jane correct in assuming a switch has occurred? Explain. (4 marks)
Jane is correct a switch has occurred (1) - give marks if this is implied but not overtly stated.
Baby Doe must be ii since he is type O (1)
His mother is A and she could be I^AI^A or I^Ai so she could give an "i" to Baby Doe. (1)
His father is AB therefore he must be I^AI^B so he could not give an "i" to Baby Doe. (1)

b. Who is the most likely candidate to be the real Baby Doe? Explain. (4 marks)
Baby Y is the most likely candidate. (1)
Mommy Y is type A so she could be I^AI^A or I^Ai – in either case she could give an "I^A" to baby Y. (1)
Daddy Y is type O – he is ii so he cannot give an I^B to Baby Y (1).
Therefore the "Y's" can't be the parents of Baby Y but they can be the parents of Baby Doe. (1)

5a. During what phase of mitosis is there a checkpoint that acts as a control to the cell cycle? What is being checked? **(2 marks)**
Metaphase (1), checking that all of the homologous chromosomes are aligned (1).

5b. What could be the result if the cell proceeds through this check point when it shouldn't? **(1 mark)**
The new cells would not have the correct number of chromosomes. (1)

5c. Why does the checkpoint happen during this phase of mitosis? **(1 mark)**
This is the last point at which this can still be corrected (0.5)
before the chromosomes are separated. (0.5)

5d. Would the resulting daughter cells be able to function properly? Why or why not? **(2 marks)**
No. (0.5) There would not be a full set of DNA in some cells. (0.5)
or
Yes. (0.5) Some cells would have a full set of DNA, but with some extra. (0.5)

6. 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

7. 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)**

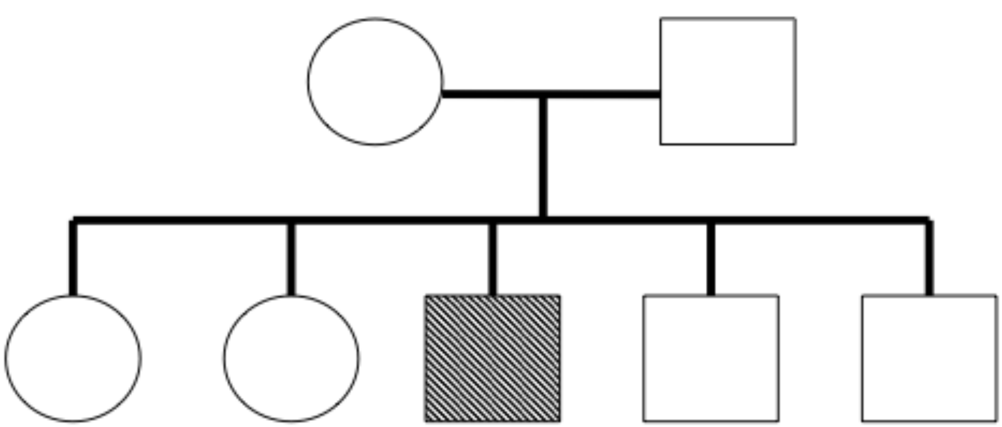
Gray male = AaRr

Yellow female = Aarr

8. In humans, curly hair (H) is dominant over straight hair (h); brown eyes (B) over blue eyes (b); and right handedness (R) over left-handedness (r). Normal vision (C) is dominant over colour blindness (c) which is X-linked. A curly-haired, brown-eyed, left-handed man marries a curly-haired, blue-eyed, right-handed woman. Both have normal colour vision. They have five children, as follows:

child 1- a daughter, curly-haired, blue-eyed, right-handed, normal vision
child 2 - a daughter, straight-haired, blue-eyed, right-handed, normal vision
child 3 - a son, curly-haired, brown-eyed, right-handed, colour blind
child 4 - a son, curly-haired, brown-eyed, right-handed, normal vision
child 5 - a son, curly-haired, blue-eyed, right-handed, normal vision

a. Create a pedigree and mark "affected" individuals who are colour-blind.



b. What is the genotype of each parent?

Father: HhBbrr X+Y   Mother: HhbbRRX+Xc

[Explanation: please note, this is not part of the answer, but simply the logic you should use to solve this kind of problem.

Based on the phenotype you can get this much info: Father: H_B_rr X+Y mother: H_bbR_ X+_
This is because for every dominant phenotype, you don't know if the individual is homozygous or heterozygous.

Let's look at Hair first - since they are both curly-haired, but they have a straight haired daughter (hh) you know that both of them must be heterozygous, or carriers for the h allele.

For eye colour – we know the mother's geneotype, and since they had three blue eyed children (bb), the father must have the b allele and is heterozygous.

For handedness, the father is left handed (rr) but all of his children are right handed, so we know the mother most likely doesn't have the r allele at all, so must be homozygous dominant (RR).

Since colour blindness is X-linked, we know the normal father has the dominant allele on his X chromosome, but since they have a colour-blind son, the mother must be a carrier for the recessive trait (X+Xc).]