

**This problem set has short answer, problem solving, fill in the blank, and multiple-choice questions. All multiple-choice questions have only 1 correct answer unless you are specifically asked to “select all that apply.”**

**For all short answer and problem-solving questions, please show your work/reasoning to get full credit.**

**You are welcome to work with colleagues, but all work must be your own. You cannot copy others. You must be in accordance with Webster’s academic honesty policy.**

**You must submit your answers as one document. You can edit this PDF on your computer or provide hand-written responses. If you choose the hand-written route, please be sure to compile your images into one document via a scanning app such as CamScanner or utilizing a word doc.**

**This problem set is worth 40 pts.**

**- ALL THE BEST & HAVE FUN! -**

1. In a monohybrid cross where parent 1 is homozygous recessive and parent 2 is heterozygous, which of the following is true [1 pt]:

- 100% of the F1 generation will express the dominant trait
- 100% of the F1 generation will express the recessive trait
- 50% of the F1 generation will express the recessive trait
- The F1 generation will produce the dominant to recessive trait in a 3:1 ratio

$aa$                        $Aa$   
 $Aa$   
 $Aa$   
 $aa$   
 $aa$   
 ahhhhhhh!

2. You cross two plants that both have light brown berries and get the following offspring (assume that berry color is controlled by one gene with two alleles:  $B$  and  $b$ ) [5 pts]

106 plants with light brown berries  $Bb$   
 53 plants with white berries  $bb$   
 49 plants with dark brown berries  $BB$

beeeeeee!

a. Which of the following is possible (**select all that apply**)?

- The parents are homozygous for the alleles that control berry color
- The parents are heterozygous for the alleles that control berry color
- One of the alleles shows incomplete dominance ✓
- Though there are three phenotypes of berry color, there are only two genotypes among the offspring

a. From the F1 generation, you cross one offspring with light brown berries and one offspring with white berries. What are the possible offspring in the F2 generation? (Show your work below then specify the genotypes, phenotypes, and ratios/frequencies of traits for the F2 generation on the next page. You may not need all the boxes)



$2 Bb : 2 bb$   
 $2 lb : 2 white$

$B \quad b$   
 $b \quad Bb \quad bb$   
 $b \quad Bb \quad bb$

Genotype	Phenotype	Ratio/Frequency
Bb	light brown	50%
bb	white	50%

complete dominance

















3. Yellow seed color is a dominant trait caused by YY or Yy, while yy results in green seeds. Round seed shape is a dominant trait caused by RR or Rr, while rr results in wrinkled seeds. These alleles sort independently. For the following cross, state the phenotype of the parents and draw a Punnett square to predict what offspring you would see. Then state the offspring phenotypes (color and shape) and frequencies on the following page. You may not need all the boxes [6 pts].

YyRr  x Yyrr 

Parent phenotype: yellow round

yellow wrinkled

Punnett square:

	YR	Yr	yR	yr
Yr	 YYRr  Yyrr	 BbRr	 Bbrr	
Yr	 YYRr  Yyrr	 BbRr	 Bbrr	
yr	 YyRr  Bbrr	 bbRr	 bbrr	
yr	 YyRr  Bbrr	 bbRr	 bbrr	

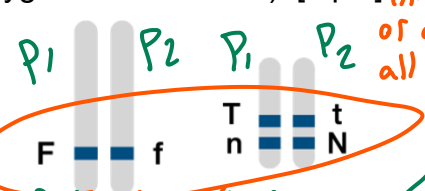
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Offspring Phenotype	Ratio/Frequency
yellow round	3/8
yellow wrinkled	3/8
green round	1/8
green wrinkled	1/8

or  
 $fT/f$   $fT/f$   $fTn$   
 $Tn/tN$   $Tn/tN$   $FTN$   
 $FTn$   
 $fTn$

4. You are breeding roses for a fundraiser on Valentine's Day. Each trait is controlled by a completely dominant and recessive allele. In addition, the  $T$  allele and  $n$  allele are completely linked (pictured is an example of a heterozygote for each trait). [5 pts]

$N_$  is normal,  $nn$  is narrow  
 $T_$  is thorny,  $tt$  has no thorns  
 $F_$  is solid color,  $ff$  is flamed color



only the big  $T$  and little  $n$  are linked?  
 or all  $T$ 's and all  $n$ 's?  $Tn/tN$

$f(TN)(Tn)(tN)(tn)$

$F(TN)(Tn)(tN)(tn)f$

You perform this cross:  $TtNnff \times TtNnFf$ . Assuming no meiotic recombination:

order?

a. What are the possible gametes for both parents

$fTn, fTn$   
 $fTn, fTn$   
 $fTn, fTn$

Parent 1:

Parent 2:

~~$fTN, fTn, fTn, fTn$~~   
 ~~$fTN, fTn, fTn, fTn$~~   
 $P_1: fTN, fTn$   
 $P_2: fTN, fTn$

This doesn't feel right

b. What combination of traits will never be observed?

narrow & no thorns ; flamed & no thorns & narrow

5. Which of the following is true about linked genes (select all that apply)? [1 pt]

- Linked genes follow independent assortment
- Linked genes are usually inherited together
- Linked genes can become unlinked by meiotic recombination
- Linked genes are always passed from father to daughter on the X-chromosome

only X-linked.

6. Your neighbor becomes inspired by you and experiments with breeding daisies. She purchases daisy strains with the following genotypes and traits [2 pts]:

Green leaves =  $G\_$  and striped leaves =  $gg$   
 Black eye =  $B\_$  and colorless eye =  $bb$   
 Eight petals =  $E\_$  and extra petals =  $ee$

She performs this cross:  $GgBbEe \times ggBbEe$

She comes running to you for help when she gets these results:

25%	Green leaves, black eyes, eight petals
25%	Striped leaves, black eyes, eight petals
12.5%	Green leaves, colorless eyes, eight petals
12.5%	Striped leaves, colorless eyes, eight petals
12.5%	Green leaves, black eyes, extra petals
12.5%	Striped leaves, black eyes, extra petals

You realize that her observations can be explained by linkage. Which two alleles are linked? (Assume no meiotic recombination)

$B$  &  $E$

beeee!

7. In humans, one of the genes determining color vision is located on the X-chromosome. The dominant allele ( $X^{RG}$ ) produces normal color vision; red-green color blindness is a recessive trait from the  $X^{rg}$  allele. A man with normal color vision marries a color-blind woman who gives birth to a color-blind but otherwise normal daughter. [3 pts]

XY male  
 XX female

b. The husband sues for a divorce on the grounds of adultery. Does he have a case? Explain in one sentence.

Yes, he would always pass on his dominant  $X^{RG}$  allele to his daughters so she should always have one dominant  $X$  allele.

c. The woman leaves her husband and ends up marrying a man with normal color vision who happens to have an autosomal dominant condition: he has six fingers because he has a mutation in the  $Gli3$  gene:  $G^m$  allele. He is a heterozygote, so he is also carrying the wild type allele:  $G^+$ . The woman is not six-fingered. What are their genotypes?

Woman:  $G^+G^+$   
 New husband:  $G^mG^+$

8. The tortoiseshell coat pattern in cats is the result of X-inactivation of the black and orange alleles of the tortoiseshell gene. You are in a pet store and you see a male tortoiseshell cat offered for \$1000 whereas the female cats are sold for only \$100. Which of the following best explains this sales practice? [1 pt]

- Because the trait is X-linked, it is more commonly seen in males. This price difference is unfair and they are taking advantage of their customers
- Because the trait is caused by X-inactivation, the females that survive are only expressing half of their X-chromosome alleles and are generally sickly. Thus, they are not as valuable and they will be short-lived
- Because X-inactivation in males affects their only X-chromosome, the tortoiseshell trait is more pronounced in males and their pattern is more desirable, hence the high price
- Because X-inactivation only happens when there are two X-chromosomes, the tortoiseshell pattern is relatively common in females and only occurs in males that have extra X-chromosomes due to aneuploidy. Thus, male tortoiseshell cats are rare and demand a high price.

9. State whether you AGREE or DISAGREE with each of the following statements. [2 pts each]

a. There can be 4 different alleles of a gene

- AGREE       DISAGREE

*There can be as many alleles as you want.*

b. For offspring to express a recessive trait, at least one parent had to be homozygous for the recessive allele

- AGREE       DISAGREE

*Aa x Aa*  
*|  |*  
*a  a*

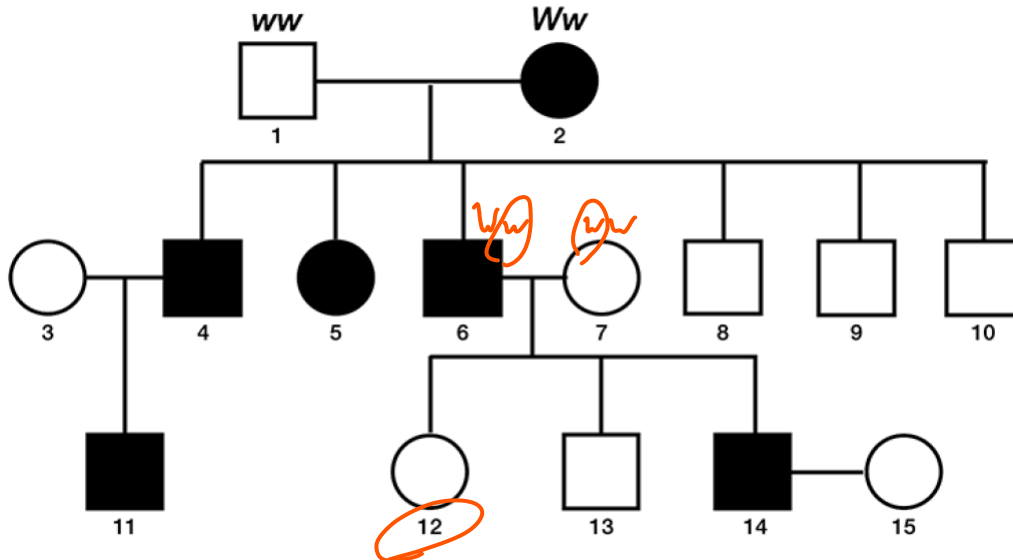
c. If a man suffers from a mitochondrial inherited disorder, none of his children (regardless of sex) will inherit this disorder

- AGREE       DISAGREE

*depends if his children's mother has the disorder.*

**Note: For all pedigrees, assume COMPLETE PENETRANCE.**

10. The following questions refer to the figure of a family's pedigree chart, some of whose members exhibit the widow's peak trait. [3 pts]



- a. What is the genotype of individual 12?

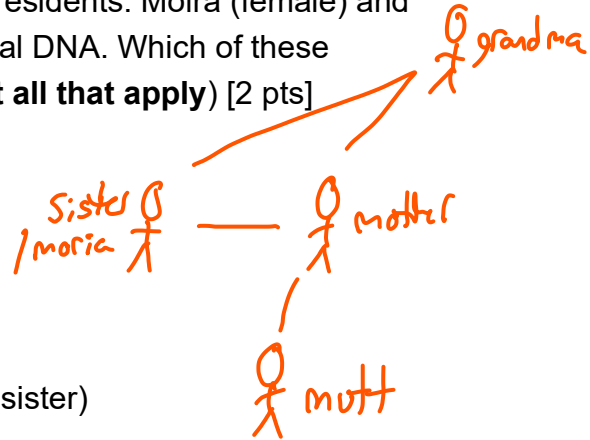
- $WW$
- $WW$  or  $Ww$
- $Ww$
- $ww$

- b. Three sons in the second generation do not exhibit this trait. What does this mean?

- the  $W$  allele is not dominant
- this trait is X-linked
- these three sons are actually triplets
- none of the above

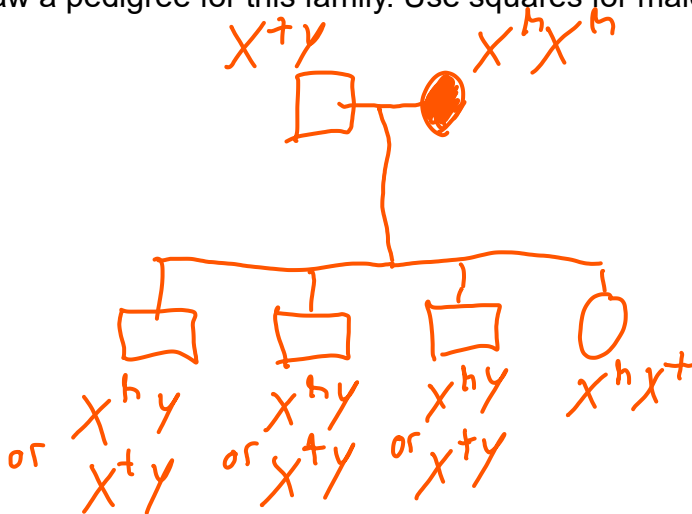
11. The town of Schitts Creek paid for free DNA testing for all residents. Moira (female) and Mutt (male) discover that they share the same mitochondrial DNA. Which of these family relationships could explain this observation? (**select all that apply**) [2 pts]

- Mutt is Moira's son
- Mutt is Moira's father
- Mutt and Moira are siblings
- Moira is Mutt's maternal aunt (Moira is Mutt's mother's sister)
- Moira is Mutt's paternal grandmother (Moira is Mutt's father's mother)



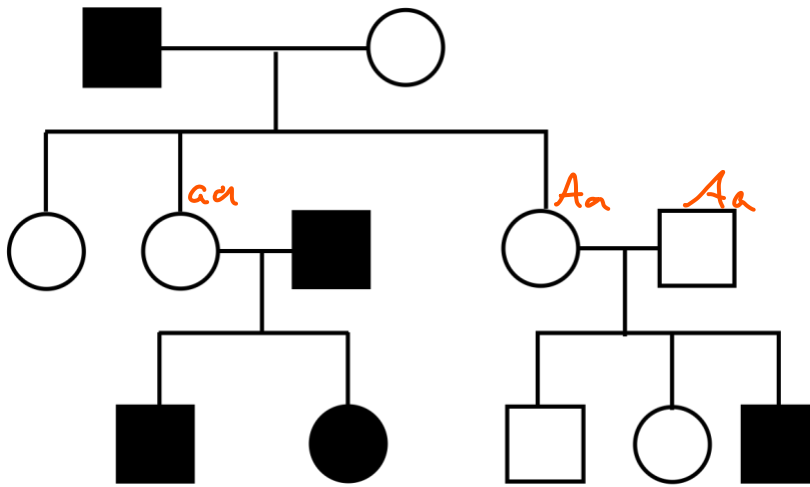
12. You are a thoroughbred breeder and have bred a male and female horse that produced 4 offspring (3 males and 1 female, in that birth order). [5 pts]

a. Draw a pedigree for this family. Use squares for males and circles for females



- b. The mare (mother) is homozygous for an X-linked allele ( $X^h$ ), which is recessive to the wild-type allele ( $X^+$ ). Her genotype gives her an advantageous trait: strong hooves. The sire (father) does not exhibit the strong hooves trait. Label each offspring on your pedigree with all possible genotypes (write them below the circles/squares).
- c. Shade in the circles/squares for the individuals that have strong hooves.

13. Which of the following modes of inheritance are possible for this pedigree (**select all that apply**) [6 pts]:

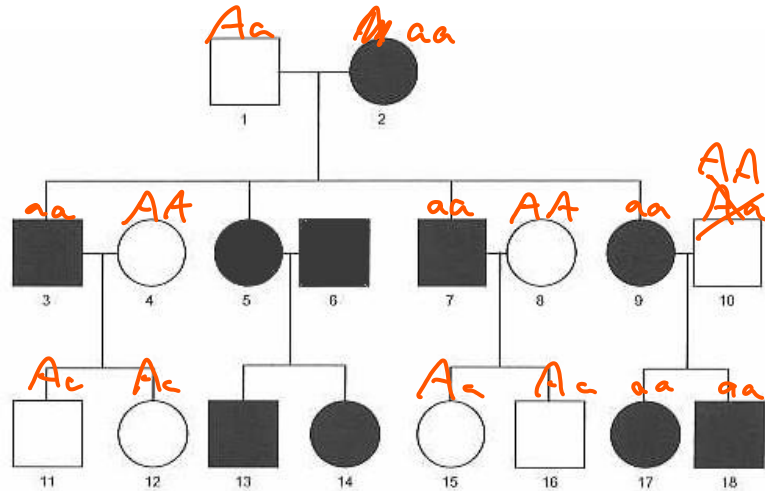


- |  |   |
|--|---|
| <input checked="" type="radio"/> Autosomal dominant  | <input checked="" type="radio"/> X-linked recessive |
| <input checked="" type="radio"/> Autosomal recessive | <input type="radio"/> Y-linked                      |
| <input type="radio"/> X-linked dominant              | <input type="radio"/> Mitochondrial                 |

EXTRA PRACTICE: I will not be grading this question, but it is provided as extra practice for you if you would like to complete it before the exam. Look at the pedigree below and answer the following questions.

a. What modes of inheritance are possible? (select all that apply)

- Autosomal dominant
- Autosomal recessive
- X-linked dominant
- X-linked recessive
- Y-linked
- Mitochondrial



b. You learn that individuals 4 and 10 (who married into the family) have no family history of the trait. You decide it is safe to assume that those two individuals do not carry the allele that causes this trait. What modes of inheritance are still possible? (select all that apply)

- Autosomal dominant
- Autosomal recessive
- X-linked dominant
- X-linked recessive
- Y-linked
- Mitochondrial