

MIDTERM 1 MENDELIAN GENETICS**PRACTICE TEST ANSWER KEY**

1. You perform a cross between a long-eared mouse and a short-eared mouse of unknown genotypes. You obtain 12 long-eared mice and 10 short-eared mice in the progeny (F1). You cross the long-eared F1 progeny with one another and you get 77 long-eared mice and 23 short-eared mice in the F2 generation.

cross 1: long-eared mouse X short-eared mouse

gives F1:

12 long-eared

10 short-eared

cross 2: long-eared F1 X long-eared F1

gives F2:

77 long-eared

23 short-eared

- a) Using letters of your own choosing, state the most likely genotypes of the original two parents, stating which phenotypes are dominant and using a capital letter for the dominant alleles.

A = long ear, dominant

a = short ear, recessive

Parents are Aa (long) x aa (short)

- b) Based on your answer to part (a), state the expected genotypes of the F1, and in what ratio they should occur

	A	a
a	Aa	aa
a	Aa	aa

so the F1 genotypic ratio should be 1 Aa : 1 aa

- c) Based on your answers to parts (a) and (b), state the expected genotypes of the F2 (offspring from cross 2), and in what ratio they should occur

In cross 2, the long-eared F1 progeny were crossed to each other, so Aa x Aa

	A	a
A	AA	Aa
a	Aa	aa

The expected genotypic ratios are: 1 AA : 2 Aa : 1 aa

- d) State the phenotype of each genotype in the F2 and use this to predict the phenotypic ratios in the F2 generation

1 AA long
 2 Aa long → 3 long : 1 short is the phenotypic ratio
 1 aa short

Alternatively: Draw the punnet square, Draw the segregation tree, or write out the probabilities and use the product and sum rules.

2. You cross a wingless fly with a normal fly and obtain 23 wingless and 27 normal flies in the F1 progeny. To test your hypothesis about the mode of inheritance you then cross wingless F1 progeny by one another, and you obtain 19 normal flies and 44 wingless flies in the F2 generation.

cross 1: wingless fly X normal fly
 gives F1:
 23 wingless
 27 normal

cross 2: wingless F1 X wingless F1

gives F2:
 19 normal
 44 wingless

- a) Using letters of your own choosing, state the most likely genotypes of the original two parents, stating which phenotypes are dominant and using a capital letter for the dominant alleles.

W dominant for wingless (also recessive for lethal)
 w recessive, normal wings
 Parents Ww (wingless) x ww (normal)

- b) Based on your answer to (a), give a genetic explanation for the ratio of phenotypes of the F1 (the progeny of cross 1).

	W	w
w	Ww	ww
w	Ww	ww

If parents are Ww x ww, offspring should be 1 Ww (wingless) : 1 ww (normal)

- c) State the expected genotypes of the F2 (the progeny in cross 2), and in what ratio they should occur:

Cross 2 is wingless x wingless, or $Ww \times Ww$

	W	w
W	WW	Ww
w	Ww	ww

so the F2 should be 1 WW : 2 Ww : 1 ww

- d) State the phenotype of each genotype in the F2 and use this to predict the phenotypic ratios in the F2 generation

1 WW lethal

2 Ww wingless → since lethal not observed, predict 2 wingless : 1 normal

1 ww normal

3. You have two purebred varieties of rabbits, one that has long ears and long whiskers, and another that has short ears and short whiskers. You wonder if ear length and whisker length are both determined by the same gene, or by two independent genes. You cross your two purebred varieties and all the F1 progeny have long ears and long whiskers. You mate two of the F1 hybrids to one another and obtain 16 offspring (F2): 13 have long ears and long whiskers, and 3 have short ears and short whiskers. Now you're not sure what to conclude, so you look more closely at both theories.

- a) Using letters of your own choosing, write out the genotypes of the two parental varieties based on the theory that it's a single gene, stating which phenotypes are dominant and using a capital letter for the dominant alleles. Predict the phenotypic ratios in the F2 from this theory.

L = long ears and whiskers (dominant)

l = short ears and whiskers (recessive)

Parents LL (long ears and whiskers) x ll (short ears and whiskers)

Ratios should be 3 (long ears and whiskers) : 1 (short ears and whiskers)

- b) Using letters of your own choosing, write out the genotypes of the two parental varieties based on the theory that it's two independent genes, stating which phenotypes are dominant and using a capital letter for the dominant alleles. Assume the two genes segregate independently and their alleles do not interact. Predict the phenotypic ratios in the F2 from this theory.

E = long ears (dominant), e = short ears (recessive)

W = long whiskers (dominant), w = short whiskers (recessive)

Parents EEWW x eeww

Ratios should be 9:3:3:1 as follows

9 E_W_ long ears, long whiskers
 3 E_ww long ears, short whiskers
 3 eeW_ short ears, long whiskers
 1 eeww short ears, short whiskers

- c) Using a Chi Square Test with a significance threshold of $p < 0.05$, are the data from this experiment alone sufficient to rule out this simple two gene theory? Show your work and put a box around the χ^2 value, the P value, and your yes/no answer.

Class	Observed	Expected	$(O-E)^2$	$(O-E)^2 / E$
E_W_	13	$9/16 \times 16 = 9$	$(13-9)^2 = 16$	1.78
E_ww	0	$3/16 \times 16 = 3$	$(0-3)^2 = 9$	3.0
eeW_	0	$3/16 \times 16 = 3$	$(0-3)^2 = 9$	3.0
eeww	3	$1/6 \times 16 = 1$	$(3-1)^2 = 4$	4.0
				$\chi^2 = 11.78$

Degrees of freedom = number of classes - 1 = 3

$\chi^2 = 11.78$

P between .01 and .005 (also acceptable to state $P < 0.01$)

YES the simple (independent and non-interacting) two gene hypothesis can be rejected (it is too unlikely that the data would be this far off if the hypothesis were true)

Question 4.

A family has a rare disorder, as indicated by the red symbols in the family tree:
(see exam)

- a) What is the mode of inheritance of this disorder?
The disease is **AUTOSOMAL DOMINANT**
- b) Cite 2 facts about the pedigree that justify your conclusion.
There is no gender bias so it is autosomal (not sex linked)
(and either of)
Every affected individual has an affected parent
Half of the kids of an affected individual are affected
- c) What is the probability that the individual marked with the arrow is a carrier?
Explain how you determined the probability.
Zero. Unaffected individuals cannot be carriers of dominant traits.

5. In dogs, the genetic control of blindness is unknown. A pedigree is shown below. Blind individuals have been shaded black. Assume that dogs I_b and II_e are heterozygous for the blindness gene. (see exam)

- (i) Is this pedigree consistent with a X-linked recessive trait? **Yes**
(ii) Is this pedigree consistent with a X-linked dominant trait? **No**
(iii) Is this pedigree consistent with an autosomal recessive trait? **Yes**
(iv) Is this pedigree consistent with an autosomal dominant trait? **No**
- (v) Propose a cross using any of the dogs in the pedigree that would allow the true inheritance pattern to be determined. Give the expected results and the conclusions that would be drawn in each case.

Example: Cross II_a with II_b. If the trait is X-linked recessive, II_a is X^dX^d and II_b is X^DY. All sons would be blind, whereas all daughters would be normal. If the trait is autosomal recessive, II_a is dd and II_b is Dd. In this case, half of all progeny (regardless of sex) would be blind.

Question 6.

A man with the genotype AaBbccDdEeFf marries a woman of genotype aaBbCcddEeFF.

- a) How many different types of gametes can each of them form?
The man is heterozygous at 5 genes so $2^5 = 32$ types of gametes
The woman is heterozygous at 3 genes so $2^3 = 8$ types of gametes

b) How many distinct F1 genotypes could be formed by combining one gamete from each of them?

Note it's not 8×32 , because some combinations are not distinct!

$Aa \times aa \rightarrow 2$ distinct F1 genotypes (Aa or aa)

$Bb \times Bb \rightarrow 3$ distinct F1 genotypes (BB, Bb, or bb)

$cc \times Cc \rightarrow 2$

$Dd \times dd \rightarrow 2$

$Ee \times Ee \rightarrow 3$

$Ff \times FF \rightarrow 2$

So $2 \times 3 \times 2 \times 2 \times 3 \times 2 = 144$ distinct diploid F1 genotypes

Question 7.

Normal parrots of a certain species have red feathers. The recessive mutation *w* causes white feathers. Parrots that are homozygous recessive *bbcc* are yellow, but the *B* and *C* genes are redundant. The *w* mutation is recessive epistatic to both *B* and *C*.

- a) Suggest a dihybrid cross in which both parents have the same genotype, that would produce progeny with the ratio 9 red : 3 yellow : 4 white. Specify the genotype at all three genes, but one of the genes should be homozygous. Show how you derive the phenotypic ratio based on the genotypic classes.

NOTE: A dihybrid cross means there are two HETEROZYGOUS genes, so one of the three genes must be homozygous.

$AaBbcc \times AaBbcc$

9 A_B_cc red

3 A_bbcc yellow

3 aaB_cc white because a epistatic

1 $aabbcc$ white

- b) Suggest another dihybrid cross in which both parents have the same genotype, that would produce progeny with the ratio 15 red : 1 yellow. Specify the genotype at all three genes, but one of the genes should be homozygous. Show how you derive the phenotypic ratio based on the genotypic classes.

$AABbCc \times AABbCc$

9 $AAB_C_$ red

3 AAB_cc red because *B* and *C* redundant

3 $AAbbC_$ red because *B* and *C* redundant

1 $AAbbcc$ yellow