

# Mendel's Laws of Heredity

## VOCABULARY

Match the phrases to the terms below. Each term may be used once, more than once, or not at all.

### Phrases

- 1.) An alternative form of a gene at a locus
- 2.) Describes an allele that needs two copies to be present to produce its phenotype
- 3.) An example of a disorder caused by a dominant allele
- 4.) Describes an allele that produces a particular phenotype even when only one copy is present
- 5.) The genetic constitution of an individual, or the combination of alleles at a particular locus
- 6.) An example of a disorder caused by a recessive allele
- 7.) Cell division during which crossing-over occurs
- 8.) Type of cell division that occurs in ovaries and testes, producing gametes
- 9.) A basic unit of inheritance, found on a chromosome
- 10.) Said to be present for genes close together on a chromosome

### Terms

allele  
 amino acid  
 chromatid  
 chromosome  
 dominant  
 gamete  
 gene  
 genotype  
 Huntington disease  
 linkage  
 locus  
 meiosis  
 pedigree  
 phenotype  
 phenylalanine  
 phenylketonuria (PKU)  
 protein  
 recessive  
 recombination

### Ans:

- 1.) *allele* 2.) *recessive* 3.) *Huntington disease* 4.) *dominant* 5.) *genotype*  
 6.) *phenylketonuria* 7.) *meiosis* 8.) *meiosis* 9.) *gene* 10.) *linkage*

**Level:** E

**Topic:** Mendel's Laws of Inheritance

## PROBLEMS

1. The albino phenotype is an inherited trait that has behavioral consequences in mice. In the offspring of two carrier mice, the Mendelian phenotypic ratio of 3 normal to 1 albino is observed. How many genes does this suggest albinism is controlled by?

**Ans:** one

**Level:** M

**Topic:** Mendel's First Law of Heredity

**Pages:** 8–10

2. The behavioral **Waltzer phenotype** in mice is characterized by head shaking, rapid circling, and irritability (van Abeelen and van der Kroon, 1967). True-breeding mice are mice that have two similar alleles at the Waltzer locus.

True-breeding Waltzer males and females, when mated, produce offspring all with the Waltzer phenotype. True-breeding Waltzer females and non-Waltzer males produce all normal offspring. Second generation (F<sub>2</sub>) results from mating the offspring from a cross between true-breeding Waltzer and non-Waltzer mice are shown below:

Normal (non-Waltzer) mice	124
Waltzer mice	48
TOTAL	172

- a. Do you think the allele for the Waltzer phenotype is dominant or recessive?

**Ans:** recessive

**Level:** E

**Topic:** Mendel's First Law of Heredity

**Pages:** 7–10

- b. Give your reason why.

**Ans:** Waltzer mice crossed with normal mice produce all normal offspring, and it looks like the ratio of phenotypes in crosses between these offspring (i.e., F<sub>2</sub> mice) give normal to Waltzer in the ratio 3:1, as expected from Mendel's First Law.

**Level:** E

**Topic:** Mendel's First Law of Heredity

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- c. Perform a chi-square test to determine if the results given above are consistent with your hypothesis.

**Ans:**

*Hypothesis: If Waltzer is caused by a recessive allele, expect 3:1 normal to Waltzer in F<sub>2</sub> generation.*

*Chi-square formula  $\chi^2 = \sum (obs - exp)^2/exp$*

Test	Obs	Exp	O-E	(O-E) <sup>2</sup>	(O-E) <sup>2</sup> /E
	124	129	5	25	0.194
	48	43	5	25	0.581

$$\chi^2 = 0.775 = \chi^2_{1df} \sim 32\% \text{ probability}$$

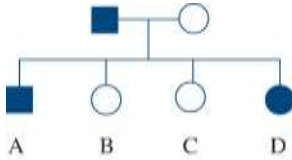
Conclusion: Retain hypothesis; the probability of getting such observed numbers is high.

Level: D

Topic: Mendel's First Law of Heredity

Pages: 8–9

3. The figure below shows a small portion of a Huntington disease pedigree:



a. Using H as the symbol for the Huntington allele and h as the normal allele, give the genotypes at the Huntington locus for each of the four children (A,B,C,D)

Ans:  $A = Hh$   $B = hh$   $C = hh$   $D = Hh$

Level: M

Topic: Huntington disease

Pages: 10–11

b. If child B marries an affected man, what is the probability that their first child would develop Huntington disease?

Ans: 0.5 (or 50%)

Level: M

Topic: Huntington disease

Pages: 10–11

c. If their first child is unaffected, what is the probability that their second child is affected?

Ans: 0.5 (or 50%)

Level: M

Topic: Huntington disease

Pages: 10–11

d. If child A marries an unaffected woman and has two children, what is the probability that **both** children are unaffected?

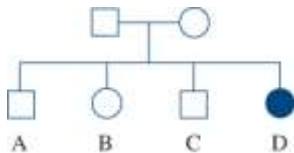
Ans:  $0.5 \times 0.5 = 0.25$

Level: D

Topic: Huntington disease

Pages: 10–11

4. The figure below shows part of a PKU pedigree:



a. Using K as the symbol for the normal allele and k as the symbol for the PKU allele, give the possible genotypes of the unaffected children (A,B,C).

Ans:

$A = KK$  or  $Kk$   $B = KK$  or  $Kk$   $C = KK$  or  $Kk$

Level: M

Topic: Phenylketonuria (PKU)

Pages: 11–12

b. Given that child A is an **unaffected** brother of a PKU child, what is the probability that he is a PKU

carrier?

**Ans:** 0.66 (or 2/3)

**Level:** M

**Topic:** Phenylketonuria (PKU)

**Pages:** 11–12

c. Assume A is a carrier. What genotype would his mate have to be for a child of the couple to be at risk for PKU?

**Ans:** *Kk (or kk, but this is less likely)*

**Level:** E

**Topic:** Phenylketonuria (PKU)

**Pages:** 11–12

d. What are A's chances (assuming he is a carrier) of marrying and producing children who are **not** at risk for having PKU? (see Box 2.2, page 13 of text)

**Ans:** *A cannot marry Kk or kk; mate has to be KK*

*Frequency of Kk = 2%    Frequency of kk = 1/10000*

*So, frequency of KK = 1 - (0.2 + 0.00001) = 0.97999 around 98%*

**Level:** D

**Topic:** Phenylketonuria (PKU)

**Pages:** 12–13

5. A mouse geneticist discovers two recessive alleles, each of which causes the mice to be deaf when two copies are present.

a. How could the geneticist determine whether the alleles occur at the same locus (i.e., are alleles of the same gene)?

**Ans:** *Cross mice with two copies of one allele with mice having two copies of the other allele. If offspring are deaf, then the alleles are at the same locus. If none of the mice are deaf, then the alleles are at separate loci.*

**Level:** D

**Topic:** Mendel's Second Law of Heredity

**Pages:** 14–17

b. If it is discovered that the alleles are at different loci, how could the geneticist discover if they were located together on the same chromosome?

**Ans:** *Do a test for linkage: Cross second-generation offspring (F<sub>2</sub>) from the mating of mice with both types of deafness and look for a departure from the expected ratio of 9:3:3:1. A lack of recombinants would indicate linkage.*

**Level:** D

**Topic:** Mendel's Second Law of Heredity

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