Lesson Self-Check

CAN YOU SOLVE IT?

FIGURE 16: Kittens with tortoiseshell fur resulted from crossing an orange cat with a black cat.

a Female cat

b Male cat

c Tortoiseshell kitten from the litter

Recall the cat breeder from the beginning of the lesson. The breeder hoped to produce a litter of kittens in which half the kittens were orange and half were black. To achieve this, the breeder crossed an orange female cat with a black male cat. When the kittens were born, three were male and three were female. As expected, half the kittens had orange fur. However, the remaining kittens had a mixture of orange and black fur called *tortoiseshell*. To complicate things further, the orange kittens were all males and the tortoiseshell kittens were all females.

Explain Refer to the notes in your Evidence Notebook to answer the following questions:

1. Why was the litter of kittens not half black and half orange?
2. Why were there only female tortoiseshell kittens?
3. Which alleles were passed on by each parent cat in this cross? Which alleles did the male offspring receive? Which alleles did the female offspring receive?

Tortoiseshell coloring in cats is usually expressed only in females. This tells us that the gene controlling black and orange color is located on the X chromosome. Males have one X chromosome with either an allele for orange fur (X^B) or one for black fur (X^b). This gives two possible genotypes for males: X^BY or X^bY. Because males have only one version of the allele, they will always express that allele. Females, however, have two X chromosomes. Thus, they can be homozygous for orange fur (X^BX^B), homozygous for black fur (X^bX^b), or heterozygous (X^BX^b).

Remember, in females one X chromosome in each cell is inactive. X inactivation does not impact homozygous females (X^BX^B and X^bX^b) because the same allele is expressed regardless of which X chromosome is active. X inactivation impacts heterozygous females (X^BX^b) because it is random. The color expressed by each cell depends on which of the two chromosomes is active. Black fur occurs on skin patches that have an inactive X^B allele. Orange fur occurs where the X^b allele is inactive. The patches of color occur randomly, giving these females their characteristic mosaic tortoiseshell pattern.

CHECKPOINTS

Check Your Understanding

Use the following information to answer Questions 1–3.

Two heterozygous, wirehaired vizslas were crossed. The genotypes of their potential offspring are shown in the Punnett square in Figure 17.

FIGURE 17: Heterozygous-Heterozygous Cross

	W	*w*
W	*WW*	*Ww*
w	*Ww*	*ww*

1. What is the phenotypic ratio of wire-coated to smooth-coated offspring?

2. What is the genotypic ratio of homozygous dominant to heterozygous to homozygous recessive offspring?

3. What genotype has a 100% chance of expressing a recessive allele?

Use the following information to answer Questions 4 and 5.

Duchenne muscular dystrophy is an X-linked recessive disease that causes degeneration and weakness in muscles. The normal condition is represented by the superscript *D,* and the allele that causes Duchenne muscular dystrophy is represented by the superscript *d*.

4. Draw a Punnett square to show a cross between a homozygous-dominant female and a male with Duchenne muscular dystrophy.

5. Which combination of parental genotypes is most likely to result in carrier daughters?

Use the following information and the Punnett square in Figure 18 to answer Questions 6–8.

The trait for purple flowers in pea plants (*P*) is dominant to the trait for white flowers (*p*).

FIGURE 18: Heterozygous-Homozygous Recessive Cross

	P	*p*
p	*Pp*	*pp*
p	*Pp*	*pp*

6. What is the probability that the heterozygous parent will donate a recessive *p* allele?

7. What is the probability that the homozygous-recessive parent will donate a recessive *p* allele?

8. What is the probability of both parents donating a recessive *p* allele?

9. Why is the known genotype in a testcross always homozygous recessive? Provide an example to support your claim.

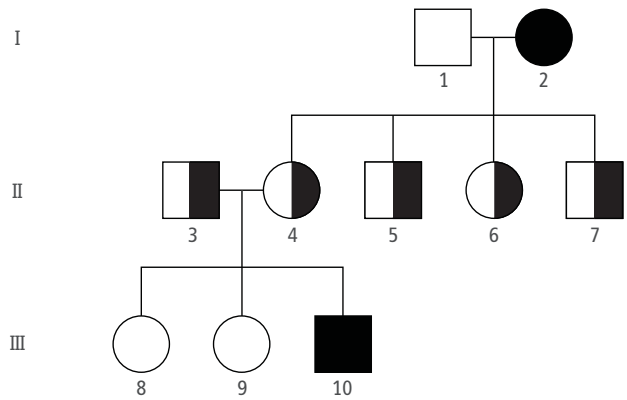
10. For each pair, calculate the probability of producing a homozygous recessive genotype. Then place the pairs in order of increasing probability.
    a. $Aa \times aa$
    b. $aa \times aa$
    c. $Aa \times Aa$

11. Parents of genotype *AABB* and *aabb* were crossed and produced all heterozygotes with the genotype *AaBb*. Heterozygotes from the F_1 generation were crossed and produced a phenotypic ratio of 9:3:3:1. How does this sequence of events support the law of independent assortment?

Use the following information and the pedigree in Figure 19 to answer Questions 12–14.

This simple pedigree traces an autosomal-recessive disorder across three generations. This disorder is not sex-linked and follows Mendelian patterns of inheritance. The dominant allele is *A,* and the recessive allele that causes the disorder is *a*.

FIGURE 19: Autosomal-Recessive Pedigree



12. The four siblings in the second generation have the same genotype. What is it?

13. What is the most likely genotype of the father in the first generation?

14. What is the genotype of both affected individuals?

15. Imagine a plant can have striped flower petals or solid flower petals. Solid coloring (*Z*) is dominant to stripes (*z*). Which parental cross would yield the following ratio of offspring: 1 homozygous dominant (*ZZ*): 2 heterozygotes (*Zz*): 1 homozygous recessive (*zz*)?

a. homozygous dominant–homozygous recessive

b. homozygous dominant–homozygous dominant

c. homozygous dominant–heterozygous

d. heterozygous-heterozygous

Use following information to answer Questions 16–18. Make a Punnett square for each cross to support your answers.

In pea plants, yellow seed color (*Y*) is dominant to green seed color (*y*); round seeds (*R*) are dominant to wrinkled seeds (*r*).

16. What is the probability that parents with the genotypes *YyRR* and *YYRR* will produce an offspring with the genotype *YYRR*?

17. What is the probability that parents with the genotypes *yyrr* and *YyRr* will produce offspring with the genotype *yyrr*?

18. What is the probability that parents with the genotypes *YYRR* and *yyrr* will produce offspring with the genotype *YyRr*?

MAKE YOUR OWN STUDY GUIDE

In your Evidence Notebook, design a study guide that supports the main ideas from this lesson:

The expression of genes determines an organism's phenotype.

Punnett squares can be used to determine the probability of offspring expressing certain traits.

If genes are sex-linked, males will express the allele found on the X chromosome while females express the allele on the active X chromosome. If the gene is located on the Y chromosome, it is expressed only in males.

Remember to include the following information in your study guide:

- Use examples that model main ideas.
- Record explanations for the phenomena you investigated.
- Use evidence to support your explanations. Your support can include drawings, data, graphs, laboratory conclusions, and other evidence recorded throughout the lesson.

There is a cause-and-effect relationship between an organism's DNA and its phenotype. Consider other cause-and-effect relationships, such as the effect a parent's DNA has on offspring.