11.2 Applying Mendel's Principles

Lesson Objectives

▭ Explain how geneticists use the principles of probability to make Punnett squares.

▭ Explain the principle of independent assortment.

▭ Explain how Mendel's principles apply to all organisms.

Lesson Summary

Probability and Punnett Squares **Probability** is the likelihood that a particular event will occur. Probability predicts the recombination of alleles:

▶ Of an allele pair, the probability of each allele in a gamete is ½, or 50 percent.

▶ When F_1 hybrid individuals are crossed, the probability of

• two recessive alleles is ¼.

• two dominant alleles is ¼.

• one dominant allele and one recessive allele is ½ (¼ + ¼).

▶ Organisms that have two identical alleles for a gene are **homozygous** for that trait. If they have different alleles for the same gene, they are **heterozygous** for that trait.

▶ Physical traits are an organism's **phenotype**. Its **genotype** is its genetic makeup.

▶ A **Punnett square** is a mathematical tool that helps predict combinations in genetic crosses.

Independent Assortment The principle of **independent assortment** states that genes for different traits segregate independently during the formation of gametes. In two-factor crosses, the phenotypes of the F_2 offspring occur in a 9:3:3:1 ratio: 9 with with both traits dominant, 3 with the first trait dominant and the second trait recessive, 3 with the first trait recessive and the second trait dominant, and 1 with both traits recessive.

A Summary of Mendel's Principles

▶ Genes are passed on from parents and determine traits.

▶ Where two or more alleles for a gene exist, some may be dominant and others recessive.

▶ In sexually reproducing organisms, offspring receive a copy of each gene from each parent. The alleles segregate when forming gametes.

▶ Alleles for different genes usually segregate independently.

Probability and Punnett Squares

1. What is probability? _____

_____

2. In a parent pea plant with the allele pair Gg, what is the probability that one gamete will contain the G allele? _____

_____

3. Complete the graphic organizer to define the characteristics of homozygous and heterozygous genotypes and phenotypes.

	Homozygous	Heterozygous
Genotype		
Phenotype		

4. The dominant allele for smooth pod shape in peas is S. The recessive allele for constricted pod shape is s. In the Punnett square, show the result of crossing two heterozygous parents (Ss). Write the genotype and the phenotype of each type of offspring in the space provided.

	S	s
S	Genotype: _____ Phenotype: _____	Genotype: _____ Phenotype: _____
s	Genotype: _____ Phenotype: _____	Genotype: _____ Phenotype: _____

For Questions 5–9, refer to the Punnett square above.

5. What is the probability of a heterozygous offspring? Explain your answer.

_____

_____

6. What is the probability of a homozygous offspring? Explain.

_____

7. What is the probability of a homozygous recessive offspring?

_____

8. What is the probability of a smooth phenotype?

_____

9. What is the probability of a homozygous recessive individual (ss) producing a gamete with a dominant allele (S)? Explain.

_____

_____

Independent Assortment

10. State the principle of independent assortment below.

_____

11. Using the principle of independent assortment, complete the Punnett square to show the results of an F_1 cross between two individuals heterozygous for both pod color (C = green and c = yellow) and pod shape (S = smooth and s + constricted). The gametes and some of the genotypes of the F_2 offspring are given.

	CS	cS	Cs	cs
CS	CCSS			
cS				ccSs
Cs			CCss	
cs		ccSs		

For Questions 12–15, refer to the Punnett square above.

12. Which genotype belongs to an offspring that is homozygous recessive for both traits? What is the probability of that genotype?

_____

13. What is the phenotype of an individual heterozygous for both traits?

_____

14. What is the probability of an F_2 offspring having the green pod color and smooth pod shape? Explain. (Note: Remember that more than one genotype can produce this phenotype.)

_____

_____

15. The Punnett square predicts a 9:3:3:1 ratio for phenotypes. Explain what that ratio means.

_____

_____

_____

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_____

_____

Summary of Mendel's Principles

For Questions 16–20, complete each statement by writing the correct word or words.

16. The units that determine the inheritance of biological characteristics are _____.

17. A form of a gene is a(n) _____.

18. If two or more forms of a gene exist, some may be dominant and others may be

_____.

19. The offspring of most sexually reproducing organisms have two copies of each gene. One came from each _____.

20. Alleles from different genes usually _____ independently from each other when gametes form.

For Questions 21–25, match the term with its description.

_____	21. Determine traits	A. parents
_____	22. Can be two of these in one gene	B. alleles
_____	23. Allele that is expressed	C. dominant
_____	24. Where genes come from	D. segregate
_____	25. What genes do during gamete formation	E. genes

26. Explain the importance of Thomas Hunt Morgan's experiments with fruit flies. Why was his work an important addition to Mendel's research?

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_____

Apply the Big idea

27. Four sisters begin attending your school. One has brown hair and brown eyes. Another has brown hair and blue eyes. The third also has blue eyes, but blond hair. The fourth has blond hair, too, but she has brown eyes. Explain how the principle of independent segregation accounts for these sisters having four different phenotypes for two traits.

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