Study Guide

**11 Study Guide**

**Big Idea**

Information and Heredity

Genetic information passes from parent to offspring during meiosis when gametes, each containing one representative from each chromosome pair, unite.

### 11.1 The Work of Gregor Mendel

- An individual’s characteristics are determined by factors that are passed from one parental generation to the next.
- During gamete formation, the alleles for each gene segregate from each other so that each gamete carries only one allele for each gene.

### 11.2 Applying Mendel’s Principles

- Punnett squares use mathematical probability to help predict the genotype and phenotype combinations in genetic crosses.
- The principle of independent assortment states that genes for different traits can segregate independently during the formation of gametes.
- Mendel’s principles of heredity, observed through patterns of inheritance, form the basis of modern genetics.

### 11.3 Other Patterns of Inheritance

- Some alleles are neither dominant nor recessive. Many genes exist in several different forms and are therefore said to have multiple alleles. Many traits are produced by the interaction of several genes.

**Performance Tasks**

**SUMMATIVE TASK**

Have students write a story about a chromosome going through meiosis for the first time. Encourage them to use illustrations and be creative, but they must give accurate information about the movement of chromosomes.

**TRANSFER TASK**

Tell students to imagine they are dog breeders for a particular breed. Spotted coats are dominant over solid coats, and curly coats are dominant over straight coats. They mate two dogs with spotted, curly coats. Two puppies have spotted, curly coats, and two have solid, straight coats. Another breeder claims the phenotypes must be due to gene linkage and cannot be due to a two-factor cross in which the two genes are not linked. Have students explain how either explanation is plausible and draw diagrams to demonstrate their reasoning. Then, have them explain why it is important to a dog breeder to know whether the phenotypes are from a gene linkage or a dihybrid cross.

**Study Online**

**REVIEW AND ASSESSMENT RESOURCES**

- **Editable Worksheets** Pages of Study Workbooks A and B, Lab Manuals A and B, and the Assessment Resources Book are available online. These documents can be easily edited using a word-processing program.

- **Lesson Overview** Have students reread the Lesson Overviews to help them study chapter concepts.

- **Vocabulary Review** The Flash Cards and Match It provide an interactive way to review chapter vocabulary.

- **Chapter Assessment** Have students take an online version of the Chapter 11 Assessment.

- **Standardized Test Prep** Students can take an online version of the Standardized Test Prep. You will receive their scores along with ideas for remediation.

- **Diagnostic and Benchmark Tests** Use these tests to monitor your students’ progress and supply remediation.

**Answers**

**THINK VISUALLY**

Students’ concept maps should include that a gene has two alleles, genes are located on chromosomes, genes help determine traits, and alleles can be dominant or recessive.

Introduction to Genetics 331
Lesson 11.1

UNDERSTAND KEY CONCEPTS
1. c  2. c
3. True-breeding organisms self-fertilize to produce offspring like themselves.
4. Mendel removed the pollen-producing parts from the flowers of his pea plants so they would not self-pollinate.

THINK CRITICALLY
5. Cross the white ram with a number of black ewes. If any offspring are black, then the white ram is heterozygous.
6. The original genotypes and the crosses could have been $Tt \times tt$ or $Tt \times Tt$. The genotype $TT$ could not have been present; if it were, all the offspring would be tall.

Lesson 11.2

UNDERSTAND KEY CONCEPTS
7. a  8. c  9. c
10. (1) The inheritance of biological characteristics is determined by genes. (2) Where there are two or more forms (alleles) of the gene for a single trait, some forms of the gene may be dominant and others recessive. (3) In most sexually reproducing organisms, each adult has two copies of each gene, one from each parent. These genes are segregated when gametes form. (4) The alleles for different genes (actually, the chromosomes) usually segregate independently.
11. $1 \text{ YY} : 2 \text{ Yy} : 1 \text{ yy}$; the Punnett square should show a cross between two heterozygous plants ($Yy$).

THINK CRITICALLY
12. The result of each fertilization is independent of any previous fertilizations, so it is possible for all offspring to have smooth coats. Each offspring could receive a recessive allele from both its parents.

Lesson 11.3

UNDERSTAND KEY CONCEPTS
13. d  14. a
15. A single gene has multiple alleles if it has more than two alleles. Two or more genes control polygenic traits.
16. Many different phenotypes are possible, because, while individuals only have two alleles each, there can be many different alleles present in the population. Different possible allele combinations can yield different phenotypes.

THINK CRITICALLY
17. No, genes provide a plan for development, but how the plan unfolds depends on the environment.
18. The color helps the ptarmigan hide from predators. In winter, its white coat color blends in with its snowy surroundings.
Lesson 11.4

UNDERSTAND KEY CONCEPTS
19. d 20. d 21. b
22. four
23. Meiosis is a process of cell division in which the number of chromosomes per cell is cut in half through the separation of homologous chromosomes.
24. It is the chromosomes that are separated during meiosis. The genes are located on the chromosomes.

THINK CRITICALLY
25. Sample answer: Meiosis I results in two daughter cells with 2N chromosomes each, while meiosis II results in four daughter cells with N chromosomes each. In Prophase I, replicated, homologous chromosomes pair up to form tetrads, while in Prophase II, the chromosomes do not replicate or form tetrads. In Metaphase I, homologous pairs of chromosomes separate, while in Metaphase II, paired chromatids separate. The final four phases of meiosis I and meiosis II are similar.

GREEN PARAKEETS
After consulting with the owner of the pet store, Susan realized she had a rare gift. White parakeets are very uncommon. The pet shop owner told Susan that two genes control feather color. A dominant Y allele results in the production of a yellow pigment. The dominant B allele controls melanin production. If the genotype contains a capital Y (either YY or Yy) and a capital B, the offspring will be green. If the genotype contains two lowercase y alleles, and a capital B, the offspring will be blue. If the genotype contains two lowercase y’s and two lowercase b’s, the offspring will be white.

1. Use Models Draw a Punnett square that accounts for the inheritance of blue pigment.
2. Use Models Construct a Punnett square that explains the inheritance of a white pigment.
3. Apply Concepts Solve the mystery by determining the genotypes and phenotypes of the parents and offspring.
4. Connect to the Big Idea What ratio of colored offspring would you expect if Susan breeds her original pair of parakeets in the years ahead? Would any offspring be green?
Connecting Concepts

USE SCIENCE GRAPHICS

26. 66 smooth and 66 wrinkled
27. Yes, the observed numbers are close to the expected values. No other cross would predict a ratio close to 50 percent for each trait.
28. No, a similar outcome would result from a cross like this if wrinkled seeds were dominant.

WRITE ABOUT SCIENCE

29. Students’ explanations should be clear and concise and include examples. They should explain that a gene has at least two alleles. Some alleles are dominant and others are recessive. An organism with a dominant allele will always exhibit that form of the trait. Recessive alleles are expressed only in the absence of dominant alleles.
30. Students’ explanations should include that these pairs are located close together on the same chromosome. When alleles of different genes are close to each other, they are said to be linked. These genes tend to be inherited together. Diagrams should indicate the alleles’ positions on one chromosome as being close together throughout meiosis.
31. Pairs of genes are found on pairs of chromosomes. The pairs of chromosomes and their genes separate during meiosis and gamete formation. Each gamete gets only one of each pair of chromosomes and one of each pair of genes. In fertilization, chromosome pairs and their genes come together from each parent to form new combinations.

Use Science Graphics

Seed coat was one trait that Mendel studied in pea plants. The coat, or covering, of the seed is either smooth or wrinkled. Suppose a researcher has two plants—one that makes smooth seeds and another that makes wrinkled seeds. The researcher crosses the wrinkled-seed plants and the smooth-seed plants, obtaining the following data. Use the data to answer questions 26–28.

<table>
<thead>
<tr>
<th>Phenotype</th>
<th>Number of Plants in the F1 Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smooth seeds</td>
<td>Expected: 60 Observed: 60</td>
</tr>
<tr>
<td>Wrinkled seeds</td>
<td>Expected: 72 Observed: 72</td>
</tr>
</tbody>
</table>

26. Predict Mendel knew that the allele for smooth (R) seeds was dominant over the allele for wrinkled (r) seeds. If this cross was Rr × rr, what numbers would fill the middle column?
27. Analyze Data Are the observed numbers consistent with the hypothesis that the cross is Rr × rr? Explain your answer.
28. Draw Conclusions Are the data from this experiment alone sufficient to conclude that the allele for smooth seeds is dominant over the allele for wrinkled seeds? Why or why not?

ANALYZING DATA

A researcher studying fruit flies finds a mutant fly with brown-colored eyes. Almost all fruit flies in nature have bright red eyes. When the researcher crosses the mutant fly with a normal red-eyed fly, all of the F1 offspring have red eyes. The researcher then crosses two of the F1 red-eyed flies and obtains the following results in the F2 generation.

<table>
<thead>
<tr>
<th>Eye Color in F2 Generation</th>
<th>Expected</th>
<th>Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red eyes</td>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td>Brown eyes</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>

32. Calculate What is the ratio of red-eyed flies to brown-eyed flies?
   a. 1 : 1  
   b. 1 : 3  
   c. 3 : 1  
   d. 4 : 1

33. Draw Conclusions The allele for red eyes in fruit flies is
   a. dominant over brown eyes
   b. recessive to brown eyes
   c. codominant with the brown-eyed gene
   d. a multiple allele with the brown-eyed gene and others

ANSWERS

32. c  
33. a
1. What happens to the chromosome number during meiosis?
   A. It doubles.
   B. It stays the same.
   C. It halves.
   D. It becomes diploid.

2. Which ratio did Mendel find in his F₂ generation?
   A. 3 : 1
   B. 1 : 3 : 1
   C. 1 : 2
   D. 3 : 4

3. During which phase of meiosis is the chromosome number reduced?
   A. anaphase I
   B. metaphase I
   C. telophase I
   D. telophase II

4. Two pink-flowering plants are crossed. The offspring flower as follows: 25% red, 25% white, and 50% pink. What pattern of inheritance does flower color in these flowers follow?
   A. dominance
   B. multiple alleles
   C. incomplete dominance
   D. polygenic traits

5. Which of the following is used to construct a gene map?
   A. chromosome number
   B. mutation rate
   C. rate of meiosis
   D. recombination rate

6. Alleles for the same trait are separated from each other during the process of
   A. cytokinesis.
   B. meiosis I.
   C. meiosis II.
   D. telophase II.

7. Which of the following is NOT one of Gregor Mendel’s principles?
   A. The alleles for different genes usually segregate independently.
   B. Some forms of a gene may be dominant.
   C. The inheritance of characteristics is determined by factors (genes).
   D. Crossing-over occurs during meiosis.

Questions 8–9
Genes A, B, C, and D are located on the same chromosome. After calculating recombination frequencies, a student determines that these genes are separated by the following map units: C–D, 25 map units; A–B, 12 map units; B–D, 20 map units; A–C, 17 map units.

8. How many map units apart are genes A and D?
   A. 5
   B. 8
   C. 10
   D. 12.5

9. Which gene map best reflects the student’s data?
   A. A
   B. B
   C. C
   D. D

Open-Ended Response
10. Explain why meiosis allows organisms to maintain their chromosome numbers from one generation to the next.