Check out the following features on your Online Learning Center:

**Study Tools**
- Interactive Tables
- Interactive Time Line
- Animated illustrations
- National Geographic Visualizing animations

**Extensions**
- Virtual Labs
- Microscopy Links
- Periodic Table Links
- Career Links
- Web Links
- WebQuest Projects
- Science Fair Ideas
- Internet BioLabs

**For Teachers**
- Teacher Forum
- Teaching Today, and much more!

Copyright © by The McGraw-Hill Companies, Inc. All rights reserved. Permission is granted to reproduce the material contained herein on the condition that such material be reproduced only for classroom use; be provided to students, teachers, and families without charge; and be used solely in conjunction with the *Glencoe Biology* program. Any other reproduction, for use or sale, is prohibited without prior written permission of the publisher.
Student Lab Safety Form

Student Name: ________________________________

Date: ________________________________

Lab Title: ________________________________

In order to show your teacher that you understand the safety concerns of this lab, the following questions must be answered after the teacher explains the information to you. You must have your teacher initial this form before you can proceed with the lab.

1. How would you describe what you will be doing during this lab?

2. What are the safety concerns associated with this lab (as explained by your teacher)?
   - ________________________________
   - ________________________________
   - ________________________________
   - ________________________________
   - ________________________________
   - ________________________________

3. What additional safety concerns or questions do you have?

# Table of Contents

## Chapter 10  Sexual Reproduction and Genetics

- Diagnostic Test .................................................. 3
- Launch Lab ......................................................... 4
- MiniLab (1) ......................................................... 5
- MiniLab (2) ......................................................... 6
- BioLab .............................................................. 7
- Real-World Biology .............................................. 9
- Enrichment ......................................................... 11
- Concept Mapping ............................................... 12
- Study Guide (English) ........................................... 13
- Study Guide (Spanish) .......................................... 17
- Section Quick Check 1 ......................................... 21
- Section Quick Check 2 ......................................... 22
- Section Quick Check 3 ......................................... 23
- Chapter Test A .................................................. 24
- Chapter Test B .................................................. 27
- Chapter Test C .................................................. 30
- Student Recording Sheet .................................... 33
CHAPTER 10
Sexual Reproduction and Genetics

Before reading Chapter 10, predict answers to questions about the chapter content based on what you already know. Circle the letter of the correct answer, and then explain your reasoning.

1. Omar’s science class visits a local science institute. The institute has a room-sized model of a cell, and the model compares and contrasts the processes of mitosis and meiosis. Which is included in the model’s explanation?
   A. Both processes involve the formation of haploid gametes.
   B. Both processes produce genetically identical daughter cells.
   C. Mitosis has five phases, while meiosis has only three phases.
   D. Mitosis has one cell division, while meiosis has two divisions.

Explain:

________________________________________________________________________

________________________________________________________________________

2. While traveling through Austria with her German class, Sharon visits the monastery where Gregor Mendel lived. Which title for Mendel does Sharon read on the monastery sign?
   A. cloning pioneer
   B. father of genetics
   C. founder of genetic engineering
   D. scientist of chromosome mapping

Explain:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

3. Sheila plants garden plants that have white flowers and collects the seeds from all the plants. She plants the seeds, expecting plants with white flowers to grow, but some of the plants have purple flowers. How could plants with white flowers produce offspring with purple flowers?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Launch Lab

CHAPTER 10

What would happen without meiosis?

In sexual reproduction, cells from each parent fuse; offspring have the same chromosome number as the parents. Explore what would happen to the chromosome number if mitosis were the only type of cell division.

Procedure
1. Read and complete the lab safety form.
2. Construct a data table with the headings Cycle Number, Stage, and Chromosome Quantity.
3. Fill in your data table for steps 4–5.
4. Model a cell with a pair of chromosomes.
5. Demonstrate mitosis.
6. Fuse one of your cells with another student’s cell.
7. Repeat steps 4–5 two more times, recording the second and the third cycles.

Data and Observations

Analysis
1. Summarize  How does the chromosome number in your model change with each cycle of mitosis and fusion?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

2. Infer  What must occur when cells fuse in order for chromosome number to remain constant?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
How can an offspring’s traits be predicted? A Punnett square can help predict ratios of dominant traits to recessive traits in the genotype of offspring. This lab involves two parents who are both heterozygous for free earlobes (E), which is a dominant trait. The recessive trait is attached earlobes (e).

**Procedure**
1. Read and complete the lab safety form.
2. Determine the gamete genotype(s) for this trait that each parent contributes.
3. Draw a Punnett square that has the same number of columns and the same number of rows as the number of alleles contributed for this trait by the gametes of each parent.
4. Write the alphabetical letter for each allele from one parent just above each column, and write the alphabetical letter for each allele from the other parent just to the left of each row.
5. In the boxes within the table, write the genotype of the offspring resulting from each combination of male and female alleles.

**Data and Observations**

**Analysis**
1. **Summarize** List the possible offspring phenotypes that could occur.

2. **Evaluate** What is the phenotypic ratio of the possible offspring? What is the genotypic ratio of the possible offspring?
Where are genes located on a chromosome? The distance between two genes on a chromosome is related to the crossover frequency between them. By comparing data for several gene pairs, a gene’s relative location can be determined.

**Procedure**

1. Read and complete the lab safety form.
2. Obtain a table of the gene-pair crossover frequency from your teacher.
3. Draw a line below and make marks every 1 cm. Each mark will represent a crossover frequency of 1 percent.
4. Label one mark near the middle of the line A. Find the crossover frequency between genes A and B on the table, and use this data to label B the correct distance from A.
5. Use the crossover frequency between genes A and C and genes B and C to infer the position of gene C.
6. Repeat steps 4–5 for each gene, marking their position on the line.

**Data and Observations**

**Analysis**

1. **Evaluate** Is it possible to know the location of a gene on a chromosome if only one other gene is used?

2. **Consider** Why would using more crossover frequencies result in a more accurate chromosome map?
Design Your Own BioLab

How can the phenotype of offspring help determine parental genotype?

Background: The traits of most plants have dominant and recessive alleles. Analysis of plants grown from seeds can be good indicators of the expected genotypes of offspring as well as phenotypes and genotypes of the parent plants.

Question: Can the phenotypes and genotypes of parent organisms be determined from the phenotype of the offspring?

Materials
Choose materials that would be appropriate for this lab. Possible materials include:
two groups of plant seeds
potting soil

small flowerpots or other growing containers
watering can or bottle
small gardening trowel

Safety Precautions

Plan and Perform the Experiment

1. Read and complete the lab safety form.
2. Hypothesize whether the phenotype of offspring could be used to infer the genotypes of the parents.
3. Design an experiment to test your hypothesis.
4. Decide what data you need to collect.
5. Create a data table to record your observations.
6. Make sure your teacher approves your plan before you proceed.
7. Conduct your experiment.
8. Cleanup and Disposal Properly dispose of seeds or plants considered to be invasive species in your area. Never release invasive species into the environment.

Data and Observations
Analyze and Conclude

1. Collect and Organize Data Count the number of seedlings of the different phenotypes in each group of plants. Prepare a graph of your data.

2. Calculate the ratio of different seedlings for each of your groups of seeds.

3. Identify two or more possible crosses that could have resulted in your observed ratio of seedlings.

4. Analyze Make a Punnett square for each cross you identified in question 3. Determine whether each possible cross could have resulted in the data you collected.

5. Evaluate how the combined data from the two seed groups affect the ratio of seedlings.

6. Draw Conclusions Based on the data from your two groups of seeds, list the genotype and phenotype of the parent plants.

7. Error Analysis Compare your calculated ratios to those of another student. Describe any differences. Combine your data with another group’s data. Infer how increasing the number of seeds analyzed affects the outcome of the experiment.
Real-World Biology: Lab

CHAPTER 10

Kernel Color in Corn

Corn is a good organism for studying genetics because many phenotypes can be seen in an ear of corn. Also, corn plants are easy to work with, and crosses can easily be made. Because each kernel is a separate seed, a single ear of corn contains many offspring. The more offspring you can count from a cross, the closer your experimental results will be to the theoretical results that a Punnett square predicts.

In this activity, you will first work with Punnett squares to find the predicted ratios of red and yellow kernels resulting from different types of crosses, including a monohybrid cross. Then you will examine an ear of corn that resulted from a monohybrid cross to find the actual ratio of red and yellow kernels.

Part A: Using Punnett Squares

Red kernel color results from a dominant allele, $R$. The homozygous dominant kernel, $RR$, and the heterozygous kernel, $Rr$, are both red. The homozygous recessive kernel, $rr$, is yellow. You will use Punnett squares to predict the theoretical results of various crosses.

Procedure

1. Fill in the Punnett square in Figure 1 to show a cross between a homozygous dominant parent and a homozygous recessive parent. Use the letters $R$ and $r$ to represent the alleles.

2. Fill in the Punnett square in Figure 2 to show a cross between a homozygous dominant parent and a heterozygous parent. Use the letters $R$ and $r$ to represent the alleles.

3. Fill in the Punnett square in Figure 3 to show a cross between a homozygous recessive parent and a heterozygous parent. Use the letters $R$ and $r$ to represent the alleles.

4. Fill in the Punnett square in Figure 4 to show a cross between two heterozygous parents, called a monohybrid cross. Again, use the letters $R$ and $r$ to represent the alleles.

Analyze and Conclude

Respond to each question.

1. Identify What are the possible genotypes and phenotypes of the kernels resulting from the cross shown in Figure 1?

2. Calculate What are the possible genotypes, phenotypes, and predicted genotypic and phenotypic ratios of the kernels resulting from the cross shown in Figure 2? In Figure 3? In Figure 4?
Part B: Looking at Corn

Now that you have determined the predicted phenotypic and genotypic ratios, you will examine an ear of corn resulting from a monohybrid (heterozygous $\times$ heterozygous) cross and compare the observed phenotypic ratio to the predicted ratio.

Procedure
1. Read and complete the lab safety form.

2. Obtain an ear of corn that is the result of a monohybrid cross.

3. Count the number of red and yellow kernels on the ear, and record the numbers in Table 1. Record the total number of kernels counted.

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of red kernels</td>
</tr>
<tr>
<td>Number of yellow kernels</td>
</tr>
<tr>
<td>Total number of kernels counted</td>
</tr>
</tbody>
</table>

Analyze and Conclude

Respond to each question and statement.

1. **Calculate** the ratio of red to yellow kernels on the ear of corn. To find the ratio, divide the number of red kernels by the number of yellow kernels and round off to the nearest whole number. This number, when compared to one, is the ratio.

2. **Compare** your observed ratio with the theoretical ratio you predicted from the monohybrid cross shown in Figure 4.

3. **Hypothesize** Would you have calculated the same ratio if you had counted only half the kernels on the ear of corn? Explain.

4. **Apply** How could you determine whether a particular red kernel is homozygous dominant or heterozygous? *Hint: Look at the Punnett squares in Part A.*

---

**Careers in Biology**

**Plant Breeding** Visit biologygmh.com for information on plant breeders. What are the responsibilities of a plant breeder?
Enrichment

Diagramming: Predicting Plant Genetic Traits

In the mid-1800s, Gregor Mendel, an Austrian monk, conducted a series of experiments that laid the groundwork for the science of genetics. Mendel was interested in plant breeding and used pea plants in his breeding experiments. He worked with seven pea-plant traits: seed shape (round or wrinkled), seed color (yellow or green), flower color (purple or white), flower position (axial or terminal), pod color (green or yellow), pod shape (inflated or constricted), and plant stem height (tall or short).

**Punnett Squares** A simple diagram called a Punnett square can be used to predict the possible genotypes of offspring that will result from a cross between plants or other organisms with known genotypes. The Punnett square was originated by Reginald Crundall Punnett, an English geneticist.

**Directions**

Complete the Punnett square below, which shows a cross between two white-flowered, tall plants with the genotype **WwTt**. (W is the dominant allele for white flowers, and w is the recessive allele for purple flowers. T is the dominant allele for tall stem, and t is the recessive allele for short stem.) The possible genotypes of the parents’ gametes are provided. Fill in the squares with the possible genotypes of the offspring. Then use the Punnett square to predict the genotypic and phenotypic ratios of the offspring.

In addition to predicting the possible genotypes of offspring, a Punnett square can be used to predict the genotypic and phenotypic ratios of possible offspring from a particular cross.

**Punnett Square for Plant Cross WwTt x WwTt**

<table>
<thead>
<tr>
<th></th>
<th>WT</th>
<th>Wt</th>
<th>wT</th>
<th>wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>WT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Complete the events chains about meiosis I and meiosis II. These terms may be used more than once: chromosomes, condense, cytokinesis, equator, line up, nuclei, pair up, separate, sister chromatids, spindle apparatus.

### Meiosis I

**Prophase I**
1. Homologous chromosomes _____________ and _____________ during synapsis; spindle fibers form.

**Metaphase I**
2. Pairs of homologous chromosomes _____________ at the cell’s _____________.

**Anaphase I**
3. Homologous chromosomes _____________ and move toward opposite ends of the cell.

**Telophase I**
4. Homologous _____________ reach the cell’s poles and _____________ usually occurs.

### Meiosis II

**Prophase II**
5. _____________ form; chromosomes condense.

**Metaphase II**
6. _____________ line up at the cell’s equator.

**Anaphase II**
7. _____________ are pulled apart by the spindle fibers and move toward opposite ends of the cell.

**Telophase II**
8. Chromosomes reach the cell’s poles, the nuclear membrane and _____________ re-form, and _____________ occurs; four cells form.
Study Guide

CHAPTER 10

Section 1: Meiosis

In your textbook, read about meiosis I and meiosis II.

Label the diagrams below. Use these choices:

- anaphase I
- anaphase II
- prophase I
- prophase II
- interphase
- metaphase I
- metaphase II
- telophase I
- telophase II

Complete the table by checking the correct column(s) for each description.

<table>
<thead>
<tr>
<th>Description</th>
<th>Mitosis</th>
<th>Meiosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Involved in the production of gametes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Involved in growth and repair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Promotes genetic variation in organisms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Consists of one nuclear division</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Produces daughter cells that are genetically identical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Involves two sets of nuclear divisions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Produces daughter cells that are not identical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Involves the synapsis of homologous chromosomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Occurs during asexual reproduction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Results in four haploid gametes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Also called reduction division</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In your textbook, read about how genetics began and the inheritance of traits.

Write the term or phrase that best completes each statement. Use these choices:

- cross-pollination
- dominant
- recessive
- self-fertilization
- gametes
- inherited
- trait

1. Mendel was the first person to succeed in predicting how traits are __________ from generation to generation.

2. In peas, both male and female sex cells, which are called __________, are in the same flower.

3. __________ occurs when a male gamete fuses with a female gamete in the same flower.

4. Mendel used the technique called __________ to breed one plant with another.

5. Mendel studied only one __________ at a time and analyzed his data mathematically.

6. In individuals with a heterozygous genotype, the __________ allele of a trait is hidden by the expression of the other phenotype.

7. In individuals with a heterozygous genotype, the __________ allele of a trait is visible in the phenotype.

In your textbook, read about Punnett squares.

Complete the Punnett square by filling in the missing information.

A student crossed true-breeding pea plants that had purple flowers (P) with true-breeding pea plants that had white flowers (p). All of the offspring had purple flowers. Then the student crossed two plants from the F₁ generation. The student’s Punnett square is shown at right. What information should the student put in each blank? Remember, the dominant allele is always written first.

<table>
<thead>
<tr>
<th>Possible gametes</th>
<th>8. ____</th>
<th>9. ____</th>
<th>10.</th>
<th>11.</th>
<th>12.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. ____</td>
<td>p</td>
<td>10.</td>
<td>11.</td>
<td>12.</td>
<td></td>
</tr>
<tr>
<td>9. ____</td>
<td>p</td>
<td>Pp</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In your textbook, read about the inheritance of traits and Punnett squares.

Use each of the terms below only once to complete the passage.

\[ \text{dihybrid} \quad \text{gene} \quad \text{genotypes} \quad \text{monohybrid} \quad \text{phenotypic ratio} \]

A cross between plants that involves one characteristic is called a (13) ____________________________ cross. Mendel also performed (14) ____________________________ crosses, which involve two (15) ____________________________ pairs, with pea plants. When he crossed two pea plants that were heterozygous for both seed shape \((Rr)\) and for seed color \((Yy)\), he observed a 9:3:3:1 (16) ____________________________ among the seeds of the offspring. A Punnett square shows the possible phenotypes and (17) ____________________________ of the offspring.

Complete the Punnett square by filling in the missing information.

<table>
<thead>
<tr>
<th>Possible gametes</th>
<th>(RY)</th>
<th>(Ry)</th>
<th>(rY)</th>
<th>(ry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(RY)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RRYY round, yellow</td>
<td>18.</td>
<td>19.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(RrYy) round, yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(RY)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Ry)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(RrYy) round, yellow</td>
<td>20.</td>
<td>21.</td>
<td>22.</td>
<td>23.</td>
</tr>
<tr>
<td>(rY)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(RrYy) round, yellow</td>
<td>24.</td>
<td></td>
<td>25.</td>
<td>26.</td>
</tr>
<tr>
<td>(ry)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(RrYy) round, yellow</td>
<td>27.</td>
<td>28.</td>
<td>29.</td>
<td>30.</td>
</tr>
</tbody>
</table>

In your textbook, read about probability.

Refer to the Punnett square above. Respond to the following statement.

31. Find the probability that a wrinkled, green seed will result. ____________________________
In your textbook, read about genetic recombination and gene linkage.

**Match the definition in Column A with the term in Column B.**

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. genes that are located on the same chromosome</td>
<td>A. chromosome map</td>
</tr>
<tr>
<td>2. shows the location of several genes</td>
<td>B. genetic recombination</td>
</tr>
<tr>
<td>3. <em>Drosophila melanogaster</em></td>
<td>C. linked genes</td>
</tr>
<tr>
<td>4. an outcome of independent assortment</td>
<td>D. fruit fly</td>
</tr>
</tbody>
</table>

For each statement below, write true or false.

5. Crossing over occurs more frequently between genes that are close together on a chromosome. **True**

6. Gene linkage was first studied by using garden peas. **False**

7. Scientists call a drawing like the one shown above a chromosome map. **True**

8. Chromosome map percentages represent actual chromosome distances. **False**

In your textbook, read about polyploidy.

Respond to each statement.

9. **Recall** the name for the occurrence of one or more extra sets of all the chromosomes in an organism’s cells.

10. **State** the term for an organism with the chromosome designation 3n.
En tu libro de texto, lee acerca de la meiosis I y meiosis II.

Identifica los siguientes diagramas. Usa estas opciones:

<table>
<thead>
<tr>
<th>Diagrama</th>
<th>Anafase I</th>
<th>Profase I</th>
<th>Anafase II</th>
<th>Profase II</th>
<th>Interfase</th>
<th>Metafase I</th>
<th>Telofase I</th>
<th>Metafase II</th>
<th>Telofase II</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td>2.</td>
<td></td>
<td>3.</td>
<td>4.</td>
<td>5.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Completa la tabla marcando la(s) columna(s) correcta(s) para cada descripción.

<table>
<thead>
<tr>
<th>Descripción</th>
<th>Mitosis</th>
<th>Meiosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Participa en la producción de gametos.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Participa en el crecimiento y la reparación.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Promueve la variación genética en los organismos.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Consiste en una división nuclear.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Produce células hijas que son genéticamente idénticas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Implica dos conjuntos de divisiones nucleares.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Produce células hijas que no son idénticas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Implica la sinapsis de cromosomas homólogos.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Ocurre durante la reproducción asexual.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Resulta en cuatro gametos haploides.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. También se llama <em>división de reducción</em>.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
En tu libro de texto, lee acerca de cómo empezó la genética y de la herencia de los rasgos.

Escribe el término o la frase que mejor complete cada afirmación. Usa estas opciones:

<table>
<thead>
<tr>
<th>autofertilización</th>
<th>dominante</th>
<th>gametos</th>
<th>heredan</th>
</tr>
</thead>
<tbody>
<tr>
<td>polinización cruzada</td>
<td>rasgo</td>
<td>recesivo</td>
<td></td>
</tr>
</tbody>
</table>

1. Mendel fue la primera persona que tuvo éxito en predecir cómo los rasgos se __________________________ de una generación a otra.

2. En los guisantes, tanto las células masculinas como las femeninas, llamadas __________________________, se encuentran en la misma flor.

3. La __________________________ ocurre cuando un gameto masculino se fusiona con un gameto femenino en la misma flor.

4. Mendel usó la técnica llamada __________________________ para cruzar una planta con otra.

5. Mendel estudió sólo un __________________________ a la vez y analizó sus datos en términos matemáticos.

6. En personas con un genotipo heterocigoto, el alelo __________________________ de un rasgo se oculta en la expresión del otro fenotipo.

7. En personas con un genotipo heterocigoto, el alelo __________________________ de un rasgo es visible en el genotipo.

En tu libro de texto, lee acerca de la cuadrícula de Punnett.

Completa la cuadrícula de Punnett con la información faltante.

Un estudiante cruzó plantas de guisantes de línea genéticamente pura que tenían flores moradas (P) con plantas de guisantes de línea genéticamente pura que tenían flores blancas (p). Todos los vástagos produjeron flores moradas. Luego, el estudiante cruzó dos plantas de la generación F1. La cuadrícula de Punnett del estudiante se muestra a la derecha.

¿Qué información debe colocar el estudiante en cada espacio? Recuerda, el alelo dominante siempre se escribe primero.
Guía de estudio, Sección 2: Genética mendeliana  continuación

En tu libro de texto, lee acerca de la herencia de los rasgos y de la cuadrícula de Punnett.
Usa los siguientes términos sólo una vez para completar el párrafo.

dihíbridos  genes  genotipos  monohíbrido  razón fenotípica

Un cruzamiento (13) __________________________ entre plantas implica una sola característica.
Mendel también realizó cruzamientos (14) __________________________, los cuales implican dos
pares de (15) __________________________, con plantas de guisantes. Cuando el realizó el cruzamiento
entre dos plantas de guisantes que eran heterocigotos en cuanto a la forma de la semilla (Rr) y el color de la
semilla (Yy), él observó una (16) __________________________ de 9:3:3:1 entre las semillas del vástago.
La cuadrícula de Punnett muestra los posibles fenotipos y (17) __________________________ del vástago.

Completa la cuadrícula de Punnett con la información faltante.

<table>
<thead>
<tr>
<th>Gametos posibles</th>
<th>RY</th>
<th>Ry</th>
<th>rY</th>
<th>ry</th>
</tr>
</thead>
<tbody>
<tr>
<td>RY</td>
<td>18.</td>
<td>19.</td>
<td>RrYy redondo, amarillo</td>
<td></td>
</tr>
<tr>
<td>Ry</td>
<td>20.</td>
<td>21.</td>
<td>22.</td>
<td>23.</td>
</tr>
<tr>
<td>ry</td>
<td>27.</td>
<td>28.</td>
<td>29.</td>
<td>30.</td>
</tr>
</tbody>
</table>

En tu libro de texto, lee acerca de la probabilidad.
Consulta la cuadrícula de Punnett anterior. Responde a la siguiente afirmación.

31. Encuentra la probabilidad de que resultará una semilla verde y arrugada. __________________________
En tu libro de texto, lee acerca de la recombinación genética y el ligamiento genético.

Relaciona la definición de la columna A con el término de la columna B.

<table>
<thead>
<tr>
<th>Columna A</th>
<th>Columna B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. genes localizados en el mismo cromosoma</td>
<td>A. mapa del cromosoma</td>
</tr>
<tr>
<td>2. muestra la ubicación de varios genes</td>
<td>B. recombinación genética</td>
</tr>
<tr>
<td>3. <em>Drosophila melanogaster</em></td>
<td>C. genes ligados</td>
</tr>
<tr>
<td>4. un resultado de una clasificación independiente</td>
<td>D. mosca de la fruta</td>
</tr>
</tbody>
</table>

Para cada afirmación a continuación, escribe «verdadero» o «falso».

5. Los entrecruzamientos ocurren con mayor frecuencia entre genes que están cercas en un cromosoma.
6. El ligamiento genético se estudió por primera vez con guisantes de jardín.
7. Los científicos denominan el dibujo anterior un mapa del cromosoma.
8. Los porcentajes del mapa del cromosoma representan la distancia real de los cromosomas.

En tu libro de texto, lee acerca de la poliploidía.

Responde a cada afirmación.

9. **Recuerda** el nombre de la ocurrencia de uno o más conjuntos adicionales de todos los cromosomas en las células de un organismo.

10. **Indica** el término para un organismo con la designación de cromosoma 3n.
Quick Check

After reading the section in your textbook, respond to each statement.

1. Define gene.

2. List the stages of meiosis I.

3. Compute the number of chromosomes that the gametes of a cat (2n = 38 chromosomes) will have. Show your work.

4. Compare and contrast anaphase I and anaphase II.

5. Devise a theory that explains why the most complex animals only reproduce sexually.
Quick Check

After reading the section in your textbook, respond to each statement.

1. Identify the function of Punnett squares.

2. Describe how Mendel showed that the green-seed trait did not disappear but was only masked.

3. Discuss how meiosis relates to Mendel’s law of segregation.

4. Apply A white rooster (WW) is crossed with a black-and-white-speckled hen (Ww). The hen lays eight eggs. Draw a Punnett square to show the possible genotypes of the chicks that will hatch.

5. Evaluate A red-flowered plant was crossed with a white-flowered variation of the plant. All of the flowers on the next generation of plants were red. Decide which flower color is recessive for this plant and which is dominant.
Quick Check

Section 3: Gene Linkage and Polyploidy

After reading the section in your textbook, respond to each statement.

1. Define genetic recombination.

2. Explain why genes close together on the same chromosome are said to be linked.

3. Demonstrate the use of the mathematical formula for finding the number of possible combinations of chromosome pairs that can be made in an organism. Use an organism with diploid cells that have five pairs of chromosomes for your demonstration.

4. Deduce how two genes for different traits that are on the same chromosome can fail to be inherited together.

5. Hypothesize one way that a diploid organism could have offspring that are 3n or 4n.
CHAPTER 10
Assessment

SECTION 10.1
Vocabulary Review

Use vocabulary terms to answer each question.

1. ____________________________ 2. ____________________________ 3. ____________________________

Understand Key Concepts

Select the best answer from the choices given, and fill in the corresponding circle.


Constructed Response

8. ________________________________________________________________

9. ________________________________________________________________

Think Critically

10. ________________________________________________________________

11. ________________________________________________________________

12. ________________________________________________________________

13. ________________________________________________________________

SECTION 10.2
Vocabulary Review

Explain the difference between the vocabulary terms in each pair.

12. ________________________________________________________________

13. ________________________________________________________________
CHAPTER 10
Assessment

Student Recording Sheet

Understand Key Concepts
Select the best answer from the choices given, and fill in the corresponding circle.

14. A B C D
15. A B C D
16. A B C D

Constructed Response

17. 

18. 

Think Critically

19. 

20. Math in Biology 

Section 10.3
Vocabulary Review
Write the vocabulary term that makes each sentence true.

21. 
22. 

Understand Key Concepts
Select the best answer from the choices given, and fill in the corresponding circle.

23. A B C D
24. A B C D
25. A B C D
26. A B C D

Constructed Response

27. 

28. 

Copyright © Glencoe/McGraw-Hill, a division of The McGraw-Hill Companies, Inc.
29. 

Think Critically
30. Careers in Biology  Record your answer for question 30 on a separate sheet of paper.
31. 

Additional Assessment
32. Writing in Biology  Record your answer for question 32 on a separate sheet of paper.

Document-Based Questions
33. 

34. 

Cumulative Review
35. 

36. 

37. 
CHAPTER 10
Student Recording Sheet

Assessment

Multiple Choice
Select the best answer from the choices given, and fill in the corresponding circle.

1. A B C D
2. A B C D
3. A B C D
4. A B C D
5. A B C D
6. A B C D
7. A B C D
8. A B C D
9. A B C D

Short Answer
Answer each question with complete sentences.

10. ________________________________
11. ________________________________
12. Record your answer for question 12 on a separate sheet of paper.
13. ________________________________
14. ________________________________
15. ________________________________
16. ________________________________

Extended Response
Answer each question with complete sentences.

17. ________________________________
18. ________________________________

Essay Question
19. Record your answer for question 19 on a separate sheet of paper.
# Table of Contents

**Chapter 11 Complex Inheritance and Human Heredity**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic Test</td>
<td>39</td>
</tr>
<tr>
<td>Launch Lab</td>
<td>40</td>
</tr>
<tr>
<td>MiniLab (1)</td>
<td>41</td>
</tr>
<tr>
<td>MiniLab (2)</td>
<td>42</td>
</tr>
<tr>
<td>BioLab</td>
<td>43</td>
</tr>
<tr>
<td>Real-World Biology</td>
<td>45</td>
</tr>
<tr>
<td>Enrichment</td>
<td>47</td>
</tr>
<tr>
<td>Concept Mapping</td>
<td>48</td>
</tr>
<tr>
<td>Study Guide (English)</td>
<td>49</td>
</tr>
<tr>
<td>Study Guide (Spanish)</td>
<td>53</td>
</tr>
<tr>
<td>Section Quick Check 1</td>
<td>57</td>
</tr>
<tr>
<td>Section Quick Check 2</td>
<td>58</td>
</tr>
<tr>
<td>Section Quick Check 3</td>
<td>59</td>
</tr>
<tr>
<td>Chapter Test A</td>
<td>60</td>
</tr>
<tr>
<td>Chapter Test B</td>
<td>63</td>
</tr>
<tr>
<td>Chapter Test C</td>
<td>66</td>
</tr>
<tr>
<td>Student Recording Sheet</td>
<td>69</td>
</tr>
</tbody>
</table>
Before reading Chapter 11, predict answers to questions about the chapter content based on what you already know. Circle the letter of the correct answer, and then explain your reasoning.

1. Kalani observes a woman who manifests the condition known as albinism. Kalani asks her biology teacher what causes albinism. Which is part of her biology teacher’s explanation?
   
   A. Albinism is a genetic disorder caused by a dominant allele.
   
   B. Albinism is a genetic disorder caused by two recessive alleles.
   
   C. Albinism is caused by environmental factors during childhood.
   
   D. Albinism results from dietary choices of the person as an adult.

   Explain.

2. Juanita is studying the history of England, and her textbook shows the pedigree of Queen Victoria. The text also introduces the concept of a pedigree. Which is the explanation of pedigree provided by the history text?

   A. a chart listing all the observable traits of a person
   
   B. a description of the genotypes of a person’s children
   
   C. a diagram that traces the inheritance of one trait
   
   D. a map of the genetic makeup of one individual

   Explain.

3. While volunteering at a hospital, Alex learns that there are several different human blood types and they are determined by alleles. For example, a person with an allele for type A blood and an allele for type B blood will have type AB blood. Alex asks a nurse if blood type A or B is dominant. What answer does the nurse give him?

   Explain.
As knowledge and understanding of human inheritance increases, long-standing ideas regarding the facts of human heredity must be reexamined. Any ideas disproven by new discoveries must be rejected.

**Procedure**

1. Read the statements below carefully and determine whether they are true or false.

   **Statements:**
   
   A. The father determines the gender of the child.
   
   B. Individuals can transmit characteristics to their offspring which they themselves do not show.
   
   C. Identical twins are always of the same gender.

2. Discuss your answers with your classmates and teacher.

**Analysis**

1. **Assess** What question was missed most often by the entire class? Discuss reasons why.

   
   
   

2. **Analyze** Why is it helpful to understand human heredity?
Where are the branches on the family tree? Unlike some organisms, humans reproduce slowly and produce few offspring at one time. One method used to study human traits is pedigree analysis.

**Procedure**
1. Read and complete the lab safety form.
2. Imagine that you are a geneticist interviewing a person about their family concerning the hypothetical trait of hairy earlobes.
3. From the transcript below, construct a pedigree. Use appropriate symbols and format.
   “My name is Scott. My great grandfather Walter had hairy earlobes (HEs), but great grandma Elsie did not. Walter and Elsie had three children: Lola, Leo, and Duane. Leo, the oldest, has HEs, as does the middle child, Lola; but the youngest child, Duane, does not.
   “Duane never married and has no children. Leo married Bertie, and they have one daughter, Patty. In Leo’s family, he is the only one with HEs. Lola married John, and they have two children: Carolina and Luetta. John does not have HEs, but both of his daughters do.”

**Data and Observations**

**Analysis**
1. **Assess** In what ways do pedigrees simplify the analysis of inheritance?

2. **Think Critically** Using this lab as a frame of reference, how can we put to practical use our understanding of constructing and analyzing human pedigrees?
How do geneticists learn about human heredity? Traditional methods used to investigate the genetics of plants, animals, and microbes are not suitable or possible to use on humans. A pedigree is one useful tool for investigating human inheritance. In this lab, you will explore yet another tool of the geneticist—population sampling.

Procedure

How do geneticists learn about human heredity? Traditional methods used to investigate the genetics of plants, animals, and microbes are not suitable or possible to use on humans. A pedigree is one useful tool for investigating human inheritance. In this lab, you will explore yet another tool of the geneticist—population sampling.

**Procedure**

Strips of PTC paper should be placed on the tongue with no attempt made to chew or swallow the strips. Tasters are left with a bitter taste in their mouths, which can be removed by drinking water.

1. Read and complete the lab safety form.
2. Construct a data table as instructed by your teacher.
3. Survey your group for the trait of PTC taster.
4. Survey your group for other traits determined by your teacher.
5. Compile the class data, and analyze the traits you investigated in the survey population. Determine which of the traits are dominant and which are recessive.

Data and Observations

Analysis

1. **Interpret Data** What numerical clue did you look for to determine whether each trait surveyed was dominant or recessive?

2. **Think Critically** How could you check to see if you correctly identified dominant and recessive? Explain why you might have misidentified a trait.
Background: Most people know that they inherit their hair color and their eye color from their parents. However, there are many other head and facial traits that humans inherit. In this lab, you will investigate a number of different inherited facial structures that combine to compose a human face.

Question: What structures that comprise the human face are actually determined genetically?

Materials
coins, 2 per team; heads = dominant trait, tails = recessive trait

Table of inherited human facial characteristics

Procedure
1. Read and complete the lab safety form.
2. Partner with a classmate.
3. One member of the team will represent the father, and one member will represent the mother. Decide which partner will represent the father and who will represent the mother.
4. Have the person representing the father flip a coin. If the coin lands heads facing up, the offspring is a female; if the coin lands tails facing up, the offspring is a male. Record the gender of the offspring.
5. Flip your coin at the same time as your partner. Flip the coins only once for each trait.
6. Continue to flip coins for each trait shown in the table. After each coin flip, record the trait of your offspring by placing a check in the appropriate box in the table.
7. Once the traits are determined, draw the offspring’s facial features, give him/her a name, and be prepared to introduce the offspring to the rest of the class.

Data and Observations
Analyze and Conclude

1. **Think Critically** Why did the partner representing the father flip the coin initially to determine the gender of the offspring?

2. **Calculate** What percent chance was there of producing male offspring? Female offspring? Explain.

3. **Recognize Cause and Effect** What are the possible genotypes of parents of the following three children: a boy with straight hair (hh), a daughter with wavy hair (Hh), and a son with curly hair (HH)?

4. **Observe and Infer** Which traits show a blending of genes?

5. **Analyze and Conclude** Would you expect other student pairs in the class to have offspring exactly like yours? Explain.
Real-World Biology: Analysis

CHAPTER 11

Improving Food Crops

Corn on the cob is a favorite summer food of many Americans. Some prefer yellow corn, while some prefer other varieties such as white or bicolored corn. Corn in shades of red, purple, and orange is used for autumn decorations, and other types of corn are used for feeding livestock. Many different types of corn have evolved since its origin in Central America approximately 8000 years ago. From the indigenous people who were its first breeders to present-day plant breeding programs, corn has been selectively bred to increase the production of desirable traits. As the world’s population increases and the amount of land available to produce food crops decreases, the concept of selective breeding is expanding to include recent discoveries in the field of genetics. These discoveries are contributing to the development of new and improved food crops.

Part A: Hybrid Vigor

A corn plant is self-fertilized, or inbred, when the pollen from a tassel is placed on the silks of the ear of the same plant. In the early 1900s, plant breeders showed that crossing individual plants from two favorable inbred varieties produced hybrid offspring that were often more vigorous and had more desirable traits than offspring produced from inbreeding. This phenomenon of hybrid vigor led to tremendous increases in corn production in the United States. In 1931, 0.1 percent of the corn planted was hybrid corn, resulting in an average yield of 24.5 bushels per acre. In 2003, almost all corn planted in the United States was hybrid corn, with an average yield of more than 140 bushels per acre.

Analyze and Conclude

Use Figure 1 to respond to each statement.

1. Explain Figure 1 shows the current method for producing corn with hybrid vigor. Use Figure 1 to explain the procedure.

2. Describe two desirable corn traits that were produced by the crosses A × B and C × D.
Part B: Genetically Engineered Foods

Modification of the genetic makeup of an organism, or genetic engineering, is a modern technique used for increasing the production of desirable traits in plants. The process of genetic engineering is rapid compared to selective breeding. However, the introduction of new genes into plant cells has led to controversy between two groups of people.

The controversy exists between those who believe in the benefits of this technology and those who are concerned about the danger of unintended outcomes.

The benefits of genetically engineered plants are believed by some to develop in three phases; these are listed in the table below along with examples and concerns about possible dangers.

<table>
<thead>
<tr>
<th>Benefits of Genetically Engineered Plants</th>
<th>Examples</th>
<th>Dangers and Unintended Outcomes</th>
</tr>
</thead>
</table>
| Phase 1: direct benefits to farmers and producers through improved efficiency | • genetically engineered plants that produce insecticidal proteins, which reduce the need for spraying plants with insecticides  
• genetically engineered plants that are resistant to weed killer | • Insect-repelling crops speed the evolution of insects resistant to insecticides.  
• Insecticidal proteins can have harmful effects on beneficial insects, such as honeybees, and animals that feed on insects.  
• Gene transfer can occur between different groups of plants; weeds can become resistant to weed killers. |
| Phase 2: direct benefits to consumers through improved foods | • seedless citrus fruit that is easy to peel  
• oils with a particular nutritive value  
• slow-ripening tomatoes | • Companies could introduce genetically engineered foods too quickly and with insufficient research.  
• Labeling and safety testing of genetically engineered foods are not required in the United States. |
| Phase 3: enhanced levels of pharmaceutical and industrial products from plants | • oral vaccines produced by plants  
• industrial oils and plastics produced by plants | • Crops genetically engineered to produce pharmaceutical drugs could crossbreed accidentally with food varieties. |

Analyze and Conclude

*Use the table above to respond to the following statement.*

1. **Present** Choose an issue or a problem listed in the table and develop a possible future scenario. The scenario should be based on evidence and employ logical reasoning. It may be presented as a narrative, a poster, two- or three-dimensional art, a song, a video, a skit, or any form of communication approved by your teacher.
Blood typing has many uses in medicine, the most important of which is in blood transfusions. Doctors must be certain that the blood they transfuse into a patient is the same type as the patient’s so that a life-threatening reaction does not occur.

Blood typing also has other uses. Forensic scientists use blood types to confirm or deny that an individual has been involved in a crime. They match the suspect’s blood type against blood found at the crime scene.

Explore Most people are familiar with the ABO blood typing system in which a person’s blood type can fall into one of four categories: A, B, AB, or O. There is also another method of typing blood—the Rh (for rhesus monkey) system, in which a person’s blood can be Rh+ or Rh–.

A number of other blood typing systems exist. These systems are listed in the table below. Explore library resources to learn more about these other systems.

Categorize Summarize the information you collect in the table below. List the frequency of each group in the general population. Some of the information needed to complete the table has been provided for you.

<table>
<thead>
<tr>
<th>System</th>
<th>Groups</th>
<th>Frequency in the General Population (average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABO</td>
<td>A, B, AB, O</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td></td>
</tr>
<tr>
<td>Rh</td>
<td>Rh+, Rh–</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rh+</td>
<td>85%</td>
</tr>
<tr>
<td></td>
<td>Rh–</td>
<td></td>
</tr>
<tr>
<td>MN</td>
<td>M, N</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Lewis</td>
<td>Le(a+b–), Le(a–b+), Le(a+b+)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Le(a+b–)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Le(a–b+)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Le(a+b+)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Le(a–b–)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cartwright</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ytª, Ytª</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ytª</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ytª</td>
<td></td>
</tr>
</tbody>
</table>
Complete the network tree about genetic disorders. These terms may be used more than once: albinism, a dominant gene, Down syndrome, Huntington’s disease, nondisjunction, too many, Turner’s syndrome.

The cause of a genetic disorder can be

1. two copies of a recessive gene
2. causing either
3. which can cause
4. which can cause
5. _________ of a type of chromosome
6. too few of a type of chromosome
7. which can cause

which can cause
In your textbook, read about basic patterns of human inheritance.

Use the terms below to complete the passage. These terms may be used more than once.

<table>
<thead>
<tr>
<th>albinism</th>
<th>alleles</th>
<th>cystic fibrosis</th>
<th>dominant</th>
</tr>
</thead>
<tbody>
<tr>
<td>heterozygous</td>
<td>homozygous</td>
<td>pedigree</td>
<td>recessive</td>
</tr>
</tbody>
</table>

A (1) __________________ shows the inheritance of a particular trait over several generations. An organism with two of the same (2) __________________ for a particular trait is said to be (3) __________________ for that trait. An organism with two different (4) __________________ for a particular trait is heterozygous for that trait. When alleles are present in the (5) __________________ state, the (6) __________________ trait will be observable. An individual who is heterozygous for a (7) __________________ disorder is called a carrier. Examples of recessive genetic disorders in humans are (8) __________________ and (9) __________________.

In your textbook, read about recessive and dominant genetic disorders.

Complete the table by writing the disease name for each description.

<table>
<thead>
<tr>
<th>albinism</th>
<th>anchondroplasia</th>
<th>cystic fibrosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>galactosemia</td>
<td>Huntington’s disease</td>
<td>Tay-Sachs disease</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disease</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
<td>caused by altered genes; results in lack of skin pigment</td>
</tr>
<tr>
<td>11.</td>
<td>recessive genetic disorder; characterized by body’s inability to tolerate galactose</td>
</tr>
<tr>
<td>12.</td>
<td>recessive genetic disorder; gene found on chromosome 15; characterized by lack of enzyme that breaks down fatty acids</td>
</tr>
<tr>
<td>13.</td>
<td>recessive genetic disorder; affects mucus-producing glands, digestive enzymes, sweat glands</td>
</tr>
<tr>
<td>14.</td>
<td>dominant genetic disorder; affects the nervous system</td>
</tr>
<tr>
<td>15.</td>
<td>autosomal dominant genetic condition; affects height and body size</td>
</tr>
</tbody>
</table>
In your textbook, read about patterns of inheritance.

For each statement below, write true or false.

16. A scientist uses a pedigree to study family history.

17. A pedigree traces the inheritance of a particular trait through only two generations.

18. In a pedigree, one who does not express the trait is represented by a darkened square or circle.

19. In a pedigree, a horizontal line between two symbols shows that these individuals are the parents of the offspring.

20. Individual III1, as shown below, is in generation II.

Refer to the pedigree above. Respond to each statement.

21. Recall if the trait is recessive or dominant based on the following information:
   In the pedigree, individuals I1 and I2 are unaffected but have an affected child.

22. Specify if parents II1 and II2, who have an affected child, are carriers of the trait.

23. Tell whether there is a dominant gene in the genotype of II4.
In your textbook, read about incomplete dominance.

*Complete the table by checking the correct column(s) for each description.*

Reminder:  
- \( R \) is dominant (normal red blood cells).
- \( R' \) is recessive (sickle-shaped red blood cells).

| 1. \( R'R' \) |  |  |
| 2. \( RR' \) |  |  |
| 3. \( RR \) |  |  |

In your textbook, read about sex-linked traits.

*Refer to the Punnett square. Respond to each statement.*

| \( X^b \) | \( Y \) |
| \( X^b \) | \( X^bX^b \) | \( X^bY \) |
| \( X^b \) | \( X^bX^b \) | \( X^bY \) |

Reminder: A female has 2 X chromosomes.
A male has an X and a Y chromosome.
\( B \) is dominant (normal color vision).
\( b \) is recessive (color blindness).

4. **Tell** if the father has color blindness.

5. **Specify** if the father has a recessive allele.

6. **State** whether the only child that could have color blindness is male or female.
In your textbook, read about chromosomes and human heredity.

Match the definition in Column A with the term in Column B.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. micrograph of chromosomes</td>
<td>A. karyotype</td>
</tr>
<tr>
<td>2. abnormal number of chromosomes</td>
<td>B. Down syndrome</td>
</tr>
<tr>
<td>3. withdrawal of tissue from the placenta</td>
<td>C. telomere</td>
</tr>
<tr>
<td>4. extra chromosome 21</td>
<td>D. nondisjunction</td>
</tr>
<tr>
<td>5. protective cap at the end of a chromosome</td>
<td>E. chorionic villus sampling</td>
</tr>
</tbody>
</table>

In your textbook, read about Down syndrome.

Draw the indicated parts of a karyotype of a child born with Down syndrome and respond to each statement.

6. Chromosome 20
7. Chromosome 21
8. Chromosome 22

9. **Tell** why this karyotype is called “trisomy.”

10. **Recall** the term for the sister chromosomes failing to separate during cell division.

11. **State** whether the risk of having a child with Down syndrome is higher in mothers who are younger or older.
Un (1) __________________________ muestra la herencia de un rasgo particular a través de varias generaciones. Se dice que un organismo con dos (2) __________________________ similares para un rasgo en particular es un (3) __________________________ para ese rasgo. Un organismo con dos (4) __________________________ diferentes para un rasgo en particular es heterócigo para ese rasgo. Cuando hay alelos presentes en el estado (5) __________________________, se observará el rasgo (6) __________________________. Un individuo que es heterócigo para un trastorno (7) __________________________ se llama portador. Son ejemplos de trastornos genéticos recesivos la (el) (8) __________________________ y el (la) (9) __________________________.

 Completa la tabla con el nombre de la enfermedad para cada descripción.

<table>
<thead>
<tr>
<th>Enfermedad</th>
<th>Descripción</th>
</tr>
</thead>
<tbody>
<tr>
<td>acondroplasia</td>
<td>causada por alteración de los genes; lo que resulta en una ausencia de pigmentación en la piel</td>
</tr>
<tr>
<td>enfermedad de Tay-Sachs</td>
<td>trastorno genético recesivo caracterizado por la incapacidad del cuerpo de tolerar la galactosa</td>
</tr>
<tr>
<td>albinismo</td>
<td>trastorno genético recesivo; gen que se encuentra en el cromosoma 15; caracterizado por la carencia de enzimas que descomponen los ácidos grasos</td>
</tr>
<tr>
<td>fibrosis quística</td>
<td>trastorno genético recesivo; afecta las glándulas productoras de mucosidad, las enzimas digestivas y las glándulas sudoríferas</td>
</tr>
<tr>
<td>enfermedad de Huntington</td>
<td>trastorno genético dominante; afecta el sistema nervioso</td>
</tr>
<tr>
<td>galactosemia</td>
<td>afección genética dominante autosomal; afecta la altura y el tamaño del cuerpo</td>
</tr>
</tbody>
</table>
En tu libro de texto, lee acerca de los patrones básicos de la herencia humana.

Para cada afirmación a continuación, escribe «verdadero» o «falso».

16. Los científicos usan el pedigrí para estudiar la historia familiar.

17. El pedigrí sigue el rastro hereditario de un rasgo en particular a través de dos generaciones únicamente.

18. En un pedigrí, aquél que no exprese el rasgo se representa con un cuadrado o círculo oscuros.

19. En un pedigrí, una línea horizontal entre dos símbolos muestra que estos individuos son los padres de la descendencia.

20. El individuo II1, como se muestra abajo, está en la generación II.

![Pedigrí](attachment:pedigrí.png)

Consulta el pedigrí anterior. Responde a cada afirmación.

21. **Recuerda** si el rasgo es recesivo o dominante según la siguiente información: En el pedigrí, los individuos I1 y I2 no se ven afectados pero tienen un hijo afectado.

22. **Especifica** si los padres II1 y II2, que tienen un hijo afectado, son portadores del rasgo.

23. **Indica** si hay un gen dominante en el genotipo de II4.
En tu libro de texto, lee acerca de la dominación incompleta.
Completa la tabla marcando la(s) columna(s) correcta(s) para cada descripción.
Recuerda: \( R \) es dominante (glóbulos rojos normales).
\( R' \) es recesivo (glóbulos rojos en forma de hoz).

<table>
<thead>
<tr>
<th></th>
<th>1. ( R'R' )</th>
<th>2. ( RR' )</th>
<th>3. ( RR )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>![Hemoglobina normal]</td>
<td>![Hemoglobina en forma de hoz]</td>
<td></td>
</tr>
</tbody>
</table>

En tu libro de texto, lee acerca de los rasgos vinculados con el sexo.
Consulta la cuadrícula de Punnett. Responde a cada afirmación.
Recuerda: Una mujer tiene 2 cromosomas X.
Un hombre tiene un cromosoma X y un cromosoma Y.
El \( B \) es dominante (visión en color normal).
El \( b \) es recesivo (daltónico).

<table>
<thead>
<tr>
<th></th>
<th>( X^B )</th>
<th>( Y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( X^b )</td>
<td>( X^b X^B )</td>
<td>( X^b Y )</td>
</tr>
<tr>
<td>( X^B )</td>
<td>( X^B X^B )</td>
<td>( X^B Y )</td>
</tr>
</tbody>
</table>

4. **Indica** si el padre es daltónico.

5. **Específica** si el padre tiene un alelo recesivo.

6. **Señala** si el único hijo que podría ser daltónico es hombre o mujer.
En tu libro de texto, lee acerca de los cromosomas y la herencia humana. 

Relaciona la definición de la columna A con el término de la columna B.

<table>
<thead>
<tr>
<th>Columna A</th>
<th>Columna B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. micrografía de cromosomas</td>
<td>A. cariotipo</td>
</tr>
<tr>
<td>2. número anormal de cromosomas</td>
<td>B. síndrome de Down</td>
</tr>
<tr>
<td>3. retiro de tejido de la placenta</td>
<td>C. telómero</td>
</tr>
<tr>
<td>4. cromosoma 21 adicional</td>
<td>D. no disyunción</td>
</tr>
<tr>
<td>5. extremo protector al final de un cromosoma</td>
<td>E. muestreo del villus coriónico</td>
</tr>
</tbody>
</table>

En tu libro de texto, lee acerca del síndrome de Down.

Dibuja las partes indicadas de un cariotipo de un niño nacido con el síndrome de Down y responde a cada afirmación.

6. Cromosoma 20
7. Cromosoma 21
8. Cromosoma 22

9. Di porqué este cariotipo se llama «trisomía».

10. Recuerda el término de los cromosomas hermanos que no se separaron durante la división de células.

11. Indica si el riesgo de tener un hijo con el síndrome de Down es más grande en madres que son más jóvenes o mayores.
Quick Check

CHAPTER 11
Section 1: Basic Patterns of Human Inheritance

After reading the section in your textbook, respond to each statement.

1. List three recessive genetic disorders.

2. Explain what a pedigree is.

3. Classify If the recessive allele for cystic fibrosis is represented as c, classify the following genotypes as homozygous dominant, homozygous recessive, or carriers: CC, Cc, and cc. Distinguish which genotype is of an individual who has cystic fibrosis.

4. Predict One parent is heterozygous for a recessive genetic disorder, and the other parent is homozygous for the dominant allele. Determine if their offspring are likely to express the recessive trait. Explain.

5. Deduce how Huntington’s disease can be passed on to offspring even though it is a dominant, lethal disorder.
Quick Check

Section 2: Complex Patterns of Inheritance

After reading the section in your textbook, respond to each statement.

1. **Define** codominance.

2. **Explain** how rabbits can have more than two different coat colors.

3. **Discuss** how environment can influence phenotype. Give one example.

4. **Distinguish** between polygenic traits and multiple alleles.

5. **Determine** why it is rare for a woman to be color blind.
After reading the section in your textbook, respond to each statement.

1. **Tell** what type of chromosomal disorder results in Down syndrome.

2. **Explain** what a telomere is.

3. **Describe** a karyotype.

4. **Classify** the human sex genotype XXX as an example of trisomy or monosomy. **Explain**.

5. **Evaluate** two tests available to examine fetal genetics. **Suggest** which test is more accurate.
CHAPTER 11 Assessment
Student Recording Sheet

Section 11.1
Vocabulary Review
Use vocabulary terms to answer each question.

1. ____________________  2. ____________________

Understand Key Concepts
Select the best answer from the choices given, and fill in the corresponding circle.


Constructed Response

7. ____________________________________________

8. ____________________________________________

Think Critically
9. Record your answer for question 9 on a separate sheet of paper.

Section 11.2
Vocabulary Review
Write the vocabulary term that makes each sentence true.

10. ____________________  11. ____________________  12. ____________________

Understand Key Concepts
Select the best answer from the choices given, and fill in the corresponding circle.


Constructed Response

16. __________________________________________

17. __________________________________________

18. __________________________________________

Think Critically
19. __________________________________________
CHAPTER 11
Assessment

20. ____________________________________________________

Section 11.3
Vocabulary Review
Write the vocabulary term that best matches each definition.
21. ____________________ 22. ____________________ 23. ____________________

Understand Key Concepts
Select the best answer from the choices given, and fill in the corresponding circle.

Constructed Response
28. ____________________________________________________
29. ____________________________________________________
30. ____________________________________________________

Think Critically
31. ____________________________________________________
32. ____________________________________________________
33. Record your answer for question 33 on a separate sheet of paper.

Additional Assessment
34. Writing in Biology Record your answer for question 34 on a separate sheet of paper.

Document-Based Questions
35. ____________________________________________________
36. ____________________________________________________
37. ____________________________________________________

Cumulative Review
38.–39. Record your answers for questions 38 and 39 on a separate sheet of paper.
CHAPTER 11
Assessment

Student Recording Sheet

Standardized Test Practice

Multiple Choice

Select the best answer from the choices given, and fill in the corresponding circle.

1. A B C D  
2. A B C D  
3. A B C D  
4. A B C D  
5. A B C D  
6. A B C D  
7. A B C D  
8. A B C D

Short Answer

Answer each question with complete sentences.

10. Record your answer for question 10 on a separate sheet of paper.

11.

12.

13.

14.

15.

16.

17.
CHAPTER 11
Assessment
Student Recording Sheet

Extended Response

Answer each question with complete sentences.

18. ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

19. ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

Essay Question

20. ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
# Table of Contents

## Chapter 12  Molecular Genetics

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic Test</td>
<td>75</td>
</tr>
<tr>
<td>Launch Lab</td>
<td>76</td>
</tr>
<tr>
<td>MiniLab (1)</td>
<td>77</td>
</tr>
<tr>
<td>MiniLab (2)</td>
<td>78</td>
</tr>
<tr>
<td>BioLab</td>
<td>79</td>
</tr>
<tr>
<td>Real-World Biology</td>
<td>81</td>
</tr>
<tr>
<td>Enrichment</td>
<td>83</td>
</tr>
<tr>
<td>Concept Mapping</td>
<td>84</td>
</tr>
<tr>
<td>Study Guide (English)</td>
<td>85</td>
</tr>
<tr>
<td>Study Guide (Spanish)</td>
<td>89</td>
</tr>
<tr>
<td>Section Quick Check 1</td>
<td>93</td>
</tr>
<tr>
<td>Section Quick Check 2</td>
<td>94</td>
</tr>
<tr>
<td>Section Quick Check 3</td>
<td>95</td>
</tr>
<tr>
<td>Section Quick Check 4</td>
<td>96</td>
</tr>
<tr>
<td>Chapter Test A</td>
<td>97</td>
</tr>
<tr>
<td>Chapter Test B</td>
<td>100</td>
</tr>
<tr>
<td>Chapter Test C</td>
<td>103</td>
</tr>
<tr>
<td>Student Recording Sheet</td>
<td>107</td>
</tr>
</tbody>
</table>
CHAPTER 12 Molecular Genetics

Before reading Chapter 12, predict answers to questions about the chapter content based on what you already know. Circle the letter of the correct answer, and then explain your reasoning.

1. While visiting the local science institute in his city, Damian visits an exhibit that displays great scientists of the twentieth century and their discoveries. For the year 1953, Damian reads about two British scientists named James Watson and Francis Crick. Which discovery was made by these scientists?
   A. double helix shape of DNA molecules
   B. molecular proof for biological evolution
   C. process for creating a large, nuclear explosion
   D. process for creating the first clone

Explain.

2. Desta is studying for an entrance exam for a nurse’s training program at a local hospital. She learns the components of a DNA molecule. What are these components?
   A. double strands of RNA twisted together
   B. molecules of amino acids linked together
   C. protein strands connected by nucleotides
   D. sugar and phosphate strands connected by nucleotide pairs

Explain.

3. While listening to a news broadcast, Ling learns of a protist in the Chesapeake Bay that has mutated into a toxic form. She looks up the term mutation in a dictionary. What definition does she find?
Launch Lab

CHAPTER 12

Who discovered DNA?

The body of knowledge concerning genetics, DNA, and biotechnology has been accumulating for nearly one and a half centuries. In this lab you will make a time line of the discovery of DNA.

Procedure

1. Work in groups of three to four to identify scientists and experiments that made important contributions to the understanding of genetics and DNA.

2. Preview the chapter in your textbook.

3. Make a time line showing when each important discovery mentioned in the textbook was made.

Data and Observations

Analysis

1. Compare and contrast your group’s time line with other time lines in the class.

2. Infer how the results of past experiments are important for each scientist that follows.
MiniLab

CHAPTER 12

Model DNA Structure

What is the structure of the DNA molecule? Construct a model to better understand the structure of the DNA molecule.

Procedure

1. Read and complete the lab safety form.
2. Construct a model of a short segment of DNA using the materials provided by your teacher.
3. Identify which parts of the model correspond to the different parts of a DNA molecule.

Analysis

1. Describe the structure of your DNA molecule.

2. Identify the characteristics of DNA that you focused on when constructing your model.

3. Infer In what way is your model different from your classmates’ models? How does this relate to differences in DNA among organisms?
How does the DNA molecule replicate? Use a model to better understand the replication of the DNA molecule.

Procedure

1. Read and complete the lab safety form.
2. Use your DNA model from MiniLab: Model DNA Structure and extra pieces to model the replication of your segment of DNA.
3. Use your model to demonstrate DNA replication for a classmate, and identify the enzymes involved in each step.

Analysis

1. **Explain** how your model of DNA replication shows semiconservative replication.

2. **Infer** How would DNA replication in a cell be affected by an absence of DNA ligase?
Background: DNA tests are important for biologists, doctors, and even detectives. Imagine that you are working in a lab where someone has brought a sample of corn from a crime scene to be analyzed. You decide to test the DNA of the corn to look for genes to identify the type of corn. Before the DNA sequence can be examined, the DNA must be extracted.

Question: How can DNA be extracted?

Materials
- corn kernels (50 g)
- beakers (2)
- blender
- cheesecloth (4 squares—30 cm on each edge)
- rubber band
- glass spooling hook
- homogenization medium (100–150 mL)
- plastic centrifuge tube (30–50 mL)
- contact lens cleaning tablet (containing papain)
- 95% ethanol (12 mL)
- distilled water (3 mL)
- test tube
- container of ice
- water bath at 60°C
- stirring rod
- timer or clock

Safety Precautions

Procedure
1. Read and complete the lab safety form.
2. Carefully weigh out 50 g of corn kernels.
3. Place the corn kernels into a beaker and cover with homogenization medium that has been warmed to 60°C. Place the beaker in a 60°C water bath for 10 min. Gently stir every 45 s.
4. Remove the beaker from the water bath and chill quickly in an ice bath for 5 min.
5. Pour the mixture into a blender and homogenize, or blend to achieve a consistent texture.
6. Filter the homogenized mixture through four layers of cheesecloth into a clean, large beaker on ice.
7. Pour 15 mL of the filtrate into a 30–50 mL plastic centrifuge tube.
8. Dissolve one contact lens cleaning tablet in 3 mL of distilled water in a test tube. Add this to the filtrate tube and mix gently.
9. Hold the filtrate tube at an angle and slowly pour 12 mL of cold 95% ethanol down the side of the tube.
10. Observe the DNA rising into the alcohol layer as a cloudy suspension of white strings. Use a hooked glass rod to spool the DNA, and allow it to dry.
11. Cleanup and Disposal Clean your lab area, disposing of chemicals and materials as directed by your teacher. Be sure to wash your hands when you are finished.
BioLab, Forensics: How is DNA extracted? continued

Analyze and Conclude

1. **Describe** the appearance of the DNA in suspension and once it has dried.

2. **Explain** why you put the corn kernels into the blender.

3. **Think Critically** Why is it important not to contaminate a sample of DNA that is to be sequenced? How would you know if you had contaminated your sample?
Real-World Biology: Analysis

CHAPTER 12 Mending Mutations

You might know someone who has asthma, arthritis, cystic fibrosis, or sickle-cell disease. These are diseases that are caused by genetic mutations. In recent years, scientists at the Human Genome Project have determined that there are more than 30,000 genes in the 46 human chromosomes. Each gene is a segment of DNA that codes for a specific protein such as eye color. Researchers are now making progress in developing methods of gene therapy for mutations. The first type of therapy developed was technology that corrected a genetic disorder by replacing the defective gene with copies of healthy ones. Scientists continue to refine the technology with improved methods for therapy. They are also identifying additional specific genes that control disorders such as cancer, diabetes, and Alzheimer’s disease.

Part A: Finding the Mutation

A team of scientists in Finland has been working for more than ten years on what might be called “the genetics of wheezing.” Their work can be best described as a series of steps. Their first step linked increased susceptibility to asthma to a 20-million-base area of Chromosome 7. Their second step in hunting the gene was to collect 900 blood samples from both healthy and asthmatic individuals in families afflicted with asthma. Their third step was to search for large sequences of DNA called haplotypes; these might predispose people to disease. Among the Finns, seven haplotypes were found in the stretch of Chromosome 7. Three of the seven haplotypes were present in more than 50 percent of the asthma patients. They were present in 30 percent of the healthy people. The presence of these haplotypes increased the risk of asthma up to 2.5 times the normal rate.

Analyze and Conclude

Use Figure 1 to respond to each question.

1. Propose The team has now associated three haplotypes with high risk for asthma. The next step is to find the gene or genes involved. How can that be done?

2. Explain Before a genetic disorder can be corrected, it is necessary to identify the defective gene that is causing the disorder. What type of mutation is illustrated in diagram (b)? How is the protein produced in (b) different from the protein produced by the normal gene (a)?
3. Apply What type of mutation is illustrated in diagram (c)? What would have to be done to correct the defective gene?

Part B: Can mutations be mended?

Cystic fibrosis (CF) is an inherited disease caused by an abnormal protein that does not allow the passage of chloride ions into and out of certain cells. As a result, those cells produce thick, sticky mucus and other secretions that clog the lungs and digestive tract. The abnormal gene that causes CF was discovered in 1989. In 1990, researchers corrected CF—in lab dishes—by adding normal copies of the gene into cells. During the following 15 years, clinical trials showed that normal genes can be transferred to CF airways and temporarily improve lung function. The CF gene therapy approach has been to add new, therapeutic genes into cells.

A new technique was used on a mutation that causes one type of disease, severe combined immune deficiency. The mutation was corrected in lab-grown cells. The researchers designed a human-made protein to grab onto the mutated gene and slice through it in the vicinity of the mutation. The break in the gene then triggered the cell’s own repair process. The cell copied a normal version of the gene and used the copy to replace a region of the cell’s gene that included the mutation. About 7 percent of the lab-grown cells had their mutation fully corrected.

Analyze and Conclude

Respond to each question and statement.

1. Explain why CF scientists state that any CF gene technology treatment might need to be repeated periodically to be effective.

2. Analyze Have researchers found a cure for severe combined immune deficiency? Explain.

CAREERS IN BIOLOGY

Nursing Visit biologygmh.com for information on nurse research coordinators. What are the responsibilities of a nurse research coordinator?
A chemical bond is a force of attraction that holds two atoms together in a compound. A variety of chemical bonds exist, including ionic bonds, covalent bonds, and hydrogen bonds. These bonds differ from one another in the way they form, their relative strength, and other characteristics. Biological molecules, like those of DNA and RNA, tend to make use of two or more types of chemical bonds, each with its own function in the molecule.

### Analyze a Problem: Bonding in a DNA Molecule

**Summarize**  The table below lists the types of chemical bonds found in a DNA molecule or used by a DNA molecule in its biochemical interactions with other molecules in the cell. Use internet sources or reference books available at your school or local library to complete the table.

**Discuss**  The bonds in DNA (or any other biological molecule) are always “just right” for the job that the molecule is supposed to do.

<table>
<thead>
<tr>
<th>Type of Bond</th>
<th>How It Is Formed</th>
<th>Relative Strength</th>
<th>How It Is Used in DNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ionic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covalent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Van der Waals force</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrophobic force</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

That is, replacing a covalent bond in a molecule with a hydrogen bond would almost certainly have a harmful effect on the molecule, preventing it from carrying out the biological function for which it is designed or destroying the molecule itself. On a separate sheet of paper, list and describe two instances in which a DNA bond is “just right” for the position in which it is located.
Complete the events chain showing the events that occur as DNA codes for RNA, which guides the synthesis of proteins, the central dogma of biology. These terms may be used more than once: cytoplasm, mRNA, ribosome, rRNA, stop codon, template, uracil.

1. RNA polymerase moves down the DNA strand as the DNA unwinds.
2. Uracil is incorporated instead of thymine.
3. Processed mRNA moves out of the nucleus and into the cytoplasm.
4. The mRNA connects to the ribosome, and tRNA carries the amino acid methionine to the start codon. More tRNA carries amino acids to the ribosome according to the codons on the mRNA.
5. The peptidyltransferase in the ribosome catalyzes the bonds between amino acids.
6. The ribosome moves along the mRNA until it reaches a stop codon.
7. The tRNA is released from the ribosome, and the ribosome subunits disassemble.
In your textbook, read about nucleotides.

Label the diagrams of DNA nucleotides and bases. Use these choices:

cytosine guanine phosphate purine pyrimidine sugar

1. ________________________________
2. ________________________________
3. ________________________________
4. ________________________________
5. ________________________________
6. ________________________________

In your textbook, read about DNA structure.

Write the term or phrase that best completes each statement. Use these choices:

adenine (A) chromosome cytosine double helix
double-ring genetic material nitrogenous bases nucleic acids
nucleotides purine single-ring

7. ________________________________, guanine (G), cytosine (C), and thymine (T) are the four ________________________________ in DNA.
8. In DNA, ________________________________ always forms hydrogen bonds with guanine (G).
9. The sequence of ________________________________ carries the genetic information of an organism.
10. Chargaff’s data states that the number of ________________________________ bases equals the number of pyrimidine bases in DNA.
11. The twisted ladder shape of DNA is called a ________________________________.
12. DNA is the ________________________________ of all organisms.
13. The pyrimidine bases have a ________________________________ structure.
14. The purine bases have a ________________________________ structure.
15. DNA and RNA are the two ________________________________ found in living cells.
16. DNA supercoils to make up the structure known as a ________________________________. 
In your textbook, read about semiconservative replication.

Match the description in Column A with the term in Column B.

**Column A**

1. unwinds in multiple areas as DNA is replicated
2. parental strands separate and serve as templates for new strands of DNA
3. the DNA of prokaryotes
4. keep the strands of DNA separate during replication
5. elongates as DNA unwinds and is replicated continuously
6. unwinds the double helix

**Column B**

A. semiconservative replication
B. DNA helicase
C. single-stranded binding proteins
D. leading strand
E. eukaryotic DNA
F. circular DNA

In your textbook, read about base pairing.

Label the diagram showing DNA replication. Use these choices:

<table>
<thead>
<tr>
<th>DNA ligase</th>
<th>DNA polymerase</th>
<th>leading strand</th>
<th>Okazaki fragments</th>
<th>parental DNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Diagram Labels:**

7. DNA ligase
8. DNA polymerase
9. Direction of replication
10. Leading strand
11. Okazaki fragments
12. Parental DNA

3’ → 5’

Lagging strand

5’ → 3’

Helicase

RNA primer
In your textbook, read about the central dogma of biology.

For each statement below, write true or false.

1. The central dogma of biology, or the mechanism of reading and expressing genes in all living things, can be expressed as follows: DNA → RNA → proteins.  **True**

2. The process of the synthesis of mRNA from DNA is called translation.  **True**

In your textbook, read about the code.

Refer to the figure. Respond to each statement.

3. Express the following sequence of DNA nucleotides as complementary mRNA codons.

   T A C G A T T A A C A A C T

4. Write the specific amino acid or code that each mRNA codon from statement 3 above represents.

5. Identify the start and stop mRNA codons.

In your textbook, read about translation and the role of the ribosome.

Use each of the terms below only once to complete the passage.

<table>
<thead>
<tr>
<th>anticodon</th>
<th>cytoplasmin</th>
<th>mRNA</th>
<th>protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>ribosome</td>
<td>start codon</td>
<td>translation</td>
<td>tRNA</td>
</tr>
</tbody>
</table>

Once the (6) _______________ is synthesized, it leaves the nucleus and enters the (7) _______________. The 5' end of the mRNA connects to the (8) _______________, where the code is read and translated to make a(n) (9) _______________ in a process called (10) _______________. In translation, (11) _______________ interprets the mRNA codon sequence. Once the mRNA is associated with the ribosome, a tRNA with the (12) _______________ CAU will bind to the mRNA (13) _______________ AUG.
In your textbook, read about prokaryote and eukaryote gene regulation.

If the statement is true, write true. If the statement is false, replace the italicized term or phrase to make it true.

1. Gene regulation is the ability of an organism to control which genes are transcribed.

2. A chromosome contains the genes for the proteins needed for a specific metabolic pathway.

3. An operator is a segment of DNA that acts as an on/off switch for translation.

4. Eukaryotes can control gene expression using transcription factors.

5. Hox genes play an important role in determining the gender of an organism.

In your textbook, read about mutations.

Refer to the figure below. Respond to the following statement.

6. Record the mRNA codon sequence that would result from a substitution mutation of A instead of G in the amino acid alanine (Ala) in the above protein.

Complete the table by filling in the missing information. Use these choices:

<table>
<thead>
<tr>
<th>mRNA Sequence</th>
<th>Mutation Sequence</th>
<th>Type of Mutation</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. UGU-CCG-GAA-CGA</td>
<td>UGC-CGG-GAA-CGA</td>
<td>substitution</td>
</tr>
<tr>
<td>8. GAA-CGU-AGC-GGU</td>
<td>GAU-CGU-AGC-GGU</td>
<td>substitution</td>
</tr>
<tr>
<td>9. UGU-UUC-CCU-UAA</td>
<td>UGU-UCC-CUU-AA*</td>
<td>frame shift</td>
</tr>
</tbody>
</table>
En tu libro de texto, lee acerca de los nucleótidos.

Identifica los diagramas de los nucleótidos y bases de ADN. Usa estas opciones:

- azúcar
- citosina
- fosfato
- guanina
- pirimidina
- purina

1. 
2. 
3. 
4. 
5. 
6. 

En tu libro de texto, lee acerca de la estructura del ADN.

Escribe el término o la frase que mejor completa cada afirmación. Usa estas opciones:

- ácidos nucleicos
- adenina (A)
- anillo doble
- anillo sencillo
- bases de nitrógeno
- citosina
- cromosoma
- hélice doble
- material genético
- nucleótidos
- purina

7. La ________________, la guanina (G), la citosina (C) y la timina (T) son las cuatro ________________ en el ADN.

8. En el ADN, la ________________ siempre forma enlaces de hidrógeno con la guanina (G).

9. La secuencia de ________________ lleva la información genética de un organismo.

10. Las reglas de Chargaff establecen que el número de bases de ________________ es equivalente al número de bases de pirimidina en el ADN.

11. La forma de escalera torcida del ADN se llama ________________.

12. El ADN es el ________________ de todos los organismos.

13. Las bases de pirimidina tienen una estructura de ________________.

14. Las bases de purina tienen una estructura de ________________.

15. El ADN y ARN son los dos ________________ que se encuentran en las células vivientes.

16. Las superespirales de ADN componen la estructura conocida como ________________.
Guía de estudio

CAPÍTULO 12
Sección 2: Replicación del ADN

En tu libro de texto, lee acerca de la replicación semiconservativa.
Relaciona la definición de la columna A con el término de la columna B.

<table>
<thead>
<tr>
<th>Columna A</th>
<th>Columna B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Se desenrolla en áreas múltiples a medida que el ADN se replica.</td>
<td>A. replicación semiconservativa</td>
</tr>
<tr>
<td>2. Las cadenas parentales se separan y sirven como guías para nuevas</td>
<td>B. ADN helicasa</td>
</tr>
<tr>
<td>las cadenas de ADN.</td>
<td></td>
</tr>
<tr>
<td>3. Es el ADN de las procariotas.</td>
<td>C. proteínas de unión monocatenarias</td>
</tr>
<tr>
<td>4. Mantienen las cadenas de ADN separadas durante la replicación.</td>
<td>D. cadena conductora</td>
</tr>
<tr>
<td>5. Se extiende a medida que el ADN se desenrolla y se replica continuamente.</td>
<td>E. ADN eucariótico</td>
</tr>
<tr>
<td>6. Desenrolla la hélice doble.</td>
<td>F. ADN circular</td>
</tr>
</tbody>
</table>

En tu libro de texto, lee acerca del apariamiento de bases.
Identifica el diagrama que muestra la replicación del ADN. Usa estas opciones:

<table>
<thead>
<tr>
<th>ADN ligasa</th>
<th>ADN parental</th>
<th>ADN polimerasa</th>
</tr>
</thead>
<tbody>
<tr>
<td>cadena conductora</td>
<td>fragmentos de Okazaki</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>10.</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>11.</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>12.</td>
<td></td>
</tr>
</tbody>
</table>

Dirección de la replicación: 3' → 5'
Guía de estudio

En tu libro de texto, lee acerca del dogma central de la biología.
Para cada afirmación a continuación, escribe «verdadero» o «falso».

1. El dogma central de la biología, o el mecanismo de lectura y expresión de los genes en todas las cosas vivientes, se puede expresar de la siguiente manera: ADN → ARN → proteínas.

2. El proceso de la síntesis del ARNm a partir del ADN se llama traducción.

En tu libro de texto, lee acerca del código.
Consulta la tabla. Responde a cada afirmación.

3. Expresa la siguiente secuencia de nucleótidos del ADN como codones del ARNm complementarios.

T A C G A T T A A C A A C T

4. Escribe el aminoácido o código específico que representa cada codón del ARNm de la afirmación 3 arriba.

5. Identifica el inicio y la detención de los codones del ARNm.

En tu libro de texto, lee acerca de la traducción y la función del ribosoma.
Usa cada uno de los siguientes términos sólo una vez para completar el párrafo.

- ARNm
- ARNt
- anticodón
- citoplasma
- traducción

Una vez que el (6) se sintetiza, éste abandona el núcleo y entra al (7) . El extremo 5' del ARNm se conecta al (8) , donde se lee el código y se traduce para producir una (9) mediante un proceso llamado (10) .

En la traducción, el (11) interpreta la secuencia de codones del ARNm. Una vez que el ARNm está asociado con el ribosoma, un ARNt con el (12) CAU se enlazará con el (13) AUG del ARNm.
En tu libro de texto, lee acerca de la regulación de genes procariotas y eucariotas.

Si la afirmación es verdadera, escribe «verdadero». Si la afirmación es falsa, substituye el término o la frase en cursiva para volverla verdadera.

1. La regulación de genes es la capacidad de un organismo de controlar qué genes se transcriben.

2. Un cromosoma contiene los genes para las proteínas necesarios para una ruta metabólica específica.

3. Un operador es un segmento del ADN que actúa como un interruptor de encendido y apagado para la traducción.

4. Las eucariotas pueden controlar la expresión de los genes usando factores de transcripción.

5. Los genes homeóticos tienen un papel importante en la determinación del género de un organismo.

En tu libro de texto, lee acerca de las mutaciones.

Consulta el dibujo a continuación. Responde a la siguiente afirmación.

6. Registra la secuencia de codones del ARNm que resultaría a partir de una mutación de sustitución de A en vez de G en el aminoácido alanina (Ala) en la proteína anterior.

Completa la tabla con la información faltante. Usa estas opciones:

<table>
<thead>
<tr>
<th>defase</th>
<th>sustitución</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secuencia del ARNm</td>
<td>Secuencia de mutación</td>
</tr>
<tr>
<td>7. UGU-CCG-GAA-CGA</td>
<td>UGC-CGG-GAA-CGA</td>
</tr>
<tr>
<td>8. GAA-CGU-AGC-GGU</td>
<td>GAU-CGU-AGC-GGU</td>
</tr>
<tr>
<td>9. UGU-UUC-CCU-UAA</td>
<td>UGU-UCC-CUU-AA*</td>
</tr>
</tbody>
</table>
Quick Check

CHAPTER 12

Section 1: DNA: The Genetic Material

After reading the section in your textbook, respond to each statement.

1. **Describe** the structure of DNA proposed by Watson and Crick.

2. **Clarify** what it means to say that the orientation of the two strands in the DNA molecule is antiparallel.

3. **Apply** Chargaff’s rule to decide how many guanine bases a length of DNA will have if it has 26 cytosine bases. Explain.

4. **Contrast** the possible structures of DNA and RNA nucleotides.

5. **Assess** The paper published by Watson and Crick on the structure of DNA is surrounded in controversy because of the lack of credit given to the work of other scientists that helped them develop their ideas. Using the story of the discovery of the structure of DNA, assess the importance of scientists’ sharing information.
Quick Check

Section 2: Replication of DNA

After reading the section in your textbook, respond to each statement.

1. **Recall** what happens to the DNA double helix so that DNA polymerase can begin adding appropriate nucleotides.

2. **Explain** what Okazaki fragments are.

3. **Describe** how Okazaki fragments are joined.

4. **Indicate** why eukaryotic DNA is replicated in multiple areas at once, while in prokaryotes, DNA replication begins in only one area.

5. The Roman emperor Claudius probably died from a buildup of toxins in his body as a result of liver failure. Historians believe his liver failed because he ate poisonous mushrooms that his wife gave him. The mushrooms contained a substance that prevents the synthesis of mRNA from DNA. **Deduce** how a substance that stops the synthesis of mRNA could cause liver failure.
Quick Check

CHAPTER 12
Section 3: DNA, RNA, and Protein

After reading the section in your textbook, respond to each statement.

1. **State** the central dogma of biology.

2. **Differentiate** between transcription and translation.

3. **Discuss** the ways in which eukaryotic pre-mRNA is processed before it reaches the ribosome.

4. **Summarize** the synthesis of mRNA.

5. **Determine** the protein sequence that would be coded for by reading the following mRNA sequence from left to right: UCUCUGGCUAUCAGC.
Quick Check

CHAPTER 12
Section 4: Gene Regulation and Mutations

After reading the section in your textbook, respond to each statement.

1. **Recall** the parts of an operon.

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

2. **Explain** what Hox genes are.

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

3. **Recall** the types of mutations that lead to frameshift mutations.

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

4. **Compare** missense mutations and nonsense mutations.

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

5. **Demonstrate** how the DNA code for a protein can be mutated by inserting a nucleotide at one point in the sequence TTTCACGAC.

   ____________________________________________________________
CHAPTER 12
Assessment
Student Recording Sheet

Section 12.1
Vocabulary Review
Write the vocabulary term that makes each sentence true.

1. ________________________________ 2. ________________________________

Understand Key Concepts
Select the best answer from the choices given, and fill in the corresponding circle.

4. A B C D  6. A B C D

Constructed Response

8. ________________________________________________________________

9. Record your answer for question 9 on a separate sheet of paper.

Think Critically

10. ________________________________________________________________

11. ________________________________________________________________

Section 12.2
Vocabulary Review
Write a sentence defining each vocabulary term.

12. ________________________________________________________________

13. ________________________________________________________________

14. ________________________________________________________________

Understand Key Concepts
Select the best answer from the choices given, and fill in the corresponding circle.

15. A B C D  16. A B C D
CHAPTER 12
Assessment
Student Recording Sheet

Construced Response

17.–18. Record your answers for questions 17 and 18 on a separate sheet of paper.

Think Critically

19. ________________________________________

20. ________________________________________

21. ________________________________________

Section 12.3
Vocabulary Review

Write a sentence that connects the vocabulary terms in each pair.

22. ________________________________________

23. ________________________________________

24. ________________________________________

Understand Key Concepts

Select the best answer from the choices given, and fill in the corresponding circle.

25. A B C D

26. A B C D

27. A B C D

Constructed Response

28. Record your answer for question 28 on a separate sheet of paper.

29. ________________________________________

Think Critically

30. Record your answer for question 30 on a separate sheet of paper.
CHAPTER 12
Assessment  
Student Recording Sheet

Section 12.4
Vocabulary Review
Write the vocabulary term that describes each process.
31.  
32.  
33.  

Understand Key Concepts
Select the best answer from the choices given, and fill in the corresponding circle.
34.  
35.  
36.  

Constructed Response
37.  
38.  

Think Critically
39.  
40.  

Additional Assessment
41. Writing in Biology  Record your answer for question 41 on a separate sheet of paper.

Document-Based Questions
42. Record your answer for question 42 on a separate sheet of paper.
43.  
44.  

Cumulative Review
45–47. Record your answers for questions 45–47 on a separate sheet of paper.
CHAPTER 12
Assessment
Student Recording Sheet

Standardized Test Practice

Multiple Choice

Select the best answer from the choices given, and fill in the corresponding circle.

1. \( \text{A} \) \( \text{B} \) \( \text{C} \) \( \text{D} \)
2. \( \text{A} \) \( \text{B} \) \( \text{C} \) \( \text{D} \)
3. \( \text{A} \) \( \text{B} \) \( \text{C} \) \( \text{D} \)
4. \( \text{A} \) \( \text{B} \) \( \text{C} \) \( \text{D} \)
5. \( \text{A} \) \( \text{B} \) \( \text{C} \) \( \text{D} \)
6. \( \text{A} \) \( \text{B} \) \( \text{C} \) \( \text{D} \)
7. \( \text{A} \) \( \text{B} \) \( \text{C} \) \( \text{D} \)
8. \( \text{A} \) \( \text{B} \) \( \text{C} \) \( \text{D} \)

Short Answer

Answer each question with complete sentences.

9. Record your answer for question 9 on a separate sheet of paper.

10. 

11. 

12. 

13. 

14. 

15. 

16. 

Extended Response

Answer each question with complete sentences.

17. Record your answer for question 17 on a separate sheet of paper.

18. 

19. 

Essay Question

20. Record your answer for question 20 on a separate sheet of paper.
Table of Contents

Chapter 13  Genetics and Biotechnology

Diagnostic Test ......................................................... 113
Launch Lab ................................................................. 114
MiniLab (1) ................................................................. 115
MiniLab (2) ................................................................. 116
BioLab ....................................................................... 117
Real-World Biology ..................................................... 119
Enrichment ................................................................. 121
Concept Mapping ......................................................... 122
Study Guide (English) ................................................... 123
Study Guide (Spanish) ................................................... 127
Section Quick Check 1 ................................................. 131
Section Quick Check 2 ................................................. 132
Section Quick Check 3 ................................................. 133
Chapter Test A ............................................................. 134
Chapter Test B ............................................................. 137
Chapter Test C ............................................................. 140
Student Recording Sheet .............................................. 143
Before reading Chapter 13, predict answers to questions about the chapter content based on what you already know. Circle the letter of the correct answer, and then explain your reasoning.

1. Thousands of years ago, humans domesticated wolves and over time have bred closely related wolf offspring. Dozens of dog breeds have emerged from wolves and other canines. Huskies were bred to be strong runners to pull sleds, and German shepherds were bred for their keen sense of smell. At times, undesirable traits, such as a weak hip in German shepherds, emerged. Which of the following explains the emergence of dog breeds from wild canines, such as wolves?
   A. As a result of human breeding attempts, inbreeding created undesirable dog traits.
   B. Humans used selective breeding to obtain desirable traits in dog breeds.
   C. Scientists used genetic engineering to manipulate wild canine genes.
   D. Through natural selection, domesticated dogs evolved from wild canines.

   Explain.

2. Scientists have taken a gene from an ocean jellyfish that creates a bioluminescent light, and they have inserted the gene into a mosquito. The mosquito with the jellyfish gene gives off a green light when it is exposed to ultraviolet light because the mosquito now possesses part of the jellyfish’s DNA. Which explains what scientists have accomplished?
   A. A new form of life was created through the process of gene cloning.
   B. DNA fingerprinting was employed to identify a key jellyfish gene.
   C. Natural selection processes were altered to change the mosquito’s DNA.
   D. The genes of the mosquito were manipulated using genetics.

   Explain.

3. In 2003, scientists completed the Human Genome Project. Describe the goal of this project.
Launch Lab

How does selective breeding work?

A deck of cards can represent the genome of a population of organisms. In this lab, you will model selective breeding to create a population of cards with similar suits.

Procedure
1. Read and complete the lab safety form.
2. Shuffle a deck of cards. Choose one suit to represent the gene you wish to select.
3. Lay the entire deck face up in 26 pairs.
4. Select the pairs that contain at least one card from your chosen suit.
5. In the space below, record the number of cards remaining and calculate the percentage of cards not selected from the starting pile.
6. Shuffle the remaining cards, and repeat steps 2–4 until all of your cards are of the suit you selected.

Data and Observations

Analysis
1. Infer why the cards were laid out in pairs.
2. Relate changes in the percentage of cards discarded after each round to how the percentage of genes might change in a population.
How are hybrid lilies produced? In this lab, you will examine techniques used by both professional plant breeders and amateur gardeners to produce the wide variety of lilies you might see growing in landscaped areas.

Procedure

1. Read and complete the lab safety form.
2. Obtain a labeled drawing of a lily flower and a fresh open lily flower. Examine the flower with a hand lens, and identify the male anthers and the female pistil.
3. Use a cotton swab to gently rub an anther to pick up pollen.
4. Trade flowers with another lab group and, using the cotton swab, gently apply the pollen from your flower to the stigma of the pistil of the new flower.

Analysis

1. Infer When breeders hybridize lilies, they transfer pollen to the stigma of an unopened lily flower and then cover the stigma with a foil cap. Why do you think this would be necessary?

2. Think Critically A breeder produces a hybrid lily, which is then allowed to grow and produce seeds naturally. When these seeds are planted, the new lily plants do not have the same characteristics as the hybrid parent. Hypothesize why this would occur.
MiniLab

CHAPTER 13

Model Restriction Enzymes

How are sticky ends modeled? Use scissors and tape to produce paper DNA fragments with sticky ends and a recombinant DNA plasmid.

Procedure

1. Read and complete the lab safety form.
2. Obtain one straight paper DNA sequence, which will represent genomic DNA, and one circular paper DNA sequence, which will represent a plasmid.
3. Find each GAATTC sequence recognized by the restriction enzyme EcoRI and cleave the genome and plasmid DNA using scissors.
4. Use tape to make a recombinant DNA plasmid.

Analysis

1. Analyze and Conclude Compare your plasmid to those made by other lab groups. How many different recombinant plasmids could be made using this particular genomic sequence? Explain.

2. Infer What enzyme did the scissors represent? Explain.
Background: Although all humans are similar genetically, variations do occur in certain segments of DNA. When cut with restriction enzymes, the variety of sizes of these fragments can be used to determine the source of a sample of DNA.

Question: Based on the DNA samples, were any of the suspects at the scene?

Materials
- various DNA samples
- electrophoresis chamber
- power source
- micropipette and tips
- prepared agarose gels
- restriction enzyme
- microcentrifuge tubes and rack
- sample-loading dye
- nontoxic dye
- staining and destaining containers
- DNA fragments of known size (control)
- ruler
- ice in foam container
- water bath at 37°C

Safety Precautions

Procedure
1. Read and complete the lab safety form.
2. Read the entire procedure.
3. Label your DNA samples.
4. Design and construct a data table you can use to record your observations when you perform gel electrophoresis of your samples.
5. Your teacher will instruct you how to prepare your samples, set up the gel electrophoresis equipment, load your samples, and run the electrophoresis.
6. Use the gel-staining dye to detect the location of DNA fragments in the gel for each of your samples.
7. Use a ruler to measure (in mm) the distance of each migrated DNA band from the wells. Record this information in your data table.
8. Cleanup and Disposal Wash and return all reusable materials. Dispose gels and other reagents in properly labeled containers. Wash your hands thoroughly.

Data and Observations
BioLab, Forensics: How can genetic engineering be used to solve a crime? continued

Analyze and Conclude

1. Interpret Data  Based on your observations, predict which suspect is incriminated by the DNA evidence.

2. Think Critically  While the amount of DNA needed for electrophoresis is not large, the amount that can be extracted from a few hairs might not be enough. How might a forensic scientist solve this problem?

3. Error Analysis  DNA fingerprints have a very high level of accuracy if they are run correctly. What are some sources of error that could lead to inaccurate results?
“Genetic Prints Help Solve Mystery of Girls Switched at Birth.” “Murder Conviction Overturned by DNA Testing: Prisoner Released.” Headlines such as these have become commonplace in recent years due to the forensic method of DNA fingerprinting, originally developed in Britain in the early 1980s. DNA fingerprinting is a method for visualizing sequences of DNA. Every person (except identical twins) has a unique sequence of base pairs. In DNA fingerprinting, scientists analyze a small number of DNA sequences that are known to vary a great deal among individuals. DNA fingerprinting has become an important tool in investigating criminal cases, identifying bodily remains, tracing heritage, and studying genetic disorders. In this activity, you will investigate the technique of DNA fingerprinting and learn how this science of identity is used to solve problems of family heritage and criminal justice.

Part A: How to Make a DNA Fingerprint

**Step 1:** DNA is extracted from cells and cut into fragments by restriction enzymes.

**Step 2:** The DNA fragments are placed on an electrophoresis gel, and electric current is applied. DNA, being negatively charged, moves through the gel to the positively charged electrode. The fragments spread out according to size.

**Step 3:** DNA fragments are separated by chemicals into single strands. Because the strands will disintegrate after a day or two, they are transferred from the gel onto a sheet of nylon. DNA probes, which are synthetic DNA segments with known sequences, are labeled with radioactive compounds. The probes are then applied to the nylon, and complementary sequences on the DNA fragments being tested attach to the probes by base pairing.

**Step 4:** The nylon sheet is exposed to X-ray film, and dark bands appear wherever the fragment DNA (from the sample) has attached to the probe.

Analyze and Conclude

**Respond to each question.**

1. **Identify** In Set 2 of the DNA fingerprints, do any of the bands in the alleged father’s DNA fingerprint match a band in the child’s DNA fingerprint?

2. **Theorize** What does this result indicate?

The DNA fingerprints in Figure 1 can be used to determine the paternity of a child. In Set 1 of the DNA fingerprints, one of the bands in the child’s DNA fingerprint is also present in the mother’s DNA fingerprint. Because none of the bands in the alleged father’s DNA fingerprint matches the child’s bands, he cannot be the father.
Part B: Applications of DNA Fingerprinting

DNA fingerprinting is useful for solving crimes and analyzing kinship relationships. Read the following problems, and analyze the DNA fingerprints to answer the questions.

Analyze and Conclude

Respond to each question and statement.

1. Analyze DNA is isolated from a hair found in a knit hat that was recovered from the scene of a bank robbery. DNA fingerprints are derived from the hair sample (labeled \(H\)) and from samples obtained from seven suspects (labeled 1 through 7). Analyze the DNA fingerprints in Figure 2. To which suspect might the hair belong? Explain.

2. Compare Figure 3 shows DNA fingerprints of a blood sample taken from a crime scene and samples taken from seven suspects. Compare the DNA fingerprints. Which suspect could have committed the crime? Explain.

3. Apply The DNA fingerprints in Figure 4 are those of members of three generations of a family, as well as those of some unrelated individuals.
   a. DNA fingerprint 7 is that of a son of two other family members. Which DNA fingerprints are those of his parents?
   b. DNA fingerprint 10 is that of the grandmother. Which DNA fingerprints are those of her daughter and of her daughter's father? Explain.

Real-World Biology: Analysis, DNA Fingerprinting continued

DNA Biology Visit biologygmh.com for information on biological technicians. What are the responsibilities of a biological technician?
Recombinant DNA is produced by combining DNA from different sources. In recombinant DNA technology, a plasmid is typically used to carry a DNA fragment from another source into a bacterial cell. The protein that the DNA fragment codes for is produced inside the bacterium. When the bacterium replicates, so does the plasmid carrying the DNA fragment. Large numbers of the recombinant bacteria are grown in cultures, producing large quantities of the protein, which can be isolated from the bacteria.

Select Proteins produced by recombinant DNA technology are used to treat diseases and synthesize vaccines. Suppose you are a writer for a medical journal and would like to write an article about the use of this technology. The table below lists six proteins produced by recombinant DNA technology currently in use. Select one of the proteins to research.

Research Once you have selected a protein, research as much detail as possible on the production and use of the protein. Questions to consider while researching include: Is this protein used widely, or is it still experimental? Are there any potential problems or side effects from the use of the protein? Are there any ethical questions involved in the use of the recombinant DNA technology that produces this protein?

Discuss Use your textbook and other reference materials to find information. Discuss your topic and possible answers to your questions with your teacher and classmates.

Write Based on your research and class discussion, write an article about the protein you selected. Provide answers for any questions you researched and discussed. Be sure to properly cite the sources you used to write your article.

### Protein Products of Recombinant DNA Technology

<table>
<thead>
<tr>
<th>Protein</th>
<th>Category</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interferons</td>
<td>immune</td>
<td>used to treat multiple sclerosis, some types of cancer, and viral infections such as hepatitis</td>
</tr>
<tr>
<td>Interleukins</td>
<td>immune</td>
<td>regulate the immune function of white blood cells; used in cancer treatment</td>
</tr>
<tr>
<td>Factor VIII</td>
<td>hormone</td>
<td>used as replacement blood-clotting factor in type A hemophilia</td>
</tr>
<tr>
<td>Erythropoietin (EPO)</td>
<td>hormone</td>
<td>stimulates bone marrow; used to treat some forms of anemia</td>
</tr>
<tr>
<td>Bovine somatotropin (BST)</td>
<td>miscellaneous</td>
<td>given to cows to increase milk production</td>
</tr>
<tr>
<td>Apolipoprotein</td>
<td>miscellaneous</td>
<td>deters the development of fatty deposits in arteries and prevents strokes and heart attacks</td>
</tr>
</tbody>
</table>
Complete the flowchart about the tools and processes used in genetics and biotechnology. These terms may be used more than once: DNA, DNA fingerprinting, DNA ligase, gel electrophoresis, plasmid, polymerase chain reaction, recombinant DNA, smaller DNA fragments, transformation.

1. DNA is cleaved using restriction enzymes to make 2.

2. DNA fragments, which are separated by 3.

3. which are sequenced using fluorescent tagged nucleotides. Copies are then made by a technique called 6.

4. and are then combined with other DNA to make 4.

5. and used to identify individuals by 5.

6. Which is carried by a 7.

7. using 8.

8. and are then inserted into bacteria through 9.
In your textbook, read about selective breeding.

*Match the definition in Column A with the term in Column B.*

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. the process in which two closely related organisms are bred to produce desired traits and eliminate undesired ones in future generations</td>
<td>A. test cross</td>
</tr>
<tr>
<td>2. the process by which desired traits in an organism are selected and passed on to their future generations</td>
<td>B. selective breeding</td>
</tr>
<tr>
<td>3. the method for determining the genotype of an organism</td>
<td>C. inbreeding</td>
</tr>
</tbody>
</table>

In your textbook, read about hybridization.

*Complete the graphic organizer about hybridization.*

Hybridization

4. Definition:

5. Used by:

6. Advantages of Hybridization:

7. Disadvantages of Hybridization:

In your textbook, read about inbreeding.

*Use each of the terms or phrases below only once to complete the passage.*

Clydesdale    harmful recessive traits    pure breeds    recessive allele

Inbreeding may be used to produce (8)_________________________. The (9)__________________________ horse is a good example of inbreeding. One disadvantage of inbreeding is that it can lead to (10)_________________________. Harmful traits can be passed on to future generations if both parents carry the (11)_________________________.

Copyright © Glencoe/McGraw-Hill, a division of The McGraw-Hill Companies, Inc.
In your textbook, read about DNA technology.

*Complete the table by using each term in a sentence.*

<table>
<thead>
<tr>
<th>Vocabulary Term</th>
<th>Sentence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Genetic engineering</td>
<td></td>
</tr>
<tr>
<td>2. Restriction enzymes</td>
<td></td>
</tr>
<tr>
<td>3. Gel electrophoresis</td>
<td></td>
</tr>
<tr>
<td>4. Recombinant DNA</td>
<td></td>
</tr>
<tr>
<td>5. Plasmids</td>
<td></td>
</tr>
<tr>
<td>6. DNA ligase</td>
<td></td>
</tr>
<tr>
<td>7. Transformation</td>
<td></td>
</tr>
<tr>
<td>8. Cloning</td>
<td></td>
</tr>
<tr>
<td>9. Polymerase chain reaction</td>
<td></td>
</tr>
<tr>
<td>10. Transgenic organisms</td>
<td></td>
</tr>
</tbody>
</table>

In your textbook, read about genetic engineering.

*Use each of the terms or phrases below only once to complete the passage.*

desired traits  expressed  gene

Selective breeding produces organisms with (11) _______________________, while genetic engineering actually changes how a specific (12) _______________________ is (13) ______________________ in an organism’s offspring.
In your textbook, read about DNA tools and recombinant DNA.

Complete the graphic organizer about recombinant DNA.

Write the term or phrase that best completes each statement. Use these choices:

- gel electrophoresis
- PCR
- recombinant DNA technology
- restriction enzymes

16. Scientists use __________________________ to cut DNA into smaller fragments.

17. A process called __________________________ separates DNA fragments by size.

18. During __________________________, DNA fragments move to the positive end.

19. __________________________ starts with a primer.

20. __________________________ are bacterial proteins.

21. __________________________ combines DNA fragments from different sources.

22. A technique called __________________________ copies a specific region of DNA.
In your textbook, read about the Human Genome Project.

Use each of the terms or phrases below only once to complete the passage.

- cleaved DNA fingerprinting
- Human Genome Project
- noncoding sequences
- Escherichia coli
- nucleotides
- protein-coding sequences

The (1) ________________________ was completed in 2003. Its goal was to determine the sequence of all the (2) ________________________ of human DNA. Scientists prepared for the HGP by starting small, using (3) ________________________. To determine one continuous human genome sequence, each of the 46 human chromosomes was (4) ________________________. Most of the sequences have no direct function and are called (5) ________________________, while less than 2 percent of the sequences are (6) ________________________. The DNA sequences unique to each individual were determined through (7) ________________________.

In your textbook, read about DNA fingerprinting.

Imagine that you are a detective trying to solve a crime that occurred ten years ago. You have DNA from the crime scene. Write a summary of how you might use DNA fingerprinting to solve your mystery.

8. __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

In your textbook, read about the genome and genetic disorders.

Complete the graphic organizer about SNP.

9. Definition:
   __________________________________________________________
   __________________________________________________________

10. Function:
    __________________________________________________________
    __________________________________________________________
En tu libro de texto, lee acerca de la reproducción selectiva.

Une la definición de la columna A con el término de la columna B que corresponda.

<table>
<thead>
<tr>
<th>Columna A</th>
<th>Columna B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. proceso por el cual dos organismos estrechamente relacionados se cruzan para producir rasgos deseados y eliminar aquellos no deseados en generaciones futuras</td>
<td>A. cruce de prueba</td>
</tr>
<tr>
<td>2. proceso por el cual se seleccionan los rasgos deseados en un organismo y se transmiten a generaciones futuras</td>
<td>B. reproducción selectiva</td>
</tr>
<tr>
<td>3. método para determinar el genotipo de un organismo</td>
<td>C. reproducción en consaguinidad</td>
</tr>
</tbody>
</table>

En tu libro de texto, lee acerca de la hibridación.

Completa la gráfica sobre la hibridación.

<table>
<thead>
<tr>
<th>Hibridación</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Definición:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>5. Utilizada por:</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

| 6. Ventajas de la hibridación: |
|                               |
|                               |

| 7. Desventajas de la hibridación: |
|                                  |
|                                  |

En tu libro de texto, lee acerca de la reproducción en consanguinidad.

Usa cada uno de los términos o frases que aparecen a continuación únicamente una vez para completar el párrafo.

Clydesdale gen alelo recesivo rasgos recesivos peligrosos razas puras

La reproducción en consanguinidad se puede utilizar para producir (8) ______________________ .

El caballo (9) ______________________ es un buen ejemplo de la reproducción en consanguinidad. Una desventaja de la reproducción en consanguinidad es que puede producir (10) ______________________ . Los rasgos peligrosos se pueden transmitir a generaciones futuras si los dos padres llevan el (11) ______________________ .
En tu libro de texto, lee acerca de la tecnología del ADN.

Completa el cuadro al usar cada uno de los términos de vocabulario en una oración.

<table>
<thead>
<tr>
<th>Término de vocabulario</th>
<th>Oración</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ingeniería genética</td>
<td></td>
</tr>
<tr>
<td>2. Enzimas de restricción</td>
<td></td>
</tr>
<tr>
<td>3. Electroforesis en gel</td>
<td></td>
</tr>
<tr>
<td>4. ADN recombinante</td>
<td></td>
</tr>
<tr>
<td>5. Plásmidos</td>
<td></td>
</tr>
<tr>
<td>6. ADN ligasa</td>
<td></td>
</tr>
<tr>
<td>7. Transformación</td>
<td></td>
</tr>
<tr>
<td>8. Clonación</td>
<td></td>
</tr>
<tr>
<td>9. Reacción de la cadena polimerasa</td>
<td></td>
</tr>
<tr>
<td>10. Organismos transgénicos</td>
<td></td>
</tr>
</tbody>
</table>

En tu libro de texto, lee acerca de la ingeniería genética.

Usa cada uno de los términos o frases que aparecen a continuación únicamente una vez para completar el párrafo.

expresa      gen      rasgos deseados

La reproducción selectiva produce organismos con (11) ______________________ , mientras que la ingeniería genética cambia en realidad la forma en que un (12) ______________________ específico se (13) ______________________ en la descendencia de un organismo.
En tu libro de texto, lee acerca de las herramientas del ADN y del ADN recombinante. 
Completa la gráfica sobre la ADN recombinante.

Escribe el término o la frase que mejor se adapte a cada oración. Usa las siguientes opciones:

- electroforesis en gel
- reacción de la cadena polimerasa
- enzimas de restricción
- tecnología del ADN recombinante

16. Los científicos usan ________________ para fraccionar el ADN en fragmentos más pequeños.

17. Un proceso que se llama ________________ separa los fragmentos del ADN por tamaño.

18. Durante la ________________, los fragmentos del ADN se mueven hacia el extremo positivo.

19. La ________________ comienza con un cebador.

20. Las ________________ son proteínas bacteriales.

21. La ________________, combina los fragmentos del ADN de diferentes fuentes.

22. Una técnica que se llama ________________ copia una región específica del ADN.
En tu libro de texto, lee acerca del proyecto del Genoma Humano.

Usa cada uno de los términos o frases que aparecen a continuación únicamente una vez para completar el párrafo.

<table>
<thead>
<tr>
<th>Escherichia coli</th>
<th>fraccionó</th>
<th>huella digital del ADN</th>
</tr>
</thead>
<tbody>
<tr>
<td>nucleótidos</td>
<td>proyecto del Genoma Humano</td>
<td>secuencias que no codifican</td>
</tr>
</tbody>
</table>

El (1) _______________ se completó en el año 2003. La meta era determinar la secuencia de todos los (2) _______________ del ADN humano. Los científicos se prepararon para el proyecto del Genoma Humano en pequeña escala, usando la (3) _______________. Para determinar una secuencia continua del genoma humano, se (4) _______________ cada uno de los 46 cromosomas humanos. La mayoría de las secuencias no tienen ninguna función directa y se llaman (5) _______________; mientras que una cantidad inferior al 2 por ciento de las secuencias son (6) _______________. Las secuencias del ADN particulares para cada individuo se determinaron a través de la (7) _______________.

En tu libro de texto, lee acerca de la huella digital del ADN.

Imagina que eres un detective que intenta resolver un crimen que ocurrió hace diez años. Tienes el ADN de la escena del crimen. Escribe un resumen de cómo podrías usar la huella digital del ADN para resolver el misterio.

8. _______________

9. Definición: _______________

10. Función: _______________
Quick Check

Section 1: Applied Genetics

After reading the section in your textbook, respond to each question and statement.

1. **Tell** what selective breeding is and why it is used.

2. **Identify** some advantages of hybrid organisms.

3. **Explain** how having a pure breed of dogs has both advantages and disadvantages.

4. **Indicate** how inbreeding leads to the development of pure breeds.

5. **Imagine** a breed of chickens in which black-and-white-speckled feathers are a recessive trait. If a breeder has a chicken that has solid black feathers, how can the genotype of this chicken be determined? Use the terms *homozygous* and *heterozygous* in your answer.
Quick Check

Section 2: DNA Technology

After reading the section in your textbook, respond to each statement.

1. **Describe** Name and describe the two different types of DNA ends that can be produced by restriction enzymes.

2. **State** the purpose of PCR.

3. **Explain** how DNA fragments are separated by gel electrophoresis.

4. **Indicate** the role of bacteria in the production of recombinant DNA.

5. **Suggest** one advantage of an organism produced by genetic engineering over an organism produced by selective breeding.
After reading the section in your textbook, respond to each question and statement.

1. **Recall** What is the Human Genome Project? What were the goals of this project?

2. **Explain** What is DNA fingerprinting?

3. **Identify** the steps in making a microarray slide.

4. **Present** the process of sequencing a genome. Use the terms *restriction enzymes* and *recombinant DNA* in your answer, and include the role of computers.

5. **Predict** two ways in which the study of the human genome might lead to better health.
CHAPTER 13  Genetics and Biotechnology

Student Recording Sheet

Section 13.1
Vocabulary Review

Write the vocabulary term that best completes each sentence.

1. ________________________________  2. ________________________________

Understand Key Concepts

Select the best answer from the choices given, and fill in the corresponding circle.

3.  A B C D

4.  A B C D

Constructed Response

5. __________________________________

6. __________________________________

7. __________________________________

Think Critically

8. __________________________________

9. __________________________________

Section 13.2
Vocabulary Review

Write the vocabulary term that best completes each sentence.

10. ________________________________  12. ________________________________

11. ________________________________  13. ________________________________
Understand Key Concepts
Select the best answer from the choices given, and fill in the corresponding circle.

14. A B C D
15. A B C D
16. A B C D

Constructed Response
17. ____________________________________________________________
18. ____________________________________________________________
19. Record your answer for question 19 on a separate sheet of paper.

Think Critically
20. a. ______________________  b. ______________________  c. ______________________
21. Record your answer for question 21 on a separate sheet of paper.
22. Record your answer for question 22 on a separate sheet of paper.

Section 13.3
Vocabulary Review
Write the vocabulary term that best completes each sentence.
23. ______________________  24. ______________________

Understand Key Concepts
Select the best answer from the choices given, and fill in the corresponding circle.
25. A B C D
26. A B C D
27. A B C D

Constructed Response
28. ____________________________________________________________
29. ____________________________________________________________
30. ____________________________________________________________
31. ____________________________________________________________
CHAPTER 13 Assessment

29. 

30. 

Think Critically
31. 

32. Careers in Biology  Record your answer for question 32 on a separate sheet of paper.

Additional Assessment
33. Writing in Biology  Record your answer for question 33 on a separate sheet of paper.

Document-Based Questions
34. 

35. 

36. 

Cumulative Review
37. 

38. Record your answer for question 38 on a separate sheet of paper.
CHAPTER 13  Student Recording Sheet

Assessment

Standardized Test Practice

Multiple Choice

Select the best answer from the choices given, and fill in the corresponding circle.

1. A B C D
2. A B C D
3. A B C D
4. A B C D
5. A B C D
6. A B C D
7. A B C D
8. A B C D

Open Ended

Answer each question with complete sentences.

9. 

10. 

11. 

12. Record your answer for question 12 on a separate sheet of paper.
13. Record your answer for question 13 on a separate sheet of paper.
14. 

15. Record your answer for question 15 on a separate sheet of paper.

Extended Response

Answer each question with complete sentences.

16. Record your answer for question 16 on a separate sheet of paper.
17. 

18. 

19. 

Essay Question

20. Record your answer for question 20 on a separate sheet of paper.