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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 14 The History of Life**

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</table>
Before reading Chapter 14, 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. Marcos and his friends have seen a movie that inaccurately portrays the conditions of early Earth as it existed approximately 4.5 billion years ago. Marcos enjoys learning about the history of Earth, and he explains to his friends the current ideas scientists have about what Earth looked like approximately 4.5 billion years ago. Which would Marcos include in his explanation?

   A. A thick atmosphere of toxic gases surrounded a thin layer of Earth’s crust.
   B. An ocean filled with microbes and organic materials covered Earth.
   C. The continents supported primitive forests and animals such as dinosaurs.
   D. The planet was only molten rock with no crust or atmospheric gases.

   Explain.

2. Candice and her family decide to tour the natural museum of history in their city. Candice is interested in fossils. Which is an example of a fossil Candice might see at the museum?

   A. a mummified cat from ancient Egypt
   B. cave drawings painted by prehistoric humans
   C. dinosaur footprints in a slab of rock
   D. prehistoric seeds from a dinosaur’s stomach

   Explain.

3. Rashida must write an essay about how life first evolved on Earth as part of an entrance exam to participate in a summer science camp. Which are examples of the information she should include in her essay? (Select two answers.)

   A. Ancestors of eukaryotic cells lived together in some association with prokaryotic cells.
   B. Early Earth conditions were the same as present-day conditions
   C. Earth’s life forms originated from cells brought to Earth by meteorites from space.
   D. Life evolved slowly over many millions of years.

   Explain.
Launch Lab

CHAPTER 14

What can skeletal remains reveal?

Fossils are all that remain of extinct organisms. Paleontologists study fossils to understand how organisms looked and behaved when they lived on Earth. In this lab, you will infer an organism’s characteristics based on skeletal remains.

Procedure
1. Read and complete the lab safety form.
2. Choose an unidentified animal from the list provided by your teacher.
3. Imagine that the animal you selected has been extinct for millions of years. Study skeletal parts, teeth, diagrams, and photos provided.
4. Based on skeletal remains alone, list the animal’s physical and behavioral characteristics.
5. Learn the identity of your animal from your teacher. Now make a new list of characteristics.

Data and Observations

Analysis
1. **Compare** the two lists. Do fossils limit what paleontologists can infer about an extinct organism? Explain.

   ____________________________________________________________

   ____________________________________________________________

   ____________________________________________________________

   ____________________________________________________________

2. **Conclude** Based on your observations, what general characteristics can be inferred about most animals based on fossilized remains?

   ____________________________________________________________

   ____________________________________________________________

   ____________________________________________________________

   ____________________________________________________________
Chapter 14
Correlate Rock Layers Using Fossils

How can paleontologists establish relative age? Scientists use fossils from many locations to piece together the sequence of Earth’s rock layers. This is the process of correlation.

Procedure
1. Read and complete the lab safety form.
2. Your teacher will assign you to a group and will give your group a container with layers of material embedded with fossils.
3. Carefully remove each layer, noting any embedded materials.
4. Make a sketch of the cross section, and label each layer and any materials contained within it.
5. Collect copies of sketches from the other groups and use them to determine the sequence of all the layers the class has studied.

Data and Observations

Analysis
1. Describe the materials in each cross section. What patterns did you observe?

__________________________________________________________________________

__________________________________________________________________________

2. Explain how your analysis would be different if different layers contained the same materials. What if some of the layers didn’t overlap? Suggest a way to gather additional data that might resolve these issues.

__________________________________________________________________________

__________________________________________________________________________
Is spontaneous generation possible?

**Background:** In the mid-1800s, Louis Pasteur conducted an experiment that showed that living organisms come from other living organisms—not from nonliving material. Pasteur’s classic experiment, which disproved the notion of spontaneous generation, laid an essential foundation for modern biology by supporting the concept of biogenesis. In this lab, you will carry out an experiment based on Pasteur’s work.

**Question:** How can the idea of spontaneous generation be disproved?

**Materials**
- beef broth
- Erlenmeyer flask (2)
- ring stand (2)
- string
- rubber stopper (2)
- bunsen burner (2)
- 5 cm of plastic tubing
- 30 cm of plastic tubing

**Safety Precautions**

**Procedure**
1. Read and complete the lab safety form.
2. Study the description of Louis Pasteur’s classic experiment that disproved spontaneous generation.
3. Design and construct a data table to record changes in color, smell, and the presence of sediments.
4. Label the flasks A and B. Flask A will be capped with a stopper holding a 5-cm piece of tubing. Flask B will be capped with a stopper holding a 30-cm piece of tubing.
5. Place 50 mL of beef broth in each flask. Cap each flask with the appropriate stopper.
6. Put each flask on a ring stand over a bunsen burner.
7. Bend the tubing on Flask B until it forms a U-shape. The bottom of the U should be near the base of the flask. Tie the end of the tubing to the ring stand to hold the U-shape.
8. Boil the broth in each flask for 30 min.
9. After the equipment and broth cool, move the apparatuses to an area of the lab where they will not be disturbed.
10. Observe the flasks over the next two weeks. Record your observations in your data table.
11. **Cleanup and Disposal** Dispose of beef broth according to your teacher’s instructions. Clean and return all equipment to the appropriate location.

**Data and Observations**
BioLab, Is spontaneous generation possible?  continued

Analyze and Conclude

1. **Describe** the experimental procedure you followed. How does it compare to the steps followed by Louis Pasteur?

2. **Compare** your findings to Pasteur’s findings.

3. **Describe** why it is important for scientists to verify one another’s data.

4. **Think Critically** Explain how Pasteur’s findings disprove spontaneous generation.

5. **Error Analysis** If your results did not match Pasteur’s results, explain a possible reason for the difference.
Radiometric dating techniques make use of unstable radioactive isotopes to measure the ages of objects from the geologic past. Isotopes are atoms of an element that have different numbers of neutrons in their nuclei. The neutrons and protons in the nucleus of an atom are usually held together by strong forces. In some isotopes, however, the forces are not strong enough to hold the nucleus together, and it breaks apart, or decays. This process is called radioactivity.

When an atom of an element decays, an atom of a different element is often formed. For example, an unstable uranium atom decays to form a stable lead atom. The uranium atom is called the parent, and the lead atom is called the daughter. Every radioactive isotope decays at a constant rate that is characteristic of that isotope.

Suppose a rock contains atoms of radioactive uranium (U-238). The parent uranium atoms have been decaying and daughter lead atoms have been accumulating at a constant rate since the rock was formed. The time required for one-half of the nuclei in a sample to decay is called the half-life of the isotope. It takes 4.5 billion years for half the U-238 atoms in a rock to decay into lead atoms. After one half-life, the numbers of U-238 atoms and lead atoms in the rock are equal. After two half-lives, there is one U-238 atom for every three lead atoms.

## Part A: Radiocarbon Dating

High-energy radiation from the Sun causes atoms of a radioactive isotope of carbon, carbon-14 (C-14), to form in the atmosphere. These atoms combine with oxygen to form radioactive carbon dioxide, which is taken in by plants and incorporated into plant tissue. Thus, C-14 enters the food chain and carbon cycle along with common C-12 atoms. There is little radioactive carbon in living things—about one atom of C-14 to one trillion atoms of stable C-12. When an organism dies, carbon no longer is taken into its body, and any C-14 present continues to decay, forming a nonradioactive isotope, nitrogen-14 (N-14). Because the half-life of C-14 is relatively short, it can be used only to date material that is less than 100,000 years old.

Suppose that an ancient human once lit a campfire in a cave dwelling and that you analyze some charcoal from that fire. The charcoal contained 100 g of C-14 when the fire was lit. The half-life of C-14 is 5730 y.

1. Complete Table 1. Note that C-14 and N-14 have the same atomic mass.
2. On the grid below, graph the data in your table to show the relationship between the passage of time and the amount of C-14 in the charcoal sample. Time 0 is the point at which radioactive decay begins. The 28,650-year point is the present time.

### Table 1

<table>
<thead>
<tr>
<th>Amount of Parent Material (C-14) in Charcoal Sample (grams)</th>
<th>Amount of Daughter Material (N-14) in Charcoal Sample (grams)</th>
<th>Number of Years that Have Passed</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5730</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11,460</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17,190</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22,920</td>
</tr>
<tr>
<td>3.125</td>
<td>96.875</td>
<td>28,650</td>
</tr>
</tbody>
</table>

### Years Passed v. Amount of C-14

![Graph of Years Passed v. Amount of C-14](image-url)
Analyze and Conclude

1. **Explain** whether carbon-14 can be used to find the ages of rocks.

2. **Evaluate** Why is radiometric dating more accurate than relative dating, which uses the law of superposition?

**Part B: Dating Ötzi, the Iceman**

On September 19, 1991, an amazing discovery was made in the mountains between Austria and Italy. Two hikers found an ancient mummified body that was partially embedded in melting glacial ice. The Iceman, as he was called first, was later nicknamed Ötzi after the mountain range in which he died. At first, Ötzi was believed to be about 500 years old, but when scientists saw the tools that were found near the body, they realized that he was older. Radiometric analysis of Ötzi’s bones and hair and the grass in his shoes showed that their carbon-14 content was 53 percent of what it would have been before death. Using a mathematical equation, scientists determined that Ötzi died between 5200 and 5500 years ago at the end of the Stone Age. Analysis of Ötzi’s body and tools is still going on to determine how he died, where he lived, and what he ate.

<table>
<thead>
<tr>
<th>Table 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Isotope</strong></td>
</tr>
<tr>
<td>Uranium-238</td>
</tr>
<tr>
<td>Potassium-40</td>
</tr>
<tr>
<td>Carbon-14</td>
</tr>
<tr>
<td>Radon-222</td>
</tr>
</tbody>
</table>

**Analyze and Conclude**

1. **Identify** the geologic era in which Ötzi lived.

2. **Calculate** If a sample of wood from one of Ötzi’s tools is found to contain only one-fourth as much carbon-14 as a sample from a living tree, what is the estimated age of the wood in the tool?

3. **Infer** Why did scientists use carbon-14 to establish Ötzi’s age instead of using the other isotopes listed in Table 2?

---

**Careers In Biology**

**Paleontology** Visit biologygmh.com for information on paleontologists. What are the responsibilities of a paleontologist?
A fossil is any evidence of preexisting life, such as footprints, burrows, tracks, trails, and fecal material. Paleontologists study fossils and the sedimentary rocks in which fossils are found to interpret the environment, habits, and morphology of ancient organisms. Paleontologists also study the changes that occur in different groups of organisms throughout geologic time to determine their evolutionary history.

Fossilization is a rare process. Only a small percentage of organisms become fossils. Organisms must be buried rapidly by sediments to prevent decomposition and predation. Except for rare occurrences, only organisms with hard parts, such as teeth, bones, or shells, are fossilized. However, many sedimentary rocks contain a rich and varied fossil record.

Select  Work in a small group, and select one of the fossil organisms listed in the table to research in depth. For example, one group might choose to research *Phacops rana*, while another group researches *Tyrannosaurus rex*.

Research  Once you have selected a fossil organism for more detailed study, use your textbook and other reference materials to research the topic. Include information about the ecology or habitat of the organism, how and when the organism became extinct, and how it is related to living organisms. Look for photographs of the fossil organism and details about how the fossils formed. Also, examine possible uses of the fossils, such as in petroleum exploration and as index fossils.

Present  Finally, present the information that you assembled about the fossil organism to your class. Show any photographs of fossils that you found, and explain how the fossils formed. As other groups give their presentations, make a list of questions you have regarding the information. After all the groups have completed their presentations, discuss the group’s questions.

<table>
<thead>
<tr>
<th>Organism</th>
<th>General Group</th>
<th>Phylum</th>
<th>Age Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Anomalocaris canadensis</em></td>
<td>proto-arthropod</td>
<td><em>Arthropoda</em></td>
<td>Early to Late Cambrian</td>
</tr>
<tr>
<td><em>Archimedes</em></td>
<td>bryozoan</td>
<td><em>Bryozoa</em></td>
<td>Mississippian</td>
</tr>
<tr>
<td><em>Cyathocrinites</em></td>
<td>crinoid</td>
<td><em>Echinodermata</em></td>
<td>Middle Silurian to Lower Mississippian</td>
</tr>
<tr>
<td><em>Isotelus maximus</em></td>
<td>trilobite</td>
<td><em>Arthropoda</em></td>
<td>Upper Ordovician</td>
</tr>
<tr>
<td><em>Phacops rana</em></td>
<td>trilobite</td>
<td><em>Arthropoda</em></td>
<td>Devonian</td>
</tr>
<tr>
<td><em>Dunkleosteus terrelli</em></td>
<td>placoderm</td>
<td><em>Chordata</em></td>
<td>Devonian</td>
</tr>
<tr>
<td><em>Tyrannosaurus rex</em></td>
<td>dinosaur</td>
<td><em>Vertebrata</em></td>
<td>Late Cretaceous</td>
</tr>
<tr>
<td><em>Protoceratops andrewsi</em></td>
<td>dinosaur</td>
<td><em>Vertebrata</em></td>
<td>Cretaceous</td>
</tr>
<tr>
<td><em>Globigerina</em></td>
<td>foraminifera</td>
<td><em>Sarcomastigophora</em></td>
<td>Paleocene to Holocene</td>
</tr>
<tr>
<td><em>Idiognathodus</em></td>
<td>conodont</td>
<td><em>Conodonta</em></td>
<td>Pennsylvanian</td>
</tr>
</tbody>
</table>

*classification not universally accepted*
Complete the flowchart about fossils. These terms may be used more than once: age, fossils, minerals, organisms, radioactive isotopes, radiometric dating, relative dating, rock layers, sediment.

1. can form when can be dated by
2. covers
3. by comparing
4. using decay of
5. and ones that are the same
6. in
7. igneous or metamorphic rock
8. replace or fill in
9. have the same types of
10. bones and hard parts
In your textbook, read about Earth’s early history.

For each statement below, write true or false.

1. Solid Earth formed about 4.6 billion years ago.  
2. Young Earth was hotter than it is today.  
3. Minerals in old rock suggest that Earth’s early atmosphere had little or no free oxygen.  
4. The lightest elements in early Earth moved to the center of the planet.  
5. Gases in Earth’s early atmosphere probably included water vapor, nitrogen, carbon dioxide, carbon monoxide, hydrogen sulfide, hydrogen, and ozone.

In your textbook, read about the geologic time scale.

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

<table>
<thead>
<tr>
<th>Statement</th>
<th>Precambrian</th>
<th>Paleozoic Era</th>
<th>Mesozoic Era</th>
<th>Cenozoic Era</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Autotrophic prokaryotes enrich the atmosphere with oxygen.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Primates evolve and diversify.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. It is divided into three periods: Triassic, Jurassic, and Cretaceous.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Dinosaurs roam the earth, and the ancestors of present-day birds evolve.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Simple organisms, such as stromatolites, live in marine ecosystems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In your textbook, read about the different categories of fossils.

Complete the graphic organizer by writing a fossil type and a description in each square. Use these choices:

- detailed mineral replicas
- impression of an organism, can be filled with minerals
- mummified or frozen remains
- petrified or permineralized
- trace fossils
- footprints, burrows, fossilized feces
- molds and casts
- original material
- replacement
- wood pores filled with minerals

18. Fossil Type: _________
   Description: _________

14. Fossil Type: _________
   Description: _________

17. Fossil Type: _________
   Description: _________

15. Fossil Type: _________
   Description: _________

16. Fossil Type: _________
   Description: _________
### Study Guide

#### CHAPTER 14

**Section 2: The Origin of Life**

In your textbook, read about ideas on the origin of life.

*Match the definition in Column A with the term in Column B. The terms may be used more than once.*

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lynn Margulis proposed this idea to explain the origin of organelles.</td>
<td>A. spontaneous generation</td>
</tr>
<tr>
<td>2. Energy from sunlight and lightning allowed the first organic molecules to form.</td>
<td>B. theory of biogenesis</td>
</tr>
<tr>
<td>3. Only living organisms can produce other living organisms.</td>
<td>C. endosymbiont theory</td>
</tr>
<tr>
<td>4. Life arises from nonlife.</td>
<td>D. Oparin hypothesis</td>
</tr>
<tr>
<td>5. Prokaryotic cells were involved in the formation of eukaryotic cells.</td>
<td></td>
</tr>
<tr>
<td>6. Francesco Redi performed a controlled experiment with flies and maggots to test this idea on the origin of life.</td>
<td></td>
</tr>
<tr>
<td>7. Stanley Miller and Harold Urey simulated early atmospheric conditions to test this idea on the origin of life.</td>
<td></td>
</tr>
</tbody>
</table>

In your textbook, read about the early ideas of origins.

Refer to the drawing of Francesco Redi’s experiment. Respond to each statement.

8. **Tell** what Redi observed in each flask as the meat decayed.

9. **Recall** what his experiment showed.
In your textbook, read about the present-day ideas of origins.

Respond to each statement.

10. **Name** two places on early Earth where organic molecules could have been synthesized.

11. **Tell** what was produced in the experiment performed by Miller and Urey.
    **State** what the significance of this product was.

12. **Recall** why a framework, such as a particle of clay, is necessary for protein assembly.

In your textbook, read about the present-day ideas of origins and cellular evolution.

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

<table>
<thead>
<tr>
<th>amino acids</th>
<th>archaea</th>
<th>clay particles</th>
<th>coding</th>
<th>eukaryotic</th>
</tr>
</thead>
<tbody>
<tr>
<td>prokaryotic</td>
<td>proteins</td>
<td>replication</td>
<td>RNA</td>
<td>template</td>
</tr>
</tbody>
</table>

For life to exist, molecules called **(13)** must form. These are made of chains of **(14)**. They might have first formed when amino acids stuck to **(15)** to aid their bonding. Clay might also have provided a protein molecule pattern known as a(n) **(16)**. Today, scientists know that the **(17)** for sequences of amino acids is provided by DNA or **(18)**. This allows for **(19)** of proteins.

Scientists hypothesize that the first cells were **(20)** and were similar to the **(21)** that live in extreme climates today. Many scientists believe that **(22)** cells evolved from these early prokaryotic cells.

In your textbook, read about cellular evolution.

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

<table>
<thead>
<tr>
<th>Description</th>
<th>Prokaryotes</th>
<th>Eukaryotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>23. Lacking most organelles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. Have no nucleus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. Are larger cells</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. Include archaea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. Contain organelles and complex internal membranes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Guía de estudio

En tu libro de texto, lee acerca de la historia de la tierra.

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

________________________  1. La Tierra sólida se formó alrededor de 4,600 millones de años atrás.

________________________  2. La Tierra en su etapa inicial era más caliente de lo que es hoy en día.

________________________  3. Los minerales en rocas viejas indican que la atmósfera en los inicios de la Tierra tenía poco o nada de oxígeno libre.

________________________  4. Al inicio, los elementos más livianos en la Tierra se movían hacia el centro del planeta.

________________________  5. Los gases en la atmósfera en los inicios de la Tierra probablemente tenían vapor de agua, nitrógeno, dióxido de carbono, monóxido de carbono, sulfuro de hidrógeno, hidrógeno y ozono.

En tu libro de texto, lee acerca de la escala geológica del tiempo.

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

<table>
<thead>
<tr>
<th>Afirmación</th>
<th>Período precámbrico</th>
<th>Era paleozóica</th>
<th>Era mesozóica</th>
<th>Era cenozóica</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Las procariotas autotróficas enriquecen la atmósfera con oxígeno.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Los primates evolucionan y se diversifican.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Aparecen muchos tipos de insectos, plantas terrestres y los primeros vertebrados terrestres.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Aparecen los mamíferos.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Los dinosaurios recorren la tierra y evolucionan los ancestros de las aves modernas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Aparecen los reptiles.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Los organismos simples, como los estromatolitos, viven en ecosistemas marinos.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
En tu libro de texto, lee acerca de las diferentes categorías de fósiles.

Completa el organizador gráfico con el tipo de fósil y la descripción en cada cuadro. Usa estas opciones:

- huellas de pisadas, madrigueras, heces fosilizadas
- impresión de un organismo, podría estar llena con minerales
- molduras de animales
- poros de madera llenos con minerales
- réplicas minerales detalladas
- huellas fósiles
- material original
- petrificado o permineralizado
- reemplazo
- restos momificados o congelados

**Guía de estudio, Sección 1: Evidencia fósil del cambio**

18. **Tipo de fósil:** ______
   **Descripción:** organismos preservados atrapados por la savia de los árboles

14. **Tipo de fósil:** ______
   **Descripción:** ______

17. **Tipo de fósil:** ______
   **Descripción:** ______

16. **Tipo de fósil:** ______
   **Descripción:** ______

15. **Tipo de fósil:** ______
   **Descripción:** ______
En tu libro de texto, lee acerca de las ideas sobre el origen de la vida.

Relaciona la definición de la columna A con el término de la columna B. Los términos se pueden usar más de una vez.

<table>
<thead>
<tr>
<th>Columna A</th>
<th>Columna B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lynn Margulis propuso esta idea para explicar el origen de los organelos.</td>
<td>A. generación espontánea</td>
</tr>
<tr>
<td>2. La energía de la luz solar y los relámpagos permitieron que se formaran las primeras moléculas orgánicas.</td>
<td>B. teoría de la biogénesis</td>
</tr>
<tr>
<td>3. Sólo los organismos vivientes pueden producir otros organismos vivientes.</td>
<td>C. teoría endosimbionte</td>
</tr>
<tr>
<td>4. La vida surge de la ausencia de vida.</td>
<td>D. hipótesis de Oparin</td>
</tr>
<tr>
<td>5. Las células procarióticas tuvieron relación con la formación de las células eucarióticas.</td>
<td></td>
</tr>
<tr>
<td>6. Francesco Redi realizó un experimento controlado con moscas y gusanos para poner a prueba esta idea acerca del origen de la vida.</td>
<td></td>
</tr>
<tr>
<td>7. Stanley Miller y Harold Urey simularon condiciones atmosféricas del inicio de la Tierra para poner a prueba esta idea acerca del origen de la vida.</td>
<td></td>
</tr>
</tbody>
</table>

En tu libro de texto, lee acerca de las primeras ideas acerca del origen de la vida.

Consulta el dibujo del experimento de Francesco Redi. Responde a cada afirmación.

8. **Indica** qué observó Redi en cada frasco a medida que la carne se descomponía.

9. **Recuerda** qué mostró su experimento.
En tu libro de texto, lee acerca de las ideas modernas acerca del origen de la vida. 

Responde a cada afirmación.

10. **Nombra** dos lugares dónde las moléculas orgánicas se pudieron haber sintetizado.

11. **Dí** qué se produjo en el experimento realizado por Miller y Urey. **Establece** cuál es el significado de este resultado.

12. **Recuerda** porqué una estructura, como una partícula de barro, es necesaria para la formación de proteínas.

En tu libro de texto, lee acerca de las ideas modernas de los orígenes y de la evolución celular.

**Usa cada uno de los siguientes términos sólo una vez para completar el párrafo.**

<table>
<thead>
<tr>
<th>ARN</th>
<th>aminoácidos</th>
<th>archaea</th>
<th>codificación</th>
<th>eucarióticas</th>
<th>partículas de barro</th>
<th>plantilla</th>
<th>procarióticas</th>
<th>proteínas</th>
<th>replicación</th>
</tr>
</thead>
</table>

Para que la vida exista, se deben formar (13) _____________________________. Éstas están formadas por cadenas de (14) _____________________________. Podían haber sido formadas cuando los aminoácidos se pegaron a (15) _____________________________. Es posible que el barro también haya proporcionado un patrón molecular de proteína llamado (16) _____________________________.

La (17) ____________________________ para secuencias de aminoácidos la brinda el ADN o el (18) _____________________________. Esto permite la (19) ____________________________ de proteínas.

Se plantea la hipótesis de que las primeras células eran (20) ____________________________ y eran similares a las (21) ____________________________ que viven en climas extremos hoy en día. Se cree que las células (22) ____________________________ evolucionaron a partir de estas células procarióticas.

En tu libro de texto, lee acerca de la evolución celular.

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

<table>
<thead>
<tr>
<th>Descripción</th>
<th>Procariotas</th>
<th>Eucariotas</th>
</tr>
</thead>
<tbody>
<tr>
<td>23. Carecen de la mayoría de organelos.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. No tienen núcleo.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. Son células más grandes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. Incluyen las archaea.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. Contienen organelos y membranas internas complejas.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Section Quick Check

CHAPTER 14
Section 1: Fossil Evidence of Change

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

1. **Tell** why so few species are preserved as fossils.

2. **Describe** what paleontologists can infer from fossils.

3. **Explain** the law of superposition. **Cite** the dating method it supports.

4. **Indicate** the type of rock in which a paleontologist would probably find fossils: igneous, metamorphic, or sedimentary. Explain.

5. **Arrange** these terms in the correct order: eras, periods, geologic time scale. Explain.

6. **Theorize** what would happen to life on Earth if a large meteor were to hit Earth tomorrow.
Quick Check

Section 2: The Origin of Life

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

1. State why most biologists consider RNA to be life's first coding system.

2. Explain why most scientists think the first cells were similar to today's archaea.

3. Describe the endosymbiont theory.

4. Examine how photosynthetic prokaryotic cells changed the atmosphere of early Earth.

5. Analyze how the ozone layer contributed to the development of eukaryotic cells.

6. Infer why various theories of how life first appeared have been proposed over time.
CHAPTER 14
Assessment
Student Recording Sheet

Section 14.1
Vocabulary Review
Write the vocabulary term that best describes each phrase.
1. __________________  2. __________________  3. __________________

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

Constructed Response
11. ______________________________________________________
12. ______________________________________________________
13. Record your answer for question 13 on a separate sheet of paper.

Think Critically
14. ______________________________________________________
15. ______________________________________________________
16. ______________________________________________________

Section 14.2
Vocabulary Review
Replace the underlined words with the correct vocabulary terms.
17. ______________________________  18. ______________________________
CHAPTER 14
Assessment
Student Recording Sheet

Understand Key Concepts

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

19. □ □ □ □
20. □ □ □ □
21. □ □ □ □
22. □ □ □ □
23. □ □ □ □
24. □ □ □ □

Constructed Response

25. 

26. 

27. 

Think Critically

28. 

29. 

30. 

31. 

CHAPTER 14  Chapter Assessment  Student Recording Sheet

32. Careers in Biology


33.


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.


40.
CHAPTER 14
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

Short Answer
Answer each question with complete sentences.

8. 
9. 
10. 
11. 
12. 
13. Record your answer for question 13 on a separate sheet of paper.
14. 
15. 

Extended Response
Answer each question with complete sentences.

16. 
17. 

Essay Question
18. Record your answer for question 18 on a separate sheet of paper.
# Table of Contents

## Chapter 15  Evolution

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<td>Chapter Test A</td>
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<td>Chapter Test C</td>
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</table>
Before reading Chapter 15, 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. Murimi must watch a documentary about the life and work of Charles Darwin as part of an assignment for her science class. Murimi takes notes during the movie to help her remember basic facts about Darwin. Which would be in her notes?
   A. Aboard the HMS Beagle, Darwin observed the changing behaviors of finches.
   B. Aboard the HMS Beagle, Darwin wrote his book *On the Origin of Species*.
   C. Darwin proposed natural selection as the mechanism for species change.
   D. Darwin provided evidence for the popular belief that species evolve.
   Explain.

2. Christina and her friends are discussing the theory of evolution. One friend states that there is no evidence to support the theory of evolution. Which line of evidence could Christina offer to contradict her friend’s statement?
   A. All animal structures have evolved to perform a specific function.
   B. Fossil evidence demonstrates the major changes of most species.
   C. Humans have bred dozens of dog varieties from ancestral wolves.
   D. Vertebrate embryos share common ancestral features such as tails.
   Explain.

3. Six different species of a small bird called a chickadee live in North America. Each species lives in a different region of the continent, but all the species have similar physical features. Explain the evolutionary relationship between these bird species.
Launch Lab
CHAPTER 15
How does selection work?

Predators can cause changes in populations by choosing certain organisms as prey. In this lab, you will look at how prey populations might respond to a predator.

**Procedure**
1. Read and complete the lab safety form.
2. Work in groups of two to cut ten 3-cm-by-3-cm squares out of a piece of **black paper** and a piece of **red paper**.
3. Make two groups of ten squares: one with two red squares and the other with eight red squares.
4. Number the squares in each group making sure that Square 1 is always red.
5. Place squares numbered side down, then choose a red square and record its number.
6. Repeat step 5 ten times.

**Data and Observations**

**Analysis**
1. **Compare** the number of times you chose Square 1 in the group with two red squares versus the group with eight red squares.

2. **Infer** A predator prefers red squares. In which group is Square 1 less likely to be eaten? Explain.
Why do some species mimic the features of other species? Mimicry is the process of natural selection shaping one species of organism to look similar to another species. Natural selection has shaped the toxic monarch butterfly and toxic viceroy butterflies to appear similar. Investigate the mimicry displayed by these two species during this lab.

Procedure

1. Read and complete the lab safety form.
2. Create a data table for recording your observations and measurements of the monarch and viceroy butterflies.
3. Observe the physical characteristics of both butterfly species and record your observations in your data table.

Data and Observations

Analysis

1. Compare and contrast the physical characteristics of the two butterfly species.

2. Hypothesize why the viceroy and monarch butterflies have bright colors that are highly visible.
Background: Natural selection is the mechanism Darwin proposed to explain evolution. Through natural selection, traits that allow individuals to have the most offspring in a given environment tend to increase in the population over time.

Question: How can natural selection be modeled in a laboratory setting?

Materials
small, medium, and large beads
forceps
short-nosed pliers

Safety Precautions

Procedure
1. Read and complete the lab safety form.
2. Divide into groups of three. One student will use forceps to represent one adult member of a predator population, one will use pliers to represent another adult member of the predator population, and the third will keep time and score.
3. Mix prey items (beads) on a table or tray.
4. In 20 s, try to pick up all possible beads using forceps or pliers.
5. After the 20 s, assign three points for each large bead, two points for each medium bead, and one point for each small bead.
6. Add up the points and use the following rules: survival requires 18 points, and the ability to produce a new offspring requires an additional 10 points.
7. Determine the number of survivors and the number of offspring. Record your observations in a data table.
8. Repeat the procedure 10 times and combine your data with the other groups.

Data and Observations
Analyze and Conclude

1. **Calculate**  Combining all of the trials of all groups, determine the percentage of forceps and pliers that survived.

2. **Evaluate**  Using data from the entire class, determine the total number of offspring produced by the forceps adult and the plier adult.

3. **Summarize**  The original population was divided evenly between the forceps adult and the plier adult. If all of the adults left, what would be the new population ratio? Use the results from the entire class.

4. **Infer**  Given the survival and reproduction data, predict what will happen to the two organisms in the study. Which adult—the forceps or the pliers—is better adapted to produce more offspring?

5. **Conclude**  Using the principles of natural selection, how is this population changing?
Natural selection is based on the principle of survival of the fittest. Fitness is how well an organism with certain characteristics can survive and reproduce in a given environment. However, those characteristics might put the organism at a disadvantage if the environment changes.

In this activity, you will model how the survival rates of lizards with different characteristics change when the environment in which they live changes. Suppose a lizard population lives on a black-and-white granite rock outcropping. There are two colors of lizards in the population: brown lizards and speckled black-and-white lizards. All the lizards eat insects, and owls that live in the environment are predators of the lizards. Using a model, you will first determine the survival rates of the two colors of lizards in the environment. Next, suppose there is a flood in the region, and a deep layer of brown mud is deposited on the granite rock. The mud dries, completely covering the rock. You will use the same model to determine the survival rate of the lizards in the changed environment.

**Procedure**

1. Read and complete the lab safety form.
2. Work with a partner. One partner will be the owl predator. The prey will be two colors of lizards, as represented by two colors of paper circles: plain brown and speckled black and white. The other partner will be the researcher and will time the predator with a stopwatch, then record the data. Lay a sheet of newspaper want ads on a desktop to represent the black-and-white rock environment.
3. With the predator’s back turned, the researcher randomly spreads the 100 circles—50 butcher-paper circles and 50 newspaper want-ad circles—from the envelope on the newspaper environment. Be sure the circles are not piled up. The predator then turns around and picks up as many circles as possible in 15 s. The number of each color of lizard should be recorded in Table 1 as Trial 1.
4. Replace the circles that were picked up and rearrange all circles on the newspaper. Repeat step 3 two more times for Trials 2 and 3. Do not change predator and researcher roles with your partner.
5. Replace the sheet of newspaper with a sheet of brown butcher paper, which represents the mud-covered rock environment. Repeat step 3 three times for Trials 1–3. Do not change predator and researcher roles.
6. Complete Table 1. Use your group’s data to calculate the average number of each color of lizard picked up from the two types of environments. Then pool the averages from all the groups and calculate class averages. Use the class averages to calculate the percentage of lizards of each color that died and that survived in each environment.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Black-and-White Rock (Newspaper)</th>
<th>Brown Mud (Butcher Paper)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Speckled Lizards Picked Up</td>
<td>Speckled Lizards Picked Up</td>
</tr>
<tr>
<td>Trial 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trial 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trial 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group Average</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class Average</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent Died</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent Survived</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Real-World Biology: **Lab, Modeling Natural Selection**  continued

**Analyze and Conclude**

*Respond to each question and statement.*

1. **Explain** Did the percentage of speckled lizards that survived change with the altered (brown) environment? Explain.

2. **Explain** Did the percentage of brown lizards that survived change with the altered (brown) environment? Explain.

3. **Generalize** Based on your observations in this activity, how might an organism’s environment affect its fitness?

4. **Speculate** Suppose the allele for speckled lizard skin color is \( B \), and the allele for brown lizard skin color is \( b \). Explain why brown lizards are not likely to disappear completely from the population living on the black-and-white rock. Assume speckled lizards and brown lizards mate randomly.

5. **Predict** Suppose after many years, the mud layer erodes and the underlying black-and white rock is exposed. What would you expect to happen to the lizard population over time?

6. **Explain** Why was it important that you and your partner not change roles between trials?

---

**CAREERS IN BIOLOGY**

**Wildlife Management** Visit biologygmh.com for information on wildlife managers. What are the responsibilities of a wildlife manager?
At the age of 22, Charles Darwin began a voyage of scientific discovery that became one of the most famous voyages of all time. His ship, the HMS Beagle, left Great Britain in 1832 for a naval surveying mission that would last almost five years. Darwin was the naturalist on the voyage. He studied and collected samples of rocks, fossils, plants, and animals at many locations along the coast of South America and various islands in the Atlantic, Indian, and Pacific Oceans.

Darwin’s most famous collecting location was on the Galápagos Islands, 900 km off the western coast of South America. On the islands, he studied plants, rocks, and animals. In particular, the many species of finches were of interest to him. Darwin theorized that these birds were descended from one ancestral bird from the South American mainland. There are currently 14 species of Darwin’s finches recognized, 13 on the Galápagos Islands and one on Cocos Island. These small birds provide an excellent example of adaptive radiation, or divergent evolution.

Select
You will write an article about Darwin’s finches. The table to the right lists the 14 different species of Darwin’s finches currently recognized. Use the table to select one of the species from each of the groups of finches—ground finches and tree finches—to research.

Research
Once you have chosen a species from each of the two groups, find as much detail as possible on the beak morphology and habitat of the species. Questions to consider while researching your finches include:

- What types of food do the birds eat?
- On which islands are the birds found?
- How do the finches illustrate adaptive radiation?
- How and why did the differences in the finch species arise?

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

### Common Name | Species Name [Alternative Name]
--- | ---
small ground finch | Geospiza fuliginosa
medium ground finch | Geospiza fortis
large ground finch | Geospiza magnirostris
sharp-beaked finch | Geospiza difficilis
cactus ground finch | Geospiza scandens
large cactus ground finch | Geospiza conirostris
small tree finch | Camarhynchus parvulus
medium tree finch | Camarhynchus pauper
large tree finch | Camarhynchus psittacula
woodpecker finch | Cactospiza pallidus [Camarhynchus pallidus]
mangrove finch | Cactospiza heliobates [Camarhynchus heliobates]
vegetarian finch | Platyspiza crassirostris [Camarhynchus crassirostris]
warbler finch | Certhidea olivacea
Cocos Island finch | Pinaroloxias inornata
Complete the flowchart about patterns of evolution. These terms may be used more than once: adaptive radiation, change in response to each other, convergent evolution, divergent evolution, Galápagos finches, many similar but distinct species, more similar to unrelated species, species with symbiotic relationships, unrelated species with similar characteristics.

Species that encounter new environments

can undergo change by

1. which occurs when species become different from their ancestors and leads to

5. such as

8. flowering plants and their pollinators

2. which occurs when species become different from their ancestors and leads to

6. such as maras and rabbits

3. which occurs when two species and leads to

7. such as

4. coevolution and leads to
Study Guide

CHAPTER 15

Section 1: Darwin’s Theory of Natural Selection

In your textbook, read about developing the theory of natural selection.

For each statement below, write true or false.

1. Charles Darwin served as naturalist on the HMS Beagle.

2. The environments that Darwin studied exhibited little biological diversity.

3. While in the Galápagos Islands, Darwin noticed slight differences in the animals from one island to the next.

4. Darwin discovered that the Galápagos mockingbirds were different species.

5. Darwin named the process by which evolution proceeds artificial selection.

Match the point from Darwin’s theory of evolution to the appropriate diagram.

A. There is a struggle to survive.
B. Living things overproduce.
C. There is variation among offspring.
D. Natural selection is always taking place.

6. 
7. 
8. 
9.
**Study Guide**

**CHAPTER 15**

**Section 2: Evidence of Evolution**

In your textbook, read about the fossil record.

*Match the description 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. show that the species present on Earth have changed over time</td>
<td>A. glyptodont</td>
</tr>
<tr>
<td>2. thought to be the ancestor of birds</td>
<td>B. ancestral traits</td>
</tr>
<tr>
<td>3. are newly evolved features such as feathers</td>
<td>C. fossils</td>
</tr>
<tr>
<td>4. are traits shared by species with a common ancestor</td>
<td>D. derived traits</td>
</tr>
<tr>
<td>5. thought to be the ancestor of armadillos</td>
<td>E. dinosaur</td>
</tr>
</tbody>
</table>

In your textbook, read about comparative anatomy and comparative biochemistry.

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

<table>
<thead>
<tr>
<th>Description</th>
<th>Homologous Structure</th>
<th>Analogous Structure</th>
<th>Vestigial Structure</th>
<th>Comparative Biochemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Modified structure seen among different groups of descendants</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Eyes in a blind fish</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. DNA and RNA comparisons that might indicate evolutionary relationships</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Bird wings and butterfly wings that have the same function but different structures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. A body structure that is no longer used for its original function but that might have been used in an ancestor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In your textbook, read about geographic distribution and types of adaptation.

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

11. Evolutionary theory predicts that species respond to similar environments in similar ways.

12. Geographic distribution is the study of the distribution of plants and animals on Earth.

13. Similar environments can lead to the evolution of similar animals, even if they are not close relatives.

14. Traits that enable individuals to survive or reproduce better than individuals without those traits are called reproduction.

15. Mimicry involves a harmless species that has evolved to closely resemble a beneficial one.

16. The type of morphological adaptation shown in the picture above is camouflage.

17. Mimicry and camouflage are morphological adaptations that increase a species’ fitness.

18. Antibiotic resistance is a form of adaptation that causes some diseases to come back in more harmful forms.
In your textbook, read about the mechanisms of evolution, speciation, and patterns of evolution.

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

- adaptive radiation
- founder effect
- allopatric speciation
- genetic drift
- directional selection
- gradualism
- disruptive selection
- sexual selection
- stabilizing selection
- sympatric speciation

1. __________________________ is a change in allelic frequencies in a population that is due to chance.

2. __________________________ removes individuals with average trait values, creating two populations with extreme traits.

3. The most common form of selection, __________________________, removes organisms with extreme expressions of a trait.

4. When a small sample of the main population settles in a location separated from the main population, the _________________ can occur.

5. In __________________________, a species evolves into a new species without any barriers that separate the populations.

6. __________________________ will shift populations toward a beneficial but extreme trait value.

7. In __________________________, a population is divided by a barrier, each population evolves separately, and eventually the two populations cannot successfully interbreed.

8. __________________________ is a change in the size or frequency of a trait based on competition for mates.

9. One species will sometimes diversify in a relatively short time into a number of different species in a pattern called __________________________.

10. The idea that evolution occurred in small steps over millions of years in a speciation model is currently known as __________________________.

Refer to the figure. Respond to each statement.

11. Specify which moth would survive if pollution increases.

   __________________________

12. State the name of the phenomenon illustrated.

   __________________________
En tu libro de texto, lee acerca del desarrollo de la teoría de la selección natural.

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

2. Los ambientes que Darwin estudió presentaban poca diversidad biológica.
3. Mientras estaba en las Islas Galápagos, Darwin observó pequeñas diferencias entre los animales de una y otra isla.
4. Darwin descubrió que los sinsontes de los Galápagos eran especies diferentes.
5. Darwin dio el nombre de selección artificial al proceso por medio del cual la evolución continúa.

Relaciona el enunciado de la teoría de Darwin sobre la evolución con el dibujo adecuado.

A. Hay una lucha por sobrevivir.
B. Las cosas vivientes se sobreproducen.
C. Existe variación entre las crías.
D. La selección natural siempre está ocurriendo.

6.  
7.  
8.  
9.
En tu libro de texto, lee acerca de los registros fósiles.

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. Muestran que las especies presentes en la tierra han cambiado a través del tiempo.</td>
<td>A. gliptodonte</td>
</tr>
<tr>
<td>2. Se pensaba que era el ancestro de los pájaros.</td>
<td>B. rasgos ancestrales</td>
</tr>
<tr>
<td>3. Son características recientemente evolucionadas como las plumas.</td>
<td>C. fósiles</td>
</tr>
<tr>
<td>4. Son rasgos compartidos por las especies con un ancestro común.</td>
<td>D. rasgos derivados</td>
</tr>
<tr>
<td>5. Se pensaba que era el ancestro de los armadillos.</td>
<td>E. dinosaurio</td>
</tr>
</tbody>
</table>

En tu libro de texto, lee acerca de la anatomía comparativa y la bioquímica comparativa.

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

<table>
<thead>
<tr>
<th>Descripción</th>
<th>Estructura homóloga</th>
<th>Estructura análoga</th>
<th>Estructura vestigial</th>
<th>Bioquímica comparativa</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Estructura modificada observada entre diferentes grupos de descendientes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Los ojos en un pez ciego</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Las comparaciones de ADN y ARN que podrían indicar relaciones evolutivas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Las alas de los pájaros y de las mariposas que tienen la misma función pero diferentes estructuras</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Una estructura corporal que ya no se usa para la función original pero que un ancestro pudo haber utilizado</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
En tu libro de texto, lee acerca de la distribución geográfica y los tipos de adaptación.

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

11. La teoría de la evolución predice que las especies responden a ambientes similares de maneras similares.

12. La distribución geográfica es el estudio de la distribución de las plantas y los animales en la Tierra.

13. Los ambientes similares pueden conducir a la evolución de animales similares, incluso si no son parientes cercanos.

14. Los rasgos que permiten a los individuos sobrevivir o reproducirse mejor que los individuos sin esos rasgos se llaman reproducción.

15. La mímica implica a una especie inofensiva que ha evolucionado para parecerse bastante a una especie benéfica.

16. El tipo de adaptación morfológica que se muestra en el dibujo anterior se llama camuflaje.

17. La mímica y el camuflaje son adaptaciones morfológicas que aumentan la adaptabilidad de una especie.

18. La resistencia antibiótica es una forma de adaptación que causa que ciertas enfermedades regresen en formas más peligrosas.
Guía de estudio

CAPÍTULO 15

Sección 3: Formación de la teoría de la evolución

En tu libro de texto, lee acerca de los mecanismos de la evolución, la especiación y los patrones de la evolución.

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

deriva genética  efecto fundador  especiación alopátrica  especiación simpátrica
gradualismo  radiación adaptiva  selección direccional  selección disruptiva
selección estabilizadora  selección sexual

1. La _________________________ es un cambio por casualidad en las frecuencias alélicas en una población.
2. La _________________________ retira a los individuos con valores de rasgos promedio para dar lugar a dos poblaciones con rasgos extremos.
3. La forma más común de selección, la _________________________, retira organismos con expresiones extremas de un rasgo.
4. Cuando una muestra pequeña de la población principal se asienta en un lugar distante de la población principal, puede ocurrir un _________________________.
5. En la _________________________, una especie evoluciona hasta convertirse en una nueva especie sin ninguna barrera que separe las poblaciones.
6. La _________________________ dirigirá las poblaciones hacia un valor de rasgo benéfico pero extremado.
7. En la _________________________, una población se divide por una barrera, cada población evoluciona de forma separada, y finalmente las dos poblaciones no pueden entrecruzarse exitosamente.
8. La _________________________ es un cambio en el tamaño o la frecuencia de un rasgo con base en la competencia por apareamiento.
9. Una especie algunas veces se diversificará en un periodo de tiempo relativamente corto para resultar en un número de especies diferentes como parte de un patrón llamado _________________________.
10. La idea de que la evolución ocurrió en pasos pequeños a través de millones de años en un modelo de especiación se conoce actualmente como _________________________.

Consulta el dibujo. Responde a cada afirmación.

11. Específica qué mariposa sobreviviría si aumentara la polución.
12. Indica el nombre del fenómeno ilustrado.

Nombre _________________________ Fecha _________________________ Curso ________________
Quick Check

1. List the four basic principles of Darwin’s theory of natural selection.

2. Recall how Alfred Russel Wallace’s theory compared to Darwin’s theory of evolution by natural selection.

3. Summarize Darwin’s ideas about evolution in one or two sentences.

4. Compare and contrast artificial and natural selection.

5. Show how artificial selection could be used to develop a new breed of wheat with higher fiber content.
Section 2: Evidence of Evolution

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

1. Define *adaptation* as it relates to evolution.

2. Explain why a once-functional structure might become a vestigial structure.

3. Differentiate between homologous structures and analogous structures.

4. Classify the color patterns of the harmless California kingsnake, which resemble those of the poisonous western coral snake, as mimicry or camouflage. Explain.

5. Predict whether antelope and squirrels or squirrels and rabbits will have more similar DNA. Explain.
After reading the section in your textbook, respond to each statement.

1. **State** the effect of genetic bottlenecks.

2. **Define** *punctuated equilibrium*.

3. **Describe** how scientists determine when evolution will not occur, according to the Hardy-Weinberg principle.

4. **Compute** A population of 100 flowering plants contains 60 plants that are homozygous for orange flowers \((OO)\), 30 plants that are heterozygous for orange flowers \((Oo)\), and 10 plants that are homozygous for white flowers \((oo)\). Determine the frequency of the \(O\) allele and the frequency of the \(o\) allele in this population. Show your work.

5. **Evaluate** whether or not sexual selection will always contribute toward survival of a species.
CHAPTER 15
Assessment
Student Recording Sheet

Section 15.1
Vocabulary Review

Write the vocabulary term that makes each sentence true.

1. ____________________________
2. ____________________________
3. ____________________________

Understand Key Concepts

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

4. [ ] A [ ] B [ ] C [ ] D
5. [ ] A [ ] B [ ] C [ ] D

Constructed Response

6. __________________________________
7. __________________________________

Think Critically

8. __________________________________
9. __________________________________
CHAPTER 15
Assessment
Student Recording Sheet

Section 15.2
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.
13. A B C D
14. A B C D
15. A B C D
16. A B C D

Constructed Response
18. ______________________________________________________
19. ______________________________________________________
20. ______________________________________________________

Think Critically
21. ______________________________________________________
22. Careers in Biology

Section 15.3
Vocabulary Review
Write the vocabulary term that best matches each description.
23. ______________________ 24. ______________________ 25. ______________________
CHAPTER 15
Assessment Student Recording Sheet

Understand Key Concepts

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

26. [ ] (A) [ ] (B) [ ] (C) [ ] (D)

27. [ ] (A) [ ] (B) [ ] (C) [ ] (D)

Constructed Response

28. 

29. 

30. 

Think Critically

31. Record your answer for question 31 on a separate sheet of paper.

32. 

Additional Assessment

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

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. 

40. 
CHAPTER 15
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.

9.

10.

11.

12.

13.

14.

Extended Response
Answer each question with complete sentences.

15.

16.

Essay Question
17. Record your answer for question 17 on a separate sheet of paper.
# Chapter 16  Primate Evolution

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<td>Chapter Test B</td>
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<td>Chapter Test C</td>
<td>100</td>
</tr>
<tr>
<td>Student Recording Sheet</td>
<td>103</td>
</tr>
</tbody>
</table>
Diagnostic Test

CHAPTER 16
Primate Evolution

Before reading Chapter 16, 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 her local zoo, Takesha observes animals in the primate house.
   A zookeeper lectures about the characteristics of primates. Which is included in the lecture?
   A. All primates have an opposable digit.
   B. Most primates are tree dwellers.
   C. Primates have eyes on the sides of their heads.
   D. The term primate refers to animals known as apes.

   Explain.

2. While watching a historical documentary on early South American explorers, Joel learns that scientists classify monkeys into Old World monkeys and New World monkeys. Which does he learn about these two groups?
   A. New World monkeys have a prehensile tail that is used as a fifth limb.
   B. New World monkeys live in northern Africa and southern Europe.
   C. Old World monkeys include baboons, spider monkeys, and squirrel monkeys.
   D. Old World monkeys live in the tropical rain forests of Central America.

   Explain.

3. While visiting the Academy of Natural Sciences in New York City, Ciana walks through the displays that explain the proposed evolution of primates. She reads about the identity and characteristics of the primate species *Homo sapiens*. What does she learn about this species?

   Explain.
If you have been to a zoo or seen pictures of African wildlife, you have probably observed monkeys, chimpanzees, and gorillas. Maybe you have even seen pictures of lemurs. What makes these animals primates? What makes you a primate? In this lab, you will investigate the special features that you share with these other primates.

**Procedure**
1. Read and complete the lab safety form.
2. Examine pictures of primates.
3. Explain what physical features you see in primates that appear in humans.
4. Create a data table in which to record your observations.

**Data and Observations**

**Analysis**
1. **Compare** the human and ape characteristics in your table. What features are similar?

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

2. **Contrast** How are primates different from the cats and dogs and other mammals around you?

   __________________________________________________________
Observe the Functions of an Opposable Thumb

How do opposable thumbs aid in everyday tasks? Explore the advantages of performing everyday activities with and without the aid of opposable thumbs.

Procedure
1. Read and complete the lab safety form.
2. Create a data table to record your observations.
3. Have a partner tape your thumbs to the sides of your hands with masking tape.
4. Using your taped hands, perform the following tasks: pick up a pen or pencil and write your name on a piece of paper, tie your shoelaces, and open a closed door. Have your partner use a stopwatch to time each task.
5. Have your partner remove the tape from your hands, then repeat the activities in step 4 with the use of your thumbs. Have your partner time each task.

Data and Observations

Analysis
1. Compare and contrast the time and effort required to complete each task with and without the aid of your thumbs.

2. Infer the advantages that ancestral primates with opposable thumbs would have had over competitors without opposable thumbs.
Minilab

CHAPTER 16
Explore Hominin Migration

Where did early hominins live? Scientists carefully record the locations where fossils are found. The latitude and longitude coordinates represent the known geographic points of each Homo species’ range.

Procedure
1. Read and complete the lab safety form.
2. Plot the following fossil sites on the map your teacher gives you. Use a different color for each species. When you are finished, lightly shade in the approximate boundaries.
   - *H. habilis* (2.4–1.4 million years ago): 37°E: 4°S, 36°E: 3°N, 36°E: 7°N, 43°E: 8°N
   - *H. neanderthalensis* (200,000–30,000 years ago): 8°E: 53°N, 66°E: 39°N, 5°W: 37°N, 36°E: 33°N

Analysis
1. Hypothesize According to the map you made, when was the earliest that hominins could have migrated out of Africa? Where did they go?

2. Determine what sets of fossils overlapped in geographic and time ranges. What does this suggest?
BioLab

CHAPTER 16
What can you learn about bipedalism from comparing bones?

Background: Humans and chimpanzees have the same number of bones in the same places, but humans walk upright and chimpanzees do not. Can you identify the skeletal features that enable humans to walk upright on two legs? Assume that you are a paleontologist and have been given chimpanzee and human bones to identify and assemble. Then, you receive a third set. How is the mystery skeleton related to the human and chimpanzee skeletons?

Question: What unique skeletal features did humans evolve to become bipedal?

Materials
envelopes containing paper bones and clues (2)
paper, pencil, and ruler

Safety Precautions

Procedure
1. Read and complete the lab safety form.
2. Make a data table to help you compare the following characteristics of each of the three fossil sets you will examine: skull, rib cage, pelvis, arms, legs, and feet.
3. Make sure your teacher approves your table before you proceed.
4. Open envelope #1.
5. Using the clues in your envelope, identify the bones, determine to which species they belong, and write down at least one distinguishing characteristic of each on your table.
6. Open envelope #2.
7. Using the new set of clues, classify each new bone as: chimpanzee, human, similar to both, similar to chimpanzee, or similar to human. Record this data in your table.

Data and Observations
BioLab, What can you learn about bipedalism from comparing bones? continued

Analyze and Conclude

1. **List** features that a scientist might use to determine if a fossil organism was bipedal.

2. **Think Critically** Based on your knowledge, do you think the mystery fossil is bipedal? Why?

3. **Conclude** What organism do you think your mystery bones represent?

4. **Compare** your table with those of other students in the class. Did you arrive at the same conclusions? If not, discuss the differences.

5. **Experiment** Chimpanzees cannot completely straighten—or lock—their knees as humans can and must use more muscles when standing upright. Try standing for 10 s with your knees locked and for 10 s with your knees bent. Describe how your legs feel at the end.

6. **Reason**, from your mystery fossil bones, what it means to say that humans evolved in a mixed, or mosaic, pattern.
Alone in the middle of an isolated desert, surrounded by exposed ridges, bare rock, and sand, two men were holding onto each other, jumping up and down and howling. It was 1974. The desert was in Northeast Ethiopia, and the men were Donald Johanson, a paleoanthropologist, and Tom Gray, a graduate student. They were jumping and howling because they had just found, on the side of a gulley, what they thought to be part of a single, primitive hominin skeleton. No such skeleton had ever been found before. Johanson and Gray returned to camp with the fossil bones and, with the other expedition researchers, stayed up all night celebrating and playing music. The Beatles song “Lucy in the Sky with Diamonds” was played over and over again. That was how the fossil skeleton got the name Lucy.

Part A: Lucy Up Close

It took three weeks of collecting at the site to recover several hundred pieces of fossil bone that would be fit together to form nearly half of Lucy’s skeleton. On first examining the skeleton, researchers found it difficult to determine what Lucy was because nothing like her had ever been discovered. They used comparative morphology, which is useful for studying fossils. Important similarities of body parts suggest relationships among earlier species and link some of them with present species.

Analyze and Conclude

Respond to each question and statement.

1. Describe The researchers concluded that Lucy was bipedal. Use Figure 1 to describe three pieces of evidence from Lucy’s bones that the researchers probably used to reach this conclusion.

2. Apply Examine the skeletons in Figure 1. Which skeleton—A or B—is that of a hominin? Give three reasons for your answer.
Part B: Lucy’s Age

In addition to studying Lucy’s morphological characteristics, it was necessary to determine approximately when Lucy had lived in order to place her correctly in the evolutionary history of the hominins. The process of radioactive dating was used to determine the age of lava that was deposited in the sedimentary layer where Lucy’s skeleton was found. This process is based on the fact that an unstable form of potassium, K-40, which is present in volcanic material, undergoes radioactive decay to form argon. The age of a lava sample can be calculated by measuring the amount of argon present in the sample and dividing that number by the decay rate of K-40. Using this method, and assuming that Lucy’s age was the same as the lava, her age was calculated to be about 3.2 million years.

Analyze and Conclude

Respond to each question and statement. Use your responses to complete the table.

Table 1: Lava Analysis

<table>
<thead>
<tr>
<th>Number of atoms of argon produced per year in 1 g of potassium</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of atoms of argon produced per year in 0.1 g of potassium</td>
<td></td>
</tr>
<tr>
<td>Amount of potassium in a lava sample</td>
<td>0.1 g</td>
</tr>
<tr>
<td>Number of atoms of argon in the lava sample</td>
<td>28,774,025,000,000 atoms</td>
</tr>
<tr>
<td>Age of the lava sample</td>
<td></td>
</tr>
</tbody>
</table>

1. Calculate The K-40 in 1 g of potassium decays to argon at a rate of 3.5 atoms per second. How many atoms of argon will be produced per year in 1 g of potassium? In 0.1 g of potassium? Record your answers in Table 1.

2. Calculate A lava sample contains 0.1 g of potassium. When the sample is heated, all the argon is released from the melted lava. There are 28,774,025,000,000 argon atoms in the sample. Calculate the age of the lava sample and record it in Table 1.

Part C: Lucy and Hominin Evolution

Johanson gave Lucy the species name *Australopithecus afarensis* because she had been found in the Afar Desert. Because of her morphology and age, Lucy was placed in the evolutionary time line as the oldest ancestor of hominins.

Analyze and Conclude

Respond to the following question.

Judge Referring to hominin evolution, one scientist stated: “First we stood up, then we got smart.” Does evidence from Lucy support or disprove this statement? Explain.

---

Paleoanthropology Visit [biologygmh.com](http://biologygmh.com) for information on paleoanthropologists. What are the responsibilities of a paleoanthropologist?
Enrichment  
CHAPTER 16  
Group Project: Endangered Primates

The biological characteristics of primates make them good candidates for extinction. They tend to reproduce slowly and generally have a small number of offspring—usually only one—during each birth cycle. It is not surprising, then, that the list of endangered species always has a disproportionately large number of primates.

The table below lists some of the 25 species thought to be the most endangered primate species in the world in 2005. The list was prepared by two organizations interested in primates—the International Primatological Society and Conservation International.

Investigate  Working in groups of eight, select one of the primate species listed below. Then do the research necessary to fill in the empty spaces in the table for the species your group has selected. Finally, complete a description of the species, describing its habitat, its biological characteristics, its niche in the ecosystem, the threat it faces, and its chances for survival.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Habitat</th>
<th>Estimated Population</th>
<th>Threat Faced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater bamboo lemur</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silky sifaka</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tana River red colobus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White-naped mangabey</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern gorilla</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western purple-faced langur</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grey-shanked douc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sumatran orangutan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Complete the network tree about the characteristics of primates. These terms may be used more than once: depth perception, forward-looking eyes, grasping, large brain, locomotion, manual dexterity, opposable first digit.

Characteristics of Primates

1. limber shoulders and hips
   including
   4. which allows for

2. for ease of
   5. binocular vision
   leading to
   7. complex mental functions

3. which create
   6. which allows for
In your textbook, read about the characteristics of primates.

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. subfamily that includes only humans and human ancestors</td>
<td>A. primate</td>
</tr>
<tr>
<td>2. active during the day</td>
<td>B. binocular vision</td>
</tr>
<tr>
<td>3. order of animals characterized by flexible hands and feet</td>
<td>C. opposable first digit</td>
</tr>
<tr>
<td>4. finger that can be brought opposite the other fingers</td>
<td>D. diurnal</td>
</tr>
<tr>
<td>5. humanlike primate</td>
<td>E. nocturnal</td>
</tr>
<tr>
<td>6. “fifth limb” used for grasping and support</td>
<td>F. hominin</td>
</tr>
<tr>
<td>7. active during the night</td>
<td>G. anthropoid</td>
</tr>
<tr>
<td>8. forward-looking eyes with overlapping fields of vision that provide greater depth perception</td>
<td>H. prehensile tail</td>
</tr>
</tbody>
</table>

Refer to the diagram of animal hands below. Respond to each question and statement.

9. **Cite** a task that the chimpanzee’s hand would enable it to do that the hand of the squirrel would not.

10. **Describe** Look at the chimpanzee hand and the squirrel hand. How do they differ? How are the chimpanzee hand and the baboon hand similar?
In your textbook, read about primate groups.

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

<table>
<thead>
<tr>
<th>Description</th>
<th>Strepsirrhines</th>
<th>Haplorhines</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Include tarsiers, monkeys, and apes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Include lemurs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Generally have more complex social systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Include anthropoids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Categorized based on characteristics of nose, eyes, and teeth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Have a range that is restricted to tropical Africa and Asia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Tend to have large eyes and ears</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Include the great apes and humans</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In your textbook, read about primate evolution.

For each statement below, write true or false.

19. The primate flexible hand might have evolved to catch insects.

20. Arboreal adaptations allowed primitive primates to escape predators.

21. The earliest primate fossil might have resembled the modern tree shrew.

22. According to the fossil record, strepsirrhines were widespread by about 50 mya.

23. Early anthropoids had small brains.

24. When anthropoids emerged, many strepsirrhines became extinct.

25. *Aegyptopithecus*, the dawn ape, evolved in Egypt about 31 mya.

26. *Aegyptopithecus* fossils show neither haplorhine nor strepsirrhine features.

Respond to the following statement.

27. **Describe** how Old World monkeys might have arrived in the New World.
Study Guide

CHAPTER 16

Section 2: Hominoids to Hominins

In your textbook, read about hominoids.

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

- anthropoids
- bonobos
- brachiation
- chimpanzees
- grasslands
- hominoids
- large brain
- primate
- Proconsul
- upright

Hominoids are all nonmonkey (1) ____________________________ . Hominoids retain some ancestral (2) ____________________________ features. Most, for example, have body types adapted for (3) ____________________________ . But hominoids have other characteristics, such as a relatively large body size, (4) ____________________________ , and high limb mobility. There is evidence that the lineage that led to humans emerged from (5) ____________________________ . The (6) ____________________________ and (7) ____________________________ are the closest living relatives to humans. During the Miocene, tropical dry forests and (8) ____________________________ began appearing in Africa. New hominoids evolved in response to the new environments. The best-known hominoid fossils are those from the genus (9) ____________________________ . This species might have been able to walk (10) ____________________________ .

In your textbook, read about hominins.

Refer to the diagrams below. In the space at the left, write the letter of the term or phrase that best answers each question.

______ 11. Which of the hominins in the illustration is bipedal?
   A. australopithecine
   B. gorilla

______ 12. Which position of the spine as it enters the skull indicates bipedalism?
   A. back of the skull
   B. base of the skull

______ 13. Which bipedal hominin species was Lucy?
   A. Ardipithecus ramidus
   B. Australopithecus afarensis

______ 14. Which came first in the evolution of hominins?
   A. big brains
   B. bipedalism
In your textbook, read about the *Homo* genus.

*In the space at the left, write the letter(s) of the term that best answers each question.*

Homo habilis → Homo ergaster → Homo erectus → Homo sapiens → Homo neanderthalensis

A   B   C   D   E

1. In the time-line sequence above, several *Homo* species are named. Which is the first one that is out of order in the sequence in which it first appears in the fossil record?

2. Of the *Homo* species named above, which one had the largest brain?

3. Which two of the species above might have been a single species but are morphologically different?

4. Which species is known as “handy man” because of its association with primitive stone tools?

In your textbook, read about the emergence of modern humans.

*Label the diagrams of skulls. Each skull will have two labels. Use these choices:*

Homo erectus  Homo habilis  Homo sapiens
1.8 mya–400,000 years ago 195,000 years ago to present 2.4–1.4 mya

5. ____________________________  7. ____________________________  9. ____________________________
6. ____________________________  8. ____________________________ 10. ____________________________

For each statement below, write true or false.

11. Of all the hominin species that ever existed, only *Homo sapiens* remained 30,000 years ago.

12. Most scientists think that humans evolved in several places around the world.

13. Neanderthals were the first to produce decorative artifacts and clothing.

14. Our species, fully modern humans, is called *Homo sapiens sapiens.*
Guía de estudio

Sección 1: Los primates

En tu libro de texto, lee acerca de las características de los primates. Relaciona la definición en la columna A con el término en la columna B.

<table>
<thead>
<tr>
<th>Columna A</th>
<th>Columna B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. sub-familia que incluye sólo a los humanos y a los ancestros humanos</td>
<td>A. primate</td>
</tr>
<tr>
<td>2. activo durante el día</td>
<td>B. visión binocular</td>
</tr>
<tr>
<td>3. orden de animales caracterizada por manos y pies flexibles</td>
<td>C. primer dígito oponible</td>
</tr>
<tr>
<td>4. dedo que se puede colocar opuesto a los otros dedos</td>
<td>D. diurno</td>
</tr>
<tr>
<td>5. primate parecido al humano</td>
<td>E. nocturno</td>
</tr>
<tr>
<td>6. “quinta extremidad” que se usa para agarrar y para apoyarse</td>
<td>F. homínido</td>
</tr>
<tr>
<td>7. activo durante la noche</td>
<td>G. antropoide</td>
</tr>
<tr>
<td>8. ojos que ven hacia el frente con campos de visión traslapados que ofrecen mayor percepción de profundidad</td>
<td>H. cola prensil</td>
</tr>
</tbody>
</table>

Consulta el siguiente dibujo de las manos de animales. Responde a cada pregunta y afirmación.

9. Cita una tarea que la mano del chimpancé le permite realizar y que la ardilla no puede realizar.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

10. Describe Observa la mano del chimpancé y la mano de la ardilla. ¿En qué se diferencian? ¿En qué se parecen la mano del chimpancé y la mano del babuino?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
En tu libro de texto, lee acerca de los grupos de los primates.

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

<table>
<thead>
<tr>
<th>Descripción</th>
<th>Estrepsirrinos</th>
<th>Haplorinos</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Se incluyen los tarseros, los monos y los simios.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Se incluyen los lemures.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Se incluyen los antropoides.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Se clasifican según las características de la nariz, los ojos y los dientes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Tienen un alcance que está restringido a Asia y África tropical.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Tienden a tener ojos y orejas grandes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Se incluyen los grandes simios y los humanos.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

En tu libro de texto, lee acerca de la evolución de los primates.

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

19. Es posible que la mano flexible del primate haya evolucionado para atrapar insectos.

20. Las adaptaciones arbóreas permitieron a los primates primitivos escapar de los depredadores.

21. Es posible que el fósil primate más antiguo se haya parecido a la musaraña de árbol moderna.

22. Según el registro fósil, los estrepsirrinos abundaban hace aproximadamente 50 millones de años.

23. Los primeros antropoides tenían cerebros pequeños.

24. Cuando los antropoides surgieron, muchos estrepsirrinos se extinguieron.

25. El *Aegyptopithecus*, el simio del amanecer, evolucionó en Egipto hace 31 millones de años.

26. Los fósiles del *Aegyptopithecus* no muestran características haplorinas ni estrepsirrinas.

Responde a la siguiente afirmación.

27. Describe cómo los monos del Viejo Mundo pudieron haber llegado al Nuevo Mundo.
Los hominoides son todos los (1) antropoides no monos. Los hominoides retienen algunas características (2) bonobos ancestrales. Por ejemplo, la mayoría tienen tipos de cuerpos adaptados para la (3) braquiación . Sin embargo, los hominoides tienen otras características, como un tamaño de cuerpo relativamente grande, un (4) cerebro grande y gran movilidad de las extremidades. Existe evidencia de que el linaje que condujo a los humanos surgió de los (5) Proconsul . Los (6) antropoides y los (7) hominoides son los parientes vivientes más cercanos a los humanos. Durante el Mioceno, los bosques secos tropicales y los (8) pastizales empezaron a aparecer en África. Los nuevos hominoides evolucionaron como respuesta a los nuevos ambientes. Los fósiles hominoides mejor conocidos son aquellos del género (9) Australopithecus . Es posible que esta especie haya podido caminar (10) erguida .

En tu libro de texto, lee acerca de los homínidos. Consulta los siguientes dibujos. En el espacio a la izquierda, escribe la letra del término o la frase que mejor responda a cada pregunta.

11. ¿Cuál de los homínidos en la ilustración es bípedo?
   A. el australopitecino
   B. el gorila

12. ¿Cuál posición de la columna, por la forma en que entra al cráneo indica el bipedalismo?
   A. la base del cráneo
   B. la parte posterior del cráneo

13. ¿Qué especie de homínido bípedo era Lucy?
   A. Ardipithecus ramidus
   B. Australopithecus afarensis

14. ¿Qué surgió primero en la evolución de los homínidos?
   A. bipedalismo
   B. cerebros grandes
Guía de estudio

CAPÍTULO 16
Sección 3: Los ancestros de los humanos

En tu libro de texto, lee acerca del género Homo.

En el espacio a la izquierda, escribe la(s) letra(s) del término que mejor responde a cada pregunta.

<table>
<thead>
<tr>
<th>Homo habilis → Homo ergaster → Homo erectus → Homo sapiens → Homo neanderthalensis</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>E</td>
</tr>
</tbody>
</table>

1. En la secuencia temporal anterior, se mencionan varias especies del Homo. ¿Cuál es la primera que está fuera de orden en la secuencia en la cual aparece primero en el registro fósil?

2. De las especies Homo mencionadas anteriormente, ¿cuál tenía el cerebro más grande?

3. ¿Cuáles dos de las especies anteriores pudieron haber sido una sola especie pero morfológicamente son diferentes?

4. ¿Qué especie se conoce como “hombre hábil” por su asociación con herramientas primitivas de piedra?

En tu libro de texto, lee acerca del surgimiento de los humanos modernos.

Identifica los dibujos de los cráneos. Cada cráneo tendrá dos identificaciones. Usa estas opciones:

- Homo erectus
- Homo habilis
- Homo sapiens

<table>
<thead>
<tr>
<th>Homo erectus</th>
<th>Homo habilis</th>
<th>Homo sapiens</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8 millones de años – 400,000 años</td>
<td>195,000 años hasta el presente</td>
<td>2.4 – 1.4 millones de años</td>
</tr>
</tbody>
</table>

5. __________________ 7. __________________ 9. __________________
6. __________________ 8. __________________ 10. __________________

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

11. De todas las especies de homínidos que hayan existido, sólo el Homo sapiens permanecía hace 30,000 años.

12. La mayoría de los científicos cree que los humanos evolucionaron en varias partes alrededor del mundo.

13. Los neandertales fueron los primeros en producir artefactos decorativos y ropa.

Section 1: Primates

Quick Check

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

1. **List** the two main categories of primates, and give examples of the types of primates in each category.

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

2. **Compare** and **contrast** anthropoids and strepsirrhines.

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

3. **Describe** the similarities among baboons, gorillas, and humans, and relate what this indicates about their evolution.

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

4. **Examine** the benefit of the opposable thumb to modern humans.

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

5. **Suggest** a likely relationship between complex primate social behaviors and the long period of dependency of primate offspring.

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
CHAPTER 16
Section 2: Hominoids to Hominins

Quick Check

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

1. Specify the group of hominins that were indisputably bipedal. Where and when did they live?

2. Explain what method scientists use to study hominoid history in addition to the fossil record. Why is the fossil record not enough?

3. Summarize one widely accepted theory about how climate change caused hominins in Africa to evolve an upright walking posture.

4. Analyze the evidence of bipedalism observed in Lucy.

5. Formulate a theory based on the following statement: The evolution of hominins is more like a bush than a tree.
Quick Check

Section 3: Human Ancestry

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

1. **List** the first undisputed member of the *Homo* genus for which fossils exist. Include when and where the species lived and at least three physical traits of the species.

   _______________________________________________________
   _______________________________________________________
   _______________________________________________________
   _______________________________________________________

2. **Report** what scientists mean by “Mitochondrial Eve” and where she probably lived.

   _______________________________________________________
   _______________________________________________________
   _______________________________________________________
   _______________________________________________________

3. **Indicate** what evidence we have from using modern technological tools that Neanderthals and modern humans are separate species.

   _______________________________________________________
   _______________________________________________________
   _______________________________________________________
   _______________________________________________________

4. **Contrast** the physical characteristics of *Homo sapiens* with all other *Homo* species.

   _______________________________________________________
   _______________________________________________________
   _______________________________________________________
   _______________________________________________________

5. **Distinguish** between the multiregion evolution model of human ancestry and the Out of Africa hypothesis.

   _______________________________________________________
   _______________________________________________________
   _______________________________________________________
   _______________________________________________________

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CHAPTER 16
Assessment

Student Recording Sheet

Section 16.1
Vocabulary Review

Replace the underlined words with the correct vocabulary terms.

1. __________________ 2. __________________ 3. __________________

Understand Key Concepts

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

4. A B C D
5. A B C D

6. A B C D
7. A B C D

Constructed Response

8. _____________________________________________________________
   _____________________________________________________________
   _____________________________________________________________
   _____________________________________________________________

9. __________________________________________

Think Critically

10. _________________________________
    __________________________________
    __________________________________
    __________________________________
    __________________________________

11. _________________________________
    __________________________________
    __________________________________
    __________________________________
    __________________________________

Section 16.2
Vocabulary Review

Write a sentence defining each vocabulary term.

12. _________________________________
    __________________________________
    __________________________________
    __________________________________

13. _________________________________
    __________________________________
    __________________________________
    __________________________________

14. _________________________________
    __________________________________
    __________________________________
    __________________________________
Assessment

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
17. A B C D
18. A B C D

Constructed Response

19.

20.

Think Critically

21.

22.

Section 16.3

Vocabulary Review

Replace the underlined words with the correct vocabulary terms.

23. ________________ 24. ________________ 25. ________________

Understand Key Concepts

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

26. A B C D
27. A B C D
28. A B C D
29. A B C D
30. A B C D
31. A B C D
32. A B C D
CHAPTER 16
Assessment

Student Recording Sheet

Constructed Response
33. 

34. 

35. 

Think Critically
36. 

37. 

38. 

Additional Assessment
39. Writing in Biology  Record your answer for question 39 on a separate sheet of paper.

Document-Based Questions
40. 

41. 

Cumulative Review
42. 

43. 
CHAPTER 16
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

Short Answer

Answer each question with complete sentences.

8. Record your answer for question 8 on a separate sheet of paper.
9. 
10. 
11. 
12. 

Extended Response

Answer each question with complete sentences.

13. 
14. 

Essay Question

15. Record your answer for question 15 on a separate sheet of paper.
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- Student Recording Sheet ..................................... 139
1. Catalina and her classmates are observing birds from behind a bird blind during a science class. Akua identifies a red-colored bird as a northern cardinal, but her friend refers to it as a redbird. Another friend asks why there is no southern cardinal. Catalina asks her teacher how the accepted name of an organism is determined. Which does her teacher tell her?
A. A consensus is taken among scientists to decide which name is used.
B. Each organism is given a unique common and scientific name derived from Latin.
C. Local scientists decide the common names of organisms in their region.
D. Scientists accept the scientific name for an organism because common names vary in use.
Explain.


2. Lauren watches a documentary on the gray wolf and learns that gray wolves living in the arctic region are large and white in color, but Mexican gray wolves are small and dull gray in color. She asks her teacher how wolves that have such different features can be considered the same species. Which response does her teacher give her?
A. Arctic and Mexican wolves are in the dog group, which is one species.
B. Arctic and Mexican wolves can breed with each other under natural conditions.
C. Both types of wolves have identical DNA, which defines them as one species.
D. Scientists use organism behaviors, physical traits, and evolutionary relationships to classify species.
Explain.


3. While visiting a zoo, Jamil is amazed at the diversity of animals that live in different regions of the planet. Jamil knows that scientists classify all animals into one large group, but he wonders about the other major groups of organisms and decides to research the major groups scientists use to classify Earth’s diversity of life. What does he learn?
Launch Lab

CHAPTER 17

How can desert organisms be grouped?

You might think of a desert as a place without much biodiversity, but a wide variety of species have adaptations for desert life. Some adaptations are useful for grouping these organisms. In this lab, you will develop a system for grouping desert organisms.

**Procedure**

1. Read and complete the lab safety form.
2. List three or four desert organisms.
3. Identify physical characteristics, behaviors, or other factors that vary among the organisms in your list. Choose one factor you can use to sort them into groups.
4. Sort the list based on the factor you selected.
5. Brainstorm a list of desert organisms not in your original list. Add each to the appropriate group.

**Data and Observations**

**Analysis**

1. **Compare** and **contrast** your grouping strategy with those developed by other students.

2. **Determine** What modifications would make your system more useful?
MiniLab

CHAPTER 17

Develop a Dichotomous Key

How can you classify items? Scientists group organisms based on their characteristics. These groups are the basis for classification tools called dichotomous keys. A dichotomous key consists of a series of choices that lead the user to the correct identification of an organism. In this lab, you will develop a dichotomous key as you group familiar objects.

Procedure

1. Read and complete the lab safety form.
2. Remove one shoe and make a shoe pile with other shoes from your group.
3. Write a question in your dichotomous key regarding whether the shoe has a characteristic of your choice. Divide the shoes into two groups based on that distinguishing characteristic.
4. Write another question for a different characteristic in your dichotomous key. Divide one of the subgroups into two smaller groups based on this distinguishing characteristic.
5. Continue dividing shoes into subgroups and adding questions to your key until there is only one shoe in each group. Make a branching diagram to identify each shoe with a distinctive name.
6. Use your diagram to classify your teacher’s shoe.

Data and Observations

Analysis

1. Relate the groups you used to classify shoes to taxa. Which group relates to kingdom, phyla, and so on?

2. Critique Explain how you were able to classify you teacher’s shoe in step 6. How could your classification system be modified to be more effective?

3. Consider The term dichotomous means “divided into two parts.” Why is the key you made called a dichotomous key?
How do the physical characteristics of various types of bacteria compare? Investigate the different features of bacteria by viewing prepared bacteria slides under the microscope during this lab.

**Procedure**

1. Read and complete the lab safety form.
2. Observe the prepared slides of bacteria with a compound light microscope.

**Analysis**

1. **Compare** and **contrast** the shapes of the individual bacteria cells you observed.

   __________________________________________

   __________________________________________

   __________________________________________

2. **Describe** Did any of your bacteria samples form colonies? What does a colony look like?

   __________________________________________

   __________________________________________

   __________________________________________

3. **Design** a classification system for the bacteria you observed based on the data you collected.

   __________________________________________

   __________________________________________

   __________________________________________
**Background:** When making a cladogram, derived characters are used to divide the organisms into groups called clades. In this exercise, you will use simulated data to learn how to make a simple cladogram and then make your own cladogram.

**Question:** How can you use organisms’ characteristics to construct a cladogram?

**Materials**
- paper and pencil
- examples of cladograms
- photographs of various organisms
- books describing characteristics of organisms

**Procedure**
1. Read and complete the lab safety form.
2. Examine the data table provided.
3. Compare the shared derived characteristics of the sample organisms. Assume that all the characteristics of your outgroup are ancestral. To make the data easier to compare, note that a “0” has been assigned to each ancestral character and a “1” to all derived characters.
4. Use the information to develop a cladogram that best shows the relationships of the organisms.
5. Make sure your teacher approves your cladogram before you proceed.
6. Choose four organisms from one of the domains you have studied that you believe are closely related.
7. Develop a table of derived characteristics of these organisms similar to the table you used in step 2. Use your table to develop a cladogram that groups the organisms based on their shared derived characters.

**Data and Observations**

---

**Data Table for Cladistic Analysis**

<table>
<thead>
<tr>
<th>Organisms</th>
<th>Characters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>b(1)</td>
</tr>
<tr>
<td>B</td>
<td>b(1)</td>
</tr>
<tr>
<td>C</td>
<td>b(1)</td>
</tr>
</tbody>
</table>

BioLab, How can organisms be grouped on a cladogram? continued

Analyze and Conclude

1. **Think Critically** How did you determine which were the ancestral and which were the derived characters of the organisms you examined?

2. **Explain** how you determined which characteristics to use to separate the clades.

3. **Explain** Which organism is the outgroup on your cladogram? Why?

4. **Critique** Trade data tables with another lab group. Use their data to draw a cladogram. Compare the two cladograms and explain any differences.

5. **Error Analysis** What type of error would mistaking analogous structures as homologous introduce into a cladogram? Examine your second cladogram and determine if you have made this error.
Real-World Biology: Analysis

CHAPTER 17

A Dichotomous Key

Have you ever watched a small child group a collection of blocks or stones of different shapes, sizes, and colors? If so, you have observed the natural inclination of humans to sort and group objects according to some type of system. We use grouping systems to help us make sense of the world in both theoretical and practical ways. We classify foods, for example, as meats, vegetables, and beverages; vehicles as cars, trucks, boats, and airplanes; clothing as shirts, pants, skirts, and shoes. The criteria that we use to classify items are based on characteristics of the items that make it possible to tell the difference between them. Scientists use classification systems to sort organisms into groups based on evolutionary relationships. Once a classification system has been constructed, it can be used by others to identify unknown plants or animals.

Part A: Using a Dichotomous Key to Identify Organisms

A dichotomous key is a tool used to identify organisms. It consists of pairs, or couplets, of descriptions of organisms. By choosing the description in each pair that matches the description of an unknown organism, you can identify the organism. Part of a dichotomous key is shown below.

```
Unknown animal

has eight legs or fewer

has more than eight legs

SPECIES A

has six legs or fewer

SPECIES B

is brown

SPECIES C

is not brown

SPECIES D
```

Analyze and Conclude

Respond to the following statement.

1. Select To identify an unknown brown, eight-legged animal, begin with the pair of descriptions in the first row of the key and choose the one that matches your animal. Continue down the key, choosing one description in each row until your animal is identified. List the order of descriptions that fit your animal, and identify its species.

Part B: Identifying Cockroaches

Identifying organisms is important in the field of pest control. For example, a pest control technician is trained to identify different species of pests and ways to control them with chemicals. A common household pest is the cockroach.
Analyze and Conclude

Respond to each question and statement.

1. **Identify** Study the picture of the cockroach to the right and identify some characteristics that you think you could use to describe a cockroach.

2. **Create** On a separate sheet of paper, create a dichotomous key that can be used to identify the following six male cockroaches. Use the sample key in Part A as an example.

<table>
<thead>
<tr>
<th>American Cockroach</th>
<th>German Cockroach</th>
<th>Australian Cockroach</th>
</tr>
</thead>
<tbody>
<tr>
<td>27.8 to 34.2 mm long</td>
<td>10.5 to 12.8 mm long</td>
<td>23 to 29 mm long</td>
</tr>
<tr>
<td>pronotum is paler than front wings with base and central markings darker brown</td>
<td>pale brownish-yellow; two dark stripes on pronotum</td>
<td>pronotum is yellowish at base with one or two large black-brown spots</td>
</tr>
<tr>
<td>front wings are glossy reddish-brown; front wings are longer than abdomen</td>
<td>front wings are reduced</td>
<td>front wings are reddish-brown with yellow stripes in front at sides; front wings are longer than abdomen</td>
</tr>
<tr>
<td>front leg has many spines on underside plus one or more at tip</td>
<td>front leg has a row of spines that decrease gradually in size</td>
<td>front leg has a row of spines that decrease gradually in size</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Little Gem Cockroach</th>
<th>Cuban Cockroach</th>
<th>Oriental Cockroach</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5 to 9.7 mm long</td>
<td>12.2 to 18 mm long</td>
<td>18 to 24 mm long</td>
</tr>
<tr>
<td>glossy yellowish to brownish</td>
<td>pale green</td>
<td>shiny blackish-brown</td>
</tr>
<tr>
<td>dark markings on abdomen and front wings</td>
<td>front wings often have a tiny brown spot about one-third from tip</td>
<td>front wings leave two or more segments of abdomen exposed</td>
</tr>
<tr>
<td>front leg has a row of long spines followed by a row of short spines</td>
<td>front leg has a few spines at top</td>
<td>front leg has many spines on underside plus one or more at tip</td>
</tr>
</tbody>
</table>

3. **Explain** Why is a dichotomous key more helpful for identifying organisms than is a book containing descriptions of organisms?

**CAREERS IN BIOLOGY**

Ecology Visit biologygmh.com for information on wetland delineation assistants. What are the responsibilities of a wetland delineation assistant?
Classification systems of organisms are designed to aid communication between scientists and other people who work with different types of organisms. There are several classification systems currently in use, but the most commonly accepted version is the six-kingdom classification system. This system has replaced the older version—the five-kingdom system. Advances in genetics have contributed to a greater understanding of the relationships between organisms that were once grouped together in the five-kingdom system, which led to the classification of the organisms in separate groups.

Scientists use scientific names for species of organisms, consisting of two parts: the genus name and the specific epithet, or specific name. A particular organism might have many different common names, but it has only one scientific name. For example, the plant with the scientific name *Monarda fistulosa* has several common names, including bee balm, bergamot, horsemint, American horsemint, long-flowered horsemint, Oswego tea, purple bergamot, oregano, plains bee balm, and fern mint. It would be easy to become confused when referring to the plant by one of its common names.

**Select** Working in a small group, select one of the organisms listed in the table to research. For example, one group in your class might research fire coral while another group researches yellow morel.

**Research** Once you have selected an organism, use your textbook, the library, or other sources to find information about the organism. Your research should include the classification of the organism within the seven taxa listed in the table. Use the table below as a model, and create a table to organize the information about the organism you selected. Your research should also include information about the organism’s characteristics and habitat. Look for photographs of the organism.

**Present** Finally, present the information that you researched about the organism to your class. Show any photographs of the organism that you found. As other groups give their presentations, complete the table. Make a list of questions you have about the information presented. After all the groups have given their presentations, have a class discussion to address everyone’s questions.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Kingdom</th>
<th>Phylum</th>
<th>Class</th>
<th>Order</th>
<th>Family</th>
<th>Genus</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire coral</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gorilla</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timber rattlesnake</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chambered nautilus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volvox</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow morel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Texas bluebonnet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Complete the network tree about domains and kingdoms. These terms may be used more than once: Domain Archaea, Domain Bacteria, Domain Eukarya, eukaryotes, fungi, Kingdom Animalia, Kingdom Archaea, Kingdom Fungi, Kingdom Plantae, plants, prokaryotes, protists.
In your textbook, read about early systems of classification.

**CHAPTER 17 Section 1: The History of Classification**

In the space at the left, write the letter of the term or phrase that best completes each statement or answers each question.

1. Which statement describes the Linnaean system of biological classification?
   A. Animals were classified as living either on land, in water, or in air.
   B. It was a six-kingdom system.
   C. It was based on behavioral and morphological similarities and differences among organisms.
   D. Plants were classified by average size and structure.

2. In binomial nomenclature, the first part of an organism’s name identifies the genus, and the second part identifies the _____
   A. family.
   B. kingdom.
   C. phylum.
   D. species.

3. What is the correct way that the scientific name for the American black bear should appear in print?
   A. Ursus A.
   B. Ursus Americanus
   C. Ursus americanus
   D. ursus americanus

**Label the diagram of taxa. Use these choices:**

- class
- family
- genus
- kingdom
- order
- phylum
- species

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In your textbook, read about determining species.

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

<table>
<thead>
<tr>
<th>Species Concept</th>
<th>Description</th>
<th>Disadvantage</th>
<th>Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Typological</strong></td>
<td>Classification is determined by comparison of (1) __________________ characteristics with a type specimen.</td>
<td>Classification does not allow for genetic (2) __________________ , such as color, within a species.</td>
<td>Descriptions provide detailed records of physical characteristics of many organisms.</td>
</tr>
<tr>
<td><strong>(3)___________</strong></td>
<td>Classification is determined by similar characteristics and ability to produce (4) _________________ offspring.</td>
<td>Some organisms interbreed occasionally. Does not account for (5) _________________ species.</td>
<td>Working definition applies in most cases.</td>
</tr>
<tr>
<td><strong>Phylogenetic</strong></td>
<td>Classification is determined by (6) _________________ .</td>
<td>Evolutionary histories are not known for all species.</td>
<td>Accounts for extinct species, considers (7) _________________ , and solves problems of other species concepts.</td>
</tr>
</tbody>
</table>

In your textbook, read about characters.

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

**Column A**

8. features of body structure such as type of beak and wings on birds

9. chromosome banding patterns that show the close relationship among chimpanzees, gorillas, and orangutans

10. model that uses comparisons of DNA sequences to estimate how long species have been evolving independently

**Column B**

A. biochemical characters

B. molecular clock

C. morphological characters
In your textbook, read about phylogenetic reconstruction. Refer to the figure below. Respond to each statement.

**11. State** the name of this kind of diagram.

**12. Identify** which dinosaur is the most recent common ancestor of the robin and *Archaeopteryx*.

**13. Determine** which traits are shared by *Archaeopteryx* and robins.

For each statement below, write true or false.

14. A branch of a cladogram is called a clade. **true**

15. Scientists have discovered and described 4 million species. **false**

16. Darwin and Haeckel used the analogy of a wheel to represent phylogenies. **false**
### Study Guide

**CHAPTER 17**

**Section 3: Domains and Kingdoms**

In your textbook, read about domains and kingdoms.

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

<table>
<thead>
<tr>
<th>Animalia</th>
<th>Archaea</th>
<th>Bacteria</th>
<th>Eubacteria</th>
<th>Eukarya</th>
<th>Fungi</th>
<th>Plantae</th>
<th>Protista</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description of Organisms</strong></td>
<td><strong>Domain</strong></td>
<td><strong>Kingdom(s)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prokaryotes whose cell walls do not contain peptidoglycan</td>
<td>1.</td>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prokaryotes whose cell walls contain peptidoglycan</td>
<td>3.</td>
<td>4.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cells with membrane-bound organelles</td>
<td>5.</td>
<td>6.</td>
<td>7.</td>
<td>8.</td>
<td>9.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the space at the left, write the letter of the term or phrase that best completes each statement.

10. Organisms are classified into domains according to ______
   - A. cell type.
   - B. cell type and structure.
   - C. cell type, structure, and nutrition.
   - D. nutrition.

11. Which organisms are in the same kingdom because they cannot form organs?
   - A. archaea
   - B. fungi
   - C. plants
   - D. protists

12. Which kingdom’s organisms have no cell walls?
   - A. Animalia
   - B. Archaea
   - C. Eubacteria
   - D. Plantae

Respond to the following statement.

13. Explain why viruses are not included in the biological classification system.
Guía de estudio

CAPÍTULO 17
Sección 1: La historia de la clasificación

En tu libro de texto, lee acerca de los primeros sistemas de clasificación.

En el espacio a la izquierda, escribe la letra del término o de la frase que mejor completa cada afirmación o responde a cada pregunta.

1. ¿Cuál afirmación describe el sistema de Linneo de clasificación biológica?
   A. Era un sistema de seis reinos.
   B. Las plantas se clasificaron según el tamaño promedio y la estructura.
   C. Los animales se clasificaron entre los que viven en la tierra, en el agua o en el aire.
   D. Se basaba en las similitudes morfológicas y de comportamiento y en las diferencias entre los organismos.

2. En la nomenclatura binomial, la primera parte del nombre de un organismo identifica el género y la segunda parte identifies el
   A. filo.
   B. reino.
   C. especie.
   D. familia.

3. ¿Cuál es la forma correcta en la cual debe aparecer impreso el nombre científico del oso negro americano?
   A. Ursus A.
   B. Ursus Americanus
   C. Ursus americanus
   D. ursus americanus

Identifica el diagrama de las categorías de clasificación. Usa estas opciones:

clase especie familia filo género orden reino

![Diagrama de categorías de clasificación]

4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________

dominio
En tu libro de texto, lee acerca de la determinación de las especies. 

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

<table>
<thead>
<tr>
<th>biológico</th>
<th>datos moleculares</th>
<th>extintas</th>
<th>fértiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>físicas</td>
<td>historia evolutiva</td>
<td>variaciones</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Concepto de las especies</th>
<th>Descripción</th>
<th>Desventaja</th>
<th>Ventaja</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tipológico</td>
<td>La clasificación se determina mediante la comparación de características (1) con un espécimen tipo.</td>
<td>La clasificación no permite las (2) genéticas, tales como el color, dentro de una especie.</td>
<td>Las descripciones ofrecen registros detallados de las características físicas de muchos organismos.</td>
</tr>
<tr>
<td>Filogenético</td>
<td>La clasificación se determina mediante características similares y la capacidad de producir crías (4) .</td>
<td>Algunos organismos se entrecruzan ocasionalmente. Esto no explica las especies (5) .</td>
<td>Explica las especies extintas, considera los (7) y soluciona problemas de otros conceptos de especies.</td>
</tr>
</tbody>
</table>

En tu libro de texto, lee acerca de los caracteres. 
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>8. las características de la estructura corporal como el tipo de pico y las alas de los pájaros</td>
<td>A. caracteres bioquímicos</td>
</tr>
<tr>
<td>9. los patrones de bandeado de cromosomas que muestran la relación cercana entre los chimpancés, gorilas y orangutanes</td>
<td>B. reloj molecular</td>
</tr>
<tr>
<td>10. modelo que usa comparaciones de secuencias de ADN para estimar cuánto tiempo las especies han estado evolucionando de forma independiente</td>
<td>C. caracteres morfológicos</td>
</tr>
</tbody>
</table>
En tu libro de texto, lee acerca de la reconstrucción filogenética.

Consulta la siguiente ilustración. Responde a cada afirmación.

11. **Indica** el nombre de este tipo de diagrama.

12. **Identifica** qué dinosaurio es el ancestro común más reciente del petirrojo y del arqueoptérix.

13. **Determina** qué rasgos son compartidos por el arqueoptérix y el petirrojo.

**Para cada afirmación, escribe «verdadero» o «falso»**.

14. Una rama de un cladograma se llama un clado.

15. Los científicos han descubierto y descrito 4 millones de especies.

16. Darwin y Haeckel usaron la analogía de una rueda para representar las filogenias.
Guía de estudio

CAPÍTULO 17
Sección 3: Los dominios y los reinos

En tu libro de texto, lee acerca de los dominios y los reinos.

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

<table>
<thead>
<tr>
<th>Animalia</th>
<th>Archaea</th>
<th>Bacterias</th>
<th>Eubacterias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eucaria</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Descripción de los organismos</th>
<th>Dominio</th>
<th>Reino(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procariotas cuyas paredes celulares no contienen peptidoglicano</td>
<td>1. _______</td>
<td>2. _______</td>
</tr>
<tr>
<td>Procariotas cuyas paredes celulares contienen peptidoglicano</td>
<td>3. _______</td>
<td>4. _______</td>
</tr>
<tr>
<td>Células con organelos unidos a las membranas</td>
<td>5. _______</td>
<td>6. _______</td>
</tr>
</tbody>
</table>

En el espacio a la izquierda, escribe la letra del término o de la frase que mejor completa cada afirmación.

10. _____ 10. Los organismos se clasifican en dominios según _____
   A. el tipo de célula.
   B. el tipo de célula, la estructura y la nutrición.
   C. el tipo de célula y la estructura.
   D. la nutrición.

11. _____ 11. ¿Qué organismos están en el mismo reino debido a que no pueden formar órganos?
   A. las archaea
   B. las plantas
   C. los hongos
   D. los protistas

12. _____ 12. ¿Los organismos de cuál reino no tienen paredes celulares?
   A. Animalia
   B. Archaea
   C. Eubacterias
   D. Plantae

Responde la siguiente afirmación.

13. Explica porqué los virus no están incluidos en el sistema de clasificación biológica.
Section 1: The History of Classification

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

1. Define taxonomy.

__________________________________________________________________________

__________________________________________________________________________

2. Identify the eight main taxa used for classification of organisms.

__________________________________________________________________________

__________________________________________________________________________

3. Demonstrate how binomial nomenclature is related to classification systems by identifying the genus name and the specific name of the domestic cat, *Felis cattus*.

__________________________________________________________________________

__________________________________________________________________________

4. Imagine three new organisms that are in the same genus. Give each of them a common name. Describe the characteristics that are similar and different.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

5. Invent names for your new organisms modeled after Linnaeus’s binomial nomenclature.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
Section Quick Check

CHAPTER 17
Section 2: Modern Classification

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

1. **List** the different types of characters that can be used to determine species or phylogenies.

2. Raccoons and lesser pandas have many corresponding sequences of nucleotides. **Predict** what will be found if their proteins are analyzed. **Assess** whether or not they are likely to be closely related.

3. **Summarize** why the definition of *species* has changed over time.

4. **Analyze** what has led to the changes in the definition of *species*.

5. **Distinguish** between analogous characters and homologous characters.
Quick Check

Section 3: Domains and Kingdoms

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

1. **Recall** how organisms are classified into domains and kingdoms.

2. **Explain** why organisms in Domain Bacteria and Domain Archaea were once classified in the same domain.

3. **Compare** and **contrast** the cells of organisms in Kingdom Plantae to cells of the organisms in Kingdom Animalia.

4. A horsetail is multicellular, has cells with membrane-bound organelles, has cell walls that contain cellulose, and is photosynthetic. **Classify** horsetails into the correct domain and kingdom.

5. **Clarify** why viruses are not classified into a domain.
Student Recording Sheet

CHAPTER 17 Assessment

Section 17.1
Vocabulary Review
Write the vocabulary term that best matches each definition.

1.  
2.  
3.  

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

4.  
5.  
6.  

Constructed Response

7.  
8.  

Think Critically

9.  

Section 17.2
Vocabulary Review
Explain the difference between the vocabulary terms in each pair.

10.  
11.  

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

12.  
13.  

14.  
15.  

16.  
17.  

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Assessment  
Student Recording Sheet

CHAPTER 17

Assessment

Constructed Response
18. 

19. 

20. 

Think Critically
21. 

22. 

23. 

Section 17.3
Vocabulary Review
Replace the italicized words with the correct vocabulary terms.
24.  
25.  
26.  

Understand Key Concepts
Select the best answer from the choices given, and fill in the corresponding circle.
27.  
28.  
29.  
30.  

Constructed Response
31.  

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CHAPTER 17 Assessment

32. 

33. Record your answer for question 33 on a separate sheet of paper.

Think Critically

34. 

35. Careers in Biology 

Additional Assessment

36. Writing in Biology Record your answer for question 36 on a separate sheet of paper.

Document-Based Questions

37. 

38. 

39. 

Cumulative Review

40. 

41. 

Name ____________________ Date ____________________ Class ____________________
CHAPTER 17
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.

9. 

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. Record your answer for question 19 on a separate sheet of paper.

Essay Question

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