Changes Over Time • Section Summary

The Fossil Record

Guide for Reading

- How do most fossils form?
- How can scientists determine a fossil’s age?
- What is the Geologic Time Scale?
- What are some unanswered questions about evolution?

Most fossils form when organisms that die become buried in sediments. Sediments are particles of soil and rock. Layers of sediments cover the dead organism. Over millions of years, the layers harden to become sedimentary rock. Some remains that become buried in sediments are actually changed to rock. These fossils are called petrified fossils. Sometimes shells or other hard parts buried by sediments are gradually dissolved. A hollow space in sediment in the shape of an organism or part of an organism is called a mold. Sometimes a mold becomes filled in with hardened minerals, forming a cast. Organisms can also be preserved in ice.

Scientists can determine a fossil’s age in two ways: relative dating and radioactive dating. Scientists use relative dating to determine which of two fossils is older. In a sequence of rock layers, the top layers are usually younger than the lower layers. Therefore, fossils found in top layers are younger than fossils found in bottom layers. Another technique, called radioactive dating, allows scientists to determine the actual age of fossils. Rocks near fossils contain radioactive elements, unstable elements that decay, or break down, into different elements. The half-life of a radioactive element is the time it takes for half of the atoms in a sample to decay. Scientists can compare the amount of a radioactive element in a sample to the amount of the element into which it breaks down to calculate the age of the rock.

The millions of fossils that scientists have collected are called the fossil record. Despite gaps in the fossil record, it has given scientists a lot of important information about past life on Earth. Almost all of the species preserved as fossils are now extinct. A species is extinct if no members of that species are still alive. Scientists have calculated the ages of many different fossils and rocks. From this information, they have created a “calendar” of Earth’s history that spans more than 4.6 billion years. This calendar of Earth’s history is sometimes called the Geologic Time Scale.

Two unanswered questions about evolution involve the causes of mass extinctions and the rate at which evolution occurs. A mass extinction occurs when many species become extinct at the same time. Scientists are not sure what causes mass extinctions. There are two theories about the rate of evolution. According to one theory, called gradualism, evolution occurs slowly but steadily. Tiny changes in a species gradually add up to major changes over very long periods of time. According to another theory, called punctuated equilibria, species evolve during short periods of rapid change. Species evolve quickly when groups become isolated and adapt to new environments. Most scientists think that evolution can occur gradually at some times and fairly rapidly at others.
The Fossil Record

This section explains what fossils are and how fossils give clues about evolution. It also describes the Geologic Time Scale, a calendar of Earth’s history.

Use Target Reading Skills

After you read the section, reread the paragraphs that contain definitions of key terms. Use all the information you have learned to write a definition of each key term in your own words.

How Do Fossils Form?

1. Circle the letter of each item that can form a fossil.
   a. bone
   b. shell
   c. stone

2. Is the following sentence true or false? Most fossils form when organisms that die become buried in sediments.

3. Particles of soil and rock are called ________________.

4. Remains of organisms that are actually changed to rock are called ________________ fossils.

5. Circle the letter of each sentence that is true about molds and casts.
   a. A mold forms when hard parts of an organism buried by sediments are gradually dissolved.
   b. A cast is a hollow space in sediment in the shape of an organism.
   c. A mold that becomes filled in with hardened materials forms a cast.
   d. A cast is a copy of the shape of an organism.

6. Is the following sentence true or false? The formation of any fossil is a common event. ____________
The Fossil Record (continued)

Determining a Fossil's Age

7. Is the following sentence true or false? By determining the age of fossils, scientists can reconstruct the history of life on Earth.

8. In what two ways can scientists determine the ages of fossils?
   a. __________________________
   b. __________________________

9. In layers of sedimentary rock, the __________________________ layer is usually at the bottom. Each higher layer is __________________________ than the layers below it.

10. Is the following sentence true or false? Relative dating can only help scientists determine whether one fossil is older than another.

11. Scientists use unstable elements that decay, called __________________________ elements, to determine the actual age of a fossil.

12. What is the half-life of a radioactive element?

13. Potassium-40 breaks down into __________________________ over time.

14. How do scientists use radioactive dating to determine the age of a fossil?

What Do Fossils Reveal?

15. The millions of fossils that scientists have collected are called the __________________________.

16. Is the following sentence true or false? The remains of all organisms have become fossils. __________________________

17. How have scientists learned about extinct species?

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18. Circle the letter of the largest span of time in the Geologic Time Scale.
   a. Precambrian Time
   b. eras
   c. periods
   d. years

19. Look at the illustration of the Geologic Time Scale in your text. What are the names of the three eras?

Unanswered Questions

20. What are mass extinctions?

21. Complete the table below about the two theories of evolution.

<table>
<thead>
<tr>
<th>Theory of Evolution</th>
<th>What the Theory Says</th>
<th>Intermediate Forms of Species?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradualism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Punctuated Equilibria</td>
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