Scan Lesson 1. Then write three questions that you have about geologic history in your Science Journal. Try to answer your questions as you read.

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### Main Idea

**Developing a Geologic Time Line**

I found this on page ________.

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### Details

#### Organize

Organize units of geologic time from longest to shortest.

<table>
<thead>
<tr>
<th>Longest</th>
<th>Shortest</th>
</tr>
</thead>
</table>

#### Categorize

Categorize units of time in the Phanerozoic eon.

<table>
<thead>
<tr>
<th>Eras</th>
<th>Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Explain

Explain the relationship among fossils, rock layers, and the divisions of the geologic time scale.

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I found this on page ________.
Geologic Time

Geologic History and the Evolution of Life

Before You Read

What do you think? Read the two statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you’ve read this lesson, reread the statements to see if you have changed your mind.

<table>
<thead>
<tr>
<th>Before</th>
<th>Statement</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>All geologic eras are the same length of time.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Meteorite impacts cause all extinction events.</td>
<td></td>
</tr>
</tbody>
</table>

Developing a Geologic Time Line

Geologists have developed a time line of Earth’s past called the geologic time scale. The scale divides the 4.6 billion years of Earth’s history into time units.

Units in the Geologic Time Scale

Eons are the longest units of geologic time. Eons are subdivided into smaller units of time called eras. Eras are subdivided into periods. Periods are subdivided into epochs (EH pocks). Notice in the geologic time line below that the units of time are not equal. Epochs are not shown on the time line.

Key Concepts

- How was the geologic time scale developed?
- What are some causes of mass extinctions?
- How is evolution affected by environmental change?

Identify Main Ideas

Highlight each head and the information that explains it to help you review this lesson.

Visual Check

1. Interpret The Jurassic period was part of what era?
The Time Scale and Fossils

As geologists developed the geologic time scale, they chose boundaries between time units based on what they observed in Earth's rock layers. Different layers contained different fossils. For example, older rocks contained only fossils of small, simple life-forms. Younger rocks contained these fossils, too. But younger rocks also contained fossils of more-complex organisms, such as dinosaurs.

Major Divisions in the Geologic Time Scale

While studying the fossils in rock layers, geologists often saw sudden changes in the types of fossils within the layers. Sometimes, fossils in one rock layer did not appear in the rock layers right above it. It seemed as though the organisms that lived during that period had disappeared suddenly. Geologists used these sudden changes in the fossil record to mark divisions in geologic time. Because the lengths of time between changes were different, the geologic time scale is divided into unequal units of time.

The geologic time scale is a work in progress. The boundaries, or lengths in time, can change as scientists make new discoveries.

Responses to Change

Sudden changes in the fossil record represent times when large populations of species of organisms died or became extinct. A mass extinction is the extinction of many species on Earth within a short period of time. There have been several mass extinction events in Earth's history. Five events are shown in the graph below. In each one, the number of genera—groups of species—decreased sharply.

Key Concept Check

2. Explain Why are fossils important in the development of the geologic time scale?

Visual Check

3. Read a Graph When was Earth's greatest mass extinction event? (Circle the correct answer.)
   a. at the start of the Silurian period
   b. at the end of the Devonian period
   c. at the end of the Permian period

[Graph showing extinction events]
**Changes in Climate**

All organisms depend on the environment for the food and the other resources that they need to live. If the environment changes quickly and organisms cannot survive in the new conditions, they die.

A rapid change in climate can cause a mass extinction. Climate can change when gas and dust from volcanoes block sunlight and reduce temperatures. The results of a meteorite crashing into Earth would also block sunlight and change climate.

The impact of a meteorite 65.5 million years ago might have caused the extinction of the dinosaurs. Evidence of this impact is in a clay layer around the world. Rocks in this layer contain the element iridium. Iridium is rare in Earth rocks. However, iridium is common in meteorites. No dinosaur fossils have been found in rocks above the iridium layer.

**Geography and Evolution**

When environments change, some species of organisms do not adapt. They become extinct. However, other species do adapt to changes in the environment. Evolution is the change in species over time as they adapt to their environments. Sudden changes in the environment can affect evolution. The slow movement of Earth’s tectonic plates can also affect evolution.

**Land Bridges** When continents collide or when sea level drops, landmasses can join together. A land bridge connects two continents that were previously separated. Over time, organisms move across land bridges and evolve as they adapt to new environments.

**Geographic Isolation** The movement of tectonic plates or other slow geologic events can cause geographic areas to move apart. When areas separate, populations of organisms can become isolated. Geographic isolation is the separation of a population of organisms from the rest of its species due to some physical barrier, such as a mountain range or an ocean.

Separated populations of species evolve in different ways as they adapt to different environments. For example, a population of squirrels was gradually separated as the Grand Canyon formed. The squirrels on one side of the canyon became adapted to a slightly different environment from the squirrels on the other side of the canyon. Each group evolved in a different way.

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**Key Concept Check**

4. Describe a possible event that could cause a mass extinction.

5. Predict If temperatures on Earth decrease, what changes might occur in a species of squirrel over time as a result of this change in climate?

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**Think it Over**

5. Predict If temperatures on Earth decrease, what changes might occur in a species of squirrel over time as a result of this change in climate?

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**Key Concept Check**

6. Summarize How can geographic isolation affect evolution?
Precambrian Time

Life has been evolving on Earth for billions of years. The oldest fossil evidence of life on Earth is in rocks that are about 3.5 billion years old. These ancient life-forms were simple, unicellular organisms, much like bacteria on Earth today.

The oldest fossils of multicellular organisms are about 600 million years old. Early geologists did not know about these rare fossils. They hypothesized that multicellular life first appeared in the Cambrian (KAM bree un) period, at the beginning of the Phanerozoic (fan er oh ZOH ihk) eon 542 million years ago (mya). Time before the Cambrian period was called Precambrian time, as shown below. Scientists today know that Precambrian time is nearly 90 percent of Earth’s history.

Precambrian Life

The rare fossils of multicellular life-forms in Precambrian rocks are from organisms that had soft bodies. These organisms were not like any organisms that live on Earth today. Precambrian life-forms lived 600 mya at the bottom of the sea. Many of these species became extinct at the end of Precambrian time.

Cambrian Explosion

Precambrian life led to a sudden appearance of new types of multicellular life-forms in the Cambrian period. This sudden appearance of new, complex life-forms is often called the Cambrian explosion.

Some Cambrian life-forms, such as trilobites, were the first organisms to have hard body parts. Because of their hard parts, trilobites were more easily preserved than were organisms with only soft body parts. More evidence of trilobites is in the fossil record. Scientists hypothesize that some of the trilobites are distant ancestors of organisms that are alive today.
**Mini Glossary**

- **eon**: the longest unit of geologic time
- **epoch (EH pock)**: a subdivision of a geologic period
- **era**: a subdivision of a geologic eon
- **geographic isolation**: the separation of a population of organisms from the rest of its species due to some physical barrier, such as a mountain range or an ocean
- **land bridge**: land that connects two continents that were previously separated
- **mass extinction**: the extinction of many species on Earth within a short period of time
- **period**: a subdivision of a geologic era

1. Review the terms and their definitions in the Mini Glossary. Use the term *mass extinction* in an original sentence.

2. Use what you have learned about geologic time to complete the table.

<table>
<thead>
<tr>
<th>Unit of Time</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eon</td>
<td></td>
</tr>
<tr>
<td>Era</td>
<td></td>
</tr>
<tr>
<td>Period</td>
<td></td>
</tr>
<tr>
<td>Epoch</td>
<td></td>
</tr>
</tbody>
</table>

**What do you think NOW?**

Reread the statements at the beginning of the lesson. Fill in the After column with an A if you agree with the statement or a D if you disagree. Did you change your mind?

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Geologic History and the Evolution of Life

Geologic Time 497
Lesson 1 | Geologic History and the Evolution of Life (continued)

Main Idea

Responses to Change

I found this on page __________.

Details

Identify the cause of a mass extinction.

Cause:

Effect:
many species on Earth become extinct within a short period of time

I found this on page __________.

Cite an example of a catastrophic event linked to a mass extinction.

I found this on page __________.

Contrast 2 ways that geography can affect evolution.

Land Bridge | Geographic Isolation

I found this on page __________.

Precambrian Time

I found this on page __________.

Identify the 3 eons of Precambrian time.

1. 2. 3.
Lesson 1 | Geologic History and the Evolution of Life (continued)

Main Idea

Identify Precambrian life-forms.

Details

There was a sudden appearance of ____________________________.

First organisms to have ____________________________.

These ____________________________ were more easily

These hard parts left more ____________________________ in the

Analyze the effects of the Cambrian explosion on the fossil record.

Analyze It Explain three ways that geologic time units compare with the time units
you use to organize events in your life.

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