

SECTION

2

Eras of the Geologic Time Scale

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What kinds of organisms evolved during Precambrian time?
- What kinds of organisms evolved during the Paleozoic, Mesozoic, and Cenozoic eras?

National Science Education Standards

LS 1a, 1b, 3d, 5a, 5b, 5c

What Happened During Precambrian Time?

Remember that geologists divide the Earth's history into four main parts. These parts are Precambrian time, the Paleozoic era, the Mesozoic era, and the Cenozoic era. During each part of Earth's history, different species arose and evolved.

Precambrian time was the longest part of Earth's history. It lasted from the time the Earth formed, 4.6 billion years ago, until about 542 million years ago. Life on Earth began during this time.

Scientists think that the early Earth was very different than the Earth today. On the early Earth, the atmosphere contained very little oxygen. It was made mostly of carbon dioxide, water vapor, and nitrogen gas. In addition, volcanic eruptions, meteorite and comet impacts, and severe storms were common. There was no ozone layer, so more ultraviolet radiation reached the Earth's surface.

Scientists think that life developed from simple chemicals in the oceans and the atmosphere. According to this hypothesis, energy from radiation and storms caused these chemicals to react. The reactions produced more complex molecules. These complex molecules combined to produce structures such as cells. ✓



This is what the early Earth may have looked like. An artist drew this picture based on information from scientists.

STUDY TIP

Organize As you read this section, make a chart showing the kinds of organisms that evolved during each of the four main parts of Earth's history.

Math Focus

1. Calculate About how long did Precambrian time last? Round your answer to the nearest hundred million years.

READING CHECK

2. Identify How do scientists think complex molecules formed on the early Earth?

SECTION 2 Eras of the Geologic Time Scale *continued*

PHOTOSYNTHESIS AND OXYGEN

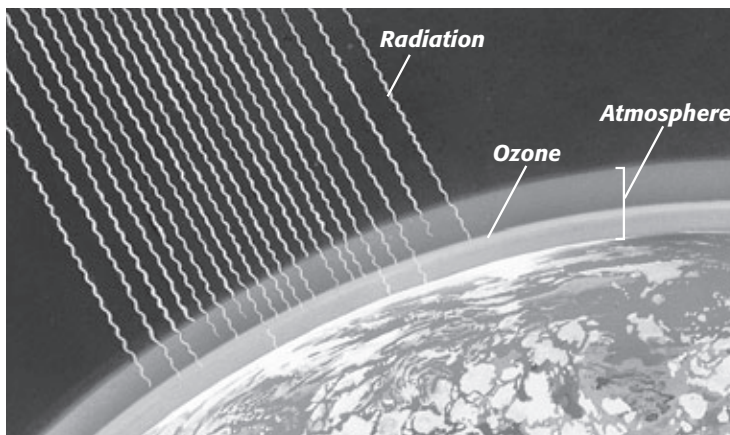
The first living things on Earth were probably *prokaryotes*, or single-celled organisms without nuclei. These early organisms did not need oxygen to survive. However, more than 3 billion years ago, organisms called *cyanobacteria* began to develop. Cyanobacteria perform photosynthesis. During *photosynthesis*, a living thing uses sunlight, water, and carbon dioxide to produce food and oxygen. ✓

READING CHECK

3. Define What is photosynthesis?

As the cyanobacteria carried out photosynthesis, they released oxygen into the atmosphere. This caused the amount of oxygen in the atmosphere to increase.

Some of the oxygen formed the ozone layer in the upper atmosphere. The ozone layer absorbs much of the ultraviolet radiation from the sun. Ultraviolet radiation is harmful to most living things. Before the ozone layer formed, life existed only in the oceans and underground. The new ozone layer reduced the radiation reaching Earth's surface. As a result, organisms were able to live on land.



Cyanobacteria released oxygen into the atmosphere during photosynthesis. Some of this oxygen formed the ozone layer, which absorbs much of the harmful radiation from the sun.

TAKE A LOOK

4. Explain Where did the oxygen come from that formed the ozone layer?





MULTICELLULAR ORGANISMS

About 2 billion years ago, single-celled organisms that were larger and more complex than prokaryotes evolved. These organisms were *eukaryotes*. They had nuclei and other complex structures in their cells. These early eukaryotic cells probably evolved into organisms with many cells.

SECTION 2 Eras of the Geologic Time Scale *continued*

What Happened During the Paleozoic Era?

The **Paleozoic era** began about 542 million years ago. It ended about 251 million years ago. *Paleozoic* comes from Greek words meaning “ancient life.” The Paleozoic era is the second-longest part of the Earth’s history. However, it was less than 10% as long as Precambrian time.

Era	Period	Millions of years ago
Paleozoic era    	Permian	299
	Carboniferous	359
	Devonian	416
	Silurian	444
	Ordovician	488
	Cambrian	542

TAKE A LOOK

5. List Give the six periods in the Paleozoic era in order from oldest to most recent.

LIFE IN THE PALEOZOIC ERA

Rocks from the Paleozoic era contain many fossils of *multicellular* organisms, or organisms with many cells. These organisms all evolved during the Paleozoic era. Most of the organisms that lived during the early Paleozoic era lived in the oceans. Some of the animals include sponges, corals, snails, clams, fishes, and sharks. ✓

During the Paleozoic era, plants and animals began to live on land. By the end of the era, forests of giant ferns, club mosses, and conifers covered much of the Earth. All of the major plant groups except for flowering plants developed during the Paleozoic. These plants provided food and shelter for animals.

Fossils indicate that crawling insects were some of the first animals to live on land. By the end of the Paleozoic, amphibians, reptiles, and winged insects had evolved. ✓

THE END OF THE PALEOZOIC

The end of the Paleozoic is marked by the largest known mass extinction. During this extinction, as many as 90% of marine species died out. Scientists are not sure what caused this extinction.




✓ READING CHECK

6. Identify Where did most animals live during the early Paleozoic?

✓ READING CHECK

7. Identify What kinds of animals were probably the first to live on land?

SECTION 2 Eras of the Geologic Time Scale *continued*

Era	Period	Millions of years ago
 Mesozoic era	 Cretaceous	146
	 Jurassic	200
	 Triassic	251

What Happened During the Mesozoic Era?

The **Mesozoic era** lasted from about 251 million years ago to about 65.5 million years ago. *Mesozoic* comes from Greek words that mean “middle life.” Many species of reptiles evolved during the Mesozoic era. They became the dominant, or main, organisms on Earth. The Mesozoic era is sometimes called the “Age of Reptiles.” ✓

READING CHECK

8. Explain Why is the Mesozoic era sometimes called the “Age of Reptiles”?

Critical Thinking

9. Infer Scientists sometimes call birds “living dinosaurs.” Why do you think this is?

LIFE IN THE MESOZOIC ERA

Dinosaurs are the most well-known reptiles that evolved during the Mesozoic. They dominated the Earth for about 150 million years. As you may know, there were many different species of dinosaurs. Some were taller than a 10-story building. Others were as small as modern chickens.

In addition to dinosaurs, the first birds and mammals evolved during the Mesozoic. In fact, many scientists think that birds evolved from some kinds of dinosaurs.

The most important land plants during the early Mesozoic era were conifers. These conifers formed huge forests. Flowering plants evolved later in the Mesozoic.

THE END OF THE MESOZOIC ERA

About 65.5 million years ago, dinosaurs and many other species became extinct. Most scientists think that this extinction was caused by the impact of a large meteorite or comet. ✓

The impact produced huge amounts of dust and ash. This blocked sunlight from reaching Earth’s surface. It also caused global temperatures to drop for many years. Without sunlight, plants began to die. Plant-eating dinosaurs soon died out because they had nothing to eat. Then, meat-eating dinosaurs died out.


READING CHECK

10. Identify What do most scientists think caused the extinction of the dinosaurs?

SECTION 2 Eras of the Geologic Time Scale *continued*

What Has Happened During the Cenozoic Era?

The **Cenozoic era** began about 65.5 million years ago and continues today. *Cenozoic* comes from Greek words meaning “recent life.” During the Cenozoic era, mammals have become the dominant organisms. Therefore, the Cenozoic era is sometimes called the “Age of Mammals.”

Era	Period	Millions of years ago
Cenozoic era 	Quaternary	1.8
	Tertiary	65.5

TAKE A LOOK

11. Identify How long ago did the Cenozoic era start?

Scientists have more information about the Cenozoic era than about any of the other parts of Earth’s history. Fossils of organisms from this era formed more recently than fossils from earlier times. Therefore, most fossils of organisms from the Cenozoic era are near the surface. This makes them easier to find. In addition, the fossils from the Cenozoic era are less likely to have been destroyed by weathering and erosion.

LIFE IN THE CENOZOIC ERA

During the early parts of the Cenozoic era, most mammals were small. They lived in forests. Later in the era, larger mammals evolved. These included mastodons, saber-toothed cats, camels, and horses. Some had long legs for running. Some had special teeth for eating certain kinds of food. Some had large brains.

We are currently living in the Cenozoic era. Humans evolved during this era. The environment, landscapes, and organisms around us today are part of this era.

The climate has changed many times during the Cenozoic era. During some periods of time, the climate was much colder than it is today. These periods of time are known as *ice ages*. During ice ages, ice sheets and glaciers grew larger. Many organisms migrated toward the equator to survive the cold. Others adapted to the cold. Some species became extinct.

 **READING CHECK**

12. Describe Give two reasons that scientists know more about the Cenozoic era than about other times in Earth’s history.

Section 2 Review

NSES LS 1a, 1b, 3d, 5a, 5b, 5c

SECTION VOCABULARY

Cenozoic era the current geologic era, which began 65.5 million years ago; also called the Age of Mammals

Mesozoic era the geologic era that lasted from 251 million to 65.5 million years ago; also called the Age of Reptiles

Paleozoic era the geologic era that followed Precambrian time and that lasted from 542 million to 251 million years ago

Precambrian time the interval of time in the geologic time scale from Earth's formation to the beginning of the Paleozoic era, from 4.6 billion to 542 million years ago

1. **List** Give the four main parts of Earth's history in order from oldest to most recent.

2. **Identify** During which era did multicellular organisms evolve?

3. **Compare** Give three ways the early Earth was different from the Earth today.

4. **Describe** How did the Earth's atmosphere change because of cyanobacteria?

5. **Identify** What kind of event marks the end of both the Paleozoic era and the Mesozoic era?

6. **Infer** Why might birds and mammals have been more likely than reptiles to survive the events that caused the extinction of the dinosaurs?

7. **Describe** What happens during an ice age?
