Name _____ Class _____ Date _____

CHAPTER 9 The History of Life on Earth

SECTION 3

Time Marches On

BEFORE YOU READ

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

- How do geologists measure time?
- How has life changed over millions of years?
- What can cause a mass extinction?

California Science Standards

7.4.d, 7.4.e, 7.4.g

How Can Geologic Time Be Measured?

Geologists have developed a time scale for the 4.6 billion years of Earth's existence. The **geologic time scale** divides these billions of years into distinct intervals of time. Each interval is distinct because it shows a particular change in life or the surface of the Earth itself.

The largest divisions in geologic time are called *eons*. Eons are divided into *eras*, the second-largest divisions of geologic time. Eras are divided into *periods*. Periods are divided into *epochs*. In the figure below, the most recent divisions of time are at the top and the oldest divisions of time are at the bottom.

STUDY TIP

Organize As you read, make a chart showing the eras of geologic times. Include major changes in life that happened during each era.

Geologic Time Scale

Eon	Era	Period	Epoch	Millions of years ago
PHANEROZOIC	Cenozoic	Quaternary	Holocene	0.01
			Pleistocene	1.8
		Tertiary	Pliocene	5.3
			Miocene	23.0
			Oligocene	33.9
			Eocene	55.8
			Paleocene	65.5
	Mesozoic	Cretaceous		146
		Jurassic		200
		Triassic		251
	Paleozoic	Permian		299
		Carboniferous		359
		Devonian		416
		Silurian		444
		Ordovician		488
		Cambrian		542
PROTEROZOIC	These three eons together are known as *Precambrian time* because they came before the Cambrian Period.			
ARCHEAN				
HADEAN				4,600

Math Focus

1. Calculate The Paleozoic Era lasted for about how many years?

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TAKE A LOOK

2. Identify The last dinosaur became extinct at the end of the Cretaceous period. In which era did this happen?

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How Is Geologic Time Divided?

The boundaries between geologic time periods correspond to major changes in Earth's history. Most boundaries are defined by major developments in living things or major extinctions of living things. **Extinction** is the death of every member of a species. Extinctions can happen because of competition among species. They can also happen when the environment changes. ☑

READING CHECK

3. Define What is extinction?

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At some points in Earth's history, mass extinctions have occured. A *mass extinction* is the extinction of many species around the same time. Gradual events, such as climate change and changes in ocean currents, can cause mass extinctions. Catastrophic events such as the impact of an asteroid can also cause mass extinctions.

Bones of dinosaurs that lived about 150 million years ago have been found at Dinosaur National Monument in Utah. About 150 million years is only 3% of the total time life has been on Earth!

What Happened in Precambrian Time?

Precambrian time stretches from the formation of Earth 4.6 billion years ago to about 542 million years ago. The early Earth was very different from today's Earth. The atmosphere did not have oxygen as it does today. Life on Earth began during this time. The first organisms appeared in Earth's oceans more than 3.6 billion years ago. These organisms were called prokaryotes. *Prokaryotes* are single-celled organisms without a nucleus. ☑

READING CHECK

4. Identify When did life first appear on Earth?

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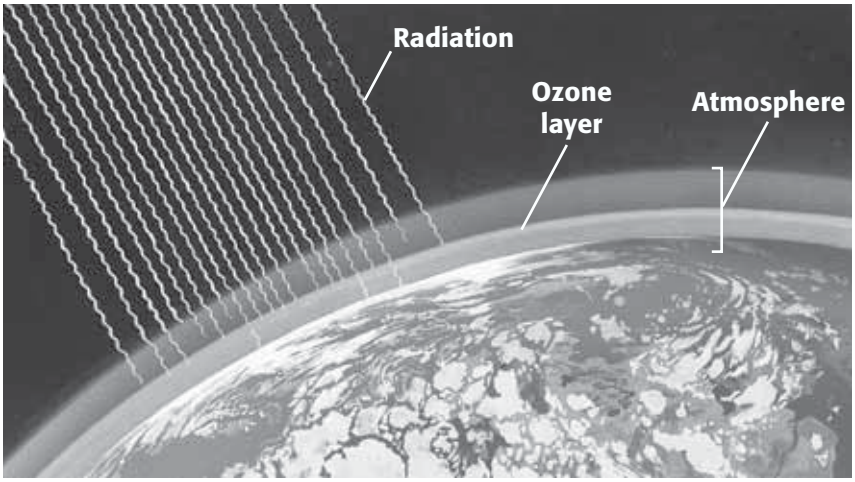
LIFE AND OXYGEN

Cyanobacteria, a type of prokaryote, were some of the first organisms on Earth. Cynanobacteria use sunlight to make their food by photosynthesis. During photosynthesis, cyanobacteria release oxygen. As these organisms photosynthesized millions of years ago, oxygen began to build up in the atmosphere.



Oxygen in the atmosphere formed a layer of ozone. Ozone absorbs harmful radiation from the sun.

As oxygen built up in the atmosphere, some of it formed ozone. *Ozone* in the atmosphere absorbs harmful radiation from the sun. Without ozone, the sun's radiation would have been deadly to organisms on land. Life during this time could only exist in the oceans and underground. As the ozone layer formed, less radiation reached Earth's surface. This allowed organisms to survive on land.

TAKE A LOOK

5. Identify How does the ozone layer function in the atmosphere?

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MULTICELLULAR ORGANISMS

After about 1 billion years, more complex organisms began to emerge. These organisms were known as *eukaryotes* and contained a nucleus and other specialized structures in their cells. Eukaryotic cells may have evolved into more complex organisms.

CALIFORNIA STANDARDS CHECK

7.4.G Students know how to explain significant developments and extinctions of plant and animal life on the geologic time scale.

Word Help: significant important

6. Describe What were the first organisms to appear on Earth?

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What Happened in the Paleozoic Era?

The *Paleozoic Era* began about 542 million years ago and ended 251 million years ago. Scientists used to think that the earliest forms of life existed in the Paleozoic Era. They now believe earlier forms of life existed in the Precambrian.

THE CAMBRIAN EXPLOSION

Many new and complex life forms appeared during the *Cambrian Period*, the first period of the Paleozoic Era. This period is often referred to as "the Cambrian explosion," but it was not an actual explosion. For the first time on Earth, there were many types of organisms that had hard parts, such as shells and exoskeletons.

Critical Thinking

7. Infer Why is it important to scientists that many organisms during the Cambrian period had hard parts?

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TAKE A LOOK

8. List List three groups of organisms that appeared during the Paleozoic.

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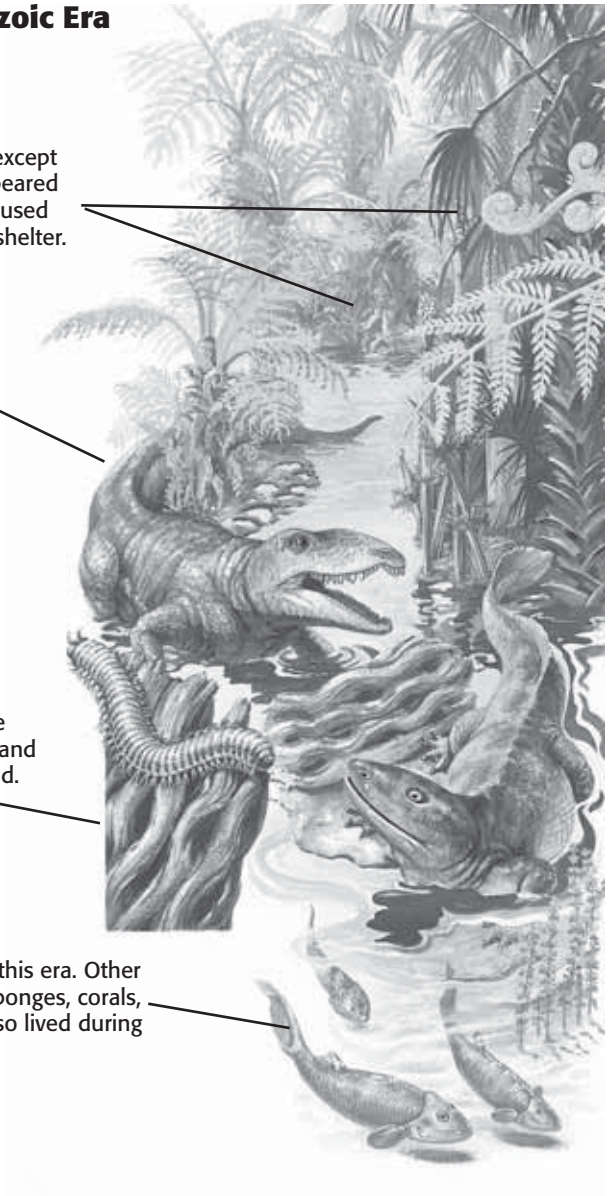
Life in the Paleozoic Era



Some types of organisms that exist today, such as ferns and salamanders, also lived during this era. However, during the Paleozoic these organisms were giants.

THE PERMIAN EXTINCTION

The largest mass extinction took place about 251 million years ago. This event at the end of the Permian period is called the *Permian extinction*. Scientists do not know for sure what caused this mass extinction. Some hypotheses include loss of coastal habitat when Pangaea formed, climate change, and volcanoes. Around 90% of marine species and 78% of land species became extinct. Groups such as reptiles and amphibians survived. ☑

READING CHECK

9. Identify What event happened at the end of the Paleozoic Era?

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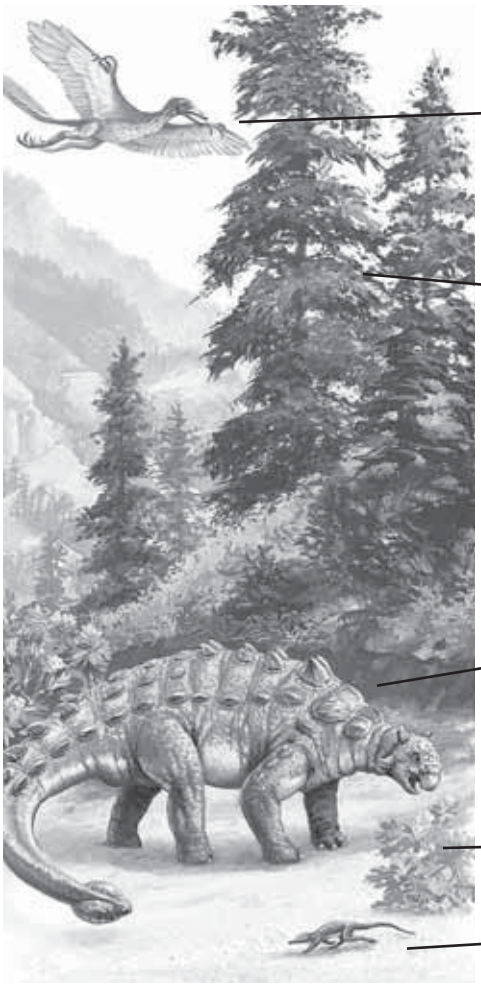
What Happened in the Mesozoic Era?

The *Mesozoic Era* began about 251 million years ago. Scientists believe that the reptiles that survived the Permian Extinction evolved into many different species in the Mesozoic Era. The Mesozoic Era is commonly called the *Age of Reptiles*.

Life in the Mesozoic Era



THE CRETACEOUS-TERTIARY EXTINCTION

About 65 million years ago, all of the dinosaurs and half of the animal and plant species became extinct. This event is called the *Cretaceous-Tertiary* (*or K-T*) *extinction*. Scientists know this mass extinction took place because many fossils disappeared from the fossil record at this time. ☑

Scientists have made several hypotheses to explain this mass extinction. According to one, an asteroid hit Earth. The impact caused giant dust clouds and fires that blocked out sunlight. With little sunlight, many plants died. Animals that ate the plants, and their predators, also died.

TAKE A LOOK

10. Identify What group of animals was dominant during the Mesozoic Era?

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11. Compare What group of plants was found in the Mesozoic, but not in the Paleozoic?

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READING CHECK

12. Identify When did the dinosaurs become extinct?

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What Happened in the Cenozoic Era?

The *Cenozoic Era* began about 65 million years ago and continues today. Scientists have more information about the Cenozoic than any other era. Cenozoic rocks formed on top of rocks from earlier eras. Because of this, Cenozoic fossils are often closer to Earth's surface. This makes them easier to find.

Critical Thinking

13. Explain Many movies and cartoons show cavemen and dinosaurs together. Explain why this view is not correct.

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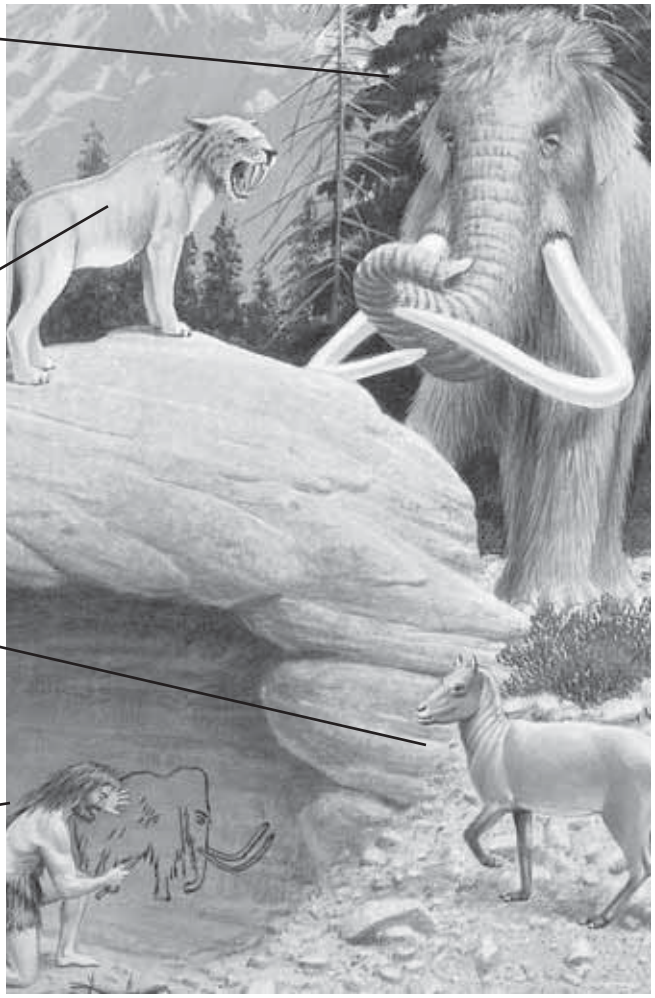
Life in the Cenozoic Era



TAKE A LOOK

14. Identify What group of animals seems to be dominant in the Cenozoic Era?

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THE CENOZOIC ERA IN RECENT TIMES

The landscape around us today developed during the Cenozoic. Climate has continued to change during this era. There have been ice ages, during which the climate was very cold. To survive, many organisms migrated toward the equator. Others adapted to the cold or became extinct. In the future, geologists might draw the line for a new era when life on Earth undergoes another major change.

Name _____ Class _____ Date _____

Section 3 Review

7.4.d, 7.4.e, 7.4.g

SECTION VOCABULARY

extinction the death of every member of a species	**geologic time scale** the standard method used to divide the Earth's long natural history into manageable parts

1. List What are the four divisions of geological time?

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2. List List three events that can cause a mass extinction.

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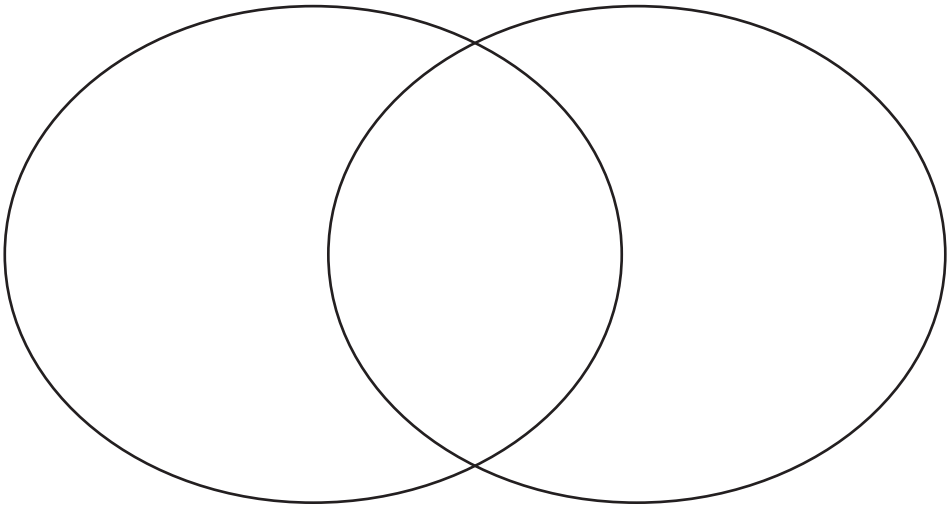
3. Compare Use a Venn Diagram to compare the types of organisms found in the Paleozoic Era and the Cenozoic Era.



4. Explain How were cyanobacteria important to the development of life on Earth?

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5. Explain How do scientists know that the K-T extinction took place?

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