

## 14.1

## KEY CONCEPT

# Earth has been home to living things for about 3.8 billion years.



## Sunshine State STANDARDS

**SC.D.1.3.2:** The student knows that over the whole Earth, organisms are growing, dying, and decaying as new organisms are produced by the old ones.

**SC.D.1.3.3:** The student knows how conditions that exist in one system influence the conditions that exist in other systems.

**SC.F.1.3.2:** The student knows that the structural basis of most organisms is the cell and most organisms are single cells, while some, including humans, are multicellular.



## FCAT VOCABULARY

fossil p. 489

## VOCABULARY

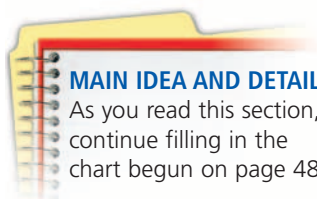
unicellular organism

p. 492

multicellular

organism p. 493

mass extinction p. 494



### MAIN IDEA AND DETAILS

As you read this section, continue filling in the chart begun on page 488.

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## BEFORE, you learned

- Living things are diverse
- Living things share common characteristics
- A species is a group of living things that can breed with one another



## NOW, you will learn

- How scientists use fossils to learn about the history of life
- About patterns in the fossil record
- About mass extinctions

## EXPLORE Fossils

### What can you infer from the marks an object leaves behind?

#### PROCEDURE

- 1 Press a layer of clay into the petri dish.
- 2 Choose a small object and press it into the clay to make an imprint of your object.
- 3 Remove the object carefully and trade your imprint with a classmate.

#### MATERIALS

- clay
- petri dish
- small object



#### WHAT DO YOU THINK?

- What object made the imprint?
- What do your observations indicate to you about how the imprint was formed?

## Fossils provide evidence of earlier life.

Imagine watching a movie about the history of life on Earth. The beginning of the movie is set 3.8 billion years ago. At that time, the ocean would have been the setting. All living things lived in the sea. The end of the movie would show Earth today—a planet that is home to millions of species living on land as well as in water and air.

Of course, learning about the history of life isn't as easy as watching a movie. Modern ideas about life's history involve careful observation of the available evidence. Much of this evidence is provided by fossils. **Fossils** are the remains of organisms preserved in the earth. Fossils provide a glimpse of a very long story. In some ways, observing a fossil is like hitting the pause button on your video machine or looking at a snapshot of another time.

## Fossils



Bones, such as this jawbone, are a common type of fossil.



This fossil trilobite formed as minerals replaced the remains of the organism.



The preserved remains of ancient mammals, like the woolly mammoth, are rare.

## Types of Fossils

You may have learned that fossils are the imprints or remains of once-living things. Most fossils are hard body parts such as bone. Perhaps you have seen displays of dinosaur skeletons in museums. These displays include fossil bones, such as the jawbone to the left. Other fossils form when minerals replace the remains of organisms or parts of organisms. The trilobite fossil shown in the middle photograph is an example of this type of fossil. Fossils also include prints made by organisms.

Very rarely, people find fossils that are the original remains of entire organisms. Explorers have found the frozen bodies of animals called woolly mammoths that lived about 10,000 years ago. The bodies of insects can be preserved in sap from plants.

## Finding the Age of Fossils

How can scientists tell that the first organisms lived in oceans, or that dinosaurs lived on land and that they disappeared 65 million years ago? These questions and others can be addressed by determining the age of fossils. There are two approaches to dating fossils—relative dating and absolute dating. In relative dating, one fossil is compared with another fossil. The relative age tells you whether a fossil formed before or after another fossil.

The places where fossils are discovered provide information about their relative ages. Much of Earth's crust is rock, and rock forms over long periods of time. Understanding when and how rock forms gives scientists information about the sequence of events in Earth's history.

Materials such as sand and mud may settle to the bottom of a body of water. Over many millions of years, layers harden into rock. Shells and other remains of organisms can be trapped in those layers, forming fossils. Newer fossils are usually found in the top layers of rock, while older fossils are in the lower layers.

The absolute age of a fossil tells you when it was formed. To find the absolute age, scientists study the radioactive elements found in rocks and fossils. Some of these elements, such as uranium, decay at a very precise rate into more stable elements, such as lead. Thus, by measuring the amount of uranium and the amount of lead in an object, scientists can determine the object's age. The more lead it has, the older it is.



**VISUALIZATION**  
CLASSZONE.COM

Explore how a fossil can form.



**CHECK YOUR  
READING**

What are the two ways scientists can determine the age of fossils?

## INVESTIGATE Fossil Records

### How do scientists interpret fossil evidence?

#### PROCEDURE

- 1 Individually examine each of your group's puzzle pieces. Consider the shape and size of each piece.
- 2 Arrange the pieces so that they fit together in the best possible way.
- 3 On the basis of your pieces, try to interpret what the overall puzzle picture may be.
- 4 Combine your puzzle pieces with another group's. Repeat steps 2 and 3.

#### WHAT DO YOU THINK?

- How did your interpretation of the puzzle picture change once you had more pieces to work with?
- Explain whether the gaps in the puzzle picture influenced your interpretation.
- Was it easier or more difficult to study the record with more "scientists" in your group?

**CHALLENGE** Brainstorm other ways scientists could learn about early life on Earth.

**SKILL FOCUS**  
Analyzing

**MATERIALS**  
puzzle pieces

**TIME**  
15 minutes



### Assembling the Fossil Record

By combining absolute dating with relative dating, scientists can estimate the age of most fossils. The information about the fossils found in a particular location is called the fossil record. By assembling a fossil record, scientists can identify the periods of time during which different species lived and died. Scientists have used the fossil record to develop an overview of Earth's history.

#### READING TIP

A species is a group of organisms with similar characteristics that can interbreed.



Information from fossils helps scientists and artists describe woolly mammoths.

## More complex organisms developed over time.

### FLORIDA Content Review

You learned in grade 6 that cells in multicellular organisms perform specialized functions, unlike cells in unicellular organisms.

One of the most striking patterns that scientists find when they study the fossil record involves the development of more complex organisms. Below you will see how scientists have reconstructed the history of a modern city to show how life has developed over time. Recall that the first organisms were made up of single cells. Most organisms living today are single-celled. However, more and more species have developed more and more complex cells and structures over time.

## Unicellular Organisms

### READING TIP

*Uni-* means "single" and *multi-* means "several" or "many."

**Unicellular organisms** are organisms made up of a single cell. The organisms in the ocean 3.8 billion years ago were made of simple, single cells. Some of these organisms are responsible for the oxygen that now makes up our atmosphere. The early atmosphere did not contain as much oxygen as it now does. As the atmosphere changed, so did life on Earth.

Different types of single cells developed over time. Over millions of years the cells of organisms became more complex. Today, there are different species of life that include organisms made up of many cells.

## Reconstructing the Past

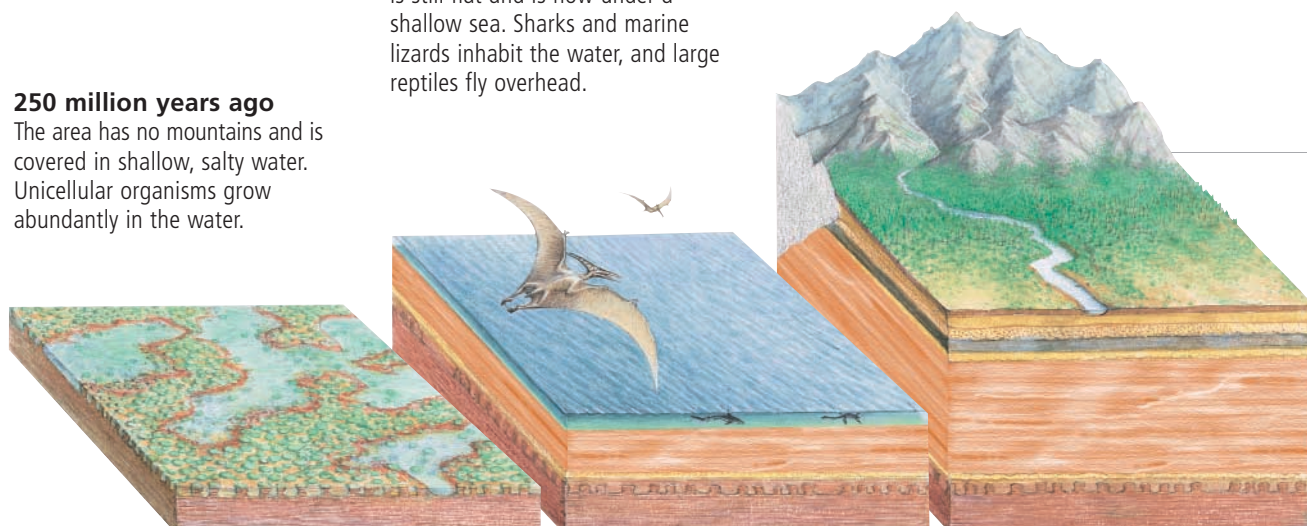
### Digging deep into the city of Denver, scientists have been able to reconstruct the ancient past.

#### 250 million years ago

The area has no mountains and is covered in shallow, salty water. Unicellular organisms grow abundantly in the water.

**70 million years ago** Colorado is still flat and is now under a shallow sea. Sharks and marine lizards inhabit the water, and large reptiles fly overhead.

**55 million years ago** The seas have been replaced by a tropical rain forest. The Rocky Mountains have been part of the landscape for over 10 million years.



## Multicellular Organisms

Around 1.2 billion years ago, organisms made up of many cells began to live in Earth's oceans. **Multicellular organisms** are living things made up of many cells. Individual cells within multicellular organisms often perform specific tasks. For example, some cells may capture energy. Other cells might store materials. Still others might carry materials from one part of the organism to another. The most complex species of multicellular organisms have cells that are organized into tissues, organs, and systems.

Recall that all organisms have similar needs for energy, water, materials, and living space. For almost 3 billion years, these needs were met only in oceans. According to fossil records, the earliest multicellular organisms were tiny seaweeds. The earliest animals were similar to today's jellyfish.



Scientists learn about early life by studying different layers of rock



**CHECK YOUR  
READING**

Explain how unicellular and multicellular organisms differ.

## Life on Land

Consider the importance of water. Without it, you and most other living things would not be able to live. About 500 million years ago, the first multicellular organisms moved from water to land.

### 37 million years ago

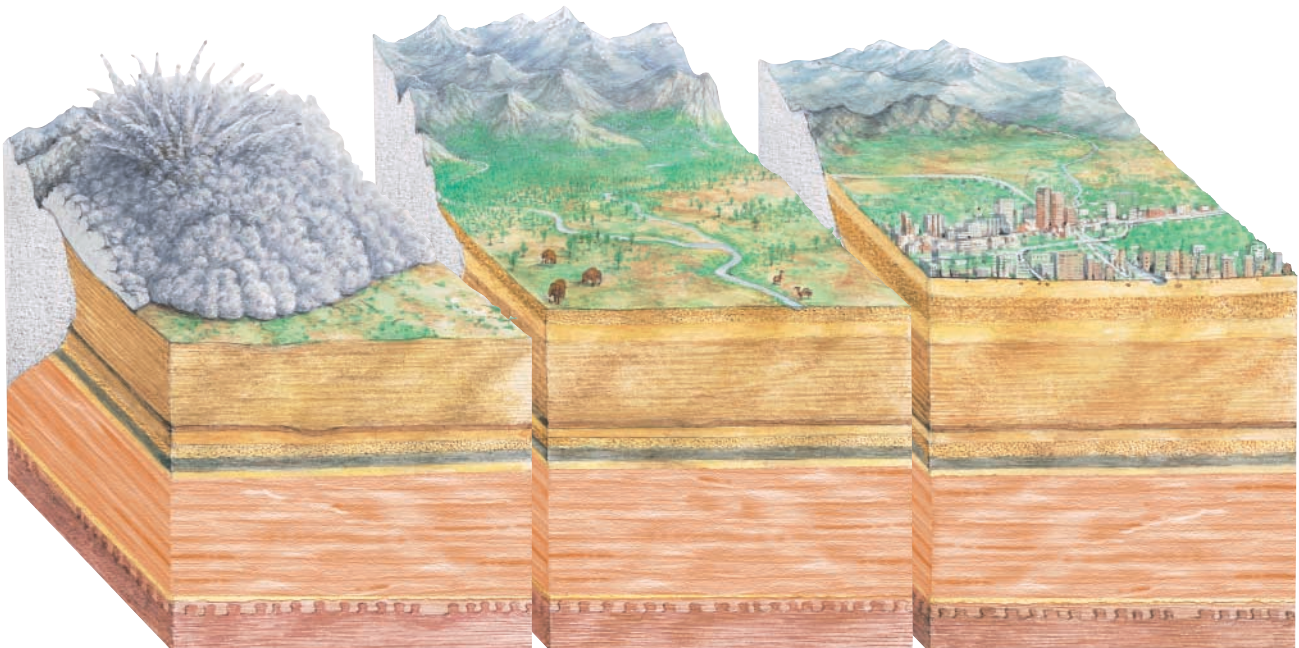
A volcanic eruption covers Colorado in a layer of hot ash, smothering plant and animal life.

### 16,000 years ago

The plains look similar to what we see today—except that camels and mammoths roam the area.

### Present day

Buildings and highways cover the land. Humans have the technology to dig through layers of rock and reconstruct the past.





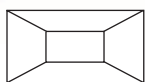
Find out more about mass extinctions.

In order to survive, these living things needed structures to help them get water. The first land-dwelling organisms were simple plants and fungi. Plants were able to obtain water from the soil through structures called roots. Fungi absorbed water from plants as well as from the soil. Insects were also probably among the first living things to inhabit land. Plants provided insects with food and shelter. After insects, animals such as amphibians and reptiles began living on land. They were followed by birds and mammals.

## Earth's history includes mass extinctions.

### VOCABULARY

Remember to make a frame game for the term *mass extinction*.



About 10,000 years ago, the last woolly mammoth died without any offspring. At that time, the species became extinct, which means it disappeared. The only way that we know that some species, such as woolly mammoths, ever existed is through the fossil record. During Earth's history, there have been several periods when huge numbers of species have died or become extinct in a very short time. These events are called **mass extinctions**.

Although the fossil record shows a pattern of mass extinctions, two of these extinctions are particularly interesting. These are the Permian Extinction and the Cretaceous Extinction. The causes of these mass extinctions are not fully known.

### Permian Extinction

About 250 million years ago, approximately 90 percent of the species living in the ocean became extinct. At the same time, many land-dwelling animals disappeared. Scientists who have studied Earth's history think that Earth's landmasses joined together, forming one enormous continent. This event would have changed the climate on land and the conditions within Earth's waters.

### Cretaceous Extinction

Fossils show that around 140 million years ago, animals called dinosaurs lived all over the planet. However, the fossil record for dinosaurs ends about 65 million years ago. At the same time, more than half of the other species living on Earth became extinct.

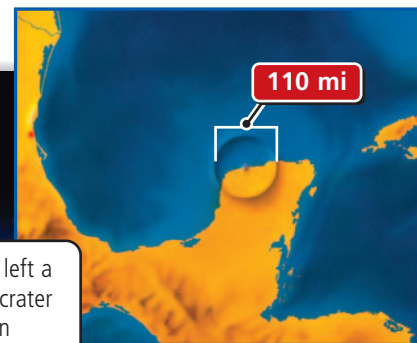
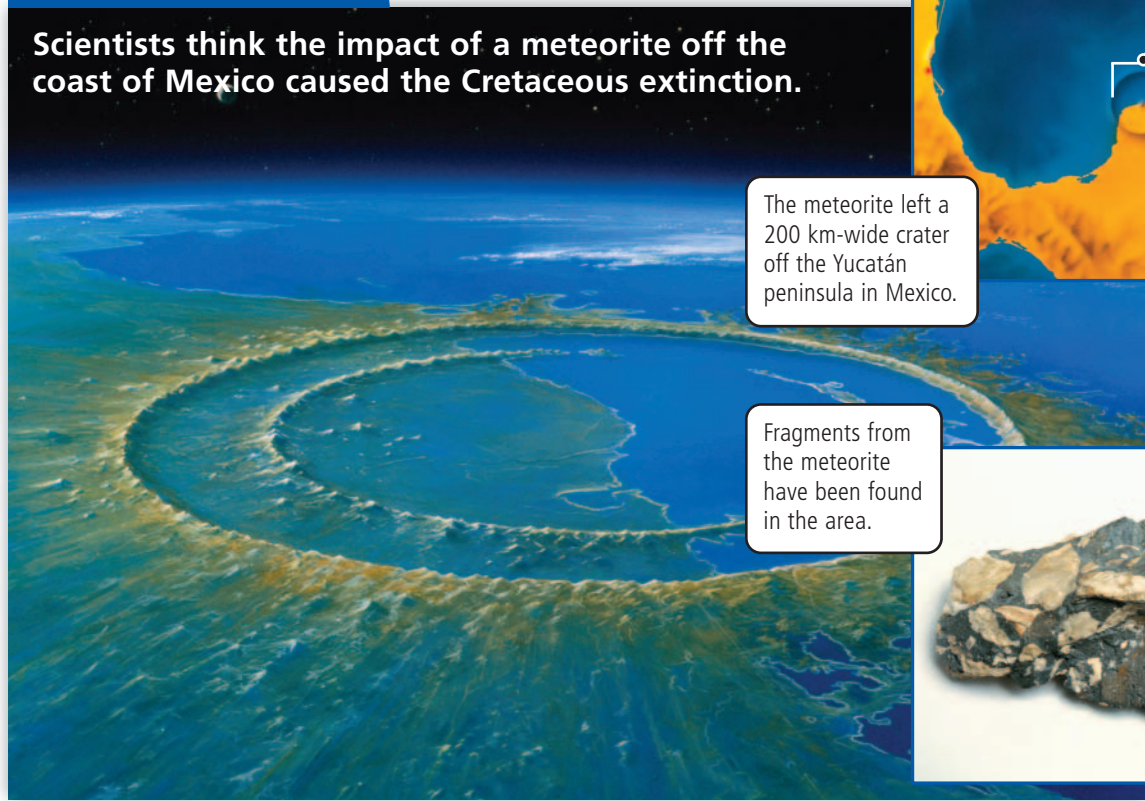
How do scientists explain the extinction of so many species? One possibility is that a very large meteorite from space collided with Earth. The collision and its aftereffects wiped out most of the existing species. The remains of such a collision, the Chicxulub crater, can be found off the coast of Mexico. The computer graphic on page 495 shows the area of impact.



The largest mass extinction, the Permian Extinction, affected many different living things but it was the most devastating to organisms that lived in oceans.

## Chicxulub Crater

Scientists think the impact of a meteorite off the coast of Mexico caused the Cretaceous extinction.



The meteorite left a 200 km-wide crater off the Yucatán peninsula in Mexico.

Fragments from the meteorite have been found in the area.



The pattern in the fossil record shows that mass extinctions were followed by periods during which increasing numbers of new species developed. There may be a connection between the extinction of one species and the development of new species. For example, the extinction of dinosaurs may have made it possible for new species of mammals to develop.

### CHECK YOUR READING

What do scientists think caused the most recent mass extinction?

## 14.1 Review

### KEY CONCEPTS

1. How do fossils help scientists understand the history of life?
2. How do scientists know that the first organisms were simple, unicellular organisms?
3. What is extinction? Give an example of a mass extinction and its results.

### CRITICAL THINKING

4. **Synthesize** How do absolute dating and relative dating help scientists assemble a fossil record for an area?
5. **Sequence** Draw a timeline showing the sequence of three major events in the history of life. Include the following terms on your timeline: *unicellular*, *multicellular*, *ocean*, *land*.

### CHALLENGE

6. **Predict** Using the Denver reconstruction as your model, explain how you would reconstruct the history of the environment in your town.