

Reflect

Sea shells seem to be everywhere. Most of the time, you will find them on beaches. But every now and then, you might find them far from the sea. For example, you might find a shell stuck in a rock high on a mountain. What might your find tell you?

How can fossils tell us which organisms lived millions of years ago?

Fossils are preserved parts or traces of animals or plants that lived in the past. Fossils are clues to the past. They tell us what organisms lived in a certain place. They can tell what the organism looked like. They can tell what the environment was like in the place where the organism lived. Fossils can also tell how organisms have changed over time. If you find fossils of seashells high in a mountain, you might be able to conclude that the mountain used to be underwater at some point in the past.



Fossils do not have dates printed on them. Yet scientists have ways to tell two things about the organisms that became the fossils. Scientists can figure out the order in which the organisms lived on Earth. Scientists can also calculate when the organisms lived on Earth using particles around or in the fossil.



Figuring out the order is relatively simple. Look at the photo on the right. It shows layers of rock. The layers of rock were formed one on top of the other. The bottom layer was laid down first. So it is the oldest layer. The top layer was laid down last. So it is the youngest layer. The layers in between are younger and younger from bottom to top.

Imagine that you baked layers of a cake on Monday, Tuesday, Wednesday, and Thursday, and you put each layer on top of the other on the day it was baked. The Monday layer would be at the bottom. The Tuesday layer would be on top of the Monday layer. Wednesday's layer would come next. And, finally, you would put Thursday's layer on top. Monday's layer would be the oldest. Thursday's layer would be the youngest.

Reflect

Now, let's take this a step further. Let's say you put walnuts in Monday's layer. You put raisins in Tuesday's layer. You put cranberries in Wednesday's layer. And, finally, you put chocolate chips in Thursday's layer. You give the cake to a friend, who knows that the bottom layer is oldest, and the top layer is youngest. What could your friend conclude about the ingredients? He could conclude that the walnuts were added first because they are in the oldest layer. He could conclude that the raisins were added second because they are in the second-oldest layer. He could conclude that the cranberries were added third because they are in the third-oldest layer. And he could conclude that the chocolate chips were added last because they are in the youngest layer.

What has this got to do with the age of fossils? Think of the walnuts, raisins, cranberries, and chocolate chips as fossils. The rock layers in which fossils are found tell the **order** of the ages of the fossils. Fossils in the bottom layer are older than fossils in higher layers. Scientists also have ways to find the **actual age** of fossils.

One way to find the actual age of a fossil is to find the age of the rock layer in which the fossil is found. This makes sense because the organism that produced the fossil was trapped in the rock when it formed. How long ago did the last dinosaurs become **extinct**, or die out forever? The youngest dinosaur fossils are found in rock layers that are about 65 million years old. Therefore, we can use that evidence to conclude that dinosaurs became extinct about 65 million years ago.



Evidence from fossils shows that dinosaurs became extinct about 65 million years ago.

You may be wondering how scientists figure out the actual age of rock layers and fossils. The process is a bit complex. But, if you are curious, do an Internet search using the key words **radioactive dating**.

What Do You Think?

Take a look at the illustrations at right. They show fossils found in different layers of rock. What is the order of these fossils from oldest to youngest?

How can fossils tell us what environments were like millions of years ago?

Scientists tell us that environments change over time. However, what evidence have they found to back up this claim? Here are two answers.

In 1988, Gordon Hubbell and a team of fossil hunters dug a hole in a desert in Peru. Today, this desert is one of the driest places on Earth. Almost no rain falls there.

Hubbell is an expert in fossil sharks. After digging for a while, Hubbell discovered a jaw bone and more than 200 sharp teeth. The teeth were shaped like triangles. Hubbell recognized the teeth. They belonged to the ancestors of one of the fiercest animals in the sea: the great white shark.

For about 20 years, the teeth were stored in Hubbell's collection of fossils. Then, in the early 2000s, another team of scientists decided to examine the teeth. Bruce MacFadden of the Florida Museum of Natural History in Gainesville, Florida, led the team. MacFadden and his team were able to figure out the age of the fossil teeth. They were four million years old! The conclusion? Four million years ago, one of today's driest places was underwater. Fossils had proved that the environment in this place has greatly changed.



Rock Layer 4



Rock Layer 3



Rock Layer 2



Rock Layer 1



A great white shark bares its teeth.

What Do You Think?

Here is another example. Today, the continent of Antarctica, which surrounds Earth's South Pole, is the coldest place on our planet. Temperatures there can dive below -84°C (-120°F). No plants or animals make their homes permanently in the interior of Antarctica. But was Antarctica always that cold and empty of living things? According to fossil evidence, the answer is no.

Scientists exploring an area in Antarctica called the Dry Valleys have found fossils of mosses and tiny animals. The fossils were unearthed in ancient lakebeds. The scientists calculated that the fossils were about 14.1 million years old. At that time, shrubs grew from the ground around the lakes. Some insects lived there, too. To support such living things, summer temperatures would have had to be much warmer than they are now. Again, fossils proved that an environment on Earth had changed greatly over time.

Look Out!

Not all parts of an ancient organism can form a fossil. Fossils are most often formed from the hard parts of organisms. The soft parts usually break down before they can be preserved in rock. However, there are exceptions. For example, animals trapped under ice may be preserved whole. This is what happened to some woolly mammoths, like the one shown in the top image at right. Woolly mammoths are extinct animals that looked a bit like modern elephants. Some lived in the icy regions close to the North Pole. Some insects are preserved whole, too. This is especially true of insects trapped in tree sap. When the sap hardens, the insect is preserved inside. This happened to the mosquito in the bottom image at right.



Look Out!

How can we represent fossils and past environments using models?

Scientists often use models to describe objects or events in nature. A **model** is a representation of a real thing. A model may be as simple as a drawing. It may be a shape made out of clay. It may be an animal reconstructed from just a few fossil bones. The dinosaur skeleton shown at left is used to make a model of a complete dinosaur.



A model may also be a diorama displayed in a natural history museum. A **museum diorama** often shows a model of both an organism and its environment. The environment may be in the present. It may also be in the distant past. The American Museum of Natural History in New York City holds an example. It shows two organisms related to human beings. They are walking on a dusty plain in Africa. This model was based on actual fossil footprints left behind by the organisms and preserved in rock. By using the shape of the footprint, scientists can draw conclusions about the body shapes and sizes of those organisms that made the prints.

Try Now

Collect a variety of small objects. These may be natural objects, such as stones or leaves, or they may be human-made objects, such as coins or marbles. Make an imprint of each object by pressing one side of the object into a piece of modeling clay. These imprints represent fossils. Label each imprint with a number, and create a key identifying the object that produced each imprint. For example: “Number 1: leaf from maple tree.” Ask your classmates to try to identify the source of each “fossil”—that is, the object that made each imprint. Ask your classmates to explain how they came up with their answers.

Discover Science: What “Lucy” Tells Us

In 1974, fossil hunters working in Africa discovered the almost complete skeleton of an organism related to human beings. Scientists determined that the skeleton belonged to an adult female. They also were able to calculate that she lived a little more than 3 million years ago. They named the skeleton “Lucy.”

Try Now

Studies of Lucy's bones revealed a number of things about her. She was less than 1.1 meter (3½ feet) tall. And she probably weighed fewer than 30 kilograms (66 pounds). But, most important, her bone structure provided evidence that she walked upright. Fossil footprints, also found in Africa, further support this conclusion. The footprints belonged to other members of Lucy's group of organisms. The footprints clearly showed two organisms walking much as we do today. As far as scientists know, Lucy and her kind were the first human-like organisms to walk upright.

What do you know?

The following chart lists five different locations on Earth today. Suppose that scientists find a fossil of an ancient organism in each location. Based on the type of fossil found there, decide how the location has changed over time. In particular, decide whether each location:

- Used to be a forest
- Used to be underwater
- Used to be a tropical island
- Has not changed since the fossil was formed

Write your answers in the third column of the chart.

Fossil	Where was it found?	How has the location changed?
sea shell	the side of a mountain	
palm branch	an ice sheet in the Arctic	
the imprint of a cactus leaf	a desert	
insect trapped in tree sap	under the ocean floor	
shark tooth	a wide-open grassland	

Fossil Safari

There are a number of ways to give students a first-hand experience with fossils. If your community, or a nearby community, has a museum of natural history, or if you are contemplating a family trip to such an area, be sure to visit exhibits that contain fossils or organisms reconstructed from fossils. Alternatively, arrange for a visit to a local college or university where fossils are kept. Check with the geology and biology departments, which are most likely to keep collections of fossils. In either case, try to arrange a visit with a curator or an educator who could identify a particular fossil and explain where it was found and how it is significant. You might ask your child to prepare for such an experience by make a list of questions concerning fossils.

Here are some questions to discuss with your child:

- What is a fossil?
- What parts of ancient organisms are most likely to become fossils?
- In what materials are most fossils found?
- If you found two different fossils, what is one way you might be able to tell which is older?
- What can a fossil tell you about ancient organisms?