Activity 4

The Fossil Record

What Do You Think?

To hold a fossil in the palm of your hand is to have millions of years of history at your grasp. Fossils tell you about history, and like all good history, they help you to understand both the present and the past.

What is a fossil?

Write your answer to this question in your Active Biology log. Be prepared to discuss your ideas with your small group and other members of your class.

For You To Do

In this activity you will have an opportunity to model different ways in which some fossils are formed. You will visit several stations.

GOALS

In this activity you will:
- Model ways in which fossils are formed.
- Explain the difference between a body fossil and a trace fossil.
- Describe the importance of fossils.
- Predict which animals are more likely to be found in the fossil record.
Station 1: Preservation in Rock
You will mold a clamshell in plaster to model how it might be preserved in rock.

1. Obtain a large paper cup. Identify the cup with the name of your group. With a paper towel, smear petroleum jelly over the inside of the cup.
2. Mix plaster in another container following the directions on the package. Work quickly to complete the next four steps.
3. Fill the cup half full of plaster.
4. With the paper towel smear some petroleum jelly on both surfaces of a clamshell. Gently press the clamshell into the plaster.
5. Sprinkle a few pieces of confetti over the surface, enough to cover about 50% of the surface.
6. Fill the rest of the container with plaster.
7. Let the plaster harden overnight.
8. In the next class, remove the hardened plaster from the container. Set the plaster on its side and cover it with a towel. With a hammer gently hit the plaster to break it at the layer of confetti.
9. Observe your plaster molds and answer the following questions in your Active Biology log:
   a) What does the plaster represent?
   b) If you had never seen the clamshell, how would you figure out what the shell looked like by studying the fossil?
   c) Clamshells have two parts to their shell. How many possible imprints could a clamshell form?
   d) Why are fossils most often found in sedimentary rock formations?

Station 2: Preservation in Resin
You will encase a seed in glue to model how it might be preserved in a material like resin.

1. Obtain a small paper plate. Write your group’s name on it. Use a paper towel to smear a small amount of petroleum jelly on a spot on the plate.
2. Using a hot-glue gun, put a bead of glue on the greased area of the plate.
3. Using tweezers, place the seed on the bead of glue. Add a few more drops of glue on top of the seed.
4. Let the glue harden overnight.

Wear goggles and be very careful when handling the hot-glue gun. Keep the hot part of the glue gun away from skin and flammable materials. Keep the glue away from skin, cloth, or other materials that may be damaged by it. Work on a surface that will not be damaged by the heat or the glue. Tell the teacher immediately of any accidents, including burns.
5. In the next class, remove the bead of glue and observe. Answer the following questions in your Active Biology log:

a) Compare your preserved seed with a sample of amber provided by your teacher. How are they different? How are they similar?

b) Explain how a seed might end up being preserved in the resin.

c) Would you ever expect to see a large animal preserved in resin? Explain your answer.

d) Which type of fossil would be easier to identify: one preserved in rock, or one preserved in resin? Explain your answer.

Station 3: Preservation in Ice

You will freeze a small object in a cup of water to model how organisms can be preserved in ice.

1. Your teacher will provide you with a paper cup half full of water that is beginning to freeze. Put your group’s name on the cup.
2. Gently push the object under the surface of the ice.
3. Add more water on top of the object.
4. Let the water freeze overnight.
5. In the next class, remove the ice from the paper cup. Answer the following questions in your Active Biology log:
   a) How do you think an organism could end up being preserved in ice?
   b) What type of organisms could be preserved in ice?

Station 4: Preserving Animal Traces
1. Flatten or roll out a piece of modeling clay to create a flat surface.
2. On the surface of the modeling clay, produce the pathway that an organism might leave in a muddy surface. Use your imagination to produce the pathway. You could represent anything from a worm crawling to a dinosaur trudging.
3. With a paper towel spread a small amount of petroleum jelly over the imprints you left in the modeling clay.
4. Mix plaster in a small plastic bag following the directions on the package. Cut the corner off the plastic bag. Squeeze enough plaster over the impression to fill the area.
5. Let the plaster dry overnight.
6. In the next class, remove the modeling clay from the plaster. Answer the following questions in your Active Biology log:
   a) In what kind of ancient environment(s) might you expect to have footprints formed?
   b) Once a set of fresh footprints have been made in the mud, what would have to happen to preserve them as rock?
THE NATURE OF THE FOSSIL RECORD

Making Models

Scientists often make models to help them understand how living things work. Models can be small-scale structures that simulate what is found in nature. For example, a scientist might reconstruct the climatic conditions of 65 million years ago to uncover what might have happened to the dinosaurs. Another type of model could be nonliving structures that work in a similar fashion. The human heart is often understood from the model of a pump. Recently, scientists have begun using computers to make mathematical models. Unlike the structural models, these models only exist as numbers. In this activity you modeled the formation of fossils.

The Importance of Fossils

What does the fossil record tell you? Among a number of things, it tells you that species are not unchangeable. The species you see around you today are not the ones that have always existed. Fossils provide direct evidence that organisms are continually evolving. However, it is important to note that evidence of evolution is very different from the theories of evolution, which you read about in the previous activity. Fossils tell you that life forms on Earth have changed. The theories attempt to explain how and why these changes took place.

Fossil Formation

Fossils are preserved evidence of ancient life. Some fossils are called body fossils. These are the preserved parts of plants and animals. Fossils may also be trace fossils. These fossils are traces of the activities of plants and animals, for example, tracks, trails, or scratch marks.

As you investigated in this activity, fossils form as a result of many processes. For example, most animals become fossilized by being buried in sediment. The sediments then accumulate and consolidate to form rock. Molds are fossils formed from the impressions in soft sediment of shells or leaves, for example, or from footprints or tracks. Casts are replicas formed when a hollow mold is subsequently filled with sediment—mud, sand, or minerals. Sometimes an insect might
become trapped in a sticky substance called resin, produced by some types of trees. The resin hardens to form amber. The insect fossil is preserved in amber, often perfectly. At other times natural mummies form when organisms are buried in areas like tar pits and peat bogs or dry environments like deserts or certain caves. Organisms buried in
glacial ice also can remain preserved for thousands of years. Finally, the cells and pore spaces of wood and bone can be preserved if filled with mineral deposits, a process called petrifaction.

Not all organisms become fossils. To begin with, very few escape the food chain. They are either eaten by other organisms or are broken down by decomposers. Soft body parts decay very quickly. You know from experience that it takes little time for meat and vegetables to spoil if left out of the refrigerator. More resistant parts, such as the exoskeletons of insects, vertebrate bones, wood, pollen, and spores take much longer to decay. Thus, the likelihood of finding these in the fossil record is much greater.

The Fossil Record

Fossils typically form where sediments such as mud or sand accumulate and entomb organisms or their traces. The layers of hardened mud, sand, and other sedimentary materials are like a natural book of the Earth’s history. Interpreting each layer is like reading the pages of a book. Unfortunately, there are many surfaces on the Earth where layers are not

<table>
<thead>
<tr>
<th>Major Divisions of Geologic Time</th>
<th>(boundaries in millions of years before present)</th>
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<tbody>
<tr>
<td>Era</td>
<td>Period Event</td>
</tr>
<tr>
<td>Quaternary</td>
<td>modern humans</td>
</tr>
<tr>
<td>Tertiary</td>
<td>abundant mammals</td>
</tr>
<tr>
<td>Cretaceous</td>
<td>flowering plants; dinosaur and ammonoid extinctions</td>
</tr>
<tr>
<td>Jurassic</td>
<td>first birds and mammals; abundant dinosaurs</td>
</tr>
<tr>
<td>Triassic</td>
<td>abundant coniferous trees</td>
</tr>
<tr>
<td>Permian</td>
<td>extinction of trilobites and other marine animals</td>
</tr>
<tr>
<td>Pennsylvanian</td>
<td>fern forests; abundant insects; first reptiles</td>
</tr>
<tr>
<td>Mississippian</td>
<td>sharks; large primitive trees</td>
</tr>
<tr>
<td>Devonian</td>
<td>amphibians and ammonoids</td>
</tr>
<tr>
<td>Silurian</td>
<td>early plants and animals on land</td>
</tr>
<tr>
<td>Ordovician</td>
<td>first fish</td>
</tr>
<tr>
<td>Cambrian</td>
<td>abundant marine invertebrates; trilobites dominant</td>
</tr>
<tr>
<td>Archean</td>
<td>primitive aquatic plants</td>
</tr>
<tr>
<td>Proterozoic</td>
<td>oldest fossils; bacteria and algae</td>
</tr>
</tbody>
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Time Not to Scale
interpreting the layers is like reading a novel that is missing most of its pages. You can read the pages that are preserved and even group them into chapters, but much important information is missing from each chapter. Paleontologists (scientists who study fossils) use index fossils. These are fossils of organisms that were widespread but lived for only a short interval of geological time. They use index fossils to divide the fossil record into chapters. For example, dinosaurs are index fossils for the Mesozoic era, the unit of time that runs from roughly 245 million years ago (abbreviated Ma) to 65 Ma. In other
words, all dinosaur species evolved and became extinct during the Mesozoic era. Whales, horses, and many other mammal groups, on the other hand, are index fossils of the Cenozoic era, the unit of time that runs roughly from 65 Ma to the present. Using this and additional fossil evidence, paleontologists infer that the Mesozoic and Cenozoic eras represent two of the major chapters in the history of life.

The graph on the previous page summarizes the distribution of four groups of animals during the Mesozoic and Cenozoic eras. (Please note that this graph is not drawn to scale along the vertical axis; for example, the peak in dinosaur diversity is comparatively a small fraction of present day mammal diversity.) Although the graph is a rough summary of just a small part of the fossil record, paleontologists can get a much more accurate picture of life’s history by examining specific pages in the record. You will do this in the next activity.

**Reflecting on the Activity and the Challenge**

In this activity you modeled some of the ways in which fossils can form. You also read about different types of fossils and the incomplete nature of the fossil record. You may have now developed a sense of the importance of fossils.

You can begin to appreciate what might be lost if fossil records were destroyed or disrupted. You will need to explain this at the town-hall meeting if you are representing one of the paleontologists.

**Biology to Go**

1. What is the difference between a body fossil and a trace fossil?
2. What are the chances of an organism becoming a fossil? Explain your answer.
3. a) What is an index fossil?
   b) How do paleontologists use index fossils?
4. Use evidence from this activity to explain how the biosphere and the geosphere are connected.
Inquiring Further

1. Carbon-14 dating

How is it possible to determine the age of organic matter using carbon-14? Research to find the physical and chemical principles on which this technique is based. What are the limitations of carbon-14 dating?