



## Making a Fossil Activity Overview

### BIG IDEA

Not every organism that died, including dinosaurs, left behind a fossil. Explore fossilization with this activity.

### OBJECTIVE

Students will follow a series of steps outlining the events needed for fossil formation and understand that this process takes place over a long period of time.

### BACKGROUND

A fossil is evidence of past life. This activity describes bone fossils. Other types of fossils, like dinosaur footprints, or trace fossils, have a similar process of fossilization. Share these basic steps of fossilization with your students to complete this activity.

#### Step 1: Death

Dinosaurs that die near water or in a windy area have a greater chance of becoming a fossil because water and wind carry sand and mud which can bury the dinosaur.

#### Step 2: Burial

The river's current pushes sand and mud over the dinosaur's body, completely covering it. The burial step is one of the most important steps, because it allows the dinosaur's body to be preserved and protects its remains from scavengers. Frequently, paleontologists find incomplete fossilized skeletons. Ask students if they have any ideas why fossilized skeletons may be incomplete. Sometimes the dinosaur's remains are scattered by scavengers, predators, or water currents before burial occurs.



## Making a Fossil Activity Overview (Cont.)

### BACKGROUND (CONT.)

#### Step 3: Permineralization

Minerals from the surrounding sand, mud, and water fill into cell spaces within the bones of the dinosaur. If available have students examine a bone or fossilized bone and notice the tiny holes in the bones. Explain that in living animals' bones (including their bones), blood vessels travel through these tiny tunnels, nourishing the bone and allowing it to strengthen and grow. When the animal dies, the blood vessels deteriorate leaving the holes behind. These holes are what allow the bones to absorb the surrounding minerals. To assess student understanding of permineralization, take a class survey, "What are fossils? Bones or rocks?" Fossils are rocks; as permineralization occurs the bone is slowly replaced with minerals, and minerals are the ingredients of rocks.

#### Step 4: Time passes

In order for the fossil to last for millions of years, it must stay completely covered. Even though rocks are stronger than bones, with time and exposure to weather, they can still erode and disintegrate.

#### Step 5: Uplift and Erosion

The layers of our Earth are constantly in motion! In order for the fossil to be discovered, the layer in which the fossil is buried must be pushed closer to the surface, or the layers covering it must be worn away.

#### Step 6: Discovery

When a fossil is discovered, it is important that it is left where it is so that a paleontologist can study it. The location of the fossil and other rocks and fossils around it are just as important as the fossil itself!





## Making a Fossil Activity Overview Cont.

### BACKGROUND (CONT.)

#### Have We Found All the Dinosaurs?

Wang & Dodson (2006) used a statistical method, the abundance-based coverage estimator (ACE), to calculate the number of genera of dinosaurs that may have existed in the Mesozoic Era. This statistical analysis only identifies those genera that have “discoverable” fossils. A genus that left no fossils at all can never be discovered, and cannot be counted by ACE or any similar statistical method based only on abundance counts.

Not all types of dinosaurs will be found in the fossil record. Some genera may have never become fossils. These dinosaurs may not have died in an environment that had the right conditions for fossilization. It is also possible that some genera were fossilized, but lost over time due to mountain building processes.

According to Wang & Dodson (2006), only 29% of “discoverable” dinosaur genera have been identified. These scientists estimate that new dinosaurs will continue to be discovered for at least another century. However, it is likely that not every dinosaur genera is recorded in the fossil record and our understanding of dinosaurs is biased based on the accessibility of the fossiliferous rock studied at the Earth’s surface. Even though rocks are stronger than bones, with time and exposure to weather, they can still erode and disintegrate.

### EXTENSIONS

- Use the MOR Outreach Kit: Fossils, to explore the different types of fossils.
- Complete the Process of Paleontology activity in this guide to learn how scientists discover, excavate, and prepare fossils for display or research.
- Visit Museum of the Rockies on a field trip to see real fossils on display.

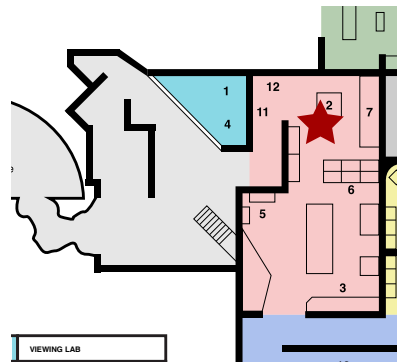


## MAKING A FOSSIL Museum Instructions

### MATERIALS

Student activity sheets, clipboards, pencils (Pens, crayons, and markers are not allowed in exhibit spaces)

### LOCATION



### ACTIVITY TIME

30 Minutes

### INSTRUCTIONS

*This activity can be used as an introduction to the Dinosaurs Under the Big Sky exhibit, providing students with a basic understanding and appreciation of how the fossils on display formed.*

Tell the students that as they explore the Dinosaurs Under the Big Sky exhibit, they will be seeing hundreds of real fossils. Today, they will explore how fossils are formed.

Use the space in front of the Viewing Lab to seat students and read the steps of fossilization (found in the Background Information) to your students. Use the replica of sedimentary rock layers along the wall by the Lab and the fossils embedded in rock on display, to provide visuals for the various steps of fossilization.

Using the activity sheet, instruct your students to draw or write the six basic steps in boxes provided.



## MAKING A FOSSIL Museum Instructions (Cont.)

### INSTRUCTIONS (CONT.)

Walk into the first portion of the Dinosaur Halls – the Hall of Growth and Behavior. Ask students to look at the graphic panels behind the displays and the displays. Ask, what kind of climate did the dinosaurs now found in Montana live in? Students should describe a climate that is moisture-rich, that supported the plants some dinosaurs ate. This climate also supported the rivers, streams, and inland sea that provided sediment to bury some dinosaurs after their death. This was a time of deposition.

Walk into the Mesozoic Media Center – the portion of the Dinosaur Halls with monitors and videos. When the video loop shows eastern Montana, ask your students what kind of climate is best for revealing and discovering fossils? Students should describe an arid climate where erosion and weathering uncover fossils. While paleontologists worldwide can find dinosaurs in other climates, the arid environment of eastern Montana helps fossil discovery by making fossils easier to find on the earth's surface.

Continue your exploration and stop in the Hall of Horns and Teeth, where Montana's *T.rex* is on display. Ask students to hypothesize the completeness of the fossil record. If 100 dinosaurs lived in your town in Montana 66 million years ago, how many of them have scientists found today? This portion of the Dinosaur Halls can be misleading when asking this question. While MOR displays multiple growth series and hundreds of real fossils, fossilization is actually rare. Use this discussion to explore how many fossils have been found and how many more scientists expect to find in the next 100 years.

Share with your students that Montana is incredibly special because scientists are able to find dinosaur fossils here. Fossilization is rare! Museum of the Rockies houses hundreds of very special fossils that help us better understand the Earth millions of years ago.



## MAKING A FOSSIL Classroom Instructions

### MATERIALS

Sheets of felt (5-6 pieces); dinosaur or animal toy; images of eastern Montana MOR Outreach Kit: Fossils

### ACTIVITY TIME

45 Minutes

### INSTRUCTIONS

*This activity can be used as a pre-lesson to a visit to Museum of the Rockies, where hundreds of real fossils are on display.*

Introduce the activity by asking students what they know about fossils. Record student answers on a whiteboard or poster paper. Revisit the list they come up with after completing the activity.

Tell the students that they will be exploring how organisms, specifically the bones of dinosaurs, become fossils.

Read the steps of fossilization (found in the Background Information) to your students. Use felt and a plastic dinosaur, along with photos of eastern Montana, to provide a visual demonstration of fossilization while describing these steps. Alternatively, have your students read this description (printable handout in the Appendix).

Using the activity sheet, instruct your students to draw or write the six basic steps in boxes provided.

Ask your students to look at the first two steps of fossilization – death and burial. Ask, when dinosaurs lived in the area that is now Montana, what kind of climate existed? Students should describe a climate that is moisture-rich, that supported the plants some dinosaurs ate. This climate also supported the rivers, streams, and inland sea that provided sediment to bury some dinosaurs after their death. This was a time of deposition.



## MAKING A FOSSIL Classroom Instructions (Cont.)

### INSTRUCTIONS (CONT.)

Now have your students look at the final two steps of fossilization – uplift, erosion, and discovery. Think about eastern Montana today. Ask, what kind of climate is best for revealing and discovering fossils? Students should describe an arid climate where erosion and weathering uncover fossils. While paleontologists worldwide can find dinosaurs in other climates, the arid environment of eastern Montana helps fossil discovery by making fossils easier to find on the earth's surface.

After exploring the process of fossilization and climate, ask students to hypothesize the completeness of the fossil record. If 100 dinosaurs lived in your town in Montana 66 million years ago, how many of them have scientists found today? Use this discussion to explore the how many fossils have been found and how many more scientists expect to find in the next 100 years.

Share with your students that Montana is incredibly special because scientists are able to find dinosaur fossils here. Fossilization is rare! If available, conclude this activity by sharing a real fossil with your students and/or revisiting the list of what students know about fossils.

# MOR FOSSILS



NAME \_\_\_\_\_

## Making a Fossil

Read or listen to the story of fossilization. Recount the key details of how fossils form.

Draw or write the steps below.

<b>Step 1:</b> _____          	<b>Step 2:</b> _____          
<b>Step 3:</b> _____          	<b>Step 4:</b> _____          
<b>Step 5:</b> _____          	<b>Step 6:</b> _____          





## Weather and Climate

Weather and climate affect fossilization.

What type of climate do you think erodes rocks and reveals fossils? Why?

In the Mesozoic Media Center, or using images in your classroom, look at images or videos of eastern Montana where we find dinosaur fossils. Based on the weather and climate of this region, why is Montana a great place to find dinosaurs?

## Have we found all the dinosaurs?

Scientists estimate that there may have been close to 1,850 genera or groups of dinosaurs. Currently, only 527 genera have been discovered.\*

Calculate how many types of dinosaurs scientists think we know about today based on this ratio. 527 in 1,850

As a decimal: \_\_\_\_\_

As a percentage: \_\_\_\_\_

Do you think scientists will uncover all the different types of dinosaurs that ever lived? Why or why not?

\*Wang, S. C., & Dodson, P. (2006). Estimating the diversity of dinosaurs. Proceedings of the National Academy of Sciences, 103(37), 13601-13605.

# MOR FOSSILS

## Activity 1: Student Handout Story of fossilization

### Step 1: Death

Dinosaurs that die near water or in a windy area have a greater chance of becoming a fossil because water and wind carry sand and mud which can bury the dinosaur.

### Step 2: Burial

The river's current pushes sand and mud over the dinosaur's body, completely covering it. The burial step is one of the most important steps, because it allows the dinosaur's body to be preserved and protects its remains from scavengers. Frequently, paleontologists find incomplete fossilized skeletons. Ask students if they have any ideas why fossilized skeletons may be incomplete. Sometimes the dinosaur's remains are scattered by scavengers, predators, or water currents before burial occurs.

### Step 3: Permineralization

Minerals from the surrounding sand, mud, and water soak into the bones of the dinosaur. If available have students examine a bone or fossilized bone and notice the tiny holes in the bones. Explain that in living animals' bones (including their bones), blood vessels travel through these tiny tunnels, nourishing the bone and allowing it to strengthen and grow. When the animal dies, the blood vessels deteriorate leaving the holes behind. These holes are what allow the bones to absorb the surrounding minerals. To assess student understanding of permineralization, take a class survey, "What are fossils? Bones or rocks?" Fossils are rocks; as permineralization occurs the bone is slowly replaced with minerals, and minerals are the ingredients of rocks.

### Step 4: Time passes

In order for the fossil to last for millions of years, it must stay completely covered. With time and exposure to weather, fossils can erode and disintegrate.

# MOR FOSSILS

## Activity 1

### Story of fossilization (Cont.)

#### **Step 5: Uplift and Erosion**

The layers of our Earth are constantly in motion! In order for the fossil to be discovered, the layer in which the fossil is buried must be pushed closer to the surface, or the layers covering it must be worn away.

#### **Step 6: Discovery**

When a fossil is discovered, it is important that it is left where it is so that a paleontologist can study it. The location of the fossil and other rocks and fossils around it are just as important as the fossil itself!

# MOR FOSSILS



01

NAME \_\_\_\_\_ ANSWER KEY \_\_\_\_\_

## Making a Fossil

Read or listen to the story of fossilization. Recount the key details of how fossils form.

Draw or write the steps below.

Step 1: <b>DEATH</b>	Step 2: <b>BURIAL</b>
Step 3: <b>PERMINERALIZATION</b>	Step 4: <b>TIME PASSES</b>
Step 5: <b>UPLIFT AND EROSION</b>	Step 6: <b>DISCOVERY</b>



## Weather and Climate

Weather and climate affect fossilization.

What type of climate do you think erodes rocks and reveals fossils? Why?

**A dry and windy climate causes more erosion and can lead to exposed fossils**

In the Mesozoic Media Center, or using images in your classroom, look at images or videos of eastern Montana where we find dinosaur fossils. Based on the weather and climate of this region, why is Montana a great place to find dinosaurs?

**Montana is a great place to find dinosaurs, because it is dry or arid. Wind and rain causes sedimentary rocks to erode, sometimes revealing fossils.**

## Have we found all the dinosaurs?

Scientists estimate that there may have been close to 1,850 genera or groups of dinosaurs. Currently, only 527 genera have been discovered.\*

Calculate how many types of dinosaurs scientists think we know about today based on this ratio. 527 in 1,850

As a decimal: 0.285

As a percentage: 28.5%

Do you think scientists will uncover all the different types of dinosaurs that ever lived? Why or why not?

**No. It is possible that all types of dinosaurs were not fossilized.**

\*Wang, S. C., & Dodson, P. (2006). Estimating the diversity of dinosaurs. Proceedings of the National Academy of Sciences, 103(37), 13601-13605.