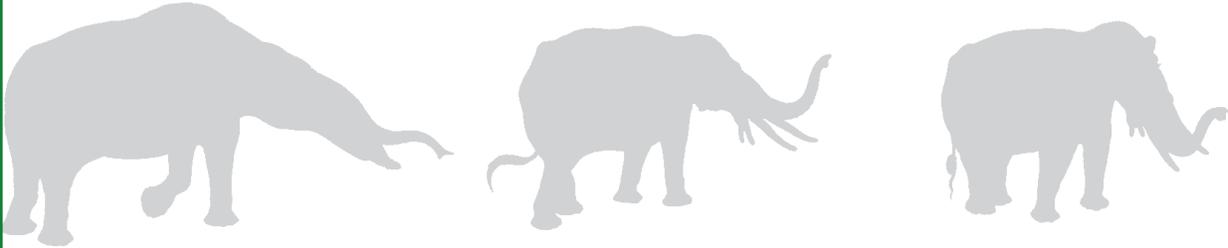


# TUSKS!



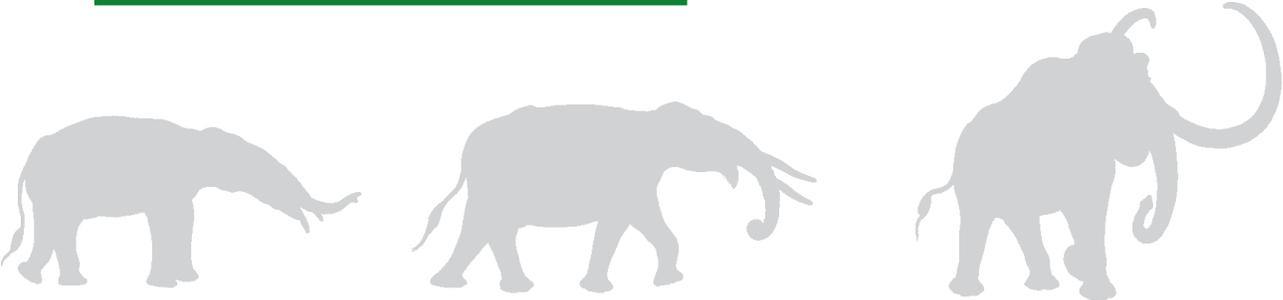
## Educator's Guide



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# Using the Guide:

## Alignment with National Education Standards

The following National Education Standards are covered within this Guide:

### LEVELS K–4

Science as Inquiry: Content Standards A and B  
Abilities necessary to do scientific inquiry  
Understanding about scientific inquiry

Life Science Standards: Content A and C  
Characteristics of organisms  
Organisms and environments

Earth and Space Science  
Properties of earth materials

Science in Personal and Social Perspectives  
Characteristics and changes in populations  
Changes in environments

History and Nature of Science  
Science as a human endeavor

### LEVELS 5–8

Science as Inquiry: Content Standards A and B  
Abilities necessary to do scientific inquiry  
Understanding about scientific inquiry

Life Science Standards: Content A and C  
Structure and function in living systems  
Populations and ecosystems  
Diversity and adaptations of organisms

Earth and Space Science  
Structure of the earth system

Science in Personal and Social Perspectives  
Populations, resources, and environments

History and Nature of Science  
Science as a human endeavor

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# Background Information



“TUSKS!” presents the fascinating story of extinct mammoths, mastodons, and their tusked relatives that roamed much of North America from 15 million to 10,000 years ago. Proboscideans or “tuskers” were giants in ancient ecosystems abundant with a wide diversity of animals and plants. Today the only living relatives of these ancient mammals are Asian and African elephants. The ultimate cause of the mass extinction of North American proboscideans as well as many other animals of the time is unknown. To learn more about “tuskers,” determined people known as **paleontologists** study fossils, frozen mummified remains, and ancient cave drawings in an attempt to piece together an ancient past.

## Fossils

**Fossils** are the remains of ancient plants and animals that have been embedded and preserved in the earth. Most fossils are excavated reflecting the origin of the word, fossilis, which is Latin for “dug up.” Fossils are important because they provide a record of past life on our planet. Fossils can range from thousands to millions, and even billions of years old. They include anything from a fossilized bone, microscopic bacteria, an impression of a leaf or footprint, or a fully preserved organism.

Fossilization can occur in several different ways. The process of fossilization determines what evidence of the organism’s presence survives. The primary forms of fossil creation are permineralization/replacement, mold/cast, trace, and whole organism preservation.

In general permineralization/replacement, mold/cast, and **trace** fossilization begins similarly. The remains of an organism will go through the following process:

1. The organism must be rapidly buried in mud, sand, or silt. This protects the organism’s remains from scavengers and other agents of decay and decomposition.
2. The soft parts of the organism, such as the skin, muscles, internal organs, and leaves will decompose quickly. However, under some rare circumstances, even soft parts have become fossilized. Hard parts of the organism such as bones, teeth and thick branches decompose much slower than the soft parts, thus giving time for them to become fossilized.
3. Over thousands or millions of years, layers of sediment build up. The layers accumulate on top of each other with the oldest layers at the bottom. With time and pressure, the weight of the overlying layers turns the bottom layers into rock. At this point the fossilization processes diverge resulting in several different types of fossils.

### **Route A:**

**Permineralization/replacement** occurs when minerals replace an organism’s organic material. This process occurs very slowly, as ground water, rich in dissolving minerals, seeps into the remains of an organism. **Permineralization** is characterized by minerals depositing in the empty spaces between cells, leaving a stone image of the organism after the organic material decays. **Replacement** is characterized by the replacement of organic molecules by minerals, one for one, as they decay. This process creates a stone replica of the original material.

# Background Information



## **Route B:**

**Molds** form when the organic material rots away, leaving an empty space in the hardened sedimentary rock. This space retains the external characteristics of the decayed organism such as its size and shape. Over time, mold fossils can become filled with sediment. When this sediment hardens into rock, it creates a **cast** fossil. The degree of detail exhibited by the cast fossil depends on the degree of detail recorded in the mold fossil.

4. The constant moving and erosion of the earth may expose deeply buried rocks and the fossils they contain. Fossils must be collected and preserved at the time they are exposed or they too will be destroyed by erosion. In Florida, human activities like mining, construction and canal building expose many fossils.

## **Complete Organism Fossilization:**

Although it is rare, there are several ways that a complete organism can be preserved. This type of preservation does not last as long as other types of fossilization. There are two ways that complete organism preservation can occur.

1. Through the process of **dehydration** or **desiccation**. This occurs only in hot, dry environments, and results from the removal of moisture from tissue.
2. Through submersion of the organism in a special environment, such as tar or bogs. Under such circumstances, the environment around the organism is without air. This prevents **bacteria** from growing and decaying the specimen. This process, however, only slows the process of decay, but does not stop it.

**Fun Fact:** *Fossils have the same shape that the original item had, but their color, density, and texture vary widely. A fossil's color, density and texture depend entirely on what minerals formed it. Most fossils are made of ordinary rock material, but some are more exotic, including one fossilized dinosaur bone, which is an opal!*

# Background Information



## Proboscideans

**Proboscideans** are large **mammals** with tusks and long, flexible trunks or “proboscises.” Proboscideans include modern elephants, their ancient fossil relatives, and other extinct species. They are sometimes called “tuskers” for short. A **tusk** is any greatly enlarged tooth that projects when the mouth is closed. The tusks of proboscideans (and narwhals) form when the incisors, or front teeth, become greatly enlarged. The tusks on walruses and boars, however, result from an enlargement of the canine (“wolf”) teeth. Tusks and teeth are the most common proboscidean fossil and they reveal much about the behavior of the animals.

Paleontologists believe that proboscideans originated in Africa 50 million years ago. From there they spread into Europe and Asia. Then in the middle of the Miocene Epoch (about 15 million years ago) early tuskers first entered North America via a land bridge that formed between Siberia and Alaska. This land bridge formed during times of lowered sea levels, allowing proboscideans and other animals several opportunities to cross into North America. Eventually, there were about 50 species of proboscideans in North America. Proboscideans lived in North America during three geological time epochs:

### 1. Miocene—24 to 5 million years ago

Early proboscideans first enter North America during the middle Miocene, about 15 million years ago.

### 2. Pliocene—5 to 2 million years ago

A series of several **ice ages** began during the early Pliocene. During the Pliocene, sea level was higher, so most proboscidean remains come from areas at higher elevations throughout inland North America. Most low-lying Gulf Coast areas were under water.

### 3. Pleistocene—2 million to 10,000 years ago

Often called “the **Ice Age**,” the Pleistocene is actually the most recent of several ice ages. The American mastodon (*Mammut americanum*) and the Columbian mammoth (*Mammuthus columbi*), the last of the North American tuskers, both became extinct 11,000 years ago.

# Background Information



## An Ancient Environment

During the various epochs the landscape of North America was vastly different from what it is today. Proboscideans were not the only giants of the time. There were other giant mammals such as the giant sloth, which was about 20 feet long and weighed 3–4 tons, and the giant beaver, which was 7 feet long, more than 3 times their size now. These animals as well as the other giant animals of the Ice Age are known as **megafauna**. The word megafauna generally describes large animals of any particular region or time. During the Ice Age, however, these animals dominated global **ecosystems**, which were also richly abundant in snakes, turtles, birds, rodents, and insects.

**Fun Fact:** During the Pleistocene the American plains were home to American lions, cheetahs, saber-toothed cats, camels, and even woolly rhinoceri.

## The Climate

Not only were the animals of North America vastly different from what we know today, but also the climate, which in some places may have been between 10 and 30 degrees F colder, depending on the season. Scientists have been able to determine the relative temperatures during the Ice Age by examining the oxygen types found in ancient tooth enamel. There are several different types of oxygen (called **isotopes**) and depending on the temperature, the air will have more or less of each type of oxygen. For example, the warmer the climate the more oxygen-sixteen ( $^{16}\text{O}$  isotope) and the less oxygen-eighteen ( $^{18}\text{O}$  isotope) will be found in the air. For colder climates the reverse is true. Because all animals must breathe oxygen to live, that same oxygen becomes incorporated into every part of the organism's body. This includes the animal's tooth enamel, which can provide researchers with information about the climate while that organism was alive.

To find out what kinds of oxygen atoms an ancient organism was breathing, paleontologists drill out a little enamel from the fossilized tooth. The enamel is then placed into a vacuum and acid is added to it to liberate the oxygen atoms. These atoms then pass through a mass spectrometer, a special machine that counts the amount of different types of oxygen atoms given off by the enamel. Then paleontologists compare these measurements to the temperature of the areas where these amounts occur today.

## Trading Places—The Great American Interchange

Before the Ice Age, a seaway separated North and South America. About three million years ago the Isthmus of Panama was formed by volcanic activity, thereby connecting the two American continents. This allowed a dispersal of animals in both directions, and a mixing of the two continental faunas. Scientists have called this event the **Great American Interchange**.

# Background Information



## South American Species that Moved North...

- Porcupines
- Capybaras
- Armadillos
- Ground Sloths
- Glyptodons
- Opossums
- Anteaters

## North American Species that Moved South...

- Llamas
- Tapirs
- Deer
- Mice and Rats
- Skunks
- Foxes
- Horses
- Elephants
- Raccoons
- Cats

As a result of the Great American Interchange, during this time the fauna of North and South America became similar. A fauna is a group of animal species that live together in the same natural community.

The Ice Age fauna of North America included a diversity of meat-eating carnivores and plant-eating herbivores. A few of these species, such as deer (*Odocoileus virginianus*) and black bears (*Ursus americanus*), still live today. However, many North American species from the Ice Age, including the tuskers, became extinct about 10,000 years ago.

# Background Information



## Extinction

Species that no longer exist today are said to be extinct. The fossil record indicates that 99% of all species that ever existed are now extinct and the current rate of extinction is alarmingly high. Once a species becomes extinct, and vanishes from the face of the Earth, it never returns.

## The Great or Ecological Pyramid

To understand the true effects of extinction, one must first understand how an organism functions within the ecosystem. All ecosystems are composed of producers (plants), primary consumers (plant-eaters), and secondary consumers (meat-eaters). These groups of organisms form an ecological pyramid. When this structure is disrupted by the loss of one organism, other organisms within the pyramid are also affected. This concept is similar to that of a food web; when a thread is broken, all animals tied to that thread are seriously affected.

## Causes of Extinction

The Ice Age peaked about 20,000 years ago, after which the Earth again began to warm. Fossil evidence shows that shortly after the peak of the Ice Age, about 12,000 years ago, humans found their way into North America. By the time the glaciers had receded northward and the Ice Age was over, some 35 different groups of species had disappeared from North America. In only a few thousand years, mammoths, mastodons, camels, horses, giant ground sloths, and many species of bears all vanished from the North American fossil record.

The current leading explanations for this sudden mass extinction are the “overkill” hypothesis and the “climate change” hypothesis.

### Overkill:

Some researchers believe that humans may have over-hunted large mammals of North America. Thus overkill contributed to their demise.

### Climate Change:

Other researchers believe that changes in climate at the end of the Ice Age may have eliminated food sources by decreasing large grasslands favored by large grazers. Climate Change may have also disrupted birth schedules and/or exposed animals to climatic conditions to which they were not adapted.

### Both of the above:

Other scientists believe that the mass extinctions may have been a combination of overkill and climate changes. Other factors, such as the spread of diseases, may have also contributed to the disappearance of large mammals in North America.

# Background Information



## Continuing the Cycle of Inspiration and Discovery

Science is a never-ending process that advances knowledge of our world. By bringing together techniques and methods, theories, dissemination of knowledge, and interpretation, scientists inspire future generations to ask new questions about our natural world.

- **Scientific Discoveries**

The uncovering of new information, such as excavations at a new fossil site, provides the raw materials of scientific research.

- **Techniques and Methods**

Improved technologies often allow new ways to look at old fossils.

- **Theories**

The hypotheses generated by scientists form the framework within which they interpret their findings.

- **Dissemination of Knowledge**

Scientists publish the results of their research for others to either confirm or question.

- **Interpretation**

Museum designers and educators interpret the findings of scientists and communicate with the public through museum exhibitions and educational programs.

## The Big Picture

Fossil evidence of both plants and animals allows researchers to unravel an ancient past.

- This information about past climates helps us put current climate fluctuations in context and may also provide insight into future climate changes.
- Knowledge of how plants and animals reacted to the dramatic shifts in climates during the Ice Age may aid researchers dealing with current conservation and global warming issues.
- By understanding the last mass extinction, we may learn more about the wave of current and impending extinctions.

# Activities: Making Trace Fossils

Section: Fossils  
Grades: 3-6  
Duration: 30 minutes



**Objective:** To teach students the process of fossil formation and the difference between trace fossils.

## Materials:

Newspaper (to cover work surface)	Large plastic container (for mixing)
Pie tins (one per student)	Metal or wooden spoon (to mix plaster)
Plaster of Paris	Paper towels (for cleaning up)
Water	

## Suggested Approach:

Tell your students that today they are going to make trace fossils. Review with the students that trace fossils are fossils that give us proof of animal life from the past. Explain that trace fossils include fossils like footprints, burrows, and fossilized feces. There are two types of trace fossils; they are called mold and cast fossils. A mold fossil is a fossilized impression made by the original organism. A cast fossil is formed when a mold fossil is filled with sediment that hardens into rock, creating a cast of the original shape.

**Fun Fact:** One famous example of trace fossil footprints can be found in Laetoli, Africa, where researchers discovered a trail of hominid footprints over 80 feet long in 1976. It did not take long for the hominids to walk the 80 feet, only a few moments, but evidence of those moments have been preserved for over 3.6 million years!

## Procedure:

1. Ask students to decide what type of trace fossil they want to make—whole handprint or footprint, fingertips only, heel only, toes only, a fist, elbow, etc. Kids can get as creative as teacher/time/space will allow.
2. Mix Plaster of Paris (a thick mixture will work better) and fill bottom of pie tins with plaster.
3. Have students make their impression (Hint: to make a more accurate trace fossil, have them make an impression while in motion. For example, for a whole footprint, place tin on well-covered floor and have student walk through it.)
4. Allow time for plaster to dry.
5. Have students take a look at each other's trace fossils and discuss what they see.

# Activities: Making Trace Fossils



## Discussion Questions:

1. The Plaster of Paris is like the mud or ash mixture, while the students are like the ancient animals that left traces of their activity through fossilization. Have students imagine that they are paleontologists and that their plaster impressions are trace fossils uncovered during a fossil dig. Can they identify the impression?
2. What can they tell about the organism or activity that created the fossils? Trace fossils are not always clear impressions; they were not created intentionally and are the remains human activity. All fossils cannot be clearly identified like those at Laetoli. However, with careful examination of the fossil evidence, scientists are able to draw conclusions about events in the past, animals that are long extinct, and how these animals interacted with their environment.

## Extension

Objective: To show how cast fossils are made.

## Materials:

Trace Fossil made in above activity  
Self-hardening Clay  
Petroleum Jelly

## Procedure:

1. Once the Plaster of Paris dries line the impression with a thin layer of petroleum jelly.
2. Gently push the self-hardening clay into the impression and remove it.
3. You now have cast fossil.

## Discussion Question:

1. How is this fossil different from the one you just made?
2. Can you see more or less details?

# Activities: Cookie Excavation

Section: Fossils  
Grades: 3-6  
Duration: 40-60 minutes



**Objective:** To provide students with an understanding of the process of excavating fossils.

## Materials (for each student):

- |                              |                  |
|------------------------------|------------------|
| 1 Hard chocolate chip cookie | 6 Toothpicks     |
| 1 Hard raisin cookie         | 2 Plastic spoons |
| 2 Paper towels               | 1 Paintbrush     |

## Suggested Approach:

Explain to the students that today they are going to be paleontologists. Explain to the students how paleontology, like archaeology, involves fieldwork, including excavation. Excavation is the digging of fossils and ancient artifacts from the ground. The work is very difficult and detail oriented requiring patience, skill, and the ability to focus in on a small area for a long period of time. Tell them that they are going to get two cookies, one chocolate chip and one raisin. As paleontologists they have to excavate and clean the fossils (chocolate chips/raisins) from the cookies. Just like paleontologists they will have special tools that they can use and they have to be very careful not to break or damage their fossils.

## Procedure:

1. Pass out the materials to each student.
2. Tell the students to begin excavating the chips or raisins from the cookies. They have to do their best to clean off all rock (excess cookie) from their fossils. Just as in the field, if they break one of their tools, like a toothpick, that tool must be discarded.
3. After 5 to 10 minutes, stop and find out if any of the students have been successful in extracting anything from the cookie. As a class, review the discussion questions.

## Discussion Questions:

1. What was it like trying to remove the raisins and/or chips from the extremely firm cookie? Which was harder? Why?
2. In what condition were the extracted chips and raisins? Were they whole or broken? Which fossil was easier to clean and why?
3. Did students get different results from the chips versus the raisins?
4. What tools worked best to do what? Has anyone broken any of his or her tools? What were the expected results? Why?

# Activities: Cookie Excavation



5. Explain to the students that when paleontologists excavate fossils they must first obtain special permits or permission. They must also keep detailed records of where each fossil is found and in what position. They do this by setting up a grid over the area that they are excavating and mapping their findings. Ask the students how long they think it would take them to excavate their cookie if they had to do this. How long do you think it would take a paleontologist to excavate an area the size of the classroom (several years)?

## Extension:

Objective: To demonstrate how paleontologists use grids and mapping to keep detail records of the site they are excavating.

## Materials (for each student):

- |                                    |             |
|------------------------------------|-------------|
| 1 large flat chocolate chip cookie | Graph paper |
| 2 Paper towels                     | Pencil      |
| 6 Toothpicks                       | Ruler       |
| 2 Plastic spoons                   |             |
| 1 Paintbrush                       |             |

## Procedure:

1. Beginning in the upper left hand corner square of the graph paper, number the squares from 1–10 going down the left side of the grid.
2. Carefully trace the cookie on the grid.
3. Use your tools to gently remove the chocolate chips from the cookie. Try to remove each chocolate chip without damaging it. Place excavated chips on a paper towel.
4. As you do this record the exact location of every chip you excavate by sketching the shape of the chocolate chip on your grid.

## Discussion Questions:

1. Which portion of the “paleontological site” had the highest concentration of “fossils?”
2. Why would this information be important to a paleontologist?
3. How would external factors (i.e. weather, location, etc.) affect the excavation process?

## Activities: Wear and Tear



**Objective:** To demonstrate to the students how scientists can make inferences based on prior evidence.

**Materials** (for each group):

8 pieces of soap (Dove or another soft soap)

1 small twig with leaves

1 piece of sandpaper folded (so both sides are rough)

1 piece of bark

1 corn husk

Masking tape

Marker/pen

Black watercolor paint (optional: to help define the impressions in the soap)

Paint brush (optional: to help define the impressions in the soap)

**Suggested Approach:**

Explain to your class what a proboscidean is: a large mammal with tusks and a long, flexible trunk or “proboscis.” Proboscideans include modern elephants, their ancient fossil relatives, and other extinct species. These large mammals are sometimes called “tuskers” for short.

Explain to the students that tusks and teeth are the most common fossils found from these animals. Tusks are any greatly enlarged teeth that project when the mouth is closed. The marks, or wear and tear, left behind on fossilized tusks and teeth can tell us a great deal about the behavior of that mammoth, mastodon, or other proboscidean.

Ask the class if anyone has had a cavity. Explain to the class that cavities are an example of wear on your teeth. What can a cavity tell you about that person or animal? The responses will probably make references to what type of food that person ate (too many sweets). Explain that today we are going to learn how paleontologists can use the marks found on fossil teeth to help determine the diet of that animal.

Tell the class that they are going to divide into groups and that you are going to pass out 4 different types of food items.

Explain the food items:

1. The twig with leaves will represent the wear on teeth of an animal that stripped leaves off trees or plants.
2. The piece of sandpaper will represent the wear on teeth that would happen if the animal ate a lot of roots.
3. The piece of bark will represent the wear on teeth if the animal ate both leaves and the twigs/branches.
4. The cornhusk will represent the wear on teeth if the animal ate tough thick grasses.

# Activities: Wear and Tear



## Procedure:

(Before Class)

Mark each food item that is going to be passed out with a different number or letter. This will help each group keep track of what food made what mark within their group. Once the groups trade teeth (soap), however, this numbering/letting system will not give away the answers when they are asked to identify another group's teeth.

(During Class)

1. Split the class into several groups of 4-6 students.
2. Pass out the materials to each group.
3. Explain that they will be making the marks as a class so that everyone knows what to do.
4. Have one student in each group hold the 2 bars of soap and have another student in each group be responsible for the food substance. Tell the students that they are going to sandwich the food substance between the teeth (the 2 bars of soap) and then pull it out. Make sure the student holding the teeth presses down just hard enough to get a good impression on the soap but not so hard that the other student can't pull out the food. (Note: If the students are having trouble seeing the impressions, have them brush a little black watercolor paint over the impression. This should help define the marks on the soap.)
5. Each time they make a mark on the soaps have them mark both those soaps with the corresponding number/letter their group has for that food substance. This can be done by placing a piece of masking tape on the soap with the correct number/letter.
6. Have the students in the group alternate who is holding the teeth and food substance so that everyone can be involved.
7. When they are done, have them examine their teeth to see what marks were left by the different food substances.
8. Have the groups trade teeth. See if they can use what they just learned to identify the marks left on another group's set of teeth.
9. Have the class check their answers and discuss their findings.

## Discussion Questions

1. Did any group identify all of the teeth right?
2. Were there any two impressions that were difficult to distinguish?
3. Was it hard to identify the other group's teeth? Did they look exactly like yours?
4. What did you learn? How can paleontologists use this kind of information when looking at other marks on tusks and bones?

# Activities: Fossil Scene Investigation



**Objective:** To teach students how to use different types of scientific evidence to draw inferences.

## Materials:

- Black construction paper (enough to make 1 paper “fossil bone” about 6” long/student)
- 1 Scissor
- 1 Yellow highlighter
- 1 Orange highlighter
- 1 Small Black light (about 6” long)
- 1 Large Shoebox
- 1 Exacto knife
- 1 pack of crayons/student
- 1 copy of each coloring page/student
- 1 copy of the worksheet/student

## Suggested Approach:

Explain to the class that during the Ice Age the animals and landscape of North America was very different from what it is today. Because many of these animals no longer exist, it is difficult to know much about their lives during the Ice Age. However, special scientists, called **paleontologists**, act like detectives and search for clues to discover information about these fossilized animals. Paleontologists use a special machine called a Mass Spectrometer to learn what the climate was like during the life of that animal. Paleontologists can also use Mass Spectrometers to learn about the diets of fossilized animals. For our investigation, we will be using a Shoebox Spectrometer, which will simulate how a Mass Spectrometer works.

*Teacher:* Today we are going to be Fossil Scene Investigators and I am going to pass out a pretend fossil bone to each student as well as two coloring pages. One of these pictures is your animal, but you will need to piece together the clues from your Fossil Scene Investigation worksheet and the data you collect from our Shoebox Spectrometer to discover whose bone you have.

## Procedure:

(Before Class)

1. Cut out bone shapes from black construction paper (about 6” long) to make the “fossil bones.” You will need one for each student.

# Activities: Fossil Scene Investigation



2. Using the orange highlighter to represent  $^{13}\text{C}$  isotopes and the yellow highlighter to represent  $^{12}\text{C}$  isotopes, create browser and grazer fossils. The browsers fossils should have 20 orange ( $^{13}\text{C}$ ) dots and 10 yellow ( $^{12}\text{C}$ ) dots. The grazer fossils should have 20 yellow ( $^{12}\text{C}$ ) dots and 10 orange ( $^{13}\text{C}$ ) dots.
3. Construct the Shoebox Spectrometer as follows. Using an Exacto knife cut a rectangle (about 5" x 2") in the bottom of the shoebox. This will be the viewing slot. Place the shoebox upside down, covering the black light. The students will slip their "fossil" inside the box next to the black light and look through the viewer to count and record the different color dots on their fossils.

(During Class)

1. Pass out a "fossil bone," a copy of the worksheet, a copy of the Browser coloring page, and a copy of the Grazer coloring page to each student.
2. Instruct the students that you will call them up in groups of 5 to look at their fossil in the shoebox spectrometer. In the mean time they are to read over the worksheet and then begin coloring the other pages.
3. Call the first group of students up to the shoebox spectrometer with their worksheet and "fossil bone." Explain to the group the process that paleontologists go through to learn about the diets of ancient animals. First the paleontologists drill out a little of the material from the fossil. This material is placed into a special container and acid is added to the fossil material, which releases the isotopes. A mass spectrometer attached to the container then counts the amount of  $^{12}\text{C}$  and  $^{13}\text{C}$  isotopes released by the fossil material.
4. Have the student slip their bone under the shoebox by the black light and look through the viewer.
5. Instruct the student that they are going to act like the mass spectrometer and count the number of yellow and orange dots on their fossil. Then they must record the numbers on their worksheet.
6. When the students are done, instruct them to return to their seat and determine if their animal is a grazer or a browser based on their data and the information on the worksheet.

## Discussion Questions:

1. What is a grazer? Browser?
2. How many grazers were there? Browsers?
3. How could you tell?
4. Do we have either of these carbon isotopes in us?
5. What are some modern animals that are grazers? Browsers?

# Activities: Fossil Scene Investigation (F.S.I.) Worksheet



Scientists, called paleontologists, act like detectives to learn about past animals and environments. They study fossils in search of clues that might help them learn about the lives of animals that roamed the planet millions of years ago. Can you be a Fossil Scene Detective and use scientific evidence to solve the mystery of your animal's diet?

As scientists we already know about the following evidence from other investigations:

- All living organisms, including plants, contain little particles called carbon atoms.
- There are different types of carbon particles called isotopes.
- Grasses have more Carbon-thirteen ( $^{13}\text{C}$ ) isotopes. Trees and bushes have more Carbon-twelve ( $^{12}\text{C}$ ) isotopes.
- In our Shoebox Spectrometer Carbon-thirteen ( $^{13}\text{C}$ ) isotopes glow orange and Carbon-twelve ( $^{12}\text{C}$ ) isotopes glow yellow.
- We are what we eat; when an animal eats a plant, the plant's carbon atoms become incorporated into every part of that animal's body.
- There are two major kinds of herbivores, animals that eat plants.
  1. Grazers – Animals that feed on different types of grasses
  2. Browsers – Animals that feed on the leaves and twigs of bushes and trees

Shoebox Spectrometer Readings:

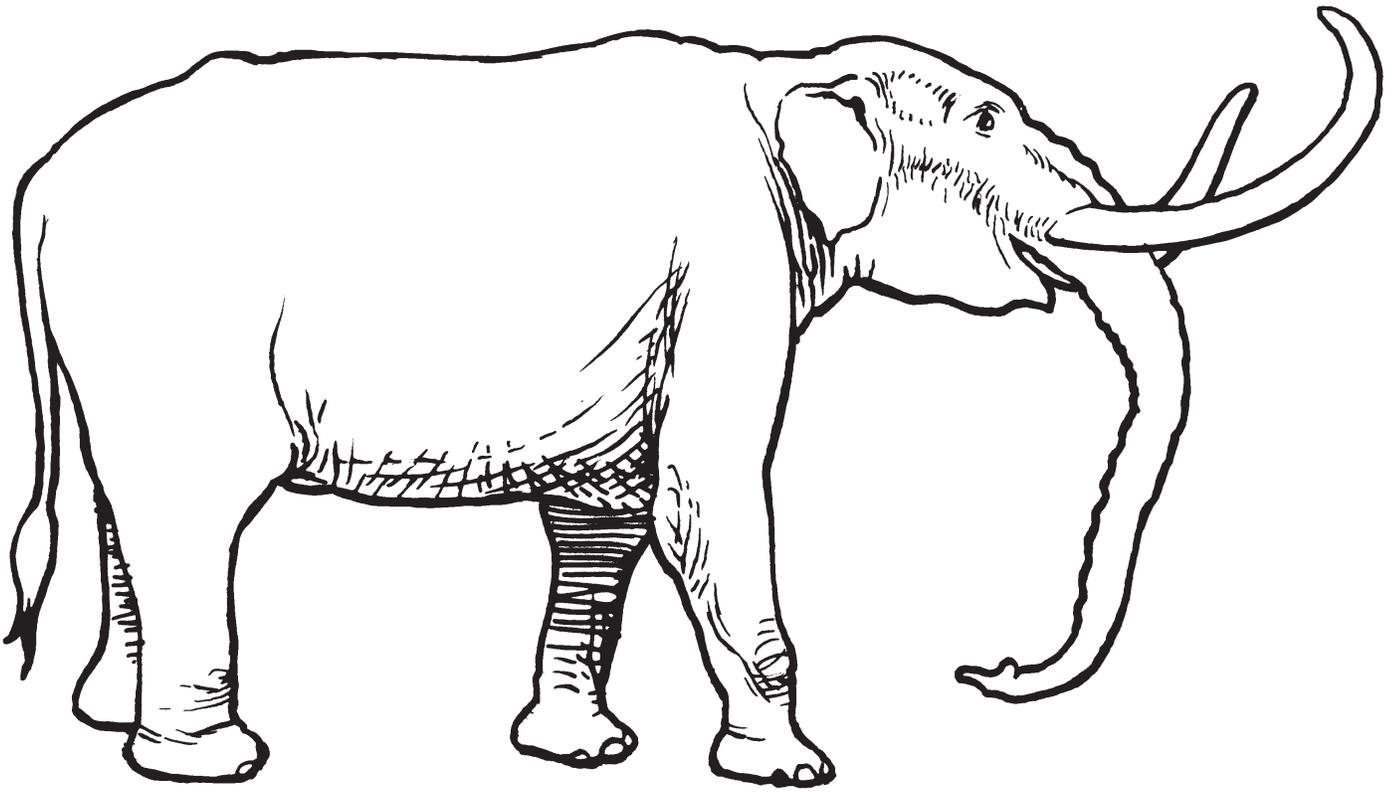
\_\_\_\_\_ Yellow Dots

\_\_\_\_\_ Orange Dots

Does your "fossil bone" belong to a grazer or a browser?

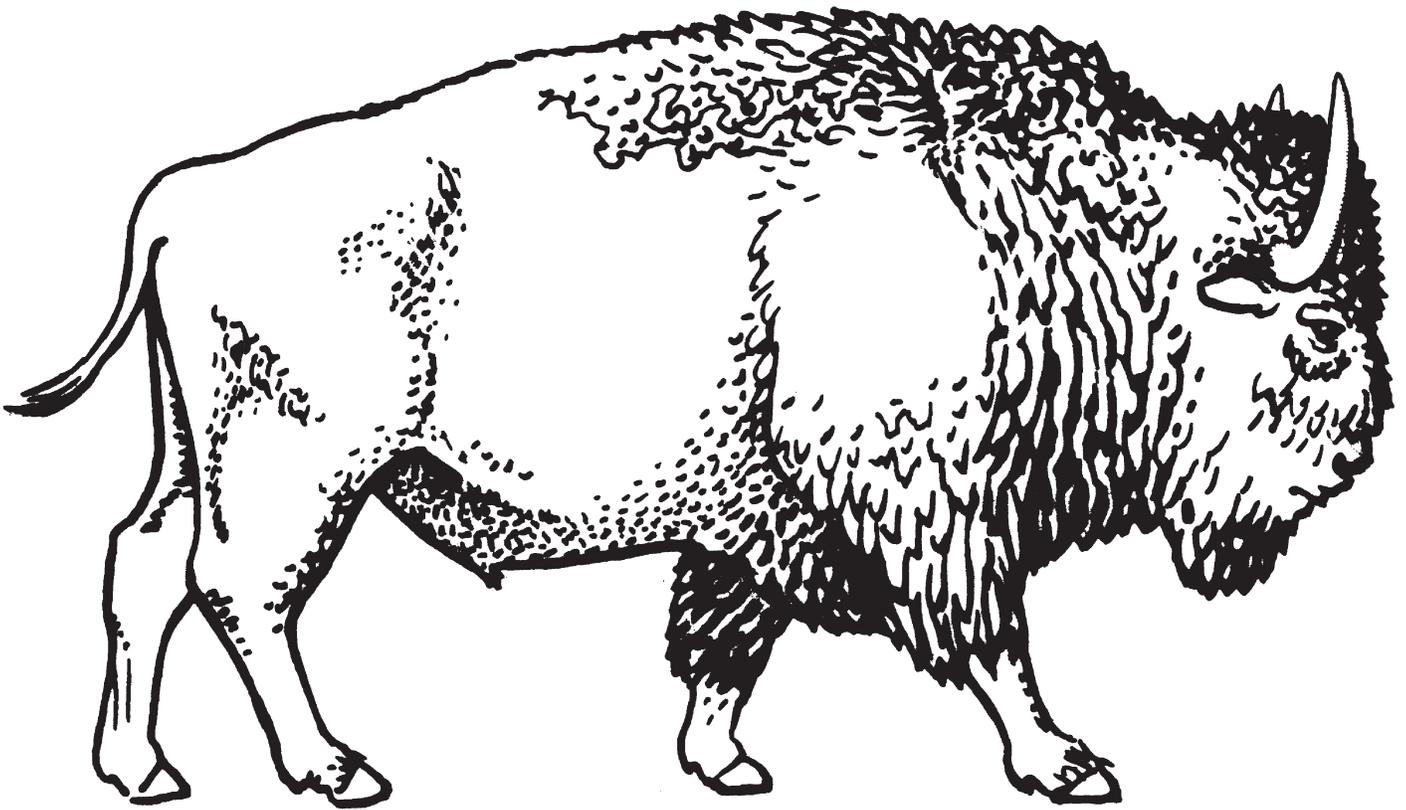
Whose bone do you have?

**Browser: Mastodon**





Grazer: Bison





## Activities: Web of Life



**Objective:** To help students understand the interconnectedness of organisms in a food web.

### Materials:

Large Ball of yarn  
Index cards (made before class)

### Suggested Approach:

Review with your class the differences between a Food Chain and a Food web. A food chain is a simple progression of organisms eating other organisms and a food web is defined as the network or web of interconnected organisms through which energy is transferred. As energy comes to the Earth from the sun, it's converted to food energy by plants. Explain to them that today they are going to see how a food web works and what happens if the web is broken.

### Procedure:

(Before Class)

Prepare some food web cards as described below, and laminate them ahead of time. This activity is based on the network of food chains that interact in an ecosystem. Make cards with plants and animals found in your region or the region you are studying. Write the name of each element of a full food web on 3-inch x 7-inch cards. To really illustrate each element in the web, glue its picture on the card. Attach both ends of each card to a string so that a card can hang around the neck of each student (the cards may be pinned onto the students' clothing instead of being hung around their necks.)

An example of a typical Pleistocene (late ice age) food web may have looked as follows:

Sun

5 plants (examples: sabal palm, oak tree, fern, grass, and fruit tree)

5 insects (dragonfly, mosquito, spider, centipede, grasshopper)

3 reptiles or amphibians (bullfrog, box turtle, snake)

2 fish (bass and catfish)

3 birds (duck, heron, and osprey)

2 raptors (Koford's condor and hawk)

3 herbivorous (mastodon, rabbit, and Skinner's pronghorn)

3 carnivorous (American Lion, Saber-toothed cat, and wolf)

3 decomposers (mushrooms, mold, worm)

Non-living components of the food web like water, air, soil

You can also add other animals (like omnivores) or plants to this food web so that everyone in the class participates.

## Activities: Web of Life



(During Class)

1. Hand out a food web card to each student. You may choose to have one big group or use a small group as the example and then divide the class into three groups of eight to ten students.
2. The person who has the Sun card starts the activity. The sun holds the end of the ball of yarn and throws or rolls it to someone holding a plant card. Each time the yarn is thrown, the individual throwing holds onto his or her end, and explains the connection. --“The sun gives energy to the grass.” After a while, the yarn will form a web in the center of the circle.
3. The next person holds onto the yarn and throws the ball to a herbivore or omnivore, explaining the connection. Examples of other connections include: “The spider eats the grasshopper;” then, “the bird eats the spider,” then, “The bird is eaten by the hawk.” This goes on until everyone holds a piece of the yarn. Make sure the yarn is long enough. The tension on the yarn must be tight to illustrate the interconnectedness of all aspects, but be sure the kids don’t wind the string around their fingers/wrists.
4. Something happens. The teacher points to a student, then announces that the student’s organism has been killed by a predator or by some other change either natural or caused by the human population. As that plant or animal drops out of the food web and lets go of the yarn, each person who feels the slack of the yarn lets go. Soon, the entire food web has fallen to the ground because one or two members of the food chain were killed. This game will be different every time, because animals and plants interact with each other in many different ways. Your students may wish to try this activity more than once.

### Discussion Questions

1. Be sure to ask your students what they learned from the activity.
2. Review the definition of extinction. How does the extinction of an animal effect different food webs/ ecosystems that they might be a part of?
3. Conversely, what if the population of one organism went out of control and grew too large? For example, what if there were too many carnivores and very few herbivores? What would the carnivores eat? What might happen to the food web?

# Activities: Junior Scientists

Grades: 2–6

Duration: 20–30 minutes



**Objective:** To help students identify misconceptions about scientists as individuals and review science as a process.

**Materials:**

- Drawing paper
- Pencil
- Crayons/markers

**Suggested Approach:**

When we hear the word, “scientist,” what does our imagination conjure up? Wild hair and big laboratories with lots of fizzing chemicals or someone who digs for dinosaur bones? I want you all to sit and think a little bit about who you think a scientist is. What do they look like? Where do they work? What do they study?

**Procedure:**

1. Have the students draw a picture of their scientists and answer the questions above (What do they look like? Where do they work? What do they study? What tools do they use?).
2. Tell them that if they want to write more about their scientists than that they can. (For example what does your scientist do with his/her free time? etc.)
3. When the students are done have them share the picture and information about their scientist.

**Discussion Questions:**

1. Ask the students to find the similarities and differences in the drawings?
2. Explain that scientists can be male or female, come from various backgrounds, and work in various fields of study. The only common connection is that all scientists are curious. They use their curiosity to understand their surroundings through observation, asking questions, doing experiments, and seeing what happens. Ask the students how they are scientists. What are they curious about? How do they learn about it?

Have they run experiments like mixing different colors of paint to see what they get?

3. Review science as a process of advancing knowledge based on inquiry and observation. This process is called the Scientific Method and begins with a person wondering “why” something happens. From there the person forms a question about an observation. Then a hypothesis is formed, which is a testable explanation for the observation. Next scientists design an experiment to test their hypothesis. Based on the data collected from the experiment, the scientist determines if their explanation or hypothesis was correct. If not, they think of another hypothesis and test that one, and if that doesn’t work, they keep trying until they find a hypothesis that is supported by lots of different scientific data or evidence. Once this happens the hypothesis becomes fact. (There is a more detailed review of Scientific Method in the Glossary.)

## Activities: Junior Scientists



4. How do they think can we use the research/information provided for us by scientists like paleontologists? How can we, as citizens, use and benefit from scientific research/information in our everyday lives?

Examples of how we use this information:

1. To help put current climate fluctuations in context and provide insight into future climate changes.
2. Knowledge of how plant and animals reacted to the dramatic shifts in climates during the Ice Age may aid researchers dealing with current conservation and global warming issues.
3. By understanding the last mass extinction, we may learn more about the wave of current and impending extinctions.

(Insert the "Exhibit Guide" here)

# Glossary



**Archaeologist** – someone who studies ancient cultures through the examination of their material remains (e.g. buildings, graves, tools, and other artifacts dug up from the ground)

**Bacteria** – a microorganism

**Browser** – an animal that feeds on the leaves and twigs of bushes and trees

**Carnivore** – an animal that eats other animals

**Cast Fossil** – A type of fossil that occurs when a mold fossil becomes filled with sediment, which hardens into rock. This creates a detail image of the part of the organism that made the mold

**Dehydration** – the removal of moisture from tissue

**Desiccation** – the removal of moisture from tissue

**Ecosystem** – This is an area that contains organisms, such as plants, animals, and bacteria, interacting with one another and the non-living components of that environment. Ecosystems can be of any size (e.g., forest, meadow, and log).

**Epoch** – A unit of geologic time that is a division of a period

**Era** – The longest division of geologic time, made up of one or more periods

**Evidence** – something that gives proof of the existence or truth of something

**Excavate** – to dig in a place carefully and methodically, taking notes about procedures, conditions, and finds of interest to a specific field of study

**Extinct** – having died out or ceased to exist

**Fauna** – the animal life of a particular region or period

**Food Chain** – a simple progression of organisms eating other organisms

**Food Web** – the network or web of interconnected organisms through which energy is transferred

**Fossils** – the remains of an animal or plant preserved inside rock or other geological deposits

**Grazer** – an animal that feeds on different types of grasses

# Glossary



**Great American Interchange** – The dispersal of animals between North and South America in both directions via the formation of the Isthmus of Panama about 3 million years ago

**Herbivore** – an animal that feeds mainly on grass or other plants

**Hypothesis** – A tentative explanation for an event, used as a basis for further investigation

**ice age** – A cold period marked by episodes of extensive glaciation alternating with episodes of relative warmth

**Ice Age** – The most recent glacial period, which occurred during the Pleistocene Epoch

**Isotope** – either of two or more forms of a chemical element that has a different number of neutrons in the nucleus (giving it a different atomic weight)

**Mammals** – animals that have hair, are warm-blooded, and nourish their young with milk

**Mass extinction** – the destruction of a whole species by force of nature such as a climate change, volcanic eruption, an asteroid collision, or human impact

**Mass spectrometer** – a special machine that counts the amount of different types of isotopes present in a substance

**Megafauna** – large animals of any particular region or time

**Mold Fossil** – A type of fossil that occurs when the organic material of an organism rots away, leaving an empty space in the hardened sedimentary rock

**Omnivore** – an animal that feeds on many different kinds of food, including both plants and animals

**Paleontologists** – someone who studies the fossil remains of extinct animals and plants

**Permineralization** – A process of fossilization that is characterized by minerals depositing in the empty spaces between cells, leaving a stone image of the organism after the organic material decays

**Proboscidean** (PRO-bo-SID-ee-un) – A large animal with tusks and a long, flexible trunk or proboscis; a member of the Order Proboscidea. This group includes modern elephants, as well as mammoths, mastodons, and other extinct species. Proboscideans also are called tuskers.

# Glossary



**Replacement** – A process of fossilization that is characterized by the replacement of organic molecules by minerals, one for one, as they decay

**Scientific method** – the system of advancing knowledge by formulating a question, collecting data about it through observation and experiment, and testing a hypothetical answer. When using the scientific method one must follow several steps:

1. Observe, State Experimental Questions - After observing a phenomenon, write down any observations and questions.
2. Gather Information - Do background investigation on the phenomenon and find out what is known about it already.
3. Formulate a Hypothesis – Based on the information gathered, write a tentative explanation for an observation, phenomenon, or scientific problem that can be tested by further investigation and experimentation.
4. Design an Experiment to Test Your Hypothesis - Determine a logical set of steps to be followed in your experiment.
5. Independent/Experimental Variable - Determine or guess which factors could affect the phenomenon you are studying. The experimental variable is the one variable the investigator chooses to vary in the experiment.
6. Perform the experiment
7. Collect Data - Record the results of the investigation in a table or chart.
8. Summarize Results - Analyze the data and note trends in the experimental results.
9. Draw Conclusions - Determine whether or not the data supports the hypothesis of the experiment and explain.

**Theory** – a set of facts, prepositions, or principles analyzed in their relation to one another and used to explain phenomena

**Trace Fossil** – fossils that give us proof of animal life from the past, including fossils like footprints, burrows, and fossilized poop. There are two types of trace fossils, mold and cast fossils

**Tusk** – Any greatly enlarged tooth which projects when the mouth is closed.

# Additional Resources



## Books

### ***Big Old Bones***

**Carrick, Carol**

This storybook is best for ages 4-9 and is shows students how fossilized dinosaur bones are like pieces to a puzzle, and scientists have not always put the puzzle together correctly. The story is about a fictitious paleontologist, Professor Potts, and his struggles to construct a dinosaur from unidentified fossilized bones.

### ***First Dog***

**Brett, Jan**

This storybook is best for ages 4-8 and is a simple, imaginative tale set at the end of the Ice Age. The story discusses how the first domestication of a wild animal may have occurred.

### ***Wild and Woolly Mammoths***

**Aliki**

This book is best for ages 6-10. The book tells of the discovery of a preserved woolly mammoth in Siberia and how scientists used information from this site, along with more recent archeological findings, to determine when and where these ancestors of the elephant lived.

# Additional Resources



## Websites

### Enchanted Learning

<http://www.enchantedlearning.com/subjects/mammals/Iceagemammals.shtml>

### Florida Museum of Natural History: Fossil Horses in Cyberspace museum

<http://www.flmnh.ufl.edu/fhc/firstCM.htm>

### Illinois State Museum

Ice ages:

[http://www.museum.state.il.us/exhibits/ice\\_ages/](http://www.museum.state.il.us/exhibits/ice_ages/)

The Pleistocene:

<http://www.museum.state.il.us/exhibits/larson/index.html>

### National Geographic

[http://news.nationalgeographic.com/news/2001/11/1112\\_overkill\\_2.html](http://news.nationalgeographic.com/news/2001/11/1112_overkill_2.html)

### Paleontology Portal

<http://www.paleoportal.org/>

### The Paleontological Society

<http://www.paleosoc.org/>

### Public Broadcasting Service, NOVA

<http://www.pbs.org/wgbh/nova/ice/chill.html>

### Science Daily

<http://www.sciencedaily.com/releases/2004/03/040319071426.htm>

### South Carolina State Museum Kids Corner

<http://www2.richland2.org/rce/Websites/fossils.htm#The%20Ice%20Age>

### Wikipedia, The Free Encyclopedia

Great American Interchange:

[http://en.wikipedia.org/wiki/Great\\_American\\_Interchange](http://en.wikipedia.org/wiki/Great_American_Interchange)

Megafauna:

[http://en.wikipedia.org/wiki/Pleistocene\\_megafauna](http://en.wikipedia.org/wiki/Pleistocene_megafauna)

# Florida Museum of Natural History

## TUSKS! Educators' Guide – Evaluation Form

Your Name \_\_\_\_\_  
School/Institution \_\_\_\_\_  
City/State \_\_\_\_\_  
E-mail \_\_\_\_\_  
Date Used \_\_\_\_\_ Grade/age \_\_\_\_\_

1. What components of the Educator's Guide did you use?

- Alignment to Standards
- Teacher Background
- Activities
- Glossary
- Additional Resources
- Field Guide

2. To what level did the activities engage the students and stimulate their curiosity and desire to learn the subject?

Not at all      1    2    3    4    5      Highly

3. Rate the effectiveness of the materials in helping to present science information to your class.

Not at all      1    2    3    4    5      Very Effective

4. Did you use the Educator's Guide in connection with your existing curriculum or did you create a new lesson around the guide?

5. What did you like best about the Educator's Guide? Least?

6. How would you improve the Educator's Guide?

7. What was our overall assessment of the Educator's Guide?  
*If you circle "Fair" or "Poor" please explain.*

Ease of use –                      Poor    1    2    3    4    5    Excellent

Relevance to Exhibit –                      Poor    1    2    3    4    5    Excellent

Appearance, layout, design -                      Poor    1    2    3    4    5    Excellent

8. Additional Comments: