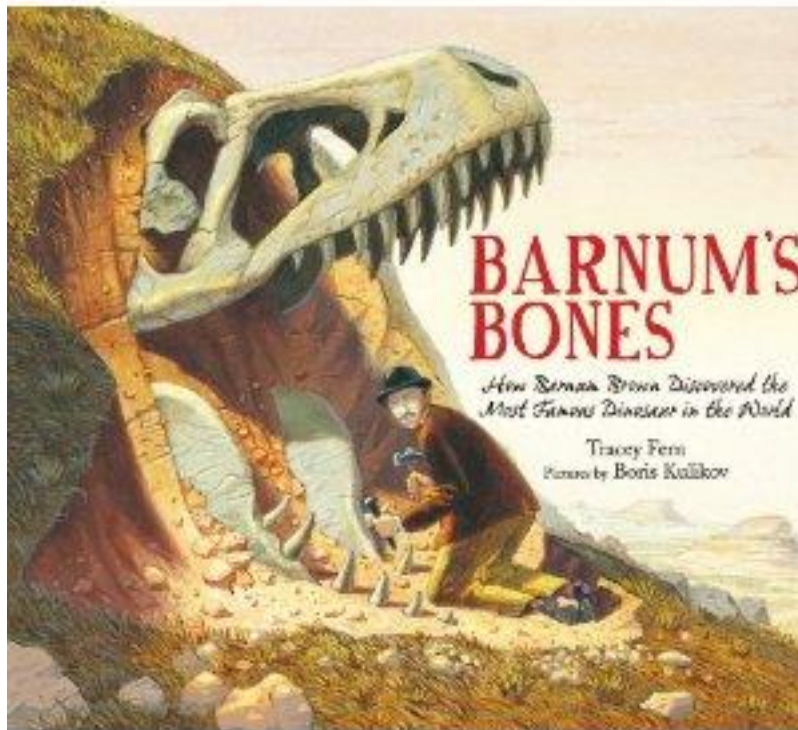


Teacher's Guide



Barnum's Bones: How Barnum Brown Discovered the Most Famous Dinosaur in the World

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Young Barnum Brown filled every nook and cranny of his Kansas home with fossil shellfish. But he dreamed of finding something much bigger than snails – he dreamed of unearthing a dinosaur – a dinosaur that no one had ever seen before. Barnum spent years searching for dinosaurs, and he found many bones. Finally in 1902, Barnum spotted something unusual while he was searching the desolate badlands of Montana. What could it be? After months of digging, cleaning, transporting and then piecing his find together, Barnum realized he had found something truly unique: the world's first specimen of a giant dinosaur that would soon be known as *Tyrannosaurus rex*!



CLASSROOM ACTIVITIES LINKED TO ENGLISH LANGUAGE ARTS

A. Friendly and Persuasive Letters

In 1902, 1905, and 1908, while Barnum was hunting for fossils in the remote badlands of Montana, he and Professor Henry Osborn, his boss at the American Museum of Natural History in New York City, wrote many letters back and forth. These letters contain scientific information about Barnum's hunt, practical information about his need for gear and money, and personal information about things like the weather, the food, and the local people. These letters were Barnum's only form of communication for months at a time and were essential to his fossil hunts.

1. Ask your students to imagine that they are friends of Barnum Brown and are curious about his life and experiences searching for dinosaurs in Montana at the turn of the 20th century. Have the students write a friendly letter to Barnum asking about his experiences. The letter should contain the date, greeting, body, closing, and signature.
2. Ask your students to pretend to be Professor Henry Osborn, Barnum's boss at the American Museum of Natural History. Have the students write a persuasive letter from Professor Osborn to Barnum, asking that he give up his fossil hunt after searching without luck for months. Make sure students follow the structure of a good persuasive argument:
 - Introduction;
 - State their position clearly;
 - Support their position with relevant evidence;
 - Address any concerns that they imagine their opposition will have with their position; and
 - Reaffirm their position and conclude that their position is superior.

B. Field Journal

A field journal is one of a paleontologist's most important research tools. Like a laboratory report, it contains all of the paleontologist's critical observations. Unfortunately, Barnum didn't always keep the most detailed records in his journal. Your students can do better!

Have your students go to the American Museum of Natural History website and look at some of Barnum's original field journals. ([Link](#)) Have students write two journal entries from 1902, one on the day before Barnum discovered his first *T. rex* bones and the second entry on the day Barnum made his discovery. A field journal often contains

personal remarks, but it is primarily a scientific tool. Remind students that good field notes are detailed, organized, and legible so that others can use them. A thorough journal entry should include:

- Date and time;
- Location and condition of all finds;
- The weather conditions and people present;
- The surrounding geology; and
- All processes used to gather and analyze the finds.

C. What's in a Name?

Barnum and Professor Osborn had to come up with a name for their newly discovered dinosaur. Professor Osborn decided upon Tyrannosaurus Rex, which means “tyrant lizard king,” because the fossil record indicated that their new dinosaur was huge and fierce.

The names of dinosaurs are often made up of combinations of Latin and Greek root words that describe the animal. The names may include where the dinosaur was discovered, what it looked like, or the name of the scientist who made the discovery. For example, the word ‘dinosaur’ is derived from ‘dino’, meaning “terrible,” and ‘saurus,’ meaning “lizard.” Using the following chart of Greek and Latin root words, ask your students to figure out what the names of these dinosaurs mean: Ankylosaurus, Astrodon, Brachiosaurus, Brontosaurus, Centrosaurus, Corythosaurus, Microceratops, Spinosaurus, Triceratops, Velociraptor.

<u>Root Word</u>	<u>Meaning</u>
Ankylo (Greek)	Crooked or hooked
Astro (Greek)	Star
Brachio (Greek)	Arm
Bronto (Greek)	Thunder
Centro (Latin)	Left
Corytho (Greek)	Helmet
Don (Greek)	Tooth
Micro (Greek)	Small
Cera (Greek)	Horn
Raptor (Latin)	Robber
Saurus (Greek)	Lizard
Spino (Latin)	Thorn or backbone
Stego (Greek)	Roof or cover
Tri (Greek)	Three
Tops (Greek)	Face
Veloci (Latin)	Speedy

CLASSROOM ACTIVITIES LINKED TO SCIENCE AND TECHNOLOGY

A. Traveling the Prehistoric Time Line

Barnum's T. rex was certainly old: approximately 65 million years old! But life on earth has existed for more than 3.5 billion years. During that time, the planet has undergone dramatic changes.

Scientists use important biological and geological changes to divide the history of life on Earth into periods of time called **eras**. The earth's eras and their approximate time spans are as follows:

Precambrian Era or Supereon: 4,600-570 million years ago

Paleozoic Era:

Cambrian Period (570-500 mya)

Ordovician Period (505-438 mya)

Silurian Period (438-408 mya)

Devonian Period (408-360 mya)

Carboniferous Period (360-280 mya)

Permian Period (280-245 mya)

Mesozoic Era (the era of dinosaurs):

Triassic Period (245-208 mya)

Jurassic Period (208-146 mya)

Cretaceous Period (146-66 mya)

Cenozoic Era:

Paleogene Period (66-24 mya)

Neogene Period (24-1.8 mya)

Quaternary Period (1.8 mya-today)

Have your students create a timeline around the classroom, divided into the four major geological periods listed above. Using the National Geographic website (<http://science.nationalgeographic.com/science/prehistoric-world/prehistoric-time-line/>) as a resource, ask students to place the following events on their timeline:

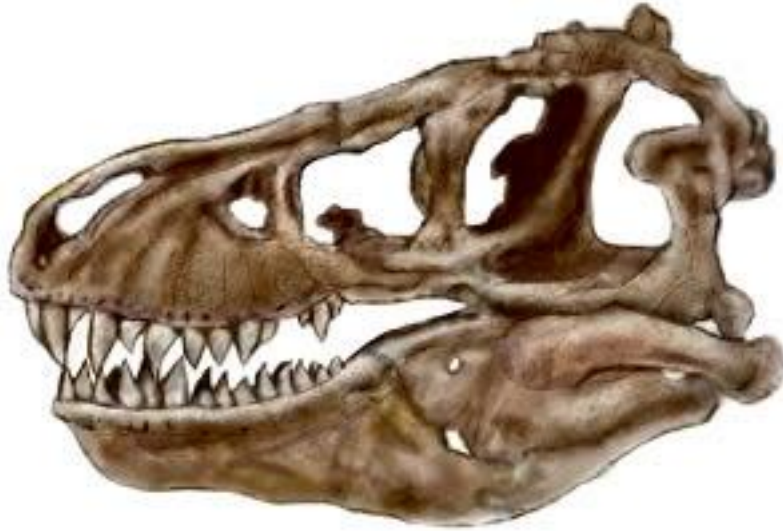
*First humans, mammoths, mastodons, saber-toothed cats (Quaternary)

- *First sheep, modern whales, bears, mice (Neogene)
- *First cats, pigs, rhinos, elephants, horses, owls and primates (Paleogene)
- *First flowering plants, snakes, crocodilians. *T. rex* and Triceratops arrive. Mass extinction kills dinosaurs (Cretaceous)
- *Many dinosaurs such as Diplodocus, Brontosaurus, and Allosaurus, first birds (Jurassic)
- *First mammals, dinosaurs such as Plateosaurus, Eoraptor, and Saturnalia, frogs, turtles (Triassic)
- *First reptiles (Carboniferous)
- *First amphibians (Devonian)
- *First spiders and land plants (Silurian)
- *First cartilaginous fish. (Ordovician)
- *Explosion of life. First shellfish, primitive fish, corals, mollusks (Cambrian)
- *Earth forms. First multi-celled animals appear (Precambrian)

B. Reading the clues: Making Inferences from Evidence

*Scientists carefully studied the size and shape of Barnum's *T. rex* skeletons to make assumptions about the way that *T. rex* lived. For example, scientists know that carnivores usually have curved, sharp teeth. The *T. rex* skull that Barnum discovered in 1908 had 6-inch-long, serrated teeth. From this fossil evidence, scientists concluded that *T. rex* was a carnivore.*

Ask your students why they think some teeth are pointy, such as canines, while others are flat, like molars. See if students can guess which are better for ripping meat from prey and which are better for grinding plants. Have students study the *T. rex* skull below, paying particular attention to the teeth and jaws. Let students examine their own teeth in a mirror. Discuss what teeth shape they think most modern-day carnivores (wolves, lions, etc...) and what teeth shape most herbivores (cows, giraffes, etc...) have.



C. Rock Collections

When Barnum Brown was a young boy, he loved to collect rocks, some of which contained fossil shellfish. There are three types of rocks: sedimentary, metamorphic, and igneous. Igneous rock forms when molten lava from the Earth's core cools and forms solid rock. Sedimentary rock forms when little bits of rock are worn away and get deposited as sediments and eventually harden. Metamorphic rocks are rocks that have been transformed by great heat or pressure. Rocks can be sorted and classified as sedimentary, metamorphic, and igneous according to their properties.

Ask your students to start a rock collection. Rocks should fit into one compartment of an egg carton. Students should try to collect rocks that look different and try to get rocks from different locations. Ask students to read non-fiction books about rocks, such as *Everybody Needs a Rock* by Byrd Baylor and *Let's go Rock Collecting* by Roma Gans. Ask students to sort their rocks into groups based on their properties such as color, texture, particle size, layering, and hardness. Finally, ask your students to label their rocks as igneous, metamorphic or sedimentary, based on these properties.

[CLASSROOM ACTIVITIES LINKED TO THE ARTS](#)

A. Cretaceous Collages

At the time T. rex lived about 65 million years ago, the landscape and climate in Montana and across the Great Plains was very different from today. Instead of barren hills and rocky formations, there was a warm, tropical sea. Rivers meandered to the sea across nearby green plains, depositing sediments picked up in the mountains to the west. Swamps flourished and forests grew where the land rose gently. Temperatures were

warm throughout the year. Many different creatures inhabited the plains, side by side with *T. rex*: mammals, amphibians, fish, birds, and other dinosaurs and reptiles.

Have your students learn about *T. rex*'s environment by reading non-fiction picture books such as *Tyrannosaurus rex* by Sara Gilbert (Mankato, MN: Creative Education, 2011), *Tyrannosaurus rex and Other Giant Carnivores* by David West (New York: Gareth Stevens Pub., 2001), and *Tyrannosaurs rex Up Close: Meat-Eating Dinosaur* by Peter Dodson (Berkeley Heights, NJ: Bailey books/Enslow Publishers, 2011). Working in groups, ask your students to create a collage to show the environment in which *T. rex* lived. Use the descriptions and illustrations in these non-fiction picture books to help students find pictures from magazines or make drawings for the collage. In class discussions, ask your students to think about:

- How does the environment they live in differ from the environment in which *T. rex* lived? How is it the same?
- How was *T. rex* dependent on its environment. How are we dependent on our environment?
- How did *T. rex* affect the environment in which it lived. How do we affect our environment?

[DINOSAUR FAQs](#)

- **What are dinosaurs?**

Dinosaurs were reptiles that lived during the Mesozoic Era, about 250-65.5 million years ago. Scientists believe they were related to modern day birds. During the Mesozoic Era, there were many different sizes, shapes, and lifestyles of dinosaurs. Some were huge, like *T. rex*, and some were quite small - only a few feet long and a couple of pounds. In addition, some were carnivores (meat-eaters), some were herbivores (plant-eaters) and some were omnivores (not too picky).

- **Where can you find dinosaur fossils?**

Dinosaurs lived all over the world from tropical to polar regions and everywhere in between. Different species of dinosaurs lived in different environments.

- **What are fossils?**

Fossils are any evidence of past life. Scientists have tried to come up with ways to group fossils. Some scientists group fossils as body fossils

and trace fossils. **Body fossils** come from the animal itself and include bones, claws, and teeth. **Trace fossils** are what the animal left behind. They can include skin impressions, footprints, and nests.

Dinosaur bone fossils were formed like this:

- ❖ A dinosaur died, and its body was left alone by scavengers;
- ❖ The dinosaur's skin and flesh rotted away and the animal was quickly buried in **sediment** (the rocky material that settles in the bottom of a liquid such as water);
- ❖ The sediment hardened. Minerals from percolating water filled some of the small spaces in the bone or replaced some of the original minerals in the bone;
- ❖ Movements in the earth's crust raised the dinosaur and erosion exposed the fossil.

- **How many *T. rex* skeletons have been found?**

So far, only eleven or so nearly complete *T. rex* skeletons have been found, although partial skeletons of many other *T. rex* have been uncovered. All of these skeletons have been found in the United States and Canada.

- **What did *T. rex* eat?**

Scientists believe that *T. rex* was a carnivore, based upon the shape of its teeth and claws as well as other evidence. *T. rex* teeth marks have been found on fossil skeletons of *Triceratops* and other large herbivorous (plant-eating) dinos. Also *T. rex* coprolites (fossilized dung) have been found with bits of bone inside. Scientists are still debating whether *T. rex* hunted its prey or scavenged from dead animals.

- **How much did *T. rex* eat in one day?**

Scientists aren't sure. It's possible that *T. rex* ate a lot at one time and then didn't eat again for some time, similar to modern-day meat-eaters like the lion.

- **How tall was *T. rex*?**

T. rex was at least 12 feet tall.

- **How much did *T. rex* weigh?**

T. rex probably weighed at least seven tons.

- **What happened to *T. rex* and other dinosaurs?**

There are many theories about what caused dinosaurs, and many other species, to go extinct at the end of the Mesozoic Era. Some scientists believe that a large meteorite that hit the Earth 65.5 million years ago most likely caused the last remaining dinos to go extinct. However, dinosaurs had been diminishing in number and diversity before the meteorite, so there may also have been other factors that contributed to their eventual extinction.

ADDITIONAL WEB RESOURCES

- **Dinosaur Fact:** <http://www.dinosaurfact.net/>
Explore this huge site filled with everything dinosaur, including a timeline and comprehensive listing of dinosaurs
- **National Geographic Prehistoric Time Line:**
<http://science.nationalgeographic.com/science/prehistoric-world/prehistoric-time-line/>
Check out this detailed description and depiction of the earth's geological timeline.
- **The Dinosauria: Truth is Stranger than Fiction:**
<http://www.ucmp.berkeley.edu/diapsids/dinosaur.html>
Learn about various species of dinosaur and trace their relationship to modern birds and reptiles.
- **Smithsonian National Museum of Natural History:**
<http://paleobiology.si.edu/dinosaurs/interactives/dig/dinodig.html>
Go on a virtual dinosaur dig to discover, uncover, prepare, transport and assemble a dinosaur.

ADDITIONAL PRINT RESOURCES

- ***Age of Dinosaurs: Tyrannosaurus rex*** by Sara Gilbert (Mankato Minnesota: Creative Education, 2011).
- ***Bones Rock! Everything You Need to Know to Be a Paleontologist*** by Peter Larson & Kristin Donnan (Montpelior, VT: Invisible Cities Press, 2004). A great guide to becoming a paleontologist, including fossil collection and cleaning.

- **Dougal Dixon's Dinosaurs** by Dougal Dixon (Honesdale, PA: Boyds Mills Press, Inc., 2007). A great reference book containing a fully illustrated exploration of 38 dinosaurs.
- ***How the Dinosaur Got to the Museum*** by Jessie Hartland (Maplewood, NJ: Blue Apple Books, 2011). A fun and informative non-fiction picture book about the discovery and transport of a Diplodocus dinosaur from Utah to the Smithsonian National Museum of Natural History.
- ***Inside Dinosaurs*** by Andra Serlin Abramson, Jason Brougham, and Carl Mehling (New York, NY: Sterling Publishing Co., Inc., 2010).

GLOSSARY

Carnivorous: A meat-eating animal.

Coprolite: Fossilized poop.

Fossils:

Herbivorous: A plant-eating animal.

Paleontologist: A scientist who specializes in the study of ancient life – plants and animals usually more than 10,000 years old.

Sediment: Tiny bits of rocky matter that settle to the bottom of a liquid.