

THE ACADEMY OF NATURAL SCIENCES  
of DREXEL UNIVERSITY

## Teacher's Guide to **Fossil Forensics** Grades 3-6

**Description:** You won't see a living *Tyrannosaurus rex* or a mastodon hanging around in your backyard (we hope!). So how do paleontologists know about extinct animals? Solve some of the mysteries of ancient adaptations and behaviors yourself. Use evidence to make inferences about ancient animals by examining fossils, artifacts, and museum specimens. Includes a guided experience in Dinosaur Hall.

**Outcomes:** Students will be able to recognize the purpose of adaptations and make predictions about the function of various parts based on morphology. Students will understand the significance that fossils hold within natural history. Students will be able to conduct a scientific investigation and come to logical conclusions through the use of models and observations. Students will be able to make connections between the anatomy of ancient animals and the anatomy of modern-day animals.

**Connection to the Academy:** Vertebrate paleontology was first studied in the United States in Philadelphia through a joint effort between the Academy of Natural Sciences and the American Philosophical Society. Since its founding, the Academy has worked with many famous paleontologists such as Dr. Joseph Leidy, Edward Drinker Cope, and recently Dr. Ted Daeschler, co-discoverer of transitional fossil *Tiktaalik roseae*. The Academy is also home to the fossil collection of President Thomas Jefferson, the first dinosaur fossils collected in North America, and a fossil specimen collected by Lewis and Clark. Today, the Academy is home to over 22,000 vertebrate paleontology specimens, with active research uncovering more every day.

### Suggested Activities Before Your Visit

- **The Beloved *Brontosaurus***- Have you ever thought you were right about something until you gained more information? How did the new information change your thoughts? Have students read the attached article, "The Beloved *Brontosaurus*," and look at the accompanying infographic. What surprised you about the article? Why does scientific knowledge change so frequently? Why has the status of *Brontosaurus* changed so many times?
  - **Extension**- Ask students to research different methods and technologies that paleontologists use when studying ancient life. How have the methods changed over time? What techniques are the same? What new technologies might paleontologists use? Students should write summaries of what they learned and share them with the class.
- **Prehistoric Adaptations** - What makes animals better adapted for one environment than another? Provide your students with example animals from a cold environment, a hot environment, a forested environment, and

#### Vocabulary

*Paleontology*  
*Fossil*  
*Adaptation*  
*Dinosaur*  
*Extinct*  
*Body Fossil*  
*Trace Fossil*

an aquatic environment. Discuss how each animal is adapted to its environment. What physical characteristics help it survive? What behaviors that the animal exhibits might help it survive? Show students pictures of animals with different lifestyles, being sure to include an herbivore, an omnivore, a carnivore, and animals with strong defenses to use against predators. Discuss how each animal is adapted to its lifestyle. Show students pictures of a diverse set of dinosaurs. What adaptations did these dinosaurs have? How are we able to determine the adaptations of animals that are no longer living? Are we able to determine everything about how each animal lived? What kinds of adaptations might it be difficult to learn about from fossil evidence?

## **Suggested Activities After Your Visit**

### **Classroom Activities**

- **How Did the Dinosaurs Live?-** How might a field biologist study a modern-day animal? What are some of the things that could be looked at to learn about the animal's life? Explain that scientists studying ancient animals have to try to determine how these animals lived their lives using only what has been left behind and fossilized. What kinds of things can be fossilized? The fossilized bones we typically think of when we say "fossils" are usually referred to as body fossils. However, fossils include much more than just bones. Fossils can include footprints, skin imprints, excrement, nests, and even fossilized traces of plants that were in the area at the time. These fossils are typically referred to as trace fossils. Body fossils and trace fossils show us different kinds of information about ancient life. What types of things can be discovered from a body fossil? Why might a fossil's placement matter? What kinds of things can be discovered from a trace fossil? How is the use of fossils to study an animal similar to and different from the study of modern-day animals?

### **Homework Assignments**

- **Paleontology Current Events-** Have students find a paleontology-related current event and write a summary of it. What was the article about? What is the significance of the article?

### **Interdisciplinary Activities**

- **The People of Paleontology-** Assign each student to a famous paleontologist to study (sample list at <http://dinosaurs.about.com/od/famouspaleontologists/> ). Students should research questions such as when they lived, what discoveries they made, where they did their research, and what theories they believed in. Students can either write a report on them, or the class can have a "Paleontology Conference" in which the students dress as their paleontologist and talk to the other students about their discoveries. Props are encouraged!

## Writing/Drawing Prompts

- Have students pretend to be their favorite dinosaur. Ask them to write a story about what a day in the life of that dinosaur would have been like. Additional research may be needed to give students more material for their stories.
  - **Extension-** Have students turn their stories into illustrated books. Students could then read their books to younger students in another class.
- Have students pretend that they are paleontologists. Ask them to write a paragraph explaining what they will be doing on their latest expedition and what they need to pack. This exercise may require an explanation of where digs happen and how fossils are obtained and packaged.

## Class Project Ideas

- **Dinosaur Research Project-** Assign each of your students to a dinosaur. Students will be asked to research their dinosaur and learn about its size, location, how it lived, when it lived, what it ate, etc. Some sample questions are provided on the attached worksheet. Have students fill out all the questions on the sheet. Create a display in the hallway where the length of each dinosaur is marked using masking tape. Have students create posters about their dinosaurs. Each student should present their poster to the class. Group them by time period and display them in your classroom.
  - **Extension-** Have students create models or dioramas of their dinosaurs, taking into account what their environment was likely to have been.
- **Fossil Dig-** Break students into groups and have them come up with their own extinct fossil animal. Students should name their animal and think about its diet, lifestyle, and physical attributes. Ask each group to make a drawing and write a paragraph about their animal (see attached planning worksheet). Have groups make fossils out of clay or other materials that could have come from their animal. Once all the fossils are made, provide each team with a large, flat storage bin with a few inches of sand or some type of covering material (recycled packing peanuts would work). Next, have each group excavate another's fossil dig. Have them record what they find as a paleontologist would. Have the students make a grid across the top of the containers with yarn and tape. Make at least a 9 by 9 grid pattern. As the students then excavate their fossil digs, have them record and draw the fossils in their correct locations on a matching piece of graph paper. Students will also be asked to measure their fossils and record the data. Groups will then get together and discuss what they can figure out from their fossils. Each group will then present what they think the animal was like from the fossils, followed by a presentation from the group that designed the fossil animal. After the process is complete, students will be asked to either make group posters or write summaries of what they learned from the process.

## Resources for Students

- Discover just one of the stories of the Academy's very own *Hadrosaurus foulkii* in *The Dinosaurs of Waterhouse Hawkins* by Barbara Kerley
- *Dinosaurs (DK Eyewitness Books)* by David Lambert

- *How Big Were the Dinosaurs?* by Bernard Most
- *Maia: A Dinosaur Grows Up* by John R. Horner and James Gorman
- Check out Dragonfly TV for a look at how two kids just like you investigate which animals lived with the dinosaurs: [pbskids.org/dragonflytv/show/dinosaurs.html](http://pbskids.org/dragonflytv/show/dinosaurs.html)
- *Dinosaurs: The Ecosystems Explorer* by Joanna Turner and Nicholas Harris
- *The Time-Life Guides: Dinosaurs* edited by Michael K. Brett-Surman
- Play Magic School Bus dinosaur quiz: [scholastic.com/magicschoolbus/games/quizzes/dinosaurs](http://scholastic.com/magicschoolbus/games/quizzes/dinosaurs)
- Read more about dinosaurs, play games, and see images of what dinosaurs may have looked like: [http://www.bbc.co.uk/sn/prehistoric\\_life/dinosaurs/](http://www.bbc.co.uk/sn/prehistoric_life/dinosaurs/)
- Learn about the Denizens of the Academy's own Dinosaur Hall: <http://www.ansp.org/explore/online-exhibits/dinosaurs/>
- Virtual tour of Smithsonian Dinosaur Hall: <http://paleobiology.si.edu/dinosaurs/interactives/tour/main.html>

## Resources for Teachers

- *Dinosaurs: The Most Complete, Up-to-Date Encyclopedia for Dinosaur Lovers of All Ages* by Dr. Thomas R. Holtz Jr.
- The website for the Academy of Natural Sciences includes wonderful information on the dinosaurs that can be found in our very own Dinosaur Hall: [ansp.org/museum/dinohall](http://ansp.org/museum/dinohall)
- For a quick reference guide to all things prehistoric, pick up a copy of *Dinosaurs and Prehistoric Life (DK Handbooks)* by Hazel Richardson
- Additional dinosaur activities can be found in *Dinosaurs for Every Kid: Easy Activities that Make Learning Science Fun* by Janice VanCleave.
- For some of the more probing questions about fossils, what happened to the dinosaurs, and the connections between dinosaurs and other animals, check out University of California Museum of Paleontology at [ucmp.berkeley.edu](http://ucmp.berkeley.edu)
- *Janice VanCleave's Dinosaurs for Every Kid* (general animal resource)
- *How Nature Works: 100 Ways Parents & Kids Can Share the Secrets of Nature* by David Burnie (general animal resource)
- *A Dictionary of Nature: 2,000 Key Words Arranged Thematically* by David Burnie (general animal resource)
- Activities about Paleontology from the National Parks Service: <http://www.nps.gov/brca/learn/education/paleontology.htm>
- <http://paleobiology.si.edu/dinosaurs/index.html>
- Article on the value of teaching paleontology in schools: <http://www.ucmp.berkeley.edu/fosrec/Stucky.html>
- [http://www.paleosoc.org/ed\\_resources.html](http://www.paleosoc.org/ed_resources.html)

## The Beloved *Brontosaurus*

The *Brontosaurus*, or “Thunder Lizard”, is the favorite dinosaur of many people. However, the *Brontosaurus* was not considered by scientists to be a real dinosaur for over a hundred years. The controversy was originally caused by a conflict called The Bone Wars, a rivalry between paleontologists Othniel Charles Marsh and Edward Drinker Cope. During The Bone Wars, each of these two paleontologists rushed to try and discover more fossils than the other. As a result, some fossils were named before enough evidence had been collected, and bad scientific practices were often used.

The first *Brontosaurus* skeleton was discovered by Othniel Charles Marsh in 1879, two years after his discovery of *Apatosaurus*. Both of these dinosaurs were named with very limited evidence to support them being separate species. *Apatosaurus* was named based solely on the discovery of its backbone, shoulders, and hips. The *Brontosaurus* discovered by Marsh was more complete, but it lacked a head. To add to the confusion, Marsh decided to place the head of another sauropod dinosaur, *Camarasaurus*, on the skeleton of what he was calling the *Brontosaurus*. Despite these problems, the public embraced the newly found *Brontosaurus*, and it became one of the most well-known dinosaur species.

In 1903, paleontologists took a closer look at the specimens and compared them to more recently found fossils. They determined that *Apatosaurus* and *Brontosaurus* were actually the same species; Marsh had found fossils of a juvenile and an adult and mistaken them for separate species. Because *Apatosaurus* had been named first, the name *Brontosaurus* was considered to be obsolete.

Now, after more than a hundred years, *Brontosaurus* is back! In 2015, a group of researchers led by paleontologist Emanuel Tschopp looked at 477 different anatomical traits on 81 different specimens using statistical analyses and determined that there were enough differences between *Apatosaurus* and *Brontosaurus* for them to be considered as separate species. Tschopp owes the discovery of differences to all of the recent advances in knowledge of sauropods such as *Apatosaurus*. Thanks to these advances, the mighty Thunder Lizard may once again inspire wonder and awe.

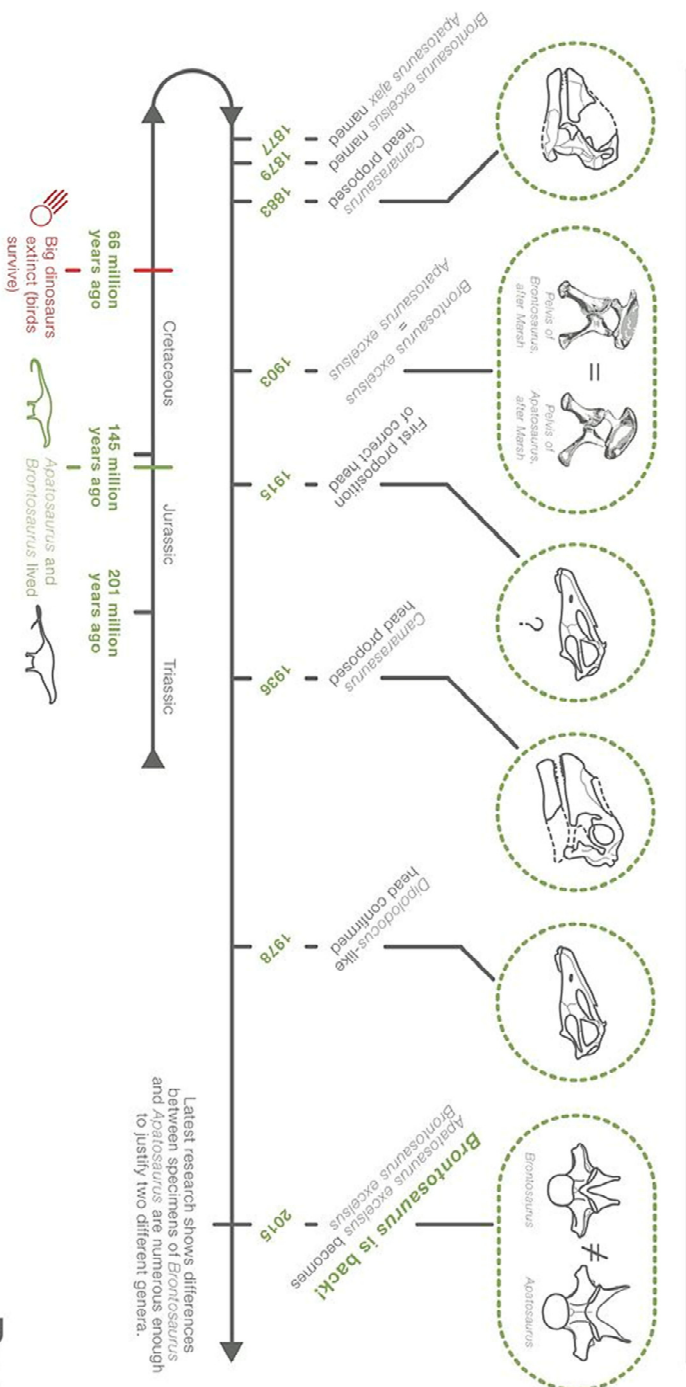
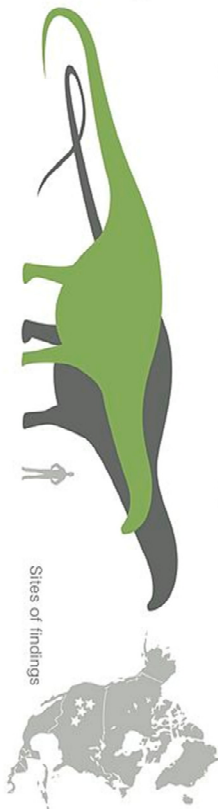
## The history of *Brontosaurus* – one of the greatest stories in paleontology

### *Brontosaurus*

Lived 150 million years ago  
 Western United States  
 Meaning: Thunder lizard  
 Diet: Herbivorous  
 Weight: 30.5 tonnes

### *Apatosaurus*

Lived 150 million years ago  
 Western United States  
 Meaning: Deceptive lizard  
 Diet: Herbivorous  
 Weight: 41.3 tonnes



# Dinosaur Research Project

Name: \_\_\_\_\_

Dinosaur: \_\_\_\_\_

What does your dinosaur's name mean?

Who discovered your dinosaur? Where was it discovered? When did it live?

How big was your dinosaur? How heavy was it?

How did your dinosaur get around?

What did your dinosaur like to eat?

Did your dinosaur live in family groups? Did it take care of its young?

Did your dinosaur have any special adaptations?

What are some fun facts about your dinosaur?

# Fossil Dig- Planning Worksheet

Group Members: \_\_\_\_\_

Extinct Animal Name: \_\_\_\_\_

Draw your Extinct Animal here:



What does your extinct animal eat? How did it obtain its food?

Where does your animal live?

What special adaptations does your animal have?

What was your animal's life like? Did it take care of its young? Did it live in packs?

What fossils are you making? Do these reveal things about your extinct animal?