Educator's Guide

STAGE NINE
EXHIBITIONS

Educator's Guide

Table of Contents

Introduction to the Exhibit

Expedition: Dinosaur brings guests into the world of dinosaurs and introduces the pioneers who pursued their fossils and the scientists who are advancing paleontology today. Learn about a wide variety of dinosaur species and the features that allowed them to survive, discover how early paleontologists unearthed fossils, and see examples of today's cutting-edge technology.

The exhibit features life-size, lifelike animatronic dinosaurs with realistic movements and sound, as well as replicas, artifacts, and interactive displays that take guests through the lives of dinosaurs and the explorers and scientists who study them to the tools and technologies used along the way. The Expedition: Dinosaur exhibit is a place where "Adventure Awaits!"

The *Expedition: Dinosaur* Educator's Guide has been developed as a resource for educators to use before and after their visit, as well as to enhance the visit itself. It provides an introduction to the content of the exhibit and provides information on how to incorporate inquiry-based instruction within and across curricula.

The Guide is divided into several sections, as follows:

- The Exhibition Themes & Orientation section includes a brief overview of each exhibit within *Expedition: Dinosaur*.
- The Curriculum Connections section outlines how the exhibition correlates to the Next Generation Science Standards.
- The remaining sections include activities that can be used to prepare for a visit and/or continue the themes of the exhibition post-visit. These sections also include prompts and activities to engage students at a deeper level during their visit.

What to Expect

During your visit, your students will:

- Discover how paleontologists, geologists and other scientists have reconstructed the world of dinosaurs;
- Learn about early fossil hunting expeditions, including the “Bone Wars” and the “Great Dinosaur Rush”; and
- Explore ideas and concepts through a variety of interactive displays and exhibits.

When you leave the exhibition, your students will understand how:

- The field of paleontology has contributed to our understanding of Earth’s early inhabitants;
- The eggs, jaws, skulls, and tails of dinosaurs contribute to our understanding of their behavior;
- The K-T Extinction Event impacted the animals living on earth; and
- The uses and capabilities of new technologies, such as fossil neutron scanning and 3D modeling, are advancing the study of fossils.

General Safety & Guidelines

- Students should be supervised at all times
- Some areas have higher than normal sound levels
- No food or beverage allowed inside the exhibition
- Cameras are allowed and encouraged as there are several photo opportunities

Exhibition Themes & Orientation

As you move through the exhibition, you will find displays and interactive stations grouped thematically. Exhibit features include:

- Campaign Tent
- Animatronic Dinosaurs
- Gizzard Interactive Display
- Dino-Quizzes
- K-T Extinction Event Video
- Wentzscope Microscope
- Interactive Topographic Sandbox
- 3-Finger Robotic Arm Dinosaur Egg Activity
- Interactive Videos

The exhibit comprises two main areas: the first is the “Bone Wars” era of the late 1800s; the second focuses on the present-day, featuring fossil neutron scanning, 3D modeling and other technologies. The following overview will help you plan your visit.

The “Bone Wars”

Focusing on the “Bone Wars” era of the late 1800’s, guests will learn about early fieldwork and fossil extraction, including a replica of a field tent complete with period tools and furnishings. Brief and informative videos tell the stories of how dinosaur fossil hunters conducted their work, how fossils were transported, and how field work has been modernized.

The Campaign Tent

Guests will learn about early fieldwork and fossil extraction, including a recreation of a field tent complete with period tools and furnishings. Brief and informative videos tell the stories of how dinosaur fossil hunters conducted their work, how fossils were transported (including by helicopter), and which field work tools and methods have changed and which have remained the same.

Explore a stack of crates with field objects that can be touched, including a jerry-can, a wood and screen specimen sieve, and a canvas pack. Open the drawers to find objects and information that help tell the story, including dinosaur egg replicas, bird bones, dynamite and nitroglycerin bottles, and tools.

Animatronic Dinosaurs

This area features animatronic animals representing five species of dinosaurs. Learn about the features of each dinosaur, including size, behavior, diet and when it lived.

- Kentrosaurus: Alive 152 million years ago (late Jurassic), the Kentrosaurus ate a plant-based diet and was both plate- and spike-backed.
- Amargosaurus: Alive in the Early Cretaceous period (130 million years ago); this herbivore was over 30 feet long and had large spines along its neck and backbone. Visitors to the exhibit can control the movement of its head.
- Velociraptor: No bigger than a modern Great Dane, the Velociraptor lived 80 million years ago (Late Cretaceous) and recent evidence indicates it may have been covered in feathers.
- Albertosaurus: Similar in size to the Amargosaurus, this carnivore lived 70 million years ago (Late Cretaceous) and hunted in packs.

- Pachycephalosaurus: Alive in the Late Cretaceous period (68-66 million years ago), the Pachycephalosaurus had a large dome of solid bone on its skull that may have been used for head-butting to prove dominance.

The Bone Wars

Also known as the “Great Dinosaur Rush”, this period of intense fossil speculation in the late 1880’s was led by Edward Cope and Othniel Marsh. Guests will hear about their exploits, see dinosaur skull replicas, and learn about the tools and supplies used in the field.

Dinosaur Anatomy and Eggs

Interactive displays and information highlight the structure of dinosaur eggs, jaws, skulls, and tails and how they played an important role in dinosaur behavior and survival.

Cases display artifacts, such as a T-rex skull replica, and a Triceratops skull model with cutouts for size reference to a Model T car and an elephant. Replicas are also included to demonstrate how early explorers could mistake cow bones from bones of a dinosaur.

Through an interactive display, visitors will also learn about the function of the gizzard, an organ shared by modern chickens and some dinosaurs.

The "Modern Era"

Focusing on present-day paleontology, visitors will learn about current technologies and how they are being deployed to help scientists learn more about dinosaurs.

Animatronic Dinosaurs

This area features animatronic animals representing three species of dinosaurs. Using a push-button panel, visitors can control the movement of each animal.

Learn about the features of each dinosaur, including size, behavior, diet and when it lived.

- Carnotaurus: The only meat-eating dinosaur know to have possessed horns, the Carnotaurus was well adapted for running. It lived during the Late Cretaceous period (72 - 69.9 million years ago)
- Stegosaurus: Plates and spikes are the prominent features of the Stegosaurus, which lived 150 – 155 million years ago (Late Jurassic).
- Triceratops: Preyed upon by the Tyrannosaurus, this herbivore lived 68 – 66 million years ago (Late Cretaceous).

Visitors can take interactive quizzes and play with a Pangea puzzle. Videos in this area focus on the K-T Extinction event and how some creatures survived it; evidence for Pangea; descendants of dinosaurs; and finding fossils.

The Carnotaurus display area features videos highlighting the efforts of a volunteer who has worked for months on a large specimen; how glues and fillers are used to keep specimens from falling apart; and safely jacketing and transporting a specimen to the lab.

The Stegosaurus display area includes videos about some of the scientific fallacies put forward by the movie, “Jurassic Park;” a specimen that offers clues about the colors of dinosaurs; and the newest discovery of a feathered dinosaur. Visitors can also view specimens through a Wentzscope microscope.

The Triceratops display area includes an interactive video station where guests can place discs on a reader to activate video clips. Topics include the use of 3D scanning, computer modeling, and CT scanning to help understand the bones and muscles of dinosaurs.

Interactive Topographic Sandbox

Visitors can create changing landscapes by manipulating the sand to create peaks and valleys and the projector will create geologic features like hills and rivers in real time.

3-Finger Robotic Arm Dinosaur Egg Challenge and Interactive Videos

Visitors can attempt to turn dinosaur eggs with a robotic arm. The display also features “eggs” that can be used to activate videos about the clues paleontologists look for on dinosaur eggs and the natural objects that get mistaken for fossilized eggs.

Curriculum Connections

The content developed for *Expedition: Dinosaur* supports student understanding of key ideas developed within the Next Generation Science Standards. The goals of these activities include students: 1) recognizing themselves as researchers and innovators; 2) developing critical thinking and problem-solving skills; and 3) exploring new concepts through discovery.

Next Generation Science Standards

Dimension 1: Practices

- Asking questions (for science) and defining problems (for engineering)
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations (for science) and designing solutions (for engineering)
- Engaging in argument from evidence
- Obtaining, evaluating and communicating information

On-Line Resource

Next Generation Science Standards
http://www.nextgenscience.org

Dimension 2: Crosscutting Concepts

- Patterns
- Cause and Effect: Mechanism and Explanation
- Scale, Proportion, and Quantity
- Systems and System Models
- Energy and Matter: Flows, Cycles and Conservation
- Structure and Function
- Stability and Change

Dimension 3: Disciplinary Core Ideas

- Domain 1: Physical Sciences
    - Structure and Properties of Matter
    - Forces and Interactions
    - Information Technologies and Instrumentation
- Domain 2: Life Sciences
    - Structure and Function
    - Growth and Development of Organisms
    - Interdependent Relationships in Ecosystems
    - Social Interactions and Group Behavior
    - Inheritance and Variation of Traits
    - Evidence of Common Ancestry and Diversity
    - Natural Selection
    - Adaptation
- Domain 3: Earth and Space Sciences
    - This History of Planet Earth
    - Earth Materials and Systems
- Domain 4: Engineering, Technology and Applications of Science
    - Engineering Design
    - Links Among Engineering, Technology, Science, and Society

International Standards for Technology in Education (ISTE) Standards for Students

1. Empowered Learner: Students leverage technology to take an active role in choosing, achieving, and demonstrating competency in their learning goals, informed by the learning sciences.
    a. Set personal learning goals, leverage technology to achieve them, and reflect on the learning process

On-Line Resource

International Standards for Technology in Education (ISTE)
http://www.iste.org/standards/ISTE-standards/standards-for-students

3. Knowledge Constructor: Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences.
    a. Plan and employ effective research strategies to locate information and other resources
    b. Evaluate the accuracy, perspective, credibility, and relevance of information.
    c. Curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions.
    d. Build knowledge by actively exploring real-world issues and problems, developing ideas and theories, and pursuing answers and solutions.

4. Innovative Designer: Students use a variety of technologies within a design process to identify and solve problems by creating new, useful, or imaginative solutions.
    a. Use a deliberate design process for generating ideas, testing theories, creating innovative artifacts, or solving authentic problems.

5. Computational Thinker: Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.
    a. Formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models, and algorithmic thinking in exploring and finding solutions.
    b. Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitation problem-solving and decision-making.
    c. Students break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitation problem-solving.

6. Creative Communicator: Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats, and digital media appropriate to their goals.

7. Global Collaborator: Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally.

Preparing for the Exhibition

Prior to your visit, review this guide and the Bishop Museum's online information about the exhibition at https://www.bishopmuseum.org/

Classroom Activities and Resources

Dinosaurs

Modify as appropriate to age group and course.

1. Have students discuss the dinosaurs they are familiar with and generate a list of traits. (Can be enhanced using a mind-mapping tool.)

2. Ask students to create/draw a fictional dinosaur. What features would it have? What kind of climate and geography would it live in? How would it defend itself? What would it eat and how would it find food?

Activity Resource

How Dinosaurs Moved

This resource page from the American Museum of Natural History includes questions and activities for students to learn about how dinosaurs moved in comparison to animals like crocodiles and birds.

Dinosaur | dī-nə- sor

1. : any of a group of extinct often very large chiefly terrestrial carnivorous or herbivorous reptiles of the Mesozoic era
2. : any of various large extinct reptiles other than the true dinosaurs.

Extinct | ek- stiŋ(k)t

1. : no longer existing

Fossil | fä- sə-l

1. : preserved from a past geologic age

Paleontologist | pā-lē- än- tä-lə-jist

1. : a scientist dealing with the life of past geological periods as known from fossil remains

Specimen | spe-sə-mən

1. : an individual, item, or part considered typical of a group, class, or whole
2. : a portion or quantity of material for use in testing, examination, or study

Paleontology

Modify as appropriate to age group and course.

1. Have students define paleontology and identify the types of skills and traits a successful paleontologist needs. What kinds of topics do they need to study? What kind of skills do they need to find and extract fossils?

2. Have students generate a list of supplies, tools, and provisions they would need to bring on a fossil hunting expedition. How would they transport the materials to the site? How would they transport fossils back to a lab?

Video Resources

Paleontology 101: The Utah 2014 Expedition

Follow a paleontologist crew as they excavate dinosaur fossils in the deserts of Utah.

Digging for Dinosaur Fossils

Visit the Children's Museum of Indianapolis's dinosaur dig site in the Black Hills of South Dakota.

Paleontology 101 – Untamed Science

This short video walks through the details of what it takes to get a dinosaur from the field into a display.

Activity Resources

Fieldwork Activities

This resource page from the Royal Geographic Society includes tips for conducting quick and easy fieldwork activities on school grounds.

Keeping a Field Journal

This resource from the American Museum of Natural History provides tips and activities for keeping a field journal.

Opening the World Through Nature Journaling

This booklet, from the California Native Plant Society, offers tips and activities for discovering the natural world through art, writing, and science.

Nature Walk Observation Notebook

This resource includes a set of nature walk observation sheets that include places for students to record the date, time, place, and weather, as well has prompts for recording what they see.

Creating a Field Journal

This lesson plan includes instructions for creating a field journal out of a manila envelope and prompts for completing the journal with descriptions, sketches, and specimens.

Observation Activity

Have students find a spot outdoors to observe, including taking notes and drawing pictures in a nature journal (or other medium), to record the following:

- What did you see in the first 3-5 minutes?
- What did you see in the second 3-5 minutes?
- What did you see in the third 3-5 minutes?
- How did your focus change? What did you see during the last observation that you weren't aware of during the first observation?

Technology
Modify as appropriate to age group and course.

1. Remind students that technologies are anything human-made that is used to solve a problem or fulfill a need.
    a. Have students create a list of equipment and technology that would be useful in finding, extracting, and studying fossils? What kinds of older equipment and technology might still be useful in this field? What kinds of new and emerging technologies might paleontologist be able to use to enhance their work?

2. Ask students to design an invention (draw or construct) that would be useful in the study of dinosaur fossils. What kinds of features would it need to be able to be used in the field? What kinds of information would it gather and/or provide?
    a. Have students seek advice (as an engineer would) from a peer and an adult to help them uncover any issues or adjustments they may need to consider making.
    b. Have them share with the class their invention and the purpose it serves.

Influential Paleontologists

Look up one or more of the paleontologists listed below. How has their work impacted the study of dinosaurs? What important contributions did they make? What interests you about their work?

Luis Alvarez

(1911 – 1988)

- Proposed the hypothesis that an asteroid caused dinosaurs to become extinct

Mary Anning

(1799 – 1847)

- Discovered the Jurassic fossils beds in Dorset, England.
- Received a lifetime annuity from the British Association for the Advancement of Science
- Was the inspiration for the children's rhyme "she sells seashells by the sea shore."

William Buckland

(1784 – 1856)

- Wrote the first complete account of a dinosaur fossil
- Pioneered the use of fossilized fecal matter to learn about primitive ecosystems

Edwin Colbert

(1905 – 2001)

- Led many expeditions that excavated important dinosaur fossils

Edward Drinker Cope

(1840 – 1897)

- Wrote over 600 papers and named nearly 1,000 fossil vertebrates
- His fossil hunting feud with Othniel Marsh became known as the Bone Wars

Stephen Jay Gould

(1941 – 2002)

- Lead promoter of evolutionary change theory, better known as punctuated equilibrium

John "Jack" Horner

(1946 -)

- Discovered that dinosaurs nurtured their young and that they were social animals
- Inspiration for Sam Neill's character in the first Jurassic Park movie

Gideon Mantell

(1790 – 1852)

- An obstetrician, he was inspired by Mary Anning to begin hunting for fossils.
- Named the Iguanodon, the giant teeth of which were the first example in history of a dinosaur fossil being discovered, analyzed, and assigned a specific genus

Othniel C. Marsh

(1831 – 1899)

- Named more popular dinosaurs, including Allosaurus, Stegosaurus, and Triceratops, then any other paleontologist.
- His fossil hunting feud with Edward Drinker Cope became known as the Bone Wars

Benjamin Franklin Mudge

(1817 – 1879)

- Discovered the Ichthyomis, the "bird with teeth."

Henry Fairfield Osborn

(1857 – 1935)

- Described and named several dinosaur species, including Tyrannosaurus rex and Velociraptor

John Ostrom

(1928 – 2005)

- In 1969, he discovered a hundred and ten million year old dinosaur
- Proposed an evolutionary link between dinosaurs and birds

Richard Owen

(1804 – 1892)

- Coined the word “dinosaur”
- One of the first scholars to study Archaeopteryx and therapsids (mammal-like reptiles)

Paul Sereno

(1957 -)

- The face of fossil hunting for a generation of school children, he has led expeditions to fossil sites all around the world
- Discovered and named the South American Eorapter, the giant sauropod Jobaria and the “great white shark lizard” Carcharodontosaurus

Patricia Vickers-Rich

(1944 -)

- Her discoveries in Australia demonstrated that some dinosaurs thrived in near-arctic conditions.

Thomas Williamson

- Researches the taxonomy, anatomy, and genealogy of groups of animals including tyrannosaurian and pachycephalosaurian dinosaurs

Dong Zhiming

(1937 -)

- Spearheaded expeditions to China's Dashanpu Formation where he unearthed the remains of a variety of hadrosaurs, pachycephalosaurs, and sauropods

Video Resources

Building a Dinosaur from a Chicken

In this TED Talk, renowned paleontologist Jack Horner discusses his goal of genetically engineering the living descendants of the dinosaur to reactive ancestral traits.

Day the Dinosaurs Died

This documentary investigates the sudden disappearance of the dinosaurs 66 million years ago.

During Your Visit

Observation Worksheet

1. What is the name of this exhibition and what does that name tell you about the displays and activities here?

2. Who is one of the paleontologists you learned about and what did they discover that you found interesting? (To extend your learning, research this person to find out more about their work.)

3. Name three of the tools paleontologists use to conduct their work.

4. Think about the work of a paleontologist. What knowledge and skills are required to become successful in this field?

5. Pick a display in the exhibition.
    a. What did you learn by looking at/interacting with the display?

6. Choose a display in the exhibition that you found particularly interesting.
    a. How would you describe this display and what you learned from it to a friend?
    b. Draw a picture/diagram that illustrates the information highlighted in the display.

7. Describe a technology that you learned about today and how it is impacted the field of paleontology.

8. Choose a technology you saw in the exhibition and draw it. Describe how it has influenced the way paleontologists conduct their work.

Activities Reflection

1. Pick an exhibition activity that you participated in.
    c. What was the task you were trying to complete?
    d. What about it was easier than you thought it would be? What was more difficult?

2. Choose another activity that you participated in.
    e. How would you describe the activity to a friend?
    f. What skills and/or information did you use to complete the activity?

3. Choose another activity in the exhibition that you found particularly interesting.
    g. What did you learn by participating in the activity?